Developing the US National Virtual Herbarium

WERA-1015 (2009-2014)

Herbaria Offer a Wealth of Resources, but Need to Be Modernized

In the 1540s, the creation of the first herbarium, a systematically arranged and labeled collection of preserved plant specimens, transformed plant science and taxonomy. Herbaria provided—for the first time—an effective way to document the plants of a particular region. In recent years, the more than 625 herbaria in the US have provided a rich source of information about plant diversity and distribution; however, these individual herbaria are disjointed, and many records are not digitized or available online. Easy access to herbaria is increasingly important for land management and conservation work. To make herbaria more complete, more integrated, and easier to use, herbaria need to take advantage of new digital and Web-based tools. To do so requires engaging those in charge of herbaria, building bridges between plant scientists and computer scientists, and raising awareness of herbarium resources among scientists, consultants, students, and members of the public.

Records in many herbaria now include a digital image of the specimen along with a ruler, color standards, and a barcode. Specimen images prepared by Sandy Long, Intermountain Herbarium.

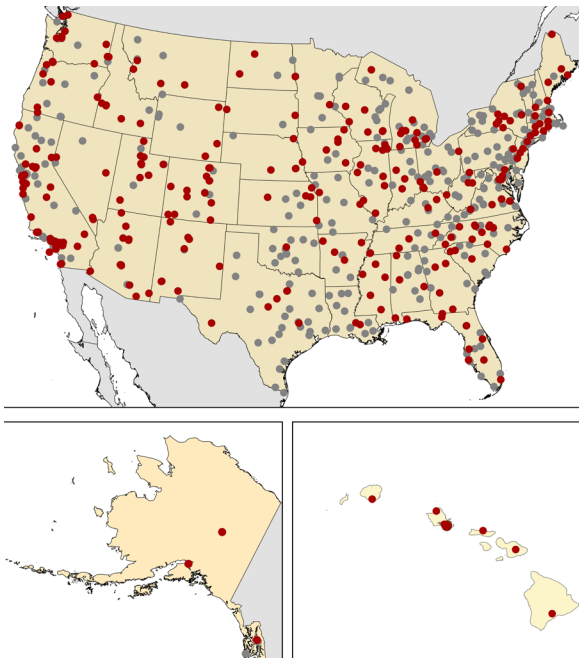
Multistate Project Coordinates National Virtual Herbarium

In 2009, representatives from herbaria across the country formed Multistate Research Project WERA-1015 to coordinate the development of a US Virtual Herbarium (USVH).

Early on, the WERA-1015 group conducted surveys to identify the critical functions of a national portal and determine software requirements. To build towards their goal of a single, national database, project members shared information and support with individual herbaria, including new protocols for storing specimen, recording specimen data, improving human resources, and making the work flow more efficient. The group also recommended available software and suitable hardware that herbaria could use to digitize their collections and make their resources accessible online.

The group's website (http://usvhproject.org/) provides information about the project, links to the existing regional networks, resources for those interested in digitization, and maps showing the status of digitization in individual herbaria. In addition to trainings and other outreach events, project members have given presentations at workshops and symposia to increase awareness and funding.

At the start of the project, there were only three regional or national herbarium networks. Today, networks cover the whole country and continue to expand to include more herbaria. By the end of 2015, 235 herbaria were sharing records through a regional network. Integration enables individuals to access from multiple herbaria in the region. In August 2015, survey responses indicated there were about 17 million records accessible through one of the major networks, a huge increase of over the number reported for 2011.



Several robust reginal networks now exist for vascular plants, the group best represented in herbaria, and national networks exist for less represented groups, including bryophytes, lichens, fungi, and algae. Each red dot on this map shows an herbarium that is contributing to one or more networks. Gray dots show herbaria not connected to a network. Multistate coordination and resource sharing eliminates redundant efforts and reduces the overall cost and difficulty of constructing these networks, and potentially, the USVH. Map generated by Mary Barkworth, Utah State University.

In 2014, a joint committee was established between USVH and iDigBio—the National Science Foundation-funded national portal for all organisms. With NSF support, WERA-1015 is helping the iDigBio project find ways to overcome the challenges of establishing a national portal, in particular, integrating herbaria that use different database platforms.

Multistate Project Improves Quality and Accessibility of Herbaria Resources

WERA-1015 has increased knowledge of the resources herbaria provide and made these resources more readily accessible. By providing free access to verifiable, downloadable information on plants and their distribution, advances in accessibility facilitate research projects and save researchers the time and cost of traveling to specific plant sites or specimen libraries.

WERA-1015's work has encouraged specimen collectors and herbaria personnel to adhere to international standards and use new tools to record more, better quality information. Higher quality records make it easier to integrate specimens into herbarium databases and networks. New tools and standards also increase the value of new collecting activity.

Having distributional information and digitized images stored online facilitates accurate identification of specimens collected in the field. Furthermore, access to modernized herbaria resources is helping develop plant identification and taxonomic skills needed to work at agencies like the US Forest Service.

Increased knowledge of plant distributions in the US over time enables more accurate ecological modeling, better land management, sustainable agricultural planning, and improved assessments of climate change impacts. In particular, this data can be used to predict areas to which an introduced species or insect pest will spread or where additional populations a native species be found.

The top image shows a 3D modeling experiment of a Lace Lichen. Photo by Timothy M. Jones. Bottom specimen image prepared by Sandy Long, Intermountain Herbarium.

Want to know more?

WERA-1015 was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund established in 1998 by the Agricultural Research, Extension, and Education Reform Act to encourage and enhance multistate, multidisciplinary research on critical issues. Additional funds were provided by contracts and grants to participating scientists. For more information, visit *http://www.waaesd.org*.

Herbarium Networks
- Pacific Northwest: pnwherbaria.org
- Pacific Herbaria: pacificherbaria.org
- Northeastern: neherbaria.org
- California: ucjeps.berkeley.edu/consortium
- Intermountain: intermountainbiota.org*
- Midwest: midwestherbaria.org/portal*
- New Mexico: nmbiodiversity.org*
- Northern Great Plains: ngpherbaria.org/portal*
- Small herbaria: nansh.org*
- Southeast: sernecportal.org*
- Southwest: swbiodiversity.org*

**These networks are connected by SEINet, a super-regional network: swbiodiversity.org/seinet*

Project Contact: Dr. Mary Barkworth (Mary.Barkworth@usu.edu)

Participating Universities:
University of Alabama
Appalachian State University
Arizona State University
Arkansas Tech University
Auburn University
Black Hills State University
Boise State University
University of California, Davis
University of the Cumberlands
Delaware State University
Fairmont State University
George Mason University
University of Georgia
University of Hawaii
Iowa State University
James Madison University
Kansas State University
University of Louisiana, Monroe
Louisiana State University
Lynchburg College
University of Michigan
Michigan State University
University of Mississippi
Mississippi State University
Northern Arizona University
University of New Hampshire
University of Nevada, Las Vegas
University of North Carolina, Wilmington
North Carolina Cooperative Extension
University of Oklahoma
Oregon State University
Portland State University
Rutgers University
University of Tennessee, Chattanooga
Troy University
Truman State University
Utah State University
Utah Valley University
Valdosta State University
Vanderbilt University
University of Vermont
Virginia Polytechnic Institute and State University
University of Washington
West Virginia University
Western Carolina University
University of Wisconsin

Participating Institutions:
Academy of Natural Sciences of Philadelphia
Botanical Research Institute of Texas
Center for Biological Informatics
Firesner Herbarium
Idaho Museum of Natural History Herbarium
The Morton Arboretum
Smithsonian Institution
USGS