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 | *Fagus grandifolia* | American beech |
| LITU | *Liriodendron tulipifera* | Tuliptree |
| ACSA3 | *Acer saccharum* | Sugar maple |
| TIAMH | *Tilia americana var. heterophylla* | American basswood |
| AEFL | *Aesculus flava* | Yellow buckeye |
| QURU | *Quercus rubra* | Northern red oak |
| QUAL | *Quercus alba* | White oak |
| CADE12 | *Castanea dentata* | 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 | Fagus grandifolia | American beech | Upper |
| LITU | Liriodendron tulipifera | Tuliptree | Upper |
| ACSA3 | Acer saccharum | Sugar maple | Upper |
| BEAL2 | Betula alleghaniensis | 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

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| LITU | Liriodendron tulipifera | Tuliptree | Upper |
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper |
| ACSA3 | Acer saccharum | Sugar maple | Mid-Upper |
| FAGR | Fagus grandifolia | 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

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| LITU | Liriodendron tulipifera | Tuliptree | Upper |
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper |
| ACSA3 | Acer saccharum | Sugar maple | Mid-Upper |
| FAGR | Fagus grandifolia | 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

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 | Mid-Upper |
| BEAL2 | Betula alleghaniensis | 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

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 |
| BEAL2 | Betula alleghaniensis | 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 |

References

Beatley, J.C. 1959. The primeval forests of a periglacial area in the Allegheny Plateau (Vinton and Jackson Counties, Ohio). Bulletin of the Ohio Biological Survey 1: 1-166 .

Braun, E.L. 1950. Deciduous forests of eastern North America. Blakiston Co., Philadelphia.

Brown, James K.; Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol.2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Delcourt, P.A., Delcourt, H.R., Ison, C.R., Sharp, W.E. and Gremillion, K.J. 1998. Prehistoric human use of fire, the eastern agricultural complex, and Appalachian oak-chestnut forests: paleoecology of Cliff Palace Pond, Kentucky. American Antiquity 63: 263-278.

Dyer, J.M. 2001. Using witness trees to assess forest change in southeastern Ohio. Canadian Journal of Forest Research. 31: 1708-1718.

Frost, C.C. 1998. Presettlement fire frequency regimes of the United States: a first approximation. In Proceedings of the 20th Tall Timbers fire ecology conference--fire in ecosystem management: shifting the paradigm from suppression to prescription. Edited by Pruden, T.L. and Brennan, L.A. Tall Timbers Research Station, Tallahassee, FL. Pp. 70-81

Guyette, R.P., Dey, D.C. and Stambaugh, M.C. 2003. Fire and human history of a barren-forest mosaic in southern Indiana. American Midland Naturalist 149: 21-34.

Hutchins, R.B., Blevins, R.L., Hill, J.D. and White, E.H. 1976. The influence of soils and microclimate on vegetation of forested slopes in eastern Kentucky. Soil Science 121: 234-241.

Iverson, L.R., Dale, M.E., Scott, C.T. and Prasad, A. 1997. A GIS-derived integrated moisture index to predict forest composition and productivity of Ohio forests (U.S.A.). Landscape Ecology 12: 331-348.

Küchler, A.W. 1964. Potential natural vegetation of the conterminous United States (map). Special Publication 36. American Geographic Society, New York.

McCarthy, B.C., Small, C.J. and Rubino, D.L. 2001. Composition, structure and dynamics of Dysart Woods, an old-growth mixed mesophytic forest of southeastern Ohio. Forest Ecology and Management 140: 193-213.

McNab, W.H. and Avers, P.E. 1994. Ecological subregions of the United States: section descriptions. USDA Forest Service Administrative Publication WO-WSA-5.

Morris, S.J. and Boerner, R.E.J. 1998. Landscape patterns of nitrogen mineralization and nitrification in southern Ohio hardwood forests. Landscape Ecology 13: 215-224.

Muller, R.N. 1982. Vegetation patterns in the mixed mesophytic forest of eastern Kentucky. Ecology 63: 1901-1917.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Rentch, J.S., Fajvan, M.A. and Hicks Jr., R.R. 2003. Spatial and temporal disturbance characteristics of oak-dominated old-growth stands in the central hardwood forest region. Forest Science 49: 778-789.

Schmidt, K.M., Menakis, J.P., Hardy, C.C., Hann, W.J., Bunnell, D.L. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. USDA Forest Service GTR-RMRS-87.

Wade, D.D., Brock, B.L., Brose, P.H., Grace, J.B., Hoch, G.A. and Patterson III, W.A. 2000. Fire in eastern ecosystems. In Wildland fire in ecosystems: effects of fire on flora. Edited by Brown, J.K. and Smith, J.K. USDA Forest Service GTR-RMRS-42-vol. 2. pp. 53-96.

Personal Communications

Davenport, B. February 15, 2005.

Nowacki, Greg. 2005. LANDFIRE Northeast modeling workshop.

Williams, C.E. 2004. Landtype mapping challenge-cost share agreement.