Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Summer 2017

Feature:
The Case for Earth Optimism

ALSO INSIDE:

SERC Scientists: The Next Generation

Crossbow Ecology

Trees Caught Emitting Methane

Left to right: Dave Norman, Ian Davidson, Katrina Lohan, Kim La Pierre (Credits: Sara Richmond, Ian Davidson, Chris Lohan and Blake La Pierre)

THE DIRECTOR'S LETTER

The Changing Faces of Science

This Earth Day, two gatherings took place on our nation's capital. Both attempted to address the future of science in an uncertain world. One, the March for Science, drew crowds eager to support the value of scientific discovery. The other, the Smithsonian's Earth Optimism Summit, brought together thought leaders in science, art, business and policy, to highlight what's working in conservation. The March for Science sought to affirm *that* science is valuable. The Earth Optimism Summit explored *how* we can use science to ensure a healthy future for our planet.

Many stories of hope emerged from the Earth Optimism Summit. You can find a few on pages 6 and 7 of the newsletter if you're craving some inspiration. The Earth Optimism Summit did not paint a naïve picture of the world, blind to the very real threats facing our environment and our society. Instead, it defied the narrative of despair with the message that we can succeed in protecting the Earth and its species—we can succeed, because in many cases we already have.

But stories of reforested lands and species recoveries aren't the only things that convince me a brighter future is possible. People are behind every successful initiative, and here at SERC many new faces are stepping up to bring science to new levels. I'd like to introduce you to four of them: Kim, Katrina, Ian and Dave.

Kim La Pierre joined this spring as SERC's newest senior scientist, heading our Ecosystem Conservation Lab. A San Francisco native, La Pierre has connected global change data from over 100 projects around the world, and plans to do more large-scale experiments here at SERC. Katrina Lohan, our second new principal investigator, uses the latest DNA techniques to zero in on the microscopic world of disease in marine ecosystems. And Ian Davidson, our third new principal investigator, makes diving expeditions to track invasive species hitchhiking in boats.

Meanwhile, thanks to our citizen science coordination team, we now have a cadre of dedicated volunteers working alongside our researchers. Last year, more than 500 citizen scientists spent nearly 6,000 hours helping us make discoveries about the coast. One, Dave Norman, has spent two years with us tracking blue crabs and river herring, two of the Chesapeake's most iconic species. When he's not out on the water doing surveys with our aquatic biologists, he leads field trips for some of the thousands of schoolchildren who visit SERC every year.

We need these new faces, because the world of ecology is changing. We've learned microbes can determine the fates of larger organisms or entire ecosystems–and yes, even humans. We've discovered ships can carry invasive species thousands of miles around the world. And we can no longer do science in isolation. The creation of global networks is empowering us to make discoveries unthinkable a few decades ago. Marine biologists, botanists, chemists and modelers are reaching across the aisle, recognizing how all their fields connect and depend on each other.

It's people like Kim, Katrina, Ian and Dave who give me optimism. As long as we have smart, curious people willing to ask the big questions, get their hands dirty, and reach out to the next generation, science will continue to move forward. And so will the Earth.

—Anson "Tuck" Hines, director

On the cover:
SERC postdoc Uzay Sezen aims a crossbow at the forest canopy, to shoot leaves off high branches for a study on forest genetics.
Full story on p. 11

RESEARCH DISCOVERIES

New Sea Squirts on the Block

Sea squirts may lack thumbs, but they can still hitchhike. According to SERC's Marine Invasions Lab, these marine invertebrates are heading north. This May, scientists published a paper in BioInvasions Records documenting three new non-native species in San Francisco Bay (*Microcosmus squamiger*, *Styela canopus,* and *Molgula ficus*), over 500 kilometers north of their previously recorded range. The lab suspects these sea squirts (a.k.a. ascidians or tunicates) hitched a ride on boats traveling up the California coast. A multiyear marine heat wave called "The Blob" might also have given them the necessary boost to settle into a new home. Going forward, the lab will watch closely to see how these species fare and what (if any) havoc they wreak.

Top to bottom: Sea squirts Microcosmus squamiger, Styela canopus *and* Molgula ficus.

Hard Truths About Shoreline Armoring

For decades, ecologists have suspected that armored shorelines impact the abundance of fish, crabs, and other aquatic life. Now there's evidence that local effects add up to impact entire ecosystems. A new study in Estuaries and Coasts shows more shoreline hardening generally means fewer fish and crustaceans.

