

13210

South-Central Interior Mesophytic Forest

BpS Model/Description Version: Aug. 2020

Update: 3/18

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Vegetation Type

Forest and Woodland

Map Zones

61, 63

Geographic Range

The mixed-mesophytic forest region (Küchler 1964) is located in two of Bailey's ecoregion sections (McNab and Avers 1994). It includes the southern portion of the Southern Unglaciaded Allegheny Plateau Section (southeastern Ohio, western West Virginia, northeastern Kentucky). It also covers the Northern Cumberland Plateau Section (eastern Kentucky and east-central Tennessee; and southern Blue Ridge ecoregion, and a very small portion in northeast Alabama and northwest Georgia). There are also scattered occurrences in northwestern and central Pennsylvania (C.E. Williams, G. Nowacki personal communication). In the southern limits of this forest type, one might find this more restricted to more northerly aspects.

These high-diversity, predominately deciduous forests occur on deep and enriched soils (in some cases due to, or enhanced by, the presence of limestone or related base-rich geology), usually in somewhat protected landscape positions such as coves or lower slopes. The core distribution of this system lies in the Cumberland and Allegheny plateaus, extending into the adjacent southern Ridge and Valley and portions of the Interior Low Plateau where it is located entirely south of the glacial boundary.

Biophysical Site Description

Mixed mesophytic forests occur on moist, topographically protected areas (e.g. coves, v-shaped valleys, north- and east-facing toe slopes) within highly dissected hills, and mountains. On slopes it forms a mosaic with pyrogenic oak-hickory forests, whereby mixed mesophytic forests are restricted to the most protected coves and oak-hickory occurs on the interfluvies. These Plateaus are mature and dissected, most of the landscape consisting of high hills and narrow valleys. Elevations range from 650-1,300ft in the Allegheny Plateau and from 1,270-2,000ft in the Cumberland Plateau (McNab and Avers 1994). The dissected topography creates strong gradients in microclimate and soil moisture and fertility at the local (watershed) scale (Hutchins et al. 1976, Iverson et al. 1997, Morris and Boerner 1998). In the absence of frequent or catastrophic disturbance, these environmental gradients determine forest composition (Hutchins et al. 1976, Muller 1982, Iverson et al. 1997, Dyer 2001).

These forests occupy the transition zone from the oak-hickory forest to the northern hardwood forest. They are among the most diverse in the US containing more than 30 canopy tree species. This type lies west of the Appalachians and transitions from the more northern sugar maple-beech-birch forest in northern West Virginia, southwestern Pennsylvania (lesser extent in northwestern and central Pennsylvania), and southern Ohio southward down the Allegheny Mountains, across the Allegheny Plateau including all the Cumberland Plateau, and into northern Alabama where it transitions to the oak-hickory-pine type of the Southern Mixed Hardwood Forest (Brown et al. 2000). Two major and distinct forest types within this Biophysical Setting (BpS) are typically recognized: mixed-oak and mixed-mesophytic. This model focuses on the mixed-mesophytic type. This model crosswalks to NatureServe Terrestrial Ecological classification, under the heading Deciduous Forest Woodland.

CES 202.596 Central and Southern Appalachian Montane Forest

CES 203.477 East Gulf Coastal Plain Northern Mesic Hardwood Slope Forest

CES 202.887 South-Central Interior Mesophytic Forest

CES 202.373 Southern and Central Appalachian Cove Forest

CES 202.886 Southern Appalachian Oak Forest

CES 202.342 Southern Piedmont Mesic Forest

Vegetation Description

A diverse closed-canopy forest with dominant species including beech (*Fagus grandifolia*), tulip-poplar (*Liriodendron tulipifera*), American basswood (*Tilia americana* var. *heterophylla*), sugar maple (*Acer saccharum*), yellow buckeye (*Aesculus flava*), *Magnolia acuminata*, and *Juglans nigra*, red oak (*Quercus rubra*), white oak (*Q. alba*) and formerly American chestnut (*Castanea dentata*) (Braun 1950, Muller 1982). The oak component tends to grade from white oaks in the southern areas to red and black oaks in the northern geographic range of this forest type. *Tsuga canadensis* may be a minor component of some stands. Trees may grow very large in undisturbed areas. In the northern areas, both white (*Fraxinus americana*) and green ash (*Fraxinus pennsylvanica*) can be up to 10-15% of forest type (C. Emanuel, personal communication). This forest type developed primarily on mesic, sheltered landscapes positions (e.g., lower slopes, coves, ravines) but also occurred on some dry-mesic slopes, where presumably fire was infrequent (Wade et al. 2000).

