Smithsonian Environmental Research Center

# ON THE EDGE

News from the Smithsonian Environmental Research Center

Spring 2020

## Special Issue: Earth Optimism

*Looking to the Future as Earth Day Turns 50*

**ALSO INSIDE:**

*Left: Tuck Hines as a Ph.D. student at the University of California, Berkeley. Right: Tuck Hines as director of SERC. (Photos courtesy of Tuck Hines)*

THE DIRECTOR'S LETTER:

# Earth Day, Fifty Years Later

It was September of 1969. I was just arriving to start a Ph.D. program in marine zoology at U.C. Berkeley. To get there, I had driven past an oil spill in Santa Barbara that had spewed 3 million gallons of crude oil into the sea months earlier. I also passed Monterey Bay, where sea otters and whales had not yet returned. It was a chaotic time, even more polarized than today—war in Vietnam, the draft, civil rights protests, marches, violence and heated rhetoric. But the most powerful impact on me was the intensity of environmental challenges I had experienced growing up in Hawai'i and California. The hippie lifestyle was in full swing, but so were pollution, traffic and habitat-destroying development.

That same month, a Wisconsin senator named Gaylord Nelson suggested something revolutionary. Inspired by student teach-ins protesting the Vietnam War, he proposed a nationwide teach-in for the environment. Seven months later, on April 22, 1970, Earth Day was born.

*Senator Ed Muskie, author of the 1970 Clean Air Act, speaks to a crowd of 40,000-60,000 people at the first Earth Day in Philadelphia. (Credit: Peter54321. Creative Commons license: https://creativecommons.org/licenses/by-sa/3.0/deed.en)*

The first Earth Day was a big day at Berkeley, full of students giving soapbox speeches laced with colorful "free speech," tie-dyed clothes and the aroma of marijuana that gave way to acrid teargas. I knew then that I had to find solutions to the complex environmental decline. For me, that meant a life pursuing environmental science.

On the other side of the country, the Smithsonian Environmental Research Center was just five years old. Still a small field station called the "Chesapeake Bay Center for Environmental Studies," it had only begun building a larger vision for a permanent presence on the Bay.

Where are we now, half a century later?

For the U.S., the 1970s ushered in a new era of ecological action. The Environmental Protection Agency, Clean Water Act and Endangered Species Act all emerged in that decade. U.S. Senator Charles McC. Mathias convinced Congress to fund $27 million for research to save the ailing Chesapeake Bay. SERC scientists helped discover a solution to one of its woes—planting streamside forests to absorb excess nutrient pollution from farms.


*Marchers at the Earth Day March for Science in 2017. (Credit: Amaury Laporte. Creative Commons License: https://creativecommons.org/licenses/by-nc/2.0/)*

And yet.

Oil spills still make headlines. Students are striking nationwide, this time to raise awareness of climate change. And now, a pandemic has brought much of society to a standstill.

It is time to renew the spirit of that first Earth Day. At the Smithsonian, we call this movement **Earth Optimism**.

Like so many people, we've had to make adjustments for the pandemic virus. A three-day Earth Optimism summit originally planned in Washington, D.C., has gone all-digital. We've had to temporarily close our campus, cancel or postpone events, and direct many staff to telework.

But I've been amazed at the resilience I've seen, inside and outside the Smithsonian. Educators remain committed to their students, rethinking months of lesson plans to teach online. In response, our colleagues have unleashed the Smithsonian's vast troves of digital resources. Stories from the Earth Optimism summit became accessible to new audiences now, at a time when the world needs positivity.

Some of those stories are in this newsletter. Mercury pollution is falling across Maryland. Scientists are finding secrets to conserving Alaska's salmon. We even have an interview with a student striker, a young girl who began her journey as a SERC homeschool student.

Earth Optimism was made for challenging times like these. We have the solutions to meet today's problems. And as the last weeks have shown, our society has the grit to step up and meet a crisis head-on. We need only scale up the solutions, channeling the determination of the human spirit.

What will your legacy be? This year, as Earth Day turns 50, find the story that inspires you and join us.

