

## **DENIN Environmental Scholars Internships**

Dates of internship: November 1, 2021 – May 13, 2022

Location: 021 Lammot DuPont Lab, University of Delaware, Newark, DE 19711

Number of positions available: 1

Faculty Mentor: Dr. Wei-Jun Cai

Graduate Student Mentor: Stephen Gonski / Xinyu Li

Professional Staff Mentor: Dr. Najid Hussain

### **Project Title:**

Advancing pH measurement technologies for coastal ocean acidification monitoring in the Delaware Estuary and Delaware's Inland Bays

### **Research Description:**

Estuarine and coastal ocean acidification is the net result of different natural and anthropogenic processes that often work in concert to acidify nearshore waters at rates that greatly surpass those of the open ocean. Water quality changes driven by acidification threatens a range of species as well as ecosystem stability. Bivalve and other sedentary carbonate-shell bearing organisms are especially vulnerable to acidification. Delaware's shellfish aquaculture industry is still in its infancy so understanding the impacts of acidification on local ecosystems is crucial for this industry to thrive. Despite the urgent threats that acidification poses to Delaware's estuarine and coastal ocean waters and the resources therein, there are currently few assets that can be leveraged to measure and assess its impacts in State waters.

In particular, the absence of acidification monitoring assets in Delaware's Inland Bays and shallow river-forced sub-estuarine areas located in the Delaware Estuary, where most of Delaware's bivalve aquaculture activities occur, limits our understanding of acidification conditions. Without acidification monitoring, the development of effective adaptation and mitigation strategies in these areas is impeded. Therefore, we propose to deploy pH/DO sensors in several locations in Indian River Bay and selected shallow, river-forced sites in the Delaware Estuary. Some of these sites are co-located with local shellfish aquaculture operations, to help fill these data and knowledge gaps. **A critical step of assessing the performance of this pH sensor is the calibration technique. We propose to collect water samples and measure pH with a very precise but time consuming meta-cresol purple (mCP) pH dye based spectrophotometric method.** Water samples will also be taken for salinity, nutrients, total alkalinity, and dissolved inorganic carbon (DIC) analysis to derive spatial variations of ocean acidification conditions in these sites.

The undergraduate student will learn practices and methods associated with mCP-based spectrophotometric pH analysis and with sensor operation and deployment. The student will also validate *in situ* sensor performance through collection and analysis of discrete water samples for marine carbonate system parameters and their empirical relationships. Using the data collected, the undergraduate student will be able to calculate the full marine carbonate system which will provide them an opportunity to pursue additional project components encompassing data

analysis and interpretation related to acidification's impacts on local bivalve shellfish. One such example would be to assess seasonal evolution of aragonite saturation state in surrounding waters, helping uncover spatial and temporal extent of aragonite undersaturation (which represent unfavorable conditions for shellfish) and help highlight their vulnerabilities to acidification. Further, if rare hypoxic events are captured at these sites, interactions between acidification and hypoxia may further be explored depending on the student's interests. This work will help to understand the status of acidification conditions in state waters and will be essential informing larger state-wide efforts aimed at responding to and mitigating regional effects of the global problem of estuarine and coastal ocean acidification.

**Research Questions:**

1. *Can we deploy and validate the performance of water quality sensors to accurately measure and capture representative acidification and marine carbonate system conditions across the full salinity range between freshwater and seawater in Delaware's estuarine and coastal ocean waters?*
2. *How can estuarine and coastal ocean acidification due to combined natural and anthropogenic influences potentially impact local commercially grown bivalve shellfish in Delaware's Inland Bays and the Delaware Estuary?*

**Student Learning Objectives: Professional and Research Skills**

**(What will the student learn to do during the internship?)** The DENIN scholars program targets several research and professional skills whose development fosters future research interest and success. Therefore, please include all skills the research experience you offer will help students develop. The table below provides the broad skills in the left column and some examples in the right column. Please retain as many broad skills as are relevant and write skills specific to your lab in the right column replacing the examples provided. Remove broad skills you will not foster and, if there are skills you will foster that are not included in the table, add them. See the example research opportunity provided.

Broad Professional Skills	Specific Skills
Express ideas in writing	Write descriptions of research procedures, create a poster of your research
Express ideas verbally	Discuss research activity in lab meetings, present poster at symposium; discuss estuarine acidification concept with visitors during UD CEOE's annual Coastal Day and other out-reach activities.
Work independently	Conduct [research activity]
Maintain professional attitude and work principles (i.e. integrity, responsibility, diligence, following ethical standards)	Be on time, learn procedures, ask questions if unsure, respect everyone you work with; learn to work as a team member in a laboratory of over 10 members.

Broad Scientific Research Skills	Specific Skills
Understand scientific terms	pH as a master variable for aquatic sciences; Estuarine mixing, salinity, eutrophication, hypoxia, carbon cycle, CO <sub>2</sub> flux, ocean acidification, and global warming.

Locate scientific articles and resources	Conduct searches for literature about pH measurements, hypoxia, and ocean acidification
Use scientific tools	Spectrophotometric pH analysis, DIC analyzer, Alkalinity titration system, glass electrode and Ca <sup>2+</sup> titration, pH and pCO <sub>2</sub> sensors.
Recognize simple patterns in research data	Vision recognition (eye balls), quantitative correlation using Excel, and basic statistics.
Understand research questions	Will discuss research questions on day 1. Will repeat in lab meetings, and will encourage the students to ask their own related research questions or sub-questions as they collected data and analyze the data.
Read and understand research articles	Will assign review papers on current topics for the students to read, will ask the students to discuss with us or present at the lab meeting.
Apply research tools and techniques in research experiments	Use a spectrophotometric pH analyzer, pH and nutrient sensors, DIC analyzer and TA titrator to conduct research (e.g., Learn new laboratory techniques related to nutrient and carbon cycling.)
Analyze research data	Use Excel to analyze data
Understand, apply, and explain scientific concepts and theories	In lab meetings, with lab personnel, and during research symposium
Identify appropriate research methods	Design experiments using biogeochemical in situ sensors, novel techniques in the lab.

**Prerequisites:**

The students should already have basic chemistry knowledge and laboratory skills. Prefer the students have already taken Analytical Chemistry, Introduction to marine sciences or Environmental chemistry or equivalent courses.

**Work Environment and Expectations:**

Laboratory environment: work location and schedule

Students will work part time in fall 2021 and spring 2022 semesters. Students will also participate in a retreat, communications workshop and end of internship spring symposium.

**Stipend:**

\$3,500 Direct deposit is required.

**Funding Source:**

National Science Foundation, Delaware EPSCoR Track I

**How to apply:**

[https://ugresearch.udel.edu/PUB\\_Program.aspx](https://ugresearch.udel.edu/PUB_Program.aspx)