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Wabasha County, MN

General Description

Wet Forest (WF) communities occur commonly in narrow zones along the margins of lakes, rivers, and peatlands; they also occur in shallow depressions or other settings where the groundwater table is almost always within reach of plant roots but does not remain above the mineral soil surface for long periods during the growing season. Because of the relatively warm and dry climate in the Eastern Broadleaf Forest (EBF) Province, WF communities are uncommon, occurring mainly in areas fed by upwelling groundwater from deep aquifers. Black ash is the most common dominant canopy tree in WF communities in the EBF Province and is usually mixed with other species, especially basswood, American elm, red elm, paper birch, yellow birch, and tamarack. American elm was historically more important, but elm populations have declined dramatically due to Dutch elm disease. WF communities dominated by white cedar are infrequent in the province. Understories are characterized by patches of shrubs, including dogwoods *(Cornus* spp.) and gooseberries or currants *(Ribes* spp.), along with speckled alder *(Alnus incana),* nannyberry *(Viburnum lentago)*, winterberry *(Ilex verticillata)*, and poison sumac *(Rhus vernix)*. Wet mucky hollows are common on the forest floor; downed logs and tip-up mounds are the primary substrate for grasses, sedges, and wetland forbs.

WF communities are strongly shaped by steady fluxes of water and nutrients supplied to deep soil layers by moving groundwater. In basins or depressions connected to annually recharged shallow aquifers, the supply of groundwater peaks early in the growing season but persists at some level through much of the summer. In settings connected to deeper aquifers that discharge groundwater throughout the year, the supply of water and nutrients is steady through the growing season. The groundwater moves laterally below the surface but often upwells to create springs, seeps, or spring runs within and adjacent to WF communities. Varied microtopography and variation in groundwater supply on sites fed by shallow aquifers result in the alternating presence of water-logged and dry conditions in upper soil layers. This variability in soil moisture in both space and time is a hallmark of the WF System and controls the availability of the oxygen needed for roots to respire, for decomposition of organic litter, and for release of nutrients in forms usable by plants.

Plant Adaptations

As in other wetland systems, deep soil layers in WF communities are continuously saturated, anaerobic, and chemically reducing. Although a potential source of water for plants, deep soil layers have few roots other than those of species that can supply oxygen to roots through specialized gas-conducting cells (aerenchyma). As a consequence, rooting is shallow in WF communities. Roots are concentrated above or near the top of the water table, and canopy trees are susceptible to windthrow. In response to water-table fluctuations, trees, shrubs, and other perennial plants must tolerate root loss from anoxia because of prolonged water-table elevation and must be able to develop and extend roots more deeply again as water levels fall. Some characteristic WF plants have adapted to this problem by producing both normal roots and adventitious roots with gas-conducting cells.

Soils & Nutrients

Soil surfaces in WF communities are saturated in the spring but dry out later in the growing season. This pattern of alternately wet and dry soil surfaces has two important consequences. First, it creates a thin surface layer of highly decomposed organic matter, or muck. Muck is physically and chemically distinct from the peat present in peatland communities and from the humus of upland forest communities (such as Mesic Hardwood Forest [MH] communities) in its ability to absorb water, adsorb metals toxic to plants, and release nutrients. Second, the soils are not saturated continuously enough to build up thick layers of peat as in Acid Peatland (AP), Forested Rich Peatland (FP), and Open Rich Peatland (OP) communities. In instances where WF communities occur on thick layers of organic matter, they have usually replaced a peatland community (because of human-caused changes in hydrology), and the production of organic matter in the WF community is roughly in equilibrium with decomposition.

The rate and pattern of release of nutrients—especially nitrogen—from mucky soils in WF communities strongly influence plant species composition and growth. Nitrogen is mineralized in mucky soils at annual rates that are only about one-half to one-tenth of rates in upland forest soils. In addition, although WF and MH communities commonly occur within feet of each other, availability of nitrogen is seasonally reversed in the two systems. In upland forests, nitrogen is mineralized to produce ammonium (NH_4^+) immediately in spring, and most of the ammonium is quickly converted by nitrification to nitrates (NO_3^-). Therefore, about half of the annual supply of nitrogen is available in late May and early June in MH forests. Because of waterlogged and cold soils, very little nitrogen is mineralized in WF forests in spring. After soils have warmed in early summer, available nitrogen is produced at a steady but slow rate during the growing season, almost completely in the form of ammonium. Nitrification is an aerobic process, so significant production of nitrate does not begin in WF communities until the surface dries, usually in mid-August or September. Therefore, in contrast to MH communities, nitrogen available for plant uptake does not reach peak levels in WF communities until late summer. Furthermore, WF communities tend to lose more nitrogen than MH communities, with as much as 10% of annually mineralized nitrogen converted to nitrogen gas that is released to the atmosphere.

