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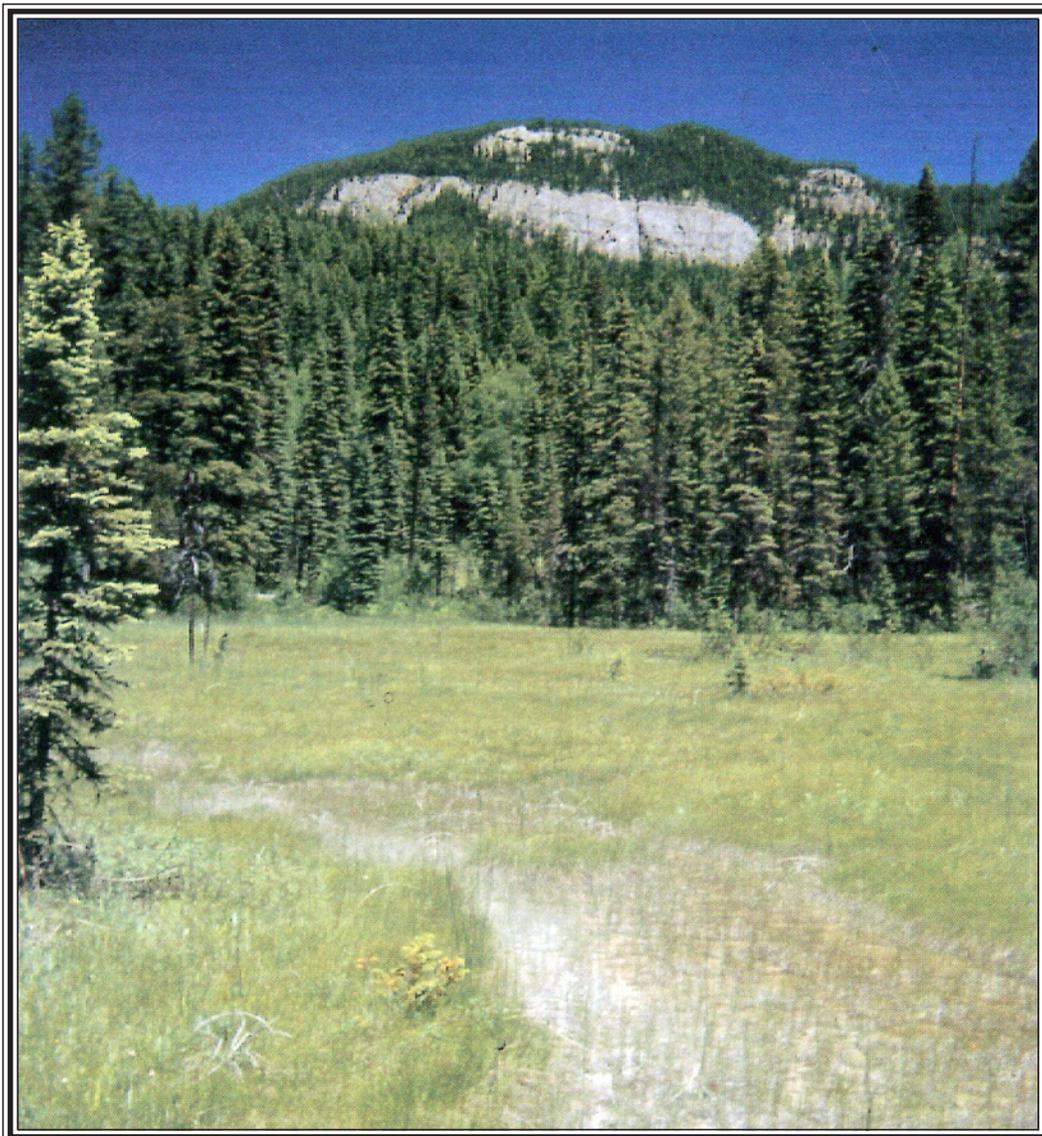
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Peatlands on National Forests of the Northern Rocky Mountains: Ecology and Conservation

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Research Summary

Peatlands are an uncommon landscape feature in the Northern Rocky Mountains of the United States and provide habitat for a number of plant and animal species dependent on these environments. As such, peatlands are an important contributor to local and regional biological diversity. Peatlands also have considerable scientific value (via coring) as repositories of pollen and ash deposits, providing insight into postglacial vegetation and climates. Included in this report are a description of the physical components, vegetation, vascular and nonvascular flora, and invertebrate fauna associated with peatlands on National Forests in northeastern Washington, Idaho, and Montana. Also included are descriptions of 58 sites representative of the diversity of peatlands present within the study area. Research needs and conservation tools to protect peatlands are discussed.

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Introduction

Peatlands are generally defined as wetlands with waterlogged substrates and approximately 30 cm or more of **peat**¹ accumulation (Kivinen and Pakarinen 1981). Once peat has developed to this depth, the availability of oxygen and nutrients essential to plant growth drops sharply, and plant roots must obtain their mineral nutrients from the saturated, oxygen-poor peat. Lack of oxygen and cool temperatures limit plant growth, microbial decomposition, and subsequent nutrient cycling. Peatlands are, therefore, dependent on external supplies of nutrients from either the atmosphere or inflowing, mineral-enriched water.

Peatlands are most extensive in northern latitudes with cool, humid climates where precipitation exceeds evapotranspiration. They are best developed on low-elevation, nearly level landforms having some degree of impeded drainage. Worldwide, extensive peatland areas occur in boreal regions, including significant portions of Siberia, Eastern Europe, Finland, Canada, and Alaska. In North America, major peatland areas are located in the Hudson Bay lowlands and Great Slave and Great Bear Lake areas of Canada, and the Glacial Lake Agassiz region of Canada and northern Minnesota (fig. 1) (Zoltai and Pollet 1983). An estimated 12 percent of Canada's land area is peatland (Zoltai 1988).

In the Northern Rocky Mountains² of the United States, peatlands are uncommon, in large part due to a climate unfavorable to their extensive development. Peatlands become even rarer southward in the cordillera. For example, in the central and southern Rocky Mountains of Wyoming and Colorado, there may be sites with adequate moisture or humidity for peatland development, but intense solar radiation may be unfavorable to the establishment of peatland plants (Larsen 1982). In the same area, summer dry

periods may limit plant growth and peat accumulation. A number of species often found in peatlands, including *Orchis rotundifolia*³ (round-leaved orchis) and *Cypripedium passerinum* (sparrow's-egg lady's-slipper), range southward into the United States along the Rocky Mountains, reaching their southern limit in Idaho, Montana, Wyoming, or Colorado (Cooper and Andrus 1994).

Peatlands are characterized by extreme environmental conditions not found in other wetland ecosystems. Due to their great mass of water-holding organic matter, peatlands are exceptionally stable and may persist for centuries. In the absence of disturbance, peatlands support **autogenic** or self-perpetuating communities. Anaerobic, acidic, and nutrient-poor peatland conditions limit decay of organic matter. This suite of environmental conditions that leads to the widespread formation of peatlands in far northern latitudes is uncommon in the Northern Rocky Mountains of the United States. The combination of habitat rarity, habitat stability, and extreme

¹Words in bold italics are defined in the glossary. The glossary also includes terms generally used to describe peatland environments and features not included in this report.

²In this report, Northern Rocky Mountains is used as a generic term to encompass the study area of Idaho, western Montana, and northwestern Wyoming. Most peatlands included here lie within the Temperate Steppe Regime Mountains Division of Bailey and others (1994). At the province level, the peatlands occur within the Northern, Middle, and Southern Rocky Mountains Provinces.

³Due to the lack of common names for many of the plant species discussed in this report, we have elected to use scientific names as the standard reference. Appendix A provides a list of common names, and in addition we have selectively used common names (in parentheses) where we thought it would help the less technical reader.

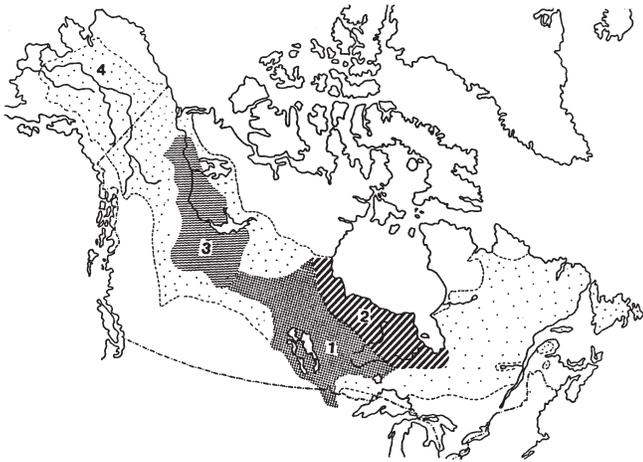


Figure 1—Major peatland concentrations in North America: (1) Glacial Lake Agassiz region, (2) Hudson Bay lowlands, (3) Great Bear-Great Slave Lake region, (4) Interior Alaska. Lightly stippled areas mark boreal regions of Canada and Alaska (Glaser 1987).

habitat conditions explain the distinctiveness of the flora in peatlands, as well as the high concentrations of rare species that are restricted to peatland environments in the Western United States. For example, in Idaho about 10 to 15 percent of the State’s rare flora are restricted to peatlands (Bursik and Moseley 1992c). The ecological, scientific, and aesthetic values of peatlands are disproportionately high compared to their extent on the landscape.

Despite their uniqueness, few studies on peatlands had been conducted in the Northern Rocky Mountains of the United States until recently (Lesica 1986; Rumely 1956). In contrast, many floristic and ecological studies of peatlands have been conducted throughout other boreal and temperate parts of the world, including numerous studies in Canada (Slack and others 1980; Vitt and Slack 1975) and the Eastern United States (Crum 1988; Damman and French 1987; Glaser 1987). Beginning in 1987, peatland inventories and monitoring studies were initiated in Idaho (Bursik 1990, 1993; Bursik and Henderson 1995; Caicco 1987, 1988; Moseley 1989, 1990, 1992; Moseley and others 1991, 1992, 1994) and Montana (Chadde and Shelly 1995; Mantas 1993). Additional studies have focused on understanding community-level and landscape-level patterns in peatlands (Bursik 1993; Bursik and Moseley 1992a,b).

Objectives

This report summarizes preliminary reports and published and unpublished studies by the authors and

other researchers in the Northern Rocky Mountains of the United States. As such, study objectives varied somewhat in each case. The objective of this report is to describe the major ecological features of peatlands including: peatland types, peatland formation, classification of major plant communities, vascular and nonvascular flora, and invertebrate fauna. Major ecological processes affecting peatlands are outlined, although specific data apart from water chemistry measurements were not collected by the authors.

A second objective was to identify major threats to peatlands and discuss the significance of these threats to the continued existence of peatlands. Management techniques to maintain peatlands and to minimize adverse impacts to these ecosystems are also discussed.

A third objective was to evaluate the conservation significance of inventoried peatlands. A ranking system using seven criteria was developed to identify sites with a high conservation value.

Methods

Because this report summarizes a number of studies, peatland sampling and inventory procedures were varied. Cited publications and reports should be consulted for field methods and data analysis techniques. In field studies conducted by the authors, at a minimum, listings were compiled of vascular plant species encountered in each peatland. Mosses were also identified at most study sites or collected for later determination. Voucher specimens were placed at various regional herbaria including the University of Idaho, University of Montana, Missoula Forestry Sciences Laboratory (Rocky Mountain Research Station), Oregon State University, University of Iowa, and the University of Alberta. Most surveyors placed special emphasis on locating plant species listed as sensitive by the U.S. Department of Agriculture, Forest Service or as species of special concern by the Idaho Conservation Data Center (IDCDC) and Montana Natural Heritage Program (MTNHP). Vascular plant nomenclature and authority names follow Hitchcock and Cronquist (1973). A common wetland sedge commonly referred to as beaked sedge was erroneously referred to as *Carex rostrata* in previous studies in the region. In this report, this species is named *Carex utriculata* (Griffiths 1989). *Carex rostrata* is apparently rare and may be present in northwestern Montana but was not encountered during peatland inventories by the authors. Moss nomenclature follows Anderson and others (1990), except for *Sphagnum*, which follows Anderson (1990).

Site Selection

Peatlands were selected for sampling based on previously published studies, interviewing knowledgeable local sources, reviewing air photos, and by searching

element occurrence records maintained by State natural heritage programs for species typically found in peatlands. A ranking system was developed to evaluate the biological and conservation significance of each peatland. Sites included in this report represent a subset of peatlands present in the region and are also a subset of the inventoried sites. First, only those occurring on National Forest lands are included. Apart from two sites in Wyoming, all the peatlands have been personally visited by one or more of the authors of this report. Second, only those peatlands having a moderate to high significance are described. It should be emphasized that a number of significant peatlands, especially those found at lower elevations, are privately owned, and many of them have not been studied in any detail. Similarly, high-elevation peatlands have been somewhat under-sampled due to their inaccessibility (Cooper and Lesica 1992). However, subalpine and peatlands generally lack the rare species found in lower elevation peatlands (Bursik and Henderson 1995).

Plant Community Sampling

A shared objective of a number of studies was an attempt to develop a classification of the major plant communities characteristic of peatlands in the region. Site description and community sampling methods

and forms developed by the Western Heritage Task Force of The Nature Conservancy (Bourgeron and others 1992) were used in Montana by Chadde and Shelly (unpublished data on file at the Northern Region Botany Program, Missoula, MT) and in Idaho by Moseley and others (1994). Circular sample plots having an area of 50 m² were subjectively placed within patches of homogeneous vegetation possessing a relatively uniform structure, composition, and hydrologic regime. In Idaho, Bursik (1993) used ECODATA sampling techniques detailed in Jensen and others (1994).

Plots were grouped into tentative community types by considering the dominant vascular plant species, similarities in environmental factors (especially substrate and hydrologic characteristics), and grouping resulting from ordinations by the authors and other researchers. In Montana, tentative community types were compared to those in a comprehensive, State-wide wetland classification developed by the Montana Riparian and Wetland Association (Hansen and others 1995).

Site Evaluation and Ranking

To assess the conservation significance of peatlands in the Northern Rocky Mountains, a ranking system was developed and used to evaluate each site's ecological features (table 1). The system was then used

Table 1—Conservation significance ranking criteria for Northern Rocky Mountain peatlands.

Attribute	Ranking
Representativeness	<ol style="list-style-type: none"> 3. Site is an outstanding example of a particular vegetation type or peatland feature. 2. Site is an adequate example of a particular vegetation or peatland type, but its value may be lessened by other factors. 1. Site is a fair to poor example of a particular vegetation or peatland type; other factors may be influencing the site.
Quality	<ol style="list-style-type: none"> 3. Site is essentially pristine; human impacts absent or minimal. 2. Some impacts apparent in surrounding watershed that may affect peatland, for example, nearby timber harvests, livestock grazing, roads. 1. Peatland has been directly affected by impacts such as draining, ditching, or exotic species.
Rarity	<ol style="list-style-type: none"> 3. Site has a high concentration of rare species, uncommon vegetation types, or peatland features. 2. Site has a low to moderate concentration of rare species, uncommon vegetation types, or peatland features 1. Rare species, uncommon vegetation types, or peatland features low in number or absent.
Diversity	<ol style="list-style-type: none"> 3. Site has a high diversity of vegetation types or peatland features. 2. Site has a moderate diversity of vegetation types or peatland features. 1. Site has a low diversity of vegetation types or peatland features.
Viability	<ol style="list-style-type: none"> 3. Site has a high probability to persist over the long term. 2. Site has moderate potential of persisting over the long term. 1. Site may not persist over the long term.
Defensibility	<ol style="list-style-type: none"> 3. Site protection feasible, completed, or already proposed. 2. Site protection possible. 1. Site protection difficult or unlikely.
Scientific and educational value	<ol style="list-style-type: none"> 3. Site has a demonstrated value for research and education; site is reasonably accessible to researchers or visitors. 2. Site has potential scientific and educational value; access varies. 1. Site has limited value for research or education; access may be difficult.

to identify highly significant peatlands and to direct conservation efforts. The system is modified from evaluation schemes developed for peatlands in Minnesota (Wright and others 1992), Maine (Davis and others 1983), and Idaho (Bursik and Moseley 1995; Jankovsky-Jones 1996; Rabe and Savage 1977).

For each peatland, seven criteria were subjectively assessed:

Representativeness—Emphasis was given to peatlands typifying the range of peatland features such as type of peatland, topographic setting, and vegetation type. Geographic representativeness is also important so that peatlands occurring within a broad range of environmental conditions are included in a representative system of protected peatlands. In this study, geographic representativeness was not used as a ranking factor because the peatlands inventoried by the authors span most of the Northern Rocky Mountains.

Quality—Peatlands undisturbed by adverse human or other negative impacts such as ditching, trampling, or invasive species were assigned a higher value.

Rarity—Emphasis was given to those peatlands having concentrations of rare plants, rare plant communities, or uncommon peatland features.

Diversity—Higher value was given to those peatlands having the greatest diversity of plant communities and other peatland components.

Viability—Emphasis was given to peatlands most likely to persist into the future, and sites that were least vulnerable to adverse human influences. Important factors include size of peatland, habitat diversity, position in the watershed, and source of water maintaining the peatland.

Defensibility—Higher value was given to peatlands having a high feasibility for protection through special designations or appropriate management practices. Sites already protected were also given high values.

Scientific and Educational Value—Peatlands having a demonstrated or potential value for research or education were judged to be of greater importance than sites with limited research or educational value.

Peatland Distribution

In the Northern Rocky Mountains, peatlands generally occur as small, discreet landscape features. On National Forests in the Northern Rocky Mountains, 29 peatlands in Idaho, 24 peatlands in Montana, three peatlands in northeastern Washington, and two peatlands in northwestern Wyoming are described in this report (table 2). Peatlands also occur on private lands in the region, typically at lower elevations. Several of these are protected by The Nature Conservancy, such as Montana's Pine Butte Swamp Preserve west of Choteau.

Table 2—Peatland sites on National Forests (NF) in Idaho, northeastern Washington, western Montana, and northwestern Wyoming. RD = Ranger District, RNA = Research Natural Area, SIA = Special Interest Area, p = proposed, TNC = The Nature Conservancy. See appendix B for descriptions of each site.

Site location	Special	Designation
Idaho		
<i>Bonner County</i>		
Armstrong Meadows	Kaniksu NF, Priest Lake RD	—
Bismark Meadows	Kaniksu NF, Priest Lake RD	—
Bottle Lake	Kaniksu NF, Priest Lake RD	RNA
Dubius Creek Fen	Kaniksu NF, Priest Lake RD	—
Hager Lake Fen	Kaniksu NF, Priest Lake RD, private	—
Hoodoo Lake	Kaniksu NF, Priest Lake RD	—
Kaniksu Marsh	Kaniksu NF, Priest Lake RD	RNA
Lamb Creek Meadows	Kaniksu NF, Priest Lake RD, private	—
Lost Lake	Kaniksu NF, Sandpoint RD	—
Mosquito Bay Fen	Kaniksu NF, Priest Lake RD, private	—
Packer Meadows	Kaniksu NF, Priest Lake RD	—
Potholes	Kaniksu NF, Priest Lake RD	RNA
Upper Priest Lake Fen	Kaniksu NF, Priest Lake RD, State of Idaho	—
<i>Boundary County</i>		
Beaver Lake (North)	Kaniksu NF, Bonners Ferry RD, State of Idaho	—
Bog Creek Fen	Kaniksu NF, Bonners Ferry RD	—
Cow Creek Meadows	Kaniksu NF, Bonners Ferry RD	—
Grass Creek Meadows	Kaniksu NF, Bonners Ferry RD	—
Perkins Lake	Kaniksu NF, Bonners Ferry RD, private	—
Robinson Lake	Kaniksu NF, Bonners Ferry RD	—
Sinclair Lake	Kaniksu NF, Bonners Ferry RD	—
Smith Creek	Kaniksu NF, Bonners Ferry RD	RNA
Three Ponds	Kaniksu NF, Bonners Ferry RD	RNA (con.)

Table 2 (Con.)

Site location	Special	Designation
<i>Custer County</i>		
Blind Summit Fen	Challis NF, Yankee Fork RD and Sawtooth NF, Sawtooth National Recreation Area	—
Iron Bog	Challis NF, Lost River RD	RNA
Sawtooth Valley Peatlands includes Bull Moose Fen Huckleberry Creek Fen Mays Creek Fen	Sawtooth NF, Sawtooth National Recreation Area	RNA
<i>Fremont County</i>		
Big Springs—Henry's Fork Confluence	Targhee NF, Island Park RD	pSIA
<i>Kootenai County</i>		
Rose Lake	Coeur D'Alene NF, State of Idaho, private	—
<i>Lemhi County</i>		
Birch Creek Fen	Targhee NF, Dubois RD, State of Idaho, private	TNC preserve
<i>Valley County</i>		
Tule Lake	Boise NF, Cascade RD	—
Washington		
<i>Pend Oreille County</i>		
Deerhorn Creek Meadows	Kaniksu NF, Priest Lake RD	—
Huff Lake Fen	Kaniksu NF, Priest Lake RD	—
Sema Meadows	Kaniksu NF, Priest Lake RD	—
Montana		
<i>Beaverhead County</i>		
Leonard Creek Fen	Beaverhead NF, Madison RD	—
Skull Creek Fens	Beaverhead NF, Wise River RD	RNA
<i>Flathead County</i>		
Bent Flat Fen	Flathead NF, Spotted Bear RD	—
Gregg Creek Fen	Flathead NF, Tally Lake RD	—
Mud Lake	Flathead NF, Spotted Bear RD	Wilderness
Sanko Creek (North)	Flathead NF, Tally Lake RD	—
Sanko Creek (South)	Flathead NF, Tally Lake RD	—
Sheppard Creek Fen	Flathead NF, Tally Lake RD	—
Trail Creek Fen	Flathead NF, Spotted Bear RD	—
Trout Lake	Flathead NF, Spotted Bear RD	—
<i>Lake County</i>		
Lost Creek Fens	Flathead NF, Swan Lake RD	—
Porcupine Fen	Flathead NF, Swan Lake RD	—
Swan River Fen	Flathead NF, Swan Lake RD	RNA
<i>Lewis & Clark County</i>		
Indian Meadows	Helena NF, Lincoln RD	RNA
<i>Lincoln County</i>		
Bowen Creek Fen	Flathead NF, Tally Lake RD	—
Cody Lake Fen	Kootenai NF, Fisher River RD	—
Hawkins Pond	Kootenai NF, Three Rivers RD	—
Tepee Lake	Kootenai NF, Libby RD	—
<i>Missoula County</i>		
Sheep Mountain Bog	Lolo NF, Missoula RD	RNA
Shoofly Meadows	Lolo NF, Missoula RD	RNA
Windfall Creek Fen	Flathead NF, Swan Lake RD	—
<i>Powell County</i>		
Butcher Mountain Fens	Flathead NF, Spotted Bear RD	Wilderness
<i>Ravalli County</i>		
Lost Trail Pass Fen	Bitterroot NF, Sula RD	pSIA
Rock Creek Wetland	Bitterroot NF, Darby RD	—
Wyoming		
<i>Park County</i>		
Sawtooth Fen-Palsa	Shoshone NF	—
Swamp Lake	Shoshone NF	SIA

Idaho and Northeastern Washington

Bursik (1990) recognized two major peatland settings in Idaho and northeastern Washington: valley peatlands and subalpine peatlands. Valley peatlands generally occur around lakes and ponds at relatively low elevations in major river valleys from northern Idaho to eastern Idaho. The biodiversity of Idaho's valley peatlands is high. Although wide-ranging across the State, valley peatlands are very rare, and contain some of the highest concentrations of rare species found in Idaho. Valley peatlands are characterized by numerous boreal species whose Idaho populations are disjunct from the main portion of their range in boreal regions of Canada.

Subalpine peatlands are more common throughout Idaho and northeastern Washington. They generally form along low-gradient, subalpine streams. Subalpine peatlands are characterized by plant species common throughout the western cordillera.

Montana

In Montana, peatlands are concentrated in the western one-third of the State. They are present in all life zones, including foothills, intermontane valley floors, montane and subalpine coniferous forests, and alpine tundra. The most extensive, floristically diverse concentration of peatlands occurs on the valley floor of the Swan Valley of northwestern Montana. This watershed is characterized by a moist climate, abundant surface water, generally calcareous substrate, and a post-glacial landscape featuring pot-holes and sidehill benches.

Northwestern Wyoming

Two peatlands from the Shoshone National Forest of northwestern Wyoming are included in this report: Swamp Lake and Sawtooth Peatbeds (the only *palsa* documented from the contiguous United States) (Collins and others 1984). Swamp Lake is a calcareous peatland featuring a number of vascular plants widely disjunct from their main ranges to the north (Evert and others 1986). Peatlands from the central Rocky Mountains have also been described in Wyoming (Cooper and Andrus 1994) and Colorado (Cooper 1991, 1996).

Physical Setting

Climate

The climate of the Northern Rocky Mountains is influenced by both maritime and continental patterns. The maritime influence producing relatively mild, wet winters is most pronounced in northern Idaho and

northwestern Montana. Traveling south and east in the region, the maritime influence decreases, and is replaced by a climate more typical of inland areas. The continental influence extends over most of the region in the summer months, bringing with it warm, dry weather and cool nights. Locally, temperature and precipitation patterns are complicated by topography, aspect, and elevation. Significant limitations to extensive peatland development apparently are the low humidities and prolonged dry periods characteristic of the region's summer months

Idaho—The climate of Idaho and extreme northeastern Washington has a strong maritime influence, especially in northern portions of the State (Ross and Savage 1967). This moderating effect decreases southward and eastward and is essentially absent from southeastern Idaho. Northern Idaho is influenced by prevailing westerly air masses from the Pacific Ocean during the winter and spring. These air masses bring prolonged, gentle rains, deep snow accumulation at higher elevations, cloudiness and frequent fog, high humidity, and winter temperatures 8 to 14 °C warmer than continental areas at similar latitudes (Cooper and others 1991). Data from the Priest River Experimental Forest in the Priest River Valley, best express the climate of peatland-supporting valleys in northern Idaho. The average annual precipitation of the Priest River Experimental Forest is 80 cm and the average annual temperature is 6.8 °C. Subalpine peatland sites in the Selkirk Mountains (for example, Smith Creek, Bog Creek, Grass Creek Meadows) probably have much higher annual precipitation and lower temperatures. Most of the precipitation occurs as snow (November through March). July and August are typically rather dry, generally averaging less than 2.5 cm precipitation per month (Ross and Savage 1967).

In central Idaho, the climate is moderated by a maritime climate during winter and early spring. Cloudy, wet weather is common. In late spring, the maritime influence is replaced by a continental climate. Dry, warm days and cold nights are typical. Precipitation occurs largely as intense but brief storms. Prolonged periods of little or no rain are quite common.

Montana—Montana west of the Continental Divide is strongly influenced by Pacific maritime air masses, although the area receives less precipitation and has cooler average temperatures than those of northern Idaho. Weather data for Kalispell (elevation 904 m) has a reported mean annual precipitation of 42 cm and an average yearly temperature of 5.8 °C (NOAA 1993). Most precipitation between November and March falls as snow. The wettest month of the year is June (6 cm), and the driest is July (3 cm) (NOAA 1993). Winters are cool and cloudy with occasional

arctic fronts that drop temperatures well below -18°C . Midsummer drought is common, and an important factor limiting the growth of peat-forming mosses (Crum 1988). Areas north and west of Kalispell have a similar climate, but precipitation and temperatures more closely resemble that of northern Idaho. Areas south of Kalispell are increasingly drier year-round.

East of the Continental Divide in Montana, the climate is quite different. The Pacific maritime influence is no longer prevalent. Rather, drier and cooler continental air masses tend to dominate. Winters are more severe and not as cloudy. Some areas experience more winds; chinook winds may lead to increased drying of exposed sites. Weather data for the town of Divide (1,648 m), near Skull Creek Meadows in southwestern Montana, report a mean annual precipitation of 32 cm and an average yearly temperature of 5.9°C (NOAA 1993).

Northwestern Wyoming—The Sawtooth Peatbeds site in northwestern Wyoming occurs in the subalpine zone of the Beartooth Mountains, at an elevation of 2,950 m. The site is characterized by long, cold winters and short, cool summers. At the Peatbeds site, wind is an important factor as it removes snow from the surface of the peatland (Collins and others 1984).

Geology

In the Northern Rocky Mountains, peatlands and other organic soil deposits occur in depressions associated with glacial till, glacial outwash, alluvial basins, or floodplain landforms. The frequency of occurrence and the size of peatlands vary across the State due to climate and the distribution of these landforms in which peatlands can form.

Idaho and Northeastern Washington—Prominent rock types in northern Idaho include granites of the Kaniksu Batholith and low-grade metamorphic Precambrian belt metasediments (Cooper and others 1991; Rabe and others 1986). Cordilleran ice sheets covered much of the Panhandle during the Pleistocene. The Selkirk Mountains were influenced more by recent late-Pleistocene and possibly Holocene alpine glaciation, as is the case with subalpine peatlands elsewhere in Idaho (Rabe and others 1986). Most northern Idaho peatlands occur in association with glacially influenced topographic features, such as cirques, kettles, scours, and outwash channels. Others, such as Kaniksu Marsh, occur in abandoned meander channels of rivers. The lack of calcareous sedimentary bedrock has produced peatlands mostly dominated by *sphagnum* mosses, rather than the *brown mosses* typical of peatlands in calcareous areas underlain by limestone. Vascular plant composition is also influenced by this difference.

Montana—Parent materials and formations are quite variable across the Northern Rocky Mountains in Montana. In the northwestern part of the State, the bedrock is predominantly meta-sedimentary rocks of the Proterozoic Era Belt supergroup. Major rock types are quartzite, siltite, argillite, and localized areas of limestone (USDA Forest Service 1995). During mountain building of the Cenozoic Era, block faulting resulted in intermountain valleys. The valley floors were first filled with deposits from eroded uplifted materials, and later with glacial tills and outwash during the Pleistocene Epoch 7,000 to 10,000 years ago (Alt and Hyndman 1986; USDA Forest Service 1983).

The mountains forming the Rocky Mountain Front and Sawtooth Range west of Great Falls are primarily limestones and sandstones. This bedrock supports peatlands dominated by brown mosses rather than sphagnum mosses, and a number of vascular plants associated with calcium-rich substrates.

The Bitterroot Range south of Missoula is comprised mostly of glaciated metamorphic rocks. Further south, granite from the eastern edge of the Idaho Batholith predominates. The Sapphire Range to the east is mainly Proterozoic sedimentary rocks with some granitic intrusions. The Sapphire Range and Bitterroot Valley floor north of Hamilton were never glaciated, however, glacial tills and outwash dominate the valley fill south of Darby. From there south to Lost Trail Pass, volcanic rock (rhyolite) dominates as the main parent material (Alt and Hyndman 1986).

Peatlands are uncommon in the southwest portion of the State. The peatlands of Skull Creek Meadows occur in the West Pioneer Range where parent materials are comprised of glacial drift, colluvium and residuum of metamorphosed sediments of the Precambrian Belt supergroup. Rock types of this sedimentary group are comprised of undifferentiated quartzite, siltite, argillite, carbonate, and sandstone. The west face of the Tobacco Root Mountains is comprised of basic to acidic metamorphic rocks. These are mostly undifferentiated gneiss, schist, amphibolite, granulite, marble, phyllite, and quartzite. Distinct metamorphic minerals such as kyanite, staurolite, sillimanite, and garnet are present locally.

Terrestrial Vegetation

The Northern Rocky Mountains lie within the western temperate coniferous forest ecosystem (Daubenmire 1969). Environmental gradients such as slope, aspect, precipitation, and elevation have important influences on the distribution of vegetation. Habeck (1987) defined several broad forest zones for this region: dry conifer woodlands dominated by *Pinus ponderosa* (ponderosa pine) and *Pinus flexilis* (limber

Table 3—General characteristics of fens and bogs (after Davis and Anderson 1991).

Characteristic	Fens	Bogs
Geographic distribution	Worldwide	Mainly boreal
Abundance	Numerous	Less numerous
Surface topography	Flat or concave	Convex (raised)
Peat depth	Shallow to deep	Deep
pH	Acidic to alkaline	Very acidic
Nutrient source	Ground water and precipitation	Precipitation
Productivity	Low to high	Low
Decomposition	Relatively high to moderate	Low
Floristic diversity	Low to high	Low

pine), and montane, inland forests of *Pseudotsuga menziesii* (Douglas-fir), *Larix occidentalis* (western larch), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock), *Abies grandis* (grand fir), *Pinus monticola* (western white pine), and hybrids of *P. engelmannii* x *P. glauca*. These forest types occur at low to moderate elevations. At higher elevations are subalpine and timberline forest of *Pinus contorta* (lodgepole pine), *Abies lasiocarpa* (subalpine fir), *Picea engelmannii* (Engelmann spruce), *Pinus albicaulis* (whitebark pine), *Tsuga mertensiana* (mountain hemlock), and *Larix lyallii* (subalpine larch).

Detailed vegetation descriptions are provided in a number of forest habitat type studies published for portions of the Northern Rocky Mountains including northern Idaho (Cooper and others 1991), central Idaho (Steele and others 1981), eastern Idaho and western Wyoming (Steele and others 1983), and Montana (Pfister and others 1977).

Peatland Types

A useful distinction can be made between two major types of peatland: **fen** and **bog**. The difference between the two is primarily based on the source of incoming water and nutrients (table 3). Continued peat accumulation such that the peatland surface becomes raised above the influence of the local **water table** leads to **ombrotrophic** “food from the sky” bog conditions. In the Northern Rocky Mountains, however, succession does not progress to this extent apart from hummocky bog microsites, and various types of fens are the major peatland type present in the region.

Fens develop on flat or gently sloping terrain and are concave or slightly raised above their surroundings (fig. 2a,b,c). Fens are **minerotrophic**, receiving nutrients from water that has percolated through mineral soil and bedrock, or which has run off from uplands into a surface source such as a creek before entering the fen. In reality, a gradient from nutrient-poor (bog and poor fen) to **mesotrophic** (sometimes termed intermediate fen) to relatively nutrient-rich peatland (rich fen) exists, sometimes within a single peatland complex.

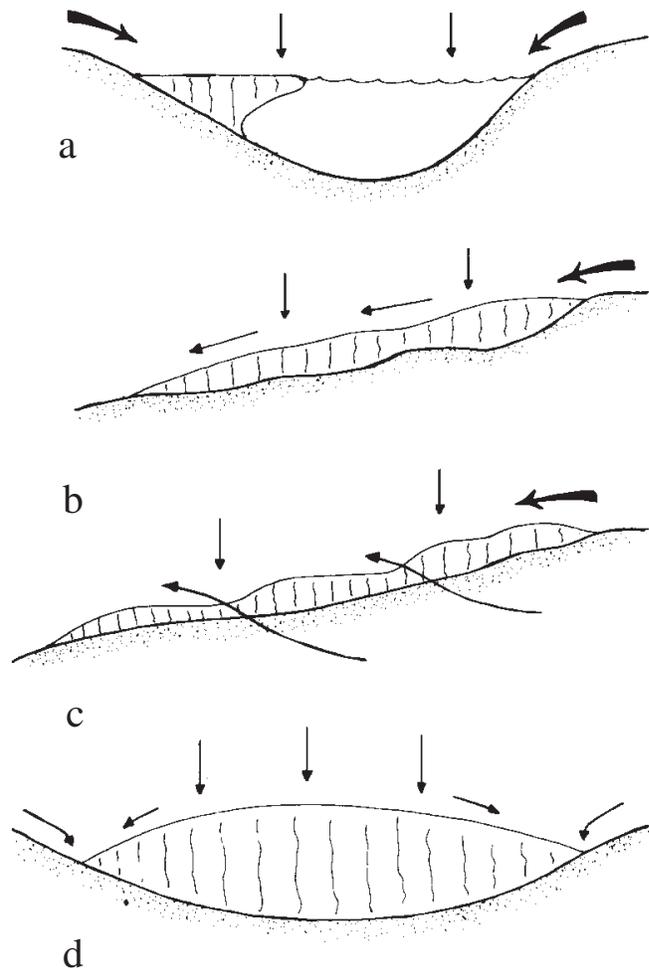


Figure 2—Major peatland types in the Northern Rocky Mountains and their water and nutrient sources: (a) Basin or lake-fill peatland, (b) Flow-through or slope peatland, (c) Patterned fen, a type of flow-through peatland, (d) bog (although essentially absent from the Northern Rocky Mountains, shown to illustrate a major difference between peatland types).

