

Chemistry in motion

Research project examines how Long Island Sound waters change with the tides

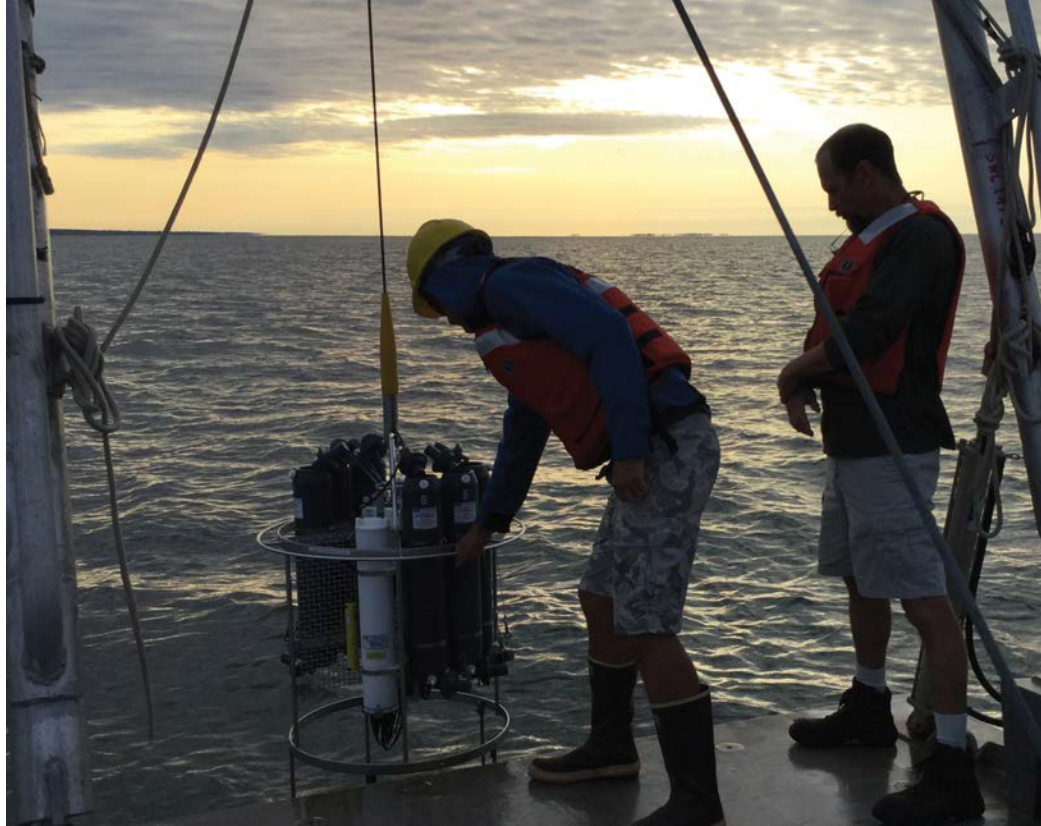
By JUDY BENSON

In the dawn semi-darkness as the sun's rays crept skyward, the docks next to the R/V Lowell Weicker bustled with activity.

A half dozen seasoned and novice marine scientists, still yawning but maneuvering apace, hauled ice-filled coolers and crates loaded with empty sample bottles onto the 36-foot vessel, docked at the University of Connecticut's Avery Point campus in Groton.

"We're basically trying to figure out what goes in and out of Long Island Sound," said Penny Vlahos, lead researcher on the project with Michael Whitney, both UConn marine sciences professors. "This will give us a baseline."

The project began in May 2016, when Vlahos, Whitney and their teams of students set out on the first research cruise to collect water samples at five sites in eastern Long Island Sound through four tidal stages in spring, summer and fall. By September of 2017, they had fin-



Chris Mills, a UConn student and crew member of the R/V Lowell Weicker, prepares to deploy a CTD rosette water sampler filled with Niskin bottles into Long Island Sound as Dave Cohen, marine technician, looks on. Photo: Judy Benson

ished that part, and were moving to the western end to repeat the process there. They will ultimately finish the project in the central Sound, sampling at a total of 15 sites across the estuary.

"It's really nice to have these days not in the lab or at a computer, when the science is really tangible," said Allie Staniec, a doctoral marine sciences student working with Vlahos, as the vessel motored toward the first sampling site off Giants Neck in Niantic. "Out here, it really gives us a sense of how the lessons we're taught and

the experiments we do really matter."

