Smithsonian Environmental Research Center

ON THE EDGE

News from the Smithsonian Environmental Research Center

Summer 2021

Meet The Ocean Of 2030

The United Nations' Decade of Ocean Science prompts new visions for a sustainable ocean of the future

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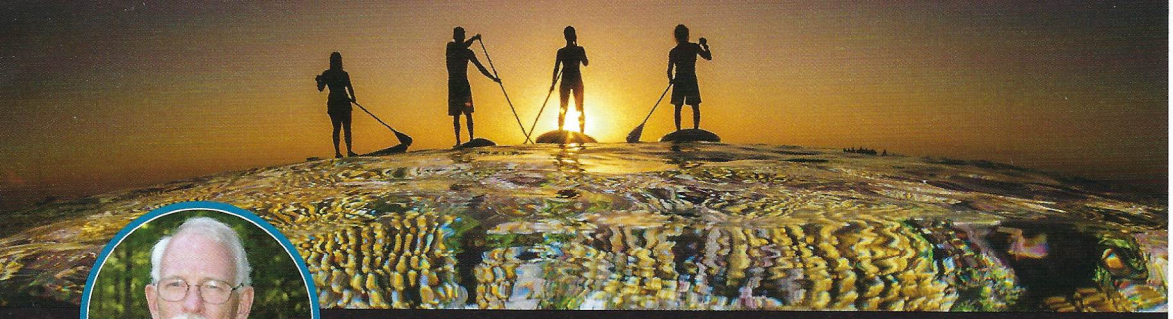
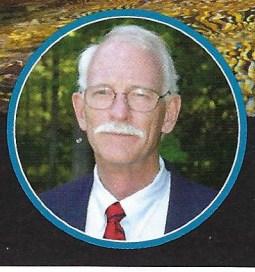
Greg Ruiz: Marine Invasions Pioneer & Service to America Medal Finalist





THE DIRECTOR'S LETTER:

Are We Ready To Dream Big Again?

On planet Earth, over 90% of the area that can support life is underwater. Most life on land—including humans—wouldn't survive without the ocean. Yet we know surprisingly little about it. Despite decades of exploration, scientists estimate we've discovered less than half of the species that dwell beneath the waves.

This year, the world is beginning to dream big again. And for many, those dreams are of the ocean.

The United Nations has declared 2021-2030 the Decade of Ocean Science for Sustainable Development, or "Ocean Decade" for short. The Ocean Decade calls on the world to imagine a healthier, more bountiful ocean for everyone by the year 2030, and to support the science we need to get there.

It hasn't been easy to dream over the last year and a half. For some of us, it may feel like our dreams have shrunk: Make it to the next day, the end of the school year, the next family member to get a vaccine. When we dared to look beyond that, we dreamed that perhaps, life might feel more normal next year.

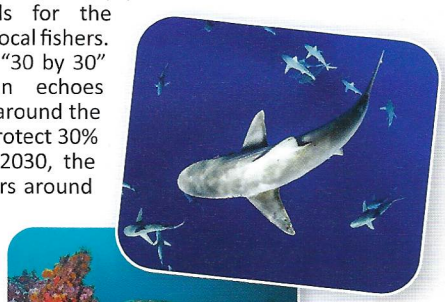
But the Smithsonian has always been called to dream big. So I was overjoyed to learn that on World Oceans Day June 8, not one but *two* Smithsonian projects received recognition from the United Nations as official "Ocean Decade Actions."

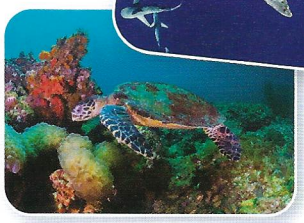
One of those projects, Marine Life 2030, is headed by SERC's own Dr. Emmett Duffy, director of the Smithsonian's Marine Global Earth Observatory. MarineGEO tracks changes in crucial nearshore marine ecosystems — saltmarshes, mangroves, seagrasses, oyster and coral reefs — that capture carbon, support high biodiversity and sustain nurseries for fisheries. Marine Life 2030 envisions a vast global network that anyone, anywhere, can tap into for information about their local sea life. Over the next 10 years, they'll work to uncover and connect knowledge of marine life from all over the world, including traditional knowledge from indigenous communities.

The second project, Coral Reef Sentinels, will deploy autonomous robots to keep tabs on coral health. Our Panama colleagues at the Smithsonian Tropical Research Institute are taking the lead on that one, with an assist from SERC.

You'll find more stories of life underwater within these pages. Our Fisheries Conservation Lab captured video proof of oyster restoration's success in the Chesapeake, using underwater cameras. Our Marine Invasions Lab made a shocking discovery that cannibalism can sabotage efforts to eradicate invasive crabs in San Francisco. You'll even hear echoes from the past, in a story of the lost shell button trade our citizen scientists are delving into.

