STATUS REPORT ON SENSITIVE PLANT SPECIES

OF FEN HABITATS,

BIG HORN MOUNTAINS, NORTH-CENTRAL WYOMING

Prepared for the Bighorn National Forest
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ABSTRACT

Systematic surveys were conducted for sensitive plant species in fen sites of the Big Horn Mountains, Bighorn National Forest. Less than a decade ago, only three such sites were known from the Mountains; two of which were based on historic collections. In this study, four different approaches were taken to document known sensitive species sites and locate new ones. As a result, 30 extant occurrence records of six sensitive plant species in fen settings and 22 more occurrences of four other Wyoming species of concern ("rare") species in fen settings are now known. The information is expanded as a synthesis of status information needed to assess species conservation needs on Bighorn National Forest, highlighting statewide information. All three ranger districts have occurrences of sensitive/rare fen plants, with the Tongue River Ranger District having the highest numbers and diversity of sensitive fen plants, reflecting the relatively extensive and diverse fen habitats and extent of glacial deposits. Preliminary results suggest that fen habitats are widespread but not abundant, and that the sensitive/rare plant species within them are highly restricted to a small subset of sites. New data on sensitive/rare fen plant species from Bighorn National Forest significantly contributes to understanding sensitive/rare fen species status in the Forest, state, and U.S. Forest Service Rocky Mountain Region.

ACKNOWLEDGEMENTS

The field surveys in this study were conducted with the help of Jim Zier, whose original discoveries pre-date the study and greatly advanced it. The identification of potential peatland sites was recorded by Dan Scaife and Amy Nowakowski, other GIS information layers were provided by David Anderson, and field surveys by Bighorn National Forest seasonal botanists including Susan Bell, Sarah Evans-Kirol, Tucker Galloway and Matthew Spann contributed significantly. On-site field visits provided discussion opportunities with Chris Williams, Amy Nowakowski, Michael Bower and Bernie Bornong, Bighorn National Forest. The coordination of Bernie Bornong was instrumental at all stages. This work reflects on previous studies of the same species in other national forests, the support and discussions with many people in Region 2, and a compendium of Yellowstone National Park collections provided by Jennifer Whipple. Joy Handley (Wyoming Natural Diversity Database; WYNDD) coordinated GIS work before and after fieldwork. Annie Munn (WYNDD) assisted in preparations before the field season and in preparing report tables. The facilities and resources of the Rocky Mountain Herbarium and expertise of Ronald Hartman and B.E. Nelson are gratefully acknowledged. This study was one in a set of five botanical studies conducted in through a challenge cost-share agreement between Bighorn National Forest and Wyoming Natural Diversity Database, University of Wyoming.

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Cover photo: Sawmill Lake Fen has the highest known concentration of fen sensitive/rare plant species in Bighorn National Forest., photo by B. Heidel

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INTRODUCTION

The project purpose is to systematically survey the sensitive fen plant species of Bighorn National Forest (the Forest), in addition to any other Wyoming plant species of concern that might occupy fens, and report on their Bighorn National Forest status. Throughout this report, the targeted fen plant species are collectively referred to as sensitive/rare species, and they include species of local concern recognized by the Forest. Elsewhere in Wyoming, fens harbors high concentrations of species designated as sensitive by the Rocky Mountain Region (U.S. Forest Service Region 2; U.S. Forest Service 2011). This includes 16 sensitive plant species and 45 other Wyoming plant species of concern (Heidel and Jones 2006, Heidel 2006, Heidel et al. 2010). Rare fen species may occur together in highly specialized habitat, making joint survey of them more effective than surveying for them individually.

Up until recently, there were only three sites known for sensitive fen/rare plants on Bighorn National Forest. Two fen species, lesser bladderwort (*Utricularia minor*) and mud sedge (*Carex limosa*) were known only from historic collection records in the vicinity of Meadowlark Lake in the Tensleep watershed dating back to 1951 and 1963. In 1982, Erwin Evert discovered both woodland horsetail (*Equisetum sylvaticum*) and russet cottongrass (*Eriophorum chamissonis*) for the first time in the Big Horn Mountains at a site later designated as Preacher Bog Special Botanical Area located in the West Fork of Big Goose Creek watershed, where detailed studies were later pursued (Neighbours and Culver 1990, Morstad 1997).

In 1997, a vegetation classification of riparian communities on the Bighorn National Forest was developed (Girard et al. 1997). It placed all vegetation types into potential (climax) vegetation, referred to as ecological type, and seral vegetation, referred to as community type. One of the 53 vegetation types identified was the Beaked sedge – Mud sedge c.t. (*Carex rostrata – Carex limosa* c.t.) It was documented in the course of vegetation sampling at two sites in the North Tongue River watershed, and the setting described simply as "bogs." There was no soil characterization included with the community type characterization, or sensitive species recorded, but the word "bog" generally refers to a peat-accumulating wetland.

Bighorn National Forest botanists doubled the number of sensitive/rare fen species sites from three to six between 2003-2006. Starting in 2006, reconnaissance fieldwork was conducted by Jim Zier, University of Wyoming doctoral graduate student, to evaluate potential thesis study sites for paleontology research. He documented well-developed fen sites in the West Fork of Big Goose Creek watershed. He also found two sensitive plant species not previously known from the Forest (Zier 2010) including English sundew (*Drosera anglica*) and lesser panicled sedge (*Carex diandra*), and new locations for the two species previously known from historic records on the Forest, mud sedge (*Carex limosa*) and lesser bladderwort (*Utricularia minor*).

All but two of the seven previously-mentioned species are designated sensitive by Region 2 of the U.S. Forest Service (USDA Forest Service 2011a; not *Carex limosa* or *Equisetum sylvaticum*). All five of the sensitive plant species have been addressed in Region 2 species conservation assessments, in which inventory work was identified as a major need throughout most of Region 2 for each of the species.

Systematic fen inventories were effective in documenting new occurrences of sensitive fen plants on the Medicine Bow and Shoshone National Forests (Heidel and Jones 2006, Heidel et al. 2010). In these studies, multi-species inventories of fen sensitive species were particularly effective insofar as they had overlapping distribution and habitat requirements. The current project was designed to apply the body of general information, and techniques on finding fen habitats in different landscapes. The overall purpose was to conduct inventories of sensitive species to improve knowledge of distribution and status, and provide the background information needed to consider responses to management activities on Bighorn National Forest. This is consistent with the need for inventory identified in each of the species conservation assessments for sensitive fen plants on Bighorn National Forest.

BACKGROUND INFORMATION ON FEN HABITAT

Peatlands are defined by three criteria: peatland soils comprised of undecayed plant material (histosols), peat depth (minimum of 40 cm [15 in] continuous profile; USDA Soil Conservation Service 1992, Richardson and Vepraskas 2001), and characteristic vegetation made up of hydrophytes (U.S. Army Corps of Engineers 2011). They are identified as essentially irreplaceable ecosystems in the R2 Forest Service Manual as amended (USDA Forest Service 2011b). Peat accumulates under stable hydrology to keep soils saturated at or near the surface, and a peatland meeting the three criteria above is a wetland system where the self-perpetuating process prevails. At boreal and subarctic latitudes, as in Alaska and northern Canada, peat can accumulate under incipient precipitation levels where climate conditions include cool annual temperatures, humid climates, and short growing seasons; allowing peat to develop faster than it can be decomposed.

At temperate latitudes, including the Rocky Mountains of the United States, stable groundwater conditions are needed to maintain peat accumulation, counteracting moderate annual temperatures and aridity during the growing season. Peatlands that are hydrologically maintained by groundwater rather than precipitation are fens, whereas peatlands that are supported mainly by precipitation are bogs. The latter term has been applied colloquially to fens, a source of confusion. Fens have relatively high pH and are richer in nutrients than bogs because water reaches them after flowing through the soil, from which it absorbs nutrients. These peatlands are also known as flow-through peatlands, and they form in either basin or sloping settings (Rydin and Jeglum 2006). The term “fen” as used in this report refers implicitly to a discrete wetland site that meets all soil, peat depth and vegetation characteristics of groundwater-fed peatland.

Fens can support a disproportionately high number of rare plant species and uncommon vegetation types due to their limited distribution, and exacting environmental conditions that combine nutrient-poor, anaerobic water chemistry with hydrological stability. In the Rocky Mountains of the United States, fen floras and vegetation consist of many vascular plant species and bryophytes that are more typical of boreal regions of Alaska and Canada and that are otherwise absent from wetland habitats in surrounding areas. Many fen plants are considered disjunct from the core of their range, and sparse in the cordilleran landscape. Fens of the United States have received attention because of their unique floras and vegetation (highlighted for the northern Rocky Mountains in Chadde et al. 1998), paleoecological records, and ecosystem

services (Bedford and Goodwin 2003). More detailed documentation of fen biodiversity and functional attributes are presented by Bedford and Goodwin (2003), Chadde et al. (1998), and highlighted in the USDA Forest Service peatland policy (USDA Forest Service 2011b). At present, about 10% of the Wyoming plant species of concern (including 16 Region 2 sensitive plant species, and 34 additional Wyoming species of concern) are associated with fen habitat (Heidel 2006, with updates).

STUDY AREA

The Bighorn National Forest study area lies in north-central Wyoming, encompassing mid- and upper elevations of the Big Horn Mountains, lying at the head of seven major watersheds of the Upper Missouri River Basin (Figure 1). The Big Horn Mountains lie about 121 km (75 miles) east of the Rocky Mountain chain, measuring approximately 129 km (80 miles) long and 48 km (30 miles) wide, rising 2800 -3100 m (9190-10,170 ft) above the Big Horn Basin to the west and the Powder River Basin to the east, respectively. They taper to the north, barely entering Montana, and are confluent with the Owl Creek Mountains at the south end. The Bighorn National Forest spans Big Horn, Johnson, Sheridan and Washakie counties. The crest of the range marks the boundary between the two eastern and two western counties.

The Big Horn Mountains were uplifted during the Laramide orogeny which began about 70 million years ago near the end of the Cretaceous period and continued into the middle Tertiary. These mountains are flanked by thrust faults to the east and west. They arose later than the Beartooth and Wind River mountains to the west, but before the Black Hills to the east. The Mountains trend north-northwest to south-south east, with three structural segments representing three separate basement blocks forming a somewhat crescent-shaped anticlinal massif (Butcher et al. 1933, Wilson 1938; discussed in Despain 1973, and Lageson and Spearing 1988).

The core of the range including the highest peaks are composed of Precambrian granite , and Paleozoic and Mesozoic sedimentary formations outcrop on the eastern and western flanks and opposite ends of the range. The Big Horn Mountains were repeatedly glaciated during the Pleistocene, and deglaciation was complete by 13,000 years ago (Porter et al. 1983). Glacial activity was concentrated at the highest elevations and glacial deposits encircle the central granite peaks, but moraine deposits can be found as low as 6500 ft (Darton 1906). Differences in modern snowpack among ranges closely relate to differences in late-Pleistocene glaciations thresholds (Porter et al. 1983), placing the Big Horn Mountains at the lower end of the longitudinal gradient. Winters et al. (2007) described the affects of glaciations on wetland features and hydrology:

> "Melting of ice at the glacial terminus as well as the formation of ice margin terraces has produced hundreds of kettle basins in the Big Horn Mountains, which support seasonal and permanent ponds and lakes, marshes and fens. These wetlands are critical habitat for amphibians, waterfowl, and many plant species. Glacial moraines are the largest bodies of unconsolidated material in many parts of the Big Horn Mountains, and store large volumes of groundwater, which is recharged annually by snowmelt. Where this water discharges in valley bottoms, it has led to the formation of fens and [other] wetlands, augments stream flows, and moderates instream temperatures during summer."

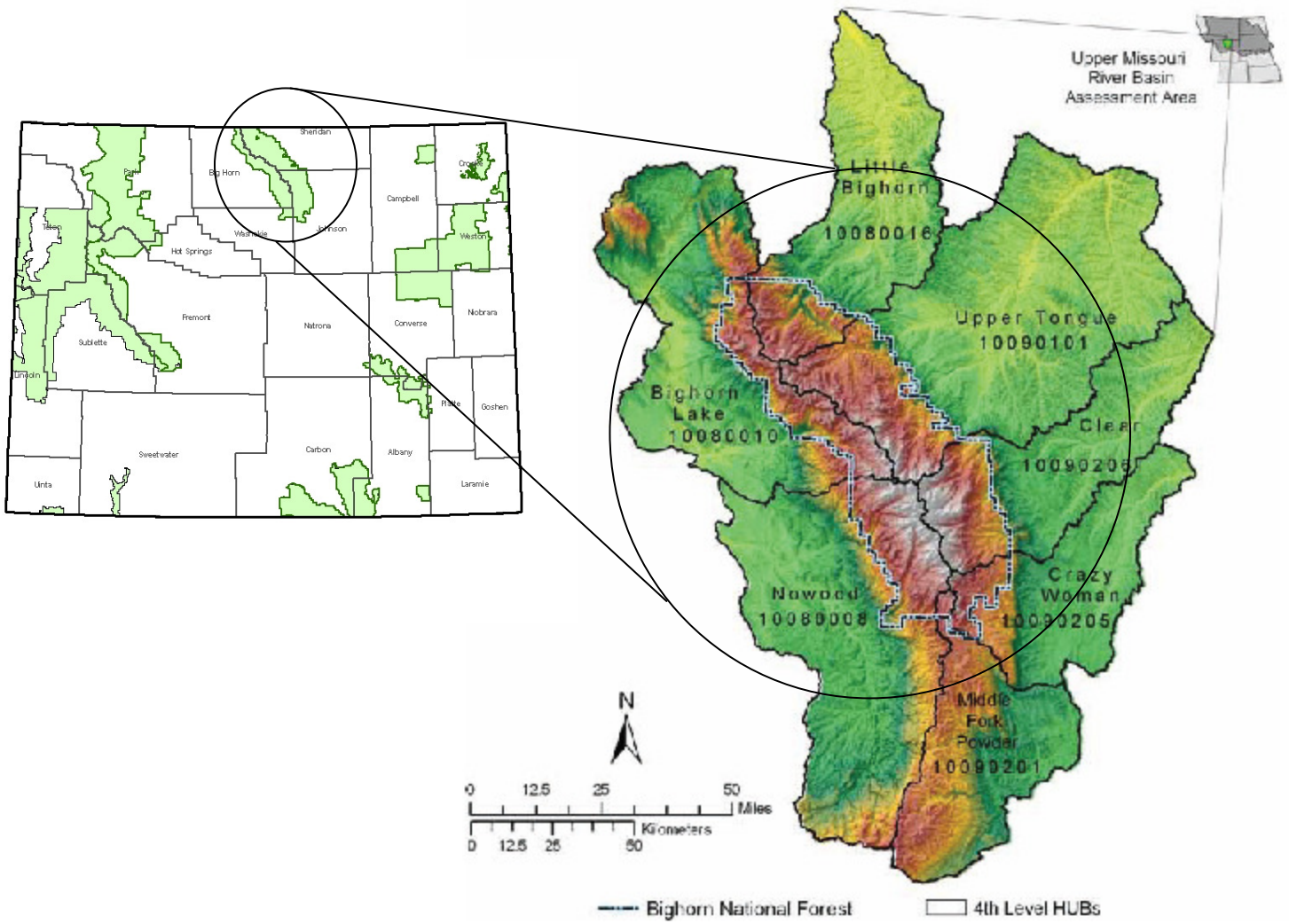


Figure 1. Bighorn National Forest study area (watershed map insert reprinted from Winters et al. 2007)

The influence of substrate parent material on terrestrial vegetation of the Big Horn Mountains across foothills and montane zones was documented by Despain (1973) and a literature review provided of all earlier Bighorn vegetation studies. He described the prevalent forest as dominated by lodgepole pine (*Pinus contorta*), and identified the distinction between calcareous and non-calcareous bedrock as a major distinction in vegetation distribution. A habitat type classification was developed for terrestrial vegetation of the Big Horn Mountains across foothills and montane zones by Hoffman (1975). These studies are the most complete terrestrial vegetation descriptions in the Bighorn National Forest, later modified into a land type classification used for Bighorn National Forest management purposes.

More recent investigations have synthesized information on the natural disturbance regimes and anthropogenic influences on Bighorn National Forest uplands, to come up with an analysis of the historic range of variability, both within stands and across landscapes, at high and low elevations (Meyer et al. 2005). This provides an excellent literature review on large-scale and frequent disturbances having potential affect on wetland systems.

The first thorough characterization of palustrine and riverine vegetation of the Big Horn Mountains was presented in a habitat type classification on Bighorn National Forest developed by Girard et al. (1997). For management purposes, the palustrine and riverine systems were collectively called riparian vegetation, said to comprise about 6% of Bighorn National Forest. The authors recognized 23 ecological types (potential natural vegetation) and 30 community types (seral vegetation, or at least not documented to be climax). Of those 53 types, at least two are described as sometimes having soils high in organic matter: Beaked sedge –Aquatic sedge c.t. and Beaked sedge – Mud sedge c.t. The first explicit statements about the presence of fen habitat in the Bighorn National Forest appeared in Winters et al. (2007) based on the inclusion of fen indicator species among sensitive/rare species known from the Forest and on field reconnaissance by the authors. More recently, digital wetland vegetation mapping was completed for the Big Horn Mountains and the rest of the state through the National Wetlands Inventory (NWI), using LANDSAT color infrared imagery and a classification system based on Cowardin et al. 1979.

Soils data was not collected in documenting Bighorn National Forest riparian vegetation (above). For purposes of this study, we just used surface geology layers that recognize the distinction between calcareous and non-calcareous lithologies. This follows the precedent of Winters et al. (2007) who organized the analysis around differences in calcareous/non-calcareous surficial soils as significantly influencing aquatic, riparian and wetland ecology.

The Burgess Junction, Wyoming weather station (481220) provides a general characterization of temperatures in the Big Horn Mountains (NOAA 2005). Burgess Junction has mean monthly annual temperature of 0.7ºC (33.4ºF), with highest mean monthly temperatures of 12.9ºC (55.2ºF) in July and lowest mean monthly temperatures of -8.5ºC (16.7ºF) in January. Nevertheless, the Big Horn Mountains and the Black Hills both have climates that differ from other Wyoming mountain ranges in having hot summer conditions

at montane elevations during a significant part of the growing season (15-21 days) with maximum temperature above 32ºC (90ºF; Curtis and Grimes 2004; based on PRISM, 1961-1990).

Peak precipitation is usually in April, averaging 6.8 cm (2.7 in). An estimated 53% of total annual precipitation falls as snow, with an average annual snowfall of 616.7 cm (242.8 in). Most of the year's moisture supply comes from snow following melt-off. In general, precipitation in the Big Horn Mountains varies with elevation. Annual precipitation increases with elevation in the mountains from about 38 cm (15 in) at 1524 m (5000 ft) to about 63 cm (25 in) at 2744 m (9000 ft; Hoffman and Alexander 1976), to as much as 102 cm (40 in) on the higher peaks (Girard et al. 1997). Precipitation in the Big Horn Mountains also varies from east to west sides; the eastern side receives much more precipitation, and the western side is more exposed to desiccating prevailing westerly winds. Finally, the water content of snow increases from south-to north, so that there is also a north-south precipitation gradient (USDA snow-survey data, in Despain 1973).

In general, the Big Horn Mountains have lower snowpack than mountains further west (Porter et al. 1983) that support fens. It is possible that the relatively low winter snowpack or the high number of hot summer days (average of 15-21 days/year with maximum daily temperature exceeding 90ºF; Curtis and Grimes 2004) fosters a climate regime that can lead to peat desiccation, as well as a fire regime that burns surface peat more than in the mountain ranges of previous Wyoming fen studies (Beartooth, Medicine Bow, Wind River Mountains, Yellowstone National Park).

METHODS

The species targeted in this study included all known sensitive/rare species documented to data, and any other Wyoming species of concern considered to be facultative or obligate fen species in the state (Heidel 2006). The first challenge in conducting the survey was developing the methods for identifying potential habitat. The first two steps in identifying targets (below) were conducted prior to the 2009 field season for pilot fieldwork that included testing and refinement. The rest of the steps for identifying targets were conducted prior to the 2010 field season, and refined as needed during fieldwork.

Identifying potential habitat to survey

Four sources of information were used to identify potential fen habitat in order to systematically survey sensitive fen plants.

1. Existing sensitive/rare records of fen plants were considered as targets for surveying additional associated species. At the start of this project, information on the habitat and distribution of known sensitive plant species was compiled and reviewed in the Rocky Mountain Herbarium on-line database and the Wyoming Natural Diversity Database in-house database. The botanical survey results by Bighorn National Forest employees were also incorporated, including two locations of russet cotton-grass (*Eriophorum chamissonis*) and one of wood horsetail (*Equisetum sylvaticum*). Specimen work by Jim Zier was underway incidental to his research, and he shared information on the sensitive/rare species additions he

had documented. There were less than ten fen sites known to support sensitive/rare plant species at the start of this project.

Many of the sensitive/rare fen species in Wyoming are fen obligates, meaning that they are restricted to fen habitats. There are also species that are sometimes in fen habitats, and they are considered to be facultative fen species. We also included wood horsetail (*Equisetum sylvaticum*) because it was known from Preacher Bog Botanical Area, a fen site, and large-leaved pondweed (*Potamogeton amplifolius*), which has been found in open water zones of fen habitat elsewhere in Wyoming. Although this study did not address alpine elevations, two additional rare species of alpine fen habitat were noted to ensure they were not overlooked in upper elevation work, short-leaf sedge (*Carex misandra*) and Nelson's sedge (*Carex nelsonii*). The reference list of species and the watershed in which they are known is represented in Table 1.

Table 1. Target list of sensitive/rare fen species in Bighorn National Forest

Scientific Name	**Common Name**	**U.S. Forest Service Status**	**Watershed**
Carex diandra	Lesser panicled sedge	Sensitive	Upper Tongue
Carex limosa	Mud sedge	Bighorn NF SOLC	Nowood
Carex misandra	Short-leaf sedge	Bighorn NF SOLC	Nowood
Carex nelsonii	Nelson's sedge	-	Upper Tongue
Drosera anglica	English sundew	Sensitive	Upper Tongue
Equisetum sylvaticum	Wood horsetail	Bighorn NF SOLC	Clear, Upper Tongue
Eriophorum chamissonis	Russet cottongrass	Sensitive	Upper Tongue
Potamogeton amplifolius	Large-leaved pondweed	Bighorn NF SOLC	Upper Tongue
Utricularia minor	Lesser bladderwort	Sensitive	Nowood, Upper Tongue

There were questions whether to retain Wyoming plant species of concern being considered for removal from tracking. In the case of mud sedge (*Carex limosa*), by 2010 it was already known from over 20 occurrences in the state. It was retained because it was considered a fen obligate, often a dominant in discrete portions of fen habitat, only known from one historic record and one recent discovery on Bighorn National Forest, and data on it from Yellowstone National Park had yet to become available to evaluate whether it warrants tracking as a species of concern. Sweetgrass (*Hierochloe odorata*; syn. *Anthoxanthum hirtum*), a "Demand" species, was also noted.

Also considered were data on bryophytes collection locations that might be indicators of fen habitat (Lenz 2010). This report was referenced but not used routinely in identifying potential habitat sites to survey, with the exception that the one known location of *Warnstorfia tundrae* was considered because it is the only known location in the Lower 48 States, and collection label information explicitly described its habitat as fen (Lenz 2006).

2. Bighorn National Forest staff identified 12 sites identified as potential peatland sites, provided as a list and accompanying GIS file. The GIS theme of potential peatland sites was not accompanied by any information. Two of the sites were also sensitive/rare plant sites in the first set (Graves Lake, Preacher Rock Bog). The 12 sites are represented in Table 2 and Figure 2.

