

The Rocky Mountain Herbarium

February 2017
Ronald L. Hartman

The Rocky Mountain Herbarium (RM) is the largest facility of its kind between Saint Louis and the West Coast. Rich in material from throughout US, Canada, and northern Europe, it is the largest collection of Wyoming and Rocky Mountains plants in the world and reflects the region's biological diversity and evolutionary history. It has been enriched over the past 40 years by an unparalleled inventory program involving 50 floristics graduate students, most of whom have become educators or researchers at state and federal agencies or environmental companies. The studies covered most state and federal lands in Wyoming, Colorado, and northern New Mexico, but also major portions of Montana and Idaho and parts of eight adjoining states. With help from staff and associates, the number of new collection exceeds 650,000. The RM, U.S. Forest Service National Herbarium¹, and the W.G. Solheim Mycological Herbarium contain more than 974,600 specimens and an additional 300,000 await mounting. Based on the number of collections, it ranks 15th in the nation of 641 herbaria, 75th in the world of 2,962 herbaria. Also at UW is the A.A. Beetle Grass Herbarium with over 30,000 collections (Ecosystem Science and Management). Thus, holdings at UW exceed 1 million accessioned specimens. The RM database contains more than 850,000 entries and 140,000 specimen images², the latter facilitated by collaboration with UW Libraries staff. This treasure trove of primary information, with a mapping function, is used extensively by the scientific community, state and federal agencies, and the public. Our informatics program is part of a regional and national consortium. In the last 20 years alone, the RM has received more than \$1,670,000 in mostly federal funding (84 projects) for graduate student education and specimen acquisition, processing, curation, databasing, and imaging. This has led to the employment of over 300 undergraduates, many of whom have been in the internship program. Our studies have vastly increased knowledge of rare plants. Fieldwork completed during the 1990s in Colorado, Idaho, Utah, Washington, and Wyoming resulted in the inventory of 79,391 mi² of state and federal lands. Most importantly, 414 species of conservation concern were documented at 1,458 sites; most of these sites of occurrence were new. Additionally, projects completed during the first decade of the 2000s in Arizona, Colorado, Idaho, Kansas, Nebraska, New Mexico, Oregon, South Dakota, Washington, and Wyoming resulted in the coverage of an additional 89,363 mi². During this period, 430 plant species of conservation concern were documented at 1,678 sites. As many of the taxa collected during the 1990s had been removed from Natural Heritage lists prior to 2000, this is even more remarkable. This vast increase in knowledge has influenced the removal of many potential or proposed species from the Federal Threatened and Endangered Species List. This work has been done in conjunction with the Wyoming Natural Diversity Database and other Natural Heritage Programs in the region.

The RM Volunteer program, established last year, has contributed more than 5,000 hours of service and we continue to add participants.

The RM continues to serve a critical role in providing plant identifications to the public, UW students and faculty, and state and federal agencies. We work closely with these agencies in documenting the introduction and spread of invasives and noxious weeds throughout the region. The Curator is a coauthor of the *Weeds of the West*. We assist the Wyoming Game and Fish Department and the Veterinary Lab with cases of wildlife and livestock poisoning.

We provide material for use in courses, including plant taxonomy, plant ecology, and general biology, and guide tours for K-12 classes in coordination with Berry Biodiversity Conservation Center, students in UW courses, and the public. We work with UW Extension in conducting workshops and field trips for the public on plant identification.

In addition to education and service, the RM, with the associated branch of UW Libraries (>5,000 printed volumes, 4,600 microfiche titles), serves a major role in research. It contains primary material that supports the writing of popular guides and scholarly works on plants identification, including the floras of Rocky Mountain National Park, the Medicine Bow Range, the Black Hills, Wyoming, and Montana. Staff and associates have described many new species and the RM is a repository for >5,900 type specimens on which new species are based. We have published numerous taxonomic and systematics treatments of genera in the sunflower, carnation, and parsley families of western US and the pineapple family of South America. These treatments are based on morphological and anatomical studies of herbarium specimens and living material, but may also include analyses of chromosome number and behavior, flavonoid chemistry, and chloroplast DNA. We have contributed treatments to the floras of California, Oregon, New Mexico, Missouri, and the Great Plains. For many years the past Curator served on the Board of Directors for the

Flora of North America (FNA) project and the RM is a center for regional review. We have also contributed numerous FNA treatments. Thus far, 20 of 30 volumes have been published by Oxford University Press (12,493 pp.). Upon completion in 2020, it will contain identification keys, descriptions, and illustrations of more than 22,000 species. In conducting research through the years, we have worked at many herbaria in the New World and have borrowed for study, several thousand specimens from all the major collections in North America. Likewise, tens of thousands of specimens from RM have been loaned for systematic study as well.

