

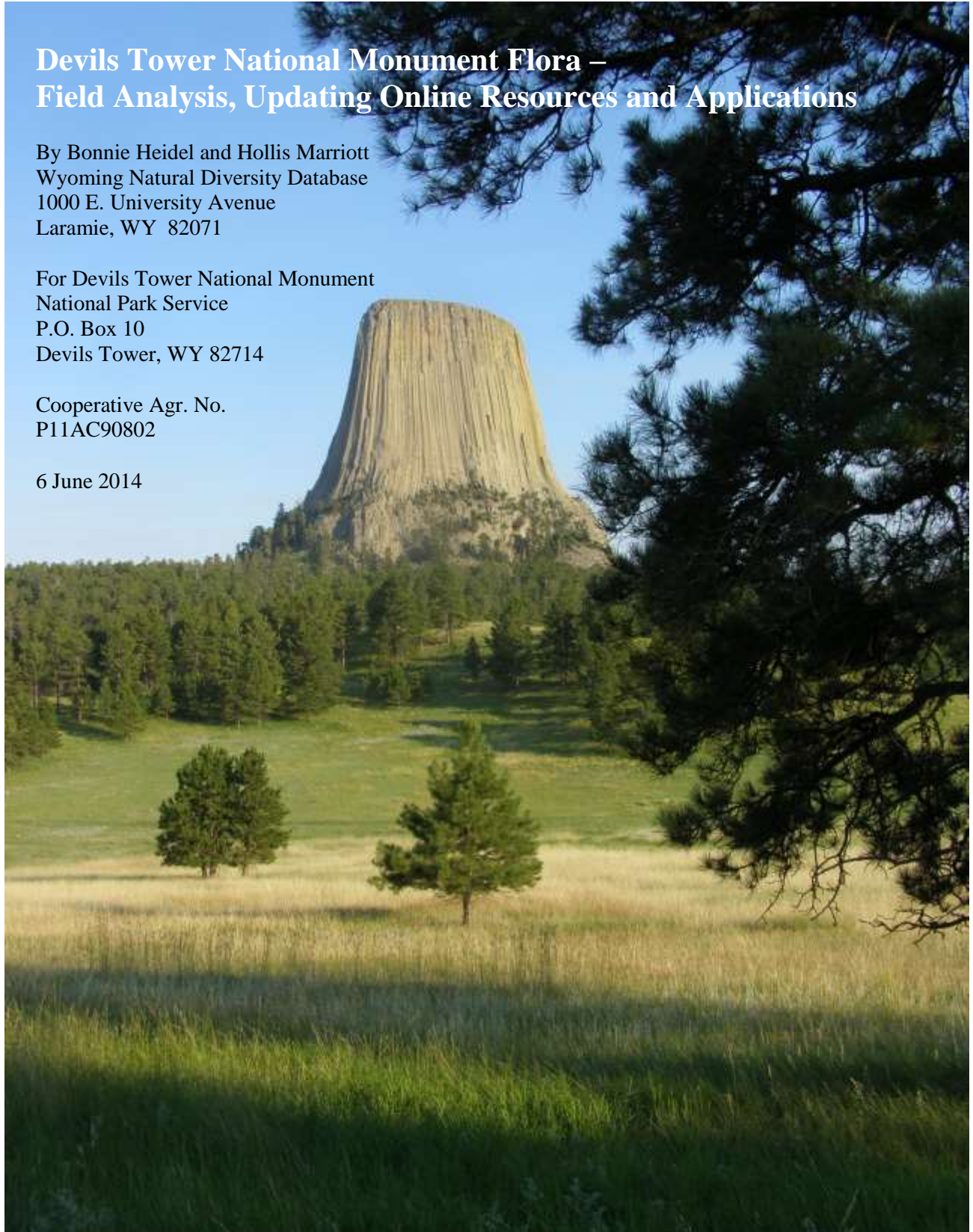
Devils Tower National Monument Flora – Field Analysis, Updating Online Resources and Applications

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Abstract

Three educational products were proposed to enhance visitor understanding and appreciation of plants at Devils Tower National Monument (DETO) including a flyer, a checklist of common plants, and a complete floristic checklist. Incidental to this, field work was conducted to address questions of species status in the flora and produce a more robust flora for an area already known for its diversity. Of the specimens collected, 12 were additions to the DETO flora, including one noxious weed (since eradicated) and one native addition to the state flora. One additional species was verified from a voucher collected in NPS plot sampling, and nine earlier reports of additions to the DETO flora were verified. A Wyoming plant species of concern was evaluated in the field to investigate whether the determination was correct. NPSpecies, the National Park Service's web-based tool for documenting species in national parks, and the Rocky Mountain Region Digital Herbarium (RMRDH), which includes the DETO specimens, were updated to ensure completeness, currency and consistency. A checklist publication of common plants and a technical checklist of all vascular plants can now be generated from NPSpecies on demand by interpretive staff, natural resource managers, researchers and the general public, using new report tools. A one page educational flyer about selected important DETO plants is submitted as a stand-alone product. After thorough technical work, the new implementation of NPSpecies is up to the task of representing the rich DETO flora, even though floras and plant taxonomy are dynamic.

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Cover photo: Devils Tower with common plants of prairie and woods, by B. Heidel

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Figure 1. All names assigned to a specimen, past and present, were entered in the “Determinations, Nomenclatural Changes” field. To clarify, a photo of corresponding physical labels is included below. This specimen was identified as *Dodecatheon conjugens* ca. 1934, and annotated to *Dodecatheon pulchellum* in 1981. Marriott updated nomenclature in 2014; this last change is strictly digital.

