General Information for Floristics Proposals
"The Boiler Plate"

Dec 2011
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The following is the evolving "boiler plate" used for proposals for funding broad-scale plant diversity inventories in the greater Rocky Mountain region.

I. A partial history of the 40-year program along with comments: "Collections, Plant Specimen Database and Website, Specimen Imaging, and Previous Inventories and Rational." (pp. 1-4)

II. A discussion on "Floristic Project: Cost-Share Agreement and Justification and Methodology of Inventory." This portion is for agencies interested in content of a proposal. (pp. 4-7)

I. Collections, Plant Specimen Database and Website, Specimen Imaging, Research Staff, and Previous Inventories and Rational.

The Rocky Mountain Herbarium (RM) has conducted 65 (50 with graduate students) intensive inventories on federal lands in Colorado, New Mexico, and Wyoming (but also AZ, ID, KS, MT, NE, OR, SD, UT, and WA). The goal has been to amass representative material to serve as the basis for floras and taxonomic revisions covering the region. Most study areas range in size from 1,300 mi^2 (extremely mountainous) to 9,000 mi^2 (plains and basins). Emphasis is on documenting species of conservation concern as well as noxious weeds and other invasive taxa (*taxon, singular; taxa* herein refers to species, subspecies, or varieties in the appropriate context), but more so vascular plant diversity as a whole. Thus, these inventories document morphological variation and distributional details (geographical and ecological) and provide material for micromolecular (alkaloids, terpenoids, flavonoids, and other secondary plant products), macromolecular (DNA), and stable isotope studies.

In 1980, the W.G. Solheim Mycological Herbarium (RMS) became associated with RM. In 1982, the National Herbarium of the U.S. Forest Service was relocated to UW (USFS; 120,000 accessions; founded in 1910 in Washington D.C. by noted forest ecologist William A. Dayton, then moved to the Rocky Mountain Research Station (RMRS), Ft. Collins, in 1968). The current holdings for RM/USFS is 944,391 collections and for RMS is 49,000, for a total of 993,391 collections, up from 302,000 in 1977. Also, UW College of Agriculture houses the A.A. Beetle Grass Herbarium (WYAC; 30,000 accessions). The combined holdings (RM, RMS, USFS, WYAC) rank UW at 15th in size of more than 750 herbaria in the nation, 5th for a state institution, and in the top two percent of herbaria worldwide (62nd of 3001 herbaria). In addition, there are over 230,000 collections in the queue from recent work. Although these specimens are unmounted, they are identified, databased, with labels, and organized by project, plant family, and species, thus available for study by students and researchers. During the past 10 years, over 191,300 specimens have been mounted and accessioned into RM/USFS (>550,000 since 1977). If we were current, the collections would consist of more than 1.42 million plant and fungal specimens ranking UW 10th in size in the nation, 3rd for a state institution. Currently, the RM/USFS contains the largest holdings of vascular plants and fungi between St. Louis and the West Coast (by a factor of two).

A recent study documenting the decline of plant collecting in the United States (Prather et al. 2004) sampled 71 herbaria including the RM/USFS. It was found that: "a remarkable number of local specimens have been collected and accessioned into one herbarium, RM, in recent years. In fact, 38% of the total number of 1990s specimens were from RM. The number of specimens in RM from the 1990s. . . is over 40 times that of the average for the other 70 herbaria. . . . Because the data from RM were so anomalous, we excluded RM from this analysis to see what effect that had on the results. . . . The change is remarkable, when RM is excluded, the resultant pattern is a steady and marked decrease in collecting since the 1960s."

In 2011, funding from UW was secured by Dr. Greg Brown, Department Head, to renovate three adjoining rooms and add 176 new cases. This has led to a significant increase in work area and cabinet space.

Also associated with the collections is the Rocky Mountain Herbarium Library (a branch of UW Libraries) which contains the vast majority of taxonomic works on North America as well as major works worldwide (>5,000 printed volumes, 4,600 microfiche titles).

