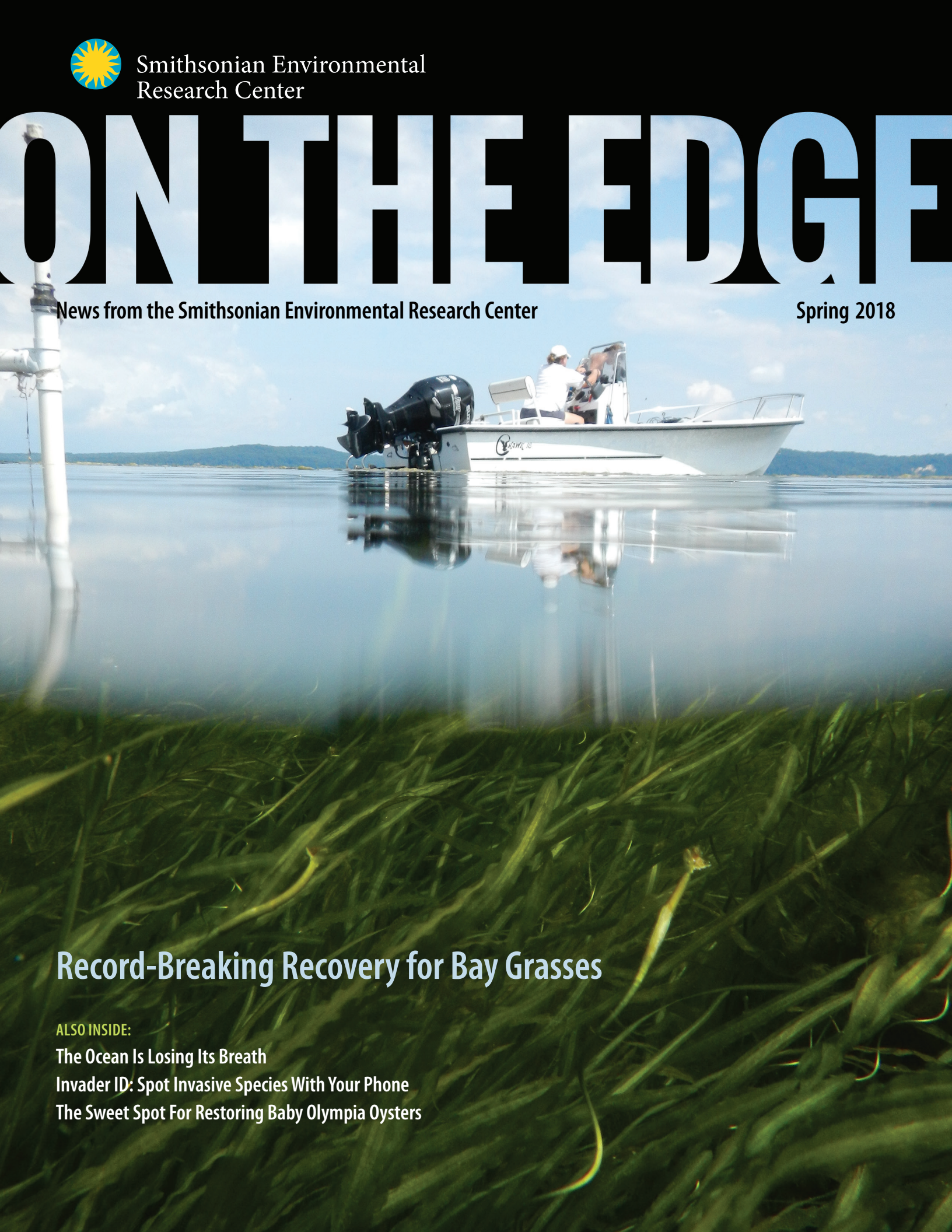
Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Spring 2018



Record-Breaking Recovery for Bay Grasses

ALSO INSIDE:

The Ocean Is Losing Its Breath

Invader ID: Spot Invasive Species With Your Phone

The Sweet Spot For Restoring Baby Olympia Oysters

When Politics and Science Collide

Scientists and politicians don't always see eye to eye. Sometimes, it can seem as though they're constantly at odds. When phrases like "war on science," "alternative facts" and "post-truth era" have invaded our cultural lexicon, it can be hard to imagine science and policy coexisting peacefully, let alone producing any kind of positive change.

