Morehead City Field Site
ENEC395: Independent Research (3 credit hours)
or
ENEC693(H): Honors Research in Environmental Science and Studies (3 credit hours) (must have qualifying GPA)

As part of the MCFS, each student conducts an independent research project or internship (if you qualify you can also conduct it as an Honors Research Project. Typically, the mentors for these projects are faculty members at the Institute of Marine Sciences (IMS) although there are also opportunities to work with people at other local university marine labs and agencies such as Duke University Marine Laboratory, NC State University, NC Aquarium and the NC Maritime Museum. Below are examples of types of projects that students could work on with each research group at IMS. Final topics are determined from discussions between each student and their mentor. Students should contact potential research advisors by *June 30, 2022* to discuss projects. Each advisor accepts a maximum of two students and projects are offered on a first come first served basis, so if you have a mentor that you identify as being your target area of research, contact them soon. ***If you are enrolling at the Morehead City Field Site, once you have decided on a mentor and received their approval, please send that information to Rachel Noble (rtnoble@email.unc.edu) so that she can help you get registered. For further information about current research at IMS see links to individual faculty member web sites at:***

https://emes.unc.edu/faculty/

In that webpage, at the top right, search by location and select Institute of Marine Sciences, and press search.

Dr. Joel Fodrie (jfodrie@email.unc.edu)

Estuarine ecology and fisheries biology: The estuarine ecology lab is broadly interested in the basic and applied ecology of coastal fishes and shellfishes, as well as the biogenic habitats on which these species depend. Our current research based at IMS emphasizes: (1) quantifying connectivity rates among marine populations and ecosystems (e.g., larval dispersal, nursery contribution); (2) exploring the natural history, restoration ecology, and climate response of coastal biogenic habitats (especially oyster reefs); (3) the landscape ecology of estuarine habitat mosaics (with a particular focus on seagrass meadows as model test ecosystems); and (4) the ecosystem and socioeconomic dynamics of expanding shellfish mariculture operations. Underpinning and unifying this range of topics is our interest in discovering, applying, and/or testing basic ecological principles to help solve applied management or conservation challenges.

Dr. Niels Lindquist (nlindquist@unc.edu)

Estuarine habitat restoration and oyster aquaculture: Levels of interest and resources are rapidly rising for restoring and creating nature-based infrastructure that protects coastal natural resources and human infrastructure vulnerable to rising sea levels and storm surges associated with increasingly strong storms. In temperate zones, oysters and the reefs they create are a major focus of coastal habitat restoration for mitigating shoreline erosion with protective shoreline reefs as a component of “living shorelines”, as well as greatly enhancing oyster populations to provide an environmentally clean and sustainable source of protein and critical micronutrients for a growing world population. At IMS, we have developed a biodegradable hardscape showing great promise for cost-effectively creating oyster reefs and sourcing immense numbers of oysters.

Dr. Rick Luettich (rick_luettich@unc.edu)

Physical oceanography-flooding, storm surge and waves in coastal North Carolina: We have developed one of the leading computer models (ADCIRC) currently in use for predicting coastal circulation, waves, storm surge and flooding associated with major storms. Opportunities exist to assist with ADCIRC validation studies for recent events (e.g., H. Dorian, H. Isaias); analysis of water level data for determining flooding statistics; and the development of software to convert model results into GIS ready products for broad distribution. Other areas of investigation include flooding and resilience, and impacts of storm surge on coastal and inland communities.

Dr. Hans Paerl (hans_paerl@email.unc.edu)

Nutrient cycling dynamics, eutrophication and water quality of estuarine and coastal waters: The Paerl laboratory specializes in the water quality of coastal and inland systems in relationship to eutrophication and impacts from human activities. Areas of investigation in the laboratory are toxin producing algae, formation of harmful algal blooms and the response to nutrient loading, and working with stakeholders and management agencies to understand the impacts of nutrient reductions on our freshwater and estuarine ecosystems. Work in the Paerl lab can include laboratory experimentation, field work and analysis of historical and current data sets combine to understand the dynamics of nutrients in coastal waters.

The ecology and management of harmful algal blooms: Issues related to water quality management feature the control of harmful algal blooms, which are exacerbated by climate change. The Paerl lab is at the forefront of research in these areas, including international and national management approaches. The Paerl Lab has led the investigation of climatic (change) impacts (storms, floods, droughts) on estuarine and coastal water quality and habitats. There are opportunities in the laboratory to study the impacts of extreme events and flooding on the development of HABs and impacts to humans and coastal ecosystems.

Production and impacts of algal toxins on estuarine and coastal biota, including man
Algal toxins can impact people through aerosols, food consumption, and even recreation. The Paerl Lab has opportunities for understanding toxin production, and risk associated with HAB toxins.

Dr. Rachel Noble (rtnoble@email.unc.edu)

Water quality in estuaries and in oysters: We work to understand the delivery of contamination into our estuaries and oceans by studying stormwater, floodwaters, and the infrastructure that humans use in daily life. By using advanced tools we can understand whether the contamination into a waterbody is from sewage or stormwater systems, and we can determine how to remediate the problem. We also study the dangerous genus of bacteria, Vibrio because it can accumulate in oysters and can cause serious disease in humans. Our laboratory conducts advanced molecular testing for viruses and bacteria to understand the risks of contamination. In our lab you can expect to do field work, benchtop science, and computer based analysis. You will learn molecular methods in this research that can be applicable to a wide number of research areas and valuable career preparation.

Development of advanced approaches for quantifying viral pathogens: In our current pandemic-focused world, our laboratory is doing exciting work to apply new molecular approaches to studying water and wastewater for COVID-19, as well as other pathogens. We are actively working with engineers to develop new rapid systems that can be used by municipalities to test water and wastewater for an array of viral and bacterial pathogens, so that we can use the system to improve our management of public health, and understand community prevalence of illness. The work requires laboratory, field, and also computer based analysis, so we are certain to provide you with training that is relevant to future careers in environmental sciences and public health.

