

SPECIMEN MANAGEMENT PLAN DRAFT PROPOSAL

Prepared by:
Biodiversity Collections Network (BCoN)
U.S. Culture Collections Network (USCCN)

A Specimen Management Plan

The recently published National Academies of Sciences, Engineering, and Medicine (NASEM) Report on Biological Collections recommends that funding agencies “...require a specimen management plan for all research proposals that include collecting or generating specimens that describes how the specimens and associated data will be accessioned into and permanently maintained in an established biological collection” (NASEM, 2020). This recommendation is also called out as a fundamental research priority in the now enacted CHIPS and Science Act ([P.L. 117-167](#)) that includes a robust reauthorization for the National Science Foundation (NSF). Others in the research community have promoted the idea of a specimen management plan (Colella, et al. 2020; Schilthuizen, et al. 2015) as well as the yet unpublished, NSF funded, Antarctic Biorepository Workshop (<https://sites.google.com/alaska.edu/antarcticbiorepository/home>) report. We endorse these recommendations and suggest that a specimen management plan become a part of all research projects that generate biological collections of any type. In the specific case of the National Science Foundation, we suggest that a Specimen Management Plan (SMP) complement, not duplicate, the currently required Data Management Plan (DMP) by providing detailed information regarding the collection, digitization, curation, and funding for accessioned specimens associated with NSF-sponsored research.

At present, there is only a cursory mention of specimen curation in the required Data Management Plan (DMP) associated with NSF Biological Sciences (BIO) directorate proposals (https://www.nsf.gov/bio/pubs/BIODMP_Guidance.pdf). Although specimens are closely linked with their associated data, as physical objects that differ widely in size, shape and method of preservation, they have very different, more diverse requirements and prerequisites, especially with respect to infrastructure needs. Therefore, the methods and infrastructure for physical specimen preservation should be the subject of a separate plan. The Division of Ocean Sciences in the Geological Sciences Directorate does provide more detailed sample archiving requirements for physical geological samples (<https://www.nsf.gov/pubs/2017/nsf17037/nsf17037.jsp>). Because biological collections are composed of a varied array of living and formerly living organisms, their long term maintenance requires curatorial expertise and knowledge regarding preservation techniques that are specific to the type of organism. Furthermore, because some biological collections are also defined as genetic resources, their stewardship and use is governed by international conventions such as the Nagoya Protocol (<https://www.cbd.int/abs/>). As currently written, an NSF DMP does not require enough information from a proposed project to ensure specimen deposition, digitization, care, and curation. In addition, it does not establish that biological collections will be adequately safeguarded and ethically managed, to make specimens available for future research endeavors.

We advocate that the NSF specimen management plan should also be conceptualized and implemented as an instrument to promote and reinforce the development, maintenance, and

enhancement of *services* built around the supporting physical and online specimen and data infrastructures. The societal value of managing specimens is very closely linked to our present and projected capability to (1) mobilize local to global specimen access and (2) build powerful tools to publish and network their diverse, expanding data extensions under FAIR and CARE data principles. In this sense, the SMP will require investments into services that also, and critically, include sustaining and new support for a collections-managing workforce; i.e., new investments in training, recruiting and advancing the professional careers of current and succeeding generations of biodiversity collections and data specialists. Such investments would provide the opportunity to diversify the collections workforce, in accordance with NSF's stated objectives of increasing equity for excellence in STEM while simultaneously promoting DEI representation improvements in the collections community. We therefore support an SMP concept that puts new support for services and service-providing people first, and will play an essential role in promoting wide-ranging, systemic change throughout institutions and research communities that have legacies or aspirations of advancing specimen-based research. In summary, the SMP should become an instrument for NSF to incentivize institutional leaders and communities to shift strategic and funding priorities, with the outcome of building up more robust and powerful services around their managed specimens and thereby to maximize the specimens' future scientific and societal impact.

1. Elements of a Specimen Management Plan

We propose that researchers embarking on projects that would generate biological collections engage and work collaboratively with a willing repository, in advance of proposal preparation, to produce an SMP detailing:

- The type and anticipated number of specimens, variety of preparations, and associated data that would be deposited.
- A set of best practices for depositing specimens and standards for data to ensure long-term utility that complements emerging recommendations for the Digital Extended Specimen.
- An estimate of the funding that would be required for the repository to curate, digitize, and care for the material once formally accessioned, and
- A plan for how to make the specimens and associated data available to the research community through data publication, in accord with all national and international collecting, import and export permitting agreements (Nagoya Protocol, etc.) that govern the maintenance and use of the collections.

The collections community, in collaboration with NSF, Society for the Preservation of Natural History Collections, American Institute of Biological Sciences, Natural Science Collections Alliance, U.S. Culture Collections Network (USCCN), and others, could provide template SMP documents that repositories could use to create individually tailored plans with researchers to submit with their NSF proposal. This would include development of cost estimate ranges for curation and digitization of various categories of specimens and preparations.

