USDA Natural Resources Conservation Service

Ecological site F128XY052WV
Thermic Very Deep Clayey Non-Cherty Limestone and Dolomite Residuum White Oak (Quercus alba)/Black Oak (Quercus velutina)

Last updated: 10/17/2019
Accessed: 05/21/2024

General information

Approved. An approved ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model, enough information to identify the ecological site, and full documentation for all ecosystem states contained in the state and transition model.

Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 128X–Southern Appalachian Ridges and Valleys

Major Land Resource Area (MLRA) 128, shown as the area shaded in gray on the accompanying figure, falls into the East and Central Farming and Forest Region. This MLRA is in Tennessee (36 percent), Alabama (27 percent), Virginia (25 percent), and Georgia (12 percent). It makes up about 21,095 square miles (54,660 square kilometers).

Most of this MLRA is in the Tennessee section of the Valley and Ridge province of the Appalachian Highlands. The thin stringers in the western part of the area are mostly in the Cumberland Plateau section of the Appalachian Plateaus province of the Appalachian Highlands. A separate area of the MLRA in northern Alabama is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. The western side of the area is dominantly hilly to very steep and is rougher and much steeper than the eastern side, much of which is rolling and hilly. Elevation ranges from 660 feet (200 meters) near the southern end of the area to more than 2,400 feet (730 meters) in the part of the area in the western tip of Virginia. Some isolated linear mountain ridges rise to nearly 4,920 feet (1,500 meters) above sea level.

The MLRA is highly diversified. It has many parallel ridges, narrow intervening valleys, and large areas of low, irregular hills. The bedrock in this area consists of alternating beds of limestone, dolomite, shale, and sandstone of early Paleozoic age. Ridgetops are capped with more resistant carbonate and sandstone layers, and valleys have been eroded into the less resistant shale beds. These folded and faulted layers are at the southernmost extent of the Appalachian Mountains. The narrow river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel.

Classification relationships

This site falls into the "Southern Limestone/Dolomite Valleys and Low Rolling Hills" ecoregional classification developed by the Environmental Protection Agency (Authors: Glenn Griffith, James Omernik, Sandra Azevedo).

The USGS-based Southeast GAP Analysis Project classifies this area under two major forest types: South-Central Interior Mesophytic Forest (CES202.887) and Southern Ridge and Valley/Cumberland Dry Calcareous Forest (CES202.457).

Ecological site concept

The Thermic Very Deep Clayey Non-Cherty Limestone and Dolomite Residuum ecological site is of large extent. This site was likely primarily forested with mixed hardwoods, currently dominated by oak and hickory. It is characterized by rolling topography with gently sloping to very steep upland hills. Ridges are typically wider and lower in elevation than other ridges in the MLRA. The primary land-use of this site currently is pasture and hay, although some areas are forested, mostly with second or third growth trees. Almost all of the forested portion has been cleared and grazed previously. Small acreages are cultivated in cropland. The forested state is considered to be a naturalized community as reference conditions could not be located for sampling and so there is no way to verify a reference community. Like most of the Ridge and Valley, this site has been heavily impacted by disturbance over the years. Where forested, transition from an oak dominated to a maple/beech dominated forest is a concern. Invasive exotic plants and pathogens also pose a threat to forest health. On the site overall, urbanization is a major issue.

Associated sites

F128XY001TN	**Thermic Cherty Dolomite Upland Oak-Hickory Forest** This ecological site often co-occurs with the non-cherty dolomite uplands. The primary difference is the fragment content in the soil profile. Much more of the cherty dolomite uplands occur as forest whereas this ecological site is primarily pasture.

Similar sites

F128XY513WV	**Mesic Limestone And Dolomite Uplands** This provisional ecological site occurs in the mesic temperature regime but has similar soil properties.

Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Quercus velutina*
Shrub	(1) *Asimina triloba* (2) *Euonymus americanus*
Herbaceous	(1) *Vitis rotundifolia* (2) *Parthenocissus quinquefolia*

Physiographic features

This ecological site occurs on summits, shoulders, and backslopes on dissected uplands weathered from dolomitic limestone and limestone. Slopes range from 2 to 50 percent. Elevation ranges from 500 to 2,130 feet. The topography ranges from ridges to rolling hills.

This site can generate runoff to adjacent, downslope ecological sites. This site does not flood.

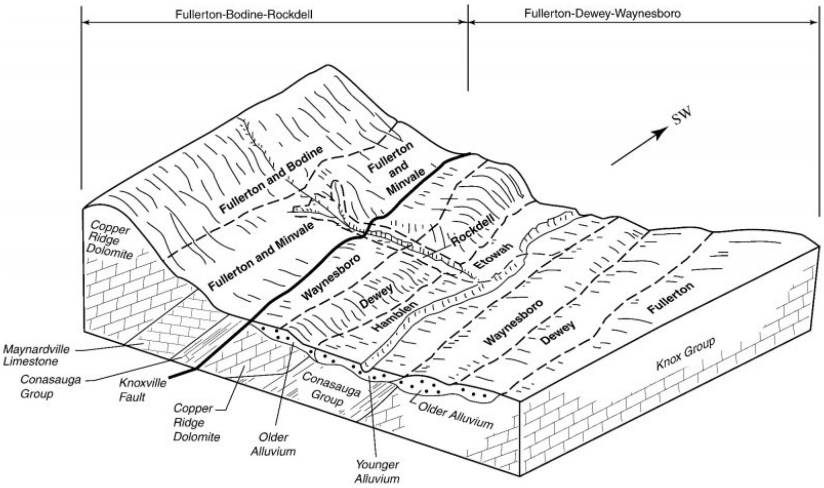


Figure 2.

Table 2. Representative physiographic features

Landforms	(1) Upland > Hill (2) Ridge
Flooding frequency	None
Ponding frequency	None
Elevation	225–645 m
Slope	2–45%
Water table depth	152 cm
Aspect	NW, SE, SW

Climatic features

This area falls under the humid, mesothermal climate classification (Thornwaite, 1948). Precipitation is fairly evenly distributed throughout the year, with little or no water deficiency during any season. The average annual precipitation in most of this area is 45 to 55 inches. It increases to the south. Maximum precipitation occurs in midwinter and midsummer, and the minimum occurs in autumn. Most rainfall occurs as high-intensity, convective thunderstorms. Snowfall may occur in winter. Average annual temperatures range from 46 to 70 degrees F, increasing to the south. The freeze-free period averages 205 days and is longest in the southern part of the area and shortest at higher elevations to the north. The growing season corresponds to climate. Local climate can be variable and microclimates factor into the distribution of plants. In general, topographic features such as slope aspect, landform, steepness, and position of the ridges and valleys are important site variables in the distribution of vegetation across the landscape (Martin, 1989).

Table 3. Representative climatic features

Frost-free period (characteristic range)	165-177 days
Freeze-free period (characteristic range)	195-208 days
Precipitation total (characteristic range)	1,168-1,321 mm
Frost-free period (actual range)	162-183 days
Freeze-free period (actual range)	191-214 days
Precipitation total (actual range)	1,143-1,346 mm
Frost-free period (average)	172 days
Freeze-free period (average)	202 days
Precipitation total (average)	1,245 mm

Climate stations used

- (1) KNOXVILLE EXP STN [USC00404946], Louisville, TN
- (2) MORRISTOWN RADIO WCRK [USC00406271], Morristown, TN
- (3) KNOXVILLE MCGHEE TYSON AP [USW00013891], Alcoa, TN
- (4) LENOIR CITY [USC00405158], Loudon, TN
- (5) DECATUR 7NE [USC00402388], Ten Mile, TN
- (6) SEVIERVILLE [USC00408179], Kodak, TN
- (7) OAK RIDGE ASOS [USW00053868], Oak Ridge, TN

Influencing water features

This site is not influenced by water from a wetland or stream.

