OP Open Rich Peatland System

photo by F.S. Harris MN DNR

Ottertail County, MN

General Description

Open Rich Peatland (OP) communities are graminoid- or low-shrub-dominated wetlands on actively forming deep (> 16in [40cm]) peat. The dominant graminoids most often are fine-leaved sedges *(Carex* spp.); shrubs, when present, typically include ericaceous species such as leatherleaf *(Chamaedaphne calyculata)* and bog rosemary *(Andromeda glaucophylla)* along with bog birch *(Betula pumila)*. Mosses are common in OP communities, particularly brown mosses in wet hollows. OP communities are widespread in the Laurentian Mixed Forest Province, where a cool climate, abundant precipitation, and the presence of poorly drained basins and glacial lake plains provide suitable conditions for peat development. OP communities also occur throughout much of the Eastern Broadleaf Forest (EBF) Province and into the Prairie Parkland (PPA) and Tallgrass Aspen Parklands (TAP) provinces. In the EBF, PPA, and TAP provinces, OP communities are near the southern and western limits of the range of peatland development in Minnesota and are generally confined to floating mats or settings where groundwater discharge is sufficient to offset higher rates of evapotranspiration caused by warmer temperatures.

Peat Characteristics and Hydrology

(For a discussion of general peatland formation in Minnesota, see Peatland Formation under the Forested Rich Peatland System on page EBF-FP1.) The peat in OP communities is moderately decomposed (hemic) and formed predominantly from graminoids and brown mosses. OP communities occur in peatland settings influenced by inputs of groundwater. Concentrations of minerals such as calcium are often abundant in groundwater that has percolated through till and can reach very high levels in areas with calcareous till deposits. Therefore, OP communities often have high concentrations of minerals (and high species diversity) in comparison with Acid Peatland (AP) communities. OP communities, however, are not rich in nutrients, especially nitrogen and phosphorus.

The water inputs to OP communities come primarily from regional or local groundwater. These supplies are steady and maintain fairly constant water levels near the peat surface, in contrast to Forested Rich Peatland (FP) and Wet Meadow/Carr (WM) communities, in which the peat surface is not continuously saturated. The continuous

saturation of peat substrates in OP communities creates anaerobic conditions that prevent establishment of trees and tall shrubs. As a result, OP communities lack the shaded habitats and shade-tolerant plant species characteristic in the understories of FP communities. OP communities have much smaller seasonal water-level oscillations than WM communities, providing conditions more favorable for formation and accumulation of peat. WM communities can be present on relatively deep sedimentary peat deposits or on deep peat on sites previously occupied by peat-forming communities. Differences in species composition and vegetation, however, distinguish OP and WM communities even when deep peat is present in WM communities. OP communities (with the exception of Northern Shrub Shore Fens [OPn81]) are usually dominated by fine-leaved graminoids, mosses, or ericaceous shrubs such as leatherleaf, while WM communities are dominated by broad-leaved graminoids, lack significant moss cover, and lack ericaceous shrubs.

Plant Adaptations

The plants characteristic of OP communities are adapted to full sunlight, sustained water levels, low nutrient levels, and high mineral levels. This environment is well suited to dominance by sun-loving herbaceous species, brown mosses, and minerotrophic *Sphagnum* species. The lack of shade from trees and shrubs favors dominance in the ground layer by shade-intolerant species, especially graminoids (in comparison with FP communities, which have more abundant forbs and shrubs in the understory). Like many wetland plants, the characteristic species in OP communities, such as sedges *(Carex* spp.) and buckbean *(Menyanthes trifoliata)*, have stems, leaves, and roots with intercellular air spaces (aerenchyma) that store oxygen and transport it from above-water structures to roots during waterlogged periods. Other plants, such as bog birch, grow on aerated hummocks, or in the case of species such as tufted bulrush *(Scirpus cespitosus)*, sterile sedge *(Carex sterilis)*, and prairie sedge *(Carex prairea)*, form hummocks that elevate the plant above persistently anaerobic peat surfaces. Generally, desiccation is not a problem for plants in OP communities because the plant-rooting zone is almost always wet and remains moist even during periods of drought when the water table drops below the peat surface.

