Rapid Assessment Reference Condition Model

The Rapid Assessment is a component of the LANDFIRE project. Reference condition models for the Rapid Assessment were created through a series of expert workshops and a peer-review process in 2004 and 2005. For more information, please visit www.landfire.gov. Please direct questions to helpdesk@landfire.gov.

Potential Natural Vegetation Group (PNVG)

R7NHHE   **Northern Hardwood Hemlock**

General Information

Contributors *(additional contributors may be listed under "Model Evolution and Comments")*

Modelers		**Reviewers**
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Vegetation Type
Forested

Dominant Species*

FAGR   TIAM
TSCA
ACSA
BEAL2

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

LANDFIRE Mapping Zones
63   61
64   60
65

Rapid AssessmentModel Zones

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

Geographic Range
Generally ranges from central New England, west to Lake Erie and south to West Virginia and Maryland. Can be included in physiograhic provinces 212b, 212c, 212d, 212e, 212f, 212g, 221a, 221b, 221d.

Biophysical Site Description
This mixed forest occurs predominantly on mesic sites over a broad range of topographic conditions, with elevations generally ranging from 1000 to 3000 ft. In the northern portion of its range it occurs primarily at higher elevations and on slope positions that favor cool, moist conditions. At lower elevations and in the southern portion of its range, it occurs more frequently in sheltered coves and valleys. Soils are usually acidic and can contain a variety of parent material and drainage conditions.

Vegetation Description
Dominant overstory species include eastern hemlock (Tsuga canadensis), American beech (Fagus grandifolia), sugar maple (Acer saccharum) and yellow birch (Betula allegheniensis). While this community as a whole occurs across a wide range of topographic conditions, the species mix can vary considerably. Hemlock will dominate the overstory on cool/moist sites at higher elevations and in shaded coves, valley bottoms and riparian areas. Moist bottomlands and footslopes may also contain a larger component of yellow birch, white ash (Fraxinus americana) and sycamore (Platanus occidentalis) (Whitney 1990). Locally, on slopes, sugar maple becomes more abundant, resulting in a beech-hemlock-sugar maple complex (Braun 2001). Other common associates include red maple (Acer rubrum), black cherry (Prunus serotina), black birch (Betula nigra), basswood (Tilia americana) and cucumber magnolia (Magnolia acuminata). The understory and mid-story are usually well developed and include hobblebush (Viburnum alnifolium), mapleleaf viburnum (Viburnum acerifolium), witch hazel (Hamamelis virginiana) , serviceberry (Amelanchier alnifolia), pin cherry (Prunus pensylvanica), large-leaved holly (Ilex monticola), and alternative-leaved dogwood (Cornus alternifolia). Common herbaceous species include wild lily of the valley (Maianthemum canadense), sensitive fern (Onoclea sensibilis), shining clubmoss (Lycopodium lucidulum), Dryopteris spinulosa (Dryopteris spinulosa), mountain woodsorrel (Oxalis montana) and

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partridgeberry (Mitchella repens) (Lutz 1930, Braun 2001).

Class structure (open, closed, all) refers to overstory conditions.

Disturbance Description

Non-Fire Disturbance: This system is dominated by long-lived, mesic species that form multi-layered uneven-aged forests over time. Canopy dynamics are dominated by single and multiple disturbances encouraging gap phase regeneration (Abrams and Orwig 1996). Larger disturbances include windthrow, insect attack and ice storms.   Although stand replacing wind events are rare, small to medium blowdown events are more common and occur at greater frequency on the plateau and exposed side slopes (Ruffner and Abrams 2003). Localized insect and disease outbreaks can create small to medium canopy gaps.

Running the VDDT model resulted in 0.9% disturbance (fire and/or wind, weather, stress) annually, consistent with disturbance rates documented by Runkle (1981, 1985) and others. Wind, weather, stress alone resulted in 0.7% disturbance annually.

Fire Regime Description: Due to the predominance of cool, moist site conditions, surface and replacement fires are extremely rare, occurring at 700-1000 year intervals. The principal cause of fuel formation leading to fire in northern hardwood ecosystems is broad-scale, storm-driven windthrow of catastrophic proportions (Hough 1936, Runkle 1982).