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General Introduction

The National Park Service (NPS) awarded funding through the Rocky Mountain Cooperative Ecosystem Studies Unit (RM-CESU) in September 2011, directing the University of Wyoming to produce a series of educational products and supporting technical information to enhance visitor understanding and appreciation of plant life at Devils Tower National Monument (DETO). Among the educational products originally envisioned were a printed checklist of common plants and a downloadable checklist of the entire flora, to promote understanding the composition and diversity of the DETO flora by visitors as well as researchers and managers. The scope of work included field surveys to check for completeness of the flora. It later included online editing as supporting technical work on the DETO flora. It evolved into a living flora project, so that the NPSpecies online database becomes the central resource for generating and maintaining floristic checklists for current and future applications. The work is presented in two chapters to represent both stages and the collaborative approach, with each chapter having a separate author.

Objectives

The primary purpose was to prepare DETO educational materials at three interest levels including a short flyer to present DETO themes as seen through its plant life (Appendix A), and the DETO flora in two formats: a checklist of common plants, and a complete checklist of all vascular plants. It also addressed two facets of inventory and data management, as means to the educational goals:

1. Field check the flora of DETO to fill gaps, resolve questions surrounding the presence of certain species, and compile results in the flora.
2. Update the online flora of DETO for public use, technical reference, and documentation consistency, and develop conventions for use of NPSpecies to produce popular checklists of common species modeled after Marriott (1995) and San Miguel and Marriott (1996).

Study Area

DETO was established on September 24, 1906 by Theodore Roosevelt as the first national monument in the United States. DETO protects the Devils Tower landmark, a cultural site and prominent columnar monolith of igneous rock rising above the Belle Fourche River in Crook County, Wyoming. It lies at the western edge of the Black Hills and is the only NPS unit in northeastern Wyoming, providing the highest level of protection for biological diversity in this area of the state.

The four management goals of DETO (NPS 2001) are to:

- Restore and maintain the health and diversity of DETO's natural systems
- Preserve archeological, historic, and ethnographic values at DETO
- Interpret the significant and varied themes of DETO
- Balance educational, spiritual, and recreational uses of DETO and its surrounding landscape to provide meaningful visitor experience.

DETO encompasses 545 ha (1347 ac; 2.1 mi²) that spans 388 m (1272 ft) in elevation. It has a continental climate augmented by montane influence of increased summer precipitation levels. The average annual precipitation is 43.5 cm (17.1 in), ranging from 1.5 cm (0.6 in) in January to 7.9 cm (3.1 in) in June. The average monthly temperature is 6.9° C (44.4° F), ranging from monthly averages of 1.3° C (34.3° F) in January to 30.7° C (87.3° F) in July (USDI NOAA 2008).

The defining geological feature at DETO is the tower-like Tertiary intrusion that rises above two older sedimentary formations, the Spearfish and Sundance Formations, which have partially eroded away. The geological origins of the tower have not been determined with certainty. Quaternary deposits are superimposed on this landscape at the base of Devils Tower as landslide and along the Belle Fourche River as alluvium.

Land cover in DETO is a mix of ponderosa pine woodlands, short- and mixed-grass prairie, isolated cottonwood and deciduous hardwood draws, barrens, wetlands, open water, agricultural land and developed landscapes (Frye et al. 2009, in Draskowski et al. 2011). Salas and Purcherellia (1998) provide the most recent, detailed vegetation map of DETO, derived from 1993 color infrared aerial imagery, recognizing 17 vegetation associations. The landscape has been modified by prescribed burns, wildfires, weed control, weed encroachment, restoration, disease-related tree mortality, hydrological regime changes, and animal use, most notably by *Cynomys ludovicianus* (black-tailed prairie dog). Vegetation monitoring programs are in place at DETO to monitor eight vegetation parameters (Ashton et al. 2012). Other vital signs monitored or proposed for monitoring in DETO are addressed in Gitzen et al. (2010).

Botanists were drawn to the Devils Tower landmark even before its designation. Some of the earliest records include specimens that were apparently deposited at the Smithsonian, as in the case of grass specimens collected by D. Griffiths in 1897. A herbarium started at Devils Tower with the collections of early staff. The level of plant collecting work at DETO grew by magnitudes with systematic effort leading to development of the first DETO checklist by Marriott (1982). The checklist contained 440 species¹ and was prepared in close collaboration with Rocky Mountain Herbarium (RM) for specimen verification, the most current accepted names, and making duplicates available to the public. Later vegetation studies at DETO expanded the floristic documentation including those of Marriot (1989, 1990), Marriot and Jones (1989), The Nature Conservancy (1996) and Merrill et al. (2003). Electronic data entry at RM made it possible to tabulate county floras and analyze large collection sets, to further analyze and interpret the DETO flora in comparison with the Crook County flora (Fertig 2001). Rare species data synthesis from RM (Fertig 2000) brought additions to light and rare species surveys at DETO (Heidel 2008) filled gaps in floristic information. The latter study documented a new plant species of concern and other additions to the DETO flora. The original work of Marriott documented well over 90% of the DETO flora to surpass the threshold for the NPS Inventory and Monitoring Program, although the size of the flora, indicator value of additions as rare or weedy, questions about species' statuses in DETO as entered in NPSpecies, and prospective changes over time placed a premium on revisiting the floristic work.

¹ The DETO vascular flora is referred to as made up of species for the sake of simplicity, although some of the species have finer taxonomic units at subspecies or variety levels. Nomenclature used in this project reflects the finest accepted taxonomic unit and in almost all cases, there is only one subtaxon per species in DETO.

