Outside Witness Testimony in Support of FY 2023 Funding for the National Science Foundation

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Subcommittee on Commerce, Justice, Science and Related Agencies

The Natural Science Collections Alliance appreciates the opportunity to provide testimony in support of fiscal year (FY) 2023 appropriations for the National Science Foundation (NSF). We encourage Congress to provide the NSF with **at least $11 billion** in FY 2023.

The Natural Science Collections Alliance is a non-profit association that supports natural science collections, their human resources, the institutions that house them, and their research activities for the benefit of science and society. Our membership consists of institutions that are part of an international network of museums, botanical gardens, herbaria, universities, and other institutions that contain natural science collections and use them in research, exhibitions, academic and informal science education, and outreach activities.

Scientific collections, and the collections professionals and scientists who make, care for, and study these resources, are an important component of our nation's research infrastructure. These collections and their associated experts contribute to the expansion of our bioeconomy. Whether held at a museum, government managed laboratory or archive, or in a university science department, these scientific resources form a coordinated network of specimens, samples, and data (for example, genetic, tissue, organism, and environmental) that are a unique and irreplaceable foundation from which scientists are studying and explaining past and present life on earth.

Natural science collections advance scientific research and education, and that informs actions to improve public health, agricultural productivity, natural resource management, biodiversity conservation, and American economic innovation. Current research involving natural science collections also contributes to the development of new cyberinfrastructure, data visualization tools, and improved data management practices. A few examples of how scientific collections have saved lives, enhanced food production, and advanced scientific discovery include:

- Scientists used museum specimens in U.S. collections to gather data on the distribution of the mosquito *Culex quadrofaciatus*, which is known to carry West Nile Virus and other pathogens. They then modeled the distribution under different scenarios of changing climates to predict regions where the species may expand in the future. Predicting the

spread of disease vectors such as these mosquitoes helps the health care community prepare for disease outbreaks and where they will happen.

- Researchers from Boston University documented Tau proteins in the brains of fluid preserved museum specimens of Downy Woodpecker. These proteins are also found in traumatic brain injuries in humans. Because of the life history traits of woodpeckers, the researchers argue these birds may have evolved a level of resistance to traumatic head injuries that could have implications for treatments for humans.
- Citrus bacterial canker disease wreaks havoc on fruit crops in Florida. Using plant specimens collected a century ago, scientists have analyzed the bacterium and traced its source. Knowledge of how the bacteria spreads allows scientists to develop effective control methods and to protect the U.S. citrus industry.
- When the 2001 anthrax attacks happened in the United States, specimens collected decades earlier allowed researchers from the Centers for Disease Control and Prevention to quickly identify the strain involved.

Scientific collections enable us to tell the story of life on Earth. There are more than 1,600 biological collections in the United States. These resources are the result of more than 200 years of scientific investigation, discovery, and inventory of living and fossil species. Scientists have collected and curated more than one billion specimens within those collections. This work is on-going as new questions continue to be asked and answered.

The institutions that care for scientific collections are important research infrastructure that enable other scientists to study the basic data of life; conduct biological, geological, anthropological, and environmental research; and integrate research findings from across these diverse disciplines. Their professional staff members train future generations with the tools and expertise required to move science forward. In-house institutional staff expertise is vital to the development and deployment of this critical research infrastructure.

Recent reports highlight the value of mobilizing biodiversity specimens and data in spurring new scientific discoveries that grow our economy, improve our public health and wellbeing, and increase our national security. In 2019, the Biodiversity Collections Network issued a community-informed call for the development of an Extended Specimen Network. The report, "Extending U.S. Biodiversity Collections to Promote Research and Education," outlines a national agenda that leverages digital data in biodiversity collections for new uses and calls for building an Extended Specimen Network. This endeavor requires robust investments in our nation's scientific collections, whether they are owned by a federal or state agency or are part of an educational institution or free-standing natural history museum or another research center.

A 2020 report by the National Academies of Science, Engineering and Medicine, *"*Biological Collections: Ensuring Critical Research and Education for the 21st Century," provides guidance to the NSF regarding the sustainability of living stock and natural history collections. The report argues that collections are a critical part of our nation's science and innovation infrastructure and a fundamental resource for understanding the natural world.

According to the U.S. Interagency Working Group on Scientific Collections (IWGSC), "scientific collections are essential to supporting agency missions and are thus vital to supporting

the global research enterprise." A 2020 report by the IWGSC, "Economic Analyses of Federal Scientific Collections," presents a framework for estimating and documenting the long-term benefits, both monetary and non-monetary, generated by federal institutional collections.