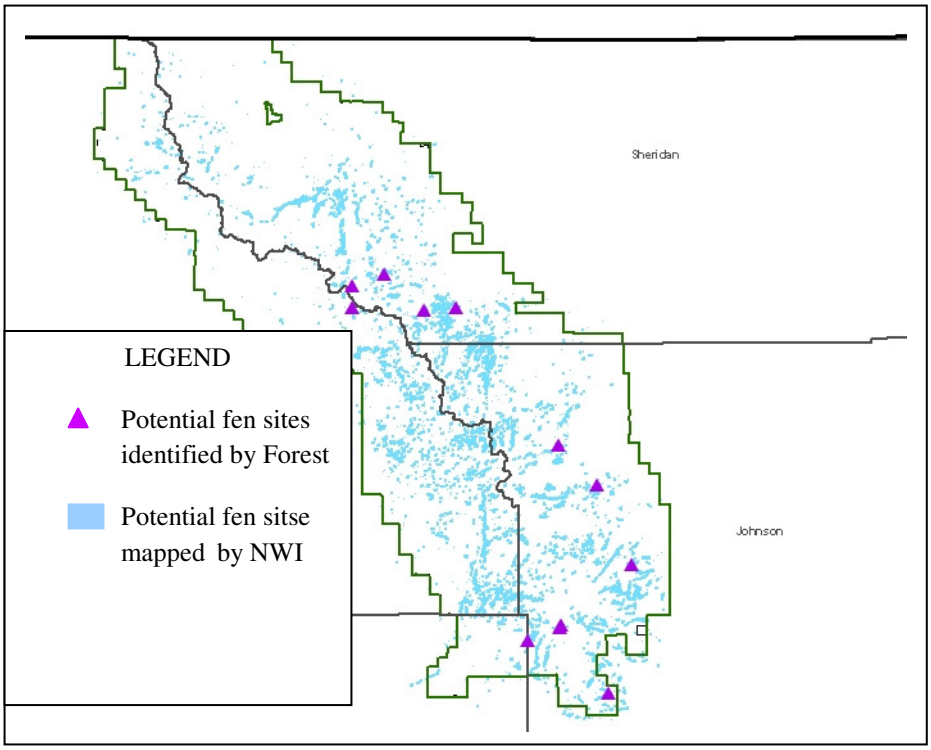


Figure 2. Potential fen sites identified by Bighorn National Forest staff and by National Wetlands Inventory mapping

Table 2. Target list of potential fen sites identified by Bighorn National Forest staff

Site	**Watershed**
Graves Lake	Upper Tongue
Doyle Creek area	Crazy Woman
Canyon Creek area	Nowood
Hesse Creek head	Middle Fork Powder
Powder River head	Middle Fork Powder
Little Sourdough Creek	Clear
French Creek Swamp	Clear
Frying Pan Lake	Clear
Preacher Rock Bog	Upper Tongue
Upper Snail Creek	Upper Tongue
Granite Creek area	Upper Tongue
West Bruce Creek area	Upper Tongue

3. The National Wetlands Inventory (NWI) mapping, recently completed for all of Wyoming (USDI Fish and Wildlife Service 2009, Copeland et al. 2010), identified peatlands in a single mapping unit (PEMB represents **P**alustrine **EM**ergent wetland with **B** - saturated soils at or just below the surface). A map that shows NWI peatland mapping with potential fen site identified by Bighorn National Forest staff superimposed is shown in Figure 2. By clipping the map product close to Bighorn National Forest boundaries, and selecting out the PEMB unit, it was determined that there are over 6000 discrete polygons mapped as peatland on the Forest, and they represent over half of the wetlands mapped on Bighorn National Forest.

4. Photointerpretation was conducted using digital color infrared aerial orthophotographs (CIR) flown in 2000 (Mr. SID) to identify and prioritize potential peatland sites. Aerial imagery for the entire Bighorn National Forest was reviewed with the digital themes superimposed that represented the three previously-mentioned sources of information (sensitive plant distribution, potential peatland sites reported by Bighorn National Forest staff, and NWI peatland mapping). Review was conducted by taking the boundaries of each quarter-quad map (dividing each USGS topographic 7.5' map into quarters), superimposing section lines, and first reviewing all rare plant occurrences to look for repeating signatures that might represent diagnostic vegetation features, while considering all sites identified by Bighorn National Forest staff or mapped by NWI.

Photointerpretation proved to be an integrative process that also incorporated secondary criteria based on 2009 reconnaissance inventory and inventories conducted elsewhere in the state to set priorities.

a. Size: A break in size values was sought that would separate up to 10% of the largest fen sites from the rest of the sites. There were no sharp breaks and 68 polygons were mapped as greater than about 8 ha (20 ac); of these 14 were mapped as greater than about 20 ha (50 ac). By comparison, the largest documented fen site in the Medicine Bow Mountains is about 16 ha (39 ac), and the largest fen site in the Beartooth Mountains is over 80 ha (200 ac).

b. Coloration, texture and hydrological patterns: High levels of photosynthetic activity late in the growing season, smoothness of texture within vegetation zones, decoupling of inflow/outflow features from vegetation zones were general characteristics used to prioritize fens sites.

c. Diagnostic vegetation features of peatlands: floating mats, solifluction patterns, drainage impediment patterns

All quarter-quad maps spanning montane and subalpine elevations of Bighorn National Forest were reviewed. Each section of each quarter-quad was scanned at about 1:24,000, zooming in to about 1:5000 or closer to inspect wetlands with rare plant occurrences, wetlands identified as potential peatland sites by Bighorn National Forest taff, or wetlands mapped by NWI as peatland. Notes on sites meeting the three criteria above were compiled.

The results were used to identify survey targets, organized by quarter-quad, cross-referenced to the methods by which they were identified. Essentially, all rare fen species and

potential fen sites identified by Bighorn National Forest staff were automatic priorities. Large sites mapped by NWI as peatland were included in priorities. Sites with diagnostic vegetation features indicating well-developed habitat were identified, including floating mats and patterning, and were made priorities to the degree that the feature(s) could be identified with confidence. The majority of sites mapped as peatland did not have large size or diagnostic features, but a premium was also placed on surveying all watersheds of Bighorn National Forest that were mapped as having high peatland density.

In preparation for fieldwork, CIR aerial imagery was printed out by quarter-quad, superimposed with the three different information sources, for all quarter-quads on the Bighorn National Forest outside of the alpine zones (Cloud Peak Wilderness Area). The printing of quarter-quads onto 8 ½" x 11" pages of paper was at almost the same scale as USGS topographic 7.5' maps (1:24,000), simplifying the matter of cross-referencing between aerial imagery and cartography. The paired aerials and maps were used for reference in setting field survey priorities before fieldwork and for navigation in the field, and used in concurrent WYNDD survey projects for sensitive/rare upland plant species.

Conducting surveys

Pilot fieldwork began in 2009 with surveys at two of Jim Zier's thesis sites for rare plants by Heidel and Zier on 13 August. Surveys were also conducted at Preacher Rock Bog Special Botanical Area and vicinity by Heidel (12 and 14 August). At each site, the sensitive plant targets were surveyed to determine precise location and extent, habitat conditions, associated species, and collective placement of sensitive species targets in the wetland feature as a whole. The compendium of sensitive species information provided a geo-referenced dataset for photointerpretation and ensuing fieldwork.

The 2010 field surveys began in early July when flowers and fruits were available for determinations, and ran through the growing season, from 6 July – 24 September. At each surveyed wetland site, the aerial photograph was referenced to plan the survey, including a traverse of all potential fen vegetation zones identified with emphasis on specialized habitats. An initial GPS point was taken at the wetland margin to document wetland location and the coordinates were recorded.

The next task was to determine whether or not fen habitat is present. This began by taking peat cores with a coring instrument in major vegetation zones and checking for both saturated surface conditions and fen vegetation. It was later abbreviated to checks for saturated conditions and fen vegetation.

In general, if a site did not have fen habitat, then an abbreviated form was completed that included a unique site identification, surveyor, date, quarter-quad, Township/Range/Section, wetland characteristics (setting, flowing water, microhabitat), prevailing vegetation structure and dominants, one or more pair of GPS readings, and comparison with NWI mapping. Sites with well-developed fen habitat were usually traversed their full length, targeting all major vegetation zones with emphasis on specialized habitat and an expanded form completed to represent additional information. The pH of peat

was measured, rare plant surveys were conducted, disturbance was described, and the fen structure and extent was described. For all sensitive plants, rare plant forms were filled out with all information not covered in the site characterization including population size (numbers or frequency), phenological stage, associated species, and all other supporting documentation (vouchers and photographs). These three sets of forms are represented in Appendix A, and a total of 111 sites were surveyed in 2009-2010 (Figure 3).

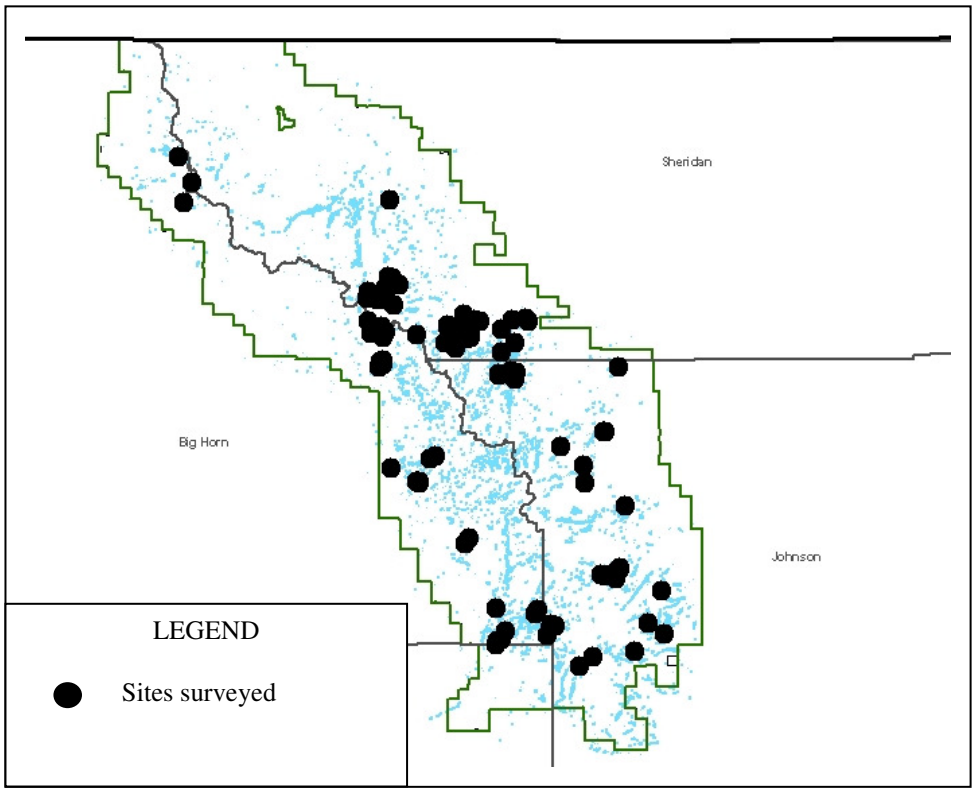


Figure 3. Sensitive/rare fen plant species survey sites in Bighorn National Forest

Survey coverage included almost all areas of high fen density as indicated by NWI at montane elevations and some areas of high fen density at subalpine elevations. It included all except one of the sites identified by Bighorn National Forest staff and most of the largest fen sites as indicated by NWI. It also targeted all known sensitive/rare plant records that did not have concerted fen species survey. Finally, it included almost all sites noted in photointerpretation as having floating peat mat or patterning features that are associated with well-developed fens. The 111 sites surveyed are neither random nor representative of fen habitat in general, but taken to capture the majority of sites with the highest likelihood of sensitive/rare fen target species. In the course of accessing target sites, other wetland sites and extensions of mapped sites were added to surveys if they were judged to have any prospective fen attributes.

Information on sensitive/rare frog species was collected incidental to plant surveys, including wood frog (*Libates sylvaticus* Bighorn population), Columbian spotted frog (*Rana luteiventris* Bighorn population), and northern leopard frog (*Lithobates pipiens*). Data were conveyed to WYNDD zoologists, and results were incorporated into a separate report in progress.

RESULTS

Of the 111 sites surveyed, only 57 were fen sites, and of those, 46 had sensitive/rare species (including sites with multiple sensitive/rare plant species). Three of the 10 target species were not found, the two alpine sedges and large-leaved pondweed, but three new target species were added. These results are summarized in Figure 4 and expanded in results. The first results section presents sensitive species data for the six sensitive fen species known from the Forest. A second results section presents the four other Wyoming species of concern in similar format. A third results section presents the reproductive biology and population biology of sensitive/rare fen species collectively. A fourth results section presents a summary of sensitive/rare species habitat and distribution on the Forest.

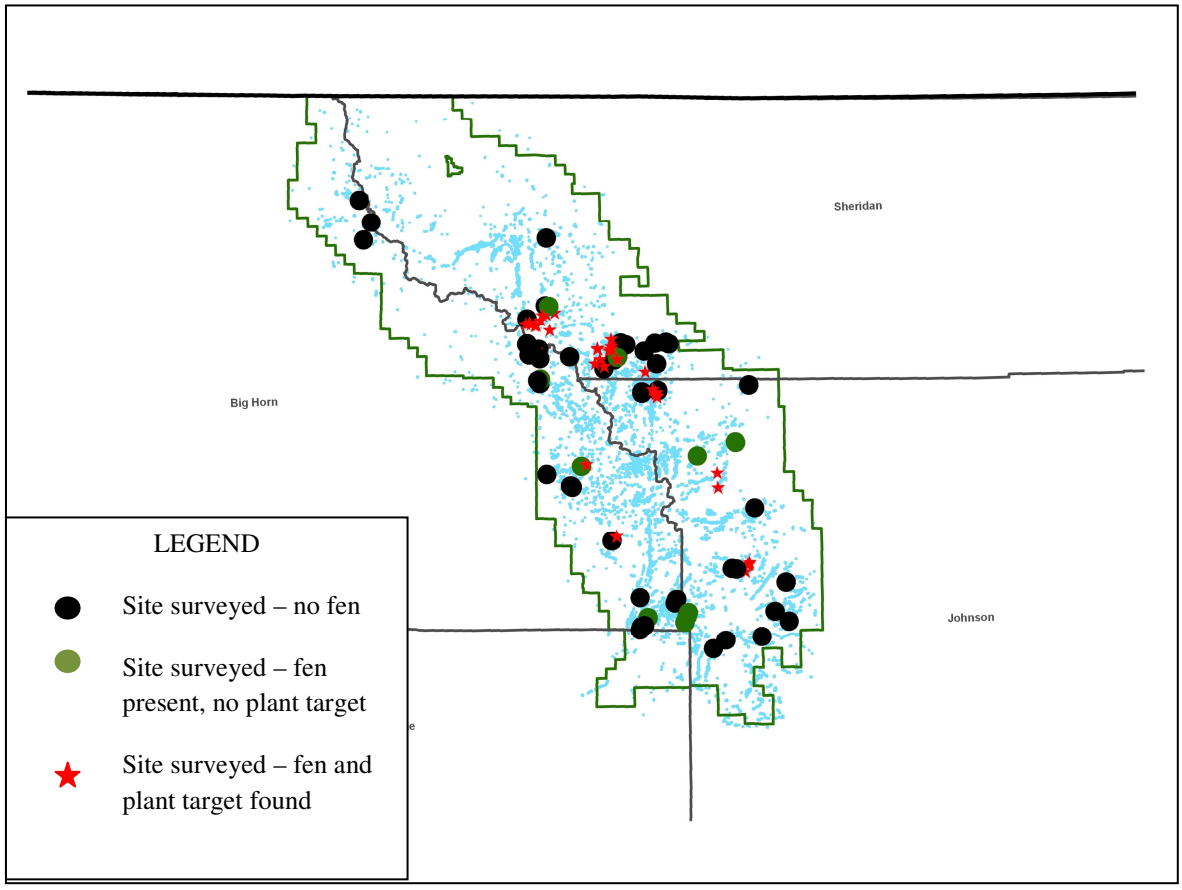


Figure 4. Survey sites with fen habitat and with sensitive/rare fen plant species in Bighorn National Forest

For purposes of this report, the term "occurrences" is roughly equivalent to "population" and represents the occupied habitat of a population. Most occurrences are confined to a single wetland, and generally just a fraction of the total wetland area. In other cases, it may refer to subpopulations in parts of large wetlands or in multiple wetlands that are close together. So the number of occurrences may be less than the number of unique wetland places a species is present, particularly in local distribution patterns where a species occurs in a tight cluster of wetland sites. This also means that there may be multiple occurrences of different species present at a single wetland site, so that the number of wetland sites with sensitive fen species locations is less than the total number of occurrences. More detailed occurrence mapping was pursued in select cases. The distribution maps in this section show single dots for each occurrence. Site-specific information and more detailed mapping are presented in Appendix B for each occurrence.

Sensitive species status information

Six sensitive fen plant species are now known from a total of 30 extant occurrences in fen settings. They sometimes occur together, so there are only 18 different fen settings where sensitive fen plants were documented. The species results are addressed on the following pages, with background information on classification, status, and description, and then information on distribution and habitat that pertains to both Bighorn National Forest and to the state as a whole. This information represents an update to species assessment documents prepared for all six species and will be used to update state species abstracts and field guide entries, to be posted at www.uwyo.edu/wyndd . In addition, state ranks have been updated and all information in this report will be considered in upcoming species of concern list updates.

LESSER PANICLED SEDGE (*Carex diandra* Schrank)

Classification

Scientific name: *Carex diandra* Schrank
Synonyms: none
Common name: Lesser panicled sedge
Family: Cyperaceae
Size of genus: There are 114 species of *Carex* reported for Wyoming in Dorn (2001). At least four additional species of sedge have been added to the state flora since 2001. There are 480 species of *Carex* reported in the *Flora of North America* (Ball and Reznicek 2002).
Phylogenetic relationships: Unknown. A member of sect. Heleoglochin, a small section.

Present legal or other formal status

U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S1S2. Current status information supports a rank change to S2, as updated in tandem with this study.

Wyoming contribution rank: Conservation of lesser panicled sedge as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn Mountains populations are even more disjunct than others in Wyoming.

Figure 5 (left): Lesser panicled sedge, close-up[1]

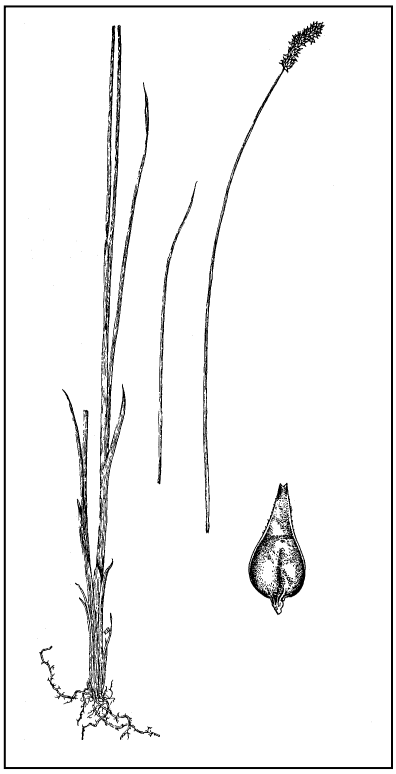


Figure 6 (right): Lesser panicled sedge, illustration from Hermann (1970).

Description

Technical description: Lesser panicled sedge is a densely tufted perennial graminoid with sharply triangular, rough-edged stems 30-70 cm high. Leaves are 1-3 mm wide with red spots or streaks on their membranous sheaths. The linear, elongated inflorescence is 1.5-6 cm long and composed of numerous individual, but closely compressed, spikes. Pistillate scales are brownish with membranous margins, and are wider, but mostly shorter, than the perigynia. Perigynia are rounded on the back and glossy brown, with a prominently serrate-margined beak that has a distinct dorsal fold, and they are deciduous earlier than most other montane sedges. Achenes are lens-shaped with 2 stigmas (Ball and Reznicek 2002, Dorn 2001, Fertig and Jones 1992, Hermann 1970, Hitchcock et al. 1969, Hurd et al. 1998, Johnston 2001). See Figures 5 and 6.

Local field characters: The dense tussocks and red-patterned leaf sheaths are characteristic. Technical keys are needed for positive determination.

Similar species: *Carex simulata* is rhizomatous. *C. cusickii* has a longer, less compacted inflorescence and leaf sheaths that are distinctly copper-colored at the tip (Dorn 2001; Hitchcock and Cronquist 1969). *Carex diandra* is similar and closely related to *C. prairea*, which has recently been found in northwestern Montana but is not known from Wyoming.

[1] All photographs in this report were taken by Bonnie Heidel unless otherwise noted

Geographical distribution

Range: Circumboreal; in North America from Newfoundland to the Yukon and south to New Jersey, Indiana, Colorado, and California (Hermann 1970, Ball and Reznicek 2002). In Wyoming it is known from the Beartooth, Big Horn, Medicine Bow and Absaroka mountains and Yellowstone Plateau in Albany, Carbon, Park, Sheridan and Teton counties.

Extant sites: Known from 19 recent records (most recently observed in 2010). There are two records in Bighorn National Forest (Table 3).

Historical sites: Known from three historic collection records in Yellowstone National Park and Medicine Bow National Forest.

Unverified/Undocumented reports: None known.

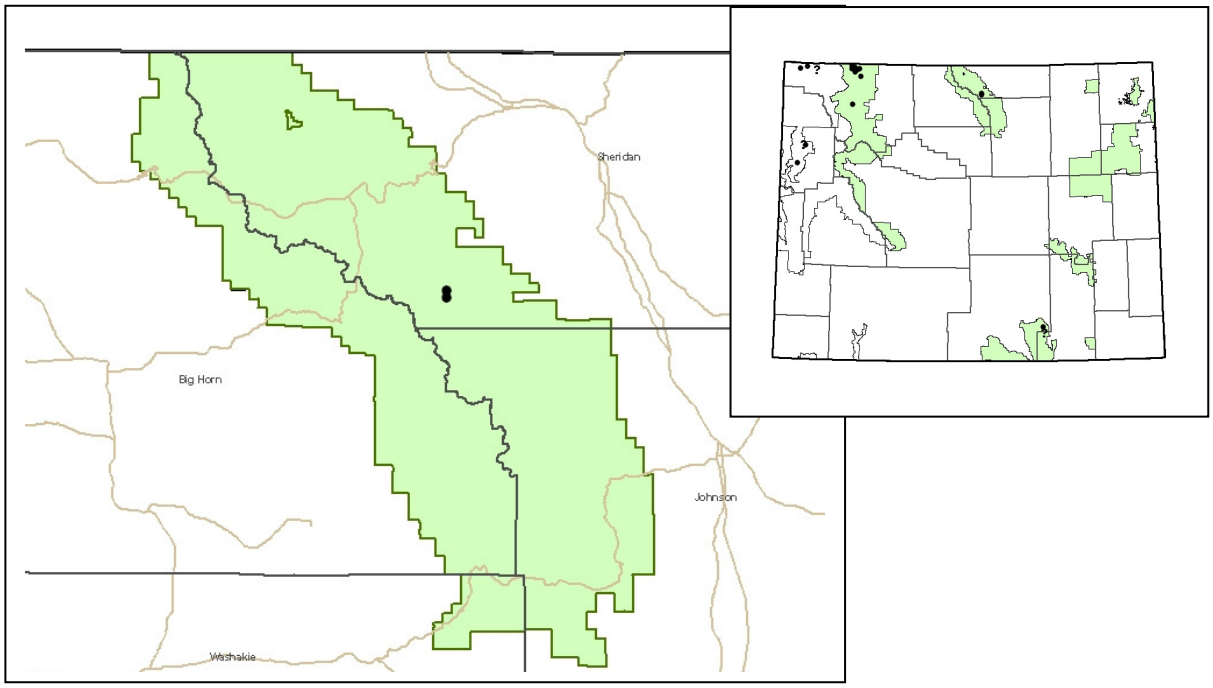


Figure 7. Distribution of lesser panicled sedge (*Carex diandra*) in the Bighorn National Forest and in Wyoming

Table 3. Bighorn National Forest occurrences of lesser panicled sedge (*Carex diandra*)

EO#	Location	County	Legal	Elev.	USGS
020	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 26	8200	Dome Lake
021	Big Moose Fen, ca 1.4 mile north of Dome Lake Reservoir, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54N R87W Sec. 35SE¼	8520	Dome Lake

Sites where present status not known: None known.

Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

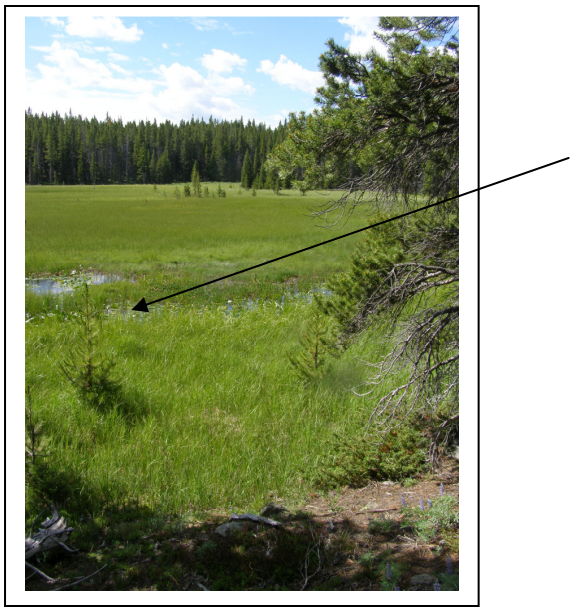


Figure 8. Habitat of *Carex diandra* in the Bighorn National Forest

Habitat

Setting and associated vegetation: Occurs across a range of fen types in the Rocky Mountain Region from poor to rich fen (Gage and Cooper 2006); water chemistry is sometimes influenced by limestone. In Wyoming, lesser panicled sedge is often found at the open-water edge of floating peat mats comprised of mud sedge (*Carex limosa*; Figure 8), but also found in non-floating peat at lake margins and on hummocks in open shrub and sedge fens. At most sites, it is restricted to small areas or narrow vegetation zones. Elevation 1860-2926 m (6100-9600 ft). It appears to be a fen obligate in the state.

In Bighorn National Forest, lesser panicled sedge appears to be restricted to the ecotone between non-floating and floating peat habitat in poor and transitional fen. Elevation 2500-2600 m (8200-8520 ft).

Frequently associated species: Lesser panicled sedge may grow on floating mats of mud sedge or *Sphagnum* mosses, as an emergent anchored directly in saturated or submerged peat, or else growing on anchored peat mounds of non-*Sphagnum* mosses and other sedges. Most sites of this species represent sites of other sensitive/rare plant species.

In Bighorn National Forest, the species associated with lesser panicled sedge include mud sedge (*Carex limosa*), slender sedge (*C. lasiocarpa*), Buxbaum's sedge (*C. buxbaumii*), English sundew (*Drosera anglica*), Lesser bladderwort (*Utricularia minor*), bog buckbean (*Menyanthes trifoliata*), water sedge (*Carex aquatilis*), hoary sedge (*C. canescens*), tall

cottongrass (*Eriophorum angustifolium*) and slender cottongrass (*E. gracile*), representing species of both anchored and floating peat mats.

Topography: Only known from basin settings, generally with no inlets and limited outlet flow.

Water and soil relationships: Fibrist soils that remain constantly saturated and anaerobic. This species may be one of the most sensitive to drops in water levels.

Population biology and demography
Phenology: Flowers and fruits July-August. This is one of the earliest sedge species to disarticulate, and cannot be reliably surveyed at the end of the growing season.

Population size and condition: At Sawmill Lake Fen, lesser panicled sedge was locally common and widely scattered; magnitudes were not determined. Its habitat was shaped like a donut, imprecisely mapped as over 0.4 ha (1 ac). At Big Moose Fen, only about 50 clumps (genets) were found.

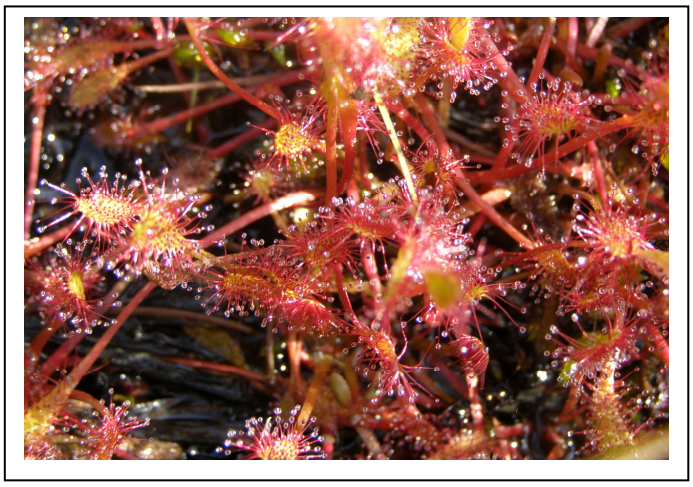
ENGLISH SUNDEW (*Drosera anglica* Huds.)

Classification
Scientific name: *Drosera anglica* Huds.
Synonyms: *Drosera longifolia*.
Common name: English sundew
Family: Droseraceae
Size of genus: This is the only species of *Drosera* reported for Wyoming in Dorn (2001).
Phylogenetic relationships: This species is believed to be a fertile amphiploid (2n=40) derived from *D. rotundifolia* (2n=20) and another diploid species with narrow leaves (Hitchcock and Cronquist 1964).

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S2. Current status information supports a rank change to S2S3, as updated in tandem with this study.
Wyoming contribution rank: Conservation of English sundew as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn Mountains populations are even more disjunct than others in Wyoming.

Description
Technical description: English sundew is an insectivorous perennial herb with stems 6-18 cm tall. Leaves have oblong to spoon-shaped blades 1-3 cm long by 3-4 mm wide, petioles 2-6 cm long, and are covered by long reddish, glandular-tipped hairs which snare insects. The

inflorescence is a one-sided raceme of 1-10 flowers with 5 white petals 3-7 mm long. The fruit is a 3-5 valved capsule (Dorn 2001, Hitchcock et al. 1961; Marriott 1991). See Figures 9 and 10.



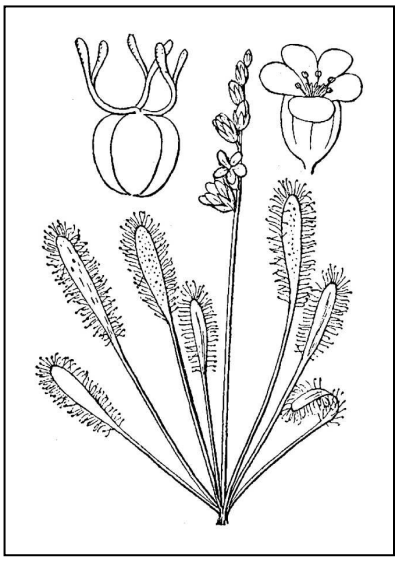


Figure 9 (left): English sundew, close-up
Figure 10 (right): English sundew, illustration from Britton and Brown (1913)

Local field characteristics: The reddish gland-tipped hairs are diagnostic.

Similar species: This is the only species of *Drosera* in Wyoming.

Geographical distribution

Range: Circumboreal, in North America from Labrador and Newfoundland to Alaska, south to California, Colorado, northern Great Lakes states, and Maine. In Wyoming, known from the Yellowstone Plateau and Absaroka, Beartooth, Bighorn and Wind River mountains in Big Horn, Fremont, Johnson, Park, Sheridan, and Teton counties.

Extant sites: Known from over 24 recent records (most recently observed in 2010). Until recently, it was only reported from two sites in all of Wyoming and one in Colorado (Wolf and Cooper 2006). There have been more recent discoveries made in the Beartooth Mountains, Targhee National Forest and Yellowstone National Park. The tabulation of current extant sites does not yet have the benefit of complete specimen data from Yellowstone National Park. It is not known whether there are several or many additional Park records to be added, but the Park Botanist notes it as locally common and widespread in suitable habitats of the Bechler region where it is under-documented (Whipple pers. commun. 2011).

There are two records in Bighorn National Forest (Table 4). It is present at perhaps the largest floating mat site in Bighorn National Forest, and in trace amounts at only about 2 km (1.5 miles) away.

Historical sites: There is one historical collection record from the southwest corner of Yellowstone National Park that has not been relocated (the Bechler region).

Unverified/Undocumented reports: None known.

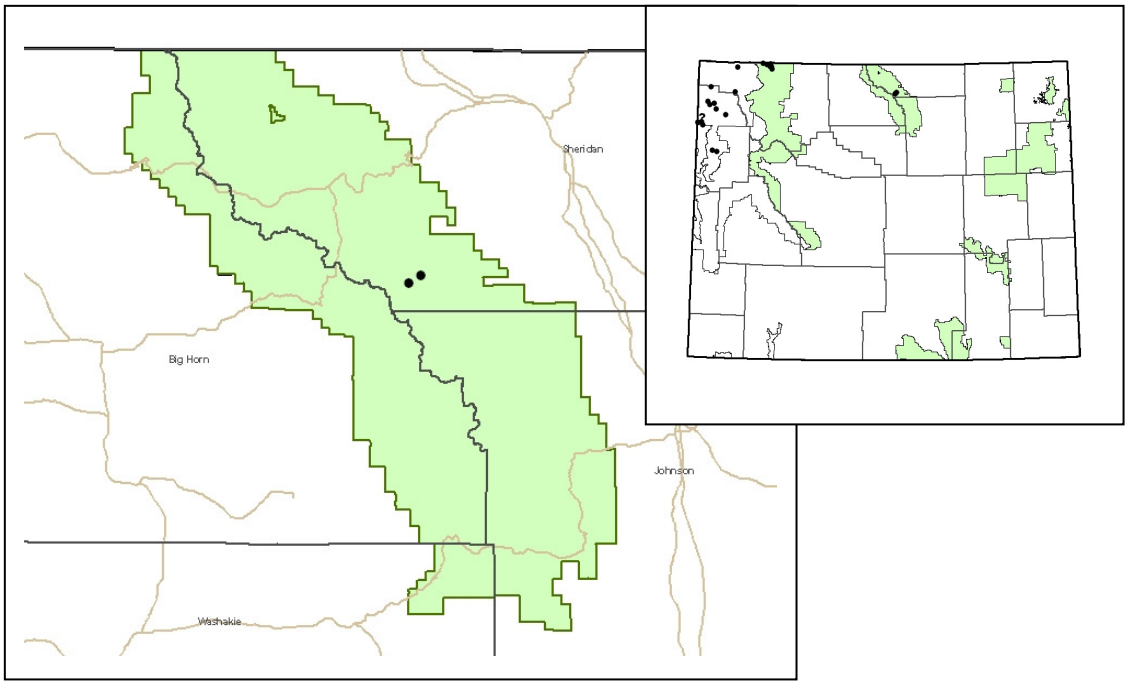


Figure 11. Distribution of English sundew (*Drosera anglica*) in the Bighorn National Forest and in Wyoming

Table 4. Bighorn National Forest occurrences of English sundew (*Drosera anglica*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5'
024	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of Burgess	Sheridan	T54NR87W Sec. 26SE¼	8200	Dome Lake
025	Lower Snail Creek Fen, ca 0.5 mile west of Twin Lakes, 0.8 mile north of Stull Lakes, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. Sec 34 SW¼	8920	Dome Lake

Sites where present status not known: none
Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

Habitat
Settings and associated vegetation: Occupies a wide array of bogs and fens across its range (Wolf et al. 2006). In Wyoming, English sundew is found in floating peat mats and shallow pools of poor to transition fens, and geothermally-influenced mineral soils that remain

saturated. The elevation spans 1890-2718 m (6200-8920 ft), among the highest elevations for this species throughout its range, higher even than its upper elevations in the Alps. It is fen obligate in Wyoming outside of the geothermally-influenced settings of Yellowstone National Park.

In Bighorn National Forest, English sundew occupies saturated floating peat mats (Figure 12). Elevation ranges from 2500-2718 m (8200-8920 ft), at the upper limits of species' elevation in the state if not rangewide.

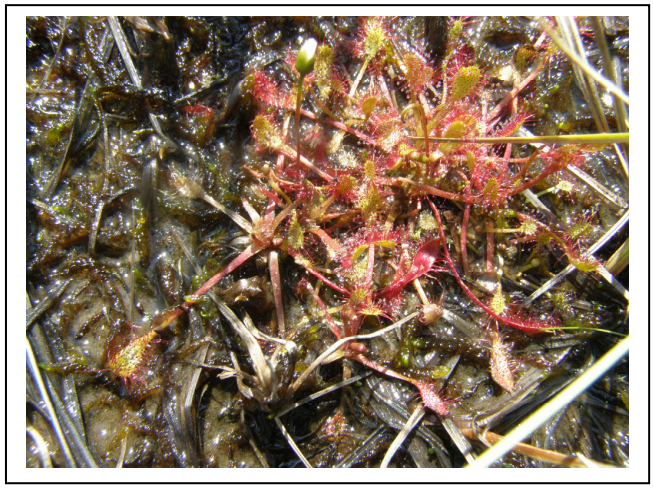


Figure 12. Habitat of English sundew (*Drosera anglica*) in Bighorn National Forest

Frequently associated species: English sundew may grow in floating mats of *Sphagnum* or of mud sedge (*Carex limosa*), often associated with emergents species like slender sedge (*Carex lasiocarpa*) and Buxbaum's sedge (*C. buxbaumii*), floating plants like bog buckbean (*Menyanthes trifoliata*) and marsh cinquefoil (*Potentilla palustris*), and submerged plants like lesser bladderwort (*Utricularia minor*). The associated bryophytes have been well-documented in boreal latitudes, but not at most Wyoming sites.

Topography: The two Bighorn National Forest sites of English sundew are a study in contrast. One is a basin fen with a large, central open water zone and concentric floating mat around it. The other is a gently sloping fen with a very small open water zone at the lower end.

Water and soil relationships: The roots of English sundew require saturated or standing water conditions associated with floating mats. Both sites of it in Bighorn National Forest may be among the wettest habitats for the species in the state, where the perennating bud is sometimes submerged (Figure 12).

<u>Population biology and demography</u>
Phenology: Flowers in late July to mid-August, and fruits in August.

Population size and condition: The two populations on Bighorn National Forest are a study in contrast. The Sawmill Lake Fen population is estimated to be at least in the 100,000 magnitude over an area mapped as roughly 0.4 ha (1 ac). The Lower Snail Creek Fen population could only be found in an area of much less than 1 m² in an entangled cluster that may number no more than 20 plants (Figure 12 shows most of the population). It is not known whether the latter is a relatively new colony, a waif, or a relict colony in decline.

RUSSET COTTONGRASS (*Eriophorum chamissonis* Meyer)

Classification
Scientific name: *Eriophorum chamissonis* Meyer
Synonyms: It is treated as a synonym of *E. altaicum* var. *neogeum* in the *Flora of North America* (Ball and Wujek 2002) but some taxonomists consider them to be separate species.
Common name: Russet cottongrass, or Chamisso's cottongrass
Family: Cyperaceae
Size of genus: There are 7 species of *Eriophorum* reported for Wyoming in Dorn (2001). There are 11 species of *Eriophorum* reported in the *Flora of North America* (Ball and Wujek 2002).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S2. Current status information supports a rank change to S3, updated in tandem with this study.
Wyoming contribution rank: Conservation of russet cottongrass as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn Mountains populations are even more disjunct than others in Wyoming.

Description
Technical description: Russet cottongrass is a perennial graminoid with creeping rhizomes and non-tufted culms 30-70 cm tall. The basal and lower leaves have a well-developed sheath and short, narrow triangular to channeled blades up to 2 mm wide. Uppermost leaves are bladeless and borne near the middle of the culm. The inflorescence consists of a single, terminal spikelet with broad, dark brown, triangular outer scales and smaller fertile scales with dark centers and paler, membranous margins. Flowers have anthers over 1 mm long, triangular achenes with an abruptly-pointed style, and numerous cinnamon or reddish bristles that elongate in fruit to form a "cotton-ball" head (Ball and Wujek 2002, Dorn 2001, Hitchcock et al. 1969). See Figures 13 and 14.

Note: Two russet cottongrass collections on Bighorn National Forest had white perianth bristles while fitting all other species characteristics. Ball and Wujek (2002) note: "The

Eripohorum chamissonis complex contains taxa based mainly on stem size and bristle color (M. Raymond 1954). Much of the variation appears to be continuous with abundant intermediates; experimental studies are needed to determine the biological basis of the variation." The Bard Spring specimen may be an aberrant tall cottongrass (*E. angustifolium*), part of the local tall cottongrass population. The Graves Lake specimen may be a genetic form of russet cottongrass, widely intermixed with russet-colored plants.

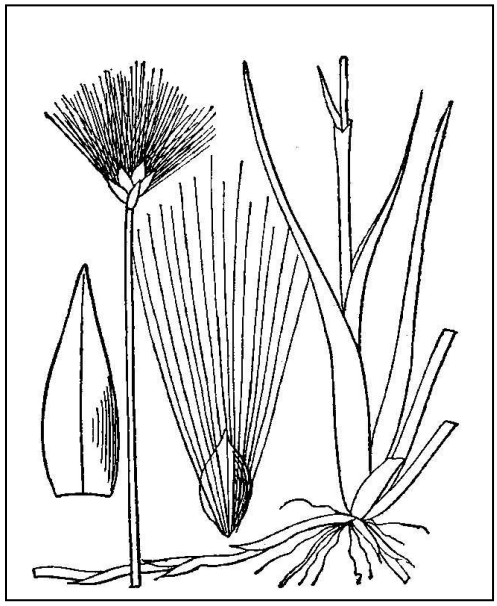


Figure 13 (left). Russet cottongrass, close-up.
Figure 14 (right). Russet cottongrass, illustration. From Britton and Brown (1913).

Local field characters: The single head and typically cinnamon or reddish bristles are distinctive.

Similar species: *Eriophorum scheuchzeri* has white bristles, dark scales without a pale margin, and anthers less than 1 mm long. *E. callitrix* has densely tufted culms (without rhizomes) and white bristles. Other *Eriophorum* species in Wyoming have branched inflorescences with 2 or more spikelets, with the possible exception of aberrant, single-headed *E. angustifolium*.

Geographical distribution

Range: Circumboreal; Greenland to Alaska, and south to Oregon, Utah, Colorado, Wisconsin and Maine. In Wyoming, known from the Yellowstone Plateau and Absaroka, Beartooth, Bighorn and Wind River mountains in Big Horn, Fremont, Johnson, Park, Sheridan, and Teton counties.

Extant sites: Known from 34 recent records (most recently observed in 2010). There are 11 records in Bighorn National Forest (Table 5). The lowest elevation one on the Forest, at Bard Springs, has identification questions attached to it and might represent an aberrant tall cottongrass (*Eriophorum angustifolium*).

Historical sites: Four historical collections are known from Yellowstone National Park and one is known from Shoshone National Forest (Park County).
Unverified/Undocumented reports: None known.

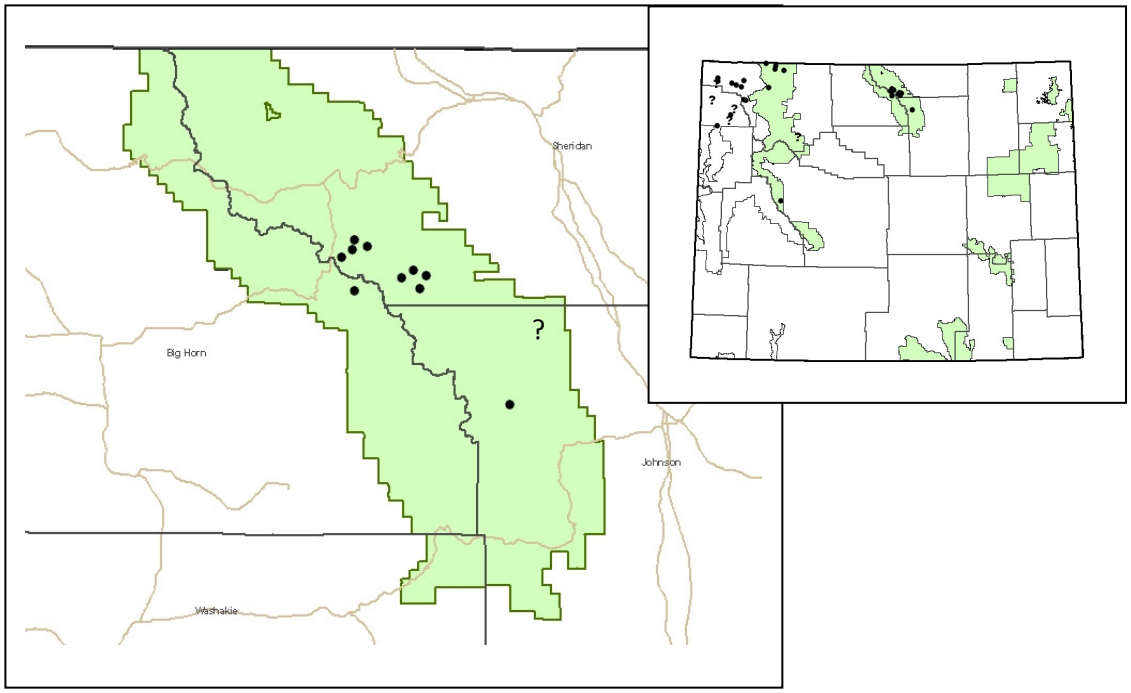


Figure 15. Distribution of russet cottongrass (*Eriophorum chamissonis*) in the Bighorn National Forest and in Wyoming. The ? represents a specimen determination question at Bard Springs.

Table 5. Bighorn National Forest occurrences of russet cottongrass (*Eriophorum chamissonis*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
009	Preacher Rock Bog due west of Preacher Rock for over 0.5 miles, along north side of Sawmill Pass-Red Grade Road, ca 16.5 air miles southwest of Sheridan.	Sheridan	T54N R86W Sec. 31	8200-8300	Dome Lake
012	Just west of East Fork South Tongue River, ca 0.75 mile south of East Woodrock Campground, ca 6 miles northeast of Antelope Butte Ski Area.	Sheridan	T54NR88W Sec. 10NE¼	8680	Woodrock
013	Wetland along tributary of Willett Creek, ca 1.25 miles west of Willett Lake, ca 1.5 miles southwest of Woodchuck Pass, ca 2.5 air miles east of Antelope Butte.	Big Horn	T53NR88W Sec. 10NE¼	9270	Shell Reservoir
020	Graves Lake Fen, ca. 1 mile east of East Fork Mohawk Creek, ca. 1.5 air miles west of Lookout Mountain.	Sheridan	T54NR87W Sec. 12, 13	8940	Woodrock

027	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of	Sheridan	T54NR87W Sec. 26	8200	Dome Lake
028	Lower Snail Creek Fen, ca 0.5 mile west of Twin Lakes, 0.8 mile north of Stull Lakes, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 34 SW¼	8920	Dome Lake
029	2.5 air miles northeast of Granite Pass via FS Rd 663, ca. 19 air miles northeast of Shell.	Sheridan	T54NR87W Sec. 15NE¼	8822	Woodrock
030	Southeast side of Elk Lake, ca. 18 air miles west of Buffalo.	Johnson	T51NR85W Sec. 14SW¼ T51NR85W	9842	Willow Park Reservoir
031	At and above confluence of East Fork of Bruce Creek and West Fork of Bruce Creek, ca 1-2 miles east of Granite Pass, ca. 17 air miles east-northeast of Shell.	Sheridan	T54NR87W Sec. 20 NE¼ T54NR87W Sec. 21 NW¼	8878	Woodrock
032	0.5 miles northeast of Dome Lake, south of FS Rd 283, ca. 20 air miles southwest of Sheridan.	Sheridan	T53NR87W Sec. 1SE¼	8700	Dome Lake
033	Bard Spring wetland area, south of Story Penrose Trail, ca 5 miles west-southwest of Story.	Johnson	T53NR84W Sec. 20SE¼	7480	Story

Sites where present status not known: We were not able to relocate the site represented by occurrence #012. It was originally reported to be a small population of about 50 plants, and the survey form was conveyed with a GIS map. There was no evidence of landscape changes to suggest that its habitat has been lost; it is likely to be extant.

Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

Habitat

Associated vegetation: Occupies anchored and floating graminoid fen and anchored shrub-dominated fen habitats in basin and sloping settings, dominated by water sedge (*Carex aquatilis*), Buxbaum's sedge (*C. buxbaumii*), russet sedge (*C. saxatilis*) and planeleaf willow (*Salix planifolia*). It is often rooted in well-developed moss mounds of *Aulocomnium palustre*. Elevation 2280-3000 m (6900-9900 ft). It is a fen obligate in Wyoming.

In Bighorn National Forest, russet cottongrass occurs in fens with well developed floating mats and well-developed string and flark patterning, i.e., in both basin and sloping fen settings (Figure 16). It is at its highest known elevations in the Forest. It might also occur in places where fen basins are in stages of decay, and where the species persists in the most intact of local peatland habitat. At Preacher Rock Bog, only part of its surface area is comprised of intact peatland habitat, and Bard Spring wetland less than 5% is intact peatland. Elevation 2280-3000 m (7480-9840 ft).

Frequently associated species: The array of settings is reflected in the many different frequently associated species including planeleaf willow (*Salix planifolia*), water sedge

(*Carex aquatilis*), mud sedge (*C. limosa*), hoary sedge (*C. canescens*), lesser bladder sedge (*C. vericaria*), few-flowered spikerush (*Eleocharis quinqueflora*), tall cottongrass (*Eriophorum angustifolium*), white marsh marigold (*Caltha leptosepala*), alpine meadow groundsel (*Packera subnuda*), and elephanthead (*Pedicularis groenlandica*).

Figure 16. Habitat of russet cottongrass (*Eriophorum chamissonis*) in Bighorn National Forest (Sawmill Lake Fen) in the zone between anchored and floating peat

Topography: In most of Wyoming, this species is restricted to basin settings. In the Bighorn National Forest, it is in both basin and sloping fens.

Water and soil relationships: Some of the Bighorn National Forest sites have well-developed springs where russet cottongrass is only present at that part of the wetland fed by springs.

Population biology and demography
Phenology: Flower and fruits mid-July-August.

Population size and condition: About half of the populations in Bighorn National Forest are large, and have flowering stem numbers approaching or exceeding the 1000's, whereas most of the rest have numbers below 100 flowering stems. Plants are colonial from long-creeping rhizomes, so flowering stem numbers (ramets) do not correspond with the number of genetic individuals, and population size is likely to be much lower than numbers determined from any census or estimate of flowering stem numbers.

SLENDER COTTONGRASS (*Eriophorum gracile* Koch)

Classification
Scientific name: *Eriophorum gracile* Koch
Synonyms: none
Common name: Slender cotton-grass

Family: Cyperaceae
Size of genus: There are 7 species of *Eriophorum* reported for Wyoming in Dorn (2001). There are 11 species of *Eriophorum* reported in the *Flora of North America* (Ball and Wujek 2002).
Phylogenetic relationships: Unknown.

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S2
Wyoming contribution rank: Conservation of slender cottongrass as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn populations are even more disjunct than others in Wyoming.

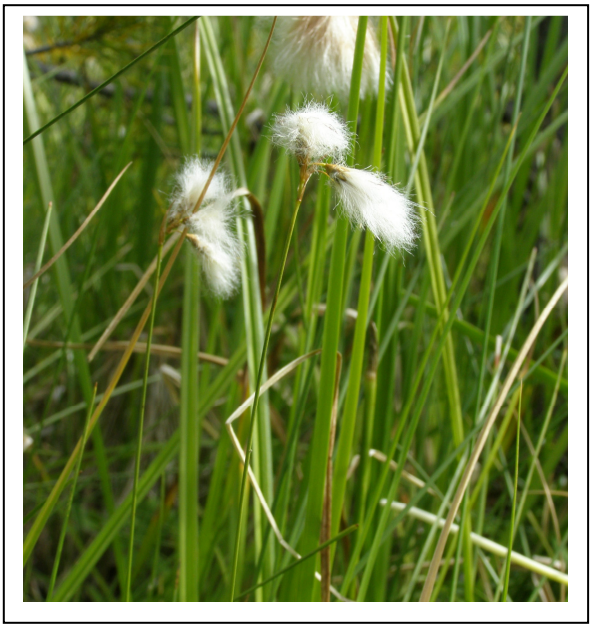
Description
Technical description: Slender cottongrass is a grass-like perennial with stems (culms) 20-60 cm high arising singly from a slender rhizome. The leaf blades are less than 2 mm wide and triangularly channeled for their entire length. The inflorescence consists of 2-5 heads (spikelets) on short, drooping stalks that often exceed the single green, leafy inflorescence bract. Scales are greenish-brown to blackish with a slender midrib. The perianth consists of numerous cottony, white bristles. Fruits are straw-colored achenes. (Ball and Wujek 2002, Dorn 2001, Hitchcock et al. 1969). See Figures 17 and 18.

Local field characters: The multiple heads, slender stem and narrow leaves are distinctive characteristics. Technical keys are needed for positive determination.

Similar species: *Eriophorum polystachion* and *E. viridicarinatum* have leaves that are flattened at the base and have two or more leafy inflorescence bracts. *E. chamissonis, E. callitrix*, and *E. scheuzeri* have single spiklets at the tip of the stem.

Geographical distribution
Range: Circumboreal; from Alaska to Labrador, and south from California to Colorado, and from Iowa to Pennsylvania (Ball and Wujek 2002, Hitchcock et al. 1969). In Wyoming, it is known from the Jackson Hole, the Beartooth, Big Horn, and Medicine Bow ranges in Albany, Johnson, Park, Sheridan, and Teton counties.

Extant sites: Known from 24 recent records (most recently observed in 2010). There are four records in Bighorn National Forest (Table 6).



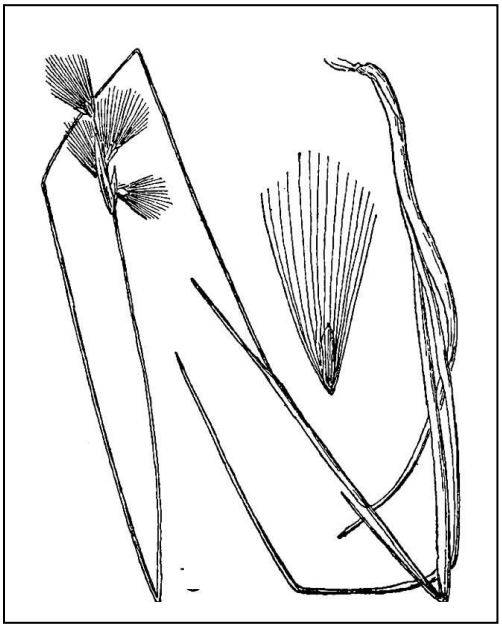


Figure 17 (left): Slender cottongrass, close-up
Figure 18 (right): Slender cottongrass, illustration from Britton and Brown (1913)

Historical sites: There is one historical record collected in either Bridger-Teton National Forest or Grand Teton National Park.

Unverified/Undocumented reports: None known.

Table 6. Bighorn National Forest occurrences of slender cottongrass (*Eriophorum gracile*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
017	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 26	8200	Dome Lake
018	West Fork Big Goose Creek Fen on west side of creek and Big Moose Fen on east side of Creek, ca 0.8-1.5 mile north of Dome Lake Reservoir, ca 15 air miles southeast of Burgess Junction.	Sheridan	T53NR87W Sec. 2NW¼ T54NR87W Sec. 35	8520	Dome Lake
019	Lower Snail Creek Fen, ca 0.5 mile west of Twin Lakes, 0.8 mile north of Stull Lakes, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54N R87W Sec. 34 SW¼	8920	Dome Lake
020	Near headwaters of South Fork of Clear Creek, ca. 0.8 air miles south-southeast of Sherd Lake, ca. 16 air miles southwest of Buffalo.	Johnson	T50NR84W Sec. 31SE4¼	8720	Lake Angeline

Sites where present status not known: none

Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

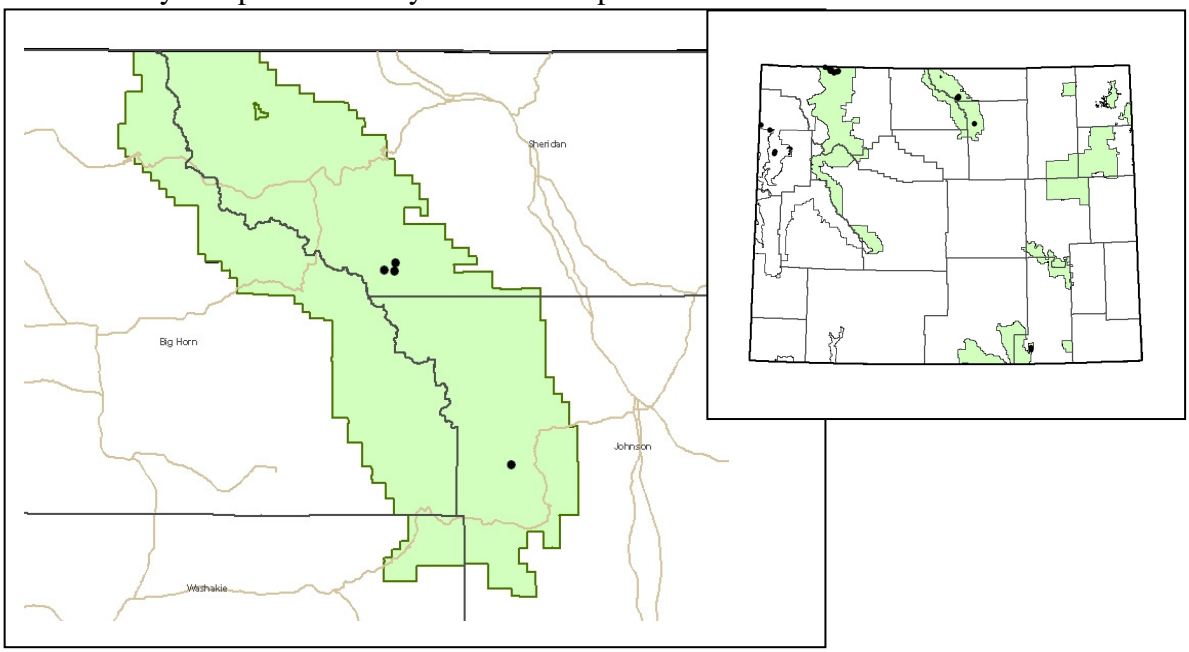


Figure 19. Distribution of slender cottongrass (*Eriophorum gracilis*) in the Bighorn National Forest and in Wyoming.

Figure 20. Habitat of slender cottongrass (Sawmill Lake Fen) Note: Mixed with russet cottongrass in this shot; appears shorter and smaller.

Habitat
Associated vegetation: Occupies transition between anchored and floating mat fen habitats in basin settings and central areas of sloping settings. Elevation 2100-2815 m (6900-9240 ft). It is a fen obligate in Wyoming.

In Bighorn National Forest, most occurrences are in basin settings (Figure 20). Elevation 2500-2718 m (8200-8920 ft).

Frequently associated species: The associated plant species in both Wyoming and Bighorn National Forest include water sedge (*Carex aquatilis*), mud sedge (*C. limosa*), Buxbaum's sedge (*C. buxbaumii*), slender sedge (*C. lasiocarpa*), tall cottongrass (*Eriophorum angustifolium*), bog buckbean (*Menyanthes trifoliata*), alpine meadow groundsel (*Packera subnuda*), and planeleaf willow (*Salix planifolia*).

Topography: Occupies basin and sloping settings.

Water and soil relationships: Wet or saturated conditions at the surface.

Population biology and demography
Phenology: Flowers mid-June-mid July; fruits present July-August.

Population size and condition: The known populations in Wyoming range in size from 30 flowering stems to nearly 1000 stems in a total area of ca 4.9 ha (12 ac; Fertig 1997). Plants are colonial from long-creeping rhizomes, so flowering stem numbers (ramets) do not correspond with the number of genetic individuals, and population size is likely to be much lower than numbers determined from any census or estimate of flowering stem numbers.

NORTHERN BLACKBERRY (*Rubus acaulis* Michx.)

Classification
Scientific name: *Rubus acaulis* Michx.
Synonyms: *Rubus arcticus* ssp. *acaulis, Cylactis arctica* ssp. *acaulis*

Common name: Northern blackberry
Family: Rosaceae
Size of genus: There are six species of *Rubus* in Wyoming (Dorn 2001).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none

State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S1. Current status information supports a rank change to S2, as updated in tandem with this study.
Wyoming contribution rank: Conservation of northern blackberry as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn populations are more disjunct than those in Yellowstone National Park.

Figure 21 (left): Northern blackberry, by Walter Fertig

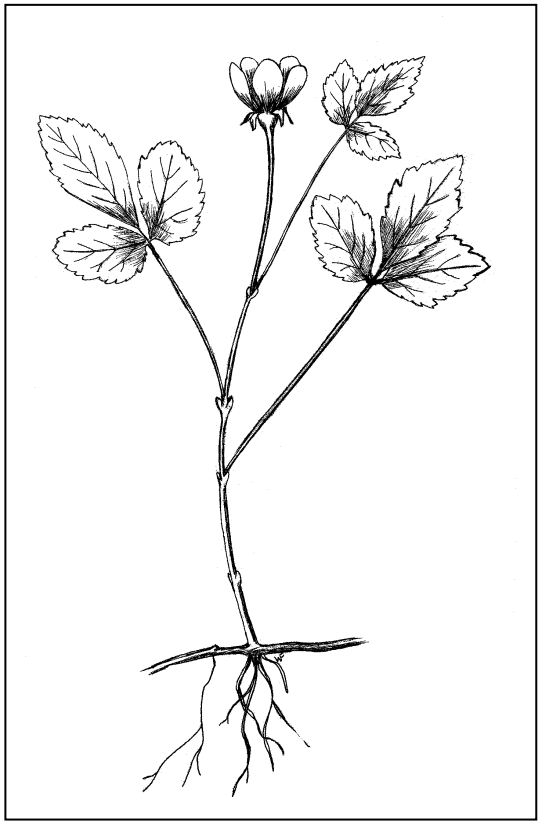


Figure 22 (right): Northern blackberry, illustration by Walter Fertig.

Description
Technical description: Northern blackberry is a low, rhizomatous, perennial herb with non-bristly/prickly stems to 15 cm high. The leaves are divided into three ovate to obovate leaflets with serrated margins. Flowers are usually solitary and have dark pink or rose-purple petals 10-15 mm long. Fruits are red, globose raspberries (Dorn 2001, Fertig et al. 1994, Hitchcock and Cronquist 1961). See Figures 21 and 22.

Local field characters: *Rubus pubescens* has smaller, white-petaled flowers and sharp-tipped leaflets. *Fragaria* ssp. have white flowers and 5 sepals and 5 sepal-like bracts. Small, vegetative individuals of *Geum macrophyllum* have pinnately compound leaves with 5 or more leaflets (terminal leaflet largest).

Similar species: *Rubus pubescens* has smaller, white-petaled flowers and sharp-tipped leaflets. *Fragaria* ssp. have white flowers and 5 sepals and 5 sepal-like bracts. Small, vegetative individuals of *Geum macrophyllum* have pinnately compound leaves with 5 or more leaflets (terminal leaflet largest).
Geographical distribution

Range: Alaska to Newfoundland south to British Columbia and Minnesota, and in the Rocky Mountains from Montana to Colorado. In Wyoming, known from the east slope of the Big Horn Mountains and Yellowstone Plateau, in Johnson, Park, and Teton counties, plus a vegetative specimen from the Medicine Bow Mountains in Albany County.

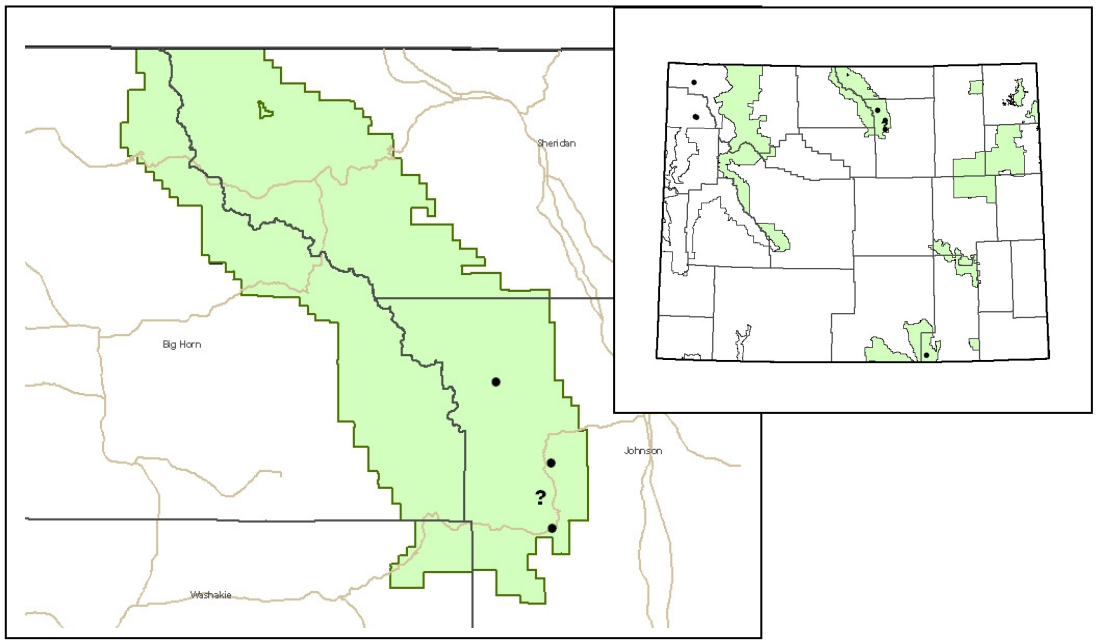


Figure 23. Distribution of northern blackberry (*Rubus acaulis*) in the Bighorn National Forest and in Wyoming. The "?" represents the vague historic collection by Tweedy.

Extant sites: Known from seven recent records (most recently observed in 2010). There are three records in Bighorn National Forest, and all three are represented in Table 7, even though only one of them (#008 on Frying Pan Lake) is a fen site.

Historical sites: The original Big Horn Mountains collection site of F. Tweedy, made "at the headwaters of Clear Creek and Crazy Woman River" in 1900, may correspond with any of the extant records in Johnson County. It is too vague to be relocated with certainty and is not included in Table 7.

Unverified/Undocumented reports: none known

Table 7. Bighorn National Forest occurrences of northern blackberry (*Rubus acaulis*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
003	Along Sourdough Creek between 0.25 air miles northeast of US Highway 16 northeast to ca 0.2 air miles northeast of confluence of Sourdough and Little Sourdough Creeks, 11-12 air miles southwest of Buffalo.	Johnson	T50N R84W Sec. 26, 34, 35	7440-7740	Hunter Mesa
007	Along Muddy Creek, ca 0.2 mile northeast of entrance to Hazelton Road (County Road 3), ca 1 mile south-southwest of Crazy Woman Campground.	Johnson	T48N R84W Sec. 2, 3	7920	Caribou Creek
008	Northeastern end of Frying Pan Lake	Johnson	T51NR85W Sec. 10NE¼	9410	Willow Park Reservoir

Sites where present status not known: none
Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

Habitat
Associated vegetation: Rangewide, northern blackberry is reported from mountain meadows and bogs or woods to alpine tundra (Hitchcock and Cronquist 1961). In Wyoming, it is known from spruce swamps, forested or shrub seepage slopes and willow carr, and floating peat mat. The Yellowstone National Park habitats are characterized as peat-accumulating settings. Elevation 2268-2868 m (7440-9410 ft).

In Bighorn National Forest, populations were only known from riparian willow carr and wet forest margins with limited organic material in the soil profiles, as described in detail by Fertig (2000). It was not on the original list of 2010 fen target species until its discovery in a floating peat mat as part of surveys. The Forest populations span the full range of species' elevation in the state. A photo of Bighorn NF fen habitat is not available. Its other wetland habitats on the Forest are presented by Fertig (200).

Frequently associated species: Associated species reported from Yellowstone National Park collection labels include haory sedge (*Carex canescens*), tufted hairgrass (*Deschampsia cespitosa*), bluejoint reedgrass (*Calamagrostis canadensis*), western blueberry (*Vaccinium occidentale*), bog birch (*Betula glandulosa*).alpine laurel (*Kalmia microphylla*), and russet cottongrass (*Eriophorum chamissonis*). Bighorn NF records associate it with vegetation dominated by planeleaf willow/beaked sedge c.t. (*Salix planifolia/Carex utriculata* c.t.) and Engelmann spruce/twinflower c.t. (*Picea engelmannii/Linnea borealis* c.t.) with additional associated species of Booth's willow (*Salix boothii*), Bebb's willow (*S. bebbiana*), Geyer's willow (*S. geyeri*), shrubby cinquefoil (*Potentilla fruticosa*), field horsetail (*Equisetum arvense*), woodland strawberry (*Fragaria vesca*), tufted hairgrass (*Deschampsia cespitosa*), short-style onion (*Allium brevistylum*), and clasping twisted-stalk (*Streptopus amplexifolius*)

(Fertig 2000). In fen habitat of Bighorn National Forest, as found at Frying Pan Lake, northern blackberry is associated with floating mats dominated by mud sedge (*Carex limosa*) where hoary sedge (*C. canescens*), planeleaf willow (*Salix planifolia*), and *Sphagnum* species are also present.

Topography: Occupies basin and sloping settings.

Water and soil relationships: The report by Fertig (2000) represents the most complete description of northern blackberry habitat requirements to date, and soils were inferred to be either histosol or inceptisol. This differs considerably from the floating peat mat habitat in which a new occurrence was documented. The one unifying factor may be stable groundwater discharge conditions. It has been noted that northern blackberry generally occupies hummocks, which are aerated settings that wick moisture from surrounding standing water. The degree of hummock development in occupied habitat has been noted at sites in both Bighorn National Forest and Yellowstone NP and represents a heterogeneity of soil and water conditions that either a requirement or a habitat alteration.

Population biology and demography
Phenology: Flowers in mid-late June, fruits in July.
Population size and condition: Bighorn National Forest is site of the only northern blackberry monitoring study in the state, where leaf cover is determined as a proxy for population size. Preliminary analysis of the trend data from six separate plots suggests that those plots in upstream shrub habitat could be in decline, while those in downstream habitat shaded by spruce could be increasing (Bighorn NF unpublished data).

LESSER BLADDERWORT (*Utricularia minor* L.)

Classification
Scientific name: *Utricularia minor* L.
Synonyms: none
Common name: Lesser bladderwort
Family: Lentibulariaceae
Size of genus: Three species are reported in Wyoming by Dorn (2001). Work underway in Yellowstone National Park may add a species (Whipple pers. commun.).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: sensitive
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S2. Specimen annotation in conjunction with FNA and with studies in Yellowstone National Park may change this number in either direction (Whipple pers. commun. 2011), so rank review is on hold and other information on the species' distribution may be revised.

Wyoming contribution rank: Conservation of lesser bladderwort as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn Mountains populations are more disjunct than others in Wyoming.

Description

Technical description: Lesser bladderwort is a perennial aquatic herb with submersed, weak stems and leaves. The leaves are 0.3-1 cm long and finely dissected, with each 3-parted leaflet further divided into 1-3 flat, toothed segments. Small bladders (1-2 mm wide) are scattered along the main leaf blade among the leaflets. The inflorescence is a raceme of 2-9 yellow flowers on an emergent stalk 4-15 cm long. The short-spurred, snapdragon-like flowers are bilobed, with the lower lip 4-8 mm long and about twice as long as the upper lip (Cronquist et al. 1984, Dorn 2001). See Figures 24 and 25.

