USDA Natural Resources Conservation Service

Ecological site F091XY008WI
Moist Clayey Lowland

Last updated: 9/27/2023
Accessed: 05/03/2024

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.

MLRA notes

Major Land Resource Area (MLRA): 091X–Wisconsin and Minnesota Sandy Outwash

The Wisconsin and Minnesota Sandy Outwash MLRA is the most extensive glacial outwash system in the northern half of Wisconsin. The total land area of the Wisconsin portion is just under 1.4 million acres (2,170 sq miles). The northern half is a former spillway for Glacial Lake Duluth. The flowing meltwater from the draining lake has left behind thick deposits of drift and carved a terraced river valley now occupied by the St. Croix and Bois Brule Rivers.

The northeastern section – the Bayfield hills – is a collapsed outwash plain where drift deposits are thick. Lacustrine materials from Glacial Lake Duluth line the northeastern tip. Moving southwest, the landscape transitions into a large pitted outwash plain. This is an area of extensive kettle holes, and, where the underlying till is less permeable, kettle lakes with some interspersed morainic hills and ridges. The glacial drift deposits are thinner in the southwestern section, although there is still no documented surface bedrock within this MLRA.

The St. Croix and Bois Brule rivers share a channel that lines much of the northwestern border of this MLRA. In some places, the underlying reddish-brown sandy loam till of the Copper Falls Formation is exposed along cut riverbanks, though most of it is covered by a mantle of outwash. Glacial lakes deposited pockets of fine-textured lacustrine materials, most of which were washed away or buried by glacial outwash and meltwater flowing through the channel. East of the channel, some of the silty and clayey lakebed deposits are found near the surface, where they impede drainage and contribute to the formation of extensive wetlands.

Historically, the area supported extensive jack pine (Pinus banksiana), scrub, and oak forests and barrens. The northern portion also supported stands of red pine (Pinus resinosa) and eastern white pine (Pinus strobus) as well. Marsh and sedge meadow, wet prairies, and lowland shrubs dominated the extensive wetland complexes in the southern tip of this MLRA (Finley, R., 1976).

Classification relationships

Relationship to Established Framework and Classification Systems:
Biophysical Settings (Landfire, 2014): This ES is largely mapped as Laurentian-Acadian Northern Hardwoods Forest and Eastern Cool Temperate Pasture and Hayland

Habitat Types of N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to two habitat types: Acer rubrum/Vaccinium-Rubus pubescens (ArVRp); Acer saccharum/Athyrium (AAt)
WDNR Natural Communities (WDNR, 2015):

Hierarchical Framework Relationships:
Major Land Resource Area (MLRA): Wisconsin and Minnesota Sandy Outwash (91X)

USFS Subregions: Bayfield Sand Plains (212Ka)

Ecological site concept

The Moist Clayey Lowland ecological site is found in the southern portion of MLRA 91X on outwash plains, lake plains, and ground moraines. These sites are characterized by very deep, somewhat poorly drained soils formed primarily in clayey lacustrine deposits. Sites have a sandy or loamy mantle on top of the clayey lacustrine deposits. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from strongly acid to slightly alkaline.

The parent materials of Moist Clayey Lowland sites were deposited by old glacial lakes, including Glacial Lake Grantsburg. Rushing meltwater from large, proglacial streams during and after Wisconsin's more recent glaciation – including one that occupied today's St. Croix River valley – eroded or capped most of the silty and clayey lacustrine materials from the glacial lakes. Moist Clayey Lowland sites are found in locations far enough from the river valleys of these old proglacial streams to have not been washed away or thickly-capped.

Moist Clayey Lowland sites have finer textures than Moist Sandy and Loamy Lowland sites. The finer texture often supports higher pH and available water capacity than sandy and loamy materials. The somewhat poor drainage differs this ecological site from other clayey sites.