**— ANSON "TUCK" HINES, SERC DIRECTOR**

**Learn more at https://earthoptimism.si.edu**

***Editor's Note:*** *In the fall 2019/winter 2020 issue, the intern spotlight on Chaz Rhodes said, "Methanotrophs emit methane, and methanogens consume it." Methanogens emit methane, and methanotrophs consume it. The mistake was the editor's, not the author's, and we regret the error.*

*Front cover image: Sarah Gignoux-Wolfsohn in Bocas del Toro, Panama. (Photo courtesy of Sarah Gignoux-Wolfsohn)*

*This Alaskan peninsula is one of the few remaining places on Earth where salmon are still sustainable. (Credit: Kelsie Moore)*

# Preserving Salmon In Alaska's Kenai Lowlands

BY KRISTEN MINOGUE

**"Not everybody in Alaska is a fisherman. But all of us live on salmon land....Salmon are like the heartbeat."**

These words, spoken by young Alaska fisherwoman Hannah Heimbuch, open a short documentary the Smithsonian created called *The Heartbeat*. Featured in the D.C. Environmental Film Festival this March, it tells the story of Alaska's Kenai Lowlands—one of the few places on Earth where salmon remain sustainable.

SERC ecologist Dennis Whigham, also in the film, has studied Alaska's landscapes and headwater streams for over 15 years. Whigham looks at the entire ecosystem to uncover what salmon need, and which "hotspots" are most important to protect. It's part of a larger collaboration, with Alaska's Kachemak Bay National Estuarine Research Reserve, Baylor University and the University of South Florida.

Much of the team's work focuses on two nutrients young salmon depend on: nitrogen and carbon. While many ecosystems like Chesapeake Bay suffer from excessive nitrogen pollution, here in Alaska, natural sources of nitrogen are critical. In streams where both carbon and nitrogen abound, young salmon can thrive.

"These are places you don't want to screw up," Whigham said.

Alder trees supply nitrogen through bacteria in their roots. Peatlands and bogs provide carbon via decomposition. For a long time, ecologists were skeptical of how much a certain type of carbon from land—"dissolved organic carbon"—could really impact streams. But in a January study, Whigham and his partners revealed adding even a little more carbon can spiral up the food web. Burgeoning algae and phytoplankton led to more insects and other stream invertebrates. That in turn nearly doubled the salmon population in regions near the extra carbon.

Today, the team hopes to map carbon-nitrogen hotspots to target for salmon conservation. They've already had some success reaching out to stakeholders. One landowner moved a proposed project when it became clear the original spot would destroy alder trees. Another group used the team's discoveries on good salmon habitat to purchase land for a local land trust.

Native American students have also joined Kachemak Bay National Estuarine Research Reserve staff in the field to observe juvenile salmon.

"They've never seen juvenile fish," Whigham said. "They live in communities that live off of fish, but they've never seen a baby fish."

Climate change still looms. Warmer waters spell trouble for young salmon that like it cold. But, Whigham pointed out, wetlands can supply cooler groundwater. Alaska certainly has the will to save its salmon. It may keep finding a way.

*Juvenile salmon swim in a sampling container, held by Coowe Walker, manager of Alaska's Kachemak Bay National Estuarine Research Reserve. (Credit: Kelsie Moore)*

*Watch the 10-minute documentary* **The Heartbeat** *and learn more about the Salmon and People Project at https://global.si.edu/projects/salmon-and-people-project*

**Link to salmon and carbon study in *Freshwater Biology*:** https://onlinelibrary.wiley.com/doi/abs/10.1111/fwb.13478?af=R

*Above: Botanist Dennis Whigham takes sampling equipment into the field in the Kenai Lowlands, Alaska. (Credit: Kelsie Moore)*

# We're Winning the Fight Against Mercury Pollution

BY KRISTEN MINOGUE

**Marylanders can celebrate at least one environmental win this year. Since 2005, toxic mercury in the state's rain has dropped over a third.**

**The new figure comes from three state monitoring stations: Beltsville, Frostburg and a weather tower in Edgewater, at the Smithsonian Environmental Research Center (SERC). All three stations belong to the Mercury Deposition Network, a collection of roughly 100 sites tracking mercury across the U.S.**

**Maryland's success partially stems from early regulations—most notably the 2006 Healthy Air Act. The act mandated reductions for some of the most dangerous pollutants in the atmosphere: nitrogen dioxides that create smog; the sulfur dioxide behind both smog and acid rain; and, of course, mercury.**

**"We've had a long time to see those changes happen," said senior scientist Cindy Gilmour, who runs the mercury station at SERC. "Other U.S. states have not had those rules in place as long." The federal government issued its first rule on mercury emissions in 2011, with the Mercury and Air Toxics Standards for Power Plants.**

