Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Spring 2022

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How To Protect Restorations From Extreme Climate Events

New History Center Opens At 1735 Woodlawn House

Woodlawn House, originally built in 1735, will open to the public this summer as the Woodlawn History Center. (Credit: Christine Dunham)

THE DIRECTOR'S LETTER:

The Challenging Legacies of History and Science

The oldest never-moved building in the Smithsonian isn't on the National Mall. It's a three-story brick house just inside the entrance to SERC, first built in 1735 and modified over nearly 300 years. Its first occupants called it Woodlawn. This summer, after years of renovations and research, visitors will be able to walk inside it for the first time when it opens as the Woodlawn History Center.

A cowrie shell bead likely from Africa, found at Sparrow's Rest, a site on the SERC property that would later become the Contee plantation. (Credit: SERC Archaeology Lab)

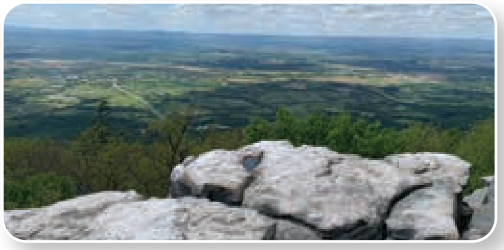
Woodlawn has forced us to confront the complex and often painful legacies humans have left behind. The Sellman family, who owned the plantation house for nearly 200 years, were key players in shaping our young nation. Their family tree includes a Revolutionary War veteran who was also a slaveholder, and soldiers who fought on both sides of the Civil War. In the new history exhibit, the names and stories of the enslaved mingle side-by-side with the stories of free citizens. Nearly every artifact from the colonial period to Jim Crow was touched by someone held in bondage.

The exhibit also tells the story of the land, and how humans have transformed their environment. Beginning with the Native Americans who used it for seasonal hunting and fishing, the Woodlawn History Center reveals how centuries of farming created rolling grasslands in some places and severely eroded slopes in others.

Gooseneck barnacles and a sponge colonize debris from the Great Pacific Garbage Patch. (Credit: SERC Marine Invasions Lab)

Science, like history, has its share of convoluted legacies. This winter our Marine Invasions Lab published a surprising discovery about plastic pollution, led by former SERC postdoc Linsey Haram. Life has found a way to thrive in—of all places—the Great Pacific Garbage Patch. Hundreds of oceanic and coastal organisms are colonizing the floating plastic trash we have dumped in the ocean. But how will this transform life in the rest of the ocean? Will it make it easier for invasive species to reach new shores?

Another postdoc, Amy Hruska, is investigating how forest fragmentation impacts migratory birds. She's retracing the footsteps of two of SERC's first scientists—Dennis Whigham and Jim Lynch—by revisiting forests they surveyed 40 years ago to see how the landscape has changed.



Forest fragmentation in Shenandoah National Park, Virginia, one of the sites SERC postdoc Amy Hruska is researching. (Credit: Amy Hruska/SERC)

Even our efforts to name species aren't immune. On the page opposite this letter, you'll find the story of a mysterious peppermint shrimp caught in the Chesapeake Bay in 2013. As SERC technician Rob Aguilar tried to identify it, he uncovered a wormhole of naming mix-ups dating back to 1860, and an entire species that may have been wrongfully demoted.

Science is never "just science." It can never escape history—in its role to decode the past, or its responsibility to the future. This is true for all fields, but especially for environmental science. We hope, later this year, you have a chance to walk through the Woodlawn History Center for yourself. We also hope, as we untangle the knots of our past, that you will join us in weaving a more supportive future.

- ANSON "TUCK" HINES, SERC DIRECTOR

Cover Photo: Marine biologist Linsey Haram working in a lab at the Smithsonian Environmental Research Center during the pandemic, analyzing sponges, hydroids and bryozoans on plastic debris. (Credit: Luz Quiñones/SERC)

THE PERPLEXING CASE OF THE PEPPERMINT SHRIMP

How the discovery of a nonnative shrimp in the Chesapeake unearthed a 160-year-old naming mystery

BY KRISTEN GOODHUE

Left: This peppermint shrimp found in the Chesapeake is considered the "true" Lysmata vittata*, based on the new study. It is a member of the Bruce Clade and has stripes running only lengthwise down its body. (Credit: Rob Aguilar/SERC); Right: This peppermint shrimp, found in Singapore, is part of the Rauli Clade—possibly a species separate from* Lysmata vittata*. Its crisscrossing red stripes make it distinct. (Credit: Arthur Anker)*

With their festive candy-cane stripes, peppermint shrimp are among the world's most popular aquarium shrimp. But when a nonnative one appeared in the Chesapeake, it sent SERC biologist Rob Aguilar down a wormhole of museum fires and 19th-century field notes. In a new study, Aguilar and SERC's Fisheries Conservation Lab identified a new potential invader in the Bay, and unraveled a taxonomic knot 160 years in the making.

The mystery began in 2013, when Virginia Institute of Marine Science biologists caught two shrimp they thought were the Chesapeake's native peppermint shrimp, *Lysmata wurdemanni*. When they brought them to SERC, Aguilar recognized one as *Lysmata wurdemanni*. But the second looked markedly different.