Fens of the Northern Rocky Mountains may be classified into three major types: poor fens, rich fens, and extremely rich fens. Distinctions exist between the three types with regard to water quality and vegetation composition. Ombrotrophic bogs are discussed briefly, although this extremely acidic, nutrient poor type of peatland is of incidental occurrence in the region.

Poor fens tend toward bog-like conditions and are codominated by bryophytes (especially sphagnum mosses) and a relatively small number of vascular species (notably members of the Cyperaceae and Ericaceae). In Minnesota, poor fens were defined as having a pH range of 4.2 to 5.8, and a calcium concentration of 2 to 10 mg/l (Glaser 1987).

Rich fens are dominated by a diverse mix of sedges, other grasslike species, shrubs, and true mosses (especially brown mosses, many genera of which are in the Amblystegiaceae). Rich fens are less acidic and have a greater concentration of calcium (10 to 30 mg/l) than poor fens (Glaser 1987).

Extremely rich fens have a very high pH (>7) and high calcium concentration (>30 mg/l) (Glaser 1987), and a characteristic species assemblage of species tolerant of highly calcareous conditions (calciphiles). In the Northern Rocky Mountains, extremely rich fens support more rare plant species than any other type of peatlands. **Marl** may comprise a large percentage of the substrate. Extremely rich fens are generally found near ground water discharge zones.

Because peatlands occur along an environmental continuum of water and nutrient conditions, the term intermediate fen is sometimes used to identify peatlands with characteristics intermediate between **poor fens** and **rich fens**. However, given their floristic and chemical similarities with poor fens, readily evident compositional differences between the two are absent, and for simplicity the terms poor fen, rich fen, and **extremely rich fen** may be used to adequately describe peatlands of the region.

Ombrotrophic or true **bogs** have a raised or convex surface (fig. 2d) and receive water and mineral nutrients from precipitation only. The received water is held above the underlying water table primarily by the low hydraulic conductivity of the peat mass. Capillary upward movement of water accounts for only a small part of the raised water table. Bog development is favored in areas with a climate having an excess of precipitation over evapotranspiration (Ingram 1983).

Bogs are characterized by a dominance of sphagnum mosses. Vascular plant species tolerant of extremely acidic, nutrient poor bog conditions are relatively few in number. Fens are often identified as “bogs” by laypersons and ecologists alike, particularly when they occur on floating mats. **Floating mats** are minerotrophic and are more accurately classified as

fens than as true bogs. Horton and others (1993) suggested adopting the terms sphagnum-rich (as in bogs and poor fens) and sphagnum-poor (rich and extremely rich fens) to replace the traditional, but often misapplied terms of bog and fen.

Several types of wetlands are sometimes confused with peatlands. **Marshes** are wetlands on mineral soil (although a large amount of decomposed organic matter may be present) with standing water for all or part of the year. In contrast to peatlands, marshes are well-aerated and rich in minerals. Common plant species of marshes include *Typha latifolia* (common cattail), *Phalaris arundinacea* (Reed canarygrass), and various coarse sedges, such as *Carex utriculata* and *C. atherodes*. **Sedge meadows** occur in shallow basins on mineral soil and are drier (for at least part of the year) than peatlands. Seasonal drying of the soil encourages microbial decomposition of plant remains, limiting organic matter accumulations. In northwestern Montana, the most common dominant of sedge meadows is *Carex lasiocarpa* (slender sedge), which is also common in peatlands.

Poor Fens

Apart from areas underlain by limestone, most peatlands in the Northern Rocky Mountains are best characterized as poor fens. Unlike bogs, these peatlands are in contact with minerally enriched ground water or receive surface runoff, and water pH is less acidic.

In general, peatlands of the region may be considered poor fens if they have a nearly continuous ground cover of sphagnum mosses. Poor fens are usually flat, acidic, and saturated to the surface or with shallow standing water. Vascular plants are present as scattered individuals rather than as a dense cover. Typical species include *Carex limosa* (mud sedge), *C. lasiocarpa*, *Dulichium arundinaceum* (Dulichium), *Potentilla palustris* (purple cinquefoil), *Vaccinium oxycoccos* (small cranberry) (Idaho only), and *Lycopus uniflorus* (northern bugleweed). Characteristic mosses include sphagnum mosses, particularly *S. subsecundum*, *S. fuscum*, and *S. angustifolium*, and brown mosses such as *Calliergon stramineum* and *Aulacomnium palustre*.

In Idaho, most of the poor fens have a nearly continuous ground layer of sphagnum mosses. Dominance is shared between **bryophyte** (moss and liverwort) and vascular species. High-elevation examples include Bog Creek Fen, Grass Creek Meadows, Cow Creek Meadows, and Smith Creek. Low-elevation peatlands with large areas of poor fens include Armstrong Meadows, Kaniksu Marsh, and Rose Lake.

In Montana, poor fens occur on noncalcareous bedrock such as the Belt series argillites and granites of the Idaho Batholith. Shoofly Meadows (Lolo National

Forest) near Missoula supports extensive poor fens along several drainages. Mary's Frog Pond (Lolo National Forest) features this type of fen in a basin setting.

Rich and Extremely Rich Fens

Floristically, rich fens (Vitt and Slack 1975) are the most diverse of the peatland types in the Northern Rocky Mountains. Geologically, rich fens are restricted to areas underlain by limestone. The water in rich fens ranges from only slightly acidic to alkaline, and is often distinctly calcareous (Chadde and Shelly 1995; Mantas 1993). *Calcareous fen* is sometimes used synonymously with rich fen. Deposits of **marl** (precipitated calcium carbonate) are typical of extremely rich fens. Most peatlands of Montana's Swan River Valley and the Glacier National Park area are best classified as rich fens. Rich fens occur throughout northern Idaho, generally as part of larger peatland complexes that also include poor and intermediate fens. Birch Creek Fen on the Targhee National Forest (Lemhi County) is perhaps the best rich fen example known from Idaho (Moseley 1992).

Rich fens are dominated by dense stands of sedges, spike rushes, and other grasslike plants. Typical species include *Carex lasiocarpa*, *C. limosa*, *C. livida* (pale sedge), *C. flava*, *C. interior* (inland sedge), *Eleocharis tenuis* (slender spike-rush), *E. rostellata* (beaked spike-rush), *Juncus alpinus* (northern rush), *J. balticus* (Baltic rush), *Eriophorum viridicarinatum* (green-keeled cotton-grass), and *E. chamissonis* (chamisso's cotton-grass). Shrubs such as *Betula glandulosa* (bog birch) and *Salix candida* (hoary willow) are often present as scattered, stunted clumps. The ground surface is covered by true mosses, mostly within the brown moss family. Commonly encountered bryophytes include *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Campylium stellatum*, and *Limprichtia revolvens*. *Scorpidium scorpioides* is sometimes found in wet depressions or hollows in fens with a high marl content. An uncommon moss, *Meesia triquetra*, is found only in calcium-rich fens. Sphagnum mosses are conspicuously absent or occur as widely scattered, small hummocks. In the rich fens of northwestern Montana, only two species of sphagnum occur with any regularity: *Sphagnum fuscum* and *S. warnstorffii*. In extremely rich fens such as Bent Flat and Trail Creek Fens (Flathead National Forest), sphagnum mosses are only present as widely scattered small hummocks.

In northern Idaho, dominant species of low-elevation (valley) rich fens include sedges such as *Carex lasiocarpa*, *C. utriculata* (beaked sedge), and *C. chordorrhiza* (rope-root sedge); other grasslike species include *Typha latifolia*, *Calamagrostis canadensis* (bluepoint reedgrass), and *Scirpus microcarpus* (small-flowered

bulrush). Typical shrubs include *Spiraea douglasii*, *Betula glandulosa*, and *Salix geyeriana*.

High-elevation (subalpine) rich fens in Idaho are typically characterized by *Carex scopulorum* (Rocky Mountain sedge), *C. aquatilis*, *Calamagrostis canadensis*, *Deschampsia cespitosa*, *Betula glandulosa*, and *Salix commutata* (undergreen willow). Brown mosses, including *Aulacomnium palustre* and *Calliergon stramineum*, are sometimes common, but under dense stands of sedges and other herbaceous plants, mosses are sometimes sparse.

Ombrotrophic Bogs

While nearly all peatlands of the Northern Rocky Mountains are best considered fens (Windell and others 1986), scattered microsites are present that could be considered ombrotrophic bogs. These sites are composed of hummocks formed by sphagnum mosses such as *Sphagnum fuscum* or *S. angustifolium*. Often the base of a shrub or a downed log supports the moss. The best examples of peatlands with bog-like microsites occur in far northern Idaho, which on average receive more summer precipitation than other areas of the region. Lack of summer precipitation is a major factor limiting the development of bogs (Crum 1988). This appears to be the case in the Northern Rocky Mountains where, due to summer drought and extremely low humidity, growth of sphagnum above the water table is limited, and poor fens rather than bogs are the likely end point of peatland succession on noncalcareous sites.

In northern Idaho, Chase Lake features pronounced sphagnum hummocks covering small areas. Similar hummocks exist at Huff Lake Fen, Armstrong Meadows, and Mosquito Bay Fen over old stumps. The apparently ombrotrophic microsites are dominated by *Sphagnum fuscum*, *S. magellanicum*, *S. centrale*, *S. angustifolium*, and *Polytrichum strictum*. In the summer, the topmost surface of the hummocks tends to dry, limiting their ability to expand upward and outward as in cooler, more humid climates.

Peatland Formation

Three major processes account for the development of most types of peatlands: *lake-filling*, *flow-through succession*, and **paludification** (fig. 2). Peatlands in the Northern Rocky Mountains can develop from both aquatic and terrestrial ecosystems, although the former setting (for example, glacial basins) is much more common than the latter.

Lake-fill peatlands are associated with *closed basins*. Lake-filling is sometimes termed **terrestrialization**, the process by which a peatland spreads across a lake. Flow-through or slope peatlands develop at sites having

an inflowing and outflowing water source, such as an open-ended basin, near a spring, or along a stream. Paludification, or swamp-formation, can occur at the margins of either type of peatland, and is the expansion of peatlands due to a gradual rise in water table as the accumulation of peat increasingly impedes drainage (Crum 1988).

Lake-Fill or Basin Peatlands

Lake-fill or basin peatlands occur in depressions such as lakes and kettleholes that formed as glaciers retreated leaving ice blocks buried in the glacial drift (fig. 3; color plates 1, 2, 9, 10). These blocks subsequently melted to form the depressions. Lakes sometime have a narrow peatland zone on their margin, but wave action may limit peat accumulations. Ponds and kettleholes, however, being smaller and often protected from high winds by the surrounding forest, are more conducive to peatland development. Deep kettleholes often have a central open water area surrounded by an encroaching mat of plant roots and peat. The process of terrestrialization occurs in these settings as the peat edge expands inward toward the center of the basin. Adjacent to the open water is a **floating mat**. Nonquaking portions of the mat closest to the outer edge of the basin where the peat mass extends downward to bottom sediments are termed anchored or **grounded**. Basins are sometimes entirely covered by an anchored or floating organic mat as at Leonard Creek Fen on the Beaverhead-Deerlodge National Forest in southwestern Montana. However, some shallow basin sites may support sedge communities better termed sedge meadows rather than fens, given their tendency to dry in summer. This seasonal drying limits peat accumulation.

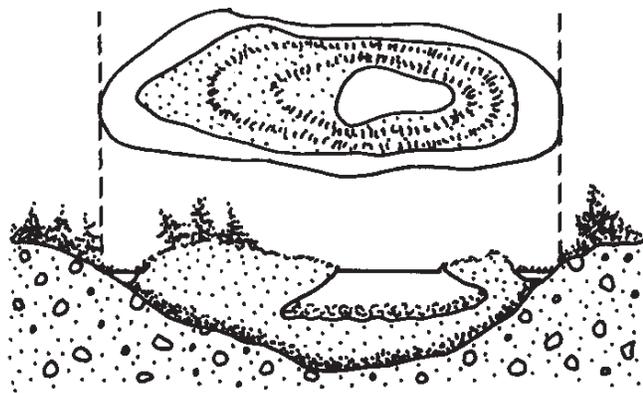


Figure 3—Lake-fill or basin peatland.

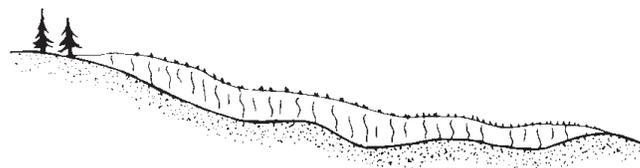


Figure 4—Flow-through or slope peatland.

Flow-Through or Slope Peatlands

Flow-through peatlands are best developed along streams and on gentle slopes and benches (fig. 4; color plates 3, 4). A continuous inflow of ground and surface water is needed to maintain this type of peatland (Moore and Bellamy 1974). Initially, sediments and plant remains accumulate near the water source and a marshy vegetation develops. Over time, enough peat may accumulate to impede water flow, which is then diverted around the peat onto new areas. Expansion of the peatland on these new areas may then occur.

Well-developed rich fens most commonly occur on flow-through sites in areas of calcium-rich, limestone bedrock. The constant inflow and outflow of water supplies minerals and removes humic acids from the peat. This is important in maintaining habitats suitable for a number of plant species, especially those restricted to calcium-influenced peatlands (*calciphiles*). Examples include the vascular plants *Orchis rotundifolia* and *Carex livida*, and the brown moss *Scorpidium scorpioides*.

Patterned Fens

Patterned or ribbed fens (*aapamires*) are a unique type of peatland characterized by a series of raised, linear hummocks oriented perpendicularly to the slope of the peatland (fig. 5; color plates 5 to 7). These ridges, or **strings**, are separated from one another by linear pools of water known by their Swedish name **flarks**.

Patterned fens are most extensive in boreal and subarctic regions of northern North America, Scandinavia, and Siberia. In North America, patterned fens occur from Alaska across much of central Canada to the Atlantic Ocean. In the contiguous United States, the most extensive patterned fens occur in Maine, Michigan, and Minnesota. The southernmost occurrence of this type of peatland appears to be in south-central Wisconsin at 43°21' north latitude (Grittinger 1970). Thompson (1983) observed that the southern limit of patterned fens is related to temperature and evapotranspiration isoclines. Their northern limit is south of the continuous permafrost of the far north, following mainly temperature isoclines.

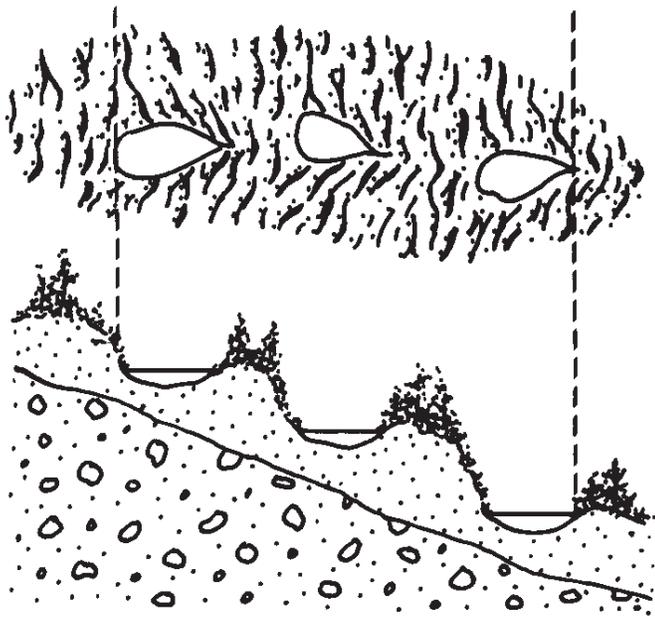


Figure 5—Generalized profile of a patterned fen (after Crum 1988).

A number of hypotheses have been proposed for the formation of patterned fens (Sorenson 1986). These generally fall into one of the following three groups (Moore and Bellamy 1974): (a) biological processes, (b) ice and frost effects, and (c) the effects of gravity. Based on analysis of core samples from a number of patterned fens, the evidence suggests that the following sequence is likely (Foster and others 1983):

1. Impeded drainage initiates peat accumulation.
2. Changes in hydrologic conditions and differing rates of peat accumulation by hummock and hollow species leads to the formation of linear patterns.
3. Pools enlarge and coalesce as underlying peats decay.

The presence of several patterned fens in the Northern Rocky Mountains of the United States are significant as isolated occurrences at the southern limit of this peatland type. Well-developed examples include Bent Flat Fen in northwestern Montana (Flathead National Forest) and Skull Creek Meadows in southwestern Montana (Beaverhead-Deerlodge National Forest). The two peatlands are very different; the Bent Flat site is a marly, extremely rich fen (Shapley 1993), while the Skull Creek peatland is a poor fen (Elliott 1992; for descriptions see appendix B). Portions of Pine Butte Fen along the Rocky Mountain Front in Montana are patterned (Lesica 1986; McAllister 1990). In Idaho, Packer Meadows features a slightly patterned peatland.

Paludification

In northern regions where peatlands are extensive, as in Canada and Alaska, paludification (color plate 8) is the predominant method of peatland formation in contrast to the terrestrialization of ponds and lakes (Neiland 1971; Noble and others 1984). Paludification is the expansion of peatlands resulting from a rise in the water table caused by peat accumulation (Crum 1988). Except for the uppermost layer, peat has a very low permeability. Water is held tightly within the peat mass or runs off along the outside margins. Paludification is favored by a cool and wet climate conducive to the growth of peat-forming mosses onto formerly upland sites. In the Northern Rocky Mountains, paludification is best observed adjacent to closed basin peatlands where peat accumulations in the basin create wetter conditions at the outer edge of the peatland. Paludification is also common near seeps. These conditions are favorable to the growth of sphagnum and other mosses which creep upslope into the adjacent forest. Although little studied in the Northern Rocky Mountains (Murray 1995), paludification is well-documented in boreal regions (Neiland 1971; Noble and others 1984), and based on peat corings, a number of studies have reported the remains of a forest layer occurring below the surface layer of sphagnum peat (Crum 1988).

Peatland Soils

Peat soils are unique in that they are largely or entirely composed of plant remains and other organic matter in various stages of decomposition. Mineral soil is lacking or a minor component of peat. As such, peatlands are *autogenic* or “self-creating,” with the plants themselves, especially the peat-forming mosses, largely influencing the course of succession on a particular peatland site.

Accumulation of peat occurs under year-long or seasonally saturated conditions where the rate of organic matter deposition is greater than the rate of microbial decomposition. As commonly used, the term “peat” is more a generic term than one based on specific properties. However, peat is a type of organic soil having a high organic matter (OM) content (by weight). Various sources report a range of minimum OM content for peat soils (depending in part on measurement techniques), from as low as 20 to 75 percent. The latter figure seems to be a more characteristic minimum for peat (Crum 1988; Gore 1983). Other terms used to describe the characteristics and components of peat are *muck* (highly decomposed peat containing mineral soil), *gyttia* (a Swedish term for fine lake bottom sediments), and *tephra* (layers of volcanic ash buried in the peat profile).

Peat soils can be classified as to the degree of OM decomposition. The ***H (humification) scale*** developed by Von Post and Granlund (1926) is a measure of the degree of decomposition, and is useful in peat classification in the field. The scale is based on the color of water squeezed from the peat, and the proportion and character of the organic material remaining after squeezing (Gore 1983). For example, if water squeezed from peat is relatively colorless, and a high degree of intact fibers remain, the peat is considered highly undercomposed and given a low rating (on a scale from 1 to 10). Conversely, if the water is very turbid (black or brown) and what little is left of the organic material after squeezing has no plant structure and is the consistency of porridge, the peat is considered highly decomposed, thus given a high *H* scale rating. More complex chemical procedures are available to determine degree of decomposition (Bahson 1968; Overbeck and Schneider 1940; Schnitzer and Kahn 1972; Von Naucke 1976).

Classification of Peatland Soils

An accumulation of peat, if deep enough, is classified as the soil order *Histosol*, or organic soil. According to the U.S. Department of Agriculture, Soil Conservation Service (1994), depths of peat required for classification as an organic soil vary depending on the composition of the underlying material. For example, a *Histosol* may be any depth if overlying bedrock, gravels, or cobbles, but must be at least 40 cm deep if overlying a mineral soil. Several peatlands cored in the Swan, South Fork of the Flathead, and lower Clark Fork river valleys in Montana had peat depths from 2 to 5.9 m (Chatters 1994a,b; Mantas 1993). In Idaho, Hager Lake Fen peat depths ranged from 2.6 to 11.4 m; Huff Lake peat accumulations were up to 10.8 m deep (Moseley and others 1992).

Histosols may be classified into three suborders, *Fibrists*, *Sapristis*, or *Hemists*, based on additional factors including volume of moss fibers, bulk density, and length of time the soil is saturated each year. *Fibrists* are the least decomposed and generally are at least three-fourths (by volume) fibers after rubbing and rinsing with water (USDA Soil Conservation Service 1994). On the *H* scale, values would be low (approximately 1 to 4). *Sapristis* have the most highly decomposed organic materials, the highest bulk density, and the smallest amount of plant fibers after rubbing. Water color after squeezing is dark gray to black (*H* scale rating 8 to 10). Generally, the fiber content is less than one-sixth after rubbing. *Hemists* are intermediate between *Sapristis* and *Fibrists*.

The next lower level of soil classification, *great group*, has three classes that characterize peatlands in the Northern Rocky Mountains. They are *Borofibrists*,

Borosapristis, or *Borohemists* (*boro* refers to cold mean annual soil temperatures less than 8 °C). The great groups are further subdivided into several subgroups.

In-depth study and formal classification of peatland soils have not been extensive in the Northern Rocky Mountains. The majority of *Histosols* from several peatlands in the Swan River Valley of Montana were Typic *Borosapristis* (Mantas 1993). Other subgroups found were Limnic *Borosapristis*, Limnic *Borohemists*, Limnic *Borofibrists*, Hydric *Borohemists*, and Hydric *Borofibrists*. In southwestern Montana, soils of the patterned fens at Skull Creek Meadows were similar. In the raised, linear hummocks (strings), Hydric *Borohemists* and Sapric *Borohemists* were typical. Low-lying hollows (flarks) were typically Sapric and Typic *Borohemists* (Svoboda 1996, personal communication).

Peat Profiles

A useful distinction of the peat profile is between the *acrotelm* and the *catotelm* (Ingram 1978). The *acrotelm* is the surface layer of peat. It contains the actively growing mosses and roots of vascular plants, and is more water permeable than the underlying *catotelm*, or the subsurface accumulation of peat. Water movement is very slow; in fact, the hydraulic conductivity of highly decomposed peat is lower than finely textured clay soils (Boelter 1965).

Peatland Water Chemistry

Rabe and others (1990) and Bursik (1990) measured water chemistry parameters in peatlands throughout Idaho and portions of northwestern Montana. Water pH was typically circumneutral; pH values ranged from 5.9 to slightly greater than 8.0. Water hardness varied from extremely soft water (30 mg/l calcium carbonate) to hard water (110 mg/l calcium carbonate) in an extremely rich fen in Montana. Calcium ion (Ca_2^+) concentrations ranged from 0.5 to 43 mg/l; magnesium ion (Mg_2^+) concentrations ranged from 0.1 to 11.0 mg/l. These values are within the ranges reported for peatlands elsewhere in North America (Bursik 1990).

Chadde and Shelly (1995) recorded pH for a number of rich fens on the Flathead National Forest, reporting a range of pH values from 6.8 to 8.4. Mantas (1993) found a similar pH range in several fens of the Swan Valley (6.5 to 8.1), and also noted that pH values rose during rain events, and dropped (becoming more acidic) when in-flow decreased. This was probably due to higher amounts of cations being flushed into the peatlands when flow was high. Also, pH was significantly higher in sites where limestone occurred in bedrock of the same watershed (Mantas 1993). In

addition, these sites were tested for cation content, including Potassium (K⁺), Sodium (Na⁺), Ca₂⁺, and Mg₂⁺. As expected, peatlands with the highest levels of these cations had the highest pH values.

Peatland Components

The term peatland encompasses all wetlands occurring on peat. Peatlands can be subdivided based on how they formed and on their water source and nutrient status (see Peatland Formation section). Peatlands can also be described based on their component parts. The presence or absence of these components is determined by the site's landform and hydrologic characteristics, vegetation, and water chemistry (Glaser 1987). The following features provide a common language for describing peatlands and are useful in evaluating their conservation significance (see Peatland Conservation section):

- Floating mat
- Carr
- Moat
- Paludified forest
- Lake/pond
- Stream
- Beaver activity
- Palsa

Floating Mats

Floating mats are a classic feature of basin or lake-fill peatlands (color plates 9, 10). Roots and rhizomes of living plants and accumulated leaf litter intertwine to form a mat that floats on water or overlies very unstable muck below. The vegetation of floating mats is variable and can be typical of that associated with poor, intermediate, or rich fens. In Idaho, floating mats are largely restricted to valley peatlands containing ponds or lakes. Their absence from subalpine peatlands may be the greatest contributing factor to floristic differences with valley peatlands (Bursik 1990).

Floating mats are ecologically stable communities because of their ability to adjust to fluctuating water levels. Vertical movement of floating mats of as much as 0.75 m annually has been reported by some researchers (Crum 1988). On floating mats, plant roots remain in constant contact with water while avoiding inundation like fixed or anchored mats. Changes in the composition of floating mat communities are generally a function of trophic status changes, especially as influenced by nutrient inputs. This makes floating mats useful monitoring sites to ascertain the effects of human activities affecting nutrient runoff into peatlands (Bursik and Moseley 1992a). In Idaho, extensive sphagnum-dominated floating mats occur

at Bottle Lake, Perkins Lake, Huff Lake, Three Ponds, Hager Lake, and Kaniksu Marsh (all on the Idaho Panhandle National Forests).

In Montana, floating mat examples occur at Lost Trail Pass (Bitterroot National Forest), Tepee Lake (Kootenai National Forest), Trout Lake (Flathead National Forest), and Leonard Creek Fen (Beaverhead-Deerlodge National Forest). At some sites, floating mats have formed on partially submerged logs in lakes and ponds. Good examples of these pioneer mats are at Robinson Lake and Beaver Lake (North) in Idaho, and at Mary's Frog Pond in Montana. Monitoring vegetation composition changes can shed light on the mode and rate of mat expansion and causal environmental factors.

Carr

Carrs are shrub-dominated fens and occur within portions of most Northern Rocky Mountain peatlands (color plate 11). Common shrubs of carrs include: *Spiraea douglasii*, *Alnus incana*, *Betula glandulosa*, and several willows, including *Salix bebbiana*, *S. drummondiana*, *S. candida*, and *S. geyeriana*. In northern Idaho, many carrs are dominated by dense monocultures of *Spiraea douglasii*. *Betula pumila*, a rare species in Idaho, is prominent in carrs of the Moyie River and Kootenai River valleys. In northwestern Montana, *Betula glandulosa* and *Alnus incana* are major carr species.

In basin peatlands, carrs are best developed in the **lagg** or moat-like ring sometimes found on the outer margin of the peatland. The moat is a zone of water accumulating because inflowing water is impeded by the peat mass and flows around the peat. Water draining from the surface of the peat mass also contributes to the moat. Water accumulates in the moat and may partially or completely ring the peatland. Carrs are well developed at many flow-through peatlands. Water in the moat and at slope or flow-through peatlands is well-aerated, nutrient-enriched, and conducive to robust shrub growth relative to the oxygen- and nutrient-poor peat mass in central portions of the peatland (color plate 12). Water draw-downs or water table fluctuations that drain and increase aeration of the peat surface and oxidation of the uppermost peat may increase shrub establishment and carr formation. Pine Butte Fen in Montana supports extensive carr habitats (Lesica 1986).

Paludified Forest

As peat accumulates in a lake basin, the water level tends to rise and "flood" adjacent uplands, a process known as *paludification*. These paludified uplands are subsequently colonized by sphagnum mosses and other peatland species. In Idaho, paludified forests are

associated most closely with valley peatlands whose lake basins are almost entirely filled with peat. These sites include Armstrong Meadows, Mosquito Bay Fen, and Upper Priest Lake Fen on the Idaho Panhandle National Forests. In Montana, Shoofly Meadows has extensive areas of paludified forest.

Cool, moist climatic conditions are conducive to paludification; while hotter, drier climates favor afforestation of paludified areas. In some areas of North America, paludification precedes the formation of poor fen and bog habitats (Crum 1988). In the Northern Rocky Mountains, it is unknown how paludification fits into broad peatland successional trends due to the prolonged summer droughts that characterize this region. Murray (1995) reported that growth and production of sphagnum mosses at Shoofly Meadows (near Missoula) was limited by full sunlight compared to growth rates of artificially shaded plants.

Paludification is best developed adjacent to sphagnum-rich peatlands (poor fens) because sphagnum mosses are the major species involved in this process. Where paludification occurs, a sequence of moist coniferous forest to forested sphagnum fen to open sphagnum fen may occur. As paludification proceeds, higher water tables kill existing trees. As mossy hummocks grow in height, trees may again establish on hummock tops but are likely to be stunted. This is in contrast to original site conditions that were usually moist but were dominated by conifers typical of the area. Intermediate stages (forested sphagnum fen) are dominated by an overstory of various conifers, including *Pinus contorta*, *P. monticola*, *Abies grandis*, *A. lasiocarpa*, *Picea engelmannii*, *Thuja plicata*, and *Tsuga heterophylla*, growing with sphagnum moss such as *S. centrale*, *Vaccinium oxycoccos* (in northern Idaho), and other fen species in the understory.

Lakes and Ponds

Periodic water level fluctuations can affect the successional dynamics of pond and lake peatlands by flooding fixed mats, depositing sediments and nutrients during high water, or by drying floating mats during low water periods. Open water attracts birds and mammals that may disperse the propagules of peatland plants or that may influence physical conditions of the site, as in the case of beavers. Acidic waters of poor-intermediate fens or alkaline waters of rich fens are also habitat for numerous invertebrate species having an affinity for a particular water chemistry (Rabe and others 1986).

Open bodies of water are associated with many basin peatlands. In Idaho, Hager Lake, Huff Lake, Three Ponds, and Potholes are peatlands associated with ponds (waterbodies less than 8 ha) (Rabe and Chadde 1994), while Mosquito Bay Fen on Priest Lake is a lake peatland (waterbodies more than 8 ha).

In Montana, examples of peatlands associated with ponds and lakes include Tepee Lake (Kootenai National Forest), Mud Lake and Trout Lake (Flathead National Forest), and Mary's Frog Pond (Lolo National Forest).

Aquatic vegetation (that is rooted in bottom sediments or floating) adds to the diversity of peatlands associated with ponds and lakes. More than 15 percent of the valley peatland flora of Idaho consists of aquatic species, while a similar percentage are species most commonly found growing submersed (Bursik and Henderson 1995). Common aquatic species include *Nuphar polysepalum*, *Potamogeton amplifolius* (large-leaved pondweed), *P. gramineus* (grass-leaved pondweed), *P. natans* (floating-leaved pondweed), *Najas flexilis* (wavy water-nymph), and *Lemna minor* (duck weed).

Stream

Several stream types described by Rabe and others (1994) are found in Northern Rocky Mountain peatlands, including spring streams with very short runs (for example, Kaniksu Marsh, Upper Priest Lake Fen, and Mosquito Bay Fen), spring streams with long reaches (Potholes), and meandering glide streams in broad valleys (Packer Meadows, Deerhorn Creek Meadows, and Dubius Creek Fen). Streams host an array of invertebrate species and may contain populations of rainbow, cutthroat, and eastern brook trout (Rabe and Savage 1977).

Beaver Activity

Beavers exert a significant influence on many peatlands, especially those having inlets and outlets allowing for beaver migration. Periodic beaver activity creates and maintains a mosaic of successional stages within a wetland complex and contributes to the habitat and floristic diversity of Northern Rocky Mountain peatlands (Bursik and Henderson 1995).

Beaver activity is responsible for the initial formation of fen habitats at Bottle Lake and Potholes in northern Idaho. Beaver damming at Packer Meadows, Beaver Lake (North), Kaniksu Marsh, and Dubius Creek Fen is responsible for the formation of large ponds or the periodic expansion of ponds into lakes. During inactivity, the dams break and large mudflats are colonized by a host of pioneer marsh and fen species. Over time, perennial, rhizomatous sedges, such as *Carex lasiocarpa* and *Carex utriculata*, colonize these mudflats. If water levels rise, the rhizomatous mats can form floating mats that allow for colonization by fen species requiring stable water levels. This pioneer mat formation has been observed over the past 10 years at Lee Lake in northern Idaho.

Wholesale changes brought on by beavers in Idaho peatlands were illustrated by Rabe and Savage (1977) at Bottle Lake Research Natural Area. Aerial photographs of Bottle Lake from 1932 and 1956 bear little resemblance to each other. Apparently 1932 was near the end of a long period without beavers at Bottle Lake. In 1932, the central doughnut-shaped, sphagnum-dominated mat was surrounded by a sedge-dominated fen with scattered trees. The mat rested on the basin bottom allowing the growth of *Thuja plicata*, *Tsuga heterophylla*, and other conifers. The lake within the mat supported emergent and submergent aquatic plants such as *Nuphar* spp. By 1956, beaver damming had flooded the sedge fen surrounding the floating mat, replacing it with aquatic plant communities and killing the scattered trees. The doughnut-shaped mat once again had become a buoyant island, conifers that had established during low water were dead, and the lake within the mat had become too deep to support species of *Nuphar*, conditions similar to those found at present.

Palsa

A *palsa* is a peat mound covering a permanently frozen (permafrost) core of peat and silt (Crum 1988). The overlying peat acts as an insulating blanket over the frozen core. Although common in the zone of discontinuous permafrost in the southern portion of the arctic tundra, in the contiguous United States the only documented occurrence is at a subalpine site (Sawtooth Peatbeds, Shoshone National Forest) in the Beartooth Mountains of northwestern Wyoming (Collins and others 1984). This occurrence is the southernmost palsa known in North America.

The palsa covers approximately 8 ha and is raised 1 to 2 m above the surrounding sedge-dominated fen. The surface of the palsa is practically devoid of vegetation apart from scattered clumps of *Deschampsia cespitosa* and plants of *Rumex paucifolius* (mountain sorrel). Permafrost is present 38 to 46 cm below the surface (Pierce 1961).

Peatland Vegetation And Flora

Vascular Flora

The vascular plant diversity associated with peatlands in the Northern Rocky Mountains is high, especially considering the small percentage of the regional landscape that is occupied by these habitats (color plates 13 through 25). The peatland vascular flora reported herein consists of 356 species, representing 164 genera and 62 families (appendix A). Six pteridophyte families (as represented by 11 genera and 20 species), two gymnosperm families (6 genera,

8 species), and 54 angiosperm families (148 genera, 328 species) were documented during the course of the peatland inventories in this region (Bursik 1990; Bursik and Henderson 1995; Chadde and Shelly 1995; Mantas 1993). Of note is the diversity of families and genera included in the regional peatland flora. Richness at these higher taxonomic levels further emphasizes the significance of these peatlands in contributing to the overall biological diversity in the Northern Rocky Mountains.

Idaho—Bursik (1990) distinguished two types of peatlands in Idaho, valley and subalpine peatlands. He found 327 vascular plant species occurring at both valley or subalpine sites, with 205 species occurring in the valley peatlands (see appendix A for a complete list of species). Subsequent study has revealed the presence of 291 vascular and 20 bryophyte species in the valley peatland flora of Idaho (Bursik and Henderson 1995).

Peatlands of the Sawtooth Valley are subalpine in elevation but intermediate in plant species composition. Boreal species found in the Sawtooth Valley peatlands include *Carex livida*, *C. buxbaumii*, *Eleocharis pauciflora*, *Drosera intermedia* (intermediate sundew), *Epilobium palustre* (swamp willow-herb), *Scirpus cespitosus* (tufted bulrush), *Carex aquatilis*, and *Swertia perennis*. Many of these are community dominants. Western cordilleran species include *Gentiana calycosa* (mountain bog gentian), *Carex cusickii* (cusick's sedge), *C. luzulina* (wood rush sedge), *Lonicera caerulea* (sweet-berry honeysuckle), *Senecio cymbalarioides* (few-leaved groundsel), and *Vaccinium occidentale* (western huckleberry).

