

Adam Greer (right) and graduate student Grace Mann prepare the towed plankton imaging instrument aboard the R/V Savannah, as Derrick Dozier-Muhammed, principal of Johnson High School, watches.

A new generation of plankton imaging systems

A team of researchers led by University of Georgia Skidaway Institute of Oceanography (SkIO) scientist Adam Greer is using a new generation of modular shadowgraph imaging systems to study plankton, allowing for more versatile and affordable approaches to researching the small, mysterious organisms in a wider range of freshwater and marine environments.

In a new paper, recently published in *Limnology and Oceanography: Methods*, Greer and his team of co-authors, which includes SkIO doctoral student Patrick Duffy and former master's student Kyle Aaron, detailed a benchtop imaging device, a handheld device, and another that can snap photos while being towed behind a vessel. Compared to older, heavier plankton imaging instruments, these new systems offer adaptability in imaging depth of field, sensor configuration, deployment method and location of deployment, allowing scientists to analyze plankton communities everywhere from the open ocean to shallow, intracoastal rivers.

"We're just trying to show people that you should be able to customize the instrument to fit the research question, as opposed to being tied to the instrument," said Greer.

Shadowgraph imaging is an optical technique that is used to reveal irregularities in a clear substance, such as, in this case, water. It involves using special lenses to turn a small, camera-facing light source into parallel beams. These parallel beams are known as collimated light, and they pass through a water sample before being focused into a camera. The

plankton in the water pass through the collimated light, and the camera detects them as shadows.

Benchtop imaging system

The benchtop imaging system is designed to sit on top of a lab bench and film collected plankton as they swim within beakers. It can pick up on the unique swimming motions of specific plankton and be used to create large machine learning training libraries to help identify rare or obscure looking plankton captured in images taken by the handheld and towed imaging systems.

Handheld plankton imaging instrument

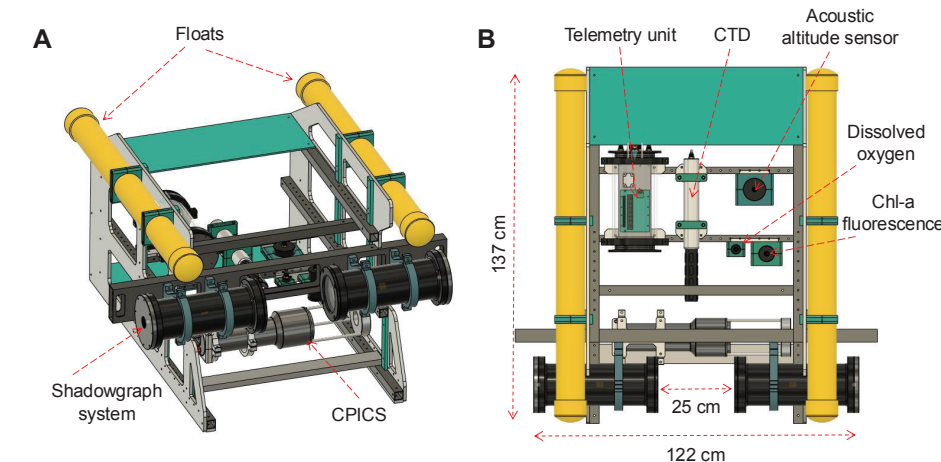
The handheld plankton imaging instrument, which is comparatively small and lightweight, is optimized for controlled experiments and shallow water observations. It is often deployed from a dock or small boat.

It has a pressure sensor that measures how deep it is underwater and takes pictures at different depths as it sinks, creating a stack of images showing the plankton at each level. These images are then displayed live on a computer screen, or they can be recorded internally.

Towed plankton imaging instrument

Weighing roughly 150 pounds, which is about an eighth of the size of traditional models, the towed instrument gets deployed and pulled by a vessel. It then dives down and up through the water column, taking images of various plankton as they pass through the device's camera. Similarly to with the handheld device, the images the instrument takes are displayed live on a computer screen, typically within the vessel's dry lab.

