

Inspiration and information for taking action
in your community and environment.

SUSTAINABILITY



IN ACTION



Lonnie G. Bunch III,
Secretary of the Smithsonian
SMITHSONIAN INSTITUTION

Since the Smithsonian was founded more than 175 years ago, it has been a scientific institution dedicated not only to learning about the natural world but also to helping sustain it for future generations.

The specimens and artifacts gathered during the U.S. Naval Exploring Expedition of 1838-1842 formed the basis of our original collections and fostered the development of science in the United States. When William Temple Hornaday, chief taxidermist at the Smithsonian's National Museum, brought back two endangered American bison from the West to live on the grounds of the Smithsonian Castle, he inspired the creation of the National Zoo and spurred the American conservation movement. The Smithsonian's involvement in the biological survey of the Panama Canal Zone from 1910-1912 led to the establishment of the Smithsonian Tropical Research Institute in Panama.

Work like this to sustain life on our planet continues to proliferate across the Smithsonian. Successful efforts at the Zoo and Conservation Biology Institute prevent species extinction; research at the Smithsonian Environmental Research Center protects ecosystems like coral reefs, wetlands, and tropical rainforests from the ravages of climate change; and the Anacostia Community Museum's Urban Waterways research and educational initiative explores the essential relationships between urban communities and their waterways, connections affecting everything from environmental justice to public health.

These and many more examples of incredible Smithsonian research past and present are found in this impressive activity guide developed by our education specialists in partnership with USA TODAY. It is our collective responsibility to build an equitable, just, and sustainable shared future. This guide will help you connect with the Smithsonian's efforts and find your own ways to make a difference.

RESEARCH HUBS ACROSS THE SMITHSONIAN

1	Smithsonian Astrophysical Observatory: Cambridge, MA	5	Smithsonian Museums: Washington, D.C. National Mall
2	Smithsonian Conservation Biology Institute: Front Royal, Virginia	6	Smithsonian's National Zoo: Washington, D.C.
3	Smithsonian Environmental Research Center: Edgewater, MD	7	Smithsonian Marine Station: Fort Pierce, Florida
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HOW TO USE A QR CODE

Look for QR codes throughout the guide for bonus online features from the Smithsonian. Use the camera app on your smartphone and hover over the QR code, then tap the banner to continue learning more.

LIFE ON A SUSTAINABLE PLANET

Life on a Sustainable Planet is the Smithsonian's initiative to collect new data about our changing planet, implement holistic approaches to environmental conservation, and educate the world about why and how sustainable solutions to climate change can benefit people and nature. Life on a Sustainable Planet uses the Institution's vast scientific resources across its global network of research centers to produce, curate, and communicate strategies for resilience to climate change and conserving the Earth's ecosystems for all living beings. Learn more at science.si.edu.

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Dr. Ellen Stofan,
Smithsonian Under
Secretary for Science
and Research
 JIM PRESTON

To most people, the Smithsonian conjures a museum on the National Mall. We are a remarkable tourist destination, but behind that is a world-class research infrastructure making a difference in the lives of Americans.

The Smithsonian conducts scientific research through a blend of vast collections, field sites, and observatories on Earth and in space. These assets allow our scientists and collaborators to address significant questions, such as understanding the origin of the universe or explaining losses in biological diversity around the globe.

From an observatory on the summit of Mauna Kea to research centers on the coasts of the Chesapeake Bay, the Caribbean Sea, and the Pacific Ocean, the Smithsonian's multidisciplinary group of researchers is seeking to understand how climate change impacts every ecosystem on Earth and how humans both contribute to the problem and can help solve it. *Our Shared Future: Life on a Sustainable Planet* marks the Smithsonian's efforts to provide an interface that connects students, scholars, citizens, scientists, and decision-makers in conversation about how to create a more sustainable planet.

In this guide, we invite you not just to listen but to participate—join us as we face some of the world's most pressing challenges and help us develop solutions for all.

Right now, more than one thousand Smithsonian scientists live and work in urban environments around the country as well as in hundreds of wild places across the world, alongside farmers, ranchers, hunters, and fishers who directly depend on a healthy planet to preserve their lives and livelihoods.

Spending decades amidst these bountiful landscapes, we've seen the threat our warming climate presents. The spacious skies and fruited plains that define our beautiful land and all that live within it and the precious way of life we've cultivated over generations could change forever without your help. But there are reasons to be optimistic—we have a chance to make things right.

Over the next twelve pages, you'll meet Smithsonian scientists from across the country and around the globe. Like you, scientists are skeptical and honest and want to safeguard the future for their children and grandchildren. I hope you'll hear them out as they exhibit their work to conserve not just our planet and our country but American life as we know it.

VISUALIZING YOUR RELATIONSHIP WITH THE ENVIRONMENT

No matter where you live—in the city, suburbs, or rural areas—our environment, or the world around us, impacts who we are, what we do, and influences our health and well-being. Let's use a creative mapping tool to visualize your place in the community, and where you might positively impact or help improve the environment around you.

1. Start by writing your name in the circle in the center of the page, or draw a small picture of yourself.
2. Then consider the following questions. Use a different colored pen or marker to answer each question.
3. You can put your answers at the end of each line extending from the center circle.

“Who am I?”

*I am a father and have 3 kids.
 I live in the mountains of North Carolina.*

“How do I interact with my environment?”

*I take mass transit to work instead of driving my car.
 I enjoy visiting natural bodies of water, such as lakes and rivers.*

“How does my environment impact me?”

*The places I visit depend on the weather. I swim in the pond during the summer and ice skate on it in the winter.
 I use the car more and do less walking when it is cold outside.*

The questions above are just a start. Each of us brings unique experiences and backgrounds. Below are more ideas for how to expand your identity map.

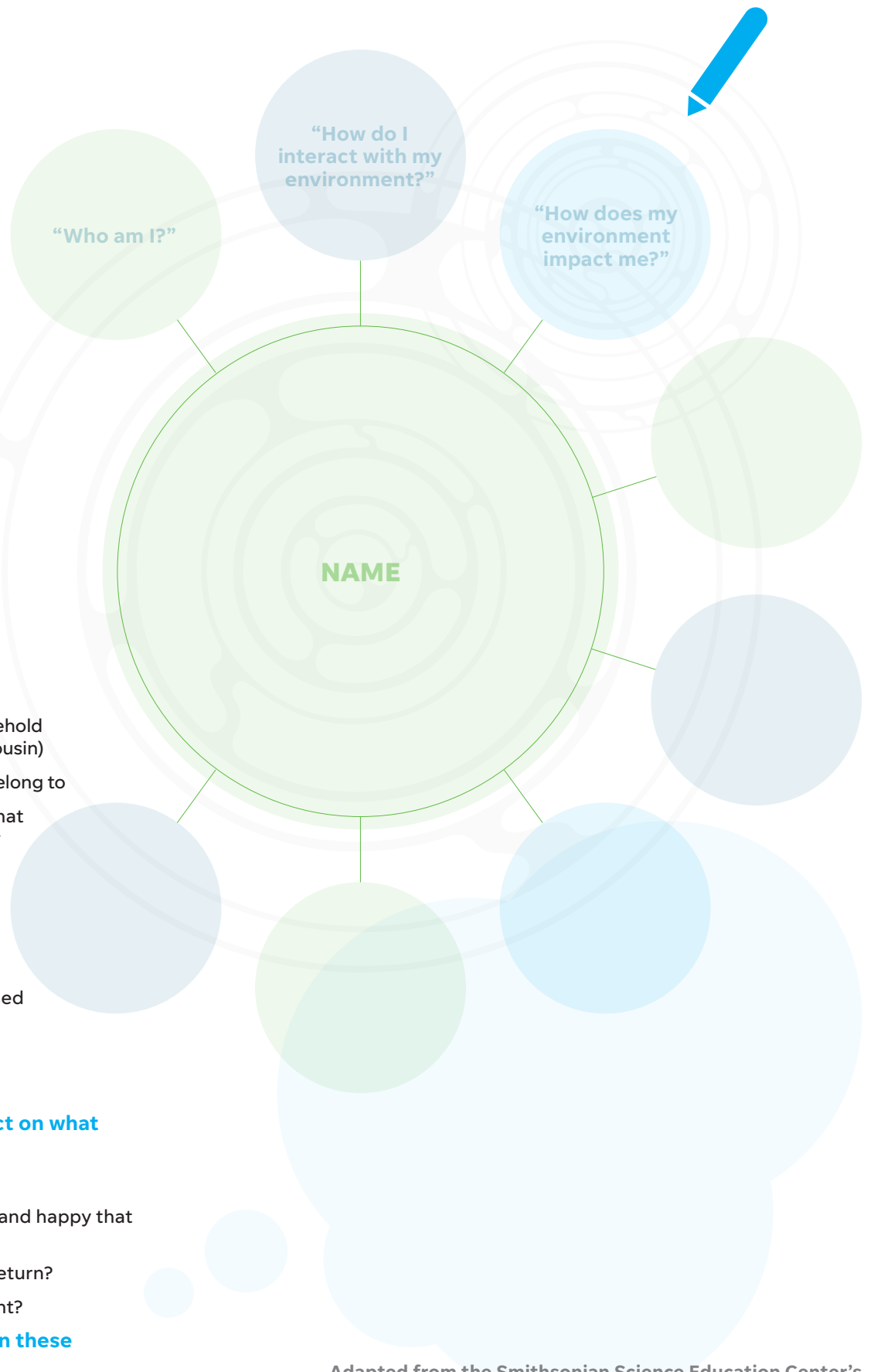
What makes you unique?