The ocean has sustained humanity for millennia. After over a century of pollution and abuse, a decade may seem like a short time to restore it. But much can change in a decade. We know that marine protected areas — when they're truly protected — work, yielding dividends for the environment and local fishers. President Biden's "30 by 30" conservation plan echoes similar calls from around the world. If we can protect 30% of the ocean by 2030, the unprotected waters around them will reap the benefits.





So what will the ocean of 2030 look like? I dream of an ocean teeming with life. An ocean where once-endangered fisheries have bounced back, and communities have the power to learn whatever they need to about the health of their local marine life. An ocean without ever-spreading invasive species. And an ocean where nearshore "blue carbon" ecosystems are thriving to reduce climate change.

At the Smithsonian, we never stopped dreaming big. We hope you also find the inspiration to dream big this year.

- ANSON "TUCK" HINES, SERC DIRECTOR

Photos, Top to Bottom: Paddleboarders over a coral reef at sunset. Besides food, a healthy ocean is also a valuable source of tourism and recreation. (Credit: Grant Thomas, Ocean Image Bank); Sharks in Hawai'i. (Credit: Kimberly Jeffries, Ocean Image Bank); Hawksbill Sea Turtle in Phi Phi National Park, Thailand. (Credit: Sean Chinn, Ocean Image Bank); Mangroves in Australia. (Credit: Matt McCurnock, Ocean Image Bank)

Front Cover: Coral reef in Egypt's Ras Mohammed Marine Park (Credit: Alex Mustard, Ocean Image Bank)

RESEARCH DISCOVERIES

Oyster habitat in the Tred Avon River, one of four tributaries biologists surveyed with video cameras. (Credit: SERC)

OYSTER RESTORATIONS PROVE THEIR WORTH ON CAMERA

BY KRISTEN GOODHUE

Roughly a quarter of Maryland's oyster habitat lies protected in sanctuaries. But few of those sanctuaries have undergone restorations, with reconstructed reefs and live oyster plantings. Meanwhile, restoration's benefits have seen hot debate. In a new study, SERC's Fisheries Conservation Lab found proof that restorations pay off, by collecting underwater video from restored and unrestored sites.

Sanctuaries with extra help from restorations routinely displayed better habitat. They had plenty of hard surfaces for young oysters to settle, plus vertical structure with nooks and crannies for animals to hide. Harvest areas and unrestored sanctuaries didn't score as high.

Underwater cameras offered another perk: speed. In a single day, biologists could survey up to 50 sites. "It's a really easy, fast method to go out and keep tally on how the reefs are doing," said lead author Keira Heggie.

Link to study: https://www.int-res.com/abstracts/meps/v667/p219-224/

THE TIDES ARE TURNING: RISING SEAS THREATEN COASTAL WETLANDS

BY DEVA HOLLIMAN

Nearly half of the coastal wetlands in the continental U.S. may be unable to survive rising sea levels, according to a recent SERC study. Wetlands can escape encroaching tides by migrating inland or rising vertically through the formation of new soil. However, if waters rise too quickly, wetlands may struggle to keep up.

Wetlands in South-Central states like Texas and Louisiana are most at risk of collapse, due to high rates of projected sea level rise and little available land for marshes to migrate. Conversely, wetlands in the Pacific Northwest may be safer, thanks to low rates of projected sea level rise and large tidal ranges.

Dr. James Holmquist collects elevation measurements at SERC's Global Change Research Wetland. (Credit: Lisa Beers)

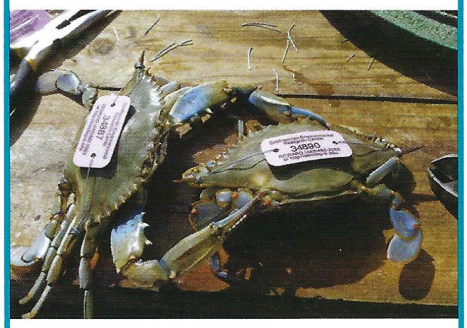
The survival of wetlands is essential to the continued prosperity of coastal communities. Wetlands protect shorelines from erosion and provide habitats for important fish and shellfish. "Our collective economic and cultural wealth is diminished if we don't have wetlands," said Dr. James Holmquist, who spearheaded the study.

Link to study: https://doi.org/10.1029/2020EF001804

RECREATIONAL CRABBING IN MARYLAND HIGHER THAN CURRENT ESTIMATES

BY KRISTEN GOODHUE

When it comes to recreational crabbing—one of Maryland's most iconic pastimes—current estimates of 8% of "total male commercial harvest" run a little low. The true figure is closer to 11%, revealed the first tagging study to estimate recreational blue crab harvest statewide.

