Smithsonian Environmental
Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center Fall 2016

Features

Also Inside

Director's Letter: The Pulse of the Ocean

As a kid growing up in Hawaii, I spent carefree time snorkeling on the reefs around Coconut Island and fishing in Kane'ohe Bay. I went to high school and graduate school in the San Francisco Bay area, where I experienced a big estuary for the first time sailing on the Bay. In college I spent an intense summer taking courses at Friday Harbor Laboratories in Puget Sound, watching the marvelous embryology of strange marine invertebrates and experiencing the world of serious research for the first time. In each of these wonderful places, with their biodiversity and natural resources, I could also see the effects of overfishing, overdevelopment, pollution, invasive species, and now climate change—all the same problems that we are tracking in Chesapeake Bay.

That's part of what makes it so gratifying for me to see what SERC's been doing in the Pacific over the last three years. Three new sites in the Pacific Ocean have teamed up with us to join MarineGEO, or the Marine Global Earth Observatory, with a fourth soon to follow. MarineGEO is a global effort to take the pulse of biodiversity in the world's oceans. Launched with just four sites in 2012, thanks to the support of visionaries Michael and Suzanne Tennenbaum, the new sites bring us to a total of nine stations, including SERC, keeping tabs on the oceans' health.

San Francisco State University has long been a partner of SERC. Our marine invasions scientists have worked side-by-side with theirs for 16 years at the Romberg Tiburon Center in San Francisco Bay. We're proud to have them as partners in MarineGEO as we embark on a new journey of discovery. Farther north, the University of Washington's Friday Harbor Laboratories are preparing to launch their own MarineGEO site, and British Columbia's Hakai Institute has just become the first Canadian site in the MarineGEO network. And on Oahu, the island where I grew up, scientists at the Hawaii Institute of Marine Biology are already studying life in the coral reefs surrounding Coconut Island. You can read more about all four stations on pages 6 and 7 of our newsletter.

The issues our neighbors on the other side of the country are facing are just as urgent as the ones we're facing here on Chesapeake Bay. Like us, they're grappling with a struggling oyster population, an onslaught of invasive species and the effects of pollution and climate change. But they're also exploring ways to restore and protect their species and ecosystems, and they're recruiting teams of citizen scientists to join the effort.

The ocean is still a mysterious place, even at the surface. At the Smithsonian, we're focusing on the thousands and thousands of miles of the coasts, the shallow edges where our resources and our impacts are greatest —and we're not looking to do it alone. We did it with ForestGEO, which as of this printing has 66 forest plots in 25 countries. ForestGEO is now almost 40 years old. MarineGEO is only four. As our new partners in the Pacific show, the movement is gaining momentum. Who knows what we'll discover in the next decade?

-Tuck Hines, director

SERC Advisory Board

On the cover and this page: Fall views at SERC

(Photo credit: Heather Soulen)

RESEARCH DISCOVERIES

Unsolved Mysteries: Rising Temps, Falling Marshes?

The world's marshes are in a precarious balance. Rising temperatures from climate change could help them grow stronger and store more carbon—or cause them to flood and disappear, says a new article by SERC biogeochemist Pat Megonigal, released at the International Union for Conservation of Nature's annual conference in September.

Marsh plants generally grow faster as things heat up. But warmer temperatures could also speed up decay aboveground and underground, making them more vulnerable to collapse as sea levels rise. To this day, decomposition's role remains a mystery. But with a new field experiment simulating futuristic warming, Megonigal's lab hopes to uncover answers. How well marshes continue to provide habitat and protect homes from floods depends on their discoveries.

DNA Reveals Key to Stopping Invasion

In the last 30 years, the invasive reed *Phragmites australis* has exploded across Chesapeake wetlands. To develop strategies to keep it in check, ecologists need to know how far its seeds are spread, because most new stands start from seeds. The answer: about 500 meters.

In a study published September in a special issue of Biological Invasions, SERC ecologists Melissa McCormick, Hope Brooks and Dennis Whigham examined DNA from 30 *Phragmites* stands in two Chesapeake subestuaries. After determining the stands' genetic relatedness, they discovered that on average seeds spread about 100 meters, and rarely exceeded 500 meters. This means managers may be able to halt its conquest by removing all *Phragmites* within 500 meters of each other.

