

2012

Hollings Marine Laboratory Annual Report



Hollings Marine Laboratory • Charleston, South Carolina

HML Annual Report

Hollings Marine Lab

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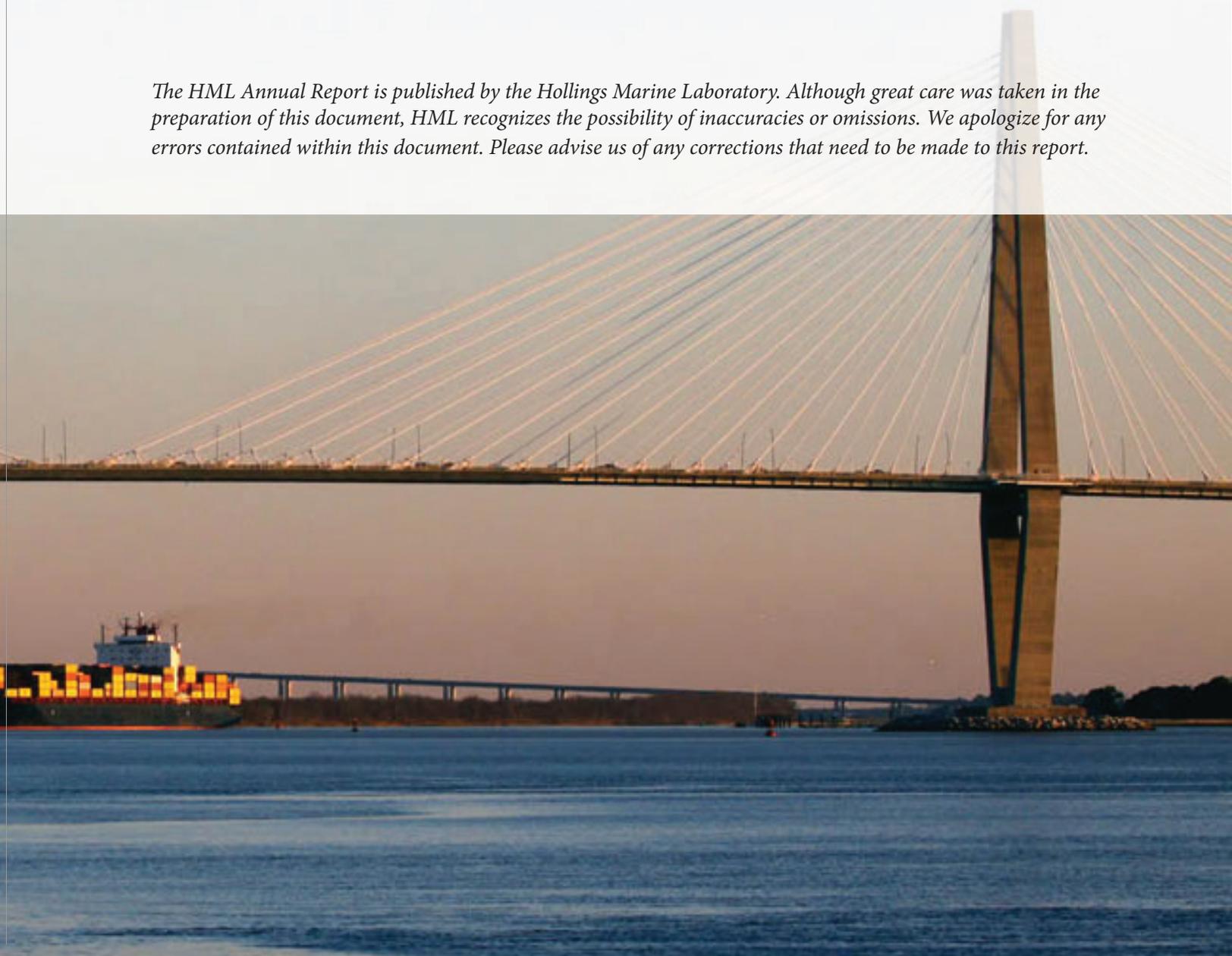
*About the cover: Front elevation of the Hollings Marine Laboratory
(Photographer: Stacey Thompson)*



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The HML Annual Report is published by the Hollings Marine Laboratory. Although great care was taken in the preparation of this document, HML recognizes the possibility of inaccuracies or omissions. We apologize for any errors contained within this document. Please advise us of any corrections that need to be made to this report.



We are pleased to share with you the 2012 Annual Report for the Hollings Marine Laboratory (HML). HML is a multi-institutional, multi-disciplinary laboratory with five primary research partners that include: the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS), the National Institute of Standards and Technology (NIST), the South Carolina Department of Natural Resources (SCDNR), the Medical University of South Carolina (MUSC) and the College of Charleston (CofC).

HML, one of five centers within the National Centers for Coastal Ocean Science (NCCOS), has had a successful year with the opening of our H-wing and continuing our mission of providing science and technology that sustains, protects and restores coastal ecosystems. Our research efforts have also emphasized an understanding of the linkages between the condition of the coastal environment and human health. With over 100,000 square feet of laboratory space designed to promote collaborative research, we are poised to continue our mission with scientific investigations that range from experiments conducted at a molecular level to studies of full-scale ecosystems.

We appreciate you taking the time to learn more about HML's accomplishments and noteworthy events in 2012. It is our hope that the information provided in this annual report will expand your interest and curiosity in HML.

Please visit us at our website

<http://coastalscience.noaa.gov/about/centers/hml>

or contact us at 843-762-8811 if you should desire any additional information.

Sincerely,

Jeffrey K. King, Ph.D.

Acting Director, Hollings Marine Laboratory



Visit the Hollings Marine Laboratory online!

2012 has been a very exciting and successful year at the Hollings Marine Laboratory (HML)! We are pleased to announce that more of our notable accomplishments, research highlights, education highlights and initiatives for 2012 can also be accessed online by visiting:

<http://coastalscience.noaa.gov/about/centers/hml>

This report provides examples of HML's numerous accomplishments, and highlights our extensive research capabilities. We encourage scientists and managers to contact us regarding additional research and collaboration opportunities.



About

The Hollings Marine Laboratory (HML) in Charleston, South Carolina, was established in 2001 as a unique 103,000 square-foot laboratory. From discovery to the development and application of innovative technologies, HML assesses environmental impacts on marine ecosystems and potential linkages to human health through collaborative research efforts by our multi-institutional, multidisciplinary science partners. NOAA and the National Institute of Standards and Technology (NIST) are federal agencies located at the facility. The South Carolina Department of Natural Resources (SCDNR) is a state agency, and the two academic partners are the College of Charleston (CofC) and the Medical University of South Carolina (MUSC).

Benefits of the Partnerships

Studies of marine environments, aquatic organisms and their integral connections to human health have become increasingly complex, and this requires an multidisciplinary approach in order to achieve success. However, the scale, diversity and connectivity of issues suggest that no single organization possesses the breadth of scientific expertise needed to address these problems completely. The partnership structure at HML was designed to address these multi-faceted, science issues. Researchers from our partner institutions work together combining expertise to conduct research they could not otherwise accomplish. The resulting synergy leveraged by partner scientists results in exciting and innovative approaches that address issues of immediate concern to coastal, marine, health and civic professionals.

Research

Research foci at HML include wildlife epidemiology and health assessments for sentinel species such as marine mammals, molecular diagnostic tools, toxin discovery, and human dimensions of coastal ecosystems. HML researchers focus on sentinel species and sentinel habitats with a goal of establishing early warning signals for environmental threats, which can then be incorporated into management decisions. By supporting management decisions with new information, innovative tools and techniques, HML is well positioned to serve as a liaison that promotes the protection, restoration and sustainability of marine animals, ecosystems and human communities.

Additional research initiatives at HML are focused on emerging issues or partner-derived, mission-focused projects. Several of our 2012 research highlights are included in this Annual Report. For a more extensive listing of our research highlights that occurred in 2012, including descriptions and points of contact, we invite you to visit our website at <http://coastalscience.noaa.gov/about/centers/hml>.

HML Hosts Two Endowed Chairs Through the South Carolina SmartState® Program

In 2002, South Carolina's General Assembly established the SmartState Program. The legislation authorizes the state's three public research institutions—Clemson University, the Medical University of South Carolina and the University of South Carolina—to use state lottery funds to create Centers of Economic Excellence in research areas that will advance South Carolina's economy. Each SmartState Center is home to one or more Endowed Chairs, world-class research scientists and engineers who are the intellectual talent of the SmartState Program. These Endowed Chairs fulfill many roles: researcher, entrepreneur, mentor, and educator. Each is supported by a research team consisting of junior faculty members, research faculty and graduate students. Presently, two of the approximately 40 Endowed Chairs have primary appointments at HML.