- | | |
|---|---|
| Age | Roles you have in your household (such as big sister, helper, cousin) |
| Race and/or ethnicity | Groups/Communities you belong to |
| Gender | Ideas that interest you or that you connect to emotionally |
| Place where you live | Things that motivate you |
| Places that are important to you or your family | Hobbies or things you like to do for fun |
| Ideas or beliefs that are important to you | Favorite foods |
| Emotions you have about the environment | Transportation methods used |
| Personality traits (such as loud, funny, shy, kind) | Ways you use energy |
| | Connections to nature |

Once you have filled out your identity map, go back and reflect on what you've written.

- How are the things you wrote down connected to the environment?
- Are there things you noticed that make it easier for you to be healthy and happy that are connected to the environment?
- What could you do to care for and keep your environment healthy in return?
- What type of relationship would you like to have with your environment?

Put any images or words that come to mind when reflecting on these questions around the border of your identity map.





“Boy Viewing Mount Fuji”
NATIONAL MUSEUM OF ASIAN ART

OUR ROLE WITHIN COMMUNITIES & ECOSYSTEMS

Feeling Connected with Nature

Let your eyes wander all over the painting above. Take at least one minute to look from top to bottom and left to right. Examine the details.

What do you see? What does this work of art make you think about and wonder? What lingering questions do you have?

Now, imagine you are the person sitting in the tree. What can you see? What can you hear? What can you feel on your skin? What emotions do you feel at this moment? What are you thinking about?

Now think about outdoor sites in your own community. Is there a special place that makes you feel more connected with nature?

Special places come in all shapes and sizes. Some places are far away, while others are just outside your back door, such as your grandmother's garden, the neighborhood park, or a local fishing spot. A special place connects us to nature and can fill us with happiness, energy, and memories.



Explore all the special places that visitors to the National Museum of Natural History have shared in the “Our Places” interactive story map. Then, add your own story about a place that is special to you.

Storytelling to Reconnect to the Environment

Today, the “Urban Waterways” initiative continues to bring together a network of activists, scholars, developers, faith leaders, government officials, community leaders, youth, and residents who have shared how they advocate for the health of their waterways and communities. Together, this group navigates the complex personal connections that communities have to the natural world. They support each other as they become active participants in helping to shape the futures of their cities.

Dr. Gail S. Lowe: Advocating for the Health of Waterways and Communities

“The health of a river in an urban community is an indication of the health of the community and its people.”

As the founder of the Anacostia Community Museum’s “Urban Waterways” initiative, Gail Lowe (1950–2015) documented the relationships between communities and their waterways, starting in her Anacostia River watershed in Washington, D.C.

Her work challenged the myth that residents just outside the Nation’s Capital are unconcerned with environmental issues.

She amplified stories of the citizens and organizations that have fought against the contamination of the Anacostia River and downstream communities. She documented locals’ accounts of the river’s current health and nostalgia for a cleaner, healthier river past, featuring both in a 2012 exhibition, “Reclaiming the Edge: Urban Waterways and Civic Engagement.”



Dr. Gail S. Lowe
ANACOSTIA COMMUNITY MUSEUM



Listen to oral histories documenting individuals’ personal experiences from areas ranging from London to the U.S., spanning from O’ahu to the Gulf Coast. Learn more about the ways these people advocate for their waterways and communities.



Students of the Anacostia Community Museum Academy enjoy a Chesapeake Estuary Tour at the Smithsonian Environmental Research Center. SUSANA RAAB, ANACOSTIA COMMUNITY MUSEUM ARCHIVES, SMITHSONIAN INSTITUTION

Honoring a Legacy of Community-Based Environmental Action

For decades, those living in communities along the Anacostia River, throughout the U.S., and worldwide have been fighting inequities in their neighborhoods. To honor and catalyze this legacy of community-based environmental action, the Smithsonian’s Anacostia Community Museum launched the Center for Environmental Justice (CEJ) on Earth Day 2023. The CEJ research hub will raise awareness of systemic injustice, empower community-driven solutions, and encourage a more equitable, healthy, and just environment for all communities.

The CEJ envisions environmentalism as a cornerstone of civic engagement. The Center will convene community experts, researchers, and Smithsonian staff as part of the museum’s decades-long commitment to community. CEJ will leverage history and current research to develop solution-based models by and for the people most affected by environmental injustice.

You can learn more about the Anacostia Community Museum and the new Center for Environmental Justice at anacostia.si.edu/CEJ



Downy rattlesnake plantain
SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER

The World Wide Web of Fungus

Did you know that anywhere you are standing on soil, there is a whole worldwide web below your feet? Like us on the Internet, all plants are connected in the soil, both by their roots and by fungi that cover them. These fungi are called mycorrhizal (my-kah-RISE-el) fungi. The fungi pull water and nutrients from the soil and supply them to plants, and they also send signals from plant to plant, all underground. A tablespoon of soil can have enough fungi to cover over a mile of roots! They are an important part of the ecosystem.

An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together.

Mycorrhizal fungi are keystone species, meaning that without them, plants and the ecosystems they belong to would disappear! Just like the Internet, if this web “goes down,” everything stops. The plants that we eat, that we use to feed our livestock, and that we need to give us oxygen to breathe, would come to an end.

Dr. Melissa McCormick: Studying Interactions of Plants and their Environments

Melissa McCormick, a scientist at the Smithsonian Environmental Research Center (SERC), studies the connection between mycorrhizal fungi and orchids. Orchids are found on every continent except Antarctica. There are over 200 species in North America, but most are small and plain, and don't look like the ones at the grocery store. The Smithsonian's North American Orchid Conservation Center was established to ensure the survival of all our native orchids. Unfortunately, over half of these native orchid species are listed as threatened or endangered.



Dr. Melissa McCormick
SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER

Pearls of Wisdom: The World of Oysters

Do you like to eat oysters? In North America, humans have eaten oysters for thousands of years. But, since the 1800s, oyster populations have declined to approximately 1% of their historic populations due to overharvesting and disease. Scientists from the Smithsonian Environmental Research Center (SERC) are trying to help.

