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Fens and Their Rare Plants in the Beartooth Mountains, Shoshone National Forest, Wyoming

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Forest Service

Rocky Mountain Research Station

General Technical Report RMRS-GTR-369

November 2017

Heidel, Bonnie; Fertig, Walter; Mellmann-Brown, Sabine; Houston, Kent E.; Dwire, Kathleen A. 2017. **Fens and their rare plants in the Beartooth Mountains, Shoshone National Forest, Wyoming.** Gen. Tech. Rep. RMRS-GTR-369. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 110 p.

Abstract

Fens are common wetlands in the Beartooth Mountains on the Shoshone National Forest, Clarks Fork Ranger District, in Park County, Wyoming. Fens harbor plant species found in no other habitats, and some rare plants occurring in Beartooth fens are found nowhere else in Wyoming. This report summarizes the studies on Beartooth fens from 1962 to 2009, which have contributed to current knowledge of rare plant distributions and biodiversity conservation. The study area is the Wyoming portion of the Beartooth Mountains in the Middle Rocky Mountains. Here, we profile 18 fens that occur over the range of elevations, settings, geomorphic landforms, and vegetation. The wetland flora from these 18 fens is composed of 58 families, 156 genera, and 336 vascular plant species—more than 10 percent of the known Wyoming flora. We discuss 32 rare vascular plant species and 1 bryophyte species associated with Beartooth fens and their State and regional significance.

Protection and management of Beartooth fens are addressed in guidance documents prepared by the U.S. Forest Service Groundwater Program, regional peatland and sensitive species policies, and the Shoshone National Forest Management Plan. Information compiled in this report increases understanding of Beartooth fens, provides a basis for future research and comparisons with mountain fens elsewhere in Wyoming and the Rocky Mountains, and contributes to conservation of fen resources and services.

Keywords: fen, wetland, rare plant, vascular flora, Beartooth Mountains, Shoshone National Forest

Cover photo: Swamp Lake Fen in the Clarks Fork Valley, Shoshone National Forest, Wyoming (photo: Mack Frost, used with permission).

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Acknowledgments

This publication reflects research by a legion of botanists and other scientists named in the report, whose Beartooth studies advance current knowledge of mountain fens and fostered additional studies. Information and insights provided by Erwin Evert are acknowledged with gratitude. Scott Laursen (Wyoming Natural Diversity Database; WYNDD) contributed during the pilot work on fens in 2002. Later fen inventory trips were accompanied by Yelena Kosovich-Anderson and Ron Anderson, Emily Elliott and Brian Elliott, Leslie Marty, and John Osgood. The geographic information system (GIS) modeling of Eli Rodemaker (Wyoming Geographic Information Science Center) and initial GIS design work of Rob Thurston (WYNDD) are acknowledged with special appreciation. The expertise of Roger Hopper (Wyoming Department of Agriculture, Analytical Services Lab) in providing water chemistry analyses is gratefully acknowledged, as are soils analyses by Ramona Belden (University of Wyoming Soils Testing Lab). This work would not have been possible without the resources of the Rocky Mountain Herbarium (University of Wyoming), along with the expertise and encouragement of Ron Hartman and B.E. Nelson. The contributions of Joy Handley and all other botanists who entered study area plant records into the database of WYNDD are much appreciated. Thanks to J. Stephen Shelly (U.S. Forest Service Region 1, Missoula, Montana), Paige Wolken (U.S. Army Corps of Engineers, Cheyenne, Wyoming), and Dave Weixelman (U.S. Forest Service Region 5, Nevada City, California) for insightful reviews. Incorporation of their comments and suggested revisions strengthened this report. The botany studies that took place in Beartooth fens were conducted through WYNDD in collaboration with the Shoshone National Forest and the U.S. Environmental Protection Agency.

We appreciate the careful editing provided by Cynthia Moser, and thank Connie Lemos and Patricia Cohn for guidance through the revision process, and for the creative layout and production of the final report.

Contents

Introduction

Peatlands are wetlands with water-saturated soils where dead organic matter in various stages of decomposition accumulates as peat. They occur extensively in northern latitudes of North America across Alaska and Canada (Rydin and Jeglum 2013). In the western United States, mountain peatlands are generally small and are dependent on localized climate and hydrological conditions that allow peat to accumulate faster than it decomposes under relatively stable inflows of groundwater over millennia (Bedford and Godwin 2003; Windell et al. 1986). Such groundwater-dependent peatlands are referred to as "fens." As defined in this report, fens have peat thickness of at least 40 cm (16 in) to meet the organic soil criterion established by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (USDA NRCS 2014).

We describe 18 fens in the Beartooth Mountains on the Shoshone National Forest (NF) in Park County, Wyoming (table 1), and the distribution of 32 rare vascular plant species and 1 rare bryophyte species associated with them. The 18 fens occur over a range of elevation, topography, and water chemistry in the Beartooth Mountains. They include most of the largest intact fens in the study area and many of those harboring more than one rare plant populations. For each fen, botanical attributes, significance, and documentation are presented as a

Table 1—Characteristics of the 18 fens described in this report. These fens are located in the southern portion of the Beartooth Mountains on the Shoshone National Forest, Wyoming.

Fen	Elevation (m)	Area (ha)	Setting	Vegetation structure	Underlying geology
Clay Butte Fen	2,740	4.7	Basin	Graminoid, shrub	Quaternary glacial deposit
Fantan Fen	2,910	4.8	Sloping	Graminoid	Quaternary glacial deposit
Ghost Creek Fen	2,410	2	Basin	Graminoid	Precambrian bedrock
Lake WGN Fen	2,890	1.9	Basin	Graminoid	Quaternary glacial deposit
Lily Lake East Fen	2,520	5.1	Basin	Graminoid	Quaternary glacial deposit
Lily Lake Fen	2,340	14.2	Sloping	Graminoid, shrub	Precambrian bedrock
Little Bear Lake Fen	2,910	4.1	Sloping	Graminoid	Quaternary glacial deposit
Little Moose Lake Fen	2,440	3.1	Basin	Graminoid, shrub	Precambrian bedrock
Littlerock Creek Fen	3,220–3,270	8.4	Sloping	Graminoid	Oldest gneiss complex
Meadow Lake Fen	2,990	4.7	Sloping	Graminoid	Quaternary glacial deposit
Meadow Lake North Fen	3,000	2.9	Basin	Graminoid	Quaternary glacial deposit
Mud Lake Fen	2,350	8.1	Sloping	Graminoid, shrub	Quaternary glacial deposit
Poke Lake Fen	2,630	4.7	Basin	Graminoid	Precambrian bedrock
Rock Creek Fen	2,340	1	Basin	Graminoid	Quaternary glacial deposit
Sawtooth Palsa Fen	2,950	8	Basin	Graminoid	Oldest gneiss complex
Swamp Lake Fen	2,010	98.9	Basin	Graminoid, shrub, forest	Quaternary alluvium and colluvium
Trail Fen	2,940	3.1	Sloping	Graminoid	Oldest gneiss complex
Wyoming Creek	3,020–3,250	mosaic	Sloping	Graminoid, shrub	Oldest gneiss complex

baseline for future research in the Beartooth Mountains and for comparison with other mountain ranges in the western United States. This report is primarily a reference for botanists and wetland ecologists, and secondarily for hydrologists, soil scientists, and other resource specialists.

Like all wetlands on public lands, fens are protected under the Clean Water Act of 1972, and managed to comply with the National Environmental Policy Act of 1969 and the Endangered Species Act of 1973 (Suzuki and Olson 2008). On National Forest lands, protection of fens and other wetlands is also governed by U.S. Forest Service Manual 2881.2 (USDA Forest Service 2010), and rules stated as Standards and Guidelines in the forest plan for each national forest, as updated by the 2012 Planning Rule (USDA Forest Service 2012a). Guidance for inventory and management of fens as groundwater-dependent ecosystems is provided by the Forest Service Groundwater Program (USDA Forest Service 2007), the peatland policy of the Forest Service's Region 2 (Rocky Mountain Region), hereafter called Region 2, (USDA Forest Service 2002), and the Shoshone NF Management Plan (USDA Forest Service 2015a).

Fens are also protected where they harbor Forest Service sensitive species (USDA Forest Service 2015b). Some fens can support a disproportionately high number of sensitive and other rare plant species and uncommon vegetation types due to their environmental conditions and stability. Mountain peatland floras include vascular plant species and bryophytes that are more typical of boreal regions of Alaska and Canada, some of which are restricted to fen habitats where present in the Rocky Mountains. The Beartooth fens described in this report support 32 vascular species recognized as Wyoming Plant Species of Concern by the Wyoming Natural Diversity Database (Heidel 2007). Four of the 32 Species of Concern occur nowhere else in Wyoming: *Amerorchis rotundifolia*, *Arctostaphylos rubra, Salix barrattiana*, and *Salix myrtillifolia*. Twelve of the 32 species are listed as sensitive by Region 2 (USDA Forest Service 2011). One bryophyte species, *Sphagnum angustifolium*, is designated as sensitive. Studies in the Beartooth Mountains study area that address fen floristic composition include Fertig and Jones (1992), Heidel and Laursen (2003b), Heidel and Rodemaker (2008), Jones and Fertig (1999b), Jones et al. (2011a,b,c) and Mellmann-Brown (2004). Studies elsewhere in Wyoming have been conducted in fens of the Medicine Bow Mountains (Heidel and Jones 2006; Heidel and Laursen 2003a; Heidel and Thurston 2004), the Big Horn Mountains (Heidel 2011), the Laramie Range (Heidel et al. 2013), Yellowstone National Park (Chadde et al. 1988; Lemly 2007; Lemly and Cooper 2011), and other locations (Heidel 2013a,b; Heidel et al. 2013). Studies elsewhere in the Rocky Mountains that address fen floristic composition include Austin (2008), Austin and Cooper (2015), Bursik (1990), Chimner et al. (2010), Cooper and Andrus (1994), Lesica (1986), and Lyon et al. (2007). In addition, Chadde et al. (1998) focused on Idaho and Montana fens, while citing information from two fens in the Beartooth Mountains study area (this report).

Over the years, fen studies in the Beartooth Mountains and elsewhere in the State have provided the basis for reevaluating what species are present and rare in the Shoshone NF and in the State, and have been used in addressing the Region 2 sensitive species list under the Forest Service sensitive species policy. The studies also provide information for maintaining the Wyoming Species of Concern list and State ranks. In the following section, the pioneering work at Swamp Lake Fen and other fen studies in the Beartooth Mountains are presented. Collectively, findings are reflected in updates to the Wyoming Species of Concern list and State species accounts, and posted online in the Wyoming Natural Diversity Database

(WYNDD 2016). Some of the rare plants in Beartooth Mountain fens have been included in earlier State and Forest Service field guides (Fertig et al. 1994; Houston et al. 2001; Mills and Fertig 1996a). Scientific names for plants used throughout this report follow the PLANTS database (USDA NRCS 2015), with synonyms and common names provided in the Appendix.

Beartooth Mountains Study Area

The Beartooth Mountains are a northwest-southeast trending landform that straddles the Montana-Wyoming State line in Park County, Wyoming and Park and Stillwater Counties, Montana. The study area is confined to the Beartooth Mountains of Wyoming (fig. 1), part of the Middle Rocky Mountains (Bailey 1997). The Beartooth Mountains occur within the Yellowstone River watershed, and portions of the range are located on three national forests, the Shoshone NF in Wyoming and the Custer and Gallatin NFs in Montana. The Absaroka-Beartooth Wilderness Area occurs in the central Beartooth Mountains, at the highest elevations in the range, and extends to the Absaroka Range.

The Beartooth Mountains formed from an anticlinal thrust wedge uplifted during the Laramide Orogeny in the late Cretaceous or early Tertiary (Foose et al. 1961). Erosion has exposed the Precambrian crystalline core of the mountains, though small areas of Mid- to Upper Cambrian and Devonian sedimentary formations remain. The extensive Precambrian formations are mapped as the "oldest gneiss complex" in Wyoming; are composed of gneiss, schist, and related metamorphic rocks that have been modified by strong faulting; and are base-poor parent material (Foose et al. 1961). Sedimentary formations are found along the southern study area boundary (locally known as the "reef"), on the eastern flanks of the Beartooth uplift, and on the prominent geologic remnant called Beartooth Butte. For purposes of this report, we include the Clarks Fork Valley, located between the Beartooth Mountains and the Absaroka Range, as part of the Beartooth study area. Sedimentary formations and Quaternary deposits derived from them provide base-rich parent material. Groundwater conditions that support fens are found on all formations, and are influenced by faults, bedding planes, and topography. The associated water chemistry differs among the geologic formations.

Wyoming fens are often in glaciated mountain landscapes (Knight et al. 2014). Three major periods of glaciation in the Beartooth Mountains resulted in extensive Quaternary deposits in valley bottoms (Love and Christiansen 1985; Pierce 1965, 1980; Pierce and Nelson 1971). Within the large crystalline fault block, U-shaped valleys and other glacial features contribute to the distinctive plateau-type benches characteristic of the Beartooth Mountains. Quaternary morainal deposits are dominated by granitic materials that originated at higher elevations in the Beartooth Mountains. There is little information about the climate over geological time apart from the characterization of the Beartooth Mountains as part of the northern Greater Yellowstone landscape, where the climate was wetter in the early Holocene (9,000–14,000 years before present [YBP]) (Whitlock and Bartlein 1993) than current conditions. The Beartooth Plateau is an alpine peneplain that hosts a number of arctic-alpine plant species that are disjunct between British Columbia and Colorado (Marr et al. 2012), including the widespread arctic-alpine plant, alpine mountainsorrel (*Oxyria digyna*) (Marr et al. 2008).

The Beartooth Plateau was first hypothesized to have areas of unglaciated refugia by Pierce (1979). The present landscape and soils have been modified by colluvial, fluvial, and frost-churning geomorphic processes (Johnson and Billings 1962; Love and Christiansen 1985).

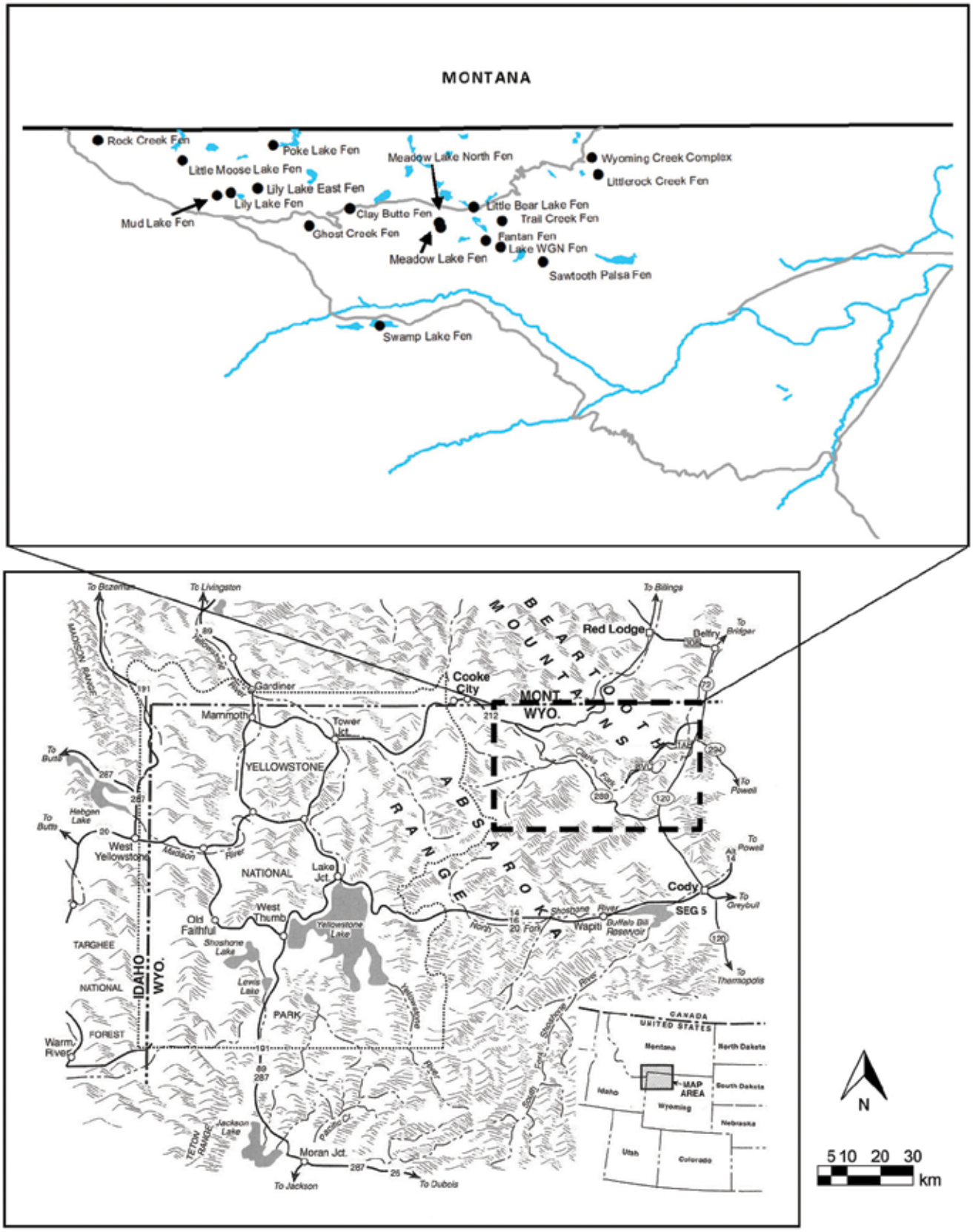

Figure 1—Beartooth Mountains study area and representative fens, Park County, Wyoming.

Wetlands are common in much of this landscape. In Wyoming, the Beartooth Mountains were identified as having high wetland density and high total wetland area (Copeland et al. 2010). Wetland soil types in the study area include Cryaquents, Cryofluvents, Cryaquepts, Cryaquolls, and Cryofibrists (USDA NRCS Soil Survey Staff 2008). The soil units mapped in the fens described in this report are Cryofibrists (USDA NRCS Soil Survey Staff 2008), with organic matter composed of undecayed or partially decayed sedge and bryophyte material, gen- erally more than 40 cm thick. Permafrost in the study area was first reported by Pierce (1961) at the Sawtooth Peatbeds. Frozen soils were also reported underlying alpine fens at the headwaters of Wyoming Creek by Johnson and Billings (1962), who noted peat depths of 46 cm (18 in). Similar depths were found at the Sawtooth Peatbeds. Permafrost is defined by substrate temperatures that remain below 0 °C (32 °F) for more than 2 years. Such soils belong to the Gelisol order and are classified as Hemic Glacistels (USDA NRCS Soil Survey Staff 2014).

The upland soils and bedrock parent material can influence the groundwater supporting fens. Upland soils in the study area consist of Inceptisols, Mollisols, and Alfisols (USDA NRCS Soil Survey Staff 2008). On Precambrian formations, soils are generally poorly developed and classified as Inceptisols, Entisols, or Mollisols. Typically they have coarse textures and low base saturations. More developed soils are classified as Haplocryolls, but with increasing elevation Eutrocryepts, Dystrocryepts, and Cryorthents become more common. At the highest elevations, alpine soils on Beartooth Plateau Precambrian formations are weakly developed and tend to have a loamy surface "A" horizon with sandy textured subsoils. Base saturations are low and soils are classified as Eutrocryepts, Dystrocryepts, and Cryorthents. Alluvial deposits derived from sedimentary formations are also found along the southern study area boundary. These soils have fine textures and high base saturations; they are classified as Typic Cryalfs, Calcic Cryalfs, or Haplocryolls (USDA NRCS Soil Survey Staff 2008).

The Beartooth Mountains have a continental climate with dry, warm summers and cold, moist winters. Annual precipitation in the Beartooth Mountains ranges from 25 to 157 cm (10 to 62 in), with a strong elevation gradient and increasingly dry conditions toward the eastern side of the mountains. Most annual precipitation falls as snow. A snow telemetry (SNOTEL) station is centrally located in the study area at an elevation of 2,853 m (9,360 ft) in subalpine spruce-fir (*Picea engelmanii-Abies lasiocarpa*) forest near Beartooth Lake (http://wcc.sc.egov.usda.gov/nwcc/site?sitenum=326). Average annual precipitation at the SNOTEL station is 81 cm (32 in) based on 1980–2015 data (Curtis and Grimes 2004) (fig. 2). The average daily minimum temperature of the coldest month (December) was −27.3 °C (−7.1 °F) between 1980 and 2015; the coldest temperature on record is −39 °C (−38.2 °F) (USDA NRCS 2016). There is extensive alpine habitat with low temperatures during the short growing season, with similarities and dissimilarities relative to arctic latitudes (Billings 1973). The alpine conditions reduce water loss and decay rates and are conducive to the accumulation of organic material despite the short growing season.

The montane and subalpine vegetation in the Beartooth Mountains of Wyoming is dominated by spruce-fir forest, lodgepole pine (*Pinus contorta*) woodland, and Douglas-fir (*Pseudotsuga menziesii*) woodland interspersed with mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), subalpine forb and herbaceous meadows, and wetlands (Driese et al. 1997; Knight et al. 2014). Stunted, tundra-like alpine vegetation covers large portions of the plateau landscape (Johnson and Billings 1962). The vegetation has been classified and described in previous studies (Fertig and Bynum 1994; Fertig and Jones 1992; Jones and Fertig 1999a,b; Tweit and Houston 1980; Walford et al. 2001).

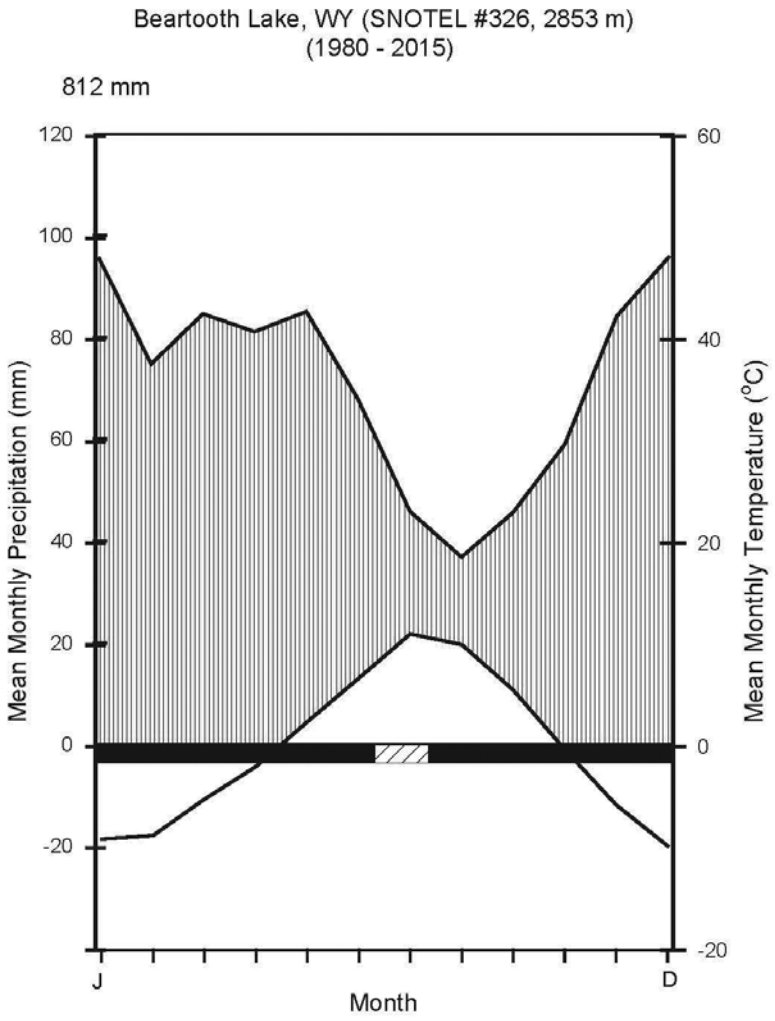

Figure 2—Climate diagram for the Beartooth Lake SNOTEL station (2,853 m), located in subalpine spruce–fir forest, for the period of record (1980 to 2015). Top line of graph shows mean monthly precipitation. Bottom line of graph shows mean monthly temperatures from January to December. Black bar indicates months with mean minimum temperatures <0 °C; diagonally hatched bar indicates that, for most years, minimum temperatures for July are >0 °C (USDA NRCS 2016).

Peatland Studies in the Beartooth Mountains

Most of the Beartooth Mountains are in Montana, but fen studies have been concentrated in the southern portion of the Beartooth Mountains in Wyoming due to environmental differences and easier access. The information presented in this report is from the Wyoming portion of the Beartooth Mountains, an area of about 828 km^2 (320 mi^2). This area is managed as part of the Clarks Fork Ranger District, Shoshone NF. The fens described in the report (fig. 1) occur from 2,010 to 3,270 m (6,590 to 10,730 ft) in elevation, spanning most of the range of the Beartooth Mountains of Wyoming. The highest elevation fens are on the Beartooth Plateau, and the lowest elevation fens are in the Clarks Fork Valley on the border between the Beartooth Mountains and the Absaroka Range.

Numerous studies have been conducted on peatlands in the southern Beartooth Mountains, though few were designed as peatland research. The first published research on a Beartooth fen described the Sawtooth Peatbeds (fig. 1; Sawtooth Palsa Fen) as raised, peat-covered mounds over a permafrost core (Pierce 1961). Palsas are large mounds that contain frozen ice lenses and frequently develop in peatland areas of boreal regions. Although isolated patches of permafrost have been reported in the Rocky Mountains as far south as Arizona, this is the only palsa-fen feature described to date in the conterminous United States (Collins

et al. 1984). Next, Johnson and Billings (1962) examined both terrestrial and wetland alpine vegetation of the Beartooth Mountains in relation to soil- forming processes. They described the "alpine bog" habitat of Wyoming Creek.

The third Beartooth fen described in a research publication was Swamp Lake Fen, where botany work started in 1979 (fig. 1, Swamp Lake Special Botanical Area; see also cover photo). Evert et al. (1986) documented nine new State vascular plant records. Swamp Lake Fen was proposed and evaluated for natural area designation based on the occurrence of a high number of rare species (Evert 1984; Johnston 1987; USDA Forest Service 1986). A floristic inventory documenting species composition and a rare plant survey noting the local distribution of rare plant species were conducted in tandem with vegetation mapping by researchers from WYNDD (Fertig and Jones 1992). None of the above-mentioned publications referred to either peatlands or fens, but Swamp Lake Fen and Sawtooth Peatbeds were included in a publication on peatlands of the Northern Rocky Mountains (Chadde et al. 1998) based primarily on these earlier works.

Pilot fen studies were conducted at six known fens including Swamp Lake Fen and Sawtooth Palsa Fen, as treated by Heidel and Laursen (2003b) and Mellmann-Brown (2004). This work provided a springboard for extensive fen studies using photointerpreta- tion and remote sensing across the montane and subalpine elevations of the Wyoming side (Heidel and Rodemaker 2008), an area of 548 km^2 (212 mi^2). The six sites were used for reference to identify and trace outlines of other wetlands that appeared to have saturated conditions late in the growing season and fen features such as floating mats or distinctive vegetative or geomorphic patterning. Photointerpretation was conducted in 2005 using color infrared digital orthophotography taken late in the 2001 growing season.

A total of 413 prospective fens were digitized. Field visits of 194 wetlands from 2005-2007 verified that 105 qualified as fens (i.e., they contained peat and met the 40-cm peat thickness criterion). GPS points were recorded at opposite ends of each peatland to project them onto digital aerial imagery and cross-check them with digitized boundaries that were based on photointerpretation. The fen settings, geology (Love and Christiansen 1985), and vegetation were recorded and the occurrence of rare plants was documented at each of the 105 fens. In addition, photographs and pH readings were taken and rare plant specimen vouchers were collected. The 105 fens ranged from 0.06 ha (0.15 ac) to 949 ha (234 ac) in area; collectively, the area sampled represented more than 75 percent of the total area digitized as potential peatland habitat in the Beartooth Mountains (Heidel and Rodemaker 2008) (fig. 3). The majority of sites that were not visited were less than 0.4 ha (1 ac) and located in the Absaroka–Beartooth Wilderness Area. It is estimated that fens account for up to 1.0 percent of the Beartooth landscape area included in this project (Heidel and Rodemaker 2008).

These fen studies did not originally investigate the alpine zone because fewer man- agement activities occur at alpine elevations than lower elevations. In 2009, two alpine wetlands with peat, Littlerock Creek Fen and Wyoming Creek, were identified based on fen indicator species. Although they did not meet the 40-cm criterion for peat thickness, they were characterized in the same way as other fen sites included in this report.

The results of the pilot and extensive fen studies were integrated with prior site studies and combined to profile the fen flora, vegetation, and environmental characteristics of fens and an array of intact, representative sites.

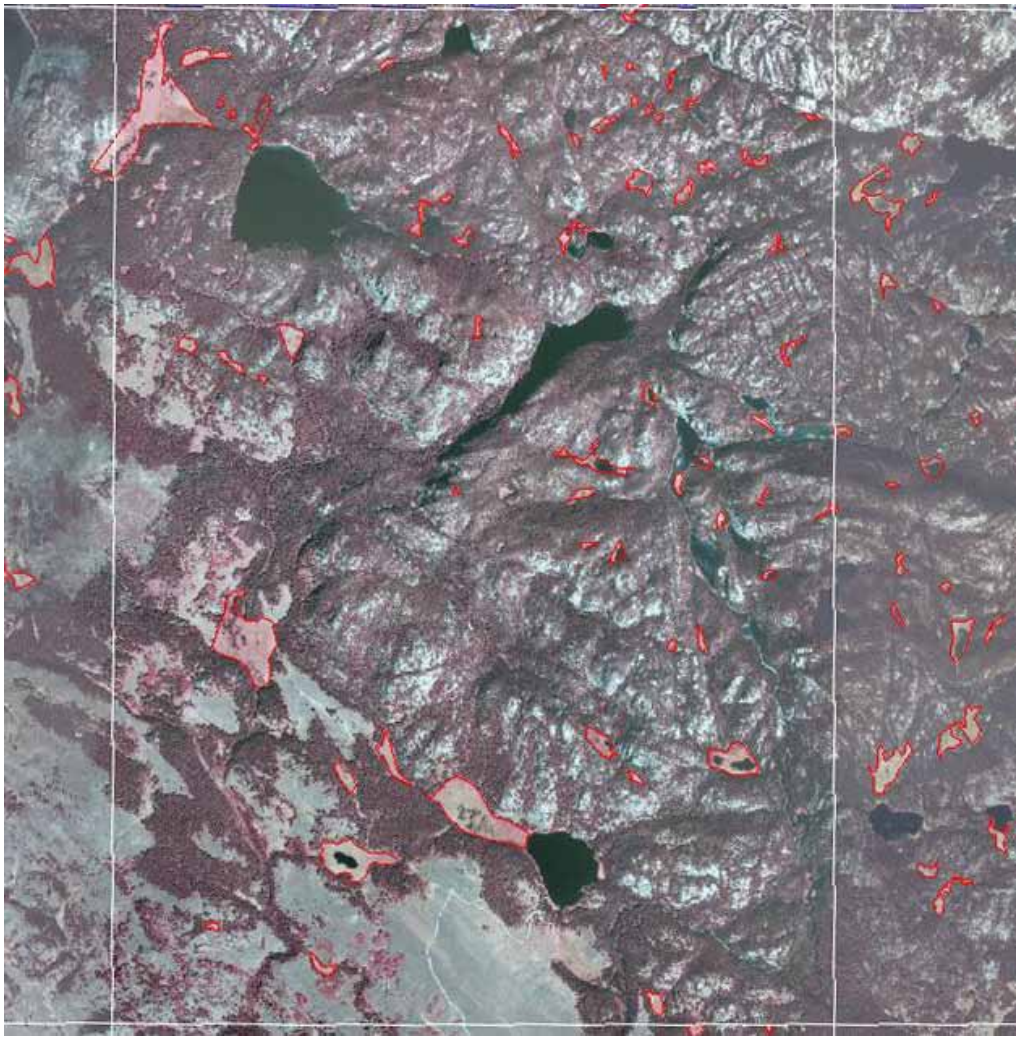

Figure 3—Potential fen sites were identified and mapped on digital orthophotograph imagery, and stored by quarter-quad. This is the Muddy Creek topographic quad, in the northwest quarter. Potential fen boundaries were digitized and are shown in red. Quarter-quad boundaries are in white. This image also shows Precambrian outcrop (upper right) and Quaternary deposits (lower left) (Heidel and Rodemaker 2008).

