

Coastwatch

NORTH CAROLINA SEA GRANT • WINTER • 2020 • ISSUE 4 • \$6.95

SCIENCE IS
EVERYWHERE
*Marine Education's
Boundless Possibilities*



Celebrations and Anticipations: Looking Ahead

As winter arrives, I hope you, your families, and communities are continuing to stay healthy and meeting COVID-19 challenges with renewed energy, personal commitment, and optimism as we look ahead to the spring. I find inspiration in the continued hard work and sacrifices made by people in health care, education, and the many industries that support our everyday needs.

Indeed, North Carolina Sea Grant's partners in research, extension, and education continue to innovate and adapt strategies to successfully meet needs in our coastal communities. There is great, and growing, strength in the range of collaborative approaches needed to sustain economic growth and enhance environmental outcomes.

This issue of *Coastwatch* certainly brings hope as well. We hear about life experiences on the coast, learn about new research findings, and get to know future leaders. And, of course, we also find North Carolina seafood recipes to warm up winter days.

I am always inspired and energized by our team — and I especially want to acknowledge Jane Harrison, who is among three leaders who recently received the Sea Grant Association President's Award for work on a national committee. The honor celebrates her commitment to advancing diversity, equity, and inclusion across the Sea Grant network of 34 programs.

Jane also is a leader here, along with a strong group of people from North Carolina Sea Grant and our partners in the Water Resources Research Institute and Space Grant programs. Together we strive to improve internally in our business practices, as well as externally in our extension, research, and communication programs. Those efforts address a constant need for education, renewals of commitment, and creating resources to achieve long-term impacts.

I, too, will be making more connections between the state and national levels in 2021 as I begin a two-year term as president of the Sea Grant Association. In my SGA roles in recent years, I have witnessed the strength of the national network and the resulting collaborations and opportunities for

our team, researchers, and partners in North Carolina.

Next year also will bring exciting changes for two team members. Terri Kirby Hathaway, North Carolina Sea Grant's marine education specialist, and Nicole McIntosh, who closely partnered with Sea Grant in her Water Resources Research Institute roles, are both moving on to new opportunities.

With over 30 years of state service and a massive network of partners across the state and nation, Terri has proven to be a leader in educational excellence on many scales. She no doubt will continue to serve and contribute in different ways during her retirement. We wish her all the best and sincerely appreciate the significant impacts she made on North Carolinians from the mountains to the sea, as well as on her colleagues in the national Sea Grant education network and the National Association of Marine Educators. We close this issue of *Coastwatch* with an interview with Terri.

Nicole also leaves a lasting footprint on the state, as she organized and advanced important research partnerships with local governments to improve water quality, and to address needs related to stormwater and water supplies. Some of these partnerships focused on coastal issues, in coordination with Sea Grant, and *Coastwatch* has highlighted them in previous issues. After 10 years with us, Nicole is shifting her focus to the full-time jobs of supporting her elementary-aged children and co-managing her family business.

It is an absolute pleasure to work with such high-caliber team members, and we wish them both well in their new adventures.

I see opportunities in the challenges and changes ahead, and I would welcome your feedback on additional ways that North Carolina Sea Grant can continue to engage you to collaborate in support of our wonderful coast.

Also, please consider offering a donation to advance and expand our program's support for student research and other enhanced educational opportunities. You can find our online link at ncseagrant.ncsu.edu/donate.

As always, you can reach me at smwhite3@ncsu.edu. All the best!

— Susan White, Executive Director, North Carolina Sea Grant

IN THIS ISSUE

CONTRIBUTING WRITERS:

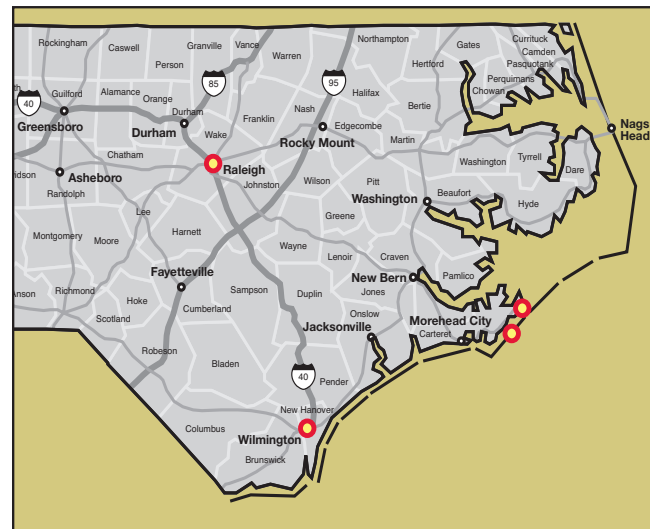
Scott Baker □ Allison Fisk □ Terri Kirby Hathaway □ Julie Leibach
Vanda Lewis □ Sara Mirabilio □ Katie Mosher □ Laura Oleniacz
Lauren D. Pharr □ Dave Shaw □ Sara Spiegler □ Joyce Taylor □ Olivia Vilá

CONTRIBUTING PHOTOGRAPHERS:

Scott Baker □ Ken Blevins □ Jaclyn Bowie □ Evangelyn Buckland
Lance Cheung □ Core Sound Waterfowl Museum & Heritage Center □ Boston Dang
Barbara Doll □ Luca Galuzzi □ Marshal Hedin □ Eric Herbst □ Jeff Janowski
Jared Kay □ Merel Kooi □ Bridgette Kyle □ Marae Lindquist
Vanda Lewis □ Jordan Luebkmann □ Don McCullough □ Baxter Miller
Bonnie Monteleone □ Lauren D. Pharr □ Jordan Ramos □ Meredith Ross
Robert Willett □ and others.

This issue includes images from Florida Fish & Wildlife, NCDOT, NC Fishes, NC Sea Grant, NC State News, NOAA, NWS, US Fish & Wildlife Service, and [VisitNC.com](https://www.visitnc.com), as well as additional photographs available via [Creative Commons.org](https://creativecommons.org) licensing and from other sources.

Settings for the stories in this issue cover numerous locales, including the city of Wilmington, Cape Lookout National Seashore, Walnut Creek Wetland Park, and the small village of Sea Level, North Carolina.



Coastwatch

FEATURES

COASTAL TIDINGS 2

PLAN, RESPOND, RECOVER, ADAPT

Building Resilience in Coastal NC

North Carolina Sea Grant's new coastal resilience specialist tells why resilience means much more than merely "bouncing back." 6

LIFE ON A 'FINGER BETWEEN TWO BAYS'

As North Carolina's shellfish aquaculture industry booms, new and established growers alike turn to Jimmy Morris for sage advice. 14

THE WINDING PATH OF RESEARCH

Flood Risk, Recognition, and the Latino and Latina Community in Wilmington, NC

When nobody showed up for her study, Olivia Vilá changed course — and her work shed new light on environmental justice. 18

N.C. SEAFOOD AVAILABILITY POSTERS insert

PLASTIC, PLASTIC, EVERYWHERE

Plastic pollution globally taints land, air, and water, but new efforts are tackling the problem in North Carolina's aquatic ecosystems. 25

HOOK, LINE & SCIENCE

The Moon, Mystery Fish, and More

Does the moon affect offshore tournament catch rates — and what's that mystery fish on your plate? 31

MARINER'S MENU

Winter Wonders

Follow these easy recipes for delights you can enjoy this holiday season and beyond. 36

NATURALIST'S NOTEBOOK

Sparrows and Rising Seas

Two coastal study sites now support hundreds of saltmarsh and seaside sparrows but might only provide habitat for 25 by 2060. 38

LAST WORD

Science Is Everywhere: An Interview With Terri Kirby Hathaway, North Carolina Sea Grant's Marine Education Specialist

From sinking sodas to seaweed in ice cream, marine education offers plenty to keep K-12 students curious. 41

□ Front Cover: Photograph courtesy of Bridgette Kyle/VisitNC.com
□ Table of Contents: Photograph courtesy of Don McCullough/CC-BY-2.0

Coastwatch

North Carolina Sea Grant • Winter • 2020 • Issue 4

Communications Director
North Carolina Sea Grant

Katie Mosher

Editor

Dave Shaw

Science Editor

Julie Leibach

Contributing Editor

Lee Cannon

Assistant Editors

Lauren D. Pharr & Allison Fisk

Designer

Linda Noble

Since 1970, North Carolina Sea Grant has aligned our goals with the National Sea Grant College Program. We provide research, education, and outreach to serve our state's coast and its communities.

Under executive director Susan White, our primary areas of emphasis include healthy coastal ecosystems, resilient communities and economies, sustainable fisheries and aquaculture, and environmental literacy and workforce development.

NOAA and the State of North Carolina fund our work. By forging enduring collaborations that bridge North Carolina's public and private universities with critical coastal needs, our program fuels discovery, learning, and real-world solutions.

Coastwatch (ISSN: 1068-784X; USPS Periodical # 010464), published quarterly (Spring, Summer, Autumn, Winter) by:

North Carolina Sea Grant

NC State University Box 8605
Raleigh, NC 27695-8605
Telephone: 919-515-2454.

Subscriptions are \$15 per year.
Email: dmsaw@ncsu.edu
URL: ncseagrant.org

Periodical Postage paid at Raleigh, NC

POSTMASTER: Send address changes to:

COASTWATCH

North Carolina Sea Grant
NC State University Box 8605
Raleigh, NC 27695-8605

North Carolina Sea Grant Coastal Offices:

Coastal Studies Institute
Wanchese, NC ☎ 252-475-3663

Center for Marine Sciences & Technology
Morehead City, NC ☎ 252-222-6307

Center for Marine Science
Wilmington, NC ☎ 910-962-2491



Printed on recycled paper. ♻️



Jashira Torres Pabón — shown here snorkeling at an outreach event — is one of four new Knauss Fellows from N.C.



Jashira Torres Pabón

Kayelyn Simmons

Joseph Fader

Cameron Adams

FOUR NEW KNAUSS FELLOWS INCLUDE NC STATE AND DUKE STUDENTS

NOAA and the National Sea Grant Office have announced the finalists for the 2021 class of the Sea Grant John A. Knauss Marine Policy Fellowship program. The 74 finalists include four graduate students from North Carolina: Jashira Torres Pabón, Kayelyn Simmons, Joseph Fader, and Cameron Adams.

“We value diversity, equity, and inclusion in our organization and the communities we serve,” says Susan White, executive director for North Carolina Sea Grant. “Through the Sea Grant Knauss Marine Policy Fellowship, we strive to provide an educational and employment opportunity for current and recent graduate students of all backgrounds, abilities, and perspectives.”

The highly competitive fellowship is a year-long program for graduate students interested in national policy issues affecting ocean, coastal, and Great Lakes resources. Since 1979, over 1,400 fellows have completed the program, becoming leaders in science, policy, and public administration.

The new finalists join more than 80 from North Carolina who have served during the four-decade history of the Knauss Fellowship. North Carolina State University and Duke University each have provided the educational training ground for two finalists this year.

Jashira Torres Pabón earned her master's degree in marine policy and administration at NC State. Through summer internships with

the National Fish and Wildlife Foundation, she has worked on policy and regulatory aspects of the recreational red snapper fishery for her thesis project. She also is an economics research assistant with North Carolina Sea Grant.

Kayelyn Simmons is a Ph.D. candidate in marine science at NC State and holds a master's degree in marine biology from Nova Southeastern University. Her doctoral research uses emerging soundscape tools, along with more conventional approaches, to better assess spatial patterns in reef ecosystems.

Joseph Fader's research as a Ph.D. candidate in Duke University's Nicholas School of the Environment explores the interaction between marine mammals and the long-line fishery and incorporates an economic analysis.

For his master's project, Cameron Adams, also from the Nicholas School of the Environment at Duke, used the latest satellite data and new drone techniques to help landowners track the retreat of their shorelines and coastal habitats.

North Carolina Sea Grant already is accepting applications from North Carolina graduate students for the next class of Knauss Fellows. The deadline to apply is February 19, 2021, at 5 p.m.

• **about the 2021 Knauss Fellows**

go.ncsu.edu/Knauss-Fellows

• **apply for a 2022 Knauss Fellowship**

go.ncsu.edu/Knauss-Fellowship

— Allison Fisk



COASTAL TIDINGS

DO GHOST FORESTS CONTRIBUTE TO CLIMATE CHANGE?

North Carolina Sea Grant and N.C. Space Grant supported a new study that has determined the spread of ghost forests across coastal North Carolina may have implications for global warming.

Ghost forests result from rising seas, which slowly kill off freshwater-dependent trees. Using models created from data on vegetation height and type, the study found 130,000 metric tons of carbon were lost from the spread of ghost forests on unmanaged or natural land on the Albemarle-Pamlico Peninsula.

As ghost forests spread between 2001 and 2014, the terrain released carbon equivalent to annual emissions from 102,900 passenger vehicles, according to

the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator.

“Our paper helps to identify areas that are most vulnerable to the impact of sea level rise and extreme weather events,” says lead author Lindsey Smart, a research associate at the North Carolina State University Center for Geospatial Analytics and former North Carolina Sea Grant — Space Grant joint fellow. “This could help guide land-management decisions and help people think about ways to adapt to these changing environmental conditions.”

NC State's College of Natural Resources also supported this research.

• **read more:** go.ncsu.edu/ghost-forests

— Laura Oleniacz & Allison Fisk

HOOK, LINE & SCIENCE GOES TO JENNETTE'S PIER

As the fall fishing season got underway, Jennette's Pier in Nags Head began offering visitors a new opportunity to learn about coastal fisheries through *Hook, Line & Science*, North Carolina Sea Grant's popular blog series.

The pier, part of the North Carolina Aquariums, features three videos that highlight some of the blog's most popular marine topics:

• Do Fish Shrink After They Die?

- Do You Eat Seafood Three or More Times a Week?
- What Does the Invasive Lionfish Eat?

“It is a natural partnership to share the Sea Grant science outreach with our audiences,” says Mike Remige, director of Jennette's Pier and a member of the North Carolina Sea Grant Advisory Board. In typical years, the pier draws about 300,000 visitors of all ages to view educational exhibits.

Sara Mirabilio and Scott Baker, fisheries specialists at North Carolina Sea Grant, developed *Hook, Line & Science*. “One of our main goals with the blog is to educate anglers about scientific research that relates to fishing,” says Baker.

“We focus on themes that, according to a previous survey we conducted, are of highest interest to North Carolina saltwater anglers,” Mirabilio adds.

Read *Hook, Line & Science* on page 31.

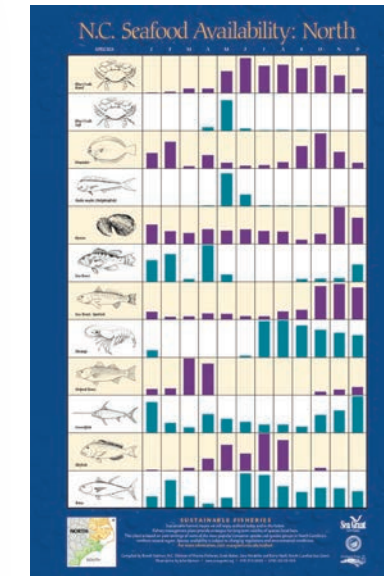
• **Hook, Line & Science:** HookLineScience.com

• **Jennette's Pier:** JennettesPier.net

— Lauren D. Pharr



Jennette's Pier in Nags Head



POSTERS HIGHLIGHT SEAFOOD SEASONS

In collaboration with local and state partners, North Carolina Sea Grant is providing freshly updated *N.C. Seafood Availability* posters to help consumers make educated decisions about the seafood they purchase and enjoy from our state's fishermen, retailers, markets, and restaurants.

