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Introduction

Mr. Chairman and Members of the Subcommittee -

It is my privilege to appear before the Subcommittee to testify about the science research and education programs conducted at the Smithsonian Institution. Over the next decade, the Smithsonian is committed to using its resources to become more engaged than ever before with the great issues of our day and to energize our work with a new spirit, capitalizing on the passion of the people of the Smithsonian for their work. The Institution completed a year-long inclusive process resulting in a Strategic Plan that is interdisciplinary and entrepreneurial, and which has been embraced by both internal and external stakeholders. It calls for us to broaden access and reach new audiences by bringing the resources of our museums and research centers to people where they learn and live. Our goal is to serve not only the millions of people who visit our museums, but to reach those who are not able to come or who are not aware of the opportunities for learning that we offer. The plan also brings focus to our future efforts in science, creating new opportunities through crossdisciplinary and collaborative approaches within the Smithsonian itself as well as with partners who share our commitment and complement our strengths.

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 ecosystems that are threatened, 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. Their work addresses some of our most pressing issues, including education about the impacts of volcanic eruptions, discovery of new planets, minimizing the growing effects of invasive species and setting the baseline for damage from the Gulf of Mexico oil spill.

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 range of disciplines. Over a thousand students intern with us each year and work with our scholars, and many more learn by visiting our field stations, museums and the National Zoo. They come to be part of our exciting science agenda and we welcome the opportunity to help them grow to be the next generation of scientists for our nation.

The home of the Smithsonian science agenda is found in a group of key facilities and units, many historical and with long and distinguished histories.

Museums

The Smithsonian is home to the National Museum of Natural History (NMNH), the National Air and Space Museum (on the Mall and at Dulles International Airport), the National Zoological Park in Washington, D.C. , and the Zoo's world-class biological conservation facility in Front Royal, Virginia. The NMNH opened one hundred years ago this year, and not only is a premier museum visited by 7.5 million people a year, but home to world class science in botany, biology, zoology, paleontology, anthropology, archeology, ornithology, earth sciences, and vulcanology. Its collections, with 126 million specimens and objects, are the largest in the world and are increasingly available to scholars and citizens alike around the world through digital access.

Combined, our science museums and the National Zoo host upwards of 15 million visitors 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 Zoo exhibits and insures that the extensive educational outreach that emanates from them is up-to-date and cutting edge.

Smithsonian Centers of Research

The nature and scope of Smithsonian science is built on a world stage, involving activities in over 80 countries. In addition to the museums, Smithsonian science is driven by a group of leading research centers that allow focus on crosscutting topics or build on physical platforms not found in the museums.

Smithsonian Environmental Research Center (SERC), 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. The reach of the SERC efforts on land/water ecosystems includes not only the Cheaspeake Bay, but the Atlantic, Gulf of Mexico, and Pacific coasts.

Smithsonian Tropical Research Institute (STRI), Panama
STRI is the world's premier tropical biology research institute, and is celebrating its 100th anniversary this year. Originated because of the construction of the Panama Canal, it has grown to become a world leader in preserving tropical forests and the ecosystems found there. Dedicated to increasing our understanding of the past, present and future of tropical biodiversity and its relevance to human welfare through studies in marine biology, terrestrial ecology and paleontology, 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 of visiting scientists from around the world. STRI works with SERC on projects relating to carbon sequestration and invasive species. My colleague Biff Bermingham is here with us to give you additional information on STRI's activities.

Smithsonian Astrophysical Observatory (SAO), Cambridge, MA
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. Its scientists are among the best in the world, and it also builds the remarkable instruments needed for astrophysical work and operates larger land- and space-based telescopes.

National Zoological Park (NZP)/Smithsonian Conservation Biology Institute (SCBI), Washington, D.C. and Front Royal, VA
National Zoo scientists are based at the Zoo in Washington, D.C., the Smithsonian Conservation Biology Institute 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 biology and zoological medicine. In addition, the Zoo cares for more than 2,000 animals representing 400 difference species.

National Air and Space Museum (NASM), 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.

Museum Conservation Institute (MCI), 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.

Many of the most important issues facing our nation and our world cross disciplines and call for a new approach that melds the strengths of units and entities. Our new strategic plan lays the groundwork for the Smithsonian to lead in such efforts. While much is yet to come, we are on our way with a number of exciting efforts that involve not only multiple units at the Smithsonian but also in collaboration with other museums and universities. We have active involvements with universities like Harvard, George Mason, Yale, Arizona State, Maryland and George Washington and we work in partnership with

the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the Office of Science and Technology Policy (OSTP), the Department of the Interior and the Department of Agriculture. These collaborations avoid duplication of effort and facilities bring teams together that can solve issues in ways that would not be the case otherwise.

