



Connecticut Sea Grant 2005-2006 Annual Report

For the time period from March 1, 2005 – March 31, 2006

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INTRODUCTION

This annual report summarizes the activities and accomplishments of the Connecticut Sea Grant College Program from March 1, 2005 to March 31, 2006. The University of Connecticut (UConn) is the formally designated Sea Grant College for the State of Connecticut, serving as the “flagship” university for the Connecticut Sea Grant College Program (CTSG). While a small marine extension program began in 1974 in conjunction with the Cooperative Extension System, the program did not receive formal designation as a Sea Grant College until 1988, marking its maturation as a full-fledged, comprehensive Sea Grant program. The program is located within the new, state-of-the-art marine sciences center on the UConn Avery Point campus, in the southeastern coastal town of Groton. A detailed history of CTSG is summarized in Appendix B of *Blueprint for a Coastal Legacy: Connecticut Sea Grant Strategic Plan 2007-2011*.

In comparison to older Sea Grant programs established in the 1960s and 1970s, CTSG is generally characterized as a small program, with an annual base budget of just under \$1M, a current staff of 10 people and a total of 6.95 FTE. Located in a state bordering Long Island Sound, “the Urban Sea”, along the highly populated Northeast corridor between New York City and Boston, the number of relevant opportunities for Sea Grant involvement are far greater than the staff and resources available to address them (see Appendix A of *Blueprint for a Coastal Legacy: Connecticut Sea Grant Strategic Plan 2007-2011*, for a description of these opportunities and challenges). As such, CTSG clearly recognizes that both its long-term impact and legacy depend critically on the program’s ability to develop and foster long-term partnerships and leverage funds and resources to achieve its planned outcomes.

In addition to the traditional research, extension, education and communication activities of CTSG, three major events demanded primary attention among the program during 2005-2006. The first major event was the preparation for submission of our 2006-2008 Omnibus proposal, including the solicitation and review of both preliminary and full research proposals, the development and review of core program elements, and development of our 2006-2008 Implementation Plan. The preparation of our Implementation Plan and 2006-2008 Omnibus submission documents is detailed in the *Connecticut Sea Grant 2006-2008 Biennial Implementation Plan*. The second major event was the preparation of the draft *Blueprint for a Coastal Legacy: Connecticut Sea Grant Strategic Plan 2007-2011*. The draft strategic plan includes a detailed summary of the strategic planning process, including activities during the time period covered by this annual report. The third major event was the (still ongoing) preparation for our second Program Assessment Team (PAT) visit, which will occur during the week of October 15, 2006. Each of these activities required significant and coordinated efforts of the CTSG staff, as overseen by the CTSG management team. In addition to these activities, CTSG also prepared for the search that will result in the hiring of a permanent director for the program. A final job announcement was disseminated during early spring 2006, with interviews scheduled for late summer.

SECTION I AWARD REPORTING

The following award reporting section reports on progress for the following individual CTSG Awards that were active between March 1, 2005 and March 31, 2006. Project titles and numbers are taken directly from NOAA Grants Online.

Award Number: NA16RG2253

Project Title: CONNECTICUT SEA GRANT COLLEGE PROGRAM: PROGRAM PLAN FOR CONTINUING SUPPORT FOR MARCH 2002 THROUGH FEBRUARY 2003 (This is the CTSG Omnibus award for 2004-2006, currently extended through 5/31/2007.)

Award Number: NA16RG1364

Project Title: CONNECTICUT SEA GRANT LONG ISLAND SOUND LOBSTER RESEARCH INITIATIVES

Award Number: NA05OAR4171025

Project Title: John A. Knauss Marine Policy Fellowship - Connecticut – BOZZI

Award Number: NA05OAR4171043

Project Title: Knauss Marine Fellowship - Connecticut – OWEN

Award Number: NA06OAR4170072

Project Title: Connecticut Sea Grant College Program Omnibus 2006-2008: Continuing Sea Grant College Support for March 2006 Through February 2008

Award Number: NA16RG1635

Project Title: DEVELOPMENT OF AN INTEGRATED RECIRCULATING AQUACULTURE SYSTEM FOR NUTRIENT BIOREMEDIATION IN URBAN AQUACULTURE

SECTION I-A

AWARD REPORTING: CONNECTICUT SEA GRANT COLLEGE PROGRAM OMNIBUS, 2002-2006

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA16RG2253

Project Title: CONNECTICUT SEA GRANT COLLEGE PROGRAM: PROGRAM PLAN FOR CONTINUING SUPPORT FOR MARCH 2002 THROUGH FEBRUARY 2003 (This is the CTSG Omnibus award for 2002-2006, currently extended through 5/31/2007.)

Time Period: March 1, 2002 – May 31, 2007 (This report for period March 1, 2005 – March 31, 2006)

Accomplishments and Outcomes: See Below

The Connecticut Sea Grant Omnibus comprises multiple projects, including those funded through our core federal funding and national strategic investment projects (NSIs). Hence, accomplishments and impacts for NA16RG2253 are presented by individual project and (internal CTSG) project number. Projects for which information is provided are as follows:

- M/PA-1:** Program Management: Administration and Planning
- M/PD-1:** Program Development
- M/PD-4:** Multi-Program and Regional Development
- A/E-1:** Sea Grant Extension Program
- A/FE-1:** Fisheries Extension Program
- E/T-11:** Sea Grant Educator Program
- M/CP-1:** Core Communications Program
- A/E-18:** Coastal Community Development Program
- R/ER-22:** The Connecticut 'Hatting' Industry as a Mercury Source for Long Island Sound
- R/ER-21:** A Ferry-Based Observing System for Long Island Sound: Application to Physical Influences of Hypoxia
- R/BT-01:** Lobster Defenses to Shell Disease: Endocrine Control of Molting and Wound Healing
- R/ER-24:** Determining the Causes of Area-Sensitivity: A Prerequisite for Saltmarsh Bird Conservation and Restoration
- R/A-36:** Development of an oligotrich ciliate as a food organism for marine aquaculture
- A/E-3:** Yale/Sea Grant Coastal Internship Program
- T-11-02:** Continued Development of an In-Situ Heat Flux Measurement Instrument and Measurement Program in Long Island Sound (NSI)
- R/ES-19:** Evaluation of the importance of ship hull fouling by privately-owned vessels as a vector for the transport of invasive species along the Eastern Seaboard (NSI)
- R/ES-20:** The control and economics of aquatic invasive species in marine aquaculture (NSI)
- N/A:** Earth Grant Geospatial Technology Extension Program
- N/A:** Nab the Aquatic Invader! A Nationwide Online Educational Program to Direct Attention to AIS Issues and Inspire Action (NSI)

N/A: Interrupting the Flow: A Northeast Regional Sea Grant Education and Outreach Collaborative Addressing Vectors of Marine Invasive Species Introductions in the Northeast Region (NSI)

Progress Report for CTSG Core Programs 2002-2006 Omnibus, NA16RG2253

M/PA-1 Program Management: Administration and Planning

Program management and administration is led by the Sea Grant Interim Director, Dr. Sylvain De Guise, in collaboration with the Associate Director, Dr. Robert J. Johnston. The management team is comprised of De Guise and Johnston, together with Extension Program Leader Nancy Balcom and Communications Coordinator Peg Van Patten. Advisory boards providing input into program direction, planning, and management are detailed in the CTSG Implementation Plans, which are duly filed each biennium with the National Sea Grant Office.

CTSG is located in the \$28M Marine Sciences Center (MSC) at the Avery Point Campus of the University of Connecticut. The campus provides infrastructure, office space and administrative services, while the MSC provides state-of-the-art infrastructure to support the continued growth of the marine science community. CTSG capitalizes on these facilities and location to expand its education and outreach programs, access the research capabilities of PIs at the facility, coordinate with other programs, and interact with coastal stakeholders. The University of Connecticut is the designated Sea Grant College for the State of Connecticut and serves as the flagship university for CTSG. A memorandum of understanding signed on December 17, 1999 defines the role of CTSG within the University. Under this agreement, CTSG, through its director, reports directly to the Vice Provost for Research and Graduate Education, who also chairs the SAB.

In comparison to older Sea Grant programs established in the 1960s and 1970s, CTSG is generally characterized as a small program, with an annual base budget of just under \$1M, a current staff of 10 people and a total of 6.95 FTE. Located in a state bordering Long Island Sound, “the Urban Sea”, along the highly populated Northeast corridor between New York City and Boston, the number of relevant opportunities for Sea Grant involvement are far greater than the staff and resources available to address them. As such, CTSG program management clearly recognizes that both the long-term impact and legacy of the program depend on the program’s ability to develop and foster long-term partnerships and leverage funds and resources to achieve its planned outcomes.

In addition to the day-to-day management and planning activities of CTSG program management, three activities demanded primary attention among CTSG management. The first major management activity was the preparation for submission of our 2006-2008 Omnibus proposal, including the solicitation and review of both preliminary and full research proposals, the development and review of core program elements, and development of our 2006-2008 Implementation Plan. The preparation of our Implementation Plan and 2006-2008 Omnibus submission documents is detailed in the *Connecticut Sea Grant 2006-2008 Biennial Implementation Plan*. The second major management activity was the preparation of the draft *Blueprint for a Coastal Legacy: Connecticut Sea Grant Strategic Plan 2007-2011*. The draft strategic plan includes a detailed summary of the strategic planning process, including activities during the time period covered by this annual report. The third major management activity was the (still ongoing) preparation for our second Program Assessment Team (PAT) visit, which will occur during the week of October 15, 2006. Each of these activities required significant and coordinated efforts of the CTSG staff, as overseen by the CTSG management team. In addition

to these activities, CTSG also prepared for the search that will result in the hiring of a permanent director for the program. A final job announcement was disseminated during early spring 2006, with interviews scheduled for late summer.

As part of these interrelated activities, CTSG during 2005-2006 engaged in the most comprehensive self- and external-evaluation that CTSG has conducted to date. In preparation for both the PAT visit and strategic planning process, CTSG management solicited and received advice and information from a diverse and extensive group of government agencies, university officials, researchers, educators, non-governmental organizations, constituents and stakeholders. This assessment was designed to ensure maximum and effective allocation and use of the resources available to the program, and the greatest possible impact on Connecticut's marine, coastal, and human ecosystems.

With regard to the research program managed by CTSG, the 2003-2008 NOAA Sea Grant Strategic Plan identifies eleven thematic areas representing critical areas of focus for sustainable resource management. These include: (1) Aquaculture; (2) Biotechnology; (3) Coastal Communities and Economies; (4) Coastal Natural Hazards; (5) Digital Ocean; (6) Ecosystems and Habitats; (7) Fisheries; (8) Marine and Aquatic Science Literacy; (9) Seafood Science and Technology; (10) Urban Coasts; and (11) Invasive Species. In fulfilling the program's Strategic Plan requirements during the period from March 1, 2005 to March 31, 2006, CTSG sought to foster coastal/marine research, extension/outreach, and education of the highest quality and relevance within these eleven thematic areas. Based on these theme areas, additional strategic guidelines and priorities of NOAA and the National Sea Grant College Program, and external advisory committees, the request for proposals (RFP) for the 2006-2008 Omnibus (developed during 2005) targeted research, education, and extension in the following topic areas:

1. Sustainable Seafood Culture, Safety, Production and Harvest;
2. Marine Biotechnology;
3. Sea Level Rise and Global Climate Change;
4. Long Island Sound Environmental and Natural Resource Issues;
5. Conservation, Management, and Restoration of Connecticut's Coastal Ecosystems.
6. Connecticut's Urban Coasts and Coastal Communities

Implementation Plan goals are based on a consideration of four complementary and interrelated elements: (1) the eleven thematic areas identified by the 2003-2008 NOAA Sea Grant Strategic Plan; (2) the five general programmatic areas identified by the 2002-2006 CTSG Strategic Plan; (3) the six specific CTSG focus areas for research, education, and outreach-extension set forth in this and prior Implementation Plans, and; (4) the three thematic focus areas of our newly developed draft 2007-2011 Strategic Plan. These thematic focus areas are:

1. Marine aquaculture and biotechnology
2. Use and conservation of marine resources, ecosystems and habitats
3. Marine and aquatic science literacy

Specific outcomes of CTSG core program elements and sponsored research are detailed in later sections of this annual progress report.

M/PD-1 Program Development

Development funds are provided to provide support to either new initiate projects and develop new ideas, or extend the scope of existing projects to useful products. To this effect, 65% of the individual project development funds were provided to initiate new projects, most of which are in progress and have yet to provide quantifiable outcomes and impacts. Funds were also provided to organize workshops and conferences, or to allow participation to conferences, supporting the presentation of research results and the sharing of ideas between colleagues. This accounted for 14% of the funds expended. Similarly, 2% of the funds were expended to fund the purchase of reprints of articles funded, in full or in part, by CTSG. This represents an important opportunity for sharing of research results. Also, 10% of the funds were expended towards the creation of educational tools that will be used to share expertise with either the general public or targeted stakeholders. Finally, CTSG has teamed with the Department of Marine Science, the National Undersea Research Center and the Avery Point regional campus of the University of Connecticut to gain full membership in the Consortium for Oceanographic Research & Education (CORE) and National Association of Marine Laboratories (NAML) to be better informed and gain recognition at the national level (9% of funds). Additional details of funded development projects are provided in the Appendix to this progress report.

M/PD-4 Multi-Program and Regional Development

Multi-program development funds are available to promote initiatives that are often regional in scope and involve more than one Sea Grant programs. Funds were expended to support a portion of a research project, in collaboration with the Long Island Sound Study program (32% of the funds). Funds were also provided to organize conferences, or to allow participation to conferences, supporting the presentation of research results and the sharing of ideas between colleagues (12% of the funds). Funds were also used to allow North American participants to travel to a workshop of the Ir-Am-Aqua, an initiative to support aquaculture as part of a collaborative the US and Ireland (55% of the funds). Additional details of funded development projects are provided in the Appendix to this progress report.

A/E-1 Sea Grant Extension Program

Accomplishments and outcomes for the CTSG Extension Program for the time period of March 1, 2005 – March 31, 2006 include the following

I. Economic Leadership

A2. Sustainable US Aquaculture

Connecticut Aquaculture Permitting Workgroup

1. CTSG extension educator Tessa Getchis convened two workshops to familiarize municipal commissions and aquaculture industry members with the permitting process.
2. Getchis convened four workshops for state and federal agencies involved in aquaculture permitting decisions to review the current policies and application process, and develop a more streamlined, straightforward permit application process.
3. Two documents, *A Guide to Marine Aquaculture Permitting in CT*, and *A Comprehensive Guide to Aquaculture in CT* were drafted by Getchis in collaboration with the regulatory agencies, which will be published in 2006 and 2007 respectively.

Business feasibility study related to the culture of shellfish products in the Northeast United States:

1. Getchis and outreach colleagues produced a technical report submitted to the USDA CSREES Northeastern Regional Aquaculture Center entitled, *Expanding shellfish culture in the NRAC region - constraints to existing industry expansion and an analysis of the economic feasibility of new, small-scale oyster culture businesses*.
2. Getchis and colleagues published a peer-reviewed abstract of their work in the *Journal of Shellfish Research*.

Environmental and Technical Assessment of Alternative Shellfish Production Methods:

1. Getchis and University of Connecticut PhD candidate Jamie Vaudrey completed one year of field work (2005) and have complete a portion of this season's study to investigate the impacts of oyster depuration gear on eelgrass.
2. Getchis and Vaudrey convened a workshop with representatives from the State Departments of Agriculture and Environmental protection to review the results of the first year of field work.
3. Getchis, Vaudrey and colleagues published a peer-reviewed abstract of their work in the *Journal of Shellfish Research*.
4. Getchis and colleagues presented their research results at three scientific conferences including the *Annual meeting of the World Aquaculture Society*, the *Annual meeting of the National Shellfisheries Association*, and at the *Milford Aquaculture Seminar*.

Cooperative Research Program:

1. CTSG extension is continuing a successful cooperative research program with aquaculture producers for the development of new species and practices/applications to diversify the products cultivated in Connecticut. CTSG extension involvement provides resources and expertise in (1) business planning and decision-making, (2) field research coordination, (3) commercial implementation, and (4) technology transfer.
2. Getchis is working with an industry member to develop a recirculating system for coral propagation. If successful, the system would reduce producer costs, environmental impacts due to effluent inputs, and stress on coral reefs from coral collection for hobbyists. Getchis assisted the grower with his 501c3 application and other business start-up forms necessary for him to apply for federal grants.
3. Getchis co-authored a proposal with the industry member to the National Sea Grant office and State Sea Grant office.
4. The industry member and Getchis have organizing a series of presentations and a hands-on workshop on coral propagation for the Northeast Aquaculture Conference and Exposition.
5. CTSG Extension Program is assisting the grower with the coordination of a regional coral bank, and attempting to enter coral propagation into the curriculum of Vo-Ag and aquaculture-themed magnet schools in the region.

Northeast Aquaculture Conference & Exposition:

1. Tessa Getchis has played a major role in developing the Northeast Aquaculture Conference & Exposition (NACE™) into a non-profit corporation since 2002, and in organizing biennial meetings held throughout the Northeast U.S., working with aquaculture extension colleagues throughout the Northeast. She is serving as the chair of the 2006 meeting, to be held in Mystic CT in December. Approximately 225 industry members, business interests, and extension specialists convene biennially to participate in informational sessions, technology transfer demos, and a trade show featuring equipment vendors and suppliers from throughout the U.S. Meeting content addresses relevant and diverse interests and informational needs of the Northeast aquaculture industry, and strengthens collaborative partnerships between regional Sea Grant/Cooperative Extension aquaculture extension personnel.
2. Connecticut Sea Grant assisted in the development of NACE as a 501c3 institution through the Maine Aquaculture Innovation Center.
3. Getchis developed an Access Records Database and Business Management System for NACE which will be used for all future conferences.
4. Getchis solicited over \$15,000 in external sponsorships for the 2006 NACE conference.

A3. Seafood Production/Technology

Connecticut Seafood Council (CSC):

1. A brochure, *Seasonal Buying Guide to Connecticut Grown/Harvested Fish and Shellfish*,

was produced by CTSG extension educator Nancy Balcom on behalf of the Council. Copies were sent to 20 Connecticut seafood retail markets for point-of-sale distribution.

2. CTSG extension educators Balcom and Tessa Getchis participated in several CSC events to raise awareness of the Connecticut seafood industry, including two legislative receptions and the Eastern States Exposition.
3. CTSG extension educator Balcom brought together the head chef of the Norwich Inn and Spa (Norwich, CT) and members of the seafood industry via the Connecticut Seafood Council to promote Connecticut seafood products during a special dinner event. Several seafood industry members have acquired this restaurant as a new customer.
4. Balcom and Getchis were interviewed for a piece on the Connecticut seafood industry in September 2005. The article, "Our own seafood", was published in *The Hartford Courant*, Flavor section, in November 2005.

Seafood HACCP Training:

1. In partnership with RI Sea Grant, CTSG extension educator Balcom offered 3 basic Seafood HACCP Alliance training courses, and 2 one-day practical courses (follow-up to the NY Sea Grant/Cornell University internet-based HACCP course), training members of the seafood industry. In addition, the ISSC Shellfish HACCP course was offered once in Connecticut.
 - a. 100 seafood processors, dealers, shellfishermen, and importers from southern New England and elsewhere (NH, NY, NJ, PA, MD, IL, and TX) met the FDA-required training requirements, enabling them to remain in business. Employees from 13 Connecticut seafood businesses were trained.
 - b. Availability of local training courses and modest registration fees reduce costs associated with meeting training requirement. Reduced costs allow southern New England businesses to train 2-3 employees and often more, easing HACCP program implementation, improving company efficiency and profitability, and ensuring greater safety for seafood consumers.
 - c. FDA inspection data comparing results of all domestic HACCP inspections versus New England-based inspections indicate percent compliance in key areas by New England firms is equal to or better than the national percent compliance. The percent of New England-based seafood processors complying with key sanitation areas is significantly higher.
 - d. Two issues of *Seafood Safety Savvy: A HACCP Update* were mailed to approximately 650 individuals and businesses in 2005-2006. Ongoing Sea Grant communication enables HACCP-trained individuals to keep their training current, and provides a means for alerting them to changes in regulations, etc.
5. CTSG extension also provided the basic Seafood HACCP Alliance training to 39 senior high school students attending vocational technical and vocational-aquaculture schools, as a "School to Career" training opportunity to enhance employability.

- a. Currently, four of 61 HACCP-trained students trained since 2002 are known to be employed by CT seafood wholesalers and shellfishermen, reducing significantly the time employers must spend on in-house training.

Seafood Education for Consumers:

1. Extension educators Balcom and Getchis shared information on seafood safety with participants attending the Sea Grant seafood display and activity at the UConn College of Agriculture and Natural Resources annual Cornucopia festival in September 2005.
2. Balcom presented an invited program, Safe Seafood, Healthy Seafood, to 47 members of the Storrs Women's Club, Storrs CT in November 2005.
3. Balcom gave a radio interview in June 2005 on red tide during the "Simply Food with Prudence Sloane" WDRC-AM 1360, WMMW-AM 1470, WWCO-AM 1240, WSNG-AM 610

II. Coastal Ecosystem Health and Public Safety

B1. Coastal Ecosystems /Coastal Habitats

NEMO's Focus on the Coast program:

1. The *Focus on the Coast* web site receives about 100 hits per month. A *Coastal Resource Inventory Tutorial* allows non-technical users to understand importance of various data layers to their town's efforts to protect coastal resources. The *Mapping Station* contains ways for users to view and analyze GIS data, tailored to differing degrees of sophistication (e.g., internet browser; "map packages" for each of the state's 36 coastal towns; resource data from the web connected to local GIS data layers).
2. 90+ municipal commissioners have participated in *Focus on the Coast* workshops.
3. *Focus on the Coast* offered as coastal NEMO module suitable for other Sea Grant-led NEMO programs to adapt and use through the National NEMO Network.

B. Nab the Aquatic Invader: A Nationwide Online Educational Program (Balcom, Payne)

Extension educator Balcom and education coordinator Payne are working with colleagues from four Sea Grant programs nationwide (IL-IN, LA, OR and NY) as well as local formal and informal educators to add new material and activities to the "Nab the Aquatic Invader" web site to make it nationally-relevant, and to coordinate community-based service projects focused on aquatic nuisance species.

1. During reporting period, 4 "Nab" workshops were held (Marine Science Day, May 2005 in Groton; Workshop at Long Island Sound Educators Conference, March 2006, Norwalk) for teachers and middle school students; Total number of participants: 72
2. After surveying East Coast colleagues, 10 aquatic nuisance species were identified which became the focus of CTSG's efforts to develop new material for the web site. Development of "rap sheets" for each of the species is on-going, and Payne is recruiting teachers to work on the project. Work is on-going.

3. Additional details on this project are found in the project report found later in this document.

C. Interrupting the Flow: A Northeast Regional Sea Grant Education and Outreach Project Addressing Vectors of Marine Invasive Species in the Northeast Region (Balcom)

1. Balcom has established two steering committees, one for addressing live marine bait and the other for hull fouling. Research of existing information and resources related to these vectors is completed, and a survey of East Coast “Clena Marina” programs is on-going to gather state-specific regulations/policies regarding hull cleaning and allowable coatings. Publication and web site development is on-going.
2. Balcom wrote an article for CTSG’s *Wrack Lines* on on-going Sea Grant –sponsored research on hull fouling as a vector of marine invasive species. “Hull fouling’s a drag on boats and local ecosystems”. *Wrack Lines* 5(1):14-17.
3. Additional details on this project are found in the project report found later in this document.

D. Assessing the Status of Marine and Freshwater ANS in CT: Laying the Groundwork for Coordinated and Comprehensive Management and Outreach (Balcom)

1. Primary output is a statewide comprehensive management plan for aquatic nuisance species, complete with priority objectives, strategies, and tasks for a five-year period. Format for plan development, review, and adoption included multi-agency steering committee, broad-based working group, public meetings, workshops, and briefings.
2. Draft plan was written by Steering Committee members in conjunction with CT Institute of Water Resources and with substantive input and review from broad-based working group. Plan was issued for public review in June/July 2005, and submitted for preliminary review to federal ANS Task Force in July 2005. Revisions were completed in November 2005.
3. A written evaluation of the plan development process was conducted in fall 2005.
4. Draft plan was submitted to leadership of Connecticut Department of Environmental Protection for in-house review in December 2005. Review is nearly complete, and it is expected to be sent to Governor’s office for signature by fall 2006.
5. Balcom gave a radio interview on the CT ANS Management Plan for WNPR-FM Public Radio in July 2005.
6. A formal update on the plan’s status was presented to the federal ANS Task Force in May 2006 during their semi-annual meeting.
7. A new grant, awarded to Balcom by the US EPA Long Island Sound Study, will support the development of a bi-state (CT and NY) ANS plan for Long Island Sound during 2007.

A/FE-1 Fisheries Extension Program

Accomplishments and outcomes of the CTSG fisheries extension program during 2005-2006 include the following:

1. A series of fact sheets on alternative fisheries management approaches was prepared including Rights-based Fisheries Management, Fisheries Co-management, Ecosystem Management, and Harvesting Agreements and Harvesting Cooperatives. These fact sheets are available in hard copy and are downloadable from the CT Sea Grant website. The fact sheets have been distributed at a number of state and regional meetings including New England Fisheries Management Council and Rhode Island Sea Grant.
2. Dr. Robert Pomeroy co-authored a book, "Fishery Co-management: A Practical Handbook" published in 2006 by CABI Publishing and International Development Research Centre. This book describes a process of community-based co-management. The book has already been translated into six languages.
3. A series of meetings have been held with representatives of the New England Fisheries Management Council and the Southern New England Fishermen and Lobstermen Association in Stonington CT to discuss the establishment of a harvesting cooperative. Assistance was also provided to the Southern New England Fishermen and Lobstermen Association on obtaining funding for extension of the town dock.
4. On 27 March 2006, Dr. Robert Pomeroy made a presentation on Alternative Fisheries Management Strategies at a regional meeting on fisheries management at the University of Rhode Island Narragansett Bay campus.
5. Dr. Robert Pomeroy obtained a grant from the Surdna Foundation to support a program that will evaluate and develop new community-based strategies for New England fisheries in order to improve management outcomes for both the fishing industry and fisheries resources. To date, this project has been used to hire the services of Dr. Syma Ebbins to work with the Stonington CT fishermen on dock extension and alternative fisheries management.
6. Dr. Robert Pomeroy and Dr. Patrick Christie (University of Washington, Department of Marine Affairs) have been approved for a National Center for Ecological Analysis and Synthesis (NCEAS) project Governance Feasibility of Marine Ecosystem-Based Management: A Comparative Analysis. The EBM Feasibility NCEAS project has three main goals: 1) assessing how to modify governance structures to facilitate effective ecosystem-based management (EBM) in developing and developed world contexts; 2) generating practical ecological and social indicators for EBM, and 3) producing analyses and planning materials useful for scientists, EBM practitioners, and policy makers around the world.
7. Presentation on Marine Zoning to the Long Island Sound Stewardship Initiative, New Haven, October 17, 2005.
8. Presentation on Alternative Fisheries Management at the Regional fisheries management workshop, University of Rhode Island campus. November 18, 2005.
9. Presentation on Governance and Ecosystem based management to the New England Fisheries Management Council, February 28, 2006, Boston.
10. Dr. Robert Pomeroy undertook an economic analysis for the project Business Feasibility Study for the Establishment of Ornamental Aquatic Plant Aquaculture in the

Northeast. The outputs of this study have been distributed by the Northeast Aquaculture Center.

11. In February and March 2006, a series of Marine Aquaculture Business workshops were held. Topics included crop insurance; trade marketing, branding and logos; scaling up the aquaculture business; aquaculture as a new business investment; and producer cooperatives. A total of 20 people attended the workshops.
12. As a result of his work on the December 2004 Asian tsunami, Dr. Robert Pomeroy was lead author on a policy paper: Pomeroy, R., B. Ratner, S. Hall, J. Pimoljinda and V. Vivekanandan. 2005. Rebuilding livelihoods in tsunami-affected coastal communities in Asia. CONSRN Policy Brief No. 2. CONSRN and WorldFish Center, Penang, Malaysia. (English and Indonesian versions). This paper has served to assist donors and development aid workers in rebuilding livelihoods in Thailand, Malaysia, Indonesia, India and Sri Lanka.
13. Workshop on The Economics of Aquaculture Biotechnology. Irish-American Conference on Aquaculture, Galway, Ireland. 5-9 July 2005.

