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Searching for Biological Specimens from Midwestern Parks: Pitfalls and Solutions

Introduction

This paper describes the results of searches of herbarium and museum collections and databases for records of vertebrate and vascular plant specimens that had been collected in 15 midwestern National Park System units. The records of these specimens were previously unknown to the National Park Service (NPS). In the course of our searches, numerous obstacles were encountered that prevented us from fully completing our task. These ranged from difficulties with the way databases are structured, to poor record-keeping, to incomplete or incorrect information on the actual location of specimens within collections. Despite these problems, we are convinced that the information to be gained from such searches is invaluable, and we believe that our experience, and the recommendations we offer, may well prove instructive to others undertaking this kind of work.

NPS is responsible for administering lands that contain natural resources of value to the USA. In the midwestern part of the nation, some of the lands are particularly important for managing and preserving natural prairies and woodlands of the Mississippi River Valley and the surrounding region. Parks in this "Heartland Network" are shown in Table 1. These 15 parks range from just under 200 to almost 95,000 acres in area, and occupy a total area of 234,191 acres.

Plant inventories for some of the parks are not complete (Bennett 1996). The status of animal inventories is summarized in the NPS Midwest Region status of inventories report. Inventories are typically based on anecdotal records of species (sight records), although a few may have voucher specimens as their basis (e.g., Hopewell Culture; Bennett and Course 1996).

Recently, NPS has become interested in determining if there are voucher specimens for plants and animals collected in the parks, either before the park was authorized or afterwards. Park records of specimens collected using the NPS permit system are incomplete and unreliable, particularly in earlier years.

Repositories of plant and animal specimens (herbaria and museums,

Table 1. The 15 National Park System units in the Heartland Network.

Park	Year authorized	Acreage
Arkansas Post National Memorial (Arkansas)	1960	389
Buffalo National River (Arkansas)	1972	94,309
Cuyahoga Valley National Park (Ohio)	1974	32,525
Effigy Mounds National Monument (Iowa)	1949	1,481
George Washington Carver National Monument (Missouri)	1943	210
Lincoln Boyhood National Memorial (Indiana)	1962	200
Herbert Hoover National Historic Site (Iowa)	1965	187
Homestead National Monument of America (Nebraska)	1936	195
Hopewell Culture National Historical Park (Ohio)	1923	1,130
Hot Springs National Park (Arkansas)	1832	5,549
Pipestone National Monument (Minnesota)	1937	282
Pea Ridge National Military Park (Arkansas)	1956	4,300
Tallgrass Prairie National Preserve (Kansas)	1996	10,894
Ozark National Scenic Riverways (Missouri)	1964	80,790
Wilson's Creek National Battlefield (Missouri)	1960	1,750

respectively) exist throughout the USA, and are typically found at colleges and universities, while a few exist as separate institutions. Some have been in existence longer than the parks, and collectors typically deposit specimens at such repositories to guarantee a long life for the collection. It is highly likely, therefore, that there exist collections of specimens from these national parks that are unknown to the NPS. The agency would benefit from the knowledge of these specimens in at least eight ways. Such knowledge would:

- Make the species inventories specimen-based;
- Make inventories more complete;
- Aid in understanding vegetation changes through time;
- Help determine the effects of management;
- Determine if particular species are no longer found in the parks;
- Aid in ecological restoration projects;
- Document previously unknown collecting activity; and
- Aid in understanding the history of the area.

Objectives

This project was initiated to search selected herbarium and museum collections and databases for records of vertebrate and vascular plant specimens collected in the 15 Heartland parks. The objectives

were to:

- Improve our knowledge of park biota by tracing unknown collections and locating specimens;
- Gather collection-level data for newer collections;
- Gather specimen-level data for older collections; and
- Assemble such data in a format usable to NPS for inclusion in the NPSpecies database.

Methods

Collections on the Worldwide Web. The study began by consulting the Natural History Collections Database, compiled for the NPS Midwest Regional Office by Susan Gucciardo (2000). This database provides statistics on flora and fauna repositories in the USA, including Universal Resource Locator addresses for those repositories having Web sites. Some of these Web sites could access the database of the repositories' collections, while others had no links at all. Each one was viewed, and those which were searchable were searched by park name/locality, or by county or state name, if possible.

