

Review of the Vascular Plant Species Checklist of Bighorn Canyon National Recreation Area

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March 2006

Introduction

The documented flora of Bighorn Canyon National Recreation Area (BICA) was reported at 739 taxa (Heidel and Fertig 2001), based on surveys and the results of prior BICA studies (Heidel and Fertig 2001, Lichvar et al. 1985; Knight et al. 1987). BICA flora results were entered in the NPSpecies database by the National Park Service to include all taxa ever reported as part of the flora, with cross-reference to national taxonomic nomenclature. The resulting NPSpecies database had 1229 entries, representing a combination of documented species, synonyms of documented species, multiple taxonomic levels of documented species, unconfirmed species, and falsely-reported species.

The objectives of this project were to ensure that the BICA entries in the National Park Service database (NPSpecies) represent the documented flora, and represent it at the finest taxonomic level consistent with Dorn (2001). In the process, cross-references were made between list entries so that any of the information sources on the BICA flora could be traced and linked to NPSpecies. Information on native and non-native species was completed, noting those species that are noxious weeds or state species of concern on the most current state noxious weed lists and the state species of concern lists of Montana and Wyoming. Information on species' distribution within BICA was reinstated, and abundance information modified from Lichvar et al. (1985) was incorporated also considering data in the vegetation study (Knight et al. 1987), collection labels, and field notes. The BICA study area spans over 60 miles in three counties that closely correspond with contrasts in topographic settings, so county-of-distribution information was also recorded.

What would seem like a simple matter of cross-referencing the existing BICA flora is complicated by the fact that there are three different Wyoming flora editions with differences in taxonomic treatments (Dorn 1977, 1992, and 2001) that are referenced in the BICA studies, the BICA flora contains a relatively high number of cases in which more than one variety of a taxon are present, and the BICA study area straddles the state line where the Montana flora is represented by Dorn (1984) which does not address taxa below the species level. Even though verification of specimens and most reconciliation of nomenclature differences were completed by Heidel and Fertig (2001), it did not incorporate the taxonomic treatments that had been published in Dorn (2001). As further complication, the BICA flora was cross-referenced to national nomenclature using information of the Biota of North America Project (BONAP; Kartesz and Meacham 1999) while the NPSpecies conventions were still in early stages of development. All NPSpecies entries for the BICA flora were reviewed in this project in order to

produce a systematic floristic checklist and synonymy cross-reference so that existing floristic information could be put to best use by the National Park Service, researchers, and the public.

Study Area

The Bighorn Canyon National Recreation Area (BICA) is described by previous researchers. For purposes of this floristic documentation, it is helpful to cross-reference results by the three political boundaries that also correspond well with the three separate biomes and hydrological segments of BICA. They are referred in this report simply by counties, but they represent the following:

Table 1. Bighorn Canyon NRA county segments

Setting \ County	Big Horn County, WY	Carbon County, MT	Big Horn County, MT and Crow Reservation
Biome	Desert and canyon	Mountain and canyon	Plains and canyon
Hydrology	Downstream	Mid-reach	Mid-reach and upstream

This is a simplistic representation, and encapsulates many other large-scale features as well as different patterns of human history of use. For example, Big Horn County, Wyoming also encompasses the large reservoir flats of Big Horn Lake and a limited portion of mountain foothills but very little of the canyon topography. Carbon County, Montana is the highest elevation portion of BICA and encompasses mainly mountain flanks and ridge systems, barely entering montane elevations. Big Horn County, Montana encompasses the fringes of the mountain foothills as well as plains. On a smaller scale, the BICA segments within Montana counties contain spring and seep aquatic features, as well as spring-fed riparian corridors, unlike the Wyoming segment of BICA with its distinct reservoir expanses.

Methods

The office and herbarium work on the BICA flora represented by this project followed from the BICA fieldwork and herbarium investigations reported earlier (Heidel and Fertig 2001). All database work was conducted in excel spreadsheets representing the BICA flora, as exported from the NPSpecies database. The initial work was conducted in a single excel spreadsheet following current data dictionary guidelines (Wotawa 2003). All original NPS database columns are in black. All added WYNDD columns are in blue. A total of 10 columns were added to the spreadsheet, and additions or edits were made to a total of 12 pre-existing columns (summarized in the methods section).