Montana—The valley peatland vascular flora in Montana consists of 174 species, representing 105 genera in 44 families (Chadde and Shelly 1995; Mantas 1993). As such, approximately 37 percent of the 118 families and 16 percent of the 658 genera reported to occur in Montana (Dorn 1984) are associated with these habitats. In limestone areas of northwestern Montana (Kootenai and Flathead National Forests), rich fens are typical. Characteristic shrubs are *Betula glandulosa*, *Alnus incana* (mountain alder), *Potentilla fruticosa*, *Rhamnus alnifolia* (alder buckthorn), *Salix bebbiana*, *S. candida*, and *S. drummondiana* (drummond willow). Important sedges include: *Carex lasiocarpa*, *C. limosa*, *C. interior*, *C. livida*, *C. utriculata*, *C. flava*, and *C. buxbaumii*. Other common grass and grasslike species include: *Eleocharis rostellata* (in extremely rich fens), *E. tenuis*, *Eriophorum viridicarinatum*, *E. chamissonis*, *Dulichium arundinaceum*, *Calamagrostis canadensis*, and *Scirpus acutus*. *Picea engelmannii* is common on the outer margins of many peatlands as well as on drier hummock tops.

In the poor and intermediate fens of west-central and southwestern Montana (Lolo and Beaverhead-Deerlodge National Forests), *Carex lasiocarpa* is replaced by other sedges and rushes, including *Carex aquatilis*, *C. limosa*, *C. utriculata*, *C. vesicaria*, *C. canescens* (gray sedge), *C. buxbaumii*, and *Eleocharis pauciflora*. Typical grasses are *Calamagrostis canadensis* and *Deschampsia cespitosa*. *Betula glandulosa* is uncommon; other shrubs including several ericaceous species are typical: *Kalmia microphylla* (small-leaved laurel), *Ledum groenlandica* (bog laurel), and *Vaccinium occidentale*.

Typical peatland forbs include: *Menyanthes trifoliata* (buckbean), typically found in pools between hummocks and in the moat around many peatlands, *Potentilla palustris*, *Drosera rotundifolia* (roundleaf sundew), *Mentha arvensis* (field mint), *Utricularia vulgaris* (common bladderwort), *Zigadenus elegans*, *Epilobium palustre* (swamp willow-herb), *Galium triflorum* (bedstraw), *Parnassia palustris* (northern grass-of-parnassus), and *Viola nephrophylla* (bog violet). The calcareous rich fens of northwestern Montana provide habitat for a number of orchids (see Rare Flora). Ferns and fern allies include: *Equisetum arvense* (field horsetail), *E. fluviatile* (water horsetail), and *E. variegatum* (variegated horsetail). *Botrychium multifidum* and *B. virginianum* are occasionally encountered moonworts.

Bryophyte Flora

Idaho—Many of Idaho's fens are sphagnum-rich peatlands; major species include: *Sphagnum centrale*, *S. magellanicum*, *S. subsecundum*, and *S. teres* (Andrus and Layser 1976; Bursik and Henderson 1995). Important brown mosses of Idaho peatlands include: *Aulacomnium palustre*, *Calliergon stramineum*, *Calliergonella cuspidata*, *Pleurozium schreberi*, *Polytrichum strictum*, and *Tomentypnum nitens*.

Montana—The rich fens of northwestern Montana can be characterized as sphagnum-poor peatlands. Only two species of sphagnum were consistently encountered in rich fens: *Sphagnum fuscum* and *S. warnstorffii*. Brown moss species indicative of calcium-rich conditions were prominent, forming a nearly continuous ground cover in many fens. Important species included: *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum*, *Limprichtia revolvens*, *Philonotis fontana*, *Pohlia nutans*, *Scorpidium scorpioides*, and *Tomentypnum nitens*. *Meesia triquetra*, an uncommon calciphile (Montagnes 1990), was present, although sparse, in several rich fens.

In west-central and southwestern Montana, typical poor fen mosses include various sphagnum mosses (*Sphagnum angustifolium*, *S. fimbriatum*, *S. magellanicum*, *S. russowii*, *S. squarrosum*, *S. subsecundum*, and *S. teres*) and brown mosses such as *Aulacomnium*

palustre, *Calliergon cordifolium*, *C. stramineum*, *Drepanocladus aduncus*, *Hypnum pratense*, and *Polytrichum strictum*.

Classification of Plant Community Types

Classifications based on vegetation provide land managers with a means to effectively identify, manage, and conserve important habitats (Ferguson and others 1989). They have been uniformly developed and widely applied in the forested ecosystems of the Northern Rocky Mountains (Cooper and others 1991; Pfister and others 1977; Steele and others 1981, 1983) and more recently for wetlands and riparian communities (Hansen and others 1995; Winward and Padgett 1989). Regional wetland community classifications that include some peatland habitats exist for portions of Idaho (Mutz and Queiroz 1983; Tuhy 1981; Tuhy and Jensen 1982; Youngblood and others 1985), and northwestern Wyoming (Chadde and others 1988; Mattson 1984). However, these studies failed to consider one of the most important components of peatlands—the structure and composition of bryophyte communities. Many mosses are useful indicators of the environment within peatlands and provide the best indication of water chemistry, height above water table, and amount of shade (Gignac and Vitt 1990). The presence of sphagnum mosses is especially important due to their control and influence on the peatland environment. For example, the degree of acidity of water in a peatland is in part due to the release of hydrogen ions by sphagnum (Crum 1988).

Table 4 is a list of plant community types that identifies communities found within Northern Rocky Mountain peatlands. Many of the listed types also occur in other types of wetlands, and on mineral as well as on organic or peat soils. Peatland classifications appear to be most useful if they are based on a combination of hydrology, water chemistry and nutrient status, and floristics (Glaser 1987). Wetland classifications from the Western United States are based largely on vascular plant floristics, ignoring bryophytes and physical features. Notable exceptions are studies by Vitt and others (1975) in Alberta, Cooper and Andrus (1994) in Wyoming, and Cooper (1996) in Colorado. Peatland communities of alpine areas have been little studied, but see Cooper and Lesica (1992).

Tree-Dominated Types—Four forested wetland types, *Picea engelmannii*/*Carex disperma* (soft-leaved sedge), *Picea engelmannii*/*Equisetum arvense*, *Pinus contorta*/*Vaccinium occidentale*, and *Picea engelmannii*/*Lysichitum americanum* (skunk cabbage), sometime occur adjacent to open peatlands. Although wet, these types are found on both organic and mineral soils. They are briefly described because of their close association with many peatlands. More information on their composition is provided by Hansen and others (1995). In northern Idaho, Cooper and others

Table 4—Peatland community types of the Northern Rocky Mountains.

Community type	Common name
Tree-dominated types	
<i>Picea engelmannii</i> / <i>Carex disperma</i>	Engelmann spruce/soft-leaved sedge
<i>Picea engelmannii</i> / <i>Equisetum arvense</i>	Engelmann spruce/field horsetail
<i>Picea engelmannii</i> / <i>Lysichitum americanum</i>	Engelmann spruce/soft-leaved sedge
<i>Picea glauca</i>	White spruce (mostly in Wyoming)
<i>Pinus contorta</i> / <i>Vaccinium occidentale</i>	Lodgepole pine/western huckleberry
Shrub-dominated types	
<i>Betula glandulosa</i> / <i>Carex lasiocarpa</i>	Bog birch/slender sedge
<i>Kalmia microphylla</i> / <i>Carex scopulorum</i>	Small-leaved laurel/holm's rocky mountain sedge
<i>Salix candida</i> / <i>Carex lasiocarpa</i>	Hoary willow/slender sedge
<i>Salix drummondiana</i>	Drummond willow
<i>Salix planifolia</i> / <i>Carex aquatilis</i>	Planeleaf willow/water sedge
<i>Salix wolfii</i> / <i>Carex aquatilis</i>	Wolf's willow/water sedge
<i>Spiraea douglasii</i>	Douglas' spiraea
<i>Vaccinium occidentale</i>	Western huckleberry
Herbaceous types	
<i>Calamagrostis canadensis</i>	Bluejoint reedgrass
<i>Carex aquatilis</i>	Water sedge
<i>Carex buxbaumii</i>	Buxbaum's sedge
<i>Carex lasiocarpa</i>	Slender sedge
<i>Carex limosa</i>	Mud sedge
<i>Carex scopulorum</i>	Holm's Rocky Mountain sedge
<i>Carex simulata</i>	Short-beaked sedge
<i>Carex utriculata</i>	Beaked sedge
<i>Eleocharis pauciflora</i>	Few-flowered spike-rush
<i>Eleocharis rostellata</i>	Beaked spike-rush
<i>Eleocharis tenuis</i>	Slender spike-rush
<i>Scirpus cespitosus</i>	Tufted bulrush

(1991) described several wet forest types within the *Abies lasiocarpa* and *Thuja plicata* series of habitat types. A *Picea glauca* community occurs at Swamp Lake Fen in Wyoming. Associated undergrowth species include *Linnaea borealis*, *Equisetum arvense*, *Carex utriculata*, and *Calamagrostis canadensis*.

Picea engelmannii/*Carex disperma* community type—occurs in east-central and southeastern Idaho and is similar to the *Picea engelmannii*/*Equisetum arvense* community type (Steele and others 1981, 1983). The undergrowth is carpeted by *Carex disperma*. Scattered shrubs are present and include *Ribes lacustre* (swamp currant) and *Rubus parviflorus* (thimbleberry). Common herbaceous species include *Calamagrostis canadensis*, *Actaea rubra* (baneberry), *Arnica cordifolia* (heartleaf arnica), *Galium triflorum*, *Pyrola secunda* (one-sided wintergreen), *Senecio triangularis* (arrowleaf groundsel), *Thalictrum occidentale* (western meadowrue), and *Equisetum arvense*. Common mosses include *Aulacomnium palustre* and *Amblystegium juratzkanum* (Steele 1974).

Picea engelmannii/*Equisetum arvense* community type—occurs at low to mid-elevations in central Montana (where sometimes locally common) and less commonly in western portions of the State (Pfister and others 1977). The type is also present in northwestern Wyoming and eastern Idaho (Steele and others 1981, 1983). The tree canopy is primarily *Picea engelmannii*, with smaller coverages of *Abies lasiocarpa* or *Pinus contorta*. In addition to *Equisetum arvense*, common undergrowth species include *Lonicera involucrata*, *Salix drummondiana*, *Calamagrostis canadensis*, *Carex utriculata*, *Smilacina stellata* (starry solomon-plume), *Streptopus amplexifolius* (twisted stalk), and *Senecio triangularis*.

Picea engelmannii/*Lysichitum americanum* community type—uncommon in low elevation valleys in northwestern Montana. When present, this type usually occurs on the outer margin of an open peatland or in the surrounding wet forest. The water table is near the ground surface most of the year and surface water is often present in depressions. Soils may have a large

percentage of organic matter. Associated species may include *Cornus stolonifera* (red-osier dogwood), *Alnus incana*, *Betula occidentalis* (water birch), *Cinna latifolia* (drooping woodreed), and *Athyrium filix-femina* (ladyfer) (Hansen and others 1995).

Pinus contorta/Vaccinium occidentale community type—uncommon and found in noncalcareous peatlands in west-central Montana and central Idaho (Pierce and Johnson 1986; Tuhy 1981; Tuhy and Jensen 1982). The type usually occurs near the outer margins of peatlands or near the outer edge of a peatland pond. Soils are typically saturated and have a high organic matter content. This community type is characterized by a discontinuous stand of *Pinus contorta* with a layer of low shrubs underneath. *Pinus contorta* appears to be regenerating in this community, as evidenced by small saplings, but there are also many standing dead trees keeping the stands relatively open in appearance. *Vaccinium occidentale* is the dominant shrub, but several other shrubs are prominent, including *Ledum glandulosum*, *Lonicera caerulea*, *Potentilla fruticosa*, and *Betula glandulosa*. *Calamagrostis canadensis* is usually present. Sphagnum mosses are typically common.

Shrub-Dominated Types—*Betula glandulosa/Carex lasiocarpa* community type—common in low to mid-elevation peatlands in west-central and northwestern Montana and northern Idaho and occurs on organic soils. The peat is saturated year-round, apart from the higher hummock tops that tend to dry in midsummer. It is characterized by a shrub stratum 0.5 to 2 m tall, dominated by *Betula glandulosa*, and a shrub canopy averaging about 25 percent cover. *Salix candida*, a low-growing willow up to 1 m tall, is frequently present at low coverages. The height of the shrubs appeared to be influenced largely by the degree of substrate aeration; taller shrubs occurred on peatland margins and areas of higher ground subject to seasonal drawdowns of the water table. The shortest shrubs were associated with perennially saturated substrates.

Carex lasiocarpa was the predominant vascular undergrowth species, reflecting its abundance and wide distribution within the study area. *Eleocharis tenuis* dominated the undergrowth of several sites and *Menyanthes trifoliata* was a common forb. *Cypripedium passerinum* was confined to this type and the adjacent forested *Picea engelmannii/Equisetum* plant association. Other sensitive or special concern species occurring in this community type were *Eriophorum viridicarinatum*, *Drosera rotundifolia*, and *Epipactis gigantea* (giant hellebore). A nearly continuous surface layer of mosses was present and common species included *Tomentypnum nitens*, *Bryum pseudotriquetrum*, *Campylium stellatum*, and *Limprichtia revolvens*.

Sphagnum fuscum and *S. warnstorffii* were the only sphagnum mosses present in this type.

This community type is similar to the *Betula glandulosa/Carex utriculata*⁴ type described by Hansen and others (1995) for western Montana. However, most communities sampled by the authors lacked the *Carex utriculata* undergrowth or had small amounts only. In Montana, *Carex utriculata* is more indicative of mineral soils or scarcely developed peatlands.

Kalmia microphylla/Carex aquatilis community type—an uncommon peatland community of poor fens at mid-elevations in western Montana; soils are wet, acidic Histosols. Associated species include *Vaccinium occidentale*, *Calamagrostis canadensis*, *Carex nigricans*, *Deschampsia cespitosa*, *Aster foliaceus* (leafy aster), and *Ligusticum tenuifolium* (slender-leaved licorice-root). A higher elevation (upper subalpine) variant of this type was described by Hansen and others (1995) in which *Carex aquatilis* is replaced by *Carex scopulorum*.

Salix candida/Carex lasiocarpa community type—an uncommon type in western Montana. This type was classified as the *Salix candida/C. utriculata* type by Hansen and others (1995), but communities occurring on peat have a predominance of *C. lasiocarpa* rather than *C. utriculata*. Its composition is similar to the *Betula glandulosa/C. lasiocarpa* type described previously. Prominent species include *Potentilla fruticosa*, *Carex aquatilis*, *Carex limosa*, *Scirpus acutus*, and *Menyanthes trifoliata*.

Salix drummondiana community type—a minor type of northwestern Montana on organic or wet mineral soils (Hansen and others 1995). A dense growth of tall willows is typical. Associated species include *Calamagrostis canadensis*, *Carex aquatilis*, *C. utriculata*, *C. vesicaria*, *Saxifraga arguta* (brook saxifrage), and *Equisetum fluviatile*.

Salix planifolia/Carex aquatilis community type—an uncommon type of central and southwestern Montana. Soils are usually organic and acidic. Associated species include *Calamagrostis canadensis*, *C. scopulorum*, and *Eleocharis pauciflora* (Hansen and others 1995). At high (alpine) elevations in southwestern Montana, *Carex scopulorum* rather than *C. aquatilis* predominates the herbaceous layer (Cooper and Lesica 1992).

⁴*Carex utriculata* was erroneously referred to as *Carex rostrata* in earlier taxonomic and ecological studies. True *Carex rostrata* is apparently very rare in the Northern Rocky Mountains, being found more commonly in boreal North America. To minimize confusion, references of other researchers to *Carex rostrata* have been changed to *Carex utriculata*. See Griffiths (1989) for a more complete discussion of these taxa.

Salix wolfii/*Carex aquatilis* community type—a minor type of central and southwestern Montana and central and eastern Idaho (Hansen and others 1995; Tuhy 1981; Youngblood and others 1985). *Betula glandulosa* and *Lonicera utahensis* (Utah honeysuckle) are common associates. Herbaceous species below the open shrub layer include *Carex aquatilis*, *C. microptera* (small-winged sedge), *C. vesicaria*, and *Deschampsia cespitosa*.

Spiraea douglasii (Douglas' spirea) community type—a minor type of northwestern Montana and northern Idaho forming thickets or occurring on peatland margins. Soils are sometimes organic, but are often poorly developed alluvial soils (Hansen and others 1995). Common associated species include *Calamagrostis canadensis*, *Carex utriculata*, and *Potentilla palustris*.

Vaccinium occidentale community type—this type occurs primarily in eastern Idaho and northwestern Wyoming (Mattson 1984). Soils are wet and acidic. Common species are *Calamagrostis canadensis* and *Carex aquatilis*.

Herbaceous Types—*Calamagrostis canadensis* community type—this type is most common on wet Mollisols having a high percentage of organic matter (Hansen and others 1995). The type is included here because of its common occurrence as part of many peatland complexes, especially in marshy areas or on peatland margins. Typical species of this type include *Calamagrostis canadensis*, *C. stricta*, *Carex utriculata*, *Geum macrophyllum* (large-leaved avens), and *Senecio triangularis*.

Carex aquatilis community type—a common type throughout the Northern Rocky Mountains (Chadde and others 1988; Hansen and others 1995; Youngblood and others 1985). Shrubs are typically absent apart from trace amounts of *Salix* spp. and *Potentilla fruticosa*. Herbaceous associates include *Carex buxbaumii*, *C. lasiocarpa*, *C. lanuginosa*, *Potentilla palustris*, and *Equisetum arvense*. In northern Idaho, this type often occurs on mineral alluvial soils at subalpine elevations.

Carex buxbaumii community type—this is a minor peatland type, and can occur on either mineral or peat substrates. In the Sawtooth Valley, this community occurs on sedge peat (Tuhy 1981). It occupies sites similar to those classified as *Carex aquatilis* and *C. lasiocarpa* types. On peat soils, *C. buxbaumii* is dominant with a low cover of other sedges such as *C. muricata*, *C. aquatilis*, *C. oederi* (green sedge), and *C. utriculata*.

Carex lasiocarpa community type—this open fen community type is a major component of the region's peatlands, and is especially prominent in northwestern

Montana, northern Utah, and southeastern Idaho (Padgett and others 1989). Shrubs are absent apart from low-growing individuals, and stands are visually characterized by a monoculture of *Carex lasiocarpa*. Overall species diversity is low. *Menyanthes trifoliata* is common. Sensitive or special-concern species occurring in this type were *Carex livida*, *Eriophorum viridicarinatum*, *Drosera anglica*, *D. rotundifolia*, and *Epipactis gigantea*. Moss coverage varies widely from nearly absent to essentially continuous. Predominant brown mosses are *Campylium stellatum*, *Limprichtia revolvens*, *Aulacomnium palustre*, *Tomentypnum nitens*, and *Bryum pseudotriquetrum*. Sphagnum mosses are prominent in some sites. Low moss coverages were associated with shallow basin fens that had seasonally fluctuating water tables. These sites may be better classified as sedge meadows. The best developed moss layers were associated with flow-through peatlands having relatively stable, constant water movement through them.

Carex limosa community type—a minor type of western Montana, Idaho, and northwestern Wyoming (Hansen and others 1995; Mattson 1984; Padgett and others 1989). The type occurs as small patches in wet depressions in peatlands or in the moat surrounding the peat mass.

Carex scopulorum community type—a fairly common type on organic soils at mid- to alpine elevations in the region. Associated species include *Calamagrostis canadensis*, *Deschampsia cespitosa*, *Juncus mertensianus*, *Phleum alpinum* (timothy), *Caltha leptosepala* (elkslip), *Dodecatheon jeffreyi* (shooting star), and *Ligusticum tenuifolium* (Cooper and Lesica 1992; Hansen and others 1995).

Carex simulata (short-beaked sedge) community type—an uncommon type found mostly in peatlands of central and southern Idaho and northwestern Wyoming (Chadde and others 1988; Mattson 1984; Youngblood and others 1985). Dense, rhizomatous monocultures of *Carex simulata* characterize this community type (Tuhy and Jensen 1982).

Carex utriculata community type—the *Carex utriculata* community is common throughout the Northern Rocky Mountains and Intermountain Region (Hansen and others 1995; Padgett and others 1989; Tuhy and Jensen 1982; Youngblood and others 1985). The type is especially common as an early colonizer of wet mineral soils, but can persist on sedge peats. Although *Carex utriculata* is strongly rhizomatous, producing near monocultures, small amounts of other species may be present.

Eleocharis pauciflora community type—a common type of acidic, organic soils of peatlands throughout the region (Hansen and others 1995; Mattson 1984;

Mutz and Queiroz 1983; Padgett and others 1989). Associated species are varied but include *Carex aquatilis*, *Pedicularis groenlandica*, *Spiranthes romanzoffiana*, and *Scirpus acutus*. Sphagnum mosses are common. In northern Idaho, *Drosera intermedia* is most common in this community type.

Eleocharis rostellata community type—an uncommon type of wet, marly peatlands such as Bent Flat Fen in northwestern Montana. The species is also locally common at Mammoth Hot Springs, Yellowstone National Park (Chadde and others 1988). Associated species include *Scirpus acutus*, *Menyanthes trifoliata*, *Carex utriculata*, *Viola nephrophylla*, and *Triglochin maritimum* (seaside arrow-grass).

Eleocharis tenuis community type—a type encountered in northwestern Montana, often occurring in close proximity to the *Betula glandulosa*/*Carex lasiocarpa* type in rich fens of Montana's Swan River Valley. In Idaho *Eleocharis tenuis* is rare (Bursik and Moseley 1995). Common associates include *Carex interior*, *C. flava*, *C. cusickii*, and *Menyanthes trifoliata*. Brown mosses such as *Tomentypnum nitens*, *Aulacomnium palustre*, and *Bryum pseudotriquetrum* are common.

Scirpus cespitosus community type—this type is limited in Idaho, occurring only in the Sawtooth Valley (Tuhy 1981). Where found, *Scirpus cespitosus* may form hummocky stands to the near exclusion of other species. *Eleocharis pauciflora* and *Carex livida* are common associates.

Rare Vascular Flora

Of the 356 vascular plant species associated with peatlands in the Northern Rocky Mountains, 48 (approximately 13 percent) are designated as species of special conservation concern in Idaho or Montana by State natural heritage programs. In addition, the Northern Region of the U.S. Forest Service has designated 30 of these 48 rare taxa as "sensitive" (USDA Forest Service 1991, 1994) (table 5). This designation confers protection to them during the planning and implementation of resource management activities on National Forest lands. As compared to other habitats, the disproportionately large number of rare species of vascular plants associated with peatlands in the Northern Rocky Mountains further underscores the importance of these habitats with respect to the biological diversity of the region.

These species, although uncommon in the Northern Rocky Mountains, are generally common when their entire worldwide range is considered. Apart from *Maianthemum dilatatum* (a Pacific coastal species, disjunct in northern Idaho), most of these species have circumboreal distributions (Lorrain 1988).

Idaho—Thirty-five vascular species in the peatland flora are considered rare in Idaho, amounting to 12 percent of the State's rare flora (Idaho Native Plant Society 1996) (table 5). Five species were undocumented in Idaho prior to recent peatland inventories: *Carex chordorrhiza*, *Eleocharis tenuis*, *Eriophorum viridicarinarum*, *Iris versicolor* (blue flag), and *Rubus pubescens* (dew berry) (Bursik and Henderson 1995). Three species are known from only a single known site in the State: *Andromeda polifolia* (bog rosemary), *Iris versicolor*, and *Maianthemum dilatatum* (bead ruby).

Montana—Twenty-one species of vascular plants typically associated with peatlands are currently considered rare in Montana (Heidel 1996) (table 5). Of these, 15 are sensitive species as designated by the Northern Region of the Forest Service (USDA Forest Service 1994). All of the rare species are boreal or north-temperate in distribution, disjunct or peripheral in Montana from more continuous ranges in the north. Species known from National Forests in Montana include *Carex chordorrhiza*, *C. livida*, *C. paupercula*, *Drosera anglica*, *D. linearis* (linear-leaved sundew), *Dryopteris cristata* (crested shield-fern), *Eleocharis rostellata*, *Eriophorum viridicarinarum*, *Liparis loeselii*, *Lycopodium inundatum*, *Scheuchzeria palustris* (podgrass), and *Scirpus cespitosus*. The rarest of these are *Drosera linearis* (three occurrences in Montana), *Liparis loeselii* (five occurrences, first collected in Montana in 1990 [Shelly and Mantas 1993]), and *Lycopodium inundatum* (two confirmed occurrences [Shelly and Mantas 1993]).

Of special interest are four rare species, (*Cypripedium calceolus* (yellow lady's-slipper), *C. passerinum*, *Orchis rotundifolia*, and *Viola renifolia* (kidney-leaved violet) that, while not restricted to peatlands in Montana, are typically found in the semi-shaded ecotones between open fens and adjacent forests. *Cypripedium passerinum*, *Drosera linearis*, *Eleocharis rostellata*, *Liparis loeselii*, *Orchis rotundifolia*, and *Scirpus cespitosus* are largely confined to rich fens and marly wetlands in portions of northwest Montana where limestone bedrock is prevalent.

The poor fens in Montana, which are typically less floristically diverse than the rich fens, also contain far fewer rare species. *Carex paupercula*, *Drosera anglica*, *Eriophorum viridicarinarum*, *Scheuchzeria palustris* and *Viola renifolia* were characteristically the only rare vascular plants found in association with the poorer peatlands.

Six additional rare plant species occur in peatlands or in marly wetlands of western Montana; however, none of these are included in this report. They are as follows: *Scirpus hudsonianus* (Glacier National Park, two occurrences, from northern Idaho), *Utricularia intermedia* (one occurrence on private land in the

Table 5—Rare vascular plant species known from peatlands in Idaho and Montana. USDA Forest Service (Northern Region): S = sensitive (USDA Forest Service, June 1994); States in which the sensitive designation applies are shown in parentheses. Global rank: G1 = critically imperiled globally because of extreme rarity; G2 = imperiled globally because of rarity; G3 = either very rare and local throughout its range or found locally in a restricted range; G4 = apparently secure globally; G5 = demonstrably secure globally. State rank: S1 = critically imperiled in State, extremely rare; S2 = imperiled in State, rare; S3 = uncommon in State, not necessarily imperiled. NP = not known in State; NT = present but not tracked by natural heritage program in State. Idaho Native Plant Society (INPS) Categories (INPS 1996): 1 = Priority 1, State endangered; 2 = Priority 2, State threatened; S = Sensitive; M = Monitor; R = Review; N = No INPS rank for Federal candidates. Species names followed by an asterisk are illustrated.

Species	USDA FS		Global rank	Idaho rank	INPS rank	Montana rank
	Northern Region					
<i>Andromeda polifolia</i>	—		G5	S1	1	NP
<i>Aster junciformis</i>	—		G5	S1	R	NT
<i>Betula pumila</i>	S (ID)		G5	S2	S	NP
<i>Carex buxbaumii</i>	S (ID)		G5	S3	S	NT
<i>Carex chordorrhiza</i>	S (ID, MT)		G5	S2	1	S1
<i>Carex comosa*</i>	S (ID)		G5	S1	1	S1
<i>Carex flava</i>	—		G5	S3	M	NT
<i>Carex leptalea</i>	S (ID)		G5	S1	S	NT
<i>Carex livida</i>	S (ID, MT)		G5	S2	S	S2
<i>Carex paupercula</i>	S (ID, MT)		G5	S2	2	S2
<i>Cicuta bulbifera</i>	S (ID)		G5	S2	S	NT
<i>Cypripedium calceolus*</i>	S (ID, MT)		G5	S1	1	S2, S3
<i>Cypripedium passerinum*</i>	S (MT)		G4, G5	NP	—	S2
<i>Drosera anglica</i>	—		G5	NT	—	S2
<i>Drosera intermedia</i>	S (ID)		G5	S1	1	NP
<i>Drosera linearis*</i>	S (MT)		G4	NP	—	S1
<i>Dryopteris cristata</i>	S(ID, MT, WA)		G5	S2	S	S2
<i>Eleocharis rostellata</i>	—		G5	NT	—	S2
<i>Eleocharis tenuis</i>	—		G5	S1	2	NT
<i>Epilobium palustre</i>	S (ID)		G5	S3	M	NT
<i>Epipactis gigantea*</i>	S (ID, MT)		G4	S3	1	S2
<i>Eriophorum viridicarinatum</i>	S (ID, MT)		G5	S1	1	NT
<i>Gaultheria hispidula</i>	S (ID, WA)		G5	S1	2	NP
<i>Hypericum majus</i>	S (ID)		G5	S1	2	NT
<i>Iris versicolor</i>	—		G5	S1	R	NT
<i>Liparis loeselii*</i>	S (MT)		G5	NP	—	S1
<i>Lomatogonium rotatum</i>	—		G5	S1	1	S1
<i>Ludwigia polycarpa</i>	—		G4	S1	1	NP
<i>Lycopodium inundatum*</i>	S (ID, MT)		G5	S2	1	S1
<i>Lycopodium sitchense</i>	S (ID)		G5	S2	S	NT
<i>Maianthemum dilatatum</i>	—		G5	S2	1	NP
<i>Muhlenbergia racemosa</i>	—		G5	S1	1	NT
<i>Orchis rotundifolia*</i>	S (MT)		G5	NP	—	S2, S3
<i>Petasites sagittatus</i>	—		G4	S3	M	NT
<i>Picea glauca</i>	—		G5	S1	2	NT
<i>Rhynchospora alba*</i>	S (ID)		G5	S2	1	NP
<i>Salix candida</i>	—		G5	S2	2	NT
<i>Salix pedicellaris*</i>	S (ID)		G5	S1	2	NP
<i>Scheuchzeria palustris*</i>	S (ID, MT)		G5	S2	2	S1
<i>Scirpus cespitosus*</i>	—		G5	NT	—	S1
<i>Scirpus hudsonianus</i>	S (ID)		G5	S1	1	S1
<i>Scirpus subterminalis</i>	S (ID, MT)		G4, G5	S3	S	S1
<i>Trientalis arctica</i>	S (ID)		G5	S3	S	NP
<i>Vaccinium oxycoccos*</i>	S (ID)		G5	S2	2	NP
<i>Viola renifolia</i>	S (MT)		G5	NP	—	S2

Photographs of the Different Types of Peatland Environments _____



Color plate 1—Shallow basin peatland. *Carex lasiocarpa* and *Carex buxbaumii* are dominant species of the open fen (foreground); *Salix bebbiana* forms a carr community on the outer edge of the basin. This site intergrades to a marsh subject to periodic drying of the surface peat. Mosses are sparse. Lost Creek Fens, Flathead National Forest, Montana. Photo by Steve Chadde.



Color plate 3—Flow-through or slope peatland. Dominant vascular species include *Betula glandulosa*, *Carex lasiocarpa*, *Carex utriculata*, and *Eleocharis tenuis*. Brown mosses such as *Bryum pseudotriquetrum*, *Limprichtia revolvens*, and *Tomenthypnum nitens* form a nearly continuous surface cover. Porcupine Fen, Flathead National Forest, Montana. Photo by Steve Chadde.



Color plate 2—Deep basin peatland. A peat mat surrounds the open water. *Sphagnum angustifolium*, and *Sphagnum teres* are common peat mosses. Vascular species include *Carex lasiocarpa*, *Carex flava*, *Carex interior*, and *Eriophorum chamissonis*. Trout Lake, Flathead National Forest, Montana. Photo by Steve Shelly.



Color plate 4—Flow-through or slope peatland. Shrubs are sparse; dominant herbaceous species are *Carex lasiocarpa*, *Carex limosa*, and *Carex utriculata*. Brown mosses carpet the ground surface. Sanko Creek Fen (North), Flathead National Forest, Montana. Photo by Steve Shelly.



Color plate 5—Patterned rich fen. Dominant species of raised strings include *Eleocharis rostellata*, *Eleocharis tenuis*, and *Carex buxbaumii*. *Menyanthes trifoliata* is common in the water-filled flarks. Bent Flat Fen, Flathead National Forest, Montana. Photo by Steve Shelly.



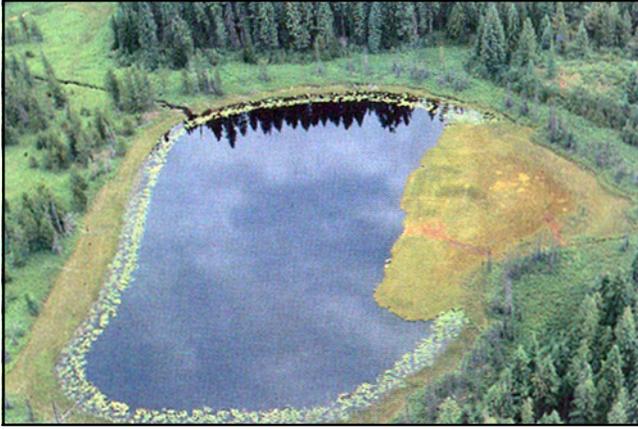
Color plate 7—Patterned poor fen. Prominent vascular species include *Deschampsia cespitosa*, *Carex aquatilis*, *Eleocharis pauciflora*, and *Carex limosa*. Mosses include *Sphagnum angustifolium*, *Sphagnum subsecundum*, *Aulacomnium palustre*, *Calliergon stramineum*, and *Drepanocladus aduncus*. Skull Creek Meadows, Beaverhead-Deerlodge National Forest, Montana. Photo by Steve Chadde.



Color plate 6—Patterned rich fen with flark (center) and strings (left and right). *Potentilla fruticosa* and *Eleocharis tenuis* are common atop the strings; *Scirpus acutus* and *Eleocharis tenuis* are common in the flarks. The substrate is a mush-like mixture of marl and peat. Bent Flat Fen, Flathead National Forest, Montana. Photo by Steve Chadde.



Color plate 8—Paludification. Expansion of a peatland into the surrounding subalpine forest of *Pinus contorta*. This process occurs as peat accumulates and leads to a gradual rise in the local water table. *Scirpus cespitosus* is a major herbaceous species. Huckleberry Creek Fen, Sawtooth National Forest, Idaho. Photo by Robert Moseley.



Color plate 9—Deep basin peatland. Aerial view of a floating mat surrounding a small lake in a basin setting. Hager Lake, Kaniksu National Forest, Idaho. Photo by Steve Spence.



Color plate 11—Carr. A peatland dominated by shrubs, in this case by *Betula glandulosa*. Porcupine Fen, Flathead National Forest, Montana. Photo by Steve Shelly.



Color plate 10—Deep basin peatland. Peatland pond supporting aquatic plants (*Nuphar polysepalum*, right) and a floating organic mat dominated by *Carex lasiocarpa* (left). *Scirpus acutus*, an emergent species, occurs along the margin of the mat. Hager Lake, Kaniksu National Forest, Idaho. Photo by Robert Moseley.



Color plate 12—Flow-through or slope peatland. Water upwelling through peat deposit. Plum Creek Fen, Swan River Valley, Montana. Photo by Steve Shelly.

Photographs of Common and Rare Peatland Plants



Color plate 13— *Carex livida* (Wahl.) Willd. (Pale sedge), Cyperaceae (Sedge Family). A circumboreal sedge that is rare in western Montana. This species is largely confined to minerotrophic (rich) fen habitats. Photo by Maria Mantas.



Color plate 14— *Cypripedium calceolus* L. (Small yellow lady's-slipper), Orchidaceae (Orchid Family). A sparsely occurring, circumboreal orchid species that is often associated with rich fens, calcareous wetlands, moist forests, and seepage areas in western Montana and northern Idaho. It is typically encountered in the semishaded ecotonal margins around peatlands. Photo by Steve Wirt.



Color plate 15— *Cypripedium passerinum* Richardson (Sparrow's-egg lady's-slipper), Orchidaceae (Orchid Family). An orchid species that is more frequent in Canada. This species is confined to ecotones of peatlands and moist seepage areas, often in areas of calcareous bedrock. The only sites in the Western United States occur in northwestern Montana. Photo by Maria Mantas.



Color plate 16— *Orchis rotundifolia* Banks (Round-leaved orchis), Orchidaceae (Orchid Family). An orchid species of Northern North America, with peripheral locations in Montana and Wyoming in the Western United States. This species often occurs with *Cypripedium passerinum* and is found along mossy streambanks, peatland margins, and in moist forests, usually in areas of limestone bedrock. Photo by Maria Mantas.



Color plate 18— *Epipactis gigantea* Dougl. Ex Hook. (Giant helleborine), Orchidaceae (Orchid Family). A wide-ranging, but sparsely occurring, orchid species in Western North America. The habitat includes rich fens, streambanks, lake margins, and thermal springs. Photo by Maria Mantas.



