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Conservation Strategy for Idaho Panhandle Peatlands

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EXECUTIVE SUMMARY

Peatlands are rare in the Panhandle region of Idaho and adjacent northeastern Washington. They are disjunct by more than 1,000 kilometers from the largely unbroken peatlands occurring at boreal latitudes in North America. As elsewhere, Panhandle peatlands are characterized by species adapted to the unique suite of conditions associated with these habitats. Nearly ten percent of the plant species of conservation concern in Idaho consists of disjunct boreal species found in these peatlands. Due to the rarity and sensitive nature of peatlands in northern Idaho we propose a comprehensive conservation strategy that will protect and maintain them and the ecological factors responsible for their occurrence and persistence. We review pertinent literature; identify significant peatlands of the Panhandle region; discuss the ecology of these sites, their important physical and biotic features, current and potential threats; recommend conservation designations and management prescriptions; and outline public education, research, and monitoring needs.

ACKNOWLEDGMENTS

This conservation strategy for Panhandle peatlands is the product of a history of collaboration between the Idaho Department of Fish and Game, Conservation Data Center (IDCDC) and the U.S. Forest Service. Numerous inventory and monitoring projects have been supported by the Idaho Panhandle National Forests (IPNF), and paleoecological research by the Intermountain Research Station. The original Conservation Strategy, upon which this document is based, would not have been possible without the expertise and tireless fieldwork of Rob Bursik, formerly of the IDCDC. The document prepared by him and Bob Moseley was soundly researched and provided an invaluable basis for proceeding with peatland conservation. Anna Hammet, North Zone Botanist with IPNF, directed this updating, and supplied us with support materials. IDCDC staff members Karen Gray, Michael Mancuso, Luana McCauley, and Shelley Cooke all contributed in major ways to the development and production of this strategy.

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PREFACE

The National Forest Management Act of 1976 and Forest Service policy require that the U.S. Forest Service manage lands under its jurisdiction to maintain populations of all existing native animal and plant species at or above the minimum viable population level (USDA Forest Service 1991). In the past, this type of biodiversity conservation took place solely on a species by species basis. More recently, other aspects of biodiversity have been recognized as important conservation elements. These include wildlife habitats (Toth et al. 1986, Patton 1992), and unique habitats (Marcot et al. 1994), and species groups. Forest Service biologists have begun utilizing species groups or guilds as conservation entities (Wisdom et al. 2003). Redirecting conservation efforts from the individual species to an ecosystem or habitat, as has been done with coastal Pacific Northwest old-growth forests, can greatly increase the efficiency and effectiveness of biodiversity conservation.

In Idaho, low and mid-elevation peatlands have been recognized as important habitats characterized by a unique suite of environmental conditions and hosting more than 40 rare plant and animal species[1] (Bursik and Henderson 1995, Idaho Conservation Data Center 2004). Idaho peatlands are disjunct by more than 1,000 km (600 mi) from the extensive peatlands of Canada. Peatlands are rare in Idaho, particularly low elevation valley peatlands, which are often isolated by vast stretches of upland. The study of the biota of Idaho's peatlands is much like the discipline of island biogeography where long-distance dispersal and persistence of relict populations must account for their flora and fauna. The isolated nature of peatland habitats in Idaho creates a laboratory for the evolution of ecotypes of more wide-ranging, disjunct species that are uniquely adapted to local conditions.

Research on several low-elevation peatlands in the Idaho Panhandle region indicates they are very sensitive to subtle changes in water levels and nutrient status brought on by human activities within the peatlands and on adjacent uplands (Bursik and Moseley 1992a, 1992b). The health and stability of unique habitats, such as peatlands, can reflect the overall health of the greater ecosystem of which they are a part. Loss of species within peatlands may reflect poor ecosystem health or improper management. This is why a comprehensive management strategy for peatlands in the Panhandle region is critical. With implementation of the outlined monitoring plan, this conservation strategy will not only aid in the conservation of sensitive peatland habitats, but it can also provide an ongoing valuable critique of prevailing management paradigms and their effects on sensitive species, rare habitats, and the surrounding forested landscape. As F. Dale Robertson, former Forest Service Chief, reflected in a 1991 management directive on the importance of wetlands and riparian areas: "Riparian areas and wetlands are some of the most diverse and productive areas of the National Forest System. Often these key areas visibly reflect the quality and success of land management activities in tributary watersheds... [therefore] I am calling on each of you to strengthen and clarify forest plan standards, where needed, to protect riparian areas and wetlands."

In response to this directive, the Idaho Panhandle National Forests (IPNF) and Idaho Conservation Data Center (IDCDC) cooperated in writing a comprehensive conservation strategy for Idaho Panhandle peatlands (Bursik and Moseley 1995). Significant peatland sites were identified on the basis of extensive field work, sites were ranked as to importance, and a database record was populated for each with information on location, threats, protection needs, management needs, and many other pertinent facts. These records are stored in a relational

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[1] As used in this document “rare” plants and animals are those for which conservation concern is indicated, either by their being currently tracked by the IDCDC or appearing on a current Forest Service list.

database which automatically locates records of plants and animals of conservation concern (element occurrence records or EOR).

As with any such document, certain elements of the 1995 strategy may become dated as more information becomes available. Those using this strategy need to be confident that it contains the best information available. In addition, there was a need on the part of Forest Service managers for support of some of the assumptions made in the original strategy, especially with regard to the effects of off-site logging, and the necessity for ample forested upland buffers around sites and inlet streams. In response to these needs, we have updated the 1995 strategy. For this current version of the strategy we (1) reviewed recent literature with regard to peatlands and fens, (2) searched the literature for information about the effects of watershed management on wetlands, (3) searched the literature for information on 41 peatland species on the Region 1 list of sensitive plant species and species of concern, (4) summarized available information for each species, (5) obtained photos of each species, and (6) made site visits to three peatland sites that had not been thoroughly documented. Much of the text of this document remains identical to that prepared by Bursik and Moseley (1995) with additional or more current research cited where pertinent. Appendix 1 contains specific information about each peatland site, consisting of a map and the site record from the IDCDC's Biotics data system. Much of the content of the site records remains as prepared by Rob Bursik with changes in condition, ownership, and recommendations made as needed. Updated information largely relates to land ownership and management. Site records were created for the three sites in Washington following a field survey. These are Sema Meadows, Deerhorn Meadows, and Huff Lake. Appendix 2 includes information on each peatland sensitive plant species and species of concern, including nomenclature, description, habitat, and distribution. Life history, ecology and population biology information are provided where available.

INTRODUCTION

Peatlands are generally defined as wetlands with waterlogged substrates and at least 30 cm (12 inches) of peat accumulation. They develop in sites that are saturated throughout the growing season and where the rate of biomass accumulation exceeds decomposition. Peatlands are an important terrestrial habitat worldwide, occupying one percent of ice-free continental land masses, including nearly 15 percent of Canada. Peatlands exert an enormous influence on the world's climate. Anaerobic respiration within peat soils may account for nearly 40 percent of the methane released into the biosphere annually. They also act as immense sinks of carbon dioxide, storing an estimated 15 to 20 percent of terrestrial carbon reserves, more than twice the amount in all living northern latitude forests (Breining 1992). Others have estimated the amount of carbon stored in peatlands is 3-3.5 times that present in moist tropical forests, despite covering half the land area (Barkham 1993).

Peatlands contain a unique biota adapted to saturated, oxygen-free, nutrient-poor, and acidic conditions, which limit microbial breakdown of plant tissues and lead to the accumulation of peat (Crum 1988). They are archives of the past, containing plant spores, pollen, and macrofossil remains which allow paleoecologists to infer physical and biotic dynamics of the postglacial landscape. This biological record has direct application to understanding the capabilities and limitations of current and future land management (Miller 1990, Schoonmaker and Foster 1991, Barber 1993). Peatlands are also important economically as a source of horticultural amendment, fiber, and energy.

Historically, peatlands were considered forbidding and worthless lands. Every attempt was made to drain them for afforestation and agriculture or to mine them for fuel. Finland has drained more than half of its 25 million acres of peatland for forestry. Less than five percent of Ireland's three million acres of peatland remain untouched (Breining 1992) and an estimated 91 percent of lowland raised bogs in the British Isles have been destroyed (Barkham 1993). Although North American peatlands have fared far better, the continued threat of direct peatland development exists. Indirect impacts from land-use activities in surrounding uplands can be of equal threat to peatland biodiversity because most species are sensitive to small changes in water chemistry and hydrology (Vitt and Slack 1975, Glaser 1987, Bursik and Moseley 1992a, 1992b).

Floristic and ecological studies of peatlands have been conducted throughout boreal and temperate parts of the world (Gore 1983), including numerous studies in Canada and the eastern United States (Glaser 1987, Crum 1988). Few studies, however, have been conducted in the northern Rocky Mountains of the United States (Rumely 1956, Lesica 1986, Bursik 1990). During the 1980s, peatlands in northern Idaho became widely recognized as important habitats for rare plants (Rare and Endangered Plants Technical Committee 1981) leading to numerous floristic inventories of peatlands around the state, largely by the Idaho Department of Fish and Game's Conservation Data Center (Caicco 1987, 1988, Moseley 1989, 1990, 1992, Bursik 1990, 1992, Moseley et al. 1991, 1994). More recently, the focus has been shifted to understanding community- and landscape-level patterns and processes in Idaho peatlands, at both spatial and temporal scales (Bursik and Moseley 1992a, 1992b, Bursik 1993, Bursik et al. 1994, Moseley et al. 1992, 1994). Compatible with this is the Forest Service’s use of the species guild concept (Wisdom et al. 2003) for identifying and protecting rare plant habitat. The guild concept is a particularly useful approach to peatland conservation because of the unique flora they support.

Peatlands of northern Idaho are largely intact when compared to those in Europe. Our challenge for maintaining the diversity of peatland communities and biota in the region, however, is no less daunting. The rarity and isolation of peatlands on the landscape is coupled with increasing, often incompatible use of adjacent uplands. These small, overlooked sites support the richest rare plant diversity of any habitat in Idaho, containing 10 percent of the state's rare flora (Bursik and Moseley 1992c). Bursik and Moseley (1995) identified 45 sites considered critical to conservation of the full array of peatland biota and communities of the Idaho Panhandle region. Our objectives in preparing this ecosystem-level conservation strategy are to: (1) describe important biotic and physical features of each site and (2) outline a strategy that will assure the long term maintenance and protection of Panhandle peatland biota, communities, and ecological processes. This strategy for the Panhandle is part of a state-wide peatland conservation effort (Moseley et al. 1991, Bursik and Moseley 1992c, Moseley 1992, Moseley et al. 1994).

STUDY AREA

The study area was limited to Boundary, Bonner, and Kootenai counties in Idaho and the extreme eastern portion of Pend Oreille County, Washington. Within Idaho, significant valley peatlands are limited to these three northern Idaho counties. The small portion of Pend Oreille County was added because it is managed by the Idaho Panhandle National Forests (IPNF). These artificial boundaries are superimposed on an area defined by mountainous terrain, the influence of continental glaciation, and a cool temperate climate with maritime influence. The study area includes portions of three sections of the ecoregional classification of McNab and Avers (1994): the Okanogan Highlands, Flathead Valley, and Bitterroot Mountains.

Climate

The study area is influenced by prevailing westerly airmasses from the Pacific Ocean during the winter and spring, creating what has been called an "inland maritime" climate. These airmasses bring prolonged, gentle rains, deep snow accumulation at higher elevations, cloudiness and frequent fog, high humidity, and winter temperatures 8 to 14^{o}C (14 to 25ºF) warmer than continental or East Coast areas at similar latitudes (Cooper et al. 1991). Data from the Priest River Experimental Forest, in the Priest River valley, best express the climate of peatland-supporting valleys in northern Idaho, where the average annual precipitation is 80 cm (31.5 inches) and the average annual temperature is 6.8^{o}C (44ºF). Although no weather stations exist, subalpine peatland sites, in the Selkirk Mountains, probably have much higher annual precipitation and lower temperatures. Most of the precipitation occurs in the winter (November through March) as snow. July and August are typically very dry, generally averaging less than 2.5 cm (1 in) per month (Ross and Savage 1967).

Geology

Prominent rock types in the study area include granites of the Kaniksu batholith and low-grade metamorphic Precambrian "belt" metasediments (Rabe et al. 1986, Cooper et al. 1991). Cordilleran ice sheets covered much of the Panhandle during the Pleistocene, including all but three of the southernmost peatland sites. The four subalpine peatland sites in the Selkirk Mountains were influenced more by late-Pleistocene and possibly Holocene alpine glaciation, as is the case with subalpine peatlands elsewhere in Idaho (Rabe et al. 1986). Most Panhandle peatlands occur on glacially-influenced topographic features, such as cirques, kettles, scours, and outwash channels. Others, such as Kaniksu Marsh RNA (Research Natural Area), occur in abandoned meander channels of rivers.

Zonal Vegetation

The study area is part of the western temperate coniferous forest ecosystem, which covers the northern Rocky Mountains of the United States (Daubenmire 1969). Typically, lower-elevation forests consist of mixed coniferous stands dominated by *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock), *Abies grandis* (grand fir), *Pinus ponderosa* (ponderosa pine), *P. monticola* (western white pine), *Larix occidentalis* (western larch), and *Pseudotsuga menziesii* (Douglas-fir), while higher-elevation forests are dominated by *Abies lasiocarpa* (subalpine fir), *Picea engelmannii* (Engelmann spruce), and *Pinus contorta* (lodgepole pine; Cooper et al. 1991).

