FP Forested Rich Peatland System

photo by N.E. Aaseng MN DNR

Roseau County, MN

General Description

Forested Rich Peatland (FP) communities are conifer- or tall shrub-dominated wetlands on deep (>15in [40cm]), actively forming peat. They are characterized by mossy ground layers, often with abundant shrubs and forbs. FP communities are widespread in the Laurentian Mixed Forest (LMF) Province. The cool climate of the region, abundant precipitation, and presence of poorly drained basins and glacial lake plains result in extensive peat development relative to other parts of Minnesota. FP communities are particularly prominent in the LMF Province in MOP and in the Tamarack Lowlands Subsection of MDL.

Peatland Formation

Most of Minnesota's peatlands began to form following climate cooling and increased precipitation about 5–6,000 years ago. Change in climate stabilized seasonal water levels in many basins and on large, flat, poorly drained landscapes such as glacial lake plains, causing saturation of soils and oxygen deficiency (anaerobic conditions). The anaerobic conditions, along with lower temperatures, inhibit plant decomposition and result in accumulation of peat. Peat accumulation rates in Minnesota are variable but generally range from 1.5 to 3 inches (4–8cm) per century. Once peat accumulates to a depth of 12–15 inches (30–40cm), the nutrients available to plants fall sharply because plants are no longer rooted in mineral soil. (In some instances, saturated soils and low-nutrient environments can develop on thinner peat deposits, either in shallow basins with small watersheds or in landscapes with nutrient-poor sandy soils.) In addition to isolating plants from mineral soil, peat adsorbs and holds nutrients, which, combined with low levels of microbial activity in anaerobic environments, limits nutrient recycling. With accumulation of peat, plants in peatlands become dependent on inputs of essential nutrients from hydrologic processes such as atmospheric deposition (especially in precipitation), surface runoff from adjacent uplands, and groundwater-derived subsurface flow. These sources usually supply very low concentrations of the essential nutrients, nitrogen and phosphorus. However, concentrations of minerals are often abundant in groundwater that has percolated through till. Therefore, peatlands influenced by inputs of groundwater (including FP and Open Rich Peatland [OP] communities) can have relatively high concentrations of minerals such as calcium and magnesium.

The peat in FP communities is moderately decomposed (hemic) and formed from woody plant debris. The water table is typically below the peat surface and drops regularly and predictably during the summer. At high water levels, pools may form on the peat surface, but undulating microtopography and low hummocks at the bases of trees provide substrates that remain dry and aerated enough to support trees and shrubs. The presence of trees and shrubs, in turn, favors herbaceous species in the ground layer that are tolerant of at least moderate levels of shade. In contrast, OP communities have water table levels that remain near the surface throughout the growing season, preventing establishment of significant tree cover and leaving the ground exposed to full sunlight. As a result, FP communities typically are richer in forb species than OP communities, because forbs tend to be more competitive than graminoids in low-light environments. Another prominent feature of FP communities is the presence of feather-mosses and brown mosses, which are adapted to high mineral content, low nutrients, and sustained moisture. Brown mosses typically dominate the moss layer, with patches of minerotrophic *Sphagnum*.

Plant Adaptations

The environment in FP communities favors dominance by herbaceous vascular plants, brown mosses, minerotrophic *Sphagnum*, and tree and shrub species that can survive periods of inundation or saturated substrates. Many of the plant species in FP communities have structures that allow them to survive water-logged conditions for short periods. For example, speckled alder *(Alnus incana)* has adventitious roots (originating from the stem or root collar) that provide access to oxygen during high water levels. Other plants grow on aerated substrates on tree bases and moss hummocks elevated above the water table. These species are often characteristic of surrounding upland forest communities and include such plants as bunchberry *(Cornus canadensis),* Canada mayflower *(Maianthemum canadense)*, starflower *(Trientalis borealis),* and bluebead lily *(Clintonia borealis).*

As in other peatland systems, plants of FP communities are adapted to low-nutrient environments. Evergreen species, which conserve nutrients by retaining their leaves from year to year, are common and include conifers such as black spruce and ericaceous shrubs such as bog rosemary *(Andromeda glaucophylla)*, Labrador tea *(Ledum groenlandicum),* and bog laurel *(Kalmia polifolia)*. Deciduous tree species, which lose nutrients when leaves are shed each year, are nearly absent from FP communities. The thickened outer leaf membranes characteristic of ericaceous shrubs and other species such as bog birch *(Betula pumila)* and the presence of chemical compounds in leaves help to reduce loss from herbivory. The low palatability of leaves also retards breakdown of litter by decomposing organisms and contributes to peat accumulation. Some species in the community, such as pitcher plant *(Sarracenia purpurea)* and sundews *(Drosera* spp.), supplement their intake of the important nutrients, nitrogen and phosphorus, with structures that trap and digest insects.

