

**Center for Marine Sciences and Technology
Annual Report -- 2009-2010**

Submitted by Dr. David B. Eggleston, Director
June 2010

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.

David Green:

Number of graduate students served: 1 – Kristin Bjornsdottir-Bulter, Ph.D.

Number of undergraduate students served: 2 – Amanda Cox (Senior), Janna Jones (Soph)

Number of businesses served: Too Numerous To Count (TNTC) Estimate >100 firms

Craig Harms:

Number of graduate students served: 1 graduate student (James Morris, completed PhD in 2009, committee member) and 3 residents (Eric Anderson, Betsy Stringer, Tres Clarke)

Number of undergraduate students served: (31 Duke undergrads in two courses, 12 CCC students in one course, 11 veterinary students in different coastal wet labs, 189 veterinary students in Raleigh based on material generated from CMAST work)

Number of businesses served: 3 NC Aquariums (not exactly businesses, but major economic attractions in coastal NC)

Jeff Buckel:

Number of graduate students served: 11 graduate students

Number of undergraduate students served: 33 undergraduate and 40 continuing education

Number of businesses served: 0 businesses

Pat McClellan-Green:

Number of graduate students served: 2

Number of undergraduate students served: 214 (210 in DE class and 4 in lab)

Number of businesses served: 0

Michael Stoskopf:

Number of graduate students served: 25

Number of undergraduate students served: 30

Number of businesses served: 0

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* provides applied research, training and education programs to assist coastal businesses to comply with state and federal regulations, adopt new processing techniques and expand into new markets through adding value to seafood products.

Program Impacts:

Foodborne illnesses account for over 20,000 hospitalizations and 5,000 deaths annually in the United States. Efforts to reduce human illnesses by the US Food and Drug Administration mandate a risk-based preventive approach on the principles of Hazard Analysis Critical Control Point (HACCP) inspections. North Carolina Cooperative Extension and Sea Grant specialists along with NC Food and Drug Protection and NC Shellfish Sanitation investigators provide education and training workshops for industry and regulatory personnel. The seafood HACCP curriculum is recognized by the US Food and Drug Administration as the standardized training workshop and participants receive a certificate from the Association of Food and Drug Officials upon course completion. In 2009, four seafood HACCP workshops were organized with 47 participants receiving their AFDO certificates of course completion. This brings the total number of individuals trained in North Carolina on seafood HACCP principles to 836 since 1997 with over 25,000 trained nationwide through efforts of the National Seafood HACCP Alliance. Impacts are compliance with state and federal seafood safety requirements, increased knowledge of seafood safety and reduced risks for consumers by implementation of a preventive food safety program. Benefits for industry and consumers are reduced risk due to potential food safety hazards in the commercial food supply. The seafood industry leads the nation in implementing the preventive approach based on the principles of Hazard Analysis Critical Control Point (HACCP) inspections.

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.
- The NCSU CMAST Marine Health Programs assumed interim leadership of the central coastal NC marine mammal stranding network. Harms CA. Maintaining marine mammal stranding response capacity in central North Carolina and transitioning to a new stranding response program. National Oceanic and Atmospheric Administration (NOAA) \$99,661, 1 October 2009 through 30 September 2010.

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 trawl census, summer research mentoring, & marine mammal strandings.
 - DVM Student Summer Research Projects – Beth Cranston, clindamycin pharmacokinetics in sea turtles
 - Manage Support for Aquatic Animal Medicine Fund for veterinary student and resident aquatic research projects, green sea turtle cold stunning clinical pathology study (Anderson) 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 210 students).
- Panelist: 2009 Environmental Health Summit, Environmentally Responsible Development of Nanotechnology, North Carolina Biotechnology Center, Research Triangle Park, October 8-9, 2009.

