Smithsonian Environmental Research Center

# ON THE EDGE

News from the Smithsonian Environmental Research Center

Fall/Winter 2015-16


## Feature:

## The Science of Resurrecting a Stream

ALSO INSIDE:

Spaghetti bryozoan found in Darwin's stomping ground

Methylmercury: New sources of the neurotoxin

Listening to life in the ocean

THE DIRECTOR'S LETTER

# Saving the Planet Isn't Simple. But It's Incredibly Satisfying.

Ecology is a messy science. Ask any field ecologist, and they could regale you with stories of trekking through alligator-infested mangrove swamps or wading waist-deep in the mud to collect soil cores from a marsh. In environmental science, slime and grime are often par for the course. But the messiness of ecology routinely goes beyond the physical. When your laboratory is a planet, the patterns aren't always neat or predictable. A web of elements weave together to create a picture that can take decades to understand. Nature is a complicated place to work.

Understanding the issues isn't simple, so neither is solving them. But *Homo sapiens* are a clever species. We can handle a little complexity.

Take seagrasses, for example. There are more than 20 species of underwater vascular plants in Chesapeake Bay, all with different growth requirements, sheltering different kinds of life. But for decades, reports on the health of the Bay have lumped them all into a single category. This fall, two ecologists looked deeper and discovered underwater plants also respond to pollution and other water quality issues differently. To restore them, we need to begin treating them like the separate species they are.

Or take the story of Muddy Creek, which you can find on page 4 of this newsletter. This year, the Smithsonian Environmental Research Center embarked on a project to restore a heavily eroded stream on our campus and reconnect it with its floodplain. But stream restorations are rarely straightforward. Many questions remain over what works and what doesn't.

So for this project, we're pulling out all the stops. Scientists are creating a thorough before-and-after study of the restoration, tracking many variables, from how much nitrogen moves from one end to the other to the types of trees growing in the floodplain. As the restoration moves forward, these data will help piece together a more complete picture of how to successfully bring a stream back to life.

These are just two issues we have taken on this year, and they're not even the most complex our world faces today. But that's why I love working at the Smithsonian. This is a place that encourages diving beneath the surface, looking beyond the simple and watching for changes over years and decades.

Our 50th-anniversary year is coming to a close. We've enjoyed half a century of messy, surprising and policy-shaping discoveries, and we couldn't have made them without partners like you. Your support will help us uncover more in the next 50 years.

The Earth needs more people able to embrace the intricacies of life. I believe humanity is capable of rising to the occasion. Will you?

—Anson "Tuck" Hines, director



***On the cover:***
*Technician Max Ruehrmund prepares to install a PVC pipe for sampling groundwater on the bank of Muddy Creek.*

*Female Holstein cow. Livestock are one of the key sources of methane to the atmosphere.* (Keith Weller/USDA)

## We've Been Underestimating Methane

For years researchers reported that the greenhouse gas methane is roughly 30 times more powerful than carbon dioxide ($CO_2$). But it's closer to 45 times more, says a new study in *Ecosystems*.

Today, most scientists calculate methane's harm with *global warming potentials*. They pick a timeframe (say, 100 years) and compare how much heat energy one pulse of methane traps versus an equal pulse of $CO_2$. But greenhouse gas emissions don't work that way in reality. They're emitted continuously. SERC's Pat Megonigal and colleague Scott Neubauer developed a new model examining what a series of pulses would do over a century. Under that model, methane had 45 times more heat-trapping potential than $CO_2$.

The older, one-pulse model has appeared in everything from cap-and-trade programs to international agreements. The new model could change things. "When you're doing research, we should be able to do better," Megonigal said.

## Bay Grasses Need Better Than "One Size Fits All"

Most research on Bay grasses focuses on salt-loving eelgrass and widgeon grass, which dominate lower Chesapeake Bay. But high-salinity zones contain just 16 percent of the Bay area where underwater plants can survive. Plants in less salty zones than those behave differently, finds an October study in *Marine Ecology Progress Series*.

SERC ecologists Chris Patrick and Don Weller tracked how underwater plants fared year-to-year in three salinity zones: low, medium and high. While nitrogen from rivers had the biggest impact in the high-salinity zone, plants in fresher water responded to suspended solids, spring chlorophyll levels and a host of other variables.

Restoring underwater plants may take a new approach. After all, the researchers point out, we manage Bay animals by species. Perhaps it's time to treat Bay plants the same way.