All major herbaria have associated libraries as immediate access to literature is imperative for plant identification, revision of taxonomic groups, and writing of floras.

Plant Specimen Database and Website– In 1991, databasing was initiated. Data are stored in a relational database (800,500+ records, 180,000+ specimen images, and 4,000+ vouchered field photos) and served through our website (http://www.rmh.uwyo.edu); also available through SEINet (ASU, Tempe) and the Consortium of Pacific Northwest Herbaria. Such data may be used with GIS in predictive modeling, ground truthing of remotely-sensed areas, managing species of conservation concern, and documenting invasives and noxious plants. Ben Legler, informatics and botanist at Burke Museum, University of Washington, recently completed a floristics master's degree while on a research assistantship in which he upgraded the database and built the website (Legler 2009, 2010, Nelson, Legler, and Hartman 2009). He has returned to Seattle to continue work on the Pacific Northwest Portal.

The RM is a member of a consortium of Front Range herbaria (COLO, CS, DBG, and GREE) for the Southern Rocky Mountains. Recent funding from the National Science Foundation is allowing for continued databasing and imaging of the collection.

Through funding from NSF to Black Hills State University, all specimens at RM/USFS from the Dakotas, Nebraska, Montana, and seven counties in northeastern Wyoming are being databased. Data from regional herbaria throughout the country via the U.S. Virtual Herbarium will be linked to allow maximum coverage.

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Recently, RMRS funded the databasing of all specimens at UW from New Mexico and Arizona, roughly 60,000 records.

The Curator and RM Manager are both members of the Wyoming Weed Team. During the past ten years, RM has received more than $98,000 from the USDA for the databasing and processing of invasive and other exotic species. This includes funding from the Montana CAPS program (Invaders Website), Wyoming CAPS, and a McIntire-Stennis grant.

Specimen Imaging– The RM has an agreement with UW Libraries (Imaging Lab, Digital Collections and Systems Department) to maintain, expand, and port the RM database and website. The RM has assisted in imaging and databasing the Grand Teton National Park herbarium (7,500 accessions). Recent work has added 8,200 new collections to RM from the Park; they have been imaged (MS student David Scott Kesonie; Kesonie and Hartman 2011). The imaging of the 5,300 nomenclatural type specimens is ongoing (funded by Andrew W. Mellon Foundation; a type specimen is one on which the description of a new species is based; it is critical to the understanding of its circumscription). Herbaria of Bandelier, Wind Cave, Devils Tower, Mount Rushmore, and Jewel Cave NPs have been imaged, and soon NPS herbaria in north central portion the nation will be as well. Larry Schmidt from UW Libraries is the lead person on these projects. The archivist with the library is overseeing the scanning of collecting books by staff and their students prior to 1967 and they are displayed on UW Libraries website.

Previous Inventories and Rational (through 2011**) –** One consequence of many intensive inventories is the discovery of undescribed taxa (Hartman 1992, Hartman and Nelson 2000; see RM website). For example, on the Shoshone NF near Cody, WY, such work during a recent 10-year period led to the discovery of six species, two subspecies, and one variety new to science. One species represented an undescribed genus.

Such inventories also contribute substantially to knowledge of species of conservation concern. Frequently, many more species of conservation (or sensitive plants) are found in an area than previously documented. This is well illustrated using four examples from Forest Service lands: Bridger-Teton (first three) and Targhee National Forests. Note the number of sensitive plants "new" or newly documented in each of the first three areas: 9, 14, and 19, respectively. Wyoming sensitive taxa are those tracked by the Wyoming Natural Diversity Database (WYNDD).

The RM staff, Ernie Nelson (BEN) and Dr. Ron Hartman (RLH), are involved in all graduate projects, but in most cases mentioned below only the graduate student is listed. Projects done by BEN or RLH, are also given. These two individuals have combined careers at RM of over 84 years; combined collection numbers of over 179,900 or nearly 30 percent of the totals for the inventories.

