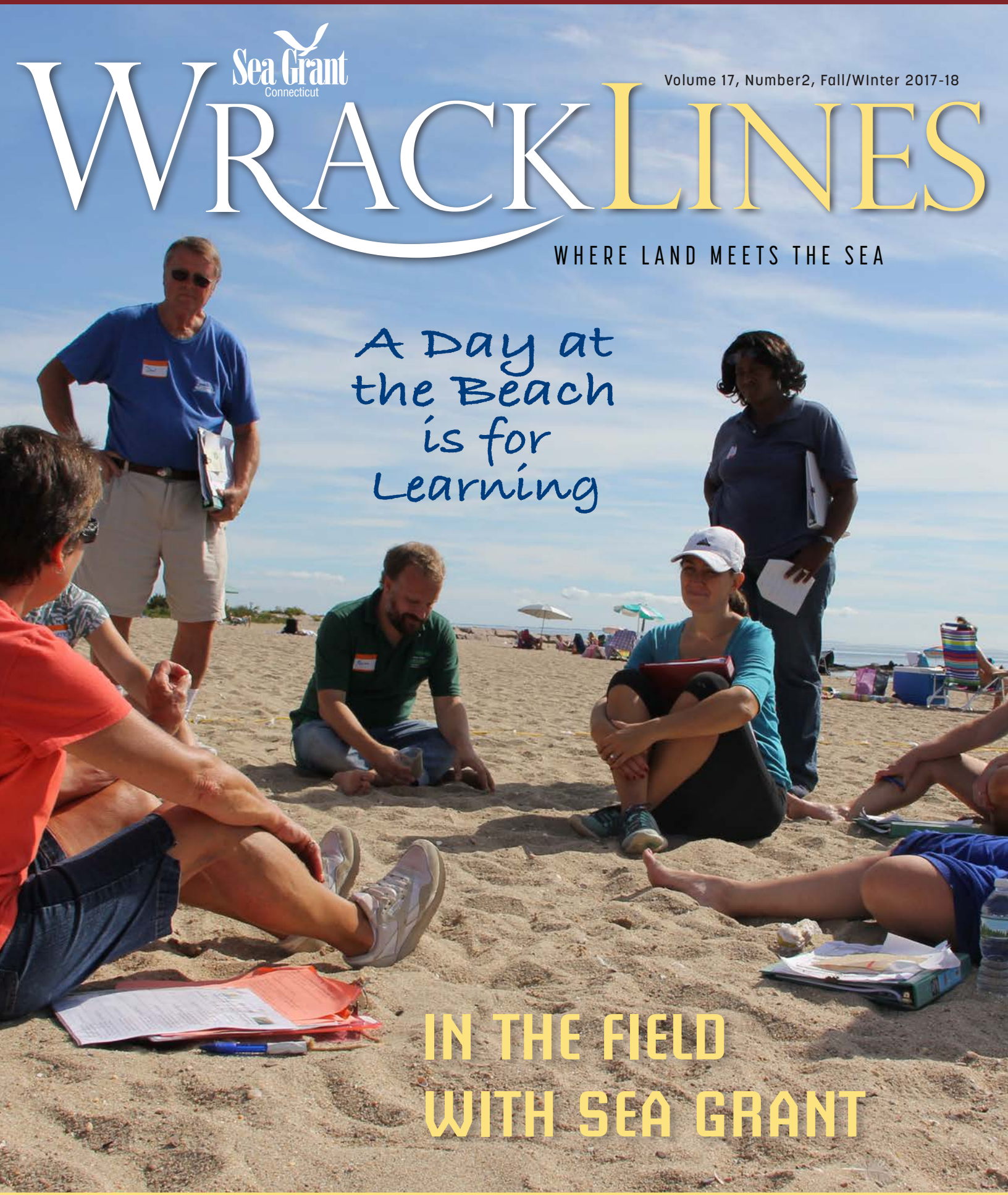
A PUBLICATION OF THE CONNECTICUT SEA GRANT COLLEGE PROGRAM AT THE UNIVERSITY OF CONNECTICUT

Sea Grant Connecticut

WRACK LINES

Volume 17, Number2, Fall/WInter 2017-18

WHERE LAND MEETS THE SEA



A Day at the Beach is for Learning

IN THE FIELD WITH SEA GRANT

CHEMISTRY IN MOTION • ENGINEERS GETING ACQUAINTED WITH AQUACULTURE • MENACE OF MERCURY

Sea Grant Connecticut

Volume 17, No. 2 Fall/Winter 2017-18

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From the EDITOR

IN THE FIELD WITH SEA GRANT

Talk to me. Please.

Photo: Nancy Balcolm

As the new communications coordinator for Connecticut Sea Grant, I have come into a distinct inheritance, one that it is my privilege and responsibility to help elevate to a new level of outreach for all the residents of this beautiful state. My predecessor, Communications Director Peg Van Patten, left me a highly respected publication in "Wrack Lines," strong in content and attractive in design. As its new editor I want to build on that legacy while making my own mark.

For that I need your help.

In this my inaugural issue, I chose the theme of "In the Field With Sea Grant," to let readers learn along with me about the interesting and important work being done by our staff and researchers. During my previous 25-plus years as a daily newspaper reporter and editor – most recently as the health and environment reporter for The Day of New London – going out with scientists to write stories about their field research was always my favorite part of the job. It gave me a chance to wade into marshes to measure sea level rise impacts, hike into dense forests in search of bears, and count river herring as they migrate upstream to spawn. Now I get to see that kind of real-world science in action at Sea Grant.

Since starting at Sea Grant in late July, I've been on boats twice, once to a site off Branford where seaweed is being grown for a testing project, and again into eastern Long Island Sound where marine scientists are researching how water chemistry changes with tidal flows. At a shellfish co-op I became acquainted with the unique equipment oyster farmers use. In a UConn lab I saw the intricate and painstaking process used to detect methylmercury in the tissue of small fish, clams and oysters. And at Hammonasset Beach State Park I joined teachers discovering how to bring marine science lessons into their classrooms. All these experiences were exhilarating, fascinating and enlightening. I gained new admiration for what it takes to do science that matters and apply it in the here and now.

My job is to communicate about that science in a way that best serves the public. This magazine is one of Sea Grant's main vehicles for carrying out that mission, but with a few changes I believe it could be more effective. From my years as a reporter, I know the public is hungry for environmental news, but unfortunately coverage in many traditional journalism outlets has contracted. This magazine can be a better means of helping to fill that void. First, I am considering a new name. "Wrack Lines" – the term used by marine scientists for the line of seaweed, shells and other debris left at the high tide line – sounds to me too much like it's a magazine just for insiders. How about calling it "Connecticut Coast and Currents" instead, to let environmental professionals and the general public alike know that this publication covers the shoreline and its great rivers that extend statewide?

I would also like to broaden the reach and appeal of the magazine, by bringing in new writers, different types of articles about issues still relevant to Sea Grant but also to a wider cross-section of readers, and making it available at more places. So please, share your ideas with me, and let me know if you'd be interested in a focus group I will be forming. If interested, contact me by Dec. 31. I can be reached at: judy.benson@uconn.edu.

Thank you and happy reading,

Judy Benson
Editor

Front Cover: Teachers gather after a day of learning how to use Hammonasset Beach State Park as a science classroom. Photo: Judy Benson

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Donna Finn, a teacher at the John J. Allison Jr. Polaris Center high school in East Hartford, creates a pressed seaweed sample during a teacher workshop at Hammonasset Beach State park. Photo: Judy Benson

Of Interest

Migrating snowy egrets often congregate at the Meigs Point marsh at Hammonsett Beach State Park in Madison in the fall. Photo: Judy Benson

A Day at the Beach is for Learning

Workshop gives teachers the tools to use a 'real environment' for lessons aligned with new science standards

By JUDY BENSON

When the science lesson involves literally turning over rocks, wading waist-deep in Long Island Sound, shaking knee-high tumblers of sand and grabbing a flapping bluefish out of a net, students can get excited -- even if those students are themselves veteran science educators.

"Holy moly," cried Sara Sandora, science curriculum leader for Madison public schools, as she flipped over a slippery kelp-colored rock to find a dozen or so Asian shore crabs scurrying underneath.

Sandora, one of 10 teachers who spent a summery day in September at a workshop at Hammonasset Beach State Park in Madison, blurted her exclamation during one of the first exercises of the session. But there would be many more such expressions to come.