Soil features

This ecological site is represented by soils in the Ultisols soil order. Soils associated with this site include Dewey, Collegedale, and Decatur. Map units having these soils as both major and minor components, either in consociations or complexes, make up most of this ecological site. These soils have a thermic temperature regime and an udic moisture regime. They are very deep, well drained, moderately to moderately slow permeable soils. Dewey soils formed in residuum from limestone. Decatur soils formed in residuum derived from limestone. Collegedale soils are formed in residuum weathered from limestone or limestone interbedded with shale. Reaction is strongly acid or very strongly acid except where the surface layer is less acid when limed. Chert is present in these soils but in general they are much cleaner than soils on geographically associated sites, where forests predominate. This site has been put into cultivation (grassland or cropland) more frequently as a result.

The dolomitic limestone, limestone, and interbedded limestone and shale ranges from Cambrian to Ordovician in age. These soils are highly weathered and leached leaving the soils with a naturally low nutrient content and low pH. These become limitations from an agricultural and timber standpoint but can be easily overcome by adequate application of lime, fertilizer, and use of best management practices (Buol et al., 1997).

Figure 9.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone and dolomite (2) Residuum–limestone and dolomite (3) Residuum–limestone and shale
Surface texture	(1) Clay (2) Clay loam (3) Loam (4) Silt loam
Family particle size	(1) Clayey

Drainage class	Well drained
Permeability class	Moderate to moderately slow
Soil depth	203 cm
Available water capacity (0-101.6cm)	11.68–16.26 cm
Soil reaction (1:1 water) (12.7-101.6cm)	5–5.5
Subsurface fragment volume <=3" (0-101.6cm)	0–12%
Subsurface fragment volume >3" (0-101.6cm)	0–2%

Ecological dynamics

The information contained in the state and transition model (STM) and the ecological site description was developed using archeological and historical data, professional experience, and scientific studies. The information presented is representative of a very complex set of plant communities. Not all scenarios or plants are included. Key indicator plants, animals, and ecological processes are described to inform land management decisions.

The historic reference plant community phase of this site is perceived to be a mixed hardwood forest, dominated by oaks now. Prior to the decimation of the American chestnut (*Castanea dentata*) by the chestnut blight, that species may have been important. White oak (*Quercus alba*), black oak (*Quercus velutina*), pignut hickory (*Carya glabra*), northern red oak (*Quercus rubra*) and tuliptree (*Liriodendron tulipifera*) most commonly occur in the canopy of forest stands although a multitude of other hardwood and some pine tree species can occur to varying degrees across the landscape. Because this site has been heavily disturbed, reference conditions were impossible to find. Therefore this is considered to be a naturalized state. Even in areas now dominated by trees, they have almost always been cleared or grazed in the past. Most stands are second or third growth. Likely, as a result, invasive exotic plant species have invaded a large portion of this site. Japanese honeysuckle (*Lonicera japonica*) in particular has become pervasive. It was often observed in the forest understory and does not appear to be radically displacing native vegetation. However, if the overstory were disturbed or removed, it could potentially become a serious problem.

This concept of the naturalized plant community was based upon field visits, a literature review and querying the data recorded by Hal DeSelm (Mains et al. 2016), a botanist at the University of Tennessee who recorded over 5,000 vegetation plots across the state over the course of his lifetime. He focused on mature stands that approximated older growth conditions.

In naturalized forest stands, the species and structure are likely the result of a series of complex disturbances including the loss of American chestnut in the 1930s (Thor and Summers 1971) (Nelson 1955), broad-scale and intense land-use change, fire and fire suppression, highly dynamic wildlife populations and a substantial climatic shift toward increased moisture availability (McEwan et al. 2011). They are forests in transition as the often dense mid-story of sugar maple (*Acer saccharum*), red maple (*Acer rubrum*) and American beech (*Fagus grandifolia*) indicates (McEwan et al. 2011). These mesophytic species are capable of achieving dominance and that species composition shift has become a concern, especially in relation to forestry and wildlife impacts. Other mid-story trees include flowering dogwood (*Cornus florida*), pawpaw (*Asimina triloba*), sourwood (*Oxydendrum arboreum*), and eastern redbud (*Cercis canadensis*).

The forest understory includes native vines, ferns, and herbs including Virginia creeper (*Parthenocissus quinquefolia*), eastern poison ivy (*Toxicodendron radicans*), muscadine (*Vitis rotundifolia*), greenbriar (Smilax spp.), littlebrownjug (*Hexastylis arifolia*), mayapple (*Podophyllum peltatum*), feathery false lily of the valley (*Maianthemum racemosum*), yellow wakerobin (*Trillium luteum*), and Christmas fern (*Polystichum acrostichoides*). Tree regeneration also represents a percentage of the understory, with the maples and American beech occurring most commonly (Hart et al. 2008).

There is strong evidence to suggest that humankind has occupied the ridge and valley and interacted with the land for the past 10,000 years or more (Chapman, 1982). Native American population demographics changed over time, as did the type and intensity of their land use practices. It is likely that land clearance and cultivation over the last several thousand years increased the amount of forest edge considerably (Chapman, 1982). The exact mechanisms of this change prior to European settlement are unclear, but there is little doubt that American Indians were cultivating crops, cutting trees to use for fuel wood and building materials, planting orchards for fruit and nut production, and using prescribed fire to clear land for settlement and open the forest for hunting. The effects of their management practices were probably highly variable across the landscape and intermediate in scale. The best available studies suggest that due to the land use practices of Native Americans in this general region, oaks and chestnuts became dominant on upper slopes, fire-adapted pines established on ridges, and disturbance-adapted hardwoods colonized old fields (Delcourt, 1998).

After European settlement and expansion in the early 1800’s, land use changed drastically both in terms of type and intensity. The early pioneers used the forests for food for themselves and their livestock in addition to cutting wood for fuel, shelter, etc. A common practice was to use forested ridges for pasture. They also cleared forests for habitation, pastures, and fields. As industrialization occurred and people moved into more urban areas, many of the pastures and fields were abandoned and reverted to forest. These forests are now largely occupied by low-quality, mixed hardwood-pine and small-sawtimber size hardwood stands (Smith, 1995).

In addition to forest clearing for small settlement farms, the forests of this area were extensively logged in the late nineteenth and early twentieth century, before the advent of modern forestry and soil conservation practices. During this time, boomtowns sprang up around lumber mills and railroads were built to accommodate the trade. Termed “the Big Cut” by local foresters, this period in history resulted in probably the most significant forest disturbance to date. Almost all forests in this region were impacted to some degree and stands which exhibit old-growth characteristics are extremely rare today.

Destructive fires often followed poor logging practices, killing young stands, damaging older tree trunks and causing heavy losses in soil fertility. However, while fire prevention and suppression programs in the 1930’s decreased the loss of forest resources to wildfire, it also impacted forest dynamics significantly (Smith, 1995). The role of fire in the greater Southern Appalachian Hardwood region as a whole (which encompasses this ecological site) is not well understood and research into the complex relationship between fire and oak forests is emerging (Arthur et al. 2012).

