

Invasion on the Mudflats • Ever-Expanding Shark Brains • Our Stormy Past • Bland Simpson's Boyhood Swims

Coastwatch

NORTH CAROLINA SEA GRANT • AUTUMN • 2021 • ISSUE 3 • \$6.95

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Autumn 2021: A Season of Variety and Opportunity

Autumn is not just a transition but also a season of contrasts within itself.

The start of a new school year brings excitement and adjustments. September marks the end of summer vacations, even if many people this year remained at home or nearby as the pandemic continues. Cooler days encourage walks to enjoy neighborhoods, parks, and our amazing beaches, and maybe to watch and listen for birds in migration. No doubt Bland Simpson's *North Carolina: Land of Water, Land of Sky*, which we excerpt in this issue, will inspire countless autumn daytrips and longer sojourns into coastal environs. Autumn also is the peak of hurricane season, bringing memories of storms from our recent and deeper past, amid new preparations for stronger and more frequent storms with climate change.

The change in season also means an online gathering of our North Carolina Sea Grant Advisory Board. We have a great mix of people who meet with us twice a year — and connect with us throughout the year to offer perspectives on topics related to our research and outreach.

Our current chair is Michael Piehler, director of the Institute for the Environment at the University of North Carolina at Chapel Hill and head of sustainability programs for the campus. Over the years Mike has worked with communities and agencies to better understand nitrogen cycling and coastal ecosystems and has mentored a cadre of future leaders.

We also have several new board members who offer a wide variety of expertise. Ricky Moore is owner and chef at Saltbox Seafood Joint in Durham (and an author as well). Amanda Martin is the state's chief resilience officer within NC Emergency Management. James Hargrove has a career in environmental science that is evolving into a career in aquaculture as owner of Middle Sound Mariculture in Wilmington. Todd Miller is the founder and longtime leader of the N.C. Coastal Federation, based in Carteret County and with offices along the coast.

Variety is also a key element in this issue of *Coastwatch*. But there is an underlying theme, too: Sea Grant's support of graduate students, fellows, and early career researchers. Start with our "Tidings" section and you will find announcements about state and national policy fellowships, and we celebrate a new study from former Sea Grant/Space Grant research fellow Melinda Martinez.

Our cover story on groundbreaking rip current forecasts has its roots in graduate work by Greg Dusek and his ongoing partnership with ocean rescue expert Dave Elder. Work by Carson Miller is featured in "Digging Up a Stormy Past," a piece by Antonio Rodriguez of UNC's Institute for Marine Science. Sienna Zuco, an undergraduate intern from UNC-Chapel Hill, helped local seafood businesses through a project with the N.C. Local Food Council, which we highlight in "New Links in the Sea-to-Table Chain."

In "Currents," Aaron Ramus of UNC Wilmington writes about his research on invasive seaweed, research we funded with our joint fellowship with the N.C. Coastal Reserve and National Estuarine Research Reserve. Kara Yopak credits her UNCW students as coauthors on research we highlight in our "Sea Science" piece, and "Hook, Line & Science" features several students as guest authors. Of course, we could not publish this magazine without the writing and editing of our science communication interns Lauren D. Pharr, Carrie Clower, and Nan Pincus.

'Tis also a season for funding opportunities for future projects. Check out opportunities on our news and funding pages at ncseagrant.org now and through the end of the year. And we are completing the process for our next set of two-year "core" research grants, so watch for news on those projects in early 2022.

As always, I'd appreciate your comments on our current work and ideas for the future. Please email me at smwhite3@ncsu.edu.

— Susan White, Executive Director, North Carolina Sea Grant

IN THIS ISSUE

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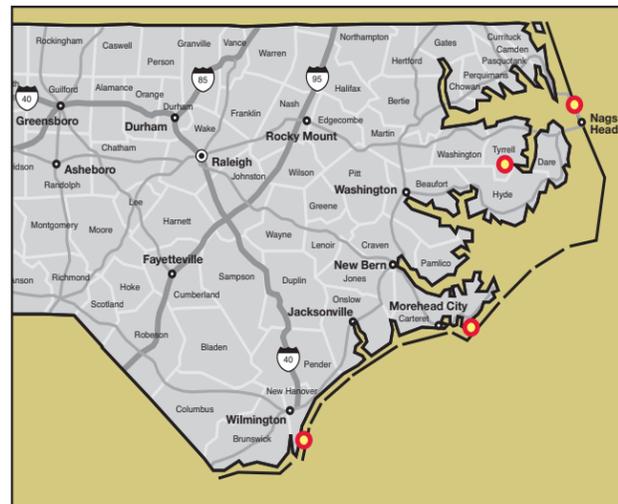
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Settings for the stories in this issue cover many locations in North Carolina, including these places from north to south on the map: Kill Devil Hills, Albemarle-Pamlico Peninsula, Harkers Island, and Masonboro Sound.



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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.

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Olivia Vilá

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NOAA AND SEA GRANT SELECT NEW KNAUSS FELLOWS

NOAA and Sea Grant have announced 74 finalists for the 2022 class of the Sea Grant John A. Knauss Marine Policy Fellowship program, including four graduate students from North Carolina: Olivia Vilá, Anderson Tran, Molly Bruce, and Colleen Baker.

The year-long fellowship honors John A. Knauss, a founder of the National Sea Grant program, NOAA administrator, and dean of the University of Rhode Island's Graduate School of Oceanography.

"The Knauss Fellowship program offers talented students an opportunity to delve deeply into the work of their host offices, offering their expertise and unique perspectives that absolutely enhance much-needed research, education, and outreach," says Susan White, executive director of North Carolina Sea Grant.

The 2022 Knauss Fellowship finalists from North Carolina have a wide array of research interests and experiences.

- **Olivia Vilá**, a Ph.D. candidate at NC State University, works with multiple interdisciplinary teams on hazard mitigation and resilience research. Her current work uses environmental justice, leadership, and policy frameworks to assess communities' ability to engage in recovery and mitigation, as well as to support improvements.

"I look forward to being pushed outside of my intellectual and professional comfort zone," Vilá says.

- **Anderson Tran** received his law degree from the University of North Carolina at Chapel Hill. After years in the natural sciences,

he shifted his career to law to become more involved in policy decisions that affect fisheries and other coastal resources.

"I hope to bring my merged scientific and legal training to help craft effective policy that will sustain our coastal resources to use and enjoy for generations to come," Tran says.

- **Molly Bruce** earned law and master's degrees from Duke University, where she focused on the intersection between water and climate. She has participated in client-centered representation and environmental policy design, as well as research using remotely sensed data from drones and satellites to monitor coastal ecosystems.

"I'm excited by the incredible opportunities I'll have as a Knauss Fellow to learn about federal policy design and the nuances of representing national interests," Bruce says.

- **Colleen Baker** holds a master's degree from Duke University in environmental management, with a focus on coastal environmental management. Her research looks at small-scale fisheries and fisheries governance.

"I have spent a lot of time understanding management decisions and evaluating fisheries policies, but the Knauss Fellowship offers me the opportunity to be on the inside of decision-making and implementation," Baker says.

This year's finalists join about 90 from North Carolina who have served during the four-decade history of the Knauss Fellowship.

- **MORE:** go.ncsu.edu/new-Knauss

— Lauren D. Pharr



NC State News

STUDY REVEALS FOUL PLAY FROM CLAVELINA OBLONGA

Clavelina oblonga

The invasive marine fouling species *Clavelina oblonga* reduces ecological diversity, according to new research that North Carolina Sea Grant and the National Science Foundation supported.

Marine fouling species are invertebrate filter-feeding organisms, like barnacles and mussels, and they also include soft-bodied "tunicates," like *Clavelina oblonga*. Tunicates use tubular openings to siphon and expel water.

Given the recent proliferation of *C. oblonga* on the coast, researchers with NC State's Center for Marine Sciences and Technology in Morehead City wanted to explore the invader's impact.

David Eggleston and Kayla Christianson duplicated experiments performed 50 years ago in Beaufort. Along the docks, they observed submerged terra cotta plates and detected 22 different fouling species that settled on the plates.

They found that wherever *C. oblonga* settled, the species rapidly crowded out others. Even when cold weather and a hurricane removed *C. oblonga*, it quickly regrew, and again reduced diversity.

"*C. oblonga* has only been here since 2015, but it seems to have no real natural predators, it crowds out native species, and it has a foothold," Eggleston says. "We will have to monitor this species and be sure that it doesn't impact our local shellfish industry."

- **the full study:** go.ncsu.edu/foul-play

— adapted from Tracey Peake's NC State News story



Cayla Cothron

COTHRON JOINS SEA GRANT TO SUPPORT A RESILIENT NC

Cayla Cothron recently joined North Carolina Sea Grant's team as a climate resilience extension associate.

"Cayla brings an impressive track record of working with communities as

a public and private sector planner," says Frank López, North Carolina Sea Grant's extension director.

"Sea Grant serves a unique role in building relationships and facilitating discussions with communities," says Cothron.

Cothron will connect with community members and natural resource managers, working alongside López, as well as North Carolina Sea Grant's coastal resilience specialist, Sarah Spiegler, and coastal construction and erosion specialist, Spencer Rogers.

Cothron also will work directly with students, fellows, researchers, and other stakeholders. In particular, she will collaborate with the North Carolina Sentinel Site Program's partners along the N.C. coast.

North Carolina is "positioned to have ongoing impacts from climate change," Cothron says, adding that this requires planning in order to mitigate damage. For instance, she already has identified a project to help a coastal community improve its climate risk communication.

"We look forward to Cayla continuing our program's commitment to helping coastal communities consider the immediate and longer-term impacts that they face from our changing climate," López says.

- **Cayla Cothron:** go.ncsu.edu/cayla

— Carrie Clower



Melinda Martinez, former joint fellow with North Carolina Sea Grant and NC Space Grant.

DO GHOST FORESTS PERPETUATE GLOBAL WARMING?

New research from Melinda Martinez, a joint fellow with North Carolina Sea Grant and NC Space Grant in 2019, has determined that standing dead trees in coastal wetland "ghost forests" are emitting greenhouse gases.

Martinez and NC State University's Marcelo Ardón measured the quantity and type of greenhouse gas emissions from dead pine and bald cypress snags in five ghost forests on the Albemarle-Pamlico Peninsula. They found that the snags increased emissions of the overall ecosystem by about 25%.

"Even though these standing dead trees are not emitting as much as the soils, they're still emitting something, and they definitely need to be accounted for," says Martinez, who recently completed her Ph.D. at NC State and now serves as a Mendenhall Fellow with the U.S. Geological Survey.

Researchers have been tracking ghost forests on the Albemarle-Pamlico Peninsula, terrain that formed due to sea level rise. Previous studies have projected that salinity from rising seas and more frequent flooding will further stress coastal ecosystems in the Southeast.

"The transition from forest to marsh from these disturbances is happening quickly, and it's leaving behind many dead trees," Martinez says. "We expect these ghost forests will continue to expand as the climate changes."

- **the full study** go.ncsu.edu/snags
- **ghost forests in Coastwatch** go.ncsu.edu/ghost

— adapted from Laura Oleniacz's NC State News story



Maya Hoon Jessica Richter

SEA GRANT AND SPACE GRANT ANNOUNCE JOINT FELLOWS

North Carolina Sea Grant and NC Space Grant have awarded joint graduate research fellowships to **Maya Hoon** of the University of North Carolina at Chapel Hill and **Jessica Richter** of East Carolina University.

The fellowships support graduate students researching high-priority needs within North Carolina watersheds, coastal areas, and nearshore environments. Fellows can utilize data from the vast archives and remote-sensing capabilities of NASA and NOAA, including data collected from airplanes, unmanned aerial vehicles, uncrewed submersibles, and other technologies.

Hoon will study how heavy metals influence the genes of microbes in the Neuse River Basin. She plans to compare the genes of organisms from the water to those in the sediment, looking for evidence the organisms are developing a tolerance for heavy metals.

Richter will generate updated shoreline maps of the Neuse River Estuary that capture shoreline erosion. The maps will provide additional tools for local planners in Craven and Pamlico counties, offering important context regarding storm-induced erosion and informing future mitigation and restoration efforts.

"This fellowship uniquely encourages students to discover ways to expand their research, using new tools and data sets, or to find new topics for tools that they know well," says Jobi Cook, associate director of NC Space Grant. "We're looking forward to the innovations this year's fellows will bring to their fields."

• **MORE:** go.ncsu.edu/sea-space

— Lee Cannon



COMMUNITY PROJECTS EXPLORE SHARKS, OYSTERS, YOUTH TRAINING, AND MORE

Six new projects in North Carolina launch this year with support from the Community Collaborative Research Grant Program (CCRG). North Carolina Sea Grant administers the CCRG Program in partnership with the William R. Kenan Jr. Institute for Engineering, Technology and Science (KIETS) and the N.C. Water Resources Research Institute (WRRI).

"The CCRG program expands its reach across North Carolina with the latest round of projects," says John Fear, deputy director for North Carolina Sea Grant and WRRI. "The ongoing focus on local needs and use of local knowledge sets up these projects for success."

• New River Oyster Restoration

Joel Fodrie of the University of North Carolina at Chapel Hill and Pat Donovan-Brandenburg of the City of Jacksonville will help identify where oyster restorations have succeeded on the New River to better plan future restoration efforts.

• Youth Training and Conceptualizing Disaster

Kathryn Stevenson of North Carolina State University and Vequainn Joyner of the Boys and Girls Club of the Coastal Plain will work in an underserved community to understand how K-12 students conceptualize disaster and to explore how to better engage community members in disaster resilience efforts.

• Contaminants and Sharks

Scott Belcher of North Carolina State University and Captain Charles Locke of F/V Salvation will work to compare contaminants present in four different shark species in the near shores of North Carolina, as well as

to determine whether mother sharks pass contaminants on to their offspring.

• Wetlands and Wastewater

East Carolina University's Natasha Bell and Greenville Utilities Commission's Jason Manning will work with a team of students to test a new hybrid constructed wetland at the Greenville Utilities Commission wastewater treatment plant.