The team, led by former SERC postdoc Matt Kornis and SERC ecologist Denise Breitburg, analyzed nearly 600 sites throughout the Chesapeake. As sea levels rise, many people will likely armor their shorelines with retaining walls (bulkheads) or boulders (riprap). Unfortunately, the study found both to be equally harmful. However, alternatives exist. Restored wetlands and "living shorelines" (which mimic natural shores) may keep aquatic critters healthy. Difficult choices lie ahead, but studies like this give us the information necessary to make smart decisions.

Link to full study: http://dx.doi.org/10.1007/s12237-017-0214-5

Battling Ship-Borne Invaders: Time for a New Game Plan

Massive cargo ships can unwittingly carry invasive species in their ballast water. But one top tactic of fighting them is getting crippled, SERC biologists report in a new study in PLOS ONE.

Since 2004, ships have been required to perform "open-ocean exchange"— flushing out coastal ballast water and replacing it with ocean water, in the hope oceanic organisms will be less likely to survive and cause havoc in coastal harbors. However, the team discovered concentrations of coastal zooplankton in ballast water have risen almost five-fold—even though every ship they sampled after 2004 followed the rules. They suspect shorter voyages and surging global trade are counteracting open-ocean exchange. That makes developing a new strategy—a way to rid ballast water of potential invaders directly onboard—even more critical.

Link to full study: https://doi.org/10.1371/journal.pone.0172468

THE NEXT GENERATION OF LEAD SCIENTISTS

by Kristen Minogue and Joe Dawson

We've said farewell to a number of gifted, now-retired scientists over the last few years. In 2017, several enthusiastic new principal investigators have stepped up to take the helm, forming new lab groups of their own. Meet three in these Q&As, edited for brevity and clarity. Want to go into more depth? Read the expanded Q&As on our blog at http://sercblog.si.edu.

Above: Kim La Pierre in a Long-Term Ecological Research (LTER) site in Konza Prairie, Kansas (Arjun Potter)

Kim La Pierre

Ecosystem Conservation Ecologist

The newest senior scientist at the Smithsonian Environmental Research Center, Kim La Pierre is starting the center's Ecosystem Conservation Lab. But while working on large-scale global experiments, she also delves into the microscopic world of bacteria.

Why do you find microbial relationships so exciting?

It's something that people haven't really thought about a lot in the past—what's below your feet; you can't see it. We don't have X-ray vision. Particularly thinking about microbes, even though they're aboveground and belowground, you can't see them without a microscope. I think it's exciting to delve into these worlds that no one has thought too much about before because we haven't really had the technology to easily study them. And now we definitely can.

What kind of bacteria research would you like to do at SERC?

I'm really interested in thinking about how bacteria are dispersing within the environment and what their population or community structure is across the landscape. Is it really uniform, that all kinds of bacteria are everywhere, or are they really patchy?...Are they even dispersing from off the SERC property in dust or wind or on people's shoes? We have very little idea about how bacteria get around. So that's something that I plan to focus on here.

You've been working on a synthesis of 101 long-term projects around the world, two at SERC's Global Change Research Wetland. What is that about?

We're really interested in thinking about how plant communities are changing in response to global change factors. So we gathered a bunch of datasets from experiments that have manipulated resources or other global change factors.

How would you explore that more deeply at SERC?

We know that global change in the world is not happening in isolation—just CO_2 increases or just temperature changes. It's all together. So that's something else that I plan to work on here at SERC, getting more of these really big experiments going.

You're from the San Francisco Bay region. Are there any areas of overlap between what you've studied in California and what you'll study in the Chesapeake?

I think every place in the world has the same environmental issues. So when thinking about conservation of ecosystems, it's really important to find the commonalities among many different systems around the world. And if there are differences, identify why there are differences….We know there are plants everywhere; there are bacteria everywhere; there are insects everywhere. What are the relative strengths of the interactions between these species at different sites? How those different interactions and suites of species respond differentially to global change factors is important to help drive overall conservation efforts.

Ian Davidson

Aquatic Inquirer

An alum of SERC's Marine Invasions Lab before leading his own lab, Ian Davidson tracks how invasive species move around. From diving under massive cargo ships to studying an invasive organism ugly enough to be nicknamed "rock vomit," Davidson looks at how human activities affect marine ecosystems.

How did you get interested in your area of study?

I grew up in Cobh (pronounced "Cove"), a small harbor town on the south coast

Ian Davidson on the shores of Cork, Ireland (courtesy Ian Davidson)

of Ireland, so I had plenty of time in rock pools when I was young. My mother grew up a stone's throw from the shoreline, right in front of the main shipping channel there, so we were always keeping an eye on the to-and-fro of the port. My dad worked in a shipyard until it closed down too, so I suppose the ingredients were there to pursue a career that heavily featured marine biology and shipping!