- Supervised and advised two undergraduates during summer 2009 research experiences. My Ryan Peiffer from Gettysburg College; “The Effects of Effluent Waste Water Containing Pharmaceuticals on Phospholipoprotein Levels and Phenoloxidase Activity in Oysters in Calico Creek, Morehead City, North Carolina, USA” and Mr. Jeff Johnson from UNC-Wilmington; “Identification of factors influencing disease related mortality in the eastern oyster *Crassostrea virginica*”
- Supervised and advised Duke Undergraduate and Rachel Carson Fellowship Scholar Mr. William Olcott during 2009-2010 academic year; “Chlorpyrifos Induced Apoptotic Effects on the Eastern Oyster, *Crassostrea Virginia*”
- Senior Project Mentor (West Carteret High School, Morehead City, NC): Ms. Mari Hawkins: Effect of tributyltin on oyster settlement behavior. February-May 2010.
- Selected presentation given to the North Carolina State University Nano Initiative Leadership Committee on “Gender specific effects, endocrine disruption and maternal transfer of engineered nanoparticles” March 23, 2010.
- Presentation: 2009 Chesapeake Research Consortium Regional Conference. “EDC effects in bivalves: Are our oysters at risk?” Baltimore, Maryland, March 25-26, 2009.
- “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, 32 Fisheries and Wildlife undergraduates (May 11 to 15, 2009)
- FW 595 Modeling Fish and Wildlife Populations (co-taught with Joe Hightower), 2 Fisheries and Wildlife graduate students (Fall 2009)
- 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 2009; 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 2009)
- Carteret County Marine Science Academy Camp. Beach seining and water quality. June 15, 2009. 55 students (7 to 9th grade).
- 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, (8/04-5/10)
- Mentor, NCSU Toxicology/Biology graduate student – Kelly O’ Neal (Summer 2009)
- Mentor West Carteret High School Senior Project – Mari Hawkins (Spring 2010)
- Mentor for *Marine Fisheries Management Fellow* – Ray Mroch, (9/08 – 8/09)
- Mentor for *Marine Fisheries Management Fellow* – Jennifer Weaver, (8/09 – present)
- Mentor for Fisheries and Wildlife undergraduate intern, Melissa Brewer (Summer 2009)
- Mentor for CALS Honors Program Research (ALS 498), Melissa Brewer (Fall 2009)
- 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.
- 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.*”
- James Morris (James Rice co-chair, C. Harms committee member) successfully defended his doctoral dissertation on invasive lionfish and continued his full time position at the NOAA Beaufort, NC laboratory. Dr. Morris was awarded the 2009 Kenneth R. Keller Award for Excellence in Doctoral Dissertation Research.

5. Research

Publications totaling 57

1. **Buckel, J. A.**, Pessutti, J. E., Rosendale, J. R., and J. S. Link. 2009. Interactions between bluefish and striped bass: behavior of bluefish under impaired conditions and overlap in resource use. *J. Exp. Mar. Biol. Ecol.* 368:129-137.
2. Bacheler, N.M., L.M. Paramore, **J.A. Buckel**, and J.E. Hightower. 2009. Abiotic and biotic factors influence the habitat use of an estuarine fish. *Mar. Ecol. Prog. Ser.* 377:263-277.
3. Taylor, J. C., W.A. Mitchell, **J. A. Buckel**, H. J. Walsh, K. W. Shertzer, G. B. Martin, and J. A. Hare. 2009. Relationships between larval and juvenile abundance of winter-spawned fishes in North Carolina, USA. *Mar. Coast. Fish.* 1:11-20.
4. Scharf, F. S., **J. A. Buckel**, and F. Juanes. 2009. Contrasting patterns of resource utilization between juvenile estuarine piscivores: the influence of relative prey size and foraging ability on the ontogeny of piscivory. *Can. J. Fish. Aquat. Sci.* 66:790-801.

