USDA Natural Resources Conservation Service

Ecological site F116CY002MO
Igneous Upland Woodland

Accessed: 05/10/2025

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): 116C–St. Francois Knobs and Basins

The St Francois Knobs and Basins is the structural center of the Ozark Dome. Elevation ranges from about 450 feet along the rivers in the southern part of the area, to 1,772 feet on the summit of Taum Sauk Mountain, the highest point in Missouri. Prominent features of this major land resource area (MLRA) are the Precambrian igneous knobs and hills that rise conspicuously to various elevations, interspersed with smooth-floored basins and valleys overlying dolomite and sandstone. Ecological sites defined for this MLRA are associated with the igneous parent materials, either in knob or basin positions. Areas influenced primarily by dolomite and/or sandstone are included in ecological sites within MLRA 116A (Ozark Highlands).

Classification relationships

Atlas of Missouri Ecoregions (Nigh and Schroeder 2002):
This ecological site occurs primarily within the following Land Type Association - OZ10a St. Francois Igneous Glade/Oak Forest Knobs

Terrestrial Natural Community Type (Nelson, 2010):
The reference state for this ecological site is most similar to Dry-Mesic Igneous Woodland

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference tate for this ecological site is most similar to CEGL005030) *Quercus velutina* - *Quercus alba*/Vaccinium (angustifolium, pallidum)/Carex pensylvanica Forest

Ecological site concept

Igneous Upland Woodlands occur in the central and southern part of the MLRA. Soils are over 40 inches to igneous bedrock, and are low in bases. These sites are often adjacent to Dry Igneous Upland Woodland ecological sites, and in places, are mapped in complex with them. Dry Igneous sites have root-restricting bedrock in the upper part of the soil profile, as do the nearby Shallow Igneous Knob Glade sites. Vegetation of the reference state is woodland with a moderately developed canopy dominated by white oak and northern red oak.

Associated sites

F116CY003MO	**Dry Igneous Upland Woodland** Dry Igneous Upland Woodlands are often downslope from Igneous Upland Woodlands, but are intermingled in other areas and mapped as a complex.
F116CY005MO	**Dry Igneous Protected Backslope Woodland** Igneous Protected Backslope Woodlands are typically downslope from Igneous Upland Woodlands, and are steeper.
F116CY010MO	**Igneous Exposed Backslope Woodland** Igneous Exposed Backslope Woodlands are typically downslope from Igneous Upland Woodlands, and are steeper.
R116CY006MO	**Shallow Igneous Knob Glade** Shallow Igneous Knob Glades have shallow soils with significant amounts of bedrock outcrop.

Similar sites

F116CY005MO	**Dry Igneous Protected Backslope Woodland** Igneous Protected Backslope Woodlands are downslope, on steeper slopes and have generally shallower soil depths than Igneous Upland Woodlands. The protected aspects make the site more mesic and closer in species composition to Igneous Upland Woodlands.

Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Quercus rubra*
Shrub	(1) *Vaccinium pallidum*
Herbaceous	(1) *Danthonia spicata* (2) *Schizachyrium scoparium*

Physiographic features

This site is on upland summit crests, shoulders and backslopes with slopes of 3 to 15 percent. The site generates runoff to adjacent, downslope ecological sites. This site does not flood.

The following figure (adapted from Simmons et al., 2006) shows the typical landscape position of this ecological site, and landscape relationships among the major ecological sites in the igneous uplands. This ecological site occurs in unit “1” on the diagram, as well as in the upper areas of unit “4”. Sites on summit crests and shoulders (labeled “1”) have more loess influence in the soil than do sites lower on the slopes, which are generally upslope from steeper, backslope ecological sites.

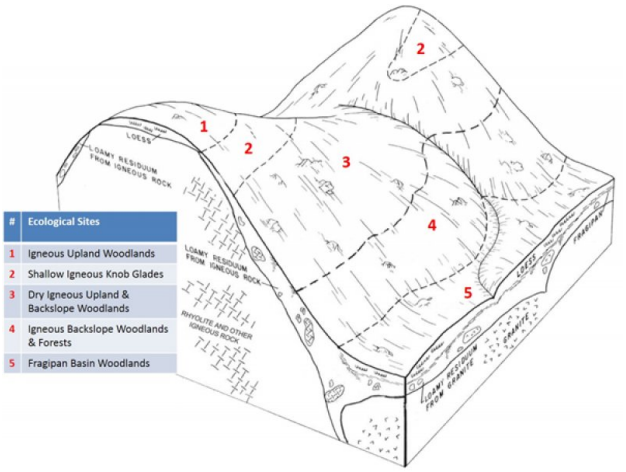


Figure 2. Major ecological sites of the igneous uplands.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Interfluve (3) Hill
Flooding frequency	None
Ponding frequency	None
Elevation	600–1,770 ft
Slope	3–15%
Water table depth	24–60 in
Aspect	Aspect is not a significant factor

Climatic features

The St. Francois Knobs and Basins have a continental type of climate marked by strong seasonality. In winter, dry-cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade reasonably humid air, snowfall and rainfall result. In summer, moist, warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce abundant amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over the region, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to successive, fast-moving fronts separating contrasting air masses.

The St. Francois Knobs and Basins experience few regional differences in climates. The average annual precipitation in this area is 42 to 46 inches. The average annual temperature is about 54 to 56 degrees F. The lower temperatures occur at the higher elevations. Mean July maximum temperatures have a range of only one or two degrees across the area.

Mean annual precipitation varies somewhat along a west to east gradient. The rainfall is fairly evenly distributed throughout the year. Snow falls nearly every winter, but the snow cover lasts for only a few days.

During years when precipitation is normal, moisture is stored in the soil profile during the winter and early spring, when evaporation and transpiration are low. During the summer months the loss of water by evaporation and transpiration is high, and if rainfall fails to occur at frequent intervals, drought will result. Drought directly affects plant and animal life by limiting water supplies, especially at times of high temperatures and high evaporation rates.

