13030
Northeastern Interior Dry-Mesic Oak Forest

BpS Model/Description Version: Aug. 2020

Modelers		Reviewers	
Daniel Yaussy	dyaussy@fs.fed.us	Thomas Schuler	tschuler@fs.fed.us
Greg Nowacki	gnowacki@fs.fed.us	Eric Sorenson	eric.sorenson@state.vt.us
None	None	None	None

Reviewers: Charles LaFon and William Nichols

Vegetation Type
Forest and Woodland

Map Zones
61, 63, 64, 65, 66

Geographic Range
This model, as it was developed, pertains to Ecological Section 221E, the Southern Unglaciated Allegheny Plateau (EPA level III region 70 -- Western Allegheny Plateau) and possibly 221H, the Northern Cumberland Plateau (northern portion of EPA level III region 68 -- Southwestern Appalachians).

NatureServe's description (2007) for the equivalent ecological system CES202.592 -- Northeastern Interior Dry-Mesic Oak Forest notes that this system is found from central New England west through Ohio and Pennsylvania and south to Virginia. It does not extend to the southernmost part of Virginia, except in the ridge and valley.

Therefore, it should be reviewed for relevancy by the zones not particularly covered by the modelers. This system is on the northern edge of its range in Vermont but is well represented in the Champlain Valley, the Taconic Mountains, and the Connecticut River valley.

Biophysical Site Description
This ecological section comprises part of the Appalachian Plateau's geomorphic province (USDA Forest Service 1995). It is a maturely dissected plateau characterized by high hills, sharp ridges, and narrow valleys in the southern unglaciated region. Bedrock is overlain by Quaternary residuum on the ridges and hilltops, colluvium on the slopes, and either or both alluvium and Pleistocene lacustrine materials in the valleys. Udalfs, Udults, and Ochrepts dominate, in combination with mesic soil temperature regime, an udic soil moisture regime, and mixed or illitic mineralogy. Soils formed in parent materials are divided into four groups: residual material, which developed in place by the weathering of underlying bedrock; colluvial material, which weathered from bedrock strata transported by water and gravity to the lower slopes; alluvium, lacustrine sediments, and outwash deposited by water; and loess deposited by wind. Precipitation averages 35-45in (900-1,150mm); it occurs mainly during summer, winter, and spring. Rain or snow is common during winter and early spring. Summers are dry with low humidity. Temperature averages 52°F (11°C). The growing season is 120-180 days. This ecological section is characterized by a relatively high density of streams, with gradients ranging from high, steep headwaters streams to low gradient rivers that flow into the Ohio River.

NatureServe (2007) provides the following description pertaining to this system type: “These oak-dominated forests are one of the matrix forest systems in the northeastern and north-central U.S. Occurring in dry-mesic settings, they are typically closed-canopy forests, though there may be areas of patchy-canopy woodlands. They cover large expanses at low to mid elevations, where the topography is flat to gently rolling, occasionally steep. Soils are acidic and relatively infertile but not strongly xeric.” Southern Appalachian Oak Forest (CES202.886 -- BpS 1315) is an equivalent system to the south (in the Southern Blue Ridge, EPA 66).

In the glaciated portion of its range, this system occurs on low, warm hilltops and gently rolling topography where till-derived soils are well drained and bedrock is generally near the surface.

In central New England, this system occurs mostly <900ft elevation, south of and at lower elevations than the Laurentian-Acadian Pine-Hemlock-Hardwood Forest system. These are associated with the warmer and drier climatic conditions and more fire-influenced landscapes that prevail in central and southern New England. Much of the area of these forests corresponds to nutrient-poor, dry to mesic, sandy glacial tills and some large areas of sand plain or shallow-to-bedrock tills (Sperduto and Nichols 2011).

Vegetation Description

The vegetation consisted of forests dominated by oaks of dry-mesic conditions, especially white oak (*Quercus alba*) and red oak (*Quercus rubra*), and, on drier sites, chestnut oak (*Quercus prinus*), black oak (*Quercus velutina*), and scarlet oak (*Quercus coccinea*). Scarlet oak and chestnut oak are absent at the northern edge of the system range. Along with oaks are varying amounts of hickory (*Carya* spp.), red maple (*Acer rubrum*), and other species such as white pine (*Pinus strobus*) and white ash (*Fraxinus americana*). American chestnut (*Castanea dentata*) was a prominent tree in these forests before chestnut blight eradicated it as a canopy constituent (NatureServe 2007). Common shrubs include mountain laurel (*Kalmia* spp.) farther south, greenbriar (*Smilax* spp.) farther south, blueberries (*Vaccinium* spp.), and huckleberries (*Gaylussacia* spp.). In the Ridge and Valley region, bear oak is an important shrub component. Herbs, forbs, and ferns are usually sparse to moderate in density. Areas experiencing frequent fire had a greater abundance of grasses and sedges.