2. Need for the Specimen Management Plan

The development and execution of this plan would formalize the process of how newly collected biological samples are added to existing biological collections and managed thereafter. Such a plan would incentivize researchers to deposit biological specimens and associated data into public repositories, work with the collection to proactively plan for the curation and digitization of the material, and provide funds specifically allocated for specimen preparation and disposition,

thereby preventing them from being cut from the budget or diverted to other aspects of the project. Most importantly, commitment to an SMP will help prevent the loss of specimens at the end of a research project or when a researcher moves to a different institution, retires, or passes away. This “dark data” was highlighted as a major issue in the NASEM report. The SMP would be a key component of current data initiatives, open science, open data, and reintegration policies that are present in several RFPs and a critical link in the process that enables the full implementation of the Digital Extended Specimen (DES).

The impact of a research project is increased through the deposition of specimens that are accessible to the wider research community in a more timely manner, stimulating new avenues of research as well as supporting reproducibility in existing research. Specimens useful for future research that have a well-thought-out management plan will be much less likely to be discarded or lost. Repositories are also valuable assets in providing information regarding ethical collection (e.g., Institutional Animal Care and Use Committee or IACUC), permitting (e.g., collecting, import, export), and other compliance issues faced during and after collection, such as benefit-sharing (e.g., Nagoya Protocol).

3. Value-Added Benefits of a Specimen Management Plan

Adoption of an SMP has advantages for individual researchers, the collection repositories, funding agencies, and publishers. We herein outline those benefits to each of these stakeholder groups.

Advantages to researchers.

- A dialog between the researcher and a repository before or during the grant-writing stage would ensure that institution-specific protocols and best practices for collection and preservation of specimens, data, and products are used.
- Collections can advise researchers on national and international laws and regulations, Institutional Animal Care and Use Committee (IACUC), Institutional Review Board (IRB), biosafety, and biosecurity, as well as ethical guidelines.
- Collections provide information about specimens and data in their or other institutions, as well as inform researchers about similar research projects, providing collaboration opportunities and preventing research duplication.
- A sound collection plan would ensure that research funds for specimen generation are used effectively, so that specimens have impact for and beyond the current research project.

Advantages to collections and institutions:

- Implementation of a SMP may direct funds to collections that are in active use. By disseminating funds at the local and regional level, NSF is creating an equitable allocation of resources, reinforcing broad training in life science, and creating a more sustainable infrastructure in support of the Extended Specimen.
- An SMP would help fulfill the obligation to preserve and make available the outcomes of a funded grant by the institution/organization that houses the collection.
- Collections would be ensured funds to catalog, digitize, maintain, and curate specimens in accordance with NSF’s mandate to fund the entire research endeavor.
- Collections receive high quality specimens with all necessary metadata that were legally collected and preserved in a format compatible with their storage.

- Data that adhere to standards and best practices and are compatible with their collection management systems.
- Where possible, collections would get (confidential) early access to information about cutting-edge research and its outcomes, allowing them to plan for how to fulfill these emerging needs.

Advantages to the funding agencies:

- Funding agencies would receive a larger and earlier return on their investments in collections that can leverage future research.
- Funding agencies would have a clearer view of which repositories preserve specimens generated through research.
- All collections that receive accessions from NSF-funded research, including small and overlooked ones, would receive some NSF funding in amounts that reflect the collection's value to NSF-funded research.
- Reinforces NSF's commitment to comprehensive and sustained support for reproducible, ethical and inclusive science through support for the maintenance of research documentation

Advantages to publishers

- Publishers would be better equipped to fulfill their mandate of exposing reproducible science through the provision of more robust sections in publications about the material examined.
- Publishers would benefit from the guidance included in an SMP to increase uniformity of citation and attribution of specimen information in publications.
- Publishers would be empowered to make the links between research, funding dollars, and collections information more transparent.
- Publishers would be better equipped to assess and facilitate authors' compliance with applicable national and international permitting agreements.

4. Recommendation

Given the above, we assert that the requirement of a Specimen Management Plan for collections-based research proposals will improve the outcome and impact of the resulting research for all involved in that process. We propose to engage the living and preserved collections communities to develop requirements and best practices for collection, deposition, accessioning, and sustained curation of specimens and associated data that result from NSF-funded proposals. The process should begin with a meeting of representatives of as many collections domains as possible, followed by domain-specific conversations that would ideally result in published best practices for the collection, deposition, and long term care of the specimens that result from collections-based research.

References:

Jocelyn P Colella, et al. 2021, The Open-Specimen Movement, *BioScience*, Volume 71 (4): 405–414, <https://doi.org/10.1093/biosci/biaa146>.

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