Gavin Naylor, Ph.D.

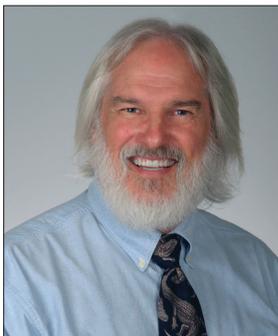
Dr. Gavin Naylor, with the College of Charleston serves as the Smart-State Endowed Chair of Marine Bioinformatics. Dr. Naylor's research interests focus on leveraging the information buried in DNA sequence data through comparative genomic approaches. His empirical work focuses on the evolution of sharks and rays while his theoretical work is based on improving our understanding of the molecular evolutionary process.

As Endowed Chair of Bioinformatics, he will serve as a resource and diversify HML's mission by helping others interested in comparative biology and DNA sequence analysis. For more information on Dr. Gavin Naylor, please visit <http://smartstatesc.org/gavin-naylor>.



Louis J. Guillette, Ph.D.

Dr. Lou Guillette, with the Medical University of South Carolina, serves as the South Carolina Smart-State Endowed Chair of Marine Genomics. Dr. Guillette's laboratory examines the developing reproductive system in a wide array of species, from fish and alligators to humans. He is particularly interested in the embryonic origins of health and disease and the underlying genetic mechanisms associated with these processes.



As the Endowed Chair of Marine Genomics, Dr. Guillette plans to expand his laboratory's current work examining the role of environmental contaminants in altering the genetic basis of health and disease in wildlife sentinels, which includes translating this work to understand human health. For more information on Dr. Lou Guillette, please visit <http://smartstatesc.org/louis-guillette>.

Visitors to HML

In 2012, HML hosted visitors that toured our facilities, gave presentations, and participated in discussions with our scientific community. Two of the guests that made a trip to HML in 2012 include Dr. Linda Birnbaum and Mr. Eric Schwaab:



Linda Birnbaum, Ph.D.

Dr Linda Birnbaum visited HML's staff and students on January 23, 2012. She is the Director of the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH) and National Toxicology Program (NTP) Division. As director, Dr. Birnbaum oversees a budget that funds multidisciplinary biomedical research programs, prevention and intervention efforts encompassing training, education, technology transfer and community outreach. She is internationally known for her research on the effects of contaminants on human and environmental health, especially in the area of reproductive health. Dr. Birnbaum's visit to HML included a tour of the facility, meetings with research scientists, and a roundtable discussion with students from the Medical University of South Carolina and College of Charleston.

Eric C. Schwaab

Mr. Eric C. Schwaab visited HML on April 24, 2012, while serving as the Acting Assistant Secretary for Conservation and Management for NOAA. During the visit, he had the opportunity to tour the facilities and meet with several HML-based researchers and administrators. Dr. Schwaab's visit was hosted with many of NOAA's regional partners including: South Carolina Sea Grant Consortium, Southeast Coastal Ocean Observing Regional Association (SECOORA), South Atlantic Fisheries Management Council, South Carolina Department of Natural Resources' Coastal Habitat Program, National Coastal Data Development Center, National Institute of Standards and Technology, College of Charleston and Medical University of South Carolina. Mr. Schwaab also used the time to discuss his role and goals for NOAA. Presently, he is serving as Assistant Administrator of NOAA for Fisheries.



HML Conducts External Panel Retreat

Leaders at HML invited an expert panel to provide third-party perspectives on research priorities that will promote HML's position as a scientific leader. Nominated by the HML director and Science Board as representing a range of expertise in research areas of interest to HML, the panel of four was tasked with (1) identifying high-priority research areas in which the laboratory has competitive advantages and (2) recommending business practice improvements that will enhance HML's long-term sustainability. The panel's ideas for organizing and refining HML's existing business model and their recommendations for future research opportunities provided HML invaluable guidance and insight for moving forward into 2013. As part of the site visit the panel met with research staff, reviewed documents, toured the facility and interviewed the Executive and Science Boards.

Panel Participants:

Dr. Stephen Weisberg, Chair (Executive Director, Southern California Coastal Water Research Project)

Dr. Tracy Collier (NOAA, Science Advisor, Oceans and Human Health; previously Director of the Environmental Conservation Division, NOAA Northwest Fisheries Science Center)

Dr. Tony Haymet (Director, Scripps Institution of Oceanography, Vice Chancellor of Marine Sciences, University of California-San Diego)

Dr. Christopher Portier (Director of the National Center for Environmental Health and Agency for Toxic Substances and Disease Registry, Centers for Disease Control)

HML Completes Construction and Renovation of H-Wing

On February 2, 2012, HML completed the construction and renovation of the H-Wing facility. The new wing at HML offers approximately 17,000 square feet of additional laboratory and office space. The H-Wing laboratories were designed to provide state-of-the-art facilities for work conducted at cellular and molecular levels.

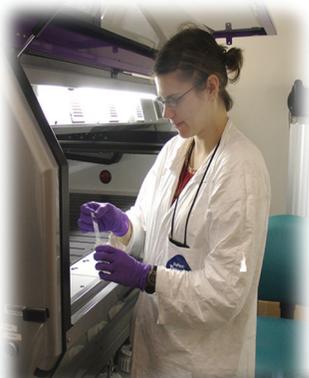
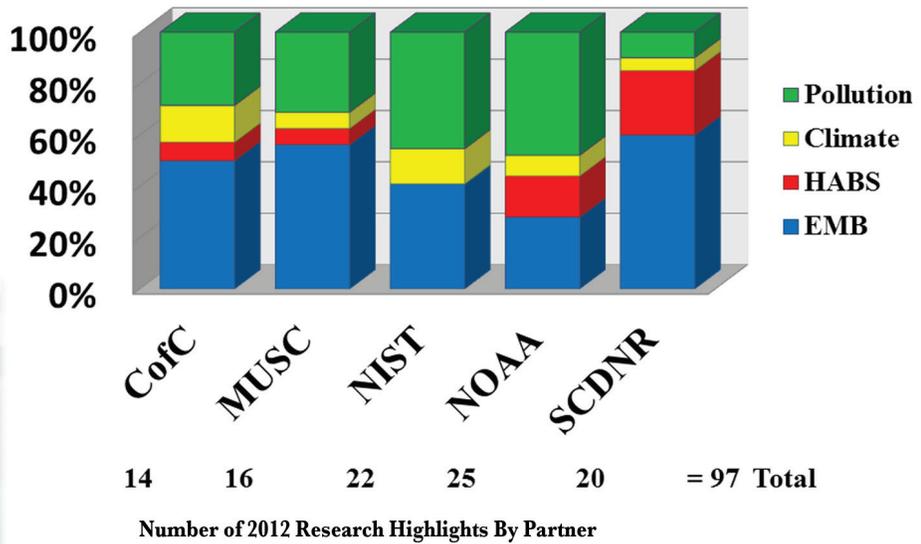
There are two large conference rooms, breakout work areas and a centralized, Information Technology (IT) Center. The new wing provides much needed space for our scientists, students and staff including a Smart education room and an IT and Bioinformatics Center.



RESEARCH HIGHLIGHTS

Research highlights for 2012 included projects that advanced NOAA’s National Centers for Coastal Ocean Science’s (NCCOS) three priorities: pollution, harmful algal blooms (HABS), and climate change. Other projects addressed emerging issues or specific needs of the institutional partners, which are represented in the emerging and mission based (EMB) group. The following pages provide examples of the research highlights for 2012. In keeping with the collaborative nature of the HML, more than 75% of the highlighted projects included a collaboration of two or more partner institutions. A brief description of all 97 research highlights and points of contact can be found on our website at <http://coastalscience.noaa.gov/about/centers/hml>.