The DETO flora is also a showcase of the Black Hills flora, which has attracted the attention of botanists from South Dakota, Wyoming, and beyond. The first Black Hills checklist was produced by Thilenius (1971) with great strides made in concerted collecting by Robert Dorn in producing the first and only Black Hills flora (Dorn 1977), reporting over 1200 species. Much of the Black Hills flora has also been put into field guide format by Larson and Johnson (1999). Marriott conducted rigorous floristic inventory the Wyoming segment of the Black Hills flora (Marriott 1985) reporting 955 species.

Chapter 1. Field Checking the Flora of Devils Tower National Monument

By Bonnie Heidel

Introduction

We field checked the flora of Devils Tower National Monument (DETO) for completeness. Selective collecting was conducted in the summer of 2012 seeking prospective additions and pursuing questionable records in the DETO flora. Questionable entries were further pursued in 2013.

Methods

A search list was prepared from three sources to use as reference in the field. The primary floristic reference used for field checking the DETO flora was the NPSpecies database, exported on 2 January 2012 with National Park Service permission. The certified list at that time showed 376 species known from DETO, 46 species probably present, 41 unconfirmed species, and one species no longer persisting; a profile that had been used in the recent planning documents (NPS 2011, Drazkowski et al. 2011). A reference list was compiled to use in fieldwork, starting with the 47 “probably present” species. The RM developed online database search tools since the time of the reports by Fertig on rare species and the flora (2000 and 2001, respectively). These were used to find out if any species not known from DETO were documented in the immediate vicinity. A search polygon was drawn around the Monument boundaries extending about 5 miles east and west and 10 miles north and south to follow prevailing topography. This expanded polygon search produced a list of 24 more species to add to the search list. Also included were three species from Devils Tower that were deposited at RM known from historical collections that may or may not have been collected within DETO boundaries. Finally, species were added to the search list that were identified as possibilities in Fertig (2001) based on a review of the Crook County flora as documented at RM in combination with the reviewers’ familiarity with species’ habitat preferences. These three approaches yielded a total of 145 species. Disparities between entries in NPSpecies, RM and Marriott (1982) were not addressed at this stage.

The reference list was used in field-checking the flora during three visits in 2012: 5-6 June, 19-21 July, and 18-20 August. A fourth trip was conducted on 13-14 July 2013 to resolve unanswered 2012 questions. Priority was placed on collecting material in flower or fruit for positive determination from throughout DETO. A four-prong approach was taken in surveys to seek out the 145 species on the search list, target taxonomic groups that tend to be under-collected, target disturbance settings and other early succession habitats that may have species

composition changes over time, and double-check far corners of DETO. Specimens were collected if there was any question whether or not a species had previously been documented. References used in the field included Dorn (2001) and Great Plains Flora Association (1986).

After the field season, the collections were verified in RM and cross-referenced to the search list. Labels were prepared and specimens mounted. Before submittal, they were photographed for the Rocky Mountain Digital Herbarium (RMRDH). Original specimens were submitted to the NPS herbarium at Mount Rushmore (MORU) and a partial set of duplicate specimens was submitted on loan to RM that include most additions to the DETO flora. All species collected in 2012-13 that were previously on record as “Probably Present”, “Potential” or “Historical” in DETO that had vouchers were changed to “Present in Park” by editing NPSpecies database.

Also after the field season, the working checklist was cross-checked against two additional data sources that include the DETO specimens represented by RMRDH and by an online data search of the RM database that was confined to DETO boundaries rather than 5-10 mile extensions. These tasks brought to light that the original search list of species to seek in DETO as used in field surveys included species already documented from DETO but not yet incorporated in NPSpecies. It also helped frame the need for editing and updating online databases (See Chapter 2). Specimens reported as additions to the DETO flora in Heidel (2008) were also verified or annotated; some verified additions had not been added to NPSpecies. Finally, the NPS vegetation monitoring plot data results from DETO (Ashton et al. 2012) were checked against the flora and NPS staff were consulted on putative additions. Voucher specimens were reviewed as available.

Results

As a result of 2012-13 field collecting, 12 additional species were documented for the DETO flora (Table 1). In addition, two DETO specimens collected by NPS vegetation monitoring staff in 2011 (Ashton et al. 2012) were reviewed. One is a valid addition to the DETO flora, *Astragalus plattensis* (Platte River milkvetch), while the second, originally identified as *Symphotrichum ericoides* (white heath aster) was annotated to *S. falcatum* var. *falcatum* (white prairie aster). *Astragalus plattensis* is included as an addition on Table 1. Five of the 12 additions were collected in riparian habitat, mainly on the Belle Fourche River, and four of the 12 additions were in difficult-to-identify groups (grasses and sedges). Many species on the search list were later found to have been collected but not entered into NPSpecies as Present in DETO.

One of the 12 species collected in 2012-13 has since been eradicated from DETO, *Centaurea maculosa* (syn. *Centaurea stoebe* ssp. *micranthos*; spotted knapweed), a state noxious weed. So even though it is newly documented, it is not currently present in the DETO flora. All other additions documented in 2012 are native species, although some are associated with early succession and may be ruderal (adapted to natural disturbance).

One of the 12 additions to the DETO flora is also an addition to the Wyoming flora, *Conyza ramosissima* (dwarf horseweed). It is a native species, but is an annual that is reported to be associated with natural disturbance (Great Plains Flora Association 1986). It was collected in the prairie dog town where it is common. It may have been introduced in recent years, persisted in

the seed bank, or is a natural element of prairie dog town vegetation that had previously been overlooked.

