

REPORTER

2020 ANNUAL REPORT | VOLUME 39



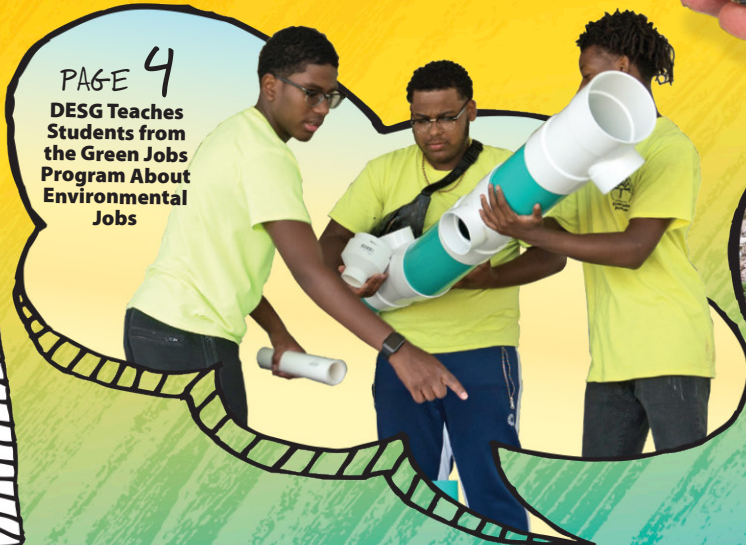
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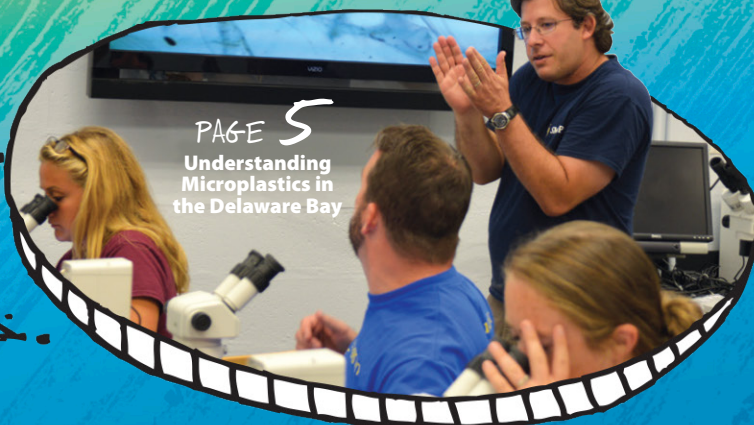
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This spring as it was time for me to write this letter, we were all suddenly faced with an unprecedented challenge in the worldwide coronavirus pandemic. While it has affected everyone in many ways, there were a few impacts that Delaware Sea Grant (DESG) could address, especially an increased need for at-home educational materials and support for our commercial fishers, whose markets rapidly contracted when restaurants were closed. I am sure we will have information on our efforts to support both of those needs and more in next year's annual report, once the full scope of changes to our operations are clear.

For now, looking back over DESG's activities in 2019, a few things stand out for me. We are moving this program forward to support more diverse research and better serve the needs of Delawareans.

DESG invests a great deal of effort and resources in support of academic research into topics that help us improve the environmental and economic health of our coastal communities. Our overall mission is to connect the latest science with real-world needs, but many of the issues we face in everyday life do not fall neatly into scientific disciplines. So in our request for proposals for the 2020–2022 research cycle, we created a new category that would encourage researchers to work with colleagues in different fields. Together with increased outreach and support, the change led to more proposals from a greater diversity of researchers, and the seven projects we funded for the next two years cross three of our focus areas and include three of the new interdisciplinary approaches. You can learn more about the funded projects on our website at www.deseagrants.org/research.

The other highlight of last year was an increased commitment to workforce development that resulted in a few exciting and innovative projects, detailed in this report. Traditionally we have provided support for graduate students in various branches of environmental sciences and engineering, and that is a core aspect of our program we are continuing to support. In 2019 we found new ways to engage students in high school and at Delaware Technical and Community College, providing them with hands-on experiences relevant to possible careers that could help restore our environment while providing a good living.

I am proud of the incredible work done by all of DESG's staff and the researchers and students we support. All of us do our work each day with the people and communities of our state in mind. This annual report shares some of the ways our program has served Delaware over the past year. I hope you find it interesting and informative.



Kathryn Coyne
Director, Delaware Sea Grant College Program



The Delaware Sea Grant Advisory Council—the statewide external advisory body to the Delaware Sea Grant College Program—was created in 1974. Its members hail from marine-oriented businesses and industry, resource management and engineering firms, state government, public interest groups, the educational sector and the media. Working within the national priorities identified by the National Sea Grant College Program, the council helps further define priority coastal issues relevant to Delaware.

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Lance Miller, DTCC student,
environmental engineering
major



Delaware Sea Grant Partners with Delaware Tech to Teach Students About Green Infrastructure

Some of the most pressing coastal issues in Delaware include sea level rise, coastal flooding and increasingly severe and frequent coastal storms. One of the most environmentally conscious ways to mitigate these events comes through green infrastructure projects, which help solve urban and climatic challenges by building with nature.

One challenge with green infrastructure projects in Delaware is the lack of experience in the design and construction of green infrastructure projects in the state.

Because of this, the DESG College Program teamed with Delaware Technical and Community College (DTCC) for a professional development opportunity focused on Coastal Green Infrastructure Design and Construction.

Christian Hauser, associate director for DESG, said that Delaware has federal and state funding available for green infrastructure projects and a number of municipalities and organizations are interested in it, but there's a dearth of qualified people to carry out the actual work.

