



Smithsonian Environmental  
Research Center

# ON THE EDGE

News from the Smithsonian Environmental Research Center Summer 2016

## FEATURE

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SEAFOOD VS. CLIMATE  
CHANGE: THE POWER  
OF BIODIVERSITY

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ACIDIFICATION

SHEDDING LIGHT ON  
EXTREME WEATHER  
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WHEN ANCIENT SOILS  
WAKE UP



## Director's Letter: Conserving Ecosystems Is Our Business

What does it mean, to say the staff at SERC are dedicated to "conserving ecosystems for a sustainable future"? For some people conservation means using less resources – less gasoline, less electricity, less materials – by being more efficient and not

being wasteful in their daily lives. For others, conservation means protecting endangered species, or managing impacts of fishing or hunting to prevent population declines. Still others emphasize protecting beautiful, exotic places on the planet. These are all part of conservation science, and SERC has contributed to science-based conservation policies and management strategies for 50 years, from land management to improved fishery management and pollution reduction.

SERC is working hard to "walk the walk" of conservation. We are protecting 2,650 acres of coastal land on the shores of Chesapeake Bay, and in 2014 we finished building a new LEED-Platinum sustainable laboratory. But SERC's conservation research goes beyond this. Our scientists focus on conserving ecosystems—interconnected communities of organisms, including humans, and their environments. Only by understanding how ecosystems work can we protect the goods, services and natural beauty they provide to sustain the whole planet.

"SERC is  
working hard to  
"walk the walk"  
of conservation."

-Tuck Hines

Flip through this newsletter, and you'll see the Earth is full of ecosystem connections. Extreme weather can impact how much ultraviolet radiation penetrates the water. Low oxygen, already a deadly threat to fish and oysters by itself, becomes even more deadly when acidification enters the picture. Scrutinizing the DNA of fungi in the soil is helping scientists unearth clues to saving endangered orchids.

Or consider our cover story: Biodiversity pays. In one of their latest discoveries, scientists with the

Smithsonian's Marine Global Earth Observatories teamed up with the Reef Life Survey to conduct more than 4,500 surveys of fish communities around the world. Diversity, it turns out, makes fish communities more productive and better able to withstand climate change. This in turn helps the billions of people who depend on seafood for protein, many of whom live in the developing world.

This year the Smithsonian launched a major new initiative: Conservation Commons. SERC and other units across the Smithsonian are pooling our knowledge and resources to propel conservation to new heights. We'll track the movement of life connecting ecosystems, explore how to create working land- and seascapes, and investigate how to sustain biodiversity-friendly food. The fourth piece of Conservation Commons, the "Earth Optimism" theme, will culminate with a summit on Earth Day 2017 focused on the successful use of environmental science to solve problems.

At the Smithsonian, we believe there is reason to be optimistic. We're a center of knowledge, not just of what is, but what could be. So keep your eyes peeled throughout the year for more updates from the conservation front.

— Anson "Tuck" Hines, director

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#### On the cover:

*With more than 1500 fish  
species, the Raja Ampat  
Islands in West Papua are  
the global center of fish  
biodiversity.*

*(Credit: Rick Stuart-Smith)*

## Please Do Not Disturb

What helps plant invasions? A recent online publication from former SERC intern Ben Sciance, senior scientists Don Weller and colleagues looked at how land use, shoreline armoring and other disturbances impact the common reed (*Phragmites australis*), an invasive plant in North American marshes. The team found that the prevalence of agriculture was the strongest predictor of presence and abundance of the common reed in the Chesapeake Bay. Why? Because farming activities release nutrients that promote establishment, growth and seed production. The team also discovered that the common reed was more frequent near shoreline armoring structures like riprap.

Controlling these invaders is tricky. The researchers suggest focusing on areas with low invasion, and include management strategies for reducing nutrient pollution, preserving natural shorelines and limiting shoreline disturbance.



Blanca Bernal, Postdoctoral Fellow  
Biogeochemistry Lab

## Climate Change Could Release Ancient Soil Carbon

Earth's deep soils store vast carbon reservoirs centuries to millennia old. Left undisturbed, they can store that carbon for millennia more. But if triggered, those reservoirs could release carbon dioxide (CO<sub>2</sub>), finds a Soil Biology & Biogeochemistry study.