Barry Nash, seafood technology and marketing specialist for North Carolina Sea Grant, says the two-sided posters are invaluable depictions of which species of fish are native to northern and southern N.C. waters — and when.

“Most people are familiar with clams, oysters, shrimp, or flounder but are less familiar with other finfish our industry harvests off the coast,” says Nash. “More importantly, most people do not know, given the state's location on the East Coast, that our species are available only in certain seasons.”

Seasonal currents and temperatures mean different species occupy the state's coastal region at different times of the year.

“The posters are great,” says John M. Aydlett, who leads the “Got to Be NC Seafood” campaign for the N.C. Department of Agriculture and Consumer Services. “They help to educate consumers on what's typically available from North Carolina's waters in order to make a decision on what species to purchase and prepare.”

Consumers can find the *N.C. Seafood Availability* posters in the centerfold of this issue or access them at go.ncsu.edu/seafood-poster.

— Lauren D. Pharr & Dave Shaw



Stacy Trackenberg

NEW FELLOW EXPLORES SEAGRASS RESTORATION

Stacy Trackenberg, a doctoral student at East Carolina University, will study seagrass restoration with support from the 2021 joint fellowship from North Carolina Sea Grant and the Albemarle-Pamlico National Estuary Partnership (APNEP).

“Stacy’s fellowship project will tie together existing resources with new approaches to best support seagrass community restoration efforts,” says John Fear, deputy director of North Carolina Sea Grant and the North Carolina Water Resources Research Institute.

The competitive fellowship, now in its fifth year, supports graduate students from institutions based in North Carolina who conduct applied research within the North Carolina portion of the APNEP region. That region covers most of the Albemarle-Pamlico watershed, including the Neuse, Tar-Pamlico, Pasquotank, Chowan, lower Roanoke, and parts of the White Oak river basins.

Trackenberg will study seagrass restoration in Back Sound in Carteret County by transplanting healthy, native seagrass from a donor bed. She says her research will reveal which fish use newly restored seagrass beds.

“I can also compare my previous observations of communities in natural beds with the communities found in these restored beds to see if they support similar communities,” Trackenberg says.

Trackenberg earned a bachelor’s in biology with a minor in marine science from the College of William and Mary in 2016. — Lauren D. Pharr

• **read more:** go.ncsu.edu/seagrass

COASTAL TIDINGS

COASTWATCH PROVIDES FREE RESOURCES FOR TEACHERS

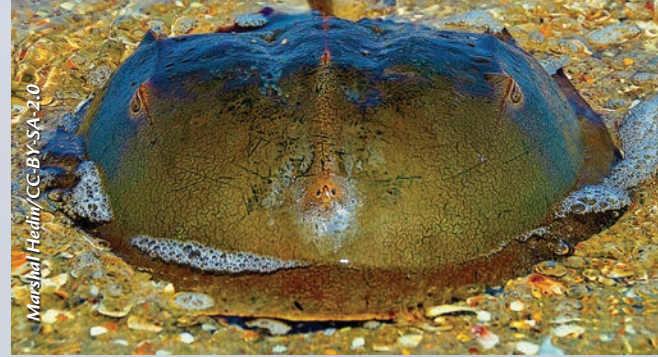
The new *Coastwatch Classroom* offers free online educational resources for teachers in grades 6 through 12.

Each edition of *Coastwatch Classroom* expands on select articles from the magazine through a series of guiding questions and a comprehensive list of related reading materials. *Coastwatch Classroom* also includes the relevant learning criteria under the North Carolina Standard Course of Study, as well as national Ocean Literacy Standards.

“We hope this new resource will open teachers’ and students’ eyes to the fascinating and important coastal research going on in their own state,” says Terri Kirby Hathaway, North Carolina Sea Grant’s marine education specialist, who developed *Coastwatch Classroom*. “I routinely hear from teachers how valuable free, trusted STEM educational materials are.”

The first installments of *Coastwatch Classroom* offer enhanced content for teachers about articles in the Autumn issue of the magazine. The inaugural edition explores how researchers are examining a way to sustainably harvest horseshoe crab blood for an important medical safety test. The second examines how citizen scientists can help monitor water quality.

- **Coastwatch Classroom:** go.ncsu.edu/Coastwatch-Classroom
 - **more educational resources from North Carolina Sea Grant:** go.ncsu.edu/homeschool
- Katie Mosher & Allison Fisk



Marshall Hedim/CC-BY-SA 2.0

Coastwatch Classroom offers teacher resources that complement popular content, including the Fall 2020 issue’s cover story.

CIVIL RIGHTS TRAIL HIGHLIGHTS NC HISTORICAL SITES

With the launch of the North Carolina Civil Rights Trail, visitors will have the opportunity to experience places where leaders and followers lived, learned, and took a stand for social justice. Potential sites stretch from locations in the western part of the state to counties along the coast.

“The national reckoning over systemic injustice heightens the relevance of our effort to develop the N.C. Civil Rights Trail,” said Angela Thorpe, director of the African American Heritage Commission, which is part of the N.C. Department of Natural and Cultural Resources. “Understanding what has come before will inspire and fuel the work ahead. We need to hear the voices and proclaim the victories that have brought us this far.”

The N.C. African American Heritage Commission is leading the initiative with funding from the William G. Pomeroy Foundation and with support from the International Civil Rights Center & Museum, Visit North Carolina, and the North Carolina



Office of Archives & History.

Thorpe says the commission will work with communities around the 50 sites where trail markers will be placed, starting in early 2021. An interactive web portal will highlight these places and others to guide people to history and experiences from the past.

— adapted by Allison Fisk from a press release from the N.C. Department of Natural and Cultural Resources

• **read more:** go.ncsu.edu/trail

COASTAL TIDINGS



NOAA

DEADLINE NEARS FOR COASTAL RESEARCH GRANTS

North Carolina Sea Grant is accepting preproposals until January 11 for projects that use applied research to address problems affecting coastal ecosystems, economies, and communities.

“This opportunity provides funding to tackle real-world problems,” says Susan White, executive director of North Carolina Sea Grant. “We welcome proposals from researchers with a diverse range of experiences and backgrounds, who will bring new strategies to consider coastal, marine, and watershed issues important to North Carolina.”

Proposed projects should reflect North Carolina Sea Grant’s multidisciplinary, integrated program of applied research, outreach, and education, and they should align with one or more primary focus areas: healthy coastal ecosystems, resilient communities and economies, sustainable

fisheries and aquaculture, and environmental literacy and workforce development.

North Carolina Sea Grant strongly encourages proposals from faculty researchers at Historically Black Colleges and Universities, Minority Serving Institutions, and/or from traditionally underserved and underrepresented communities, as well as from faculty who can demonstrate how their work and related outreach will benefit underserved and underrepresented communities. Sea Grant also encourages multi-campus teams.

Additionally, North Carolina Sea Grant funds fellowships, community collaborations, pilot projects, and more.

- **Core Research Grants**
ncseagrant.ncsu.edu/core-funding
- **more funding opportunities**
go.ncsu.edu/sea-grant-funding

— Allison Fisk & Dave Shaw

SEA GRANT OFFERS PAID SUMMER INTERNSHIPS

The National Sea Grant Office’s Community Engaged Internships are available this summer for undergraduates who are from under-resourced, underrepresented, or indigenous and tribal populations.

From June to August, mentors will engage students interested in marine science. Interns will focus on place-based research, extension, education, or communication that respects and integrates local ways of knowing.

The internships will vary and include opportunities involving on-the-ground learning experiences that extend the knowledge of community stakeholders to address coastal or marine issues. Interns also will participate in professional development and training opportunities, peer discussions, and more activities.

The program encourages applicants from groups historically underrepresented in the sciences, including African American, American Indian or Alaska Native, Hispanic and Latino, female, first-generation college students, veterans, LGBTQ+, and students with disabilities. In addition, the program welcomes applications from students who have worked to overcome educational or economic disadvantages or who have personal or family circumstances that may complicate their career paths.

Eligible interns must be undergraduates at a 2-year or 4-year college or university. In North Carolina, applicants should contact North Carolina Sea Grant’s Jane Harrison for more information: jane_harrison@ncsu.edu.

— Dave Shaw



Jane Harrison

HARRISON EARNS NATIONAL ACCOLADES

Jane Harrison, North Carolina Sea Grant’s coastal economics specialist, received the Sea Grant Association President’s Award in October for leadership of the National Sea Grant Diversity, Equity, and Inclusion Visioning Team. Harrison shares the honor with Mona Behl, associate director of Georgia Sea Grant, and Sarah Kolesar, research and fellowship leader for Oregon Sea Grant.

Fredrika Moser, SGA president and director of Maryland Sea Grant, presented the award to Harrison, Behl, and Kolesar.

“They have been fearless in their pursuit of placing Sea Grant in a leadership position on advancing the ideas that a diverse, equal, inclusive, and just Sea Grant network is a stronger and more effective research, education, and outreach program,” said Moser, during the virtual ceremony.

Susan White, director of North Carolina Sea Grant and incoming president of the Sea Grant Association, notes the national committee’s accomplishments in crafting a 10-year DEI vision plan and establishing the Community Engaged Undergraduate Internship Program, which is available to students from underrepresented and indigenous communities nationwide.

“We celebrate Jane’s national role,” White says, “as well as her leadership on diversity topics within our program, on campus, and in the community.”

— Katie Mosher & Allison Fisk

• **North Carolina Sea Grant’s Vision for Diversity, Equity, and Inclusion**
go.ncsu.edu/DEI

PLAN, RESPOND, RECOVER, ADAPT

BUILDING RESILIENCE IN COASTAL NC

BY SARAH SPIEGLER

NORTH CAROLINA SEA GRANT'S
NEW COASTAL RESILIENCE SPECIALIST
TELLS WHY RESILIENCE MEANS
MUCH MORE THAN "BOUNCING BACK."



Bridgette Kyle/VisitNC.com



Don McCullough/CC-BY-2.0

THE N.C. COAST PROVIDES UNLIMITED OPPORTUNITIES FOR ADVENTURE, WHICH KEEPS VISITORS COMING BACK YEAR AFTER YEAR.

A RESILIENT NORTH CAROLINA IS A STATE WHERE OUR COMMUNITIES, ECONOMIES, AND ECOSYSTEMS ARE BETTER ABLE TO REBOUND, POSITIVELY ADAPT TO, AND THRIVE AMID CHANGING CONDITIONS AND CHALLENGES, INCLUDING DISASTERS AND CLIMATE CHANGE; TO MAINTAIN AND IMPROVE QUALITY OF LIFE, HEALTHY GROWTH, AND DURABLE SYSTEMS; AND TO CONSERVE RESOURCES FOR PRESENT AND FUTURE GENERATIONS.”
—THE NORTH CAROLINA OFFICE OF RECOVERY AND RESILIENCE

Most people who have lived in coastal North Carolina or who have visited our coast would agree that we have something special here. Our state boasts quaint coastal towns and over 300 miles of barrier islands with white sandy beaches, including over 100 miles of national seashore. North Carolina also has 12,000 miles of estuarine shoreline, including expansive, shallow sounds on the backside of the barrier islands. These landscapes are home to a wide variety of flora and fauna and provide unlimited opportunities for outdoor adventures, which keeps visitors coming back year after year.

As a full-time resident of coastal N.C.,

I love the smell of the salt air on an afternoon walk and, while on a ferry ride between the barrier islands, delight in seeing a pelican perched atop a buoy. There is the strange sense of mystique and mysteriousness while looking into the water of the creeks, sounds, and inlets that run into the vast openness of the Atlantic Ocean. I still find it thrilling to see a pod of dolphins or a sea turtle pop its head out of the water on the way to Cape Lookout National Seashore, and I feel a peace and calmness that settles over me during a walk down the beach or through a trail in the maritime forest.

As the new coastal resilience specialist for North Carolina Sea Grant, I work with partners

RESILIENCE CAN APPLY TO INDIVIDUALS, FAMILIES, COMMUNITIES, CITIES, THE ENVIRONMENT, AND INFRASTRUCTURE, SUCH AS N.C. 12 ON THE OUTER BANKS, SHOWN HERE AFTER FLORENCE.

NORTH CAROLINA SEA GRANT'S RESILIENCE-BUILDING INITIATIVES

For years, North Carolina Sea Grant has supported community and ecosystem resilience through a variety of projects and initiatives. Examples of past and present work include:

- The N.C. Resilient Coastal Communities Program go.ncsu.edu/NC-communities
- Regional Flood-Resilience Research on Communities and Infrastructure go.ncsu.edu/flood-resilience
- Fortifying Buildings for Hurricanes go.ncsu.edu/fortify-now

go.ncsu.edu/fortify-now

- Coastal Rivers Flood Mitigation go.ncsu.edu/flood-mitigation
- Transportation and Infrastructure Planning in Eastern N.C. go.ncsu.edu/the-road
- North Carolina Sentinel Site Cooperative go.ncsu.edu/Sentinel-Site
- Developing Capacity with the Town of Plymouth go.ncsu.edu/Plymouth
- Long-term Climate Change Planning with the Town of Nags Head go.ncsu.edu/TheLongView

- The Coastal Landscapes Initiative and Related Homeowner Strategies go.ncsu.edu/coastal-landscaping
- Free At-Home Educational Resources During the Pandemic go.ncsu.edu/homeschool
- The North Carolina Sea Grant COVID-19 Resource Hub go.ncsu.edu/COVID-resource-hub
- Research and Information about Climate Change go.ncsu.edu/Coastwatch-climate
- ... and more.



Jordan Liebkentnam

IN 2016, NORTH CAROLINA SEA GRANT AND THE TOWN OF NAGS HEAD COLLABORATED ON A COMMUNITY PLANNING PROCESS THAT PRIORITIZED CLIMATE ADAPTATION.

and stakeholders up and down the coast and throughout the state to help strengthen the resilience of our remarkable communities and natural coastal ecosystems. After having spent the past two years with North Carolina Sea Grant as the coordinator of the N.C. Sentinel Site Cooperative, focusing on the impacts of sea level rise, I understand what an important and challenging task we have ahead of us here.

ECOSYSTEMS AND COMMUNITIES

Resilience can take many forms and mean different things to different people, as is evident from how popular the concept has become in a wide range of media and professional fields. Resilience can apply to individuals, families, communities, cities, infrastructure, the environment, and more. The resilience of a system is now extensively used to communicate how and why we think it is important to support our communities and our way of life.

Being resilient means we can adjust and adapt to change, with our communities well-equipped to recover rapidly from repeated stressors, in both the short term and long term.

In the climate change adaptation field, we often distinguish between “community resilience” and “ecosystem resilience.” In both cases, resilience is the capacity of the community or ecosystem to prevent, withstand, respond to, and recover from a disruption.

These two frameworks are closely connected. The more resilient our ecosystems, the more they provide healthy seafood, recreational opportunities, protection of shorelines and infrastructure, less stormwater runoff, and fewer polluted waterways. Efforts that foster community resilience, like building social capital by forming strong networks and community groups, often closely correspond with the resilience of the adjacent ecosystems. Alongside the benefits of healthier ecosystems, community and social structures help us adapt and build back strongly.

Not surprisingly, more resilient natural systems often result in more resilient communities, and vice versa, bringing more economic and social stability. Protecting the environment can go hand in hand with job creation, for instance, if we take this approach. In fact, innovative and effective

Continued



Lairce Cheung / U.S. Department of Agriculture



Core Sound Waterfowl Museum & Heritage Center

THE AFTERMATHS OF MATTHEW, FLORENCE (HERE), MICHAEL, AND DORIAN ARE JUST SOME OF THE LATEST REMINDERS THAT COASTAL NORTH CAROLINIANS ARE NO STRANGERS TO HAZARDS.

long-term solutions will rely on understanding how ecological, economic, and socio-cultural systems are connected.