5. Bacheler, N. M., L. M. Paramore, S. M. Burdick, **J. A. Buckel**, and J. E. Hightower. 2009. Variation in movement patterns of red drum inferred from conventional tagging and ultrasonic telemetry. *Fish. Bull.* 107:405-419.
6. Bacheler, N. M., **J. A. Buckel**, J. E. Hightower, L. M. Paramore, and K. H. Pollock. 2009. A combined telemetry – tag return approach to estimate fishing and natural mortality rates of an estuarine fish. *Can. J. Fish. Aquat. Sci.* 66: 1230-1244.
7. Butler, C. M., P. J. Rudershausen, and **J. A. Buckel**. 2010. Feeding ecology of Atlantic bluefin tuna (*Thunnus thynnus*) in North Carolina: diet, daily ration, and consumption of Atlantic menhaden (*Brevoortia tyrannus*). *Fish. Bull.* 108: 56-69.
8. Bacheler, N. M., J. E. Hightower, S. M. Burdick, L. M. Paramore, **J. A. Buckel**, and K. H. Pollock. 2010. Using generalized linear models to estimate selectivity from short-term recoveries of tagged red drum *Sciaenops ocellatus*: effects of gear, fate, and regulation period. *Fisheries Research* 102: 266-275.
9. Rudershausen, P. J, **J. A. Buckel**, J. Edwards, D. P. Gannon, C. M. Butler and T. W. Averett. Feeding ecology of blue marlin, dolphinfish, yellowfin tuna and wahoo from the North Atlantic, with comparisons to other oceans. *Trans. Am. Fish. Soc.*, in press
10. Rudershausen, P.J, W.A. Mitchell, **J.A. Buckel**, E. Williams, and E. Hazen. Developing a two-step fishery-independent design to estimate the relative abundance of deepwater reef fish: application to a marine protected area off the southeastern United States. *Fisheries Research*, in press
11. **Buckel, J. A.**, Pessutti, J. E., Rosendale, J. R., and J. S. Link. 2009. Interactions between bluefish and striped bass: behavior of bluefish under impaired conditions and overlap in resource use. *J. Exp. Mar. Biol. Ecol.* 368:129-137.
12. Bacheler, N. M., L. M. Paramore, **J. A. Buckel**, and J. E. Hightower. 2009. Abiotic and biotic factors influence the habitat use of an estuarine fish. *Mar. Ecol. Prog. Ser.* 377:263-277.
13. Taylor, J. C., W. A. Mitchell, **J. A. Buckel**, H. J. Walsh, K. W. Shertzer, G. B. Martin, and J. A. Hare. 2009. Relationships between larval and juvenile abundance of winter-spawned fishes in North Carolina, USA. *Mar. Coast. Fish.* 1:11-20.
14. Scharf, F. S., **J. A. Buckel**, and F. Juanes. 2009. Contrasting patterns of resource utilization between juvenile estuarine piscivores: the influence of relative prey size and foraging ability on the ontogeny of piscivory. *Can. J. Fish. Aquat. Sci.* 66:790-801.
15. Bacheler, N. M., L. M. Paramore, S. M. Burdick, **J. A. Buckel**, and J. E. Hightower. In press. Seasonal variation in age-specific movement patterns of an estuarine fish inferred from conventional tagging and telemetry. *Fish. Bull.*
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17. **Eggleston, D. B.**, G. W. Bell, S. P. Searcy. (2009). Do Blue Crab Spawning Sanctuaries in North Carolina Protect the Spawning Stock? *Transactions of the American Fisheries Society* 138: 581-592.
18. Bell, G. W., **D. B. Eggleston** and E. J. Noga. (2010). Molecular keys unlock the mysteries of variable survival responses of blue crabs to hypoxia. *Oecologia.* 163: 57-68.
19. Bell, G. W., **D. B. Eggleston** and E. J. Noga. (2009). Environmental and physiological controls of blue crab avoidance behavior during exposure to hypoxia. *Biological Bulletin* 217:161-172.