Another important disturbance in the eastern forest was the loss of the American chestnut to the exotic chestnut blight fungus in the early 1900’s. It had moved through Tennessee, killing most chestnut trees by 1930 (Hart, 2008). It is widely accepted that chestnut was replaced by oak and hickory species, especially in upland areas; although, other species including red maple would also have benefited (Keever, 1953; Stephenson et al., 1991).

Most oak species would likely also have responded favorably to the heavy disturbances caused by logging and fire in the early years of settlement. The combined result is the heavily oak-hickory dominated forests common on upland sites today.

Present-day disturbances include poor logging practices such as high-grading or diameter-limit cutting, which selects higher-quality trees for extraction and leaves defective or unhealthy trees. This results in forest stands that are degraded in terms of genetics, species composition, forest health, and timber quality. Most stands in this ecological site have been high-graded multiple times.

Invasive exotic pest plant species are negatively impacting the overall health of forested stands. Plant species of concern in forests include tree of heaven (*Ailanthus altissima*), Asian bittersweet (*Celastrus orbiculatus*), autumn olive (Elaeagnus umbellate var, parviflora), bicolor lespedeza (*Lespedeza bicolor*), the exotic privets (Ligustrum spp.), princess tree (*Paulownia tomentosa*), kudzu (*Pueraria montana* var. lobata), multiflora rose (*Rosa multiflora*), and the exotic honeysuckles (Lonicera spp.). Forests are particularly susceptible to exotic plant invasion after a disturbance, which further complicates management decisions. In general, in the South, invasive exotic plants should be considered in nearly every management scenario.

The Tennessee Division of Forestry lists the major areas of concern for forest pests: emerald ash borer, gypsy moth, southern pine beetle, hemlock woolly adelgid, oak decline, thousand cankers disease and walnut twig beetle and dogwood anthracnose. Of these, gypsy moth, oak decline, and dogwood anthracnose would be of primary concern on this ecological site.

A state and transition model for this ecological site follows this narrative. Thorough descriptions of each state, transition, plant community, and pathway follow the model. Experts base this model on available experimental research, field observations, professional consensus, and interpretations. It is likely to change as knowledge increases.

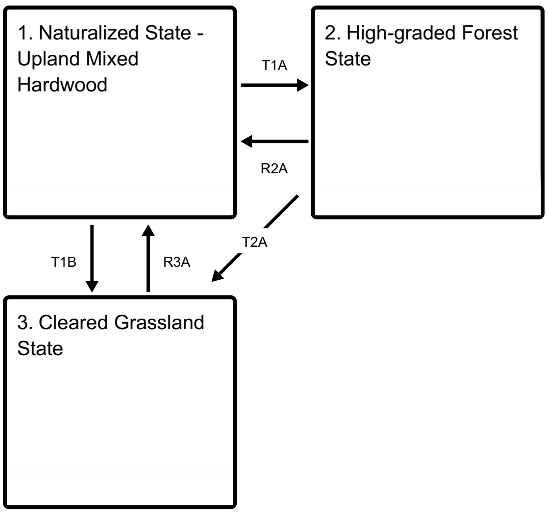
Plant communities will differ across the major land resource area because of the naturally occurring variability in weather, soils, and aspect. The Reference Plant Community is not necessarily the management goal. The biological processes on this site are complex. Therefore, representative values are presented in a land management context. The species lists are representative and are not botanical descriptions of all species occurring, or potentially occurring, on this site. They are not intended to cover every situation or the full range of conditions, species, and responses for the site.

The following diagram suggests pathways that the vegetation on these sites will most likely take, given the above general descriptions of climate, soils, and disturbance histories. Specific areas with unique soils and disturbance histories may have alternative pathways not shown on this diagram. This information is intended to show what might happen given average site conditions and a history of repeated disturbances as described above. Local professional guidance should always be sought before pursuing a treatment scenario.

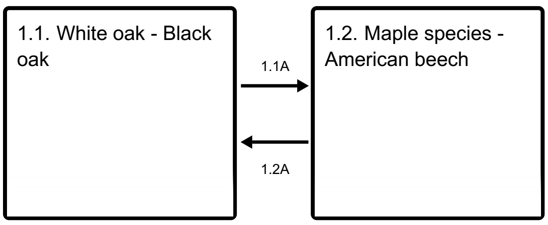
It is worthwhile to note that this site is geographically associated with the Thermic Cherty Dolomite Uplands; the primary difference being fragment content within the soil profile. Because the soils on this site are much cleaner (fewer chert fragments), they are better suited to agricultural production, especially pasture and hay. This is likely the reason much more of it has been cleared from the forested state.

State and transition model

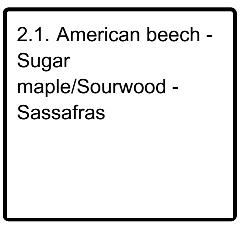
Ecosystem states



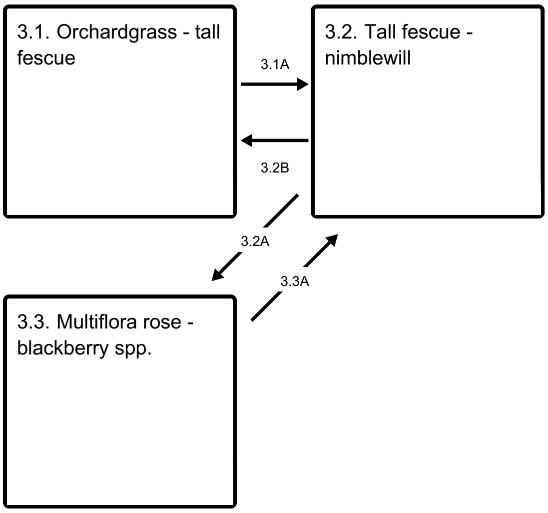
State 1 submodel, plant communities



State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Naturalized State - Upland Mixed Hardwood

The naturalized state for this ecological site is characterized by a closed-canopy hardwood forest dominated by oaks. Yellow poplar may be more common on these sites than on similar drier sites, indicating that fragment content is related to soil moisture. Yellow poplar would be more competitive on sites with more available moisture while white oak, for example, would likely do better on drier sites. In order for this state to be maintained, the mixed hardwood species, especially oaks, must be present in multiple age classes. In most cases red maple, sugar maple and American beech are colonizing the midstory and understory. A species composition shift toward these more mesophytic species is widely recognized throughout the eastern United States (McEwan et al., 2011).

Dominant plant species

- white oak (*Quercus alba*), tree
- black oak (*Quercus velutina*), tree
- southern red oak (*Quercus falcata*), tree
- tuliptree (*Liriodendron tulipifera*), tree

Community 1.1
White oak - Black oak

This phase is dominated by oaks and hickories in the overstory currently, but mid-story composition is shifting toward more shade and moisture-loving species. The understory is relatively rich in herbaceous diversity (including vines) but tree regeneration overwhelmingly favors the shade-tolerant species. For this phase to regenerate back to oak, numerous complex and site-specific factors may be necessary. These include acorn production, seedling establishment, advanced regeneration from seedlings, and timely release (Brose et al., 2013). Several types of management can be employed to this end including prescribed fire, mechanical and chemical competition control, site preparation, and planting. However, depending on the stand and its history, management for oak/hickory is typically intensive and often requires multiple treatments over time (~10 - 25 years), (Loftis, 2004). Without intensive management, in most cases, stands will naturally succeed to a more mesophytic forest type dominated by shade tolerant species (the maples and American beech). Dendroecology studies in nearby, very similar old-growth forest stands indicate that oak species have dominated stands for the past 300 years. They speculate that the recent proliferation of maples in the understory will inhibit regeneration of oak and pine under the current disturbance regime (Hart et al., 2012). Oak and hickory can regenerate in canopy gaps formed by uprooted trees, but only on very dry sites, indicating that gap-phase dynamics will favor maple overall (Hart and Kupfer, 2011).