SERC leads research on coastal ecosystems—where the land meets the sea—to inform environmental management policies, best business practices, and a sustainable planet. Headquartered on the Chesapeake Bay, the nation's largest estuary—an area where a freshwater river or stream meets the ocean—SERC sits just 25 miles from Washington, D.C., and covers more than 2,600 acres of forests, wetlands, marshes, and 15 miles of protected shoreline.

Scientists from SERC study these coastal ecosystems to learn more about oyster biology and their reef habitats. Oysters are important to aquatic ecosystems because they provide shelter and food for other organisms. They also filter and clean the water by consuming microorganisms. One species, the eastern oyster, lives in the waters off of the east coast of North America all the way from Canada to the Gulf of Mexico.

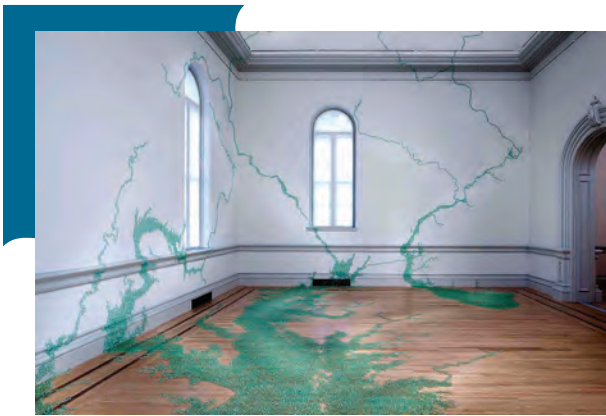
SERC and other environmental centers are working to restore oyster populations not just for eating but for improved water quality and increased ecological diversity. Using strategies such as modifying harvesting practices, designating areas as oyster sanctuaries—areas where oysters cannot be harvested—and oyster planting, scientists and environmentalists hope to restore oyster populations to healthy and sustainable levels.



Spiked Crested Coralroot “Orchid-gami”
NORTH AMERICAN ORCHID CONSERVATION CENTER

All orchids rely on mycorrhizal fungi to survive. If soil doesn't contain healthy fungi, orchids will die or not be able to grow. To preserve our orchids and other plants, we must keep the fungus in our soil healthy. We can do this by planting native plants, avoiding the use of pesticides, and disturbing the soil as little as possible.

Maya Lin: An Artist Exploring What Happens in Communities Out of Balance



Folding the Chesapeake
SMITHSONIAN AMERICAN ART MUSEUM

From the Vietnam Veterans' Memorial in Washington, D.C. to the Civil Rights Memorial in Montgomery, Alabama, Maya Lin has dedicated her artistic career to monumental artworks that connect people to the

natural world. She uses stone, wood, light, shadow, water, and other elements that inspire reflection about how we affect the environment and how the environment affects us.



“Maya Lin 1:5”
NATIONAL PORTRAIT GALLERY, SMITHSONIAN INSTITUTION

Maya Lin created *Folding the Chesapeake* for the Smithsonian's Renwick Gallery to present the large waterway as a vital, living system. She used the shape and color of glass marbles—tokens of a familiar childhood pastime—to emphasize the beauty and relevance we must see in our waterways in order to protect them.

Lin's ongoing project, *What Is Missing*, encourages the public to identify personal ties to nature, with the belief that before we can protect something, we must realize it is in danger. This multi-sited memorial includes a crowd-sourced “connective map highlighting memory, action, and hope.” In the National Portrait Gallery's exhibition,

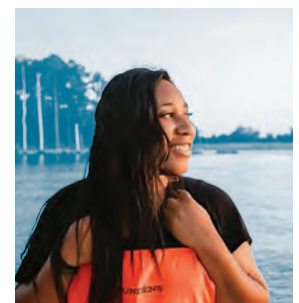
“One Life: Maya Lin,” Lin explains, “We are getting people to reflect and engage on a personal level—getting people to connect back to nature.”



If you would like to learn more about orchid conservation and access Orchid-gami models to construct your own, visit the North American Orchid Conservation Center website.

Imani Black: Sustaining Aquaculture on Maryland's Eastern Shore

Aquaculture can also help restore oyster and other shellfish populations. Aquaculture is the breeding, rearing, and harvesting of fish, shellfish, and other aquatic organisms. It can help meet future food needs and ease burdens on natural resources.



Imani Black
CAROLINE J. PHILLIPS

Imani Black's family were watermen for 200 years. She is an African American oyster farmer on the Eastern Shore of Maryland. She recognizes that oysters are keystone species—species that have a role in maintaining ecosystem health. She works to restore oyster and other shellfish populations back to healthy levels both locally and globally. To help spread her love for working on the water, she started an organization that works to educate and empower women from underrepresented groups about the benefits and joys of working in the aquaculture industry to help increase the diversity of the workforce.

Learn more about Imani Black's career pathway in an interview from the National Museum of African American History and Culture: s.si.edu/ImaniBlack

Return to your identity map on page 3. Add in a personal memory about a time you felt at home in nature. What made it special? Who were you with? What could you do to protect that environment?



OUR PLACE



Using seine-netting to collect animals from the Indian River Lagoon near Smithsonian's Marine Station in FL.
SMITHSONIAN MARINE STATION

The Smithsonian works where humans and nature meet to find workable solutions to climate change and to build a more sustainable planet. As the world's largest museum, education, and research complex, we strive to be a resource for all communities.

We want to support you with the knowledge, resources, and connections you need to protect your community from the challenges that lie ahead.

Our role includes research on wildlife in the land and sea, including forests, grasslands, deserts, marshes, and oceans. We also collaborate with nations facing the worst effects of climate change. We are making our data freely available and accessible, so everyone can use them and learn from our findings. We study environmentally friendly architecture, design practices, and new materials to help make our existing buildings more friendly to nature. Finally, we are working on all seven continents and in over 140 countries to motivate everyone to take action to protect their communities from climate change.

