

Botanical and Ecological Inventory of Peatland Sites on the Medicine Bow National Forest



Prepared for Medicine Bow National Forest

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ABSTRACT

Peatlands are specialized wetland habitats that harbor high concentrations of Wyoming plant species of special concern. Intensive botanical and ecological inventories were conducted at five select peatland sites on Medicine Bow National Forest to further document the vascular flora, update information on plant species of special concern, initiate documentation of the bryophyte flora composition, and to document the vegetation associations. This provides a preliminary summary of peatland botanical and ecological resources on Medicine Bow National Forest, data for comparison between sites, and both floristic and vegetation plot datasets for comparison between Medicine Bow National Forest and Shoshone National Forest where parallel studies were undertaken. It might be used for more more extensive systematic inventories of peatlands and their associated botanical and ecological attributes across the Forest, or related efforts to evaluate watershed, wildlife, and other values associated with peatlands.

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Cover Landscape photo: Open water pool within "Elk Creek Bog" surrounded by *Elecharis quinqueflora* (Few-flowered spikerush Herbaceous Vegetation). Photo by B. Heidel

Upper left: Bog sedge (*Carex paupercula*) is only known in Wyoming from Medicine Bow National Forest, disjunct over 400 miles from nearest known populations in Bitterroot and Flathead National Forests, Montan. Its largest known population is at the Elk Creek site. Photo by B. Heidel

Lower left: Autumn willow (*Salix serissima*) is only known in Wyoming from the one Crow Creek populaton on Medicine Bow National Forest. It is the only willow species to produce catkins in late summer or autumn. Photo by John Challey

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INTRODUCTION

The overall purpose of this project was to locate and inventory well-developed peatland sites on the Medicine Bow National Forest for their botanical and ecological features. It represents a spinoff of botanical and ecological studies in the Forest, adding or augmenting the vascular flora and bryophyte flora, adding and updating the rare plant species information, and analyzing the peatland vegetation associations present in the Medicine Bow National Forest.

Peatlands are the focus of this study project because they have high biodiversity significance in Wyoming, harboring over 10% of the state plant species of special concern (52 of 487, as listed in Fertig and Heidel 2002). On the Shoshone National Forest, they harbor ca 26% of the state species of concern (27 of 105 species; from Fertig 1998), or 47% of the Sensitive species on the Forest (7 of 15 species, based on USDA Forest Service 1994). Many vascular and nonvascular plant species and plant communities of the Rocky Mountains are known only from peatlands, often comprising wetland communities that are compositionally unique in the region and species-rich (Chadde et al. 1996). Despite their biodiversity significance, and prospective diversity and uniqueness, peatlands have not been inventoried in the state apart from select site inventories and research natural area evaluations.

Peatlands have additional research and resource values that support the case for baseline inventory. They are “windows” into the geologic past, preserving pollen records and other microfossils, charcoal layers, and macrofossils as a faithful chronology of surrounding vegetation (e.g., Pennak 1963, Barber 1993). They perform important hydrological and water quality functions. For example, in the lab they have been shown to accumulate heavy metals such as uranium (Zielinski and Meier 1988, and Robbins et al. 1990, as cited in USDI FWS 1997) and in the field they appear to concentrate heavy metals such as iron (Sturges 1967). They also have extremely low rates of hydrologic conductivity (Sturges 1968), and streams emanating from groundwater-fed peatlands have lower total dissolved solids than the contributing groundwater (Sturges 1967), acting at least in some cases as hydrological buffers that stabilize downstream flows (Verry and Boelter 1978). There is also evidence that gross alpha and beta radiation present in snow and groundwater is filtered by the peatland (Sturges and Sundin 1968). In some landscapes, rare native cutthroat trout benefit from the water cleansing actions of fens in headwaters of streams (USDI FWS 1997).

Peatlands develop at such a slow rate that they are for all practical purposes, irreplaceable. For example, peat accumulates in Colorado at rates of 4.3 – 16.2 inches per thousand years Cooper 1990, as cited in USDI Fish and Wildlife Service 1997). Removal of peat deposits profoundly alters hydrology and the substrate that peatland species need to grow, curtailing or setting back Holocene succession. Thus, they fall outside the wetland mitigation framework and “functioning fens” have been placed within “Resource Category 1” of the USFWS wetland mitigation policy (Federal Register Vol. 46. No 15. Feb. 4 1981).

They are also threatened at some level. In adjoining states, active peat-mining capitalizes on the commercial values of peatlands. Peat has high water-absorption capacity, and is sold commercially for improving soil structure, increasing organic content, and shifting pH. Peat has also been considered as an alternate energy fuel elsewhere in the country (Farnham 1978). Information is not widely available on the vulnerability and risks to peatland resources in the

Rocky Mountains except under direct threat (e.g., peat-mining activities in Colorado are summarized in Cooper 1990a, as cited in USDI FWS 1997) but real estate development, water development and other changes to hydrology, grazing and haying are among potential impacts (USDI FWS 1997). Baseline information is needed to assess effects of land use practices in the peatland and in the immediate watershed. Direct and indirect threats have been particularly well-documented in Europe (Barber 1993, Grunig 1994).

What are peatlands? They are defined as wetlands with waterlogged substrates and organic substrates (i.e., peat substrate, or “histosols”) that have 20% or greater organic carbon content by weight (USDA Soil Conservation Service 1992). The depth threshold ranges from 20-60 cm minimum, depending on degree of decay and clay content (USDA Soil Conservation Service 1992). Commonly, peatlands are characterized as having a minimum 30 cm depth of peat at the surface or greater (USDI 1997, Chadde et al. 1998). The anaerobic conditions and slow rate of decay fosters peat accumulation, a unique autogenic process that results in an exceptionally stable habitat over centuries. They are very low in essential nutrients Nitrogen and Phosphorus, and some peatlands are high in potentially toxic elements Manganese and Aluminum (discussed in Small 1972). They are extensive in northern latitudes with cool, humid conditions (Farnham 1978, Grunig 1994). In the Rocky Mountains of the United States, peatlands are uncommon, in large part due to unfavorable climate (USDI FWS 1997).

“The combination of habitat rarity, habitat stability, and extreme habitat conditions explain the distinctiveness of the flora in peatlands, as well as the high concentrations of rare species that are restricted to peatland environments in the Western United States.” (Chadde et al. 1998).

The unique characteristic of peatland habitat, namely their autogenic development, means that the presence and abundance of peat-forming species determines the nature of the peat substrate over time in the absence of disturbance. These peat-forming species have rootstocks that are slow to decay, often high in lignin, various adaptations to anaerobic water-logged conditions, and often have elevated terminal buds to preclude being literally buried alive. Peat deposits accumulate as undecayed organic material that originates from sedges and other graminoid dominants, as well as from mosses. Some of the most fundamental distinctions in peatland habitat depend on whether the peat substrate is derived from graminoids or from bryophytes (especially *Sphagnum* mosses).

This document provides a synthesis and expansion of information on peatland sites on the Medicine Bow Unit and one site on the Pole Mountain Unit of the Laramie District on the Medicine Bow National Forest. The results of this inventory at five select peatland sites provide a springboard for documenting the collective botanical and ecological resources of peatlands, the “search images” for identifying peatlands using remote-sensing techniques, and more systematic documentation of peatland distribution on the Forest.

METHODS

The criteria for study site selection, techniques used in the field, references used in specimen review, and methods used in the analysis of vegetation sampling data are summarized in the following sections.

Site Selection

Prospective study sites were identified prior to fieldwork based on the presence of peatland indicator species, i.e., those Wyoming plant species of special concern that are “obligate” peatland species and are not known to occur in other wetland types. This list was prepared in comparing the list of vascular plant species that occupy peatlands compiled in Chadde et al. (1998) against the Wyoming plant species of concern list, making provisional interpretations of peatland obligates from Wyoming element occurrence records and professional experience. Nine sites were identified, but most of these were based on collection labels with no more detailed collection location than the section. In addition, we consulted University of Wyoming palynologists and searched published or unpublished reports. At least four additional or overlapping sites were identified, including a recent pollen sample site reported by Mark Lyford and Jane Beiswenger on the Sand Lake Road, a prospective peatland site within the Libby Flats study area of Chris Hiemstra, a hydrology research site reported at “Elk Creek Bog” by Sturgis (1967, 1968 a, b, c), and peatland indicator species and peatland vegetation feature reported in a previous WYNDD study (Jankovsky-Jones et al. 1995).

Black and white orthophotos were initially sought for all study sites (<http://www.wygisc.uwyo.edu/doqq/>), but coverage was available only for the one site in the Pole Mountain Unit and none in the Medicine Bow Range. Recent Forest Service color aerial photographs taken in the late August and early September of 2001 were secured for most Medicine Bow Range study sites and 1996 aerials for the rest. They were duplicated in color xeroxes, and used in the field along with U.S.G.S. topographic maps (7.5' quads).

Field Inventory

A record and overview of each site was prepared documenting its location, access, tentative peatland boundaries, and general description. Topographic maps and aerial photos were used to delimit the study area and sort the range of habitats present. Different patterns on the aerial photographs were marked as tentative indication of different vegetation structure.

Rare plant survey was conducted throughout the peatland body. For all rare plant species, a voucher specimen was collected if the population was not previously documented, and a photograph was taken as conditions permitted. Population size and extent were estimated, and habitat characteristics recorded. A “rank” was assigned to the population as indication of its quality, condition, and contribution to species’ viability. Key factors include population size, population extent, and presence/absence of habitat alteration.

The initial delimitations were checked and merged or split in the field. Within each area of discrete vegetation structure, predominant plant associations and distinctions in plant associations were noted. Vegetation plots were subjectively placed in homogeneous areas and representative sites within each vegetation zone. Homogeneity was visually judged by uniform patterns of stature, density, and the patterns associated with composition and species’ dominance in particular. Each 0.5 m² plot was demarcated with a 0.5 x 1.0 m PVC frame. In each plot, cover values were determined for all vascular plant species to the nearest 10% (also recognizing trace, 1%, and 5% as sparse cover values). Cover values were also determined for bryophyte species.

Vouchers were collected for unknown vascular plant species and for all bryophyte species in each plot. The number of plots per site ranged from 4 (Crow Creek and Libby Flats) to 19 (Elk Creek – East and West, combined), with a total of 40 plots.

