

Ecological site F115XB014MO

Chert Limestone/Dolomite Protected Backslope Forest

Accessed: 05/06/2024

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-Illinoian-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 Chert Woodland.

Missouri Department of Conservation Forest and Woodland Communities (MDC, 2006):

The reference state for this ecological site is most similar to a Mixed Oak-Hickory 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 primarily in Land Type Associations of the following Subsections:

Inner Ozark Border

Outer Ozark Border

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”.

Chert Limestone/Dolomite 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 Chert

Limestone/Dolomite Exposed Backslope Woodland ecological site. These sites are in scattered upland locations in the Missouri River watershed. Soils are typically moderately deep over limestone/dolomite bedrock, with gravelly surfaces. The reference plant community is forest dominated by white oak, black oak, post oak and other hardwoods.

Associated sites

F115XB004MO	Loess Upland Woodland Loamy Upland Woodlands are typically upslope on hillslope summits, crests and shoulders.
F115XB046MO	Chert Limestone/Dolomite Exposed Backslope Woodland Chert Limestone/Dolomite Exposed Backslope Woodland, occupying the southerly and westerly aspects of steep, dissected slopes are mapped in complex with the Chert Limestone/Dolomite Protected Backslope Forest ecological site
R115XB009MO	Shallow Limestone/Dolomite Upland Glade/Woodland Shallow Limestone/Dolomite glade are commonly associated downhill with this site.

Similar sites

F115XB046MO	Chert Limestone/Dolomite Exposed Backslope Woodland Chert Limestone/Dolomite Exposed Backslope Woodland, occupying the southerly and westerly aspects of steep, dissected slopes are mapped in complex with the Chert Limestone/Dolomite Protected Backslope Forest ecological site
-------------	---

Table 1. Dominant plant species

Tree	(1) <i>Quercus alba</i> (2) <i>Quercus velutina</i>
Shrub	(1) <i>Rhus aromatica</i>
Herbaceous	(1) <i>Elymus virginicus</i>

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. The site receives runoff from upslope summit and shoulder sites, and generates runoff to adjacent, downslope ecological sites. This site does not flood.

The following figure (adapted from Davis, 2002) 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 “2”, on steep backslopes with northerly and easterly aspects. Loamy Upland Woodlands (labeled “1”) are typically upslope on hillslope summits, crests and shoulders. Shallow Limestone/Dolomite glade sites are commonly associated with this site, but are not shown on the figure.

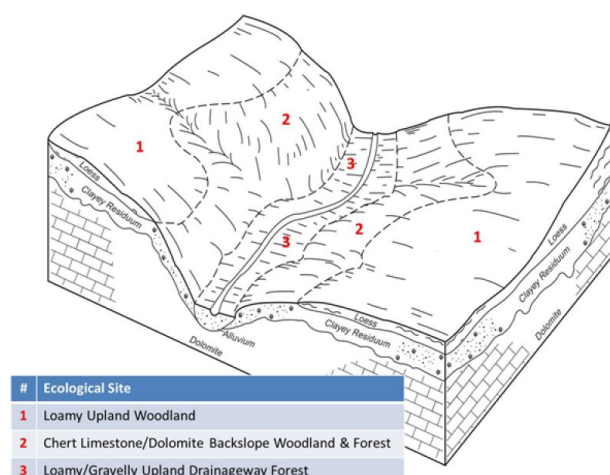


Figure 2. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Hill
Flooding frequency	None
Ponding frequency	None
Slope	15–70%
Water table depth	61–152 cm
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)	164 days
Freeze-free period (average)	191 days
Precipitation total (average)	1,168 mm

Climate stations used

- (1) ST CHARLES 7 SSW [USC00237398], Saint Louis, MO
- (2) ROSEBUD [USC00237300], Gerald, MO
- (3) COLUMBIA U OF M [USC00231801], 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. (Vano 2005).

Soil features

These soils are underlain with limestone and/or dolomite bedrock at 20 to 40 inches deep. The soils were formed under woodland vegetation, and have thin, light-colored surface horizons. Parent material is slope alluvium over residuum weathered from limestone and dolomite, overlying limestone bedrock. They have gravelly to very gravelly silt loam surface layers, with clayey subsoils that have moderate to high amounts of chert gravel and cobbles. These soils are not affected by seasonal wetness. Soil series associated with this site include Bardley and Gatewood.

