Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Spring 2021

How COVID Restrictions Empowered One Wetland Team To Get More Data Than Ever

THE DIRECTOR'S LETTER:

Growth in a Crucible

Let me tell you two stories about adaptation amid suffering. In the rivers of Chesapeake Bay, Eastern oysters often experience severe oxygen loss, driven by nutrient pollution and harmful algal blooms that drain oxygen from the water. One of our postdoctoral fellows, Sarah Donelan, discovered that when young oysters experience the dual stress of low oxygen and hotter temperatures, it scars them. Early exposure makes the oysters less able to cope if they face the same double stressors later in life. They focus more on growing their shells, and less on the tissue inside that allows them to stay fit and produce more oysters.

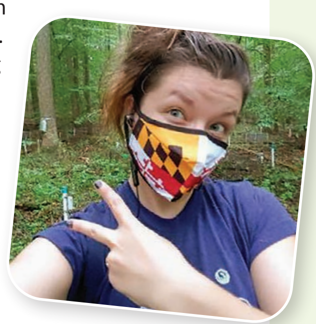
Meanwhile, in caves across North America, bats are fighting off a lethal disease known as white-nose syndrome. Another SERC postdoctoral fellow, Sarah Gignoux-Wolfsohn, discovered some bat colonies are evolving to resist the disease. By analyzing the genetics of two bat colonies, she and her colleagues discovered 63 mutations that could be helping bats survive. These were not new mutations. All 63 *already existed* in the colonies during recent outbreaks. But after the disease passed through, those mutations became far more dominant. The bat colonies grew stronger under pressure.

Which story describes us today?

If you're like me, you can probably relate to the oysters. It's tempting, after a painful experience, to build a protective shell and not risk expanding the more meaningful but fragile parts of our lives. But the bat colonies suggest that sometimes, the seeds of survival are already present and merely need something to spur them to grow.

So far, 2021 has proven just as much a crucible as 2020. SERC has survived by reaching out to our friends, pooling the resources we already have and transforming them into something new.

Our climate scientists are more active than ever. Some spent the pandemic setting up a new experiment called **TEMPEST**, to simulate futuristic storm surges in SERC forests. Another team, who had planned to spend last summer gathering data on how well wetlands store the greenhouse gas methane, had to do a complete 180 when travel restrictions set in. They responded by shipping sampling kits to colleagues across the U.S. to collect data for them. The **Blue Methane** project was a hit. The team received data from twice as many places as they would have been able to visit in person.



Our public engagement team launched **Science To Go**, creating a new way to bring hands-on science into people's homes. Since last autumn, SERC has shipped hundreds of free, kid-friendly kits to Anne Arundel County Public Libraries, with materials for activities on DNA (last October) and fungi (this March). For each experiment, SERC hosted a live webinar where one of our scientists did the activities with families and took them on a virtual tour of their lab or field site.

With the U.S. rejoining the Paris Accords, the nation is also taking new steps to adapt to climate change. Our scientists are ready to do what the Smithsonian does best: Share our knowledge so that sound, science-based policies can shape our future.

The next decade holds many more crucibles for us: environmental justice, stemming biodiversity loss, achieving equity in STEM, and ensuring everyone has access to a healthy, sustainable future. With your support, we can summon our resources to take on these issues as well. Will you join our team, and help shape the world to come?

— ANSON "TUCK" HINES, SERC DIRECTOR

Top: Eastern oysters (Crassostrea virginica) *in Maryland's Upper Tangier Sound. (Credit: Steve Droter/Chesapeake Bay Program); Left: Little brown bat* (Myotis lucifugus) *from a New York colony whose members evolved to resist white-nose syndrome. (Credit: Sarah Gignoux-Wolfsohn); Right: Anya Hopple, a postdoctoral researcher with Pacific Northwest National Laboratories, poses for a selfie by the TEMPEST experiment she helped set up at SERC.*

Front Cover: Erika Koontz samples a wetland in Monie Bay for the Blue Methane project. (Credit: Kyle Derby/Maryland DNR)

Oysters from an oyster sanctuary in Harris Creek, Maryland. (Credit: Will Parson/Chesapeake Bay Program) https://creativecommons.org/licenses/by-nc/2.0/

