Ecological site R116BY024MO
Shallow Limestone Upland Glade/Woodland

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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.

MLRA notes

Major Land Resource Area (MLRA): 116B–Springfield Plain

The Springfield Plain is in the western part of the Ozark Uplift. It is primarily a smooth plateau with some dissection along streams. Elevation is about 1,000 feet in the north to over 1,700 feet in the east along the Burlington Escarpment adjacent to the Ozark Highlands. The underlying bedrock is mainly Mississippian-aged limestone, with areas of shale on lower slopes and structural benches, and intermittent Pennsylvanian-aged sandstone deposits on the plateau surface.

Classification relationships

Terrestrial Natural Community Type in Missouri (Nelson, 2010): The reference state for this ecological site is most similar to a Limestone Glade. Missouri Department of Conservation Forest and Woodland Communities (Missouri Department of Conservation, 2006): The reference state for this ecological site is most similar to Limestone/Dolomite Woodland. National Vegetation Classification System Vegetation Association (NatureServe, 2010): The reference state for this ecological site is most similar to Schizachyrium scoparium - Bouteloua curtipendula - Rudbeckia missouriensis - Mentzelia oligosperma Wooded Herbaceous Vegetation (CEGL002251). Geographic relationship to the Missouri Ecological Classification System (Nigh & Schroeder, 2002): This ecological site occurs primarily within the following Land Type Associations: Upper Sac River Oak Savanna/Woodland Low Hills Stockton Prairie/Savanna Dissected Plain Big Sugar Creek 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”. Shallow Limestone Glade/Woodlands occur in dissected areas where the underlying limestone is exposed, primarily in the Sac River watershed and tributaries in Dade County and Cedar County, Missouri. Small areas also occur to the south in the Elk River watershed, primarily over dolomite. Soils are very shallow to limestone bedrock. The reference plant community ranges from open areas of grasses and forbs interspersed with bare bedrock, to areas with shrubs and widely scattered chinkapin and post oak.

Associated sites

F116BY003MO	**Chert Upland Woodland** Chert Upland Woodlands are often upslope, where soils are very deep.
F116BY006MO	**Chert Limestone Upland Woodland** Chert Limestone Upland Woodland are adjacent and often upslope, where soils are 20 to 40 inches to limestone bedrock.

F116BY011MO	**Chert Limestone Protected Backslope Forest** Chert Limestone Protected Backslope Forests are adjacent and often downslope, on steep northern and eastern aspects, where soils are 20 to 40 inches to limestone bedrock.
F116BY034MO	**Chert Limestone Exposed Backslope Woodland** Chert Limestone Exposed Backslope Woodlands are adjacent and often downslope, on steep southern and western aspects, where soils are 20 to 40 inches to limestone bedrock.

Similar sites

R116BY025MO	**Shallow Sandstone Upland Glade/Woodland** Shallow Sandstone Upland Glade/Woodlands are also glades on similar landscape positions but on sandstone. Structure is similar but species composition is in many ways different.

Table 1. Dominant plant species

Tree	(1) *Quercus muehlenbergii*
Shrub	(1) *Bumelia lanuginosa* (2) *Rhus aromatica*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Bouteloua curtipendula*

Physiographic features

This site is on upland crests, shoulders and backslopes with slopes of 3 to 50 percent. The site generates runoff to adjacent, downslope ecological sites, and in places receives runoff from upslope summit and shoulder sites. This site does not flood.

The following figure (adapted from Dodd, 1985) shows the typical landscape position of this ecological site, and landscape relationships with other ecological sites. It is within the area labeled “2” on the figure, shown here on knobs. Shallow Limestone Upland Glade/Woodland sites are typically associated with Chert Limestone Upland Woodland sites, labeled “4”.

Figure 1. Landscape relationships for this ecological site.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Knob (3) Bluff
Flooding frequency	None
Slope	0 − 50 %

Water table depth	150 cm
Aspect	W, SE, S, SW

Climatic features

The Springfield Plain 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 Springfield Plain experiences few regional differences in climates. The average annual precipitation in this area is 41 to 45 inches. Snow falls nearly every winter, but the snow cover lasts for only a few days. The average annual temperature is about 55 to 58 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 along a west to east gradient. 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.