Delaware Tech has a number of programs focused on engineering, field work, landscape design and surveying and some students will be in the program for two years and then immediately enter the workforce.

"The intent was to educate people that may enter the workforce and join companies and organizations that don't have that green infrastructure experience," said Hauser. "Through this program, those students will have that experience."

Students looked at green infrastructure projects throughout coastal watersheds, including estuarine sites and freshwater ecosystems, and learned about living shoreline design and

construction, oyster reefs for improved water quality, rain gardens, riparian buffers and native plants.

Field-based internship experiences allowed students to learn about specific green infrastructure projects and contribute to work on a variety of projects.

Students visited a living shoreline at Rutgers University and visited North Creek Nursery and Green Lights Native Plant Nursery in Landenberg, Pennsylvania. Two students helped with the construction of a subtidal oyster reef with the Delaware Center for the Inland Bays to improve water quality in Rehoboth Bay.

Students had a resume and cover letter review, as well as a mock job interview to test their technical knowledge and help with the soft skills necessary to gain meaningful jobs.

Lance Miller, an environmental engineering major at Delaware Tech, said he liked how the internship aligned with what he learned in class.

"One day during the internship, we did storm water management and that week in class, we also learned about storm water management. I got to see theoretically how a rain garden works, but also see how it works in the actual field," said Miller.

Some of the students who participated in the class were from international backgrounds.

Richard Yancy, a civil engineering student at Delaware Tech, hopes to take the knowledge he learned and apply it back home in Liberia.

"I'm trying to one day go back home and make my environment better by building coastal reefs to help control erosion and help with invasive species to build a better environment," said Yancy.

DESG Teaches Students From the Wilmington Green Jobs Program About Environmental Jobs

The DESG College Program hosted students from the Wilmington Green Jobs program in Lewes and Wilmington to teach them about green energy and community gardening.

The Green Jobs Program is coordinated by Martha Narvaez, a policy scientist in the University of Delaware's Water Resources Center, and led by the City of Wilmington's Department of Parks and Recreation. In 2019, fourteen high school students from Wilmington worked with UD faculty and staff, participating in hands-on outdoor environmental work, learning about environmental issues and exploring career opportunities for six weeks over the summer.

The students worked 25 hours a week, earning minimum wage while accomplishing projects or learning about the work being performed by the nonprofits that hosted the students.

At UD's Hugh R. Sharp Campus in Lewes, the students learned about green energy and toured UD's 2-megawatt wind turbine, as well as Delaware's burgeoning oyster aquaculture industry.

The experience was led by David Christopher, DESG's marine education specialist, and Christopher Petrone, director of DESG's Marine Advisory Service (MAS).

Darion Gray, the lead counselor for the Wilmington Green Jobs program and the executive director of the Wilmington Youth Leadership Commission, said it was great to have the students travel outside of Wilmington and interact with DESG.

"We won't get to see a wind turbine in Wilmington and so my hat's off to Sea Grant for letting the students experience the importance of clean energy," said Gray.

The students helped DESG build equipment for the start of a new aquaculture demonstration project the program plans to implement. Students learned about the gear necessary to launch an oyster farm and saw the challenges facing oyster farmers in Delaware. The gear was provided by Mark Casey of Delaware Cultured Seafood.



DESG aquaculture specialist Dennis McIntosh (*at right in photo above*), a faculty member at Delaware State University (DSU), helped students assemble oyster bags while explaining their value.

Christopher and Ed Hale, DESG's fisheries, seafood and aquaculture specialist, led the students in building a floating upweller system (or FLUPSY), which is used to grow out oyster seed while protecting the spat from predation.

Students also worked with Jamē McCray, a human-environment interaction specialist with DESG, earlier in the summer at the Southbridge Community Garden where they helped weed and learned about the impact of community gardens. They discussed how climate change impacts urban areas, which resonated as Wilmington had recently experienced a flash flood.

The experience showed students the importance of giving back to their community and living off the land while being educated about healthy eating, being exposed to new foods and learning about pollinators.



McCray talked about the importance of urban gardens and explained the path that led to her DESG career.

"Our talk gave the students a window into different career pathways, especially as a black woman with a Ph.D. in the sciences," McCray said. "If you know that something is an option, you might take it, and doing environmental work doesn't have to be a hobby. It is a viable career if you want it."



Jamē McCray, DESG's human-environment interaction specialist





◀ Toys and gear left by the coast over time can make their way into our waterways.



◀ Microplastics collected and viewed under a microscope

Understanding Microplastics in the Delaware Bay

In recent years, scientists have realized that in addition to large garbage patches in the ocean, much smaller pieces of plastic—known as microplastics—also pose a serious problem for the world’s waterways. These microplastics, materials found in the marine environment that occur in sizes below five millimeters, are broadly distributed as the most abundant form of marine debris observed at the ocean surface.

To help study microplastics in the Delaware Bay, DESG awarded funds in 2016 to UD associate professor Jonathan Cohen.

Cohen and Julie Steinberg, then a master’s student, used those initial funds to look at the distribution and concentration of microplastics in the Delaware Bay, collecting water samples at five stations and finding that microplastics were indeed present in the environment.

Steinberg helped analyze those samples and she, Cohen and UD undergraduate Haley Glos worked out methodologies to isolate the plastics from the rest of the samples to develop a standard protocol for sampling and identification of microplastics in water.

After that initial study, Cohen brought Anna Internicola, currently a Sea Grant-funded graduate student in Cohen’s lab, onboard to help continue the study. *(See story on the next page to learn about a smaller, related project Internicola undertook this past year as a joint Sea Grant–Delaware National Estuarine Research Reserve Fellow.)*

With the initial observations confirming that microplastics are a concern in Delaware Bay, the researchers wanted to dig deeper into how much can be found where and when, as well as what drives the microplastics distribution.