Fen Flora

Documentation of the Beartooth Mountain fen flora began with peatland-related studies from the Beartooth Plateau (Evert 1982; Johnson 1962) and in 1979 at Swamp Lake Fen. Forest-wide rare plant species surveys were conducted in the Shoshone NF, including the Beartooth Mountains, from 1995 through 1997 (Fertig 1997, 1998; Mills and Fertig 1996b), though they did not focus on the Beartooth Mountains or on wetland species. Baseline rare plant surveys, floristic inventory, and vegetation description of Lake Creek (a proposed Research Natural Area) led to the discovery of a fen east of Lily Lake in 1996 (Lily Lake East Fen; fig. 1) (Jones and Fertig 1999b). In response to the proposed widening of the Beartooth Highway (U.S. Highway 212), intensive botanical surveys were conducted along the road corridor and documented rare plant occurrences in Clay Butte Fen and Little Bear Lake Fen (fig. 1) (ERO Resources Corporation 1999a,b, 2000). In 2007–2008, vascular floristic inventories of the Absaroka Range in Montana and the Beartooth Mountains in both Wyoming and Montana were conducted (Elliott 2014) and included fens.

In 2001, Heidel determined that about 10 percent of the Wyoming Plant Species of Concern at that time occurred in peatlands, based on comparison of the Wyoming Species of Concern list with species in Chadde et al. (1998). Since 2001, some fen species have been

removed from the list because they have been found to be more common than previously known. Collectively compiled from the studies described above, the wetland flora from the 18 Beartooth fens comprises 58 families, 156 genera, and 336 vascular plant species (Appendix), more than 10 percent of the known Wyoming flora (Dorn 2001 and subsequent additions). More recently, a catalog and atlas of vascular plants in the Greater Yellowstone Area was published, the first floristic publication to refer to fen habitat in Wyoming (Evert 2010).

Bryophytes are an integral component of fen vegetation (Vitt 2006, 2014). The first concerted collecting of fen bryophytes in the study area was conducted at Swamp Lake Fen (Elliott 1995), and reflected in Wyoming checklists compiled by Eckel (1996, 2007). Since then, systematic floristic bryophyte inventories have been conducted in the Beartooth Mountains (Kosovich-Anderson 2009, 2010, 2011).

Fen Vegetation

In the 1990s, peatland vegetation sampling was conducted by WYNDD researchers for the Shoshone NF as part of forest-wide vegetation studies to characterize major riparian and wetland vegetation types (Walford et al. 2001). Soils were classified in the field (USDA Soil Conservation Service 1994), and samples were collected for verification. At each fen, vegetation was sampled in a circular plot (radius of 11.36 m or 37.25 ft) in which cover and height of all vascular plant species were recorded (Houston 1993). Field work was conducted in 1993, 1995, 1996, and 1997 (Walford et al. 2001). The resulting classification identified 12 plant community types reported to have organic soils, a requisite of peatlands (Walford et al. 2001). Most of the plant community types sampled on organic soils were in the Beartooth Mountains portion of the Shoshone NF. Six of the 18 fens described in this report were sampled by Walford et al. (2001). Moss cover from Shoshone NF vegetation on Histosols was reported as ranging from 10 to 50 percent (Walford et al. 2001). Wetland vegetation information from these sampling efforts is limited but provided preliminary characterizations, and served as the basis for the following descriptions of forested, shrub-dominated, graminoid-dominated, and aquatic community types in Beartooth fens.

Many of the characteristic vascular plants of Wyoming fen vegetation are summarized in Knight et al. (2014). Studies of fen vegetation conducted in Wyoming and adjoining States are cited in this report (Austin and Cooper 2015; Carsey et al. 2003; Chadde et al. 1998; Cooper and Andrus 1994; Lemly 2007; Lemly and Cooper 2011).

Forested Vegetation

Forested fen vegetation in the Beartooth Mountains is found at the low elevations in the Clarks Fork Valley, mainly below 2,200 m (7,200 ft) (Heidel and Rodemaker 2008). Clarks Fork Valley has a tree canopy of Engelmann spruce (*Picea engelmannii*), white spruce (*P. glauca*), or hybrids of *P. engelmannii* × *P. glauca* (Haselhorst and Buerkle 2013), mainly at lower study area elevations. Understory species include *Equisetum arvense*, sometimes with high cover of *Carex disperma*, *C. interior*, or *C. leptalea* on mossy hummocks. In the Beartooth Mountains, forested fens or forested portions of fens were located at points of groundwater discharge along stream segments and valley toe slopes (Heidel and Rodemaker 1998) (fig. 4). A plant association of Engelmann spruce and *Equisetum arvense* is described

Figure 4—Forested fens are dominated by *Picea* species. This forested stand borders the graminoid-dominated portions of Swamp Lake Fen, where individuals of relatively pure *P. glauca* and hybrids with *P. engelmannii* are present (photo: Bonnie Heidel, WYNDD).

from the Beartooth Mountains by Walford et al. (2001), and is noted as occurring in fens of central and western Montana (Chadde et al. 1998).

Shrub Vegetation

Shrub fen vegetation is found at elevations from 2,010 to 3,270 m in the Beartooth Mountains. Walford et al. (2001) described two shrub height categories: tall (over 0.6 m; 2 ft) and low (under 0.6 m). Tall shrub communities have *Salix boothii*, *S. planifolia*, or *S. wolfii*, often associated with *Carex utriculata*. Low shrub communities have *Salix planifolia*, often associated with *Carex scopulorum* at high elevations, and with *C. aquatilis* and other sedges at low elevations. Uncommon willows, such as *Salix candida* (fig. 5), may be locally prevalent. *Salix* species present in the study area are described in Fertig and Markow (2001).

Graminoid Vegetation

Graminoid fen vegetation, composed of grasses and grass-like plants, is found at elevations from 2,010 to 3,270 m in the Beartooth Mountains (Heidel and Rodemaker 2008). The most abundant species are sedges (family Cyperaceae). *Carex scopulorum* is the most important sedge in "alpine bog" vegetation (Johnson and Billings 1962). Dominants at lower elevations include *C. aquatilis*, *C. limosa, C. simulata*, *C. utriculata*, and *Eleocharis pauciflora* (Heidel and Laursen 2003b; Mellmann-Brown 2004; Johnson and Billings 1962, Walford et al. 2001). In addition, *Triglochin maritima* (family Juncaginaceae) is also reported as a dominant graminoid species at Swamp Lake Fen (Fertig and Jones 1992). Graminoid-dominated fens may be mistaken for non-fen wetlands, but they retain saturated conditions at or near the surface and have sufficient thickness of accumulated peat to be classified as peatlands.

Figure 5—Shrub dominated fens range from low shrub height and density to tall shrub height and high density. This low shrub stand at Mud Lake Fen is dominated by *Salix candida* (photo: Bonnie Heidel, WYNDD).

Peat characteristics vary in graminoid-dominated fens, and sometimes contribute to microhabitats for rare plants that are often discernible on aerial imagery (Heidel and Rodemaker 2008). For example, floating mats are composed of peat derived from graminoid vegetation and may be dominated by *Carex limosa*, *C. simulata*, *C. lasiocarpa*, and *Menyanthes trifoliata* with or without solid mats of *Sphagnum* mosses (figs. 6 and 7). The mats form around open water and are suspended over the water column. Most floating mats occur in shallow basins, but a few border deep lake basins. Patterned fens are composed of parallel mound-swale series in sloping settings, oriented perpendicular to the slope, and can be discerned on aerial imagery. The patterning results from geomorphic peat formation processes, forming "stripes" with narrow, raised, elongate hummocks of moss and graminoid vegetation, separated by shallow, narrow depressional swales (Rydin and Jeglum 2013) (figs. 8 and 9). The peat thickness and underlying conditions may differ between the mounds and the swales (figs. 10 and 11), and the swales may or may not be inundated for part or all of the growing season. The mounds have a prevalence of *C. scopulorum* and the moss *Aulacomnium palustre*. Common associated species include *Packera subnuda, Sedum rhodanthum, Symphyotrichum foliaceum* var. *apricum*, and *Polygonum bistortoides*. The swales may have standing water with aquatic vegetation, emergent cover, or merely shorter, sparser cover of *C. scopulorum* and *Caltha leptosepala* on exposed peat with little moss cover.

Aquatic Floating and Submerged Vegetation

Small pools and ponds of shallow water support floating and submerged vegetation within fens or bordering fen habitat. Many such open-water features are locally dominated by *Nuphar polysepala* floating on the surface. Small, shallow pools are often dominated by *Sparganium angustifolium*, *Callitriche* species, and brown mosses (e.g., *Drepanocladus*

Figure 6—In graminoid-dominated fens, floating mats that extend out over water sometimes form. This floating mat has *Carex limosa* and *Sphagnum* mosses (photo: Sabine Mellmann-Brown).

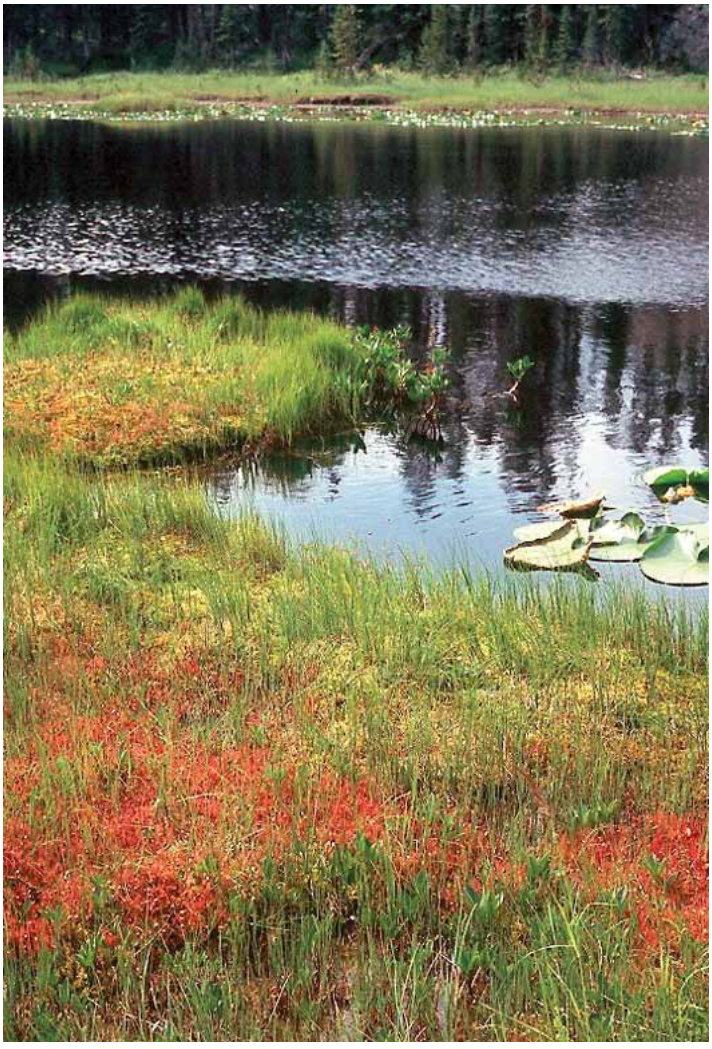

Figure 7—Floating mats high in *Sphagnum* mosses support an abundance of *Drosera anglica* at Poke Lake Fen (photo: Bonnie Heidel, WYNDD).

Figure 8—Graminoid-dominated fens sometimes have microtopography of parallel linear mounds and intervening swales. The swales may have standing water or peat exposed at the surface (photo: Bonnie Heidel, WYNDD).

Figure 9—Mounds and exposed swales are both dominated by *Carex scopulorum* at Little Bear Lake Fen. The mounds have higher vascular plant cover, higher moss cover, and higher species diversity compared to swales (photo: Bonnie Heidel, WYNDD).

Figure 10—A soil core collected from a mound showed evidence of oxidized iron in the mineral portion at the base (left side of photo), indicating fluctuating water table and seasonal aerobic conditions (photo: Bonnie Heidel, WYNDD).

Figure 11—A soil core collected from a swale directly adjoining the mound in figure 10 showed no evidence of oxidized iron in the mineral portion at the base, suggesting underlying differences over short distances (photo: Bonnie Heidel, WYNDD).

aduncus). *Chara* species are macroscopic green algae and have been observed in alkaline Beartooth fens. They grow profusely in alkaline shallow pools and in littoral waters with precipitated carbonates, or marl (Hutchinson 1975).

Environmental Characteristics

Geology and Soils

Beartooth fens occur in basins or on slopes, usually separate but sometimes present within a single wetland complex. Basin (topogenous) fens occupy peat-filled depressions or depressions that are partially filled by peat around open water. Sloping (soligenous) fens occur at gently sloping valley margins, the base of alluvial fans, and other headwater settings where groundwater discharges near the surface. Both basin and slope fens are also found in Yellowstone National Park (Lemly and Cooper 2011). Basin fens appear to be more numerous than sloping fens in the Beartooth Mountains based on field surveys to date (71 of 105 fens, or 68 percent; Heidel and Rodemaker 2008). Underlying geology was determined for each site by using Love and Christiansen (1985), as represented in digital form. Field notes were taken on any rock outcrops that directly adjoined fens.

Fens must have a peat thickness of at least 40 cm within the upper 80 cm (31 in) of the soil to meet one of the criteria for designation as an organic soil established by the USDA NRCS. (Study area fens had a contiguous peat thickness of at least 40 cm thickness from the surface downward, but please see USDA NRCS 2014 for an explanation of additional potential criteria for soil properties such as clay content and depth to lithic contact). Peat thickness was measured by coring surface peat with an Oakfield or McAuley auger. The augers could sample only to 90 cm, so total peat thickness was not measured in most fens (table 2). A central location was selected for coring to obtain the deepest cores possible. In fens with more than one dominant vegetation type, multiple cores were taken (i.e., in forest-, shrub-, and graminoid-dominated portions of fens). A 40-cm minimum peat thickness was used to define fens in early Beartooth fen studies (Heidel and Laursen 2003b; Mellmann-Brown 2004) and extensive inventories from 2004 through 2006 (Heidel and Rodemaker 2008). In later work,

Table 2—Characteristics of peat in Beartooth Mountain fens.[a]

Fen	Peat thickness[b] (cm)	Depth to water table (cm)	Peat pH[c]	Peat conductivity (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	Standing water pH	Standing water conductivity (µS/cm)
Clay Butte Fen	>90	0	6.2–7.1	180–320	27–53	3.6–6.3	0.9–1.1	6.9–7.6	140–260
Fantan Fen	>90	–[d]	–	–	–	–	–	–	–
Ghost Creek Fen	>90	2–11	5.6–5.7	67–78	4.9–5.3	2.0–2.3	3.3–4.0	6.6	48
Lake WGN Fen	>90	–	–	–	–	–	–	–	–
Lily Lake East Fen	>90	0–1	4.3–5.0d[e], 5.3-6.0	50–400[e] 54–60	3.9–7.2	1.5–2.6	2.1–2.9	6.4	27
Lily Lake Fen	>90	0–5	6.3	91–180	11–28	2.6–5.2	3.0–3.6		96–250
Little Bear Lake Fen	>90	0–10	5.5–5.7	14–73	1.2–3.6	0.3–1.0	1.0–5.0	6.1	18
Little Moose Lake Fen	>90	–	4.9–5.5[e]	110–360[e]	–	–	–	–	–
Littlerock Creek Fen	19–35	1	5.9	19	1	0.3	1.4	6.6	11
Meadow Lake Fen	>90	0–15	5.1–5.6	13–71	1.4–5.5	0.2–0.7	0.8–3.8	6.7	18
Meadow Lake North Fen	>90	4	5.6	34	2.4	0.3	1.6	6.1	17
Mud Lake Fen	>90	0	6.9	270	43	8.7	3.6	7.9	280
Poke Lake Fen	>90	–	–	–	–	–	–	–	–
Rock Creek Fen	>90	–	–	–	–	–	–	–	–
Sawtooth Palsa Fen	Est. 310–460[f]	–	–	–	–	–	–	–	–
Swamp Lake Fen	6,10[g]	0–10	7.5–7.6	530–770	58–85	30–49	6–11	7.3–8.4	400–520
Trail Fen	>90	–	–	–	–	–	–	–	–
Wyoming Creek	46[h]	0	5.2	43	2.5	0.6	2	5.7	14

[a] Peat thickness was measured using augers. Depth to water table, pH of soil water, and concentrations of Ca2+, Mg2+, and Na+ of soil water were measured from peat core holes in Beartooth Mountain fens; pH and conductivity were also measured in adjacent standing water (pool, pond, or stream).
[b] Heidel and Rodemaker (2008).
[c] pH and all other water chemistry data are from Heidel (2009) unless otherwise stated.
[d] "–" indicates that data are not available.
[e] Heidel and Laursen (2003a).
[f] Pierce (1961).
[g] Stephen Jackson, botany professor/palynologist, Botany Department, University of Wyoming, Laramie, Wyoming, 2007, personal communication.
[h] Johnson and Billings (1962).

however, two alpine sites with peat thickness ranging from 20 to 40 cm (8 to 16 in) were also included. All cores documented continuous peat from the surface downward. Some peat cores were suspended above the water column (floating) and others were continuous down to mineral soil (anchored).

Hydrology

Fens are supported by groundwater, which can originate from multiple sources. Hydrology information for Beartooth fens is limited to records of the locations of source water inlets, where present, and outlet streams. There are both basin and sloping fens at headwater positions that have no inlets.

Water Chemistry

Peatland water chemistry can have a major influence on the distribution of plant species and has been used as a basis for fen classification (Rydin and Jeglum 2013). Early European fen classifications were based on pH values (Sjörs 1948), then expanded to include electrical conductivity, base richness, and concentrations of major cations, particularly calcium (Ca^2+), magnesium (Mg^2+), and sodium (Na+) (Rydin and Jeglum 2013). Using this approach, fens are classified along a continuum from poor (low pH, electrical conductivity, and ionic concentrations) to extremely rich (highest pH, electrical conductivity, and ionic concentrations) (fig. 12). Although developed for more extensive peatlands in boreal regions, the poor-to-rich classification has been applied to mountain fens in the western United States (Bursik 1990; Chadde et al. 1998; Cooper and Andrus 1994; Lesica 1986; Weddell 2005). Water chemistry was sampled in Beartooth fens to better characterize environmental conditions and examine the influence of water chemistry on the distribution of rare plant species.

At 13 Beartooth fens, water chemistry was sampled in 2009 over a range of elevation, parent material, and settings. These fens were selected from the 105 fens identified previously (Heidel and Rodemaker 2008), and 11 are described in this report (table 2). At each of the 13 fens, pH was measured and water samples were collected in a central location within areas dominated by forest, shrub, or graminoid vegetation, resulting in multiple measurements for some fens. For the pH readings, first a 15-cm (6-in) peat core at or below the water table was removed with an auger, and water was allowed to refill the hole. Next the pH probe was immersed in the hole to take pH readings. Water samples were then collected from the hole. At sites with patterned microtopography, the peat pH of both mounds and swales were measured, usually within 1 meter of one another. A water sample was also collected from the nearest source of surface water. Surface water samples were collected in shallow, open-water pools surrounded by peat. If there was no open water surrounded by peat, then surface water samples were collected from adjoining lakes or streams. Measurements of pH were taken using an Oakton® Instruments pH meter, calibrated each morning prior to measurements by using pH 4, 7, and 10 standards. Measurements and water samples were collected from July 21 through July 23, 2009.

Water samples were packed with dry ice and shipped overnight to the Wyoming Department of Agriculture, Analytical Services Laboratory in Laramie, Wyoming. Upon receipt, water samples were promptly filtered through 0.45-µ hydrophilic polytetrafluoroethylene syringe filters to remove suspended material, acidified to 1 percent v/v with both trace metal-grade nitric and hydrochloric acid, and analyzed by using collision-reaction cell

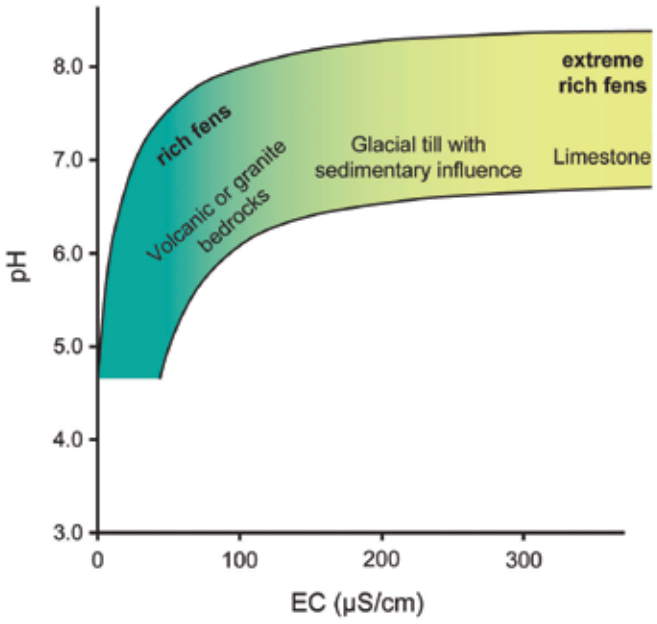

Figure 12—The range of pH and electrical conductivity observed in fens corresponds with poor-to-rich gradients. Poor fens occur in environments where waters have acidic pH and low electrical conductivity, whereas extreme rich fens occur in environments with neutral-to-basic pH and high electrical conductivity. Rare plants of the Beartooth Mountains are often at the extreme ends of the gradient (based on adaptation in Lemly [2007] from Malmer [1986]).

inductively coupled plasma mass spectrometry (Agilent 7500ce) for 3 prevalent cations (Ca^{2}+, Mg^{2}+, and Na+), electrical conductivity, and 29 secondary or trace minerals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, platinum, potassium, selenium, silicon, silver, strontium, thallium, thorium, titanium, uranium, vanadium, and zinc) using U.S. EPA method 200.8 (Creed et al. 1994). Aliquots of un- filtered water samples were also used to determine pH (Standard Methods 4500-H and 4500-B) and electrical conductivity (Standard Methods 2510B; American Public Health Association et al. 2005). Both analyses were carried out by using a Radiometer TIM870 Titration Manager with a pH2001-8 Red Rod combination pH electrode, calibrated at pH 4 and pH 10 and checked at pH 7 with a CDC566T four-pole conductivity cell calibrated with 0.01M KCL (1,406 µS/cm) corrected to 25 °C (77 °F).

The resulting pH values from the 11 Beartooth fens ranged from 5.1 to 7.6 and the pH values of surface water ranged from 5.7 to 8.4 (table 2) (Heidel 2009). Most pH values measured in the field and in the laboratory were the same, and all were within 0.2. The Ca^{2}+ concentrations ranged from 0.8 to 85.0 mg/L in peat (table 2) (Heidel 2009). Of the secondary and trace minerals tested, 8 of 29 were not detectable (antimony, beryllium, cadmium, platinum, selenium, silver, thallium, and thorium).

The pH and Ca^{2}+ results spanned values typically associated with poor to extremely rich fens (fig. 12, after Malmer 1986). The pH readings at the highest elevation sites were consistently acidic. Our pH measurements showed differences within fens as great as 0.9 pH units at a given time (e.g., Clay Butte Fen). They also showed difference over time. Results documented in 2009 differed significantly from 2002 pH values at Lily Lake East Fen (5.3–6.0 in 2009 vs. 4.3–5.0 collected by the same methods at nearly the same locations in 2002) (Heidel 2009; Heidel and Laursen 2003b). At Lily Lake East Fen, Booth and Zygmunt (2005) measured pH in the water expelled from Sphagnum moss growing over a range of microhabitat conditions and reported values ranging from 3.7 to 5.6. Although they used methods that were fairly specific to the study of Sphagnum microhabitats, the range in pH values observed indicates considerable local variation in pH values.

The range of pH values in Beartooth fens may be explained by their association with both base-rich and base-poor bedrock formations, as well as Quaternary deposits from different mixtures of the formations in alluvium, colluvium, and glacial till. Lemly and Cooper (2011) analyzed multiscale factors controlling vegetation and plant species distribution in peatland-sthroughout Yellowstone National Park and determined that the primary gradient driving plant species distribution is site-level water chemistry. They described fens of Yellowstone National Park within the context of the poor-to-rich gradient except for the geothermally influenced peatlands. However, variations in pH values within individual fens, over time, and with elevation were not addressed.

Disturbance

Signs of disturbance were noted when the extensive fen inventory was conducted from 2005 through 2007 (Heidel and Rodemaker 2008). Anthropogenic disturbances include grazing by cattle (*Bos* spp.), horses (*Equus caballus*), or sheep (*Ovis aries*); roads and ditches; and presence of noxious weeds. Natural disturbances included fire, and concentrated wildlife use by native ungulates and beavers (*Castor canadensis*).

Description of 18 Beartooth Fens

This report describes 18 fens that occur across a range of elevation, lithology, geomorphic settings, vegetation types, and water chemistry conditions in the Beartooth Mountains (table 1), including many of the largest fens with rare plant populations. We describe the 3 earlieststudied fens (Swamp Lake Fen, Sawtooth Palsa Fen, Wyoming Creek), and 15 additional fens.

Swamp Lake Fen is the largest of all fens documented in the Beartooth Mountains to date. It is profiled first because it is often a basis for comparing other Beartooth fens. Descriptions of the other 17 fens are presented alphabetically by assigned place names that reflect the nearest local named landmark on U.S. Geological Survey 7.5-minute topographic maps. Each fen is delineated on an aerial photograph.

Swamp Lake Fen

Location: Swamp Lake Fen is located at the base of the Cathedral Cliffs along the Clarks Fork Valley, on the south side of Chief Joseph Highway (State Highway 296) about 3.2 km (2 mi) east of the Crandall Ranger Station and about 54.7 km (34 mi) northwest of Cody. It has public access from County Road 128, which leads to a public boat launch at the K-Bar Z Ranch at the west end (figs. 13 and 14), closed off above the fenbetween east and west ends.

Area: 98.9 ha (244.4 ac)

Elevation: 2,010 m (6,600 ft)

Environment: Swamp Lake Fen is in a large basin with slightly sloping forested fen on the southern perimeter. It is in the Clarks Fork Valley, underlain by Quaternary alluvium and colluvium, and surrounded by collapsed glacial moraine topography derived from the dolomitic Cathedral Cliffs, and Precambrian outcrops (figs. 15 and 16). The central open water is surrounded by marsh and fen vegetation. There are two tributaries, Oliver Gulch and Corral Creek, and one outlet. The single peat thickness measurement was reported at

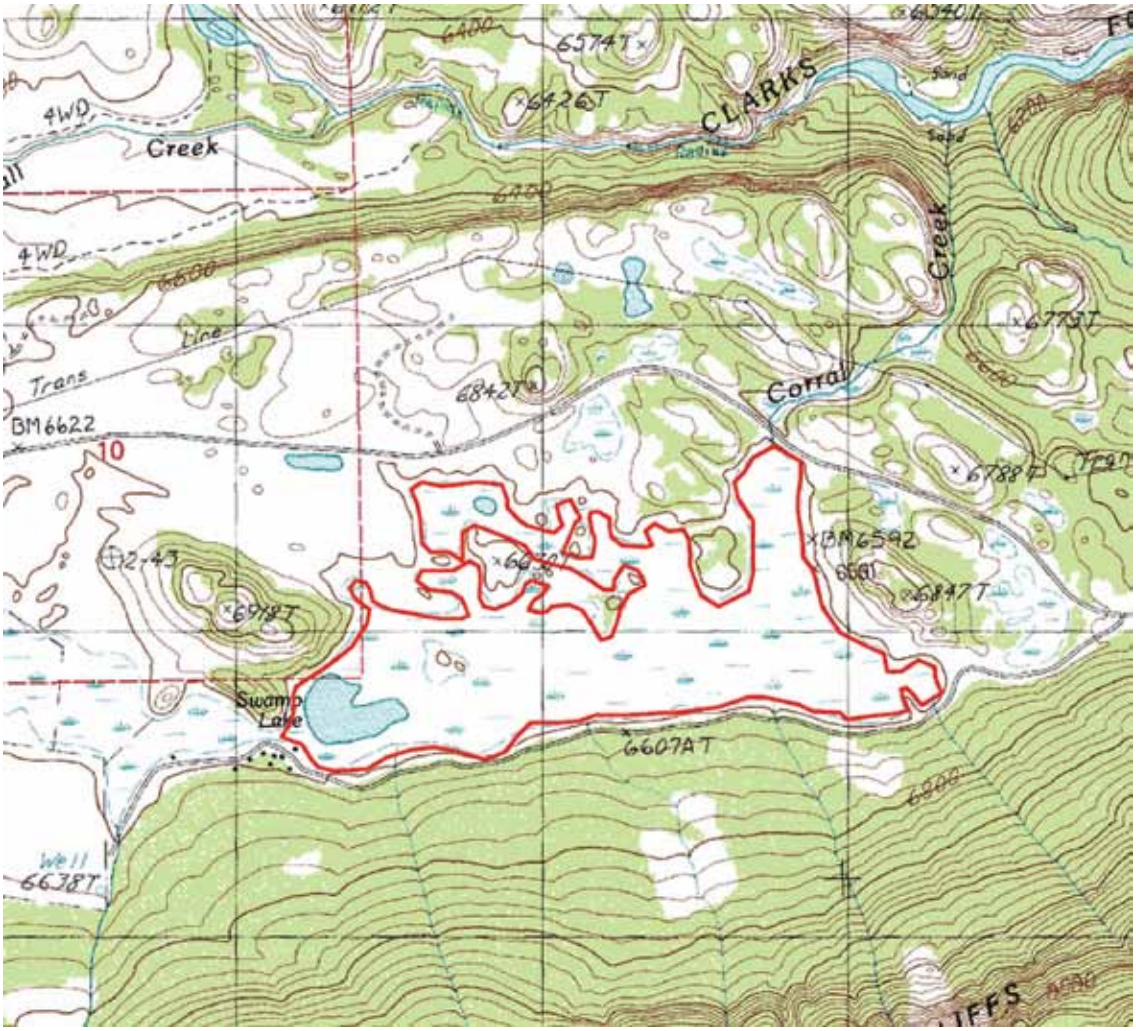

Figure 13—Topographic map of Swamp Lake Fen, outlined in red.

Figure 14—Swamp Lake Fen in a basin setting on a color infrared aerial image.

Figure 15—Overview of Swamp Lake Fen in 1987 (photo: Hollis Marriott, WYNDD).

Figure 16—Overview of Swamp Lake Fen in 2007 (photo: Bonnie Heidel, WYNDD).

6.1 m (20 ft; Stephen Jackson, botany professor/palynologist at University of Wyoming, Botany Department, personal communication, 2007). Peat pH measured in graminoid- and forest-dominated portions of the fen ranged from 7.5 to 7.6 (table 2) (Heidel 2009). Swamp Lake Fen had the highest levels of major cations (Ca^{2}+, Mg^{2}+, and Na+) in peat samples (table 2) (Heidel 2009), consistent with an extreme rich fen.

Vegetation: Eight different plant communities were described at Swamp Lake Fen by Fertig and Jones (1992). The southern fen margin is lined by *Picea* species, including relatively pure *P. glauca* and hybrids with *P. engelmannii* (Haselhorst and Buerkle 2013). Toward the interior of the fen, the trees are stunted (Fertig and Jones 1992). Graminoid-dominated portions of the fen have floating mats of *Carex simulata*, margins with *C. utriculata*, and an area with *Triglochin maritima* and *Eleocharis quinqueflora* (figs. 17 and 18), which are associated with precipitated carbonates, or marl. The marl has mound and swale patterns that are present on the east end. The basin is filled by a mosaic of emergent vegetation in standing water including *Schoenoplectus acutus* and *Typha latifolia*. A band of *Alnus incana* was also noted at the west end.

Figure 17—East end of Swamp Lake Fen in 1992 (photo: George Jones, WYNDD).

Figure 18—East end of Swamp Lake Fen in 2007 (photo: Bonnie Heidel, WYNDD).