**Gilmour launched SERC's mercury monitoring program in 2007. At the time, SERC's 120-foot meteorological tower was already collecting data on weather and other chemicals in rain.**

**"I thought it would be great to put mercury on top of that," she said. She approached the Maryland Department of Natural Resources and suggested adding SERC as a third Mercury Deposition Network site in Maryland. "We said, guys, you're just about to put mercury controls on power plants. This would be a great time to start looking at this." The state has funded SERC's mercury station ever since, as well as SERC's projects monitoring mercury and the neurotoxin methylmercury in streams.**

**For Gilmour, the falling mercury in rain marks a major milestone. But it's only the beginning of a long journey. Slashing mercury concentrations in rain is one step; tracking it in streams and food webs is another. Her lab will continue watching mercury, to help ensure Maryland continues moving forward.**

**And while improvements didn't come cheap—Gilmour estimates pollution control systems cost roughly $1 billion for each large power plant—for taxpayers, more breathable air cost just a few extra cents per month.**

**"For a few cents on our electric bills over the last 10 years, we got this," Gilmour said. "We also got reductions in asthma. We got increases in how clear our air is. The air's less yellow and it's more transparent."**

*Above: SERC's 120-foot weather tower, where scientists have been collecting data on mercury in rainfall since 2007. (Credit: Kristen Minogue/SERC); Background Photo: The steam billowing out of Maryland's Chalk Point Power Plant has already passed through emissions-cleaning technology, thanks to healthier air regulations. (Credit: Cindy Gilmour/SERC)*

# EIGHT WAYS WE CAN SAVE THE OCEAN'S OXYGEN

BY KRISTEN MINOGUE

The ocean is losing its breath. Two years ago, an international team of scientists known as $GO_2NE$ (the Global Ocean Oxygen Network) published a report in Science with a stark picture of oxygen loss in Earth's waters. It's a problem not just for animals, but for people and economies—especially those that rely on tourism or subsistence fishing.

*Denise Breitburg, a scientist emeritus with the Smithsonian Environmental Research Center, authored an IUCN report on ways to restore the ocean's oxygen. (Credit: Tina Tennessen/SERC)*

This winter, a new report emerged from the International Union for the Conservation of Nature. The ocean could lose 3-4% of its total oxygen by the end of the century if nothing changes. Large fish like tuna, sharks and marlin are among the most vulnerable. In the closing chapter, led by Denise Breitburg of the Smithsonian Environmental Research Center, the authors created a massive blueprint for resuscitating the ocean.

The key lies in cracking two conundrums—**nutrient pollution** and **climate change**. Nutrient pollution happens when chemicals like nitrogen and phosphorus fuel massive growths of algae, which suck oxygen from the water. Climate change is more subtle, but just as powerful: Warmer water can't hold as much dissolved oxygen. Warm water also doesn't mix as well, so oxygen from the atmosphere that's abundant near the surface doesn't reach all the deeper water that needs it.

Fortunately, these two problems are linked. Solving one can help the other—and the ocean will breathe easier for it.

## HERE ARE EIGHT SOLUTIONS FROM THE REPORT:

1. **TREAT WASTEWATER TO GET RID OF NITROGEN AND PHOSPHORUS.** Cleaning up sewage isn't glamorous, but it works. Ask the residents of Great Britain, who saw oxygen in the Thames River rebound in the 1960s and 1970s, when they treated their wastewater to remove both chemicals. A 10-fold increase in the number of species in the river followed. Cities are hotspots for nutrient pollution. Making their copious waste a little cleaner can go a long way.

2. **MAKE FARMING MORE EFFICIENT.** Much of the nutrient pollution comes from excess fertilizers, which flow into water bodies and create oxygen-sucking algal blooms. Setting reasonable limits on the amount of nutrients plants receive—while ensuring they get what they need—could save farmers money and help the ocean. Better farming practices could also help solve climate change: Agriculture is responsible for roughly 10% of human greenhouse gas emissions worldwide.

3. **CAPITALIZE ON FORESTS AND WETLANDS.** Plant them, preserve them, restore them; forests and wetlands are indispensable for absorbing carbon from the atmosphere. But in the right places, they can also combat nutrient pollution. Beside streams, they can absorb nutrient pollution before it enters the water.