The accompanying picture of the Gatewood series shows abundant chert fragments in the upper part of the soil, over a reddish clay subsoil. Cherty limestone/dolomite bedrock limits rooting depth. Picture courtesy of John Preston, NRCS.



Figure 7. Gatewood series

Table 4. Representative soil features

Parent material	(1) Slope alluvium–dolomite (2) Residuum–dolomite
-----------------	--

Surface texture	(1) Very gravelly silt loam (2) Gravelly silt loam (3) Very gravelly loam
Family particle size	(1) Clayey
Drainage class	Moderately well drained to well drained
Permeability class	Very slow
Soil depth	51–102 cm
Surface fragment cover <=3"	20–60%
Surface fragment cover >3"	0–15%
Available water capacity (0-101.6cm)	2.54–7.62 cm
Calcium carbonate equivalent (0-101.6cm)	0%
Electrical conductivity (0-101.6cm)	0–2 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	35–60%
Subsurface fragment volume >3" (Depth not specified)	0–50%

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.

Chert Limestone/Dolomite Protected Backslope Forest has a moderately developed canopy (50 to 70 feet tall and 60 to 80 percent canopy cover) dominated by white oak along with black oak, post oak and other hardwoods adapted to drier conditions. Compared to the associated Loamy Limestone/Dolomite Protected Backslope Forests, this ecological site is less productive with more of a woodland character.

Chert Limestone/Dolomite Protected Backslope Forests occur in rather protected landscape positions on steep slopes in the deeper valleys. While the upland prairies and savannas had an estimated fire frequency of 1 to 3 years, this ecological site burned less frequently (estimated 10 to 25 years) and with lower intensity. The moderately deep soils and occasional fires make this community transitional between forest and 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.

These ecological sites would have also been subjected to occasional disturbances from wind and ice, as well as grazing by large native herbivores, such as bison, elk, and deer. Wind and ice would have periodically opened the canopy up by knocking over trees or breaking substantial branches off canopy trees. Such canopy disturbances allowed more light to reach the ground and favored reproduction of the dominant oak species. Grazing by native large herbivores would have kept understory conditions more open, also creating conditions more favorable to oak reproduction.

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

and domestic grazing. Most existing occurrences have a younger (50 to 80 years) canopy layer whose composition has been altered by timber harvesting practices. An increase in hickories over historic conditions is common. In addition, in the absence of fire, the canopy, sub-canopy and woody understory layers are better developed. The absence of periodic fire has allowed more shade-tolerant tree species, such as sugar maple, white ash, or hickories to increase in abundance.

Uncontrolled domestic grazing has diminished the diversity and cover of woodland ground flora species, and has introduced weedy species such as gooseberry, buckbrush, poison ivy and Virginia creeper created a more open understory and increased soil compaction.

Chert Limestone/Dolomite Protected Backslope Forests are only moderately productive timber sites. 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. However, without some thinning of the dense stands, the ground flora diversity can be shaded out and productivity of the stand may suffer.

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 other woodland sites in the region. Control of woody species will be more difficult. Protected aspect woodlands did evolve with some fire, and their composition and structure often reflects more open, woodland conditions than adjacent forest sites, with more woodland ground flora species that can respond to fire.