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. Deep sinkholes often have a microclimate significantly cooler, moister, and shadier than surrounding surfaces, a phenomenon that may result in a strikingly different ecology. 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; 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 (characteristic range)	150-160 days
Freeze-free period (characteristic range)	180-190 days
Precipitation total (characteristic range)	1,170 mm
Frost-free period (actual range)	150-160 days
Freeze-free period (actual range)	180-190 days
Precipitation total (actual range)	1,170 mm

Frost-free period (average)	160 days
Freeze-free period (average)	190 days
Precipitation total (average)	1,170 mm

- (1) STOCKTON DAM [USC00238082], Stockton, MO
- (2) SPRINGFIELD [USW00013995], Springfield, MO
- (3) MT VERNON M U SW CTR [USC00235862], Mount Vernon, MO

Influencing water features

This ecological site is not influenced by wetland or riparian water features. High temperatures, intense solar radiation, and dry conditions prevail throughout much of the growing season, although soils may be saturated in spring, winter and late fall. Frost upheaval frequently disrupts these shallow soils during the dominant season. While evapotranspiration remains the most constant water feature, evapotranspiration rates typically peak in the summer and become dominant. The surface runoff pulse is greatly influenced by extreme weather events.

Soil features

These soils are underlain with limestone bedrock at less than 20 inches. The soils were formed under prairie vegetation, and have dark, organic-rich surface horizons. Parent material is limestone residuum. These soils are loamy and are skeletal, with high amounts of limestone gravel, channers and flagstones. They are not affected by seasonal wetness. Soil series associated with this site include Gasconade and Moko.

The accompanying picture of a roadcut in the Moko series shows the shallow depth to the fractured limestone bedrock that characterizes this ecological site. Picture from Baker (1998).

Figure 8. Moko series

Table 4. Representative soil features

Parent material	(1) Residuum – cherty limestone
Surface texture	(1) Flaggy silty clay loam (2) Gravelly silt loam
Family particle size	(1) Loamy
Drainage class	Well drained to somewhat excessively drained
Permeability class	Moderately slow to slow
Soil depth	10 – 50 cm
Surface fragment cover <=3"	10 – 40 %

Surface fragment cover >3"	0 – 20 %
Available water capacity (0-101.6cm)	2.54 – 5.08 cm
Calcium carbonate equivalent (0-101.6cm)	Not specified
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	Not specified
Soil reaction (1:1 water) (0-101.6cm)	5.1 – 7.3
Subsurface fragment volume <=3" (Depth not specified)	10 – 50 %
Subsurface fragment volume >3" (Depth not specified)	10 – 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.

Glade plants in general possess many adaptations enabling them to survive in a harsh environment often subject to widely fluctuating extremes of temperature and moisture. The following conditions are general characteristic of most limestone glades (Nelson and Ladd 1983; Nelson et al. 2013):
• Calcareous bedrock at or near the surface because of major erosional activity;
• Moderate to steep slopes in deeply dissected drainages or hilly to mountainous terrain with a southern or western exposure with intense solar radiation;
• Extremely thin soil cover interspersed with abundant rock fragments and rock outcrops;
• Exceptionally dry conditions throughout much of the growing season, although soils may be seasonally saturated in spring, winter, and fall;
• Peripheral areas and sometimes large expanses of the glades themselves characterized by a mosaic of stunted, often gnarled trees and shrubs.

The shallow soils of this ecological site limit the growth and abundance of trees and support the native grasses and forbs that dominate

these systems. Fire played an important role in the maintenance of these systems, as well. It is likely that these sites burned at least once every five years. These periodic fires removed the litter and stimulated the growth and flowering of the grasses and forbs. They also further limited the growth and dominance of trees, especially eastern redcedar1.

Fire tolerant chinkapin oak and post oak occupied islands and edges of deeper soils, creating a complex mosaic of open glade and low-density woodland. During fire-free intervals, woody species increased, but not to densities on over-grazed glades.

In the absence of fire, woody species, especially eastern redcedar, quickly occupy the site. This is especially true after grazing has reduced grass cover and exposed more surface to the dispersal of eastern redcedar seeds by birds. Once established, eastern redcedar can quickly fill in a glade/woodland system, especially if grazing has diminished the vigor of the diverse flora. Many glades have been heavily grazed and suffer substantial redcedar invasion. Removal of the eastern redcedar by chainsaw and the application of prescribed fire have proven to be an effect way to management these systems.

Glade/Woodland Complexes harbor a wide diversity of plants and animals. Grasses such as little bluestem, Indiangrass, and sideoats grama, are also found on prairies. But other species, such as Missouri coneflower, limestone calamint, and the federally listed Missouri bladder-pod (Lesquerella filaformis), are only found on limestone/dolomite glades. Desert-adapted animals, like scorpions and tarantulas, also occupy healthy glades.