Rare Species: The number of Wyoming Plant Species of Concern found at Swamp Lake Fen was originally reported at 28 species (Fertig and Jones 1992). All but one of these species, *Botrychium virginianum*, are directly associated with fen habitat. Since 1992, two more Species of Concern have been found, *Packera indecora* and *Utricularia minor*. Ten of the species were later found to be more common than previously known and were removed from the Species of Concern list (Heidel 2007). The 19 Wyoming Species of Concern found at Swamp Lake Fen are *Amerorchis rotundifolia*, *Arctostaphylos rubra*, *Botrychium virginianum*, *Carex concinna*, *C. diandra*, *C. leptalea*, *C. limosa*, *C. livida*, *C. microglochin*, *Eriophorum viridicarinatum*, *Kobresia simpliciuscula*, *Muhlenbergia glomerata*, *Packera indecora*, *Primula egaliksensis*, *Salix candida*, *S. myrtillifolia*,

Sparganium natans, *Trichophorum pumilum*, and *Utricularia minor*. Earliest botanical collections were made by Evert, Dorn, Hartman, and Lichvar (Evert 1984; Evert et al. 1986) and systematic plant surveys were conducted by Fertig (Fertig and Jones 1992).

Significance: Swamp Lake Fen is the largest fen in the study area (fig. 19), is one of the more alkaline fens in the study area, and supports the highest concentration of Plant Species of Concern among fens in Wyoming. It occurs at the lowest elevation of profiled sites and is one of the few in the study area that includes forested fen vegetation. Two of the rare plant species, *Arctostaphylos rubra* and *Salix myrtillifolia*, occur nowhere else in Wyoming. *Arctostaphylos rubra* is disjunct from boreal latitudes and the population at Swamp Lake Fen is the only known location in the conterminous United States. *Salix myrtillifolia* is disjunct from boreal latitudes in the Rocky Mountains, is not known from Montana, and also occurs in Colorado. Swamp Lake Fen was the first place of discovery for many of the rare plant species of Beartooth fens (table 3) and has a well-documented, diverse flora (Appendix). In 1987, the area was designated as Swamp Lake Special Botanical Area (Evert 1984; Johnston 1987; USDA Forest Service 2015a; Wolf 1986).

Disturbances: State Highway 296 (Chief Joseph Highway) was rebuilt across the Swamp Lake Fen outlet in the 1970s. The 1988 Clover Mist crown fire burned the slopes above Swamp Lake Fen and salvage logging was implemented after the fire. Runoff gullies formed (fig. 20) and erosion debris fans were noted in 1989 and 1992 (Fertig and Jones

Figure 19—Swamp Lake Fen is the largest fen in the study area with a length of more than 3 km, (photo: Bonnie Heidel, WYNDD).

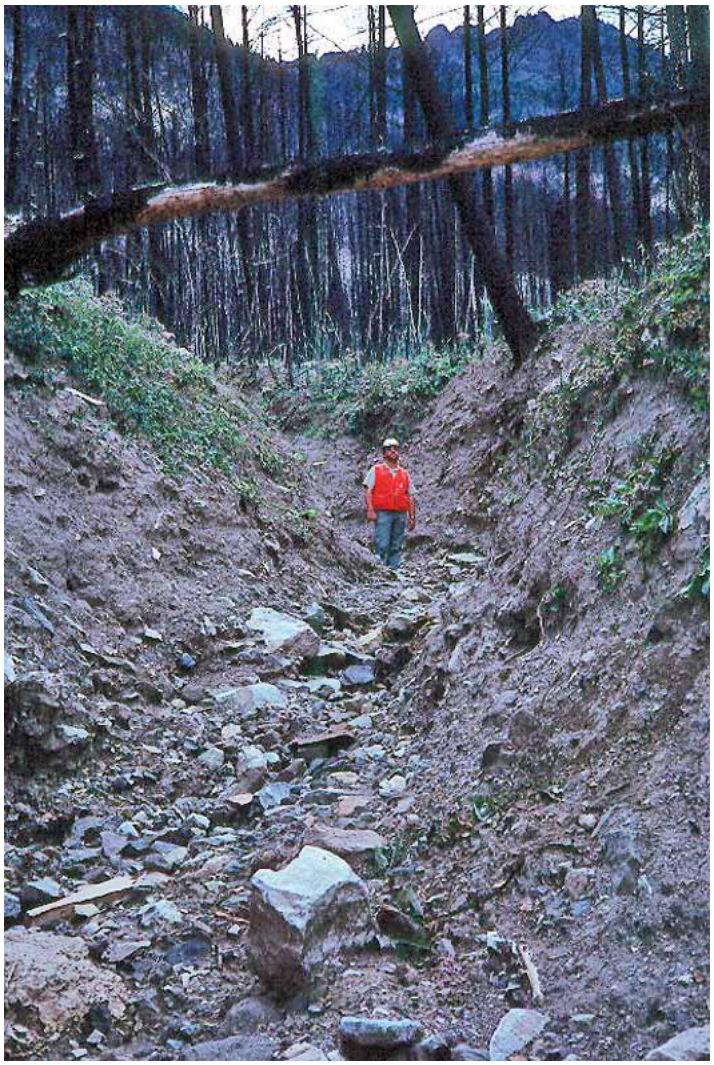

Figure 20—A gully formed directly above Swamp Lake Fen in 1989 after the 1988 fire burned slopes above (photo: George Jones, WYNDD).

1992). Private lands upstream from Swamp Lake Fen have been drained. Water level fluctuations are indicated by high-water marks in hydrologically connected ponds. Current range management does not allow horses to use the wetland. Swamp Lake Fen was also the site of a fox (*Vulpes vulpes*) farm, mink (*Mustella vison*) ranch, and gravel pit in the past (John Mumma, Shoshone National Forest Supervisor, personal communication, ca. 1986). Wildlife, most notably elk (*Cervus elaphus*) and moose (*Alces americanus*), use Swamp Lake Fen and the surrounding area. *Cirsium arvense* is a localized invasive species mainly at the wetland margin (Heidel and Laursen 2003b). *Astragalus cicer*, a nonnative species formerly used in postfire rehabilitation, was widely seeded for stabilization after the 1988 fire and has been observed in fen habitat (Rocky Mountain Herbarium 2016).

Documentation: Evert (1984), Evert et al. (1986), Wolf (1986), Johnston (1987), Fertig and Jones (1992) with updates in, Fertig (1997, 1998), Chadde et al. (1998), Heidel and Laursen (2003b), Heidel and Rodemaker (2008), Heidel (2009), Jones et al. (2011c).

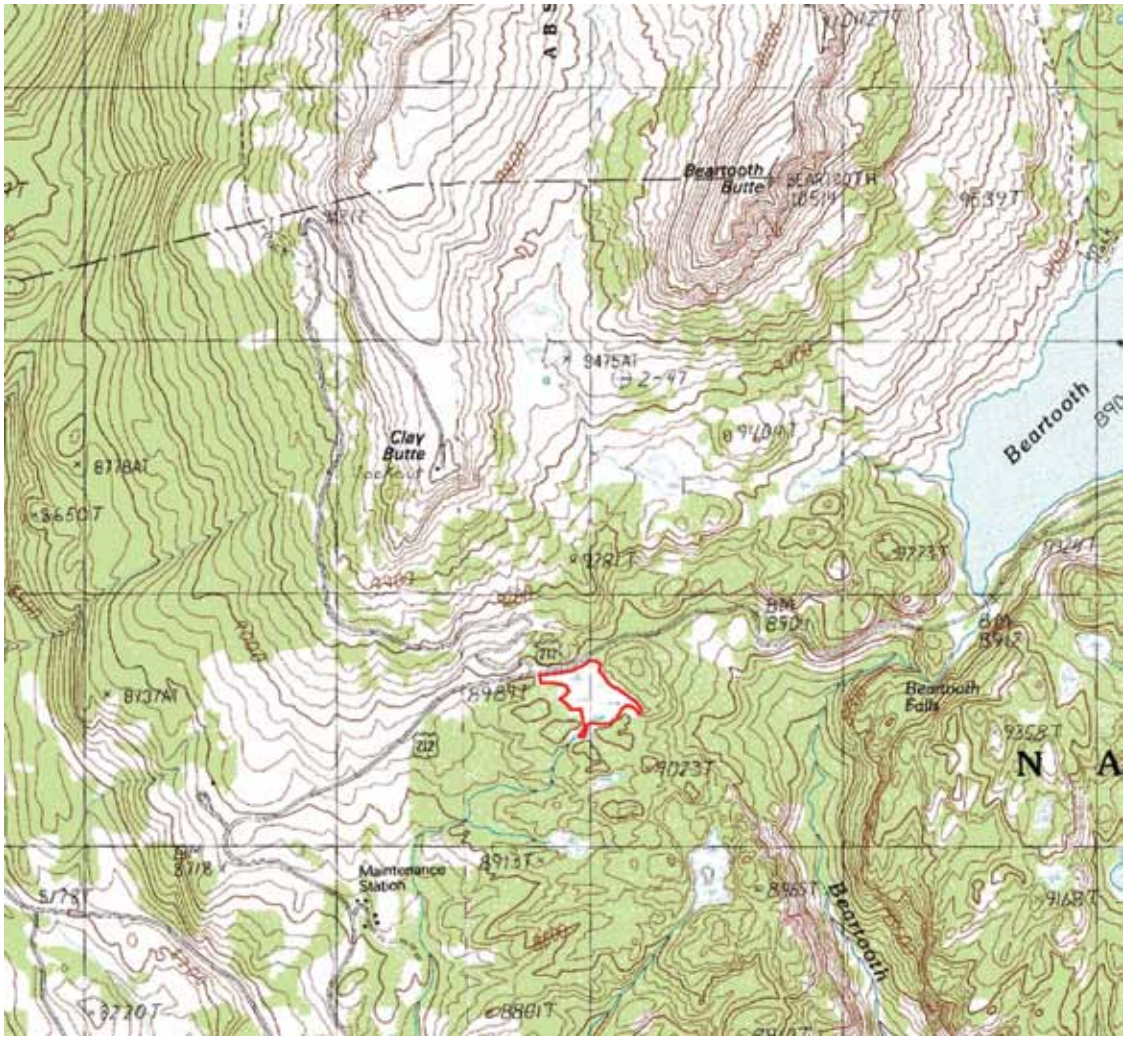

Figure 21—Topographic map of Clay Butte Fen, outlined in red.

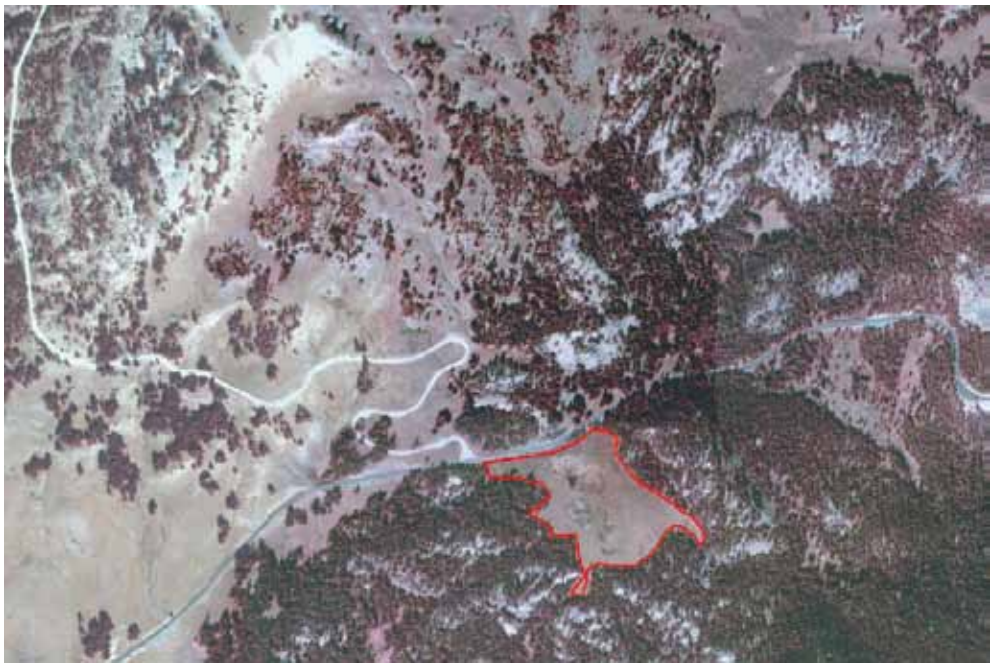

Figure 22—Clay Butte Fen, outlined in red, in a basin setting on a color infrared aerial image.

Figure 23—Clay Butte Fen is one of three fens addressed in this report that lie within the Beartooth Highway corridor (U.S. Highway 212, in foreground) (photo: Bonnie Heidel, WYNDD).

Clay Butte Fen

Location: Clay Butte Fen is located at the base of Clay Butte, on the south side of the Beartooth Highway (U.S. Highway 212), almost across from the sign for the turnoff to the Clay Butte fire tower (figs. 21–23).

Area: 4.7 ha (11.6 ac)

Elevation: 2,740 m (8,980 ft)

Environment: Clay Butte Fen is a basin fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger used to core the peat. The peat pH values ranged from 6.2 in a floating mat to 7.1 in a tall shrub-dominated portion of the fen (table 2) (Heidel 2009). Clay Butte Fen has an outlet in the southwestern corner that drains into an unnamed tributary of Beartooth Creek.

Vegetation: Graminoid vegetation is prevalent and is interrupted by swales and pools that have floating mats in some places (fig. 24). The graminoid-dominated portion of the fen has *Carex aquatilis* and *Carex livida* (Mellmann-Brown 2004). The fen perimeter has low to tall shrub vegetation on three sides. The low shrub communities have *Salix planifolia* with *Carex aquatilis* (Heidel and Laursen 2003b; Mellmann-Brown 2004; Walford et al. 2001); the tall shrub community has *Salix eastwoodiae* and *S. farrie* with *Carex utriculata* (Mellmann-Brown 2004; Walford et al. 2001). The floating mats have *Carex*

Figure 24—Overview of Clay Butte Fen and an array of pools and vegetation zones (photo: Bonnie Heidel, WYNDD).

limosa, with *Eleocharis quinqueflora*. The pools have submerged and floating vegetation. Pools in the southeast corner have *Sparganium angustifolium*, those at the northwest corner have *Nuphar polysepala*, and pools at the south end are filled with bicarbonate-accumulating *Chara* species (Hutchinson 1975). The fen is surrounded by subalpine forest except on the north margin, where it borders the highway.

Rare Species: Six Wyoming Plant Species of Concern are present: *Carex diandra*, *C. leptalea*, *C. limosa*, *C. livida*, *Eriophorum gracile*, and *Utricularia minor*, most of which were first reported by Mellmann-Brown (ERO Resources Corporation 1999b, 2000; Mellmann-Brown 2004).

Significance: Clay Butte Fen is the most alkaline of the fens at higher elevations in the study area, likely due to calcium carbonate-rich parent material. It has many rare species—some near their upper elevation limits—and an array of pools. Some of its rare species were mentioned in an evaluation of Beartooth Butte as a potential Research Natural Area (Jones and Fertig 1999a), but it lies outside of currently proposed boundaries (USDA Forest Service 2015a).

Disturbances: The fen adjoins the Beartooth Highway (U.S. Highway 212). Current plans are to widen the highway by expanding the roadbed away from the fen. The Beartooth Highway is designated a National Scenic Highway and all of the fen falls within the travel corridor management zone (USDA Forest Service 2015a).

Documentation: ERO Resources Corporation (1999b), Walford et al. (2001), Heidel and Laursen (2003b), Mellmann-Brown (2004), Heidel and Rodemaker (2008), Heidel (2009).

Fantan Fen

Location: Fantan Fen is located 1.1 km (0.7 mi) east-southeast of Fantan Lake. It is accessible from the Beartooth Highway (U.S. Highway 212) via Forest Service Road 149 and by four-wheel-drive (4WD) vehicle or on foot (figs. 25 and 26).

Area: 4.8 ha (11.9 ac)

Elevation: 2,910 m (9,560 ft)

Environment: Fantan Fen is a sloping fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). The fen appears to straddle a ridge that is a hydrological divide draining in opposite directions into Paradise Lake and Chain Lakes, both of which drain into Canyon Creek (figs. 25, 26, and 27). A cliff rises abruptly to the north. Peat thickness exceeded the 90-cm length of the auger.

Vegetation: *Carex scopulorum* is prevalent on linear peat mounds with high cover of the moss *Aulacomnium palustre* (figs. 27 and 28). Between the mounds on swale flats is sparse cover of *Carex scopulorum* growing with little or no moss cover. A few swales also have *Eriophorum angustifolium* (fig. 29). Pools are present on the steeper gradient, behind mounds covered by *Carex vesicaria*. The fen is surrounded by dry, open grassland to the east, forest to the west, and a rugged outcrop to the north.

Rare Species: None are known to date.

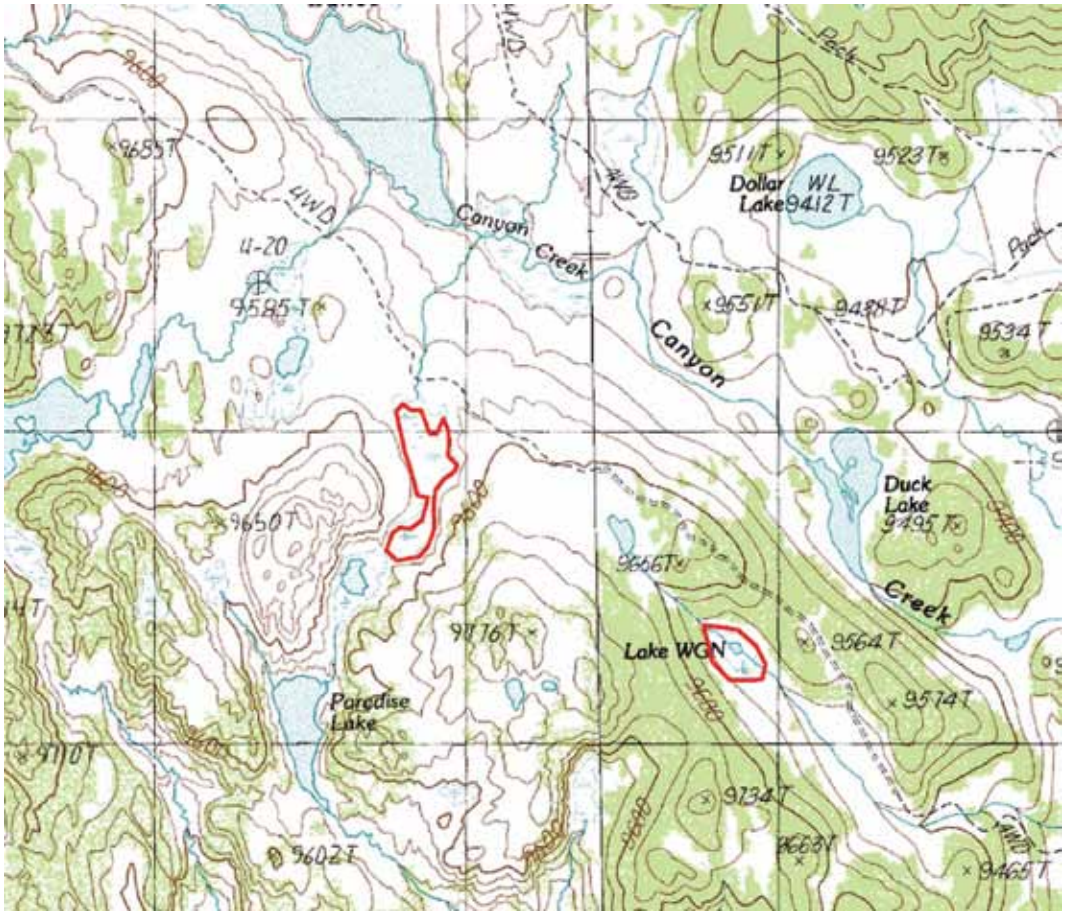

Figure 25—Topographic map of Fantan Fen (at left) and Lake WGN Fen.

Figure 26—Fantan Fen in a sloping setting on a color infrared aerial image.

Figure 27—Peat mound and intervening swale patterns at Fantan Fen are parallel to slopes (photo: Bonnie Heidel, WYNDD).

Figure 28—Fantan Fen peat mound and swale patterns are subtle at eye level (photo: Bonnie Heidel, WYNDD).

Figure 29—Tall cottongrass (*Eriophorum angustifolium*) in Fantan Fen swales (photo: Bonnie Heidel, WYNDD).

Significance: Fantan Fen occupies an unlikely setting for a fen, straddling a ridge.

Disturbances: None have been identified. A 4WD road is located downslope of the fen, but no offroad use has been noted. Hummocks at the southeastern borders may reflect past grazing. The fen lies in lands managed for backcountry nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Heidel and Rodemaker (2008).

Ghost Creek Fen

Location: Ghost Creek Fen is located at the headwaters of Ghost Creek, about 1.1 km (0.7 mi) south of the Beartooth Highway (U.S. Highway 212). It is accessible by Forest Service Road 118 and on foot (figs. 30 and 31).

Area: 2.0 ha (4.9 ac)

Elevation: 2,410 m (7,900 ft)

Environment: Ghost Creek Fen is a basin fen underlain by Precambrian bedrock (Love and Christiansen 1985). It lies south of a steep outcrop and fault line (Love and Christiansen 1985) (fig. 32). In this graminoid-dominated fen, pH in peat was measured at 5.6 in a

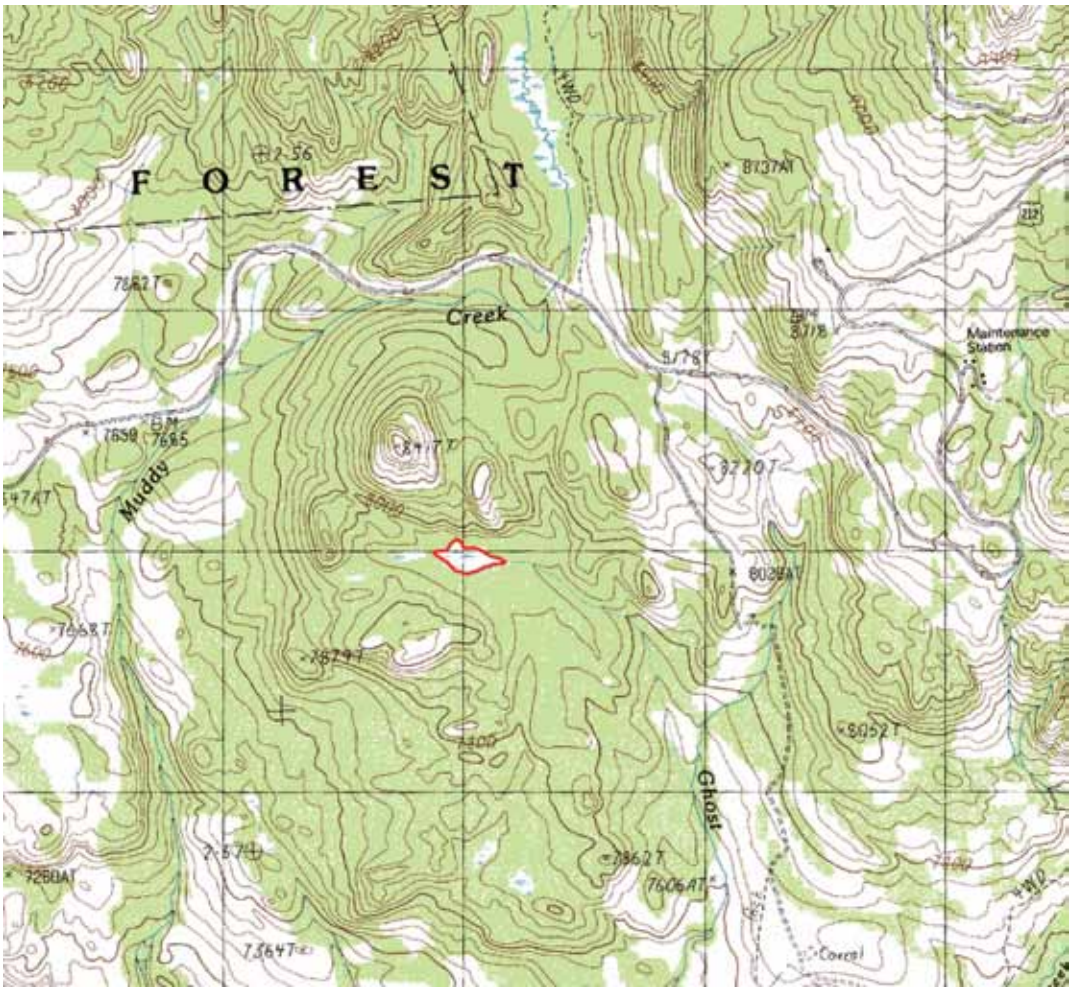

Figure 30—Topographic map of Ghost Creek Fen, outlined in red.

Figure 31—Ghost Creek Fen, outlined in red, in a basin setting on a color infrared aerial image.

Figure 32—Overview of Ghost Creek Fen and central floating mat zones with small pools (photo: Bonnie Heidel, WYNDD).

floating mat and 5.7 in adjoining peat (table 2) (Heidel 2009). Peat thickness exceeded the 90-cm length of the auger. The fen is located at the headwaters of Ghost Creek.

Vegetation: The graminoid vegetation of Ghost Creek Fen has *Carex interior* and *C. buxbaumii*, with *C. lasiocarpa* abundant in standing water. Floating mats adjoining the open-water pools have *Carex limosa* and *Menyanthes trifoliata*, with abundant

Drosera anglica in some places. Along the perimeter are broad bands of *Calamagrostis canadensis*. Vegetation around the outlet is tall shrub grading into forest. The fen is surrounded by dry forests and rugged outcrop knolls to the north and south.

Rare Species: Eight Wyoming Plant Species of Concern are present: *Carex diandra*, *C. leptalea*, *C. limosa*, *C. microglochin*, *Drosera anglica*, *Eriophorum chamissonis*, *E. gracile*, and *Utricularia minor*, most of which were first collected by Mellmann-Brown in 2004 (table 3). In addition, the Columbia spotted frog (*Rana luteiventris*), a U.S. Forest Service sensitive species (USDA Forest Service 2015b) was photographed incidental to plant surveys at Ghost Creek Fen.

Significance: Ghost Creek Fen is significant in having a high concentration of Species of Concern for its size, including combinations of species not reported elsewhere, notably *Drosera anglica* with *Eriophorum chamissonis* and *E. gracile*.

Disturbances: There are no signs of direct disturbance. The floating mat appeared to be lower and less buoyant in drought years. The discrete ring of *Calamagrostis canadensis* around much of the outer perimeter may reflect fluctuations in water level and susceptibility of the margins to shifts from anaerobic to aerobic conditions. Fire scars have been observed on tree stumps bordering Ghost Creek Fen. It lies in lands managed for motorized backcountry recreation and forest restoration (USDA Forest Service 2015a).

Documentation: Heidel and Rodemaker (2008), Heidel (2009), Elliott (2014).

Lake WGN Fen

Location: Lake WGN Fen is located 1.1 km (0.7 mi) northwest of Sawtooth Lake, at the head of a small tributary draining into Sawtooth Lake. It is identified as Lake WGN on topographic maps. It is accessible from the Beartooth Highway (U.S. Highway 212) via Forest Service Road 149 and by 4WD or on foot (figs. 25 and 33).

Figure 33—Lake WGN Fen, outlined in red, in a basin setting on a color infrared aerial image.

Area: 1.9 ha (4.7 ac)

Elevation: 2,890 m (9,480 ft)

Environment: Lake WGN Fen is a basin fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). It is located at the head of a small, open valley that drains into Sawtooth Lake. Spring-fed rivulets enter on three sides (fig. 34). The incised outlet has downcut to underlying mineral layers (fig. 35). Peat thickness exceeded the 90-cm length of the auger.

Vegetation: Lake WGN Fen is dominated by graminoids, and has a central floating mat of *Carex limosa*. Both mounds and swales are dominated by *Carex scopulorum*, with the moss *Aulacomnium palustre* also occurring on the mounds. Subalpine forests of *Pinus albicaulis* and *Picea engelmannii* are on the adjacent hillslopes. A corridor of wet and dry meadows extends down the valley between the fen and Sawtooth Lake.

Rare Species: Two Wyoming Plant Species of Concern, *Carex limosa* and *Eriophorum chamissonis*, occur at Lake WGN Fen (Heidel and Rodemaker 2008).

Significance: Lake WGN Fen has a surface that resembles a saucer, flat in the center and sloping at the margins. Conspicuous springs are present at the perimeters (fig. 34), whereas most of the Beartooth fens visited do not have pronounced springs discharging at the surface.

Disturbances: No signs of disturbance were noted. However, this fen has an incised stream channel outlet, where the floating mat vegetation is 0.5 m (20 in) higher than

Figure 34—Lake WGN Fen has pronounced springs at the perimeter. This view is from the upper end looking inward (photo: Bonnie Heidel, WYNDD).

Figure 35—The outlet of Lake WGN Fen is eroded to the mineral layer, though there are saturated floating mats directly above the incised channel. This view is from the outlet at the lower end looking inward (photo: Bonnie Heidel, WYNDD).

the adjoining stream channel (fig. 35). It lies in lands managed for back-country nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Heidel and Rodemaker (2008), Heidel (2009).

Lily Lake East Fen

Location: Lily Lake East Fen is about 1.1 km (0.7 mi) east-northeast of Lily Lake. It was referred to as "Lily Lake Fen" by Heidel and Laursen (2003b) before the recognition of a separate fen that directly adjoins Lily Lake, and was called "East Lilypad Peatland" by Booth and Zygmunt (2005). It is accessible from the Lily Lake Campground on foot (figs. 36 and 37).

Area: 5.1 ha (12.6 ac)

Elevation: 2,524 m (8,280 ft)

Environment: Lily Lake East Fen is a basin fen that lies along a fault line and is underlain by Precambrian bedrock (Love and Christiansen 1985). Outcrop hills rise to the north. The peat pH readings documented in 2008 were 5.3 (*Sphagnum* mat) to 6.0 (graminoid-dominated portion of the fen; table 2) (Heidel 2009). Measurements taken at the same locations in 2002 were 4.3 (*Sphagnum* mat) and 5.0 (graminoid vegetation) (Heidel and Laursen 2003b). In addition, pH measurements of the water retained by *Sphagnum* peat in

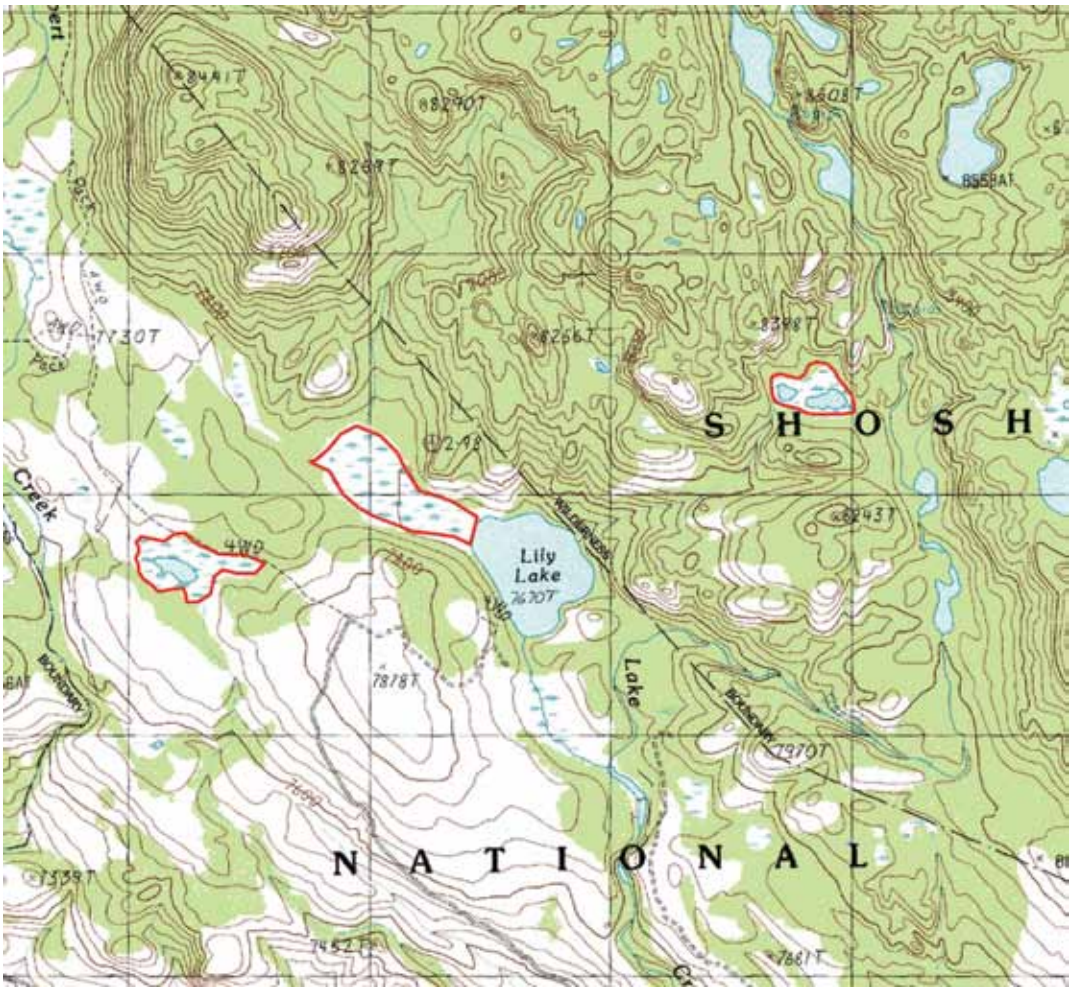

Figure 36—Topographic map of Lily Lake Fen (north end of Lily Lake), Lily Lake East Fen, and Mud Lake Fen, outlined in red.

the full range of local microhabitats were collected in 2002 (Booth and Zygmunt 2005), reported at 3.7 to 5.6.