As in other peatland systems, plants in OP communities are visibly affected by low-nutrient conditions and often have adaptations enabling them to exist on the limited nutrients in substrates and surface water. Particularly evident are reduced growth forms. Many of the characteristic shrubs and graminoids are very short. The dominant graminoids tend to have very narrow leaves (typically < 1/3 inch [3mm] wide), with species such as fen wire grass *(Carex lasiocarpa),* candle-lantern sedge *(C. limosa),* creeping sedge *(C. chordorrhiza),* and white beak rush *(Rhynchospora alba)* most common. OP communities are also characterized by insectivorous plants, including pitcher plant *(Sarracenia purpurea),* sundews *(Drosera* spp.), and bladderworts *(Utricularia* spp.), which supplement their intake of both nitrogen and phosphorus by capturing and digesting insects. Although nutrients are low in OP communities, concentrations of minerals such as calcium can be very high near groundwater discharge points, particularly where peatlands are underlain by calcareous glacial deposits. Plants that thrive in areas of calcareous groundwater discharge include tufted bulrush *(Scirpus cespitosus)*, Kalm's lobelia *(Lobelia kalmii),* marsh arrowgrass *(Triglochin palustris)*, and grass of Parnassus *(Parnassia* spp.), along with the rare species twig rush *(Cladium mariscoides).*

Floristic Regions

Based on geographic variation in species composition, OP communities in Minnesota are grouped into two floristic regions: the Northern Floristic (OPn) Region and the Prairie Floristic (OPp) Region (Fig. OP-1). Communities from both floristic regions are present in the EBF Province, although OPn communities are more prevalent. Communities in the OPp Region are at the western climatic limit in Minnesota of peatland formation

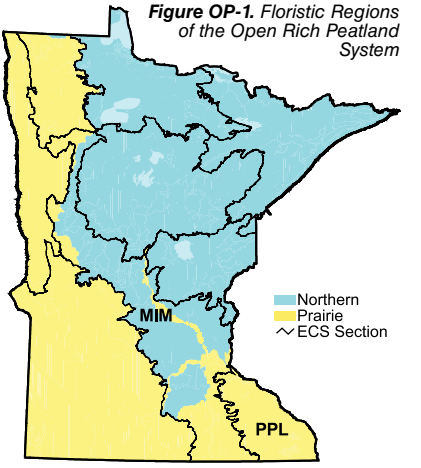

Figure OP-1. *Floristic Regions of the Open Rich Peatland System*

and are subject to fires and water stress during periods of drought. Therefore, they lack some of the characteristic OP species that are less tolerant of drought, including ericaceous shrubs such as leatherleaf, bog rosemary, and small cranberry *(Vaccinium oxycoccos);* insectivorous plants such as pitcher plant, sundews, and bladderworts; and ferns and fern allies such as crested fern *(Dryopteris cristata)* and water horsetail *(Equisetum fluviatile),* all of which are typically present in communities in the OPn Region (Table OP-1). On the other hand, OPp communities have species common in the drier and more fire-prone landscapes of western Minnesota that are not present in the OPn Region. Examples of these species are grass-leaved goldenrod *(Euthamia graminifolia)*, Buxbaum's sedge *(Carex buxbaumii)*, and narrow reedgrass *(Calamagrostis stricta)* (Table OP-2).

Variation Among Classes

The plant community classes in the OPn Region are divided into two groups based on differences in topography, substrate, and hydrology. Classes in the first group—Northern Shrub Shore Fen (OPn81) and Northern Rich Fen (Basin) (OPn92)—form in basins underlain by fine-textured substrates with relatively low hydraulic conductivity. As a result, these peatlands are influenced primarily by stagnant (rather than flowing) groundwater. They are characterized by level or slightly concave peat surfaces and are common where irregular topography allows the development of poorly drained, isolated peat-filled depressions. They also form on floating mats adjacent to lakes, ponds, and rivers and in lagg zones between larger peatlands and adjacent uplands. The two community classes in this group differ from one another primarily in frequency of inundation by surface runoff or rising lake levels. Northern Shrub Shore Fens are occasionally inundated (and as a result are somewhat similar to WM communities), whereas Northern Rich Fens (Basin) are less frequently inundated.

The classes in the second group of OPn communities—Northern Extremely Rich Fen (OPn93) and Northern Rich Fen (Water Track) (OPn91)—form on flat or slightly sloping surfaces, such as broad glacial lake plains. These communities are associated with lenses of sandy substrates that have high hydraulic conductivity. Because of the porosity of the subterranean sands, these peatlands are influenced by inputs of groundwater that create surface water flow and the formation of water tracks on the peatland surface. The elongated water tracks slope gently in the direction of drainage and sometimes form characteristic ribbed fen patterns visible on aerial photos. The water track communities differ from one another in mineral concentrations and pH. Northern Extremely Rich Fens are fed by highly calcareous groundwater and have characteristic calciphilic plants, whereas Northern Rich Fens (Water Track) have circumneutral water chemistry and lack calciphilic species.