The BICA preferred technical name was determined for each vascular plant taxon (i.e., the Latin name; also referred to as the scientific name) in four steps. Each taxa was reviewed to determine whether the name is in Dorn (2001), whether it is the finest taxonomic level in Dorn (2001), and whether it represents the finest taxonomic level in the United States. A few species in BICA are only known from Montana but not from Wyoming, and in these cases, regional floras are used. In all other cases, the BICA preferred name corresponded to the finest taxonomic level in Dorn (2001). These Yes/No columns were followed by an added Synonymy

column to list the links to BICA Preferred Name for those taxa that were not the BICA preferred names. This review was conducted for the 1229 entries in the NPSpecies database for BICA. It was determined that the NPSpecies database did not include entries for all names in Dorn (2001) so 115 additions were made for standardization and completeness. The steps in this process are represented in the list of added columns, below.

New columns

1. In Dorn (2001) – Yes/No
2. Finest taxonomic treatment in Dorn (2001) – Yes/No
3. Finest taxonomic treatment in national reference (Kartesz and Meacham 1999) – Yes/No
4. Preferred BICA name? – Yes/No
5. Preferred BICA name link (if Preferred BICA name? = N)

All entries were cross-checked with the aid of taxonomic references to determine synonymy, including the PLANTS database (USDA PLANTS 2006). The editing was done using the Data Sort tool, sorting primarily on family name, Latin name, park status, and on added fields. Additions were made if the taxonomic treatment in Dorn (2001) was not included. It is intended that all records would be transferred to entry under the BICA preferred names, and that the five columns created for this process serve as a record and a reference for searching on all previously-reported BICA names. There were no changes made to family names as used in the original NPSpecies database, despite changes in Dorn (2001) that split families (e.g., Liliaceae, in the broad sense).

After the taxonomic cross-referencing was completed, the Park Status information was reviewed. The NPSpecies records included not only confirmed taxa and unconfirmed or falsely-reported taxa, but many taxa of unknown status (Table 1).

Table 1. Original NPSpecies record entries for the Bighorn Canyon NRA flora

Park (BICA) Status	Confirmed	Unconfirmed	False	Unknown Status
Total no. of taxa	739	163	76	244

The following pairs of tables represent the process of cross-referencing nomenclature with BICA status for three taxa that are in BICA. The first step was to determine the BICA preferred name (almost always equals the finest taxonomic treatment in Dorn 2001), linking the other names to the preferred name, and filling in the correct Park (BICA) status. Together, the columns on “Preferred BICA Name” and “Park (BICA) Status” can be used to generate a list of the BICA flora using preferred nomenclature. Table 2 represents the original NPSpecies database, and Table 3 represents entries for the same taxa with the addition of columns to document the review process.

Table 2. NPSpecies entries for the first two families in the Bighorn Canyon NRA flora

Family Name	Latin Name	Park Status
Aceraceae	<i>Acer glabrum</i>	Present in Park
Aceraceae	<i>Acer glabrum</i> var. <i>glabrum</i>	Present in Park
Aceraceae	<i>Acer negundo</i>	Unconfirmed
Aceraceae	<i>Acer negundo</i> var. <i>interius</i>	Present in Park
Agaveae	<i>Yucca glauca</i>	Present in Park
Agaveae	<i>Yucca glauca</i> var. <i>glauca</i>	-

Table 3.

Expanded table of NPSpecies entries for the first two families in the Bighorn Canyon NRA flora

Family Name	Latin Name	Dorn (2001)	Finest Tax. Trmt. In Dorn	Finest Tax. Trmt. Natl	Preferred BICA Name?	Preferred BICA Name Link	Park (BICA) Status
Aceraceae	<i>Acer glabrum</i>	Y	Y	N	Y		Present in Park
Aceraceae	<i>Acer glabrum</i> var. <i>glabrum</i>	N	N	Y	N	<i>Acer glabrum</i>	Present in Park
Aceraceae	<i>Acer negundo</i>	Y	N	N	N	<i>Acer negundo</i> var. <i>interius</i>	Present in Park
Aceraceae	<i>Acer negundo</i> var. <i>interius</i>	Y	Y	Y	Y		Present in Park
Agaveae	<i>Yucca glauca</i>	Y	Y	N	Y		Present in Park
Agaveae	<i>Yucca glauca</i> var. <i>glauca</i>	N	N	Y	N	<i>Yucca glauca</i>	Present in Park

