Smithsonian Institution

Written Testimony of

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Nature in Crisis: Biodiversity Loss and Its Causes

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Introduction

Thank you, Chairwoman Johnson, Ranking Member Lucas, and distinguished members of the Committee, for the opportunity to provide testimony to you today on Biodiversity loss and its causes. My name is Steven L. Monfort and I am the Director of the Smithsonian's National Zoo and Conservation Biology Institute.

At the National Zoo we care for some of the rarest species on earth, and along with that comes a moral and ethical responsibility, shared by all internationally-accredited zoos, to work across the continuum from individual animals in our care to the work we are doing to save species in nature. Although trained as a wildlife veterinarian and research scientist, I now lead a team of dedicated scientists and animal care professionals within the broad discipline of conservation biology: a value-driven discipline that is based on the premise that biological diversity and functioning ecosystems are of benefit to current and future human societies, and all life on earth.

I also co-founded the Smithsonian's Conservation Commons, a Smithsonian-wide effort to bring the cumulative expertise of our scientists together—along with key partners across sectors—to tackle complex conservation problems on a global scale. It is an honor to represent the work of my colleagues, not just from the National Zoo and Conservation Biology Institute, but also from our Environmental Research Center, our Tropical Research Institute, the National Museum of Natural History, and numerous researchers all over the world.

The Smithsonian has been studying biodiversity for more than 170 years. We provide the basic science that tells us how the planet has changed. We look back over millions of years to understand where we have been, and forward to understand where we are going. It is important to note that our scientists have also teamed up with the Smithsonian Science Education Center, the Center for Folk Life and Cultural Heritage, Smithsonian Enterprises, and Smithsonian Facilities, to redouble efforts in conveying science-based solutions to the public: through community curricula, through building design for energy efficiency, and through best practices regarding sustainability.

Why Does Biodiversity Matter?

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the global body that assesses the state of biodiversity and nature's contributions to people. The recent findings IPBES report highlight the need for this hearing. To us, the findings of the report are startling, but not surprising. The factors identified as drivers of loss in biodiversity have been well known for years, it is the scale of the findings that are cause for concern. Dire findings can seem overwhelming, and it can feel like there is nothing we can do to reverse the trend. However, that is not true. There is reason for optimism.

It is not too late to address biodiversity loss, but doing so will require leadership, collaboration, and speedy cooperation, including in areas of conservation, technology, and science. It is not hyperbole to say, our health and wellbeing depends on it.

As is stated in the recent Global Assessment Report from the Inter-Governmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES report), when we talk about "biodiversity," we are referring to nature and its vital contributions to people, and which is "essential for human existence and good quality of life." Biodiversity provides the structural integrity to what we broadly define as nature. Humans are inextricably linked and dependent on this diversity because every breath we take, every drop of water we drink, and every bite of food we consume is in one way or another dependent on biodiversity and functioning ecosystems. But nature's benefits also include things like carbon sequestration, erosion and flood control, biochemicals, pharmaceuticals, genetic resources, industrial products, productive fisheries, pollinator services, and so much more, adding up to trillions of dollars to the global economy each year.

The World Economic Forum's Global Risk Report 2018 lists ecological collapse and biodiversity loss among the top 10 risks in terms of impact to humankind. And while an awareness of the dangers presented by climate change has increased, biodiversity losses related to habitat destruction and fragmentation, overharvesting, invasive species, pollution, and generally, the adverse human impacts on ecosystem function are often underappreciated.

Biodiversity loss is not a new phenomenon, we have been documenting it for decades. It took 200,000 years for the human population to reach 1 billion people, and only 200 more to reach nearly 8 billion. Today, human impacts on natural resources and biodiversity have resulted in planetary changes so profound that we have entered a new geological era, the Anthropocene. As a simple illustration of how spectacularly dominant the human footprint has become one need only look at our livestock, which now constitutes 96% of all mammalian biomass on the planet, whereas wild mammals represent only 4%. Likewise, for birds, chickens constitute 60% of the biomass of all avian species on Earth.

