USDA Natural Resources Conservation Service

Ecological site R108XD845IA
Shale Upland Savanna

Last updated: 10/17/2024
Accessed: 05/11/2025

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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, Western Part MLRA covers parts of both Iowa and Missouri and is known locally as part of the Southern Iowa Drift Plain. A silty loess deposit of varying thickness (5 to 20 feet) covers a series of glacial advances known collectively as pre-Illinoisan till. This till, deposited more than half a million years ago, was subjected to multiple instances of extreme erosion as well as periods of subdued erosion and intense weathering. The loess is thickest in the western part of the MLRA and generally thins eastward. In some areas, the loess has been removed and the older weathered till, called a “paleosol,” entirely exposed. These highly weathered soils, or paleosols, have a high content of clay, which slows the downward movement of water through the profile and causes water to move laterally instead of vertically. Wet areas, or “side-hill seeps,” commonly form where these paleosols become exposed along hillsides (Prior, 1991).

The dominant soil orders in this MLRA are Mollisols and Alfisols and, to a lesser extent, Entisols and Inceptisols. Most of the soils are Udolls or Udalfs. Aquolls are on the flatter interfluves. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained to poorly drained, and silty, loamy, or clayey. These soils on uplands include somewhat poorly drained, nearly level Argiudolls (Macksburg series); moderately well drained, gently sloping to strongly sloping Argiudolls (Sharpsburg series); poorly drained, nearly level Argiaquolls (Winterset series); and well drained strongly, sloping to steep Hapludalfs (Gara, Lindley, Ladoga, and Armstrong series) (USDA-NRCS, 2006).
The western part of the Illinois and Iowa Deep Loess and Drift is a segment of three other MLRAs within the Central Feed Grains and Livestock Region. The other areas are: the West-Central part (108C), the East-Central part (108B) and the Eastern part (108A).

Classification relationships

Major Land Resource Area (MLRA): Illinois and Iowa Deep Loess and Drift, Western Part (108D)

USFS Subregions: Central Dissected Till Plains Section (251C); Loess Hills (251Cb) and Central Dissected Till and Loess Plain (251Cc) Subsections (Cleland et al, 2007)

Relationship to Other Established Classifications:
NatureServe Classification: Ecological System North-Central Interior Dry-Mesic Oak Forest and Woodland (4116); Ecological Association: Quercus marcrocarpa Northern Tallgrass Open Woodland (CEGL002158) (NatureServe, 2013)
Landfire Biophysical Setting: Central Tallgrass Prairie (4314210) (Landfire, 2009)

Ecological site concept

Shale Upland Savannas are within the red areas on the map (Figure 1). These sites formed in 6 to 20 inches of loamy or silty sediments over shale residuum parent material. They can be found on convex side slopes and escarpment-like areas on uplands. Typically, these sites are located down slope from till ecological sites. Soils are typically either Mollisols or Mollic Alfisols. Mollisols are characterized by dark colored surfaces high in organic matter due to the dominant prairie vegetation, Mollic Alfisols are characterized by a slightly thinner organic surface horizon and a zone of clay accumulation deeper in the soil. These sites have rooting restrictions at 20 to 60 or more inches. The reference community is savanna with scattered *Quercus macrocarpa* and an herbaceous layer of *Andropogon gerardii*, *Sorghastrum nutans*, and *Schizachyrium scoparium*.

Associated sites

R108XD863IA	**Till Upland Prairie** Till Upland Prairie.Fine and fine-loamy textured soils including Adair, Armstrong, Bucknell, Gara, Lamoni and Shelby series.
R108XD824IA	**Wet Upland Drainageway Prairie** Wet Upland Drainageway Prairie. Fine and fine-silty textured soils including Ackmore, Colo, Vesser and Zook series.
R108XD841IA	**Loamy Footslope Savanna** Loamy Footslope Savanna. Fine-loamy and fine-silty textured soils including Arbor, Ely, Judson and Olmitz series.

Similar sites

R108XD835IA	**Shale Backslope Savanna** Shale Backslope Savanna. Fine textured soil including the Clanton and Bauer series.