## Melting Permafrost, Dead Zones High-Risk for Methylmercury

Coastal dead zones, wetlands, thawing Arctic permafrost: These are just a few places scientists identified as high-risk for production of methylmercury, the neurotoxin in some seafood high in the food chain. The good news? The human body wasn't one.

In 2013, SERC microbial biologist Cindy Gilmour and Oak Ridge National Laboratory colleagues pinpointed two genes, collectively called *hgcAB,* that can transform mercury into methylmercury. In the first global survey of methylmercury-producing organisms, published October in *Science Advances*, they surveyed thousands of environments for the genes. Finding them in thawing permafrost suggests climate change could escalate the threat. But there's more good news: Most methylmercury in the food chain comes from newer, not older, deposits. If we control current mercury emissions, we stand a good chance of slashing the risk.

*Above Right: Eelgrass is just one of 23 species of submerged aquatic vegetation in Chesapeake Bay.* (NOAA)

*Right: Many wetlands contain microbes able to create methylmercury.* (Grace Schwartz/SERC)

# Resurrecting the Floodplain

## Uncovering the secrets to restoring a stream

by Kristen Minogue

*SERC senior scientist Tom Jordan stands in the heavily eroded streambed of Muddy Creek.*

IN THE FORESTS OF EDGEWATER, MD., A STREAM CALLED MUDDY CREEK IS SINKING. By itself this is hardly news. The Chesapeake's ailing streams span thousands of miles, and the watershed's states have devoted hundreds of millions of dollars towards trying to restore them. It's part of a gargantuan effort to clean up the Chesapeake. Sick streams create a sick bay, and environmental managers are anxious to stem the nutrient and sediment overload from streams. But for all the zeal surrounding stream restorations, their success rate hasn't always lived up to the hype. How effective can they be—and what do they need to succeed?

Fortunately, this stream happens to be under the watch of SERC scientists. And the restoration of Muddy Creek may yield some answers.

### Raising the Depths

Muddy Creek flows through the back woods of the Smithsonian Environmental Research Center (SERC). Its steep banks drop 10 feet to the streambed below, the product of decades of erosion. This spells trouble whenever storms break. A shallower, healthier stream would flood over its banks, letting water soak into the adjacent floodplain.

"That's why they call them floodplains," explained Tom Jordan, SERC nutrient ecologist and a principal investigator on the project. Floodplains can also trap sediments and the phosphorus often attached to them. But because of Muddy Creek's depth, it's completely cut off from its floodplain. The source of the erosion is the drainage culvert under nearby state highway 468. During storms, water speeds through and out of the narrow culvert, tearing away the banks and sending nutrients and other pollutants downstream.

"It's kind of like when you put your finger over a hosepipe and the water comes out quicker," said Joshua Thompson, a postdoc studying the stream in Jordan's lab. Thompson grew up near the source of the Hamble River in England. "Whenever it rained, I used to go out there to see the flow, because it was just such an awesome thing to look at," he said. "I got excited about, what happens? Where does the water go when it rains?"

Right now, much of this stream's water goes straight to the Bay. But Muddy Creek is on the verge of a relatively new kind of restoration, which will raise the streambed, restore its floodplain and—hopefully—slow it down.

The technique is called "regenerative stormwater conveyance." It entails filling a 450-meter (1350-foot) branch of the stream with sand and wood chips to raise the water level, and using boulders to create miniature dams to slow the water and provide stability. The stream itself will run underground during restoration, inside a small pipe that contractors will install at the very beginning. Once the sand and wood chips are set, they'll remove the pipe and water will bubble up over the top.

"I can't wait to see that," Jordan said. "I've heard it's pretty spectacular. First there's just dirt and then, boom, there's a stream."

*Funding for this project came from the Chesapeake Bay Trust, the Chesapeac
Trust Fund, and restoration contractors Underwood & Associates. SERC reta*

### Restoration in Real Time

For Maryland, the study couldn't have come at a more urgent time. The state needs answers. It has a federal mandate to slash nitrogen, phosphorus and sediments leaching into the Bay by 2025, since those are key culprits behind algal blooms and dead zones. The clock is ticking, and stream restorations are among the most popular solutions.

"People are passionate about Chesapeake Bay," said Chris Patrick, a SERC research associate monitoring the stream's aquatic life. "They want to fix it. They want to spend money to fix it."

Right now data are mixed on how well restorations work and the best way to do them. A 2013 study found while restorations can change how streams flow, they don't consistently remove nutrient pollution. Review papers examining dozens of other studies have found similar results: Many restorations aren't that successful.