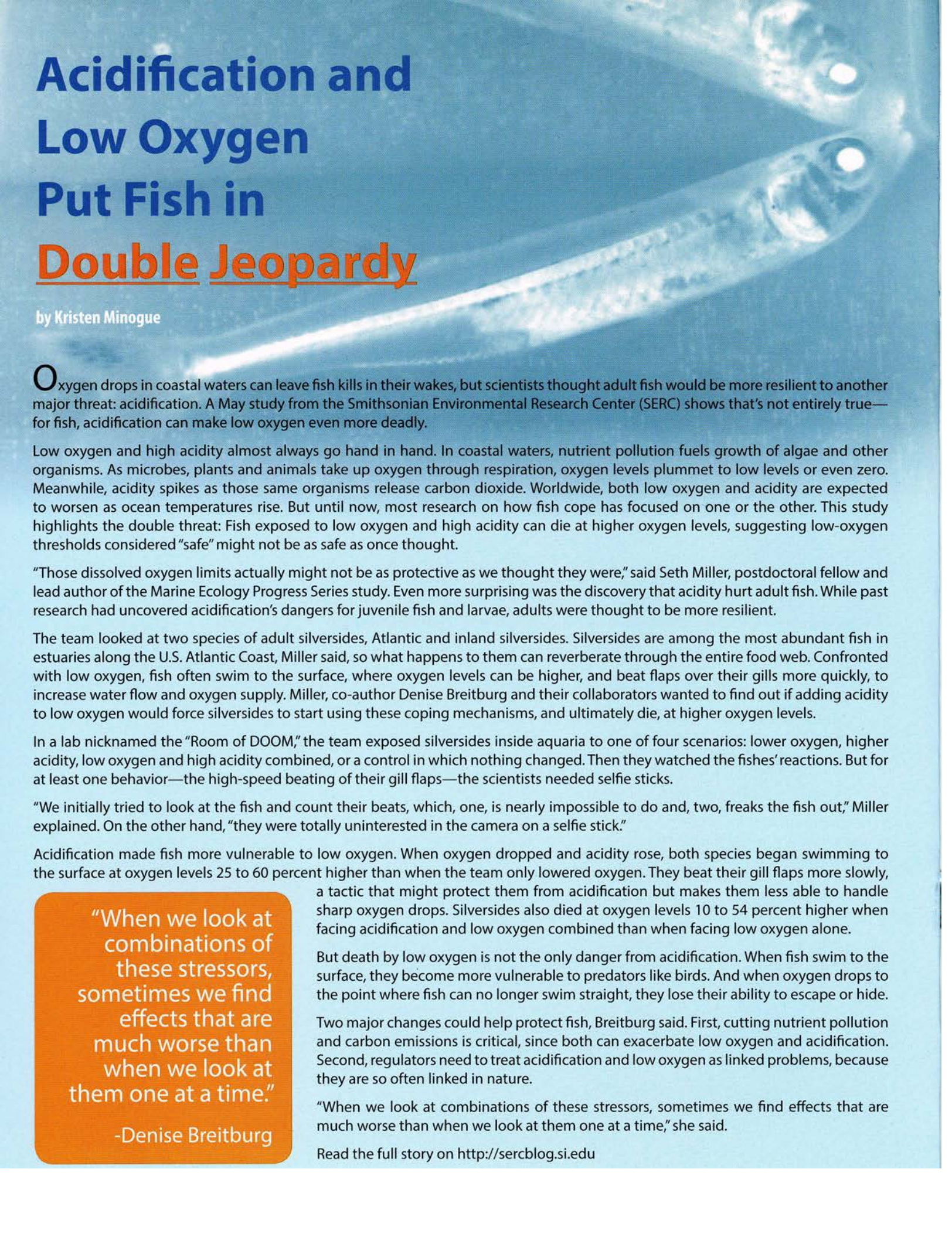
Taking soils beneath Florida scrub oaks, SERC biogeochemists Blanca Bernal, Pat Megonigal and colleagues tested how soils at three depths (surface, 1 meter and 3 meters) reacted when they added organic materials that could infiltrate soils as climate change progresses. After two months, these materials caused deep-soil microbes to emit up to 16 percent of the soil's stored carbon as CO<sub>2</sub>—though those same soils had no detectable microbial activity before. While deep soils were once thought to carry little weight in the global carbon budget, "they are active and they can be releasing carbon back to the atmosphere," Bernal said. And as for the microbes: "It's not that they are dead. They are just dormant."

