USDA Natural Resources Conservation Service

Ecological site F091XY007WI
Moist Sandy and Loamy Lowland

Last updated: 9/27/2023
Accessed: 05/10/2025

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.

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 Pine Barrens, Laurentian Oak Barrens, Laurentian-Acadian Northern Hardwoods Forest, Eastern Cool Temperate Pasture and Hayland, and Eastern Cool Temperate Row Crop

Wetland Forest Habitat Type Classification System for N. Wisconsin (Kotar and Burger, 2017) and Habitat Types of N. Wisconsin (Kotar, 2002): The sites of this ES keyed out to three habitat types: Acer rubrum/Vaccinium-Rubus pubescens (ArVRp); Acer rubrum-*Abies balsamea*/Vaccinium-Cornus (ArAbVCo); Fraxinus nigra/Onoclea (FnOn)

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

USFS Subregions: Bayfield Sand Plains (212Ka)
Small sections occur in the Mille Lacs Uplands (212Kb) subregion

Wisconsin DNR Ecological Landscapes: Northwest Sands, Northwest Lowlands

Ecological site concept

The Moist Sandy and Loamy Lowland Ecological Site is scattered throughout MLRA 91X on moraines, stream terraces, outwash plains, and lake plains. These sites are characterized by very deep, somewhat poorly drained soils that formed primarily in sandy outwash and loamy alluvium. Some sites formed in eolian or lacustrine deposits, and some sites are underlain by loamy till. Precipitation, runoff from adjacent uplands, and groundwater discharge are the primary sources of water. Soils range from very strongly acid to neutral.

Moist Sandy and Loamy Lowland sites are differentiated from other sites based on parent materials and drainage. These sites have sandy and loamy materials that often have lower pH and available water capacity than clayey materials. The somewhat poor drainage differs this ecological site from other sandy and loamy sites.

Associated sites

F091XY005WI	**Wet Sandy and Loamy Lowland** These sites occur on depressions and drainageways on outwash plains and lake plains. They primarily form in sandy outwash are subject to some flooding. 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 Sandy and Loamy 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

F091XY008WI	**Moist Clayey Lowland** These soils formed in a sandy outwash mantle over clayey lacustrine deposits over sandy lacustrine deposits, or loamy glaciofluvial deposits over clayey lacustrine deposits. Like Moist Sandy and Loamy Lowland sites, soils are very deep and are somewhat poorly drained, but Moist Clayey Lowland sites have finer particle size classes. The vegetative communities found on Moist Clayey Lowland sites have comparable tolerances to poorer drainage but sometimes have higher nutrient requirements than those found on Moist Sandy and Loamy 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) *Abies balsamea* (2) *Acer rubrum*

Shrub	(1) *Corylus cornuta* (2) *Vaccinium*
Herbaceous	(1) *Maianthemum canadense* (2) *Impatiens capensis*

Physiographic features

These sites formed on outwash plains, lake plains, and ground and disintegration moraines. Slopes are 0 to 4 percent. Sites are on footslope and toeslope positions.

These sites are not subject to ponding or flooding. Some sites have a perched seasonally high water table (episaturation) at depths of 6 to 18 inches below the soil surface, while other sites have an apparent water table (endosaturation) at depths of 6 to 24 inches. The water table can drop to greater than 60 inches during dry conditions. Runoff is primarily negligible to low, but some sites have high runoff potential.

Table 2. Representative physiographic features

Hillslope profile	(1) Footslope (2) Toeslope
Slope shape across	(1) Linear
Slope shape up-down	(1) Concave
Landforms	(1) Outwash plain (2) Lake plain (3) Ground moraine
Runoff class	Negligible to high
Flooding frequency	None
Ponding frequency	None
Elevation	590–1,969 ft
Slope	0–4%
Water table depth	6–24 in

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)	94-111 days
Freeze-free period (characteristic range)	122-136 days
Precipitation total (characteristic range)	30-33 in
Frost-free period (actual range)	92-117 days
Freeze-free period (actual range)	120-141 days
Precipitation total (actual range)	30-33 in
Frost-free period (average)	103 days
Freeze-free period (average)	129 days
Precipitation total (average)	31 in