"It didn't match anything that we knew of in the Atlantic," he said. It did, however, match an Indo-Pacific species: *Lysmata vittata*. Thus began Aguilar's journey into a saga that started in 1860, with another Smithsonian biologist named William Stimpson.

Stimpson first applied the name *Lysmata vittata* in 1860, after finding the peppermint shrimp in Hong Kong. However, Stimpson's description was sparse—one Latin paragraph. Aguilar traced the original specimen to the Field Museum of Chicago, only to discover it had burned in the Great Chicago Fire of 1871.

Fortunately, a more detailed *Lysmata vittata* description existed from Hong Kong: from carcinologist A. J. Bruce in 1986. Because Stimpson's original specimen was ashes, the team needed a "neotype" to serve as the species standard. Aguilar designated Bruce's specimen as the neotype for *Lysmata vittata*. Since the nonnative Chesapeake shrimp was identical, it also received the title of true *Lysmata vittata*.

But the mystery deepened. Because Aguilar's search revealed a host of other shrimp styled *Lysmata vittata*—and they didn't all match the one from Hong Kong.

Take one specimen from Brazil. When first discovered, scientists thought it was a new species: *Lysmata rauli*. However, other researchers noted the Brazil shrimp resembled another shrimp in Thailand, also labeled *Lsymata vittata*. They promptly demoted *Lysmata rauli* to a junior synonym.

But what if the Thailand shrimp wasn't a true *Lysmata vittata*?

Five years into the project, Aguilar and his colleagues had collected *Lsymata* specimens and RNA sequences from around the world. And they noticed significant differences. The Brazil and Thailand shrimp had crisscrossing red stripes. Bruce's Hong Kong shrimp, and the nonnative Chesapeake shrimp, had stripes that only ran lengthwise down their bodies. Other differences appeared under the microscope: an "accessory branch" on an antennule, and the number of segments on their claws.

Were the biologists who first named *Lysmata rauli* truly wrong?

"Our data at this point was saying, well, wait a second, maybe not. *Lysmata rauli* is likely valid," Aguilar said.

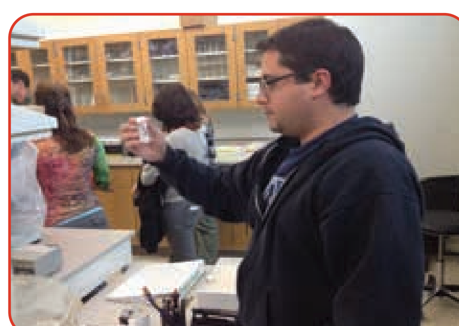
For now, Aguilar's study divides *Lysmata vittata* into a species complex with two clades. The "Bruce Clade" contains Bruce's Hong Kong shrimp, the nonnative Chesapeake shrimp and others from temperate regions like Japan, Korea, southern Russia and New Zealand. The "Rauli Clade" includes the Brazil and Thailand shrimp and *Lysmata vittata* from warmer regions like India, Australia, and the Caribbean. They seem to overlap in Hong Kong.

Do the differences matter? Knowing the Bruce Clade may prefer cooler zones could help predict their movements in the Chesapeake. Aguilar suspects *Lysmata vittata* will spread widely in the Mid-Atlantic—though it's still uncertain how the nonnative peppermint shrimp could impact the Bay.

How the shrimp got here is also an enigma. Some aquarium animals turn invasive when released, accidentally or deliberately (this is almost always a bad idea). But biologists don't think that happened with *Lysmata vittata*. Unlike the Bay's native peppermint shrimp, *Lysmata vittata* are pricier and difficult to find in local aquarium stores. Aguilar's team suspects the shrimp more likely hitchhiked in large cargo ships. But that's a mystery for another day.

LINK TO FULL ARTICLE:

https://academic.oup.com/jcb/article/42/1/ruab079/6514241



Rob Aguilar, a biologist with SERC's Fisheries Conservation Lab, spent five years finding the correct name for a mystery peppermint shrimp found in the Chesapeake Bay. (Credit: Kristen Goodhue/SERC)

OCEAN PLASTIC
IS CREATING NEW COMMUNITIES OF LIFE ON THE HIGH SEAS

Coastal Organisms Thrive on Floating Plastic Debris in the "Great Pacific Garbage Patch"

BY KRISTEN GOODHUE

Coastal plants and animals have found a new way to survive in the open ocean—by colonizing plastic pollution. A new commentary published Dec. 2 in *Nature Communications* reports coastal species growing on trash hundreds of miles out to sea in the North Pacific Subtropical Gyre, more commonly known as the "Great Pacific Garbage Patch."

"The issues of plastic go beyond just ingestion and entanglement," said Linsey Haram, lead author of the article and former postdoctoral fellow at the Smithsonian Environmental Research Center (SERC). "It's creating opportunities for coastal species' biogeography to greatly expand beyond what we previously thought was possible."

Gyres of ocean plastic form when surface currents drive plastic pollution from the coasts into regions where rotating currents trap the floating objects, which accumulate over time. The world has at least five plastic-infested gyres, or "garbage patches." The North Pacific Subtropical Gyre, between California and Hawai'i, holds the most floating plastic, with an estimated 79,000 metric tons of plastic floating in a region over 610,000 square miles. While "garbage patch" is a misnomer—much of the pollution consists of microplastics, too small for the naked eye to see—floating debris like nets, buoys and bottles also get swept into the gyres, carrying organisms from their coastal homes with them.