But beyond the headlines, it's happening. It's happening here in Chesapeake Bay, and in other parts of the world. These places are proving when policy and science work together, remarkable things can unfold.

Take the Chesapeake Bay Program. In the late 1970s, as the Bay's health was spiraling downward, Senator Charles "Mac" Mathias (R-Md.), for whom SERC's laboratory building is named, helped convince Congress to fund a $27 million scientific study to find out why. Scientists investigated and responded: Nutrient pollution from fertilizers and development was a major source of the Bay's woes. Policymakers listened and acted: In 1983 the Environmental Protection Agency, the District of Columbia and the six states in the Chesapeake Bay watershed banded together to rein in nutrient pollution. The Chesapeake Bay Program was born.

It was still an uphill struggle for the next three decades, with setbacks, disagreements and controversies. But it's paid off. Today, after suffering the worst decline in 400 years, the Bay's underwater grasses have rebounded in the largest seagrass resurgence ever recorded. Scientists from SERC and other organizations throughout the U.S. pooled over three decades of data to make that discovery this spring. That means hundreds of millions of dollars' worth of nutrient filtration, blue crab habitat and other vital services are returning to the Bay. The 30-year nutrient diet is working.

Or take invasive species. Most ships unwittingly carry invasive species across the ocean, either outside their hulls or in their hulls' ballast water. For much of the 20th century, ships dumped that ballast water wherever they docked, discharging potential invaders with it. But in 1996, Congress passed the National Invasive Species Act. Now every major ship entering U.S. harbors must report to SERC and the U.S. Coast Guard how they manage their ballast water—by exchanging it in the open ocean, where coastal invaders are less likely to survive, or by treating their ballast water onboard. In 2016, the international community stepped up its game even further. SERC scientists helped inform the International Maritime Organization, and thanks to their new Ballast Water Management Convention, soon every ship involved in international trade will be required to treat their ballast water for potential invaders.

Mercury levels are also declining in aquatic food webs and the fish we eat. Over the years, SERC's science has helped inform regulations to reduce mercury emissions from coal-fired power plants, and developed ways to trap mercury in toxic waste dumps.

We've seen signs of hope in Maryland too. Last year, our state legislature passed a law committing the state to getting 25 percent of its electricity from renewable sources by 2020. In total, 29 states have similar renewable energy laws in place, proving that environmental action isn't just up to the feds.

I won't naïvely imagine a world where politicians accept scientific discoveries without question and make policies that fit the data perfectly. We have different missions. Scientists may think about decades and centuries, while also pointing clearly to serious impacts today. Politicians think about the next election and what their constituents want now. However, both groups are converging on the urgency of finding effective solutions.

Instead, let's envision a world where scientists and politicians can talk to each other. Not only on Capitol Hill, but in labs, in forests, in farms and on docks. A world where all stakeholders—politicians, business leaders, scientists and residents—can meet face to face and brainstorm solutions that make sense for everyone. We're working to create that here, at SERC. If we can do it here, there's hope for the rest of the world.

— ANSON "TUCK" HINES, DIRECTOR

Top photos, left to right: Former EPA Administrator Gina McCarthy with SERC technician Sam Benson in 2013. (Kristen Minogue/SERC) Tuck Hines (second from right) wades into the Rhode River with former Maryland state senator Bernie Fowler (second from left) and others in 2010. (Peter G. Cane/SERC) Former Maryland Senator Charles Mathias (left) and Tuck Hines in 1989. (Smithsonian Institution Archives)

Front Cover Photo: A scientist tests water quality and seagrass biomass on the Susquehanna Flats, in upper Chesapeake Bay. (Cassie Gurbisz)

RESEARCH DISCOVERIES

Olympia Oysters. (Credit: Brian Cheng / UCDavis)

BIOLOGISTS FIND GOLDILOCKS ZONE FOR BABY OLYMPIA OYSTERS

Sometimes the water is too cold. Sometimes it's too fresh. And sometimes—or some places—it's just right. In San Francisco Bay, Olympia oyster larvae need hard surfaces to settle on and grow. But where, when and how well they settle depends on the water's temperature and saltiness. SERC biologist Andy Chang and other California scientists pinpointed a sweet spot: warmer than 16°C (61°F), and almost as salty as the open ocean (25 to 30 parts per thousand).