Superimposed upon the basic MLRA climatic patterns are local topographic influences that create topoclimatic, or microclimatic variations. For example, air drainage at night may produce temperatures several degrees lower in the basin and floodplain ecological sites downslope from this ecological site. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in basins and valleys. Nearby Glade ecological sites

may have higher daytime temperatures due to bare rock and higher reflectivity of these un-vegetated surfaces. Slope orientation is an important topographic influence on climate. Summits and south-and-west-facing slopes are regularly warmer and drier than adjacent north- and-east-facing slopes. Finally, the climate within closed-canopy woodland communities is measurably different from the climate of open-canopy woodlands within this ecological site.

References:
University of Missouri Climate Center. Accessed May, 2012. http://climate.missouri.edu/climate.php

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

Table 3. Representative climatic features

Frost-free period (characteristic range)	137-145 days
Freeze-free period (characteristic range)	164-169 days
Precipitation total (characteristic range)	45-47 in
Frost-free period (actual range)	136-148 days
Freeze-free period (actual range)	163-170 days
Precipitation total (actual range)	45-47 in
Frost-free period (average)	141 days
Freeze-free period (average)	166 days
Precipitation total (average)	46 in

Climate stations used

- (1) FARMINGTON [USC00232809], Farmington, MO
- (2) FREDERICKTOWN [USC00233038], Fredericktown, MO
- (3) ARCADIA [USC00230224], Arcadia, MO

Influencing water features

The site generates runoff to adjacent, downslope ecological sites. The water features of this upland ecological site include evapotranspiration, surface runoff, and drainage. Each water balance component fluctuates to varying extents from year-to-year. Evapotranspiration remains the most constant. Precipitation and drainage are highly variable between years. Seasonal variability differs for each water component. Precipitation generally occurs as single day events. Evapotranspiration is lowest in the winter and peaks in the summer. Water stored as ice and snow decreases drainage and surface runoff rates throughout the winter and increases these fluxes in the spring. The surface runoff pulse is greatly influenced by extreme events. Conversion to high intensity land uses tends to increase runoff, but also decreases evapotranspiration. Depending on the situation, this might increase groundwater discharge, and decrease baseflow in receiving streams.

Soil features

These soils have acidic subsoils that are low in bases. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is slope alluvium and residuum weathered from acid igneous rock such as diorite. Sites on summit crests generally have loess in the upper part. They have silt loam surface layers that range to gravelly and very gravelly and cobbly, particularly on lower slope positions, with loamy subsoils that have moderate amounts of volcanic gravel and cobbles. These soils are not affected by seasonal wetness. Soil series associated with this site include Hassler, Mudlick, and Trackler.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–diorite (2) Residuum–diorite
Surface texture	(1) Cobbly silt loam
Family particle size	(1) Loamy
Drainage class	Moderately well drained to well drained
Permeability class	Moderately slow to moderate
Soil depth	40–72 in
Surface fragment cover <=3"	5–10%
Surface fragment cover >3"	10–25%
Available water capacity (0-40in)	6–7 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (0-40in)	0–2 mmhos/cm
Sodium adsorption ratio (0-40in)	0
Soil reaction (1:1 water) (0-40in)	3.5–6
Subsurface fragment volume <=3" (Depth not specified)	5–10%
Subsurface fragment volume >3" (Depth not specified)	10–25%

Ecological dynamics

Information contained in this section was developed using historical data, professional experience, field reviews, and scientific studies. The information is representative of very complex vegetation communities. Not all scenarios or plants are included or discussed. Key indicator plants, animals and ecological processes are described to help guide land management decisions. Plant communities will differ across the MLRA 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 historic reference community for Igneous Upland Woodland has a moderately developed canopy (50 to 70 feet tall and 60 to 80 percent closure) that is dominated by white oak (*Quercus alba*), black oak (*Quercus velutina*), and northern red oak (*Quercus rubra*) and occasional shortleaf pine (*Pinus echinata*) with a sun loving woodland ground flora. Increased canopy heights and higher stocking densities of white oak are associated with the deeper soil depth ranges of the correlated soil components (Nelson, 2010).

Igneous Upland Woodlands likely had an estimated fire frequency of 3 to 5 years. These periodic fires kept woodlands open, removed the litter, and stimulated the growth and flowering of the grasses and forbs. (Ladd, 1991; Frost, 1996) During fire free intervals, woody species, especially black hickory (*Carya texana*), winged elm (*Ulmus alata*) and eastern redcedar (*Juniperus virginiana*) would have increased and the herbaceous understory diminished. The return of fire would have opened the woodlands up again and stimulated the abundant ground flora.

Igneous Upland Woodlands were also subjected to occasional disturbances from wind and ice, as well as grazing by native large herbivores. Wind and ice would have periodically opened the canopy up by knocking over trees or breaking substantial branches off canopy trees. Grazing by native herbivores would have effectively kept understory conditions more open, creating conditions more favorable to oak reproduction and sun-loving ground flora species.

In the long term absence of fire, woody species will encroach into these woodlands (Nigh and Schroeder, 2002). Once established, these woody plants can quickly fill the woodland system. Most of these ecological sites today are more dense and shady with a greatly diminished ground flora. Removal of the younger understory and the application of prescribed fire have proven to be effective management tools (MDC, 2006).

These sites have undergone periodic timber harvests and infrequent domestic livestock grazing. Most existing occurrences have a younger (50 to 80 years) canopy whose composition has been altered by timber harvesting practices. An increase in hickories (Carya sp.) over historic conditions is common. The absence of periodic fire has allowed more shade-tolerant tree species, such as red maple (*Acer rubrum*), winged elm, coralberry (Symphoriocarpus orbiculatus) and hickories to increase in abundance increasing canopy cover and stand densities (Nelson, 2010). Some less sloping sites have been cleared and converted to non-native cool season grassland.