Floristic Regions

There are three floristically distinct groups of WF communities. These groups have strong geographic affinities and are recognized as separate floristic regions within the WF System: the Northern Floristic (WFn) Region, the Southern Floristic (WFs) Region, and the Northwestern Floristic (WFw) Region (Fig. WF-1). The WFn Region covers nearly all of the LMF Province and extends into the EBF Province in the Hardwood Hills and Anoka Sand Plain subsections. The WFs Region lies mostly within the EBF Province but extends into the southeastern quarter of the LMF Province and into the Prairie Parkland (PPA) Province. The WFw Region is mostly within the Tallgrass Aspen

Parklands Province, extending into the extreme western part of the LMF Province and possibly the northernmost part of the EBF Provoince. The WFw Region is not treated in detail in this field guide.

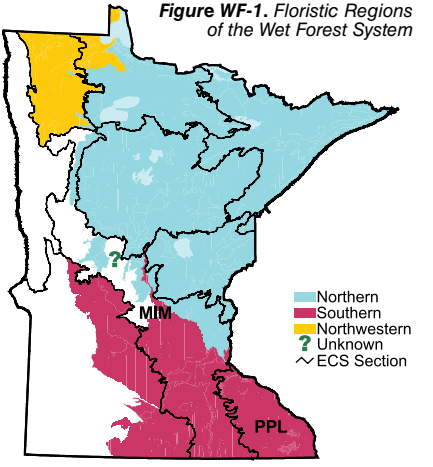

Figure WF-1. *Floristic Regions of the Wet Forest System*

Differences in species composition among the WFn, WFs, and WFw Regions appear to be strongly influenced by regional floristic variation in surrounding landscapes. This may be because WF communities are often present in narrow, linear ecotonal zones between uplands and adjacent lakes, rivers, and peatlands and so are regularly exposed to colonization by plants from adjacent, more extensive communities. Regional floristic variation in the WF System also appears to be related to regional differences in groundwater hydrology, especially differences in local relief and groundwater head, depth and conductivity of regional aquifers, and groundwater temperature and chemistry. The influence of groundwater hydrology on variation in species composition among WF communities is especially evident in the response of plants to patterns of water flow, mineral content, and temperature.

Groundwater Hydrology and Plant Indicators of WFn Communities

Communities of the WFn Region exhibit greater variation in vegetation and in landscape setting than WFs or WFw communities. WFn communities occur most often in settings that are transitional between upland forests (MH and FD communities) and northern peatlands (AP, FP, OP, and WM communities) and have many plants that are characteristic of these adjacent, more extensive communities. WFn communities are hydrologically very distinct from WFw and WFs communities. The WFn Region lies in an area that receives more precipitation (especially as snow) and has more runoff than either the WFs or WFw regions. WFn communities are highly influenced by the groundwater component of this runoff, which moves annually through shallow, local aquifers into streams, lakes, and peatlands. In comparison with groundwater in the WFw and WFs regions, this groundwater is substantially more dilute, has lower, nearly neutral pH, is warmer, and is more seasonal in its abundance. Because the WFs and WFw regions are significantly warmer and drier than the WFn Region, WFs and WFw communities are largely restricted to settings where deep aquifers deliver steady supplies of groundwater through the growing season, independently of the annual hydrologic cycle.