Vegetation: Graminoid vegetation surrounds two open-water pools that are bordered by well-developed floating *Sphagnum* mats (fig. 38). *Carex lasiocarpa* encircles pools of standing water, *Carex limosa* and *Menyanthes trifoliata* are mixed into the floating *Sphagnum* mats, and *Carex vesicaria* is on adjoining peat. There is also an aquatic community of floating and submerged vegetation. The wet forest border is narrow and has *Ledum glandulosum*. The surrounding uplands are forested, but the rugged topography supports mainly dry, open woodland, with rock outcrops to the north.

Rare Species: Seven Wyoming Plant Species of Concern are present: *Carex diandra*, *C. leptalea*, *C. limosa*, *Drosera anglica*, *Eriophorum gracile*, *Sphagnum angustifolium*, and *Utricularia minor*. Two other species previously reported, *Carex buxbaumii* and *Epilobium palustre* var. *palustre*, are no longer regarded as rare in the State. The rare species were first documented in 1996 by Fertig and Mellmann-Brown (Fertig 1997, 1998; Jones and Fertig 1999b; Jones et al. 2011a). The fen was also visited by two other research teams (Booth and Zygmunt 2005; Heidel and Laursen 2003b), both of whom collected *Sphagnum angustifolium*. *Utricularia minor* was recently added (Heidel 3341

Figure 37—Lily Lake East Fen in a basin setting on a color infrared aerial image.

Figure 38—Overview of Lily Lake East Fen with two large pools and floating mats (photo: Scott Laursen, WYNDD).

RM). The collector and the collection number in the Rocky Mountain Herbarium (RM) are provided; see table 3 for more information.

Significance: Lily Lake East Fen has a fairly acidic pH (table 2) and more pH readings over time than other study area fens. It has well-developed floating mats with *Sphagnum angustifolium* present. It is one of only two fens in the study area where testate amoebae microfossils were used as hydrological proxies for environmental and paleoenvironmental conditions (Booth and Zygmunt 2005).

Disturbances: The fen is located within the Absaroka-Beartooth Wilderness Area, and no signs of disturbance were observed in the vicinity. It is also within the proposed Lake Creek Research Natural Area.

Documentation: Fertig (1997, 1998), Jones and Fertig (1999b) with updates in Jones et al. (2011a), Heidel and Laursen (2003b), Booth and Zygmunt (2005), Heidel and Rodemaker (2008), Heidel (2009).

Lily Lake Fen

Location: Lily Lake Fen is located on the northwest end of Lily Lake. It is accessible from the Lily Lake Campground by foot (figs. 36 and 39).

Area: 14.2 ha (35.1 ac)

Elevation: 2,340 m (7,680 ft)

Environment: Lily Lake Fen is in a basin, but it has a slight slope down to Lily Lake. It is underlain by Quaternary glacial deposits, and bordered on one side by Precambrian bedrock along a fault line (Love and Christiansen 1985). Lily Lake Fen is a very subtly sloping fen with a series of large pools in the middle (fig. 40). Peat thickness exceeded the 90-cm length of the auger. The pH in peat was measured at 6.3 in both shrub-dominated and graminoid-dominated portions of the fen in July 2008 (table 2) (Heidel 2009).

Vegetation: Three vegetation zones are present from the lower to upper ends of the fen: tall shrubs immediately above the lake, a graminoid-dominated zone mixed with pools, and a low shrub-dominated zone at the upper end. Common species include *Salix wolfii*, *S. boothii*, *Carex scopulorum*, *C. limosa*, *Menyanthes trifoliata*, and *C. utriculata*.

Figure 39—Lily Lake Fen, outlined in red, in a sloping setting with a series of large pools on a color infrared aerial image.

Figure 40—Overview of Lily Lake Fen directly above Lily Lake (left of view) showing portions of the fen dominated by shrubs. (photo: Bonnie Heidel, WYNDD).

Rare Species: Six Wyoming Plant Species of Concern are present: *Carex diandra*, *C. leptalea*, *C. limosa*, *Eriophorum gracile*, *Packera indecora*, and *Salix candida* (Heidel and Rodemaker 2008). In addition, *Potamogeton amplifolius* and *Potamogeton praelongus* are submerged in Lily Lake at the shoreline adjoining fen boundaries (Fertig 1998).

Significance: Lily Lake Fen has areas of well-developed shrub habitat. It has among the largest known populations of *Carex diandra* and *Packera indecora*. There is one report in the literature of a pollen profile at Lily Lake in the Beartooth Mountains (Whitlock and Bartlein 1993) though the exact location is not given. This fen is much more accessible and apparent from the lake than Lily Lake East Fen, so it seems to be the more likely of sampling sites in the area. But the profile has not been published apart from generalizations made about palynology in the Yellowstone region.

Disturbances: Lily Lake Fen is located close to the Lily Lake Campground, but does not receive recreational use apart from people fishing at the lakeshore. It is within an active grazing allotment, but no cattle trails or other signs were evident. The fen could be affected if lake levels were manipulated. It lies in lands managed for vegetation and landscape patterns influenced not only by natural disturbances but also by prescribed fire, timber harvest, and other silviculture treatments (USDA Forest Service 2015a).

Documentation: Heidel and Rodemaker (2008), Heidel (2009).

Little Bear Lake Fen

Location: Little Bear Lake Fen is located at the southeastern end of Little Bear Lake. It is crossed by the Beartooth Highway (U.S. Highway 212); more than 90 percent of the fen is located on the south side of the highway (figs. 41 and 42).

Area: 4.1 ha (10.3 ac)

Elevation: 2,910 m (9,560 ft)

Environment: Little Bear Lake Fen is a sloping fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger. Peat pH values were measured at 5.5 in a mound and 5.7 in a directly adjoining swale (table 2) (Heidel 2009).

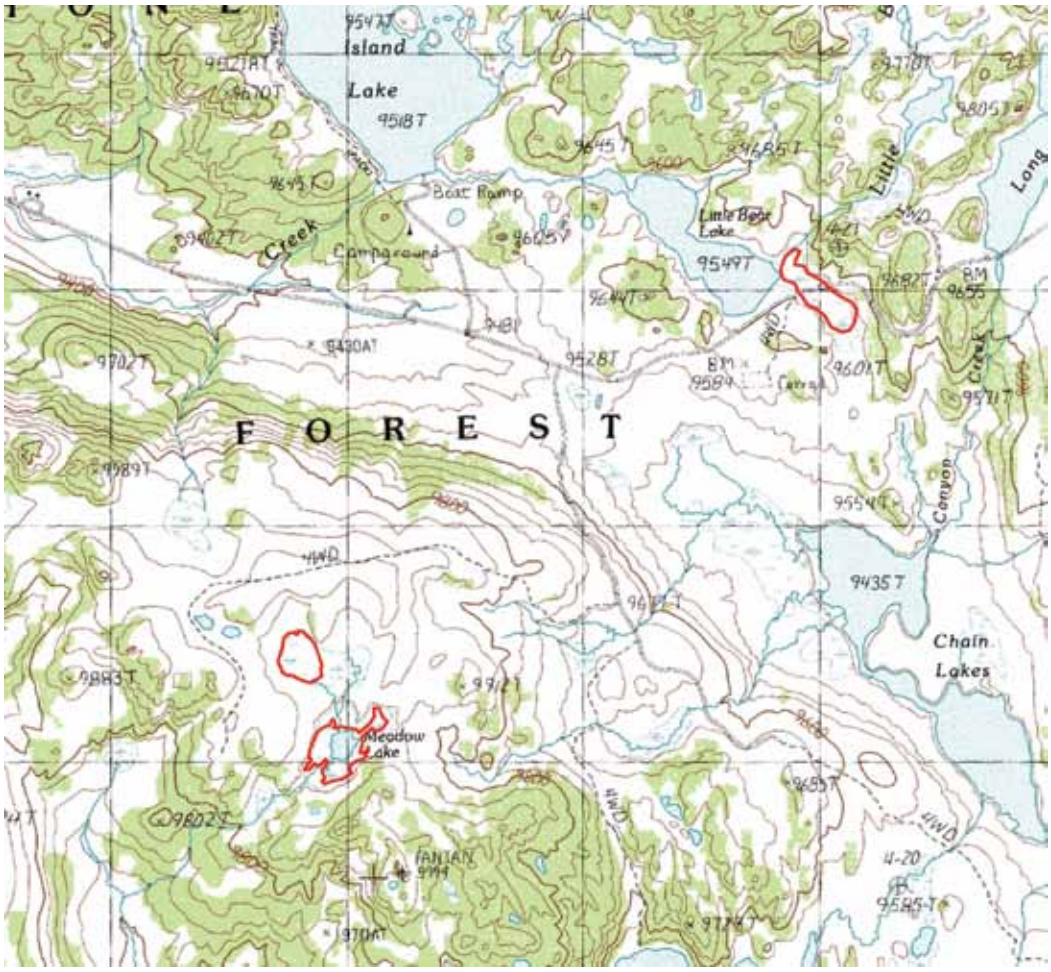

Figure 41—Topographic map of Little Bear Lake Fen, Meadow Lake Fen and Meadow Lake North Fen (at left), outlined in red.

Figure 42—Little Bear Lake Fen in a sloping setting on a color infrared aerial image.

Figure 43—Peat mounds and intervening swales add a distinct microtopography to Little Bear Lake Fen (photo: Bonnie Heidel, WYNDD).

Vegetation: Little Bear Lake Fen has a series of elongate mounds and swales over much of the area (fig. 43). *Carex scopulorum* is on peat mounds with high cover of the moss *Aulacomnium palustre*. Between the mounds are swales with much sparser cover of *Carex scopulorum* and sometimes with *Carex saxatilis* but with little or no moss cover. Central areas have *Carex limosa* mixed with *C. scopulorum* and *C. saxatilis*. There is a large swale filled with *Carex utriculata* at the western edge of the fen. A low shrubland of *Salix glauca* associated with *Caltha leptosepala* is located at the southern end on mineral soils. Little Bear Fen is surrounded by dry grassland, with open woodland and outcrops scattered on more rugged terrain to the east.

Rare Species: Plant surveys were first conducted by Mellmann-Brown for ERO Resources Corporation (1999b, 2000). Two Wyoming Plant Species of Concern are present: *Carex limosa* and *Sparganium natans* (ERO Resources Corporation 1999b, 2000; Mellmann-Brown 2004).

Significance: Little Bear Lake Fen is among the larger fens at this elevation and has very elongate peat mounds and swales.

Disturbances: This is the only major fen in the Beartooth Mountains of Wyoming that is traversed by a highway (U.S. Highway 212). Current plans for widening of the highway call for replacing a portion of the roadbed with a bridge to restore the natural drainage pattern. Water levels were monitored with 6 surface water gauges and 13 wells in Federal Highway Administration-sponsored baseline studies. Eventually, the raised portion of the road through the wetland will be replaced by a bridge, a change that may restore the natural drainage pattern but may also lower current water levels in the southern section of the fen (Mellmann-Brown 2004). The Beartooth Highway is designated as a National Scenic Highway, and all of the fen is located within the travel corridor management zone (USDA Forest Service 2015a).

Documentation: ERO Resources Corporation (1999b, 2000), Mellmann-Brown (2004), Heidel and Rodemaker (2008), Heidel (2009).

Little Moose Lake Fen

Location: Little Moose Lake Fen is on the south end of Little Moose Lake. It is accessible via Forest Service Road 130 and by 4WD or on foot (figs. 44 and 45).

Area: 3.1 ha (7.7 ac)

Elevation: 2,440 m (8,000 ft)

Environment: This basin fen is in a lacustrine setting underlain by Precambrian bedrock (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger. The pH measurements in peat were made in 2002, reporting 4.9 in a *Sphagnum* mat and 5.5 in the graminoid-dominated portion of the fen (Heidel and Laursen 2003b). In addition, pH measurements of the water retained by *Sphagnum* peat in the full range of local microhabitats were collected in 2002 (Booth and Zygmunt 2005), reported at 4.3 to 6.1.

Vegetation: The fen vegetation of Little Moose Lake is predominantly graminoid, with well-developed floating mats at the lakeshore and shrubs bordering the uplands. The fen has *Carex aquatilis* and *Carex utriculata* (Heidel and Laursen 2003b; Walford et al. 2001). The floating mat has *Carex limosa* and *Menyanthes trifoliata*, and perimeter areas have *Salix planifolia* and *Carex aquatilis*. The fen is surrounded by conifer forest; dry parkland to the east; rugged, sparsely wooded knolls to the west, and Little Moose Lake to the north.

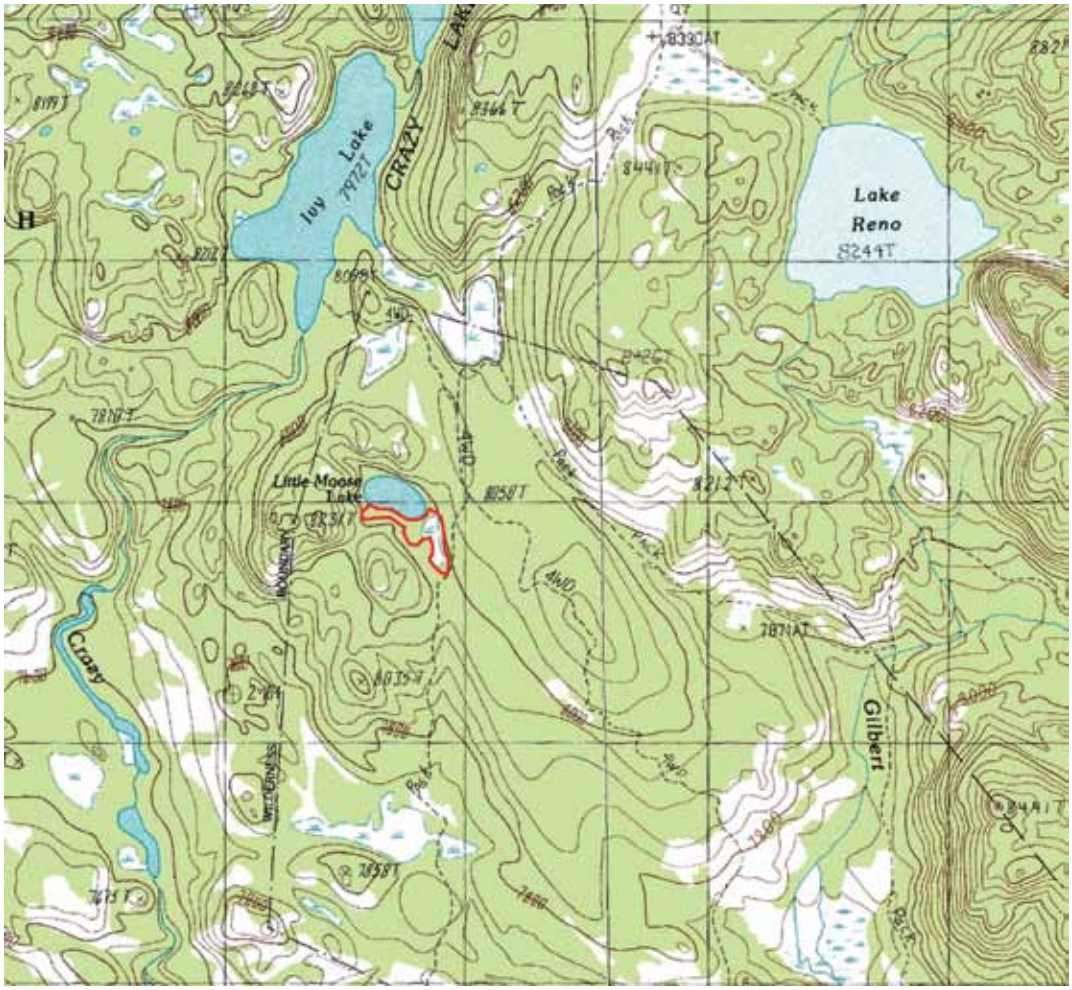

Figure 44—Topographic map of Little Moose Lake Fen, outlined in red.

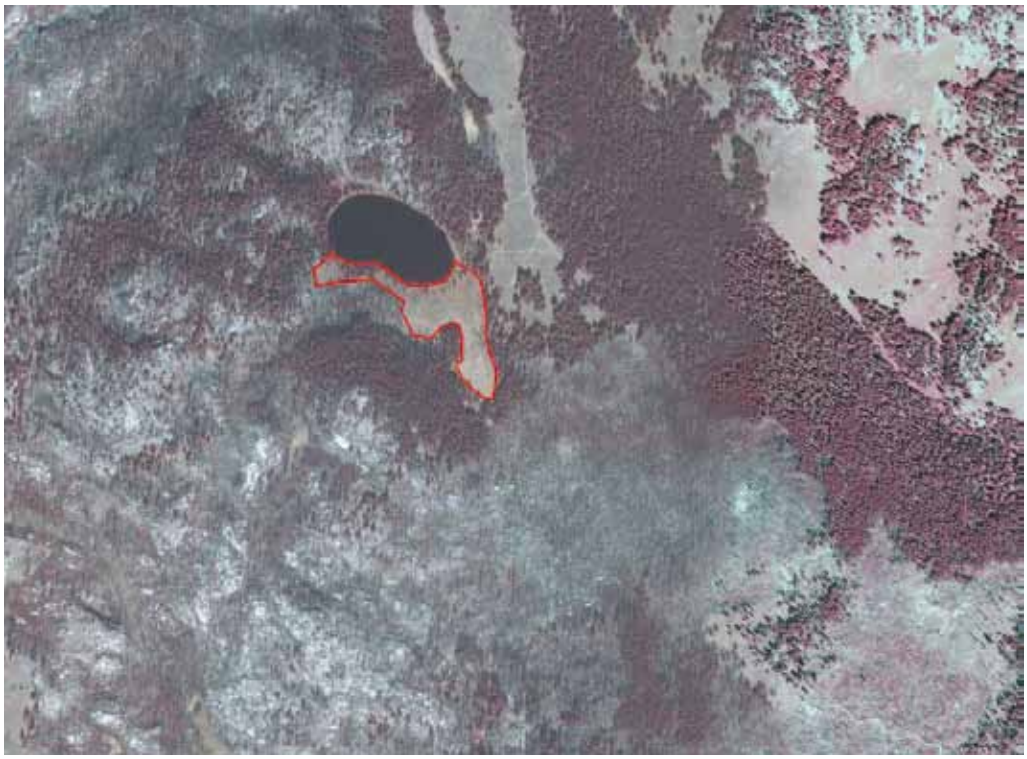

Figure 45—Little Moose Lake Fen in a basin setting on a color infrared aerial image.

Rare Species: Six Wyoming Plant Species of Concern are present: *Carex diandra*, *C. leptalea*, *C. limosa*, *Drosera anglica*, *Eriophorum gracile*, and *Potamogeton praelongus*. They were first documented by Fertig and Mellmann-Brown in 1996 (Fertig 1997, 1998). These species are concentrated on the floating mat along the lakeshore. This fen was surveyed again for rare plants (Heidel and Laursen 2003b), when *Sphagnum angustifolium* was first documented. In 2009 water chemistry was sampled and *Utricularia minor*, an additional rare plant, was found.

Significance: Little Moose Fen is significant in having a well-developed floating mat in one of the few lakeshore settings. It is one of two fens in the study area where testate amoebae microfossils were used as proxies for environmental and paleoenvironmental conditions (Booth and Zygmunt 2005). The fen also harbors a high concentration of Species of Concern.

Disturbances: The fen was part of a cattle allotment when it was first surveyed (Mills and Fertig 1996b), and livestock trampling was noted in the original surveys. It lies in lands managed for motorized backcountry recreation and forest restoration (USDA Forest Service 2015a).

Documentation: Fertig (1997, 1998), Heidel and Laursen (2003b), Booth and Zygmunt (2005), Heidel and Rodemaker (2008).

Littlerock Creek Fen

Location: Littlerock Creek Fen is located about 0.8 km (0.5 mi) east of Christmas Lake at the head of an unnamed tributary to Littlerock Creek. It is located about 1 km (0.6 mi) southeast of the Beartooth Highway (U.S. Highway 212) and lies directly southwest of Forest Service Trail 623 (figs. 46 and 47).

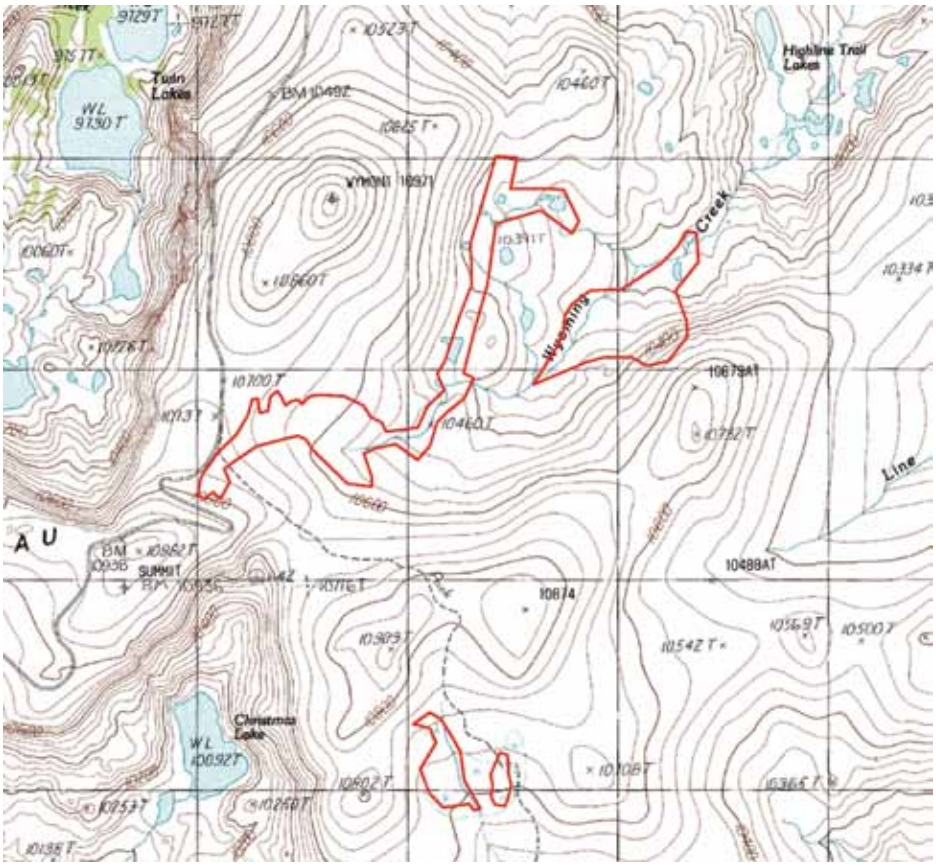

Figure 46—Topographic map of Littlerock Creek Fen (two red outlines to the south) and Wyoming Creek Complex, outlined in red.

Area: 8.4 ha (20.8 ac)

Elevation: 3,220–3,270 m (10,560–10,740 ft)

Environment: Littlerock Creek Fen is a south-facing sloping fen, underlain by Precambrian bedrock mapped as "oldest gneiss complex" (Love and Christiansen 1985). Peat thickness ranged from 19 to 35 cm (7 to 14 in); this fen is one of two alpine fens where the 40-cm-thickness threshold was waived. The fen is dissected by a stream and has diffuse borders grading into seeps and wet and dry meadow. The pH of the peat was measured at 5.9 (table 2) (Heidel 2009). In the middle of the fen are several large isolated mounds of turf more than 50 cm (20 in) in height. Polygons formed by frost action as described by Johnson and Billings (1962) occur along the upper margin. The fen boundary is subtle on the south and east sides (fig. 48).The fen is bordered by rocky ridges on the north and west sides with a semipermanent snowbank to the west (fig. 49).

Vegetation: The vegetation has *Carex scopulorum* and *Salix planifolia* (Walford et al. 2001). Sparsely vegetated late snowmelt slopes and flats border the west side. The fen is surrounded by dry, alpine meadow and gravelly ridges.

Rare Species: Two Wyoming Plant Species of Concern are present, *Carex nelsonii* and *Eriophorum callitrix* (Fertig 1998). Two other Species of Concern, *Carex misandra* and *Pedicularis oederi*, occur mainly along fen margins (Heidel and Rodemaker 2008). In addition, *Phippsia algida* and *Koenigia islandica* are present in snowmelt-fed seeps

Figure 47—Littlerock Creek Fen in a sloping setting on a color infrared aerial image.

Figure 48—Alpine fen boundaries are subtle, and peat depth is shallow, deceiving an early motorist at Littlerock Creek Fen (photo: Bonnie Heidel, WYNDD).

bordering the west side of the fen. The latter is an annual throughout its range and the former is regarded as an annual in Colorado (Weber and Wittmann 2012), but a perennial in Wyoming (Dorn 2001). *Poa alpina* ssp. *vivipara* was also documented in Littlerock Creek Fen (Heidel 3023, 3055). Although this species is common in Wyoming, the viviparous subspecies was not previously known from the conterminous United States (Soreng 2007).

Significance: Littlerock Creek Fen is large for an alpine fen and harbors four Wyoming Plant Species of Concern in or adjoining the fen, and two more rare species along the fen margins.

Disturbances: Forest Service Trail 623 passes around the northeastern part of the fen, and was historically used by motorized vehicles, as evidenced by the automobile that remains

Figure 49—Rocky ridges, late-melting snow banks, and seeps encircle Littlerock Creek Fen (photo: Bonnie Heidel, WYNDD).

(fig. 48). This trail is no longer maintained or signed along the highway. The area was part of a sheep allotment up until about 2000. It lies in lands managed for backcountry nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Fertig (1997, 1998), Heidel and Rodemaker (2008), Heidel (2009).

Meadow Lake Fen

Location: Meadow Lake Fen almost encircles Meadow Lake. It is located 1.3 km (0.8 mi) northwest of Fantan Lake. It is accessible from the Beartooth Highway (U.S. Highway 212) via Forest Service Road 149 and by 4WD or on foot (figs. 41 and 50). Area: 4.7 ha (11.1 ac)

Elevation: 2,990 m (9,800 ft)

Environment: Meadow Lake Fen is a sloping fen in a basin setting underlain by Quaternary glacial deposits (Love and Christiansen 1985). It has mounds and shallow, narrowly spaced swales on the perimeter slopes of a small lake (fig. 51). Peat thickness exceeded the 90-cm length of the auger. The peat pH was measured at 5.1 in a mound and at 5.6 in an adjoining swale (table 2) (Heidel 2009). The peat sample also had the highest titanium levels (0.020 mg/L) among any of the study fens (Heidel 2009). The fen has an inlet fed by Meadow Lake North Fen, and the outlet drains into an unnamed tributary of Table Creek.

Vegetation: *Carex scopulorum* is on peat mounds with high cover of the moss *Aulacomnium palustre*. Swales have sparse cover of *Carex scopulorum* and little or no moss cover (fig. 52).

Rare Species: *Carex limosa* was found by Yelena Kosovich-Anderson and Heidel in 2008.

Figure 50—Meadow Lake Fen in a sloping setting above the basin on a color infrared aerial image.

Figure 51—Patterned slope fen habitat lies above the small lake of Meadow Lake Fen (photo: Bonnie Heidel, WYNDD).

Significance: Meadow Lake Fen represents a fen formed at basin slopes. It is at the upper elevation limit of *Carex limosa*.

Disturbances: No potential threats have been identified. It lies in lands managed for back-country nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Heidel and Rodemaker (2008), Heidel (2009).

Figure 52—Peat mounds and intervening swales rise above Meadow Lake in linear patterns (photo: Bonnie Heidel, WYNDD).

Meadow Lake North Fen

Location: Meadow Lake North Fen is located less than 1 km (0.6 mi) northwest of Meadow Lake and about 2.2 km (1.5 mi) south of Island Lake. It is accessible from the Beartooth Highway (U.S. Highway 212) via Forest Service Road 149 and by 4WD or on foot (figs. 41, 53 and 54).

Area: 2.9 ha (7.2 ac)

Elevation: 3,000 m (9,840 ft)

Environment: Meadow Lake North Fen is in a basin setting underlain by Quaternary glacial deposits (Love and Christiansen 1985). The fen has no stream inflow, and its outlet drains to the south and east into Meadow Lake. Peat thickness exceeded the 90-cm length of the auger. The peat pH was measured at 5.6 (table 2) (Heidel 2009) and had the highest iron levels (0.596 mg/L) among samples (Heidel 2009).

Vegetation: Meadow Lake North Fen has a broad, elongated portion of graminoid vegetation and contains open-water swale pools with *Carex scopulorum* on peat mounds in combination with high cover of the moss *Aulacomnium palustre*. Large, elongate pools are bordered by *Carex aquatilis*, which also fills the shallowest swales. These pools variously have submerged vegetation of *Sparganium angustifolium*, *Callitriche* species, or the moss *Drepanocladus aduncus*. The area is surrounded by dry, open ridges.

Figure 53—Meadow Lake North Fen in a basin setting, with elongate pools, on a color infrared aerial image.

Figure 54—Meadow Lake North Fen is encircled by glacial erratics (photo: Bonnie Heidel, WYNDD).

Rare Species: There are none known.

Significance: Meadow Lake North Fen fills a basin where the basin itself tilts. It has the largest pool-filled swales of the Beartooth fens. It lies immediately upstream from Meadow Lake Fen, where peat accumulation is restricted to the basin perimeter.

Disturbances: Distinct hummocks are along part of the southwestern margin and may be a remnant of past grazing. There are no current signs of use by pack animals or other recreational uses. The fen lies in lands managed for backcountry nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Walford et al. (2001), Heidel and Rodemaker (2008), Heidel (2009).

Mud Lake Fen

Location: Mud Lake Fen is about 1.0 km (0.6 mi) west of Lily Lake. It is identified as Mud Lake on the 1988 Absaroka-Beartooth Wilderness map. It is accessible by Forest Service Road 130 with 4WD and lies directly to the south (figs. 36 and 55).

Area: 8.1 ha (20.0 ac)

Elevation: 2,350 m (7,700 ft)

Environment: Mud Lake Fen is a basin fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger. The pH in peat was measured at 6.9 (table 2) (Heidel 2009). Peat samples had the highest silicon concentrations (20 mg/L) among the 11 fens sampled (Heidel 2009).

Vegetation: This graminoid-dominated fen has *Carex utriculata*, and contains an inner floating mat and central open water. Vegetation plot data were collected in a broad band of *Salix candida* that includes part of the floating mat and was characterized as low shrubland (fig. 5) (Walford et al. 2001). In addition, the northeastern corner has *Salix wolfii*, *Betula glandulosa*, and *Carex aquatilis*. The open water has extensive areas of floating *Chara* species with *Carex lasiocarpa* and *C. vesicaria* around the margins. The surrounding gently sloping uplands are mainly open forest with some montane grassland.

