

SPNHC

Small Collections Symposium

The Contribution of Small Natural History Collections in the 21st Century

Conveners: Gil Nelson/Anna Monfils

Co-Sponsors: iDigBio, Small Collections Network (SCNet), Natural Science Collections Alliance (NSCA)

Program (3 tracks):

Thursday, 21 May 2015

8:10-10:10 a.m. Track One

Small collections - the key to educating future generations of scientists

8:10-8:30 a.m. Why small collections - what is unique, valuable and important, Anna Monfils (Central Michigan University), Gil Nelson (Florida State University/iDigBio)

The national digitization initiative is gathering momentum, and small natural history collections are joining the effort to data base biodiversity. The inclusion of small collections is critical. Small collections are a valuable data resource and pivotal in training the next generation of collections professionals. Small collections have unique holdings, representative of their field stations, local botanical communities and expertise of their collections staff. Often affiliated with primarily undergraduate educational institutions, small collections have an opportunity to directly engage and train undergraduates in the skills and competencies needed in the next generation of scientists. The inclusion of a diverse group of collections professionals provides the depth and breadth of training to stabilize the digitization effort and insure the growth and continuation of curation science. The outreach potential of small collections can be tailored to the immediate regions, and often involves close association with state and federal agency personnel and local societies. Small collections provide a personal and regional method of advocating for a collections and collection use, and serve an institutional advantage by increasing the profile and networking capacity of the affiliated museum, university or college. This talk will cover recent initiatives and efforts to promote, enhance, and sustain small natural history collections and the unique potential for small collections to advance collections based research, education and outreach.

8:30-8:50 a.m. Human diversity and the opportunities to engage students in small collections, Roland Roberts (National Science Foundation)

Small collections potentially provide information that fills geographic gaps and improve our knowledge as we attempt to assess biodiversity and understand the factors influencing organismal distribution. These collections are usually built through the accumulation of vouchers resulting from the taxonomic interests of researchers, allowing for intensive, systematic sampling of taxa. Alternatively, small collections may represent comprehensive surveys of local biodiversity, providing opportunities to capture information not usually represented in larger collections. Thus, the taxonomic composition of small collections is usually unique and the specimens represent intensive local sampling of biodiversity. Along with this unique scope in their composition, small collections are also positioned to address unique educational and training opportunities. They can better interface with the local community, including 2-year colleges, in training and outreach activities. Additionally, faculty associated with small collections have the flexibility to embrace curriculum reform that addresses critical integrative training needs, including efforts to broaden participation, engaging communities not usually represented in biodiversity or natural history research. Highlighting these opportunities, in part, support the critical role that small collections play in satisfying research and workforce needs.

8:50-9:10 a.m. AIM-UP!: Bringing big data to educators at small institutions, Kurt Galbraith (Department of Biology, Northern Michigan University), Joe Cook (Department of Biology and Museum of Southwestern Biology, University of New Mexico)

Museum specimens and the data that accompany them represent an extraordinary resource for teaching core biological concepts to undergraduates. However, this resource has traditionally been accessible only to students fortunate enough to attend institutions with natural history collections. Even when available for teaching, collections are often used for relatively narrow purposes (e.g., to illustrate taxonomic characters in organismal courses). Thus, integration of specimen-based learning into biology curricula has not yet become widespread, despite strong pedagogical reasons for bringing collections into the classroom. Recent efforts to massively digitize specimens and associated data and to increase their online accessibility are breaking barriers that once inhibited instructors from using these rich educational resources. Students and citizen scientists can now access vast troves of specimen data from any internet-connected computer and use them to explore a variety of biological phenomena. The NSF-funded Research Coordination Network, Advancing Integration of Museums into Undergraduate Programs (AIM-UP!), is taking advantage of this burgeoning resource by developing new classroom applications for specimen data. Network participants are tapping into museum databases to provide place-based exercises that go beyond traditional classroom uses of specimens. Educational modules are being constructed to facilitate active, student-driven exploration of natural history data to learn about diverse topics, including geographic patterns of phenotypic variation, biotic responses to climate change, and dynamics of co-evolving systems. These efforts provide models that educators can adapt to their specific needs as they further develop relevant student learning experiences, while also highlighting the significant contributions of collections to various biological disciplines.