Forest overstory. The overstory of this community is dominated by hardwood species, most commonly white oak, black oak, the red oaks and yellow poplar but overall species composition is high.

Midstory species include sourwood (Oxydendrum arboreum), sassafras (Sassafras albidum), eastern redbud (Cercis canadensis), flowering dogwood (Cornus florida), Carolina buckthorn (Frangula caroliniana), and common serviceberry (Amelanchier arborea). Shade tolerant hardwoods are a natural part of the dynamic of this ecological site, but have become more dominant in the midstory of most stands than they might naturally be due to lack of disturbance over time. Shade tolerant species include American beech, sugar maple and red maple.

Note: In this document, overstory and understory are defined as 2 broad elevational strata separating plants either over 13 feet in height or equal or under 13 feet in height, respectively. More finely defined elevational increments are defined in the Canopy Structure table. Refer to the Percent Surface Cover by Woody Materials table for more information regarding standing dead and downed wood.

Forest understory. Herbaceous diversity is not as high as in other associated ecological sites (not yet described). Occurrence and abundance vary based on topography and are lowest on ridges and south-facing shoulders and side slopes and highest on lower north-facing side slopes. Commonly occurring species include feathery false lily of the valley (Maianthemum racemosum), littlebrownjug (Hexastylis arifolia), mayapple (Podophyllum peltatum), cutleaf toothwort (Cardamine concatenata), the bellworts (Uvularia spp.), American cancer root (Conopholis americana), trefoil (Desmodium spp.), jack in the pulpit (Arisaema triphyllum), sweet cicely (Osmorhiza spp.), trailing arbutus (Epigaea repens), the violets (Viola spp.), wood sorrel (Oxalis montana), black cohosh (Actaea racemosa), forest licorice bedstraw (Calium circaezans), and yellow wakerobin (Trillium luteum).

Native vines are important in this ecological site; although, it is unclear how much disturbance plays a role in their abundance. Poison ivy (Toxicodendron radicans), for example, tends to do better in disturbed areas and can often be an indication of a past disturbance, such as grazing, if found in proliferation. Other important vines include greenbriar (Smilax spp.), muscadine (Vitis rotundifolia), Virginia creeper (Parthenocissus quinquefolia), and crossvine (Bignonia capreolata).

Regenerating tree species such as American beech and the maples represent most of the understory overall although vines can be more abundant in places.

Dominant plant species

- white oak (*Quercus alba*), tree
- black oak (*Quercus velutina*), tree
- tuliptree (*Liriodendron tulipifera*), tree

Table 5. Soil surface cover

Tree basal cover	3-5%
Shrub/vine/liana basal cover	1-2%
Grass/grasslike basal cover	0-1%
Forb basal cover	0-1%
Non-vascular plants	0-1%
Biological crusts	0%
Litter	60-89%
Surface fragments >0.25" and <=3"	0-5%

Surface fragments >3"	2-15%
Bedrock	0%
Water	0%
Bare ground	0%

Table 6. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	0-5%
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	0-5%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	0-7%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	0-7%
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0-6%
Tree snags** (hard***)	0-1%
Tree snags** (soft***)	0-2%
Tree snag count** (hard***)	25 per hectare
Tree snag count** (hard***)	49 per hectare

*** Decomposition Classes: N - no or little integration with the soil surface; I - partial to nearly full integration with the soil surface.**

**** >10.16cm diameter at 1.3716m above ground and >1.8288m height--if less diameter OR height use applicable down wood type; for pinyon and juniper, use 0.3048m above ground.**

***** Hard - tree is dead with most or all of bark intact; Soft - most of bark has sloughed off.**

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	11-20%	0-1%	0-5%
>0.15 <= 0.3	–	1-20%	0-2%	1-5%
>0.3 <= 0.6	–	0-5%	–	–
>0.6 <= 1.4	1-5%	1-5%	–	–
>1.4 <= 4	1-5%	1-5%	–	–
>4 <= 12	2-25%	–	–	–
>12 <= 24	2-45%	–	–	–
>24 <= 37	30-75%	–	–	–
>37	20-30%	–	–	–

Community 1.2
Maple species - American beech


Figure 10. Maple in the mid-story of an oak dominated forest

This community phase has not yet been attained in most cases because forests currently dominated by oaks and hickories are in transition. Without management or large-scale disturbance, stands will naturally succeed to more mesophytic species composition in the overstory and the oaks and hickories will lose their dominance over time. Small-scale gap dynamics caused by tree throws would likely be a natural part of this state and would favor the maple component in forest stands (Hart et al. 2012). A recent study of red maple on the nearby Cumberland Plateau found that canopy accession strategy and climate-growth relationships are critical factors in the shift from state 1.1 to state 1.2 (Hart et al. 2012). Red maples are gap-opportunists and can take advantage of smaller-scale disturbances such as tree-throws. Oaks in contrast, seem to have needed high frequency, intense disturbances to establish their current dominance in the forest. Red maples do best in times of cool, wet springs preceded by wet autumns and warm winters (Hart et al. 2012). Depending on climate conditions in the coming years, the weather may or may not favor their continued establishment. Red maple might also cause local environmental changes that facilitate perpetuation of favorable conditions for regeneration such as modification of understory light levels and soil characteristics (Nowacki and Abrams 2008). The denser canopies might reduce understory temperature and increase relative humidity, which would also favor the more shade-tolerant, moisture loving state (Alexander and Arthur 2010). Prescribed fire has been suggested as a management tool to reverse the trend. While it may be a useful tool in some cases and most likely in combination with other management approaches, using fire alone is unlikely to produce the desired results in most stands (Clark and Schweitzer 2013).

Forest overstory. The forest overstory is dominated by mature maples and American beech. Tree throws create small-scale gap dynamics in the forest, which favor recruitment of the maples and in some cases, yellow poplar. Oaks and hickories will always be a part of the species composition in this state, but will not be dominant.

Forest understory. Forest understory composition will be similar to community phase 1.1, dominated by native herbs, forbs, and vines. Shade tolerant trees will be present in the regeneration. Spring ephemeral wildflowers will be prolific in places.

Dominant plant species

- American beech (*Fagus grandifolia*), tree
- red maple (*Acer rubrum*), tree

- sugar maple (*Acer saccharum*), tree

Pathway 1.1A
Community 1.1 to 1.2

White oak - Black oak

Maple species - American beech

Time (typically >100 years) with little or no large-scale disturbance will favor shade tolerant, late successional species including sugar maple, red maple and American beech.

Pathway 1.2A
Community 1.2 to 1.1

Maple species - American beech

White oak - Black oak

Establishment of advanced oak regeneration (natural or planted) is critical to recruiting oak back into the overstory. If that is desirable, a combination of natural and managed steps will likely be required to favor oak. Depending on the residual stand, management recommendations might include timber stand improvement, mechanical or chemical treatment of unwanted species, and prescribed fire. Consultation with a professional forester is recommended prior to implementation of any management practice, especially the use of prescribed fire. Arthur et al. (2012) discusses conditions when fire should and should not be used in oak management.