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27. Fire, S. E., Wang, Z., Leighfield, T. A., Morton, S. L., McFee, W. E., McLellan, W. A., Litaker, R. W., Tester, P. A., Hohn, A. A., Lovewell, G., **Harms, C.**, Rotstein, D. S., Barco, S. G., Costidis, A., Sheppard, B., Bossart, G. D., Stolen, M., Durden, W. N., Van Dolah, F. M. 2009. Domoic acid exposure in pygmy and dwarf sperm whales (*Kogia* spp.) from southeastern and mid-Atlantic U.S. waters. *Harmful Algae* 8: 658-664.
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- A pilot study. Mar. Environ. Res.
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 38. **Stoskopf, M. K.** (accepted 2009) Normal Hematology of Elasmobranchs. Schalm's Textbook of Veterinary Hematology, Williams and Wilkins, Baltimore, MD.
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 45. **Stoskopf, M. K.** (2009) Normal Hematology of Elasmobranchs. Schalm's Textbook of Veterinary Hematology, Williams and Wilkins, Baltimore, MD.
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 47. **Stoskopf, M. K.** (Editor) (2009) Health and Safety in the Third World 2009. Course CD. NCSU EMC
 48. **Stoskopf, M. K.:** (2009) Herptile Medicine: 2006 and 2008. Course CD. NCSU EMC
 49. **Stoskopf, M. K.**, D. Mulcahy, D. Esler (2010) Evaluation of a Portable Automated Serum Chemistry Analyzer for Field Assessment of Harlequin Ducks, *Histrionicus histrionicus*. *Veterinary Medicine International*.
 50. Whittier, Christopher .A., Michael R. Cranfield and. **M. K. Stoskopf** (submitted 2009) Real-time PCR Detection of *Campylobacter* spp. in Wild Mountain Gorillas (*Gorilla beringei beringei*).
 51. Henson-Ramsey, Heather, Ashley Schneider, **M. K. Stoskopf** (submitted 2010) A Comparison of Multiple Esterases as Biomarkers of Organophosphate Exposure and Effect in Two Earthworm Species.
 52. Knowlton, Frederick F., Eric M. Gese, Jennifer Adams, Karen Beck, Todd Fuller, Dennis Murray, Todd Steury, **M. K. Stoskopf**, William Waddell, Lisetter Waits. (submitted

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53. Chinnadurai, Sathya K., A.J. Birkenheuer, H.L. Blandon, R. G. Maggi, N. Belfiore, H.S. Marr, E.B. Breitschwerdt, **M. K. Stoskopf** (accepted 2009) Prevalence of Selected Vector-Borne Organisms and Identification of Bartonella Species DNA in North American River Otters (*Lontra canadensis*). *Journal of Wildlife Diseases*.
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 57. Freeman, K., G. A. Lewbart, C.A. Harms, W. Robarge, M. Law, **M.K. Stoskopf**. (2009) Characterizing Eversion Syndrome in Captive Scyphomedusa Jellyfish. *Journal of Veterinary Research*. 70(9):1087-1093. (doi: 10.2460/ajvr.70.9.1087)

Grants (50 total - \$5,621,903)

1. **Buckel, J. A.**, Hightower, J., Letcher, B. and Scharf, F. Effects of habitat alteration and biotic interactions on survival of juvenile estuarine fish NC Sea Grant. 2/10-1/12. \$167,000.
2. **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.
3. **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
4. **Buckel, J. A.**, Hightower, J., Letcher, B. and Scharf, F. Effects of habitat alteration and biotic interactions on survival of juvenile estuarine fish NC Sea Grant. 2/10-1/12. \$167,000.
5. **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.
6. **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
7. 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. 5/06-4/09. NOAA Fisheries and the Environment (FATE). \$124,729.
8. **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.
9. **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.
10. **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.