Table 1. Additions to Devils Tower National Monument based on 2012-2013 collections

Scientific name	2012 NPSpecies entry for DETO	Nativeness	Setting	Life Form	First Specimen ²
<i>Astragalus plattensis</i>	none	Native	Upland	Forb	MO s.n.
<i>Carex praticola</i>	Probably present	Native	Upland	Graminoid	BH 3607, 3664
<i>Cenchrus longispinus</i>	none	Native	Upland	Graminoid	HM 12545
<i>Centaurea maculosa</i>	none	Non-native	Upland	Forb	HM 12570
<i>Conyza ramosissima</i>	none	Native	Upland	Forb	BH 3667
<i>Epilobium brachycarpum</i>	none	Native	Upland	Forb	HM 12547
<i>Lycopus americanus</i>	none	Native	Wetland	Forb	HM 12556
<i>Prunella vulgaris</i>	none	Native	Upland	Forb	HM 12557
<i>Sphenopholis obtusata</i> var. <i>obtusata</i>	none	Native	Wetland	Graminoid	BH 3661
<i>Stachys palustris</i>	Probably present	Native	Wetland	Forb	BH 3665
<i>Typha angustifolia</i>	none	Native	Wetland	Graminoid	BH 3671
<i>Typha latifolia</i>	Probably present	Native	Wetland	Graminoid	BH 3674
<i>Xanthium strumarium</i>	Probably present	Native	Wetland	Forb	BH 3666

Specimens of the species additions to the DETO flora reported in Heidel (2008) were double-checked as part of this project (Table 2). Some of the twelve had been entered by NPS staff into NPSpecies, some of the specimens were scanned and entered into the RMRDH specimen database, and others were not entered in either database. The set included three redeterminations and a species that was not new but had been collected much earlier though not entered into NPSpecies as Present. In total, nine of the set represent additions to the DETO flora. Adding them to the 12 above-mentioned additions brings the total number of DETO flora additions to 22 species.

² This column give the collector's initials and collection number. HM is Hollis Marriott, BH is Bonnie Heidel, and MO is Merran Owen.

Table 2. Additions to Devils Tower National Monument based on 2007-2008 collections

Scientific name as reported in Heidel (2008)	2012 NPSpecies entry for DETO	Nativeness	Setting	Life form	2014 Comment	First Specimen
<i>Alopecurus arundinaceus</i>	none	Non-native	Wetland	Graminoid		BH 2892
<i>Carex vulpinoidea</i>	none	Native	Wetland	Graminoid		BH 3156
<i>Carex xerantica</i>	none	-	-	-	Annotated to <i>Carex praegracilis</i> , not an addition	
<i>Catabrosa aquatica</i>	none	Native	Wetland	Graminoid		BH 3156
<i>Conium maculatum</i>	Present	Native	~Wetland	Forb		BH 2906
<i>Eleocharis acicularis</i>	Present	Native	Wetland	Graminoid		BH 3241
<i>Filago prolifera</i>	none	Native	Upland	Forb		BH 2905
<i>Glyceria grandis</i>	none	Native	Wetland	Graminoid	Annotated to <i>Glyceria borealis</i> , an addition	BH 3157
<i>Gnaphalium exilifolium</i>	none	-	-	-	Annotated to <i>Pseudognaphalium viscosum</i> , not an addition	
<i>Juncus torreyi</i>	Present	Native	Wetland	Graminoid		BH 3238
<i>Physalis heterophylla</i>	none	-	-	-	Collected previously but not entered into NPSpecies	
<i>Poa glaucifolia</i>	Present	Native	Wetland	Graminoid	Originally identified as <i>Poa arida</i> , a synonym, and an addition	BH 2904

Concerted collecting was conducted to address species of questionable status, as in the case of a milkweed specimen annotated to *Asclepias verticillata* (whorled milkweed). Revisits were made in 2013 in the vicinity of the original 1981 collection site by the same collector. A set of collections were made, each consisting of multiple individual plants, representing the full range of variability. They were compared against material at RM and all material, including the original 1981 specimen, were provisionally redetermined as *A. pumila* (plains milkweed). The specimens warrant further consideration by the taxonomic authority, who has yet to work on the genus for *Flora of North America north of Mexico* (Flora of North America Editorial Committee 1993+). Until such time, it is treated in this study as a false report in the DETO flora and the Wyoming species of concern list, known from no other locations in the Monument or the state. The field investigation that supports the case for deleting it from the flora is presented in Appendix B. The compilation of all known species present in DETO is in Appendix C.

Discussion

The current checklist includes species that were not on the 1982 checklist, differences that are likely to include additions to the flora over time. Several additions are in the riparian corridor, including non-native species such as *Alopecurus arundinaceus* (creeping meadow foxtail) and native species such as *Stachys palustris* (hedge nettle). This might indicate that riparian vegetation along the Belle Fourche River in DETO continues to change since the Keyhole Reservoir dam was constructed in 1950-1952. This possibility is supported in noting that *Salix exigua* (sandbar willow) was collected along the river in DETO by C. L. Porter in 1962 but could not be relocated in any subsequent floristic surveys. About half of the 22 additions are wetland species and some occupy localized wetland habitats rather than the riparian corridor.

The addition of early succession species to the flora, including *Cenchrus longispinus* (sandbur) and *Conyza ramosissima* (dwarf horseweed), might reflect accidental visitor introductions associated with vehicles or footwear. Animals and wind are also potential dispersal vectors for these two species, respectively. The campground and parking lot areas are places most likely to have early succession native species and weed seed carried in. Alternatively, the horseweed species could be associated with prairie dog vegetation, so prairie dog vegetation literature is under review to help interpret its status in DETO and in Wyoming.

