



“Partnerships like this really pay dividends—helping students gain experience in different positions to inform their career choices, while providing a new delivery mechanism to communicate the department’s work to the broader public.”



—Edward Hale
Biometrist, Division of Fish & Wildlife





DIRECTOR'S LETTER

DELAWARE SEA GRANT

In everything we do, the people of Delaware Sea Grant (DESG) strive to find ways to serve our fellow citizens while advancing knowledge and student success. Whether we are working on community development, education, coastal resiliency or aquaculture, our guiding principle is always to bring the best science and achieve the greatest benefit for Delaware's citizens, our communities and the unique environment we call home.



Delaware Sea Grant Knauss Fellow Lauren Knapp graduated from the program in January at a ceremony with Rear Admiral Tim Gallaudet, assistant secretary of commerce for oceans and atmosphere (left); Craig McLean, assistant administrator for NOAA research (second from right); and National Sea Grant Program Director Jon Pennock (right), a UD CEOE alumnus.

Julia Guimond had a year-long research fellowship (page 13). Another partnership with the Delaware Department of Natural Resources and Environmental Control hosted CEOE graduate student Lane Johnston for a fellowship in the Fish and Wildlife Division (page 5). I expect in next year's report we will have several additional successful partnerships to share as well.

Everything DESG does ultimately comes down to people. The people we serve, and the people who have contributed their time and talents to making DESG what it is today. I can't end this letter without thanking the acting director who preceded me, Ed Lewandowski. Ed provided steadfast leadership while advancing Delaware Sea Grant's mission through recruiting new Marine Advisory Service (MAS) specialists, deepening our partnership with Delaware State University, and helping to create our new approach to giving students additional fellowship opportunities.

Kathryn Coyne
Director, Delaware Sea Grant College Program

To do this, DESG invests a great deal of time, energy and resources into supporting research and education. Every research project funded by DESG includes funding for a graduate student. We strive to provide opportunities for students to learn and serve their community both in and out of the lab, and to develop the skills they will need to make a positive impact. Since 1979, Delaware Sea Grant has sent 37 students to Washington, D.C. as Dean John A. Knauss Marine Policy Fellows. These are prestigious positions by which fellows gain experience working in the federal government for a year. Our most recent fellows were Lauren Knapp, a doctoral candidate in the University of Delaware College of Earth, Ocean, and Environment (CEOE) and Katrina Tomacek, J.D., from American University. Laura completed a successful year as a Knauss Fellow at the U.S. Army Corps of Engineers, and Katrina worked as a fellow in the National Oceanic and Atmospheric Administration Fisheries Office of Law Enforcement.

In an effort to expand fellowship opportunities for our students closer to home, we are connecting with local partners here in Delaware to develop these relationships into an even larger part of DESG's commitment to student education and service to our community. In this report, you can read about a successful partnership in 2017 with the Delaware National Estuarine Research Reserve, where CEOE graduate student



DESG Director Kathryn Coyne (center) and CEOE Dean Estella Atekwana (right) thanked Ed Lewandowski for his service as the acting director of both the Marine Advisory Service and DESG overall at a recent meeting of the Sea Grant Advisory Council.



 **ADVISORY COUNCIL**

 **STAFF DIRECTORY**

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 business and industry, resource management and engineering firms, state government, public interest groups, the pre-college 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.

- Jennifer Adkins
Partnership for the Delaware Estuary
- Gene R. Bailey
Diamond State Port Corporation
- Bill Baker
Bill's Sport Shop
- Chris Bason
Delaware Center for the Inland Bays
- Mark Biddle
DNREC*
- Ruth Briggs-King
Delaware General Assembly
- Kimberly Cole
Delaware Coastal Programs
DNREC*
- Sarah Cooksey
The Nature Conservancy Delaware
- Gerard Esposito
Delaware Sea Grant
Advisory Council Chair
Tidewater Utilities, Inc.
- Namsuo Suk
Delaware River Basin Commission
- Brenna Goggin
Delaware Nature Society, Inc.

- Kate Hackett
Delaware Wild Lands, Inc.
- Simeon Hahn
National Oceanic and Atmospheric
Administration (NOAA)
- Jeanie Harper
Seafood Retailer (retired)
- Daniel J. Leathers
Office of the Delaware
State Climatologist,
University of Delaware
- Sharon Lynn
City of Rehoboth Beach
- Dyremple Marsh
Delaware State University
- David B. McBride
Delaware General Assembly
- Tonyea Mead
Delaware Department of Education
- William J. Miller, Jr.
Delaware River and Bay Authority
(retired)

- Christopher Moore
Mid-Atlantic Fishery
Management Council
- Betsy Reamer
Lewes Chamber of Commerce
& Visitors Bureau
- Michelle Rodgers
University of Delaware
- Dave Saveikis
DNREC*
- F. Gary Simpson
Delaware General Assembly
- Halsey Spruance
Delaware Museum of Natural History
- Hilary Valentine
Delaware Technical
Community College
- Katherine Ward
Delaware Press Association
- Stuart Widom
Calpine Corporation

Administration

- Kathy Coyne
Director
- Edward Lewandowski
Acting Director, Marine Advisory Service
- Mark Jolly-Van Bodegraven
Director, Environmental Public Education
- Lisa Ridenour
Fiscal Officer/Assistant Director, Sea Grant
and Sponsored Programs

Marine Advisory Service

- Edward Lewandowski
Coastal Communities Development
Specialist, Acting MAS Director
- John Ewart
Aquaculture, Fisheries, and
Water Quality Specialist
- Jamē McCray
Environmental Social Scientist
- Christopher Petrone
Marine Education Specialist
- Danielle Swallow
Coastal Hazards/Climate
Resilience Specialist
- Edward Whereat
Citizen Monitoring Program Coordinator

**Environmental Public
Education**

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- Pam Donnelly
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Delaware Sea Grant's horseshoe crab model has been a popular outreach and teaching tool since 1996. Last year, DESG updated information on how it meets science standards to help educators integrate it into their curricula and its impact went worldwide. Learn more on page 14.