What projects are you most excited about?

I work with great people in a wonderful system in Sitka, Alaska, on invasive *Didemnum vexillum* management ("rock vomit"), so that's certainly a favorite. It involves diving surveys and developing ways to control or eradicate *D.vex* in one bay up there, and the Sitka community is a great one to visit.

What do you wish more people knew about invasive species?

The main reason invasions matter is because we're rearranging the biodiversity of the planet, not because a particular species has a certain impact. Of course, impacts matter, but we've never had a situation where one species (us) has dominated the dispersal of organisms on this scale.

There's an opening line from a paper by a famous ecologist—David Tilman—that stuck with me: "The most striking feature of Earth is the existence of life, and the most striking feature of life is its diversity." Rearranging that diversity is a key aspect of the Anthropocene that contributes to dramatic changes in nature, some of which we are only beginning to understand.

As a conservationist, where does your motivation come from?

There are countless examples of great conservation theory and practice to counteract the major issues of environmental degradation. There's little point in getting bogged down in any suggestion that negative trends are irreversible or beyond conservation or restoration—we must argue for better approaches, develop them, and demonstrate them.

Katrina Lohan

Marine Parasite Hunter

Lohan uses DNA to identify parasites that defy classification by sight—even with microscopes.

Weird truth: There are more parasites on Earth than non-parasites. Katrina Lohan would know, having spent over a decade studying them. After five years with SERC's Marine Invasions Lab, Lohan is now in charge of launching the center's new Marine Disease Ecology Lab.

What do you find most fascinating about parasites?

I'm intrigued by the David and Goliath aspect of it, that parasites are super small, [often] overlooked, and most people don't even think about them in terms of what role they play in ecosystems or what they could possibly be doing…. And yet, they're extremely important. The more we learn about parasites, the more we realize that they control their hosts. They can actually completely change the behavior of their hosts.

What are your favorite parasites?

There is a parasite that replaces the tongue of fish [*Cymothoa exigua*]…. It actually eats away the tongue and replaces it, so when the fish opens its mouth, what you see is the parasite rather than the fish's tongue. That I think is pretty crazy. But I think one of the parasites that I find particularly intriguing, though I don't study it, is *Toxoplasma* [*Toxoplasma gondii*]….It will actually make mice, rather than turning away from cat smells, attracted to the smell of cat urine and actually seek out cats, which would then eat the mice, which then allows the parasite to finish its reproductive cycle inside the cats.

How is DNA helping you understand parasites?

The parasite I studied for my Ph.D. looks like, in very nondescriptive terms, a circle with some circles inside of it. There's really not much to it to be able to [generate] any sort of species-level description. Maybe not even a genus level. And unfortunately that's true for a lot of small single-celled organisms. And there's also a lot of parasites that have very different-looking life stages. What they look like inside their host is not what they look like outside….Through the use of DNA, we now know that they're not all different species.

What projects are you most excited to work on in your new lab?

Most of the [oyster] parasites that we've been looking at, like *Perkinsus* and *Haplosporidium*, cause pretty severe disease in the Chesapeake Bay, but those same parasites in Panama did not really appear to greatly impact their hosts. So I'm really curious to find out why….I'm also really interested in taking some of the ballast water work to the next level and looking at, okay, if these parasites are in ballast water, what happens to them when they're discharged? What's their likelihood of surviving?

Moving Beyond Despair:

Reflections on the Smithsonian's 1st Earth Optimism Summit

by Ryan Greene and Kristen Minogue

THESE DAYS, "EARTH OPTIMISM" might sound like an oxymoron. From mass extinctions to global climate change, the list of dread-filled environmental headlines seems endless. While this doom-and-gloom list is true (and we should be paying attention to it), there are other lists that are also true and worthy of our attention. Hence the Smithsonian's inaugural Earth Optimism Summit. This three-day conference illuminated some items on an optimistic list highlighting stories of environmental hope, success, and change in the right direction.

"Given all the negative news reports about the state of our planet and the difficulties of governments working together to solve them, it would be easy to be cynical or pessimistic," said Smithsonian Secretary David Skorton at the summit's opening. "But I believe we have plenty of reason to be optimistic."

The summit's origins date back to World Oceans Day in 2014, when Smithsonian marine biologist Nancy Knowlton and others launched the #OceanOptimism Twitter campaign, challenging the widespread narrative of hopelessness surrounding our oceans. Knowlton's argument was simple: Glimmers of hope are vital. Without them, we will lose the energy necessary to tackle the monumental challenges facing our marine environments.

