

13180

Southern and Central Appalachian Cove Forest

BpS Model/Description Version: Aug. 2020

Update: 4/6/2018

Modelers		Reviewers	
Milo Pyne	milo_pyne@natureserve.org	None	None
None	None	None	None
None	None	None	None

Reviewer: Model adopted from the Great Smoky Mountains National Park Landscape Conservation Forecasting project and description modified to match the model definitions. No revised description was available from the project.

Vegetation Type

Forest and Woodland

Map Zones

57, 59, 61

Geographic Range

This Biophysical Setting (BpS) model represents the “cove forests” or mixed-mesophytic forests (including “Acid Coves” with hemlock) of sheltered topographic positions in the Southern Blue Ridge and central Appalachian Mountains, ranging from northwestern Georgia through the southern Appalachians of the Carolinas and Virginia. It is found in an area that generally corresponds (in the south) with the Appalachian Oak region of Küchler (1964). To the northern end of its range, it includes parts of the Northern Hardwoods and Oak-Pine regions, and to the west it includes the higher elevation and more rugged parts of the Mixed Mesophytic region (e.g. Pine and Black Mountains in Kentucky). This range is generally consistent with M221 of Keys et al. (1995).

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 cove or mixed mesophytic forests are restricted to the most protected coves and oak-hickory occurs on the interfluves. 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 United States containing more than 30 canopy tree species. This model focuses on the cove or mixed-mesophytic type in the Southern and Central Appalachian regions.

NatureServe (2007) defines this system as not including rich, mesophytic "cove" forests of the Cumberland Plateau and Interior Low Plateau, even though some of these approach or exceed

Appalachian examples in their species composition and or their "coveyness." This will be interpreted as variability within South-Central Interior Mesophytic Forest (CES202.887 -- BpS 1321).

Vegetation Description

A diverse closed-canopy forest with dominant species including beech (*Fagus grandifolia*) yellow-poplar (*Liriodendron tulipifera*), American basswood (*Tilia americana* var. *heterophylla*), sugar maple (*Acer saccharum*), yellow buckeye (*Aesculus flava*), red oak (*Quercus rubra*), white oak (*Quercus alba*) and formerly American chestnut (*Castanea dentata*) (Braun 1950, Muller 1982). 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).

NatureServe (2007) notes that *Fraxinus americana*, *Aesculus flava*, *Betula lenta*, *Magnolia acuminata*, *Magnolia fraseri*, *Halesia tetraptera*, *Prunus serotina* and *Tsuga canadensis* are the most frequent dominant canopy species. Canopies are generally very diverse, with all species potentially occurring in one 20x50-meter plot in rich cove areas.

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
AEFL	<i>Aesculus flava</i>	Yellow buckeye
QURU	<i>Quercus rubra</i>	Northern red oak
QUAL	<i>Quercus alba</i>	White oak
CADE12	<i>Castanea dentata</i>	American chestnut

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

Disturbance Description

The mixed-mesophytic forest type is fire regime class III, 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. Stand replacement fires happen very infrequently. This BpS is susceptible to Gypsy Moth, but its 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 and oaks are not typically a dominant species in stands of this type.

NatureServe (2007) makes note that this system is naturally dominated by stable, uneven-aged forests, with canopy dynamics dominated by gap-phase regeneration on a fine scale. Occasional extreme wind or ice events may disturb larger patches. Natural fire dynamics are not well-known and probably only occurred in years that were extremely dry. Fires may have occurred at moderate frequency but were probably usually low enough in intensity to have only limited effects. Most of the component species are among the less fire-tolerant in the region.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	994	8		
Moderate (Mixed)	498	15		
Low (Surface)	100	77		
All Fires	77	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

Cove or Appalachian mixed-mesophytic forests occur more continuously on north and east facing toe slopes, and inter-finger with oak-hickory on side slopes up to the northern hardwood zone and higher elevations.

NatureServe (2007) notes that most individual patches are 10s-100ac. Because it frequently occurs in mosaics with other systems, separation distance for occurrences has a strong effect on the size of occurrences. Complexes of 1,000's of acres of this system are possible.

