

Center for Marine Sciences and Technology
Annual Report -- 2008-2009

Submitted by Dr. David B. Eggleston, Director
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The principal mission of the Center for Marine Sciences and Technology (CMAST) is to discover innovative solutions to questions and problems in marine systems and provide effective communication of these discoveries, by promoting multidisciplinary studies among research scientists, educators and extension specialists from the participating NC State University colleges, enhancing interaction with other educational institutions and agencies concerned with marine sciences and coastal natural resources, and providing a focal point for citizen contact with NC State University's marine science and extension faculty. A description of CMAST research, extension and education activities and programs may be found on our web-site (www.cmast.ncsu.edu/) and via our newsletters.

The five university-wide strategic thrust areas are:

- *Providing leaders for the state, nation and the world* – CMAST Summer Fellows and Intern Program, Graduate & Undergraduate, and Resident Training, and K-12 Educational Outreach is providing hands-on research and education experiences in coastal and marine sciences.
- *Creating educational innovation* – By virtue of its location on the campus of Carteret Community College, its “2 +2” Program between CMAST/MEAS and the Carteret Community College’s “Applied Marine Biology & Aquaculture Program”, and faculty and students that cut across three Colleges, CMAST is uniquely qualified to expand its role as a branch campus of NCSU and meet the goals of the UNC Tomorrow Report.
- *Improving health and well-being* – CMAST faculty & staff are researching a wide range of topics that affect directly human, animal and environmental health and well being, ranging from monitoring aquatic animal health as an indicator of human health risks, to seafood safety, to the effect of pharmaceuticals in the marine realm, to improving water quality of coastal waters critical to tourism.
- *Fueling economic development* - CMAST faculty & staff are collaborating in a Phase II North Carolina Biotechnology grant to develop a business plan for a Center of Innovation in Marine Biotechnology to facilitate the transfer of ideas and knowledge to job growth. CALS is constructing a mariculture facility in Carteret County that will serve as a pilot demonstration facility for the transfer of mariculture technology to private industry as a means to diversify jobs and income in eastern NC, while simultaneously meeting growing demands for seafood. Both the *Seafood Laboratory* and *Marine Ecology & Conservation* programs at CMAST have provided assistance to value-added seafood products and new aquaculture ventures, respectively.
- *Driving innovation in energy and the environment* – In partnership with the UNC-system and Duke University marine science programs, CMAST is a key partner and one of the leaders in the recent establishment of a North Carolina Environmental Observing Network System (NC-

EONS) in Pamlico Sound. The purpose of NC-EONS is to enable scientific research for advising, protecting and sustaining our state's marine resources for the long term benefit of its citizens through real-time observing systems and integrated water quality data. CMAST faculty also conduct cutting edge research linking global climate change to water quality and biological responses, and are partners in an Ecosystems Services Research Partnership with the EPA that is hastening the pace of innovation in energy and the environment.

The CMAST Student Center and Sustainable House has been re-designed as a demonstration facility for the latest in "green" building technologies, hurricane protection and alternative energy as it pertains to coastal environments. The long-range plan is to couple private industry, NCSU Engineering, and Carteret Community College to conduct research and development, as well as job training in the rapidly growing "green" building industry.

The information below is for inclusion in college reports:

1. *Changes in Service Environment*

- Four initiatives have been funded that are increasing the size of our faculty and staff:
- Oyster Restoration in North Carolina. This \$5 million NOAA-funded project is a partnership between the NC Coastal Federation, NC Division of Marine Fisheries, NC State University, NC Sea Grant, and UNC-Wilmington to restore oyster reefs in NC. This project will add technical support staff and graduate students to CMAST.
- NOAA Cooperative Institute (CI). NOAA awarded a CI to the Florida Atlantic University's Harbor Branch Oceanographic Center to focus on ocean exploration, research and technology development for the US East Coast. CMAST and NCSU/MEAS will lead the "Shelf Frontiers" part of this CI in collaboration with UNC-W and NOAA/NMFS Beaufort. This project will add technical support staff and graduate students to CMAST.
- NCSU Marine Aquaculture Research Center in Marshallburg, NC could add one new faculty member support staff, and new facilities in Carteret County, NC.
- NC Marine Magnetic Resonance Imaging and Spectroscopy Facility in partnership with UNC/NCSU Department of Biomedical Engineering provides a unique research resource to research faculty working in Carteret County, NC and is being relocated from NOAA Beaufort to CMAST to improve accessibility and allow for expansion. The facility will allow investigation of questions ranging from how sea food spoils, to how toxins, drugs or environmental stressors affect the physiology of marine animals, and supports resident interns, graduate students and new faculty.

2. *Compact Plan: Major initiatives from your Compact*

- CMAST did not submit a Compact Plan, however, Eggleston communicated with Deans Solomon, Arden and Wynne the need to consider linkages between PAMS, CVM, and CALS and CMAST-based programs.
- Eggleston communicated with Vice Chancellor Terri Lomax to seek ways in which NCSU Engineering might become more actively involved in Marine Sciences in general and CMAST specifically.
- Eggleston provided input to NCSU's response to the UNC GA *UNC Tomorrow Report* via four means: (i) direct input to PAMS Dean's office, (ii) J. Rice's meeting with

Provost Neilsen, (iii) Eggleston's participation in Provost Neilsen's Open Faculty Forum, and (iv) via Courtney Thornton, UNC GA Research office.