A NEW OPEN OCEAN

The authors call these communities neopelagic. "Neo" means new, and "pelagic" refers to the open ocean, as opposed to the coast. Scientists first began suspecting coastal species could use plastic to survive in the open ocean for long periods after the 2011 Japanese tsunami, when they discovered that nearly 300 species had rafted all the way across the Pacific on tsunami debris over the course of several years. But until now, confirmed sightings of coastal species on plastic directly in the open ocean were rare.

For this discovery, Haram teamed up with Ocean Voyages Institute, a nonprofit that collects plastic pollution on sailing expeditions, and a pair of oceanographers from the University of Hawai'i at Manoa. The oceanographers, Jan Hafner and Nikolai Maximenko, created models that could predict where plastic was most likely to pile up in the North Pacific Subtropical Gyre. They shared that information with Ocean Voyages Institute.

Linsey Haram, a marine biologist who studies organisms on ocean plastic, on an expedition to British Columbia. (Credit: Stephen Page)

One advantage of the institute, Haram—now a fellow at the American Association for the Advancement of Science—pointed out, is the low carbon footprint of its vessels. "It can take a lot of energy to get out to the middle of the ocean with a gas-powered boat," she said. "So they use large-cargo sailing vessels to go around and remove plastics from the open ocean."

Plastic debris with a mix of coastal barnacles (pink and striped) and a gooseneck barnacle from the open ocean. (Credit: SERC Marine Invasions Lab)

During the first year of the COVID-19 pandemic, Ocean Voyages Institute founder Mary Crowley and her team managed to collect a record-breaking 103 tons of plastics and other debris from the North Pacific Subtropical Gyre. She shipped some of those samples to SERC's Marine Invasions Lab. There, Haram analyzed the species that had colonized them. She found many coastal species—including anemones, hydroids and shrimp-like amphipods—not only surviving, but thriving, on marine plastic.

A SEA OF QUESTIONS

For marine scientists, the very existence of this "new open ocean" community is a paradigm shift.

"The open ocean has not been habitable for coastal organisms until now," said SERC senior scientist Greg Ruiz, who heads the Marine Invasions Lab where Haram worked. "Partly because of habitat limitation—there

Floating debris with a mix of coastal organisms (the yellow podded hydroids Aglaophenia pluma*) and open-ocean organisms (*Planes *crab and gooseneck barnacles) collected in 2018 by the Ocean Cleanup in collaboration with the Smithsonian Institution. (Credit: The Ocean Cleanup)*

wasn't plastic there in the past—and partly, we thought, because it was a food desert."

The new discovery shows that both ideas do not always hold true. Plastic is providing the habitat. And somehow, coastal rafters are finding food. Ruiz said scientists are still speculating exactly how—whether they drift into existing hot spots of productivity in the gyre, or because the plastic itself acts like a reef attracting more food sources.

Now, scientists have another shift to wrestle with: How these coastal rafters could shake up the environment. The open ocean has plenty of its own native species, which also colonize floating debris. The arrival of new coastal neighbors could disrupt ocean ecosystems that have remained undisturbed for millennia.

"Coastal species are directly competing with these oceanic rafters," Haram said. "They're competing for space. They're competing for resources. And those interactions are very poorly understood."

And then there is the invasive-species threat. Scientists have already seen that begin to play out with Japanese tsunami debris, which carried organisms from Japan to North America. Vast colonies of coastal species floating in the open ocean for years at a time could act as a new reservoir, giving coastal rafters more opportunities to invade new coastlines.

"Those other coastlines are not just urban centers….That opportunity extends to more remote areas, protected areas, Hawaiian Islands, national parks, marine protected areas," Ruiz said.

The authors still do not know how common these "neopelagic" communities are, whether they can sustain themselves or if they even exist outside the North Pacific Subtropical Gyre. But the world's dependence on plastic continues to climb. Scientists estimate cumulative global plastic waste could reach over 25 billion metric tons by 2050. With fiercer and more frequent storms on the horizon thanks to climate change, the authors expect even more of that plastic will get pushed out to sea. Colonies of coastal rafters on the high seas will likely only grow. This long-overlooked side effect of plastic pollution, the authors said, could soon transform life on land and in the sea.

Williams College, the Scripps Institution of Oceanography, the Institute of Ocean Sciences in British Columbia and the Applied Physics Laboratory of the University of Washington also contributed to this article.

LINK TO FULL ARTICLE:

https://www.nature.com/articles/s41467-021-27188-6

Luz Quiñones, a scientist in SERC's Marine Invasions Lab, analyzes a mix of coastal organisms (the podded hydroid Aglaophenia pluma*) and open-ocean organisms (*Lepas *gooseneck barnacles) on a colonized net. (Credit: Smithsonian Institution)*

Anika Albrecht of Ocean Voyages Institute, on a 2020 expedition collecting plastic in the North Pacific Subtropical Gyre, where she served as Chief Mate. (Photo courtesy of Ocean Voyages Institute 2020 Gyre Expedition)

A Postdoc Travels Back 40 Years to Uncover New Truths of Forest Fragmentation

BY CAITLYN DITTMEIER
Outreach and Communications Intern, Smithsonian Working Land and Seascapes Initiative

At 6 a.m., bird songs chime a new day of field work for SERC postdoc and Chesapeake Working Land and Seascapes ecologist Amy Hruska. Recording the species for every tweet and chirp she hears for 20 minutes is hard work, but Hruska is more concerned about a looming silence. Since 1970, 1 billion birds have disappeared from North American forests, leading scientists like Hruska to study the effects of habitat loss on local populations.