The study, published January in *Estuaries and Coasts*, tracked oyster settlement for five years in four Bay sites. In warmer, dryer years, oysters began setting earlier and farther upstream. Wetter winters—with the injection of extra freshwater—pushed settlement downstream. The discovery gives managers a shot at restoring the long-imperiled oysters. If they can keep an eye on conditions in winter and early spring, it could help them decide what time is "just right" to plant new oyster reefs for the baby larvae to settle on.

Link to oyster study: https://doi.org/10.1007/s12237-016-0182-1

OVER A CITY'S WORTH OF SHIP HULLS ENTERS THE U.S. EACH YEAR

Ship Hull. (Credit: Kim Holzer)

Most oceangoing ships carry unwanted hitchhikers: creatures like mussels, barnacles and bryozoans that latch onto their hulls and get ferried to other countries or continents. If conditions are right, some of those creatures take root in their new homes as invasive species. It's a big biosecurity threat, but no one had calculated exactly how big.

Led by Whitman Miller, biologists from SERC, the Navy and Excet, Inc., collected data on all commercial ships arriving to the U.S. from 2011 to 2014. In a paper published February in *Biological Invasions*, they combined that with information on approximate hull sizes to estimate total "wetted surface area." The result: If you lined up every hull entering the U.S. annually, they would cover roughly 200 square miles—about three times the size of Washington, D.C. That's a lot of space potential invaders could occupy.

Link to ship study: https://doi.org/10.1007/s10530-018-1672-9

MISTAKEN IDENTITY: ASIA HAS ITS OWN SPECIES OF SOFT-SHELL CLAM

For over a century, soft-shell clams have been unwitting identity crisis victims. Take two varieties: *Mya arenaria*, found in Europe and both U.S. coasts, and their Asian counterparts, *Mya japonica*. It's extremely difficult to tell them apart by sight. Many concluded they were one species.

Soft-shell clams. Top: Mya arenaria. *Bottom:* Mya japonica. *(Irina Volvenko/Far Eastern Federal University)*

In a *Zoological Journal of the Linnean Society* study, Chinese, Russian and U.S. scientists closed the case by looking at their DNA and sperm shapes. With SERC biologists Rob Aguilar and Matt Ogburn, they examined over 150 soft-shell clams from around the world. All the Asian Pacific clams fell neatly into their own group, indicating that, yes, *Mya japonica* is in fact its own species. In a final surprise, the team discovered two *Mya japonica* clams in British Columbia—their first northeast Pacific appearance. The two clams had been mistaken for *Mya arenaria* since 2011.

Link to clam study: https://doi.org/10.1093/zoolinnean/zlx107

The Ocean Is Losing Its Breath:

In Broadest View Yet of World's Low Oxygen, Scientists Reveal Dangers and Solutions

BY KRISTEN MINOGUE

Low oxygen caused the death of these corals and crabs in Panama. (Arcadio Castillo/ Smithsonian)

In the past 50 years, the amount of water in the open ocean with zero oxygen has gone up more than fourfold. In coastal water bodies, including estuaries and semi-enclosed seas, low-oxygen sites have increased more than 10-fold since 1950. Scientists expect oxygen to continue dropping even outside these zones as Earth warms. To halt the decline, the world needs to rein in both climate change and nutrient pollution, an international team of scientists asserted in a new paper published Jan. 4 in *Science*.

Marine ecologist Denise Breitburg in the Rhode River.

"Oxygen is fundamental to life in the oceans," said Denise Breitburg, lead author and marine ecologist with the Smithsonian Environmental Research Center. "The decline in ocean oxygen ranks among the most serious effects of human activities on the Earth's environment."

The study came from a team of scientists from GO_2NE (Global Ocean Oxygen Network), a new working group created in 2016 by the United Nation's Intergovernmental Oceanographic Commission. The review paper is the first to take such a sweeping look at the causes, consequences and solutions to low oxygen worldwide, in both the open ocean and coastal waters. The article highlights the biggest dangers to the ocean and society, and what it will take to keep Earth's waters healthy and productive.