Associated sites

F091XY006WI	**Wet Clayey Lowland** These sites occur on depressions and drainageways on lake plains and outwash plains. They primarily form in clayey lacustrine deposits are subject to occasional ponding. Soils are very deep and poorly or very poorly drained. They are saturated for much of the year. They are wetter and occur lower on the drainage sequence than Moist Clayey Lowland sites.
F091XY011WI	**Sandy Upland** These soils formed primarily in sandy outwash or sandy eolian deposits, but some sites formed in sandy lacustrine or loamy alluvium underlain by sandy outwash. Soils are very deep and are moderately well or somewhat excessively drained. They are neutral to extremely acid and lack a spodic horizon. They are drier and occur higher on the drainage sequence than Moist Sandy and Loamy Lowland sites.
F091XY012WI	**Loamy Upland** These soils formed in loamy lacustrine, loamy alluvium, loamy till, sandy outwash, sandy eolian, or loess deposits. Some sites have underlying lacustrine deposits, till, or basalt bedrock. They are moderately well or well drained. They are drier and occur higher on the drainage sequence than Moist Sandy and Loamy Lowland sites,
F091XY015WI	**Dry Upland** These sites formed in sandy outwash or eolian deposits. Soils are very deep, excessively drained, and lack a spodic horizon. They are much drier and occur higher on the drainage sequence than Moist Sandy and Loamy Lowland sites.

Similar sites

F091XY007WI	**Moist Sandy and Loamy Lowland** These soils formed in sandy outwash and loamy alluvium. Like Moist Clayey Lowland sites, soils are very deep and are somewhat poorly drained, but Moist Sandy and Loamy Lowland sites have coarser particle size classes. The vegetative communities found on Moist Sandy and Loamy Lowland sites have comparable tolerances to poorer drainage but have lower nutrient requirements than those found on Moist Clayey Lowland sites.
F091XY003WI	**Floodplain** These sites occur in depressions and flats on floodplains. They form in sandy to silty alluvium and are somewhat poorly to very poorly drained. They are subject to flooding. Their vegetative communities may sometimes be similar to those found on Moist Sandy and Loamy Lowland sites.

Table 1. Dominant plant species

Tree	(1) *Pinus strobus* (2) *Acer rubrum*
Shrub	(1) *Vaccinium*
Herbaceous	(1) *Maianthemum canadense* (2) *Pteridium aquilinum*

Physiographic features

These sites formed on outwash plains, lake plains, and ground moraines. Slopes range from 0 to 15 percent. Sites are on summit, backslope, and footslope positions.

These sites are not subject to ponding or flooding. Sites have a perched seasonally high water table (episaturation) at depths of 6 to 12 inches below the soil surface. The water table can drop to greater than 60 inches during dry conditions. Runoff is very low to low.

Table 2. Representative physiographic features

Hillslope profile	(1) Summit (2) Backslope (3) Footslope
Slope shape across	(1) Concave
Slope shape up-down	(1) Linear
Landforms	(1) Outwash plain (2) Lake plain (3) Ground moraine
Runoff class	Very low to low
Flooding frequency	None
Ponding frequency	None
Elevation	785–1,115 ft
Slope	0–15%
Water table depth	6–12 in
Aspect	Aspect is not a significant factor

Climatic features

The continental climate of the Wisconsin and Minnesota Sandy Outwash MLRA is typical of northern Wisconsin – colder winters and warmer summers. In general, the northern latitudes have cooler summers, colder winters, lower precipitation, and shorter growing seasons than the south; however, neither average annual precipitation nor average annual minimum and maximum temperatures vary greatly within this MLRA. The climate of the northernmost tip is somewhat affected by Lake Superior and receives higher annual precipitation in the form of lake effect snow.

Table 3. Representative climatic features

Frost-free period (characteristic range)	95-114 days
Freeze-free period (characteristic range)	128-138 days
Precipitation total (characteristic range)	30-33 in
Frost-free period (actual range)	92-118 days
Freeze-free period (actual range)	127-141 days
Precipitation total (actual range)	29-33 in
Frost-free period (average)	105 days