SIGNIFICANT PEATLAND SITES

Bursik (1990) recognized two types of peatlands in Idaho, on the basis of vascular floristic composition: (1) *valley peatlands* are rare and generally occur around lakes and ponds at relatively low elevations in major river valleys from near the Canadian border in the north, to near Driggs in eastern Idaho; (2) *subalpine peatlands* are common throughout the same portion of Idaho, but form along low-gradient, subalpine streams. Subalpine peatlands are characterized by species common throughout the western cordillera of North America, while valley peatlands are characterized by numerous boreal species whose Idaho populations are disjunct by hundreds of kilometers from the main portion of their range in boreal Canada. The highest concentration of valley peatlands in Idaho is in the Panhandle region, where they are associated with features related to continental glaciation. Subalpine peatlands that occur in the Panhandle are transitional toward valley peatlands based on the presence of numerous boreal species in addition to the typical Cordilleran species. Subalpine peatlands in the Panhandle range in elevation from 1,311 to 1,666 m (4,301-5,466 ft), while valley peatlands range from 641 to 1,154 m (2,103-3,786 ft).

Forty-five significant peatland sites have been identified in the Idaho Panhandle region, including three in Pend Oreille County, Washington (Table 1; Figure 1; Appendix 1). The Washington sites were included because they occur along the western edge of the Priest River valley, which contains the densest concentration of peatland sites in the Panhandle, and are managed by the Idaho Panhandle National Forests. Sites range from 48^{o}59' N latitude, along the Canadian border (Bog Creek), south to 47^{o}29' N in the lower Coeur d'Alene River valley (Thompson Lake). Only four of the Panhandle sites are subalpine peatlands (Bog Creek, Grass Creek Meadows, Cow Creek Meadows, and Smith Creek RNA), all of which are located in the Selkirk Mountains near the Canadian border.

Sites were identified over the course of eight years of field work in the Idaho Panhandle by Rob Bursik and Bob Moseley (Figure 1). They range in size from 8 to 580 ha (10-1,433 ac). Each site was ranked on richness, rarity, condition, and other values (interpretive values, wildlife, fisheries, etc.). The 45 sites represent most of the diversity of flora, communities, and ecological features known in peatlands of the region. The 37 sites located in Boundary and Bonner counties were also identified in a wetlands conservation strategy for those counties written for the Environmental Protection Agency (Jankovsky-Jones 1997).

Among the Idaho sites, 21 are in Bonner County, 14 in Boundary County, and five in Kootenai County. As stated above, the Priest River valley contains the most sites with 19. Eleven sites occur in the Kootenai River valley, eight in the Pend Oreille River drainage, five in the Spokane/Coeur d'Alene drainage, and two in the Moyie River drainage (Table 1).

Table 1. Significant peatland sites in the Idaho Panhandle region, arranged from north to south. RNA = Research Natural Area, CE = conservation easement, WRP = Wetlands Reserve Program, WMA = Wildlife Management Area. Protection categories are discussed in the text.

	Site	Protection Class	Protection Status	Management	County	River Drainage
1	Bog Creek Fen			USFS	Boundary	Kootenai
2	Robinson Lake			USFS	Boundary	Moyie
3	Grass Creek Meadows			USFS	Boundary	Kootenai
4	Sinclair Lake			USFS	Boundary	Moyie
5	Cow Creek Meadows			USFS	Boundary	Kootenai
6	Smith Creek RNA	I	RNA	USFS	Boundary	Kootenai
7	Dawson Lake			USFS,IDL,PVT	Boundary	Kootenai
8	Upper Priest Lake Fen			USFS,IDL	Bonner	Priest
9	Mosquito Bay Fen	I		USFS,PVT	Bonner	Priest
10	Armstrong Meadows			USFS	Bonner	Priest
11	Bottle Lake RNA	I	RNA	USFS	Bonner	Priest
12	Perkins Lake			USFS,TRIBAL,PVT	Boundary	Kootenai
13	Huff Lake Fen			USFS	Pend Oreille	Priest
14	Bonner Lake			PVT	Boundary	Kootenai
15	Herman Lake			PVT	Boundary	Kootenai
16	Packer Meadows			USFS	Bonner	Priest
17	Sema Meadows			USFS	Pend Oreille	Priest
18	Rose Fen			PVT	Boundary	Kootenai
19	Bear Creek Fen			IDL,PVT	Bonner	Priest
20	Three Ponds RNA	I	RNA	USFS	Boundary	Kootenai
21	Bismark Meadows		CE (WRP)	USFS,PVT	Bonner	Priest
22	Potholes RNA	I	RNA	USFS	Bonner	Priest
23	Deerhorn Creek Meadows			USFS	Pend Oreille	Priest
24	Hager Lake Fen		CE	USFS,PVT	Bonner	Priest
25	Lamb Creek Meadows			USFS,PVT	Bonner	Priest
26	Beaver Lake (North)			USFS,IDL	Boundary	Pend Oreille
27	McArthur Lake WMA		WMA	IDFG,PVT	Boundary	Kootenai
28	Lee Lake			PVT	Bonner	Priest
29	Chase Lake	I		IDL,PVT	Bonner	Priest
30	Kaniksu Marsh RNA	I		USFS	Bonner	Priest
31	Walsh Lake			PVT	Bonner	Pend Oreille
32	Chipmunk Potholes			IDL,PVT	Bonner	Priest
33	Dubius Creek Fen			USFS	Bonner	Priest
34	Blue Lake			IDL,PVT	Bonner	Priest
35	Gamlin Lake			BLM,TRIBAL,PVT	Bonner	Pend Oreille
36	Beaver Lake (South)			TRIBAL,PVT	Bonner	Pend Oreille
37	Lost Lake			USFS	Bonner	Pend Oreille
38	Shepherd Lake			IDFG,PVT	Bonner	Pend Oreille
39	Hoodoo Lake			USFS,PVT	Bonner	Pend Oreille
40	Kelso Lake			USFS,PVT	Bonner	Pend Oreille
41	Twin Lakes Fen			PVT	Kootenai	Spokane/Cd'A
42	Hauser Lake Fen			IDFG,PVT	Kootenai	Spokane/Cd'A
43	Rose Lake	I		USFS,IDFG,PVT	Kootenai	Spokane/Cd'A
44	Hidden Lake			IDFG,PVT	Kootenai	Spokane/Cd'A
45	Thompson Lake			USFS,BLM,PVT	Kootenai	Spokane/Cd'A

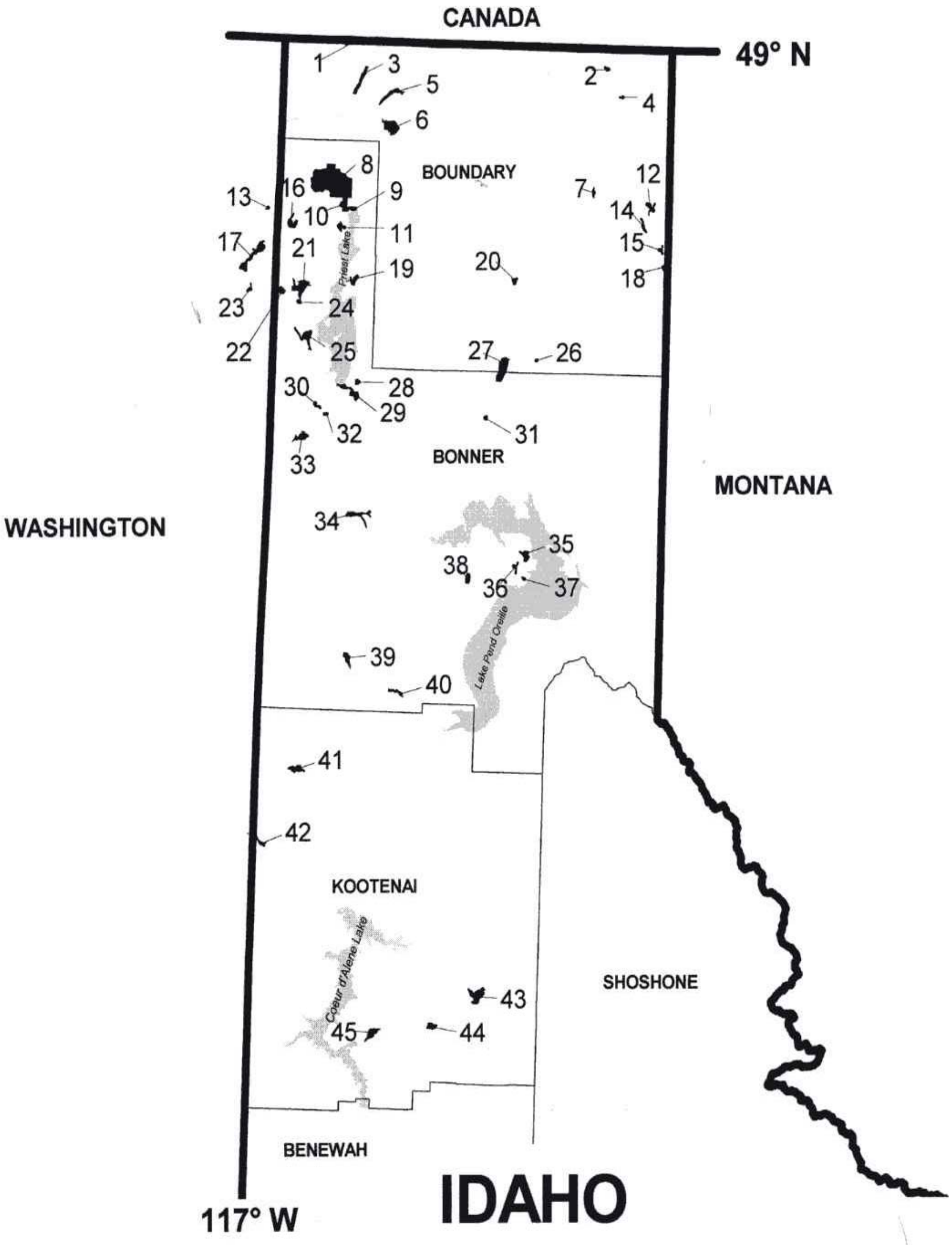

Figure 1. Location of peatland sites in the Idaho Panhandle region (numbers correspond to sites in Table 1).

A majority of the peatland sites are entirely or partially on publicly owned land (Table 1). The U.S. Forest Service, Idaho Panhandle National Forests, is the primary land manager, managing part or all of 29 sites. Other federal and state agencies, including the Bureau of Land Management, Idaho Department of Lands, and Idaho Department of Fish and Game, and two Indian Tribes are also peatland managers. Six of the sites are entirely private land, while portions of 20 others are privately-owned. Few of these private sites have any legal or voluntary protection.

ECOLOGY

Peatlands are unique ecosystems characterized by organic (peat) soils that result from a rate of biomass production exceeding that of decomposition (Vitt et al. 1995). However, peatlands are generally recognized by a characteristic vegetation. Peatlands can be further subdivided into bogs, which are ombrotrophic, receiving water and mineral nutrients only from rain water, and fens, which are minerotrophic, receiving nutrients from groundwater that has percolated through mineral soil and bedrock, or from a combination of groundwater and runoff. All peatlands are on a trophic gradient from base-poor (bog and poor fen) to base-rich (rich fen). The trophic status is indicated by the pH of the soil solution.

Bogs are dominated by *Sphagnum* mosses. Fens range from poor fens, which tend toward bog conditions and are dominated by bryophytes (especially *Sphagnum* spp.) and some vascular species (sedges and ericads), to rich fens, which are dominated by sedges, other graminoids, and true mosses. One type can grade imperceptibly into another. Because the most salient distinguishing feature among peatland types appears to be whether they are *Sphagnum*-rich (bog/poor fen) or *Sphagnum*-poor (rich fen), Horton et al. (1993) suggested adopting these terms to replace the traditional, often misapplied, terms bog and fen. However, for the purpose of this document we have used “rich” and “poor” in the traditional sense, to refer to the mineral status of the fen as indicated by the dominant vegetation.

Almost all Panhandle peatland habitat is fen. Both rich and poor fen habitats are represented, often within the same site. Only very scattered microsites, in the form of hummocks no more than 10 m^2, constitute ombrotrophic bog. These hummocks contrast sharply in form and floristic composition with surrounding minerotrophic fen where they occur at Chase and Huff lakes. The few peatlands supporting bog microsites occur in the northern Panhandle, which on average receives the most summer precipitation within the study area. Lack of summer precipitation has been shown to limit the geographic extent of raised bog formation (Crum 1988). This appears to be the case in Idaho where, under prevailing patterns of precipitation, poor fen is the likely end-point of peatland succession.

The characteristics of fens are determined by their close ties to groundwater. Their hydrology, water chemistry, and vegetation are determined in large part by the fact that they occur where groundwater discharges to the plant rooting zone (Bedford and Godwin 2003). Even the different trophic levels, which are used to classify fen types, are a function of the extent to which groundwater influences the rooting zone. This is determined both by the height of the water table and the balance of ground vs. surface water entering the fen. Only a small amount of ground water input to a peatland is necessary to raise pH and alter vegetation (Siegel 1983). It has long been recognized that the pH of the soil water is of primary importance in determining the distribution of plant species in fens (Vitt and Slack 1975, Anderson and Davis 1997). Other important factors for vascular plants include cation concentration, the concentration of rock elements (P, Al, Mn, Al, Si), and amount of overstory. For bryophytes, microtopography and water availability are most important (Anderson and Davis 1997).

A distinctive feature of fens related to their groundwater relationship, is low availability of nitrogen and phosphorus. Unless enriched in nitrogen by atmospheric deposition, runoff from agricultural lands, or seepage from septic systems, fens are inherently low in available nitrogen. Phosphorus appears to be even more limiting, especially in rich fens where the constant input of ground water rich in calcium bicarbonate, calcium sulfate, or iron ensures that most phosphorus is adsorbed, or precipitated into relatively unavailable forms (Bedford and Godwin 2003).