Forests once covered 95% of the Chesapeake Bay landscape. But after centuries of intensive farming and development, approximately half of that forest has been cleared. The remaining forest exists in insular patches, bordered by croplands, roads and cities. Scientists understand that fragmentation threatens native wildlife, but they know far less about its impacts over a long period of time.

Curious to know more, Hruska launched a new project investigating how changing land use has transformed the Bay landscape over the past 40 years. To do so, she's revisiting the same forest patches that SERC researchers studied decades ago.

In the late 1970s and early 1980s, plant ecologist Dennis Whigham and ornithologist James Lynch surveyed Maryland upland forests in one of the earliest studies on landscape fragmentation in the region. These SERC scientists were interested in relating fragmentation to declines in migratory songbirds. But since most forested lands in the Mid-Atlantic were and still are privately owned, little data on forest patches existed.

Barring a few sites, "everything we looked at had never been sampled before," Whigham said.

The project showed fragmentation's impacts are complex. Forest patches are important for songbirds, but the impacts vary by species. Migratory species like wood thrushes were found to be less tolerant of fragmentation than common backyard species like blue jays.

The Whigham-Lynch study was the largest of its kind at the time.

"They sampled 270 plots. That is huge!" said Hruska, who's resurveying as many of the patches as she can. It's a tall task. Whereas teams of botanists and birders helped Whigham and Lynch, Hruska works mostly solo. But she enjoys the challenge.

Top photo: Amy Hruska pauses for a selfie after conducting a songbird survey. (Credit: Amy Hruska); Left: Blue jay, a common backyard bird that is more resilient to forest fragmentation. (Credit: Frank Miles, U.S. Fish and Wildlife Service)

"Using indicator species is a good first step in terms of making connections and thinking about conservation on your own land." — Amy Hruska

"There are many interesting questions we can ask just by going places people have already been," she said.

To locate the original patches, Hruska follows a paper trail. At SERC and the Smithsonian Institution Libraries and Archives, she digitized Whigham and Lynch's files of field notes, datasets and hand-drawn topographic maps. Using Geographic Information Systems (GIS), she compares historical maps with new satellite imaging of the landscape to study how the patches have changed over time.

With permission from landowners, Hruska visits forest fragments of varying sizes and shapes and bordered by different land uses. She practices the same surveying methods as past researchers—recording bird calls and counting and measuring plants during the summer—to gain a consistent comparison between old and new datasets.

"To me, this project has everything," Hruska said. "First, there is an archaeological component: going to the archives and sorting through old data. Second, the field component allows me to work with really engaged landowners and managers and collect data on really unique forest patches. Third, I get to embrace my inner computer geek with mapping and coding."

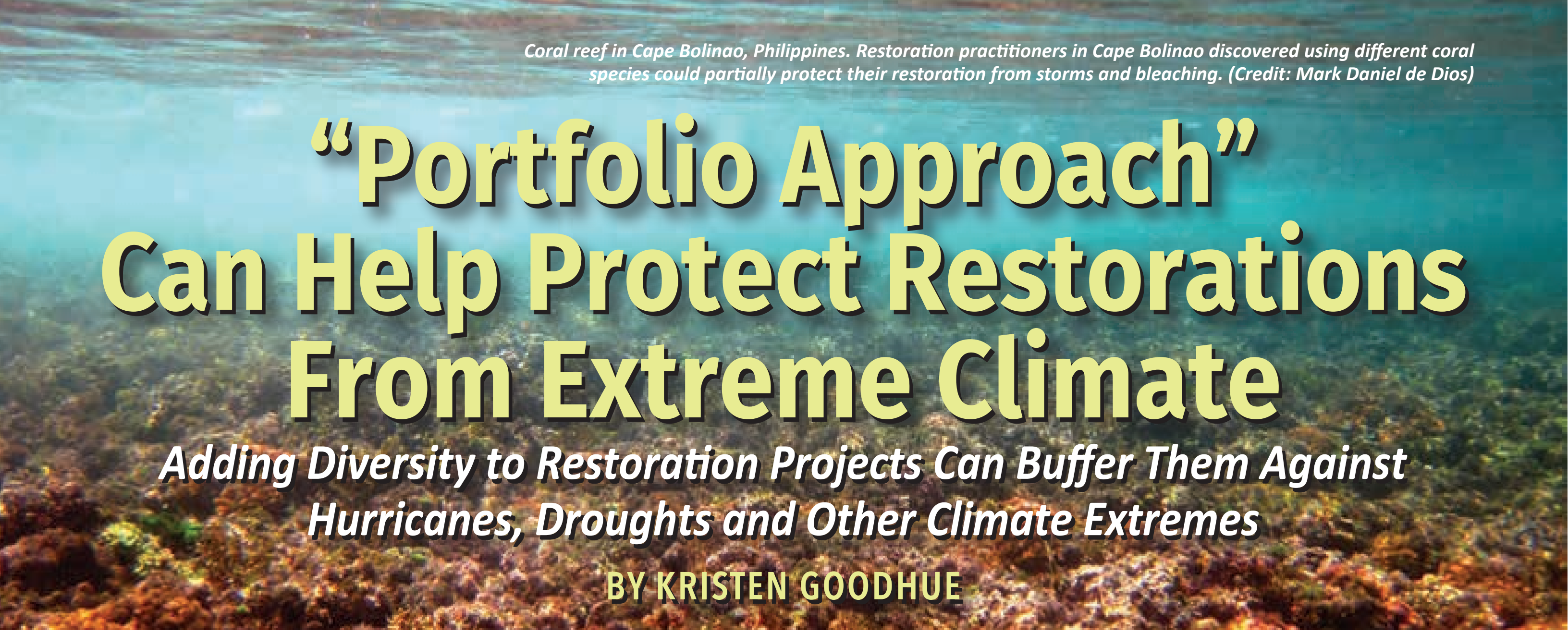
Studying the landscape from multiple angles has allowed Hruska to identify patches altered by agriculture, compared to others carved by the D.C. urban sprawl. To her surprise, half the patches remained about the same size. A third decreased, primarily from urbanization. The rest grew, reflecting forest regrowth on abandoned agricultural fields.

