USDA Natural Resources
Conservation Service

Ecological site F093AY010MN
Moist Sandy Forest

Last updated: 9/06/2024
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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): 093A–Superior and Rainy Stony and Rocky Till Plains and Moraines

The Superior Stony and Rocky Loamy Plains and Hills, Western Part is located and completely contained in northeastern Minnesota. This area has both the highest and lowest elevations in the state, as well as some of the state's most rugged topography (Ojakangas and Matsch, 1982). The MLRA was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin glaciation as well as pre-Wisconsin glacial periods. The geomorphic surfaces in this MLRA are geologically very young (i.e., 10,000 to 20,000 years) and dominated by drumlin fields, moraines, small lake plains, outwash plains, and bedrock-controlled uplands (USDA-NRCS, 2022).

There are thousands of lakes scattered throughout the region that were created by these glacial events. Most of these lakes are bedrock-controlled in comparison to adjacent glaciated regions where glacial drift deposits are much thicker and the lakes occur in depressions atop the glacial drift (Ojakangas and Matsch, 1982). In contrast to adjacent MLRAs, the depth to the predominantly crystalline or sandstone bedrock in MLRA 93A is relatively shallow because the most recent glacial events were more erosional than depositional (Ojakangas and Matsch, 1982).

Classification relationships

Major Land Resource Area (MLRA): Superior Stony and Rocky Loamy Plains and Hills, Western Part (93A)

USFS Subregions: Northern Superior Uplands Section (212L); North Shore Highlands

Subsection (212Lb)

Relationship to Other Established Classifications:
FDn32-Northern Poor Dry-Mesic Mixed Woodland-Northern Floristic Region (Minnesota Department of Natural Resources, 2005)

Ecological site concept

This site is a conifer-dominated woodland of jack pine, black spruce, and red pine with a mix of hardwoods including paper birch and quaking aspen. Soils are course textured, very deep, and somewhat poorly drained.

Associated sites

F093AY012MN	**Sandy Upland Forest** The Sandy Upland Forest ecological site is located on uplands with soils that are course textured and moderately well drained to somewhat excessively drained. Available water capacity ranges from 2-5 inches.

Similar sites

F093AY012MN	**Sandy Upland Forest** The Sandy Upland Forest ecological site is located on uplands with soils that are course textured and moderately well drained to somewhat excessively drained. Available water capacity ranges from 2-5 inches.

Table 1. Dominant plant species

Tree	(1) *Pinus banksiana* (2) *Picea mariana*
Shrub	(1) *Amelanchier* (2) *Vaccinium angustifolium*
Herbaceous	(1) *Maianthemum canadense* (2) *Cornus canadensis*

Physiographic features

This site is often situated on pitted outwash plains, flats, and end moraines. No ponding or flooding occurs, but the site does have a seasonal high water table. Runoff class is low to medium and slopes are less than 3%.

Table 2. Representative physiographic features

Landforms	(1) Outwash plain (2) Flat (3) End moraine
Runoff class	Medium
Flooding frequency	None
Ponding frequency	None
Elevation	1,310–1,900 ft
Slope	0–3%
Water table depth	13–18 in
Aspect	Aspect is not a significant factor

Climatic features

The average annual precipitation is 26-32 inches (66 to 81 centimeters). Measurable climatic variation (due to the lake effect) near some of Lake Superior may alter temperature and precipitation (Hillman & Nielsen, 2023). About 65 percent of the precipitation falls as rain during the growing season (May through September) and about 21 percent falls as snow. The freeze-free period averages about 130 days and ranges from 97 to 150 days (USDA-NRCS, 2022).

