Wolsfeld Woods Scientific and Natural Area, Hennepin County, MN

General Description

Mesic Hardwood Forest (MH) communities are present in the Eastern Broadleaf Forest (EBF) Province on upland sites with soils that retain water and in settings where wildfires are infrequent. These forests are characterized by continuous, often dense canopies of deciduous trees. Beneath the main canopy are successively shorter strata composed of shade-adapted seedlings, shrubs, and herbs. Basswood, sugar maple, and northern red oak are the most common canopy dominants, but MH communities are characteristically mixtures of at least four species. Other associated or occasionally dominant tree species include American elm, bur oak, paper birch, quaking aspen, white oak, black ash, red elm, green ash, bitternut hickory, black cherry, hackberry, and big-toothed aspen.

Plants in MH communities have access to predictable supplies of water and nutrients, but growth of understory plants is limited by light because of dense forest canopies. Typical sites are buffered from seasonal drought by fine-textured soils capable of holding or perching rainfall. At the same time, soils are well drained and are water logged or saturated only after spring snowmelt or heavy, prolonged rains. Consequently, plants in MH communities rarely experience diminished respiration due to soil anoxia. Essential nutrients, especially nitrogen, are mineralized from decaying organic matter at relatively high rates (twice those of Fire-Dependent Forest/Woodland (FD) and of Wet Forest (WF) communities). As a result, in MH communities nutrients in dead plant material quickly become available again for uptake by plants during the spring and early summer months. Overall, resource availability in MH communities follows a predictable annual or seasonal pattern (in comparison with FD communities, where nutrients and carbon are released episodically by burning). Tree mortality in older MH communities is rather constant, with stand-regenerating disturbances such as wildfires and catastrophic windthrow uncommon. The death of established canopy trees is most often caused by windthrow or disease affecting individual trees or small patches of trees or by other fine-scale disturbances.

Plant Adaptations

Competition for light has a strong influence on the species composition and structure of MH communities. Older forests commonly have several, nearly closed layers of

woody plants, including a well-defined forest canopy, subcanopy, and shrub layer. These layers combine to produce continuous, if not overlapping, cover. Thus, most sunlight is filtered and attenuated before it reaches herbaceous plants and seedlings on the forest floor. Measurements of light intensity have been reported on forest floors in closed-canopy sugar maple stands of just 0.1% to 2% of direct sunlight. The plants of MH communities have strategies that appear to be adapted to the low intensity of light in these forests. For example, herbs and tree seedlings in the ground layer have enzyme stores and accessory pigments that allow for rapid photosynthesis as flecks of sunlight briefly pass over them, thereby minimizing the cost of maintaining the large stores of enzymes typical of plants growing in full sunlight. Another adaptive strategy to low light levels in MH communities is exemplified by the presence of herbaceous ground-layer species that develop rapidly in the spring, capturing and storing most of their annual energy needs before trees become fully leaved. There are varying degrees of this strategy, but for several common species in the EBF Province, this pattern of rapid early development has evolved to the point where aboveground stems develop completely, produce flowers and seeds, and die back before the leaves of canopy trees fully expand in May or early June.

In addition to light intensity, the quality (i.e., wavelength) of light changes as light is transmitted, absorbed, or reflected as it passes through the canopy to the forest floor. Light quality affects the production of the hormones in plants that control growth and form. Some woody plants are extremely plastic in form in response to the varied light conditions in MH communities. For example, red elm and pagoda dogwood *(Cornus alternifolia)* are often decumbent under low light levels, spreading horizontally beneath the duff and producing many small aerial stems. Upon reaching a light gap or after the death of an overhead tree, a single aerial stem will become dominant to form a tree or shrub with the classic upright growth form. Often, the common canopy trees have large colonies of offspring beneath them, forming banks of seedlings that remain in the understory for years until a gap opens in the canopy. For example, sugar maple trees commonly produce numerous offspring that can persist for 20 to 30 years in deep shade as knee-high seedlings with just a pair of leaves and then begin to grow up to several feet per year in response to change in light intensity should the canopy open above them.

