Ecological site F115XB036MO
Calcareous Limestone Protected Backslope Forest

Accessed: 04/25/2024

General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

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): 115X–Central Mississippi Valley Wooded Slopes

The Central Mississippi Valley Wooded Slopes, Western Part (area outlined in red on the map) consists mainly of the deeply dissected, loess-covered hills bordering the Missouri and Mississippi Rivers as well as the floodplains and terraces of these rivers. It wraps around the northeast corner of the Ozark Uplift, and constitutes the southern border of the Pre-Illinoisan-aged till plain. Elevation ranges from about 320 feet along the Mississippi River near Cape Girardeau in the south to about 1,020 feet on the highest ridges near Hillsboro, MO in the east. Local relief varies from 10 to 20 feet in the major river floodplains, to 50 to 100 feet in the dissected uplands, with bluffs of 200 to 350 feet along the Mississippi and Missouri Rivers. Underlying bedrock is mainly Ordovician-aged dolomite and sandstone, with Mississippian-aged limestone north of the Missouri River.

Classification relationships

Terrestrial Natural Community Type in Missouri (Nelson, 2010):
The reference state for this ecological site is most similar to a Dry-Mesic Limestone/Dolomite Forest.

Missouri Department of Conservation Forest and Woodland Communities (MDC, 2006):
The reference state for this ecological site is most similar to a White Oak Forest.

National Vegetation Classification System Vegetation Association (NatureServe, 2010):
The reference state for this ecological site is most similar to a Quercus alba - Quercus rubra - Quercus muehlenbergii / Cercis canadensis Forest (CEGL002070).

Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002):
This ecological site occurs in the Outer Ozark Border Subsection, in the following Land Type Associations:
Harrisburg Oak Woodland/Forest Hills
Rock Bridge Woodland/Forest Low Karst Hills
Central Missouri Oak Woodland/Forest Hills

Ecological site concept

NOTE: This is a “provisional” Ecological Site Description (ESD) that is under development. It contains basic ecological information that can be used for conservation planning, application and land management. After additional information is collected, analyzed and reviewed, this ESD will be refined and published as “Approved”.

Calcareous Limestone Protected Backslope Forests are within the green areas on the map. They occupy the

northerly and easterly aspects of steep, dissected slopes, and are mapped in complex with the Calcareous Limestone Exposed Backslope Woodland ecological site. These sites are in the eastern part of the MLRA, north of the Missouri River. They are closely associated with Limestone/Dolomite Glade ecological sites, often occurring directly downslope. Other close ecological site associates include Chert Limestone/Dolomite woodland and forest sites, and loess woodland sites, which are upslope. Soils are high in bases, and are moderately deep over dolomite or limestone bedrock, with gravelly surfaces. The reference plant community is forest dominated by chinkapin oak and white oak, along with northern red oak, sugar maple, bitternut hickory, white ash, red elm and black walnut, with a well-developed understory and a rich herbaceous ground flora.

Associated sites

R115XB009MO	**Shallow Limestone/Dolomite Upland Glade/Woodland** Shallow Limestone/Dolomite Upland Glade/Woodlands are often closely associated with this ecological site.
F115XB014MO	**Chert Limestone/Dolomite Protected Backslope Forest** Chert Limestone/Dolomite Protected Backslope Forests are generally upslope on northerly and easterly aspects.
F115XB046MO	**Chert Limestone/Dolomite Exposed Backslope Woodland** Chert Limestone/Dolomite Exposed Backslope Woodland are generally upslope on southerly and westerly aspects.

Similar sites

F115XB014MO	**Chert Limestone/Dolomite Protected Backslope Forest** Chert Limestone/Dolomite Protected Backslope Forests are on similar northerly and easterly aspects but are generally more productive.