Wyoming and Salt River Ranges, WY (1990, 1992, 1993, 1994, 1995), RLH, BEN, 3,080 mi^2, 19,267 coll.; 1,087 taxa, 34 sensitive taxa (9 "new" to area); total occurrences 130; 2 state records.

West Slope Wind River Range, WY (1990, 1991), Walter Fertig, 1,700 mi^2 , 13,724 coll.; 1,034 taxa, 27 sensitive plants (14 "new" to area); total occurrences 69; 1 state record.

Gross Ventre Wilderness and Mount Leidy Highlands, WY (roadless, mostly above 9,500 feet elevation) (1994, 1995), RLH, 1,330 mi^2, 6,591 coll.; 833 taxa, 26 sensitive taxa (19 "new" to area); total occurrences 66; 2 state records.

Targhee NF, WY, ID (1991, 1992), Stuart Markow, 3,000 mi^2, 13,400 coll.; 1,104 taxa, 21 sensitive taxa; total occurrences 34; 1 state record.

Examples of similar work on Bureau of Land Management lands in Wyoming provided the following results.

Upper Green River Basin, WY (1994, 1995), Thomas K. Cramer, 4,500 mi^2, 9,950 coll.; 1,047 taxa, 26 sensitive taxa; total occurrences 54; 1 species new to science.

Southwestern WY, adjacent UT (1994, 1995), Charmaine (Refsdal) Delmatier, 6,817 mi^2, 8,855 coll.; 1,175 taxa, 56 sensitive taxa; total occurrences 223; 10 state records!; 1 species new to science

Great Divide Basin, WY (1994, 1995), Laura A. (Welp) Fertig, 5,060 mi^2, 8,260 coll.; 877 taxa, 13 sensitive taxa; total occurrences 32.

Southern Powder River Basin/Eastern Grasslands, WY (1994, 1995), BEN, RLH, 14,000 mi^2, 12,617 coll.; 958 taxa, 46 sensitive taxa; total occurrences 108; 1 state record.

South-central Wyoming (1996, 1997), Beth A. (Ward) Burkhart, 6,000 mi^2, 9,265 coll.; 1,020 taxa, 20 sensitive taxa; total occurrences 60.

Upper North Platte River Drainage, WY (1997, 1998), Amy Roderick Taylor, 7,000 mi^2, 10,445 coll.; 1,047 taxa, 26 sensitive taxa; total occurrences 104.

Likewise, abbreviated information from some recent studies on Forest Service lands in Colorado, Washington, and Wyoming are summarized below:

Park Range/Sierra Madre, CO/WY (1988-1990), Nancy Kastning, 5,290 coll.; 825 taxa.

Flat Tops and White River Plateau, CO (1990, 1991), James P. Vanderhorst, 6,500 coll.; 884 taxa.

San Miguel and Lower Dolores River Drainages, CO, adj. UT (1993, 1994), Margarette J. Lyon, 7,163 coll.; 997 taxa.

Upper Dolores River Drainage, CO (1994, 1995), San Juan NF, Lynn Moore, 9,601 coll.; 976 taxa.

East Slope, Central Colorado (1995, 1996), Pike NF, Timothy W. Chumley, 7,368 coll.; 1,075 taxa.

Western Coville NF, WA (1995, 1996, 1997), Jean Wood, 7,600 coll.; 902 taxa.

Northern Absarokas, WY (1996, 1997), Shoshone NF, David M. Rosenthal, 10,200 coll.; 1,067 taxa.

Northern Gunnison Basin, CO (1997, 1998), Gunnison NF, Kevin Taylor, 11,460 coll.; 999 taxa.

South-central Colorado (1998, 1999), San Isabel, Rio Grande NFs, Brian A. Elliott, 20,585 coll.; 1,393 taxa.