"Look at all us grown-ups getting so captivated," said Donna DuBaldo, one of the workshop leaders, as six or seven of the teachers kneeled in the sand to pick small finfish and hermit crabs out of a seine net. "Think of how 8-year-olds and 9-year-olds are going to react." The daylong program, run by Connecticut Sea Grant for 15 years and sponsored by the EPA Long Island Sound Study, has taught scores of teachers how to use Hammonasset's varied habitats – from salt marsh to rocky intertidal to sandy beach to dune – as an outdoor science classroom. Called the Long Island Sound Mentor Teacher (LISMT) program, its purpose has been to show teachers how to incorporate Long Island Sound into their classrooms. But this time, the program took on new relevance.

Now, the workshop is presenting hands-on activities and cross-disciplinary concepts directly aligned with the Next Generation Science Standards, a national curriculum adopted thus far in 18 states. In 2015, Connecticut became one of those states, when the state Board of Education set a five-year timeline for implementation.

Diana Payne, education coordinator for Connecticut Sea Grant and organizer of the workshop, said the new standards are a major improvement in the way science has been taught.

"We're finally going to do science in the classroom the way science is actually practiced," she told the teachers. The standards, developed in response to concerns about a shortage of U.S. workers with science and engineering skills, emphasize hands-on problem solving and learning through investigation rather than lectures. The three subject areas – physical science, life science, and earth and space science – are taught through a "three-dimensional" approach in which students apply science and engineering practices, learn the core ideas of each discipline and discover cross-cutting concepts that link them together. The standards don't proscribe particular textbooks, curriculum or lessons, though, leaving states and schools free to develop those independently. That's where the LISMT workshop comes in.

Donna Rand, workshop co-leader and science specialist at Glastonbury-East Hartford Magnet Elementary School, let the teachers know they could expect to get their feet wet and their hands dirty.

"We're going to apply science to a real environment," she told the teachers, seated on picnic tables at a pavilion, as beachgoers toting towels and folding chairs filed past on their way to a spot near the water. "We're going to give you all the equipment you need to bring your kids here – the seine nets, resource guides, minnow traps." She and DuBaldo had written a section in Sea Grant's Long Island Sound Curricular Resource Guide about using Hammonasset as a class field site that the teachers would be taking home with them that day.

When bringing a class to the beach, she and DuBaldo said, teachers should realize that they will probably have students who've never been there before, and start with the basics. They passed out some large roadmaps.

"We usually start off asking the kids, 'where in the world is Long Island Sound?'" Rand said.

Locating the Sound and Hammonasset led to a demonstration about the Sound's watershed that extends to the entire state. Then Rand and DuBaldo took the group on a short hike to an intertidal area for a lesson about invasive species and data collection that enlisted the services of the Asian shore crabs hiding under nearly every rock. It was the first of four activity stations at different locations at the park, a logistical challenge teachers used to working in traditional walled classrooms have to prepare for.

"You cannot do this alone," DuBaldo said, as teachers sat along a driftwood log awaiting instructions for their next

station. "You need to get other teachers and parents involved at various stations."

Paying attention to the tides is also key to success, Rand said.

"You really want to bring your class here at low tide," she said.

After stopping at an overlook where the rubble of a glacial moraine shares the shoreline with large boulders, the group broke for lunch and prepared for an afternoon in the water. As sunbathers and swimmers enjoyed 76-degree water and 84-degree air temperatures, the teachers donned waders and learned how to drag seine nets. Their haul included small fish called silversides and the bluefish pursuing them, along with ctenophores (also called comb jellies), small shrimp, hermit crabs and several kinds of seaweed. Much of the catch was transferred into buckets and hauled back for closer examination with magnifiers, a microscope and identification guides set up on a makeshift picnic table lab.

"Identifying is good, but concepts are better," DuBaldo told the teachers, suggesting how they should use the live specimens with their students. "Ask the students to think about whether these fish like light or dark. Ask them to think about how they move."
Peg Van Patten, recently retired communications director for Connecticut Sea Grant and author of its 2006 book about seaweed, next gave a lesson about the different kinds, their use in foods and other products, and demonstrated an arts-and-crafts project of pressing seaweed.

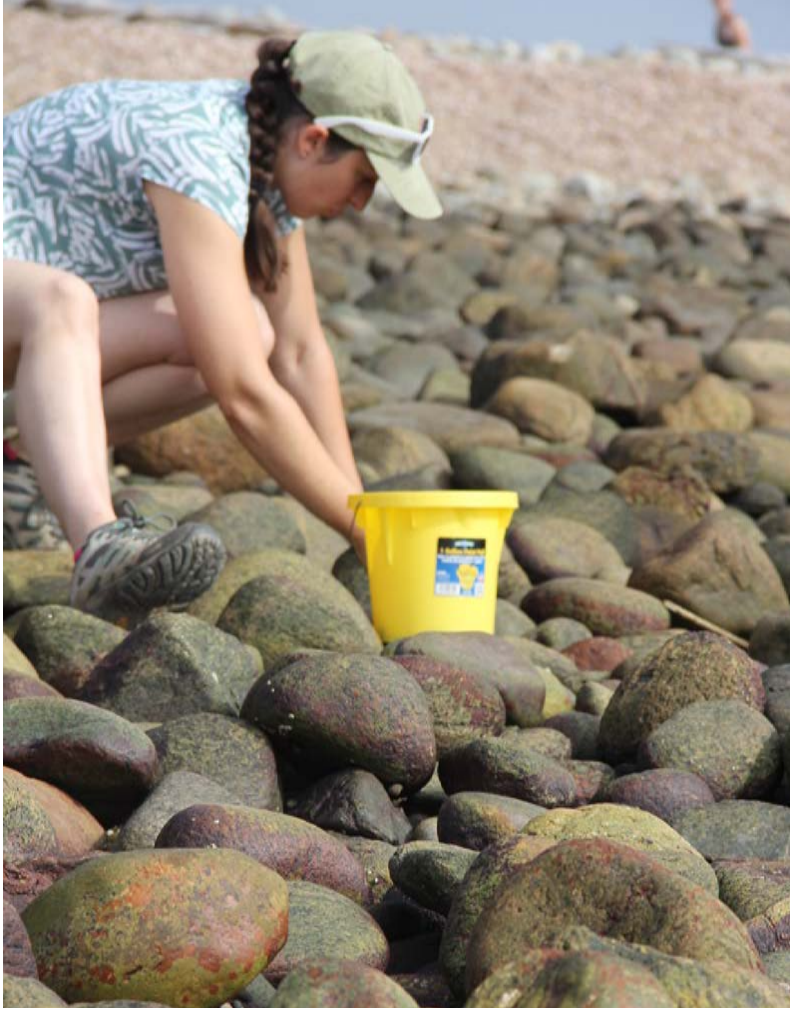
"You can preserve it for the scientific value or for the artistic value," she said, as the teachers arranged Irish moss, sea lettuce and rock weed on sheets of paper.
For the final activity, the teachers headed to the beach for a geology lesson that involved sifting sand, then some time for reflection about using the beach experiences for art, creative writing, music and physical education lessons that would complement the science.

Asian shore crabs, an invasive species, were collected by teachers from a rocky area of the shoreline at Hammonasset Beach State Park. Photo: Judy Benson

"We've taught kids how to use the seine net in gym class, using balls," DuBaldo said.

At the end of the day, teachers were eager to put what they'd learned into action.

"I want to come back with a group,"



One of the participants in the teacher workshop turns over rocks in search of Asian shore crabs. Photo: Judy Benson

said Doreen Abubakar, who works with an environmental education organization in New Haven.

As he filled a canvas bag with Long Island Sound guides, magnifiers, and hydrometer and other materials, Keith Sevigny, coach for STEM / engineering at the Annie Fisher STEM Magnet School in Hartford, showed his excitement.

"I've got a whole bunch of things I'd love to do," he said. "This is what the kids need, to be learning science not from a book, but from real life. Now that I've got the program, I've just got to work on getting a bus."