3. *Diversity: Initiatives and progress*

- CMAST is an equal opportunity employer
- Information about CMAST programs and employment opportunities are freely available through our web-site, newsletters, and by visiting our faculty, staff & students.
- CMAST faculty strive to integrate high school, community college, undergraduate and graduate students into research and extension programs.

4. *Instructional Program Advances*

- CMAST faculty offers a variety of hands-on workshops at CMAST or in the field.
- Provide educational opportunities to students and employees at Carteret Community College, UNC Chapel Hill's Institute of Marine Science, Duke University's Marine Lab, NC Division of Marine Fisheries, and NOAA's Beaufort Laboratory.
- CMAST faculty offer in-house and teleconferenced courses to NCSU's main campus.
- CMAST hosts residents from the NCSU College of Veterinary Medicine and teaches a variety of short courses and workshops in support of the Veterinary Medicine Program.
 - Teach in Aquavet I (<http://web.vet.cornell.edu/public/aquavet/index.htm>).
 - Involve DVM students in research and marine animal pathology activities: sea turtle pharmacokinetic research, sea turtle trawl census, summer research mentoring, & marine mammal strandings.
 - DVM Student Summer Research Projects – Coral Lipid Profiles as Markers of Health – Kelly Britt 3rd Year DVM student ; Bill Fish Head Anatomy – Michelle Mehalik 4th year DVM student
 - Manage Support for Aquatic Animal Medicine Fund for veterinary student and resident aquatic research projects. (Supported green turtle ionized calcium and Vitamin D studies (Stringer), soft coral immunology investigations (Holder), and lionfish health investigations (Anderson).
 - Facilitate provision of sea turtle, marine mammal and sea bird carcasses for exotic animal pathology selective, marine mammal medicine elective, and WAAZM workshops.
 - Conducted sea turtle medicine senior block for full block of 6 students.
- Lectures in support of NCSU courses TOX 701 unit on Liver and Kidney toxicity, TOX 495 unit on Endocrine Disruption, TOX 401 unit on Liver and Kidney toxicity.
- Taught Distance Education course (Tox 201-601 “ Poisons, people and the environment” with enrollment of 99 students).
- Invited Participant and Committee Member—NC Interagency Committee on Endocrine Disruptors and their Impact on Fisheries.
- Invited Participant: 2008 Environmental Health Summit, Pharmaceuticals in the Environment, North Carolina Biotechnology Center, Research Triangle Park, November 10-11, 2008.
- Hosted two undergraduates and 1 high school student for summer 2008 research experiences. Mr. David Bennett (UNC-Chapel Hill) “Techniques and method development for detection of carbon based nanoparticles in tissue samples”; Mr. James Wong (Duke University) “Analysis of fish, *Fundulus heteroclitus*, tissues for evidence of

endocrine disruption in coastal waters”; Ms. Mari Hawkins (West Carteret High School) “Effect of Temperature, Oxygen and Bacterial Stress on the Immune Response of *Crassostrea virginica*.”

- Presentation at US Environmental Protection Agency, “Endocrine disruption in invertebrates and what molluscan models tell us” Research Triangle Park, NC December 10, 2008.
- Presentation in Duke University Marine Laboratory, Ecotoxicology and Pollution Course; “Endocrine disruption in mollusks; the affect of EDCs on neuropeptide hormones responsible for sexual morphology, reproduction and behavior.” Beaufort, NC April 28, 2008.
- Hosted annual meeting of the Carolinas Chapter of the Society of Environmental Toxicology and Chemistry (48 participants). Poster and platform presentations (April 2008).
- Select (one of twelve) faculty participant in Nanonet Workshop, European Union and Natural Environment Research Council Knowledge Transfer Network, Hornton Grange, Conference Park, University of Birmingham, Birmingham, UK. November 11-12, 2007.
- Invited presentation given to the California Department of Toxic Substances Control on “Emerging Contaminants”: Nanotechnology Symposium II: Potential Hazards of Nanoparticles in the Environment. Sacramento CA, October 3, 2007.
- CMAST faculty helped to develop scientific program for the Annual One Medicine Symposium held in RTP, NC December 10 and 11, 2008. The theme was Earth, Wind and Fire: A One Medicine Approach to Climate Change and included a session on harmful algal blooms.
- CMAST faculty coordinated the American College of Zoological Medicine Short Course (June 2008) and delivered 15 hours of lecture on water quality and fish, marine mammal, sea turtle and invertebrate medicine to veterinarians preparing to sit boards in zoological medicine.
- Hosted Annual Fish Health Management course offered to veterinarians and non-veterinarians to introduce fundamental principles of management and medicine for ornamental fish and aquatic invertebrates (October 2008).
- “Interacting Effects of Humans and Nature: Hurricanes, Fishermen and the Blue Crab”, SPICOSA, Brest, France, October 2008.
- “Freshwater Pond Grow-Out of Blue Crabs in NC”, NC Fisheries Forum, NC Sea Grant, New Bern, NC, March 2009
- “Blue Crab Pond Grow-Out & Stock Enhancement: Further Progress from NC”, MD DNR, Chesapeake Bay Foundation, Annapolis, MD, January 2009.
- “Marine Sciences and CMAST”, Leadership NC, Carteret Community College, Morehead City, NC, February 2009
- “Future of Fisheries Science & Management”, Duke University Marine Laboratory, Beaufort, NC, April, 2009
- “Oyster Restoration and Metapopulation Dynamics in NC”, CMAST/NC DMF Workshop, Morehead City, NC, May 2009.
- FS354 Food Sanitation (distance education) and FS 322 guest lecture and laboratory
- ZO586 (20 students) Guest lecture on post-harvest handling and quality of aquatic fishery products.