This same logic underpinned the Earth Optimism summit. Here, students, artists, researchers and policymakers shared their reflections on the past and their visions of the future. Stories of conservation success seemed to take an infinite number of forms, from unconventional farmers growing sustainable kelp to communities using affordable healthcare to address the root causes of deforestation. Though the approaches varied, the goal was the same: a healthier home planet for all.

Included in this array were a number of stories about work here at the Smithsonian Environmental Research Center (SERC). Plant ecologist Dennis Whigham described how he and others are working to conserve the 200-plus native orchid species in North America. Marine ecologist Matt Ogburn discussed how his lab is using cutting-edge monitoring techniques to aid river herring conservation efforts in the Chesapeake Bay. Finally, forest ecologist John Parker explained how his century-spanning BiodiversiTree experiment is revealing the multifaceted role of biodiversity in our ecosystems.

"Wildlife, people and functioning landscapes can and do coexist very effectively on the planet," said SERC director Tuck Hines, a member of the summit's leadership committee. "We need more examples of that, and to learn from those success stories."

None of these researchers worked alone. Each project demonstrated how scientists can team up with members of their communities. According to Whigham, this collaboration generates the energy that drives their science forward.

"When we find citizen science folks out there who see what we're doing and get excited about it, that feeds back and enables us to continue," he said.

This type of feedback loop is exactly what the Earth Optimism Summit was all about. By inspiring and celebrating collaboration, this conference was a reminder that working on tough problems is hard, but not friendless. There are countless people in countless places devoting themselves to our common future. And as Secretary Skorton declared, if we commit ourselves to working with and for each other, we may just be able to reach our goals.

"Is it naïve to be optimistic about the Earth?" Skorton asked as the summit kicked off. "I don't think so…. When organizations and, most important, individuals, work together, we can and we will make a difference."

Planting A 100-Yea

"Biodiversity is risk manage diversity in our ecosystems. So others

John tree i

In winter 2013, SERC ecologist John Parker began a massive undertaking: Plant 20,000 trees for a new biodiversity project designed to last a century. He succeeded with a crew of technicians, interns and over 100 citizen scientist volunteers. They divided the forest—BiodiversiTree—into dozens of plots with one, four or 12 tree species, to see whether biodiversity helps a forest function better. Four years into the proje covery: While on average, diver surviving trees, they have more a more steady average; single- skyrocket or crash. Just like the s

r Forest Experiment

*ment. This is why we protect bio-
o if we lose one species, there are
left around to pick up the slack."*
—John Parker

*Parker inspects a young sycamore
n BiodiversiTree.*

ect, they've made a startling dis-
se plots so far don't have more
stability. Multispecies plots hold
species plots are more likely to
stock market, it pays to diversify.

Conserving Orchids in the Wild

"Our mission is really simple: It's to conserve the genetic diversity of all the native orchids, initially in the U.S. and Canada. But showing that that model works, we're going to think globally about all the 30,000 species that are out there."
—Dennis Whigham

Over 200 orchid species blossom throughout North America, and more than half are endangered or threatened somewhere in their native ranges. In 2012, SERC ecologist Dennis Whigham teamed up with the U.S. Botanic Garden to create the North American Orchid Conservation Center. Their goal: Find the secrets to conserving all North American orchid species and clues to help propagate them in the wild. Headquartered at SERC, the coalition now has dozens of collaborators, including botanic gardens, universities and conservation organizations. The Smithsonian also houses one of the world's largest collections of orchid mycorrhizal fungi, the specific fungi orchids need to germinate and grow.

Left to right: Dragon's Mouth orchid (Gary Van Velsir); Showy orchis; Dennis Whigham, founder of the North American Orchid Conservation Center

Tracking Chesapeake Recoveries

"A lot of our iconic Chesapeake Bay species have come back pretty well in response to direct management actions, from bald eagles and ospreys that responded to banning DDT and have come back in huge numbers, to things like blue crabs and striped bass that have responded well to sustainable fisheries management."
—Matt Ogburn

In addition to river herring, Matt Ogburn's lab also tracks crabs, sharks and cownose rays.

The last few decades have been a roller coaster for popular Chesapeake animals like blue crabs and striped bass. Matt Ogburn heads SERC's Fish and Invertebrate Ecology Lab, which has been tracking several Bay fisheries for 30 years or more. One of their latest hopeful discoveries centers on river herring. Once barred from their spawning grounds by dams and other structures, these migratory fish have seen many streams reopen as those structures come down. Using an underwater acoustic camera called DIDSON, Ogburn's team detected an estimated 1.3 million migrating up a single river.