Adjacency or Identification Concerns

This model replaces in part the Northern Hardwood Conifer/White Pine PNVG (NHDW2).   Because this community can occur in a variety of topographic positions and elevations, it can be associated with a wide range of PNVG's within the Northern Hardwood, Transition Appalachian Oak-Northern Hardwood and Appalachian Oak Groups. Using the International Ecological Classification Standard, this community corresponds most closely with the Appalachian (hemlock)-Northern Hardwood Forest (CES202.593) (NatureServe 2004).

Past logging in many areas has altered this system by creating a predominantly even age structure, that contains a much higher proportion of shade intolerant species. In many areas, this change in species composition is further aggravated by decades of overbrowsing by deer (Runkle 1982, Abrams and Orwig 1996), which has significantly reduced the hemlock component and reduced species and structural diversity in many areas. This community has also been significantly altered through exotic insect and diseases, including the beech scale disease complex, which has been causing widespread mortality of American beech for the last 20 years and more recently the hemlock woolly adelgid, which kills hemlock in all age and size classes.

 Sugar maple decline is another current forest health concern that is attributed to a combination of factors including insect defoliations, drought, and site factors related to soil nutrient status (impacted by acid deposition) (Horsley, et al., 2002). Second growth stands are characterized by an under representation of significant habitat elements such as large diameter trees, canopy gaps, gap saplings, "tip-up" mounds, coarse woody debris, and a limited range of seral stages (Litvaitis, 2003, Lorimer and Frelich 1994).

Other forest health concerns in the region include changing soil nutrient status due to acid deposition and concerns about potential increases in ozone from industrial byproducts.

The four "Northern Hardwood" models in the Rapid Assessment (R6NHMB, R7NHHE, R7NHNE, and R7NHSP) occur across both the Northeast and Great Lakes model zones and have several similarities, including: high moisture/nutrient gradients; historically included more conifer; often dominated by sugar maple; windthrow is the main disturbance agent with fires occurring every ~1,000-2,000 years. There are

also several differences, including: beech has limited extent west of eastern Wisconsin and the central Upper Peninsula of Michigan; the amount of hemlock varies. Additional similar PNVGs include: R7BEMA, R7NHMC, R6MABA.

Scale Description

Sources of Scale Data	☑ Literature	☐ Local Data	☑ Expert Estimate

Both small and large-scale disturbances characterize the natural disturbance regime of this region, with wind, insects/diseases, and icestorms as primary disturbance agents. These forests are characterized by small scale disturbance, with a high degree of vertical structure and fine grained patch size (Spies, 2004). However, medium-scale intensity disturbances also characterize the region (Runkle, 1982; Ruffner, unpublished). A significant glazing or ice storm events can be expected every 50 years or so (Hough, 1963). Depending on the severity of ice loading, damage may range from minimal to severe crown damage.

SMALL GAP DYNAMICS:
Gap sizes range from 28 square meters to 2009 square meters, with a mean of 200 square meters. Canopy turnover rates of 0.5-2% per year with a return interval of 50-200 years characterize old growth beech and hemlock stands (Runkle, 1981, 1985). Repeat disturbances affecting the same location may be common. More recent estimates of the return interval based on actual tree ring analysis suggest that 10-20% of the canopy may be disturbed every decade depending on the topographic position of the stand (Ruffner, unpublished).

MESO AND LARGE CANOPY DISTURBANCES:
Large scale disturbances can affect areas ranging from 100 to 1,000 hectares (Ruffner, unpublished). Larger scale blowdowns affect upland and side slope sites more often (10 to 30 years) than more protected riparian sites (250 years) (Ruffner and Abrams, 2003).

SUMMARY
Disturbances on the scale of a single dead tree make up a significant portion of the landscape. This disturbance regime strongly favors tolerant species but allows opportunists to persist in low densities (Runkle 1982). On high plateaus and exposed slopes, small-scale wind disturbances are a common agent driving gap dynamics (Ruffner and Abrams 2003). Tornados and windstorms often affect large areas as stand replacing disturbances which foster regeneration of intolerant and intermediate species (Ruffner unpublished).

Issues/Problems

The vegetation composition and disturbance regimes used in this model are based largely on old growth communities in Northern Pennsylvania, particularly the Tionesta Scenic and Natural Area. As a result, the vegetation description may not accurately describe conditions across the entire geographic range of this community.