And while it is certainly true that climate change is a real threat to biodiversity, it is the escalation of infrastructure and development in parallel with human population increases that been and will continue to be the major drivers of biodiversity loss. Over the next decade trillions of dollars will be invested in new infrastructure—roads, hydroelectric dams, mining, agriculture, tourism, and energy development—that supports livelihoods for billions of people. Without proper planning, this development has potential for creating devastating losses in cultural and biological diversity. As just one example, it is estimated that 15 million miles of new roads will be built by 2050—enough to circle the globe 625 times—and 90% of these new roads will be in developing countries where much of world's biodiversity exists. This development will result in direct impacts on biodiversity such as animal mortalities, collisions, barriers to movement, and indirect impacts such as habitat fragmentation, increases in hunting, species invasions, pollution, the spread of pathogens with pandemic potential, and deforestation and degradation with a reduction in ecosystem services.

Biodiversity annually yields trillions of dollars in economic benefits, with 70% of the world's poor deriving their livelihoods from natural resources. And the loss of biodiversity is directly linked to increases in global pandemic disease threats, crime associated with wildlife trade and trafficking, as well as conflicts related to scarcity of natural resources like water and livestock grazing, amongst others.

Nature's benefits are not limited solely to our physical survival, but also to our spiritual well-being and our cultural identities. In fact, the very origins of environmental conservation lie buried deep within our ancient cultures, traditions and even in our religious beliefs. In short, both our biological and cultural diversity—our very identities—are interwoven within the rich tapestry we define as nature.

Efforts to set aside protected areas and national parks have proven useful, but they are insufficient for sustaining a biodiverse planet. That is because we now live on a planet that has effectively become a landscape mosaic of diverse land uses, and we have yet to fully understand how to effectively manage human development while mitigating the adverse impacts on biodiversity and ecosystem function. As the world seeks to address issues like climate change, we must act with greater urgency, and with new and swift ways to collaborate across disciplines, cultures, and time-zones to stem biodiversity loss. Sustainable infrastructure development has to be the new norm based on research and the development and implementation of a new set of best practices. The Smithsonian and its colleague organizations are up for the challenge.

The Role of the Smithsonian

Throughout its 172-year history the Smithsonian Institution has earned its reputation as one of the world's great knowledge institutions. While our buildings, products, events, and exhibits share knowledge with the public and partner organizations, our researchers and curators contribute to this knowledge every day. But less widely known, is that hundreds of Smithsonian scientists and scholars work across the spectrum of biodiversity and conservation science: from genomes to individuals and populations; to forests, watersheds and fisheries; to understanding the impacts of infrastructure development, pandemic diseases and human-animal conflict; our scientists are focused on understanding and sustaining biodiversity.

For example, our life-science researchers are experts in taxonomy, natural history, physiology and ecology, and our paleontologists provide geo-historical data and analyses essential for placing current changes in a deep-time perspective. We are an authoritative source for scientific information on species extinctions and other critical conservation issues at the level of both species and ecosystems. The Smithsonian has the long-term data and expertise to study human impacts (e.g., deforestation, desertification, climate change, ocean acidification, invasive species, overharvest of natural resources, and pollution) over an unmatched range of temporal and spatial scales, and to model outcomes and develop mitigation strategies. Our expertise ranges from analyzing landscape and seascape changes to monitoring environmental and ecological data around the globe. We deploy state-of-the-art methods, ranging from geospatial technologies to assess and monitor ecosystem changes revealed by satellite imagery to genomic analyses exploring the links between genetic variation and functioning ecosystems. We have built and monitor a global network of forest plots (ForestGEO), we are core partners with the National Ecological Observatory Network (NEON), and we are developing an analogous network for coastal ocean ecosystems (MarineGEO). Our scientific platforms support investigations of tropical and temperate ecosystem dynamics, carbon flux, and the impacts of climate change on biodiversity and ecosystem function.

Our physical collections are unparalleled and support understanding both of ongoing changes and of information relevant for crafting solutions. We hold the largest and most comprehensive collections of biological specimens in the world, including frozen biorepositories of individuals, and even whole communities of organisms. Some specimens date back centuries and hold potential for comparing current and past geographic ranges, phenology, and DNA; our collections will serve similar essential

purposes for future conservation scientists. Also, we manage an extensive and expanding living collection of plants, animals, and fungi that act as insurance populations to safeguard against extinctions and provide stock for future reintroductions. We have developed genetic management tools tailored to small captive populations that focus on effective ways to sustain species that are extremely difficult to study in their natural environments.