Ecosystems in Flux: Green Carbon and Blue Carbon with Pat Megonigal

by Ryan Greene

SERC biogeochemist Pat Megonigal studies where heat-trapping greenhouse gases like carbon dioxide and methane come from (sources) and where they get stored (sinks). Here are some of his recent discoveries about how these gases move through "green carbon" ecosystems like upland forests, and "blue carbon" ecosystems like tidal marshes.

GREEN CARBON

Because soils in upland forests are home to loads of methane-absorbing microbes, scientists have long treated these forests as substantial methane sinks. But according to a recent study in New Phytologist by Megonigal and Scott Pitz, a Johns Hopkins graduate student, trees in upland forests can actually emit methane from their trunks. This could mean upland forests are smaller methane sinks than we thought: On average, tree emissions caused forests to consume 1 to 6 percent less methane than previously estimated. Occasionally, Megonigal and Pitz even found tree emissions could switch the forest from being a methane sink to a methane source. Since methane can trap up to 45 times more heat than carbon dioxide, even minor changes in its cycling can have major consequences for the climate.

But where is all this methane coming from?

The short answer is, no one really knows. Megonigal has some ideas: It's possible microbes and fungi living in and on the trees are to blame. Or it might be methane drawn up from groundwater by the roots. Or maybe it's something else entirely. Though Megonigal and Pitz didn't close the case on this mysterious methane, they paved the way for future detective work. Pitz and SERC intern Andrew Sample designed a high-frequency monitoring system using box-like flux chambers attached to tree trunks. By measuring methane concentrations every 45 minutes, these chambers revealed that trees don't just emit methane randomly—their emissions follow a daily pattern. Paul Brewer, a postdoctoral fellow in the Biogeochemistry Lab, will use this high-frequency monitoring system to further characterize these daily patterns, in the hopes of zeroing in on the sneaky source of all this methane.

SERC postdoc Paul Brewer attaches methane-monitoring equipment to a tree.

BLUE CARBON

When it comes to greenhouse gases, tidal marshes are something of a seesaw. On the one hand, wetland plants absorb a lot of carbon dioxide as they grow, storing it in the soil as "blue carbon." On the other hand, a wetland's waterlogged soils provide an oxygen-free environment that methane-emitting microbes love. The marshes' impact on global climate depends on the balance between carbon in their soils and methane released by these microbes. If carbon-absorbing plants win, the marsh acts as a greenhouse gas sink. If methane-emitting microbes win, it acts as a greenhouse gas source.

But this balance is expected to shift over the next hundred years as carbon dioxide levels rise and nitrogen-based nutrient pollution gets worse. In a new study in Biogeochemistry, Pat Megonigal simulated the future in order to predict this shift.

Pat Megonigal

Working with Adam Langley and Melissa Pastore from Villanova University, Megonigal used an array of space-age chambers at SERC's Global Change Research Wetland to expose the marsh to levels of carbon dioxide and nitrogen it's expected to face in the coming century. Over nine years, they watched how different experimental conditions shifted the balance of blue carbon storage and methane release.

They discovered higher levels of carbon dioxide alone tended to make the marsh a net source of greenhouse gases. But higher levels of nitrogen (alone or with carbon dioxide) tended to push the marsh toward being a greenhouse gas sink. While these patterns may not hold true for all marshes, Megonigal and his team did find that in every futuristic scenario, the marsh stored significantly more carbon belowground in the form of new soil. The last finding would seem hopeful, because as sea levels rise, one of marshes' best chances of surviving comes from building more soil.

Green Carbon Study link: http://dx.doi.org/10.1111/nph.14559
Blue Carbon Study link: http://dx.doi.org/10.1007/s10533-017-0312-2

Alaskan Alders Shape Fates of Wetlands, Streams—And Salmon

by Joe Dawson

In Alaska, salmon mean serious money, and learning about their lives could pay off in future fish harvests. There's a lot to study, down to how a single type of tree impacts their habitats. "There is this strong connection between land and stream and between the fish and the stream," said SERC plant ecologist Dennis Whigham.

Whigham and his colleagues explored those habitats and those trees, the alders, in a May study in Science of the Total Environment. The team sampled two wetland-lined headwater streams in Alaska's Kenai Peninsula from 2012 through 2014. Headwater streams provide critical sanctuary for roughly 250,000 juvenile salmonids, a group that includes salmon, trout, and char. The streams were almost identical, except for one key difference: One flowed through a wetland with alders; the other did not.

Normally, plants have to grow deep roots to get the nitrogen they need. But bacteria in alder roots make nitrogen more available to these trees and eventually the broader ecosystem. "If you give a plant nitrogen, it hardly needs roots," Whigham said.