E/T-11 Sea Grant Educator Program

The CTSG Sea Grant Educator program is implemented by CTSG Education Coordinator Diana L. Payne. Accomplishments and impacts for 2005 – 2006 include:

Awards

Who's Who Among America's Teachers (Diana L. Payne, CTSG Education Coordinator)

Conference Presentations / Papers

- Payne, D. L., & Rader, L. *Ocean Literacy: Connections through Science Education Standards*. Long Island Sound Educators conference, Norwalk, CT, March 31, 2006.
- Balcom, N. C., & Payne, D. L. *Nab The Aquatic Invader*. Long Island Sound Educators conference, Norwalk, CT, March 31, 2006.
- Payne, D. L., & Babb, I. G. *An Analysis of a Teacher Research Experience as Professional Development for In-service Teachers*. Association for Science Teacher Education. Portland, OR, January 14, 2006.
- Reed, R. E. S., Payne, D. L., & Babb, I. G. *Advancing Collaboration: Analysis of the Effectiveness of Research and Education Partnerships at Sea using Real-Time Technology and Professional Development*. Oceans 2005 MTS / IEEE conference. September 21, 2005.
- Payne, D. L., & Carlson, J. *Explore the Ocean Without Getting Wet: Multimedia Expeditions to Arctic and to the New England Seamount Chain*. National Marine Educators Association, Maui, HI, July 16, 2005.
- Babb, I. G., Payne, D. L., & Reed, R. E. S. *Teacher Research Experiences – Exploring the New England Seamount Chain*. Poster presentation, Conference on Teacher Research Experiences (funded by NSF), Narragansett, RI, April 26, 2005.
- Babb, I. G., Payne, D. L., & Reed, R. E. S. *Teacher Research Experiences – Exploring the New England Seamount Chain*. Poster presentation, Neag School of Education Day of Research, Storrs, CT, April 20, 2005.
- Payne, D. L. *Whale of a Share-A-Thon*. National Science Teachers Association conference, Atlanta, GA. March 31, 2005.

Education / Outreach Activities

- Assisted in coordination of the Long Island Sound Educators conference: March 31, 2006; **193 participants**; CTSG, NYSG and US EPA LISS support; **2 presentations** (see above)
- Participated in the Quahog Bowl (CT / RI regional of the National Ocean Science Bowl); participated as Timekeeper; March 4, 2006
- Coordinated the *Telling Your Story* workshop at UConn Avery Point October 6, 2006; a course developed by COSEE-NE to teach scientists how to share their “story” with K-12 educators and students; **16 participants**
- Facilitated the NOAA OE Professional Development Institute July 27, 2006 in Narragansett, RI; **17 participants**
- Facilitated the NOAA OE Professional Development Institute July 26, 2006 in Portland ME; **8 participants**
- Presentation for the staff of Schooner, Inc. on *Aquatic Invasive Species of Long Island Sound*; July 7, 2005; **15 participants**

- Participated in the University of New Hampshire Sea Grant Education TAT; June 21-22, 2005
- NOAA OE Professional Development Institute April 29, 2005 at the American School for the Deaf – presentation on NOAA OE and education; **12 participants**

Extended (Multi-day) Consultations with teachers

- 1 high school teacher
- 1 elementary school teacher

Externally Funded Projects

National Oceanic & Atmospheric Administration (NOAA)

- 2005: (National Undersea Research Program) *CanyBal* (PI: Babb; Mullineaux). Served as Education and Outreach Coordinator.
- 2005: (National Sea Grant) Nab The Aquatic Invader! – A Nationwide Online Educational Program to Direct Attention to AIS Issues and Inspire Action (PI: Goettel, Domske, Lindstedt, Luke, Balcom, Payne). Served as Northeast Region Education Coordinator.
- 2005: (Office of Ocean Exploration) Deep Atlantic Stepping Stones (Co-PI: Watling, Babb). Served as Education and Outreach Coordinator.

Ongoing

- Serving as SENEME (Southeastern New England Marine Educators) chapter representative to the NMEA (National Marine Educators Association) – a voting SENEME and NMEA Board position
- Serving on the New England Ocean Sciences Education Collaborative (NEOSEC); serve on the NEOSEC Governing Council
- Serving as an Advisor to the Sea Grant / AZA project to develop a program for zoos and aquaria on Aquatic invasive species

M/CP-1 Core Communications Program

The Core Communications project M/CP-1 for Connecticut Sea Grant included one full time Communications Director, Margaret (Peg) Van Patten, at the University of Connecticut at Avery Point. Major ongoing duties of the Communications Director included planning and implementing the Communications strategy and budget, overseeing publications, and working with UConn Communications on media relations. The Communications Director also maintains the program web site.

Much of the 2005 included an additional task, the development, photography, writing, design, and publication of a new 105-page book, *Seaweeds of Long Island Sound*. This was supported by an external grant from US EPA. It was completed on December 27, formally published in January, marketed in February and featured in the UConn Advance in March 2006. Ms. Van Patten gave a workshop to help K-12 teachers incorporate the algae, and the book, into current national and state science standards at The Maritime Aquarium on March 30. Since then this book has been adopted for use in school systems in Cheshire, Darien, Greenwich, Stamford, and other places in Connecticut. This book is also used by the Peabody Fellows, a program for K-12 teachers at the Yale Peabody Museum.

Major Accomplishments

- Wrote, designed, researched, photographed, and marketed *Seaweeds of Long Island Sound*.
- Participated in development of Connecticut Sea Grant's strategic planning and performance assessment planning as part of management team.
- Continued core program publications such as *Wrack Lines* magazine. (Tasks include writing, editing, fundraising, design, production oversight, and distribution.
- Collected and disseminated Sea Grant research results (journal reprints etc.) to the Sea Grant library and to users.
- Maintained and updated the CTSG website.
- Monitored program effectiveness by tracking web trends and doing surveys on publications.
- Interaction with sponsored scientists to stay informed of research progress
- Supported Sea Grant staff with editing, publications preparation, and publicity for events.
- Print and electronic surveys for *Wrack Lines* magazine were developed and implemented.

Regional and National Meetings Attended

- Represented Connecticut Sea Grant at the Northeast Regional Sea Grant Meeting in Bristol, RI
- Represented Connecticut Sea Grant Communications at the National Sea Grant Outreach meeting in Puerto Rico in May.

Boards and Committees Served

- Participated on the USEPA Long Island Sound Study's Communications subcommittee (reviewed 33 grant proposal applications for Long Island Sound Futures Fund, March 2006)
- Wrack Lines Magazine Editorial Board, chair (2 meetings during this period)
- Planning Committee for biennial Long Island Sound Research Conference

Associations

- member of Sea Grant Communications network
- member of Sea Grant Webmasters network
- member of Phi Delta Kappa
- member of Northeast Algal Society

Presentations Given

- Johns Hopkins Center for Talented Youth workshop at UConn Avery Point: gave workshop on benthic marine algae, Nov. 12, 2005. approx. 54 students in 2 sessions
- Presentation about nitrogen in Long Island Sound to home-schooled students (grades 4 & 5) involved in Lego Robotics Ocean Challenge finals. (*these students subsequently did a community outreach program that won a top award in the Lego competition.)
- Marine Sciences Day at UConn Avery Point, May 2005: gave presentation to approx. 25 students and 4 teachers
- Presentation to summer camp youth at Marinelife Aquarium in Mystic CT, Summer 2005. Approximately 30 youth and instructors.
- Talk on marine communications careers given to class of C. Cuomo at University of New Haven, May 2005. Approximately 18 students.
- Avery Point Day, October 2005. Displayed Sea Grant exhibit, poster, and publications.
- Workshop for teachers at The Maritime Aquarium, March 30, 2006.

A/E-18 Coastal Community Development Program

The Coastal Community Development Program (CCDP) of Connecticut Sea Grant (CTSG) was created in 2002, as part of a national effort of the same name instituted within the Sea Grant network. As with each of the Sea Grant programs around the country, CTSG receives \$50,000 per year to be applied directly to research, education and outreach focused on coastal communities. While a variety of issues are addressed by these programs nationwide, a strong common denominator is the impact of urbanization on coastal resources, economies and health.

With a long history of community-oriented work to its credit, CTSG was able to hit the ground running from Day One of the national CCDP. By 2002, Sea Grant and the Department of Extension had been partners for over a decade in a national award-winning educational program for local land use officials focusing on the links between land use and water quality. In fact, the *Nonpoint Education for Municipal Officials* (NEMO) Program, with its successful track record in Connecticut and its adoption by Sea Grant programs in many other states, was the original inspiration for the creation of the national CCDP.

CTSG invests its CCDP funding in the NEMO Program to develop new programs and tools specific to the coast, and to leverage statewide NEMO programs and services to the benefit of Connecticut's coastal communities. The CCDP incorporates outreach education, technical tool development and original cutting-edge research.

Brief Description of Major Accomplishments

A New Educational Program: Managing Stormwater in Urban Areas

Many of Connecticut's coastal communities are highly urbanized, yet to date little information specific to the linkage between land use and water quality in these urbanized areas was available to decision makers. The presentation is organized into five sections, starting with a description of the importance of water resources, giving an overview of *Connecticut's Changing Landscape* focusing on their municipality, a review of how developed landscapes affect water resources, strategies for reducing the impact of development and finally, how cities can get started implementing these strategies.

Although the urban focus is new, linkage of land use to water quality reflects what NEMO has been teaching for over a decade. The relationship of impervious surface to water resource health is very well documented in urban areas. What is less well known is how to reduce the "ecological footprint" of urban areas, while retaining the economic viability that keeps an urban area vital. To bridge this information gap, we relied on a number of studies, reports and the work of colleagues in other states. Key sections of the CT Stormwater Quality Manual were also referenced.

The strategy highlighted in this presentation is termed "restorative redevelopment." A key strategy is to reduce and disconnect impervious surfaces and to encourage multiple uses of green spaces for both aesthetic, recreational and stormwater renovation. Redevelopment and mixed uses are also encouraged to increase the efficiency of land use and provide a more vital urban setting and is a key component of the state's Smart Growth strategy.

Working with coastal towns: in-depth partnerships result in bottom-line impacts

The “Municipal Initiative” is a unique program developed in collaboration with the CT Department of Environmental Protection, that allows the NEMO Team to focus more resources on a few municipalities, establishing relationships between the program and these towns from the initial educational workshop through implementation of on-the-ground changes. Because of the time commitment required for this program, the NEMO Team can only focus on a few towns per year, however, the chosen towns then serve as case studies and examples to other towns in Connecticut. Selected towns must designate a contact person for the initiative who will be responsible for facilitating communication both between the program and the town, and among various commissions within the town. In addition, a NEMO Task Force must be established whose membership includes, at a minimum, members of the following commissions or boards: planning, zoning, inland wetlands, conservation and the office of the chief elected official (town council; board of selectmen, mayor’s office). Other groups, such as town departments, land trusts and economic development commissions are also encouraged to participate.

The Municipal Initiative, now in its fifth year, has paid considerable dividends in the form of changes to local land use plans, policies, practices and procedures catalyzed by NEMO educational programs. As part of the Sea Grant CCDP, the Municipal Initiative has included several coastal towns.

In 2005, NEMO worked with three communities under this initiative: Killingworth, Killingly, and Torrington. All have completed the goals they had identified. Killingworth, a coastal nonpoint town, has focused on preserving the rural character of the community through natural resource-based planning. They have conducted a GIS-based resource inventory of the community and formed an open space planning subcommittee to begin to apply the information in the inventory to prioritize lands for preservation and acquisition. Further changes include new stormwater regulation changes to allow for “low impact development” techniques that will reduce the effect of development on water quality.

In 2004, the NEMO program published *Putting Communities in Charge*, a review of the actions communities are taking as a consequence of NEMO’s outreach education. Additional copies of the report or the summaries can be ordered or downloaded from the NEMO website (<http://nemo.uconn.edu/publications/>).

Reducing the Impact of Development in Coastal Communities

1. Statewide Training on New Stormwater Guidance

In 2005, NEMO in collaboration with CT DEP, developed and organized statewide training workshops on a new DEP publication, the *2004 Stormwater Quality Manual*. NEMO team members had worked with DEP and a steering committee of state agency representatives and private professionals, in the development of the manual. The manual provides guidance to both land use decision makers and development professionals on stormwater practices to protect water quality. Prime among these practices are “low impact development” (LID), site-level practices that minimize the volume and maximize the quality of stormwater leaving the site.

NEMO team members conducted 20 workshops, reaching nearly 1,000 local land use decision makers, design engineers, state agency personnel, and town staff. The result of these workshops is that many towns are incorporating the practices outlined in the manual into their regulations. The professionals in the development field have also begun to use the manual as a standard reference text. The upshot of both the publication and the subsequent training workshops is that both the decision makers and the development community have a single source on which to design and evaluate development proposals.

2. Contractor Low Impact Development Workshop

After many years of successful NEMO education in the towns of Connecticut, it became apparent that town personnel and conservation members had a grasp of the “why” behind the use of low impact development (LID) techniques. However, it also became apparent that the “how” of installing these techniques in the field was the next challenge facing the widespread use of LID. This lack of understanding of proper installation techniques has been the cause of failures of LID practices in Connecticut and around the country.

The CT NEMO team set out to address this situation by creating a workshop targeted to the contractors that might be asked to install these tools. Flyers were sent out to local excavation and landscape contractors, placed in various town halls, and were also distributed electronically through various listservs. Although this workshop was being produced as part of the Niantic River Watershed Project, advertising was done statewide.

The workshop was held on February 23, 2006 in the Marine Sciences Building at the UCONN Avery Point campus and hosted by the CT Sea Grant Program. Presentation topics ranged from an introduction to stormwater issues and LID concepts, to specific installation and maintenance issues associated with LID techniques. Two consultants also provided information on field experiences with LID techniques, and a developer provided a testimonial on why green techniques are beneficial to both the environment and to the “bottom line.” More than 20 contractors signed up, as well as engineers, town and state personnel, for a final count of more than 40 participants. Verbal feedback from several participants has been very positive, and we have had requests to perform similar workshops in other locations.

Cutting-Edge Research to Characterize An Urbanizing Coast

CCDP funds leverage other NEMO projects and support, in particular some of the innovative remote sensing-based research ongoing at NEMO’s new parent unit at UConn, the *Center for Land use Education and Research (CLEAR)*. Some of the projects with the greatest relevance and utility to the state’s coastal communities are summarized below.

Connecticut’s Changing Landscape (On-going)

The *Connecticut’s Changing Landscape (CCL)* project consists of four land cover maps of Connecticut from 1985, 1990, 1995 and 2002. The CCL project focuses in particular on the growth of urban land in the state – a topic of particular importance to coastal communities, which CCL data show are more than 50% more developed than the state average. NEMO has demonstrated that remote sensing-derived land cover can be a key piece of information for local communities when reviewing and revising their land use plans and regulations; however, NEMO

had always relied on static land cover maps, with no information about land cover trends over time. By creating four dates of land cover spanning a 17-year period, the CCL project made it possible, for the first time, to quantify and view land cover change. The change map is a unique and informative piece of information for town officials (figure).

One of the projects that “spun off” of the CCL is the ***Coastal Area Land Cover Change Analysis Project (CALCAP)***. The CALCAP Project provides an improved understanding how and where development within Connecticut's coastal area and lower Connecticut River towns may be affecting coastal Connecticut's most significant ecological and coastal recreation areas. Examples of such areas include rare habitat coves of the lower Connecticut River with rare species habitat and major coastal recreation destinations such as Hammonasset Beach State Park. The information is delivered in a format that will be helpful to managers responsible for developing strategies to address threats to Connecticut's most critical coastal areas originating from development activities outside the boundaries of existing protected open space. NOAA’s Office of Ocean and Coastal Resource Management provided project funding through the National Coastal Zone Management Program. More about the project, including the results of the analysis, can be accessed from the CCL website (<http://clear.uconn.edu/projects/landscape/>).

Invasive Species Research (On-going)

The UConn Geospatial Technology Program is a sister project of NEMO under the CLEAR banner, focusing on new remote sensing, GIS and GPS techniques and tools. In 2004, the GTP began working with the CCDP to investigate the potential of new, high resolution remote sensing data to the problem of invasive species management along the coast. Advanced sensors incorporated into some of the newer generation of satellites may make it possible for remote sensing scientists to distinguish between different species of marsh plants from satellite data. If these techniques can be developed, it will open up an entire new field of characterizing, mapping, and tracking change in invasive plants along the coast. This work is being partially funded by the Long Island Sound Study National Estuary Program, and is a collaboration between UConn and Wesleyan University.

Estimate of Funding Leveraged 2001-2006

Granting Agency	Year Awarded	Amount
CT DEP (section 319)	2001	\$100,000
CT DEP (section 319)	2002	\$100,000
U.S. EPA	2002	\$80,000
CT DEP (section 319)	2003	\$100,000
CT DEP (section 319)	2004	\$100,000
CT DEP OLISP	2004	\$43,000
IAGT	2004	\$25,000
EPA LISS	2004	\$48,347
CT DEP (section 319)	2005	\$70,000
CT DEP (section 319)	2005	\$50,000
EPA LISS	2005	\$90,611
CT DEP (section 319)	2006	\$75,000
CT DEP (319 – Jordan Cove Research Project)	2006	\$50,000

CT DEP (Niantic River Watershed Protection Plan)	2006	\$35,000
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TOTAL		\$966,958
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CT DEP (Connecticut Department of Environmental Protection)
 CT DEP OLISP (Office of Long Island Sound Program)
 IAGT (Institute for Applied Geospatial Technology)
 EPA LISS (EPA Long Island Sound Study)

Percent Funding Allocation by Activity

100 % NEMO
 60% Education and Outreach
 10% Comprehensive Land Use Planning
 10 % Low Impact Development
 15% Land use codes/ordinance review/revision
 5% Other Smart Growth Activities

Publications

Rozum, J. and C. Arnold. 2004. *Putting Communities in Charge: a progress report on an educational support system for local land use decision makers*. Published by the Center for Land use Education and Research, University of Connecticut. Publ#041215.1

Rozum, J. 2005. *A new resource for water quality protection: The 2004 CT Stormwater Quality Manual*. The Habitat, Vol. XVII No. 2.

Rozum, J., E Wilson and C Arnold 2005. *Strengthening Integration of Land Use Research and Outreach through Innovative Web Technology*. Journal of Extension, 43(5):#5IAW1.

**Progress Report for CTSG Research and NSI Programs
2002-2006 Omnibus, NA16RG2253**

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

R/ER-22 The Connecticut 'Hatting' Industry as a Mercury Source for Long Island Sound

Check one: This is a Progress Report Final report

Project Title: The Connecticut 'hatting' industry as a Mercury source for Long Island Sound

Principal Investigator(s) and Affiliation(s):

1. Johan C. Varekamp, Earth & Environmental Sciences, Wesleyan University, Middletown CT 06459-0139

ACCOMPLISHMENTS: (What was done? What was learned?) Summarize findings and significant achievements. In addition to scientific discoveries and accomplishments, make sure to specify any opportunities for training, education, and development that have occurred.

1. An additional 3 cores from western LIS were analyzed for Hg, in conjunction with meta data regarding age and sediment type. These cores are all located west of the mouth of the Housatonic river and all three show the double peaks of Hg enrichment that we have correlated with the wet periods of 1900-1910 and 1955-1975. These small spikes are the result of floods that brought Hg contaminated sediment into western Long Island Sound.
2. We continued our work on Hg analyses of plants from sites in Danbury heavily contaminated with hatting Mercury. We sampled genetically modified cottonwood trees and natural cottonwood trees from the Barnum Court experimental site (project run by the town of Danbury) and analyzed roots, stems, bark and leaves for Hg to investigate the Hg uptake and partitioning in plants.
3. One student worked most of this year on these projects: Asia Neupane, a Wesleyan undergraduate student who is also a minority (Nepalese) and university scholar (gifted student). She also ran a program analyzing hair from Wesleyan University community members and raised awareness on Hg in fish, both from marine and terrestrial sources.
4. We bought (used) and installed a fluorescence Hg analyzer for picogram Hg analyses, which will be applied this fall for direct studies of Hg evasion from sediment, soils and plants.

BENEFITS AND IMPACTS: Cite benefits, applications, and uses stemming from this project. Include those expected in the future. **Where possible, please quantify.** Include who is applying the research results and uses that can be anticipated outside the research community. Make sure to specify how the project has contributed:

- **To the development of the principal discipline(s) of the project.**

We determine in how far 'old' Hg sources such as upland sediment contaminated with Hg hundreds of years ago still form a source of Hg for the coastal environment. In addition, we study in how far plants can extract Hg from soils and form a transport medium of particulate carbon with a Hg load towards the coastal areas.

- **To other disciplines.**

We are studying the effectiveness of phytoremediation of Hg through genetically modified plants. In addition, we study the mechanisms of Hg uptake by plants which is applicable to edible plants as well. We have also studied the spectral characteristics of plants that are contaminated by Hg, as a lead on for remote sensing of plants to map contaminated areas from space.

- **To the development of human resources.**

We have educated several students from Wesleyan University and Amherst College in the use of Hg analyzers and interpretation of Hg data in sediments.

- **To physical, institutional, and information resources.**

Creation of a web site on Hg in hair and fish in diets

- **To technology transfer.**

Installation of a hyper sensitive Hg analyzer – instruction for one student.

- **To society.**

Through our Hg-in-hair project we have drawn widespread attention to the issue of Hg pollution of fish, both marine and terrestrial and how diets influence Hg burdens of humans. We have spread awareness in many coastal communities about the persistence of old Hg sources and residence of these contaminants in the sediments. We also discovered that in the mid 1970s Hg-rich material was dispersed during some dredging, discharge or storm event. A widespread layer rich in coal, flyash and slag is found in at least two cores. The roigin of these contaminants is as yet unknown.

PROJECT PUBLICATIONS AND PRODUCTS: Include published materials with complete references, as well as those which have been submitted but not yet published and those in press. For published articles, please send 12 copies to the Connecticut Sea Grant Communications Office.

Journal Articles:

1. Dunagan, S.C., M. S. Gilmore and **J. C. Varekamp**, Effects of Mercury on visible/near-infrared reflectance spectra of Mustard Spinach plants (*Brassica rapa* P.), J. of Envir. Pollution, in review.

Conference Papers and Presentations:

1. Dunagan, S., Gilmore, M., and **Varekamp, J.C.**, Remote sensing of Mercury-contaminated soils through plant reflection spectra. AGU fall meeting, 12/2005.
2. Goldoff, B, Varekamp, J.C., and Neupane, A., Mercury Contamination In W-Connecticut and Long Island Sound from historic hat-making sources. Geol. Society America annual meeting, Philadelphia, October 2006

3. Varekamp, J.C., Mercury contamination in Long Island Sound, USA, from the historic hat-making industry. ISEG meeting, Beijing, China, September 2006
4. Varekamp, J.C., Phytoremediation of Hg-contaminated soils with genetically modified Cottonwood. ISEG meeting, Beijing, China, September 2006

Other articles, such as proceedings or book chapters:

Varekamp, J.C., Mecray, E.L., and Zierzow, T., 2005, Once spilled, still found: Metal contamination in Connecticut wetlands and Long Island Sound sediment from historic industries. Chapter in book on 'Our Changing Coasts', editors Whitelaw and Visiglione, E.Elgar Publishers, Chapter 9, p. 122-147.

Web sites, Software, etc.:

<http://www.wesleyan.edu/hghair>

Technical Reports / Other Publications:

Planned Publications:

1. Hatting Hg in the Housatonic watershed and Long Island Sound
2. Mercury budget of Long Island Sound

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 2

Total number of Masters degree candidates who worked with you: 0

Total number of Ph.D. candidates who worked with you: 0

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

R/ER-21 A Ferry-Based Observing System for Long Island Sound: Application to Physical Influences of Hypoxia

Check one: This is a [X] Progress Report [] Final report

Project Title: A ferry-based observation system for Long Island Sound: Application to physical influences on hypoxia

Principal Investigator(s):

1. Daniel L. Codiga

Affiliation(s) (e.g., University or Organization)

1. University of Rhode Island, since September 2004 (formerly University of Connecticut)

COLLABORATORS AND PARTNERS: Partners in the project are Robert Wilson (Stonybrook University) and Duane Waliser (Jet Propulsion Lab, formerly Stonybrook University), who had funding separately from New York Sea Grant to carry out a similar effort with no mooring component and a ferry sampling effort in central LIS with an additional emphasis on meteorological parameters.

The EPA Long Island Sound Study office has provided support through its base program funds to continue the ferry sampling aspect of this project for two years, through September 2006. The equipment is on loan to University of Rhode Island from University of Connecticut.

GOALS AND OBJECTIVES: Summarize project goals and objectives. If you have already completed a Project Summary page for this research project, this section only needs to be completed if goals and objectives have changed significantly.

ACCOMPLISHMENTS:

A. Preliminary research findings

Stratification (moored profilers): (1) Spring-neap cycle of tidal mixing not a dominant factor. (2) Restratification within a day (a few days) after wind events in eastern (central) sound. (3) Salt advection by deep residual circulation important.

Residual circulation (ferry ADCP, eastern LIS): Eastward residual (tidally-averaged) flow out of LIS is concentrated near the surface in the southern portion of the estuary, and deeper inward flow is strongest near the bottom near the central and northern portions. Estimated volume transport of the exchange flow is 28,000 m³/s, implying that the residual circulation plays an important role, together with dispersion by tidal currents, in transporting materials in to and out of LIS from the nearby coastal ocean through Block Island Sound.

B. Significant achievements: Observing system established

1. MV John H. ferry: Sampling from November 2002 to present

To date, some data from some 5200 ferry transits has been collected. Of these, ~3200 are of adequate quality and have been converted to a gridded data product for use by modelers.

2. Moored CTD/DO profiler deployments completed

Deployments of nominally two-month duration were carried out in both spring and summer/fall of 2002 and 2003. Multiple high-quality records have been collected from sites in the central and

eastern sound. A short summer record from the western sound demonstrated additional measurement of irradiance to help relate profiles of DO and primary productivity.

C. Public outreach

Two wood-framed glass-faced bulletin board cases have been installed in the passenger area of the ferry. A poster providing an overall description of this project is installed in one case. In the other, a flat-panel PC monitor displays oceanographic data in real time as it is sampled by instruments mounted on the ferry.

BENEFITS AND IMPACTS:

The ferry-based sampling of velocities and water properties in this project will be of use in calibrating and verifying the hydrodynamic component of numerical models that are used in support of regulatory actions regarding management of eutrophication in LIS. Analysis of the observations made through the moored profiler component of the project will improve understanding of how stratification evolves, a process central to hypoxia and associated water quality management issues. The display in the passenger area of the ferry, visible to hundreds of thousands of people each year, helps increase awareness and educate the general public outside the research community; it includes a poster with an overall description of the project, and a continually updating PC monitor that shows the data as it is collected in real time.

PROJECT PUBLICATIONS AND PRODUCTS:

Journal Articles:

Codiga, D.L. and D.A. Aurin. Residual circulation in eastern Long Island Sound: Observed transverse-vertical structure and exchange transport. *Continental Shelf Research*. Under revision.

Conference Papers and Presentations:

Codiga, D. and D. Aurin: Observed Residual Circulation in Eastern Long Island Sound: Transverse-Vertical Structure, and Exchange Transport. Abstract for oral presentation, Long Island Sound Research Conference, Stony Brook, NY, November 2004.

In October 2003, as requested by the Scientific and Technical Advisory Committee of the EPA Long Island Sound Study, an invited presentation about this project was given by Codiga at a workshop on the System-Wide Eutrophication Model.

In August 2004, as requested by the Maryland Sea Grant Program, an invited presentation about LIS hypoxia including results from this project was given by Codiga at a workshop on Oxygen Dynamics in Chesapeake Bay.

Technical Reports / Other Publications:

FOSTER-LIS: Oceanography with the MV John H of the Cross-Sound Ferry Fleet. Poster describing overall project, displayed in passenger area of ferry.

Real-Time Oceanographic Measurements: How to Read the Live Display.

Poster explaining components of real-time data presentation, displayed in passenger area of ferry.

Codiga, D.L. FOSTER-LIS Gridded Data Product: Observed Current Profiles and Near-Surface Water Properties from Ferry-based Oceanographic Sampling in Eastern Long Island Sound. First draft April 2006.

STUDENTS:

Total number of K-12 students who worked with you:

Total number of undergraduates who worked with you:

Total number of Masters degree candidates who worked with you:

Total number of Ph.D. candidates who worked with you: 1

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name: Mr Dirk Aurin

While my new affiliation is URI, Mr Aurin is continuing in the UConn graduate program. His new advisor is Heidi Dierssen.

Degree Sought: PhD

Thesis or Dissertation Title:

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

R/BT-01 Lobster Defenses to Shell Disease: Endocrine Control of Molting and Wound Healing

Check one: This is a Progress Report Final report

Project Title: Lobster Defenses to Shell Disease: Endocrine Control of Molting and Wound Healing

Principal Investigator(s) and Affiliation(s):

1. Hans Laufer, Department of Molecular Biology, University of Connecticut and the Marine Biological Laboratory, Woods Hole, MA.

COLLABORATORS AND PARTNERS:

Professors James Stuart, and James Bobbitt, Department of Chemistry, University of Connecticut
Professor Uwe Koehn, Department of Statistics, University of Connecticut
Dr. X Vafepoulon, York University, Toronto, Canada.
R. Smolowitz, Marine Biological Laboratory, MA
Joseph Bagshaw, Wooster Polytech

PROJECT PUBLICATIONS AND PRODUCTS: Include published materials with complete references, as well as those which have been submitted but not yet published and those in press. For published articles, please send 12 copies to the Connecticut Sea Grant Communications Office. Include:

Journal Articles:

Biggers, W.J. and H. Laufer. 2004. Identification of juvenile hormone-active alkylphenols in the lobster *Homarus americanus* and in marine sediments. Biol. Bull. 206:13-24.