The vascular and bryophyte floras of the peatland were recorded in visiting all major vegetation zones and their representative plant associations for associated species, also targeting microhabitat features such as wetland margins, springs and seeps, stream margins, and the hummocks around isolated trees in each wetland. In surveying the vascular flora, a running floristic list of species was kept. The best-documented and largest peatland site flora in Wyoming is that compiled for Swamp Lake (211 species; Fertig and Jones 1992; and later Fertig collections), so it was used in creating a database file for compiling floristic information from all sites in the Shoshone National Forest study, and then for a comparison of the peatland flora in the Medicine Bow National Forest.

Two of the peatland sites had published pH readings, at Elk Creek and Sand Lake Road. Inferences were made about pH at the other sites based on species present in keeping with characterizations of Cooper and Andrus (1994) and Chadde et al. (1998).

The original taxonomic nomenclature of the Swamp Lake checklist was modified using current taxonomic treatments (Dorn 2001). References that were used for vascular plant identification in the field included Dorn (1997, 2001), Johnston (2001), and Hurd et al. (1998). All vascular plant specimens that were collected are deposited at the Rocky Mountain Herbarium (RM.)

Moss specimens were examined upon returning from the field using the keys and characteristics presented in Lawton (1977), Vitt et al. (1988), and comparison with the checklist of the moss flora of Wyoming (Eckel 1996). Determination of each specimen is being undertaken by Judy Harpel, Bryologist with the Pacific Northwest Region of the U.S. Forest Service, who provided specimen determinations to date for the collections made at two of the five sites. Bryophyte specimen vouchers will be deposited at RM.

Vegetation Classification

Multivariate analyses were run to contribute to a peatland vegetation classification scheme for the Forest, add to the peatland plant community information described previously on Swamp Lake Fen (Fertig and Jones 1992) and on Lily Lake (Jones and Fertig 1999), and cross-reference results with other peatland vegetation classification results in and around Wyoming including parallel results from Shoshone National Forest. The sampling and analysis of peatland vegetation in this study and the refinements in Wyoming vegetation classification that have been made since 1992 provide more complete vegetation classification information. The plant association types do not have adequate sample numbers from different sites to support a “new” system of classification, and the focus on plot uniformity excludes the heterogeneity in microtopography that is inherent in some plant associations. But it expands existing descriptions of plant associations in Wyoming and has potential for expanded analysis in the future. They are named according to species dominance or co-dominance of vascular species under natural conditions. It differs from the naming conventions of Cooper and Andrus (1994) which includes moss species dominance, and appears to include indicator species.

Plot data, including bryophyte and vascular plant cover values from peatland plots in both Medicine Bow National Forest and Shoshone National Forest, were entered into a peatland database. A detrended correspondence analysis (DCA) was run using PC-ORD (Version 4.0), including both vascular and nonvascular species. A second DCA was run including vascular species alone. These analyses were performed to visually inspect the relative similarity of plot composition. One forested peatland stand and one shrubland stand were sampled in Shoshone NF that shared no species with other wetland stands. Since the lack of continuity in the vegetation dataset resulted in poor analysis using DCA, these two stands were removed from analysis.

The next step in formally classifying vegetation associations was then to run a two-way species indicator analysis (TWINSPAN). TWINSPAN is a divisive and hierarchical classification system that uses the species present within each plot and their coverage values to make dichotomous breaks between plots. Only the plot data for vascular plants was used because we did not have the benefit of moss specimen determinations from all five study sites, pooling datasets from both national forests for both the DCA and TWINSPAN analyses to document similarities and dissimilarities.

Six levels of divisions were considered with the vascular species data, using a minimum number of 5 indicator species per division. The data were not transformed before analysis. The final plot groups are referenced by the dominant species as corresponding with previously documented and published plant association names. Plant associations that are represented by only 1-2 plots are treated as provisional unless they have been documented and published elsewhere.

A synopsis of the plant associations was prepared and cross-referenced to all previously published peatland plant association names in Wyoming as presented in Cooper and Andrus (1994), the results of 2002 peatland inventory on Shoshone National Forest, and the northern Rocky Mountains classification presented by Chadde et al. (1998). In addition, plant associations that sorted out in the first five TWINSPAN divisions of ordination were identified, and types that did not sort out but which may correspond with other vegetation classifications are in parentheses. These include the earliest semblances of wetland classifications in the region, like that of Windell et al. (1986) with its brief descriptions of communities dominated by several peatland species (*Betula glandulosa*, *Carex aquatilis*, *C. utriculata*, *Eleocharis pauciflora* [*E. quinqueflora*], and *Salix wolfii*), the information sources include Research Natural Area establishment reports, and wetland classifications from adjoining areas (e.g., Hansen et al. 1995). Copies of the detailed vegetation reports of Cooper (1990b, 1992, and 1993 as cited in USDI 1997) were not available in time for this study. These plant association names have not standardized and include permutations with moss species dominants and indicator species as well as vascular species dominants. Results are also cross-referenced to a working national vegetation classification that includes peatland plant associations as part of the NatureServe ecology plant community information resources (2003), posted electronically at: <http://www.natureserveexplorer.org>

Aerial photos were used in the field along with U.S.G.S. topographic maps (7.5' quads). Peatland boundaries and in some cases, vegetation zones were marked in the field and digitized from the aerial photos back in the office.

STUDY AREAS

The five study sites lie within the Laramie District of Medicine Bow National Forest, including the Pole Mountain Unit east of Laramie, and the Medicine Bow Unit west of Laramie, Wyoming (Figure 1). They are in montane and subalpine elevation zones (7,900-10,460 ft). The study sites are referenced in this report by the nearest geographic features and include from east to west: Crow Creek Fen, Sheep Mountain Fen, Sand Lake Road Fen, Libby Flats Fen, and Elk Creek Fen.

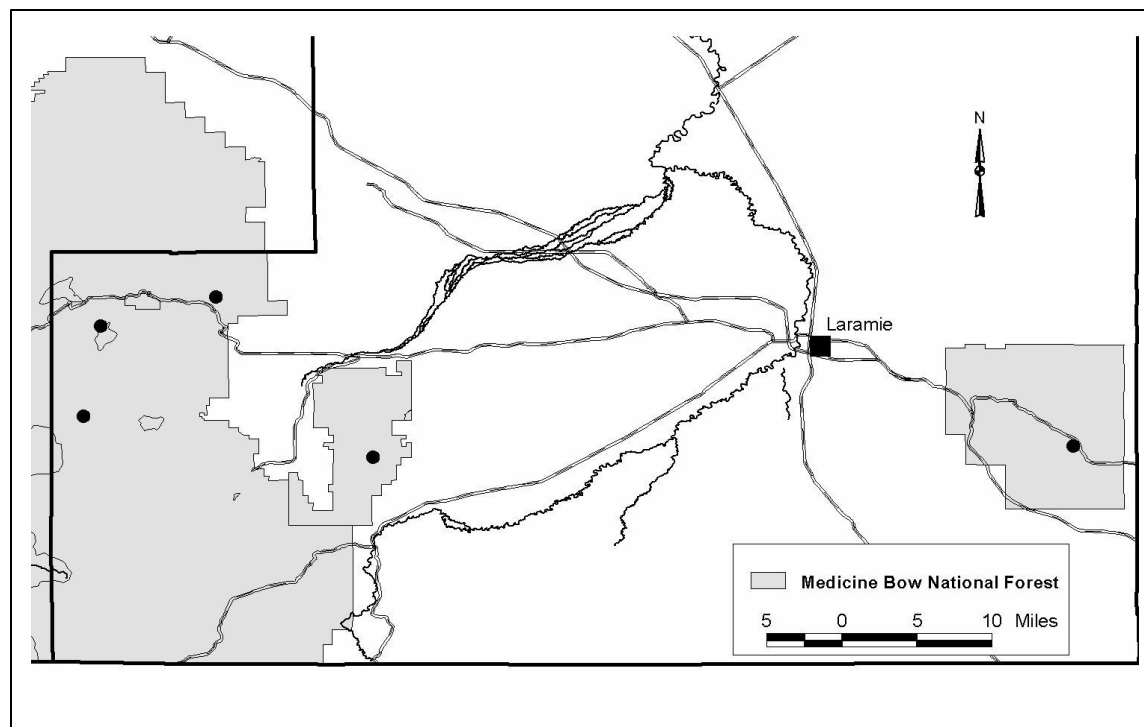


Figure 1. Map of Medicine Bow National Forest peatland study sites

They represent a wide range of minerotrophic peatlands, called “fens,” as found in the Rocky Mountains. “True bogs” are ombrotrophic systems and are not present in the Rocky Mountains (Chadde et al. 1998). The water source(s), setting and parent material dictate over pH. Three of the Medicine Bow National Forest study sites are in drainage courses but fed by groundwater. In addition, Sand Lake Road Fen is in a small basin formed as a glacial kettle, and Libby Flats Fen is fed by seepage in a setting that is barely perceptible as a shallow basin.

Peatlands have been classified based on many parameters, including water source, vegetation structure, floristics, and wetland function. It is not the purpose of this paper to evaluate the classification systems in the Rocky Mountains but to cross-reference them. They are discussed by Moore and Bellamy (1974), USDI FWS (1997), and Chadde et al. (1998). The five study sites are all rich fens (circumneutral or alkaline) in basin or flow-through settings. They are identified in National Wetland Inventory references as palustrine emergent wetlands and shrub-dominated wetlands, which include a wide array of wetland types that do not accumulate peat. A summary of site characteristics is presented below. Only shrub- and graminoid-peatlands are

generally large enough to be included as mapping units of the National Wetland Inventory in keeping with the classification system of Cowardin et al. (1977).

Table 1. Peatland study sites in Medicine Bow National Forest

SITE	ELEV. (ft)	SETTING	SIZE (ha)	PEATLAND FEATURES				
				Shrub	Graminoid	Spring Stream	Pond	Patterned "strings"
Sheep Mountain	9,160-9,320	Head of drainage	32.10	X	X	X		
Elk Creek	9,680-9,800	Heads of drainages	20.39	X	X	X	X	
Crow Creek	7,900	Midway on drainage	7.25	X	X			
Sand Lake Road	8,950	Basin	1.25	X	X	X		
Libby Flats	10,460	Seep above drainage	0.88		X			?

Peatlands are comprised of up to six vegetation zones that can readily be discerned on aerial photographs, corresponding with vegetation stature and pattern, as follows:

Forested peatland (Spruce swamp)

Shrub peatland (grading into carr)

Graminoid peatland*

Sphagnum mat, a form of graminoid peatland with floating mats in poor fen basins

Patterned peatland, a form of graminoid peatland in flow-through settings characterized by linear parallel patterns of vegetated mounds and open water pools

Pond peatland, an open water peatland habitat

The two main zones represented among Medicine Bow National Forest study sites are the graminoid and shrub peatlands (see previous table), with small areas of open water pool, sphagnum mat and patterned peatland formation that had limited floristic differentiation from surrounding zones. In addition, streams and flowing springs may also be present and are distinct on aerial photographs, with their own microhabitat.