## Key to Oysters' Future Lies Deep in Past

It's no secret Chesapeake oysters are in dire straits. But what about oysters of the deep past? To understand past human harvests, scientists from SERC, the National Museum of Natural History, William & Mary and elsewhere published the first Bay-wide study of oysters from the Pleistocene (780,000 years ago) until now in Proceedings of the National Academy of Sciences.

Under precolonial American Indian harvesting, oyster size didn't shrink as it has today—indicating oysters weren't overfished. One key is that American Indians primarily harvested near-shore oysters. Today's technologies enable deep-water harvesting. History could offer clues that a sustainable future is possible. The right balance of restoration, harvest and aquaculture might provide shelters similar to the deep-water reefs American Indians left intact.





# Acidification and Low Oxygen Put Fish in Double Jeopardy

by Kristen Minogue

Oxygen drops in coastal waters can leave fish kills in their wakes, but scientists thought adult fish would be more resilient to another major threat: acidification. A May study from the Smithsonian Environmental Research Center (SERC) shows that's not entirely true—for fish, acidification can make low oxygen even more deadly.

Low oxygen and high acidity almost always go hand in hand. In coastal waters, nutrient pollution fuels growth of algae and other organisms. As microbes, plants and animals take up oxygen through respiration, oxygen levels plummet to low levels or even zero. Meanwhile, acidity spikes as those same organisms release carbon dioxide. Worldwide, both low oxygen and acidity are expected to worsen as ocean temperatures rise. But until now, most research on how fish cope has focused on one or the other. This study highlights the double threat: Fish exposed to low oxygen and high acidity can die at higher oxygen levels, suggesting low-oxygen thresholds considered “safe” might not be as safe as once thought.

“Those dissolved oxygen limits actually might not be as protective as we thought they were,” said Seth Miller, postdoctoral fellow and lead author of the Marine Ecology Progress Series study. Even more surprising was the discovery that acidity hurt adult fish. While past research had uncovered acidification’s dangers for juvenile fish and larvae, adults were thought to be more resilient.

The team looked at two species of adult silversides, Atlantic and inland silversides. Silversides are among the most abundant fish in estuaries along the U.S. Atlantic Coast, Miller said, so what happens to them can reverberate through the entire food web. Confronted with low oxygen, fish often swim to the surface, where oxygen levels can be higher, and beat flaps over their gills more quickly, to increase water flow and oxygen supply. Miller, co-author Denise Breitburg and their collaborators wanted to find out if adding acidity to low oxygen would force silversides to start using these coping mechanisms, and ultimately die, at higher oxygen levels.

In a lab nicknamed the “Room of DOOM,” the team exposed silversides inside aquaria to one of four scenarios: lower oxygen, higher acidity, low oxygen and high acidity combined, or a control in which nothing changed. Then they watched the fishes’ reactions. But for at least one behavior—the high-speed beating of their gill flaps—the scientists needed selfie sticks.

“We initially tried to look at the fish and count their beats, which, one, is nearly impossible to do and, two, freaks the fish out,” Miller explained. On the other hand, “they were totally uninterested in the camera on a selfie stick.”

Acidification made fish more vulnerable to low oxygen. When oxygen dropped and acidity rose, both species began swimming to the surface at oxygen levels 25 to 60 percent higher than when the team only lowered oxygen. They beat their gill flaps more slowly, a tactic that might protect them from acidification but makes them less able to handle sharp oxygen drops. Silversides also died at oxygen levels 10 to 54 percent higher when facing acidification and low oxygen combined than when facing low oxygen alone.