Laufer, H., Demir, N., and Biggers, W. 2005. Response of the American lobster to the stress of shell disease. J. Shellfish Res. 24: 757-760.

Laufer, H., Pan, X., Biggers, W.J., Capulong, C.P., Stuart, J.D., Demir, N., and Koehn, U. 2005c. Lessons learned from inshore and deep-sea lobsters concerning alkylphenols. Invert. Reprod. Develop. 48: 109-117.

Laufer, H., Demir, N., Pan, X., Stuart, J.D., and Ahl, J. 2005d. Methyl farnesoate controls adult male morphogenesis in the crayfish, *Procambarus clarkii*. J. Insect Physiol. 51: 379-384.

Conference Papers and Proceedings:

Laufer, H., Demir, N., and Pan, X. 2005b. Shell disease in the American lobster and its possible relations to alkylphenols. New England Aquarium, Aquatic Forum Report 05-173-175.

Laufer, H., Demir, N., Capulong, C.P., Pan, X., Biggers W.J. 2005e. Hormonal responses of lobsters to stresses of Long Island Sound. Long Island Sound Research Conference Proceedings 7: 41-43.

Laufer, H., Demir, N., Capulong, C, Pan, X., Biggers, W.J. 2006. Hormonal Responses to Lobsters of Long Island Sound. Long Island Sound Research Conference Proceedings. 7: 41-43.

Book chapters:

Laufer, H. and E.H. Baehrecke, 2004. "Regulation of Cell Growth, Differentiation, and Death during Metamorphosis "in: Cell Cycle and Growth Control: Biomolecular Regulation and Cancer". Gary S. Stein and Arthur Paradee, editors, Wiley-Liss publishers, NY. Pgs 369-395.

Undergraduate Students Poster Presentation

Jolanta Jedrzkiewicz, Anna Jedrzkiewicz and Selvia Osei. Ca Content of Unaffected and Shell Diseased Lobster Shells. Frontiers in Undergraduate Research. April 7-8, 2006 Presentation.

Meeting Presentation

Laufer, H., W.J. Biggers. 2004. Alkylphenols are Endocrine Disruptors in *Capitella* and are present in Lobsters. 10th International Congress for Invertebrate Reproduction and Development meeting. New Castle upon Tyne, UK. July 2004. Abstract.

Laufer, H. N. Demir, and W.J. Biggers 2005. Lobsters response to stressors of shell disease. Society for Integrative and Comparative Biology Annual meeting. Abstracts San Diego, CA. Jan 2005. Pg 174.

Laufer, H., N. Demir, X. Pan and J. Stuart. 2005. Can shell abrasion and alkylphenols contribute to our understanding of shell disease in lobsters? 15th International Congress of Comparative Endocrinology Proceedings, Boston, MA. May 2005. pg. 89.

Future Meeting Presentation

Laufer, H. and N. Demir. 2006. Lessons learned about shell disease from carapace abrasion. 2006 Northeast Regional Meeting of the Society for Developmental Biology. April 28-30, 2006, Marine Biological Laboratory, Woods Hole, MA.

PATENTS & COPYRIGHTS: List those awarded or pending resulting from this project.

TECHNOLOGIES & TECHNIQUES: List new technologies or methods developed.
Bioassay for CHHa & CHHb- to sort out polly functional neuro peptide activities
Quantitative Extraction of Alkylphenols and sensitive GC/MS assay
Molt induction by shell abrasion in crustacea

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0
Total number of undergraduates who worked with you: 9
Total number of Masters degree candidates who worked with you: 1
Total number of Ph.D. candidates who worked with you: 4
Total number of Post Docs & visiting Professors: 3

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name: Neslihan Demir
Degree Sought: PhD
Thesis or Dissertation Title: Responses of Crustacea to molting and shell disease

Student Name: Phong Huynh
Degree Sought: PhD
Thesis or Dissertation Title: Characterization of CHHa: its inhibitory roles and expression in the lobster and crayfish

Student Name: Hua Bai
Degree Sought: PhD student in Marine Biology 2004-2005 Transferred
Thesis or Dissertation Title:

Student Name: Jungrak Auterat
Degree Sought: Degree from Thailand University
Thesis or Dissertation Title: Worked on MF & Alkylphenol assays

ACCOMPLISHMENTS

Shell disease in the American lobster, *Homarus americanus*, is on the increase in Long Island Sound (LIS), Connecticut (Millstone Environmental Lab, 2004), Rhode Island, Massachusetts inshore waters and is beginning to appear in Maine waters. The disease disfigures the shell and in severe cases leads to the demise of the organism.

We are making several interesting findings relating to the biology of shell disease (SD). Lobsters with shell disease seem to molt more frequently than unaffected lobsters (Laufer et al., 2003, 2005, 2005ab). In 7 of 10 months throughout the year for which we have data for comparison (Fig 1), the SD lobsters have more of the molting hormone, ecdysone, in their hemolymph or blood than unaffected ones. Ecdysone concentrations in hemolymph are determined by radioimmunoassay (RIA) as described by Chang (1984), and Laufer et al. (2005) using a polyclonal antibody against ecdysones. The average ecdysone concentration for 210 unaffected lobsters was 57 ± 16 ng/ml, while 76 SD lobsters had 89 ± 32 ng/ml in their blood (statistically highly significant by 2 way analysis of variance, $P=0.002$) (Fig 2). The lowest level of ecdysone in unaffected lobsters was in July, this is the time of year this population (average weight 375 g) usually molts. Following molting the frequency of SD appears to have decreased. We consider that molting is a defense of the lobster to shed its carapace and to fend off shell disease

Unaffected lobsters do not normally molt while they are berried or ovigerous. They carry eggs which may take as much as eleven months until they hatch and are released as larvae from the mother's pleopods. SD lobsters have been reported to be molting. Our examination of SD ovigerous lobsters revealed ecdysone levels averaging as high as 165 ± 53 ng/ml (N=5), while unaffected ovigerous lobsters have about 13 ± 4 ng/ml (N=17) (statistically highly significant by the student's t-test, $P < 0.005$) (Fig3). These findings support the idea that molting is a lobster's defense against SD even at the cost of a brood of embryos, which if shed with the carapace at a molt would be lost (Laufer et al., 2005bcd 2006).

Effects of Shell Abrasion on Molting and Shell Healing

To determine whether molting is induced by shell damage or a defense against infection, we determined the effect of partial shell abrasion on the molting process. We used the Louisiana crayfish, *Procambarus clarkii* as an experimental model for lobsters and used eyestalk ablation as a positive control to induce molting (Laufer et al., 2005d). Untreated crayfish were used as negative controls. Hemolymph was drawn at intervals to monitor ecdysones over time by ecdysone radioimmunoassay.

Eyestalk ablation induced an ecdysone peak of 278 ± 34 ng/ml by day 40, with molting occurring by day 45. Unoperated controls did not molt, while their hemolymph ecdysones increased in response to repeated bleedings by 60 days with bleedings varying at 5, 10, 20, and 30 days 131 ± 17 , 92.1 ± 16 , 19.8 ± 9.8 , and 12.7 ± 2.1 ng/ml, respectively. Repeated bleeding appear to induce a modest increase in ecdysone. Cuticle abraded experimentals molted by day 50, preceded by an ecdysone peak of 209 ± 37 ng/ml at day 45. These results suggest that carapace damage induces increased concentrations of ecdysones in the hemolymph and molting. These results were statistically significant by Student's t-test ($P < 0.002$). (Figure 4) (Laufer et al., 2005a, Laufer and Demir 2006).

The experiments suggest that skeletal damage by abrasion induced molting and may be similar to the enhanced molting seen in shell disease lobsters. These increases appear to be induced by shell damage, and suggest that induced molting may be a crustacean defense against shell damage.

Details of the role of ecdysones in shell repair have been elucidated in collaboration with Dr. Vafopoulou of York University of Toronto. The ecdysone nuclear receptor (EcR) has been cloned and antibodies raised (Riddiford et al 2003). Fluorescent labeling of the antibodies has allowed for the visualization of which cells of abraded animals express EcR, i.e. are able to respond to ecdysone, and the time course of the response. Using confocal laser scanning microscopy, EcR was found in epidermal cells below the abraded area. This response occurred after a time lag of 18-20 days. Thus, epidermal cells below the abrasion respond to ecdysone. Neighboring (uninjured) epidermal cells did not develop EcR. Therefore, the elevated ecdysone levels of injured animals are detected by injured but not uninjured epidermal cells. The immediate response to injury was expression of EcR in the haemocytes, which aggregate under the abrasion. Since these cells contain haemocyanin, a principle phenoloxidase source in crustaceans (Hughes, 1999), this finding raises the prospect that ecdysone induces haemocytes to become involved in sclerotization and/or immune responses following injury.

Alkylphenols May Influence Shell Disease

In a search for bioactive compounds affecting lobsters, we started to look for compounds such as methoprene, an insecticide used in LIS to control mosquitoes, which are carriers of West

Nile virus. We had developed a sensitive bioassay for the detection of compounds with juvenile hormone (JH) activity (Biggers and Laufer, 1992, 1996, 1999, 2004). Methoprene is an analogue of insect JH and works by preventing the metamorphosis of mosquito larvae into pupae and adults. While we did not detect methoprene in lobsters, we did find bioactive compounds in lobster blood, in some tissue samples and in ocean sediments (Biggers and Laufer, 2004). These compounds were identified by gas chromatography-mass spectrometry (GC/MS) to be alkylphenols (Figures 9a, 9b). They were found in varying concentrations in the hemolymph of lobsters ranging from μg quantities to undetectable levels. The compounds which were found are #1: 2-t-butyl-4-(dimethylbenzyl)phenol in amounts as high as 1.15 $\mu\text{g}/\text{ml}$ in blood and up to 21.6 $\mu\text{g}/\text{g}$ in sediment; compound #2: 2,6-bis(t-butyl)-4-(dimethylbenzyl)phenol occurred up to 13 $\mu\text{g}/\text{ml}$ in blood and 4.7 $\mu\text{g}/\text{g}$ in sediment; compound #3: 2,4-bis-(dimethylbenzyl) phenol occurred in blood up to 19.8 $\mu\text{g}/\text{ml}$ and in sediment at 24.99 $\mu\text{g}/\text{g}$; and compound #4: 2,4-bis-(dimethylbenzyl)-6-t-butylphenol achieved in blood and sediment up to 70.7 $\mu\text{g}/\text{ml}$ and 125.6 $\mu\text{g}/\text{g}$, respectively. The detection limit was 0.3 ng/ml with the method used (Biggers and Laufer, 2004; Laufer et al., 2005, 2005be)(Tables 1a&1b)(Figures 9a&9b).

Alkylphenols are of major interest for several reasons. They are first and foremost known to be vertebrate estrogenic endocrine disruptors (Biggers and Laufer, 2004). They are in the marine environment as a result of anthropogenic activity. They are difficult to remove from the marine environment and tend to persist. We found alkylphenols to be endocrine disruptors in an invertebrate bioassay on *Capitella capitata*, a marine annelid worm, where they promote larval metamorphosis, behaving like compounds with JH bioactivity (Biggers and Laufer, 1992, 1996, 1999, 2004). Most significant for the present context, is that we found them to be present in lobster hemolymph in 42% of SD animals compared to 23% of unaffected lobsters (Table 1a, 1b). Furthermore, these compounds, #1: 2-t-butyl-4-(dimethylbenzyl) phenol; #2: 2,6-bis(t-butyl)-4-(dimethylbenzyl)phenol; #3: 2,4-bis-(dimethylbenzyl) phenol and #4: 2,4-bis-(dimethylbenzyl)-6-t-butylphenol, exist in higher concentrations in SD animals than in unaffected ones (Laufer et al., 2005b). These results were analyzed statistically by Mann-Whitney test and found to be statistically significant for compound # 1, approaching significance for compound #2, approaching high significance for compound #3, and highly significant for compound #4. Thus alkylphenols are implicated as possibly playing a role in lobster shell disease. (Compare Table 1a vs. 1b).

What the role of alkylphenols in SD may be, is the subject of our current research. We have preliminary evidence that the structure of the shell is substantially weakened in shell diseased animals, and it is likely that alkylphenols can interfere in shell formation and shell hardening, making the shell more susceptible to invasion and destruction by microorganisms.

Alkylphenols in Offshore Deep Sea Lobsters

In our quest to find how pervasive the presence of alkylphenols is, we had the opportunity to examine 15 offshore lobsters (Table 2b). Only one (6.7%) of these had detectable levels of 2 alkylphenols in its hemolymph, while an examination of embryos carried by five of these offshore lobsters revealed that three of five batches of embryos (60%) were contaminated with alkylphenols (Table 2a). Our interpretation of these results is that the temperature of the offshore waters from which the lobsters were captured were too low to permit egg maturation and reproduction. Therefore, the mothers had to have been inshore in order to mature their ovaries and to reproduce. This is where the mothers became contaminated and passed the contamination on to their broods. The 15 adults become decontaminated in the cleaner offshore

environment, but the embryos continued to be contaminated because of their relatively impervious shell (Laufer et al., 2005bc).

Our finding alkylphenols in significantly higher concentrations and in higher frequency in shell-diseased lobsters (Tables 1a, 1b) suggest that these chemical contaminants may contribute to the occurrence of the disease, possibly by interfering in shell formation, making the lobster more susceptible to microbial invasion and shell destruction. The finding of contaminated embryos at a higher frequency than the occurrence of alkylphenols in the mothers' blood suggests that lobsters, by being in clean water for a period of time, may be cleared of chemical contamination. Thus the remediation of alkylphenols contamination in lobsters is possible. (Laufer et al., 2005a, b, c) (Compare Tables 2a and 2b).

Stress and control of molting by hormones

There is little doubt that shell disease represents a major stress to the lobster. Also, we have shown quite clearly that ecdysones are increased with the stress of SD (Laufer et al 2005, 2005abc, 2006). This raises interesting endocrinological questions, since ecdysone production is negatively controlled by MIH, molt inhibiting hormone. Chang et al. (1998,1999) reported that stresses like heat shock, anoxia, among others, result in an increase in production and secretion of particular neurohormones into the blood. These are neuropeptides of the crustacean hyperglycemic hormone (CHH) family of peptides, which are synthesized by the x-organ-sinus gland complex of the crustacean eyestalk. It makes sense for those CHHs to increase under stress, since these hormones are multifunctional (Liu et al. 1997). MIH (molt inhibiting hormone) reduces the frequency of molting and MOIH (mandibular organ inhibiting hormone) another CHH family member, reduces reproductive functions in crustacea (Laufer et al 2003). CHH secretion increases the glucose supply in the blood, to give stressed lobsters the energy for rapid flight to escape stressful situations. However, what is not clear in this situation is how ecdysone levels increase in an environment of increasing stress which should result in more MIH (CHH). How does the lobster endocrine regulatory system compensate for the stress of SD? It may shut down MIH production despite the stress, contrary to responses to heat shock and anoxia reported by Chang et al. (1998,1999) it is possible that the molting hormone may overwhelm the MIH-CHH production system. This set of questions is being investigated by two graduate students, Phong Huynh and Neslihan Demir, currently working in the Laufer lab toward their Ph.Ds. Working with pure preparations of molecularly synthesized CHHa&b, they are showing that CHHa, which has been designated by others as having MIH activity, and CHHb which is an MOIH, both share multiple CHH activities: CHH activity, MIH activity, and MOIH activity. Further work is needed to indicate the control of these hormones under stress conditions.

Possible Relations of Alkylphenols

The possible relationship between alkylphenols (known endocrine disruptors) and SD, that is suggested by the statistical analysis of our data has resulted in our looking for possible modes of action of alkylphenols. The evidence from the literature suggests that these compounds may interfere with shell hardening (sclerotization) during the molting process. For instance, Zomer & Lipke (1981) showed that compound 2, also know as MON-0585, because the Monsanto Co. intended to market it for insecticidal activity. It has interfered with sclerotization of insect cuticle. Our current working hypothesis is that the 4 alkylphenols we found in lobster blood and tissues interfere with cuticle hardening during the molt, thus making the shell more susceptible to SD (Laufer et al 2005, 2005b).

This interpretation is supported by recent experiments conducted in our laboratory. We studied the incorporation of radioactively labeled H^3 -tyrosine, which normally becomes H^3 N-acetyl dopamine (eg. Figures 7a) in newly molted lobster cuticle (see Figure 6). Each tyrosine or its derivative molecule cross-links 4 protein molecules during the normal shell hardening process (Figure 7b). We introduced alkylphenols into cuticle preparations during the molting process and found in 9 of 10 trials the presence of these compounds interfered with H^3 -tyrosine incorporation. In half of these experiments the reduction of labeled compound incorporation was cut by 50% or more. Thus we have substantial preliminary evidence of alkylphenolic interference in sclerotization. The ultimate test of this hypothesis will be the synthesis of radioactive alkylphenols by Professor Bobbitt (see for example Figure 5). This synthesis has been performed using non-radioactive chemicals. When these compounds are made radioactive we can follow their incorporation and metabolism during the molting process to test the hypothesis of their action.

Furthermore, another predictable consequence that follows from an interference of alkylphenols in protein cross-linking during sclerotization is that calcium carbonate incorporation into the shell may be reduced during molting. We have investigated shell strength by a physical DMTA (Dynamic Mechanical Thermal Analysis) measurement process (Chiotelli et al 2000, Chartoff 1997) and by calcium content measurements (by Atomic Absorption Spectrometer Analysis). The DMTA test showed that the SD specimen was less stable and significantly less resilient to temperature challenges (Figure 8a) compared to the more stable unaffected cuticle by more than $50^{\circ}C$ (Figure 8b).

Calcium content of unaffected shells averaged 15.6% (n=5) while SD shells averaged 11.6% (n=3). While the numbers of samples tested are still small, the project is in progress and the results obtained are statistically significant (p=0.05%) (Figures 10a). Six different regions of the carapace were compared for Ca. content. Each region was higher in Ca content from unaffected animals than in SD animals (Figure 10b). This experiment was conducted by 3 undergraduate students and was reported at the April 7-8, 2006, Frontiers in Undergraduate Research Meeting, in Storrs.

Opportunities for Training Education and Development

Dr. Laufer presently has six undergraduate student assistants in research or undertaking special independent study research projects for course credit.

Tessa Getches, CT Sea Grants, teaches a college course in Aquaculture at the University of Connecticut in Storrs. The students are introduced to laboratory demonstrations and are encouraged to do independent research. Dr. Laufer has participated in giving demonstrations to the class.

Significant progress and advances in research on the subject of this project are being reported in reviewed and edited scientific journals as well as presented at appropriate national and international scientific meetings. Examples include Laufer presented a paper at the International Symposium on Comparative Endocrinology, in Boston Tuesday May 24th, 2005 (Laufer et al 2005 abstract). Laufer has given four other research presentations in 2005, one on January 8, in San Diego, CA at the annual meeting of the Society of Integrative and Comparative Biology. A second lobster conference at the University of Rhode Island-a lobster workshop was organized for fishermen, government officials, environmental regulators, academic researchers, and interested participants from the general public. This presentation occurred on February 16 at the URI Coastal Institute. It received press coverage from sixty-five news media that reported on

Laufer's presentation by the next day, (This information was reported by Peg Van Patten, CT Sea Grant Public Relations Office) including the New York Times, The Washington Post, The Boston Globe, USA Today, CNN news, NPR, WCBS among others. Additional reports followed in subsequent days.

An oral presentation by Laufer was given on research results at a meeting of the Northeast Regional Aquaculture Center in Dartmouth, MA (NRAC) on Thursday February 24.

A fourth presentation was given at the Boston Campus of the University of Massachusetts on Saturday March 12 on the subject of Lobster Shell Disease to fishermen, scientists, legislators and environmental regulators to bring them up to date on the status of the field (a review of this talk has been published) (Laufer et al 2005 in the New England Aquarium Journal).

Dr. Laufer will present a talk: Laufer, H. and N. Demir. 2006. Lessons learned about shell disease from carapace abrasion. 2006 Northeast Regional Meeting of the Society for Developmental Biology. April 28-30, 2006, Marine Biological Laboratory, Woods Hole, MA.

BENEFITS AND IMPACT

Understanding how SD affects the endocrine system in lobsters and how hormones and alkylphenols, known endocrine disruptors, are involved in the regulation of the disease and of the wound-healing process will enhance our understanding of the lobster's natural defenses in warding off SD. The disease affects a large, and increasing, proportion of the lobster population. A relationship between alkylphenols, known endocrine disruptors, and SD appears to exist. We expect to learn how these compounds contribute to the disease. This should lead to strategies to prevent the occurrence of SD. A method to remediate the effects of SD was observed in deep-sea lobsters and may be useful in the future to aid in our efforts to maintain healthy lobster populations. This study will benefit our knowledge of lobster defenses against SD and will have an impact on our knowledge of maintaining the health and viability of lobsters, which are a valuable natural and commercial resource.

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Note: Figures referenced in this progress report are available from the CTSG Office.

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

**R/ER-24: Determining the Causes of Area-Sensitivity: A Prerequisite for Saltmarsh
Bird Conservation and Restoration**

Check one: This is a [] Progress Report [] Final report

Project Title: Determining the causes of area-sensitivity: A prerequisite for saltmarsh bird conservation

Principal Investigator(s) and Affiliation(s):

1. Chris Elphick / University of Connecticut
2. Margaret Rubega / University of Connecticut

GOALS AND OBJECTIVES: Summarize project goals and objectives. If you have already completed a Project Summary page for this research project, this section only needs to be completed if goals and objectives have *changed significantly*.

The overriding objective of this study is to evaluate multiple potential causes of area-sensitivity in saltmarsh breeding birds, so as to provide prescriptions for enhancing bird protection in Connecticut's limited saltmarsh habitats. Specifically, we will test hypotheses that attribute the absence of certain species from small marshes to: (1) increased predation on eggs and nestlings, (2) reduced survival of fledglings or adults, (3) an altered food supply, (4) systematic differences in plant distributions that might influence habitat selection, (5) increased vulnerability of nests to flooding, and (6) random settlement patterns.

There have been no significant changes in the objectives.

ACCOMPLISHMENTS:

Almost all field work for this project has been completed, with the remaining work (delayed from 2005) planned for this summer and fall. Laboratory work (sorting and identification of invertebrate samples) has recently been completed. Preliminary analyses of most data sets have been conducted and a draft report outlined. Remaining data analyses are planned for this summer, with completion of the report writing and preparation of manuscripts planned for the fall and winter. Several other manuscripts, to which this project contributed have already been completed or will be soon. Two undergraduate students have developed and conducted independent projects in association with this grant (financial support for these projects came from other sources, but the work would not have been possible had the larger project not been under way). Two new graduate students have entered our research group and are developing thesis projects that will build upon and expand this study.

BENEFITS AND IMPACTS:

Teasing apart the potential mechanisms that could account for observed patterns of area-sensitivity in saltmarsh birds is a prerequisite for devising management actions that will increase use of small marshes. Even if it is not possible to devise such strategies, then this work will provide information necessary to prioritize saltmarsh management actions across the state and regionally, and to manage for saltmarsh bird populations most efficiently. By focusing on saltmarsh sparrows we will add to our knowledge of the conservation needs of two species that have been ranked among the highest priorities for avian conservation research in eastern North America. Moreover, our work also will provide similar information for other saltmarsh birds, and we believe that much of this research has broad relevance for managing saltmarsh communities. For example, our analysis of food supply has relevance to all insectivorous species that use salt marshes as well to the conservation of the invertebrates themselves.

More generally, area-sensitivity is a pervasive phenomenon, occurring in a variety of habitats and affecting numerous species. Yet, few attempts have been made to distinguish the relative importance of different possible mechanisms in any system. Our work, therefore, will both broaden our knowledge of area-sensitivity to an additional habitat and highlight the multifaceted nature of the problem by testing multiple explanations within the same system.

Preliminary analysis suggest that many of the explanations for area-sensitive occurrence patterns in other systems are not supported by our data. If this result holds true, it would suggest both that salt marshes might differ from those systems in which most area sensitivity studies have occurred (primarily forests, and to some extent grasslands), and that an understanding of the phenomenon in other systems may be more complex than has been thought. Additional hypotheses (not included in the original study) have thus been developed and we are now initiating new work to address those. We have also initiated a major study to collate and analyze patterns of area sensitivity in birds across studies, which will place the Sea Grant funded work in a broad global context.

PROJECT PUBLICATIONS AND PRODUCTS:

Work on this specific project is not yet completed, but a number of products are already completed or in progress from the broader research program to which the Sea Grant funding is contributing. These are listed below:

Journal Articles:

- Greenberg, R., C. Elphick, J. C. Nordby, C. Gjerdrum, H. Spautz, G. Shriver, B. Schmeling, B. Olsen, P. Marra, N. Nur, and M. Winter. In press. Between the devil and the deep blue sea: nesting ecology of tidal marsh sparrows. In R. Greenberg, S. Droege, J. Maldonado, and M. V. McDonald (eds.) *Vertebrates of Tidal Marshes: Ecology, Evolution and Conservation. Studies in Avian Biology*.
- Gjerdrum, C., C.S. Elphick, and M. Rubega. 2005. What determines nest site selection and nesting success in saltmarsh breeding sparrows? *Condor* 107: 849-862.

Conference Papers and Presentations:

- Elphick, C.S., C. Gjerdrum, and M. Rubega. 2005. Evaluating habitat model predictions of saltmarsh sparrow abundance and productivity. *Annual meeting, American Ornithologists' Union, Santa Barbara, USA.*
- Gjerdrum, C., Elphick, C.S., and M. Rubega. 2005. Nests out of water: strategies for success in a flooding environment. *Annual meeting, American Ornithologists' Union, Santa Barbara, USA.*
- Humphries, S., C.S. Elphick, C. Gjerdrum, and M. Rubega. 2005. Testing the function of nest domes in Saltmarsh Sharp-tailed Sparrows. (Poster) *Annual meeting, American Ornithologists' Union, Santa Barbara, USA.*
- Elphick, C. 2005. Sparrows in the saltmarsh: Adventures in population monitoring, habitat modeling, and restoration ecology. Invited research seminar for US-EPA, Narragansett Laboratory Rhode Island.

Other articles, such as proceedings or book chapters:

Data from this study have been used for a detailed example of how to use multivariate data analysis techniques in a forthcoming book: *Analysis of Ecological Data* (A.F. Zuur, E.N. Ieno, and G.M. Smith, eds.).

STUDENTS: The numbers below refer to all students who have worked on the project and thus includes both those receiving direct financial support and those receiving logistical support.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 3 (plus 1 recently graduated undergraduate student)

Total number of Masters degree candidates who worked with you: 1 (plus one recently graduated MS student)

Total number of Ph.D. candidates who worked with you: 1 (plus we have provided samples to a second PhD student as a side-line to our own work)

Undergraduate students who conducted independent research projects in conjunction with their work on this study:

Selena Humphreys. 2003-05. What determines nest construction variability in saltmarsh-sharp-tailed sparrows?

Kira Sullivan-Wiley. 2004-05. Nest attendance and brood provisioning in female saltmarsh-sharp-tailed sparrows.

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

One MS student (Jason Hill) and one PhD student (Trina Schneider) have worked with us on our saltmarsh sparrow project. Both are new students who have helped with a small portion of the field work for this study. Both are currently developing research projects of their own that will build on and extend the Sea Grant funded work.

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

R/A-36 Development of an oligotrich ciliate as a food organism for marine aquaculture

Check one: This is a Progress Report Final report

Project Title: Development of an oligotrich ciliate as a food organism for marine aquaculture

Principal Investigator(s) and Affiliation(s):

1. George B. McManus, University of Connecticut

COLLABORATORS AND PARTNERS: List any additional organizations or partners involved in the project.