At the individual level, we are all familiar with personal resilience and the varying levels of time, energy, and resources it takes to overcome traumatic events in our lives and within our families. Sometimes, these events happen very suddenly, while sometimes they are small, slow, and occur over a long time, resulting in cumulative, chronic stress. Trauma, both short-term and long-term, wears down our ability to bounce back.

At the individual and community levels, we are facing stressors at the coast. Such stressors include sudden events, such as hurricanes, and longer-term, slower changes, such as sunny-day or high-tide flooding. Both types of stressors impede our ability to build stronger, more resilient systems. These and other natural hazards, as well as man-made hazards — such as coastal development, building in low-lying areas, and lack of strict setbacks from eroding shores — make our communities and coastal ecosystems more vulnerable.

PAST, PRESENT, AND FUTURE

Coastal North Carolinians are no strangers to hazards. The grit and determination of people

who have lived in these harsh environments at the edge of the sea, for many generations, is part of coastal North Carolina's history.

The "Ca'e Bankers," for instance, lived in settlements like Diamond City during the 19th century in what is now Cape Lookout National Seashore. For the Ca'e Bankers, the long-term, harsh realities of living in a barrier-island setting became too much to overcome after 1899's Great Hurricane, a storm the National Park Service calls "one of the deadliest hurricanes ever to move through the western Atlantic; possibly a Category 4 Cape Verde storm...with winds that reached 140 mph as it crossed the Banks near Diamond City." After this storm, most of the islanders floated what remained of their homes across the sound to relocate in Morehead City and Down East communities, such as Harkers Island and Marshallberg.

Today, climate change exacerbates the hazards we are experiencing at the coast. The process by which our earth is warming — through greenhouse gases released from burning fossil fuels — is continuously trapping heat that would otherwise escape our atmosphere. Because of increasing temperatures, the hazards that we have always experienced in North Carolina are becoming more extreme.

Jessica Whitehead, chief resilience officer for the state of North Carolina, spoke about the

impacts of climate change in a presentation to the Oak Island Beach Preservation Society this past fall. Whitehead, formerly of North Carolina Sea Grant, said that in our state resilience requires a "triple bottom-line approach, to thinking not just about our environment, but also what it means to our communities, and what it means to have good, healthy coastal economies."

She compared the effects of climate change on coastal hazards to the infamous homeruns during the steroid era of major league baseball in the 1990s, when hitters hit the long ball more often than ever before in the history of the league, and homerun records fell.

As Whitehead also said, "climate change really is a threat multiplier to the challenges that we already are facing along the coast."

AS RECORDS FALL

Hans Paerl at the University of North Carolina at Chapel Hill's Institute of Marine Science in Morehead City published a 2019 study with several coauthors noting six of the state's seven highest-recorded precipitation events had occurred in the last 20 years. Increasing rainfall and hurricanes such as Floyd (1999), Matthew (2016), and Florence (2018) have brought catastrophic flooding, adverse economic impacts, and ecological damage that has included the increased runoff of pollutants

A TRUE CA'E BANKER: DEVINE GUTHRIE, PREACHER, WHALER, AND BOATBUILDER, AS PHOTOGRAPHED AT DIAMOND CITY.

into coastal ecosystems and estuaries.

In the United States, the number of days of sunny-day flooding, also known as high-tide or tidal flooding, has doubled since 2000. The impacts of tidal flooding include overwhelmed sewage treatment plants and public utilities, disruption of transportation corridors, reduced property values, and threats to public health. Sea level rise multiplies the impacts. In North Carolina, by 2060 the city of Wilmington will experience almost a foot of sea level rise, under NOAA's lowest sea level projections, and potentially as much as 2 to 4 feet as the global climate continues to warm over the next 40 years.

Higher temperatures will result in significant challenges for coastal habitats and communities, including many of the places on the North Carolina coast and around the country that are of important cultural, social, ecological, and economic value. 2019 marked our state's hottest year in history.

The ball is flying farther and faster. Hurricanes "on steroids," with more rainfall and strength, are crossing into higher latitudes.

All while sea levels rise and records fall.

Yet, more people are moving to the coast. In 2010, 52% of people in the United States already lived in coastal watershed counties and 39% in coastal shoreline counties. Population projections in North Carolina have suggested further increases of 8% in our coastal watershed counties by the end of this year.

In the past, adaptation to climate change was a last resort, with efforts focused first on mitigation — slowing down climate change by decreasing the amount of carbon dioxide released into the atmosphere. In addition to mitigation efforts, however, now adaptation also has become a vital strategy to adjust to the changes that we already are experiencing in our communities and natural habitats.

Resilience offers a framework to manage risk and decrease our vulnerability to present and future climate change impacts and to prioritize and coordinate our efforts. The process of building resilient systems fosters the ability to plan, respond, recover, and adapt in a changing system.

BOUNCING FORWARD

In the past few years, resilience has shifted in emphasis from the old idea of "bouncing back" from a disturbance to "bouncing forward." A homeowner, for example, might decide to rebuild after a hurricane destroys a bulkhead on their property with a living shoreline, a technique that in some locations can better protect homes from future storms and sea level rise.

What is the "new normal" in a world with climate change, and how do we plan for future conditions?

As hurricanes become more frequent and intense, as sunny-day flooding becomes a common occurrence, building resilient systems will require addressing complex, wicked, and tangled challenges with innovative solutions. Solutions must also be fair and equitable, especially because communities facing the greatest risks from climate change often have the fewest resources to address them.

In addition, the scale of the solutions must match the scale of the challenge at hand. While remembering to turn off our lights as we leave a

Continued

room will help on an individual level, slowing down and adapting to climate change will require decreasing fossil fuel use and switching to other forms of renewable energy at local, state, and national levels — and it will require large-scale, coordinated adaptation efforts.

Whitehead and others have noted a number of actions individuals can take:

- learning flood risk (by visiting fris.nc.gov);
- building the lowest floor of new infrastructure above known flood levels and adding a safety buffer (the “freeboard,” which the FEMA National Flood Insurance Program uses to measure the additional height above base flood elevation);
- avoiding first-floor enclosures;
- exploring living shorelines and other ways to reduce marsh erosion on your property; and
- purchasing flood insurance (for owners and renters).

In addition, Holly White, principal planner for the Town of Nags Head and a Sea Grant partner on several projects, also recommends: reaching out to flood officials to ask about historical flooding and mitigation for your property; elevating mechanical and electrical equipment; using flood-resistant materials below base flood elevation; and elevating heated living spaces.

On the community level, we can build resilience by taking steps such as:

- mapping and documenting lessons learned from previous storms;



WHAT IS THE “NEW NORMAL” IN A WORLD WITH CLIMATE CHANGE, AND HOW CAN WE PLAN FOR FUTURE CONDITIONS?

WHAT IS THE NC CLIMATE RISK ASSESSMENT AND RESILIENCE PLAN?

The NC Climate Risk Assessment and Resilience Plan is a framework to guide state action, engage policymakers and stakeholders, facilitate collaboration across the state, focus the state’s attention on climate resilience, and address underlying stressors.

This plan provides:

- our best understanding of the projected change in the climate;
- climate justice impacts;
- state infrastructure, assets, programs, and services within 11 critical sectors that are vulnerable and at risk to climate and non-climate stressors;
- actions currently underway; and
- recommendations for nature-based solutions

to enhance ecosystem resiliency and to sequester carbon in the state’s natural and working lands.

The NC Climate Risk Assessment and Resilience Plan also describes next steps for implementing and updating resilience initiatives.

Of particular note, Chapter 5 discusses the tropical systems that frequent our state:

“North Carolina is one of the three U.S. states that experiences the most tropical storm activity. Coastal communities throughout North Carolina have been dealing with the impacts of coastal storms and sea level rise over their entire history, but vulnerability and risk continue to increase with rising population and growth. Storms and sea level rise will certainly continue, and recent storm trends and flooding have been at historical levels of intensity.”

The same chapter also looks ahead at planning efforts:

“To advance towards the goal of climate resiliency, cabinet agencies must work together with our local, private, and academic partners... Increasing climate resilience in coastal North Carolina requires working together to adapt to climate-related extreme events and long-term risks, by integrating resilience thinking and actions into our way of working and living. Increased resilience in a changing climate preserves economic, natural, and cultural resources; minimizes social disruption and displacement from extreme events; and lessens the need for disaster recovery spending.”

The NC Climate Risk Assessment and Resilience Plan, including all appendix reports, is available online.

DEQ.nc.gov/ncResiliencePlan.



COORDINATED, WIDE-REACHING, AND HOLISTIC APPROACHES CAN MAKE OUR COMMUNITIES AND ECOSYSTEMS MORE RESILIENT.

- participating in resilience and hazard planning efforts;
- incorporating future conditions like sea level rise into land-use planning and architectural design;
- encouraging natural and nature-based solutions like wetland restoration;
- exploring grants that fund building back stronger, higher, and in less risky places; and
- limiting the size of structures near flooding sources.

Susan White, executive director of North Carolina Sea Grant, says that taking steps to create a resilient coast remains a high priority.

“North Carolina Sea Grant continues building on our history of initiatives through significant research investments and outreach partnerships to address community planning, risk assessment, and aspects of construction that foster a more resilient North Carolina coast,” White says. “Several new projects and future opportunities will expand our focus

on resilience and our work with coastal communities.”

Ultimately, considering resilience in all its forms, in all its contexts, likely will require extremely difficult decisions about how and where we live as the impacts of coastal hazards become more extreme in our communities — decisions not unlike the ones the Ca’e Bankers of the 1800s faced.

In the fall of 2018, North Carolina governor Roy Cooper passed Executive Order 80 (EO80), “North Carolina’s Commitment to Address Climate Change and Transition to a Clean Energy Economy.” This led to the publication of *The NC Climate Risk Assessment and Resilience Plan*, a comprehensive effort to address vulnerability to climate change at a state level. That plan included input from numerous stakeholder groups and scientists, including North Carolina Sea Grant partners and stakeholders.

I look forward to my expanded role as coastal resilience specialist for North Carolina Sea Grant, especially as the program builds more partnerships and funds research prioritizing coordinated, wide-reaching, and holistic approaches to make our communities and ecosystems more resilient. Our state faces many challenges, but by working together North Carolinians can adapt and bounce forward. 🌊



THE NC CLIMATE RISK ASSESSMENT AND RESILIENCE PLAN INCLUDES A FOCUS ON INFRASTRUCTURE AND SERVICES THAT ARE VULNERABLE TO STRESSORS.

Life on a 'Finger Between Two Bays'

JIMMY MORRIS BEGAN CLAM FARMING IN THE EARLY 1980S AND BUILT A THRIVING, HIGHLY ADAPTABLE FAMILY BUSINESS. TODAY, GROWERS AND UNIVERSITIES ALIKE IN OUR STATE HAVE LEARNED TO RELY ON HIS EXPERTISE.

BY KATIE MOSHER

Jimmy Morris (left) chats with Sea Grant's Chuck Weirich after a day of research in 2018.



Resilience is a way of life for Jimmy Morris, founder of Morris Family Shellfish Farms and the Mill Point Hatchery in the small village of Sea Level, located in Carteret County's Down East communities.

Often described as the dean of North Carolina shellfish mariculture, Morris began clam farming in the early 1980s. Phillip "Skip" Kemp, then a member of the North Carolina Sea Grant extension team, introduced Morris to the idea of growing shellfish.

Morris has a scientific streak that builds on

Morris remains a grower, and a key partner in Sea Grant's shellfish aquaculture research and outreach. Eric Herbst, who joined Sea Grant this summer as the coastal aquaculture specialist based in Morehead City, notes he connected with Morris early on.

"I was immediately impressed with his wealth of knowledge, not only of shellfish biology, but also gear and strategies, along with the business elements of mariculture," Herbst says.

Back in the 1980s, Morris had made a slow but steady shift from being a fifth-generation commercial fisherman to becoming a full-time

and harvesting. And as others saw his success, a small growers' cooperative evolved.

"A lot of growers were fishermen in the same predicament that I was," Morris recalls. "I helped a lot of them get started." He still sells seed to some of those growers and their families, along with new oyster farms.

Weathering the Storms

The first decade set a pace for the Morris operations.

"From early on, he recognized the value of diversification, starting out farming clams and quickly expanding to include oysters,"

The Morris operation (left) includes a hatchery and nursery for oysters and clams. Students were among key members of a pre-pandemic Sea Grant research team (right) that identified best methods and gear for oyster growout in various locations along the coast.

his natural curiosity and observations from years of working waters and land. Those combined skills prompted him to start the state's first and still longest-serving shellfish hatchery, initially set up in a fish house he estimates was built in the 1920s.

shellfish farmer, drawing upon his knowledge of working the waters of Core Sound, Styron Bay, and Nelson Bay.

He looked to mariculture as an opportunity to provide a balanced annual income by controlling the cycles of planting

Herbst says. "He also diversified his business operations to become vertically integrated, first growing-out clams and oysters for the half-shell market, and later expanding to include hatchery and nursery operations."

Continued

But along the N.C. coast, the best-laid plans must be adapted to prepare for and respond to coastal storms.

In 2003, Hurricane Isabel destroyed the Morris family home, along with the original hatchery, nursery, and grow-out operations, totaling about 8 million clams. Learning from that storm, and recognizing that his land is “a finger between two bays,” Morris built a much stronger hatchery on higher pilings.

Getting the hatchery running allowed him to grow oysters to a stage known as eyed larvae, which the state needed for reef restoration and creating new oyster sanctuaries. “I earned money to continue rebuilding,” he recalls.

The Morris family also adapted how the farms were planted, choosing water-based gear that was better fortified to withstand hurricanes’ wave energy.

But in 2018, the farm again suffered significant damage as Hurricane Florence hit the docks, water tanks, and building, taking all his seed. The storm even moved a cast-iron pump off a pier that was already six feet off the water. “Hurricane Florence was 130 mph at Cape Lookout,” he recalls, “But Ocracoke didn’t get anything.”

Morris worked through 2019 and into 2020 in recovery mode, which included locating cages that had been carried into the woods. “I lost 1,000 and got about 800 back. The others must have gone out into the ocean,” he speculates.

But post-Florence water flow from inlets, along with favorable winds, also seemed to change the water chemistry during 2019. That was fine for his site, he says, as the higher salinity “keeps the oysters salty and growing.”

Science and Experience

In shellfish culture, hatcheries include algae production for food, broodstock conditioning, spawning, hatching, larval culture, setting, and nursery operations. Morris now provides millions of oyster and clam seed to shellfish growers.

The Morris operation is often described as among the largest shore-based nursery systems on the East Coast. Through connections with hatcheries from Florida to Maine, he not only can help provide stability in seed supply for N.C. growers, but also gain information on innovations and new technology.



Eric Herbst



Baxter Miller

The new N.C. Shellfish Farming Academy (above) has included field trips to the Morris Family Shellfish Farms and the Mill Point Hatchery in the Sea Level community. Morris (below) started growing shellfish in the early 1980s after shifting from a career in commercial fishing.

Morris also has been a key partner with coalitions to restore reefs, producing more than 100 million oysters that were stocked in coastal oyster sanctuaries. He had the first contract to provide spat larvae for the state of North Carolina, which were set on shell to continue growing in designated estuarine waters. Restored reefs improve ecosystems, with some larvae even riding currents out of the formal sanctuary boundaries and boosting wild growth.

Today, three generations of the Morris family work in the aquaculture business. In busy times, they employ up to 10 workers from rural Down East communities. His nephew led

tours for the N.C. Shellfish Farming Academy, which launched earlier this year.

Through the academy, North Carolina Sea Grant and Carteret Community College are providing lessons for new growers, as well as folks who may want to start a business. Funded by a grant from the National Sea Grant College Program and the National Oceanic and Atmospheric Administration’s aquaculture program, the academy is so popular that a second session was quickly added this fall.

