Ecological site FX052X99X092
Saline Subirrigated (Ssb)

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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): 052X–Brown Glaciated Plains

The Brown Glaciated Plains, MLRA 52, is an expansive and agriculturally and ecologically significant area. It consists of approximately 14.5 million acres and stretches across 350 miles from east to west, encompassing portions of 15 counties in north-central Montana. This region represents the southwestern limit of the Laurentide Ice Sheet and is considered to be the driest and westernmost area within the vast network of glacially derived prairie pothole landforms of the northern Great Plains. Elevation ranges from 2,000 feet (610 meters) to 4,600 feet (1,400 meters).

Soils are primarily Mollisols, but Entisols, Inceptisols, Alfisols, and Vertisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick, and in some areas glacially deformed bedrock occurs at or near the soil surface (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). The bedrock is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton et al., 2004). The result is a geologically young landscape that is predominantly a level till plain interspersed with lake plains and dominated by soils in the Mollisol and Vertisol orders. These soils are very productive and generally are well suited to dryland farming. Much of this area is aridic-ustic. Crop-fallow dryland wheat farming is the predominant land use. Areas of rangeland typically are on steep hillslopes along drainages.

The rangeland, much of which is native mixedgrass prairie, increases in abundance in the eastern half of the MLRA. The Wisconsin-age till in the north-central part of this area typically formed large disintegration moraines with steep slopes and numerous poorly drained potholes. A large portion of Wisconsin-age till occurring on the type of level terrain that would typically be optimal for farming has large amounts of less-suitable sodium-affected Natrustalfs. Significant portions of Blaine, Phillips, and Valley Counties were glaciated approximately 150,000 years ago during the Illinoisan age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic-ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The Dry Shrubland climatic zone represents the northernmost extent of the big sagebrush (Artemisia tridentata) steppe on the Great Plains. Because similar soils occur in both southern and northern portions of the MLRA, it is currently hypothesized that climate is the primary driving factor affecting big sagebrush distribution in this area. However, the precise factors are not fully understood at this time.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and adjacent southern Saskatchewan are home to the Northern Montana population of greater sage grouse (Centrocercus urophasianus), and large portions of this area are considered to be a Priority Area for Conservation (PAC) by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 2013). This population is unique among sage grouse populations because many individuals overwinter in the big sagebrush steppe (dry shrubland) in the southern portion of the MLRA and then migrate to the northern portion of the MLRA, which lacks big sagebrush (dry grassland), to live the rest of the year (Smith, 2013).
Areas of the till plain near the Bearpaw and Highwood Mountains as well as the Sweetgrass Hills and Rocky Mountain foothills are at higher elevations, receive higher amounts of precipitation, and have a typic-ustic moisture regime. These areas have significantly more rangeland production than the drier aridic-ustic portions of the MLRA and have enough moisture to produce crops annually rather than just bi-annually, as in the drier areas. Ecological sites in this higher precipitation area are classified as the Moist Grassland climatic zone.

Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
• Climate Zone: N/A

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)
• Domain: Dry
• Division: Temperate Steppe
• Province: Great Plains-Palouse Dry Steppe Province 331
• Section: Northwestern Glaciated Plains 331D
• Subsection: Montana Glaciated Plains 331Dh
• Landtype association/Landtype phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Mesomorphic Shrub and Herb Vegetation Class (2)
• Subclass: Shrub and Herb Wetland Subclass (2.C)
• Formation: Salt Marsh Formation (2.C.5)
• Division: *Distichlis spicata* - *Hordeum jubatum* Great Plains Saline Marsh Division (2.C.5.Na)
• Macrogroup: Great Plains Saline Wet Meadow and Marsh Macrogroup (2.C.5.Na.1)
• Group: Western Great Plains Saline Wet Meadow Group (2.C.5.Na.1.b)
• Alliance: Sarcobatus vermiculatus Great Plains Wet Shrubland Alliance
o Association: Sarcobatus vermiculatus / Pascopyrum smithii - (*Elymus lanceolatus*) Shrub Wet Meadow
o Association: Sarcobatus vermiculatus / *Distichlis spicata* - (*Puccinellia nuttalliana*) Shrub Wet Meadow