Embedded submesic ravines and concave landforms support slightly more diverse forests characterized by mixtures of oaks, several hickories, *Cornus florida*, and sometimes *Liriodendron tulipifera*. Small hillslope pockets with impeded drainage may support small isolated wetlands with *Acer rubrum* and *Nyssa sylvatica* characteristic (NatureServe 2007).

In New Hampshire, this forest system is marked by the appearance of oaks other than red oak, hickories, and numerous other southern plant species that are found in the Appalachian states and reach their northern limit in central New England. It is also coincident with the decreased abundance and frequency of *Tsuga canadensis* (hemlock) and *Fagus grandifolia* (American beech), which are more prominent in the Laurentian-Acadian Pine-Hemlock-Hardwood Forest system, although both are still commonly present, particularly in dry-mesic or mesic sites. *Acer saccharum* (sugar maple) and *Betula alleghaniensis* (yellow birch) are found in low abundance and are restricted to more mesic sites. Shrub and herbaceous species include *Vaccinium angustifolium* (lowbush blueberry), *V. pallidum* (hillside blueberry), *Gaylussacia frondosa* (blue

huckleberry), *G. baccata* (black huckleberry), *Viburnum acerifolium* (maple-leaved viburnum), *Comptonia peregrina* (sweet-fern), *Hamamelis virginiana* (American witch-hazel), *Gaultheria procumbens* (eastern spicy-wintergreen), *Carex pensylvanica/lucorum* (Pennsylvania and Blue Ridge sedges), *Deschampsia flexuosa* (wavy hair grass), *Oryzopsis asperifolia* (white-grained rice grass), *Danthonia spicata* (poverty oatgrass), *Pteridium aquilinum* ssp. *latiusculum* (bracken fern), *Lysimachia quadrifolia* (whorled yellow-loosestrife), and *Lechea intermedia* (round-fruited pinweed) (Sperduto and Nichols 2011).

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
QUAL	*Quercus alba*	White oak
QUVE	*Quercus velutina*	Black oak
QUPR2	*Quercus prinus*	Chestnut oak
QURU	*Quercus rubra*	Northern red oak
QUCO2	*Quercus coccinea*	Scarlet oak
ACRU	*Acer rubrum*	Red maple
PIST	*Pinus strobus*	Eastern white pine
CARYA	*Carya*	Hickory

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

Disturbance Description

This system is impacted by disturbances at different scales and in different seral states (estimated historic frequencies for the various modeled disturbances are included in this description below). In the later, more persistent portions of the life cycle, small canopy gaps may be created across the landscape by the death of individual (or small numbers of) trees which topple. However, weather related events (ice, wind, etc.) could have created gaps in the mature canopy that range from individual tree size to larger areas depending on the specific incident. Fire also occurred, mostly at low and moderate intensities, and could create much larger openings or more open forest canopies when they occur in any seral stage.

Most oaks are long-lived with typical age of mortality ranging from 200-400yrs. Scarlet and black oaks are shorter-lived with typical ages being ~50-100yrs, while white oaks can live as long as 600yrs. Extreme wind or ice storms occasionally create larger canopy openings.

The dry-mesic oak forest is predominantly Fire Regime I, characterized by low-severity surface fires. Historically, indigenous fires accounted for >95% of the ignitions over these landscapes. Vegetation types varied based on fire frequency and intensity. Grassland prairies burned often (annually, biennially) and were probably associated with flat to slightly rolling terrain that effectively carried fire. These grasslands, deliberately maintained by Native Americans for hunting purposes, were probably scattered throughout the forest matrix. Oak-hickory tree-sprout and shrub thickets occurred where fire frequency was a bit less, probably 3-9yrs. Also, sprout conditions would arise immediately after catastrophic burns that would top-kill tree-dominated communities.

