SCIENCE AT THE SMITHSONIAN

Every day, in every corner of the globe, Smithsonian science examines some of the world's most complex—and time-sensitive—problems. Whether they are protecting imperiled natural resources, assessing the consequences of climate change or keeping aircraft safe from bird strikes, Smithsonian scientists apply what they learn to improve the quality—and quantity—of life on Earth.

Today, more than 500 Smithsonian staff scientists, augmented by an equal number of fellows and hundreds of international collaborators, conduct research in field stations and laboratories on all seven continents and serve as national and international experts in a wide scope of disciplines. Whether they are looking 5 million years into the past or imagining the future at the edge of the universe, our scientists are forging new paths of discovery and understanding.

The basis for Smithsonian science derives from the founding of the Institution in 1846 and the selection of Dr. Joseph Henry, a prominent physicist, as the first Secretary. Henry was drawn to the Smithsonian because he saw a need for science research to support national needs. The Smithsonian was one of the nation's first science institutions, and its role was critical—no other federal agency was engaged in science in the 1850s, and research universities had yet to emerge in the United States. Over the years, the Smithsonian has continued to play an important role in addressing the science needs of our nation, but the expansion of the research agenda of the country spawned many other entities with research missions. These include land-grant universities (1862), research universities (1876), the U.S. Geological Survey (1879), the National Science Foundation (1950), NASA (1958) and NOAA (1970). In addition, federal agencies like the Department of Defense, the Department of Commerce, the Department of Energy, the Department of Transportation and the Environmental Protection Agency developed their own research capacities. In the case of the Department of Energy, it created an array of national laboratories, each of which has a specific mission and maintains large-scale facilities for use by its own scientists and those from other institutions. Today, the nation has a wide array of organizations and hundreds of universities involved in research, either doing it themselves or sponsoring research for others.

Through this time of change, the Smithsonian has remained steadfast in its commitment to science research. Its activities are distinctive in that they are focused in a select set of areas that are broadly defined topically. In comparison, at a research university, scientific research is aligned with the traditional disciplines, such as physics, chemistry, biology, life sciences and earth sciences, in which degrees are offered. At the Smithsonian, science research is organized more generally, including the origins of the universe, preserving biodiversity, the origins of life, planetary sciences and climate change. Also, while Smithsonian science is pursued through research, there are significant components related to public service, educational outreach and the maintenance of facilities that serve the needs of non-Smithsonian scientists. For example, the Smithsonian has developed a world-class tropical research capability at Smithsonian Tropical Research Institute (STRI) in Panama, where its scientists are among the leaders in understanding how the

complex diversity of the tropics integrates into the survival of the world's species. At the same time, the Smithsonian makes its facilities in Panama available to hundreds of visiting scholars and students each year who conduct their own research and add to the world's knowledge of the tropics.

The nature of Smithsonian science overlaps with, but is different than, that of others. It is this distinctiveness that helps justify its aims and allows Smithsonian scientists to serve national interests in ways others cannot.

How is the Smithsonian unique among our nation's science entities?

In a 2003 report, the prestigious National Research Council of the National Academies cited the Smithsonian as "a world-class scientific institution, a unique contributor in specific areas, and an important resource to the United States' research enterprise." As the largest museum and science complex in the world, the Smithsonian has convening power and rich opportunities for collaboration. Our singular advantages include:

Museums

The Smithsonian is home to the National Museum of National History, the National Air and Space Museum (on the Mall and at Dulles), and the National Zoo in Washington, D.C. as well as its world-class biological conservation facility in Front Royal, Virginia. Among these facilities, upwards of 15 million people make visits annually, offering the largest, single opportunity in the world to educate the public about science. The science research done by the Smithsonian informs museum exhibits and insures that the extensive educational outreach that emanates from them is up-to-date and cutting edge.

In addition to the museums, the Smithsonian Museum Conservation Institute (MCI) is one of the world's few research centers focused on the science of restoration and preservation of artifacts. The MCI has specialists, many with Ph.D.s, whose talents are essential to the task of restoration and preservation.

National Collections

Irreplaceable and comprehensive, the Smithsonian has the richest, largest and most-used natural history collection on Earth. Tens of millions of artifacts and specimens, some as old as the Earth itself, serve as a baseline against which to measure change; they are a reference for Smithsonian scientists and those in other federal agencies, including the National Oceanic and Atmospheric Administration and the U.S. Department of Agriculture, as well as scientists around the world who study processes that have modified Earth and shaped the human environment. They reflect a legacy of more than 150 years of research, exploration, discovery and conservation, and they inform Smithsonian publication, education and exhibition. Universities have researchers, but not extensive collections—our collections set us apart from all other research and scholarly institutions.