- ZO/MEA 695 - Thesis Research
- ZO/MEA 699 - Thesis Preparation
- ZO/MEA 895 – Dissertation Research
- FW 314 Coastal Ecology and Management, 30 Fisheries and Wildlife undergraduates (May 11 to 16, 2008)
- CBS 817 – Advanced Topics in Zoological Medicine I
- CBS 818 – Advanced Topics in Zoological Medicine II
- CBS 695 - Thesis Research
- CBS 699 - Thesis Preparation
- CBS 895 – Dissertation Research
- FW 695 - Thesis Research
- FW 699 - Thesis Preparation
- FW 895 – Dissertation Research
- Presentation at NC State University’s Continuing Education Sportfishing School (Hatteras, NC) entitled “Fishery Management and Conservation” (June 2008; 40 students)
- Poster, program article, newspaper reports, and local television reports on scientific sampling of pelagic game fish at Big Rock Blue Marlin tournament, Morehead City, NC (June 2008)
- Fisheries Biology laboratory for 4-H middle school students (CMAST: Aug 2008; 15 students)
- Beach seining, geocaching (treasure hunt with gps units), and marine science seminar for 5th graders from White Oak Elementary in Cape Carteret. October 2008; 100 students.
- Hosted 12 undergraduate NCSU students for Coastal Processes course (MEA459).
- Hosted ~ 15 undergraduate NCSU students for Ecology of Fishes field trip.

Mentoring Activities

- Dissertation advisor for Duke University graduate student—T. Michelle Blickley, (8/04-present)
- Mentor, Toxicology rotation student – Sarah Wickman (summer 2008)
- Mentor for Duke University’s “Preparing Future Faculty Program” – Elliott Hazen (9/07 – 8/08)
- Mentor for *Marine Fisheries Management Fellow* – Ray Mroch, (9/08 – present)
- Mentor for Fisheries and Wildlife undergraduate intern – Adam Stephenson (summer 2008)
- Mentor for *Marine Fisheries Management Fellow* – Tim Ellis (7/07-8/08)
- Mentor for Duke University undergraduate independent study - Kirill Zavalin (Spring 2008)
- Mentor West Carteret High School independent study – Morrell Fox (Spring - Summer 2008)
- Mentor West Carteret High School summer intern – Mari Hawkins (Summer 2008)
- Chuck Crapo, Ph.D. (Visiting Scientist). Host for Alaska Sea Grant Seafood Specialist. Dr. Crapo participated in the CMAST seminar series and visited with several local seafood businesses to learn about technology transfer in the mid-Atlantic region.

- Matt Stallworth (CMAST Undergraduate Summer Scholar). Conduct a study (10-week) on isolation of histamine-producing bacteria in yellowfin tuna and mahi-mahi from mid-Atlantic and Hawaiian waters.
- Kayla Norman (West Carteret High School senior). Conduct a study (15-contact hour) on future demand and supply of seafood in North Carolina and the USA.
- The following High School students participated in Dr. Eggleston's research on oyster settlement in Pamlico Sound: Ashley Hodges, Cody Newman, Brandon Eudy, Mariel Grossman, Marlowe Crews, Cynthia Medina, Jobie Gaskins, Morty Gaskill, Adrianna Herina, and Davison Gaskill.
- Four CMAST Summer 2008 fellows: Josh Wiggs, Kirk Smith, Morrell Fox and David Bennett.
- Kristín Björnsdóttir (Ph.D. candidate). Co-advise student who completed her seventh semester on dissertation "*Prevalence and characterization of toxigenic histamine-producing bacteria in fresh tuna.*"
- Kirk Smith (NCSU Sophomore, CMAST Undergraduate Summer Scholar). Advise student in a 10-week study of three test kits for rapid determination of histamine in fish against a HPLC diode array method.
- Mari Hawkins (West Carteret H.S., CMAST Undergraduate Summer Scholar). Advise student in a two-week field experience in purging of hybrid striped bass for improving the appearance and taste profile.
- Cameron Giblin (West Carteret H.S.). Advise student as mentor for her senior project (15 contact hours) on the safety and nutritional quality of North Carolina fish and shellfish.

5. Research

Publications (64)