Table 1. Dominant plant species

Tree	(1) *Quercus macrocarpa*
Shrub	Not specified
Herbaceous	(1) *Andropogon gerardii* (2) *Sorghastrum nutans*

Physiographic features

Shale Upland Savannas are of small extent, and can be found on hillslopes in uplands near the eastern end of MLRA 108D. Slopes are generally less than 14 percent. These sites typically occur along side slopes where excessive erosion has removed nearly all the loess and glacial till deposits, exposing the weathered shale bedrock beneath.

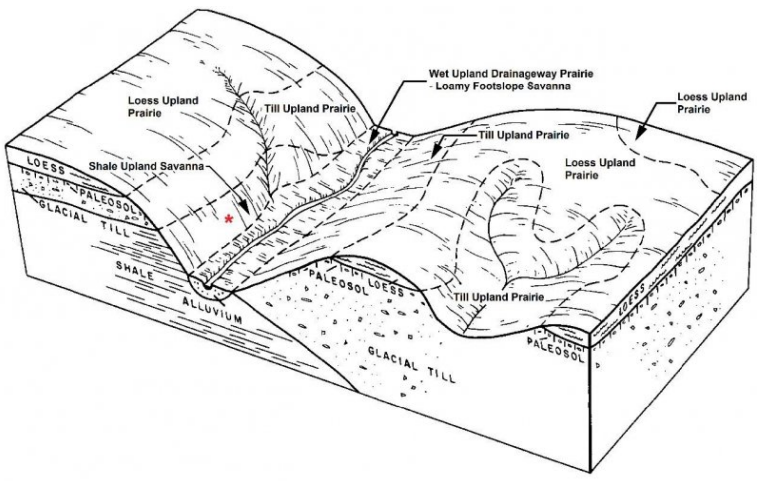


Figure 2. Block diagram representing typical soil-landform sequences in loess ridges, glacial till side/footslopes. Red asterisk identify soil component correlated to Shale Upland Savanna.

Table 2. Representative physiographic features

Landforms	(1) Hillslope
Runoff class	Medium to very high
Flooding frequency	None
Ponding frequency	None
Elevation	649–1,348 ft
Slope	9–14%
Water table depth	24–80 in
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The soil temperature regime of MLRA 108D is classified as “mesic” where the mean annual soil temperature is between 46 and 59°F (Soil Survey Staff, 2014). The average freeze-free period of this ecological site is about 166 days, while the frost-free period is about 144 days.

Average annual precipitation is 31 inches, which includes rainfall plus the water equivalent from snowfall. The average annual low and high temperatures are 38 and 60°F, respectively.

Table 3. Representative climatic features

Frost-free period (characteristic range)	135-144 days
Freeze-free period (characteristic range)	157-171 days
Precipitation total (characteristic range)	36-37 in
Frost-free period (actual range)	134-149 days
Freeze-free period (actual range)	157-176 days
Precipitation total (actual range)	35-38 in
Frost-free period (average)	141 days
Freeze-free period (average)	165 days
Precipitation total (average)	36 in

Climate stations used

- (1) WINTERSET 1N [USC00139132], Winterset, IA
- (2) INDIANOLA 2W [USC00134063], Indianola, IA
- (3) KNOXVILLE [USC00134502], Knoxville, IA
- (4) MARYVILLE 2E [USC00235340], Maryville, MO
- (5) CLARINDA [USC00131533], Clarinda, IA
- (6) CRESTON 2 SW [USC00131962], Creston, IA

Influencing water features

This ecological site is not influenced by wetland or riparian water features. Land Capability Class is 6e (Land Capability Classification, 2016). The soils at this site are assigned to hydrologic group D (Hydrologic Soil Group, 2016). Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Source of water is from both direct precipitation and upslope loess and till upland sites. Endosaturation can occur at a minimum of 2 feet below the surface, and a maximum depth of greater than 6.5 feet.

Redoximorphic concentrations at 12 inches to 40 inches depth. There is some difficulty in assessing drainage class due to the gray color inherited from the shale parent material.