ON HOT AFTERNOONS, LIVE OYSTERS CAN CAUSE "SUPERSPREADER" EVENTS OF DERMO DISEASE

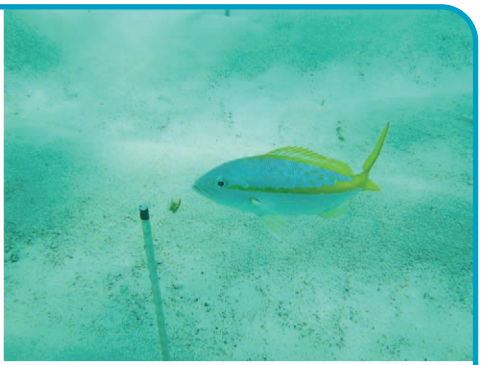
Scientists once thought the biggest superspreader events of Dermo, a parasite-borne disease plaguing Eastern oysters, occur when infected oysters die, releasing large bursts of parasites. But a new study reveals live infected oysters can cause superspreaders too.

SERC biologists ran several experiments to see how much parasite oysters released at different temperatures, salinities and times of day. On especially hot days from noon to 6pm, live oysters could release similar amounts of parasite as dead oysters—over 1,000 cells per hour.

"If in these higher-temperature events they're releasing more, then you have ongoing pulses from a live oyster versus a one-and-done pulse from a dead oyster," said lead author Sarah Gignoux-Wolfsohn. To combat this, she suggested oyster farmers could consider sinking oysters deeper in the water during hotter days. Managers could also consider removing live infected oysters from reef restorations.

Link to study: https://doi.org/10.1017/S0031182020002383

GLOBAL "BITEMAP" REVEALS HOW MARINE FOOD WEBS MAY CHANGE WITH CLIMATE



A yellowtail fish approaches a "squid pop" in the coastal waters off Mexico. (Credit: Brigitta van Tussenbroek/Universidad Nacional Autónoma de México)

Where are small marine animals most vulnerable to getting eaten? Last fall, an international team of scientists sketched the first global "BiteMap" showing where the ocean's mid-sized predators are most active, spanning waters around five continents. Project BiteMap came from a collaboration led by the Marine Global Earth Observatory, headquartered at SERC.

To map predator appetites, scientists enticed fish and crabs with "squid pops." Similar to cake pops at coffee shops, squid pops consist of dried squid meat on a stick. Squid pops got eaten most often in the subtropics, where temperatures are hot but not equator-level hot. But to the team's surprise, their analyses revealed temperature had an even stronger influence on *which* animals were present than how much they were eating. Project BiteMap offered another reminder that on our interconnected planet, climate change can touch everything.

Link to study: https://www.pnas.org/content/117/45/28160

FIRST MATURE ATLANTIC STURGEON DETECTED IN PATUXENT RIVER IN NEARLY A CENTURY

Since a taste for caviar emerged in the late 1800s, Atlantic sturgeon have plummeted. While populations persist in some rivers, Maryland's Patuxent River remains largely deserted. In 1997 watermen retrieved a single juvenile there. The last report of an adult sturgeon came from 1924.

