Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Fall/Winter 2018

The Mysterious Migrations of Cownose Rays

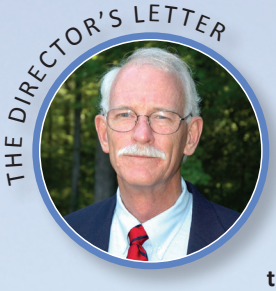
ALSO INSIDE:

Invasive Species On The Last Frontier

How Nature Can Help Save Us From Climate Change

Interns East & West

Yes, We Can Beat Climate Change. Nature Can Help.



Three years ago this month, something extraordinary happened. In December 2015, representatives of 195 nations met in Paris and committed to meeting climate change head on. In a binding agreement, they pledged to cut emissions, adapt to climate change, and help vulnerable countries, aiming to keep Earth from crossing a 1.5°C warming threshold. To many who had watched years of bitter international debates, it was nothing short of a miracle.

Today, much of that jubilation can seem like a distant memory. Earlier this fall, a new report from the Intergovernmental Panel on Climate Change painted a stark vision of a world warmed 2°C versus 1.5°C. And on Black Friday (of all days), the government revealed how the United States is already feeling the effects of climate change. But despite the rhetoric, I know we have what it takes to win.

First, the U.S. is still part of the Paris Agreement. It announced its intention to withdraw in summer 2017, but that doesn't go into effect until 2020. Meanwhile, many cities, states and organizations throughout the country have picked up the torch.

Second, there's another story that came out on the heels of the new climate change report. It's still possible for the U.S. to meet its Paris goals. A new study revealed 21 "natural climate solutions" that can sustain both people and the environment, while slashing our carbon emissions. Restoring forests topped the list, as they're some of our most powerful carbon absorbers. So did managing forests to cut the risk of devastating wildfires, and sustainable farming practices, like planting cover crops or improving how we use fertilizers. The study also recommends ecosystem approaches to reducing emissions of methane, an even more powerful greenhouse gas. These solutions are win-wins. And combined, they could cut our carbon footprint by over a trillion kilograms within the next decade. This large number would equal 21 percent of our greenhouse gas emissions in 2016.

Volunteers care for trees at BiodiversiTree, SERC's forest restoration experiment. (Credit: SERC)

Pat Megonigal, co-author of a new report on natural climate solutions, kneels beside an experiment in SERC's Global Change Research Wetland. (Credit: SERC)

I'm proud that our scientists were part of that team. Together with The Nature Conservancy and other scientists around the world, ecologists from SERC—including SERC's Associate Director for Research Pat Megonigal and two former postdocs who started their careers here—helped create a real, concrete vision for how we can overcome climate change.

For some, the power of nature is easy to overlook. The ecosystem services nature provides are too often taken for granted. Clean energy and clean transportation dominate most talks about how to keep rising temperatures at bay. SERC is focused on building "net-zero-energy" facilities that rely on renewable energy for our campus. Because the reality is, all of these solutions matter. Climate change is tied to every facet of society, and they will all need to be part of the ultimate victory.

Here at SERC, we've been steeped in ecosystem science for over 50 years. We've seen how our forests have started growing faster in response to global warming, offering us a much-needed assist in soaking up carbon. We know wetlands can build soil to outpace sea level rise, if given the opportunity. We've been watching how plants grow in futuristic, high-carbon dioxide chambers since 1986 on our Global Change Research Wetland.

Discoveries like this unfold over decades, but at SERC they're often funded by short-term grants designed to last just a few years. We're used to doing a lot with a little. Even the smallest gift can make an enormous difference.

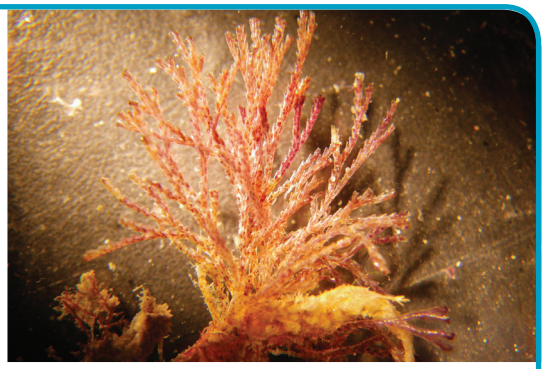
Knowledge is power—the power to face challenges and come up with strategies that work. Ultimately, knowledge gives us the power to create a better world. Citizens in 195 nations still stand ready to create that world, and we stand ready to help them.