In MH communities, nutrients and organic matter accumulate at the soil surface in leaf litter and humus. (This contrasts with FD communities, for example, where nutrients are leached deeply into the soil, and the humus layer is periodically consumed by fire, and with WF and Floodplain Forest (FF) communities, which are sinks for nutrients transported from uplands in groundwater or runoff.) Deeply rooted plants in MH communities extract base elements such as calcium, magnesium, and potassium from deep in the mineral soil and deposit them on the surface in plant litter. Species such as sugar maple, basswood, and elm, which are abundant in many stands, shed leaves with high amounts of nutrients, contributing to high nutrient content in the humus. As a result, much of the plant activity in MH forests is concentrated in the soil surface and rich humus layer. Many herbaceous plants are rooted almost entirely in humus, and many woody plants have a high proportion of their roots near the surface. Sugar maple is especially noteworthy for its ability to form secondary roots or risers that grow upward from deep roots and spread prolifically through the humus layer.

Landscape Setting, Soils, and History
The distribution of MH communities in the EBF Province is strongly influenced by landscape and soil features that provide protection from wildfires. Most important is topography. Within the EBF Province, MH communities occur most often on rugged terrain where the spread of fire is interrupted by irregular ground-level air currents and by frequent presence of relatively moist, shaded north-facing slopes. The flatter areas

in the province tended to burn regularly in the past and are more likely to support FD or Upland Prairie (UP) communities. (In comparison, in the Laurentian Mixed Forest (LMF) Province, MH communities often occur on level to rolling landscapes with fine-textured soils that retain or pond water.) Most MH communities in the EBF Province are on high stagnation moraines and stream-dissected blufflands. On especially steep or tall slopes in these landscapes, MH communities usually occur on shaded north or east aspects or on moist lower slopes. In contrast, FD and UP communities tend to occur on upper south- to west-facing slopes in these landscapes. Streams, rivers, and lakes also historically provided protection from wildfires. Along the southwestern border of the EBF Province, patches of MH communities occurred on the northeast sides of water bodies because fires started most frequently in the prairies to the west and were spread by southwesterly winds. Rugged terrain and water-related firebreaks could act alone or in concert to produce habitats that were isolated, moist, pocked with vernal pools, and experienced diminished wind speeds. These effects helped to reduce the probability of fire, but no site in the EBF Province was completely safe from fire during periods of extreme drought or unusual wind.

Another determinant of where MH communities occur within the EBF Province is the presence of sites with clayey, compacted, or cemented soil horizons about 20 to 30 inches (50 to 75cm) below the ground surface. These dense layers tend to impede the drainage of snowmelt and rainfall. As a result, in the spring the soil is saturated above these horizons, keeping the humus wet and promoting rapid green-up of the ground-layer plants, both of which help to deter fires. In the EBF Province, about 60% of all MH communities occur on soils with dense lower horizons that perch water. Interestingly, about 85% of all soils with impermeable subsurface horizons in Minnesota's forested regions are occupied by MH communities. This suggests rather strongly that in Minnesota MH communities have played a role in the genesis of soils with impermeable layers, and once established, MH communities tend to persist on these sites.

When land surveyors and Euro-American settlers described the EBF Province and its plant communities in the mid-1800s, the general consensus was that fires, originating in the prairie regions, were spreading into and destroying a large, rather solid block of MH communities that occupied much of the province. Scientists of the era, relying mostly on description and intuition, supported this view of the region's vegetative history, and it was widely accepted that these forests were Minnesota's expression of the deciduous broadleaf forest that formed the climax vegetation across much of the eastern United States. Subsequent pollen diagrams and soil surveys from the region suggest, however, that MH communities and other wooded communities were expanding their range into the prairies at about the time the first Europeans arrived in Minnesota. The following paragraphs describe in more detail the development of vegetation in the EBF Province in the period following the melting of the last glaciers in Minnesota.