The addition of 22 species is a modest expansion of the original checklist of 440 species (Marriott 1982), some of which were likely to have arrived at DETO over the intervening years. It is a minor contribution to the NPS Inventory and Monitoring program that aims for documentation of floras and faunas at or above 90% thresholds. However, the incremental additions and losses of such species may be some of the most telling biological trends and hardest to detect. There are vegetation monitoring programs, and though they were not designed to track floras, there are no other routine avenues for documenting change. Therefore, promoting use of the DETO checklist and ensuring that vouchers are collected for all proposed species changes found in vegetation monitoring plots would be helpful.

One of the greatest challenges in this project and biggest refinements to the floristic picture has been in updating the online databases and supporting documentation, addressed in the following chapter.

Chapter 2. Updating the Online Flora of Devils Tower National Monument

By Hollis Marriott

The second stage of the project involved updating two online botany resources for DETO: NPSpecies, the web-based tool of NPS for documenting species in national parks, and the Rocky Mountain Digital Herbarium (RMRDH). The project was timely. NPSpecies underwent a major revision recently and digital herbarium records are to be linked to NPSpecies records as vouchers. This will be easier to implement now that NPSpecies for DETO and the park's digital herbarium are up-to-date and consistent.

About the Online Resources

NPSpecies

NPSpecies is a web-based resource for collecting, managing and sharing information about species in national parks (National Park Service 2013). The basic building block is the park species record, which contains information about a given species in a given park unit. The website provides search and report tools to generate species lists for parks, and reports about individual species.

In 2013, NPSpecies underwent a major redesign and software upgrade to make it more streamlined and easier to use. There was a shift in philosophy as well. In the past, certified species lists were generated for parks. These remained “official” until a new round of revision took place. Now NPSpecies is dynamic -- a work in progress. Taxa can be added, removed or modified whenever new data become available. This is a realistic and useful approach, for species lists are expected to change, even after intensive inventory, as new introductions are discovered, noxious species are successfully eradicated, and taxonomic concepts are refined.

NPSpecies is evidence-based, with park species records linked to vouchers, reports and observations. Candidate evidence applications are currently being evaluated, so this functionality is not available yet.

Responsibility for managing NPSpecies resides at the park level, with one or more staff designated as Points of Contact. While NPSpecies records can only be edited by designated staff and cooperators, anyone can submit new information for consideration via the web interface (“Make a Suggestion”).

Rocky Mountain Region Digital Herbarium

Digital herbaria are now common, and the number continues to grow at an increasing rate (Beaman and Cellinese 2012; Tschöpe et al. 2013). Digitization contributes to specimen preservation as well as dissemination of knowledge. The latter is especially relevant for smaller collections that are not widely known, or that have been difficult to access (Schmidt 2007). Towards these ends, the National Park Service Northern Great Plains Network of Parks and the University of Wyoming Libraries have collaborated to create the RMRDH to “increase park and public access to herbarium specimens ... to make scientifically collected and documented NPS

plant specimens available to public users from botanical researchers to amateur native plant enthusiasts in an accessible, non-destructive manner” (Schmidt 2011).

The RMRDH initially included records and images for approximately 3500 physical specimens stored in two locations -- MORU and Wind Cave National Park. Collections from Ft. Laramie National Historic Site and the Teton Science School (Markow- Murie Herbarium) have been added. Images were processed at the Digital Collections Lab, University of Wyoming Libraries, and are available through their Digital Research Collections website. A set of images was provided to the National Park Service as well.

The RMRDH offers a searchable web interface for access to high-resolution photographs and label data for specimens, as well as geo-referenced locations for many (<https://www-lib.uwyo.edu/digitalherbaria/index.php>, accessed May 2014). This information is available to the public, but records can be flagged to hide sensitive data. “The publicly available digital images of herbarium specimens have been well-received by the parks. The Northern Great Plains Inventory & Monitoring Program has found the images and corresponding database very useful for verifying park species lists and assisting with plant identification” (Schmidt 2012).

Methods

Nomenclature

NPSpecies relies on the Integrated Taxonomic Information System (ITIS; <http://www.itis.gov/>) as its primary source of taxonomic information. The USDA PLANTS Database (<http://plants.usda.gov/>) is another nomenclatural resource widely used by federal agencies. Both ITIS and PLANTS were evaluated before updating nomenclature for this project. PLANTS has been relatively inactive for several years, but now has new staff and is moving forward (pers. comm. to Marriott from M. Garland, Botanist, USDA NRCS National Plant Data Team). Both ITIS and PLANTS are incorporating Flora of North America (FNA) treatments as they become available, and thus are converging. ITIS also relies on current taxonomic experts and the Flora of North America Expertise Network, which provides periodic updates. For all these reasons, ITIS became the main nomenclatural source for this project.

NPSpecies and ITIS are linked in such a way that one simply chooses a name from ITIS to add or update a park species record. All relevant name fields are then filled. Parks are free to use names other than those accepted by ITIS, and synonyms can be included as well. During review, synonyms were added in some cases to show prior or other commonly-used names for taxa. Use of synonymy is addressed in Summary and Discussion below.

The RMRDH database currently does not link to a nomenclatural source and names must be entered by the user. Some name fields can be filled from pull down lists -- family, genus, specific epithet and authority.