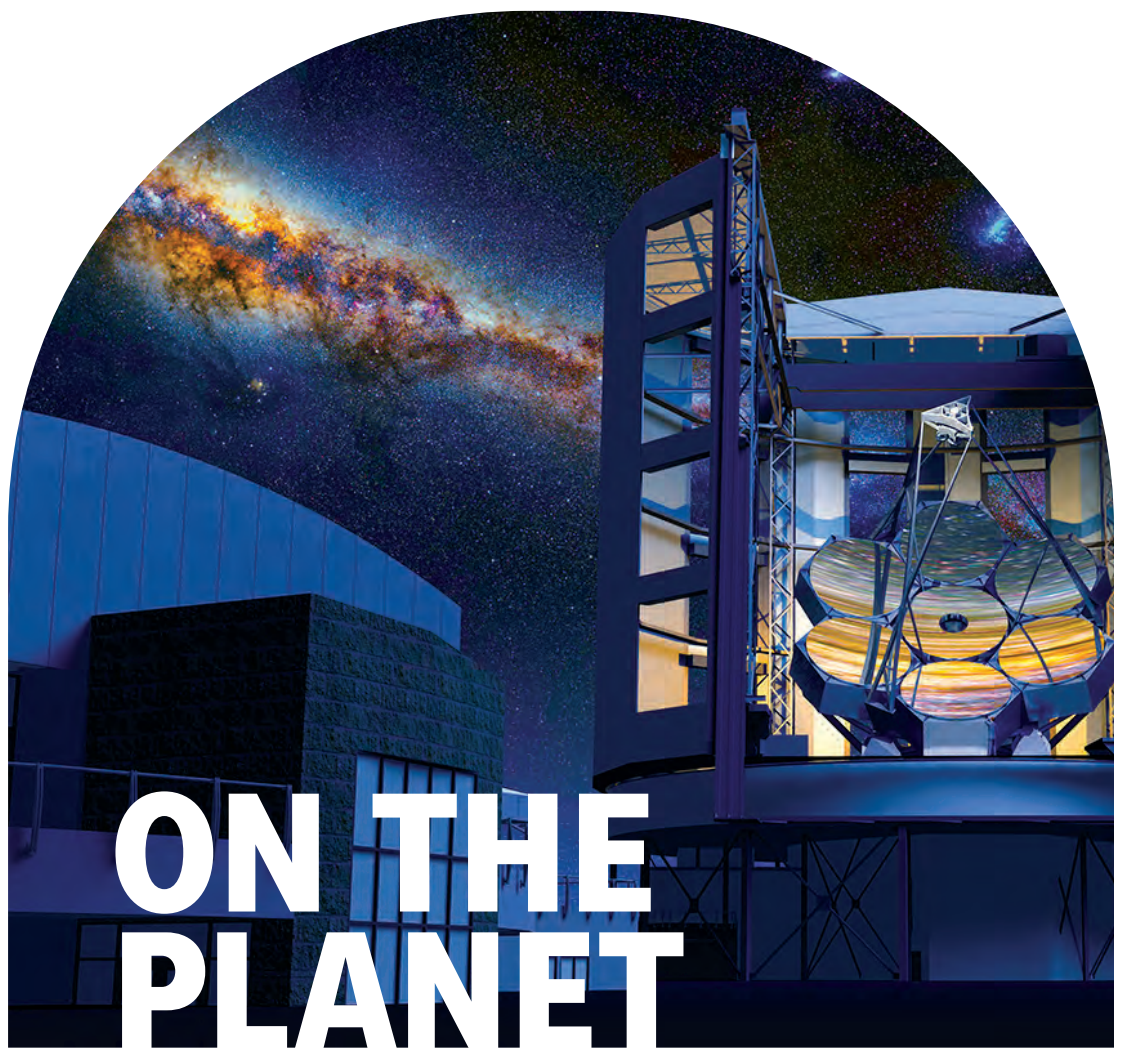
Through our eight research centers along the United States east coast and Panama, we partner with communities, non-profits, schools, universities, and governments to develop strategies to protect our planet from climate change. We perform research all over the world to understand how we have benefitted from nature and where we haven't returned the favor. Through these connections between humans and nature, we discover how climate change impacts our health and well-being.

Oceans

If you've ever had the chance to see coral reefs up close, even in a documentary, you have likely felt awe in the presence of these complex underwater ecosystems teeming with sea life. But beyond the beauty you see in the variety of living things found in a healthy coral reef, these ecosystems also carry additional benefits to society. They protect coastlines from storms and erosion, support local economies, offer recreation opportunities like scuba diving and snorkeling, offer sources of food, and contribute to new advances in medicine.

Dive into the Dynamic World of Coral Reefs

Whether you're a budding marine biologist, game enthusiast, or a teacher looking for cool science content, we've got you covered. In the educational interactive "Secrets of the Sea," navigate the hidden treasures of a coral reef, making connections between the creatures that live in a coral reef ecosystem. Then, learn more about the careers of scientists and researchers like Dr. Knowlton who use cutting-edge technology to understand the impact of humans on our oceans.



ON THE PLANET



Top Right: Giant Magellan Telescope, GMT CORPORATION
Bottom Right: Mark Torchin SMITHSONIAN TROPICAL RESEARCH INSTITUTE

Dr. Nancy Knowlton: Celebrating Conservation Success Stories

Nancy Knowlton is a coral reef biologist who studies, celebrates, and strives to protect the many life forms that call the sea home. She started her Smithsonian career at the Smithsonian Tropical Research Institute in Panama and then at the National Museum of Natural History. She currently serves as the Sant Chair for Marine Science Emerita and served as the scientific leader of the Census of Marine Life until its completion in 2010. Knowlton authored the book, "Citizens of the Sea," featuring captivating details of ocean organisms and their environment, alongside brilliant underwater photographs of marine life. She has been a member of the Advisory Council for MarineGEO (a network of partners worldwide dedicated to tracking the vital signs of coastal marine life) and mentors emerging marine biologists, researchers, and science writers.



Dr. Nancy Knowlton
NANCY KNOWLTON

In 2017, Knowlton founded the "Earth Optimism" movement to highlight the success of large-scale and small-scale actions taken to improve the Earth.

Volunteer to Collect Data about Marine Litter



Sorting marine litter
YASMINE FLORENT

Climate change and the loss of biodiversity both challenge nature and society in intertwined ways. In the sea, these changes might be invisible to the casual observer. That's what inspires MarineGEO—a growing network of partner observatories around the world—to reveal how and why coastal marine life and habitats are changing in response to these challenges. They use data to develop evidence-based solutions to these problems.

Did you know that the trash that makes its way from the land into our oceans can act as a life raft for creatures, including invasive species?

MarineGEO is working on a project called "Ocean Travelers," and you can help! Community science engages volunteers to collect or classify data to help scientists and their research. In the community science project, Cientificos de la Basura (or "garbage scientists"), you can help scientists by recording beach litter and the creatures that live on it.



Forests

Many people dream of coming up with the next “big idea” for their field—maybe a new tool or new way of thinking. But, as some Smithsonian scientists have found, radically changing our world can sometimes be as simple as connecting with others. Ecologists at the Smithsonian Tropical Research Institute (STRI) in Panama have worked at the Barro Colorado Island Research Station since 1923. But in 1980, they began a new project using simple techniques to better track tree growth and death over time. As other scientists around the world adopted the same techniques, they started to share information about their sites, eventually leading STRI to host the Forest Global Earth Observatory (ForestGEO)—a collaborative network consisting of more than 70 forest research sites across the world from the redwoods in California to African savannas and Orangutan habitat in Malaysia. Bringing together scientists from so many forests supports monitoring these increasingly threatened habitats and provides a community to offer resources and training to forest scientists. Now, ForestGEO researchers collaborate on topics like carbon storage, biodiversity, and the future of forests to impact how people around the world manage their forests and to calculate the true value of preserving them for future generations.

How can you connect or collaborate with others to impact environmental issues in your community?

Dr. Steve Canty: Studying Life at the Intersection of Habitats



Dr. Steve Canty
JORDAN CISSELL, SMITHSONIAN

Ocean and forest ecosystems may seem to have nothing in common, but some people work at the important intersection of both habitats. Dr. Steve Canty, who is based at the Smithsonian Environmental Research Center, collects data about mangrove forests and then gives that data to communities to support their decisions about managing mangroves.

Mangroves provide an important natural infrastructure and protection to nearby populated areas by preventing erosion and absorbing storm surge impacts during extreme weather events such as hurricanes. Mangroves are also home to a wide variety of wildlife that come to nest, forage, and hunt there.

Mangroves are one of the planet’s most productive and biologically diverse ecosystems, but since 1980, 20% of the world’s mangroves have been lost. As a plant delicately adapted to saltwater, mangrove forests face many threats from changes in ocean chemistry, sea level rise, and removal for commercial development or agriculture.

Steve uses his senses, cameras, and maps to assess the current state of the mangrove forest and how they change over time. However, one of his primary scientific tools is listening! He talks with local people to better understand the vast knowledge that communities have collected over generations living near this special environment.

Preservation and conservation are important to protect mangroves and the animals and people who depend on them.

Migration & Animals: Movement of Life

Do you like mysteries and puzzles? Smithsonian scientists do too. They want to know when, where, and why animals migrate. Some animals, like white-bearded wildebeest and Arctic terns, migrate immense distances in search of mates and resources like food and water that are necessary for survival. But where animals go, what habitats they occupy, and why they travel such long distances are often a mystery.