11. **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. NC Sea Grant. \$53,234.
12. **Buckel, J. A.** Marine Fisheries Fellowship Program: A cooperative agreement between North Carolina Division of Marine Fisheries and North Carolina Sea Grant. 7/10-6/15. North Carolina Coastal Recreational Fisheries License Fund - Department of Environment & Natural Resources. \$186,705.
13. **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. 2/10-1/12. NC Sea Grant. \$36,704.
14. **Buckel, J. A.** Comparative analysis of two methods of aging summer flounder: scales vs otoliths. 1/09-12/09. NC Division of Marine Fisheries Conservation Fund- NC Department of Environment and Natural Resources. \$21,105.
15. **Buckel, J. A.,** Rudershasusen, 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 2009, \$8,000)
17. **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).
18. **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).
19. **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).
20. **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).
21. **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).
22. **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).
23. **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).
24. **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).
25. **Eggleston, D. B.** NMFS-Sea Grant Fellowship in Population Dynamics. NOAA/National Sea Grant. May 2008-2011. \$113,976/PI (5-29097).
26. **Eggleston, D. B.** Abiotic drivers of fishery-dependent and -independent catch efficiency in the North Gulf of Mexico. Environmental Defense Fund. June 2007-July 2010. \$64,551/PI (5-28298).

27. **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).
28. **Eggleston, D. B.** Performance-based aquatic vegetation monitoring. APNEP (prime) and NC Division of Marine Fisheries/DEHNR June 2009-2010. \$20,259/PI (5-51185).
29. **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. \$225,000/PI (5-50967).
30. Connectivity between deep and shallow ecosystems: Ecosystem-based management of new shelf edge MPAs. NOAA-OAR/FAU/UNC-W. **D. Eggleston** (PI), R. He, D. Kamykowski, J. Buckel (co-PIs). \$10,000/1 yr. (5-51562).
31. Informing Habitat Enhancement in Pamlico Sound. NC Division of Marine Fisheries. **D. Eggleston** (PI), C. Hardy, R. Luettich (co-PIs), 199,888, 2 yrs. (Submitted directly to NC DMF; Approved for funding; Will re-budget and submit via NCSU PINS).
32. Small-Scale Wind Turbine Demonstration Project in the NC Coastal Zone. North Carolina Energy Office for Renewable Energy Projects. **D. Eggleston** (PI), B. Miles, A. Randall, J. Peang-Meth, K. Youngblood (co-PIs). \$43,901/1 yr. (pending).
33. Collaborative Research: Connectivity in western Atlantic seep populations: Oceanographic and Life History Processes Underlying Genetic Structure. NSF-Biological Oceanography. **D. Eggleston** (co-PI), C. VanDover (PI), R. He, C. Young, T. Schultz (co-PIs). \$1,243,811 (NCSU portion = \$679,403/4 yrs. (pending).
34. Trophic Interactions In A Changing Ocean: Does Ocean Acidification Facilitate Destabilizing Predatory Impacts by Crushers and Drillers on Oysters? NSF-Ocean Acidification. **D. Eggleston** (PI); w/ D. Berquist, P. Kingsley-Smith & L. Burnette co-PIs. \$322,219/2 yrs. (pending).
35. Carolina Climate Explorers Program: Undergraduate Education, Training, & Research Partnership in Climate Science and Coastal Earth Observation. NASA Global Climate Change Education. **D. Eggleston** co-PI, T. Allen (PI), w/ 6 other co-PIs. \$1,042,517/3 yrs. (NCSU portion = \$233,002), (pending).
36. Evaluation of a Small-Scale Wind Turbine to Support the NC Marine Aquaculture Industry. NC Green Business Fund. **D. Eggleston** (PI) with B. Miles (co-PI). \$278,566/2 yrs. (pending).
37. **Green, D. P.** NC Fishery Resource Grant Program 2010. “*Validation of Microwave Cooking Instructions for Not-Ready-to-Eat Seafood*” (\$23,500, 12 mos).
38. **Green, D. P.** NCDA&CS, US FDA Rapid Response Grant sub-contract. 2010. “*Development of a North Carolina Food Industry Recognition Program*” (\$25,000, 2/1/2010-7/1/2010).
39. **Green, D. P.** NC Sea Grant Program 2010. “*Development of marine industries and processing systems: seafood science and technology program*” (\$79,754, 01/01/10-01/31/11).
40. **Green, D. P.** Virginia Tech University, USDA Integrated Research Program. 2009. “*Market assessment of value-added tilapia products*” (\$20,868 sub-award of \$60,000 prime, 10/1/09-9/30/10).
41. Aquarium Health Management: PI **Stoskopf**; CoPI's **Harms, Kennedy-Stoskopf, Lewbart**. NC DENR \$356,476 10-01-2009 thru 9/30/2012
42. Lewbart, G. A., Christian, L. S., **Harms, C. A.** Veterinary medical services rendered to the Museum of Natural Sciences. (North Carolina Department of Environment and Natural Resources) \$51,263, 1 January 2009 through 30 June 2011.