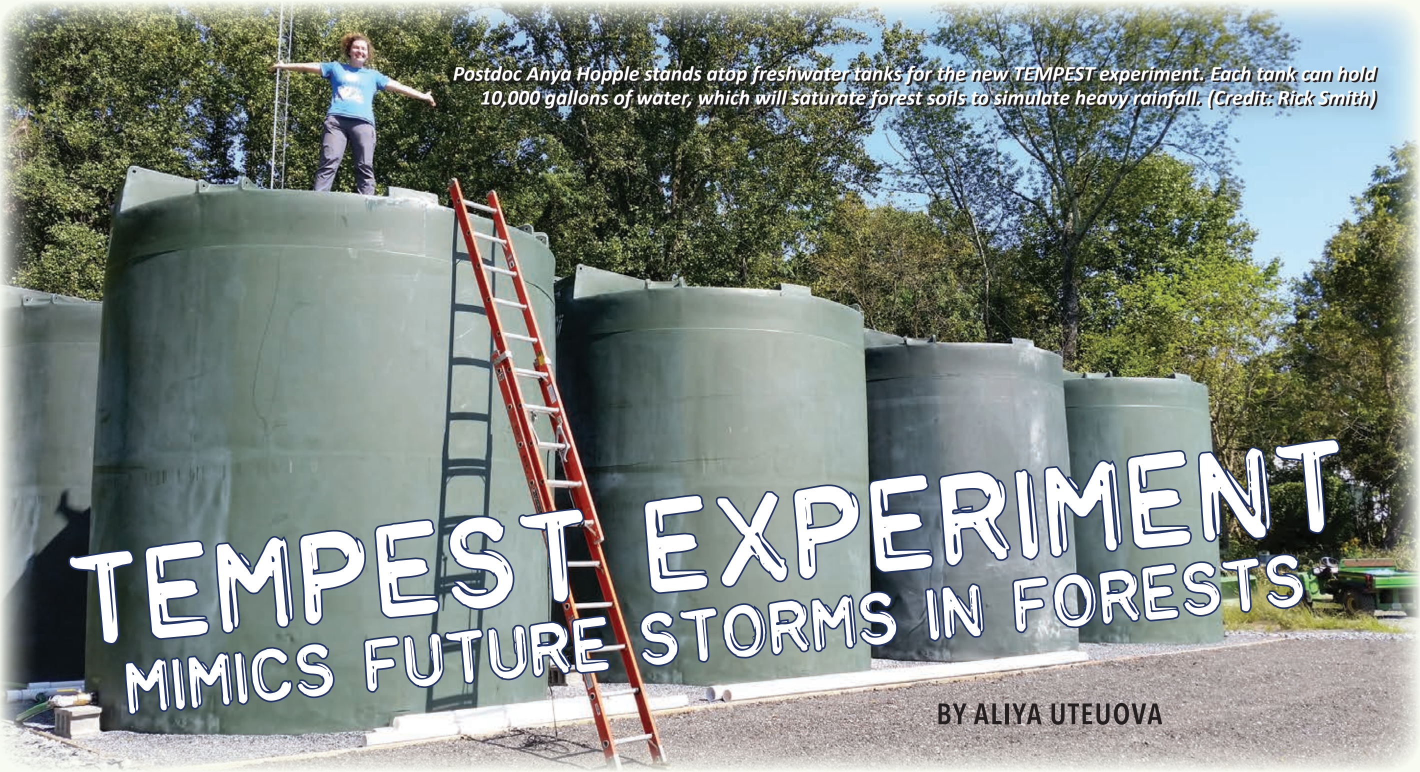
Atlantic Sturgeon, Acipenser oxyrinchus oxyrinchus. *(Credit: Virginia State Parks) https://creativecommons.org/licenses/by/2.0/*

But in a new study led by former SERC intern Michelle Edwards, SERC biologists detected an adult male in the Patuxent in autumn 2016 that other researchers had tagged in Virginia. They detected the sturgeon using acoustic receivers SERC maintains in the river as part of the Atlantic Cooperative Telemetry Network, which SERC leads. The sturgeon traveled 45 miles upstream, possibly searching for a mate. Recolonizing the Patuxent would be another upstream battle, the authors said, after a century of environmental degradation. But for a fish endangered in the Chesapeake, any sighting offers clues for conservation.

Link to study: https://doi.org/10.1656/045.027.0417

TEMPEST EXPERIMENT MIMICS FUTURE STORMS IN FORESTS

BY ALIYA UTEUOVA



Postdoc Anya Hopple stands atop freshwater tanks for the new TEMPEST experiment. Each tank can hold 10,000 gallons of water, which will saturate forest soils to simulate heavy rainfall. (Credit: Rick Smith)

Heavy rains and storm surges rank among the most common natural weather events in the United States. They occur in every state. They're also one of the most widely felt impacts of climate change, making it impossible to ignore the economic and physical harm they leave in their wakes.

In a forest at the Smithsonian Environmental Research Center (SERC), scientists are working to uncover how sudden deluges could impact forests in decades to come. Called TEMPEST, the new experiment will mimic intense freshwater rainstorms and saltwater storm surges by inundating parts of the forest.

SIMULATING A STORM

"No one has ever tried to assess the effect of storm surges on ecosystem ecology using an ecosystem-scale manipulation," said Anya Hopple, postdoctoral researcher at the Pacific Northwest National Laboratory and visiting researcher at SERC.

"TEMPEST" stands for **T**errestrial **E**cosystem **M**anipulation to **P**robe the **E**ffects of **S**torm **T**reatments. It's a partnership between SERC, the Pacific Northwest National Laboratory and the U.S. Department of Energy. Two scientists from Global Aquatics Research LLC, Rick Smith and Stella Woodard, led the project's engineering and installation.