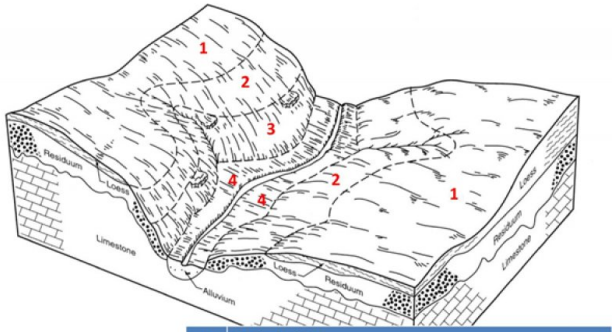
Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Quercus muehlenbergii*
Shrub	(1) *Cercis canadensis* (2) *Lindera benzoin*
Herbaceous	(1) *Maianthemum racemosum* (2) *Sanguinaria canadensis*

Physiographic features

This site is on backslopes with slopes of 15 to 70 percent. It is on protected aspects (north, northeast, and east), which receive significantly less solar radiation than the exposed aspects. Sites are often downslope from limestone/dolomite glades. The site generates runoff to adjacent, downslope ecological sites. This site does not flood.

The followingt figure (adapted from Young et al., 2003) shows the typical landscape position of this ecological site, and landscape relationships among the major ecological sites in the uplands. The site is within the area labeled “3”, and is often closely associated with Chert Limestone/Dolomite sites (labeled “2” in the figure), as well as Shallow Limestone/Dolomite Glade sites.



#	Ecological Site
1	Deep Loess Upland Woodland
2	Chert Limestone/Dolomite Backslope Woodland & Forest
3	Calcareous Limestone Backslope Woodland & Forest
4	Loamy/Gravelly Upland Drainageway Forest

Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Hill
Flooding frequency	None
Ponding frequency	None
Slope	15–70%
Water table depth	60 in
Aspect	N, NE, E

Climatic features

The Central Mississippi Valley Wooded Slopes, Western Part has 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 Central Mississippi Valley Wooded Slopes, Western Part experiences regional differences in climates, but these differences do not have obvious geographic boundaries. Regional climates grade inconspicuously into each other. The basic gradient for most climatic characteristics is along a line diagonally crossing the MLRA from northwest to southeast. Both mean annual temperature and precipitation exhibit gradients along this line.
The average annual precipitation in most of this area is 38 to 48 inches. The average annual temperature is 53 to 57 degrees F. Mean January minimum temperature follows the northwest-to-southeast gradient. However, mean July maximum temperature shows hardly any geographic variation in the MLRA. Mean July maximum temperatures have a range of only two or three degrees across the area.

Mean annual precipitation varies along the same gradient as temperature. Seasonal climatic variations are more complex. Seasonality in precipitation is very pronounced due to strong continental influences. June precipitation, for example, averages three to four times greater than January precipitation. Most of the rainfall occurs as high-intensity, convective thunderstorms in summer. Snowfall is common in winter.

During years when precipitation comes in a fairly normal manner, moisture is stored in the top layers of the soil 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. In regions of appreciable relief, for example, air drainage at nighttime may produce temperatures several degrees lower in valley bottoms than on side slopes. At critical times during the year, this phenomenon may produce later spring or earlier fall freezes in valley bottoms. Higher daytime temperatures of bare rock surfaces and higher reflectivity of these unvegetated surfaces may create distinctive environmental niches such as glades and cliffs. 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 a canopied forest is measurably different from the climate of a more open grassland or savanna areas.

Source: University of Missouri Climate Center - http://climate.missouri.edu/climate.php; accessed June 2012

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, United States Department of Agriculture Handbook 296 - http://soils.usda.gov/survey/geography/mlra/

Table 3. Representative climatic features

Frost-free period (average)	181 days
Freeze-free period (average)	202 days
Precipitation total (average)	46 in

Climate stations used

- (1) FULTON [USC00233079], Fulton, MO
- (2) COLUMBIA U OF M [USC00231801], Columbia, MO
- (3) COLUMBIA RGNL AP [USW00003945], Columbia, MO

Influencing water features

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.