Rare Species: Six Wyoming Plant Species of Concern are present: *Carex diandra*, *C. limosa*, *Eriophorum gracile*, *Packera indecora*, *Salix candida*, and *Sparganium natans*, most of which were first documented by Mills (Fertig 1997, 1998; Mills and Fertig 1996b).

Significance: Mud Lake Fen has the only shrubland where *Salix candida* is common.

Figure 55—Mud Lake Fen in a basin setting on a color infrared aerial image.

Disturbances: Mud Lake was grazed by livestock when first surveyed (Mills and Fertig 1996b). Its north margin is very close to Forest Service Road 130A, which gets heavy use by 4WD and offroad vehicles. Shrubs and tree saplings were selectively cut from the northeastern lobe for wildlife habitat management purposes in the 1990s. An unauthorized camping site and pulloff were noted near its northwestern margin incidental to extensive surveys (Heidel, personal observation, 2006). It lies in lands managed for vegetation and landscape patterns influenced not only by natural disturbances, but also by prescribed fire, timber harvest, and other silviculture treatments (USDA Forest Service 2015a).

Documentation: Mills and Fertig (1996b), Fertig (1997, 1998), Heidel and Rodemaker (2008), Heidel (2009).

Poke Lake Fen

Location: Poke Lake Fen is located immediately west of Granite Lake, about 1.6 km (1 mi) south of the Wyoming-Montana State line. It is accessible from the Beartooth Highway (U.S. Highway 212) via the Clay Butte Road trailhead or the Muddy Creek trailhead and then on foot (figs. 56 and 57).

Area: 4.7 ha (11.6 ac)

Elevation: 2,630 m (8,640 ft)

Environment: Poke Lake Fen is a basin fen with a very irregular outline, underlain by Precambrian bedrock (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger. It has no stream inlet but has an outlet that drains into Granite Lake.

Figure 56—Topographic map of Poke Lake Fen, outlined in red.

Figure 57—Poke Lake Fen in a basin setting on a color infrared aerial image.

Vegetation: Graminoid fen vegetation at Poke Lake Fen encircles elongated ponds, with small areas dominated by short shrubs (fig. 58). There are two large ponds, including a humic blackwater pond at the north end. The dominant graminoid is *Carex buxbaumii*. Floating mats are dominated by *Carex limosa* with *Menyanthes trifoliata*, and *C. vesicaria* occurs in patches. Areas dominated by short shrubs have *Salix planifolia* and *Carex scopulorum*. The fen is bordered by subalpine forest.

Figure 58—Poke Lake Fen has extensive floating mats of mud sedge (*Carex limosa*) (photo: Bonnie Heidel, WYNDD).

Rare Species: Four Wyoming Plant Species of Concern are present: *Carex limosa*, *Drosera anglica*, *Juncus filiformis*, and *Utricularia minor*. Plant surveys were first conducted in 2006 by Heidel (Heidel and Rodemaker 2008).

Significance: Poke Lake Fen has an extensive floating mat, contains one of only two known populations of *Juncus filiformis* in the Beartooth Mountains, and is a high elevation occurrence for *Drosera anglica* in Wyoming.

Disturbances: The fen lies within the Absaroka-Beartooth Wilderness Area and no signs of disturbance were observed.

Documentation: Heidel and Rodemaker (2008).

Rock Creek Fen

Location: Rock Creek Fen is located about 2.4 km (1.5 mi) north-northeast of Fox Creek Campground near the Montana State line. It is accessible via the Gallatin National Forest trailhead leading to Vernon Lake and on foot (figs. 59 and 60).

Area: 1.0 ha (2.5 ac)

Elevation: 2,340 m (7,680 ft)

Environment: Rock Creek Fen is a basin fen underlain by Quaternary glacial deposits (Love and Christiansen 1985). It lies south of a steep outcrop and a mapped fault line (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger.

Vegetation: Rock Creek has a large, central floating mat dominated by *Carex limosa* and *Menyanthes trifoliata* and low moss cover. The floating mat is surrounded by a ring of *Carex limosa* and high moss cover. The outermost ring of graminoid-dominated vegetation has *Carex utriculata*, *C. buxbaumii*, and *Calamagrostis canadensis*. The area is bordered by a rocky knoll on the north and by dry, open forests.

Rare Species: Four Wyoming Plant Species of Concern are present: *Carex limosa*, *Drosera anglica*, *Eriophorum chamissonis*, and *E. gracile*. The first plant survey was conducted at Rock Creek Fen in 2007 by Heidel, E. Elliott, and B. Elliott (table 3).

Significance: Rock Creek Fen is unusual in its abundance of floating mat vegetation and its very symmetrical, concentric vegetation zonation.

Disturbances: The fen lies within the Absaroka–Beartooth Wilderness Area, and no signs of disturbance were observed.

Documentation: Heidel and Rodemaker (2008).

Sawtooth Palsa Fen

Location: Sawtooth Palsa Fen is in the middle of a larger 35.6 ha (88.0 ac) area of wetland due south of Sawtooth Mountain. It is labeled as “Peat Beds” on topographic maps and on the Shoshone NF Map. It is accessible from the Beartooth Highway (U.S. Highway 212) and the Morrison Trail (Forest Service Road 120) by 4WD or on foot (figs. 61 and 62).

Area: About 8 ha (19.8 ac) of the wetland is palsa.

Elevation: 2,950 m (9,680 ft)

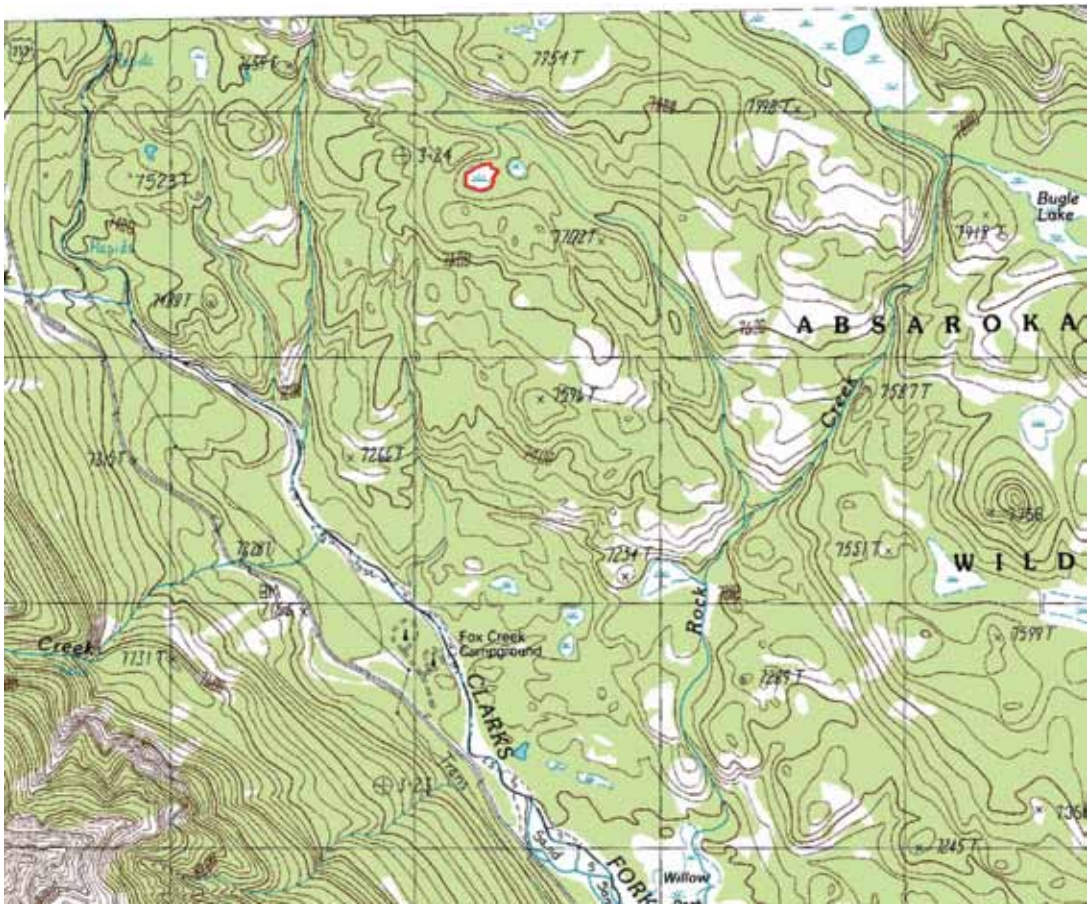

Figure 59—Topographic map of Rock Creek Fen, outlined in red.

Figure 60—Rock Creek Fen in a basin setting on a color infrared aerial image.

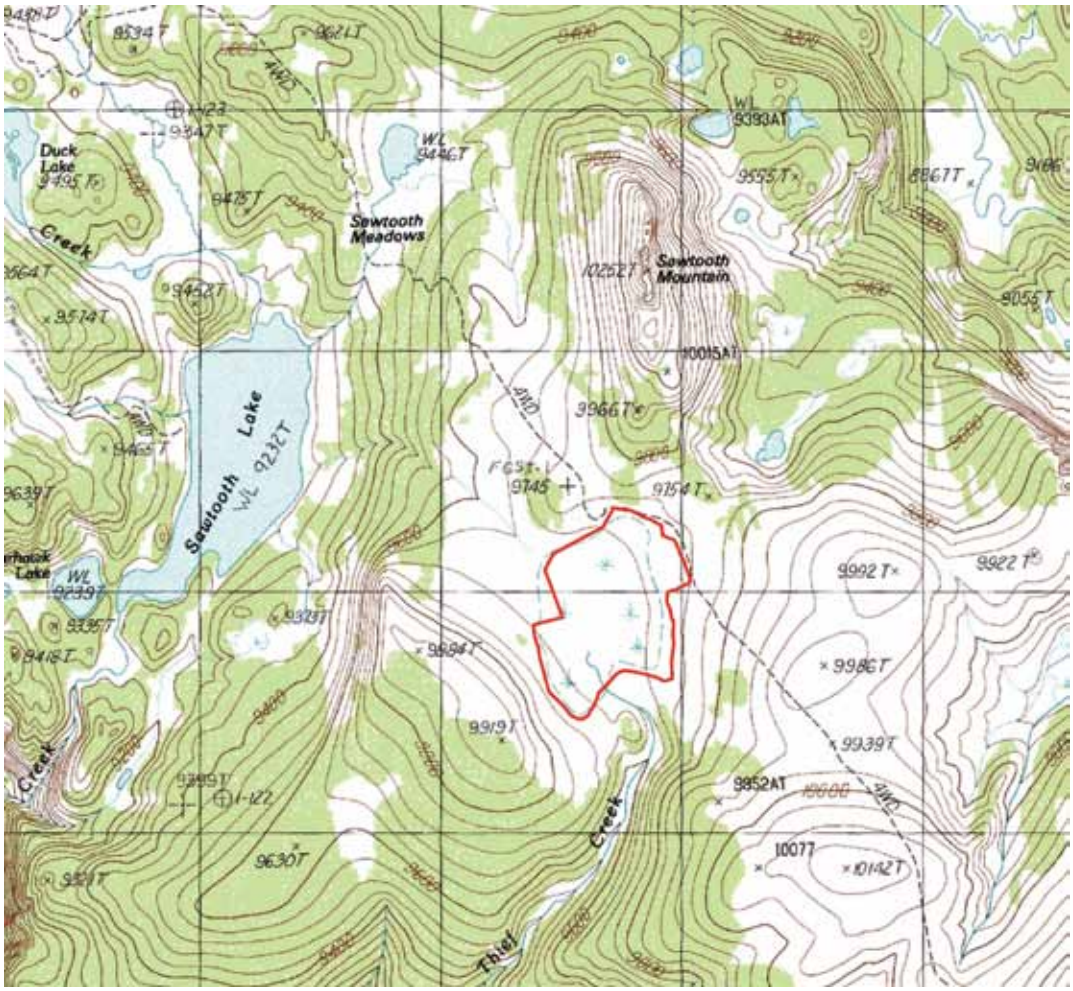

Figure 61—Topographic map of Sawtooth Palsa Fen, outlined in red.

Environment: Sawtooth Palsa Fen lies in a broad subalpine basin underlain by "oldest gneiss complex," a deeply weathered Precambrian rock surrounded by Quaternary glacial deposits with a raised peat deposit and permafrost (Pierce 1961). It differs from all other known basin fens in that it has a dome shape, referred to as "palsa" (fig. 63). Collins (1984) reported it as about 1,000 km (620 mi) south of the southernmost palsa fens in Canada. A palsa is typically an ombrogenous bog, formed at below-freezing average annual temperatures under moist conditions (Vitt 2006). It is the only known palsa in the 48 contiguous States, though isolated patches of permafrost occur throughout the Rocky Mountains as far south as Arizona (Pierce 1979; discussed in Collins 1984). It is in a basin but straddles a hydrological divide and drains south into Thief Creek and northwest into Canyon Creek. The depth to permafrost was reported as 38 to 46 cm (15 to 18 in) by Pierce (1961). Measurements made in 2007 found depth to permafrost at 46 to 56 cm (18 to 22 in) (USDA NRCS 2008). The original locations of depth measurement are unknown so trend cannot be interpreted, but permafrost thaw rates have accelerated over the last decades in peatlands of higher latitudes (Rydin and Jeglum 2013). Questions remain as to whether the permafrost is melting. Polygonal frost-wedge patterns are present (figs. 64 and 65). The palsa is raised 1 to 2 m (3 to 6 ft) above the surrounding wetland; it is almost devoid of vegetation and pocked by thaw depression pools (figs. 66 and 67). Th palsa does not have any saturated peat conditions at the surface, so all pH measurements

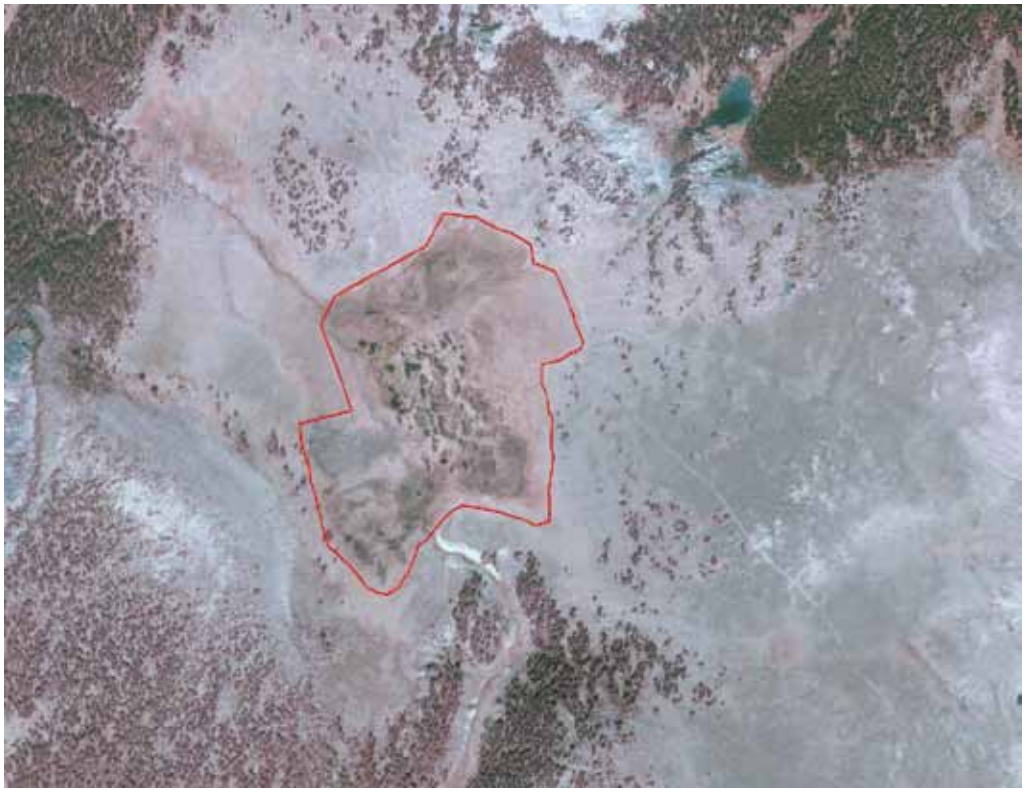

Figure 62—Sawtooth Palsa Fen in a basin setting on a color infrared aerial image.

Figure 63—Sawtooth Palsa Fen has a central raised palsa dome in the middle of a graminoid-dominated fen (photo: Sabine Mellmann-Brown).

were taken from open water of pools and outlets. Peat thickness was estimated at 3.1 to 4.6 m (10 to 15 ft) (Pierce 1961).

Vegetation: The peat substrate of the palsa is desiccated and oxidized, and the sparse vegetation is concentrated in polygon cracks. *Festuca brachyphylla* and *Deschampsia cespitosa* are the most common plants on top of the palsa. Encircling fen vegetation has dense cover of *Carex scopulorum* and *C. canescens*, and patchy cover of *C. aquatilis* and

C. illota. Some of the slightly raised areas have *Salix planifolia*. The moss cover is high in most surrounding communities, and bryophytes are locally dominant on some mounds to the exclusion of vascular plants. More details are provided by Chadde et al. (1998), Collins et al. (1984), Mellmann-Brown (2004), and Pierce (1961). Sawtooth Palsa Fen is surrounded by dry meadow, with open subalpine woodland of *Picea engelmannii* and *Pinus albicaulis* on parts of the surrounding basin rim.

Rare Species: *Agrostis mertensii* is the only Wyoming Plant Species of Concern known from the palsa; Heidel collected this species in 2007.

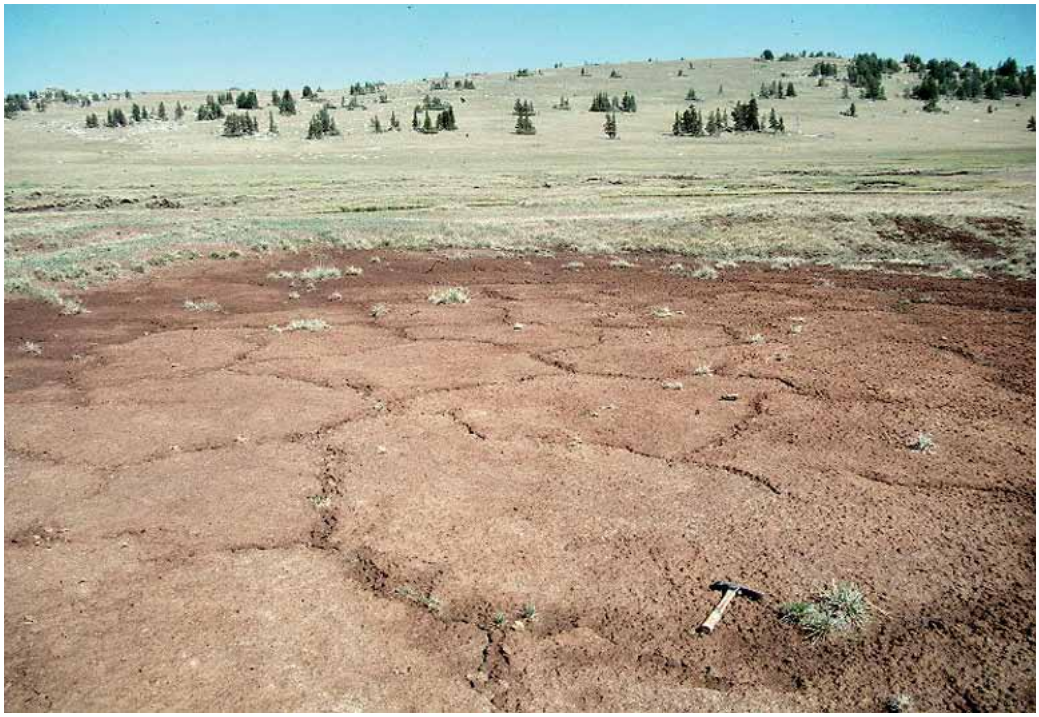

Figure 64—Frost-heave polygon patterns at Sawtooth Palsa Fen in 1987 (photo: Hollis Marriott, WYNDD).

Figure 65—Frost-heave polygon patterns at Sawtooth Palsa Fen in 2003 (photo: Sabine Mellmann-Brown).

Figure 66—Thaw-depression pool at Sawtooth Palsa Fen in 1987 (photo: Hollis Marriott, WYNDD).

Figure 67—Thaw-depression pool at Sawtooth Palsa Fen in 2003 (photo: Sabine Mellmann-Brown).

Significance: Sawtooth Palsa Fen is the only known palsa, or remnant of true bog formed under past climates, in the lower 48 States (Collins et al. 1984). It is included in the current Shoshone NF Management Plan as the proposed Sawtooth Peatbeds Geological Area (USDA Forest Service 2015a). It may represent the southernmost example of the Gelisol soil order. It is the only fen in the study area where peat has been dated by radiocarbon techniques (Pierce 1961, 1980). The top of the peat layer was dated at 7,570 +/- 400 YBP, and the bottom of the peat layer was dated at 8,600 +/- 300 YBP.

Disturbances: There was one accidental entry of cattle in the Sawtooth Palsa Fen in 2004. As a result, the polygonal pattern on the palsa was obscured by trampling as photographed by Mellmann-Brown, who revisited the site 1 year after sampling vegetation (Mellmann-Brown 2004).

Documentation: Pierce (1961, 1965), Pierce and Nelson (1971), Collins et al. (1984), Mellmann-Brown (2004), Heidel and Rodemaker (2008), Jones et al. (2011b).

Trail Fen

Location: Trail Fen is located about 0.8 km (0.5 mi) south of Hauser Lake, immediately to the east of the Beartooth Loop National Recreational Trail (Forest Service Trail 613 as shown on the topographic map). It is accessible from the Beartooth Highway (U.S. Highway 212) via the Morrison Trail (Forest Service Road 120) and Forest Service Trail 613 (figs. 68 and 69).

Area: 3.1 ha (7.7 ac)

Elevation: 2,940 m (9,640 ft)

Environment: Trail Fen is a basin fen with a slight slope in the northwest, underlain by "oldest gneiss complex" (Love and Christiansen 1985). Peat thickness exceeded the 90-cm length of the auger. The fen has well-developed pools (fig. 70) and a perennial inlet that feeds a stream running its entire length (fig. 71).

Vegetation: The graminoid vegetation includes mound and swale zones at the northwest end. *Carex scopulorum* is on the peat mounds with high cover of the moss *Aulacomnium palustre*. A much sparser cover of *Carex scopulorum* and *C. limosa* occurs in the swales. The rest of the basin has *C. scopulorum* and *Deschampsia cespitosa*. The fen is surrounded by rolling terrain with dry meadow, open woodland, and low outcrops.

Rare Species: One Wyoming Plant Species of Concern is present, *Carex limosa* (Heidel and Rodemaker 2008).

Significance: Trail Fen is the highest elevation where *Carex limosa* has been found in the study area. It is one of the few fens with a major inlet and stream channel along its length.

Disturbances: Distinct mounds along part of the margins may be a remnant of past grazing history. There are no signs of use by pack animals or other recreational uses even though a major trail runs along the fen.

Documentation: Heidel and Rodemaker (2008).

Wyoming Creek

Location: Wyoming Creek is located about 3.2 km (2 mi) south of the Montana State line, immediately east of the Beartooth Highway (U.S. Highway 212). At the head of Wyoming Creek are a highway pulloff and unsigned trailhead for Forest Service Trail 623. Wyoming Creek is less than 1.6 km (1 mi) north of Littlerock Creek Fen, separated by a high ridge. The Wyoming Creek site is a wetland complex rather than an area of discrete, continuous fen habitat. In this report, it is referred to as Wyoming Creek without "Fen" in the name because fen habitat is widely scattered rather than in a continuous block (figs. 46 and 72).

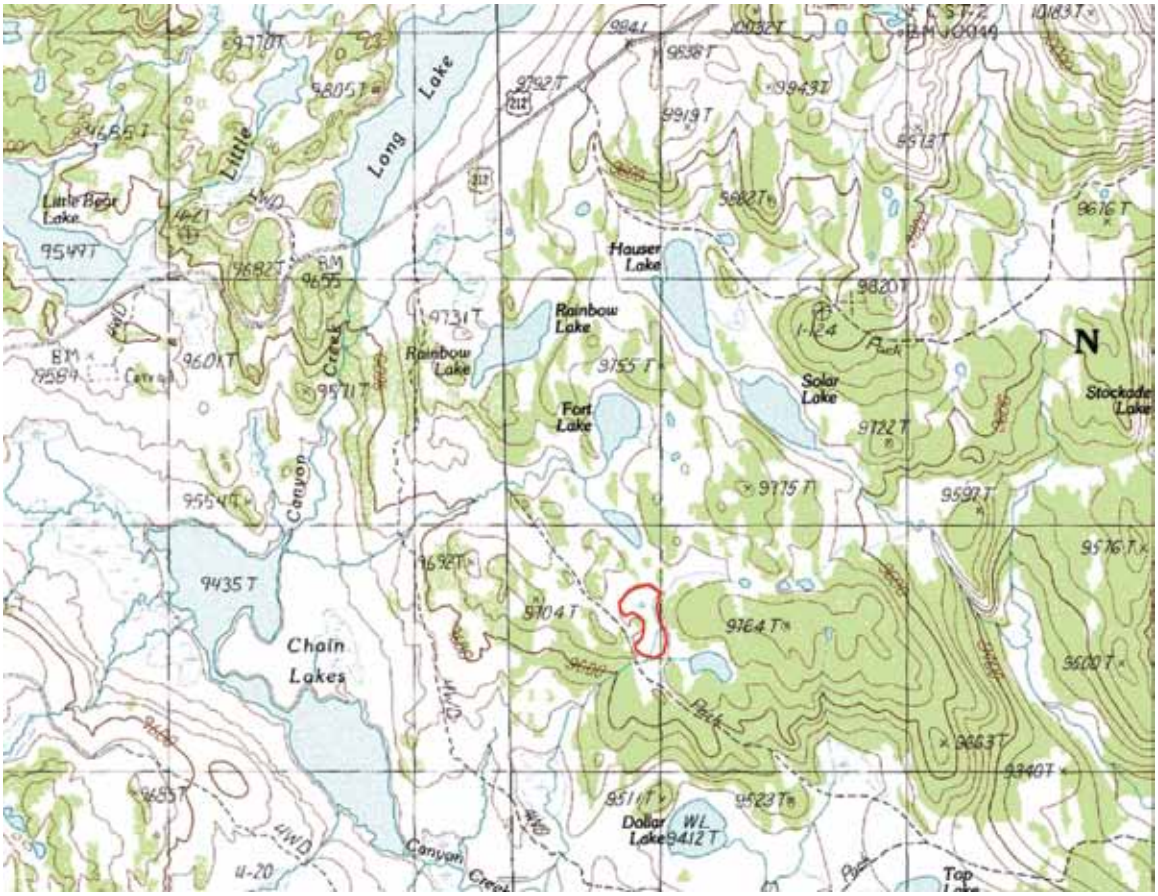

Figure 68—Topographic map of Trail Fen, outlined in red.

Figure 69—Trail Fen in a basin setting on a color infrared aerial image.

Figure 70—Trail Fen pools (photo: Bonnie Heidel, WYNDD).

Figure 71—A discrete stream—uncommon within the fens studied—runs the length of Trail Fen (photo: Bonnie Heidel, WYNDD).

Area: Undetermined peatland area, forming mosaic Elevation: 3,020–3,250 m (9,920–10,680 ft)

Environment: The Wyoming Creek wetland complex is underlain by the "oldest gneiss complex" in the Beartooth Mountains (Love and Christiansen 1985). The headwaters of Wyoming Creek have a series of terraces, likely the product of mass movement downslope by saturated soil composed of a series of at least six stairsteps (after Johnson and Billings

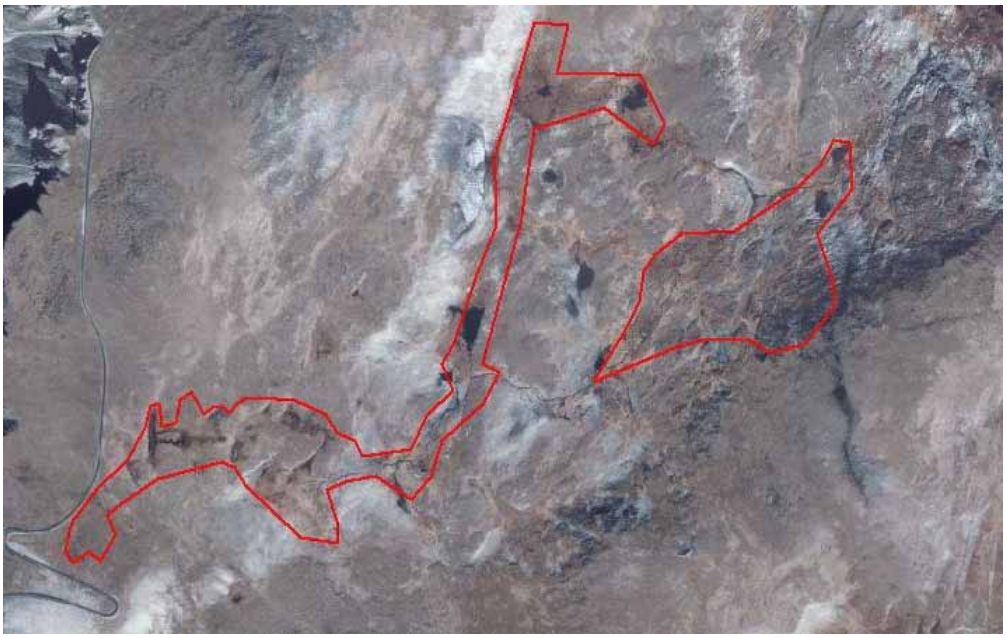

Figure 72—Wyoming Creek in a sloping setting on a color infrared aerial image.

1962). Peat thickness of 46 cm (18 in) was reported by Johnson and Billings (1962) with permafrost depths (i.e., freezing part of the peat profile) as shallow as 30 cm (12 in) early in the summer. The setting was described by Johnson and Billings (1962) as lying below snow accumulation areas in shallow basins which receive abundant meltwater during the summer. Measurements of pH 5.2 were documented for peat mounds at the head of a tributary of Wyoming Creek (table 2) (Heidel 2009). It was one of two fens with detectable mercury in peat (Heidel 2009).

Vegetation: Johnson and Billings (1962) described the presence of "alpine bog" vegetation at the head of Wyoming Creek and observed *Carex scopulorum*, often with *Eriophorum callitrix* and *Salix planifolia*. They referred to patterns of vegetation and topography in fen habitat that reflect intensive freezing and thawing of saturated soils, including small, unvegetated frost boils, and terracing (Johnson and Billings 1962). A latticework pattern was noted in recent visits (fig. 73). The mosaic also has early- and late-melting snowbanks with well-developed vegetation along seeps and wet meadows associated with churning or heaving of soil around wetland patches and snowbanks. The surrounding uplands include dry rocky meadows, dominated by *Geum rossii*.

Rare Species: Nine wetland Plant Species of Concern occur in the Wyoming Creek, though only six occur in fen portions of the wetland complex. Johnson (1962) and Johnson and Billings (1962) documented two species as restricted to peat-lined terraces: *Carex misandra* and *Eriophorum callitrix*. They also documented two species from the fen as new to the Beartooth Mountains, *Carex nelsonii* (from fens) and *Juncus albescens* (later re-determined as *J. triglumis* var. *triglumis*), in addition to *Pedicularis oederi*, which occurs in a variety of habitats. Three other species were collected from adjoining terraces with frost action (*Kobresia sibirica*, *Koenigia islandica*, *Phippsia algida*). In addition, *Sphagnum angustifolium* was collected in 2008 by Ron Hartman. Most of the aforementioned vascular species were also found in the highway corridor in tributaries of Wyoming Creek by Mellmann-Brown, and in the Twin Lakes area, part of the Line Creek Research Natural Area

Figure 73—Wyoming Creek fen habitat forms a mosaic of peat mounds and swales (photo: Bonnie Heidel, WYNDD).

to the west, by Fertig and Mike Bynum (ERO Resources Corporation 1999b, 2000; Fertig 1997, 1998; Fertig and Bynum 1994).

Significance: Wyoming Creek exemplifies the polygonal patterns that result from intensive freezing and thawing of saturated ground at alpine elevations (Johnson and Billings 1962). Locations of the vegetation sampling and depth to permafrost measurements by Johnson and Billings (1962) were not permanently marked, but their early research findings provide valuable background information.

