

# Regional and Statewide Challenges in Marine Science for the 21<sup>st</sup> Century

## A. Education

### 1. Business of Marine Biotechnology Program – Innovations in Education UNC system Sponsored by MARBIONC – Marine Biotechnology in North Carolina

**The Idea:** Identify well-trained scientists who have ideas about how to translate research into business opportunities and ensure that they have solid business skills to maximize their chance of success. Successful marine biotechnology industries require entrepreneurs with expertise in both science execution and business practices. The first graduates of this program matriculate in May 2007.

**Project Execution:** Faculty in the Center for Marine Science and the Cameron School of Business collaborate to offer four postdoctoral fellowships in marine biotechnology. Candidates must have a Ph.D. in a biotechnology-related area and are expected to conduct research in marine science laboratories in the center while pursuing a professional MBA degree in UNCW Cameron School of Business. Students master the core functions of business, develop analytical and quantitative business skills, and study current and future business issues through real-world experiences with regional companies involved in marine biotechnology. The research portion involves working in one of three focus areas in UNCW's MARBIONC program (Marine Biotechnology in North Carolina): marine pharmaceuticals; mariculture; or bioassays, tests, and screens.

**External Impact:** The goal of this two-year program is to produce individuals with a solid science background as well as the business skills needed to prosper in a modern competitive business environment. Measurable external impacts already realized include a new rapid detection kit for bacterial pathogens in oysters (pathogen-free certification is required prior to sale or interstate transport), new species-specific food formulations for fish mariculture, and novel detection methods for new marine natural products in neurology, immunology, and pulmonary toxicology. The City of Wilmington designated March 12-16, 2007, as Marine Biotechnology Week.

**Internal Impact:** Marine science is interdisciplinary, with chemical, physical, biological, and earth scientists collaborating in synergistic ways. The Business of Marine Biotechnology program has illustrated that further synergy, perhaps with even larger impact, can be achieved by collaborating with other disciplines. Marine science with business is one prime example; marine sciences with biomedical sciences provides opportunities in Oceans and Human Health (OHH); and the interaction of marine science with engineering provided the basis for the developing Integrated Ocean Observing System (IOOS). UNCW is employing the cross-disciplinary approach in a variety of ways to develop new programs in marine policy, coastal margin economics, marine science education, and coastal public health agendas. Without completely revising course curricula in a variety of departments and schools, new and highly innovative undergraduate, graduate, and postdoctoral training possibilities allow our students to achieve degrees with significant, heightened future impact.

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## **2. Existing Graduate Degree Programs in a Variety of Aspects of Marine Science Directed by the Departments of Biology and Marine Biology, Chemistry and Biochemistry, Geography and Geology, Environmental Studies, and the Center for Marine Science**

**The Idea:** Graduate education trains the next generation of scientists. The present mantra of interdisciplinary training provides students with the most adaptable knowledge, and also provides them guidance in how to work within groups of individuals with widely different expertise. This is a special set of skills that can be learned. Five departments offer graduate training in this unique interactive fashion.

**Project Execution:** Marine sciences at UNCW cut across the curriculum, individual programs at the graduate level address specific disciplines, and the Center for Marine Science addresses interdisciplinary aspects of marine science. All faculty who are involved in the graduate training of any marine-related field are members of the Center for Marine Science, one cohesive binding element for marine sciences at UNCW.

**External Impact:** Both Ph.D. and M.S. graduates have been added to the community in the fields of academics, regulatory, governmental, policy, and consulting fields. Since inception of the first graduate program in marine biology in 1980, 309 students have graduated in Marine Biology alone. The Ph.D. degree in Marine Biology was added to the marine sciences programs within the past five years, and has graduated its first Ph.D. Prestigious national fellowships and regional recognition have already been awarded candidates in UNCW's wide variety of marine science programs. A current standing crop of 65-80 graduate candidates populate the six extant degree programs in marine science. Nearly all of our graduates remain in their field of choice.

**Internal Impact:** The marine sciences represent the most popular and prestigious of all UNCW graduate programs. Classes are fully populated each year. The marine sciences have transformed the way UNCW looks at collaborative endeavors and, in part, fueled the rapid growth of the Center for Marine Science. The marine sciences now have formal educational and research ties to the Cameron School of Business, the Watson School of Education, the School of Nursing, and the Division for Public Service and Continuing Studies.