Plant communities in the OPp Region are divided into two classes based on differences in hydrology and water chemistry. Prairie Extremely Rich Fens (OPp93) develop at highly calcareous groundwater discharge points and have characteristic calciphilic plants. Prairie Rich Fens (OPp91) occur in glacial drainages that are influenced by lateral movement of groundwater, and lack calciphilic species.

Table OP-1 *Plants useful for differentiating the Northern from the Prairie Floristic Region of the Open Rich Peatland System.*

				frequency (%)	
	Layer	Common Name	Scientific Name	OPn	OPp
Northern Floristic Region	Tree	Tamarack (C, U)	*Larix laricina*	32	8
		Black spruce (U)	*Picea mariana*	14	2
		White cedar (U)	*Thuja occidentalis*	6	-
	Tall Shrub	Speckled alder	*Alnus incana*	27	-
		Balsam willow	*Salix pyrifolia*	18	-
	Low Shrub	Leatherleaf	*Chamaedaphne calyculata*	41	-
		Bog rosemary	*Andromeda glaucophylla*	34	-
		Small cranberry	*Vaccinium oxycoccos*	27	-
		Labrador tea	*Ledum groenlandicum*	14	-
		Large cranberry	*Vaccinium macrocarpon*	11	-
		Bog laurel	*Kalmia polifolia*	5	-
	Forb	Buckbean	*Menyanthes trifoliata*	36	5
		Round-leaved sundew	*Drosera rotundifolia*	34	-
		Intermediate bladderwort	*Utricularia intermedia*	30	3
		Pitcher plant	*Sarracenia purpurea*	29	3
		Scheuchzeria	*Scheuchzeria palustris*	16	-
		Three-leaved false Solomon's seal	*Smilacina trifolia*	12	-
		Spatulate-leaved sundew	*Drosera intermedia*	11	-
	Fern	Northern marsh fern	*Thelypteris palustris*	51	10
		Water horsetail	*Equisetum fluviatile*	34	7
		Crested fern	*Dryopteris cristata*	18	-
	Graminoid	Creeping sedge	*Carex chordorrhiza*	43	1
		Candle-lantern sedge	*Carex limosa*	32	5
		Lake sedge	*Carex lacustris*	27	5
		Beaked sedge	*Carex utriculata*	23	-
		White beak rush	*Rhynchospora alba*	19	-
		Slender cottongrass	*Eriophorum gracile*	17	1
		Bristle-stalked sedge	*Carex leptalea*	14	-
		Silvery sedge	*Carex canescens*	11	-
		Slender sedge	*Carex echinata*	11	-
		Chamisso's cottongrass	*Eriophorum chamissonis*	10	1

(C) = canopy tree (U) = understory tree

Succession

OP communities can develop from WM communities if conditions become suitable for accumulation of organic matter and rooting contact with mineral soil is reduced. If peat continues to accumulate over time, the peat surface and water table become elevated, and the rate of water flow and inputs of minerals to the plant-rooting zone are gradually reduced. Conditions then become favorable for invasion by minerotrophic *Sphagnum* species. Once *Sphagnum* is present, it further reduces available minerals by absorbing them—particularly calcium—and replacing them with hydrogen ions, causing the peat surface to become increasingly acidic. The site then becomes suitable for more acid-tolerant *Sphagnum* species, and pH continues to fall. Below pH 5.5, the water chemistry changes from a bicarbonate-buffered system to a humic–acid buffered system. Subsequent production of humic acids by peat decomposition and living *Sphagnum* accelerates the acidification process. The higher parts of hummocks rapidly become more acidic and boglike, while hollows usually retain more minerotrophic water chemistry and brown mosses. Eventually, the brown moss species in the hollows are replaced by oligotrophic *Sphagnum* species, completing transformation of the OP community to an AP community. However, if inputs of minerals via groundwater or