And that's precisely what they found: Grasses in the 'Alder' site had only one-fifth as much root mass as in the "No Alder" site, but their roots had three times higher nitrogen concentrations. Previously, the researchers also found a positive link between the amount of alder in the watershed and nitrogen concentrations in streams. This information could prove critical in the future, as scientists expect alder trees to expand northward, stirred by carbon dioxide and warmer temperatures.

The exact effects on these streams and juvenile fish are still unknown. Other research suggests that additional nitrogen could lead to more green mass aboveground and more plant-eating organisms, rippling up the food web. Scientists also found decreases in belowground biomass and increases in decomposition, which will likely change

balances in the carbon cycle that plants and animals depend on. Less root mass could mean less-stable stream banks and more sediment in the water. Figuring out the risks and outcomes of these changes could lead to healthier fish populations.

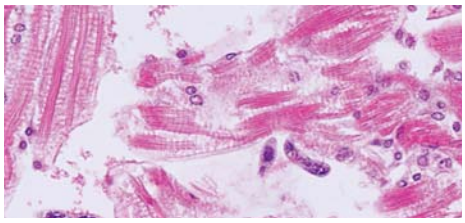
To read the full story on our blog, visit http://sercblog.si.edu/?p=7973
Research study DOI: https://doi.org/10.1016/j.scitotenv.2017.03.290

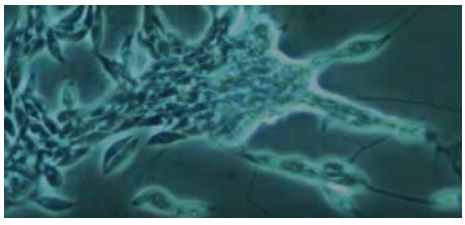
Slime Nets and Other Microscopic Invaders Lurking In Ships

by Kristen Minogue

Large creatures like zebra mussels and lionfish generally draw the spotlight when talking about invasive species. But for every visible invader, there are hundreds more too minuscule to see with the naked eye.

Biologists in SERC's Marine Invasions Lab and the National Zoo are working to detect the invisible invaders. In two recent studies, they took DNA samples from ballast water tanks of massive cargo ships. The first—a 2016 study—looked for microscopic protists in ships entering Chesapeake Bay. The second, published in the June issue of Diversity and Distributions, looked for protist parasites entering ports on all three U.S. coasts. They discovered thousands of types of microbes hidden inside. Some had never been detected in ballast water, and some didn't match anything known to science. The four groups below are just a few that bear watching:





Top: Hematodinium perezi *parasite in blue crab tissue (Hamish Small and Jeffrey Shields, VIMS). Bottom: Slime net colony (Dan Martin)*

Labyrinthulids ("slime nets") Slime net protists take their name from the web-like ectoplasm around their cells. While they're not all parasites, they have a stained record. *Labyrinthula zostera* is behind seagrass wasting disease, and others have caused diseases in corals and hard clams. The biologists discovered over 150 different kinds of slime nets in their surveys.

Syndinids These parasitic dinoflagellates are famous for infecting fish, crustaceans and even other dinoflagellates. The syndinid *Hematodinium perezi* survives by infecting the tissues of blue crabs. The Smithsonian team found syndinids in ballast water for the first time in the 2016 study, and detected six different types in the 2017 paper.

Apicomplexans Roughly 4,000 known species of Apicomplexans live in the world, and they're all parasites. Their ranks include the infamous *Plasmodium*, the agent behind malaria. *Cryptosporidium struthionis*, one species the Smithsonian team detected, causes poultry disease.

Ichthyosporeans This class includes fish-infecting *Dermocystidium* parasites, and *Rhinosporidium*, which infects some birds and mammals, including humans. Like syndinids, this group had never been spotted in ballast water until the 2016 study, and some in the 2017 study matched no organisms known to science.

To read the full story, visit http://sercblog.si.edu/?p=7999
Research Study Link (2017): http://dx.doi.org/10.1111/ddi.12550
Research Study Link (2016): http://dx.doi.org/10.1007/s00248-015-0684-6

We couldn't fulfill our mission without the generous support of donors and volunteers.