• Shoreline Erosion in Nags Head

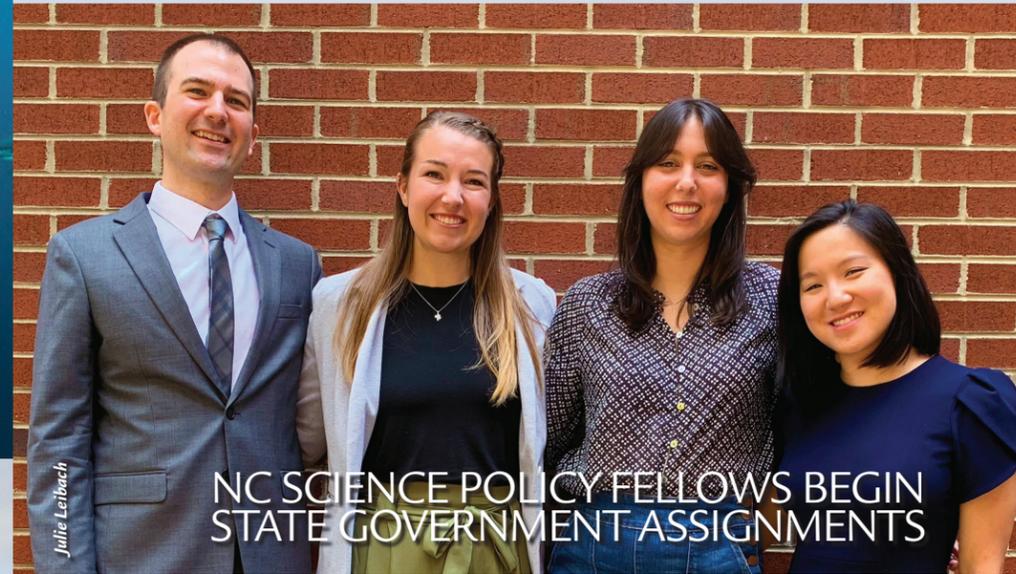
Reide Corbett with East Carolina University and Holly White with the Town of Nags Head will be working to provide the town with highly accurate shoreline erosion data to inform Nags Head's new Shoreline Management Plan.

• Endangered Freshwater Mussels

Greensboro Science Center's Lindsey Zarecky and the N.C. Wildlife Resources Commission's Rachel Hoch will create a new innovative visitor display at the Greensboro Science Center, based on endangered freshwater mussel research, and also will develop a video about freshwater mussels.

"The CCRG program provides stakeholders an opportunity to collaborate on community-related initiatives that address relevant problems and issues," says Raj Narayan, associate director of KIETS. "The CCRG continues to nurture the creativity and resiliency of these communities and enables authentic partnerships focused on developing innovative approaches and solutions with beneficial outcomes and impact."

• **MORE:** go.ncsu.edu/CCRG — Lauren D. Pharr



NC SCIENCE POLICY FELLOWS BEGIN STATE GOVERNMENT ASSIGNMENTS

New NC STEM Policy Fellows (left to right): Matthew Kollman, Stephanie Batalis, Emma Hughes, and Rachael Wolff.

Four new North Carolina STEM Policy Fellows recently began yearlong roles in high-level state government offices. The fellowship provides non-academic career opportunities for recent graduate students in science, technology, engineering, and math.

"Our incoming fellows will bring new perspectives and energy as they address policy challenges and opportunities on important issues," says Susan White, North Carolina Sea Grant's executive director.

This year's fellowship class includes students from four North Carolina universities.

• **Matthew Kollman**, a doctoral candidate at NC State University, studies the chemistry of deriving sustainable products from renewable resources.

"As an NC STEM Policy Fellow, I look forward to working on a wide range of topics, while learning about and supporting advances in science and technology by innovative North Carolinians," says Kollman, who will serve in the N.C. Department of Commerce Office of Science, Technology & Innovation.

• **Emma Hughes** graduated with a masters from Duke University's Nicholas School of the Environment.

"I became interested in using my knowledge and skills to uplift the protection and preservation of natural and cultural resources during my time at Duke, and I'm excited to continue this type of work," says Hughes, who will serve with the N.C. Department of Natural and Cultural Resources Office of the Secretary.

• **Rachael Wolff** recently graduated with a master's degree in city and regional planning from the University of North Carolina at Chapel Hill.

"As a storyteller at heart, whether through data or words, I think this fellowship will be a great opportunity to communicate the initiatives of the State Energy Office and transform science policy into equitable action," Wolff says of her new role in the N.C. Department of Environmental Quality.

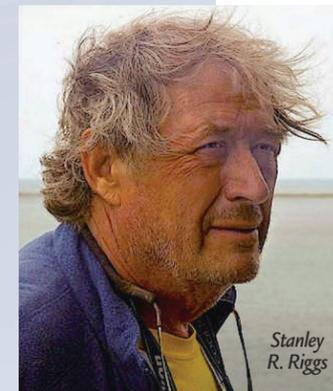
• **Stephanie Batalis** has devoted the past four years to pursuing her Ph.D. in biochemistry at Wake Forest University.

"My current work in Wake Forest Innovation Quarter, a designated North Carolina Research Park, has shown me what can happen when research and innovation meet," says Batalis, who will serve with the North Carolina Biotechnology Center to support in-state innovation.

The 2021 NC STEM Policy Fellowships also include professional development sessions in science policy and communication, developed in partnership with Sigma Xi, The Scientific Research Honor Society, based in Research Triangle Park.

North Carolina Sea Grant administers the fellowship, now in its second year, with a matching grant from Burroughs Wellcome Fund and support from some of the fellowship host offices.

• **MORE:** go.ncsu.edu/stem-fellows



Stanley R. Riggs

RIGGS WINS AWARD FOR CAREER EXCELLENCE IN MARINE GEOLOGY

The Society for Sedimentary Geology has awarded East Carolina University's Stanley R. Riggs the Francis P. Shepard Medal in recognition of his seminal contributions to marine geology.

"Stan has been at the forefront of research, trying to understand how our coastal systems work and respond to stressors," says John Fear, North Carolina Sea Grant's deputy director. "All those he has taught, encouraged, and inspired continue his work and are helping make our state more resilient to the constant hazards, natural and manmade, that we face."

For decades, North Carolina Sea Grant has supported numerous projects Riggs spearheaded. During his career, he explored the water bodies around Roanoke Island, located sand resources off the Outer Banks and mapped the hard bottoms

of Onslow Bay, and even trekked deep into the striking nightscapes of the Outer Albemarle Peninsula.

"This award is the product of a large team of coastal marine scientists and students working together since the 1960s to understand and manage the many complex aspects of North Carolina's world-class coastal system," says Riggs, who also has written for *Coastwatch*.

"Many different state and federal agencies, universities, nonprofits, local and state leaders, and particularly the local citizens in eastern N.C. have contributed to the science, funding, publication, education, and implementation aspects that led to this award," Riggs says. "This is a team award."

• **Riggs's nonprofit, NC Land of Water**
NCLandofwater.org

• **"A Brief History of Sea Level Rise in North Carolina"**
go.ncsu.edu/a-brief-history

• **"The Greatest Show on the East Coast"**
go.ncsu.edu/greatest-show

— Lauren D. Pharr

THIS WET LAND WATER- LOVING LAND

BY BLAND SIMPSON

excerpts from *North Carolina:
Land of Water, Land of Sky*

Continued



Setting for a boyhood swim: sunrise at Kitty Hawk.

Tom_Saunders, flickr.com/people/tombass9/

Bland Simpson, North Carolina's oft-honored voice of our state's coast, has written a new tribute to North Carolina's striking environs and residents. We're delighted to provide these short excerpts that capture just a few of North Carolina: Land of Water, Land of Sky's many flavors, a blend of personal and collective history as only he can tell it.

SWIMMING AT DAWN

Before sunrise on warm summer mornings at Kitty Hawk, my father would awaken my first cousin Johnny and me, both of us not yet six, by shaking our feet, and we would come to quickly, put on our swimming trunks, and then follow him through the dunes, dew still on the sea oats and pennyworts, down to the tide line of the Atlantic Ocean.

Sometimes the glow from way out beyond the Gulf Stream clouds would be a deep red, other mornings it might be a faint yellow, with a promising fair-weather pink on the high clouds, nothing yet but the color of ash on the lower puffs closer to the sea. We would stand silently, just we three, for a few moments, till my father, a former Navy navigator, spoke in the voice of command, saying briskly, "All right, let's go!"

And in we went, over the sea-foam and into the surf after him, the plunge always shocking, as our warm bodies hit the frigid waters that had come all the way down to our cottage doorsteps from Labrador. Yet we knew by now what to expect, and to be immersed in those waters and in that moment with him were pieces of an incalculable joy. My father would have already swum twenty yards out and back by the time we got in up to our necks, and then he would pick us up, each in turn, pull us out of the water and



Up the shoreline from Salmon Creek lay Bertie County's nearly brand-new beach, nicknamed "Tall Glass of Water," the first public swimming access in Bertie.

toss us, and we would all three splash about a bit till he turned and pointed east and said, "Here it comes."

So advised, we all kept a keen eye on the horizon till the first arc of red glow cut through and laid daylight abroad out over the ocean, and before we knew it the full sun sat itself right up on the eastern edge and fired the sky. Never on these bracing mornings were we out for more than twenty or thirty minutes, yet we knew how pure and how purely important it all was, for no one else was ever up and about.

The sea was ours, and we were the sea's, and soon, after my father got us in to shore and, leaving us there, returned

alone to the water, he swam forty or fifty yards out and then kept swimming, parallel to the beach, the quarter mile up to the old fishing pier and back, and we went back up on the porch, found towels and dried off, and stood watching his progress, wondering and marveling over what strength it must take to do that, to be a man swimming powerfully in the sea, and dreaming of a year to come when we might do that too.

BEAUTIFUL BERTIE

Many years later, at the dedication of the North Carolina Coastal Land Trust's 1,000-acre Salmon Creek gift to the people of North Carolina, I sat near the

Town of Windsor's Mayor James Hoggard and next to County Commissioner Ron Wesson, just 100 yards or so from the cypress-lined mouth of Salmon Creek into Albemarle Sound. In light-gray sweater and black slacks, my wife Ann as president stood and spoke happily as she presented the deed to this magical tract to North Carolina State Parks: "Now that much of Salmon Creek becomes a State of North Carolina natural area, we may forever find ways to connect people from all over the state, nation, and world — and especially people from right here in Bertie County and the surrounding area — with this precious landscape and with these precious waters."

Magical? A fair call, in terms of the confluence of cultures that has happened here: A former Indian village, Mettaquem, sat in this place; Lost Colonists, some if not all, may have sought shelter here

after abandoning Roanoke Island in the late 1580s, and archaeologists led by the First Colony Foundation are literally digging into that matter; and Nathaniel Batts lived in his trading post here in the mid-1600s (a "rude and desperate man," proselytical Quaker George Fox called him). Two centuries afterward, a massive Capehart family herring fishery anchored itself hereabouts.

Just a short way up the shoreline from Salmon Creek lay Bertie County's nearly brand-new beach, nicknamed "Tall Glass of Water," and Ron Wesson — who as the African American chair of the Bertie County Commission had signed the deed for it — spoke to me later with real pride and emotion about this first ever public swimming access in Bertie for all people.

He himself (a Dun and Bradstreet executive who worked all over the world before retiring back home) had not been

able to learn to swim here in his own then-segregated home county, so his mother, a schoolteacher for forty-two years, had driven Ron and his cousins over to Rocky Mount to kin and to the Tar River every weekend till the boys *did* learn. When the county held the May 2019 grand opening of this Bertie beach, featuring food, games, and *swimming*, Ron recalled 900 people showing up and one scene in particular: "This touches my heart — one little lad was in the water and he says, 'Commissioner, thank you for letting us come to play at your beach!' and I said, 'This is *your* beach, and as you grow up, you have to take care of it!'"

HARKERS ISLANDER

In one man's life, the heartiness, the fearlessness, and the confident self-reliance of Harkers Island's people could clearly be seen. *Exploring North Carolina* host Tom Earnhardt, who had a cottage on the island's southeast shore for over forty years, from which he could boat down the Drain to Lookout Bight and fish for red drum and false albacore alike, has told me much about his across-the-street neighbor Donald Willis, an American hero then and now.

Once when Donald was a boy of only nine, his mother woke him in the middle of the night. She was one of the island's midwives, and she said urgently: "Mrs. — is going to lose her baby and she might die herself — you've got to go to Beaufort and get the doctor."

Back then, with no bridge to the mainland, water was the only way. So Donald went down to the dock, mid-island, south shore, to the family's small sailing skiff — "First, I had to break the ice off the sail," he recalled for Tom — and sailed west across the mouth of North River in the dark.