Soil features

These soils are underlain with limestone bedrock at 20 to 40 inches. The soils were formed under a mixture of prairie and woodland vegetation, and have dark, organic-rich surface horizons that are enriched in places by upslope prairie glades. Parent material is slope alluvium over residuum weathered from limestone, overlying limestone bedrock. They have very gravelly silt loam surface layers, with clayey subsoils that have moderate to high amounts of chert and limestone gravel and cobbles. These soils are base-rich, but do not contain free carbonates. These soils are not affected by seasonal wetness. Soil series associated with this site include Clinkenbeard.

Table 4. Representative soil features

Parent material	(1) Slope alluvium–dolomite (2) Residuum–dolomite
Surface texture	(1) Very gravelly silt loam
Family particle size	(1) Clayey
Drainage class	Well drained

Permeability class	Not specified
Soil depth	20–40 in
Surface fragment cover <=3"	35–50%
Surface fragment cover >3"	5–30%
Available water capacity (0-40in)	2–3 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)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	25–40%
Subsurface fragment volume >3" (Depth not specified)	5–20%

Ecological dynamics

Information contained in this section was developed using historical data, professional experience, field reviews, and scientific studies. The information presented is representative of very complex vegetation communities. Key indicator plants, animals and ecological processes are described to help inform 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 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.

Calcareous Limestone Protected Backslope Forests have a well-developed forest canopy (60 to 80 feet tall and 80 to 90 percent cover) and subcanopy dominated by a mixture of oaks and other hardwoods adapted to cooler, more mesic site conditions. White oak and chinquapin oak are common, along with red oak, sugar maple, bitternut hickory, white ash, red elm and black walnut. This ecological site exhibits a structurally diverse understory and an abundant forest ground flora. While similar to deeper Chert Protected Backslope Forests, the shallower carbonate soils limit tree height, but create an environment where a wider variety of species occur in a more complex structural arrangement.

In this region flanked by historic fire-prone prairies, savannas and open woodlands, Calcareous Limestone Protected Backslope Forests occur in rather protected landscape positions on lower, steep slopes in the deeper valleys furthest from the prairie uplands. While the upland prairies and savannas had an estimated fire frequency of 1 to 3 years, Calcareous Limestone Protected Backslope Forests burned less frequently (estimated 10 to 25 years) and with lower intensity.

The moderately deep soils and occasional fires make this community transitional between a forest and more closed woodland, with more open woodland conditions being created briefly after the periodic fires. Site conditions overall, however, favor shade and moisture loving forest species that quickly redevelop after fire.

Historically, grazing by large native herbivores, such as bison, elk, and deer, also kept understory conditions more open. In addition, Calcareous Limestone Protected Backslope Forests are subject to occasional disturbances from wind and ice, which periodically open the canopy up by knocking over trees or breaking substantial branches of canopy trees. Such canopy disturbances allow more light to reach the ground and favor reproduction of the dominant oak species.

Today, these communities have been cleared, converted to pasture or have undergone repeated timber harvest

and domestic grazing. Most existing sites have a younger (50 to 80 years) canopy layer whose composition may have been altered by timber harvesting practices. An increase in hickories over historic conditions is common. The absence of periodic fire allowed more shade-tolerant tree species, such as sugar maple, white ash, or hickories to increase in abundance.