However, restoration is a difficult thing to measure, Jordan pointed out—especially when it comes to removing nutrients and sediments. Impacts of groundwater, multiple tributaries, and never-ending changes in stream flow make total nutrient removal a hard figure to pin down.

The Muddy Creek project may be the most thorough attempt to get a full picture. Scientists will track the stream before, during and after restoration. They'll monitor how much nitrogen, phosphorus and sediment go into and out of the restored section, and compare it to an unrestored stream nearby. They're doing a similar restoration at an urban stream behind Annapolis Harbor Center, with another control stream.

Jordan's lab has already lined the Muddy Creek banks with white PVC pipes to sample groundwater nutrients. At both ends of the restoration, they've inserted instruments called *sondes*, electronic and optical sensors that take data on nutrients, acidity, oxygen and other water-quality indicators every 15 minutes. Other scientists, like Patrick, will investigate how the restoration impacts leaf decomposition, stream biodiversity and stream shape. They're even monitoring the trees. Oaks and beeches, which prefer dry soil, have grown up around the eroded stream. Once the floodplain returns, those species may vanish, and wetter species like maple and spicebush may replace them.

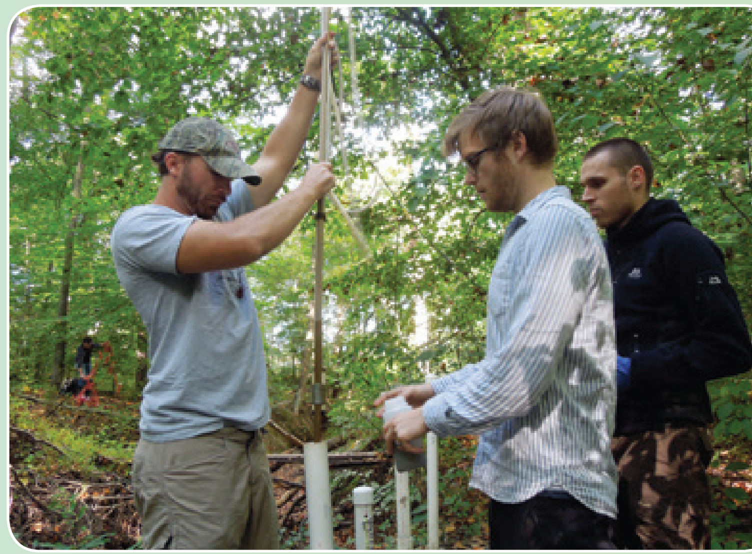
"This is a natural process," says Jay O'Neill, a technician in SERC's plant ecology lab which is tracking the trees. "These oaks and beeches, they're here, but they weren't part of the original, natural community."

Jordan is especially interested in tracking the different speeds and energies of the stream. If restored streams struggle to remove nutrients most during high-energy storms, creating larger or stronger restorations might be the solution. But the answers are still waiting.

"You're really taking a stream and pushing it in a direction that it doesn't normally go all of a sudden," Jordan said. "I don't know what we'll find."

*ake Rivers Association, the Governor's Chesapeake Bay and Coastal Bays*
*ins publication rights for all data.*

*SERC research associate Chris Patrick lays out a mesh of leaf litter to measure decomposition. "This should be a perennial stream. It should be wet right now….[T]he fact that the groundwater table has dropped so much is what's causing this bare bed."*



*Left to right: SERC Technician Max Ruehrmund, postdoc Joshua Thompson and intern Jan Kreibich take a water sample from one of the Muddy Creek piezometers (groundwater wells).*

*SERC technician Jay O'Neill (right) shows volunteer Steve Myers how to measure the width of a tulip poplar tree. The return of the floodplain could transform the forest as the soil becomes wetter.*

# What Does Ocean Life Sound Like? by Kristen Minogue

*Postdoc Erica Staaterman listens to the ocean for a living. Often seen as a silent landscape, special underwater hydrophones reveal that it harbors a wealth of sound from even its smallest creatures, which Staaterman shows in this abridged Q&A.*

Noel Tendick

*Erica Staaterman*

**Q: In California, you described a "chorus of mantis shrimp." What was that like?**
We called them rumble groups. Sometimes they would have two rumbles per group, sometimes three rumbles per group, sometimes four or five.

**Q: Why might only male shrimp make sound?**
Mantis shrimp dig burrows into the mud and they defend them really fiercely, especially during the mating season.… If you're a male and you have your burrow, you might want to stake your claim and call out and say, okay, I'm advertising for females, but I'm also advertising to the other males that this is my territory.