* Delaware Department of Natural Resources and Environmental Control

The breadth of work undertaken by DESG can make it hard to grasp the program's overall impact. The rest of this *Reporter* is organized into the National Sea Grant College Program's four focus areas to allow readers to dig into the specific work in each topic area. But to start, presented below are some numbers to provide a snapshot of the work overall, and on the facing page we have news of the ways in which DESG staff have been honored for their innovation and hard work this past year.

IN 2017, DESG STAFF TAUGHT:



▲ DESG environmental social scientist Jamè McCray (second from right) teaches students about wind energy during a field trip to Delaware Technical and Community College's campus in Dover.

847

K-12 students
directly

531

educators

>100

people about
wind energy

45 economic
development
professionals about
renewable energy
opportunities

The year's new
15 Second Science
episodes were
viewed

33,903

times



672

oysters were used in a
preliminary investigation
of new disinfecting
technologies at DSU



55

attendees



at DESG workshops
on aquaculture
opportunities

*Helping Students
& Society*



ACCOLADES

Falk Receives National Sea Grant Extension Award—William Q. Wick Visionary Career Leadership

Jim Falk served Delaware Sea Grant for 39 years, most of them as associate director of the program and director of the Marine Advisory Service, the extension office of DESG. When he retired in 2017, DESG lost a knowledgeable advocate for our communities and an invaluable leader. His impact on the Sea Grant College Program, not just here in Delaware, but across the country, was recognized by the National Sea Grant organization with the William Q. Wick Visionary Career Leadership Award for Administration during a ceremony in Astoria, OR, in the fall.



Jim Falk served Delaware Sea Grant for 39 years.

The William Q. Wick Visionary Career Leadership Award for Administration recognizes outstanding career achievement, leadership, vision, and contributions to Sea Grant Extension through programming or administration by a Sea Grant extension professional. Falk not only led the day-to-day operations of Delaware Sea Grant for much of his career, he also authored many publications researching residents' perceptions of coastal issues, providing information and support for tourism, and summarizing the achievements of Delaware Sea Grant for national audiences.

His dedication to the program and the people of coastal Delaware whom it serves made Falk a terrific leader and gained the attention of all those who worked with him. Delaware Sea Grant congratulates him on the well-deserved William Q. Wick Visionary Career Leadership Award for Administration.



Lewandowski Honored with New Sea Grant Award

Ed Lewandowski, acting director of DESG's Marine Advisory Service, received the inaugural **Mid-Atlantic Sea Grant Early Career Achievement Award**. This award recognizes early career Sea Grant professionals who have shown noteworthy enthusiasm, performance, accomplishments and impacts within their program.



Lewandowski was recognized for the impact he has made through his work with the **Sustainable Coastal Communities Initiative (SCCI)** in helping with community development efforts in towns throughout Delaware, including Laurel, Leipsic, Bowers Beach,

Lewes and Little Creek. SCCI is a collaboration among DESG, the University of Delaware College of Agriculture and Natural Resources' Cooperative Extension and the Institute for Public Administration.



▲ Project VIDEO immersed viewers in areas of the R/V Joides, as in this view of the control room.



Project VIDEO—Winner

Delaware Sea Grant marine education specialist Chris Petrone and UD doctoral student Lisa Tossey won **First Place** in the audiovisuals category of the 2017 National Federation of Press Women Communications Contest for Project VIDEO, a virtual reality tour of the ocean drilling research vessel *JOIDES Resolution*. The project was covered in-depth in last year's *Reporter* after it placed first in the Delaware Press Association Communications Contest. Project VIDEO also earned an **APEX Grand Award** in the electronic media category. It was among 100 projects selected by APEX for grand awards from nearly 1,400 submissions.



Petrone Honored by Marine Education Peers

Chris Petrone also received the inaugural **Johnette D. Bosarge Memorial Award** by the National Marine Educators Association. The award recognizes "loyalty, efficiency and enthusiasm for marine and aquatic education." Since joining DESG in 2011, Petrone has had a significant impact on science education in the Mid-Atlantic region, instructing both students and K–12 teachers and serving in leadership roles with many professional organizations to share his skills and knowledge with other educators.





Internship Opportunity Helps UD Graduate Student Explore Fisheries Management

Atantic menhaden (*Brevoortia tyrannus*) are silvery fish that can be found along the East Coast of the United States and into Nova Scotia. Since the 1800s, menhaden have been used in fertilizer, animal feed and fish oil. Today, menhaden byproducts are used in everyday merchandise too, including lipstick and salad dressing.



Part of the herring family, Atlantic menhaden are an important regional fishery. In Lewes, Delaware,

Atlantic menhaden are a keystone species that play a critical role in the marine food chain, particularly as a food source for striped bass, bluefish, weakfish and ospreys.

Through an internship with the Delaware Department of Natural Resources and Environmental Control (DNREC), University of Delaware graduate student Lane Johnston got a behind-the-scenes look at how DNREC effectively manages the menhaden population in Delaware's local waters.