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-109 days
Freeze-free period (characteristic range)	123-143 days
Precipitation total (characteristic range)	26-32 in
Frost-free period (actual range)	44-114 days
Freeze-free period (actual range)	97-150 days
Precipitation total (actual range)	26-32 in
Frost-free period (average)	93 days
Freeze-free period (average)	130 days
Precipitation total (average)	29 in

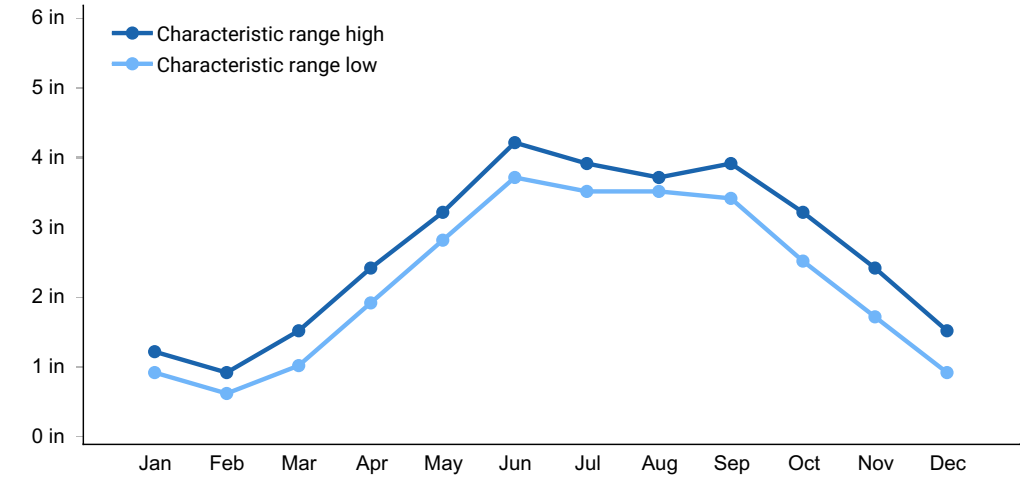


Figure 1. Monthly precipitation range

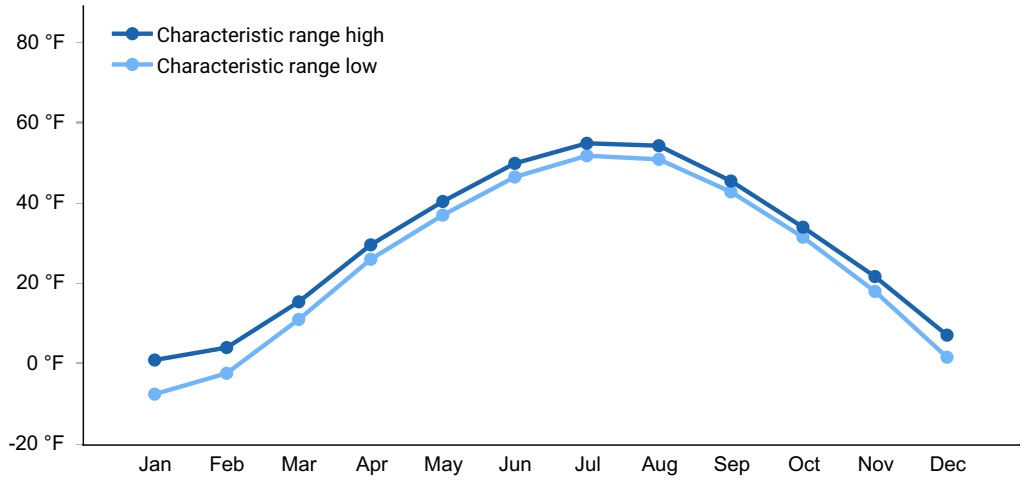


Figure 2. Monthly minimum temperature range

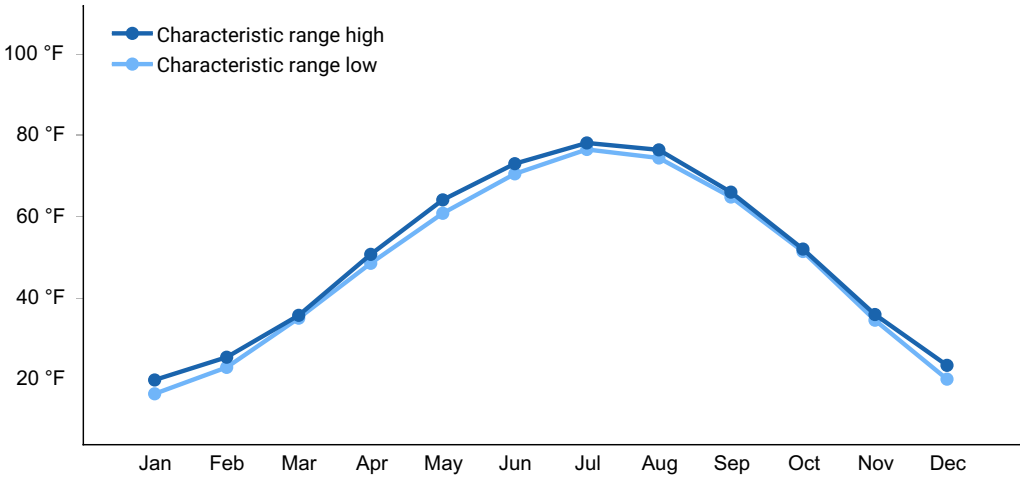


Figure 3. Monthly maximum temperature range

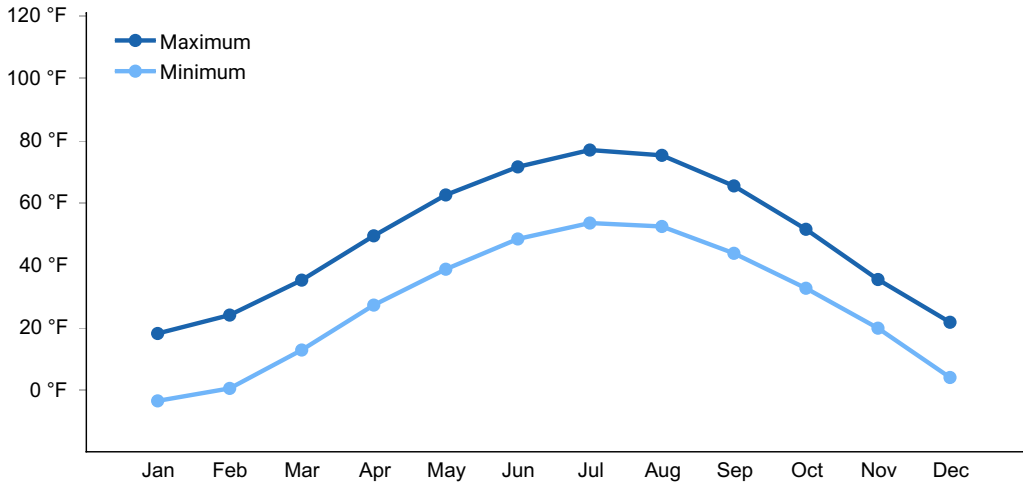


Figure 4. Monthly average minimum and maximum temperature

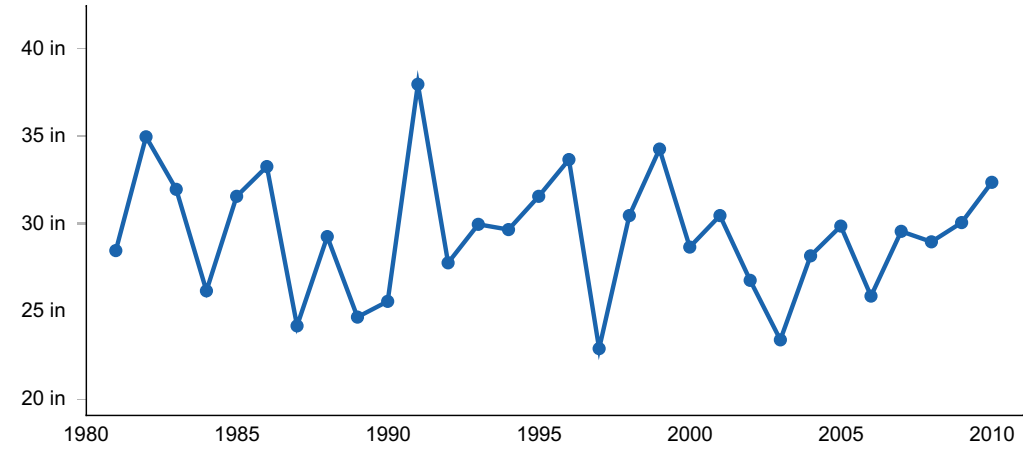


Figure 5. Annual precipitation pattern

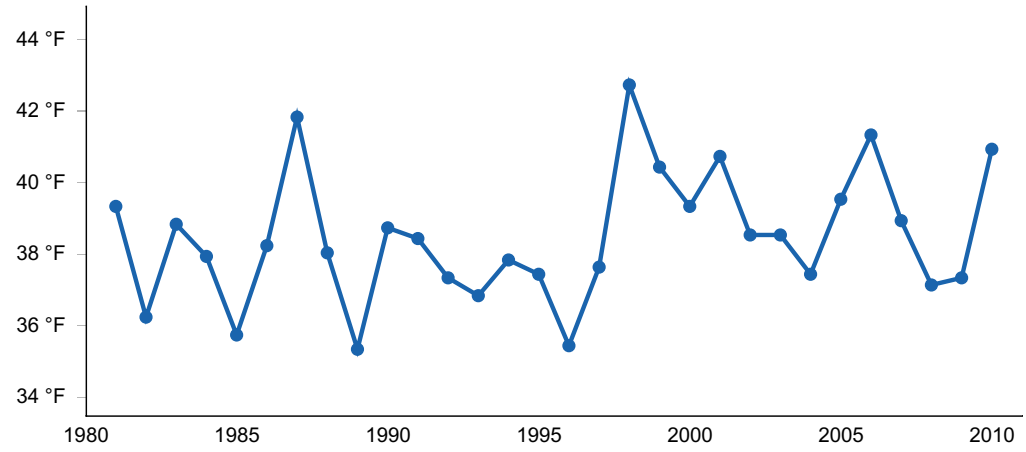


Figure 6. Annual average temperature pattern

Climate stations used