“We take classes out to see his operation to get an idea of the work involved managing things at that scale,” explains Bryan Snyder, a mariculture associate with North Carolina Sea



Robert Willett/Raleigh News & Observer

Hurricane Florence damaged the Morris aquaculture operations, displacing hundreds of cages used to grow oysters to maturity — but Morris and the family business rebounded and adapted.

Grant. A few years back, Snyder was a student at CCC, and Morris was among his mentors for a research project.

Morris knows that results of demonstration projects are shared with competitors, but he sees the value in supporting the broader community.

Scientists from NC State University, the University of North Carolina at Chapel Hill, UNC Wilmington, and other universities, along with their graduate students, often seek out Morris as a collaborator. Those projects are not just on aquaculture topics. They include studies ranging from how soundscapes affect oyster larvae recruitment to the development of seagrass restoration approaches using clams, as well as studies of shellfish bacteria and their effects on humans and ecosystems.

“I am impressed with the long-standing relationship he has with North Carolina Sea Grant, serving as an industry partner or collaborator in multiple applied-research projects over the years,” Herbst notes.

A current initiative looks to diversify the shellfish species grown in the state. Dave Cerino of CCC leads a team looking at potential for crops of sunray venus clams, and the research team includes Ami Wilbur, who heads the shellfish hatchery at UNCW.

Morris has tested the clams and provides real-water perspective that identifies how survival and growth are based on changing salinity. Those changes can be especially strong when a storm may bring a flush of freshwater

runoff downstream to some leases.

In recent years, Morris also has worked with Oyster South, a group that includes growers, researchers, gear businesses, restaurants, and others who support the industry. One project provided a digital microscope that he uses in research — and to demonstrate shellfish growth to visitors.

For example, high-resolution images reveal hard clams just two weeks old. “These clams are getting busy,” he explains. “They’ll be crawling before too long.”

The Morris farm was a demonstration site for a gear research project led by former Sea Grant aquaculture specialist Chuck Weirich, who praises the personal connections that Morris makes. “He may not be one to go to meetings, but he will take time to talk one-on-one,” says Weirich, who moved to the National Sea Grant Office in 2019.

Looking Ahead

Earlier this year, the N.C. Local Foods Council featured Jimmy Morris as a local seafood champion.

And now, on any given day, you will find him on the phone, fielding questions about how to grow oysters and clams. Beginners to experienced growers stop to chat about challenges and expectations for new gear, weather forecasts, and much more.

When Ryan Bethea, owner of Oysters Carolina, was making his own shift to shellfish

farming, he did an externship with Jimmy’s son James, who also grows shellfish. Bethea met and learned from Jimmy, too. “We couldn’t be here without them,” says Bethea, who continues to pay forward those connections in his own outreach efforts in the industry and beyond, such as participating in a Sea Grant video about mariculture careers.

In November, Morris hosted a field trip for the second session of the shellfish academy, answering questions and explaining gear and business choices.

And while a global pandemic has brought new challenges throughout the state’s shellfish supply chain this year, Jimmy Morris still sends shellfish to restaurants throughout the region and state, and has maintained a special connection to the Sea Level NC restaurant in Charlotte.

Down East customers also know to check the coolers at Lookout Grocery. Over the years, online orders have come from as far away as Florida and Texas.

As 2020 comes to a close, Jimmy Morris has no plans to retire. “This body is made to move,” he says with a chuckle. 📍

- [information and resources about aquaculture:](https://go.ncsu.edu/Sea-Grant-aquaculture) go.ncsu.edu/Sea-Grant-aquaculture
- [aquaculture in Coastwatch:](https://go.ncsu.edu/Coastwatch-aquaculture) go.ncsu.edu/Coastwatch-aquaculture



Wilmington's winding Cape Fear River

Mr. Tim DC/CC BY-ND-2.0

THE WINDING PATH OF RESEARCH

BY OLIVIA VILÁ

Flood Risk, Recognition, and the Latino and Latina Community in Wilmington, NC

When nobody showed up for her study, a social scientist changed course. Now, her findings shed new light on a key component of environmental justice.

Integrating principles of citizen science and environmental justice into decision-making and policy-making processes may help address water-related inequities. My own research focuses on disaster and natural hazards, but graduate students, as well as emerging researchers and scholars, can draw lessons from a range of disciplines and across research topics.

My original research proposed helping the Latino and Latina community map their flooding concerns and community assets. I thought doing so could create a more accurate representation of flood risk for this population. Before going into the field, I recognized I needed to work with collaborators in the community who already had established trust with the Latino and Latina community, especially because the schedule for my study did not allow enough time for me to genuinely build up trust in that community.

Because of this, I connected with El Centro Hispano at the University of North Carolina Wilmington. Together, the El Centro team and I discussed strategy, revised research materials, and coordinated bilingual volunteers who could help recruit and run the interactions with participants.

The results? My first day of data collection arrived and no one except for the research volunteers showed up.

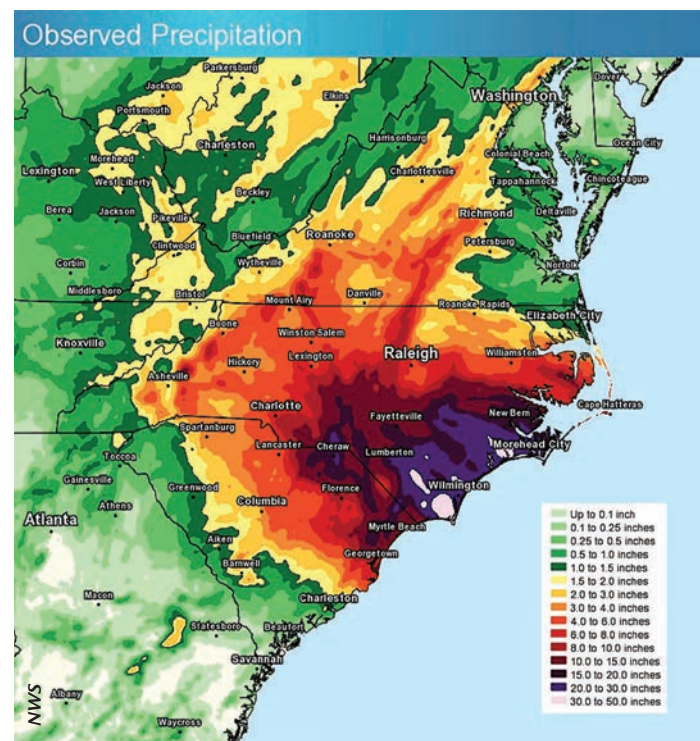
I was devastated. My initial reactions were that I had selected a terrible venue for participants to meet and that I should have done more outreach and promotion.

Still, my gut was telling me something different: No matter what venue I picked or how much outreach I did, nobody would show up.

TAKE 2

For research to reflect the needs of a community, it must involve that community in the process. So, instead of sticking with my original plan, which I had developed in academic isolation, I decided to go back to the drawing board. This time, I devised a research plan in collaboration with the Latino and Latina community, integrating the community into the scientific process.

I spent the next several months immersing myself in the community and having conversations with stakeholders who knew it much better than I did. I also went to community meetings and got to know the



Wilmington was ground zero for Florence's deluge, but measuring precipitation is far easier than understanding the fallout from flooding for a marginalized community.



The results that began to emerge from Olivia Vilá's groundbreaking work unexpectedly helped define her identity as a scholar.

socio-political landscape of the study area. Through this iterative and collaborative process, my research design evolved in a way that aligned with community needs and context, while still adhering to the broad goals I had

set forth in my original research proposal.

This meant that my study shifted in a couple of meaningful ways.

First, my research population changed from the Latino and Latina community in Wilmington to the individuals and organizations who work with that community. As I had come to find out, there were deep issues of fear and distrust of outsiders — barriers that I couldn't overcome within the timeframe of a short study cycle. In addition, by researching the individuals and organizations who worked with the Latino and Latina community in Wilmington, I actually was able to focus my research on better understanding issues associated with flood events and recovery for the population I wanted to target.

Second, instead of creating community-relevant maps of flood risk for geographically-identified areas of importance to the Latino and Latina community — where they live, work, and enjoy recreation — I'm creating network maps of the people and organizations who can

support the Latino and Latina community to better prepare for, respond to, and recover from flooding events.

Although environmental justice work had inspired my original intention with maps, what I hadn't considered was that the population I was hoping to help by mapping their spaces didn't want to be mapped. In fact, the population I hoped to help feared interactions with government and political processes.

So, while the new research design was more feasible and more relevant, was it still useful for my study's goals? Was my research completely sidetracked because my original plan didn't work?

On the contrary, the results that began to emerge in the data unexpectedly illuminated the thread, the theoretical framework, that was going to help define my identity as a scholar.

WHAT IS ENVIRONMENTAL JUSTICE?

Historically, environmental injustices have been documented in terms of the disproportionate exposure to environmental risks and hazards that people of color and low-income populations face. However, some of the most recent discussions in environmental justice have begun to highlight how environmental injustice also is a matter of recognition, political representation, and participation.

Continued



Ken Blevins/Star-News

Vilá's research revealed different levels of recognition of the Latino and Latina community and its experience with flooding in Wilmington.

For example, it is not enough simply to know if flooding impacts the Latino and Latina community. I must also ask if and how flooding disproportionately impacts the community. Do those in power understand who flooding disproportionately impacts? Do people in power respect the perspectives and experiences of people in the community who experience flooding? Do people who feel the impacts of flooding participate in decision-making?

The findings emerging in my study seem to be consistent with environmental justice research. Through my engagement with people and organizations involved in disaster response, recovery, and hazard mitigation, it became clear there are different levels of recognition of the Latino and Latina community in Wilmington. Additionally, leaderships appear to play an important role in facilitating that recognition. Those variations in recognition seem related to the extent to which the organization or local officials could, or would, effectively serve that community.

In other words, inequity in the distribution of resources and risks seems to be, at least in part, related to the awareness and understanding of marginalized populations.

As a disaster social scientist, the finding that recognition may be an important component for equitably serving marginalized communities is especially exciting, because recognition remains one of the least understood components of environmental justice.

The answers to the questions my study posed will not only be relevant for decision-making and policy-making associated with flooding, natural hazards, or disasters; such findings can inform any process that results in the distribution and allocation of risks and resources.

LOOKING AHEAD

Community members and organizations who have collaborated on the project have been receptive to the research findings. To continue

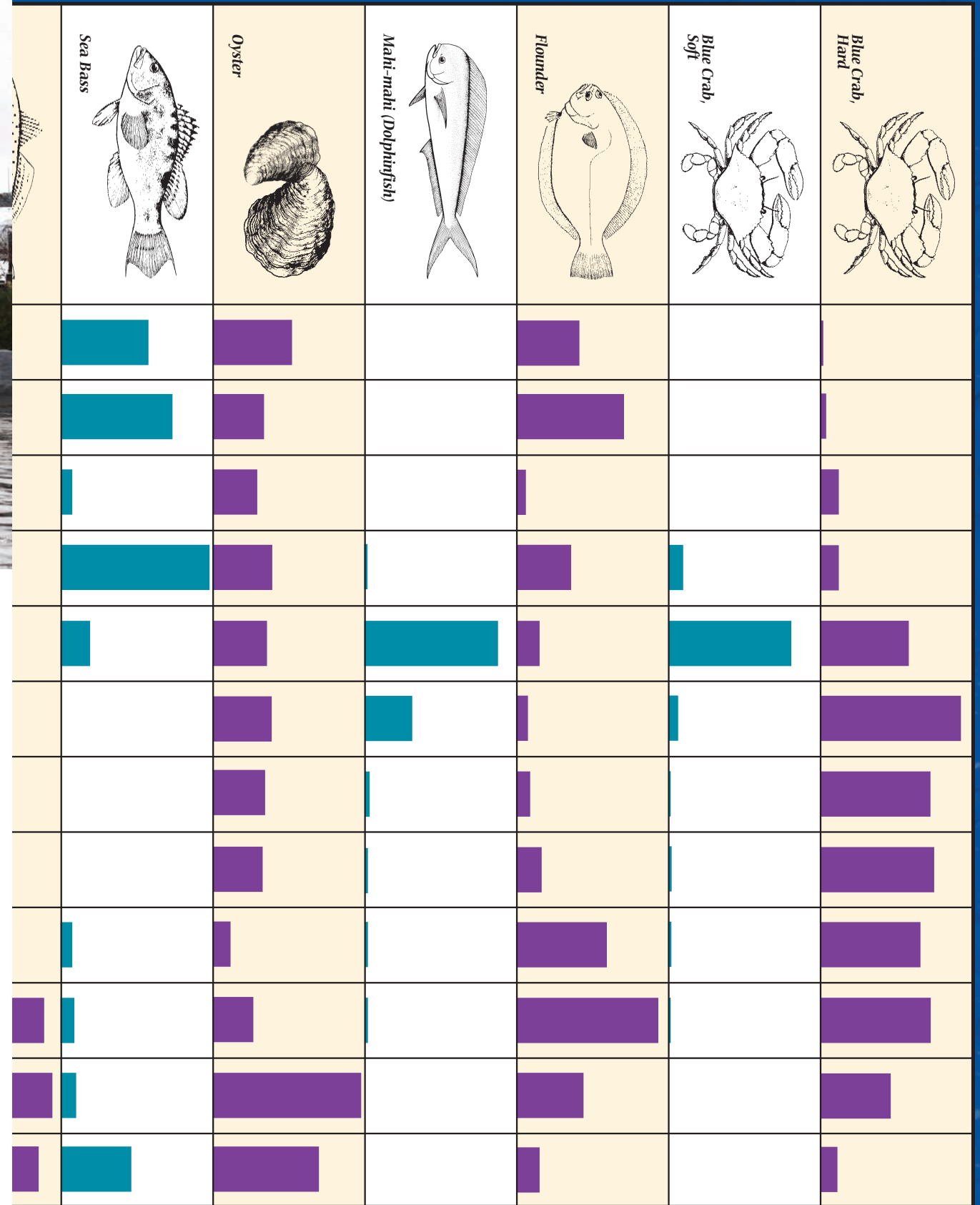
to build and nurture partnerships, I plan to work with stakeholders in the community as I analyze my results, and, based on my research, as we then develop products the community can use. I also hope to bring the work directly to the community.

I plan to present this research in summer 2021 at the annual Natural Hazards Workshop and Researchers Meeting in Boulder, Colorado, where I hope to share findings at one of the most diverse conferences I've ever attended.