Selected plants with high fidelity for the WFn Region in comparison with the WFs and WFw regions are presented in Table WF-1. The only plant species with high affinity for WFn communities that also have higher affinity for the WF System than any other system are balsam fir, common oak fern *(Gymnocarpium dryopteris)*, long beech fern *(Phegopteris connectilis)*, brownish sedge *(Carex brunnescens)*, shining firmoss *(Huperzia lucidula)*, fine-nerved sedge *(Carex leptonervia),* and panicled bluebells *(Mertensia paniculata)*. These species all have affinity for WF communities that are transitional to MH forests. Many of the plants with high fidelity for the WFn Region are equally at home in mossy habitats in upland communities in the FD System and in peatland communities in the FP and AP systems. Among these plants are several evergreen species such as balsam fir, white cedar, goldthread *(Coptis trifolia)*, and twinflower *(Linnaea borealis),* and herbaceous and deciduous species such as bristle-

Table WF-1. *Plants useful for differentiating the Northern from the Southern and Northwestern Floristic Regions of the Wet Forest System.*

			Common Name	Scientific Name	frequency (%) WFn	WFs	WFw
Northern Floristic Region	Moss Substrate Affinity	Deciduous	Bristle-stalked sedge	*Carex leptalea*	37	6	-
			Three-fruited bog sedge	*Carex trisperma*	23	-	-
			Big-leaf white or northern white violet	*Viola blanda* or *V. macloskeyi*	17	3	-
			Brownish sedge	*Carex brunnescens*	15	3	-
			Lowbush blueberry	*Vaccinium angustifolium*	10	-	-
		Evergreen	Balsam fir (U)	*Abies balsamea*	63	3	11
			White cedar (U)	*Thuja occidentalis*	43	-	-
			Goldthread	*Coptis trifolia*	41	-	-
			Twinflower	*Linnaea borealis*	20	-	-
			Three-leaved false Solomon's seal	*Smilacina trifolia*	18	-	3
			Black spruce (U)	*Picea mariana*	15	-	-
			Shining firmoss	*Huperzia lucidula*	14	-	-
			Creeping snowberry	*Gaultheria hispidula*	12	-	-
			One-sided pyrola	*Pyrola secunda*	10	-	-
		Other	Common oak fern	*Gymnocarpium dryopteris*	53	3	-
			Bluebead lily	*Clintonia borealis*	46	3	3
			Fly honeysuckle	*Lonicera canadensis*	35	-	7
			Large-leaved aster	*Aster macrophyllus*	33	6	-
			Long beech fern	*Phegopteris connectilis*	23	-	-
			Mountain ashes (U)	*Sorbus* spp.	18	-	-
			Drooping wood sedge	*Carex arctata*	13	-	-
			Hairy honeysuckle	*Lonicera hirsuta*	13	-	-
			Fine-nerved sedge	*Carex leptonervia*	10	-	-
			Panicled bluebells	*Mertensia paniculata*	10	-	-

(U) = understory tree

stalked sedge *(Carex leptalea),* three-fruited bog sedge *(Carex trisperma)*, three-leaved false Solomon's seal *(Smilacina trifolia)*, and big-leaf white or northern white violet *(Viola blanda* or *V. macloskeyi)*. There are no evergreen plants that have their highest fidelity in the WF System for WFs communities, and only one evergreen plant (pink shinleaf *[Pyrola asarifolia]*) that has highest fidelity within the system for WFw communities. Mosses themselves are rather diagnostic of WFn communities. The most important high-affinity moss species in WFn communities are *Plagiomnium ellipticum, Calliergon cordifolium, Hypnum lindbergii, Climacium dendroides, Thuidium delicatulum,* and *Thuidium recognitum*.

Groundwater Hydrology and Plant Indicators of WFs Communities

Communities of the WFs Region have been documented most commonly at contacts between steep, high bedrock walls and alluvial bottomlands of the St. Croix, Minnesota, and Mississippi rivers and their tributaries. WFs communities are also present in deep valleys and at bases of slopes adjacent to highlands composed of glacial drift. In either case, local relief is often high, resulting in substantial vertical head in aquifers and the presence of active springs and spring runs in many WFs communities. The primary aquifers are relatively conductive bedrock layers or basal layers of till over bedrock. Secondary aquifers may consist of confined layers of sand and gravel (called stringers) that hydrologically connect the sites where WFs communities occur to highlands composed of glacial till. These highlands can be many miles away from the zones of discharge. The groundwater is typically cold, and its chemistry somewhat alkaline, reflecting the composition of the sedimentary bedrock and calcareous drift.