Conservation practices

Prescribed Burning
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Upland Wildlife Habitat Management
Forest Trails and Landings
Forest Stand Improvement
Fuel Break
Forest Management Plan - Written
Forest Management Plan - Applied

State 2
High-graded Forest State

Forests in the high graded state have been logged using diameter-limit cut methods multiple times in most cases. This results in a stand with undesirable species composition, low vigor, and poor health. The genetic quality of the forest has been depleted due to the best trees being taken out over time. While oak and hickory species are often still present in this state, individual trees are often "wolfy" and defective. These are the trees that would have been undesirable from a timber perspective and so left after multiple entries of logging. Notably, hickory has often been left because sawmills historically did not have the capability to process them.

Community 2.1
American beech - Sugar maple/Sourwood - Sassafras

Canopies in the high graded state are generally thick enough to prevent adequate oak regeneration; more shade tolerant species such as red maple, sugar maple and American beech will predominate. Oak and hickory species that remain are typically of low genetic quality in terms of timber. Stands that have been high graded multiple times often show a conspicuous lack of white oak and northern red oak.

Forest overstory. The overstory is dominated by American beech, sugar maple, and red maple. Tuliptree and red and white oak species can be present but individuals are typically not high quality and do not represent the genetic potential of the stand, nor will they occur in large numbers. Blackgum, sourwood, sassafras, and dogwood can be important midstory species in addition to smaller maples and American beech.

Forest understory. The understory can be diverse across stands. Species noted include buckeye (Aesculus spp.), Virginia creeper (Parthenocissus quinquefolia), greenbrier (Smilax glauca, Smilax rotundifolia), grapevine (Vitis spp.), ebony spleenwort (Asplenium platyneuron), little brown jug (Hexastylis ruthii), nakedflower ticktrefoil (Desmodium nudiflorum), fragrant bedstraw (Galium triflorum), Christmas fern (Polystichum acrostichoides), etc. Forest understories will also include large numbers of regenerating tree seedlings.

Table 8. Ground cover

Tree foliar cover	10-25%
Shrub/vine/liana foliar cover	0-1%
Grass/grasslike foliar cover	0%
Forb foliar cover	0-1%
Non-vascular plants	0%
Biological crusts	0%
Litter	60-70%
Surface fragments >0.25" and <=3"	0%
Surface fragments >3"	2-5%
Bedrock	0%
Water	0%
Bare ground	0%

Table 9. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	0-2%	0-2%	–	0-2%
>0.15 <= 0.3	0-3%	0-4%	–	0-3%
>0.3 <= 0.6	0-3%	1-3%	–	0-1%
>0.6 <= 1.4	0-5%	1-5%	–	–
>1.4 <= 4	5-15%	1-5%	–	–
>4 <= 12	5-10%	1-5%	–	–
>12 <= 24	25-50%	–	–	–
>24 <= 37	15-25%	–	–	–
>37	–	–	–	–

State 3
Cleared Grassland State

This state represents a once-forested area now cleared for pasture. Most pastures are very old and have been established for a long time. Management practices focus primarily on maintaining healthy pasture conditions rather than new pasture establishment, although that is certainly an option. Balancing stocking rates, grazing rotation, and nutrient inputs are the primary management concerns. Pastures in good condition fall into the MDWRV (G128XY021TN) forage suitability group (FSG) in Tennessee. Forage species rated as excellent for this site include the legumes alfalfa, ladino clover, and red clover. Cool season grasses rated as excellent include annual ryegrass, orchardgrass, tall fescue, timothy, and winter small grains. Warm season grasses rated as excellent include bermudagrass, big bluestem, caucasian bluestem, eastern gamagrass, indiangrass, little bluestem, switchgrass, pear millet and sorghum sudangrass. Some species listed as excellent were not included in this description because they are known to have invasive tendencies and should be avoided if possible. In general, pasture management recommendations focus on maximizing desirable forage species to outcompete undesirable or weedy species. Production practices that result in overgrazing and low fertility levels favor emergence, propagation, and growth of weeds (Green et al., 2006). Effective pasture management includes the following practices: - maintaining proper soil pH and fertility levels - using controlled grazing practices - mowing at proper timing and stage of maturity - allowing new seedlings to become well established before use, and - renovating pastures when needed (Green et al. 2006). Perilla (*Perilla frutescens*) mint is an exotic, invasive weed that has become a major problem in many pastures. It causes more cattle deaths (in Tennessee) than any other toxic plant (Steckel and Rhodes, 2007). Keeping a ready supply of quality feed available for farm animals in the late summer and early fall will help to minimize the risk to livestock. Cattle will not normally feed on perilla unless there is a shortage of other feed.

Community 3.1
Orchardgrass - tall fescue

Figure 11. Well managed pasture

The dominance of orchardgrass (*Dactylis glomerata*), red clover (*Trifolium pratense*), and tall fescue (*Schedonorus arundinaceus*) in this community phase indicate that nutrient levels are adequate, and grazing rotations are long enough to allow pasture plants to recover. Overstocking and infrequent pasture rotation will allow weedier species to invade, such as nimblewill and rush.

Forest overstory. The overstory in the grassland state is minimal and consists of a few trees growing along the parameter of pastures, and scattered shade trees within pastures.

Forest understory. Pastures in good condition fall into the MDWRV (G128XY021TN) forage suitability group (FSG) in Tennessee. Forage species rated as excellent for this site include the legumes alfalfa, ladino clover, and red clover. Cool season grasses rated as excellent include annual ryegrass, orchardgrass, tall fescue, timothy, and winter small grains. Warm season grasses rated as excellent include bermudagrass, big bluestem, caucasian bluestem, eastern gamagrass, indiangrass, little bluestem, switchgrass, pear millet and sorghum sudangrass. Some species listed as excellent were not included in this description because they are known to have invasive tendencies and should be avoided if possible.

Table 10. Ground cover

Tree foliar cover	0-2%
Shrub/vine/liana foliar cover	0-2%
Grass/grasslike foliar cover	60-70%
Forb foliar cover	20-30%
Non-vascular plants	0%
Biological crusts	0%
Litter	0-5%
Surface fragments >0.25" and <=3"	0-3%

Surface fragments >3"	0-15%
Bedrock	0%
Water	0%
Bare ground	0-2%

Community 3.2
Tall fescue - nimblewill

Figure 12. Overgrazed pasture

This community phase is transitional to a more degraded phase. While some desirable pasture plants are still present [E.g. tall fescue, white clover (*Trifolium repens*)], [Dallisgrass (*Paspalum dilatatum*), Crabgrass (Digitaria spp.) and other warm season plants], undesirable species such as nimblewill (*Muhlenbergia schreberi*), rush (Carex spp.), cinquefoil (Potentilla spp.), thistle (Cirsium spp.) and little barley (*Hordeum pusillum*) will begin to proliferate. Heavy grazing pressure may favor weedy species over grass (Rhodes and Phillips, 2012). Just removing or reducing livestock will not always be enough to restore desirable conditions after a point. Some type of nutrient improvement may also be needed.

Community 3.3
Multiflora rose - blackberry spp.

Figure 13. Blackberry growing in a pasture

Pastures with a history of overgrazing can be susceptible to invasion by weedy plants, brambles, and small trees if grazing pressure is reduced and nothing further is done to improve the site. Indicator plants for this phase include blackberry, broomsedge, and multi-flora rose. Clipping undesirable plants and adding nutrient input can help pastures in this phase recover. Goats, mowing and herbicide can be useful for clearing unwanted plants.