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: North Central Brown Glaciated Plains (42o) and Glaciated Northern Grasslands (42j)

Ecological site concept

This provisional ecological site occurs in all climatic zones of MLRA 52. Figure 1 illustrates the distribution of this ecological site based on current data. This map is approximate, is not intended to be definitive, and may be subject to change. Saline Subirrigated is a moderately extensive ecological site, approximately 57,000 acres, occurring on alluvial landscapes throughout MLRA 52. It occurs on alluvial fans, floodplains, drainageways, and stream terraces where a seasonal water table occurs 24 to 40 inches below the surface and salts have accumulated.

The distinguishing characteristics of this site are that it receives additional moisture from groundwater water and that saline, sodic, or saline-sodic conditions are evident in the upper 20 inches of soil. Soils for this ecological site are typically very deep (more than 60 inches) and derived from alluvium. Soil textures in the upper 4 inches are typically loam, clay loam, or silty clay. Characteristic vegetation is mostly western wheatgrass (Pascopyrum smithii) and sodium-tolerant bunchgrasses. The principal shrub is greasewood (Sarcobatus vermiculatus), but Gardner’s saltbush (Atriplex gardneri) may also be common. Total shrub cover is approximately 25 percent.

Associated sites

FX052X99X091	**Saline Overflow (Sov)** Saline Overflow is found adjacent to the Saline Subirrigated ecological site, usually on higher terraces where groundwater is farther from the surface.
FX052X99X060	**Overflow (Ov)** Overflow is found adjacent to the Saline Subirrigated ecological site usually on higher terraces and in areas that have not accumulated salts in the soil profile.
FX052X99X003	**Alkali Flat (Af)** Alkali Flat is found adjacent to the Saline Subirrigated ecological site, usually in depressions or playas where ponding is frequent and of long duration.
FX052X99X084	**Slough (Sl)** Slough is found adjacent to the Saline Subirrigated ecological site, usually in oxbows or channels where flooding is very frequent and a water table is shallow and persistant.

Similar sites

FX052X99X091	**Saline Overflow (Sov)** This site differs from Saline Subirrigated ecological site in that it receives additional moisture primarily from surface water rather than from groundwater. A water table, if present, is greater than 40 inches below the surface.
FX052X99X060	**Overflow (Ov)** This site differs from Saline Subirrigated ecological site in that soils do not contain accumulated salts in the upper 20 inches and a water table, if present, is greater than 40 inches below the surface. Site supports a diverse herbaceous plant community and is more productive.
FX052X99X003	**Alkali Flat (Af)** This site differs from the Saline Subirrigated ecological site in that it occurs in depressions. It is also ponds water for long durations whereas Saline Subirrigated ecological site does not.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY092MT

Physiographic features

Saline Subirrigated is a moderately extensive ecological site occurring on alluvial fans, floodplains, drainageways, and stream terraces.

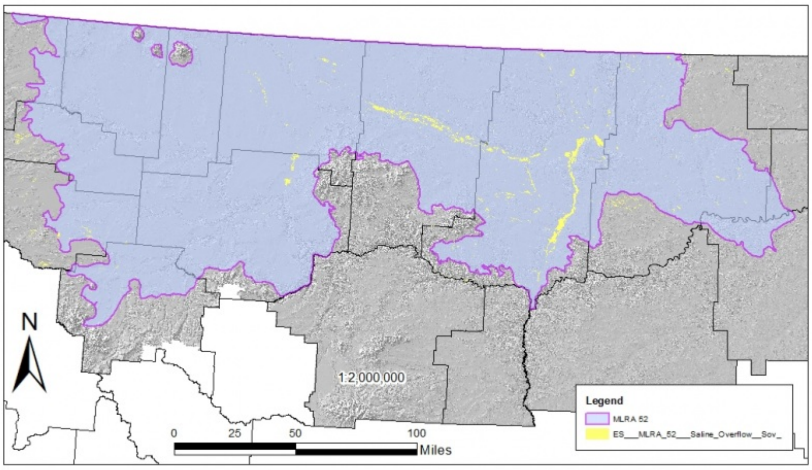

Figure 1. Figure 1. General distribution of the Saline Subirrigated ecological site by map unit extent.