The opportunity grew out of a conversation with Jennifer Merrill, then Delaware Sea Grant's research manager. Johnston wanted to learn more about fisheries management policy issues and how information is exchanged with the community, and Merrill helped secure DESG funding for Johnston to work under the guidance of Ed Hale, a biometrician in DNREC's Division of Fish and Wildlife.



Atlantic Menhaden
(*Brevoortia tyrannus*)

Johnston has learned how Hale and others at DNREC develop technical reports based on data (such as age, growth and abundance) the state collects. The data is incorporated into fishery models that managers use to evaluate, predict and manage a stock of fish, factoring in commercial catch, federal estimates for recreational catch and stakeholder input from public meetings. She has helped conduct field surveys, met with fisheries biologists and heard

public concerns. It has been fascinating, she said, to explore how hard science can influence policy decisions.



Scientists and policy people do not always speak the same language. My goal is to understand both sides and to be able to effectively communicate to each group.



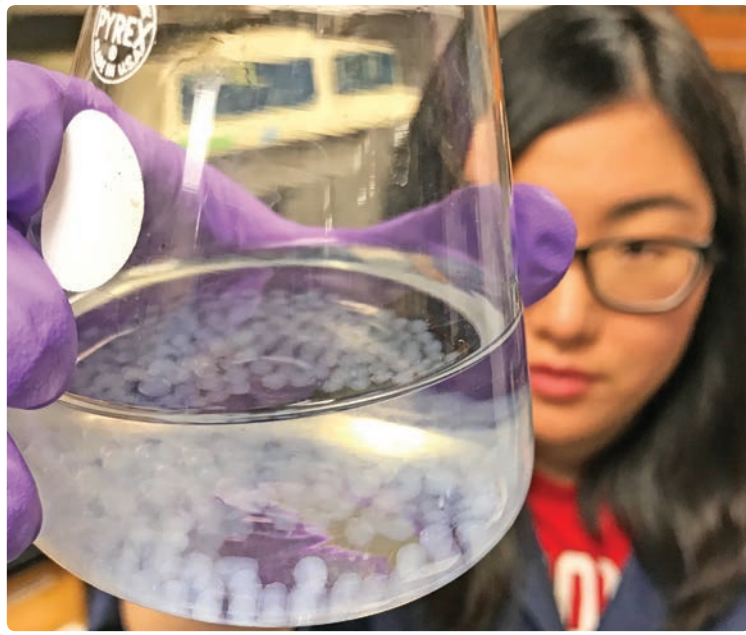
—Lane Johnston
University of Delaware Graduate Student



According to a 2015 report by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, the state of Delaware generated close to \$6.7 million in commercial landings and over \$100 million in sales associated with recreational fishing. Fisheries create jobs, too, at bait shops, gas stations, boatyards and more, Hale said. Nationally, U.S. commercial fishing, the seafood industry and recreational fishing support 1.6 million full- and part-time jobs.

A major focus of Johnston's work has been creating and maintaining a blog to communicate DNREC's fisheries work to the public. The blog follows her experience learning how science and hard data is turned into management strategies—specifically how fisheries data become guidelines and rules for how marine resources are effectively and sustainably managed. Topics have included a history of the Atlantic menhaden fishery, why biological data about fish is important, and how data is collected and used to make stock assessment models and implement fishing regulations.

"This is where partnerships like this pay dividends," said Hale, "helping students gain experience in different positions to inform their career choices, while providing new delivery mechanisms to communicate the department's work to the broader public."



Healthy Coastal Ecosystems is one of the most funded topics in Delaware Sea Grant-supported research. Below are updates on three projects nearing completion. Six new Healthy Coastal Ecosystems research projects were funded to begin in 2018 and run to 2020.

Studying Ways to Address Harmful Algae

Kathy Coyne and her student Yanfei Wang are using bacteria to attack harmful algae. Their work shows that bacteria can be embedded in any of several porous materials to prevent them from spreading beyond areas where people want to deploy them. This could allow for targeted application of the bacteria, for instance near shellfish beds, to prevent or mitigate blooms of toxic algae without risking the escape of the bacteria into the wider environment.

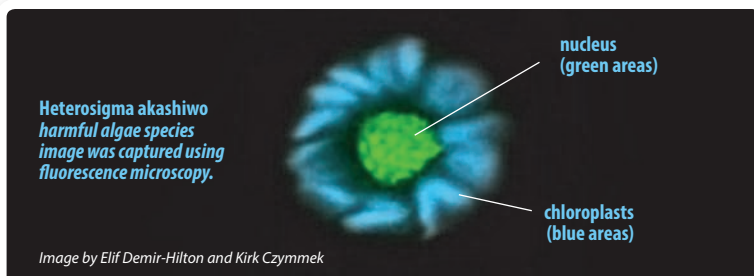
Ocean Acidification Shown to Affect Dogfish in Multiple Ways

Danielle Dixon, a graduate student and an undergraduate tested the effects of ocean acidification on juvenile smooth dogfish (*Mustelus canis*), following research she had done on adults of the small shark species. As with those animals, the pups showed impaired ability to track prey with chemical cues. And for the first time, the research also showed the sharks' electrosensory system is impaired by the altered pH of the seawater as well.



Harmful Algae More Diverse Than Thought

Genetic analysis of a harmful algae species that occurs both in the Delaware Inland Bays and around the world revealed it may be more than one species. DESG-funded researcher Tye Pettay analyzed regions of the chloroplast, mitochondrial and nuclear genomes of *Heterosigma akashiwo*, algae that can have negative impacts on fish health. The research studied cultures of *H. akashiwo* from the Inland Bays, New Zealand, and the West Coast of the United States and Canada. The newly discovered diversity could translate into differences in toxicity between *H. akashiwo* populations, where some are more harmful than others, and understanding these differences could influence management decisions.