Our scientists are leaders and innovators in species conservation, including discovering the link between genetic diversity, health and reproduction in wildlife species; establishing the critical importance of migratory connectivity; pioneering the fields of endangered species assisted breeding, endocrinology and cryobiology. Our programs have reintroduced endangered species such as golden lion tamarins to the Atlantic coastal rainforests of Brazil, black-footed ferrets to the great American plains, Przewalski's horses to the Gobi Desert of Mongolia and China, and scimitar-horned oryx into the Sahelian grasslands of North Africa.

Examples of Smithsonian Biodiversity and Conservation Science

The full scope of the Smithsonian's contributions to Conservation science are many and varied, with significant contributions from each of our science and research units. There are simply too many to name, but highlights include:

Smithsonian Environmental Research Center (SERC).

SERC research addresses the global interactions of humans with the planet's biosphere, concentrating on linked coastal ecosystems, where 70% of the human population resides and where most of U.S. economic enterprise is based. SERC scientists seek to understand and inform solutions for major problems of climate change, pollution, land-use and habitat alteration, over-fishing, and invasive species.

- **Marine Invasive Species.** SERC is home to the largest most comprehensive program in the world on marine invasive species, a source of billions of dollars of impacts annually in the U.S. Designated by Congress in the National Invasive Species Act of 1996, SERC works with the U.S. Coast Guard to track management practices of ballast water in commercial shipping – a major source of planktonic propagules for invasive species. All commercial ships arriving to all ports in the U.S. are required to report to SERC on their ballast water management releases, and to exchange their ballast water in mid-ocean. SERC conducts surveys of U.S. bays and ports for invasive species and maintains a national database for all marine and estuarine invertebrates and algae – over 550 species.

- **Biodiversity of Nearshore Coastal Ecosystems.** SERC's 50 years of biodiversity research tracks long-term changes in composition and abundance of all species of fish and invertebrates in Chesapeake Bay, the nation's largest estuary. SERC developed a genetic bar code library for fish and invertebrates in the Bay and provides counsel to fishery management on protecting and recovering stocks of fish and shellfish.

- **Smithsonian's Marine Global Earth Observatory**. SERC is the national headquarters for the Smithsonian's Marine Global Earth Observatory network, which works with partner institutions and countries to make long-term standardized measures of changes in the biodiversity at 15

nearshore coastal sites in the Americas and other locations around the globe. This is a developing network, which will increase to approximately 50 sites in the next 15 years.

National Museum of Natural History (NMNH)

Science at the Smithsonian's NMNH stands upon a grand legacy of exploration, discovery, premier collections-based research and public outreach. Our science today tackles fundamental scientific challenges, has global impact on society and is widely cited by the greater scientific community. Our collections are fundamental to understanding the world's natural and cultural diversity, and the development of sustainable plans for the future.

- To standardize the preservation of Earth's biodiversity at a global scale, the Global Genome Initiative (GGI) was created to provide a one-stop index to all publicly available scientific genomic samples on Earth, working with an expanding network has 87 partners from 31 countries with over 3 million genetic samples available for research.

- In partnership with BGI Shenzhen, and many others, in what is considered a *moonshot* for biology, we have launched the Earth BioGenome Project, which aims to sequence, catalog and characterize the genomes of all of Earth's eukaryotic biodiversity over the next ten years. Outcomes will be essential for developing new drugs, creating new bio-synthetic fuels, biomaterials and food sources for the rapidly growing human population. Ultimately, results will help find new solutions for preserving biodiversity and sustaining human societies.

- The "Healthy Reefs, Healthy People" Initiative is a project coordinated by the NMNH through a field site in Ft. Pierce, Florida. This multi-institutional, multi-country partnership produces a science and community-based "Report Card." The project provides trusted information to create conservation management actions at the local, national, and regional level across four countries. In some cases, communities are already measuring increasing fish populations as a result.