Model Evolution and Comments

Model Assumptions:
Replacement and surface fire frequency = 1000 years
Moderate scale wind disturbances occur every 140 years and result in >20% canopy reduction.
Insect and disease related disturbance was not modeled separately and is assumed to be included in the moderate wind/weather/stress disturbance.
Catastrophic stand replacing wind events are expected to occur every 1000 years.
Although single and multiple tree releases are the dominant type of disturbance, it is anticipated that resulting canopy gaps will be too small to result in a change in class and these disturbances are not included in the model.

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Succession Classes**

Succession classes are the equivalent of "Vegetation Fuel Classes" as defined in the Interagency FRCC Guidebook (www.frcc.gov).

Class A   10 %

Early1 All Struct

Description

Early age classes include forests less than 50 years of age. Initially young stands have an even-aged structure and may include yellow birch, black birch, beech, basswood, white ash, hemlock and black cherry. As the stand matures, intermediate and intolerant species move into the canopy and beech and hemlock exist in the understory and midstory. Tree size ranges from seedling through pole. Closed canopy conditions exist throughout most of this class and with the exception of the early stand initiation phase, there is little development of herbaceous or shrubby vegetation. Class A succeeds to Class B.

Dominant Species* and Canopy Position

FAGR	Low-Mid
TSCA	Low-Mid
BELE	Mid-Upper
BEAL2	Upper

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	80 %	100 %
Height	Tree Regen <5m	Tree Medium 10-24m
Tree Size Class	Pole 5-9" DBH	

☐ Upper layer lifeform differs from dominant lifeform.
   Height and cover of dominant lifeform are:

Class B   35 %

Mid1 Closed

Description

Closed canopy conditions exist throughout the 50-199 year life of this class. Beech and hemlock move into the middle to upper portions of the canopy, and the overstory will include a mixture of intermediate and intolerant species such as yellow birch, basswood, red maple, magnolia cucumber and black cherry. Both even and un-even-aged stand structure conditions may exist and forests in this class will start to develop a well established shrub and herbaceous layer. Class B succeeds to Class E.

Dominant Species* and Canopy Position

FAGR	Mid-Upper
TSCA	Mid-Upper
ACSA3	Lower
ACRU	Mid-Upper

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	80 %	100 %
Height	Tree Short 5-9m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.
   Height and cover of dominant lifeform are:

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*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.

Class C   5 %

Mid1 Open
Description
This fifty to 199 year old class is characterized by open canopy conditions resulting from partial blowdown, glaze events or localized insect and disease outbreaks. Greater than 20% overstory mortality occurs during these events, which creates open canopy conditions and stimulates development of the understory and midstory.   Associate intermediate and intolerant species such as red maple, black birch, basswood, black cherry, and magnolia cucumber will become established in greater abundance. Canopy gaps close laterally and this class succeeds to B within two to three decades.

Fuel model 11 may occur where windthrow has created large quantities of slash.

Dominant Species* and Canopy Position

FAGR	Mid-Upper
TSCA	Mid-Upper
ACSA3	Low-Mid
TIAM	Mid-Upper

Upper Layer Lifeform
☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	40 %	79 %
Height	Tree Regen <5m	Tree Medium 10-24m
Tree Size Class	Medium 9-21"DBH	

☐ Upper layer lifeform differs from dominant lifeform.
    Height and cover of dominant lifeform are:

Class D   5 %

Late1 Open
Description
Class D includes forests 200 years of age or older that have open canopy conditions resulting from medium intensity disturbance events that result in partial overstory mortality.   Like Class C, these events create open canopy conditions that stimulate development of the understory and midstory, as well as increase the abundance of intermediate and intolerant species.   Like Class E, beech, hemlock and sugar maple are the dominant overstory species and occur in all size classes. Canopy gaps close laterally and this class succeeds to E within one to two decades.

Dominant Species* and Canopy Position

FAGR	All
TSCA	All
ACSA3	All
PRSE2	Upper

Upper Layer Lifeform
☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	40 %	79 %
Height	Tree Regen <5m	Tree Tall 25-49m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform.
    Height and cover of dominant lifeform are:

Fuel model 11 may occur where windthrow has created large quantities of slash.