Part of the challenge was reconciling disparate values for “Park (BICA) Status” for entries that represented the same taxa. There were taxa that are confirmed as present in BICA that had synonyms that were recorded as unconfirmed or no status in BICA. There were falsely-reported taxa in BICA had varieties that were recorded as unconfirmed or no status in BICA. All corrections to Park (BICA) Status were made directly in the original column rather than create a new column. This is the only exception in which review edits were made throughout entries of an existing spreadsheet column rather than create a new column. The great majority of edits and additions were simple cases of applying the previously-reported BICA status to all synonyms (e.g., *Oligoneuron rigidum* var. *humile* = *Solidago rigida* var. *humilis*) and to all different levels of taxonomic treatment (e.g., *Acer glabrum* is not regularly split into varieties in Wyoming, in general or in the most recent flora in particular, so *Acer glabrum* is preferred over *A. g.* var. *glabrum*.). A few cases represented taxonomic revisions to the taxon (e.g., the splitting of *Platanthera hyperborea* into two species). There were also cases in which accepted spelling conventions have changed, and both spellings are entered as separate records and cross-referenced.

In keeping with the prior checklist work, all taxa that are not known within current BICA boundaries are recorded as false reports. Taxa that were reported in the BICA flora based on misidentified specimens are also recorded as false reports. Taxa that were reported but for which

there are no known vouchers at the Rocky Mountain Herbarium (RM) of the Bighorn Canyon National Recreation Area Herbarium (BHC) are recorded as unconfirmed reports.

There were almost no changes to the confirmed BICA flora, with no subsequent investigation to fill BICA floristic documentation gaps identified in Heidel and Fertig (2001). One overlooked voucher was added (*Lappula cenchusoides*) and one immature specimen was redetermined (dropping *Sisymbrium loeselii*). There were also a pair of observation changes made; realizing the need to voucher all observations. *Androsace septentrionalis* was collected but the material discarded in 2001 as too tiny a specimen set for mounting and is thus included as observation. *Aster conspicuous* was reported to have been observed, but was never seen in flower and is rejected as meeting the confidence criteria for reporting observations. Two taxa were added to the BICA flora as unconfirmed pending specimen annotation: *Delphinium bicolor* ssp. *calcicola* (appears to be represented by *Collins 563 RM*) and *Penstemon laricifolius* var. *exilifolius* (represented by *Booth s.n. RM* and discussed as this taxon in an unpublished masters thesis). It was previously suggested by Robert Dorn (personal communication) that species reported in Lichvar et al. (1985) with no known vouchers might have specimens deposited at the New York Botanical Garden rather than RM or the Bighorn Canyon NRA Herbarium (BHC). Searches of the New York Botanical Garden – Virtual Herbarium (New York Botanical Garden 2006) were conducted, and four specimens from Bighorn Canyon were among them, but they are all duplicates.

There was one case in which the BICA taxa were not determined to variety (*Apocynum cannabinum*) when the voucher was verified at BHC. Though it appears that the *A. c.* var. *hypericifolium* is more likely to be present based on surrounding distribution, the NPSpecies preferred name is left at the species level. There are no cases in which the BICA preferred name is at the genus level. Annotation of the immature *Corispermum* voucher specimen from BICA provisionally placed it in *C. americanum* though *C. villosum* could not be ruled out, and it is assigned to the former.

The 2001 collection label files were checked for associated species not otherwise reported in the flora, and the following four were added as unconfirmed taxa: *Castilleja pulchella* (previously collected outside BICA by Lichvar; changed to unconfirmed in Carbon Co., MT), *Eleocharis acicularis* (unconfirmed in Big Horn Co., WY), *Elymus lanceolatus* var. *lanceolatus* (unconfirmed in Big Horn Co., WY), and *Glyceria borealis* (unconfirmed in Big Horn Co., MT).