The 19 projects completed during the 1990s in Colorado, Idaho, Utah, Washington, and Wyoming resulted in inventory of 79,391 mi^2 of mostly state and federal lands and acquisition of 180,342 numbered collections. Most importantly, 414 different taxa of conservation concern were encountered at 1,459 sites; the vast majority of sites of occurrence were not documented previously. In Wyoming alone, more than 90 taxa were removed from the sensitive plant lists as a consequence of work by RM. Additionally, 25 projects completed during the 2000s in Arizona, Colorado, Idaho, Kansas, Nebraska, New Mexico, Oregon, South Dakota, Washington, and Wyoming resulted in inventory of 89,363 mi^2 of mostly state and federal lands and collection of 227,355 numbered specimens. Thus, during the 2000s, 430 different sensitive plant taxa were encountered at 1,678 sites. As many of the taxa collected during the 1990s were removed from lists prior to 2000, this is even more remarkable. These data do not include results from 10 projects completed during the 1980s nor during 2010 and beyond of comparable magnitude.

Following is a list of graduate students that have completed or initiated floristic projects since 2000 (**staff projects included**)

Student/staff	*Yr.**	*Area*	*size (mi^2)*	*# coll.*	*# coll./ mi^2*
Kevin Taylor	2000	N Gunnison Basin, CO	2,700	11,461	2.4
Amy Taylor	2000	Upper N. Platte R., WY	7,000	10,445	1.5
Brian Elliott	2000	S-cent. CO	5,000	20,585	4.1
Barbara Packer	2000	Laramie Range, WY	3,900	9,168	2.4
Nelson	2001	SE WY	7,401	9,460	1.3
Melanie Arnett	2002	S Gunnison Basin, CO	2,400	8,584	3.6
Hartman/Nelson	2002	Routt NF, CO	2,200	8,421	3.8
Emily Holt	2002	Upper Arkansas R., CO	3,300	9,122	2.8
Heather Bradtke	2002	Umatilla NF, OR, WA	5,000	12,312	2.4
Sarah Nunn	2003	Arapaho/Roosevelt, NF CO	1,300	5,000	3.9
Luanne Lum	2004	Bighorn Basin, WY	9,740	13,508	1.4
Joy Handley	2005	Payette NF, ID	5,100	10,061	4.0
Hartman/Nelson	2005	Valles Caldera, NM	239	5,250	21.9
Peter Ebertowski	2005	Thunder Basin NG, WY	8,000	10,027	1.3
Brian Reif	2006	Santa Fe NF, NM	2,500	12,038	4.8
Erin Foley	2006	Arapaho NF, adj. BLM, CO	2,200	7,186	0.7
Grace Kostel	2006	Buffalo Gap/Oglala NG, NE, SD	1,500	10,606	7.1
Hartman/Nelson	2006	Coconino Plateau & Vic., AZ	6,000	6,700	1.1
Rob Massatti	2007	E Slope Wind River Mtns., WY	1,800	9,534	5.3
Jeanette Flaig	2007	E San Juans Mtns., CO	4,900	11,023	2.2
Rachel Newton	2008	BLM Wetlands, WY	2,500	7,502	3.0
Jill Larson	2008	Carson NF, NM	5,000	15,360	3.1
David Scott	2009	G. Teton NP and Wilderness, WY	1,000	5,180	5.2
Nelson/Hartman	2009	Pryor Mtns. and vic.		3,758	
Bernadette Kuhn	2009	Comanche/Cimarron NG, CO/KS		9,287	
Emily Elliott	2009	Beartooth/Gallatin/Custer NF		14,312	
Laura Lukas	2009	Med Bow (Snowy Range)		9,788	
Richard McNeill	2009	Lewis and Clark NF, MT		9,861	
Nelson/Hartman	2009	Pryor Mts., MT		3,758	
Hans Hallman	2010	Ashland/Sioux dist., Custer NF		9,196	
Ben Legler	2010	Vermejo Park, NM		7,626	
Joey Charboneau	2013	BLM, Valley/Phillips Cos., MT		12,820	
Michael Kirkpatrick	2013	White River NF, CO		11,450	
Josh Irwin	2014	Salmon-Challis NF, ID		11,697	
Emma Stewart	2014	Beaverhead NF, MT		9,532	
Lori Brummer	2016	Uncompahgre+, W-central CO		12,556	
Georgia Thomas	2016	Selway-Bitterroot Wilderness, ID		5,800	
Totals on projects completed			**93,743**	**356,478**	**3.9**