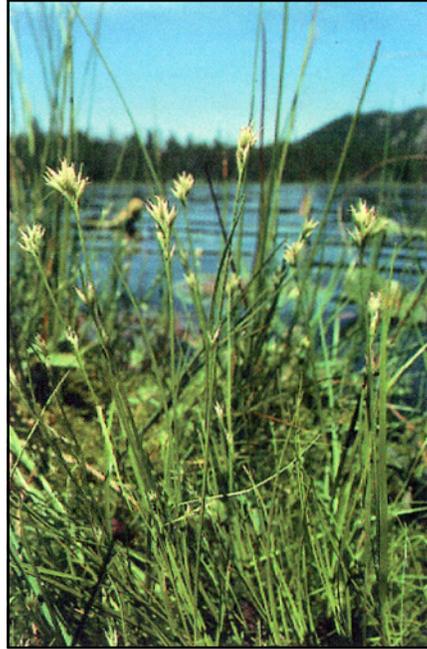
Color plate 17— *Drosera linearis* Goldie (Linear-leaved sundew), Droseraceae (Sundew Family). A carnivorous plant found primarily in boreal regions of Canada, but occurring peripherally, and rarely, in northwestern Montana. This species occurs in fens and on peat mats around ponds and lakes, often in association with sphagnum moss. Photo by Maria Mantas.



Color plate 19— *Liparis loeselii* (L.) Rich. (Fen-orchid), Orchidaceae (Orchid Family). An orchid species that is rare in the Western United States. In Montana, it is known only from a few rich fens. *Sphagnum warnstorfi* is the maroon-colored peat moss. Photo by Steve Chadde.



Color plate 20— *Lycopodium inundatum* L. (Northern bog clubmoss), Lycopodiaceae (Clubmoss Family). A circumboreal species, known in the Western United States from only a few locations in Montana. It occurs in basin fens and on floating peat mats adjacent to ponds. *Drosera anglica* is also present in this photograph. Photo by Maria Mantas.



Color plate 22— *Rhynchospora alba* (L.) Vahl. (Beak-rush), Cyperaceae (Sedge Family). A circumboreal species occurring peripherally in sphagnum moss peatlands in northern Idaho. Photo by Robert Moseley.



Color plate 21— *Tomenthypnum nitens*. A hummock-forming brown moss of rich fens. This photo shows the characteristic golden color of this species. Photo by Steve Chadde.



Color plate 23— *Scheuchzeria palustris* L. (Podgrass), Scheuchzeriaceae (Scheuchzeria Family). A circumboreal species occurring peripherally in western Montana. It is found in rich fens and on peat mats near ponds. Photo by Maria Mantas.



Color plate 24— *Vaccinium oxycoccos* L. (Small cranberry), Ericaceae (Heath Family). A circumboreal species that is peripheral in northern Idaho. It is confined to poor fens. Photo by Robert Moseley.



Color plate 25— *Menyanthes trifoliata* L. (Bog buck bean), Menyanthaceae (Buck-bean Family). A wide-ranging species that occurs in wetlands and peatlands, including flarks in patterned fens. In the Rocky Mountains it occurs south to Colorado. Photo by Maria Mantas.

Swan Valley), *Carex tenuiflora* (Glacier National Park), *Gentianopsis macounii* (fringed gentian) and *Salix serissima* (autumn willow) (Front Range), *Gentianopsis simplex* (hiker's gentian) (three occurrences in Montana).

Wyoming—Swamp Lake Peatland contains a large number of vascular plants considered rare in the State, including two species known only from this location in the continental United States: *Arctostaphylos rubra* and *Salix myrtilifolia* (blueberry willow). Other disjunct boreal species occur at the site: *Primula egalikensis* (primrose), *Scirpus pumilus* (bulrush), *Carex livida*, *C. scirpoidea* var. *scirpiformis*, *C. microglochin*, *C. limosa*, *Kobresia simpliciuscula*, *Eriophorum viridicarinaratum*, and *Orchis rotundifolia*.

Peatlands as Historical Archives

Aside from having a unique biota, peatlands also provide an important historical perspective through the plant fossils and volcanic ash preserved in their peat deposits (Heidel 1995). In the Northern Rocky Mountains, a number of peatlands have had core samples taken and analyzed. In northern Idaho, Hager Lake has been the subject of four *paleoecological* studies (Hansen 1939; Mack and others 1978; Moseley and others 1992; Rumely 1956). Hansen (1939) described the general stratigraphy of the peat deposits and reported the presence of several volcanic ash layers. Based on pollen remains in the peat, he inferred a post-glacial forest initially dominated by species of cool-moist climates, then changing to species of warm-dry conditions, and more recently returning to a predominance of species adapted to a cool and dry climate. Rumely (1956) confirmed the post-glacial forest history reconstructed by Hansen, and noted the importance of periodic, stand-replacing fire. Mack and others (1978) subdivided the warm-dry and the current cool-moist climatic periods into two distinct phases.

Other peatlands cored in the Northern Rocky Mountains include Lost Trail Pass peatland on the Idaho-Montana border (Mehring and others 1977a,b), Mary's Frog Pond (Karsian 1995) and Sheep Mountain Bog (Hemphill 1983) on the Lolo National Forest, Smeads Bench on the Kootenai National Forest (Chatters 1994a). For the most part, these studies were focused on a reconstruction of post-glacial vegetation and climate of the surrounding region. For example, the Lost Trail Pass study examined Holocene vegetation changes and volcanic ash chronology for this part of the Bitterroot Mountains.

From analysis of core samples, a post-glacial record of regional and on-site vegetation can be reconstructed

using pollen and plant macrofossils preserved in the peat (Barber 1993). Peat deposits enable ecologists to address questions about landscape and community development and evolution in the context of centuries or millennia rather than over only several field seasons as is often the case (Schoonmaker and Foster 1991). Whether a given ecosystem is stable and relatively unchanging, or whether it is dynamic and undergoing frequent and rapid changes can be determined by analyzing peat deposits. Models for community development and landscape evolution supported from studies of the peatland archives can provide more enlightened and long-term management strategies, not only for the peatlands, but for Rocky Mountain ecosystems as a whole (Bursik and Moseley 1992c).

Based on peat core analyses, the origin of a peatland's vegetation can be inferred. Important factors influencing the type of vegetation may be the age of the peatland (Bursik 1990), water chemistry, hydrology, and the chance arrival of plant propagules that initially colonize the site. Latitudinal and elevational differences, the variety of prevailing climatic regimes, and the physical nature of the peat deposits are also likely important in determining vegetation patterns and development.

Only one paleoecological study was recently undertaken in the Northern Rocky Mountains to reconstruct the on-site vegetational development of a peatland itself, in contrast to inferring the vegetation composition of the surrounding landscape. The study, comparable to studies by Watts and Winter (1966) and Miller and Futyma (1987), was undertaken in 1992 at Hager Lake, ID (Bursik and others 1994; Moseley and others 1992). Vegetation research conducted in the fen during the early 1950's (Rumely 1956) was redone 40 years later (Bursik and Moseley 1992b). They found significant changes in surface water chemistry, floristic composition, and the spatial arrangement of community types. For example, 14 vascular plant species had become extirpated from the site during the intervening four decades, including four rare species. Nine species had immigrated to the site. It was hypothesized that these changes resulted from adjacent land management practices, including ditching and timber harvest (Bursik and Moseley 1992b). Another explanation, however, could have been that these were normal fluxes inherent in a dynamic ecosystem.

To test which of these two scenarios was correct, a paleoecological study was undertaken to address the question of longer-term change. The goal was to ascertain whether or not ecological changes documented between 1952 and 1992 are within the range of pre-settlement variability or are a consequence of recent human disturbances. Results indicated that vegetationally, the most dynamic time during the

600 year history of Hager Lake Fen represented in the cores was early in this century. This coincides with settlement by the first Europeans in the Hager Lake area (Rumely 1956). It appears that repeated ditching from about 1920 until 1988 kept water levels in Hager Lake Fen lower than the previous 300 years. Conversely, surface waters became increasingly minerotrophic following logging and land clearing prior to 1952, but cessation and recovery from these disturbances, in combination with low water levels, caused subsequent oligotrophication during the last 40 years. Many land managers consider these small, isolated peatlands to be relatively immune to the effects of management practices occurring on adjacent terrain. These data suggest that this may not be the case and that these sites are closely linked to external, landscape-level processes (Bursik and Moseley 1992b).

Peatland Fauna

Invertebrates

The open water environments found at many peatlands are important habitat for numerous invertebrate and vertebrate animal species (see appendix C for a profile of invertebrates associated with peatlands). In many ponds and standing water areas associated with peatlands, dense masses of submerged vegetation are present and provide habitat for numerous invertebrate species. The importance of submerged plants as invertebrate habitat has long been recognized (Crowder and Cooper 1972; Dvorak 1978; Fairchild 1981; Johnson and Crowley 1980; Kreeker 1939; Krull 1970; Porter 1977; Smith 1972). This complex matrix affects invertebrate communities by providing refuge for prey, periphyton for grazers and herbivores, hunting perches for substrate-dependent predators, and access to the entire water column by substrate-preferring organisms (Rabe and Gibson 1984).

Several detailed studies of macroinvertebrate fauna associated with peatland and wetland sites in the northern Rockies have been conducted by: Rabe and others (1986, 1990), Rabe and Chadde (1995), and Rabe and Savage (1977). These references are a good source of additional information. Many of these studies concentrated specifically on peatlands and wetlands contained within the Forest Service Research Natural Areas (RNA) system. Each of these sites is unique with respect to the particular complement of peatland and aquatic features and associated diversity of macroinvertebrates. Potholes RNA and Kaniksu Marsh RNA in northern Idaho are among the peatland ponds containing the greatest variety of peatland components. These sites together with Hager Lake and Bottle Lake supported the highest species richness of peatland macroinvertebrates. In Bottle

Lake, the extensive floating mat surrounded by a deep pool on one side and a shallow moat on the other probably accounts for high levels of macroinvertebrate diversity (Rabe and Savage 1977).

Vertebrates

The northern bog lemming (*Synaptomys borealis*) typically inhabits sphagnum bogs and fens, but is also occasionally found in other habitats including mossy forests, wet subalpine meadows, and alpine tundra. The species is boreal in distribution, occurring in North America from near treeline in the north, south to Washington, Idaho, Montana, Minnesota, and New England.

The northern bog lemming is a small, grayish brown, vole-like microtine, related to the true arctic lemmings (*Lemmus*). Nine poorly differentiated subspecies are currently recognized. The northern bog lemming has a total length of 118 to 140 mm including its very short tail (19 to 27 mm) (Banfield 1974; Hall 1981). The combination of a tail less than 28 mm and a longitudinal groove in the upper incisors distinguish the northern bog lemming from all other mice found in the Northern Rocky Mountains (Reichel and Beckstrom 1994).

A few relict populations occur in the lower 48 States; the subspecies *chapmani* occurs in Montana, Idaho, and northeast Washington (Hall 1981). Bog lemmings are known from four locations in Idaho and eight in Washington, all within 80 km of the Canadian border (Groves and Yensen 1989). The reasons for the disjunct nature of the populations may include: (1) the localized nature of its habitat and (2) the patchy distribution of a boreal species that was more widely distributed during the Pleistocene.

The U.S. Forest Service, Northern Region lists the northern bog lemming as sensitive. It is listed as a species of special concern by the Idaho Conservation Data Center and Montana Natural Heritage Program (Idaho Conservation Data Center 1994; Reichel and Beckstrom 1994).

Prior to 1992, evidence of bog lemmings in Montana included: six locations on the west side of Glacier National Park and Shoofly Meadows in the Rattlesnake drainage north of Missoula. In 1992 and 1993, 10 new populations of northern bog lemmings were discovered in western Montana (Reichel and Beckstrom 1994).

In Montana, elevation of the sites supporting northern bog lemming ranged from 1,360 to 1,800 m. At eight of ten sites where northern bog lemmings were caught during 1992 to 1993, the habitats were characterized by thick mats of sphagnum moss. One site had a thick moss layer of *Tomentypnum nitens* rather than sphagnum. Thick moss mats appear to be the most reliable indicator of a potential site.

All occupied northern bog lemming sites were relatively open. Several occupied sites had an open overstory of *Abies lasiocarpa* or *Picea engelmannii*, others were without a tree component. Shrubs were present on all sites, however, in most areas the moss habitat areas were without shrubs on at least part of the patch. *Betula glandulosa* and *Salix* spp. (typically less than 1.5 m tall) were present at all sites. Graminoid cover ranged from 40 to 90 percent. *Eleocharis pauciflora* was dominant at one site; dominant sedge species at other sites included *Carex aquatilis*, *C. arcta*, *C. buxbaumii*, *C. canescens*, *C. lasiocarpa*, *C. utriculata*, and *C. vesicaria*.

The grizzly bear (*Ursus arctos*), a Federally listed Threatened Species, and the woodland caribou (*Rangifer tarandus*), an Endangered species, are known to utilize subalpine peatlands of the Selkirk Mountains. Grizzly bears have also been sighted at valley peatland locations in the Priest River Valley. In Montana, grizzly bear scat was observed in Swan Valley peatlands by several of the authors during the course of inventories and forage in Pine Butte Swamp along the Rocky Mountain Front.

Peatland Conservation

The biological significance of peatland habitats in the Northern Rocky Mountains, and the sensitivity of these habitats to environmental conditions requires conservation approaches that ensure protection for these important sites.

Integrity of peatland ecosystems is inherently tied to hydrologic conditions. Although fairly small in size, peatlands are sustained by water and nutrient resources derived from much larger portions of the surrounding landscapes. Under naturally occurring hydrologic regimes, peatlands are relatively stable ecosystems. However, resiliency, or the ability to recover from disturbance, is low in peatlands. Recovery from major disruptions to water or nutrient flows or to the removal of vegetation may require centuries. Rates of peat accumulation have been estimated to be approximately 2 cm per century in boreal and temperate climates (Crum 1988), but this figure likely varies widely and is also influenced by inflows of sediment. Land-use activities that directly impact peatlands (such as peat mining, draining) and indirect impacts such as upslope timber harvest or road construction can cause changes to peatland biodiversity because many species are sensitive to minor changes in water chemistry and hydrology (Bursik and Moseley 1992a,b; Damman and French 1987; Glaser 1987; Vitt and Slack 1975).

Fortunately many protection measures are already in place or are available for conserving peatlands on National Forests. Following is a discussion of threats

to maintaining peatland integrity, current management guidelines, protection through special designations, monitoring, and research needs and public education.

Threats

The two most critical factors affecting the abundance and distribution of peatland species in the Northern Rocky Mountains appear to be water levels and the nutrient concentration of incoming water. Natural factors such as wildfire, drought, and beaver activity bring periodic changes in these two factors and consequent shifts in location and abundance of peatland species. The abrupt, large-scale, and often irreversible nature of changes in hydrology and nutrient concentrations that result directly or indirectly from human activities, however, may be beyond the tolerance level of resident populations.

Direct impacts that may threaten the integrity of peatland ecosystems and associated plant and animal populations include ditching and drainage, peat mining, livestock grazing, water flow regulation, and invasion by exotic plant species. Several peatlands in Idaho and Montana have been significantly altered by major ditching, filling, and development. Although National Forest peatlands are not subject to development, some of these sites have been altered by ditching and drainage. Studies of Hager Lake Fen in Idaho have documented significant vegetation changes and loss of species diversity over a 40 year period, attributed in part to hydrologic changes resulting from ditching (Bursik and Moseley 1992a). During this 40 year period, 14 plant species disappeared from the site, including four rare species.

Little peat mining has taken place in the Northern Rocky Mountains, although limited local peat operations are known to occur in Idaho and Montana. This type of habitat destruction may be increasing, however, as private landowners and mining companies become increasingly interested in exploiting peat.

Although not a significant threat to most peatlands, livestock grazing takes place within and around some of the peatlands on National Forests in Idaho and Montana. Livestock grazing directly impacts vegetation through removal and trampling, and may result in soil compaction, and altered local hydrologic conditions. Indirect impacts associated with grazing may include altered water chemistry.

Artificial regulation of water levels around lakes and water flows associated with streams is another potential threat. Peatlands around lakes with regulated water levels could be threatened with a loss of species dependent on naturally fluctuating water regimes. Naturally occurring water regulators in peatland systems include beaver. The erratic dam building and flooding activities associated with beaver is critical to the maintenance of habitat diversity,

which allows numerous species adapted to various seral stages to survive. Removing beaver from peatlands may have negative impacts on the overall functioning of the ecosystem. Long-term static water levels can lead to the gradual depauperization of the flora in peatlands (Crum 1988).

Management activities on landscapes that have peatlands imbedded within them can potentially threaten system integrity, if they adversely alter hydrologic regimes and nutrient regimes. Hydrologic conditions of individual peatlands result from their placement within an overall drainage system. Since most peatlands in Idaho and Montana are flow-through systems, water is obtained from the lands higher up in the drainage. Certain off-site management activities, such as timber harvest, road building, and livestock grazing that alter hydrologic and nutrient regimes may adversely impact peatlands. The degree of impact of these activities on peatlands is the result of many factors including the extent and intensity of land management activity or disturbance, and the particular physiographic features of the drainage. Off-site management activities need to be planned so that hydrologic and nutrient conditions remain within the range of natural variability. Additional threats to peatlands may arise from point source water pollution.

Invasion by exotic plant species is apparent in some peatlands. Reed canary grass (*Phalaris arundinacea*) is a commonly observed exotic species in peatlands, and is able to aggressively spread by rhizomes. Canada thistle (*Cirsium arvense*) may also invade peatlands following disturbances such as wheel ruts or fire.

Management of Peatlands on National Forests

Conservation of peatland habitats on National Forests is accomplished in several ways. A combination of State and Federal laws, agency policy, and management standards and guidelines set forth in forest plans collectively provide conservation mechanisms for many peatlands. Additional protection mechanisms include application of special designations to the most significant sites (discussed in the next section).

The presence of sensitive plant and animal species in peatlands affords protection through policy and guidelines aimed at maintaining viable populations of these species. The Clean Water Act and State water quality standards help prevent the occurrence of activities or pollution that could result in altered water chemistry and nutrient regimes in peatlands.

Peatlands fall under various categories of management direction in forest plans within Montana and Idaho. Generally, peatlands meet the criteria of jurisdictional wetlands that often fall within a riparian management area in the forest plans. Management

standards and guidelines in these management areas usually emphasize nonmanipulative management, although some timber harvest, grazing, and road building may still be permitted. Special use permits for such activities as peat harvesting are not issued in these areas.

Although existing management direction, policy, and laws provide a framework for conserving these highly significant peatlands, additional protection could be provided through development of more specific management strategies. In particular, a better articulation of how off-site management practices influence peatland hydrology and water chemistry would be beneficial.

Site Protection Through Special Area Designations

A common conservation approach to protecting highly significant biological sites on National Forests is through the employment of special designations such as Research Natural Areas (Forest Service Manual 4063) and Special Interest Botanical Areas (Forest Service Manual 2072). These designations allow for recognition of exceptional biological features, such as areas of significant biological diversity with rare biota, or high quality examples of representative ecosystem types. Research Natural Areas have the following objectives: (1) preserve and maintain biological diversity, (2) form a network of reference areas containing a wide range of ecological conditions in the United States, (3) monitoring baseline conditions for determining the effects of management practices on terrestrial and aquatic ecosystems, and (4) educational purposes (Federal Committee on Ecological Reserves 1977). The Special Interest Botanical Area is a recreation designation with the goal of acknowledging and highlighting a special area of the National Forest (Shevok 1988). The unique botanical features of an area are protected, yet access and interpretation of these features for the public may also be considered.

Designation of special areas is accompanied by development of site specific management and monitoring direction to ensure maintenance of a site's ecological integrity. Botanical Areas and Research Natural Areas typically disallow manipulative management activities such as timber harvest and cattle grazing. Additional benefits of designation include recognition of an area by the broader scientific and ecological community, resulting in focused points for interdisciplinary ecological study.

Of the sites included within this report (table 2), ten are presently within established or proposed Research Natural Areas, and five are within candidate or proposed Special Interest Botanical Areas. Two Montana sites occur within designated Wilderness.

Site Evaluation and Ranking

It is important to evaluate the site's physical and biological features when considering the significance of a peatland site for inclusion in a special area designation. Rankings for each peatland was, therefore, summarized (table 6). This information is useful for determining which sites are most biologically significant and which areas should and can be protected through special area designation.

Idaho—Several peatlands stand out as having the greatest ecological diversity in terms of the number of peatland components: Potholes and Kaniksu Marsh. Rose Lake and Mosquito Bay Fen are also notable. These sites are among the most floristically diverse peatlands in Idaho, each containing more than 100 plant species (Bursik and Henderson 1995). With the exception of Rose Lake, these sites also contain the densest concentrations of rare plant populations.

Seven sites had very high significance ranking scores (table 6). Four of these sites lie within established Research Natural Areas (Bottle Lake, Kaniksu Marsh, Potholes, Smith Creek), and Three Ponds Research Natural Area. Two additional highly significant sites, Armstrong Meadows and Upper Priest Lake Fen, occur within the Upper Priest Scenic Area of the Kaniksu National Forest. This group of peatlands represent most of the ecological and floristic diversity known in northern Idaho peatlands. Several features, however, are not well represented, including bog microsites, paludified forest, and *Typha latifolia*/*Carex lasiocarpa* communities found on floating mats.

The remaining Idaho sites had moderate scores. Three peatlands are within established Research Natural Areas (Iron Bog, Sawtooth Valley, and Three Ponds). Several sites partially on private land are part of Nature Conservancy preserves (Birch Creek Fen and Hager Lake Fen). The remaining sites are not within formally designated special protection areas. Bursik and Moseley (1995) discussed additional conservation measures for peatlands of northern Idaho.

Montana—Three sites examined by the authors had very high scores: Shoofly Meadows (Lolo National Forest), Swan River Fen (Flathead National Forest), and Bent Flat Fen (Flathead National Forest) (table 6). Shoofly Meadows is a proposed Research Natural Area. Swan River Fen lies within the established Swan River Research Natural Area. Bent Flat Fen is not within any special designation area, but Botanical Area may be appropriate given the uniqueness of this habitat and its associated rare plant populations.

Six additional sites had moderate rankings, with five occurring on the Flathead National Forest. Butcher Mountain Fens and Mud Lake lie within the Bob Marshall Wilderness. Lost Creek Fen and Porcupine Fen are candidate Botanical Areas. Trail Creek Fen

Table 6—Summary of conservation significance rankings. Sites are listed for each State by their scoring; the highest ranked sites are listed first. The two Wyoming sites, Sawtooth Fen and Swamp Lake, were not ranked by the authors. RNA = Research Natural Area. TNC = The Nature Conservancy.

Site	Representa- tiveness	Quality	Rarity	Diversity	Viability	Defensi- bility	Scientific and educational value	Total	Comments
Idaho									
Armstrong Meadows	3	3	3	3	3	3	3	21	Upper Priest Scenic Area
Kaniksu Marsh	3	3	3	3	3	3	3	21	RNA
Bottle Lake	3	3	3	3	3	3	2	20	RNA
Packer Meadows	3	3	3	3	3	3	2	20	
Potholes	3	3	3	3	3	3	2	20	RNA
Smith Creek	3	3	3	3	3	3	2	20	RNA
Upper Priest Lake Fen	3	3	3	3	3	3	2	20	Upper Priest Scenic Area
Birch Creek Fen	3	1	3	3	3	3	3	19	TNC preserve (part)
Dubius Creek Fen	3	2	3	3	3	2	3	19	
Hager Lake Fen	3	2	3	3	3	2	3	19	Conservation Easement (part)
Bog Creek Fen	3	3	3	2	3	2	2	18	
Cow Creek Meadows	3	2	3	3	3	2	2	18	Grazed
Grass Creek Meadows	3	2	3	3	3	2	2	18	Grazed
Perkins Lake	3	2	3	3	2	2	3	18	
Three Ponds	3	3	2	2	3	3	2	18	RNA
Rose Lake	3	2	2	3	3	1	3	17	Mostly private
Sinclair Lake	3	2	2	2	3	2	3	17	
Tule Lake	3	3	2	2	3	2	2	17	
Beaver Lake (North)	2	2	2	3	3	2	2	16	
Iron Bog	3	2	1	2	3	2	3	16	RNA
Lost Lake	2	3	2	2	3	2	2	16	
Mosquito Bay Fen	3	2	3	3	2	1	2	16	Mostly private
Sawtooth Valley Peatlands	3	2	1	2	3	3	2	16	RNA
Lamb Creek Meadows	3	2	2	2	2	2	2	15	
Robinson Lake	3	2	2	2	2	2	2	15	
Bismark Meadows	2	2	2	2	2	2	2	14	
Big Springs-Henry's Fork Confluence	2	2	1	2	3	2	2	14	
Blind Summit Fen	3	1	2	2	2	2	2	14	
Hoodoo Lake	2	1	2	2	1	2	2	12	Grazed
Washington									
Deerhorn Creek Meadows	3	3	3	3	3	2	2	19	
Huff Lake Fen	3	2	3	3	3	2	3	19	
Sema Meadows	3	3	3	2	3	2	2	18	
Montana									
Indian Meadows	3	3	3	3	3	3	3	21	RNA
Shoofly Meadows	3	3	3	3	3	3	3	21	RNA
Swan River Fen	3	3	3	3	3	3	3	21	Established RNA
Bent Flat Fen	3	3	3	3	3	2	3	20	Candidate botanical area
Lost Creek Fens	3	3	3	3	2	2	3	19	Candidate botanical area
Trail Creek Fen	3	3	3	3	3	2	2	19	
Mud Lake	3	3	3	2	3	3	2	19	Within wilderness
Skull Creek Fens	3	3	3	2	3	3	2	19	RNA
Butcher Mountain Fens	3	3	2	2	3	3	2	18	Within wilderness
Porcupine Fen	3	2	3	3	2	2	3	18	
Sheep Mountain Bog	2	3	3	2	2	2	3	17	RNA
Rock Creek Wetland	3	2	3	2	2	2	2	16	Candidate botanical area

(con.)

Table 6 (Con.)

Site	Representativeness	Quality	Rarity	Diversity	Viability	Defensibility	Scientific and educational value	Total	Comments
Tepee Lake	3	2	2	2	2	2	3	16	Candidate botanical area
Bowen Creek Fen	2	2	3	2	2	2	3	16	
Trout Lake	3	2	2	2	2	2	2	15	
Gregg Creek Fen	2	2	2	3	2	2	2	15	
Leonard Creek Fen	3	2	2	2	2	2	2	15	
Lost Trail Pass Fen	3	2	3	1	1	1	3	14	
Windfall Creek Fen	2	2	2	2	2	2	2	14	
Cody Lake Fen	2	2	2	2	2	2	2	14	
Sanko Creek (South)	2	2	2	2	2	2	2	14	
Sanko Creek (North)	2	2	2	2	2	2	2	14	
Hawkins Pond	2	2	2	1	2	2	1	12	
Sheppard Creek Fen	2	2	2	1	2	1	1	11	

is not within any special designation area. The final site, Skull Creek Fens (Beaverhead-Deerlodge National Forest) is within the Skull-Odell Research Natural Area.

Research and Monitoring Needs

Conservation of peatlands is dependent on an understanding of the distribution, composition, and function of these ecosystems. Although the inventory efforts summarized in this report provide a foundation for understanding the ecology of Northern Rocky Mountain peatlands, additional research and monitoring is needed to more fully examine the functioning of peatlands within broader landscapes. It is important to understand the consequences of landscape management practices on these biologically significant ecosystems.

Inventory

Inventories of peatlands on National Forests in Idaho and Montana have resulted in a fairly complete understanding of their distribution, occurrence, and composition. However, there remain unsurveyed areas and it is likely that other significant peatland sites will be discovered.

Biotic inventory in Northern Rocky Mountain peatlands has focused primarily on the vascular flora (Bursik 1990; Bursik and Henderson 1995) and, to a lesser extent, on bryophytes (Bursik and Henderson 1995; Chadde and Shelly 1995), and aquatic

invertebrates (Rabe and Savage 1977; Rabe and others 1986, 1990). Further inventory work is needed on terrestrial vertebrate and invertebrate fauna, fungi, and bryophytes of peatlands.

Classification

Classification is often considered the first step in understanding the nature and dynamics of habitats in order to properly manage them. During initial studies of the region's peatlands, the authors attempted to discern repeating patterns of vegetation that could be used in a classification of habitats, similar to other wetland classifications in the region (Hansen and others 1995; Mutz and Queiroz 1983; Tuhy 1981). This habitat classification could then be used as a basis of peatland ecosystem conservation efforts (Bursik and Moseley 1992c). Following the collection of a large amount of community-level data, it is evident that standard classification methods have serious shortcomings when applied to peatlands. Preliminary unpublished results yield a large number of community types occurring in the field as patches of extremely small size in a complex mosaic of vegetation. Mapping and subsequent management of these types within a single peatland is impracticable in most cases. Others have also concluded that peatland classifications based solely on vegetation dominance are of limited value except in a localized context (Crum 1988; Gore 1983).

Future efforts should be directed toward refining descriptions and classifications of entire peatlands in terms of a combination of physical features, hydrology, water chemistry, and floristics (Glaser 1987). The

widely accepted peatland classification that recognizes bog, poor fen, rich fen, and extremely rich fen is sufficient for most purposes in the region and has the advantage of being relatively easy to apply in the field.

Monitoring

The establishment of long-term studies, including monitoring programs have been recommended for a variety of ecological systems (Leopold 1962; Likens 1983). Carefully designed monitoring studies can lead to a better understanding of the magnitude and direction of change in dynamic landscapes and alter human activities and management paradigms appropriately (Mueggler 1992; Noss 1990). Recent re-analysis of early studies on peatlands in northern Idaho have revealed a significant level of change in these systems that is likely attributed directly or indirectly to human activities (Bursik and Moseley 1992a; Bursik and others 1994).

It is important that monitoring be carefully designed with specific objectives that address critical management and information questions at the system, community, and population levels. Permanent monitoring plots have been established in seven northern Idaho peatlands to determine changes of water chemistry and vegetation over time (Bursik and Moseley 1992a,b; Bursik and others 1994; Moseley and others 1994). Monitoring surface water quality and invertebrate populations in several National Forest peatlands has been conducted for many years (Moseley and others 1994; Rabe and Chadde 1994; Rabe and Savage 1977; Rabe and others 1986). Monitoring studies should be initiated at additional Northern Rocky Mountain peatlands.

Routine vegetation and water chemistry monitoring is recommended for peatlands where management activities such as grazing or timber harvest occur within or immediately adjacent to site boundaries. Determination of effects on the flora or vegetation should result in alteration of the management activity accordingly or avoidance of that management option in or near peatlands in the future.

Research

Gorham (1994) suggested a number of research topics for peatlands in Canada. Many are applicable to peatlands of the Northern Rocky Mountains. A standardized classification of peatlands based on landscape features, hydrology and water chemistry, and vegetation would be useful in describing peatlands. Such a multifaceted classification would provide a useful tool for predicting or modeling a site's potential as rare plant habitat. Hydrologic studies are needed to protect and maintain peatland integrity, and have direct bearing on how lands adjacent to peatlands may be best managed without degrading peatlands. Additional floristic inventories are needed

both of vascular and nonvascular plant species. This would lead to refinement of peatland community classifications and a better understanding of rare plant distribution within the study area. Autecological studies of individual species, especially those dominating peatlands or of rare species, are needed. The role of peatlands in reconstructing vegetational history of the surrounding landscape has been demonstrated in portions of the region, but geographic gaps remain.

Other areas of research interest include peatland habitat values and uses for wildlife, the importance of peatlands for vertebrates and invertebrates, plant dispersal mechanisms via wildlife, gradients responsible for plant distribution with peatlands, population genetics of rare peatland species, the history of paludified forests in the region, and the role of beaver in successional dynamics within peatlands.

Hager Lake Fen is one of the best-studied Northern Rocky Mountain peatlands. It has been the subject of several paleoecological studies, some of which are still in progress (Hansen 1939; Mack and others 1978). Rumely (1956) carried out a detailed vegetation study of Hager Lake Fen, which has been used to ascertain 40 year vegetation and floristic changes at the site (Bursik and Moseley 1992a). The report of Karg (1973) was used to detect floristic and vegetation changes at Huff Lake Fen (Bursik and Moseley 1992b).

Education

Public education is an important component of efforts to conserve significant biological resources such as peatlands. It is important that educational materials are developed on peatlands in order to maintain their integrity. This material should describe the impact of peatlands on local and regional hydrologic processes (for example, their role in water storage and flood control), their value as habitat for numerous unique and unusual organisms, as archives of post-glacial landscape history, and where they cover large areas as in Canada, their role as carbon sinks in relation to global warming.

Glossary

The glossary includes terms that are in bold italics in the text. Other words describing peatlands are included because of their use in international peatland research studies and to encourage a standardized language to describe peatlands. The glossary was adapted from Crum (1988), Glaser (1987), Gore (1983), and Sorenson (1986).

Aapamire (Finnish)—A patterned peatland developed on a slight slope, with ridges of peat (*strings*) alternating with hollows or pools (*flarks*); also known as *string bog* or *string fen*.

Accumulation—Growth of organic matter in an ecosystem as a result of the difference between gross primary productivity and total community respiration.

Acidophile—A plant adapted to acidic environments. Plants adapted to habitats with dilute acid waters.

Acrotelm—The uppermost horizon in a peat profile consisting of relatively porous and undecomposed peat. The concept is largely based on the work of Soviet hydrologists, who divide a peat deposit into two layers (*acrotelm* and *catotelm*) with contrasting physical and biological properties (Ingram 1978, 1983). The acrotelm or active layer is responsible for most water transmission through a peatland on account of its high hydraulic conductivity. It can also be defined as the zone of maximum water table fluctuations and oxygen penetration from the atmosphere.

Anastomosis—A network of interconnecting channels in a peatland.

Apron—An extensive downslope fen developed where the lags on either side of a domed bog join.

Ash content—The percentage of mineral solids remaining after a peat sample is burned.

Autogenic—Self-perpetuating communities where the course of succession is directed by the properties of the plants themselves. In poor fens and bogs, sphagnum mosses are especially important in controlling succession.

Bog—An ombrotrophic peatland, that is, one deriving water and nutrients only from the atmosphere. Bogs are highly acid and nutrient-poor and dominated by sphagnum mosses and ericaceous shrubs (and eventually, in much of North America, by black spruce). Bogs occur on peat elevated above the regional water table. Different types of bogs have been defined, some of which are actually *fens*:

Basin bog—Occupying the basin of a pond or lake; a lake-fill bog.

Blanket bog—Covering irregular terrain, developed in oceanic areas with cool temperatures and persistently high humidity.

Continental bog—An inland raised bog, less elevated and less convex than in oceanic regions.

Domed bog—Raised above ground level by a marked convexity, often with a concentric or eccentric pattern of ridges and depressions and/ or pools.

Flat bog—A fen developed under the influence of ground water and lacking the convexity of a bog.

Marly bog—A rich, highly calcareous fen.

Plateau raised bog—A relatively flat-topped, oceanic bog raised well above the level of the regional water table.

Quaking bog—A floating mat, often marginal to a lake or pond, floating on water or on unconsolidated peat and yielding underfoot.

Raised bog—Any ombrotrophic peatland but often used to describe oceanic bogs distinctly elevated above the regional water table. Inland (or *continental*) bogs are also raised but are only slightly elevated.

Slope bog—Bog on sloping terrain but not covering topographic irregularities as typical of more extensive blanket bogs; also known as a hanging bog.

String bog (aapamire)—String bogs are typically fens, but bog conditions may occur on well-developed ridges of peat.

Transition bog—A poor fen with vegetation intermediate between a fen and a bog.

Boreal region—A circumpolar forest region in the northern hemisphere that is generally dominated by conifer tree species. The boreal forest extends north to the treeless tundra and south to the mixed conifer or deciduous forests or temperate grasslands.

Boundary layer—See *Grenzhorizon*.

Brown moss—A true moss, as opposed to a “white moss” (peat moss).

Brown-moss peat—Organic sediments primarily composed of the brown mosses or Amblystegiaceae; typical genera in Northern Rocky Mountain peatlands include *Calliargon*, *Campylium*, *Cratoneuron*, *Drepanocladus*, and *Limprichtia*.

Bryophyte—Mosses and liverworts.

Bulk density—The weight per volume or mass of peat, including both organic and mineral content. Bulk density increases with decomposition.

Capillary water—Water occupying small pore spaces of the soil and moving in response to evaporation by means of cohesion of water molecules and adhesion to soil surfaces.

Carr—A peatland dominated by broad-leaved shrubs or trees.