Igneous Upland Woodlands are moderately productive timber sites. Unmanaged timber harvests in this region typically results in removal of the most productive trees, or high-grading of the stand. This can result in poorer quality residual timber and a shift in species composition away from more valuable oak species. Carefully planned single tree selection or the creation of small group openings can help regenerate more desirable oak species and increase vigor on the residual trees.

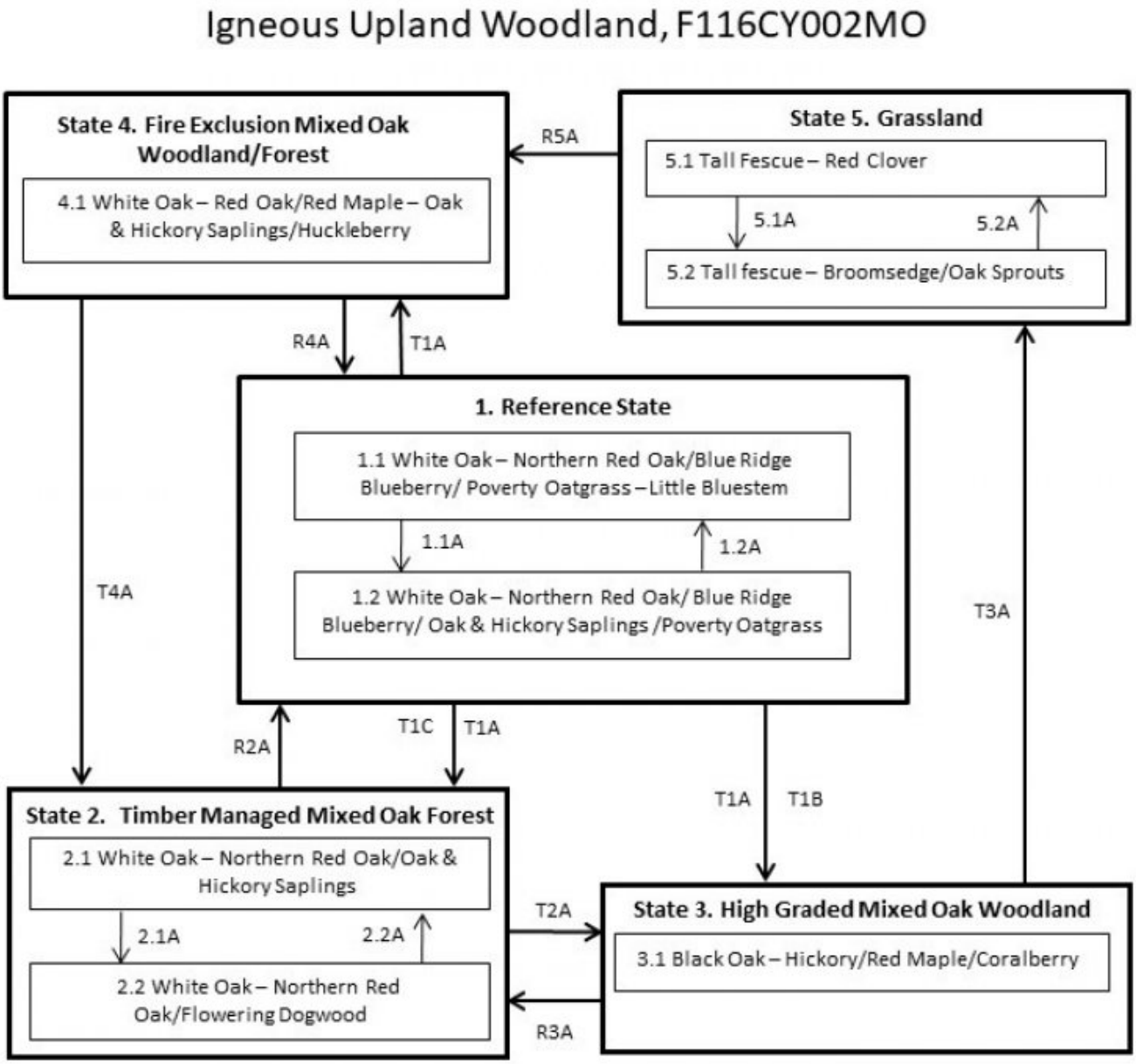
Clear-cutting does occur and results in dense, even-aged stands of primarily oak. This may be most beneficial for existing stands whose composition has been highly altered by past management practices. Thinning and prescribed fire can play a beneficial role in the management of this ecological site.

Some soil properties may vary with ecological dynamics and management regimes, particularly in the upper part of the soil profile. Unrestricted grazing in woodland communities generally results in an increase in bulk density of the surface horizon and a decrease in infiltration rates. Long-term fire exclusion allows for a buildup of leaf litter increasing surface organic material over time. Conversion to grassland may result in soil loss from the clearing process and from erosion before the grassland is well established. Long-term, proper grassland management results in higher soil pH levels and higher levels of calcium and magnesium from pasture liming. These effects may extend a foot or more into the soil profile (Conant and others, 2001; Schellberg, and others, 1999).

A state and transition model for the Igneous Upland Woodland Ecological Site (F116CY002MO) follows this narrative. 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.

The following diagram suggests some pathways that the vegetation on this site might take. There may be other states not shown on the diagram. This information is intended to show what might happen in a given set of circumstances. It does not mean that this would happen the same way in every instance. Local professional guidance should always be sought before pursuing a treatment scenario.