43. **Harms, C. A.**, Papich, M.G., Cranston, E.A., Flanagan, J.P. 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.
44. **Harms, C. A.**, Watts, B.H. Predation on important commercial and recreational fishes along the coast of North Carolina by the bottlenose dolphin (*Tursiops truncatus*). (North Carolina Sea Grant) \$4900, 1 June 2009 through 30 June 2010.
45. **Harms, C. A.** Maintaining marine mammal stranding response capacity in central North Carolina and transitioning to a new stranding response program. National Oceanic and Atmospheric Administration (NOAA) \$99,661, 1 October 2009 through 30 September 2010.
46. Blickley, T. M. (**P. McClellan-Green**, dissertation advisor) Procter & Gamble Graduate Fellowship (awarded once every 3rd year to a North American (Canada, USA and Mexico) graduate student.
47. **McClellan-Green, P.** Florida Fish and Wildlife- Analysis of Queen Conch (*Strombus gigas*) Neuropeptide Expression, \$7,500. (no timeline).
48. **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.
49. **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.
50. Shark Husbandry Review: PI **Stoskopf, M. K.** NC DENR \$31,688 11-01-2009-10/31/2010.

Published Abstracts

- Björnsdóttir-Butler, K., Bolton, G.E., **Green, D.P.** 2010. Effect of pH and phosphate treatment on bacterial growth and histamine production in Mahi-mahi and Yellowfin Tuna. Institute of Food Technologists Annual Meeting, July 17-21, Chicago, Illinois.
- Björnsdóttir, K., Bolton, G.E., Jaykus, L.a., McClellan-Green, P.D., **Green, D.P.** 2009. Colony lift hybridization method for enumeration of histamine-producing bacteria in scombroid fish. 3rd Trans-Atlantic Fisheries Technology Conference, Sept. 15-18, Copenhagen, Denmark.
- Bolton, G.E., Björnsdóttir, K. Nielsen, D. **Green, D.P.** 2009. Effect of high hydrostatic pressure on histamine-forming bacteria in yellowfin tuna and mahi-mahi skinless portions. Institute of Food Technologists Annual Meeting, June 6-9, Anaheim, Calif.

Books

- **Green, D. P.** Sensory evaluation of fish freshness and eating qualities, Chapter 3. In Handbook of Seafood Quality, Safety and Health Effects. Cesaretti Alasalvar, Fereidoon Shahidi, Kazuo Miyashita, and Udaya Wanasundara (Eds.) Wiley Blackwell. (2010), pp 29-38.
- **Green, D. P.** Processing crustaceans, Chapter 13. In The Seafood Industry (2nd Edition). George Flick, Jr., Roy Martin and Linda Granata (Eds.) Wiley-Blackwell Publishing Co. In Press.
- **Stoskopf, M. K.** (submitted 2009) Coelenterates. In: Invertebrate Medicine, 2nd edition. G. Lewbart (editor) Wiley-Blackwell Press.