While Vlahos, Staniec and fellow student Allison Byrd took readings on salinity, temperature and other measures before capping the samples for lab analysis for the marine chemistry side of the project, another group kept track of what the tides were doing. Using an acoustic current profiler, Steven Denignan-Schmidt, doctoral candidate in oceanography, and graduate student

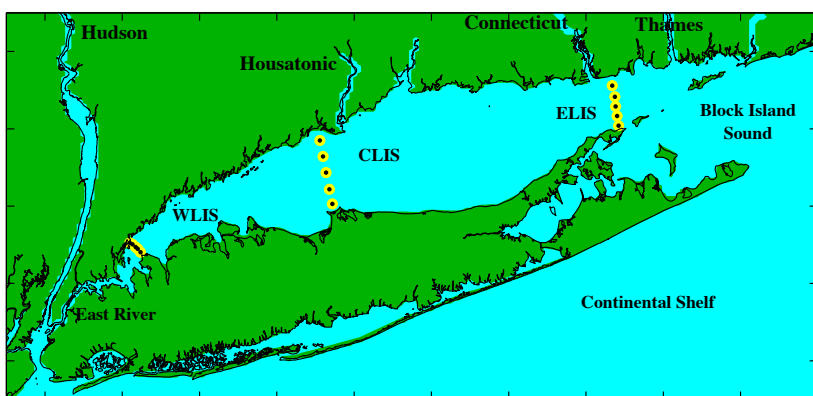


Figure 1 Location map showing LIS study sampling stations. There are 5 stations on each line.

Map: Michael Whitney
Graphic: Michael Whitney

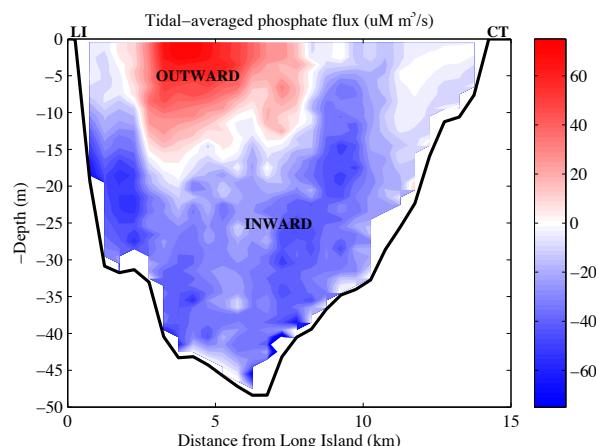


Figure 2 Tidal-averaged phosphate flux through the Eastern LIS section observed in May 2016. Red indicates outward transport towards the east and the blue indicates inward transport towards the west. Results from this cruise showed phosphate was being imported from the Continental Shelf to the land, a significant finding.

Yan Jia measured the changes in direction, volume of flow and other physical parameters of how the water is moving through the Sound with tides and river discharges.

“As we’re moving across the Sound, we’re taking measurements across the depths,” said Denignan-Schmidt. As he spoke, his computer screen displayed a colorful image painted by the acoustic profiler of the otherwise unseen underwater streams coursing through the water columns.

From each round of sampling, levels of carbon and nitrogen particles would be analyzed with a filtration test. Other lab tests would measure dissolved organic carbon and inorganic carbon, two byproducts of natural biological activity, fossil fuel emissions and other industrial processes flowing in from rivers and falling from the atmo-

sphere that alter the chemistries and habitats of waterways worldwide. The project is also measuring alkalinity and four compounds that plague urbanized watersheds like the Sound’s at excess levels – phosphates, nitrates, nitrites and ammonium. Each set of results is then paired with its matching tidal stage. A separate set of tests would look for pesticide residues.

“This will give us a baseline,” Vlahos said.

While it’s a large and dynamic estuary, the Sound can be understood with a fairly simple analogy. Think of it as a gigantic bathtub, with multiple spigots and drains that at various times feed and empty water in and out – sometimes simultaneously. The largest rivers – the

Housatonic, Connecticut and Thames – supply most of the fresh water, mixing with salty ocean pushing in from the East River and the Atlantic Ocean at either end. Along with the constant flux of the tides and river currents, the Sound is also in constant change through the seasons and weather conditions.

“The dynamics during a very dry year and a very wet year are very different,” Vlahos said.

Despite decades of research into the Sound, its chemical and physical profile has never been fully characterized this way before, Vlahos and Whitney said. Doing so now is essential for being able to track how climate change will affect it.



Allie Staniec, a doctoral marine sciences student, empties water from the Niskin bottles in preparation for the next sample collection. Photo: Judy Benson

“It’s what needs to be done,” said Whitney. “But to do that you need an interdisciplinary team. By measuring both the chemistry and physical characteristics at the same time, you get a result that is greater than the sum of its parts, because you’re observing nutrient and carbon transports.”