“

Resiliency is planning and preparing today for tomorrow's hazards like storms and sea level rise, so that communities can thrive and bounce back more readily.



—Shawn Garvin
Secretary, Department of Natural Resources
and Environmental Control

”

Local Delaware Communities Attend Inaugural Resilient and Sustainable Communities Summit

More than 250 stakeholders from Delaware agencies, academic institutions, nonprofits and 22 local Delaware communities—including Wilmington and Claymont—gathered in Dover last fall for the inaugural Delaware Resilient and Sustainable Communities Summit.

The event was sponsored by DESG, the University of Delaware, DNREC and the Department of Transportation to highlight changing climate and weather conditions with a focus on improving community preparedness and response. Delaware's low-lying elevation makes the state especially vulnerable to flooding from storms and sea level rise, particularly since no part of the state is more than eight miles from tidal waters.

DNREC Secretary Shawn Garvin welcomed attendees, saying, “Resiliency is planning and preparing today for tomorrow's hazards like storms and sea level rise, so that communities can thrive and bounce back more readily.”

The Summit occurred on the heels of an above average 2017 hurricane season that included 17 named storms and six named hurricanes, including three Category 4 hurricanes in the United States. Panel discussions focused on issues such as storms, climatology and changing conditions in Delaware; how to improve resiliency at the community level; and a series of lessons learned, best practices and success stories from the field. Each session concluded with a robust Q&A session where audience members directly engaged with the panelists.

“While many groups already work together, the summit demonstrated that more information, resources and networking opportunities are needed to assist communities statewide in preparing for and adapting to changing weather and flooding events,” said Jennifer Merrill, then DESG research manager.

Storms are an important factor in major coastal flooding events, with March and October usually being standout months for coastal storms in

Delaware. Climate scientist John Callahan, with the Delaware Geological Survey, debuted the latest sea level rise planning scenarios for Delaware (the result of collaborative work by DGS and DNREC) that can be used by emergency planners when considering future projects.

Lessons from Hurricane Sandy

Nancy Balcom, associate director of Connecticut Sea Grant, delivered the event's keynote address, sharing results of a two-year social science study to understand how people reacted to storm warnings and made decisions to stay or go during Hurricane Sandy. The effort, supported by the Connecticut, New York and New Jersey Sea Grant programs, focused on how people obtained storm warning reports, what factors influenced



decision-making and how storm warnings could be more effective.

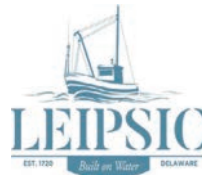
The study revealed five general classes of attitudes about hurricanes, ranging from those who were “first out” or eager to leave if a hurricane was in the forecast to “diehards” who were confident in their ability to ride out a storm, along with barriers to evacuation such as pets and medical, financial or transportation issues, among other things. While local and state officials were considered trustworthy sources of information, Balcom said, the study revealed that people make decisions based on previous experience, and that communication on a variety of platforms (television, Internet and social media) is important.



Delaware Sea Grant Helps Leipsic Plan and Build Its Future

In 2017, the Working Waterfronts Initiative led by DESG Marine Advisory Service Acting Director Ed Lewandowski for UD's Sustainable Coastal Communities Initiative (SCCI) made significant strides in promoting economic vitality for Leipsic, a small Kent County town just outside Bombay Hook National Wildlife Refuge.

In the first half of the year, funding from SCCI was used to hire a South Carolina-based consultant to develop a brand identity to promote the town and unify its public representation. Colors, typefaces, graphics and messaging all grew from the town's brand statement, "We are Leipsic, Delaware's working waterfront and we are built on water."



SCCI arranged for changes on the ground too. Working with the University of Delaware's Bachelor of Landscape Architecture Program, Lewandowski and his colleague, Jules Bruck (left), associate professor of landscape architecture, coordinated the design and planting of landscaping surrounding Leipsic's town hall. The building is also home to the Leipsic Watermen and Farmers' Museum, another new effort to draw people into town.

The Working Waterfronts Initiative's years of work in the town had its most public success yet with Leipsic's inaugural Oyster Festival in October 2017, which drew more than 1,500 people to the 180-resident town and delighted locals and visitors alike. Learn more about the festival at www.lepsicoysterfest.com and view a video of Leipsic's mayor discussing the impact of the festival and DESG's work at www.Bit.ly/2siyQt7.

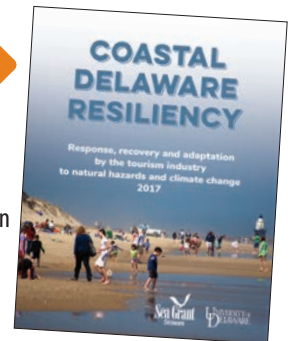


eBee Drone

Helping to create and maintain resilient communities and economies requires working on a number of different fronts, and Delaware Sea Grant addresses them all. Emergency preparedness, as featured in the article on the facing page, is certainly part of building resilience, but it is also important to support local economies and individual businesses, as well as study the way coastal hazards affect the region.

Delaware Sea Grant Issues Report on Coastal Tourism Resiliency

A Delaware Sea Grant (DESG) report, prepared with UD's Sustainable Coastal Communities Initiative, outlined ways the state's \$3 billion tourism industry can prepare for flooding and other climate change effects. *Coastal Delaware Resiliency: Response, recovery and adaptation by the tourism industry to natural hazards and climate change 2017* highlights resources that can help business owners identify activities that are essential for continued operation, prepare for risks and create a recovery plan in the event of a natural disaster. The report can be downloaded at www.deseagrants.org.