Natural Science Preserves
The Smithsonian operates and conducts research on several natural preserves, including the tropical forests at STRI, 16 miles of Chesapeake Bay shoreline at the Smithsonian Environmental Research Center (SERC), and 3,000 acres of grasslands and temperate forests at the Conservation and Research Center in Front Royal, Va.—the CRC has recently been designated as a part of the National Science Foundation's network of natural observatories. In addition to these preserves, the Smithsonian is a partner in others, like the 50,000-acre Mpala Research Centre in Kenya, where scientists research wildlife and landscape ecology. All of these facilities have established baselines for documentation of species and habitat studies. They serve as research sites for Smithsonian scientists and large numbers of visiting scientists and students. They also enable Smithsonian scientists to participate, and in some cases lead, global consortia studying interconnected issues, such as the Smithsonian Institution Global Earth Observatories (SIGEO) project, in which researchers observe forests around the world to understand the impact of climate change on nature.

Scientific Facilities
The Smithsonian's scientific facilities allow for studies of micro-organisms, entire ecosystems and the outer regions of space. From smaller research centers such as Fort Pierce in Florida to the larger ones found at STRI and the Smithsonian Astrophysical Observatory (SAO), these sites have specialized equipment that is maintained for use by Smithsonian scientists and visiting scientists. SAO not only allows scientists to operate a number of major telescopes—including a billion-dollar "great observatory" operated for NASA—but also has the capacity for designers and builders to create the scientific equipment that is part of large telescopes, including those that go into space.

Educational Science Outreach
All of the Smithsonian's museums, natural science preserves and field stations are involved in educational outreach. More than 150,000 K-12 students and their teachers visit our education centers each year, and the National Science Resources Center provides curriculum materials for hundreds of K-12 schools. Millions more visit our Web sites, such as the Encyclopedia of Life, where social networking tools assist the Smithsonian to work interactively with teachers to develop lesson plans and improve the science basis for learning exercises. Combined with the millions of people who visit the museums on the Mall, the educational science outreach from the Smithsonian reaches a vast audience.

Breadth, Depth and Scope of Research
Smithsonian science is organized differently than that found in universities or government agencies. Its focus, combined with its museums and research centers, give the Smithsonian a perspective others do not have.

Example: The Smithsonian applies a wide range of disciplines to the study of climate change, including those in the research fields of anthropology, paleobiology, ornithology, geology, astrophysics, botany, ichthyology, ecology and marine biology. Few, if any, other organizations could research a topic with such a multifaceted approach.

Commitment to Long-term Research

The Smithsonian is exceptional in its ability to undertake long-term studies that require large-scale data gathering. Research carried out over years and even decades is now recognized as fundamental and vital, both to scientific understanding and to society's ability to make informed policy choices about such issues as ocean conservation. Many ecological processes vary over extended periods—something short-term observations may not detect. The Smithsonian has managed study sites for decades, obtaining valuable data on such long-term trends.

Example: Smithsonian scientists have been conducting research on Barro Colorado Island in Panama for 86 years, fostering a base of primary scientific information unequaled by any other single biological research site on Earth.

Where does the Smithsonian excel?

Smithsonian science focuses resources and expertise in four major areas:

Origin and Nature of the Universe

The Smithsonian is a leader in the fields of science that explore the universe, working to understand how the stars and planets formed and explain phenomena such as dark matter and black holes. At the National Air and Space Museum, researchers study planetary science, terrestrial geophysics and the remote sensing of environmental change. The Smithsonian Astrophysical Observatory's more than 300 scientists research astronomy, astrophysics, earth and space sciences, and science education.

Example: Astrophysicists at SAO recently discovered a young solar system that has two asteroid belts just like our solar system; they also discovered a new type of "puffy" planet—the largest planet yet found.

Formation and Evolution of Earth and Similar Planets

Since the dawn of modern geology more than a century ago, the Smithsonian has collected and studied rocks and minerals to learn about the surface of the Earth and other planets. The National Museum of Natural History's Global Volcanism Program monitors volcanic eruptions worldwide. Our knowledge of the surface characteristics of other planets has helped NASA pinpoint safe landing sites for three successful Mars missions.

Example: Scientists at NASM discovered an impact basin on Mercury that is more than 430 miles wide and completely exposed—a scientific first. This recent finding will give scientists greater insight to other impacts and tectonic forces of the planet.

Discovering and Understanding Biological Diversity

The Smithsonian is an international force in the fields that analyze biological diversity—paleobiology, ecology, marine biology, systematics and biological conservation. Our collections and living laboratories uniquely position us to study the natural world. Smithsonian scientists have discovered and named hundreds of thousands of species; our collections include more than 250,000 of the type specimens used to represent individual species.

Example: Smithsonian ornithologists discovered a new species of bird—the olive-backed forest thrush—while conducting an extensive biodiversity census in a remote region of Gabon, Africa in 2008.

Human Diversity and Cultural Change

Understanding the specific processes that shape human language, biology and culture is a major field of endeavor for the Smithsonian. Expertise in anthropology, ethnology and archaeology is reinforced by an extensive collection of monographs, photographs, field notes, recordings and films. These resources enable the Smithsonian to play an important role in examining the ways that human interaction, time and nature interact to effect life on earth.

Example: Archaeological research at the Arctic Studies Center provides deep-time records on how changing climate and environments have influenced northern peoples and cultures—forcing migrations, culture changes, adaptations, cultural extinctions and abandonment of territory.