DIVERSITY

Peatlands are characterized by unique plant communities and a largely unique bryophyte flora (Vitt et al. 1995). In fact, many species are restricted to this habitat, and therefore are of very limited distribution in Idaho and are of conservation concern (Table 2).

In his initial study of the peatland flora of Idaho and northwestern Montana, Bursik (1990) found 327 vascular species occurring at both valley and subalpine sites, with only 205 species occurring in the valley peatlands. Subsequent study has revealed the presence of 291 vascular and 20 bryophyte species in the valley peatland flora of Idaho alone (Bursik and Henderson 1995), the majority of which are found in Panhandle peatlands. Subalpine peatland plant diversity is not as high in the Panhandle region as it is elsewhere in Idaho. Two of the four subalpine peatlands included in this conservation strategy, Cow Creek Meadows and Smith Creek RNA, are well-inventoried floristically (Bursik 1993). These sites contain a combined 115 species (15 bryophyte and 100 vascular). Floristic composition of the other two subalpine sites (Bog Creek and Grass Creek Meadows) appears similar.

RARE FLORA

Panhandle peatlands are habitat for more than 30 plant and lichen species of conservation concern in Idaho (IDCDC 2004; Table 2; Appendix 2), representing about 10 percent of the state's rare flora. Several species are known from only one or two sites in Idaho, including *Andromeda polifolia*, *Drosera intermedia*, *Iris versicolor*, *Meesia longiseta*, *Maianthemum dilatatum*, *Nymphaea leibergii,* and *Trichophorum alpinum* (See Table 2 for common names). Within the study area, *Meesia longiseta* and *Nymphaea leibergii* are only known from historical collections. Several other taxa occur exclusively within the study area, including *Betula pumila*, *Carex chordorrhiza*, *C. comosa*, *C. magellanica* ssp. *irrigua*, *Dryopteris cristata*, *Gaultheria hispidula*, *Hypericum majus*, *Lycopodium dendroideum*, *Petasites sagittatus, Salix pedicellaris*, *Sanicula marilandica*, *Trichophorum alpinum*, *Trientalis europaea* ssp. *arctica*, *Utricularia intermedia*, and *Vaccinium oxycoccos*. The remaining species occur in peatlands elsewhere in Idaho.

Maianthemum dilatatum is disjunct in Idaho from the west coast (Lorain 1988). The remaining rare species are boreal or north-temperate in distribution, disjunct in Idaho from more continuous ranges to the north (Bursik 1990). Those most consistently associated with Panhandle peatlands include *Cicuta bulbifera*, *Epilobium palustre*, *Hypericum majus*, *Schoenoplectus subterminalis*, and *Trientalis europaea* ssp. *arctica*. The sites richest in rare flora are Mosquito Bay Fen, Kaniksu Marsh RNA, and Chase Lake, containing 21, 17, and 16 rare plant populations, respectively (Table 3).

Table 2. Plant and lichen taxa within the peatland guild, that are of conservation concern in Idaho. Global ranks are G5 unless specified. Taxa marked with an * are only known in Idaho from populations in the Panhandle region. Forest Service status: S = sensitive; C = species of concern. Sub-guild: A = aquatic, OB = ombrotrophic bog, P = poor fen, I/R = intermediate/rich fen, PF = paludified forest, and SC = shrub carr.

Scientific name[1]	**Recent synonym**	**Common name**	**Sub-guild**						**USFS Status**	**IDCDC Rank**
			A	**OB**	**P**	**I/R**	**PF**	**SC**		
*Andromeda polifolia**		Bog rosemary		X	X		X		S	S1
*Betula pumila**	*Betula pumila* var. *glandulifera*	Dwarf birch		X	X			X	S	S2
Carex buxbaumii		Buxbaum's sedge				X			S	S3
*Carex chordorrhiza**		String-root sedge				X			S	S1
*Carex comosa**		Bristly sedge			X	X			S	S1
Carex flava		Yellow sedge				X			S	S3
Carex leptalea		Bristle-stalked sedge				X			S	S2
Carex livida		Pale sedge				X			S	S2
Carex magellanica ssp. *irrigua**	*Carex paupercula*	Poor sedge				X			S	S2
*Cetraria sepincola**		Bog birch lichen						X	C	S2
Cicuta bulbifera		Bulb-bearing water hemlock	X			X			S	S2
Cypripedium parviflorum var. *pubescens*	*Cypripedium pubescens* var. *pubescens*	Yellow lady's slipper				X	X	X	S	S1
Diphasiastrum sitchense	*Lycopodium sitchense*	Sitka clubmoss				X	X		C	S2
Drosera intermedia		Spoon-leaved sundew			X				S	S1
*Dryopteris cristata**		Crested shield fern				X	X		S	S2
Epilobium palustre		Swamp willow-weed				X			S	S3
Epipactis gigantea		Giant helleborine				Rich			S	S3
Eriophorum viridicarinatum		Green-keeled cottongrass				X			S	S2
*Gaultheria hispidula**		Creeping snowberry			X	X			S	S2
*Hypericum majus**		Large Canadian St. John's wort				X			S	S3
*Iris versicolor**		Blue flag iris				X	X		S	S2

Scientific name[1]	Recent synonym	Common name	Sub-guild						USFS Status	IDCDC Rank
			A	OB	P	I/R	PF	SC		
Lobaria hallii		Hall's lungwort						X	C	S3
Lycopodiella inundata	*Lycopodium inundatum*	Northern bog clubmoss				X			S	S2
*Lycopodium dendroideum**		Ground pine				X	X		S	S2
*Maianthemum dilatatum**		Beadruby					X		C	S1
Meesia longiseta		Meesia			X	X			S	G4?S1
Muhlenbergia glomerata		Spike muhly				X			-	S2
Muhlenbergia racemosa[2]		Green muhly				X			S	
Nymphaea leibergii	*Nymphaea tetragona* var. *leibergii*	Pygmy waterlily	X						C	SH
*Petasites sagittatus**		Arrowleaf coltsfoot				X			S	S3
Rhynchospora alba		White beakrush		X	X				S	S2
Salix candida		Hoary willow				X		X	S	S2
*Salix pedicellaris**		Bog willow						X	S	S2
*Sanicula marilandica**		Black snakeroot				X			C	S3
Scheuchzeria palustris		Pod grass				X			S	S2
Schoenoplectus subterminalis	*Scirpus subterminalis*	Water clubrush	X						S	G4G5S3
Sphagnum mendocinum		Mendocine peatmoss			X	X			S	G4S1
Symphyotrichum boreale	*Aster junciformis*	Rush aster				X	X		S	S2
Triantha occidentalis ssp. *brevistyla*	*Tofieldia glutinosa* var. *absona*	Short-styled sticky tofieldia				X			S	T4S1
*Trichophorum alpinum**	*Scirpus hudsonianus*	Hudson Bay bulrush				X			S	S1
Trientalis europaea ssp. *arctica**	*Trientalis arctica*	Northern starflower				X	X		S	S3
*Utricularia intermedia**		Mountain bladderwort	X						C	
*Vaccinium oxycoccos**		Bog cranberry			X				S	S2

[1] Nomenclature follows ITIS (2004).

[2] See recommendation under *Inventory, Monitoring, and Research Needs*.

Table 3. Rare plants and lichens with their sites of occurrence (site numbers are those used in Table 1).

Scientific Name	Sites
Andromeda polifolia	9
Betula pumila	12,14,15,19,27
Carex buxbaumii	1,5,9,10,21,25
Carex chordorrhiza	9,12,18,28,29,30,33,41
Carex comosa	12,35,39,40
Carex flava	1,5,12,14,15,26,27
*Carex lacustris**	27,40
Carex leptalea	5,8,9,10,12,16,19,21,22,24,29,34,40
Carex livida	9,41
Carex magellanica ssp. *irrigua*	1,3,5,6,9,10,19,21,22,30,32
Cetraria sepincola	17,30,43
Cicuta bulbifera	2,7,12,14,15,22,27,28,29,30,34,35,36,37,38,40
Cypripedium parviflorum	27
Diphasiastrum sitchense	3,6
Drosera intermedia	6
Dryopteris cristata	10,12,17,19,21,22,23,24,28,29,30,32,34,37,40
Epilobium palustre	9,10,12,18,21,22,24,27,28,29,30,32,33,41,44,45
Epipactis gigantea	
Eriophorum viridicarinatum	9,17,27,30
Gaultheria hispidula	8,9,10,11,13,17,19,21,22,23,29,30
Hypericum majus	2,4,9,21,22,25,24,28,29,30,31,35,36,38,39,40,42
Iris versicolor	9
Lobaria hallii	
*Ludwigia polycarpa**	43,45
Lycopodiella inundata	5,9,11,24,26,29,30,42
Lycopodium dendroideum	8,9,21,23,25,28,29
Maianthemum dilatatum	19
Meesia longiseta	
Muhlenbergia glomerata	17
Petasites sagittatus	10,12,17,19,21,23,25,27,29,30,40
Rhynchospora alba	9,12,17,28,29,30,41
Salix candida	9,14,19,27
Salix pedicellaris	8,9,10,12,16,17,22,23,28,30,33
Sanicula marilandica	10,21,22
Scheuchzeria palustris	4,9,11,12,13,17,18,24,28,29,30,33,41
Schoenoplectus subterminalis	4,11,12,15,18,24,28,29,30,31,35,36,37,38,40,41,44
Symphyotrichum boreale	9,14,15,18,22,28,29,36,42
Triantha occidentalis ssp. *brevistyla*	9
Trichophorum alpinum	3,5,17
Trientalis europaea ssp. *arctica*	1,3,5,6,8,9,10,16,17,19,21,22,23,24,28,29,30,32
Vaccinium oxycoccos	8,9,10,11,13,17,19,21,22,24,28,29,30
*Vallisneria americana**	41,45

*Not currently on Forest Service Sensitive or Species of Concern lists, so does not appear in Table 2.

RARE FAUNA

The northern bog lemming (*Synaptomys borealis*), a rodent restricted largely to peatland habitats, is known from Cow Creek Meadows and is considered rare in Idaho. The grizzly bear (*Ursus arctos*), a federally listed Threatened species, and the woodland caribou (*Rangifer tarandus caribou*), an Endangered species, are known to utilize the four subalpine peatlands of the Selkirk Mountains. Grizzly bears also use valley peatland locations in the Priest River valley.

ECOLOGICAL FEATURES AND HABITAT GUILDS

Recently, there has been an effort by Forest Service planners to utilize species groups and focal species to plan for the protection of species at risk and sensitive habitats (Wisdom et al. 2003). Peatland plants are particularly compatible with this approach because of their habitat specificity. On the IPNF, groups of species related to specific habitats are referred to as "habitat guilds." Two guilds predominate at peatland sites, the aquatic and peatland guilds. The peatlands guild is broken down into five subguilds:

- Ombrotrophic bog
- Poor fen
- Intermediate/rich fen
- Paludified forest
- Shrub carr

Peatland species are commonly associated with two or more subguilds (Table 2).

Note that each peatland subguild is associated with, and named for, one of the ecological features used by Bursik and Moseley (1995) to assess the richness of peatland sites (Table 4). Floating mats do not have a unique subguild because all of the peatland subguilds, except paludified forest, can exist as a floating mat. Species of intermediate and rich fens are combined into a single subguild. An aquatic guild is associated with lake, pond, and beaver pond ecological features of peatlands. In the sections that follow, the aquatic and peatland guilds are discussed within the context of peatland ecological features.

Lakes, Ponds, and Beaver Ponds

Lake, pond, and beaver pond ecological features are present at a majority of peatland sites (Table 4). Water bodies less than 8 ha (20 ac) in size are considered ponds, and those greater than 8 ha lakes (Cowardin et al. 1979). Hager Lake Fen, Huff Lake Fen, Three Ponds RNA, Potholes RNA, and Chipmunk Potholes are centered around ponds, while Mosquito Bay Fen on Priest Lake, McArthur Lake, and Twin Lakes Fen occur on the margins of large lakes. Where present, ponds and lakes affect the successional dynamics of a peatland with periodic water level fluctuations that can flood fixed mats, deposit sediment and nutrients during high water, or leave floating mats stranded during low water. Cyclic drought and wave action on lakes and ponds are responsible for the formation and expansion of floating mats. Open water also attracts birds and mammals that may be dispersal vectors for peatland species or which may influence physical conditions of the site, as in the case of beaver (*Castor canadensis*). The soft, acidic waters of peatlands are also the habitat for numerous invertebrate species, several of which are strictly adapted to such conditions (Rabe et al. 1986).

Table 4. Ecological features of Idaho Panhandle peatlands. (Bog = ombrotrophic bog; Poor = poor fen; Int = intermediate fen; Rich = rich fen; Mat = floating mat; Carr = shrub carr; Pal = paludified forest; Litt = vegetated littoral or limnetic zones; Str = stream; Beav = beaver activity).