Freeze-free period (average)	133 days
Precipitation total (average)	31 in

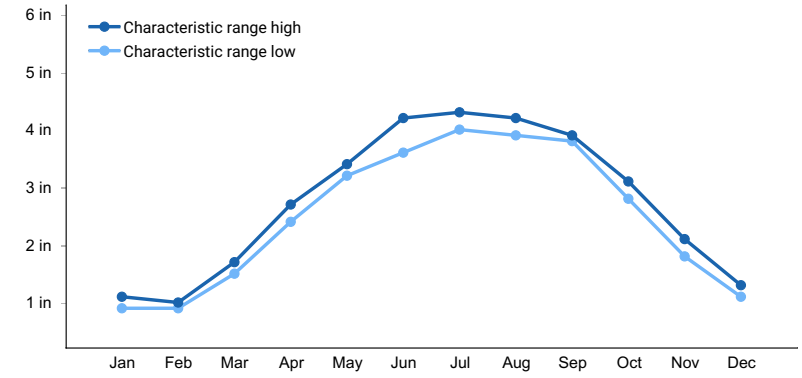


Figure 1. Monthly precipitation range

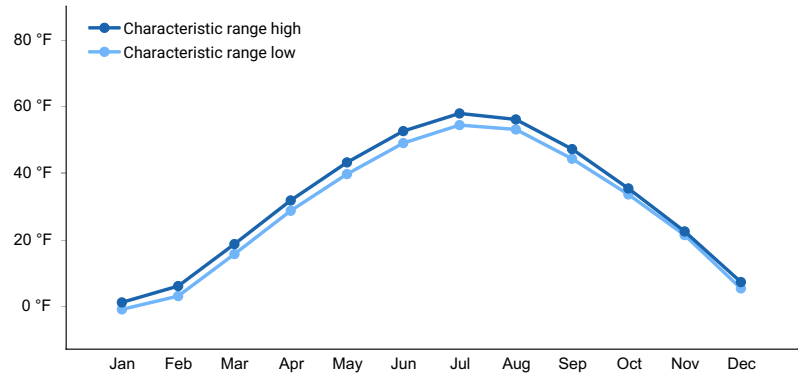


Figure 2. Monthly minimum temperature range

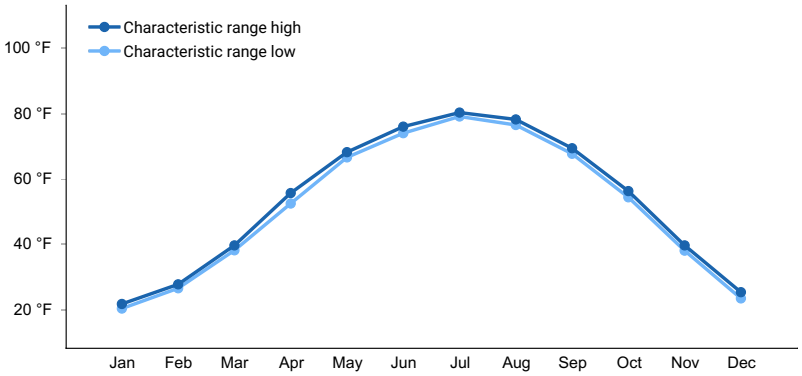


Figure 3. Monthly maximum temperature range

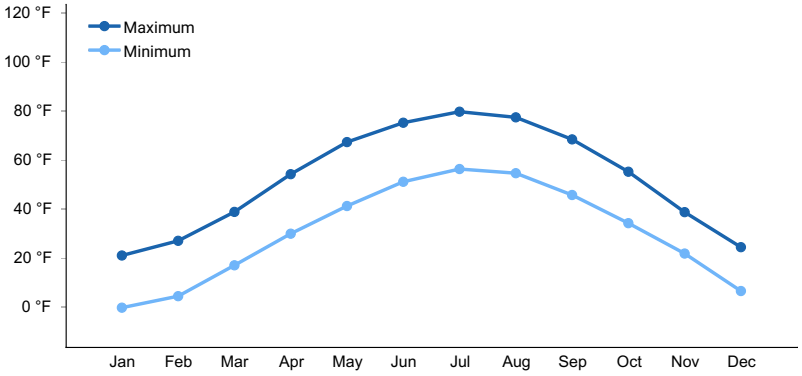


Figure 4. Monthly average minimum and maximum temperature

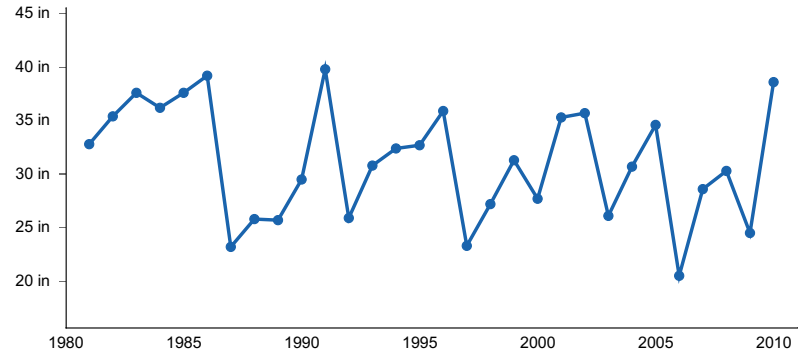


Figure 5. Annual precipitation pattern

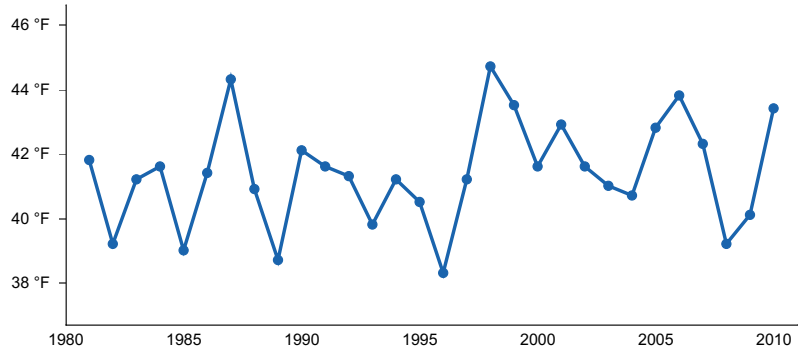


Figure 6. Annual average temperature pattern

Climate stations used

- (1) GRANTSBURG [USW00014995], Grantsburg, WI
- (2) DANBURY [USC00471978], Danbury, WI
- (3) MINONG 5 WSW [USC00475525], Minong, WI
- (4) BRUNO 7ENE [USC00211074], Bruno, MN
- (5) BRULE RS [USC00471131], Brule, WI

Influencing water features

Water is received primarily through precipitation, runoff from adjacent uplands, and groundwater discharge. Water is discharged from the site primarily through runoff, evapotranspiration, and groundwater recharge.

Permeability of these sites is very slow. Hydrologic group is D or C/D.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Allendale, Centuria, and Meenon soil series. Allendale is classified as an Alfic Epiaquod; Centuria is an Aquic Glossudalf; and Meenon is an Aquic Arenic Hapludalf.

These soils formed in a sandy outwash mantle over clayey lacustrine deposits over sandy lacustrine deposits, or loamy glaciofluvial deposits over clayey lacustrine deposits. Soils are very deep and are somewhat poorly drained. These sites do not meet hydric soil requirements.