Hruska has expanded her study to include patches in Virginia as well. As she returns to the forests this May, she will collect more data to determine which plant and songbird species are most sensitive to fragmentation. Biodiversity forms the foundation of healthy, functioning ecosystems. Knowing which species indicate a healthy landscape can help landowners monitor forest quality.

"Using indicator species is a good first step in terms of making connections and thinking about conservation on your own land," said Hruska. "It's not the perfect solution, but it has the potential to be the snowball that creates change." Bird-friendly changes in land management could transform the Chesapeake Bay landscape over the next 40 years to ensure the songs of biodiverse forests endure.

Wood thrushes like this one are more sensitive than some other songbird species to forest fragmentation. (Credit: Amy Hruska)

Background photo: View of fragmented forest landscape in Shenandoah Valley, Virginia. (Credit: Amy Hruska)



Coral reef in Cape Bolinao, Philippines. Restoration practitioners in Cape Bolinao discovered using different coral species could partially protect their restoration from storms and bleaching. (Credit: Mark Daniel de Dios)

"Portfolio Approach" Can Help Protect Restorations From Extreme Climate

Adding Diversity to Restoration Projects Can Buffer Them Against Hurricanes, Droughts and Other Climate Extremes

BY KRISTEN GOODHUE

California is no stranger to extreme events. Record-breaking wildfires or heat waves make headlines nearly every year. But in the winter of 2017, another type of extreme devastated underwater life: A series of "Pineapple Express" storms from Hawai'i created extreme rainfall not seen since the state began record-keeping in 1895.

"Several atmospheric rivers came and dumped water on the Bay area," said Chela Zabin, a marine biologist at the San Francisco branch of the Smithsonian Environmental Research Center (SERC) and lead author of a new study on climate extremes.

"For Northern California, 2017 was the wettest winter on record," said Andy Chang, a SERC biologist and coauthor. "Given our changing climate, record-breaking, once-in-a-lifetime wet years like 2017 are now projected to occur much more often."

The downpours wreaked havoc on an oyster and eelgrass restoration site that Zabin, Chang and other ecologists had worked on since 2012, as part of the San Francisco Bay Living Shorelines Project. The water's saltiness plummeted to five parts per thousand—levels Olympia oysters can withstand for days but not months. When the team checked the restoration later in spring and summer, not a single oyster had survived. However, all was not lost. The following fall, oysters began growing there again naturally. New oyster larvae had drifted into the barren restoration, likely from more central parts of the bay less affected by the extreme rain.

Chela Zabin, a marine ecologist with the Smithsonian Environmental Research Center, and Thomas Abbott, a UC Davis biologist, check the status of oysters at a restoration site in Hayward, San Francisco Bay. (Credit: Geana Ayala/UC Davis)

The discovery that other sites could buffer an ailing restoration inspired the team to look further, at other restorations around the world. Could building in more diversity—by varying species, locations or other elements—make restorations more resilient to climate extremes? The answer, published February in *Frontiers in Ecology and the Environment*, is a resounding *yes*.

DIVERSIFYING THE PORTFOLIO

Many restoration projects attempt to prepare for gradual impacts of climate change, like sea level rise. But extreme events pose a different sort of danger, one that can devastate a restoration without much warning.

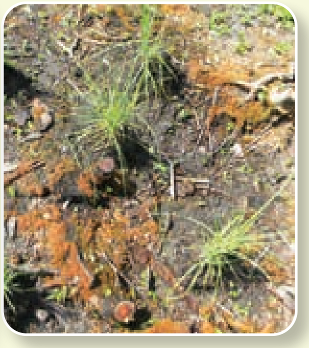
The new paper, led by Zabin, advocates treating restorations like stock investments. Creating a "portfolio effect" by diversifying some aspects of a restoration could give it a shot at withstanding uncertainty.