Site	Bog	Poor	Int	Rich	Mat	Carr	Pal	Lake	Pond	Litt	Str	Beav
Bog Creek Fen			x	x		x			x	x	x	
Robinson Lake				x	x			x		x		
Grass Creek Meadows		x	x	x		x					x	
Sinclair Lake			x	x	x	x			x	x		
Cow Creek Meadows		x	x	x		x			x			
Smith Creek RNA		x	x	x		x			x	x	x	
Dawson Lake				x	x			x		x	x	x
Upper Priest Lake Fen		x	x	x		x	x		x	x	x	
Mosquito Bay Fen	x	x	x	x		x	x	x	x	x	x	
Armstrong Meadows		x	x	x		x	x				x	
Bottle Lake RNA		x	x	x	x			x		x	x	x
Perkins Lake		x	x	x	x	x		x		x		x
Huff Lake Fen	x	x	x	x	x	x			x	x		
Bonner Lake				x		x		x		x		
Herman Lake				x				x		x		
Packer Meadows		x	x	x		x	x		x		x	x
Sema Meadows		x	x	x		x					x	
Rose Fen			x	x	x				x	x		
Bear Creek Fen		x	x	x			x				x	
Three Ponds RNA			x	x	x				x	x		
Bismark Meadows			x	x		x	x		x	x	x	
Potholes RNA		x	x	x	x	x	x		x	x	x	x
Deerhorn Creek Meadows			x	x		x	x		x	x	x	x
Hager Lake Fen		x	x	x	x		x		x	x		x
Lamb Creek Meadows				x		x			x	x	x	x
Beaver Lake (North)			x	x	x				x	x		x
McArthur Lake WMA				x	x	x		x	x	x	x	x

Site	Bog	Poor	Int	Rich	Mat	Carr	Pal	Lake	Pond	Litt	Str	Beav
Lee Lake		x	x	x	x	x	x		x	x	x	x
Chase Lake	x	x	x	x	x	x	x	x	x	x	x	x
Kaniksu Marsh RNA		x	x	x	x	x	x		x	x	x	x
Walsh Lake				x		x		x		x		
Chipmunk Potholes			x	x	x	x			x	x		x
Dubius Creek Fen			x	x		x			x	x	x	x
Blue Lake			x	x	x	x		x		x	x	x
Gamlin Lake				x	x	x		x		x		x
Beaver Lake South				x	x	x		x	x	x	x	x
Lost Lake			x	x	x	x		x		x		x
Shepherd Lake				x	x	x		x	x	x		x
Hoodoo Lake				x		x		x		x	x	
Kelso Lake			x	x	x	x		x	x	x	x	
Twin Lakes Fen		x	x	x	x	x		x	x	x	x	
Hauser Lake Fen			x	x	x	x		x	x	x		
Rose Lake		x	x	x	x	x		x	x	x	x	x
Hidden Lake		x	x	x	x	x		x	x	x		
Thompson Lake		x	x	x	x	x		x		x		

Fifteen percent of the valley peatland flora of Idaho consists of aquatic species (Bursik and Henderson 1995). Aquatics generally occur in littoral (<2 m depth) zones of vernal pools, small ponds, and lakes throughout northern Idaho, generally at lower elevations. This guild is not restricted to peatlands. *Potamogeton natans* (floating-leaved pondweed), other *Potamogeton* spp., *Myriophyllum* spp. (water-milfoil), and *Utricularia* spp. (bladderworts), occur alone or in combination in shallow littoral zones. *Nuphar polysepalum* (yellow pond lily) and *Brasenia shreberi* (water-shield) are frequently present as monocultures in deeper littoral zones. *Potamogeton amplifolius* (large-leaved pondweed), *P. praelongus* (white-stalked pondweed), and *P. richardsonii* (Richardson's pondweed) are common in limnetic (>2 m) zones.

Four species on IPNF lists are members of the aquatic guild: *Cicuta bulbifera*, *Nymphaea leibergii*, *Schoenoplectus subterminalis*, and *Utricularia intermedia* (Table 2). *Nymphaea leibergii* was collected from Granite Lake in the 1890s, but has not been found there since, and is believed extirpated. The listed threatened species *Howellia aquatilis* (water howellia) was historically recorded at one site in the Pend Oreille subbasin (Spirit Lake), but is believed to have been extirpated from that site. The nearest known populations are in Latah County, Idaho and Spokane County, Washington. No other populations have been found to date in northern Idaho, even though high quality habitat exists.

Ombrotrophic Bog (True Bog)

True bogs can develop in glacial scours, kettle holes, isolated oxbows, old lakebeds, and at or near the heads of drainages where inflow is limited. Unlike poor fens, the thick mats of peat accumulate upwards forming hummocks, often at the bases of shrubs or on downed logs, and eventually raise themselves above the influence of the water table. Water and nutrients are received solely from precipitation. True bog habitats only exist in scattered microsites in Panhandle peatlands (Table 4) probably due to a climate with a pronounced summer drought. The best example of true bog is at Chase Lake where distinctly raised hummocks, dominated almost exclusively by *Sphagnum* spp., have formed over areas up to 10 m^2. Similar hummocks exist at Huff Lake Fen, Armstrong Meadows, and Mosquito Bay Fen over old stumps. Ombrotrophic bogs are dominated by *Sphagnum fuscum*, *S. magellanicum*, *S. centrale, S. angustifolium*, and *Polytrichum strictum*. Vascular species are few or absent and are restricted to those tolerant of acidic conditions (poor fen species). Some of the plants adapted to these unique environments, such as *Andromeda polifolia*, *Carex chordorrhiza*, *Gaultheria hispidula*, *Rhynchospora alba*, and *Vaccinium oxycoccos,* are of conservation concern in Idaho. The pH values are very acidic, ranging from 3 to 4. Compared to rich fens (pH 6 to 7.5) the difference is equal to that between vinegar and salt water (Crum 1992).

Poor Fen

Poor fens occur in glacial scours, kettle holes, isolated oxbows, old lakebeds, and at or near the heads of drainages where inflow is limited. Extensive poor fen habitat exists at many of the sites. Thick layers of *Sphagnum* peat have accumulated since the end of continental glaciation, about 6,000-7,000 years ago. Poor fens are minerotrophic, receiving nutrients from water percolating through mineral soil or bedrock, and are quite acidic (pH values 4-6). These communities are characterized by a solid mat of *Sphagnum* moss with scattered stems of vascular plants, including *Carex limosa* (mud sedge), *Carex lasiocarpa* (slender sedge), *Dulichium arundinaceum* (dulichium), *Comarum palustre* (= *Potentilla palustris*; purple marshlocks), *Lycopus uniflorus* (northern bugleweed), and sometimes plants of conservation concern such as *Carex comosa*, *Carex chordorrhiza*, *Scheuchzeria palustris*, and *Vaccinium oxycoccos*. Poor fens support the oldest plant communities in northern Idaho and have changed little since the end of glaciation (Bursik and Moseley 1995, Moseley 1989). These communities are often erroneously referred to as bogs, especially when they occur as floating mats in seepage lakes. However, true bogs are not minerotrophic. Some of the most extensive poor fens occur at Hager Lake Fen, Chase Lake, Perkins Lake, Bottle Lake RNA, Kaniksu Marsh RNA, Upper Priest Lake Fen, Lee Lake, and Twin Lakes Fen.

Intermediate and Rich Fen

Intermediate and rich fens are *Sphagnum*-poor peatlands with vascular plants contributing the majority of cover and composition. Most people usually refer to these communities as marshes or wet meadows. However, fen soils are organic, usually with little or no decomposition of organic material, while true marshes have mineral soils and usually high rates of decomposition. Like poor fens, intermediate and rich fen communities can occur on floating or fixed organic mats. The pH values range from 6 to 7.5.

Intermediate fens have a high cover of bryophytes as well as vascular plants, especially sedges. Characteristic bryophytes include *Sphagnum* spp., particularly *S. subsecundum* and *S. angustifolium,* and the brown mosses *Calliergon stramineum* and *Aulacomnium palustre*. *Carex cusickii* (Cusick's sedge), *Dulichium arundinaceum,* and *Comarum palustre* are also indicative of intermediate fens. The primary feature distinguishing intermediate from rich fens is the presence of *Sphagnum* moss; rich fens have few (if any) *Sphagnum* species present. Bryophytes are more sensitive indicators of trophic status than vascular plants because they have much narrower niches along the poor- to rich-fen gradient (Vitt et al. 1995).

Valley peatlands with extensive intermediate fen habitat include Armstrong Meadows, Huff Lake Fen, Chase Lake, Kaniksu Marsh RNA, Twin Lakes Fen, Hauser Lake Fen, Rose Lake, and Thompson Lake. Intermediate fens with equal prominence of bryophyte and vascular species are characteristic of subalpine peatland sites (Bog Creek Fen, Grass Creek Meadows, Cow Creek Meadows, Smith Creek RNA).

Rich fens are dominated by dense stands of certain sedge species, such as *Carex lasiocarpa* (slender sedge), *Carex utriculata* (beaked sedge), or *C. chordorrhiza* (string-root sedge); other graminoids including *Scirpus microcarpus* (small-fruited bulrush), *Typha latifolia* (cattails), and *Calamagrostis canadensis* (bluejoint reedgrass); and shrubs, such as *Spiraea douglasii* (hardhack), *Betula glandulosa* (bog birch), and willow (*Salix* species). Rich fens in subalpine habitat are characterized by *Carex scopulorum* (Holm's mountain sedge), *Carex aquatilis* (water sedge), *Calamagrostis canadensis, Deschampsia cespitosa* (tufted hairgrass), *Kalmia microphylla* (bog laurel), and *Betula glandulosa*. Several rare species are found in rich fens, including *Carex leptalea, Carex magellanica* ssp. *irrigua,* and *Trientalis europaea* ssp. *arctica*.

Rich fens are the most diverse of the peatland types in northern Idaho, and cover the most area. All Panhandle peatlands contain rich fen communities (Table 4). Three rich fen types occur in valley peatlands. Dense rhizomatous monocultures of *Carex lasiocarpa* occur at Mosquito Bay Fen, Sinclair Lake, Rose Lake, Chase Lake, and Dubius Creek Fen. Marsh-like *Typha latifolia/C. lasiocarpa* rich fens occur on floating mats at McArthur Lake WMA, Chase Lake, Blue Lake, Gamlin Lake, Beaver Lake (South), Shepherd Lake, Hoodoo Lake, Kelso Lake, and Rose Lake. Many of the shrub carr habitats (described below), dominated by dense stands of *Spiraea douglasii*, *Betula glandulosa,* and *Salix* spp., are classified as rich fens (Table 3).

Floating Mat

On floating mats the living vegetation occurs on a mat of peat that floats on water or very unstable muck below. All of the peatland subguilds previously discussed can occur on floating mats. Floating mats are a classic feature of valley peatlands that occur on the margins of ponds or lakes (Table 3). Their absence from subalpine peatlands may be the greatest contributing factor to floristic differences with valley peatlands (Bursik 1990).

Floating mats contain the most ecologically stable communities within peatlands because they adjust to fluctuating water levels by as much as 0.75 m annually, maintaining constant contact with water while never becoming inundated like fixed mats (Crum 1988). Changes in the composition of floating mat communities are generally a function of trophic status changes, making them ideal monitoring sites to ascertain the effects of human activities that may contribute to nutrient runoff into peatlands (Bursik and Moseley 1992a). Extensive *Sphagnum*-dominated floating mats occur at Bottle Lake RNA, Perkins Lake, Huff Lake, Three Ponds RNA, Hager Lake Fen, Lee Lake, Chase Lake, and Kaniksu Marsh. Examples of extensive intermediate and rich fen floating mats dominated by shrubs, cattails, and sedges occur at Dawson Lake, Blue Lake, Gamlin Lake, Beaver Lake (South), Lost Lake, Shepherd Lake, and Thompson Lake.

At some sites, small, floating mats dominated by various bryophyte and vascular species have formed on partially submerged logs in lakes and ponds. Particularly good examples of these pioneer mats are at Robinson Lake, Huff Lake Fen, and Beaver Lake (North). Monitoring these mats (as with the permanent transects at Huff Lake Fen) can shed light on the mode and rate of mat expansion in the Panhandle region and environmental factors that affect it.

Paludified Forests (Peatland Swamp)

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. As the water table continues to rise, trees begin to die. In some environments paludification precedes the formation of poor fen and true bog (ombrotrophic) habitats (Crum 1988), but warmer, drier climatic periods may favor reforestation.

Paludified forests typically occur on the margins of closed peatland basins and often form a mosaic with poor fen, rich fen, or shrub-carr communities. These communities occur with the expansion of peatlands and result from a rise in the water table from peat accumulation. The overstories of paludified forests are characterized by an odd combination of conifers including *Pinus contorta* (lodgepole pine) and *P. monticola* (western white pine), with lesser amounts of *Abies lasiocarpa* (subalpine fir), *A. grandis* (grand fir), *Picea engelmannii* (Engelmann spruce), *Thuja plicata* (western redcedar), or *Tsuga heterophylla* (western hemlock), with a soil that is *Sphagnum* peat. The understory is dominated by *Sphagnum* moss species and some vascular plants, including some rare species found in poor fens and ombrotrophic bogs. One species–*Maianthemum dilatatum*–has only been found in a single location in northern Idaho in a paludified forest.

Paludified forests are associated most closely with valley peatlands whose lake basins are almost entirely filled with peat. These sites include Upper Priest Lake Fen, Mosquito Bay Fen, Armstrong Meadows, Deerhorn Creek Meadows, and Lee Lake (Table 3).

Shrub Carr

"Carr" refers to fen habitats with a shrub stratum. They may be classified as intermediate or rich fen, depending on the prominence of *Sphagnum* spp. This type of habitat occurs at most Panhandle peatlands (Table 3). The origin of the term carr was not researched, but it has been widely adopted regionally (Lesica 1986, Boggs et al. 1990, Heinze 1994, Bursik and Moseley 1995, Chadde et al. 1998), to refer to the wide variety of shrub community types occurring on organic soils. The shrub canopy in fen habitats ranges dramatically as to height, density, and species.

Shrubs can occur in nearly impenetrable thickets along low gradient channels, as stringers along high gradient streams, as patches within riparian forests, or on margins of meadows and open-fen communities. Most commonly, one or several species dominate vast areas of moist to wet, sometimes seasonally flooded fen. Shrub species characteristic of carr habitats in northern Idaho include *Spiraea douglasii*, *Alnus incana* (thinleaf alder), *Betula glandulosa*, and several willows, including *Salix bebbiana* (Bebb's willow), *S. drummondiana* (Drummond's willow), and *S. geyeriana* (Geyer's willow). One of the more widespread shrub carr communities consists of a dense monoculture of tall *Spiraea douglasii*.