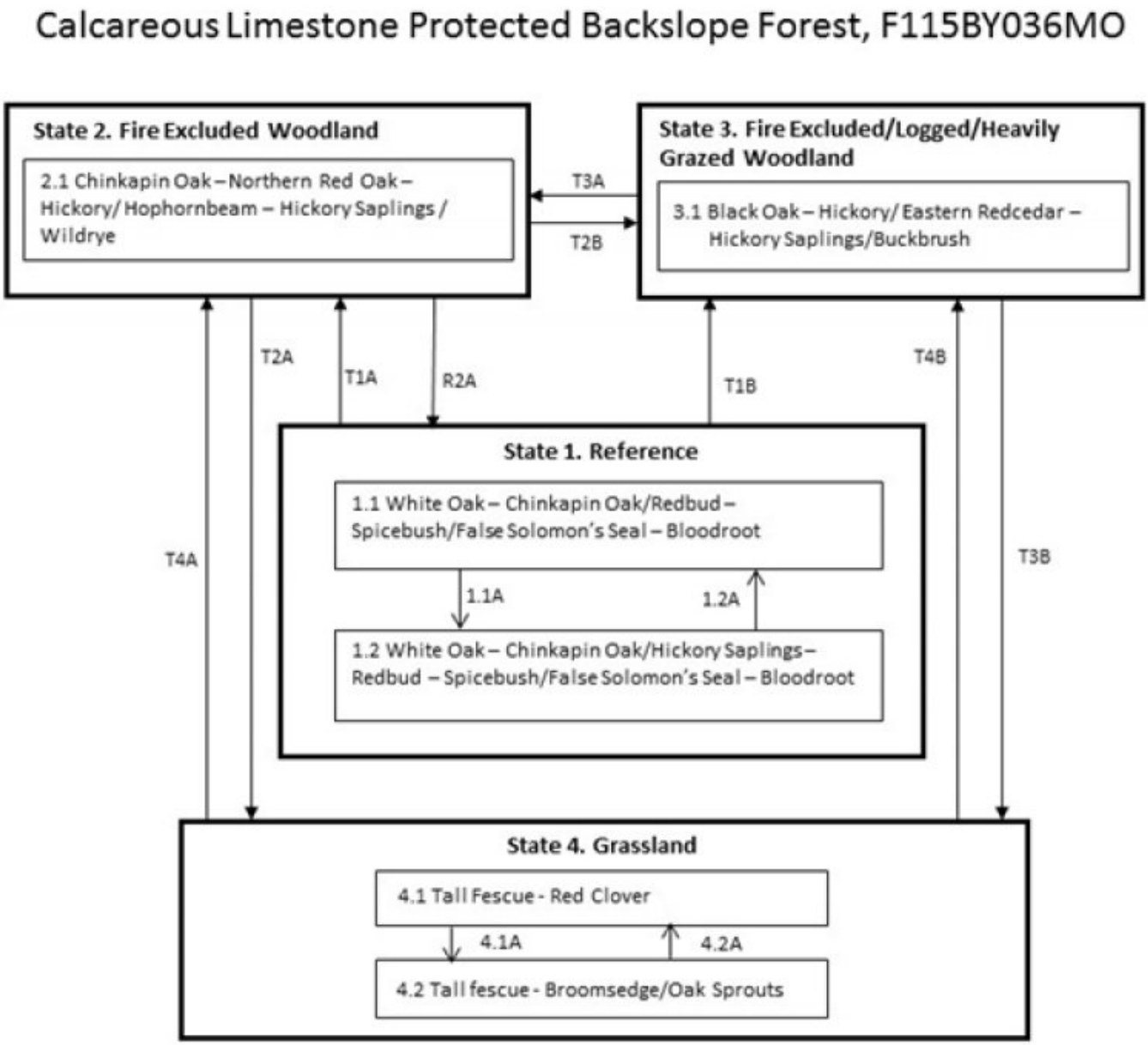
Uncontrolled domestic grazing has also diminished the diversity and cover of woodland ground flora species, and has often introduced weedy species such as gooseberry, buckbrush, poison ivy and Virginia creeper. Grazed sites also have a more open understory. In addition, soil compaction and soil erosion related to grazing can lower site productivity.

Calcareous Limestone Protected Backslope Forests are only moderately productive timber sites. Timber harvest in this region typically is done using single-tree selection, and often results in removal of the most productive trees, or high-grading of the stand. This can result in poorer quality 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.