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

Figure 9. State and transition diagram for this ecological site

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 6. Community 1.1 forest overstory composition

Common Name	Symbol	Scientific Name	Nativity	Height M	Canopy Cover (%)	Diameter Cm	Basal Area (square M/hectare)
Tree							
chinquapin oak	QUMU	*Quercus muehlenbergii*	Native	–	0-10	–	–
post oak	QUST	*Quercus stellata*	Native	–	0-10	–	–
blue ash	FRQU	*Fraxinus quadrangulata*	Native	–	0-10	–	–
dwarf hackberry	CETE	*Celtis tenuifolia*	Native	–	0-10	–	–

Table 7. Community 1.1 forest understory composition

Common Name	Symbol	Scientific Name	Nativity	Height (m)	Canopy Cover (%)
Grass/grass-like (Graminoids)					
sideoats grama	BOCU	*Bouteloua curtipendula*	Native	–	1-5
little bluestem	SCSC	*Schizachyrium scoparium*	Native	–	1-5
puffsheath dropseed	SPNE2	*Sporobolus neglectus*	Native	–	1-5
Mead's sedge	CAME2	*Carex meadii*	Native	–	1-5
flatstem spikerush	ELCO2	*Eleocharis compressa*	Native	–	1-5
Lindheimer panicgrass	DIACL	*Dichanthelium acuminatum var. lindheimeri*	Native	–	1-5
Crawe's sedge	CACR3	*Carex crawei*	Native	–	1-5
big bluestem	ANGE	*Andropogon gerardii*	Native	–	1-5
switchgrass	PAVI2	*Panicum virgatum*	Native	–	1-5
prairie dropseed	SPHE	*Sporobolus heterolepis*	Native	–	1-5
Bush's sedge	CABU5	*Carex bushii*	Native	–	1-5
Forb/Herb					

pinnate prairie coneflower	RAPI	*Ratibida pinnata*	Native	–	1-5
aromatic aster	SYOB	*Symphyotrichum oblongifolium*	Native	–	1-5
butterfly milkweed	ASTU	*Asclepias tuberosa*	Native	–	1-5
Sampson's snakeroot	ORPE	*Orbexilum pedunculatum*	Native	–	1-5
Tharp's spiderwort	TRTH	*Tradescantia tharpii*	Native	–	1-5
pale purple coneflower	ECPA	*Echinacea pallida*	Native	–	1-5
devil's-tongue	OPHU	*Opuntia humifusa*	Native	–	1-5
small skullcap	SCPA7	*Scutellaria parvula*	Native	–	1-5
purple prairie clover	DAPU5	*Dalea purpurea*	Native	–	1-5
limestone calamint	CLAR5	*Clinopodium arkansanum*	Native	–	1-5
blue wild indigo	BAAUM	*Baptisia australis var. minor*	Native	–	1-5
prairie tea	CRMO6	*Croton monanthogynus*	Native	–	1-5
slimleaf milkweed	ASST	*Asclepias stenophylla*	Native	–	1-5
hoary puccoon	LICA12	*Lithospermum canescens*	Native	–	1-5
chickenthief	MEOL	*Mentzelia oligosperma*	Native	–	1-5
slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	Native	–	1-5
prairie rosinweed	SITE	*Silphium terebinthinaceum*	Native	–	1-5
Michaux's croton	CRMIE	*Croton michauxii var. ellipticus*	Native	–	1-5
pasture heliotrope	HETE3	*Heliotropium tenellum*	Native	–	1-5
widowscross	SEPU	*Sedum pulchellum*	Native	–	1-5
limestone adderstongue	OPEN	*Ophioglossum engelmannii*	Native	–	1-5
Missouri orange coneflower	RUMI	*Rudbeckia missouriensis*	Native	–	1-5
diamondflowers	STNIN	*Stenaria nigricans var. nigricans*	Native	–	1-5
meadow garlic	ALCA3	*Allium canadense*	Native	–	1-5
western silver aster	SYSE2	*Symphyotrichum sericeum*	Native	–	1-5
Carolina larkspur	DECA3	*Delphinium carolinianum*	Native	–	1-5
Shrub/Subshrub					
fragrant sumac	RHAR4	*Rhus aromatica*	Native	–	2-5
Carolina buckthorn	FRCA13	*Frangula caroliniana*	Native	–	2-5
leadplant	AMCA6	*Amorpha canescens*	Native	–	1-5
gum bully	SILA20	*Sideroxylon lanuginosum*	Native	–	1-5
spotted St. Johnswort	HYPU	*Hypericum punctatum*	Native	–	1-5
Nonvascular					
wart lichen	VEMA6	*Verrucaria marmorea*	Native	–	1-5
fishscale lichen	PSDE60	*Psora decipiens*	Native	–	1-5
sarcogyne lichen	SARE18	*Sarcogyne regularis*	Native	–	1-5