For more than a century, Smithsonian scientists have worked to uncover these global mysteries by tracking animal movement across land, sea, and sky. Scientists want to know more about animal movements and how people can better protect critical animal habitats.

On land, Smithsonian’s National Zoo and Conservation Biology Institute scientists and partners study a variety of species around the world. In Kenya and Tanzania, scientists are tracking the long-distance migrations of wildebeest to discover how populations are impacted by changes to the landscape.

Scientists help identify routes that animals use to help protect their travel paths.

And in Myanmar, scientists track the endangered Asian elephant to identify where their movements cross paths with villages and agricultural fields to help minimize human/wildlife conflict in shared habitats.

In water, Smithsonian Environmental Research Center scientists built a network of buoys to pick up signals from tagged fish, including sharks and rays, that visit the Chesapeake Bay and migrate along the East Coast. Scientists hope the data will reveal the secrets of shark migration and how human activity, such as climate change and development, impacts shark and ray populations. When and why do sharks migrate? Is climate change warming waters? If so, what does that do to sharks’ ranges? How do humans impact wintering and nursery grounds of sharks and rays?

And in the air, scientists at the Zoo’s Migratory Bird Center are piecing together the puzzle of bird migration. Birds wearing tags like tiny backpacks share their location along migratory journeys that can stretch thousands of miles across oceans and continents—the record-setting species is the Arctic tern that travels 44,000 miles! Tracking data teaches scientists where birds travel, which helps them identify the important habitats to conserve.

As technology advances, the science of tracking animals—and the answers to these mysteries—evolves. Each step brings scientists closer to understanding animal behavior in our changing world and to finding sustainable solutions for preserving animals’ natural habitats.



Scientists use GPS collars to study the movements of wildebeest across East Africa’s grassland savannas
SMITHSONIAN’S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE

Marshes, Plants, and Climate Oh My!

What is the weather like outside where you are today? Weather patterns over a long period of time make up a place’s climate. The Earth’s weather changes quickly, but the climate has been slow to change until recently, which is affecting local communities. Scientists at the Smithsonian study climate change from many different angles to help us better understand what actions we can take globally and locally.

The Smithsonian Environmental Research Center is home to the Global Change Research Wetland, the world’s longest study of marshes to help understand the effects of climate change. Marshes protect our shores by keeping the soil from washing away, shielding us from storms, and providing a safe habitat for many fish and animals to grow up. Drs. Pat Megonigal and Genevieve Noyce study how rising carbon dioxide, nitrogen pollution, invasive species, microbes, and heat affect marsh growth. Their research site in the marsh is an outdoor laboratory. They use many different sizes of chambers that look like see-through tents to conduct experiments. They have heat lamps, lights, and equipment throughout the marsh to measure all of these complex parts of the marsh ecosystem.

Dr. Richard Barclay and Dr. Scott Wing: Using Clues from the Past to Better Understand Our Future

Researchers Rich Barclay and Scott Wing from the National Museum of Natural History use Ginkgo trees to study how much carbon dioxide (CO₂) was in the atmosphere millions of years ago. They grow Ginkgos under different levels of CO₂, then count and measure the small pores (stomata) on the undersides of their leaves. The higher the CO₂ level, the less porous the leaves. This relationship seen in living Ginkgos can then be applied to fossil Ginkgo leaves to reconstruct CO₂ levels in the atmosphere millions of years ago. This helps Earth scientists understand how CO₂ has influenced past climate and how it will affect future climate.



You can help as a community scientist by joining the count. Scan the QR code to learn more!



Left: Mason Scher (center) looks at fossil and dried Ginkgo leaves with mentors Drs. Rich Barclay (left) and Scott Wing (right) JAMES DI LORETO, SMITHSONIAN INSTITUTION



Right: Drs. Genevieve Noyce and Pat Megonigal SAIRAH MALKIN, HORN POINT LABORATORY

TAKING THE RESEARCH FURTHER...



“Mamakadendagwad” SMITHSONIAN AMERICAN ART MUSEUM

Ecosystems and Conservation

Living sustainably requires a balance of give and take with nature. While nature benefits humanity greatly, we must allow nature time to replenish its resources. Before European settlers arrived in North America, more than 40 percent of the continent was covered by prairie, and more than 60 million bison grazed in this vast habitat. In addition to herds of migrating bison, pronghorn antelope, and elk roamed these grasslands, supporting Indigenous human populations. Today, only a fraction of the prairie, and its bison population, remain. But the Indigenous communities who have stewarded, respected, and protected their environment—their homelands—for thousands of years are working today to restore and conserve these natural ecosystems.

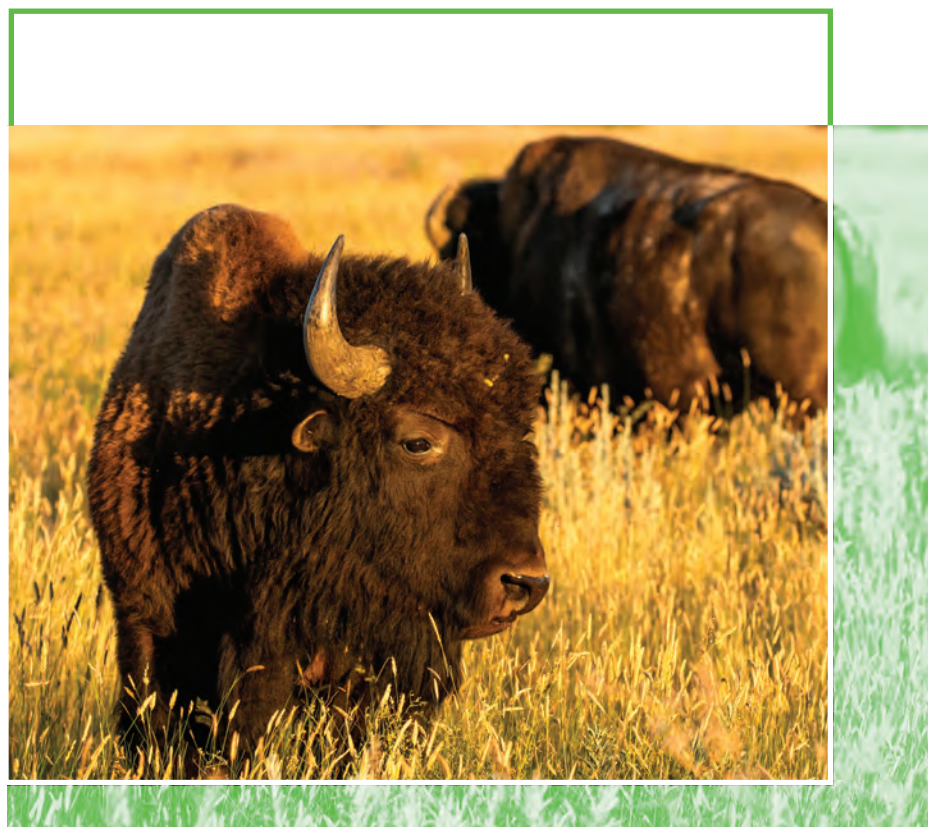
Across our nation, American Indian peoples are working to protect the wildlife and the environment that is part of their culture. In New York, the Akwesasne Mohawk people are working to protect the black ash trees used to make baskets, an important cultural tradition. In southern California and northwest Mexico, the Kumeyaay people of the Campo Kumeyaay Nation are carefully managing their lands to preserve the water supply that has been drastically reduced by cattle grazing. In Minnesota, the Leech Lake Ojibwe are trying to restore wild rice habitat that has been depleted by human development and activity. And in Washington State, the Lummi Nation is saving the salmon their people have depended on for thousands of years.

In partnership with the American Prairie, the Smithsonian’s National Zoo and Conservation Biology Institute is working to protect and restore the American prairie. Together, these organizations are researching how humans have changed the grasslands and how these changes have affected the diverse wildlife that calls it home. Their goal is to reintroduce species that have disappeared from this landscape and restore balance in the prairie ecosystem.