9:10-9:30 a.m. Small collections working together: CollectionsEducation.org, Erica Kimmel (Chicago Academy of Sciences, Peggy Notebaert Nature Museum, formerly Sagehen Creek Field Station), Ashley Morris (Middle Tennessee State University), Travis Marsico (Arkansas State University), Anna Monfils (Central Michigan University), Brad Ruhfel (Eastern Kentucky University), Debra Linton (Central Michigan University)

Because small natural history collections often depend heavily on the motivation and inspiration of only one or several individuals, collaborations between such collections is essential. CollectionsEducation.org is the result of a cross-collection collaboration between five herbarium managers at five diverse institutions. The project designed a curriculum for an updated university-level botany course that integrates traditional taxonomic practices, ongoing citizen science initiatives, and digital-age herbarium curatorial skills. This course was taught by four of the collaborators over the fall and spring semesters of 2014, and through it, students produced archival-quality, research-ready plant collections that became part of our national biodiversity archive. This presentation will cover a brief overview of our collaboration process, as well as research findings demonstrating the success of, and areas for further improvement in, our curriculum.

9:30-9:50 a.m. Citizen science: A symbiotic future for research and education using biological collections, Emily Meineke (North Carolina State, Entomology), Steven D. Frank (North Carolina State, Entomology), Robert Dunn (North Carolina State, Biology)

Museum collections offer a lens into the past and a way to predict the future. These functions are especially valuable now as we try to anticipate how biodiversity will change with global shifts in climate and land use. Collections also offer a way to learn about the species that live with us in our most immediate environments, species that arguably should have the most pronounced effects on our wellbeing. Several recent projects leverage small collections from the past and larger, more recent collections built by the public to ask questions in biology while connecting citizens to native biodiversity. At NCSU, we house several such projects at various stages of development that use large and small

collections for education. The most developed project School of Ants forged new symbioses between science and education. The most nascent of our projects will use herbaria to track herbivory across unprecedented scales of space and time. Here, we present this project as an example of how traditional research on small collections can be expanded to include a public component that builds larger collections and involves K-12 students in science.

9:50-10:10 a.m. Collections Internships for College Students: Designing an Interdisciplinary Program, Emily Smith (Randolph College)

Many colleges and universities have neglected their natural history collections, and are thus overlooking a tremendously valuable resource, which offers students the opportunity to apply their classroom learning to expand and develop marketable skills in nearly every academic discipline. In the Natural History Collections Project (NHCP) at Randolph College, undergraduate students in a variety of majors learn basic tasks of collections management, such as identification, conservation, tagging, digitization, and preparation of specimens, as well as utilizing collections for independent research, as reference material for art, and inspiration for creative writing. The NHCP also aims to make the collections accessible to the public through online catalogs, collaborative exhibitions, a student-maintained blog and social media, and outreach programs such as the science division's annual Science Festival. By approaching natural history collections from cultural, aesthetic, and historical perspectives, as well as from a scientific one, educators and museum specialists are in a better position to gain allies in the wider community and to receive funding and logistical support for maintaining their collections, while the next generation of collections specialists in a variety of disciplines acquires a wealth of training and inspiration. I will discuss methods for designing interdisciplinary opportunities which create partnerships between students and faculty, academic departments and the local community, resulting in the public perception of collections as a valued and vital resource.

Break 10:10-10:30 a.m.