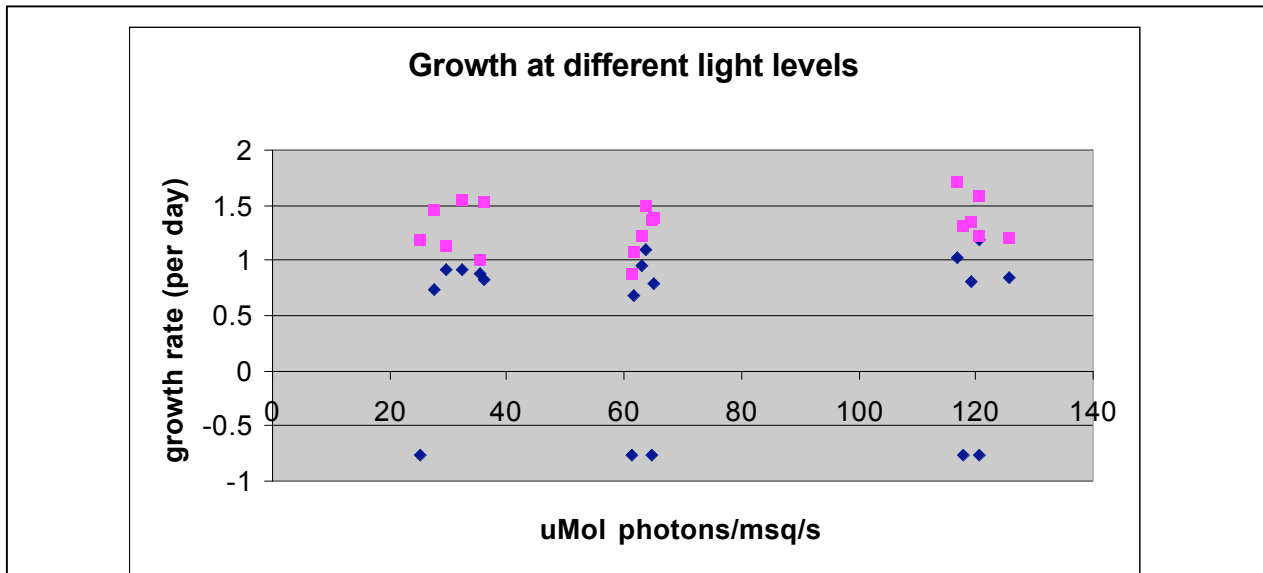
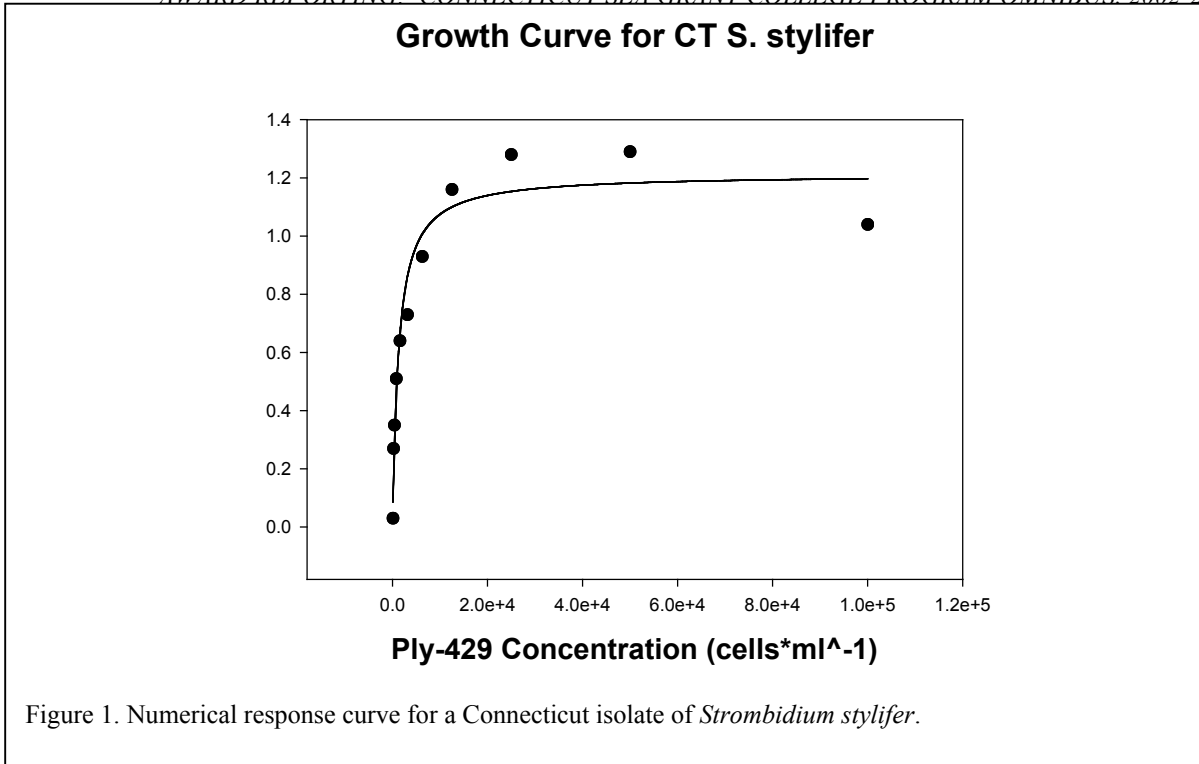
Dr. Gary Wikfors (NOAA Aquaculture lab at Milford CT) has been advising us on larval feeding.

ACCOMPLISHMENTS:

The organism we have selected for its potential use as a food organism for marine aquaculture is *Strombidium stylifer*, a planktonic oligotrich ciliate. Unlike most of its congeners and other close relatives in the ciliate world, *S. stylifer* can be reliably isolated from the environment, nearly “on demand”. We have obtained isolates from coastal waters in Scotland, Brazil and several sites on the Northeast US coast. Also unlike many other ciliates, it is readily cultivable. We have maintained some isolates in the laboratory for two years. Thus, it holds promise for use as a food organism, especially in parts of the world that do not have access to culture collections or funds to purchase and maintain commercially-available feeds.

To date, we have focused on four main issues: 1) obtaining a variety of isolates from Connecticut; 2) quantifying growth and feeding rates *in vitro*; 3) studying effects of light on growth rates; and 4) evaluating effects of length of time in culture on physiological performance, particularly food-saturated growth rates.

Figure 1 shows a typical “numerical response” curve for effect of food concentration on growth rate. The flat part of the curve, above about 10,000 cells/ml food concentration, indicates that for this experiment, the maximum growth rate was between 1 and 1.2 per day. The steepness of the initial part of the curve indicates that this species reaches its maximum rate at a relatively low food concentration (a few hundred cells per ml). This is because this ciliate is a mixotroph, using the chloroplasts from ingested food to perform photosynthesis. Because of its low food requirements, we think it will be an efficient food source for marine aquaculture.



Strombidium stylifer is an obligate mixotroph. Although it obtains nutrition from ingesting microalgae, its supplementation of the latter via photosynthesis is required, as indicated by the fact that it will not grow in darkness, even if given saturating food levels. The level of light required for growth is small, however. In two experiments, we found growth to be saturated when light was as low as 25 $\mu\text{Mol photons m}^{-2}\text{s}^{-1}$ (Figure 2). This indicates that high irradiances will not be required to grow this ciliate for aquaculture operations.

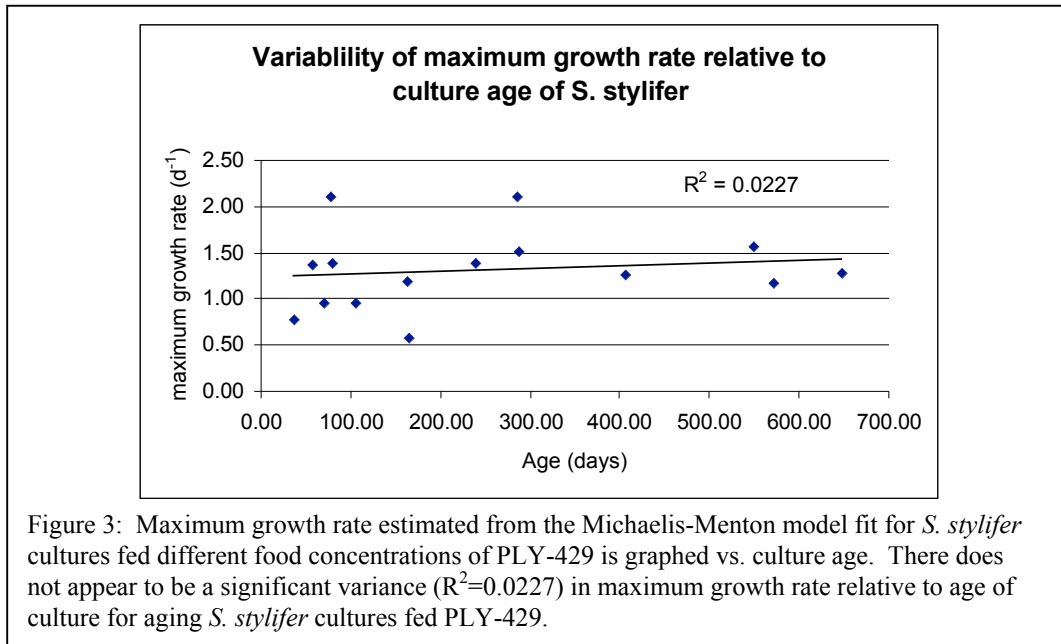


Figure 3: Maximum growth rate estimated from the Michaelis-Menton model fit for *S. stylifer* cultures fed different food concentrations of PLY-429 is graphed vs. culture age. There does not appear to be a significant variance ($R^2=0.0227$) in maximum growth rate relative to age of culture for aging *S. stylifer* cultures fed PLY-429.

One significant issue for the use of *S. stylifer* in aquaculture is whether its physiological vigor can be maintained over many generations in culture. In some ciliates, growth and ingestion rates decline over time under cultivation and cultures “crash” inexplicably as they age. We have maintained some isolates of *S. stylifer* for two years in culture at UConn. To evaluate whether older cultures decline in vigor, we compared maximum growth rates (saturation value in the numerical response curve) from cultures of various ages. Contrary to experiences with other ciliates (Montagnes et al. 1996), *S. stylifer* showed no decline in maximum growth rate over time up in long-term culture (Figure 3). This indicates that aquaculturalists may not face the dilemma of reordering or reisolating the ciliate as often as they otherwise might have.

Future efforts for the remainder of the grant will be focused on measuring the biochemical content (proteins and lipids) of *S. stylifer* and in conducting pilot experiments on feeding with fish larvae.

Montagnes, D. J. S., J. D. Berger, and F. J. R. Taylor. 1996. Growth rate of the marine planktonic ciliate *Strombidopsis cheshiri* Snyder and Ohman as a function of food concentration and interclonal variability. *Journal of Experimental Marine Biology and Ecology* 206:121-132.

BENEFITS AND IMPACTS:

We are developing fundamental information about the physiology of an important planktonic ciliate that appears to be widely distributed in coastal ecosystems. If our efforts to cultivate it on a larger scale are successful it may become the first ciliate that is routinely used in marine aquaculture.

PROJECT PUBLICATIONS AND PRODUCTS: Include published materials with complete references, as well as those which have been submitted but not yet published and those in press. For published articles, please send 12 copies to the Connecticut Sea Grant Communications Office. Include:

Journal Articles:

None to date.

Conference Papers and Presentations:

1. McManus, G. B., Costas, B. A., Snoeyenbos-West, O., Pirog, K., Katz, L. A. A tale of two? ciliates: *Strombidium oculatum* and *S. stylifer* in Atlantic tide pools. American Society of Limnology and Oceanography, Santiago de Compostela, Spain, Jun 2005.
2. Terry, FE, B Costas, G McManus and L Katz. Biogeography of marine ciliates *Strombidium oculatum* and *S. stylifer*. New England Molecular Evolutionary Biologists Meeting, Wellesley, MA, Nov 2005
3. Costas, BA, GB McManus, and A Payson. Understanding the distribution and habitat conditions of morphologically similar tide pool ciliates through the use of molecular probes. American Society of Limnology and Oceanography, Victoria, BC, Jun 2006

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 3

Total number of Masters degree candidates who worked with you: 1

Total number of Ph.D. candidates who worked with you: 0

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name: Katharine Haberlandt

Degree Sought: Master of Science

Thesis or Dissertation Title: Examining the usefulness of the oligotrich ciliate, *Strombidium stylifer*, as a potential food source for marine larval species.

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

A/E-3 Yale/Sea Grant Coastal Internship Program

Check one: This is a Progress Report Final report

Project Title: **Yale/Sea Grant Coastal Internship Program**

Principal Investigator(s) and Affiliation(s):

1. Peter Raymond/ School of Forestry and Environmental Studies, Yale University
2. Martha Smith/ Center for Coastal & Watershed Systems, School of Forestry & Environmental Studies, Yale University

ACCOMPLISHMENTS:

CT Sea Grant funds the only internship program specifically focused on coastal resources at the Yale School of Forestry and Environmental Studies. During this grant period, it has provided a unique opportunity for 11 students to gain practical experience on very different projects. In most cases, students produce a project report at the end of their internship, however due to the nature of some of the projects, other appropriate materials are sometimes produced.

The internships over this grant period generally fall into the following categories:

- Implementing independent research projects which provide scientific information needed by communities to address current resource problems;
- Conducting research and clinical projects within the context of YFES interdisciplinary research initiatives on coastal watershed biophysical and socio-economic health; and
- Providing community outreach and education in collaboration with local citizen groups to increase community involvement in coastal resource protection.

BENEFITS AND IMPACTS:

The Yale/CT Sea Grant internship program provides graduate students with the opportunity to apply their skills and expertise in many different aspects of coastal management. It is not a typical research project that has one geographical or discipline focus. This program has increased the flow of scientific information to coastal communities in many different ways. While some student projects may address a specific immediate need, others provide the basic information to address a larger issue over a long time span. An annotated internship project description follows, with notes regarding the internship benefits to the coastal community and, where the former student is now applying skills learned as a Sea Grant intern.

2004 Internship Projects

Assessment of Wetland Condition: A New Approach for New England Salt Marshes.

Debora Fillis reviewed current coastal wetland assessment techniques used in New England by EPA and state agencies and a “rapid” assessment technique that is proposed as a new standard for the region. She also performed wetland assessments in several Connecticut coastal wetlands using the rapid technique. Deb is now working as the Wetland Monitoring and Assessment Coordinator for the Delaware Department of Natural Resources and Environmental Control.

Great Gull Island Bird Nesting Habitat Restoration.

Maura Leahy investigated the feasibility of using fire, among other methods, to control invasive vegetation on an island bird sanctuary in Long Island Sound. She collected basic information using her semester long research project, enabling her to write a proposal for additional funding for restoration work from the U. S. Fish and Wildlife Service. When it became evident that a simple solution for controlling the vegetation would not be found, Maura presented her initial findings in a poster at the August 2004 Society of Ecological Restoration Conference in British Columbia, soliciting suggestions and comments from conference attendees. Her work has also just been published in the March 2006 issue of Ecological Restoration.

The Birds of the Quinnipiac River Tidal Marsh: Avian Health and Management.

Michelle Murdock reviewed and compiled ecosystem information pertaining to bird life in the Quinnipiac River tidal marsh. Using this information, she highlights the habitat requirements for four native bird species in need of conservation attention in the Marsh. The report concludes with management technique suggestions for enhancing marsh bird habitat. The results were also shared with the New Haven Bird Club. Michelle is currently working on a bird survey in Yosemite National Park.

Heavy metal contaminant levels and transport dynamics of polluted Quinnipiac River sediments in New Haven, CT.

Beth Owen sampled and analyzed sediment cores from the Quinnipiac River bed near an old industrial area slated for redevelopment by the City of New Haven. Beth’s research addressed two components that have potential to contribute to the metal contaminant analysis and sediment transport literature. First, her analyses contributed to the meager analytical data on sediment quality available for the lower Quinnipiac River. Second, her research contributed to the understanding of the relative importance of short and medium-term sediment dynamic in the area.

Beth has recently completed a one-year Knauss Fellowship at NOAA’s Estuarine Reserves Division, and is now working as an education coordinator with the Maine Sea Grant.

A Community Supported Investigation into the Spatial and Temporal Variation of Indicator Bacteria in the Hoosic River Watershed.

Elena Traister implemented a robust water quality sampling program with two objectives: first, to understand where bacterial pollution was a problem within the upper Hoosic River Watershed; and second, to determine the most representative sampling program to characterize water quality. She found that the decreasing forest cover was relational to decreasing water quality; and water quality monitoring, in addition to consideration of weather variations, should be consistent with time of day and year to accurately characterize changing water quality. Elena taught at the Massachusetts College of Liberal Arts this past year, and will begin doctoral program at Yale School of Forestry and Environmental Studies in the fall of 2006.

Hydraulics of Nature-Like Fishways; Velocity Cross-Section Analyses of Sennebec and Guilford Lakes Nature-Like Fishways.

Laura Wildman produced an exemplary project report documenting the design of two nature-like fishways; one in Connecticut and the other in Maine. These multi-species fish passages are more common in Europe, but she hopes this information will promote their wider use in North America. Laura is currently employed by American Rivers and hopes to use the project information she gathered in an American Rivers publication for wider distribution.

2005 Internship Projects

Mercury Cycling in New Haven Rivers: A Comparison of Urban and Non-Urban Watersheds.

Joel Creswell is interested in the relationship of mercury to industrial centers. For his project he analyzed mercury concentrations in water samples from urban and non-urban streams in the New Haven area with the hypothesis that concentrations would be higher in the urban areas than the less developed areas. Initial results were inconclusive, likely due to a small sample set. Joel has been continuing the project through the school year and hope that a larger data set will provide a clearer indication if mercury concentrations in streams are related to the density of development.

Understanding the Impetus, Context and Viability of the Long Island Sound Stewardship Initiative.

Erin Flanagan analyzed the links and impacts between the National Estuaries Program's prescriptive content, the Long Island Sound Study's problem orientation around land use, and the Long Island Sound Stewardship Act's proposed solution to the issue of rehabilitating the Long Island Sound ecosystem. From analyses presented in a class paper, she summarized information into draft fact sheets, describing and explaining descriptive and rehabilitative programs and processes for Long Island Sound. As restoration activities in Long Island Sound continue, a review and analyses by a disinterested "outsider" of current programs can offer insights into their effectiveness.

Mapping Water Stress in the Salmon River Watershed, Southeastern Connecticut.

Emily Levin evaluated whether suburban development in five towns in the Salmon River Watershed poses a threat to natural flow patterns. The study was carried out in partnership The Nature Conservancy's Lower Connecticut River Program. By combining information from GIS land use maps and the water resource requirements of

current and proposed development, she was able to offer an analysis of what impacts increasing suburban development will have on the flow regime of a relatively healthy river. Emily currently works as the Restoration Program Manager for the Ipswich River Watershed Association—a river that has been impacted many demands diminishing its flow regime.

Three Scientific Fact Sheets on Coastal Ecology; A Community Outreach Project.

Judy Preston built on information presented in a graduate class on estuaries to prepare relevant fact sheets for a local community watershed group, the Oyster River Coalition. The fact sheets will be used to educate local landowners about the wetland environments in the community. Three fact sheets, in final review before production, cover the American Oyster, Wetland Soils (redox) and Salt Panne.

Climatic and Anthropogenic Controls on Fecal Coliform Levels in the Norwalk River.

Huiyan Zhao performed a statistical analysis of bacterial water quality data collected in the Norwalk River and analyzed by a local NGO, Earthplace's Harbor Watch/River Watch program. This was an excellent partnership effort as the Earthplace program works with high school students and adult volunteers, teaching them how to collect and analyze water samples. The program has amassed large data sets of water quality data, but further analysis of the data is not being performed. Huiyan was able to use her skills to see if significant patterns could be found in one sample set.

Her analyses of fecal Coliform and E.coli data found higher levels based on proximity to waste treatment plants and rainfall events. She is currently working in an environmental testing laboratory and waiting to hear if her results will be accepted for publication in Water Research.

PROJECT PUBLICATIONS AND PRODUCTS

Journal Articles:

Leahy, Maura K. and Ann E. Camp. 2006. **Making Way for Terns: Restoration at Great Gull Island.** Ecological Restoration 24:1 pp. 36-40.

Conference Papers and Presentations:

Great Gull Island Bird Nesting Habitat Restoration, poster by Maura Leahy at the August 2004 Society for Ecological Restoration conference in British Columbia.

Planned Publications:

Zhao, Huiyan and Peter A. Raymond. **Climatic and Anthropogenic Controls on Fecal Coliforms in the Norwalk River, Connecticut, USA.** Submitted in November 2005 to *Water Research*.

Three Fact Sheets prepared by Judy Preston and targeted for landowners in the Oyster River Watershed

- The American Oyster,
- Wetland Soils (redox), and
- Salt Panne

Other Products:

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 0

Total number of Masters degree candidates who worked with you: 11

Total number of Ph.D. candidates who worked with you: 0

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name	Degree Sought/Awarded:	Thesis or Dissertation Title¹:
Joel Creswell	MESc - 2006	n.a.
Debora Fillis	MEM - 2005	n.a.
Erin Flanagan	MEM - 2006	n.a.
Emily Levin	MEM - 2005	n.a.
Maura Leahy	MESc - 2005	n.a.
Michelle Murdock	MESc - 2005	n.a.
Beth Owen	MEM - 2005	n.a.
Judy Preston	MEM - 2007	n.a.
Elena Traister	MESc - 2005	n.a.
Laura Wildman	MEM - 2004	n.a.
Huiyan Zhao	MESc - 2005	n.a.

¹ As the School of Forestry and Environmental Studies is a professional program, masters students are not required to complete traditional thesis.

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

**Continued Development of an In-Situ Heat Flux Measurement Instrument and
Measurement Program in Long Island Sound (T-11-02 CT)**

Principal Investigator(s) and Affiliation(s):

J. P. Boyle, Ph.D. (Western Connecticut State University) -- sole PI

COLLABORATORS AND PARTNERS: List any additional organizations or partners involved in the project.

Steven N. Long, Director Air-Sea Interaction Research Facility
Observational Science Branch
NASA Goddard Space Flight Center
Wallops Flight Facility

ACCOMPLISHMENTS:

With regard to instrument development three major, significant accomplishments were achieved: (1) the entire electronics package is now incorporated into the Multi-Sensor Float (MSF) allowing for autonomous operation and reducing instrument noise, (2) an on-board accelerometer is now part of the MSF electronics package allowing simultaneous measurement of sea state parameters and (3) the MSF flux plate has been redesigned in partnership with the vendor to improve sensitivity and allow production at a reduce cost.

With regard to flux measurement in western Long Island Sound, the primary achievement was mounting a downwelling longwave radiation instrument on the R/V Connecticut during its July/August 2004 and 2005 transects in western Long Island Sound. These measurements were the first downwelling longwave radiation measurements in far western LIS and represent the only nighttime measurements anywhere in the LIS region.

During the period of the grant, the PI participated in three field programs and two multi-investigator laboratory experiment campaigns, as follows:

August 2003	CBLAST-Low	Martha's Vineyard Coastal Observatory
April 2004	FEDS 2004	NASA Air-Sea Interaction Research Facility
July 2004/2005	RVCT Transects	Western Long Island Sound

Jan/Feb. 2006 MSF Cal0

NASA Air-Sea Interaction Research Facility

A significant amount of training and education also occurred. During the period of the grant, 5 different undergraduate students were employed and taught both practical (e.g., soldering, machining) and research (data analysis) skills. The scientific and measurement issues as well as data collection and analysis concepts associated with NSGO grant T-11-02 CT were incorporated into seven different undergraduate courses taught by the PI, as follows:

MTR 175	Analytical Meteorology
ES 210	Physical Oceanography
MTR 298	Data Analysis and Modeling for Atmospheric Science
MTR 310	Atmospheric Thermodynamics
MTR 320	Meteorological Instrumentation
MTR 450	Senior Research
PHY 510	Thermodynamics

BENEFITS AND IMPACTS

The principle benefit of the MSF is that it is an inexpensive, easily deployable instrument which can be used to simultaneously characterize multiple processes at the air-sea interface, such as net heat exchange, solar radiation, sea surface temperature (SST), sea state and surface currents. Use of this information would improve the scientific understanding of the coupled ocean-atmosphere system to better predict and quantify events such as El Nino/Southern Oscillation and tropical storms.

As indicated below under Technologies and Techniques, we are developing an algorithm to derive radiometric ocean skin temperature using MSF measurements. As the MSF is relatively inexpensive and potentially deployable from aircraft, hundreds could be deployed in an ocean region supporting validation of satellite-based SST.

As indicated below under Technologies and Techniques, the surface contact MSF is an autonomous Lagrangian drifter at the air-sea interface. As such, hundreds could be deployed in an ocean region supporting validation of satellite-based microwave measurements of wind speed parameters.

PROJECT PUBLICATIONS AND PRODUCTS:

Journal Articles:

“Field Results from a 2nd Generation Ocean/Lake Surface Contact Heat Flux, Solar Irradiance and Temperature Measurement Instrument – the Multi-Sensor Float”. J. P. Boyle; In press, 2006: *Journal of Atmospheric and Oceanic Technology*

Conference Papers and Presentations:

“Measurement of Net Ocean Surface Heat Flux, Solar Irradiance, near-Surface Temperature and Sea State using a Surface Contact Lagrangian Buoy,” *Marine Technology Society/IEEE Oceans Conference*, 18 – 21 September 2006 (submitted).

“Characterization of Longwave (Infrared) Radiation Exchange between the Atmosphere and Long Island Sound – with application toward understanding the causes of Hypoxia,”

9th Annual Connecticut State University Faculty Research Conference, 22 October 2005.

“Measurement of Net Ocean Surface Heat Flux, Solar Irradiance and Temperature during the CBLAST-Low field Program using a novel surface contact Multi-Sensor Float,” *16th Symposium on Boundary Layers & Turbulence*, Amer. Meteor. Soc. (J2.5), August 9-12.

“Air/Sea Heat Flux, Solar Irradiance and Temperature Measurement using a Surface Contact Multi-Sensor Float,” *5th Office of Naval Research/Marine Technology Society Buoy Workshop*, March 8 – 10.

Web sites, Software, etc.:

NASA Goddard Space Flight Center Science Highlights Website:

<http://neptune.gsfc.nasa.gov/science/pre/200601>

WCSU Website:

<http://www.wcsu.edu/physics/meteorology-photos.asp>

PATENTS & COPYRIGHTS: List those awarded or pending resulting from this project.

The research measurements performed under NSGO Grant T-11-02 CT are based on an instrument design originally patented under United States Patent 5,020,919 issued 4 June, 1991. Several specific adaptations to this design have been made, but these adaptations are probably not patentable at this time. More field-testing is required and the most recent version of the device is still undergoing improvement.

TECHNOLOGIES & TECHNIQUES: List new technologies or methods developed.

TECHNOLOGIES

The 3rd generation autonomous MSF partially developed using funds available from T-11-02 CT incorporates two new technologies:

Autonomous Flux Package: the original MSF was designed to be tethered to a WOCE-type Lagrangian drifter for data logging, power and telecommunications support. During the course of this grant, the electronics and power supply have been incorporated into the MSF allowing

autonomous operation. This is a significant benefit. Results from the CBLAST-Low field campaign indicated the WOCE-type buoy and the MSF have different drift characteristics which severely limited the operational range of MSF measurements. This constraint is now removed.

On-board dual and triple axis accelerometers: The MSF must be light and wave following to ensure the flux plates are maintained within the aqueous thermal conductive sub layer. Because it is wave following, accelerometers were mounted on the MSF to measure sea state parameters such as wave slope and wave spectrum. Limited tests at the NASA Air-Sea Interaction Research Facility were successful.

METHODS

Two important oceanic variables can be derived using measurements from the 3rd generation autonomous MSF and new methods associated with NSGO grant T-11-02 CT, as follows:

Derived SST: Thermocouples embedded within the flux plates measure water surface temperature. Preliminary data from an infrared imaging camera and infrared pyrometer collected in January and February 2006 at the NASA Air-Sea Interaction Research Facility indicate these temperatures are 0.15 –0.25 K lower than radiometric water skin temperature. We are developing an algorithm, using simultaneous net heat flux measurement, to derive SST from the *in-situ* thermocouple measurement. As the MSF is relatively inexpensive and potentially deployable from aircraft, hundreds could be deployed in an ocean region supporting validation of satellite-based SST.

Measured Surface Currents: The MSF is a light, wave-following, autonomous surface drifter buoy which may be capable of accurate measurement of wind-driven surface currents. Based on preliminary estimates of surface current data collected during experiments in January and February 2006 at the NASA Air-Sea Interaction Research Facility, we anticipate MSF measured surface drift rates will be consistent with values obtained using standard techniques such as CODAR.

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: [0]

Total number of undergraduates who worked with you: [5]

Total number of Masters degree candidates who worked with you: [0]

Total number of Ph.D. candidates who worked with you: [0]

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

R/ES-19 Evaluation of the importance of ship hull fouling by privately-owned vessels as a vector for the transport of invasive species along the Eastern Seaboard (National Strategic Investment)

Check one: This is a Progress Report Final report

Project Title: Evaluation of the importance of ship hull fouling by privately-owned vessels as a vector for the transport of invasive species along the eastern seaboard

Principal Investigator(s) and Affiliation(s):

1. Robert B. Whitlatch
2. Richard W. Osman
3. Nancy Balcom

Affiliation(s) (e.g., University or Organization)

1. University of Connecticut
2. Smithsonian Environmental Research Center
3. Connecticut Sea Grant College Program

GOALS AND OBJECTIVES: Summarize project goals and objectives. If you have already completed a Project Summary page for this research project, this section only needs to be completed if goals and objectives have *changed significantly*.

The 4 objectives of the project are: 1. Determine the degree of hull fouling on privately-owned sail and power vessels which make regular voyages between the east coast of Florida and New England, 2. Examine the survivorship of hull fouling species as the vessels move from southern to northern eastern seaboard waters to assess which species are most likely to become established in New England waters, 3. Assess the effectiveness of different hull maintenance protocols and/or vessel transit pathways for reducing or eliminating the transport of hull fouling species, and 4. Work with Sea Grant Marine Advisory Programs located along the eastern seaboard to provide information to marina operators and vessels owners regarding potential problems of hull fouling as a transport vector of invasive species.