- **Stoskopf, M. K.** (submitted 2009) Carnivore Reintroduction. In: Carnivore Biology, edited by R. Powell and L. Boitano. Oxford Press
- **Stoskopf, M. K.** (2009) Normal Hematology of Elasmobranchs. Schalm's Textbook of Veterinary Hematology, Williams and Wilkins, Baltimore, MD.

Journal Editorials

- **Green, D. P.** 2009. The food safety control system revolution, Editor's Column. J. Aquatic Food Product Technology, Vol. 18(4): 295-296.
- **Green, D. P.** 2009. Beyond fish oils and omega-3s, Editor's Column. J. Aquatic Food Product Technology, Vol. 18(1-2):1-2.

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

- 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

- Organized and served as co-chair for the 3rd Trans-Atlantic Fisheries Technology Conference held on September 15-18, 2009 in Copenhagen, DK, with 200 participants from 35 countries.
- Organized and gave presentation at four Seafood HACCP workshops. Three-day instructional workshops were held in Morehead City (NCSU) and in Columbia, SC (with Clemson University) in addition to Segment Two workshops held in Morehead City and Asheville, NC with a total of 47 participants.
- Organized NC Dairy High Temperature Short Time (HTST) milk pasteurization workshop in Raleigh for industry and regulatory personnel with a total of 15 participants.
- Presentation, *Food entrepreneurship: facilitating innovation through partnerships*. Nash, B.

and Green, D.P. Seafood Science and Technology Conference, October 26-28, 2009. New Orleans, LA with 100 participants.

- Presentation, North Carolina Aquaculture Development Conference, pre-meeting tour of CMAST on seafood quality and safety with 28 participants.
- Presentation, UNC Seafood Quality and Safety Workshop for Environmental Health Specialists on “*Seafood-borne parasites as potential pathogens of humans*” for a total of 34 participants.
- Presentation, NC Division of Environmental Health Centralized Intern Training (CIT) workshops (three) on “*Food Preservation*” for environmental health specialists with a total of 34 in attendance.
- Presentation, Carteret County Environmental Health ServSafe Workshop on “*Managing Seafood Safety in Food Service and Retail Establishments*” for food and lodging specialists for a total of 20 participants.
- Presentation, Leadership North Carolina tour on behalf of NC State University and CMAST during summer program in Atlantic Beach for business leaders across the state for a total of 40 participants.
- Presentation, Carteret County Marine Science Academy hands-on program and presentation on “*Food Processing and Preservation*” during summer program to 55 students and teachers in 7th, 8th and 9th grades.
- Presentation, NC Eastern Region Public Health Association on seafood safety with 35 participants.
- Presentation, NC Agriculture Commissioner’s Food Safety Program on seafood safety with 400 participants.
- Presentation, Duplin County Extension workshop on starting a new food business with 12 participants.
- Presentation, Better Process Control Acidified Foods workshop presentations with 30 participants.
- Participated in Dairy Tech quarterly meeting as Department Extension Leader in High Point, NC.
- Participated in NC Value-added Share Program as advisory panel member in Kannapolis, NC.
- Participated in Growing NC AgBiotech Landscape as advisory panel member in Wilmington, NC.
- Participated in NC Public Television OPEN NET program on food safety in Raleigh, NC.

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, PAFL and MARC.
- 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 20 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.

- CMAST hosted Teen Drop-Out Prevention/Teen Pregnancy group on June 24, 2009 (25 teens with approximately 15 babies, 2 expectant teens and 5 chaperons) from Harnett County Cooperative Extension with a tour of CMAST and CCC Aquaculture Facility, including a program by graduate students showing the aquatic life found in Bogue Sound with discussion on Marine Science Careers.
- Marine animal necropsy demonstration for the Marine Sciences Academy, a summer program for Carteret County middle school students.

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.