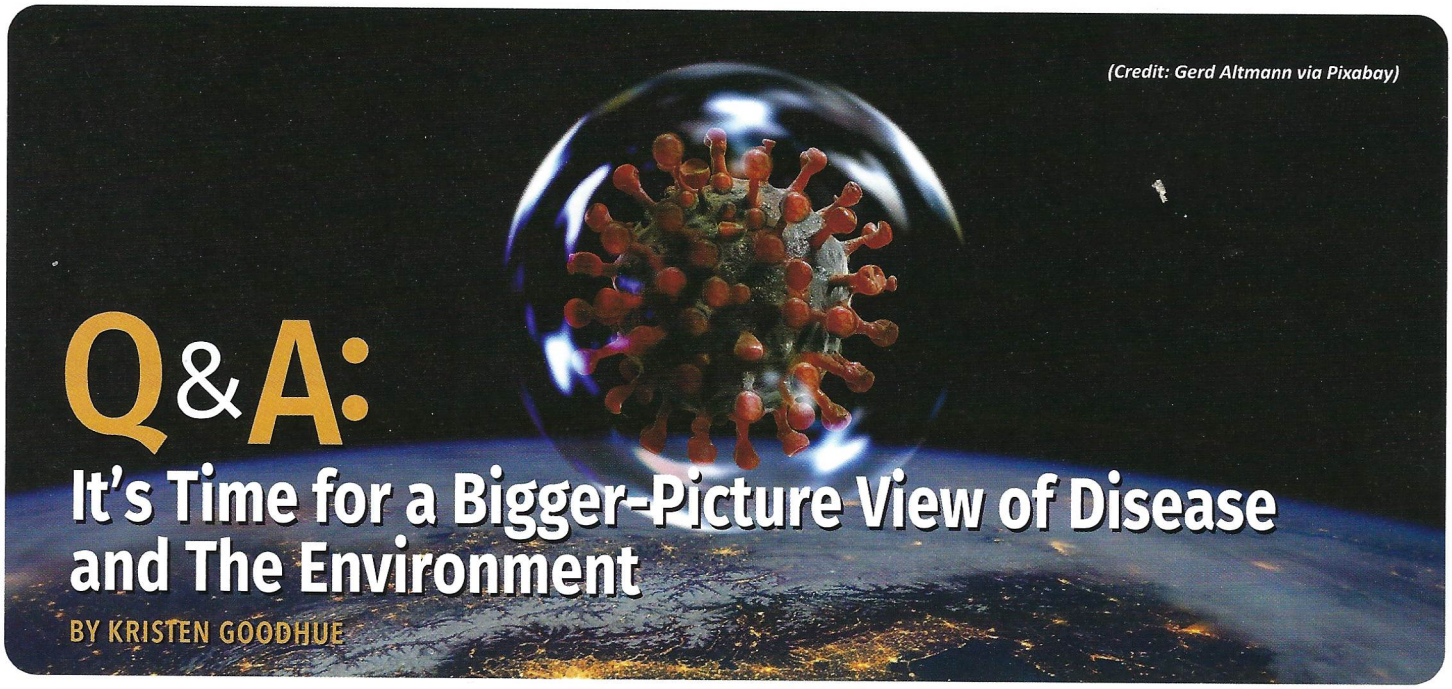


Biologists outfitted crabs with these pink tags, offering a reward to crabbers who found them and reported the catch. (Credit: Kim Richie/SERC)

Unlike commercial crabbers, recreational crabbers aren't required to report their catches, which makes getting accurate estimates difficult. To get a clearer picture, biologists and local watermen marked 6,800 crabs with vinyl tags containing a phone number and reward offer. Anyone finding a tagged crab could tell biologists where they caught it and if they were a commercial or recreational crabber, giving biologists the numbers they needed.

Crab migrations proved to be the missing piece. When biologists left crab movement out of their equations, the recreational estimate stayed near 8%. But once they accounted for how crabs migrate throughout the Bay, they uncovered the 11% figure.

Link to study: https://doi.org/10.1139/cjfas-2020-0112



(Credit: Gerd Altmann via Pixabay)

Q&A:

It's Time for a Bigger-Picture View of Disease and The Environment

BY KRISTEN GOODHUE

Diseases don't spread in a vacuum. But in most big-picture environmental models, parasites, viruses and other disease-spreading pathogens have been left out. In a new article published May in Nature Ecology and Evolution, a team of scientists makes the case that today, we have the tech and global connectivity to change that. In this Q&A, we talked with lead author Dr. James Hassell, a wildlife veterinarian and disease ecologist with the Smithsonian Conservation Biology Institute's Global Health Program, and co-author Dr. Katrina Lohan, a parasite and disease ecologist at SERC. Edited for brevity and clarity. Read the extended version on SERC's Shorelines blog: https://sercblog.si.edu/q-and-a-disease-and-the-environment

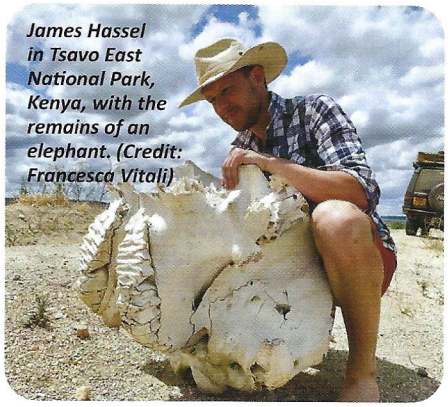
Q: We've seen how diseases can spill from animals to humans with COVID-19. How big of a threat is disease spillover, even beyond COVID?