Savannas and woodlands developed within a moderate burning regime, with fire return intervals (FRIs) averaging every 5-15yrs. Closed-canopy oak-hickory forests would develop where FRIs stretched beyond 15yrs. Shade-tolerant, fire-sensitive maples (and associated late-successional

trees) would regenerate and form understories beneath oak-hickory canopies when fire was excluded over several decades. With continued fire exclusion, maple and other late successional species would gradually replace overstory oaks and hickories through gap capture (Sutherland and Hutchinson 2003). A mosaic of vegetation types comprised oak-hickory landscapes contingent on fire history (Cutter and Guyette 1994). In a recent study on fire history of a red oak stand in West Virginia, it was found that FRIs ranged from 7-32yrs from 1846-2002 with a median of ~16yrs, and prior to the fire control era, FRIs ranged from 7-15yrs (Schuler and McClain 2003). Schuler and McClain stated that these observations did not deviate significantly from previous research in the oak forests of Ohio, Maryland, and Missouri. The above description was taken from Rapid Assessment (RA) model R6OAHI -- Oak Hickory.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	38	14		
Moderate (Mixed)	24	23	5	50
Low (Surface)	9	63	2	25
All Fires	5	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

Pre-European oak-hickory forests covered 100s of 1,000s of contiguous acres.

These were historically among the most important matrix forests of the Northeast. They covered extensive areas where conditions were not extreme. Upslope they may grade into more xeric oak ridge systems or rocky oak-pine forests/woodlands (NatureServe 2007). At the edge of its range in northern New England, this system is generally a large patch forest.

Non-Fire Disturbances

Disturbance and successional dynamics are driven by wind events. Tree falls and crown removal are the primary results from the wind disturbance in conjunction with the shallow root systems. The wind events that can occur are downbursts and microbursts from thunderstorms, tornados, and general circulation winds around severe low-pressure systems. Data for long-term events are estimated from current conditions and sparse historical data. Heavy, catastrophic windstorms and tornados are estimated to have occurred at >1000yr intervals. Estimates of rotation periods for wind events range from 1,200-2,400yrs (Whitney 1986). Insect attacks follow wind or ice storm damage and contribute to the breakup of the stands, generating large amounts of coarse, woody debris. In the northern part of the range, ice plays a role in canopy disturbance. See LaFon (2016) for more information on ice storms which can be highly variable in frequency and impacts.

Adjacency or Identification Concerns

Dry-mesic oak forests often occur on hilltops and side slopes. Though often contiguous, patches of oak are virtually always convoluted and inter-fingered with other systems, especially Mesophytic Cove Forests and Dry-Xeric Oak-Pine Forests. At the highest elevations, this BpS may grade into Northern Hardwood Forests. Small patches of other communities, such as rock outcrops and mountain wetlands, are sometimes embedded within this group.

A 2017 BpS reviewer noted the need to add adjacency information for the northern range of this type. As of October 2017, this has not been completed.

Issues or Problems
This type occurs across many coarse-mapped Rapid Assessment PNVGs. Many oak-dominated models are redundant, overlapping, or similar.

With a long history of human habitation, many of these forests today are early- to mid-successional, where *Pinus strobus*, *Pinus virginiana*, or *Liriodendron tulipifera* may be dominant or co-dominant (NatureServe 2007).

American chestnut was once a dominant species in this type but was reduced dramatically in the 1930s. Mountain laurel and rhododendron have increased in the understory in many places in absence of fire, which could pose regeneration problems in the future. Invasive exotics such as tree-of-heaven (*Ailanthus altissima*), privet (*Ligus* spp.), and many others are on the increase and also pose forest health issues. Exclusion of fire is slowly transitioning oak forests on better sites to shade-tolerant species such as beech and maple.

In addition, a buildup of ericaceous shrubs and other species might lead to fire intensity beyond the range of historical variability when fires were more frequent. Consequently, overstory mortality in conjunction with fire may be significant and harm remnants of rare communities that add significant diversity to the landscape (Schuler personal communication).

Across this and many ecosystems in the Northeastern US deer may have profound impacts on oak regeneration and spring ephemerals (Rawinski 2015, USFS). Gypsy moth impacts chestnut oak, possibly leading to mortality. Cynipid wasps impact oaks.