Tobias Kukulka, associate professor in UD’s College of Earth, Ocean and Environment (CEOE), is the principal investigator on a closely related study to determine the distributions of microplastic marine debris, both by location and by time of year. The study is also examining physical controls and biological effects of the emerging pollution issue.

Together with Cohen and UD graduate student Alan Mason, Kukulka used physical oceanography and numerical modeling to determine that microplastics accumulate in the Delaware Bay in hot spots driven by buoyancy, winds and tides, all of which lead to high variability of microplastic distributions (across space and time) in the bay.

Specifically, these hot spots form at what are known as salinity fronts, areas where the fresh water from the Delaware River meets the salt water of the Atlantic Ocean.

Now, the researchers have received funds from DESG for 2020–2022 to try to understand the sources and the fate of microplastics, particularly as they are connected to land use.

Cohen and Kukulka will work with Helga Huntley, an associate research professor in CEOE who is a physical oceanographer with expertise in ocean transport analysis,

and Tracy DeLiberty, associate professor in CEOE and Graduate Geographic Information System (GIS) Certificate Director, to continue and expand the microplastics work.

GIS will be used to understand the production of plastic and of mismanaged plastic waste along the Delaware Bay. They will use that information to pinpoint watersheds and sub-watersheds where they expect to find inputs of material in hopes of tying together the microplastic pathways from production to the biological impact.

“In these two years, we might not be able to solve the entire problem, but that’s the large picture and we’re going to try and start painting it,” said Huntley.

Ultimately, Cohen will look at how the microplastics are impacting creatures in and around the Delaware Bay. With information about the origins, transport and impact on biology, they can begin making specific management recommendations for particular regions and particular plastic groups.

“The ultimate goal is to make the link back to the biota,” said Cohen. “That’s the original question. Not just are plastics in the bay, but are they having a biological impact?”

That’s something that the state and other stakeholders are concerned about.”



Did you know?

The Weakfish is the official state fish of Delaware, known for its historic abundance and economic value.



Weakfish
(*Cynoscion regalis*)



Duane Raver, Jr.

Investigating Microplastics in Delaware Rivers

UD master's student Anna Internicola (right) has spent the last year studying microplastics in the Murderkill and St. Jones rivers, two major tributaries that feed into the Delaware Bay, as the 2019–2020 DESG—Delaware National Estuarine Research Reserve Fellow.



The research is part of a larger project overseen by Jonathan Cohen, associate professor in UD's CEOE, that aims to create a risk assessment to see which areas and which organisms in the bay are most at risk for exposure to microplastics.

Internicola's fellowship project was informed by preliminary research she and Cohen had done looking at the distribution of microplastics within the bay, where they noticed high concentrations located near the mouth of the Murderkill and the St. Jones rivers.

In addition to determining if the rivers were possible sources of microplastics, their research also showed that there were more microplastics in the bay in April than in June, which coincided with a big river discharge event.

"We wanted to see if more plastic was also going to be found in these rivers during large river discharge events," said Internicola.

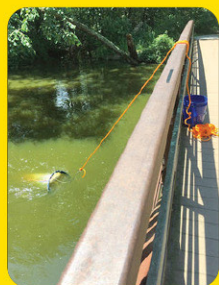
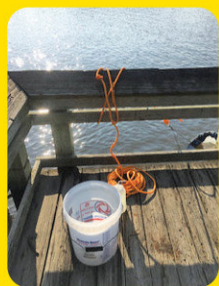
In order to do that, they worked with the Delaware Environmental Observing System (DEOS) to receive email alerts when a large river discharge event occurred in these rivers. Within 24 hours of receiving those messages, Internicola collected samples from three different sites along the St. Jones by holding a net in the river for 15 minutes, then bottling what she captured, preserving it in formaldehyde and bringing it back to the UD lab in Lewes for analysis.

In addition to Internicola, two others in Cohen's lab helped with the project: Hayden Boettcher, another master's student who sampled the Murderkill, and Ian Johnson, who worked at UD during a Research Experience for Undergraduates (REU) program over the summer of 2019.

"We recently finished up sorting through our samples and counting the microplastics, so we haven't done any statistical analysis yet, but just a quick glance at our data, what we found in the rivers is very similar to what we've been seeing in the bay," said Internicola.

While the data she collected will contribute to the scientific understanding of microplastics in the Delaware Estuary, Internicola's favorite part of the fellowship was getting to interact with people in the community when she would go out to conduct her research.

"Every site that I went to, there was always somebody fishing or walking, and people would come up to me and ask me what I was doing. I would tell them about my research, and it was a really great and organic way to talk about microplastics," said Internicola. "A lot of people asked me, 'Well, is it ok for me to eat the fish? How are these microplastics affecting me?' I got to hear what people thought was most important to them about the issue."



▲ A few sites where Anna Internicola collected water samples.





Reasons why crab pots become derelict

Boats run over crab pot lines, severing the pots from their marker buoys.

Pots can also be lost during storms and improper rigging or degraded lines can increase line breakage rates.

People simply don't come back to their pots after they have been set.

Finding Lost Crab Pots

In February 2019, DESG's Kate Fleming and UD's Art Trembanis conducted exploratory surveys in Rehoboth Bay with a side-scan sonar looking for crab pots that had been lost or abandoned beneath the surface of the water, known as derelict crab pots.

They found 160, with more than half residing in Bay Cove near Dewey Beach, which showed that derelict crab pots posed a problem for the Delaware Inland Bays.

Fleming and Trembanis led a more intense study and cleanup of the area in January 2020 with representatives from UD, DESG and the Delaware Department of Natural Resources and Environmental Control (DNREC) locating and removing 114 derelict crab pots from Bay Cove and Love Creek.