— ANSON "TUCK" HINES, SERC DIRECTOR

Front Cover Photo: SERC biologist Kim Richie watches over a cownose ray in a holding tank. Biologists tagged over 40 cownose rays in a study following their yearly migrations from the Chesapeake to Florida. (Credit: SERC)

RESEARCH DISCOVERIES

NEW INVADERS ENCROACH ON THE LAST FRONTIER



The branching bryozoan **Bugula neritina.** *(Credit: Melissa Frey)*

Alaska has fewer marine invaders than almost any other U.S. state. But that could be changing. With help from volunteers, biologists at the Smithsonian Environmental Research Center (SERC), Temple University and the University of Alaska, Fairbanks, found a new arrival in Ketchikan: the branching bryozoan *Bugula neritina*.

Citizen scientists have helped biologists in Alaska since 2007, through SERC's Plate Watch program. In 2010, a volunteer discovered another invader in Ketchikan, the golden star tunicate. *Bugula*, the newest invader, hadn't reached as far north on the West Coast as Alaska until now. Elsewhere, it's messed up fishing and aquaculture operations. Ketchikan is a shipping hub, so *Bugula* likely came via boat. But *Bugula* wasn't the only surprise. The same study reported *Ciona savignyi*, a tunicate not seen in Alaska since 1903. All three animals could alter Alaska's ecosystems.

Link to full study: https://doi.org/10.3391/bir.2018.7.4.02

A tidal wetland at SERC. (Credit: Gary Peresta/SERC)

WITH AN ASSIST FROM NATURE, WE MAY GET TO PARIS ANYWAY

The United States may have declared its intention to withdraw from the Paris Agreement on climate change, but scientists are still exploring ways the country could meet its original goals. And nature can lend a far more powerful hand than once thought, if given the chance.

Led by The Nature Conservancy, scientists from SERC and other organizations looked at 21 "natural climate solutions," like restoring forests and wetlands, planting cover crops and natural forest management. Several solutions aren't terribly costly and come with side benefits, including increased yields for farmers or decreased risks of catastrophic wildfires. If the market is open enough, these natural solutions could cut an estimated 1.2 trillion kilograms off the U.S.'s yearly carbon emissions—just enough to hit the country's 2025 targets for the Paris Agreement.

Link to full study: https://dx.doi.org/10.1126/sciadv.aat1869

JEKYLL OR HYDE? INVASIVE PLANTS CAN BOOST BLUE CARBON STORAGE

Invasive species rarely make things black and white. A new paper revealed some plant invaders could help fight climate change by bolstering "blue carbon," carbon in coastal environments like salt marshes, mangroves and seagrasses. But animal invaders can do the opposite.

Marsh boardwalk with **Phragmites** *(Credit: Gary Peresta/SERC)*

The four authors—two invasions biologists at SERC and two wetland ecologists in Ireland—gathered data from 104 studies worldwide. They found when especially powerful plants invaded, like the reed *Phragmites*, biomass more than doubled (and by extension, the ability to store carbon). Meanwhile animals, by trampling and grazing, cut biomass nearly in half.

The authors don't advocate spreading invaders. The crucial question, they emphasized, is whether to eradicate established ones. "We're talking about how to best manage systems that are already impacted by humans," said co-author Christina Simkanin.

Link to full study:
https://doi.org/10.1111/gcb.14426

There and Back Again?

Longest Cownose Ray Migration Study on Atlantic Reveals Clues for Conservation

BY KRISTEN MINOGUE

Cownose rays are migratory animals that come into the Chesapeake in summer and swim to Florida for the winter. (Credit: Jay Fleming/SERC)

Every summer, cownose rays stream into Chesapeake Bay to give birth to their pups and mate. When autumn comes, they disappear—presumably to migrate south, but no one knew for certain where they spent the winter. Now, after a three-year tagging study led by the Smithsonian Environmental Research Center (SERC), scientists have solved the mystery. Cownose rays all along the Atlantic winter near Cape Canaveral, Florida, and it's likely they return to the same spots each summer.

CREATURES OF CONTROVERSY

Cownose rays are large stingrays native to the Chesapeake, with dark brown or olive-gray backs and white bellies. They reproduce slowly. Most mothers give birth to only one pup a year, and they don't mature until age seven or eight, making them vulnerable to intense fishing or sudden population declines.

