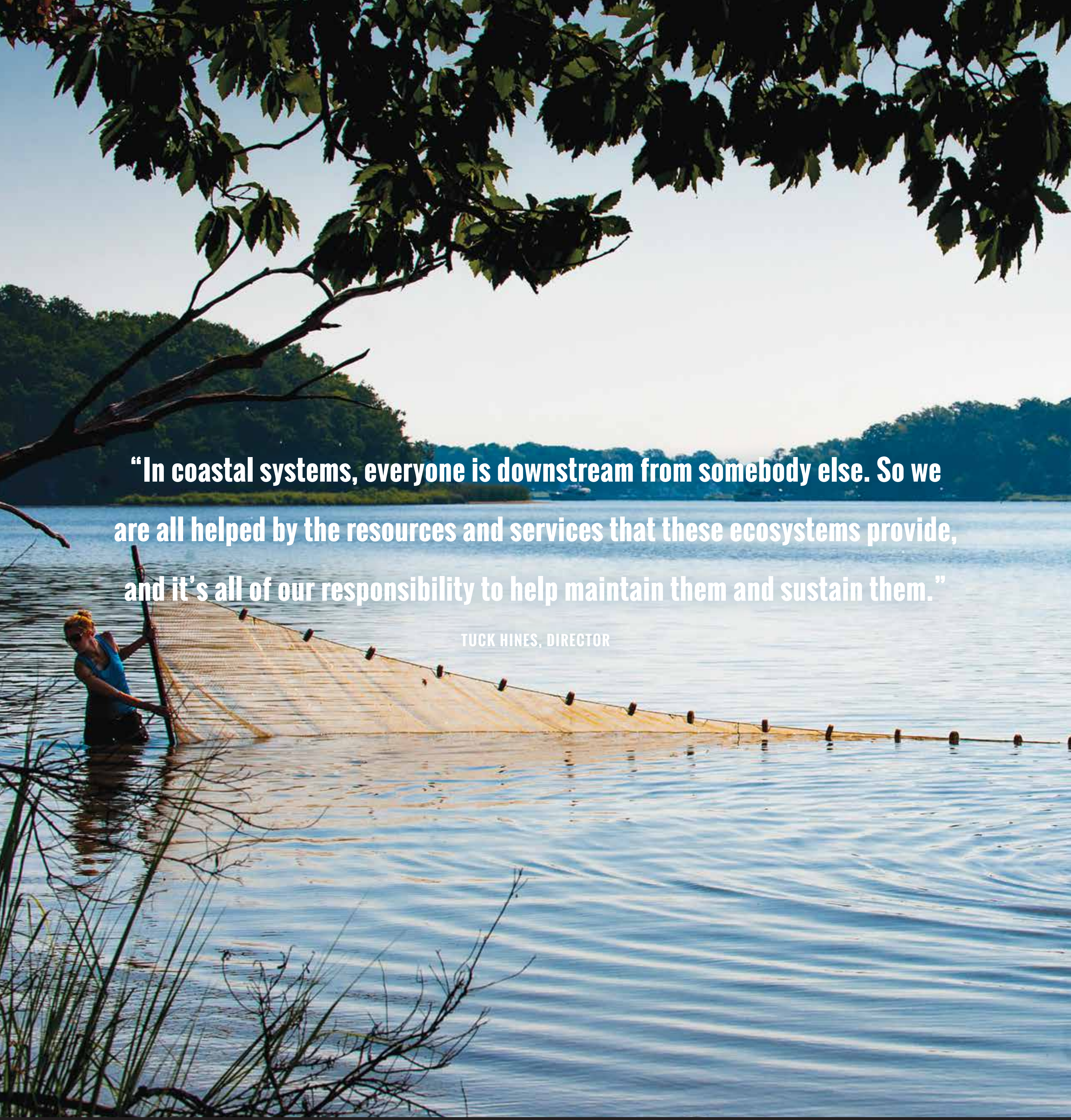
Smithsonian Environmental
Research Center

ON THE EDGE

CELEBRATING
50
YEARS



"In coastal systems, everyone is downstream from somebody else. So we are all helped by the resources and services that these ecosystems provide, and it's all of our responsibility to help maintain them and sustain them."