Connecticut Sea Grant resources for teachers:

The Long Island Sound Curricular Resource Guide can be downloaded at: http://seagrant.uconn.edu/2010/03/02/long-island-sound-curricular-resource-guide/

To request copies of "Seaweeds of Long Island Sound," by Peg Van Patten, visit: http://seagrant.uconn.edu/2009/01/01/seaweeds-of-long-island-sound-new-second-edition/

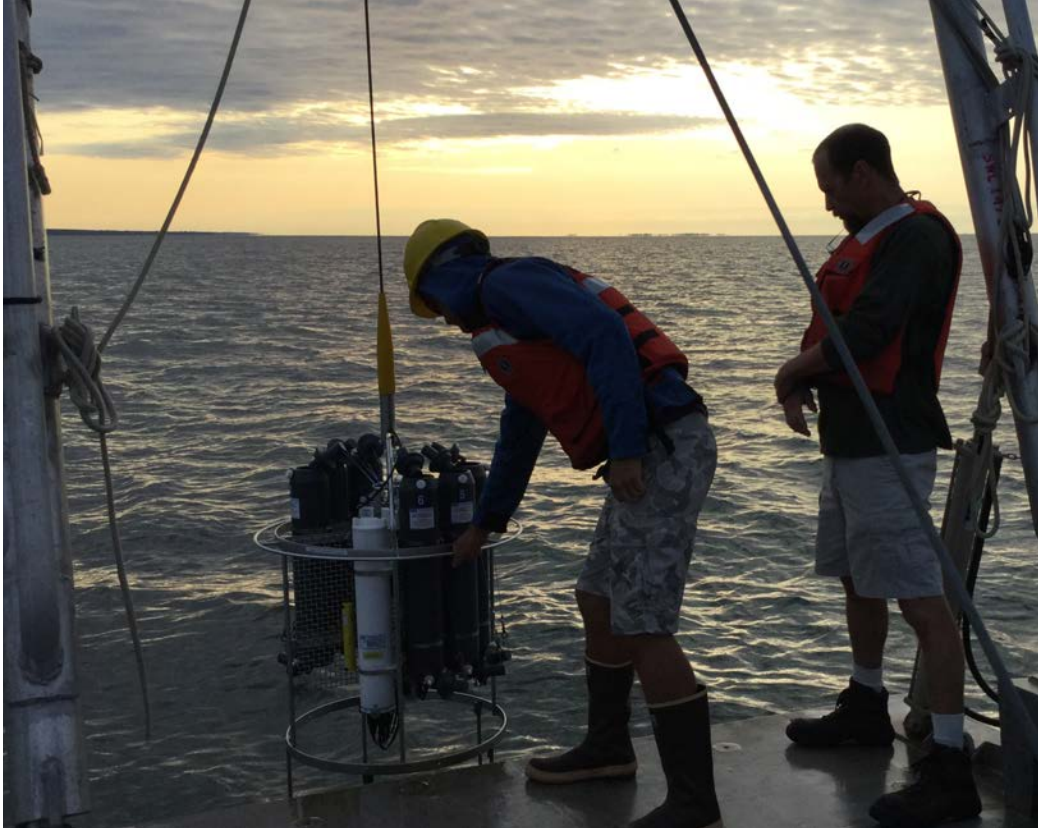
To request copies of "Salt Marsh Plants of Long Island Sound," visit: http://seagrant.uconn.edu/2009/01/01/salt-marsh-plants-of-long-island-sound-2/

To see a complete list of Connecticut Sea Grant educational guides available for purchase or download, visit: http://seagrant.uconn.edu/publications/education/

Chemistry in motion

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

By JUDY BENSON



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

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 finished 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

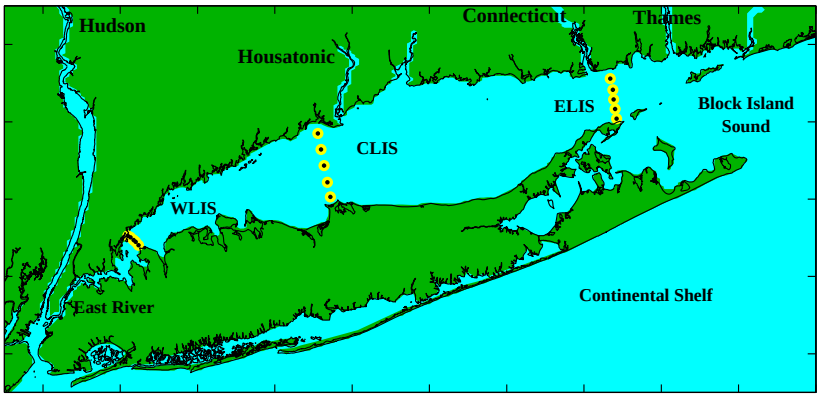


Figure 1 Location map showing LIS study sampling stations. There are 5 stations on each line.

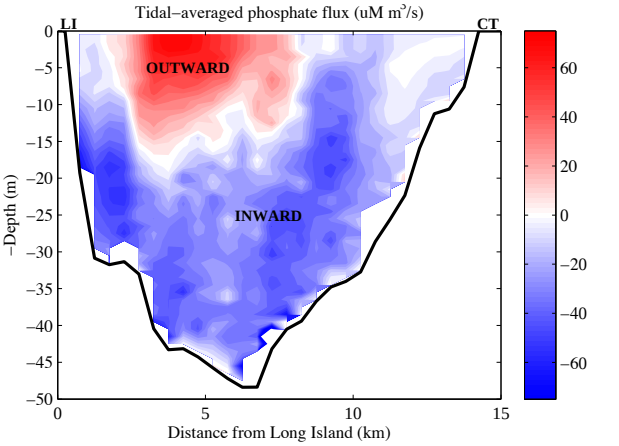


Figure 2 Tidal-averaged phosphate flux through the Eastern LIS section observed in May 2016. Red indicates outward transport towards the east and the blue indicates inward transport towards the west. Results from this cruise showed phosphate was being imported from the Continental Shelf to the land,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

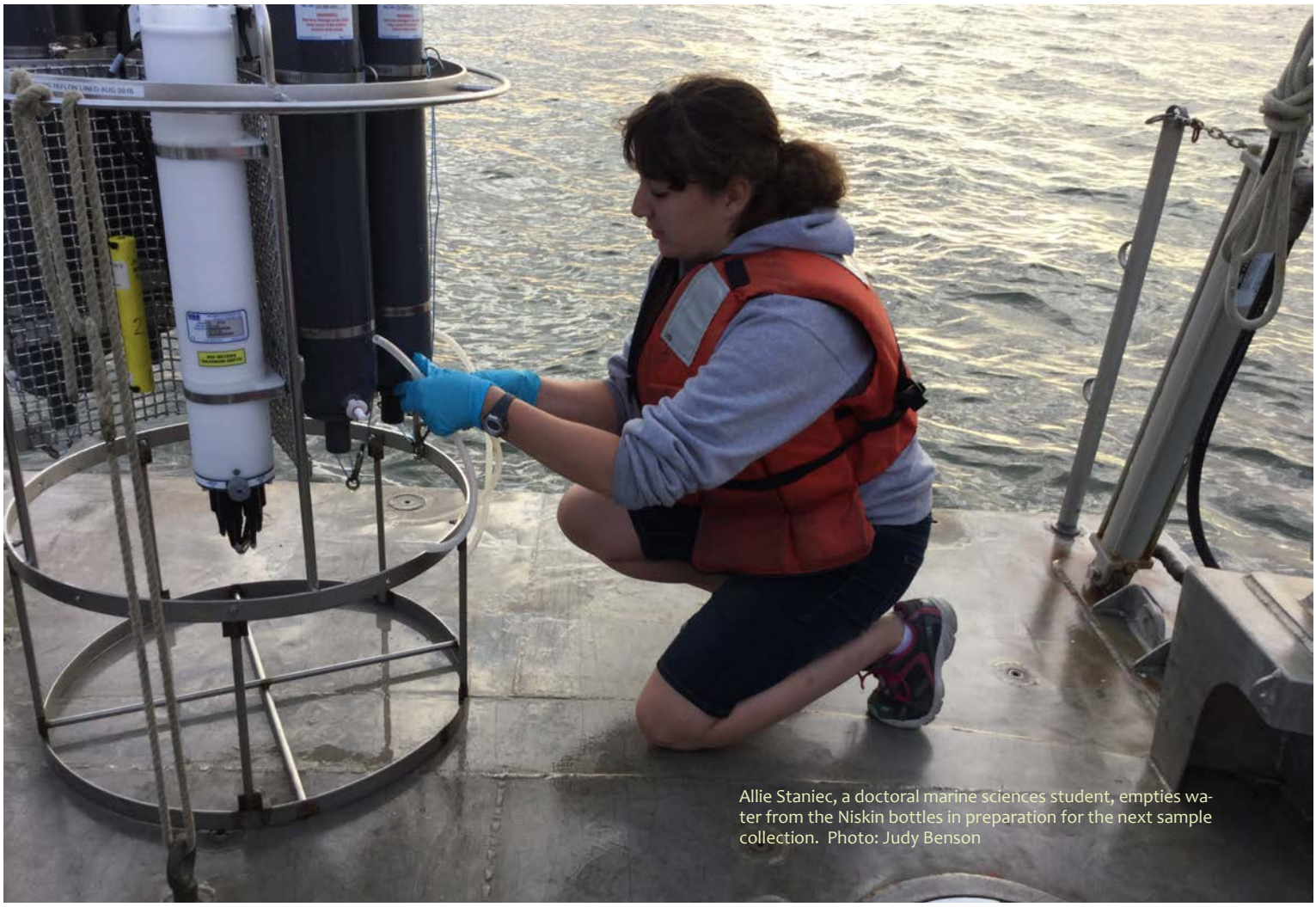
From each round of sampling, levels of carbon and nitrogen particles would be analyzed with a filtration test. Other lab tests would measure dissolved organic carbon and inorganic carbon, two byproducts of natural biological activity, fossil fuel emissions and other industrial processes flowing in from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