About 6,000 to 8,000 years ago, during the warmest and driest period following the recession of the glaciers, the EBF Province was mostly prairie. Wooded vegetation was limited to sites extremely well protected from fire. It is unlikely that MH communities as described in this guide were present at the time, but some species characteristic of MH communities probably occurred in areas of wooded vegetation. Such sites are recognizable today by well-developed forest soils with highly leached surface horizons and thick subsoil horizons enriched with clay. The climate in the province became cooler and moister about 4,000 years ago, initiating an expansion of woody vegetation containing oak species, birch, hazel, and ironwood. Areas that today have soils with features characteristic of both forest soils and prairie soils probably became forested at this time. At the most protected sites (i.e., those sites that were wooded even during the warmest and driest period 6,000 to 8,000 years ago), a case can be made for modest increases in basswood, ironwood, elm, and ash at this time. Sites throughout the EBF Province and the southwestern edge of the LMF Province also show change in

vegetation beginning about 1,000 years ago in some cases and about 500 to 300 years ago in others. These dates coincide roughly with the warm Medieval Climatic Anomaly (about 750 to 1,100 years ago) and the cooler and moister Little Ice Age Anomaly (beginning about 750 years ago and culminating about 300 to 500 years ago). In each of these climate anomalies, the response of vegetation in the EBF Province was an increase in the presence of the fire-sensitive tree species typical of MH communities. These climatic events most likely encouraged sugar maple, basswood, elm, and ash to expand to their current ranges. The contemporary presence of oak-dominated MH communities on soils with virtually none of the features associated with long occupation by deciduous forest indicates that these forests were almost certainly established in response to these most recent climatic events.

Thus, the general trend of vegetation history in the EBF Province is the spread of MH communities across the glaciated portions of the landscape for the past 4,000 years. The sequence of prairies, followed by oak-aspen (and ironwood) woodlands, followed by dry-mesic oak forests, and eventually by forests dominated by sugar maple, basswood, ash and elm is evident in nearly all pollen diagrams in the region. The change in vegetation toward increasingly mesic, fire-sensitive species and forest structure may well be explained by a decrease in fire frequency caused by an increasingly moist and possibly cooler climate. Perhaps as important in promoting change toward mesic forest vegetation was the conversion of prairie soils to forest soils once wooded vegetation became established on sites, because forest soils retain water more effectively than prairie soils, thereby reinforcing even modest increases in precipitation. The sequence of development of forest soils in the EBF Province began with the formation of closed-canopy oak forests, followed by the loss of prairie grasses due to shade, the buildup of deciduous leaf litter and humus, the acidification and decalcification of the upper soil horizons, and the eventual movement of clays from upper to lower soil horizons. The lower soil horizons, because of their increased clay content and structure, tend to perch rainfall and snowmelt, causing forest soils to retain moisture more readily than prairie soils. There are some exceptions to this pattern of soil development in the EBF Province, most notably on the Anoka Sand Plain and the loess-covered Paleozoic Plateau, where the parent material has very little clay, and the presence of forest communities does not lead to the formation of typical forest soils with their characteristic clayey or dense subsoil horizons.

Floristic Regions

MH communities in Minnesota are grouped into four floristic regions based on general differences in species composition (Fig. MH-1). Three of these floristic regions are represented in the EBF Province: the Northern Floristic (MHn) Region, the Central Floristic (MHc) Region, and the Southern Floristic (MHs) Region. MHn communities are rare and generally limited to wet-mesic habitats in Polk, Mahnomen, and Clearwater counties and possibly to deep ravines in northernmost Washington County. MHc communities are prevalent in the northern extent of the EBF Province from Polk County to Stearns County. Southeast of Stearns County, MHc communities are rare and limited to cool microhabitats or unusual habitats that contain populations of northern plants. MHs communities occur throughout the EBF Province and are especially prevalent from Stearns County to the southeastern border of Minnesota. Communities of the fourth region, the Northwestern Floristic (MHw) Region, do not occur in the EBF Province.