Local field characters: Flowering plants are rarely seen, and the delicate, submerged plants may be hidden by detritus. Technical keys are needed for positive determination.

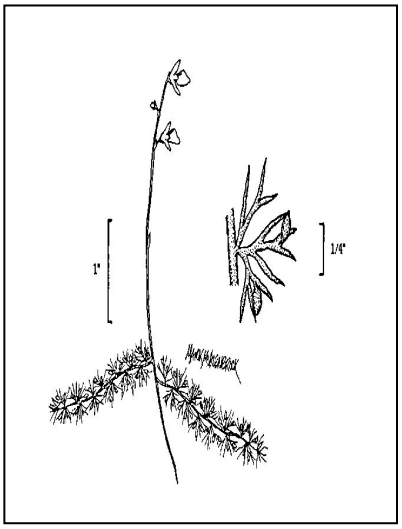


Figure 24 (left): Lesser bladderwort, close-up
Figure 25 (right): Lesser bladderwort, illustration from USDA NRCS (2011)

Similar species: *Utricularia macrorhiza* (*U. vulgaris*) has leaves 10-50 mm long, forked leaf segments, and flowers 12-18 mm long. *U. intermedia* has bladders 2.5-4.0 mm long, borne on separate, leafless branches.

Geographical distribution

Range: Circumboreal, extending south in North America to California, Colorado, Indiana and New Jersey. In Wyoming, known from the Yellowstone Plateau, Jackson Hole, Laramie Basin, and Absaroka, Big Horn, Laramie and Medicine Bow Mountains, in Albany, Fremont, Johnson, Park, Sheridan and Teton counties.

Extant sites: Known from 24 recent records (most recently observed in 2010). There are eleven extant records in Bighorn National Forest (Table 8). All specimens of *Utricularia* deposited at Rocky Mountain Herbarium (RM) were sent on loan to the *Flora of North*

America author, and a specimen from Preacher Rock Bog collected by Erwin Evert that he originally identified as common bladderwort (*Utricularia vulgaris*) was annotated and redetermined to be *U. minor*. The loaned specimens did not return to RM until fall 2011, so we did not have the benefit of this information nor did we find this species when surveying the other two target species in Preacher Rock Bog.

Historical sites: The historical record "near the head of Tensleep Creek" was collected by C.L. Porter in 1959. Habitat was searched extensively around Meadowlark Lake as one possible interpretation of the location, without finding suitable habitat. It seems more likely that the earlier collection corresponds to the occurrence on a headwater tributary like Baby Wagon Creek, or that it was originally collected higher up the East Tensleep Creek watershed. There were targeted areas that appeared to have fen habitat which did not get surveyed. In addition, one historical collection site in the Laramie Range, last collected by C.L. Porter in 1958, was relocated in 2011.

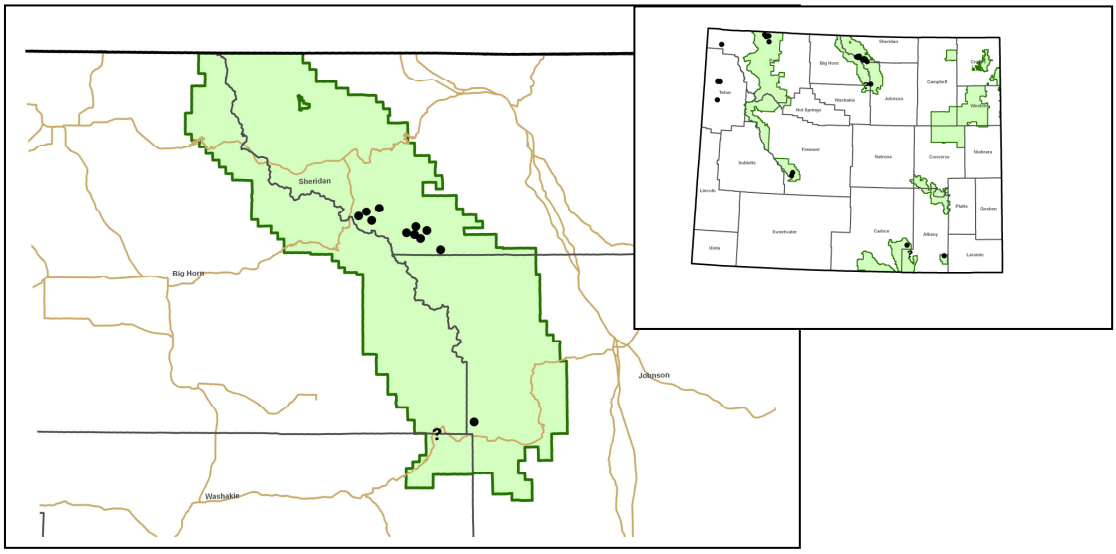


Figure 26. Distribution of lesser bladderwort (*Utricularia minor*) in the Bighorn National Forest and in Wyoming. The "?" represents the historic collection by Porter.

Table 8. Bighorn National Forest occurrences of lesser bladderwort (*Utricularia minor*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
013	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of Burgess	Sheridan	T54NR87W Sec. 26	8200	Dome Lake
015	West Fork Big Goose Creek Fen on west side of creek, and Big and Little Moose Fens on east side of creek, ca 0.8 mile north of Dome Lake Reservoir, ca 15 air miles southeast of Burgess	Sheridan	T53NR87W Sec. 2NW¼ T54NR87W Sec. 35SW¼	8600	Dome Lake
016	Lower Snail Creek Fen, ca 0.5 mile west of Twin Lakes, 0.8 mile north of Stull Lakes, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 34	8920	Dome Lake

018	Graves Lake Fen, ca 1 mile east of East Fork Mohawk Creek, ca 1.5 air miles west of Lookout Mountain.	Sheridan	T54NR87W Sec. 12, 13	8940	Woodrock
019	ca. 4 air miles east-southeast of Granite Pass, midway between Duncan and Calvin Lake at head of unnamed tributary of East Fork South Tongue River, ca. 10 air miles south-southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 23SW¼	9120	Woodrock
020	Woodrock Fen, 2.5 air miles northeast of Granite Pass via FS Rd 663, ca. 19 air miles northeast of Shell.	Sheridan	T54NR87W Sec. 15W½	8914	Woodrock
021	Bruce Creek Fens, at and above confluence of East Fork of Bruce Creek and West Fork of Bruce Creek, ca. 1-2 miles east of Granite Pass, ca. 17 air miles east-northeast of Shell.	Sheridan	T54NR87W Sec. 20NE¼	8878	Woodrock
022	0.2 miles northwest of Park Reservoir and west of outlet, ca. 15 air miles west of Story.	Sheridan	T53NR86W Sec. 16NE¼	8400	Park Reservoir
023	0.4-1 mile northeast of Dome Lake, both sides of FS Rd. 283, ca. 19 miles west of Story.	Sheridan	T53NR87W Sec. 1 SW¼	8680	Dome Lake
024	Baby Wagon Creek wetlands, ca. 19 air miles northeast of Ten Sleep.	Johnson	T49NR85W Sec. 29NW¼	9485	Powder River Pass
025	Preacher Rock Bog, ca 1/8 miles west of Preacher Rock	Sheridan	T54N R86W Sec. 31	8200	Dome Lake

Unverified/Undocumented reports: none known
Sites where present status not known: none
Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.

Figures 27 and 28 (left and right): Habitat of lesser bladderwort; with mud sedge as dominant to right.

Habitat

Associated vegetation: Habitat of lesser bladderwort was originally characterized as submerged in shallow ponds, lakes, and slow-moving streams (Figures 27, 28). It grows affixed to the bottom, rather than free-floating. More specifically, most Wyoming occurrences are in basin fens, with the exception of geothermally-heated wetland complexes in Yellowstone National Park, and the possible exception of beaver ponds in the southern Laramie Range that may or may not have been built within peatland systems. Elevations are at 2012-2891 m (6600-9485 ft).

In Bighorn National Forest, all known occurrences are in fens that have floating mats. Elevation 2268-2868 m (7440-9410 ft) representing the highest elevations for it in the state.

Frequently associated species: Lesser bladderwort is associated with species that grow as emergents, in standing water at the margin of peatland pools, or in floating mats, including mud sedge (*Carex limosa*), water sedge (*C. aquatilis*), slender sedge (*C. lasiocarpa*), beaked sedge (*C. utriculata*), lesser bladder sedge (*C. vesicaria*), Buxbaum's sedge (*C. buxbaumii*), bog buckbean (*Menyanthes trifoliata*) and *Sphagnum* spp. It is sometimes intermixed with common bladderwort (*Utricularia macrorhiza*), but they are more often found at different depths of the same wetland. The submerged plants with which it is most closely associated are often submerged aquatic mosses (*Drepanocladus spp, Calliergon* spp. and others) but information is sketchy.

Topography: It is mainly in basin settings, with the exception of a couple well-developed sloping settings.

Water and soil relationships: Requires standing water throughout the growing season, at least in small pockets between peat mounds. Its floating mat habitat rises and falls with surface water levels.

Population biology and demography

Phenology: Flowers in August, identifiable in vegetative condition July-September.
Population size and condition: In general, it is only possible to determine population extent and frequency class, but not population size without seining or submerged surveys.

Status information on other Wyoming plant species of concern

Four additional Wyoming plant species of concern ("rare species") were documented at a total of 24 extant occurrences. It should be noted that three of the four species were not rooted on peat substrate, but either there were fen features in the same setting, organic soil in the profile, or they may occur as fen species elsewhere in the state. Information on these four species follows the format of the previous section.

MUD SEDGE (*Carex limosa* L.)

Classification
Scientific name: *Carex limosa* L.
Synonyms: none
Common name: Mud sedge
Family: Cyperaceae
Size of genus: There are 114 species of *Carex* reported for Wyoming in Dorn (2001). At least four additional species of sedge have been added to the state flora since 2001. There are 480 species of *Carex* reported in the *Flora of North America* (Ball and Reznicek 2002).
Phylogenetic relationships: Unknown. A member of sect. Limosae, a small section.

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S2. Current status information supports a rank change to S3, as updated in tandem with this study. It was considered for dropping as a Wyoming species of concern prior to this study, but considered appropriate to document as an indicator species.
Wyoming contribution rank: Conservation of *Carex limosa* as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation. The Big Horn populations are more disjunct than others in Wyoming.

Figure 29 (left): Mud sedge, close-up
Figure 30 (right): Mud sedge, illustration from Hermann (1970)

Description

Technical description: Mud sedge is a perennial with stems (culms) 20-60 cm tall from long-creeping rhizomes that are covered by yellowish-brown felty hairs (these hairs are sometimes obscure). Leaves are 1-2 mm wide, and tend to be channeled rather than flat. The terminal spike of the inflorescence is 13-27 mm long and consists entirely of staminate flowers. One to three lateral, pistillate spikes are 1-2.5 cm long and nod on slender stalks. Pistillate scales are light to dark brown with a prominent midvein, a rounded to sharp-pointed (cuspidate) tip, and are commonly as long and wide as the perigynium. Perigynia are 2.3-4.2 mm long, elliptic to ovate, pale greenish or straw colored and covered with small rounded bumps. Achenes 3-sided with 3 stigmas (Ball and Reznicek 2002, Dorn 2001, Hitchcock et al. 1969; Hermann 1970, Hurd et al. 1998, Johnston 2001). See Figures 29 and 30.

Local field characters: The dangling spikes on a delicate stalk are shared characteristics of *Carex limosa* and *C. paupercula*. The narrow, blue-green leaves are characteristic. It stays vegetative under some conditions. Technical keys are needed for positive determination.

Similar species: *Carex paupercula* has shorter terminal spikes and long-pointed pistillate scales that are narrower and longer than the perigynia. *Carex livida* and *C. buxbaumii* have erect lateral spikes. *C. capillaris* has tufted stems and scales that are smaller than the perigynia (Dorn 1992).

Geographical distribution

Range: Circumboreal, from Labrador and Newfoundland to Alaska, south to California, Colorado, Nebraska, Indiana and Delaware. In Wyoming, known from the Absaroka, Beartooth, Big Horn, Sierra Madre, and Wind River ranges, and Yellowstone Plateau, in Big Horn, Carbon, Johnson, Park, Sheridan, Sublette, and Teton counties.

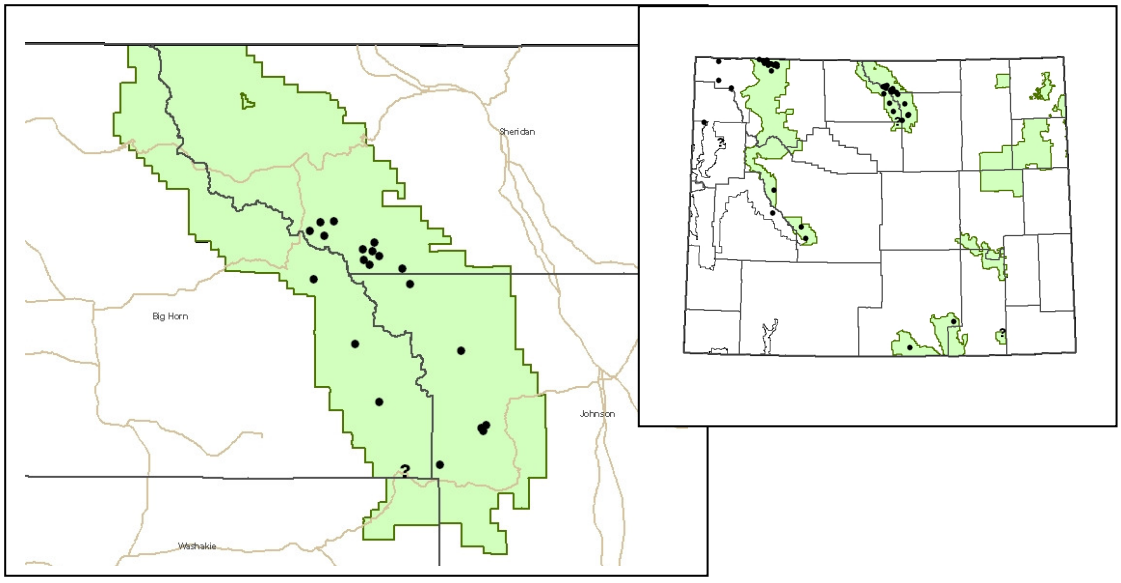


Figure 31. Distribution of mud sedge (*Carex limosa*) in the Bighorn National Forest and in Wyoming. The "?" represents the historic collection by Beetle.

Extant sites: Known from 59 recent records (most recently observed in 2010), including 12 Yellowstone National Park records and two Grand Teton National Park records that just became available in fall 2011. There are 20 extant records in Bighorn National Forest (Table 9). Mud sedge is the most common of the "rare" species, present at all well-developed fen sites on the Forest except at highest elevations. Up until recently, the Forest had only one historic record and a report of it among two vegetation sampling plots (Girard et al. 1997).

Historical sites: Efforts were made to relocate the only historical record in the state, from "Meadowlark Lake, near inlet" by searching in the area of all three inlets (East Tensleep, Garnet and Bull creeks). There was no semblance of suitable habitat, so either the locations were upstream from the inlets or else the habitat is no longer present. The historic collection was made in 1951 by A.A. Beetle. Further surveys are needed upstream before treating this record as extirpated.

Unverified/Undocumented reports: none known

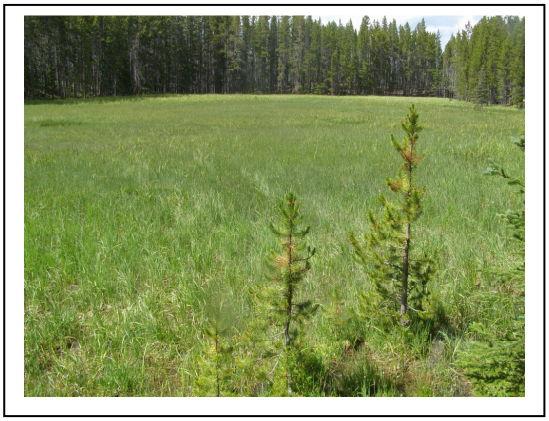
Table 9. Bighorn National Forest occurrences of mud sedge (*Carex limosa*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
031	Sawmill Lake Fen, just south of Sawmill Lakes, ca 0.7 mile north of former Twin Lakes Campground, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 26	8200	Dome Lake
032	West Fork Big Goose Creek Fen on west side of creek, and Big and Little Moose Fens on east side of creek, ca 0.8 mile north of Dome Lake Reservoir, ca 15 air miles southeast of Burgess Junction.	Sheridan	T53NR87W Sec. 2 T54NR87W Sec. 35	8520	Dome Lake
033	Upper Snail Creek Fen, Lower Snail Creek Fen, and third unnamed fen, ca 0.5 mile west of Twin Lakes, 0.8 mile north of Stull Lakes, ca 15 air miles southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 3 W ½ T 54NR97W Sec. 33 SE ¼	8920	Dome Lake
036	ca. 0.7 air miles west of Dome Lake, between Porcupine and Wilderness Creeks, ca. 20.5 air miles west of Story.	Sheridan	T54NR87W Sec. 10SE¼	9080	Dome Lake
037	0.4-1 mile northeast of Dome Lake, both sides of Forest Service Road 283, ca 19 miles west of	Sheridan	T53NR87W Sec. 1W½	8680	Dome Lake
038	Upper Stull Lake and uppermost headwater wetland above it, ca. 0.7-1 air miles west of Dome Lake Reservoir, ca. 21 air miles west of Story.	Sheridan	T53NR87W Sec. 3SW¼ T53NR87W Sec. 9NE¼	8910	Dome Lake
039	Lily Lake and adjoining wetland, ca. 2 air miles southwest of Elk Mountain, accessed via FS Trail 066, ca. 16 air miles east-northeast of Hyattville.	Big Horn	T50NR87W Sec. 11SE¼ T50NR87W Sec.12SW¼	9540	Lake Solitude
040	South of Medicine Lodge Creek, ca 1.5 air mile northeast of Upper Paint Rock Lake, ca 17 air miles northeast of Hyattville.	Big Horn	T51NR87W Sec. 5NE¼	9480	Shell Lake

041	Graves Lake Fen, ca 1 mile east of East Fork Mohawk Creek, ca 1.5 air miles west of Lookout Mountain.	Sheridan	T54NR87W Sec. 12SE¼ T54NR87W Sec.13NW¼	8940	Woodrock
042	ca 4 air miles east-southeast of Granite Pass, midway between Duncan and Calvin Lake at head of unnamed tributary of East Fork South Tongue River, ca 10 air miles south-southeast of Burgess Junction.	Sheridan	T54NR87W Sec. 23SW¼	9120	Woodrock
043	Woodrock Fen, 2.5 air miles northeast of Granite Pass via FS Rd 663, ca. 19 air miles northeast of Shell.	Sheridan	T54NR87W Sec. 15	8822	Woodrock
044	Bruce Creek Fens, at and above confluence of East Fork of Bruce Creek and West Fork of Bruce Creek, ca 1-2 miles east of Granite Pass, ca 17 air miles east-northeast of Shell.	Sheridan	T54NR87W Sec. 20NE¼ T54NR87W Sec. 21NW¼	8878	Woodrock
045	Between McKinnon and Moraine Creeks near FS Trail 817, ca. 2 air miles east of Shell Creek Ranger Station, ca. 16 air miles east of Shell.	Big Horn	T53NR88W Sec. 21SE¼	8625	Shell Reservoir
046	Northeastern end of Frying Pan Lake, upper end of South Piney Creek, ca. 18 air miles west-northwest of Buffalo.	Johnson	T51NR85W Sec. 10NE¼	9409	Willow Park Reservoir
047	Baby Wagon Creek wetlands, ca. 19 air miles northeast of Ten Sleep.	Johnson	T49NR85W Sec. 29NW¼	9480	Powder River Pass
048	Near headwaters of South Fork of Clear Creek, ca. 0.8 air miles south-southeast of Sherd Lake, ca. 16 air miles southwest of Buffalo.	Johnson	T50NR84W Sec. 31SE¼	8720	Lake Angeline
049	Near headwaters of South Fork of Clear Creek, ca. 0.8 air miles south-southeast of Sherd Lake, ca. 16 air miles southwest of Buffalo.	Johnson	T50NR84W Sec. 31SE¼	8720	Lake Angeline
050	Among South Fork Ponds near headwaters of South Fork of Clear Creek, ca. 0.6-0.7 air miles east of Sherd Lake, ca. 15.5 air miles southwest	Johnson	T50NR84W Sec.29SW¼ T50NR84W	8556	Hunter Mesa Lake
051	Immediately east to 0.5 miles north of Bighorn Reservoir, ca. 18.5 air miles west of Kearney.	Johnson	T53NR86W Sec. 27SE¼	8600	Park Reservoir
052	0.2 miles northwest of Park Reservoir and west of outlet, ca. 15 air miles west of Story.	Sheridan	T53NR86W Sec. 16NE¼	8400	Park Reservoir

Sites where present status not known: It is not known whether the location of the two sample plots for the beaked sedge – mud sedge c.t. (*Carex utriculata – C. limosa* c.t.) reported by Girard et al. (1997) can be obtained.

Areas surveyed but species not located: All other Bighorn National Forest sites of fens that were surveyed represent surveys where this species was not located.



Figures 32-34. Mud sedge habitat
Above: Dominant across pothole.

Upper right: Dominant in large free-floating mats in lake.

Right: Dominant around pool at lower end of large, sloping fen.

Habitat

Associated vegetation: Occurs rangewide in *Sphagnum* bogs, wet meadows and shores (Ball 2002). In Wyoming, it is most abundant in floating peatland mats but present in different fen types, water bodies, and water chemistry (Figures 32-34); uncommon in wet meadows that might represent relict or degraded habitat. Soils are wet to saturated at the surface. It was previously characterized as a fen obligate in the state (Heidel 2006) but it is present on a couple borderline fens in Bighorn National Forest. Elevation 2012-3170 m (6600-10,400 ft).

In Bighorn National Forest, mud sedge spans the gamut from floating to anchored peat. The beaked sedge – mud sedge c.t. (*Carex utriculata – Carex limosa* c.t.) is said to occur "on bogs" (Girard et al. 1997). The species was also found in at least one site that is not currently fen habitat but may represent degraded fen habitat. Elevation 2500-2908 m (8200-9540 ft).

Frequently associated species: Mud sedge is often a monodominant, but is sometimes co-dominant with bog buckbean (*Menyanthes trifoliata*), *Sphagnum* mosses, and submerged mosses. Other commonly associated species include sedges that may grow as emergents including slender sedge (*Carex lasiocarpa*), water sedge (*C. aquatilis*), Buxbaum's sedge (*C. buxbaumii*), beaked sedge (*C. utriculata*), and lesser bladder sedge (*C. vesicaria*). It is noteworthy that there is a guild of sensitive/rare plants that are primarily found in association with floating mats of mud sedge on floating mat habitat or bordering it. These include lesser panicled sedge (*Carex diandra*), English sundew (*Drosera anglica*), slender cottongrass (*Eriophorum gracile*), and lesser bladderwort (*Utricularia minor*). All Bighorn National

Forest occurrences of these four sensitive species were always found with mud sedge in the same wetland if not the same wetland zone.

In 2010 surveys, it was rarely found to be co-dominant with beaked sedge (*Carex rostrata*), though often present in the same wetland. The *Carex rostrata – Carex limosa* c.t. may warrant further documentation as a community type. Girard et al. (1997) characterized associates: "Traces of big sagebrush and shrubby cinquefoil are present. Parry's sedge or tufted hairgrass are sometimes prevalent. Forb composition is variable and primarily composed of non-riparian species. Common yarrow, alpine leafybract aster, northern bedstraw, largeleaf avens, mountain bluebells, elephanthead lousewort, goldcup cinquefoil, and common dandelion are often present." With the exception of elephanthead lousewort (*Pedicularis groenlandica*), none of the previously species were found directly associated with *Carex limosa* in Bighorn National Forest fen sites.