The device is currently configured to reach depths up to 60 meters; however, it can also operate in much more shallower waters. Its camera depth of field is adjustable, allowing researchers to take high-quality, informative images in nutrient dense areas (that are often chock-full of plankton) as well as in the open ocean, where plankton populations are sparser.



A) Example arrangement of a towed, compact vehicle design for sampling shelf seas. B) Vehicle dimensions and arrangement of sensors. All sensors are connected to the telemetry unit via underwater cables (not shown).

Semester at Skidaway

The Semester at Skidaway domestic field study program brings undergraduate ocean science majors to the Georgia coast, where they take courses and build their research skills through a series of field trips and experiential learning activities.

Aboard the 104-foot Research Vessel Savannah, senior undergraduate student Madison Neely sifts through a table full of marine life collected during a trawl in the Wassaw Sound just minutes earlier. She separates the specimens by species, counts them, and takes notes on a clipboard to assess the biodiversity of the body of water.

Neely is one of seven senior undergraduate students who participated in the University of Georgia Skidaway Institute of Oceanography (SkIO) fall 2024 Semester at Skidaway domestic field study program.

The program immerses senior ocean science majors from UGA Franklin College's Department of Marine Sciences in a semester-long, hands-on learning experience on the Georgia coast. It serves as a capstone for students before graduation.

Students engage in field trips to scientifically and culturally significant locations, explore the coastal area aboard SkIO's fleet of small vessels and participate in an overnight research expedition on the R/V Savannah. They also take up to 18 credit hours of in-person courses taught by SkIO faculty, all while living in housing facilities on the SkIO campus, located on Skidaway Island in Savannah, Ga.

"The primary goal of the Semester at Skidaway program is to provide experiential learning for our ocean science majors," said Clark Alexander, director of SkIO. "We offer them hands-on experience in the field using advanced scientific techniques and help them hone their research and presentation skills, giving them a competitive edge in their future careers."

"We learn best by doing," added Clifton Buck, SkIO faculty member and director of the Semester at Skidaway program. "The university and the faculty in our department recognize experiential learning is one of the most effective ways that students can master new skills and build knowledge. This principle was always front and center as we began planning the residential program that became Semester at Skidaway."

Throughout the program, students visit the Port of Savannah, Wormsloe State Historic Site, Wassaw Island, the Tybee Island Marine Science Center, Sapelo Island National Estuarine Research Reserve and the UGA Marine Extension and Georgia Sea Grant Aquarium.

(Continued inside)



Clark Alexander, director of SkIO, speaks to Semester at Skidaway students about the geological development of Wassaw while on a field trip to the uninhabited island.



Madison Neely (green helmet) takes notes on a clipboard while her classmates sift through marine life captured during a trawl in the Wassaw Sound.

Associates of Skidaway Institute

The Associates of Skidaway Institute (ASI) is part of the University of Georgia Foundation, a 501(c)3 tax-exempt organization. ASI provides a broad range of support for the research and education activities on the campus of the University of Georgia (UGA) Skidaway Institute of Oceanography.

The institutions and organizations represented on campus include:

UGA Skidaway Institute of Oceanography
 UGA Marine Extension and Georgia Sea Grant
 NOAA Gray's Reef National Marine Sanctuary
 Georgia Southern University
 Savannah State University
 The Nature Conservancy
 Georgia Institute of Technology
 Georgia Department of Natural Resources

Nonprofit Org.
 U.S. Postage
 PAID
 Athens, GA
 Permit No. 165

Skidaway Campus | NOTES

Associates of Skidaway Institute
 10 Ocean Science Circle
 Savannah, Georgia 31411

In this issue:

Semester at Skidaway
 Plankton Imaging System
 New Advanced Flow Cytometer
 Isotope Ratio Mass Spectrometry
 Georgia Oyster Industry

Semester at Skidaway (continued)

“The memories we have made are going to stick with me long after this semester,” said Neely. “As I approach graduation in December, I can’t stop thinking about what an incredible semester this is to wrap up my time at the University of Georgia.”