¹The U.S. Forest Service National Herbarium was founded in Washington DC in 1911 by William A. Dayton, in 1970 it was moved to the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado, and in 1982 was transferred to the University of Wyoming on indefinite loan.

²**Below**, specimens of Rocky Mountain fringed gentian (*Gentianopsis detonsa* var. *elegans*). Compare the quality of the actual plants, one collected by Aven Nelson in 1900, the other by Laura E. Lukas in 2007. The dry climate of Laramie is ideal for preservation, and storage in closed cabinets prevents flowers from fading significantly. The specimen by Lukas was mounted on standard heavy-weight archival paper (100% rag, 11.5 × 16.5 inches). Included are specimen label (lower right), accession number with RM identifier (lower left), and barcode (upper right). The red “db” next to the Lukas label indicates the sheet was databased. The barcode links specimen image to label entry in RM Database (www.rmh.uwo.edu). For an informative exercise, go the website and enter *Gentianopsis detonsa elegans*, 420+ specimen records appear, many with images (by clicking on the image it can be enlarged five times). The Google map shows the coarse distribution of the species. By clicking on the map several times, it enlarges and the collection sites resolve. Click on a square and the label data appear on the right. If you choose not to enter a scientific name, a polygon can be used to circumscribe an area, then by hitting “search specimens,” specimen records of all species appear in sets of 100.



Rocky Mountain Herbarium

Jan 2015

Summary

Ronald L. Hartman
Curator, Professor of Botany
B. Ernie Nelson
Collections Manager

The Rocky Mountain Herbarium (RM, 1893) with the integrated National Herbarium of the U.S. Forest Service (USFS, 1911) and the associated Wilhelm G. Solheim Mycological Herbarium (RMS; 1929) contains the world's largest assemblage of plants and fungi from the greater Rocky Mountain region. It contains more than 1,260,000 plant specimens and ranks 15th in the nation of 641 herbaria.

The staff of the RM have developed a philosophy to aggressively inventory the flora of the Rocky Mountains and adjacent plains and basins. This region was vastly under-collected and many roadless areas had not been botanized. Such areas are remote and often requiring hikes of 10 to 25+ miles, although many others are easily reached by vehicle yet remain unexplored. The result has been a relatively “fine grain” sampling in order to capture, based on voucher specimens, species distributions as a whole. In addition, genotypic/phenotypic variation and ecological differentiation are documented. Impressive, yet not excessive, numbers of collections per unit area (~5 specimens/mi²) have been obtained. The development of new tools through the decades that place broad-scale floristics into an interdisciplinary framework with biogeography, ecology, and land management is fortuitous. These include computer hardware and software advances, informatics, the Internet, website development, GIS applications, and molecular systematics.

In 1978, the RM initiated this major floristic inventory of the greater Rocky Mountain region. The inventory now is the largest program of its kind in the annals of North American botany and, arguably, temperate Northern Hemisphere. More than 63 (50 by MS students) major floristic studies have been completed and 640,000 new collections have been obtained for the Flora of the Rocky Mountains project (13 states; Figs. 1, 2).

The projects completed during the 1990s in Colorado, Idaho, Utah, Washington, and Wyoming resulted in the inventory of 79,391 mi². Most importantly, **414 different species of conservation concern were documented at 1,459 sites**, most of these sites of occurrence were new. Additionally, projects completed during the first decade of the 2000s in Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Oregon, South Dakota, Washington, and Wyoming resulted in the inventory of 89,363 mi² of mostly state and federal lands. During this period, **430 different plant species of conservation concern were documented at 1,678 sites**. As many of the taxa collected during the 1990s had been removed from Natural Heritage lists prior to 2000, this is even more remarkable.