The effort was funded and coordinated by DNREC through an active community-based removal grant with the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program.

"We were able to not only get pots up but learn something about their potential impacts too," said Fleming, a coastal ecology specialist for DESG.

Lost pots can cause damage to boat propellers, and they have the potential to "ghost fish," trapping sea creatures that die and rebaiting the pots.

Delaware's Inland Bays permit only recreational crabbing—with the exception of one spot in Little Assawoman Bay—and the crab pot season runs from March 1 to November 30.

In December 2019, Trembanis and members of the Coastal Sediments Hydrodynamics and Engineering Lab (CSHEL) returned to the areas

and used side-scan sonar to identify 322 derelict crab pots in Bay Cove and 169 pots in Love Creek.

"The numbers were frightening when we went out almost a year ago, and it became more so when we did the fuller surveys in December," said Trembanis.

Hunter Tipton, a UD master's degree student and a member of the CSHEL Lab, uploaded the pot locations—or waypoints—onto the side-scan sonars of the boats participating in the January cleanup. Over the course of three days—two days in Bay Cove and one in Love Creek—the crews used those points to locate the crab pots in the bay.

The shallow bay allowed crew members to throw grappling hooks or use boat hooks to manually haul the pots—which were heavy and sometimes filled with sediment—onto their boats where they were cleaned. Participants recorded the pots' weight, the pot type, pot material, whether the pot had a bycatch reduction device attached or not and the condition of the pot, among other information.

To learn about the potential species that can be captured and killed, they also documented pots that were ghost fishing and what deceased animals they found inside, including blue crabs, remnants of diamondback terrapins and dead oyster toadfish.

Some pots were in good enough condition to be reused in future outreach and education programming. The researchers are hoping to leverage the information they've collected to develop outreach and education materials about how the public can minimize pot loss and the environmental impacts of lost pots.

Because the Delaware Inland Bays largely only allow for recreational fishing, recreational boaters and crabbers are the targeted audiences for outreach and education, and there may be opportunities to leverage support from these groups.



Healthy Coastal Ecosystems (HCE) are at the heart of not only DESG's work, but also our lives and economies throughout the state.

Bacteria Bullets

Communities around the world increasingly are grappling with the dangerous effects of microscopic algae that suddenly grow out of control in salty bays or freshwater lakes. This dramatic growth may be triggered by storms, a glut of nutrients, rising temperatures and potentially other factors. Called harmful algal blooms (HABs), these massive events can produce toxins that sicken people, marine mammals, fish and birds, sometimes even resulting in death. Local economies dependent on tourism, clean beaches and healthy fisheries also suffer losses.

Dinoflagellates are among the most toxic HAB species. While many dinoflagellates are nontoxic and a source of food for other marine organisms, a few species are notorious for "blooming," or reproducing in such great numbers that they color coastal waters brownish red, hence the name "red tide."

During a bloom, these dinoflagellates can also release poisons, including neurotoxins that get boosted into the air by breaking waves, causing respiratory distress in people and wildlife nearby. Other dinoflagellate toxins accumulate in fish and shellfish, sickening people and animals who eat them.

But now these harmful algae may finally have met their match. In 2019, DESG director Kathryn Coyne received a patent on an application to keep these toxic organisms in check without harming other sea life.



"It feels great to be an inventor and to have developed an application that will really do some good to mitigate or prevent these harmful algal blooms," Coyne said.

Target Toxic Algae

She developed the product on a Sea Grant-funded research project with doctoral student Yanfei Wang.

"We have been working with a microbe that produces chemical compounds, or algicides, that kill dinoflagellates," said Coyne, who is also an associate professor of marine biosciences in UD's CEOE.

In related research funded by NOAA, Coyne and fellow UD marine scientists found that the algicide produced by this microbe did not have a negative effect on fish, shellfish, or other types of algae.

For the DESG project, Coyne and Wang embedded this microbe within porous, gel-like alginate beads to act as a "mini bioreactor." The microbe continued to produce the algicide when held within the beads, suggesting that they could be deployed in mesh bags to prevent or mitigate dinoflagellate blooms in the environment.

Coyne said, "By having the microbe retained in these beads, they're still dispersing algicidal compounds that target dinoflagellates and could be strategically placed where needed."

DELAWARE SEA GRANT





Trips are designed for beginners and experienced paddlers using kayaks, canoes and paddleboards. It was funded by UD's SCCI and designed by some of lower Delaware's most experienced paddlers, tourism professionals and outdoor guides.

6.9% 
annual rate of tourism growth
due to water-based activities

DESG Helps with Coastal Delaware Paddling Map to Support Tourism

Years ago, when DESG's Ed Lewandowski worked at the Center for the Inland Bays, his morning commute took him past surf shops in Dewey Beach. He remembers one morning seeing brightly colored kayaks set up outside of a store and he thought to himself, "Nobody kayaks. Nobody's going to use those."

Now, after working to create a free Coastal Delaware Paddling Map and companion website detailing the best paddles along Delaware's coastal resort area, Lewandowski laughs while recalling just how wrong he turned out to be.

"That was the beginning of the interest in the industry, and it just blew up," said Lewandowski, coordinator of the University of Delaware's Sustainable Coastal Communities Initiative (SCCI).

Delaware's coastal resorts host around 20,000 paddlers every year with an annual growth rate of 6.9%, according to a 2015 study of the sports and leisure market potential conducted by ESRI, an international supplier of geographic information systems (GIS) software.



The map is designed to serve local paddlers and to promote paddling activities to the millions of visitors who flock every summer to the southern Delaware coast, generating additional local economic and tourism growth.