The NASEM, BCoN, and IWGSC reports, articulate a common vision of the future of biological collections and define a need to broaden and deepen the collections and associated data to realize the potential for biodiversity collections to inform 21st century science. Because the NSF is the only agency that supports research in all fields of science, it is ideally suited lead a national effort to build the Extended Specimen Network, which will require the engagement of computer and information scientists, geoscientists, life and environmental scientists, and anthropologists.

Collections are a critical resource for advancing the knowledge needed to address current global challenges such as climate change, biodiversity loss, and pandemics. The COVID-19 crisis has illustrated how inextricably linked humans are to the natural world. Biological collections, their extended data, and the experts that build and study them are globally important for understanding where viruses such as SARS-CoV-2 exist in nature or when they cross from their current hosts to humans.

The United Nation's (UN) Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has warned that about a million species of plants and animals worldwide face extinction within the next few decades. This would not only be an unprecedented loss of global biodiversity but also a loss of valuable genetic diversity that has implications for human health and well-being. Robust investments must be made to support efforts to grow and digitize natural history collections and conduct critical collections-based science that can help prevent these losses.

The NSF plays a unique role in protecting and expanding access to our nation's scientific collections. It supports research that uses existing collections as well as studies that gather new natural history specimens. NSF's Directorates for Biological Sciences (BIO), Geosciences (GEO), and Social and Behavioral and Economic sciences support research and student training opportunities in natural history collections. The NSF is also an important supporter of national biological research infrastructure that houses natural history collections, such as living stock collections and field stations.

The NSF funds evolving work to digitize high priority specimen collections. The result of this effort is that irreplaceable biological specimens and their associated data are now accessible through the Internet to researchers, educators, and the public. More than 130 million specimens are now online, with millions more awaiting digitization. This project involves biologists, computer scientists, and engineers in multi-disciplinary teams who develop innovative imaging, robotics, and data storage and retrieval methods. Resulting new tools and approaches expedite the digitization process and contribute to the development of new products and services of value to other industries. Museum specimens and associated data also represent an extraordinary resource for teaching core concepts in science.

An example is the multi-institutional openVertebrate (oVert) project, which creates high-resolution 3D anatomical data for scientific specimens of amphibians, reptiles, fishes, mammals,

and birds held in U.S. museums. Through its NSF-supported partner MorphoSource, an open-access online repository, these data have been downloaded more than 100,000 times and viewed over 1 million times by faculty, veterinarians, exhibit designers, K12 teachers, and artists resulting in more than 200 scientific publications. In addition, more than 2,000 undergraduate students have learned from these data and visualizations while studying zoology, veterinary science, art, and design.

In addition to supporting research, NSF's science, technology, engineering, and mathematics (STEM) education programs enhance the ability of museums, botanic gardens, zoos, and other research institutions to provide science learning opportunities for students. NSF's Advancing Informal STEM Learning program furthers our understanding of informal science education outside of traditional classrooms. The program makes important contributions to efforts to make STEM more inclusive of historically underrepresented groups.

Conclusion

Investments in NSF have always been in the national interest and their value continues to grow. Scientific collections contribute to improved public well-being and national economic security. It is not possible to replace this important documentation of our nation's heritage. Specimens collected decades or centuries ago are increasingly used to develop and validate models that explain how species, including viruses, parasites, and pathogens have dispersed around the world, as well as how and when they might infect humans now and in the future. NSF is the primary funding source that provides support to institutions that preserve at-risk scientific collections. These small grants help ensure these collections are not destroyed and their data lost.

Please support funding of at least $11 billion for NSF in FY 2023. Investments in NSF programs that support natural science collections research and education are essential if we are to maintain our global leadership in innovation and biodiversity research.

In addition to appropriations, Congress is currently considering multiple proposals to significantly expand NSF's mission and budget. The proposed investments in technological research will enable the biodiversity collections community to build the cyberinfrastructure and databases necessary to mobilize biodiversity data in ways that bolster 21st century science and drive innovation. We applaud these efforts to invest in our nation's scientific and technological enterprise and urge that robust investments also be made in basic and foundational research.

Furthermore, we also request that Congress provide additional economic relief—such as the provisions outlined in the RISE Act (HR.869, S.289) that are now part of the U.S. Innovation and Competition Act (S. 1260)—to the U.S. research community, including natural history museums, botanical gardens, and other science centers, that have suffered significant budget disruptions resulting from reduced public attendance or closures associated with responding to the COVID-19 pandemic.

Thank you for your thoughtful consideration of this request and for your prior support of the National Science Foundation.