Table 2. Representative physiographic features

Landforms	(1) Alluvial fan (2) Flood plain (3) Drainageway (4) Stream terrace
Flooding duration	Brief (2 to 7 days)
Flooding frequency	None to occasional
Ponding frequency	None
Elevation	2,000–3,870 ft
Slope	0–2%
Water table depth	24–40 in
Aspect	Aspect is not a significant factor

Climatic features

The Brown Glaciated Plains is a semi-arid region with a temperate continental climate that is characterized by frigid winters and warm to hot summers (Cooper et al., 2001). The average frost-free period for this ecological site is 115 days. The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Summer rainfall comes mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Severe drought occurs on average in 2 out of every 10 years. Annual precipitation ranges from 10 to 17 inches, and 70 to 80 percent of this occurs during the growing season (Cooper et al., 2001). Extreme climatic variations, especially droughts, have the greatest influence on species cover and production (Coupland, 1958, 1961; Biondini et al., 1998).

During the winter months, the western half of MLRA 52 commonly experiences chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain foothills and decrease eastward. In addition to producing damaging winds, prolonged chinook episodes can result in drought or vegetation kills due to the reaction of plants to a "false spring" (Oard, 1993).

Table 3. Representative climatic features

Frost-free period (average)	115 days
Freeze-free period (average)	140 days
Precipitation total (average)	13 in

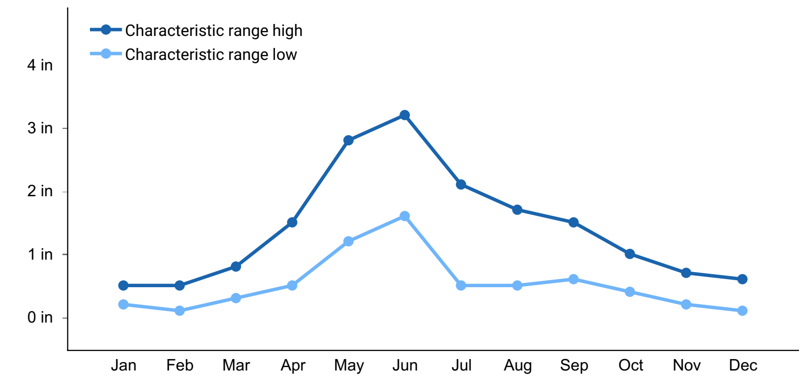

Figure 2. Monthly precipitation range

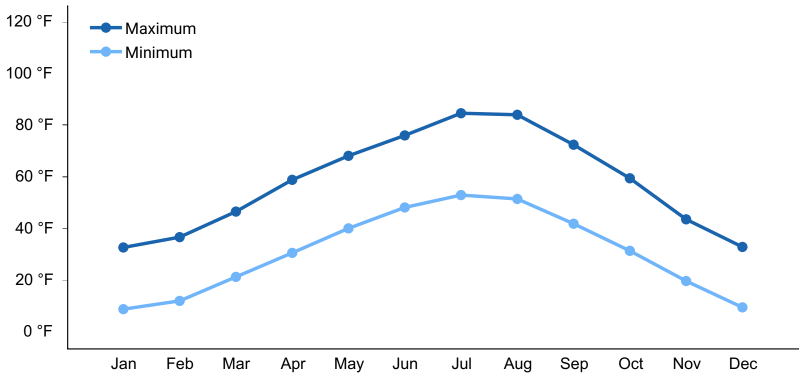

Figure 3. Monthly average minimum and maximum temperature

Climate stations used

- (1) GERALDINE [USC00243445], Geraldine, MT
- (2) CONRAD [USC00241974], Conrad, MT
- (3) TURNER 11N [USC00248415], Turner, MT
- (4) CONTENT 3 SSE [USC00241984], Zortman, MT
- (5) GOLDBUTTE 7 N [USC00243617], Sunburst, MT
- (6) SACO 1 NNW [USC00247265], Saco, MT
- (7) CARTER 14 W [USC00241525], Floweree, MT
- (8) CHESTER [USC00241692], Chester, MT
- (9) HARLEM [USC00243929], Harlem, MT
- (10) LOMA 1 WNW [USC00245153], Loma, MT