Is there a plant or animal that is important to your family or your local community? What can you do to preserve the nature around you?

Conservation of Culture and History on our Planet

We don’t always think about our culture as threatened by our changing environment. Extreme weather events have made it important to think about how we protect and preserve important works of art and historical artifacts. After the 2010 Haitian earthquake, conservators (people who care for and repair objects of cultural interest) came together to help recover culturally important sites and objects. This impactful work inspired the Smithsonian to create the Smithsonian Cultural Rescue Initiative (SCRI). Today, SCRI supports people around the world with training in resilience, cultural heritage, and disaster response. Smithsonian conservators often visit places damaged after significant weather events so they can help restore important cultural items. SCRI also offers resources to help you preserve treasured family photos and documents in case of damage, accessible by scanning the QR code.



Bison
ANDY BOYCE, SMITHSONIAN'S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE

TEMPO graphic NASA



Keeping Pace with TEMPO

Air pollution damages vegetation and can cause long-term health issues in people, and yet until recently, we didn’t have a good way to measure it. Just weeks ago, the Smithsonian Astrophysical Observatory recently launched the Tropospheric Emission: Monitoring of Pollution instrument (TEMPO) to monitor air pollution across most of North America from space. The instrument will be able to resolve differences in air pollution in 4 square miles—the size of midtown Manhattan or the entire town of Jackson Hole, Wyoming. Dr. Kelly Chance and team aim to use TEMPO to discover how much pollution is in the air, where it comes from, and how different air pollutant levels change throughout the day. TEMPO will, for example, help us understand how oil refineries, automobiles, and wildfires impact air quality in the surrounding area and will inform local authorities and the public on better ways to keep people safe. TEMPO sits in geostationary orbit, meaning it will stay in one spot in the sky, about 22,000 miles above North America and will scan the area during daylight hours. Scientists can also control it to study unexpected events such as volcanic eruptions and chemical spills. Overall, what we learn from TEMPO will help us live safer and healthier lives.

Learn more about TEMPO at tempo.si.edu



The TEMPO team NASA

APPLIED SOLUTIONS

Youth Leaders Taking Action in their Communities

What are some environmental concerns in your region? Since 2019, staff from Smithsonian Affiliations and the National Zoo and Conservation Biology Institute have partnered with local organizations to support and mentor youth in more than 20 cities nationwide and to explore student-led, community-focused environmental action.

Laurel, Maryland

The Earth Optimism club at the Chesapeake Math and IT Academy North High School is transforming their school campus into an environmental learning laboratory help from mentors at the World Wildlife Fund. They've been planting native pollinator plants, and stenciling storm drains for watershed awareness. They oversee a compost program and run a campaign to responsibly recycle electronics.



Anchorage, Alaska

Working with the Anchorage Museum, youth leaders addressed parts of the city's climate action plan. These Climate Communicators produced a virtual summit that brought together students in their area to network and share ideas for environmental action, ranging from alternative transportation methods to sustainability in food systems.

Lowell, Massachusetts

With the help of mentors from the Lowell Parks and Conservation Trust, Lowell National Historical Park, and Mass Audubon, high school students formed the Environmental Youth Task Force. Their work includes planting trees and plants that attract pollinators like bees in local parks and presenting their concerns to their Congressperson in a meeting at her office.



Miami, Florida

Working with the Phillip and Patricia Frost Museum of Science, student leaders formed "Small Changes Big Impact" to communicate sustainability tips and action ideas. They organize park and beach clean-ups via social media platforms, such as Instagram and TikTok.



Are there groups in your community where you might volunteer or join? If you haven't found a group that's right for you, how can you bring people together to address an issue that matters to you?

Left Photo, Top Row: Students on the water SMITHSONIAN AFFILIATIONS
 Middle Photo, Top Row: Students planting trees LOWELL PARKS AND CONSERVATION TRUST
 Right Photo, Top Row: Students leading a beach clean-up THE FROST SCIENCE MUSEUM
 Left Photo, Second Row: Teachers in front of a storm drain SMITHSONIAN AFFILIATIONS

Dr. Mary Hagedorn: Using Biotechnology to Help the Environment

"The social good of caring for others could also be extended to caring for and protecting our ecosystems and our planet so that every child can grow up to see and experience beautiful and wild places on Earth."

There are hundreds of coral species of all colors, shapes, and sizes. They are sometimes mistaken for plants because of the branchlike features or rock-hard skeletons some create around their soft bodies, but they are animals! Reef corals support healthy ocean food webs, protect our coastlines, and are home to more than 25% of all marine life.

Unfortunately, coral reef ecosystems are severely threatened. Some threats are natural, such as diseases, predators, and storms. Other threats are caused by people, including pollution, unsustainable fishing practices, and climate change that raises ocean temperatures.

As a senior research scientist at the Smithsonian's National Zoo and Conservation Biology Institute, Mary Hagedorn worked with her team to develop an innovative conservation program for coral species—a world-class genomic library and frozen repository or "biobank" that includes twelve coral species from two of the world's major oceans.



Dr. Mary Hagedorn MARCO GARCIA
 Coral SMITHSONIAN NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE



Biotechnology Guide cover SMITHSONIAN SCIENCE EDUCATION CENTER

Learn more about the world's most pressing issues and become an agent for change in your community. A series of free research guides investigates the science that underlies the United Nations Sustainable Development Goals. Developed by the Smithsonian Science Education Center in collaboration with the InterAcademy Partnership, the guides offer young people a chance to define and implement their own sustainable actions to help solve the greatest challenges of our time.



"Inventing Green" across Diverse Industries

How have different sectors of the economy, ranging from the beer brewing industry to the contractors who are constructing roads, sidewalks, and bridges, responded to climate change through eco-friendly, "green" inventions? In a series of short video interviews from the Lemelson Center for the Study of Invention and Innovation at the National Museum of American History, learn more about how nine contemporary inventors create sustainable solutions in their line of work.

Hear from innovators like Kim Jordan, co-founder and former CEO of New Belgium Brewing Co. in Fort Collins, Colorado, who dedicated the brewery to environmental stewardship from its outset. Meet inventor David Stone, who incorporated recycled materials into a new concrete substitute called Ferrock, making it not just carbon neutral but carbon negative, meaning that it absorbs more CO₂ than was used to produce it. These stories show that there are ways to innovate in the name of sustainability in every industry.



Waste steel dust
 JOYCE BEDI, LEMELSON CENTER, NATIONAL MUSEUM OF AMERICAN HISTORY

APPLIED SOLUTIONS



Conservation Success: Giant Pandas

Giant Panda,
Xiao Qi Ji
SMITHSONIAN'S
NATIONAL ZOO AND
CONSERVATION
BIOLOGY INSTITUTE

It is easy to feel overwhelmed by environmental challenges, but there are inspiring stories of conservation success all around us that bring hope for the future. Collaborative efforts underway to save wildlife can truly make a difference.

An iconic story of collaboration and success at the Smithsonian is that of the giant pandas. For over 50 years, the Smithsonian's National Zoo and Conservation Biology Institute has created and maintained one of the world's foremost panda conservation programs.

Throughout that time, the Zoo continues to demonstrate the wonders of science and teamwork in saving this beloved species. Through the collective efforts of animal care staff, scientists, researchers, international collaborators, and conservationists, there have been significant milestones in the understanding of giant panda behavior, health, habitat, and reproduction.

Native to China, giant pandas live in forest habitats that are fragmented due to urban development and deforestation. These disconnected fragments of their habitat make it harder for giant pandas to find food and mates. Together, Zoo ecologists and scientists from the China Wildlife Conservation Association are working to connect and expand fragmented panda habitat. And it's working! From tracks and traces the bears leave behind (like poop!), scientists can see that the forest corridors successfully link panda populations.