Next, the database was filtered to include only those repositories which had placed information on their collections into a database, although they had Web site access to the information. This list was then reviewed for relevance and usefulness to the project. Approximately ten institutions were selected and all were contacted by phone or e-mail, with varying degrees of success. The names of all contacts and the status of the computerization of the collections were recorded in a Microsoft Excel spreadsheet / database.

Collection site visits . It was discovered that the Zoological Department of the Field Museum in Chicago had a complete database of their specimens, but the staff did not have time to query it for this study. Therefore, a trip was made to the museum in order to perform queries of the database on-site. Although there was a locality field in the database, the staff member we consulted was not sure if it had ever been used when entering data. Queries were thus performed for each county in which the 15 Heartland parks are located, and the results printed out.

Because the Field Museum also has extensive botanical collections, the Herbarium staff was consulted to determine a method to search the non-databased specimens. First, the collector's log book was studied to determine if links could be found between collectors and the parks, but such information was not recorded there. Second, the folders containing a common grassland species, *Bouteloua curtipendula*, were searched manually for those counties in which the Heartland parks are located. Three were found, but the labels did not give specific locality information. This species was picked at random and no others were tried. No published list of specimens from any of the 15 parks was ever found that referred to them being deposited in the Field Museum.

A site visit to the Missouri Botanical Garden (MBG) in St. Louis was made specifically to look for specimens from Hot Springs National Park collected by E. J. Palmer in the 1920s and 1930s. The original reference to these specimens (Palmer 1926) was discovered in the park archives by the park historian. One day was spent by at the MBG's Monsanto Center searching for woody plant specimens of half the species in the 1926 Palmer report. The curator of the herbarium printed out the records for all the Palmer collections from Arkansas that were in the herbarium database. These were searchable on the Web, but a search would have taken too long to do because the Web site does not allow multiplex searching by several fields.

Floristic references . It was thought that references providing historical narratives on collecting in the parks would be useful, because non-computerized institutions could search for species names that the collectors had recorded, and collectors' names could be entered into databases without locality queries being available. Floras of all states in the study were consulted for this purpose. The bibliography information was then recorded along with a code to explain how the text relates to this study.

Natural Heritage Inventories . The Natural Heritage Inventories of the eight states in the study were considered to be possibly valuable sources. Since the inventories have information on which species are rare in the state, it was thought that, consequently, they might also have information on historical collections of those species. The eight Natural Heritage Programs were contacted by letter, telephone, or fax, and each was requested to search its database for information relating to the parks of the state. The results from those who responded were also recorded in the Excel spreadsheet.

Index Herbariorum. The latest *Index Herbariorum* (Holmgren 1990) was consulted, and all herbaria in the USA were evaluated based on the information on collections provided there. An attempt was made to contact all herbaria that appeared to be useful to the study. All attempts were recorded in the Excel database. In cases where contact attempts were successful, the status of the computerization of the collections in those herbaria was recorded. For herbaria with adequate databases, searches of collections were performed by the herbarium staff.

Park managers . It was necessary to contact resource managers of ten of the fifteen parks in order to refine the reference list provided in the proposal for this project. It was not clear whether the references were already known to the park, or were to be considered leads for further searching. Some managers had more to add to the list of references, others said it was complete, and still others said that many of the collections of the listed studies were not known. The suggestions given by the re-

source managers were then undertaken.

NPS Natural Resource Bibliography. The NPS Natural Resource Bibliography on the Web (NPS 2000) was searched for each of the 15 parks and relevant references, if any, were recorded.

Automated National Catalog System (ANCS) records. A file containing records of specimens from the ANCS listings for 10 of the 15 parks was reviewed for specimens that were not on-site at the parks. All the repositories listed for off-site specimens were contacted for information about the specimens and others that may be at the repositories.

Latitude and longitude searches. No searches using park latitudes and longitudes were performed. Only one herbarium Web site was searchable via latitude and longitude, but it was not necessary to use those coordinates because it was also searchable by park name. A few other repositories allowed searches by park latitude and longitude, but no results were found.