Topography: *Carex limosa* is typically in basin settings, but was also found in low numbers in drainage settings within sloping patterned fen.

Water and soil relationships: Mud sedge is sometimes a "pioneer" that forms a floating mat extending across open water. In Bighorn National Forest, it is found in many different successional stages of mat development that include thin and thick peat mats and anchored mats. Its name "mud sedge" may refer to the fact that it is often in relatively sparse cover, exposing the underlying substrate, and is often in settings with marl accumulation or algal accumulation on submerged vegetation, hence the "muddy" moniker.

Population biology and demography
Phenology: Flowers in late June-mid July, fruits present in July-August.
Population size and condition: The majority of populations in Wyoming are reported as being abundant or dominant, with flowering stem numbers of undetermined magnitude. Plants are colonial from short rhizomes, so flowering stem numbers (ramets) do not correspond with the number of genetic individuals, and population size is likely to be much lower than numbers determined from any census or estimate of flowering stem numbers.

SARTWELL'S SEDGE (*Carex sartwellii* Dewey)

Classification
Scientific name: *Carex sartwellii* Dewey Synonyms: none
Common name: Sartwell's sedge
Family: Cyperaceae
Size of genus: There are 114 species of *Carex* reported for Wyoming in Dorn (2001). At least four additional species of sedge have been added to the state flora since 2001. There are 480 species of *Carex* reported in the *Flora of North America* (Ball and Reznicek 2002).
Phylogenetic relationships: Unknown. A member of sect. Holarrhenae, a small section (Reznicek and Catling 2002).

Present legal or other formal status
U.S. Fish & Wildlife Service: none

U.S. Forest Service – Rocky Mountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: S1
Wyoming contribution rank: Conservation of *Carex sartwellii* as a widespread species at the edge of its range in Wyoming signifies a low-level contribution to rangewide conservation.

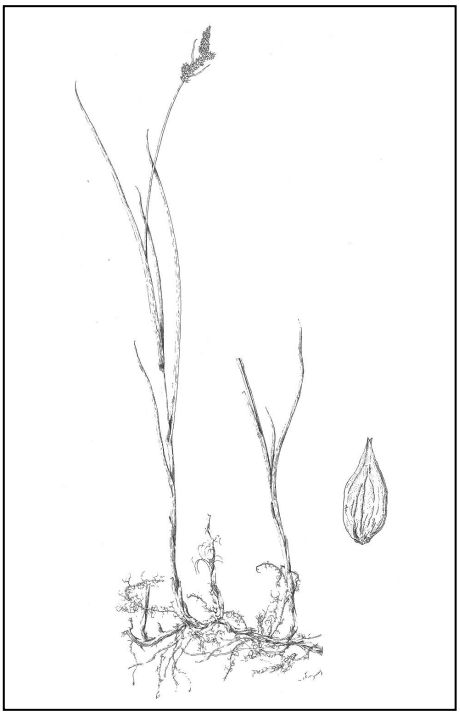


Figure 35. Sartwell's sedge, illustration from Hermann (1970)

Description

Technical description: Sartwell's sedge is a perennial with culms arising singly or together from an elongate brown or blackish creeping rhizome. Leaves are flat, 2-5 mm wide, and scattered along the culm (not restricted to a basal cluster). Leaf sheaths are elongate and green-streaked on the ventral surface rather than white hyaline. Inflorescence dense, ovoid to cylindric, 2-5 cm long, and composed of 15-20 or more sessile, androgynous spikes (with the staminate flowers arranged above the pistillate ones). Lowermost spikes are subtended by long, leafy bracts. Flowering scales scarious or hyaline-margined, straw-colored or light brown except for the pale midrib, and nearly as long as or equaling the perigynia. The ovate to elliptic perigynia are 2.3-4 mm long, narrowly wing-margined, ventrally nerved, and taper to a short, bi-toothed beak. The achenes are lens-shaped and pistillate flowers have 2 stigmas (Dorn 2001, Fertig 1998, Hitchcock et al. 1969, Johnston 2001). See Figure 35.

Local field characters: The large, loose clones can be easily overlooked because flowering and fruiting are sometimes uncommon. The tall, 3-sided vegetative culms scattered along the rhizome are distinctive (Reznicek and Catling 2002), and they impart a lime-green color to the surrounding vegetation from its broad stem leaves (Fertig 1998).

Similar species: *Carex praegracilis* has dark brown to black lower leaf sheathes, leaves arranged in a basal cluster, and perigynia without thin margins or ventral nerves. *C. simulata*

has dark, wingless and nerveless perigynia under 2.7 mm long. *C. diandra* and *C. cusickii* have copper-margined or spotted ventral leaf sheaths and clustered stems rather than stems borne along creeping rhizomes (Hitchcock et al. 1969; Dorn 2001).

Geographical distribution

Range: Quebec to British Columbia and Northwest Territories, south to Idaho, Colorado, Missouri, and Pennsylvania. In Wyoming, known from scattered locations in Jackson Hole, Yellowstone Plateau, Big Horn and Medicine Bow Mountains, and the Cheyenne Basin.
Extant sites: Known from five recent records (most recently observed in 2010). It was documented for the first time at one Bighorn National Forest site as part of surveys for sensitive/rare fen species (Table 10).

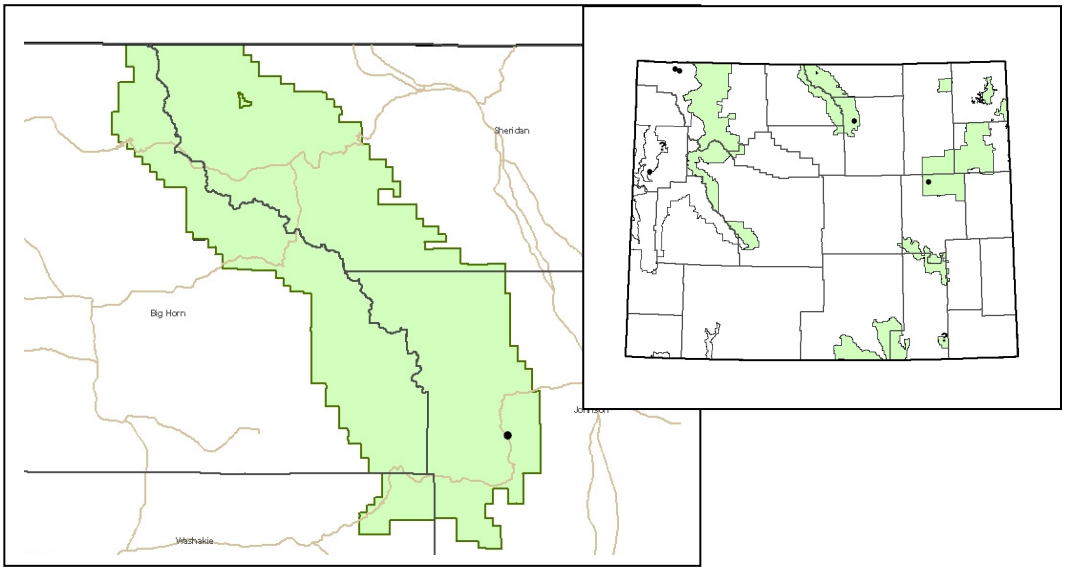


Figure 36. Distribution of Sartwell's sedge (*Carex sartwellii*) in the Bighorn National Forest and in Wyoming.

Historical sites: Known historically from the Pole Mountain area of the Laramie Range and from the Moran area of Jackson Hole, both collected in 1964 by W.M. Johnson.

Unverified/Undocumented reports: none known

Table 10. Bighorn National Forest occurrences of Sartwell's sedge (*Carex sartwellii*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
009	Little Sourdough Creek on north side, ca 10 air miles southwest of Buffalo.	Johnson	T49NR84W Sec. 2 SE¼	8120	Caribou Creek

Sites where present status not known: none
Areas surveyed but species not located: This species was not previously documented from the Big Horn Mountains, so it cannot be ruled out from other places. It seemed as though similar settings were restricted to headwaters of Clear and Crazy Woman Creeks.

Habitat

Associated vegetation: Reported from fens, wet prairies, sedge meadows, marshes, open thickets and swamps; stream, pond and lake shores, and ditches, often in shallow water (Reznicek and Catling 2002). In Wyoming, most occurrences are in montane riparian vegetation, with exception of a Cheyenne Plains occurrence. Elevation 1463-2438 m (4800-8000 ft).

In Bighorn National Forest, it was collected at the upper margins of wet meadow that had lower zones of localized peat accumulation around springs above the Little Sourdough Creek, at 2908 m (8120 ft).

Frequently associated species: Populations in the National Elk Refuge are often found in communities dominated by Sartwell's sedge, or Baltic rush (*Juncus balticus*), and tufted hairgrass (*Deschampsia cespitosa*) on mossy, moist organic black soils. In the Big Horn Mountains, it occurred with roughbent (*Agrostis scabra*), timber wild oatgrass (*Danthonia intermedia*), and tufted hairgrass (*Deschampsia cespitosa*).

Topography: Most sites are in riparian settings, though sometimes associated with springs and seeps above the valleybottom. In addition, part of the National Elk Refuge populations are in palustrine settings of fen habitat (Fertig 1998).

Water and soil relationships: Information on soils is sketchy but suggests that peat or turf is often in the soil profile, retaining soil moisture through the early part of the growing season.

Population biology and demography

Phenology: Flowers June-early July; fruits present July-August.
Population size and condition: Population size information is available for what is perhaps the largest of the seven occurrences at the National Elk Refuge, where several thousand culms observed (since the plant is rhizomatous, this could represent 500-5000 genetic individuals) and the species was often locally dominant ((Fertig 1998). In the Big Horn Mountains, it was found in high density in a small area of perhaps less than 10 m^2 to date.

WOODLAND HORSETAIL (*Equisetum sylvaticum* L.)

Classification

Scientific name: *Equisetum sylvaticum* L.
Synonyms: none
Common name: Woodland horsetail
Family: Cyperaceae
Size of genus: There are seven species reported in Dorn (2001). There are 11 species reported in the *Flora of North America* (Hauke 1993).
Phylogenetic relationships: unknown

Present legal or other formal status

U.S. Fish & Wildlife Service: none

U.S. Forest Service – Rocky Mountain Region: Species of Local Concern on Bighorn National Forest
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S1. Current status information supports a rank change to S2, as updated in tandem with this study.
Wyoming contribution rank: Conservation of *Equisetum sylvaticum* as a disjunct species in Wyoming signifies a medium-level contribution to rangewide conservation.

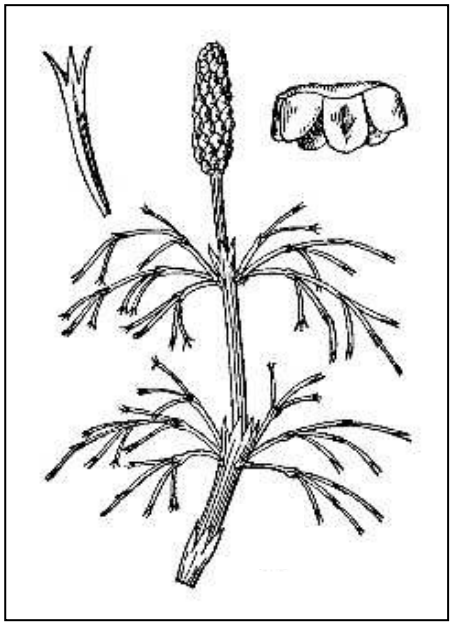


Figure 37 (left): Woodland horsetail
Figure 38 (right): Woodland horsetail, illustration from Britton and Brown (1913)

Description

Technical description: Woodland horsetail is a perennial with dimorphic, annual sterile and fertile stems. Sterile stems are 30-70 cm tall, greenish, and have 8-18 ridges bearing rows of sharp (often hooked) spicules. The main stem is 1.5-3 mm wide with a large central cavity over 1/2 its diameter. Sheaths are 4-12 mm long with persistent reddish-brown teeth fused into 2-5 clusters. Stem branches are slender, drooping, and twice-branched and arranged in whorls at the nodes of the main stem. Fertile stems are initially straw-colored to pale brown, unbranched and topped with round-tipped deciduous cones (strobili) 15-30 mm long. These stems later produce whorls of green, compound branches similar to the sterile stems (Dorn 2001, Hauke 1993, Hitchcock et al. 1969). See Figures 37 and 38.

Local field characters: The stem branches are branched again, a diagnostic characteristic.
Similar species: *Equisetum arvense* and *E. fluviatile* have simple (unbranched) whorled lateral branches and sheath teeth that are not fused.

Geographical distribution

Range: Circumboreal, from Greenland, Labrador and Newfoundland to Alaska, south to Washington, Wyoming, South Dakota, Iowa, Ohio and Virginia. In Wyoming, known only from the Black Hills and Big Horn Mountains of Crook, Johnson and Sheridan counties.

Extant sites: Known from 10 recent records (most recently observed in 2010). There are two records in Bighorn National Forest (Table 11).

Historical sites: none

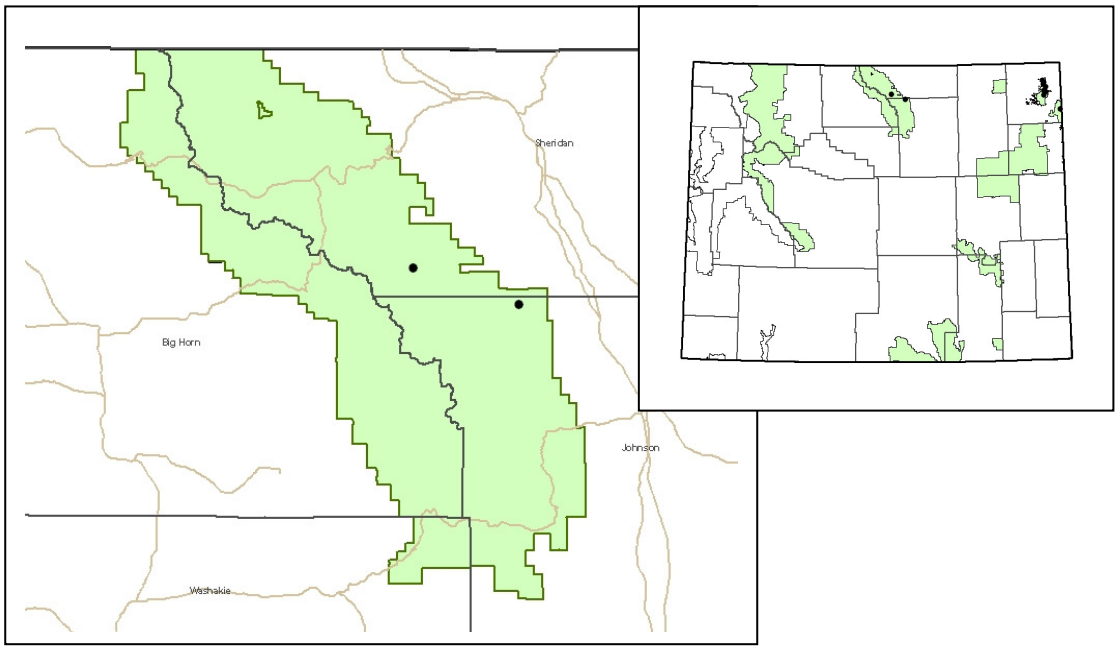


Figure 39. Distribution of woodland horsetail (*Equisetum sylvaticum*) in the Bighorn National Forest and in Wyoming.

Unverified/Undocumented reports: none

Table 11. Bighorn National Forest occurrences of wood horsetail (*Equisetum sylvaticum*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5'
003	Preacher Rock Bog due west of Preacher Rock for over 0.5 miles, along north side of Sawmill Pass-Red Grade Road, ca 16.5 miles	Sheridan	T54N R86W Sec. 31, T54MR87W Sec. 36	8200-8300	Dome Lake
008	Bard Spring wetland area, along Penrose Trail, ca 6 miles west-southwest of Story.	Johnson	T53NR84W Sec. 20SW¼, 29NE¼	7400	Story Little Goose Peak

Sites where present status not known: none

Areas surveyed but species not located: This species was sought in three wetlands close to Preacher Rock Bog. Forest margins were routinely checked in the rest of 2010 surveys, but it was not found.

Habitat

Associated vegetation: Rangewide, in wet meadows, marshes, streambanks, and moist woods, often on subacidic soils (Lellinger 1985). In Wyoming, it occurs in valleybottom woodland along creeks, streambanks and ponds, and at seepages borders of forest openings. Elevation 1220-2530 m (4000-8300 ft).

Figure 40 (left): Habitat of wood horsetail

Figure 41 (right): Habitat of wood horsetail (Bard Spring)

In Bighorn National Forest, it occurs at seeps and groundwater discharge zones at the border between forests and wetland openings (Figures 40-41). The substrates are turf and thin layers of peat, although none have been found to be as deep as 40 cm. If they are part of fen ecosystems under natural conditions, then they are at outer margins, in settings where some or most inner core areas of the wetlands are no longer classified as peatland. Elevation 2255-2530 m (7400-8300 ft).

Frequently associated species: In the Black Hills, it is associated with mesic deciduous woods that usually include paper birch (Betula papyrifera) and beaked hazel (Corylus cornuta), and may also include white spruce (Picea glauca), Ponderosa pine (Pinus ponderosa), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pensylvanica*), hop hornbeam (*Ostrya virginiana*), dwarf red raspberry (*Rubus pubescens*), common red raspberry (*R. ideaus*),white spiraea (*Spiraea betulifolia*), snowberry (*Symphoricarpos albus*), and understory herbs.

In Bighorn National Forest, it is associated with Engelmann spruce (*Picea engelmanii*),lodgepole pine (*Pinus contorta*), soft-leaf sedge (*Carex disperma*), hoary sedge (*C. canescens*), water sedge (*C. aquatilis*), tufted hairgrass (*Deschampsia cespitosa*),tall cottongrass (*Eriophorum angustifolium*), northern crane's-bill (*Geranium bicknellii*),

streambank saxifrage (*Saxifraga odontoloma*), and arrowleaf ragwort (*Senecio triangularis*). It is rarely associated with species in the surrounding drier habitats like small-leaf pussytoes (*Antennaria microphylla*), Virginia strawberry (*Fragaria virginiana*), and white clover (*Trifolium repens*); the latter is not native.

Topography: Black Hills occurrences are in valleybottom settings. Bighorn National Forest occurrences are in basin settings in headwater positions.

Water and soil relationships: Saturated or moist conditions are required when spores are produced early in the growing season. The substrate has high organic content, which retains moisture.

Population biology and demography
Phenology: Produces spores in strobili in May and early June. Recognized by vegetative characteristics throughout the growing season.

Population size and condition: Estimates of stem numbers at Wyoming occurrences range from less than 100 to over 1,000,000. One if not both occurrences on Bighorn National Forest are the largest in the state. Plants are colonial from rhizomes, so stem numbers (ramets) do not correspond with the number of genetic individuals, and population size is likely to be much lower than numbers determined from any census or estimate of flowering stem numbers.

WHITE-STEM PONDWEED (*Potamogeton praelongus* Wulf.)

Classification
Scientific name: *Potamogeton praelongus* Wulf.
Synonyms: none
Common name: White-stem pondweed
Family: Potamogetonaceae
Size of genus: There are 18 species in the genus in Wyoming, not counting the close relatives placed in the *Stuckenia* genus (Dorn 2011).
Phylogenetic relationships: unknown

Present legal or other formal status
U.S. Fish & Wildlife Service: none
U.S. Forest Service – Rocky Mountain Region: none
Global Heritage rank: G5
State Legal status: none
State Heritage rank: The more recent list update (Heidel 2007) reported an SRANK of S1. Current status information supports a rank change to S1S2, as updated in tandem with this study. However, new information is expected on the status of all *Potamogeton* species in Yellowstone National Park, so rank updates in this genus are tabled until information that is expected to overhaul state status becomes available.

Wyoming contribution rank: Conservation of *Potamogeton praelongus* as a widespread species at the edge of its range in Wyoming signifies a low-level contribution to rangewide conservation.

Description

Technical description: White-stem pondweed is a submersed, rhizomatous aquatic forb with whitish to olive-green, sparsely branched, rounded stems 10-30 dm long. The leaves are all submersed and morphologically similar, with sessile, entire-margined, oblong to lance-shaped blades 10-25 cm long and 20-30 mm wide. Stipules are 4-10 cm long, whitish, firm, and persistent. Flowering and fruiting stalks are 10-30 cm long and usually extend above the surface of the water. The inflorescence is a loose spike 3-5 cm long composed of greenish flowers. Fruits are achenes 4-5 mm long with a prominent dorsal keel (Cronquist et al. 1977; Dorn 2001). See Figures 42 and 43.

Local field characters: The whitish stem is a consistent characteristic. Technical keys are needed for positive identification.

Figure 42 (left): White-stem pondweed, by Jim Zier

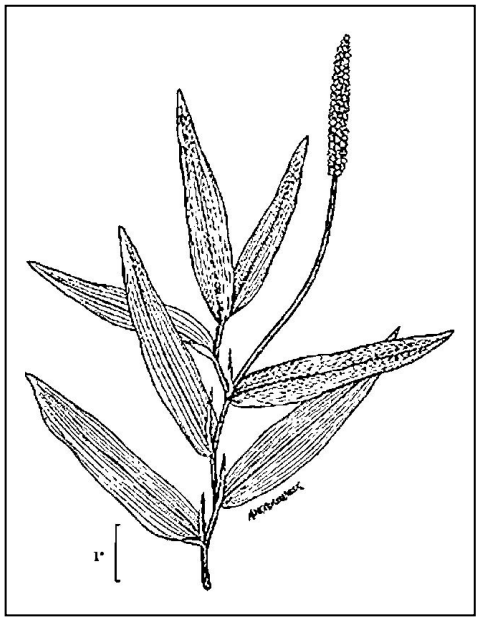


Figure 43 (right): White-stem pondweed, illustration from USDA NRCS 2011

Similar Species: *Potamogeton richardsonii* has leaves with flat tips and blades mostly under 10 cm long and fruits less than 3.5 mm long. *P. crispus* has leaves 3-12 mm wide with finely toothed margins. *P. amplifolius* has morphologically distinct floating and petioled submerged leaves (Cronquist et al. 1977; Dorn 2001).

Geographical distribution

Range: Circumboreal, from Alaska to Newfoundland south to California, Colorado, Indiana, and New Jersey. In Wyoming, known from the Absaroka, Beartooth, Big Horn, and Medicine Bow Mountains and Yellowstone Plateau, in Albany, Johnson and Park counties.

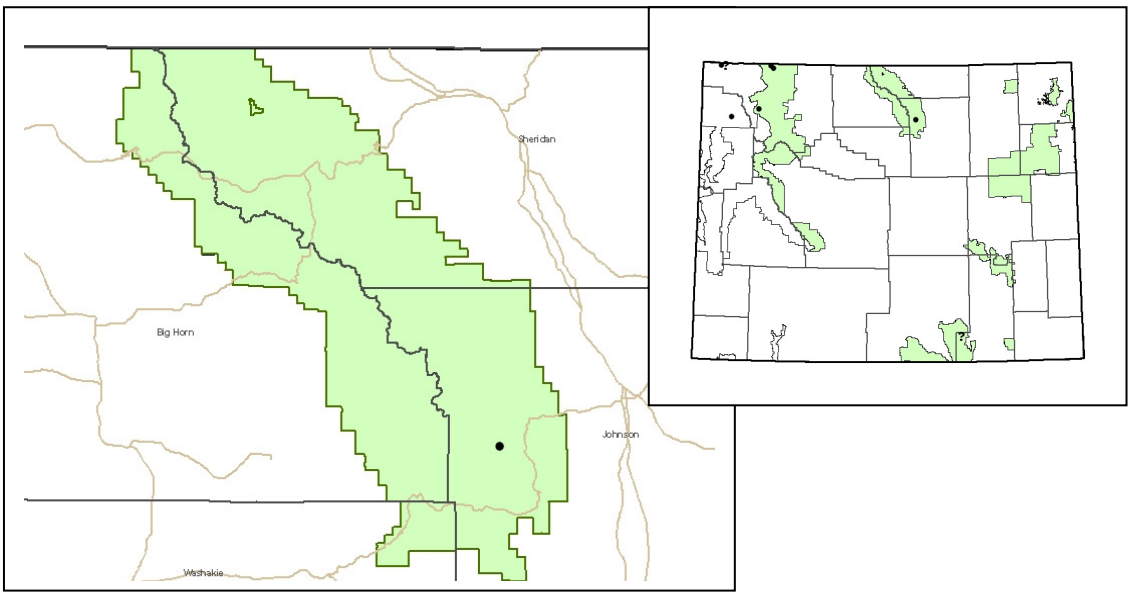


Figure 44. Distribution of white-stem pondweed (*Potamogeton praelongus*) in the Bighorn National Forest and in Wyoming.