You don't need to be a scientist to help save species. Small sustainable actions we take every day can make a big impact. The actions you take in your daily life can contribute to another conservation success story. What species do you hope to see for generations to come?

Our Shared Health

All life on Earth—human, plant, animal, and bacterium alike—depend on each other to build a sustainable planet where all will prosper. People need pure water to drink, clean air to breathe, and hearty plants and animals to keep us fed, entertained, and healthy. By maintaining a robust natural world, we can keep our friends, families, and communities safe from the challenges that lie ahead.

Nearly three out of four infectious diseases, including the viruses that cause COVID-19 and the flu, come from animals. As we build and expand our cities, we come in closer contact with animals that can make us sick. Changes to our climate also cause animals to migrate to new areas and bring diseases with them. But it's not a one-way street. According to the Centers for Disease Control and Prevention, humans can also make animals sick—animals such as cats, dogs, zoo animals, minks, and even deer!

Across more than 140 countries, the Smithsonian's scientists examine the connections between human, plant, animal, and environmental health. They have collected samples from around the world, including living collections of animals and plants and historical and cultural collections that provide context by showing us the history of humans' relationship with nature through time. Notably, scientists actively monitor animal and plant species that tend to carry harmful viruses that can affect humans. These species serve as an early warning system for emerging threats to human health.

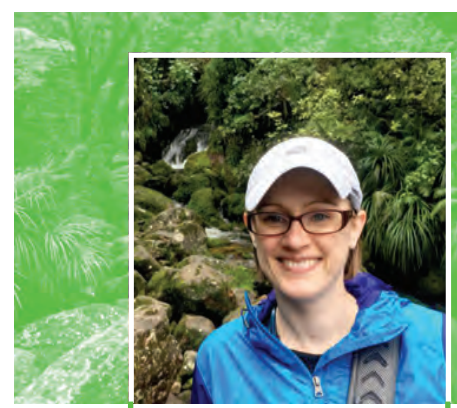
To test whether an animal is carrying a harmful germ, scientists need to collect a sample from that animal. It's not that easy to draw blood from a lion in the wild, so instead, one way scientists get the "scoop" on animal health is by studying their poop!

Dr. Maureen Wanjiku Kamau of the Mpala Research Center in Kenya is collecting poop as part of her research fellowship with the Global Health program at the Smithsonian's National Zoo and Conservation Biology Institute. She collects the poop of endangered black rhinos to determine when they are breeding and how healthy the population is. In the U.S., Dr. Katrina Lohan at the Smithsonian Environmental Research Center studies river otter poop. She wants to discover what types of parasites are moving through food webs and what animals the otters eat since we eat some of the same food. Who knew poop held the answer to so many questions? Scan here to read an article about her "Poop Party" research.



Dr. Maureen Wanjiku Kamau
SMITHSONIAN'S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE

"Scientists are interested in learning how germs move around the planet so they can predict where diseases might pop up."



Dr. Katrina Lohan
SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER



River Otter MATTHEW FREYER

Would you like to learn more about where disease outbreaks originate? Scan the QR code to visit the National Museum of Natural History's online exhibit entitled "Outbreak: Epidemics in a Connected World."





“The Grand Canyon of the Yellowstone, 1893-1901”
SMITHSONIAN AMERICAN ART MUSEUM

ENVISIONING OUR SHARED FUTURE

People act to create the future they desire every single moment of the day, generating many possibilities of what the future might look like. The scientists, activists, and artists you’ve read about in this guide are working to make positive changes in their communities and environment. Artworks like the ones seen here can help us ask questions about the future we’re creating and the alternative futures we could move toward.

Notice the similarities and differences between the two scenes, particularly the sunlight, air, water, and plants. How does each of these things feel in one landscape versus the other? The artists painted these two landscapes as big as an entire gallery wall to give the viewer an immersive experience. Imagine if you could enter these two paintings and stand in these landscapes. What would the sensory experience be in each? What would you see, feel, smell, taste, and hear? As you consider the different experiences in each landscape, think about what might cause these two environments—past and future—to be so radically different.

Using the space to the right, draw or write a story about what a sustainable future looks like for you. You might use ideas you have seen in books, films, art, or other media, or even this guide, to help you imagine the types of future you do or do not want. Think about the sensory experience as you immerse yourself in that envisioned space. What steps could you take to help make that space a reality?

“Manifest Destiny” SMITHSONIAN AMERICAN ART MUSEUM



Taking Action

Pick one part of the future you imagined. Then, think about an action you can take to help create that future. Your actions can range from personal choices to actions that can make a global impact. You can draw on the examples below, or think of your own.

You can...

Make a personal behavior change

Talk to your family or colleagues and make changes as a group, like implementing composting

Share information or collaborate with others in your community locally or globally

Engage with local, state, or national lawmakers about ideas that matter to you

Help scientists collect data on the environment, or educate others!

The first step is crafting a goal that’s right for you. That means identifying something that is important to you and that you have the skills, talent, and drive to achieve. Think about who you might collaborate with and who might benefit from your chosen action. Then, fill out the pledge.

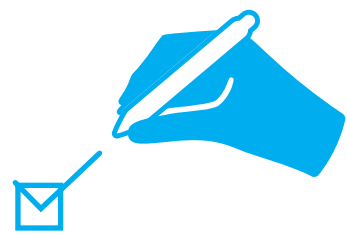
I, _____, pledge to make some small changes to my day, these are the ones I’ll do right now:

This is what I’m working towards in the next week, month, or year:

Image Credits COVER TSeine-netting to collect animals from the Indian River Lagoon, Smithsonian Marine Station; **Page 2** Secretary Lonnie G. Bunch III, Smithsonian Institution; **Page 3** Under Secretary for Science and Research Ellen Stofan, Jim Preston **Page 4** Boy Viewing Mount Fuji by Katsushika Hokusai, Freer Gallery of Art, Gift of Charles Lang Freer; Dr. Gail S. Lowe, Anacostia Community Museum; Students of the Anacostia Community Museum Academy enjoy a Chesapeake Estuary Tour with the Smithsonian Environmental Research Center. Photograph by Susana Raab, Anacostia Community Museum Archives, Smithsonian Institution; **Page 5** Downy rattlesnake plantain, Smithsonian Environmental Research Center; Dr. Melissa McCormick, Smithsonian Environmental Research Center; Spiked Crested Coralroot “Orchid-gami”, North American Orchid Conservation Center; Imani Black, Caroline J. Phillips; Maya Lin, Folding the Chesapeake, 2015, fiberglass marbles, Smithsonian American Art Museum, Gift of Debbie Frank Petersen, 2016.26, © 2015, Maya Lin; Maya Lin 1:5 by Karin Sander, National Portrait Gallery, Smithsonian Institution; acquired through the generosity of the Academy of Achievement/Wayne and Catherine Reynolds; 2015 Portrait of a Nation Prize Recipient; **Page 6** Seine-netting to collect animals from the Indian River Lagoon, Smithsonian Marine Station; Giant Magellan Telescope, GMTO Corporation; Mark Torchin in the field, Courtesy of Mark Torchin, Smithsonian Tropical Research Institute; Nancy Knowlton, Courtesy of Nancy Knowlton; Ocean Travelers image of sorting marine litter, Yasmine Florent; Smithsonian Secrets of the Sea interactive, Office of Educational Technology; **Page 7** Dr. Steve Canty, Jordan Cissell, Smithsonian; Wildebeest Conservation, Smithsonian’s National Zoo and Conservation Biology Institute; Drs. Genevieve Noyce and Pat Magonigal, Sairah Malkin, Horn Point Laboratory; Dr. Rich Barclay, Mason Scher, and Dr. Scott Wing look at fossil and dried Ginkgo leaves, Photo by James Di Loreto, Smithsonian Institution **Page 8** Tom Uttech, Mamakadendagwad, 2015-2016, oil on canvas, Smithsonian American Art Museum, Museum purchase made possible by the American Art Forum, 2017.3, © 2016, Tom Uttech, courtesy Alexandre Gallery, New York; Bison, Andy Boyce, Smithsonian’s National Zoo and Conservation Biology Institute; TEMPO graphic, NASA; The Tempo Team, NASA **Page 9** Anchorage Teens for Climate Action Summit Logo, Courtesy of the Anchorage Museum; Students on the Water, Courtesy of Smithsonian Affiliations; Students Planting Trees, Courtesy of Lowell Parks and Conservation Trust; Students Leading a Beach Clean-Up, Courtesy of the Frost Science Museum; Teachers in front of a Storm Drain, Courtesy of Smithsonian Affiliations; Dr. Mary Hagedorn, Marco Garcia; Coral, Smithsonian’s National Zoo and Conservation Biology Institute; Biotechnology Guide cover, Smithsonian Science Education Center; Waste steel dust, Joyce Bedi, Lemelson Center, National Museum of American History; **Page 10** Giant Panda, Smithsonian’s National Zoo and Conservation Biology Institute; Dr. Maureen Wanjiku Kamau, Smithsonian’s National Zoo and Conservation Biology Institute; Dr. Katrina Lohan, Smithsonian Environmental Research Center; River Otter, Matthew Freyer; **Page 11** Thomas Moran, The Grand Canyon of the Yellowstone, 1893-1901, oil on canvas, Smithsonian American Art Museum, Gift of George D. Pratt, 1928.7.1; Alexis Rockman, Manifest Destiny, 2004, oil and acrylic on wood, Smithsonian American Art Museum, Museum purchase through the Luisita L. and Franz H. Denghausen Endowment, 2011.36A-D, © 2004, Alexis Rockman; **Page 12** Bird-Friendly Coffee, Smithsonian’s National Zoo and Conservation Biology Institute; “The Gardens at Chewonki,” Community of Gardens, Smithsonian Gardens; Robert Ebendorf, Off the Street, On the Beach, 1992, mixed media of found objects, mostly plastic, Smithsonian American Art Museum, Gift of Kenneth R. Trapp in honor of Robert Ebendorf, 2003.27.1, Students in Action, Smithsonian Environmental Research Center.

Brought to You By *Sustainability in Action* print edition is a collaboration between the **Smithsonian Institution**, **USA TODAY**, and **Funnel Design Group**. Content for this publication has been contextualized, modified, and adapted for brevity, using Smithsonian sources, including interviews, descriptions, and content from experts in the field referenced. From the Smithsonian: National Museum of African American History and Culture, National Portrait Gallery, Smithsonian Environmental Research Center, Smithsonian’s National Zoo and Conservation Biology Institute, Smithsonian Science Education Center, Office of Advancement, Office of Communications and External Affairs, Office of the Under Secretary for Education, Office of the Under Secretary for Science and Research, and the Smithsonian community.

ACTIONS YOU CAN TAKE TOWARDS SUSTAINABILITY



Protecting our planet starts with you! Explore the provided ideas to learn how simple changes to your daily routine can help counter a challenge on a global scale. What small changes can you make?

Looking for actions that help protect air quality?



Celebrate in an eco-friendly way.

A balloon can travel thousands of miles and end up damaging the ecosystem where it lands. Balloons can especially harm birds and marine life, who mistake the debris for food. Consider bubbles, lanterns, or paper party supplies such as confetti or streamers to add some pizzazz to your celebrations.



Get on the go greener.

What options do you have for getting from point A to point B in your area? Can you bicycle or walk? Can you take a bus, subway, train, or carpool with friends and family? How we move matters.

Looking for actions that help protect ocean life?



Carry a reusable shopping bag.

Skip plastic bags that often end up in the ocean. Remember to bring a reusable bag on every shopping trip.



Pick up trash.

Litter from anywhere can make its way to streams, rivers and lakes. Grab a friend and pick up trash in your local community.

Looking for actions that help protect habitats on land?



Carry a reusable water bottle.

Stay hydrated, save money, and reduce your carbon footprint. Reconsider single-use plastics like water bottles. While it still takes energy to manufacture and distribute reusable water bottles, this process only has to take place once, not once per drink!



Drink Bird Friendly® coffee.

When you purchase Bird Friendly® certified coffee, you preserve critical habitat for birds and wildlife, fight climate change, protect biodiversity, and support farmers committed to conserving bird and wildlife habitat by farming sustainably.



Let your electronics sleep.

While it might be tempting to keep your laptop or computer logged in and ready to go at a moment's notice, you can save energy by putting your electronic devices in "sleep mode" or shutting them down.



Be a savvy chocolate lover.

Many chocolate candies contain palm oil—whose collection often involves cutting down trees and hurting endangered animal populations in the rainforest. Be sure to look for "certified sustainable palm oil" on labels.



Mend and repair clothing.

Clothing manufacturing is one of the world's most energy-intensive processes. Make it last. Repairing clothing instead of replacing it can help reduce energy, raw materials, and water consumption.



Make your windows "bird-safe".

One billion birds die yearly by crashing into windows, most during the migration season. By using external insect screens, tape, or decals and by turning off your lights or closing your blinds in the evening, you can help birds tell when a window is a window.



Reduce food waste.

Be a smart shopper and consider what you are buying and when it will be eaten. Plan meals and use shopping lists. Visit grocery stores more often and buy less during each trip—you'll waste less food if you only purchase what you need for the next few days. Bring your leftovers home from restaurants in reusable containers.



Grow your own food.

By planting a garden—even in a container—you can brighten up your neighborhood and provide fresh produce and flowers for your family. If you're just getting started, Smithsonian Gardens offers tips on native plantings. Take the "Green Ambassador" Challenge. s.si.edu/GreenAmbassador



Turn off the faucet.

Turn off the water while brushing your teeth or washing dishes. Those two to three minutes without the sink on can save two to three gallons of water each day. Check your water bills regularly. If you see a big spike, that might mean there's a leak in your home somewhere.



Clean up carefully.

Many household chores can be done with simple, non-toxic ingredients like vinegar, baking soda, or lemon juice. Even if you don't live near the coast, water—and anything else that goes down your drain—can eventually end up in the ocean. Opt for eco-friendly cleaning products when you can.



Make art!

Take inspiration from artist Robert Ebendorf, who made "Off the Street, On the Beach," using materials that he collected while walking with his daughter around the beach and on the way to school. He then assembled these found pieces of glass, wire, spoons, and plastic into a playful necklace. What a way to make a statement!

Third Row: Bird-Friendly Coffee SMITHSONIAN'S NATIONAL ZOO AND CONSERVATION BIOLOGY INSTITUTE
Fourth Row: "The Gardens at Chewonki," Community of Gardens SMITHSONIAN GARDENS
Fifth Row: Robert Ebendorf, Off the Street, On the Beach SMITHSONIAN AMERICAN ART MUSEUM
Last Row: Students in Action SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER

Looking for extensions on these ideas?



Volunteer.

Some of our researchers at the Smithsonian rely on community scientists—volunteers who actively help out with research projects in the field or in the lab. Learn more at si.edu/volunteer/citizenscience



Stay Informed.

Seek out information to stay informed about local, national, and global environmental news and research. The National Museum of Natural History's "Ocean Portal," ocean.si.edu, is an unique, interactive news site.



Share your stories.

Have you made an eco-friendly change? Tell others. Share photos of green spaces that inspire you. You have the power to inspire—especially your friends and family.



Get involved.

The tool Eco-Health Relationship Browser provides information about major ecosystems, the services they provide, and how the loss of those services may affect people.