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
FAGR	<i>Fagus grandifolia</i>	American beech
LITU	<i>Liriodendron tulipifera</i>	Tuliptree
ACSA3	<i>Acer saccharum</i>	Sugar maple
TIAMH	<i>Tilia americana</i> var. <i>heterophylla</i>	American basswood
QURU	<i>Quercus rubra</i>	Northern red oak
JUNI	<i>Juglans nigra</i>	Black walnut
CADE12	<i>Castanea dentata</i>	American chestnut
TSCA	<i>Tsuga canadensis</i>	Eastern hemlock

Species names are from the NRCS PLANTS database. Check species codes at <http://plants.usda.gov>.

Disturbance Description

The mixed-mesophytic forest had surface fires with return intervals 30-100yrs+ (Wade et al. 2000). Mixed severity fires will occur approximately every 500yrs opening the canopy with increased mortality. This effect may also be achieved by recurrent, severe insect defoliations or droughts. Straight-line winds or microbursts may cause blow-downs on a scale of 1-100ac. Due to the mesic nature of these forests, stand replacement fires happen very infrequently. Ice storm damage is a more common disturbance than fire in this system, and yet ice storm frequency directly feeds into fuel loading at these sites. The oaks found within this forest type are susceptible to Gypsy Moth, but these effects are not included in this model since it is a recent invasive. Another prominent current issue is Oak Decline, but its impact on reference conditions is not known.

Landscape context impacts fire regimes, especially for BpSs occurring near fire-dependent BpSs such as this one. The adjacent oak ecosystems probably had frequent surface fires which would have moved into this BpS.

Additionally, see the following papers for more information:

- Rentch (2010): specificity on wind impacts, especially regarding directionality and implications of crown asymmetry
- Scumacher and Carson (2013): Homogenization of understory due to changes in disturbance regimes (has good literature review).

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	844	9		
Moderate (Mixed)	572	14		
Low (Surface)	101	77		
All Fires	78	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Mixed-mesophytic forest occur more continuously on north- and east-facing toe slopes, and interfinger with oak-hickory on side slopes up to the northern hardwood zone and higher elevations.

Adjacency or Identification Concerns

Mapping mixed mesophytic forests would likely focus on specific topographic positions, such as coves, valley bottoms typically v-shaped (excluding broad u-shaped floodplains), lower north and east facing slopes; sometimes west and south facing lower slopes where moisture permits; wet-mesic to mesic conditions on the landscape; rich fertile conditions/sites; shaded topographic positions (Nowacki personal communication). On side slopes, mixed mesophytic forest interbraid with oak-hickory forests, with mixed-mesophytic occurring in v-notches and coves (drainages) and oak-hickory on interfluves.

This forest type grades into Northeastern Interior Dry-Mesic Oak Forest (1303), where it grades into northern sites when soils are drier, e.g., shallower soils, sandier parent material, and as elevation is increased. In contrast the South-Central Interior Mesophytic Forest (1320) has gentler slopes with soils featuring a higher water holding capacity.

Issues or Problems

Though Küchler (1964) mapped and described this region as mixed-mesophytic, witness tree data (from early land surveys) and studies of old-growth forests suggest that mixed-oak forests were more abundant than mixed-mesophytic forests in many areas prior to European settlement (Beatley 1959, McCarthy et al. 1987, Abrams et al. 1995, Dyer 2001, McCarthy et al. 2001, Rentch et al. 2003). Delineating the potential boundaries of "mixed-mesophytic" forest type today should recognize that this boundary is influenced by human management interactions, e.g., historic logging and high-grading, the absence of fire, deer populations (herbivory, see Abrams and Johnson 2012, and Tuttle et al. 2013), and non-native invasive species (plants, animals, insects and disease).

Native Uncharacteristic Conditions

Tree of Heaven (*Ailanthus altissima*) is a significant invader in these sites, due to its ability to persist in fairly intact canopy as well as its highwater demand (K. Brown, personal communication).

Comments

See Tuttle et al. (2013) for synthesis of current issues facing this BpS, and potential management ideas.

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Herb	0.5-1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Herb	>1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	0-0.5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	0.5-1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	1.0-3.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	>3.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	A	A	A	A	A	A	A	A	A	A
Tree	10-25	UN	UN	UN	UN	UN	UN	UN	B	B	B
Tree	25-50	UN	UN	UN	UN	UN	C	C	D	D	D
Tree	>50	UN	UN	UN	UN	UN	UN	UN	E	E	E

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A	2	Early Development 1 - All Structures
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FRAM2	Fraxinus americana	White ash	Upper
LITU	Liriodendron tulipifera	Tuliptree	Upper
ULAM	Ulmus americana	American elm	Upper
BELE	Betula lenta	Sweet birch	Upper

Description

Regenerating stands established after catastrophic disturbance, primarily wind and ice storms and infrequently by fire. Tree regeneration unfolds from a combination of stump and root sprouts and the seedbank. This short-lived stage exists until canopy closure occurs and resource competition for growing space begins.