HML 2012 Research Highlights (Breakout by Partner and Theme)

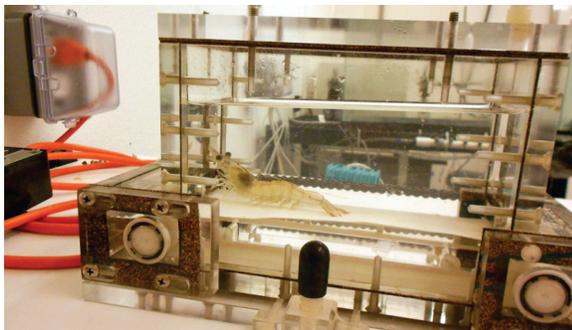


Impaired Performance in Crustaceans Exposed to Hypoxia and Hypercapnic Hypoxia

Point of Contact: Lou Burnett, burnett@cofc.edu, 843-762-4828

Human populations along our country's coastline continue to increase. Burdened by the increasing flow of nutrients, sediments and pollutants associated with high human population density and development, the waters along our coastline are becoming less able to support the marine life that we love and rely on for food, recreation and a healthy global environment. For example, most marine organisms require oxygen to breathe. Scientists have learned that areas of low oxygen, called hypoxia, are increasing in frequency, severity and duration in coastal areas. Added to this, atmospheric levels of CO₂ are increasing at ever higher rates. As CO₂ levels increase, the acidity of ocean waters increases. Thus, marine life is threatened by a two-pronged attack on the quality of the waters they need to survive.

With support from the National Science Foundation, College of Charleston faculty and students at the HML are using a novel approach to assess the combined effects of hypoxia and high CO₂/acidity on the health of commercially important shrimp and crab species. Much like a doctor uses treadmill stress tests to evaluate human health, College of Charleston scientists are using underwater treadmills to evaluate the ability of shrimp and crabs to perform daily activities of finding food, avoiding predators, mating and migrating, all of which are critical to sustaining abundant populations of these natural resources. The HML has unique laboratory facilities and equipment that allow investigators to simulate hypoxic and acidic waters, and therefore, directly test the impacts of low oxygen and high CO₂ on the ability of marine organisms to perform normal activities that are critical to survival and reproduction. The project also benefits from unique access to aquaculture experts and shrimp lines through the SCDNR. Together with colleagues from other HML partners, the same "stress test" approach can be used to examine the impacts of man-made pollutants, such as chemicals and pharmaceuticals, on marine organisms which are simultaneously experiencing low oxygen and acid conditions. Such stress tests are allowing HML scientists to explore the resilience and response of marine shrimp and crab populations to the combined threats of multiple natural and manmade stressors. The data from these studies can be used to develop predictions that can guide resource managers in the face of regional and global threats to economically and ecologically critical populations of marine organisms.



COLLEGE OF CHARLESTON

Biodiversity and Evolution of Sharks, Skates and Rays**Point of Contact:** *Gavin Naylor, gipnaylor@gmail.com, 843-725-4806*

Sharks and rays play important roles as apex predators in marine systems, though many have become imperiled from overfishing. The decline has been so precipitous that elasmobranchs are now the second most imperiled vertebrate class, after amphibians. Despite their ecological importance, their phylogenetic placement at the base of gnathostome vertebrates, and attention to their recent population declines, we still lack basic information about their species diversity, evolutionary relationships, and life histories. Effective management of marine resources depends on such information.

In response, the research group at HML is focused on three areas:

1. *Development of Novel Methods.* The technique of “gene capture” is used to target and isolate DNA from genes of interest for subsequent investigation. The approach has been used to explore sequence variation in candidate genes associated with autism, schizophrenia, and cancer as well as with the regulation of embryological development. However, probes that are designed for one species generally do not work on others. We have recently found a way to extend the reach of gene capture approaches to cross-species comparisons, making it possible to examine, for example, why diseases affect some species but not others. We are using these methods to identify homologous sets of genes across elasmobranch species to better understand their evolutionary histories.

We are also developing novel methods for sharing virtual information across the internet, using the comparative anatomy and evolution of sharks and rays as a model.

2. *Theory.* Evolutionary biologists in the HML are using both simulation and empirical data to explore the theoretical effects of DNA base compositional bias in distorting the evolutionary signal that is latent in most DNA sequences.

3. *Empirical Data Collection.* Work completed in 2012 by the HML elasmobranch research group and international collaborators has revealed a large diversity of previously undescribed species (<http://www.nature.com/news/shark-species-more-diverse-than-thought-1.10879>) as well as several cases where species that were considered extinct were actually alive. This work has implications for the management of shark fisheries and marine protected areas worldwide. The work will also provide a better understanding of the historical biogeography and likely movements of species over an evolutionary time scale.



Collaborative Institutions: Commonwealth Scientific and Industrial Research Organisation, American Museum of Natural History-New York, Duke University, Woods Hole Oceanographic Institution and Harvard Medical School

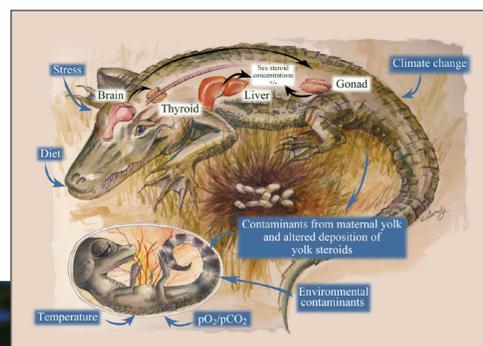
Potential Role of Contaminants on Growth and the Development of the Reproductive System of the American Alligator

Point of Contact: *Louis J. Guillette, lou.guillette@gmail.com, 843-876-2051*

Environmental contaminants are now a ubiquitous part of the ecological landscape, and a growing literature describes the ability of many of these chemicals to alter the developmental trajectory of the embryo. Because many environmental pollutants are readily bioaccumulated in lipid-rich tissues, wildlife models can attain considerable body burdens. Embryos are often exposed to these pollutants through maternal transfer, and a growing number of studies report long-term or permanent developmental consequences. Embryos are not exposed to one chemical at a time but are chronically exposed to many chemicals simultaneously. Developing organisms interpret and integrate environmental signals to produce adaptive phenotypes that are prospectively suited for probable demands in later life.

In 2012, MUSC's scientists appointed to HML have continued their investigations into the role of environmental contaminant exposure during development in altering the growth trajectory and ovarian function of alligators, a well-developed sentinel species for ecosystem health in the freshwater and estuarine wetlands of the southeastern United States. Using alligator eggs collected from a lake polluted with agricultural pesticides and nutrients, we observed that hatchlings were born with smaller body masses but grew faster during the first five months of life, as compared to reference-site alligators. Importantly, variation in growth of offspring from different clutches was also noted, indicating that parental genetics also plays a role. In addition, ovaries from Lake Apopka alligators displayed decreased gene expression for aromatase, the enzyme that makes estrogens, and follistatin, a protein important in ovarian regulation. These differences were noted after the fertility hormone, FSH, was administered.

Here, the scientists used an approach commonly used in human infertility clinics worldwide and have looked at important endpoints of infertility/subfertility in wildlife and humans. The researchers noted that, following embryonic exposure to a mixture of endocrine-active contaminants, the developing ovary does not function normally and these abnormalities persist, suggesting they are life long abnormalities similar to what we now observe some human populations. These data add to the growing literature from our group suggesting that (1) wildlife are effective sentinels of human reproductive health and (2) that exposure early in life leads to life-long alterations in health, or what has been called the “embryonic origins of adult disease.”

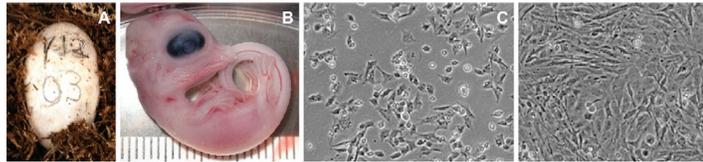


MEDICAL UNIVERSITY of SOUTH CAROLINA

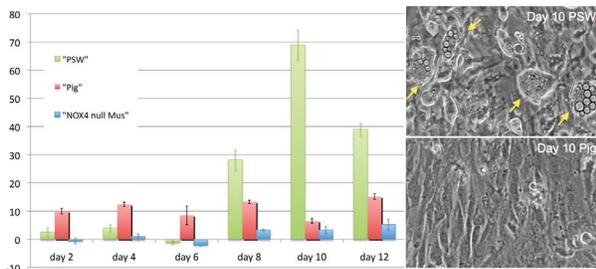
Lung Adaptations of Deep Diving Marine Mammals: Lung Repair Mechanisms and Potential Deleterious Effects of Sonar and Toxins

Point of Contact: John E. Baatz, baatzje@musc.edu, 843-792-1049

The ability of marine mammals to tolerate extreme pressure and maintain health in low-oxygen environments associated with deep dives make them ideal subjects for scientific investigation. Species of particular importance to the U.S. Navy currently include the bottlenose dolphin, the beaked whale, and the California sea lion. Specifically, identification of underlying adaptations of deep diving marine mammals to extended periods of low oxygen tension (hypoxia associated with lung collapse), or physiological impacts