Specimen voucher information was copied from links into all of the BICA preferred name entries that represent confirmed species, so that there is a voucher specimen cited for the BICA preferred name as well as synonyms previously reported for the BICA flora.

Three columns were added to the spreadsheet for importing into NPSpecies database that represent distribution. The Bighorn River traverses three counties in Montana and Wyoming. It was not the original survey intent to document the flora at the county level, but a significant number of the entries represent additions to the county floras, some records are only observation rather than specimen, and storing information in this way makes it easiest to fill gaps while providing use for botany and ecology research. Those counties where voucher specimens have

been collected are marked by “X” and those counties that only have observations to support the record are marked by “X”. This replicates the information in Heidel and Fertig (2001). The three added columns are listed from south to north (upstream to downstream) and include:

New columns

1. Big Horn County, WY
2. Carbon County, MT
3. Big Horn County, MT

The current Wyoming flora (Dorn 2001) represents county-of-distribution information, and those taxa that represent additions to the documented flora of Big Horn County, WY are asterisked in the respective distribution column.

Information was entered in seven existing columns for all taxa representing BICA preferred names. Only the “nativity” field had entries at the onset. The previously-mentioned distribution information provides valuable context for this information.

Entries to existing columns

1. Abundance - Note whether the species is abundant or rare from vegetation plots, readily available collection records, and field notes. It generally corresponds with the values in Lichvar et al. (1985) taking into account the re-determinations made on species' identifications, and splitting the three categories of these researchers (Abundant, Frequent, Infrequent) into the four in the NPSpecies database (Abundant, Common, Uncommon, Rare). The abundance information in Lichvar et al. (1985) was based on one season of fieldwork as applied to specific habitats regardless of how widespread are the habitats or representative are the locales for BICA as a whole. For example, *Iris missouriensis* (Rocky Mountain iris) is recorded in Lichvar et al. (1985) as “abundant” in “marshlands” and the voucher collections were from both counties in Montana. The only large marshland basins in BICA are in Wyoming, while there are zones of wetland species, i.e., marsh species, around riparian corridors as well as seeps and small swales in Montana; all of which are highly restricted on the landscape. I did not observe it in local abundance at any site in Montana to the best of my recollection. Therefore, it is recorded in this report as “Uncommon” as present in Big Horn and Carbon counties, Montana, rather than as “Abundant.” After completing all abundance entries by using Lichvar et al (1985) with the caveats above, the entries were cross-checked with vegetation plot data in Knight et al. (1987), and the collection labels and field notes of the author. “Rare” is used sparingly for those species that are only known in low numbers from one place, to the best of my recollection. For the annual species on this list, the dry conditions of the 2001 field season may have affected observed abundance.
2. Nativity – Edit existing records and enter for added records, referencing Fertig (1999) and Hartman and Nelson (2000). Note: there taxa that are native in parts of North America but possibly non-native in the two states were noted as non-native, in keeping with Fertig (1999).
3. NativityDetails - Note any special cases, e.g., for taxa that may be accidental and not persisting. There are a few unusual circumstances in which a native species is present

in BICA as both a cultivated species and an escape, e.g., *Celtis occidentalis* (Hackberry).

4. Cultivation - Enter for cultivated species (Y).
5. CultivationDetails - Enter whether the taxa is cultivated at homesteads, shelterbelts, or fields; and whether persisting or spreading.
6. LocalList – Enter if the species is a noxious weed in Montana, Wyoming, or any of the three counties (Y).
7. LocalListDetails – Enter the state(s) and county(ies) in which the species is designated as noxious.

There are two fields in NPSpecies for noting whether or not a species is weedy, and the context of its weediness. The definitions are broad and the BICA context is complex, with many native species that are ruderal around corrals, non-native species that are in both native vegetation and non-native vegetation, and short-lived native and non-native species that are widespread in man-made habitats like reservoir flats. The list of noxious weeds as recognized in both states represents the most serious weed management concerns and they were cross-referenced as posted for Montana (Rice 2006) and for Wyoming at (Wyoming Department of Agriculture. 2006).