Influencing water features

Formal studies on hydrologic processes have not been conducted for this site. Hydrologic processes as they are currently conceptualized are considered provisional and require further investigation. This is a typically a floodplain site that receives additional moisture from groundwater and occasionally stream overflow, but it may also occur in drainageways. On floodplains, the site may be flooded for brief durations during major flood events. Typically, the site has groundwater connectivity with the stream channel at some time during the year and a seasonal groundwater table is present between 24 and 40 inches below the soil surface, particularly during spring. In drainageways, hydrology is primarily underground. Spring recharge from surrounding uplands concentrates in drainageways, forming a local water table 24 to 40 inches below the surface. The local water table is seasonal, typically occurring for only a few months in the spring, but is sufficient to increase production on the site. Groundwater dynamics are not well documented, but it is possibly a flow-through site or recharge site. Conceptual hydrological diagrams are shown in Figure 2.

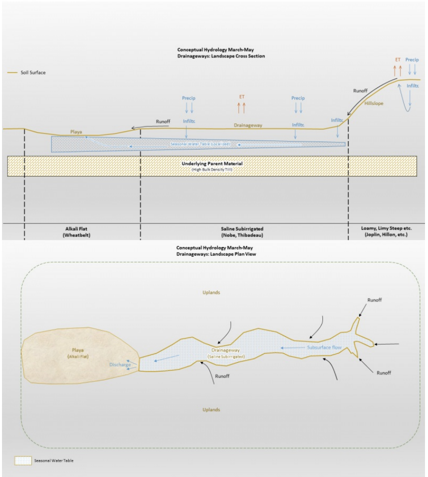

Figure 4. Figure 2. Conceptual Hydrological Diagrams.

Soil features

Soils that best represent the central concept for this ecological site are the Thibadeau soils and the Nobe soils. The Thibadeau soil is in the Fluvents great group while the Nobe soil is in the Orthents great group. Both soils are characterized by a surface horizon that lacks enough organic matter to have a mollic epipedon (USDA-NRCS, 2016). The Thibadeau soil is in the fine-loamy family, meaning it contains between 18 and less than 35 percent clay in the particle-size control section, and has mixed mineralogy. The Nobe soil is in the fine family, meaning it contains between 35 and 60 percent clay in the particle-size control section, and has smectitic mineralogy. The parent material for these soils are typically alluvium deposits. These and all soils in this concept are characterized by an accumulation of salts in the upper 20 inches and are endosaturated, meaning that they receive additional moisture from groundwater. The soil moisture regime for all soils in this ecological site concept is ustic, which means that the soils are moist in some or all parts for either 180 cumulative days or 90 consecutive days during the growing season but are dry in some or all parts for over 90 cumulative days. Thibadeau is also considered oxyaquic, which means it is saturated within 150 cm of the soil surface for: 20 or more consecutive days; or 30 or more cumulative days. These soils have a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface horizon textures in this site are commonly loam, clay loam, or silty clay. The upper 4 inches of soil typically contains 20 to 45 percent clay. The underlying horizons typically contain 20 to 48 percent clay and are often stratified. Textures are typically loam or clay loam, but may also have strata of fine sandy loam, silt loam, or silty clay loam. Organic matter in the surface horizon typically ranges from 2.8 to 3.4 percent organic matter, and moist colors vary from light yellowish brown (2.5Y 6/3) to dark grayish brown (2.5Y 4/2). Calcium carbonate equivalent varies, but is typically less than 15 percent throughout the soil profile. The upper 20 inches of soil contain accumulated salts, as evidenced by an electrical conductivity of 4 or more, a sodium absorption ratio of 13 or more, or both. Soil pH classes are neutral to strongly alkaline in the surface horizon and slightly alkaline to very strongly alkaline in the subsurface horizons. The soil depth class for this is site is typically very deep (more than 60 inches). Typically, the upper 20 inches of soil does not contain coarse fragments.