Results

In the time allotted to this project, 329 sources of specimen information were evaluated for the 15 parks (Table 2). In the final report of the project as submitted to the NPS Midwest Regional Office, an appendix was included containing a complete listing of the 329 sources with information on each, extracted from the Excel file. The appendix (which had to be omitted from the present paper because of space considerations) also contains hot links to other files, all of which are provided with the final report in the form of computer files at a file transfer protocol (FTP) site: http://www.ies.wisc.edu/pub/jpbennet/NPS. Access to these files does not require a password. Instructions for using the files are provided at the FTP site. The appendix does not contain fields for specific collector names or collection dates because the sources do not consistently have this data. For example, collector names are not available for the Tulane University or University of Kansas collections, and the dates are not available for New York Botanical Garden collections. The information displayed in each hotlink is the total amount of data recovered from the source, and any missing information is simply not available.

The individual park for which we found the greatest number of sources was Hot Springs, with 30 sources (9% of the total). Homestead had the least, with 8 sources (2% of the total). Individual parks averaged about 18 sources.

The sources fell into two groups: computerized data sources and literature sources. The characteristics of the source, and the degree of usefulness of each, were coded and are shown in Table 3. These codes are used in the appendix for brevity. Almost a fourth of the sources were computerized databases that could be searched on-site, but not via a Web site. Almost a fifth were collections that were not computerized in

Table 2. Number of sources of specimen data for the 15 parks. The category "All 15 parks" includes sources of data that could be searched for all the parks in the study, not just a single park.

Park; number of data sources			
Arkansas Post	17	Hot Springs	30
Buffalo	24	Lincoln Boyhood	16
Cuyhoga Valley	24	Ozark	14
Effigy Mounds	18	Pea Ridge	19
George Washington Carver	14	Pipestone	17
Herbert Hoover	18	Tallgrass Prairie	17
Hopewell Culture	21	Wilson's Creek	12
Homestead	8	*All 15 parks*	*60*
			Grand total = 329

Table 3. Number of sources by characteristic code for 329 specimen data sources.

Code	**Number of sources**	**Code explanation**
0	61	0 = Collections are not computerized in any way; no database at all.
	21	
2	76	1 = Collections are currently being entered into a database but are not yet searchable, even on site.
3	17	
4	33	2 = Collections are databased and can be searched on site, but not via a Web site.
5	2	
A	31	3 = Collections are searchable through the Web but not through search fields that are useful, or specimens that are useful have not been entered into the database.
B	6	
B,C	1	
C	18	4 = Collections are fully searchable through remote access on Web site.
C,D	2	
D	6	5 = Web site only describes collections but does not allow searches.
E	2	
F	2	A = Text contains no search leads.
G	3	B = Text contains some vegetation distribution by county.
H	2	C = Text contains some history of past collectors.
I	1	D = Text listed where a collection/voucher specimens is/are located.
n/a	2	
nc	43	E = Text mentions that live specimens were released, or that data was observational, i.e., no collections were made.
		F = Text contains flora/fauna distributions by some area other than county but none of particular relevance to this study.
		G = Text implies a collection was made but does not provide further information.
		H = Text lists species present or provides an inventory.
		I = Text not seen, but collections were found serendipitously at MBG and University of Missouri.
		n/a = Not applicable.
		nc = No contact made.

any way at all. Ten percent were fully searchable on a Web site. Thirteen percent of the sources were not contacted. Six percent of the collections were being entered into a database but were not yet searchable. Ten percent of the literature sources provided no leads at all as to collections, while 5% provided some history of collecting. Five percent of the searchable collections did not have useful search fields or specimens entered that were relevant to this study.

We were able to retrieve record information from 56 sources (17%) (Table 4), with Hot Springs having the greatest number. All parks had some record information, although Lincoln Boyhood had the smallest, with only one source.