The Stakes

"Approximately half of the oxygen on Earth comes from the ocean," said Vladimir Ryabinin, executive secretary of the Intergovernmental Oceanographic Commission that formed the GO_2NE group. "However, combined effects of nutrient loading and climate change are greatly increasing the number and size of 'dead zones' in the open ocean and coastal waters, where oxygen is too low to support most marine life."

In areas traditionally called "dead zones," like those in Chesapeake Bay and the Gulf of Mexico, oxygen plummets to levels so low many animals suffocate and die. As fish avoid these zones, their habitats shrink and they become more vulnerable to predators or fishing. But the problem goes far beyond "dead zones," the authors point out. Even smaller oxygen declines can stunt growth in animals, hinder reproduction and lead to disease or even death. Low oxygen also can trigger the release of dangerous chemicals such as nitrous oxide, a greenhouse gas up to 300 times more powerful than carbon dioxide, and toxic hydrogen sulfide. While some animals can thrive in dead zones, overall biodiversity falls.

Climate change is the key culprit in the open ocean. Warming surface waters make it harder for oxygen to reach the ocean interior. Furthermore, as the ocean as a whole gets warmer, it holds less oxygen. In coastal waters, excess nutrient pollution from land creates algal blooms, which drain oxygen as they die and decompose. In an unfortunate twist, animals also need more oxygen in warmer waters, even as it is disappearing.

People's livelihoods are also on the line, the scientists reported, especially in developing nations. Smaller, artisanal fisheries may be unable to relocate when low oxygen destroys their harvests or forces fish to move elsewhere. In the Philippines, fish kills in a single town's aquaculture pens cost more than $10 million. Coral reefs, a key tourism attraction in many countries, also can waste away without enough oxygen.

"It's a tremendous loss to all the support services that rely on recreation and tourism, hotels and restaurants and taxi drivers and everything else," said Lisa Levin, a co-author and marine biologist with the University of California, San Diego. "The reverberations of unhealthy ecosystems in the ocean can be extensive."

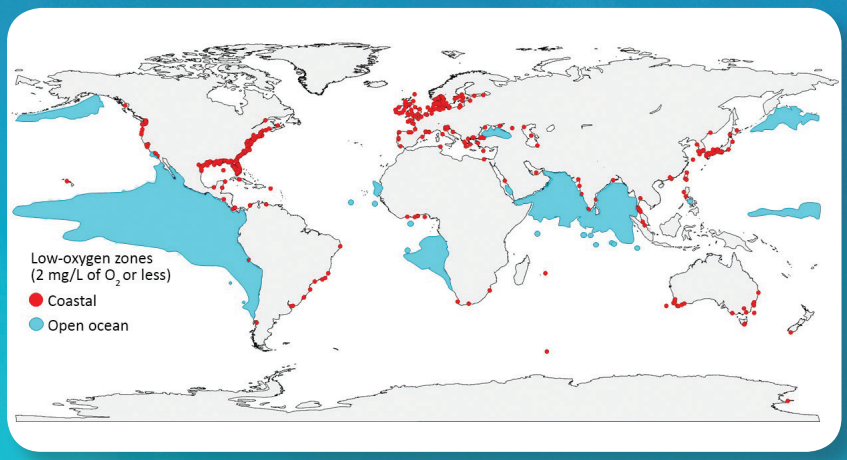
Some popular fisheries could benefit, at least in the short term. Nutrient pollution can stimulate production of food for fish. In addition, when fish are forced to crowd to escape low oxygen, they can become easier to catch. But in the long run, this could result in overfishing and damage to the economy.

Winning the War: A Three-Pronged Approach

To keep low oxygen in check, the scientists said the world needs to take on the issue from three angles:

- **Address the causes: nutrient pollution and climate change.** While neither issue is simple or easy, the steps needed to win can benefit people as well as the environment. Better septic systems and sanitation can protect human health and keep pollution out of the water. Cutting fossil fuel emissions not only cuts greenhouse gases and fights climate change, but also slashes dangerous air pollutants like mercury.