TUCK HINES, DIRECTOR

Photo credit: Steve Sniteman

This year marks the 50th anniversary of SERC– a milestone in a story of astounding transformation.

When I arrived in 1979 as a young marine ecologist from California, I was thrilled to work for the Smithsonian, and was struck by the beauty of the forest and ever-changing Chesapeake. But already the planet showed signs of more troubling change.

SERC began in 1965 as a bequest of an abandoned dairy farm, dedicated to studying effects of weather and human development on Chesapeake Bay. At first my office and lab were in Java Dairy's ramshackle milking barn, before a new lab wing replaced them. My job was to discover what was happening to creatures in the estuary. There seemed to be plenty of blue crabs and clams then, but oysters were mostly gone, and I wanted to know why yellow perch and rockfish were disappearing. Intense fishing worried me. Old-timers told of dense submerged vegetation that had vanished. Eagles and ospreys were rare.

In this special issue, you will see how SERC scientists used the Rhode River site as a model for connections among the land, sea and atmosphere. Our long-term data revealed drastic changes easily masked by the noise of short-term fluctuations. Our research has spanned the entire Chesapeake watershed, Florida, Belize, the West Coast and beyond. And it has led to solutions and policy changes for acid rain, nutrient and mercury pollution, overfishing and climate change. None of this would have been possible without the enthusiasm of interns, grad students, fellows, volunteers and donors.

Today, with a growing campus of new buildings on a protected landscape, SERC's community of over 200 people envisions innovative conservation for the sustainable future of the planet. The next 50 years will apply biogenomics, engage citizen scientists in Global Earth Observatories, and convene the best minds to solve the most difficult problems. New challenges await in the next half-century, but our 50-year history shows tremendous power to catalyze success.

– TUCK HINES, DIRECTOR

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Cover photo by Kim Richie

SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER:

A HISTORY

1200 BCE. - c.1652
Native Americans use the land as seasonal fishing and hunting grounds

1652
Quaker Thomas Sparrow settles on future SERC property, calls farm “Sparrow’s Rest”

1750
Nicholas Maccubin builds brick mansion on former Sparrow’s Rest, visible today

1735 (est.)
William Sellman starts an adjacent plantation, also on future SERC property. The Sellmans remain on the land until c.1915

1819
War of 1812 naval lieutenant John Contee buys Sparrow’s Rest and mansion, names plantation after the British ship HMS Java, which he helped defeat

1859
Java plantation divided between Contee’s two sons and becomes Contee Farm and Java Farm

1915
Robert Lee Forrest establishes the Java Dairy Farm on former Java Farm

1962
Forrest dies and leaves 368-acre dairy farm to the Smithsonian

1965
Smithsonian Environmental Research Center born (originally “Chesapeake Bay Center for Field Biology”), begins operating in old Java Dairy Farm buildings

Photos (left to right): *Contee Mansion c. 1950 by James C. Wilfong; SERC Farm Fields by Nicole Campbell; Old Java Barn; Global Change Research Wetland by Thomas Mozdzer; The Sustainable Mathias Lab*

OF THE LAND

1970
Work/Learn internship program at SERC begins

1971
SERC begins watershed stream monitoring program

1981
Blue crab and fish data collection begins in Rhode River

1987
Global Change Research Wetland experiment created

1989
Marine Invasive Species program begins

1996
SERC takes over Smithsonian UV monitoring at on-site weather tower

2004
Mercury pollution research program starts

2008
SERC acquires the Contee Farm and reunites the two pieces of the Java Plantation

2014
Environmentally sustainable Charles McC. Mathias Lab complete

THE LAND, THE SEA & HUMANITY

Photo credit: Chuck Gallegos, with aerial support from LightHawk

> "The handprint of man is everywhere on Earth. There is no place that you can go that you don't see the consequences of human activities."
>
> **- DENNIS WHIGHAM, SERC SENIOR SCIENTIST**

We have seen the Earth change. Since the Smithsonian Environmental Research Center was born in 1965, global temperatures have climbed. Sea levels have risen. The world has faced new battles against climate change, invasive species, habitat destruction and pollution in our rain, rivers and estuaries. Our species has left its footprints in all of these problems, though often unintentional and unforeseen.