Table 4. Representative soil features

Parent material	(1) Alluvium
Surface texture	(1) Loam (2) Clay loam (3) Silty clay
Drainage class	Somewhat poorly drained to moderately well drained
Soil depth	60–72 in
Available water capacity (0-40in)	2.8–3.1 in
Calcium carbonate equivalent (0-5in)	0–14%

Electrical conductivity (0-20in)	4–16 mmhos/cm
Sodium adsorption ratio (0-20in)	13–40
Soil reaction (1:1 water) (0-40in)	6.6–9.6

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM) (Figure 3), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The Saline Subirrigated provisional ecological site in MLRA 52 Dry Grassland consists of five states: The Reference State (1), the Altered State (2), the Invaded State (3), the Cropland State (4), and the Post-Cropland State (5). Plant communities associated with this ecological site evolved under the combined influences of climate, grazing, and fire. Extreme climatic variability results in frequent droughts, which have the greatest influence on the relative contribution of species cover and production (Coupland, 1958, 1961; Biondini et al., 1998). Due to the dominance of cool-season graminoids, annual production is highly dependent upon mid- to late-spring precipitation (Heitschmidt and Vermeire, 2005; Anderson, 2006).

Native grazers also shaped these plant communities. American bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocapra americana), elk (Cervus canadensis), and deer (Odocoileus spp.) were also common. Small mammals such as prairie dogs (Cynomys spp.) and ground squirrels (Urocitellus spp.) also influenced this plant community (Salo et al., 2004). Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus) also played an important role in the ecology of these communities (Lockwood, 2004).

The historic ecosystem experienced periodic lightning-caused fires with estimated fire-return intervals of 6 to 25 years (Bragg, 1995). Historically, Native Americans also set periodic fires. The majority of lightning-caused fires occurred in July and August, whereas Native Americans typically set fires during spring and fall to correspond with the movement of bison (Higgins, 1986). Generally, the mixed-grass ecosystem is resilient to fire and the primary effects of fire are reduction of litter and short-term fluctuations in production (Vermeire et al., 2011, 2014). However, studies have shown that shorter fire-return intervals can have a negative effect, shifting species composition toward warm-season, short-statured grasses (Shay et. al., 2001; Smith and McDermid, 2014). Nonnative annual bromes have become naturalized in relatively undisturbed grasslands (Ogle et al., 2003; Harmoney, 2007). They can be present in any state within the scope of this ecological site, but their abundance varies depending on precipitation and germination conditions. They typically are not abundant enough to have a significant ecological impact, but further study is required to assess this.

Hydrology, particularly of groundwater, is another major ecological driver for this site. Hydrologic alterations, particularly alterations that raise the water table or increase the duration of the seasonal water table, may have a significant effect on species composition and production. In some cases, severe salinization may occur. On portions of this site the hydrology has been significantly altered by irrigation, major dams, and diversions. The implications of this alteration have not been fully studied and require further investigation.

Improper grazing of this site can result in a reduction in the cover of the mid-statured cool-season, rhizomatous wheatgrasses and sodium-tolerant bunchgrasses along with an increase in inland saltgrass (*Distichlis spicata*) and foxtail barley (*Hordeum jubatum*). Improper grazing practices include any practices that do not allow sufficient opportunity for plants to physiologically recover from a grazing event or multiple grazing events within a given year and/or that do not provide adequate cover to prevent soil erosion over time. These practices may include, but are not limited to, overstocking, continuous grazing, and/or inadequate seasonal rotation moves over multiple years.