Cation exchange capacity—Ability of a soil to adsorb or exchange positively charged ions on colloidal surfaces.

Catotelm—The lower horizon of a peat profile consisting of decomposed peat. Hydraulic conductivity through the catotelm is very low. See *Acrotelm*.

Collapse scar—A fen-like depression surrounded by a peat ridge, resulting from the melting of the ice core of a palsa or peat plateau.

Cupola—The uppermost portion of a raised bog.

Drunken forest—A stand of black spruce in subarctic regions of discontinuous permafrost, generally on peat plateaus where the ice core melts. This causes trees to lean or fall because of the unstable peat.

Dystrophic—Refers to the dark, extremely oligotrophic water in bogs resulting from the release of humic acids from vegetation.

Eccentric peatland—A raised bog having a surface that slopes mostly in one direction.

Ericad—A member of the Ericaceae, or heath family.

Eutrophic—Rich in available nutrient ions. Eutrophic lakes are often highly productive owing to an abundance of phosphate and nitrate. Oxygen may be deficient due to an overpopulation of plankton.

False bottom—A muddy suspension of undecayed organic matter in peatland lakes and ponds. When exposed at the surface, mat-forming sedges typically colonize the material.

Fen—A type of peatland that receives significant inputs of water and dissolved solids from a mineral source, such as runoff from mineral soil or ground water discharge. A fen is therefore considered to be geogenous and its vegetation minerotrophic. Fens are generally characterized by (1) surface waters with a pH above 4.2 and calcium concentration higher than 2 mg/l, (2) a higher diversity of species, and (3) landform patterns that are usually lower than the surrounding uplands.

Extremely rich fen—A type of fen with a very high pH (>7) and calcium concentration (>20 to 30 mg/l) and a characteristic assemblage of plant species.

Rich fen—A type of fen that has a slightly higher range in pH and calcium concentration (>10 mg/l) than poor fens. The division between poor, rich, and extremely rich fens is not sharp but consists of a continuous range in variation.

Poor fen—A type of fen that contains at least one minerotrophic indicator species and weakly geogenous surface waters (in contrast to bogs). Originally described in Sweden as having a pH range of 3.8 to 5.7. Calcium concentration is 2 to 10 mg/l.

Fiber Content—The percentage of peat remaining after sieving under a gentle stream of water, indicating the degree of decomposition. The *rubbed fiber* content provides a more meaningful index, and represents the percentage of organic matter remaining after rubbing 8 to 10 times between thumb and fingers.

Fibric peat—Scarcely decomposed peat consisting mainly of sphagnum moss; see *Humification scale*.

Flark—A water-filled depression or pool that is elongated perpendicularly to the slope. Flarks usually have distinctive species assemblages in contrast to adjacent raised *strings* (see *Strangmoor*).

Floating mat—See *quaking bog* under *bog*.

Geogenous—Water supplied from a mineral source (ground water or surface runoff).

Grenzhorizon (German)—The boundary layer of peat marking a change some 2,500 years ago toward cool, moist climates favorable to an increase in peat accumulation.

Grounded mat—Peat accumulation in a lake-fill basin extending from the bottom of the basin to its surface (also termed anchored mat). The grounded mat is joined at a hinge line to the floating mat.

Gytia (Swedish)—Organic matter deposited as grayish to blackish bottom mud.

Heath—Vegetation on well-drained mineral soil dominated by ericaceous shrubs. The word is also used to designate a shrubby member of the Ericaceae (or heath) family.

Hemic peat—Peat of intermediate decomposition; see *Humification (H) scale*.

Hinge line—Boundary between a floating fen and a grounded mat.

Hochmoor (German)—A raised bog with ombrotrophic waters.

Hollow—Wet depressions or pools between the hummocks on the peatland surface.

Humic substances—Products of the incomplete decomposition of cellulose and lignin, consisting of humic and fulvic acids in addition to a remnant called *cumin* (fraction that is not dissolved on treatment with dilute alkali).

Humification—A measure of peat decomposition determined by measuring the concentration of humic materials extracted from a peat sample.

Humification (H) scale—An indication of the degree of decomposition of peat from *fibrous* (light-colored, scarcely decomposed sphagnum peat) to *hemic* (partly decomposed peat derived from reed-sedge vegetation) to *sapric* (dark, well-decomposed peat primarily derived from bottom sediments and sedge vegetation).

Hummock—A mound of sphagnum or other moss sometimes providing anchorage for trees, shrubs, herbaceous species, and mosses and lichens requiring drier conditions than those found at the base of the hummock.

- Hydraulic conductivity**—The rate at which water moves through soil.
- Kettlehole**—A depression caused by melting of an ice block surrounded or covered over by till on glacial retreat. Lakes, ponds, and basin peatlands occupy such depressions.
- Lagg (Swedish)**—The outer margin of a peatland that receives runoff directly from mineral uplands or the adjacent peat mass; occupied by standing or sometimes moving water (as a *moat*).
- Layering**—The development of roots on the lower branches of trees where the branches come into contact with a wet moss substrate.
- Marl**—A deposit of calcium carbonate resulting from biotically induced changes in the carbonate-bicarbonate balance in freshwater basins. Marl also results from evaporation or abrupt temperature changes causing the escape of carbon dioxide from soluble calcium bicarbonate and the formation of insoluble calcium carbonate.
- Marsh**—A grassy wetland developed on mineral soil in areas with standing water at least part of the year. Marshes are well-aerated and rich in minerals and store little or no peat.
- Mesotrophic**—With a mineral content intermediate between oligotrophic and eutrophic.
- Mineral soil water limit**—The demarcation between minerotrophic and ombrotrophic conditions, that is, between fens and bogs.
- Minerotrophic**—Receiving nutrients from ground water and, therefore, rich in minerals as compared to an ombrotrophic situation (deriving minerals only from the atmosphere). Plants that require waters that have been enriched by runoff or ground water derived from mineral soil.
- Mire**—General term for any type of peatland.
- Mire complex**—A term used to describe a peatland that contains areas of both bog and fen.
- Moor**—A peatland, any area of peat accumulation, whether minerotrophic or ombrotrophic. In England, the term refers to an upland vegetation consisting of ericaceous shrubs (such as heather).
- Moss**—Bog (rarely used as such in North American literature); also a bryophyte of the class Bryopsida, or true mosses, sometimes referred to as *brown mosses* in contrast to the Sphagnopsida (peat mosses). Brown mosses are abundant in rich fens.
- Muck**—Dark, well-decomposed peat high in ash content, largely derived from fen vegetation.
- Mud bottom**—Wet low areas of peatlands having exposed muddy peat amid scattered plants.
- Muskeg**—An expanse of acid peatland bearing black spruce and an undergrowth of ericaceous shrubs and a ground cover of sphagnum mosses. In Canada, the term is commonly used synonymously with any type of peatland.
- Oligotrophic**—Poor in nutrients and therefore low in productivity.
- Ombrotrophic**—“Food from the sky;” bog ecosystems that receive nutrients only from the atmosphere.
- Paleoecology**—The study of past climates and vegetation based on an analysis of pollen, spores, and macrofossil remains deposited in sediments, including peat.
- Palsa (Finnish)**—A peat-covered mound covering a permafrosted core.
- Paludification**—Swamping, becoming wet by flooding, especially applied to the expansion of peatlands owing to a gradual rise in water table as peat accumulation impedes drainage. A term first used to describe the growth of peat over forest soils. Paludification has since been used to describe the growth of peat over any upland soil.
- Patterned fen**—A minerotrophic peatland containing networks of pools (flarks) and ridges (strings) oriented perpendicular to the slope; see *strangmoor*.
- Peat**—Organic matter (the dead remains of plants) deposited under water-soaked conditions as a result of incomplete decomposition. Primary, secondary, and tertiary peat deposits correspond to aquatic, sedge, and sphagnum peat, and reflect the degree of water retention and ground water influence.
- Peatland**—Any waterlogged area containing an accumulation of peat 30 cm or more thick. Any type of peat-covered terrain, including fens, bogs, and muskegs.
- Quaking mat**—See *quaking bog* (floating mat) under *bog*.
- Rand**—The sloped area between the lagg and a raised bog.
- Recurrence surface**—A zone of abrupt change in the peat from dark and well decomposed to light-colored and fibrous, marking a change to cooler and moister conditions favorable to the development of bog vegetation and deposition of sphagnum peat.
- Reduction zone**—The anaerobic layers of peat where organic material accumulates owing to incomplete decomposition.
- Reed-sedge peat**—Hemic peat composed of reeds, sedges, and grasses in the early (fen) stages of peatland succession.

Regeneration complex—An aggregation of hummocks and hollows on the bog surface, with bog growth achieved by the successive formations of hummocks on hollows and hollows on hummocks.

Ribbed fen—See *Aapamire*, patterned fen.

Sapric peat—Very decomposed peat; see *Humification (H) Scale*.

Sedge meadow—A sedge-dominated wetland similar to a fen but developed on mineral soil and less water-soaked during part of the season.

Soligenous—Peatlands that receive water and nutrients from the surrounding soils.

Sphagnol—A lignin-like component of the cell walls of sphagnum moss.

Sphagnum—The peat mosses; the sole genus of mosses within the class Sphagnopsida. Sphagnum mosses differ from other mosses in the way their branches are arranged on the plant. Branches are clustered along the stem into groups called fascicles. Each fascicle has two or more spreading branches and one or more pendant or hanging branches. Young branches are usually crowded at the end of the stem into a head or capitulum.

Sphagnum lawn—Poor fen; a flat, wet, acid peatland, under the influence of ground water, transitional to a bog.

Sporotrichosis—A disease caused by *Sporothrix schenckii*, contracted by handling horticultural peat. The disease causes skin eruptions and eventually moves to vital organs through the lymphatic system.

Strangmoor (German)—Refers to an individual patterned fen and differs slightly from the similar term aapamoor, which refers to a broader, more regional vegetation unit.

String—A peat ridge oriented perpendicularly to the slope in a patterned fen. See *Flark*, *Patterned Fen*, and *Aapamire*. Strings are the elevated and better-drained portions of a patterned fen.

Swamp—A forested wetland, flooded during part of the year or with moving ground water, well aerated, rich in minerals, and storing little or no peat. Swamps may be forested with deciduous or coniferous trees. Conifer swamps developed on peat are sometimes termed *treed fens*.

Tephra—Layers of volcanic ash found in peat profiles.

Terrestrialization—The process by which a peatland spreads out over a lake.

Vernal pool—A water-filled depression resulting from snowmelt.

Water table—The top of the zone of saturation where all the pore spaces are filled with water (in contrast to the aerated upper zone of peat or mineral soil).

Water track—A small, shallow channel for runoff water across the peatland surface.

White-moss peat—Peat that is primarily composed of sphagnum moss.

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Appendix A: Vascular and Nonvascular Plant Species of Peatlands in Idaho and Western Montana

Vascular plant nomenclature follows Hitchcock and Cronquist (1973). Common names are those developed by the Northern Region, U.S. Department of Agriculture, Forest Service (U.S. Department of Agriculture, Forest Service 1992). Moss nomenclature follows Anderson and others (1990), except for *Sphagnum*, which follows Anderson (1990).

Pteridophytes

Isoetaceae

Isoetes lacustris L. Lake quillwort

Lycopodiaceae

Lycopodium annotinum L. Stiff clubmoss

Lycopodium clavatum L. Running-pine

Lycopodium inundatum L. Bog clubmoss

Lycopodium obscurum L. Groundpine

Equisetaceae

Equisetum arvense L. Field horsetail

Equisetum fluviatile L. Water horsetail

Equisetum laevigatum A. Br. Smooth scouring-rush

Equisetum palustre L. Marsh horsetail

Equisetum sylvaticum L. Wood horsetail

Equisetum variegatum Schleich. Variegated horsetail

Ophioglossaceae

Botrychium multifidum (Gmel.) Ruprecht Leathery grape-fern

Botrychium virginianum (L.) Swartz. Virginia grape-fern

Ophioglossum vulgatum L. Adder's-tongue

Dryopteridaceae

Athyrium filix-femina (L.) Roth ex Mertens Ladyfern

Dryopteris carthusiana (Vill.) H.P. Fuchs Mountain wood-fern

Dryopteris cristata (L.) Gray Crested shield-fern

Gymnocarpium dryopteris (L.) Newm. Oak-fern

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn. Brackenfern

Gymnosperms

Cupressaceae

Juniperus communis L. Common juniper

Thuja plicata Donn. Western redcedar

Pinaceae

Abies grandis (Dougl.) Forbes Grand fir

Abies lasiocarpa (Hook) Nutt. Subalpine fir

Picea engelmannii Parry Engelmann spruce

Pinus contorta Dougl. Lodgepole pine

Pinus monticola Dougl. Western white pine

Tsuga heterophylla (Raf.) Sarg. Western hemlock

Angiosperms

Alismataceae

Alisma gramineum Gmel. Narrowleaf waterplantain

Alisma plantago-aquatica L. American waterplantain

Sagittaria cuneata Sheld. Arumleaf arrowhead

Sagittaria latifolia Willd. Wapato

Apiaceae

Angelica arguta Nutt.
Angelica pinnata S. Wats.
Cicuta bulbifera L.
Cicuta douglasii (DC.) Coult. & Rose
Ligusticum canbyi Coult. & Rose
Ligusticum tenuifolium Wats.
Ligusticum verticillatum (Geyer) C. & R.
Osmorhiza chilensis H. & A.
Sanicula marilandica L.
Sium suave Walt.

Sharptooth angelica
Pinnate-leaved angelica
Bulb-bearing water-hemlock
Douglas water-hemlock
Canby's licorice-root
Slender-leaved licorice-root
Verticillate licorice-root
Mountain sweet-cicely
Black snake-root
Hemlock water-parsnip

Araceae

Lysichitum americanum Hulten & St. John

Skunk cabbage

Asteraceae

Anaphalis margaritacea (L.) Britt.
Antennaria microphylla Rydb.
Antennaria pulcherrima (Hook.) Greene
Arnica amplexicaulis Nutt.
Arnica latifolia Bong.
Arnica cordifolia Hook.
Aster eatonii (Gray) Howell
Aster foliaceus Lindl.
Aster junciformis Rydb.
Aster laevis L.
Aster modestus Lindl.
Bidens cernua L.
Bidens vulgata Greene
Cirsium arvense (L.) Scop.
Cirsium scariosum Nutt.
Cirsium vulgare (Savi) Tenore
Crepis runcinata (James) T. & G.
Erigeron peregrinus (Pursh) Greene
Helianthella uniflora (Nutt.) T. & G.
Hieracium albiflorum Hook.
Petasites sagittatus (Banks) Gray
Senecio cymbalarioides Buelk
Senecio hydrophilus Nutt.
Senecio indecorus Greene
Senecio pseud aureus Rydb.
Senecio triangularis Hook.
Solidago canadensis L.
Sonchus arvensis L.
Tanacetum vulgare L.
Taraxacum officinale Weber

Common pearly-everlasting
Rosy pussy-toes
Showy pussy-toes
Clasping arnica
Orange arnica
Heart-leaf arnica
Eaton's aster
Leafy aster
Rush aster
Smooth aster
Few-flowered aster
Nodding beggar-ticks
Tall bur-marigold
Canada thistle
Elk thistle
Bull thistle
Meadow hawkbeard
Subalpine daisy
One-flowered helianthella
White-flowered hawkweed
Arrowleaf coltsfoot
Few-leaved groundsel
Alkali-marsh butterweed
Rayless mountain butterweed
Streambank groundsel
Arrowleaf groundsel
Canada goldenrod
Field milk-thistle
Common tansy
Common dandelion

Balsaminaceae

Impatiens aurella Rydb.

Orange balsam

Betulaceae

Alnus incana (L.) Moench
Alnus sinuata (Regel) Rydb.
Betula glandulosa Michx.
Betula occidentalis Hook.
Betula papyrifera Marsh.
Betula pumila L.

Mountain alder
Sitka alder
Bog birch
Water birch
Paper birch
Bog birch

Boraginaceae

Mertensia paniculata (Ait.) G. Don.
Myosotis laxa Lehm.

Panicle bluebells
 Small-flowered forget-me-not

Brassicaceae

Cardamine oligosperma Nutt.
Rorripa islandica (Oed.) Borbas
Rorripa sinuata (Nutt.) Hitchc.

Few-seeded bittercress
 Marsh yellowcress
 Spreading yellowcress

Campanulaceae

Lobelia kalmii L.

Kalm's lobelia

Caryophyllaceae

Stellaria calycantha (Ledeb.) Bong.
Stellaria longifolia Muhl.

American starwort
 Longleaved starwort

Ceratophyllaceae

Ceratophyllum demersum L.

Hornwort

Callitrichaceae

Callitriche hermaphroditica L.
Callitriche verna L.

Autumnal water-starwort
 Spring water-starwort

Cornaceae

Cornus canadensis L.
Cornus stolonifera Michx.

Bunchberry
 Red-osier dogwood

Caprifoliaceae

Linnaea borealis L.
Lonicera caernlea L.
Lonicera involucrata (Rich.) Banks
Lonicera utahensis Wats.

Twinflower
 Sweet-berry honeysuckle
 Twin-berry
 Utah honeysuckle

Cyperaceae

Carex aquatilis Wahl.
Carex arcta Boott
Carex atherodes Spreng.
Carex aurea Nutt.
Carex bebbii Olney
Carex brunnescens (Pers.) Poir.
Carex buxbaumii Wahl.
Carex canescens L.
Carex capillaris L.
Carex chordorrhiza Ehrh.
Carex comosa Boott
Carex crawfordii Fern.
Carex cusickii Mack.
Carex diandra Schrank
Carex disperma Dew.
Carex flava L.
Carex dioica L.
Carex interior Bailey
Carex lacustris Willd.
Carex lanuginosa Michx.
Carex lasiocarpa Ehrh.
Carex lenticularis Michx.
Carex leptalea Wahl.
Carex limosa L.
Carex livida (Wahl.) Willd.
Carex luzulina Olney
Carex microptera Mack.

Water sedge
 Northern clustered sedge
 Awned sedge
 Golden sedge
 Bebb's sedge
 Brownish sedge
 Buxbaum's sedge
 Gray sedge
 Hair sedge
 Rope-root sedge
 Bristly sedge
 Crawford's sedge
 Cusick's sedge
 Lesser-panicled sedge
 Soft-leaved sedge
 Yellow sedge
 Yellow-bog sedge
 Inland sedge
 Lake sedge
 Woolly sedge
 Slender sedge
 Lentil-fruited sedge
 Bristle-stalked sedge
 Mud sedge
 Pale sedge
 Woodrush sedge
 Small-winged sedge

<i>Carex muricata</i> L.	Muricate sedge
<i>Carex nebraskensis</i> Dewey	Nebraska sedge
<i>Carex norvegica</i> Retz.	Scandinavian sedge
<i>Carex oederi</i> Retz.	Green sedge
<i>Carex paupercula</i> Michx.	Poor sedge
<i>Carex scopulorum</i> Holm	Holm's Rocky Mountain sedge
<i>Carex simulata</i> Mack.	Short-beaked sedge
<i>Carex stipata</i> Muhl.	Sawbeak sedge
<i>Carex utriculata</i> Boott	Beaked sedge
<i>Carex vesicaria</i> L.	Inflated sedge
<i>Dulichium arundinaceum</i> (L.) Britt.	Dulichium
<i>Eleocharis acicularis</i> (L.) R. & S.	Needle spike-rush
<i>Eleocharis ovata</i> (Roth.) R. & S.	Ovoid spike-rush
<i>Eleocharis palustris</i> (L.) R. & S.	Common spikesedge
<i>Eleocharis pauciflora</i> (Lightf.) Link	Few-flowered spike-rush
<i>Eleocharis rostellata</i> Torr.	Beaked spike-rush
<i>Eleocharis tenuis</i> (Willd.) Schultes	Slender spike-rush
<i>Eriophorum chamissonis</i> C.A. Meyer	Chamisso's cotton-grass
<i>Eriophorum gracile</i> Koch	Slender cotton-grass
<i>Eriophorum polystachion</i> L.	Many-spiked cotton-grass
<i>Eriophorum viridicarinum</i> (Engelm.) Fern.	Green-keeled cotton-grass
<i>Rhynchospora alba</i> (L.) Vahl.	White beakrush
<i>Scirpus acutus</i> Muhl.	Hardstem bulrush
<i>Scirpus cespitosus</i> L.	Tufted bulrush
<i>Scirpus cyperinus</i> (L.) Knuth	Wool-grass
<i>Scirpus fluviatilis</i> (Torr.) A. Gray	River bulrush
<i>Scirpus hudsonianus</i> (Michx.) Fern.	Hudson bulrush
<i>Scirpus microcarpus</i> Presl	Small-flowered bulrush
<i>Scirpus pumilus</i> Wats.	Bulrush
<i>Scirpus subterminalis</i> Torr.	Water clubrush

Droseraceae

<i>Drosera anglica</i> Huds.	Great sundew
<i>Drosera intermedia</i> Hayne	Intermediate sundew
<i>Drosera linearis</i> Goldie	Linear-leaved sundew
<i>Drosera rotundifolia</i> L.	Roundleaf sundew

Elaeagnaceae

<i>Shepherdia canadensis</i> (L.) Nutt.	Canada buffaloberry
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Ericaceae

<i>Andromeda polifolia</i> L.	Bog-rosemary
<i>Gaultheria hispidula</i> (L.) Muhl.	Creeping snowberry
<i>Gaultheria humifusa</i> (Grah.) Rydb.	Alpine wintergreen
<i>Gaultheria ovatifolia</i> Gray	Slender wintergreen
<i>Kalmia microphylla</i> (Hook.) Heller	Small-leaved laurel
<i>Ledum glandulosum</i> Oeder	Labrador-tea
<i>Ledum groenlandica</i> Oeder	Bog laurel
<i>Menziesia ferruginea</i> Smith	Menziesia
<i>Pyrola asarifolia</i> Michx.	Pink wintergreen
<i>Pyrola secunda</i> L.	One-sided wintergreen
<i>Pyrola uniflora</i> L.	Woodnymph
<i>Vaccinium caespitosum</i> Michx.	Dwarf huckleberry
<i>Vaccinium globulare</i> Rydb.	Globe huckleberry
<i>Vaccinium membranaceum</i> Dougl.	Big huckleberry
<i>Vaccinium myrtillus</i> L.	Dwarf bilberry
<i>Vaccinium occidentale</i> Gray	Western huckleberry
<i>Vaccinium oxycoccos</i> L.	Small cranberry

Fabaceae

Trifolium repens L.
Vicia americana Muhl.

White clover
 American vetch

Gentianaceae

Gentiana affinis Griseb.
Gentiana calycosa Griseb.
Gentiana detonsa Rottb.
Gentiana simplex Gray
Swertia perennis L.

Pleated gentian
 Mountain bog gentian
 Smaller fringed gentian
 Hiker's gentian
 Swertia

Grossulariaceae

Ribes lacustre (Pers.) Poir.

Swamp currant

Hippuridaceae

Hippuris vulgaris L.

Common mare's-tail

Hydrocharitaceae

Elodea canadensis Rich. in Michx.
Elodea nuttallii (Planch.) St. John
Vallisneria americana L.

Canada waterweed
 Nuttall's waterweed
 Tapegrass

Hypericaceae

Hypericum formosum H.B.K.
Hypericum majus (Gray) Britt.
Hypericum perforatum L.

Western St. John's-wort
 St. John's-wort
 Common St. John's-wort

Iridaceae

Iris versicolor L.
Sisyrinchium angustifolium Mill.

Blue flag
 Blue-eyed grass

Juncaceae

Juncus acuminatus Michx.
Juncus alpinus Vall.
Juncus balticus Willd.
Juncus brachyphyllus Wieg.
Juncus effusus L.
Juncus ensifolius Wikst.
Juncus filiformis L.
Juncus nevadensis Wats.
Juncus nodosus L.
Juncus tenuis Willd.
Juncus tweedyi Rydb.
Juncus vaseyi Engelm.

Tapertip rush
 Northern rush
 Baltic rush
 Short-leaved rush
 Soft rush
 Dagger-leaf rush
 Thread rush
 Nevada rush
 Tuberous rush
 Slender rush
 Tweedy's rush
 Vasey's rush

Juncaginaceae

Triglochin maritimum L.
Triglochin palustre L.

Seaside arrow-grass
 Marsh arrow-grass

Lamiaceae

Lycopus americanus Muhl.
Lycopus uniflorus Michx.
Mentha arvensis L.
Prunella vulgaris L.
Scutellaria galericulata L.
Scutellaria laterifolia L.

Cut-leaved water horehound
 Northern bugleweed
 Field mint
 Self-heal
 Marsh skullcap
 Mad-dog skullcap

Lentibulariaceae

Utricularia gibba L.
Utricularia intermedia Hayne
Utricularia minor L.
Utricularia vulgaris L.

Bladderwort
 Mountain bladderwort
 Lesser bladderwort
 Common bladderwort

Liliaceae

Allium schoenoprasum L.
Disporum trachycarpum (Wats.) Benth. & Hook.
Maianthemum dilatatum (How.) Nels. & Macbr.
Smilacina stellata (L.) Desf.
Streptopus amplexifolius (L.) DC.
Tofieldia glutinosa (Michx.) Pers.
Zigadenus elegans Pursh

Chives
 Wartberry fairy-bell
 Beadruby
 Starry Solomon-plume
 Twisted-stalk
 Sticky tofieldia
 Glaucous zigadenus

Lemnaceae

Lemna minor L.
Spirodela polyrhiza (L.) Schleid.

Water duckweed
 Great duckweed

Lythraceae

Lythrum salicaria L.

Purple loosestrife

Menyanthaceae

Menyanthes trifoliata L.

Buckbean

Najadaceae

Najas flexilis (Willd.) Rost. & Schmidt

Wavy water-nymph

Nymphaeaceae

Brasenia schreberi Gmel.
Nuphar polysepalum Engelm.
Nuphar variegatum Engelm.
Nymphaea odorata Ait.

Water-shield
 Spatter-dock
 Yellow water-lily
 Fragrant water-lily

Onagraceae

Epilobium alpinum L.
Epilobium angustifolium L.
Epilobium glaberrimum Barbey
Epilobium glandulosum Lehm.
Epilobium palustre L.
Epilobium watsonii Barbey
Ludwigia polycarpa Short & Peter.

Alpine willow-herb
 Fireweed
 Smooth willow-herb
 Common willow-herb
 Swamp willow-herb
 Watson's willow-herb
 Many-fruit false-loosestrife

Orchidaceae

Corallorhiza trifida Chat.
Cypripedium calceolus var. *parviflorum* (Salis.) Fern.
Cypripedium passerinum Richards.
Epipactis gigantea Dougl.
Habenaria dilatata (Pursh) Hook.
Habenaria hyperborea (L.) R. Br.
Habenaria orbiculata (Pursh) Torr.
Habenaria saccata Greene
Liparis loeselii (L.) L.C. Rich
Listera cordata (L.) R. Br.
Orchis rotundifolia Banks.
Spiranthes romanzoffiana Cham.

Yellow coral-root
 Small yellow lady's-slipper
 Sparrow's-egg lady's-slipper
 Giant helleborine
 White orchis
 Northern green bog-orchid
 Round-leaved rein-orchid
 Slender bog-orchid
 Fen orchid
 Heart-leaf twayblade
 Round-leaved orchis
 Hooded ladies-tresses

Plantaginaceae

Plantago major L.

Common plantain

Poaceae

Agrostis alba L.
Agrostis tenuis Sibth.
Agrostis exarata Trin.
Agrostis scabra Willd.
Agrostis thurberiana Hitchc.
Alopecurus aequalis Sobol.

Redtop
 Colonial bentgrass
 Spike bentgrass
 Tickle-grass
 Thurber bentgrass
 Short-awn foxtail

<i>Bromus ciliatus</i> L.	Fringed brome
<i>Bromus inermis</i> Leys.	Smooth brome
<i>Calamagrostis canadensis</i> (Michx.) Beauv.	Bluejoint reedgrass
<i>Calamagrostis stricta</i> (Timm) Koeler	Narrow-spiked reedgrass
<i>Cinna latifolia</i> (Trevir.) Griseb.	Drooping woodreed
<i>Dactylis glomerata</i> L.	Orchard-grass
<i>Danthonia californica</i> Boland.	California oatgrass
<i>Danthonia intermedia</i> Vasey	Timber oatgrass
<i>Deschampsia cespitosa</i> (L.) Beauv.	Tufted hairgrass
<i>Elymus trachycaulus</i> (Link) Gould ex Skinners	Bearded wheatgrass
<i>Glyceria borealis</i> (Nash) Batch.	Northern mannagrass
<i>Glyceria grandis</i> Wats.	American mannagrass
<i>Glyceria striata</i> (Lam.) Hitchc.	Fowl mannagrass
<i>Hierochloa odorata</i> (L.) Beauv.	Sweetgrass
<i>Muhlenbergia glomerata</i> (Willd.) Trin.	Marsh muhly
<i>Muhlenbergia richardsonis</i> (Trin.) Rydb.	Mat muhly
<i>Panicum acuminatum</i> (Swartz.) Muhl.	Panic-grass
<i>Phalaris arundinacea</i> L.	Reed canarygrass
<i>Phleum pratense</i> L.	Common timothy
<i>Poa palustris</i> L.	Fowl bluegrass
<i>Poa pratensis</i> L.	Kentucky bluegrass
<i>Puccinellia pauciflora</i> (Presl) Munz	Weak alkaligrass
<i>Sphenopholis obtusata</i> (Michx.) Scribn.	Slender wedgegrass
<i>Trisetum canescens</i> Buckl.	Tall trisetum
<i>Trisetum cernuum</i> Trin.	Nodding trisetum
<i>Zizania aquatica</i> L.	Indian rice
Polygonaceae	
<i>Polygonum amphibium</i> L.	Water smartweed
<i>Polygonum coccineum</i> Muhl.	Water smartweed
<i>Polygonum hydropiperoides</i> Michx.	Waterpepper
<i>Rumex maritimus</i> L.	Golden dock
<i>Rumex occidentalis</i> S. Wats.	Western dock
<i>Rumex paucifolius</i> Nutt.	Mountain sorrel
Potamogetonaceae	
<i>Potamogeton amplifolius</i> Tuckerman	Large-leaved pondweed
<i>Potamogeton berchtoldii</i> Fieb.	Baby pondweed
<i>Potamogeton crispus</i> L.	Curly pondweed
<i>Potamogeton epihydrus</i> Raf.	Ribbon-leaf pondweed
<i>Potamogeton foliosus</i> Raf.	Leafy pondweed
<i>Potamogeton gramineus</i> L.	Grass-leaved pondweed
<i>Potamogeton natans</i> L.	Floating-leaved pondweed
<i>Potamogeton richardsonii</i> (Bennett) Rydb.	Richardson's pondweed
<i>Potamogeton robbinsii</i> Oakes	Robbins' pondweed
<i>Potamogeton zosteriformis</i> Schum.	Flatstem pondweed
Primulaceae	
<i>Dodecatheon jjeffreyi</i> Van Hoatte	Jeffrey's shooting star
<i>Dodecatheon pulchellum</i> (Raf.) Merrill	Few-flowered shooting star
<i>Lysimachia ciliata</i> L.	Fringed loosestrife
<i>Lysimachia thyrsiflora</i> L.	Tufted loosestrife
<i>Trientalis arctica</i> Fisch.	Northern starflower
Ranunculaceae	
<i>Anemone parviflora</i> Michx.	Small-flowered anemone
<i>Caltha leptosepala</i> DC.	Elk slip marsh marigold
<i>Ranunculus flammula</i> L.	Creeping buttercup
<i>Ranunculus gmelinii</i> DC.	Small yellow water-buttercup
<i>Ranunculus pensylvanicus</i> L.	Pennsylvania buttercup

Rhamnaceae

Rhamnus alnifolia L. 'Her.
Rhamnus purshiana DC.

Alder buckthorn
 Cascara

Rosaceae

Amelanchier alnifolia Nutt.
Crataegus douglasii Lindl.
Fragaria vesca L.
Fragaria virginiana Duchesne
Geum macrophyllum Willd.
Geum rivale L.
Potentilla fruticosa L.
Potentilla norvegica L.
Potentilla palustris (L.) Scop
Rosa acicularis Lindl.
Rubus parviflorus Nutt.
Rubus pedatus J.E. Smith
Rubus pubescens Raf.
Spiraea densiflora Nutt.
Spiraea douglasii Hook.

Western serviceberry
 Black hawthorn
 Woods strawberry
 Virginia strawberry
 Large-leaved avens
 Water avens
 Shrubby cinquefoil
 Norwegian cinquefoil
 Purple cinquefoil
 Prickly rose
 Thimbleberry
 Raspberry
 Dewberry
 Subalpine spiraea
 Douglas' spiraea

Rubiaceae

Galium boreale L.
Galium trifidum L.
Galium triflorum Michx.

Northern bedstraw
 Small bedstraw
 Sweetscented bedstraw

Salicaceae

Populus tremuloides Michx.
Populus trichocarpa T. & G.
Salix bebbiana Sarg.
Salix candida Fluegge
Salix commutata Bebb
Salix drummondiana Barratt
Salix farriae Ball
Salix geyeriana Anderss.
Salix myrtillofolia Anderss.
Salix pedicellaris Pursh
Salix planifolia Pursh
Salix rigida Muhl.
Salix scouleriana Barratt
Salix serissima (Bailey) Fern.
Salix sitchensis Sanson
Salix wolfii Bebb

Quaking aspen
 Black cottonwood
 Bebb's willow
 Hoary willow
 Undergreen willow
 Drummond willow
 Farr's willow
 Geyer willow
 Blueberry willow
 Bog willow
 Planeleaf willow
 Diamond willow
 Scouler willow
 Autumn willow
 Sitka willow
 Wolf's willow

Santalaceae

Comandra livida Richards

Northern bastard toad-flax

Saxifragaceae

Mitella breweri A. Gray
Mitella nuda L.
Parnassia fimbriata Konig
Parnassia palustris L.
Saxifraga arguta D. Don
Tiarella trifoliata L.

Brewer's mitrewort
 Bare-stemmed mitrewort
 Fringed grass-of-parnassus
 Northern grass-of-parnassus
 Brook saxifrage
 Trefoil foamflower

Scheuchzeriaceae

Scheuchzeria palustris L.

Pod grass

Scrophulariaceae

<i>Castilleja miniata</i> Dougl.	Scarlet paintbrush
<i>Melampyrum lineare</i> Desr.	Narrow-leaved cow-wheat
<i>Mimulus guttatus</i> DC.	Common monkey-flower
<i>Mimulus moschatus</i> Dougl.	Musk-flower
<i>Mimulus primuloides</i> Benth.	Primrose monkey-flower
<i>Pedicularis bracteosa</i> Benth.	Bracted lousewort
<i>Pedicularis groenlandica</i> Retz.	Elephant's head
<i>Verbascum thapsus</i> L.	Common mullein
<i>Veronica americana</i> Schwein.	American speedwell
<i>Veronica scutellata</i> L.	Marsh speedwell

Sparganiaceae

<i>Sparganium emersum</i> Rehmman	Simplestem bur-reed
<i>Sparganium eurycarpum</i> Engelm.	Broadfruited bur-reed
<i>Sparganium minimum</i> Fries.	Small bur-reed

Typhaceae

<i>Typha latifolia</i> L.	Common cattail
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Valerianaceae

<i>Valeriana dioica</i> L.	Northern valerian
<i>Valeriana sitchensis</i> Bong.	Sitka valerian

Violaceae

<i>Viola glabella</i> Nutt.	Pioneer violet
<i>Viola macloskeyi</i> Lloyd	Small white violet
<i>Viola nephrophylla</i> Greene	Northern bog violet
<i>Viola palustris</i> L.	Marsh violet
<i>Viola renifolia</i> Gray	Kidney-leaved violet

Mosses

<i>Aulacomnium palustre</i> (Hedw.) Schwgr.
<i>Bryum caespiticium</i> Hedw.
<i>Bryum pallescens</i> Schleich.
<i>Bryum pseudotriquetrum</i> (Hedw.) Gaertn.
<i>Bryum weigelii</i> Spreng.
<i>Calliergon cordifolium</i> (Hedw.) Kindb.
<i>Calliergon giganteum</i> (Schimp.) Kindb.
<i>Calliergon stramineum</i> (Brid.) Kindb.
<i>Calliergonella cuspidata</i> (Hedw.) Loeske
<i>Campylium stellatum</i> (Hedw.) C. Jens.
<i>Climacium dendroides</i> (Hedw.) Web. & Mohr
<i>Cinclidium stygium</i> Sw. in Schrad.
<i>Conardia compacta</i> (C. Mull.) Robins.
<i>Cratoneuron filicinum</i> (Hedw.) Spruce
<i>Dicranum undulatum</i> Brid.
<i>Drepanocladus aduncus</i> var. <i>polycarpus</i> (Bland. ex Voit) G. Roth
<i>Drepanocladus capillifolius</i> (Warnst.) Warnst.
<i>Fissidens adianthoides</i> Hedw.
<i>Fontinalis neomexicana</i> Sull. & Lesq.
<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs
<i>Helodium blandowii</i> (Web. & Mohr.) Warnst.
<i>Hypnum lindbergii</i> Mitt.
<i>Hypnum pratense</i> (Rabenh.) W. Koch ex Spruce
<i>Leptobryum pyriforme</i> (Hedw.) Wils.
<i>Limprichtia revolvens</i> (Sw.) Warnst.
<i>Meesia triquetra</i> (Richt.) Angstr.