Prescribed fire can play a beneficial but limited role in the management of this ecological site. The higher productivity of these sites makes it more challenging than on woodland sites in the region. Control of woody species will be more difficult. Protected aspect forests did evolve with some fire, but their composition often reflects more closed, forested conditions, with fewer woodland ground flora species that can respond to fire. Consequently, while having protected aspects in a burn unit is acceptable, targeting them solely for woodland restoration is not advisable.

A State and Transition Diagram follows. Detailed descriptions of each state, transition, plant community, and pathway follow the model. This model is based on available experimental research, field observations, professional consensus, and interpretations. It is likely to change as knowledge increases.

State and transition model



Code	Event/Activity
T1A	Fire-free interval (20+ years); logging
T1B	Fire suppression; heavy grazing by livestock; logging
T3A	Livestock removal
T2B	Heavy grazing by livestock; logging
T2A, T3B	Clearing; grassland seeding; grassland management
T4A	Tree planting; long term succession (50+ years); no grazing
T4B	Long term succession (50+ years); light periodic grazing
R2A	Understory removal; prescribed fire
1.1A	Fire-free interval 20+ years
1.2A	Fire 10-25 year cycle
4.1A	Over grazing; no fertilization
4.2A	Brush management; grassland seeding; grassland management

Figure 7. State and transition diagram for this ecological s

State 1

Reference

The Reference State was dominated by white oak and chinkapin oak. Maximum tree age was likely 150 to 300 years. Periodic disturbances from fire, wind or ice maintained the dominance of oaks by opening up the canopy and allowing more light for oak reproduction. Long disturbance-free periods allowed an increase in more shade tolerant species such as hickory, white ash, northern red oak and sugar maple. Two community phases are recognized in this state, with shifts between phases based on disturbance frequency.

Community 1.1
White Oak – Chinkapin Oak/Redbud – Spicebush/False Solomon's Seal – Bloodroot

This phase is an old growth forest with a white oak and chinkapin oak overstory. The canopy and understory are well developed with good structural and species diversity. This phase experienced some periodic burning (estimated 10 to 25 years) but with low intensity.

Forest overstory. Overstory Composition species lists are based on Nelson (2010) and field surveys.

Forest understory. Understory Composition species lists are based on Nelson (2010) and field surveys.

Community 1.2
White Oak – Chinkapin Oak/Hickory Saplings – Redbud – Spicebush/False Solomon's Seal – Bloodroot

This community phase is associated with long disturbance-free periods allowing an increase in more shade tolerant species such as hickory, white ash, northern red oak and sugar maple.

State 2
Fire Excluded Woodland

Fire suppression has allowed these previously open woodlands to become dense with less fire-tolerant trees and saplings such as northern red oak, and hickory. The dense, shaded conditions and lack of fire has caused the ground flora to decrease in cover and diversity. Aromatic sumac often forms a dense shrub understory under these conditions. However, many of the original herbaceous species persist as small plantlets or in the seed bank. Consequently, thinning of the woody species and the re-introduction of fire has shown these communities to be exceptionally resilient, and a return, after a period of many years, to the reference condition is possible.

Community 2.1
Chinkapin Oak – Northern Red Oak – Hickory/ Hophornbeam – Hickory Saplings / Wildrye

This is the only phase associated with this state at this time. See the corresponding state narrative for details.

State 3
Fire Excluded/Logged/Heavily Grazed Woodland

In addition to fire exclusion, many of these sites have been subjected to heavy grazing by domestic livestock and periodic logging. Like State 2, these areas are dense and shady with a diminished ground flora. In addition, grazed areas exhibit a lower diversity of native ground flora species and an increased abundance of eastern redcedar and other invasive natives such as buck brush. Like State 2, restoration using thinning and fire is possible, but will take longer and require more effort. Restricting livestock access and eliminating logging will be necessary for successful restoration.