Further degradation of the site due to improper grazing can result in a community dominated by greasewood and foxtail barley. Mid-statured rhizomatous grasses are eliminated or nearly so. Unpalatable forbs such as povertyweed (*Iva axillaris*) are common. An invaded state occurs when non-native species invade the site. Potential invasive species on this site are curly dock (*Rumex crispus*), knotweed (Polygonum spp), and kochia (*Bassia* *scoparia*). Invasive species dynamics are not well understood at this time and further investigation is needed to fully document ecological pathways and processes.

The Saline Subirrigated ecological site is poorly suited to cropland. Regardless, many acres have been converted to cropland. Cereal grains such as wheat and barley are, at best, marginally successful on this site. Typically, cropping operations are directed at increasing perennial hay production. Seeding of introduced grasses for hay production may be successful, particularly if salt-tolerant species such as RS, or hybrid, wheatgrass (*Elymus hoffmannii*) are used. Irrigation is sometimes used in an effort to increase production, but this site is poorly suited to irrigation practices due to accumulated salts and a seasonally high water table.

When taken out of production, the site is either allowed to revert back to perennial grassland or is seeded with introduced species. Sites left to undergo natural plant succession after cultivation can, over several decades, support rhizomatous grasses such as western wheatgrass and inland saltgrass, although cover and production of these species are lower than in the Reference State. Those sites seeded with non-native species, particularly salt-tolerant grasses, may persist with this cover type indefinitely. When reseeded to native species, productive sites such as Loamy, may take over 75 years for the soil to return to the pre-disturbed state (Dormaar and Willms, 1990). The Saline Subirrigated ecological site will likely take longer due to the difficult growing conditions. Further investigation is needed to better evaluate this.

The state-and-transition model (STM) (Figure 3) suggests possible pathways that plant communities on this site may follow as a result of a given set of ecological processes and management. The site may also support states not displayed in the STM diagram. Landowners and land managers should seek guidance from local professionals before prescribing a particular management or treatment scenario. Plant community responses vary across this MLRA due to variability in weather, soils, and aspect. The Reference community phase may not necessarily be the management goal. The lists of plant species and species composition values are provisional and are not intended to cover the full range of conditions, species, and responses for the site. Species composition by dry weight is provided when available and is considered provisional based on the sources identified in the narratives associated with each community phase.

State 1: Reference State
The Reference State (1) contains two community phases. This state evolved under the combined influences of climate, grazing, and fire, with climatic variation having the greatest influence on cover and production. In general, this state was resilient to grazing and fire, although these factors could influence species composition in localized areas. Vegetation is characterized by mid-statured rhizomatous grasses, sodium-tolerant bunchgrasses, and salt-tolerant deciduous shrubs.

Phase 1.1: Reference Community Phase
The Reference Community Phase (1.1) is typically characterized by greasewood, rhizomatous grasses, and sodium-tolerant bunchgrasses. Rhizomatous grasses are the dominant functional group. Western wheatgrass and inland saltgrass are the principle species, but thickspike wheatgrass (*Elymus lanceolatus*) may be present as well, particularly in the northern extent of this site. Sodium-tolerant bunchgrasses such as alkali sacaton (*Sporobolus airoides*) and Nutall’s alkaligrass (*Puccinellia nuttalliana*) are common. Other grass species are rare and may include foxtail barley and Sandberg bluegrass (*Poa secunda*). On wetter sites, alkali cordgrass (*Spartina gracilis*) may be present. Common forbs are povertyweed, and wooly plantain (*Plantago patagonica*). The predominant shrub is greasewood. Other shrubs that may occur are Gardner’s saltbush and silver sagebrush. Total canopy cover of shrubs is approximately 25 percent. The approximate species composition of the reference plant community is as follows:

Percent composition by weight
Rhizomatous Wheatgrass 30%
Inland Saltgrass 10%
Sodium-tolerant bunchgrasses 15%
Alkali Cordgrass 0-5%
Other Native Grasses 5-10%
Native Forbs 5%
Greasewood 25%
Other Native Shrubs/Subshrubs 5%