How is the Smithsonian a resource to the larger science community?

Every day, in every part of the world, the Smithsonian advances scientific discovery and works to better the quality of life on the planet.

Sparking Inquiry and Advancing Discovery

The Smithsonian represents a community of researchers from inside the Institution and from without who follow where the science leads, sparking inquiry and expanding the boundaries of the known world. Much Smithsonian research seeks to identify and understand basic principles that may be many years away from application to specific problems. Federal funding makes this research possible.

Example: Core support of the SAO X-ray Astronomy Group in the '70s and '80s led to the development of the Chandra X-ray Observatory, the foremost X-ray telescope in the world and an impressive, NASA-funded, national facility available to all astronomers.

Fostering Collaboration and Access to World-class Resources

The Smithsonian provides researchers with access to its unique network of scientists, collections, laboratories, field sites and past research. The Smithsonian also collaborates with universities and museums across the globe to tackle projects too complex for any one institution to undertake alone.

Example: STRI's facilities provide a unique opportunity for long-term ecological studies in the tropics and are used extensively by 38 staff scientists and approximately 900 visiting scientists from around the world every year.

Promoting Science Literacy and Careers in Science

Through fellowships and internships in every science unit, the Smithsonian mentors and trains the next generation of researchers. But our interaction with nascent scientists starts even earlier. The National Science Resources Center was established in 1985 jointly by the Smithsonian Institution and the National Academies to improve science education in America's schools—a critical indicator of our nation's ability to lead in the future.

What are the challenges ahead?

To maintain its cutting-edge research in the years to come, the Smithsonian needs to be attuned to where it can best contribute to solving complex scientific issues and adjust its unique resources accordingly. In the coming months, through both the strategic plan and deeper discussions scheduled for the Regents early next year, these issues will be examined.

- Increasing capabilities for interdisciplinary research (internal)
- Connecting important scientific assets to create more synergy
- Developing a clear vision for science education
- Finding key partners within the federal and university sectors.

Where is Smithsonian science conducted?

In addition to the seven main science units listed below, Smithsonian science can be found throughout the world. Smithsonian has research centers and field sites in dozens of locations, from the arid savannahs of Namibia where biologists help conserve cheetahs to the arctic tundra where anthropologists help conserve human cultures; from examining how currents work in the deep ocean to how a black hole works in deep space.

Smithsonian Environmental Research Center, Edgewater, Md.
SERC is the leading national research center for understanding environmental issues in the coastal zone. Its scientists engage in interdisciplinary studies that address issues such as global climate change, watershed pollution, the maintenance of productive fisheries, the changes wrought by invasive species and the ecology of fragile wetlands and woodlands.

Smithsonian Tropical Research Institute, Panama
STRI is the world's premier tropical biology research institute, dedicated to increasing our understanding of the past, present and future of tropical biodiversity and its relevance to human welfare. STRI's facilities provide a unique opportunity for long-term ecological studies in the tropics and are used extensively by both Smithsonian scientists and hundreds visiting scientists from around the world.

National Museum of Natural History, Washington, D.C.
The work of the scientific staff at NMNH spans anthropology, botany, entomology, mineral sciences, invertebrate zoology, paleobiology and vertebrate zoology. Their interdisciplinary work addresses important topics such as biological diversity, climate change, molecular systematics, ecosystem modeling and the documentation and preservation of human cultural heritages. NMNH scientists also work at the Smithsonian Marine Station in Fort Pierce, Fl.—a research center specializing in marine biodiversity and ecosystems of Florida.

Smithsonian Astrophysical Observatory, Cambridge, Mass.
SAO is arguably the largest and most diverse astrophysical institution in the world, where scientists carry out a broad program of research in astronomy, astrophysics, earth and space sciences and science education. The Observatory's mission is to advance our knowledge and understanding of the universe through research and education in astronomy and astrophysics.

National Zoological Park, Washington, D.C.
National Zoo scientists are based at the Zoo in D.C., the Conservation and Research Center in Front Royal, Va. and at field sites around the world. They conduct research to aid in the survival or recovery of species and their habitats and ensure the health and well-being of animals in captivity and in the wild. During the past 28 years, more than 4,300 people from 109 countries have been trained through the Zoo's professional programs in conservation and zoological medicine.

National Air and Space Museum, Washington, D.C.
Scientists at NASM's Center for Earth and Planetary Studies, a NASA-supported program, study a variety of geological processes, such as volcanism, floods, crater formation, tectonics and sand movement. Many of the studies also address topics of concern for climate change. The scope of research activities includes work on Mercury, Venus, the moon, Mars, asteroids and some satellites of the outer solar system.

Smithsonian's Museum Conservation Institute, Suitland, Md.
Researchers use state-of-the-art instrumentation and scientific techniques to provide technical research studies and interpretation of art, as well as anthropological and historical objects. Their work assists scientists, art historians and conservators as they place objects within a culture and a time period, look for new cultural influences within societies and compare cultural and technological change across different periods and geographic areas. The institute is the only Smithsonian resource for technical studies and analyses for the majority of Smithsonian collections.