Commitment to Long-term Research and Large Scale Science Platforms

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. 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.

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 (NSRC) 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. NSRC improves the teaching and learning of science with K-12 science programs in more than 1200 school districts representing 30% of the U.S. student population in 48 states and more than nine countries. The Smithsonian Center for Education and Museum Studies (SCEMS) provides curriculum materials to teachers so they can incorporate museums, exhibits and collections into their work. SCEMS also conducts Internet webinars on various topics that attract 20,000 participants from across the United States and 100 countries. More will come as the Smithsonian mobilizes its pan-institutional educational programs, which is underway with the hiring of our first Director of Education, Claudine Brown, who is also here with me today. The Smithsonian is uniquely equipped to help with the important issue of scientific literacy, a growing challenge as the world of science moves faster and becomes ever more complicated.

National Collections

Scientific collections are an essential component of the national scientific infrastructure, as documented in the 2009 report of the Interagency Working Group on Scientific Collections (OSTP, 2009). 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 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.

The Smithsonian has developed an ambitious plan to create a "Digital Smithsonian" — to digitize the resources of the Institution, including much of its collection, for the widest possible use by current and future generations. This will broaden access to those treasures, safeguard them for future generations, speed research, add meaning, encourage collaboration, and integrate our holdings across museums and programs. Our collections have been used repeatedly to answer basic and historical questions regarding many significant issues of the day. For example, regarding the impacts of the Deepwater Horizon oil spill, knowing what the conditions were like before the event is essential. The Smithsonian is committed to long-term studies of ecosystems and biodiversity, and the data and collections that have resulted can play a crucial role in situations such as that posed by the Gulf of Mexico oil spill.

This spill already has been described by many experts as the worst man-made ecological disaster in U.S. history. The extent of the ecological impact, its geographic extent, and possibilities for remediation at this point are only estimates, not known facts. Given the likely economic impacts of the spill and future costs, the accuracy of before and after comparisons is important. The NMNH collections contain hundreds of thousands of specimens collected by the Department of Interior's Bureau of Ocean Energy Management, Regulation and Enforcement and others since 1974 at different depths and locations in the Gulf over many years.

My staff recently estimated that fully 58% of publicly available specimen-based records from the Gulf of Mexico are housed at the Smithsonian. I would like to emphasize that many marine research institutions around the Gulf and elsewhere will play key roles in assessing damage and measuring remediation and recovery in the years ahead. The Smithsonian is ready to collaborate and support that work in any way it can.

Other efforts in regard to responding to the oil spill include coordinating with the U.S. Fish and Wildlife Service to send four veterinarians from the National Zoo to the Gulf Region to work in conjunction with other federal agency vets. The vets from the National Zoo will work on a rotating basis for the next eight weeks; each of the four vets will serve for two week intervals at an incident command center in Houma, Louisiana in a mostly strategic basis coordinating relief efforts. The vets will oversee the logistics and release of recovering wildlife–primarily birds—from the affected region. The first vet, Dr. Judilee Marrow, was deployed, Sunday, July 11.

The Strategic Plan and Focus on Grand Challenges for Science

Unlocking the Mysteries of the Universe

Since the late 1800's the Smithsonian has played a lead role in developing the understanding of the fundamental nature of the universe, dark matter and galaxy formation. The Smithsonian, particularly the Smithsonian Astrophysical Observatory, the National Air and Space Museum and the National Museum of Natural History will focus on applying the integrative research of their scientists to today's big questions regarding the origin and evolution of the Earth, planets, stars, galaxies, and the universe, thereby harnessing the collaborative energy of scientists, scholars, and cultural experts.

Areas of specific focus will be the study of the origin and evolution of the Earth and solar system; the effects of geologic and meteoric phenomena on Earth's atmosphere and biosphere; research into the discovery and characterization of exo-planets in the habitable zone; research using our rich collections, including the national meteorite collection; and research into the next generation of ground- and space-based astronomical telescope mirrors and instrumentation that will enable the next generation of research.

The Smithsonian Astrophysical Observatory (SAO) is a prime example of the way in which the Smithsonian collaborates with other organizations. SAO's partnership with Harvard University to form the Harvard-Smithsonian Center for Astrophysics has, since 1973, grown to be the most powerful astronomical observatory in the world. SAO's pioneering efforts in the development of orbiting observatories and large ground-based telescopes, in the application of computers to astrophysical problems, and in the integration of laboratory measurements, theoretical astrophysics and observations across the electromagnetic spectrum have contributed greatly to unveiling the secrets of the universe. These efforts have principally been supported by competitively awarded contracts and grants from NASA and NSF. From studying planets around other stars to charting galaxies moving at almost the speed of light, SAO scientists remain dedicated to the increase of knowledge about those physical processes that shape the natural world, and to the diffusion of this knowledge to the scientific community, to teachers and students and to the general public.