The floristic variation among MH communities follows a geographic trend common to other systems in this classification. In general, common plants in northeastern Minnesota reach their southwestern range limits in the coolest and wettest local habitats. Conversely, plants widespread in the Great Plains and southwestern Minnesota tend to reach their northeastern range limits in dry, warm habitats, such as sandy riparian corridors. In the EBF Province, MHn and MHc communities are visibly differentiated from MHs communities by the presence of at least some northeastern plants. Where
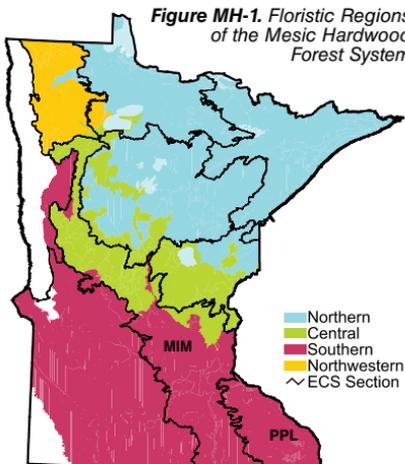
MHn and MHc communities co-occur, they are separated locally by habitat: MHn communities usually are present on wet-mesic sites, while MHc communities occur on dry-mesic and mesic sites.

MHc communities are transitional between MHn and MHs communities. There are large regions of northern and northeastern Minnesota where only MHn communities occur, while the southeastern corner of the state has almost entirely MHs communities. MHc communities, in contrast, are most common in the central and eastern portion of the state in a zone of overlap between MHn and MHs communities. Several observations suggest that the distribution of MHc and MHs communities in the EBF Province is correlated with elevation and local climatic conditions.

Figure MH-1. *Floristic Regions of the Mesic Hardwood Forest System*

Legend:
- Northern
- Central
- Southern
- Northwestern
- ∼ ECS Section

MHc communities are most prevalent on high (usually between 1,300 and 1,650 feet in elevation), rugged terrain in the Hardwood Hills Subsection, where the duration of snow cover is usually greater than 105 days, and mean annual soil temperatures are below 8°C. MHc communities can also occur at lower elevations in the province in settings where local site conditions promote cooler soil temperatures. These settings include the Anoka Sand Plain, where the presence of extensive peatlands and high water tables leads to locally cooler soil temperatures. MHc communities also occur at low elevations in deep ravines in the blufflands of southeastern Minnesota and along the St. Croix and Mississippi rivers. The valley floors and lower slopes of these ravines are generally protected from direct sunlight and are cooled by cold-air drainage and sometimes by cool air from persistent ice in fissures in rocky substrates. MHs communities, although widespread in the province, are present almost entirely on sites below 1,100 feet in elevation, where snow cover usually lasts less than 100 days, and mean annual soil temperatures are higher than 8°C.

Plant Indicators of MHn, MHc, and MHs Communities

Plant species with high fidelity for MHn relative to MHc and MHs communities are listed in Table MH-1. In general, nearly all of the species that differentiate the MHn Region are more common in Minnesota in WF communities than in MH communities. Especially well represented are ferns and fern allies such as common oak fern *(Gymnocarpium dryopteris)*, long beech fern *(Phegopteris connectilis)*, and groundpines *(Lycopodium dendroideum* or *L. hickeyi)*. Common also are evergreens such as balsam fir, shining firmoss *(Huperzia lucidula)*, and even some herbaceous species that have overwintering leaves such as bunchberry *(Cornus canadensis)*, naked miterwort *(Mitella nuda)*, and drooping wood sedge *(Carex arctata)*.

MHc communities tend to occur on sites that were occupied by northern FD communities (especially jack pine woodlands or forests) in the early Holocene Epoch (10,000 to 8,000 years ago) and by southern FD communities or UP communities during the mid-Holocene Epoch (about 8,000 years ago and continuing until rather recent times). Therefore, MHc communities are much more likely than MHs communities to have plants characteristic of FD communities, including bracken *(Pteridium aquilinum)*, pale vetchling *(Lathyrus ochroleucus)*, Lindley's aster *(Aster ciliolatus)*, and round-leaved dogwood *(Cornus rugosa)* (Table MH-2).