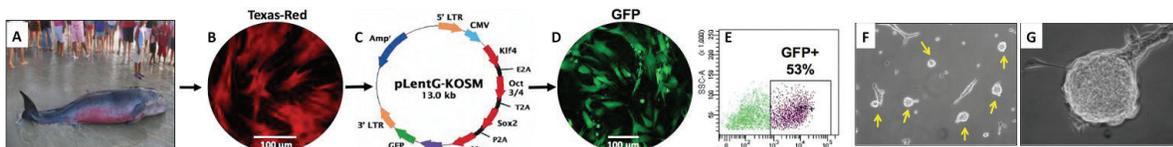


of sonar or toxin exposure, would significantly impact development of potential treatments for lung injury in marine mammals. However, progress in these areas have been considerably obstructed by the lack of reliable models that mimic either the physiology of deep diving marine mammals or effects of acute (or chronic) sonar and toxin exposures. HML scientists are utilizing cutting edge techniques developed in our laboratory to gain scientific understanding into lung



cellular and molecular mechanisms in marine mammals that protect against hypoxic injury. Utility of these studies will have applications in the areas of: 1) marine mammal health 2) submarine warfare, 3) sentinel exposure to dangerous conditions/toxins and 4) decompression sickness & other breathing disorders. HML scientists are melding cutting edge

cellular and molecular technologies that do not yet exist in other laboratories. These include: 1) cryopreservation techniques to salvage/store live tissues from stranded marine mammals; 2) primary and stem cell cultures; and 3) gene expression arrays and proteomic tools for elucidating effects of sonar on a variety of cells of diving marine mammals. Products of this study include molecular diagnostics for the establishment of safety standards for sonar use in the SOFAR channel or optimal sonar frequency ranges to minimize effects on marine mammal health. In addition, the methodology developed herein will also be capable of determining effects of toxins or environmental stressors on marine mammals and potential therapeutic development for treatments thereof. The PIs have published work on a method for the cryopreservation/banking of viable lung tissue from stranded marine mammals and the isolation & culture of primary cell types from thawed pieces of tissue and have used stem cell technology to make iPSCs.





NATIONAL INSTITUTE of STANDARDS and TECHNOLOGY

Responding to the Deepwater Horizon Oil Spill: Interlaboratory Comparisons, Sample Protocol Development and Sample Archival

Point of Contact: *John Kucklick, john.kucklick@nist.gov, 843-725-4816*

The Deepwater Horizon (DWH) oil spill began on April 10, 2010, and eventually impacted about 500 miles of the Gulf of Mexico's shoreline. NIST scientists located at HML aided with the response within days after the spill began and continued to help other government agencies with understanding the spill's effects.

The spill required that NOAA determine if marine mammals were exposed and subsequently affected by the oil. During this process, NOAA relied heavily on NIST's expertise in marine sample collection, archival, and sample measurement. NIST also assisted NOAA with the health assessment of wild dolphins by developing and conducting sampling procedures specifically geared toward oil components that may be present in dolphins.

Many samples collected by NOAA scientists during the dolphin health assessments, which included marine mammals samples collected as a part of the Northern Gulf of Mexico's Unusual Mortality Event (UME) (2010 – current), were sent to the NIST Marine Environmental Specimen Bank (ESB) for storage. The Marine ESB is a biorepository that archives marine animal samples at cryogenic temperatures under clean-room conditions in a secure environment. Samples in the Marine ESB are logged into a specimen tracking database, and when requested by NOAA, shipped to investigators measuring health indicators in the dolphins.

A major challenge of NOAA's response to the spill was assessing quality and comparability of oil contamination data in samples being generated by dozens of laboratories involved in the DWH damage assessment. In response, NIST conducted four interlaboratory exercises for oil marker compounds in sediment, mussel tissue, oil and in whole blood and plasma. Participants provided data on a reference sample, typically a Standard Reference Material (SRM), and an unknown sample. This resulted in approximately 100 data sets for about 90 target compounds.

NOAA used the data to assess if laboratories can measure specific oil components and how well data from different labs compare.

One important product from the exercises was the production of a new NIST reference sample (SRM 2279 Gulf of Mexico Crude Oil), that was prepared from DWH crude oil and released for sale and distribution in March 2012. This reference sample has been well characterized for different oil components and is available to all laboratories performing crude oil analysis.



NATIONAL INSTITUTE of STANDARDS and TECHNOLOGY

Mercury Isotopes in Bird Eggs Reveal Mercury Sources

Point of Contact: *Rusty D. Day, russell.day@nist.gov, 843-762-8904*

Mercury is a highly toxic and ubiquitous contaminant that has numerous sources, both man-made (e.g., coal-fired power plants) and natural (volcanos). Both biological and abiotic transformations lead to the buildup of different mercury species (i.e. Hg[0], Hg[II], methylmercury, etc.) in the environment. Stable isotopes are non-radioactive elemental isotopes differing from each other in their atomic masses. Mercury has seven stable isotopes each differing slightly in physiochemical properties. The abundance of specific mercury isotopes in a sample gives clues to mercury sources. New high-precision isotope ratio capability provided by multi-collector inductively coupled plasma mass spectrometry (MC-ICPMS) has changed the study of mercury and enhanced our ability to address questions related to mercury sources and biogeochemical processes.



Researchers at HML are working on the Seabird Tissue Archival and Monitoring Project (STAMP), which is a partnership between NIST's Marine Environmental Specimen Bank (ESB) at HML and the U.S. Fish and Wildlife Service (USFWS), to collect and archive seabird eggs from Alaskan subarctic and arctic marine environments. Mercury isotope signatures in murre (*Uria* spp.) eggs from the STAMP archive were recently used to elucidate mercury sources to the Arctic. Mercury concentrations were anomalously high in eggs from Norton Sound relative to other Bering Sea colonies and were accompanied by distinctly different mercury stable isotopes signatures ($\delta^{202}\text{Hg}$ and $\Delta^{199}\text{Hg}$). The results suggest a geological mercury source to the Norton Sound food web. Likewise, ^{13}C to ^{12}C isotope ratios were lower in these eggs relative to Bering Sea murre eggs indicating food web carbon originating from land. The significant terrestrial carbon source associated with the elevated mercury in Norton Sound points to the Yukon River and smaller Seward Peninsula watersheds as the likely mercury sources.

The results of this study show that mercury isotope signatures provide an effective means for discriminating terrestrial geogenic (i.e., not man-made) mercury sources from oceanic/atmospheric reservoirs in coastal marine environments. Future work will focus on more detailed isotopic characterization of terrestrial and oceanic mercury sources to allow quantitative source apportionment of mercury in Alaskan seafood, and tracking of long-term temporal changes of terrestrial mercury inputs resulting from permafrost and glacial melting.

Collaborative Institutions: U.S. Fish and Wildlife Service, Environment Canada, and University of Pau



NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION

Changes in Health and Well-Being in Communities Affected by the Deepwater Horizon Disaster

Point of Contact: Susan Lovelace, susan.lovelace@noaa.gov, 843-762-8933

HML researchers are developing a method to monitor the relationship between the health and well-being of coastal residents and the health of the adjacent coastal environment, such as those disrupted by the Deepwater Horizon environmental disaster. The method uses indicators of human well-being that include health, safety, economic security, county government structure, education, access to food and water, access to critical services, social cohesion, social conflict, environmental use and occupation structure. Indicators are measured using existing data collected by other agencies and organizations that are analyzed for the measurement of particular aspects of well-being. This research covers coastal counties directly affected by the Deepwater Horizon oil spill, as well as a selection of unaffected counties for comparison. Researchers have compiled annual data for 2000-2010 for these counties. During 2012, the data were analyzed over time to explore how changes in environmental health and services affect well-being. The results will provide government agencies with data upon which to prepare and protect communities from future disasters and assist in recovery efforts afterwards. Additional information can be found at www.hml.noaa.gov/dwh

The results of a workshop to assist HML in developing the best set of indicators resulted in the publication of NOAA Technical Memorandum No. 146, *Prioritizing County-Level Well-Being: Moving Toward Assessment of Gulf Coast Counties Impacted by the Deepwater Horizon Industrial Disaster (2012)*. Also during 2012, two related and completed Master's theses have explored specific questions related to the project. A full report and publications are in preparation as are efforts to disseminate the results to NOAA and Gulf of Mexico communities.





NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION

Assessing Injuries to a Sentinel Species in the Gulf of Mexico Following the Deepwater Horizon Oil Spill

Point of Contact: *Lori Schwacke*, lori.schwacke@noaa.gov, 843-725-4821

NOAA researchers at HML led a study that demonstrated bottlenose dolphins in Barataria Bay, Louisiana, are exhibiting signs of severe ill health. Barataria Bay is an area that received heavy and prolonged exposure to oil after the Deepwater Horizon (DWH) oil spill in 2010. The study, which included a team of researchers with expertise in wildlife epidemiology, toxicology and veterinary medicine, conducted comprehensive physicals of 32 live dolphins in August 2011. Preliminary data analysis found that many of the dolphins in Barataria Bay are underweight, anemic, have low blood sugar and/or show symptoms of liver and lung disease. Nearly half of the dolphins sampled also had abnormally low levels of the hormones that help with stress response, metabolism and immune function.

HML partnered with NOAA Fisheries and other academic, state and federal partners to conduct the Barataria Bay dolphin study as well as other ongoing photo-monitoring and remote biopsy studies of estuarine dolphin populations in the northern Gulf of Mexico. The studies are part of the Natural Resource Damage Assessment (NRDA), a process led by NOAA but involving trustees from other federal agencies as well as the Gulf States. The NRDA is quantifying injuries and identifying restoration projects following the DWH oil spill.



Preliminary results from the Barataria Bay dolphin health study were shared with the public in March 2012, so that stranding responders and veterinarians could better care for live stranded dolphins and look for similar health conditions in the dead stranded dolphins in the Gulf. Since February 2010, more than 700 dolphins have stranded in the northern Gulf of Mexico—well above the normal stranding rate, prompting NOAA Fisheries to declare an Unusual Mortality Event. HML's efforts in the Gulf of Mexico and with NRDA continue.

HML partners provided critical support for the DWH response and injury assessment and are working to develop new technologies to support not only the DWH damage assessment but also future oil-spill damage assessments. NOAA, NIST and MUSC are partnering to develop and test new genomic tools and innovative analytical methods to examine biomarkers of oil exposure and potentially associated endocrine effects from remotely collected marine mammal tissues.

Collaborative Institutions: NIST, MUSC



SOUTH CAROLINA DEPARTMENT of NATURAL RESOURCES

Evaluation of Habitat Utilization, Recruitment Bottlenecks and Movement of Coastal Striped Bass Population

Point of Contact: *Tanya Darden, dardent@dnr.sc.gov, 843-725-4876*

Striped bass (*Morone saxatilis*) is a long-lived species that has shown population declines during the past decade. Within South Carolina's Charleston Harbor estuary, drains the small, tidally-influenced, Ashley River. Historically, this estuary supported a striped bass population, but very few adult fish and no young of year (YOY) have been observed in the Ashley River since monthly sampling began in the early 1990s. In recent years, the state of South Carolina set goals to reestablish historic biodiversity levels, and restoring a key indicator species like striped bass is a priority. The SCDNR and CofC research team at HML has been evaluating the potential for re-establishing a self-sustaining striped bass population in the coastal Ashley River.

Through our use of hatchery-produced fish and genetic identification tools in an experimental field-stocking design, we have determined that a substantial YOY recruitment bottleneck occurs in this coastal system during their first summer, which appears to indicate a thermal tolerance limitation. However, laboratory challenge experiments suggest temperature and salinity alone are not the critical limitation(s), with a more likely synergistic interaction of additional factors being responsible for the bottleneck. Field data support this idea based on striped bass occurrence throughout the upper portions of the system in low salinity, lower temperature and highly structured habitats.

A critical aspect of any restoration work is determination of population sustainability. Following three years of experimental-scale stocking, we documented the presence of non-stocked YOY striped bass in the system for the first time in over a decade, likely representing natural reproduction and recruitment within the system. The documentation of non-stocked YOY recruitment has continued for three successive years. Therefore, it appears that even with a summer YOY recruitment bottleneck, adequate habitat and resources are available for long-term survival of the striped bass in the Ashley River.

Through our long-term field research, we have documented the potential to re-establish a coastal striped bass population in the Ashley River. We are in the process of modeling our experimen-



tal results to build a restoration plan for coastal striped bass that is similar in genetic diversity to natural striped bass populations. The resulting plan will be a valuable tool and serve as a model for striped bass restoration efforts in other systems. HML continues to be a critical facility involved in this project, in terms of the genetic analyses, fish growout, data integration and analyses, as well as the collaborative aspects of the project.

Collaborative Institution: CofC



SOUTH CAROLINA DEPARTMENT of NATURAL RESOURCES

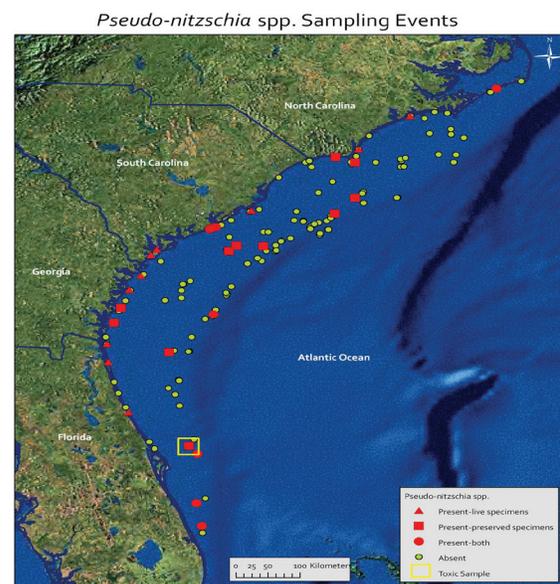
The Occurrence and Source of Domoic Acid in the Southeastern United States

Point of Contact: Dianne I. Greenfield, greenfielddd@dnr.sc.gov, 843-725-4823

Domoic acid (DA) is a potent neurotoxin produced by certain species of the diatom genus *Pseudo-nitzschia*. This compound has been linked to marine mammal strandings, bird deaths, and shellfish toxicity. Extensive research has been conducted to understand the ecology and physiology *Pseudo-nitzschia* species on the West Coast; however, comparatively little is known about *Pseudo-nitzschia* in the Southeast. Recent evidence from pigmy sperm whale mortalities linked with DA and blooms *Pseudo-nitzschia* off the coast of North Carolina suggest that DA may be an increasing regional threat. The current study is part of a collaborative effort by HML partners bringing complementary expertise to assess the distribution of *Pseudo-nitzschia* and potential threat of DA across the Southeast.

SCDNR researchers obtained opportunistic water samples from the coasts of North Carolina, South Carolina, and Georgia during the spring/summers of 2009-2011. The primary source of water samples was the Marine Resources Monitoring, Assessment, and Prediction program within the Marine Resources Research Institute. Samples were also collected from the Southeast Area Monitoring and Assessment Program, land-based monitoring, and various educational and research cruises. Each sample was assessed for presence of *Pseudo-nitzschia* using microscopy, and positive samples were used to isolate cells for laboratory culturing by SCDNR's Harmful Algal Bloom laboratory. Species- identification was confirmed using scanning electron microscopy and tested for DA production by NOAA's Marine Biotoxins Program. Additionally, relevant environmental parameters were measured and related to the presence of *Pseudo-nitzschia*.

Results confirmed that *Pseudo-nitzschia* has a broad geographic distribution spanning the Southeast. Several samples tested positive for DA, and a toxigenic isolate of *P. pseudodelicatissima* was obtained from the Florida coast. These findings are strong evidence that DA produced by *Pseudo-nitzschia* poses a regional health and environmental threat. However, research on *Pseudo-nitzschia* in the Southeast is in its infancy. Much work is needed to understand the environmental factors that trigger blooms as well as the development of tools to identify and quantify cells, thereby enhancing early warning capabilities to predict toxic events and safeguard public health. Ongoing collaborative work includes the development of species specific molecular probes that will facilitate future *Pseudo-nitzschia* identification.



EDUCATION HIGHLIGHTS

Our partner institutions and HML provide several programs and initiatives that allow students the opportunity to conduct research at the laboratory. During 2012, there were approximately 50 students that participated in educational programs, which included opportunities for summer undergraduate research as well as masters and doctoral level research. The following paragraphs provide greater detail on the major educational programs and research opportunities that are available at HML.

