

Ecological site R092XY009WI Loamy Sandstone Uplands

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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): 092X—Superior Lake Plain

The Wisconsin portion of the Superior Lake Plain (MLRA 92) corresponds very closely to the Superior Coastal Plain Ecological Landscape published by Wisconsin Department of Natural Resources (WDNR 2015). The following brief overview of this MLRA is borrowed from that publication.

The Superior Coastal Plain is bordered on the north by Lake Superior and on the south by the Northwest Sands, Northwest Lowlands, and North Central Forest Ecological Landscapes. The total land area is approximately 1.2 million acres, which mostly consists of privately-owned forestland. The climate is strongly influenced by Lake Superior, resulting in cooler summers, warmer winters, and greater precipitation compared to more inland locations. The most extensive landform in this ecological landscape is a nearly level plain of lacustrine clays that slopes gently northward toward Lake Superior. The coastal plain is cut by deeply incised stream drainages and interrupted by the comparatively rugged Bayfield Peninsula.

During the Late Wisconsin glacial period, this area was covered with the advancing and retreating lobes of Superior and Chippewa. The landscape was rippled with moraines, but they were subdued by deposition of lacustrine materials. As the glaciers receded, glacial lakes riddled the landscape—most notably, Glacial Lake Duluth. The glacier receded eastward, exposing the western Lake Superior Basin. The ice covered the eastern basin, blocking the outlet of the lake, and continued to recede and contribute meltwaters that filled the glacial lake. The deep, red clays were deposited during this period of glacial lakes. The meltwaters from the glacier also contained sands which were deposited along the edge of the glacial lakes as beach deposits. Deep, narrow valleys have since been carved by rivers and streams flowing north into Lake Superior.

Historically, the Superior Coastal Plain was almost entirely forested. Various mixtures of eastern white pine (*Pinus strobus*), white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), white birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*), quaking aspen (*Populus tremuloides*), and northern white-cedar (*Thuja occidentalis*) occurred on the fine-textured glacio-lacustrine deposits bordering much of the Lake Superior coast. Sandy soils, sometimes interlayered with clays, occur in some places. Such areas supported forests dominated by eastern white pine and red pine (*Pinus resinosa*). Eastern white pine was strongly dominant in some areas, according to mid-19th century notes left by surveyors of the federal General Land Office (Finley, R. 1976). Dry-mesic to wet-mesic northern hardwoods or hemlock-hardwood forests were prevalent on the glacial tills of the Bayfield Peninsula. Large peatlands occurred along the Lake Superior shoreline, associated with drowned river mouths.

Classification relationships

Habitat Types of N. Wisconsin (Kotar, 2002): This ES keys out to *Acer rubrum* – *Abies balsamea* / *Vaccinium* spp. – *Cornus canadensis* [ArAbVCo].

Biophysical Setting (Landfire, 2014): This ES is mapped as Laurentian-Acadian Northern Hardwoods Forest-Hemlock; and Laurentian – Acadian Sub-boreal Mesic Balsam Fir-Spruce Forest – Coastal. This ES is more similar

to the Boreal Balsam Fir-Spruce Forest.

WDNR Natural Communities (WDNR, 2015): This ES is most similar to the Boreal Forest.

USFS Subregions: Superior-Ashland Clay Plain Subsection (212Ya); May contain small areas of Ewen Dissected Lake Plain Subsection (212Jo), Winegar Moraines Subsection (212Jc), Gogebic-Penokee Iron Range Subsection (212Jb), and NorthShore Highlands Subsection (212Lb)*

*Located in Upper Peninsula of Michigan (212J) and Minnesota (212Lb)

Major Land Resource Area (MLRA): Superior Lake Plain (92)

Ecological site concept

Loamy Sandstone Uplands occurs on the sandstone outcrops located on the shore of Lake Superior on the mainland and the Apostle Islands. The soils on these sites formed loamy alluvium and till or clayey till, underlain by sandstone bedrock. The solum depth can range, but the soil is always underlain by sandstone within 100 cm. These sites are moderately well to somewhat poorly drained. These sites receive water primarily through precipitation. Sites may have a seasonally high water table at a depth of 32 to 60 cm, but will remain somewhat saturated throughout the growing season. The sites range from strongly acid to neutral.