Volunteers are key players in every aspect of our work—research, education and outreach. Every donation helps ensure that this research continues, that our education programs run smoothly, that our lecture series remains free, and that we keep you informed through newsletters, email and the Web. Below are three supporters we would like to recognize:

Volunteer Spotlight: Dave Norman

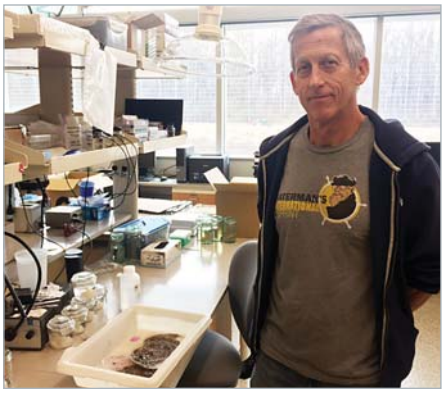
by Sara Richmond

Dave Norman's first visit to the Smithsonian Environmental Research Center (SERC) wasn't to help with a field trip or assist researchers in the crab lab, as he has done for the past two years. He was competing in a triathlon on its campus. The experience stuck with him, and when he retired a year later, he contacted SERC to ask how he could get involved as a volunteer.

The mix of science and education opportunities was a perfect fit for Norman. He says he was part of the "Jacques Cousteau generation," who grew up with the explorer's books and movies. His initial plans to become a marine biologist changed—he practiced law for 30 years before becoming a seventh-grade math teacher—but when he retired, his love of water brought him back to the field.

Some days, he joins the education crew leading field trips. "It's a teacher's dream come true to teach in a setting like SERC," he says. "It's really engaging and eye-opening for students."

But most of the time, Norman works as a citizen science volunteer with SERC's Fish and Invertebrate Ecology Lab, affectionately known as the "crab lab" for its wealth of blue crab research. For example, he helps determine if Chesapeake Bay holds enough food to support blue crab populations by studying samples of sand and other sediment taken from the Bay. He also works on SERC's River Herring Conservation Project. River herring populations have declined in recent decades, possibly due to overfishing, pollution, and the presence of dams and other structures that block them from spawning areas. The river herring project tracks herring spawning in Maryland and Virginia tributaries to determine if the fish are reaching their spawning grounds, or if human impacts are interfering.



Left: Dave Norman joins SERC biologists on a river herring survey (Kim Richie). Right: Norman looks at sediment samples in SERC's Fish & Invertebrate Ecology Lab (Sara Richmond)

One of his favorite parts about volunteering with the citizen science program, he says, is that he gets to work as part of a team of other volunteers and researchers. He also enjoys participating in field work that frequently takes him out on the water, such as day-long trips collecting herring samples in Maryland and Virginia.

He encourages others who are thinking about volunteering to "jump in with both feet," especially if they have an interest in nature or nature education, working with kids, or working with collaborative teams. While people don't have to volunteer (or compete in a triathlon) to visit SERC, "it's a beautiful setting to work in, and the work is rewarding," he says. "It's a hands-on opportunity to work alongside SERC investigators, and they provide you with context as to how it fits into the other research here and its relevance."

Donor Spotlights

Dwight Johnson: Mr. Johnson's recent gift has changed the life of a young intern. His generous $16,400 donation enabled Ryan Greene to participate in SERC's first Bicoastal Communications Internship. After seven weeks honing his writing and art skills at SERC's headquarters in Edgewater, Md., Ryan has now moved to SERC'S long-term lab at California's Romberg Tiburon Center to cover SERC's marine biologists there for 11 weeks. Thank you, Mr. Johnson!

Gary Mullard: Mr. Mullard made us all feel very Earth-Optimistic at SERC with his $500,000 unrestricted gift annuity. This impactful donation will benefit SERC for years to come as we work to fulfill our mission. In his words: "I have always been an environmentalist, and I am glad to be able to help your organization with their vital work to help the serious problems that we face." Thank you, Mr. Mullard!

If you feel inspired to be a part of SERC's mission by giving, please visit www.serc.si.edu and click the **DONATE** button, or contact Brian Magness, Development Director, at (443) 482-2205, MagnessB@si.edu.

Thank you for all you do for SERC!

Ryan Greene

HUMANS ARE SHORT and TREES CAN'T TALK

That's why Uzay Sezen carries a crossbow and liquid nitrogen into the forest with him.

by Ryan Greene

Uzay Sezen, armed with his crossbow and liquid nitrogen in Harvard Forest.

Above: Jessica Shue organizes sample tubes and plans the team's next move.
Below: Tools of the trade: Intern Alex Koure holds a crossbow for high leaves, a pole pruner for low leaves, and a water bottle they toss for everything in between.

UZAY SEZEN IS A NEW POSTDOC at the Smithsonian Environmental Research Center (SERC), and he's on the hunt for good data. Literally.

With senior scientist Sean McMahon and other members of the Quantitative Ecology Lab, Sezen is embarking on a multiyear study that aims to unveil the genetic patterns of tree growth. Their mission: Find out if tree species present at both SERC and Harvard Forest grow in the same way, and whether there are particular genes they express when they grow. Not only will this help us understand how trees respond to day-to-day changes in sunshine, temperature, and rainfall, but it may provide insight into how forests will react (and already are reacting) to global factors like climate change.