The Smithsonian Environmental Research Center began as the Chesapeake Bay Center for Field Biology, rooted in the belief that humans and nature can live in balance. Since arriving on an abandoned farm 50 years ago, Smithsonian scientists have explored the impacts of humanity on the Earth. Sometimes, we began monitoring the planet's troubles years or decades before policymakers took action. But we do more than watch. The search for knowledge has also helped uncover solutions. The stories in the next few pages tell much that is troubling, but good science can—and already has—helped us move forward. Most importantly, these stories are unfinished, as is our work.

Photo credit: Karen McDonald

SAVING THE WATERSHED

It began with seagrass. The year was 1971, and underwater plants in the Bay were disappearing fast. Scientists didn't know for certain why, but they had a feeling chemicals running off farm lands had something to do with it.

For creatures in the Chesapeake, underwater plants were critical. They offered food and shelter for tiny juvenile crabs and fish to hide from predators. If they were in danger, so was the Bay. That year three ecologists began investigating chemicals streaming into the Chesapeake, starting the Smithsonian Environmental Research Center's ongoing quest to help restore the Bay.

It was a time of environmental upheaval. Less than a decade earlier, Rachel Carson had published "Silent Spring," highlighting the pesticide DDT's harmful effect on songbirds. In light of that, SERC scientists initially focused on herbicides. But their studies soon unmasked another killer: nutrient runoff—most notably nitrogen and phosphorus, key elements in fertilizer. "Nutrient pollution" fueled the growth of massive algal blooms on the water's surface, blocking light to seagrasses below.

Soon politicians began waking up to the problem. Charles Mathias, a first-term Republican senator from Maryland, began pushing for legislation to protect the Bay. His efforts bore fruit with the 1983 Chesapeake Bay Agreement. For the first time, Maryland, Virginia, Pennsylvania and the District of Columbia made a pact to restore the nation's largest estuary. Other states followed in the years to come. In 1984, SERC ecologists discovered if streamside forests stood between farms and rivers, they could sharply reduce harmful chemicals reaching the Bay.

But they had a long road ahead. It was becoming clearer that overgrowths of planktonic algae, fed by excess nutrient runoff, were behind much of the Bay's poor health. Starved for light, underwater plants found photosynthesis nearly impossible. Algae also sucked oxygen from the water, creating dead zones lasting anywhere from hours to months.

In 1991, SERC scientists began tracking the growth of algal plankton blooms in the Rhode River, one of the Bay's tributaries. Ecological modelers searched for patterns in watersheds across the Chesapeake. Nutrient ecologists tracked the journey chemicals took to the Bay from farm fields, city sewers and even the air.

The Bay remains in danger. But alliances to save it are growing larger, and seagrasses are slowly beginning to recover. Ecologists at SERC will continue to watch the Bay, which can offer clues to saving itself and threatened watersheds around the world.

1971
SERC begins to study chemicals in runoff from farms

1983
First Chesapeake Bay Agreement signed, Chesapeake Bay Program formed

1984
SERC discovers streamside forests can absorb nutrient pollution from farms

1991
SERC begins 19-year data on algal blooms in Rhode River

1998
Maryland Water Quality Improvement Act requires farmers to follow nutrient management plans when applying fertilizer

2000
Chesapeake 2000 signed, creating 100 goals to restore the Bay

2009
Obama declares Chesapeake Bay a "national treasure," Annapolis becomes first jurisdiction in watershed to ban phosphorus in fertilizer

A SUSTAINABLE HARVEST

No creature captures the heart of Chesapeake culture quite like the blue crab. Its sapphire claws and succulent meat inspired scientists to name it *Callinectes sapidus*, the "beautiful, savory swimmer." More than seafood, it embodies a way of life and point of pride for Chesapeake natives.

But its future came dangerously close to ruin at the end of the 20th century. After four decades of plenty, blue crab numbers plummeted in the early 1990s. Prices soared to over $300 a bushel. Chesapeake restaurants were forced to import crab meat from other states and even species in southeast Asia—a blow to the region's dignity and economy. By 2008, the Obama administration declared the blue crab fishery a federal disaster.