When I started this study, I had misrecognized the study population I was trying to research, which ultimately led to research methods that were not effective. However, more culturally appropriate and relevant research methods ultimately yielded better and more practical research. 📍

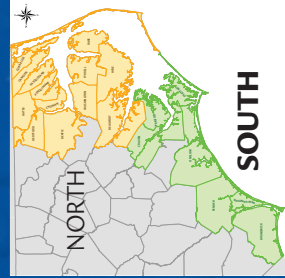
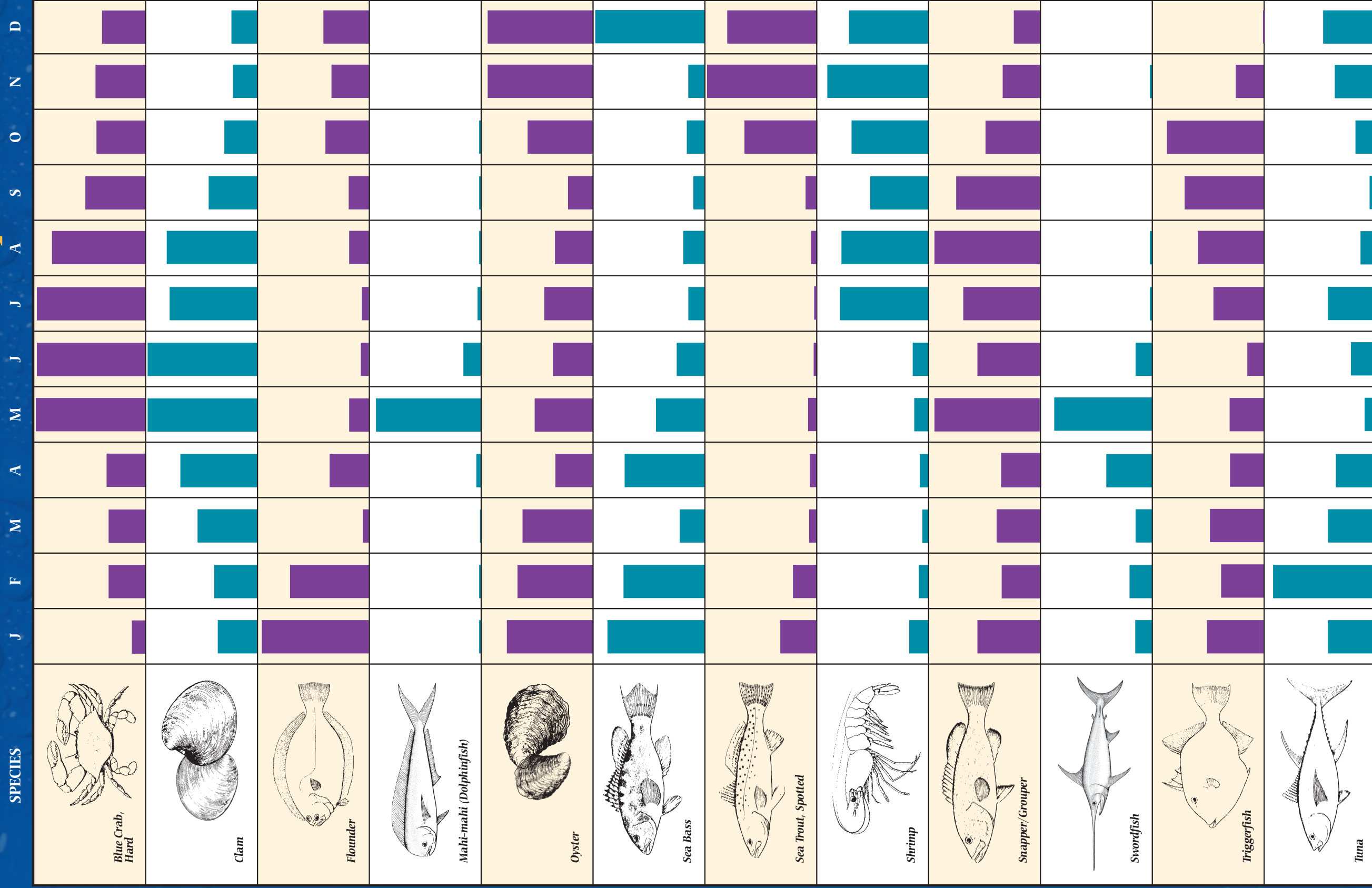
Olivia Vilá received a joint North Carolina Sea Grant - NC Water Resources Research Institute Graduate Research Fellowship and is a doctoral student at North Carolina State University.

- North Carolina Sea Grant - NC Water Resources Research Institute Graduate Research Fellowship: go.ncsu.edu/ncsg-wrri-fellows
- more fellowships available through North Carolina Sea Grant: go.ncsu.edu/fellowships



N.C. Seafood Availability: North

N.C. Seafood Availability: South



SUSTAINABLE FISHERIES

Sustainable harvest means we will enjoy seafood today and in the future. Fishery management plans provide strategies for long-term viability of species listed here. This chart is based on past landings of some of the most popular consumer species and species groups in North Carolina's southern coastal region. Species availability is subject to changing regulations and environmental conditions. For more information, visit: ncseagrant.ncsu.edu/seafood.

Compiled by Brandt Salmon, N.C. Division of Marine Fisheries; Scott Baker, Sara Mirabilio and Barry Nash, North Carolina Sea Grant. Illustrations by John Norton • www.ncseagrant.org • 919-515-2454 • UNC-SG-20-10B





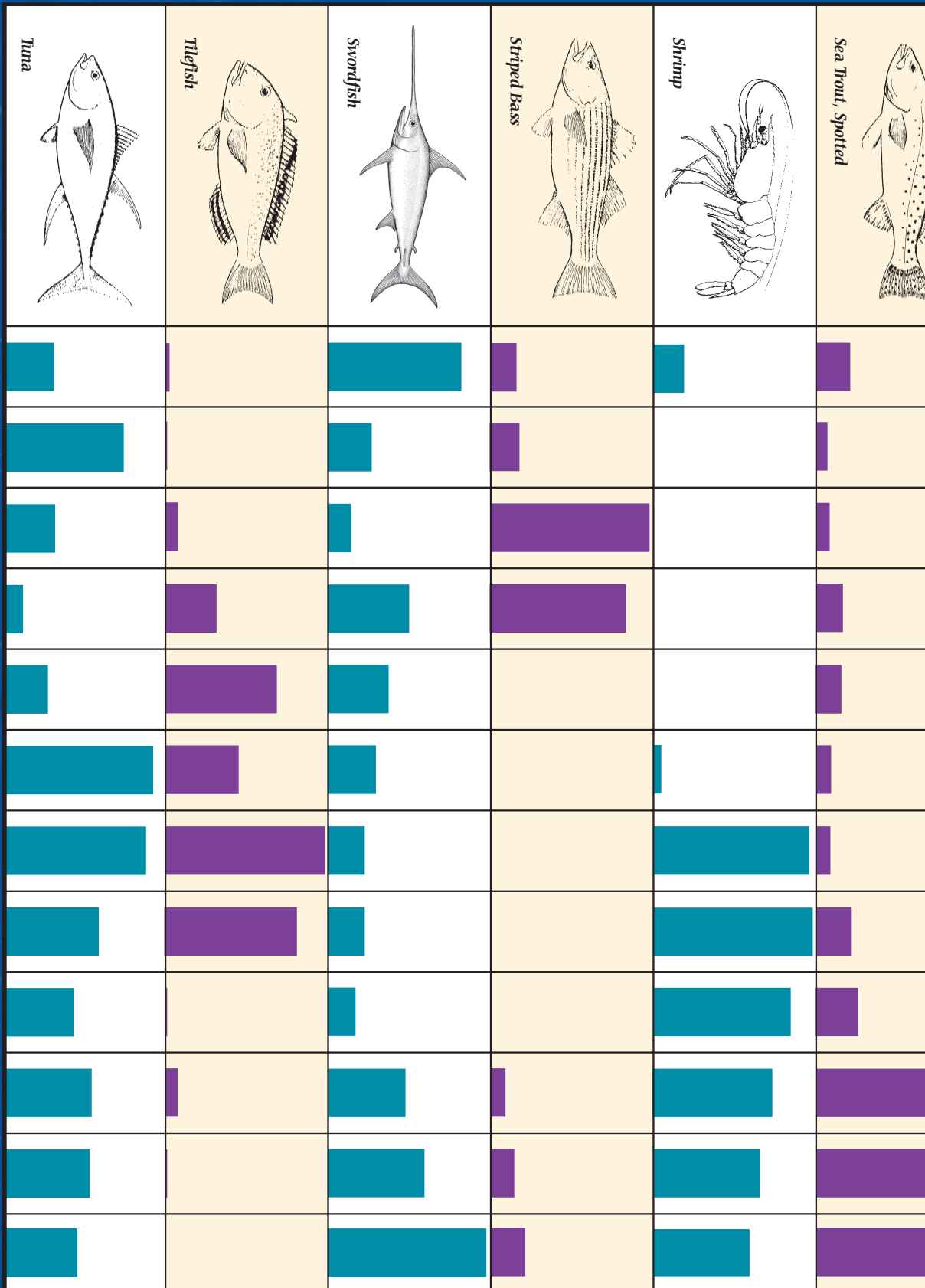
BY JULIE LEIBACH

PLASTIC, PLASTIC, EVERYWHERE

PLASTIC POLLUTION GLOBALLY TAINTS LAND, AIR, AND WATER. NORTH CAROLINA IS RAMPING UP EFFORTS TO BETTER UNDERSTAND AND TACKLE THE PROBLEM IN AQUATIC ECOSYSTEMS.

PLASTIC POLLUTION COMES IN A CONTINUUM OF SIZES AND SHAPES.

Merel Kooi/Wageningen University & Research



SUSTAINABLE FISHERIES

Sustainable harvest means we will enjoy seafood today and in the future.

Fishery management plans provide strategies for long-term viability of species listed here. This chart is based on past landings of some of the most popular consumer species and species groups in North Carolina's northern coastal region. Species availability is subject to changing regulations and environmental conditions.

For more information, visit: ncseagrant.ncsu.edu/seafood/.

Compiled by Brandt Salmon, N.C. Division of Marine Fisheries; Scott Baker, Sara Mirabilio and Barry Nash, North Carolina Sea Grant. Illustrations by John Norton • www.ncseagrant.org • 919-515-2454 • UNC-SC-20-10A



When Durham-based artists Jaclyn Bowie, Nyssa Collins, and Anna Wagner set out to create an outdoor sculpture made of rubbish at Walnut Creek Wetland Park, they wanted their subject to resonate with the local community. The urban nature center, located a short drive from downtown Raleigh, is popular with school groups, families, and other visitors.

“What would be something that many people of many different ages and backgrounds could connect to?” Bowie recalls wondering.

Inspiration struck when the trio was collecting trash for their piece from Walnut Creek, part of the Neuse River watershed. Inside a waterlogged tire, they spied a small catfish. Intrigued, they later researched catfish and came across the Carolina madtom (*Noturus furiosus*), a diminutive freshwater species native to the Tar and Neuse river basins. The fish has nearly disappeared from the latter because of habitat loss and water quality degradation, among other problems, and the N.C. Endangered Species Act considers it “threatened.”

In that 5-inch fish the artists found their muse — only their sculptural rendition is larger-than-life and composed almost entirely of litter they gathered from local waterways and

diverted from dumpsters. Stretching 20 feet and weighing an estimated 800 pounds, the finished piece is stuffed to the gills with sundry discards such as a car bumper (it adds shape to the frame), DVDs (they lend sheen to the eyes); a hobbled carousel horse, and “tons of plastic bottles.”

“It puts art supplies in a new light,” Wagner says.

The formidable fish out of water is also a stark symbol of how much refuse can be found in river systems. As conduits to the sea, rivers are prime channels for marine debris, a catchall term to describe solid, manufactured,



Lauren D. Pharr



NCFishes.com

DURHAM ARTISTS CREATED THIS SCULPTURE OF A CAROLINA MADTOM CATFISH OUT OF TRASH. THE SPECIES, *NOTURUS FURIOSUS*, IS NATIVE TO THE NEUSE AND TAR RIVER BASINS.

or processed material that ends up in the marine environment.

“A lot of times we throw things away and think that they don’t exist anymore,” Collins says. Their sculpture is a reminder that “the things that you discard are still around, and we need to reckon with them.”

WADING THROUGH

Plastic pollution is a global environmental threat.

“Plastic has been found in fresh and salt water, sediment like sandy beaches and soils, and in our food,” says Sarah Latshaw, Southeast

regional coordinator for the National Oceanic and Atmospheric Administration’s Marine Debris Program.

Last September, researchers reporting in *Science* estimated that in 2016, 19 to 23 million metric tons, or 11%, of plastic waste generated globally entered aquatic ecosystems, including freshwater and marine environments. The team predicted that annual emissions could reach up to 53 million metric tons per year by 2030, despite ambitious global reduction efforts.

When it comes to marine debris, plastic forms the majority of pollution. Usually between 60 and 90% of the trash that gathers on



Jaclyn Bowie

USING LITTER, MEMBERS OF CONSERVATION CORPS NORTH CAROLINA HELPED CREATE THIS SIGN, LOCATED AT WALNUT CREEK WETLAND PARK.

shorelines, the sea surface, and the sea floor is made up of one or more plastic polymers.

Plastic litter occurs in an array of shapes and sizes, from dozens of feet long to practically invisible to the naked eye. The tinier pieces, known as microplastics, occur through two means: Either they are purposefully manufactured — one example is plastic pellets, or nurdles, which are melted down to make other items — or they form when larger plastic pieces degrade or fragment. The breakdown of so-called macroplastics is the primary way that those miniscule pieces form.

Our understanding of the health and ecological impacts of plastic pollution ranges from well-documented to limited. Where macroplastics are concerned, the deleterious effects can be easy to see. For example, derelict fishing gear can entangle marine mammals, seabirds, and sea turtles, among other creatures.

Marine debris might also contribute to the spread of invasive species by providing artificial habitats. Indeed, researchers have found species rafting on marine litter outside of their typical range.

In 2013, scientists described a rich microbial community that lives on plastic litter — the “plastisphere.” A recent paper noted that understanding how those microbes affect processes like plastic degradation and chemical cycling is “an important area to explore.”

Meanwhile, macro- and microplastic ingestion has been documented in a host of organisms spanning the food chain. Filter feeders such as oysters are among the organisms most susceptible to microplastic ingestion.

Lab experiments have found microplastic exposure to cause reduced feeding, survival, and reproductive success in organisms such

as mussels, oysters, copepods, and lugworms. However, such studies typically use particle sizes that are smaller, or concentrations that are greater, than those generally reported in the field.

“It’s the dose that makes the poison,” says Bart Koelmans, an environmental scientist who studies microplastics at Wageningen University in the Netherlands. For any chemical, “you cannot say it’s inherently safe or toxic.”

For now, experts like Koelmans generally consider the ecological risks of microplastics to be rare. However, if emissions remain the same or increase, he says, it’s not a matter of if, but rather of when, adverse effects become widespread.

PATHWAYS FOR PLASTIC

Plastic marine debris comes from a variety of sources, both land-based and sea-based.

On the water, ships lose cargo, garbage

Continued

floats off boats, and fishing gear goes rogue, to name a few means of dispersal. Deliberate dumping occurs, too.

Globally, one of the largest contributors to marine debris is poor waste management on land. Trash and particles can escape at any point in the process due to inadequate procedures.

Even seemingly proper waste disposal can go awry. For instance, “materials that are placed in blue recycle bins, at your curb, could become marine debris on a windy day,” says Lisa Rider, executive director of Coastal Carolina Riverwatch.

Unbridled plastic can eventually escape terra firma by sliding down storm drains, riding on wind, or washing into rivers — the routes are many.

In 2017, a study published in *Nature Communications* estimated that rivers alone potentially deposit more than 2 million metric tons of plastic waste into the ocean each year. A related paper, submitted for publication by *Science Advances*, found small urban rivers to be among the most polluting.

Here in North Carolina, no studies to date have quantified the amount of plastic in our coastal waters, or estimated how much is coming from rivers, according to Barbara Doll, North Carolina Sea Grant’s water protection and restoration specialist and a faculty member of NC State University’s Biological and Agricultural Engineering Department.