Up Taylor's Creek he sailed on, to Beaufort Fisheries, where he docked. When he rang the bell on the waterside dock, the night watchman soon appeared, a .38 pistol on his hip. "What're you doing here?" asked the watchman, who then heard Donald's story, the need of the

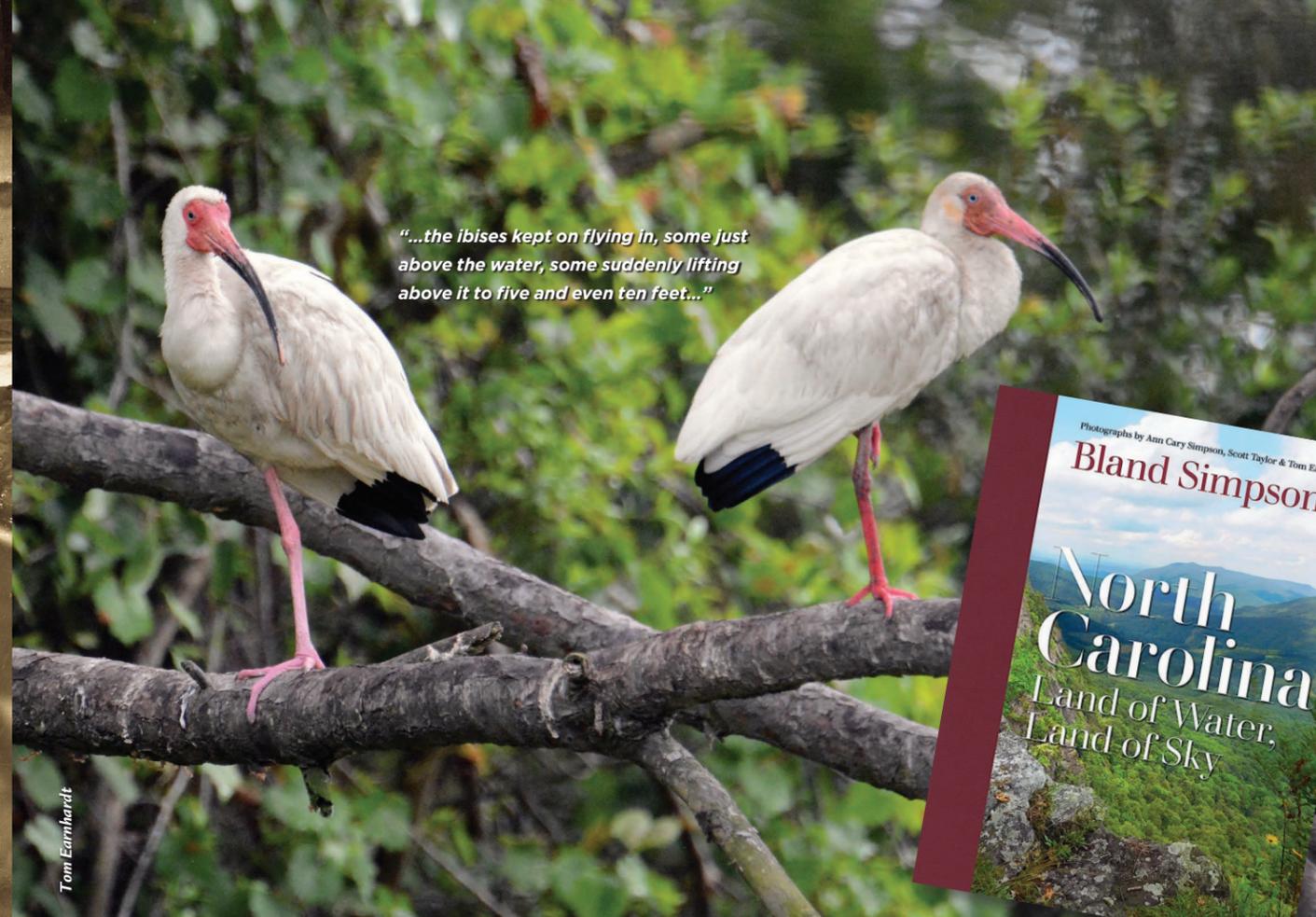
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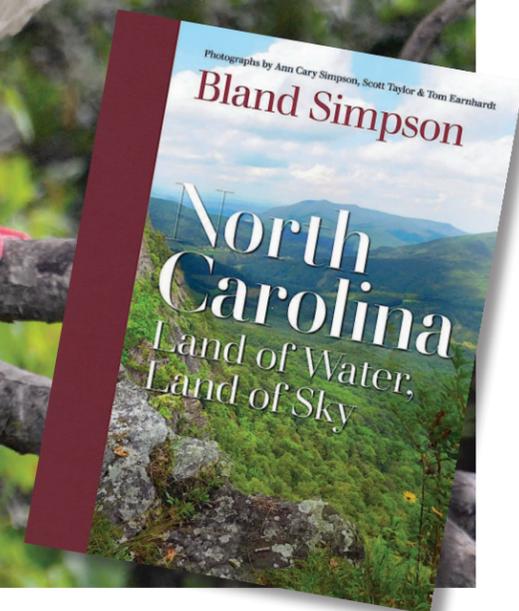
On D-Day, Harkers Island's Donald Willis piloted a Coast Guard landing craft, like the one in this picture of Normandy on that fateful June 6. Willis took cannon fire, which left his boat dead in the water. He swam to a nearby craft — its pilot fatally shot — and took more soldiers ashore.

Library of Congress



"...the ibises kept on flying in, some just above the water, some suddenly lifting above it to five and even ten feet..."

Tom Earmhardt



woman back on Harkers Island. They went inside, and the watchman wound the crank on the wall and then started talking on the first telephone Donald had ever laid eyes on.

"The doctor'll be here soon," the watchman hung up and said.

Presently here came the doctor, wearing a long overcoat, with his bag. He walked down to the fish house dock with the nine-year-old sailor and said to Donald, "Where are we going?"

"Harkers Island," said the boy.

The doctor climbed into the sailing skiff, asking nothing more.

All the way back, all in the dark.

The mother in labor lived.

"Plenty of light," Donald would recall. "You had the stars — any boy on Harkers Island could've done it."

Donald Willis made his maritime career in the U.S. Coast Guard.

One day during World War II the chief called his men together and asked them, "Who knows how to fish? Net fish?"

And Donald raised his hand.

"OK," said the chief. "You're a deaf-mute, and you're going to France."

In France, Donald Willis worked with the French Resistance, indeed feigning as a deaf-mute on fishing boats off the French coast in the face of Nazi patrols, taking soundings with a lead line, triangulating with church steeples, making faint pencil notes on the blade of an oar, and then, when pulling up alongside another fishing boat, holding that oar out and using it to get in close, effectively handing that oar to one of its men, who would file with the Resistance this crucial look-of-shore-from-sea information, Donald getting an imperceptibly different oar in return, one with its blade sanded — a clean slate, as it were — ready for more key nautical inscriptions.

This was March 1944, before D-Day that June.

When June 6 came, Donald Willis piloted a landing craft, which, after putting one company of soldiers on the Normandy shore, as he turned back for

his ship, took cannon fire astern, leaving the boat dead in the water. He spotted, nearby, a Higgins craft with its pilot shot dead and fallen over the wheel, so he swam to *that* craft, set the dead mariner down upon the deck, and piloted on back to his ship and began taking more soldiers ashore.

ROOKERY

One July evening along about seven thirty, our great friends Belinda and Michael McFee, Ann, and I were all sitting in a seventeen-foot bateau, anchored in four feet of water, high tide in a 100-foot-wide channel curving through the middle of a great marsh near Beaufort, the ceiling broken with gray and black clouds, a few shafts of sunlight now and again falling in the distance. The light kept shifting as the broad, gray clouds moved over us, dropping down and at one point shining up the distant semiglobes and cranes of the state port with cool sunlight. Everywhere, the endless light-green marsh grass stood

out brilliantly in the gloaming.

We had been brought to this extraordinary spot at dusk by an equally extraordinary person, award-winning Smyrna biologist-teacher Miriam Sutton, a native Kinstonian whose family had had a cottage on the Neuse River's Minnesott Beach when she and her longtime-fishing-partner brother were growing up: "That's where we learned fishing, boating, all that mess!"

Miriam — a very fit, ever-smiling, sandy-haired recent retiree — had once taught in Asheville for a spell, saying of that time, "I said I needed an ocean up there. Gave 'em eight years, that was *long enough*." She moved back east in the mid-1990s, got a kayak as soon as she returned, and "started exploring — that's what I came back for!" By now, she has been floating these waters in small craft for nearly twenty-five years — a thoroughly skillful boater, she put out a second anchor when a breeze started to push us around, keeping us oriented to the northeast, our eyes on the prize.

To wit: a hammock, an oblong live-oak-and-myrtle islet perhaps 100 yards long and 20 to 25 feet high, a small significant spot in great marshes we have gone around one side or the other for many years, yet never gone in. The hammock lay there, an intense deep green, with the broader light green of the marsh grasses stretching out around it forever.

Yet the hammock was getting whiter by the moment, for this was a serious rookery, and more birds kept streaming in as the evening moved swiftly from twilight toward dusky dark and as storm clouds to our south lay rain out over the ocean. By fives, tens, fifteens came the white ibises, the mature birds with black wing tips, the immatures without, all as if led by their long thin downcurved bills right to this very place.

Egrets aplenty greeted them, a couple of big, brown immature night herons too, one great blue heron.

And one roseate spoonbill.

Rarity of rarities for North Carolina.

Soon afterward, David Cecelski told us that he almost always saw a dozen, maybe fifteen, ibises fishing back in Morton's Millpond on the west side of upper Clubfoot Creek in Harlowe miles away. "When they're done, they head off to the southeast — do you think they could be going to the rookery you saw? Or is that too far?"

Not too far at all. Walker Golder, the great colonial water-bird authority who helped establish Audubon's sanctuary system in our many coastal waters, once tracked by plane mature ibises going from Battery Island off Southport all the way to Lake Waccamaw just to fish for their young back in those Cape Fear River nests, a flight distance of *forty* miles each way!

And here this night near Beaufort, just before the rain found us and sent us back into port, all the while the ibises kept on flying in, some just above the water, some suddenly lifting above it to five and even ten feet, Miriam observing this and saying wisely: "Because of us." 📷

Lifeguard observations from Kill Devil Hills were used to develop a new national rip current forecast model.

RIP CURRENTS MODEL BEHAVIOR

BY JULIE LEIBACH

Drawing on lifeguard expertise and artificial intelligence, researchers are improving rip current forecasting for beachgoers nationwide.

Continued

Tom Saunders, flickr.com/people/tombass99/



“The really dangerous days are blue-sky, nice weather on the beach, with local wave-generating conditions that make high-velocity rip currents that are very, very dangerous.”

— SPENCER ROGERS

NOAA

Signs of a rip current include a narrow gap of darker, seemingly calmer water between areas of breaking waves and whitewater.

Several years ago in late September, Bob Schiffer rode his bike to the beach at Kill Devil Hills for a dip in the ocean, as he often did. Before heading to the water, he hung up his backpack on a pole with a waving red flag — a no-swimming alert indicating hazardous surf conditions. His plan was to repeatedly propel himself, porpoise-style, through shallow water, then backstroke to where he had started as part of a strength-building exercise he had practiced numerous times.

The sea was turbulent that day, with waves breaking in all directions, recalls Schiffer, who at the time lived on the Outer Banks. He had barely begun his routine when he suddenly discovered that he was nowhere close to the beach. “It happened as if I were on an express train,” he says, and “I realized I was in a rip” — that is, a narrow current of water flowing away from shore.

As a teenager growing up in New York City,

Schiffer served as a beach lifeguard. He knew the common safety protocol: If you’re caught in a rip current, try to break free by swimming parallel to shore. Otherwise, float and call for help.

The churning water made swimming futile. Spying bystanders in the distance, Schiffer yelled for someone to call 911. Then he tried to relax, turning the face of his watch away from sight so he wouldn’t dwell on the time.

About 40 minutes later, help came splashing toward him. David Elder, lifeguard and supervisor of Kill Devil Hills Ocean Rescue, had received the distress call and arrived with a torpedo-shaped float. Schiffer grabbed hold and together they kicked back to shore.

The next day, the two ran into each other at a local café. Schiffer remembers wearing a rain slicker and that Elder pointed to its off-white interior, noting, “That’s the color of your

complexion when I came to see you.” In the ocean, treading water at what seemed like 50 yards from shore, Schiffer wasn’t aware of how drained he’d become.

Rip currents are the leading cause of death on surf beaches worldwide. Preliminary data collected by the National Weather Service suggests that in 2020, 65 rip-current related fatalities occurred in the United States and Puerto Rico. But that number doesn’t reflect

unreported or undocumented drownings. (In this article, “drowning” implies fatality.)

Given that the majority of drownings occur on unguarded beaches or outside of regular beach patrol times, the actual U.S. death rate could be more than 100 a year, according to U.S. Lifesaving Association (USLA) executive director Chris Brewster and colleagues, reporting in *Natural Hazards and Earth System Sciences* in 2019.

This public safety threat has driven researchers to devise ways to predict hazardous rips. Until recently, efforts centered on a tool first pioneered in the 1990s, which National Weather Service forecasters have tailored to their locales. Just this past spring, the National Oceanic and Atmospheric Administration officially launched a new model designed to provide more precise and timely forecasts than ever before.

The tool combines lifeguard observations of rip currents and rescue reports with artificial intelligence to deliver an hourly forecast up to six days out for many U.S. coastlines — including in Hawaii, Puerto Rico, and Guam. Greg Dusek, NOAA senior scientist and project lead, says that with additional refining, forecasts will be available for the entire continental U.S., and even the Great Lakes, “hopefully not too far down the future.”

Ultimately, researchers aspire to warn swimmers of rip currents on their specific stretch of shore — in real time.

“Our long-term vision is that as a beachgoer points their smartphone at the beach, they will be alerted to locations where there are potential rips,” says Alex Pang, a computer scientist at UC Santa Cruz and a colleague of Dusek’s. In short, “we want to save lives.”

WADING IN

Back in the early 2000s, lifeguard David Elder was becoming increasingly frustrated with the number of rip-related close calls and fatalities

Continued

that his team was encountering. He wondered if there was a way to improve rip current forecasting, particularly for the sake of people on unguarded beaches.

“What I realized was the problem that we were experiencing was a lack of knowledge and an inability of the average patron to be able to understand what a rip current was,” says Elder, who has over 30 years of lifeguarding experience, and whose team has advanced certification from the USLA. “We need to inform them about [rips] in a more timely manner,” he adds — before they set foot on the sand.

Rip currents occur along beaches with breaking waves, including some Great Lakes shorelines. But their mere existence doesn't spell danger. Speed is one key determinant. Many rip currents are so languid that swimmers won't notice them. Others “can exceed the fastest Olympic swimmers at their worst,” says Spencer Rogers, North Carolina Sea Grant's coastal erosion and construction specialist.