Selected plants with high fidelity for WFs communities in comparison with WFn and WFw communities are listed in Table WF-2. Plants with high affinity for WFs

Table WF-2. *Plants useful for differentiating the Southern from the Northern and Northwestern Floristic Regions of the Wet Forest System.*

		Common Name	Scientific Name	frequency (%) WFn	WFs	WFw
Southern Floristic Region	Disjunct Populations	Bulblet fern	*Cystopteris bulbifera*	1	36	-
		Virginia spring beauty	*Claytonia virginica*	-	23	-
		Cut-leaved toothwort	*Cardamine concatenata*	-	23	-
		False rue anemone	*Enemion biternatum*	-	20	-
		Goldie's fern	*Dryopteris goldiana*	-	13	-
	Associated with Springs	Skunk cabbage	*Symplocarpus foetidus*	2	36	-
		False mermaid	*Floerkea proserpinacoides*	-	20	-
		Spring cress	*Cardamine bulbosa*	-	16	-
		Pensylvania bitter cress	*Cardamine pensylvanica*	2	13	-
		Bog bluegrass	*Poa paludigena*	-	13	-
		American water pennywort	*Hydrocotyle americana*	-	10	-
		True forget-me-not	*Myosotis scorpioides*	-	10	-
		Icelandic yellow cress	*Rorippa palustris*	-	10	-
	Floodplain Forest Affinity	Wood nettle	*Laportea canadensis*	10	80	-
		Tall coneflower	*Rudbeckia laciniata*	3	60	7
		White avens	*Geum canadense*	9	53	-
		Cleavers	*Galium aparine*	2	43	-
		Honewort	*Cryptotaenia canadensis*	1	43	-
		Virginia waterleaf	*Hydrophyllum virginianum*	1	36	-
		Bland sedge	*Carex blanda*	3	33	-
		Brome-like sedge	*Carex bromoides*	3	23	-
		Hawthorn	*Crataegus* spp.	1	23	3
		Tall scouring rush	*Equisetum hyemale*	-	23	-
		Missouri gooseberry	*Ribes missouriense*	-	23	-
		Prickly ash	*Zanthoxylum americanum*	2	20	-
		Blue phlox	*Phlox divaricata*	-	20	-
		Gregarious black snakeroot	*Sanicula gregaria*	-	20	-
		Appendaged waterleaf	*Hydrophyllum appendiculatum*	-	16	-
		Virginia knotweed	*Polygonum virginianum*	-	16	-
		False nettle	*Boehmeria cylindrica*	1	13	-
		Common elder	*Sambucus canadensis*	-	13	-
	Mesic Hardwood Forest Affinity	Wild geranium	*Geranium maculatum*	1	66	-
		Common enchanter's nightshade	*Circaea lutetiana*	5	60	3
		Two-leaved miterwort	*Mitella diphylla*	6	50	-
		Zigzag goldenrod	*Solidago flexicaulis*	8	40	-
		Common false Solomon's seal	*Smilacina racemosa*	2	36	3
		Ironwood (U)	*Ostrya virginiana*	3	33	-
		Blue cohosh	*Caulophyllum thalictroides*	1	30	-
		Maidenhair fern	*Adiantum pedatum*	-	30	-
		Bloodroot	*Sanguinaria canadensis*	3	26	-
		Blue beech (U)	*Carpinus caroliniana*	1	26	-
		Hairy-leaved sedge	*Carex hirtifolia*	-	26	3
		Red-berried elder	*Sambucus pubens*	3	16	-
		Shining bedstraw	*Galium concinnum*	-	16	-
		Large-flowered trillium	*Trillium grandiflorum*	2	13	-
		White bear sedge	*Carex albursina*	-	13	-
		Mayapple	*Podophyllum peltatum*	-	13	-
		Giant Solomon's seal	*Polygonatum commutatum*	-	13	-
		Drooping trillium	*Trillium flexipes*	-	13	-
		Sharp-lobed hepatica	*Hepatica acutiloba*	-	13	-

Table WF-2. *continued on next page*

Table WF-2. *continued*

Southern Floristic Region	Other	Michigan lily	*Lilium michiganense*	3	40	-
		Crooked aster	*Aster prenanthoides*	-	30	-
		Golden ragwort*	*Senecio* spp.	5	30	-
		Reed canary grass	*Phalaris arundinacea*	3	20	-
		Smooth-sheathed sedge	*Carex laevivaginata*	-	16	-
		Wood's sedge	*Carex woodii*	-	16	-
		Silvery spleenwort	*Deparia acrostichoides*	-	13	-
		Duckweed	*Lemna* spp.	1	13	-
		Porcupine sedge	*Carex hystericina*	2	13	-