The map includes 16 unique trips that range from 1 to 10 miles—from Milton down to Fenwick—and offers excursions through marshes, woodlands, bays and the ocean. The map includes seven designated paddling zones:

- Prime Hook Zone (*trip map at right*)
- Broadkill River Zone
- Cape Henlopen Zone (*trip map above*)
- Lewes–Rehoboth Canal Zone
- Rehoboth Bay Zone
- Indian River Zone
- Little Assawoman Bay and Canal Zone

Other partners in the effort included NOAA, the Delaware State Parks (DNREC), Southern Delaware Tourism, Quest Kayak and Conservation Community Consulting.

Lewandowski said the idea for the map came up at a meeting of the Lewes–Rehoboth Canal Improvement Association, where he serves on the board. Originally, he proposed to make a paddling map and website just for that area, but Scott Thomas, director of Southern Delaware Tourism, suggested expanding the idea to other parts of coastal Delaware.

In early March 2019, Matt Carter of Quest Kayak took Lewandowski and others on the project to look at several locations throughout coastal Delaware, starting along the Broadkill River.

The group took notes on access points, launch facilities, bathroom facilities and parking fees. From there, a local contractor, Conservation Community Consulting, put it all on a map.

PaddleCoastalDelaware.com will regularly update details on the map, such as launches, paddling safety, routes, providers and partners. In combination, the paper map and companion website will provide coastal residents and visitors with useful information for nature-based recreation and promote additional business for local outfitters, guides and others who serve tourists.

Prime Hook Zone—Prime Hook NWR Visitor Center to Foord's Landing, Length: 3.1 miles





DESG coastal hazards specialist Danielle Swallow (at the podium) presents to local citizens at workshop.

Emergency Preparedness Workshops Key DESG Offering

Delaware Sea Grant teamed with UD's Institute for Public Administration for an emergency preparedness workshop in September 2019 geared towards adults over the age of 55, their families and caretakers to help older adults prepare for emergencies by addressing their unique needs and concerns.

Participants received training on evacuation routes and shelters, emergency supply kits, and managing health and mobility issues and were given the opportunity to fill out an emergency health communications card. They could also engage with emergency responders, healthcare providers, agencies and businesses who exhibited information on the services available to older adults before, during, or after emergency events.

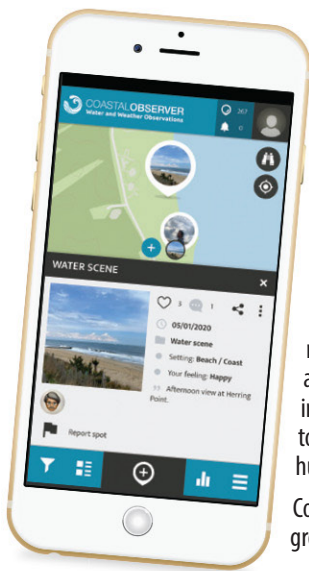
Emergency preparedness trainings, especially for vulnerable populations, have become a regular offering of coastal hazards specialist Danielle Swallow as she works to help Delaware communities build their resilience.

Resilient Communities and Economies (RCE) is an essential focus area for DESG for many reasons. Our state has the lowest mean elevation in the country, so intensifying coastal storms and sea level rise are important hazards we must address. And many of the economic drivers of our communities have shifted over the years, whether away from agriculture or manufacturing or responding to changing natural resources. DESG helps our towns and communities look to the future and prepare for the lives they want to have.

CTSG Internship Partnership

Sam Koeck, a University of Delaware student double-majoring in materials engineering and marine science, spent last summer working on a coastal restoration project in his home state of Connecticut in a unique partnership between the Sea Grant programs of both states. Koeck helped install, upgrade or rebuild several components of the largest living shoreline in New England. The project is on a former industrial site and uses methods like creating artificial reefs offshore, building tree trunk berms on the beach and planting native beachgrasses, all designed to help protect the site from erosion.

Read more about Koeck's Sea Grant internship on Connecticut Sea Grant's (CTSG) website at <https://seagrant.uconn.edu/?p=5412>.



New Coastal Observer App Asks Public to Document Weather

To help Delawareans adequately discuss and document rising sea levels and flood-prone areas, the Delaware Resilience Awareness Project (DelRAP), a project of the University of Delaware and Delaware Sea Grant, has created the Coastal Observer app, available on Android and Apple products.

Coastal Observer users report basic environmental observations and how the current setting impacts their mood. Researchers also encourage people to use the app for weather observations, documenting water levels in certain areas, and noting changes in water quality to document how the environment is impacted by human practices.

Coastal Observer is meant to shine a light on the growing impacts of sea level rise and climate change in Delaware by encouraging citizens to be more active in monitoring weather and water locally, which will help researchers build a pathway for a sustainable future.



Koeck said, "It makes me feel good knowing that this is helping advance restoration."

▲ UD student Sam Koeck (wearing white hat in center) with partners in his internship: DESG Associate Director Chris Hauser (in blue), Prof. Jennifer Mattel of Sacred Heart University (on right), and CTSG staff.

Quick Facts

Atlantic Sturgeon
(*Acipenser oxyrinchus oxyrinchus*)

Weight: Up to 800 pounds

Life Span: 60 years

Length: Up to 14 feet

Juvenile sturgeon caught and handled pursuant to NMFS ESA Permit #19255-01



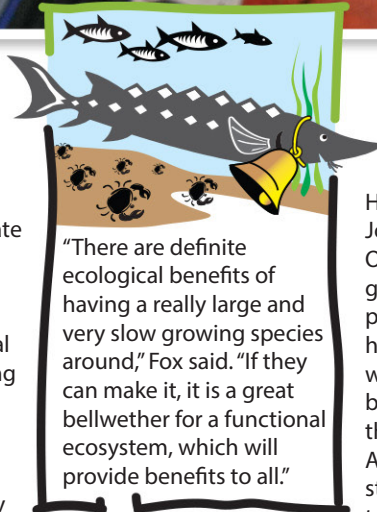
Sturgeon Research Up and Down the Bay, Along the Coast

Working with faculty and graduate students at Delaware State University (DSU) and the University of Delaware, DESG has been supporting research into Atlantic sturgeon for several years, trying to advance an understanding of what threatens these endangered fish and how people might support their recovery.