10:30 a.m.–12:10 p.m. Track Two (part one)

Digitization practices and challenges in small collections and museums

10:30-10:50 Small entomology collections: How to manage, Janaki Krishna (Natural History Museum of Utah), Christy Bills (Natural History Museum of Utah)

Being an entomology collection manager of a small collection can mean working in isolation, away from other professionals and the benefits of the exchange of ideas and experience that collaboration can bring. Also, managers of small collections can feel intimidated by the scope of larger collections and not feel as important or as welcome to the national conversation. However, "small" entomology collections can hold thousands, or even, hundreds of thousands of individual specimens, of unique regional, taxonomic or historic importance. It's vital for those specimens to be included in any metadata efforts and for those specimens to be properly cared for. The managers of small collections often need additional resources to successfully answer curation questions, advocate for their collections, understand funding opportunities, seek partnerships, weigh database options, discover outreach possibilities and navigate the treacherous world of professional acronyms. Fortunately, there are many resources available, many options for connection and places for ongoing conversations where managers of small entomology collections can get answers.

10:30-10:50 a.m. Biological field stations as repositories of biodiversity data, Hilary Swain (Archbold Biological Station), Gil Nelson (Florida State University/iDigBio)

Field stations throughout N. America, linked by the Organization of Biological Field Stations, provide a network of people, natural observatories, and collection data. In a recent survey, 86% of 48 respondents supported on-site collections. Here we present a case study of one of the largest such collections, at Archbold Biological Station ABS, a renowned not-for-profit in Florida. ABS has a broad scientific research, education and conservation mission but is not formally affiliated with any university or museum. As a component of its long-term research, ABS curates a diverse, multi-taxon, specimen-based, research Collection used by staff scientists and other investigators. The Collection is a unique, irreplaceable record of regional biodiversity, with an emphasis on the Florida scrub habitat including threatened and endangered species, and non-natives. After 75 years of growth, the Collection includes ~270,000 specimens identified to species including arthropods (95%) plants, bryophytes, mammals, birds, fish, and herptiles, representing ~10,392 species. In the last five years the Collection has contributed to numerous research projects, descriptions of 12 new species, made hundreds of loans, been accessed on-site by 110 investigators, and resulted in 58 publications. ABS has made available on-line ~10,000 specimens of plants and arthropods, and has databased the all vertebrates, plants, and bryophytes. Remaining specimen data are not yet accessible online via www-based portals. Archbold is partnering with iDigBio, seeking support to database, image and migrate specimen data to the internet. We describe how such projects at field stations will advance biological research, promote benefits to conservation, and increase educational outreach.

11:10-11:30 a.m. Managing Multiple Small Collections in an Interdisciplinary Museum, Lena Hernandez (Museum of Science & History of Jacksonville, FL)

You are always going to be short on something – time, supplies, or expertise – when working with small collections. Usually, you are short on everything. This problem is exacerbated when your collections are very diverse. Meeting the needs of your collections, no matter the size or composition always depends on three universal responsibilities: Advocating for your collection, identifying and utilizing your available resources to their fullest, and lots of carefully planned work. Fulfilling these responsibilities will help you meet the needs of your collections both now and in the future. The diverse collections of the Museum of Science & History of Jacksonville include: Living animals; historical artifacts; archives; and herbaria, vertebrate, invertebrate, paleontological, and geological specimens. MOSH's collections will serve as a reference, illustrating proper collections stewardship when managing multiple small collections.

11:30-11:50 a.m. Challenges and obstacles to digitizing small paleontology collections, Laura Vietti (Geology Department, University of Wyoming)

The Geology Department at the University of Wyoming is in the early stages of digitizing its paleontology collections (n=~ 40,000 specimens) and has encountered many challenges and obstacles. Most of our digitization issues arise from variations in fossil color, composition, size, shape, preparations, and breadth of meta-data (field notes, lab notes, maps, photographs, geo-referencing). Because fossil specimens vary across many of these fields, the digitization process differs specimen-to-specimen and requires an adaptive digitization workflow. In turn, adaptive workflows in the paleontology field require advanced equipment, extensive training, and specialized workers, which in the context of small collections is especially difficult to achieve due to limited funds and personnel. Here, I present examples of these various digitizing challenges and hope to stimulate discussion on methods for overcoming them.

