

**13500**

## **Central and Southern Appalachian Spruce-Fir Forest**

BpS Model/Description Version: Aug. 2020

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### **Vegetation Type**

Forest and Woodland

### **Map Zones**

61

### **Geographic Range**

This system ranges from western North Carolina and eastern Tennessee (Balsam Mountains and Great Smokey Mountains) to the mountains of Virginia and West Virginia. The Northern Hardwood component also occurs in a small part on Black Mountain. in eastern Kentucky. The northern limit is either Maryland or Pennsylvania.

### **Biophysical Site Description**

This system consists of forests in the highest elevation zone of the Southern Blue Ridge and parts of the central Appalachians. Generally occurring on all topographic positions above 1676m (5500ft), up to the highest peaks, but can be found as low as 975m (3200ft) at the northern range in West Virginia (NatureServe 2007). Occurs in the Central Appalachian Broadleaf-Coniferous and Forest Meadow ecological provinces, and the Northern Ridge and Valley and Blue Ridge Mountain ecological sections (others also likely). Generally, site conditions are poor, with short frost-free seasons.

Soils are highly variable, ranging from deep mineral soils to well-developed boulder fields. Soils may be saturated for long periods from a combination of precipitation and seepage. Any kind of bedrock may be present, but most sites have erosion-resistant felsic igneous or metamorphic rocks (NatureServe 2007). Toward the southern end of the range, soils are most often rocky and acidic, with low base saturation; toward the northern end, sites tend to be characterized by shallow, poorly developed, easily eroded soils on steep slopes. A thick organic soil layer is frequently present.

Overall hydrology is mesic, ranging from wet in bogs, seeps, and the most protected sites to dry-mesic on some exposed upper slopes and ridges. Mesic conditions and generally a cool, wet climate are maintained by high annual rainfall, frequent fog deposition, low temperatures, and heavy shading. This type would have dominated the landscape throughout with inclusions of other forest types in wetter spots, or at higher elevations.

### **Vegetation Description**

Vegetation consists primarily of forests dominated by *Picea rubens*, *Abies fraseri*, or *Abies balsamea*, occasionally by *Sorbus americana*. *Betula alleghaniensis*, *Tsuga canadensis*, and *Quercus rubra* are the only other locally common canopy species (NatureServe 2007).

This system produces stable, uneven-aged forest in various combinations of dense evergreen, broadleaf, and mixed forest with canopy dynamics dominated by gap-phase regeneration on a fine scale. The highest elevations support nearly pure expanses of Fraser fir (*Abies fraseri*) and/or red spruce (*Picea rubens*); balsam fir (*Abies balsamea*) replaces Fraser fir in Virginia and West Virginia north of Mount Rogers. Associated species in these upper elevations include yellow birch (*Betula alleghaniensis*), mountain ash (*Sorbus americana*), pin cherry (*Prunus pensylvanica*), mountain maple (*Acer spicatum*), hobble bush (*Viburnum alnifolium*), and bearberry (*Vaccinium erthrocarpum*). American beech (*Fagus grandifolia*) may occur in pure stands at a small scale. With decreasing elevations, typical northern hardwood species (*B. alleghaniensis*, *F. grandifolia*, and *Aesculus flava*) mix with *P. rubens*. As *P. rubens* drops out, various combinations of *B. alleghaniensis*, *F. grandifolia*, *A. flava*, *Acer saccharum*, and *Quercus rubra* dominate. Eastern hemlock (*Tsuga canadensis*) may be locally important.

A well-developed deciduous shrub layer is common, and a dense evergreen shrub layer (or shrub-dominated community, "heath balds") can develop on more exposed sites. A few associations have dense shrub layers of *Rhododendron catawbiense*, *Rhododendron maximum*, or *Vaccinium erythrocarpum*. The lower strata is often dense, and diversity may be high with many Southern Appalachian endemics; dominated by mosses, ferns, or forbs.