The researchers will release 80,000 gallons of freshwater onto 2,000-square-meter forest plots, to mimic the effects of storms. That much water equals a 6-inch rain event over 10 hours. Average precipitation in Annapolis, just a few miles from SERC, ranges from 3 to 4.5 inches per *month*. They'll be simulating downpours that are extreme – yet already becoming more frequent.

In another forest plot nearby, they'll repeat the experiment with saltier water. They'll release the water through drip lines stretched across the forest plots, to saturate the soil. These simulations will occur two to four times per year and continue for a decade.

Last fall the scientists carried out a full system test, drawing seawater from the nearby Rhode River, passing it through a filter and storing it in a large bladder. For the freshwater experiment, they trucked the water in and stored it in large 10,000-gallon tanks. They then used the freshwater to test the irrigation system that delivers water to the forest plots. They'll start the freshwater storm simulations during summer 2021 and the seawater simulations in 2022.

STRESSED OUT BY SALT?

Coastal forest ecosystems are incredibly important to the global carbon cycle. They also provide habitat, which is why scientists are striving to understand how extreme storms will affect them. Scientists suspect that over time, experimental storm surges, just like natural ones, could spell trouble for trees and other plants.

Saltwater surges could be especially problematic. "We think the saltwater effect will be minor at first until a tipping point, when it will dramatically increase the tree mortality rate," said Patrick Megonigal, head of the Biogeochemistry Lab at SERC.

Adding salt onto freshwater forests could stress the trees and gradually affect their physiology. That in turn might make it difficult for them to photosynthesize and acquire the nutrients essential for their survival.

"Certain types of vegetation and trees are equipped to exist and thrive in really [salty] conditions," Hopple said. Mangrove trees, for example, can exclude salt from their roots or excrete it from their leaves. "But freshwater vegetation does not have the same mechanisms of coping."

Scientists expect the short-term responses to be smaller. Since they're continuously monitoring the forest plots to avoid excessive stress, it's possible the plants will be resilient enough to survive brief exposures to excess water and salt. But the more frequently these extreme storm events occur, the more those impacts could build up. They could reach a point where the flora become so stressed, they no longer recover.

Eventually Hopple hopes to take data from TEMPEST and churn it into mathematical models, which could predict how other forests might respond to extreme weather.

"This would allow us to understand and anticipate what's going to happen decades from now, or what may be happening right now," she said.

Left to right: These irrigation lines will saturate a SERC forest with 80,000 gallons of water to simulate extreme rainfall and storm surges. (Credit: Rick Smith); Postdoc Anya Hopple poses for a selfie by a filtration system for seawater from the Rhode River; Rick Smith stands beside a 20,000-gallon rubber bladder for storing seawater. (Photo courtesy of Rick Smith)

How One Wetland Team Used COVID Restrictions To Get More Data Than Ever

BY KRISTEN MINOGUE

Like many scientists, Erika Koontz was hired for a specific project. She had just begun work as a technician with the Smithsonian Environmental Research Center's Biogeochemistry Lab. Her new supervisor, James Holmquist, had an ambitious project in mind: Uncover how wetlands across the U.S. store—or emit—the powerful greenhouse gas *methane*.

"It's a dataset that's really never been attempted before, to be housed under one single project," Koontz said. Koontz would visit six wetlands across the country, sampling porewater methane and measuring the flux of methane into and out of their soils.

Koontz started her job in March 2020. Enough said on that subject. The next six months were some of the busiest of her life.

"Since there's no travel, we thought, well how do we still figure out how to accomplish this part of the project, which is gathering lots of data from many different places?" Koontz recalled.

Holmquist devised a solution as ambitious as the original project. They would ship sampling kits to over a dozen research stations, and remotely teach onsite scientists—some of whom had never taken a porewater sample in their lives—how to collect the data.

"Basically, sending my brain in a box out there," Koontz said.

Clearing the Methane Fog

In climate change forecasts, wetlands are among the biggest wild cards. They protect coasts from hurricanes and flooding, and store more carbon dioxide (CO_2) per square meter than many forests. But with methane—a greenhouse gas up to 45 times more powerful than carbon dioxide—wetlands vary widely.