Table 8. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 9. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 10. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Animal community

Wildlife Wildlife habitat: oaks provide hard mast; numerous native legumes provide high-quality wildlife food; native warm-season grasses provide extensive cover and nesting habitat; and a diversity of forbs provides a diversity and abundance of insects. Post-burn areas can provide temporary bare-ground – herbaceous cover habitat important for turkey poults and quail chicks. Game species that utilize this ecological site include: Northern Bobwhite will utilize this ecological site for food (seeds, insects), cover needs (escape, nesting and roosting cover) and brood-rearing habitat. Cottontail rabbits will utilize this ecological site for food (seeds, soft mast) and cover needs. Turkey will utilize this ecological site for food (seeds, green browse, soft mast, and insects) and nesting and brood-rearing cover. Turkey poults feed heavily on insects provided by this site type. White-tailed deer will utilize this ecological site for browse (plant leaves in the growing season, seeds and soft mast in the fall/winter). This site type also can provide escape cover. Breeding bird species associated with this ecological site's reference state condition: Field Sparrow, Yellow-breasted Chat, Blue-winged Warbler, Brown Thrasher, Indigo Bunting, Red-headed Woodpecker, Eastern Bluebird, Northern Bobwhite, Prairie Warbler, and Eastern Towhee. Amphibian and reptile species that may be associated with this ecological site's reference state: collared lizard (Crotaphytus collaris collaris), five-lined skink (Eumeces fasciatus), six-lined racerunner (Cnemidophorus sexlineatus), flat-headed snake (Tantilla gracilis), eastern coachwhip (Masticophis flagellum flagellum), red milk snake (Lampropeltis triangulum syspila), eastern narrow-mouthed toad (Gastrophyne carolinensis), coal skink (Eumeces anthracinus pluvialis), ground snake (Snora semiannulata), and prairie ring-necked snake (Diadophis punctatus arnyi). Small mammals likely associated with this ecological site's reference state condition: eastern woodrat (Neotoma floridana) and peromyscus species. Invertebrates – Many native insect species are likely associated with this ecological site's reference state condition, especially native bees, ants, beetles, butterflies and moths, and crickets, grasshoppers and katydids. Insect species likely associated with this ecological site's reference state condition: dusted skipper butterfly (Atrytonopsis hianna), cobweb skipper butterfly (Hesperia metea), pepper and salt skipper butterfly (Amblyscirtes hegon), Delaware skipper butterfly (Atryone logan logan), crossline skipper butterfly (Polites origenes), native ants (Crematogaster lineolata, Monomorium minimum, Forelius pruinosus Paratrechnia terricola), and native bees (Colletes aestivalis, Andrena helianthiformis, Protandrena rudbeckiae, Lasioglossum coreopsis, Anthidium psoraleae and Dianthidium subrufulum). Other invertebrates: black widow spider (Latrodectus mactans) and striped bark scorpion (Centruroides vittatus) (This section prepared by Mike Leahy, Natural Areas Coordinator, Missouri Department of Conservation, 2013. References for this section: Fitzgerald and Pashley 2000b; Heitzman and Heitzman 1996; Jacobs 2001; Johnson 2000; Pitts and McGuire 2000; Schwartz and others 2001)

Other information

Forestry Management: Site index values are less than 30 for eastern redcedar and generally less than 40 for oak. Productivity is very low. No timber management opportunities exist. These sites are valuable for wildlife purposes and watershed protection. Severely reduced rooting depth restricts tree growth and increases windthrow hazards. These sites respond well to prescribed fire as a management tool. Limitations: Surface stones and surface rock; very shallow soil depth. Surface stones and rocks are problems for efficient and safe equipment operation. Severe seedling mortality due to high soil surface temperatures and low available water holding capacity is possible. Machine planting and mechanical site preparation is not recommended. Hard bedrock at shallow depths may interfere with equipment operation. Rock outcrops may cause breakage of timber when harvesting. Surface stones and rocks will make equipment use extremely difficult. 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

Potential Reference Sites: Shallow Limestone Upland Glade/Woodland Plot PLHOCA06 – Moko soil Located in Pleasant Hope CA, Polk County, MO Latitude: 37.429681 Longitude: -93.298301 Plot STLACE05 – Gasconade soil Located in Stockton Lake COE/CA, Cedar County, MO Latitude: 37.574269 Longitude: -93.665836 Plot SPNACA_JK05 – Moko soil Located in Springfield Nature Center, Greene County, MO Latitude: 37.127052 Longitude: -93.244542

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Contributors

Doug Wallace
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Approval

Nels Barrett, 10/07/2020

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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	10/06/2020
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:

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

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

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

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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:**