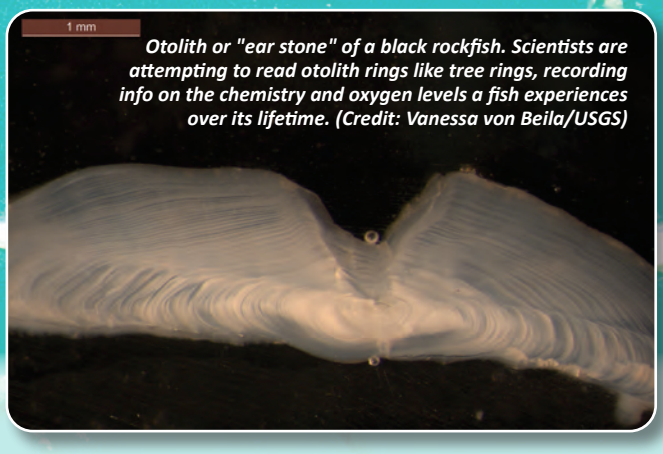
4. **DEPLOY REAL-TIME MONITORING NETWORKS.** The Argo Float Programme has over 4,000 floats in ocean waters around the world. More than 300 have oxygen sensors that take data every 10 days. Monitoring networks can help detect low-oxygen events in the ocean when they occur, enabling governments to respond quickly. They can also detect patterns, making it easier to predict when seasonal low-oxygen events in the ocean will happen and how long they will last.

*Researchers deploy an Argo float in the Indian Ocean. (Photo: Alicia Navidad,/CSIRO. Map: JCOMMOPS)*

5. **USE FISH AS "MOBILE MONITORS."** Fish have small, calcified growths called **otoliths** in their ears. As they grow, they record the chemistry of the water as the fish travels through it. Scientists are just now starting to read these otoliths like tree rings, attempting to trace when and where in their lives fish have passed through low-oxygen waters.

6. **ACT GLOBALLY AND LOCALLY.** When an issue impacts the entire world—be it climate change, low oxygen or plastic pollution—international networks are critical for understanding the full scope and shaping policy. The $GO_2NE$ team was the first such network to make studying ocean oxygen loss its key mission. But it's important not to overlook local and

*Background photo: Sea bass inside Gray's Reef National Marine Sanctuary in Savannah, Georgia. (Credit: Greg McFall/NOAA)*




*Otolith or "ear stone" of a black rockfish. Scientists are attempting to read otolith rings like tree rings, recording info on the chemistry and oxygen levels a fish experiences over its lifetime. (Credit: Vanessa von Beila/USGS)*

regional work. That's where leaders make decisions about restoration and green infrastructure. It's also where new initiatives get field tested. If these programs succeed—and often even if they *fail*—they provide valuable lessons for communities elsewhere.

**7 LOOK AT THE WHOLE ECOSYSTEM.**
When oxygen plummets, it can reverberate through the entire marine food web. But for decades, governments have set fishing rules that treat each species separately, like an island–crabs, oysters, salmon, tuna. That's starting to change. Managers are beginning to embrace more "ecosystem-based" approaches. For low oxygen, this could mean setting size limits to protect species that are vulnerable when they're young and small. Or, it could mean avoiding fishing in certain places or seasons when animals are most threatened by low oxygen.

**8 CREATE MARINE PROTECTED AREAS WITH FLEXIBLE BOUNDARIES.** Marine protected areas work. Study after study has shown they're among the most successful programs for helping fish populations rebound, increasing catch outside protected areas, and helping fisheries remain strong in the face of climate change. Adding low oxygen into the equation could make them even more resilient. Many low-oxygen events are seasonal, especially on the coast where most fishing takes place. Flexible boundaries would help protect animals when and where they're most vulnerable, while still allowing fishers to make a living.

*Streamside forests like this one can help absorb harmful nutrient pollution, stopping it before it reaches the ocean. (Credit: SERC)*

For years the ocean's struggle to hold onto its oxygen has gone largely unnoticed. But the good news, as the new report points out, is that we don't need to solve every challenge separately. One set of solutions can solve a multitude of threats—including threats to developing nations and their economies, where many people don't have the luxury of moving away when resources dry up.