Managers faced a dilemma: How to keep the tradition of the Bay waterman alive, and yet do it sustainably.

Fortunately SERC had been tracking blue crabs since 1981. SERC's trawling surveys on the Rhode River predate even the heralded Winter Dredge Survey, the Bay-wide crab count done every year since 1989. SERC scientists discovered from 2000 on, not enough baby crabs were emerging in the Bay to sustain the population. There weren't enough adult females left to spawn them. Meanwhile, up to 80 percent of Virginia's catch and more than half of Maryland's consisted of females. These realities indicated overfishing had a major hand in the decline. But it also revealed a way forward.

Saving the fishery depended on protecting adult females, the mothers of the next generation. In a triumph of science and policy working together, both states reduced female harvests in 2008 based on SERC's findings. The next two years saw a sharp rebound. But recently, fishing pressure on females has returned and numbers have again declined. SERC research is searching once more for solutions.

Other fisheries also need rescuing. Chesapeake oysters have sunk below 1 percent of historic levels, victims of exploitation, acidification and disease. Marine ecologists at SERC are uncovering secrets on how coastal acidification can stunt growth, and how the Bay's nightly dead zones leave oysters vulnerable to disease. River herring also have suffered heavy losses. SERC biologists recently employed sonar videos to track the fish, allowing them to see through the murky waters 24/7.

Like blue crabs, their salvation depends on science and policy joining forces. With enough hard data and good management, the Chesapeake could see all these fisheries return to the days of plenty.

1981
SERC begins crab and fish surveys in Rhode River

1985-87
Dermo epidemic hits oysters in Chesapeake, spurred by warm winters and drought

1988
Maryland launches first pilot version of blue crab Winter Dredge Survey

1992
Blue crabs show first signs of decline, with 56% nosedive

2008
Blue crab fishery officially labeled a "federal disaster," SERC research helps advise regulations in Maryland and Virginia

2013
SERC launches underwater sonar surveys for river herring

2015
SERC discovers shallow-water dead zones make oysters more vulnerable to Dermo disease

HALTING THE INVASION

Photo credit: Monaca Noble

Rock vomit. Blue catfish. Phragmites. Northern snakehead. Species have moved to new places since the dawn of life. But never in Earth's history has it happened at such a rate.

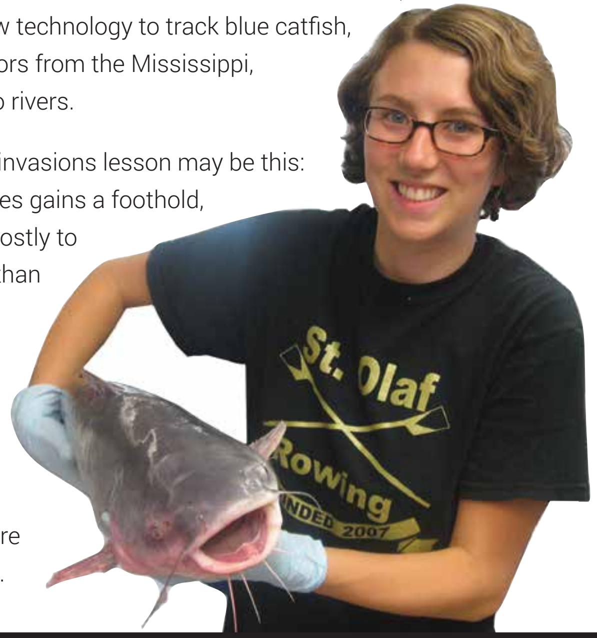
America received a wake-up call in 1989 in the form of the zebra mussel. Zebra mussels arrived in the Great Lakes from the Caspian Sea, when European cargo ships inadvertently took them up in ballast water inside their hulls. The ships' crews were completely unaware that the ballast water they discharged in the Great Lakes—part of their normal operations—contained a dangerous new species. In 1989 an estimated 50,000 people in Michigan lost water for three days when zebra mussels clogged the pipes.

Congress responded with the National Invasive Species Act of 1996. The act created the National Ballast Information Clearinghouse (NBIC), run by the Smithsonian Environmental Research Center and the U.S. Coast Guard. By law, every major cargo ship entering U.S. waters must report to NBIC describing how it treats its ballast water to reduce delivery of potential invaders.