Soil features

These soils have a rooting restriction between 20 to more than 60 inches. The soils were formed under savanna vegetation, and have dark, organic-rich surface horizons. Parent material is residuum from shale. The soils have silt loam surface horizons (Table 5). Subsoils are loam, clay loam, silty clay loam or silty clay. Some soils are affected by seasonal wetness in spring months. Soil series associated with this site include Bauer and Clanton.

Table 4. Representative soil features

Parent material	(1) Residuum–shale
Surface texture	(1) Loam (2) Clay loam (3) Silty clay loam (4) Silty clay
Drainage class	Moderately well drained
Permeability class	Very slow to moderate
Soil depth	20–60 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (Depth not specified)	3–6 in
Calcium carbonate equivalent (Depth not specified)	0%
Soil reaction (1:1 water) (Depth not specified)	5.3–6.7
Subsurface fragment volume <=3" (Depth not specified)	2–3%
Subsurface fragment volume >3" (Depth not specified)	3%

Ecological dynamics

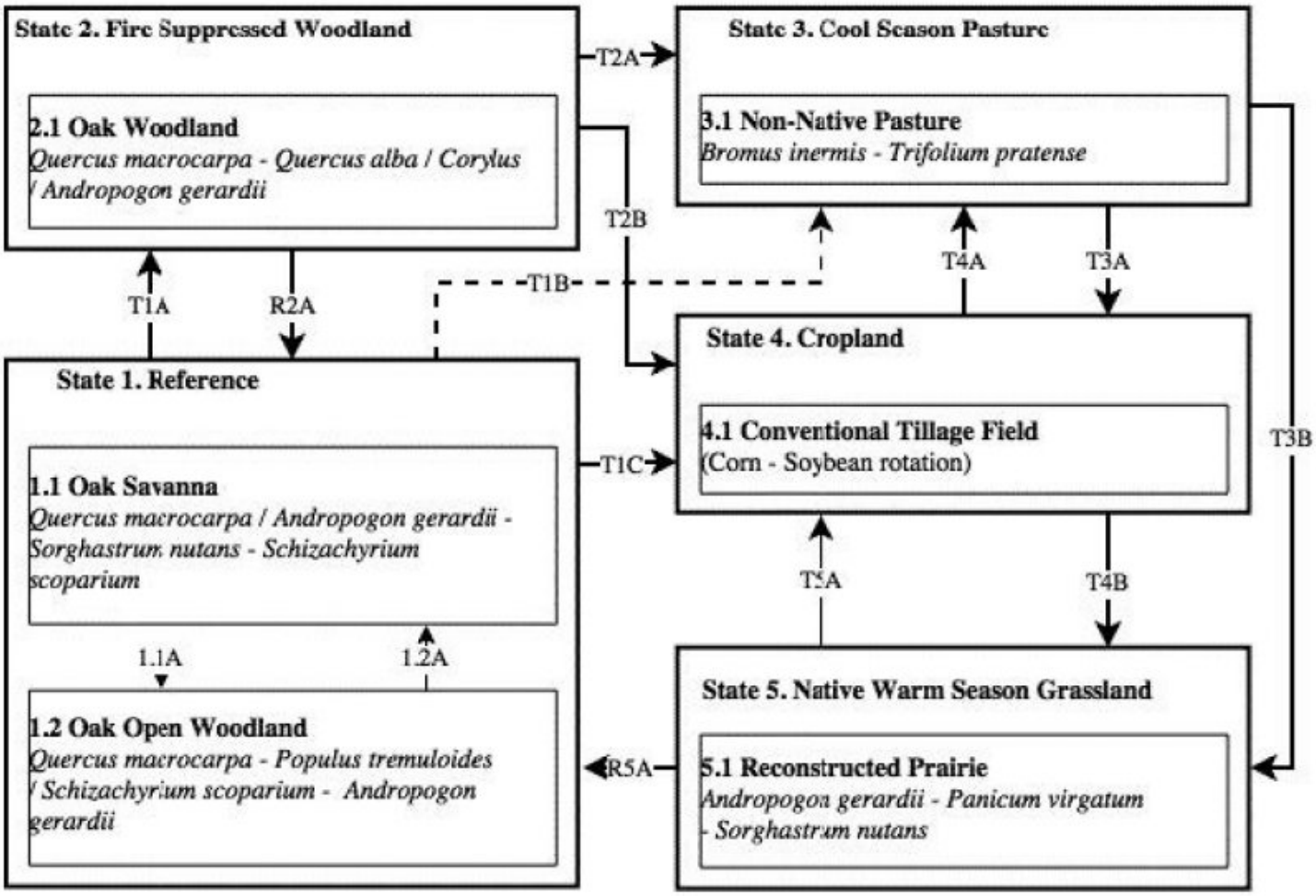
Reference plant community is categorized as a shale upland savanna and includes grasses and forbs, with scattered oak grubs and clumps of shrubs. The grubs form as multi-stemmed stump sprouts and are the result of repeated exposure fire. The oak grubs huge root masses allowed them to achieve canopy ascension even after annual fires. Species composition typically includes *Andropogon gerardii*, *Schizachyrium scoparium*, *Sorghastrum nutans*, *Quercus macrocarpa*, and *Quercus alba*.