Study area characterization for each of the five sites is incorporated in the following results section.

RESULTS

Rare Species Results

The Medicine Bow National Forest study sites harbor 7 rare peatland plant species. There was one or more rare plant population documented at all of the Medicine Bow Range peatland sites. Results for interpreting botanical significance are summarized in Table 2. None of the species currently has sensitive species designation by Region 2 of the U.S. Forest Service (1994); a list that is undergoing revision.

The 7 rare peatland plants species include at least two that are not known from other national forests in Wyoming, including *Carex paupercula* (Bog sedge) and *Salix serissima* (Autumn willow). All of the species are boreal species that are rare in the Rocky Mountains south of the 49th parallel including some that are widely-disjunct (e.g., *Carex paupercula* is not known between northwestern Montana and the Medicine Bow Range.) Most of the rare species population sizes are limited, numbering in the 100's or less, with the exception of *Carex paupercula* (Bog sedge) and *Epilobium oregonense* (Oregon willow-herb).

In addition to these study site species, three other rare peatland species have been collected from the Medicine Bow National Forest but were not present among the study sites: *Carex diandra* (Lesser-panicled sedge; an obligate), *Carex limosa* (Mud sedge; an obligate) and *Lomatogonium rotatum* (Marsh felwort; a facultative peatland species that is also present in alkaline meadows). The ten rare peatland species known from the Medicine Bow National Forest to date represent close to 20 % of the rare peatland species in Wyoming.

Northwestern Wyoming has the highest known concentration of rare peatland species, reflecting the biogeography of peatland species, the landscape setting, and the survey efforts to date. Three of the rare peatland species previously only known from northwestern Wyoming were documented in the largest of the Medicine Bow National Forest study sites for the first time in 2002, suggesting that the peatland flora and rare species in particular is incompletely documented.

Table 2 on the following page presents the rare plant species on the Medicine Bow National Forest peatland study sites.

Table 2. Rare plant species on Medicine Bow National Forest peatland study sites

Scientific Name	Common Name	G Rank	S Rank	MEDICINE BOW NATIONAL FOREST					Sho-shone NF
				Sheep Mt	Elk Cr	Crow Cr	Sand Lake Rd	Libby Flats	
<i>Amerorchis rotundifolia</i> (<i>Orchis rotundifolia</i>)	Round-leaved orchid	G5	S1						X
<i>Arctous rubra</i> (<i>Arctostaphylos rubra</i>)	Red manzanita	G5	S1						X
<i>Botrychium virginianum</i>	Rattlesnake fern	G5	S1						X
<i>Carex concinna</i>	Beautiful sedge	G4G5	S1						X
<i>Carex diandra</i>	Lesser panicled sedge	G5	S1S2						X
<i>Carex leptalea</i>	Bristly-stalk sedge	G5	S2	X					XX
<i>Carex limosa</i>	Mud sedge	G5	S2						X
<i>Carex livida</i>	Livid sedge	G5	S1						X
<i>Carex microglochin</i>	False uncinia sedge	G5	S2						X
<i>Carex paupercula</i>	Bog sedge	G5	S1		X				
<i>Carex scirpoides</i> var. <i>scirpiformis</i>	Canadian single-spike sedge	G5	S1						X
<i>Drosera anglica</i>	English sundew	G5	S2						X
<i>Epilobium oregonense</i>	Oregon willow-herb	G5	S1		X		X	X	
<i>Eriophorum gracile</i>	Slender cottongrass	G5	S1	X					X
<i>Eriophorum viridicarinatm</i>	Green keeled cottongrass	G5	S1						X
<i>Kobresia simpliciuscula</i>	Simple kobresia	G5	S1						X
<i>Muhlenbergia glomerata</i>	Marsh muhly	G5	S1						X
<i>Potamogeton praelongus</i>	White-stem pondweed	G5	S1						X
<i>Primula egaliksensis</i>	Greenland primrose	G4	S1						X
<i>Salix candida</i>	Hoary willow	G5	S2	X		X	X		X
<i>Salix farriae</i>	Farr's willow	G4	S2						X
<i>Salix myrtilifolia</i> var. <i>myrtilifolia</i>	Myrtleleaf willow	G5T5	S1						X
<i>Salix serrisima</i>	Autumn willow	G4	S1			X			
<i>Sparganium natans</i> (<i>Sparganium minimum</i>)	Small bur-reed	G5	S1						X
<i>Trichophorum pumilum</i> (<i>Scirpus pumilus</i>)	Pygmy bulrush	G3Q	S1						X
<i>Utricularia minor</i>	Lesser bladderwort	G5	S2						X

Vegetation Association Results

Detrended Correspondence Analysis (DCA) ordination of 76 peatland plots analyzes vascular plant data to show similarities between vegetation plots on Medicine Bow and Shoshone National Forests (Figure 2.) Stands that are from the same site are represented by the same symbol, and each symbol is labeled by plot number. The plot numbers 39-78 are from Medicine Bow National Forest. The Medicine Bow National Forest study sites are in most sectors of the ordination except the lower righthand corner, reflecting the range of peatland vegetation associations relative to the sample set as a whole.

Four major vegetation associations sort out in DCA ordination, two that are shared in common between Medicine Bow and Shoshone National Forests, and two that are separate. The one that is not present among the Medicine Bow National Forest study sites is dominated by Mud sedge (*Carex limosa*) usually with codominance by Bog buckbean (*Menyanthes trifoliata*) Note: These species are known from elsewhere on the Forest. The Few-flowered spikerush (*Eleocharis quinqueflora*) plots of the Medicine Bow National Forest sort out in a tight cluster that is separate from those of Swamp Lake. The other two present in both Shoshone and Medicine Bow National Forests include vegetation associations dominated by Analogue sedge (*Carex simulata*) and Beaked sedge (*Carex utriculata*). None of the wooded vegetation associations sorted out as distinct, and two of the 78 from Shoshone National Forest are so dissimilar that they were removed from analysis to eliminate skewing, including the single spruce forest (*Picea glauca*) plot on Swamp Lake and a shrub plot at Swamp Lake. The four major vegetation associations represent only 27 of the plots (Figure 2).

Twinspan distinguished the same discrete peatland plant associations identified in DCA. All four peatland plant associations sorted out, also noting high dissimilarity between northern and southern (Shoshone and Medicine Bow) plots of *Carex simulata*, much like the *Eleocharis quinqueflora* plots on Medicine Bow National Forest sorted out from the scattering of *Eleocharis quinqueflora* plots on Swamp Lake of Shoshone National Forest.

In addition to these, Twinspan delimited discrete peatland plant associations of water sedge (*Carex aquatilis*). Both *Carex aquatilis* and *C. utriculata* were also distinguished from but closely related to carr associations dominated by Planeleaf willow (*Salix planifolia*/*Carex aquatilis* and *Salix planifolia*/*Carex utriculata*, respectively) in ordination results. The balance of the plots did not sort out in a pattern consistent with prior classification or replicated species' dominance. Four other plant associations of small sample size from Shoshone National Forest were distinguished that have been described elsewhere in the state or region, including plant associations dominated by *Carex lasiocarpa*, *Carex vesicaria*, *Eleocharis rostellata* and vegetation associations that are not strictly peatland dominated by *Scirpus acutus*. In addition, a peatland association dominated by *Salix wolfii* has been reported in Colorado (Windell et al. 1985) and the Centennial valley in Montana but not described. Non-peatland vegetation dominated by *Alnus incana* and *Typha latifolia* were present in Swamp Lake but not sampled.

At least two of the plant associations that are present on Shoshone National Forest may be circumboreal. The plant association dominated by *Carex limosa* is referred to as Mud sedge hollow (Caricetum limosae) by Grunig in Grunig (1994.) The plant association dominated by *Carex lasiocarpa* is referred to as Slender sedge swamp (Caricetum lasiocarpae in Braun-Blanquet conventions for plant association nomenclature) by Grunig in Grunig (1994).

Peat derived from *Sphagnum* spp. is a separate order of soil taxonomy, the fibrist histosols (USDA SCS 1992), and Twinspan results suggest that the vegetation dominated by *Sphagnum* spp. is different at some level of classification from vegetation lacking *Sphagnum*. All Shoshone National Forest plots with 90-100% *Sphagnum* cover grouped together in Twinspan ordination and represented floating vegetation mats encroaching on open water with vascular plant species dominance by *Carex limosa* – *Menyanthes trifoliata*. The *Carex limosa* – *Menyanthes trifoliata* plant association also occurs separate from floating *Sphagnum* mats, under more circumneutral conditions, as sampled in three plots in Swamp Lake that grouped separate from those with *Sphagnum*. Small areas of *Sphagnum*-dominated habitat were found and sampled in Elk Creek, the largest less than 10 m X 20 m, but they did not form floating mats or have unique composition.

There are at least 11 peatland plant associations on the five Medicine Bow National Forest study sites, presented by site in Table 3, in contrast to only four peatland plant associations that sorted out in Detrended Correspondence Analysis ordination (Figure 2, next page). The associations that are shared at the largest number of sites are graminoid plant associations dominated by *Carex simulata* or *Carex utriculata*. Note: This table includes all peatland plant associations reported for Wyoming, not just those found on the study sites, cross-referenced by Cooper and Andrus (1994) and Chadde et al. (1998).