Extant sites: Known from six recent records (most recently observed in 2010). There is one record in the Bighorn National Forest (Table 12).

Historical sites: Known from two historical sites, one in the Yellowstone Plateau, and the other in the Medicine Bow Mountains.

Unverified/Undocumented reports: none

Table 12. Bighorn National Forest occurrences of white-stem pondweed (*Potamogeton praelongus*)

EO#	Location	County	Legal Description	Elev. (ft)	USGS 7.5' Quad
009	All of Sherd Lake and pond to immediate south.	Johnson	T50NR84W Sec. 30SW¼ T50NR84W Sec. 31NW¼	8743	Lake Angeline

Sites where present status not known: none
Areas surveyed but species not located: Surveys for *Potamogeton amplifolius* were unsuccessful. Submerged species targets were surveyed in the course of 2010 surveys to the extent it was visible from the surface.

Habitat
Associated vegetation: Occurs in deep water lakes and slow-moving streams (Cronquist et al. 1977). In Wyoming, occurs in ponds, lakes, and central open water areas of fens at 2012-2804 m (6600-9200 ft).

In Bighorn National Forest, it was documented in a shallow lake perimeter and associated elongate pond. It was not associated with fen vegetation, but is included as part of this report because it appears to be a facultative fen species elsewhere in the state. Elevation 2665 m (8743 ft).

Frequently associated species: In Sherd Lake, it was associated with green algae. In the elongate pond, it was associated with yellow pond-lily (*Nuphar polysepala*).
Topography: Lakes and ponds in basin settings, with limited inflow and outflow.
Water and soil relationships: It is often rooted in organic sediments and reported from variable depths. The one known fen setting for it is in the Beartooth Mountains in the open water pool of a poor fen.

Population biology and demography
Phenology: Flowers June-July, fruits present July-August. Only vegetative material was found in mid August 2010.
Population size and condition: Abundant around Sherd Lake edge and nearby wetland; the only occurrence where frequency is noted.

Summary of population biology of sensitive/rare fen species

The following information on reproductive biology and population ecology of the ten sensitive/rare fen species addresses them as a group because there are many commonalities among them, and the contrasts are insightful. This information provides data context.

Reproductive biology
Type of reproduction: Most of the sensitive/rare fen plant species of Bighorn National Forest have vegetative reproduction, and some have not been observed in sexual reproduction stages on the Forest to date including woodland horsetail (*Equisetum sylvaticum*), white-stemmed pondweed (*Potamogeton praelongus*) and lesser bladderwort (*Utricularia minor*). A few like lesser panicled sedge (*Carex diandra*), have specialized adaptation to survive burial in peat-accumulation, with an upward growth of the perennating bud that literally outgrows peat burial over time. Seeds of the sensitive/rare fen plant species are likely to be adapted for germination on organic substrate, although the possibilities of dispersal into new habitat are slim, fecundity often appears low in relatively high or low water levels, and seeds may have difficulty germinating in anaerobic, nutrient poor conditions.

Pollination biology: The sensitive/rare species that are monocots are wind-pollinated. The sensitive/rare species that are dicots are likely to have generalist pollinators or self-compatibility. Pollination vectors of northern blackberry (*Rubus acaulis*) have not been determined, though Fertig (2000) reports that it produces an open, cup-shaped flower that is attractive to a broad range of generalist pollinators, and that only honeybees were directly observed visiting flowers in 1999. No fruit production was documented in the Sourdough Creek population in 1999. English sundew is likely to resemble round-leaf sundew (*Drosera rotundifolia*) in being self-pollinating (autogamous). Throughout most of the range of round-leaf sundew, the flowers never open and are cleistogamous, while some plants produce chasmogamous flowers that open briefly for a couple hours during the brightest sunlight

(Engelhardt 1998 in Wolf and Cooper (2006). To date, lesser bladderwort (*Utricularia minor*) is only known to have self-fertilizing (chasmogamous) flowers (Taylor 1989 in Neid 2006).

Seed dispersal and biology: Water is the primary dispersal vector of sensitive/rare fen species. The overwintering structures of lesser bladderwort (*Utricularia minor*) called "turions" are also reported to be dispersed by waterfowl and other species might have seeds dispersed in this way.

Population ecology

General summary: Census data and estimates for the sensitive/rare species of fen habitats are never more than estimates of true population size because vegetative reproduction makes it impossible to determine what constitutes an individual. For example, the largest northern blackberry (*Rubus acaulis*) population on Bighorn National Forest is estimated as having over 100,000 stems (ramets), but the underground connectivity is unknown so that the total number of genets is unknowable. In these cases, the stem numbers represent the upper limit of population numbers. Only species that form discrete tussocks/clumps can be censused, like lesser panicled sedge (*Carex diandra*), although any one tussock or clump may represent more than one individual. In these cases, the clump numbers represent the lower limit of population numbers.

Population estimates are also difficult to make because some of the species may be difficult to see if they grow as submergents (*Utricularia minor*), layered in the water column and difficult to see from above the surface, or obscured by surrounding emergent vegetation, algae or suspended detritus. In addition, fruiting may be greatly reduced in some years and non-flowering stems are much harder to discern than flowering stems, particularly when intermixed with other species. For all the above reasons, survey results are presented as originally recorded, whether as stem counts, area estimates or frequency estimates, without trying to convert into population size figures.

Competition: Fen species are generally poor competitors. They flourish under water chemistry conditions that most other plants cannot survive, in wetlands of low primary productivity. Oxidation of peat, prolonged submergence of some peat species, or high levels of surface run-off into fen habitat change water chemistry and may give competitive advantage to robust, native wetland plants that are habitat generalists such as bluejoint reedgrass (*Calamagrostis canadensis*), beaked sedge (*Carex utriculata*), and broad-leaved cattail (*Typha latifolia*).

Herbivory: Few signs of herbivory were noted on sensitive/rare fen plant species in the course of survey. Moose and elk are native ungulates that frequent fen habitat. Some fen areas are part of large grazing allotments. No sensitive/rare fen species were found in areas of intense livestock use.

Hybridization: None known.

Summary of distribution and habitat of sensitive/rare fen species in the Big Horn Mountains

The following information on distribution and habitat of sensitive/rare fen species addresses them as a group, an initial step toward understanding the collective fen resources on Bighorn National Forest.

Sensitive/rare fen plant species occur in the central massif of the Big Horn Mountains, at montane to subalpine elevations that encircle higher elevations of the Cloud Peak Wilderness Area. There are no known fens in the northern and southern massifs, despite areas mapped as having high peatland density as mapped around Bald Mountain by the National Wetland Inventory. There are no known fens at foothills elevations. This pattern is thought to reflect the window of suitable geology and climate that dictate stable hydrology for peat accumulation. Of the seven major watersheds that emanate from the Big Horn Mountains, the four that feed from the central massif, Big Horn, Clear, Nowood, and Tongue River watersheds all have headwater fen sites that were field-verified during 2010 surveys.

The east side of the Big Horn Mountains has all ten of the sensitive/rare fen plant species, whereas the west side has only three. The east side covers a much larger area, but also has more annual precipitation and appears to have more extensive glacial deposits.

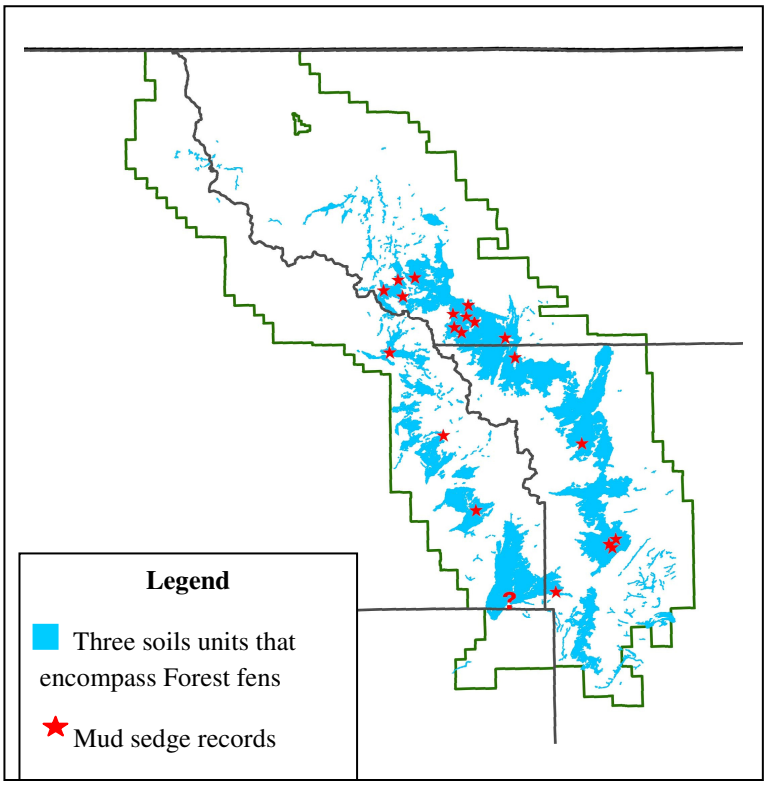
Of the ten sensitive/rare plant species, at least three have numbers that approach or exceed Shoshone National Forest and possibly Yellowstone National Park. They include mud sedge (*Carex limosa*), russet cottongrass (*Eriophorum chamissonis*), and lesser bladderwort (*Utricularia minor*). Their populations in the Big Horn Mountains are geographically separated from nearest populations in the Beartooth and Wind River ranges, persisting as concentrations of isolated, disjunct relict populations.

Fen habitat appears to closely follow glacial deposits. It is most consistently found in collapsed glacial moraine, where the sites are often small basins. Some of the largest sites are associated with lateral and terminal moraines, forming either basin or sloping settings. There are at least 10 unique land type association units as defined by Bighorn National Forest that have known sensitive/rare fen plants (59, 118, 127, 129, 140, 146, 191, 202, 207, and 231). Soils mapping for Bighorn National Forest (USDA Forest Service 1999) may provide information with stronger fidelity to fen distribution. Three units contain all sensitive/rare fen plant occurrences on the Forest. A map of these three soil layers, merged, represents a working hypothesis of maximum montane fen distribution in Bighorn National Forest (Figure 45). Their attributes are summarized in Table 13.

Table 13. Soils units that encompass Bighorn National Forest sensitive/rare fen plant species

Unit	Soil	Plant Association	Setting
11	Agneston-Leighcan	*Picea engelmannii/ Vaccinium scoparium*	Montane and subalpine mountain slopes, 5 to 30 percent slopes
16	Cryaquolls	*Salix* spp./ *Juncus compressus*	Montane and subalpine mountain slopes,
19A	Frisco -	*Pinus contorta/ Vaccinium scoparium*	Montane and subalpine glacial till, 2 to
19B	Frisco - Troutville	*Pinus contorta/ Picea engelmannii/ Vaccinium scoparium*	Montane and subalpine glacial moraines, 2 to 40 percent slopes.

Figure 45. Soils units that encompass Bighorn National Forest sensitive/rare fen plant species – distribution of mud sedge (*Carex limosa*) superimposed



Many of the sensitive/rare fen species occurred at sites that had streams traversing peatland habitat. This was rarely observed in the Beartooth or Medicine Bow Mountains, and this hydrological characteristic cannot be reliably used to identify or rule out fen habitat in aerial photointerpretation. The stream channels cut down to mineral soil. Many of the sloping peatland sites had their shallowest peat depth along the stream channel, but this was not evaluated consistently throughout.

All of the sensitive/rare plant species that are fen obligates in the Bighorn National Forest are wetland obligates throughout their range (USDI ACE 2011). This includes lesser panicled sedge, English sundew, russet cottongrass, slender cottongrass, lesser bladderwort, and mud sedge. Sartwell's sedge and white-stem pondweed are also wetland obligates; the other two are facultative wetland species in the Rocky Mountains. There is not an accepted wetland vegetation classification much less fen vegetation classification in Wyoming. The reader is referred to the few studies that address Wyoming fen vegetation, using different methods and classification systems, including work in fens of a Wind River watershed (Cooper and Andrus 1994), in Yellowstone National Park (Lemly 2007, Lemly and Cooper 2011), in the Medicine Bow Mountains (Heidel and Jones 2006) and preliminary work in the Beartooth Mountains (Heidel et al. 2010).

Four provisional fen vegetation types were observed during the course of surveys. Perhaps the most widespread fen type in the Big Horn Mountains is dominated by water sedge (*Carex aquatilis*), both as monodominant and in admixtures with low cover of planeleaf willow (*Salix planifolia*) or with other graminoids. There may also be areas where lesser bladder sedge (*Carex vesicaria*) and few-flowered spikerush (*Eleocharis quinqueflora*)

are common if not locally dominant or co-dominant, particularly at higher elevation fen sites. This species is pervasive as a dominant and as a common species, in both fen and non-fen habitat. This type is described by Girard et al. (1997).

The easiest plant association to distinguish is that dominated by mud sedge (*Carex limosa*) where it occurs as floating mat vegetation, with or without slender sedge (*Carex lasiocarpa*), bog buckbean (*Menyanthes trifoliata*) and *Sphagnum* mosses. Most but not all sensitive/rare fen plant species occurrences had this vegetation type present if not directly associated. The succession or gradient from floating to anchored mat has not been well-documented in the Rocky Mountains and there are paired sites that might lend themselves to such studies. For example, mud sedge forms large floating islands in Lily Lake that are discernible on aerial photos that are buffeted by the winds so that their locations may change between years. Less than 100 m (330 ft) away is a small wetland with a central central zone of mud sedge that had lost all standing water around it in the comparatively dry, west-side groundwater conditions of 2010, surrounded by yellow pond-lily (*Nuphar polysepala*) and long-leaf pondweed (*Potamogeton nodosus*) lying limp on exposed flats that would ordinarily be an open water zone. This drying-out process can happen selectively in small wetlands compared to adjoining large wetlands, and may favor the conversion of floating mats to anchored peat vegetation. This type is described by Girard et al. (1997) as co-dominant with water sedge.

One of the most common fen vegetation types in the Medicine Bow Mountains, planeleaf willow/water sedge e.t. (*Salix planifolia/Carex aquatilis* e.t.), was found to occur occasionally in fen habitat on the Big Horn Mountains but much more common in non-fen habitat. It was the only shrub fen type found at fen sites, as a mid- to low- height growth form of planeleaf willow (*Salix planifolia*) associated with water sedge (*Carex aquatilis*). It is the prevalent type at Upper Snail Creek Fen and the outer vegetation zone at Sawmill Lake Fen. It was also found at many non-fen sites, including sites of shallow peat (less than 40 cm) or seeps with this same association, more typically with the tall shrub stature associated with better aeration. This plant association could be found side-by-side in fen and non-fen habitat on Willett Creek tributaries where the difference between fen and non-fen habitat may be due to the presence/absence of major springs supporting peat accumulation. This type is described by Girard et al. (1997).

There are extensive zones of beaked sedge e.t. (*Carex utriculata* e.t.) in standing water at some fen sites, and they may have a peat substrate, even though inundated. It is often a wetland margin zone at fen sites, forming a low diversity zones subject to water level oscillations. It is the most extensive vegetation at Graves Lake Fen, in standing water. This type is described by Girard et al. (1997).

Summary of management activities in sensitive/rare fen habitat in the Big Horn Mountains

This section draws heavily from the discussion of the historical range of variability for Bighorn National Forest terrestrial disturbances compared to existing conditions (Meyer et al. 2004) as it relates to management considerations in fens (Heidel et al. 2010). Terrestrial disturbances have different affects on wetland systems than they do in the uplands, but they

are directly linked. There are few management activities and land uses taking place directly within Bighorn National Forest fen habitat, but many activities occurring in the catchments surrounding fen sites, or in the larger landscape. It is a rudimentary summary based on field observations, the literature, and prior studies.

Fire - Fire disturbance is challenging to evaluate because it has the longest history in the study area. Like many other disturbances, it is variable in its timing, extent and intensity, and may be conditioned by other disturbances like drought or disease, or in turn lead to other disturbances (Heidel et al. 2010). Fire history and fire return interval data are sketchy for large areas of the Big Horn Mountains (Meyer et al. 2004). Lodgepole pine forest is the most widespread timber type in the Big Horn Mountains (Despain 1973, Hoffman 1975, Hoffman and Alexander 1976) and often burns in stand-replacing fires. A composite map of stand age data for the Forest shows many of the uplands surrounding sensitive/rare plants are timber stands in the 90-160 year old range (Meyer et al. 2004). Fires can affect the timing and volume of surface runoff, precipitation percolation, and the nutrient and sediment loads in the catchment. Wildfires can also burn surface layers of peat under late-season drought conditions.

Grazing - Grazing activity has various forms of influence that include trampling, trailing, canopy reduction, decline of palatable species and increase of unpalatable ones, hedging of woody deciduous growth, and eutrophication (Heidel et al. 2010). All of these impacts can affect soils, hydrology, vegetation, and microtopography, particularly if the patterns of grazing may be concentrated or prolonged. In general, the most common signs of past grazing are pronounced hummocks within the fen or at margins of springs. Hummock formation may foster peat oxidation, providing aerobic conditions conducive to tree establishment, or establishment of robust, competitive herbaceous species. Grazing takes place within some Bighorn National Forest fens.

Logging – Two well-developed fen sites were centers of tie-hacking, including Bruce Creek Fen Complex and Graves Lake. The former is the site of a tie-hacking cabin and interpretive signs. The latter has vestiges of tie-hacking piles that were never moved downstream. In addition, a corner of Sawmill Lake Fen has logged stumps. These may reflect logging with use of horses, conducted roughly a century ago. The presence of such early logging may have pre-empted modern logging or other later, more intense management practices, so may not represent response to current practices. Logged stands are in the vicinity of several sensitive/rare fen sites though only one is noted as having logging to the border. Logging can have many of the same type of impacts as fire, though expressed differently. A study of the affects of logging on plant species diversity of fens is available for northwestern Montana (Jones 2003).

Roads and vehicle traffic: Most Bighorn National Forest fen sites harboring sensitive/rare plant species are not near developed roads. The Preacher Rock Bog is the site in closest proximity, with a Forest Service Road 26 running its length and having a buffer of no more than 20 m at one spot. In addition, old logging roads are in the vicinity of several sites, and most of these have been closed off. There were occasional signs of travel by all terrain

vehicles (ATVs) in fen habitat margins. Even snowmobiles have the potential to affect fen habitat conditions and functions (Gage and Cooper 2009).

Water impoundments - Water impoundments were almost absent in the Beartooth Mountains, and were most frequently associated with beaver in the Medicine Bow Mountains, so it was interesting to see these developments in the study area. There are at least ten large reservoirs of greater than 20 acres in the Big Horn Mountains, as well as drop structures that artificially maintain raised lake levels. Some have reserved municipal and irrigation water use and are not on Bighorn National Forest but on in-holdings. They are generally in headwater positions on glacial deposits, corresponding to fen settings. Impoundments may have flooded or filled fen habitat when they were constructed, and artificially elevate water levels in fens that are hydrologically influenced by the raised groundwater levels. The drop structure that elevated water levels on Meadowlark Lake may have inundated habitat for mud sedge and any associates, a species that was apparently collected at the lake shore in 1951.

DISCUSSION

Overview

Survey results provide the information needed to assess species conservation on Bighorn National Forest as highlighted in this report, detailed in occurrence records (Appendix B), and accompanied by GIS files of positive and negative survey results. They also support review of state ranks, the state species of concern tracking status, distribution and habitat information, and the U.S. Forest Service Rocky Mountain Region designation of plant species as sensitive. Most of the sensitive/rare species in this study will receive a new state rank and one will be dropped from tracking as a state species of concern.

There were really only three Bighorn National Forest sensitive/rare fen species that were widespread in the Big Horn Mountains, having over ten records and found in all three ranger districts: mud sedge (*Carex limosa*), russet cottongrass (*Eriophorum chamissonis*) and lesser bladderwort (*Utricularia minor*). Of these, mud sedge is typically abundant while russet cottongrass is rarely abundant, and its population numbers on the Forest are magnitudes lower than mud sedge. Lesser bladderwort might warrant a change in its state tracking status if not its sensitive status, but it would be beneficial to see if it has persisted in Preacher Rock Bog and to get the results of Yellowstone National Park collections first.

Of the six sensitive fen plants documented in this survey, four are at or near their maximum elevation in Wyoming and possibly in all of the Rocky Mountains. These include lesser panicled sedge (*Carex diandra*), russet cottongrass (*Eriophorum chamissonis*), English sundew (*Drosera anglica*), and northern blackberry (*Rubus acaulis*). It is possibly that the upper elevation limits of these species might be extended by targeted survey in the alpine and subalpine zones of the Big Horn Mountains.

Sweetgrass (*Hierochloe odorata*) was found in the majority of fen and non-fen sites where there was concerted survey. It was also often noted in a wide range of montane

palustrine, lacustrine and riverine settings traversed incidental to surveys, including places where it was locally common. So there is no attempt to address it in this report.

Bighorn National Forest sensitive/rare fen species are suited to treating as a species group in combination with implementation of the U.S. Forest Service Region 2 peatland policy (U.S. Forest Service 2011). The fen obligates in particular are almost all boreal disjunct species as present in the Rocky Mountains of the United States, and their presence in the Big Horn Mountains signifies an added degree of disjunction and distribution significance. They are common in their center of distribution at northern latitudes, precluding their consideration under the Endangered Species Act. Some of them are now known from multiple occurrences in several Wyoming landforms. The ones that are locally common are further called in to question. If we consider that many populations are relict populations, and many of the species have vegetative reproduction and limited sexual reproduction, these are reasons to evaluate their population numbers and abundance conservatively. By and large, previous information on habitat specificity of the ten sensitive/rare fen plants is supported. Moreover, the Big Horn Mountains may have some of the most arid climate supporting fen habitat of any mountains in Wyoming, providing unique opportunities to evaluate environmental specificity, ecological amplitude, and fidelity to fen habitat. The magnitude of threats to sensitive/rare fen plants are difficult to determine, but the growth rate of peat at fractions of a centimeter per century indicates that the habitat is not restorable in typical vegetation management timeframes, and argues for a cautious approach. Finally, information is wanting to determine habitat trends and ultimately, population trends. For all these reasons, sensitive/rare fen species are apt to be among the more sensitive floristic elements within peatland habitat, and sensitive to hydrological change if not climate change. They may also be indicators of sensitive animal habitat. As such, they lend themselves to treatment as a group in any prospective development of conservation strategies.

No single method for identifying new sensitive/rare ren plant populations worked better than the others. Of the 30 sensitive species records and 22 rare species records added in recent years, only a couple new records were added by looking closer at sites that were already known to have a sensitive/rare fen species present. Likewise, most of the sites identified by U.S. Forest Service staff were fen sites, some of which were found to have additional sensitive/rare fen species occurrences present. NWI mapping identified magnitudes more fen sites than we could conceivably inventory, but the size, signatures present, and distribution provided a prioritization and distribution strategy. Photointerpretation is held out as the single best stand-alone approach, but is more powerful in combination with the other information, and is weak in evaluating very small fen sites and fen vegetation zones that are inclusions of other wetland types.