Smithsonian's National Zoo and Conservation Biology Institute (NZP/SCBI)

We are known for excellence and leadership in zoo and conservation science, and our science-based approach to animal management and public education. We conduct world-class research, for pioneering science-based solutions to stem the loss of biodiversity, for aiding in the survival or recovery of species and their habitats, and for building international capacity in conservation biology. Our scientists were among the founders of the field of conservation biology, and continue as leaders today, with global perspectives, diverse expertise, and long-term experience in conducting inter-disciplinary zoo- and field-related research. NZP/SCBI leads in the study, management, protection, and restoration of threatened species, ecological communities, and ecosystems.

- Scientists partnered with Peru LNG to sustain biodiversity during and after the construction of a 400-km long natural gas pipeline across the Andes mountains. Such partnerships can assist in designing smart, biodiversity-friendly infrastructure projects that ensure economic, social and environmental sustainability while protecting biodiversity and ecosystem services.

- Ensuring excellence in animal care and breeding for some of the rarest species on earth, our scientists and researchers are partnering to reintroduce iconic endangered species such as

golden lion tamarins to the Atlantic coastal rainforests of Brazil, black-footed ferrets to the great American plains, and scimitar-horned oryx into the Sahelian grasslands of North Africa.

In Panama, our **Smithsonian Tropical Research Institute (STRI)** serves as the home of the ForestGEO program, which is a global network of scientists and 67 forest research sites in 27 countries where scientists monitor more than 12 million trees in an effort to advance our understanding of how forests respond to environmental change.

Smithsonian's Global Health Program—Impacts on Human Health

The drivers of biodiversity overlap with the drivers of disease emergence: human population growth, land use change, and increased human-animal interactions. To most effectively preserve both biodiversity and human life, we must pursue a holistic and multidisciplinary approach. The "One Health" paradigm addresses biodiversity and health concerns by evaluating human, animal, and environment data. The Smithsonian has been doing this for decades. We have a broad range of expertise—from landscape ecologists, Geographic Information Systems (GIS) specialists, wildlife health veterinarians, geneticists, animal care staff, reproductive physiologists and molecular diagnosticians—all working to address these issues. The most critical piece to the puzzle is partnerships, including regional, transboundary and international partnerships to make sure our work is broadly effective. Just as critical is the need to prepare the next generation to keep these efforts ongoing.

Our team collaborates in a global disease-surveillance project—PREDICT—working in 30 countries to strengthen capacity for detection and discovery of viruses that can move between animals and people and that have pandemic potential. We know that pandemics are most likely to emerge in areas where humans develop previously undisturbed ecosystems, which brings wildlife, livestock and humans into close proximity. Responding to pandemics like Ebola and SARS can cost in the tens of billions of dollars, whereas new knowledge about viruses can help to predict where pandemics are most likely to occur, improve responsiveness, and ultimately save human lives. There is an urgent need to determine causal relationships between biodiversity loss and health, in order to guide appropriate interventions that mitigate risks posed to animal and human health.

Understanding the threats. To best address the threats to human and wildlife health:

- Our landscape ecologists deploy the latest technology and partner with other entities (e.g., NASA, foreign governments, NGOs) to not only evaluate but forecast land use change, but also to investigate on-the-ground changes in land management including features such as fencing, roads and infrastructure development, which can have a direct impact on the survivability of species.

- Our veterinarians study how increase human-livestock-wildlife interactions lead to increasing rates of disease transmission among species. Already our team has discovered over 1,200 novel mammalian viruses, and modeling shows that there are over 500,000 viruses as yet undiscovered. We are gathering and interpreting the data and now prioritizing risks that best need our attention.

- Our scientists are working to understand human behaviors and cultural norms, which can impact both human and animal survival. Along with the Office of Science and Technology Policy, we are collectively working to bridge the hard and soft sciences to better understand the factors that lead to land use change and increased human-animal interactions.

Mitigating the threats. Given that living with animals is a reality, and that human-animal interactions are on the rise, learning to live safely along with animals is an effective method of preserving biodiversity. Examples include:

- Our scientists seek to understand the causes and solutions related to human-elephant conflict in Southeast Asia, including animal movements, sources of conflict, and the design of methods to mitigate impacts, including providing new knowledge needed to guide public policies, supporting the creation of public service/education announcements and community engagement. These efforts have all helped to save both animal and human lives.

- Our veterinarians have identified that living in close proximity to bats can present major health risks for humans, and they have worked with public officials to raise awareness about this issue, and to educate the public about how to live safely with bats.