11:50-12:10 p.m. Research opportunities using data from small collections, Pam Soltis (Florida Museum of Natural History, University of Florida, iDigBio)

Ongoing developments in phylogenetics coupled with emerging cyber-infrastructure and new data sources provide unparalleled opportunities for mobilizing and integrating massive amounts of information

from organismal biology, ecology, genetics, climate, and other areas such that patterns in complex data will emerge, yielding new hypotheses for further study. Although most available specimen records come from large collections, small collections also have important roles to play. Attempts to integrate heterogeneous data across spatial and temporal scales reveal challenges and opportunities for our understanding of plant evolution. Workflows that integrate public data from taxonomy, distributions, climate, phylogeny, and predictions of global change through novel algorithms and workflows have demonstrated the capacity for data-driven science for discovery of new biodiversity patterns, with fundamental implications for conservation and management of plant species. Unfortunately, these integrated analyses are often limited by the absence of digitized data from small collections, which are often the most abundant source of data for nearby rare species. Although numerous questions and specific hypotheses may be addressed through integrated analyses of biodiversity and environmental data, perhaps the greatest value of such data-enabled science will lie in the unanticipated patterns that emerge. These patterns will be much richer when data from small collections are included. Examples of the value of small collections in research will be presented.

Lunch 12:10-1:30 p.m.

1:30-3:10 p.m. Track Two (Part Two)

Digitization practices and challenges in small collections and museums

1:30-1:50 p.m. Strategies for digitizing small vertebrate collections, Laura Abraczinskas (Michigan State University Museum)

The Michigan State University Museum houses over 111,000 vertebrate specimens. The specimens date from 1844 and are preserved as skins, skulls, skeletons, fluid-preserved materials, tanned hides, frozen tissues, DNA samples, nests, eggs, anatomical preparations, and taxidermy mounts. Like many collections-holding institutions, the Museum began digitizing collections in the early 1990s by key-entering text data into a computer database. At that time, the primary goals of digitization were to facilitate collections management and to effectively provide specimen information on an as-requested basis. Over time, the Museum employed multiple strategies for vertebrate collections digitization and related activities such as inventory, reconciliation, data enhancements, and standards conformance. These strategies included developing written protocols for digitization; selecting standard terminology for specimen preparation types; utilizing standard resources for taxonomical and geographical data; modifying database fields to conform to Darwin Core standards; employing best practices and resources for georeferencing and inventory; dividing complex projects into smaller discreet components; and utilizing multiple original data sources and documents to reconcile records and enhance specimen data. Original records and specimen data sources included catalog ledgers, cards, accession documents, field notes, specimen tags, egg slips, necropsy reports, correspondence documents, archival records, and dissertations. Multiple numbering systems and collections catalogs in use since the Museum's founding in 1857 were accommodated. Today, the Museum is part of the Global Registry of Biorepositories, has two institutional codes for vertebrate collections, and digitized records are published to the GBIF, iDigBio, VertNet, and FishNet2 online portals. Our digitized vertebrate specimen records are accessed every day.

1:50-2:10 p.m. The Fairbanks Museum: a small, rural, New England natural history museum's challenge to adapt, Mary Beth Prondzinski (Alabama Natural History Museum, representing Fairbanks Museum)

The 120 year old Natural History Museum created by Franklin Fairbanks, a member of the illustrious Fairbanks Scales family, to house his burgeoning collection of specimens, was a gift to the people in the small rural hamlet of St. Johnsbury, Vermont. Though created as an educational institution, its collections still possess merit in their extraordinary stories of Victorian acquisition and splendor. Through

the museum's website and database, we hope to bring these collections into public awareness to relate their story of how they landed in a rural New England museum

With technological advances and increased knowledge, the underpinnings of a Natural History museum built in the late 19th century are in desperate need of improvement. The expense and upkeep of such enhancements increases yearly, while support for these costs continues to decline. As the requirements for maintaining and showcasing collections become more complex, the value of preserving artifacts must be discerned by the public that they serve. The ability to absorb these costs into the community consciousness remains a challenge to the collection custodians who fight a daily battle with less-than-adequate provisions.