1. Schwenke, K. L. and **Buckel, J. A.** 2008. Age, growth, and reproduction of dolphinfish *Coryphaena hippurus* caught off the coast of North Carolina. *Fishery Bulletin* 106:82-92.
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12. Bacheler, N.M., **J.A. Buckel**, J.E. Hightower, L.M. Paramore, and K.H. Pollock. in press. A combined telemetry tag return approach to estimate fishing and natural mortality rates of an estuarine fish. *Can. J. Fish. Aquat. Sci.*
13. Choi, K., Law, J. M., **Harms, C. A.** and Lehman, W. 2007. Hypoxia-reperfusion triggers immunocompromise in tilapia (*Oreochromis niloticus*). *J Aquat Anim Health* 19:128-140.
14. Birkenheuer, A. J., **Harms, C. A.**, Neel, J., Marr, H. S., Tucker, M. D., Acton, A., Tuttle A. D. and Stoskopf, M. K. 2007. The identification of a genetically unique *Piroplasma* in North American river otters (*Lontra canadensis*). *Parasitology* 134: 631-635.
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- analyzers for sea turtle health assessment. *J Am Vet Med Assoc* 233: 470-475.
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 61. Henson-Ramsey, H., Levine, J. Kennedy-Stoskopf, S. Taylor, S. K. Shea, D. **Stoskopf, M. K.** (2008) Development of a Dynamic Pharmacokinetic Model to Estimate Bioconcentration of Xenobiotics in Earthworms. *Environmental Modeling and Assessment*. 1420-2026 (Print) 1573-2967 (Online) DOI 10.1007/s10666-007-9132-4
 62. Tuttle, A. D., Burrus, O. Burkart, M. A. Scott, P. W. **Stoskopf, M. K.** and Harms, C. A. (2008) Three cases of gastric prolapse through the gill slit in sand tiger sharks, *Carcharhinus (Rafinesque)*. *Journal of Fish Diseases*. 31, 311-315.
 63. **Green, D.P.** 2008. Editor's Column: Scientific reviews – evaluating the science of the journal. *J. Aquatic Food Product Technology*, Vol. 17(3): 213-215.
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Grants (51)

1. **Buckel, J. A.**, Hightower, J. Pollock, K. and Scharf, F. Does density-dependent mortality occur in an estuarine fish? NC Sea Grant. 2/08-1/10. \$155,000.
2. Lankford, T., Jr., **Buckel, J. A.** Coastal patterns of juvenile bluefish recruitment in the Middle- and South-Atlantic Bights. Bluefish Research Program (NOAA/NMFS/CMER) at Rutgers University. 10/07-9/08. \$90,000 (\$37,943 to NCSU)
3. **Buckel, J. A.**, Burgess, T., Ng, A., Williams, E. and Rudershausen, P. Pilot survey of deepwater reef fishes off North Carolina using a two-stage, adaptive design. NC Sea Grant Fishery Resource Grant. 4/07-3/08. \$46,572.
4. **Buckel, J. A.** and Burgess, T. Novel approach to estimating relative long-term survival of black sea bass and red porgy in the North Carolina reef fishery. NC Sea Grant Fishery Resource Grant. 4/07-3/08. \$53,930.
5. **Buckel, J.**, Ellis, T., Hightower, J., Pollock, K., and B. Burns. Movement and mortality of spotted seatrout in North Carolina: a combined conventional tag and telemetry approach. North Carolina Coastal Recreational Fisheries License Fund. 8/09-7/12. \$299,563 (year 1 awarded at \$98K)

6. Mitchell, W. A., Taylor, J. C., **Buckel, J. A.** and Hightower, J. E. Feasibility of using hydroacoustics to estimate river herring run size in Albemarle Sound, NC. NC Sea Grant Fishery Resource Grant. 8/07-7/09. \$142,916.
7. **Buckel, J. A.** Using biological and habitat data to identify strategic habitat areas for juvenile fish in Albemarle Sound, North Carolina: Marine Fisheries Fellowship. NC Division of Marine Fisheries Conservation Fund. 1/08-12/08, \$18,000.
8. Martin, G. B., Shertzer, K., **Buckel, J. A.** and Taylor, J. C. Fishery Indices for the Southeast Atlantic: Biological indicators of coastal and estuary-dependent fishery production in the US South Atlantic. 5/06-4/08. NOAA Fisheries and the Environment (FATE). \$124,729.
9. **Buckel, J. A.** and Thigpen, J. Enhancing the quality of North Carolina's Fisheries Extension and Applied Research Products. 5/1/04-6/30/09. National Sea Grant. \$169,130.
10. **Buckel, J. A.**, Hightower, J. and Pollock, K. Factors influencing escapement of red drum in North Carolina: a conventional tag and telemetry approach. 2/06-1/08. NC Sea Grant. \$166,668.
11. **Buckel, J.**, Ellis, T., Hightower, J. and Burns, B. Collecting the preliminary data necessary to design and conduct an effective long-term tagging study on spotted seatrout (*Cynoscion nebulosus*). NC Fishery Resource Grant. 8/08-12/09 \$62,061.
12. **Buckel, J. A.**, Burgess, T., Williams, E., Mitchell, W. and Rudershausen, P. Pilot survey of deepwater reef fishes off North Carolina using a two-stage, adaptive design: Part 2 – use of Chevron trapping. NC Fishery Resource Grant. 4/08-3/09. \$44,920.
13. **Buckel, J. A.** and Hodson, R. Marine Fisheries Management Fellowship: A cooperative agreement between North Carolina Division of Marine Fisheries and North Carolina Sea Grant. 2/06-1/08. \$53,492
14. **Buckel, J. A.** and Voiland, M. Marine Fisheries Management Fellowship: A cooperative agreement between North Carolina Division of Marine Fisheries and North Carolina Sea Grant. 2/08-1/10. \$53,492.
15. **Buckel, J. A.**, Rudershausen, P., Gregory, R. Britt, D. and P. Zook. A Comparison Between Circle and 'J' Hook Performance in the Wahoo, Yellowfin Tuna, and Mahi Troll Charter and Recreational Fishery of North Carolina. NC Fishery Resource Grant. 5/08-4/10. \$60,300.
16. **Buckel, J. A.** Scientific sampling of blue marlin, yellowfin tuna, wahoo, and dolphin captured during the Big Rock Blue Marlin tournament. Big Rock Blue Marlin tournament committee (June 2008, \$8,000)
17. **Lewbart GA**, Christian LS, **Harms CA.** Veterinary medical services rendered to the Museum of Natural Sciences. 2008 - 2011 (North Carolina Department of Environment and Natural Resources) \$60,000 (\$20,000/yr)
18. **Harms, C. A.** Characterization of Amebocytes Found in Clinically Normal and Diseased Gorgonian Sea Fans. 2008 (Morris Animal Foundation sponsor for Veterinary Student Scholar Katharine Holder) \$2000
19. **Stoskopf, M. K., Harms, C. A., Lewbart G, Kennedy-Stoskopf S.** Aquarium Health Management. 2009 (North Carolina Aquariums) \$95,832
20. **Harms, C. A.**, Papich MG, Cranston EA, Flanagan JP. Pharmacokinetics of clindamycin in loggerhead sea turtles (*Caretta caretta*) after a single IV, IM or oral dose. 2009 (Association of Amphibian and Reptilian Veterinarians Conservation and Research Committee) \$3000.
21. **Harms, C. A.**, Watts BH. Predation on important commercial and recreational fishes along the coast of North Carolina by the bottlenose dolphin (*Tursiops truncatus*). 2009 (North