In a study documenting 1,197 taxonomic novelties published from 1975 through 1994 from North America north of Mexico, New Mexico was 7th in new taxa with 26 species, 3 subspecies, and 12 varieties (41 taxa total), Wyoming was 10th with 24, 1, and 7 (32 taxa total), and Colorado was 11th with 21, 4, and 4 (29 taxa total), respectively (Hartman and Nelson 1998). Regarding taxa new to science by region, the Rocky Mountains was third with 181 species, 26 subspecies, and 74 varieties (287 taxa total), California was second: 223, 118, and 118 (459 taxa total), and the Intermountain Region (Great Basin) was first: 317, 32, and 247 (596 taxa total). This is both a reflection of the amount of ongoing floristic and taxonomic work by state or region as well as the level of continued investigation warranted.

From a scientific and conservation perspective, obtaining high quality voucher specimens is of utmost importance. The biological soundness of the Endangered Species Act and the Nature Conservancy's (including the Natural Heritage Programs') databases is founded on specimens housed in more than 750 herbaria (university, college, free-standing museum, botanical garden) throughout the country.

Furthermore, carefully prepared voucher specimens are the working ingredients on which scholarly floras, taxonomic revisions, databases and plant atlases, as well as species new to science are based. Examples of these four categories, respectively, are:

1) Flora of the Great Plains (RLH, families Apocynaceae, Asclepiadaceae, Oleaceae), Flora of North America (17 volumes [352 to 911 pages each] thus far published by Oxford University Press of the projected 31 volumes) Greg Brown coauthored Bromeliaceae and genus *Oönopsis* [Asteraceae], RLH contributed to three families; Flora of Oregon, Jepson Manual of the Flora of California, and Flora of Missouri– RLH and Rich Rabeler contributed Caryophyllaceae;

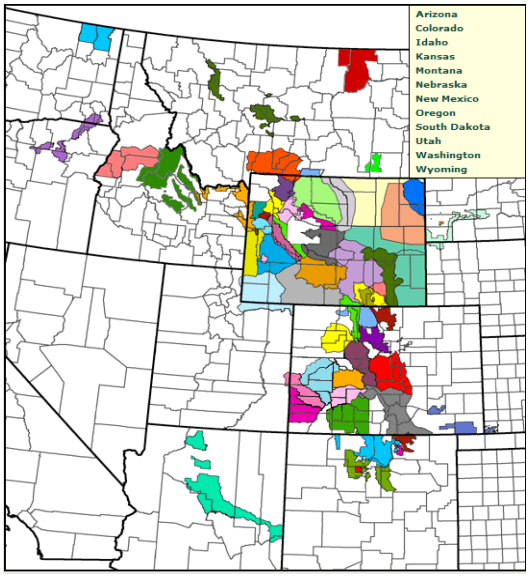
2) revisions of the genera *Oönopsis* (Brown, in prep.), *Rayjacksonia* (Lane and Hartman 1994), *Salix* of North America (Dorn, several publications);

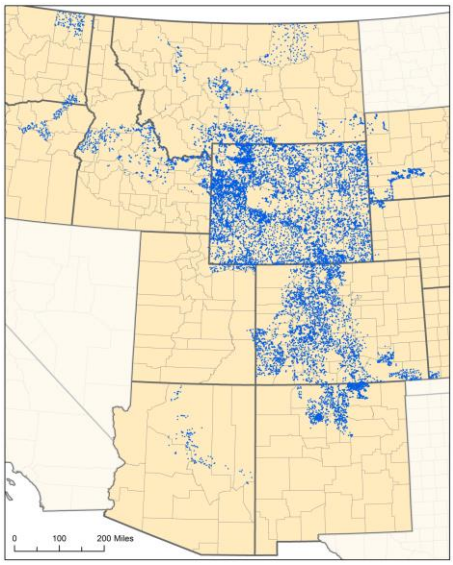
3) RM Plant Specimen Database (Hartman et. al 2009), The Atlas of Vascular Plants of Wyoming (Chumley 1998);