Table 3. Plant associations on Medicine Bow National Forest peatland study sites in comparison with other regional peatland classifications

Plant Associations	Common Name	Strct	MEDICINE BOW NATIONAL FOREST					Shoshone NF	Cooper and Andrus (1994) in B-T NF	Chadde et al. (1998) in N. Rocky Mts.
			Sheep Mt	Elk Cr	Crow Cr	Sand Lake Rd	Libby Flats			
<i>Carex aquatilis</i> - <i>Viola epipsela</i>	Water sedge	Gram fen						X	X	X
(<i>Carex aquatilis</i> – <i>Eleocharis quinqueflora</i>)	Water sedge – Few-fl'd spikerush	Gram fen		X						
(<i>Carex canescens</i>)	Hoary sedge	Gram fen	X							
(<i>Carex lasiocarpa</i>)	Slender sedge	Gram fen						X		X
<i>Carex limosa</i> - <i>Menyanthes trifoliata</i>	Mud sedge – Bog buckbean	Gram fen						X	X	X
<i>Carex simulata</i>	Analogue sedge	Gram fen	X	X	X	X		X		X
<i>Carex utriculata</i>	Beaked sedge	Gram fen	X		X	X		X	X	X
(<i>Carex vesicaria</i>)	Lesser bladder sedge	Gram fen					X	X		
<i>Eleocharis quinqueflora</i> - <i>Drepanocladus aduncus</i>	Few-flowered spikerush	Gram fen		X			X	X	X	X
(<i>Eleocharis rostellata</i>)	Beaked spike-rush	Gram fen						?		X
<i>Schoenoplectus acutus</i> (<i>Scirpus acutus</i>)	Hardstem bulrush	Gram marsh						X		
<i>Typha latifolia</i>	Broad-leaved cattail	Gram marsh						X		
<i>Alnus incana</i>	Speckled alder	Shrubl						X		
<i>Betula glandulosa</i>	Bog birch	Shrubl								
<i>Ledum glandulosum</i>	Labrador tea	Shrubl						X		
<i>Mixed shrub/ Carex simulata</i>	Mixed shrub/ Analogue sedge	Shrubl								

<i>Salix discolor- Potentilla fruticosa/ Carex simulata</i>	Pussy willow- Shrubby cinquefoil/	Shrubl			X					
<i>Salix planifolia/ Carex aquatilis</i>	Planeleaf willow / Water sedge	Shrubl	X					X		
<i>Salix planifolia/ Caltha leptosepala</i>	Planeleaf willow /	Shrublr							X	
<i>Salix planifolia/ Carex utriculata</i>	Planeleaf willow / Beaked sedge	Shrubl		X	?					
<i>(Salix wolfii)</i>	Wolf willow	Shrubl						?		X
<i>Picea glauca "muskeg"</i>	White spruce woodland	Stunted forestd swamp						X		
<i>Picea glauca/ Equisetum arvense</i>	White spruce forest	Forestd swamp						X		
<i>Isoetes bolanderi - Calliergon sarmentosum</i>	Bolander's quillwort	Submer ged in pools							X	
<i>Potamogeton perfoliatus</i>	Clasping- leaf pondweed	Submer ged in pools							X	
<i>Sparganium angustifolium - Callitriche sp.</i>	Narrowleaf bur-reed	Submer ged in pools		?					X	
<i>Nuphar polysepalum - Potamogeton natans</i>	Floating pondweed	Floatng in lakes							X	

Floristic Results

The collective flora at the Medicine Bow National Forest peatland sites includes 160 vascular plant species (Appendix A). The documented vascular flora is less than that of the vascular flora documented in the Shoshone National Forest sites (Total=245), and possible explanations are differences in peatland diversity, the prior intensive floristic inventory work at Shoshone National Forest sites such as Swamp Lake over the course of growing seasons, the skewing of Shoshone numbers by the singular Swamp Lake site, and the preliminary nature of floristic documentation to date in Medicine Bow National Forest. The known flora represents a modest 5.7% of the statewide flora presented below the genus level in Wyoming (Dorn 2001), but includes species that are concentrated or restricted to peatland habitats.

To date, 13 species of moss have been determined by Judy Harpel from two of the smaller of the five study sites. By comparison, the state moss flora has been documented to date to include 315 species (Eckel 1996).

Site Overviews

The information that follows presents a summary of site-by-site results and background information, including a concise description of location, record of the survey, and description of site characteristics, accompanied by maps and annotated aerial photos. It provides context for the primary botanical and ecological results. The sites are presented in sequence from the largest to the smallest, corresponding to the sequence in Table 1.

Sheep Mountain

County: Albany

Location: T14N R77W Sections 10, 11, and 15

Topographic map: Lake Owen, WY (4110632)

Directions: Medicine Bow Range, Sheep Mountain Game Refuge, approximately 22 miles west of West Laramie. There are three access points from Hwy 11 along the western margin of Sheep Mountain. The shortest distance and largest parking area is from the game refuge parking lot 3 miles south of the junction between Hwy 11 and 45. It is a minimum of a 3 mile hike (from the game refuge parking lot) to the peatland. There is also access 1.8 miles south from Co. Hwy 11 to a Forest Service public access sign and small pulloff along Hwy. 11, hiking over 7 miles to the peatland, or at the mouth of Fence Creek, with a small pulloff along Hwy. 11, hiking over 5 miles to the peatland.

Field survey date: 7-8 Sept 2002

Field survey investigator: Bonnie Heidel

Elevation: 9,160 - 9,320 ft (2792 m – 2841 m)

Setting: Headwaters

pH: unknown (alkaline)

Size: 32.1 ha



Figure 3. Aerial photo of Sheep Mountain Fen (FS Photo 101-52 of 09-10-01)



Figure 4. Map of Sheep Mountain Fen (Lake Owen Quad, 7.5')

Setting and wetland description: Sheep Mountain Fen lies at the headwaters of Fence Creek at the summit of the granite escarpment that is Sheep Mountain. Fence Creek has a very small catchment on top of the escarpment with its arid terrain, so the groundwater that supports such a large peatland and its stable environment is presumed to have a deep-seated source such as associated with fault lines. The surrounding outcrops are Sherman Granite (Love and Christiansen 1985). There are no surface inlets. There is a distinct stream course running through most of it, and it is incised ca. 1 m. deep in upper reaches. Scattered outcrops rise to the east and sparse, open woods of *Pinus contorta* and *P. flexilis* surround it with few spruce at the perimeter. The schematic geological cross-section through Sheep Mountain cuts across the head of Fence Creek (Figure 5; from Knight 1953; see lower righthand corner of diagram). It does not show any fault lines or bedding planes in the granite as are hypothesized to be groundwater sources for the fen.

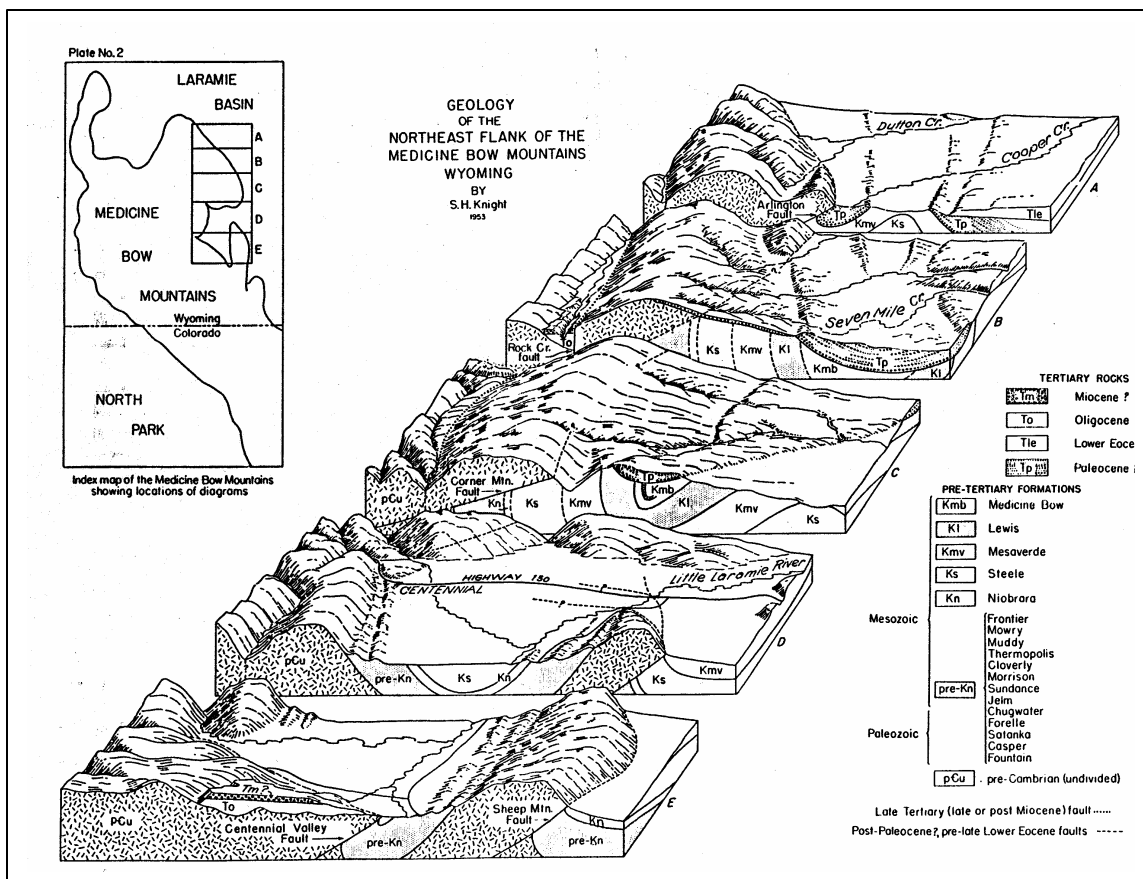


Figure 5. Geology of the northeast flank of the Medicine Bow Mountains (Knight 1953)

Most of the peatland has a significant shrub component, varying greatly by stature and density. The bends and arms of the drainage course make it difficult to grasp its extent and diversity, except by traversing it. The peatland is almost continuous for 1.5 miles except for a place near the midpoint where it constricts and there is wet forest. Its linear outline also has several large tributary lobes of peatland. It has almost 200 feet of relief across its length and even gradient. Upper reaches have a few very wet habitats that are probably openwater pools in

early summer. The lower end is affected by beaver ponds and grades into continuous cover of *Carex canescens*.

Distinguishing botanical features: Sheep Mountain Fen represents the largest peatland known to date in the Medicine Bow National Forest in its length and total area. It supports an exceptionally well-developed shrub peatland habitat, and graminoid peatland associations not documented elsewhere in this study, including vegetation dominated by *Carex canescens*. The continuous reaches of this peatland have been fully delimited, but the isolated pockets of peatland and possible presence of peatlands in headwaters of nearby drainages have not been systematically evaluated. Several peatland sedges not found elsewhere in the study were collected within one surprisingly diverse sheltered pocket of peatland habitat removed from the main body and covering much less than 0.5 acre, indicating that a broader landscape evaluation may contribute qualitatively as well as quantitatively to the documentation of peatland resources.

This peatland supports populations of three rare boreal plant species that are not otherwise known on the Medicine Bow National Forest, including Bristly-stalk sedge (*Carex leptalea*), Slender cotton-grass (*Eriophorum gracile*) and Pygmy bulrush (*Trichophorum pumilum*). Prior to this study, all three species were only known in Wyoming from the northwestern corner of the state, and were considered disjunct in Colorado. The population of the other rare plant species, Hoary willow (*Salix candida*), has only ca. 100 plants, but this is larger than both other populations on Crow Creek Fen and Sand Lake Road Fen.