- Carolina Sea Grant) \$4900.
22. **Kennedy-Stoskopf, S.** University Extension, Engagement, and Economic Development Grant “*Science Matters*” (\$10,000, 7/1/07-6/30/08).
 23. Blickley, T. Michelle. (**P. McClellan-Green**, dissertation advisor) Procter & Gamble Graduate Fellowship (awarded once every 3rd year to a North American (Canada, USA and Mexico) graduate student).
 24. **McClellan-Green, P.** Florida Fish and Wildlife- Analysis of Queen Conch (*Strombus gigas*) Neuropeptide Expression, \$7,500. (no timeline).
 25. **McClellan-Green, P.** “Identification of factors influencing disease related mortality in the eastern oyster *Crassostrea virginica*” FRG Blue Crab and Shellfish Research Program, June 1, 2009-May 31, 2010. \$32,349.10.
 26. **McClellan-Green, P.** “Spawning characteristics and reproductive capacity of blueback herring stocks in the Albemarle Sound, North Carolina” North Carolina Marine Resources CRFL Fund, Jan. 1, 2010-Dec. 31, 2011. Year 1 funded (\$44,665) \$91,509.
 27. **Eggleston, D. B.** “Blue crab dependence on SAV nurseries in Albemarle Sound”. NC Sea Grant/Blue Crab Research Grant Program, May 2007-2009. \$42,479/PI (5-27649).
 28. **Eggleston, D. B.** “Oyster dispersal and meta-population dynamics in Pamlico Sound: Part I, larval dispersal”. NC Sea Grant. May 2005-2009. \$102,029/PI (5-26552 and 5-26570).
 29. **Eggleston, D. B.** “Oyster dispersal and meta-population dynamics in Pamlico Sound: Part II, settlement, survival and spawning potential”. NC Sea Grant, FRG Program. \$40,000, May 2006-2009/PI (5-28006).
 30. **Eggleston, D. B.** “Blue crab (*Callinectes sapidus*), an integrated research program of basic biology, hatchery technologies, and potential for replenishing stocks”. University of Maryland (prime) and NOAA. November 2006-2009. \$220k/PI (529016 and 5-27220).
 31. **Eggleston, D. B.** “Blue crab stock enhancement: further progress in freshwater pond rearing”. NC Sea Grant/Blue Crab Research Grant Program. May 2007-2009. \$19,000/PI (5-27650).
 32. **Eggleston, D. B.** “Initiation of an Inter-Institutional Environmental Observation Network System for North Carolina (NC EONS)”, UNC-W (prime) and UNC General Administration, \$54,000/PI (5-28628).
 33. **Eggleston, D. B.** “Oyster dispersal and meta-population dynamics in Pamlico Sound: Part II, settlement, survival and spawning potential”. NC Sea Grant. May 2008-2010. \$87,000/PI (5-28781, 5-28844, 5-28848).
 34. **Eggleston, D. B.** “Timing and route of movement in mature female blue crabs in the White Oak River”. NC Sea Grant/Blue Crab Research Grant Program. May 2008-December 2009. \$69,992/PI (5-28964).
 35. **Eggleston, D. B.** “NMFS-Sea Grant Fellowship in Population Dynamics”. NOAA/National Sea Grant. May 2008-2010. \$113,976/PI (5-29097).
 36. **Eggleston, D. B.** “Abiotic drivers of fishery-dependent and –independent catch efficiency in the North Gulf of Mexico”. Environmental Defense Fund. June 2007-December 2009. \$64,551/PI (5-28298).
 37. **Eggleston, D. B.** “Timing and route of movement in mature blue crabs in northeastern NC”. NC Sea Grant/Blue Crab Research Program. May 2009-2010. \$6,000/PI (5-50401).
 38. **Eggleston, D. B.** “Caribbean network of deep-water refugia for exploited marine species”. NSF/PIRE. July 2009-2013. \$1,326,997/co-PI w/ R. Lipcius, PI (pending).
 39. **Eggleston, D. B.** “Collaborative Research: Interacting effects of local demography and larval connectivity on estuarine metapopulation dynamics in a network of reserves”.