Surface textures include loamy fine sand, loamy sand, and loam. Subsurface textures include sand, clay, loam, and clay loam. Soil pH ranges from strongly acid to slightly alkaline with values of 5.3 to 7.4. Carbonates are present up to 5 percent beginning at 30 inches.

Figure 7. Meenon Soil Series sampled on 07/23/2019 in Burnett County, WI.

Table 4. Representative soil features

Parent material	(1) Outwash (2) Lacustrine deposits (3) Glaciofluvial deposits
Surface texture	(1) Loam (2) Loamy sand
Drainage class	Somewhat poorly drained
Permeability class	Very slow
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0%
Available water capacity (0-60in)	3.78–7.16 in
Calcium carbonate equivalent (0-40in)	0–5%
Soil reaction (1:1 water) (0-40in)	5.3–7.4
Subsurface fragment volume <=3" (0-40in)	0–10%
Subsurface fragment volume >3" (0-40in)	0–2%

Ecological dynamics

Mature forests on this ecological site are likely dominated by red maple when there is an absence of fire disturbance. White may be an important species on some sites and may become a more important species as a super canopy in the future. There may be a small admixture of oaks (pin, white, red, and burr) in some places. There usually is not much of a shrub layer present on this ES, but when present there may be honeysuckle, service berry, and blueberries. The ground flora in this ES is not well developed and may include bracken fern, large leaved aster, Canada mayflower, wild sarsaparilla, bunch berry, starflower, and sessile leaved bellwort.