Gutsy Genetics Reveals an Invader's Favorite Foods

White perch and menhaden rank high in the diets of invasive blue catfish, known for their voracious appetites. A recent study, led by SERC biologist Rob Aguilar, used a relatively new technique to identify the almost-unrecognizable slop in fish stomachs: DNA barcoding.

SERC's Fish & Invertebrate Lab analyzed DNA from over 100 blue, white and channel catfish stomachs. Looking at the prey that were fish, they could only identify about 9 percent to species by sight alone. DNA barcoding—extracting a DNA fragment from digested tissue and looking it up in a DNA library—identified 90 percent. Most DNA references came from the Chesapeake Bay Barcode Initiative, a Smithsonian project to catalogue DNA for all the Bay's fish and major invertebrates. Though this study focused on catfish in Maryland rivers, scientists say the technique could change how food webs are studied Bay-wide.

Left to right: Rob Aguilar, Brooke Weigel and Paige Roberts (Photo credit: Fish and Invertebrate Lab/ SERC

Time Lords & Ladies of History's Trash

by Emily Li

People don't usually think of archeologists as dumpster divers. But sifting through trash for hidden treasures is exactly what the volunteer citizen scientists of the Smithsonian Environmental Research Center (SERC) Archaeology Lab do every Wednesday. They don't scavenge anything for themselves. Instead, they take away new skills, and a chance to put together a historical puzzle larger than themselves.

"We look back thousands of years," said Jim Gibb, the lead volunteer and coordinator of the lab. Recalling the BBC's time-traveling Doctor Who in his police call box, he added, "I always tell people—we're the time lords."

Reading the bones

In 1649, a Quaker named Thomas Sparrow and his family moved to Maryland. Originally English emigrants to Virginia, they were escaping growing tension in the colony in the mid-17th century. When Maryland passed the 1649 Act of Toleration allowing freedom of worship, Sparrow took his wife, two young children and a servant to "Sparrow's Nest," a 590-acre parcel of land on the Rhode River that had belonged to his father and now sits on the SERC campus.

The Sparrows lived there for almost a century. In 1705, one of their descendants–Thomas Sparrow's grandson—stole a boat and became a pirate in the Carolinas. (Unfortunately, there's no evidence he was related to Captain Jack Sparrow.) Their neighbors, the Shaws, arrived shortly after the first Thomas Sparrow, christening their land "Shaw's Folly." But by the mid-1700s, both families had moved on: The Sellman family took over Shaw's Folly in 1729, and the Sparrows sold their land to Annapolis merchant Nicholas Maccubin in 1747. Maccubin then built a mansion whose brick chimneys still stand at SERC today.

The site's rich past is reflected in the historical trash deposits SERC's citizen science volunteers are sorting through. They've discovered oyster shells, foot-long keys, pieces of ceramic and glass, pipes, bone fragments, preserved fish scales, and handcrafted nails. Together, these individual pieces paint a much larger picture of the relationship between people and their environment. For example, analyzing and identifying bone fragments tells the story of what these families had for dinner on an average Tuesday night in the 17th century.

"You'd think they'd be hunting deer, but in the thousands of bone samples we have identified, we have three deer fragments," said Gibb. "These people were not eating deer."

"I like sorting through the soil to see what you come up with, whether you find a nail, or pottery, or buttons"

- Janet Herron

Gibb believes only the first two generations of Shaws and Sparrows hunted deer, which was usually reserved for aristocrats in the Old World. By the time the third generation were cooking dinner, they were sick of venison and had reverted to two English favorites: beef and pork. But according to the bones in their separate trash middens, the two families didn't prefer them equally. "We have the Sparrow family seemingly having a preference for beef, and the Shaw family seeming to have a preference for pork," Gibb explained.

This difference is about more than taste—it also indicates how the families used their land. Eating more beef, today or centuries ago, causes greater ecological damage than eating pork. Pound for pound (and stomach for stomach), cows eat far more than pigs do, which means more land, more plowing and tilling, and more manure.

"Two different animals, two different effects on the environment, two different lines of husbandry practices," Gibb said. "This is something we're exploring in great detail now."