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

Chert Limestone/Dolomite Protected Backslope Forest, F115BY014MO

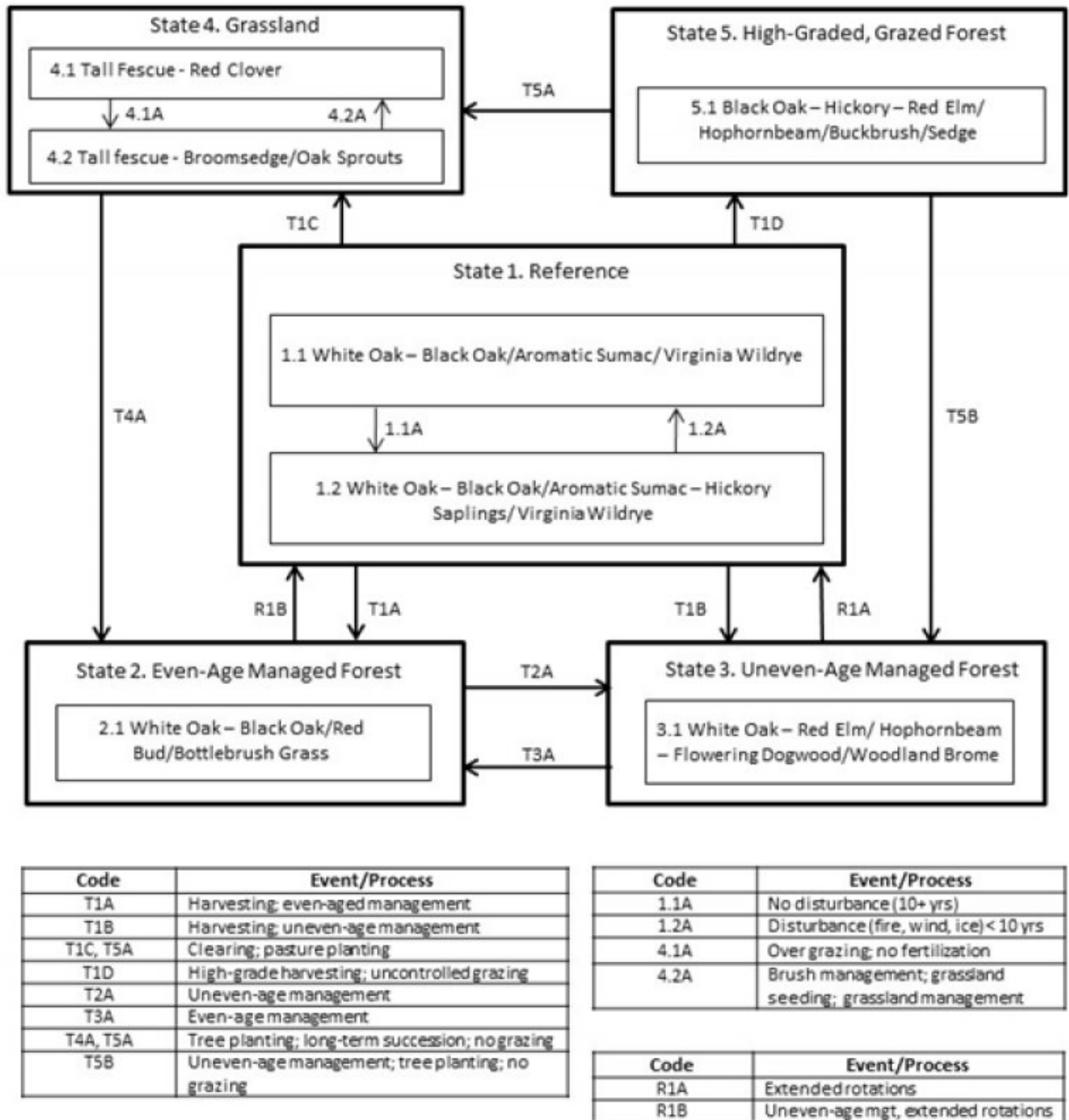


Figure 8. State and transition diagram for this ecological s

State 1

Reference

The Reference State was dominated by white oak and black 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 and sugar maple. Two community phases are recognized in this state, with shifts between phases based on disturbance frequency. The reference state is rare today. Some sites have been converted to grassland (State 4). Others have been subject to repeated, high-graded timber harvest coupled with domestic livestock grazing (State 5). Fire suppression has resulted in increased canopy density, which has affected the abundance and diversity of ground flora. Many Reference sites have been managed for timber harvest, resulting in either even-age (State 2) or uneven-age (State 3) forests. In the absence of disturbance, more shade tolerant species such as hickory, white ash and others increase in importance and add structural diversity to the system.