The students take six or seven courses, each ranging from one to four credit hours, covering a variety of marine science topics. Through these courses, they learn how to conduct interdisciplinary fieldwork, analyze ocean data, explore the South Atlantic Bight, study global biogeochemical cycles and more.

One course, Oceanographic Field Expedition, taught by SkIO faculty member Jay Brandes, prepares students to plan, execute and document results from a research cruise. The high point of the course, and the entire Semester at Skidaway program, is the aforementioned two-day trip aboard the R/V Savannah, where students collect samples to answer curiosity-driven, individual research questions.

Students develop their research questions and analyze their samples applying techniques learned in the Oceanographic Field and Lab Methods course taught by SkIO faculty member Natalie Cohen. They use their results for their final research presentations.

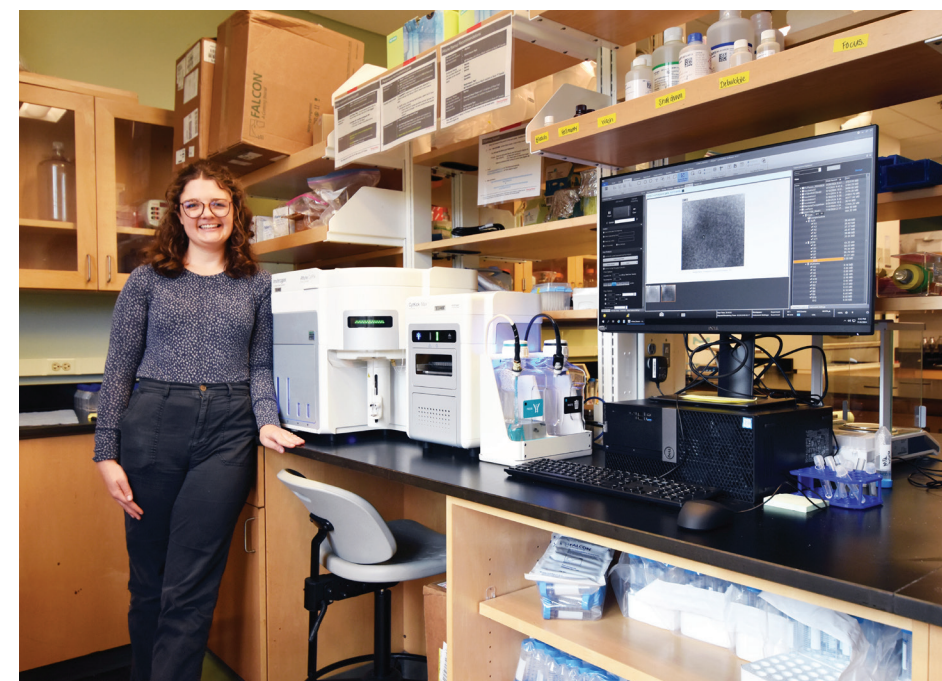
“If you’re curious about marine science as a career, there’s no better way to experience it than here,” said Buck. “At Skidaway, you’ll work side-by-side with experts in the field. Many faculty have projects that will get you out in the field collecting samples, generating data and drawing conclusions. Interested students shouldn’t just take my word for it—talk

Cohen lab installs new, advanced flow cytometer with imaging capabilities

The UGA Skidaway Institute of Oceanography (SkIO) has received and installed a new, advanced flow cytometer with imaging capabilities in the lab of faculty member Natalie Cohen.

The new tool, called the Attune CytPix Flow Cytometer, is unique in that it combines acoustic focusing with a brightfield imaging system, allowing scientists to see clear images of samples, such as microscopic plankton, as they’re passed through the machine, rather than solely receive information about the size, shape and fluorescent features of the samples, as is common in more traditional flow cytometers.

The flow cytometer is capable of capturing and storing images at a rate up to 6,000 images per second. The acoustic focusing feature ensures that images are sharp.