**Contact Information:** The Departments of Biology and Marine Biology, Chemistry and Biochemistry, Geography and Geology, Environmental Studies, and Center for Marine Science offer specialized programs.

## **3. Future Graduate Degree Programs in Marine Science**

### **a. M.A. Degree in Coastal and Ocean Policy**

**Proposed by the Center for Marine Science in collaboration with the departments of Political Science, Economics and Finance, Environmental Studies, Health and Applied Human Sciences, Geography and Geology, Biology and Marine Biology, Chemistry and Biochemistry, and Physics and Physical Oceanography, and Earth Sciences**

**Idea:** At a national level, there is a mix of master's degree programs designed to train professionals to work in fields requiring a knowledge of coastal and ocean policy. These include programs at University of Miami, Nova University, Florida Institute of Technology, the University of Delaware, the University of Rhode Island, Texas A & M, Oregon State University, University of Washington, and University of California at Santa Barbara. These programs are all different in their curriculum content and the weight they give science and policy courses, but all of the programs include some course work that provides some knowledge and understanding of coastal and ocean policy issues and the science underlying resource management

issues. Accordingly, it is clear that other coastal regions understand the importance of this subject area and are attempting to address their needs through educational programs at the master's level.

**Project Execution:** The Center for Marine Science in consultation with the Department of Political Science at UNCW proposes a broad-based, multidisciplinary master's degree program in Coastal and Ocean Policy. This program would be implemented in conjunction with several other departments including Economics and Finance, Environmental Studies, Health and Applied Human Sciences, Geography and Geology, Biology and Marine Biology, Chemistry and Biochemistry, and Physics and Physical Oceanography, and Earth Sciences. It will be a professional, non-thesis multidisciplinary master's degree program.

**External Impact:** In North Carolina, the options for pursuing a degree in coastal and ocean policy are somewhat limited. There is a program at Duke University but it is a Master's in Environmental Management and students can specialize in coastal environmental management. The proposed program at UNCW will be somewhat similar to Duke's program but will provide additional opportunities for this training at a state university at substantially reduced tuition cost. East Carolina University only provides a doctoral degree in Coastal Resource Management. The proposed program, in addition to providing professionals who could help address the needs of coastal North Carolina upon graduation, could also potentially produce students well prepared to enter ECU's doctoral program. Accordingly, there is no comparable master's program in the state to train the next generation of professionals who will be forced to confront a wide range of coastal and ocean policy problems.

**Internal Impact:** The development of a new professional, multidisciplinary master's degree program in Coastal and Ocean Policy is consistent with the University of North Carolina Wilmington's strategic vision as articulated in *Transforming Ideas into Action: A Strategic Plan 2005-2010* (February 23, 2005) that states "UNCW will promote and engage in high-quality scholarship and in master's-focused graduate education. . . ." This is supported by UNCW's mission (May 16, 2005) to provide "the highest quality undergraduate and graduate academic experience in an extensive array of programs at the baccalaureate and master's levels..." and "UNCW seeks to celebrate and study the heritage and environment of the coastal region, and to enrich its quality of life, economy, and education." A master's degree program in Coastal and Ocean Policy would not only extend the university's post-baccalaureate curriculum, but also complement and reinforce current undergraduate degree programs in Environmental Studies, Biology and Marine Biology, Political Science, and impact students with minors in diverse areas such as Environmental Studies, Oceanography, and Public Administration. The proposed master's degree program would also complement existing graduate programs including the Master of Science degree programs in Marine Science, Marine Biology, Chemistry, and Geology; the Master's of Public Administration (MPA); the postgraduate Environmental Studies Certificate program; and, the proposed Master's of Environmental Studies.

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Other academic efforts in Physics and Physical Oceanography and in Environmental Studies are underway at the graduate level. UNCW's Marine Sciences are committed to being the best in the state, if not the best on the eastern seaboard.

International programs are under development or discussion with the University of Southampton in the UK, with Bermuda Biological Station for Research, with the Seaquarium of Curacao, and within the coastal

communities of Honduras, Belize, and the U.S. Virgin Islands.