One year later, SERC's Marine Invasions Lab launched invasive species surveys in Alaska that now cover most U.S. coastal states. Its scientists opened a California branch with help from San Francisco State University in 2000, and began studying Central America with the Smithsonian Tropical Research Institute in 2007.

SERC biologists began finding new invaders on both sides of the country. They confirmed the first Chinese mitten crab sightings in the U.S. Atlantic, caught the first northern snakehead fish in the Rhode River, and discovered the "rock vomit" tunicate *Didemnum vexillum* in Alaska with San Francisco State. SERC also looks at already-rooted invaders, like the *Phragmites australis* reed exploding across North American marshes. In the water, biologists use new technology to track blue catfish, enormous predators from the Mississippi, Missouri and Ohio rivers.

The most critical invasions lesson may be this: Once a new species gains a foothold, it is difficult and costly to eradicate. Better than fighting invaders, or even finding them early, is preventing them from arriving and spreading at all. SERC scientists are leading this effort.



1989
Zebra mussels shut off water to 50,000 people in Monroe, Mich.

1996
Congress passes National Invasive Species Act (NISA), naming SERC as national resource

1997
National Ballast Information Clearinghouse created at SERC and Coast Guard (part of NISA), SERC begins surveys in Alaska

2000
SERC opens a lab in California to study West Coast marine invasions

2005
First Chinese mitten crab spotted in Chesapeake

2010
SERC scientists discover "rock vomit" in Alaska

THE FUTURE OF CLIMATE CHANGE

> “If we can study and understand how forests absorb the carbon, how much they take in, how much they’re releasing, we can get a better understanding of what’s going to happen around the world.”
>
> – DAWN MILLER, FOREST ECOLOGY TECHNICIAN

By 1987, the scientific debate over global warming had reached a turning point. Global temperatures and carbon dioxide were on the rise, and ice cores from Antarctica had shown an unequivocal link between the two stretching back 150,000 years. The question was no longer whether climate was changing, but how Earth’s ecosystems would react.

It was in that year SERC launched what would become the longest-running field experiment of its kind, now known as the Global Change Research Wetland. Its goal was no less than to predict how 95 percent of the world’s plant species would respond to increased atmospheric carbon dioxide (CO_2).

At first, the wetland experiment set out to answer one major puzzle: How much excess CO_2 could plants absorb, and how much would keep piling up in the atmosphere? Forecasts of the climate’s fate hinged on the answer. It began as a futuristic project nestled in a SERC marsh. Inside open-top plastic chambers that would have looked at home in a 1960s science fiction novel, researchers raised CO_2 concentrations to twice that in the atmosphere. In effect they were attempting to grow wetland plants in the atmosphere of 2100. They replicated the wetland experiment in a scrub oak forest in Florida.

Photo Above: *Bert Drake manipulates CO_2 on the Global Change Research Wetland.* Opposite Page (left to right): *John Parker scales a kapok tree in Panama; Pat Megonigal shows EPA Administrator Gina McCarthy how to measure elevation in the Global Change Research Wetland; Candy Feller studies how mangroves are pushing north with climate change (Photo: Kennedy Warne).*

Within a decade the two experiments revealed plants could absorb at least some of humanity's surplus CO_2. Plants in Maryland and Florida ate up the extra carbon vigorously. But would this actually happen in the real world? After a separate two-decade study, scientists discovered trees in the SERC forest had grown two to four times as quickly in the last 22 years as they had in the last two centuries. The most likely culprits behind the sudden growth spurt were the rising CO_2 and the longer growing season.

But there were some serious side effects. Droughts tended to stamp out plants' ability to absorb more CO_2. (Ironically, so did higher temperatures.) Plants were also less nutritious, as native plants grown under high CO_2 had less nitrogen—and therefore less protein. This made them less likely to suffer from hungry insects, but also less valuable for human food.