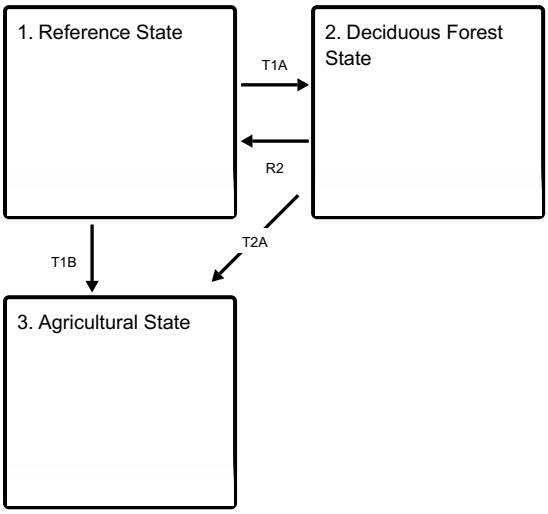
While these sites at present are wetter than may be optimal for Sugar maple, once established in full succession canopy trees are likely to “dry” the site due to increased evapotranspiration allowing Sugar maple to become a dominant canopy member on these sites. The opposite condition of “swamping” has been noted on these sites, where heavy cutting on these sites leads to an elevated water table. Due to their connection to water table elevation, soil wetness, and evapotranspiration of a full canopy these sites have a variety of species mixtures at

present. Additionally many soils in this ES may experience infrequent flooding that could affect species composition. Greater soil wetness may tilt this site towards species such as Black ash rather than Sugar maple.

Current stands on this Ecological Site can represent a broad array of species composition and all potential successional stages, however, the Advanced Successional stage of the Reference State is uncommon and instead the Deciduous Forest State (Aspen – Red maple) is likely to be the most common state that one finds.

State and transition model

Ecosystem states



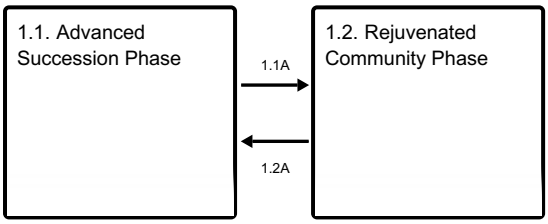
T1A - Stand replacing disturbance that includes fire.

T1B - Removal of forest cover and tilling for agricultural crop production.

R2 - Deciduous forest community is slowly invaded by Black ash and Sugar maple as seed source allows.

T2A - Removal of forest cover and tilling for agricultural crop production.

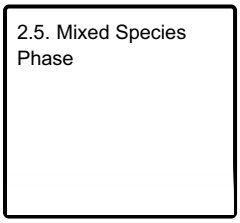
State 1 submodel, plant communities



1.1A - Blow-downs and ice storms create canopy openings.

1.2A - Disturbance-free period for 30+ years.

State 2 submodel, plant communities



State 1
Reference State

The reference plant community is categorized as mesic to wet-mesic forest community dominated by Red maple. White pine is a common associate and scattered oaks may be present where opening existed for their establishment. Sugar maple and Basswood are not common, but may appear. Shrub layers are usually poorly developed or altogether absent on this ES and may contain hazelnut (beaked and American) service berry, rhubus

species, bush honey suckle, and blueberries. Ground flora is not well developed but likely contains sedges, ferns (interrupted, lady, bracken), and hog peanut.

Dominant plant species

- red maple (*Acer rubrum*), tree
- eastern white pine (*Pinus strobus*), tree

Community 1.1
Advanced Succession Phase

In the absence of major, stand-replacing disturbance this community is dominated by red maple and white pine. The tree sapling and shrub layer in this community is not well developed due to dense shade created by the tree canopy. Where canopy gaps existed shade intolerant species may be found (various oaks). The herb layer is likely to consist of sedges, ferns (interrupted, lady, bracken), and hog peanut

Dominant plant species

- red maple (*Acer rubrum*), tree
- eastern white pine (*Pinus strobus*), tree
- sedge (*Carex*), other herbaceous
- common ladyfern (*Athyrium filix-femina*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- interrupted fern (*Osmunda claytoniana*), other herbaceous
- American hogpeanut (*Amphicarpaea bracteata*), other herbaceous

Community 1.2
Rejuvenated Community Phase

Figure 8. Image courtesy of UWSP taken on 07/23/2019 in Burnett County, WI.