At one time, Atlantic sturgeon were a key commercial fishery on the Delaware Bay, supporting a valuable meat and caviar industry in the late 19th century operating out of Bowers Beach and Delaware City. And long before its importance to industry, sturgeon fed the people who lived along the Delaware River, including the original Lenape inhabitants.

Atlantic sturgeon are also important ecologically according to DSU professor Dewayne Fox, who has worked on DESG-funded research and in collaboration with DESG fisheries and aquaculture specialist Ed Hale.

Significant fishing of Atlantic sturgeon essentially ended early in the 20th century due to over-fishing and declining water quality. Despite reduced fishing pressure, Atlantic sturgeon did



"There are definite ecological benefits of having a really large and very slow growing species around," Fox said. "If they can make it, it is a great bellwether for a functional ecosystem, which will provide benefits to all."



not recover and were listed as endangered in 2012.

Hale, Fox, and UD faculty John Madsen and Matt Oliver, together with graduate students and postdoctoral researchers, have begun to untangle why the fish may not be recovering, despite the Endangered Species Act's protections, and are starting to develop new tools to help.

With the end of direct commercial fishing and improvement over the past few decades of some water quality problems like limited dissolved oxygen, Hale said the habitat is better and sturgeon are reproducing, but recovery has been limited because sturgeon continue to be killed.

In fact, based on studies of the distinct subpopulation of Delaware River Atlantic sturgeon, Hale said it appears some of the sturgeon dying here could be visitors from other river subpopulations and population segments.

Biologists initially thought bycatch—when fishers catch sturgeon accidentally while targeting other species—was the principal issue limiting recovery. Oliver and his students created a sturgeon forecasting tool to help fishers avoid areas where they might accidentally catch the fish, which can grow to hundreds of pounds and well over 10 feet long and damage their nets. Hale helped connect Delaware's commercial fishers with the tool, which uses weather and water predictions together with an understanding of the sturgeons' preferred conditions.

"It is light years ahead of its time in terms of potential utility to fisheries management," Hale said. And efforts are continuing to refine and expand the product.

But Hale said other research suggests ship strikes are responsible for half of the sturgeon killed. Research in Fox's lab showed sturgeon don't respond to ship noise, either because it is ever-present in the busy shipping channels or because they don't recognize it as a threat. In 2018 and 2019, Hale and Fox worked on research to evaluate what percentage of killed sturgeon are being found, and Fox and Madsen worked on DESG-funded research to better understand the details of sturgeons' habitat preferences. If they can determine how many adults are in the Delaware Estuary, how successful they are at reproducing and the mortality rate, Hale said they can move towards developing a risk assessment that fisheries managers could use to help determine the next steps to encourage sturgeon recovery.

"It is important to the social and economic history of the state," Hale said. "I am interested in recovery, in getting back to a fishable population. We are seeing what looks like the start of recovery in the Hudson River. If you want a fishery to return one day, this is what you have to do."



Sustainable Fisheries and Aquaculture (SFA) is perhaps the clearest example of Sea Grant's dual focus to protect our coastal communities' interdependent economies and ecosystems. In Delaware, the emphasis has been on shellfish aquaculture for many years, and in 2019 that work expanded to Delaware Bay (*story below*). But DESG staff and researchers also work on wild finfish topics, such as the sturgeon efforts reported on the facing page.

Restoring Oyster Populations with Remote Set

After decades of effort to return oyster aquaculture to the Inland Bays started paying off with farmed oysters for sale in 2018, DESG fisheries, aquaculture and seafood specialist Ed Hale (*right*) started investigating a new area in 2019. While there are 343 acres of Inland Bays grounds available for aquaculture, there are 5,983 acres of state waters in the Delaware Bay where commercial operations currently harvest oysters. Using a process called *remote setting*, those watermen could replenish areas of lower concentration to augment wild harvest of bottom-grown oysters.

To begin exploring the possibility, Hale set up a 19-foot tank with rotary aeration and set a high volume of spat—juvenile oysters—on 250 oyster shells. Once the spat was established on the shell, the batch was placed in a third of an acre of Delaware Bay where it will grow over the next two years before being ready to harvest. This helps watermen replenish oyster stock while providing protected habitat for juvenile fish and crabs and improving water quality in the bay while the oysters grow out.



Why are oyster reefs important?

- « Support marine biodiversity and provide refuge for juvenile fish
- « Oysters are filter feeders which improve water quality and clarity
- « Protect the shoreline and reduce erosion
- « Economically, eating local oysters helps support watermen

Where to Buy Inland Bays Oysters

Several small businesses are now growing and selling aquaculture oysters from Rehoboth and Indian River bays. Consumers and restaurants can contact them directly to buy fresh raw oysters year-round.

Delaware Cultured Seafood

Phone: 302-OYSTER1

Email: info@delawareoysters.com

Friends Clams & Oysters LLC

Phone: 302-855-1119

Email: friendsheshe@gmail.com

Tower 3 Oyster Company

Phone: 704-641-4273

Email: charlesgiffordiv@gmail.com

Delivery available for an additional fee

To find information about other local seafood and where to buy, visit www.deseagrant.org/seafood

ENVIRONMENTAL WORKFORCE



The success and response of the class led Moshier to offer a UD Potpourri Class in spring 2020 that focused primarily on coastal topics, which Nennstiehl also took after having such a good experience with the Science of the Delaware Coast class.