But death by low oxygen is not the only danger from acidification. When fish swim to the surface, they become more vulnerable to predators like birds. And when oxygen drops to the point where fish can no longer swim straight, they lose their ability to escape or hide.

Two major changes could help protect fish, Breitburg said. First, cutting nutrient pollution and carbon emissions is critical, since both can exacerbate low oxygen and acidification. Second, regulators need to treat acidification and low oxygen as linked problems, because they are so often linked in nature.

“When we look at combinations of these stressors, sometimes we find effects that are much worse than when we look at them one at a time,” she said.

Read the full story on <http://sercblog.si.edu>

“When we look at combinations of these stressors, sometimes we find effects that are much worse than when we look at them one at a time.”

-Denise Breitburg



# Biodiversity Protects Fish From Climate Change

by Kristen Minogue

**B**illions of people rely on seafood for protein, especially in developing nations. But for many of the world's fish, surviving climate change and other environmental pressures is an increasingly stressful undertaking. This May, scientists detected one thing that could help: biodiversity. Having more species makes fish communities more productive and more resilient to rising temperatures and temperature swings.

The loss of species all over the globe has troubled scientists and the public for decades. But the question of whether biodiversity offers practical value—for humans and ecosystems—remained controversial. The new study, published in the *Proceedings of the National Academy of Sciences*, offers the most thorough proof yet that preserving marine biodiversity can benefit people as much as it benefits the oceans.

"Biodiversity is more than a pretty face," said lead author Emmett Duffy, director of the Smithsonian's Tennenbaum Marine Observatories Network and senior scientist at the Smithsonian Environmental Research Center. "Preserving biodiversity is not just an aesthetic or spiritual issue—it's critical to the healthy functioning of ecosystems and the important services they provide to humans, like seafood."

The discovery came out of the Reef Life Survey, a project that conducted more than 4,500 underwater surveys in 44 countries. Many surveyors were citizen scientists, volunteer divers who received training from scientists at the University of Tasmania. Armed with the most comprehensive global dataset on marine biodiversity involving standardized counts, the researchers tracked how 11 environmental factors influenced total fish biomass on coral and rocky reefs around the world. Surprisingly, one of the strongest influences was biodiversity. The number of species (species richness) and the variety in how they use their environment (functional diversity) both increased fish biomass. The boost in fish resources from biodiversity was second only to that of warm temperatures.

Temperature had a more complex impact on fish biomass. On average, warmer ocean temperatures tended to boost fish biomass, while wider temperature fluctuations hindered it. But biodiversity made fish communities more resilient against changing climate. In communities with only a few species, fish biomass tended to increase with rising temperatures until seas warmed above 20 degrees Celsius (68 degrees Fahrenheit)—at which point biomass started to fall. But communities with many species remained stable at these higher temperatures.

The researchers found a similar buffering effect of diversity against temperature swings. While both high- and low-diversity communities were less productive under fluctuating temperatures, high-diversity communities suffered only half as much as low-diversity ones. The researchers suspect when temperatures fluctuate, a community with many species has better odds that at least a few of them can thrive in the new normal.

In effect, their discoveries highlight how the environmental and human worlds are inextricably linked. "Preserving local biodiversity is not only an ethical directive with aesthetic and genetic insurance value," said co-author Sergio Navarrete of the Pontifical Catholic University of Chile. "It is an imperative for human life."

Read the full story on <http://sercblog.si.edu>

"Preserving biodiversity is not just an aesthetic or spiritual issue - it's critical to the healthy functioning of ecosystems and the important services they provide humans, like seafood."

-Emmett Duffy

# DNA Pinpoints Hot Spots for Restoring Orchids

by Kristen Minogue

Orchids need fungi. But finding those fungi can be tricky, until a new study using DNA found them in more places than anyone suspected.

The U.S. has 14 federally endangered or threatened orchids, and over 100 endangered or threatened at the state level. But Earth's 26,000-plus known orchid species share one thing: None grow from seed in the wild without a suitable fungus. This poses a dilemma for scientists working to restore at-risk orchids: How to detect where those fungi are?