As SERC entered the 21st century, it ramped up climate change research on tidal wetlands, adding new long-term experiments on sea-level rise, excess nitrogen and non-native plants. The scientists discovered wetlands have a remarkable ability to build themselves up in the face of rising seas, making it even more vital to conserve them. Farther south, they found more evidence of climate change as Florida mangroves pushed north. Milder winters and a shortage of cold snaps have empowered these normally tropical plants to creep into the temperate zone.

SERC's quest to understand carbon has taken its scientists to Panama, Norway, Abu Dhabi and the Ross Sea off Antarctica. Its legacy continues in ForestGEO, a network tracking how more than 60 forests around the globe are responding to climate change, and in MarineGEO, its coastal counterpart.

The world is slowly awakening to the reality of global change. In 2013 President Obama issued an executive order telling the nation to prepare for the impacts of climate change. A year later the Smithsonian made its first official statement on climate change, citing more than a century of research in its books. As the planet prepares, SERC will keep seeking answers for the decades to come.

1970
Atmospheric CO_2 at Mauna Loa 326 parts per million

1985
Antarctic ice cores show link between CO_2 and rising temperatures

1987
SERC launches Global Change Research Wetland project and begins measuring forest tree growth

1988
Intergovernmental Panel on Climate Change formed

1996
SERC begins elevated CO_2 experiment on Florida scrub oak ecosystem

2010
SERC discovers trees growing more quickly thanks to higher CO_2

2013
Atmospheric CO_2 at Mauna Loa reaches 400 parts per million, Obama issues executive order on climate change

2014
Smithsonian issues first official statement on climate change

CLEARING THE AIR

Photo credit: Cynthia Gilmour

The Clean Air Act of 1963 heralded a new age in the war on air pollution. For the first time, the federal government threw its weight behind research not only to understand air pollution—then largely termed "smog"—but to control it. But back then, the problem was as hazy as the atmosphere. The next 30 years saw a series of amendments as new discoveries rolled in. One of the biggest issues was acid rain.

> "We were getting rain as acidic as vinegar in the 1980s."
>
> - TUCK HINES

The first rain chemistry monitoring program in Maryland began at the Smithsonian Environmental Research Center in 1974. In its first decade, scientists witnessed nearby streams become nearly 10 times more acidic, damaging fish eggs and larvae.

The chemicals behind acid rain, sulfur dioxide and nitrous oxides, weren't in the original Clean Air Act. But after an outpouring of research, the Clean Air Act Amendments of 1990 remedied that, creating the first federal cap-and-trade program. An environmental success story followed. SERC's long-term monitoring has shown drops in rainfall acidity across the mid-Atlantic.

Ozone was the next hot issue. More ultraviolet radiation from the sun was piercing through Earth's atmospheric ozone shield. Behind the problem were chlorofluorocarbons—ozone-destroying chemicals like Freon, once common in refrigerators and air conditioning. The Smithsonian launched what is now the world's longest spectral UV record, pinpointing the most harmful rays, UV-B. Since 1975 the Smithsonian has tracked UV in Rockville, Md., on the mountains of Hawaii and on SERC's meteorological tower. The quest also inspired SERC's first voyages to the Southern Ocean around Antarctica in the 1990s.

More recently, mercury captured the spotlight. Major advisories warn against overconsumption of tuna, swordfish and other fish high on the food chain.

Most mercury enters the atmosphere—and rain—through emissions from coal-burning power plants. In 2006 SERC researchers showed a direct link between the amount of mercury in rainfall and the amount of its more toxic cousin, methylmercury, in fish. That work helped provide much-needed evidence supporting regulations on mercury emissions from power plants. Federal and state regulations have since slashed mercury deposition throughout the U.S. In 2011 the Environmental Protection Agency issued the first national standards regulating mercury emissions from power plants. SERC now tracks mercury in rain, streams and fish to determine if these new rules are effective.