Yet cownose rays have been dogged by controversy. In the early 2000s they were saddled with partial blame for oyster declines because their diet includes shellfish. (Later studies cleared their names. Oysters had been declining years before cownose rays became more abundant, and oysters make up just a small percent of their diets. Though rays sometimes snack on unprotected juvenile oysters on reef restorations, in general they prefer weaker shellfish like soft-shell clams.)

Later, in 2015, bowfishing tournaments for cownose rays began raising alarm among some Marylanders. In response, the Maryland government voted to become the first state to create a fishery management plan to conserve the cownose ray.

SERC marine ecologist Matt Ogburn (front) and intern Claire Mueller search for bull sharks and cownose rays near Fort Pierce, Florida, in January 2018. (Credit: Jay Fleming/SERC)

"Because of the slow birth rate, we know that if we don't manage them, and instead harvest them in a way that heavily impacts the population and causes a population decline, it'll take a long time for them to recover," said Matt Ogburn, SERC marine biologist and lead author of the study. "If we lose something important, we could lose it for decades."

TAGGING AND TRACKING

The new study, published in *Marine Ecology Progress Series*, marks the first time scientists have tracked cownose ray migrations along the Atlantic coast for a full year or more. Knowing where they go every year will help fill in some longstanding knowledge gaps, as Maryland decides how to manage the rays. It's part of the Smithsonian Institution's new Movement of Life Initiative. Scientists from the Virginia Institute of Marine Science (VIMS) and Savannah State University also joined the effort.

To tag the rays, scientists spent three summer-fall field seasons teaming up with commercial fishers. These fishers were not trying to catch cownose rays, but the animals often appear as accidental bycatch in their pound nets or haul seines. Many of the fishers had worked with the scientists before, partnering with VIMS co-author Bob Fisher or on SERC's crab tagging studies.

"Collaborative efforts with commercial fishers are built on trust, straight talk, and inclusion to investigate common problems and opportunities," said Fisher, who has studied cownose rays for nearly three decades.

After transferring the rays to a holding tank, the researchers gave them general and local anesthesia and inserted a small acoustic tag inside them. Once the rays had recovered from surgery, the scientists released them.

Bob Fisher, a biologist with the Virginia Institute of Marine Science, releases a tagged cownose ray into the water. (Credit: Sayer Fisher)

As the rays continued their journeys, the tags emitted a series of "pings" unique to each ray. Hundreds of receivers line the Chesapeake and the Atlantic coast, waiting to pick up their signal. These receivers were placed by dozens of scientists from institutions along the East Coast, all sharing data on different species. If a ray passed within half a kilometer of a receiver, the receiver would record data about the ray's location. Then the data were shared through the Atlantic Cooperative Telemetry Network and Florida Atlantic Coast Telemetry Network.

Scientists release a tagged cownose ray into the water. (Credit: Jay Fleming/SERC)

HOME FOR THE SUMMER?

The teams tagged 42 rays total. Most they tagged in Virginia, with five in Maryland and two in Georgia. Of those rays, 28 had their signals detected multiple times over a period longer than 90 days, enough time for scientists to get a sense of their migration behavior.

Regardless of where scientists tagged the rays, every ray they detected in winter went to the same spot: a region just off the coast of Cape Canaveral, Florida. The greater challenge was figuring out if cownose rays go back to the same places each summer.