Lifeguards are expertly trained to spot dangerous rips — not by their speed, which is nearly impossible to detect with the naked eye — but by recognizing other signature traits, such as a

narrow band of darker, seemingly calmer water between breaking waves on either side.

Guards also recognize when weather and ocean conditions have aligned such that rescues will be likely. “The really dangerous days are blue-sky, nice weather on the beach, with local wave-generating conditions that make high-velocity rip currents that are very, very dangerous,” says Rogers, who has served on a national rip current task force with NOAA, NWS, and USLA partners. “Those are the days where we have the most fatalities and the most rescues, because it doesn't look threatening.”

The probability that a hazardous rip current will occur is what drives NOAA's new forecasting tool. In other words, it hinges on the question, “How likely is this rip current to cause a swimmer distress?” says Dusek, who began the project as a Ph.D. student at the University of North Carolina at Chapel Hill.

Broadly speaking, three major factors contribute to rip current formation: wave conditions, tide, and the shape of the sea floor, or bathymetry. To build his model, Dusek had to figure out how to weight those factors such that their relationship predicted dangerous rips.

For help, he turned to Elder, who supplied him with a set of lifeguard observations and rescue reports from the summers of 2008 and 2009. Dusek then plugged historical ocean and weather data into the model to see how accurately it predicted hazardous rips reflected in the lifeguard data, tweaking the tool as necessary.

Using human observations — albeit ones rooted in expertise — to hone a computer model might raise eyebrows. “That kind of more qualitative observation, at first, could seem less powerful than a very quantitative speed measurement, but for the purposes of developing a hazard forecast, it's actually perfect,” says Melissa Moulton, a coastal physical oceanographer at the University of Washington in the Applied Physics Laboratory and at the National Center for Atmospheric Research.

A few years ago, Moulton and Dusek tested the model against measurements that she and scientists from Woods Hole Oceanographic Institution had recorded with current meters submerged off the U.S. Army Corps of Engineers Field Research Facility in Duck. They wanted to see if the model predicted hazardous rips when the meters had recorded strong currents going offshore.

HOW TO SPOT A RIP

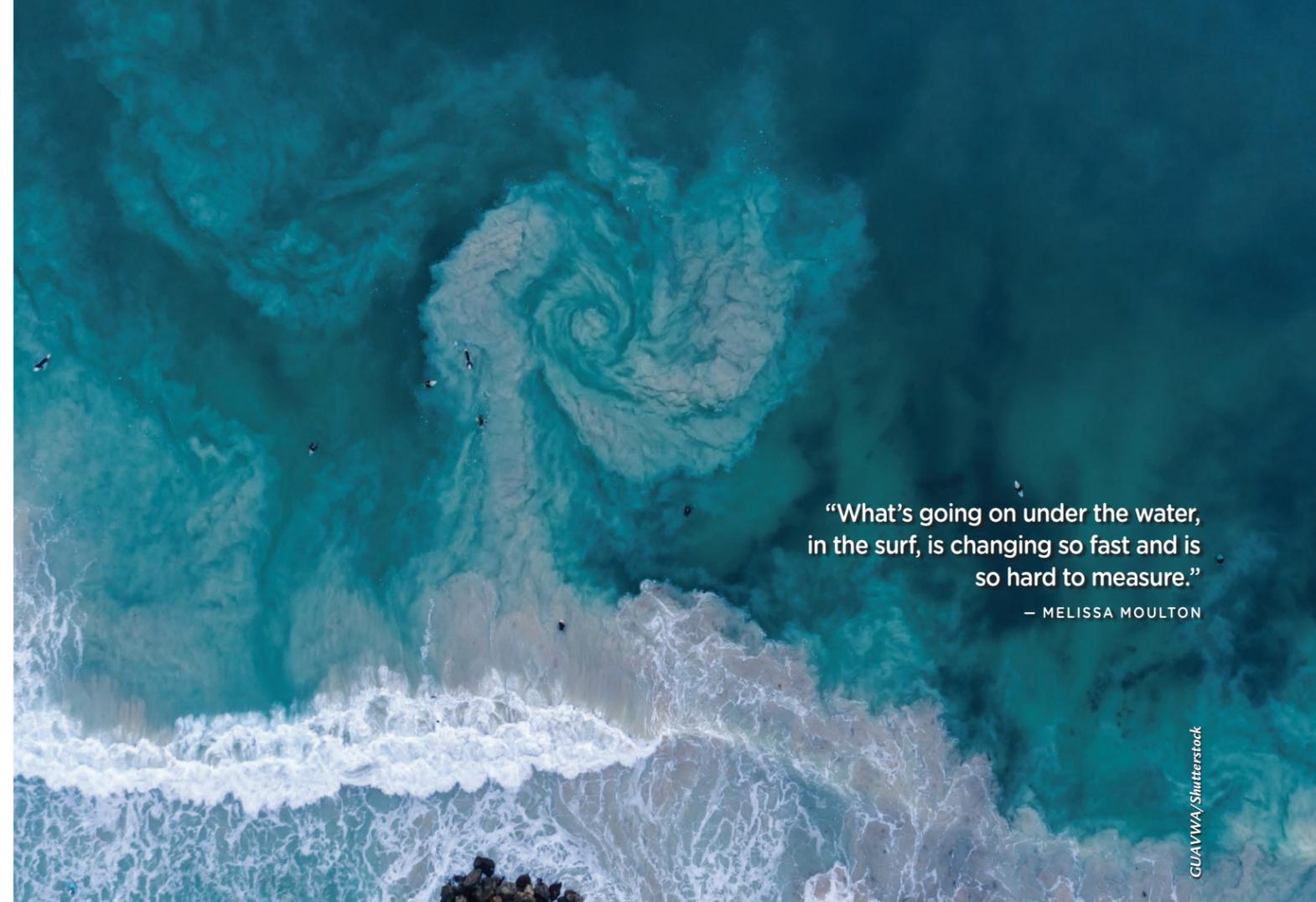
Rip currents are currents of water that flow away from shore at beaches with breaking waves. Although rips come in different sizes and vary locally, there are signature signs to look for:

- A narrow gap of darker, seemingly calmer water between areas of breaking waves and whitewater;
- A channel of churning, choppy water;
- A difference in water color; and
- A line of foam, seaweed, or debris moving seaward.

For more rip current resources, including a safety brochure, go to go.ncsu.edu/ripcurrents.



John McCord/Coastal Studies Institute



GUAVWA/Shutterstock

“What's going on under the water, in the surf, is changing so fast and is so hard to measure.”

— MELISSA MOULTON

Rip currents occur on surf beaches around the globe. The rocky structure at the bottom of the frame likely contributed to this rip, photographed in Australia and distinguishable by a swirling sediment plume.

“We found that those totally different types of observations were remarkably consistent with each other,” she says. “I was really surprised how the lifeguard-derived hazard model and me, sticking a current meter in water, gave such a similar answer for the way that waves and tides control the presence of strong rip currents.” The team published their study in *Weather and Forecasting* in 2017.

Over time, Dusek and NOAA colleagues have improved the model with additional lifeguard observations from other beaches in and outside of North Carolina. Indeed, the suite of conditions that promote hazardous rip formation along our state's barrier island shoreline aren't identical to those along, say, rocky West Coast beaches. The model must crunch numbers differently depending on where it's forecasting.

“The baseline model that we trained in North Carolina worked pretty well everywhere else we tested,” Dusek says, and yet “we can improve it dramatically if we have good observations in other places.”

FILLING IN GAPS

In March 2021, Dusek's rip current model debuted as part of NOAA's Nearshore Wave Prediction System, a tool that forecasts wave conditions, overwash, and erosion. The system seamlessly provides data for the rip model to make its predictions.

Many National Weather Service Forecast Offices are now using the new rip forecasts in conjunction with an older forecasting method to issue their rip guidance. The traditional method — which entails manually entering

values for different weather and ocean conditions into a spreadsheet — has limitations for which the new model helps compensate, says Steve Pfaff, warning coordination meteorologist for the NWS Forecast Office in Wilmington.

“I think this is a great leap forward,” Pfaff says. For decades, forecasters have been “hamstrung, only able to provide a composite rip current risk for the beaches of an entire county.” The new model's resolution enables meteorologists to home in on mile-long sections and provides hourly forecasts nearly a week in advance.

In addition, whereas the old method relied on a three-tier warning structure — low risk, moderate, or high — the new model provides a zero to 100% probability of hazardous rips occurring, similar to a rain forecast.

Continued



“What I realized was the problem that we were experiencing was a lack of knowledge and an inability of the average patron to be able to understand what a rip current was.”

— DAVID ELDER

Kill Devil Hills Ocean Rescue

Kill Devil Hills Ocean Rescue lifeguard Reggie Kelly holds a yellow flag, warning swimmers to be cautious of strong currents.

When Dusek and his doctoral advisor, Harvey Seim of UNC-Chapel Hill, first described the model in 2013 in the *Journal of Coastal Research*, they noted a 67% improvement over the old forecasting method for Kill Devil Hills. Since then, Dusek says, “pretty much everywhere we test, we see an improvement with the new approach, with obviously the added benefit [that] we’re not just giving you

one value for today; we’re giving you much more information going much further into the future.”

“It’s really the first time we’ve had sophisticated numerical model guidance for rip currents that goes out that far and for that many beaches,” adds Mark Willis, Wilmington’s meteorologist in charge.

From a planning perspective, advance warning is crucial to emergency managers. Case in point: This past August, the University of North Carolina Wilmington was hosting an event on Wrightsville Beach, and the school’s emergency manager was concerned about the rip current risk.

Combining the old and new rip forecasting approaches, “we were able to say with a higher



Courtesy of Alex Pang/UC Santa Cruz



Courtesy of Alex Pang/UC Santa Cruz

Examples of virtual overlays delineating a rip current.

level of confidence, yes, there’s a moderate risk of rip currents for New Hanover County — in particular, Wrightsville Beach today — and we think that the rip probabilities will be highest during the morning,” Pfaff says.

ON THE HORIZON

Despite years refining his model, Dusek acknowledges that “there’s still a lot of work to do.”

One important limitation is the tool’s treatment of bathymetry, a critical factor in rip current

formation. For instance, channel rips can occur when a break between sandbars or reefs creates a conduit for water flowing back out to sea.

But capturing data on a constantly shifting sea floor is difficult, to say the least.

“What’s going on under the water, in the surf, is changing so fast and [is] so hard to measure,” says Moulton, the coastal physical oceanographer.

The rip model currently uses an approximation for bathymetry; specifically, it considers whether a big storm occurred several days prior to a given forecast. “From our research data we saw that, following a storm — you know, a pretty large wave event — the shape of the bottom would end up being pretty favorable to rip currents,” Dusek says.

Nor does the model yet account for the influence of structures, such as groins, jetties, and piers, which can promote rip currents as incoming waves deflect. Such structures can also influence how sediment moves and thereby affect bathymetry.

Dusek also plans to further improve the model using data beyond lifeguard observations. “Even though lifeguards are really good at doing this, there’s going to be different interpretations depending on where you are,” he says, “so a lifeguard in Kill Devil Hills, North Carolina, is probably going to see the beach differently than a lifeguard in San Diego, California.” Plus, most beaches don’t have guards, so many nearshore nuances go unobserved.

Dusek and colleagues think surf webcams — internet-connected cameras attached to stationary structures like piers — could provide missing data. The idea is that a camera would capture video of the surf, and a computer would analyze the imagery for tell-tale signs of dangerous rips. Positive identifications would then be used to enhance the rip current model.

Alex Pang of UC Santa Cruz is developing that technology using a process called machine learning; the team is testing its capability using footage from a regional array of webcams operated by the Southeast Coastal Ocean Observing Regional Association.

Dusek and Pang’s ultimate goal is to enable beachgoers to use their own smartphones to detect rip currents in real time. They envision docking stations located on elevated locations, such as piers and beach access points, where

Continued



“How do you tell a 55-year-old male and a 19-year-old kid the same message? And where do you tell them that, and how do you say it?”

— DAVID ELDER

Robert Alford/Shutterstock

Red flags signal no swimming because of hazardous surf conditions.

visitors can position their phones, open an app, and take steady footage of the shoreline in front of them. The app would then reveal dangerous rips with a virtual overlay marking their path, similar to Instagram filters that stick “whiskers and funny noses over someone’s selfie,” Pang says.

Pfaff says the concept is promising. Seeing a rip current illuminate on your phone “has a sense of realness to it,” he notes. “As far as an educational tool, I think that’s amazing.”

GETTING THE MESSAGE

The rip current that Bob Schiffer survived in Kill Devil Hills wasn’t his last. This past June, he and his daughter and grandson were playing in the surf at Ocean City, Maryland, when he discovered that he was again caught in a rip.

The prospect of drowning in front of loved ones filled Schiffer with anxiety, and he began frantically swimming. “Years of training and experience were erased by a flash of emotion,” he says.

Schiffer’s family escaped to shore, where his daughter immediately sought help. Once again, a lifeguard pulled him out of the water, shaken but unscathed.

In retrospect, Schiffer says he overlooked certain realities that likely contributed to the close call: He’s older, he hadn’t been in the ocean in a while, and, having once been a competitive swimmer, he fancied himself somewhat invincible.