The 56 sources contained a total of 3,292 specimens representing 991 species across all 15 parks. It is not known if there are duplicates in these tallies, so the actual numbers may be lower. Time did not allow us to break down the species and specimens by park. However, the breakdown by biotic group is shown in Table 5. This table is a bit misleading because the herpetofauna and mammal sources are mostly all one source, the University of Michigan collections, and are repeated for many parks. The plants group are actually the largest category of specimens and collections (17%), followed by birds at 12%.

A tabulation of results by source and park is shown in Table 6. Fifteen sources contained specimens or specimen data from all the parks in the study.

The 56 sources are hotlinked in the final report's appendix. Some of these sources are actual Excel spreadsheets in native format from the source and have not been edited. Many contain county-level information only, and each park will have to determine individually if the records refer to specimens from within park boundaries. Other hotlinks are for Microsoft Word text files or images of texts. Some of the hotlinks are only for the first page of a set of records because including the entire original document would have been prohibitively long. All originals will be sent to each park and the NPS Prairie Cluster long-term ecological monitoring office for their files.

As a result of contacts found in *Index Herbariorum*, some curators were able to provide helpful information. For example, Iowa State University provided bibliographic information on many studies performed in the Iowa counties of Allamakee and Cedar, in which Effigy Mounds National Monument and Herbert Hoover National Historic Site, respectively, are located. These studies often mentioned the location of voucher specimens, although no subsequent action could be taken because the repositories mentioned were not computerized, and it was too late in the study for travel to those locations. Also, the herbaria are too understaffed to search for hundreds of specimens by hand.

Table 4. Number of sources from which records were retrieved for the 15 parks. The source category "All 15 parks" (see Table 2 caption) contained no source records because once records were found for a particular park, that information was moved to the park category to which it belonged.

Park; number of data sources from which records retrieved			
Arkansas Post	2	Hot Springs	9
Buffalo	5	Lincoln Boyhood	1
Cuyhoga Valley	5	Ozark	5
Effigy Mounds	2	Pea Ridge	4
George Washington Carver	5	Pipestone	5
Herbert Hoover	2	Tallgrass Prairie	4
Hopewell Culture	2	Wilson's Creek	2
Homestead	3	*All 15 parks*	*0*
		Grand total = 56 (17% of 329 total sources)	

Table 5. Number of record sources by biotic group.

Biotic group; number of record sources			
All	1	Herpetofauna	13
Birds	7	Mammals	19
Bryophytes	5	Plants	10
Fish	1	**Grand total**	**56**

A large amount of specimen data was found for two parks: Pipestone and Hot Springs. For Pipestone, we were able to locate label data for almost 500 specimens at the University of Minnesota Herbarium. These specimens contained "Pipestone National Monument" in the management area field, and were fully searchable at the Web site. However, twenty-five records were viewable on a screen, and it was not possible to download the results of the search from the Web site. We contacted the database manager with a request for the full query results, and these were sent by e-mail at no charge. The Pipestone records represent the best retrieval of all the parks in the study, and are the model which other collection institutions should follow. The complete set of Pipestone records are in an Excel spreadsheet as part of the final report to NPS.

It appears that there has been a lot of collecting activity at Hot Springs for some time. The park provided a list of collectors dating back to 1804, and we were able to locate specimens gathered by one of the collectors, E. J. Palmer. We also discovered collections by another botanist, Delzie Demaree, of whom park officials had no knowledge. There is also evidence of collections by H. R. Gregg at the National Herbarium in Washington, but we were unable to verify their existence.

The earliest collections from Hot Springs were those of Palmer in the early 1920s. Palmer published findings on specimens of the woody spe-

Table 6. Specimen collections from the 15 parks by source and biotic group.