Researching from the ground up

On a blistering Wednesday afternoon, a team of volunteers piles into the Sellman House, now the headquarters of the archaeology lab. A skull sits in the trashcan. Shelves of artifacts tower from floor to ceiling, femur bones and ceramic shards glowing faintly in the overhead light. High schoolers gather in the back room by the coffee, while the retired people gather around sifters beside buckets of oysters waiting to be brushed and cleaned. As they pick through the sediment, they have plenty of time to discuss discoveries—and stretch their imaginations.

"There's always an element of surprise ... It's what makes it fun"

- Kathleen Clifford

"We make up stories about the artifacts we find," said citizen scientist Leo Plourde. "Maybe one houshold was stealing silverware from another. Maybe someone's wife was having an affair."

But the citizen scientists aren't just asking questions. They're answering them with independent research, whether dating clay pipes, studying eroded topsoil flow, or analyzing pollen cores. Plourde, who's been with the lab for a year and a half, is working with another citizen scientist to measure and statistically analyze oyster shells. They hope the information will shed light on how oysters were being gathered historically and how abundant they were millenia ago, which could feed into a conversation on seafood management and conservation today. According to Plourde, some of the shells date as far back as the early Woodland period (1000-200 BCE).

The volunteers come from all walks of life, from high school and masters programs to the National Security Administration. Janet Herron, a U.S. Government Publishing Office retiree, said her experience in archaeology has been both exciting and calming.

"I like sorting through the soil to see what you come up with, whether you find a nail, or pottery, or buttons," said Herron as she rolled what looked like a large grain of sand between her fingers. "I like the discovery part of it, when you get back and shine it all up."

"There's always an element of surprise ... It's what makes it fun," said Kathleen Clifford, a volunteer with a masters in Classical Archaeology, who has been with the lab nearly since its inception. "The difficulties you come across in your research questions are just opportunities to direct and adjust."

Perhaps it's easy to be optimistic in an environment like the Archaeology Lab, where there's just as much data as there are questions—and enthusiasm. Just then, Herron tapped on my shoulder, carefully dropping the grain of sand into my palm.

"Look," she said excitedly. "It's a vertebra. I wonder from what?"

MarineGEO's Westward Expansion

by Kristen Minogue

Imagine gazing into the ocean off Maryland knowing what life is under the waves, what's driving the food web, and how healthy the water is. Then, imagine being able to discover the same thing for another coast halfway around the world. That vision—of a network vast enough to take the pulse of coastal waters worldwide—began becoming a reality at the Smithsonian in 2012. It's called the Marine Global Earth Observatory, or MarineGEO.

Back in 2012, it had only four sites, all on the Atlantic: The Smithsonian Environmental Research Center (SERC) in Chesapeake Bay, the Smithsonian Marine Station in Florida, Carrie Bow Cay in Belize, and the Smithsonian Tropical Research Institute in Panama. The original four were called the Tennenbaum Marine Observatories Network, after Michael and Suzanne Tennenbaum, whose donation jumpstarted the network. Today, MarineGEO has nine sites, with three on the Pacific and memoranda of understanding for sites in Texas A&M University and Hong Kong University. And there is one more Pacific site to come.

"The MarineGEO aspiration has always been to extend around the world … The ocean is connected everywhere," said Emmett Duffy, MarineGEO's director based out of SERC.

San Francisco State University—a long-time partner of SERC—was the first non-Smithsonian site to sign on in 2013. The University of Hawai'i at Mānoa joined a year later. British Columbia's Hakai Institute began gearing up this summer, and the University of Washington's Friday Harbor Laboratories will soon follow.

Entering the Pacific was critical. "The Atlantic and the Pacific are two different oceans," said Ross Whippo, MarineGEO's head technician. "You'd be hard pressed to come up with some result in a specific place in the Atlantic Ocean with some observation or experiment and expect it to hold true everywhere around the world."

Some differences are stark. The Atlantic coast of the United States is riddled with bays, whose floors are covered in sand and seagrass. The Pacific coast, by contrast, is generally colder and rockier. Kelp forests—towers of brown algae sheltering thousands of marine species—dominate much of the underwater landscape. Nutrients, instead of streaming off land, upwell from the deep ocean. And while low-oxygen "dead zones" come in day-night cycles in the Atlantic's shallow waters, Pacific waters more often face long-term oxygen depletion.

How do researchers create a modus operandi that can monitor both coasts—and sites beyond North America? While each MarineGEO site can conduct its own experiments, all sites are doing four surveys: water quality; habitat mapping; measuring processes, like feeding and predation; and surveying biodiversity around "foundation species" like seagrasses, oysters, corals and kelp.