Adjacency or Identification Concerns

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

NatureServe (2007) makes the following comments regarding adjacent Ecological Systems: This system (BpS 1318) is usually bordered by Southern Appalachian Oak Forest (CES202.886 -- BpS 1315) in the Southern Blue Ridge. The border with adjacent systems is gradational. It may also contain small embedded patches of Southern Appalachian Montane Cliff and Talus (CES202.330) or other small-patch systems. Southern Appalachian Oak Forest (CES202.886 -- BpS 1315) occurs upslope from this system.

In the southern Appalachians, the "richer" phase of Southern and Central Appalachian Cove Forest (CES202.373 this BpS, 1318) occurs downslope from the hemlock "phase" ("acidic cove forests") and tends to be more mesic and more species-rich than the hemlock-dominated areas.

Issues or Problems

Witness tree data (from early land surveys) and studies of old-growth forests suggest that mixed-oak forests were generally more abundant on the landscape than mixed-mesophytic forests prior to European settlement (Beatley 1959, McCarthy et al. 1987, Abrams et al. 1995, Dyer 2001, McCarthy et al. 2001, Rentch et al. 2003). The delineation of the 'cove' or 'mixed-mesophytic' forest type today is influenced by the absence of fire, deer herbivory, and non-native invasive species (plants, animals, insects and disease). The absence of fire is causing an expansion of some of the characteristic mesic taxa out of coves, potentially replacing previous oak-dominated vegetation on drier and more exposed sites than those typically associated with mesic vegetation.

This model was developed to represent the true cove or mixed-mesophytic forest type within the Southern and Central Appalachian region.

Native Uncharacteristic Conditions

Uncharacteristic types (structure/composition/etc.) that may frequently occur today in this BpS include non-native invasive species (plants, animals, insects, pathogens, etc.), deer herbivory (limiting species composition and structure), and absence of fire. The exotic tree *Ailanthus altissima* may dominate local canopy gaps, replacing *Liriodendron*; the exotic grass *Microstegium vimineum* may dominate the herbaceous stratum of stands where it has become established.

Comments

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	A	A	A	A	A	A	A	A	A	A
Herb	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Herb	>1.0	A	A	A	A	A	A	A	A	A	A
Shrub	0-0.5	A	A	A	A	A	A	A	A	A	A
Shrub	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Shrub	1.0-3.0	A	A	A	A	A	A	A	A	A	A
Shrub	>3.0	A	A	A	A	A	A	A	A	A	A
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	C	C	C	C	C	C	C	B	B	B
Tree	10-25	D	D	D	D	D	D	D	E	E	E
Tree	25-50	D	D	D	D	D	D	D	E	E	E
Tree	>50	D	D	D	D	D	D	D	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 6 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FAGR	<i>Fagus grandifolia</i>	American beech	Upper
LITU	<i>Liriodendron tulipifera</i>	Tuliptree	Upper
ACSA3	<i>Acer saccharum</i>	Sugar maple	Upper
BEAL2	<i>Betula alleghaniensis</i>	Yellow birch	Upper

Description

Regenerating stands are established after catastrophic disturbance, primarily wind and ice storms and less frequently by fire. Tree regeneration unfolds from a combination of stump and root sprouts and the seed bank. 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	26	Mid Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LITU	<i>Liriodendron tulipifera</i>	Tuliptree	Upper
BEAL2	<i>Betula alleghaniensis</i>	Yellow birch	Upper
ACSA3	<i>Acer saccharum</i>	Sugar maple	Mid-Upper
FAGR	<i>Fagus grandifolia</i>	American beech	Mid-Upper

Description

Mid-seral closed overstory; stem exclusion stage. Intense competition begins after canopy closure (~10-20yrs.) and lasts until trees are large enough to form, upon their death, canopy gaps that are not captured by lateral growth of neighboring trees. This "released" growing space that is captured by tree and shrub regeneration. *Liriodendron tulipifera* and *Betula alleghaniensis* may temporarily out compete some other slower-growing species.