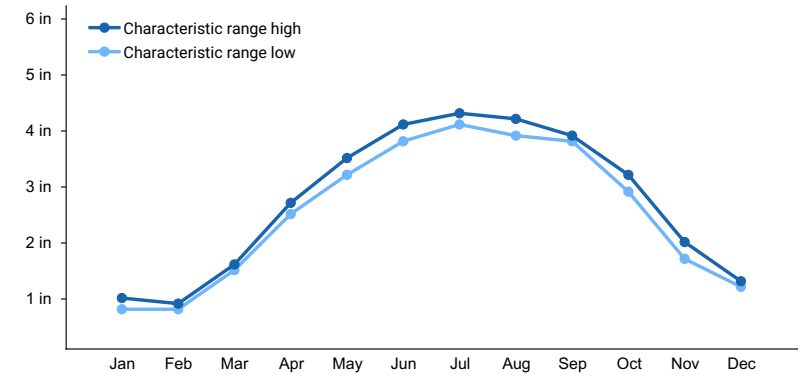


Figure 1. Monthly precipitation range

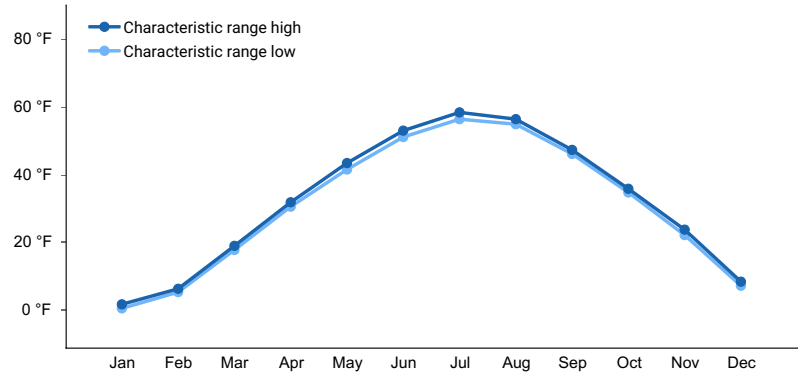


Figure 2. Monthly minimum temperature range

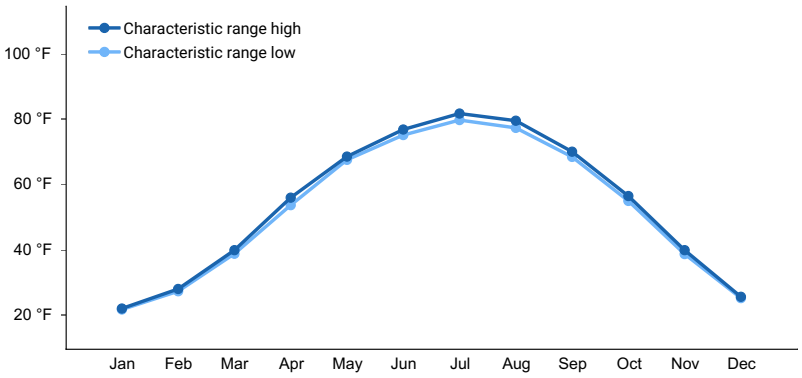


Figure 3. Monthly maximum temperature range

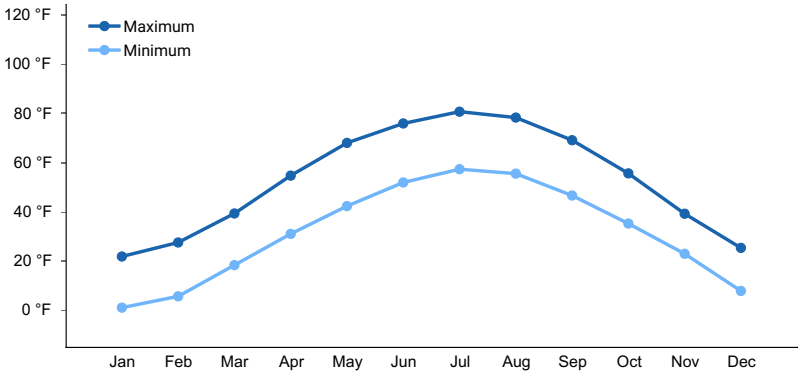


Figure 4. Monthly average minimum and maximum temperature

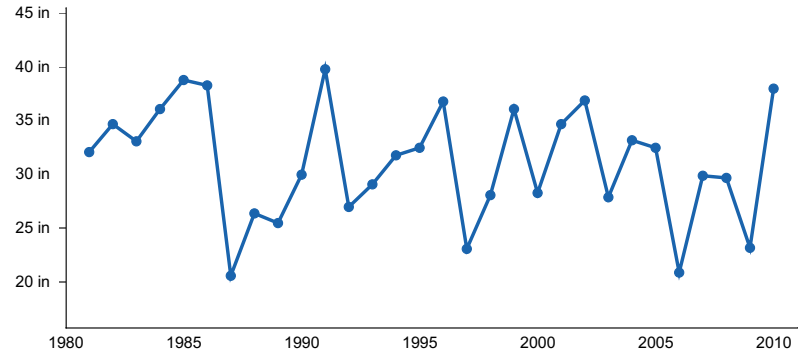


Figure 5. Annual precipitation pattern

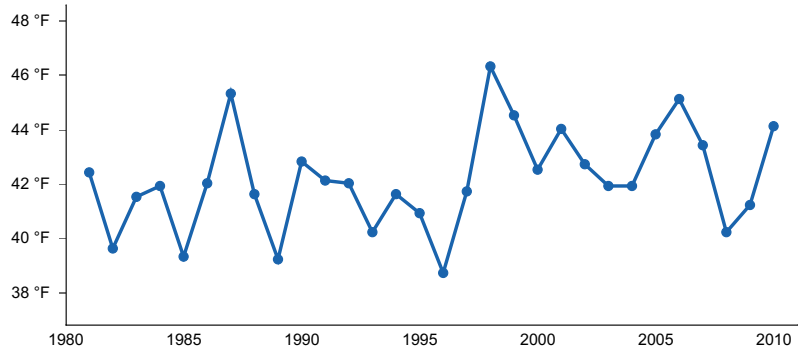


Figure 6. Annual average temperature pattern

Climate stations used

- (1) DANBURY [USC00471978], Danbury, WI
- (2) SOLON SPRINGS [USC00477892], Solon Springs, WI
- (3) BRULE RS [USC00471131], Brule, WI
- (4) GRANTSBURG [USW00014995], Grantsburg, 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 range from very slow to rapid. Hydrologic group is C, A/D, B/D, or C/D.

Wetland description

Hydrogeomorphic Wetland Classification: None
Cowardin Wetland Classification: None

Soil features

These sites are represented by the Au Gres, Bushville, Flink, Lino, Magnor, Meehan, Parkfalls, Perchlake, Plover, Poskin, and Tula soil series. Au Gres is classified as a Typic Endoaquod; Bushville is an Aquic Arenic Hapludalf; Flink is a Typic Epiaquod; Lino, Meehan, and Perchlake are Aquic Updipsamments; Magnor, Plover, and Poskin are Aquic Glossudalfs; and Tula is an Argic Fragiaquod.

These soils formed in sandy outwash, sandy lacustrine deposits, sandy eolian deposits, or loess that is sometimes underlain by sandy or loamy till. Soils are very deep and somewhat poorly drained. Soils do not meet hydric soil requirements.

The surface texture of these sites is primarily loamy sand or sand. Subsurface textures range from sand to silt loam. Soil pH ranges from very strongly acid to neutral with values of 4.8 to 7.3. Surface fragments less than 3