Momentum is building with the addition of Texas A&M University and Hong Kong University. "The idea of MarineGEO seems to be catching on," said Duffy. "People are very interested in working together in answering big questions." The biggest question, the one that originally inspired MarineGEO, is biodiversity.

"The core of MarineGEO is biodiversity," Whippo said. "That's what MarineGEO is really all about. And I think it will be really exciting to see, as the network grows and spreads across the globe, to see how relationships between biodiversity and human impacts change."

CALVERT ISLAND BRITISH COLUMBI

Hakai Institute's Calvert boat ride from Vancouv waters. Hakai's MarineG marine habitats: kelp, se and rocky intertidal zon with help from drones (systems") and partnerin groups to better unders Monitoring will be critic accident took place, acc Margot-Hessing Lewis. and after data, "we'd be calamity," she said.

MarineGEO-Hawaii Coconut Island (Photocredit: Forest & Kim Starr)

Kane'ohe Bay: University of Hawa

MarineGEO's Hawaiian o on Kane'ohe Bay's Cocor island off of Oahu. Mary Conservation Biology In teamed up with scientist of Marine Biology, part o at Mānoa. Next June, the biodiversity of the island impact of humans. Addit Hawai'i is training native students in natural scien monitoring, and mergin incorporating the ecolog indigenous groups.

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MarineGEO-Hakai: Hakai marine ecologist Margot Hessing-Lewis & the Nearshore Tech Team (Photo credit: Margot Hessing-Lewis/Hakai Institute)

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FRIDAY HARBOR LABORATORIES: UNIVERSITY OF WASHINGTON

Friday Harbor Laboratories sit on San Juan Island, roughly 80 miles northwest of Seattle. Salmon restoration is a major issue, partly because orca whales that frequent the island need salmon for food. "The orcas are starving because they live on Chinook salmon," says director Billie Swalla. Surface conditions also can change sharply in enclosed waters. Friday Harbor is preparing to install instruments to measure ocean acidification and other environmental factors, making it a natural fit for MarineGEO. Though a formal agreement is pending, Swalla says she hopes the entire College of the Environment at the University of Washington will join.

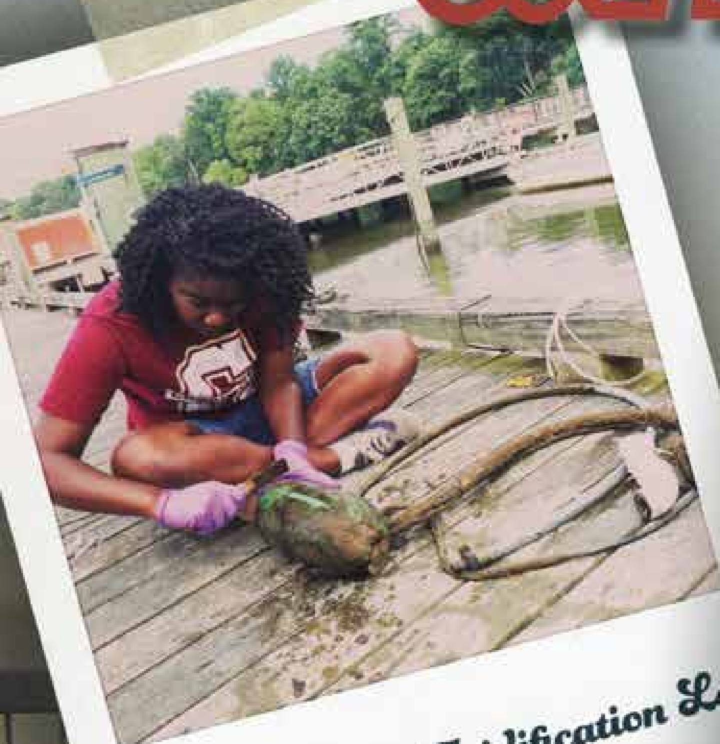
MarineGEO-Friday Harbor: MarineGEO head technician Ross Whippo (Photo credit: Pema Kitaeff/University of Washington)

MarineGEO-California: SERC biologist Greg Ruiz (Photo credit: Ross Whippo/SERC)

Romberg Tiburon Center: San Francisco State University

The marine station of San Francisco State University, the Romberg Tiburon Center has been a second home for SERC researchers for over a decade before becoming MarineGEO's first non-Smithsonian site in 2013. This summer, scientists surveyed natural and restored eelgrass, detected bat rays and leopard sharks with sonar video, and tested "squid pops," small sticks with dried squid meat planted underwater to study predators. With a major city nearby, San Francisco Bay is shaped by many human impacts. But lead scientist Kathy Boyer sees MarineGEO as a chance to track their conservation and restoration projects and discover keys to success.