Floristic Regions

Based on general differences in species composition, FP communities in Minnesota are grouped into three "floristic" regions: the Northern Floristic (FPn) Region, the Southern Floristic (FPs) Region, and the Northwestern Floristic (FPw) Region (Fig. FP-1). All three Floristic Regions are represented in the LMF Province. However, the FPs and FPw Regions extend only into the southern and western edges of the Province. Differences in species composition among FPn, FPs, and FPw communities are presented in Table FP-1. Both FPs and FPw communities are at the edge of the range of climate suitable for peat-forming vegetation. It is likely that frequent drought, prolonged drawdown of the water table, and more frequent fire reduce the presence of characteristic FPn species in FPs and FPw communities. Notable among these are white cedar, balsam fir, and ericaceous shrubs such as creeping snowberry *(Gaultheria hispidula)* and leatherleaf *(Chamaedaphne calyculata).*

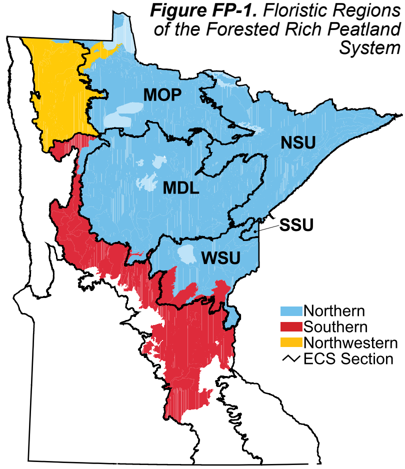


Figure FP-1. *Floristic Regions of the Forested Rich Peatland System*

Forested Rich Peatland System

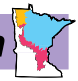
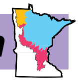


Table FP-1. *Plant species useful for differentiating the Northern, Southern, and Northwestern Floristic Regions of the Forested Rich Peatland System.*

Region	Layer	Common Name	Scientific Name	Frequency (%) FPn	FPw	FPs
Northern Floristic Region	Tree	White cedar (C)	*Thuja occidentalis*	49	3	–
		Balsam fir (C)	*Abies balsamea*	30	3	–
		White cedar (U)	*Thuja occidentalis*	49	10	–
		Mountain ashes (U)	*Sorbus* spp.	14	–	–
		White pine (U)	*Pinus strobus*	6	–	–
	Tall Shrub	Fly honeysuckle	*Lonicera canadensis*	29	–	4
		Black chokeberry	*Aronia melanocarpa*	8	–	–
		Diamond-leaved willow	*Salix planifolia*	6	–	–
	Low Shrub	Creeping snowberry	*Gaultheria hispidula*	62	7	–
		Leatherleaf	*Chamaedaphne calyculata*	38	–	4
		Bog rosemary	*Andromeda glaucophylla*	35	7	–
		Bog laurel	*Kalmia polifolia*	15	–	–
	Forb	Goldthread	*Coptis trifolia*	62	14	–
		Bluebead lily	*Clintonia borealis*	34	3	4
		Pitcher plant	*Sarracenia purpurea*	24	7	–
		Round-leaved sundew	*Drosera rotundifolia*	16	–	4
		One-flowered pyrola	*Moneses uniflora*	15	–	–
		Heart-leaved twayblade	*Listera cordata*	14	–	–
		Small northern bog orchid	*Platanthera obtusata*	14	–	–
		Lesser rattlesnake plantain	*Goodyera repens*	13	–	–
		Indian pipe	*Monotropa uniflora*	11	–	–
		Early coralroot	*Corallorhiza trifida*	10	–	–
		Gaywings	*Polygala paucifolia*	9	–	–
		Palmate sweet coltsfoot	*Petasites frigidus*	7	–	–
		Small round-leaved orchis	*Orchis rotundifolia*	7	–	–
		Spurred gentian	*Halenia deflexa*	6	–	–
	Fern	Bristly clubmoss	*Lycopodium annotinum*	10	–	–
		Dwarf scouring rush	*Equisetum scirpoides*	7	–	–
Southern Region	Tree	Red maple	*Acer rubrum*	7	–	30
	Shrub	Winterberry	*Ilex verticillata*	9	–	35
	Vine	Virginia creeper	*Parthenocissus* spp.	5	10	57
Northwestern Floristic Region	Shrub	Shrubby cinquefoil	*Potentilla fruticosa*	1	34	–
	Forb	Tall meadow-rue	*Thalictrum dasycarpum*	1	28	4
		Arrow-leaved sweet coltsfoot	*Petasites sagittatus*	5	24	–
		Fireweed	*Epilobium angustifolium*	3	17	–
		Wood strawberry	*Fragaria vesca*	3	17	–
		Rough bugleweed	*Lycopus asper*	–	10	–
		Black-eyed Susan	*Rudbeckia hirta*	–	10	–
		Marsh grass-of-Parnassus	*Parnassia palustris*	2	10	–
		Clayton's sweet cicely	*Osmorhiza claytonii*	–	7	–
		Grass-leaved goldenrod	*Euthamia graminifolia*	1	7	–
		Columbine	*Aquilegia canadensis*	1	7	–
		Eastern panicled aster	*Aster lanceolatus*	1	7	–
	Graminoid	Common reed grass	*Phragmites australis*	4	17	–
		Sterile sedge	*Carex sterilis*	–	14	–
		Clustered muhly grass	*Muhlenbergia glomerata*	1	10	–
		Mexican muhly grass	*Muhlenbergia mexicana*	–	7	–
		Mat muhly grass	*Muhlenbergia richardsonis*	–	7	–