ACCOMPLISHMENTS

While we are still in the process of analyzing information collected, to date we have sampled the hulls of more than 80 vessels and the pilings and floating docks of 15 marinas ranging from Florida to Rhode Island. The vessels examined ranged in size from 34' to 155'; 32% were sailing vessels and remaining 68% were power craft.

Sampling consisted of diver surveys which recorded the percentage of fouling on the hull, keel, rudder, propeller shaft, propeller and, when available, the bow thruster. Underwater digital photographs were taken when fouling was discovered in order to provide a quantitative estimate of percent cover of fouling organisms as well as permanent record of which species were found on particular sections of the hull. Voucher specimens were taken with an underwater suction sampler in order to confirm taxonomic identifications. Marina sampling consisted of taking 10 haphazardly positioned quantitative underwater photographs and 5 quantitative suction-samples at each of several locations in addition to diver surveys in order to obtain representative estimates of the species and relative percent coverage of fouling organisms on docks and pilings.

The degree of hull fouling on the vessels varied from zero to heavily fouled and no correlation was found between the degree of fouling and vessel size or where the vessel was moored at the time of sampling. The hulls of sail boats had a slightly higher number of fouling species on them than power craft. Of the vessels sampled, 75% had some degree of fouling ranging from lightly (1-10%) to heavily fouled (81-100%) surfaces. The highest level of fouling (~20-40% cover) was typically found to occur on the rudders, propeller and propeller shafts of the vessels. Most of the vessel hull fouling ranged from 0-10% cover, while the keels of the vessels normally had little (<5% cover) to light (5-10% cover) fouling. A variety of taxa were found on the vessel hulls with the most common groups being barnacles, bryozoans and polychaete worms. Less common groups included ascidians, sponges, and bivalves.

Preliminary analysis indicates the species fouling the vessel hull were generally correlated with the fouling fauna found where the vessel was moored in its winter port. Several vessels arriving in Mystic, CT and Newport, RI from the Ft. Lauderdale area had extensive fouling of non-native species. Many of these species appeared to be stressed or moribund.

Our preliminary findings indicate that vessels moving from southern to northern waters take a variety routes along the eastern seaboard. Some rely heavily on using the inland coastal waterway while others transit in coastal waters with 2-4 stopovers during their journey. A few vessels leave Florida, move to Bermuda and then transit to CT or RI waters. We found that while many vessels had their 'winter' port in Florida, the vessels would often make cruises into the Carribean; thus potentially acting as a vector of transport of hull fouling species from this area into Florida. While present sample size is relatively small, our hull fouling surveys seem to suggest that vessels traveling northward and spending more time in brackish water conditions (e.g., upper Chesapeake Bay) were less fouled than vessels which transited in more open water conditions.

Most vessel operators followed a very regular schedule of hull maintenance. This usually involved yearly or bi-yearly renewal of bottom anti-fouling paints and periodic inspection of the

hull to assess the degree of hull fouling. Most operators relied on copper-based anti-fouling paints. Some operators used brushes or coarse, woven clothes to periodically remove fouling organisms from their vessel hulls.

BENEFITS AND IMPACTS

Once aquatic nuisance species have invaded a particular region, they are very difficult of impossible to control. Defining the vectors of invasive species transport is critical to our understanding of alien species movement how to manage the vectors in order to reduce/eliminate transport of the non-native species. Vessel hull fouling is recognized as a primary transport vector of many marine invaders and privately-owned vessel hulls represent an important transport vector along the eastern seaboard. Our proposed work will identify the extent of annual movements of non-native species along the eastern seaboard via privately-owned craft and evaluate protocols to reduce the transport of these species.

PROJECT PUBLICATIONS AND PRODUCTS

Journal Articles:

Whitlatch, R.B., R.W. Osman and S.G. Bullard. Distributions and organism-habitat associations of non-native marine fouling species along the U.S. eastern seaboard. Being prepared for submission to *Bioinvasions*

Whitlatch, R.B. and R.W. Osman. Recreational vessel hull fouling as a vector for the transport of non-native species along the U.S. eastern seaboard. Being prepared for submission to *Science or Nature*.

Conference Papers and Presentations:

Whitlatch, R.B, R.W. Osman and N.C. Balcom. 2005. The role of recreational vessels as potential transport vectors for non-native species. Benthic Ecology Meeting, Quebec, Canada

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.:

Technical Reports / Other Publications:

Whitlatch, R.B. 2005-06. Unwanted guests: What's hitching a ride on your vessel? *Ocean Navigator*, May/June. Issue 146: 12-13.

Balcom, N.C. 2005-06. Hull fouling's a drag on boats and local ecosystems. *Wracklines* 5: 14-17. Connecticut Sea Grant CTSG-06-04

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 4

Total number of Masters degree candidates who worked with you: 1

Total number of Ph.D. candidates who worked with you: 0

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name: Jeffery Mercer

Degree Sought: MS.c.

Thesis or Dissertation Title: Regional comparisons of invasive species diversity along the U.S. eastern seaboard: Effects on transport potential

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

**R/ES-20 The control and economics of aquatic invasive species in marine aquaculture
(National Strategic Investment)**

Check one: This is a Progress Report Final report

Project Title: Aquatic Invasive Species Research: The control and economics of aquatic invasive species in marine aquaculture

Principal Investigator(s) and Affiliation(s):

1. Robert B. Whitlatch, University of Connecticut
2. Richard W. Osman, Smithsonian Environmental Research Center
3. Sandra E. Shumway, University of Connecticut
4. Charles Adams, University of Florida
5. Tessa Getchis, CT Sea Grant College Program

GOALS AND OBJECTIVES: Summarize project goals and objectives. If you have already completed a Project Summary page for this research project, this section only needs to be completed if goals and objectives have *changed significantly*.

1. Determine the degree to which the invasive ascidians affect the growth and mortality of shellfish that they foul. 2. Determine the effectiveness of biological control to prevent or impede the recruitment of invasive ascidians into shellfish populations. Studies will focus on the use of native gastropods *Mitrella lunata*, *Anachis lafresnayi*, *Anachis avara* that we have shown to consume large quantities of ascidian recruits but not shellfish. The potential advantage of preventive biological control is that once inoculated with the predators, future treatment may be unnecessary. 3. Determine the effectiveness of treatment of shellfish populations to control fouling and damage by invasive ascidians. Studies will focus on the use of calcium oxide (quicklime), brine, or freshwater. These low-cost treatments have the potential to kill the ascidians with little or no impact on the shellfish. 4. Determine the economic implications associated with fouling by invasive species and the economic cost/benefits associated with treatment and biological control.

ACCOMPLISHMENTS

We conducted a series of preliminary experiments examining the effects of the recent invasion colonial ascidian, *Didemnum* sp., on the growth and survival of blue mussels, bay scallops and eastern oysters. These experiments consisted of using different size classes of shellfish (20 large and 50 small shellfish per bag with 7 replicates per treatment) and enclosing them in vexar mesh bags and adding colonies of the ascidian to the bags. The bags were deployed at a field site near the Avery Point campus for two months. Upon retrieval the bags were processed to obtain the following information: individual shellfish growth and survival. Digital photographs were taken of the bags and shellfish to determine the extent of ascidian growth. The shellfish were frozen for latter estimates of condition index. While we are still processing the data, preliminary results indicate the ascidian had no significant effects on the survival of oysters, scallops and mussels. Scallop growth was negatively affected by an increasing amount of *Didemnum* overgrowth.

We also organized a special session on biofouling at the 98th Annual Meeting of the National Shellfisheries Association, Monterey, CA, March 26-30, 2006. The special session consisted of 13 scientific presentations: B. Hayden (NIWA, New Zealand), S. Bullard (University of Hartford), A. Brand (University of Liverpool), L. Rodriguez (University of California, Davis), J. Greene (University of New Hampshire), P. Barnes (Malaspina University-College), B. Dewey (Taylor Shellfish, WA), P. Gribbon (University of New South Wales, Australia), C. Carver (Mallet Research Services, Newfoundland), V. Maxwell (Louisiana Sea Grant Development Program), N. LeBlanc (Atlantic Veterinary College, Prince Edward Island), S. Fisher (Pittsburg, Paint and Glass), C. Adams (University of Florida). Approximately 150 individuals attended the special session.

BENEFITS AND IMPACTS

This research will quantify the threat of invasive species to commercially-important shellfish, test various methods that can be used to eliminate or control these invaders, and assess the economic implications of fouling and alternative control measures. This information will be important to both mariculturists and managers of these resource species.

PROJECT PUBLICATIONS AND PRODUCTS

Journal Articles:

Conference Papers and Presentations:

Bullard, S., R.B. Whitlatch, R.W. Osman and S.E. Shumway. 2006. Impacts of the colonial ascidian *Didemnum* sp. on mussels, oysters and scallops. 98th Annual Meeting of the National Shellfisheries Association, Monterey, CA.

Adams, C., S.E. Shumway, R.B. Whitlatch and T. Getchis. 2006. The economic implications associated with biofouling in shellfish aquaculture. 98th Annual Meeting of the National Shellfisheries Association, Monterey, CA

Technical Reports / Other Publications:

Bullard, S., R.B. Whitlatch, S.E. Shumway and R.W. Osman. 2005-06. Scientists crying 'foul': Sea squirt are invading Long Island Sound. *Wracklines* 5: 2-7. Connecticut Sea Grant Program CTSG-06-04

Gethis, T.S. 2005-06. What's putting aquaculturists in a 'foul' mood? *Wracklines* 5: 8-10.
Connecticut Sea Grant Program CTSG-06-04

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of K-12 students who worked with you: 0

Total number of undergraduates who worked with you: 4

Total number of Masters degree candidates who worked with you: 0

Total number of Ph.D. candidates who worked with you: 0

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles. (Cut and paste as needed.)

Student Name:

Degree Sought:

Thesis or Dissertation Title:

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

Earth Grant Geospatial Technology Program

Check one: This is a Progress Report Final report

Project Title: Support of the Earth Grant Geospatial Technology Program

Principal Investigator(s):

1. Michael (Sandy) Prisløe

Affiliation(s) (e.g., University or Organization)

1. UConn, College of Agriculture and Natural Resources, Cooperative Extension System

Associate Investigator(s)

1. Chester Arnold

2. Daniel Civco, Ph. D.

Affiliation(s)

1. UConn, College of Agriculture and Natural Resources, Cooperative Extension System

2. UConn, College of Agriculture and Natural Resources, Natural Resources Management and Engineering

OBJECTIVES

The Earth Grant Geospatial Technology Program at UConn is one of 14 similar programs nationwide that have been established since 2000 and that are being supported through a variety of funding mechanisms by NOAA, NASA and USDA. The long-term goal of the national effort is to create a Geospatial Extension Specialist position in all 50 states and Puerto Rico. Each state program is designed and implemented locally to best meet the needs within the state.

Geospatial technologies include geographic information systems (GIS), satellite and airborne remote sensing (RS), global positioning systems (GPS) and other automated technologies that use and/or create spatial information. The UConn Geospatial Technology Program focuses on introducing these state-of-the-art technologies to new and potential users through seminars, workshops, and hands-on training classes. The program helps municipal agencies, businesses, non-profit organizations and others determine how geospatial technologies can be integrated into

their day-to-day operations to improve information management, planning, analysis and decision making.

RATIONALE

Geospatial technologies are relatively new but very important technologies that are just finding their way into business and municipal government applications. There are too few experts in the use of these technologies employed in business and government to fully exploit their potential. The purpose of the Geospatial Technology Program is to help inform potential users about geospatial technology, geospatial datasets and applications. To this end the program serves to facilitate the adoption and use of appropriate geospatial technology to improve business and municipal government operations.

ACCOMPLISHMENTS

The Earth Grant Geospatial Technology Program (GTP) is an ongoing program that has become a core educational/outreach component of the Center for Land Use Education and Research (CLEAR). The GTP has developed two hands-on training courses:

- Geospatial Technologies at Work – An intensive five-day course that teaches students how to use ArcView®, a desktop GIS, and that introduces many of Connecticut's public domain GIS datasets.
- GPS for GIS – A one-day course that teaches students how to use a global positioning system to acquire data for use in a GIS.

The Geospatial Technologies at Work course is offered each January and June and is limited due to teaching laboratory facilities to 15 participants. To date over 100 individuals, representing municipal and state governments, state agencies, academia, NGOs, and private businesses, have taken the course. The GPS for GIS course is offered on an irregular basis. Approximately 50 individuals have taken this training.

The GTP organized and sponsored a Remote Sensing workshop, held at UConn, Storrs in August 2003, to introduce attendees to remote sensing technology and applications. Over 100 individuals attended.

The GTP has successfully applied for and engaged in several externally funded research projects. These have included research into methods to measure impervious area of watersheds (supported by the Institute for Water Resources) and the use of high resolution satellite imagery to detect and map *Phragmites australis* (supported by the Institute for the Application of Geospatial Technology).

BENEFITS

The GTP was instrumental in the design and development of the Impervious Surface Analysis Tool (ISAT). ISAT is a software extension to ArcView 3.x and ArcGIS 8.x that estimates the percent area of a watershed that is covered with impervious surfaces. Code for the tool was written by staff at the NOAA Coastal Services Center. ISAT is available for download from the

NOAA CSC's web site at <http://www.noaa.gov/crs/is>. To date over 400 individuals have downloaded the software.

PROJECT PUBLICATIONS AND REPORTS

Journal Articles

Wilson, E.H., J.D. Hurd, D.L. Civco, M.P. Prisloe, C. Arnold. 2003. Development of a geospatial model to quantify, describe and map urban growth. *Remote Sensing of Environment* 86: 831-838.

Civco, D.L., J.D. Hurd, E.H. Wilson, C.L. Arnold, and S. Prisloe 2002. Quantifying and describing urbanizing landscapes in the northeast United States. *Photogrammetric Engineering and Remote Sensing* 68(10):1083-1090.

Other articles, such as proceedings or book chapters:

Chabaeva, Anna A., Civco, D. L. and S. Prisloe. "Development of a Population Density and Land Use based Regression Model to Calculate the Amount of Imperviousness." ASPRS Annual Conference Proceedings, Denver, CO, May 23-28, 2004.

Hurd, James D., E. H. Wilson, D. L. Civco, S. Prisloe and C. Arnold. In Press. Temporal characterization of Connecticut's landscape: methods, results and applications. Proceedings of the American Society of Photogrammetry and Remote Sensing Annual Conference, Anorage, AK. May 5-9, 2003.

Prisloe, M., Giannotti, L. and W. Sleavin. "Determining Impervious Surfaces for Watershed Modeling Applications." Proceedings: 8th National Nonpoint Source Monitoring Workshop." EPA/905-R-01-008, October 2001, 178-194.

Technical Reports / Other Publications:

Training course manuals

Geospatial Technologies at Work Five-day hands-on training course

GPS for GIS One-day hands-on training course

STUDENTS: We are expected to document how many students at various education levels are supported by our research and education projects. Therefore please take a moment to describe students supported directly or indirectly from your award.

Total number of undergraduates who worked with you: [2]

Total number of Masters degree candidates who worked with you: [4]

Total number of Ph.D. candidates who worked with you: []

Student Name: Anna Chabaeva, UConn
Degree Sought: MS
Thesis or Dissertation Title: Development of a Population Density and Land Use Based Regression Model to Calculate the Amount of Imperviousness

Student Name: Cheney Shreve, Wesleyan
Degree Sought: MS
Thesis or Dissertation Title: Estimating the Coverage of *P. australis* in the Wetland Regions of the Connecticut River Using Remotely Sensed Data

Student Name: Brian Holdt, UConn
Degree Sought: MS
Thesis or Dissertation Title: Forest Fragmentation Due to Land Parcelization: a Remote Sensing and GIS Analysis

Student Name: Tracy Krueger, Wesleyan
Degree Sought: MS
Thesis or Dissertation Title: Exploring Ways to Quantify Erosion in Coastal Connecticut Using Remote Sensing, Aerial Photographs and Detailed Ground Surveys

Note: C. Shreve and T. Krueger are affiliated with Wesleyan University. Both were supported with a GTP Fellowship that was awarded through the CT Space Grant College Consortium as part of the Earth Grant Geospatial Technology Program.

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

Nab the Aquatic Invader! A Nationwide Online Educational Program to Direct Attention to AIS Issues and Inspire Action (National Strategic Investment)

Check one: This is a Progress Report Final report

Project Title:

Nab the Aquatic Invader! A Nationwide Online Educational Program to Direct Attention to AIS Issues and Inspire Action (CT portion)

Principal Investigator(s) and Affiliation(s):

1. Nancy Balcom / CT Sea Grant
2. Diana Payne / CT Sea Grant

COLLABORATORS AND PARTNERS: This is a multi-program national education project that involves Principal Investigator Robin G. Goettel, Illinois-Indiana Sea Grant, Helen Domske, New York Sea Grant, Dianne Lindstedt, Louisiana Sea Grant, Jon Luke, Oregon Sea Grant

ACCOMPLISHMENTS

1. Participated in planning meeting in Chicago IL August 2005
2. Surveyed Sea Grant colleagues along East Coast and developed list of ten representative candidate ANS from the East Coast
3. Conducted workshop for formal and informal K-12 educators on Nab and invasive species – introducing them to the website and its resources, and provided paperwork to teachers interested in participating in the development of activities for the East Coast species; 31 March 2006, LIS Educators Conference, Norwalk CT

BENEFITS AND IMPACTS

Not enough progress to date to cite benefits or impacts

PROJECT PUBLICATIONS AND PRODUCTS

NONE to date

STUDENTS: We are expected to document how many students are supported by our projects.

Total number of Ph.D. candidates who worked with you: 1 – Diana Payne

**CONNECTICUT SEA GRANT PROJECT REPORT
2005-2006**

**Interrupting the Flow: A Northeast Regional Sea Grant Education and Outreach
Collaborative Addressing Vectors of Marine Invasive Species Introductions in the
Northeast Region (National Strategic Investment)**

Check one: This is a Progress Report Final report

Project Title: Interrupting the Flow: A Northeast Regional Sea Grant Education and Outreach
Collaborative Addressing Vectors of Marine Invasive Species Introductions in the Northeast
Region

Principal Investigator(s) and Affiliation(s):

1. Nancy Balcom / CT Sea Grant

COLLABORATORS AND PARTNERS: This is a Northeast regional outreach project, with Judy Pederson, PI, MIT Sea Grant, Tracey Crago, WHOI Sea Grant, Rob Gough, Salem Sound Coastwatch, Tracy Hart, ME Sea Grant, Chuck O'Neill, NY Sea Grant, Malia Schwartz, RI Sea Grant, Mark Wiley, NH Sea Grant

ACCOMPLISHMENTS

1. Participated in several regional planning conferences
2. Established steering committees for hull fouling and bait worm/packing sub-projects
3. Developed draft survey for baitworm dealers, submitted to OSP for IRB review
4. Drafted outreach materials for hull fouling, seeking graphic designer to complete

BENEFITS AND IMPACTS

Not enough progress to date to determine benefits and applications – in progress

PROJECT PUBLICATIONS AND PRODUCTS

None completed to date.

SECTION I-B

AWARD REPORTING: CONNECTICUT SEA GRANT LONG ISLAND SOUND LOBSTER RESEARCH INITIATIVES

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA16RG1364

Project Title: CONNECTICUT SEA GRANT LONG ISLAND SOUND LOBSTER
RESEARCH INITIATIVES

Time Period: 07/01/2001 - 12/31/2006 (This report for period March 1, 2005 – March 31,
2006)

Accomplishments and Outcomes: See Below

Lobster Research Initiative (Development funds):

1. Lobster development funds provided partial support for the printing of the special issue reporting the results of the lobster health research initiative in the *Journal of Shellfish Research* in October 2005. Support was also provided by NOAA Fisheries, NY Sea Grant, CT Dept. Environmental Protection, NYS Department of Environmental Conservation, and CTSG Extension.
2. The Steering Committee for Lobster Disease Research reviewed outstanding questions regarding the pesticide modeling efforts and sought proposals to determine lobster LC50s for the pesticide sumithrin. A contract with Hydroqual to conduct additional modeling was agreed upon and put into place (through NY Sea Grant).
3. A second no-cost extension for the remaining lobster development funds was requested and approved, to facilitate the funding of the anticipated work on sumithrin.

Lobster Extension Program

1. Balcom served as co-editor with Dr. Anthony Calabrese, NOAA Fisheries (retired) for the special lobster research issue of the *Journal of Shellfish Research* 24(3), published in October 2005. 24 manuscripts were peer-reviewed and edited. Balcom also coordinated the printing of the issue with Dr. Sandra Shumway, editor of the journal for the National Shellfisheries Association.
2. Balcom co-authored the lead article of the issue with Dr. Jack Pearce, NOAA Fisheries (retired). The article synthesized the collective results of the extensive research initiative.
3. Balcom co-authored a summary report, *Responding to a Resource Disaster: American Lobsters in Long Island Sound 1999-2004*, with Penny Howell, CT Department of Environmental Protection. The 24-page report was sent to more than 600 state and federal legislators in Connecticut and New York, and distributed to members of the lobster industry, media, state and federal resource agencies, and the interested public. More than 1,000 copies have been distributed to date.
4. Balcom and fisheries extension specialist, Antoinette Clemetson of NY Sea Grant, completed their joint bi-state lobster extension program by co-authoring a perspective piece for *Fisheries*, on the effects of litigation on the lobster extension and research programs. The article was accepted for publication in the June 2006 issue.

5. Balcom was invited to give two presentations on the results of the lobster research initiative: to the Northeastern Mosquito Control Association during their annual meeting in November 2005 in Northhampton, MA, and for the UConn Coastal Perspectives Lecture Series in March 2005. (This presentation was taped and aired on the local CT-N cable access channel in April 2005.)
6. A formal evaluation to assess both the research initiative and the extension component was undertaken by CTSG in fall 2005, using written survey tools.

SECTION I-C

AWARD REPORTING: JOHN A. KNAUSS MARINE POLICY FELLOWSHIP - CONNECTICUT - BOZZI

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA05OAR4171025

Project Title: John A. Knauss Marine Policy Fellowship - Connecticut - BOZZI

Time Period: 02/01/2005 - 01/31/2006 (This report for period March 1, 2005 – March 31, 2006)

Accomplishments and Outcomes

Laura Bozzi's Knauss Fellowship was completed successfully. Ms. Bozzi, who graduated from Yale University in 2004, was placed on the NOAA Science Advisory Board. As a Knauss Fellow, she was able to attend Congressional hearings, meet with high level NOAA officials. She organized 3 Science Advisory Board meetings and participated in the Board's strategic planning process. Laura left the Fellowship a month early to take a position as Fishery Management Policy Analyst at the Pacific Fishery Management Council in Portland, OR.

About her Knauss experience, Laura said, "The fellowship opens doors – both during the year, when it's possible to attend high level meetings or meet influential and inspiring leaders, and then afterwards, when the network of Knauss alumni and those that know of them is a great help in securing future jobs and opportunities."

Current contact info:

Laura Bozzi

Pacific Fishery Management Council

7700 NE Ambassador Place, Suite 200

Portland, Oregon 97220-1384

Office Phone: (503) 820-2280

SECTION I-D

AWARD REPORTING: KNAUSS MARINE FELLOWSHIP - CONNECTICUT - OWEN

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA05OAR4171043

Project Title: Knauss Marine Fellowship - Connecticut - OWEN

Time Period: 02/01/2005 - 01/31/2006 (This report for period March 1, 2005 – March 31, 2006)

Accomplishments and Outcomes

“Beth” Owen’s Knauss Fellowship was completed successfully. Ms. Owen, who was completing Master of Environmental Management degree at Yale University’s School of Forestry and Environmental Studies, was placed in the NOAA Estuarine Reserves Division for her Knauss Marine Policy Fellowship. She became the Estuarine Reserve Division’s Policy and State Partnership Development Coordinator, and worked with various state agencies and university partners around the nation. Beth had oversight and management of two reserves in California, the Elkhorn Slough Reserve and the San Francisco Bay Reserve. She also took on some communications duties and prepared Monitoring Reports on the Reserve System’s System-wide Monitoring Program, which included information on site-based research, coastal management, and education applications of monitoring data collected over a ten-year period. Beth is now Education Coordinator for Maine Sea Grant in Orono, ME.

About her Knauss experience, Sarah said, “I expected to (and did indeed) gain a new perspective on marine, coastal, and estuarine science, policy, and education issues, since I had never worked in state or federal government before....the experience was very valuable.”

Current contact info:

Beth Owen

Maine Sea Grant College Program

The University of Maine

5784 York Complex

Orono, Maine 04473

207-581-1440 - phone

207-581-1426 - fax

beth.owen@maine.edu

SECTION I-E

AWARD REPORTING: CONNECTICUT SEA GRANT COLLEGE PROGRAM OMNIBUS, 2006-2008

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA06OAR4170072

Project Title: Connecticut Sea Grant College Program Omnibus 2006-2008: Continuing Sea Grant College Support for March 2006 Through February 2008

Time Period: 03/01/2006 - 02/28/2008 (This report for period March 1, 2005 – March 31, 2006)

Accomplishments and Outcomes:

As of March 31, 2006 the funds for this award had not yet been received from NOAA. Hence, no substantive activities occurred on this award between March 1, 2005 and March 31, 2006.

SECTION I-F

AWARD REPORTING: DEVELOPMENT OF AN INTEGRATED RECIRCULATING AQUACULTURE SYSTEM FOR NUTRIENT BIOREMEDIATION IN URBAN AQUACULTURE

Grantee: University of Connecticut, Connecticut Sea Grant College Program

Award Number: NA16RG1635

Project Title: DEVELOPMENT OF AN INTEGRATED RECIRCULATING
AQUACULTURE SYSTEM FOR NUTRIENT BIOREMEDIATION IN URBAN
AQUACULTURE

Time Period: 09/01/2001 - 08/31/2005 (This report for period March 1, 2005 – March 31, 2006)

Accomplishments and Outcomes:

Check one: This is a [] Progress Report [] Final report

Project Title: Development of an Integrated Recirculating Aquaculture System for
Nutrient Bioremediation in Urban Aquaculture

Principal Investigator

Charles Yarish

Affiliation

Department of Ecology & Evolutionary Biology, University of Connecticut at Stamford

Associate Investigators

1. Christopher D. Neefus
2. George P. Kraemer
3. Thierry Chopin
4. George Nardi
5. John Curtis

Affiliations

1. Department of Plant Biology, University of New Hampshire, Durham, NH
2. Department of Environmental Sciences and Biology, Purchase College, SUNY
3. Department of Biology, University of New Brunswick, Saint John, NB, CANADA
4. Great Bay Aquaculture, Portsmouth, NH
5. Bridgeport Regional Vocational Aquaculture School, Bridgeport, CT

OBJECTIVES:

Objective 1: Develop and demonstrate the performance of a continuously operating, integrated recirculating aquaculture system, from which finfish and marine plant biomass is harvested;

- Objective 2: Demonstrate that acceptable water quality can be maintained in such a system and that effluent nutrient levels are well below guidelines being developed by the EPA;
- Objective 3: Compare four candidate native species of *Porphyra* to act as biofilters and as crops;
- Objective 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);
- Objective 5: Provide education in the technical and scientific aspects of aquaculture at both high school and university levels.

ACCOMPLISHMENTS:

While fish culture is well understood, little was known about tank culture of *Porphyra*. The large-scale tank system was constructed for the project adjacent to the Great Bay Aquaculture (GBA) fish hatchery (Fig. 1, appended photos). There are two modular systems (6 m X 12 m footprint) each consisting of four 3,200 L tanks; one tank grows fish, the other three contain seaweed. A similar system was replicated at Bridgeport (CT) Regional Vocational Aquaculture School (BRVAS; Fig. 2).

Overlapping data sets at three scales (1, 50, and 3200 L) produced generally consistent results. Growth rate, N uptake, and pigment content were temperature dependant, with species-specific optima. *Porphyra linearis*, for example, grows best at 10°C, while *P. amplissima* performs best at 20°C. Low light and elevated nutrient availability produced tissue with high pigment content. Although the growth rates of *P. amplissima* and *P. dioica* were reduced in the dark, the thalli still removed ammonium (Fig. 3). The European species, *Porphyra dioica*, was in culture as part of doctoral research conducted in the UConn lab. All work with that taxa was within the lab and material was discarded after autoclaving. Growth of *Porphyra* was not photo-inhibited at full sunlight, and saturated at levels < 10% of full sunlight, advantageous since commercial applications use high densities with low light levels.

The effluent exiting GBA's cod grow-out tanks was rich in inorganic nutrients (120 μM NH_4^+ , 2,600 μM NO_3^- , 20 μM PO_4^{3-}) *Porphyra amplissima* grew faster on a medium of undiluted effluent than on diluted effluent, but slower in Von Stosch medium than in the effluent (Fig. 4). Stocking density affected growth rate and biomass yield (and, hence, N removal; Fig. 5). Growth limitation at high densities probably resulted from ammonium and carbon limitation. We found evidence of ammonium toxicity for *P. amplissima*; growth rates at 2500 μM were less than 25% of rates at 300 μM (Fig. 6).