- NSF/Biological Oceanography. July 2009-2012. \$1,034,612/PI w/ T. Wolcott, E. North, & R. Luettich, co-PIs. (pending).
40. **Eggleston, D. B.** “Performance-based aquatic vegetation monitoring”. APNEP (prime) and NC Division of Marine Fisheries/DEHNR June 2009-2010. \$20,259/PI.
 41. **Eggleston, D. B.** “Ecological performance measures of large-scale, sub-tidal oyster restoration”. NC Coastal Federation (prime) and NOAA Habitat Restoration, American Re-Investment and Recovery Act. June 2009-December 2010. \$200,000/PI.
 42. **Eggleston, D. B.** “Supporting Ecosystem-Based Management (EBM) of Shelf Frontiers”. UNCW (secondary), Florida Atlantic University (prime) and NOAA. July 2009-2014. ~\$400k/yr. plus ship-, AUV-, ROV-time/PI with R. He and J. Buckel NCSU co-PIs. (NOAA CI was awarded: http://www.noaanews.noaa.gov/stories2009/20090506_institute.html).
 43. **Green, D. G.** Cornell University “*An internet training program on sanitation, good manufacturing and hygienic practices for food processors, wholesalers and warehouses*” (\$8,970 sub-award of \$444,655 prime, USDA-CSREES Integrated Research, Education and Extension Grants Program, 9/1/05-8/31/2009).
 44. **Green, D. G.** NC Sea Grant Program “*Develop an Industry Blueprint on Commercializing Value-Added Seafood and a Consumer’s Guide to Home Seafood Preparation*” (\$5,000, 7/1/08-5/31/09).
 45. **Green, D. G.** NC Fishery Resource Grant Program “*Producing farmed hybrid striped bass for year round markets*” (\$19,643, 5/1/2006-3/31/2009).
 46. **Green, D. G.** NC Fishery Resource Grant Program “*A total quality system (TQS) for grading, traceability and marketing North Carolina seafood*” (\$41,650, 4/1/2007-6/30/2009).
 47. **Green, D. G.** National Fisheries Education & Research Foundation “*A rapid method to quantify toxigenic histamine-producing bacteria in fish*” (\$19,521, 1/1/2008-6/30/2009).
 48. **Green, D. G.** NC Sea Grant Program “*Development of Marine Industries and Processing Systems: Seafood Science and Technology Program*” (\$83,735, 2/1/2008-6/30/2009).
 49. **Green, D. G.** NC Fishery Resource Grant Program “*Assessment and validation of North Carolina bluefin tuna industry practices*” (\$5,000 sub-award of \$37,700 prime, 6/1/2007-5/31/2009).
 50. **Green, D. G.** NC Biotechnology Center “*8th International Joint Meeting of the Seafood Science and Technology Society and the Atlantic Fisheries Technology Conference, in conjunction with the 1st North Carolina Marine Biotechnology Symposium*” (\$7,500 award, in addition to \$38,400 matching funds, 10/01/2008-10/24/2008).
 51. **Green, D. G.** NC Fishery Resources Grant Program “*Mariner’s Menu Online: Blogging New Seafood Recipes to Meet Consumer Demand for North Carolina Seafood*” (Pending, \$13,560).

6. Extension

In addition to presentations by faculty, staff and students within the US and on the international stage, CMAST has numerous recent and exciting extension programs, including:

Marine Science and Education Partnership (MSEP)

- CMAST is a key member of MSEP, which is a coalition of directors of marine science institutions and agencies, and other leaders in Carteret County, whose goal is to use

science, technology and education to enhance the climate for marine-related businesses and industry in rural areas of NC. MSEP contributed \$127 million and 3,162 jobs to Carteret County in 2004.

Seafood Technology

- Pre-harvest Conditions, Handling Affect Sensory Quality of Freshwater Fish. David P. Green. Global Aquaculture Advocate, September/October 2008. pp. 61-62.
- Quality Counts: A Consumer's Guide to Selecting North Carolina Seafood. Barry Nash, David Green and Bill Bath, NC Sea Grant, UNC-SG-08-01. Poster.
- Water Activity: One Measure of Shelf Life Control and Sensory Assessment for Aquaculture Producers, David Green. Seafood Currents newsletter, Vol. 1, No. 3 & 4.
- Small Business of the Year - Spotlight on David Green. Business NC Magazine, Dec. 2008. page 20.
- Environmental Factors Lead to Shrimp Decline: Questions and Answers. David Green. In "Can the Shrimp Industry Survive in the Carolinas?" The News and Observer, Sunday September 14, 2008. Section E, pages 1-2.
 - Continue participation on Seafood HACCP Alliance editorial committee to deliver education and training workshops to update industry and regulatory personnel on the FDA guidance manual.
 - Respond to technical information and service requests by industry in HACCP compliance, processing and packaging technology and value-added products.
 - Implement education and training program in sensory assessment of NC hybrid striped bass.
 - Implement an industry fee-for-service program to support the education and training programs offered by the NCSU Seafood Laboratory.