A summary of the state-significant plant species and plant communities follows.

Table 4. Rare plant species of Sheep Mountain study site

Scientific Name	Common Name	G Rank	S Rank	EO Rank
<i>Carex leptalea</i>	Bristly-stalk sedge	G5	S2	B
<i>Eriophorum gracile</i>	Slender cotton-grass	G5	S1	Undet.
<i>Salix candida</i>	Hoary willow	G5	S2	B
<i>Trichophorum pumilum</i>	Pygmy bulrush	G3Q	S1	Undet.

Table 5. Plant associations of Sheep Mountain study site

Scientific Name	Common Name	G Rank	S Rank
<i>Salix planifolia</i> / <i>Carex aquatilis</i>	Planeleaf willow/Water sedge Shrub Fen or Carr	Undet.	Undet.
<i>Carex utriculata</i>	Beaked sedge Herbaceous Vegetation	G4	S2
<i>Carex simulata</i>	Analogue sedge Herbaceous Vegetation	G5	S3
<i>Carex canescens</i>	Hoary sedge Herbaceous Vegetation		

Evidence of alteration: A ditch runs along the lower west margin of the wetland from the area of the beaver ponds down to an aqueduct. This is a historic diversion that may have drained lower reaches of peatland habitat. The ditch was excavated out of crumbly granite, has filled in, and no longer diverts water. The series of beaver ponds in the lower segments may have contributed to the shift in downstream vegetation composition to mainly willow carr prior. The lower end also

has the heaviest grazing from pack stock if not from cattle. The habitat below the beaver ponds is willow thicket and meadow that has little or no peatland characteristics. There are a few very well-established hunting camps along the margins, and most have at least a scattering of exotic grasses on-site that were probably brought in with hay. There are fire scars throughout surrounding upland woodlands.

Elk Creek

County: Albany

Location: T15N R79W Sec. 28 W ½ and Sec. 29 E ½

Topographic map: Keystone, WY (4110623)

Directions: Medicine Bow Range, from Albany, go west on Forest Service Road 500 to Rob Roy Reservoir. At the northwest corner of the reservoir and the mouth of Elk Creek, go north on Forest Service Road 555 for 2.5 miles. Walk on the old road south for at least 0.3 miles to the point where the clearcut ends on both sides of the road, and go west to the Elk Creek West peatland. Elk Creek East peatland is most readily accessed from a clearcut on Forest Service Road 555 immediately north of it. This site is highly accessible on par with the two roadside study sites.

Field survey date: 22 and 24 Aug 2002

Field survey investigators: Bonnie Heidel and Scott Laursen

Elevation: 9680 ft – 9800 ft (2128 m – 2987 m)

Setting: Headwaters

pH: unknown

Size: 20.4 ha

Setting and wetland description: Elk Creek Fens lie at the heads of two parallel side tributaries of Elk Creek. Each of these headwater fens is ca. 0.5 miles long. There are no surface inlets. There are small streamcourses running much of their lengths. Quartzite, a metasedimentary bedrock of the Libby Group, outcrops in the shallow soils of surrounding gentle terrain. A fault line runs diagonally near the head of the headwater fens (Love and Christianson 1985). A ridge marking the Continental Divide rises to the west and Rob Roy Reservoir is located a couple miles to the southeast. Forests of *Pseudotsuga menziesii* and *Pinus contorta* surround the wetlands, and a few scattered spruce are at the perimeter.

The peatland vegetation of both drainageways is dominated by *Eleocharis quinqueflora*, a relatively short, sparse graminoid vegetation. The most homogenous *Eleocharis* segments are on the steepest slopes. There are also discrete areas of willow carr. It appears that *Carex utriculata* increases under trampling of stock or wildlife and it has colonized the pits where water tests were conducted in the 1960's. They are the only known sites with sphagnum species or a sphagnum mat cover in the Medicine Bow National Forest study sites. Elk Creek West is also the only study site with open water pools within the peatland (see cover).

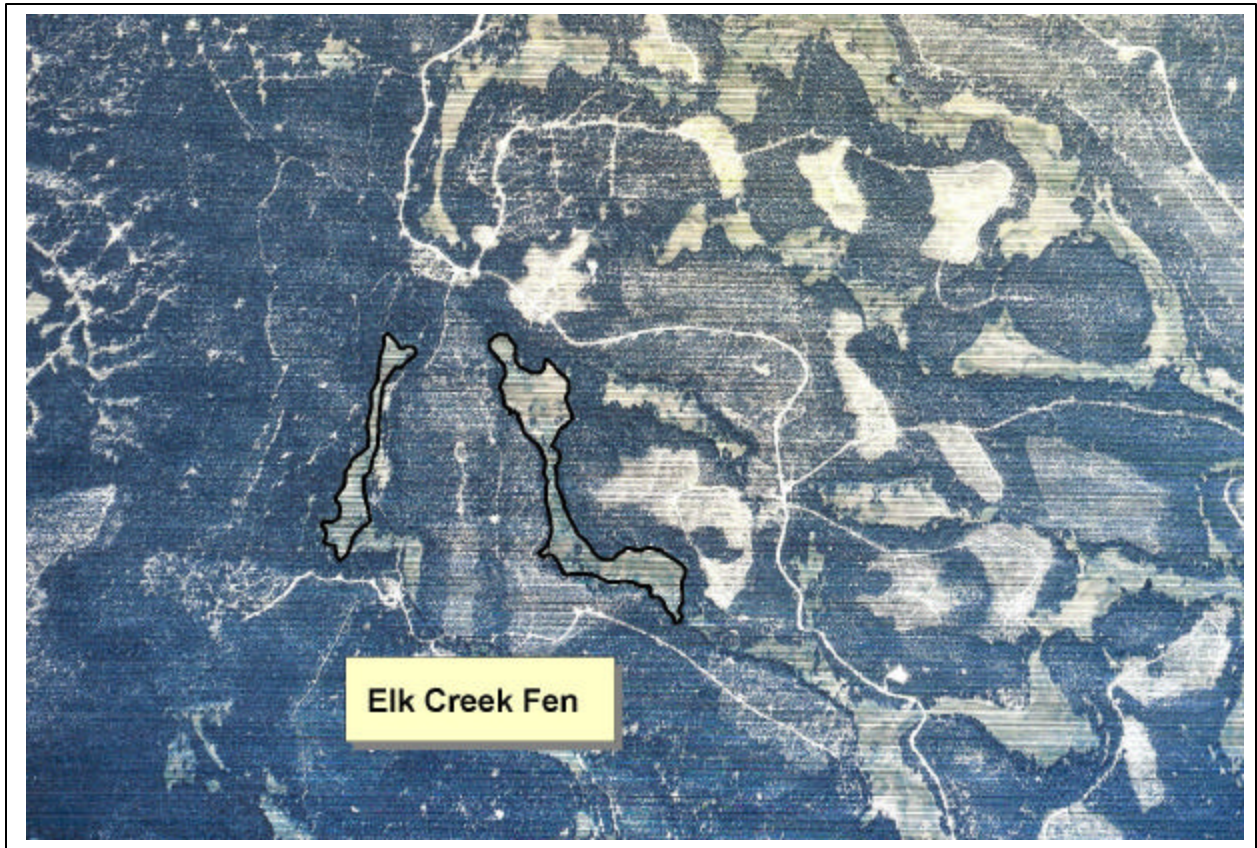


Figure 6. Aerial photo of Elk Creek Fen system (FS Photo 301-192 of 08-26-01)

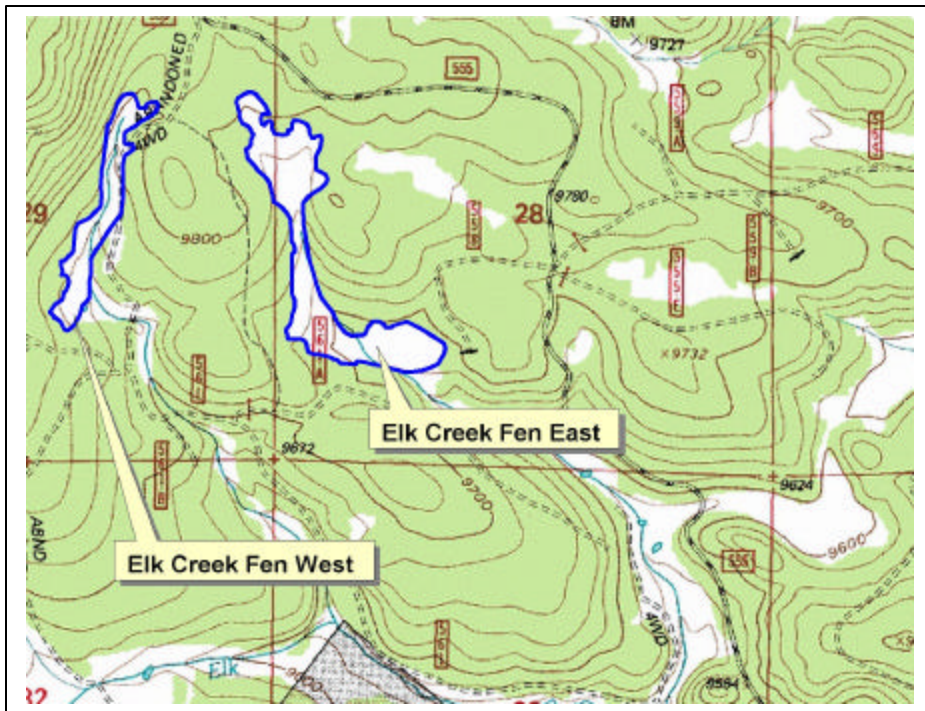


Figure 7. Map of Elk Creek Fen system (Keystone Quad, 7.5')

Distinguishing botanical features: Elk Creek Fens represent the only documented peatland system comprised of more than one major peatland body. Survey was not conducted beyond these two peatland bodies to evaluate peatland distribution on the landscape. Together the drainageway peatland bodies support the most extensive *Eleocharis quinqueflora* graminoid peatland habitat of the study sites, the only Sphagnum mat habitat and Sphagnum flora of the study sites, the only known site of *Carex paupercula* among study sites and certainly the largest known population of it (though the species has been collected elsewhere on the Forest), and the largest known population of *Epilobium oregonense*. The site is well-suited as an outdoor classroom by relative ease of access, well-developed biotic and abiotic peatland features, and level of documentation to date.

