LANDFIRE Biophysical Setting Model

Biophysical Setting 5713500 **Central and Southern Appalachian Spruce-Fir Forest**

☐ *This BPS is lumped with:*
☐ *This BPS is split into multiple models:*

General Information

Contributors (also see the Comments field) **Date** 8/15/2007

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Vegetation Type
Forest and Woodland

Map Zone
57

Model Zone

☐ Alaska	☐ N-Cent.Rockies
☐ California	☐ Pacific Northwest
☐ Great Basin	☐ South Central
☐ Great Lakes	☐ Southeast
☐ Northeast	☑ S. Appalachians
☐ Northern Plains	☐ Southwest

Dominant Species*

PIRU	FAGR
BEAL2	TSCA
ABFR	ACSA3
ABBA	QURU

General Model Sources
☑ Literature
☐ Local Data
☑ Expert Estimate

Geographic Range

This system ranges from western NC and eastern TN (Balsam Mountains and Great Smokey Mountains) to the mountains of VA and WV. The northern hardwood component also occurs in a small part on Black Mountain in eastern KY.

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

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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.

Disturbance Description

This setting 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 to 200yrs and are the primary disturbances. Rare extreme weather events are also important large-scale disturbances. Insect outbreaks, including bark beetles, spruce budworm (20-yr intervals), and butt rot (a fungi; predisposes stands 50-70yrs old to windthrow), are also important disturbances (USDAFS 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 to 1,000-year 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

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most frequent on sites where northern red oak dominates.

Lumbering + 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 slow on badly burned sites. Windthrow produces dense fir seedlings if fir overstory is mature (SAF 1980)

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 4500' 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.

Native Uncharacteristic Conditions

Climate change may be resulting in warmer conditions in the Southern Appalachians, restricting the occurrence of this type to less area than it occupied prior to Euro-American settlement.

Earlier, unnatural fires fueled by logging slash turned large expanses of this system into grass-shrub-hardwood scrub that has not recovered to conifer dominance after 90yrs. (NatureServe 2007).

Anthropogenic disturbances and stresses, beyond the effects of logging, have had major effects on dynamics in these systems in recent decades. An introduced insect, the balsam woolly adelgid (Adelges piceae), has killed almost all of the mature Abies fraseri. Saplings are not susceptible, resulting in many dense stands of young trees. It is unclear if these stands will establish seedlings before they too are killed (NatureServe 2007).

Stress caused by concentrated air pollutants on the mountain tops has been suggested as a cause of observed growth declines in Picea rubens (NatureServe 2007).

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

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acres remain, while other intact patches are dozens of acres embedded in landscapes of degraded spruce-fir systems (NatureServe 2007).

Issues/Problems

In modern times other disturbances, especially logging, logging slash fires, balsam woolly adelgid (an exotic species), chestnut blight (exotic fungus), acid deposition, and climate change are playing an important role. Because of the declining area of this community, any large windthrow events can be locally significant. The balsam wooly adelgid has decimated the endemic Fraser fir populations throughout its range. Although regeneration of Fraser fir is plentiful, the continued presence of the adelgid ensures a lack of recruitment to mature size. Additionally, there has been a large increase in downed woody debris resulting from extensive tree mortality.

Comments

The model is based on R8SAHE -- Southern Appalachian High-Elevation Forest, combined with R7SESF -- Southeastern Red Spruce - Fraser Fir. Although R7SESF has only three boxes in its model, these modelers felt that R8SAHE better represented the Southern Appalachian / MZ61 area better than R7SESF.

R8SAHE modelers: Rob Klein (rob_klein@nps.gov)
R7SESF modelers: KellyAnn Gorman (kellyann_gorman@nps.gov), Erin Small (esmall@fs.fed.us), Sue Gawler (sue_gawler@natureserve.org)

It is possible that human caused (anthropogenic) fires are more important than natural fires. Further, it is presumed that some openings observed by settlers involved Indian activity (J. Dan Pittillo, comment on R7SESF).

Referenced Documents are copied from R8SAHE and R7SESF, with two new references.

Recommended Reviewers: Rob Klein (rob_klein@nps.gov); J. Dan Pittillo, W. Carolina University, Cullowhee, NC; Erin Small, USFS (esmall@fs.fed.us); Sue Gawler (sue_gawler@natureserve.org); Carl Nordman (carl_nordman@natureserve.org).

Vegetation Classes

Class A 18 %

Early Development 1 All Structure

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☑ Tree

Fuel Model 8

Indicator Species* and Canopy Position

BEAL2	Upper
PRPE2	Upper
RUAL	Mid-Upper
ACSP2	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	21 %	80 %
Height	Tree 0m	Tree 10m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

(Class age = 0-35yrs); 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.

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Class B 13 %

Mid Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 5

Indicator Species* and Canopy Position

BEAL2	Upper
PIRU	Mid-Upper
ABFR	Mid-Upper
ABBA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	71 %	100 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

(Class age = 36-65yrs); 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

Class C 11 %

Mid Development 1 Open

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 9

Indicator Species* and Canopy Position

BEAL2	Upper
ABFR	Mid-Upper
PIRU	Mid-Upper
ABBA	Mid-Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	41 %	70 %
Height	Tree 10.1m	Tree 25m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

(Class age = 36-65yrs); 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 (class D). That is, over time, in the presence of a seed source, spruce and fir will re-occur.

Class D 58 %

Late Development 1 Closed

Upper Layer Lifeform

- [ ] Herbaceous
- [ ] Shrub
- [x] Tree

Fuel Model 5

Indicator Species* and Canopy Position

BEAL2	Upper
PIRU	Upper
ABFR	All
ABBA	All

Structure Data (for upper layer lifeform)

	Min	Max
Cover	81 %	100 %
Height	Tree 25.1m	Tree 50m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.

Description

(Class age = 66yrs+); 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

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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 (500yrs+, until a major disturbance occurs), although individual trees are not this long-lived.

Class E 0 %

[Not Used] [Not Used]

Upper Layer Lifeform

- ☐ Herbaceous
- ☐ Shrub
- ☐ Tree

Fuel Model

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover	%	%
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** V

Historical Fire Size (acres)

Avg
Min
Max

Sources of Fire Regime Data

- ☑ Literature
- ☐ Local Data
- ☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	830.7			0.00120	93
Mixed	11990			8.3E-05	6
Surface					
All Fires	776			0.0013	

Fire Intervals (FI):
Fire Interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

Additional Disturbances Modeled

- ☑ Insects/Disease
- ☑ Wind/Weather/Stress
- ☐ Native Grazing
- ☐ Competition
- ☐ Other (optional 1)
- ☐ Other (optional 2)

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