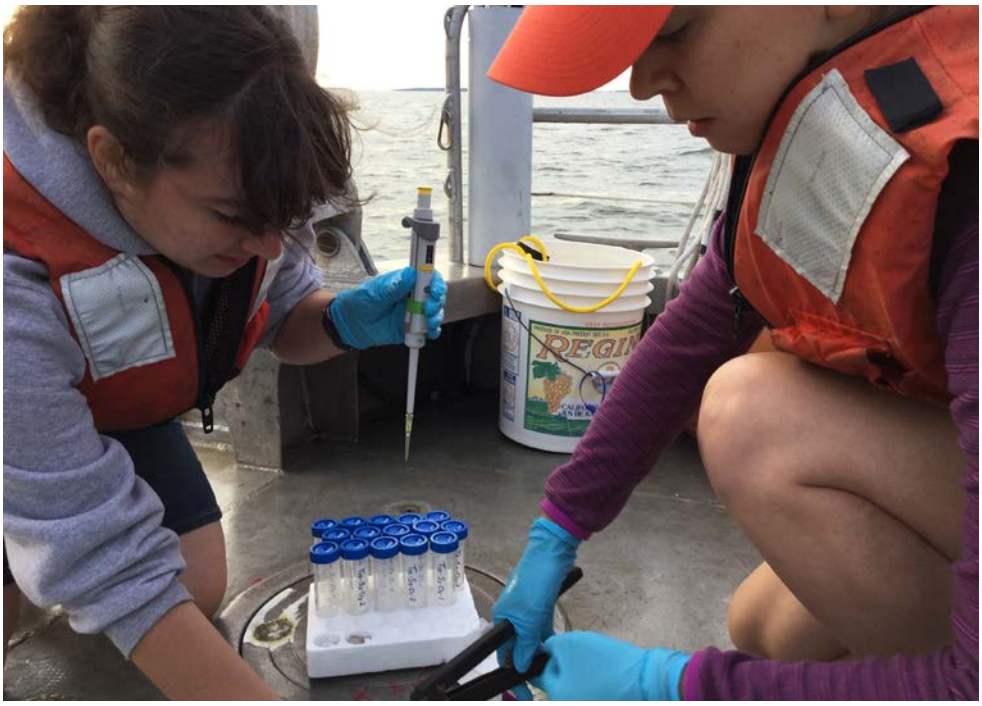
Having a complete picture of how the chemistry of the Sound changes through the tides and seasons is essential, Vlahos and Whitney said, to understand what the tipping points are when parts of the estuary get starved of oxygen and suffocate marine life, as happens periodically in the western and central 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

Van Patten recognized at national Sea Grant conference

By JUDY BENSON

Crowning her 30 years of distinguished service to Connecticut Sea Grant, Margaret "Peg" Van Patten received the first-ever Communications Service Award in October during the 2017 Sea Grant Extension Assembly and Communicator Conference in Astoria, OR.

"Peg is not only a communicator but also a scientist," said Nancy Balcom, associate director of Connecticut Sea Grant, in announcing the award. "She earned her master's degree studying kelp, a native brown seaweed. Her work contributed to the development of culture techniques for kelp, which has become a new aquaculture industry in the Northeast."

When Van Patten's career began, her office was equipped with just a typewriter and a telephone. By the time she retired, she was developing websites and editing video.

"There were always opportunities to learn and grow," she said. "Sea Grant is all about bringing people and science together in a way that solves coastal problems. I loved being part of that – that's why I now call myself a Sea Grant volunteer."

Van Patten served as a one-woman communications program, overseeing media relations, print and electronic publications and was the creator and editor of the award-winning Wrack Lines magazine. She described that part of her job as "a dream come true."

Drawing on a broad scope of talents, Van Patten also taught public relations classes at the University of Connecticut, mentored students in science writing, coordinated the International Beach Cleanup efforts in the state for more than a decade and worked with the National Oceanic and Atmospheric Administration in organizing and training volunteers for the national Phytoplankton Monitoring Network in Connecticut. She also developed a draft crisis management plan for the national Sea Grant Network and still found time to give workshops to various audiences about seaweed identification and uses, which she continues to do in retirement. She is also the author of a 2006 guidebook still in wide use, "*Seaweeds of Long Island Sound*." Her enthusiasm for sharing her seaweed expertise was evident during a lesson she gave to teachers in September at Hammonasset Beach State Park in Madison.

Margaret "Peg" Van Patten tells about Irish moss during a lesson about Long Island Sound seaweed to a group of teachers at Hammonasset Beach State Park. Photo: Judy Benson

"There were many challenges in my work but it has been tremendously rewarding," she said. "I'm tremendously honored to be selected to receive this new award from my peers, who are a group of exceptionally talented professionals."

Engineers get acquainted with aquaculture

Unique equipment needs of shellfish farms present new possibilities for equipment designs

By JUDY BENSON

Oyster farmers and engineers have a lot in common.

That wouldn't be obvious, unless you were part of a tour at the Noank Aquaculture Cooperative this summer.

"We're not fishermen, we're farmers," said Jim Markow, president of the co-op, located where the Mystic River flows into Long Island Sound, as he showed the engineers' group the co-op's tanks, docks, vessels and cold room for sorting and packaging oysters.

Jim Markow, president of the Noank Aquaculture Co-operative, leads a group of agricultural and biological engineers on a tour last summer. Photo: Tessa Getchis

The main difference, he told the group, is that while terrestrial farmers rely on good soil and rainfall for their food crops and animal feed, what aquaculture farmers need most are healthy rivers where shellfish grow. Without the engineering systems that clean sewage and control runoff, shellfishing couldn't happen in urbanized waterways like Long Island Sound. Those are just two examples the engineers heard that day about how their skills are critical to this industry that puts fresh local clams and oysters on menus of fish markets and restaurants throughout Connecticut and beyond.

The engineers came to the co-op during the Northeast Agricultural and Biological Engineering Conference in nearby Groton, a field trip to a local site relevant to their work with equipment and systems for farms, food processing plants, laboratories and other workplaces. After three days of technical presentations during the conference, the visit to the co-op gave the engineers a chance to see a real-world application for their expertise in designs for water quality, sanitation, harvesting, temperature control and other areas they may not have considered.

Aside from their mutual interest in devices for unique uses in businesses that rely on plants and animals, the engineers and shellfishermen also share a connection to Connecticut Sea Grant. Extension Educator Tessa Getchis was among four Sea Grant staff participating in presentations and panel discussions at the conference, and also arranged the trip to the co-op.

"Aquaculture is agriculture, just different plants and animals than farmers typically work with," said Getchis, who works with shellfishermen along the state's coastline who produce its $30 million annual oyster and clam harvest. "We're trying to give our growers information, tools and resources so they can do their jobs better and faster and as cost-efficiently as possible. We rely heavily on engineers for equipment, but we may take them for granted."

Farmers, she said, "are also innovators." Since aquaculture is still a relatively new industry, the technology used to support it is still developing.

"The needs can be very specific to an operation or a geographic location," she said.

Co-op officer Steve Plant, owner of Connecticut Cultured Oysters, showed the engineers a real-life example of what that's come to mean there.

"We had to come up with equipment that can go out and do some heavy lifting in almost no water," said Plant, as he showed the group a 24-foot Carolina Skiff with a custom crane and rake attached. "We're using some innovative designs here."