#### BpS Dominant and Indicator Species

| Symbol | Scientific Name              | Common Name      |
|--------|------------------------------|------------------|
| PIRU   | <i>Picea rubens</i>          | Red spruce       |
| BEAL2  | <i>Betula alleghaniensis</i> | Yellow birch     |
| ABFR   | <i>Abies fraseri</i>         | Fraser fir       |
| ABBA   | <i>Abies balsamea</i>        | Balsam fir       |
| FAGR   | <i>Fagus grandifolia</i>     | American beech   |
| TSCA   | <i>Tsuga canadensis</i>      | Eastern hemlock  |
| ACSA3  | <i>Acer saccharum</i>        | Sugar maple      |
| QURU   | <i>Quercus rubra</i>         | Northern red oak |

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

#### Disturbance Description

This Biophysical Setting (BpS) is characterized by stable, uneven-aged forests with canopy dynamics driven primarily by single or multiple tree disturbances resulting in gap-phase regeneration. Natural disturbances include lightning fire, debris avalanches, wind events, and ice storms (White and Pickett 1985, Nicholas and Zedaker 1989). Occasional extreme wind events disturb larger patches on the most exposed slopes. Strong winds, extreme cold, rime ice, and other extreme weather are periodically important (NatureServe 2007).

Weather disturbances, including windthrow, insect attack (especially bark beetle, spruce budworm, fungi), and ice storms, occur at intervals of 100-200yrs and are the primary disturbances. Rare extreme weather events are also important large-scale disturbances. Insect outbreaks, including bark beetles, spruce budworm (20yr intervals), and butt rot (a fungi;

predisposes stands 50-70yrs old to windthrow), are also important disturbances (USDA Forest Service 1973). These disturbances likely pre-dispose the forest to fire during drought conditions.

Fire Regime Group V. Surface fire is extremely rare, at greater than 1,000yr intervals, while replacement fire is more frequent, at 300-1,000yr intervals, and affects large patch sizes. As much as 25% of this biophysical setting may be considered a non-fire regime. In spruce-fir dominated parts of this setting, replacement fires are severe and kill most trees and understory, removing most if not all of the canopy and allowing pioneer species to emerge. Recent research indicates that on the most exposed sites, stand replacement fires in spruce-fir can result in a stable shrub-dominated community ("heath balds"). Mixed fires pass through the understory of the northern hardwood component, killing most of the smaller trees, leaving behind some large, well-established trees while creating canopy openings. Occurrence of fire is most frequent on sites where northern red oak dominates.

Lumbering and fire and/ or fire alone will scarify soils and pin cherry dominates badly burned areas. Yellow birch invades stands and becomes dominant later. Invasion by spruce-fir is slow on badly burned sites. Windthrow produces dense fir seedlings if fir overstory is mature (Society of American Foresters 1980)

### Fire Frequency

| Severity         | Avg FI | Percent of All Fires | Min FI | Max FI |
|------------------|--------|----------------------|--------|--------|
| Replacement      | 824    | 93                   |        |        |
| Moderate (Mixed) | 11710  | 7                    |        |        |
| Low (Surface)    |        |                      |        |        |
| All Fires        | 770    | 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

Primarily fine-scale (single- and multiple-tree) canopy gap dynamics.

Generally covers most of the landscape in the limited areas at the tops of the highest mountain ranges. Natural patches range from hundreds to thousands of acres. A couple remnant patches of thousands of acres remain, while other intact patches are dozens of acres embedded in landscapes of degraded spruce-fir systems (NatureServe 2007).

### Adjacency or Identification Concerns

The northern hardwood component of this biophysical setting can have a nearly indistinguishable transition to the adjacent cove-hardwood community (mixed mesophytic). Montane oak forests can be found above 4500ft on very exposed slopes.

NatureServe (2007) also notes the following regarding identification of this system: Bordered by Southern Appalachian Northern Hardwood Forest (CES202.029 -- BpS 1309) or Appalachian (Hemlock) Northern Hardwood Forest (CES202.593 - BpS 1370) at lower elevations. It may contain embedded small patches of Southern Appalachian Rocky Summit (CES202.327) and Southern Appalachian Grass and Shrub Bald (CES202.294 - BpS 1414).

This system is similar to the spruce-fir systems of the northern Appalachians and the boreal forests but differs in having less frequent natural fire, having southern seasonal dynamics (shorter winters, less extreme cold temperatures, lack of long summer days), lacking a history of glaciation, and in a flora and fauna that has southern Appalachian endemics and lacks some characteristic northern species.

High-elevation spruce-fir in West Virginia is placed in this system because its location well below the glacial boundary and presence of species of more southern affinity (e.g., *Rhododendron maximum* and *Vaccinium erythrocarpum*) differentiate it from the northern Appalachian system, despite having *Abies balsamea* rather than *Abies fraseri*. *Abies balsamea* appears to be infrequent in this system, for example being restricted to wet areas in West Virginia.