Undergraduate Programs

Minorities in Marine and Environmental Sciences Internship Program (MIMES): The Marine Resources Division of the South Carolina Department of Natural Resources (SCDNR) offers internship positions for undergraduate, minority students. The program receives funding from the National Science Foundation and other cooperating partners, such as NOAA, and other state agencies. It also provides interested students with an opportunity to work at HML. During the 12-week program, students develop a research project while learning scientific problem solving, writing and presentation skills. Mentors experienced in various fields of marine, environmental and coastal ocean science (including chemistry, marine biology, marine policy, toxicology, microbiology, fisheries science, marine, estuarine and wetland ecology) provide instruction and guidance for the interns. At the conclusion of the program, students complete written reports and make oral presentations that describe their summer research. For more information please visit <http://www.dnr.sc.gov/marine/minority/>

Summer Undergraduate Research Program (SURP): The Medical University of South Carolina (MUSC) offers outstanding undergraduate students the opportunity to work closely with faculty members on cutting-edge biomedical research projects. Participants in this 10-week program are to perform at a graduate student level. Students are placed with faculty members whose research is closely related to academic interests

and professional goals of the students. Students work with faculty on an individual basis or as part of a research team. In 2012, HML hosted seven students that participated in this program. The students came from universities located throughout the United States including: Morris College, Brown University and the Universities of Miami, Arizona, and Portland. For more information please visit <http://www.musc.edu/grad/summer/surp/general.html>



Research Experiences for Undergraduates (REU) Program: This program is funded by a grant through the National Science Foundation and hosted locally by the College of Charleston (CofC). Each summer, CofC provides research training for as many as 10 students for 10 weeks. The program focuses on the multidisciplinary theme of “Marine Organism Health: Resilience and Response to Environmental Change.” Students participating in this program investigate the impacts of climate change, natural disasters, pollution, and coastal development. There are a wide variety of research projects available to students ranging from marine organisms at the individual level to the community and population levels. In 2012, HML hosted four students that participated in this program. Home institutions for these students included: Virginia Tech, University of Arizona, DePauw University and University of North Carolina-Wilmington. For more information please visit <http://reu.cofc.edu>

NOAA’s Hollings Scholars: The Hollings Scholarship Program is sponsored by NOAA and provides successful undergraduate applicants with awards that include academic assistance for full-time study during the 9-month academic year; a 10-week, full-time internship position during the summer at a NOAA facility; and, if reappointed, academic assistance for full-time study during a second 9-month academic year. In 2012, HML hosted one Hollings Scholar from the University of Maryland. For more information, please visit <http://www.oesd.noaa.gov/scholarships/hollings.html>

Graduate Programs

Our academic partners (CofC and MUSC) offer programs that provide graduate students the opportunity to conduct research at HML while they complete their coursework and other requirements pursuant to master’s or doctor of philosophy degrees. While working at the laboratory, graduate students are able to participate in activities at their home institution, but they also have access to seminars and other resources at HML. Moreover, these students are provided the unique opportunity to collaborate with other students, post-doctoral fellows, staff scientists and principal investigators that are actually affiliated with other HML-based partners. The close proximity of scientists with diverse skill sets and expertise, coupled with state-of-the-art laboratory space and equipment, provide students a distinctive environment where an investment in graduate education can be amplified.

In 2012, HML was the research home to 33 students pursuing a master’s degree. The majority of these students are part of the CofC’s Graduate Program in Marine Biology or the Master of Science in Environmental Studies Program. For more information please visit <http://spinner.cofc.edu/marine/students/regs.html> and <http://mes.cofc.edu/>

During the 2012 calendar year, HML also provided opportunities to eight students pursuing a doctor of philosophy degree through the Marine Biomedical and Environmental Sciences Center at the Medical University of South Carolina. For more information please visit <http://academicdepartments.musc.edu/mbes/>

Home Institution of 2012 Students at HML

In 2012, HML attracted undergraduate and graduate students affiliated with other nationally recognized colleges and universities. In these cases, students work closely with mentors to accomplish some element of their research while on location at our laboratory. In 2012, HML hosted 14 undergraduate or graduate-level students that were primarily affiliated with other non-partner, academic institutions.

Colleges and Universities with Students Conducting Research at HML

Brown University

St. Mary's University

Clemson University

University of Arizona

College of Charleston

University of Maryland

DePauw University

University of Miami

Hawaii Pacific University

University of North Carolina

Maryville College

University of North Carolina, Wilmington

Medical University of South Carolina

University of Portland

Morris College

Virginia Institute of Technology

Post-Doctoral Research Opportunities

Because of our state-of-the-art facilities and synergistic research environment, the HML attracts the very best in post-doctoral research fellows. In fact, opportunities abound for those post-doctoral researchers interested in developing advanced tools and/or assessing the impacts of environmental stressors on marine ecosystems and human health. In 2012, there were 13 post-doctoral fellows conducting research at HML. All of these individuals have contributed to HML's highly productive and collaborative research environment. Questions concerning opportunities for post-doctoral research at HML should be directed toward the principal investigators conducting work in a specific field of interest.



Facilities at the Hollings Marine Laboratory

The HML is a laboratory designed to promote interdisciplinary research through the sharing of expertise, specialized equipment, space, and other resources. Among the many tools available to scientists, the HML is equipped with state-of-the-art analytical instrumentation necessary to identify and quantify pollutants, toxicants, and pathogens; Level 2+ biosafety laboratories for dealing with viruses and other disease-causing organisms; seawater systems and aquaculture facilities to produce quantities of selected marine species for research; a nuclear magnetic resonance (NMR) facility for identification of marine toxins and potential pharmaceutical agents; an ecological field collection launching and sample preparation area; a cryogenic specimen bank for preservation of a variety of marine-related biological samples, including protected species, and one of the nation's leading genomic laboratories devoted to marine species.

The HML has more than 41,000 square feet of laboratory space including:

Analytical and Environmental Chemistry

- Chemical measurement laboratories for environmental analyses which include elemental or molecular mass, molecular structure, and quantity of substances
- Nuclear magnetic spectrometry
- Mass spectrometry, including liquid chromatography, tandem, gas chromatography, and inductively coupled plasma mass spectrometry

Aquatic Production

- Ten independent seawater culture systems each with a self-contained filtration package totaling more than 100 cubic meters of culture volume together with a support lab and food preparation area
- Access to Waddell Mariculture Center



Ecological Field Processing

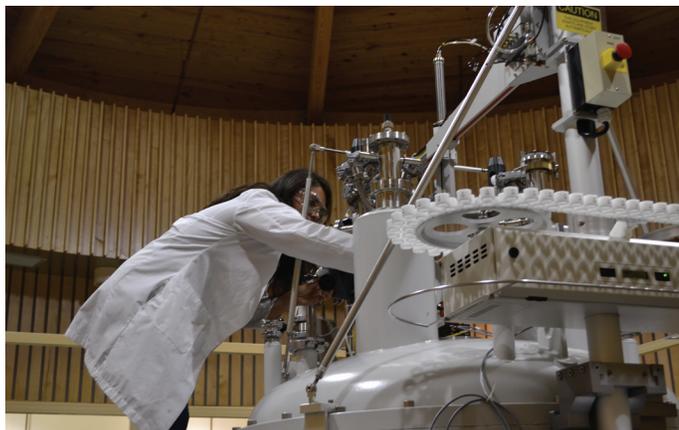
- Facilities for launching field collection activities, sample processing and equipment storage for ecological assessments and a platform for testing new tools and techniques
- An 18-foot *TideCreek* boat R/V with 82" beam

Cellular-Molecular Biology

- Biosafety Level 2+ facilities
- Marine Genomics Core Facility equipped with: a Tissuelyser Homogenization System for RNA extractions; Nanodrop Spectrophotometer and Qubit Fluorometer for RNA quantifica-

tion; Agilent Bioanalyzer for RNA quality measurement; Agilent Microarray Hybridization oven; Agilent Microarray scanner; Agilent Feature Extraction Software; Rosetta Resolver data warehousing and gene expression analysis system; and Genespring and DNA Star gene expression analysis software

- Illumina MiSeq sequencer
- CEQ 8000 Genetics Analysis System sequencers (2)
- ABI 7500 and ABI 7000 Real-time PCR Instruments
- Illumina Eco qPCR instrument
- Genetix Q-bot colony picking robot
- Dako MoFlo sorting flow cytometer



Microscopy

- Scanning Electron Microscope
- Confocal Microscope with multi-line argon, green helium neon, and red helium neon lasers
- Light Microscopes

Marine Environmental Specimen Bank and Reference Materials Production Facility

- Cryogenic facilities for long term-archival of well documented and preserved specimens for both retrospective and comparative environmental health analysis
- Clean rooms
- Specialized equipment for production of reference and control materials used in analytical and environmental chemistry