Pathway 3.1A
Community 3.1 to 3.2


Orchardgrass - tall fescue


Tall fescue - nimblewill

Overstocked pasture with infrequent rotation.

Pathway 3.2B
Community 3.2 to 3.1


Tall fescue - nimblewill


Orchardgrass - tall fescue

Rotational grazing with a longer recovery period and higher grazing height; improved fertility.

Pathway 3.2A
Community 3.2 to 3.3


Tall fescue - nimblewill


Multiflora rose - blackberry spp.

Overgrazed; low fertility

Pathway 3.3A
Community 3.3 to 3.2


Multiflora rose - blackberry spp.


Tall fescue - nimblewill

Clipping pasture with nutrient improvement or controlled grazing.

Transition T1A
State 1 to 2

Selective harvesting and high grading multiple times results in degradation of forest stand quality in terms of altered species composition, forest structure, and genetic fitness. Diameter limit cuts, incorrectly implemented, remove the biggest and best trees and leave those of lowest quality in terms of both timber and ecology.

Transition T1B
State 1 to 3

Forest clearing, herbicide application, and establishment of pasture plants, hay or crops will convert forested stands to a grassland state. Most pastures in this site are old and were converted many years ago.

Restoration pathway R2A
State 2 to 1

Restoration practices to be implemented should be determined strictly on a stand-by-stand basis as conditions may vary depending on the type and extent of past logging practices or wind/ice/fire damage as well as the presence or absence of invasive non-native plants. In general, a large scale disturbance such as a clear-cut would allow stand re-establishment over time. In some cases, planting desirable species (primarily oaks) could be merited. If planting is determined to be a viable option, competition control and protection from deer browse is important. Improved tree stock is recommended for the best results. Further management practices such as weed control, timber stand improvement (TSI) and thinning would likely be needed intermittently during stand re-establishment to achieve the desired result.

Transition T2A
State 2 to 3

Forest clearing, herbicide application, and establishment of pasture plants, hay or crops will convert forested stands to a grassland state. Most pastures in this site are old and were converted many years ago.

Restoration pathway R3A
State 3 to 1

Abandoned pastures can revert back to forest naturally, although the presence of invaisve, non-native plants may prevent desirable species establishment. In the past, most of this ecological site has been cleared and grazed and then abandoned but invasive plants were not as prolific then. It is almost certain that some type of weed control will be needed in addition to the natural regeneration process. Additionally, planting desirable species can sometimes be merited. If this approach is attempted, improved tree planting stock, competition control and prevention of deer browse is recommended. Sites may need multiple treatments over time and monitoring is critical to successful restoration.

Additional community tables

Table 11. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
tuliptree	LITU	*Liriodendron tulipifera*	Native	18.3–33.5	30–35	33–50.8	–
red maple	ACRU	*Acer rubrum*	Native	4–8.8	5–25	7.6–10.2	–
black oak	QUVE	*Quercus velutina*	Native	15.2–39.6	5–25	55.9–96.5	–
white oak	QUAL	*Quercus alba*	Native	15.2–42.7	20–25	45.7–73.7	–
sugar maple	ACSA3	*Acer saccharum*	Native	4–22.9	5–10	17.8–40.6	–
southern red oak	QUFA	*Quercus falcata*	Native	12.2–30.5	5–10	68.6	–
pignut hickory	CAGL8	*Carya glabra*	Native	4–4.6	0–5	0–5.1	–
American beech	FAGR	*Fagus grandifolia*	Native	4–7.6	0–5	10.2–12.7	–
black cherry	PRSE2	*Prunus serotina*	Native	7.6–10.7	0–5	0–22.9	–
sourwood	OXAR	*Oxydendrum arboreum*	Native	6.1–13.4	1–2	20.3–25.4	–

Table 12. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Undefined					
American cancer-root	COAM	*Conopholis americana*	Native	0–0.2	0–1
Forb/Herb					
bedstraw	CRUCI2	*Cruciata*	Native	0–0.2	0–1
Canadian woodnettle	LACA3	*Laportea canadensis*	Native	0–0.2	0–1
ticktrefoil	DESMO	*Desmodium*	Native	0–0.3	0–1
Shrub/Subshrub					
mapleleaf viburnum	VIAC	*Viburnum acerifolium*	Native	0–1.4	0–5
Carolina buckthorn	FRCA13	*Frangula caroliniana*	Native	0–0.6	0–1
bursting-heart	EUAM9	*Euonymus americanus*	Native	0–0.3	0–1
Tree					
American beech	FAGR	*Fagus grandifolia*	Native	1.4–4	5–10
sugar maple	ACSA3	*Acer saccharum*	Native	0.2–4	1–10
pawpaw	ASTR	*Asimina triloba*	Native	1.4–4	2–5
black cherry	PRSE2	*Prunus serotina*	Native	0–0.2	1–2
white oak	QUAL	*Quercus alba*	Native	0.2–0.3	0–2
pignut hickory	CAGL8	*Carya glabra*	Native	0–0.3	1–2
sassafras	SAAL5	*Sassafras albidum*	Native	0–1.4	0–2
tuliptree	LITU	*Liriodendron tulipifera*	Native	0.2–0.3	0–1
red maple	ACRU	*Acer rubrum*	Native	0–0.2	0–1
sweetgum	LIST2	*Liquidambar styraciflua*	Native	0.3–0.6	0–1
flowering dogwood	COFL2	*Cornus florida*	Native	0–0.3	0–1
blackgum	NYSY	*Nyssa sylvatica*	Native	0–1.4	0–1
eastern redbud	CECA4	*Cercis canadensis*	Native	0.2–0.3	0–1
common serviceberry	AMAR3	*Amelanchier arborea*	Native	0–0.6	0–1
Vine/Liana					
muscadine	VIRO3	*Vitis rotundifolia*	Native	0–0.3	0–10
greenbrier	SMILA2	*Smilax*	Native	0–0.6	0–1
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	0.2–1.4	0–1
eastern poison ivy	TORA2	*Toxicodendron radicans*	Native	0–0.6	0–1
saw greenbrier	SMBO2	*Smilax bona-nox*	Native	0–0.6	0–1

Animal community

The mixed hardwood forests that represent the naturalized state provide important mast production for a variety of wildlife species. Acorns in particular are an extremely important food source for birds and mammals during the dormant season (McShea et al., 2006). Ninety-six species of birds and mammals are known to consume acorns, especially in fall and winter (Martin, 1961). Acorns produced from white oak tree species (white oak, chestnut oak, etc.) are typically more palatable than acorns from the red oak group, although red oak acorns are still an important food source, particularly in the winter season when acorns from white oak species have already been consumed. Examples of animals that consume acorns within this ecological site include insects such as the acorn weevil, birds (e.g. wild turkeys, northern bobwhite quail, woodpeckers, blue jays, crows), small mammals (e.g., chipmunks, fox squirrels, flying squirrels, rabbits, mice, voles, raccoons and opossums), and large mammals (e.g., white-tailed deer, red and gray foxes, black bear), (Dickson, 2004). Prior to its extinction, the passenger pigeon would have been an important consumer and distributor of acorns as well (Frelich and Reich, 2002).

Oak is considered a foundation species for wildlife in the eastern forest (McShea et al., 2006). However, oak species have considerable variability in acorn production (crop size from year to year), which can substantially affect the availability of mast for wildlife. Providing variety in hard and soft mast producing species can help to ensure that food is available from season to season and from year to year. Hickory nuts can also be important mast for wildlife. In fact, hickory makes up 10 to 20 percent of squirrel diets in similar systems (Apsley and Gehrt, 2006).