"For so long, people have been studying CO_2," said Alice Stearns, a technician in the Biogeochemistry Lab with Koontz and Holmquist. "We know the methane's here, but we just don't know to what extent."

Luckily, they had an entire wetland network to tap into for data. It's called the National Estuarine Research Reserve System (NERR), and contains 29 wetlands around the U.S. Originally Koontz was supposed to visit six. But with remote sampling, suddenly all 29 wetlands were on the table.

"This is the kind of thing that the NERR system is really built for," said Robert Dunn, research coordinator for the North Inlet-Winyah Bay NERR site in South Carolina. When Holmquist asked if his site could help with the project, Dunn immediately agreed.

Erika Koontz pauses for a selfie with Shelby Cross (left) and Kyle Derby (center) while doing methane sampling in Maryland's Jug Bay, one of the few sites she could visit in-person during the pandemic.

In the end a total of 14 NERR sites signed on—over double what they'd envisioned before the pandemic.

All that remained was deciding what to put in the box.

Reports From The Ground

Kat Beheshti received her kit in September. A Ph.D. student, Beheshti was writing her dissertation at the Elkhorn Slough NERR site near San Francisco Bay. The kit contained stakes, vials, filters, syringes and sippers for extracting porewater. Koontz had also created a video with Holmquist's family, where she demonstrated the sampling procedure. It was the closest the team could come to figuratively shipping Koontz's brain in a box.

"Getting the package and opening everything up, it was like Christmas," Beheshti said.

Under the new plan, each station would take four methane porewater samples at three subsites, giving Holmquist's team 12 data points. Ideally, since the onsite scientists were volunteering their time, the sampling would take just one or two days. But things rarely go as planned. Beheshti and her husband visited five subsites, because two failed.

"There was just no porewater," she said. "We tried different holes. We tried leaving the sipper well in for a time. We tried everything." In the end they found an alternate subsite much farther away, with similar plants and elevation. Mission accomplished.

As autumn 2020 drew to a close, Holmquist's team had a tidy store of data to analyze over the winter. Besides methane samples from the 14 NERR sites, Koontz and Stearns had collected data from SERC wetlands. Holmquist hopes to use this data to create more accurate maps of wetland methane and saltiness. Along the way, he also hopes to figure out the most efficient way to collect data that captures the vast diversity of U.S. wetlands.

"More sites and fewer data points per site? Fewer sites and more data points per site?" Holmquist asked. "The question we're trying to answer is, what's the cost-benefit?"

Koontz, meanwhile, is still busy processing porewater samples and methane flux data they collected over the year. Someday soon, she may be able to visit the places she's only touched through water in a sampling vial.

Top L-R: Jim Holmquist (front) and Erika Koontz (Credit: Jim Holmquist); Alice Stearns (Credit: Kristen Minogue/SERC); Kat Beheshti (Photo courtesy of Kat Beheshti); Robert Dunn (Photo courtesy of Robert Dunn)

Background: Wetland in Monie Bay, Maryland. (Credit: Kyle Derby/Maryland DNR)


Jonathan Lefcheck (left) and intern Claire Murphy examine a striped burrfish cloaked in eelgrass on a 2019 survey. (Photo courtesy of Jonathan Lefcheck)


Bay scallops, a lucrative fishery that disappeared with the eelgrass, are now starting to return. (Photo: JJ Orth)


Robert "JJ" Orth stands beside a VIMS tank for holding seagrass flowers, which the team used to generate seeds for the eelgrass restoration. (Credit: Paul Richardson)

Seagrass Restoration Brings New Life To Once-Forsaken Bays BY KRISTEN MINOGUE

Two decades ago, eelgrass had all but disappeared from Virginia's South Bay—and many other small bays along Virginia's eastern shore. After a disease and hurricane wiped them out in the 1930s, many thought eelgrass would never return.

Today, a 20-year restoration has transformed South Bay and neighboring bays into an oasis. And as a new *Science Advances* report shows, many other benefits returned with the eelgrasses: clearer waters, abundant animal life, and a powerful sink for carbon and nitrogen pollution.

"This restoration is great. It's provided all this habitat," said SERC marine biologist Jonathan Lefcheck, a co-author on the report. "But we know now that the habitat's being used and actually may be an important source for biodiversity throughout the region."

The restoration began with Robert "JJ" Orth of the Virginia Institute of Marine Science. Past attempts to restore eelgrass to Virginia's coastal bays had largely failed, leading some to think those bays had become inhospitable. That changed in 1997, when Orth's team came across a few eelgrass patches growing naturally in South Bay.