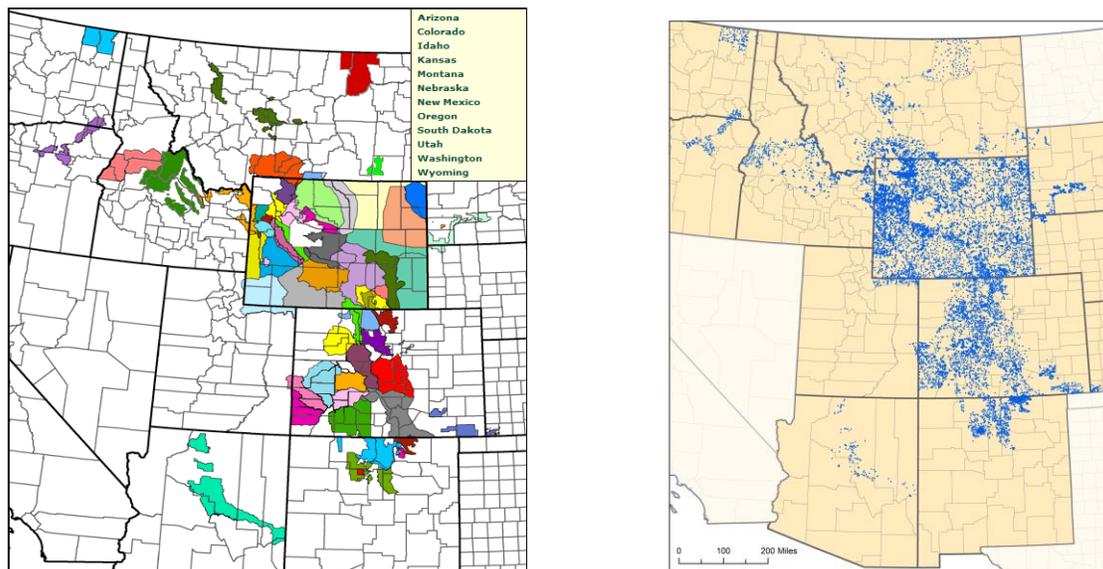
In 1991, the RM Plant Specimen Database was initiated. Currently it serves over 850,000 specimen records, 140,000 specimen images, and over 4,000 vouchered field photographs (www.rmh.uwyo.edu). Recently, the database has been rebuilt using MySQL. The new web interface is among the best in the field. We have a memorandum of understanding with UW Library (Imaging Lab, Digital Collections, and Systems Department) for housing and maintaining the website and database.

Since 2000, the RM has received six NSF grants in collaboration with regional and national herbaria for databasing projects (including mosses and micro-/macrofungi). Thus, since 1997, more than \$1,670,000 (little or no overhead) from 84 cost-share agreements with the USFS, BLM, NPS, NRCS, and USFWS have been acquired for inventory, specimen processing, databasing, imaging, and curation. Several of the recent ones are in collaboration with Larry Schmidt, UW Library.

- Databasing/georeferencing of ~30,000 specimens of vascular plant species from Arizona and New Mexico at RM. This complements data acquisition on ~45,000 recent collections from north central New Mexico (five projects funded separately by USFS, BLM, and Ted Turner Ranch) and 6,500 collections from selected areas in Arizona (USFS).
- The databasing of 18,000 specimens from BLM lands in Wyoming.

- The imaging/databasing of the 6,500 specimens in the Grand Teton National Park herbarium (funded by UW/NPS; www-lib.uwyo.edu/digitalherbaria/public). Likewise the processing/imaging of 8,002 collections obtained recently in the Park. We have completed the imaging of herbaria at Bandelier National Monument and the Black Hills cluster: Devils Tower, Jewel Cave, Wind Cave, Mount Rushmore. The latter group of herbaria were databased by Mark Gable, Black Hills State University. We are imaging NPS herbaria in the Northern Great Plains Inventory and Monitoring Network.
- The processing/imaging of 55,924 specimens from recent inventories on Shoshone NF.
- The databasing of RM specimens from the Missouri Plateau (eight of 23 counties in Wyoming and major portions of Montana, the Dakotas, and northern Nebraska) funded by NSF through Black Hills State).
- Imaging/databasing ~5,900 nomenclatural type specimens at RM, funded by Andrew W. Mellon Foundation. [A type specimen is one on which the description of a species new to science is based; they are critical to understanding the circumscription of a species.]
- Imaging the herbaria of Yellowstone NP (~10,000 specimens), Bighorn Canyon National Recreation Area, Teton Science School, Casper College, NRCS, USFS, and BLM offices in Pinedale, and Fort Laramie Historic Site.