Table MH-1. *Plants useful for differentiating the Northern from the Central and Southern Floristic Regions of the Mesic Hardwood Forest System.*

		Common Name	Scientific Name	frequency (%)		
				MHc	MHn	MHs
Northern Floristic Region	Ferns & Fern Allies	Groundpines	*Lycopodium dendroideum* or *L. hickeyi*	1	32	-
		Common oak-fern	*Gymnocarpium dryopteris*	-	24	-
		Wood horsetail	*Equisetum sylvaticum*	1	13	-
		Shining firmoss	*Huperzia lucidula*	1	12	-
		Long beech-fern	*Thelypteris phegopteris*	-	12	-
	Evergreen*	Balsam fir (U)	*Abies balsamea*	7	55	-
		Bunchberry	*Cornus canadensis*	2	25	-
		Drooping wood-sedge	*Carex arctata*	5	23	-
		Naked miterwort	*Mitella nuda*	1	23	-
	Other	Bluebead lily	*Clintonia borealis*	15	69	-
		White spruce (U)	*Picea glauca*	1	25	-
		Swamp red currant	*Ribes triste*	1	20	-
		Palmate sweet coltsfoot	*Petasites frigidus*	-	17	-
		Yellow birch (U)	*Betula alleghaniensis*	1	15	1
		Small enchanter's nightshade	*Circaea alpina*	2	15	-
		Drooping woodreed	*Cinna latifolia*	2	13	-
		Mountain-ashes (U)	*Sorbus* spp.	-	11	-

* includes species with over-wintering leaves   (U) = understory tree

Table MH-2. *Plants useful for differentiating the Central from the Northern and Southern Floristic Regions of the Mesic Hardwood Forest System.*

		Common Name	Scientific Name	frequency (%)		
				MHc	MHn	MHs
Central Floristic Region	Fire-Dependent Forest Affinity	Bracken	*Pteridium aquilinum*	54	38	8
		Pale vetchling	*Lathyrus ochroleucus*	31	26	2
		Lindley's aster	*Aster ciliolatus*	25	22	1
		Round-leaved dogwood	*Cornus rugosa*	23	13	8
		Spreading dogbane	*Apocynum androsaemifolium*	19	13	4
		Veiny pea	*Lathyrus venosus*	18	15	-
		Lowbush blueberry	*Vaccinium angustifolium*	17	8	-
		Wild honeysuckle	*Lonicera dioica*	15	6	4
		Big-toothed aspen (U)	*Populus grandidentata*	14	6	3
	Other	Hog-peanut	*Amphicarpaea bracteata*	64	20	32
		Downy arrow-wood	*Viburnum rafinesquianum*	60	33	14
		Round-lobed hepatica	*Anemone americana*	53	43	4
		Pale bellwort	*Uvularia sessilifolia*	51	39	4
		Pointed-leaved tick-trefoil	*Desmodium glutinosum*	45	3	33
		Leatherwood	*Dirca palustris*	35	24	5
		Large-flowered trillium	*Trillium grandiflorum*	32	7	5
		Nodding fescue	*Festuca obtusa*	24	7	13
		Blue beech (U)	*Carpinus caroliniana*	24	3	19
		Side-flowering aster	*Aster lateriflorus*	18	15	2
		Yellow lady-slipper	*Cypripedium calceolus*	12	4	7
		Tall blackberries	*Rubus allegheniensis* and similar *Rubus* spp.	11	3	5

(U) = understory tree

In the EBF Province, MHs communities occur in the habitats most protected from fire. Generally these areas have rugged terrain and a well-developed system of drains, streams, and rivers. For this reason, the ground layer of MHs communities contains many species that are also common in the riparian communities of the Floodplain Forest (FF) System (Table MH-3). Among these species are trees such as hackberry and box

Table MH-3. *Plants useful for differentiating the Southern from the Central and Northern Floristic Regions of the Mesic Hardwood Forest System.*