Challenge Laboratories

- Suite of laboratories adaptable to environmental conditions that include light, temperature, salinity and oxygen for animal health and toxicology research

Level 2+ Biosafety Laboratories

- Four Level 2+ laboratories to bring in unknowns and separate projects that require a heightened level of safety and isolation

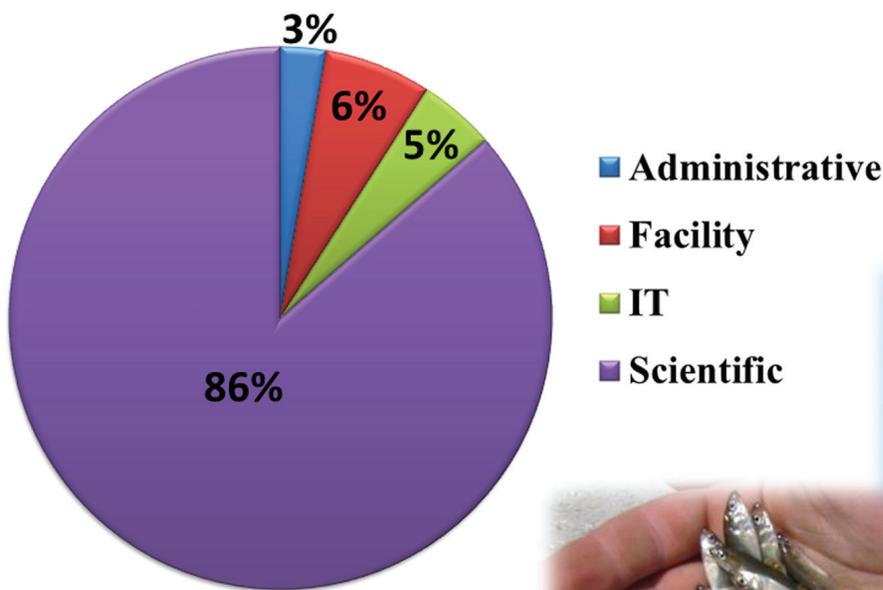
Nuclear Magnetic Resonance

- High field facilities and laboratories to support structural biology, metabolomics and natural product research
- 800 MHz instrument
- 700 MHz instrument
- Auxiliary equipment such as magic angle and flow probe

Hollings Marine Laboratory Demographics

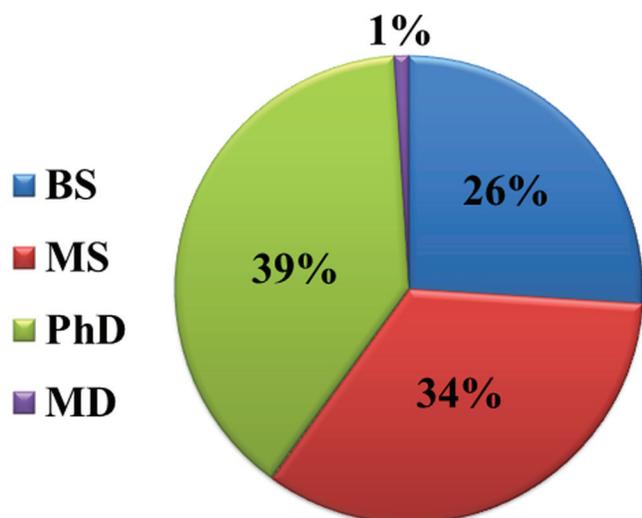
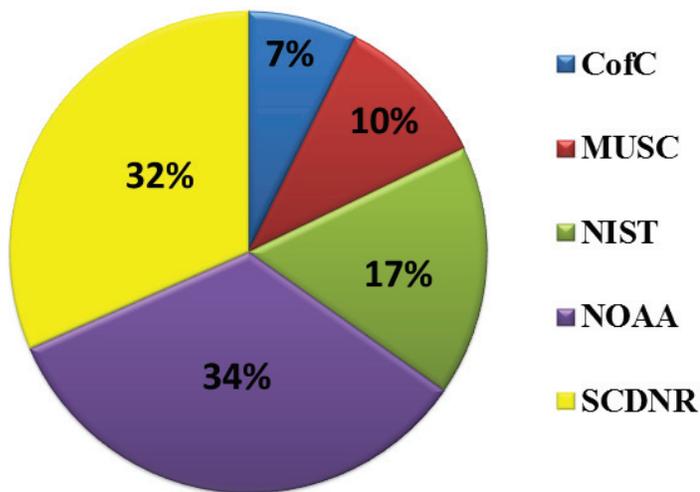
HML is a multi-institutional, multi-disciplinary laboratory that provided a safe work environment for more than 160 personnel in 2012. Excluding students and visiting scientists, the HML supported 110 affiliated staff. This includes personnel serving in an administrative, facility, IT, or scientific capacity. HML is able to maintain operations with very few support staff. In fact, more than 80% of the total staff assigned to HML was serving in a scientific capacity. The following pages provide a more comprehensive look at HML's demographic data for 2012.

HML's 110 Affiliated Staff



Among the five partners, there were more than 95 scientists with primary appointments at HML during the 2012 calendar year. Approximately 40% of our scientists have obtained a PhD or MD degree. Another 34% have a master's degree. Backgrounds for these individuals are incredibly diverse, with scientific expertise in fields such as zoology, earth sciences, environmental science/engineering, oceanography, coastal resources management, microbiology, marine biology, marine science/chemistry, organic chemistry, pharmacology, sociology, public health, and medicine. From aquatic organisms and ecosystems to human health and well-being, the depth and breadth of available expertise allows HML's scientists and principal investigators to evaluate and subsequently derive solutions to the most complex, multi-scale questions. This wealth of knowledge and experience in numerous disciplines provides opportunities for collaborations that result in comprehensive and incredibly insightful solutions. Our personnel and unique collaborative environment have positioned HML on a local, regional and national level to lead scientific investigations that focus on the dynamic and interdependent relationship between aquatic/marine ecosystems and human health.

HML's 95 Affiliated Scientists



HML Scientists: Academic Degrees

HONORS AND AWARDS

In 2012, several of HML's scientists received recognition for their contributions to the scientific community.

Name	Honors/Awards
Louis Guillette Jr., MUSC	<i>Joy Goodwin Endowed Lectureship, Auburn University School of Veterinary Medicine, Auburn, Alabama, March 2012</i>
Louis Guillette Jr., MUSC	<i>L.J. Robert B. Greenblatt Endowed Lectureship, Medical College of Georgia, Augusta, Georgia, March 2012</i>
Louis Guillette Jr., MUSC	<i>L. Floyd Clarke Endowed Lectureship, University of Wyoming, Laramie, Wyoming, April 2012</i>
Clay Davis, NIST	<i>Clemson University, College of Engineering and Science, Outstanding Young Alumnus Award for 2012</i>
John Kucklick, NIST	<i>Department of Commerce 2012 Silver Medal Award</i>
Amanda Moors, NIST	<i>Department of Commerce 2012 Bronze Medal Award</i>
Rebecca Pugh, NIST	<i>Department of Commerce 2012 Bronze Medal Award</i>
Dianne Greenfield, SCDNR	<i>Dean's Scholar Bonus Award, University of South Carolina, Columbia, South Carolina</i>
Dianne Greenfield, SCDNR	<i>American Society of Limnology and Oceanography (ASLO) Early Career Travel Award</i>
Michelle Reed, SCDNR	<i>ASLO Multicultural Program Award</i>

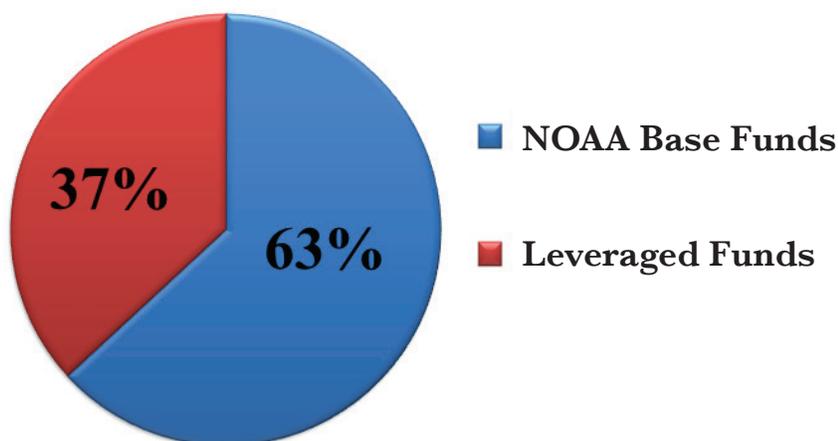
PUBLICATIONS

During the 2012 calendar year, scientists at HML collectively published 55 journal articles, book chapters, and technical reports. References for these publications may be found at <http://coastalscience.noaa.gov/about/centers/hml>