- Our wildlife health teams have developed international training programs to help save humans AND wildlife, including deploying new knowledge gained from work on wildlife under human care at the NZP/SCBI to some of their counterpart species in nature (e.g., giant pandas, mountain gorillas, rhinos).

The Smithsonian's Multiplier Effect

While our scientists work worldwide to generate and share knowledge to conserve biodiversity, they also work across disciplines to amplify the work and create impact in communities:

- **Smithsonian Science for Global Goals:** Smithsonian scientists and educators have teamed up with the Inter-Academy Partnership to develop community curricula—available online to all—which are helping the world's future decision makers learn how to analyze the complex issues facing us as a society. The first module, "Zika!" which helps communities develop ways to prevent mosquito-borne illness, is already being applied and is protecting the health of many communities.

- **Increasing Sustainability of Smithsonian Research and Education Facilities:** Even in some of our oldest museum buildings, the Smithsonian has been moving to improve the sustainability of our infrastructure, and has won many LEED certifications in recent years. The SERC constructed the first LEED Platinum science research facility in the U.S., and is now developing plans for a net-zero emissions facility near the Chesapeake Bay to serve as a meeting place for world experts to solve large ecosystem challenges.

- **Training the next generation**. Training well-informed technicians, managers, researchers, and leaders (across sectors) continues to be a major component of the Smithsonian's contribution to conservation. In 40 years, more than 4,300 people from 109 countries have received professional conservation training from the Smithsonian. The exciting opportunity here is that so many people come back to us—or we go to them—later to collaborate on conservation

projects. Untold other individuals and groups work with us and or partners via citizen science efforts.

The Case for Optimism

We must make a case for optimism when facing biodiversity loss. If the public is constantly bombarded with messages about an ongoing biodiversity apocalypse We inadvertently send a message that species are on an inevitable trajectory towards extinction. Doing so without providing solutions risks fostering a sense of helplessness amongst the public who may conclude that nothing they do can make a difference. At the Smithsonian, a team of scientists and curators began to collect stories of what was working all over the world, and discovered many examples of conservation success: in the ocean, on the land, in the coastal intersection between land and sea, in cities, on farms, and in many parts of the U.S. and abroad. We decided to continue to search for stories and to find ways to share them. As a result, we launched **Earth Optimism** in 2017, which reached hundreds of millions of people worldwide—in person through events and online—with stories of conservation success. We partner with farmers, fishers, scholars, thought leaders, students, and organizations from many sectors, to share and curate stories of success. In doing so, we have inspired communities into action. We plan to amplify our message and collaborate with additional organizations to meet our goal of reaching one billion people around the world on the anniversary of Earth Day, 2020.

We can also be optimistic about the emergence of new scientific breakthroughs and technologies like artificial intelligence, machine learning, genomics, remote sensing, and drones—tools that have great potential for helping to achieve positive conservation outcomes.

But one simply cannot conserve or manage wildlife resources remotely using technology alone. The Smithsonian seeks to demystify and democratize access to scientific knowledge and inspire visitors to see themselves as problem solvers and planet-savvy citizens We need to continue educating and training a new generation of people doing the ground-truthing, managing resources, wildlife protection, and mitigation of conflict. . We do this informally through our exhibitions, directly through curriculum developed by the Smithsonian Science Education Center, and at the highest levels through the Smithsonian-Mason School of Conservation. We also engage citizen scientists through citizen science programs, such as Wildlife Insights, whereby volunteers place "camera traps" (infrared-activated cameras) across the landscape in parks and other natural areas to collect photos of wildlife, with more than 6 million photographic images captured to date, which have helped researchers identify nearly 2,000 species and answer critical conservation questions about mammal distribution and abundance worldwide.

Convening for Conservation

The Smithsonian is a convening power—we bring people together and provide a setting where all voices can be heard to discuss some of the planet's toughest challenges and thorniest problems. In my own experience, greater collaboration yields greater results.