"When we saw that, the light went on," Orth recalled. "Maybe there's something about these bays—like, no seeds." Orth was correct: The openings to these bays were so narrow, seeds from other Chesapeake restorations had a hard time getting inside. While nearby regions saw seagrasses returning, these bays had been left behind.

Over the next 20 years, researchers and volunteers scattered nearly 75 million seeds at over 500 sites. Gradually the project expanded to include four bays, all located in the Virginia Coast Reserve of The Nature Conservancy: South, Cobb, Spider Crab and Hog Island Bays.

The restored eelgrass now covers over 9,000 acres, roughly 17 times more area than the spots where Orth's team originally planted seeds, and it continues to spread. The benefits rippled out to the rest of the environment. According to the new report, the water became clearer, and the eelgrass beds store even more carbon and nitrogen as they age.

Biodiversity flooded back too. Only a few years after the restoration began, invertebrates were just as abundant in restored bays as in nearby places where eelgrass had never disappeared. Fish also took advantage of the new habitat. Even bay scallops—a once multimillion-dollar industry that vanished with the eelgrasses—are slowly climbing back.

"It can happen pretty quickly," Orth said. "In 20 years, we saw a rapid recovery of all these basic services that people thought would have never returned."

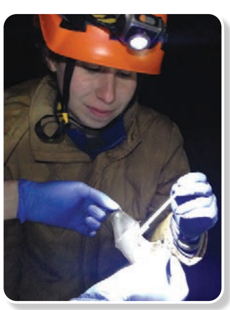
Link to study: https://advances.sciencemag.org/content/6/41/eabc6434

"Soft Sweep" Evolution Helps Bats Resist Deadly White-Nose Syndrome BY KRISTEN MINOGUE

For decades, the fungal disease white-nose syndrome has devastated North American bats. But in a long-awaited hopeful sign, a team led by SERC postdoc Sarah Gignoux-Wolfsohn discovered some bat colonies are evolving to resist it.

The new study looked at little brown bats (*Myotis lucifugus*). Once widespread, some colonies have suffered complete wipeouts from the disease. But others have slowly recovered, even after declines of up to 98%.

The researchers first sampled bats that died during a 2008-2009 white-nose outbreak in New York and New Jersey. In 2016, the team returned to the same caves with Sarah Gignoux-Wolfsohn (then at Rutgers University-New Brunswick), to sample descendants of the survivors.



After analyzing entire genomes of fatalities versus survivors, the team found 63 mutations that could have helped bats survive. These mutations *already* existed in the colonies during the outbreak, but in low amounts. Nearly a decade later, those mutations had spiked.

Evolutionary biologists call this a "soft sweep." Unlike hard sweeps, where a brand-new mutation emerges to combat a threat, soft sweeps take advantage of what's already there. Because soft sweeps are faster than hard sweeps, they may prove critical for bats to evolve resistance.

"It usually takes a long time for new mutations to arise after an environmental change," Gignoux-Wolfsohn said. "And so the presumption is that then, basically, everyone would die because there wouldn't be enough time."

However, only one mutation was linked to immunity. The others that they could link to a specific region dealt with hibernation and metabolism. This could be because white-nose syndrome infects hibernating bats. It wakes them up periodically and stirs them to action, burning through their fat reserves.

"They essentially are dying of starvation," Gignoux-Wolfsohn said. The other mutations may help bats burn fat more slowly, or resist having their winter slumber disturbed.


A little brown bat (Myotis lucifugus) *from an abandoned mine in Walter Williams Preserve, New York. (Credit: Sarah Gignoux-Wolfsohn)*

Knowing which colonies have these mutations could help prioritize which caves to treat. But "soft sweep evolution" throws something else into sharp relief: Genetic diversity pays. Soft sweep evolution thrives by amplifying existing mutations. It needs plenty of options to succeed, especially when new threats are unpredictable.

"We don't know what the next white-nose syndrome is," said Gignoux-Wolfsohn.