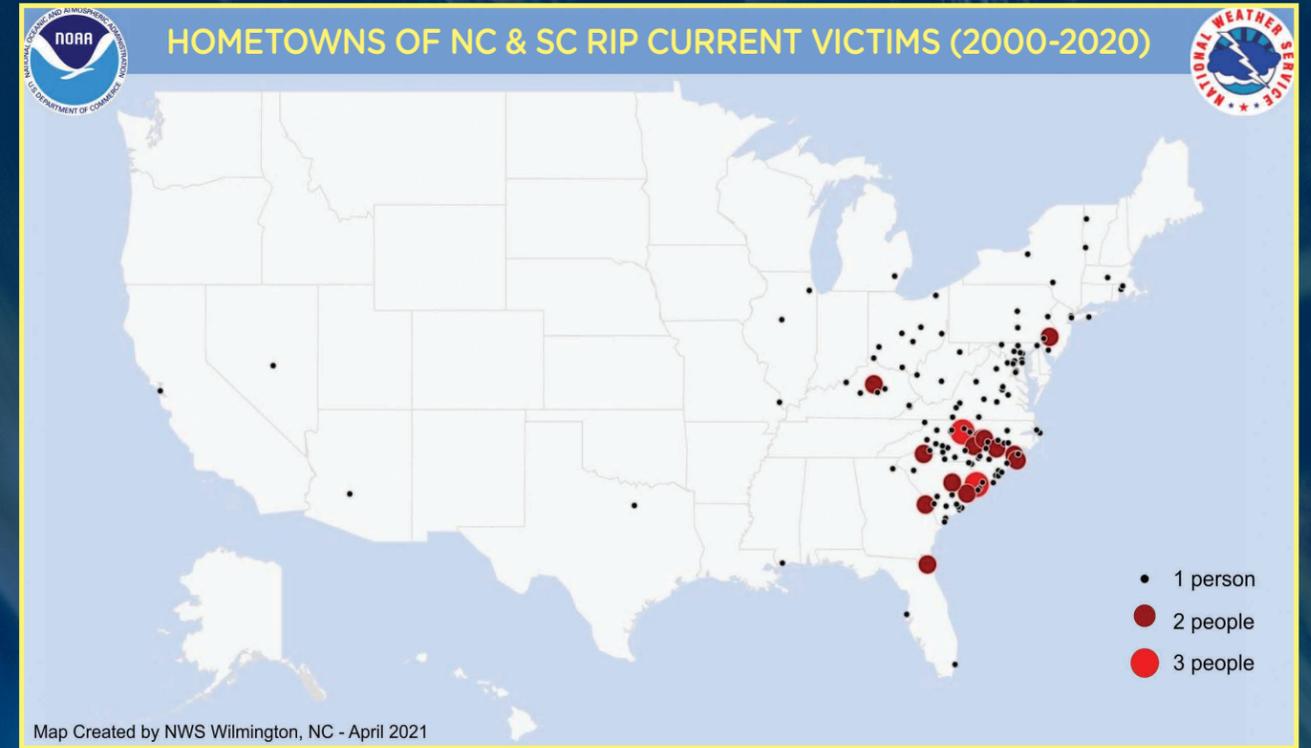
Not everyone will experience such an epiphany. An enhanced rip current forecast is one step to saving more lives, but a prediction is only as good as the messaging around it. In that regard,

building public awareness “has a long way to go,” says Pfaff.

Elder agrees. “How do you tell a 55-year-old male and a 19-year-old kid the same message? And where do you tell them that, and how do you say it?”

“This is something I’m passionate about,” Elder adds, “because I can see the faces in front of me, right now, who should have known this stuff and who will never get a chance to.” In North and South Carolina alone, more than 170 people have drowned in rip currents since 2000.

For Schiffer’s part, he’s changing his ways. “I’m accustomed to swimming alone, and was accustomed to swimming early before the beach opened,” he says. “I’ve now made a pact with my children, my daughters, that Grandpa will no longer do that, that I will abide by all of the reasonable standards.”



BY THE NUMBERS

Anyone can get caught in a rip current. The map above “highlights the need to talk about rip currents not only within coastal areas, but also in cities well inland, across the country,” says Victoria Oliva, a meteorologist with the NWS Forecast Office in Wilmington. “Whether someone lives in Greensboro, North Carolina, or Kentucky, if they ever visit a beach, they need to be aware of rip currents — what they are and how to stay safe.”

The Wilmington office provided the rip current-related statistics below. The data applies to North and South Carolina and extends from 2000 through July 31, 2021, except where noted.

- Known rip current deaths: 172 (141 males, 25 females, 6 whose gender was undocumented).
- Men ages 41 through 50 comprised the majority of male fatalities; women ages 31 through 40 constituted the majority of female fatalities.
- Most drownings occurred between noon and 5 p.m.
- 51% of deaths involved people visiting from outside North and South Carolina.
- Since 2010, 27% of fatalities have been considered “bystanders,” or people who entered the water in an attempt to rescue someone else in distress.
- 2013 saw a record 17 known rip current fatalities.
- In 2020, 11 known rip current drownings occurred.

RIP CURRENTS

Know your options

Rip currents are powerful currents of water moving away from shore. They can sweep even the strongest swimmer away from shore. If at all possible, swim near a lifeguard.

IF CAUGHT IN A RIP CURRENT

- ◆ Relax, rip currents don’t pull you under.
- ◆ Don’t swim against the current.
- ◆ Swim out of the current, then to shore.
- ◆ If you can’t escape, float or tread water.
- ◆ If you need help, yell or wave for assistance.

SAFETY

- ◆ Know how to swim.
- ◆ Never swim alone.
- ◆ If in doubt, don’t go out.
- ◆ Swim near a lifeguard.

More information about rip currents can be found at the following websites:
weather.gov/safety/ripcurrent
usla.org

AERIAL VIEW OF A NORTH CAROLINA SALT MARSH FRINGING THE UPLAND FOREST. AT THE BOUNDARY, NOTICE THE DEAD AND DYING TREES. THIS GHOST FOREST IS EVIDENCE OF SALT MARSH TRANSGRESSION. CLOCKWISE FROM THE BOAT, RESEARCHERS INCLUDE JOSHUA HIMMELSTEIN, ANTONIO RODRIGUEZ, NAOMI NICE, YASAMIN SHARIFI, AND MOLLY BOST.

BY ANTONIO B. RODRIGUEZ

DIGGING UP A STORMY PAST

SEDIMENT SAMPLES HUNDREDS OF YEARS OLD OFFER INSIGHT INTO HOW HURRICANES AND NOR'EASTERS CAN AFFECT LANDWARD MIGRATION OF SALT MARSHES.

Continued

Antonio B. Rodriguez is a coastal geologist at the University of North Carolina at Chapel Hill's Institute of Marine Sciences, within the Department of Earth, Marine, and Environmental Sciences. Here, he describes research into how big storm events influence the rate of salt marsh migration into upland areas. The work was recently published in *Quaternary Science Reviews*. The first author is Carson Miller, who was a master's student in Rodriguez's lab at the time. Miller is now a doctoral candidate at the University of Texas at Austin where she's studying the geology of the Gulf of Mexico inner continental shelf. Grad student Molly Bost, a doctoral candidate at UNC studying oyster reefs, salt marshes, and tidal creeks, also contributed to the research. North Carolina Sea Grant provided research funding.

Salt marshes are extensive along the estuaries and sounds of North Carolina, where they connect tall upland forests with shallow coastal waters. These important ecosystems provide refuge for fish, improve water quality, sequester carbon dioxide from the atmosphere, and help control shoreline erosion and flooding during storms.

Salt marsh area is declining globally and locally, largely due to human impacts, such as conversion of habitat into developments and navigation channels. However, new salt marsh is forming in some places where sea level rise has inundated upland forest. These locations have become intertidal, with salty soils, and are ideal for marsh colonization.

Landward expansion of salt marshes, called transgression, can offset some of the ongoing losses. The rate of salt marsh transgression is directly related to the slope of the upland forest surface and the rate of sea level rise. Low upland slopes and high rates of sea level rise promote rapid salt marsh transgression.

Parsing the various factors that influence transgression can help scientists to more accurately project salt marsh coverage under different climate change scenarios. Improved understanding can also inform management



CARSON MILLER AND ANTONIO RODRIGUEZ PULL A CORE OUT OF THE SALT MARSH WITH A RATCHET JACK. IN THE BACKGROUND, MOLLY BOST OFFERS ENCOURAGEMENT.

practices related to construction along the landward edge of salt marshes.

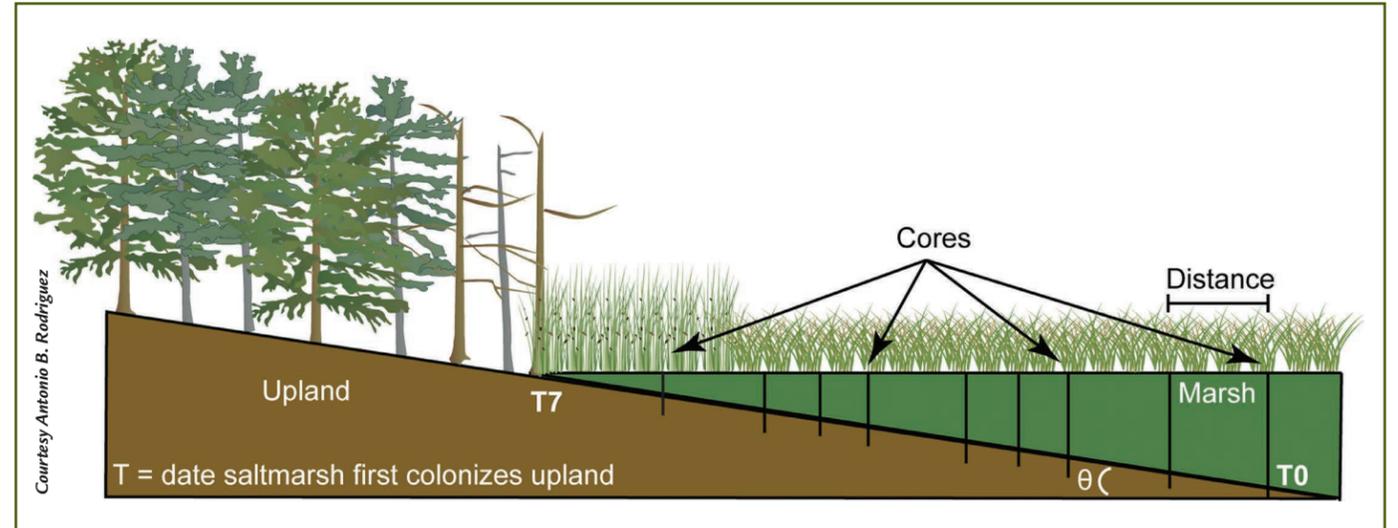
For our study, we wanted to know if major storms like hurricanes and nor'easters contribute to salt marsh transgression. Storms are commonly associated with elevated water levels (albeit temporarily), and they deliver salt to upland soils. They also can cause inlets to form through barrier islands, thereby increasing the connection between ocean and estuary, resulting in higher tides over the marsh.

We decided to look back in time to see how past storms have affected salt marsh

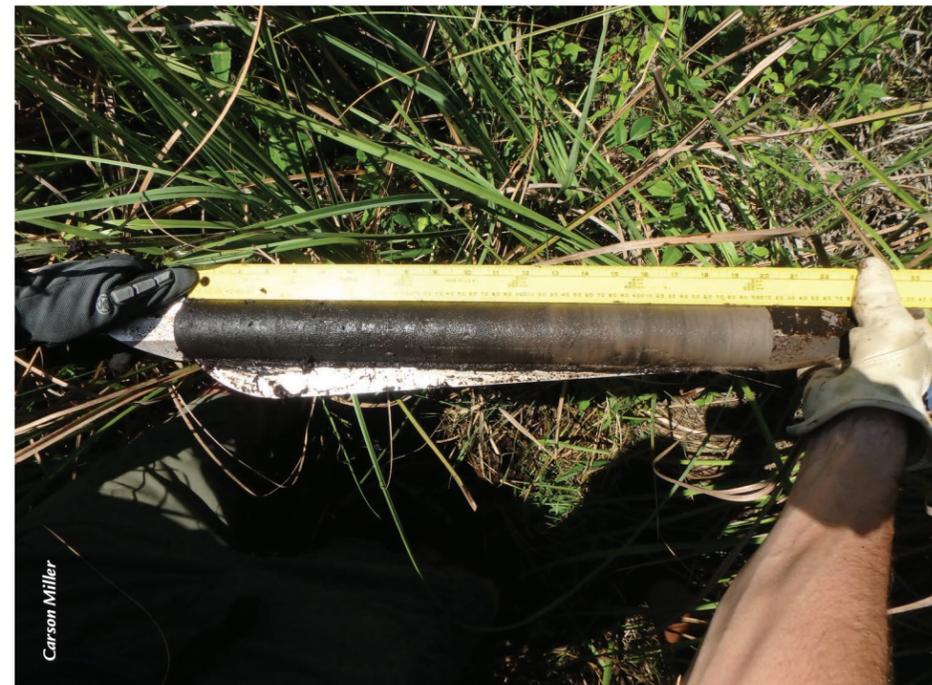
movement along coastal North Carolina.

As part of her master's thesis project at the University of North Carolina at Chapel Hill's Institute of Marine Sciences, graduate student Carson Miller measured rates of salt marsh transgression during a stormy period from about 1400 to 1675 C.E.

During that 275-year stretch, the number of inlets through the Outer Banks was greater than it is today, stemming from an increase in nor'easter activity and associated beach erosion, surge, and overwash, according to research published by colleagues at East Carolina



AN ILLUSTRATION OF SALT MARSH TRANSGRESSION AND CORE SAMPLE PLACEMENT.



THIS CORE SHOWS A SAMPLE OF UPLAND FOREST PEAT.

University. Greater storminess during that time period wasn't restricted to North Carolina — it characterized the entire western North Atlantic.

To reconstruct rates of salt marsh transgression, we collected sediment samples, called cores, from salt marshes that fringe bays near the Neuse River Estuary and Core Sound.

We had positioned the cores in a line from the marsh's estuary edge to the upland forest boundary. Each core contained layers

of salt marsh peat that had accumulated over time atop layers of upland forest peat. As a rule of thumb, the closer a core's location was to the forest, the less marsh peat there was in the sample, and the more recently the marsh had migrated to that area.

In a given core sample, we identified the transition between upland forest peat and marsh peat by the absence of organisms found in brackish water typical of salt marsh habitat. The

layer of marsh peat appearing at that transition represented when marsh grass first appeared in the upland area. To figure out that time period, we aged blades of grass stuck in the marsh peat using a tool called carbon-14 dating.