Workshops organized and presentations given

- Delivered Fish Health Management Workshop, a 3-day continuing education program for veterinarians and fish health professionals, at CMAST.
- 8th Joint Meeting of the Seafood Science and Technology Society and Atlantic Fisheries Technology Conference, including the 1st North Carolina Marine Biotechnology Symposium. Organized and hosted the three-day event with 50 oral and poster presentations. (155 attendees, \$45,900 in receipts).
- Organized eight seafood HACCP workshops as supervisory instructor. Three-day workshop and seven Segment Two workshops with non-degree certification of course completion given from the Association of Food and Drug Officials (AFDO). (76 attendees, \$7,673 in receipts).
- North Carolina Aquaculture Development Conference. Provided CMAST tour and update to 25 participants on two FRG funded hybrid striped bass studies on fish purging and traceability.
- UNC Seafood Quality and Safety Workshop for Environmental Health Specialists, 2008. Gave presentation on "*Seafood-borne parasites as potential pathogens of humans*" for 34 participants.
- NC DEH Centralized Intern Training workshop, 2008. Gave presentation on "*Food Preservation*" for 19 environmental health specialists.

- Carteret County Environmental Health ServSafe Workshop, 2008. Gave presentation on “*Managing Seafood Safety in Food Service and Retail Establishments*” for 20 participants.
- Carteret County Leadership for Educators workshop, 2008. Gave presentation on “*Seafood quality and safety issues*” during summer program to 22 attendees.
- Carteret County Marine Science Academy, 2008. Gave presentation on “*Food Processing and Preservation*” during summer program to 58 students and teachers in 7th, 8th and 9th grades.

Fisheries and Aquaculture Research

Demand for fisheries products is increasing rapidly while supplies decline. Fisheries and aquaculture research has identified (i) information leading to sustainable fisheries and habitat management in NC, (ii) novel techniques for aquaculture of fish and blue crabs, and the technology transfer of these techniques for commercialization and job growth, and (iii) technical support and education for commercial and recreational fishers in NC.

Environmental and Molecular Toxicology

Escalating coastal development brings the need for novel and rapid means of detecting degraded habitat, water quality, and organism health (reproduction, growth and development) and the technology to reduce negative impacts. Environmental and molecular toxicology has identified novel techniques for rapidly assessing water quality and the health of marine organisms, as well as the source of bacterial contaminants.

Veterinary Medicine

CMAST provides the only veterinary college in the U.S. with a coastal presence and, in addition to training students, provides innovative surgical repair and medical treatment to injured sea turtles and marine mammals in support of the mission of NOAA, the NC Aquarium System and the sea turtle hospital on Topsail Island. In addition, veterinary medicine provides novel techniques that support the detection and treatment of disease in NC’s aquaculture industry.

- Innovations in clinical service (new techniques, methods, clinical trial protocols):
 - Unit attending veterinarian for CMAST and PAFL.
- Primary clinical contact for 3 NC Aquariums with monthly site visits and continuing
- Primary clinical contact for Karen Beasley Sea Turtle Rescue and Rehabilitation Center with monthly site visits.
- On call for marine mammal strandings conducted about 34 marine mammal necropsies, including some beach responses with euthanasia.
- The Marine Magnetic Resonance Imaging and Spectroscopy Facility is relocating closer to CMAST where there is more space for additional capacity. The facility will allow investigation of questions ranging from how sea food spoils, to how toxins, drugs or environmental stressors affect the physiology of marine animals.
- Clinical support for NMFS sea turtle health assessments and NMFS lionfish research facility.
- Representation on the NMFS Marine Mammal Unusual Mortality Event (MMUME) Working Group (Kennedy-Stoskopf).

- Hosts CVM Mobile Surgery Unit and veterinary students for twice yearly feral cat spay/neuter weekends in collaboration with local humane group.

Distance Education and high-speed internet communications

- CMAST provides high speed internet service (1 gigabyte/sec.) that supports teleconference and distance education activities in the Carteret County area from the community college to our research university partners.
- CMAST provides numerous courses to main campus, as well as receiving courses from main-campus that support students from NCSU, UNC-CH and Duke University. See Instructional Program Advances above for many examples.

K-12 Education

- Research on the blue crab and oysters has provided hands-on research experiences and teacher support for fifth-grade to high school students throughout eastern NC. These hands-on research opportunities have benefited students from economically depressed areas with little opportunity for hands-on research and jobs in science.
- Graduate students working with blue crabs (Erika Millstein) and endangered NC freshwater mussels (Jennifer Hurley) shared their work with students visiting the NC Museum of Natural Sciences, Fall and Spring semesters 2007-2008.

7. Initiatives and public service activities

CMAST Research & Extension Activities help the State by:

- Partnering with the NC Museum of Natural Sciences to train graduate students to become more comfortable and effective communicators when interfacing with the general public to describe their research projects. This is part of the “Science Matters” Program. Erika Millstein shared her work on blue crabs and Jennifer Hurley explained her work with endangered NC freshwater mussels Spring Semester 2008.
- Partnering with the NC Museum of Natural Sciences to develop an exhibit called “One Health – One Earth” to highlight the inter-dependency of human and animal health with the well-being of our shared environments. This will be mounted in the new addition to the Museum and will initially include a segment on harmful algal blooms (HAB), their impact on human and aquatic animal health and why the world’s oceans are experiencing an increase in HAB events. Supporting tourism by keeping the animals at the NC Aquariums healthy and responding to the health needs of sea turtles and marine mammals on our coast.
- Supporting eastern North Carolina businesses by conducting and supporting conferences and meetings that draw people to the coast.