- (1) GRAND PORTAGE [USC00213296], Grand Portage, MN
- (2) WOLF RIDGE ELC [USC00219134], Finland, MN
- (3) DULUTH [USW00014913], Duluth, MN
- (4) ELY 25E [USC00212555], Ely, MN

- (5) KETTLE FALLS [USC00214306], Voyageurs Natl Park, MN
- (6) BRIMSON 2S [USC00210989], Brimson, MN
- (7) KABETOGAMA [USC00214191], Orr, MN

Influencing water features

This site does not flood or pond but does have a seasonal high water table of 13 - 18 inches (33 - 46 centimeters).

Wetland description

N/A

Soil features

Representative soil series include Gnesen and Oysterlake. Parent materials are sandy outwash, loamy material over gravelly outwash, and loamy material over sand-skeletal outwash. Surface textures include loam, very fine sandy loam, fine sandy loam, sandy loam, and stony loam. Soils in this group are Inceptisols and Entisols and are very deep, somewhat poorly drained, and have a seasonal high water table.

Table 4. Representative soil features

Parent material	(1) Outwash
Surface texture	(1) Loam (2) Very fine sandy loam (3) Fine sandy loam (4) Sandy loam (5) Stony loam
Drainage class	Somewhat poorly drained
Permeability class	Moderately rapid to rapid
Depth to restrictive layer	80 in
Soil depth	80 in
Surface fragment cover <=3"	0%
Surface fragment cover >3"	0–2%
Available water capacity (0-60in)	4–7 in
Calcium carbonate equivalent (0-40in)	0%
Electrical conductivity (Depth not specified)	0 mmhos/cm

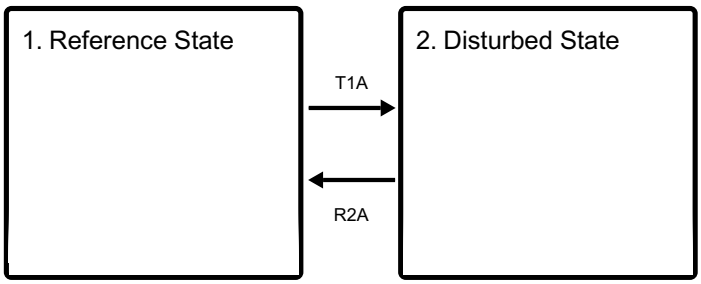
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (0-40in)	4.5–6
Subsurface fragment volume <=3" (Depth not specified)	3–28%
Subsurface fragment volume >3" (Depth not specified)	3–32%

Ecological dynamics

This site is a mixed woodland composed of jack pine, black spruce, and red pine with a mix of paper birch and quaking aspen. Historically, fire was a disturbance factor and served to promote pine regeneration. A review of historical Public Land Survey records showed severe surface fires occurred about 210 years. (MN DNR, 2005).