Palustriella commutata (Brid.) Ochyra
Palustriella decipiens (De Not.) Ochyra
Philonotis fontana (Hedw.) Brid.
Philonotis fontana var. *caespitosa* (Jur.) Schimp.
Philonotis fontana var. *pumila* (Turn.) Brid.
Plagiomnium venustum (Mitt.) T. Kop.
Platydictya jungermanioides (Brid.) Crum
Pleurozium schreberi (Brid.) Mitt.
Pohlia longicolla (Hedw.) Lindb.
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. & Mohr) Andrews
Polytrichum commune Hedw.
Polytrichum formosum Hedw.
Polytrichum juniperinum Hedw.
Polytrichum strictum Brid.
Rhizomnium magnifolium (Horik.) T. Kop.
Rhizomnium pseudopunctatum (Bruch & Schimp.) T. Kop.
Rhytidadelphus triquetrus (Hedw.) Warnst.
Scorpidium scorpioides (Hedw.) Limpr.
Sphagnum angustifolium (C. Jens. ex. Russ.) C. Jens.
Sphagnum capillifolium (Ehrh.) Hedw.
Sphagnum centrale C. Jens.
Sphagnum compactum DC ex Lam. & DC
Sphagnum contortum Schultz
Sphagnum fimbriatum Wils. ex Wils. & J.D. Hook.
Sphagnum fuscum (Schimp.) Klinggr.
Sphagnum girgensohnii Russ.
Sphagnum magellanicum Brid.
Sphagnum mendocinum Sull. & Lesq.
Sphagnum platyphyllum (Lindb.) Sull.
Sphagnum rubellum Wils.
Sphagnum riparium Angstr.
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome
Sphagnum subobesum Warnst.
Sphagnum subsecundum Nees in Strum
Sphagnum teres (Schimp.) Angstr.
Sphagnum warnstorffii Russ.
Thuidium recognitum (Hedw.) Lindb.
Tomentypnum nitens (Hedw.) Loeske
Warnstorfia exannulata (Schimp. in BSG) Loeske
Warnstorfia fluitans (Hedw.) Loeske

Appendix B: Peatland Site Descriptions

Descriptions of 58 peatlands occurring on National Forests in Idaho, northeastern Washington, western Montana, and northwestern Wyoming are included here. While not an exhaustive list, all of the described sites, apart from the two sites in Wyoming, were personally visited by one or more of the authors and are representative of the variety of peatlands present in the Northern Rocky Mountains.

Idaho

Bonner County

Armstrong Meadows

Kaniksu National Forest, Priest Lake Ranger District.

Description—Armstrong Meadows is on the west side of the thoroughfare (the connecting channel between Upper Priest Lake and Priest Lake) in the Selkirk Mountains of northern Idaho. Armstrong Meadows is a rich fen dominated by *Spiraea douglasii*, *Alnus incana*, *Calamagrostis canadensis*, *Carex utriculata*, *C. vesicaria*, *C. aquatilis*, *C. lasiocarpa*, *C. buxbaumii*, and *C. cusickii*. Smaller areas of poor fens are also present, dominated by *Sphagnum centrale*, *S. teres*, *Aulacomnium palustre*, *Carex lasiocarpa*, *C. cusickii*, *Eriophorum chamissonis*, *E. gracile*, *Menyanthes trifoliata*, *Betula glandulosa*, and *Salix pedicellaris*. Margins of the meadow are a carr characterized by *Spiraea douglasii*, *Alnus incana*, and other shrubs. Paludified forest is present south of the sphagnum moss-dominated portions of Armstrong Meadows. Trees of *Thuja plicata*, *Tsuga heterophylla*, and *Pinus monticola* are covered at their base by hummocks of *Sphagnum centrale*. Between the hummocks are pools of water with *Scirpus microcarpus*, *Equisetum sylvaticum*, *E. fluviatile*, *Calamagrostis canadensis*, *Senecio triangularis*, *Glyceria grandis*, *Carex brunnescens*, and *C. leptalea*. *Vaccinium globulare*, *Linnaea borealis*, *Cornus canadensis*, *Rubus pedatus*, and *Aralia nudicaulis* are common on the hummocks.

Significance—Nearly 100 vascular and bryophyte plant species occur at Armstrong Meadows, making it one of the most floristically diverse peatlands in Idaho. Ten major habitat features identified for Northern Rocky Mountain peatlands are found at Armstrong Meadows. Populations of ten rare plant species occur at Armstrong Meadows: *Dryopteris cristata*, *Carex leptalea*, *C. paupercula*, *C. buxbaumii*, *Gaultheria hispidula*, *Vaccinium oxycoccos*, *Trientalis arctica*, *Salix pedicellaris*, *Epilobium palustre*, and *Botrychium lanceolatum*.

Conservation—Bursik and Moseley (1995) recommended establishing Armstrong Meadows as a Botanical Area in recognition of the site's unique flora and plant communities. Armstrong Meadows is one of a handful of northern Idaho peatlands with interpretive potential. It would provide a peatland experience

in a wild setting, even though it is easy to access after a short hike with little elevation gain.

Bismark Meadows

Kaniksu National Forest, Priest Lake Ranger District (plus private ownership).

Description—Bismark Meadows is 5 km west of Priest Lake, in the Selkirk Mountains of northern Idaho. Bismark Meadows contains a mosaic of fen communities along Reeder Creek, a low-gradient, meandering stream. The most extensive peatland type is a shrub carr dominated variously by *Spiraea douglasii*, *Alnus incana*, *Betula glandulosa*, *Salix geyeriana*, and *S. bebbiana*. Interspersed among the carr are sedge-dominated rich fens characterized by *Carex utriculata*, *C. lasiocarpa*, *C. vesicaria*, *C. buxbaumii*, *C. cusickii*, *Juncus balticus*, *Petasites sagittatus*, and *Phalaris arundinacea*. *Lycopodium obscurum* var. *dendroidium* grows in the wet forested habitats around the Bismark Work Center. In the northwestern lobe of Bismark Meadows along Reeder Creek, rich fens dominated by *Carex utriculata*, *Scirpus microcarpus*, *Carex canescens*, *C. aquatilis*, *Potentilla palustris*, and *Calamagrostis canadensis* are present. On the west side of Reeder Creek are scattered patches of *Sphagnum centrale* and *S. angustifolium* growing beneath shrubs and around the base of conifers in a paludified forest.

Significance—Bismark Meadows is one of the few valley peatlands in Idaho that formed along a low gradient stream and not adjacent to a pond or lake. It contains only pockets of peat, while much of the area occurs on largely mineral substrate. Although it has been heavily and directly impacted by human activities, the condition of the communities remains very good and the scattered pockets of sphagnum moss-dominated paludified forest may actually be rather extensive to the west (unsurveyed). In spite of the impacts, the area supports populations of seven rare plants: *Carex buxbaumii*, *C. leptalea*, *Dryopteris cristata*, *Epilobium palustre*, *Gaultheria hispidula*, *Lycopodium obscurum* var. *dendroidium*, and *Trientalis arctica*. There are also historical collections of *Vaccinium oxycoccos* from Bismark Meadows. Although much of the site is drained and hayed or grazed, eastern portions appear to be intact and may support extensive poor fens.

Conservation—Bursik and Moseley (1995) recommended establishing Bismark Meadows as a Botanical

Area in recognition of its unique flora and plant communities. Public interpretation is not recommended. Bismark Meadows is partially privately owned.

Bottle Lake

Kaniksu National Forest, Priest Lake Ranger District.

Description—Bottle Lake lies along the west side of Priest Lake in the Selkirk Mountains of northern Idaho, northwest of Bottle Bay and about 75 km north of Priest River. Bottle Lake lies within Bottle Lake Research Natural Area. Bottle Lake is a 6 ha sphagnum moss-dominated fen and lake. The open water of Bottle Lake covers 0.8 ha. The open water is surrounded by a mat of vegetation ranging between 5 to 20 m wide. Beyond the mat is a swampy border of standing and downed trees and various aquatic plants. A meadow (0.4 ha) on the northwest side of the lake is a wet fen during prolonged wet weather. The surrounding area is heavily forested with old-growth *Thuja plicata*, *Tsuga heterophylla*, and *Pinus monticola*.

Significance—Bottle Lake Research Natural Area (RNA) contains an excellent example of a sphagnum-dominated peatland. The rare fern, *Blechnum spicant*, occurs on an upland site within the RNA.

Conservation—The site has been protected as a Forest Service Research Natural Area.

Dubius Creek Fen

Kaniksu National Forest, Priest Lake Ranger District.

Description—Dubius Creek Fen is 27 km north of Priest River, in the Selkirk Mountains of northern Idaho. Dubius Creek Fen contains a diverse mosaic of peatland communities. Shrub carrs dominated by *Spiraea douglasii*, *Betula glandulosa*, *Salix geyeriana*, *S. pedicellaris*, *S. bebbiana*, *Rhamnus alnifolia*, and *Alnus incana* occur throughout the area. In some portions of the carr, *Sphagnum centrale* is common. Further west *Spiraea douglasii* covers a large area. Wetter portions of the peatland are a poor fen dominated by *Sphagnum subsecundum*, *Carex lasiocarpa*, *C. utriculata*, *C. aquatilis*, *C. muricata*, *C. cusickii*, *Agrostis scabra*, *Veronica scutellata*, *Potentilla palustris*, *Lycopus uniflorus*, *Scutellaria galericulata*, and *Scirpus microcarpus*. Two rare species, *Epilobium palustre* and *Salix pedicellaris*, are common in this habitat.

A large arm of the fen extends to the north near the divide between Dubius Creek and Moores Creek. The north end of the northern lobe is covered by a rich fen codominated by *Carex lasiocarpa*, *C. chordorrhiza*, *C. utriculata*, and *Potentilla palustris*. Only a few scattered patches of poor fen (characterized by *Sphagnum subsecundum* and *Carex limosa*) break up this extensive and uniform rich fen. *Scheuchzeria palustris* is found in the poor fens.

Significance—Dubius Creek Fen contains one of the most extensive rich fens dominated by *Carex lasiocarpa*

in northern Idaho. The codominance by *C. chordorrhiza* is significant. The emergent rich fen community around the ephemeral beaver pond is very diverse and unique. Overall, seven habitat features of Panhandle peatlands were identified at this site: poor fen, rich fen, shrub carr, vegetated littoral zones, ponds, a stream, and beaver activity. This is one of only a few low-elevation valley peatlands in northern Idaho that has formed along a stream and not adjacent to a lake. More than 60 plant species are known from Dubius Creek Fen. Five species considered rare in Idaho are found in the peatland: *Carex chordorrhiza*, *Epilobium palustre*, *Hypericum majus*, *Scheuchzeria palustris*, and *Salix pedicellaris*.

Conservation—Bursik and Moseley (1995) recommended establishing Dubius Creek Fen as a Botanical Area in recognition of its unique flora and plant communities. Dubius Creek Fen would be a suitable site for public interpretation about peatland communities in northern Idaho. Due to the extensive nature of the peatlands, trails could easily be placed to avoid adverse impacts to the site.

Hager Lake Fen

Kaniksu National Forest, Priest Lake Ranger District (plus private ownership, including a Nature Conservancy conservation easement).

Description—Hager Lake is a 2 ha pond located 6 km west of Priest Lake in the Selkirk Mountains of northern Idaho. The basin of Hager Lake is enclosed and underlain by ice-contact fluvial gravels. It is a seepage pond with no apparent inlet or outlet. The depression likely formed as a result of an ice block melting near the terminus of the glacier that occupied this portion of the Priest River Valley; a depression commonly referred to as a “glacial kettle.” The origin of the basin dates between 11,500 and 12,000 years ago based on the presence of Glacier Peak tephra near the base of peat cores extracted in 1992 (Bursik and others 1994).

Several distinct plant communities are found at Hager Lake Fen. The most extensive is a shrub carr dominated by a dense stand of *Spiraea douglasii*. This shrub carr covers most of the fen north of Hager Lake, except for the northeastern corner, which was cleared and reditched in 1988. This area was harvested for hay in 1994. The *Spiraea douglasii* shrub carr also occurs in a band around Hager Lake. Lodgepole pine (*Pinus contorta*) and western white pine (*Pinus monticola*) trees are scattered throughout the shrub carr. The middle of the fen basin north of Hager Lake is covered by a rich fen codominated by *Carex lasiocarpa* and *Spiraea douglasii*. A floating mat (1 ha) encroaches on the south side of the lake. The floating mat is a poor fen community dominated by *Sphagnum angustifolium*, *S. subsecundum*, and *S. centrale*. Common vascular species include *Vaccinium oxycoccos*, *Scheuchzeria palustris*, *Carex limosa*, *Kalmia microphylla*, and

Lycopus uniflorus. Coring done on the floating mat indicates that it dates from about 6,700 years ago based on the presence of Mount Mazama tephra near the top of lake sediments below the mat (Peter Mehringer, unpublished data on file at Washington State University, Pullman). Between the floating mat and the *S. douglasii* shrub carr to the south is a fixed mat zone. The fixed mat also occurs around the east, west, and north lake margins. The fixed mat is characterized by poor fen vegetation codominated by *Sphagnum subsecundum*, *C. lasiocarpa*, and *Dulichium arundinaceum*. Two rare species are found in this community: *Lycopodium inundatum* and *Hypericum majus*. A narrow, shallow littoral zone is found on the east, west, and north lake margins. It is characterized by *Nuphar polysepalum*, *Brasenia schreberi*, *Potamogeton natans*, *Scirpus acutus*, and the rare *S. subterminalis*. **Significance**—Hager Lake Fen supports 75 vascular and bryophyte plant species, including five considered rare in Idaho: *Scirpus subterminalis*, *Trientalis arctica*, *Vaccinium oxycoccus*, *Scheuchzeria palustris*, and *Hypericum majus*. Four other rare species were previously documented from Hager Lake and are now believed extirpated: *Epilobium palustre*, *Dryopteris cristata*, *Carex leptalea*, and *Lycopodium obscurum* var. *dendroidium*. Hager Lake contains one of the more extensive floating mats in Idaho and the poor fen community growing on the mat is exceptional.

Hoodoo Lake

Kaniksu National Forest, Priest Lake Ranger District. **Description**—Hoodoo Lake is 16 km southeast of the town of Priest River in northern Idaho. Hoodoo Lake is a very shallow drainage lake (80 ha) that completely dried in 1994. The lake bottom mud was still saturated, but was largely unvegetated in July 1994. The lake is surrounded by an emergent rich fen dominated by *Scirpus acutus*, *Typha latifolia*, *Eleocharis palustris*, *Glyceria borealis*, *Juncus* spp., *Carex lasiocarpa*, *Potentilla palustris*, and the very rare (but locally prominent at Hoodoo Lake) *Carex comosa*, which is known from only one other site in Idaho. Drier fen areas around the emergent rich fen are also rich fen communities characterized by *Carex lasiocarpa*, *C. utriculata*, *C. oederi*, *Calamagrostis stricta*, *Agrostis scabra*, and *Potentilla palustris*. Scattered plants of *Hypericum majus* are found in these rich fen habitats. The rich fen grades into a mesic marsh meadow with scattered *Spiraea douglasii*, *Alnus incana*, and *Salix bebbiana* shrubs with *Agrostis stolonifera*, *Phalaris arundinacea*, *Danthonia intermedia*, *Poa palustris*, *Glyceria striata*, *Prunella vulgaris*, *Cirsium vulgare*, and *C. arvense* being prominent herbaceous species. All of the communities at Hoodoo Lake were heavily grazed in 1994.

Significance—The floristic diversity of this site is moderate (approximately 50 species have been identified).

Hoodoo Lake supports one of only two known populations of *Carex comosa* in Idaho. It is prominent with *Scirpus acutus*, *Carex lasiocarpa*, and *Eleocharis palustris* in the emergent fen surrounding the lake. Only one other rare species, *Hypericum majus* is found at Hoodoo Lake. The rich fen communities tend toward marsh conditions. They are similar to the rich fen communities found elsewhere in northern Idaho, particularly those at Walsh Lake, north of Sandpoint. These types of fen communities are more common in low-elevation valley peatlands elsewhere in Idaho. *Carex oederi* is prominent in the drier fen habitats at Hoodoo Lake. It is sparse in northern Idaho, though it is common in valley peatlands in Fremont County in extreme east central Idaho. Five of the 12 critical habitat features of northern Idaho peatlands were identified at Hoodoo Lake: rich fen, shrub carr, vegetated littoral zone, a lake, and a stream (Bursik and Moseley 1995).

Kaniksu Marsh

Kaniksu National Forest, Priest Lake Ranger District. **Description**—Kaniksu Marsh is on the west side of the lower Priest River in northern Idaho. The wetland is within Kaniksu Marsh Research Natural Area and consists of an undisturbed, 36 ha crescent-shaped marsh and wet meadow, and adjacent forested slopes. Open water, less than 2 m deep, with submergent aquatic plants surrounds an island of floating rich fen. The central portion of the marsh ranges from shallow water to saturated soil and is dominated by *Carex lasiocarpa* with a few areas of poor fen dominated by *Sphagnum centrale* and *S. magellanicum*. The pond surrounding the floating mat is well vegetated with *Potamogeton natans* and *Brasenia schreberi*. To the west, extensive shrub carr and a rich sedge fen is dominant along a spring stream. Further west, a wet *Picea-Tsuga* forest with some paludified areas is present. The old-growth and second-growth forests surrounding the peatland are composed of *Pinus ponderosa*, *P. monticola*, *Larix occidentalis*, *Abies grandis*, *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, *Picea engelmannii*, and *Pinus contorta*.

Significance—The low-elevation wetlands in the Research Natural Area support a diversity of vegetation types. At least five rare plant species are present: *Eriophorum viridicarinatum*, *Gaultheria hispidula*, *Lycopodium inundatum*, *Trientalis arctica*, and *Vaccinium oxycoccus*.

Lamb Creek Meadows

Kaniksu National Forest, Priest Lake Ranger District (plus private ownership).

Description—Lamb Creek Meadows is 1.5 km west of Priest Lake in the Selkirk Mountains of northern Idaho. The south end of Lamb Creek Meadows is a rich

sedge-dominated fen characterized by *Carex lasiocarpa*, *C. lanuginosa*, *C. utriculata*, *C. buxbaumii*, *C. cusickii*, *Eriophorum gracile*, *E. chamissonis*, and a few patches of *Typha latifolia*. The entire fen was covered with shallow standing water in June 1991. The perimeter of the fen is ditched, and the margins of the ditch are covered by a dense monoculture of *Spiraea douglasii*. Several slightly raised areas are found within the fen otherwise dominated by sedges. The raised areas are covered with shrub carr dominated by *Spiraea douglasii*, *Betula glandulosa*, *Salix geyeriana*, and *Alnus incana*. The northwestern portion of Lamb Creek Meadows is ditched and is seasonally cut for hay. On the northeastern end (headwaters of Reynolds Creek) rich sedge-dominated fen similar to that found on the south end is interspersed with shrub carr similar to that found on the south end. *Trientalis arctica*, *Carex buxbaumii*, *Hypericum majus*, and *Epilobium palustre* are rare plants found in this area. A series of beaver ponds form the headwaters of Reynolds Creek, which enters Priest Lake on the south side of Kalispell Bay. The ponds are shallow and well vegetated. *Potamogeton gramineus*, *P. berchtoldii*, *Utricularia vulgaris*, *Eleocharis acicularis*, and *Sparganium fluctuans* are common.

Significance—A limited inventory has revealed the presence of more than 35 vascular species in Lamb Creek Meadows. Four Idaho rare species are found in Lamb Creek Meadows: *Trientalis arctica*, *Hypericum majus*, *Epilobium palustre*, and *Carex buxbaumii*. Lamb Creek Meadows contain six of the habitat features identified in northern Idaho peatlands: rich fen, shrub carr, small ponds, vegetated littoral zones, a stream, and beaver activity (Bursik and Moseley 1995).

Lost Lake

Kaniksu National Forest, Sandpoint Ranger District.

Description—Lost Lake is 3 km due east of Garfield Bay and 1.5 km north of Mineral Point on the south side of the Pend Oreille peninsula south and west of Lake Pend Oreille. Lost Lake is a seepage lake nearly 30 acres, with no apparent inlet or outlet. Beavers have been active at this site in the past, but they were not active in 1994 and much of the lake was dried up during this dry year. The lake appears to be shallow throughout, entirely lacking a limnetic zone (greater than 2 m deep). Aquatic plants growing in the lake include *Myriophyllum sibiricum*, *Nuphar polysepalum*, *Potamogeton natans*, *P. amplifolius*, *P. gramineus*, *P. berchtoldii*, *Callitriche heterophylla*, *Najas flexilis*, *Scirpus acutus*, *Utricularia minor*, *Lemna minor*, and the rare *Scirpus subterminalis*.

Marginal floating mat communities are mostly poor fens characterized by *Typha latifolia*, *Carex lasiocarpa*, *Dulichium arundinaceum*, *Potentilla palustris*, *Equisetum fluviatile*, and at least three bryophytes: *Sphagnum teres*, *Aulacomnium palustre*, and *Calliergon*

stramineum. The fixed portions of the mat are hummocky with trees of *Thuja plicata* and *Tsuga heterophylla*, and the shrubs *Alnus incana*, *Cornus stolonifera*, *Rhamnus alnifolia*, and *Spiraea douglasii* occupying sphagnum moss-covered hummocks. *Carex lasiocarpa*, *D. arundinaceum*, *P. palustris*, *Phalaris arundinacea*, *Bidens cernua*, *Menyanthes trifoliata*, *Scutellaria galericulata*, *Mentha arvensis*, *Lycopus uniflorus*, *Carex cusickii*, *C. retrorsa*, and *Eriophorum gracile* are dominant in the wet, moss-covered depressions in between. *Epilobium palustre* and *Cicuta bulbifera* are rare species found scattered throughout the mat. The rare *Dryopteris cristata* is found on the tree and shrub-covered sphagnum moss hummocks. Some portions of the fixed and floating mats are rich fens dominated by *Typha latifolia*, *Scirpus acutus*, and various species of *Carex*.

Significance—Lost Lake is somewhat similar to the rest of the peatlands in the vicinity of Lake Pend Oreille. Lost Lake is unique in having abundant poor fen on floating and fixed mats in addition to rich fens. The floating rich fens are very interesting and diverse. They contain many species typically associated with marsh habitats (for example, *Typha latifolia* and *Scirpus acutus*) along with species nearly restricted to peatlands (for example, *Carex lasiocarpa*, *Dulichium arundinaceum*, *Potentilla palustris*, and *Drosera rotundifolia*). This type of rich fen occurs at only very scattered sites north of Lake Pend Oreille and the Pend Oreille River.

Lost Lake contains populations of four rare plants: *Scirpus subterminalis*, *Epilobium palustre*, *Dryopteris cristata*, and *Cicuta bulbifera*. Seven of 12 habitat features of northern Idaho peatlands were identified at Lost Lake: poor fen, rich fen, floating mat, vegetated littoral zones, shrub carr, a lake, and beaver activity (Bursik and Moseley 1995).

Mosquito Bay Fen

Kaniksu National Forest, Priest Lake Ranger District (plus private ownership).

Description—Mosquito Bay Fen is at the north end of Priest Lake on the west side of Mosquito Bay. A diversity of peatland habitats are present. A rich fen dominated by *Carex lasiocarpa*, *C. chordorrhiza*, and *C. muricata* covers as much as one-third of the open fen area. A wet, emergent rich fen dominated by *Carex livida*, *Rhynchospora alba*, and *Equisetum fluviatile* covers about one-fourth of the open fen. The remainder of the open area is covered by poor fen characterized by the above species and *Sphagnum* spp., *Potentilla palustris*, *Kalmia microphylla*, *Vaccinium oxycoccos*, and *Andromeda polifolia*. Poor fen habitats are smaller and localized, usually in the form of slightly raised hummocks surrounded by poor or rich fen. Scattered patches of *Pinus contorta* clearly mark some of the poor fen habitats at the fen. Extensive rich fen shrub

carr communities ring the graminoid and bryophyte-dominated central portions of the fen. They are dominated primarily by *Spiraea douglasii* and *Betula glandulosa*, *Rhamnus alnifolia*, *Alnus incana*, and other shrubs. Paludified forest habitats surround most of the graminoid- and shrub-dominated fen habitats. They are characterized by *Abies lasiocarpa*, *Picea engelmannii*, *Thuja plicata*, *Tsuga heterophylla*, *Pinus contorta*, and *P. monticola*. The undergrowth of the paludified forests is dominated by *Sphagnum angustifolium*, *S. centrale*, *Scirpus microcarpus*, *Calamagrostis canadensis*, *Dulichium arundinaceum*, *Carex brunnescens*, and *Spiraea douglasii*. There are sphagnum moss hummocks growing over old stumps in the paludified forest. The hummocks reach more than 1 m in height above the surrounding substrate.

Significance—One hundred forty-one species (11 bryophyte and 130 vascular) are known from Mosquito Bay Fen. This is the single most floristically diverse peatland in Idaho. It also supports the most exceptional paludified forest habitat in the state. Present are populations of 20 rare plant species:

Andromeda polifolia (only population known in Idaho), *Aster junciformis*, *Carex buxbaumii*, *C. chordorrhiza*, *C. leptalea*, *C. livida*, *C. paupercula*, *Geocaulon lividum*, *Epilobium palustre*, *Eriophorum viridicarinatum*, *Gaultheria hispidula*, *Hypericum majus*, *Iris versicolor* (only site in Idaho or the Pacific Northwest), *Lycopodium obscurum* var. *dendroidium*, *Lycopodium inundatum*, *Rhynchospora alba*, *Salix pedicellaris*, *Scheuchzeria palustris*, *Trientalis arctica*, and *Vaccinium oxycoccos*.

Conservation—This site is one of the most significant of the 45 high-priority peatlands in northern Idaho identified by Bursik and Moseley (1995). The small portion that is administered by the Forest Service should be considered for Research Natural Area or Botanical Area designation.

Packer Meadows

Kaniksu National Forest, Priest Lake Ranger District.

Description—Packer Meadows is 11 km west of Priest Lake in the Idaho Panhandle. Packer Meadows contains a unique mosaic of fen communities along a low-gradient meandering stretch of Packer Creek. Within the mosaic are patterned peatlands on slight slopes. The raised strings run perpendicular to the slope and are covered with *Sphagnum* spp., *Betula glandulosa*, *Pedicularis groenlandica*, *Carex utriculata*, *Salix pedicellaris*, and *Equisetum fluviatile*. The shallowly inundated flarks are dominated by *C. utriculata*, *C. cusickii*, *C. leptalea*, and *C. aquatilis*. Other small areas of nearly level substrate are poor fen dominated by *Sphagnum* spp., *Carex limosa*, *Drosera rotundifolia*, *Eriophorum polystachion*, and other poor fen species. Areas of poor fen are hummocky with *Sphagnum centrale* hummocks occurring beneath *Betula*

glandulosa, *Picea engelmannii*, and *Abies lasiocarpa*. *Trientalis arctica* occurs on these hummocks. Sedge-dominated rich fen covers a majority of Packer Meadows. These areas appear more mesic with shallow, firm peat. They are dominated by *Calamagrostis canadensis*, *Carex utriculata*, *Senecio triangularis*, *C. aquatilis*, and *C. scopulorum*. Periodic beaver activity on Packer Creek on the south end of Packer Meadows leads to the formation of a several-hectare shallow lake, but no lake was present in 1991. The East Fork of Packer Creek Fen is characterized by sloped poor fen communities that are subirrigated. The slopes are as great as 7 percent. They are covered with *Sphagnum* spp., *Calamagrostis canadensis*, *Carex scopulorum*, *Eriophorum polystachion*, *C. leptalea*, and *Eriophorum chamissonis*. These sloped fens are interspersed between areas of *Picea engelmannii* and *Abies lasiocarpa* paludified forest where deep hummocks of *Sphagnum centrale* cover the base of the trees.

Significance—Because of its elevation, Packer Meadows is somewhat intermediate floristically between subalpine and valley peatlands, containing numerous boreal species that are restricted to valley peatlands and many cordilleran species characteristic of subalpine peatlands (Bursik 1990). Elevationally (3,360 ft), it is the highest known site with paludified forest habitat in northern Idaho. The poor fen communities in the East Fork Fens are similar to those found at Smith Creek Research Natural Area, Cow Creek Meadows, and Grass Creek Meadows at higher elevations in the northern Selkirk Range. Also unique is the string-flark patterned ground of the gradually sloped poor fen in Packer Meadows.

Three rare species are known to occur at Packer Meadows: *Carex leptalea*, *Trientalis arctica*, and *Salix pedicellaris*.

Potholes

Kaniksu National Forest, Priest Lake Ranger District.

Description—Potholes is on the north side of Kalispell Creek 1.5 km west of the Idaho/Washington border in northern Idaho, approximately 60 km north-northwest of Priest River, ID. The peatland is within Potholes Research Natural Area. The site is an example of a diverse wetland resulting from Pleistocene glaciation. Surrounding forests are dominated by *Tsuga heterophylla* and other conifers. Elevations in the Potholes Research Natural Area range from 828 to 960 m. The area contains a large upwelling cold spring. Spring ponds drain into a stream that supplies water for wet meadows, a fen, and several beaver ponds. In places, low dams have been built by beaver. The ponds are drained by three streams; two of these unite on a lower bench supporting *Alnus* spp., meadows, marshes, and a sphagnum moss-dominated fen.

A number of rare plant species are found in the area including: *Gaultheria hispidula*, *Vaccinium oxycoccos*, *Epilobium palustre*, *Trientalis arctica*, *Salix pedicellaris*, *Carex leptalea*, and *C. paupercula*. Two rare plant communities also occur in the Research Natural Area: the *Thuja plicata*/*Lysichitum americanum* habitat type and the *Thuja plicata*/*Equisetum arvense* community type.

Upper Priest Lake Fen

Kaniksu National Forest, Priest Lake Ranger District. **Description**—Upper Priest Lake Fen is at the south-east end of Upper Priest Lake in the Idaho Panhandle. The fen covers about 25 ha. It contains a short spring stream that emerges within the fen. The spring feeds a small, shallow pond. Portions of the peatland communities are poor fen dominated by *Carex lasiocarpa*, *C. diandra*, *C. utriculata* and various sphagnum mosses (*Sphagnum angustifolium*, *S. capillifolium*, and *S. centrale*). A unique shrub carr covers much of the non-treed peatland and is dominated by *Betula pumila*, *Spiraea douglasii*, *Salix pedicellaris*, *Kalmia microphylla*, and *Vaccinium oxycoccos* over a nearly continuous mat of sphagnum mosses.

Paludified forest with *Abies lasiocarpa*, *Tsuga heterophylla*, *Thuja plicata*, *Picea engelmannii*, and *Abies grandis* surrounds the open fen. The undergrowth is characterized by *Sphagnum angustifolium*, *S. teres*, *S. centrale*, *S. magellanicum*, *Carex brunnescens*, *Scirpus microcarpus*, *Athyrium filix-femina*, *Linnaea borealis*, *Vaccinium globulare*, *Calamagrostis canadensis*, and *Cornus canadensis*.

Significance—At least 60 vascular and bryophyte plant species are known from Upper Priest Lake Fen. Along with Mosquito Bay Fen, it contains the most exceptional paludified habitat in Idaho. The shrub carr is unique, unlike any other shrub carr in northern Idaho. Rare plants at this site include: *Carex leptalea*, *Vaccinium oxycoccos*, *Gaultheria hispidula*, *Salix pedicellaris*, and *Trientalis arctica*.

Boundary County

Beaver Lake (North)

Kaniksu National Forest, Bonners Ferry Ranger District (plus State of Idaho).

Description—Beaver Lake is in northern Idaho along the west slope of the Cabinet Mountains, 6 km south of Naples and 20 km south of Bonners Ferry. Beaver Lake (North) is a small pond that sits nearly on the crest of a west-east trending ridge. The pond was formed by continental ice that flowed down the Purcell Trench during the Pleistocene, scouring adjacent mountain slopes. The pond is the headwaters of Dyree Creek, a small creek flowing southeast from the pond, eventually to the Pack River. Most of the shoreline is steep and has little littoral zone or wetland vegetation.

The eastern shore, however, has a narrow zone of *Carex flava* along the edge of the lake and several floating sphagnum mats, some of which contain *Lycopodium inundatum*. *Carex lasiocarpa*, *Drosera rotundifolia*, and *Potentilla palustris* are common on the sphagnum.

Significance—The biodiversity highlight of Beaver Lake (North) is the small floating mats at the eastern end of the pond, which contains the relatively rare peatland species *Lycopodium inundatum*. Otherwise, floristic diversity is low, due to the limited number of habitats around this pond with a steep shoreline. A small population of the rare sedge, *Carex flava*, occurs on the shore near the mats.

Bog Creek Fen

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Bog Creek Fen lies along the United States-Canadian border in the Selkirk Mountains of extreme northern Idaho. Bog Creek is a slow-moving, low gradient, meandering stream. Fen communities have formed along the stream scattered between *Abies lasiocarpa*-*Picea engelmannii*-*Pinus contorta* forest. These are mostly fens dominated by sedges; sphagnum mosses are sparse. This is one of the few sub-alpine peatland sites supporting *Carex lasiocarpa* (the species is typically restricted to valley peatlands). *Carex utriculata*, *C. aquatilis*, *C. scopulorum*, *C. lasiocarpa*, and *Eriophorum polystachion* are prominent.

Significance—This site contains populations of *Carex flava*, *C. buxbaumii*, *C. paupercula*, and *Botrychium minganense*. Grizzly bears (*Ursus arctos*) and woodland caribou (*Rangifer tarandus caribou*) are also known to use this drainage. This appears to be a unique and valuable peatland site, which may represent an intermediary between the low elevation valley peatlands dominated by boreal species and higher subalpine peatlands dominated by numerous western cordilleran species. It is one of few high-quality subalpine peatland sites known from northern Idaho.

Cow Creek Meadows

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Cow Creek Meadows are located along Cow Creek in the extreme northern portion of the Selkirk Mountains, 10 km south of the United States-Canada border.

Cow Creek Meadows contain scattered open sphagnum-rich and sphagnum-poor fen habitats over a 5 km stretch along the upper reaches of Cow Creek. Four major wetland plant communities occur at Cow Creek Meadows (Bursik 1993):

1. Sphagnum moss-dominated fens supporting the rare species known from the site (*Carex buxbaumii*, *C. paupercula*, *C. leptalea*, *C. flava*, *Lycopodium inundatum*, *Trientalis arctica*, and *Scirpus hudsonianus*)

2. *Carex scopulorum* fen
3. *Carex vesicaria*-*C. utriculata* fen
4. *Deschampsia cespitosa*-*Danthonia intermedia*-*Calamagrostis canadensis* wet meadows

Pinus contorta, *Abies lasiocarpa*, and *Picea engelmannii* moist to wet forests occur between the fen communities. Much of the upper portion of the drainage was burned in the 1967 Trapper Peak fire.

Significance—Subalpine sphagnum moss-dominated fen communities in Cow Creek Meadows are more rare in extreme northern Idaho than in the major river valleys of north-central Idaho (for example, the Lochsa River drainage). They appear to be transitional in floristic composition to valley peatland communities based on the number of boreal species they contain. One hundred and one plant species (11 bryophyte and 90 vascular) are known from the fens; seven are considered rare in the State: *Carex buxbaumii*, *C. flava*, *C. leptalea*, *C. paupercula*, *Lycopodium inundatum*, *Scirpus hudsonianus*, and *Trientalis arctica*.

The population of *Scirpus hudsonianus* is one of only two found in the State. One of the few documented Idaho populations of the northern bog lemming (*Synaptomys borealis*) occurs in Cow Creek Meadows. Grizzly bear and woodland caribou use of the area is high.