The system at GBA has been successfully operated with Atlantic Cod in combination with three species of *Porphyra* (*P. umbilicalis*, *P. amplissima*, *P. linearis*). The system has been running for nearly a year, alternating between flow-thru mode and integrated recirculating mode. The cod have grown to 650 g (7-fold increase). We routinely monitored water quality, fish growth rates, nori growth rate, pigment production, and nitrogen removal (Fig. 7). We have generated a predictive model of the nutrient levels that should be maintained in the system for different fish:seaweed biomass ratios (Fig. 8). Ammonium levels maintained during integrated operation were well below stress levels for the fish and in some cases were below the concentrations in water coming into GBA from Great Bay.

The yet-unresolved problem impeding the immediate project application is the limited productive lifespan of *Porphyra*. Reproduction is apparently triggered after growth to a certain size, with declines in photosynthetic, and nutrient uptake, and growth rates. Objective 6 (Provide business model for start-up and operation of an urban aquaculture business based on integrated

finfish/seaweed recirculating aquaculture system) was not completed, due to the mid-course reduction in funding.

BENEFITS:

We have developed a working prototype system at demonstration scale (4 x 3200 L). Results demonstrate that an aquaculture system that integrates finfish and *Porphyra* generates commercially valuable biomass while remediating eutrophic fishfarm effluent. GBA continues to use the system to polish water as part of its recirculating seawater system. BRVAS uses the system as a curricular tool. The project has identified research areas for further investigation. The economic viability of the project remains to be evaluated.

The educational component of the project was large; two graduate students conducted thesis work as part of the project (two of which are continuing to investigate aspects of the biology of *Porphyra* in an integrated aquaculture context). Eight undergraduate students received training in research methodologies and data analysis. One high school Science Scholar completed a three-month long project that dovetailed with team research.

PUBLICATIONS AND PRESENTATIONS

A. Book Chapters

- Chopin, T., Yarish, C., and Sharp, G., 2005 - Beyond the monospecific approach to animal aquaculture ... the light of integrated aquaculture. In: Ecological and Genetic Implications of Aquaculture Activities. T. Bert (Ed.). Kluwer Academic Publishers, Dordrecht (in press).
- McVey, J.P., Stickney, R.R., Yarish, C., and Chopin, T., 2002 - Aquatic polyculture and balanced ecosystem management: new paradigms for seafood production: 91-104. In: *Responsible Marine Aquaculture*. Stickney R.R. and McVey J.P. (Eds.). CABI Publishing, Oxon, 391 p.
- Rawson Jr., M.V., Chen, C., Ji, R., Zhu, M., Wang, D., Wang, L., Yarish, C., Sullivan, J.B., Chopin, T., and Carmona, R., 2002 - Understanding the interaction of extractive and fed aquaculture using ecosystem modeling: 263-296. In: *Responsible Aquaculture*. Stickney R.R. and McVey J.P. (Eds.). CABI Publishing, Oxon, 391 p.
- Sahoo, D. and C. Yarish. 2005. Mariculture of seaweeds. In R. Andersen (Ed.). *Psychological Methods: Algal Culturing Techniques*. Ch. 15. Academic Press, Elsevier Publ. pp. 219-237.

B. Full-length articles in refereed journals

- Broom, J.E., W.A. Nelson, C. Yarish, W.A. Jones, R. Aguilar Rosas, L.E. Aguilar Rosas. 2002. A reassessment of the taxonomic status of *Porphyra suborbiculata*, *Porphyra carolinensis* and *Porphyra lilliputiana* (Bangiales, Rhodophyta) based on molecular and morphological data. *European J. Phycology*. 37:227-235.
- Carmona, R., G.P. Kraemer, C. Yarish. 2005. In press, 2005. Exploring Northeast American and Asian species of *Porphyra* for use in an integrated finfish-algal aquaculture system. *Aquaculture*.
- Chopin, T., Buschmann, A.H., Halling, C., Troell, M., Kautsky, N., Neori, A., Kraemer, G.P., Zertuche-Gonzalez, J.A., Yarish, C., and Neefus, C., 2001 - Integrating seaweeds into marine aquaculture systems: a key towards sustainability. *J. Phycol.* 37: 975-986.
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- Neefus, D.D., A.C. Mathieson, A.S. Klein, B. Teasdale, T. Bray and C. Yarish. 2002. *Porphyra birdiae* sp. nov. (Bangiales, Rhodophyta): A new species from the Northwest Atlantic. *Algae* 17 (4): 203-216.
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- Pedersen, A., G. Kraemer and C. Yarish. 2004. The effects of temperature and nitrogen in nutrient uptake in different species of *Porphyra* from Long Island Sound (US). *J. Exp. Mar. Biol. & Ecol.* 312: 235-252.
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C. Papers in Refereed Conference Proceedings

- Carmona, R., Chanes, L., Kraemer, G., Chopin, T., Neefus, C., Zertuche, J.A., Cooper, R., and Yarish, C., 2002 - Nitrogen uptake by *Porphyra purpurea*: its role as a nutrient scrubber. *In: Proceedings of the Fifth Biennial Long Island Sound Research Conference, Stamford, USA: 87-91.* Van Patten P. (Ed.). *Connecticut Sea Grant College Program, Groton, USA*, 152 p.
- Chopin, T., Yarish, C., Neefus, C., Kraemer, G., Zertuche-Gonzalez, J., Belyea, E., and Carmona, R., 2001 - Aquaculture from a different angle: the seaweed perspective, and the rationale for promoting integrated aquaculture. *In: Marine Aquaculture and the Environment: a Meeting for Stakeholders in the Northeast. Proceedings of the Workshop, Boston, USA: 69-72.* Tlusty, M.F., Bengston, D.A., Halvorson, H.O., Oktay, S.D., Pearce, J.B. and Rheault Jr., R.B. (Eds.). *Cape Cod Press, Falmouth, XVI + 324 p.*
- Chopin, T., Yarish, C., Sharp, G., Neefus, C., Kraemer, G., Zertuche-Gonzalez, J., Belyea, E., Carmona, R., Saunders, G., and Bates, C., 2001 - Development of integrated aquaculture

- systems for responsible coastal zone management. *In: Aquaculture and its Role in Integrated Coastal Zone Management. Proceedings of the European Aquaculture Society International Workshop, Oostende, Belgium: 77-80. European Aquaculture Society, vi + 145 p.*
- Kraemer, G.P., Carmona, R., Chopin, T., and Yarish, C., 2002 - Use of photosynthesis measurements in the choice of algal species for bioremediation. *In: Proceedings of the Fifth Biennial Long Island Sound Research Conference, Stamford, USA: 113-117. Van Patten P. (Ed.). Connecticut Sea Grant College Program, Groton, USA, 152 p.*
- Rawson Jr., M.V., Chen, C., Ji, R., Zhu, M., Wang, D., Wang, L., Yarish, C., Sullivan, J.B., Chopin, T., and Carmona, R., 2001 - Integration of fed and extractive aquaculture. *In: Proc. International Symposium on Marine Fishery and Aquatic Products Processing Technology, Rongcheng, China, September 11-13, 2001: 263-278. UN Economic and Social Commission for Asia and the Pacific, Proceedings of the Workshop, 690 p.*

D. Published Conference Proceedings

- Chopin, T., C. Yarish, C. Neefus, G. Kraemer, J. Zertuche-Gonzalez, E. Belyea & R. Carmona. 2001. The role of seaweeds in integrated aquaculture and their contribution to nutrient bioremediation of coastal waters. *In: Chopin, T. and P.G. Wells (Eds.). 2001. Opportunities and Challenges for Protecting, Restoring and Enhancing Coastal Habitats in the Bay of Fundy. Proc. 4th Intl. Conference on Coastal Zone Canada. Sept.17-22, 2000. Environment Canada, Atlantic Region Occasional Report No. 17, Environment Canada, Dartmouth, Nova Scotia, pp. 41.*

E. Conference Presentations

The 22nd Milford Aquaculture Seminar, Milford, CT (Feb. 25-27, 2002) as published in a Book of Abstracts. p. 48:

- J.J. Curtis, S.W. Lonergan, P.J. Trupp, P. He, R. Carmona, C. Yarish, G.P. Kraemer, C. Neefus, T. Chopin, G. Nardi. A cooperative study on the aquaculture of *Porphyra leucosticta* (Rhodophyta) for an integrated finfish/seaweed recirculating aquaculture system in an urban application.

The 41th Annual Northeast Algal Symposium, Durham, NH (April 20-21, 2002) as published in a Book of Abstracts:

- Blodgett, M., B. Teasdale, A.S. Klein, C. Yarish, and C.D. Neefus. A northern range extension of *Porphyra rosengurthii* based on molecular identification.
- Yarish, C., P. He, R. Carmona, S. Liu, G.P. Kraemer, C.D. Neefus, T. Chopin, G. Nardi, J. J. Curtis, S.W. Lonergan and P. J. Trupp. The aquaculture of *Porphyra leucosticta* (Rhodophyta) for an integrated finfish/seaweed recirculating aquaculture system in an urban application.

The Annual Meetings of the Botanical Society of America and the Phycological Society of America (Botany 2002):

- Yarish, C., P. He, R. Carmona, S. Liu, G. Kraemer, C. Neefus, T. Chopin, G. Nardi, J. Curtis, S. Lonergan And P. Trupp. The Aquaculture of *Porphyra leucosticta* (Rhodophyta) for a finfish/seaweed recirculating aquaculture system in an urban application. Book of

Abstracts: 83 (Abstract No. 326), 186 p.
(www.botany2002.org/section8/abstracts/32.shtml)

The 3rd Asia-Pacific Phycological Forum, Tsukuba, Japan (Algae 2002):

Kraemer, G.P., C. Yarish and R. Carmona. Comparison of the bioremediation potential of *Porphyra* spp.

Yarish, C., M.V. Rawson, Jr., T. Chopin, D.R. Wang, C. Chen, R. Carmona, L. Wang., R. Ji and J. Sullivan. Ecosystem modeling: A tool to understand the interactions between extractive and fed aquaculture.

The Northeast Aquaculture Conference and Expo and Urban Aquaculture Symposium, Nov. 15-16, 2002, Warwick, RI:

Yarish, C., G. Kraemer, R. Carmona, P. He, X. Tang, C.D. Neefus, T. Chopin, S. Miller, G.C. Nardi and J.J. Curtis. An update on the bioremediation potential of *Porphyra* spp. in an integrated aquaculture system with finfish. The Northeast Aquaculture Conference and Expo (Nov. 15-16, 2002) as published in a Book of Abstracts. p. 23 (invited presentation).

The 42nd Annual Northeast Algal Symposium, Saratoga, NY (April 20-21, 2003):

Kim, J.K., G.P. Kraemer, C.D. Neefus, I. Chung and C. Yarish. Effects of NH₄ and temperature on the growth and nitrogen concentration of *Porphyra*. The 42nd Annual Northeast Algal Symposium, Saratoga, NY (April 20-21, 2002) as published in a Book of Abstracts. p. 21.

Day, J.P., C.D. Neefus, G. Kraemer, C. Yarish and T. Chopin. The effects of light and ammonium on growth, pigmentation and ammonium uptake of native *Porphyra* species. The 42nd Annual Northeast Algal Symposium, Saratoga, NY (April 20-21, 2002) as published in a Book of Abstracts. p. 36.

The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003):

Neefus, C.D., A.C. Mathieson, A.S. Klein, B. Teasdale, T. Bray and C. Yarish. *Porphyra birdiae* Neefus et Mathieson (Bangiales, Rhodophyta): A new species from the Northwest Atlantic. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf, Pp. 96-97 (poster)

Day, J.P., C.D. Neefus, G.P. Kraemer, C. Yarish and T. Chopin. Effects of light and ammonium on growth, ammonium uptake and pigmentation of four *Porphyra* (Bangiales, Rhodophyta) species native to the Northwestern Atlantic. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon

(June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf, Pp. 85 (poster).

Pereira, R., I. Sousa-Pinta and C. Yarish. Studies on the life history of the Portuguese red alga *Porphyra dioica* (Brodie and Irvine) under varying environmental conditions. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf. p. 71.

Kraemer, G. P., R. Pereira, D. Snellgrove, R. Carmona, C. Neefus, T. Chopin and C. Yarish. Algal bioremediation of eutrophic effluents in small scale integrated aquaculture systems. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf. p. 59.

Kim, J.K., G.P. Kramer, C.D. Neefus, I.K. Chung and C. Yarish. A comparison of four native *Porphyra* species from New England in response to ammonium and temperature in small tank system. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf.

Cudiner, S., Gillies, N. and C. Yarish. Benthic marine algal herbarium of Long Island Sound digital collection. The 57th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Glenardon, Oregon (June 14-19, 2003) as published in a Book of Abstracts on the http://www.psaalgae.org/meeting/PSAprogram_Final.pdf.

Long Island Sound Research Conference, Oct. 24-26, 2002, Groton, CT:

Hariskov, S.D., S. Miller, C. Yarish, R. Hamilton. Free amino acids composition of several *Porphyra* species from the East Coast US. Long Island Sound Research Conference, Oct. 24-26, 2002, Groton, CT.

The 43rd Annual Northeast Algal Symposium, Groton, CT, NY (April 23-25, 2004; C. Yarish, Co-convener):

Kim, J.K., G.P. Kraemer, C.D. Neefus, I. Chung and C. Yarish. Effects of temperature and ammonium on growth and nitrogen uptake in four species of *Porphyra*. Published in a Book of Abstracts. p. 31.

Kraemer, G. P., D. Snellgrove, R. Pereira and C. Yarish. Bioremediation of eutrophic aquaculture effluents by *Porphyra*: Diurnal patterns and influence of stocking density. Published in a Book of Abstracts. p. 32.

C. Yarish senior organizer and session Co-Chair of an invited symposium “Seaweed Culture and Integrated Aquaculture Developments” at “Aquaculture – An Ecologically Sustainable and

Profitable Venture for The Meetings of the World Aquaculture Society's Aquaculture 2004 meetings, Honolulu, Hawaii, March 1-5, 2004.

Yarish, C., G. Kraemer, J. Kim, Carmona, P. He, C.H. Sohn, C.D. Neefus, T. Chopin, D. Snellgrove, G.C. Nardi, K. Shadel, J.J. Curtis, R. Pereira. The bioremediation potential of the economically important red alga, *Porphyra*, in an integrated aquaculture system with finfish, published in a book of Abstracts, Pp. 659, abstract #737 (invited presentation);

Neori, A., Thierry Chopin, Max Troell, Alejandro H. Buschmann, George P. Kraemer, Christina Halling, Muki Shpigel, Charles Yarish (abstract #992) Integrated aquaculture: rationale, evolution and state of the art, emphasizing seaweed biofiltration. Published in a book Of Abstracts, Pp. 428, abstract #992 (invited presentation)

Chung, I.K., Y.H. Kang, S.J. Ryu, J.A. lee, T.H., Seo, J.A, Shin, Y.F. Yang and C. Yarish Evaluation of the sustainable seaweed integrated aquaculture system in Korea. Published in a book Of Abstracts, Pp. 114, abstract #1166 (invited presentation)

He, P., M. Jiahai, X.G. Fei, C. Yarish (abstract # 1326). *Porphyra* aquaculture development and its use in bioremediation in China. Published in a book Of Abstracts, p. 262, abstract #1326 (invited presentation).

C. Yarish invited speaker to the symposium entitled "Pharmacological Aquaculture" at "Aquaculture – An Ecologically Sustainable and Profitable Venture for The Meetings of the World Aquaculture Society's Aquaculture 2004 meetings, Honolulu, Hawaii, March 1-5, 2004.

Yarish, C., D.B. Sahoo, X.G. Fei, P. He, C.H. Sohn, M. Notoya, A. Buschmann and T. Chopin. "Mariculture of seaweeds and their utilization: Opportunities for the Pharmaceutical and Phycosupplement Industries" (abstract #1166) published in a book Of Abstracts, Pp. 659, abstract #1326 (invited presentation).

C. Yarish invited participant to:

EU Workshop "ON PRODUCTION IN SEaweEDS PURIFYING EFFLUENTS FROM MARINE ANIMAL FARMS." Workshop was held at the Universidade do Algarve, Portugal, November 27-29, 2003. At these meetings CY presented a keynote lecture entitled "An update on the bioremediation potential of *Porphyra* spp. in an integrated aquaculture system with finfish: implications for coastal zone management."

CIIMAR - Centre for Marine and Environmental Research, University of Porto, Portugal, entitled "Mariculture of Seaweeds and Their Utilization."

C. Yarish invited participant and session co-chair at the international workshop on "Aquaculture, Ecology and Economics: Towards a Sustainable Paradigm" that was held December 9-11, 2003 Puerto Varas, Chile. At these meetings I presented a paper entitled "Integrated aquaculture for a sustainable development of aquaculture."

C. Yarish invited keynote speaker to The 5th Asia-Pacific Conference on Algal Biotechnology, October 18-21, 2003, Qingdao, P.R. China.

C. Yarish, C.D. Neefus, G. Kraemer, R. Carmona, P. He, Tang, R. Pereira, T. Chopin, G.C. Nardi, J.J. Curtis and D.B. Sahoo. Seaweed Cultivation and Biotechnology: Opportunities for Integrating Seaweeds in Aquaculture Systems for Bioremediation and Industry Diversification. Published in a book of Abstracts, Pp. 14, K-2.

C. Yarish was the co-organizer and co-convenor (with R. De Philippis) of an invited symposium entitled "Use of Algae in Environmental Management" at The 5th Asia-Pacific Conference on Algal Biotechnology, October 18-21, 2003, Qingdao, P.R. China.

Chung, I.K., S.J. Ryu, Y.H. Kang, J.A. Lee, T.H. Seo, J.A. Shin, and C. Yarish. Development of the sustainable seaweed integrated aquaculture system in Korea. Published in a book of Abstracts, Pp. 94, S4-I-1.

He, P., M. Jiang, C. Yarish, S.J. Lin, C.F. Chen, Y.Q. Dai, Q.L. Wu and B. Shi. Eutrophication and bioremediation by *Porphyra* cultivation in Lusi nori farm. Published in a book, Pp. 106, S4-P-2.

The 5th Asia-Pacific Conference on Algal Biotechnology, October 18-21, 2003, Qingdao, P.R. China (contributed papers):

Tang, X.R., H.X. Jiang, X.G. Fei and C. Yarish. New life cycles of *Porphyra katadai* var. *hemiphylla* in culture. Published in a book of Abstracts, Pp. 71, S3-O-3.

He, P., C. Yarish, X. Tang, R. Pereira and J. Curtis. The free conchospore culture of Northeast American *Porphyra* species: Applications for a finfish/seaweed recirculating aquaculture systems in an urban environment. Published in a book of Abstracts, Pp. 76, S3-O-8.

C. Yarish invited participant to the PISCES XII, Session 4: MEQ/BIO Topic Session. Aquaculture in the ocean ecosystem held in Seoul, South Korea, Oct. 14, 2003. C. Yarish was a co-author on several papers even though I was not able to attend the meetings since I was on travel to Shanghai, People's Republic of China.

M. V. Rawson, C. Chen, D.R. Wang, C. Yarish and J. B. Sullivan. "Approaching coastal aquaculture from an ecosystem perspective."

C.H. Sohn, I.K. Chung, Y.F. Yang and C. Yarish. Historical review and future perspectives of aquaculture industry in Korea.

I.K. Chung, S.J. Ryu, Y.H. Kang, J.A. Lee, T.H. Seo, J.A. Shin, C. Yarish and Y.F. Yang. Evaluation of the bioremediation capability of the seaweed aquaculture in Korea.

C. Yarish and C.D. Neefus invited Symposium participants to Integrated Aquaculture and Balanced Ecosystem Management: Polyculture on a Grand Scale at the Coastal Zone '03 Coastal Zone Management Through Time, July 13-17, 2003.

C. Yarish, C.D. Neefus, G. Kraemer, R. Carmona, P. He, Tang, R. Pereira, T. Chopin, G.C. Nardi and J.J. Curtis. The bioremediation potential of *Porphyra* spp. in an integrated aquaculture system with finfish: implications for coastal zone management for coastal New England. In U.S. National Oceanic and Atmospheric Administration. Coastal Services Center. 2003. Coastal 03. Proceedings of the 13th Biennial Coastal Zone Conference, Baltimore, MD, Jul 13-17, 2003. NOAA/CSC/20322-CD. CD-ROM. Charleston, SC: NOAA Coastal Services Center.

The 58th Annual Meetings of the Phycological Society of America and the Society of Protozoologists, Williamsburg, Virginia (August 6-12, 2004):

C. Yarish, G. Kraemer, C.D. Neefus, R. Carmona, D. Snellgrove, P. He, Tang, R. Pereira, and G.C. Nardi. The bioremediation opportunities of *Porphyra* spp. in an integrated land-based aquaculture system with finfish in coastal New England. Book of Abstracts at <http://www.psaalgae.org/meeting/PSA2004Program-all.pdf>, P. 54.

E. Invited Scholarly Colloquia, Presentations or Symposia

C. Yarish presented an invited presentation to Southampton College, Long Island University, Southampton, NY, Feb. 28, 2002, entitled "Ecosystem Modeling: a tool to Understand the Interactions between Extractive and Fed Aquaculture."

C. Yarish presented an invited presentation to Inje University, South Korea, April 16, 2002, entitled "Using ecosystem modeling for seaweed aquaculture."

C. Yarish presented an invited presentation and teleconference to Marine Biology Department, University of Los Lagos and other Chilean Universities, Sept. 7, 2001, entitled "Advances in seaweed aquaculture."

C. Yarish was an invited participant to the first Joint Coordination Panel on Living Marine Resources between South Korean-US, April 11, 2002. He gave a paper entitled: "An overview of a regional Sea Grant and NOAA aquaculture initiative: the rediscovery of fish/seaweed integrated systems in north america." C. Yarish, G. Kraemer, C. Neefus, T. Chopin, S. Miller, Nardi, J.J. Curtis.

C. Yarish was an invited participant at the 1st Joint Coordination Panel on Living Marine Resources between South Korean-US, April 11, 2002, where he was a co-author on a paper entitled "Integrating Aquaculture using Ecosystem Models." M. V. Rawson, C. Chen, M.Y. Zhu, L. Wang, D.R. Wang, C. Yarish, J. Sullivan, T. Chopin and R. Carmona.

C. Yarish presented an invited presentation to The NOAA Central Library Seminar Series, Silver Spring, MD, August 2, 2001, entitled "The Importance of Seaweed Aquaculture."

C. Yarish presented an invited presentation to the West Sea Fisheries Research Institute, NFRDI, Department of Maritime Affairs, South Korea, September 22, 2001. NFRDI is the parallel organization to NOAA/DOC, in South Korea. His presentation was entitled: “The role of marine algae in reducing aquaculture effluents.”

C. Yarish was an invited participant at the 5 th US-PR China Living Marine Resource Panel Meetings, April 19-22, 2002, Sanya, Hainan Island, PR China, and presented a series of presentations including a review of his cooperative seaweed research program (2000-2001) with the Chinese Academy of Sciences, Shanghai Fisheries University and Ocean University of Qingdao. The formal presentations to the Panel include: “Development of an integrated recirculating aquaculture system for nutrient bioremediation in urban aquaculture” (C. Yarish, P. He, J. Curtis); “Integrated Finfish/Seaweed Recirculating Systems”(C. Yarish, G. Kraemer, C.D. Neefus, T. Chopin and G. Nardi); “Establishment of a harmful algal bloom monitoring and integrative remedy system in China” (C.S. Lin, C. Yarish and P. He); and “Development of a cooperative research program on *Porphyra* between US and China“ (C. Yarish and X. Tang).

Curtis presented a project description and update of this research program to the City of Bridgeport Board of Education meeting in June, 2002.

C. Yarish (CY) was the Science Co-Chair (with R. Newell), for the International Division of the Office of Oceanic and Atmospheric Research, NOAA/DOC, of the 31st Joint Meeting of the UJNR Aquaculture Panel Meeting that was held from October 16-24, 2002 in Yokohama and Shiogama, Japan. The business meeting and symposium were held on October 16-18 in Yokohama at the Fisheries Research Agency. CY was involved in organizing the thematic portion of the meetings entitled “Aquaculture and Stock Enhancement of Algae and Filter Feeders” and the “Studies on Coastal Fisheries Resources and Aquaculture in the Tohoku Region.” At the 31st Joint Meeting of the United States-Japanese Natural Resource (UJNR) Aquaculture Panel’s satellite symposium (“Studies on Coastal Fisheries Resources and Aquaculture in the Tohoku Region”) in Shiogama, Japan, October 21, 2002, CY presented a paper (co-authors: Rawson, Jr. M.V., Chopin, T., Wang, D. R., Chen, C., Carmona, R., Chen, C., Wang, L., Ji, R. and Sullivan, J.) entitled “Ecosystem modeling and the importance of seaweed aquaculture in managing small coastal embayments in tropical regions.” CY was also a co-author on G.P. Kraemer’s presentation entitled “Bioremediation and mariculture potential of local and Asian species of *Porphyra*” and T. Chen’s presentation “Genetic manipulation of *Porphyra* (nori) by transgenics” at the symposium in Yokohama (Oct. 17, 2002).

C. Yarish invited to participate in a international symposium on “International Advances in Higher Education,” Shanghai Fisheries University, Shanghai, PR China, Nov. 1, 2002. Made a joint presentation with Mr. J. Curtis (Principal of the Bridgeport Regional Vocational Aquaculture School-BRVAS) on “The Sino-American Long Distance Education in Fisheries Science.” The presentation highlighted major achievements between UConn, BRVAS and SFU over a 6 year period using distance learning technologies.

C. Yarish invited seminar to the University of Connecticut's evening Coastal Studies Seminar Series (March 11, 2003). Presented a seminar entitled "Ecosystem modeling and the importance of seaweed aquaculture in managing small coastal embayments."

C. Yarish attended Aquaculture Biotech workshop (May 17-19, 2004) that was being sponsored by the Martin Ryan Institute, National University of Ireland, Galway and the RI/CT Sea Grant College Programs. He gave a presentation entitled "Seaweed cultivation and biotechnology: Opportunities for integrating seaweeds in aquaculture systems for bioremediation and industry diversification."

C. Yarish, was a member of the U.S.-Korea Joint Coordination Panel Meeting for Aquaculture Cooperation. At the 2nd meetings of the panel (Feb. 28-March 1, 2004, Honolulu, Hawaii), he participated in planning bilateral programs and presented a paper entitled "Development of Open Water and Land Based Integrated Aquaculture Systems."

C. Yarish gave an invited presentation to a Phycology Colloquim, January 13-14, 2004, sponsored by The Universidad Autónoma de Baja California, California State University at Fullerton and the University of Connecticut, with the support of the UABC-UConn TIES Program (a US AID/Mexico sponsored project) C. Yarish presented a paper entitled "Sustainable development of aquaculture: Bioremediation potential of *Porphyra* spp. In an integrated aquaculture system with finfish."

C. Yarish was an invited participant to The UNESCO Program of the International Training Workshop on Application of Marine Biotechnology at the Institute of Oceanology, Chinese Academy of Sciences, Qingdao, PR China, Oct. 21, 2003. C. Yarish presented a paper and workshop entitled "Introduction to the large scale cultivation of seaweeds."

SABBATICAL PARTICIPATION. The following scientists participated in the project during sabbatical leaves taken in residence at UConn:

- Jose Zertuche, PhD
- Jin Ae Lee, PhD
- Ikyo Chung, PhD
- C.H. Sohn, PhD

STUDENTS:

Total number of undergraduates participating on project: 8 (4 from Purchase College, 4 from UConn)

Total number of Masters degree candidates who worked with you: 3 (1 UConn, 2 UNH)

Total number of Ph.D. candidates who worked with you: 2 (1 UConn, 1 University of Porto, Portugal)

Graduate Students

Student Name: Jang K. Kim

Degree Sought: MS in Ecology and Evolutionary Biology, UConn

Thesis Title: Ammonium and phosphate uptake and assimilation under different environmental conditions by three *Porphyra* species

Student Name: Are Pedersen
Degree Sought: PhD in Ecology and Evolutionary Biology, UConn
Dissertation Title: Ecophysiological studies of *Porphyra*: Inorganic nitrogen uptake, free amino acid, and pigment contents as functions of growth environment

Student Name: Troy L. Bray
Degree Sought: MS in Plant Biology, UNH
Dissertation Title: A morphological and molecular survey of *Porphyra purpurea* (Roth) C. Agardh (Rhodophyta, Bangiales) in the northwest Atlantic

Student Name: Jennifer P. Day
Degree Sought: MS in Plant Biology, UNH
Dissertation Title: Effects of light and ammonium on growth, N uptake and pigmentation of *Porphyra umbilicalis* Kützing, *P. linearis* Greville, *P. leucosticta* Thuret in Le Jolis, *P. amplissima* Kjellman

Student Name: Rui Pereira
Degree Sought: PhD in Ecology, University of Porto (Portugal)
Dissertation Title: Studies on the ecophysiology and biochemistry of *Porphyra dioica* Irvine et Brodie in culture

SECTION II IMPACTS

CTSG Connects Teachers to Marine Science through Research Experiences and Regional Professional Development Institutes: For the past five years, the CTSG education coordinator, in partnership with the UConn-based NOAA National Undersea Research Center (NURC) and the NOAA Office of Ocean Exploration (OE), has been innovatively connecting educators with scientific and educational research communities through participation on research cruises and access to information generated through these cruises. This award-winning, richly diverse set of educational opportunities and products enhances ocean science literacy among teachers and students. CTSG served as the education and outreach coordinator on six cruises off the east coast of the U.S., responsible for incorporating educational components into the research cruises.