Willow communities are often associated with low-gradient meandering channels within fens, and are characterized by *Salix drummondiana* with lesser amounts of, or codominance by, *Salix geyeriana* and *S. sitchensis* (Sitka willow). Other shrub community types of low-gradient streams include *Salix bebbiana*, *Spiraea douglasii*, *Alnus incana*, or *Betula glandulosa* community types. Along higher gradient streams, *Alnus incana*, *Alnus sinuata*, *Cornus sericea* (red-osier dogwood), and *Rhamnus alnifolia* (alder buckthorn) occur as community dominants. Patches of *Cornus sericea*, *Salix bebbiana*, *Crataegus douglasii* (Douglas hawthorn), and *Crataegus suksdorfii* (Suksdorf's hawthorn) are common in association with cottonwood forests on larger stream systems. *Crataegus columbiana* (Columbia hawthorn) is only found in warm, lower elevation drainages like the St. Joe, Coeur d'Alene, Kootenai, and lower Pend Oreille. Channel bars are frequently vegetated with *Salix exigua* (coyote willow).

Two rare willow species, *Salix candida* (hoary willow) and *Salix pedicellaris* (bog willow), can be found in shrub carrs or as inclusions in open fen. *Betula pumila* (dwarf birch), a rare species in northern Idaho, can be found in shrub-carrs in the Moyie and Kootenai river systems. Hybrids between *Betula pumila* and *Betula glandulosa*–known as *Betula X sargentii*–occur in the Priest River drainage. One rare lichen, *Cetraria sepincola* (bog birch lichen), is found exclusively on the branches of bog and dwarf birches. Other rare plant species found in shrub-carr communities include *Cypripedium parviflorum* var. *pubescens*, *Carex leptalea*, *Carex magellanica* ssp. *irrigua*, *Dryopteris cristata*, *Lycopodium dendroideum*, *Petasites sagittatus*, and *Gaultheria hispidula*. Rare *Botrychium* species (moonworts) can also be found on the margins of these communities.

Streams

Several stream types described by Rabe et al. (1994) are found in Panhandle peatlands (Table 3), including spring streams with very short runs (e.g., at Kaniksu Marsh RNA, Upper Priest Lake Fen, and Mosquito Bay Fen), spring streams with long reaches (Potholes RNA), and meandering glide streams in broad valleys (all four subalpine peatlands, plus Packer Meadows, Deerhorn Creek Meadows, Bear Creek Fen, and Dubius Creek Fen). Several lake sites serve as the headwaters for creeks (e.g., Bottle Lake RNA and Chase Lake). Streams are the main feature allowing for beaver activity, which is a significant part of Panhandle peatland ecology. Streams provide habitat for an array of invertebrate species, and several contain populations of rainbow, cutthroat, and eastern brook trout (Rabe and Savage 1977). Some are home to a few vascular and bryophyte plants adapted to life in moving water.

ROLE OF NATURAL DISTURBANCE

Natural disturbances generally serve to increase diversity and derail succession. Wildfire and beaver activity are landscape-scale disturbances that are a part of the history of Panhandle peatlands. Beaver activity probably played a part in the origin and development of some valley peatlands and contributed to habitat diversity. The roles played by other natural disturbances such as wildfire and windthrow are less obvious.

Beaver

Beaver create, modify, and maintain natural wetland habitats and create cyclical disturbance and succession in the landscape on both short and long time-scales (Keddy 2000). Peatland development may be significantly altered or even initiated by beaver (Mitchell and Niering 1993), and beaver can cause paludification (Crum 1988).

Beaver exert an enormous influence on Panhandle valley peatlands. Beaver activity was responsible for the initial formation of fen habitats at two of the RNA peatlands, Bottle Lake and Potholes. Damming at Packer Meadows, Beaver Lake (North), Kaniksu Marsh RNA, Beaver Lake (South), and Dubius Creek Fen is responsible for the formation of large ponds or the periodic expansion of ponds into lakes. A beaver dam is responsible for flooding of a large portion of Bismark Meadows. 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*, colonize these mudflats. When water levels rise again, the rhizomatous mats can become buoyant, forming floating mats which provide substrate for the colonization of *Sphagnum* and other fen species.

Wholesale changes brought on by beaver in Idaho peatlands were illustrated by the study of Rabe and Savage (1977) at Bottle Lake RNA. 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 beaver at Bottle Lake. In 1932, the central doughnut-shaped, *Sphagnum*-dominated mat was surrounded by a sedge 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 (*Nuphar polysepalum*) and submergent aquatic plants. By 1956, beaver damming had flooded the sedge fen surrounding the floating mat, replacing it with littoral plant communities and killing the scattered trees. The doughnut-shaped mat once again had become a buoyant island, the conifer trees that had been established on it during low water were dead, and the lake within the mat had become too deep to support *Nuphar*. These conditions still persist.

Permanent damming of peatland ponds and lakes could significantly disrupt processes at play for millennia that have allowed the long-term persistence of a wide array of species adapted to various successional stages within the peatland. Long-term stability (maintenance of water level and nutrient status) in peatlands leads toward poor fen formation and a gradual depauperization of the flora as sphagnum takes over and guides the course of succession autogenically (Crum 1988). Episodic beaver activity creates and maintains a mosaic of successional stages within a site and contributes to the habitat and floristic diversity of Panhandle peatlands (Bursik and Henderson 1995).

Wildfire

It is estimated that, prior to European settlement, stand-replacing fires occurred western redcedar and western hemlock habitat types at average intervals of 200 to 250 years (Morgan et al. 1996, Smith and Fischer 1997). Morgan et al. (1996) have concluded that current fire severity and frequency in these mesic forests may be within a natural range. Wildfires affect wetlands by increasing subsurface flow, opening the soil to erosion, and increasing sediment and nutrient inputs (Clark 1994). Little is known about the magnitude and duration of these effects on peatlands, but they probably depend on the steepness of the catchment, the size of the receiving wetland, and the magnitude of runoff events in the year following the fire.

CONSERVATION STRATEGY

The development and updating of this conservation strategy is evidence that the Forest Service recognizes the value of peatlands as unique ecological systems and sources of biodiversity, and the need to plan for their conservation. The foundation of this strategy is the research that was conducted between 1987 and 1995, identifying the elements of diversity (primarily rare plant species and plant communities) at numerous peatland sites throughout the Idaho Panhandle region. This body of knowledge allowed Bursik and Moseley (1995) to evaluate and rank peatland sites on the basis of richness, rarity, condition, and viability among other factors. Site-specific management and protection needs were incorporated into the site records (Appendix 1). Site records are maintained and updated as new information is submitted to the IDCDC.

Our approach to the conservation of biodiversity within Panhandle peatlands involves:

- Identification and tracking of peatland conservation sites
- Identification of threats to the integrity of peatlands
- Management recommendations for minimizing threats
- Identification of opportunities for public education, monitoring, and research

The identification of conservation sites has been discussed previously. The remaining elements of this strategy will be addressed in turn.

Threats

As stated earlier, the two most critical factors affecting the distribution of peatland species are water level and water chemistry (Nicholson 1995, Wheeler et al. 1983). With respect to water chemistry, pH emerges as a primary determinant of species distribution (Vitt and Slack 1975, Anderson and Davis 1997). Other important variables of water chemistry include the concentration of calcium and magnesium cations (Vitt and Slack 1975, Nicholson 1995) and concentrations of rock elements (P, Fe, Mn, Al, and Si; Anderson and Davis 1997). Water chemistry is determined by a myriad of factors related to the nature of the catchment basin, geology, climate, biotic factors, and both natural and human disturbance. Wildfires, climatic extremes, and beaver activity are natural disturbance processes that bring about periodic changes in water level and nutrient content and consequent shifts in location and abundance of peatland species. Even in the absence of overt disturbance, peatland communities change and shift in response to their own alteration of their environment (Crum 1988). Disturbances within the natural range of variability are important to maintaining diversity in peatlands (Bowles et al. 1990, Jacobson et al. 1991). However, human activities can produce abrupt, large-scale changes, or changes that are too frequent or otherwise beyond the tolerance level of some resident plant populations to relocate and persist. In order to manage for peatland conservation in the context of upland forest management, managers need guidance as to what actions will alter the ecosystem in excess of the intensity and frequency of natural disturbance. Related to this is the question of whether a given peatland is resilient to shifts in certain variables, or if certain factors have made it less resilient, for example, excessive fuels accumulation or extensive roads or other development within the catchment.

Threats are generally divided into two types: those acting on the peatland, its floodplain, inlet streams, and outlet streams directly (on-site) and those acting on the watershed (off-site). This distinction is somewhat artificial, both types of disturbance having the capacity to cause irreversible damage to the peatland through changes in hydrology or water chemistry. Serious changes in hydrology are most likely to come from on-site factors such as dams, ditching, stream channelization, and development or mining in the floodplain. Offsite threats can be more difficult to detect, but their effects can be mitigated in various ways. Changes in water chemistry are generally brought about by disturbances within the watershed that lead to increases in erosion and sedimentation. Logging in adjacent uplands is always considered a potential off-site threat with respect to our peatlands (Chadde et al. 1998), but forested peatlands are harvested for timber in Canada and elsewhere in the world, making it an on-site threat.

On-site impacts

On-site activities that can threaten the integrity of peatland ecosystems or communities include ditching and drainage, peat mining, livestock grazing, water flow regulation, invasion by exotic plant species, repeated trampling, and off-road vehicles.

Ground disturbance. Several large areas of former peatland in the Idaho Panhandle have been totally altered by ditching, filling, and development, and are barely recognizable as peatlands today. An area near Coolin, in the Priest River Valley, was identified as a “cranberry bog” in surveyor records from the late 1800s. The site no longer supports *Vaccinium oxycoccos* (bog cranberry) and has little peat substrate remaining, after being drained. The major portion of Bismark Meadows, one of the priority peatland sites, was ditched and drained for hay and pasture starting early in the last century. Native peatland communities are now limited to areas that were not drained, or where drainage was not maintained, and large areas are dominated by *Phalaris arundinacea* (reed canarygrass) (Lichthardt et al. 2004).

Ground disturbance around Hager Lake fen, associated with homesteading in the early 1900s, had profound effects on the flora by causing temporary eutrophication. An increase in weedy wetland species in the pollen and macrofossil record, and changes in the composition of vegetation zones within the fen, are indicative of eutrophication (Rumely 1956, Bursik and Moseley 1992a, Bursik et al. 1994). The disappearance of 14 species during a 40-year period, including four rare species, was likely the result of ditching, which eliminated flooding around the lake (Bursik and Moseley 1992a). Without flooding, shrub growth in the surrounding *Spiraea douglasii* carr simply became too dense to allow these species in the understory (Bursik et al. 1994).

Peat mining has caused serious impacts to peatlands in Canada and Europe, but has been very limited in the Northern Rocky Mountains. Little peat mining has taken place in Idaho, and only one peatland on private land in the Panhandle is known to be semi-actively mined. However, private landowners and mining companies have recently shown an interest in this resource (Bursik and Moseley 1995, Chadde et al. 1998).

Livestock grazing. Livestock within or on the margins of a site represent a large nutrient input, and their trampling disturbs the soil, encouraging weed invasion. Livestock grazing takes place within and around peatland communities at several of the privately owned sites and within two managed by the Forest Service (Cow Creek Meadows and Grass Creek Meadows). Cattle grazed on National Forest lands within the Hoodoo Lake site until a few years ago. The margins of Hoodoo Lake contain the only remnants of native peatland communities in Hoodoo Creek because of its history of cattle grazing. Grazing may still occur on private lands adjacent to Hoodoo Lake.

Bursik (1993) recommended measures to protect sensitive peatland communities at Cow Creek Meadows from direct grazing impacts. The IPNF initiated vegetation monitoring in the peatland in 2004.

Impoundments are water bodies that are controlled by a dam at their outlets. The dams may be earthen, or be engineered for controlling the level of the impounded water. As used here, the term refers to man-made impoundments. Beaver are also notorious for creating impoundments. Man-made impoundments are often constructed to maintain an artificially high water level and can affect not only the dynamics of the wetland but also its relation to groundwater, and thereby its water chemistry. Dams can also act as nutrient traps, retaining sediment and organic matter that can contribute to eutrophication, and that would otherwise nourish downstream wetlands (Mitsch and Gosselink 1993). Long-term static water levels can effect a gradual depauperization of the flora in peatlands (Crum 1988). Peatlands that adjoin impounded lakes (McArthur Lake, Twin Lakes Fen, Hauser Lake Fen, Robinson Lake) could lose species dependent on fluctuating water regimes. Erratic hydrological regimes like those historically produced by beaver are a critical aspect of habitat diversity. At McArthur Lake, Idaho Department of Fish and Game managers have begun implementing a summer drawdown to emulate natural, annual hydrologic cycles. Effects of this management on peatland plant communities and rare plants are not yet known.

Stream channelization. Both stream channelization and bank destabilization can lead to steam downcutting that ultimately drains wetlands (Mitsch and Gosselink 1993). Bank destabilization is often related to livestock grazing.