For conference organizer Glenn Warner, the visit to the co-op was a chance to expand horizons for himself and others who spend their professional lives figuring out ways to solve real-world problems. Warner is professor in the Department of Natural Resources and the Environment at the University of Connecticut and director of the Connecticut Institute of Water Resources.

"We had about 90 students, graduate students and professionals from all over the Northeast and Canada, giving presentations on food engineering, agricultural

continued on next page...

An oyster hatching tank is one of the types of equipment engineers learned about during their tour last summer.
Photo: Tessa Getchis

engineering, biosystems problems," Warner said. "Since we were so close to Long Island Sound, we wanted to take advantage of the chance to learn about aquaculture and some practical applications that may be new to us."

For Getchis, bringing the engineers and the shellfishermen together fit naturally into her supporting role in the state's growing aquaculture industry. For the past 18 years she's been working to build relationships along the coast, help troubleshoot problems and shepherd in new techniques to make shellfishing more profitable and productive. Current projects include tests on a new type of gear for oyster farmers, and a new water quality testing method that could expand areas where oysters and clams could be harvested. She also plays the part of diplomat, bringing state or local agencies together with shellfishermen to resolve conflicts, and helps the commercial harvesters through the regulatory and permitting processes.

"I spend a lot of time talking to people about what their challenges are," she said. "When I started this job, I spent a lot of time on boats with them, learning a lot from them and seeing how hard they work and developing trust relationships."

But, she is quick to point out, she also considers the concerns of regulators and interested residents, seeking to find ways to balance meeting the needs of industry without risking public health or squandering good will over shared use of the public resources of the state's waterways.

"We're doing our best to increase public awareness about Connecticut seafood production and to discuss the importance of marine aquaculture in our state," she said. "I've spent a lot of time talking to farmers, regulators, tour groups and concerned residents."

The best ideas and creative solutions, she believes, rise out of putting "a bunch of passionate people in a room."

For the engineers, experiencing the sights, sounds and smells of the oyster co-op stoked some new enthusiasm for applying their problem-solving and technical design skills in new ways.

"The people at the conference were really excited about the possibilities," Getchis said.

Newly harvested oysters await packaging in the cold room at the co-op. Photo: Tessa Getchis.

A group from the Northeast Agricultural and Biological Engineering Conference tour the room where algae grown for juvenile oysters is cultivated in large tanks. Photo: Tessa Getchis

TESTING PROJECT COULD EXPAND YIELDS OF SEAWEED GROWN IN LONG ISLAND SOUND

By JUDY BENSON

If seaweed farming has a future in Long Island Sound, the groundwork being laid by Anoushka Concepcion and her team at Connecticut Sea Grant will be among the ones to thank.

"We're trying to figure out what the standards should be, in the interests of public health," she said, as she began a summer weekday of multiple stops between seaweed testing sites. "For a new industry, the last thing we need is for someone to get sick."

Four years ago, Concepcion, assistant aquaculture extension educator at Sea Grant, began this task, with funding from NOAA National Sea Grant. Though complicated and seemingly obscure, it's work that's essential to helping a commercial industry for at least two types of native seaweed to grow in the state. It could help unleash its promising potential if the hurdles she and others are working on can be overcome. Now, most of the seaweed consumed in this country comes from overseas. Proponents of this nutritious sea vegetable see an untapped opportunity for a locally grown crop to supplant the imported seaweed most prevalent in Asian cuisine and processed into a thickener for foods and cosmetics. But seaweed researchers and would-be growers can't yet fully take on the challenge of finding and expanding markets and consumer demand for local seaweed.

What's holding them back is the absence of federal guidelines on potential hazards, water quality, storage, optimal processing temperatures and other standards critical to maintaining product safety. That's where Concepcion comes in, doing the field work and data collection needed for state regulators to figure out what the standards should be.

"We need this information so the state can make a recommendation about whether they will allow commercial cultivation, and if so, where," Concepcion said.

Concepcion's job – a little like helping figure out rules so an informal sport can start organized competitions – is to harvest and supply testing samples of seaweed grown in multiple seasons at different areas of the Sound to be both sold fresh or preserved through drying or freezing. Samples collected from seaweed lines set by commercial fishermen are sent cold and raw to two state labs for testing of heavy metals, pesticide residues, harmful bacteria and other pathogens. Samples dried and packaged at a West Haven commercial kitchen that employs developmentally disabled adults also go to the labs.

"We're also working with a food testing lab that will be testing for molds and yeasts and shelf life," she said.

In 2017, a dozen acres of seaweed was being cultivated in the Connecticut waters of the Sound by four producers, all growing one type of seaweed – kelp. These enterprises currently follow state guidelines for public health standards for sales of fresh kelp -- wide brown ribbons that turn translucent green when cooked – as well as crop that's processed, cut into kelp noodles and packaged. The guidelines will ultimately be replaced by regulations for permitting and public health standards.

"We've got kelp pretty much figured out, but we've been at it for seven years," she said, referring to Sea Grant's seaweed technology transfer efforts that predate her current project. Her work is the latest chapter in more than three decades of Sea Grant-funded research and outreach that laid the foundation for commercial seaweed farms in the state and elsewhere in the Northeast, spearheaded by University of Connecticut Ecology and Evolutionary Biology Prof. Charles Yarish, based at UConn's Stamford campus. Now, Concepcion's focus is on *Gracilaria tikvahiae*, a lacey reddish-purple species that provides shelter in the wild for snails, sea urchins and other marine organisms, and is salad for sea turtles and fish. While kelp is grown by seeding it onto lines, then anchoring sets of lines in a grid along the sea floor, Gracilaria doesn't need structure. It can be grown by threading cuttings onto a thick rope which is tied to a mooring and allowed to sway in the surf. For all types of seaweed farming, the start-up investment is relatively modest: a state lease or license for the undersea grounds, a boat with an anchor and a winch, buoys and line. Fast growing and easy to propagate from cuttings, Gracilaria takes about a month for a 2-ounce bundle to double in size, depending on nutrient levels in the waters where it's growing.

"It's native to Long Island Sound," Concepcion said. "It's usually found in high nutrient, shallow waters. You'll find it attached to lobster pots. We just thread seed bundles into the long line."

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Left, Gracilaria is removed from a tank at the Bridgeport aquaculture school. Above, Gracilaria grown on lines is pulled out of Branford harbor. Photos: Judy Benson

Concepcion's day of field work began at the Bridgeport Regional Aquaculture & Technology Education Center, where Gracilaria stock for the project is grown in large bubbling tanks of sea water. What distinguishes these particular plants from what can be found washed up on beaches across the Sound is that these are verified as all being the native species of Gracilaria, not the invasive *Gracilaria vermiculophylla* that is emerging as the dominant type in the estuary.

She and Annalee Mears, a University of Connecticut marine sciences undergraduate interning with Sea Grant, scooped nets full of dripping clumps from the tank, then removed excess water using kitchen salad spinners. They then weighed and tied clusters to the line.

Next stop that day was the Marrakech Inc. commercial kitchen, where bags of Gracilaria were delivered for drying and packaging.

"They'll dehydrate it at about 100 degrees Fahrenheit for about 40 hours," Concepcion said, as she set bagfuls of seaweed inside a large refrigerator at the facility. "They've been playing with getting the best temperature."

After that came the docks of King Lobsters in Branford, where owner D.J. King has been diversifying into oyster farming, scup fishing and now seaweed farming since the Sound's lobster population crashed in the late 1990s. About 5 percent of his income now comes from commercial kelp farming, he said, and Gracilaria could be added in the future.

"I started doing this when we started to not catch anything," said King, as he motored his boat, Concepcion and Mears on board, to the site where two Gracilaria lines had been set a few weeks earlier.

The three first hauled in the lines, untied the seaweed bundles and collected them in buckets. One line had been hauled out a week after being set, dipped in fresh water to discourage other marine life from smothering the seaweed, then reset. The other line had been set without the treatment. Comparisons of the two methods will be used to inform future Gracilaria farmers.

"We submerge the dip line in fresh water for 20 minutes to kill off fouling organisms," Concepcion said.

After the old lines are hauled and emptied, the newly seeded lines are hooked onto buoys and released into the water for the start of another growing cycle.

Back on shore, the harvested seaweed was packaged and iced for transport to the testing labs.

"We have to do this for two seasons," Concepcion said. "Within two years, we'll know whether open water Gracilaria cultivation will be allowed anywhere, or only at specific sites."