Class E   45 %

Late1 Closed
Description

Class E is characterized by an un-even age structure with beech, hemlock and sugar maple occurring in all size classes, including overstory trees over 200 years of age. In forests with a hardwood/hemlock mix, a well developed shrub and rich herbaceous layer exists. Whereas in hemlock dominated stands, the shrub layer consists almost exclusively of hobblebush or other shade tolerant shrub species, with a less well developed herbaceous layer. The overstory is characterized by large diameter beech, hemlock, sugar maple and yellow poplar, with minor inclusions of basswood, red maple or other long-lived intermediate and intolerant species.

Dominant Species* and Canopy Position

FAGR	All
TSCA	All
ACSA3	All
BEAL2	Upper

Upper Layer Lifeform
☐ Herbaceous
☐ Shrub
☑ Tree

Fuel Model 8

Structure Data (for upper layer lifeform)

	Min	Max
Cover	80 %	100 %
Height	Tree Regen <5m	Tree Tall 25-49m
Tree Size Class	Large 21-33"DBH	

☐ Upper layer lifeform differs from dominant lifeform. Height and cover of dominant lifeform are:

Disturbances

Disturbances Modeled

☑ Fire
☐ Insects/Disease
☑ Wind/Weather/Stress
☐ Native Grazing
☐ Competition
☐ Other:
☐ Other

Historical Fire Size (acres)

Avg: no data
Min: no data
Max: no data

Sources of Fire Regime Data

☑ Literature
☐ Local Data
☑ Expert Estimate

Fire Regime Group: 5

I: 0-35 year frequency, low and mixed severity
II: 0-35 year frequency, replacement severity
III: 35-200 year frequency, low and mixed severity
IV: 35-200 year frequency, replacement severity
V: 200+ year frequency, replacement severity

Fire Intervals (FI)

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inverse 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. All values are estimates and not precise.

	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	1000			0.001	50
Mixed					
Surface	1000			0.001	50
All Fires	500			0.00201	

References

Abrams, M. D. and D. A. Orwig. 1996. A 300 year history of disturbance and canopy recruitment for co-occurring white pine and hemlock on the Allegheny Plateau, USA. Journal of Ecology. 84, 353-363.

Braun, E. L. 2001. Deciduous forests of Eastern North America. 2nd ed. The Blackburn Press. 596 pp.

Hough, A. F. 1936. A climax forest community on East Tionesta creek in Northwest Pennsylvania. Ecology Vol. 17 (1). 28 pp.

Hough, A. F. 1963. What a glaze storm brings. PA Forestry 53:4-5.

Litvaitis, J.A. 2003. Are pre-Columbian conditions relevant baselines for managed forests in the northeastern United States? Forest Ecology and Management 185: 113-126.

Lorimer, C.G., and L.E. Frelich. 1994. Natural disturbance regimes in old-growth northern hardwoods. Journal of Forestry 92:33-38.

Lutz, H. J. 1930. The vegetation of hearts content, a virgin forest in northwestern Pennsylvania. Ecology. Vol. XI (1). 29 pp.

Natureserve Explorer. 2004. http://natureserve.org/explorer/servlet/NatureServe.

Ruffner, C. M. and M. D. Abrams. 2003. Historical ecology of Allegheny plateau forests. Submitted to the Allegheny National Forest as a component of the revised forest plan. Unpublished. 19pp.

Runkle, J.R. 1981. Gap regeneration in some old-growth forests of the eastern United States. Ecology 62: 1041-1051.

Runkle, J. R. 1982. Patterns of disturbance in some old-growth mesic forests of Eastern North America. Ecology, 63(5). Pp. 1533-1546.

Runkle, J.R. 1985. Disturbance regimes in temperate forests. In The ecology of natural disturbance and patch dynamics. Pp. 17-33. Edited by S.T.A. Pickett and P.S. White. Academic Press, New York.

Spies, T.A. 2004. Ecological concepts and diversity of old-growth forests. Journal of Forestry 102: 14-20.

Whitney, G. G. 1990. The history and status of the hemlock-hardwood forests of the Allegheny plateau. Journal of Ecology. 78, 443-458.