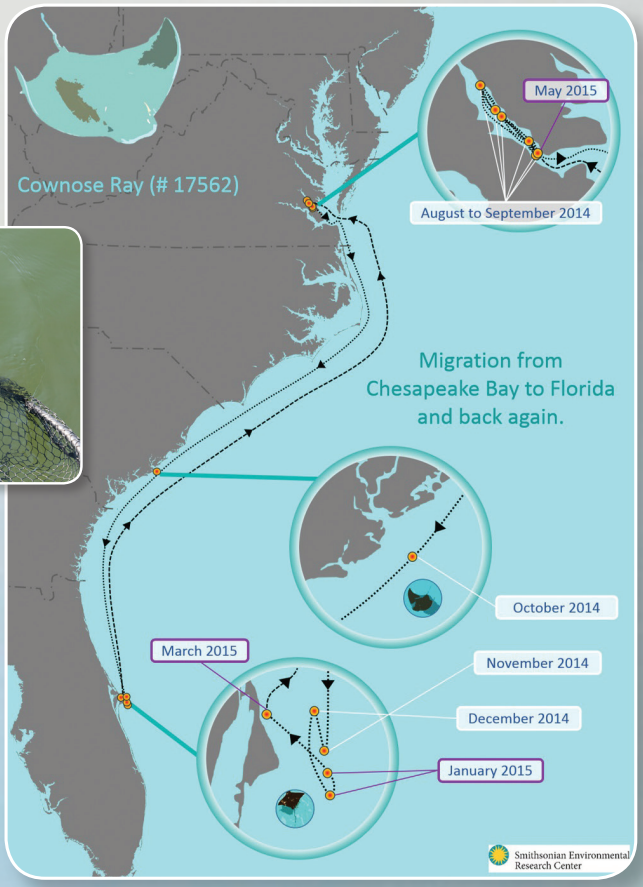
While most rays returned to the same regions where scientists tagged them the previous year—some even to the same rivers—many rays were tagged in the fall, when they might have already left their summer homes. Only five rays sent out location signals for both summer 2015 and summer 2016. Four of those rays (three from Virginia and one from Georgia) returned to their original regions. The fifth spent both summers in the Chesapeake, but the first summer in Virginia and the second in Maryland.

This pattern could make conservation even more critical. If cownose rays are returning to the same places each summer, that means the Chesapeake likely has its own distinct population. Intense fishing of rays in the Chesapeake, especially during summer, could wipe out a large slice of the species' genetic diversity.

"If they're really tied to one specific place, then you'll be removing a whole piece, a whole unique segment, from the population," Ogburn said.

While scientists have unraveled one mystery about the rays, there are still many unknowns. Not least, the authors emphasized, is their role in the Chesapeake as a whole. By turning over sediment, a bit like tilling a garden, rays could play a vital role for organisms like shellfish and crabs that live on the Bay floor. As Maryland develops the first official management plan for cownose rays, studies like this will offer more guidance on how to manage one of the most enigmatic creatures in the Chesapeake.

Link to full study:
https://www.int-res.com/abstracts/meps/v602/p197-211/



This female ray, tagged as #17562, started its journey in Virginia's York River in fall 2014, swam to Florida for the winter and returned to the same river by May 2015. (Credit: Laura Patrick/SERC)

"If we lose something important, we could lose it for decades."

Background: Underwater shot of cownose rays in a holding tank. Cownose rays migrate to Chesapeake Bay every summer to give birth to their pups and mate. (Credit: SERC)

INTERN SNAPSHOTS

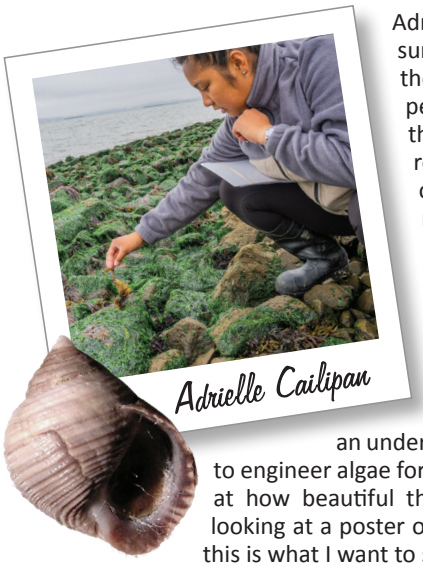
BY PHILIP KIEFER, SCIENCE WRITING INTERN

ADRIELLE CAILIPAN:

War of the Periwinkles

SERC-West San Francisco intern

There's a war of attrition playing out on the beaches of San Francisco Bay. A tiny invasive snail called the rough periwinkle might be pushing out its native counterpart, the checkered periwinkle. But no one is sure why, or even how quickly it's spreading.



Adrielle Cailipan spent her summer trying to understand the secret to the rough periwinkle's success. While there could be a number of reasons, Cailipan focused on one—perhaps the rough periwinkle is out-eating the checkered one. To test that, she devised a game for the snails: an algae-eating contest.

Cailipan admits she has a weakness for algae. As an undergraduate, she studied how to engineer algae for sustainable biofuel. "Look at how beautiful these are!" she exclaimed, looking at a poster of single-celled algae. "See, this is what I want to study."

For the eating contest, she turned the snails loose on algae-coated PVC plates. Fortunately, the snails left a shiny clean path behind them as they munched, making it easier for Cailipan to measure how much they ate. Her lab is still processing the results. If the rough periwinkles are mowing down more algae, biologists will have a better sense of why they're so prosperous. Otherwise, it's back to the drawing board.