Even more encouraging: Most of these solutions are in place somewhere in the world. The challenge now is scaling them up. The report doesn't promise the road will be smooth. Some will take serious financial commitments. But the payoff is a healthier, more bountiful ocean for decades to come.

## THE FULL IUCN REPORT, "OCEAN DEOXYGENATION: EVERYONE'S PROBLEM" IS AVAILABLE HERE:

**https://portals.iucn.org/library/node/48892.**
**Chapter 11 outlines adaptations and solutions.**

*The Global Ocean Oxygen Network ($GO_2NE$) is a working group of UNESCO's Intergovernmental Oceanographic Commission. Created in 2016, the $GO_2NE$ team is dedicated to better understanding the causes and impacts of oxygen loss in the world's ocean. Learn more at https://en.unesco.org/go2ne.*

*Brown chromis fish in Flower Garden Banks National Marine Sanctuary. (Credit: Emma Hickerson/NOAA)*

# DONOR SPOTLIGHT:

# CHRISTINE ARENA

BY KRISTEN MINOGUE

*One of the newest members of SERC's advisory board, Christine Arena is a communications veteran with a passion for environmental and social issues. In 2018, she produced the documentary series* Let Science Speak. *Today, she's donating her time and talent to help produce videos for SERC. Her newest short film premiered this April at the Smithsonian's digital Earth Optimism summit. In this Q&A, she talks about what gives her purpose and optimism. Edited for brevity and clarity. Read the full Q&A at https://sercblog.si.edu.*

**What drew you to join the SERC advisory board?**
I live by the San Francisco Bay. Over the last century, the Pacific Ocean has risen 4 to 8 inches along our shores, and it could rise another 2.4 to 3.4 feet by 2100. That is why SERC's research to understand rapid change in coastal communities is so critical.

Not only do we need to spark a more inclusive conversation about climate change impacts, but we need to encourage a broader community of scientists, policymakers, business leaders and other experts to collaborate on the solutions. The Smithsonian is uniquely positioned to facilitate both.

**What inspired you to tell scientists' stories?**
I consider scientists our front line of defense when it comes to climate change, so it's a privilege to help tell their stories. I also appreciate that different communities have different ways of processing information and thinking about climate change.

*(Photo courtesy of Christine Arena)*

Human stories told by trustworthy people can break through to some audiences more effectively than a statistic, chart or graph. Scientists' personal stories can help establish trust, while relaying important information about how climate impacts us and what we can do—and are already doing—to fix it.

**What gives you hope and optimism for Earth's future?**
It can feel overwhelming to work in a space where we are constantly assessing the damage wrought by the climate crisis. But this clarity can also be a gift, one that forces a sincere engagement. I believe what matters most is what we do *right now*. We have a short window of time, and the solutions are now within our reach.

This is America's modern moonshot moment, and the corresponding sense of urgency leaves no room and no time for despondence. Am I optimistic? Perhaps "determined" is the correct word. This nation can and will come together across party aisles and generational divides and rise to our greatest challenge. We absolutely must.

*Watch the Let Science Speak video series at www.letsciencespeak.com*

# Volunteer Spotlight: Kallan Benson on Speaking Up for Climate and Turning Down the U.N. BY KRISTEN MINOGUE

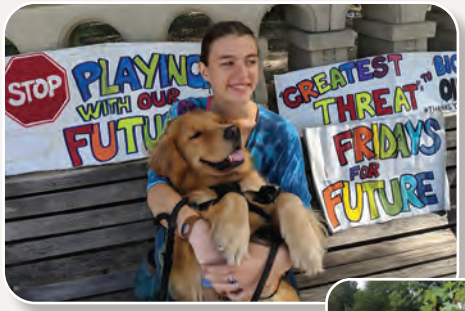
It would be tempting say Kallan Benson isn't your typical student. Homeschooled since preschool age, she remembers doing SERC's homeschool programs with her younger brother, Reece.

"We made toothpaste one time," she recalled. "Reece's group, him and two of our other friends, their strategy was just put everything in….Every flavor, they just put it all in. No one wanted to taste it."

But as a Fridays For Future organizer, Kallan is one of thousands. The tidal wave of students striking for climate action is gaining momentum. Benson is among those leading the charge.

Environmental stewardship has a long history in the Benson house. Her mother, Kimberly, is a former marine scientist with the National Oceanic and Atmospheric Administration. Her father, Carl, helped create Climate Stewards of Greater Annapolis. The family has also studied and volunteered at SERC for over a decade, searching for "zombie" mud crabs, tending trees in SERC's BiodiversiTREE forest and Fossil Atmospheres project, and tagging saw-whet owls.