Disturbances: Current plans for widening U.S. Highway 212 require avoidance of wetlands. The Wyoming Creek wetland complex is potentially affected by road management practices and runoff. The pullout at the head of Wyoming Creek attracts motorists. Grazing was identified as a potential threat to some Wyoming Creek Species of Concern (Fertig 1998), but the sheep grazing lease was terminated about 2000 (Decision Notice of January 9, 2003). Use of pack animals now requires a permit and is thus limited. This wetland complex lies in lands managed for back-country nonmotorized recreation in the summer and motorized winter recreation (USDA Forest Service 2015a).

Documentation: Johnson (1962), Johnson and Billings (1962), Fertig (1997, 1998), ERO Resources Corporation (1999b), Heidel (2009).

Rare Plants of Beartooth Fens

There are 32 Wyoming vascular Plant Species of Concern that occur in fens of the Beartooth Mountains (table 4) as determined from the overlap between the species listed in Chadde et al. (1998) and those on the Wyoming Plant Species of Concern list (Heidel 2007). Of the 32 species, 12 are designated as sensitive in U.S. Forest Service Region 2 (Rocky Mountain Region), hereafter called Region 2 (USDA Forest Service 2013) (table 4). In addition, there is one Wyoming nonvascular plant Species of Concern that occurs in fens of the Beartooth Mountains, and it is likewise designated as sensitive in Region 2 (USDA Forest Service 2015b) (table 4). Four of the vascular species were later removed from rare species status in Wyoming (Heidel 2012): *Carex leptalea*, *C. limosa*, *Packera indecora*, and *Sparganium natans*. Five of the vascular species were reassigned a rare species status from "track" to "watch" (table 4): *Carex livida*, *Drosera anglica*, *Eriophorum chamissonis*, *E. gracile*, and *Utricularia minor*. The 32 species exclude 12 species, previously tracked as Species of Concern by WYNDD, that were removed from consideration because they were found to be more widespread in the State than previously known (Keinath et al. 2003). These species are: *Agoseris lackschewitzii*, *Botrychium virginianum*, *Carex buxbaumii*, *C. dioica* (syn. *C. gynocrates*), *Comarum palustre* (syn. *Potentilla palustris*), *Eleocharis rostellata, Listera cordata, Petasites sagittatus, Salix farriae, Symphyotrichum boreale* (syn. *Asterjunciformis*), *Tephroseris lindstroemii* (syn. *Senecio fuscatus*), and *Thalictrum alpinum*.

The rare vascular plant species of Beartooth fens separate into two groups by elevation; 6 species occur primarily in the alpine range (2,900 to 3,340 m, or 9,510 to 10,960 ft) and 26 occur at lower elevations (1,980 to 2,940 m, or 6,490 to 9,640 ft). Four of the rare plant species are characterized by Johnson (1962) and Johnson and Billings (1962) as alpine species (table 4), to which we add *Agrostis mertensii* based on Weber and Wittmann (2012) and *Salix barrattiana* based on Dorn (2001). Almost all of the rare vascular plant species of Beartooth fens (31) have their centers of distribution in arctic or boreal latitudes. The exception is *Carex nelsonii*, a regional endemic (Heidel 2012).

Eighteen of the vascular plant Species of Concern are obligate wetland plants in western mountains of the United States (Lichvar et al. 2014). This means that they almost always occur in wetlands (Lichvar et al. 2012) (table 4). Most are found only in fen habitat, and even though we now know this habitat is more common in the study area than previously thought, only a fraction of fens support rare species.

For each of the 32 rare plant species, the description of Beartooth populations, elevation range, and number of populations in the study area are reported in table 3, cross-referencing the 18 Beartooth fens described in this report. Species' distribution and habitat in the Beartooth Mountains refer to the Wyoming portion of the mountains unless otherwise stated. The history of documentation is briefly described for each species in the following pages and presented in table 3. Ten of the rare Beartooth plant species were first discovered in Wyoming at either Swamp Lake or Wyoming Creek. Updated information on rare plant species distribution in Wyoming is maintained by WYNDD and Rocky Mountain Herbarium (RM), and is posted in WYNDD reports and in State plant species accounts (WYNDD 2016). Of the 32 species, 14 have conservation assessments prepared for Region 2. The reader is also referred to the RM online database (RM 2016) for collection label information to accompany the distribution and habitat information in this report.

Table 3—Environmental characteristics associated with occurrences of the 32 rare plants species and 1 bryophyte species in fens of the Beartooth Mountains described in this report, numbers of known populations, and documentation of herbarium specimen collections.

Species	Elevation range in Beartooth Mtns. (m)	Setting in Beartooth Mtns.	Vegetation structure of habitat in Beartooth Mtns.	Total Beartooth Mtns. populations	Total Wyoming populations	Collections from the Beartooth Mtns. study area (Sequenced by earliest year, grouped by fen name as acronym among 18 profiled fens, then by collector. Collections from other locations in the Beartooth Mountains study area are prefaced by "elsewhere.")
Agrostis mertensii	2,900–3,260	Basin	Graminoid	3	13	Elsewhere – Mellmann-Brown (1109, 1115, 1199, 1206, 1211, 1212, 1213, 1214) 1998 RM; (2605b) 1996 RM. SPF – Heidel (2989) 2007 RM; E. Elliott (3559) 2007 RM.
Amerorchis rotundifolia	2,010–2,100	Basin	Forest	3	3	SLF – Pearson (82) 1924 RM; Lichvar (2062) 1979 RM; Evert (7454) 1984 MOR, (7841) 1985 RM, MOR, (4092) 2004 RM; B.E. Nelson (16885) 1989 RM; Fertig (13370) 1992 RM. Elsewhere – Evert (7834) 1985 RM, (40900) 2004 RM, MOR, NY; B. Elliott (14082) 2008 RM.
Arctous rubra	2,010	Basin	Margin of forest	1	1	SLF – Evert (7494) 1984 RM, MOR; Dorn (4119) 1984 NY, RM; Hartman (18548) 1984 RM; B.E. Nelson (16876) 1989 RM.
Carex concinna	2,010–2,130	Basin	Margin of forest	2	6	SLF – Evert (9824) 1986 RM; Fertig (13368) 1992 RM. Elsewhere – Evert (40914) 2004 RM; E. Elliott (562) 2007 RM.
Carex diandra	2,010–2,740	Basin	Graminoid	8	24	SLF – Evert (7666) 1984 RM, (7874) 1985 RM; Fertig (13348) 1992 RM; Heidel (2618) 2004 RM. LMLF – Mills (126) 1995 RM; Heidel (2204) 2002 RM. LLF/MLF – Mills (145, 147, 153) 1995 RM; Mellmann-Brown (1621) 2004 RM; Fertig (17301) 1985 RM; Heidel (2833, 2867) 2006 RM. LLEF – Fertig (17310) 1996 RM. CBF – Mellmann-Brown (1159, 1169) 1999 RM, (1510) 1998 RM, Fertig (18873) 1999 RM; Heidel (3021) 2007 RM. GCF – Mellmann-Brown (1628) 2004 RM; Heidel (2960) 2007 RM. Elsewhere – Heidel (3004) 2007 RM.
Carex leptalea	1,980–2,740	Basin	Forest	13	32	Elsewhere – Dorn (3606) 1980 RM; Heidel (2627) 2004 RM; Evert (40899, 40916) 2004 RM; Heidel (2604) 2004 RM, (2747, 2763) 2005 RM, (2838, 2840) 2006 RM, (3033) 2007 RM. SWL – Evert (4737) 1982 RM, (7658) 1984 RM, (40905) 2004 RM; Dorn (5011) 1989 RM; Nelson (16868) 1989 RM; Heidel (2616) 2004 RM. LMLF – Fertig (17250) 1996 RM. LLEF – Fertig (17306) 1996 RM. GCF – Heidel (2615) 2004 RM, (2961) 2007 RM. CBF – Heidel (3016) 2007 RM.
Carex limosa	2,010–2,940	Basin, sloping	Graminoid	15	66	SLF – Evert (7505) 1984 RM; Dorn (4128) 1984 RM, (5014) 1989 RM, NY; Hartman (18559) 1984 RM, Lichvar (7026) 1984 RM; Nelson (16886) 1989 RM; Fertig (13356, 13387, 13398) 1992 RM; Jones (858) CWC. CBF – Fertig (14518) 1993 RM, (18871) 1999 RM. LLEF – Fertig (17313) 1996 RM. LBLF – Mellmann-Brown (1132) 1998 RM. LMLF – Mills (124) 1995 RM. MLF

Table 3—*Continued.*

Species	Elevation range in Beartooth Mtns. (m)	Setting in Beartooth Mtns.	Vegetation structure of habitat in Beartooth Mtns.	Total Beartooth Mtns. populations	Total Wyoming populations	Collections from the Beartooth Mtns. study area (Sequenced by earliest year, grouped by fen name as acronym among 18 profiled fens, then by collector. Collections from other locations in the Beartooth Mountains study area are prefaced by "elsewhere.")
Eriophorum viridicarinatum	2,010	Basin	Graminoid	1	12	SLF – Dorn (4140) 1984 RM; Evert (7505) 1984 RM, (7854) 1985 RM; Nelson (16887) 1989 RM; Fertig (13354) 1992 RM.
Juncus filiformis	2,630	Basin	Graminoid	1	20	PLF – Heidel (2855) 2006 RM.
Kobresia simpliciuscula	2,010	Basin	Graminoid	1	6	SLF – Dorn (4141) 1984 RM; Evert (7503) 1984 RM, (7843) 1985 RM; Lichvar (7021) 1984 RM; Fertig (13351, 13402) 1992, (18860) 1999 RM.
Muhlenbergia glomerata	2,010	Basin	Graminoid	1	17	SLF – Hartman (18563) 1984 RM; Fertig (13344, 13388) 1992 RM.
Packera indecora	2,010–2,410	Basin	Shrub, margin of forest	10	10	Elsewhere – Williams (s.n.) 1932 NY; Robertson 1365 (1977) RM, Mellmann-Brown (1153) 1999 RM; Dorn (3601) 1980 RM, Heidel (2607) 2004 RM; (2849) 2006 RM. SLF – Heidel (2617) 2004 RM, (2841) 2006 RM, (3032) 2007 RM, (3040) 2007 RM. LLF – Mellmann-Brown (1623) 2004 RM; Heidel (2832) 2006 RM.
Pedicularis oederi	3,110–3,340	Sloping	Graminoid	1	1	WCC – Pennell (24000) 1938 RM; Hitchcock (13499) 1945 RM; Evert (42058) 2007 RM; B. Elliott (14621) 2008 RM; Heidel (3356) 2009 RM. LCF – Walford (2486) 1996 RM. Elsewhere – Phillips (44b) 1958 RM; Scott (4736) 1985 RM; Bynum (605, 639) 1994 RM; Fertig (15126) 1994 RM, (17288) 1996 RM; Mellmann-Brown (2345) 1996 RM; E. Elliott (5666, 6261, 6379, 6424) 2008 RM; B. Elliott (13921) 2008 RM; Hartman (87892, 87962) 2008 RM.
Potamogeton amplifolius		Basin	Openwater	1	6	LLF – Fertig (17303) 1996 RM.
Potamogeton illinoensis	2,370	Basin	Openwater	1	5	Elsewhere – Heidel (2848) 2006 RM.
Potamogeton praelongus	2,340	Basin	Openwater	1	15	LLF – Fertig (17304) 1996 RM.
Primula egaliksensis	2,010	Basin	Graminoid	1	2	SLF – Hartman (18561) 1984 RM; Evert (7844) 1985 RM, (9823) 1986 RM, (40907) 2004 RM; Nelson (16888) 1989 RM; Fertig (13399) 1992 RM.
Salix barrattiana	2,990–3,200	Sloping	Shrub	1	1	WCC – Pattie (790) 1964 RM; Dorn (1111) 1970 RM, (1742) 1972 RM, (5222) 1991 RM, (5332) 1992 RM; Heidel (3359) 2009 RM.
Salix candida	2,010–2,340	Basin	Graminoid	3	25	SLF – Evert (7488) 1984 RM, (7853) 1985 RM; Dorn (4121, 4123) 1984 RM; Nelson (16883) 1989 RM; Fertig (13349) 1992 RM; MLF/LLF – Mills (148, 149, 165) 1995 RM; Mellmann-Brown (1619) 2004 RM; Walford (994) 1993; Heidel (2716) 2005 RM, (3250) 2008 RM. MLF – Mellmann-Brown (1619). 2004 RM. Elsewhere – Heidel (2765) 2005 RM.

Table 3—*Continued.*

Species	Elevation range in Beartooth Mtns. (m)	Setting in Beartooth Mtns.	Vegetation structure of habitat in Beartooth Mtns.	Total Beartooth Mtns. populations	Total Wyoming populations	Collections from the Beartooth Mtns. study area (Sequenced by earliest year, grouped by fen name as acronym among 18 profiled fens, then by collector. Collections from other locations in the Beartooth Mountains study area are prefaced by "elsewhere.")
Carex limosa	2,010–2,940	Basin, sloping	Graminoid	15	66	– Mills (161) 1995 RM; Mellmann-Brown (1620) 2004 RM; Heidel (2745) 2005 RM. GCF – Mellmann-Brown (1629) 2004 RM; Heidel (2954) 2007 RM. LLF – Heidel (2834) 2006 RM. PLF – Heidel (2853) 2006 RM. RCF – Heidel (3012) 2007 RM. LWGNF – (2973) 2007 RM. Elsewhere – Heidel (3030a) 2007 RM. MLF – Heidel (3243) 2008 RM.
Carex livida	2,010–2,740	Basin	Graminoid	2	26	SLF – Dorn (5013) 1984 RM; Evert (7867) 1985 RM; B.E. Nelson (16875, 16888) 1989 RM; Fertig (13355) 1992 RM. CBF – Mellmann-Brown (1127) 1998 RM; Fertig (18865) 1999 RM.
Carex microglochin	2,010–2,410	Basin	Graminoid	2	20	SLF – Dorn (4145) 1984 RM; Evert (7506) 1984 RM, (7848) 1985 RM; Lichvar (7028) 1984 RM; B.E. Nelson (16880) 1989 RM. GCF – Heidel (2952) 2007; E. Elliott (3251) 2007 RM.
Carex misandra	3,030–3,290	Sloping	Graminoid	1	12	WCC/LCF – Bliss (788) 1955 RM; Johnson (204, 233) 1960 RM; Aldrich (153) 1979 RM; Evert (3408) 1981 RM, (6207, 6226) 1983 RM; Mellmann-Brown (1124) 1998 RM; Heidel (3022) 2007 RM.
Carex nelsonii	3,170–3,290	Sloping	Graminoid	1	16	WCC/LCF – Johnson (232) 1960 RM; Mellmann-Brown (1114, 1119b, 1122, 1135, 1136 , 1137, 1138, 1187) 1998 RM; Fertig (17263) 1996 RM.
Drosera anglica	2,270–2,630	Basin	Graminoid	6	27	LLEF – Doutt (152) 1930 YELLO; Fertig (17311) 1996 RM. LMLF - Mills (122) 1995 RM; Fertig (17246) 1996 RM. GCF – Mellmann-Brown (1632) 2004 RM; Heidel (2759) 2005 RM; E. Elliott (3226) 2007 RM. PLF – Heidel (2856) 2006 RM. RCF – Heidel (3009) 2007 RM; E. Elliott (3844) 2007.
Equisetum fluviatile	2,480	Basin	Graminoid	1	3	Elsewhere – Fertig (17291) 1996 RM.
Eriophorum callitrix	3,050–3,290	Sloping	Graminoid	1	5	WCC/LCF and elsewhere – Johnson (58b) 1958 RM; Evert (2430) 1980 RM, (4740) 1982 RM, (420576) 2007 RM; Dorn (4103) 1984 RM; Scott (4942) 1985 CWC, RM; Mellmann-Brown (2590) 1996 RM; Heidel (3024) 2007; E. Elliott (3657) 2007 RM; Hartman (87897) 2008 RM; B. Elliott (13917, 14627, 14715, 14725) 2008 RM.
Eriophorum chamissonis	2,270–2,910	Basin	Graminoid	4	41	GCF – Mellmann-Brown (1961) 2004 RM; Heidel (2956) 2007 RM; E. Elliott (3254) 2007 RM. RCF – Heidel (3010) 2007 RM; E. Elliott (3830) 2007 RM. LWF – Heidel (2974) 2007 RM.
Eriophorum gracile	2,270–2,780	Basin	Graminoid	9	25	LMLF – Mills (129) 1995 RM. MLF – Mills (158, 162) 1995 RM. LLEF – Fertig (17312) 1996 RM. CBF – Mellmann-Brown (1203) 1999 RM. RCF – Heidel (3011) 2007 RM; E. Elliott (3831) 2007 RM. GCF – Heidel (2958) 2007 RM; Elliott (325) 2007 RM. Elsewhere – Heidel (3030b) 2007 RM.

Table 3—*Continued*.

Species	Elevation range in Beartooth Mtns. (m)	Setting in Beartooth Mtns.	Vegetation structure of habitat in Beartooth Mtns.	Total Beartooth Mtns. populations	Total Wyoming populations	Collections from the Beartooth Mtns. study area (Sequenced by earliest year, grouped by fen name as acronym among 18 profiled fens, then by collector. Collections from other locations in the Beartooth Mountains study area are prefaced by "elsewhere.")
Salix myrtillifolia	2,010	Basin	Graminoid	1	1	SLF – Evert (7489) 1984 RM, MOR; (7873) 1985 RM; Dorn (4118) 1984 RM, (5221) 1991 RM; Lichvar (7039) 1984 RM; Fertig (13380) 1992.
Sparganium natans	2,010–2,910	Basin	Openwater	6	16+	SLF – Porter (6791) 1955 RM; Evert (7147) 1984 RM; Fertig (13367) 1992 RM. LLF – Heidel (2835) 2006 RM. MLF Heidel (2977) 2007 RM; E. Elliott (3225) 2007 RM. Elsewhere – Mellmann-Brown (1610) 2004 RM; Heidel (2648) 2006 RM.
Trichophorum pumilum	2,010	Basin	Graminoid	1	8	SLF – Dorn (4133) 1984 RM; Evert (7498) 1984 RM, MOR, (7846) 1985 RM, (9822) 1986 RM; Nelson (16889) 1989 RM; Fertig (13350) 1992 RM.
Utricularia minor	2,010–2,780	Basin	Openwater	6	39	SLF – Fertig (16797) 1996 RM. PLF – Heidel (2854) 2006 RM. GCF – Heidel (2955) 2007 RM. CBF – Heidel (3019) 2007 RM. LLEF – Heidel (3341) 2009 RM. GCF – E. Elliott (3225) 2007 RM.
Sphagnum angustifolium	2,470–2,900	Basin	Graminoid	2	3	Elsewhere – Weber (B44268) 1973 COLO. LLEF – Booth (s.n.) 2002 BING; Heidel (s.n.) 2002 RM. WC – Hartman (87944) 2008 RM.

Table 4—Global conservation ranking, State and regional conservation status, and wetland indicator status for the 32 rare plant species and 1 bryophyte species that occur in fens of the Beartooth Mountains described in this report.

Species	FS sensitive status (Regions 1[a] and 2[b])	Global rank[c]	Wyoming State rank	Wyoming status[d]	Present in Beartooth Mtns. of Montana[e]	Montana State rank[f]	Wetland indicator status[g]
Agrostis mertensii		G5	S2	Track	Yes	S3?	FACU
Amerorchis rotundifolia	R1, R2 S	G5	S1	Track	No	S3	OBL
Arctostaphylos rubra		G5	S1	Track	(Not in MT)	–	FAC
Carex concinna		G5	S1	Track	No	S4	FAC
Carex diandra	R2 S	G5	S2	Track	Yes	S4	OBL
Carex leptalea	Formerly R1, R2 S	G5	S3	Delete	Yes	S4	OBL
Carex limosa		G5	S3	Delete	Yes	S3S4	OBL
Carex livida	R2 S, formerly R1 S	G5	S3	Track	No	S4	OBL
Carex microglochin		G5?	S2	Track	(Reported in MT)	–	FACW
Carex misandra		G5	S2	Track	Yes	S3S4	FACU
Carex nelsonii		G3	S3	Track	Yes	S2?	FAC
Drosera anglica	R1, R2 S	G5	S3	Watch	Yes	S3	OBL
Equisetum fluviatile		G5	S1	Track	No	S4	OBL
Eriophorum callitrix		G5	S2	Track	Yes	S2S3	OBL
Eriophorum chamissonis	R2 S	G3	S3	Watch	No	S4	OBL
Eriophorum gracile	R1, R2 S	G5	S3	Watch	No	S3	OBL
Eriophorum viridicarinatum	Formerly R1 S	G5	S2	Track	No	S4	OBL
Juncus filiformis		G5	S2	Delete	No	SNR	FACW
Kobresia simpliciuscula	R2 S	G5	S1	Track	No	S3	FACW
Muhlenbergia glomerata	Formerly R2 S	G5	S2	Track	No	SU	FACW
Packera indecora		G5	S2	Delete	Yes	S4?	FACW
Pedicularis oederi		G5	S2	Track	Yes	S3	No status
Potamogeton amplifolius		G5	S1	Track	No	–	OBL
Potamogeton illinoensis		G5	S1	Track	No	–	OBL
Potamogeton praelongus		G5	S1	Track	No	–	OBL
Primula egaliksensis	R2 S	G4	S1	Track	(Not in MT)	–	OBL
Salix barrattiana	R2 S	G5	S1	Track	Yes	S2	FACW
Salix candida	R2 S	G5	S2	Track	No	S3S4	OBL
Salix myrtillifolia	R2 S	G5	S1	Track	(Not in MT)	–	FACW
Sparganium natans		G5	S2	Delete	No	S4	OBL
Trichophorum pumilum		G5	S1	Track	No	S3	FACW
Utricularia minor	R2 S	G5	S3	Watch	No	S3	OBL
Sphagnum angustifolium	R2 S	G5	S1	Track	No	S2	Not applicable

[a] Sensitive plants species of U.S. Forest Service Region 1 in Montana (http://www.fs.usda.gov/detail/r1/plants-animals/?cid=stelprdb5130525).
[b] Sensitive plant species of U.S. Forest Service Region 2 (http://www.fs.usda.gov/wps/portal/fsinternet/detail/r2/plants-animals/?cid=stelprdb5350842).
[c] NatureServe global and state ranking and definitions (NatureServe. 2016. NatureServe Explorer. (http://www.natureserve.org/explorer/index.html).
[d] Wyoming Natural Diversity Database (Heidel 2012) as posted on WYNDD homepage (http://www.uwyo.edu/wyndd/).
[e] Based on Lesica (2012).
[f] Montana Natural Heritage Program as posted on MTNHP homepage (http://mtnhp.org/plants/).
[g] Wetland indicator status codes and descriptions (Lichvar et al. 2012):
OBL (Obligate wetland plants) – Almost always occur in wetlands
FACW (Facultative wetland plants) – Usually occur in wetlands
FAC (Facultative wetland plants) – Occur in wetlands and nonwetlands
FACU (Facultative upland plants) – Usually occur in nonwetlands, but may occur in wetlands

Agrostis mertensii Trin. (northern bentgrass, Poaceae) is a boreal species that reaches its southern limits in Colorado, where it is described as "common on tundra" (Weber and Wittmann 2012), and in Utah. It is known from the Beartooth Mountains of Montana (Lesica 2012, Montana Natural Heritage Program 2015). In Wyoming it occurs in the Beartooth, Absaroka, Medicine Bow, Teton, and Wind River mountains, growing in meadows, open and forested stream, and lake margins. At Sawtooth Palsa Fen, it grows with *Carex paysonii* and *Festuca brachyphylla* on the central portion of the palsa on raised mounds covered by oxidized, desiccated peat, consistent with its categorization as a facultative upland species (Lichvar et al. 2014). *Agrostis mertensii* was collected from the Beartooth Mountains first in 1998 by Mellmann-Brown and then in 2007 at the Sawtooth Palsa Fen by Heidel and Elliott (table 3).

Amerorchis rotundifolia (Banks ex Pursh) ex Hulten (roundleaf orchid, Orchidaceae) (fig. 74) is a boreal species at its southern limits in the Beartooth Mountains of Wyoming, the extent of its distribution within Region 2. It is not known from the Beartooth Mountains of Montana. It is otherwise known in the Rocky Mountains from both sides of the Continental Divide in northwestern Montana (Lesica 2012; Montana Natural Heritage Program 2015) and in northern Idaho. Wyoming populations grow in spruce forest at Swamp Lake Fen and other forested fen locations in the Clarks Fork Valley. It occurs on peat accumulated at the base of trees within a microhabitat of moss and graminoid vegetation. *Amerorchis rotundifolia* was first collected near Swamp Lake in 1924 by E. Pearson and D. Pearson, and not again until 1979 by Lichvar (Evert 1986) (table 3). It was surveyed at Swamp Lake Fen by Fertig (Fertig and Jones 1992) and more recently documented on the opposite side of the Clarks Fork Valley (Elliott and Elliott 2011). Conservation status for *Amerorchis rotundifolia* in Region 2 is summarized by Handley and Heidel (2005).

Figure 74—Roundleaf orchid (*Amerorchis rotundifolia*) at Swamp Lake Fen (photo: Walter Hartung, used with permission).

Arctostaphylos rubra (Rehder & Wilson) Fernald (syn. *Arctous rubra*; red fruit bearberry, Ericaceae) (fig. 75) is a disjunct boreal species, and its occurrence at Swamp Lake Fen is the only known location in Wyoming and the lower 48 States. It grows at the borders between forested and graminoid-dominated portions of the fen. It is commonly associated with *Juniperus horizontalis*, *Betula glandulosa*, *Salix planifolia*, and *S. candida*. *Arctostaphylos rubra* was first collected in 1984 by Evert, Dorn, Hartman, and Lichvar (Evert et al. 1986) and was later surveyed by Fertig (Fertig and Jones 1992).

Figure 75—Red fruit bearberry (*Arctous rubra*) at Swamp Lake Fen, the only place it occurs in the lower 48 States (photo: Jennifer Whipple, used with permission).

Carex concinna R. Br. (beautiful sedge, Cyperaceae) is a boreal species at its southern limits in eastern Colorado (Crins 2002; Weber and Wittman 2012). Although present in Montana, it is not known from the Beartooth Mountains (Lesica 2012). In Wyoming, *Carex concinna* occurs in the Beartooth Mountains, Black Hills, Wind River Range, and Yellowstone Plateau. It grows in forests beside streams and wetlands on moist, mossy, or deep duff

surfaces. At Swamp Lake Fen, it grows on hummocks at the base of trees in forested portions of the fen and at the transition between the fen and uplands. *Carex concinna* was first collected from the Beartooth Mountains at Swamp Lake Fen in 1986 by Evert (table 3) and was later surveyed by Fertig (Fertig and Jones 1992).

Carex diandra Schrank (lesser panicled sedge, Cyperaceae) (fig. 76) is a circumboreal species that is occasional to rare throughout most of its United States range (Cochrane 2002a). It reaches its southern limits in New Mexico and is present in Montana, including the Beartooth Mountains (Lesica 2012). In Wyoming, *Carex diandra* is also known from the Yellowstone Plateau, Medicine Bow Mountains, and Big Horn Mountains. It grows along pool and lake margins of graminoid-dominated fens at Clay Butte Fen, Lily Lake East Fen, Ghost Creek Fen, Lily Lake Fen, Mud Lake Fen, and Swamp Lake Fen. The first collection from the study area was made by Evert at Swamp Lake Fen in 1984 (table 3). *Carex diandra* was surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Gage and Cooper (2006a).

Figure 76—Lesser panicled sedge (*Carex diandra*) at Clay Butte Fen (photo: Sabine Mellmann-Brown).

Carex leptalea Wahlenb. (bristlystalked sedge, Cyperaceae) (fig. 77) has the widest distribution in North America of any sedge species (Cochrane 2002b), extending as far south as Mexico and from coast to coast. It is known from all surrounding States, including the Beartooth Mountains in Montana (Lesica 2012). In Wyoming, *Carex leptalea* also occurs in the Black Hills, Medicine Bow Range, Jackson Hole, and Yellowstone Plateau areas and is no longer recognized as a State Species of Concern. It grows in forested or shrub-dominated fens, or at wooded fen margins, typically in shade on peat with high moss cover. It occasionally grows with *Equisetum arvense*. It was first collected from Swamp Lake in 1982 by Evert (table 3) and surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Gage and Cooper (2006b).

Figure 77—Bristlystalked sedge (*Carex leptalea*) at Ghost Creek Fen (photo: Sabine Mellmann-Brown).

Carex limosa L. (mud sedge, Cyperaceae) (fig. 78) is a circumboreal species that reaches its southern limits in the Uintah Mountains of Utah (Ball 2002). It is also known from fens in Nebraska and from the Beartooth Mountains in Montana (Lesica 2012). In Wyoming, *Carex limosa* is also known from the Big Horn Mountains, Medicine Bow Range, Sierra Madre Range, Wind River Range, Jackson Hole, and Yellowstone Plateau and is no longer recognized as a State Species of Concern. *Carex limosa* is prevalent in floating mats of basin fens at Lily Lake East Fen, Ghost Creek Fen, Lake WGN, Lily Lake Fen, Mud Lake Fen, Poke Lake Fen, Rock Creek Fen, and

Figure 78—Mud sedge (*Carex limosa*) at Mud Lake Fen (photo: Sabine Mellmann-Brown).

Swamp Lake Fen. It is also found at higher elevations in sloping fens, including Little Bear Lake Fen, Meadow Lake Fen, and Trail Fen. It was first collected from Swamp Lake Fen in 1984 by Evert (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Gage and Cooper (2006c).

Carex livida L. (livid sedge, Cyperaceae) (fig. 79) is a circumboreal species at its southern limits for the Rocky Mountains in Larimer and Park Counties, Colorado (Rochrock and Reznicek 2002). It is otherwise known from northwestern Montana (Lesica 2012). In Wyoming, *Carex livida* occurs in the Beartooth Mountains, Wind River Range, Jackson Hole, and Yellowstone Plateau. It grows on floating mats in graminoid-dominated vegetation of basin fens at Clay Butte Fen and Swamp Lake Fen. It was first collected in Wyoming at Swamp Lake Fen in 1985 by Evert (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). It was subsequently found at Clay Butte Fen by Mellmann-Brown (2004). Its conservation status in Region 2 is summarized by Gage and Cooper (2006d).

Figure 79—Livid sedge (*Carex livida*) at Swamp Lake Fen (photo: Sabine Mellmann-Brown).

Carex microglochin Wahlenb. (fewseeded bog sedge, Cyperaceae) (fig. 80) occurs in North America, Eurasia, and South America, where it is regarded as a separate subspecies (Cochrane 2002c). It extends south in the Rocky Mountains to Colorado, Utah, and Wyoming and is reported for Montana though there are no known voucher specimens (Lesica 2012). In Wyoming, it is known from the Beartooth Mountains, upper Green River Basin, Wind River Range, and Yellowstone Plateau. *Carex microglochin* grows in graminoid-dominated portions of basin fens, including Swamp Lake Fen and Ghost Creek Fen. It was first collected in Wyoming in 1984 at Swamp Lake Fen by Evert, Dorn, and Lichvar (Evert et al. 1986) and was later surveyed by Fertig (Fertig and Jones 1992). It was subsequently documented at Ghost Creek Fen by Mellmann-Brown in 2004 (table 3).

Figure 80—Fewseeded bog sedge (*Carex microglochin*) at Ghost Creek Fen (photo: Sabine Mellmann-Brown).

Carex misandra R. Br. (*Carex fulginosa* in Ball and Mastroguiseppe 2002; shortleaf sedge, Cyperaceae) is a circumboreal species, extending as far south as Colorado and Utah (Ball and Mastroguiseppe 2002). It extends as far south in Canada as central Alberta and northern British Columbia (Marr et al. 2012). In Montana it is known from the Beartooth and Bitterroot Mountains (Lesica 2012) and is more widespread in Colorado (Weber and Wittmann 2012). In Wyoming, it is also known from the Bighorn Mountains and Wind River Range. *Carex misandra* grows in wet meadows, in willow thickets, along streambanks, in alpine tundra and fen margins, and at the transition between peatland and wet meadow in Littlerock Creek Fen and Wyoming Creek. It was first collected in Wyoming in 1955 by L. Bliss and Johnson (1962) near Wyoming Creek and Littlerock Creek Fens (table 3). Its distribution on the Beartooth Plateau may represent one very large population.