Claire Zwiars Cook, a doctoral student in Natalie Cohen’s lab, stands next to the new Attune CytPix Flow Cytometer.

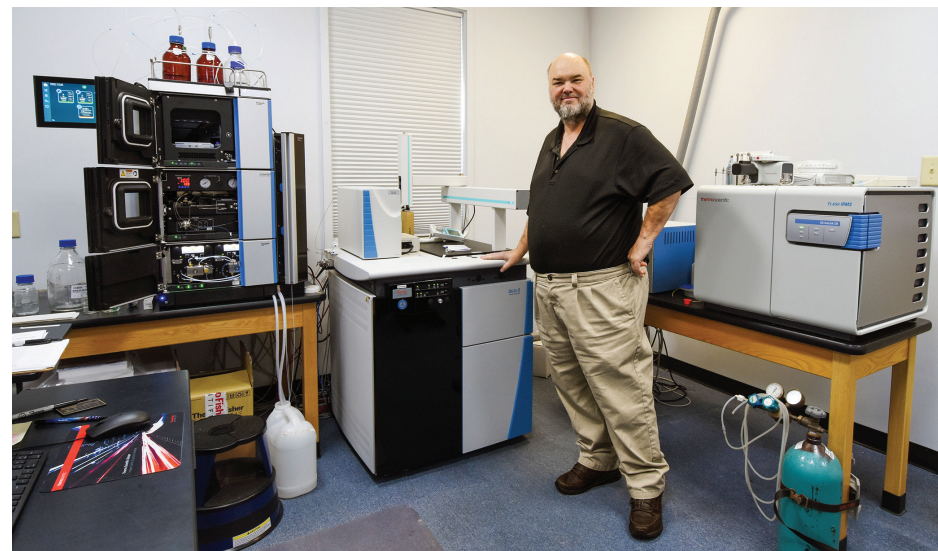


2024 Semester at Skidaway students with their resident advisor Emilee Story (green helmet) aboard the R/V Savannah. From left to right: Kayleigh Everhart, Sam Gebhardt, Brigitte Lueder, Jackson Vassy, Emilee Story, Madison Neely, Chloe Baldwin and Lia Wagner.

to our alumni about their experiences.”

“I feel much more confident, not only in my abilities as a student but also as a scientist,” added Everhart. “The skills I’ve learned, both in the classroom and out of it, will stay with me no matter where my path leads.”

SISIL installs state-of-the-art isotope ratio mass spectrometry system



Jay Brandes stands with the new isotope ratio mass spectrometry system in the Skidaway Island Stable Isotope Laboratory.

The UGA Skidaway Institute of Oceanography’s (SkIO) Skidaway Island Stable Isotope Laboratory (SISIL) has received and installed a new, advanced isotope ratio mass spectrometry system, enabling scientists to analyze stable isotopic composition in both solids and complex mixtures of compounds, such as amino acids or DNA. The system is also ideal for training both undergraduate and graduate students.

The new system has significantly lower sample size requirements than the equipment it is replacing and allows for new measurements of sulfur isotopes at the SISIL facility.

Along with the new mass spectrometer, the modernized setup includes both a new elemental analyzer interface, capable of handling solids, such as hair, soil and pieces of organisms, and a new liquid chromatography interface, used for more complex mixtures of compounds. The liquid chromatography interface is the first of its kind installed in the United States.

The system was funded by a \$404,000 National Science Foundation (NSF) grant.

A growing oyster industry

By Emily Kenworthy (Originally published in *We Are Georgia*)

Georgia’s budding oyster aquaculture industry is beginning to spur community and economic growth.

Oysters begin life as tiny larvae, drifting in the water column until they find a hard surface—often other oysters—on which to settle and grow. As adults, they create underwater reef communities that attract fish, crabs, and other marine life, forming the foundation of a thriving ecosystem.

A similar oyster community is taking shape on land, driven by the rise of sustainable oyster aquaculture in Georgia. University of Georgia researchers, shellfish farmers, restaurants, nonprofits, and state agencies are teaming up to grow Georgia’s coastal economy with oysters at the center.