James: It's a major threat. All the statistics show that the rate at which new diseases are appearing from animals, particularly from wildlife, is increasing. And that's projected to continue increasing as we keep on coming into closer contact with wildlife.

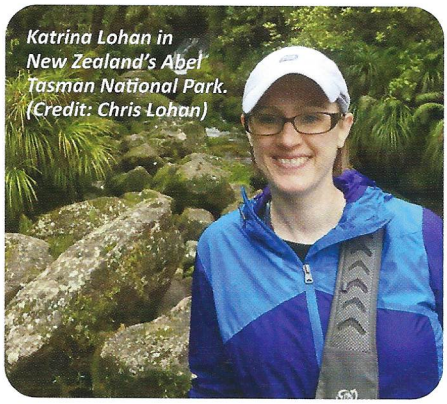
Q: The world already has many models looking at transmission of diseases like COVID-19 or the Ebola virus. What are those models missing?

James: They're very much focused on a single pathogen. And they're unable to take into account how those pathogens are interacting with other pathogens or other parasites in the landscape, and also how environmental change is affecting those pathogens.

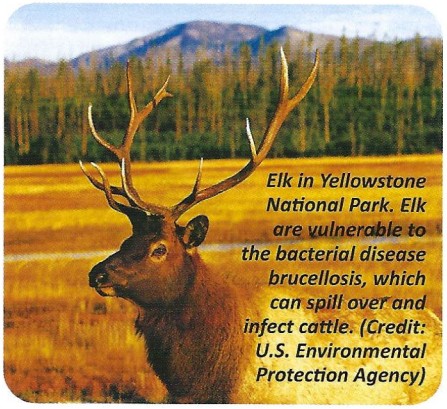
Katrina: The traditional disease focus has been that you're looking at one host species and you're looking at one parasite species and you're studying that interaction. But that's not our reality. That's not realistic in the world that we live in....We don't live in a vacuum. We don't live in a sterile world, and so this really brings it into a more realistic construct.



James Hassel in Tsavo East National Park, Kenya, with the remains of an elephant. (Credit: Francesca Vitali)



Katrina Lohan in New Zealand's Abel Tasman National Park. (Credit: Chris Lohan)



Elk in Yellowstone National Park. Elk are vulnerable to the bacterial disease brucellosis, which can spill over and infect cattle. (Credit: U.S. Environmental Protection Agency)

Q: What makes this kind of disease modeling possible now, as opposed to 10 or 20 years ago?

Katrina: The fact that we live in an era of big data. That we're growing more and more accustomed to having the computational ability, the types of supercomputers that would be needed to be able to parameterize and run a model like this that wouldn't take years to finish.

Q: What else makes you excited or hopeful for what big-picture disease models can offer?

James: Because you're constructing these models from the bottom up, you're able to make predictions about really any group of pathogens within this system....You could apply it not only to the viruses we're most worried about, for pandemics, but also to groups of neglected tropical diseases.

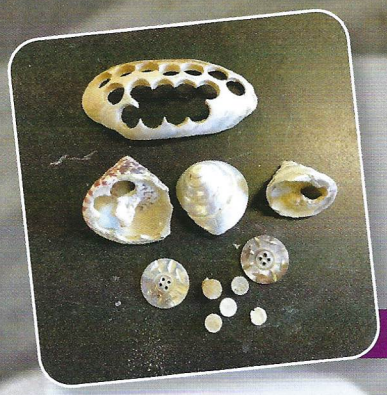
Katrina: You could also use them to look at the best way to conduct aquaculture, or to do agriculture or livestock. What do you need in those communities to increase the health of the animals that you're trying to keep alive? Even for conservation purposes, right? If you're reintroducing [an endangered] species, what do you need that ecosystem to look like?

Q: Last question: Are viruses alive?

Katrina: There's definitely a debate....Because viruses do not have the ability to reproduce on their own, the fact that they have to infect another organism in order to reproduce is the primary argument I've heard as to why they are not considered living creatures. But they clearly do find a mechanism to reproduce.

James: They share a lot of characteristics with living organisms. Like, they can reproduce and they can evolve through natural selection. So yeah, there's arguments on both sides. It depends who you talk to.