Entries to existing columns

1. Weedy – All species with state or county status on noxious weed lists are indicated by “Y” = Yes.
2. WeedDetails – All state and county noxious weed lists and weed priority categories are noted

In addition to all the previously-mentioned entries, two columns were added as placeholders for existing NPSpecies columns on rare plant status. There is not sensitive species legislation in either Montana or Wyoming, but both states have state species of concern lists and watch lists (Montana Natural Heritage Program 2003, Keinath et al. 2003). These lists contain all narrow endemics (i.e., globally imperiled species ranked G1-G2) and many regional endemics (globally vulnerable species ranked G3), as well as many species that are disjunct or peripheral, with state ranks of S1-S1. All cross-references to these lists are indicated by the state (Montana or Wyoming) and the list status (species of concern or watch).

New columns

1. SOC Status – All state species of concern (SOC) and watch status are referenced, and cases in which the species is on one state list but not present in the corresponding state segment of BICA are noted.
2. Biogeography comments – Miscellaenous notes are made, e.g., noting all species that are narrow or regional endemics, and whether the BICA distribution represents the northernmost distribution or lowest elevation segments of species’ distributions. Information is also available, but was not included, to cross-reference taxa by their biogeographic affinity.

Finally, summary tallies were calculated for the BICA flora to determine the number of taxa at each level (family, genus, species, subtaxa), the number of native and non-native species, the number of cultivated species, the number of noxious weeds. They are reported in the results

section. The database file is conveyed as a separate product in Excel. Finally, a floristic checklist template is provided as a draft for BICA publication and reference.

Results

As a result of this project, there is now an annotated BICA floristic list of taxa confirmed from BICA consistent with Dorn (2001), as presented in Appendix A. There is a second table of all unconfirmed and false reports for species in the BICA flora that are consistent with Dorn (2001), as presented in Appendix B. The complete record of results is represented in the electronic database files. A prototype of a Park checklist for public use is also printed and submitted separately as a reformatted product for consideration, though this would ideally include common names. The process of cross-referencing taxonomic nomenclature required the addition of over 100 records to the original NPSpecies dataset. The resulting database of 1341 entries represents a standing reference in the NPSpecies system that has many applications.

All entries for the BICA flora have been assigned or re-assigned a correct Park Status. The current tabulation of the dataset is presented in Table 4.

Table 4. Edited NPSpecies record entries for the Bighorn Canyon NRA flora

Park (BICA) Status	Confirmed	Unconfirmed	FALSE	Other	Total
Total no. of taxa with BICA Preferred Name=Y	739	46	93		877
Total no. of taxa with BICA Preferred Name=N	399	24	32	12	470

The few cases when Dorn (2001) was not the preferred name correspond reflect taxa that are in Montana but not Wyoming (*Arabidopsis thaliana*, *Bryonia alba*, *Lesquerella lesicii*); cases of exotic species as well as a narrow endemic species.

A break-down of the flora by taxonomic unit, native and non-native species, and other basic groups is presented in Table 5.

Table 5. Components of the Bighorn Canyon NRA flora

BICA flora components	Families	Genera	Native/ Non-native	Noxious Weeds	Cultivated	Species of Concern+ Watch in MT/WY
Total no. of confirmed BICA taxa	79	370	628/111	31	15	38

The largest families of vascular plants in BICA are the Aster family (Asteraceae), comprised of 167 species and the Grass family (Poaceae), comprised of 99 species. The largest genera of vascular plants in BICA are the Milkvetch genus (*Astragalus*), comprised of 21 species and the Sage genus (*Artemisia*), comprised of 13 species.

Information added to the floristic database indicates that there are 31 noxious weeds in BICA if it fell within a single state. There are 10 noxious weeds of Montana in Montana

segments of BICA and 12 other noxious weeds of Wyoming in the Wyoming segment of BICA, in addition to six noxious weeds recognized by both states and at both ends of BICA, and including county noxious weed lists. The most serious noxious weeds are listed in the previous vascular flora report (Heidel and Fertig 2001).