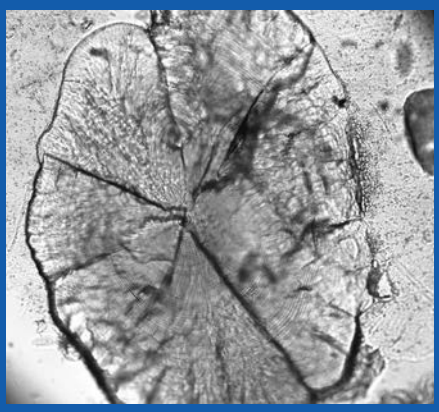
Anoushka Concepcion and Annalee Mears remove Gracilaria grown on lines off Branford and package it for testing at a state laboratory. Photo: Judy Benson

Annalee Mears, a UConn marine sciences student, weighs Gracilaria taken from a tank at the Bridgeport Regional Aquaculture & Technology Education Center before packaging it for drying as part of a testing project. Photo: Judy Benson.

Searching for the menace of mercury

Researchers examine small fish, shellfish for traces of toxic heavy metal

By JUDY BENSON



An image of an otolith, a small bone used to age fish, viewed under a microscope. Photo: Julie Pringle

Just a little bit of mercury can do a lot of damage, especially to the developing brain and spinal cord of a fetus or young child.

Since that's true for humans, those same effects could be magnified in other creatures. Take, for example, clams, oysters and copepods, microscopic cousins of shrimp. These all eat tiny amounts in their everyday diets of single-celled plants called phytoplankton that absorb mercury directly from sea water. For small fish and shellfish, the buildup of this heavy metal in their systems could be having some adverse impacts. Considering that these are the main food for shorebirds, larger fish and sea mammals, that means mercury is being passed up through the marine ecosystem, all the way to the types of fish regularly consumed by people.

Working with that premise, Zofia Baumann and her team of researchers at the University of Connecticut have been trying to understand precisely how and where mercury is entering the marine food chain by focusing on Atlantic silversides. These small finfish live in coves and inlets from Florida to the Magdalen Islands in eastern Canada.

"Silversides are really important forage fish," said Baumann, adding that they're a main food for two species favored by recreational and subsistence fishermen in Long Island Sound – bluefish and striped bass. "This fish is a stepping stone for mercury bioaccumulation to larger predators."

Hardshell clams and oysters are also being studied, along with meat samples from larger fish caught in waters off New Haven. Those were provided by the New Haven Bioregional Group, an advocacy organization concerned about whether subsistence fishermen who rely on their catch as a main source of protein for their families are getting too much mercury in their diets.

"We know that there are a lot of subsistence fishermen in New Haven," said Lynne Bonnett, a member of the group who helped collect the samples. "It's an environmental justice issue."

Baumann, assistant research professor in the UConn Marine Sciences Department, said that while people should be encouraged to eat fish and shellfish for good health, she wanted to learn whether there is also a risk they should know about. Subsistence fishermen and their family members – especially women of child-bearing age and young children – could be unwittingly accumulating mercury in their systems through regular consumption of catch from certain areas.

"What is the potential risk of exposure over time and in different locations?" she asked.

Baumann and Robert Mason, professor in the marine sciences and chemistry departments at UConn, began working to answer that question in 2016. That's when they launched a two-year project funded by Connecticut Sea Grant to quantify levels of mercury found in these species at five embayments, from Mumford Cove in Groton near the eastern end of the Sound to Calf Pasture Beach in Norwalk near the western end. Their research is examining how one specific type of mercury – methylmercury, an organic compound of mercury that is the most common source of mercury poisoning in humans – passes through the food webs of these embayments. A third question they are studying is whether there's an optimal nitrogen level in the water that tempers the magnitude of mercury bioaccumulation in finfish and shellfish, and identify what that level is.

"If you add nitrogen, you stimulate growth over the whole scope of the food web," Baumann said. "But how

much is too much is such a fine line. People are very concerned that there's too much nitrogen in the Sound, for good reason. But I don't believe things are just linear."

In other words, while the excess nitrogen entering the Sound from sewage plant effluent, agricultural runoff, lawn fertilizers and other sources chokes off the Sound's oxygen supply when it gets too high, at a lower but still undefined "sweet spot," nitrogen could be acting as a buffer for mercury bioaccumulation. Identifying that level could inform projects to remove excess nitrogen from the Sound, so that limited funds for sewage plant upgrades and runoff capture are spent wisely.

The researchers started by first looking at maps created for earlier projects showing levels of mercury in sediments in the Sound, the legacy of generations of industry in Connecticut and beyond. The mercury came down rivers in discharges from factories, and from the atmosphere through emissions of coal-fired power plants that fall to earth and travel into waterways. Once airborne, it circulates widely.

"The crazy thing with mercury is that when it's in its gaseous state, it stays in the atmosphere for up to two years, and travels a far distance," Baumann said. "It's a global pollutant but local sources and associated implications are important to examine."

The maps, Baumann said, showed mercury levels higher in the western sound, where discharges from the hat making industry of the late 1800s in Danbury ended up, along with decades of effluent from New York City. But the maps, Baumann said, only showed mercury levels in the sediments of the open waters of the Sound, not in the many coves and inlets where the bottom-of-the-food chain species congregate. These are also the areas where subsistence and recreational fishermen get most of their catch.

"Nobody had tested the embayments," she said. "One of our goals was to fill in that knowledge gap, to find out if the embayments are following the same pattern as the deeper parts of the Sound."

Once the questions had been articulated, the painstaking research process began. That involved enlisting graduate students to wade into the five shallow coves to net dozens of the little fish – most under four inches long – and collect dozens of hardshell clams and oysters.

On a bright day at low tide last August, Gunnar Hansen sloshed through the soft sand in Mumford Cove with Wesley Huffman. Both doctoral students in marine sciences, they had left their labs and laptops for the morning in pursuit of clams. Rakes in hand, they tilled the bottom repeatedly for their harvest.

"Ideally, we're looking for clams that are under two years old, about two inches wide," Hansen said. "The bottom here is pretty soft, which is nice, because when I feel something, it's usually a clam."

After about 15 minutes of raking and turning, Huffman called to Hansen across the cove.

"How many do you have so far?" he asked.

"Like, three," Hansen replied.

"How many do we need?"

"Fifteen," said Hansen.

A few days earlier, Hansen had been in a lab at UConn's Avery Point campus carefully measuring a dry white powder with little resemblance to its original state. It was the meat of clams he had harvested earlier that had been freeze-dried for the mercury tests.

In an adjacent lab, graduate student Julie Pringle and Charles Dyke, a marine sciences undergraduate in his senior year, applied some unique skills to the project. Both are advised by Baumann's husband Hannes, who is an assistant professor of marine sciences at UConn.

Dyke sat at a lab table, holding a clamp with partially dissected silverside in one hand while he used tweezers to extract a tiny speck of bone called an otolith from the head. Roughly the size of a grain of rock salt, otoliths are essential parts of the hearing systems of vertebrates including those of humans. To fisheries biologists, they are valuable storehouses of information about the rates and patterns of growth of individual fish. Once extracted by Dyke, Pringle prepared each otolith onto a slide to view it under a microscope.

"The width of each ring is proportional to the growth of the fish," Pringle explained, showing a striking black-and-white image on her computer screen resembling a cross section of a tree trunk with a vivid pattern of rings. "Each ring represents one day of growth. We're go-

Anglers fish in New Haven harbor, where samples from large fish were taken and tested for methhylmercury, Photo: Lynne Bonnett

continued on next page...

ing to go through and count all those rings to see how old the fish is."