Link to Nature article: https://www.nature.com/articles/s41559-021-01454-8



CITIZEN SCIENCE:
Shells Tell Story of Long-Gone Button Industry

BY MARISA SLOAN, Northwestern University's Medill School of Journalism

EDGEWATER, Md. — The Smithsonian Environmental Research Center's Environmental Archaeology Lab is easy to miss, hidden within a basement on the sprawling 2,650-acre campus. Those who manage to find it can expect to be greeted by an eclectic spread: microscopes, coffee mugs, miniature dinosaurs and shelves full of both books and animal bones.

"By the way, you don't have any cell service here," warned Linda Perkins, who has worked at the lab as a citizen scientist for five years. "If you need to make a call, I can show you how to get out the back door."

Perkins was sifting through trays of broken cone top shells excavated from the waste piles of a button factory in the small community of Denton, Maryland. Throughout the 19th and early 20th centuries, mother-of-pearl buttons—cut out of shells left behind by sea snails and treated in chemical baths—were popular for their strength and attractive sheen. The Denton factory, called simply "the button factory" by residents, was constructed in 1933 and transformed shells into buttons until its closure in 1996.

"It's not the age that matters for us," said Dr. Jim Gibb, archaeologist and head of the lab. "It's the process, different gender roles, involved labor relations and rural electrification."

Environmental archaeologists study how humans changed ecosystems in the past and adapted to those changes. Sometimes, lessons learned in the past provide valuable insight for present-day issues, like climate change. At SERC, Gibb and his team of citizen scientists are interested in uncovering how the button industry impacted the local ecosystem and shaped the lives of the community that hosted it.

Surviving factory machinery provides clues to the button-making process. Workers first soaked shells to soften them and remove the smell of the sea, and then drilled button-shaped "blanks" from the undersides using a lathe fitted with a tubular saw. Various other machines then sanded the ends of each finished blank to silky smoothness, sorted them by size and sliced them into uniform thickness.

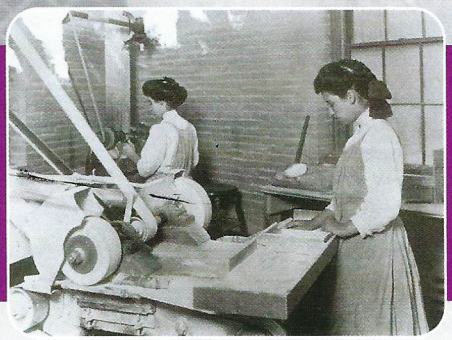
Citizen scientist Linda Perkins shows a punched-out mussel shell with holes where "blanks" for buttons were cut out. (Credit: Kristen Goodhue/SERC)

Workers discarded trimmings of the process in the yard near the factory's buildings, sometimes even using them to pave Denton's parking lots and alleys or increase the fertility of agricultural soil. During their research, SERC scientists recovered shells imported from around the world: black abalone from the eastern Pacific, yellow sandshell from the Mississippi and Gulf of Mexico, pearl oyster and cone top shell from the south Pacific, and toothed top shell from the Indian Ocean.

The findings hint at a local species unsuitable for button making, complicating the question of shell sourcing and the role of the Denton community in the worldwide manufacturing network of the time.

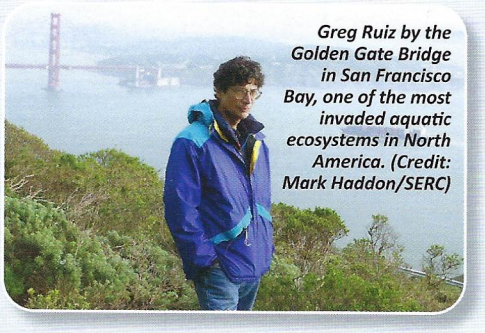
The introduction of cheaper, plastic buttons drove most mother-of-pearl button shops out of business in the 1950s. The popularity of bigger, brighter buttons in the psychedelic 1960s was the metaphorical nail in the coffin. Only a select few were able to adapt by occupying a niche role in the industry.

"The last shop owner in Maryland was doing specialty work with Barbie dolls and sequined performance costumes for Elvis Presley," Gibb said, referring to a plant on Elliott Island that closed down in the 1990s. If you want to follow in the fashionable footsteps of Barbie and the "King of Rock 'n' Roll," look no farther than Etsy, a popular online marketplace that specializes in handmade and vintage items. A simple search for mother-of-pearl buttons brings up over 9,000 results.