There are any number of small town libraries and schools that contain similar collections or dioramas donated by invested local residents. Most of these small collections are managed by volunteers or townspeople untrained in the complexities of maintaining and preserving collections that have no way to connect with the larger community of collections caretakers and professionals.

2:10-2:30 p.m. SCNet: Supporting digitization in small collections, Gil Nelson (iDigBio/Florida State University), Anna Monfils (Central Michigan University)

The Small Collections Network (SCNet) developed from a series of meetings of curators, managers, and directors of small collections. SCNet is devoted to supporting small to moderately sized natural history collections, especially in specimen digitization and in the mobilization of biodiversity data. Such collections constitute a major source of information for understanding global biodiversity. Typically regional in scope and often with strong ecological, taxonomic, and geographic biases, they may hold specimens that are unduplicated in larger collections and can represent intense samplings of community composition that have the potential to significantly expand our knowledge of landscape-level biogeography. As a result, small collections constitute a singularly important resource for the study of regional and continental ecosystems both past and present. SCNet believes that digitizing and sustaining these collections will expand their accessibility, enhance the impact of the data they generate, ensure incorporation of these data into ongoing biological and paleobiological research, and foster a support network of like-sized institutions.

2:30-2:50 p.m. Getting started: Digitizing multiple small collections at UCSB, Laurie Hannah (Cheadle Center for Biodiversity, University of California, Santa Barbara)

The Cheadle Center for Biodiversity and Ecological Restoration (CCBER) is the home of the University of California, Santa Barbara's biological research and teaching collections. Begun in 1956 with the creation of the herbarium and the zoology collection, these collections have grown and broadened to include close to 200,000 vertebrate, invertebrate, algal, plant anatomy, and microfossil specimens, as well as faculty archives. The collections range from 700 to 90,000 specimens in size and are, for the most part, largely focused on the central coast of California. Though housed on a medium-sized state university campus, resources for curation, digitization, and preservation of these collections are slim to none. However, through a series of state and federal grants, strategic planning, creative leveraging of staff responsibilities, serendipity, and the generosity of others, CCBER staff and volunteers have made considerable progress towards digitizing their collections. This presentation is aimed at small institutions who are unsure how to begin a digitization project and who need guidance in deciding what collection(s) to digitize and how to find funding. I will discuss the challenges CCBER faced as a small center with no permanent collections staff and few additional resources, the strategies used to successfully undertake the digitization of five distinct collections, and some lessons learned along the way.

2:50-3:10 p.m. Recruiting and managing volunteers in small collections, Melissa Islam (Denver Botanic Gardens)

Volunteers are a valuable resource to small collections when thoughtfully recruited, trained and recognized. As collections work expands to include virtual management in addition to physical management, properly trained, flexible volunteers can follow this shift in priorities and contribute significantly to digitizing small collections. As the Denver Botanic Gardens herbaria has increased in professional staff and collection management, we transformed our relationship with volunteers. Previously, volunteers were not consistently trained, poor quality work was overlooked, and staff scrambled to meet the needs of volunteers. We then implemented a certification program, job descriptions, and trained volunteers with clearly articulated protocols and procedures. Within a year, the dynamic between staff and volunteers changed dramatically. Volunteers are now well-trained, independent and flexible in shifting tasks. They are open to learning new protocols as these are improved and better understand their contribution to collection care as well as natural history. In nine months, staff and volunteers imaged 54,000 specimens to link to our previously databased records. Although we continue to spend quite a bit of time managing volunteers, the amount of work that is accomplished could not occur by staff alone. Volunteers image newly accessioned or annotated specimens, database from images, and georeference specimens in addition to their work with the physical collections. Digitization has also attracted a different group of volunteers to our collections thereby expanding our volunteer base. Our team of volunteers are an asset to the collections as well as an advocate for them.