Native Uncharacteristic Conditions
American chestnut was once a dominant species in this type but was reduced dramatically in the 1930s. Mesification due to lack of fire and increase in red maple; beech historically widely spaced but now more widespread with coppice due to mortality of canopy from beech bark disease.

Comments
Climate change may result in an increase in greenbrier and ericaceous shrubs such as mountain laurel in northern part of range. Growing season is likely to be drier, resulting in an increased potential for fire and potential for forest type to migrate north. Increase of chestnut oak, white oak, and black oak in northern part of type is predicted.

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	B	B	B	B	B	B	UN	UN	UN	UN

Shrub	0.5-1.0	B	B	B	B	B	B	UN	UN	UN	UN
Shrub	1.0-3.0	B	B	B	B	B	B	UN	UN	UN	UN
Shrub	>3.0	B	B	B	B	B	B	UN	UN	UN	UN
Tree	0-5	C	C	C	C	C	C	UN	UN	UN	UN
Tree	5-10	C	C	C	C	C	C	D	D	E	E
Tree	10-25	C	C	C	C	C	C	D	D	E	E
Tree	25-50	C	C	C	C	C	C	C	C	C	C
Tree	>50	C	C	C	C	C	C	C	C	C	C

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 **3** **Early Development 1 - All Structures**

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ANGE	Andropogon gerardii	Big bluestem	Lower
SCHIZ4	Schizachyrium	Little bluestem	Lower
SONU2	Sorghastrum nutans	Indiangrass	Lower
	Quercus spp		Mid/Upper
GAYLU	Gaylussacia Kunth	Huckleberry	Mid
VACCI	Vaccinium spp	Blueberry	Lower

Description

Class A is grassland prairie with scattered to moderate cover of canopy trees and resprouts maintained by frequently recurring fire. These patches would typically be <100ac but may have been >500ac. Native Americans used these lands for hunting and agriculture/native plant gathering. If fire is absent, the amount of woody cover will increase and move the community to the mid-seral, open stage.

Maximum Tree Size Class

Resprouts >4.5ft, <5” DBH; Trees >7m, >5” DBH

Class B **22** **Mid Development 1 - Open**

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUAL	Quercus alba	White oak	Mid/Upper
QURU	Quercus rubra	Northern red oak	Mid/Upper
ANGE	Andropogon gerardii	Big bluestem	Low
QUVE	Quercus velutina	Black oak	Mid/Upper

PIST	Pinus strobus	Eastern White Pine	Upper
GAYLU	Gaylussacia	Huckleberry	Mid
VACCI	Vaccinium spp	Blueberry	Lower
SCHIZ4	Schizachyrium	Little bluestem	Lower
SONU2	Sorghastrum nutans	Indiangrass	Lower

Description

This is an early tree regeneration (seedling; root and stump sprouts) phase with moderate cover of mature trees; fire frequency is ~3-9yrs. Areas that receive frequent surface fires will be populated by fire-adapted species such as oaks and hickories. These fires will top-kill seedlings and sprouts and a proportion of the saplings. These communities will develop into the mid-seral, open oak-hickory forest class. Occasional fires of high severity will top-kill most trees, moving the community back to the early-seral class.

Maximum Tree Size Class

Resprouts >4.5ft, <5" DBH; Trees >7m, >5" DBH

Class C 50 Mid Development 2 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUAL	Quercus alba	White oak	Upper
QURU	Quercus rubra	Northern red oak	Upper
QUVE	Quercus velutina	Black oak	Upper
QUCO2	Quercus coccinea	Scarlet oak	Upper
PIST	Pinus strobus	Eastern White Pine	Upper
ANGE	Andropogon gerardii	Big bluestem	Low
QUVE	Quercus velutina	Black oak	Mid/Upper
PIST	Pinus strobus	Eastern White Pine	Upper
GAYLU	Gaylussacia	Huckleberry	Mid
VACCI	Vaccinium spp	Blueberry	Lower
SCHIZ4	Schizachyrium	Little bluestem	Lower
SONU2	Sorghastrum nutans	Indiangrass	Lower

Description

This class is defined as open oak savannas and woodlands with an FRI of 5-15yrs (which could be longer in the northern part of the range). The canopy closure is <60%. This community quite commonly experiences frequent surface fires. If fire is absent from this community for an extended period, the canopy will become less open, moving the community into the late-seral, closed canopy (60-100%), oak-pine forest (Class D).