Understanding and Sustaining a Biodiverse Planet

Research will focus on such questions as: how to sustain a biologically diverse Earth; how does this diversity change across geography and through time; and how do we better understand the life-sustaining services of ecosystems and best sustain their contributions to human well-being locally and globally?

The Smithsonian's research supports many strands of the U.S. Global Change Research Program (USGCRP) by providing baseline data, measurements and monitoring of change in the biosphere and atmosphere. The Smithsonian's observation and monitoring capabilities ensure a long-term, high-quality and high-resolution record of the state of natural variability and change in climate; improve our understanding of the natural and human-induced forces of change; and increase the accuracy of environmental models and projections of future conditions. This includes a focus on forests through the expansion and sustainment of the Smithsonian Institution Global Earth Observatories (SIGEO) network. SIGEO is a leader in the world in forming international partnerships

involving 21 countries that have joined together to promote large-scale environmental monitoring and maintain banks of data allowing for sophisticated analyses.

The Smithsonian is also a leader in DNA barcoding which includes leadership in an international initiative devoted to developing a global standard for the identification of biological species. The new technique uses a short DNA sequence from a standardized position in the genome as a molecular diagnostic for species identification. As the recognized U.S. leader in DNA barcoding, the Smithsonian seeks to increase its capacity in research and training. These activities directly support the biodiversity theme of our Strategic Plan, and also link to access initiatives, such as the Encyclopedia of Life and SIGEO.

The Encyclopedia of Life, (EOL at www.eol.org) is an ambitious project at the National Museum of Natural History that will become a key repository of scientific information about virtually every form of life on Earth. The EOL is a Web-based, online database that has financial, logistical and research support from numerous partners including private foundations. It is expected to encompass the 1.9 million known species of animals, plants, and other life forms in about 10 years. The database will be configurable for all types of audiences, from students and scientists to policy makers and the general public, and is intended to allow free access to all. The NMNH is uniquely positioned to contribute to this global effort of documenting every known species currently living on Earth, through its extensive and broad collections as well as through the scientific staff who provide the context for these specimens. The specimens require scientific expertise to provide related ecological and evolutionary information.

EOL is an unprecedented research initiative that is designed to broaden access to Smithsonian collections and knowledge, and share these resources with America and the world. It includes collaboration with other parts of the Smithsonian and leading institutions across the country and abroad. The first phase of this initiative was developed with support from the MacArthur and Sloan Foundations, and currently provides access to 180,000 species pages, as well as 20 million pages of literature related to biological diversity, through the Biodiversity Heritage Library. The next phase of this project will expand information to 500,000 species pages and some 50 million pages of literature, as well as develop resources for students and teachers across the nation over the next three years.

Another example of the Smithsonian's external collaborations is looking at the amphibian extinction crisis. A systematic global assessment of all 5,743 known amphibian species has found that one-third of them are in danger of elimination at an alarming rate by a pathogen known as the chytrid fungus, according to the American Association for the Advancement of Science. In May of last year, eight institutions joined together to save amphibians from the brink of extinction in the eastern region of Panama—an area rich with diverse amphibian species. Experts from the Smithsonian's National Zoological Park, the Smithsonian Tropical Research Institute, Africam [sic] Safari Park, the Cheyenne Mountain Zoo, Defenders of Wildlife, the Houston Zoo and the Zoo New England have pooled their energy and resources to form the Panama Amphibian Rescue and Conservation Project to protect a number of species from complete loss. The project consists of three distinct and complementary parts: the ongoing operation of El Valle Amphibian Conservation Center in western Panama, run by the Houston Zoo; the Amphibian Chytrid Cure Research Program initiated at the

National Zoo in collaboration with Vanderbilt University; and the construction and operation of the new Summit Park Amphibian Rescue Center in Panama.

The Future

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 Board of Regents early next year, these issues will be examined:

- Increasing capabilities for interdisciplinary research.
- Connecting important scientific assets to create more synergy.
- Developing a clear vision for science education, which my colleague Claudine Brown will address in her testimony.
- Addressing the national needs for scientific literacy.
- Finding additional key partners within the federal and university sectors.

With the help of our 6,000 employees, hundreds of volunteers and extensive collections, and through internal and external collaborations, the Smithsonian strives to address important issues in science today, improve scientific literacy and ensure a brighter future for us all.

In conclusion, thank you for this opportunity to share with you some of the unique aspects of the Smithsonian Institution's science research and the various ways in which we contribute to the world's understanding of complex and important issues.