From a habitat perspective, oak-hickory forests are extremely important. For example, numerous birds depend on different stages of these forest systems to survive. The Appalachian region, the location of this ecological site, is the center of the summer breeding range of neotropical migratory birds. Neotropical migrants include forest-interior, forest-edge, and early-successional species and comprise 65 to 85 percent of breeding birds (Smith, 1995). The Indiana bat is the primary threatened and endangered bat species. Shaggy bark (e.g., shagbark hickory) and scaly bark (white oak) species provide excellent roosting sites for this species. The Northern long eared bat is not listed yet, but is expected to be and would also use associated trees as roosting sites.

Young (1 to 10 year post-disturbance) upland oak forests function as high-quality food sources for myriad wildlife species. Fruit producing early successional plants such as pokeweed and blackberry, young shrubs, and tree sprouts play an important role in the diets of several bird species, arthropods, and small mammals that serve as prey for numerous snake, bird, and mammal predators (Greenberg, et al. 2011). Mature stands serve as habitat for wild turkey in fall and winter where they utilize acorns as an important part of their diet. Additionally, most forest-dwelling amphibians, reptiles, birds, and mammals required at least a sawtimber stage of maturity in similar forest systems in New England (Healy, 2002).

Snags, cavity trees, and downed logs provide habitat for a wide variety of wildlife species; as such, they are important components of oak-hickory forests on this ecological site. Snags are standing dead or dying trees, and downed logs are simply logs that are on or near the forest floor. Cavity trees are live trees with holes big enough to shelter animals. This includes trees with cavities in the limbs, which can actually be more important to some wildlife species than larger hollow trees. Snags are created by lightning, storm breakage, fire, disease, insects, drought, flooding, cultural practices, among other factors that contribute to tree mortality.

Wildlife species are affected by ecological dynamics in upland oak forests to varying degrees. Management must consider all factors that could impact wildlife populations and be site-based in application. A balance of successional stages in sustainable proportions across the landscape (multiple forest age classes) with consideration for snags and cavity trees will sustain high quality food sources and habitat for wildlife overall.

Hydrological functions

Soils in forests have well developed structure, which is maintained by many factors of the forest environment. The surface of the soil is protected from raindrop impact by the forest canopy and the surface organic layers (Carmean, 1957), infiltration is generally good and runoff is low.

Long-term research on mixed hardwood forests in this region indicates that there is little long-term effect of clearcutting and other logging practices on hydrologic and water quality sustainability, especially at smaller scales (Swank et al., 2001). Harvesting increases annual water yield typically only during the first 4 to 5 years after cutting. However, harvesting practices vary and have an impact on the severity of impact to hydrologic function. For example, clear-cut size, logging techniques, and the density and condition of logging roads can all create more surface soil disturbance which results in more runoff. Following best management practices (BMPs) is a good way to avoid the negative impacts of logging to soil and water resources both in the short and long term.

Unlike the short-term effect of most forestry practices, conversion of forest land to pasture or lawn (urban use) can result in higher bulk densities and lower infiltration rates and water holding capacities in soils, which can be attributed to higher compaction associated with land management practices (Price et al., 2010). This leads to increased runoff and can negatively influence water quality. Good pasture management can reduce negative effects to some extent and should always be employed to protect soil and water quality wherever possible.

Recreational uses

Most of site is under private ownership so public recreation opportunities are limited. However, some of the western part of the Conasauga Ranger District (Chattahoochee-Oconee National Forest) falls within this ecological site. The opportunities there include bicycling, camping and cabins, hiking, horse riding, nature viewing, off-highway vehicle riding, picnicking, and scenic driving.

Similar opportunities can be found on smaller parcels of land owned by the Tennessee Valley Authority. A few of their Small Wild Areas (SWAs) on this ecological site have hiking trails and scenic overlooks. Norris Dam State Park and Norris Watershed have recreational opportunities on this site as well. Most of these areas are forested.

Wood products

This ecological site is dominated by forests in varying stages of succession. Most forestland is held by small, private landowners. Only a small extent of this ecological site occurs on public land. Important wood products include hardwood sawlogs (red oak, white oak, ash, tuliptree, walnut, cherry, sugar maple, and hickory), crosstie logs, hickory handle logs, white oak stave logs, hardwood pulpwood, softwood logs and veneer logs (Tennessee Forest Products Bulletin, 2013).

Other information

Site index data was not collected for this ecological site (forested naturalized state) because suitable stands for sampling could not be located.

Inventory data references

Plots for the naturalized reference community were taken at Oak Ridge Reservation and Norris Watershed. Transition communities were recorded on land owned by the Tennessee Valley Authority and on private property. Data recorded by Hal DeSelm (Mains et al. 2016) was also incorporated.

Other references

Alexander, Heather D. and M.A. Arthur. 2010. Implications of a predicted shift from upland oaks to red maple on forest hydrology and nutrient availability. Canadian Journal of Forest Research 40: 716-726.

Apsley, David and S. Gehert. 2006. Enhancing food (mast) production for woodland wildlife in Ohio. Extension Fact Sheet F-60-06, Ohio State University Extension, School of Natural Resources, Columbus, OH.

Arthur, Mary A., H.D. Alexander, D.C. Dey, C.J. Schweitzer, and D.L. Loftis. 2012. Refining the oak-fire hypothesis for management of oak-dominated forests of the eastern United States. Journal of Forestry 110: 257-266.

Braun, E. Lucy. 1947. Development of the Deciduous Forests of Eastern North America. Ecological Monographs 17(2): 211 - 219.

Brose, Patrick H., D.C. Dey, R.J. Phillips, and T.A. Waldrop. 2013. A meta-analysis of the fire-oak hypothesis: Does prescribed burning promote oak reproduction in eastern North America? Forest Science 59(3): 322 – 334.

Buol, Stan W., F.D. Hole, R.J. McCracken, R.J. Southard. 1997. Soil Genesis and Classification (4th ed.). Ames, Iowa: Iowa State University Press. Pp. 353 - 359.

Carmean, Willard H. 1957. The structure of forest soils. The Ohio Journal of Science 57(3): 165-168.

Case, Earl C. 1925. The valley of east Tennessee: The adjustment of industry to natural environment. Bulletin 36. Division of Geology, Nashville, Tennessee.

Chapman, Jefferson, P.A. Delcourt, P.A. Cridlebaugh, A.B. Shea, and H.R. Delcourt. 1982. Man-land interaction: 10,000 years of American Indian impact on native ecosystems in the lower little Tennessee River valley, eastern Tennessee. Southeastern Archaeology 1: 115–121.

Clark, Stacy L. and C.J. Schweitzer. 2013. Red maple (*Acer rubrum*) response to prescribed burning on the William B. Bankhead National Forest, Alabama. In: Guldin, James M., ed. 2013. Proceedings of the 15th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-GTR-175. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 271-276.

Condley, Brandon C. 1984. The ridge top chestnut oak forest community of the Ridge and Valley Physiographic Province and adjacent areas. M.S. Thesis. The University of Tennessee, Knoxville.

Dale, Virginia H., L.K. Mann, R.J. Olson, D.W. Johnson, and K.C. Dearstone. 1990. The long-term influence of past land use on the Walker Branch forest. Landscape Ecology 4(4): 211-224.

Delcourt, Paul. A. and H.R. Delcourt. 1998. The influence of prehistoric human-set fires on oak-chestnut forests in the southern Appalachians. Castanea 63: 337–345.