Hatchery beginnings

If you’ve seen Georgia oysters on a restaurant menu, there’s a good chance they started at UGA Marine Extension and Georgia Sea Grant’s Shellfish Research Lab on Skidaway Island. Home to the state’s only shellfish hatchery, researchers at the lab began producing single oysters in 2015 to advance the aquaculture industry. In 2024, the lab sold 3 million oyster seeds to seven farms across the Southeast, including three in Georgia.

When the state passed a law in 2019 that allowed leases for farming using floating cages, researchers such as shellfish research lab director Tom Bliss were ready to share guidance with new farmers.

“When individuals get into farming, we’ll answer questions they have about gear or site location,” says Bliss. “For those that have a lease, we’ll go out there with them and share tips we’ve learned through our research on gear types and growing techniques and pass that onto them to improve their efficiency and maximize product.”

Seventeen people took the first aquaculture training course from the lab in 2022.

Fresh from the farm

Laura and Perry Solomon, founders of Tybee Oyster Co., are finding success as one of the first floating cage farms on the coast. Both trained engineers have deep ties to Georgia and an appreciation for local food as an expression of community and culture.

“Everyone involved in this industry is passionate, and they have purpose, and they’re collaborative,” says Laura Solomon. “We just hadn’t felt that in a lot of other communities. They felt like our people.”

Since the Solomons got their farm approved in 2022, specialists at the Shellfish Lab have offered technical assistance, helping them avoid pitfalls and address challenges.

“It’s nice to have a collaborative partner who’s been in this before and can help you brainstorm ideas or do the research to help you solve a problem,” says Laura.



Laura Solomon, co-owner of Tybee Oyster Co., grows single oysters on one of the first floating cage oyster farms in Georgia.



Marine Extension and Georgia Sea Grant staff recycle shells collected during their annual oyster roast fundraising event.

Recycling for reefs

As oyster aquaculture continues to grow, ensuring the long-term health of the Georgia coastline remains a priority. Getting discarded shells back to Georgia’s estuaries to create new oyster reefs is critical to this goal.

For nearly two decades, Marine Extension and Georgia Sea Grant worked with the Georgia Department of Natural Resources Coastal Resources Division to recycle shells on the coast.

However, there wasn’t much shell recycling in inland areas like Atlanta and Athens until recently.

In 2020, Hunt Revell co-founded Shell to Shore, an Athens-based nonprofit that collects shells from inland area restaurants and transports them to the coast. In just three years, Shell to Shore has engaged more than two dozen restaurants in oyster shell recycling.

“We’ve moved a decent amount of weight for a small little group,” says Revell. “There’s a couple hundred thousand pounds of shell that would have been in trash cans and landfills, and it’s not.”

Any restaurant that sells oysters can participate in recycling. Businesses are provided plastic barrels for collecting discarded shells. These get emptied regularly by the Shell to Shore team. The shells are then transported to central or coastal recycling stations where they cure for several months before being deployed in coastal waterways.

To better coordinate statewide recycling efforts, Marine Extension, the state’s Coastal Resource Division, and Shell to Shore launched the “We Recycle Shell” coalition in 2023. The group is working with 34 restaurants across Georgia. In its first year, the coalition helped recycle over 87,000 pounds of shells.

Roughly 70,000 pounds of that was used by Shellfish Research Lab researchers to create experimental reefs in Glynn and Chatham counties.

“Oysters provide tremendous environmental benefit, and getting more shell back into the water to support those efforts,” says Bliss.

The coalition intends to create a long-term plan for shell recycling, build recycling infrastructure, and identify future sites for oyster restoration projects.

From tiny oyster seed cultivated at the Shellfish Research Lab to market-size oysters harvested by farmers and recycled shells returned to the estuary, every step of Georgia’s oyster industry contributes to a sustainable cycle. These combined efforts support coastal ecosystems and local economies, fostering a community where oysters support life in and out of the water.