Based on historic records, ecological and soils literature, and scattered examples of old forest stands (Curtis, 1959; Finley, 1976; Wilde, 1976; Schulte and Mladenoff 2001; Kotar et al. 2002) we can conclude that this Ecological Site historically was dominated primarily by coniferous forests. Balsam fir and white spruce were major dominants, but there were considerable admixtures of white and red pine. Mesic hardwoods, especially sugar maple and basswood, find soil conditions on this Ecological Site to be sub-optimal and they occur only sporadically. The 19th and early 20th century logging and associated fires have drastically altered the forest composition and structure. Today's stands are most often dominated by varying mixtures of aspen, white birch, red maple, and balsam fir. Ground flora includes bracken fern, ostrich fern, wood ferns, Canada mayflower, wood anemone, and mosses.

This ES has a finer soil texture, retains more moisture, and can have a more neutral pH to allow for a broader vegetative community than the Sandy Sandstone Uplands. This ES differs from other loamy sites by its shallow solum truncated by lithic contact.

Associated sites

R092XY007WI	Wet Loamy or Clayey Lowlands These sites are poorly drained soils formed in mainly clayey though sometimes loamy glaciofluvial and silty glaciolacustrine sediments. They have a seasonally high water table and remain saturated for much of the growing season, creating hydric conditions. HGM criteria: recharge, Depressional. The loamy sites are located lower in the drainage sequence than Loamy Sandstone Uplands, and remain saturated much longer during the year.
R092XY011WI	Moist Loamy Lowlands These sites are somewhat poorly drained soils formed in various parent materials, but are primarily loamy. The loamy texture causes the soil to remain moist for much of the growing season, but does not remain saturated long enough to form hydric conditions. These sites are located lower in the drainage sequence than Loamy Sandstone Uplands, and remain saturated longer during the year.

Similar sites

R092XY008WI	Sandy Sandstone Uplands These sites are shallow sandy soils that overly sandstone bluffs along the shore of Lake Superior. They are excessively drained, do not remain saturated any time of the year, and are strongly acidic. These sites differ from Loamy Sandstone Uplands based on their texture and drainage. They are located on a similar landscape.
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R092XY014WI	Loamy Uplands These sites are deep, moderately well to well drained loamy soils. They formed in loamy and silty till, glaciolacustrine, or glaciofluvial deposits. Some sites have a sandy mantle. Many sites have a seasonally high water table, but does not remain saturated for the growing season. Soils range from strongly acid to strongly alkaline, and some sites have carbonates present. Both sites are characterized with the ArAbVCo Habitat Type. This site has a deep solum, and has a wider range of pH than the Loamy Sandstone Uplands.
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Table 1. Dominant plant species

Tree	(1) <i>Acer rubrum</i> (2) <i>Abies balsamea</i>
Shrub	(1) <i>Corylus cornuta</i> (2) <i>Amelanchier</i>
Herbaceous	(1) <i>Eurybia macrophylla</i> (2) <i>Cornus canadensis</i>

Physiographic features

This site occurs on knolls, ridges, hillslopes, interfluves, and terraces located on bedrock-controlled hills and till plains. Landform shape ranges from linear to convex. Elevation of the landforms range from 185 to 400 meters above sea level. Slopes range from 0 to 15 percent. This site occurs on all slope aspects.

Table 2. Representative physiographic features

Landforms	(1) Hills > Knoll (2) Till plain > Terrace
Runoff class	Low to very high
Elevation	185–210 m
Slope	0–15%
Water table depth	30–61 cm
Aspect	Aspect is not a significant factor

Climatic features

Loamy Sandstone Uplands are located along the shore of Lake Superior on the Bayfield Peninsula, and the Apostle Islands. The annual average precipitation is 27-31 inches, with an average snowfall range of 72-132 inches (PRISM, 1981-2010). The annual average maximum and minimum temperatures are 51oF and 30oF, respectively (PRISM, 1981-2010). Being mostly located directly on the lake, the Loamy Sandstone Uplands sites tend to have a lower maximum temperature and a higher minimum temperature than some of the PESDs located inland of the Lake Superior. The length of the freeze-free period ranges from 162 to 194, with an average of 179 days (Table 2). The length of the frost-free period ranges from 138 to 166, with an average of 152 days (Table 2). These ranges occur because this PESD has sites located all around the Bayfield Peninsula that are subject to different wind and precipitation patterns. A few sites even occur further inland from the lake, and others are located on the small Apostle Islands, with various aspects. This PESD is very similar to Sandy Sandstone Uplands because they occur adjacent to each other.