Gathering Data on Storm Impacts and Creating New Methods of Research

DESG-funded researcher Art Trembanis and his graduate students have developed and tested protocols and methodologies for collecting reliable data on the shape of beaches and the seafloor under nearshore waters using a variety of autonomous robotic vehicles. These next-generation tools and techniques have allowed them to study changes to the coast due to nor'easters and other strong storms.



▲ Jack Puleo visiting an elementary school to provide basic advice to always keep an eye on the waves.

DESG Research Uncovers Common Causes of Surf Zone Injury

About a decade ago, the chief of medicine at Beebe Hospital in Lewes approached DESG's coastal hazards specialist for help in understanding spikes in emergency room traffic caused by injuries people were sustaining while at the beach, hoping they could find ways to reduce the problem.

After some initial research by its Marine Advisory Service, DESG sponsored more detailed investigations by Jack Puleo, professor in UD's College of Engineering, who authored two papers in 2018 featuring what he has learned in years of study. Puleo also began outreach into the community in an effort to reduce the number of surf zone injuries during summer 2017.

Puleo and a graduate student, Matt Doelp, began in 2015 by investigating whether the aggregated injury data from Beebe could be correlated directly with any particular environmental factor, such as waves of a certain height or conditions at a certain time of day. They published a paper with their results, but those studies could not draw a direct connection between any one condition and an increase in injury rates.

While most serious injuries resulted from high-risk activities like skimboarding or bodysurfing, half of the injuries Beebe Hospital treated occurred while people were simply wading.



▲ Matt Doelp
UD Graduate Student

"Conditions on our coast are fairly constant," Puleo said. Waves tend to be two- to three-foot high, and the beach slope is fairly uniform, though steep. Having proven it was not a simple case of one factor causing the problem, Puleo, Doelp and a number of undergraduates approached the puzzle from another direction.

Instead of studying only environmental conditions, they conducted counts and surveys of beachgoers and analyzed the injury data in more detail. Tourists, defined as anyone who did not live in Sussex County, were six times more likely to be injured than locals. While most serious injuries resulted from high-risk activities like skimboarding or bodysurfing, half of the injuries Beebe Hospital treated occurred while people were simply wading. Puleo and his team learned that of those injuries, almost three-quarters (72.4 %) of the people had their backs to the ocean when they were hurt.

To try to reduce the number of injuries, Puleo created an educational piece he distributed in Delaware beach communities, and he visited several elementary school classrooms providing basic advice to always keep an eye on the waves, don't dive into water of an unknown depth and talk to beach patrols about wave conditions.



72.4%
of wave related injuries occur when people had their backs to the ocean.

Discovering some of the more common injuries and their causes did not answer the original question of why surf zone injuries seemed to spike at certain times, however. Doelp and Puleo's most recent publication from their years of research finally provided an answer: it isn't one environmental condition, but rather a combination of conditions and their interplay with human decisions that leads to spikes in injuries.

Wave height matters, for instance, but only when big enough to be dangerous yet small enough that people may not realize the risk and go swimming anyway. Injury rates rise on really hot days, when the temperature encourages people to spend more time in the water. Several other factors play a role as well, but none of them explain increased injury rates by themselves. Only when certain factors occur at the same time is there a correlated increase in injury rates.

Puleo uncovered the trends by applying a method of statistical modeling that used the first seven years of data to accurately predict what the eighth year data should (and did) show. The model, with the trends it revealed, is the foundation for a possible future project that could lead to a system to assess real-time conditions and provide a prediction of relative risk, perhaps giving beachgoers one more tool to make good decisions and avoid spending part of their vacation in the emergency room.



► The shores of Delaware's Inland Bays are increasingly popular for residences and recreation.

▼ DESG research used data from Hurricane Sandy in 2012 to model water level scenarios in the Inland Bays.



Sea Grant Research Examines Inland Bays, Coastal Storms and Flood Risk

The Delaware Inland Bays are similar to many bodies of water up and down the East Coast, separated from the Atlantic Ocean by narrow barrier beaches and islands. In 2012, Hurricane Sandy made many people aware of the risk of flooding from these kinds of water bodies, also known as back bays.

DESG-funded researcher Nobu Kobayashi of UD's Center for Applied Coastal Research in the College of Engineering developed a model of storm-driven water level changes in the Rehoboth and Indian River Bays that revealed some valuable information that could affect how planners may want to prepare for future storms.



▲ Nobu Kobayashi used a 30-meter wave tank to build and test storm protection structures.

Kobayashi says one popular suggestion for preventing inland



bay flooding has been to consider flood gates to close off connections between the bays and the ocean during storms, which would be intended to prevent storm surge from coming up waterways like the Indian River Inlet and flooding communities surrounding the bay.



Kobayashi's work showed water coming over barrier beaches, known as wave overtopping or overwash, during Hurricane Sandy could have resulted in water levels in the bay that were about 4 to 8 inches higher if the Indian River Inlet were closed off and unable to act as a drain for that extra seawater.

"During a major storm, water coming directly from the ocean to the bay (over the beaches) can be as large as water coming in the inlet," Kobayashi said. "If that happens, having the inlet can reduce flooding because if the water gets too high, it can escape."