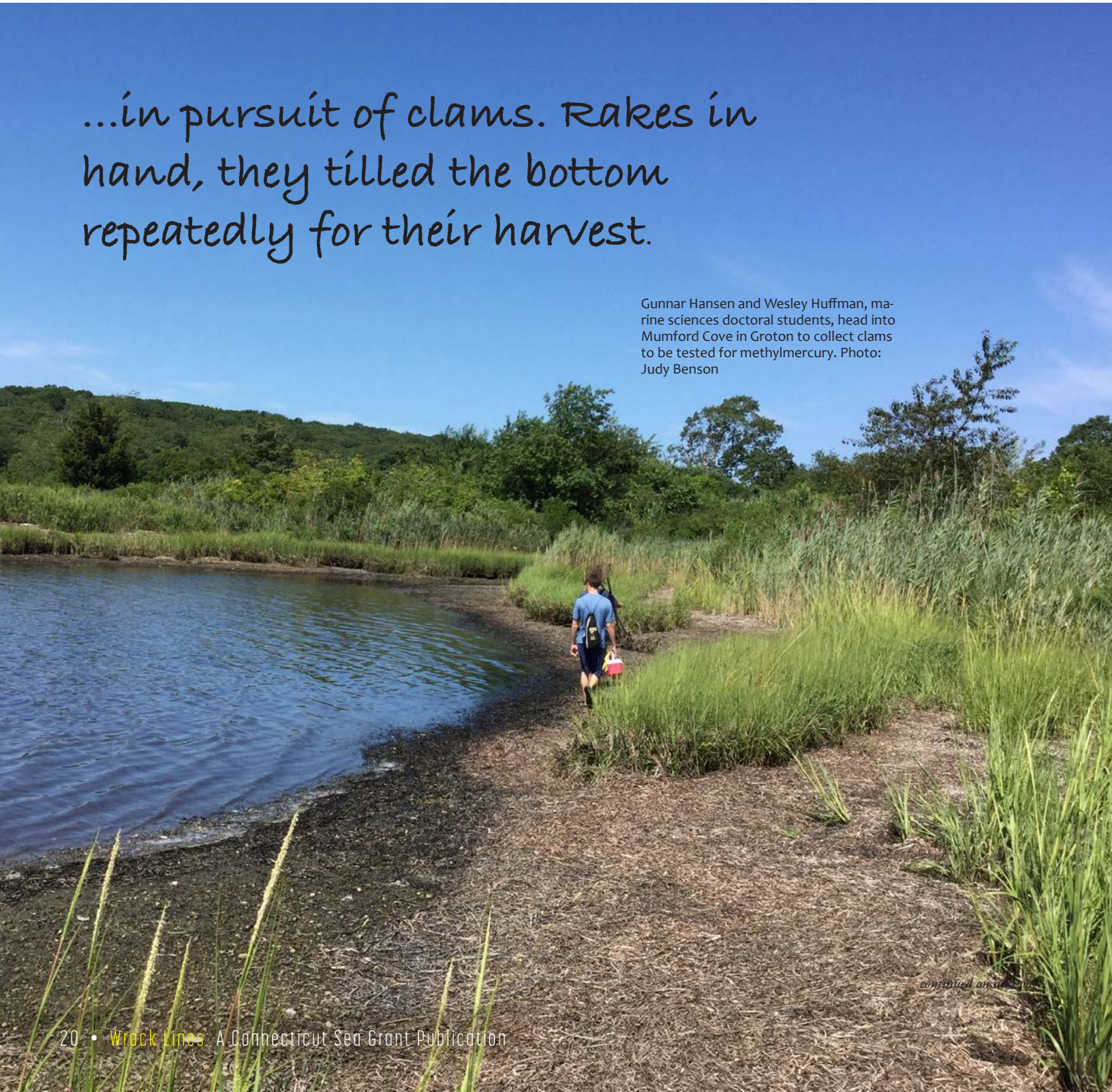
Once the fish is aged, that information is paired with the amount of methylmercury measured in its muscle tissue, Baumann explained. To do that, a complex process is used in which a sample of fish tissue is freeze dried, then ground into a powder. It is then diluted and mixed with chemicals that enable detection of methylmercury with a highly sensitive instrument, the Tekran Model 2700 Automated Methylmercury Analysis System.

"The theory is that faster growing fish have less mercury in them," Baumann said.

In a third section of the lab, Alexandra Swift, a high school senior from Darien interning there for the summer, examined a spreadsheet of data from fish tissue samples on a computer screen as Baumann looked on. Earlier that summer, Swift had learned how to extract the otoliths, providing many of the ones Pringle used for the slides.

As of September, Baumann said, the project was about three-

...in pursuit of clams. Rakes in hand, they tilled the bottom repeatedly for their harvest.



Gunnar Hansen and Wesley Huffman, marine sciences doctoral students, head into Mumford Cove in Groton to collect clams to be tested for methylmercury. Photo: Judy Benson

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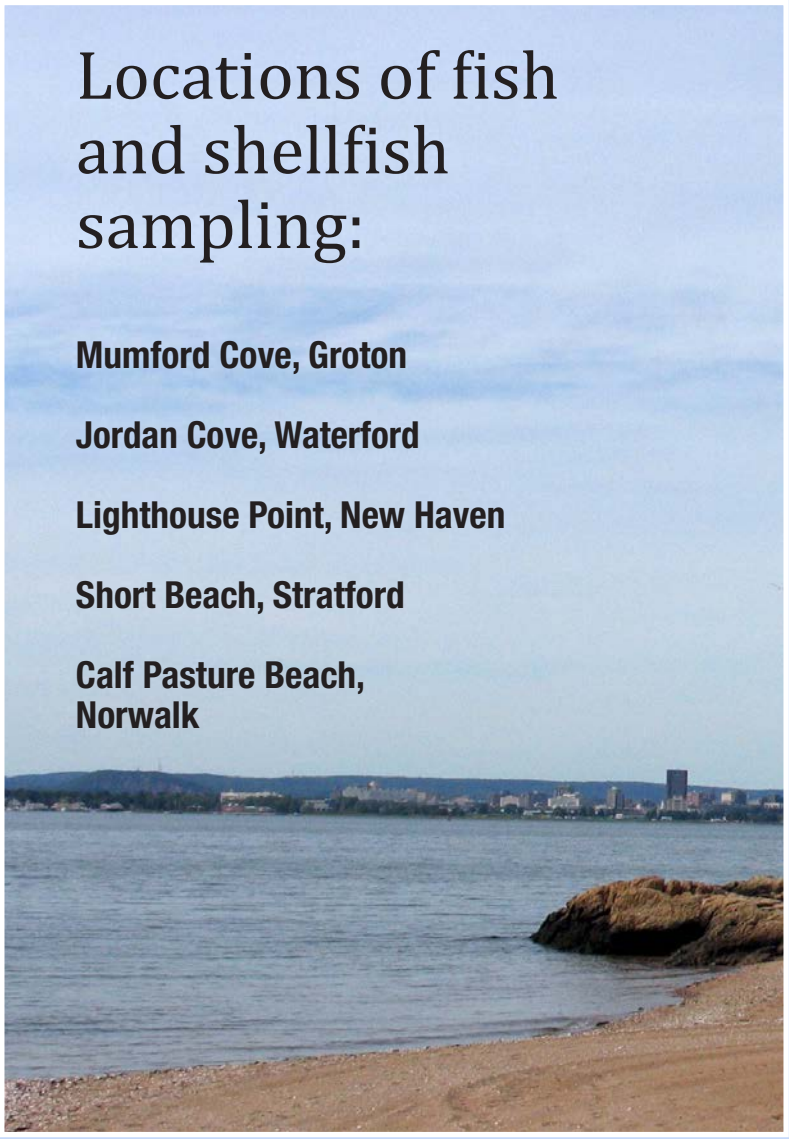
quarters of the way completed, with all the field samples collected and lab analysis well underway. Preliminary results, presented at a conference in Providence in July, show mercury concentrations are highest in fish and shellfish from the western and eastern ends of the Sound, and lowest in samples from the New Haven area, Baumann said.

Ultimately, the research will contribute to the overall picture of how mercury is persisting and moving through the environment, and could also have some practical applications to everyday life. The state Department of Public Health, Baumann noted, issues advisories about fish consumption that include especially strong warnings for pregnant women and children. For Long Island Sound, consumption advisories are mostly based on contaminants other than methylmercury. Very few fish harvested from the Sound are analyzed for this toxin, Baumann said.

"They were only able to test a narrow range of fish," Baumann said. "And they were measuring total mercury, not methylmercury."