For two decades, ecologists have buried mesh packets of orchid seeds in the soil and tracked where they germinated. More recently, molecular ecologists began using DNA primers—tiny DNA fragments that latch onto organisms' DNA and are used to create millions of copies, generating a genetic picture of just about everything in an environment.

"The idea is that it ought to pick up everybody," said Melissa McCormick, lead author and SERC molecular ecologist. "In reality, it doesn't....some of these orchid fungi it doesn't pick up very well."

In the new *Journal of Ecology* study, University of Mexico co-author Lee Taylor designed specialized primers to detect what general primers missed. Taylor designed primers to latch onto only DNA of fungi for three orchids: downy rattlesnake plantain (*Goodyera pubescens*), mauve sleepwort (*Liparis liliifolia*) and crane fly orchid (*Tipularia discolor*). After burying hundreds of orchid seed packets throughout the SERC forest, the team checked where orchids germinated. Meanwhile, McCormick sampled DNA from the soil using the new primers.

The primers found fungi almost everywhere orchid seeds germinated. But they also detected fungi in sparser amounts in places without orchid germination. Spots

like that could pinpoint where fungi exist but need reinforcements—enabling ecologists to focus on places with the best shot at success.

Read the full story on <http://sercblog.si.edu>



Melissa McCormick, Principal Investigator  
Molecular Ecology Lab

# Shedding Light on Extreme Weather Events

by Heather Soulen



In July 2002, record temperatures and drought caused 400,000 acres in Quebec to go up in flames. As seen in the image above, the jet stream channeled a thick plume of smoke over much of the East Coast, including Maryland some 900 miles away (red dot is SERC).

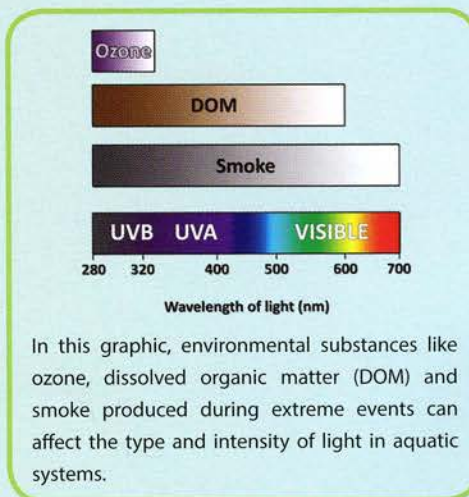
Pat Neale, senior scientist in SERC's Photobiology Lab, remembers that summer. He said during the Quebec fires, the smoke made things in Maryland look hazy, but added, "What you didn't realize was that

part of the UV spectrum was almost completely wiped out"

Extreme events like heat waves, droughts, wildfires and heavy precipitation are on the rise thanks to climate change. Such events alter how much light can penetrate aquatic environments. Neale has been collecting solar spectral data from a monitoring system at the top of SERC's meteorological tower since 1996. In his latest publication, Neale looks at how extreme events can change ultraviolet (UV) radiation and dissolved organic matter in lake ecosystems.

Since light is important to most organisms, extreme weather could mean life or death for some. During droughts very little water flows into lakes. This means less dissolved organic matter and particulates enter aquatic systems, causing light to penetrate deeper through the water. Too much UV light can damage fish eggs, larvae and plankton DNA. On the flipside, drought-induced dust storms, smoke from wildfires or extreme precipitation and floods lower UV penetration.

But the kind of UV matters as well. Short wavelength UVB is more damaging while long wavelength UVA is more intense. "UV is used as an environmental cue by a lot of animals," Neale said. Many organisms use different parts of the UV spectrum as cues for foraging, refuge-seeking and mating—meaning changes in UV could alter their behavior. For them, extreme weather in itself may not be their biggest worry, but the timing in relation to life-cycle events could be.



In this graphic, environmental substances like ozone, dissolved organic matter (DOM) and smoke produced during extreme events can affect the type and intensity of light in aquatic systems.