Weeds. Existing information on peatland sites indicates that only a few are threatened by weeds within the wetland itself. Some peatland features, particularly sphagnum mats, appear resilient to weeds, possibly due to the specialized adaptations needed for growth in this substrate. Based on pre-1995 data, a few sites have been invaded by exotics and two have had commercial species such as cranberries or wild rice introduced. A control program for *Lythrum salicaria* (purple loosestrife) is ongoing at Rose Lake and Thompson Lake, and this weed has also been observed at Hauser Lake. At McArthur Lake, a number of introduced species are degrading and possibly replacing fen communities at the south end of the lake. At Kaniksu Marsh, *Taraxacum officinale* (dandelion) and *Cirsium vulgare* (bullthistle) are invading the east end of the marsh. At Armstrong Meadows, *Phalaris arundinacea* occurs along a trail through the fen. The commercial cranberry, *Vaccinium macrocarpon*, has been introduced at Hidden and Thompson Lakes. At Hidden Lake it is replacing native poor fen communities. At the same two sites, the non-native *Zizania palustris* (wild rice) has been introduced and is replacing native marsh communities.

Chadde et al. (1998) state that *Phalaris arundinacea* is a common exotic species in peatlands. Bursik and Moseley (1995) did not note this aggressive species in their exotics comments, but it was listed as a community type at several sites. At Bismark Meadows large areas were planted to *P. arundinacea* for hay. *Cirsium arvense* (Canada thistle) may also invade peatlands as a result of soil disturbances such as by wheel ruts or fire, and can be abundant in artificially drained areas of peatlands such as Bismark Meadows. *Potentilla norvegica* (Norwegian cinquefoil) is common in shrub carr and rich fen communities at Bismark Meadows. It seems to be coexisting with the native species, but this species should be watched for in other peatland sites.

Many of the sites were drained at one time and used for hay production or forage. Among these, Bismark Meadows may include the largest expanse of private holdings recently used for cultivation. These areas support large stands of pasture grasses including *Poa pratensis* (Kentucky bluegrass) and *Phalaris arundinacea*, and also have extensive infestations of *Cirsium arvense.* In the middle section of the Sema Meadows complex, *Poa pratensis* is a major component on the east side of the stream, probably because of a history of grazing by pack stock.

Bursik believed that peatland vegetation would reclaim drained sites as ditches fill, even in the presence of pasture grasses and other exotics. This appears to have been the case historically, as many of the sites that were drained in the past are now occupied by native fen communities. Exotics adapted to wetlands, such as *Lythrum salicaria* (purple loosestrife) may be a much larger threat than upland or facultative wetland exotics.

Trampling by anglers is a common concern at peatland sites. It is particularly harmful to *Sphagnum* mats. At Beaver Lake North, repeated trampling threatens a population of the clubmoss *Lycopodiella inundata*.

Off-road vehicles can cause massive soil disturbance, altering peatland vegetation by compacting the organic soil, or opening sites for weed invasion. Many of the sites are susceptible to vehicle traffic because of their proximity to roads.

Afforestation. Most forested peatland features in northern Idaho appear to be the result of paludification of upland forests, as opposed to tree invasion. However, tree invasion is occurring at Bog Creek Fen and Grass Creek Meadows. The reason for tree invasion is not known. It may be related to a lowering of the water table or to inclusions of mineral soil within the peatland. Canopy closure, whether by trees or shrubs, is associated with a decrease in plant diversity. In some regions, fire is considered an important management tool for maintaining open areas, community diversity, and rare plant habitat in peatlands (Bowles et al. 1990, Jacobson et al. 1991).

Off-site impacts

Off-site impacts are changes in hydrology or water chemistry of the peatland resulting from disturbances to the watershed. It is difficult to preserve peatlands without maintaining the integrity of the site by careful management of human activities in surrounding uplands, in many cases throughout much of the watershed (Gorham 1991). Moss (1998) sums it up this way: “What happens to a lake is determined by what happens in its catchment” and this can certainly be extrapolated to all types of wetlands, especially small ones with little capacity to buffer nutrient inputs. Off-site (i.e., upland) disturbances that have been identified as potential threats to peatland ecology include:

- Land development
- Agriculture
- Deforestation (timber harvest and wildfires)
- Road construction and maintenance
- Mining

Ground disturbance associated with all these activities is the most widespread off-site threat to Panhandle peatlands. Disturbances that remove ground cover or expose bare soil have the potential to increase the sediment load to surface water. Sediment introduced to streams will eventually be flushed out and accumulate in wetlands (Forman and Alexander 1998). Nutrients added to wetlands in runoff or sediment deposition alter water chemistry and in high enough levels can lead to eutrophication (Keddy 2000). Although small changes in pH and trophic status can bring about shifts in species composition of peatlands, eutrophication is accompanied by major and usually irreversible changes in the flora of a wetland (Mountford et al. 1993). Peatlands may be particularly sensitive to nutrient inputs because their flora is related to their low nutrient status. Depending on the extent of the disturbance, upland buffers included in peatland sites may not be adequate to eliminate this threat.

Land development. There is current and potential housing construction at several peatland sites. Land moving and excavating activities associated with housing developments could result in large inputs of sediment. The extent of development, proximity to the peatland or its input streams, and practices used to control runoff are critical in determining what the effects on the peatland will be. Sewage treatment effluent is another source of nutrients associated with housing development and has been a source of concern at Beaver Lake South.

Agricultural runoff. Because they occur in mountainous terrain, Panhandle peatlands are generally not threatened by runoff from agricultural fields. However, at Hauser Lake Fen deposition of sediment from an upstream feedlot is the likely cause of progressive die-back of the sphagnum mat and loss of two peatland species (Björk, pers. comm.), and at Hoodoo Lake cattle once grazed around the peatland, occupying the lake bed itself in dry years.

Deforestation. Many of the effects of deforestation on streams and wetlands are the same, whether the cause is wildfire or timber harvest. Disregarding for the moment the effects of logging roads, these two disturbances–one natural and the other not–can pragmatically be discussed together, especially because timber harvest is often accompanied by broadcast burning. It is well accepted that both timber harvest and wildfire are accompanied by a loss of nutrients from a site through leaching and soil erosion (Feller and Kimmins 1984, National Research Council 1986, Clark 1994). Removal of forest cover can result in increased watershed erosion, disrupting mineral and nutrient balances and increasing suspended sediments in aquatic systems (Schindler et al. 1980, Bayley et al. 1992). Wildfire, and broadcast burning following timber harvest, can represent major nutrient inputs to streams and wetlands (Clark 1994). Excessive nutrient loading can result in eutrophication and alter the flora of a site. The effect of deforestation on water chemistry of a peatland will be determined by a variety of site factors and management variables including:

- Size of disturbed area
- Volume of water associated with the peatland
- Steepness of terrain
- Fire intensity
- Frequency of disturbance
- Intensity of runoff events following disturbance
- Distance of disturbance from the peatland
- Logging practices (including stream buffers)

A great deal of research has been dedicated to determining the effects of deforestation on the water quality of streams and lakes, mostly with respect to fish habitat.

Most of the research looking at the effects of deforestation on aquatic systems has measured nutrient input to streams rather than the receiving wetlands or water bodies. Bayley et al. (1992) saw nitrogen forms increase in streams following fire. After high-intensity fire, concentrations of elemental nitrogen and nitrate remained elevated for 6 years after the first fire, and for 9 years after the second fire. After a lower intensity fire, only nitrate increased. Jewett et al. (1995), working in New Brunswick, considered post-harvest effects on stream discharge and streamwater chemistry to be short-term–increases were insignificant after about 5 years.[2] Feller and Kimmins (1984) found increased concentrations and fluxes of potassium and nitrate for 2-3 years following partial clearcutting of two small watersheds in southwestern British Columbia. In a watershed in northern Idaho, clearcutting and burning slash altered the quality of stream water, but nitrate did not change significantly and phosphorus was not measured (Snyder et al. 1975). With respect to regulated logging, including recent practices to protect fish habitat (USDA Forest Service 1995), elevated nutrient levels in streams following logging may not be significant and are probably short-lived (Feller and Kimmins 1984). However, sediment and nutrients accumulate and concentrate in wetlands, including peatlands (Forman and Alexander 1998, Keddy 2000). Streams are not the only source of increased nutrient input following deforestation. Subsurface flow and sheet and gully erosion are additional sources.

Effects of nutrient inputs to lakes appear to be more pronounced than to streams. Moderate and intensive levels of timber harvest produced increases in total nitrogen and potassium of 10 to 25 percent in three, 30-ha (75-ac) Canadian shield lakes (Steedman 2000). This magnitude of increase was thought unimportant to lake phytoplankton, but represents enormous inputs considering the size of these lakes. Schindler et al. (1980) observed significant increases in the annual yield of nitrogen following a large blowdown, and further increases after a subsequent fire. In the year after the burn, nitrate-N increased 3.4 and 9 times relative to pre-impact.

Deforestation has affected peatlands and peatland watersheds worldwide, but we were unable to find documented changes to peatlands or wetlands resulting specifically from watershed deforestation, although the importance of water chemistry and hydrology are well documented. Bursik and Moseley (1992b) attributed the loss of thirteen species from Huff Lake Fen to forest fires and logging because they were prominent disturbances during the time period in question. Their research involved pollen analysis of peat cores. This type of painstaking, expensive research is probably necessary to elucidate long-term change in these systems. The cause of changes observed is necessarily speculative. Effects of soil disturbance in the watershed might be detected, as in this case, by the elimination of sensitive species or by a more obvious change such as an increase in exotic or large, rhizomatous species. Also, the response of vegetation may not be linear–changes may be subtle up to some threshold level at which irreversible change takes place.

Forestry practices have a large impact on sedimentation and nutrient runoff. In one study, commercial clearcuts yielded turbidity values between 10 and 100 times larger than cuts conducted to protect water values (Lee 1980). The logging system, equipment, and post harvest treatment used can greatly reduce the amount of ground/vegetation disturbance. Clearcutting methods of timber harvest have high potential for altering peatland ecology by increasing sedimentation (Keddy 2000). However, the most important factor determining the potential for

[2] Most of the research on stream chemistry is related to fish habitat and in interpreting results may not consider cumulative effects to wetlands or water bodies.

sedimentation and/or eutrophication due to timber harvest is the extent of access roads (National Research Council 1986, Forman and Alexander 1998).

Roads are major sources of sediment because they expose soil to erosion, intercept subsurface flow, impede infiltration, and occasionally result in mass wasting (National Research Council 1986, Belt et al. 1992, Forman and Alexander 1998). Some of the soil eroded from roads, ditches, and cutbanks is funneled to streams and eventually flushed into ponds, lakes, or wetlands where it can disrupt aquatic ecosystems. Roads are the primary source of erosion and sediment yield related to logging operations.

Site Design

Each peatland site has boundaries that were delineated to include all peatland habitat, lake and pond, adjacent marsh and other wetland habitats, and upland buffers (Bursik and Moseley 1995, Appendix 1). Adequate upland buffer zones are critical to the maintenance of species and community diversity in these sites. The actual size of the upland buffer zone varies depending on slope, aspect, and vegetation but generally extends 200 m (660 ft) from the wetland/water margin into the adjacent upland. Boundaries were not surveyed; they were drawn on a 7.5-minute USGS quad during or after a field visit.

When designing the sites, Bursik and Moseley used the 200-meter buffer as a general guide that could be applied to all sites, and recommended that this buffer extend along the entire reach of inlet streams to protect incoming water quality. The size of this buffer was based on the high conservation value of these sites and possible offsite threats from activities that could not always be predicted.

In relation to biodiversity conservation, a buffer zone is an undisturbed area or area of compatible use, surrounding a reserve, with the purpose of minimizing edge effects (Noss and Harris 1986). The most appropriate size for the buffer zone is a difficult question. Among other things, it depends on the conservation target, predicted threats, and the scale of disturbance processes. For example, a buffer zone of 30 to more than 240 m is required to protect internal forest conditions from edge effects (Chen et al. 1995). In other cases, a buffer zone might consist of a surrounding undeveloped zone in which natural disturbances could be allowed to operate. It is now widely recognized that the most effective way of conserving biodiversity is often by utilizing large reserves that encompass interacting ecological features and in which natural disturbances and compatible uses can operate (Baker 1992, Baydack et al. 1999, Dale et al. 2000).

A related function of upland buffers is to protect water quality. With regard to stream and wetland protection, buffer strips or filter strips are bands of undisturbed vegetation bordering the stream, wetland, or water body that serve to promote infiltration and deposition of suspended solids in overland flow (Lacey 2000). They protect the aquatic system from sediment-laden runoff from upslope roads, skid tracks, and other erodible surfaces. However, buffer strips do not provide protection from sediment delivery via channelized flow or gully erosion. Other functions of buffer strips include (Belt et al. 1992, Voller 1998):

- Providing large organic debris that creates fish habitat
- Providing fine organic matter that supports invertebrates
- Maintaining stream temperatures
- Providing cover for wildlife
- Stabilizing banks

The width of the buffer required to filter overland flow has been the subject of much research which was thoroughly reviewed by Belt et al. (1992). It is dependent on steepness of slopes; extent and proximity of disturbance; soil and vegetation of the buffer; and the amount of acceptable risk, which is related to the value of the resource being protected. Where the highest possible water quality standard is to be maintained, buffer strips as wide as 100 m (330 ft) have been recommended for 70% slopes (Belt et al. 1992). It is important to note that such buffers are not effective in controlling channelized flows originating outside the buffer. In rare instances these can move sediment thousands of feet (Belt et al. 1992).

In summary, the 200-m upland buffer was used as a general guide for designing peatland conservation sites, and while it serves more than adequately as a filter for overland flow, it probably is inadequate for keeping certain disturbances such as roads, agriculture, or mining far enough from the peatland and does not protect it from channelized flow resulting from these and other disturbances. It may be adequate if these activities utilize practices that reduce or retain sediment yield.

The 200-m buffer also does not adequately define a reserve or protected area which should include good representation of both upland and wetland communities, and be large enough for natural processes to operate. The 45 significant peatland sites are essentially reserves and proposed reserves. Class I sites in public ownership, that do not already have Research Natural Area (RNA) status, were nominated as RNAs in the 1995 Strategy. RNA is a Forest Service management designation for lands set aside to represent specific community types and managed for biodiversity, research, and education.