Dr. Nathan Hall (nshall@email.unc.edu)

Water clarity of NC estuaries: Water clarity is fundamental to the productivity and ecosystem health of North Carolina's estuaries. An understanding of the factors that govern water clarity and attenuation of photosynthetically active radiation can foster sound management of our aquatic resources, particularly submerged aquatic vegetation. Several possible projects deal with direct measurements, remote sensing, and modeling of optical properties (phytoplankton, sediments/ detritus, dissolved organic matter) and light attenuation in NC estuarine waters.

Effects of harmful algae on oysters: Raphidophytes are a class of potential harmful phytoplankton that are common to North Carolina estuaries and may negatively impact survival, growth, and fecundity of oysters. Possible projects will experimentally test the impacts of exposure to raphidophytes at different life stages of the eastern oyster. Information from this project will inform management of estuarine water quality and siting of oyster reef restoration locations.

Dr. Tony Rodriguez (abrodrig@email.unc.edu)

Reconstructing the past to better prepare for the future: With accelerating sea-level rise, increased storminess, and larger coastal populations in our future, it is important to understand how those stressors influence coastal environments, such as barrier islands, bays, saltmarsh, sea grass, oyster reefs and deltas. Reconstructing the evolution of coastal systems and determining the drivers and rates of change will help us better prepare for the future. We collect and analyze a variety of geological and historical data to address the sustainability of coastal environments.

Intertidal oyster reef growth and changes in salt marsh area through time: As sea-level rises, both intertidal oyster reefs and saltmarshes need to keep up or else they will lose their position in the tidal frame. Understanding the conditions that optimize growth of these habitats is important, especially considering communities construct oyster reefs and plant saltmarsh as "nature-based infrastructure" to combat shoreline erosion. We use drones and lasers to measure growth directly and collect cores to see how their composition (including carbon burial) changes through time and in different settings.

Dr. Janet Nye (jnye@unc.edu)

Physiological determinants of range expansion in marine fishes : Upper and lower temperature tolerances determine the range of marine ecotherms. However, we know surprisingly little about temperature tolerances for many species, even those that are recreationally and commercially important. Students will quantify the upper and/or lower temperature tolerances of marine fishes, shrimp and crabs to be able to project current and future range limits of our important marine resources. effect of environmental factors including climate change on marine fish and invertebrates. This fall we expect to have students conduct experiments in the lab to answer the following questions such as: How does temperature and salinity affect the growth of Gulf flounder (or perhaps some other species like snappers and triggerfish)? What are the differences in methods to determine upper and lower temperature limits of crabs such as stone crabs, Sargassum crabs and blue crabs, and 3) Can temperature tolerances explain the migrations of estuarine dependent fishes' use of seagrass beds in NC?

Assessing vulnerability of coastal communities to climate change: Many people that live at the coast are dependent on marine natural resources and must adapt to the future impacts of climate change. In

addition to climate change they must also adapt to "pulse" events like hurricanes, heat waves and cold spells. This work will compare indicators of social adaptability to the frequency, duration and intensity of pulse events like hurricanes and heat waves to identify vulnerable coastal communities in the US and Australia.
Dr. Johanna Rosman (jrosman@email.unc.edu)

Understanding water motion in reef and marsh systems: Marine systems such as coral reefs, oyster reefs and salt marshes have complex geometries that exert drag on currents, dissipate wave energy, and enhance turbulent mixing. These processes in turn affect nutrient uptake, larval settlement, thermal stress, and sedimentation, so affect how reef and marsh systems evolve over time. There is increasing recognition that natural systems can be used to reduce wave energy and protect shorelines from erosion but designing these "living shorelines" to be successful requires both understanding of how reefs and marshes impact water motion, and how water motion affects their ability to persist and grow. My lab has opportunities for students to use computer models and field measurements to investigate these issues.

Processes controlling dissolved oxygen distributions in estuaries: Dissolved oxygen concentrations in estuarine systems are controlled by a combinations of physical transport processes (air-sea exchange, vertical mixing) and biological processes (consumption, production). In many estuaries, oxygen consumption rates can exceed the rates at which oxygen is replenished by physical processes, resulting in low oxygen levels that are harmful to organisms such as oysters and fish. There are opportunities for students use measurements and/or models to investigate how physical and biological processes interact to control oxygen levels in estuarine systems, including the microtidal wind-driven Neuse River estuary, and local oyster reef and aquaculture facilities.

Additional mentors exist that work outside of the UNC Institute of Marine Sciences, a brief list of some of those scientists and their areas of expertise is below (contact Rachel Noble to pursue):

James Morris (NOAA Beaufort Lab, james.morris@NOAA.gov) – Invasive species and aquaculture; e.g., mapping lionfish populations using genetic techniques

David Gill (Duke Marine Lab, david.gill@duke.edu)-Marine conservation, global marine policy, coral reefs

Grant Murray (Duke Marine Lab, grant.murray@duke.edu) – Coastal policy, marine ecology, small-scale fisheries

Doug Nowacek (Duke Marine Lab, dpn3@duke.edu) – Marine mammals and bioacoustics

Andy Read (Duke Marine Lab, aread@duke.edu)

Tal Ben-Horin (NCSU CMAST, tbenhorin@ncsu.edu) Shellfish physiology and histology, shellfish mortality and ecology

Carol Price (NCSU CMAST, carol.price@ncaquariums.com) apex predator ecology, shark conservation and education

Matthew Godfrey (NC Wildlife Resources Commission, matt.godfrey@ncwildlife.org) sea turtle biology, marine conservation