Community 1.1

White Oak – Black Oak/Aromatic Sumac/ Virginia Wildrye

This phase has an overstory that is dominated by white oak and black oak with hickory and post oak also present. Periodic disturbances including fire, ice and wind create canopy gaps, allowing white oak and black oak to successfully reproduce and remain in the canopy. It is likely that this phase burned at least once every 10 to 25 years.

Forest overstory. The Overstory Species list is based on field surveys and commonly occurring species listed in Nelson (2010).

Forest understory. The Understory Species list is based on field surveys and commonly occurring species listed in Nelson (2010).

Community 1.2

White Oak – Black Oak/Aromatic Sumac – Hickory Saplings/ Virginia Wildrye

This phase is similar to community phase 1.1 but oak and hickory understory densities are increasing due to longer periods of fire suppression and lack of disturbance. 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.

State 2

Even-Age Managed Forest

These forests tend to be rather dense, with an under developed understory and ground flora. Thinning can increase overall tree vigor and improve understory diversity. Continual timber management, depending on the practices used, will either maintain this state, or convert the site to uneven-age (State 3) forests.

Community 2.1

White Oak – Black Oak/Red Bud/Bottlebrush Grass

This is an even-aged forest management phase. Logging activities are removing higher volumes of white oak causing a decrease in white oak in the canopy and an increase in black oak. Large group, shelterwood or clearcut harvests create a more uniform age class structure throughout the canopy layer while also opening up the understory and allowing more sunlight to reach the forest floor.

State 3

Uneven-Age Managed Forest

Uneven-Age Managed forests can resemble the reference state. The biggest difference is tree age, most being only 50 to 90 years old. Composition is also likely altered from the reference state depending on tree selection during harvest. In addition, without a regular 15 to 20 year harvest re-entry into these stands, they will slowly increase in more shade tolerant species such as sugar maple and white oak will become less dominant.

Community 3.1

White Oak – Red Elm/ Hophornbeam – Flowering Dogwood/Woodland Brome

This is an uneven-aged forest management phase. Selective logging activities are removing higher volumes of white oak causing a decrease in white oak in the canopy and an increase in red elm. Density numbers, especially more shade tolerant species, are increasing at the lower size-class levels.

State 4

Grassland

Conversion of forests to planted, non-native pasture species such as tall fescue has been common in this MLRA. Steep slopes, abundant surface fragments, low organic matter contents and soil acidity make non-native pastures challenging to maintain in a healthy, productive state on this ecological site. If grazing and active pasture management is discontinued, the site will eventually transition, over time, to State 2 (Even-Age).

Community 4.1

Tall Fescue - Red Clover

This phase is a 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 poor grassland management. Over grazing and inadequate or no fertility application has allowed tall fescue, multi-flora rose, thistle and other weedy species to increase in cover and density reducing overall forage quality and site productivity. Clovers will decrease or go away with no fertilization and overgrazing although Dutch white clover will leave last. Soil pH and bases such as calcium and magnesium are lower, relative to well-managed pasture.

State 5

High-Graded, Grazed Forest

Forested sites subjected to repeated, high-graded timber harvests and uncontrolled domestic grazing transition to this state. This state exhibits an over-abundance of hickory and other less desirable tree species, and weedy understory species such as buckbrush, gooseberry, poison ivy and Virginia creeper. The vegetation offers little nutritional value for cattle, and excessive stocking damages tree boles, degrades understory species composition and results in soil compaction and accelerated erosion and runoff. Exclusion of livestock from sites in this state coupled with uneven-age management techniques will cause a transition to State 3 (Uneven-Age).

Community 5.1

Black Oak – Hickory – Red Elm/ Hophornbeam/Buckbrush/Sedge

Due to high-grade logging and uncontrolled grazing, this community phase exhibits an over-abundance of hickory and other less economically desirable tree species and weedy understory species such as buckbrush, gooseberry, poison ivy and multi-flora rose. The understory vegetation offers little nutritional value for cattle, and excessive livestock stocking damages tree boles, degrades understory species composition and results in soil compaction and accelerated erosion and runoff.