Information added to the floristic database indicates that there would be 38 species of concern and watch species in BICA if it fell within a single state. There are 22 species of concern or watch species of Montana in Montana segments of BICA and 1 species of concern of Wyoming in the Wyoming segment of BICA; in addition to four species of concern recognized in both states and found in both states. There is also an addition to the Montana flora, *Conioselinum scopulorum* (rock lovage), which may warrant consideration as a species of concern. There are additional cases of species that are rare in one state, but only found in the BICA segment of the other state. In addition to rarity, there are some of the highest concentrations of Wyoming Basin endemics at their northern range limits, montane species in a low-elevation canyon setting, and an intriguing juxtaposition of species from many different biogeographic affinities. Rare species of BICA are reported in Heidel and Fertig (2000).

Comparison of results with Dorn (2001) for the most current county-of-distribution information for Wyoming indicated that there are 29 additions to the flora of Big Horn County, Wyoming that were documented by specimen vouchers collected in the BICA study area. Comparable information on Montana county-of-distribution is not published for reference.

An unpublished list entitled “Plants Planted by the Historic Ranches” was provided by Suzanne Morstad from National Park Service files at BICA after the 2001 floristic inventory was conducted, listing at least 13 species. Of these, at least five are reported but unvouchered cultivated species on this list. Results are cross-referenced with the inventory results to date. Additional cultivated species were documented, though homestead sites were only visited incidental to most survey work. The unpublished list and additional cultivated species are summarized in Appendix C. It includes many persisting homestead plantings, two species which have escaped and become major management concerns (*Elaeagnus argentea*, *Tamarix chinensis*), one crop (*Medicago sativa* var. *sativa*), possible transplanting of native species at homesteads (*Fraxinus pensylvanica*), and at least one species that may have been more recently planted for stabilization or wildlife cover (*Elymus elongatus*). The homestead sites in the BICA landscape are centered at water sources, may have been historic introduction sites of exotic species in the area, and have not been completely inventoried, circumstances which collectively may warrant further botanical investigation if they are priorities for cultural resource management.

Two special cases were identified that were not anticipated. Eight of the species in the original NPSpecies are not reported from BICA in any of the known botany and ecology references that address the BICA flora (Heidel and Fertig 2000, 2001; Knight et al. 1987; Lichvar et al. 1984, 1985). They were included in RM herbarium searches to be sure there are not vouchers. At least one involved closely related spelling for confirmed species (e.g., *Symphyotrichum ciliatum* as confirmed, but *S. ciliolatum* added as an entry with no known reports.) They are recorded as false reports with a question mark added. In addition, 12 species in the original NPSpecies are not valid species entries. Some of these entries were at the genus

level (e.g., *Aster* spp.) Others were bogus taxa that may reflect a mistaken entry transcription (e.g., *Helianthus quinquenervis* as a separate entry from the valid entry of *Helianthella quinquenervis*). The bogus entries have “NA” recorded in Park Status, and are in the tally under “Other” in Table 4. There is no merit in keeping these records in a reference database.

There are 10 species with precise location information but wanting specimens that are included in the BICA flora, including *Euphorbia esula* var. *uralensis* (leafy spurge). There are also at least five cultivated species reported from homesteads on BICA that warrant confirmation of their persistence that are not included in the flora. There are at least three species that might be non-persisting members of the flora associated with roads (*Aegilops cylindrica*, *Panicum milaceum*, *Salvia reflexa*).

Discussion

This report represents a cross-reference and minor update to the previous floristic report (Heidel and Fertig 2001), following the taxonomic treatment in the current Wyoming flora (Dorn 2001). It also maintains the cross-reference to the associated voucher information and county-of-distribution information, and adds abundance information. The process of conducting botany work on BICA has demonstrated the need for voucher specimen documentation, an appropriate follow-up in documenting the known flora, and potentially refining it at the county level.

This report has potential use in natural resource management as a cross-reference and coordination reference to exchange with local weed districts, as a reference in the inventory of homestead plantings, and as a reference to help in determining appropriate plant materials for any restoration or landscaping efforts. Beyond this, it serves as a testimony to the diverse flora of the BICA biomes, and it potentially serves as a reference for BICA as an outdoor classroom, a reference for botany and ecology researchers, , and a contribution to both the Inventory and Monitoring Program and the NPSpecies database nationwide.

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