Table OP-2 *Plants useful for differentiating the Prairie from the Northern Floristic Region of the Open Rich Peatland System.*

				frequency (%)	
	Layer	Common Name	Scientific Name	OPn	OPp
Prairie Floristic Region	Shrub	Sage-leaved willow	*Salix candida*	12	48
		Shrubby cinquefoil	*Potentilla fruticosa*	8	34
	Forb	Grass-leaved goldenrod	*Euthamia graminifolia*	-	43
		Kalm's lobelia	*Lobelia kalmii*	10	41
		Spotted Joe pye weed	*Eupatorium maculatum*	9	37
		Swamp lousewort	*Pedicularis lanceolata*	4	35
		Stemless blue violets	*Viola* spp.*	5	34
		Eastern panicled aster	*Aster lanceolatus*	2	33
		Swamp milkweed	*Asclepias incarnata*	3	32
		Cut-leaved bugleweed	*Lycopus americanus*	1	32
		Flat-topped aster	*Aster umbellatus*	5	31
		Sunflower	*Helianthus* spp.**	-	30
		Canada goldenrod	*Solidago canadensis*	2	26
		American grass-of-Parnassus	*Parnassia glauca*	3	23
		Rough bugleweed	*Lycopus asper*	1	22
		Swamp thistle	*Cirsium muticum*	-	22
		Northern bedstraw	*Galium boreale*	-	20
		Common mint	*Mentha arvensis*	1	18
		Lesser fringed gentian	*Gentianopsis procera*	1	18
		Riddell's goldenrod	*Solidago riddellii*	-	18
		Marsh arrowgrass	*Triglochin palustris*	-	16
		Virginia mountain mint	*Pycnanthemum virginianum*	-	13
		Prairie loosestrife	*Lysimachia quadriflora*	-	12
		Silverweed	*Potentilla anserina*	-	12
		Germander	*Teucrium canadense*	-	11
		Spotted water hemlock	*Cicuta maculata*	-	11
		Poor gerardia	*Agalinis purpurea*	-	10
	Graminoid	Narrow reedgrass	*Calamagrostis stricta*	6	78
		Buxbaum's sedge	*Carex buxbaumii*	4	51
		Tall cottongrass	*Eriophorum polystachion*	7	44
		Sterile sedge	*Carex sterilis*	1	29
		Mat muhly grass	*Muhlenbergia richardsonis*	-	28
		Rigid sedge	*Carex tetanica*	-	25
		Sartwell's sedge	*Carex sartwellii*	1	24
		Tufted hair grass	*Deschampsia cespitosa*	-	22
		Big bluestem	*Andropogon gerardii*	-	19
		Baltic rush	*Juncus arcticus*	-	14
		Woolly sedge	*Carex pellita*	-	10

**Viola nephrophylla* and similar *Viola* spp. ***Helianthus giganteus, H. grosseserratus,* or *H. nuttallii*

other sources are sufficient to compensate their removal by *Sphagnum*, succession to AP communities may be stopped or slowed. In comparison with OP communities, AP communities have very little contact with groundwater, have *Sphagnum* in hollows as well as on hummocks, and lack rich minerotrophic species (see page EBF-OP6) for an explanation of minerotrophic versus bog species). The predominance of calcareous till and the marginal climatic conditions in the EBF Province limit the development of *Sphagnum* to isolated basins with stable water tables and small watersheds, so succession of OP communities to AP communities is uncommon in the province.

Non-Mineotrophic Peatland Species

Because only those species listed below can persist in the ombrotrophic conditions of bogs, the occurrence of any other species can be considered an indicator of minerotrophic conditions. However, some seedlings, particularly of tree species, can germinate in bogs but are short-lived and should not be considered as minerotrophic indicators.

	Common Name	Scientific Name
Tree	Tamarack	*Larix laricina*
	Black spruce	*Picea mariana*
	Jack pine	*Pinus banksiana*
Low Shrub	Bog rosemary	*Andromeda glaucophylla*
	Leatherleaf	*Chamaedaphne calyculata*
	Creeping snowberry	*Gaultheria hispidula*
	Bog laurel	*Kalmia polifolia*
	Labrador tea	*Ledum groenlandicum*
	Lowbush blueberry	*Vaccinium angustifolium*
	Velvet-leaved blueberry	*Vaccinium myrtilloides*
	Small cranberry	*Vaccinium oxycoccus*
	Lingonberry	*Vaccinium vitis-idaea*
	Dwarf misletoe	*Arceuthobium pusillum*
Forb	Stemless lady's slipper	*Cypripedium acaule*
	Round-leaved sundew	*Drosera rotundifolia*
	Heart-leaved twayblade	*Listera cordata*
	Indian pipe	*Monotropa uniflora*
	Pitcher plant	*Sarracenia purpurea*
	Three-leaved false Solomon's seal	*Smilacina trifolia*
Graminoid	Bog wiregrass sedge	*Carex oligosperma*
	Few-flowered sedge	*Carex pauciflora*
	Poor sedge	*Carex paupercula*
	Three-seeded bog sedge	*Carex trisperma*
	Tussock cottongrass	*Eriophorum spissum*
	Tawny cottongrass	*Eriophorum virginicum*