"Every class, you came in and you had an hour and a half of all new material and it was incredible," said Nennstiehl. "You were never bored. Every Wednesday, I couldn't wait to go into the class because I knew if it was anything like the last one, it was going to be really interesting."

Due to the popularity and engagement, the Science of the Delaware Coast class will be offered again in fall 2020.

Lifelong Learning by the Sea

Growing up in Rehoboth, Gary Nennstiehl was always interested in sea life, and when he attended the University of Delaware as an undergraduate, he considered becoming a marine biologist. He ended up having a successful career working 41 years at Perdue Farms in Salisbury, Maryland, but never lost that curiosity about marine life and fish ecology.

In the fall of 2019, Nennstiehl was able to explore that passion as DESG partnered with the Osher Lifelong Learning Institute (OLLI) at the University of Delaware to offer a 10-week Science of the Delaware Coast class at the Hugh R. Sharp Campus in Lewes.

Christopher Petrone, director of the DESG Marine Advisory Service, coordinated the class and said with the median age of Sussex County residents increasing, a goal for DESG has been to design more programming for active retired adults.

With OLLI serving as an academic cooperative for adults 50 and over, the partnership made sense for both sides.

"2019 was a big year for our connection to OLLI, and we're looking forward to doing more with them," said Petrone. "It's a great audience, and it's interesting to talk with folks who have backgrounds in all sorts of things."

Anna Moshier, OLLI's Kent and Sussex County program manager, said that based on the

"Everyone who took the class told me how remarkable the speakers were, how much they enjoyed hearing about their research and learning what UD is out there doing," said Moshier. "Our members feel more a part of UD through this initiative."

feedback from class participants, she imagines the partnership will continue to thrive.

Offered throughout the fall of 2019, classes were taught by DESG extension specialists, as well as UD students and faculty members. Classes covered topics ranging from the importance of wetlands to the aquatic food web and emergency preparedness, among others.

The class participated in hands-on learning opportunities such as a marsh walk, plankton towing and beach seining. They also learned about the tools used in the Robotic Discovery Labs and got to investigate plankton under microscopes.

Gerri Stephenson, who has been taking OLLI classes since 2011 and serves on the OLLI Sussex Council, enjoyed learning about the history of the area, as well as the hands-on learning opportunities and listening to the speakers.

"Every speaker who shared their knowledge and experiences were so well informed and dedicated to their field that it made me see why Sea Grant and the University of Delaware is so important," said Stephenson.





LITERACY & DEVELOPMENT



Chesapeake Bay Bowl 2020

The Chesapeake Bay Bowl, regional competition of the National Ocean Sciences Bowl, returned to the University of Delaware's Hugh R. Sharp Campus in Lewes in 2020, organized by DESG education specialist David Christopher. Ten teams competed, representing high schools from Delaware, Maryland, Virginia and Pennsylvania, and the team (pictured above) from Lead for the Future Academy in Clarksburg, Maryland, finished first.



Knauss Fellow Job Placement

Delaware Sea Grant's 2019 Knauss Fellow, Christine Hirt, successfully completed her time at the National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management and took a position as a program manager at the National Offshore Wind Research & Development Consortium. Hirt's master's degree in marine policy from UD CEOE and her career goals have both been focused on offshore wind, and the John A. Knauss Marine Policy Fellowship provided her a year in Washington, D.C. after graduation and a springboard into her career.

Hirt worked in the Office of Coastal Management's Division of Policy, Planning and Communications, writing talking points and speeches for NOAA leadership, planning congressional visits to National Estuarine Research Reserves, and working on "anything policy-related," including new executive orders, legislative analysis and new initiatives from the agency.

Environmental Literacy and Workforce Development (ELWD) means outreach to all interested members of the community and students from preschool through graduate school. DESG views ELWD as an essential focus area closely integrated with all the others, educating the public and preparing the next generation of scientists, community planners and policy makers.

DESG Marine Advisory Service Director Chris Petrone (left) and Maggie Pletta (right) look on as Tamika Mickle, a teacher from Baltimore, practices taking a weather reading during the Climate Academy run by DESG, Delaware National Estuarine Research Reserve and other partners of the National Oceanic and Atmospheric Administration. ▼



NOAA and Sea Grant Keep Climate Academy Running

Teachers from Delaware, Connecticut, New Jersey and Maryland gathered at the University of Delaware's Lewes campus to learn about climate, environmental change and Meaningful Watershed Education Experiences (MWEEs) at the 2019 Climate Academy.

The professional learning opportunity was hosted by the National Oceanic and Atmospheric Administration, the Delaware Sea Grant College Program and the Chesapeake and Delaware national estuarine research reserves.

In previous years, the academy was held as part of the National Science Foundation's (NSF) Maryland and Delaware Climate Change Education Assessment and Research (MADE CLEAR) project, but after the NSF funding ended, NOAA and DESG decided to continue the academy on their own because climate change is an important topic that many teachers do not have a background in and previous academies were successful and received positive feedback from the participants.

2020 Readership Survey

(on the reverse side of this card)

UD's Hugh R. Sharp
Campus Wind Turbine.
The University chose
wind power to meet its
commitment to reduce
its carbon footprint
due to the favorable
winds in the coastal
area of Lewes and also
for the educational
and research
opportunities
it presents.

Lifelong Learning
by the Sea

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Your chance to win! Respond by December 31, 2020

Complete the brief survey and mail to be entered to win the coastal prize package valued at over \$200. Or you can enter online at www.deseagrant.org/survey.