Estimated Total Annual Production*
Low - 700
Representative Value - 1,100
High - 1,400
* Estimated based on current observation – subject to revision

Phase 1.2: At-Risk Community Phase
The At-Risk Community Phase (1.2) occurs when site conditions decline due to drought, improper grazing management, or a combination of these factors. This community phase is characterized by the dominance of inland saltgrass and a decline in cool-season, rhizomatous wheatgrasses. Sodium-tolerant bunchgrasses such as Nutall's alkaligrass have been eliminated or nearly so. Palatable shrubs such as Gardner's saltbush may sustain browsing damage and begin to decline in vigor in this phase. Foxtail barley and unpalatable forbs such as povertyweed may also increase in this phase.

Community Phase Pathway 1.1a
Drought, improper grazing management, or a combination of these factors can shift the Reference Community Phase (1.1) to the At-Risk Community Phase (1.2). These factors favor a decrease in rhizomatous wheatgrasses and an increase in inland saltgrass and foxtail barley.

Community Phase Pathway 1.2a
The At-Risk Community Phase (1.2) can return to the Reference Community Phase (1.1) with normal or above-normal spring precipitation and proper grazing management.

Transition T1A
Improper grazing practices, hydrologic alteration, or a combination of these factors weaken the resilience of the Reference State (1) and drive its transition to the Altered State (2). The Reference State (1) transitions to the Altered State (2) when rhizomatous grasses become rare and contribute little to production. Greasewood, foxtail barley, and unpalatable forbs such as povertyweed dominate the plant community.

Transition T1B
The Reference State (1) transitions to the Invaded State (3) when invasive plant species invade the Reference State (1). Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced. In addition, other rangeland health attributes, such as reproductive capacity of native grasses and soil quality, have been substantially altered from the Reference State (1).

Transition T1C
Tillage or application of herbicide followed by seeding of cultivated crops such as wheat, barley or introduced hay transitions the Reference State (1) to the Cropland State (4).

State 2: Altered State
The Altered State (2) consists of one community phase. The dynamics of this state are driven by improper grazing management, hydrologic alteration, or a combination of these factors. Foxtail barley and unpalatable forbs increase at the expense of rhizomatous grasses and palatable shrubs. Hydrologic alterations that raise the water table may also cause a decline in rhizomatous grasses and an increase in foxtail barley. Proper grazing management or hydrologic restoration can reduce foxtail barley cover and increase the cover of rhizomatous wheatgrasses. This recovery may take decades, especially if soil properties are substantially altered (Dormaar and Willms, 1990).

Phase 2.1: Greasewood/Foxtail Barley Community Phase
The Greasewood/Foxtail Barley Community Phase (2.1) occurs when site conditions decline due to long-term improper grazing management or when water tables rise due to altered hydrology. Rhizomatous grasses have been eliminated or nearly so. Foxtail barley and unpalatable forbs such as povertyweed are common and may account for as much as 75 percent of the total production. Greasewood is common in this phase but palatable shrubs such as Gardner's saltbush are rare and have poor vigor.

Transition T2A
The Reference State (1) transitions to the Invaded State (3) when invasive plant species invade the Reference State (1). Exotic plant species dominate the site in terms of cover and production. Site resilience has been substantially reduced. In addition, other rangeland health attributes, such as reproductive capacity of native grasses

and soil quality, have been substantially altered from the Reference State (1).

Transition T2B
Tillage or application of herbicide followed by seeding of cultivated crops such as wheat, barley or introduced hay, transitions the Altered State (2) to the Cropland State (4).

Restoration Pathway R2A
Reduction in livestock grazing pressure alone may not be sufficient to restore the Altered State (2) to the Reference State (1) (Dormaar and Willms, 1990). Practices such as range seeding (Hart et al., 1985) or restoration of the natural hydrology may be necessary, but these are management intensive and costly. Therefore, returning the Altered State (2) to the Reference State (1) can require considerable energy and cost and may not be feasible within a reasonable amount of time.