During this project, a new field was added to the RMRDH database to track determinations and nomenclatural changes, as explained below in DETO Digital Herbarium Review and Update.

NPSpecies Review

The plant species list for DETO was reviewed and updated following the NPSpecies User Guide (National Park Service 2013). Marriott also consulted with Alison Loar, National Data Manager for NPSpecies, and Rene Ohms, Point of Contact for DETO.

Most records in NPSpecies were current with regards to nomenclature. For species requiring updates, prior names were kept as synonyms. In cases of misidentification, the reported taxon was assigned Not in Park (False Report) status, and the new taxon was added. Several species well outside their native range at DETO had been included due to data entry error during a vegetation mapping project (Salas and Pucherelli 1998); these were removed. Some records were redundant, for example records for full species and varieties (e.g. *Agropyron cristatum* and *Agropyron cristatum* var. *cristatum*). In these cases, the full species name was kept as a synonym for the subspecific taxon and the redundant record was removed.

Some species were not documented with known vouchers. These were assigned an Occurrence status of Unconfirmed and remain In Review (Record Status). Their status may be clarified when evidence applications for NPSpecies are available (see also Summary and Discussion below).

New park species records for DETO were added based on vouchers from surveys by Heidel and Marriott in 2007, 2008, 2012 and 2013. Searches of the RMRDH and the RM also produced new records (i.e. not all taxa collected for the DETO herbarium had been included in NPSpecies).

Occurrence status and nativeness status were reviewed for all plant species on the DETO list. Nativeness was updated based on the USDA PLANTS Database.

With NPSpecies up-to-date for DETO, the foundation was in place for generating plant brochures using the new reporting tools. Marriott worked with Rene Ohms, DETO Chief of Resource Management and NPSpecies Point of Contact, and Alison Loar, NPSpecies Data Manager, to design park-specific tags and a custom report template.

First we developed a set of park-specific tags to use to select plant species from NPSpecies and group them for the brochure. Tags are attribute fields for park species records:

“Each park species record is assigned attributes related to its status in the park; for example, its occurrence status, abundance, nativeness, and other designations. NPSpecies system-wide attributes and tags are standard categories and designations that apply across all parks and species. In addition, *parks can create their own custom attributes* [emphasis added], called “park tags,” and apply them to their park species records. For example, perhaps a park wants to set up a list of spring wildflowers, or identify the park subunits in which species occur. These types of designations are possible through park tags” (NPS 2013; *NPSpecies User Guide section 2.*).

DETO staff wanted a brochure with three lists of common species: wildflowers, trees/shrubs and grasses. To generate these lists from NPSpecies, we created the park tags shown in Table 3. Species were to be listed by common name, so we populated the Park Preferred Common Names field for all species flagged as common (NPS 2013; *NPSpecies User Guide section 4.5.6*).

Table 3. Park tags for the Devils Tower plant brochure. “Common” indicates whether a species will be included in the brochure. “Growth Form” is used to group species into lists: wildflowers (herbs), trees and shrubs (including vines), and grasses and grass relatives (graminoids). Ferns and fern allies are not included in the brochure, but can easily be added in the future (see discussion at end of section).

Tag Groups		
Common	Growth Form	Flower Color
Yes	Tree	Yellow
No	Shrub	White
	Graminoid	Blue / Purple
	Herb	Red / Pink / Rose
	Vine	Green or Inconspicuous
	Fern or fern ally	

An earlier wildflower checklist (Marriott 1995) and Marriott’s familiarity with the DETO flora were the basis for decisions as to which species to include, and Park Preferred Common Names. However, these can easily be changed in NPSpecies if needed (see Discussion below).

Once the necessary fields were populated, Marriott worked with Ohms and Loar to design a Park Custom Report for the plant brochure. Park Custom Reports are templates constructed by NPS data management staff at the request of and in consultation with park staff. Any custom reports for a park are available to users of NPSpecies online, on the Reports page. We designed a template that grouped plants by growth form, and for wildflowers, by flower color.

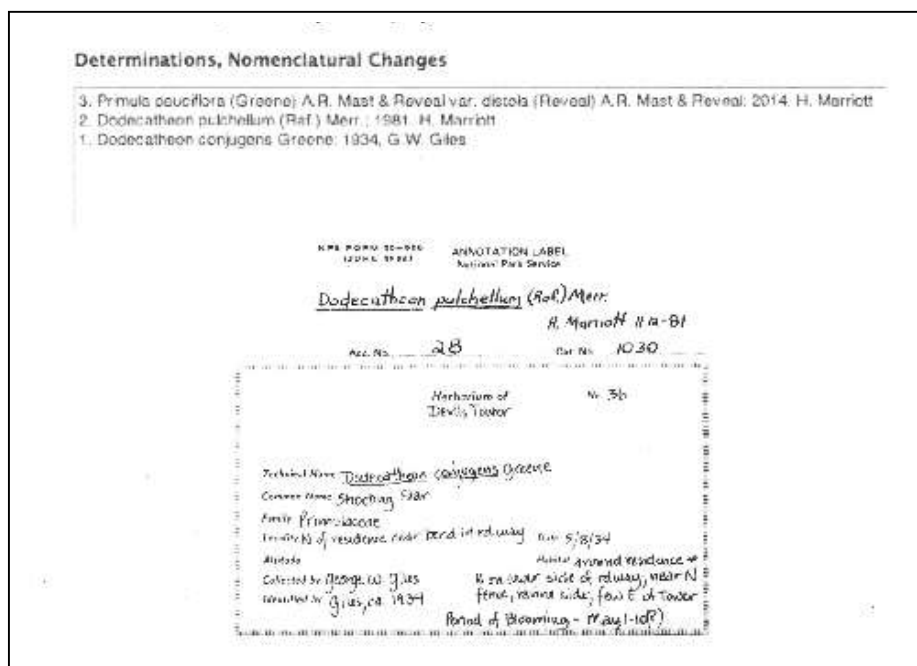
Review of DETO Digital Herbarium Specimens

The 800 records (specimens) already in the digital herbarium at the start of this project were reviewed, edited and updated. Many required nomenclatural changes, as most were collected before 1985. Others were redetermined based on recent taxonomic treatments. Some cleanup of miscellaneous errors was needed as well, which is not uncommon for large newly-digitized data sets.