State and transition model



Code	Event/Process
T1A	Fire suppression > 20 years
T1B, T2A	Logging – high grading
T3A	Clearing; grassland seeding; grassland management
T1C, T4A, 2.2A	Managed forest harvesting; forest stand improvement
1.1A	Fire-free interval 10-15 years
1.2A	Fire interval 3-5 years
2.1A	20-30 years of limited logging disturbance
5.1A	Over grazing; no fertilization
5.2A	Brush management; grassland seeding; grassland management
R2A, R4A	Forest stand improvement and prescribed fire interval 3-5 years
R3A	Logging cessation; forest stand improvement
R5A	Cessation of grazing & haying; native tree, forb and grass planting

Figure 9. State and Transition Diagram

State 1

Reference State

The historical reference state for this ecological site was old growth oak woodland with an open understory and a dense ground flora of native grasses and forbs. This state was dominated by white oak, northern red oak, with occasional black oak, post oak, and shortleaf pine. Periodic disturbances from fire, wind or ice maintained the woodland structure and diverse ground flora species. Long disturbance-free periods allowed an increase in both the density of trees and the abundance of shade tolerant species. Two community phases are recognized in the reference state, with shifts between phases based on disturbance frequency. Reference sites are uncommon today. Most of these sites have been subject to repeated, high-graded timber harvest (State 3). Fire suppression has resulted in increased canopy density, which has affected the abundance and diversity of ground flora (State 4). Relatively few Igneous Upland Woodlands have been managed effectively for timber harvest (State 2), resulting in either even-age or uneven-age forests. Some areas have been cleared and planted to cool-season grassland species (State 5) and are being used for grazing and haying.

Dominant plant species

- white oak (*Quercus alba*), tree
- black oak (*Quercus velutina*), tree
- northern red oak (*Quercus rubra*), tree
- post oak (*Quercus stellata*), tree
- black hickory (*Carya texana*), tree
- white ash (*Fraxinus americana*), tree
- shortleaf pine (*Pinus echinata*), tree
- pignut hickory (*Carya glabra*), tree
- shagbark hickory (*Carya ovata*), tree
- flowering dogwood (*Cornus florida*), tree
- Blue Ridge blueberry (*Vaccinium pallidum*), shrub
- Carolina buckthorn (*Frangula caroliniana*), shrub
- fragrant sumac (*Rhus aromatica*), shrub
- St. Andrew's cross (*Hypericum hypericoides*), shrub
- Carolina rose (*Rosa carolina*), shrub
- winged sumac (*Rhus copallinum*), shrub
- sassafras (*Sassafras albidum*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- little bluestem (*Schizachyrium scoparium*), grass
- rock muhly (*Muhlenbergia sobolifera*), grass
- southeastern wildrye (*Elymus glabriflorus*), grass
- blue wildrye (*Elymus glaucus*), grass
- cypress panicgrass (*Dichanthelium dichotomum*), grass
- slimleaf panicgrass (*Dichanthelium linearifolium*), grass
- Bush's sedge (*Carex bushii*), grass
- oval-leaf sedge (*Carex cephalophora*), grass
- nakedflower ticktrefoil (*Desmodium nudiflorum*), other herbaceous
- elmleaf goldenrod (*Solidago ulmifolia*), other herbaceous
- downy ragged goldenrod (*Solidago petiolaris*), other herbaceous
- perplexed ticktrefoil (*Desmodium perplexum*), other herbaceous
- hairy sunflower (*Helianthus hirsutus*), other herbaceous
- Parlin's pussytoes (*Antennaria parlinii*), other herbaceous
- Dillenius' ticktrefoil (*Desmodium glabellum*), other herbaceous
- calico aster (*Symphyotrichum lateriflorum*), other herbaceous
- white arrowleaf aster (*Symphyotrichum urophyllum*), other herbaceous
- queendevil (*Hieracium gronovii*), other herbaceous

Community 1.1
White Oak-Northern Red Oak/Poverty Oat Grass-Little Bluestem

This phase has white oak and northern red oak that dominate the overstory with little bluestem and poverty oat grass dominating the open ground layer. Numerous forbs and sedges are also present. Shrubs and forest understory trees can be locally abundant.

Forest overstory. Canopy cover ranges from 60 to 80 percent. White oak and northern red oak dominate with scattered black oak and post oak. Shortleaf pine occurs on many sites.

Forest understory. Two understory layers are present - 20 to 30 foot tall small tree layer and a dense native forb and grass ground layer with scattered shrubs.

Table 5. Soil surface cover

Tree basal cover	1-2%
Shrub/vine/liana basal cover	0-1%
Grass/grasslike basal cover	0.1-1.0%
Forb basal cover	0.1-1.0%
Non-vascular plants	0-1%
Biological crusts	0%
Litter	75-90%
Surface fragments >0.25" and <=3"	0-1%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 6. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	0-1%
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	0-1%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	0-1%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	0-2% N*
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0-1% N*
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	0-4 per acre
Tree snag count** (hard***)	0-4 per acre

*** 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 (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	0-1%	0-1%	0-2%	0-1%
>0.5 <= 1	0-2%	0-2%	0-2%	0-5%
>1 <= 2	0-5%	0-5%	0-2%	0-1%
>2 <= 4.5	1-25%	0-1%	–	–
>4.5 <= 13	5-50%	0-1%	–	–
>13 <= 40	10-50%	1-2%	–	–
>40 <= 80	50-75%	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Community 1.2
White Oak-Red Oak/Oak and Hickory Saplings /Poverty Oat Grass

This phase is similar to community phase 1.1 but oak and hickory densities are increasing due to longer periods of fire suppression. Displacement of some grasses and forbs may be occurring due to shading and competition from the increased densities of oak and hickory saplings in the understory.

Forest overstory. Canopy cover ranges from 70 to 80 percent. White oak and northern red oak dominate with scattered black oak and post oak. An occasional shortleaf pine occurs on many sites.

Forest understory. Displacement of some grasses and forbs is occurring due to shading and competition from the increased densities of oak and hickory saplings.