4) description of species and varieties new to science (RLH, 18, mostly Apiaceae, Caryophyllaceae, and Asteraceae; Dorn, 17, willows and general flora).

Without quality voucher specimens, taxonomists and conservation biologists cannot apply their expertise to the question: What is sensitive? Furthermore, they cannot evaluate the veracity of an identification, the status of a questionable taxon, or the phylogeny of a taxonomic group. This fact has been emphasized strongly at meetings of the Colorado Rare Plant Technical Committee and its counterparts in New Mexico and Wyoming.

Fortunately, although floristic, sensitive plant, and taxonomic studies may encounter botanical novelties and very often sensitive plants previously unknown to an area, this should not be of great concern. In the vast majority of cases, at least in the Rockies, such plants are found in relative abundance, although they may be restricted to fairly specific habitats or substrates (e.g., limestone, basalt, volcanic ash, sand dunes), often beyond easy reach by earlier botanists. Thus, they may only need monitoring.





Left figure – Study areas of intensive inventory by RM. Typically, 8,000 to 12,000 collections were obtained for each project. Two additional projects (not shown) on the west slope of Colorado are underway and Phillips County has been included with Valley County (red), northeastern Montana.

Right figure – Collecting sites associated with inventory from 1978 through 2010. In most cases, each dot represents 50-150+ collections.

II. Floristic Project: Cost-Share Agreement and Justification and Methodology of Inventory.

Agency Cost for a two-year floristics project: $30,000: **(Based on figures from 2011)**

$ 5,250 for UW overhead, 17.5 percent
$17,000 for graduate student, $8,500 per summer: gas for personal vehicle, per diem, other expenses
$ 4,750 for RLH and BEN to train and assist with project each summer
$ 2,000 for supplies
$ 1,000 for UW Information Technology to sustain the database

Included in the 1:1 match is the cash funding from the agency and the other needs listed below **vs.** time (collecting, sorting, and identifying specimens), supplies, and database production and associated specimen label generating by graduate student and staff at the University. This includes support by UW for the student as a teaching or research assistant ($11,700+) during each academic year. [In reality the match is 1:2 or 3, agency vs. UW, but the University will not agree to sign a cooperative agreement for more than 1:1]

Processing area: at least 10 x 15' with electricity for two plant driers and a compact freezer in a warehouse or garage (must be enclosed) with a concrete or wooden floor. We provide the driers and freezer (see below).

Housing: the graduate student will need housing for two summers (May through August); likewise for RLH or BEN for four to six weeks each summer.

Products RM provides Agency.

The goal is to conduct a general floristic inventory for the Agency with special emphasis on sensitive and invasive taxa. Representative specimens of all vascular plants (ferns and allies, conifers, and flowering plants) will be obtained at a frequency relative to their abundance throughout the area. Most projects ranged from 3,000 mi^2 to 6,000 mi^2.

All taxa in flower and fruit are vouchered at intervals of 10 miles or 3,000 vertical feet. The number of sites over each interval depends on the diversity of habitats; species collected are not duplicated over a segment. Then the collection process is repeated over the next road or trail segment, or the collector moves to a new area. The project will be initiated in May and continue through August; likewise, the following year.

An estimated 9,000 to 12,000 plant collections will be obtained over the two summers. To put these figures in prospective, most taxonomists collect but 5,000 to 20,000 specimens during a life time, in large part due to specialization in one or more plant groups. Data associated with each collection include location (distance and direction from one or more landmarks, Township, Range, Section, and GPS coordinates) and habitat (substrate, aspect, slope, elevation, plant community, abundance, etc.).