When the DETO herbarium was digitized, original determinations (from specimen labels) were entered in name fields. Any annotations were included in a Notes field, along with what

was thought to be the current name based on USDA PLANTS. This information was reorganized during this project to follow recommended practices (e.g. Güntsch et al. 2009; Holetschek ca. 2009; Tschöpe et al. 2013). Name fields now contain the most recent determination or nomenclatural update. A field was added to track all annotations and nomenclatural changes, both physical (on the specimen) and digital (Figure 1). New records and images were added to the RMRDH for specimens collected by Heidel and Marriott in 2007, 2008, 2012 and 2013. The physical specimens were sent to MORU.

Figure 1. All names assigned to a specimen, past and present, were entered in the “Determinations, Nomenclatural Changes” field. To clarify, a photo of corresponding physical labels is included below. This specimen was identified as *Dodecatheon conjugens* ca. 1934, and annotated to *Dodecatheon pulchellum* in 1981. Marriott updated nomenclature in 2014; this last change is strictly digital.



Results

The known flora of Devils Tower National Monument now stands at 471 taxa (Appendix C). Another 11 taxa are unconfirmed and remain in review; their status may be clarified when evidence applications for NPSpecies are available. The list also includes 27 taxa that had been reported for DETO based on false or historical reports; they have been assigned an Occurrence status of Not in Park. They remain on the list to clarify history; this is especially useful for taxa that are difficult to identify. In total, 31 new taxa were added to the DETO plant list based on recent field work and herbarium searches.

Only three plant species collected at DETO are now considered historical, i.e. once no longer persisting (Table 1). Historical status was assigned judiciously. Without thorough inventory, it is difficult to argue that a species once present is extirpated. For example, *Elymus villosus* (hairy

wild-rye), previously known from the DETO area only from an 1897 collection, was flagged for survey (Fertig 2000) and found by Heidel in 2008. In addition, species can persist as seed, or may grow in the general area, occurring occasionally within the park. For these reasons, several species previously reported as historical for DETO were reclassified as present (also in Table 3).

Table 4. Historical plant species of Devils Tower National Monument

Now considered historical		
<i>Silene menziesii</i>	Menzies' campion	Campground, 1962. Not seen in 50+ years; disturbance frequent in campground
<i>Salix exigua</i> var. <i>exigua</i>	sandbar willow	Sand bars in Belle Fourche River, 1962. Not seen in 50+ years; habitat lost due to dam upstream (Keyhole Reservoir)
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	spotted knapweed	Campground, 2012. Very small population; eradicated
Previously considered historical		
<i>Verbesina encelioides</i>	golden crownbeard	Prairie dog town, 1977. Occurs in surrounding area; may persist as seed
<i>Secale cereal</i>	annual rye	Base of bridge, 1981. Occurs in surrounding area

At present, 70 non-native taxa have been documented in the park, representing 15% of the known flora. Most are minor components of the vegetation, or are restricted to disturbed areas. Designated noxious species are shown in Table 4.

Table 5. Designated noxious plant species of Devils Tower National Monument (Wyoming Department of Agriculture 2003; Crook County Weed Control 2007)

Species	Nativeness	Designated Noxious
<i>Arctium minus</i>	Non-native	WY, Crook Co.
<i>Carduus nutans</i>	Non-native	WY, Crook Co.
<i>Cicuta maculata</i> var. <i>angustifolia</i>	Native	Crook Co.
<i>Cirsium arvense</i>	Non-native	WY, Crook Co.
<i>Cirsium vulgare</i>	Non-native	Crook Co.
<i>Conium maculatum</i>	Non-native	Crook Co.
<i>Convolvulus arvensis</i>	Non-native	WY, Crook Co.
<i>Cynoglossum officinale</i>	Non-native	WY, Crook Co.
<i>Elymus repens</i>	Non-native	WY
<i>Euphorbia esula</i> var. <i>uralensis</i>	Non-native	WY, Crook Co.
<i>Kochia scoparia</i>	Non-native	Crook Co.
<i>Lygodesmia juncea</i>	Native	Crook Co.
<i>Melilotus officinalis</i>	Non-native	Crook Co.
<i>Onopordum acanthium</i>	Non-native	WY, Crook Co.
<i>Ranunculus testiculatus</i>	Non-native	Crook Co.
<i>Salsola tragus</i>	Non-native	Crook Co.
<i>Verbascum Thapsus</i>	Non-native	Crook Co.

Discussion

Review of online botanical resources for DETO proved justified. Many records had to be edited to make the digital herbarium and NPSpecies up-to-date and consistent. Revisions included nomenclatural updates, corrected misidentifications, new determinations based on new taxonomic treatments, and deletion of obvious false reports and redundant records. The plant list was expanded with 22 additions from field work and nine from herbarium searches. The confirmed flora of DETO now stands at 471 taxa.