Fridays For Future began in fall 2018, inspired by then-15-year-old Greta Thunberg's decision to sit outside the Swedish parliament each Friday to demand climate-friendly policies. Kallan began striking in the U.S. that December. Fridays For Future doesn't advocate for a specific policy or party. Rather, their mission statement reads, "We profoundly appreciate all efforts to find solutions to the climate crisis."




*Kallan Benson, with the family's golden retriever, Osage. The dog is their unofficial "Climate Anxiety Therapy." (Credit: Carl Benson)*

*The Benson family (Kallan, Kimberly and Reese from left to right) help care for SERC's BiodiversiTREE forest in 2016. (Credit: SERC)*

They got a curveball last September, when the United Nations announced Fridays For Future would receive one of its Champions of the Earth awards. As Kallan and roughly a dozen other members scrambled to write an acceptance speech, a radical idea emerged. They would turn the award down.

"We said we would hold the award, to give back to our leaders when they actually took action," Kallan said. "Because in our view, we're kind of the facilitators to grow the political will. But they're the ones that are really going to have to make large-scale change."

It's difficult to predict exactly what that change will be, Kallan said. Renewable energy is an obvious step. But the world of 2100 largely depends on which climate impacts can be stopped and which require adaptation. However, she remains doggedly hopeful.

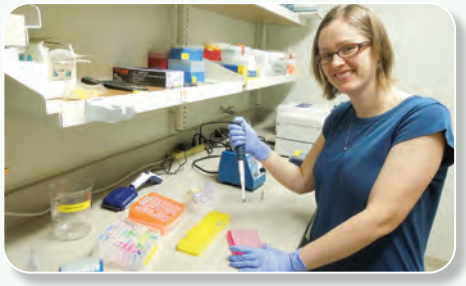
"Climate activism really helps with some of that climate anxiety," she said. "It helps you to move forward and feel like you're actually doing something. But also, it's a huge issue, which means that our action has to be just as big. We have to be out there."

# In Florida's Oceans, It's DNA vs. Disease

BY KRISTEN MINOGUE

Parasitic slime nets attacking seagrasses. A disease that melts coral tissue down to the skeleton, whose exact cause remains unknown. If these aren't the first places you'd look for optimism, you're not alone.

Katrina Lohan heads SERC's Marine Disease Ecology Lab. She and postdoc Sarah Gignoux-Wolfsohn studied both ailments in Florida. They look for hope in the microscopic realm of DNA.



*Katrina Lohan, head of SERC's Marine Disease Ecology Lab. (Credit: Kristen Minogue/SERC)*

This January they published two papers searching for microbes infecting seagrasses and corals, using a technique called *metabarcoding*. Metabarcoding makes thousands of copies of one tiny DNA section. By targeting DNA common to many organisms in a sample, biologists can sequence—and if they're lucky, identify—every organism present.

"Genetics is really cool, because it offers you a much better picture of what's actually present," Lohan said.

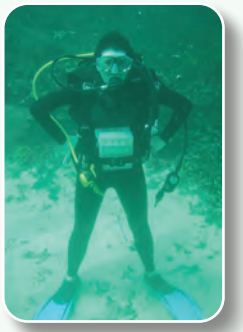
For seagrasses, Lohan knew exactly what to look for: a slime net called *Labyrinthula*. However, many *Labyrinthula* species exist. Not all cause seagrass wasting disease. So, Lohan tested two DNA sections to see which better identified disease-causing slime nets. The first identified a dozen slime nets, but only one was infectious. She lucked out with the second: It found only infectious ones.

Gignoux-Wolfsohn's task was less straightforward. She studied a 2014 outbreak of white band disease in Florida's staghorn corals with Miami ecologist Bill Precht and three others. But no one knows what causes that disease. Her study tackled another question: *What microbes keep corals healthy?*

Previously, she'd noticed healthy corals in Panama generally shared one bacteria genus—*Endozoicomonas*. That genus was all but absent on Florida corals she sampled. Florida corals—even ones without outward disease signs—teemed with *Rickettsiales* bacteria. It's possible *Rickettsiales* makes corals more vulnerable.