The appropriate size for buffers around a peatland and along its inlet and outlet streams should be determined as part of an overall watershed plan. The design should consider the types of management planned, extent and duration of disturbance, and connectivity of the site with other aquatic features. The main catchment basin of the peatland should be managed for maximum protection of water quality. Compatible uses would not include extensive roading, building roads across steep slopes, mining, or other activities that produce large amounts of sediment or jeopardize slope or bank stability.

Site Feature Evaluation

All 45 peatland sites addressed in this strategy are important for the maintenance of a diverse peatland ecosystem in northern Idaho. The sites were classified by Bursik and Moseley (1995) into two protection classes on the basis of the number of rare plant species (Table 3), the richness of ecological features (Table 4), and the degree to which they have been modified by human use (site condition). Class I sites are those that qualify for RNA status based on their ecological and floristic diversity. Nine peatlands meet biodiversity and condition criteria to qualify them as Class I sites.

Several peatlands stand out as having the greatest ecological diversity. Chase Lake contains all 12 of the ecological features discussed previously (Table 4). It contains the most extensive floating mats known in the region and the largest bog microsites in the state. In addition, extensive poor, intermediate, and rich fen communities occur around beaver ponds upstream along the inlets and downstream along Chase Creek. Potholes RNA and Kaniksu Marsh RNA contain 10 of the twelve ecological features. Both of these sites lack bog microsites and lake habitats, although each contains a large pond. Rose Lake also has 10 features, lacking only bog habitat and paludified forest. Mosquito Bay Fen also supports 10 features, lacking a floating mat and beaver activity. These five 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 most rare plant populations (Table 3).

Current Protection

Five Class I sites had already been protected as Research Natural Areas prior to the 1995 Strategy: Smith Creek RNA, Bottle Lake RNA, Three Ponds RNA, Potholes RNA, and Kaniksu Marsh RNA (Table 5). The RNA designation used by federal agencies, including the Forest Service and BLM, is an ideal protection vehicle for relatively small, unique habitats such as Panhandle peatlands. These peatland RNAs include most of the ecological and floristic diversity known in northern Idaho peatlands. Several features, however, are not well-represented, including bog microsites (absent from the five sites), paludified forest (poorly represented), and *Typha latifolia/Carex lasiocarpa* rich fen found on floating mats (absent from these sites, despite all supporting a rich fen).

Table 5. Summary of sites with protected status.

Site	RNA	SIA	WMA	Conservation easement
Bismark Meadows				X
Bottle Lake	X			
Gamlin Lake			X (in part)	
Hager Lake				X
Hidden Lake			X (in part)	
Kaniksu Marsh	X			
McArthur Lake			X	
Potholes	X			
Rose Lake			X (in part)	
Smith Creek	X			
Thompson Lake			X	
Three Ponds	X			

Another Forest Service designation, for which all peatland sites on National Forest lands qualify, is that of Special Interest Area (SIA). The Special Interest Area (SIA) is a Forest Service designation that recognizes special botanical, zoological, or geologic features, protects them without eliminating many management options, and encourages public education. It is a less restrictive land use designation than a RNA.

Several sites, including Rose Lake, Hidden Lake, Thompson Lake, and McArthur Lake WMA, are wholly or partially managed by the Idaho Department of Fish and Game as Wildlife Management Areas, where they are largely protected from inappropriate development activities. Most of the peatlands around Gamlin Lake are being protected by the BLM. The Inland Northwest Land Trust holds a conservation easement on the main tract at Hager Lake Fen. The Forest Service manages a small, but important tract, while the third tract is privately owned. Upper Priest Lake Fen is protected as part of the Upper Priest Lake Scenic Area by the Forest

Service and Idaho Department of Lands. One of the two private owners of Rose Fen is voluntarily protecting part of this important site in the Kootenai River valley.

Two sites have been placed in conservation easements by the primary owners: Hager Lake Fen and Bismark Meadows. Drained portions of Bismark Meadows are now being restored under the Wetlands Reserve Program (WRP) administered by the EPA. Forest Service parcels around Bismark Meadows are the most natural.

Protection Recommendations and Opportunities

Today there are more protection vehicles available than there were at the writing of the original strategy. At that time, The Nature Conservancy (TNC) was the only private group pursuing conservation through land purchase. Today, the Inland Northwest Land Trust, operating out of Spokane, Washington has assumed at least one of TNC's easements (Hager Lake) and has other projects underway in the Panhandle. At least one other land trust, the Clark Fork–Pend Oreille Conservancy, is active in the region. The Confederated Kootenai Tribes has purchased land at Perkins Lake and the Kalispel Tribe at Gamlin Lake, in both cases for wildlife habitat. The BLM has also purchased a portion of Gamlin Lake for wildlife habitat and recreational opportunities. The National Park Service's National Natural Landmarks (NNL) program is beginning to evaluate peatlands as a possible natural history classification theme for the Northern Rocky Mountain region.

Class I sites

In addition to those Class I sites already established as RNAs, three other peatland sites merit the maximum protection available: Mosquito Bay Fen, Rose Lake, and Chase Lake. The requirement for the RNA-eligible habitats being "pristine" or largely unaltered by humans (Federal Committee on Ecological Reserves 1977) is met at these sites because the minor attempts to ditch and drain these peatlands failed. Assuring the long-term protection of these important sites would result in representation of most of the known Panhandle peatland habitat and floristic diversity within a protected-areas system. Perkins Lake contains additional unique communities, but has been significantly altered by a county road and public boat dock, and is no longer considered a candidate for RNA designation. Protection for this important site could be conferred by designation as a SIA. There is an angler dock that, while it was built through a floating mat, now protects the rest of the mat from trampling. An interpretive sign has also been installed.

All three of the recommended RNAs are only partially publicly-owned, and Chase Lake has no federal land to make it eligible for RNA protection. Because of the mixed ownership, which includes significant private land, these three sites are the highest priorities for land acquisition, land exchange, wetland restoration, and conservation easement programs.

Mosquito Bay Fen should be the highest land acquisition priority of any privately owned peatland in Idaho. Only about ten percent of the nearly 50 ha (120 ac) of peatland habitat is under Forest Service management. This land is incorporated into the Upper Priest Lake Scenic Area, which is protected in an agreement between the USFS and Idaho Department of Lands. Two private parties own most of Mosquito Bay Fen. RNA designation could proceed following acquisition.

Fen habitats along Rose Creek on the southwestern side of Rose Lake are managed by the Forest Service and the Idaho Department of Fish and Game as part of the Coeur d'Alene River Wildlife Management Area. Large tracts of peatland habitat on the east, west, and north sides of the lake and further upstream along Rose Creek are privately owned. If acquired, these could be incorporated into the wildlife management area. The peatland areas on Forest Service land surrounding Rose Lake could then be designated a RNA.

The largest portion of Chase Lake is on land managed by the Idaho Department of Lands. The Nature Conservancy or other conservation group should approach the department regarding the cost of safeguarding this diverse site. The Department of Lands' mandate is to maximize return to the public school endowment, regardless of the source. This can be done with conservation money as well as from resource extraction. In addition, land protection efforts of the Conservancy, BLM, and Forest Service should focus on the south end and northwestern corner of the lake, which are currently under private ownership.

During the process of establishing a RNA or SIA, site boundaries should be reviewed and natural features such as ridgetops used as much as possible to define the site. The primary catchment basin should be included if at all possible. The types of management activities allowed in upland portions of the site would be specified in the establishment record. Linking of nearby wetlands should also be considered.

Class II Sites

The remaining 36 peatlands are all Class II sites and should be afforded some level of protection, if none currently exists. All Class II peatland sites on National Forest lands qualify for the SIA designation. Cow Creek Meadows has been nominated as a Special Interest Botanical Area (Bursik 1993), but has not yet been established as such. Huff Lake Fen has been developed as a SIA, but has not yet been established. Informal recognition of a site as a SIA or interpretive area is not sufficient to protect it. Long-term maintenance and management of the site requires that it be surveyed, documented, authorized at the National level, and incorporated into the Forest Plan.

In 1996, Steve Rust, RNA program coordinator for the IDCDC, met with IPNF botanist, Mark Mousseaux, and prioritized for conservation efforts those sites with significant Forest Service management. Priority was based primarily on biodiversity value. Their recommendations were recorded in the site records (Appendix 1) and are summarized in Table 6. High priority sites would receive funding priority for site visits, monitoring, and implementing management and protection needs.

Table 6. Prioritization of National Forest sites for protection efforts.

High priority	**Priority**	**Low priority**
Armstrong Meadows	Cow Creek Meadows	Bismark Meadows
Bog Creek Fen	Sinclair Lake	Dubius Creek Fen
Grass Creek Meadows		Hager Lake Fen
Huff Lake		Hoodoo Lake
Packer Meadows		Kelso Lake
		Lamb Creek Meadows
		Lost Lake
		Perkins Lake
		Robinson Lake
		Rose Lake

Unclassified Sites

Peatland communities and organic soils are expressed to varying degrees throughout the Idaho Panhandle. Small peatlands in depressions, ponds, or floodplains are also important to biodiversity, but offer a special challenge in finding and protecting them. Floodplain and flow-through peatlands along streamcourses can occur as a mosaic with mineral soils. Small sites are an important component of biodiversity, especially if linked hydrologically to nearby wetlands. If peat "pockets" near a significant site could be incorporated into a single preserve design, it would greatly enhance the site.

A small wetland has little capacity to buffer increased inputs of sediment and nutrients. If a peatland guild is identified in a proposed activity area, we recommend the site be protected from direct disturbance and well-buffered from off-site disturbance. Inland Native Fish Strategy (INFS) standards can be used to determine buffer width, with the width increased where there is greater potential for soil loss (steep slopes, more erodible soils, etc.). Protection of input streams is of equal importance.

Management Considerations and Opportunities

The original strategy encouraged a hands-off approach to conservation, and this remains central to our approach to these unique sites. Although natural disturbance has featured highly in the history of many of these sites, these processes often operate within long time frames and are difficult to emulate. Regarding reserve design, the conservation literature strongly supports designation of large areas in which compatible uses and natural processes can be allowed to operate (Baker 1992, Baydack et al. 1999, Dale et al. 2000). In their current form, the sites alone are not adequate to constitute a preserve, and the proper management of the main watershed of each will be integral to their protection.

With regard to peatlands, compatible uses are those that can occur in such a way as to protect water quality and not affect hydrology. This includes a limited amount of timber harvest and management, with the most important consideration being the extent and siting of access roads. Basins with high fuel build up could benefit from prescribed fire that maintains a natural range of stand structure. Compatible uses can also include recreation such as boating or fishing if access for those activities can be controlled through the construction of docks and/or boardwalks.

Management needs must be evaluated on a site-specific basis. Each site has been given a management urgency rank, 1-5, with 1 being the most urgent (Appendix 1). Justification of the rank is contained in the management urgency comments. Following are some examples of management needs that have been indicated at some sites within the study area and elsewhere.

Water level manipulation

At peatlands where water is impounded by dams or weirs, there may be some capacity to manipulate water levels to create habitat diversity or emulate a season pattern. At McArthur Lake WMA, Idaho Department of Fish and Game has implemented a variable hydrological regime that emulates seasonal water level fluctuations and beaver activity. Monitoring the effect of this management on peatland communities, plants of conservation concern, and water chemistry would allow adaptive management at that site and help determine whether it could be used at other pond/lake sites with impoundments (Robinson Lake, Twin Lakes Fen, Hauser Lake Fen). Cooperation between the Forest Service and IDFG will be critical in obtaining this information.

Overstory removal

Tree invasion has been noted at Grass Creek Meadows and Bog Creek Fen. However, afforestation is not currently considered a serious threat to Panhandle peatlands and the physical disturbance caused by tree removal could allow weed invasion. If tree removal is considered at a specific site to protect a plant population or rare subguild such as poor fen, we recommend documenting the justification for this management and gathering vegetation data needed to monitor its effects. We also recommend that all of the downed trees be left on site.

Fuels reduction

Because of the potentially deleterious effects of stand-replacing fire on water quality, carefully conceived burns might be used to protect peatlands from catastrophic wildfires. Prescribed fire could be used to control excessive fuel build-up, while maintaining a natural range of forest structure within a watershed.

Weed control

Weed control is probably the most oft-cited management need, although exotics within the peatland itself have only been documented at a few sites. There is a need to reassess the weed situation at these sites. Chemical control of weeds in wetlands is difficult. A biocontrol insect has been used on *Lythrum salicaria* (purple loosestrife) at Rose Lake and Thompson Lake. It is very important that weed control efforts around peatlands be carried out selectively and that the results be documented and shared among land managers.

Site Ownership/Management

Land ownership of peatland sites is a critical factor in designing and implementing a conservation strategy, and the objectives of the particular land management agency are almost as important as public vs. private ownership. Idaho Department of Fish and Game (IDFG), Idaho Department of Lands (IDL), and the Tribes have fairly specific mandates and/or management objectives that are not necessarily compatible with rare plants and communities. Proponents of biodiversity protection within the Forest Service, IDCD, and the public can fill an important role simply by informing land managers about the significance of peatland sites and the specific biological elements of concern.

Probably the most important distinction between private and public ownership is that federally managed wetlands are protected from drainage and development, whereas private lands are not. Federal land-management agencies such as the Forest Service and BLM have management designations such as RNA, SIA, and ACEC (Area of Critical Environmental Concern) for lands set aside for research, conservation, or education, whereas state agencies within Idaho do not. Federal agency observance of the Clean Water Act and their own regulations to protect fish habitat (USDA Forest Service 1995), mean that wetlands will be afforded a high degree of protection from land management activities. Unfortunately, it does not necessarily protect them from the effects of grazing.