1963
Clean Air Act passed

1974
SERC launches first rain monitoring program in Maryland

1975
Smithsonian starts world's longest record of spectral UV in sunlight

1993
Most states have mercury advisories against eating top-predator fish, especially for children and pregnant women

1990
Clean Air Act Amendments of 1990 take steps to fight acid rain

2004
SERC begins mercury research program

2005
Maryland Healthy Air Act requires reduction in Hg emissions from the largest Maryland coal-fired power plants

2011
EPA issues the Mercury and Air Toxics Standards (MATS), regulating Hg emissions nationally for the first time.

2014
EPA proposes the Clean Power Plan to regulate CO_2 emissions for the first time

Photo credit: Kiel Edson

OPENING THE DOORS

The first students to walk the SERC grounds were the interns. They arrived in 1970, a time when internships were all but unheard of. During the day they worked alongside ecologists in the field. They slept in a former hayloft from the land's dairy-farm days, which had been converted to offices and a small dormitory.

The Work/Learn internship program was built on the idea that students should be active players and not merely passive receptacles for information. And it flourished. More than 1,000 interns have made their way to the campus since that first cohort. But it is not only interns who learn by doing. The same philosophy guides how SERC treats everyone who comes searching for knowledge: The best way to learn science is to live it.

A typical SERC field trip can include pulling up a crab line, sifting through an oyster bar and wading chest-deep in the river dragging a large seine net. Like all science, there's an element of uncertainty as well. Students from grade school up have designed their own experiments at SERC, because science is less about knowing all the answers than finding them.

The end of the century also saw the rise of a new devotee: the citizen scientist. Citizen scientists come from all walks of life, but they share a desire to take part in research as volunteers, from their computers, their backyards or by working beside scientists. SERC's history with citizen scientists dates back to the 1980s. These volunteers have turned otherwise impossibly large projects into realities. They have conducted massive tree censuses in the woods. They have searched for invasive species on the shores of Alaska. They have unearthed 17th-century artifacts from old plantation homes, and they have tagged and recaptured crabs.

In 2014 SERC hired its first citizen science coordinator, marking the beginning of a new era of citizen involvement. After 50 years, we've discovered science works best when it can draw from everyone. And it's not a spectator sport.

LOOKING FORWARD

SERC has always been about connections—among the land, water and people. In its next 50 years, SERC aims to be even more of a hub for environmental problem-solving. We will build on our success to inform real-world decisions for wise policies, best business practices and a sustainable planet.

FORESTGEO AND MARINEGEO

The Smithsonian's Global Earth Observatories, ForestGEO and MarineGEO, track the health of forests and marine ecosystems worldwide. SERC leads the temperate zone of ForestGEO, which maps millions of trees on six continents. MarineGEO launched in 2012 with sites in the U.S., Panama and Belize, and plans to add more with SERC's Rhode River providing a leading model for observatories around the globe.


Photo credit: Kim Richie

> “We have the capacity to do the things that no other institution can do. And I believe that because of that, it’s our responsibility to do things that no other institution can do. The hard stuff. The subtle stuff. The slow stuff. The multivariate stuff. The stuff that happens catastrophically. The stuff that’s big.”
>
> –JESS PARKER, SERC SENIOR SCIENTIST

ECOSYSTEM CONSERVATION

SERC is dedicated to keeping ecosystems healthy, so they can nourish all life that relies on them. Projects like the North American Orchid Conservation Center target at-risk species. Others confront larger issues of clearing the water, restoring forests and oyster reefs, and protecting the shore.

THE 100-YEAR FOREST EXPERIMENT

In 2013 SERC launched BiodiversiTree, an experimental forest with over 20,000 seedlings planted on former cropland. Ecologists and volunteers will watch how the forest grows over the next century. As they watch, they will look for answers on climate change, biodiversity and the legacy of farming.

BIOGENOMICS

DNA holds the key to many of nature’s secrets. With the new Mathias Lab, SERC scientists can now do biogenomics on site. From invasive predators and parasites to the microbes involved in mercury pollution, SERC is using the latest technology to decipher—and solve—some of the planet’s biggest problems.

CITIZEN SCIENCE

From its early days, members of the public have worked alongside SERC scientists as partners in discovery. Whether planting forests, restoring fisheries, searching for invaders or unearthing artifacts, citizen scientists are a crucial part of SERC research. A new Citizen Science Commons will connect active participants in our research observatories around the world.

ENVIRONMENTAL LEADERSHIP

Science needs economics and social justice as partners to create a sustainable future. A new Environmental Leadership Center will bring together scientists, educators, business leaders, policymakers and concerned citizens. Interns and fellows will bring their research skills to real-world problems. Here, at our Chesapeake site, people of all backgrounds can brainstorm science-based solutions for safeguarding the planet and its resources.