- **Protect vulnerable marine life.** With some low oxygen unavoidable, it is crucial to protect at-risk fisheries from further stress. According to the GO_2NE team, this could mean creating marine protected areas or no-catch zones in areas animals use to escape low oxygen, or switching to fish that are not as threatened by falling oxygen levels.



Areas where oxygen has dropped to 2 milligrams per liter or less. Red dots mark coastal zones, and blue areas mark open ocean zones. (Credit: GO_2NE working group. Data form World Ocean Atlas 2013, provided by R. J. Diaz)

- **Improve low-oxygen tracking worldwide.** Scientists have a decent grasp of how much oxygen the ocean could lose in the future, but they do not know exactly where those low-oxygen zones will be. Enhanced monitoring, especially in developing countries, and numerical models will help pinpoint which places are most at risk and determine the most effective solutions.

Members of the GO_2NE working group in Monterey, Calif. Not shown: Jing Zhang, Daniel Conley and Brad Seibel (Francisco Chavez)

"This is a problem we can solve," Breitburg said. "Halting climate change requires a global effort, but even local actions can help with nutrient-driven oxygen decline." As proof Breitburg points to the ongoing recovery of Chesapeake Bay, where nitrogen pollution has dropped 23 percent since its peak, thanks to better sewage treatment, better farming practices and successful laws like the Clean Air Act. While low-oxygen is still a problem in the Chesapeake, in Maryland the area of water with zero oxygen has shrunk dramatically. "Tackling climate change may seem more daunting," she added, "but doing it is critical for stemming the decline of oxygen in our oceans, and for nearly every aspect of life on our planet."

Link to research paper: http://science.sciencemag.org/content/359/6371/eaam7240

"Oxygen is fundamental to life in the oceans."

Chesapeake Bay's Underwater Plants Stage Record-Breaking Comeback, Thanks to Nutrient Diet

BY KRISTEN MINOGUE

Between the 1950s and 1970s, tens of thousands of acres of Chesapeake Bay's underwater grasses vanished due to chronic pollution and natural disasters. Today, thanks to efforts to rein in harmful nutrients like nitrogen and phosphorus, they've achieved a new victory: the largest underwater grass resurgence ever recorded.

Since 1984, nitrogen in the Bay has dropped 23 percent, and phosphorus 8 percent, reports a March study in *Proceedings of the National Academy of Sciences*. As a result, Chesapeake Bay grasses shot up more than fourfold.

Underwater grasses are worth trillions of dollars for society. They protect shorelines from erosion, store carbon, and nourish popular species like young blue crabs. They're also "sentinel species," a gauge of the Bay's overall health.

"Big increases in the grasses mean that we're really succeeding in our effort to restore the Chesapeake Bay," said co-author Don Weller, an ecological modeler at the Smithsonian Environmental Research Center.

Managers have long suspected cutting nutrient pollution held the key to restoring underwater grasses. In 1983, policymakers united to clamp down on nutrients by forming the Chesapeake Bay Program, a partnership of the Environmental Protection Agency, the District of Columbia and the six states in the Chesapeake Bay watershed.

To see how well those efforts paid off, scientists pooled over 30 years of data. They examined aerial surveys of grass beds and nutrient levels in the Bay from 1984 through 2015, historical records of land use and how much fertilizer different areas used. Then, they analyzed how nutrient pollution impacted underwater grasses in the entire Bay and in 120 smaller subestuaries.

The fate of underwater grasses was directly tied to nutrient pollution. Plants lost ground where more nutrients streamed into the Bay, primarily from agriculture and urbanization. That strong link also meant the plants' fourfold recovery stemmed from the overall *decline* in Bay nutrients over the last three decades.

Today, the Bay has roughly 97,000 acres of underwater grasses. That's still just over half the ultimate goal, 185,000 acres. But now there's proof that the Bay's three-decade nutrient diet is working.

"This is a message of hope," said lead author Jonathan Lefcheck, marine ecologist at Bigelow Laboratory for Ocean Sciences. "And I look forward to a future when the Bay is filled with grasses, something I never thought I would see during my lifetime!"