Table 3. Representative climatic features

Frost-free period (characteristic range)	96-114 days
Freeze-free period (characteristic range)	126-138 days
Precipitation total (characteristic range)	787-838 mm
Frost-free period (actual range)	87-114 days
Freeze-free period (actual range)	121-138 days

Precipitation total (actual range)	787-838 mm
Frost-free period (average)	104 days
Freeze-free period (average)	131 days
Precipitation total (average)	813 mm

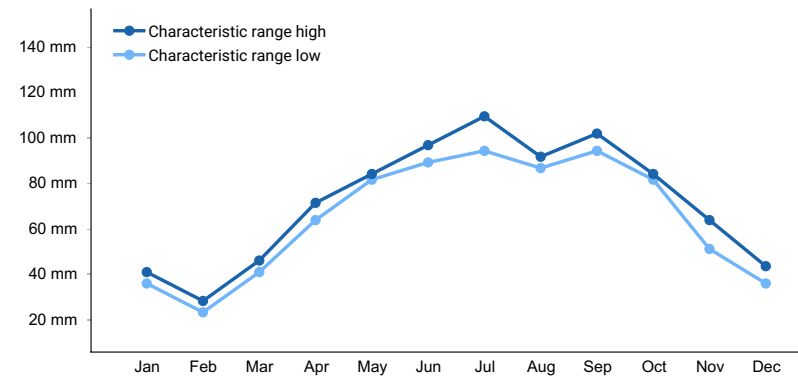


Figure 1. Monthly precipitation range

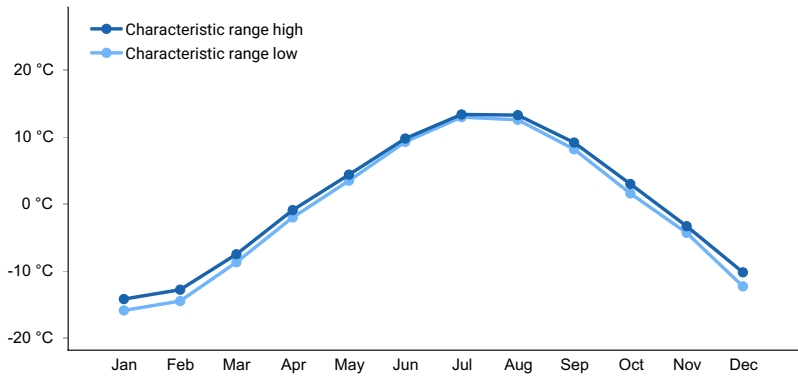


Figure 2. Monthly minimum temperature range

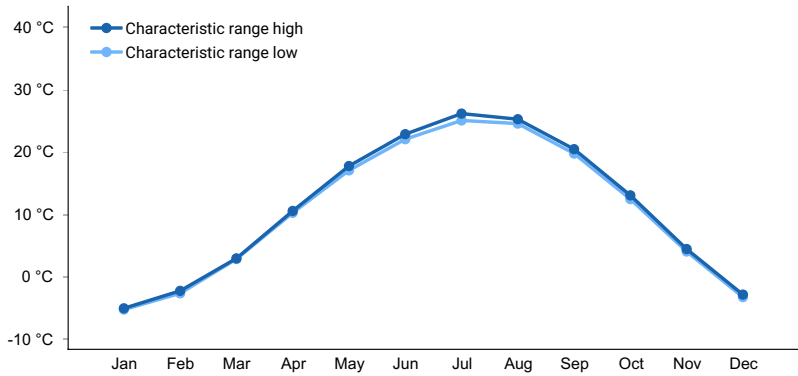


Figure 3. Monthly maximum temperature range

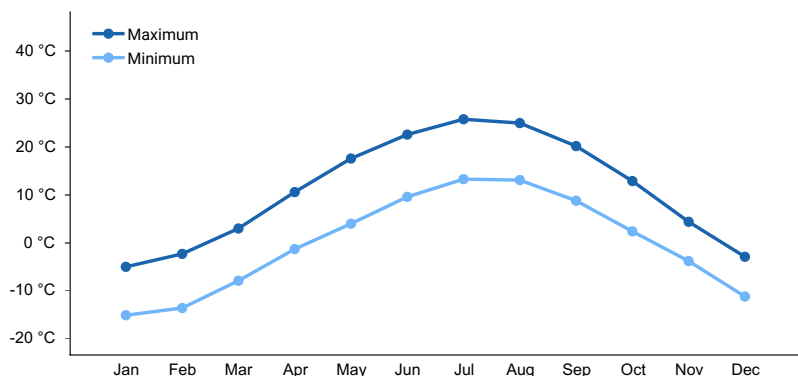


Figure 4. Monthly average minimum and maximum temperature

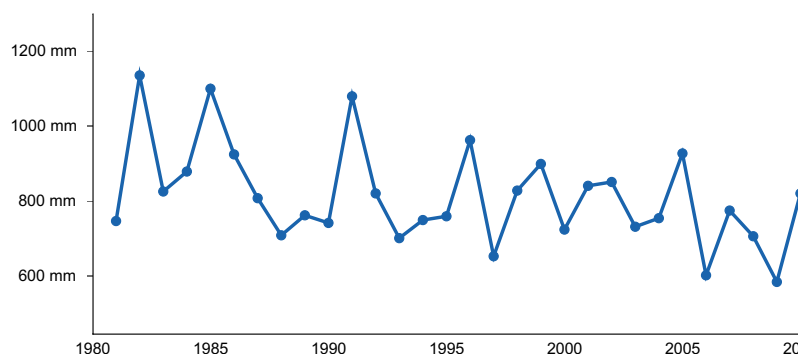


Figure 5. Annual precipitation pattern

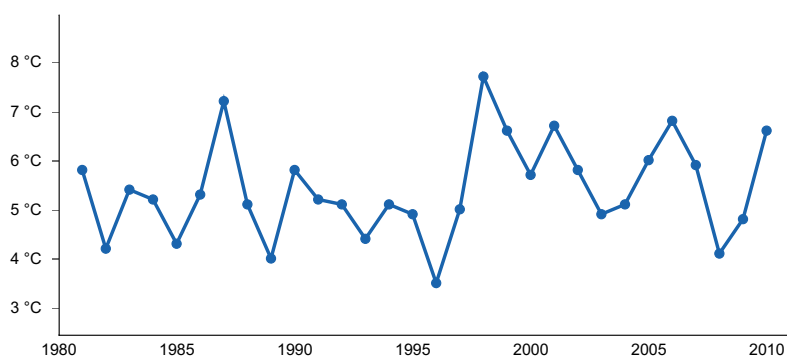


Figure 6. Annual average temperature pattern

Climate stations used

- (1) ASHLAND EXP FARM [USC00470349], Ashland, WI
- (2) BAYFIELD 6 N [USC00470603], Bayfield, WI
- (3) MADELINE ISLAND [USC00474953], La Pointe, WI

Influencing water features

Water is received primarily through precipitation. Water is discharged from the site primarily through runoff or evapotranspiration.

Permeability of the soil ranges from very slow to moderately slow resulting in a runoff potential that is low to very high. The hydrologic group of this site is B or C.

Enough water will percolate into the soil resulting in an apparent seasonally high water table (endosaturation) at a depth of 30 to 61 cm that may occur during any month. Water that percolates into the soil is generally lost through plant uptake and evapotranspiration. The sandstone bedrock restricts any further ground water recharge.

Soil features

The soils of this site are represented by the Abbaye, Lapoin, and Zeba soil series. These soils are classified as Haplorthods (Abbaye and Lapoin) and Endoaquods (Zeba).

This ecological site is characterized by moderately deep, moderately well drained and somewhat poorly drained soils formed in loamy till (Abbaye), loamy alluvium over clayey till (Lapoin), or in loamy drift (Zeba); all underlain by sandstone within 100 cm. Abbaye and Lapoin soils occupy similar landscape positions while Zeba soils occupy wetter flats, depressions, and drainageways.