Source	Biotic Group	Parks	Completeness
Cleveland Museum	Plants	Cuyahoga Valley	Complete
Field Museum	Birds	Arkansas Post, Buffalo, Pea Ridge, Pipestone, Ozark, Homestead, Cuyahoga Valley	Complete
Field Museum	Mammals	Hot Springs, Herbert Hoover	Complete
Kansas State University	Plants	Tallgrass Prairie	Complete
Minnesota Natural Heritage Program	Many	Pipestone	Complete
Missouri Botanical Garden	Plants	Hot Springs	Incomplete
New York Botanical Garden	Bryophytes	Buffalo, Hot Springs, Pipestone, George Washington Carver, Ozark	Complete
Smithsonian	Plants	Hot Springs	Incomplete
Truman State University	Plants	George Washington Carver, Ozark	Complete
Tulane University Museum	Fish	Buffalo	Complete
University of Arkansas at Fayetteville	Mammals	Hot Springs	Complete
University of Kansas	Mammals	Buffalo, Pea Ridge, Effigy Mounds, Herbert Hoover, Tallgrass Prairie, Pipestone, George Washington Carver, Ozark, Wilson's Creek, Cuyahoga Valley, Hopewell Culture	Complete
University of Michigan Museum	Herpetofauna	Arkansas Post, Buffalo, Hot Springs, Pea Ridge, Lincoln Boyhood, Effigy Mounds, Tallgrass Prairie, George Washington Carver, Ozark, Wilson's Creek, Homestead, Cuyahoga Valley, Hopewell Culture	Complete
University of Michigan Museum	Mammals	Pea Ridge, Tallgrass Prairie, George Washington Carver, Homestead, Cuyahoga Valley	Complete
University of Minnesota Herbarium	Plants	Pipestone	Complete
University of Missouri	Plants	Hot Springs	Incomplete

cies he collected (Palmer 1926), but not on those of the herbaceous species. He stated that the woody specimens were deposited at the Arnold Arboretum, the MBG, and the University of Arkansas. A visit to the MBG located 115 records in their database of Palmer specimens from Garland County, many with the phrase "hot springs" in the locality field. However, of these 115 records, only 11 of the specimens were actually at MBG, because the remainder are located at the University of Mis-

souri Herbarium in Columbia. The MBG database includes the University of Missouri records, so both are retrieved. The MBG database only contains about one-quarter of all the specimens at MBG because it is not yet complete. A physical search of part of the MBG herbarium for Palmer specimens using the woody species mentioned in Palmer 1926 located 20 out of 35 taxa.

A search by the curator at University of Missouri located 97 Palmer specimens, even though MBG listed 111. Some of the supposed University of Missouri specimens in the MBG database were actually physically at MBG, which could explain the discrepancy. Another search at the university also located some of Palmer's Hot Springs specimens from the 1930s. A search of the National Herbarium's type database, which is on the Worldwide Web, located two Palmer isotype specimens from Hot Springs. These are very important specimens for the park. Finally, findings on the herbaceous specimens that Palmer 1926 refers to were never, to our knowledge, published. The only way to discover these specimens is by manual searching of the herbarium, but without a species list it may not be possible. Only a few of them can be retrieved using the printouts from each herbarium.

Another collector at Hot Springs was H. R. Gregg. Park officials provided a 1935 list of 451 specimens from the park that are supposedly deposited at the National Herbarium, but this can only be verified by a visit there.

Finally, a specimen collected by Demaree in 1942, with "Hot Springs National Park" actually written on the label, was located by chance at MBG (Figure 1). Curators at MBG and University of Missouri were able to retrieve records for Demaree collections at both herbaria. The park had no record of Demaree collections. Those Demaree specimens which are in the two databases can be incorporated into the park's database, but others will have to be searched for manually.

It should also be pointed out that MBG may not contain all the Palmer and Demaree specimens they are supposed to have because some of them may have been deaccessioned by Robert E. Woodson during his tenure as herbarium director in the period 1948-1963 (Solomon 1998). Some specimens therefore could have been transferred to any of 68 other botanical institutions during this period, and it may not be possible to locate them.