For Vlahos, the project is the fulfillment of a goal she’s had since she started at UConn in 2001 to create a complete chemical and physical profile of the Sound. For her doctoral thesis while a student at the University of Massachusetts, she had done a similar project measuring the carbon coming in and going out of an area of the North Atlantic, from Cape Hatteras to the Georges Bank. Then in 2014, she and Whitney began a three-year precursor project to the current one, when they measured how much organic carbon was entering and leaving the Sound. They quantified how the levels vary with seasons and changes in river flows, showing that the estuary alternatively imports carbon from the ocean, then exports it. Overall, the Sound exports carbon about 85 percent of the time, and imports it for the remainder, their research showed. Now, the current project is measuring carbon levels within a broader suite of compounds and physical characteristics, creating a big-picture canvas for the entire system.

“I’ve always wanted to do this research for Long Island Sound,” Vlahos said. “We’re also hoping to do another project on all the rivers coming into the Sound, to get a grasp on those in wet years and dry years.”

Having a complete picture of how the chemistry of the Sound changes through the tides and seasons is essential,

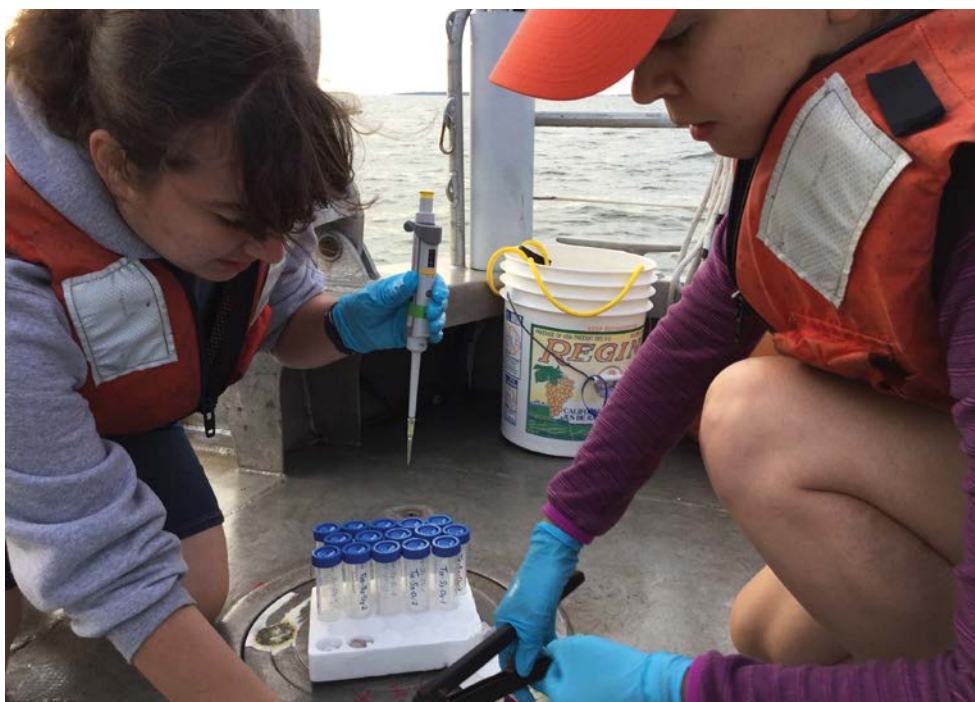
Vlahos and Whitney said, to understand what the tipping points are when parts of the estuary get starved of oxygen and suffocate marine life, as happens periodically in the western and central sections. Their results could contribute to better decisions about investments in sewage plant upgrades, storm water controls, protection of wetlands that filter pollutants and limits on shoreline development.

“This work will help managers understand the real controlling parameters,” she said. “A lot of money is being spent on nitrogen removal, but there are other influences on Long Island Sound. Carbon and nitrogen are so intertwined. Do we want to put all our money into nitrogen?”

The research findings will also be incorporated into the Blue Plan being written for the Sound, Vlahos said. That project, led by the state Department of Energy and Environmental Protection with input from Sea Grant and other partners, will be an inventory of the resources and uses of the Sound, along with a plan to guide how its waters and submerged lands are used in the future.

As the waters of the Sound warm and carbon levels increase with climate change, she added, having this information as a starting point will be critical to understanding how best to protect and continue long-term restoration efforts.

“We’ve already got results we’re really excited about,” Vlahos said. “From the first cruise, we found that phosphate was being imported from the Continental Shelf to the land. You don’t expect that.”



Allie Staniec, left, and Allison Byrd, a marine sciences graduate student, fill vials with water collected from Long Island Sound for testing later in a UConn laboratory. Photo: Judy Benson

Prof. Penny Vlahos, center, reads data from a multi-probe meter on dissolved oxygen, salinity and temperature of a water sample to Allison Byrd. Behind her is Yan Jia, a marine sciences graduate student, with a handheld profiler. Photo: Judy Benson