### **Research Efforts in Marine Science**

**The Idea:** Sustained, intentional focus over four decades has enabled marine sciences at UNCW to evolve from a relatively small program to an internationally-recognized program. Pre-eminence requires several elements, including: adequate facilities, state-of-the-art equipment, appropriate support staffing including the executive level, the finest faculty, and extramural programs and support that augment the research.

**Project Execution:** Collaborative programs in marine sciences are fostered and developed in the Center for Marine Science. Programs are supported by three main mechanisms: 1) establishment and maintenance of core facilities that house highly technical and expensive equipment, equipment that is available to all faculty and students for their research programs. Core facilities are directed by selected core leader faculty members who each has a paid technician to run the instruments. Approximately \$4.5 million in capital support has been expended since 1999; 2) competitive pilot projects are supported on an annual basis and require collaboration between two or more faculty in an area of synergy. Products resulting from pilot projects include publications, presentations, and successful grant applications. These products are tracked annually; 3) annual equipment proposals. This latter category has been used to set up core facilities in DNA sequencing, analytical spectroscopy, nutrient analysis, and stable isotope mass spectrometry. Programs are overseen by an Internal Advisory Committee that advises the Center for Marine Science on programmatic support and project review. Individual efforts are also encouraged, and these individually form the basis of collaborative efforts. All faculty have the laboratory and office space needed to conduct their projects. Space is allocated on need, not indirect cost recovery.

**External Impact:** Funding for marine science research at UNCW has grown exponentially in the past decade and during the past five years. As shown below, UNCW administers approximately one-half of the funding for marine science research within the 16-campus University of North Carolina.

#### Marine Science Research Funding, 2001-06

<u>Institution</u>	<u>Amount</u>	<u>Percent</u>
ASU	\$ 110,279	0.11%
ECSU	2,836,414	2.86%
ECU	3,624,242	3.65%
NCA&TSU	595,527	0.60%
NCSU	20,948,855	21.12%
UNCC	292,771	0.30%
UNCCH	8,618,137	8.69%
UNCG	376,728	0.38%
UNC-GA	13,695,999	13.80%
UNCW	48,111,655	48.49%
Total	99,210,607	100%

The UNC Wilmington marine science community is the largest in the state and one of the largest on the east coast, measured by research funding, square footage of research facilities, numbers of researchers, faculty, students, degree programs, and related data.

UNCW researchers established the North Carolina backbone for the anticipated Integrated Ocean Observing System proposed by NOAA, continue to administer and support Aquarius underwater habitat in Florida, and carry out research in local and international waters throughout the world. More than 135 active research programs are presently carried out by just over 50 academic and research faculty.

Several programs are poised to make a significant impact externally. These include CORMP, which has operational gear in the water to support the NOAA IOOS program, scheduled for implementation in 2008. IOOS seeks to set the stage for a domestic ocean and coastal observing database. Also, MARBIONC is poised to take the lead in a new Center of Innovation program being sponsored by N.C. Biotechnology Center. This program seeks to enhance marine biotechnology economic development in the coastal regions, collaboratively among Carteret, Dare, and New Hanover county marine science facilities and the state's three Aquaria. NURC already is the logistical partner for mixed gas diving in the region bordered by Virginia to the North and Mexico to the South. As NURC moves from a logistical administration to a cooperative institute, it too will take a major leadership role in its region of influence. Translation of Aquarius from an underwater habitat to an underwater observatory is paramount in that administrative move.

**Internal Impact:** The marine sciences programs at UNCW account for more than 65 percent of the extramural budget of the university. Large-scale interdisciplinary marine research programs at UNCW include, but are not limited to:

- a) *National Undersea Research Center (NURC)*, funded by NOAA and responsible for operations extending from the NC/Virginia line to the Texas/Mexico border, including: *Aquarius*; mixed-gas and saturation diving expertise; ship and boat operations; and submersibles; open to researchers throughout higher education;
- b) *Coastal Ocean Research and Monitoring Program (CORMP)*, a federally funded, ocean-observing partnership directed by UNCW, using buoys, pier-based stations, and vessel-based missions for research in physical oceanography, meteorology, marine biology, chemical oceanography, and related fields;
- c) *Oceans and Human Health* initiatives, with funding from NIH, CDC, EPA, the N.C. Biotechnology Center, and others, include several marine biomedical and marine biotechnology areas of emphasis. Harmful Algal Bloom Laboratories for Analytical Biotechnology (HABLAB) is an acknowledged world leader in microalgal taxonomy and ecology, toxin identification, molecular mechanisms of toxicity, toxin biosynthesis, and "pharmaceuticals from the sea"; several patents are in process, including one with potential for treating cystic fibrosis;
- d) *Mariculture*, with funding from USDA, Sea Grant, and elsewhere, is focused on high value marine species, such as flounder and black sea bass, which can be cultivated inland and marketed at home and abroad. Significant progress has been made in the development of breeding and grow-out methods. Partners include NCSU, Brunswick Community College, and South Brunswick High School.
- e) *Economic Development*: Research activities with significant potential for economic development receive support from the \$2 million, state-funded MARBIONC *Marine Biotechnology* initiative at CMS. One component of this initiative is the postdoctoral training in Marine Biotechnology and Business mentioned above. The marine biotechnology initiatives at UNCW involve strong partnerships with community colleges, the private sector, and the N.C. Biotechnology Center. UNCW worked closely with NCBC, the economic development community, and local governments to establish the Southeastern Office of the NCBC. The program has one patent, five additional patents pending, and several new disclosures in the works. A new biotechnology building is in the planning stages.
- f) *Coastal ecology and ecosystem dynamics including restoration*: From beach renourishment to oyster restoration, from coral recruitment to fisheries replenishment, UNCW investigators use their individual

and collective talents to address coastal issues in North Carolina. Applying their talents in topics like global warming and circulation, biodiversity, and tidal creek ecology, UNCW brings a wealth of talent to coastal ocean programs in NOAA, NSF, Sea Grant, DENR, and EPA.

Each of these extramural efforts has increased the prominence of marine science within UNCW. Our impact on other programs continues to rise, with integration across the curriculum and fiscal contributions by marine sciences to other venues within UNCW. Discussions on the academic role of marine science within the university are beginning to solidify on an increased administrative structure. Presently, marine science is disbursed among five departments, more than one school, and the Center for Marine Science.

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### **Outreach Efforts Related to Marine Science**

Public outreach is embedded in research activities, such as the Lower Cape Fear River Program (which partners with industry and local governments to monitor water quality) or the Tidal Creeks Program (which developed strategies in cooperation with New Hanover County and state agencies to reopen some waterways that had been closed to the harvesting of shellfish). Both of these programs have shared governance between academic and private partners, are co-funded by the participants, and make substantial a substantial difference in the quality and surveillance of public waters.

The marine biotechnology initiatives at UNCW involve strong partnerships with community colleges, the private sector, and the N.C. Biotechnology Center. UNCW worked closely with NCBC, the economic development community, and local governments to establish the Southeastern Office of the NCBC. MARBIONC anticipates being asked to lead the State's Center of Innovation in Marine Biotechnology, based primarily on the success of its active programs and expertise.

Faculty and students from numerous departments within the College of Arts and Sciences (biological sciences, chemistry, earth sciences, physics and physical oceanography.), as well as the Cameron School of Business, Watson School of Education, and School of Nursing participate in the research and outreach activities of the Center for Marine Science, thus fostering multidisciplinary perspectives and enhancing the educational experience provided to both undergraduate and graduate students, consistent with UNCW's strategic plan.

The Marine Quest program directed by the Division for Public Service and Continuing Studies operates out of the center. Center faculty often participate in educational outreach to participants in this K-12 program. Associated with Marine Quest are also adult learning programs like Odyssey. Odyssey provides a variety of continuing education topics in marine science and often draws upon the talents of marine science faculty at UNCW.

Planet Ocean, the Center for Marine Science public outreach activity, provides four lectures annually. The program strives to educate the public on the value of marine science research and on the persons involved. We endeavor to bring in one federal employee in an executive position of one of the ocean agencies to talk about the agency. NSF, NOAA, and NIH have all participated. Our lead speaker next year comes from the CDC. We fill out the remaining three slots annually with one international topic speaker, and two faculty from UNCW. Lectures routinely play to a full house.