State and transition model

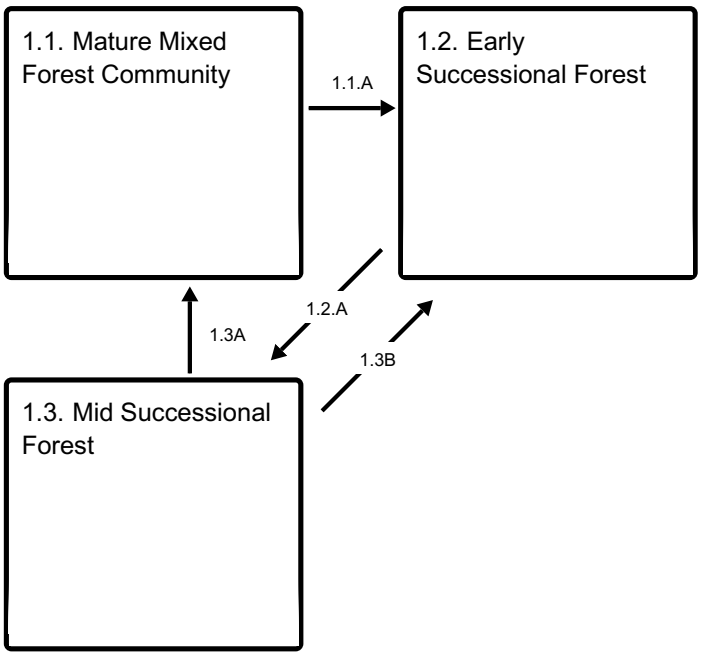
Ecosystem states



T1A - Disturbance of site

R2A - Management activities ; restore to the reference site

State 1 submodel, plant communities



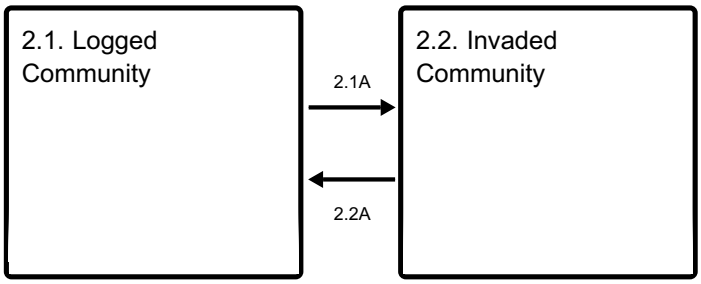
1.1.A - Disturbances; partial canopy removal

1.2.A - Natural succession

1.3A - Natural succession absent severe disturbances

1.3B - Site disturbance

State 2 submodel, plant communities



2.1A - Introduction of invasive plant species

2.2A - Non-native plant eradication

State 1
Reference State

The reference state is a coniferous woodland composed of pine and spruce with a mix of hardwood species such as aspen and paper birch. Canopy cover is variable and ranges from patchy to continuous. Dominant canopy species include jack pine, black spruce, red pine, and in some cases, white pine.

Dominant plant species

- jack pine (*Pinus banksiana*), tree

- black spruce (*Picea mariana*), tree
- red pine (*Pinus resinosa*), tree
- serviceberry (*Amelanchier*), shrub
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous

Community 1.1
Mature Mixed Forest Community

This is a mature (95+ years) mixed-canopy woodland. Black spruce is dominant mixed with jack pine, paper birch, white pine, and balsam fir. (MN DNR, 2005).