Additional community tables

Table 5. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)	Diameter (Cm)	Basal Area (Square M/Hectare)
Tree							
white oak	QUAL	<i>Quercus alba</i>	Native	–	–	–	–
chinquapin oak	QUMU	<i>Quercus muehlenbergii</i>	Native	–	–	–	–
white ash	FRAM2	<i>Fraxinus americana</i>	Native	–	–	–	–
shagbark hickory	CAOV2	<i>Carya ovata</i>	Native	–	–	–	–
slippery elm	ULRU	<i>Ulmus rubra</i>	Native	–	–	–	–
pignut hickory	CAGL8	<i>Carya glabra</i>	Native	–	–	–	–
post oak	QUST	<i>Quercus stellata</i>	Native	–	–	–	–

Table 6. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (M)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
oval-leaf sedge	CACE	<i>Carex cephalophora</i>	Native	–	–
little bluestem	SCSC	<i>Schizachyrium scoparium</i>	Native	–	–
Virginia wildrye	ELVI3	<i>Elymus virginicus</i>	Native	–	–
woodland muhly	MUSY	<i>Muhlenbergia sylvatica</i>	Native	–	–
hairy woodland brome	BRPU6	<i>Bromus pubescens</i>	Native	–	–
hairy wildrye	ELVI	<i>Elymus villosus</i>	Native	–	–
eastern bottlebrush grass	ELHY	<i>Elymus hystrix</i>	Native	–	–
Indian woodoats	CHLA5	<i>Chasmanthium latifolium</i>	Native	–	–
Forb/Herb					
pointedleaf ticktrefoil	DEGL5	<i>Desmodium glutinosum</i>	Native	–	–
bloodroot	SACA13	<i>Sanguinaria canadensis</i>	Native	–	–
largeflower bellwort	UVGR	<i>Uvularia grandiflora</i>	Native	–	–
roundlobe hepatica	HENOO	<i>Hepatica nobilis var. obtusa</i>	Native	–	–
dutchman's breeches	DICU	<i>Dicentra cucullaria</i>	Native	–	–
early meadow-rue	THDI	<i>Thalictrum dioicum</i>	Native	–	–
meadow zizia	ZIAP	<i>Zizia aptera</i>	Native	–	–
elmleaf goldenrod	SOUL2	<i>Solidago ulmifolia</i>	Native	–	–
cutleaf toothwort	CACO26	<i>Cardamine concatenata</i>	Native	–	–
Shrub/Subshrub					
fragrant sumac	RHAR4	<i>Rhus aromatica</i>	Native	–	–
American hazelnut	COAM3	<i>Corylus americana</i>	Native	–	–
Tree					
eastern redbud	CECA4	<i>Cercis canadensis</i>	Native	–	–
hophornbeam	OSVI	<i>Ostrya virginiana</i>	Native	–	–
flowering dogwood	COFL2	<i>Cornus florida</i>	Native	–	–

Animal community

Wildlife (MDC 2006):

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.

Bird species associated with early-successional forests are Prairie Warbler, Field Sparrow, Brown Thrasher, Blue-winged Warbler, White-eyed Vireo, Blue-gray Gnatcatcher, Yellow-breasted Chat, Indigo Bunting, and Eastern Towhee.

Birds associated with late-successional forests include Worm-eating warbler, Whip-poor-will, Great Crested Flycatcher, Ovenbird, Pileated Woodpecker, Wood Thrush, Red-eyed Vireo, Northern Parula, 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: Field collected site index values average 56 for oak. Timber management opportunities are fair. 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, and should be used with caution on a particular site if timber management is the primary objective. Favor white oak, post oak, and black oak.

Limitations: 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

Chert Limestone/Dolomite Protected Backslope Forest – Potential Reference – F115BY014MO:

Plot WESPCA03 – Sonsac soil

Located in Weldon Springs Conservation Area in St. Charles County, MO

Latitude: 38.6751,

Longitude: -90.772959

Other references

Davis, Keith O. 2002. Soil Survey of Osage County, Missouri. U.S. Dept. of Agric. Natural Resources Conservation Service.

Ladd, D. 1991. Reexamination of the role of fire in Missouri oak woodlands. Pp. 67-80 in G.V. Brown, James K.; Smith, Jane Kapler, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

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.

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:**

17. **Perennial plant reproductive capability:**