A summary of the state-significant plant species and plant associations is presented below.

Table 6. Rare plant species of Elk Creek study site

Scientific Name	Common Name	G Rank	S Rank	EO Rank
<i>Carex pauperculata</i>	Bog sedge	G5	S1	A
<i>Epilobium oregonense</i>	Oregon willow-herb	G5	S1	A

Table 7. Plant associations of Elk Creek study site

Scientific Name	Common Name	G Rank	S Rank
<i>Eleocharis quinqueflora</i>	Few-flowered spikerush Herbaceous Vegetation	Undet.	Undet.
<i>Salix planifolia</i> / <i>Carex utriculata</i>	Planeleaf willow/Beaked sedge Shrub Vegetation	G4	S2
<i>Carex aquatilis</i> – <i>Eleocharis quinqueflora</i>	Water sedge – Few-flowered spikerush Herbaceous Vegetation	G5	S3
<i>Carex simulata</i>	Analogue sedge Herbaceous Vegetation		

Evidence of alteration: Clearcuts of different ages surround both peatlands, at varying distances from peatland borders. Some logging units are too old to see clear margins on aerial photos, but it appears that logging took place in at least one case right up to the margin of trees left at the peatland border. There is an extensive road system associated with the local logging operations, some of which are gated. A road used regularly by ATV's lies between the two peatlands, skirting Elk Creek West. It is rutted and regularly used, but does not cross peatland habitat.

Livestock grazing affects are indicated by the eutrophication and green algal blooms of the easiest to access open-water peatland pools of Elk Creek West, though there is little sign of trampling or shift in vegetation composition caused by grazing. Grazing is more extensive, productive and generally favorable in downstream meadows on both drainages. The peatland margins are very abrupt, and lacking in tall, productive emergent vegetation. An adventuresome cow-calf pair was present in an early August visit to the head of Elk Creek West. Little or no grazing is evident in the north end of Elk Creek East and light grazing in the Elk Creek West. There is regular grazing in the southernmost end of Elk Creek East that has resulted in

hummocky trampled terrain and some kind of ditching in the southernmost end of Elk Creek East that may have been put in for livestock that has also altered hydrology.

Some if not all of the *Sphagnum* mat areas show signs of drying out and were like walking on hard upland habitat at the time of the August visit. Dessication and accompanying oxidizing conditions may result in vegetation changes and loss of this *Sphagnum* habitat. There are no inlets to these wetlands, but a casual early August visit to Elk Creek West indicated there may be temporary highwater condition from runoff. Their capacity to act as sponges may be deterred if they are drying out between summer precipitation events and flooding after them.

The West Elk Creek Fen ("Elk Creek study bog") is the site of the only peatland hydrology research in the Forest (Sturges 1967, Sturges 1968 a, b, c). A series of three hydrological studies have documented high site water quality in relation to surrounding groundwater, documenting extremely low hydraulic conductivity (a "sponge" effect; Sturges 1967), as well as constancy in peatland mineral concentrations (Sturges 1968a). They have also documented that this peatland screened radionuclides from snowmelt water (Sturges and Sundin 1968). If drought or logging have affected groundwater recharge, surface runoff, peat oxidation and mineralization, then a re-sampling of these same parameters may shed light on the nature and implications of alteration.

Crow Creek

County: Albany

Location: T14N R71W Sec 3 NW ¼

Topographic map: Sherman Mountains East, WY (4110523)

Directions: Medicine Bow Range, south branch of Crow Creek on W side of Happy Jack Road (Hwy 210) across from junction with Forest Service Road 701, ca.12 air miles southeast of Laramie.

Field survey date: 11 Aug 2002

Field survey investigators: Bonnie Heidel and Scott Laursen

Elevation: 7,900 ft (2408 m)

Setting: midway along drainage

pH: unknown

Size: 7.3 ha

Setting and wetland description: Crow Creek wetland is in the upper reach of the South Fork of Crow Creek. It lies below the Sherman Mountains on open planar surfaces of the Laramie Range, with a woodland fringe at southern and western margins, immediately west of Hwy 210 (Happy Jack Road). The same rugged Sherman granite that outcrops in the Sherman Mountains and in the Sheep Mountains is the bedrock that underlies the site (Love and Christianson 1985).

Its willow thicket and low willow community within 0.1 miles of the highway have the highest local species diversity and represent shrub peatland habitats. Over 2/3 of the upstream area to the west and south is hummocky, homogenous vegetation dominated by *Carex utriculata* and soil pits would need to be dug to determine whether this area is or was peatland.



Figure 8. Aerial photo of Crow Creek Fen (Digital orthophoto 4110563NW)

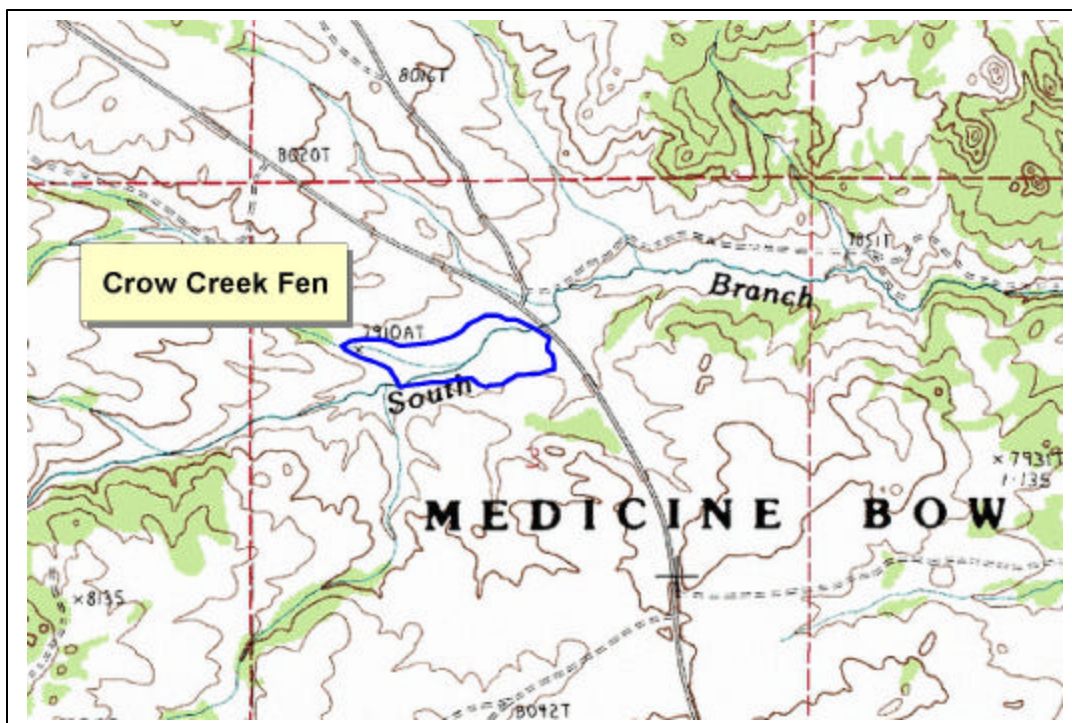


Figure 9. Map of Crow Creek Fen (Sherman Mountains East Quad, 7.5')

Distinguishing botanical features: Crow Creek Fen represents the only study site in the Laramie Range. It has been characterized as a “willow classroom”, with six species of *Salix* documented to date, including the two rare species. It harbors the only occurrence of *Salix serissima* known in Wyoming (see cover), and a small population of *Salix candida*.

Vegetation zones are marked on the aerial photo in Figure 8. Most of the area is covered by a low-diversity *Carex utriculata* cover. The tall shrub thicket in the northeast corner (upper right) is habitat for *Salix serissima*. The *Carex simulata* graminoid peatland in a small east-central area (far right) support *Salix candida*. A shrub peatland vegetation dominated by *Salix planifolia* with *Carex aquatilis* spans the southeastern area (lower right.)

A summary of the state-significant plant species and plant associations is presented below.

Table 8. Rare plant species of Crow Creek study site

Scientific Name	Common Name	G Rank	S Rank	EO Rank
<i>Carex paupercula</i>	Hoary willow	G5	S2	C
<i>Salix serissima</i>	Autumn willow	G4	S1	C

Table 9. Plant associations of Crow Creek study site

Scientific Name	Common Name	G Rank	S Rank
<i>Carex utriculata</i>	Beaked sedge Herbaceous Vegetation	G5	S3
<i>Salix planifolia</i> / <i>Carex utriculata</i> – <i>C. simulata</i>	Planeleaf willow/ Beaked and Analogue sedge Shrub Vegetation	Undet.	Undet.
<i>Carex simulata</i>	Analogue sedge Herbaceous Vegetation	G4	S2
<i>Salix discolor</i> - <i>Potentilla fruticosa</i> / <i>Carex simulata</i>	Pussy willow - Shrubby cinquefoil/ Analogue sedge Shrub Vegetation	Undet.	Undet.

Evidence of alteration: Some areas of the peatland had about 50% of the herbaceous vegetation removed by grazing earlier in the growing season, confounding meaningful vegetation canopy cover estimates and documentation of species composition. Most vegetation showed signs of trampling, and some areas had hummock development. Trampling and other indirect effects of grazing have also shifted vegetation composition.

The rare willow species are concentrated at the east end of the wetland near the highway, and any expansion of the highway right-of-way could impact a significant fraction of the *Salix serissima* and *S. candida* populations or at least the hydrology of their habitat. Highway maintenance activities are not potential impacts unless they alter hydrology or involve herbicide drift.

Sand Lake Road Fen

County: Albany

Location: T16N R78W Sec. 21 SW ¼ of NW ¼

Topographic map: Centennial, WY (4110632)

Directions: Medicine Bow Range, ca. 3 miles northwest of Centennial, on the west side of FS Road 101 (Sand Lake Road), 0.1 miles north of its junction with Hwy 130.

Field survey date: 9 Aug 2002

Field survey investigators: Bonnie Heidel, Scott Laursen and John Proctor

Elevation: 8950 ft (2680 m)

Setting: Basin

pH: 6.7-6.9 within peatland; in contrast with 7.7 readings in the surrounding uplands and in the outlet below the road (from Reider 1983)

Size: 1.25 ha

Setting and wetland description: The Sand Lake Road Fen is thought to represent a modified glacial kettle surrounded by Pinedale Till (Reider 1983) and has a nearly oval basin outline. The till is comprised of metamorphic parent material that is predominantly quartzite and includes dolomite. This is the only “basin peatland” among the five study sites. It lies within plain view of the Forest Service Road to Sand Lake that skirts it. There are no surface inlets. A small rivulet emanates near the middle of the fen, runs eastward and dissipates, perhaps intercepted by the elevated roadbed that has no culverts. The fen has no open-water spring-fed pools but there is at least one small moss-capped springhead upwelling in the middle. The fen is nearly level, rising slightly to the north, and with an abrupt 1-2 m rise along northwestern margins where the peatland is distinctly sloped.