Table 8. Soil surface cover

Tree basal cover	1-2%
Shrub/vine/liana basal cover	0-1%
Grass/grasslike basal cover	0.1-1.0%
Forb basal cover	0.1-1.0%
Non-vascular plants	0-1%
Biological crusts	0%

Litter	75-90%
Surface fragments >0.25" and <=3"	0-1%
Surface fragments >3"	0-1%
Bedrock	0%
Water	0%
Bare ground	0-5%

Table 9. Woody ground cover

Downed wood, fine-small (<0.40" diameter; 1-hour fuels)	0-1%
Downed wood, fine-medium (0.40-0.99" diameter; 10-hour fuels)	0-1%
Downed wood, fine-large (1.00-2.99" diameter; 100-hour fuels)	0-1%
Downed wood, coarse-small (3.00-8.99" diameter; 1,000-hour fuels)	0-2% N*
Downed wood, coarse-large (>9.00" diameter; 10,000-hour fuels)	0-1% N*
Tree snags** (hard***)	–
Tree snags** (soft***)	–
Tree snag count** (hard***)	0-4 per acre
Tree snag count** (hard***)	0-4 per acre

*** 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 10. Canopy structure (% cover)

Height Above Ground (Ft)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.5	–	–	–	–
>0.5 <= 1	–	–	0-5%	0-5%
>1 <= 2	0-5%	10-20%	5-10%	5-20%
>2 <= 4.5	0-5%	10-30%	10-40%	10-30%
>4.5 <= 13	10-20%	–	–	–
>13 <= 40	30-40%	–	–	–
>40 <= 80	40-60%	–	–	–
>80 <= 120	–	–	–	–
>120	–	–	–	–

Pathway 1A
Community 1.1 to 1.2

White Oak-Northern Red Oak/Poverty Oat Grass-Little Bluestem

White Oak-Red Oak/Oak and Hickory Saplings /Poverty Oat Grass

This pathway results from a fire-free interval of 10 to 15 years.

Pathway 2A
Community 1.2 to 1.1

White Oak-Red Oak/Oak and Hickory Saplings /Poverty Oat Grass

White Oak-Northern Red Oak/Poverty Oat Grass-Little Bluestem

This pathway results from a fire interval of 3 to 5 years.

Conservation practices

Prescribed Burning

State 2
Timber Managed Mixed-Oak Forest

This state develops from mixed oak woodlands, which over time, increase in canopy cover, eventually transitioning into forest-like communities. These early woodlands tend to be rather dense with a depauperate understory and ground flora. Periodic timber management, along with the absence of fire, will maintain this phase. Continued exclusion of prescribed fire without a regular 15 to 20 year harvest re-entry into these stands, will slowly create an increase in more shade tolerant species. White oak will become less dominant and understory species such as flowering dogwood and hickory will become more dominate and cause a transition to community phase 2.2. With periodic unmanaged logging that result in high-grading the stand, this state will transition to the High Graded Mixed Oak Woodland state (State 3). Restoration back to the reference state is possible with selective thinning to favor white oak and northern red oak species and a prescribed fire interval of 3 to 5 years are typically used.

Community 2.1
White Oak-Red Oak/Oak and Hickory Saplings

Oak and hickory species are increasing due to fire suppression. Displacement of grasses and forbs is occurring due to shading and competition from the increased densities of oak and hickory saplings. Periodic logging keeps this phase in a younger seral stage of development. Canopy cover ranges from 70 to 85 percent. Most stands are 50 to 80 years of age.

Forest overstory. Canopy cover ranges from 70 to 85 percent. Younger white oak and northern red oak dominate with scattered black oak and post oak. Oak and hickory species are increasing due to fire suppression. Shortleaf pine occurs on many sites.

Forest understory. Displacement of grasses and forbs is occurring due to shading and competition from the increased densities of oak and hickory saplings and more shaded conditions.

Community 2.2
White Oak-Red Oak/Flowering Dogwood

This phase occurs when harvest re-entry and prescribed fire is limited or stopped. Ground cover further diminishes but a richer understory of flowering dogwood, sassafras and serviceberry increases. Canopy cover ranges from 80 to 90 percent. Most stands are 60 to 90 years of age. This phase will transition back to Phase 2.1, if well managed forest harvesting occurs.

Forest overstory. Canopy cover is increasing with white oak, red oak, and hickories dominating the overstory.

Forest understory. Ground cover is diminishing, but a richer understory and mid-story layer of flowering dogwood, sassafras, and serviceberry is increasing.

Pathway 1A
Community 2.1 to 2.2

This pathway results from 20 to 30 years of limited logging disturbance.

Pathway 2A
Community 2.2 to 2.1

This pathway results from well managed forest harvesting.

Conservation practices

Forest Trails and Landings
Forest Stand Improvement
Fuel Break

State 3
High Graded Mixed-Oak Woodland

This state is subjected to repeated, high-grading timber harvests resulting in a significant reduction in white oak and northern red oak densities. Fire cessation has also occurred. This state exhibits an over-abundance of black oak and hickory and other less desirable tree species, and weedy understory species such as coralberry, gooseberry, poison ivy and Virginia creeper. Proper forest management techniques can create a transition to State 2. This state is often experiences clearing/clear-cutting and conversion to grassland, State 5.

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Organic matter depletion
- Aggregate instability
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Wildfire hazard from biomass accumulation
- Terrestrial habitat for wildlife and invertebrates

Community 3.1
Black Oak-Hickory/Red Maple /Buckbrush

This phase is dominated by black oak and hickories along with other less commercially valuable woody species. White oak and northern red oak are greatly diminished or even removed due to repeated high-grading, timber harvesting of the stand.

Forest overstory. Black oak and hickories along with other less commercially valuable woody species are common. White oak is greatly diminished or even removed.

Forest understory. A weedy understory of species such as buckbrush, gooseberry, poison ivy and Virginia creeper is increasing.

State 4
Fire Excluded Mixed-Oak Woodland/Forest

This state is dominated by white oak and northern red oak. They can form relatively even-aged stands, dating to when fire suppression became the dominant management characteristic on the site. This stage can occur relatively quickly (10 to 20 years). Canopy closures can approach 70 to 90 percent with decreasing ground flora. Without active management or long term presence of fire, woody species will continue to encroach into these woodlands. Once established, these woody species can quickly fill the woodland system. Most occurrences of this state today are dense and shady with a greatly diminished ground flora. Removal of the younger understory, opening the upper canopy, and the application of prescribed fire has proven to be effective management tools in restoring the stage back to the reference state. Some logging typically occurs. These states are good wildlife sites.