Community 3.1
Black Oak – Hickory/ Eastern Redcedar –Hickory Saplings/Buckbrush

This is the only phase associated with this state at this time. See the corresponding state narrative for details.

State 4

Grassland

Conversion of other states to non-native cool season species such as tall fescue and red clover has been common. Occasionally, these pastures will have scattered oaks. Long term uncontrolled grazing can cause significant soil erosion and compaction. A return to the reference state may be impossible, requiring a very long term series of management options. If oak sprouting is left unchecked and grazing is eliminated or reduced then over time this state will transition to a fire excluded woodland or to a high-graded/grazed woodland.

Community 4.1
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 and to woodland communities (where liming is not practiced).

Community 4.2
Tall fescue - Broomsedge/Oak Sprouts

This phase is the result of over use, poor grassland and grazing management and lack of adequate nutrient application. Oak sprouts, oak saplings, and invasive species are increasing as a result of poor management.

Additional community tables

Table 5. 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	–	–	–	–
northern red oak	QURU	*Quercus rubra*	Native	–	–	–	–
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	–	–	–	–
sugar maple	ACSA3	*Acer saccharum*	Native	–	–	–	–
blue ash	FRQU	*Fraxinus quadrangulata*	Native	–	–	–	–
mockernut hickory	CATO6	*Carya tomentosa*	Native	–	–	–	–
white ash	FRAM2	*Fraxinus americana*	Native	–	–	–	–
shagbark hickory	CAOV2	*Carya ovata*	Native	–	–	–	–
slippery elm	ULRU	*Ulmus rubra*	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (Ft)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
eastern bottlebrush grass	ELHY	*Elymus hystrix*	Native	–	–
hairy woodland brome	BRPU6	*Bromus pubescens*	Native	–	–
hairy wildrye	ELVI	*Elymus villosus*	Native	–	–
woodland muhly	MUSY	*Muhlenbergia sylvatica*	Native	–	–
Forb/Herb					
hairy woodland brome	BRPU6	*Bromus pubescens*	Native	–	–
bloodroot	SACA13	*Sanguinaria canadensis*	Native	–	–
largeflower bellwort	UVGR	*Uvularia grandiflora*	Native	–	–
roundlobe hepatica	HENOO	*Hepatica nobilis var. obtusa*	Native	–	–
eastern greenviolet	HYCO6	*Hybanthus concolor*	Native	–	–
wild comfrey	CYVI	*Cynoglossum virginianum*	Native	–	–
early meadow-rue	THDI	*Thalictrum dioicum*	Native	–	–
clustered blacksnakeroot	SAOD	*Sanicula odorata*	Native	–	–
dutchman's breeches	DICU	*Dicentra cucullaria*	Native	–	–
meadow zizia	ZIAP	*Zizia aptera*	Native	–	–
pointedleaf ticktrefoil	DEGL5	*Desmodium glutinosum*	Native	–	–
cutleaf toothwort	CACO26	*Cardamine concatenata*	Native	–	–
feathery false lily of the valley	MARA7	*Maianthemum racemosum*	Native	–	–
Shrub/Subshrub					
Carolina buckthorn	FRCA13	*Frangula caroliniana*	Native	–	–
northern spicebush	LIBE3	*Lindera benzoin*	Native	–	–
Tree					
eastern redbud	CECA4	*Cercis canadensis*	Native	–	–
red mulberry	MORU2	*Morus rubra*	Native	–	–
slippery elm	ULRU	*Ulmus rubra*	Native	–	–
hophornbeam	OSVI	*Ostrya virginiana*	Native	–	–
American bladdernut	STTR	*Staphylea trifolia*	Native	–	–
Vine/Liana					
Virginia creeper	PAQU2	*Parthenocissus quinquefolia*	Native	–	–

Animal community

Wildlife (MDC 2006):

This forest type contains high structural and compositional diversity important for a number of songbirds and amphibians.