INTERN SN



Jasmin : Ocean Acidification Lab

Cole : Terrestrial Ecology Lab

Jasmin Graham: An Acid Test for the Coasts

In the open ocean, acidification is a widely acknowledged environmental threat. In coastal estuaries, where freshwater and seawater meet, sharp acidification swings make the issue far murkier. To gain some clarity, intern Jasmin Graham of SERC's Ocean Acidification Lab spent the summer monitoring creeks along the Rhode River.

Graham and the rest of the lab observed carbon dioxide (CO_2) and alkalinity, the water's ability to resist a pH change when acid is added. They suspect phytoplankton are responsible for much of the fluctuation in acidity. But light intensity and time of day also had high impacts.

Ultimately, the lab hopes their research will help establish what a "normal" range of acidification in estuaries is. In the ocean, acidification is setting marine life up for tragedy. But in estuaries, where fluctuations are more common, animals may have an easier time adapting.

Cole Caceres: Cooking for Invasive Beetles

Cole Caceres has two passions: science and cooking. He found the perfect mix interning with SERC's Terrestrial Ecology Lab, where he acted as personal chef for 500 Japanese beetles.

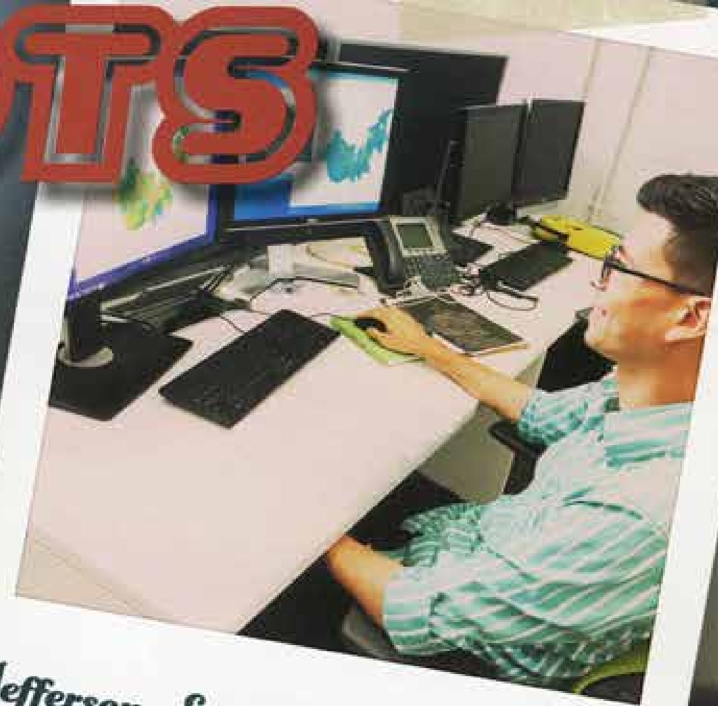
Caceres wanted to know if a plant's chemicals help it ward off hungry invaders. One school of thought suggests invasive herbivores excel partly because native plants haven't evolved effective defensive chemicals. Another camp, however, proposes invasive herbivores don't have the stomach for native chemicals.

In Caceres' cooking experiment, each insect received two food squares: a beige control and a green one with a special kick—the chemicals in one of 25 plants in the study. Caceres weighed the squares before and after 24 hours to determine which sample each beetle preferred. Afterwards, the lab is sending the samples to the Smithsonian Tropical Research Institute in Panama. There, scientists will zero in on molecular differences between plants, so SERC scientists can better understand the plant chemical defenses.

APSHOTS

by Emily Li

Anna : Terrestrial Ecology Lab



Jefferson : Ecological Modeling Lab

Anna Nordseth: An Army of Clay Caterpillars

Anna Nordseth, a summer intern with SERC's Terrestrial Ecology Lab, received a take-home assignment during her first week on the job: Make 900 clay caterpillars as bait for predators.