The scimitar-horned oryx is a magnificent desert-adapted antelope that once numbered nearly one million animals distributed across the Sahelian grasslands of North Africa. The species was declared "extinct in the wild" in the late 1980s due to over-hunting. Fortunately, large populations of this species were maintained in zoos and private collections, including at the NZP/SCBI. The Smithsonian already had a long history of leadership in understanding and developing husbandry, health, genetic and

reproductive management protocols for this species, when in 2010 we helped to establish a global network of stakeholders interested in reintroducing oryx back into the wild in Chad. Key to our success was engaging the government of Abu Dhabi, which managed large captive herds of oryx, and the government of Chad, which was interested in restoring this species to their historic rangelands. Through this unique partnership, the first oryx were returned to the wild in 2016. Smithsonian scientists continue to monitor the daily movements of these released animals using GPS-enabled tags so that we understand the species' ecology and life-history patterns, as well as the factors associated with either success or failure of this ambitious initiative. The team has a goal of growing the reintroduced herd to more than 500 animals by 2021. Restoring oryx to the wild will have a huge and positive impact on the conservation and management of the entire Sahelian grasslands ecosystem, including for the people who depend upon these ecosystems for their livelihoods. This is an example that demonstrates the value of science, when paired with proper resources, know-how and support from the private sector, to ensure the continued health of our planet, our people and our communities.

We can achieve many more such successes if we move beyond traditional partnerships amongst conservation organizations and government wildlife and natural resource departments. We must adopt new and innovative cross-sectoral approaches to problem solving. This means nature and environment sectors must join other sectors, including infrastructure, energy, health, finance, agriculture, among others. Real win-win solutions will emerge from adopting core environmental principles and increased standards of practice that recognize that integrating conservation into development practice—across multiple sectors—is good for business, good for our families and for every citizen of our country, and for the world.

Another great example at the Smithsonian of such a win-win approach comes from our Tropical Research Institute. The Panama Canal is a massive lifeline of global commerce. In 2010, the canal closed for only the third time in its 100-year history, due to extensive flooding from heavy rains and runoff in the canal zone. Since then, the Smithsonian's Agua Salud Project has been studying how supporting native species and improving agroforestry practices can restore degraded landscapes wile preventing catastrophic water runoff into the canal. In a related story, large commercial ships were routinely striking whales as they entered the Pacific Ocean from the Panama Canal. While catastrophic for the animals, it was also costly and disruptive for global trade. Our scientists tracked whales using GPS-enabled tags to understand their movements and by collaborating with the Canal Authority, this data was used to establish new shipping lanes, and the result has been a 93% reduction in ship-whale collisions. This is an excellent example of how science can be used to solve conservation problems that are win-win for our global economy and for our efforts to save species.

Collaborative, cross-sectoral, and creative problem solving like the examples provided above will be key to meeting this global challenge. Nature needs to be at the decision-making table: not as an interloper, but as an existential partner if it is to fulfill its role in providing its incredible benefits to current and future human societies.

Thank you for the opportunity to testify today on these critical conservation issues. I look forward to answering any questions you may have.

Steven L. Monfort, Ph.D., D.V.M.

John and Adrienne Mars Director, Smithsonian's National Zoo and Conservation Biology Institute

Dr. Monfort is the John and Adrienne Mars Director of the Smithsonian's National Zoo and Conservation Biology Institute. At the National Zoo in Washington DC, Monfort oversees a collection of more than 1,800 animals, representing 300 species. He also directs the Conservation Biology Institute headquartered on 3,200-acres in Front Royal, VA, where scientists study and breed more than 20 species, including some that were once extinct in the wild, like the black-footed ferret and the scimitar-horned oryx. More than 300 National Zoo and Conservation Biology Institute scientists and their partners are working to save species in more than 30 countries. Throughout his career, Dr. Monfort has used multidisciplinary, collaborative science to help save species and habitats and restore animals to the wild. He is an expert in zoo biology, animal health, reproductive biology, behavioral ecology, and conservation biology. He was an early innovator in developing noninvasive endocrine monitoring techniques that are now widely used for assessing reproductive status and well-being of wildlife species in zoos and in the wild. Additionally, Monfort founded the Smithsonian-Mason School of Conservation and helped catalyze and launch a number of significant conservation initiatives, including the Sahara Conservation Fund, Conservation Centers for Species Survival, Panama Amphibian Rescue and Conservation Project, and the Global Tiger Initiative. Monfort received a B.A. from the University of California San Diego, D.V.M. and M.S. degrees from the University of California Davis, and a Ph.D. from George Mason University.