The survey results are by no means exhaustive but the resulting positive distribution data and negative survey data provide the first dataset to be considered in prefield reviews for sensitive fen species. The second dataset to consider is the soils base layer as clipped to represent those three units that harbor all fen obligates on the Forest. The third dataset to consider is NWI mapping, as preliminary indication of presence/absence in the catchment.

Finally, photointerpretation is an appropriate step in pre-field review and in preparation for any field reconnaissance, looking for sites that resemble the representative sites and fen features presented in Appendix C.

Noteworthy fen sites

The Bighorn National Forest contains outstanding sensitive/rare fen species populations, and concentrations of sensitive/rare fen species populations, representing bundles of fen resources. The following is a brief highlight of four noteworthy fen areas, including those with high concentrations of sensitive/rare plants, and with well-developed fen features or features not known to occur elsewhere in the Forest. The one fen site with a management unit designation is the Preacher Rock Bog Special Botanical Area. All of the sites that are profiled on the following pages are in the Tongue River Ranger District and watershed of Sheridan County. They are relatively intact sites, with reference to criteria enumerated by Rocchio (2006). Descriptions of these select sites are accompanied by a set of aerials, topographic maps, and on-site photographs in Appendix C.

Bruce Creek Fen Complex - Best examples of patterned fen, with five discrete wetland segments, also lying beside a historical campsite of tie-hackers, providing basis for considering early historical disturbances. Sensitive/rare species include a small populations of mud sedge (*Carex limosa*) and lesser bladderwort (*Utricularia minor*), and a large population of russet cottongrass (*Eriophorum chamissonis*).

Graves Lake Fen – Among the largest field-verified fen site on the Bighorn National Forest, with a tie-hacking history that may shed light on the affects of logging around sensitive/rare species habitat, and with the only raised peat mound feature developed around a spring head found during 2010 surveys. Sensitive/rare species include large populations of mud sedge (*Carex limosa*), russet cottongrass (*Eriophorum chamissonis*), and lesser bladderwort (*Utricularia minor*) in addition to at least wood frog (*Libates sylvaticus* Bighorn population).

Preacher Rock Bog – Two adjoining fen areas where wood horsetail (*Equisetum sylvaticum*) and russet cottongrass (*Eriophorum chamissonis*) were first discovered on the Bighorn National Forest. It may offer a benchmark for studies in succession and the future of peatlands as boreal relicts, with over half of the area comprised of decayed peatland. Recently, a bladderwort specimen collected by the discoverer of this site, Erwin Evert, was redetermined to be lesser bladderwort (*Utricularia minor*).

Sawmill Lake Fen – This may be the deepest peatland known in the state, reportedly over 10 m (Zier personal communication), perhaps deeper even than Swamp Lake Special Botanical Area, a peatland of over 200 acres on Shoshone National Forest. It has among the most acidic water chemistries of Bighorn National Forest fen sites, and the highest known concentration of sensitive/ rare fen species. Sensitive/rare species include large populations of lesser panicled sedge (*Carex diandra*), mud sedge (*C. limosa*), English sundew (*Drosera anglica*), russet cottongrass (*Eriophorum chamissonis*), lesser bladderwort (*Utricularia minor*) and a small population of slender cottongrass (*E. gracile* population), in addition to

wood frog (*Libates sylvaticus* Bighorn population), Columbian spotted frog (*Rana luteiventris* Bighorn population), and northern leopard frog (*Lithobates pipiens*).

Many other fen sites or groups are noteworthy, including but not limited to: Upper and Lower Snail Creek Fens, West Fork Big Goose Creek Complex (Big and Little Moose Fens and West Fork Big Goose Creek Patterned Fen), Woodrock Fen and others.

Possible directions for future work

Species conservation assessments need to be updated with the information gathered in this study and related national forest studies if they are to represent compiled species information. In the absence of any signs of this activity, the much briefer species evaluations have been updated as part of this study (Appendix D). State rank updates and tracking status changes have also been made as a result of this and prior studies. Thus, it is timely to review the status of Region 2 sensitive fen species in the next review cycle.

Survey of Bighorn National Forest sensitive/rare fen species represents the third national forest fen study among Region 2 national forests in Wyoming. The information presented in this report is current and robust for the state of Wyoming. It represents a timely update in the state conservation status for most species, with two exceptions. First, English sundew data updates are not available yet from Yellowstone National Park, as reported in Lemly (2007) and Lemly and Cooper (2011). Second, there is a study underway of the submerged aquatic flora of Yellowstone National Park that has one more year of fieldwork and that is expected to revise numbers and other status information for lesser bladderwort and for species of pondweed (*Potamogeton* spp.) and for bladderworts (*Utricularia* spp.)

It may be as important if not more important to prepare conservation strategies that collectively address the sensitive plants species, possibly in combination with associated sensitive animals, and with Region 2 peatland policy (USDA Forest Service 2011b). In the absence of any models for Region 2 conservation strategies for individual sensitive plant species, conservation strategies for multiple sensitive plant species, or for sensitive plant species in combination with their habitat, such conservation strategy work has little precedent. It might include other Region 2 sensitive species that are fen obligates besides the ones addressed in this report, as found in Shoshone and Medicine Bow National Forests.

This report provides a framework for expanding baseline inventory of sensitive/rare fen plant species on Bighorn National Forest. First, it is possibly but not certain that canvassing all fen habitat on national forest in the Dome Lake and Park Reservoir quad areas would produce additional records of the three rarest sensitive fen plants on Bighorn National Forest: lesser panicled sedge (*Carex diandra*), English sundew (*Drosera anglica*) and slender cottongrass (*Eriophorum chamissonis*). Inventory boundaries might be drawn to more closely fit watershed boundaries, consistent with Winters et al. (2007). Second, we failed to find the historic records of two species from the Meadowlark Lake area and associated Tensleep Creek drainage, where more intensive and extensive work is needed to determine whether they are extant. Third, it is likely that higher elevation surveys would document additional locations of the six sensitive fen species targets because most of them reach

subalpine elevations. This would help assess the degree to which species' distributions extend into special management designations like the Cloud Peak Wilderness Area. It might also provide information on the alpine rare species like short-leaf sedge (*Carex misandra*) and Nelson's sedge (*C. nelsonii*). Only a few sites that were originally identified as survey priorities did not get surveyed in 2010, and these were mainly remote sites at higher elevations.

There has already been a survey for northern blackberry (*Rubus acaulis*; Fertig 2000), but it did not address upper montane/lower subalpine fen habitat. This is the only sensitive species among those documented in this study that is not a fen obligate on Bighorn National Forest. Therefore, systematic surveys in the vicinity of South Piney headwaters and Frying Pan Lake may be added to the slate of work that expands baseline inventory for sensitive fen species (above).

Floristic inventories have previously been pursued through Rocky Mountain Herbarium on Bighorn National Forest (Nelson and Hartman 1984), but not with the same intensity as more recent work (Hartman pers. commun.). Expanded floristic inventory may advance sensitive/rare fen species documentation. The 2010 studies vouchered about 30 species additions to the flora of the Big Horn Mountains that were not included in Nelson and Hartman (1984). Many of these are wetland plants, and expansion of original floristic work would provide a baseline for botany and vegetation resources collectively. Perhaps one of the least-documented vegetation zones are submerged plants, whether in lacustrine, palustrine, or riverine settings. One of the species collected in the Sawmill Lake Fen peat profile is nodding water nymph (*Najas flexilis*), a species that is known from the extant flora of every state adjoining Wyoming but not the Wyoming flora (Dorn 2001). On a small scale, floristic documentation might also be pursued for noteworthy fen sites, expanding the work started at Preacher Rock Bog (Neighbours and Culver 1990). A bryophyte flora was documented at select sites (Lenz 2011) that might also be expanded to include the full range of wetland habitats.

Noteworthy fen sites might be studied in greater detail by sampling dominant vegetation and the vegetation of sensitive species habitat to fill gaps in riparian vegetation classification, get more detailed information on the water chemistry in these zones, and to differentiate occupied sensitive species habitat from prevailing habitat at various sites. The Heidel and Jones (2006) study is a model for documenting the breadth and nature of botanical and ecological fen resources. Zoology work, including amphibians and invertebrates, might also be appropriate. Both vegetation and floristic work are highly recommended if these sites were to be considered in the special botanical area and research natural area programs.

The six activities outlined in previous paragraphs are all seen as advancing the body of sensitive/rare fen species information on Bighorn National Forest. The seventh activity and the most basic of all is part of Forest operations, conducting biological evaluations for sensitive fen species. This report provides the tools for such species work.

This report does not provide a rigorous evaluation of fen habitats on the Forest. Recent updates to the Forest Service Manual characterize fen habitat as not possible to mitigate, and possessing special water-holding functions. Thus, it is important to delimit fen habitat. We were not random in sampling 111 sites, though we did try to reach all sectors of the Forest where peatland habitat was mapped as common. The NWI mapping identifies peatland as the single most abundant and extensive wetland type on the Forest and our fieldwork suggests that while it is widespread, it may be absent from parts of the Forest where it is mapped, and that at the scale of specific sites, it is a starting point but not a robust record for even the best-developed sites (Appendix C). We do not have the data to determine the number of peatland sites or extent, which lie somewhere between the 6000+ areas (polygons) mapped by NWI and the 57 field-verified sites surveyed in this study. While it was beyond the scope of this project to determine the extent and nature of peatland habitat on the Forest, but the data collected could feed into fen mapping. A tiered approach may be appropriate, focusing or stratifying based on the select soil units (soils units 11, 16, 19) separate from all others.

Information on the terrestrial disturbance history (Meyer et al. 2005) is available but does not apply to palustrine systems in the same way as it does for terrestrial systems. Current palynological studies in fens and lake sediments may provide context for any future mapping. Major strides in sorting out complex wetland landscapes might be possible by building vegetation sampling databases linked directly to soils data. The delimitation of fens proved to be among the more complex of any previous Wyoming fen study area, possibly due to the more arid climate and difference of natural disturbance regimes. These were manifest in certain landscapes and in extensive wetland complexes having traces, gradients or mosaics of fen and non-fen vegetation, soils, and hydrology features associated with peat accumulation. It is hypothesized that the Big Horn Mountains has wetlands that were fens in past centuries or millennia, but which dried and oxidized. The first reported fen site in the Mountains, Preacher Rock Bog, proved to have much wet meadow habitat based on soil cores that were taken during 2010 surveys, so understanding wetland mosaics at this site may provide a foundation for understanding the fen distribution pattern across the landscape.

This report represents the first botanical assessment of the biological diversity values associated with fens in the Big Horn Mountains. Information dissemination is an immediate short-term need that includes distributing this report. This work complements Forest and Regional initiatives, and provides a springboard for maintaining the significant sensitive/rare fen plant species diversity of the Big Horn Mountains.

LITERATURE CITED

Ball, P.W. and A.A. Reznicek. 2002. *Carex*. In: Flora of North America Editorial Committee, eds. 1993+. *Flora of North America North of Mexico*. Vol. 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York and Oxford. pp. 254-572. [different sections prepared by different authors]

Ball, P.W. and D.E. Wujek. 2002. *Eriophorum*. In: Flora of North America Editorial Committee, eds. 1993+. *Flora of North America North of Mexico*. Vol. 23.

Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York and Oxford. pp. 12-27.
Bedford, B.L. and K.S. Goodwin. 2003. Fens of the United States: distribution, characteristics, and scientific connection versus legal isolation. Wetlands 23(3):608-629.
Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions. 3 vols.* Charles Scribner's Sons, New York. Vol. 1: 323. Courtesy of Kentucky Native Plant Society. Scanned by Omnitek Inc.
Bucher, W.H., R.T. Champerlain and W.T. Thom. 1933. Results of structural research work in Beartooth-Bighorn region, Montana and Wyoming. Bull. Am. Assoc. Pet. Geol. 17: 680-693.
Chadde, S.W., J.S. Shelley, R.J. Bursik, R.K. Moseley, A.G. Evenden, M. Mantas, F. Rabe, and B. Heidel. 1998. Peatlands on national forests of the northern Rocky Mountains: ecology and conservation. USDA Forest Service General Technical Report RMRS-GTR-111. Rocky Mountain Research Station, Ogden UT.
Copeland, H.E., S.A. Tessman, E.H. Girvetz, L. Roberst, C. Enquist, A. Orabona, S. Patla and J. Kiesecker. 2010. A geospatial assessment on the distribution, condition, and vulnerability of Wyoming's wetlands. Ecological Indicators 10: 869-879.
Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC.
Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1977. Volume 6, The Monocotyledons. Intermountain Flora: Vascular Plants of the Intermountain West, USA. Columbia University Press, New York.
Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1984. Volume 4, Subclass Asteridae. Intermountain Flora. Vascular Plants of the Intermountain West, USA. New York Botanical Garden, Bronx, NY.
Curtis, J. and K. Grimes. 2004. *Wyoming Climate Atlas*. Wyoming Water Resources Data System, Laramie, WY.
Darton, N.H. 1906. Geology of the Bighorn Mountains. Geol. Serv. Prof. Paper. 51. 129 pp.
Decker, K., D.R. Culver, and D.G. Anderson. 2006. *Eriophorum chamissonis* C.A. Mey. (Chamisso's cottongrass): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].
Decker, K., D.R. Culver, and D.G. Anderson. 2006. *Eriophorum gracile* W. D. J. Koch (slender cottongrass): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].
Despain, D. G. 1973. Vegetation of the Big Horn Mountains, Wyoming, in relation to substrate and climate. Ecological Monographs 43(3):329-354.
Dorn, R.D. 2001. *Vascular Plants of Wyoming*, third edition. Mountain West Publishing, Cheyenne, WY.
Engelhardt, T.L. 1998. Pollination ecology of the round-leaved sundew, *Drosera rotundifolia* L (Droseraceae) in Sequoia National Park, California. PhD dissertation. California State University, Fullerton, CA.

Fertig, W. and G. Jones. 1992. Plant communities and rare plants of the Swamp Lake Botanical Area, Clarks Fork Ranger District, Shoshone National Forest. Unpublished report prepared for the Shoshone National Forest by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W., C. Refsdal, and J. Whipple. 1994. *Wyoming Rare Plant Field Guide*. Wyoming Rare Plant Technical Committee, Cheyenne WY.

Fertig, W. 1998. Plant species of special concern and vascular plant flora of the National Elk Refuge. Unpublished report prepared for the US Fish and Wildlife Service by the Wyoming Natural Diversity Database, Laramie, WY.

Fertig, W. 2000. Ecological assessment and monitoring program for northern blackberry in Bighorn National Forest, Wyoming. Report prepared by the Wyoming Natural Diversity Database, Laramie, WY.

Gage, E. and D.J. Cooper. 2006. *Carex diandra* Schrank (lesser panicled sedge): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].

Gage, E. and D.J. Cooper. 2006. *Carex limosa* L. (mud sedge): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/aleteshumilis.pdf [date of access].

Girard, M., D. L. Wheeler, and S. B. Mills. 1997. Classification of riparian communities on the Bighorn National Forest. R2-RR-97-02. USDA Forest Service, Rocky Mountain Region, Sheridan, WY. 308 pp.

Hauke, R.L. 1993. Equisetaceae. In: Flora of North America Editorial Committee, eds. 1993+. *Flora of North America North of Mexico*. Vol. 2. Pteridophytes and Gymnosperms. Oxford University Press, New York and Oxford. pp. 76-84.

Heidel, B. 2006. Fen indicator plants of Wyoming. *Castilleja* 25(3): 10-11.

Heidel, B. and G. Jones. 2006. Botanical and ecological characteristics of Fens in the Medicine Bow Mountains, Medicine Bow National Forest, Albany and Carbon Counties, Wyoming. Prepared for the Medicine Bow National Forest. Wyoming Natural Diversity Database, Laramie, WY.

Heidel, B. 2007. Wyoming plant species of concern. Wyoming Natural Diversity Database, Laramie, WY.

Heidel, B., W. Fertig, S. Mellmann-Brown and K. Houston. 2010. Fens in the Beartooth Mountains, Shoshone National Forest – a technical report. Prepared for the Shoshone National Forest. Wyoming Natural Diversity Database, Laramie, WY.

Hermann, F. J. 1970. Manual of the Carices of the Rocky Mountains and Colorado Basin. Agriculture Handbook No. 374. USDA Forest Service, Washington, DC. 397 pp.

Hitchcock, C.L. and A. Cronquist. 1961. Pt.3. Saxifragaceae to Ericaceae. In: C.L Hitchcock, A. Cronquist, M. Ownbey, and J.W. Thomas. Vascular Plants of the Pacific Northwest.

Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1969. Pt. 1. Vascular Cryptograms, Gymnosperms, and Monocotyledons, IN: Hitchcock, C.L., A. Cronquist, M. Owenbey, and J.W. Thompson (eds). Vascular Plants of the Pacific Northwest. University of Washington Publications in Biology 17(1): 1-914.University of Washington Publication in Biology 17(12): 1-597.

Hoffman, G.R. 1975. Forest vegetation of the Bighorn Mountains, Wyoming: a habitat type classification. A report to the Forest Service. 135pp.

Hoffman, G.R. and R. R. Alexander. 1976. Forest vegetation of the Bighorn Mountains, Wyoming. A habitat type classification. USDA. Forest Service Research Paper RM-170. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hurd, E.G., N.L. Shaw, J. Mastrogiuseppe, L.C. Smithman, and S. Goodrich. 1998. Field Guide to Intermountain Sedges. USDA Rocky Mountain Research Station, Gen. Tech. Rep. RMRS-GTR-10.

Johnston, B.C. 2001. Field guide to sedge species of the Rocky Mountain Region: The genus *Carex* in Colorado, Wyoming, western South Dakota, western Nebraska, and western Kansas. Renewable Resources R2-RR-01-03. Denver, CO. USDA Forest Service Rocky Mountain Region.

Jones, W.M. 2003. Kootenai National Forest peatlands: description and effects of forest management. Report to the Kootenai National Forest, Montana, Montana Natural Heritage Program.

Ladyman, J.A.R. 2006. *Rubus arcticus* L. ssp. *acaulis* (Michaux) Focke (dwarf raspberry): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].

Lageson, D.R. and D.R. Spearing. 1988. *Roadside Geology of Wyoming*, 2nd ed. Mountain West Publishing Company, Missoula, MT.

Lemly, J.M. 2007. Fens of Yellowstone National Park, USA: Regional and local controls over plant species distribution. Masters Thesis, Colorado State University. Fort Collins, CO.

Lemly, J. M and D.J. Cooper. 2011. Multiscale factors control community and species distribution in mountain peatlands. Botany 89: 689-713.

Lenz, M.J. 2006. *Warnstoria tundrae* (Arnell) Loeske (Campyliaceae) new for Wyoming. Evansia 23(3): 68.

Lenz, M. 2011. The bryophyte flora of Bighorn National Forest fens - a checklist. Report prepared for the USDA Forest Service - Bighorn National Forest by the Wyoming Natural Diversity Database - University of Wyoming, Laramie, Wyoming.

Love, J. D. and A. C. Christiansen. 1985. Geologic map of Wyoming, explanation for the geologic map, and principal sources of geologic data and references cited for geologic map of Wyoming. U.S. Geologic Survey, 1985. Reston,VA. Digital version.

Marriott, H.J. 1991. Rare plants of Grand Teton National Park, annual report. Unpublished report prepared for the National Park Service by the Wyoming Natural Diversity Database, Laramie, WY.

Massatti, R.T. 2007. A floristic inventory of the East Slope of the Wind River Mountain Range and vicinity, Wyoming. Masters Thesis. University of Wyoming, Laramie, WY.

Meyer, C.B.; Knight, D.H.; Dillon, G.K. 2005. Historic range of variability for upland vegetation in the Bighorn National Forest, Wyoming. Gen. Tech. Rep. RMRS-GTR-140. Fort Collins, CO: Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Morstad, A.S. 1997. The mechanisms of paludification in upland forests without native bog trees. M.Sc. thesis. New Mexico Highlands University, Las Vegas, NM.
Neid, S.L. 2006. *Utricularia minor* L. (lesser bladderwort): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].
Neighbours, M. and D. Culver. 1990. 1989 Floristic survey of Preacher Rock Bog, Bighorn National Forest, Wyoming. Report prepared for the Tongue Ranger District, Bighorn National Forest, by the Wyoming Natural Diversity Database, Laramie, WY.
Nelson, B.E. and R.L. Hartman. 1984. Flora of the Big Horn Mountains, Checklist. Unpublished report prepared by the Rocky Mountain Herbarium, University of Wyoming, Laramie, WY.
Porter, S.C., K.L. Pierce and T.D. Hamilton. 1983. Late Wisconsin mountain glaciations in the western United States. Pp. 71-111 *In*: Wright, H.E., ed. *Late-Quaternary Environments of the United States.* Volume 1. The Late Pleistocene. University of Minnesota Press, Minneapolis, MN.
Reznicek, A.A. and P.M. Catling. 2002. *Carex* Linnaeus sect. Carex. Pages 498-501 in Flora of North America Editorial Committee (editors), *Flora of North America North of Mexico*, Volume 23, Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York, NY
Richardson, J.L. and M.J. Vepraskas, eds. 2001. *Wetland Soils*. Lewis Publishers, Washington, D.C.
Rocchio, J. 2006. Rocky Mountain subalpine-montane fen ecological system: Ecological integrity assessment. Prepared for the Environmental Protection Agency. Colorado Natural Heritage Program, Fort Collins, CO.
Rocky Mountain Herbarium. 2009. Collection records, including RM Specimen Database on-line at: http://www.rmh.uwyo.edu/University of Wyoming, Laramie, WY.
Rydin, H. and J. Jeglum. 2006. *The Biology of Peatlands*. Oxford University Press. Oxford, England.
USDA Forest Service – Region 2. 2011a. Sensitive species of the Rocky Mountain Region. Posted at: http://www.fs.fed.us/r2/resources/ . Denver, CO. Downloaded May 2011.
USDA Forest Service - Region 2. 2011b. Supplement No. 2600-2011-2 as update to FSM2630 Manual - Management of Wildlife and Fish Habitat. 30 Sept. 2011.
USDA Forest Service. 1999. Integrated resource inventory. (Region 2, Bighorn National Forest). Digital layers provided by Bighorn National Forest.
USDA Natural Resources Conservation Service. 2011. The PLANTS Database (http://plants.usda.gov, 8 December 2011). National Plant Data Team, Greensboro, NC 27401-4901 USA.
USDA Soil Conservation Service. 1992. Keys to Soil Taxonomy. Soil Management Support Services Tech. Monograph No. 19. Pocahantas Press, Inc. Blacksburg, VA.
USDI Army Corps of Engineers. 2011. National Wetland Plant List. Posted at: http://geo.usace.army.mil/wetland_plants/index.html .
USDI National Oceanic and Atmospheric Assocation. 2005. Wyoming climate summaries. Annual precipitation data for Burgess Junction, Wyoming. Posted electronically at: http://www.wrcc.dri.edu/summary/climsmwy.html.

Wilson, C.W. 1938, The Tensleep fault, Johnson and Washakie Counties, Wyoming. J. Geol. 46: 868-881.

Winters, D.S., D.J. Cooper, J.D. Hamerlinck, N. Lee, J.R. Maxwell, D.P. Peterson, N.L. Poff, F.J. Rahel, D.M. Staley and E.E. Wohl. 2004. Aquatic, Riparian and Wetland Ecosystem Assessment for the Bighorn National Forest. Report 1 of 3. Introduction and Ecological Driver Analysis. Denver: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region.

Wolf, E.C., E. Gage, and D.J. Cooper. 2006. *Drosera anglica* Huds. (English sundew): A Technical Conservation Assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/ [date of access].

Zier, J. 2010. The Bighorn peatland chronicles. *Castilleja* 29(1): 4-6.

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