Link to study:
https://doi.org/10.1111/mec.15813

Left: SERC postdoc Sarah Gignoux-Wolfsohn takes a sample from the wing of a little brown bat, to analyze its genome for helpful mutations. (Photo courtesy of Sarah Gignoux-Wolfsohn)

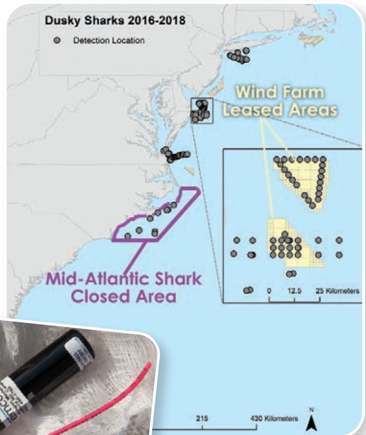
Shark Tags Reveal Endangered Species Returning To Natural Refuge BY KRISTEN MINOGUE

In the mid-Atlantic, an endangered shark is making a comeback. Led by former SERC postdoc Chuck Bangley, scientists tagged nearly two dozen dusky sharks as part of the Smithsonian's Movement of Life Initiative. They discovered a protected zone created 16 years ago is paying off—but it may need some tweaking with climate change.

In the 1980s and 1990s, overfishing wiped out anywhere from 65 to 90 percent of the Chesapeake's duskies, said Bangley, now a postdoc at Dalhousie University in Nova Scotia. Managers banned intentional dusky shark fishing in 2000. Five years later, they created the Mid-Atlantic Shark Closed Area encompassing most of the North Carolina coast. The zone prohibits bottom longline fishing, which can accidentally ensnare duskies, for seven months of the year.

But is the partial refuge working?

Bangley and SERC's Fisheries Conservation Lab fitted 23 dusky sharks with "acoustic telemetry tags." The tags emit pings that hundreds of receivers can pick up when a shark swims by. The receivers are part of a grassroots effort called the Atlantic Cooperative Telemetry Network, which SERC leads. Nearly 200 scientists have joined forces to put receivers along the Eastern Seaboard and share data. With so many receivers listening, biologists can create high-resolution maps of species' favorite travel routes.



Dusky sharks are using the Mid-Atlantic Shark Closed Area, but not when people expected. The zone prohibits bottom longline gear from January through July. However, tagged dusky sharks entered from November through May. Bangley suspects the waters could be warming, prompting sharks to move north sooner in the year.

Should North Carolinians be worried about having dusky sharks for neighbors? Not really, according to Bangley.

"Dusky sharks only really occur that close to shore during colder months, or as juveniles," he said. "They're really not thought to be a real threat to people."

Dusky sharks have proven one thing: With the right protections, even a species facing local extinction can return.

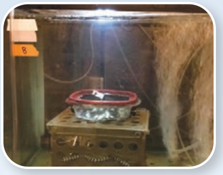
"This is a species that we were afraid was going to be impossible to bring back," Bangley said. "And it's actually coming back to the point where now we're having to think about things like, all right, now how do we manage interactions between these species and people? It's a good problem to have."

Link to study: https://afspubs.onlinelibrary.wiley.com/doi/full/10.1002/mcf2.10120

Top L-R: Chuck Bangley holds a blacknose shark, another shark species he has been tagging along the U.S. East Coast. (Credit: Jay Fleming/Smithsonian); Scientists put these black acoustic tags inside sharks to track their journeys. The tags emit "pings" that receivers along the shore can pick up when a shark swims nearby. (Credit: Jay Fleming/Smithsonian); Map of juvenile dusky shark detections, marked by gray dots. (Credit: Study authors); A dusky shark Smithsonian biologists tagged near Ocean City, Maryland. (Credit: Danielle Hall/Smithsonian Ocean Portal)

Stressed-Out Young Oysters May Grow Less Meat On Their Shells

BY KRISTEN MINOGUE



Early exposure to tough conditions—particularly warmer waters and low oxygen—could leave lasting scars on oysters' ability to grow meaty tissue, SERC biologists reported in a new study published this winter.

Eastern oysters in Chesapeake Bay live mostly in shallow tributaries. It's a rough environment for shellfish that can't move. During hotter months, oxygen levels can swing drastically, from perfectly healthy levels in the day to near zero at night. To save energy, some oysters focus more on shell growth than tissue growth. That could pose a problem for anyone in the seafood industry.

"What we all of course want to eat at the raw bar is the oyster tissue," said lead author and SERC postdoc Sarah Donelan. "Customers and restaurants might be less pleased if there's less tissue in what looks to be a large oyster."