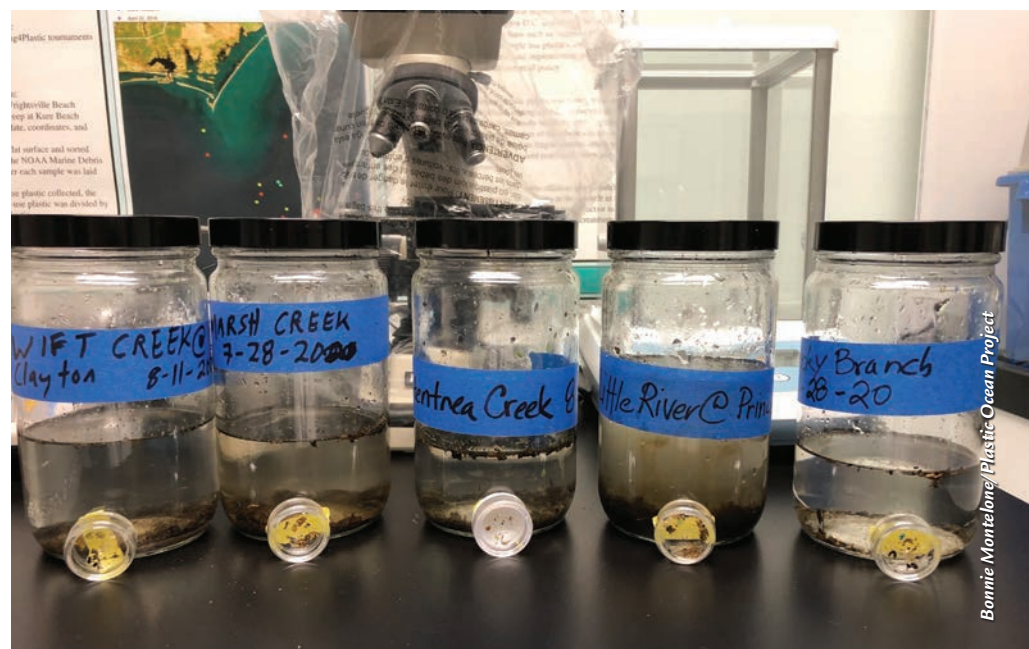
To that end, Doll, along with N.C. Sea Grant coastal resources and communities specialist Gloria Putnam and NC State University research associate Jack Kurki-Fox, are investigating the plastic that wends into coastal waters from inland sources.

With funding from NOAA’s Marine Debris Program and National Sea Grant Office, they are sampling what kinds of plastic, and how much, course through the Neuse River watershed, which drains an area of nearly 5,600 square miles to Pamlico Sound, North Carolina’s largest estuary.

The sampling sites cover a range of drainage areas and a variety of land use. While



USING PVC PIPES, BUOYS, AND WIRE FENCING, RESEARCH ASSOCIATE JACK KURKI-FOX ASSEMBLED A DEBRIS COLLECTOR BASED, WITH PERMISSION, ON A DEVICE CALLED THE LITTER GITTER, PATENTED BY OSPREY INITIATIVE, AN ENVIRONMENTAL CONTRACTOR.



BONNIE MONTELEONE, EXECUTIVE DIRECTOR OF PLASTIC OCEAN PROJECT, IS ANALYZING WATER SAMPLES FROM THE NEUSE RIVER BASIN TO QUANTIFY THE TYPES AND AMOUNTS OF MICROPLASTICS THEY CONTAIN.

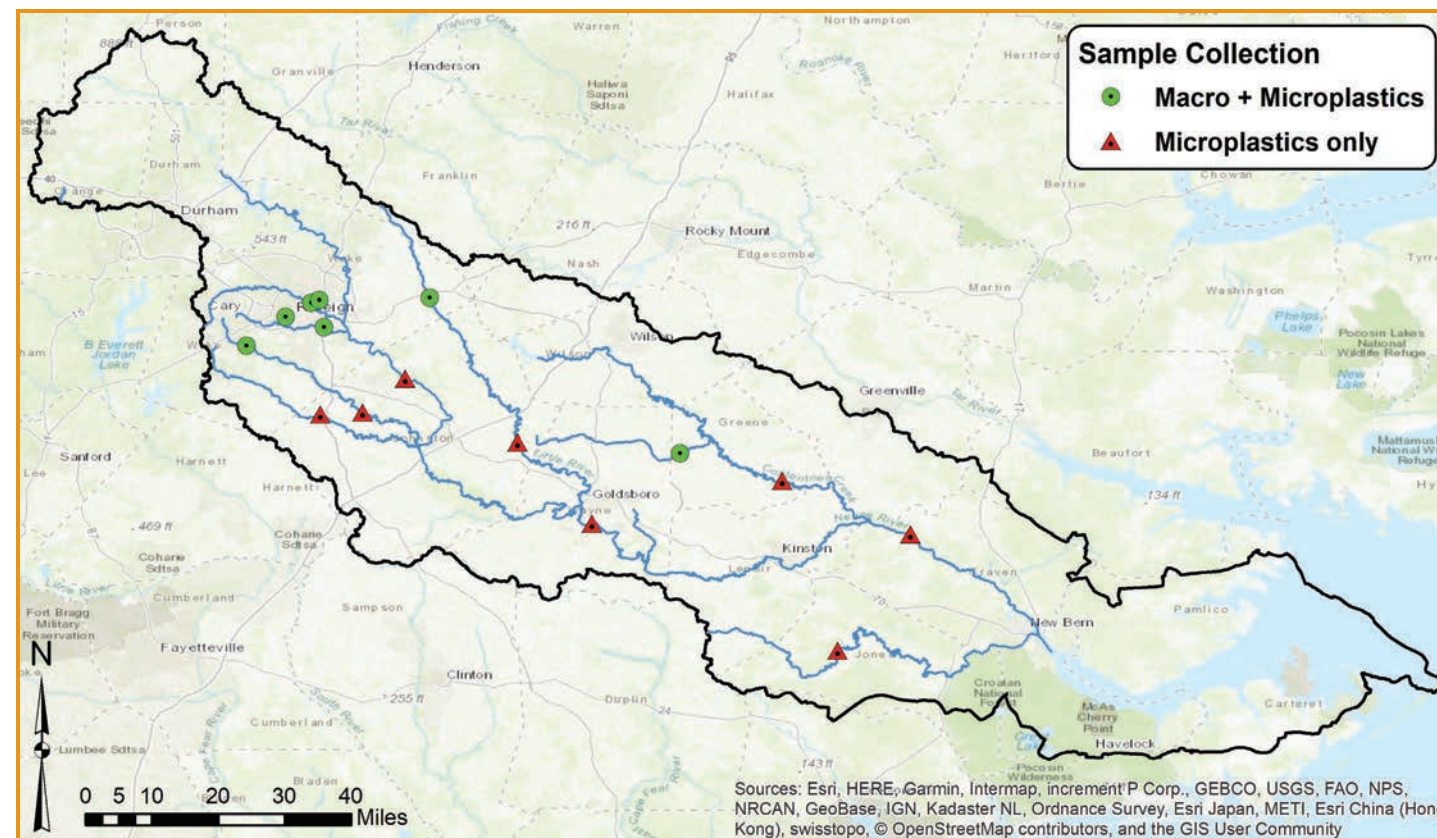
the upper watershed is highly developed, agricultural and forested land dominate the lower portion.

At 15 sites, the team is using a fine mesh net to gather samples of microplastics for later analysis in the lab by the nonprofit organization Plastic Ocean Project, based in Wilmington.

At seven of those sites, the researchers are also

gathering data on macroplastics through visual assessments, as well as by physically collecting trash and taking stock of the haul.

“How much of this trash is coming from urban versus rural areas into our rivers?” Doll says. “We hope to identify relationships between watershed characteristics and the type and amount of micro- and macroplastics you find.”



A RESEARCH TEAM IS GATHERING LITTER FROM 15 SITES WITHIN THE NEUSE RIVER BASIN AS PART OF A STUDY ON PLASTIC LOADING INTO PAMLICO SOUND.

The study will end about a year from now, but the team already has some preliminary data. For example, during a recent visual assessment on a rainy day at Marsh Creek in northeast Raleigh, in under 30 minutes Putnam counted nearly 150 plastic containers — mostly drink bottles — floating downstream, among other litter.

“This method of counting floating plastic provides a low-cost tool to help us characterize how much and what kind of material is moving through our urban waterways to the Neuse River,” Putnam says.

Simply considering the Marsh Creek tally, it’s no wonder that artists Bowie, Collins, and Wagner had plenty of media to build their sculpture.

TAKING OUT THE TRASH

Battling the juggernaut of plastic pollution demands a multipronged approach.

“Plastic is complex, but society is

even more complex, and there is no silver-bullet solution for the plastic problem,” says Koelmans of Wageningen University.

One important approach entails curbing plastic consumption. “By reducing waste at the source, or making purchases that reduce waste through reuse, you are working towards eliminating the possibility of consumer marine debris,” says Rider of Coastal Carolina Riverwatch.

For its part, North Carolina is addressing the challenge of marine debris through state and regional efforts. For example, in 2019, representatives from agencies and organizations in Georgia, South Carolina, and North Carolina completed the Southeast Marine Debris Action Plan, an effort to improve coordination throughout the Southeast region over the next three years.

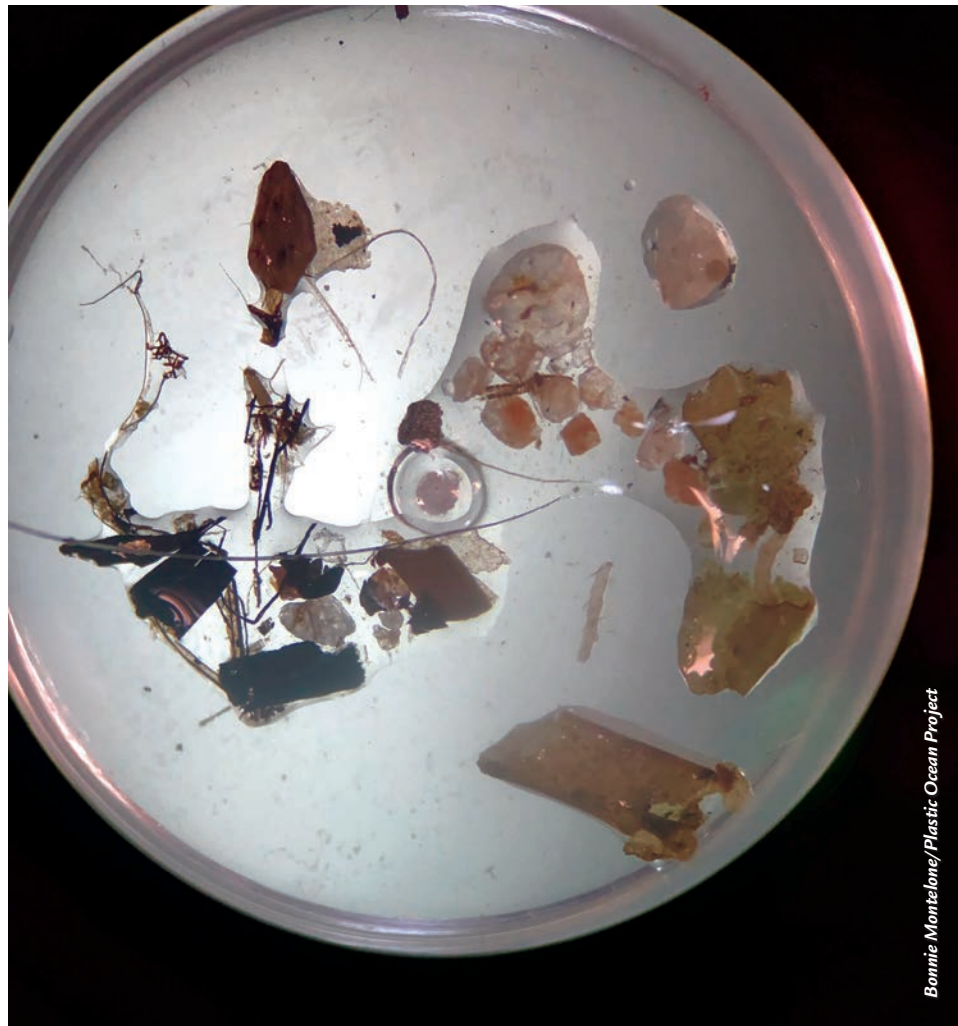
Meanwhile, in January 2020, the state unveiled the North Carolina Marine Debris Action Plan, which provides a framework

for prevention and removal of marine debris along the coast. The leadership team included members of North Carolina Sea Grant, the North Carolina Coastal Federation, the North Carolina Coastal Reserve and National Estuarine Research Reserve, the North Carolina Marine Debris Symposium, and Coastal Carolina Riverwatch.

“The North Carolina Plan’s leadership team and stakeholders participated in the development of the Southeast Plan to ensure both plans complemented each other,” says NOAA’s Latshaw. “While the Southeast Plan is focused on broad regional topics to reduce marine debris within and across state borders, the North Carolina Plan is able to focus on specific state actions.”

Goals of the state plan include improving construction practices to reduce marine debris caused by storms and flooding, expanding volunteer cleanups, funding contractors

Continued



Bonnie Montelone/Plastic Ocean Project

AN EXAMPLE OF MICROSCOPIC DEBRIS COLLECTED BY RESEARCHERS FROM N.C. SEA GRANT AND NC STATE UNIVERSITY'S DEPARTMENT OF BIOLOGICAL AND AGRICULTURAL ENGINEERING.

to annually clean public waterways and lands, wrangling abandoned vessels, and understanding the extent and type of plastic pollution in N.C. waters.

"I think that the collaborative group has done a really great job to do check-in calls or check-in virtual meetings with folks that are interested in keeping the [N.C.] plan updated and fresh," says Rider, who founded the N.C. Marine Debris Symposium. "We don't want this plan to just sit on a shelf. We want it to be a plan that evolves over time."

In February 2020, the Town of Beaufort became the first community to officially endorse the state plan. "The vast amount of debris and toxins going into our waterways

is unsustainable," Mayor Rett Newton proclaimed, according to the *Carteret County News-Times*. "It is bad for the health of our citizens and visitors, bad for the health of our amazing coastal ecosystem, and it is bad for commerce. We must greatly reduce (and eventually eliminate) these pollutants."

SEEING THE LIGHT

Raleigh Arts, part of the city's Parks, Recreation, and Cultural Resources Department, originally put out a public art call for a litter sculpture as part of Mud Day. The community festival, held at Walnut Creek Wetland Park, is designed to celebrate nature.

Bowie, Collins, and Wagner had planned

to include members of Conservation Corps North Carolina — a group of young people who work on outdoor projects — to help them collect trash for their catfish installation, but plans changed when Mud Day was canceled because of the COVID-19 pandemic.

But the artists were still able to include Conservation Corps in a smaller, related project: a wetland-themed sign featuring a yellow-bellied slider and a blue heron, adorned with local litter.

Despite the setbacks, the artists were pleased with their project. "It was so nice to bring art to people who hadn't necessarily gone to seek it out," Wagner says.

The litter sculpture struck a chord with Raleigh resident Christy Perrin, who, as North Carolina Sea Grant's sustainable waters and communities coordinator, has collaborated with Walnut Creek Wetland Park on various projects.

"It makes me very happy to see a local animal species shared with the community in a beautiful way," Perrin says. "For me, it is a poignant connection between the trash that we throw away and the animals that our actions impact." 🌱

- **North Carolina Marine Debris Action Plan:** go.ncsu.edu/NCMarineDebrisPlan
- **Southeast Marine Debris Action Plan:** go.ncsu.edu/SEMarineDebrisPlan

For more on plastic pollution in the marine environment:

- **A Scientific Perspective on Microplastics in Nature and Society**, by *Science Advice for Policy by European Academies*, 2019: sapea.info/topics/microplastics
- **Marine Litter: Vital Graphics**, published by *UN-Environment, GRID-Arendal*, 2016: grida.no/publications/60

Scott Baker



The Moon, Mystery Fish, and More

The Latest Science for Anglers

BY SCOTT BAKER AND SARA MIRABILIO

DOES THE MOON AFFECT OFFSHORE TOURNAMENT CATCH RATES?

Yes — and moon phase influences some gamefish more than others.

A few weeks ago, I captured this image of the moon during mid-afternoon. It reminded me that the phase of the moon can have an impact on anglers' catch rates.