"You need to not put all your eggs in one basket," Zabin said. "Because we just don't know, really, how extreme an event's going to be, what form it's going to take, where it's going to hit, how severe the impact might be."

To get more data, the team scoured the scientific literature for restoration projects hit by climate extremes. They also talked to restoration practitioners on the ground in places that recently suffered an extreme event.

A wetland restoration in Dickinson, Texas. By spacing out planting over multiple years, practitioners found some of the more well-established plants survived Hurricane Harvey in 2017. (Credit: Philip Smith, Galveston Bay Foundation)

*A natural, never-plowed tussock meadow where the tussock sedge (*Carex stricta*) dominates. This was the "desired outcome" for a wetland restoration at the University of Wisconsin-Madison Arboretum. (Credit: Joy Zedler)*

At a wetland restoration in Wisconsin, scientists added diversity by planting tussock sedge in different soils and elevations. These photos show tall mounds, short mounds, peat pots and flat ground. (Credit: James Doherty)

> *"Success is way more likely if we're planting more species, at more sites, over more years."*

They found 24 projects, from coral reefs in the Philippines to pine forests in France.

Most of the projects (83%) incorporated diversity to some degree. And diversity almost always paid off. Though extreme climatic events routinely took their toll, 85% of the diversity-including projects saw some treatments perform better than others when faced with those extremes.

In the Philippines, some portions of a coral restoration better withstood multiple extremes—including a Category 4 typhoon, a bleaching event and a monsoon—because the designers included different species and different restoration techniques. At a wetland restoration in Texas, spacing out planting over multiple years ensured some plants survived Hurricane Harvey in 2017.

"Wetland plants that went in the summer before Harvey didn't have time to grow roots and stabilize the soil, so acres were just washed away," said coauthor Laura Jurgens, a marine biologist at Texas A&M University at Galveston. "But sections planted earlier survived."

Even restorations with just one species could find ways to vary things up. A wetland restoration at the University of Wisconsin-Madison Arboretum, focused primarily on the tussock sedge, experimented with different elevations. They planted some sedges in tall, medium or small soil mounds, some in peat pots, and some on flat ground. The project suffered two extremes—a drought in year one and extreme rainfall in year two. "Bet-hedging" ensured some parts of the project survived either event.

OVERCOMING THE OBSTACLES

However, making diversity a key component of restorations will take more than a shift in planning. The barriers are real: from securing funding to managing public expectations. The authors hope their study will help convince funders and policymakers to build more flexibility into projects.

"Sometimes we're so focused on getting this one species back in this one area, but the reality of our changing climate means that we really need to think about the long-term resilience of projects," Jurgens said. "Success is way more likely if we're planting more species, at more sites, over more years."

The paper suggests some low-hanging fruit restoration planners could use. As the Wisconsin wetland study showed, even small variations in a landscape can make the difference between surviving and perishing. The San Francisco Bay Living Shorelines Project also highlighted the benefits of multiple target species. In addition to oysters, the project also sought to boost eelgrass. While oysters returned naturally after the 2017 downpour, the eelgrass needed extra help. Coauthor Katharyn Boyer of San Francisco State University's Estuary & Ocean Science Center led the eelgrass replanting effort. In the process, she discovered diversifying the timing and spacing of plantings can hedge bets that some portions will escape extreme events.

"Around a large estuary, we have seen vulnerable new eelgrass plantings experience different degrees of impact from the same extreme event, emphasizing the need to spread the risk of losses over multiple restoration sites," Boyer said.

Washington College and the University of California, Davis, also contributed to this study. It is available online at https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2471.

Sandpipers hunting on the restored oyster reefs at the San Francisco Bay Living Shorelines Project in San Rafael, San Francisco Bay. (Credit: Geana Ayala/UC Davis)

Chela Zabin, a marine ecologist with the Smithsonian Environmental Research Center, counts oysters and Fucus rockweed in the intertidal zone in San Francisco Bay. (Credit: Jeff Blumenthal/SERC)

Biodiversity Makes Reefs Tick—But It Needs Big Players

BY KRISTEN GOODHUE

Three thousand reefs. (Technically 3,040 reefs, for those who like precision.) That's how many underwater sites scientists and volunteers poured over in the latest effort to uncover how much biodiversity matters for reef health.

The answer: Quite a lot.

Scientists have known for years that diverse fish communities help ocean ecosystems flourish, even when facing rising temperatures and climate change. But the latest study, published in *Nature Communications*, reveals it's about more than numbers. Which species call a reef home can matter as much as how many there are. That holds especially true when it comes to large predator fish.

"It's like your stock market portfolio. It's important to have a diversity of investments to protect yourself from any one stock losing its value," said lead author Jonathan Lefcheck, SERC biologist and Tennenbaum Coordinating Scientist for the Marine Global Earth Observatory Network. "But it never hurts to have a few heavy hitters, like Apple or Microsoft."

For the new study, Lefcheck and his coauthors relied on a global database called Reef Life Survey. Reef Life Survey is a nonprofit, citizen science program where trained SCUBA divers do censuses of reefs worldwide. It's led by Rick Stuart-Smith and Graham Edgar of the University of Tasmania, also coauthors of the study. To date, the program has gathered biodiversity data from nearly 4,000 reefs.