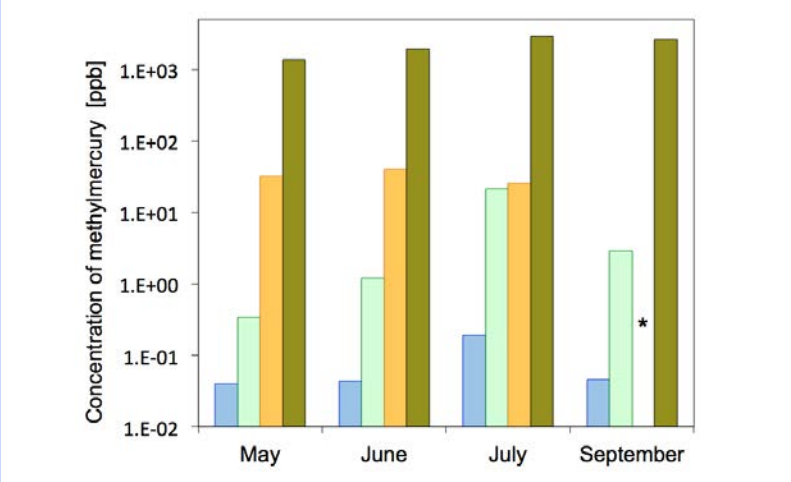
The difference, she said, is that methylmercury levels are more significant in assessing the overall risk of fish consumption. In marine fish, 95 percent of mercury is methylmercury, but the percentage can be lower in fish from estuaries such as the Sound, she noted. Since eating fish should be encouraged as part of a healthy diet, Baumann said, basing the warnings on more precise information would be an important public service. She noted that because detecting methylmercury levels is more difficult and time consuming, fewer methylmercury measurements are available.

"This science is going to inform policies and guidelines for protecting human health," she said.



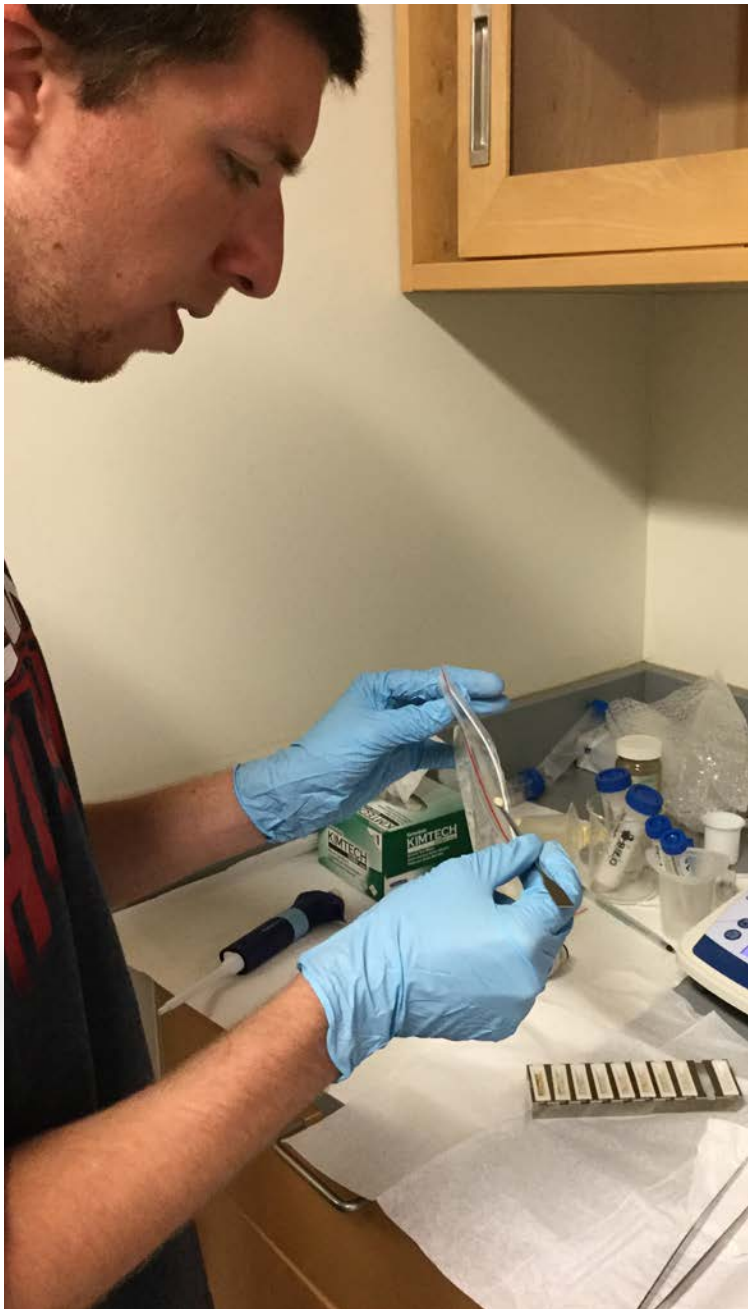
The concentrations of methylmercury in seawater are shown in blue; concentrations in phytoplankton are shown in light green; concentrations in copepods are shown in yellow; and concentrations in Atlantic silversides are shown in dark green. The graph also shows how concentrations change during the spring-summer season. Graphic: Zofia Baumann

A volunteer from the New Haven Bioregional Group scrapes off a sample of tissue from a fish caught in New Haven harbor to be tested for methylmercury at the UConn labs. Photo: Lynne Bonnett



Prof. Zofia Baumann holds one of the Atlantic silversides being tested for methylmercury. Photo: Judy Benson

Numbers of samples:



Gunnar Hansen measures a sample of dehydrated clam that will be analyzed for methylmercury levels. Photo: Judy Benson

Dehydrated clam samples await testing for methylmercury in one of the marine sciences labs at the University of Connecticut's Avery Point campus. Photo: Judy Benson

BIOS

Zofia Baumann has been an assistant research professor of marine sciences at the University of Connecticut since fall of 2014, with a research focus on bioaccumulation of metal contaminants. Originally from Szczecin, Poland, Baumann earned her doctorate in the School of Marine and Atmospheric Sciences at Stony Brook University in Stony Brook, N.Y. Outside of her academic interests, she enjoys taking walks with her kids and husband. She loves traveling.

Anoushka Concepcion has been an assistant extension educator with Connecticut Sea Grant and the University of Connecticut's Cooperative Extension since 2011, specializing in marine aquaculture. In addition to earning her master's degree in aquaculture from the University of Rhode Island, Anoushka has previously been manager of an algae lab at a commercial shrimp hatchery in the Florida Keys. She lives in Rhode Island with her husband and two precocious daughters.

Tessa Getchis is an aquaculture extension specialist with Connecticut Sea Grant and UConn Extension Programs. She works primarily on commercial and recreational shellfisheries, assisting farmers and doing field research, and also hosts public outreach events about Connecticut seafood and aquaculture. She earned a master's degree in aquaculture from the University of Rhode Island. Tessa serves as a member of the town of Stonington Shellfish Commission and as a coach for an elementary school running club in Mystic, where she lives with her husband and two daughters.

Diana Payne has been the education coordinator for Connecticut Sea Grant since 1999, with expertise in ocean literacy and experience as an evaluator on projects for the National Science Foundation, the National Oceanic and Atmospheric Administration and the U.S. Department of Education. She earned her bachelor's and master's degrees in biology and her doctorate in educational psychology from the University of Connecticut. Outside of her professional interests, she enjoys traveling.

Penny Vlahos has been a professor of marine sciences at the University of Connecticut since 2007, with a research focus on environmental chemistry and biogeochemistry. Originally from Toronto, Canada, Vlahos earned her doctorate at the University of Massachusetts in chemical oceanography. As residents of the Long Island Sound shoreline, she and her family are vested in preserving the integrity of this important waterway.

Michael Whitney is an associate professor of marine sciences at the University of Connecticut. His research focus is on coastal processes and river influences in the marine environment. He grew up in Connecticut, earned his bachelor's degree at Yale University and his doctorate at the University of Delaware. Whitney works with collaborators to address water quality issues affecting Long Island Sound and its marine resources.

Meet Connecticut's Knauss Fellows:

The John A. Knauss Marine Policy Fellowship provides a unique educational and professional experience to graduate students who have an interest in ocean, coastal and Great Lakes resources and in the national policy decisions affecting those resources. Named after one of Sea Grant's founders, the national program matches highly qualified graduate students with hosts in the legislative and executive branch of government in the Washington, D.C. area, for a one-year paid fellowship. Connecticut Sea Grant recommended the applications of two Yale University graduates who were ultimately chosen for the fellowship for 2017:

Ariana Spawn, who earned a master's degree in environmental management with a focus in ocean and coastal policy, has been working in the office of Sen. Cory Booker of New Jersey. Before coming to Yale in 2016, she was a research associate with the Environmental Law Institute, working on domestic and ocean management issues in Washington D.C. and in Louisiana on Deepwater Horizon oil spill recovery and restoration.

Julia Luthringer earned a master's degree in environmental management, with a focus on marine conservation management and policy. She has spent her Knauss fellowship year working as a congressional affairs analyst in the National Oceanic and Atmospheric Administration's Office of Oceanic and Atmospheric Research.

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