Unconfirmed Taxa

Eleven plant species on the DETO list are considered unconfirmed and remain in review; there are no known vouchers at this time. The status of some may be clarified when evidence applications for NPSpecies are available. However, at least several are known to be based solely on written reports. It is highly recommended that park species records be backed by voucher specimens; indeed, best practices require vouchers as verifiable records (e.g. Beaman and Cellinese 2012; Utah State University 2014). All botanists are guilty of misidentification on occasion, especially in difficult groups such as sedges (*Carex*), composites (Asteraceae) and grasses (Poaceae). In addition, taxonomic revision may split or redefine taxa; without a voucher, it would be impossible to determine whether a taxon occurs in DETO.

Synonymy

When plant names in NPSpecies were updated, prior names were kept as synonyms unless they were misidentifications. Park staff may wish to consider setting a policy for synonyms. It is not the responsibility of the park to maintain all synonymy; that service is provided by ITIS. The NPSpecies User Guide suggests that synonyms include names that “may have been used to identify the park species in the past, or that may be used in other regions or by other taxonomic classification systems” (National Park Service 2013).

Plant Names and Data Entry

As described in Methods (Nomenclature), NPSpecies is linked to ITIS in such a way that all name fields are filled when a taxon is selected. In contrast, name fields in the RMRDH database are filled individually by the user. Ideally the RMRDH would be linked to a nomenclatural source such as ITIS or USDA PLANTS, with the option of using a synonym instead of the standard name. Name fields could then be filled automatically, as in NPSpecies. This would greatly help with consistency, and would minimize data entry error.

Common Names

The RMRDH database includes a Common Name field, and common names from USDA PLANTS were entered during herbarium digitization. They were not reviewed during this project, for several reasons. A review of conventions for common names is provided by Kartesz and Thieret (1991) with recommendations, but there are many different approaches and not a single authority. The most widely-used national references, USDA PLANTS, ITIS and FNA are

not always in agreement. In addition, whenever a specimen in the digital herbarium is annotated, the common name would have to be changed as well, and yet most taxonomists ignore common names. If the RMRDH were linked to a nomenclatural source such as ITIS or USDA PLANTS, common names would be included whenever scientific names were entered or changed.

In NPSpecies, common or colloquial names are supplied by ITIS when a scientific name is chosen. There also is a Park Preferred Common Name field, to be filled by park staff. This is a useful feature, as common names for a given species often vary across the NPS system. If this field is empty, ITIS common names, often multiple per species, are included in species lists. Park Preferred Common Names currently are not used by DETO. Populating this field would be a good next step to improve NPSpecies functionality for website and park visitors.

NPSpecies Park Custom Report and Brochure

With the Park Custom Report created in NPSpecies, DETO plant checklist brochures can be generated as needed, and a link can be added to the park website for downloading. Content will change whenever NPSpecies is updated, with no need to compile and format new lists. The template can be modified as well, as staff learn more about visitor needs and interests. For example, the park may wish to include fields for habitat and blooming period. This new dynamism and convenience of NPSpecies has the potential to provide staff, researchers and visitors with easy access to current information about the park flora.

Other Projects

Herbaria for other NPS units in the Black Hills have been digitized and are ready for review. Park records in NPSpecies also may need to be reviewed, if park staff have not already done so. Much of the groundwork is now in place, and projects at other units can focus on updating online botany resources rather than developing methodology.

Overall Summary and Discussion

Devils Tower National Monument has a documented flora of 471 species, a high diversity of vascular plant species for an area of 545 ha (1347 ac; 2.1 mi²). This does not include three documented species that are since extirpated. Essentially, over a third of the vascular plant species known from the Black Hills have been collected in DETO. This size flora is on par with much larger national park units. It reflects the overlap of Great Plains and Rocky Mountain floras, northern and southern elements, a diversity of both terrestrial and wetland habitats. It also includes many of the non-native species known from the Black Hills.

The tasks of updating the NPSpecies database and the RMRDH, and annotating MORU specimens, contributed significantly to the scope of work. The development of online herbarium databases provides tremendous study tools that have all the more value with technical review to increase accuracy.

Taxonomic editing work is imperative but no substitute for staff interest and vigilance, as in the case of the NPS employee who alerted researchers to the presence of spotted knapweed

(*Centaurea maculosa*) in the campground and those employees who took action to eradicate it. Staff and visitors, newly-armed with information on the DETO flora, are some of the best prospects for detecting species invasions. Everyone from web designers to park naturalists are essential in making this information available to staff and visitors.

If restoration plantings get underway in the limited areas of DETO that had been plowed, then it would be appropriate to maintain a record of all plant materials and their sources, especially if they include cultivars rather than locally harvested seeds, and noting the dual status of such native species that are both indigenous and introduced as recorded in NPSpecies.

Additions to the DETO flora have been documented but possible losses to the flora have not been addressed, with the exception of historical species. In addition, one Wyoming species of concern was not relocated during surveys, cut-leaved evening-primrose (*Oenothera laciniata*), but the timing and extent of survey are incomplete for documenting extirpation. Showy species previously reported from near developments might warrant re-survey, as would species sensitive to recent prescribed burn or herbicide practices that have not been documented in vegetation monitoring.

The DETO flora is more than a task list item of the NPS inventory and monitoring program. It is integral to gauging most of the DETO vital signs (Drazkowski et al. 2011). Is the flora stable, expanding or contracting, and how does this differ among plant groups? Our work confirms that the flora is dynamic. The flora is a fundamental natural resource that represents new opportunities to enhance visitor appreciation and understanding, and is essential in meeting DETO management objectives.

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