Link to full study: https://doi.org/10.1073/pnas.1715798115

Top photo: Unhealthy eelgrass covered in algae. (Jon Lefcheck) Middle photos: Two scallops on seagrass (J. J. Orth) and a shrimp in eelgrass. (John Carroll)

Volunteer Spotlight: Steve Myers

BY SARA RICHMOND

After Steve Myers retired from nearly 40 years in information technology, he decided to try something different. For nearly three years, he's taught students how to use seining nets and paddle canoes, measured trees at a stream restoration site and monitored mangroves as a volunteer at the Smithsonian Environmental Research Center (SERC).

With SERC's education program, Steve leads field trips with visiting students. "One of my favorite parts of volunteering is seeing the reaction on the kids' faces when they experience something they've never done before, especially kids who have grown up in the city," he says. "Seeing them hold a fish or a crab for a first time—that's kind of neat."

Steve admits feeling apprehensive at first, as he had no prior teaching experience. However, he says he's learned something new with every field trip, and encourages others to not be intimidated by the idea of teaching for the first time. "If you like being outside, chances are you're going to like being here," he says.

When not working with field trips, you can often find Steve doing citizen science in the lab or forest. One project centers on mangroves and climate change. In the tropics and subtropics, mangrove plants protect shores from hurricanes, shelter fish and birds, and improve water quality. As Earth's temperatures warm, mangroves are migrating north, so SERC researchers want to understand how conditions in their new homes may affect them. To find out, they planted mangroves from Florida, Baja California and Panama in chambers that mimic temperate and tropical environments. Steve helps collect data on how different mangrove species react to chillier temperatures. With SERC's Stream Restoration Project, Steve is helping determine the impact of a recent restoration in Muddy Creek, a stream that runs through SERC's campus. Before its restoration in early 2016, the stream had eroded to the point that its channel was several feet deep. Now that the stream has been restored to a shallower depth, Steve and other citizen scientists are tracking how trees along its banks are faring by measuring their circumferences. Ultimately, their work will help determine which stream restoration strategies are most effective.

Steve Myers on the SERC seining beach. (Sara Richmond)

Steve hopes students and other visitors leave SERC with a clearer understanding of how everything in nature is tied together. "You can't alter one thing without having an impact on something else," he says. "In the past, humans haven't done a very good job of managing those relationships, so it's even more important that we manage them now."

Want to join the team?

Contact Karen McDonald (mcdonaldk@si.edu) for education or Alison Cawood (cawooda@si.edu) for citizen science.

Citizen Science: Help Spot Invaders With Your Smart Phone

BY KRISTEN MINOGUE

Strange things grow on the bottoms of docks: brightly colored sponges, mat-like tunicates, and flower-shaped anemones. Many of these mysterious life forms are invasive species. This spring, Smithsonian marine biologists launched **Invader ID**, an online citizen science project calling on anyone with an Internet connection to help detect them.

Biologist Brianna Tracy with the Smithsonian Environmental Research Center.

The project centers on San Francisco Bay. With over 200 non-native species, it's the most invaded estuary in North America. "The majority of the species that we identify in the San Francisco Bay are invasive," said Brianna Tracy, a biologist with the Smithsonian Environmental Research Center.

Tracy works with the center's Marine Invasions Lab, which has studied San Francisco Bay for nearly 20 years. To track the Bay's underwater life, the team hangs plastic tiles from docks. Three months later, they pull the tiles from the water and identify all the colorful marine organisms growing on them. By Tracy's count, the invaders are dominating. "Almost everything we see on a plate is nonnative….We get maybe one native species per panel sometimes."

Over the years, the team has collected thousands of tiles. But with little more than a skeleton crew to examine them, they're experiencing some serious bottlenecks.

That's where citizen science comes in. The biologists photograph every tile they collect. This spring they uploaded nearly 8,000 photos of 160 tiles on the Invader ID Website, launched March 21 on the citizen science platform Zooniverse. Each photo asks citizen scientists to identify a different organism on a tile. (Sponge? Anemone? Barnacle? Mollusk?) If viewers get stumped, Invader ID also offers a few helpful questions. (Hard or soft? Patterned or one color? Long and skinny, or short and stubby?)