inches can be present up to 5 percent, and fragments greater than 3 inches can be present up to 2 percent. Subsurface fragments less than 3 inches can be present up to 14 percent, and fragments greater than 3 inches can be present up to 3 percent. Carbonates are absent.

Table 4. Representative soil features

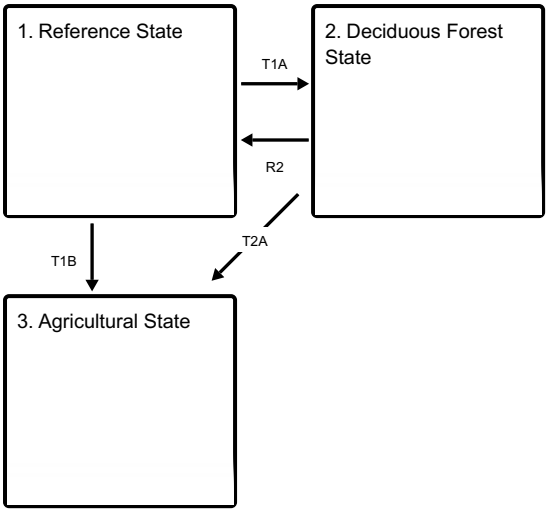
Parent material	(1) Outwash (2) Lacustrine deposits (3) Till (4) Eolian deposits
Surface texture	(1) Sand (2) Loamy sand
Drainage class	Somewhat poorly drained
Permeability class	Very slow to rapid
Soil depth	80 in
Surface fragment cover <=3"	0–5%
Surface fragment cover >3"	0–2%
Available water capacity (0-60in)	3.28–9.67 in
Soil reaction (1:1 water) (0-40in)	4.8–7.3
Subsurface fragment volume <=3" (0-40in)	0–14%
Subsurface fragment volume >3" (0-40in)	0–3%

Ecological dynamics

Historically, wildfire was the main controlling factor of forest community dynamics. Following a severe, stand-replacing fire, any of the species present on the landscape could become established, depending on seed source availability and specific conditions of post-fire seedbed. The newly established young stands of any species were easily eliminated by recurring fires, but differences in fire-resisting properties among the species began to play a role in any species' survival success. Many pine and oak species were dominant in the region because of their fire-resistant properties and successful regeneration post-fire. With clear cutting and continued fire suppression, many of these species adapted to fire; those intolerant of shade are replaced by other species. Species such as white pine and red oak are still common on the landscape based on their tolerance to some shade; these species to establish under a canopy, and in time, may become a component of the canopy. Red maple is sensitive to fire, but in its absence, it has the ability to dominate sites based on its shade tolerance and prolific seed production.