Maximum Tree Size Class

Pole 5-9" DBH

Class C	1	Mid Development 1 - Open
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LITU	<i>Liriodendron tulipifera</i>	Tuliptree	Upper
BEAL2	<i>Betula alleghaniensis</i>	Yellow birch	Upper
ACSA3	<i>Acer saccharum</i>	Sugar maple	Mid-Upper
FAGR	<i>Fagus grandifolia</i>	American beech	Mid-Upper

Description

Mid-seral closed overstory; stem exclusion stage. Intense competition begins after canopy closure (~10-20yrs.) and lasts until trees are large enough to form, upon their death, canopy gaps that are not captured by lateral growth of neighboring trees. This "released" growing space that is captured by tree and shrub regeneration. *Liriodendron tulipifera* and *Betula alleghaniensis* may temporarily out compete some other slower-growing species.

Maximum Tree Size Class

Pole 5-9" DBH

Class D	4	Late Development 1 - Open
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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	Mid-Upper
BEAL2	<i>Betula alleghaniensis</i>	Yellow birch	Middle

Description

Mature forest with gaps created by wind, ice storms, insect and disease, and to a lesser extent by fire, leading to "open" overstory conditions. 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 over time. Dominant species include *Fagus grandifolia*, *Acer saccharum*, *Liriodendron tulipifera*, *Castanea denata*, *Tilia americana* var. *heterophylla*, *Aesculus flava*, *Tsuga canadensis*, *Prunus serotina*, *Quercus alba*, and *Quercus rubra*.

Maximum Tree Size Class

Large 10-32" to Very Large >33"DBH

Class E	63	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
BEAL2	<i>Betula alleghaniensis</i>	Yellow birch	Middle

Description

Closed-canopy mixed-mesophytic forests that develop on mesic landscape positions and have dominant trees that are mature to very mature. Dominant species include *Fagus grandifolia*, *Acer saccharum*, *Liriodendron tulipifera* and *Castanea denata*, *Tilia americana* var. *heterophylla*, *Aesculus flava*, *Tsuga canadensis*, *Prunus serotina*, *Quercus alba* and *Quercus rubra*.

Maximum Tree Size Class

Large 10-32" to Very Large >33"DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:CLS	10
Mid1:CLS	11	Late1:CLS	80
Mid1:OPN	11	Late1:CLS	80
Late1:CLS	81	Late1:CLS	999
Late1:OPN	81	Late1:OPN	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
Replacement Fire	Early1:ALL	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Early1:ALL	Early1:ALL	0.002	500	No	0
Surface Fire	Early1:ALL	Early1:ALL	0.01	100	No	0
Alternative Succession	Mid1:OPN	Mid1:CLS	1	1	No	20
Replacement Fire	Mid1:OPN	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.002	500	No	0
Optional 1	Mid1:OPN	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Mid1:OPN	Mid1:OPN	0.003	333	No	0
Insects or Disease	Mid1:OPN	Mid1:OPN	0.004	250	No	0
Surface Fire	Mid1:OPN	Mid1:OPN	0.01	100	No	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Mid1:CLS	Mid1:OPN	0.002	500	No	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Optional 1	Mid1:CLS	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Mid1:CLS	Mid1:OPN	0.003	333	No	0
Insects or Disease	Mid1:CLS	Mid1:OPN	0.004	250	No	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.01	100	No	0
Alternative Succession	Late1:OPN	Late1:CLS	1	1	No	20
Replacement Fire	Late1:OPN	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Late1:OPN	Late1:OPN	0.002	500	No	0
Wind or Weather or Stress	Late1:OPN	Early1:ALL	0.002	500	Yes	0
Optional 1	Late1:OPN	Early1:ALL	0.002	500	Yes	0
Insects or Disease	Late1:OPN	Late1:OPN	0.004	250	No	0
Surface Fire	Late1:OPN	Late1:OPN	0.01	100	No	0

Replacement Fire	Late1:CLS	Early1:ALL	0.001	1000	Yes	0
Mixed Fire	Late1:CLS	Late1:OPN	0.002	500	No	0
Wind or Weather or Stress	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Optional 1	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.003	333	No	0
Insects or Disease	Late1:CLS	Late1:OPN	0.004	250	No	0
Surface Fire	Late1:CLS	Late1:CLS	0.01	100	No	0

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