Right now, Invader ID has a small fraction of the roughly 20,000 tiles in their database. But if the first phase succeeds, the biologists hope to expand it to include tiles from Alaska as well as San Francisco.

The ultimate "dream big goal," Tracy said, would be for people to be able to hang tiles from their own docks for three months, snap a photo and upload it to Invader ID. But for now, she hopes Invader ID gives people a glimpse of life beneath the surface. "What they're scraping off their boats and what's growing underneath the dock is more than just mud and oysters and algae."

Want to join the project?

Visit Invader ID at https://www.zooniverse.org/projects/serc/invader-id.

Donor Spotlight: Helen Horwitz

BY BRIAN MAGNESS

Hal and Helen Horwitz. (Photo courtesy of Helen Horwitz)

In 2017, Helen Horwitz established the Hal and Helen Horwitz Orchid Conservation Endowment through a generous gift in memory of her late husband, Harold "Hal" Horwitz. Hal was an avid photographer, who moved from underwater photography to wildflowers and orchids. "We spent most of our summers, May through Labor Day, in an RV traveling to where orchids were blooming to photograph them," Helen said. "I would scout for orchids while Hal took photos. I'm passionate about the outdoors and nature and it was a super way to do things together."

While giving presentations of his photography, Helen remembered her husband always said, "Sit back and enjoy the beauty of nature, but always know what it means to our future."

Hal and Helen were among the first supporters of the North American Orchid Conservation Center (NAOCC), headquartered at SERC. North America is home to over 200 orchid species, and over half are endangered or threatened somewhere in their native range. In 2012 the Smithsonian and the U.S. Botanic Gardens created NAOCC to assure the survival of all native orchids in the U.S. and Canada. Today more than 20 organizations across the continent have joined.

The couple first met Dennis Whigham, SERC scientist and NAOCC founder, a few decades ago at a Wildflower Symposium at The Nature Foundation at Wintergreen. "Dennis helped us learn more about orchids and the need for conservation," Helen said. "Hal was on the committee for NAOCC and orchids are something we learned about together….When Hal died in 2015, I wanted something to perpetuate NAOCC and Hal's love of orchids."

The endowment will provide NAOCC funding in perpetuity, while annual gifts are important for the organization's day-to-day needs. "For me, endowment and annual giving are two parts of a whole. I hope to be able to make a donation every year as long as I can," she said.

"The future of NAOCC depends on the active involvement of volunteers, including individuals and organizations that support NAOCC financially," said Dr. Whigham. "Helen, in Hal's honor, was the pioneer in moving NAOCC along that path to financial success by establishing the Hal and Helen Horwitz Orchid Conservation Endowment. But most important, Helen is more than a supporter of NAOCC. She is a wonderful person and friend."

Several of Hal Horwitz's beautiful native orchid photographs are on the NAOCC website: northamericanorchidcenter.org/featured-hal-horwitz/.

Want to help SERC's conservation research?

To make a gift, donate online at www.serc.si.edu or contact Brian Magness (magnessb@si.edu).

SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER
1965–2015

647 Contees Wharf Road
Edgewater, MD 21037

SERC Open House | SATURDAY, MAY 19 • 10AM–4PM

Get inspired at SERC's annual festival of science and Bay Optimism! Enjoy hands-on activities on land and water with Smithsonian scientists working in your backyard. Discover environmental success stories from Chesapeake Bay and around the world, and learn how you can be a part of them.

Food and drink available for purchase. Parking at South River High School, with free shuttle bus. RSVP online, and be entered to win a Whole Foods gift bag! For full details visit www.serc.si.edu/openhouse.

Activities include:

- Boat Rides
- Hay Rides
- River Seining
- Oyster Bar
- Face Painting
- Live Music

Photos: SERC and Kate Jones

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

443-482-2200 • www.serc.si.edu

ON THE EDGE
Kristen Minogue – *writer, editor*
Christine Dunham – *copy editor*
Sara Richmond – *writer, volunteer*
Stacey Saadeh Smith – *designer*
Brian Magness – *contributing writer*
All photos are credited to SERC unless otherwise noted.

To send a comment, please email minoguek@si.edu.