For sensitive plants, a voucher specimen will be made only if more than 20 individuals occur in a population; for federally listed plants, documentation will be by digital images. Emphasis may be placed on areas under consideration for habitat management and landscape modification. Knowing where sensitive plants occur is critical to their protection and to managing biodiversity.

A plant specimen database for use with GIS will be provided. This will contain the species name, location, habitat information, elevation, date of collection, collector and collection number, etc., for each specimen. Additional fields will contain accuracy of the geographic coordinates (g = determined by GPS, 1 = within one legal section, 2 = within two sections, etc.), phenology (flowering, fruiting, vegetative), and land ownership (FS, BLM, NPS, or state; private only if written permission is received). It will be in a format compatible with ArcGIS or other ESRI products and can be used to display the distribution of collections for any taxon documented (see dynamic atlas at the RM website).

One or two sets of representative plant specimens will be provided for use by the Agency (reference collection for plant identification by employees). A set consists of one specimen of each taxon for which a duplicate is available, unmounted, in newspaper with labels (800 to 1,000 specimens). If requested, this set of specimens will be mounted at RM (cost per specimen is ca. $1.40). Additional unmounted duplicates will be made available to state and regional herbaria.
The original set of specimens to be housed at RM/USFS will be curated in perpetuity. They are invaluable vouchers available for study by a diversity of agency and academic scientists.

Reports: An interim and a final report (digital) on the project will be provided by 30 April following each field season. A copy of the thesis (upon completion, usually after the end of the agreement period) will be made available in paper or digital format.

Delivery of specimens and database. We request that the completion date for the project be 30 April of the third year (e.g., summer/academic year = year 1; likewise = year 2 and 3 [through 30 April]) for delivery of products and specimens. Invariably it takes a minimum of 9 months following each field season to sort and identify the specimens and build the database. The work load on the RM staff is compounded by the fact that during a typical year, we conduct four to six inventories of federal lands simultaneously and have five to eight graduate students at various stages of completing their projects. We are always completely occupied during summers with field work, thus the production of labels and sorting the sets of plants for distribution must await the fall/spring following the third summer (12 months following the final report delivered 30 April year 2). The agency also will receive a copy of the M.S. thesis within a year following the end of the agreement (frequently the student has a job elsewhere prior to graduation and time is limited).

Relevant data will be shared with Natural Heritage Program. Occurrence records on sensitive plants of a state have been and continues to be obtained, in part, from resident herbaria. Such information forms the core of the Natural Heritage database. These data have been supplemented by extensive site information, additional surveys, etc. The status of a sensitive plant is determined by botanists belonging to the program and federal agencies (primarily NPS, FS, BLM, and FWS). Likewise noxious weeds are listed by the USDA and state agricultural committees.

Methodology

Discovery of new sites for a sensitive plant involves obtaining adequate information concerning its habitat from literature, herbaria, and Heritage Programs. Often known sites are visited to evaluate habitat characteristics. The use of soil and geology maps is often crucial. This is especially true for plants that inhabit specific substrates. Other sensitive plants may be restricted to certain plant community types. Because suitable habitats **are not randomly distributed across the landscape,** the use of a grid and a random numbers table is not especially productive. The most fruitful approach is to develop an "image" of potential habitats. This is a proven and productive approach long-used by systematists when searching for members of a genus under study (often called the **meander method)**. When in a vehicle or on foot, likely habitats are explored. While moving between potential locations, other sites encountered are also searched for sensitive plants that may be less specific in their habitat requirements. In the process, all vascular plants in flower or fruit will be documented at regular intervals in the diversity of habitats represented.