*Golden ragwort or Western heart-leaved groundsel *(Senecio aureus* or *S. pseudaureus)*

communities that are also more frequent in the WF System than any other system include Michigan lily *(Lilium michiganense)*, bulblet fern *(Cystopteris bulbifera)*, skunk cabbage *(Symplocarpus foetidus)*, crooked aster *(Aster prenanthoides)*, Wood's sedge *(Carex woodii)*, spring cress *(Cardamine bulbosa)*, silvery spleenwort *(Deparia acrostichoides)*, Pennsylvania bitter cress *(Cardamine pensylvanica)*, Goldie's fern *(Dryopteris goldiana)*, bog bluegrass *(Poa paludigena)*, true forget-me-not *(Myosotis scorpioides)*, Icelandic yellow cress *(Rorippa palustris)*, and American water pennywort *(Hydrocotyle americana)*. A few WFs plants, including bulblet fern, Virginia spring beauty *(Claytonia virginica)*, cut-leaved toothwort *(Cardamine concatenata)*, false rue anemone *(Enemion biternatum)*, and Goldie's fern, have disjunct populations in northern riparian habitats along the Mississippi River and around large lakes such as Lake Mille Lacs, Winnibigoshish Lake, Leech Lake, and Lake Superior. Presumably, large water bodies and river valleys have an ameliorating effect on local climate that allows plants typical of WFs communities to occur well into the WFn Region. Several plants with highest affinity for WFs communities are intimately associated with springheads and cold-water runs. These plants include skunk cabbage, false mermaid *(Floerkea proserpinacoides)*, and spring cress. The majority of the plants with high fidelity for WFs relative to WFn and WFw communities are actually more frequent in MH communities and Floodplain Forest (FF) communities, most likely because WFs communities often occur at bases of steep valley walls in zones of transition between upland and floodplain forests.

Disturbance Regimes of WFn, WFs, and WFw Communities

The most frequent natural disturbance in WF communities is flooding, typically caused by cyclical increases in precipitation or by beaver activity. If flooding is severe enough, it can kill canopy trees and bring about conversion to WM or Marsh communities. Other potential disturbances include fire and windthrow. Historically, WFn and WFs communities were affected by catastrophic fires very infrequently, with rotations of 800 to more than 1,000 years (Table WF-3). WFw communities were affected by catastrophic fires about twice as often as WFn and WFs communities, a result of being surrounded by fire-prone woodlands, prairies, and open wetlands that burned severely during drought periods. Relative to WFn and WFs communities, WFw communities also had much greater frequencies of moderate disturbances such as light surface fires and patchy windthrow of canopy trees.

Table WF-3. *Historic tree species composition and disturbance regimes in Wet Forest Classes.*

	Historic Tree Species Frequency by Class and Stand Age						Historic Disturbance Rotation Periods by Class (in years)		
	young forest age	young forest species	mature forest age	mature forest species	old forest age	old forest species	Stand-Regenerating Fire	Moderate Surface Fire + Patchy Windthrow	Catastrophic Windthrow
Northern Floristic Region						ranges →	800-1000+	110-340	365-480
WFn55	0 - 75 yrs	**black ash**	75 - 195 yrs	**black ash**	> 195 yrs	black ash *(tamarack)* *(white spruce)*	>1000	140	370
WFn64	0 - 75 yrs	**black ash**	75 - 135 yrs	**black ash**	> 135 yrs	**black ash** *(tamarack)* *(white spruce)*	>1000	110	480
WFn53	0 - 55 yrs	**balsam fir** *(white cedar)*	75 - 105 yrs	**white cedar**	> 155 yrs	white cedar *(white spruce)* *(balsam fir)* *(tamarack)*	800	340	365
Southern Floristic Region									
WFs57	**0-35 yrs**	(insufficient data)	**55 - 135 yrs**	(insufficient data)	**> 135 yrs**	(insufficient data)	none	140	630
Northwestern Floristic Region									
WFw54	0 - 55 yrs	**quaking aspen** *(balsam poplar)* *(black ash)* *(tamarack)*	55 - 105 yrs	tamarack quaking aspen black ash	> 105 yrs	tamarack quaking aspen	490	20	250

bold = >50% normal = 25-50% *(italics)* = 10-25%