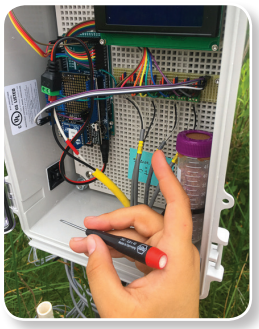
Top to bottom: Checkered periwinkle snail, Littorina scutulata *(Credit: Jon Sullivan); Adrielle Cailipan searches for periwinkle snails on the Oakland waterfront. (Credit: Philip Kiefer/SERC); Rough periwinkle snail,* Littorina saxatilis *(Credit: Jan Delsing); The snails left visible trails in the algae plates as they grazed. (Credit: Adrielle Cailipan/SERC); Checkered periwinkle photo used by permission of Creative Commons License here: https://creativecommons.org/licenses/by-nc/2.0/*

MAYA BHALLA-LADD:

Engineering the "Wetland of the Future"

SERC-East Chesapeake intern

Step out onto the boardwalk of SERC's Global Change Research Wetland, and you'll find yourself surrounded by windows into a future world. Clear plastic chambers dot the wetland, each containing a possible future atmosphere. Scientists hope to understand how the ecosystem will respond to a hotter, more carbon-rich planet by bringing that atmosphere into the here and now.



This summer, intern Maya Bhalla-Ladd worked with SERC ecologist Roy Rich on the engineering that runs the climate experiments. Sometimes, that involved cutting PVC pipe to build scaffolding for the instruments. But her main job: Construct and program an instrument to measure the temperature of each chamber.

"I think that the instrumentation that enables science is so cool, and that we don't spend enough time thinking about it," she said.

The device she and Rich created has a sensor that translates air temperature into an electric signal. That signal then goes to an open-source device (called an "Arduino board") that can record data on a computer. By knowing the temperature inside the chambers, scientists can tell how much the chambers themselves—in addition to the carbon dioxide they're pumping in—could be affecting their experiments.

"This kind of work is so different from anything I learn in school," Bhalla-Ladd said. "I like that every day forces me to learn something new to keep moving forward."

Top to bottom: Maya Bhalla-Ladd beside a hand-crafted temperature sensor. (Credit: Maya Bhalla-Ladd/SERC); A finished instrument on the marsh (Maya Bhalla-Ladd/SERC)

Jon Lefcheck breaks down an experiment in a wet lab at the Virginia Institute of Marine Science. (Photo courtesy Jon Lefcheck)

Q&A: JON LEFCHECK

MarineGEO Pioneer

BY KRISTEN MINOGUE

As the new coordinating scientist for the Marine Global Earth Observatories (MarineGEO), Jon Lefcheck will go from studying Chesapeake seagrasses to exploring coasts around the globe. In this Q&A, learn about some weird discoveries and creatures he's encountered so far. Edited for brevity and clarity. Read the extended version at https://sercblog.si.edu/meet-jon-lefcheck

You were the first in your family to attend college. What motivated you to take a different road?

I always liked school—oddly enough, yeah, I know. I liked science. I pushed my parents to send me to private high school so that I could get more into my studies, and they were hugely supportive the entire way. I think that was their dream, that they would have a kid that would grow up to go on to college.

Last spring, when you were at the Virginia Institute of Marine Science, you and Bob Orth documented a record four-fold recovery of Chesapeake Bay's underwater plants since 1984. How did that happen?

That's in large part due to our own efforts to police ourselves and the kinds of stuff that we're dumping into the Bay, different kinds of pollutants, runoff from people fertilizing their lawns and fertilizing their crops. Those management efforts have actually paid off.

At SERC you joined the Marine Global Earth Observatories, or MarineGEO. What is MarineGEO?

It's a partnership, a community of collaborators that are distributed all over the world. We've got places in Florida, Panama, Belize, Hong Kong, Hawai'i, Vancouver, and they're all committed to working together to go after questions about the health and future of coastal ecosystems. Seagrasses, coral reefs, mangroves, marshes, oysters, the whole gamut.

Why should people care about coasts, or how many species they have?

Coastal systems are providing a refuge for babies that grow up to create the foundation of coastal fisheries. So they're important….They allow my colleagues and friends here or in Kansas, or my mother at home in Connecticut, to order striped bass at a restaurant and know that that came from, grew up in, probably seagrass bed in Chesapeake Bay. So being able to make a link between the health of those systems, show biodiversity plays into that….