State and transition model

Ecosystem states



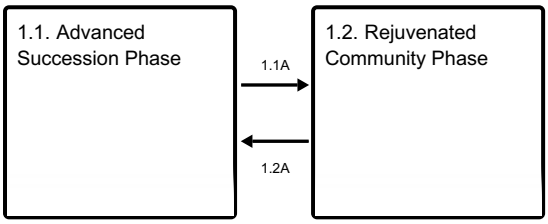
T1A - Stand replacing disturbance that includes fire.

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

R2 - Deciduous forest community is slowly invaded by conifers.

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

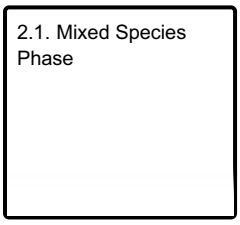
State 1 submodel, plant communities



1.1A - Light to moderate intensity fires, blow-downs, ice storms.

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

State 2 submodel, plant communities



State 1
Reference State

Figure 7. Image courtesy of UWSP taken on 06/18/2019 in Douglas County, WI.

Reference state is a forest community dominated by balsam fir (*Abies balsamea*) and red maple (Acer rubrun). Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- red maple (*Acer rubrum*), tree

Community 1.1
Advanced Succession Phase

In the absence of major disturbance—particularly fire—these sites are dominated by a canopy of balsam fir and red maple. Red oak (*Quercus rubra*) may be present, but has low coverage and is only able to regenerate in gaps. A small amount of white pine and red pine may be present in some stands as well. The shrub layer is not well developed and dominated by red maple saplings, beaked hazelnut (*Corylus cornuta*), and blueberries (Vaccinium, spp.). The ground layer is dominated by Canada mayflower (*Maianthemum canadense*) with small amounts of various other species (sedges, swamp dewberry, grasses, and sphagnum).

Dominant plant species

- balsam fir (*Abies balsamea*), tree
- red maple (*Acer rubrum*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- blueberry (*Vaccinium*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous

Community 1.2

Rejuvenated Community Phase

The canopy of the rejuvenated community is still dominated by original species, but the understory now also includes a well-established younger cohort and perhaps a few additional seedlings and saplings of less shade tolerant species. Red oak and pines (red and white) are common on sites, but have moderate shade tolerance and require canopy breaks to regenerate. They are unable to compete with red maple and balsam fir to maintain a co-dominant position in the canopy in advanced succession, but individuals may be maintained.

Dominant plant species

- red maple (*Acer rubrum*), tree
- balsam fir (*Abies balsamea*), tree

Pathway 1.1A
Community 1.1 to 1.2

Light intensity fires, crown breakage from ice and snow and small scale blow-downs create canopy openings, releasing advance regeneration and stimulating new seedling establishment. Some additional less shade tolerant species such as red oak may be able to enter the community.

Pathway 1.2A
Community 1.2 to 1.1

A long period without major canopy disturbance allows gradual replacement of oldest canopy trees by younger cohorts. Small scale disturbances may still occur periodically, but once second or third canopies are established there is minimal new regeneration taking place and the forest gradually returns to mature state.

State 2
Deciduous Forest State

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

Post disturbance pioneer community of aspen and paper birch with mixtures of other species from available seed sources. Pure, or mixed, aspen – paper birch community replaces the reference state community. If seed source is present, red maple and young cohorts of balsam fir readily becomes member of this community.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree
- paper birch (*Betula papyrifera*), tree
- red maple (*Acer rubrum*), tree
- balsam fir (*Abies balsamea*), tree
- beaked hazelnut (*Corylus cornuta*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- clubmoss (*Huperzia*), 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

Figure 9. Image courtesy of UWSP taken on 07/24/2019 in Burnett County, WI.

Indefinite period of applying agricultural practices.

Transition T1A
State 1 to 2

Reference State Deciduous Forest State

Stand replacing disturbance that must include fire to create conditions for aspen and paper birch to colonize the site.

Transition T1B
State 1 to 3

Reference State Agricultural State

Removal of forest cover and tilling for agricultural crop production

Restoration pathway R2
State 2 to 1

Deciduous Forest State Reference State

Deciduous forest community is slowly invaded by conifers

Transition T2A
State 2 to 3

Deciduous Forest State Agricultural State

Removal of forest cover and tilling for agricultural crop production.

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.

Other references

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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):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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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:**