- Providing high speed internet backbone that supports education in the Carteret County area from the community college to our research university partners.
- Supporting NC by reaching out to the nation and the world through collaborative efforts to solve problems that occur not only in our backyard but on every corner of this planet.
- Employing eastern North Carolina citizens in both permanent and temporary positions; the training provided to temporary employees has allowed them to secure permanent jobs in related fields (e.g., NC Division of Marine Fisheries).
- Providing recreational and commercial fishers in eastern NC with assistance on Fishery Resource Grant projects and outreach products that extend research results.

8. Students

Kristín Björnsdóttir (Ph.D. student, NCSU, D. Green advisor)
 Amy Haase (MS student, NCSU, D. Eggleston advisor)
 Erika Millstein (MS student, NCSU, D. Eggleston advisor)
 Ray Mroch (MS student, NCSU, D. Eggleston advisor)
 Christina Durham (MS student, NCSU, D. Eggleston advisor)
 Geoff Bell (Ph.D. student, NCSU, D. Eggleston advisor)
 Brandon Puckett (Ph.D. student, NCSU, D. Eggleston advisor)
 Mary Radlinksy (Ph.D. student, NCSU, D. Eggleston advisor)
 Ryan Rindone (MS student, NCSU, D. Eggleston advisor)
 T. Michelle Blickley (Ph.D student, Duke University, P. McClellan-Green advisor)
 Kyle Adamski (MS student, NCSU, J. Buckel advisor)
 James Morley (Ph.D. student, NCSU, J. Buckel advisor)
 Tim Ellis (Ph.D. student, NCSU, J. Buckel advisor)
 Sarah Friedl (MS student, NCSU, J. Buckel advisor)

9. Fund-Raising: Private fund-raising successes

- A Living Trust of property is in the process of being donated to the NCSU PAMS Foundation and will serve as housing and dockage for a CMAST Visiting Scholars program.
- Five local corporations have been contacted and have expressed support for our CMAST Summer Scholars program.
- Other CMAST Development Opportunities have been promoted to appropriate individuals and groups throughout the year-a list of these can be found on our web-site (www.cmast.ncsu.edu).

10. Administration: Achievements and staff changes

Key administrative achievements include (1) upgraded web-site, (2) re-designed network switches, LAN and phone system, (3) publication of newsletters, (3) safety plans and procedures on-line, (4) upgrades and security of Fisheries & Oceans warehouse, (5) hosting Congressional Delegation, (6) roof replacement, (7) construction of a new boat shelter providing protection of state research vessels from the environment, and (8) construction of Magnetic Resonance Imaging facility at Fisheries & Oceans Warehouse.

11. Recommendations and concerns for the future

- Four major concerns and recommendations for CMAST remain:
 - Funding of student /faculty housing to provide visiting faculty, staff and students economical, safe and convenient accommodations which, in turn, will increase use of the facility, interaction with main-campus, and promote educational activities.
 - Increase resident faculty, which will increase the critical mass necessary to promote multi-disciplinary research programs, economic growth via biotechnology, and provide courses for undergraduate and graduate students.
 - Provide state-appropriated operating budget.
 - Increase wet-laboratory space.

12. Providing world leaders

All faculty at CMAST interact with and are recognized for their excellent scholarly activities by colleagues throughout the world.

13. Impacting energy and the environment

- The principal mission of the Center for Marine Sciences and Technology (CMAST) is to discover innovative solutions to questions and problems in marine systems and provide effective communication of these discoveries. An emerging mission is to become a model for the latest technology in sustainable coastal building and alternative energy.
- Examples of CMAST support for sustaining the environment may be found in the research, education and extension/outreach examples found throughout this report.
- An example of our commitment to energy may be found in the revised design of the CMAST student/faculty house, which has been approved by NCSU as a LEED building, and through the planned use of wind turbines from PacWind Inc. to generate electrical power and as a demonstration facility.

14. Improving health and well-being

- CMAST researchers are improving (1) seafood safety, (2) water quality, (3) aquatic animal health, as well as providing research in support of (4) sustainable coastal ecosystems and fisheries through the research described throughout this report.
- Seafood safety and quality workshops provide North Carolina businesses, regulatory personnel and citizens with science-based technical information and training. Our programs were expanded to include new rules and record-keeping requirements under the Bioterrorism and Preparedness Act of 2002. Education programs continue to be offered in HACCP compliance, traceability and authenticity, quality control and value-added product development. Impacts of these programs are greater compliance with current state and federal health regulations, dollars saved due to improved processes, market growth and job creation. Participants are able to make more informed decisions based on up-to-date information provided. The NCSU Seafood Lab has provided training for over 700 individuals in HACCP since 1997 who receive non-degree certificates from the

Association of Food and Drug Officials (AFDO). The demand for seafood safety and quality education and training programs remains strong; with growing interest in areas of value-added product development and traceability.

- Provide cutting edge clinical expertise that raises the national standards for veterinary care. Develop and improve telemedicine and record systems to support our clinical management of the NC Aquariums. Improve the standard of care in the practicing community of North Carolina, the USA, and the World by providing professional development opportunities for veterinarians. Provide a leadership role in Department, CVM, VTH, NCSU, and national and international organizations. Contribute time and talents to the wider community.
- Provide data necessary to produce and implement fishery management plans for state- and federally-managed species (e.g., blue crab and red drum).

15. Creating educational innovation

CMAST faculty, staff and students are creating educational innovation through hands-on, inquiry-based education, (2) web-based teaching tools, and (3) providing hands-on experience for young people.