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



There are no species unique to the FPs Region relative to the FPn and FPw Regions, although within the FP System red maple, winterberry *(Ilex verticillata),* and Virginia creepers *(Parthenocissus* spp.) reach their highest frequency in FPs communities. The FPw Region is characterized by several species that are rare in the FPn and FPs Regions. Among these are species common in calcareous and rich fens, such as shrubby cinquefoil *(Potentilla fruticosa)* and marsh grass-of-Parnassus *(Parnassia palustris),* which are present in tamarack swamps associated with calcareous groundwater seepage zones in northwestern Minnesota.

Variation Within the Northern Floristic Region

In plant community composition and ecosystem function, the FPn Region is the most varied of the three Floristic Regions in the FP System. It is represented by seven Native Plant Community Classes with ranges that together cover the entire LMF Province. The FPn community Classes can be divided into two groups based on differences in topography, substrate, and hydrology. Communities in the first group—Northern Rich Spruce Swamp (Basin) (FPn62), Northern Cedar Swamp (FPn63), Northern Rich Tamarack Swamp (Eastern Basin) (FPn72), and Northern Rich Tamarack Swamp (Western Basin) (FPn82)—form in basins underlain by fine-textured substrates with relatively low hydraulic conductivity. These communities are influenced primarily by stagnant groundwater and are common where irregular topography allows the development of poorly drained, isolated depressions. They typically form in peat-filled depressions and on floating mats adjacent to lakes, ponds, or rivers.

Communities in the second group—Northern Rich Spruce Swamp (Water Track) (FPn71) and Northern Rich Tamarack Swamp (Water Track) (FPn81)—form on flat or slightly sloping surfaces, such as glacial lake plains and appear to be associated with lenses of sandy substrates within otherwise clayey landscapes. The sand lenses have high hydraulic conductivity, channeling groundwater into overlying peatlands and producing flowing, mineral-influenced surface water. In these settings, FP communities are associated with water tracks that slope gently in the direction of water flow.

Succession

FP communities can develop from Wet Forest (WF) communities if conditions become suitable for accumulation of organic matter (peat) and rooting contact with mineral soil is reduced. These conditions typically occur in settings where the water table becomes elevated or stabilized so that the ground surface is continuously saturated. As peat accumulates, and the peat surface and water table rise, rates of water flow and inputs of minerals to the peat surface are gradually reduced and the community is transformed into a Forested Rich Peatland. Conditions then become suitable for invasion of the site by minerotrophic *Sphagnum* species, which absorb and retain minerals—particularly calcium—and release hydrogen ions, increasing the acidity of surface waters. As acidity increases, more acid-tolerant *Sphagnum* species become established at the site and pH gradually falls. Above pH 5.5, the water chemistry is buffered by bicarbonate. At pH 5.5, an important change occurs, with the water chamistry no longer buffered by bicarbonate, marking conversion to an Acid Peatland. As pH continues to drop, at some point below pH 5.5 the water chemistry becomes buffered by humic acids. The higher parts of hummocks quickly become more bog-like and minerotrophic *Sphagnum* species in hollows are replaced by oligotrophic species. The transformation of an FP community to an AP community can be stopped or slowed if groundwater or surface water inputs to the site increase and supply enough minerals to compensate their removal by *Sphagnum*.

When peatlands have well-developed hummock and hollow topography, it is possible to have characteristics of both AP and FP communities in the same site. Initially, both hummocks and hollows in rich peatland communities have similar water chemistry, but as peat accumulates and the surface becomes more isolated from mineral-rich water, hummocks change more quickly in water chemistry than hollows. The hummocks, which are elevated above the water table, often become lower in minerals and more acidic and support species characteristic of AP communities. The hollows, which remain in contact with mineral-rich water, have water chemistry and flora typical of FP communities. The site then is characterized by a mosaic of patches of AP and FP communities until the hollows also become dominated by acidic species of *Sphagnum*. Mosaics of FP and AP communities occur most commonly in settings where woody plants (shrubs and trees) are abundant because these sites often are hummocky from presence of stumps, roots, and fallen trees. Although initially formed over woody debris or tree bases, the hummocks become amplified by growth and accumulation of moss. The settings most likely to have abundant trees and shrubs are also those with slightly larger water-table drawdowns, making the establishment of woody plants possible.