Now both the Army Corps of Engineers and the Federal Emergency Management

Agency (FEMA) are using Kobayashi's model in concert with existing modeling to improve flood risk estimation as they plan their work. The DESG award that enabled Kobayashi to publish this analytical model for bay flooding in 2017 also produced two other papers. On each paper, Kobayashi involved a different graduate student, helping to increase the impact of the Sea Grant funding. While studying how rock seawalls and sand dunes functioned in combatting wave overtopping and how the overwash affected the shoreline, he also provided real-world experience for his students, who came from China, South Korea and India.

"It's hands-on academic training with a practical feel because they can see it actually happening in Delaware," Kobayashi said. "I'm using Delaware as a big lab."

To a layman, Kobayashi's actual lab seems quite large. For the seawall study, Kobayashi and his students built beaches, dunes and rock seawalls in a 30-meter-long wave tank in the warehouse-like Center for Applied Coastal Research, then filled the tank with water and created waves, over and over again, to see how the structures would hold up.

The seawalls buried under sand seemed to provide the best combination of overwash reduction and aesthetic acceptability. The research may lead to some of the first guidelines for how to build structures along our beaches to help protect communities from increasingly powerful coastal storms.

SUSTAINABLE FISHERIES



▲ *Pat Gaffney, Professor, Marine Biology and Biochemistry*



▲ *Shawn Polson, Associate Professor, Computer & Information Sciences*

Studying Oyster Health Through Microbes

Probiotics and a healthy gut microbiome are known to be important to human health, but did you know that oysters have a microbiome too?

DESG-funded researchers are exploring what natural microbes live with the Eastern Oyster, *Crassostrea virginica*, to better understand how these microbes contribute to oyster health or disease.

Since 2010, University of Delaware professors Shawn Polson, Eric Wommack and Pat Gaffney have studied the oyster's extrapallial cavity, the area that sits between the outer shell and the oyster itself. This unique space is closed-off from the outside environment by a membrane and filled with fluid. It also is where the oyster makes its shell.

The researchers say their work has confirmed that the oyster has a distinct microbiome that is different from seawater and that the oyster controls and maintains this environment. "When we started this study that wasn't entirely clear," said Polson, a biologist with expertise in DNA analysis and bioinformatics.

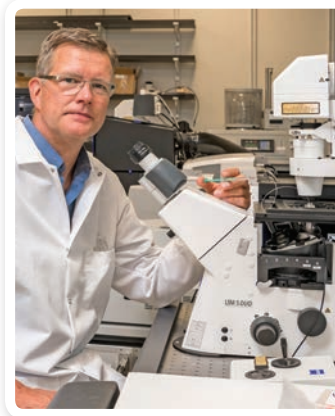
In the study, the researchers sampled 700 wild-caught Delaware Bay oysters and selectively-bred disease resistant oysters from

the Broadkill River between October 2016 to November 2017. The team collected weight measurements, tissue samples and fluid from the extrapallial cavity, as well as water samples from the surrounding seawater.

Early results show that a core group of bacteria capable of calcification call this unique ecosystem home, while other bacteria in the cavity vary seasonally or even month to month. Microbes similar to some of the core residents have been shown to participate in calcification in other environments, so the researchers theorize that the core bacteria may help the oyster build its shell.

"This is curious until you consider climate change, then it becomes relevant," said Wommack, an environmental microbiologist. The ocean has absorbed some of the carbon dioxide humans have added to the atmosphere.

The increase in carbon dioxide in the ocean has decreased the pH of ocean water, which makes



calcium less available to organisms that use it to build their shells and skeletons.

The team is also exploring whether the bacteria are contributing to the oyster's resistance to protistan diseases like Dermo and MSX. Wommack explained that some oysters have resistance characteristics, but why this occurs or how you can tell a disease-resistant oyster from a non-disease-resistant oyster remains poorly understood.

This is where genotyping can help. Gaffney is looking at specific differences between individual oysters as a means to probe into the oyster genome. Meanwhile, UD graduate student Amanda Zahorik has prepared samples for DNA sequencing to identify and compare bacteria present within a given sample.

Microbial communities are often thought of as "black boxes" where complex molecules or toxins are transformed into things that plants or animals need to grow, but an emerging consensus among scientists is that microbial community diversity matters to resilience.

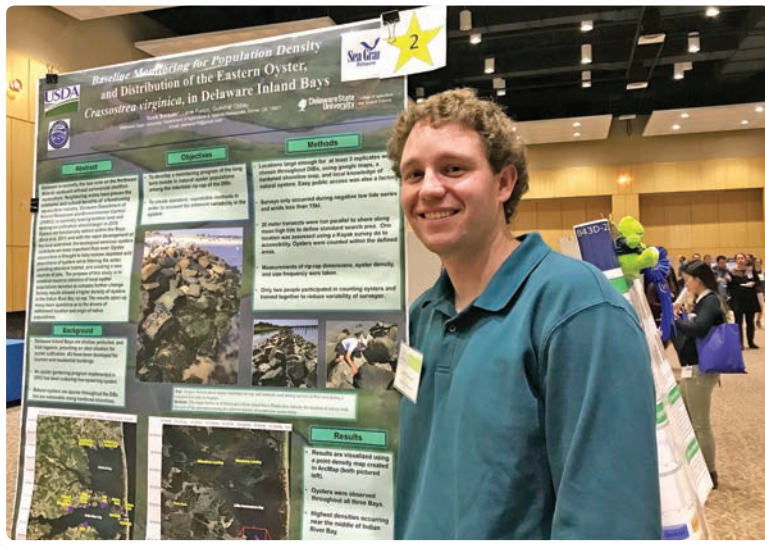


In biology, we think of diversity as resilience. For example, the diversity within coral reefs or tropical rainforests can help these ecosystems to withstand pulses of change. *If we find a specific group of bacteria that seem to be associated with disease resistance in oysters we can investigate how the bacteria are doing this*—are they producing antimicrobial peptides, natural antibiotics that prevent disease or is it something the host itself controls? We need to understand how the system works before we can leverage those mechanisms.