Using the times that salt marsh first colonized upland areas and the distances between the cores, we could calculate rates of salt marsh transgression.

We found that salt marshes at two different sites migrated 2 and 10 times faster, on average, during the 1400-1675 stormy period than the non-stormy period that followed. Sea level rise was less than 1 millimeter a year during both timespans.

We also looked at transgression post-1865 — after the Industrial Revolution — when sea level rise had increased nearly three-fold, to 2.4 millimeters a year. Salt marsh transgression occurred on average 7 times faster than it did during the previous non-stormy period.

The study highlights that, in addition to contributions from sea level rise, changes in storminess also modulate salt marsh transgression rates. This finding is important because both storminess and the rate of sea level rise are projected to increase in the future. As development along the landward edge of salt marsh continues, will the area of this essential habitat be maintained or lost? 📧

• [READ THE FULL STUDY: GO.NCSU.EDU/SALTMARSH-TRANSGRESSION](https://go.ncsu.edu/saltmarsh-transgression)



BY SUSAN WEST

New Links in the Sea-to-Table Chain

THE NORTH CAROLINA LOCAL FOOD COUNCIL RESPONDS IN THE PANDEMIC'S DARKEST HOUR

Baxter Miller



Ray Midgett

When food producers quickly lost wholesale markets in spring of 2020, the North Carolina Local Food Council was prepared to act.

ideos of farmers plowing green beans, cabbage, and other fresh produce back into the ground ran side by side with images of empty grocery store shelves and long lines of hungry Americans at food banks when the COVID-19 pandemic swept across the country in 2020. Food systems struggled to adjust to the sudden loss of markets as stay-at-home orders went into effect and schools, restaurants, and other businesses closed to help protect public health.

Food import and export supply chains ruptured. NOAA Fisheries reports that U.S. seafood exports to China fell 45% in February 2020 after ports and seafood processing plants in that country closed — a harbinger of the sort of market turmoil N.C. seafood producers would face.

Barry Nash, North Carolina Sea Grant's seafood technology and marketing specialist, says that how quickly food producers lost wholesale markets in spring of 2020 was jolting — but, he adds, the North Carolina Local Food Council was prepared to act.

“The Council’s focus immediately transitioned to helping food producers adapt to the loss of food service industry revenue streams and remain viable during the pandemic, and to helping get food to food banks and the people who needed it,” says Nash, who serves as Council chair.

The North Carolina Local Food Council supports the 35 food councils that serve counties and towns across the state. Food councils bring stakeholders together to build resilient food systems that improve access to healthy food, protect natural resources, and support economic development.

Representatives from 21 member organizations and three regional councils serve on the Council. “It’s unique in that not all states have a formal way for the different organizations working on food systems to collaborate and share information and resources,” says Angel Cruz, the Council’s coordinator and the academic and extension initiatives manager with the Center for Environmental Farming Systems at North Carolina State University.

The Council’s history also makes it unique. Established by the state legislature in 2009, the program’s members valued the collaboration enough to reorganize and continue even after the legislative mandate expired.

“Early in the pandemic, the Council leadership team began exchanging information about the food system challenges we were seeing — the pinch points where food access and distribution were getting stuck — and that’s when we began meeting weekly,” Cruz says.

The loss of restaurant and other food service markets shook the commercial fishing industry to its core in the first half of 2020. A Rutgers University study noted that prior to the pandemic, restaurants pulled in 70% of the money spent on seafood in the United States.

The study surveyed commercial fishermen in states from Maine through North Carolina and found that *two-fifths* of the fishermen did not go fishing for portions of the March-to-June 2020 timeframe due to market disruptions tied to the pandemic. Nearly all the fishermen who did continue to fish reported a decline in income compared to previous years.

In fact, NOAA Fisheries reported an overall 23% decrease in landings revenue for species in the Southeast during the first six

months of 2020 compared to 2019. Black sea bass revenue fell by 65% and dolphinfish (“mahi-mahi”) by 53%, declines that reflected closings of “white tablecloth” restaurants, where both species are popular.

Incorporating direct sales to consumers into business models helped soften the blow for local seafood producers and farmers when wholesale demand slowed.

“People were already looking for local foods because often local foods are healthier and fresher than food from other states and other countries,” Nash says. “But the popularity of online sales and home delivery programs accelerated with the pandemic.”

Local food producers often can adjust to market changes faster than national food systems because they usually have less volume of product to move, shorter supply chains, and serve smaller areas. However, not all small business owners have the technological skill to develop a strong online marketing presence and reach new customers.

To help address that challenge, the North Carolina Local Food Council created a student intern program called Remote Internship to Support Enterprises for Local Foods (RISE), which North Carolina Sea Grant co-sponsored. The project paired seven paid college students skilled in digital technology with local food producers, farmers markets, and food hubs to develop websites, videos, newsletters, and social media posts.

“The internet allows producers to create a brand, tell their story, and directly connect with customers on a personal level,” says Sienna Zuco, a student intern from the University of North Carolina at Chapel Hill. In addition to working with several local seafood companies to help build websites designed to meet marketing goals, Zuco created tutorials so clients can update product information, add blog posts, and make other changes as their businesses grow. After graduating in December, Zuco began working as a communications assistant for the Council.

Susan Hill, co-founder of Down East Mariculture in Williston, wanted to improve an existing website to attract more online traffic and feature stories about the history of the business and the town. “Sienna and the RISE project helped us take our website to the next level and tell our story,” Hill says.

In Engelhard, Diamond Shoal Shrimp Company did not have a website, and co-owner Patrice Clarke was looking for a way to promote shrimp cakes, the company’s new product. “Our shrimp cakes meet what customers are looking for now,” she says. “They’re easy to order online and prepare at home, trends that took off with the pandemic and are likely to continue.”

Sea Grant plans to follow up with RISE clients in the seafood industry to evaluate the economic impact of the project and to identify any additional outreach that could help local producers adjust to digital platforms.

Nash and Cruz say much of the energy of the North Carolina Local Food Council lies in the networking opportunities it fosters. Nash points to a new grant that will add seafood producers and

Continued



Mike Halimsk

Two-fifths of the commercial fishermen in states from Maine through North Carolina did not go fishing for portions of the March-to-June 2020 timeframe due to market disruptions from the pandemic.

retailers engaged in direct marketing to the North Carolina Department of Agriculture's *Visit NC Farms* app that connects consumers with local farms.

"That partnership came about because of the Council," Nash explains. "Serving on the Council has allowed me to connect with other people working on direct marketing projects and discuss how we can raise the visibility of seafood producers."

Cruz recalls that in some areas the amount of food going to food pantries and banks increased by up to 300% when restaurants, school cafeterias, and other food service industries closed or operated at reduced capacity under stay-at-home orders. However, many charitable organizations lacked adequate cold storage space for perishable goods.

"That was one of the pinch points, one of the challenges, the Council heard about," she says. Council members connected food charities with Sysco Corporation, and the company's refrigerated delivery trucks, idled by the pandemic, became cold storage facilities in food pantry parking lots.

Now there are initiatives underway to permanently increase cold storage facilities in the state. "That's not something the Council directly did," Cruz explains, "but I think we helped create that change by sharing data."

The Council's website is a resource for information on local

food and local food councils. Comprehensive guides to North Carolina's oysters, strawberries, and shrimp point consumers to local sources and feature videos, profiles of local food producers, and recipes, including many from *Mariner's Menu*, Sea Grant's guide to preparing seafood dishes.

Consumers can also read stories about "food champions," people going the extra distance to promote local foods, like chef Ricky Moore, known for the use of North Carolina seafood at his restaurant, the Saltbox Seafood Joint in Durham.

Cruz says that Council members gained valuable experience after addressing critical food system vulnerabilities tied to the pandemic. "In the future, I think we will continue to be involved in different ways, including finding long-term solutions to making our food system more resilient and more prepared for future pandemics, climate change, and other challenges," she says.

Nash notes that the U.S. became a net importer of food in 2005, and has remained one since — which is why the North Carolina Local Food Council will always be a crucial resource for groups that want to build or strengthen local food economies.

"We have the graying of the commercial fishing fleet and of farmers too, and we need to show younger people that these businesses can be profitable," he says. "Otherwise, we are going to lose access to local foods." 📧

With shorter supply chains and less volume to move, local food producers often adjust to market changes faster than national systems.



Scott Taylor

NORTH CAROLINA SEA GRANT'S SEAFOOD CONSUMER AWARENESS CAMPAIGN

In addition to collaborating with the North Carolina Local Seafood Council during the pandemic, North Carolina Sea Grant immediately began an award-winning public service campaign. Not only did the campaign highlight existing and new avenues for consumers to purchase the state's seafood, it also provided strategies and tips to consumers for both seafood preparation and preserving freshness.

These initiatives supported the state's seafood industry during a dire economic period and provided lasting resources for consumers and businesses:

- "How to Freeze NC Seafood," the cover story from the summer 2020 issue of *Coastwatch*, touted alternative strategies for seafood consumers, highlighting how to preserve and prepare fresh seafood. This also appeared as part of the online *Currents* series. Visit go.ncsu.edu/freeze-fresh.
- Consumer surveys indicated a widespread desire for seafood recipes, which we provided online through the *Mariner's Menu* site, as well as a regular feature online and in print in every 2020 issue of *Coastwatch*. North Carolina Sea Grant partners, such as the National Marine Fisheries Service, regularly used and promoted these recipes. In addition, *Carteret County News Times* featured *Mariner's Menu* recipes in a calendar that the paper published in December 2020. Visit MarinersMenu.org.
- Leveraging the popularity of *Mariner's Menu*, in 2020 North Carolina Sea Grant also developed 13 *Mariner's Menu* posters, which news media in turn published in newspaper food sections around the state, including outlets in Dare County at the coast and Chatham County in the piedmont, as well as *919* magazine in Raleigh. Visit go.ncsu.edu/menu-poster.
- In print and online, North Carolina Sea Grant also published the 2020 "Seafood Availability Posters," which highlight dozens of species and their availability by month and by region of the North Carolina coast. These posters represented a fresh update to information consumers have relied on for years as the popular series has evolved since



VisitNC.com

the 1970s. *Coastwatch* also carried the posters. Visit go.ncsu.edu/seafood-availability.

- Last year, enhanced webspace and a new print and online brochure touted farmed shellfish and promoted the availability of shellfish from North Carolina farmers. This broadened availability helps supplement the otherwise more limited seasonality of shellfish caught during wild harvests. Visit go.ncsu.edu/wild.
 - For the first time in 2020, "A Primer on North Carolina's Seafood" offered webspace that provides information on North Carolina fisheries, consumer safety and health tips, strategies for seafood preparation, cultural resources, and more. Visit go.ncsu.edu/seafood-primer.
 - Throughout the pandemic, North Carolina Sea Grant social media feeds also regularly emphasized and amplified key seafood consumer awareness campaign messages and themes, as well as a wide array of new and existing resources (for example, through "#FishyFriday"). Visit [@SeaGrantNC](https://twitter.com/SeaGrantNC) and facebook.com/ncseagrant.
 - From the start, "North Carolina Sea Grant's COVID-19 Resource Hub" provided an immediate portal to resources for seafood consumers, marine science educators, and seafood industry owners and employees. Visit go.ncsu.edu/covid-hub.
- In July, North Carolina Sea Grant's Barry Nash, Katie Mosher, and Vanda Lewis received a Grand Award, top honors from the 2021 APEX Awards for Communication Excellence, for spearheading the Seafood Consumer Awareness Campaign.

READ MORE

- **North Carolina Local Food Council:** nclocalfoodcouncil.org
- **RISE:** nclocalfoodcouncil.org/rise-for-local-foods
- **NC Shrimp Promotion:** go.ncsu.edu/shrimp
- **NC Oyster Promotion:** go.ncsu.edu/oyster-time
- **NC Strawberry Promotion:** go.ncsu.edu/strawberries

“Understanding the distribution and impacts of invasive and non-native species on coastal ecosystems is a pressing management issue. Aaron’s previous research, as well as past Coastal Research Fellows’, has suggested that these impacts are likely context-dependent and not always negative.”

— BRANDON PUCKETT, RESEARCH COORDINATOR AT THE NC COASTAL RESERVE



Aaron Ramus

INVASION ON THE MUDFLATS

NEW RESEARCH REVEALS THE IMPACT OF THE INVASIVE SEAWEED *GRACILARIA* ON HARD CLAMS AND OTHER INTERTIDAL BOTTOM-DWELLERS.

BY AARON RAMUS

Aaron Ramus received the 2020 Coastal Research Fellowship, which North Carolina Sea Grant and the N.C. Coastal Reserve and National Estuarine Research Reserve Program sponsor jointly. Ramus, a Ph.D. candidate at the University of North Carolina Wilmington, studies the ecological impacts of *Gracilaria* in estuaries in the Southeast. He received his master’s in marine biology from UNC Wilmington and his bachelor’s in biology from the University of North Carolina at Chapel Hill.

INTERTIDAL MUDFLATS, SHALLOW MUDDY AREAS EXPOSED DURING LOW TIDE, ARE ACTUALLY QUITE COMMON IN NORTH CAROLINA’S ESTUARIES. Although they might not seem as scenic or picturesque as other coastal habitats, these intertidal mudflats are home to myriad invertebrates — species without a backbone — as well as to fish and seabird populations.

These mudflats also support numerous fisheries, including the hard clam *Mercenaria mercenaria*. Hard clams are edible, filter-feeding bivalves that constitute the basis for a popular recreational and major commercial shellfishery in North Carolina that generates more than \$3.7 million annually, according to the N.C. Division of Marine Fisheries.

However, many of North Carolina’s

mudflats are now also home to a new species — a black, stringy, disheveled-looking seaweed known as *Gracilaria vermiculophylla*. In fact, non-native *Gracilaria* has recently invaded almost every estuary in the southeastern United States, from Georgia to Maryland, and it appears *Gracilaria* is here to stay.