Break 3:10-3:30 p.m.

3:10-5:30 p.m. Track Three

Reaching out to small collections

3:30-3:50 p.m. Ten years of the Society of Herbarium Curators: past, present and future, Andrea Weeks (George Mason University)

The year 2015 marks the 10th anniversary of the Society of Herbarium Curators (SHC), an organization founded with the goal of uniting herbaria large and small. This presentation will chart SHC's inception from early meetings of curators in the southeastern United States, to its formal incorporation, to its recent emergence as a model for sustaining regional networks of herbaria over the long-term. The mission of SHC includes promoting and expanding the role of herbaria in botanical research, teaching, and service to the community at large, providing a forum for discussion and action on all issues confronting herbaria, and extending its influence towards the preservation of endangered herbaria. Our outreach newsletter, *The Vasculum*, social media presence and student research grant competition are some of the ways that we advance this broad mission. SHC also provides regionally based herbarium consortia with a framework for formalized democratic governance via SHC chapters. Activities of these chapters were originally envisioned to include local outreach activities, advocacy for small herbaria, and the development of community standards of curation. However, they now include the collection and management of digitized herbarium data across institutions. I argue that the long-term success of curating digitized herbaria, whether large or small, will hinge on our community's ability sustain collaborations beyond the influence of any one herbarium, curator or research grant. I will also provide examples of our success in incorporating small or endangered herbaria from Tennessee and Virginia into regional digitization efforts in the southeastern United States.

3:50-4:10 p.m. Reaching out to small collections, Zack Murrell (Appalachian State University), Michael Denslow (Appalachian State University), Joseph McKenna (Appalachian State University)

A robust cyberinfrastructure is the foundation of continental and global scale biodiversity informatics data management and mobilization. Although we recognize the value of the human infrastructure involved, we

often overlook the complexities of human infrastructure development and maintenance. The SouthEast Regional Network of Expertise and Collections (SERNEC) offers an example of infrastructure development that has been very successful in encouraging and facilitating curators from small and mid-sized herbarium collections to embrace community best practices. We can trace the history of development from regional and state-level efforts over the past century. Within the past decade, this group was funded by NSF as a Research Coordination Network and then more recently as an NSF ADBC Thematic Collections Network called the “Key to the Cabinets.” We have joined the Society of Herbarium Curators as the Southeast Chapter to provide governance structure for long term sustainability. Our efforts have explored the resource needs of the 233 herbaria in the Southeast US, examined the diversity of expertise associated with these collections, and developed an effective communication structure to facilitate collaborations. Activities have led to collaborations with curators from other taxonomic domains, interactions with state natural heritage programs, and the development of education modules for outreach to primary and secondary schools. We intend to continue these efforts in order to strengthen our interconnections and also our ties within our individual institutions and communities. We perceive that our ongoing efforts can have positive impacts on the health of natural history collections, conservation, science and science education.

4:10-4:30 p.m. Large and Small Collections: Partners in a time of Challenges and Opportunities, Barbara Thiers (New York Botanical Garden)

There are about 73 million specimens in 600 herbaria in the U.S. Large herbaria (with more than 100,000 specimens) number 101; medium-sized herbaria (50,000-99,999 specimens) number 58. And small herbaria (fewer than 49,000 specimens) number 429. The majority of federal government collections are small, the medium category has the largest state govt. and university herbaria, and private institutions account for a larger proportion of the large herbaria. Herbaria are concentrated in the region of the country east of the Mississippi.