She deployed the caterpillars in BiodiversiTREE, an experimental woodland with plots of one, four or 12 species. She surveyed them regularly, recording damage marks and attempting to identify which predators made them.

Though the lab is still analyzing her data, Nordseth has already noticed an unusual pattern. While she expected to see bird and insect damage, some caterpillars were gnawed around the ends—a sign that rodents have risen to the bait. Ultimately, her experiment will help uncover how tree diversity impacts the food web, and possibly lend support to preserving biodiversity as a whole.

Jefferson Riera: Wetlands – Sink or Swim?

For SERC intern Jefferson Riera, wetlands mean wasp stings, scratches and severe sunburns. But he knows wetlands are worth protecting. That's why this summer, with SERC's Ecological Modeling Lab, he worked to develop a baseline understanding of wetland elevation—before it's too late.

Riera's project involved correcting elevation data in a SERC wetland. Past data relied on LiDAR (Light Detection and Ranging), which uses a laser scanner on an airplane to record energy reflections from the ground. However, laser pulses don't always reach the soil because of vegetation.

To remedy this, the lab is performing "full waveform LiDAR correction." Unlike regular LiDAR, which records only a few pulses, full waveform LiDAR should show everything the laser encounters from plane to ground. Riera also performed a vegetation class correction, thus far reducing the LIDAR error by 14 centimeters. He hopes this research can help preserve regions vulnerable to sea level rise.

When The Going Gets Tough, Baby Oysters Get Growing

by Kristen Minogue

Baby oysters are stronger than they look. In shallow coastal waters, where oxygen plummets and acidity spikes in day-night cycles, building a decent shell should be a challenge. But young oysters are often able to adjust to adversity—and, sometimes, grow more quickly to make up for lost time.

The discovery came from a team of marine ecologists at the Smithsonian Environmental Research Center (SERC), who published the new study in the journal PLOS ONE.

"It's really impressive what these oysters are able to do," said lead author Andrew Keppel, who worked on the project as a graduate student and later technician in SERC's Marine Ecology Lab before joining the U.S. Naval Academy.

It's much-needed good news for the imperiled shellfish. Eastern oysters were once so abundant in Chesapeake Bay, early settlers risked running ships aground of them. But centuries of overfishing slashed populations below 1 percent of precolonial levels. In the mid-20th century, the diseases MSX and Dermo took their toll. Today, nutrient pollution subjects oysters to intensifying day-night cycles of low oxygen (a.k.a. "diel-cycling hypoxia") and high acidity.

And yet, at least as juveniles, they're surprisingly resilient.

Keppel, fellow technician Rebecca Burrell and SERC senior scientist Denise Breitburg placed baby oysters inside dozens of aquaria, adjusting the water chemistry to mimic the Bay's oxygen and acidity cycles. Growth slowed during the first two weeks oysters experienced tougher environments. But after an initial "adjustment phase," growth rates generally evened out. Some oysters even began growing more quickly than oysters in normal waters. While their shells weren't as large as oysters in healthier waters during the course of the experiments, they were catching up.

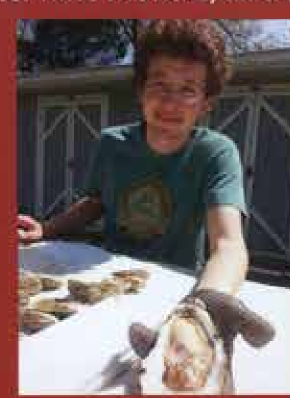
"Where we did see a negative effect, it was only for the first couple weeks of the experiment, and then after that they grew just fine," Breitburg said. The only exception, she noted, was when oxygen remained low constantly, rather than cycling from low to high—and even then, some of the oysters were able to adjust.

The team made another surprising discovery when they put some of those oysters in the Rhode River. There, oysters previously exposed to harsher conditions bounced back, outpacing normally-grown oysters. After nine months, all the oysters were roughly the same size.

How are they doing it? That, Keppel and Breitburg said, is still a mystery. One guess is that when oxygen drops, oysters might enlarge their gills to get more oxygen, which could also give them more food.

Eastern oysters still face an uphill battle. Low-oxygen cycles make them more vulnerable to Dermo disease as adults, and could hurt reproduction. But those anxious to restore baby oysters can take heart.