Dominant resource concerns

- Plant productivity and health
- Plant structure and composition
- Plant pest pressure

Community 4.1
White Oak-Northern Red Oak/Red Maple-Oak and Hickory Saplings/Huckleberry

This phase, due to fire exclusion, has higher densities of red maple and oak and hickory saplings that increase shade levels. Grass and forb diversity and ground cover are decreasing.

Forest overstory. The overstory has increased densities of red maple and white and northern red oak.

Forest understory. The understory is dense and shady with a greatly diminished ground flora.

State 5
Grassland

Conversion of wooded sites to planted, non-native grassland species such as tall fescue is a stage that is primarily associated with summit and shoulder positions of this ecological site. If active grassland management is discontinued, the site will eventually transition to phase 5.2 with an increase in broomsedge and oak sprouts. Return to the reference state from this state may be impossible requiring a very long term series of costly management options and stages. Many species may need to be eventually planted or reseeded to restore the system. Conversion to grassland may result in soil loss from the clearing process and from erosion before the grassland is well established. Long-term grassland management results in higher soil pH levels and higher levels of calcium and magnesium from pasture liming. These effects may extend a foot or more into the soil profile. The effects of liming are more evident in phase 5.1.

Community 5.1
Tall Fescue-Red Clover

This phase is well managed grassland, composed of non-native cool season grasses and legumes. Grazing and haying is occurring. The effects of long-term liming on soil pH, and calcium and magnesium content, is most evident in this phase. Studies show that these soils have higher pH and higher base status in soil horizons as much as two feet below the surface, relative to poorly managed grassland phase 5.2 and to woodland communities where liming is not practiced (Conant and others, 2001; Schellberg, and others, 1999).

Community 5.2
Tall Fescue-Broomsedge/Oak Sprouts

This phase is the result of poor grassland management. Over grazing and little fertility application has allowed broomsedge and oak sprouts to increase in cover and density reducing overall forage quality and site productivity. Soil pH and bases such as calcium and magnesium are lower, relative to well-managed pastures (phase 5.1).

Dominant resource concerns

- Sheet and rill erosion
- Ephemeral gully erosion
- Organic matter depletion
- Plant productivity and health
- Plant structure and composition
- Plant pest pressure
- Terrestrial habitat for wildlife and invertebrates
- Inadequate livestock water quantity, quality, and distribution

Pathway 2A
Community 5.2 to 5.1

Tall Fescue-Broomsedge/Oak Sprouts

Tall Fescue-Red Clover

This pathway results from brush mangament, grassland seeding, and good grassland management including rotational grazing and integrated pest management.

Conservation practices

Brush Management
Forage Harvest Management
Forage and Biomass Planting
Integrated Pest Management (IPM)
Prescribed Grazing

Transition 1C
State 1 to 2

This transition is the result of well managed forest harvesting for timber products.

Transition 1A
State 1 to 2

This transition is the result of fire suppression that exceeds 20 years.

Transition 1A
State 1 to 3

This transition is the result of fire suppression that exceeds 20 years.

Transition 1B
State 1 to 3

This transition is the result of periodic unmanaged logging that results in high-grading the stand.

Transition 1A
State 1 to 4

This transition is the result of fire suppression that exceeds 20 years.

Restoration pathway 2A
State 2 to 1

This restoration pathway is the result of selective thinning to favor white oak and red oak species and a prescribed fire interval of 3 to 5 years.

Conservation practices

Prescribed Burning
Restoration and Management of Rare and Declining Habitats
Forest Stand Improvement

Transition 2A
State 2 to 3

This transition is the result of periodic unmanaged logging that results in high-grading the stand.

Restoration pathway 3A
State 3 to 2

This restoration pathway results in cessation of unmanaged logging; selective thinning and harvesting with a forest management plan.

Conservation practices

Forest Trails and Landings
Forest Stand Improvement
Forest Management Plan - Applied

Transition 3A
State 3 to 5

This transition is the result of site clearing/clear cutting, grassland seeding, and grassland management.

Restoration pathway 4A

State 4 to 1

This restoration pathway results in selective thinning to favor white oak and red oak species and to open up the understory canopy. A prescribed fire interval of 3 to 5 years is initiated.

Conservation practices

Prescribed Burning
Restoration and Management of Rare and Declining Habitats
Forest Stand Improvement

Transition 4A
State 4 to 2

This transition is the result of well managed forest harvesting for timber products.

Restoration pathway 5A
State 5 to 4

This restoration pathway is the result of cessation of grazing and haying, native tree, forb, and grass planting. (This may be a long restoration process.)

Conservation practices

Access Control
Tree/Shrub Site Preparation
Tree/Shrub Establishment
Restoration and Management of Rare and Declining Habitats

Additional community tables

Table 11. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
white oak	QUAL	*Quercus alba*	Native	36–60	20–40	5–19	–
black oak	QUVE	*Quercus velutina*	Native	42–70	10–30	–	–
northern red oak	QURU	*Quercus rubra*	Native	42–70	10–30	5–19	–
black hickory	CATE9	*Carya texana*	Native	30–50	10–20	–	–
white ash	FRAM2	*Fraxinus americana*	Native	36–60	5–20	–	–
post oak	QUST	*Quercus stellata*	Native	30–50	10–20	5–21	–
shagbark hickory	CAOV2	*Carya ovata*	Native	30–50	5–20	5–11	–
shortleaf pine	PIEC2	*Pinus echinata*	Native	42–70	5–10	–	–