Carex nelsonii Mack. (Nelson's sedge, Cyperaceae) is a Rocky Mountain species that occurs as far north as the Beartooth Mountains of Montana, extending south to central Colorado

and northeastern Utah (Murray 2002). In Wyoming, it is also known from the Bighorn Mountains and Medicine Bow, Sierra Madre, and Wind River Ranges. *Carex nelsonii* grows in moist sedge meadows, sloping fens, and alpine tundra, on rocky slopes, and along lakeshores. It was first collected at Wyoming Creek by Johnson (1962) and has since been collected more widely across the Beartooth Plateau (table 3).

Drosera anglica Huds. (English sundew, Droseraceae; fig. 81) is a circumboreal species that reaches its southern extent in the San Juan Mountains, Colorado (Weber and Wittmann 2012b). It is known from the Beartooth Mountains and elsewhere in Montana (Lesica 2012). In Wyoming, it is also known from the Yellowstone Plateau, Jackson Hole, and the Big Horn Mountains. It usually grows on floating mats, particularly floating mats of *Sphagnum*, as found at Lily Lake East Fen, Poke Lake Fen, and Rock Creek Fen. This species was first collected in 1930 by M. Doutt, apparently at Lily Lake East Fen, and was found at Little Moose Lake in 1995 by Mills (Mills and Fertig 1996b) (table 3). Additional mapping was conducted at Lily Lake East Fen in 1996 by Fertig and Mellmann-Brown (Fertig 1997). Its conservation status in Region 2 is summarized by Wolf et al. (2006).

Figure 81—English sundew (*Drosera anglica*) at Ghost Creek Fen (photo: Sabine Mellmann-Brown).

Equisetum fluviatile L. (water horsetail, Equisetaceae) is a circumboreal species at the southern limits of its Rocky Mountain distribution in Wyoming, but it extends farther south along the east and west coasts of North America. It occurs in Montana but is not known from the Beartooth Mountains (Lesica 2012). In Wyoming, it also occurs on the Yellowstone Plateau and is known from a historical collection by Aven Nelson (6548 RM) on Jackson Lake in 1899 before the water level was raised in 1906 (Marston et al. 2005). In Wyoming, habitat includes wetlands and the margins of pools, ponds, and streambanks. In the Beartooth Mountains, it has been collected only once—in 1996—from a dried pond on clay-rich soil among *Carex utriculata* within a broad meadow valley along Muddy Creek wetland by Fertig, Mellmann-Brown, and Houston (Fertig 1997) (table 3).

Eriophorum callitrix Cham. ex C.A. Mey. (arctic cottongrass, Cyperaceae) (fig. 82) is a circumboreal species with an arctic-alpine distribution and southern limits in Wyoming (Ball and Wujek 2002). It also occurs in Montana, including the Beartooth Mountains (Lesica 2012), and in the Wind River Range of Wyoming. It grows in sloping fens, in sedge meadows, and along streambanks at Littlerock Creek Fen and Wyoming Creek. At Wyoming Creek, it was described as occupying peat terraces in association with *Carex scopulorum* (Johnson and Billings 1962). It was first collected in Wyoming at Wyoming Creek by Johnson (1962) and its distribution on the Beartooth Plateau may represent one extensive population (table 3).

Figure 82—Arctic cottongrass (*Eriophorum callitrix*) at Wyoming Creek (photo: Bonnie Heidel, WYNDD).

Eriophorum chamissonis C.A. Mey. (Chamisso's cottongrass, Cyperaceae; fig. 83) is a circumboreal species at its southern limits in Colorado and Utah. It occurs in Montana, but is not known from the Beartooth Mountains (Lesica 2012). In Wyoming, *Eriophorum chamissonis* is also known from the Big Horn Mountains, southern Absaroka Range, Wind River Range, and Yellowstone Plateau. It grows in graminoid-dominated fens, including Ghost Creek Fen, Lake WGN Fen, and Rock Creek Fen. It was first collected in the Beartooth Mountains at Ghost Creek Fen in 2004 by Mellmann-Brown (table 3). Its conservation status in Region 2 is summarized by Decker et al. (2006a).

Figure 83—Chamisso's cottongrass (*Eriophorum chamissonis*) (photo: Bonnie Heidel, WYNDD).

Eriophorum gracile W.D.J. Koch (slender cottongrass, Cyperaceae) (fig. 84) is a circumboreal species at its southern limits in the Rocky Mountains in Colorado (Ball and Wujek 2002). It occurs in Montana, but is not known from the Beartooth Mountains (Lesica 2012). In Wyoming it occurs in the Beartooth Mountains, Jackson Hole, Yellowstone Plateau, Medicine Bow Mountains, and Big Horn Mountains. It grows in graminoid-dominated fens, often on floating mats, at Lily Lake East Fen, Ghost Creek Fen, Little Moose Lake Fen, and Rock Creek Fen. It was first collected at Little Moose Lake Fen in 1995 by Mills (Mills and Fertig 1996b), at East Lily Lake Fen in 1996 by Fertig and Mellmann-Brown (Fertig 1997, 1998), and at Ghost Creek Fen in 2004 by Mellmann-Brown (table 3). Its conservation status in Region 2 is summarized by Decker et al. (2006b).

Figure 84—Slender cottongrass (*Eriophorum gracile*) (photo: Bonnie Heidel, WYNDD).

Eriophorum viridicarinatum L. (thinleaf cottongrass, Cyperaceae) is a boreal species that reaches its southern Rocky Mountain limits in Colorado. It occurs in Montana but is not known from the Beartooth Mountains (Lesica 2012). In Wyoming, *Eriophorum viridicarinatum* is also known from Jackson Hole and the Yellowstone Plateau. It was first collected in the study area at Swamp Lake Fen in 1984 by Evert and Dorn (Evert et al. 1986) (table 3) and later surveyed by Fertig, who described its habitat as a type of graminoid-dominated fen (Fertig and Jones 1992).

Juncus filiformis L. (thread rush, Juncaceae) is a circumboreal species at its southern limits in New Mexico. It occurs in Montana but is not known from the Beartooth Mountains (Lesica 2012). In Wyoming it is known from the Beartooth Mountains, Yellowstone Plateau, Jackson Hole, and Sierra Madre Range and is no longer recognized as a State Species of Concern. It grows in a range of wet habitats such as riverbanks, lakeshores, and seepage areas, including thermally influenced peatlands. It was first collected at Poke Lake Fen in Wyoming in 2006 by Heidel (table 3). It was also found at a nearby gravelly, rocky shore of Granite Lake, Wyoming.

Kobresia simpliciuscula (Wahlenb.) Mack. (simple kobresia, Cyperaceae) is a circumboreal species that reaches its southern extent in the Rocky Mountains of Colorado and Utah. It is not known from Montana (Lesica 2012). In Wyoming, it is known from the Beartooth Mountains and Wind River Range and in the upper Green River Basin. At Swamp Lake Fen it grows on floating mats with *Carex simulata*, and on moist, calcium carbonate-rich

hummocks with *Eleocharis quinqueflora* and *Triglochin maritima* (Fertig and Jones 1992). In Wyoming, it was first collected at Swamp Lake Fen in 1984 by Evert and Dorn (Evert et al. 1986) (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Decker et al. (2006c).

Muhlenbergia glomerata (Willd.) Trin. (marsh muhly, Poaceae) is a boreal species that is sparsely distributed at temperate latitudes. It occurs in Montana but is not known from the Beartooth Mountains (Lesica 2012). It occurs in Wyoming in the Black Hills, Yellowstone Plateau, upper Green River Basin, and Jackson Hole. At Swamp Lake Fen, *Muhlenbergia glomerata* is associated with *Carex simulata*, *Eleocharis quinqueflora*, and *Triglochin maritima* in graminoid-dominated fens, at the edges of forested fens, and on ant mounds (Fertig and Jones 1992). It was first collected in the Beartooth Mountains at Swamp Lake Fen in 1984 by Evert and Hartman (table 3) and was surveyed by Fertig (Fertig and Jones 1992).

Packera indecora (Greene) Á. Löve & D. Löve (syn. *Senecio indecorus*; elegant groundsel, Asteraceae) occurs in eastern Canada and in the Rocky Mountains (Trock 2006). It is present in Montana, including the Beartooth Mountains. It reaches its southern extent in the Beartooth Mountains in Wyoming and does not occur elsewhere in the State. It grows in graminoid- and shrub-dominated fens, along streams and river bars, on mud flats, and in disturbed areas. It is no longer recognized as a Wyoming Plant Species of Concern. It is present at Mud Lake Fen and Lily Lake Fen and along the shoreline at Swamp Lake Fen. In the Beartooth Mountains, it appears to grow as a biennial, fluctuating in population numbers between consecutive years (Heidel, personal observations, 2004–2009). It was found in other wetlands that apparently burned in the Clover Mist Fire of 1988. It was first collected near Crazy Creek in 1932 by L. Williams.

Pedicularis oederi Vahl. ex Hornem. (Oeder's lousewort, Scrophulariaceae) (fig. 85) is an arctic-alpine species that is disjunct between central British Columbia and south-central Montana (Marr et al. 2012), where it is known from the Beartooth and Crazy Mountains (Lesica 2012). In Wyoming, it is widespread on the Beartooth Plateau, forming a single, very large population, the only one in the State. The study area represents the extent of its distribution in Region 2. It is the only species among the rare Beartooth fen species in Montana that is not on the National Wetland Plant list. It occupies habitat that ranges from turf communities of Geum rossii to wet meadows and graminoid-dominated fens and fen margins. It was first collected in the Beartooth Mountains in 1938 by F. Pennell (24000, 24010 RM) and is represented by many subsequent collections (table 3).

Figure 85—Oeder's lousewort (*Pedicularis oederi*) at Wyoming Creek (photo: Bonnie Heidel, WYNDD).

Potamogeton amplifolius Tuck. (largeleaf pondweed, Potamogetonaceae) is common throughout much of North America (Haynes and Hellquist 2000), and scattered widely across locations in the interior western United States. It is present in northwestern Montana, but not in the Beartooth Mountains (Lesica 2012). In Wyoming, *Potamogeton amplifolius* is known from the Beartooth Mountains and the Sierra Madre Range, Big Horn Mountains, and Wind River Range. At Lily Lake, it was rooted in organic rich mud that may or may

notindicate peat substrate. It was also found in Lily Lake and adjoining Lily Lake Fen, as well as in slow-moving streams. It was first collected in the Beartooth Mountains in 1996 at Lily Lake and Lily Lake East Fen by Fertig and Mellmann-Brown (Fertig 1997, 1998) (table 3).

Potamogeton illinoensis Morong (Illinois pondweed, Potamogetonaceae) is a widespread New World species (Haynes and Hellquist 2000). It is present in northeastern and northwestern Montana but not in the Beartooth Mountains (Lesica 2012). In Wyoming, it is also known from historical collections in the Laramie Basin, Sweetwater River valley, Wind River Range, and Yellowstone Plateau. It occurs in deep ponds and lakes and slow-moving streams. It was first collected in the Beartooth Mountains by Heidel in 2006 (Heidel and Rodemaker 2008), when it was collected from over 1 m depth in a small open-water area at Bugle Lake (table 3).

Potamogeton praelongus Wulfen (whitestem pondweed, Potamogetonaceae) is a widespread northern species, extending as far south in the Rocky Mountains as Colorado. It is known from western Montana but not from the Beartooth Mountains (Lesica 2012). In Wyoming, this species is known from the Beartooth Mountains, Big Horn Mountains, Medicine Bow Range, and Yellowstone Plateau. It grows in conditions that range from slow-moving streams to deepwater lakes as found at Lily Lake below Lily Lake Fen and at Little Moose Lake Fen. In Wyoming, it was first collected in the Beartooth Mountains in 1996 at Lily Lake and Little Moose Lake by Fertig and Mellmann-Brown (Fertig 1997, 1998) (table 3).*Primula egaliksensis* Wormsk. ex Hornem. (Greenland primrose, Primulaceae) (fig. 86) occurs across boreal and arctic latitudes of North America and the Russian Far East, extending as far south as Colorado. It is not known from Montana (Lesica 2012). In Wyoming, the only known populations are in the Wind River Range and at Swamp Lake Fen. It grows at Swamp Lake Fen primarily on peat hummocks that are calcium carbonate-rich with *Eleocharis quinqueflora* and *Triglochin maritima*, and to a lesser extent on floating mats of *Carex simulata* (Fertig and Jones 1992). *Primula egaliksensis* was first collected in Wyoming at Swamp Lake Fen in 1984 by Evert and Hartman (Evert et al. 1986) (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Anderson et al. (2006).

Figure 86—Greenland primrose (*Primula egaliksensis*) at Swamp Lake Fen (photo: Walter Fertig, WYNDD).

Salix barrattiana Hook. (Barratt's willow, Salicaceae) (fig. 87) is an arctic-alpine species at its southern range limits (Argus 2010; Dorn 2010). The Beartooth Mountain population is the only one known in the conterminous United States, and it spans the State line, partially in Montana and the rest in Wyoming (Lesica 2012). It was first collected in the Beartooth Mountains and in Wyoming in 1964 by D. Pattie and collected later that year by G. Argus (table 3). Its habitat in the Beartooth Mountains has been described as boggy lakeshores, streambanks, and wet meadows (Ladyman 2005), but it has also been collected on broad willow flats on histic soils (Heidel 3359). Its conservation status in Region 2 is summarized by Ladyman (2005).

Figure 87—Barratt's willow (*Salix barrattiana*) at Wyoming Creek (photo: Bonnie Heidel, WYNDD).

Salix candida Flueggé ex Willd. (hoary willow, Salicaceae) (fig. 88) is a boreal species that extends south to Colorado in the Rawah Range and South Park (Argus 2010; Dorn 2010; Weber and Wittmann 2012). It is known from Montana but not from the Beartooth Mountains (Lesica 2012). In Wyoming, it is also known from the Laramie, Medicine Bow, and Wind River Ranges, Yellowstone Plateau, and upper Green River Basin. In the Beartooth Mountains, it grows in graminoid- and shrub-dominated fens including Mud Lake Fen and Swamp Lake Fen. It was first collected in the Beartooth Mountains at Swamp Lake Fen in 1984 by Evert and Dorn (Evert et al. 1986) (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Decker (2006).

Figure 88—Hoary willow (*Salix candida*) (photo: Sabine Mellmann-Brown).

Salix myrtillifolia Andersson (blueberry willow, Salicaceae) (fig. 89) is a disjunct boreal species that reaches its southern extent in South Park, Colorado (Argus 2010; Dorn 2010; Weber and Wittmann 2012). It is not known from the Montana flora. Swamp Lake Fen is the only known location in Wyoming. It was first collected there in 1984 by Evert, Dorn, and Lichvar (Evert et al. 1986) (table 3) and was later surveyed by Fertig (Fertig and Jones 1992). Its conservation status in Region 2 is summarized by Neid et al. (2006).

Figure 89—Blueberry willow (*Salix myrtillifolia*) at Swamp Lake Fen (photo: Jennifer Whipple, used with permission).

Sparganium natans L. (syn. *Sparganium minimum*; small bur-reed, Sparganiaceae) is a circumboreal species that reaches its southern range limits in the Rocky Mountains in Colorado. In Wyoming, it is also known from the Yellowstone Plateau, Jackson Hole, and Wind River and Medicine Bow Ranges. It grows submerged in shallow pools at Little Bear Lake Fen, Mud Lake Fen, and Swamp Lake Fen with other submergents such as Callitriche species. It also occurs in ponds bordered by emergents such as *Carex lasiocarpa*. It does not appear to be restricted to fens, and Weber and Wittmann (2012) reported it from subalpine marshes and old beaver ponds. It is no longer recognized as a Wyoming Plant Species of Concern. The species was first collected in the Beartooth Mountains in 1955 by C.L. Porter, possibly from Swamp Lake Fen, and was found there in 1984 by Evert (table 3).

Trichophorum pumilum (Vahl) Schinz & Thell. (syn. *Scirpus pumilus*; Rolland's bulrush, Cyperaceae) (fig. 90) is a circumboreal species that is at its southern extent for the Rocky Mountains in South Park, Colorado (Weber and Wittmann 2012); it is also present in California (Crins 2002). It is known from Montana but not from the Beartooth Mountains (Lesica 2012). In Wyoming, it is also known from the Gros Ventre Range, Jackson Hole, Medicine Bow Range, and upper Green River Basin. At Swamp Lake Fen, it grows on sparsely vegetated mounds of peat with high calcium carbonate accumulation (Fertig and Jones 1992). It was first collected in Wyoming at Swamp Lake Fen by Dorn and Evert (Evert et al. 1986) (table 3) and was later surveyed by Fertig (Fertig and Jones 1992).

Figure 90—Rolland's bulrush (*Trichophorum pumilum*) (photo: Bonnie Heidel, WYNDD).

Utricularia minor L. (lesser bladderwort, Lentibulariaceae) (fig. 91) is a circumboreal species that reaches its southern extent in the Rocky Mountains of Colorado. In Wyoming, it is known from the Yellowstone Plateau, Jackson Hole, and Laramie Basin, and the Laramie, Medicine Bow, Big Horn, and Wind River mountains. It grows submerged in shallow water and pool margins of basin fens, often beside floating mats as found at Clay Butte Fen, Ghost Creek Fen, and Swamp Lake Fen. It was first collected in the Beartooth Mountains at Swamp Lake Fen in 1996 by Fertig, Walford, and Mellmann-Brown (Fertig 1997) (table 3). Its conservation status in Region 2 is summarized by Neid (2006).

Figure 91—Lesser bladderwort (*Utricularia minor*) (photo: Bonnie Heidel, WYNDD).

Sphagnum angustifolium (Russ.) C. Jens. (narrowleaf sphagnum, Sphagnaceae) is the only bryophyte species in Wyoming designated as sensitive by the U.S. Forest Service, Rocky Mountain Region. However, *Sphagnum angustifolium* is perhaps the most common *Sphagnum* species across North American boreal peatlands (Vitt 2014). It has sporadic distribution in the Rocky Mountains extending as far south as Colorado. In Wyoming, it is known from the Beartooth Mountains, where it was first collected in 1973 by W. Weber, but since then it has not been observed in the area. It has also been collected from the Big Horn Mountains (Lenz 2011) and the Wind River Range (Kosovich-Anderson 2014). Elsewhere in the Beartooth Mountains, it occurs at Lily Lake East Fen, collected from floating *Sphagnum* mat in 2002 by Heidel and Laursen (2003b) and by Booth and Zygmunt (2005); at Wyoming Creek, collected in 2008 by Hartman; and at Top Lake, collected in 2009 by Kosovich-Anderson (Kosovich- Anderson 2010).

One of the putative Wyoming Plant Species of Concern, *Carex scirpodea* Michx. var. *scirpiformis* (Mack.) O'Neill & Duman (Canadian single-spike sedge, Cyperaceae), is in the current State flora (Dorn 2001), but not accepted as distinct from *C. scirpodea* var. *scorpoidea* by Dunlop (2002). The only other known population of this variety in Wyoming is from the Flat Creek Fen in the National Elk Refuge near Jackson. In Swamp Lake Fen it is associated with *Carex simulata*, *Eleocharis quinqueflora*, and *Triglochin maritima*; it grows in graminoid-dominated portions of the fen on calcium carbonate-rich peat and on fen borders dominated by stunted spruce forest (Fertig and Jones 1992). It was first collected in Wyoming at Swamp Lake Fen in 1984 by Dorn (Evert et al. 1986) and was later surveyed by Fertig (Fertig and Jones 1992).

Two Wyoming Plant Species of Concern are known from moist habitats adjacent to fens in the Beartooth Mountains, but have not been documented growing on peat: *Carex infirminervia* (*C. deweyana* var. *bolanderi* misappl.) and *Viburnum edule*, collected in the Clarks Fork River Valley. Four additional Wyoming Species of Concern are known from moist habitats bordering alpine fens in the Beartooth Mountains, but have not been documented growing on peat: *Juncus triglumis* var. *triglumis*, *Kobresia sibirica*, *Koenigia islandica*, and *Phippsia algida* (see the information on Littlerock Creek Fen and Wyoming Creek).

Disturbances

Fens are vulnerable to anthropogenic and natural disturbances (Rocchio 2006a,b; Weixelman and Cooper 2009; Weixelman et al. 2007). Management or land use activities that disturb the groundwater-dependent hydrological regime of a fen, causing drying or warming, are potential threats (Sikes et al. 2010). Anthropogenic disturbances observed in Beartooth fens include roads, grazing, ditches, and noxious weeds. Natural disturbances include fire and concentrated use by wildlife (Heidel and Rodemaker 2008). Levels of anthropogenic disturbances are lower in Beartooth fens compared to levels reported for fens in the Sierra Nevada Mountains of California (Sikes et al. 2010; Weixelman and Cooper 2009), in the San Juan Mountains of Colorado (Chimner et al. 2010), and in mountains of west-central Colorado (Austin and Cooper 2015; Johnston et al. 2012).

Anthropogenic Disturbances

Most land use history in the Beartooth Mountains predates the National Environmental Protection Act (NEPA) of 1969, and is alluded to but not chronicled in the preparation of NEPA documents of the Shoshone NF and the revised Shoshone NF Management Plan (USDA Forest Service 2015a).

Three of the 18 fens described in this publication are located in or adjoining the Beartooth Highway (U.S. Highway 212) corridor that is proposed for widening. Little Bear Fen is crossed by the highway, Clay Butte Fen is bordered by the highway, and Wyoming Creek is directly below the highway. Surveys identified them as vulnerable (ERO Resources Corporation 1999a,b, 2000) and avoidance measures were proposed to move construction out of fen habitat or to design construction with features (bridges, culverts) to minimize hydrological alteration at the Little Bear Lake Fen. During construction of Chief Joseph Highway (State Highway 296) in the the 1970s, the highway was paved and the culvert at the outlet of Swamp Lake Fen was replaced. Water impoundments, drainage, and diversions were absent in fens in the study area, except for one ditch remnant that was observed at the south end of the study area in the Clarks Fork Valley (Heidel and Rodemaker 2008).

Cattle and horse grazing operations in the Clarks Fork Valley are based out of private ranches in the valley. Sheep grazing was historically widespread in alpine and subalpine elevations of the Beartooth Mountains, but the last of all sheep allotments were retired by about 2000 (Decision Notice of January 9, 2003). Several of the high elevation fens are hummocky above the wetland, possibly reflecting the legacy of sheep-grazing. One rare species, *Amerorchis rotundifolia*, is considered to be palatable to livestock (Fertig 1995) and others, including *Muhlenbergia glomerata* and *Primula egaliksensis*, are inferred to be palatable (Fertig 1995). The rare shrub species *Arctostaphylos rubra* was thought to be browsed more heavily by elk and moose than by livestock (Fertig 1995). Past grazing may have affected population numbers of rare species, and influenced microsite soil and hydrological conditions. The species described in the previous section occur at Swamp Lake Fen, where grazing by horses is excluded from the fen.

Commercial timber harvest in the Beartooth Mountains was limited to the Clarks Fork Valley, and limited by access. In 1989, salvage logging took place on hillslopes above Swamp Lake Fen following the Clover Mist Fire (1988). The Beartooth fens described here are mostly free of weeds and nonnative plant species in general. *Cirsium arvense*, a common

weedy species, was found at two Beartooth fens (Appendix). Encroachment by nonnative species seeded to stabilize the eroding soil above Swamp Lake Fen includes *Astragalus cicer*, growing directly above the fen (Heidel 3034 RM) and in low numbers in the fen.

Natural Disturbances

Signs of elk and moose were common in Beartooth fens and included browsing, trampling, and scat. There was no evidence that wildlife use affected shrub vigor or longevity. Old, unoccupied beaver lodges were present where *Populus tremuloides* grew above fens of the Clarks Fork Valley (Heidel and Rodemaker 2008).

The most recent major fire in the study area was the Clover Mist Fire (1988), a stand-replacing fire that burned the wooded hillslopes above Swamp Lake Fen. After the fire, water runoff and erosion increased and deep gullies formed on adjoining slopes; debris flows were noted in 1989 and 1992 (Fertig and Jones 1992). The extensive Clover Mist Fire also burned near Rock Lake Fen. Disturbance by wildfire can alter runoff, snow interception, water percolation, groundwater flows, and surface flow volume and timing (Luce et al. 2012) but has not been evaluated in the study area.

The fen fieldwork conducted in the Beartooth Mountains from 2002 to 2007 coincided with a period in which more than 70 percent of Wyoming was in moderate to exceptional drought through most or all of the growing season (Wyoming State Climate Office 2015), consistent with field observations in the Beartooth Mountains study area. At Ghost Creek Fen and Rock Creek Fen, the floating mats that appeared on aerial imagery were not buoyant when visited in 2005. At Ghost Creek Fen, Rock Creek Fen, and Lily Lake Fen, the transition from wetland vegetation to adjacent upland vegetation was dominated by *Calamagrostis canadensis*. Although this grass species is native, it is tolerant of shifts from aerobic to anaerobic conditions, conferring competitive advantage under fluctuating water levels.

Future Directions

In this final section, recommendations for future work on fens of the Beartooth Mountains and elsewhere are presented, similar to the framework proposed for fens of California (Sikes et al. 2010). Related policy directives and steps toward improved management of fens on national forests are briefly described.

Inventory

Over the past decade, there has been increased interest in documenting fen resources on public lands in Wyoming (Heidel 2011; Heidel 2012; Heidel 2013 a,b; Heidel and Jones 2006; Heidel and Laursen 2003 a,b; Heidel and Rodemaker 2008; Heidel and Thurston 2004; Lemly 2007; Lemly and Cooper 2011; Mellmann-Brown 2004) and in Colorado (Austin 2008; Austin and Cooper 2015; Chimner et al. 2010; Johnston et al. 2012; Lyon et al. 2007). The following factors have contributed to the need for improved information on the distribution of fens: increased awareness of the rare plants and other biota that occur in fens; the unique ecosystem qualities of many fens, particularly carbon and water storage; recognition that fens are irreplaceable and very old ecosystems (Charman 2002)—most fens in the Rocky Mountains are more than 6,000 years old; the potential for fens to serve as indicators of climate change (Drexler et al. 2013); and revised policy directives with explicit language

addressing groundwater-dependent ecosystems (GDEs). The development of standardized inventory protocols by the Forest Service Groundwater Program has resulted in more consistent data collection and data management for fens and springs on national forests (USDA 2012b,c).

More information is needed on fens in the Beartooth Mountains. For Wyoming, most of the unsurveyed fens are small (<0.4 ha; 1 ac) and many are located in theAbsaroka-Beartooth Wilderness Area. A systematic fen inventory is warranted for the Beartooth Mountains in Montana. More work on alpine fens is needed in both States, including documentation of peat thickness and continuity. A comprehensive inventory of GDEs, including springs, fens, and other groundwater-fed wetlands, throughout the Beartooth Mountains would be informative, particularly in areas of high wetland density. This effort would ideally include additional biotic inventories (fauna, vascular and nonvascular flora) to improve documentation of local and regional biodiversity, thus contributing to more informed management on the Shoshone NF. More complete floristic inventories are needed for quantitative comparisons and biodiversity assessments among Rocky Mountain fens. The National Wetlands Inventory mapping (USDI Fish and Wildlife Service 2014) and 1-m resolution color digital orthophoto imagery of the National Agricultural Imagery Program (NAIP) became available for the study area after the 2005–2007 fieldwork, and offer additional resources for conducting inventories of Beartooth fens.

Classification

Statewide wetland vegetation has been classified in Montana (Hansen et al. 1995) and in Colorado (Carsey et al. 2003), with advances in Wyoming by Walford et al. (2001) and others. However, outstanding gaps exist in the study area and the rest of Wyoming. A classification for Wyoming wetland vegetation and an ecological classification of fens would ideally include bryophyte species, reflecting their contributions to biomass, vegetation cover, and diversity. Classification of Beartooth fens would cover a wide range of conditions and serve as a springboard for wetland classification work elsewhere in the State.

Groundwater chemistry is critical in regulating the distribution of fen vegetation in mountainous regions (Lemly and Cooper 2011; Weixelman and Cooper 2009). Expanded baseline research on peat and groundwater chemistry is warranted in the Beartooth Mountains, within and among fens and and over time (table 2). Resulting information would contribute to classification of Beartooth fens and provide valuable context for existing vegetation and water chemistry data over the elevation gradient within the Beartooth Mountains. Comparisons with existing fen classifications that incorporate water chemistry could then be conducted (Bridgham et al. 1996; Vitt 2006; Wheeler and Proctor 2000).

Research and Monitoring

Fens in the Beartooth Mountains occur across a wide range of elevations, geomorphic settings, and substrates that influence peat-forming processes, local hydrology, and biodiversity. This range of fen settings provides a natural laboratory for monitoring and research.

Fens require stable hydrological conditions and are important for their water storage and release capacities. Hydrological research and monitoring are needed at select sites to address site-specific questions. For example, at Sawtooth Palsa Fen, monitoring depth to permafrost and discharge at the two outlet streams could assist in determining the impact of

climate change on the hydrology of this unique fen and surrounding wetland. At Swamp Lake Fen, hydrological data on surface flow could contribute to assessing impacts of the drained wetland upstream, an elevated outlet downstream, and postfire runoff in the absence of forest regeneration since the 1988 fire. If management activities on the Shoshone NF have the potential to impair fen functionality, hydrological monitoring would be warranted.

Mountainous areas are the only locations in Wyoming where precipitation exceeds evaporation (Curtis and Grimes 2004), and mountain snowpacks serve as Wyoming's primary source of water. Many mountain fens occur in headwater positions with outlets but no inlets. Research on fen water storage and release, possibly in tandem with research on nutrient storage and release, could provide landscape-scale perspectives documenting the role of fens in watershed hydrology. Improved understanding of the hydrology of mountain fens would contribute to the evaluation of potential climate change impacts, including vulnerability assessments for mitigation and adaptative management on national forests (Littell et al. 2012).

Globally, peatlands store carbon and nitrogen, retaining about one-third of the world's soil carbon and 16 to 28 percent of the world's soil nitrogen while occupying only 3 to 4 percent of the Earth's surface (Dise 2009; Vitt 2014). Peat thickness in fens of the Beartooth Mountains (table 2) and elsewhere (Chimner et al. 2010) suggests that cumulative carbon storage could be considerable in mountain ranges with high fen densities. Basic research on carbon dynamics, quantification of carbon pools, determinants of local and regional peat accumulation, and potential impacts of climate change are needed for mountain fens thoughout the western United States. In addition, little is known about the nutrient status of mountain fens, including nitrogen and other macronutrients, as well as micronutrients.

Repeat visits to document trends in the rare species described in this report would inform future conservation efforts. Monitoring of rare plant populations would include periodically assessing population numbers and extent, as well as visiting and documenting additional sites with habitat potential to support certain species. Monitoring of rare plant populations is a high priority for species that occur in fens subject to management-related hydrological changes and current or potential encroachment of invasive species. Changes in plant phenology and visitation by pollinating insects have been documented for high elevation environments throughout the western United States (Boggs and Inouye 2012; Inouye et al. 2000, 2002). Although many rare fen species are wind-pollinated, tracking seasonal changes and annual patterns of plant phenology and pollinator visitation could contribute to assessment of climate change impacts.

Peatlands have long been recognized as archives of past environments (Charman 2002). Accumulated peat can contain charcoal, pollen, and microfossils and macrofossils of past vegetation, as well as records of the ecological and hydrological development of the peatland itself through charcoal, diatoms, invertebrate remains, and testate amoebae shells. Limited palynological information has been collected in the study area (Whitlock and Bartlein 1993). For Beartooth fens, additional radiocarbon dates at a specific site could provide insights into the initiation of peat accumulation and spatial development of the fen. Additional radiocarbon dates over a range of elevations and in different environments could elucidate patterns of peat accumulation over past millennia in response to changing climates. In concert with other paleoecology research, such as lake cores, examination of peat cores from the Beartooth Mountains could contribute to reconstruction of past vegetation and climatic conditions in this part of the Rocky Mountains.