—Eric Wommack, Deputy Dean and Professor, College of Agriculture & Natural Resources
Professor, College of Earth, Ocean, & Environment





Promoting sustainable fisheries and aquaculture is vital to our nation's economy and beneficial to seafood consumers' health. Because many wild fisheries are at or above sustainable harvest levels, aquaculture will be increasingly important to supply many fish and shellfish. Delaware Sea Grant has focused on promoting the potential of oyster aquaculture in the Inland Bays for years, and in 2017, the program added some new research efforts to the work.

Delaware Sea Grant Continues to Support and Promote Aquaculture



In 2017, Aquaculture Specialist John Ewart provided an update on shellfish aquaculture in the Delaware Inland Bays to the Sussex Economic Development Action Committee, working to build awareness of the potential in the nascent industry. DNREC issued the first bottom leases for shellfish aquaculture in the Inland Bays in 2017. The first round did not result in the designated areas of the Inland Bays being fully leased, so DNREC reopened leasing at the end of the year and into 2018. In fall 2017, Ewart held two workshops to help potential shellfish farmers learn about the aquaculture process.

Delaware Sea Grant Partnership with Delaware State University Continues to Advance

DESG's collaboration with Delaware State University (DSU) has been deepening for years, especially in the sustainable fisheries and aquaculture focus area, and in 2017 that partnership took a couple of important steps forward. DESG exists to serve the entire state of Delaware, and ongoing work with DSU strengthens its presence in Dover and the mid-state region.

DSU student Scott Borsum received DESG funding in 2017 to research oyster genetics, which he presented at the 2018 Delaware Wetlands Conference in January. Borsum conducted observational surveys of 14 sites in Delaware's three Inland Bays to gather baseline data on oyster populations and their genetic make-ups in advance of aquaculture oysters being planted in the bays. His research also provided data the Center for the Inland Bays is using to assess and improve its oyster gardening efforts, in which volunteers tend oysters for their ecological benefits.

DESG also hired a part-time extension agent outside of the University of Delaware for the first time in 2017 when it contracted with DSU faculty member Dennis McIntosh to work on aquaculture issues for DESG. His Sea Grant work will start in earnest this year.



DSU Research Showed Potential for New Disinfecting Technologies

A DESG research mini-grant allowed McIntosh to conduct a pilot test of two new disinfecting technologies. The initial work, conducted during summer 2017, involved three DSU undergraduates and showed both new technologies were safe for use with live oysters (i.e. the disinfecting treatments did not kill the oysters themselves). Success with this pilot study will allow McIntosh and his team to apply for funding from other sources to test the efficacy of the technologies in reducing bacterial contaminants in oysters after they are harvested to ensure they are safe for consumers.

▲ In his DESG-supported experiment, Dennis McIntosh (left) placed different oysters in four treatment systems housed in one 2,000-liter tank to ensure the temperature was the same for all systems.

ENVIRONMENTAL WORKFORCE



▲ UD graduate student Julia Guimond collects bags from seepage meters she used to study the flow of water into or leaving the bank and bottom of the tidal channel in the marsh.

▶ Guimond shows off the device she used to estimate permeability, or the ease with which water can move, through the marsh platform.

Fellowship at St. Jones Reserve Benefits Graduate Student Research

Coastal marshes play an important role in filtering nutrients and pollutants from water. They slow water movement, too, which can reduce damage and protect communities from severe storms, while also supporting vegetation and marine organism growth, and create recreational opportunities for people.

UD doctoral student Julia Guimond is particularly interested in how water movement interacts with the biology and chemistry of the marsh and how those interactions relate to the amount and makeup of the water that is transported to the coastal ocean.

Salt marshes are valuable for their ability to sequester, or store, carbon dioxide from the atmosphere, so understanding how this stored carbon is affected by the physical movement of water during tidal cycles is important to predict how these conditions might change with sea level rise and increased precipitation.

Funded through a fellowship from DESG, in partnership with the Delaware National Estuarine Research Reserve (DNERR), Guimond collected water samples from across the marsh

at St. Jones Reserve, a brackish estuarine system located on the St. Jones River.

She gathered data about the saltiness of the water, the temperature and depth in different vegetation zones, and monitored water quality parameters that helped to determine what chemical reactions were happening in the water. Monthly checks on how fast the water moved through the marsh helped her understand seasonal and local changes, too.



One of the amazing things about marshes is that under the right conditions, they can vertically accrete—or grow—against sea level rise. Marshes are highly connected systems, so how sea level rise affects the hydrology of the marsh is connected to the chemistry below the water's surface, which connects to the vegetation.



—Julia Guimond
University of Delaware Doctoral Student



As the tidal cycle brings water in and out through channels connected to the ocean, water and nutrients are transported or exchanged between the marsh and the tidal channels. What and how much is exchanged depends on water movement and can have an impact on the amount of carbon stored in the system.

Guimond hopes to use the data she has collected to form a predictive model to understand how the St. Jones Reserve marsh might change under different

climate conditions. Quantifying the role of marshes in sequestering carbon and the potential for the release of carbon with storm surges, climate change and sea level rise could help advance stewardship and ecological preservation efforts.