Top left: Shells from various stages of the button-making process. Top to bottom: A mussel with holes from punched-out blanks; white abalone shells; red and white trochus; two finished buttons and five unfinished blanks. (Credit: Kristen Goodhue/SERC); Bottom L-R: Workers in the sorting room of a shell button factory in the early 20th century, c. 1910-1920. (Credit: Robert Ervin via Freshwater and Marine Image Bank, University of Washington); Workers in a pearl button factory in the early 20th century, c. 1908-1919. (Credit: Library of Congress); Small cutting plant and operatives on Mississippi River in the early 20th century, c. 1910-1920. (Credit: Robert Ervin via Freshwater and Marine Image Bank, University of Washington)

Background: Dozens of cone top shells from a closed factory in Denton, Maryland, wait to be measured and cataloged at SERC's Environmental Archaeology Lab. For decades, their inner iridescent coating was valued for mother-of-pearl buttons. (Credit: Marisa Sloan/Medill)



Greg Ruiz by the Golden Gate Bridge in San Francisco Bay, one of the most invaded aquatic ecosystems in North America. (Credit: Mark Haddon/SERC)

Q&A: Greg Ruiz, Service to America Medal Nominee

BY MADELEINE WEYAND-GEISE & KRISTEN GOODHUE

Every year over 100,000 cargo ships dock in U.S. ports. Many unwittingly carry microscopic invaders that can cause billions of dollars in damage when released. Dr. Greg Ruiz, principal investigator of SERC's Marine Invasions Lab, has spent nearly 30 years helping ships combat marine invaders, earning him a nomination for the 2021 Career Achievement Service to America Medal. Dubbed the "Oscars" of government service, the Service to America Medals recognize federal workers breaking barriers and overcoming challenges in service to their country. In this edited Q&A, Ruiz discusses what's kept him going.

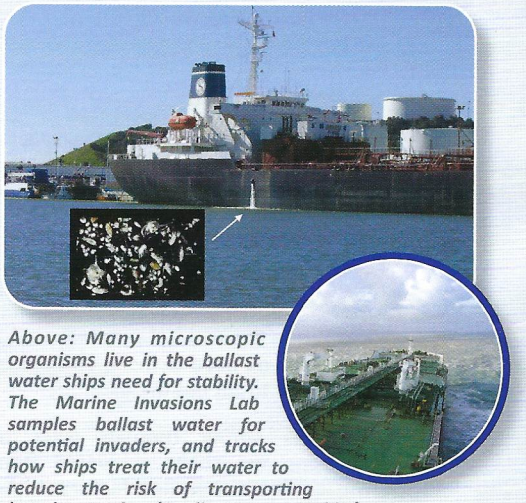
Q. What drove you to study marine invasions?
Growing up along the coast of California, I became increasingly fascinated by the composition of marine communities, including how and why they change. It became increasingly clear early in my career that invasions are a major driver of change in coastal bays. However, understanding of differences among regions and underlying causes is still limited. This knowledge gap spurred my interest in marine biogeography and invasion dynamics.

Q. What do you wish more people knew about marine invasions?
I wish more people knew about the current magnitude of organisms moved around the globe by human activities, and the risks this poses for coastal ecosystems. Though unintended, the flux of aquatic organisms moved by commercial and recreational vessels is stunning and threatens conservation efforts of key protected areas and endangered species.

Q. How has the pandemic impacted your work?
During a normal summer, there would be several field surveys in bays throughout North America. Other teams would board and sample biota on commercial ships. Laboratory experiments and local field sampling campaigns would be underway. Collaborative research projects would be underway in several other countries. We were also scheduled to host an international conference in spring 2021 in Annapolis. All of this was put on pause for a year.

Q. You're a finalist for the Service to America Career Achievement award – what do you believe is your greatest achievement?
Advancing a comprehensive view of biological invasions and biosecurity in marine ecosystems. By focusing on underlying mechanisms, this work has informed state, federal, and international marine biosecurity policy to reduce the risk of new invasions.

I've been fortunate enough to assemble a great research group in my lab at SERC. We recently have launched a coastal marine biosecurity network to coordinate research, management and training across the Americas. I look forward to expanding this network and collaborative exchange of ideas and approaches across countries.



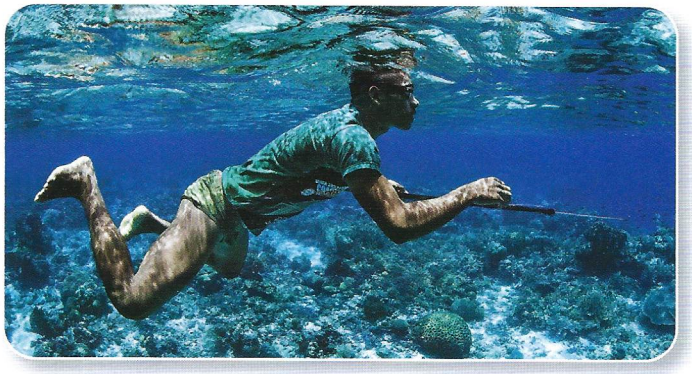
Above: Many microscopic organisms live in the ballast water ships need for stability. The Marine Invasions Lab samples ballast water for potential invaders, and tracks how ships treat their water to reduce the risk of transporting invasive species. (Credit: Monaca Noble/SERC); Right: Massive ships like this oil tanker on its way to Alaska can often inadvertently carry invasive species on their voyages. (Credit: Monaca Noble/SERC)