Conservation and Management

Recognition of the ecological values of Beartooth fens has resulted in special designation, partially with the intention of protecting and fostering future research at these sites. Swamp Lake Special Botanical Area is designated (Johnston 1987), and a proposal to designate Sawtooth Palsa Fen as a Special Geological Area (Sawtooth Peatbed Geological Area) is included in the Shoshone NF Resource Management Plan revision (USDA Forest Service 2015a). Final designation awaits an establishment report. Likewise, the Lake Creek proposed Research Natural Area, which includes Lily Lake East Fen and Poke Lake Fen, awaits an establishment report. Poke Lake Fen and Rock Creek Fen are located within the Absaroka-Beartooth Wilderness, which provides protection from many management activities and assures maintenance of natural conditions and processes (Public Law 98-550). Management guidance for fens without special designation is provided by regional peatland policies, and the Shoshone NF Management Plan.

Management of fens and other GDEs has been hampered on public lands due to limited information on their locations, characteristics, and condition. Improved inventory and assessment of fens is occurring across national forests nationwide, facilitated by the development of protocols, guidance, and assistance from the Forest Service Groundwater Program (USDA Forest Service 2007). For improved management of fens, the first step for many Forest Service management units is the assessment of GDE resources and identification of management or land use activities that may be affecting the groundwater resources (USDA Forest Service 2007). The work of resource managers supports agency commitments to protect, conserve, and restore waters, watersheds, and listed wildlife and plant species and their habitats and to conserve biological diversity. For fens and other GDEs, this work begins with information about their distribution, condition, function, and value, as well as the influence of current management (USDA Forest Service 2010). This report summarizes work to date on fens that occur on a portion of the Shoshone NF, but additional inventory and assessment are needed, as noted earlier. For many national forests, next steps include integration of GDE protection with other management (roads, timber, grazing) and conservation priorities. Where fens have been compromised by management or land use, restoration efforts should be guided by the best available science and information regarding the specific site(s).

A review of statutes and policies that establish management requirements related to GDEs can be found in the Groundwater Dependent Ecosystem Inventory and Monitoring Business Requirements Analysis (USDA Forest Service 2012a,b). In addition, several sections of the 2012 Planning Rule (USDA Forest Service 2012c) include further consideration of GDEs during the revision of forest plans.

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Appendix—Vascular flora of Beartooth Mountains Fens, Wyoming.

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Abies lasiocarpa var. *lasiocarpa*	*Abies bifolia*	subalpine fir	Pinaceae	X															X		
Acer glabrum		Rocky Mountain maple	Aceraceae																X		
Actaea rubra		red baneberry	Ranunculaceae																X		
Agoseris glauca		pale agoseris	Asteraceae															X			X
Agoseris lackschewitzii		Milk Creek agoseris	Asteraceae	X																	
Agrostis exarata		spike bentgrass	Poaceae															X	X		
Agrostis mertensii		northern bentgrass	Poaceae															X			
Agrostis scabra	*Agrostis hiemalis*	rough bentgrass	Poaceae																X		
Agrostis stolonifera		creeping bentgrass	Poaceae																X	X	
Agrostis variabilis		mountain bentgrass	Poaceae			X												X		X	
Allium brevistylum		shortstyle onion	Alliaceae																X		
Allium cernuum		nodding onion	Alliaceae																X		
Alnus incana ssp. *tenuifolia*		thinleaf alder	Betulaceae					X	X		X								X		
Alopecurus pratensis		meadow foxtail	Poaceae								X								X		
Amerorchis rotundifolia	*Orchis rotundifolia*	roundleaf orchid	Orchidaceae																X		
Anemone multifida var. *multifida*	*Anemone multifida* var. *hudsoniana*, *A. m.* var. *sansonii*	Pacific anemone	Ranunculaceae																X		
Anemone parviflora		smallflowered anemone	Ranunculaceae	X															X		
Angelica arguta		Lyall's angelica	Apiaceae	X															X		
Antennaria corymbosa		flat-top pussytoes	Asteraceae	X									X								
Antennaria lanata		woolly pussytoes	Asteraceae			X				X								X			X

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Antennaria luzuloides		rush pussytoes	Asteraceae															X			
Antennaria microphylla		littleleaf pussytoes	Asteraceae																X		
Antennaria pulcherrima		handsome pussy-toes	Asteraceae						X		X								X		
Arceuthobium americanum		American dwarf mistletoe	Viscaceae					X													
Arctostaphylos rubra	*Arctous rubra*	red fruit bearberry	Ericaceae																X		
Arctostaphylos uva-ursi		bearberry	Ericaceae																X		
Arnica mollis		hairy arnica	Asteraceae				X											X			
Astragalus cicer		chickpea milkvetch	Fabaceae																X		
Astragalus eucosmus		elegant milkvetch	Fabaceae												X			X	X		
Astragalus miser			Fabaceae																X		
Betula glandulosa		timber milkvetch	Betulaceae	X		X		X	X		X				X				X		
Botrychium virginianum		rattlesnake fern	Ophioglossaceae																X		
Bromus ciliatus		fringed brome	Poaceae			X															
Bromus inermis var. *inermis*		smooth brome	Poaceae																X		
Bromus marginatus	*Bromus marginatus* var. *carinatus*	mountain brome	Poaceae																X		
Calamagrostis canadensis		bluejoint	Poaceae	X	X	X	X	X	X		X	X			X	X	X	X	X		X
Calamagrostis purpurascens		purple reedgrass	Poaceae															X			
Calamagrostis rubescens		pinegrass	Poaceae																X		
Calamagrostis stricta ssp. *inexpansa*	*Calamagrostis inexpansa*	northern reedgrass	Poaceae								X						X	X	X		

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Calamagrostis stricta ssp. *stricta*		slimstem reedgrass	Poaceae												X						X
Callitriche palustris		vernal water-starwort	Plantaginaceae							X											
Callitriche stenoptera		northern water-starwort	Plantaginaceae							X								X			
Caltha leptosepala		white marsh marigold	Ranunculaceae	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X
Calypso bulbosa		fairy slipper	Orchidaceae																X		
Cardamine breweri		Brewer's bittercress	Brassicaceae																X		
Carex aquatilis		water sedge	Cyperaceae	X		X		X	X	X	X			X	X	X	X	X	X	X	
Carex aurea		golden sedge	Cyperaceae								X				X	X			X		
Carex bebbii		Bebb's sedge	Cyperaceae																		
Carex buxbaumii		Buxbaum's sedge	Cyperaceae	X		X		X								X	X		X		
Carex canescens		silvery sedge	Cyperaceae	X		X	X	X	X	X				X		X		X			
Carex capillaris		hair-like sedge	Cyperaceae								X				X				X		
Carex concinna		low northern sedge	Cyperaceae																X		
Carex diandra		lesser panicled sedge	Cyperaceae	X		X		X	X		X				X		X		X		
Carex disperma		softleaf sedge	Cyperaceae	X				X	X						X		X		X		
Carex gynocrates	*Carex dioica*	northern bog sedge	Cyperaceae	X		X	X				X			X	X			X	X		
Carex haydeniana		cloud sedge	Cyperaceae																		X
Carex heteroneura var. *chalcioleps*	*C. atrata* var. *chalcioleps*	Holm sedge	Cyperaceae							X											
Carex illota		sheep sedge	Cyperaceae		X		X			X		X	X	X				X		X	X
Carex interior		inland sedge	Cyperaceae			X			X						X				X		
Carex lachenalii	*Carex bipartita*	twotipped sedge	Cyperaceae	X														X			
Carex lasiocarpa		woollyfruit sedge	Cyperaceae			X		X			X				X		X				
Carex leptalea		bristlystalked sedge	Cyperaceae	X		X			X		X								X		
Carex limosa		mud sedge	Cyperaceae	X		X		X	X	X	X		X		X	X	X		X	X	
Carex livida	*C. livida* var. *radicaulis*	livid sedge	Cyperaceae	X															X		
Carex macloviana		thickhead sedge	Cyperaceae																X		X

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Carex microglochin		fewseeded bog sedge	Cyperaceae			X													X		
Carex microptera	*Carex festivella,* var. *C. macloviana* var. *microptera*	smallwing sedge	Cyperaceae															X	X	X	
Carex misandra	*Carex fuliginosa*	shortleaved sedge	Cyperaceae									X									X
Carex nebrascensis		Nebraska sedge	Cyperaceae																		
Carex nelsonii		Nelson's sedge	Cyperaceae									X									X
Carex neurophora		alpine nerve sedge	Cyperaceae															X			
Carex nigricans		black alpine sedge	Cyperaceae															X			
Carex norvegica var. *stevenii*	*Carex stevenii*	Steven's sedge	Cyperaceae	X																	
Carex paysonis		Payson's sedge	Cyperaceae															X			X
Carex pellita	*Carex lanuginosa*	woolly sedge	Cyperaceae															X	X		
Carex petasata		Liddon sedge	Cyperaceae																X		
Carex phaeocephala		dunhead sedge	Cyperaceae															X			X
Carex praeceptorum		early sedge	Cyperaceae															X			
Carex praegracilis		clustered field sedge	Cyperaceae																X		
Carex pyrenaica		Pyrenean sedge	Cyperaceae			X	X		X												X
Carex saxatilis		rock sedge	Cyperaceae	X						X	X							X			
Carex scirpoidea ssp. *pseudoscirpoidea*		western singlespike sedge	Cyperaceae															X			X
Carex scirpoidea ssp. *scirpoidea*	*Carex scirpoidea* ssp. *scirpiformis*	northern singlespike sedge	Cyperaceae																X		
Carex scopulorum		mountain sedge	Cyperaceae	X	X	X	X			X		X	X	x				X		X	X
Carex simulata		analogue sedge	Cyperaceae	X							X								X		
Carex utriculata	*Carex rostrata* var. *utriculata*	Northwest Territory sedge	Cyperaceae	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Carex vesicaria		blister sedge	Cyperaceae	X	X	X	X		X				X		X	X	X				
Castilleja miniata		giant red Indian paintbrush	Orobanchaceae			X															
Castilleja rhexifolia		splitleaf Indian paintbrush	Orobanchaceae				X											X			X
Catabrosa aquatica		water whorlgrass	Poaceae																		
Ceratophyllum demersum		Coon's tail	Ceratophyllaceae																X		
Chamerion angustifolium var. *angustifolium*	*Epilobium angustifolium* var. *angustifolium*	fireweed	Onagragaceae	X							X							X	X		
Chimaphila umbellata var. *occidentalis*		pipsissewa	Ericaceae																X		
Cicuta maculata		spotted water hemlock	Apiaceae												X						
Cinna latifolia		drooping woodreed	Poaceae																		
Cirsium arvense		Canada thistle	Asteraceae						X										X		
Cirsium scariosum		meadow thistle	Asteraceae																X		
Cirsium vulgare		bull thistle	Asteraceae																X		
Comarum palustre	*Comarum palustre*	purple marshlocks	Rosaceae			X	X	X	X		X					X	X		X		
Cornus sericea	*Cornus stolonifera* var. *stolonifera*	redosier dogwood	Cornaceae																X		
Danthonia intermedia		timber oatgrass	Poaceae	X														X			
Danthonia unispicata		onespike danthonia	Poaceae														X		X		
Dasiphora fruticosa ssp. *floribunda*	*Potentilla fruticosa*; *Pentaphylloides floribunda*	shrubby cinquefoil	Rosaceae				X	X	X		X				X				X		

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Deschampsia cespitosa		tufted hairgrass	Poaceae	X	X	X	X			X	X	X		X		X		X	X	X	X
Deschampsia elongata		slender hairgrass	Poaceae																		
Dodecatheon pulchellum	*Dodecatheon pauciflorum*	darkthroat shootingstar	Primul	X																	
Draba albertina		slender draba	Brassicaceae									X						X			X
Drosera anglica		English sundew	Droseraceae			X					X						X				
Eleocharis palustris		common spikerush	Cyperaceae															X	X		
Eleocharis quinqueflora	*Eleocharis pauciflora*	fewflower spikerush	Cyperaceae	X	X		X				X		X						X		
Eleocharis rostellata		beaked spikerush	Cyperaceae																X		
Elymus glaucus		blue wildrye	Poaceae																		
Elymus spicatus	*Agropyron spicatum;* & *Pseuodroegneria spicata*; includes ssp. *inermis* & ssp. *spicata*	bluebunch wheatgrass	Poaceae																X		
Elymus trachycaulus var. *trachycaulus*	*Agropyron caninum*	slender wheatgrass	Poaceae			X									X				X		
Epilobium anagallidifolium		pimpernel willowherb	Onagraceae				X			X								X			X
Epilobium ciliatum var. *ciliatum*		fringed willowherb	Onagraceae						X										X		
Epilobium halleanum		glandular willowherb	Onagraceae			X															
Epilobium leptophyllulm		bog willowherb	Onagraceae				X	X			X								X		
Equisetum arvense		field horsetail	Equisetaceae	X					X						X				X		

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Equisetum fluviatile		water horsetail	Equisetaceae																		
Equisetum hyemale var. *affine*		scouringrush horsetail	Equisetaceae	X															X		
Equisetum variegatum		variegated scouringrush	Equisetaceae	X					X										X		
Erigeron acris		bitter fleabane	Asteraceae																X		
Erigeron peregrinus var. *callianthemus*	*Erigeron peregrinus* var. *scaposus; E. glacialis* var. *glacialis*	subalpine fleabane	Asteraceae																X		
Eriophorum angustifolium	*Eriophorum polystachion*	tall cottongrass	Cyperaceae	X	X	X	X	X		X	X			X		X	X	X			
Eriophorum callitrix		arctic cottongrass	Cyperaceae									X									
Eriophorum chammisonis		Chamisso's cottongrass	Cyperaceae			X	X	X									X				
Eriophorum gracile		slender cottongrass	Cyperaceae	X		X			X		X						X				
Eriophorum viridicarinatum		thinleaf cottonsedge	Cyperaceae																X		
Eurybia conspicua	*Aster conspicuus*	western showy aster	Asteraceae																X		
Festuca brachyphylla		alpine fescue	Poaceae															X			
Festuca minutiflora		smallflower fescue	Poaceae																		X
Fragaria vesca		woodland strawberry	Rosaceae	X															X		
Fragaria virginiana		Virginia strawberry	Rosaceae								X								X		
Frasera speciosa	*Swertia radiata*	elkweed	Gentianaceae																X		
Galium boreale		northern bedstraw	Rubiaceae																X		
Galium trifidum		threepetal bedstraw	Rubiaceae				X	X	X									X	X		

Species scientific name (PLANTS)	Synonym	Common name (PLANTS)	Family	Clay Butte Fen	Fantan Fen	Ghost Creek Fen	Lake WGN Fen	Lily Lake East Fen	Lily Lake Fen	Little Bear Lake Fen	Little Moose Lake Fen	Littlerock Creek Fen	Meadow Lake Fen	Meadow Lake North	Mud Lake Fen	Poke Lake Fen	Rock Creek Fen	Sawtooth Palsa Fen	Swamp Lake Fen	Trail Fen	Wyoming Creek
Galium triflorum		fragrant bedstraw	Rubiaceae																X		
Gentiana affinis	*Pneumonanthe affinis*	pleated gentian	Gentianaceae																X		
Gentiana algida		whitish gentian	Gentianaceae									X						X			X
Gentianella amarella	*Gentianella amarella* ssp. *acuta*	autumn dwarf gentian	Gentianaceae												X				X		
Gentianella tenella		Dane's dwarf gentian	Gentianaceae						X						X			X			
Gentianopsis thermalis	*Gentiana detonsa*	Rocky Mountain fringed gentian	Gentianaceae	X		X	X	X	X		X				X				X		
Geranium richardsonii		Richardson's geranium	Geraniaceae						X												
Geranium viscosissimum	*Geranium viscosissimum* var. *nervosum*	sticky purple geranium	Geraniaceae																X		
Geum macrophyllum var. *perincisum*		largeleaf avens	Rosaceae						X		X				X				X		
Glyceria borealis		small floating mannagrass	Poaceae						X								X				
Glyceria striata		fowl mannagrass	Poaceae						X										X		
Goodyera oblongifolia		western rattlesnake plantain	Orchidaceae																X		
Heracleum maximum	*Heracleum lanatum; H. sphondylium ssp. lanatum*	common cowparsnip	Apiaceae																X		
Heuchera cylindrica var. *cylindrica*		roundleaf alumroot	Saxifragaceae																X		
Hippuris vulgaris		common mare's-tail	Hippuridaceae						X						X		X		X		
Hordeum brachyantherum		meadow barley	Poaceae	X															X		
Hordeum jubatum		foxtail barley	Poaceae																X		

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Juncus arcticus ssp. *littoralis*	*Juncus balticus*; *J. arcticus* var. *balticus*	mountain rush	Juncaceae								X				X				X		
Juncus biglumis		twoflowered rush	Juncaceae									X									X
Juncus brevicaudatus		narrowpanicle rush	Juncaceae																X		
Juncus castaneus		toad rush	Juncaceae																		X
Juncus drummondii		Drummond's rush	Juncaceae	X								X						X			X
Juncus ensifolius		swordleaf rush	Juncaceae																X		
Juncus longistylus		longstyle rush	Juncaceae	X					X										X		
Juncus mertensiana		Mertens' rush	Juncaceae		X		X	X					X					X			X
Juncus parryi		Parry's rush	Juncaceae											X							
Juncus triglumis	*Juncus triglumis* var. *triglumis*	three-hulled rush	Juncaceae																		X
Juniperus communis var. *depressa*		common juniper	Cupress																X		
Juniperus horizontalis		creeping juniper	Cupress								X								X		
Kalmia microphylla		alpine laurel	Ericaceae							X			X			X	X	X		X	X
Kobresia myosuroides	*Kobresia bellardii*	Bellardi bog sedge	Cyperaceae	X															X		X
Kobresia simpliciuscula		simple bog sedge	Cyperaceae																X		
Koenigia islandica		island purslan	Polygonaceae									X									X
Lactuca tatarica	*Lactuca pulchella*	Tatarian honeysuckle	Asteraceae																X		
Ledum glandulosum		western Labrador tea	Ericaceae	X				X				X				X		X			
Lemna turionifera		turion duckweed	Lemnaceae																X		

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Leucopoa kingii	*Hesperochloa kingii*	spike fescue	Poaceae																X		
Linnaea borealis	*Linnaea borealis* ssp. *americana*	twinflower	Linnaceae								X								X		
Listera cordata		heartleaf twayblade	Orchidaceae																X		
Lonicera involucrata		twinberry honeysuckle	Caprifoliaceae	X					X								X		X		
Luzula multiflora var. *frigida*		common woodrush	Juncaceae																		X
Luzula parviflora		smallflowered woodrush	Juncaceae	X			X	X										X			
Luzula spicata		spiked woodrush	Juncaceae															X			X
Lycopodium annotinum		stiff clubmoss	Lycopodiaceae			X															
Maianthemum racemosum	*Smilacina racemosa*	feathery false lily of the valley	Convallariaceae																X		
Maianthemum stellatum	*Smilacina stellata*	starry false lily of the valley	Convallariaceae																X		
Medicago sativa		alfalfa	Fabaceae																X		
Melilotus officinalis		yellow sweetclover	Fabaceae																X		
Menyanthes trifoliata		buckbean	Menyanthaceae	X		X			X		X				X	X	X		X		
Mimulus guttatus	Erythranthe guttata	seep monkeyflower	Phyrmaceae																		
Mitella pentandra		fivestamen miterwort	Saxifragaceae																X		
Mitella stauropetala		smallflower miterwort	Saxifragaceae																X		
Moneses uniflora	*Pyrola uniflora*	single delight	Ericaceae																X		
Muhlenbergia andina		foxtail muhly	Poaceae																X		
Muhlenbergia filiformis		pullup muhly	Poaceae																X		

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Muhlenbergia glomerata	Included in *Muhlenbergia racemosa* by some authors	spiked muhly	Poaceae																X		
Muhlenbergia richardsonis		mat muhly	Poaceae																X		
Myriophyllum sibiricum	*Myriophyllum exalbescens M. spicatum* var. *exalbescens*	shortspike watermilfoil	Haloragaceae												X				X		
Nemophila breviflora			Hydrophllaceae	X																	
Nuphar lutea ssp. *polysepala*		Rocky Mountain pond-lily	Nymphaceae	X	X				X						X		X				
Orthilia secunda	*Pyrola secunda*	sidebells wintergreen	Ericaceae						X										X		
Osmorhiza depauperata		bluntseed sweetroot	Apiaceae																X		
Oxytropis deflexa var. *sericea*		blue nodding locoweed	Fabaceae																X		
Packera indecora		elegant groundsel	Asteraceae						X						X				X		
Packera paupercula	*Senecio pauperculus*	balsam groundsel	Asteraceae																X		
Packera subnuda	*Senecio cymbalarioides*; *Packera buekii*	Buek's groundsel	Asteraceae	X	X		X	X	X	X	X	X	X	X			X	X		X	X
Parnassia fimbriata var. *fimbriata*		fringed grass of Parnassus	Parnassiaceae	X	X														X		
Parnassia palustris var. *montanensis*	Includes var. *tenuis*	mountain grass of Parnassus	Parnassiaceae						X						X				X		
Pedicularis groenlandica		elephanthead lousewort	Plantaginaceae	X	X	X	X	X	X	X	X			X		X	X	X	X		
Pedicularis oederi		Oeder's lousewort	Plantaginaceae																		X

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Petasites frigidus var. *sagittatus*	*Petasites sagittatus*	arctic sweet coltsfoot	Asteraceae								X								X		
Phippsia algida		icegrass	Poaceae									X									X
Phleum alpinum		alpine timothy	Poaceae				X	X		X						X		X			X
Phleum pratense		timothy	Poaceae	X															X		
Phyllodoce empetriformis		pink mountainheath	Ericaceae				X	X										X			
Picea engelmannii		Engelmann spruce	Pinaceae	X		X		X	X		X								X		
Picea glauca		white spruce	Pinaceae			?					?								X		
Pinus contorta var. latifolia		lodgepole pine	Pinaceae	X		X		X	X		X						X		X		
Pinus flexilis		limber pine	Pinaceae																X		
Plantago major		common plantain	Plantaginaceae																X		
Platanthera aquilonis	Included in *Habenaria hyperborea*	northern green orchid	Orchidaceae	X							X				X				X		
Platanthera obtusata	*Habenaria obtusata*	bluntleaved orchid	Orchidaceae	X					X										X		
Poa alpina		alpine bluegrass	Poaceae															X			X
Poa arida	*Poa glaucifolia*	plains bluegrass	Poaceae								X								X		
Poa arnowiae		Wasatch bluegrass	Poaceae																		
Poa leptocoma		marsh bluegrass	Poaceae															X	X		
Poa palustris		fowl bluegrass	Poaceae																X		
Poa pratensis		Kentucky bluegrass	Poaceae						X										X		
Poa reflexa		nodding bluegrass	Poaceae	X																	
Poa trivialis		rough bluegrass	Poaceae																X		
Poa wheeleri		Wheeler's bluegrass	Poaceae															X			
Polygonum amphibium	*Polygonum coccineum; Persicaria coccinea*	water knotweed	Polygonaceae																X		
Polygonum bistortoides		American bistort	Polygonaceae							X		X						X			X

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Polygonum viviparum	*Bistorta vivipara*	alpine bistort	Polygonaceae	X			X	X				X	X	X		X		X	X		X
Populus tremuloides		quaking aspen	Salicaceae																X		
Potamogeton alpinus		alpine pondweed	Potamogetonaceae														X				
Potamogeton amplifolius		largeleaf pondweed	Potamogetonaceae				X														
Potamogeton epihydrous		ribbonleaf pondweed	Potamogetonaceae													X					
Potamogeton foliosus		leafy pondweed	Potamogetonaceae																X		
Potamogeton illinoiensis		Illinois pondweed	Potamogetonaceae																		
Potamogeton praelongus		whitestem pondweed	Potamogetonaceae								X										
Potamogeton pusillus var. *pusillus*		small pondweed	Potamogetonaceae			X													X		
Potentilla diversifolia		varileaf cinquefoil	Rosaceae	X								X			X			X			X
Potentilla effusa	*Potentilla hippiana* var. *effusa*	branched cinquefoil	Rosaceae																X		
Potentilla gracilis		slender cinquefoil	Rosaceae	X							X								X		
Primula egaliksensis		Greenland primrose	Primulaceae																X		
Prosartes trachycarpa	*Disporum trachycarpum*	roughfruit fairybells	Calochortaceae																X		
Pseudotsuga menziesii var. *glauca*		Douglas-fir	Pinaceae	X															X		
Pyrola asarifolia		liverleaf wintergreen	Ericaceae																X		
Pyrola chlorantha	*Pyrola virens*	greenflowered wintergreen	Ericaceae																X		

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Pyrola minor		snowline wintergreen	Ericaceae			X															
Ranunculus cymbalaria		alkali buttercup	Ranunculaceae																X		
Ranunculus eschscholtzii		Eschscholtz's buttercup	Ranunculaceae															X			X
Ranunculus hyperboreus		high northern buttercup	Ranunculaceae																		X
Ranunculus longirostris	*Ranunculus aquatilis* var. *diffusa*	longbeak buttercup	Ranunculaceae																		
Ranunculus pygmeus		pygmy buttercup	Ranunculaceae																		X
Ranunculus sceleratus var. *multifidus*	*Hecatonia scelerata*	cursed buttercup	Ranunculaceae																X		
Ranunculus uncinatus		Idaho buttercup	Ranunculaceae																X		
Rhodiola integrifolia	*Sedum integrifolium*	varileaf cinquefoil	Crassulaceae																		X
Ribes cereum var. *pedicellare*	Includes *Ribes cereum* var. *inebrians*	whisky currant	Grossulariaceae																X		
Rorippa palustris var. brevicaudata		bog yellowcress	Brassicaceae																X		
Rosa acicularis ssp. *sayi*		prickly rose	Rosaceae						X												
Rosa woodsii		Woods' rose	Rosaceae																X		
Rubus idaeus ssp. *strigosus*	*Rubus idaeus* var. *aculeatissimus*	varileaf cinquefoil	Rosaceae																X		
Rubus parviflorus		thimbleberry	Rosaceae																X		
Rumex crispus		varileaf cinquefoil	Polygonaceae																X		
Salix barclayi		Barclay's willow	Salicaceae														X				
Salix barrattiana		varileaf cinquefoil	Salicaceae																		X
Salix bebbiana		varileaf cinquefoil	Salicaceae						X										X		

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Salix boothii		Booth's willow	Salicaceae						X						X				X		
Salix brachycarpa		shortfruit willow	Salicaceae			X	X		X									X	X		
Salix candida		sageleaf willow	Salicaceae						X						X				X		
Salix drummondiana		Drummond's willow	Salicaceae	X																	
Salix eastwoodiae		mountain willow	Salicaceae	X																	X
Salix farriae		Farr's willow	Salicaceae	X							X										
Salix geyeriana		Geyer willow	Salicaceae						X										X		
Salix glauca		grayleaf willow	Salicaceae							X		X									X
Salix interior	*Salix exigua* var *interior*; *S. e.* var. *pedicellata*	sandbar willow	Salicaceae																X		
Salix lutea		yellow willow	Salicaceae						X												
Salix myrtillifolia		blueberry willow	Salicaceae																X		
Salix nivalis	*Salix reticulata*	varileaf cinquefoil	Salicaceae									X									X
Salix petrophila	*Salx arctica* ssp. *petraea*	varileaf cinquefoil	Salicaceae																		X
Salix planifolia		diamondleaf willow	Salicaceae	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X
Salix pseudomonticola		false mountain willow	Salicaceae																X		
Salix wolfii		Wolf's willow	Salicaceae					X	X									X	X		X
Sambucus racemosa var. *melanocarpa*		Rocky Mountain elder	Adoxaceae																X		
Saxifraga cespitosa		tufted alpine saxifrage	Saxifragaceae																		X
Saxifraga odontoloma		brook saxifrage	Saxifragaceae				X	X													
Saxifraga subapetala		Yellowstone saxifrage	Saxifragaceae									X									
Schoenoplectus acutus var. *occidentalis*	*Scirpus acutus*	tule	Cyperaceae																X		
Schoenoplectus tabernaemontani	*Scirpus validus*	softstem bulrush	Cyperaceae																X		

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Scutellaria galericulata		marsh skullcap	Menyanthaceae						X												
Sedum rhodanthum		redpod stonecrop	Crassulaceae		X		X			X		X						X			X
Senecio amplectens	*Senecio amplectens*	showy alpine ragwort	Asteraceae									X									
Senecio integerrimus		lambstongue ragwort	Asteraceae	X		X						X			X						
Senecio lugens		small blacktip ragwort	Asteraceae																X		
Senecio serra		tall ragwort	Asteraceae																X		
Shepherdia canadensis		russet buffaloberry	Elaegnaceae								X								X		
Sibbaldia procumbens		creeping sibbaldia	Rosaceae															X			
Sisyrinchium idahoense var. *occidentale*		varileaf cinquefoil	Iridaceae																X		
Solidago missouriensis var. fasciculata		Missouri goldenrod	Asteraceae																X		
Sorbus scopulina var. *scopulina*		Greene's mountain ash	Rosaceae																X		
Sparganium angustifolium		narrowleaf bur-reed	Sparganiaceae		X				X					X		X	X			X	
Sparganium natans	*Sparganium minimum*	small bur-reed	Sparganiaceae							X					X				X		
Spiraea betulifolia var. *lucida*		shinyleaf spirea	Rosaceae																X		
Spiranthes romanzoffiana		hooded lady's tresses	Orchidaceae	X		X	X	X			X					X	X		X		
Stellaria borealis		boreal starwort	Caryophyllaceae															X			
Stellaria longifolia		longleaf starwort	Caryophyllaceae																X		
Stellaria longipes		longstalk starwort	Caryophyllaceae															X	X		X

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Stuckenia filiformis	*Potamogeton filiformis*	fineleaf pondweed	Potamogetonaceae																X		
Swertia perennis		felwort	Gentianaceae						X										X		
Symphoricarpos albus		common snowberry	Caprifoliaceae																X		
Symphyotrichum boreale	*Aster junciformis; A. borealis*	northern bog aster	Asteraceae																X		
Symphyotrichum foliaceum var. *apricum*	*Aster foliaceus* var. *apricus*		Asteraceae	X		X				X				X				X			X
Symphyotrichum lanceolatum ssp. *hesperium* var. *hesperium*	*Aster lanceolatus* var. *hesperius; A. hesperius*	white panicle aster	Asteraceae					X		X									X		
Symphyotrichum spathulatum	*Aster spathulatus*	western mountain aster	Asteraceae														X	X			
Taraxacum laevigatum		rock dandelion	Asteraceae																X		
Taraxacum officinale		common dandelion	Asteraceae								X								X		
Thalictrum alpinum		alpine meadow-rue	Ranunculaceae								X								X		
Thalictrum occidentale		western meadow-rue	Ranunculaceae	X					X										X		
Tragopogon dubius		yellow salsify	Asteraceae																X		
Trichophorum pumilum	*Scirpus pumilus*; *S. rollandii*	Rolland's bulrush	Cyperaceae																X		
Trifolium hybridum		alsike clover	Fabaceae																X		
Trifolium pratense		red clover	Fabaceae																X		
Trifolium repens		white clover	Fabaceae																X		

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Triglochin maritima		seaside arrowgrass	Juncaginaceae																X		
Triglochin palustris		marsh arrowgrass	Juncaginaceae																X		
Trisetum spicatum		spike trisetum	Poaceae	X								X									X
Trisetum wolfii		Wolf's trisetum	Poaceae	X														X			
Trollius laxus var. *albiflorus*	*Trollius albiflorus*	American globeflower	Ranunculaceae				X	X							X			X			X
Typha latifolia		broadleaf cattail	Typhaceae												X				X		
Utricularia macrorhiza	*Utricularia vulgaris*	common bladderwort	Lentibulariaceae	X					X						X				X		
Utricularia minor		lesser bladderwort	Lentibulariaceae	X		X		X								X			X		
Vaccinium scoparium		grouse whortleberry	Ericaceae					X	X		X							X			
Vahlodea atropurpurea	*Deschampsia atropurpurea*	mountain hairgrass	Poaceae																X		
Valeriana occidentalis		western valerian	Valerianaceae								X				X						
Veronica americana		American speedwell	Plantaginaceae																X		
Veronica wormskoldii		American alpine speedwell	Plantaginaceae	X														X			X
Viola macloskeyi var. *pallens*		smooth white violet	Violaceae						X		X						X		X		
Viola palustris		marsh violet	Violaceae					X													

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