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- black spruce (*Picea mariana*), tree
- red pine (*Pinus resinosa*), tree
- paper birch (*Betula papyrifera*), tree
- serviceberry (*Amelanchier*), shrub
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- bunchberry dogwood (*Cornus canadensis*), other herbaceous
- twinflower (*Linnaea borealis*), other herbaceous

Community 1.2
Early Successional Forest

This community (0-55 years) is characterized by a young woodland dominated by jack pine. Hardwoods, such as quaking aspen and paper birch, are common. (MN DNR, 2005).

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- paper birch (*Betula papyrifera*), tree
- quaking aspen (*Populus tremuloides*), tree

Community 1.3
Mid Successional Forest

This mixed canopy transitional community (55-95 years) is noted for an increase in red pine and paper birch and a decline in jack pine and quaking aspen. (MN DNR, 2005)

Dominant plant species

- red pine (*Pinus resinosa*), tree
- paper birch (*Betula papyrifera*), tree
- black spruce (*Picea mariana*), tree
- balsam fir (*Abies balsamea*), tree
- eastern white pine (*Pinus strobus*), tree

Pathway 1.1.A
Community 1.1 to 1.2

Disturbance from fire, windthrow, or other factors that removes the canopy layer.

Pathway 1.2.A
Community 1.2 to 1.3

Time and natural succession will transition the 1.2 community to the 1.3 community in the absence of any large disturbances.

Pathway 1.3A
Community 1.3 to 1.1

In the absence of large disturbances, time and natural succession will transition the community to a mature woodland.

Pathway 1.3B
Community 1.3 to 1.2

A large disturbance will transition the community back to an earlier successional stage.

State 2
Disturbed State

This is a woodland state characterized by anthropogenic disturbances such as logging. Human activities are often a conduit for the introduction and spread of invasive species. The type, severity, and duration of the disturbance will perpetuate variability in the early successional plant community. Seed sources and management activities will also influence plant regeneration. Future field study is needed to develop a more detailed and diagnostic list of plant species for this state.

Characteristics and indicators. Site disturbance; logging and/or invasive plant species.

Dominant plant species

- quaking aspen (*Populus tremuloides*), tree

- paper birch (*Betula papyrifera*), tree
- jack pine (*Pinus banksiana*), tree
- serviceberry (*Amelanchier*), shrub

Community 2.1
Logged Community

Removal of canopy trees for timber harvest results a highly disturbed understory. Shrubs often initially dominate post-logging. The type and severity of disturbance, available seed sources, and any associated management inputs will determine the plant community on site.

Dominant plant species

- paper birch (*Betula papyrifera*), tree
- quaking aspen (*Populus tremuloides*), tree
- jack pine (*Pinus banksiana*), tree
- serviceberry (*Amelanchier*), shrub

Community 2.2
Invaded Community

This community is characterized by the presence of non-native plant species. Numerous tree, shrub and ground layer invasive species are possible. Human activities (logging, development, recreation) can introduce seeds to a site. Without management intervention, these species can alter the natural composition of the plant community.

Dominant plant species

- jack pine (*Pinus banksiana*), tree
- black spruce (*Picea mariana*), tree
- honeysuckle (*Lonicera*), shrub
- buckthorn (*Rhamnus*), shrub
- Japanese knotweed (*Polygonum cuspidatum*), other herbaceous

Pathway 2.1A
Community 2.1 to 2.2

Activities such as logging may introduce invasive plant species.

Pathway 2.2A
Community 2.2 to 2.1

Management inputs to successfully eradicate invasive plants on site.

Transition T1A
State 1 to 2

Disturbance of site through anthropogenic activities such as road building, dam construction, and logging.

Restoration pathway R2A
State 2 to 1

Restoration of each site will require a plan unique to the current site conditions. Timber stand improvement activities and/or invasive species eradication may be needed.

Additional community tables

Inventory data references

No field plots were established for this project. A review of the scientific literature was used to approximate the plant communities for this ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional. Future field verification will refine the plant communities described in this project.

Other references

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Contributors

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Approval

Suzanne Mayne-Kinney, 9/06/2024

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	05/21/2025
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):**

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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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):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

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

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

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

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

17. **Perennial plant reproductive capability:**