For this study, Donelan teamed up with SERC senior scientists Matt Ogburn and Denise Breitburg. They took 3600 young oysters, each about 3 months old, and exposed them to four scenarios. For 18 days, some oysters experienced hotter water temps, some experienced nightly swings of low oxygen, some experienced both, and some neither.

At first, all the oysters were roughly the same size regardless of what treatment they'd received. But after a two-month break, Donelan put half the oysters back into experimental tanks. When faced with the same rough conditions again, oysters that had suffered from both low oxygen and hotter waters in Phase One started showing signs of strain.

Compared to more pampered oysters, oysters that suffered both stressors *twice* grew their shells more than their tissue. Their tissue-versus-shell growth rate was merely half that of oysters without that early double exposure.

Why wouldn't early exposure toughen them up? In this case, Donelan suspects the combination of warming and low oxygen caused an irreversible change. Perhaps a critical gene turned off—or turned on. Perhaps something in the oysters' microbiome shifted, making them less efficient at processing oxygen.

Fortunately, oyster farmers have some options for protecting their stock. This could involve tracking water oxygen levels, or bubbling extra oxygen into oxygen-starved zones. For farmers with indoor systems, keeping young oysters in tanks longer could offer more protection.

"Of course it's more of a time investment to have to move oysters around or look at dissolved oxygen profiles on your farm, but it could be worth it," Donelan said.

Link to study: https://esajournals.onlinelibrary.wiley.com/doi/10.1002/eap.2315

Left: SERC postdoc Sarah Donelan studies how animals adapt to threats: animals like eastern oysters in the Chesapeake or these dogwhelk snails (Nucella lapillus) *in Massachusetts. (Credit: Chris York); Right: In experimental tanks like this, Sarah Donelan simulated the effects of warmer water and low oxygen in Chesapeake Bay on Eastern oysters. (Credit: Sarah Donelan/SERC); Background: Eastern oyster* (Crassostrea virginica)*, taken in the Choptank River in May 2019. (Credit: Sarah Donelan)*

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Spring Virtual Events

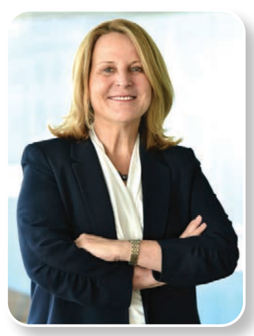
SERC's evening lectures are back, with a new lineup of virtual science talks running every third Tuesday of the month now through October! All our webinars will be recorded. Visitors can sign up online to watch live, or to receive a link to the recordings after the event at https://serc.si.edu/visit/eveninglectures.

EARTH OPTIMISM PANEL: THE HIDDEN WORKINGS OF FORESTS AND THEIR FUTURE

Tuesday, April 20 • 7pm Eastern

Speakers: Sean McMahon, Geoffrey "Jess" Parker and Jess Shue

As carbon-storing and carbon-cycling juggernauts, forests are a major tipping point for whether our planet can keep climate change at bay. On April 20, join three Smithsonian forest scientists for a special pre-Earth Day panel. Discover how trees store and move carbon, from the level of microscopic cells to the sweeping canopies of America's woodlands. The panelists will share decades of knowledge from SERC forests in Maryland. They'll also reveal discoveries on how forests around the world are responding to climate change, through work with the Smithsonian's Forest Global Earth Observatory. This live conversation will include plenty of time for audience Q&A.



LESSONS FOR ADDRESSING CLIMATE CHANGE FROM THE COVID-19 PANDEMIC

Tuesday, May 18 • 7pm Eastern

Speaker: Alice Hill, Council on Foreign Relations

The COVID-19 pandemic has caused a crisis unlike any other in living memory. It has also exposed the consequences of failing to prepare for catastrophic risk on a global scale. Both pandemics and climate change act as threat multipliers, amplifying risks to global political stability, economic security and social welfare. In our May 18 webinar, Alice Hill of the Council on Foreign Relations will explore the vast similarities between climate change and pandemics, and reveal how the world's response to COVID-19 offers critical insights into how countries and communities can prepare for the worsening impacts of climate change.

Top to bottom: Sean McMahon (Photo courtesy of Sean McMahon); Jess Parker (Credit: SERC); Jess Shue (Credit: Uzay Sezen); Above: Alice Hill (Credit: University of Virginia)

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