Disturbances described in Pathway 1.1A lead to increased species and structural diversity of the forest community. Depending on seed source, various oaks (red, pin, bur, white) regenerate in the canopy openings and in time join red maple in the dominant canopy. The relative density of the shrub and herb layers may increase during this stage. Many herb layer species that were present with very low abundance in the advanced-succession community typically form much larger population clusters as there is more light penetrating the canopy.

Dominant plant species

- red maple (*Acer rubrum*), tree
- eastern white pine (*Pinus strobus*), tree
- northern red oak (*Quercus rubra*), tree
- blueberry (*Vaccinium*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous

Pathway 1.1A
Community 1.1 to 1.2

Natural mortality in the oldest age classes—sporadic small-scale blow-downs and ice storms—create openings for entry of various oaks.

Pathway 1.2A
Community 1.2 to 1.1

In the absence of canopy reducing disturbances natural succession leads to community dominance by the most shade-tolerant species resulting in return to community phase 1.1. The longer the time without disturbance the more likely that red maple will dominate.

State 2
Deciduous Forest State

Figure 9. Image courtesy of UWSP taken on 07/23/2019 in Burnett County, WI.

Post disturbance pioneer community of aspen, white birch, and red maple with mixtures of other species from available seed sources are common in this state. This state can have broad variation depending on what seed sources are available as these sites readily supply water and nutrients in quantities that many species can thrive with. Depending on age and tree species composition the shrub and herb layer in this state can vary considerably. Namely with the dominance of aspen there is likely to be very little in the shrub layer.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- red maple (*Acer rubrum*), tree
- European white birch (*Betula pendula*), tree
- serviceberry (*Amelanchier*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous

Community 2.1
Mixed Species Phase

This is a mid-successional community. The oldest tree cohort is made up of remnants of the pioneer communities of either Jack pine, red pine, or aspen. This cohort is in the process of being replaced by more shade tolerant white pine. Red oak is also frequent associate. In absence of major disturbance this community phase transitions into Reference State Community.

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree

- quaking aspen (*Populus tremuloides*), tree
- eastern white pine (*Pinus strobus*), tree
- northern red oak (*Quercus rubra*), tree

State 3
Agricultural State

Indefinite period of applying agricultural practices. Cropping systems vary on these sites and likely include tillage, row crops, hay or pasture. Agricultural development of these sites could include drainage. Crops likely include alfalfa, corn, soybeans, and hay or pasture.

Transition T1A
State 1 to 2

Major stand-replacing disturbance. Historically, fire was a component in this forest ecosystem though severe blow downs are likely to have occurred as well. Logging starting in the 19th century also causes this transition. These disturbances created the environment suitable for natural regeneration of many shade-intolerant species and for commercial planting.

Transition T1B
State 1 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Restoration pathway R2
State 2 to 1

Deciduous forest community is slowly invaded by Black ash and Sugar maple as seed source allows.

Transition T2A
State 2 to 3

Removal of forest cover, tilling and application of other agricultural techniques to grow agricultural crops.

Additional community tables

Inventory data references

Plot and other supporting inventory data for site identification and community phases is located on a NRCS North Central Region shared and one drive folder. University Wisconsin-Stevens Point described soils, took photographs, and inventoried vegetation data at community phases within the reference state. The data sources include WI ESD Plot Data Collection Form - Tier 2, Releve Method, NASIS pedon description, NRCS SOI 036, photographs, and Kotar Habitat Types.

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Contributors

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Approval

Suzanne Mayne-Kinney, 9/27/2023

Acknowledgments

NRCS contracted UWSP to write ecological sites in MLRA 91. Completed in 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)	
Contact for lead author	
Date	09/27/2023
Approved by	Suzanne Mayne-Kinney
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):**

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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:**