Table 12. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
poverty oatgrass	DASP2	*Danthonia spicata*	Native	0.1–1	10–20
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.1–3	10–20
rock muhly	MUSO	*Muhlenbergia sobolifera*	Native	0.1–2	5–10
whitetinge sedge	CAAL25	*Carex albicans*	Native	0.1–2	5–10
Forb/Herb					
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	0.1–2	5–10
Virginia threeseed mercury	ACVI	*Acalypha virginica*	Native	0.5–1	5–10
licorice bedstraw	GACI2	*Galium circaezans*	Native	0.1–0.2	5–10
downy ragged goldenrod	SOPE	*Solidago petiolaris*	Native	0.1–2	5–10
perplexed ticktrefoil	DEPE80	*Desmodium perplexum*	Native	0.2–1	5–10
manyray aster	SYAN2	*Symphyotrichum anomalum*	Native	0.5–3	5–10
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	0.1–0.3	5–10
St. Andrew's cross	HYHY	*Hypericum hypericoides*	Native	0.5–3	5–10
hairy sunflower	HEHI2	*Helianthus hirsutus*	Native	0.1–2	5–10
nakedflower ticktrefoil	DENU4	*Desmodium nudiflorum*	Native	0.5–2	5–10
violet lespedeza	LEVI6	*Lespedeza violacea*	Native	0.1–1	5–10
Shrub/Subshrub					
lowbush blueberry	VAAN	*Vaccinium angustifolium*	Native	0.2–3	5–20
Carolina buckthorn	FRCA13	*Frangula caroliniana*	Native	1–6	5–20
fragrant sumac	RHAR4	*Rhus aromatica*	Native	0.5–5	5–20
Tree					
red maple	ACRU	*Acer rubrum*	Native	5–10	5–10
common serviceberry	AMAR3	*Amelanchier arborea*	Native	5–10	5–10
flowering dogwood	COFL2	*Cornus florida*	Native	5–10	5–10
sassafras	SAAL5	*Sassafras albidum*	Native	5–10	5–10

Table 13. Community 1.2 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)	Diameter (In)	Basal Area (Square Ft/Acre)
Tree							
white oak	QUAL	*Quercus alba*	Native	36–60	20–40	5–19	–
northern red oak	QURU	*Quercus rubra*	Native	42–70	15–30	5–19	–
black oak	QUVE	*Quercus velutina*	Native	42–70	10–30	–	–
black hickory	CATE9	*Carya texana*	Native	30–50	15–25	–	–
white ash	FRAM2	*Fraxinus americana*	Native	36–60	10–20	–	–
shagbark hickory	CAOV2	*Carya ovata*	Native	30–50	10–20	5–11	–
post oak	QUST	*Quercus stellata*	Native	30–50	10–20	5–21	–
shortleaf pine	PIEC2	*Pinus echinata*	Native	42–70	5–10	–	–

Table 14. Community 1.2 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
little bluestem	SCSC	*Schizachyrium scoparium*	Native	0.1–3	5–15
poverty oatgrass	DASP2	*Danthonia spicata*	Native	0.1–2	5–15
rock muhly	MUSO	*Muhlenbergia sobolifera*	Native	0.1–2	0–5
whitetinge sedge	CAAL25	*Carex albicans*	Native	0.1–2	0–5
Forb/Herb					
Virginia threeseed mercury	ACVI	*Acalypha virginica*	Native	0.5–1	0–10
downy ragged goldenrod	SOPE	*Solidago petiolaris*	Native	0.1–2	5–10
elmleaf goldenrod	SOUL2	*Solidago ulmifolia*	Native	0.1–2	5–10
manyray aster	SYAN2	*Symphyotrichum anomalum*	Native	0.5–3	5–10
trailing lespedeza	LEPR	*Lespedeza procumbens*	Native	0.1–0.3	5–10
nakedflower ticktrefoil	DENU4	*Desmodium nudiflorum*	Native	0.5–2	5–10
perplexed ticktrefoil	DEPE80	*Desmodium perplexum*	Native	0.2–1	5–10
licorice bedstraw	GACI2	*Galium circaezans*	Native	0.1–0.2	5–10
hairy sunflower	HEHI2	*Helianthus hirsutus*	Native	0.1–2	0–10
St. Andrew's cross	HYHY	*Hypericum hypericoides*	Native	0.5–3	5–10
violet lespedeza	LEVI6	*Lespedeza violacea*	Native	0.1–1	5–10
Shrub/Subshrub					
Carolina buckthorn	FRCA13	*Frangula caroliniana*	Native	1–6	10–20
fragrant sumac	RHAR4	*Rhus aromatica*	Native	1–5	10–20
lowbush blueberry	VAAN	*Vaccinium angustifolium*	Native	0.5–3	5–20
Tree					
red maple	ACRU	*Acer rubrum*	Native	5–10	10–15
common serviceberry	AMAR3	*Amelanchier arborea*	Native	5–10	5–10
sassafras	SAAL5	*Sassafras albidum*	Native	5–10	5–10
flowering dogwood	COFL2	*Cornus florida*	Native	5–10	5–10
white ash	FRAM2	*Fraxinus americana*	Native	5–10	0–5
northern red oak	QURU	*Quercus rubra*	Native	5–10	0–5
black oak	QUVE	*Quercus velutina*	Native	5–10	0–5
bitternut hickory	CACO15	*Carya cordiformis*	Native	5–10	0–5

Animal community

Wildlife (MDC, 2006):
Wildlife habitat: Oaks on this site provide abundant hard mast; scattered shrubs provide soft mast; native legumes provide high-quality wildlife food.

Sedges and native cool-season grasses provide green browse; native warm-season grasses provide cover and nesting habitat; and a diversity of forbs provides a diversity and abundance of insects.

Post-burn areas can provide temporary bare-ground and herbaceous cover habitat is important for turkey poults and quail chicks.

Birds species associated with this site are Indigo Bunting, Red-headed Woodpecker, Eastern Bluebird, Northern Bobwhite, Summer Tanager, Eastern Wood-Pewee, Whip-poor-will, Chuck-will’s widow, Red-eyed Vireo, Rose-breasted Grosbeak, Yellow-billed Cuckoo, and Broad-winged Hawk.