		Common Name	Scientific Name	frequency (%)		
				MHc	MHn	MHs
Southern Floristic Region	**Floodplain Forest Affinity**	Virginia waterleaf	*Hydrophyllum virginianum*	10	1	69
		Cleavers	*Galium aparine*	2	1	53
		Honewort	*Cryptotaenia canadensis*	11	-	51
		Wood-nettle	*Laportea canadensis*	4	4	46
		White avens	*Geum canadense*	7	2	45
		Hackberry (U)	*Celtis occidentalis*	1	-	38
		Missouri gooseberry	*Ribes missouriense*	1	2	38
		Box elder (U)	*Acer negundo*	2	1	37
		Kidney-leaf buttercup	*Ranunculus abortivus*	4	4	37
		Wild grape	*Vitis riparia*	7	-	33
		Charming sedge	*Carex blanda*	4	1	29
		Moonseed	*Menispermum canadense*	-	-	20
		Stinging nettle	*Urtica dioica*	1	-	17
	Spring Ephemerals	Dutchman's breeches	*Dicentra cucullaria*	-	3	22
		Cut-leaved toothwort	*Dentaria laciniata*	-	-	17
		False rue-anemone	*Isopyrum biternatum*	-	-	17
		White trout-lily	*Erythronium albidum*	1	-	16
		Mayapple	*Podophyllum peltatum*	-	-	16
		Virginia spring-beauty	*Claytonia virginica*	-	1	12
	Other	Sharp-lobed hepatica	*Anemone acutiloba*	6	-	36
		Gregarious black snakeroot	*Sanicula gregaria*	5	-	26
		Spreading Jacob's-ladder	*Polemonium reptans*	-	-	24
		Blue phlox	*Phlox divaricata*	-	-	23
		Elegant bedstraw	*Galium concinnum*	-	-	21
		Heart-leaved aster	*Aster cordifolius*	1	-	20
		Sprengel's sedge	*Carex sprengelii*	-	-	17
		Common snakeroot	*Eupatorium rugosum*	-	-	17
		Drooping trillium	*Trillium flexipes*	-	-	16
		White bear-sedge	*Carex albursina*	-	-	15
		Hairy-leaved sedge	*Carex hirtifolia*	-	-	14
		Bladdernut	*Staphylea trifolia*	-	-	14
		Bulblet bladder-fern	*Cystopteris bulbifera*	1	-	12
		Showy orchis	*Galearis spectabilis*	-	-	12
		American ginseng	*Panax quinquefolium*	1	-	12
		Stickseeds	*Hackelia* spp.	-	-	11
		Rue-anemone	*Anemonella thalictroides*	-	-	10

(U) = understory tree

elder, climbing plants such as wild grape *(Vitis riparia)* and moonseed *(Menispermum canadense)*, and herbaceous species such as blue phlox *(Phlox divaricata)*, Dutchman's breeches *(Dicentra cucullaria)*, and heart-leaved aster *(Aster cordifolius)*. Incidentally, many of the characteristically FF plants listed in Table MH-3 occur widely in southern deciduous forests in the EBF Province but also extend their ranges into the LMF Province in limited habitats along major rivers or large lakes such as Upper and Lower Red Lake, Leech Lake, Lake Winnibigoshish, Mille Lacs Lake, and Lake Superior. It is possible that rivers and large lakes afford some protection from frost and provide an extended growing season that allows southern plants to grow far to the north in Minnesota. It is also possible that the historically higher levels of human activity and disturbance associated with large rivers and lakes may have contributed to the presence of characteristic MHs plants along water bodies far north of the typical range of MHs communities. MHs communities typically have higher levels of disturbance (especially from wind; see below) than either MHn or MHc communities and have species adapted to at least moderate levels of disturbance.