The average gravel content within the soil can be as much as 7 percent, while the average content of cobbles and stones can be as much as 8 percent. Soil reaction (pH) in the upper 100 cm ranges from very strongly acid to neutral. Carbonates occur as shallow as 18 cm (Lapoin), but are generally absent.

Table 4. Representative soil features

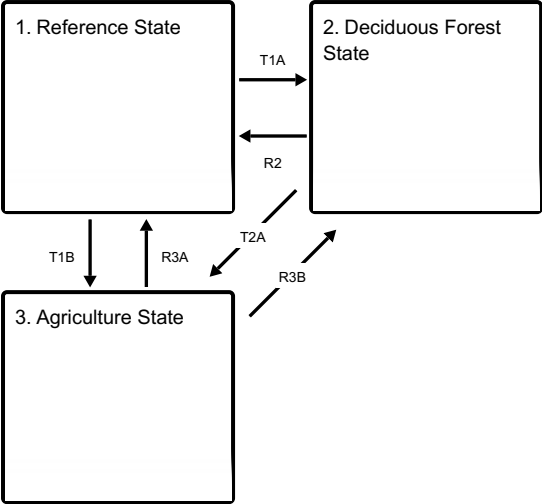
Parent material	(1) Alluvium (2) Till (3) Drift (4) Glaciofluvial deposits
Surface texture	(1) Loam (2) Sandy loam (3) Loamy sand
Drainage class	Moderately well drained to somewhat poorly drained
Permeability class	Very slow to moderately slow
Soil depth	20–99 cm
Surface fragment cover >3"	0–2%
Available water capacity (0-152.4cm)	11.99–15.06 cm
Calcium carbonate equivalent (0-101.6cm)	0–3%
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.2
Subsurface fragment volume ≤3" (0-101.6cm)	3–7%
Subsurface fragment volume >3" (0-101.6cm)	2–8%

Ecological dynamics

Because of relatively poorly drained soils historic fire disturbance has likely been less frequent and less severe than on the better drained sites. This is evident by the presence (historic and current) of shade-tolerant and fire sensitive species such as red maple, balsam fir and white spruce. Aspen stands are common in current communities, but they are largely the result of fires associated with past logging. Red maple and balsam fir are the most obvious succeeding species, but white pine and white spruce may also become more important in the future as seed source availability increases. Although the shade-tolerant sugar maple occurs sporadically in some stands its competitive ability is reduced by excessive soil moisture and relatively low nutrient availability. For these reasons it is likely to remain only as a sporadic associate rather than the dominant species in mature forest communities as is typically the case on all mesic sites throughout northern Wisconsin.

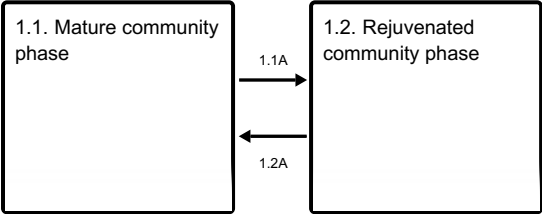
State and transition model

Ecosystem states



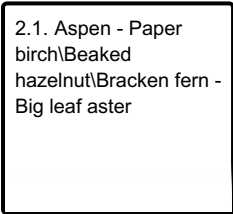
- T1A** - Stand replacing disturbance that includes fire.
- T1B** - Removal of forest cover and tilling for agricultural crop production.
- R2** - Deciduous forest community is slowly invaded by conifers.
- T2A** - Removal of forest cover and tilling for agricultural crop production.
- R3A** - Cessation of agricultural practices leads to natural reforestation, or site is replanted.
- R3B** - Cessation of agricultural practices leads to natural reforestation, or site is replanted.

State 1 submodel, plant communities

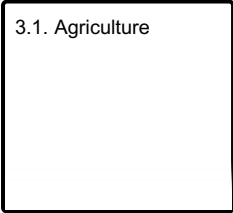


- 1.1A** - Blow-down, sever ice storm, or large scale mortality in overstory.
- 1.2A** - Advanced regeneration response to canopy disturbance.