Maximum Tree Size Class

Sapling >4.5ft; <5"DBH

Class B	8	Mid Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LITU	Liriodendron tulipifera	Tuliptree	Upper
FRAM2	Fraxinus americana	White ash	Upper
ACSA3	Acer saccharum	Sugar maple	Lower
FAGR	Fagus grandifolia	American beech	Lower

Description

Mid seral closed overstory; stem exclusion stage. Although canopy closure occurs at approximately 10 years of age, intense competition between canopy dominants begins after the stand is ~20yrs old. Large gaps are not common, as mortality from tree suppression tends to result from crown overtopping, not gap formation. Red oak is found as seedlings in the understory, and is found as a canopy dominant in later successional stages. These stands will remain in this self-thinning, closed canopy condition until approximately 60yrs old.

Maximum Tree Size Class

Medium 9-21"DBH

Class C	5	Late Development 1 - Open
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FAGR	Fagus grandifolia	American beech	Upper
ACSA3	Acer saccharum	Sugar maple	Upper
LITU	Liriodendron tulipifera	Tuliptree	Upper
fram2	<NOT FOUND IN NRCS>	<NOT FOUND IN NRCS>	Upper

Description

Mature forest with gaps created by wind, ice storms, insect and disease, and to a lesser extent by fire leading to small gap openings. Low intensity fires may occur, but more severe fires with the potential for gap formation and alteration of canopy structure are much less frequent. Partial canopy disturbances from moderate-level wind events and ice storms are common and lead to multi-cohort stands. These events generally remove 25-50% of the canopy. Canopy would typically close after approximately 10yrs.

Maximum Tree Size Class

Large 21-33"DBH

Class D	3	Late Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FAGR	<i>Fagus grandifolia</i>	American beech	Upper
ACSA3	<i>Acer saccharum</i>	Sugar maple	Upper
LITU	<i>Liriodendron tulipifera</i>	Tuliptree	Upper
QURU	<i>Quercus rubra</i>	Northern red oak	Upper

Description

Closed-canopy, mature, mixed-mesophytic forests that develop on mesic landscape positions, on deep, rich soils, and the presence of limestone and/or base-rich geologic parent material. Dominant trees are 100yrs+ of age. Dominant species include *Fagus grandifolia*, *Acer saccharum*, *Liriodendron tulipifera*, *Quercus rubra*, *Tilia americana* var. *Heterophylla*, *Aesculus flava*, *Tsuga canadensis*.

Maximum Tree Size Class

Large 21-33"DBH

Class E	82	Late Development 2 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ACSA3	<i>Acer saccharum</i>	Sugar maple	Upper
LITU	<i>Liriodendron tulipifera</i>	Tuliptree	Upper
FAGR	<i>Fagus grandifolia</i>	American beech	Upper
QURU	<i>Quercus rubra</i>	Northern red oak	Upper

Description

Late successional stands, >120yrs old, which feature: some individual trees nearing maximum age and size for their species, multiple canopy strata, gaps, regeneration of multiple age and size classes, and coarse woody debris (standing and down) (Davis 1993). Dominant species: *Fagus grandifolia*, *Acer saccharum*, *Liriodendron tulipifera*, *Quercus rubra*. Fire is infrequent with low

intensity (e.g., surface fires during droughts). Canopy structure is maintained by wind, ice, insect and disease events – and the scale of disturbance is dominated by gap dynamics (Davis 1993).

Maximum Tree Size Class

Very Large >33"DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:CLS	9
Mid1:CLS	10	Late1:CLS	60
Late1:OPN	61	Late1:OPN	119
Late1:CLS	61	Late2:CLS	119
Late2:CLS	120	Late2:CLS	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Mixed Fire	Early1:ALL	Early1:ALL	0.002	500	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.003	333	Yes	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.004	250	Yes	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.01	100	No	0
Replacement Fire	Late1:OPN	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Late1:OPN	Early1:ALL	0.005	200	Yes	0
Surface Fire	Late1:OPN	Late1:OPN	0.01	100	No	0
Alternative Succession	Late1:OPN	Late2:CLS	0.013	77	Yes	0
Mixed Fire	Late1:CLS	Late1:OPN	0.002	500	Yes	0
Insects or Disease	Late1:CLS	Late1:OPN	0.002	500	Yes	0
Wind or Weather or Stress	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Surface Fire	Late1:CLS	Late1:CLS	0.01	100	No	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.025	40	Yes	0
Replacement Fire	Late2:CLS	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Late2:CLS	Late2:CLS	0.002	500	No	0

Wind or Weather or Stress	Late2:CLS	Late2:CLS	0.003	333	No	0
Insects or Disease	Late2:CLS	Late2:CLS	0.003	333	No	0
Surface Fire	Late2:CLS	Late2:CLS	0.01	100	No	0

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