It is a fen dominated mainly by a diverse short-stature shrub and graminoid association. Shrub dominants include: *Betula glandulosa*, *Potentilla fruticosa*, and *Salix planifolia* in association with *Carex simulata*. There is also tall willow carr in a northcentral area, as well as in bands on eastern and southern boundaries. The tall willow carr is dominated by *Salix geyeri*. The rivulet margins have the only deposits of marl that are visible at the peatland surface, and there is localized graminoid vegetation dominated by *Carex simulata*. The eastern end has a small low-lying area where there is likely to be standing water in the spring, probably due to impoundment by the elevated roadbed, where *Carex utriculata* is locally dominant. The fen is surrounded by *Populus tremuloides* with scattered *Picea engelmannii* along its borders and *Pinus contorta* in the uplands.

This is the only peatland study site with detailed soil documentation. Soils at the interior peatland soil sample along a terrestrial-wetland gradient are terric cryofibrist with a 68 cm organic horizon overlying a mixture evenly split between sand, silt and clay fractions (from Reider 1983). Carbonate samples from the B horizon of nearby forest soils have been dated to Altithermal dates of 4735 BP and 5230 BP (Sanson 1972, Sanson and Reider 1974, and Reider 1977). The grass phytoliths in these soils indicating a more open, non-forested setting (Reider 1977). These soils may pre-date the nearby fen (Reider 1983). Interbedded sand, silt and clay lenses in the till deposits may account for the hydrological conditions conducive to stable groundwater discharge and resulting peatland development. Underlying the till, there is also ...

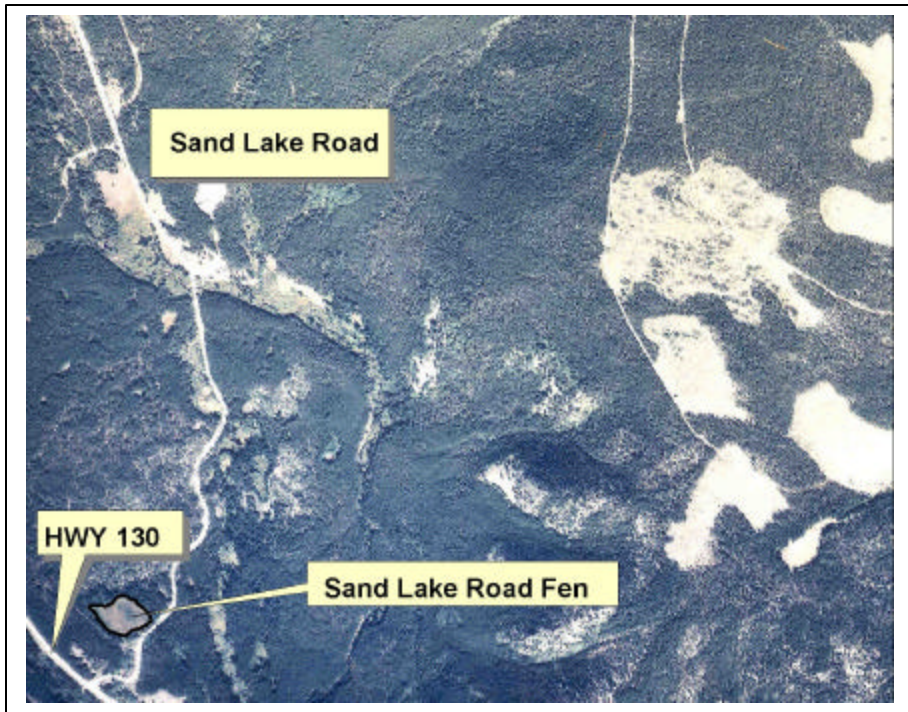


Figure 10. Aerial photo of Sand Lake Road Fen (FS Photo 101-93 of 09-10-01)

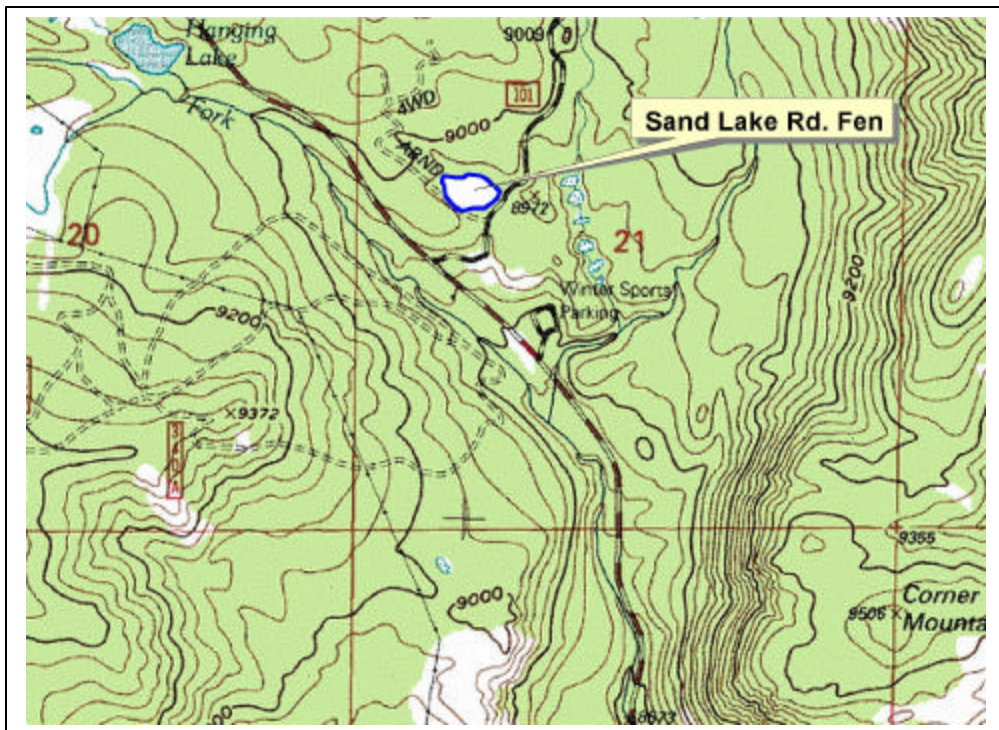


Figure 11. Map of Sand Lake Road Fen (Centennial Quad, 7.5')

It is uniquely suited as an outdoor classroom by ease of access, well-developed biotic and abiotic peatland features, and level of documentation to date.

Distinguishing botanical features: Sand Lake Road Fen has high species richness within sample plots and the site as a whole despite its limited size.

It harbors small populations of two state plant species of special concern, including Oregon willow-herb (*Epilobium oregonense*) and Hoary willow (*Salix candida*). It also harbors two well-developed shrub plant associations that have not been well-documented in Wyoming and were not documented at other sites in this study. They are under review for addition to the state vegetation classification.

A summary of the state-significant plant species and plant associations is presented below.

Table 10. Rare plant species of Sand Lake Road study site

Scientific Name	Common Name	G Rank	S Rank	EO Rank
<i>Epilobium oregonense</i>	Oregon willow-herb	G5	S1	BC
<i>Salix candida</i>	Hoary willow	G5	S2	C

Table 11. Plant associations of Sand Lake Road study site

Scientific Name	Common Name	G Rank	S Rank
<i>Mixed shrub/ Carex simulata</i>	Mixed shrub / Analogue sedge Shrub Vegetation	Undet.	Undet.
<i>Salix geyeriana/ Carex simulata</i>	Geyer's willow/Analogue sedge Shrub Vegetation	Undet.	Undet.
<i>Carex simulate</i>	Analogue sedge Herbaceous Vegetation	G4	S2
<i>Carex utriculata</i>	Beaked sedge Herbaceous Vegetation	G5	S3

Evidence of alteration: There is an old clearcut to the north that is evident on recent aerial photographs (2001), located upslope in the microcatchment. The moss mat at this upslope margin is dead or dying in places, possibly an affect of logging and/or drought. There were no signs of surface runoff at the time of visit. The elevated Forest Service roadbed (Sand Lake Road, FS Rd. 101) lies directly to the east and it may impede surface water and groundwater flow out of the wetland at least in spring. The eastern margin of the wetland shows signs of ponding. There is an old undeveloped roadbed along the south boundary that is blocked from use, it predates the Sand Lake Road and does not affect groundwater movement. Exotic and ruderal species around the outer perimeter are rare, indicating no regular livestock use in the past. They include *Phleum pratense*, *Agrostis alba* and *Trifolium repens*, and all three are uncommon around the perimeter.

Libby Flats

County: Albany

Location: T16N R79W Sec. 28 NW ¼ of SE ¼

Topographic map: Medicine Bow Peak, WY (4110633)

Directions: Medicine Bow Range, From Hwy 130, turn onto the gravel road across Libby Flats that begins across from and immediately west of Libby Lake Road (Forest Service Road 346). (Note it is gated part of the summer until it is passable.) Continue 1 mile south to a fork in the road. Take the less-traveled fork south on foot for 0.5 miles to an outcrop ridge overlooking a saddle. Follow the base of the ridge across the saddle and continue east past 2 little rocky knolls.

Field survey date: 14 Aug 2002

Field survey investigators: Bonnie Heidel, Scott Laursen, and John Proctor

Elevation: 10,460 ft (3188 m)

Setting: headwaters

pH: unknown

Size: 0.88 ha

Setting and wetland description: Libby Flats Fen lies above a branch of Libby Creek, within a wet meadow complex covering open expanses at the head of the drainage. It is situated directly below Libby Flats at a midslope position below tree-covered ridges and near small rocky, tree-covered “islands” on abrupt little knolls. The fen is a nearly circular area ca 2/3 down the open slope. It is not a basin but a midslope upwelling, with a slight break in topography at its upper margin. The soils are derived from the Libby Creek Group.

The circular fen area is dominated by *Eleocharis quinqueflora*, or relatively short stature and sparse cover. There is a possible string-flark system of *Carex aquatilis* ridges and *Eleocharis quinqueflora* swales in parallel bands extended from the rest of the fen down to the creek below it. Sampling was concentrated in the circular fen area (about 30 m across), extending to the putative string-flark fen complex directly below.