I dug into the archives to pull out this popular and still often-cited research study from 2007. It may be a little dated by fisheries science standards, but readers take heart: Many of the gamefish examined occur throughout the world, and scientists can predict the movements of the moon and earth for at least another 50 million years!

• Research Need

Competitive anglers will use any tool or information available to catch more fish — or, in the case of offshore fishing tournaments, to catch more fish than the next boat catches.

Environmental signals can and do alter the behavior of wildlife, including fish. Perhaps the most consistent environmental signal is the lunar calendar (new moon to new moon, 29.5 days). But, most fisheries work has revealed that catch rates and lunar phase are often species-specific.

Furthermore, most of the research has focused on commercial fisheries. Compared to marine recreational fisheries, large quantities of high-quality landings records offer scientists easy access to data on a much larger scale.

But, fear not, recreational anglers. There is another venue where high-quality angler catch records exists — as part of almost every highly regulated (and often financially incentivized) offshore sportfish tournament.

• What did they study?

Scientists collected anglers' "catch-per-unit-effort records" from 145 offshore fishing tournaments in New South Wales, Australia, during a 9-year consecutive period. They separated their analyses by different types of tournaments (e.g., shark or marlin), given the differences in fishing practices, and cross-checked them with the moon phase.

The research focused on eight popular

Continued

gamefish: black marlin, blue marlin, striped marlin, blue shark, shortfin mako shark, tiger shark, yellowfin tuna, and dolphin fish. Incidentally, the black and striped marlin are the only two of these species not found in the Atlantic Ocean off North Carolina.

• **What did they find?**

Scientists found a relationship between catch rates and lunar phase for 5 of the 8 species as shown here. Note that researchers determined no significant trends for blue marlin, striped marlin, and tiger shark.

Species	Moon Phase with Highest Catch Rates
Black marlin	between full moon and last quarter
Blue marlin	(no relationship)
Striped marlin	(no relationship)
Blue shark	new moon
Shortfin mako shark	first quarter
Tiger shark	(no relationship)
Yellowfin tuna	first quarter
Dolphin fish	first quarter

This was a large dataset, representing 145 tournaments, 381 fishing days, and 14,319 total fish. The majority of these fish were marlins

(43%), yellowfin tuna (27%), and dolphin fish (17%).

• **What should anglers know?**

The scientists speculated that the species' prey (baitfish) also moved in association with lunar cycles, although they did not test for this in the study.

In addition, the differences in observed catch rates by species could be due to biology. For example, some species may be able to pursue and capture prey during more segments of the lunar cycle than others.

— Summary compiled by Scott Baker

DOES THE TYPE OF HABITAT AFFECT JUVENILE FISH?

Research shows sportfish generally have higher populations in natural and restored habitats.

• **Research Need**

The loss of estuarine habitats is impacting wildlife in ways that scientists don't yet fully understand. Restoration efforts are helping to address the effects of these losses. But what happens when different species require different coastal habitats? A one-size-fits-all habitat restoration approach may benefit some species over others.

Quantifying the number and condition of juvenile fish by species across habitats can help us to determine whether habitat restoration efforts are benefiting species we want to protect.

• **What did they study?**

Researchers in Florida studied how juvenile sportfish fare in different kinds of habitats: natural, restored, and "impacted" — ecosystems that urbanization has affected.

The scientists used historical images to initially determine how to classify estuary habitats. Researchers then looked at population density (the number of fish within a defined area), fish growth, habitat composition, and other factors to determine where juvenile sportfish thrive.

The research team focused much of their efforts on common snook, but also looked at over a dozen other species including 4 species popular with anglers: black drum, red drum, sheepshead, and spotted seatrout.

• **What did they find?**

Scientists determined that the population density of juvenile sportfish was generally greatest at natural sites. They also found that restored sites did well, too, sometimes better than natural sites. Both natural and restored sites did better on average than impacted sites.

Snook appeared to be widespread across sites, showed the most growth, and were in the best condition at natural and restored sites as opposed to impacted sites.

Some habitats with specific features were dominated by high numbers of a single species.

For example, while researchers found juvenile sheepshead at all sites, high numbers were associated with shoal grass and oysters. Juvenile red drum were high in number at a single site close to the inlet and associated with mud and rock. In contrast, juvenile black drum were found along marsh grass shorelines. Finally, juvenile spotted seatrout were found in the highest numbers in red mangrove and oyster rocks.

• **Anything else?**

Prey fish may be a good indicator of habitat suitability. Sites with a high diversity of prey fish fostered better growth for snook.

The researchers also suggested that water transparency could influence prey-predator interactions for snook, because clear water allows prey to see predators more easily.

• **So what?**

These results indicate that restoring habitats is worthwhile when trying to protect sportfish and that considering multiple kinds of habitat and species requirements is important when we design restoration efforts.

Researchers suggest that "targeted" habitats — restored habitats that account for the requirements of specific fishes — offer the best solution.

Assessing past efforts will help to increase understanding of the best practices for coastal estuarine habitat restoration.

— Summary compiled by Allison Fisk and Scott Baker

HOW WILL CLIMATE CHANGE AFFECT SPAWNING AMERICAN SHAD?

By the 2090s, the spawning season for American shad could begin 12 days earlier.

American shad are on the move right now. These fish migrate down rivers to the ocean and south during the fall and winter.

Historically, American shad have supported important sport and commercial fisheries along the Atlantic coast. However, overfishing and the construction of dams, which block spawning migrations, have depleted many shad populations. Federal and state resource agencies are working to restore

American shad to many North Carolina rivers throughout the state.

Recreational and commercial fishing, pollution, habitat loss, and industrial water sewage also impact "anadromous" species of fish, which spend most of their life cycle in saltwater but move upriver from the sea to lay their eggs.

But what role is climate change having on the life cycles of some of our anadromous species?

Warmer water plays a significant role in the life cycles of aquatic fishes, as water temperature can serve as one environmental cue for spawning to begin. Will warmer temperatures lead to earlier-than-normal spawning in shad?

• **Research Need**

The American shad, an anadromous fish whose populations in the Hudson River Estuary in New York have dramatically decreased, are very important to both commercial and recreational fishing. With stocks in the Hudson River and other locations along much of the U.S. East Coast becoming so low, there is concern that these population numbers will not recover naturally.

Researchers want to know whether warmer temperatures are affecting the reproductive cycle of the American shad. And, if so, how so?

• **What did they study?**

To understand the effects of water temperature on the reproductive cycle of the American shad, researchers collected and analyzed long-term temperature data from Poughkeepsie Water Treatment Facilities, daily air temperature data from the North American Land Data Assimilation System, and fish egg count data from the Hudson River Monitoring Program.

Their results made it possible to develop models to project future temperature changes in the Hudson River estuary to help predict the spawning life cycle of the American shad and other fish species.

• **What did they find?**

Ovary development increased in the American shad as water temperatures

Continued



Florida Fish and Wildlife/CC BY-ND 2.0

Some sportfish fare well in both natural and restored habitats.



Will warmer temperatures lead to earlier-than-normal spawning in American shad?

US Fish & Wildlife Service

increased. The onset of spawning seasons appears closely linked to mean and peak June water temperatures in the study area. With warming waters, the spawning season for American shad is predicted to begin 12 days earlier by 2090 and be 3 days shorter overall.

• *Anything else?*

The Hudson River Fisheries Unit has developed an American shad recovery plan. With new practices, the closure of the Hudson River American Shad fishery, and habitat restoration, Hudson River Fisheries Unit predicts that American shad numbers will be in a steady state of recovery over the next several decades.

• *So what?*

Because these results indicate that the

rate at which ovaries mature in American shad increases as water temperatures rise, American shad will lay their eggs earlier in the year as waters continue to warm.

Researchers predict that water temperatures in the Hudson River will continue to increase over the next century and acknowledge that factors not examined here — like changes in availability of zooplankton (prey for American shad), or the introduction of new invasive species — may also alter these model results.

Projection models from this study will help in predicting effects on reproduction and spawning cycles of American shad. Furthermore, these modeling systems will be essential for understanding the current and future effects of climate change on other marine fishes.

— Summary compiled by Lauren D. Pharr

WHAT'S IN YOUR PLATTER?

We might have enjoyed pangasius without even knowing it.

• *Research Need*

Pangasius fish, primarily *Pangasius hypophthalmus* (commonly called “tra” or “swai”) and *Pangasius bocourti* (“basa”), belong to the Pangasiidae family of catfish. This imported, farm-raised, low-cost freshwater fish has white flaky flesh, a delicate texture, and a clean taste.

Pangasius is one of the fastest growing fish commodities — if not the fastest growing — on the U.S. market. The fish first appeared on the U.S. market around 2005, entered the National Fisheries Institute’s top 10 consumed seafoods in the U.S. around 2009, and has held the No. 6 spot every year since 2011.

For a species to remain in the top 10 consumed seafoods in the United States is a significant achievement. This list alone makes up 86% of all the U.S. seafood consumption, and the U.S. is only behind China and Japan in terms of total seafood consumption.

As of 2002, federal government regulations have allowed only North American catfish to be labeled as “catfish.” However, during the early rise of pangasius in the U.S. marketplace, packagers labeled pangasius as “catfish” and competed directly with North American native catfish in the Ictaluridae family.

Yet, if pangasius is popular enough with American consumers to make and move up in the top 10 list, why is it consumers rarely see pangasius (or “tra,” “swai,” or “basa”) on restaurant menus? Americans consume roughly 70% of their seafood in restaurants, but if restaurants are using pangasius, are they labeling the fish as something else or not labeling it at all?

• *What did they study?*

Scientists collected 47 different fish products at 37 restaurants in a single Southeast city. The fish products represented three categories: (1) items labelled as “catfish”,

(2) expensive items labelled as “grouper” and other species, and (3) items generically labelled as “fish” with no further identification given (e.g., as “Fish of the Day” or in a “Fish Platter”). Restaurants prepared the fish in various ways, offering grilled, deep-fried, pan-fried, blackened, crusted, and raw products.

The research team purchased each product as a take-out meal and immediately transported it to the lab to determine whether the product was a pangasius species or not. Additional analysis identified whether those products testing as pangasius species were tra, swai, or basa.

• *What did they find?*

Fourteen of the 47 fish products sampled (nearly 30%) were pangasius species, all of which were tra or swai. None of the 14 had been labeled on restaurant menus as pangasius (or as tra, swai, or basa).

Nine fish samples in the study were not identified at all on menus, and six of these tested as pangasius. Of 15 fish products labeled as “catfish,” researchers confirmed that four were pangasius, not domestic catfish. Finally, of the 18 dishes that menus identified as

“grouper,” four actually were pangasius.

Analysis of menu pricing revealed that restaurants used pangasius as a stand-in both for high-priced fish dishes and cheaper ones.

• *Anything else?*

Researchers described cooked grouper fillet as generally thicker than that of pangasius, separating in large flakes or chunks with a firmer texture. The team characterized pangasius as a thin fish fillet that often crumbled easily into small pieces.

• *So what?*

Although this research only looked at restaurants in a single city, all that pangasius brought into the U.S. each year has to go somewhere — and it seems probable that other restaurants throughout the U.S. also serve pangasius. Compared to similar but previously conducted studies, pangasius mislabeling or lack of labeling appears to be on the rise.

Seafood mislabeling continues to be a problem in the U.S. and other parts of the world. Always ask about the identity of the fish you purchase. 📷 — Summary by Scott Baker

HookLineScience.com

Pangasius with rice and red pepper.



cyclonebill/CC BY-SA 2.0



Vanda Lewis

• *Classic Oyster Dressing*



Vanda Lewis

• *Striped Bass Chowder*

Winter Wonders

BY VANDA LEWIS
AND JOYCE TAYLOR

MARINER'S MENU, ONE OF THE FASTEST-GROWING SITES FOR SEAFOOD RECIPES ON THE WEB, FEATURES BLOGGER AND PHOTOGRAPHER VANDA LEWIS'S PICTURES WITH RECIPES THE LATE JOYCE TAYLOR DEVELOPED. LEWIS SELECTED THESE DELIGHTS TO ENJOY THIS HOLIDAY SEASON AND BEYOND.

CLASSIC OYSTER DRESSING

- 2 cups oysters, drained, liquid reserved
- 6 cups French bread, cut into small cubes
- 4 tablespoons butter
- 1 cup celery, chopped
- 1 cup onion, chopped
- 1 teaspoon poultry seasoning
- 1 teaspoon dried thyme leaves
- 1/2 teaspoon salt
- 1/2 teaspoon black pepper, freshly ground
- 1 egg, beaten

Toast the bread until golden brown. Meanwhile, melt butter in a small saucepan. Lightly sauté the celery and onion. Add poultry seasoning, thyme, salt, and pepper.

Place 4 cups of cubed bread in a large bowl. Crumble remaining 2 cups of bread and place them in the bowl. Combine with vegetable-seasoning mix. Add oysters and egg and toss lightly. Mix in the reserved oyster liquid until stuffing is moist but not packed.

Place in a greased baking pan and bake uncovered at 375° F for about 30 to 40 minutes, until done (and crusty on the outside).

STRIPED BASS CHOWDER

- 1 1/2 pounds striped bass fillets, skinless
- 4 tablespoons butter
- 1/3 cup green onions, sliced, including tops
- 1 1/2 cups russet potatoes, diced
- 32-ounces chicken broth
- 1 teaspoon salt
- 1/2 teaspoon white pepper, freshly ground
- 1 cup milk
- 1 cup heavy cream
- 1 tablespoon fresh parsley, minced

Poach fish in lightly salted water. Flake and set aside.

In a medium saucepan, melt butter. Sauté the onions and potatoes until tender. Add broth, salt, and pepper. Bring to a simmer. Stir in the milk, then cream. Heat, but do not boil.

Add flaked fish and cook only until the fish is heated, about 10 minutes. Garnish with parsley.

FRESH SPOTTED TROUT WITH HERBS

- 1 1/2 pounds spotted trout fillets
- 1/2 cup flour
- 1/2 cup dry bread crumbs
- 1/4 teaspoon cayenne pepper
- salt
- black pepper, freshly ground
- 3 tablespoons canola oil
- 3 tablespoons butter
- 2 tablespoons fresh lemon juice
- 4 tablespoons fresh chives, chopped
- 3 tablespoons fresh parsley, chopped

In a shallow dish, combine flour, bread crumbs, and cayenne. Lightly salt and pepper the fish. Dredge lightly in the flour mixture.

Heat oil in a skillet to 375° F. Add butter and melt. Place the fish, skin sides down, in the skillet, and sauté about 4 to 5 minutes. Flip and repeat, cooking until done. Remove and place on a serving dish.

Next, add lemon juice, chives, and parsley to the skillet. Stir well and heat. Drizzle over the cooked fish.

BAKED SPOTTED TROUT WITH ORANGE-RICE STUFFING

- 4 spotted trout fillets
- 2 tablespoons butter
- 1/2 cup celery, chopped, including leaves
- 2 tablespoons green onion, finely chopped
- 1/2 cup fresh orange juice
- 1 tablespoon fresh lemon juice
- 1 1/2 teaspoons orange zest
- 1/4 teaspoon salt
- 1 cup cooked rice
- 1/3 cup toasted almond slivers
- 1 1/2 tablespoons butter, melted
- salt
- black pepper, freshly ground



Vanda Lewis

• *Fresh Spotted Trout with Herbs*



Vanda Lewis

• *Baked Spotted Trout with Orange-Rice Stuffing*

In a medium saucepan, melt 2 tablespoons of butter over medium heat. Sauté the celery and onion until tender. Add orange juice, lemon juice, zest, and salt. Bring to a boil. Add rice and stir well. Cover and remove from heat. Let it stand for 5 minutes, then add the almonds.