MEET THE OCEAN OF 2030

BY KRISTEN GOODHUE

Imagine a world where an artisanal fisher in Senegal can check her phone for not just the weather, but the forecast for harmful algal blooms. Or an indigenous community in Alaska can upload traditional knowledge of salmon into a global knowledgebase. Or a conservationist in Indonesia can determine, with a couple swipes on a smart phone, the best spot to place a marine protected area for endangered fish.

That's the vision of Marine Life 2030, one of roughly 30 ocean conservation programs to receive official endorsement from the United Nations on World Oceans Day June 8. It's part of the U.N.'s 2021-2030 Decade of Ocean Science for Sustainable Development, or "Ocean Decade" for short.



A spearfisher in Indonesia. One of Marine Life 2030's primary goals is to help local fishers better access info that can impact their livelihoods. (Credit: Erik Lukas, Ocean Image Bank)

The ocean contains over 90% of the livable space on Earth. We know of roughly 200,000 species beneath the waves. But it's estimated perhaps 1 million more species may still be out there, awaiting discovery. And for the species that are on our radar, data are often poorly connected and inaccessible to those who need it most—the people who rely on the sea for their food and livelihood.

That's where Marine Life 2030 comes in.

"The ocean's diverse life is the heart of ecosystems that provide essential protein, livelihoods, and coastal protection to billions of people worldwide," said project co-lead Dr. Emmett Duffy, director of the Smithsonian's MarineGEO program, based at the Smithsonian Environmental Research Center. "Yet biodiversity is the crucial missing piece in existing ocean observing."

"We're managing a store without knowing 70% of our inventory," said Dr. Chris Meyer, fellow project co-lead at the Smithsonian's National Museum of Natural History.

Marine Life 2030 envisions a world where anyone can tap into information about their local marine fisheries and ecosystems. A world where predicting sea life trends is as simple as pulling up a weather forecast.

Doing that means developing artificial intelligence and other technologies to create and connect open-access resources. It means assembling a DNA library of the world's marine species, which the team has christened "Ocean Biocode." It means reaching out to indigenous and local leaders around the world, who often know local marine life best.

It's a high mark to hit. But success will mean the ocean of 2030 will be a clearer, more connected realm—where everyone who has a stake in the ocean has a voice.

To learn more about Marine Life 2030 and other efforts of the U.N. Ocean Decade, visit https://www.oceandecade.org/.

The European green crab, Carcinus maenas. They're identifiable by looking at the five spines on either side of their eyes and a mottled olive-green carapace. (Credit: SERC)

HOW SCIENTISTS RESPONDED TO THE DRAMATIC COMEBACK OF CALIFORNIA'S MOST UNWANTED CRAB

BY MARISSA SANDOVAL

In an artificially created estuary near San Francisco Bay, called Seadrift Lagoon, a very real problem arose when European green crabs (*Carcinus maenas*) arrived in the 1990s. After taking up residency, the invasive species population grew immensely as the crabs feasted on Dungeness crabs, clams and oysters—a grim problem for the native animals and migratory shorebirds who rely on them.

The stark situation demanded major intervention. In 2009, researchers from SERC's Marine Invasions Lab, the University of California, Davis, and Portland State University partnered to eradicate the local green crab population through intensive trapping.

But their efforts accidentally led to even more crabs. Now, over a decade later, the teams who addressed the problem head-on have published a paper in the *Proceedings of the National Academy of Sciences* on what they learned from a conservation effort gone awry. Led by Ted Grosholz of the University of California, Davis, the new study advocates for major caution when working with invasive species whose life history is like European green crabs.

"Eradication has often been seen as the ultimate gold standard in invasive species management, but complete removal is like getting the toothpaste back in the tube," said co-author Dr. Andy Chang, ecologist and program leader for SERC's marine invasions research in San Francisco. "We've learned how important it is to tailor management strategies and goals to the species and the situation."

LESSONS FROM THE FIELD

Starting in 2009, scientists and volunteers tirelessly set out and collected traps each summer for European green crabs. After removing them from the lagoon, the team donated the crabs to a local farm, where their high amounts of nitrogen and calcium could serve as fertilizer.

At first, their efforts appeared to pay off. Green crab numbers plummeted from 125,000 crabs in 2009 to less than 10,000 in 2013. The crew had eliminated over 90% of the invaders.

So you can imagine the surprise when, in 2014, the scientists found themselves with 300,000 adult European green crabs.