**Q: What do you think is the strangest animal sound?**
The Weddell seal. It's really wacky. It sounds like a spaceship.

**Q: Describe the purpose of your film festival series, Beneath the Waves.**
To encourage scientists to use film as a tool to communicate their research to the world. A lot of scientists are doing that now, especially with smaller, cheaper cameras and everything. We basically provide a platform for scientists to share their stories.

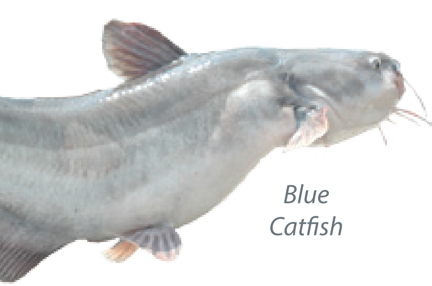
**Q: How would you like to use sound in the Chesapeake?**
Oyster reef restoration….It could be really useful if you could put a hydrophone in the water and say, oh, great, there's tons of oyster toadfish here and lots of gobies and lots of other sound producers. This is a good, healthy oyster reef—without having to jump in and try to survey it visually, because it's just really hard to see in these waters.

*Still curious? Read the extended Q&A and listen to recordings of ocean creatures at http://sercblog.si.edu.*

# Decoding Like a Spy by Heather Soulen

*Rob Aguilar of SERC's Fish and Invertebrate Ecology Lab co-authored a DNA barcoding paper this September in the journal Environmental Biology of Fishes. "DNA barcoding" is easiest to think about as a unique code for every species, Aguilar explains in this abridged Q&A.*

*Rob Aguilar*



*Blue Catfish*

**Q: Tell us about the paper.**
[It] was about using DNA barcoding to identify digested fish prey remains in the stomach contents of two non-native catfish species: the blue catfish and flathead catfish.

**Q: What is DNA barcoding?**
When people talk about DNA barcoding, they're talking about using a very short sequence of genetic code…. Different species will have different barcode patterns.

**Q: Why was DNA barcoding important for this paper?**
A lot of times when you look at gut contents of fish, prey items that are fish from the stomachs of other fish, they're heavily digested….You're like, "That is a fish, but I don't know what species that [fish] is." Particularly as many of the species are similar morphologically, even when they're alive and in pristine condition, so it gets really hard to tell those apart when they're digested.

**Q: You're doing a little DNA barcoding work here at SERC. What are the projects?**
We have two barcoding projects we're doing. One is, we're creating a complete genetic barcode library of fish and major invertebrates in Chesapeake Bay….Then we're doing our own gut content barcoding work where we're looking at the stomach contents of blue catfish, which again are non-native; channel catfish, which are not native but have been established in the Chesapeake Bay for a number of years; and the native white catfish. We're able to sequence the fish prey items from those catfish and then test them against our positively identified species that we've collected, and also other sequences collected by other researchers in the [DNA barcoding] databases.

*The Smithsonian Institution is a founding member of The Consortium for the Barcode of Life, which aims to collect DNA sequences from every species on Earth. Read the full Q&A at http://sercblog.si.edu*

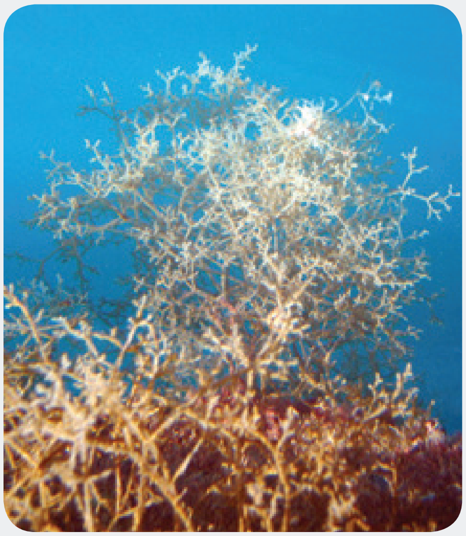
# Scientists Find Invasive Spaghetti Bryozoan in Darwin's Stomping Ground

by Linda McCann and Monaca Noble

The spaghetti bryozoan *(Amathia verticillata)* adds the Galápagos Islands to its long list of invaded regions.

This species is particularly known for its massive size and fouling ability. As its name implies, it looks a lot like spaghetti, and early researchers gave it equally colorful descriptions, such as "clumps of freshly cut hay," "great tangled streamers," "dirty strands of cellophane noodles" and, finally, "large clumps of transparent spaghetti."