HML FINANCIAL INFORMATION

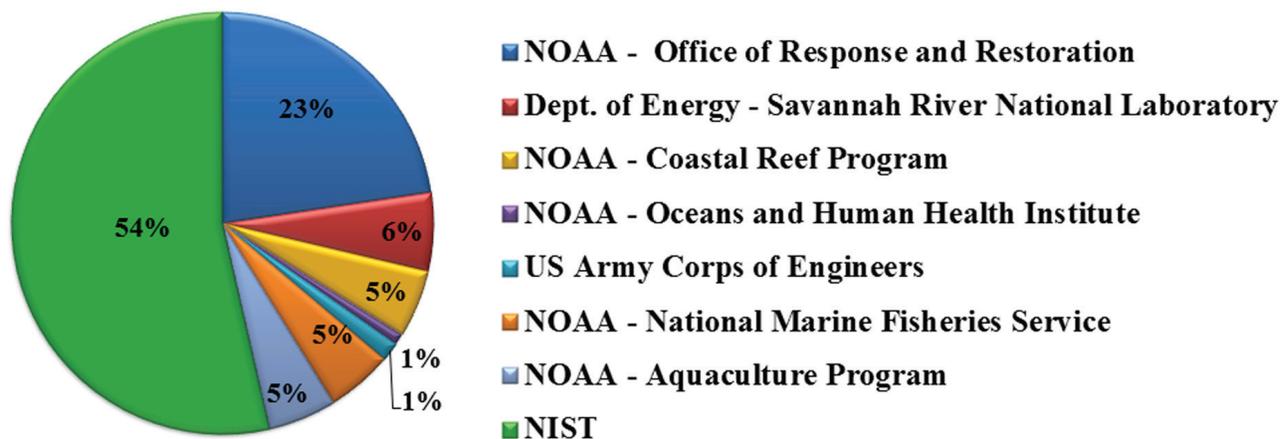
As previously stated, five partner institutes are represented within HML. The NOAA/ National Ocean Service’s National Centers for Coastal Ocean Science (NCCOS) serves as lead for facility operations/maintenance and supports the salary and research efforts of approximately 30 scientists. In 2012, total funding for HML operations, NOAA-based staff and NCCOS-derived science/research was approximately \$5.1 million. Approximately 63% of those funds were contributed as base funds through congressional appropriations to NOAA. The remaining 37% were associated with leveraged (or reimbursable) funds.

2012 Primary Funding



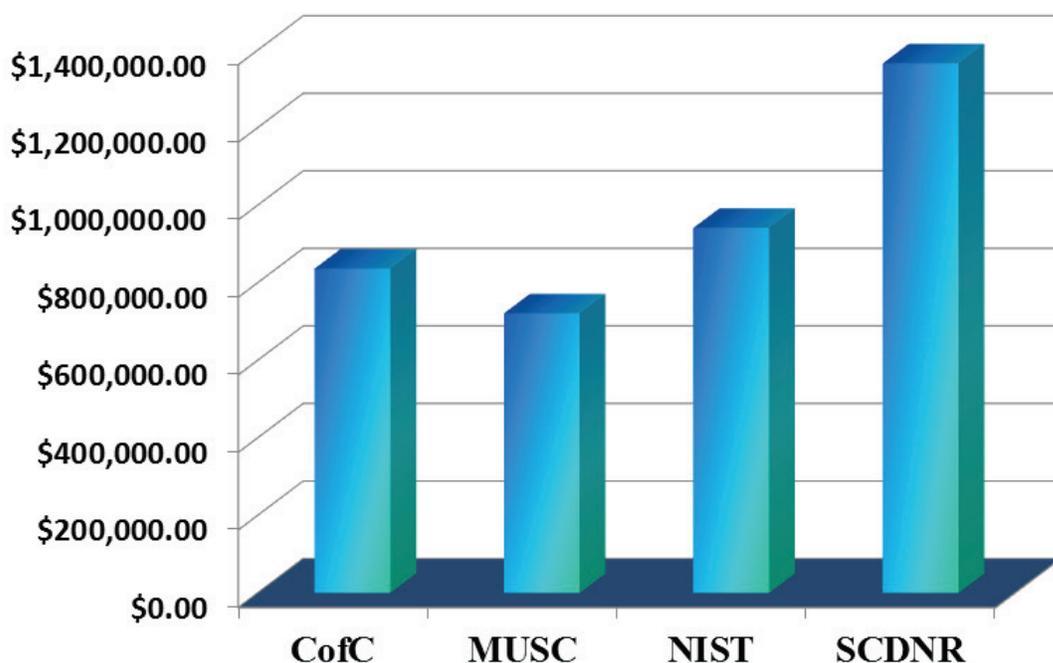
A breakout of leveraged funds contributed to HML during 2012 is provided in the second figure. The National Institute of Standards and Technology (NIST) contributed approximately \$1 million (54%) of the leveraged funds received in 2012.

2012 Leveraged Funds



In 2012, HML's partner institutions were also successful in securing external funding for use in fulfilling collaborative research objectives for the laboratory. When NOAA scientists assigned to HML are excluded from calculations, our other researchers with primary appointments to the laboratory collectively received approximately \$3.8 million in combined grants and awards. A breakout of grants and awards by partner is provided below.

HML's Grants/Awards for 2012



Hollings Marine Laboratory Leadership

Jeffrey King, Ph.D., *Acting Director, Hollings Marine Laboratory
National Centers for Coastal Ocean Science, National Ocean Service, NOAA*

Lori Schwacke, Ph.D., *Oceans and Human Health Branch Chief, Hollings Marine
Laboratory, National Centers for Coastal Ocean Science, National Ocean Service, NOAA*

HML Executive Board

David Kennedy, *Chair, Assistant Administrator, National Ocean Service,
National Oceanic and Atmospheric Administration*

Willie May, Ph.D., *Associate Director for Laboratory Programs and Principal Deputy,
National Institute of Standards and Technology*

Robert Boyles, *Deputy Director for Marine Resources,
South Carolina Department of Natural Resources*

Stephen Lanier, Ph.D., *Vice President, Academic Affairs and Provost, Medical University
of South Carolina*

George Hynd, Ph.D., *Provost and Executive Vice President for Academic Affairs,
College of Charleston*

HML Science Board

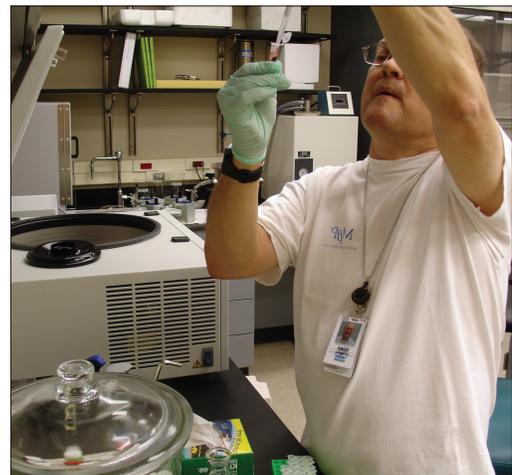
Paul Becker, Ph.D., *Chair, NIST HML Site
Director, National Institute of Standards and
Technology*

Geoff Scott, Ph.D., *Director, Center for Coastal
Environmental Health and Biomolecular Research,
National Centers for Coastal Ocean Science,
National Ocean Service, NOAA*

Robert Van Dolah, Ph.D., *Director, Marine
Resources Research Institute, South Carolina
Department of Natural Resources*

Louis Guillette, Ph.D., *Director, Marine Biomedicine and Environmental Sciences Center,
Center of Economic Excellence Endowed Chair of Marine Genomics Medical University of
South Carolina*

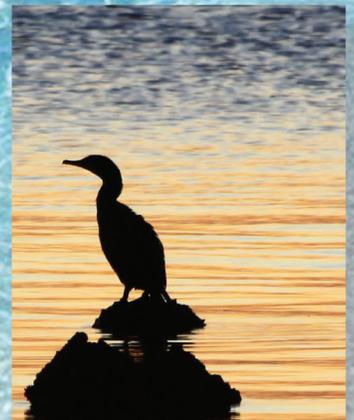
Robert Podolski, Ph.D., *Director, Grice Marine Laboratory, College of Charleston*





HML Annual Report

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