The reefs the team used for this study ranged from the rocky shores of British Columbia in the north to the tip of Tierra del Fuego by the South Pole.

To tease out the impact of biodiversity from other factors, the biologists used a compare-contrast method. First, they chose 173 "reference reefs"—healthy reefs with thriving fish populations. Then, they compared each reference reef to all its nearby reefs in the database—reefs no more than 100 kilometers away. Each reference reef had about 16 "comparison reefs" on average, though a few had over 100. They used total fish biomass (the mass of all fish on a reef, regardless of species) to indicate how healthy a reef was compared to its neighbors, and its potential value to people.

They discovered at the healthiest reefs, biodiversity had nearly six times more impact on fish biomass than other influences, like temperature, pollution and water clarity.

But the story took a more surprising turn when they investigated what type of biodiversity mattered. To measure this, the team looked at which species neighboring reefs lost or gained compared to their reference reefs.

Losing big species, it turned out, was nearly four times more harmful than a drop in the number of species. Larger fish like sharks and groupers are especially vital for making their habitats tick.

Unfortunately, large fish are often among the first to disappear. Fishing disproportionately removes the biggest swimmers, something multiple studies and local indigenous knowledge have shown.

The ultimate solution, however, could allow both reefs and fishing communities to prosper. Marine protected areas have proven their worth many times over. Fish grow larger and more abundant in protected zones. And since marine life spreads, protected zones often increase the catch for fishers outside those areas.

To get the biggest value for restoration, this study suggests one modification: Add protection strategies that target high performers. When top predators flourish, the effects often cascade down to help the entire reef ecosystem and the people it sustains.

"Big fish tend to need big territories, and many travel long distances to specific breeding spots," said Emmett Duffy, coauthor and director of the Marine Global Earth Observatory Network. "Protecting them requires a network of reserves strategically placed so they can safely roam."

LINK TO FULL STUDY:

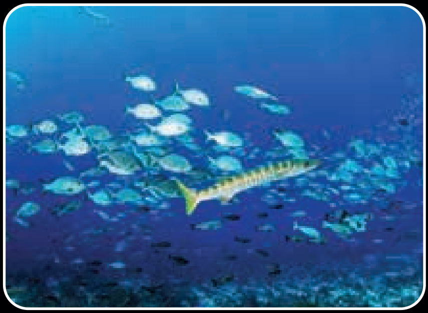
https://www.nature.com/articles/s41467-021-27212-9

*Top photo: A school of yellowtail kingfish (*Seriola lalandi*) at Lord Howe Island in Australia. The presence of large fish like yellowtails can help keep ecosystems healthy and productive, a new study found. (Credit: Rick Stuart-Smith, Reef Life Survey); Left: A Reef Life Survey diver surveys fishes in Raja Ampat, Indonesia. (Credit: Rick Stuart-Smith, Reef Life Survey)*

*Goliath grouper (*Epinephelus itajara*) in the Florida Keys National Marine Sanctuary. Goliath groupers are top-predator fish that can grow up to 8 feet long. (Credit: Graham J. Edgar)*

*Potato cod (*Epinephelus tukula*) in a no-fishing zone of the northern Great Barrier Reef, another top-predator fish that can grow over 6 feet long. (Credit: Graham J. Edgar.)*

Jonathan Lefcheck (left) examines a striped burrfish with SERC intern Claire Murphy. (Photo courtesy of Jonathan Lefcheck)



Reef fish surveys at Raja Ampat in Indonesia, which has the highest richness of fish species anywhere on Earth. (Credit: Rick Stuart-Smith, Reef Life Survey)

Voices from the Past:

Woodlawn House Unlocks Three Centuries of Stories

The Smithsonian's Oldest In-Place Building Opens to Visitors for the First Time BY KRISTEN GOODHUE

This summer, a new history exhibit opens in the brick house at SERC's entrance: the Woodlawn History Center. Built in 1735, Woodlawn is the oldest Smithsonian building still in its original location. Visitors will hear stories from generations who lived and worked on the land, and see how their lives wove into the American tapestry.

Woodlawn House, with its three primary sections: the 1970s wing in white, the 1735 kitchen in the center, and the three-story 1841 wing. (Credit: Christine Dunham/SERC)

For nearly two centuries, Woodlawn served as the plantation home of the Sellman family. Coming to America in indentured servitude, the Sellmans left a double-sided legacy as soldiers, innovators and slaveowners. Some of the enslaved we know only by first names on family wills. Others, like Dennis Simms who worked on the neighboring Contee plantation, left detailed oral testimony of life in bondage.

"This is American history at the local level," said Christine Dunham, SERC historian and program specialist. "I see it as every point in American history, from slavery to immigration, Jim Crow, technological change and beyond, also happening here."

Citizen scientists from SERC's all-volunteer Environmental Archaeology Lab excavated most of the 200-plus artifacts on view. As the exhibit highlights the land's inhabitants, from Native Americans to SERC scientists, it reveals how each group reshaped the terrain.

"This exhibit tells the stories of different people and how they transformed the world around them," said Jim Gibb, head of the Environmental Archaeology Lab. "The shapes of the lands, forests and waters of this area are the products—intentional and unintentional—of the people who lived here."