Conservation—Cow Creek Meadows have been recommended for Botanical Area designation. The site includes the reaches of Cow Creek supporting peatland habitats. The boundaries of the site were proposed by Bursik (1993) to extend from the bridge over Cow Creek on Forest Service Road 2545 in the SE 1/4 section 4, T64N, R3W, to the uppermost meadows in the extreme NE 1/4 section 13, T64N, R4W. The old Cow Creek Road (Forest Service 655) serves as the northern boundary, and an old, unnumbered logging road that accessed the burned-over area south of the creek serves as the southern boundary.

Grass Creek Meadows

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Grass Creek Meadows is along Grass Creek in the Selkirk Mountains of northern Idaho. Grass Creek drains northward into Canada and ultimately into the Kootenai River. Grass Creek contains open fen habitats scattered along its upper reach. Fens dominated by sphagnum mosses contain the rare species known from the site. Other major communities include:

1. *Carex scopulorum* fen
2. *Carex vesicaria*-*C. utriculata* fen
3. *Deschampsia cespitosa*-*Danthonia intermedia*-*Calamagrostis canadensis* wet meadows

Significance—Subalpine sphagnum moss-dominated fen communities as exist in Grass Creek Meadows are more rare in extreme northern Idaho than in the major river valleys of north-central Idaho. They are somewhat transitional in floristic composition to valley peatland communities based on the number of boreal species they contain. The fens contain several rare plant populations, including: *Carex paupercula*, *Trientalis arctica*, and *Scirpus hudsonianus* (one of two populations known from Idaho). Grizzly bear and woodland caribou use is high in the Grass Creek Meadows.

Perkins Lake

Kaniksu National Forest, Bonners Ferry Ranger District (plus private ownership).

Description—Perkins Lake is in the Purcell Mountains of northern Idaho, 3 km west of the Idaho-Montana boundary. Perkins Lake contains a diversity of fen communities along its northeastern shore and on its western side (that is mostly privately owned). Extensive floating mats ring the lake margins and fixed mats extend into the fen area west of the lake. The floating mats on the northeastern side of the lake are unstable and are dominated by *Betula pumila*, *Alnus incana*, and *Spiraea douglasii*. The undergrowth is dominated by *Carex lasiocarpa*, *Calamagrostis canadensis*, and various sphagnum and brown mosses including *Sphagnum angustifolium*, *S. centrale*, *S. magellanicum*, *S. teres*, *Aulacomnium palustre*, *Calliergon stramineum*, and *Polytrichum strictum*.

The lake margins are dominated by *Typha latifolia* and various sedges, including *Carex lasiocarpa*, *C. cusickii*, and *Dulichium arundinaceum*. Shrub carr also covers much of the fen west of the lake. It is interspersed with *Carex*/sphagnum moss-dominated poor fen communities, which extend at least 0.4 km from the lake margin to the west.

Significance—Perkins Lake contains very unique peatland plant communities unlike those found elsewhere in northern Idaho. The *Betula pumila* carr is unusual in that it occurs on a floating mat. Most of the fen communities are poor fens with a nearly solid mat of sphagnum and brown mosses. Scattered areas are poor fens while areas closer to the upland boundary are rich fens with little moss cover and greater vascular plant coverage. The poor fens are very diverse with shrub carr communities being interspersed with sedge/graminoid-dominated areas with the two types grading freely into one another. Some scattered patches of *Pinus contorta* and *Pinus monticola* give evidence of historically dynamic water levels, possibly related to beaver activity on the outlet. The lake contains some of the highest diversity of aquatic plant species known in the State. More than 100 vascular and bryophyte plant species are known from Perkins Lake making it one of the most floristically diverse peatlands in the

State. Present are populations of 13 rare plant species: *Aster junciformis*, *Betula pumila*, *Carex chordorrhiza*, *C. comosa* (one of only two populations in the State), *C. flava*, *C. leptalea*, *Cicuta bulbifera*, *Dryopteris cristata*, *Epilobium palustre*, *Rhynchospora alba*, *Salix pedicellaris*, *Scheuchzeria palustris*, and *Scirpus subterminalis*.

Conservation—Special designation is recommended for this site due to its high biodiversity value.

Robinson Lake

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Robinson Lake is 3 km south of the Canadian border just southeast of Eastport in the Moyie River Valley of the Purcell Mountains. Robinson Lake is in the pioneering stages of peatland development. The eastern lobe of the lake appears to be growing through a lake-fill sequence with an accumulating island of lake sediment building in the middle of the basin with slightly deeper moat areas adjacent to uplands. The western lobe of the lake contains numerous small pioneer mat communities on floating and partially emergent logs. This site offers a glimpse at the initial stages of two different types of peatland formation. The small mats contain several of the most prominent of the peatland-dominating sedges in northern Idaho: *Carex lasiocarpa*, *C. canescens*, *C. diandra*, and *C. muricata*; and a host of other species, including *Drosera rotundifolia*, that are restricted to peatland habitats in the area.

Significance—This site contains populations of two species considered rare in Idaho: *Cicuta bulbifera* and *Hypericum majus*. Robinson Lake represents the earliest stages of peatland development and is, therefore, significant in providing an understanding of the process of peatland formation. Despite the fact that water levels are regulated at the outlet (which may have increased the size of the lake), the pioneering peatland communities are largely the product of natural processes.

Conservation—Any special designations should protect the entire lake and a 200 m wide buffer into the adjacent uplands, which rise rather steeply from the edge of the lake. This should serve to protect the water quality of the lake and allow for natural recruitment of fallen trees into lake margins.

Sinclair Lake

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Sinclair Lake is in the Purcell Mountains of northern Idaho, 10 km south of Eastport, on the United States-Canadian border. Floating mats supporting poor fen communities occur around Sinclair Lake. The mat community is dominated by *Sphagnum angustifolium*, *S. subsecundum*, *Carex lasiocarpa*, *C. muricata*, *C. limosa*, *Potentilla palustris*, *Drosera*

anglica, *D. rotundifolia*, and *Lycopus uniflorus*. A *C. lasiocarpa* fen extends over several hectares west of the lake, ringed by a *Spiraea douglasii* shrub carr. Littoral zones of the lake are characterized by *Nuphar variegatum*, *Brasenia schreberi*, *Potamogeton gramineus*, *Dulichium arundinaceum*, *Carex lasiocarpa*, and scattered plants of *Scirpus subterminalis*. The Spokane International Railroad bed partially filled in the eastern side of the lake. A fishing dock is on the north side of the lake near the parking area.

Significance—Sinclair Lake contains representative rich and poor fens and floating mats. Four rare plants occur around the lake: *Scirpus subterminalis*, *Scheuchzeria palustris*, *Hypericum majus*, and *Aster junciformis*. Two species of sundew (*Drosera anglica* and *D. rotundifolia*) are sympatric as are two species of cottongrass (*Eriophorum gracile* and *E. chamissonis*). This is one of few northern Idaho peatlands with spike reedgrass (*Calamagrostis stricta*), which is more common in fens of east-central Idaho. The lake contains a fair diversity of aquatic plants, including *Nuphar variegatum*, the less common of north Idaho's two native yellow waterlilies.

Conservation—Any protective measures should include the lake and surrounding peatland communities and upland areas north to the Forest Service property boundary, and east to the Spokane International Railroad bed. Sinclair Lake has high interpretive potential. The present dock would be very useful, and a wooden walkway could be constructed to access the peatland.

Smith Creek

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Smith Creek (within Smith Creek Research Natural Area) is along the crest of the Selkirk Mountains in northern Idaho, 37 km northwest of Bonners Ferry. An outstanding example of divide crossing by glacial ice occurs in the Smith Creek Research Natural Area, as evidenced by the glacial trough that runs across the Selkirk Crest in an east-west direction. Elevations in the Research Natural Area range from 1,433 m at the lower boundary of the Research Natural Area to 2,055 m on the summit of Joe Peak.

The main features of the area are the outstanding wetland communities of the valley bottom, including undisturbed sphagnum moss-dominated peatlands and associated ponds, and other wetland areas dominated by *Carex* spp., *Eriophorum polystachion*, and *Picea engelmannii*. The upland forest vegetation consists largely of subalpine fir series forest associations. Of special interest is the subalpine fir/white rhododendron (*Rhododendron albiflorum*) community type.

Significance—The site contains outstanding peatland communities; habitat for woodland caribou, an endangered species, and grizzly bear, a threatened species; supports a population of the heather vole (*Phenacomys intermedius*), considered rare in Idaho; and populations of five rare plants: *Drosera intermedia*, *Trientalis arctica*, *Ribes howellii*, *Lycopodium sitchense*, and *Carex paupercula*.

Additionally, *Leptarrhena pyrolifolia* occurs in the Smith Creek Research Natural Area. This plant has a limited distribution in Idaho, occurring only in the wettest forest communities of extreme northern Idaho. Unusual aquatic species occur in the area, including the algae *Ulothrixzonata*, which occurs in unusually high densities in the streams of the RNA, and an uncommon Diptera, *Palpomyia* sp.

Three Ponds

Kaniksu National Forest, Bonners Ferry Ranger District.

Description—Three Ponds (within Three Ponds Research Natural Area) is on the western edge of the Purcell Trench near Bonners Ferry, ID. The Research Natural Area is 7 km southwest of the Bonners Ferry Ranger Station. Three Ponds is a small, heavily-glaciated basin containing three small ponds. Each pond is shallow, between 1 to 2 ha, without fish, and with the pond level controlled by beavers. Middle Pond has a central mat dominated by *Carex lasiocarpa* and sphagnum moss about 0.4 ha in area.

Significance—Undisturbed, high-production lakes, especially at low- to mid-elevations are rare in Idaho.

Conservation—The site is within the Three Ponds Research Natural Area.

Custer County

Blind Summit Fen

Challis National Forest, Yankee Fork Ranger District. Sawtooth National Forest, Sawtooth National Recreation Area.

Description—The largest continuous expanse of peat lies at the headwaters of Marsh and Valley Creeks, an area known as Blind Summit. It gets this name because the hydrologic divide between the two creeks is nearly imperceptible. This is an important divide, however, not only because it separates the Middle Fork from the main Salmon River drainage, but because it also is the boundary between the Sawtooth National Recreation Area and the Challis National Forest. The site is about 3 km long, 0.5 km wide, and covers about 73 ha. Most of the area is covered by turfs of *Eleocharis pauciflora* and *Carex livida* and to a lesser extent by *Scirpus caespitosus*. A majority of the turf is quaking mat. Grounded *Carex simulata* and *Salix wolfii* / *Carex utriculata* communities cover small areas. *Deschampsia cespitosa* and *Pinus contorta* / *Vaccinium occidentale* community types occur at the periphery.

The water that surfaces in the peatland probably originates in the morainal and glacial outwash features southwest of the fen. The ground water flows northeast through the glacial till until it hits impermeable bedrock and then surfaces. The quaking mat of Blind Summit Fen is subirrigated by numerous springs and parallels the granitic bedrock slopes at the north-eastern edge.

Significance—Blind Summit Fen is a valley peatland of high biological significance in Idaho.

Conservation—Cattle graze heavily on the periphery of the peatland, generally in upland areas with a firm mineral substrate. A well-used dirt road follows the northeast side of the fen and impinges on it in a few places.

Sawtooth Valley Peatlands

Sawtooth National Forest, Sawtooth National Recreation Area.

Description—The Sawtooth Valley Peatlands is an established Research Natural Area, with three units as follows:

Bull Moose Fen—The site is between moraines of Decker and Redfish Lake Creeks about 1.5 km north of Huckleberry Creek Fen. There is an extensive area containing a mosaic of *Scirpus caespitosus* and *Eleocharis pauciflora* peatlands on moderate slopes. A unique feature of this fen is the peat terrace that occurs along the southern boundary. The terrace is 6 to 10 m higher than the adjacent part of the fen and is the source of several spring-fed rivulets that cascade down the face. Other wetland communities present include *Pinus contorta* / *Vaccinium occidentale*, *Carex utriculata*, *Salix drummondii* / *Carex utriculata*, *Betula glandulosa*, *Deschampsia cespitosa*, and *Carex simulata* community types.

Huckleberry Creek Fen—The site is between the moraines of Hell Roaring and Decker Creeks. It lies about 4 km north of Mays Creek Fen and 1.5 km south of Bull Moose Fen. The fen has a high community diversity occurring in a mosaic of types, replacing each other over relatively short distances. Excellent examples of communities dominated by *Scirpus caespitosus*, *Carex livida*, and *Carex buxbaumii* types are present. Other types include *Pinus contorta* / *Vaccinium occidentale*, *Carex utriculata*, *Salix drummondiana* / *Carex utriculata*, *Betula glandulosa*, *Deschampsia cespitosa*, and *Carex simulata* community types.

Mays Creek Fen—The site is between moraines of Yellow Belly Lake and Hell Roaring Creek. The Hell Roaring Creek road parallels the northern boundary, so access is convenient. Featured are a high diversity of community types, replacing each other over relatively short distances. Excellent and extensive examples of the rare *Scirpus caespitosus* and *Carex livida* types and somewhat less of the *Carex*

buxbaumii type are present. Other types include *Pinus contorta* / *Vaccinium occidentale*, *Carex utriculata*, and *Eleocharis pauciflora*. The fen is largely undisturbed. **Significance**—The three units of the Sawtooth Valley Peatlands Research Natural Area encompass the full range of diversity found in the Sawtooth Valley and Stanley Basin areas of central Idaho. These peatlands occur in a relatively high intermontane valley and have a mixture of boreal and cordilleran floristic and community elements, which are unique for Idaho.

Conservation—Some cattle grazing, recreational use, and firewood cutting occur around the margins of these sites, but a majority of each site is undisturbed due to the unstable nature of the substrate. These peatlands are within the established Sawtooth Valley Peatlands Research Natural Area.

Iron Bog

Challis National Forest, Lost River Ranger District. **Description**—Iron Bog is in the southeastern extent of the Pioneer Mountains near the Custer County/Butte County boundary, and is within the Iron Bog Research Natural Area. The wetland is a poor fen located within a relatively dry sagebrush-steppe ecosystem. The fen is at a relatively flat valley bottom with steep slopes above. Elevation of the fen is 2,130 m. Hummocks in the fen support a variety of plants including many species of *Carex*, *Kalmia polifolia*, *Ledum glandulosum*, and *Vaccinium occidentale*. *Betula glandulosa*, *Salix* spp., *Alnus incana*, and *Pinus contorta* occur at the edge of the fen where the sphagnum moss substrate is thicker. A band of *Abies lasiocarpa* borders the fen on the southwest side. The fen is formed on poorly drained alluvium deposited by glaciers. Origin of the ponds is uncertain, but were possibly formed by a glacial moraine or an old beaver pond. A fault forms a drainage in the southwestern part of the Research Natural Area that feeds the fen. The northeast-facing slope above the fen is a mosaic of *Pseudotsuga menziesii* and sagebrush/grass communities.

Significance—The occurrence of this poor fen is particularly unusual due to its location in a dry ecosystem at lower timberline. This site lies just north of the Snake River Plain. The area contains a very complex geology; this, and the hydrology of the fen have been the focus of studies by scientists from the University of Wisconsin–Milwaukee.

Conservation—Some timber cutting for poles and firewood has occurred in the RNA. The area has been impacted by grazing in the past, but was fenced in 1990 to exclude cattle. The site is an established Research Natural Area.

Fremont County

Big Springs-Henrys Fork Confluence

Targhee National Forest, Island Park Ranger District.

Description—The site is downstream from the confluence of Henry's Lake outlet and Big Springs outlet and includes land on both the north and south sides of the Henry's Fork River. An extensive spring-fed wetland complex is dominated by the *Carex utriculata* community type. The *Carex nebraskensis*, *C. aquatilis*, *C. praegracilis*-*C. aquatilis*, *C. simulata*, *Eleocharis palustris*, *Juncus balticus*, and *Deschampsia cespitosa* community types are present in lesser amounts. The *Salix geyeriana* / *Carex utriculata* community type is present along the Henrys Fork with the low willow type *Salix wolfii* / *Carex aquatilis* away from the channel. *Pinus contorta* with a mesic graminoid undergrowth is present on portions of the complex with slightly raised topography.

Significance—The large area and community diversity are significant. Three plant species of concern occur within the site: *Carex buxbaumii*, *Cicuta bulbifera*, and *Epilobium palustre*. The *Carex buxbaumii* population may possibly be the largest in the State. The *Cicuta bulbifera* population is the only one in southern Idaho, disjunct by over 550 km from the next nearest Idaho populations. The site should be considered for designation as a Botanical Area.

Conservation—The site is within a popular recreation area. The reach of the Henrys Fork is a high use area for floating, fishing, and picnicking. Impacts are minimal and confined to minor amounts of trampling at isolated spots along channel banks. It has been recommended for Special Interest Area designation.

Kootenai County

Rose Lake

Coeur d'Alene National Forest, Fernan Ranger District; Idaho Department of Fish and Game; private.

Description—Rose Lake has extensive floating and fixed mats along the lake margins covered by a mosaic of: (1) sphagnum moss-dominated poor fens (the least extensive community), (2) poor fen dominated by sphagnum mosses (*Sphagnum angustifolium*, *S. centrale*, *S. subsecundum*, *S. teres*), *Carex* spp., and *Spiraea douglasii*, (3) rich fen dominated by *Typha latifolia*, *Carex* spp., *Potentilla palustris*, *Eleocharis palustris*, and *Equisetum fluviatile*, and (4) rich and fen shrub carrs characterized by *Spiraea douglasii*, *Alnus incana*, *Salix geyeriana*, *Pinus contorta*, and *Betula occidentalis* with and without sphagnum moss-covered substrate. These fen communities grade freely into one another. Abundant marsh vegetation dominated by *Sparganium emersum*, *Carex vesicaria*, *Phalaris arundinacea*, and *Equisetum fluviatile* are found on the northern margins of Rose Lake and around much of Porters Lake, to the west of Rose Lake, which is part of the Rose Lake wetland complex. Shallow aquatic communities in the lake are dominated by *Nuphar polysepalum*, *Brasenia*

schreberi, *Ceratophyllum demersum*, *Myriophyllum sibiricum*, *Potamogeton natans*, *P. robbinsii*, and *Elo-dea canadensis*. Deeper water areas (1.5 to 3.0 m) are dominated by *Potamogeton amplifolius*, *P. praelongus*, *Elo-dea canadensis*, and *Myriophyllum sibiricum*.

Significance—Rose Lake contains the full range of aquatic, marsh, and fen communities found in the lower Coeur d’Alene River drainage. Ten of the 12 critical habitat features of Panhandle peatlands were identified at Rose Lake: poor fen, rich fen, floating mats, shrub carr, a lake, ponds, vegetated aquatic areas, a stream, and beaver activity. While Rose Lake contains only one rare plant population (*Ludwigia polycarpa*), it is exceptionally diverse floristically with more than 100 species having been identified from the various wetland and aquatic habitats at the lake.

Conservation—Attempts were made to drain most of the wetlands surrounding Rose Lake. Most of these efforts failed, but the duration of successful draining and the effects of vegetation clearing on the fen communities is unknown. All appear to have recovered and site quality seems high. A number of summer and permanent homes are found around the lake margins. Because the Rose Lake wetland complex well represents the range of wetland and aquatic habitats found in the lower Coeur d’Alene drainage, it has been nominated as a Research Natural Area.

Lemhi County

Birch Creek Fen

Targhee National Forest, Dubois Ranger District; Idaho Department of Fish and Game; U.S. Bureau of Land Management, Lemhi Resource Area; private, including a Nature Conservancy preserve.

Description—Birch Creek Fen is at the headwaters of Birch Creek in the Birch Creek Valley, which is a large intermontane valley bounded by the Beaverhead Range on the east and Lemhi Range on the west. These are arid, calcareous ranges with most of the runoff sinking into alluvial fans along their base and surfacing in the fen. Birch Creek Fen is a collection of low-elevation, alkaline wetland communities occurring on peat and mineral substrates. It is at the head of Birch Creek, which emanates from at least 51 springs in the site.

Significance—The site contains several rich fen features, including a diversity of communities and the only known marl deposits in Idaho. Eight rare plant species are known from Birch Creek Fen, including *Primula alcalina*, a globally rare primrose species is known on only four sites in Idaho.

Conservation—The fen has a long history of homesteading, livestock grazing, and recreational use, and portions are seriously degraded. Because of the outstanding and unique aquatic and wetland communities,

however, considerable protection effort is being expended to recover and protect the site by the Bureau of Land Management, Forest Service, and The Nature Conservancy.

Valley County

Tule Lake

Boise National Forest, Cascade Ranger District.

Description—Tule Lake is a unique, isolated valley peatland ecosystem adjacent to Warm Lake in Valley County, ID. The lake is approximately 10 ha and is surrounded by rich fen communities dominated by *Carex aquatilis*, *C. utriculata*, and *C. lasiocarpa*. Scattered raised sphagnum moss-dominated poor fen microsites are found throughout. Small mats have broken from the margins of the organic mat and float freely in the lake. The floating mat around the lake supports many species that are restricted to such habitats at valley peatlands in Idaho. This includes *Drosera rotundifolia*, *Dulichium arundinaceum*, *Potentilla palustris*, *Carex lasiocarpa*, *Lycopus uniflorus*, and others. The presence of these species distinguish the lower elevation valley peatlands floristically from the higher elevation subalpine peatlands. This site has typical and dominant subalpine peatland plant species present on the fixed margins, perhaps indicating that the floristic differences may be attributable to the presence or absence of a floating mat at a particular site. For this reason, Tule Lake is a fascinating and valuable site. It is also one of the most isolated known valley peatland sites in the State.

Significance—The site harbors several rare plant populations including *Scirpus subterminalis*, *Rhynchospora alba*, and *Carex buxbaumii*.

Conservation—The lake is specially managed as a fly-fishing-only trophy trout lake. Fisherman traffic has impacted portions of the organic mat, but the impact is confined to the frequently used access trails. The site has not been afforded any formal protection

Washington

Pend Oreille County

Deerhorn Creek Meadows

Kaniksu National Forest, Priest Lake Ranger District.

Description—Deerhorn Creek Meadows includes fen communities and adjacent conifer and sphagnum moss-dominated paludified margins along the low-gradient margins of Deerhorn Creek, a tributary of the Priest River. Several small beaver ponds are also found in the meadows. Common vascular plants include *Carex aquatilis*, *C. cusickii*, *C. lasiocarpa*, and *C. utriculata*. Mosses present include *Aulacomnium palustre*, *Calliergon stramineum*, *Polytrichum commune*, *Sphagnum*

angustifolium, *S. capillifolium*, *S. subobesum*, and *S. warnstorffii* (Bursik and Henderson 1995).

Significance—The area supports populations of several rare plants including *Gaultheria hispidula*, *Dryopteris cristata*, *Trientalis arctica*, and others.

Conservation—The site is not formally protected. Timber harvesting activity has occurred in the surrounding upland forests within the drainage over the last 50 years.

Huff Lake Fen

Kaniksu National Forest, Priest Lake Ranger District.

Description—Huff Lake Fen is 19 km northwest of Nordman, ID, and less than 2 km west of the Idaho border. The lake lies in a glacial kettle adjacent to Granite Creek in the Priest River drainage at an elevation of 950 m. A valley-type peatland is present adjacent to the open water. Peat cores taken from the site in 1992 revealed the presence of several ash layers, including Mazama (about 6,700 years before present) and Glacier Peak tephras (about 11,700 years before present). Huff Lake is about 3 ha. Predominant aquatic plants are *Potamogeton natans* and *Nuphar polysepalum*. A narrow floating mat occurs around much of the lake. Dominant mosses of the mat include *Sphagnum angustifolium*, *S. rubellum*, *S. centrale*, and *S. subsecundum*. Common vascular plant species include *Carex aquatilis*, *C. limosa*, *C. lanuginosa*, and *Scheuchzeria palustris*. Anchored mats on the outer edge of the basin are dominated by *Carex utriculata* and *Spiraea douglasii*. Swamp and carr habitats on the north, east, and west edges of the lake support trees of *Thuja plicata*, *Tsuga heterophylla*, *Pinus contorta*, and *Picea engelmannii*. The trees are typically growing atop sphagnum moss hummocks. Shrubs occur on low-lying areas between the hummocks; major species include *Menziesia ferruginea*, *Vaccinium globulare*, *V. membranaceum*, *Rhamnus alnifolia*, and *Cornus stolonifera*.

Significance—Huff Lake is an excellent example of a valley peatland (Bursik 1990). Valley peatlands often support a large number of boreal plant species whose main range is far north in central and northern Canada. Four Forest Service sensitive and State rare species reported from Huff Lake by Karg (1973) were apparently absent in 1992 (Bursik and Moseley 1992b). Other species had also decreased, while a number increased in abundance. Bursik and Moseley surmised that changes to the hydrology of the site through ditching and prolonged drought, and oligotrophication of water in the basin (resulting from timber harvests and fire in the basin) was responsible for the vegetation changes.

Conservation—Huff Lake receives a moderate amount of use by anglers. This has resulted in trampling damage to shoreline communities (Bursik and

Moseley 1992b). No formal protective designation has been applied to the site.

Sema Meadows

Kaniksu National Forest, Priest Lake Ranger District.

Description—Sema Meadows occurs along low-gradient lower reaches of Sema Creek in the Priest River Valley of northeastern Washington. The site is poorly inventoried botanically but supports fen communities dominated by sedges and sphagnum mosses and probably also includes some paludified conifer swamp on the forested margins. Much of the upland forest within the drainage is mature to old growth western redcedar-western hemlock forest.

Significance—The site harbors several rare plant populations including *Trientalis arctica*, *Dryopteris cristata*, and the particularly rare grass *Muhlenbergia glomerata*.

Conservation—Sema Meadows is within the Grizzly Bear Recovery area of the Priest Lake Ranger District, but is afforded no special protection.

Montana

Beaverhead County

Leonard Creek Fen

Beaverhead-Deerlodge National Forest, Madison Ranger District.

Description—Leonard Creek Fen is at the southern end of the Tobacco Root Mountains of southwestern Montana. The fen is at the head of a headwaters tributary to Leonard Creek. The town of Ennis is 8 km to the southeast. Leonard Creek Fen is a 1.6 ha basin supporting a floating organic mat. *Sphagnum magellanicum* is the primary peat-forming species, and forms sphagnum moss lawns and small hummocks across the floating mat. *Drepanocladus capillifolius* is present in wet depressions. Important vascular plants include *Eleocharis pauciflora* in the moss lawn and *Carex canescens* on hummocks. The organic mat is bordered by an open water moat on the outer edge of the basin. *Menyanthes trifoliata*, *Nuphar* spp., *Carex vesicaria*, and *Utricularia minor* are common moat species. The basin, which has a seasonal outlet into Leonard Creek, is surrounded by upland *Pinus contorta* forest, with scattered *Picea* and *Pinus albicaulis*. *Spiraea betulifolia* and *Juniperus communis* are common undergrowth species.

Significance—The site, although small, is an excellent example of organic mat development over a former open water basin.

Conservation—Cattle grazing on the periphery of the peatland is a concern. The site is not formally protected.

Skull Creek Meadows

Beaverhead-Deerlodge National Forest, Wise River Ranger District.

Description—Skull Creek Meadows are in the West Pioneer Mountains of southwestern Montana, 80 km south of the town of Anaconda. Skull Creek Meadows occupy a gently sloping basin at the headwaters of Skull Creek, a tributary of the Wise River. The West Pioneers are a granitic block of the Idaho Batholith. The site is underlain by more recent glacial till. Two fens are included within the site, separated by subalpine coniferous forest dominated by *Pinus contorta*. The upper fen is at an elevation of 2,415 m; the lower fen is at 2,400 m. The fens are patterned, with slightly raised areas (strings) alternating with hollows (flarks), oriented perpendicularly to the gentle slope. Dominant species of the fens include *Deschampsia cespitosa*, *Carex aquatilis*, *Eleocharis pauciflora*, and *C. limosa*. Various sphagnum mosses and other mosses form an important bryophyte layer; major species include: *Sphagnum angustifolium*, *S. fimbriatum*, *S. russowii*, *S. subsecundum*, *Aulacomnium palustre*, *Calliergon cordifolium*, *C. stramineum*, *Bryum weigelii*, *Drepanocladus aduncus*, *Palustriella commutata*, and *Philonotis fontana*.

Significance—Skull Creek Meadows feature an excellent, undisturbed example of a poor fen. The string-flark patterning is very unusual in peatlands of this region.

Conservation—The entire peatland complex is within the Skull-Odell Research Natural Area.

Flathead County

Bent Flat Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Bent Flat Fen is in the Flathead Range of northwestern Montana, 8 km east of Spotted Bear Ranger Station (summer headquarters). The site is within the Spotted Bear River drainage, which flows into the South Fork of the Flathead River. Bent Flat is an extremely rich (calcareous) patterned fen extending over 4 to 5 ha. Patterned fens are a type of peatland more common in boreal latitudes to the north, but uncommon in Montana. The fen features a series of distinctive elongated hummocks (strings) and hollows (flarks) oriented perpendicularly to the slope of the drainage. Marl-like deposits underlie both the strings and flarks, reflecting deposition of fine-textured calcareous silts and sands from the several inflowing seeps and streams. The hummocks are 10 to 30 cm above the adjoining hollows. The vegetation reflects both the high water table and the calcium-rich substrate. Upper portions of the fen are dominated by various spike rushes (*Eleocharis pauciflora*, *E.*

rostellata, *E. tenuis*) and *Scirpus acutus*. *Carex buxbaumii* is also common. *Potentilla fruticosa*, *Betula glandulosa*, and scattered, stunted *Picea engelmannii* occur on hummocks and are more common on the lower part of the fen. *Tomentypnum nitens* is a major hummock-forming moss; other mosses present include *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Campylium stellatum*, *Limprichtia revolvens*, and *Scorpidium scorpioides*. Sphagnum mosses are sparse. Spruce fringes the margin of the fen.

Significance—Bent Flat Fen is a unique, extremely rich fen with well-developed patterning, extensive marl deposits, and a large number of rare plants that are restricted to calcareous habitats. These include: *Eleocharis rostellata*, *Carex livida*, *Cypripedium calceolus*, *Cypripedium passerinum*, *Drosera anglica*, *Scirpus caespitosus*, and *Eriophorum viridicaratum*.

Conservation—Protection measures to maintain inflowing water quality is recommended. Given the uniqueness of the site, special designation such as Botanical Area is warranted.

Gregg Creek Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Gregg Creek Fen is in the Salish Mountains of northwestern Montana. The site is drained by Gregg Creek, a tributary of Good Creek and the Stillwater River. Gregg Creek Fen features peatland and wet forest and shrub communities within an undisturbed portion of the Gregg Creek watershed. Mosses present include *Bryum pseudotriquetrum*, *Campylium stellatum*, *Limprichtia revolvens*, and *Sphagnum fuscum*. A diverse shrub carr, dominated by *Potentilla fruticosa*, *Betula glandulosa*, and *Rhamnus alnifolia* lies immediately upstream. The upper, east end of the wetland is a wet *Picea* forest with an undergrowth of *Equisetum arvense* and *Senecio triangularis*. Adjacent upland slopes are dominated by mature spruce, *Abies lasiocarpa*, and scattered large, fire-scarred *Larix occidentalis*.

Conservation—The site is not formally protected.

Mud Lake

Flathead National Forest, Spotted Bear Ranger District.

Description—Mud Lake is within the Bob Marshall Wilderness of northwestern Montana, South Fork Flathead River drainage. The site is about 22 km south southeast of the Meadow Creek Trailhead, and 1.6 km northeast of the Salmon Forks Guard Station. Trail 80 crosses the northwest corner of the fen surrounding the lake. Mud Lake features an extensive peatland along its margin. The organic mat adjacent to open water is floating; nearer the shore, the mat is anchored to underlying sediments. The lake elevation is 1,326 m. The fen is dominated by *Carex lasiocarpa*

and *Salix candida*. Minor associated species include *C. limosa*, *C. interior*, and *Menyanthes trifoliata*. *Betula glandulosa* occurs on the basin margin adjacent to the surrounding forest of *Abies lasiocarpa* and *Picea engelmannii*. Mosses have not been collected at this site.

Conservation—Mud Lake is within the Bob Marshall Wilderness.

Sanko Creek Fen (North)

Flathead National Forest, Spotted Bear Ranger District.

Description—North Sanko Creek Fen is in the Salish Mountains of northwestern Montana, 24 km west of the town of Whitefish. Sanko Creek is a tributary of Logan Creek that flows into Tally Lake and the Stillwater River. North Sanko Creek Fen features two wetland areas. One is a small pond, 0.4 to 0.8 ha in size and up to 3 to 4 m deep, and surrounded by a floating to anchored organic mat and a wet meadow. The other wetland is a north-south oriented fen about 2.4 ha in extent. The fen is surrounded by moist *Picea* forest. *Larix occidentalis* is common on adjacent uplands. The fen has a series of broad, gently sloping terraces with interspersed water tracks and upwelling pools of water. Prominent vascular plant species of the fen include *Betula glandulosa*, *Carex lasiocarpa*, *C. utriculata*, and *C. limosa*. Mosses include *Bryum pseudotriquetrum*, *Calliergon giganteum*, *Campylium stellatum*, *Limprichtia revolvens*, *Palustriella commutata*, *Sphagnum fuscum*, and *Tomentypnum nitens*.

Conservation—The site is not formally protected.

Sanko Creek Fen (South)

Flathead National Forest, Spotted Bear Ranger District.

Description—South Sanko Creek Fen is in the Salish Mountains of northwestern Montana, 24 km west of the town of Whitefish. The site is near a headwaters tributary of Sanko Creek, a tributary of Logan Creek and Stillwater River. South Sanko Creek Fen is a small peatland covering 2 to 3 ha. The fen is oriented east-west along the base of a slope. A number of seeps and springs emerge from the toe of this slope and maintain wet conditions in the peatland. Dominant species include *Betula glandulosa*, *Salix candida*, and *Carex lasiocarpa*. *Eriophorum chamissonis* is common at the western end. Mosses form a nearly continuous surface layer and include *Bryum pseudotriquetrum*, *Campylium stellatum*, *Limprichtia revolvens*, *Hypnum lindbergii*, and *Tomentypnum nitens*.

Conservation—The site is not formally protected.

Sheppard Creek Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Sheppard Creek Fen is in the Salish Mountains of northwestern Montana. The site is

34 km west of the town of Whitefish. Sheppard Creek Fen is a 1 ha peatland maintained by springs on the north edge of the fen. Forested lands surrounding the fen are classified as the *Abies lasiocarpa*/*Vaccinium scopulorum* habitat type. The present forest cover is predominantly pole-sized *Pinus contorta*. *Ledum glandulosum* is a common undergrowth species. The margins of the fen are dominated by *Picea* with an undergrowth of *Equisetum sylvaticum*. The peatland has a nearly continuous coverage of hummock-forming sphagnum moss, including *Sphagnum warnstorffii*. Important vascular plants include *Betula glandulosa*, *Salix drummondiana*, and *Carex utriculata*. Brown mosses include *Aulacomnium palustre*, *Calliergon stramineum*, and *Pohlia nutans*.

Conservation—The site is not formally protected.

Trail Creek Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Trail Creek Fen is in the Flathead Range of northwestern Montana. The site is within the Spotted Bear River drainage, 13 km east of the southern end of Hungry Horse Reservoir (South Fork Flathead River). The nearest town is Hungry Horse, located 100 km to the north. Trail Creek Fen is on a gently sloping bench 75 m above Spotted Bear River. The site contains three abandoned beaver dams and ponds and a well-developed peatland on the upper, easternmost portion of the wetland. The former beaver ponds are dominated by *Carex lasiocarpa*, *C. utriculata*, and *Scirpus acutus*. The margins between the old ponds and adjacent conifer forest are peatlands dominated by the moss *Tomentypnum nitens* and the vascular plants *Carex lasiocarpa*, *Eleocharis* spp., *Betula glandulosa*, *Salix candida*, and scattered, stunted *Picea engelmannii*. Other mosses include *Calliergon giganteum*, *Campylium stellatum*, *Hypnum lindbergii*, *Sphagnum fuscum*, and *S. warnstorffii*.

Significance—Trail Creek Fen is a relatively large, highly calcareous peatland. Populations of the following rare plants are known from the site: *Carex livida*, *Cypripedium calceolus*, *C. passerinum*, *Orchis rotundifolia*, *Drosera anglica*, and *Eriophorum viridicarinatum*.

Conservation—The site is not formally protected.

Trout Lake

Flathead National Forest, Spotted Bear Ranger District.