## Shaping the Future as an Environmental Educator

by Jan Wilson



I grew up in the Pacific Northwest and am of a generation that was lucky enough to be able to leave the house after school or on Saturday mornings to play outside for hours with the other neighborhood kids. We made hiding places in scotch broom thickets, climbed on fallen logs, wandered in the woods, had bracken fern spear fights and in the short, sweet summers spent time at a local beach on Puget Sound. It was idyllic, but at the time I took it all for granted.

I was a curious kid and for awhile thought I'd be a scientist. I created a tiny laboratory in a closet off the carport. In glass jars I had an odd collection of bugs, caterpillars and one unwilling garter snake. My youth microscope had pride of place, but with only a flashlight for light it was next to useless. Later in high school, challenges with math turned me towards the humanities instead of science.

Now, fifty-some years later, I've chosen to return to the outdoors where I spend time in the spring and fall on a Rhode River dock at the Smithsonian Environmental Research Center (SERC) teaching elementary and middle school kids about the great watershed of the Mid-Atlantic states and the Chesapeake Bay. We search through oyster baskets, do tests to measure water quality, use microscopes to examine plankton, put on waders to catch fish using a seining net and learn about the habits of that most famous inhabitant of the bay, the blue crab (*Callinectes sapidus*).

In a living lab on the SERC portion of the Rhode River, I'm learning at a very quick pace about all the wonderful habits of oysters and crabs. Did you know that every mature female blue crab with fertilized eggs has to maneuver her way to the mouth of the Bay? From SERC that's just under 120 miles of walking and swimming with and against the Bay's tides and currents, and they're no Michael Phelps. It's an amazing trek and it's all done

so that they can release their eggs into the water with high salinity levels necessary for egg development and hatching. Because blue crab larvae can't swim or move much on their own and simply drift with the currents, they're considered plankton. That's right, blue crabs are considered plankton. Within a month or two they go through several changes from one larval form to the next, culminating in their transformation into tiny crabs or "juveniles" as scientists call them.

I often feel like my 12-year-old self again, reading and collecting all sorts of new information and ideas. In that aspect, volunteering at SERC is highly rewarding. But that is not why I'm volunteering. I want to help bring the wonder of the natural world to children. It's the one way I believe we can stir children to want to be caretakers of their part of the Earth. If we can impress young students with the remarkable lives and functions of animals that share the Bay with them, we have a chance -- I hope a good chance -- that they'll see its value and feel the urge to be the protectors that we, the older generation, haven't been.

When we catch a blue crab and bring it up to the dock, I say, "Look at the color of its top shell, its carapace." It's a lovely muddy green that provides a beautiful contrast to his blue claws. I then say, "Now turn around and look at the river." Every time, every single time, the students say, "Whoa," "Wow" or some version of "Oh my gosh" when they discover the crab's carapace is exactly the color of the river. That is a moment of wonder. That's what I hope they'll remember as they grow older and become teens, and then adults. I hope they become people who want to ensure the health of the Bay or whatever part of the natural world they settle into. That's why I volunteer at SERC, to try to bring them those moments of wonder.



# Smithsonian Environmental Research Center

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## SERC Summer Programs: Choose Your Own Adventure

For the first time, SERC is offering summer programs for all ages, K through adult. Bring your scout troop, senior center, birding club, book club, summer camp, sports team or group of friends to SERC for an exciting and educational hands-on experience. You can choose from a variety of options, and we'll help you customize it to suit your group. Our summer 2016 lineup includes:

- Guided hikes
- Canoe trips
- Science Talks
- Hands-on science with seining, oyster creature sorting and more!



To plan your trip or learn more, contact Karen McDonald at [McDonaldK@si.edu](mailto:McDonaldK@si.edu) or (443) 482-2216.

## SERC Summer Evening Lectures

- Wednesday, July 20, 7pm: "Restoring Muddy Creek: An Experiment to Revive a Degraded Stream" with Dr. Joshua Thompson (SERC postdoc)
- Tuesday, August 16, 7pm: "Endangered Plants and the Importance of Habitat" with Paula Becker (Maryland Department of Natural Resources)



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### On The Edge

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