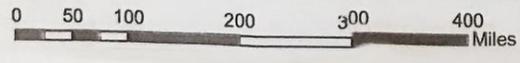
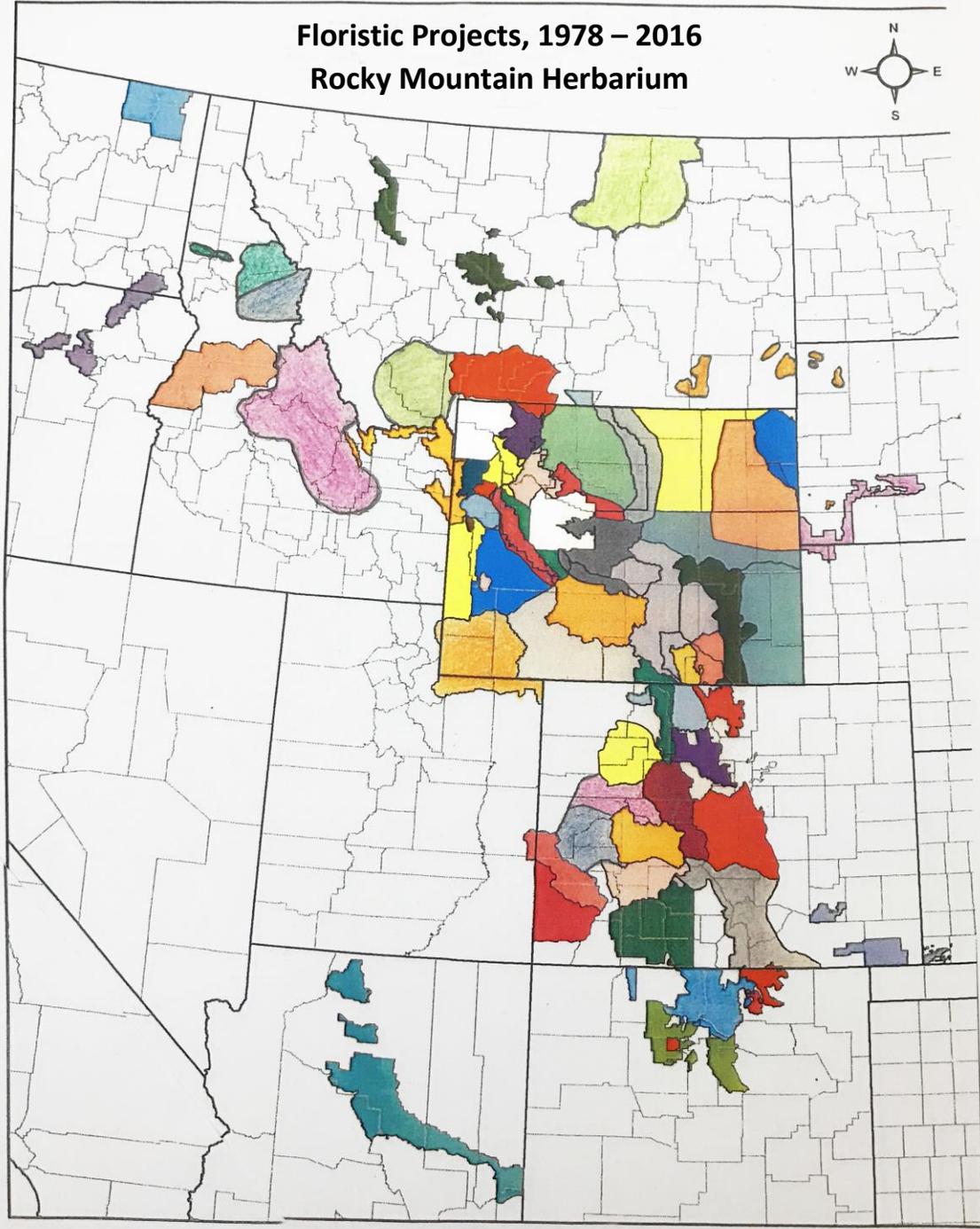
Additionally, two collaborative NSF proposals have been submitted, one for databasing and imaging of specimens from the Southern Rockies, and one for a national archive for specimen images.



Left figure – Map of study areas where intensive inventories have been conducted by students and staff of the RM. The number of collections range from 8,000 to 20,000 per project. Additionally, Phillips County to the west of Valley County (red), northeastern Montana, was included in the study. Projects not shown include two in western Colorado (W Central Colorado and White River National Forest), Beaverhead NF, Montana, Selway-Bitterroot Wilderness, Idaho, and Clearwater NF, Idaho.

Right figure – This is a detailed map of all collecting sites associated with the botanical inventory conducted between 1978 and 2010. In most cases, a dot represents 50-150+ collections.

Floristic Projects, 1978 – 2016
Rocky Mountain Herbarium



Map created 4/23/2009. Ben Legler