Discussion

In three months of searching for specimen records we were able to locate 329 sources of data, and found specimen records in 56 (or 17%) of them. This is not a very high return rate. A more acceptable rate of return would be closer to 50%. This low rate of return is due to a number of factors, including technological limitations at specimen repositories, poor communication by repository

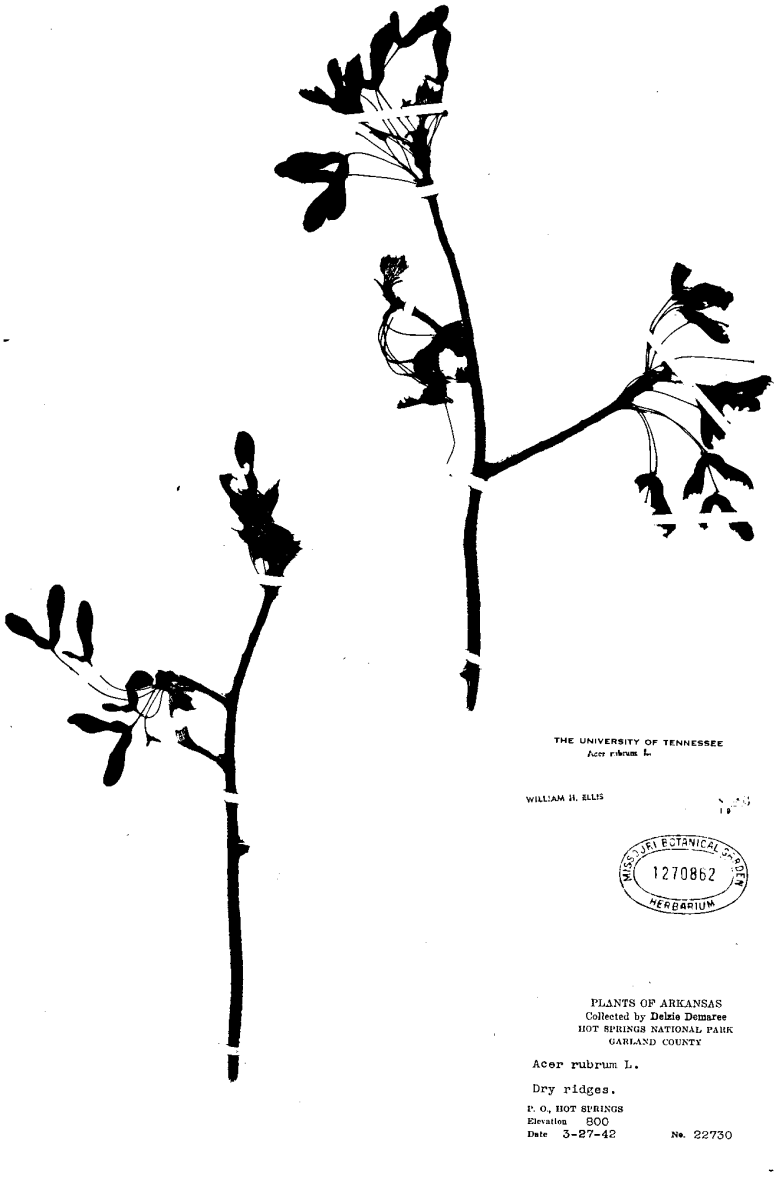

Figure 1. Red maple specimen collected by Delzie Demaree, 27 March 1942. Note that it is specifically labelled as having been collected in Hot Springs National Park. Missouri Botanical Garden Herbarium specimen #1270862.

officials, incomplete record histories, and the lack of time to concentrate on a single park because the project scope included 15 parks.

We found more specimen data for plants than for animals. This may be due to the investigators' greater familiarity with herbaria, the fact that there are more herbaria in existence than museums, that more herbaria are computerized, or that there are more plant specimens in existence.

Although we found only one source of data for Lincoln Boyhood, it was encouraging that we found specimen data for every park in the study. This is an indication that national parks are attractive to collectors and that there is a good chance that data do exist for any park under study. More investigation may turn up even more sources for these parks.

The quality of the data is highly variable, ranging from detailed label information that includes the park name in a field, to lists of species with no label information at all. Label information fields are inconsistent among repositories, as there is no standardization between them. Even though we were able to collect data for almost 3,300 specimens, there is little we could do with it because of the lack of standardization. Each collection will have to be hand-entered into NPS databases because there is no way to automate the process.

In addition, historical collections, when found, often have very incomplete data associated with them. Label information is very sparse, and location data is often non-existent. It is very rare to find specimens with park names or township, range and section identifiers. One specimen may require a day or more of research just to determine its geographic location.