Fieldwork aside, she called the fellowship a great opportunity to gain practical experience with proposal writing, planning and executing a budget, which she said “all graduate students should learn.”

DESG is continuing the Healthy Coastal Ecosystems Fellowship program in summer 2018 to advance the understanding of what makes coastal ecosystems sustainable and resilient to past, present and future pressures.

LITERACY & DEVELOPMENT



To maintain a sustainable relationship with our coastal environment, we must continually educate the public and prepare the next generation of scientists, community planners and policy makers. Recognizing this, Delaware Sea Grant invests in environmental literacy and workforce development at every level, from preschool to graduate school, while conducting outreach to all interested members of the community.

✓ 15 Second Science Worked into College Course

A Texas A&M professor found new ways to use *15 Second Science*, the series of videos DESG creates and shares on social media to provide quick information on interesting marine science topics. An introductory oceanography class at Texas A&M University required students to watch 30 of the episodes and write questions about their five favorites. The students' questions then became a quiz for the entire class.



15
SECOND
SCIENCE

QUIZ
TIME!



▲ Horseshoe Crab Model Has International Impact

One of DESG's most popular, long-running teaching tools reached a new, international audience in 2017. Woodside resident Betsy Lawrence spends the school year teaching third grade in Papua, Indonesia, and for a new introduction to her unit on Ecosystems and Food Chains, she gave her students DESG's horseshoe crab model to build. The students, who were from Indonesia, the United States, Australia and the Netherlands, embraced the hands-on learning. (More on the horseshoe crab model at www.deseagrants.org/products/horseshoe-crab-model).



◀ Marine Education from Delaware Sea Grant Helps Businesses Grow

Support from DESG Education Specialist Chris Petrone directly helped two local businesses in 2017. In its first year of operation, Sun Otter Tours offered a variety of tours throughout southern Delaware's coastal region, and its Beach Science tour was one of the popular options. Petrone provided engaging and valuable instruction to participants when Sun Otter brought tours to campus, helping this new business thrive.

Petrone also helped a local day care provider launch a new weeklong Camp Energy in August. Petrone provided a series of professional development workshops on climate change and renewable energy to instructors at Kids' Cottage Learning Center, which was then able to create Camp Energy for 5- to 9-year-olds. Petrone also helped plan and lead hands-on wind and solar power activities at the camp, which generated an estimated \$3,000 in revenue for the business.

RESPOND BY
Dec. 31, 2018

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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) _____



25th Anniversary Coast Day Crab Cake Cook-off Cookbook

In celebration of this local tradition, we published a cookbook featuring the top three recipes from the past 25 years. Start cooking seafood with the WINNING recipe below!

2017 Finalist



Pecan Crusted Crab Cakes with Fresh Creamed Corn

Lynne Laino, Lewes, DE

- 2 lbs. lump crab meat
- 2 eggs
- 1 tbsp. fresh lemon juice
- 1 tsp. lemon rind
- 1 c. Hellman's mayonnaise
- 1 tsp. yellow mustard
- 2 tsp. Worcestershire sauce
- ½ tsp. hot sauce
- 1 sleeve of saltines, crushed

- 3 c. finely crushed pecans
- Canola oil for frying

Creamed Corn

- 8 ears of corn, cut from the cob (about 4 c.)
- 3 tbsp. butter, divided
- ½ c. diced sweet onion
- 2 finely diced jalapeños
- ¾ c. light cream
- ½ tsp. salt

In a large frying pan, melt 1 tbsp. of butter and cook the onion and jalapeños until very soft. Transfer to the bowl of a food processor or a blender. Melt 2 tbsp. of butter in the frying pan and add the corn, cook and stir frequently for 10 minutes and stir in the salt. Remove ¼ c. of corn for garnish. Add the light cream to the remaining corn, simmer for 5 minutes until slightly thickened. Cool slightly and add to the food processor. Process until almost smooth.

Pick through crab meat to remove any shells or cartilage. In a large bowl, whisk eggs and add the lemon juice, rind, mayonnaise, mustard, Worcestershire, hot sauce and crushed saltines. Stir together and gently toss in the crab meat. Form mixture into cakes. Put the crushed pecans in a rimmed baking sheet and coat each crab cake on all sides.

Heat Canola oil in a large frying pan and cook the pecan crusted crab cakes until golden. Remove to paper towel lined baking sheet.

To serve, spoon creamed corn on a plate, top with a crab cake and sprinkle with the reserved corn. Serve immediately.

To order www.deseagrant.org/crab-cake-cookbook or contact the UD Environmental Public Education Office at 302-831-8083 or marinecom@udel.edu

Proceeds benefit Delaware Sea Grant.

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SCIENCE
SERVING
COASTAL
COMMUNITIES

Seafood Festival
at Coast Day



PRESENTED BY



**FREE PARKING
& ENTRY**

Date:

Sun., Oct. 7, 2018
(rain or shine)

Where:

University of Delaware
Hugh R. Sharp Campus
1044 College Drive
Lewes, DE 19958

Time:

11 A.M.—5 P.M.

Family fun &
educational event!

More Info: **WWW.DECOASTDAY.ORG**



ABOUT DELAWARE SEA GRANT

The Delaware Sea Grant 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.

Delaware Sea Grant is one of 33 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.



Whether educators, communicators or extension agents, Delaware Sea Grant 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's communities prepare for a changing environment and economy

ENVIRONMENTAL LITERACY AND WORKFORCE DEVELOPMENT

Training and supporting the next generation of environmental and scientific leaders



College of Earth, Ocean, & Environment

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DELAWARE SEA GRANT COLLEGE PROGRAM REPORTER

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