State 2 submodel, plant communities



State 3 submodel, plant communities



State 1
Reference State

Reference state is a forest community dominated by mixed conifers, principally balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*) and scattered individuals of northern white cedar (*Thuja occidentalis*), or white pine

(*Pinus strobus*), often with admixture of several deciduous species, typically trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), or red maple (*Acer rubrum*). Depending on history of disturbance, two community phases can be distinguished largely by differences in dominance of tree species and community age structure.

Community 1.1

Mature community phase





In absence of stand replacing disturbance (period of 60-80 years) this community is dominated entirely by conifers, or it contains an admixture of old and decaying stems of aspen and/or paper birch. This mixture would be a result of typical succession processes of conifer invasion of pioneer aspen-birch stands. In some areas, white pine, northern red cedar, or red maple are common associates. Pre-European settlement forests often contained scattered very large, old white pines that had survived one or more stand-replacing fires in the past. The tree reproduction layer is dominated by balsam fir, with lesser abundance of white spruce and/or red maple. The density of the reproduction is strongly dependent on degree of canopy openings resulting from natural mortality, or small scale disturbance by wind and ice storms. The shrub and herb layers also depend on the degree of canopy opening. The dominant shrub typically is beaked hazel (*Corylus cornuta*). Common associates are mountain maple (*Acer spicatum*), junberry (*Amelanchier* spp.), bush- honeysuckle (*Diervilla lonicera*), fly-honeysuckle (*Lonicera Canadensis*) and blueberries (*Vaccinium* spp.). The herb layer often is well developed and species rich. Bracken fern (*Pteridium equilinum*) and large-leaved aster (*Eurybia macrophylla*) typically dominate the layer. Other well-represented species include, wild sarsaparilla (*Aralia nudicaulis*), bunchberry (*Cornus Canadensis*), twisted stalk (*Streptopus roseus*), yellow bead-lily (*Clintonia borealis*) and sweet-scented bedstraw (*Galium triflorum*).

Community 1.2

Rejuvenated community phase



Disturbance described in 1.1A typically removes over-mature trees, especially old aspen and birch, from the overstory and releases advanced regeneration of balsam fir and white spruce, leading to community dominated by

these species. Some presence of red maple and white pine may also result under favorable conditions, but trembling aspen and paper birch regeneration typically is not successful if disturbances do not include fire.

Pathway 1.1A Community 1.1 to 1.2



Mature community phase



Rejuvenated community phase

Blow-down, severe ice storm, or large scale mortality in overstory.

Pathway 1.2A Community 1.2 to 1.1



Rejuvenated community phase



Mature community phase

Rejuvenated community matures into Community Phase 1.1 in a self-replacement process.

State 2 Deciduous Forest State

The deciduous forest phase may be pure or mixed aspen and paper birch. Often red maple is an associate in this community phase. A shrub layer of beaked hazelnut is not uncommon on these sites.

Community 2.1 Aspen - Paper birch\Beaked hazelnut\Bracken fern - Big leaf aster



State 3
Agriculture State

Agricultural crops may be grown if the land has been cleared. Row crops are uncommon and sites in this state are most likely in hay production.

Community 3.1 Agriculture

Hay production is the most likely crop in this state, but pasture could be a possible use as well.

Transition T1A State 1 to 2

Stand replacing disturbance that may include blow-down or ice storm, but must include fire to eliminate slash and competing vegetation and expose mineral soil to allow aspen and/or paper birch to colonize the site by seed. Alternatively, if the disrupted reference state community included aspen trees, the species may become re-established by vegetative means, which typically is more successful than colonization by seed.

Transition T1B State 1 to 3

Removal of forest cover and tilling for agricultural crop production.

Restoration pathway R2 State 2 to 1

Deciduous forest community is slowly invaded by conifers.

Transition T2A State 2 to 3

Removal of forest cover and tilling for agricultural crop production.

Restoration pathway R3A State 3 to 1

Cessation of agricultural practices leads to natural reforestation, or site is replanted.

Restoration pathway R3B State 3 to 2

Cessation of agricultural practices leads to natural reforestation, or site is replanted.

Additional community tables

Other references

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Approval

Chris Tecklenburg, 4/09/2020

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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	05/19/2024
Approved by	Chris Tecklenburg
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:**
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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:

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):**
-

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:**
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