Disturbance Regimes of MHn, MHc, and MHs Communities

MH communities historically had low rates of catastrophic disturbance from fires and windstorms. Along with WF communities, they are the least disturbed forest communities in the state. Rotation periods for catastrophic fire and wind are in excess of 370 and 360 years, respectively, and often greater than 1,000 years. Disturbances that result in the partial loss of canopy trees, such as light surface fires and moderate windthrow, were far more frequent. MHn communities tended to have the lowest rates of partial canopy disturbance, with rotation periods of 130 to 160 years for moderate surface fire and patchy windthrow. MHc communities were somewhat more disturbed, with rotation periods for partial canopy disturbances of 40 to 140 years. MHs communities had the highest rates of moderate disturbance, with rotation periods of 20 to 160 years (Table MH-4). For MHn and MHc communities there are more explicit references to fire than wind in the Public Land Survey notes, suggesting that surface fires played a more important role than wind. For MHs communities, wind is explicitly referenced more than fire, suggesting that wind played a greater role than fire. This is in spite of the fact that MHs communities were embedded in a matrix of FD and UP communities, which burned frequently. Climatic data for the past 50 years are consistent with the notion that MHs forests are more frequently damaged by wind (probably including ice-laden trees) than are deciduous forests in the MHc and MHn Floristic regions. About three to four times as many damaging windstorms per acre are reported for the MHs Region than for the MHc Region and MHn Region, respectively.

Table MH-4. *Historic tree species composition & disturbance regimes in Mesic Hardwood 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 ⟶	430-970	130-160	800-1000+
MHn35	0 - 55 yrs	paper birch *(quaking aspen)* *(sugar maple)* *(northern red oak)*	95 - 205 yrs	paper birch *(sugar maple)* *(white spruce)*	> 295 yrs	white pine sugar maple *(paper birch)*	970	130	>1000
MHn44	0 -35 yrs	**quaking aspen**	95 - 195 yrs	white spruce *(quaking aspen)* *(paper birch)* *(balsam fir)*	> 195 yrs	white spruce quaking aspen *(paper birch)* *(balsam fir)*	430	160	960
MHn46	0 - 35 yrs	**quaking aspen**	> 95 yrs	quaking aspen *(white spruce)* *(American Elm)****	!	--	600	160	800

Table MH-4 *continued on next page.*

Table MH-4. continued

Central Floristic Region — ranges ➝

							370-1000+	40-140	380-1000+
MHc26	0-35 yrs	**quaking aspen** *(paper birch)* *(American elm)**** *(basswood)*	55-135 yrs	paper birch *(quaking aspen)** *(northern red oak)*	> 135 yrs	quaking aspen* *(paper birch)* *(white spruce)* *(northern red oak)* *(white pine)*	370	75	910
MHc36	0-35 yrs	**northern red oak** *(basswood)* *(quaking aspen)**	> 95 yrs	sugar maple *(basswood)* *(American elm)****	⋮	--	>1000	40	380
MHc38	⋮	(insufficient data)	⋮	(insufficient data)	⋮	(insufficient data)	--	--	--
MHc37	0-55 yrs	**quaking aspen** *(paper birch)*	55-135 yrs	sugar maple *(basswood)* *(American elm)**** *(northern red oak)* *(paper birch)*	>135 yrs	*(quaking aspen)* *(American elm)**** *(sugar maple)* *(white spruce)*	515	70	>1000
MHc47	0-55 yrs	*(basswood)* *(bur oak)* *(quaking aspen)* *(paper birch)* *(sugar maple)*	55-155 yrs	*(basswood)* *(bur oak)* *(sugar maple)* *(paper birch*	> 155 yrs	basswood *(bur oak)* *(white pine)* *(sugar maple)*	>1000	140	>1000

Southern Floristic Region — ranges ➝

							1000+	20-160	360-1000+
MHs37	0-55 yrs	**northern red oak** *(white oak)*** *(basswood)*	>95 yrs	white oak** basswood *(northern red oak)* *(American elm)****	⋮	--	>1000	20	390
MHs38	0-35 yrs	**northern red oak** *(basswood)*	> 75 yrs	sugar maple *(basswood)* *(American elm)**** *(ironwood)* *(northern red oak)* *(white oak)*	⋮	--	>1000	35	360
MHs39	0-35 yrs	northern red oak *(basswood)* *(quaking aspen)*	> 75 yrs	sugar maple *(basswood)* *(American elm)**** *(northern red oak)*	⋮	--	>1000	50	680
MHs49	0+ years	American elm**** basswood *(sugar maple)*	⋮	--	⋮	--	--	160	>1000

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

*includes big-toothed aspen   **includes bur oak   ***includes red elm   ****includes red and rock elm