Why do I care about biodiversity? Biodiversity drives ecosystems. Ecosystems give us pretty much everything that we like along the coastline.

Do you have a favorite species?

Today it's an amphipod. It's a small shrimp called *Dulichiella appendiculata*. Sometimes I call them "Dude-lichiella," because they're very sexually dimorphic, which means that the males look different than the females, and the males have a claw that's as big as their body….I like to think he's like a body builder, "Dude-lichiella."

Jon Lefcheck (right) at Swansea University in Wales with colleague John Griffin. Lefcheck taught a course on mathematical modeling in Wales in 2017. (Photo courtesy Jon Lefcheck)

Volunteer Spotlight: Bruce Birdsell, Educator for All Ages

BY SARA RICHMOND

When Bruce Birdsell had just begun retirement, he attended a SERC Open House and learned about volunteer opportunities. That led him to sign on with SERC's education program, where he has been a volunteer for the past six years.

According to Bruce, volunteering aided the transition into retirement. Besides helping fill a newly open schedule, it was refreshing to work outdoors after a career in corporate management.

As an education volunteer, Bruce assists with the *Shoreline Connection* program, a field trip for third- through 12th-graders. He also leads canoe trips, guiding students along Muddy Creek and the Rhode River as they look for wildlife and discuss SERC research.

"The real reward is when you get the 'aha moment' from the kids," he said. When this happens, their excitement over catching fish with seine nets or exploring oyster reefs becomes visible. "You can see in their reaction that a light bulb has gone off."

Sitting on the SERC docks, Bruce Birdsell leads a water quality station as part of a visiting field trip.

Not all students arrive at their "aha" moments in the same way. Some students haven't spent significant time outdoors, and are often hesitant about some of the field trip activities, particularly canoeing. Another student visitor who was scared of canoeing shared that it wasn't from lack of experience: Her dad had taken her canoeing and purposely flipped their boat. By the end of her visit to SERC, she had regained her confidence. "I told her she could go home and tell her dad she's a pro now," Bruce said. Bruce was also part of the first group of volunteers to be trained as docents. SERC docents lead public tours of SERC's facilities and serve as ambassadors at SERC-hosted events. The tour itinerary depends on the group, but it may, for example, include a tour of the Mathias Lab, a stop at the Beaver Pond sampling weir, a walk along the marsh boardwalk, or a visit to the Reed Education Center and dock, along with a discussion of ongoing research and outreach programs.

For those considering volunteering, Bruce suggests they take some time to explore where they fit in, whether it's in the education, citizen science, docent or other programs. "You may have one idea coming in about what you want to do, but find multiple opportunities that fit."

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Donor Spotlight: The France-Merrick Foundation

Thanks to a generous gift from the France-Merrick Foundation, SERC was able to build a permanent pavilion outside of our Philip D. Reed Education Center, providing outdoor shelter for school groups and other visitors. The 1200 square-foot pavilion has greatly improved SERC's ability to run outdoor education programs in all weather conditions, serving as a teaching space for outdoor field stations.

Credit: Emily Loffredo/SERC

"When there's bad weather, we can do programs and activities inside the pavilion," said Karen McDonald, SERC's education coordinator. On one recent field trip, they led two groups of 25 kids each in their field trip stations. "It was very helpful because we didn't have room in the Reed Center and we couldn't do activities on the docks."

Besides students, members of the public can also enjoy the pavilion while visiting SERC's hiking trails and education grounds, and as a meeting place for public programs, including SERC's citizen science programs, guided canoe trips and docent tours.

The France-Merrick Foundation is one of Maryland's largest private foundations. For decades, it has been dedicated to supporting organizations that help preserve and protect the environment, make the public aware of its priceless natural heritage, and pass it on to future generations. The Foundation's funding has focused mostly on the ecological health of the Chesapeake Bay and its rivers and streams, with an emphasis on both preserving natural areas and helping to restore natural habitats. The Foundation's funding also enhances future generations' connection to the environment through hands-on environmental education.

The Smithsonian Environmental Research Center is recognized by the IRS as a 501(c)3 nonprofit organization. Contributions to SERC may be tax-deductible.
Visiting hours: Mon.-Sat., 8:30am-4:30pm. Closed Sundays & federal holidays

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