A summary of land ownership and management of the 45 peatland sites is shown in Table 1 and summarized in Table 7. Twenty-six sites involve some degree of private ownership, and six are entirely private. Two sites in mostly private ownership–Hager Lake Fen and Bismark Meadows–are in conservation easements. Each of the private sites represents a unique opportunity/challenge for conservation options. Occasionally there may be opportunities for landowners to sell or trade lands to public agencies or conservation groups. However, the most common way landowners reap financial benefit from protecting wetlands is through conservation easements. The benefits of conservation easements for Panhandle peatlands could be great because so many sites involve private ownership.

TNC of Idaho has facilitated the transfer of some private holdings in peatland sites to the BLM and Tribes. At Perkins Lake, formerly private holdings of lakefront and upland are now owned by the Kootenai Tribe which manages them for wildlife habitat. At Gamlin Lake, 50 acres of private holdings have been transferred to the BLM and 160 acres to the Kalispel Tribe, and most of Beaver Lake South is now owned by the Kalispel Tribe.

Table 7. Summary of ownership and management of 45 peatland conservation sites.

Ownership	Managing agency	Number of sites
Public	USFS only	17
Mixed	USFS in part	12
Mixed	Idaho Fish and Game + private	4
Mixed	Idaho Dept. of Lands + other	5
Mixed	BLM + other	2
Private		6

Public Education

> *"It is doubtful that a person exists who is not captivated by the carnivorous adaptations of sundews and bladderworts to the nutrient-poor environs of peatlands, or who has not been shocked at the quaking underfoot when traversing a floating mat for the first time. In the past, knowledge of the whereabouts of Panhandle peatlands and their intriguing constituents have been restricted to locals who forage for cranberries in the fall, a few adventuresome fishermen, and a handful of biologists, teachers, and their students. If we can make the public aware of the incredible aesthetic, recreational, and pragmatic values of peatlands as habitat for numerous unique and unusual organisms, as sites of landscape monitoring, as archives of landscape history, and as carbon sinks in the battle against global warming, we will achieve public support for their long-term protection."*
> Bursik and Moseley (1995)

Privately owned peatlands and those around popular recreation lakes require special attention with respect to public education. Lake associations should be informed of the sensitive nature of the peatland habitats on their lakes. These associations, comprised of lakefront homeowners, are generally very concerned about maintaining water quality and preserving pristine habitats around their lakes. Educating residents about the potential detrimental effects that sewage, fertilization, and ground disturbance within the buffer zones have on peatlands would be an important role for local conservation groups.

Thanks to the comprehensive nature of the peatland inventory in the Panhandle region, we can select certain representative easy-to-get-to sites among the peatland SIAs to expose and educate the public without resulting in significant resource damage. Interpretive facilities are generally not compatible with RNA objectives and should be discouraged from established or potential RNAs, except under special circumstances, such as at Perkins Lake and Rose Lake Fen, where roads and boat docks already provide reasonable access to peatland communities.

At Huff Lake Fen, on the Priest Lake Ranger District, a viewing platform was constructed as recommended in the original Conservation Strategy, and a first-rate interpretive display explains the ecology of the fen and asks visitors to remain on the walkway. Another site on the Priest Lake Ranger District has great interpretive potential–Dubius Creek Fen is located just east of Highway 57, approximately half-way between Priest River and Priest Lake. The extensive nature of peatland communities coupled with easy access make this another excellent candidate for a visitor center and interpretive walkways. Other easily accessible sites with interpretive potential include Sinclair Lake and Perkins Lake on the Bonners Ferry Ranger District. Perkins Lake has an extensive floating dock for angler access that was built through the floating mat in the late 1980's. There is also an interpretive sign at the dock. A well-maintained road skirts the edge of the lake and fen communities, offering access to a considerable amount of habitat for similar purposes. Sinclair Lake also has an angler dock and excellent access to fen communities surrounding the lake where a wooden plank walkway could be constructed.

An Idaho Fish and Game boat launch at Rose Lake provides a staging and parking area for an interpretive walkway that could extend into the fen communities along the east side of the lake, if this area were acquired by a public agency or conservation group. Upper Priest Lake Fen occurs along a portion of the Idaho Centennial Hiking Trail. A boardwalk system through the extensive fen and paludified forest communities could provide a peatland wilderness experience for hikers enjoying the state's natural heritage.

Peatlands are important for wildlife of all types. At least two Panhandle peatlands (Dawson Lake and McArthur Lake WMA) are part of the state's Watchable Wildlife Program, complete with wildlife viewing areas. A trail system has been constructed on BLM land at Gamlin Lake, that routes visitors around the wetland and enhances wildlife viewing. Coordination of the development of interpretive walkways in Panhandle peatlands could be done through the Watchable Wildlife Program. Forest Service, BLM, and IDFG botanists and wildlife biologists can work together in design and placement of trails, and in development of interpretive programs appropriate for each site. Education of Lake Associations could also be done through the Watchable Wildlife Program.

Inventory, Monitoring, and Research Needs

Inventory

Although it is likely that additional significant sites will be discovered, we believe that after two decades of inventory the most important peatland sites in the Panhandle are included in this conservation strategy. Inventory of the peatland habitats themselves is considered largely complete in the Idaho Panhandle region. When new sites are discovered they should be documented and added to the Conservation Site Database maintained by the IDCDC. Anyone using this strategy should be aware that new sites may have been documented since this writing. Also, numerous sites exist that were considered too small or too altered to include among the 45 sites listed here, but nonetheless represent important habitat.

Biotic inventory in Panhandle peatlands has focused almost exclusively on the vascular flora (Bursik 1990, Bursik and Henderson 1995) and, to a lesser extent, on bryophytes (Bursik and Henderson 1995) and aquatic invertebrates (Rabe and Savage 1977, Rabe et al. 1986). Inventory work is still needed on terrestrial vertebrate and invertebrate fauna, fungi, and bryophytes of Panhandle peatlands. Scattered trapping of small mammals has revealed the presence of disjunct populations of bog lemmings in at least one Panhandle peatland (Groves and Yensen 1989). With further inventory, similar finds are likely among the lesser known portions of the peatland biota.

Floristic inventory is incomplete or incompletely documented at a number of sites. For example, certain species are currently on the Forest Service sensitive list that were not on the list at the time they were noted, and therefore no IDCDC record exists for certain sites. Information needs are noted in the site record (Appendix 1). Revisits to any of the sites are also important because global positioning systems (GPS) now allow us to more accurately map plant populations, and new threats may become evident. Even unsuccessful attempts to locate a population of a species of concern may yield important information and can be entered in the element occurrence record (EOR). Repeat visits to Hauser Lake indicate that two species, *Juncus bolanderi* (Bolander's rush) and *Lycopodiella inundata*, may have been extirpated.

Monitoring

The establishment of long-term studies, including monitoring programs, has been recommended for a variety of ecological systems (Leopold 1962, Likens 1983). Through carefully designed monitoring studies we can begin to understand the magnitude and direction of change in dynamic landscapes and alter human activities and management paradigms appropriately (Noss 1990, Mueggler 1992). Reanalysis of early studies of Panhandle peatlands (Rumely 1956, Karg 1973) has revealed a disturbing level of change that is likely attributed directly or indirectly to human activities (Bursik and Moseley 1992a, 1992b, Bursik et al. 1994). We recommend that monitoring of plant communities, aquatic invertebrates, and water chemistries at peatland sites begin as soon as possible, with RNAs given priority.

Data on surface water quality and invertebrate populations have been collected at a number of sites and could be used as a baseline for monitoring. Fred Rabe, professor emeritus, University of Idaho, has studied invertebrate populations for many years (Rabe and Savage 1977, Rabe et al. 1986, Rabe and Chadde 1994). The volumes of data amassed by Dr. Rabe from Panhandle peatlands over the past several decades should be cataloged and organized for future use in monitoring and research.

Periodic reanalysis of water chemistry, flora, and vegetation along permanent transects and within permanent plots established at Cow Creek Meadows, Grass Creek Meadows, Smith Creek RNA, Hager Lake Fen, and Huff Lake Fen should be continued. Since the 1995 strategy, monitoring has been limited to Cow Creek Meadows and Grass Creek Meadows because of grazing issues at those sites.

Monitoring plots at Cow Creek Meadows and Grass Creek Meadows will be important to detecting change, but their value for determining the effects of grazing is limited because the baseline data represent over 60 years of cattle grazing. Finding separate control sites would also be difficult because there are only four significant subalpine peatlands in the Panhandle.

As in the 1995 strategy, we recommend placing at least two permanent plots in all Class I peatlands for monitoring vegetation. For plant community-scale monitoring we recommend following the protocol developed for peatland community monitoring in the Sawtooth Valley (Moseley et al. 1994; Appendix 3).

Routine vegetation and water chemistry monitoring is also recommended for peatlands where ground-disturbing management activities such as grazing or timber harvest occur within or immediately adjacent to site boundaries. Results of monitoring should be used to adjust management practices.

Where funding is not available for more intensive monitoring, valuable information can be gained from periodic site visits. In the time since Bursik and Moseley did the bulk of their work, global positioning systems have greatly increased our precision in mapping plant populations and the ease with which accurate data can be collected and entered. The result is that rare plant sighting forms can now be more accurately used as a monitoring method. Observations of *Carex comosa* at Perkins Lake indicated that one population is repeatedly mowed. Follow-up visits will help determine the effect of this disturbance. The location of weed infestations at a site can be documented and monitored over time as well. Data of these types, collected from peatland sites in this region, provide the best basis for decisions about management and protection needs for peatlands. Through Forest Service and IDCDC cooperation in collecting and storing data, we have begun to build an invaluable information source for basing management decisions.

The IDCDC's Conservation Site Database is an important way to track sites with regard to land ownership changes, threats, conservation status, and other important variables. Following a site visit, notes on observed threats, changes in ownership status, or general observations can be sent to the IDCDC and used to update the relational database, which is linked to the element occurrence and reference databases.

Plant taxa of conservation concern

The IPNF maintains a list of Sensitive Species and Species of Concern. Those that are part of the aquatic and peatland guilds are listed in Table 2, and a fact sheet for each can be found in Appendix 2. Because these taxa must be addressed in Forest planning, it is important that the list accurately reflect the conservation status of the taxa listed.

For some of the taxa reviewed for this strategy there is little information or conflicting information. Some, such as *Meesia longiseta* and *Nymphaea leibergii*, have only historical records in the Panhandle. For others there is a need to review the specimens upon which the species identity or distribution is based. The following recommendations grew out of research we conducted for this strategy.

- Idaho specimens of *Drosera intermedia* have only tentatively been identified and require verification by an expert. The University of British Columbia Herbarium could also be contacted to inquire about current referral of their specimens.

- We recommend that *Carex lacustris* (lakeshore sedge) be added to the IPNF list of Species of Concern. It occurs near, although not on, National Forest lands at McArthur Lake and Kelso Lake. The IDCDC tracks it as an S1 species.

- We recommend that *Muhlenbergia glomerata* be added to the Forest Service Sensitive Species list and placed in the peatland guild, intermediate fen subguild. Specimens were collected at Sema Meadows in 2003, and the species is tracked by the Washington Natural Heritage Program. This species is treated in Appendix 2.

- We recommend *Muhlenbergia racemosa* be removed from the peatland guild. It's placement on the Region 1 Sensitive Species list should also be reevaluated. This species is not tracked by the IDCDC and is not considered a peatland species.

- We recommend that the aquatic plant *Vallisneria americana* (tapegrass) be added to the IPNF list of Species of Concern and to the aquatic guild. It occurs at Twin Lakes Fen and Thompson Lake. It is tracked by the IDCDC as S1.

Several taxa in the peatland guild are not obligate peatland species, but have been placed there because they sometimes occur in peatlands or have been found on the margins of peatlands. However, they should not be considered peatland indicators. These include *Epipactis gigantea*, *Cypripedium parviflorum* var. *pubescens,* and *Maianthemum dilatatum,* which can occur in peatlands, and *Diphasiastrum sitchense* and *Lobaria hallii*, which have only been found on the margins of peatlands. *Maianthemum dilatatum* is common in upland habitats on the west side of the Cascades and could therefore occur in uplands in this region as well. *Lobaria hallii* is a lichen that occurs on the bark of riparian trees and shrubs in moist or riparian areas.

Research

Hager Lake Fen is the best-studied of the Panhandle peatlands. It has been the subject of several paleoecological studies, some of which are still in progress (Hansen 1939, Rumely 1956, Mack et al. 1978, Bursik et al. 1994). Rumely (1956) conducted a detailed vegetational study of Hager Lake Fen, which was later used to ascertain 40-year vegetational 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). Peat cores extracted from Huff Lake Fen in 1992 have yet to be analyzed, and could provide further insight into successional processes and long-term change. Vegetation and floristic monitoring studies have also been initiated at Cow Creek Meadows and Smith Creek RNA to ascertain the effects of cattle grazing on fen communities and rare plant populations (Bursik 1993).

Further synecological research on peatland communities and autecological studies of peatland species (particularly those considered rare) should be encouraged among graduate students and researchers at regional universities. Studies of the relationship of rare species to disturbance and habitat variables are particularly desired by Forest Service managers. Other areas of research interest include peatland habitat values and uses for wildlife, terrestrial vertebrate and invertebrate population dynamics in peatlands, plant dispersal mechanisms via wildlife, gradients responsible for plant distribution within peatlands, population genetics of rare peatland species, the history of paludified forests in the region, and the role of beaver in successional dynamics within Panhandle peatlands.

Individuals Contacted about this Conservation Strategy

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