Fire, grazing, drought, are all disturbances influencing the dynamics at this site. These sites likely burned every 1 to 3 years. Grazing by whitetail deer, and prairie elk, was rare. Bison as well may have been also present, grazing to a lesser extent. Disturbances from these animals removed thatch, litter, and reduced the proliferation of small trees and shrubs (Mutel, 2008).

As this region was settled, fire suppression was common in these savannas and any existing savannas not yet converted to agriculture have since shifted to a woodland or forest state, even as the moderately deep depth to shale bedrock tends to inhibit quick canopy regrowth. Areas converted to agriculture are commonly used for corn and soybean production today.

State and transition model

R108DY845IA Shale Upland Savanna



Code	Process
T1A	Fire Suppression > 20 years; woody invasion
T1B	Tillage; vegetative seeding; grassland management
T1C, T3A, T5A	Tillage; conservation cropping system
T2A	Woody removal; tillage; vegetative seeding; grassland management
T2B	Woody removal; tillage; conservation cropping system
T4A	Vegetative seeding; grassland management
T3B, T4B	Vegetative seeding; prescribed fire; grassland management
1.1A	Fire-free interval 10+ years
1.2A	Fire interval 1-3 years
R2A	Woody removal; prescribed fire 1-3 years
R5A	Vegetative seeding; prescribed fire 1-3 years; tree planting; long rotation

State 1
Reference

As an oak savanna, this state has a reference plant community which is categorized as savanna and includes grasses, forbs, scattered oak grubs, and clumps of shrubs. Periods of 10 to 20 years with no fire and no grazing can

cause this state to shift into an Oak Open Woodland. Conversely, Grazing and browsing accompanied by fire intervals of 1 to 3 years will shift this phase back towards the reference community. Fire suppression greater than 20 years will cause this state to shift to an Oak Woodland. Restoration to the reference state is possible through removal of woody species and prescribed fires every 1-3 years. Conversion to cropland, or pasture are also typical transitions from reference state, the transition to cropland involves tillage and a conventional cropping system, and the transition to pasture is similar, requiring tillage, vegetative seeding, and grassland management.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Community 1.1
Oak Savanna

A savanna community with bur oak and multiple native grasses.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.2
Oak Open Woodland

Increase in woody species.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- quaking aspen (*Populus tremuloides*), tree
- little bluestem (*Schizachyrium scoparium*), grass
- big bluestem (*Andropogon gerardii*), grass

Pathway P1.1A
Community 1.1 to 1.2

Fire free interval 10 plus years.

Pathway P1.2A
Community 1.2 to 1.1

Fire interval 1-3 Years

State 2
Fire Suppressed State

This oak woodland forms as a result of a fire suppression interval of greater than 20 years on the reference state. The woody species have invaded enough to cause significant canopy closure. Restoration to the reference state requires removal of the woody species and a prescribed fire interval of 1 to 3 years. Two transitions to other states are also possible. The transition to a cool season pasture state is accomplished through woody species removal, tillage, vegetative seeding and grassland management processes. The cropland state is the other possibility, requiring woody removal, tillage, and a conventional cropping system (Woodland Health, 2004).