Reptile and amphibian species include ornate box turtle, northern fence lizard, five-lined skink, broad-headed skink, six-lined racerunner, flat-headed snake, rough earth snake, and timber rattlesnake.

Domestic livestock: Currently, domestic cattle grazing is absent or very limited on wooded sites due to lack of water, access issues, and high amounts of acorns on the ground in the fall that are detrimental to cattle. On sites that have been cleared of trees and converted to cool-season grasses cattle grazing occurs. Heavily grazed pasture states can reduce water quality through exposed mineral soil and lack of adequate ground/overstory cover that increases soil erosion and soil compaction.

Hydrological functions

The water features of this upland ecological site include evapotranspiration, surface runoff, and drainage. Each water balance component fluctuates to varying extents from year-to-year. Evapotranspiration remains the most constant. Precipitation and drainage are highly variable between years. Seasonal variability differs for each water component. Precipitation generally occurs as single day events. Evapotranspiration is lowest in the winter and peaks in the summer. Water stored as ice and snow decreases drainage and surface runoff rates throughout the winter and increases these fluxes in the spring. The surface runoff pulse is greatly influenced by extreme events. Conversion to cropland or other high intensities land uses tends to increase runoff, but also decreases evapotranspiration. Depending on the situation, this might increase groundwater discharge, and decrease baseflow in receiving streams.

Recreational uses

Hunting, bird watching, horseback riding, camping, and hiking are recreational uses of this ecological site. Reference and well managed sites provide good hunting for turkey, white-tailed deer, and squirrel. Recreational uses are reduced in the heavily grazed grassland state and high-graded woodland state.

Wood products

This ecological site is moderately productive. Timber harvesting can occur but care must be taken to maintain the integrity and character of the site.

Potential products include lumber, oak staves, pallet materials, and in some cases oak veneer (only on well managed or old growth sites).

Management: Field measured site index values range from 47 to 56 for northern red oak, 48 to 63 for black oak, and 59 for shortleaf pine (NRCS, 2014). Higher site index values are usually associated with protected and lower slopes and lesser site index values associated with exposed and upland slopes. Forest management opportunities are generally good. These groups respond well to even-aged management. Restrict clear cuttings to less than 30 acres or group selection cuttings of 2 to 5 acres. Uneven-aged management using single tree selection and crop tree release are other options that can be used if clear cutting is not desired or warranted or if sites occur on exposed slopes. Using prescribed fire as a management tool could have a negative impact timber quality, may not be fitting, or should be used with caution on a particular site if timber management is the primary objective. Favor white oak and northern red oak on higher productivity sites and black oak, scarlet oak and shortleaf pine (Ozark region) on lower productivity sites (NRCS, 2002).

Limitations: No major equipment restrictions or limitations exist; coarse fragments are possible in subsurface profile; restricted soil depth. Moderate seedling mortality during low rainfall periods due to possible limited rooting depth and low to moderate available water capacity. Disturbing the surface excessively during site preparation activities increases soil losses, which may also leave coarse fragments on the surface. Erosion is a hazard when slopes exceed 15 percent. On steep slopes, traction problems increase. Track type equipment or yarding with cables may be necessary (NRCS, 2002).

Other products

Additional opportunities exist in the reference and well managed woodland states for agroforestry undertakings like

wild crafting activities, such as seasonal harvesting spring and summer florals and native blueberries.

Other information

Historically, black bears were common across the area. Their reduced numbers were directly correlated with the westward expansion of the European settlers and uncontrolled hunting. Like other mobile animals in the area, bears would have used multiple ecological sites. Other predators like the mountain lion and wolf have disappeared from these sites in a similar manner.

Today sightings of black bears and mountain lions are increasing throughout the area due a natural migration of these species from other states and regions.

Table 15. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
shortleaf pine	*PIEC2*	59	59	86	86	50	–	–	
black oak	*QUVE*	48	63	32	46	50	–	–	
northern red oak	*QURU*	47	56	32	43	50	–	–	

Inventory data references

The data contained in this document is derived from analysis of inventories, ecological interpretation from field evaluations, and various reference papers and books.

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Sampling methods (nested plots/transects/releve)

Reference Inventory Plots:
BUMOCA01 Buford Mountain CA; Mudlick
BUMOCA02 Buford Mountain CA; Mudlick
TASASP03 Taum Sauk SP; Trackler
HUMOCA04 Hughes Mountain CA; Trackler

Level 2 and reconnaissance inventory:

2003: Nigh/Meinert-Initial reconnaissance/site mapping. Three weeks of recon on numerous 116C sites.

2007: Reconnaissance plots on Stegall Mountain and Taum Sauk Mountain.

2012: Central States Forest Soils Workshop field sites (6) in 116C.

2013: Reconnaissance on numerous igneous mountains working on reference plots. Taum Sauk, Hughes, Peck Ranch, Russel Mountain, Johnson Shut-Ins, Mill Mountain NA, Buford

Type locality

Location 1: Iron County, MO	
Township/Range/Section	T35N R3E S34

UTM zone	N
UTM northing	4174745
UTM easting	703570
Latitude	37° 41′ 50″
Longitude	-90° 41′ 27″
General legal description	Igneous Upland Woodland at Buford Mountain Conservation Area.
Location 2: Iron County, MO	
Township/Range/Section	T35N R3E S34
UTM zone	N
UTM northing	4174753
UTM easting	703461
Latitude	37° 41′ 50″
Longitude	-90° 41′ 31″
General legal description	Igneous Upland Woodland at Buford Mountain Conservation Area.
Location 3: Washington County, MO	
Township/Range/Section	T36N R3E S28
UTM zone	N
UTM northing	4186644
UTM easting	701364
Latitude	37° 48′ 17″
Longitude	-90° 42′ 45″
General legal description	Igneous Upland Woodland at Hughes Mountain Conservation Area.

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Contributors

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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	05/10/2025
Approved by	Nels Barrett
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:**