Impacts:

- In 2005, 7 CT educators participating in two cruises shared their research experiences with peers and students through lesson plans, images, video, web-based technology and multimedia.
- Teacher Professional Development Institutes allowed more 37 educators to participate in the research cruises through daily logs and images posted to the web site <www.oceanexplorer.noaa.gov> and to utilize expedition-related lesson plans. Institute host sites in 2005 included the American School for the Deaf, the URI Coastal Institute and the Gulf of Maine Research Institute.

CTSG Resources Enhance Learning: CTSG develops a variety of educational products to meet the learning needs of its myriad clientele. New materials produced between 2001 and 2006 cover topics ranging from invasive species to lobsters, aquaculture to fisheries, seafood safety to seaweeds (see Appendix A, sect. B2; Appendix C). Many materials are provided to Connecticut teachers and/or schools free of charge, and are utilized by educators with The Maritime Aquarium in Norwalk, Mystic Aquarium, Soundwaters, Project Oceanology, Schooner Inc., and the Living Museum, among others, for programs, camps, and workshops offered to students and teachers throughout the region throughout the year.

Impacts:

- In 2005, CTSG distributed more than 12,600 copies of publications, resource materials, and reprints to teachers, schools, environmental education organizations, industry members, families, individuals, scientists, resource managers, and colleagues.
- CTSG publications were utilized by Mystic Aquarium in programs for 300 children, ages 7 to 16 years, attending their 2005 summer camp.
- 70 4th-6th grade teachers from Hartford, Norwich, and New London (traditionally underrepresented / underserved communities) received CTSG publications through their participation in Mystic Aquarium's Morton Salt Outreach Program in 2005.
- CTSG publications were used in training of Soundwaters staff, who then shared the information with more than 300 upper elementary and middle school students participating in after-school programs from 24 western and southwestern Connecticut

communities, including Norwalk and Stamford (traditionally underrepresented/underserved communities).

CTSG as a Resource for Home-Schooled Children: A presentation on nitrogen and Long Island Sound by the communications director to six home-schooled 4th and 5th graders from Stonington provided key information that the students applied in a local outreach program.

Impact:

- The team of 6 students, competing with 20 middle schools, won the Judge's Award (1st place) in the First Lego League Ocean Odyssey Challenge in 2006 for their presentation on nitrogen overloads in Long Island Sound and the Mystic River. To extend the project to their local community of Stonington/Mystic, they developed and distributed 300 flyers describing the problems of excess nitrogen in Long Island Sound and the Mystic River, and providing residents with information on reducing fertilizer use through soil testing. One student also received a Sierra Club Award. The club requested 100 copies of the flyer to distribute at the Nature Conservancy on nearby Fisher's Island, NY.

CTSG Strengthens Vocational Agriculture/Aquaculture Education: The demand for higher education in the field of aquaculture has risen dramatically across the U.S. Connecticut currently has 19 regional vocational agriculture high schools, with 68 teachers and 2,500 students. All offer some training in aquaculture, however, two of the largest (New Haven and Bridgeport) focus exclusively on aquaculture and marine trades. A marine science magnet high school is also in the planning stages for Groton. As these specialized agricultural and magnet schools graduate gifted students, the majority of the students seek higher education options in fields including marine sciences and aquaculture, while others move directly into the work force. CTSG strives to address the needs of both types of students.

Impacts:

- CTSG provides "School to Career" training in seafood HACCP to vocational agriculture/technical high school seniors to enhance employability. Four of 61 HACCP-trained students are employed by CT seafood wholesalers and shellfishermen, reducing significantly the time employers must spend on in-house training.
- CTSG extension facilitates connections between teachers and researchers, and recruits students into UConn marine science and aquaculture programs by serving on advisory boards/planning committees for the schools in Bridgeport, New Haven, and Groton.
- CTSG extension is promoting interest in the University's aquaculture and marine science programs by facilitating early college experience (ECE) courses for 15 students attending the Bridgeport Vocational-Aquaculture High School. ECE is an academic program that enables students to take college courses at their high school. CTSG interacts with teachers and students, evaluating progress. Students acquire new knowledge and skills to prepare them for higher education or a career in aquaculture.
- CTSG extension partners with UConn campuses, colleges and departments to expand and enhance student opportunities in aquaculture science through the development of both minors and majors in aquaculture, and teaching courses to enhance the aquaculture

curriculum (introduction to aquaculture, aquaculture economics, and extension methods for sustainable coastal resource management) and satisfy student demand.

CTSG Enhances Graduate/Undergraduate Education: CTSG enhances graduate and undergraduate educational experiences through fellowship, internship, and research support. In partnership with the U.S. EPA, an annual graduate *CT LIS Fellowship* is awarded. Fellows report to the CT co-chair of the LISS Science and Technical Advisory Committee and complete a major research / policy project under supervision of a mentor. For more than a decade, CTSG has facilitated graduate *Yale Sea Grant Internships* in partnership with the Yale School of Forestry and Environmental Studies. Short-term, focused, Sea Grant internships are awarded for projects linking watershed use and coastal policy. *Knauss Marine Policy Fellowships* provide opportunities for post-graduate experience in marine policy at the federal level.

Impacts:

- The 2005-2006 CT LIS Fellow worked with CTSG's Balcom to conduct Generic Nonindigenous Aquatic Organism risk analyses for 10 species considered potential threats to Long Island Sound. This work provides key missing information for the marine section of the draft Connecticut Aquatic Nuisance Species Management Plan.
- The 2004-2005 CT LIS Fellow reviewed and synthesized the results of papers published between 1994 and 2005 for water column, sediment, and biota contaminant findings in Long Island Sound. The review findings indicate that priority pollutants continue to pose ecological and human health risks to LIS, and that there is increasing evidence from other rivers and estuaries that emerging contaminants are likely to pose similar ecological risks, particularly in highly urbanized systems such as LIS. A research paper, Contaminants of Concern, is in development.
- In 2005, 5 Yale graduate students completed Sea Grant internships working directly with, and providing assistance to, stakeholders, users, and policy makers that both depend on and influence marine and coastal resources in the New Haven region.
- 1 Yale Sea Grant intern subsequently was awarded a Knauss Marine Policy Fellowship. Five interns in total have gone on to positions with NOAA, Sea Grant, U.S. EPA, consulting firms, and environmental organizations.
- 2 graduate students applying through CTSG were awarded Knauss Marine Policy Fellowships for 2005. One has since become an employee of Maine Sea Grant as a marine educator.
- 18 graduate and undergraduate students received financial support (i.e., assistantships, part-time employment) through CTSG research grants awarded for 2005.
- 66 students at the Storrs and Avery Point campuses have benefited from the teaching and expertise of CTSG staff in subjects including aquaculture, fisheries management, and resource economics.

CTSG Contributes to Understanding Lobster Shell Disease: Building upon previously-funded work investigating crustacean molting hormones, CTSG researchers investigated anecdotal industry reports that female lobsters were molting while still carrying their eggs.

Impacts:

- The discovery that shell-diseased lobsters produce abnormally-high concentrations of the molting hormone, ecdysone, provided resource managers with a better understanding of what may be causing some “berried” (egg-carrying) lobsters to molt prematurely.
- The determination that alkyphenols (estrogenic chemicals used in plastic and rubber manufacturing) appear to interfere with melanization (tanning) and hardening of lobster shells indicates that the recovery and health of the LIS lobster resource may be adversely affected by anthropogenic factors not previously considered, as well as disease and environmental conditions.

CTSG Investigates the Cause of Lobster Resource Disaster: CTSG-funded researchers made significant contributions to the collective research effort investigating the potential cause(s) of the lobster die-off (reported in 2004). The multidisciplinary nature of the research and resource monitoring initiatives yielded both a likely cause of the die-off and a wealth of new information and tools to improve understanding of the impacts of natural and human environmental stressors on the health of the American lobster stock, providing lobster biologists and resource managers with extensive new information to help guide management decisions.

Impacts:

- CTSG’s Balcom served as co-editor with Dr. Anthony Calabrese, NOAA Fisheries (retired) for the special lobster research issue of the *Journal of Shellfish Research* 24(3), published in October 2005. 24 manuscripts were peer-reviewed and edited. Balcom also co-authored the lead article of the issue with Dr. Jack Pearce, NOAA Fisheries (retired), which synthesized the collective results of the extensive research initiative.
- Balcom co-authored a summary report, *Responding to a Resource Disaster: American Lobsters in Long Island Sound 1999-2004*, with Penny Howell, CT Department of Environmental Protection. The 24-page report was sent to more than 600 state and federal legislators in Connecticut and New York, and distributed to more than 400 members of the lobster industry, media, state and federal resource agencies, and the interested public.
- Balcom and fisheries extension specialist, Antoinette Clemetson of NY Sea Grant, co-authored a perspective piece for *Fisheries*, on the effects of litigation on the lobster extension and research programs. The article was accepted for publication in the June 2006 issue.

CTSG Facilitates the Aquaculture Permitting Process: CTSG convened multiple workshops for state and federal agencies involved in aquaculture permitting decisions to review the current policies and application process, and develop a more streamlined, straightforward permit application process. Progress towards this long-term goal includes two draft documents (a *Guide to Marine Aquaculture Permitting in CT* and a *Comprehensive Guide to Aquaculture in CT*)

written by CTSG extension in collaboration with the regulatory agencies. Two workshops were held to familiarize municipal commissions and aquaculture industry members with the permitting process.

Impact:

- The state and federal agencies that regulate aquaculture operations have a better, more efficient working relationship. Individuals/businesses applying for permits have improved lines of communication with resource managers.

CTSG Contributes to the Growth and Diversity of the CT Aquaculture Industry: CTSG extension initiated a successful cooperative research program with aquaculture producers for the development of new species and practices/applications to diversify the products cultivated in Connecticut. Although shellfish culturists possess the knowledge and skill to carry out research projects, they are often limited by time, manpower, and money. CTSG extension involvement provides resources and expertise in (1) business planning and decision-making, (2) field research coordination, (3) commercial implementation, and (4) technology transfer. Coupled with the potential economic benefit of new industries, alternative species culture may alleviate harvest pressure on traditional species. This program provides new skills to producers, and promotes an ability to earn additional profits with a minimal amount of investment and risk. It is the only program of its type available to CT aquaculture producers.

Impacts:

- Getchis is working with an industry member to develop a recirculating system for coral propagation by assisting the grower with his 501c3 application and other business start-up forms necessary for him to apply for federal grants and co-authoring a proposal with the industry member to the National Sea Grant office and State Sea Grant office.
- CTSG Extension Program is assisting the grower with the coordination of a regional coral bank, and attempting to enter coral propagation into the curriculum of Vo-Ag and aquaculture-themed magnet schools in the region.

CTSG Supports Northeast Aquaculture Industry Growth through Professional Development: CTSG extension has played a major role in developing the Northeast Aquaculture Conference & Exposition (NACETM), the purpose of which is to provide freshwater and marine aquaculturists with opportunities to acquire new skills and information that will enhance production and/or marketing facets of their industry. By enabling producers to diversify their operations, undertake new promising ventures, or culture new species, this effort helps ensure that they will have a sustainable resource into the future.

Impacts:

- CTSG's Getchis assisted in the development of NACE as a 501c3 institution through the Maine Aquaculture Innovation Center.

CTSG aids Local Communities in Understanding the Role of Nitrogen on Estuarine Ecosystems: CTSG researchers, working with colleagues at URI and Dominion Power, collected

multi-year data from local water bodies which can be used to calculate nitrogen loading estimates and monitor changes in nutrient loading, water quality, and habitat conditions over time. Town planners and environmental planners can use/adjust the nitrogen loading values to reflect proposed development scenarios and resultant potential changes in nitrogen loading.

Impact:

- Community groups (Friends of Oswegachie Hills and Save the River, Save the Hills) concerned with proposed developments in the Niantic River watershed used the sampling data and nitrogen load estimates to question the impact of proposed zoning changes on water quality.

CTSG Investigates Lasting Impacts of the Hatting Industry as Source of Mercury: CTSG researchers investigated mercury levels in cores of sediments from tributaries in western Connecticut located near significant hat manufacturing activities for nearly 300 years. The hatmaking process involved solutions of mercury and nitric acid; today, extremely high levels of mercury remain in the nearby soil and river sediments, and bio-accumulates in the food chain.

Impacts:

- The City of Danbury, CT contracted with UConn for a follow-up risk assessment of the mercury levels in Danbury. Data has been shared with CT DEP. Public lectures, flyers, news articles, and signs are used to alert local residents about behaviors associated with higher risk of mercury exposure (e.g., consumption of fish caught in local waters).
- Remote sensing of contaminated areas is being used experimentally to outline areas where plant reflectance spectra indicate the underlying soil is mercury-contaminated.
- With EPA-funded scientists, CTSG researchers are using genetically-modified cottonwood plants for phytoremediation (extractions) of soils with high mercury concentration.

CTSG Promotes Safe Processing of Seafood: CTSG extension, in partnership with RISG and state and federal agencies, regularly offers seafood and shellfish HACCP training, enabling seafood and shellfish businesses in southern New England to remain in compliance with FDA-mandated training. A regional training partnership was established to (1) ensure that industry members in southern New England have access to required training courses on a regular basis; (2) engage instructors from state and federal regulatory environments to broaden perspective and expertise available to course participants; (3) provide pertinent, timely HACCP and food safety-related information post-training through print/electronic newsletters; and (4) share responsibility for organizing/teaching the courses.

Impacts:

- 100 seafood processors, importers, and dealers received HACCP training, enabling them to remain in business; includes 127 CT seafood-related businesses ranging in size from <\$100,000 per year to >\$10 million in gross income per year, and employing 1-100+ employees.
- Availability of local training courses and modest registration fees reduce costs associated with meeting training requirement. Reduced costs allow southern New England

businesses to train 2-3 employees and often more, easing HACCP program implementation, improving company efficiency and profitability, and ensuring greater safety for seafood consumers.

- FDA inspection data comparing results of all domestic HACCP inspections versus New England-based inspections indicate percent compliance in key areas by New England firms is equal to or better than the national percent compliance. The percent of New England-based seafood processors complying with key sanitation areas is significantly higher.
- Two issues of *Seafood Safety Savvy: A HACCP Update* were mailed to approximately 650 individuals and businesses in 2005-2006. Ongoing Sea Grant communication enables HACCP-trained individuals to keep their training current, and provides a means for alerting them to changes in regulations, etc.

CTSG Partners to Develop CT Aquatic Nuisance Species (ANS) Management Plan:

Addressing aquatic plants, freshwater vertebrates and invertebrates, and marine species, the plan implements a coordinated approach to minimizing the ecological, socioeconomic and public health impacts of ANS in the State of Connecticut, and coordinates myriad research, educational, monitoring, and regulatory efforts that currently exist to focus on commonly-identified priorities, strategies, and tasks. The plan, drafted in concert with CT DEP and CT Institute of Water Resources, with input from numerous stakeholders, is undergoing formal review by CT DEP and the office of the Governor. Once accepted, it will be submitted officially to the ANS Task Force.

Anticipated Impacts:

- Upon implementation, CT will benefit from a comprehensive and coordinated approach to address early detection and monitoring, rapid-response, control and eradication, spread prevention, and policy / legislative needs with respect to aquatic nuisance species in a timely manner. Coupled with appropriate research to address local/regional problems and educational programs targeted at a range of audiences to raise awareness of the issue, the result should be more efficient use of available resources to address priority ANS problems in CT, better coordination among involved parties, and a greater awareness of the problems ANS cause locally, nationally, and globally.
- Marine ANS priorities will be identified/addressed in a bi-state management plan for LIS.

CTSG investigates private boat hull fouling as ANS vector: Researchers investigated the role of hull fouling on private boats that travel along the East Coast between winter and summer ports as a vector of marine invasive species. Divers examined boat hulls in marinas located in RI, CT, NC, and FL, comparing the assemblages found to the abundance and distribution of organisms in nearby waters. Hull fouling coverage ranged from ~ <10% to >80% of below-water surfaces.

Impact:

- Hull fouling on private boats is a potentially significant vector of marine invasions.

CTSG Protects and Preserves Connecticut's Priority Coasts: A multi-media educational program focusing on protecting and preserving CT's priority coastal habitats, *Focus on the Coast*, targets local land use decision makers in CT's coastal zone. Information about the

importance, value and location of migratory fish runs, tidal marshes, and submerged aquatic vegetation is contrasted with satellite-derived land cover information demonstrating the location and extent of urbanization. A cutting-edge web site containing maps and mapping information gives local land use officials data and tools to use.

Impacts:

- The *Focus on the Coast* web site receives about 100 hits per month. A *Coastal Resource Inventory Tutorial* allows non-technical users to understand importance of various data layers to their town's efforts to protect coastal resources. The *Mapping Station* contains ways for users to view and analyze GIS data, tailored to differing degrees of sophistication (e.g., internet browser; "map packages" for each of the state's 36 coastal towns; resource data from the web connected to local GIS data layers).
- 90+ municipal commissioners have participated in *Focus on the Coast* workshops.
- *Focus on the Coast* offered as coastal NEMO module suitable for other Sea Grant-led NEMO programs to adapt and use through the National NEMO Network.

CTSG Shares Marine Education Resources and Techniques: CTSG education coordinator traveled to (1) Nicaragua in 2005 as an environmental education consultant for a local NGO, CAMPLAB, meeting with 8 educators to share resources and assist in the development of an environmental education program for use in school in the remote Pearl Lagoon region; and 2) Belize in 2005 as an environmental education consultant to 3 NGOs working with fishermen and resource management entities, as well as schools and rural communities.

Impacts:

- The resources and classes are still in use in the Pearl Lagoon region, even though CAMPLAB is no longer in business (Nicaragua).
- Through the Wildlife Conservation Society (Belize), 62 fishermen were trained in fisheries catch data collection; 18 fishermen trained in the use of radio and GPS; 6 reserve managers trained in evaluating MPA management effectiveness; newsletters on spawning aggregation monitoring updates distributed to 300 fishermen; 350 pamphlets on Nassau grouper distributed to fishermen; 300 pamphlets on queen conch and spiny lobster distributed to school children; production and broadcasting of a TV "spot" to inform fishermen and general public about new legislation to protect the Nassau grouper and its spawning sites on prime time television and local cable networks.
- Friends of Nature (Belize) conducted environmental education programs with 6 primary schools and 1 high school, ranging in size from 150 to 600 students.
- TASTE (Belize) conducted environmental education programs with 425 students from schools in mainly rural districts, 75 students in science clubs, and 110 adults, from 19 villages and towns.

CTSG Spreads the Sea Grant Model: Fabiola Lafarga, former coordinator of fisheries and aquaculture for the State of Baja California Mexico, and graduate student, Autonomous University of Baja California (UABC), participated in an exchange program with 2 CTSG extension staff through UABC and the UCONN Training, Internships, Education, and

Scholarship (TIES) Partnerships, to learn more about fisheries management, and aquaculture and fisheries extension programs. Representatives from Baja State government requested CTSG assistance in forming a program modeled after SG extension, to proactively foster relationships among government agencies, university researchers, and maritime industries.

Impact:

- Lafarga developed recommendations and strategies for implementing a formal extension program, modeled after Sea Grant extension, in the State of Baja California, Mexico.

CTSG Collaborates on Study-Abroad Exchange Program with Brazil: Undergraduate students from UCONN, Universidade Federal Fluminense (UFF), Niteroi, and Universidade Federal da Paraiba (UFPB), Joao Pessoa, had the opportunity to participate in an exchange program.

Impact:

- Four students from Brazil spent one semester learning about coastal resource management and extension methods from CTSG extension staff.

CTSG Holds Aquaculture Workshop with Irish Colleagues: Continuing a collaboration that began with a 1988 Memorandum of Understanding between Ireland, Northern Ireland, and the Northeast Sea Grant programs, CTSG co-sponsored and co-organized an Aquaculture Biotechnology Workshop in Galway, Ireland. CTSG staff and UCONN faculty were presenters.

Impacts:

- A research proposal “Consumer Preferences and the Economic Viability of Marine Aquaculture Biotechnology: An Ireland-American Research Initiative” was submitted for funding to the USDA, International Science and Education Grants Program. Additional funding is being sought from the McMullen Family Foundation, Curran Charitable Foundation, and American Ireland Fund. Project development is being coordinated with Auburn University, Alabama.
- A state-of-the-art paper, “The Economics of Biotechnology in Aquaculture,” has been prepared and requested by individuals worldwide.

CTSG and the 2004 Asian Tsunami: Following the December 2004 Asian tsunami, the U.S. Department of State requested that the CTSG’s fisheries extension specialist undertake an assessment in Thailand, Malaysia, and Indonesia for potential U.S. government assistance. The Consortium to Restore Shattered Livelihoods in Tsunami-Devastated Nations (CONSRN),—composed of WorldFish Center, Southeast Asian Fisheries Development Center (SEAFDEC), Network of Aquaculture Centers in Asia (NACA), UN Food and Agriculture Asia-Pacific Regional Office, and Bay of Bengal Program— requested that the CTSG fisheries extension specialist prepare guidelines for rehabilitating livelihoods in tsunami-affected coastal communities in Asia.

Impacts:

- After an on-the-ground evaluation, an assessment report was prepared which resulted in a \$2 million rehabilitation project for Thailand.

- The livelihood guidelines, completed in mid-2005, are now used by international, regional, and national organizations to direct rehabilitation efforts for 100s of 1,000s of households in the region.
- The lessons learned from this activity will be useful in disaster management in the U.S.

CTSG and Marine Protected Areas: Effective management of marine protected areas (MPAs) requires continuous feedback of information to achieve objectives. In 2000, a global collaborative initiative was launched to improve the management of MPAs. The initiative focused on working with managers, planners, and other decision-makers around the world to develop a set of indicators for assessing the effectiveness of MPA use. This initiative was aimed at both enhancing the potential and capability for adaptive management of MPAs, as well as improving understanding of how effective are MPAs currently in place around the world. This initiative was supported by World Wildlife Fund (WWF), The World Conservation Union (IUCN), World Commission on Protected Areas (WCPA), and NOAA.

Impacts:

- CTSG's fisheries extension specialist was the lead author of the output of this initiative, *How is Your MPA Doing? A Guidebook of Natural and Social Indicators for Evaluating Marine Protected Area Management Effectiveness*, published in 2003. Since then, the approach presented in the guidebook is being used by more than 100 MPAs around the world, including marine reserves in the U.S. The NOAA, National Ocean Service, International Programs Office has developed an international grants program specifically supporting use of the guidebook.

CTSG and Alternative Fisheries Management: Co-management is one of a number of promising new and alternative fisheries management approaches that have emerged in recent years for fisheries management. Through this process, fishers are empowered to become active members of the fisheries management team, balancing rights and responsibilities, and working in partnership, rather than antagonistically, with government. CTSG fisheries extension has been undertaking activities in Asia and the wider Caribbean, assisting governments and non-governmental and people's organizations in developing co-management strategies.

Impacts:

- The applied conservation efforts related to this work on co-management have produced a range of outcomes, including the transformation of the governance of and a new management paradigm for small-scale fisheries.
- The applied conservation outcomes of co-management have been (1) improved enforcement of rules and regulations, (2) increased participation of resource users in management, (3) improved levels of equity in terms of fair treatment and representation, (4) greater local control over the resource, (5) reduced conflicts, (6) improved economic conditions of households, and (7) improvements in ecosystem health.
- Outputs and outcomes generated by the efforts in Asia have had broad impacts on small-scale fisheries management in other parts of the world, including Africa, Central America and the Caribbean. These outputs and outcomes are now being transferred through active extension efforts in the Northeast United States where training and education programs

have opened up discussions among fishermen and state and federal managers on alternative fisheries management, including co-management and rights-based management.

CTSG Collaborates Locally to Strengthen UConn Marine Science Programs: Key marine programs located at the UConn Avery Point campus include the Department of Marine Sciences (DMS), undergraduate Coastal Studies and Coastal Maritime Studies programs (AP), NOAA National Undersea Research Center (NURC), and CTSG. Involved in coastal and marine research and education, these entities benefit from strengthened collaborations, and frequent and efficient communications for the strategic development of a focused and unified vision for the marine endeavor at UConn.

Impacts:

- Leveraging CTSG, NURC, DMS, and AP funds enabled UConn to secure representation from the National Association of Marine Laboratories (NAML) and become a full board member of the Consortium for Oceanographic Research and Education (CORE), a Washington, DC-based non-profit organization representing leading public and private ocean research and education institutions, aquaria and industry.
- Monthly meetings of CTSG, NURC, DMS and AP foster new collaborations and the sharing of information and resources between the parties (e.g., sharing of equipment and other resources, sharing of information regarding undergraduate and graduate education, inclusion of external partners, both commercial and governmental, in planned strategic economic development and scientific objectives, and CTSG sponsorship of ship time to enhance an ANS project using NURC's remotely operated underwater vehicles and including a joint NURC-CTSG educational component).

CTSG Works Regionally to Protect Long Island Sound: The Long Island Sound Study (LISS) is a bi-state cooperative effort involving researchers, regulators, user groups and other concerned organizations/individuals working together to protect and improve the health of the Sound by implementing the 1994 Comprehensive Conservation and Management Plan. CTSG is an active partner in LISS through its (1) Management Committee, (2) Science and Technical Advisory Committee, (3) Implementation Team, and (4) Education and Outreach Committee.

Impacts:

- The Long Island Sound Study Research Grant Program, a cooperative effort of the U.S. EPA, CTSG, and NY Sea Grant programs, funds research that addresses priority informational needs of federal and state decision-makers responsible for protecting and enhancing the viability of Long Island Sound and its resources. A Memorandum of Understanding between the three entities represents a biennial financial commitment of \$450,000 (\$400,000 from EPA, and \$25,000 each from CTSG and NYSG). In fulfillment of this partnership, CTSG contributed \$25,000 in 2005 to support the research initiative.
- During 2005, CTSG staff received \$138,700 in grants from the U.S. EPA LISS to augment extension and education programs focused on building a better understanding and awareness of LIS and the management actions being undertaken to protect and restore the Sound's vitality. This critical support facilitates the LIS Mentor Teacher

Program, the CT LIS Fellows Program, as well as the development of new publications, posters, and other educational materials.

CTSG Calculates Cost-Benefits Associated with Industrial Water Use: In coordination with numerous outside partners, including US EPA, CTSG staff (Associate Director Johnston) played a principal role in the §316(b) rule cost-benefit analysis. This included substantial research to estimate use and nonuse values associated with impingement and entrainment reductions nationwide. The Phase II rule was promulgated in 2004, and the Phase III rule is scheduled for promulgation in late 2006.

Impacts:

- Numerous economic analyses necessary for appropriate estimation of benefits and costs of these EPA regulations were completed, including the development of a nationwide stated preference survey to estimate how public values for fishery resources (including use and nonuse values) are affected by I&E fish losses (survey is currently under OMB review).
- The work contributed to the development of policies that significantly reduced the negative environmental and economic impacts of at least 1,216 commercial facilities nationwide.
- Phase II regulations resulting from this work alone will generate an estimated \$82.9 million in economic benefits to recreational and commercial fisheries nationwide; depending on model assumptions, additional nonuse benefits of these regulations to U.S. households could exceed \$200 million.