### Issues or Problems

### Native Uncharacteristic Conditions

### Comments

None

## 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        | UN               | UN    | A     | A     | A     | A     | A     | A     | A     | A      |
| Tree                 | 5-10       | UN               | UN    | A     | A     | A     | A     | A     | A     | A     | A      |
| Tree                 | 10-25      | UN               | UN    | UN    | UN    | C     | C     | C     | B     | B     | B      |
| Tree                 | 25-50      | UN               | UN    | UN    | UN    | UN    | UN    | D     | D     | D     | D      |
| Tree                 | >50        | UN               | UN    | UN    | UN    | UN    | UN    | D     | D     | D     | D      |

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 | 17 | Early Development 1 - All Structures |
|---------|----|--------------------------------------|

Indicator Species

| Symbol | Scientific Name              | Common Name          | Canopy Position |
|--------|------------------------------|----------------------|-----------------|
| BEAL2  | <i>Betula alleghaniensis</i> | Yellow birch         | Upper           |
| PRPE2  | <i>Prunus pensylvanica</i>   | Pin cherry           | Upper           |
| RUAL   | <i>Rubus allegheniensis</i>  | Allegheny blackberry | Mid-Upper       |
| ACSP2  | <i>Acer spicatum</i>         | Mountain maple       | Mid-Upper       |

Description

Typical young gap-replacement species dominated by pioneer hardwoods. Mostly single to multiple tree-sized gaps, but extreme weather-driven and/or fire events can create larger openings. *Betula alleghaniensis*, *Rubus alleghaniensis*, *Rubus canadensis*, *Prunus pennsylvanica*, *Quercus rubra*, *Fagus grandifolia*, *Acer spicatum*.

Maximum Tree Size Class

Pole 5-9" DBH

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|                |           |                                   |
|----------------|-----------|-----------------------------------|
| <b>Class B</b> | <b>14</b> | <b>Mid Development 1 - Closed</b> |
|----------------|-----------|-----------------------------------|

Indicator Species

| Symbol | Scientific Name              | Common Name  | Canopy Position |
|--------|------------------------------|--------------|-----------------|
| BEAL2  | <i>Betula alleghaniensis</i> | Yellow birch | Upper           |
| PIRU   | <i>Picea rubens</i>          | Red spruce   | Mid-Upper       |
| ABFR   | <i>Abies fraseri</i>         | Fraser fir   | Mid-Upper       |
| ABBA   | <i>Abies balsamea</i>        | Balsam fir   | Mid-Upper       |

Description

Typical stand development following most single-tree to stand-replacement events. Middle-aged stand with hardwoods still dominating the upper canopy but conifers increasing in dominance in the middle stories. *Betula alleghaniensis*, *Abies fraseri* or *A. balsamea*, *Picea rubens*, *Prunus pennsylvanica*, and *Fagus grandifolia*. *Quercus rubra* may be locally important on more exposed sites. Fuel model may be 8 in stands lacking a significant conifer component.

Pin cherry dies out of these sites at ca ~23-40yrs of age and is replaced by dense seedlings of spruce and fir. Windthrow disturbance reduces the canopy of pin cherry and yellow birch. Gaps are colonized by conifer seedlings

Maximum Tree Size Class

Medium 9-21"DBH

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|                |           |                                 |
|----------------|-----------|---------------------------------|
| <b>Class C</b> | <b>11</b> | <b>Mid Development 1 - Open</b> |
|----------------|-----------|---------------------------------|

Indicator Species

| Symbol | Scientific Name | Common Name | Canopy Position |
|--------|-----------------|-------------|-----------------|
|--------|-----------------|-------------|-----------------|

|       |                       |              |           |
|-------|-----------------------|--------------|-----------|
| BEAL2 | Betula alleghaniensis | Yellow birch | Upper     |
| ABFR  | Abies fraseri         | Fraser fir   | Mid-Upper |
| PIRU  | Picea rubens          | Red spruce   | Mid-Upper |
| ABBA  | Abies balsamea        | Balsam fir   | Mid-Upper |

#### Description

More open stands dominated by northern hardwoods, especially red oak, resulting from rare mixed fires. This class occasionally occurs in the southern parts of the range, but is not characteristic further north in Virginia or West Virginia. In the absence of disturbance, this will class succeed to a closed stand. That is, over time, in the presence of a seed source, spruce and fir will re-occur.