The plant samples are placed in labeled plastic bags stored on ice for processing the following day, and field notes are recorded. The freezer provides ice in 1-gallon jugs (5-15). The primary collecting tool is a 24 oz. bricklayer's hammer with its chisel end. Following each trip, the route(s) and date are marked on a USGS quad sheet and BLM or FS map. The plant driers are 6' long, 20" wide, and 24" tall constructed from 1/4" plywood. Near the top of each dryer, a horizontal frame covered with sturdy wire mesh separates the light bulbs, 15" below, from the plant presses. Heat is from five, 150 watt incandescent light bulbs. Two-inch holes along the bottom of the drier provide for the circulation of warmed air through the plant presses. For plant presses, end boards are cut from 1/4" plywood; straps are made from 1" webbing. Cardboards separate samples, each within a folded sheet of numbered newsprint. Drying time is 36 to 48 hours. Typically we collect one day, 12 to 16+ hours with driving, and the specimens are pressed the next day. Once dried, they are bundled for transport to UW.

At the start of each academic year (September), the plant specimens are sorted by family and genus. Within a genus, they are sorted by species or by "morphotype." Subsequently, they are identified. For most species there are several to many collections at various stages of flowering and fruiting, thus efficiency and accuracy of determination is markedly increased. The material is compared with authenticated specimens in the herbarium. The collection information is databased by interns and proofed by the collector and BEN.

This research is part of the Program in Floristics, a master's degree program in Botany at the University of Wyoming; Hartman is the major professor. BEN and RLH spend four to six weeks each assisting on the project each summer. Thus the student will continue to benefit from two individuals with extensive experience. Our time in the field and in assisting the graduate student during the academic year is included in the cost-share match for the cooperative agreement. The time spent in doing fieldwork by the student as well as staff member averages 60+ hours per week each. The student spends time processing and identifying plant specimens (20-30 hours per week) during the academic year.

This cost is quite reasonable when placed in perspective. Federal agencies not only have the responsibility to uphold the Endangered Species Act but also to inventory and manage wisely the biological diversity. Such intensive, broad-scale inventories provide substantial insight concerning questions such as: What plant species warrant protection? How diverse botanically is the study area? Which areas have the greatest diversity? What factors contribute to "hot spots" of high diversity? And now, what is the effect of global change on our lands. In this regard we would provide a baseline upon which future studies may be compared.

Grad students are required to provide their own vehicle (often supplemented by an agency vehicle); BEN and RLH have always used their personal vehicles.

Management implications

Federal agencies are mandated to inventory and manage biodiversity wisely. Regarding vascular plants, this survey constitutes a major step for an agency. The primary goal is to provide the agency with data on the distribution of sensitive plant species. It will lead to a much more complete and vouchered inventory of these taxa, including ones that previously have not been documented. If taxa new to science are encountered, they will be described in the scientific literature. Before critical taxa can be managed, their existence must be known. Emphasis will be placed on areas of habitat management and landscape modification. Knowing where sensitive plants occur is critical to their protection and to managing biodiversity (plants in this case). A second accomplishment will be documenting occurrences of noxious weeds so that attempts to control or eradicate them will be more successful. Finally, the overall documentation of the vascular plant flora will be accomplished. A representative set of 800 to 1,000+ plant specimens will serve as a resource for plant identification by agency personnel. The database with 9,000 to 12,000+ records will include spatial and ecological distributions and flowering/fruiting periods for each of the 1000 to 1,200 taxa. These can be viewed as a series of species layers to serve as a management tool when interfaced with ArcGIS or other GIS software. They will also be served from the RM website.

References

The following individuals are very familiar with our botanical inventories and sensitive plant surveys.
Bob Mountain, Medicine Bow-Routt National Forest, Laramie, Wyoming
Kim Reid, Custer National Forest, Billings, Montana
Steve Shelley, FS Region 1 botanist
Mike Hays, Clearwater and Nez Perce National Forest, Kooskia, Idaho
Carol Dawson, BLM State botanist, Colorado
Wendy Velman, BLM State botanist, Montana
Bonnie Heidel, Wyoming Natural Heritage Program
Emma Stewart Freeland, BLM State botanist, Wyoming

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