"Areas that experience this kind of diel-cycling hypoxia may actually be perfectly suitable for growing oysters—at least for the young spat," Breitburg said. "Once they're a bit older, though, there may be some negative consequences in terms of growth, disease and reproduction. But at least as juveniles, they seem to have a pretty amazing ability to acclimate."



Lead author Andrew Keppel shucks adult oysters for disease analyses

CRANKING UP THE HEAT IN THE "WETLAND OF THE FUTURE"

BY JOE DAWSON

Last fall, while volunteering in a plant lab at George Washington University, I heard about an experiment starting up at the Smithsonian Environmental Research Center (SERC). The project, a global warming simulation in the wetlands surrounding Chesapeake Bay, was helmed by SERC postdoc Roy Rich. I've been a wetlands enthusiast since I spotted my first blue heron as a kid, and global climate change is, in my mind, the most pressing issue humans face today. I was ready to sign up. I met Roy and asked the same questions I have since answered over and over again since joining the project:

"You're heating up a swamp?" Yes.

"And adding CO_2?" Yes.

"In a greenhouse?" No.

"Out in the open?" Yes.

"Umm, how?" Well...

In SERC's Global Change Research Wetland (a.k.a. "wetland of the future"), we're using infrared heat lamps above ground and heated wires below ground to warm up plots of marsh. Some plots will have plastic walls around them and carbon dioxide pumped in to simulate a warmer world with higher CO_2 concentrations.

Other warming experiments have found both higher temperatures and increased carbon spur plant growth. Our experiment takes this one step further. We want to know whether global warming will change the elevation of entire wetlands. As wetland plants grow, die off and decompose, dead plant matter gets stacked higher and higher, and wetlands actually gain elevation. If plants grow faster under higher temps, the soil might also build up faster. If that happens, wetlands could be a crucial buffer against rising ocean levels, keeping coastal flooding at bay.

Of course, when I first met Roy, the project existed only on paper. Last winter we faced the daunting task of actually building it.

There's a Bible verse about building a house on sand that could easily apply to setting up an experiment in a marsh. The ground is damp at its driest, a shallow pond at other times. Any structure that needs to stay put has to be kept in place with poles that go 3 feet or more into the ground.

In winter, lots of wetland animals had migrated away or were hibernating. But when the weather warmed up, the animals came back in abundance. Ospreys circled in groups close to sundown; snapping turtles cropped up here and there; a pair of black rat snakes mated and sunned themselves outside the office; wild turkeys led their chicks in single-file lines through the forest. Magical.

With an ambitious undertaking like this, we needed specialized help from other scientists. Surface elevation can be a little finicky to get right. Scientists from the Virginia Institute of Marine Sciences and U.S. Geological Survey came to install soil elevation tables and do the precise measurements. After running into an electrical problem in early May, Roy got some advice from an electrical engineer who just happened to be at SERC's Open House in May.

The construction of this experiment has been at points difficult and frustrating. But this particular experiment will give us a sense of whether wetlands can protect the mainland from sea level rise. Being part of it helps me push through digging posts 5 feet deep in a frozen marsh.

We flipped the switch on in early June. The lamps are hot; the ground is warm. We'll need years of data to draw conclusions about how the treatments are affecting soil elevation. For now, we can pat ourselves on the back a little, fix things if they break, and sit on our hands while marsh grass grows and dies. Hopefully we will gain a little more knowledge, another dose of insight into how our world works.

This is an abridged version of the original article. To read the full version, visit http://sercblog.si.edu

Joe Dawson checks a control box for underground heating cables

FALL EVENING LECTURE SERIES

Conserving Ecosystems for the Next Generation

Join us in the Mathias Laboratory on Tuesday, November 15, for the finale of SERC's 2016 evening lecture series! Keynote lecture is free and features a special dessert reception in the Mathias atrium. No pre-registration required.

Robert Lee Forrest Keynote Lecture

"Twenty Years of Urban Ecology in the Baltimore Ecosystem Study"

Steward Pickett of Cary Institute of Ecosystem Studies

Tuesday, November 15, 8-9pm with reception at 7pm

Mathias Laboratory

(Photo Credit: Christopher G. Boone/BES LTER)

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Gusty genetics: http://dx.doi.org/10.1007/s10641-016-0523-8

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On The Edge

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