Description—Trout Lake is on the west side of the Flathead Range of northwestern Montana near the east shore of Hungry Horse Reservoir (South Fork Flathead River). The site is about 40 km southeast of the town of Hungry Horse. Trout Lake is a deep pond surrounded by organic mat communities (floating and anchored). A sedge meadow dominated by *Carex*

lasiocarpa lies southwest of the pond. Several species of sphagnum moss (*Sphagnum angustifolium*, *S. squarosum*, *S. teres*, and *S. warnstorffii*) form a nearly continuous carpet adjacent to the pond. Other mosses include *Aulacomnium palustre* and *Calliergon giganteum*. Important vascular plants include *Carex lasiocarpa*, *C. flava*, *C. interior*, and *Eriophorum chamissonis*.

Significance—Trout Lake is an excellent example of an organic mat surrounding a deep pond. *Lycopodium inundatum*, *Drosera anglica*, and *Scheuchzeria palustris* are known from the peat mat.

Conservation—The site is easily reached by car and already supports a handicapped-accessible fishing dock. Most of the organic mat, however, is undisturbed by human use. The site is not formally protected.

Lake County

Lost Creek Fens

Flathead National Forest, Spotted Bear Ranger District.

Description—Lost Creek Fens are in the northern Swan Valley of northwestern Montana. The fens are within the Spring Creek drainage that flows into Swan Lake, 3 km to the north. Lost Creek Fens contains two distinctly different types of fens separated by a patch of moist coniferous forest. The northern fen (elevation 960 m) is at the toe of a slope. An upwelling spring supplies water to a thick accumulation of peat which gently slopes to the south. Major species include *Betula glandulosa*, *Carex lasiocarpa*, and *Eleocharis tenuis*. *Tomentypnum nitens* is a major moss; other mosses include *Bryum pseudotriquetrum*, *Dicranum undulatum*, *Helodium blandowii*, and *Philonotis fontana* var. *pumila*. The southern fen (elevation 945 m) has two shallow potholes filled with peat and alluvium. The water table fluctuates seasonally; drawdown in the fall hastens peat decomposition and minimizes peat accumulation. *Carex lasiocarpa* and *C. buxbaumii* are dominant. *Carex livida* is fairly common. A very wet marginal zone is lined with *Betula glandulosa*, *Potentilla fruticosa*, and *Rhamnus alnifolia*. Wet *Picea*/*Equisetum* communities are also present. *Lysichitum americanum* is a common associate.

Significance—A number of rare plant species are present: *Epipactis gigantea*, *Carex livida*, *C. paupercula*, *Cypripedium calceolus*, *C. passerinum*, *Liparis loeselii*, and *Eriophorum viridicarinatum*.

Conservation—The site has been proposed as a Forest Service Botanical Area.

Porcupine Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Porcupine Fen is in the Swan Valley of western Montana, 10 km south of the town of Swan Lake. The fen is at the headwaters of a tributary of Porcupine Creek, a tributary of the Swan River. Porcupine Fen is at the toe of a slope from which several springs emerge. This constant supply of mineral-rich water has favored the accumulation of organic matter. The site supports a diverse flora, including a nearly continuous surface layer of brown mosses (common species include *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Limprichtia revolvens*, and *Tomentypnum nitens*). Important vascular plants include *Betula glandulosa*, *Carex utriculata*, *C. interior*, and *Eleocharis tenuis*. The site is ringed by wet to moist *Picea* forests, except on a portion of the west margin, where a clearcut upslope of the fen extends down nearly to the fen.

Significance—The site is an excellent example of a flow-through fen. A number of rare plants occur: *Cypripedium calceolus*, *Epipactis gigantea*, *Liparis loeselii*, and *Eriophorum viridicarinatum*.

Conservation—Maintenance of inflowing water quality is critical to the protection of this site. The site is not formally protected.

Swan River Fen

Flathead National Forest, Spotted Bear Ranger District.

Description—Swan River Fen is within the Swan Valley of northwestern Montana, about 6 km south of Swan Lake, and is within the Swan River Research Natural Area. The site adjoins a reach of the Swan River that flows north into Swan Lake. The fen is found in the south-central portion of the Research Natural Area, southwest of the Drumlin Island. Swan River Fen is a significant peatland due to its unique dome-like shape, deep peat deposits (3 to 4 m thick), and its concentration of sensitive plant species. The fen is maintained by several seeps that emerge from the toeslope of the adjoining upland. The center of the peat dome also has an upwelling spring. Water from this feature radiates outward across the surface of the peat mass. A moat (lagg) surrounds much of the peat dome. *Alnus* spp. are common in the lagg. The sloping sides of the peat dome (rand) support scattered *Picea*. Atop the peat dome, common species include stunted *Betula glandulosa*, *Carex lasiocarpa*, *C. limosa*, *C. utriculata*, *C. interior*, *Menyanthes trifoliata*, *Eriophorum viridicarinatum*, and *Eleocharis tenuis*. Mosses include *Bryum pseudotriquetrum*, *Campylium stellatum*, *Meesia triquetra*, *Cratoneuron filicinum*, *Calliergon giganteum*, *Hypnum pratense*, *Thuidium recognitum*, *Limprichtia revolvens*, *Sphagnum fuscum*, *S. warnstorffii*, and *Tomentypnum nitens*.

Significance—The well-developed peat dome supporting a large number of rare plants is highly significant. Rare plants of the peatland include: *Carex livida*,

C. pauperula, *Epipactis gigantea*, *Eriophorum viridicarinatum*, and *Liparis loeselii*.

Conservation—The peatland and surrounding forests are within the Swan River Research Natural Area.

Lewis and Clark County

Indian Meadows

Helena National Forest, Lincoln Ranger District.

Description—Indian Meadows is adjacent to and partially within the Scapegoat Wilderness of west-central Montana. The site is 17 km northeast of the town of Lincoln and encompasses the headwaters of Indian Meadow Creek, a drainage within the Blackfoot River watershed. Indian Meadows is a major feature of the Indian Meadows Research Natural Area. Elevations of the Research Natural Area range from 1,692 to 2,034 m. The meadows occupy a glaciated bench bordered by low hills to the north and south. Depressions on the bench support wetlands that include ponds, floating organic mats and poor fens, sedge meadows, and marsh communities. Major community types (c.t.) include: *Salix geyeriana*/*Carex utriculata* c.t., *Potentilla fruticosa*/*Deschampsia cespitosa* c.t., *Calamagrostis canadensis* c.t., *Carex lasiocarpa* c.t., *C. utriculata* c.t., and the *Eleocharis palustris* c.t. Four rare plant species are known from the fens: *Carex livida*, *Drosera linearis*, *D. rotundifolia*, and *Scirpus subterminalis*.

Significance—Indian Meadows is a pristine site with meadow, fen, and marsh communities in excellent ecological condition.

Conservation—The wetlands and surrounding forest are within the Indian Meadows Research Natural Area.

Lincoln County

Bowen Creek Fen

Kootenai National Forest, Tally Lake Ranger District.

Description—Bowen Creek Fen is in the Salish Mountains of northwestern Montana, near the boundary between the Flathead and Kootenai National Forests. The site includes a small tributary of Bowen Creek that flows into Good Creek and the Stillwater River. Bowen Creek Fen is a subalpine zone peatland (mean elevation 445 m) associated with a second-order stream. Water enters the peatland from the east and flows mostly across the surface of the peat toward the southwest. Sphagnum moss is predominant over most of the fen surface, and has formed hummocks 15 to 25 cm tall. The lowermost end of the wetland has an active beaver pond and adjacent marsh. *Betula glandulosa* and smaller amounts of *Salix candida* are important shrubs. *Carex lasiocarpa*, *C. utriculata*, and *Potentilla palustris* are common herbaceous

species. Mosses include: *Bryum pseudotriquetrum*, *Campylium stellatum*, *Drepanocladus uncinatus*, *Meesia triquetra*, *Calliergon giganteum*, *Helodium blandowii*, *Cratoneuron filicinum*, *Hypnum pratense*, and *Sphagnum warnstorffii*. Northern bog lemming (*Synaptomys borealis*), a Northern Region sensitive species, is known to occur in the fen. *Viola renifolia*, also sensitive, occurs upstream along a small creek. *Abies lasiocarpa* and *Pinus contorta* dominate the slopes adjacent to the fen.

Conservation—The site is not formally protected.

Cody Lake

Kootenai National Forest, Fisher River Ranger District.

Description—Lower Cody Lake is in the Purcell Mountains of northwestern Montana, 24 km southeast of the town of Libby. The series of three ponds are drained by Cody Creek, a tributary of the Fisher River. Cody Lake is the lowermost of three small ponds (0.4 to 0.8 ha) that occur near the headwaters of Cody Creek. Cody Lake, 1,430 m, is the most significant because it has a deep (up to 4 m) body of water fringed by a thick organic mat. A diversity of peatland species are present adjacent to the pond. Important shrubs include: *Betula glandulosa*, *Salix candida*, and *Kalmia microphylla*. Major graminoids include: *Carex lasiocarpa*, *Eleocharis* spp., *Carex utriculata*, and *C. limosa*. *Menyanthes trifoliata* is a common forb. Mosses include: *Tomentypnum nitens*, *Sphagnum warnstorffii*, *Campylium stellatum*, *Calliergon giganteum*, *Bryum pseudotriquetrum*, *Leptobryum pyriforme*, *Rhizomnium magnifolium*, and *Hamatocaulis vernicosus*. *Scorpidium scorpioides*, an indicator of calcium rich environments, occurs adjacent to the pond. The peatland is habitat for the Northern Region sensitive species northern bog lemming (*Synaptomys borealis*). Adjacent upland forests are dominated by *Picea*, *Larix occidentalis*, and *Pseudotsuga menziesii*.

Significance—Cody Lake is an excellent example of a deep pond surrounded by an encroaching organic mat.

Conservation—The site is not formally protected.

Tepee Lake

Kootenai National Forest, Libby Ranger District.

Description—Tepee Lake is 24 km south of Libby, MT, within the Libby Creek watershed at the headwaters of an unnamed tributary to Cowell Creek. Tepee Lake features a small, deep pond surrounded by floating and anchored organic deposits. The site is the only known location on the Kootenai National Forest and in Lincoln County for great sundew *Drosera anglica*, an uncommon plant confined to peatland habitats. Dominant species of the organic mat include *Carex lasiocarpa*, *Dulichium arundinaceum*, *C. utriculata*, and *C. limosa*. Prominent mosses include species of *Sphagnum subsecundum*, *Tomentypnum nitens*,

Aulacomnium palustre, *Calliergon giganteum*, and *Pohlia longicolla*. Conifers line the margin of the pond basin but nearby uplands have been largely cut-over. **Significance**—A large organic mat (anchored and floating) is present at Tepee Lake. The rare plants *Drosera anglica* and *Scheuchzeria palustris* occur on floating portions of the mat near the lake edge.

Conservation—Lands surrounding the lake are managed for timber and only a narrow forested buffer exists between the peatland and cut-over stands. The site is not formally protected.

Missoula County

Mary's Frog Pond

Lolo National Forest, Missoula Ranger District.

Description—Mary's Frog Pond is a designated Forest Service Botanical Area in the Lolo Creek drainage of west-central Montana, 32 km southwest of Missoula. The site features a deep pond fringed by a mat of floating and anchored peat. The pond margin is dominated by several species of sphagnum moss (*Sphagnum angustifolium* and *S. mendocinum*), *Calamagrostis canadensis*, *Carex utriculata*, *Vaccinium occidentale*, and *Ledum glandulosum*. *Drosera rotundifolia* is common on floating mats near the pond edge.

Significance—Mary's Frog Pond supports uncommon sphagnum moss-dominated poor fen communities and a large population of *Drosera rotundifolia*. *Sphagnum mendocinum*, an uncommon moss, has been identified from this site.

Conservation—The site is a designated Forest Service Botanical Area.

Sheep Mountain Bog

Lolo National Forest, Missoula Ranger District.

Description—Sheep Mountain Bog is 18 km north-east of Missoula in the West Twin Creek drainage of the Rattlesnake Mountains of west-central Montana. The site is within the Sheep Mountain Bog Research Natural Area. Elevations of the Research Natural Area range from 1,830 to 2,130 m. Sheep Mountain Bog occupies a small cirque basin within the upper-montane and lower subalpine zones. Sheep Mountain Bog (actually a poor fen) is a well-developed sphagnum moss peatland covering 0.6 ha. The deep peat deposits date back 11,500 years and contain pollen and spore records valuable for reconstructing historical vegetation of the area (Hemphill 1983). Presently, sphagnum moss forms a nearly continuous mat across the entire fen. Several uncommon vascular plant species are associated with the sphagnum moss mat. Mosses have not been identified from this site.

Significance—Sheep Mountain Bog Research Natural Area contains a population of *Carex paupercola*, listed as sensitive by the Northern Region, Forest

Service. Another sensitive species, the northern bog lemming (*Synaptomys borealis*) may occur within the Research Natural Area.

Conservation—The site lies within the Sheep Mountain Bog Research Natural Area, established in 1987.

Shoofly Meadows

Lolo National Forest, Missoula Ranger District.

Description—Shoofly Meadows is within the eastern Rattlesnake Mountains of west-central Montana, about 30 km northeast of Missoula. It contains the headwaters of the East Fork of Rattlesnake Creek drainage. The site features a shallow, spring-fed pond with numerous small islands. Dominant shrubs on the islands and margins include *Ledum glandulosum*, *Kalmia microphylla*, and *Vaccinium occidentale*. Major graminoids include *Calamagrostis canadensis*, *Carex aquatilis*, *C. buxbaumii*, *C. limosa*, *C. utriculata*, and *Eleocharis pauciflora*. Common forbs are *Potamogeton gramineus*, *Potentilla palustris*, and *Spiranthes romanzoffiana*. A number of sphagnum mosses are present: *Sphagnum angustifolium*, *S. riparium* (rare in the contiguous United States), *S. russowii*, *S. squarossum*, *S. subsecundum*, and *S. teres*. Other mosses include *Aulacomnium palustre*, *Pohlia nutans*, and *Polytrichum strictum*. Several peat-filled drainages occur downstream from the upper marsh-wet meadow. *Eleocharis pauciflora* dominates much of these areas. *Drosera rotundifolia* is locally common.

Significance—Shoofly Meadows is a large, undisturbed complex of marshes, wet meadows, and poor fens. Excellent research opportunities are afforded by the site. The area is protected as a Research Natural Area.

Conservation—The wetlands and surrounding area have been proposed as a Research Natural Area.

Windfall Creek Fen

Flathead National Forest, Swan Lake Ranger District.

Description—Windfall Creek Fen occupies a small, shallow basin formed by glacial scouring. The center of the basin is a sedge meadow dominated by a nearly pure stand of *Carex lasiocarpa*, with smaller amounts of *C. buxbaumii* and *Dulichium arundinaceum*. Margins of the basin support *C. buxbaumii*, *C. interior*, and various brown mosses such as *Aulacomnium palustre* and *Bryum pseudotriquetrum*. Notable is the presence of *Lycopodium inundatum* and *Drosera rotundifolia*.

Conservation—The site is not formally protected.

Powell County

Butcher Mountain Fens

Flathead National Forest, Spotted Bear Ranger District.

Description—Butcher Mountain Fens are in the Bob Marshall Wilderness of northwestern Montana, within the South Fork Flathead River drainage. The site is 1.5 km south of Big Prairie Guard Station on the west side of the South Fork. Butcher Mountain Fens are a

pristine rich peatland complex located at the north-eastern base of Butcher Mountain. The fens occur on gently sloping terrain drained by Butcher Creek, which flows through the site. Mean elevation of the site is 1,450 m. The entire surrounding area is underlain by limestone. The open fens are bordered by moist *Picea engelmannii* forest communities. The ecotone between forest and open fen is dominated by various species of *Salix* and *Ledum glandulosum*. The fen contains sphagnum and other mosses, plus numerous carices including *Carex interior* and *C. livida*. Mosses have not been collected.

Conservation— Butcher Mountain Fens are in the Bob Marshall Wilderness.

Ravalli County

Lost Trail Pass Fen

Bitterroot National Forest, Sula Ranger District.

Description—Lost Trail Pass Fen is in the Bitterroot Mountains of western Montana near Lost Trail Pass, just north of the Montana-Idaho Stateline. Elevation of the site is 2,150 m. Lost Trail Pass Fen is a peatland formed by organic matter infilling a small glacial depression. *Sphagnum fuscum* predominates the ground layer; other mosses include *Calliergon stramineum* and *Warnstorfia fluitans*. *Mimulus primuloides* is present, and a large population of the uncommon *Drosera anglica* occurs on the sphagnum moss hummocks. The peatland margins support a *Vaccinium occidentale* community.

Conservation—The site is adjacent to the Lost Trail Pass Ski Area and is subject to infilling from the parking lot. The area has been proposed as a Botanical Area.

Rock Creek Wetland

Bitterroot National Forest, Darby Ranger District.

Description—Rock Creek Wetland is on the western edge of the Bitterroot Valley of west-central Montana. The site is along Rock Creek, a tributary of the Bitterroot River, 1.5 km east of Lake Como, and 10 km northwest of Darby. Rock Creek Wetland is on an outwash fan near the mouth of Rock Creek Canyon. The west end of the wetland features extensive shrub carr communities on wet organic soil. The east end is drier with less peat accumulation. The main water source for the wetland appears to be a channel of Rock Creek originating at the dam on Lake Como. Water flows through the wetland in a number of small streams. *Betula glandulosa* and scattered conifers (*Picea engelmannii*, *Pinus contorta*) are dominant woody species. Common undergrowth species include *Carex utriculata*, *C. interior*, *Calamagrostis canadensis*, and *Bidens cernua*. Peat-forming sphagnum mosses (*Sphagnum fuscum*, *S. magellanicum*) dominate the

ground layer at the west end of the wetland. The brown moss *Aulacomnium palustre* is also common.

Significance—The site is a unique occurrence of a low-elevation valley peatland (400 ft) in an area largely altered by agriculture and housing developments. Two Northern Region sensitive plant species are known from the site: *Carex paupercula* and *Dryopteris cristata*. *Meesia triquetra*, an uncommon moss usually found in calcareous peatlands, is also present.

Conservation—The site is not formally protected.

Wyoming

Park County

Sawtooth Peatbeds

Shoshone National Forest.

Description—Sawtooth Peatbeds is a subalpine fen in the Beartooth Mountains of northwestern Wyoming at an elevation of 2,950 m. The site features a **palsa**, an accumulation of peat overlying permafrost (Collins and others 1984). The palsa is raised 1 m above a surrounding fen and wet meadow dominated by *Carex scopulorum*, *C. aquatilis*, and *C. illota*. *Deschampsia cespitosa* occurs atop drier hummocks. The permafrost layer occurs at a depth of about 40 cm below the peat surface. The palsa surface is sparsely vegetated; scattered clumps of *Deschampsia cespitosa* and plants of *Rumex paucifolius* and *Selaginella densa* are the predominant vascular plant species. Mosses are present but have not been identified. Sphagnum mosses are absent.

Significance—Sawtooth Peatbeds is the only known occurrence of a palsa known from the 48 contiguous states (palsas are typically found in tundra areas at high latitudes).

Conservation—Cattle grazing has occurred at the site. The site is not formally protected.

Swamp Lake

Shoshone National Forest, Clarks Fork Ranger District.

Description—Swamp Lake is at the base of the Cathedral Cliffs in the Absaroka Mountains of northwestern Wyoming, 3.2 km east of Crandall Ranger Station. Swamp Lake features three peatland types (Elliott 1997): a calcareous marl fen, a *Picea glauca* peatland, and a sedge and shrub fen. Common species of the marl fen are *Carex microglochin*, *Kobresia simpliciuscula*, and *Scirpus pumilus*. Undergrowth species of the *Picea glauca* fen include *Linnaea borealis*, *Equisetum arvense*, *Carex utriculata*, and *Calamagrostis canadensis*. Species of the sedge and shrub fen include *Carex utriculata*, *C. aquatilis*, *C. simulata*, *Triglochin maritimum*, *Betula glandulosa*, and *Potentilla fruticosa*. The site also features

several species widely disjunct from their ranges in boreal Canada. Rare mosses include *Scorpidium scorpioides* and *Cinclidium stygium*, the latter species known only from two fens in the Western United States, Swamp Lake and Pine Butte Fen in Montana. Other mosses include *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Campylium stellatum*, *Calliergon cordifolium*, *Drepanocladus aduncus*, *Hypnum revolutum*, *Palustriella commutata*, *Tomentypnum nitens*, and *Warnstorfia exannulata*.

Significance—Swamp Lake supports populations of a number of species widely disjunct from their main ranges further north (Evert and others 1986). These include *Arctostaphylos rubra*, *Carex limosa*, *C. livida*, *C. microglochin*, *C. scirpiformis*, *Orchis rotundifolia*, *Kobresia simpliciuscula*, *Primula egalikensis*, *Salix myrtilifolia* var. *myrtilifolia*, and *Scirpus pumilus*.

Conservation—Human disturbance is evident at this site (including logging in the immediate vicinity), and measures are recommended to protect this unique concentration of rare plants restricted to highly calcareous environments.

Appendix C: Invertebrates Associated with Peatlands in the Northern Rocky Mountains

This summary of invertebrate fauna of peatlands and similar habitats is arranged by taxonomic groups. The information is intended to give the reader an idea of the types of organisms that are associated with aquatic portions of peatlands. It is not our intention to provide a comprehensive, site-by-site description for each area. Some of the discussion compares invertebrate species composition of wetland ponds (including peatland ponds or marsh ponds). Refer to the references for more detailed information. This information was provided by Dr. Fred Rabe, retired professor from the University of Idaho, and Russell C. Biggum.

Phylum Porifera (sponges)

Freshwater sponges (*Spongilla lacustris*) were abundant in Hoskins Lake (Kootenai National Forest; Rabe and Chadde 1995). Clusters grew erect and prostrate from submerged tree branches, rocks, and dead leaf stems of *Nuphar polysepalum*. The sponge is a filter feeder. No sponges were noted in the large pond adjacent to Hoskins Lake. An isolated sponge colony was observed in Bottle Lake Research Natural Area (Kaniksu National Forest). *Spongilla lacustris* is associated with clean environments. It has disappeared in several lakes in north Idaho where water quality has decreased.

Phylum Cnidaria (hydra)

Hydra are common in shallow areas of standing and running water and uncommon in swift currents or wave-swept shores (Thop and Covich 1991). They do not occur on soft substrates and require debris as an attachment site. These organisms feed on microcrustaceans and often contain green zoochlorellae-like freshwater sponges. They have a low tolerance to water pollution.

Phylum Platyhelminthes (flatworms)

Most flatworm species in the Northern Rocky Mountains are associated with spring-fed streams. Two genera (*Phagocata* spp. and *Polycelis coronata*) were identified in Huckleberry Creek in the Sawtooth Valley Peatlands Research Natural Area of Idaho (Moseley and others 1994). *Polycelis coronata* is associated with small montane streams. It is collected on the undersides of rocks and is not tolerant of poor water quality.

Phylum Annelida (leeches and aquatic earthworms)

Leeches (Class Hirudinea) occurred in about the same frequency in peatland ponds as marsh ponds. Up to four different species were identified in some of the

marsh ponds compared to no more than one species in peatland ponds except in Hoskins Pond (Kootenai National Forest) where three species were noted (*Bractracobdella picta*, *Dina parva*, *Haemopsis marmorata*). This may have been due to the more alkaline water at this site. Leech cocoons affixed to the bottom side of the floating leaves of *Nuphar polysepalum* are common at many wetland sites. These cocoons contain several eggs that hatch 3 to 4 weeks after they are laid (Barnes 1980). The majority of peatland ponds sampled to date contain no leeches.

Aquatic earthworms (Class Oligochaeta) were not recorded because most of these worms occur in bottom sediments that have not been sampled.

Phylum Mollusca (snails and clams)

Fingernail clams (Family Sphaeriidae) were common in the majority of wetland ponds (peatland and marsh). They consisted of species of *Sphaerium* and *Pisidium*. These ponds do not contain larger mussels because the proper host fishes for the glochidia are not present and the waters are poor in calcium (Pennak 1989).

Snails (Class Gastropoda) were observed as often in peatland ponds as marsh ponds. However, there were no more than two species at an individual peatland site compared to a maximum of eight taxa in marsh ponds. The majority of species and largest numbers of individuals occurred in alkaline conditions. Marsh ponds containing from 3 to 8 species of snails had alkalinity readings (in terms of equivalent CaCO_3) of 104 to 187 mg/l and alkaline pHs of 8.4 to 9.3. In comparison, peatland ponds had alkalinity readings of 3 to 30 mg/l with pHs close to 7.0. No clams or snails were found in samples from Iron Bog peatland (alkalinity of 0 and pH 4.2).

The following gastropods were identified from peatland ponds. All forms except *Promentus* are classed as scrapers, feeding mostly on periphyton scraped off the leaves of macrophytes in the water. *Promentus* is a collector-gatherer: *Ferrisia* sp., *Gyraulus parvis*, *Physa gyrina*, *Physella* sp., *Planorbella campanulata*, *P. trivolvis*, *Promentus exacuous*, and *P. umbilicatellus*.

Phylum Crustacea (scuds, clam shrimp, microcrustaceans)

Scuds or freshwater shrimp (*Hyallela azteca*) were common in shallow areas of all wetland ponds sampled. *Gammurus lacustris*, another amphipod

larger in size, is found only in more alkaline marsh ponds. Freshwater shrimp are either omnivorous, general scavengers, or detritus feeders (Pennak 1989). Individuals occurring in aquatic vegetation may often be observed browsing on the film of microscopic plants, animals, and organic debris covering leaves, stems, and other substrates. They are benthic and often rest among vegetation (McCafferty 1983).

Clam shrimp (Order Conchostraca) were found early in the spring at sites such as Hager Lake. The entire body of a clam shrimp is enclosed within a bivalve carapace so the organism looks like a small clam (Pennak 1989). They are filter feeders and belong to the class Eubranchiopoda together with the Suborder Cladocera, which contains *Daphnia*.

Members of the Order Cladocera and Class Copepoda are microcrustaceans comprising zooplankton found in the water column. Cladocera were common in all wetland ponds. The number of cladocera species on the average were substantially greater in peatland ponds than marsh ponds. A maximum of eight or nine species were identified from individual peatland sites compared to a maximum of five or six from marsh ponds. Cladocerans are filter feeders.

There is a major difference between the distribution of microcrustaceans in vegetated and nonvegetated sites in a peatland (Rabe and Gibson 1984). Smaller species less than 0.5 mm in length were much more abundant than *Daphnia* at vegetated sites. *Daphnia* occurred most frequently in deep water away from vegetation. However, later in the season they are most common in shallow sites. The shift to these locations coincides with decreasing plant biomass in the shallow water due to senescence and waterfowl foraging. In contrast, small cladocerans show an opposite shift to deeper water where macrophyte density is greater.

Peatland ponds dominated by *Nuphar polysepalum* were sampled for cladocerans during midsummer (Rabe and others 1990). Generally, the most common species of open water areas were *Daphnia* and another large cladoceran species, *Holopedium*, whereas small species such as *Ceriodaphnia*, *Polyphemus*, and *Alona* occurred mostly among the *Nuphar* plants.

In Iron Bog, *Chydorus sphaericus* was the only cladoceran collected in the pond's highly acidic waters (pH 4.2).

A high degree of similarity existed between crustacean species in peatland and marsh ponds. Lake species were slightly different. Cladocerans found in peatland ponds include: *Acoperus harpae*, *Alona* sp., *Alonella* sp., *Camptocercus* sp., *Ceriodaphnia* sp., *Chydorus ovalis*, *Chydorus* sp., *Daphnia schodleri*, *D. similis*, *Daphnia* sp., *Holopedium* sp., Macrothricidae,

Pleuroxis sp., *Polyphemus* sp., *Scapholeberis* sp., *Sida* sp., *Simocephalus* sp.

Class Copepoda is well represented in the zooplankton. Larger calanoid copepods reaching lengths of 34 mm inhabit mostly open water and were infrequent amongst aquatic vegetation (Rabe and others 1990). Smaller cyclopoid copepods were noted mostly in the vicinity of large aquatic plants. This same pattern was exhibited by cladocerans where the larger individuals were concentrated outside the plant mass apparently to avoid predation (Johnson and others 1986).

Class Ostracoda (seed shrimp) are primarily benthic crustaceans most commonly associated with aquatic vegetation and silt bottoms occurring where there is little current (McCafferty 1983). Some feed on algae and decomposing vegetation (Barnes 1980).

Hydracarina (water mites) belong to the Class Acari that also includes ticks. The most common water mites in peatland ponds were red and are classified as higher water mites. These parasitize immature insects in the water such as damselflies and dragonflies (McCafferty 1983). After considerable growth as a parasite larvae the mite transforms to a nymph stage and then to an adult. In these free-living stages it becomes carnivorous or omnivorous.

Phylum Uniramia / Subphyllum Hexapoda (Class Insecta)

Order Ephemeroptera (mayflies)

Mayfly taxa found in peatland ponds were: *Baetis hageni*, *Caenis lattipennis*, *Caenis* sp., *Callibaetis* sp., *Centroptilum* sp., *Cinygma integrum*, *Siphonurus* sp. Mayflies occurred in 68 percent of the peatland ponds sampled and averaged 1.7 species per site (Rabe and Chadde 1995; Rabe and others 1990). *Callibaetis* sp. was the most common taxon. They are widely distributed, occurring in peatlands and in extreme habitats including warm desert springs and sewage treatment ponds (McCafferty 1983). *Centroptilum* sp. and *Baetis* sp. were each found at one site. They belong to the same family as *Callibaetis* but are much less tolerant and live primarily in a lotic environment (Merritt and Cummins 1984). *Caenis* sp. is typically a pond dweller and is associated with silt bottoms or dense, filamentous plant growths.

Order Trichoptera (caddisflies)

Caddisfly taxa found in peatland ponds include: *Banksiola crotchii*, *Chyranda* sp., *Desmona* sp., *Dicosmoecus* sp., *Glyphopsyche irrorata*, *Lenarchus* sp., *Lepidostoma* sp., *Limnephilus* sp., *Mystacides* sp., *Ocetis* sp., *Oxyethira* sp., *Phryganea cinera*, *Polycentropus* sp., *Psychoglypha* sp., *Synclita* sp., and *Triaenodes* sp. Caddisflies were found at 87 percent of

the sample sites and averaged 2.3 taxa per pond. The most common taxa were *Oxyethira*, *Polycentropus*, *Banksiola* and *Phryganea*. *Oxyethira* frequents submerged beds of aquatic plants where they feed on filamentous algae by puncturing the cells and eating the contents. *Polycentropus* is primarily a predator adapted to warm lentic conditions and can survive vernal conditions (Wiggins 1977). *Banksiola* feeds largely on filamentous algae and constructs cases of plant materials arranged spirally, often with some ends trailing. *Phryganea* lives in a wide variety of habitats. Larvae ingest dead and living plant and animal materials (Wiggins 1977).

Order Odonata (dragonflies)

Dragonflies and damselflies occurred at 87 percent of the sampled peatlands and averaged 3.2 species per site. Dominant genera were *Leucorrhinia*, *Aeshna*, and *Enallagma*. *Leucorrhinia* sprawls along the bottom and climbs on vegetation (McCafferty 1983). Other odonates that occurred in peatland ponds include: *Aeshna interrupta*, *Aeshna* sp., *Anax junius*, *Cordulia* sp., *Enallagma boreale*, *Ischeura perparva*, *Ischeura* sp., *Lestes disjunctus*, *Leucorrhinia hudsonica*, *Libellula* sp., *Ludsonia* sp., *Somatochlora* sp., and *Sympetrum obtusum*.

Aeshna actively stalk their prey, which includes invertebrates and small fish. They are sometimes cannibalistic. The damselfly *Enallagma* is found in both lentic and lotic environments. Johnson and others (1986) and Coughlan and others (1985) reported that older instars of *Enallagma* were primarily responsible for regulating the growth rate of the microcrustacean *Daphnia schodleri*. If access to the water column is provided by aquatic plant growth, damselflies, which are substrate dependent, become "sit and wait" predators for prey species such as *Daphnia*.

Order Diptera (flies)

Fly larvae were present in 94 percent of the peatland ponds sampled and averaged 4.4 species per pond (Rabe and Chadde 1995; Rabe and others 1986; Rabe and others 1990). The family Chironomidae was the dominant group. Dipteran taxa included: *Aedes* sp., *Alluaudomyia* sp., *Anopheles* sp., *Bezzia* sp., *Chaoborus* sp., *Chironomus* sp., *Chrysops* sp., *Corynoneura* sp., *Cricotopus* sp., *Microspectra* sp., *Palpomyia* sp., *Paradixa* sp., *Polypedilum* sp., *Prioncera* sp., *Procladius* sp., *Pseudodiamesa* sp., *Pseudolimnophilia* sp., and *Simulium* sp. This group is probably the most widely adapted of all aquatic insects and are represented by herbivores, detritivores, and carnivores (McCafferty 1983). *Bezzia*, the biting midges known as "punkies" or "no-see-ums," were collected at many sites. *Chaoborus* or phantom midge is a planktonic diptera living in deep ponds such as Hager Lake and

Bottle Lake. It preys on zooplankton and insects, such as mosquitoes. *Chaoborus* may remain on the bottom or burrow during daylight and move to more open water locales at night or when light is reduced by snow or ice cover (McCafferty 1983). Specialized air bladders function as hydrostatic organs and aid in this vertical movement.

Order Coleoptera (beetles)

Beetle larvae and adults as a group were present in 94 percent of the ponds sampled and averaged 2.9 taxa per pond. Taxa included: *Acilius* sp., *Bidessus* sp., *Cleptelmis* sp., *Crenitis* sp., *Cyphon* sp., *Deronectes* sp., *Derovatellus* sp., *Donacia* sp., *Dytiscus* sp., *Enochrus* sp., *Galerucella nymphaeae*, *Graphoderus liberus*, *Gyrinus consobrinus*, *Halipplus dorsomaculatus*, *H. gracilis*, *H. hoppingi*, *H. immaculata*, *H. insularis*, *H. irnmaculicollis*, *H. salinarus*, *H. subguttalus*, *Helophorus* sp., *Hydraena* sp., *Hydroporus* sp., *Hygrotus* sp., *Ilybius* sp., *Laccobius* sp., *Peltodytes* sp., *Rhantus* sp., and *Tropisternus lateralis*.

A large share of the taxa were predaceous water beetles (Dytiscidae). Adults obtain air either by breaking through the surface film or from bubbles attached to aquatic plants (Usinger 1963). Eggs are laid in wet places just out of water, or more commonly, on or in plants under the water. The larvae, like the adults, are predaceous and sometimes cannibalistic.

Order Heteroptera (true bugs)

True bugs were found in all peatland ponds sampled, averaging 3.9 species at each site (Rabe and Chadde 1995; Rabe and others 1986; Rabe and others 1990). The following Heteroptera taxa were identified from peatland ponds: *Buenoa confusa*, *Callicorixa audeni*, *Gerris buenoi*, *G. incognitus*, *Gerris* sp., *Halipplus gracilis*, *H. immaculicollis*, *Halipplus* sp., *H. dorso-maculatus*, *Hesperocorixa atopodonta*, *H. laevigata*, *H. michiganensis*, *Lethocerus amencanus*, *Limnoporus notabilis*, *Mesovelvia mulsanti*, *Microvelvia pulchella*, *Notonecta kirbyi*, *N. undulata*, *Ranatra fusca*, *Sigara* sp., and *Trichocorixa* sp. *Mesovelvia mulsanti* (water treader) was commonly associated with *Nuphar polysepalum*. Even though they are green in color suggesting plant feeding, *Mesovelvia* are predatory on surface insects and ostracods that they spear (Lehmkuhl 1979).

During the course of sampling, three new State records for Idaho were found in the order Heteroptera: *Buenoa confusa* (Kaniksu Marsh), *Hesperocorixa atopodonta* (Hager Lake), and *H. michiganensis* (Hager Lake and Kaniksu Marsh) (Rabe and others 1986). The large numbers of *H. michiganensis* constitute prey for *Notonecta undulata* at Kaniksu Marsh.

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This overview of peatland ecology and conservation on National Forests in the Northern Rocky Mountains describes physical components, vegetation, vascular and nonvascular flora, and invertebrate fauna on peatlands. Detailed site descriptions for 58 peatlands in Idaho, Montana, and northeastern Washington are included.

Keywords: wetlands, rare plants, fens, vascular flora, bryophytes, aquatic insects



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