We were unable to tally the number of species and specimens by each park from this data. This is because some of the collections sources are for more than one park. We did not have time to break out the specimens by park in these sources.

Some of the sources contain data that is specific to the county level only, not to the park level. This means some of the specimen data may not be useful at all because the specimens may not be from parks. These records will have to be checked by park officials before they can be useful.

Recommendations

Our first recommendation is to not conduct similar searches in the future for more than one park. Our survey of 15 parks led to constant confusion about which source was for which park. We were unable to concentrate our efforts because we were trying to find records for so many parks. A higher rate of return would be more acceptable, and could be achieved, if the focus were on one park instead of many.

Our second recommendation is to have searches performed by subject-matter experts. Our expertise is in botany, and we were able to locate botanical specimens easily and accurately. Our success with animal specimens was not good because our familiarity with the subject was not

expert.

Third, future searches should include more time for manual searches based on species lists from published sources. Many collections are still not yet computerized or Web-enabled, and on-site searches will be more productive. Of the 15 parks we studied, the one that would benefit the most from a more detailed study of off-site specimen collections is Hot Springs. This study uncovered what appear to be very site-specific collections that are sufficiently documented to merit further study. Some of the specimens are known by species and repository.

Twenty-three specific recommendations by park and specimen repository are listed in the spreadsheet version of the final report's appendix. These recommendations refer to both complete and incomplete searches, and are too detailed to summarize in a narrative. Future work could include follow-up investigations of the incomplete searches, either by resuming the contacts to determine if more computerization has been performed, or carrying out the recommendations listed in the final report's appendix.

For Hot Springs, the Palmer and other collections at MBG, University of Missouri, and the Smithsonian can be completed by following these steps:

1. Complete the inventory of woody specimens by manually searching for them in the herbaria using the published list.
2. Locate the herbaceous specimens using computer lists from the herbaria. Specimens not yet computerized cannot be located.
3. Locate specimens collected by Demaree at MBG and University of Missouri using computer lists from the herbaria. Determine if there are any at the Smithsonian.
4. Locate specimens collected by Gregg at the Smithsonian using the list from the park.

Specimens not yet computerized in any of these herbaria that are not on published lists cannot be located except by chance. Specimens that have been deaccessioned by any of the herbaria probably cannot be located at all. The four tasks outlined above, however, would add considerably to our knowledge of off-site Hot Springs collections.

Conclusions

This project began with a worthy goal: discover specimens of plants and animals from national parks that the parks have no knowledge of. The goal, however, contains a paradox: How can one find specimens from parks if the specimens are unknown? This paradox made the project difficult from the start, and frustrated our efforts throughout. The project was unable to focus on tangible items and products. There is no easy solution to this problem because, by nature, the project is searching for positive evidence based on negative evidence.

In spite of this inherent problem, we were able to uncover evidence of almost 1,000 taxa and almost 3,300

specimens that could be from the 15 parks. Records of plants outnumbered animal records. Almost a fourth of the sources were computerized databases that could be searched on-site, but not via a Web site. Almost a fifth were collections that were not computerized in any way at all. Ten percent were fully searchable on a Web site. Records of specimens were found for all 15 parks. Data quality was highly variable, and we were unable to standardize the data for automatic incorporation into NPS databases.

Further work is needed to focus the work on sets of records with a high probability of success for NPS. Just searching for records is only half the work. The other half is performing quality assurance checks on the data, standardizing the data, and finally, entering the data into NPS databases. This project was unable to carry out these latter steps due to time, funding, and logistical constraints.

On the plus side, however, NPS is to be lauded for initiating this project and getting started on this important task. The biological resources of the national parks are under increasing pressure from humanity. Changes in biota are often subtle and go unnoticed until it is too late. Retrospective studies such as this are a start to uncovering the biological history of an area, and hopefully will lead to greater preservation and restoration of park biodiversity. The NPS should not abandon this work because one project such as this yielded a low return.

Ed. note: This article is based on a final report (dated 23 February 2001) to the Heartland Network Inventory and Monitoring Program, National Park Service Midwest Regional Office, Omaha, Nebraska (Interagency Agreement IA6370A0002).

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