Wild turkey, white-tailed deer, and eastern gray squirrel depend on hard and soft mast food sources and are typical upland game species of this type.

Birds associated with this ecological site include Worm-eating warbler, Whip-poor-will, Great Crested Flycatcher, Ovenbird, Pileated Woodpecker, Wood Thrush, Red-eyed Vireo, Northern Parula, Louisiana Waterthrush (near streams), and Broad-winged Hawk.

Reptile and amphibian species associated with mature forests include: ringed salamander, spotted salamander,

marbled salamander, central newt, long-tailed salamander, dark-sided salamander, southern red-backed salamander, three-toed box turtle, western worm snake, western earth snake, and American toad.

Other information

Forestry (NRCS 2002, 2014):

Management: Estimate site index values for oak range from 45 to 60. Timber management opportunities are fair to good. Create group openings of at least 2 acres. Large clearcuts should be minimized if possible to reduce impacts on wildlife and aesthetics. Uneven-aged management using single tree selection or small group selection cuttings of ½ to 1 acre are other options that can be used if clear cutting is not desired or warranted. Using prescribed fire as a management tool could have a negative impact on 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, northern red oak, and chinkapin oak.

Limitations: Large amounts of coarse fragments throughout profile; bedrock is within 40 inches. Surface stones and rocks are problems for efficient and safe equipment operation and will make equipment use somewhat difficult. Disturbing the surface excessively in harvesting operations and building roads increases soil losses, which leaves a greater amount of coarse fragments on the surface. Hand planting or direct seeding may be necessary. Seedling mortality due to low available water capacity may be high. Mulching or providing shade can improve seedling survival. Mechanical tree planting will be limited. Erosion is a hazard when slopes exceed 15 percent. On steep slopes greater than 35 percent, traction problems increase and equipment use is not recommended.

Inventory data references

Calcareous Limestone Protected Backslope Forest – Potential Reference – F115BY036MO

Plot DABOCA_JK20 - Clinkenbeard soil
Located in Daniel Boone CA, Warren County, MO
Latitude: 38.793122
Longitude: -91.37924

Plot GRCASP_KS07 – Clinkenbeard soil – no veg cover
Located in Graham Cave State Park, Montgomery County, MO
Latitude: 38.906763
Longitude: -91.575943

Other references

MDC, 2006. Missouri Forest and Woodland Community Profiles. Missouri Department of Conservation, Jefferson City, Missouri.

Natural Resources Conservation Service. 2002. Woodland Suitability Groups. Missouri FOTG, Section II, Soil Interpretations and Reports. 30 pgs.

Natural Resources Conservation Service. Site Index Reports. Accessed May 2014. https://esi.sc.egov.usda.gov/ESI_Forestland/pgFSWelcome.aspx

NatureServe, 2010. Vegetation Associations of Missouri (revised). NatureServe, St. Paul, Minnesota.

Nelson, Paul W. 2010. The Terrestrial Natural Communities of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Nigh, Timothy A., & Walter A. Schroeder. 2002. Atlas of Missouri Ecoregions. Missouri Department of Conservation, Jefferson City, Missouri.

Vano, Julie A. 2005. Land Surface Hydrology in Northern Wisconsin: Influences of climatic variability and land cover. University of Wisconsin-Madison.

Young, Fred J., Caryl A. Radatz, & Curtis A. Marshall. 2003. Soil Survey of Boone County, Missouri. U.S. Dept. of Agric. Natural Resources Conservation Service.

University of Missouri Climate Center - http://climate.missouri.edu/climate.php; accessed June 2012

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, United States Department of Agriculture Handbook 296 - http://soils.usda.gov/survey/geography/mlra/

Contributors

Fred Young
Doug Wallace

Acknowledgments

Missouri Department of Conservation and Missouri Department of Natural Resources personnel provided significant and helpful field and technical support in the development of this ecological site.

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:

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17. **Perennial plant reproductive capability:**