When *Gracilaria* invades, it forms complex micro-habitats in these intertidal areas that previously were largely devoid of vegetated structure. Because predators — such as whelks, seabirds, stingrays, and blue crabs — play a major role in controlling populations of benthic (bottom-dwelling) invertebrates on intertidal mudflats, *Gracilaria* could provide benthic prey with a refuge from predators. This could potentially modify predator-prey interactions on invaded mudflats, with important implications for the production of hard clams in North Carolina estuaries.

Many invasive species have negative effects on the functioning and health of ecosystems and pose serious challenges for managers. In particular, it’s often unclear exactly where invasive species occur, and, even when we do know, we frequently don’t understand the invader’s impacts adequately.

For my Coastal Research Fellowship, I sought to address these challenges in two ways. First, I conducted surveys to enhance our understanding of *Gracilaria*’s distribution and abundance (and, thus, its potential impacts) along the N.C. coast. I searched the “water-bearing” N.C. Coastal and National Estuarine Research Reserves for *Gracilaria* and, when I located it, recorded its abundance.

My survey detected the presence of invasive *Gracilaria* in five reserves and revealed that *Gracilaria* covered more than 10% of

Continued



Aaron Ramus



Aaron Ramus

Does the presence of *Gracilaria* affect the production of hard clams, like these on the Masonboro Sound? Aaron Ramus conducted research on intertidal mudflats in the Masonboro Island National Estuarine Research Reserve to find out.

intertidal mudflats in four of the reserves — all of which are along the central and southern portion of the state's coast. Ultimately, I developed a web-based interactive map of *Gracilaria*'s distribution and abundance to assist managers in their endeavors.

Second, I examined the indirect effects of *Gracilaria* on predator-prey interactions and on other aspects of the benthic community, including the production of hard clams, by conducting an experiment on intertidal mudflats in the Masonboro Island National Estuarine Research Reserve. My experiment manipulated the presence of *Gracilaria* and predators simultaneously in experimental plots by either manually removing *Gracilaria* or using cages to exclude predators.

After two months, I sampled the plots

using sediment cores to collect smaller invertebrates and juvenile hard clams and by digging with a clam rake to recover adult hard clams. The results showed:

- *Gracilaria* strongly and positively affects the overall abundance and diversity of the benthic community.
- Predator exclusion had a negligible effect on the benthic community. The natural mortality of juvenile hard clams (as well as other benthic invertebrates) is very high, independent of whether predators are excluded.
- Most importantly, neither predator exclusion nor the presence of *Gracilaria* significantly influenced the production of hard clams.

These findings suggest that *Gracilaria*'s overall impact on the ecosystem falls

somewhere between positive and neutral. It would appear that invasive *Gracilaria* is neither “good” nor “bad” for this estuarine shellfishery and is simply a new feature of North Carolina's mudflats. Consequently, taking management actions to eradicate this invasive seaweed might not be necessary to preserve the health of our state's hard clam fishery. 📺

Watch a video about Aaron Ramus's research on non-native *Gracilaria*.

go.ncsu.edu/invaders

View an interactive map of *Gracilaria*'s distribution and abundance.

go.ncsu.edu/the-map



Coastal Research Fellow Aaron Ramus on the mudflats in the Masonboro Island National Estuarine Research Reserve.



NC State University Photos

THE WATERSHED WISDOM LESSON PLAN

FREE RESOURCES FOR K-12 EDUCATORS TO ENRICH ONLINE AND IN-PERSON LEARNING

BY CHRISTY PERRIN

Christy Perrin serves as sustainable waters and communities coordinator for North Carolina Sea Grant and the N.C. Water Resources Research Institute. She helps run the statewide N.C. Watershed Stewardship Network (WSN) in partnership with N.C. Division of Water Resources. Perrin, Paula Edelson of PBS North Carolina, and Lauren Daniel of N.C. Division of Water Resources Water Education led a WSN team that recently won a national APEX Grand Award for Publication Excellence for The Watershed Wisdom Lesson Plan.

AS THE PANDEMIC CONTINUES TO AFFECT K-12 LEARNING MODELS, SEVERAL THOUSAND NORTH CAROLINA TEACHERS, STUDENTS, AND FAMILIES ALREADY HAVE ACCESSED THE FREE WATERSHED WISDOM ONLINE LESSON PLAN.

Watershed Wisdom provides a thorough introduction to the value of water and of maintaining healthy watershed ecosystems. The lesson plan includes guidance for elementary school teachers and a wide range of activities for North Carolina students. In addition, a companion

Continued



Kayaking on the Neuse River.

“Learning from Home Guide” highlights activities that teachers can assign online to accommodate remote learning across the state.

We designed *Watershed Wisdom* to support North Carolina teachers by providing them with an easily accessible lesson plan that meets required N.C. Essential Standards. We created it to get students outdoors, empower them, teach them about their local watersheds, and prompt student-parent interactions with the concepts at home.

Our PBS North Carolina partners helped us to achieve this and more. They led development of *Watershed Wisdom*, including a completely interactive online component, “Ways of Watersheds.” The lesson plan makes a wide range of tools available, from videos to maps to interviewing activities.

Portions of the lesson plan are below. *Watershed Wisdom* is available in full at no cost by opening a free Learning Media account at go.ncsu.edu/wisdom.

THE WATERSHED WISDOM LESSON PLAN

OVERVIEW

As is the case in many states, North Carolina has suffered its share of flooding, and its citizens have coped with fairly significant periods of

drought and polluted waterways. With environmental issues such as extreme weather events on the rise, everyone — and especially students — should understand that water is a natural resource that needs to be valued and protected.

Designed for alignment with North Carolina 4th-grade and 5th-grade science standards but appropriate for all students regardless of age and location, *Watershed Wisdom* is a blended lesson that combines interactive components with hands-on projects. With enough content to fill two full weeks of class time, the lesson begins with a host of activities to introduce students to the topic, including River Avengers (available at go.ncsu.edu/river), a short animation featuring four youngsters who pose an inquiry to the class: What ideas do students have to keep the river near their school safe and clean?

The rest of the lesson helps students gain the knowledge they will need to solve that inquiry through creative design-thinking tasks, group events, an interactive map activity provided by the EPA’s *EnviroAtlas* website, and other rich content that serves not only to educate students about water but to inspire them to take action to protect this valuable resource.

Time allotment: Seven to 10 class periods for the entire lesson plan. Each activity takes a class period or less.

Learning objectives:

- Students can define and describe the water cycle.
- Students can define and describe the watershed ecosystem.
- Students can discuss the threats watershed ecosystems face.
- Students can describe actions people can take to protect and promote watershed health.

SAMPLE: THE “WAYS OF WATERSHEDS” INTERACTIVE SESSION

Entertaining video segments and interactive components help define and describe the water cycle and watersheds, feature information on the importance of watershed management, and provide strategies on how best to take care of local watersheds.

Teaching Tips: go.ncsu.edu/the-tips

Support Materials for Students (and more):

go.ncsu.edu/ways

SAMPLE: THE “WADDED WATERSHED” ACTIVITY

In this activity, students will use crumpled paper and markers to create model watersheds and track the flow of surface water across “land.”

Teacher Handout for Wadded Watershed:

go.ncsu.edu/teacher-handout

Video Demonstration of Wadded Watershed:

go.ncsu.edu/video-demo

“LEARNING FROM HOME” (THE EDUCATORS’ GUIDE)

Watershed Wisdom has several activities that are accessible at home via printed handouts and online interactive activities. Many of these lessons are perfect to assign through Google Classrooms, Canvas, Seesaw, or any other program to share assignments with your classroom.

Access the guide: go.ncsu.edu/guide

In addition to PBS North Carolina, North Carolina Sea Grant partnered on Watershed Wisdom with N.C. Division of Water Resources and with the North Carolina Watershed Stewardship Network’s K-12 team, which included NC Project Wet, the North Carolina Water Resources Research Institute, Town of Hillsborough and City of Raleigh stormwater staff, and the Albemarle-Pamlico National Estuary Partnership. GSK also provided funding for the project.

Watch Krista Brinck, science specialist at Abbot Creek Elementary, on the value of teaching elementary students about water and watersheds (video):

go.ncsu.edu/Krista

The Watershed Wisdom Lesson Plan

go.ncsu.edu/Wisdom



The Watershed Wisdom Lesson Plan includes “River Avengers,” an animated video.



Crab-Stuffed Baked Potatoes



Smoked Fish Cheddar Spread



Fried Striped Bass with Parmesan



Spotted Trout Chowder

FALL FAVORITES

BY VANDA LEWIS AND JOYCE TAYLOR

MARINER'S MENU, NORTH CAROLINA SEA GRANT'S POPULAR ONLINE SEAFOOD GUIDE, FEATURES BLOGGER AND PHOTOGRAPHER VANDA LEWIS'S PICTURES WITH HUNDREDS OF RECIPES THE LATE JOYCE TAYLOR DEVELOPED. ENJOY THESE SAVORY SPECIALS THIS FALL.

CRAB-STUFFED BAKED POTATOES

- 2 cups of backfin crabmeat
- 4 medium baking potatoes
- 6 tablespoons of butter, melted
- 1/2 cup of light cream
- 1/4 cup of sour cream
- 1 cup of shredded mozzarella cheese
- 1/2 teaspoon of salt
- 1/4 teaspoon of white pepper, freshly ground
- 2 tablespoons of fresh parsley, chopped

Preheat the oven to 400° F.

Scrub the potatoes with a brush. Rub them lightly with canola oil.

Bake at 400° F until done, about 40 to 60 minutes.

When cool to the touch, cut the potatoes in half lengthwise. Carefully scoop out the pulp, leaving a firm shell about 1/4-inch thick. Combine pulp, margarine, cream, sour cream, cheese, salt, pepper, and parsley. Then, gently stir in the crabmeat, being careful not to break apart the pieces.

Stuff the shells with the mixture. Sprinkle it all lightly with paprika. Bake it at 400° F until heated through, about 15 minutes.

SMOKED FISH CHEDDAR SPREAD

- 2 cups of flaked smoked fish
- 8 ounces of cream cheese
- 1/2 cup of mayonnaise
- 1/4 teaspoon of salt
- 1/2 teaspoon of white pepper, freshly ground
- 1/4 teaspoon of cayenne pepper
- 1 1/2 teaspoons of fresh garlic, minced
- 1/3 cup of fresh chives, chopped
- 1 1/2 cups of medium cheddar cheese, grated
- crackers

In a medium bowl, combine the cream cheese, mayonnaise, salt, white pepper, cayenne, garlic, and chives. Gently blend in the fish and cheese, taking care not to break apart the flakes.

Chill thoroughly. Place in a serving bowl, and serve with assorted crackers.

FRIED STRIPED BASS WITH PARMESAN

- 1 1/2 pounds of striped bass fillets, skinless, cut into serving-size pieces
- 3/4 cup of flour
- 3/4 teaspoon of salt
- 1/4 teaspoon of black pepper, freshly ground
- 1/3 cup of Parmesan cheese, freshly grated
- 2 eggs
- 2 tablespoons of milk
- 1 cup of Panko crumbs
- 2 tablespoons of canola oil
- 2 tablespoons of butter

In a shallow dish, combine the flour, salt, pepper, and Parmesan. Beat the eggs and milk in another shallow dish.

Pat the fish dry. Dip it in the flour mixture, then in egg. Coat lightly with the Panko crumbs.

Heat the oil in a skillet to 375° F. Add the butter, and melt. Place the fish in the pan, and cook for about 4 minutes. Turn it, and repeat, cooking until done.

SPOTTED TROUT CHOWDER

- 1 1/2 pounds of spotted trout, skinless fillets, cut into 1-inch pieces
- 3 tablespoons of butter
- 1/2 cup of onions, chopped
- 1/2 cup of green onions, chopped, including tops
- 1 cup of celery, chopped
- 1/2 cup of carrots, shredded
- 3 tablespoons of flour
- 4 cups of chicken broth
- 1/2 teaspoon of dried thyme leaves
- 1/2 teaspoon of salt
- 1/4 teaspoon of white pepper, freshly ground
- 1 cup of heavy cream
- 1/4 cup of fresh parsley, chopped

In a large saucepan, melt the butter. Lightly sauté the onions, green onions, celery, and carrots. Blend in the flour.

Stir in the broth gradually. Add thyme, salt, and pepper. Simmer over low heat for 10 minutes or until thoroughly heated.

Slowly stir in the cream. Add fish, and simmer until done, about 8 to 10 minutes. Garnish with fresh parsley. 🍴

For hundreds of free seafood recipes, visit [MARINERSMENU.ORG](https://www.marinersmenu.org)



The Ever-Expanding Brains of Atlantic Sharpnose Sharks

THIS SHARK'S BRAIN NEVER STOPS GROWING THROUGHOUT ITS ENTIRE LIFE, ESPECIALLY THE REGIONS RESPONSIBLE FOR MOTOR CONTROL AND SENSE OF SMELL.

BY KARA E. YOPAK

OVER THEIR LIFETIMES, SOME SPECIES OCCUPY DIFFERENT ENVIRONMENTS AND EXHIBIT DISTINCT LIFE STAGES, KNOWN AS “ONTOGENETIC SHIFTS.”

The life histories of most sharks involve these ontogenetic shifts, which can include changes in habitat and diet, as well as behavioral changes at the onset of sexual maturity.