Gignoux-Wolfsohn's study also unearthed a direct link between hotter temperatures and white band disease. Today, heat and other environmental stressors could be transforming corals down to their microbes.

"Corals in Florida are obviously dealing with a lot more stress than the corals in Panama," she said. "They're right next to Miami Beach."



*Sarah Gignoux-Wolfsohn diving in Bocas del Toro, Panama. (Photo courtesy of Sarah Gignoux-Wolfsohn)*

But knowing which bacteria make corals more resilient—and which environmental conditions boost those bacteria—could up the chances of successful restorations, she added.

For Lohan, tools like metabarcoding are cause enough for optimism, even if they're just beginning to reveal answers.

"There is this part of me that has optimism in human ingenuity, and our ability to continue to create new technologies that help us learn more," she said.

**Link to seagrass study in Diseases of Aquatic Organisms:** https://www.int-res.com/abstracts/dao/v137/n2/p145-157/

**Link to coral study in Diseases of Aquatic Organisms:** https://www.int-res.com/abstracts/dao/v137/n3/p217-237/

*Top photos: Staghorn corals* (Acropora cervicornis) *with white band disease. (Credit: Sarah Gignoux-Wolfsohn and Bill Precht)*

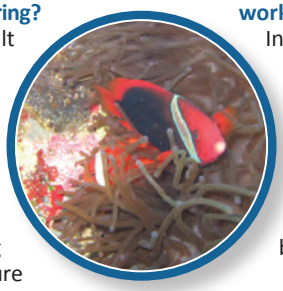
# Sarah Donelan: How Animal Parents Buff Up Children Before Birth

BY KRISTEN MINOGUE

***Every parent wants to give their children the best shot at life. But some species can toughen their offspring before they enter the world. It's called transgenerational plasticity. This Mother's Day, we're celebrating the moms (and dads) in nature that use it. Learn more in this Q&A with SERC postdoc Sarah Donelan. Edited and condensed for clarity.***

**How does "transgenerational plasticity" allow parents to change their offspring?**

The environment an adult experiences during its own lifetime can have effects on how its offspring behaves....Parents can give information to their offspring without talking to them. They do this via passing along chemicals, like hormones, that can help or hurt the offspring during their lives, or by making sure their offspring are born in a certain environment.



**What kinds of animals experience this?**

There's some cool work in coral reef fish. There's work out of Australia that has shown that increased acidification and temperature have negative effects on coral reef fish metabolism. They're more stressed. Their heart rate is higher, and they grow less. But there's work that shows that when parents are in acidified and warm conditions, the offspring aren't affected negatively.

**Where does transgenerational plasticity work well?**

In certain situations, we hypothesize, the environmental stressors are just exacerbations—stressors organisms have seen previously. Now they're getting more extreme. We predict that in those situations, parental effects, transgenerational plasticity, may be beneficial.

**How could it backfire?**

By the introductions of entirely [new] cues, like road noise or buildings going up. Parents can't accurately perceive what those cues are, or they may misinterpret those environmental cues.

*Sarah Donelan in Wellfleet, Massachusetts. (Credit: Patricia Donelan)*

**What does this mean for animals we see outside?**

If you see a butterfly in your garden, monarchs are migratory, so the environment a monarch experienced in Mexico or further south is still affecting how it's behaving in your garden.... Organisms are products of their past. And I think that's a really good thing to remember, in that we have to think all ecosystems are connected.

**Read the extended Q&A:**

https://sercblog.si.edu/sarah-donelan-how-parents-prep-offspring-for-tough-lives-before-birth/

*Left photo: Red and black anemone fish. Research has shown that if parents of coral reef fish like this experience ocean acidification, their offspring are better adapted to cope. (Credit: Dwayne Meadows/NOAA)*

SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER
1965–2015

647 Contees Wharf Road
Edgewater, MD 21037

## We're looking forward to welcoming you back to the SERC campus as soon as it is safe.

*In the meantime, we hope everyone reading this remains healthy and resilient as we weather the pandemic together.*

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

Visiting hours: Mon.-Sat., 8:30am-4:30pm. Closed Sundays & federal holidays.

**443-482-2200 • www.serc.si.edu**

All photos are credited to SERC unless otherwise noted.

**ON THE EDGE**

Kristen Minogue – *writer, editor*
Stacey Saadeh Smith – *designer*
Christine Dunham – *copy editor*

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