In general, small collections are regionally- or taxon-focused, often with a few main collectors, a larger proportion of whom may be lesser known. These collections may not be duplicated elsewhere, and may be less often included in inventories and monographic studies. Specimens in smaller collections will likely be more recently collected and more uniformly documented than those in larger collections. Specimens in larger collections most likely span a larger geographic, temporal and taxonomic range, are likely duplicated elsewhere, and are more frequently studied.

Because of the complementarity among small and large collections, consultation of both is needed for the broadest possible range of collection coverage. This creates a natural basis for collaboration in both digitization projects and the research projects that digitization projects have been designed to serve. To date, a disproportionately small number of small collections are involved in collaborative networks and digitization projects. This problem needs to be addressed both through greater awareness of the strengths of smaller herbaria on the part of larger ones, and through more action on the part of smaller herbaria to demonstrate their readiness for collaboration and to initiate collaborative projects.

4:30-4:50 p.m. A list of US-based natural history collections, François Michonneau (iDigBio, Florida Museum of Natural History), Larry Page (iDigBio, Florida Museum of Natural History)

While herbaria are listed in an actively managed directory since 1935 -- the index herbariorum -- no similar directory exists for zoological collections. Yet, a comprehensive list of natural history collections is critically needed by the community to facilitate the location of specimens of interest and improve collaboration across institutions. Specifically, this list will allow the identification of collections that are not

digitized. Here, we present an initial draft of this list that includes over 1,000 collections across the US. We will present an overview of their geographical locations, their taxonomic scope. This list is available on the iDigBio website, and we welcome updates from the community, on the information listed and suggestions for collections that may not be included.

4:50-5:10 p.m. Building a Networked National Community: NIBA Research Coordination Network, Rob Gropp (American Institute of Biological Sciences)

In recent years, the scientific community has developed a national strategy for a Network Integrated Biocollections Alliance (NIBA) to establish a framework for leveraging the wealth of resources represented by the nation's biocollections through digitization of specimens and associated metadata, creating a massive, distributed tool for addressing grand challenges across a wide range of scientific endeavor. Significant progress has been made toward the implementation of NIBA, but much more work remains. In 2014, the National Science Foundation funded a Research Coordination Network (RCN) grant to support efforts to foster the continued engagement with and development of a sustainable, networked community of practice. The NIBA RCN is working with the community to evaluate current and future needs. This talk will summarize work and findings thus far, as well as solicit input on future activities.

5:10-5:30 p.m. The role of small natural history collections in contributing to understanding species' distributions, Travis Marsico (Arkansas State University), Jeremy J. Caron (Central Michigan University), Richard Carter (Valdosta State University), Emily Gillespie (Marshall University), Erica Krimmel (Chicago Academy of Sciences, Peggy Notebaert Nature Museum), Ross McCauley (Fort Lewis College), Ashley B. Morris (Middle Tennessee State University), Gil Nelson (Florida State University), and Anna K. Monfils (Central Michigan University)

How do small natural history collections contribute to our understanding of biodiversity patterns through space and time? To begin addressing this question, collaborators in eight states (AR, CA, CO, FL, GA, MI, TN, and WV) gathered vouchered vascular plant collection information from large and small institutions in their respective states. In each state, 40 species were randomly selected, 10 from each of four categories: rare S1, rare S2, common native, and invasive. Collection data were partitioned by size of herbarium into two classes, large (>100,000 specimens) and small (<100,000 specimens) collections. From the resulting data sets, occurrence data were analyzed by collection size, county, specific locality, and date of collection. The four species categories were compared to determine the relative contribution of small collections to the distribution information available in the states. We found that small collections contribute to county-level and even more so to site-level spatial distribution knowledge, and that the proportion of these contributions differ by state, species category, and geographic focus and research interests of personnel from individual collections. Our study quantifies and summarizes the patterns. We conclude that small collections are important, often uniquely so, in documenting distribution of species through space and time. Therefore, in order to accurately characterize biodiversity, it is imperative to include small collections in national digitization and data sharing efforts.