How could the crab population have exploded 30 times higher in only a year's time? Did other crabs migrate from nearby estuaries? Did other regions in California observe similar trends? Or was another phenomenon at work?

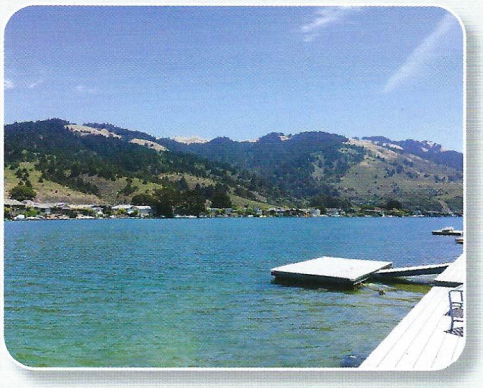
THE CANNIBALISM CONUNDRUM

Though by all observable metrics, the aggressive approach should have done the trick, the research teams discovered they hadn't been looking at the right thing.

Cannibalism among green crabs had helped keep the population in check. Adult crabs feed on younger ones, in addition to bivalves and Dungeness crabs. So when trapping efforts inadvertently selected for larger crabs, most adults were caught. By removing adult crabs, scientists were removing a major force that kept juvenile survival low. Juveniles were free to grow up with far less predation, and grow they did.

"Cannibalism is common in some populations of marine invertebrates," said Chang. "Sometimes the role it plays in controlling the size of the population can be well hidden until just the right conditions come along—like a bunch of scientists unwittingly trapping all the adults!"

Three lines of evidence support this as the reason behind the boom: First, surrounding estuaries where teams *didn't* remove crabs didn't experience dramatic increases in crab population. Second, researchers conducted controlled experiments demonstrating that when the size difference between juvenile and adult crabs increased, larger crabs cannibalized more of the smaller ones. And finally, scientists compared genetic data from the Seadrift population and five other nearby lagoons and determined that the population was isolated—meaning no mass exodus of crabs came to Seadrift from other sites.



During their pursuit of the reason behind the boom, all the while the research team stayed hard at work combating the new crabs. Their new, more informed strategy became one of continuous monitoring and trapping, but not taking out so many adults that the crab population rebounded again.

Controlling the European green crab population has been no easy task, and these feisty crustaceans have served as a cautionary tale for invasion teams to sometimes strive for management rather than elimination altogether.

Link to study: https://doi.org/10.1073/pnas.2003955118

Photos L-R: SERC biologist Linda McCann (right, blue cap) works with a team of staff and interns measuring green crabs. (Credit: SERC); Julie Gonzalez, a graduate student at the University of California, Davis, holds up an invasive European green crab. (Credit: SERC); San Francisco's Seadrift Lagoon, where scientists tracked an invasion, a partial eradication and a surprising re-explosion of European green crabs. (Credit: SERC)

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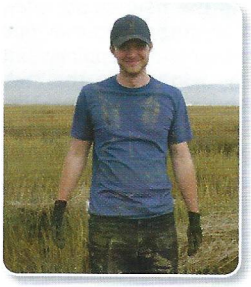


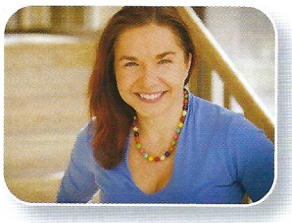
STORIES FROM THE SMITHSONIAN'S WETLAND OF THE FUTURE

Tuesday, September 21 • 7-8pm Eastern

Speakers: Dr. James Holmquist and Dr. Genevieve Noyce, Smithsonian Environmental Research Center

How much can wetlands protect us from the impacts of climate change today, and will they still be able to a century from now? In SERC's Sept. 21 webinar, scientists James Holmquist and Genevieve Noyce will reveal the latest findings from experiments on SERC's Global Change Research Wetland, where scientists are fast-forwarding to the year 2100. They'll also explore how scientists are using big data to calculate what coastal wetlands around the world mean for Earth's carbon budget and efforts to mitigate climate change.

KEYNOTE ROBERT LEE FORREST LECTURE: FROM GLOBAL CHANGE TO LOCAL ACTION



Tuesday, October 19 • 7-8pm Eastern

Speaker: Dr. Katharine Hayhoe, Chief Scientist of The Nature Conservancy

Climate change isn't just a problem for polar bears or future generations anymore – it's affecting us here and now. In today's politically charged environment, are we still able to act on climate? In our series finale lecture, join Katharine Hayhoe as she untangles the complex science connecting our choices to future impacts and highlights actions underway right now to combat this critical issue.

Top left: James Holmquist (Credit: Lauren Brown); Bottom left: Genevieve Noyce (Credit: Sairah Malkin, Horn Point Laboratory); Above: Katharine Hayhoe (Credit: Artie Limmer, Texas Tech University)

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

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