Maximum Tree Size Class
Small trees <21" DBH; Large 21-33" DBH

Class D 18 Late Development 1 - Closed

Upper Layer Lifeform: Tree
Upper Layer Canopy Cover: 61 - 80%
Upper Layer Canopy Height: Tree 5.1m - Tree 25m

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUAL	Quercus alba	White oak	Upper
QURU	Quercus rubra	Northern red oak	Upper
QUCO2	Quercus coccinea	Scarlet oak	Upper
QUVE	Quercus velutina	Black oak	Upper
PIST	Pinus strobus	Eastern White Pine	Upper

Description
Class D is defined as closed oak-pine forest. Understories of oak and pine seedlings exist. Stand-replacement fires in late-succession types are rare and will result in return to an earlier stage. Occasional mixed fire will send the system to a mid-succession open Class C. Surface fires maintain the late-succession open forest type. If the late-succession open forest type persists for ~70yrs without any fire, it will convert to a late-succession mixed mesophytic closed forest type. This conversion is a result of species shift from dominant oaks to dominant maple, tulip tree in southern part of range, and beech, which do not support fire as readily.

Maximum Tree Size Class
Large 21-33" DBH

Class E 7 Late Development 2 - Closed

Upper Layer Lifeform: Tree
Upper Layer Canopy Cover: –70-<100%
Upper Layer Canopy Height: Tree 5.1m - Tree 25m

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ACRU	Acer rubrum	Red maple	Upper
ACSA3	Acer saccharum	Sugar maple	Upper
LIRIO	Liriodendron	Tulip tree	Upper
FAGR	Fagus grandifolia	American beech	Upper
QURU	Quercus rubra	Northern red oak	Upper
QUCO2	Quercus coccinea	Scarlet oak	Upper

PIST	Pinus strobus	Eastern White Pine	Upper
QUAL	Quercus alba	White oak	Upper

Description
Mixed mesophytic forests develop during the absence of fire. Dense understories of shade-tolerant species develop. Replacement fires are very rare. Gap-phase dynamics will maintain this system. Large-scale wind and drought events might convert this system to the late-succession open Class C. Wind events may remove the overstory, releasing the shade-tolerant mid-story and converting the stand to the closed canopy mixed-mesophytic class. Surface fire will result in the system remaining in the current class type.

Northern red oak would occur in the northern extent of this Biophysical Setting (BpS), whereas white and scarlet would occur in the southern extent.

Note, the upper-layer canopy cover is set at 70-100%. Importantly, a reviewer notes that 100% canopy closure is not seen. We set it this way so that pixels 90-100% would not be mapped as Uncharacteristic Native (UN) in the Succession Class layer.

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:OPN	2
Mid1:OPN	3	Mid2:OPN	19
Mid2:OPN	20	Mid2:OPN	299
Late1:CLS	20	Late1:CLS	999
Late2:CLS	20	Late2: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	0.5	2	Yes	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.01	100	Yes	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.15	7	No	0
Alternative Succession	Mid2:OPN	Late1:CLS	1	1	Yes	15
Wind or Weather or Stress	Mid2:OPN	Mid1:OPN	0.003	333	Yes	0
Replacement Fire	Mid2:OPN	Early1:ALL	0.008	125	Yes	0
Mixed Fire	Mid2:OPN	Mid1:OPN	0.01	100	Yes	0

Surface Fire	Mid2:OPN	Mid2:OPN	0.2	5	No	0
Alternative Succession	Late1:CLS	Late2:CLS	1	1	Yes	70
Replacement Fire	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Wind or Weather or Stress	Late1:CLS	Late2:CLS	0.003	333	Yes	0
Mixed Fire	Late1:CLS	Mid1:OPN	0.005	200	Yes	0
Wind or Weather or Stress	Late1:CLS	Mid2:OPN	0.007	143	Yes	0
Mixed Fire	Late1:CLS	Mid2:OPN	0.015	67	Yes	0
Surface Fire	Late1:CLS	Late1:CLS	0.075	13	No	0
Replacement Fire	Late2:CLS	Mid1:OPN	0.001	1000	Yes	0
Wind or Weather or Stress	Late2:CLS	Mid1:OPN	0.007	143	Yes	0
Surface Fire	Late2:CLS	Late2:CLS	0.02	50	No	0

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