How, though, do you ask a tree which genes it's using?

The answer is RNA sequencing. Trees have lots of genes, but only some are active at any given time. A molecule called messenger RNA is a good indicator of gene activity, because it's what brings DNA's "instructions" to the places in the cell where proteins are made. RNA sequencing lets scientists like Sezen isolate and analyze all the messenger RNA in a sample. This means they can take a leaf from a tree and see which genes were active at a particular moment in time.

This all sounds pretty straightforward: Collect some leaves. Send them to a facility for RNA sequencing. Get on with your analysis. Simple, right?

Well, not really. There are two problems. First, humans are short, and many leaves are simply out of reach. Hence the crossbow—a technique Sezen learned while doing research on palm trees in Costa Rica. By shooting arrows attached to a fishing line, Sezen can drape the line over hard-to-reach branches and shake the leaves down by hand.

The second problem is that RNA tends to degrade quickly. To use RNA sequencing to ask trees what they're up to, Sezen needs to keep the RNA intact. That's why he flash-freezes the trees' leaves in a container of liquid nitrogen immediately after he collects them.

"You want to freeze the physiological state that the tree is in, and get a snapshot, like a photograph, and that will tell us what's going on at that moment in all these genes that are active," he said.

With these logistical hurdles crossed, Sezen and his team can turn their attention to their overall goal: They want to map out the gene activity of five tree species growing here at SERC and at another plot at Harvard Forest. First they're interested in establishing a baseline of all the genes these trees normally express. Then they plan to monitor the trees over the course of the next three years to see how gene expression changes throughout the growing season and how it changes year to year.

The team will "basically take snapshots and see what's going on when, and what genes are being upregulated and downregulated…especially tied to growth," said SERC technician Jessica Shue.

The fact that Harvard Forest is further north than SERC will add another layer of information to the picture. Comparing sites at two latitudes may help pinpoint climate-specific differences in gene activity—a high priority given the gravity of climate change.

The first step, though, is getting out into the field to collect and flash-freeze the trees' leaves. They'll need good data to puzzle out how genetics, growth and global climate interact.

"We're hoping that we can tie it all together. It's kind of a big, bold project," Shue said. "We're at the very beginning."

This research, funded by the National Science Foundation's Macrosystems program, is led by Sean McMahon, principal investigator of SERC's Quantitative Ecology Lab, and his colleague Nate Swenson at the University of Maryland.

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Summer Activities Lineup

Our popular Bay Optimism evening lecture series continues, with free talks on land preservation and cleaning up pollution. **Save the date for our keynote lecture October 17**, with Sherman's Lagoon cartoonist Jim Toomey. We've also got archaeology digs, a citizen science parasite hunt and the return of Saturday morning canoe trips. Our trails are open for hiking year-round—we're only closed Sundays and federal holidays!

Saturday Canoe Trips

(advance registration required)
Sat., Aug. 5, 9am-12pm
Sat., Aug. 12, 9am-12pm
$25/adult, $20/child 15 & under.
Contact Karen McDonald (mcdonaldk@si.edu or 443-482-2216) to sign up.

Citizen Science Projects

(advance registration required)
Contact Alison Cawood (cawooda@si.edu or 443-482-2271) to sign up.

Salt Marsh Plant Census
Weekdays, **Mon. July 24-Fri., Aug. 4,** 8:00am-4:30pm

Chesapeake Bay Parasite Project
Morning slots (9am-12:30pm) & afternoon slots (1pm-4:30pm) available all days
Fri., Aug. 11-Sun., Aug. 13
Wed., Aug. 16
Fri., Aug 18-Sun., Aug 20

Archaeology Dig Day
Sat., Aug. 12, 9:30am-3:30pm

Bay Optimism Evening Lectures

(free, no registration required)

"Bridging the Science-Policy Gap to Protect a Watershed"
with Greg Bowen
(American Chestnut Land Trust)
Tue., July 18, 7-8pm

"Clean Air, Clean Water: How Cutting Air Pollution is Helping Save the Bay"
with Lewis Linker (EPA)
Tue., August 15, 7-8pm

Photo: Kim Holzer

"Filtering Out Pollution with Riparian Buffers"
with Don Weller (SERC)
Tue., Sept. 19, 7-8pm

"Science Through the Eyes of Sherman's Lagoon"
with Jim Toomey
(cartoonist)
Keynote Robert Lee Forrest Lecture
Tue., Oct. 17, 8-9pm

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