In the Galápagos, Smithsonian researcher Linda McCann first discovered the noodle-like strands of this animal while snorkeling in Tortuga Bay, a semi-enclosed embayment near the town of Puerto Ayora on the south side of Santa Cruz Island. McCann was participating in the first International Workshop on Marine Bioinvasions of Tropical Islands at the Charles Darwin Research Station. During the workshop, a more detailed survey of the Puerto Ayora vicinity was undertaken with several additional scientists. They discovered the species in Franklin's Bay, a second small embayment just outside of Puerto Ayora. Oddly, the species was not found in Puerto Ayora, despite this being the main region of boat traffic on this island.



*Of unknown origin, the spaghetti bryozoan has clogged fishing gear and killed native seagrasses in U.S. ports. Dan Minchin/Marine Organism Investigations*

*Linda McCann heads to a sampling site in Panama. McCann studies marine life all along the West Coast of North America.*

This unusual bryozoan had previously invaded the United States West Coast, where it was first detected in the early 1900s. It is so widely distributed that its native region is difficult to determine. But several regions are good candidates, including the Gulf of Mexico, the Caribbean, and the southern part of the U.S. East Coast. Published records of impacts are rare, but it has killed off sections of native seagrass beds in San Diego Bay, fouled boats in California, and clogged shrimp-fishing gear in Galveston Bay, Texas.

The spaghetti bryozoan is a colonial animal made up of many individuals called *zooids*. The zooids feed by extending their tentacles into the water column and funneling food particles into their mouths. The zooids are hermaphroditic, meaning they have both male and female reproductive organs. They produce large yolky eggs that hatch into planktonic larvae, which usually settle on a hard substrate within hours.

This bryozoan could have attached to floating debris rafting across the ocean, so natural dispersal to the islands can't be ruled out. But the Galápagos are over 1000 kilometers from the nearest continent. Thus, it seems likely that a ship or boat hull brought the species to the Galápagos.

Many recreational vessels visit the Galápagos from all over the world. The islands have seen a dramatic increase in tourism in recent years, and Puerto Ayora is a major hub for waterborne transportation throughout the island chain.

Potential impacts to this world heritage site of the spaghetti bryozoan and other invaders are of considerable concern, and were a major focus of the recent workshop in Puerto Ayora. We don't yet know whether this bryozoan occurs on any other islands in the Galápagos chain, as there are still limited surveys to evaluate the extent of marine invasions here. Smithsonian scientists plan to go back to the Galápagos in April 2016 to do a more extensive survey of the islands' fouling communities, working with a team of local and visiting scientists to more thoroughly survey these spectacular marine communities and develop strategies to minimize future invasion risks.

*This discovery was published in BioInvasions Records (2015) by Linda McCann, Inti Keith, Dr. James Carlton, Dr. Gregory Ruiz, Dr. Terence Dawson, and Dr. Ken Collins.*

SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER
1965–2015

P.O. Box 28
647 Contees Wharf Road
Edgewater, MD 21037

# SURPRISE: $6 Million Anniversary Gift Largest in SERC History

The night of September 12 was supposed to be about celebrating the past. But before the sun set over the ruins at the Smithsonian Environmental Research Center's 50th-anniversary dinner, new Smithsonian Secretary David Skorton announced a surprise gift: An anonymous $6 million donation that paved a new path for the future.

"This is an organization that doesn't have alumni," Skorton said. "This is an organization that brings people together because of the ability of the scientists, the professionals here, the communicators, to deal with what has got to be one of the two or three biggest problems on the Earth right now."

The anonymous donors (still living) are leaving $6 million dollars as a planned gift, or part of a will. Donating via will is a time-honored tradition at the Smithsonian. The half-million dollar gift that launched the Institution in 1846 came from the will of Englishman James Smithson. SERC began when dairyman Robert Lee Forrest willed his 368-acre farm to the Smithsonian. The recent donation will help establish an endowment to support SERC's research and education. It will enable scientists to make more discoveries and allow SERC to inspire more students to explore nature.

*L to R: Roger Krone, Hellen Krone, Dr. David Skorton (Smithsonian Secy), John Schwieters*

*Interested in joining the mission? Visit http://serc.si.edu and learn how you can support discoveries in the Chesapeake, California, Alaska and around the world.*

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

443-482-2200 • www.serc.si.edu

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

All photos are credited to SERC unless otherwise noted.

**On The Edge**
Kristen Minogue – *writer, editor*
Christine Dunham – *copy editor*
Sarah Conway – *graphic designer*