DeSelm, Hal. R. 1984. Potential national natural landmarks of the Appalachian ranges natural region: Ecological report. University of Tennessee, Knoxville.

Dickson, James G. Wildlife and upland oak forests. In: Spetich, Martin A., ed. 2004. Upland oak ecology symposium: history, current conditions, and sustainability. Gen. Tech. Rep. SRS-73. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 311 p.

Evans, Richard M. 1992. Soil and water conservation plan for: The University of Tennessee Forestry Experiment Station.

Green, Jonathan D., W.W. Witt, and J.R. Martin. 2006. Weed management in grass pastures, hayfields, and other farmstead sites. University of Kentucky Cooperative Extension Service publication AGR-172.

Greenberg, Catherine H., R.W. Perry, C.A. Harper, D.J. Levey, J.M. McCord. 2011. The role of recently disturbed upland hardwood forest as high quality food patches. In: Sustaining Young Forest Communities: Ecology and management of early successional habitats in the Central Hardwood Region, USA. Managing Forest Ecosystems. pp. 121–141.

Hart, Justin L., S.L. van de Gevel, and H.D. Grissino-Mayer. 2008. Forest dynamics in a natural area of the southern Ridge and Valley, Tennessee. Natural Areas Journal 28: 275–289.

Hart, Justin L. and J.A. Kupfer. 2011. Sapling richness and composition in canopy gaps of a southern Appalachian mixed Quercus forest. Journal of the Torrey Botanical Society 138(2): 207-219.

Hart, Justin L., S.L. Clark, S.J. Torreano, and M.L. Buchanan. 2012. Composition, structure, and dendroecology of an old-growth Quercus forest on the tablelands of the Cumberland Plateau, USA. Forest Ecology and Management 266: 11-24.

Hart, Justin L., M.L. Buchanan, S.L. Clark., and S.J. Torreano. 2012. Canopy accession strategies and climate-growth relationships in *Acer rubrum*. Forest Ecology and Management 282: 124-132.

Johnson, E.A. 1952. Effect of farm woodland grazing on watershed values in the southern Appalachian Mountains. Journal of Forestry 50(2): 109 – 113.

Keever, C. 1953. Present composition of some stands of the former oak-chestnut forest in the southern Blue Ridge Mountains. Ecology. 34: 44-54.

Loftis, David L. 2004. Upland oak regeneration and management. In: Proceedings of the Upland oak ecology symposium. USDA Forest Service, Gen. Tech. Rep. SRS-73, Southern Research Station, Asheville, NC. pp 163 - 167.

Lorimer, Craig G. 2001. Historical and ecological roles of disturbance in Eastern North American forests: 9,000 years of change. Wildlife Society Bulletin 29: 425–439.

Mains, A., Ferro, B., and Schlarbaum, S.E. "The Natural Terrestrial Vegetation of Tennessee Project Database", Natural Resources Conservation Service and The University of Tennessee Tree Improvement Program, 2016.

Martin, Alexander C., H.C. Zim, and A.L. Nelson. 1961. American wildlife and plants: A guide to wildlife food habits. Dover, New York, New York, USA.

Martin, William H. 1971. Forest communities of the dissected uplands in the Great Valley of east Tennessee and their relationship to soil and topographic properties. PhD Dissertation. The University of Tennessee, Knoxville.

Martin, William H. 1989. Forest patterns in the Great Valley of Tennessee. Journal of the Tennessee Academy of Science 64(3): 137 – 143.

McEwan, Ryan W., J.M. Dyer, and N. Pederson. 2011. Multiple interacting ecosystem drivers: Toward an encompassing hypothesis of oak forest dynamics across eastern North America. Ecography 34: 244-256.

McGrath, J.C., and W. K. Clatterbuck. 2013. Assessing anthropogenic and natural disturbances: Vegetational response to similarly aged clearcut and tornado disturbances in an East Tennessee oak-hickory forest. In: Proceedings of 15th Biennial Southern Silvicultural Research Conference, Hot Springs, AR, November 18-20, 2009. e-Gen. Tech. Rep. SRS-175. Asheville, NC: USDA Forest Service, Southern Research Station. pp. 81-90.

McShea, William J., W.M. Healy, P. Devers, T. Fearer, F.H. Koch, D. Stauffer, and J. Waldon. 2007. Forestry matters: Decline of oaks will impact wildlife in hardwood forests. Journal of Wildlife Management 71(5): 1717-1728.

Nelson, Thomas C. 1955. Chestnut replacement in the southern highlands. Ecology 36(2): 352-353.

Nowacki, Gregory J. and M.D. Abrams. 2008. The demise of fire and ‘‘mesophication’’ of forests in the eastern United States. BioScience 58: 123–138.

Olson, David F. , Jr. 1959. Site index curves for upland oak in the southeast. USDA, Forest Service. Southeastern Forest Experiment Station Research Note 125.

Price, Katie, C.R. Jackson, and A.J. Parker. 2010. Variation of surficial soil hydraulic properties across land uses in the southern Blue Ridge Mountains, North Carolina, USA. Journal of Hydrology 383: 256-268.

Rhodes, G. Neil Jr., and W.P. Phillips Jr. 2012. PB1801 Weed Management in Pastures and Hay Crops, http://trace.tennessee.edu/utk_agexcrop/157.

Schlaegel, Bryce E., D.L. Kulow, and R.N. Baughman. 1969. Empirical yield tables for West Virginia yellow poplar. West Virginia University Agriculture Experiment Station Bulletin 574T.

Smith, David W. 1968. Vegetational changes in a five county area of east Tennessee during secondary succession. M.S. Thesis. The University of Tennessee, Knoxville.

Smith, David W. 1995. The southern Appalachian hardwood region. Regional Silviculture of the United States. John Wiley & Sons, Inc. New York, NY, 643, 173-225.

Steckel, Larry and N. Rhodes. 2007. Perilla mint. University of Tennessee Extension Service publication W135.

Stephenson, Steven L., H.S. Adams, and M.L. Lipford. 1991. The present distribution of American chestnut in the upland forest communities of Virginia. Bulletin of the Torrey Botanical Club 118:24-32.

Swank, Wayne T., J.M. Vose, and K.J. Elliott. 2001. Long-term hydrologic and water quality responses following commercial clearcutting of mixed hardwoods on a southern Appalachian catchment. Forest Ecology and Management 143: 163 - 178.

Tennessee Forest Products Bulletin. July - September, 2013. Volume 39(3).

Thor, Eyvind and D.D. Summers. 1971. Changes in forest composition on Big Ridge Natural Study Area, Union

County, Tennessee. Castanea 36: 114-122.

Thornthwaite, Charles W. 1948. An approach toward a rational classification of climate. Geographical Review 38(1): 55-94.

United States Department of Agriculture, Soil Conservation Service. 1992. Hardwood forest grazing. Woodland Fact Sheet No. 7. Columbia, Missouri.

Williams, Samuel C. 1928. Early travels in the Tennessee country, 1540-1800: With introductions, annotations and index. The Watauga Press, Johnson City, Tennessee.

Contributors

Belinda Ferro
David Moore
Jennifer Mason

Approval

Nels Barrett, 10/17/2019

Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

---

6. **Extent of wind scoured, blowouts and/or depositional areas:**

---

7. **Amount of litter movement (describe size and distance expected to travel):**

---

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

---

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

---

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

---

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

---

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

---

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

---

14. **Average percent litter cover (%) and depth (in):**

---

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

---

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if**

their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:

---

17. **Perennial plant reproductive capability:**