**SECTION III
PERFORMANCE MEASURES**

(NOT REQUIRED AS PART OF THE 2005-2006 ANNUAL REPORT)

**SECTION IV
APPENDICES**

a. Management Team and Staff Composition

Management team composition and percentage of time the Sea Grant Director and management staff devoted to Sea Grant:

FTEs (Full Time Employees = 12 man months) Devoted to Sea Grant

Sea Grant Staffing	# of Individuals	# of FTEs funded by Sea Grant \$	# of FTEs funded by Non-Sea Grant \$
Administrative	3	1.0	1.0
Communications	1	1.0	0.0
Extension	5	2.36	1.09
Education	1	0.5	0.0
TOTAL	10	4.86	2.09

Mgmt. Team Member	Position	FTEs devoted to Sea Grant
Sylvain DeGuise	Director	0.5
Robert Johnston	Assoc. Director	0.5
Nancy Balcom	Extension Leader	0.8
Peg Van Patten	Communications Director	1.0

b. Program Development Projects (2005-2006)

	PI	Federal funds	Matching funds	Topic
M/PD-1-individual projects				
West Haven least tern	Milan Bull	2,619	-	research
Cancer in sharks	Joanna Borucinska	4,750	-	research
Improved valuation of ecological benefits associated with aquatic living resources	Robert Johnston	3,250	-	research
Carbon cycle research cruise	Penny Vlahos	1,200	-	research
Impacts of mooring systems and boating traffic on eelgrass	Alan Banister	1,000	-	research
Sodium channel sequencing in lobsters	Hans Dam and Senjie Lin	4,500	-	research
Didemnum in Eastern Long Island Sound	Robert Whitlatch	1,800	-	research
Epitheliocystis field survey in Arctic char	Salvatore Frasca Jr.	4,500	-	research
Passive chemical samplers for contaminants in the Thames River	Penny Vlahos	2,000	-	research
Aquatic toxicology workshop	Sylvain De Guise	2,000	-	workshop
Northeast Algal Society student travel	Senjie Lin	1,200	-	conference
American Fisheries Society meeting attendance	Robert Pomeroy	500	-	conference
International Association of Aquatic and Marine Librarians	Jan Heckman	627	-	conference
Coastal Perspectives lecture series	Patricia Kramer	1,000	-	conference
Reprints of research paper	Hans Laufer	200	-	reprints
Conservation Biology publications costs	Peter Auster	700	-	reprints
Atlantic salmon culture in CT (educational video)	Sandra Millan-Trip	2,000	-	education
Manual on the genetics and breeding of bay scallops	Sheila Styles	2,000	-	education
Consortium for Oceanographic Research & Education (CORE) membership	UConn	3,000	8,500	membership
National Association of Marine Laboratories (NAML) membership	UConn	500	1,200	membership
M/PD-4-multi-program projects				
Aquaculture, Biotechnology, Economics, and Policy meeting of Ir-Am-Aqua,	Edward Monahan	13,500	-	workshop

Ireland

Seaweeds of the Northeast poster	Jim Sears	500	1,000	conference
Long Island Sound Educators Conference	Diana Payne	2,000	-	conference
9th International Conference on Shellfish Restoration	Rick Devoe	500	-	conference
Multi-component evaluation to minimize the spread of aquative invasive species (LISS)	Charles Yarish	7,898	101,756	research

c. List of Partnerships (2005-2006)

Federal, Regional, Local, State, NGOs and International

Federal	Regional	Local & State	NGOs	International
Academy of Natural Sciences	Atlantic States Marine Fisheries Commission	CT Agricultural Experiment Station	A Living Museum	BARBADOS: University of the West Indies – Centre for Resource Management and Environmental Studies
National Aeronautics and Space Administration	Interstate Environmental Commission	CT DEP—Inland Fisheries, Marine Fisheries, Wildlife, Water Management, Boating, Pesticides Program, Office of Long Island Sound Programs	Audubon Connecticut	BELIZE: Belize Dept. of Fisheries
NOAA Coastal Services Center	New England Interstate Water Pollution Control Commission	CT Dept. of Agriculture, Bureaus of Aquaculture and Marketing / Promotion	bird conservation organizations	BELIZE: Friends of Nature, Placencia
NOAA Fisheries	New York City Dept. of Environmental Protection	CT municipal commissions	Connecticut College Arboretum	BELIZE: Toledo Association for Sustainable Tourism and Empowerment, Punta Gorda
NOAA National Sea Grant	New York State Dept. of Environmental Conservation, Bureau of Marine Resources	CT State Department of Education	CT Working Lands Alliance	BELIZE: Wildlife Conservation Society, Belize City
NOAA Office of Ocean Exploration (OE)	Rhode Island Dept. of Environmental Management		Eastern Connecticut Resource Conservation and Development Council	BRAZIL: Universidade Federal da Paraiba, Joao Pessoa
Quinebaug-Shetucket National Heritage Corridor	Rhode Island Dept. of Health		Environmental Defense	BRAZIL: Universidade Federal Fluminense, Niteroi
Silvio O. Conte National Fish & Wildlife Refuge	USDA Northeast Regional Aquaculture Center		Lake Waramaug Association	CHILE: University de Los Lagos
U.S. Army Corps of Engineers—New England District	US EPA Long Island Sound Study		Long Island Sound Foundation	CZECH: Academy of Sciences
U.S. Food and Drug Administration	NOAA National Undersea Research Center- Groton, CT		Long Island Sound Watershed Alliance	GRENADA: Fisheries Division
U.S. Geological Survey (Connecticut and New York Districts)	NOAA Fisheries- Milford, CT Laboratory		ME Aquaculture Innovation Center	IRELAND: Martin Ryan Marine Sciences Institute, National University of Ireland
US Coast Guard Homeland Security Port, New London			Mystic Aquarium and Institute for Exploration	MEXICO, State Secretary of Agriculture
US EPA Long Island Sound Study National Estuary Program			Narragansett Bay Baykeepers	MEXICO: Autonomous University of Baja California
US EPA National Center for Environmental Economics			New England Aquarium	MEXICO: Federal Dept. of Agriculture, Livestock, Rural Development, Agriculture, Fisheries and Food
US EPA Office of Water			New York Aquarium	MEXICO: State of Baja California government
US EPA Regions 1 and 2			Ocean Technology Foundation	ITALY: Universita di Bologna
US Fish & Wildlife Service (Southern New England-New York Bight Coastal Ecosystems Program)			Project Oceanology	
US Food and Drug Administration			Resources for the Future	
US Geological Survey (Connecticut and New York Districts)			Save the Bay (Rhode Island)	
USDA Cooperative State Research Education and Extension Service			Schooner, Inc.	

Federal (cont.)	Regional (cont.)	Local & State (cont.)	NGOs (cont.)	International (cont.)
USDA Natural Resources Conservation Service			Soundwaters	
			The Maritime Aquarium at Norwalk	
			The Nature Conservancy, Connecticut Chapter	
			The Waterkeepers Alliance	

Industry, Academic, Sea Grant, Other

Industry/ Business	Academic Institutions	SG Programs	Other
Abt Associates, Inc.	American School for the Deaf	IL-IN Sea Grant	Association of Food & Drug Officials
Applied Sustainable Aquaculture	Bodega Marine Laboratory, University of California	LA Sea Grant	CT Bar Association
Aquarion Water Company	Bridgeport Regional Vocational Aquaculture School	Maine Sea Grant	CT Chapter of the American Planning Institute
Aquatic Control Technology	Bryn Athyn College	MIT Sea Grant	CT Federation of Lakes
Commercial lobstermen in Connecticut and New York	Center for Ocean Science Education Excellence – New England (COSEE-NE)	NH Sea Grant	CT Invasive Plant Working Group
Cross Sound Ferries Services, Inc.	Chesapeake Biological Laboratory, University of Maryland	NY Sea Grant	CT Invasive Plants Council
CT Farm Bureau	Clark University	OR Sea Grant	National Marine Educators Association
CT Seafood Council	Connecticut College	RI Sea Grant	National NEMO Network
CT Shellfish Aquaculture Industry	Cornell Cooperative Extension	VT Sea Grant	Northeast Algal Society
Dominion Nuclear Millstone Environmental Laboratory	Cornell College of Veterinary Medicine	WHOI Sea Grant	Northeastern Agricultural and Resource Economics Association
East Coast Shellfish Growers Association	CT Institute of Water Resources		Seafood HACCP Alliance
First Pioneer Farm Credit	CT school districts and teachers		Southeastern New England Marine Educators
Fish Mart, Inc.	Fairfield University		UConn Avery Point campus administration
Great Bay Aquaculture, Portsmouth, NH	George Mason University		UCONN Office of International Affairs
Innovative Mosquito Management, Inc.	Gulf of Maine Research Institute		UCONN University Communications
Lockhart Environmental	Institute for Applied Geospatial Technology		UCONN Library System
marinas and private boat owners	Marine Biological Laboratory, Woods Hole, MA		
Northeast Farm Credit Ag Enhancement Program	Marine Sciences Research Center, Stonybrook University		
South Central Regional Water Authority	ME Cooperative Extension		
	Purchase College-SUNY		

Industry/ Business (cont.)	Academic Institutions (cont.)	SG Programs (cont.)	Other (cont.)
	RI Cooperative Extension		
	Rutgers Cooperative Extension		
	UCONN Center for Land Use Education and Research		
	UCONN Coastal Environmental Laboratory		
	UCONN Cooperative Extension		
	UCONN Dept. of Pathobiology and Veterinary Sciences, Agricultural & Resource Economics, Molecular & Cell Biology, Ecology & Evolutionary Biology, Marine Sciences, Natural Resources Management & Engineering		
	University of Arizona		
	University of California, Davis		
	University of Delaware		
	University of Hartford		
	University of Louisiana		
	University of Maine		
	University of Massachusetts, Dartmouth		
	University of Nevada-Reno		
	University of New Brunswick		
	University of New Hampshire		
	University of New Haven		
	University of Oregon		
	University of Rhode Island		
	Wesleyan University		
	Western Connecticut State University		
	Williams College–Mystic Seaport		
	Woods Hole Oceanographic Institute		
	Yale University		

d. Leveraged Funds (Not Shown as Match)

Please list leveraged funds (from Feb. 1st or March 1st through March 31, 2006) from non-Sea Grant sources (but managed by Sea Grant) which are not used as match, their dollar amounts, and the number of years of funding.

Project	Source	Amount	Years
CT LIS Fellows Program	EPA LISS*	42,359	2
Environmental and Technical Assessment of Alternative Shellfish Production Methods	NOAA	38,432	2
LIS Mentor Teachers Program	EPA LISS	58,523	1
Northeast Aquaculture Conference and Exposition Sponsorships	Private	10,950	1
2003 Aquaculture Industry Assessment-- Publications	OTF Small Grants	1,000	1
NEMO: Decision Support Tools to Protect Water Quality	CTDEP	70,000	1
Jordan Cove Urban Watershed National Monitoring Project	CTDEP	50,000	1
Niantic River Watershed Protection Plan	CTDEP	27,000	1
Riparian Buffer Analysis	EPA LISS	90,611	1
Earth Grant Geospatial Technology Extension	NOAA	50,000	1
Exploring community-based management arrangements for New England fisheries	Surdna Fdn.	15,000	1
Community-based Oyster Restoration in the Oyster River, Old Saybrook	NOAA	700	1
Risk Management for Agricultural Producers	USDA	2000	1
Sustainable eastern oyster production in the Quinnipiac River	Quinnipiac River Fund	1200	1
Environmental and Technical Assessment of Alternative Shellfish Production Methods	NOAA	29000	1

* Long Island Sound Study

e. Publications

e.1. Publications List

Peer-reviewed Journal Articles and Book Chapters (27)

Branco, Alison B., Kremer, James N. 2005. The relative importance of chlorophyll and colored dissolved organic matter (CDOM) in the attenuation of light in shallow estuaries. *Estuaries* 28(5):643-652.

Carmona, R., G. P. Kraemer, and C. Yarish. 2006. Exploring Northeast American and Asian species of *Porphyra* for use in an integrated finfish-algal aquaculture system. *Aquaculture* 252: 54-65.

Chang, E. S. 2005. Stressed-out lobsters: crustacean hyperglycemic hormone and stress proteins. *Integrat. Comp. Biol.* 45:43-50.

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Christie, P., K. Lowry, A.T. White, E.G. Oracion, L. Sievanen, R.S. Pomeroy, R.B. Pollnac, J. M. Patlis, and R.V. Eisma. 2005. Key findings from a multidisciplinary examination of integrated coastal management process sustainability. *Ocean and Coastal Management* 48:468-483

Clark, H. and J. N. Kremer, 2005. Estimating direct and episodic atmospheric nitrogen deposition to a coastal waterbody. *Mar. Env. Res.* 59:349-366.

Cuomo, C. R. Valente, and D. Dogru. 2005. Seasonal variations in sediment and bottom water chemistry of western Long Island Sound: implications for lobster mortality. *J. Shellfish Res.* 24(3):805-814.

De Guise, S., B. Morsey, J. Maratea, M. Goedken, I. Sidor & J. Atherton. 2005.

Development of assays to evaluate cellular immune functions in the American lobster, (*Homarus americanus*). *J. Shellfish Res.* 24(3):705-711

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Johnston, R.J. 2005. Changing Community Preferences for Coastal Zone Development and Conservation: Implications of Population Growth for Natural Resource Values” Chapter 13 in D.M. Whitelaw and G.R. Visgilio, eds. *Americas Changing Coasts: Private Rights and Public Trust*. Edward Elgar Publishing, pp. 201-224

Johnston, R.J. and T.J. Tyrrell. 2005. A Dynamic Model of Sustainable Tourism. *Journal of Travel Research* 44(2): 124-134.

- Johnston, R.J., J.J. Opaluch, M.J. Mazzotta, and G. Magnusson. 2005. Who Are Resource Nonusers and What Can They Tell Us About Nonuse Values? Decomposing User and Nonuser Willingness to Pay for Coastal Wetland Restoration. *Water Resources Research* 41(7), doi:10.1029/2004WR003766.
- Johnston, R.J., E.Y. Besedin, R. Iovanna, C. Miller, R. Wardwell, and M. Ranson. 2005. Systematic Variation in Willingness to Pay for Aquatic Resource Improvements and Implications for Benefit Transfer: A Meta-Analysis. *Canadian Journal of Agricultural Economics* 53(2-3): 221-248.
- Kremer, James N. 2005. Too Many Neighbors! Nitrogen in the Coastal Zone. Chapter in: *Our Changing Coast: Private Rights and Public Trust*, Diana M. Whitelaw and Gerald R. Visiglio, eds. Edward Elgar: Northampton, MA
- Laufer, H., N. Demir and W. J. Biggers. 2005. The Lobster's Response to The Stress of Shell Disease. *J. Shellfish Research* 24(3):757-760
- Medler, S., Brown, K., Chang, E. S., and D. L. Mykles. 2005. Eyestalk ablation has little effect on actin and myosin heavy chain gene expression in adult lobster skeletal muscles. *Biol. Bull.* 208:127-137.
- Mullen, T. E., K. R. Nevis, C. J. O'Kelly, R. J. Gast & S. Frasca, Jr. 2005. Nuclear small-subunit ribosomal RNA gene-based characterization, molecular phylogeny, and PCR detection of the Neoparamoeba from western Long Island Sound Lobster. *J. Shellfish Res.* 24(3): 719-731
- Pearce, J. and N. Balcom. 2005. The 1999 Long Island Sound lobster mortality event: findings of the comprehensive research initiative. *Journal of Shellfish Research* 24(3): 691-697.
- Pollnac, R. and R. Pomeroy. 2005. Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean & Coastal Management* 48: 233-251
- Pomeroy, R.S., L.M. Watson, J.E. Parks and G. A. Cid. 2005. How is your MPA Doing? A Methodology for Evaluating the Management Effectiveness of Marine Protected Areas. *Ocean and Coastal Management* 48:485-502
- Pomeroy, R.S., E. G. Oracion, R. B. Pollnac and D. A. Caballes. 2005. Perceived Economic Factors Influencing the Sustainability of Integrated Coastal Management Projects in the Philippines. *Ocean and Coastal Management* 48:360-377.
- Pomeroy, R.S., E. G. Oracion, R. B. Pollnac and D. A. Caballes. 2005. Perceived Economic Factors Influencing the Sustainability of Integrated Coastal Management Projects in the Philippines. *Ocean and Coastal Management* 48:360-377.
- Rozum, J. S., E. Wilson, C. Arnold. 2005. Strengthening Integration of Land Use Research and Outreach Through Innovative Web Technology. *J. Extension*, 43(5), Article #5IAW1.
- Smith, S. G., and Chang, E. S. 2005. Molting and growth. In: *Blue Crabs* (V. S. Kennedy and E. Cronin, eds.). Maryland Sea Grant, Baltimore

Valente, R.M. and C. Cuomo. 2005. Did multiple sediment-associated stressors contribute to the 1999 lobster mass mortality event in western Long Island Sound, USA? *Estuaries* 28(4): 529-540.

Walker, A. N., Bush, P., Puritz, J., Wilson, T., Chang, E. S., Miller, T., and Horst, M. N. 2005. Bioaccumulation and metabolic effects of the endocrine disruptor methoprene in the lobster, *Homarus americanus*. *Integrat. Comp. Biol.* 45(1): 118-126.

Walker, A. N., P. Bush, T. Wilson, E. Chang, T. Miller & M. N. Horst. 2005. Metabolic effects of acute exposure to methoprene in the lobster, *Homarus americanus*. *J. Shellfish Res.* 24(3): 787-794

Technical Reports (14)

Balcom, N., W. Hyatt, N. Murray, and P. Bresnahan. 2005. State of Connecticut Aquatic Nuisance Species Management Plan. CT ANS Working Group. 118 pp.

Besedin, E.Y, R.J. Johnston, and M.H. Ranson. 2005. Responses to National Center for Environmental Economics (NCEE) Comments Received 9/12/05 (Willingness To Pay Survey for Section 316(b) Phase III Cooling Water Intake Structures). Technical Memorandum to the Office of Water, US EPA, Washington, DC. Cambridge, MA: Abt Associates, Inc.

Besedin, E.Y, R.J. Johnston, and M.H. Ranson. 2005. Responses to National Center for Environmental Economics (NCEE) Comments Received 8/30/05 (Willingness To Pay Survey for Section 316(b) Phase III Cooling Water Intake Structures). Technical Memorandum to the Office of Water, US EPA, Washington, DC. Cambridge, MA: Abt Associates, Inc.

Besedin, E., R.J. Johnston (as contractors for U.S. EPA), and E.C. Helm. 2005. Agency Information Collection Activities: Proposed Collection; Comment Request; Willingness To Pay Survey for Section 316(b) Phase III Cooling Water Intake Structures: Instrument, Pre-Test, and Implementation, EPA ICR Number 2155.02 *Federal Register* 70(110), June 9.

Besedin, E. and R.J. Johnston (as contractors for U.S. EPA). 2005. EPA Response to Second-Round Public Comments for the ICR Notice Published on November 23, 2004 (69 FR 68140)

Besedin, E. and R.J. Johnston (as contractors for U.S. EPA). 2005. Supporting Statement for Information Collection Request for Phase III §316(b) Requirements for Cooling Water Intake Structures under the National Pollutant Discharge Elimination System Permit Program. U.S. EPA Office of Water, Washington D.C.

Besedin, E. and R.J. Johnston (as contractors for U.S. EPA). 2005. EPA Response to First-Round Public Comments for the ICR Notice Published on November 23, 2004 (69 FR 68140).

Chang, E. S., Stentiford, G. D., Neil, D. M., and Chang, S. A. 2005. Crustacean hyperglycemic hormone and hemolymph metabolites: stress responses in two lobster species. NOAA Tech. Rep. NMFS.

Flimlin, G., R. Pomeroy and D. Schoor. 2005. Business feasibility for ornamental aquatic plant culture in the Northeast United States. Northeast Regional Aquaculture Center.

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Mahon, R., P. McConney, J. Parks and R. Pomeroy. 2005. Reconciling the needs of fisheries and conservation on coral reefs. World Fisheries Congress.

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<http://www.worldfishcenter.org/pdf/FisheriesResearch.pdf> WorldFish Center, Penang, Malaysia.

Pomeroy, R., B. Ratner, S. Hall, J. Pimoljinda and V. Vivekanandan. 2005. Rebuilding livelihoods in tsunami-affected coastal communities in Asia. CONSRN Policy Brief No. 2. CONSRN and WorldFish Center, Penang, Malaysia. (English and Indonesian versions).

Van Patten, Peg. 2005. Connecticut Sea Grant Annual Report 2004. 32pp

Published Abstracts/Papers in Proceedings (9)

Codiga, D. 2005. Observed Residual Circulation in Eastern Long Island Sound: Transverse Vertical Structure and Exchange Transport. P. 89 In: *Proceedings of the Seventh Biennial Long Island Sound Research Conference 2004* Stony Brook NY. Long Island Sound Foundation.

Getchis, T. 2005. An assessment of the needs of Connecticut's shellfish aquaculture industry. P. 91 In: *Seventh Biennial Long Island Sound Research Conference Proceedings 2004*. Stony Brook NY. Long Island Sound Foundation. 106 pp.

Getchis, T. 2005. An assessment of the needs of Connecticut's shellfish aquaculture industry. P. 91 In: *Seventh Biennial Long Island Sound Research Conference Proceedings 2004*. Stony Brook NY. Long Island Sound Foundation. 106 pp.

Gilmore, M., D. Civco, S. Prisloe, J. Hurd, and E. Wilson. 2005. Application of remote sensing technologies for the delineation and assessment of coastal marshes and their constituent species around Long Island Sound. P. 91 In: *Seventh Biennial Long Island Sound Research Conference Proceedings 2004*. Stony Brook NY. Long Island Sound Foundation. 106 pp.

Hurd, J.D., D.L. Civco, M.S. Gilmore, S. Prisloe & E.H. Wilson. 2005. Coastal marsh characterization using satellite remote sensing and *in situ* radiometry data: preliminary results. Proceedings of the American Society of Photogrammetry and Remote Sensing Annual Conference, March 7-11, 2005, Baltimore, MD. 12 p.

Johnston, R.J. 2005. Aquatic Resource Improvements and Benefits Transfer: What Can We Learn From Meta-Analysis? In published proceedings of *Benefits Transfer and Valuation Databases: Are*

We Heading in the Right Direction? An International Workshop. Sponsored by the US Environmental Protection Agency and Environment Canada. pp 5.30-5.76.

Laufer, H., N. Demir, C. Capulong, X. Pan, and W. Biggers. 2005. Hormonal responses of lobsters to stresses of Long Island Sound. Pp. 41-43 In: *Seventh Biennial Long Island Sound Research Conference Proceedings 2004*. Stony Brook NY. Long Island Sound Foundation. 106 pp.

Rhodes, E., Garrison, R., Getchis, T., Macfarlane, S., and Morse, D. 2005. Expanding shellfish aquaculture in the NRAC Region - constraints to existing industry expansion and an analysis of the economic feasibility of new, small-scale oyster culture businesses. *Journal of Shellfish Research*. 24(4):1269.

Varekamp, J., E. Thomas and M. Groner. 2005. The late Pleistocene-Holocene history of Long Island Sound. Pp. 27-32 In: *Seventh Biennial Long Island Sound Research Conference Proceedings 2004*. Stony Brook NY. Long Island Sound Foundation. 106 pp.

Theses, Dissertations (1)

Hamilton, J.F. 2005. A coupled hydrodynamic-larval transport model for assessing source-sink recruitment dynamics in estuarine habitats. (Currently - Post-doctoral Associate, Department of Marine Sciences, University of Connecticut)

Newsletters and Periodicals (13)

Balcom, N. and L. Pivarnik. (2005). *Seafood Safety Savvy: A HACCP Update* (Issue 10). Connecticut Sea Grant and URI Cooperative Extension and Sea Grant. 3 pp.

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Balcom, Nancy. 2006. Hull fouling's a drag on boats and local ecosystems. *Wrack Lines* 5(1):14-17 Winter 2005-2006.

Getchis, Tessa. 2006. What's putting aquaculturists in a foul mood? *Wrack Lines* 5(1):8-10. Winter 2005-2006.

Payne, D. 2005. News from NMEA: From National Awards to Natural Disasters. *The Nauplius*, 17(1).

Payne, D. 2005. News from NMEA: What does NMEA do? *The Nauplius*, 16(1).

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Prisloe, S. 2006. "Phrag" is a Drag: a bird's eye view of a pesky invasive plant. *Wrack Lines* 5(1):11-13. Winter 2005-2006.

Rozum, J. 2005. A new resource for water quality protection: The 2004 CT Stormwater Quality Manual. *The Habitat*, Vol. XVII No. 2.

Van Patten, M. 2006. Letter From the Editor *Wrack Lines* 5:1. Inside cover.

Van Patten, M. (ed.) 2006. *Wrack Lines* 5:1. Winter 2005-2006. 24pp.

Videos/CDs/DVDs (0)

None

Handbooks/Manuals/Guides (3)

Getchis, T.S. 2004 (revised in 2005, 2006). Guide to Shellfishing along the Coast of Connecticut. Connecticut Sea Grant College Program and Connecticut Department of Agriculture, Bureau of Aquaculture. CTSG-04-06R. 7pp.

Rozum, J. 2005. A new resource for water quality protection: The 2004 CT Stormwater Quality Manual. *The Habitat*, Vol. XVII No. 2.

Van Patten, M. 2006. Seaweeds of Long Island Sound. Connecticut Sea Grant. 104 pp. + 165 illustrations. ISBN 1-878301-09-8. CTSG-06-01.

Press Releases (6)

Van Patten, M. Connecticut Sea Grant Researcher Chris Elphick Wins Nation Award for Bird Conservation

Van Patten, M. Pomeroy named Senior Researcher at WorldFish Organization

Van Patten, M. Connecticut Sea Grant Introduces New Interim Director

Van Patten, M. Connecticut Sea Grant Seeks New Program Director

Balcom, N. and M. Van Patten. Study on Lobster Die-off Now Available to Public

Van Patten, M. Telling Your Story Workshop Helps Scientists Bring Research into the Classroom

Other (20)

Books, Monographs (3)

Calabrese, A., N. Balcom, and A. Clemetson (Guest eds.) 2005. Contributions to the Long Island Sound Lobster Research Initiative, 2001-2004. Special issue of the *J. Shellfish Res.* 24(3):687-875

Kellert, Stephen R. 2005. Building for Life: Designing and Understanding the Human-Nature Connection" Island Press. 307 pp. Illustrated. ISBN: 1-55963-721-8 (paperback); ISBN 1-55963-673-4 (hardcover).

Pomeroy, R.S. and R. Rivera-Guieb. 2006. Fisheries co-management: a practical handbook. CABI International, Rome and International Development Research Centre, Ottawa, Canada. 264 pp. Also available online as an e-book at http://www.idrc.ca/ev_en.php?ID=92339_201&ID2=DO_TOPIC

Booklets (1)

Wahle, L. and N. Balcom. 2002, reprinted in 2005. *Living Treasures: The Plants and Animals of Long Island Sound*. Connecticut Sea Grant and the US EPA Long Island Sound Study. 48 pp.

Fact Sheets (5)

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Pomeroy, R. 2005. Ecosystem Management. Connecticut Sea Grant College Program. Fisheries & Aquaculture Fact Sheet Series. CTSG-05-01. 2pp.

Rivara, K., Keaney, J., and Getchis, T.S. 2005. The Oyster River, Old Saybrook, Connecticut: community-based shellfish restoration. NOAA-Ocean Trust. 2pp.

Smith, L. and P. VanPatten. 2005. Seaweed: a Natural Bioremediator in Finfish Aquaculture. Fact sheet published by New York Sea Grant Institute. 2pp.

Brochures (2)

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Molnar, J. & Getchis, T.S. (2003) Community-based oyster restoration...cleaner water, improved habitat, and more oysters. Connecticut Sea Grant College Program. CTSG-03-05. 2pp.

Posters (2)

Codiga, D. FOSTER-LIS: Oceanography with the MV John H of the Cross-Sound Ferry Fleet. Mounted in public display case with real-time data in passenger area of ferry. (with assistance from M. Van Patten.)

Factor, J. and A. Clemetson. 2003. Lobster life cycle and habitat. Poster/newsletter supplement. New York and Connecticut Sea Grant Programs.

Web Sites (7)

Getchis, T. and N. Balcom.. Invasive Species of Long Island Sound
www.seagrant.uconn.edu/LISINV.htm

Prisloe, S. University of Connecticut Geospatial Technology Program
<http://clear.uconn.edu/geospatial>

Prisloe, S. Connecticut GIS User to User Network <http://ctgis.uconn.edu>

Prisloe, S. National Geospatial Technology Network <http://geospatialextension.org/>

Rozum, J. 2004. Focus on the Coast (Contributor). <http://nemo.uconn.edu/FOTC/>

Van Patten, M. Connecticut Sea Grant website www.seagrant.uconn.edu

Van Patten, M. Wrack Lines website www.seagrant.uconn.edu/wrackhome.htm

e.2 Publications Table

Category	# of Pubs
Peer-reviewed journal articles/book chapters	27
Technical reports	14
Proceedings/Symposia	9
Theses/Dissertations	1
Videos/CDs/DVDs	0
Handbooks/manuals/guides	3
Press Releases	6
Newsletters/Periodicals	13
Other (e.g. websites, such as Haznet or SGNIS)	20

f. Students Supported

Category	# of new Students	# of Continuing Students	# of Degrees Awarded*
Knauss Fellowship	2	0	
Industry Fellowship	0	0	
NMFS/SG Fellowship	0	0	
State Fellowship	1	1	
SG Supported MS/MA Graduate Students	9	6	3
SG Supported Ph.D. Graduate Students	10	8	1
SG Supported Under-Graduate Students	24	26	unavailable
Other	0	0	
TOTAL	46	41	

* Information on degrees awarded derived from completed thesis titles.

g. Program Awards and Honors

1. *Robert Johnston*, Charles R. Goeldner Article of Excellence Award: Best 2005 Article in the *Journal of Travel Research*.
2. *Robert Johnston*, Outstanding Service Award, Northeastern Agricultural and Resource Economics Association, 2006.
3. *Robert Pomeroy*, Senior Research Fellow, WorldFish Center, Penang, Malaysia, 2005
4. *Diana Payne*, Who's Who Among America's Teachers, October 2005