The house went through multiple transformations as well. In 1841, the Sellmans had half the house torn down to create a grander three-story wing. In the 1910s, the house passed to the Kirkpatrick-Howats, who added a passive solar wing in the 1970s. The Smithsonian purchased the land in 2008.

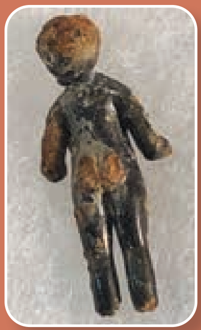
This is a living history exhibit, and the Smithsonian is always looking for a more complete picture. Descendants of the Piscataway, Nanticoke, Sellmans, Browns, Contees, Jupiters, Maccubins, Shaws, Simms, Sparrows and any others who called this land home are welcome to share their families' stories. Please contact Christine Dunham (DunhamC@si.edu) to contribute. Watch for our summer newsletter for more in-depth stories from Woodlawn.

ARTIFACTS from centuries past

(Credit: SERC Environmental Archaeology Lab)

These keys, used by the Sparrow family, were likely for locking valuables in chests rather than locking doors.

Bone knife handle carved with the name "Sparrow," a family who in the 1700s lived on what would later become the Contee plantation.



Pewter figurine. This may have been a toy, but its exact purpose remains a mystery.

Donor Spotlight: Newburger-Schwartz Family Foundation

Training the Next Generation of Environmental Educators BY BRIAN MAGNESS

Over the past six years, the Newburger-Schwartz Family Foundation has played a key role in SERC's Education Program by sponsoring 18 education internships. The interns have designed and implemented new teaching modules, led hands-on demonstrations, and provided educational experiences for the thousands of schoolchildren who come to SERC for field trips each year. When COVID struck, the interns helped create interactive virtual field trips, empowering students to do hands-on science closer to home. These interns, mostly undergraduates, are also gaining valuable real-life experience towards their environmental science teaching careers.

The Foundation, founded by Beth Newburger-Schwartz, the late Richard Schwartz and their children, has a stated mission "to foment a more rational discourse," according to board member Eric Newburger.

Eric Newburger and Beth Newburger-Schwartz practice shark tagging with bananas substituting for sharks, a field trip activity designed by SERC education staff and interns. (Credit: Karen McDonald/SERC)

"SERC's Education Intern Program is about training the next generation of environmental scientists and science communicators—both the interns themselves and the young people who attend the programs they facilitate," Newburger said. "Our board members have been very pleased that our gifts are able to have such a long-lasting impact."

The next cohort of Foundation-sponsored interns will arrive at SERC this spring. These 12-week paid internships will help SERC launch its post-COVID, in-person education programs, and provide informative experiences, both for the interns and the many children that will take part in this Smithsonian program.

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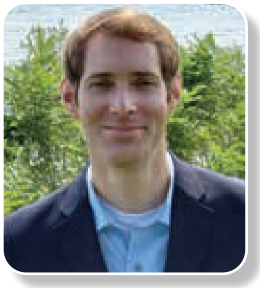
Upcoming Events: Spring Earth Optimism Lectures

SERC's virtual evening science lectures continue, with speakers from the Chesapeake Bay and around the world. Lectures run every third Tuesday of the month at 7pm ET, January through October, with two bonus lectures. All of our lectures are recorded, and live closed captions are available. Learn more and view recordings of past talks at https://serc.si.edu/visit/eveninglectures.



CHANGING THE FUTURE LANDSCAPE OF A WATERSHED, ONE POLICY AT A TIME

Tuesday, April 26 • 7pm ET

Speaker: Matt Johnston, Director of Environmental Policy for Anne Arundel County

The science has been clear for a long time: To protect streams—and the Chesapeake Bay—from pollution, it's imperative to reduce impervious surfaces like roads and parking lots. While science can define our problems and point us in the right direction, policy is a critical player in delivering solutions. On April 26, join us for a bonus Earth Optimism lecture with Matt Johnston, the director of environmental policy for Maryland's Anne Arundel County, where the Smithsonian Environmental Research Center is based. He'll reveal several new policies Anne Arundel has pursued over the last few years to roll back the advancing impervious surfaces. Discover how one county is using science-based policies to create environmental success stories.

FOLLOWING AFRICAN MAMMALS WITH THE MOVEMENT OF LIFE

Tuesday, May 17 • 7pm ET

Speaker: Dr. Jared Stabach

For over 100 years, the Smithsonian has been tracking animals around the world to better understand their movements and conserve their populations. Today those efforts have come together under a single network: The Movement of Life Initiative. In our May Earth Optimism webinar, join wildlife ecologist Jared Stabach for a journey into the Smithsonian's animal tracking and conservation activities in Africa. He'll take you to Chad, where the Smithsonian and partners have been reintroducing the scimitar-horned oryx, once extinct in the wild. He'll then move on to Kenya, where they're using artificial intelligence to more effectively count wildebeest and other large mammals in high-resolution satellite and aerial imagery. Finally, Jared will pan out to reveal how giraffe populations are rebounding across the continent.

Left: Matt Johnston (Photo by Matt Johnston); Right: Jared Stabach (Photo by Ricardo Stanoss/Smithsonian)

The Smithsonian Environmental Research Center is recognized by the IRS as a 501(c)3 nonprofit organization. Contributions to SERC may be tax-deductible.

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ON THE EDGE

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