#### Maximum Tree Size Class

Large 21-33"DBH

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|                |           |                                    |
|----------------|-----------|------------------------------------|
| <b>Class D</b> | <b>58</b> | <b>Late Development 1 - Closed</b> |
|----------------|-----------|------------------------------------|

#### Indicator Species

| Symbol | Scientific Name       | Common Name  | Canopy Position |
|--------|-----------------------|--------------|-----------------|
| BEAL2  | Betula alleghaniensis | Yellow birch | Upper           |
| PIRU   | Picea rubens          | Red spruce   | Upper           |
| ABFR   | Abies fraseri         | Fraser fir   | All             |
| ABBA   | Abies balsamea        | Balsam fir   | All             |

#### Description

Dense, closed, stable, mature forest dominated by spruce and/or fir, although pioneer hardwoods are still the tallest trees at the beginning of this stage. The pioneer hardwoods (Yellow birch, sorbus, sugar maple, and buckeye would be other hardwoods), starting with birch, begin to drop out as stands age, although shade-tolerant hardwoods may continue to regenerate and comprise a significant component of the understory. *Betula alleghaniensis*, *Abies fraseri* or *A. balsamea*, *Picea rubens*, *Fagus grandifolia*, *Acer saccharum*. *Tsuga canadensis* or *Quercus rubra* may be locally important. A well-developed deciduous shrub layer and dense herbaceous layer may occur. Stands may be stable in this stage for long periods of time until a major disturbance occurs, although individual trees are not this long-lived.

#### Maximum Tree Size Class

Large 21-33"DBH

### **Model Parameters**

#### **Deterministic Transitions**

| From Class | Begins at (yr) | Succeeds to | After (years) |
|------------|----------------|-------------|---------------|
| Early1:ALL | 0              | Mid1:CLS    | 35            |
| Mid1:OPN   | 36             | Late1:CLS   | 65            |
| Mid1:CLS   | 36             | Late1:CLS   | 65            |
| Late1:CLS  | 66             | Late1: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 |
|---------------------------|-----------------------|---------------------|-------------------------|-----------------------|-----------------------------------------------------|------------------------------|
| Replacement Fire          | Early1:ALL            | Early1:ALL          | 0.0005                  | 2000                  | Yes                                                 | 0                            |
| Mixed Fire                | Mid1:OPN              | Mid1:OPN            | 0.0001                  | 10000                 | No                                                  | 0                            |
| Replacement Fire          | Mid1:OPN              | Early1:ALL          | 0.001                   | 1000                  | Yes                                                 | 0                            |
| Wind or Weather or Stress | Mid1:OPN              | Early1:ALL          | 0.0018                  | 556                   | Yes                                                 | 0                            |
| Insects or Disease        | Mid1:OPN              | Mid1:OPN            | 0.002                   | 500                   | No                                                  | 0                            |
| Mixed Fire                | Mid1:CLS              | Mid1:OPN            | 0.0001                  | 10000                 | Yes                                                 | 0                            |
| Replacement Fire          | Mid1:CLS              | Early1:ALL          | 0.001                   | 1000                  | Yes                                                 | 0                            |
| Wind or Weather or Stress | Mid1:CLS              | Mid1:OPN            | 0.0013                  | 769                   | Yes                                                 | 0                            |
| Insects or Disease        | Mid1:CLS              | Mid1:OPN            | 0.0013                  | 769                   | Yes                                                 | 0                            |
| Mixed Fire                | Late1:CLS             | Mid1:OPN            | 0.0001                  | 10000                 | Yes                                                 | 0                            |
| Replacement Fire          | Late1:CLS             | Early1:ALL          | 0.0015                  | 667                   | Yes                                                 | 0                            |
| Wind or Weather or Stress | Late1:CLS             | Mid1:OPN            | 0.003                   | 333                   | Yes                                                 | 0                            |
| Insects or Disease        | Late1:CLS             | Mid1:OPN            | 0.003                   | 333                   | Yes                                                 | 0                            |
| Wind or Weather or Stress | Late1:CLS             | Early1:ALL          | 0.003                   | 333                   | Yes                                                 | 0                            |
| Insects or Disease        | Late1:CLS             | Early1:ALL          | 0.003                   | 333                   | Yes                                                 | 0                            |

### References

None