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree

- white oak (*Quercus alba*), tree
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass

Community 2.1
Oak woodland

An increase in return fire interval results in a community with more woody species.

Dominant plant species

- bur oak (*Quercus macrocarpa*), tree
- white oak (*Quercus alba*), tree
- American hazelnut (*Corylus americana*), shrub
- big bluestem (*Andropogon gerardii*), grass

State 3
Cool Season Pasture

This state is formed from a native reference state, Fire suppressed woodland, or cropland which has been transformed into a cool season pasture due to several processes. In order to transform a native reference state, it requires tillage, vegetative seeding, and grassland management. From a fire suppressed woodland, in addition to those processes involved in the reference state transition, it also requires woody removal. The Cropland transition to this state can be accomplished by only vegetative seeding and grassland management. Conversely, a transition to a cropland state from this state requires tillage and a conventional cropping system. This state can also transition to a native warm season grassland state by vegetative seeding, prescribed fire and grassland management processes.

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- red clover (*Trifolium pratense*), other herbaceous

Community 3.1
Non-native pasture

seeded non-native grasses and forbs

Dominant plant species

- smooth brome (*Bromus inermis*), grass
- red clover (*Trifolium pratense*), other herbaceous

State 4
Cropland

In this state, tillage, seeding and herbicide has destroyed all of the original savanna. All other states can transition to this state through a combination of woody removal, if necessary, along with tillage, and a conventional tillage cropping system. Corn and soybeans are the principal crops. Variation in management within this state creates a wide range of soil properties and can be detrimental to the environment. Transitions to either a cool season pasture or a native warm season grassland are possible. The transition to cool season pasture state requires vegetative seeding and grassland management. The native warm season grassland state can be accomplished by vegetative seeding, prescribed fire and grassland management.

Community 4.1
Conventional Tillage Field

Corn - soybean rotation is the most common crop.

State 5
Native Warm Season Grassland

The Native warm season grassland state is a result of a transition from either a cool season pasture or cropland. Both require vegetative seeding, prescribed fire, and grassland management. It is possible to restore this state to the reference state by vegetative seeding, prescribed fire interval of 1 to 3 years, tree planting and a long rotation.

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- switchgrass (*Panicum virgatum*), grass
- Indiangrass (*Sorghastrum nutans*), grass

Community 5.1
Reconstructed prairie

Native warm season grass reconstructed prairie with various native forbs

Dominant plant species

- big bluestem (*Andropogon gerardii*), grass
- Indiangrass (*Sorghastrum nutans*), grass
- switchgrass (*Panicum virgatum*), grass

Transition T1A
State 1 to 2

Fire suppression of 20 years or more; woody invasion.

Transition T1B
State 1 to 3

Tillage; vegetative seeding; grassland management

Transition T1C
State 1 to 4

Tillage; conservation cropping system.

Restoration pathway R2A
State 2 to 1

Woody removal; prescribed fire 1-3 years.

Transition T2A
State 2 to 3

Woody removal; tillage; vegetative seeding; grassland management

Transition T2B
State 2 to 4

Woody removal; tillage; conservation cropping system.

Transition T3A
State 3 to 4

Tillage; conservation cropping system.

Transition T3B
State 3 to 5

Vegetative seeding; prescribed fire; grassland management.

Restoration pathway T4A
State 4 to 3

Vegetative seeding; grassland management

Transition T4B
State 4 to 5

Vegetative seeding; prescribed fire; grassland management.

Restoration pathway R5A
State 5 to 1

Vegetative seeding; prescribed fire 1-3 years; tree planting; long rotation.

Transition T5A
State 5 to 4

Tillage; conservation cropping system

Additional community tables

Inventory data references

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

Other references

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Contributors

John Hammerly (john.hammerly@usda.gov)
Dan Pulido (dan.pulido@usda.gov)

Approval

Suzanne Mayne-Kinney, 10/17/2024

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This ESD was originally approved prior to April 2021.

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)	John Hammerly, soil scientist Dan Pulido, SSOL
Contact for lead author	
Date	05/11/2025
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

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

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

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

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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:**