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DELAWARE SEA GRANT COLLEGE PROGRAM

REPORTER

University of Delaware
Environmental Public Education Office
222 South Chapel Street, Suite 102
Newark, DE 19716-3530

1. Do you use Delaware's bays, beaches or coastal areas for recreation or pleasure? Yes No

2. When compared to 10 years ago, do you think the health of our coastal and marine resources are:
 Much better Somewhat better About the same Somewhat worse Much worse Don't know

3. Which broad issues affecting Delaware's coast are most important to you? (Check your top three choices.)
 Safe and sustainable seafood supplies
 Vibrant and economically sustainable coastal communities
 Communities resilient to coastal storms and hazards
 Healthy coastal ecosystems
 Climate change and/or sea level rise
 Environmental literacy for all age groups

4. If Delaware Sea Grant could help to solve one major coastal problem in Delaware, what should it be?

5. After reading this issue of *Reporter*, which actions, if any, do you plan to take within the next six months? (Check all that apply.)
 Read more about environmental issues
 Attend an environmental event
 Take part in a Sea Grant workshop, lecture or seminar
 Visit **www.deseagrant.org**
 Visit DESG on YouTube, Facebook, Instagram or Twitter
 Other (Please specify): _____

6. How would you rate the overall quality of this report?
 Excellent Very Good Average Good Poor
Comments or suggestions:

7. How would you prefer to receive future issues of this report?
 Print Printable PDF Website Online video digest
8. What is your age? Under 20 20-29 30-39 40-49
 50-59 60-69 70 +
9. Is your occupation directly/indirectly related to Delaware's coastal environment? Yes No
10. May we contact you about future Delaware Sea Grant activities?
 Yes, by mail Yes, by email Yes, by phone No thanks
11. Other comments or suggestions:

Name _____
Address _____

City _____ State _____ Zip _____
Daytime Telephone _____
 I would like to subscribe to Delaware Sea Grant's e-newsletter.
(Provide email address) _____



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Annual Coast Day Crab Cake Cook-off Cookbook Recipe

In celebration of this local tradition, we published a cookbook featuring the top three recipes from the past 30 years. Start cooking seafood with the WINNING recipe below!

2019 Finalist



Chef Ray's Coastal Crab Cakes

Ray Sheehan, New Egypt, NJ

2 large eggs, beaten	2 tbsp. sliced green onion
$\frac{3}{4}$ c. mayonnaise	$\frac{1}{2}$ c. minced celery
1 tbsp. Dijon mustard	1 c. bread crumbs
1 tbsp. Old Bay seasoning	1 tbsp. fresh tarragon, chopped
$\frac{1}{4}$ c. fresh lemon juice	$\frac{1}{2}$ c. shredded sharp cheddar cheese
2 tsp. hot sauce	$\frac{1}{2}$ c. shredded pepper jack cheese
$\frac{1}{2}$ tsp. kosher salt	2 c. Panko bread crumbs (for coating crab cakes)
$\frac{1}{4}$ tsp. black pepper	2 c. heavy cream
2 lbs. jumbo lump crab meat, picked over to remove any shell	Vegetable oil (for frying)
$\frac{1}{2}$ c. minced red onion	

In a large bowl, whisk the eggs, mayonnaise, mustard, Old Bay seasoning, lemon juice, hot sauce, salt and pepper to combine. Add the red and green onions, celery, bread crumbs, tarragon, shredded cheese and crab meat; mix gently until well combined, taking care not to overmix. Cover with plastic wrap and refrigerate for 30 minutes. Form the crab mixture into approximately 20 cakes. Dip the cakes one at a time into the heavy cream, and then coat with the Panko. Refrigerate until you are ready to cook the crab cakes.

Heat $\frac{1}{4}$ inch of the vegetable oil in a 12-inch skillet to 375 degrees. Alternatively heat oil in a deep fryer. Fry the crab cakes in batches, 5 at a time for 2 to 3 minutes per side, until cooked through and golden brown. Transfer the cakes from the hot oil to drain on a sheet tray lined with paper towels. Allow to cool for 1 to 2 minutes before serving.



Order the Cookbook Today!

Contact the UD Environmental
Public Education Office
at 302-831-8083 or
marinecom@udel.edu

Proceeds benefit Delaware Sea Grant.



The Delaware Sea Grant (DESG) College Program helps people wisely use, manage and conserve our state's valuable marine and coastal resources. We do this through an integrated program of research, education and outreach built upon active partnerships with state and federal agencies, local businesses, nonprofit organizations and community members.

DESG is one of 34 Sea Grant programs nationwide, in every coastal and Great Lakes state, as well as Guam and Puerto Rico. The National Sea Grant Program was created by Congress in 1966 and is part of the National Oceanic and Atmospheric Administration.



PAGE 4 Wilmington Green Jobs participants assemble a floating upweller system, used for oyster farming, with guidance from DESG Marine Advisory Service specialists David Christopher and Ed Hale.

Whether educators, communicators or extension agents, DESG staff and the researchers supported by the program conduct their work on local issues within the four focus areas of the National Sea Grant College Program:

HEALTHY COASTAL ECOSYSTEMS

Protecting and restoring Delaware's environment and the valuable natural resources it provides

SUSTAINABLE FISHERIES AND AQUACULTURE

Advancing sustainable commercial fishing in Delaware's waters and fostering local aquaculture

RESILIENT COMMUNITIES AND ECONOMIES

Helping Delaware communities prepare for a changing environment and economy

ENVIRONMENTAL LITERACY AND WORKFORCE DEVELOPMENT

Training and supporting the next generation of environmental and scientific leaders



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