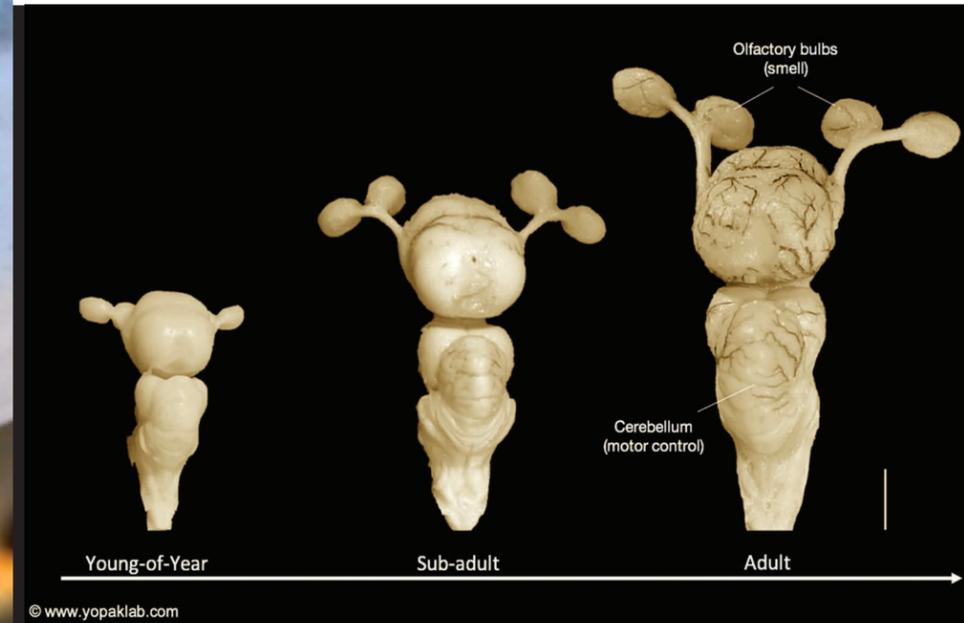
In addition, fishes — including sharks — commonly experience indeterminate growth, whereby their bodies and organs grow throughout their lives. However, very little work has been done to explore changes in the shark brain across life stages, which could provide insights into shifts both in sensory perception and behaviors.

We measured changes in overall brain size (relative to body size), as well as the proportion the

brain occupies by major brain regions, throughout ontogeny, in the Atlantic sharpnose shark.

As with other fishes, overall brain size grew significantly with body mass throughout the entire life of the Atlantic sharpnose shark, but most quickly during juvenile life stages. Brain regions also increased in size as well, but at different rates.

In particular, the regions of the brain that process odor cues (olfactory bulbs) and that are



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NOAA

responsible for motor control (the cerebellum) occupied larger and larger proportions of total brain size as the animal matured.

Changes in the relative size of the olfactory bulbs across life stages may reflect an increased reliance on smell at the later stages of life of Atlantic sharpnose sharks, while changes in the relative size of the cerebellum may be indicative of the ability to capture faster prey or an increase in the migratory nature of this species as it moves to offshore habitats with the onset of sexual maturity.

Sharks have always had a reputation for having a keen sense of smell, but recent work from our lab also suggests that olfactory abilities may vary between shark species, in addition to changing during the lifespan of a single shark.

Because a shark's brain continues to grow as the animal ages, its brain is very “plastic.” This means that changes in the environment, including human-caused disturbances, could significantly alter normal patterns of brain development — and, thus, behavior. 🧠

READ THE FULL STUDY:

“Ontogenetic Shifts in Brain Size and Brain Organization in the Atlantic Sharpnose Shark”
<https://doi.org/10.1159/000511304>

Kara E. Yopak, from the Department of Biology and Marine Biology at the University of North Carolina Wilmington, leads the “UNCW ZoMBiE Lab” (Zootomological Morphology of the Brain and its Evolution). The lab focuses on the evolution of the brain within and across sharks and their relatives, particularly the ways in which variation in brain size, structure, and cellular composition across species can inform complex behaviors and sensory specialization.

FOLLOW:

@ProfSharkBrain and @YopakZoMBiELab

This story originally appeared on
[HookLineScience.com](https://www.hooklinescience.com)

ABOVE: The brain of an Atlantic sharpnose shark, showing the regions that process smell (olfactory bulbs) and motor control (cerebellum) across life stages, including adulthood (far right). Scale: The vertical bar to the right of the adult brain equals 2 cm. Images adapted from Laforest et al. (2019). All rights reserved. BELOW: The underside of a sharpnose shark, showing its nostrils, over the mouth.



NC State University Photos

Oyster Reefs, Self-Releasing Hooks, and the Mysterious Wanderings of Southern Flounder

CURATED BY SCOTT BAKER AND SARA MIRABILIO, FISHERIES SPECIALISTS AT NORTH CAROLINA SEA GRANT

DOES PROTECTING OYSTER REEFS BENEFIT OTHER MARINE ORGANISMS?

Creating no-harvest zones on oyster reefs also helps the fish and crustaceans that live on the reefs.

by Aiman Raza, biology major at the University of Maryland, Baltimore County, and former intern at the Smithsonian Environmental Research Center in the Fisheries Conservation Lab

• Research Need

In the 19th century, the Chesapeake oyster fishery was the largest in the world. However,

due to habitat degradation, disease-causing parasites, and over-harvesting, the number of oysters in the bay has significantly decreased.

Oysters have been the subject of intensive management efforts, but there are many gaps in our understanding of oyster reef ecosystems. We know oysters provide many ecological services, such as water filtration, nitrogen removal, and habitat for other species.

At the Smithsonian Environmental Research Center, we were interested in seeing how protecting oyster reefs affects other species that live around them, specifically fish and crustaceans.

• What did I study?

I was interested in seeing whether there was a higher abundance and diversity of fish and crustacean species on harvested or non-harvested oyster reefs.

To answer this question, I analyzed GoPro video footage of oyster reefs from three tributaries in the Chesapeake Bay: the James, Great Wicomico, and Choptank rivers. Each tributary had one reef that was actively harvested and a neighboring reef where harvesting was prohibited. After watching the videos, I compared the number and types of fish and crustaceans in oyster sanctuaries compared to harvested zones.

• What did I find?

There was a higher abundance of fish and crustaceans, as well as higher diversity, on protected reefs compared to harvested reefs.

This study provides evidence that fish and crustacean species benefit from creating no-harvesting areas and highlights the importance of oyster reefs for healthy ecosystems. Expanding this study to more sites could provide new data to help guide oyster reef management in the future.

• Anything else?

The James River had a higher abundance and diversity of organisms compared to the other two sites.

In addition, I was able to identify many different species of fish and crustaceans in

the GoPro videos of the tributaries, including striped bass, summer flounder, and black sea bass, as well as blue crabs and grass shrimp. What's more exciting is that some of these species, like striped bass and blue crabs, are federally managed. Spotting them in our videos is a good indicator that the species benefit from no-harvest zones.

• So what?

Focusing our efforts on protecting valuable oyster reef habitat not only will benefit oysters but also the important fish and crab species that depend on them. As the demand for oysters increases and affects the oyster fishery, it is critical to understand how this might impact the broader ecosystem of the Chesapeake Bay.

CAN SELF-RELEASING HOOKS MINIMIZE FISH INJURIES DURING CATCH-AND-RELEASE?

A bite-shortened hook, designed to release fish without handling, shows promise.

by Holden Earl Harris, postdoctoral research associate at the University of Florida's Nature Coast Biological Station

• Research Need

Releasing fish can help conserve their populations, but the process of capturing and handling fish also can result in injuries or death. These "discard effects" present a major conservation issue in recreational fisheries. Even if the percentage of injuries and mortalities are relatively small, fisheries where large numbers of fish are released can have cumulative effects that impact the population.

Fishing practices and gears that minimize handling, hook injuries, and air exposure can considerably improve the chances for survival of released fish. In particular, efficient dehooking substantially reduces the physiological stress in fish that typically occurs during the landing and release process.

Earlier field trials with bonefish on Palmyra Atoll found the species would "spit out" bite-shortened hooks once they were reeled in toward the angler and the angler gave slack in the fishing line. The idea appeared promising and prompted the researchers at the Nature Coast Biological Station to begin more rigorous testing.

• What did we study?

To our knowledge, these are the first assessments of hooks designed to self-release from fish and to fully eliminate fish handling.

On 150 spotted seatrout, we tested whether standard, barbless, or bite-shortened hooks would allow anglers to reel in the popular coastal sport fish and then allow the fish to self-release while still in the water.

• What did we find?

We found promising results for the bite-shortened modified hook, which enabled anglers to land 91% of hooked spotted seatrout and then release 87% of those fish without direct

Continued



NOAA

An oyster reef in the Chesapeake Bay.



UF/IFAS Nature Coast Biological Station

An easy release off a bite-shortened hook.

handling. In comparison, the self-release success rates were 47% using barbless hooks and 20% using standard, unmodified hooks.

We also found that smaller fish could be self-released without handling at higher rates. Length-regulated fisheries often protect smaller fish, and reducing mortality in these fish especially can help conserve resources.

- *So what?*

A proven and effective self-releasing hook could have broad conservation and management applications in recreational fisheries as a means of minimizing or eliminating injuries and mortalities in catch-and-release fishing. Foreseeable uses of self-releasing hooks could include cases of restricted fishing in sensitive fishing areas, such as no-take aquatic protected areas or areas experiencing unsustainable fishing pressure. Further research with different lures, species, and anglers can inform conservation strategies.

WHERE DO SOUTHERN FLOUNDER GO IN THE WINTER?

Southern flounder move offshore to spawn, but their migration patterns might be more mysterious than we thought.

by Mason Collins, a graduate student in marine biology at UNCW, formerly with the South Carolina Department of Natural Resources and with the U.S. Forest Service in Alaska

- *Research Need*

Working with other U.S. South Atlantic states, the N.C. Division of Marine Fisheries recently concluded that not only is the state's southern flounder population overfished but also that overfishing is still occurring. The poor status of the stock requires considerable reductions in harvest to allow rebuilding.

Determining how much these fish mix across states will help to better understand the impacts of present and future fishing practices, informing strategies to rebuild and sustain the stock.

Adult southern flounder leave estuaries for the ocean during the fall and spend the winter in offshore habitats, where they presumably spawn. As waters warm in spring, flounder



Mason Collins, graduate student in marine biology at UNC Wilmington.

return to coastal and estuarine habitats, but conventional tagging data has shown that their return locations often are hundreds of miles away from their original tagging sites.

More recent studies of flounder genetics and chemical tracers indicate a well-connected flounder population throughout the South Atlantic. But how does this happen? Are flounder from Florida estuaries spawning in the same offshore locations as fish from North Carolina? Or are flounder merely wandering back inshore in different states?

- *What did we study?*

We used pop-up satellite tags to estimate the offshore locations of southern flounder during the winter. In fall of 2020, we cooperated with fishermen to tag 100 fish captured at several inshore sites close to ocean inlets along the North Carolina coast.

We programmed the tags to pop off the fish on specific dates between mid-January and mid-March to cover most of the winter spawning period. Upon release, the tags floated to the surface and transmitted their locations via satellite.

- *What did we find?*

Most southern flounder left the estuaries and went to the ocean. However, some fish remained in the estuary or stayed very close to the ocean shoreline. The absence of offshore movements by these fish could be related to stress from capture and tagging or could mean that individual southern flounder might not spawn every year.

The offshore movements of southern flounder were not as extensive as we expected, with many fish still using nearshore habitats during the winter. We did observe some fish near the outer edge of the shelf, in deeper waters, where past egg and larval collections suggest that spawning occurs. However, the offshore movements were generally straight off the North Carolina coast, as opposed to southward migrations that we expected, based on past tagging studies.

Results are still preliminary, with additional tagging planned for 2021 and 2022, but the early returns reveal a different picture of where southern flounder travel during the winter.

read the full studies and more
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Banded water snake, Lower Roanoke River Wetland Game Lands.

Do Water Snakes Get Thirsty?

A RESEARCH TEAM ENTERS SWAMPY TERRAIN TO HAND-CAPTURE SNAKES AND MEASURE THE REPTILES' SENSITIVITY TO DEHYDRATION.

BY LAUREN D. PHARR

ANYONE WHO HAS SPENT A SATURDAY ON A BOAT KNOWS THE IMPORTANCE OF DRINKING WATER AND STAYING HYDRATED WHEN IT'S WARM OUT. Humans, in fact, can live without food much longer than we can live without water. But does this general rule apply to other animals, like reptiles, some of which live in freshwater?

The Snakes

Both the banded and brown water snakes are freshwater amphibious species that live throughout North Carolina. These snakes utilize various sources of water in the environment to remain hydrated and keep their electrolytes balanced. After a meal, they take in more water, which suggests that feeding increases their thirst.

The Question

Under what conditions do water snakes

change their drinking and feeding behavior?

Researchers hand-captured live specimens of banded and brown water snakes from creeks and swampy habitats in Alachua County, Florida. They maintained each snake in a cage, and, during a one-hour period each day, they provided access to a pool of tap water and food, which included live feeding fish.

The research team then observed the feeding behavior of the snakes and continuously weighed each one to measure any evidence of the effects of dehydration.

The Answer

All snakes drank freshwater when they experienced relatively small amounts of dehydration. Snakes that had access to food but not water readily ate while dehydrated, but stopped eating during prolonged dehydration.

Overall, both freshwater and semi-marine species of water snakes are more sensitive to dehydration than other species of snakes.

According to the research team, by documenting the relationship between freshwater availability and feeding behavior in water snakes, it might be possible to better understand how these snakes and similar animals evolved. 📖

READ THE FULL STUDY:

"Thirst and Drinking in North American Watersnakes"
go.ncsu.edu/thirst

Lauren D. Pharr, a Ph.D. student in Fisheries, Wildlife, and Conservation Biology at NC State University, also is a science communicator with North Carolina Sea Grant, a Southeast Climate Adaptation Science Center Global Change Fellow, and winner of NC State's Forestry and Environmental Resources Fellowship for Excellence in Graduate Education.

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Coastwatch Nets New State and National Honors

Over the summer, *Coastwatch* received new recognition for material that that we published during the pandemic. The Science Communicators of North Carolina honored Julie Leibach and Dave Shaw for feature stories, and all four issues from last year earned the magazine another national APEX Award for Publication Excellence.

If you're counting, that makes five honors for Leibach's writing and 13 for the magazine overall in the last three years.

And all of *Coastwatch's* award-winning content is **free** online.

go.ncsu.edu/Coastwatch-awards



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