Distinguishing botanical features: This is the highest-elevation peatland site and the smallest peatland site. In general, high elevation sites have been characterized as having lower species diversity and fewer of the boreal disjuncts compared to peatlands in valley and montane zones (Bursik 1991). This is consistent with the site information from the Libby Flats fen compiled to date, but the smallness of size and lack of multiple vegetation zones as found in other sites is likely to also contribute to this pattern.

The series of linear ridges and swales are a putative string-flark patterned peatland complex (see Chadde et al. 1998), not found in the other study sites. This feature warrants closer examination. It was initially not considered part of a patterned peatland zone because swales were not filled with standing water.

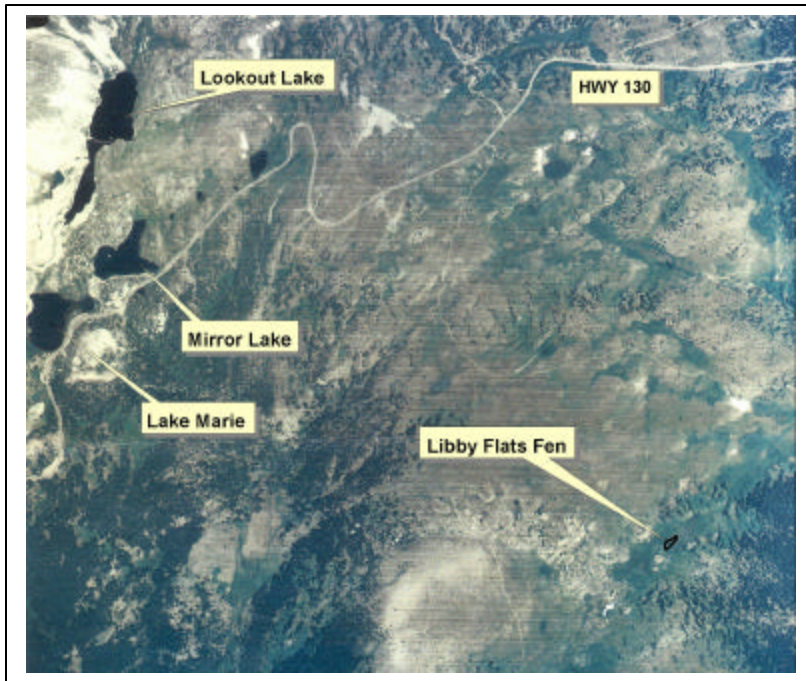


Figure 12. Aerial photo of Libby Flats Fen (FS Photo 496-8 of 08-07-96)

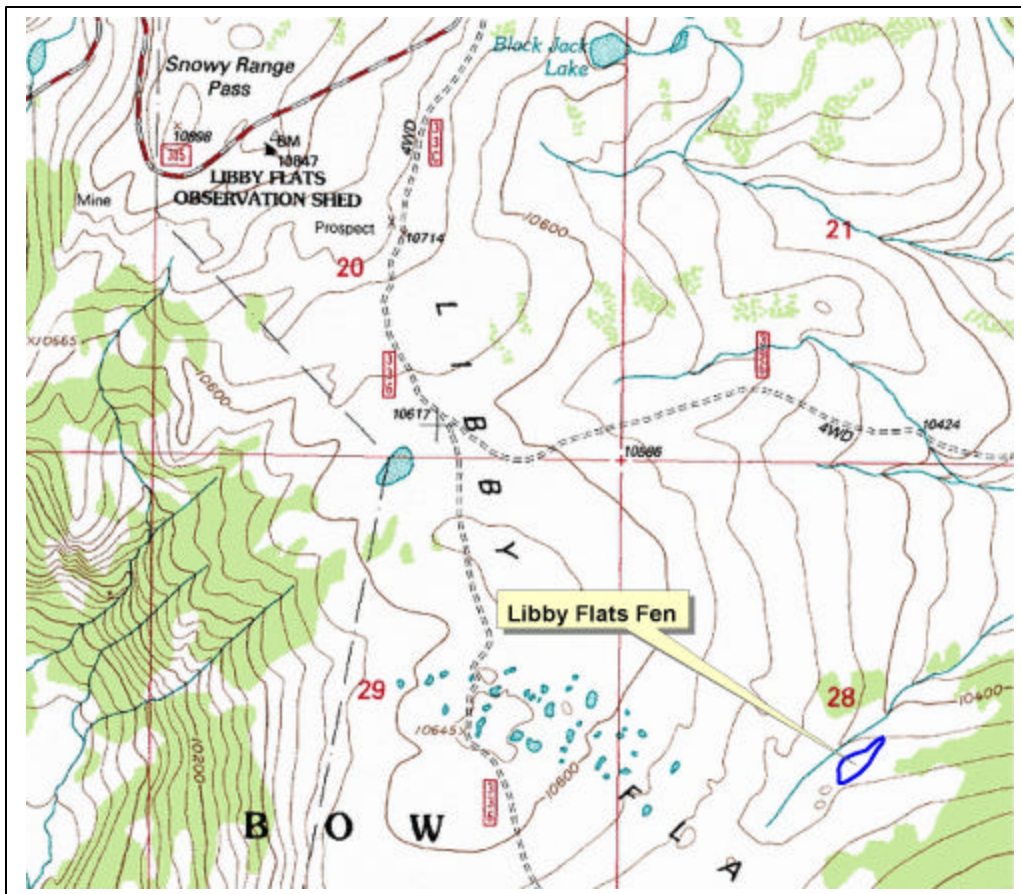


Figure 13. Map of Libby Flats Fen (Medicine Bow Peak Quad, 7.5')

A summary of the state-significant plant species and plant associations is presented below.

Table 12. Rare plant species of Libby Flats study site

Scientific Name	Common Name	G Rank	S Rank	EO Rank
<i>Epilobium oregonense</i>	Oregon willow-herb	G5	S1	B

Table 13. Plant associations of Libby Flats study site

Scientific Name	Common Name	G Rank	S Rank
<i>Eleocharis quinqueflora</i>	Few-flowered spikerush Herbaceous Vegetation	G4	S2
<i>Carex vesicaria - forbs</i>	Lesser bladder sedge Herbaceous Vegetation	G4Q	-

Evidence of alteration: There is no evidence of human disturbance apart from the study stakes. There are 2-3 circular areas devoid of vegetation that are centrally located in the fen and do not appear to be upwellings. These may be caused by elk rutting, consistent with elk sign. There is a two-track road within ½ mile of the fen, but no effects are apparent. A small rebar stake is located in the fen marking it in a system of plots laid out in a grid system across Libby Flats by Chris Hiemstra and his doctoral thesis work in press. Any livestock grazing on Libby Flats could affect this peatland feature.

DISCUSSION

The seven rare peatland species (ten known from the Forest collectively) and eleven peatland plant associations identified to date represent a relatively high concentration of biodiversity features in a localized habitat of the Medicine Bow National Forest. They also represent an intriguing “catalogue” of features without knowing how complete a segment this represents of the catalogue. The three mountain ranges of the Medicine Bow National Forest represent the only expressions of the Southern Rockies in Wyoming, so biogeographically, the results help link peatland documentation in the Northern and Southern Rockies along with the paucity of information from the Central Rockies.

The five peatland sites are all in multiple-use landscapes. There are simultaneous questions whether any given site is affected by the various surrounding land uses and developments, and the potential collective affects on botanical and ecological resources of peatlands across the Forest. It may be difficult to answer these questions simultaneously and it is not the purpose of baseline studies to address management questions. We propose an expansion of this pilot study to get a better grasp of peatland botanical and ecological resources (“the catalogue”), including development of remote-sensing techniques, for Medicine Bow National Forest reference.

The Medicine Bow National Forest site with the highest concentration of rare species, Sheep Mountain, was also visited relatively late in the season for systematic species survey (early September), so it is an automatic priority for more complete rare species and floristic

inventory. Revisits to the four other study sites may be considered part of intensive monitoring if there is need to standardize or modify vegetation sampling techniques. Cooper and Andrus (1994) used a 25 m sq plot and the Wyoming Natural Diversity Database is moving toward modified Whittaker plots (Stohlgren et al. 1995) that are compatible with this earlier work.

Hydrological research is beyond the scope of biological inventory, but consistent documentation of at least pH, conductivity, and depth to water table is recommended as part of the expanded baseline peatland inventory conducted with vegetation sampling, and its utility as reference. Consultation with hydrologists may help determine whether replications of the studies by David Sturges in the 1960's could help evaluate the influence of land use changes. Hydrological research was also recommended for Shoshone National Forest peatlands (Heidel and Larsen 2003), particularly at the most thoroughly documented peatland site in Wyoming in terms of biological resources, the Swamp Lake Fen. It has been subject to major hydrological change that may provide insights into peatland system function and hydrological/ecological trends elsewhere in Wyoming. Most of the Swamp Lake watershed burned in 1988 crownfires. The previous year, in 1987, Highway 296 was reconstructed as it passed downstream from Swamp Lake, and the culvert in the new highway road bed was appreciably higher than the Swamp Lake water surface at the time. There have been 12 consecutive years of above-average precipitation as indicated by Cody climate records (1989-2000) and comparison of the 1994 aerial photographs with present conditions indicates that 2002 was still in a relative highwater condition (Heidel and Larsen 2003).

In recent months, information has been conveyed about a designated Research Natural Area containing a "sphagnum peatland" on Medicine Bow National Forest in the Sierra Madre Range, Encampment District (John Proctor, personal communication.) It lies within the headwaters of the East Fork of Battle Creek in an area where other peatlands and rare peatland species are reported (Jankovsky-Jones et al. 1995.) This indicates that inclusion of the Sierra Madre in more extensive peatland inventory will contribute appreciably to a more complete peatland resources catalogue for the Medicine Bow National Forest.

It may be possible to pursue phylogeographic analysis with robust floristic data from well-documented Medicine Bow National Forest peatland sites (e.g. Bursik 1990, Lesica 1986), but the levels of floristic documentation accomplished in multi-purpose one-time visits were far from complete in cataloguing the vascular flora at any given site. Documentation of the bryophyte flora is at much earlier stages, and we did not have the benefit of specimen determinations from all five study sites. It is important to formalize this aspect of study design if the nonvascular flora is to be addressed as part of the expanded peatland inventory.

Last but not least, this emerging picture of peatland botanical and ecological resources on Medicine Bow National Forest might be used for more intense site studies of relationships and processes, as well as inventory of wildlife and other biological values associated with peatlands.

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