Lay out the fillets on a work surface, skin sides up. Spoon stuffing onto the fillets. Roll up each fillet and place the seam side down on a parchment-lined baking sheet. Brush with 1 1/2 tablespoons of melted butter. Lightly salt and pepper. Bake at 375° F until done, about 12 to 15 minutes. 🍴

Visit the *Mariner's Menu* archive of free recipes: MarinersMenu.org.



Sparrows and Rising Seas

EFFECTS OF CLIMATE CHANGE ON MARSH BIRDS IN COASTAL NORTH CAROLINA

LAUREN D. PHARR

Jeff Janowski

Marae Lindquist and her team went into the field during the winters of 2019 and 2020 in order to gauge the impact of sea level rise on two species of sparrow.

UNDER THE MOST OPTIMISTIC SCENARIOS, SEAS WILL RISE WORLDWIDE OVER THE NEXT 80 YEARS TO LEVELS THAT ARE A FOOT HIGHER THAN THEY WERE IN 2000, ACCORDING TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION MODELS. Not surprisingly, research predicts rising sea levels will continue to have significant impacts on low-lying coastal habitats.

Salt marshes — coastal grasslands that flood — filter nutrients and reduce the impact of coastal storms by absorbing wave energy. They also serve as habitats for aquatic and avian species. Both the saltmarsh sparrow and seaside sparrow are “tidal marsh obligates,” meaning that they spend their entire lives in tidal marsh ecosystems.

Although sea level rise can cause salt marshes to increase in elevation, research has found that sea level rise and habitat loss across the expansive marsh habitat of coastal

North Carolina potentially imperils many marsh species.

“When the sea rises, the marsh and plants can drown because of the water inundation, which shifts marsh habitats into unstable habitat for our sparrows,” says Marae Lindquist, a doctoral student in biology and marine biology at the University of North Carolina Wilmington. “If habitat declines or is degraded, it can lead to population declines for the species that depend on that habitat, especially like saltmarsh and seaside sparrows.”

As a recipient of the 2019 North Carolina Sea Grant and N.C. Sentinel Site Cooperative Joint Fellowship, Lindquist is studying the effects of sea level rise on two areas in southeastern North Carolina — Masonboro Island and Bald Head State Natural Area — in order to help predict changes in the numbers of saltmarsh and seaside sparrows.

Under the direction of Raymond Danner at UNCW, Lindquist is modeling habitat changes at low, moderate, and high levels of sea level rise through the year 2060. Her research will

help determine the future effects of sea level rise on habitats of both the saltmarsh and seaside sparrow. Her work will serve as a valuable tool for the U.S. Fish and Wildlife Service to inform upcoming decisions about whether to list the saltmarsh and seaside sparrows as endangered or threatened.

Saltmarsh and Seaside Sparrows

The saltmarsh sparrow lives along the East Coast of North America. As a result of climate change and other human-influenced impacts, saltmarsh sparrow breeding populations have declined by 9% annually since 1998; research predicts that without future conservation efforts, these sparrows will go extinct by mid-century.

The seaside sparrow lives in tidal marshes along the Atlantic Coast of North America and the Gulf of Mexico. Some seaside sparrows are migratory, while others are year-round residents. Seaside sparrows are an indicator species, meaning, in this case, that they serve as a tool for indicating the health or degradation of coastal marshes.

The lives of saltmarsh and seaside sparrows are very secretive.

Both species spend most of their time on the ground, foraging at low tide under the cover of cordgrass found in coastal salt marshes. When the tide rises, the sparrows will recede into higher marsh habitat. Once the marsh grass cover disappears, their habitat is no longer safe from flooding or predators.

Working in the Marsh

Lindquist conducted most of her fieldwork from January to March in 2019 and 2020. After completing her first field season, she soon realized how important it was to explore the impact of sea level rise on the

sparrows' wintering habitats.

“A lot of wonderful research is being done on breeding grounds, but there is a gap in knowledge in the impacts of sea level rise in the wintering grounds,” Lindquist says. “Although the marsh grass looks a bit drab in the winter, it really accentuates the beauty in and around the marsh, such as a flock of ibis foraging or a saltmarsh sparrow blending into the cordgrass after being released. It wasn't uncommon when traveling to our field sites to come across beautiful nature, such as a pod of dolphins or large flocks of cormorants.”

Lindquist, her research partner, Evangelyn Buckland, and her undergraduate research technician, Sofia Campuzano, used the daily tide

levels to determine whether they would be doing “mark-recapture,” “radio-telemetry,” or both. On mark-recapture days, the team set up nets in high marsh habitats above high-tide level, which allowed for the capture of more sparrows than at low or mid-tides.

Lindquist and her team actively flushed the birds into the nets, extracted them, and took body measurements. The team also attached radio tags to a subset of sparrows in order to track their movements through the marsh, gathering data to help understand the sparrow's territory and habitat use, as well as to determine the overall population density of the species.

“When you are going into the field almost

Continued



Marae Lindquist



Marae Lindquist

Rising seas threaten the habitats of the seaside sparrow (left) and saltmarsh sparrow (right).

every day, working around tides and weather is always the hardest part," Lindquist says. "For one of our sites, we had to take a boat, and sometimes we could not get into the field on windy days, because we use a little jon boat to get into shallow creeks to get to our field sites."

Key Findings

Although Lindquist, Campuzano, and Buckland spent days in the field collecting data, they completed most of their work in the lab. Undergraduate researcher Cassidy Mason helped with running sea level rise models, using existing spatial data from NOAA and habitat data from the U.S. Fish and Wildlife Service's National Wetland Inventory.

"Cassidy did a great job," says Lindquist. "Most of the research was computer-centric and modeling-centric."

In combination with the data Lindquist's team collected in the field, they now could predict the future populations of saltmarsh and seaside sparrows.

"These findings have major implications for the abundance of sparrows at both study sites," Lindquist explains. "Our models show that without marsh mitigation, winter habitat will decrease a lot by 2060."

In fact, she predicts marshland habitat in the two areas in her study that now support 305 saltmarsh and seaside sparrows will decrease so significantly that it will only support about 25 sparrows total.

Although Lindquist only has population estimates for a small area on each island, the predicted habitat changes were widespread across the Masonboro Island and Bald Head State Natural Area.

Lindquist's new NOAA Margaret A. Davidson Fellowship will allow her to expand her research over the next few years. She plans to re-run all of her sea level rise configured models with added parameters and higher resolution data. These models, in turn, will provide a framework to address and conserve other species of concern.

For Lindquist, the new research also means returning to striking terrain.

"I always love going into the field and really being in the place where these birds spend their whole lives," she says. "The marsh in the winter is one of my favorite places to spend time." 📍



Boston Dang



Evangelyn Buckland

At home in the field, Marae Lindquist carefully frees a sparrow from a marsh net (above) for her research. With support from a new NOAA fellowship, she plans to expand her work in her beloved winter terrain.

North Carolina Sea Grant and N.C. Sentinel Site Cooperative Joint Fellowship
go.ncsu.edu/joint-fellowships



Science Is Everywhere

AN INTERVIEW WITH TERRI KIRBY HATHAWAY,
 NORTH CAROLINA SEA GRANT'S MARINE EDUCATION SPECIALIST

*From sinking sodas to seaweed in ice cream,
 marine education offers plenty to keep K-12 students curious.*



Marine science offers students a world of possibilities. In 2010 Terri Kirby Hathaway met Naku, a beluga whale, at Mystic Aquarium in Connecticut.

Early in Terri Kirby Hathaway's career, she worked as a biological technician and researcher in Florida, Louisiana, and Texas, spending much of her time "examining fish guts." She then served for 18 years as an award-winning education curator for the N.C. Aquarium on Roanoke Island.

Since 2003, as North Carolina Sea Grant's marine education specialist, Hathaway has coordinated coastal curricula for classrooms across the state and organized teacher workshops. She co-authored North Carolina's Amazing Coast, writes for Coastwatch,

and publishes Scotch Bonnet, a popular seasonal newsletter for educators. Her long list of honors includes NC Wildlife Federation's Conservation Educator of the Year and the National Marine Educators Association's James Centorino Award for non-formal educators, as well as their Honorary Membership Award for distinguished service to the organization.

As she transitions to retirement, the irreplaceable Hathaway spoke with us about the state of marine education today and how she has enjoyed helping teachers keep students curious about science.



Jared Kay/VisitNC.com

Science is everywhere, even behind Hanan Shabazz's cooking wizardry at Benne on Eagle restaurant in Asheville.

What do students enjoy learning about most in their classrooms?

Terri Kirby Hathaway: They often seem to like having someone from the outside come into the classroom and talk to them, an expert. What I've found, though, is that most students really enjoy learning *outside* the classroom. Field trips and going outdoors, going someplace new, or even just going out in the schoolyard.

Experiential learning is more exciting for the students because it's something a little different. Of course, it does need to be guided to some extent, but a lot of times you can sneak in the learning, like that commercial where they're sneaking the vegetables into the chicken nuggets. If you can have the kids playing a game that teaches them something — and they're learning while they're having fun — they don't even realize they're learning.

Why is science important for grade-school students to understand and appreciate?

Because science is everywhere. Science is in this tree I'm looking at outside my window. It's in your home. It's in your kitchen. Baking is chemistry. Cooking is science, getting everything to mix well together. Kids, I think, don't necessarily realize that science is everywhere. They think they're never going to use science, or math, for that matter. So, they wonder why they have to learn it.

But some of it will come up later in life, and they'll say, "You know what? I learned how to do that when I was in school." It will be relevant when they grow and get a little smarter and a little wiser, as they broaden their horizons. If we make a subject relevant to students now, they'll be curious, and curiosity is actually even more important than learning science. With curiosity, you can learn anything.

What would help teachers the most as they teach their students about the environment or marine science or biology or any other related fields?

I think we can help the teachers learn the scientific method. If we introduce it to teachers, then they can introduce their students to current or historical research and show how it comes about. You start with a question — and you get a question by having some of that curiosity, having considered why something is the way it is.

Introducing students to actual scientists, which I think we regularly do in *Coastwatch* magazine, also helps students see why researchers studied what they did, how they did it, and what they learned. Scientists don't always get answers. You might have to tweak something and try again, and there's nothing wrong with that. You have to adjust and be flexible. It's also important for students to understand that a lot of times research will bring up new questions.

Continued



Meredith Ross/VisitNC.com

A can of Pepsi sinks, and Diet Pepsi floats. But would this pre-pandemic Pepsi float have lived up to its name? Hathaway says people of all ages often learn best through hands-on experiments and simple metaphors about everything from buoyancy to climate change and glacial melt.



Luca Galluzzi, www.galluzzi.it/CC-BY-SA 2.5



If you encounter Terri Kirby Hathaway beachcombing or grocery shopping, get ready for a discussion about seaweed in ice cream — or about any of the many wonders of marine science.

Incidentally, for a long time, science was not tested in the elementary grades in North Carolina, so schools never really taught it. Elementary schoolteachers didn't view it as important or worth class time, and elementary teachers typically don't get a real heavy science education anyway when they're in college.

But, several years ago now, they started testing science after the end of the 5th grade. That was a big change, and it became much easier to get elementary schoolteachers interested in doing workshops with North Carolina Sea Grant.

Are there any particular subject areas that seem to appeal more to kids with learning disabilities or other special needs?

I've had special needs teachers in workshops or in programs who seem to pick out certain types of things that have helped some of their students. If there's something that their students can put in their hands and manipulate, that's always good.

A couple of times I did a workshop on density — buoyancy and floating — and some of the teachers said they couldn't wait to use it with their students with special needs. You've got a bucket of water, and you have to decide whether this thing will float or sink or, if it's neutrally buoyant, whether it will "fink." If you put an orange in a tank of water, it will float, but if you peel that orange and put it back in the tank, it will sink. You've changed its density (its mass per volume) by taking off its buoyant "life jacket."

I love to do this with same-sized cans of Pepsi and Diet Pepsi. Diet Pepsi floats and Pepsi sinks, because the sugar and other ingredients in Pepsi make it denser. Teachers can ask students to weigh the cans and make them think about what's different between a soda and a diet soda.

What's an effective method for educating students about climate change?

It helps to know your audience. You've got to find out what they know

or think about climate change. Then, you can ask a few questions and think about how you frame things.

For instance, a lot of people don't really know how a greenhouse works or understand the greenhouse effect, so it helps if you talk in different terms or metaphors about what causes climate change. We're burning more fossil fuels, which means there's more carbon dioxide going into the air, and it's creating a blanket around the Earth. That blanket keeps the extra carbon dioxide from escaping into the atmosphere; that causes the Earth to warm up. And students understand how you get hot under a blanket. Well, that's what global warming is. People can visualize a heat-trapping blanket around the Earth.

You can make it relevant or meaningful to the student by relating it to something that they already know. That's actually a key to effectively educating anyone about anything.

What is the single most important thing that teachers need to consider about student learning — regardless of whether the content is about our coast, the environment, climate change, or science in general?

A lot of teachers have learned you can't just teach one way. You have to have a bunch of different styles, because students learn differently, and you need to know the learning styles of your students. We all learn differently, and so teachers have to present information in different ways — maybe with a game, maybe have students read a story or write a report, or have them tell a story. We need to use different methods of teaching to reach different students with the same information.

You served with North Carolina Sea Grant for 17 years. What has that been like?

It's been my dream job. I have a degree in marine biology, so, I've always liked sharing that knowledge. I do it at the grocery store. I do it when I'm walking on the beach. A bunch of us put together this humorous list at a conference that starts "you must be a marine educator if..." And there are about 15 things on the list.

My favorite?

You must be a marine educator if you're at the grocery store picking out ice cream in the freezer section and ask a random stranger if they know ice cream contains seaweed. 🌊

- Terri Kirby Hathaway on Sea Stars: go.ncsu.edu/sea-stars and on Naked Sea Butterflies: go.ncsu.edu/sea-butterflies
- North Carolina's Amazing Coast: go.ncsu.edu/amazing
- Coastwatch Classroom for teachers: go.ncsu.edu/Coastwatch-Classroom
- More educational resources from North Carolina Sea Grant: go.ncsu.edu/homeschool



North Carolina Sea Grant
 North Carolina State University
 Box 8605
 Raleigh, NC 27695-8605

Periodicals
 Postage Paid
 at Raleigh, NC

LEIBACH WINS BEST FEATURE AWARD FOR THIRD STRAIGHT YEAR

Coastwatch readers are no strangers to Julie Leibach's fabulous work. In her first year with North Carolina Sea Grant, she won the 2018 Best Feature Writing Award from the NC Association of Government Information Officers, which she followed up with a win in 2019, too.

How do you top that?

Well, she found a way. This year, she won NCAGIO's Best Feature Writing Award and was runner-up in the same category.

In case you missed it, you can dive into this year's Summer or Autumn issues to read her most recently honored work, or you can read any of her award-winning writing for *Coastwatch* online:

- Blood Draw at the Horseshoe Corral (winner, 2020): go.ncsu.edu/Blood-Draw
- The Road to Resilience (runner-up, 2020): go.ncsu.edu/The-Road
- Testing the Waters (winner, 2019): go.ncsu.edu/Testing-the-Waters
- The Long View (winner, 2018): go.ncsu.edu/TheLongView

Browse *Coastwatch* by issue, by subject, and by what's most popular: NCCoastwatch.org



Teach

Use free educator resources to enrich student learning.


Access our new supplementary material for educators to dive into *Coastwatch* with students in grades 6 to 12. For more information: go.ncsu.edu/Coastwatch-Classroom


Connect

Keep up with North Carolina Sea Grant.

 ncseagrant.org

 facebook.com/ncseagrant

 [@SeaGrantNC](https://twitter.com/SeaGrantNC)

 [ncseagrant](https://pinterest.com/ncseagrant)

North Carolina Sea Grant

Your link to research and resources for a healthier coast.