State 3: Invaded State
The Invaded State (3) occurs when invasive plant species invade adjacent native grassland communities. Invasive species dynamics on this site are not well understood. Potential invasive species that have been documented on this site are curly dock, knotweed, and kochia. Noxious weeds such as saltcedar have not been confirmed on this site, but do have the potential to invade. Saltcedar is very aggressive and typically will displace native species and dominate ecological function when it invades a site. Further study is needed to fully assess the ecological dynamics of the Invaded State (3).

Transition T3A
Tillage or application of herbicide followed by seeding of cultivated crops such as wheat, barley or introduced hay, transitions the Invaded State (3) to the Cropland State (4).

State 4: Cropland State
The Cropland State (4) occurs when land is put into cultivation. This site is poorly suited to crops, however, many acres are cultivated despite its limitations. Occasionally, cereal grains such wheat, and barley are attempted, but this site is poorly suited to such crops and cereal grain production is generally unsuccessful. Most frequently, the site is planted to non-native perennial species for production of hay. In some cases, irrigation is used in an attempt to increase production. Flood irrigation is most common although center pivot sprinklers are used in some cases. Cropping and irrigation projects have vastly altered vegetation and hydrology on much of the Saline Subirrigated ecological site. Irrigation frequently results in salinization due to the combination of high water tables and accumulated salts in the soil. Foxtail barley is common on salinized sites.

Transition T4A
The transition from the Cropland State (4) to the Post-Cropland State (5) occurs with the cessation of cultivation or haying. The site may be simply abandoned or it may be seeded to perennial forage species. Such seedings may be comprised of introduced grasses/legumes or a mix of native species.

State 5: Post-Cropland State
The Post-Cropland State (5) occurs when cultivated cropland is abandoned and allowed to either re-vegetate naturally or is seeded back to perennial species for grazing or wildlife use. This state can transition back to the Cropland State (4) if the site is put back into cultivation.

Phase 5.1: Abandoned Cropland Phase
The Abandoned Cropland Phase (5.1) occurs when cropland is abandoned. In the absence of active management, the site can re-vegetate naturally and, over time, potentially return to a perennial grassland community with western wheatgrass and inland saltgrass. Shortly after cropland is abandoned, annual forbs, biennial forbs, and foxtail barley invade the site. Eventually, these pioneering species are replaced by western wheatgrass and inland saltgrass. Invasion of the site by exotic species, such as curly dock, will depend upon the site’s proximity to a seed source. Fifty or more years after cultivation, these sites may have species composition similar to phases in the Reference State (1). However, soil quality is consistently lower than conditions prior to cultivation (Dormaar and Smoliak, 1985), making a shift to the Reference State (1) is unlikely within a reasonable timeframe.

Phase 5.2: Perennial Grass Phase
The Perennial Grass Phase (5.2) occurs when the site is seeded to perennial forage species. When seeded to introduced species, particularly salt-tolerant introduced perennial grasses such as RS, or hybrid, wheatgrass, this

community phase can persist for several decades. Such seedings may also occur in conjunction with irrigation or water spreading practices. A mixture of native species may also be seeded to provide species composition and structural complexity similar to that of the Reference State (1). However, the site is unlikely to return to pre-cultivation conditions within a reasonable timeframe, particularly if hydrology is altered by irrigation or water spreading.

Transition 5A
Tillage or application of herbicide followed by seeding of cultivated crops such as wheat, barley or introduced hay transitions the Post-Cropland State (5) back to the Cropland State (4).

State and transition model

Inventory data references

One low-intensity plot was available for the Saline Subirrigated ecological site. A plot from a Saline Subirrigated ecological site within MLRA 53A was also used for reference. These plots, in combination with professional experience and a review of the scientific literature, were used to approximate the reference plant community. Information for other states and community phases was obtained from a review of the scientific literature and professional experience. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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Approval

Kirt Walstad, 12/28/2022

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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	04/11/2024
Approved by	Kirt Walstad
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):**

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

---

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

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17. **Perennial plant reproductive capability:**