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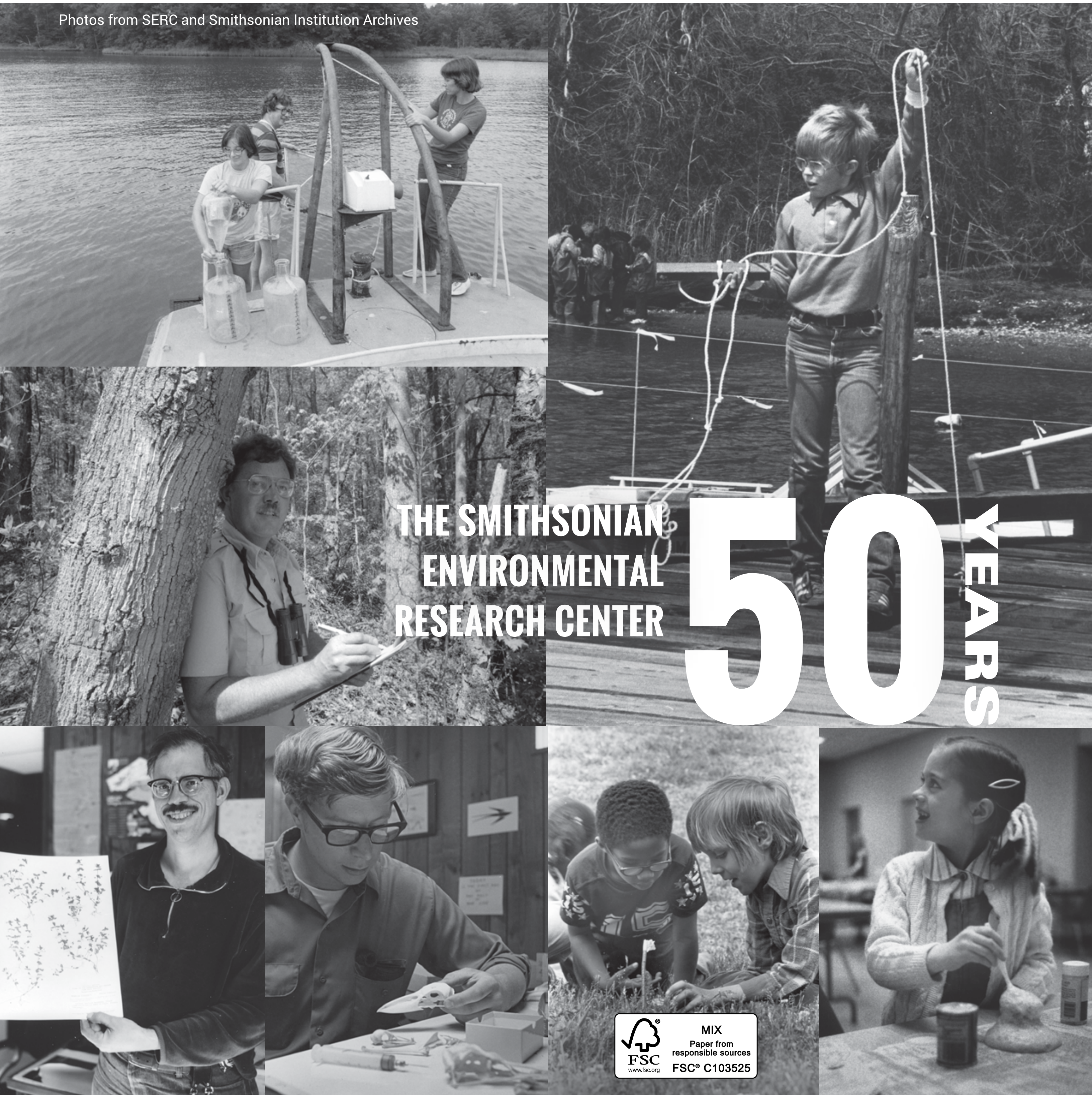
Photos from SERC and Smithsonian Institution Archives



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