USDA Natural Resources
Conservation Service

Ecological site FX052X99X003
Alkali Flat (Af)

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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 around 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). It 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 the 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 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 & Herb Wetland Subclass (2.C)
• Formation: Salt Marsh Formation (2.C.5)
• Division: Sarcobatus vermiculatus - Allenrolfea occidentalis - Schoenoplectus americanus North American Interior Brackish Marsh, Playa & Shrubland Division (2.C.5.Nd)
• Macrogroup: Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland Macrogroup (2.C.5.Nd.1)
• Group: Distichlis spicata - Puccinellia lemmonii - Salicornia spp. Alkaline-Saline Marsh & Playa Group (2.C.5.Nd.1.a)
• Alliance: No existing correlation
• Association: No existing correlation

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) & 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. Alkali Flat is an ecological site of limited extent occurring throughout MLRA 52 on playas and lake plains where clay and salts have accumulated.

The distinguishing characteristic of this site is soils that contain accumulated salts and are ponded for long periods, typically for 7 days or more. Soils for this ecological site are typically very deep (more than 60 inches) and derived from clayey alluvium or glaciolacustrine deposits. Soil textures in the upper 4 inches are typically clay or silty clay and have a clay content greater than 45 percent. Soils typically have an ochric epipedon and distinct slickensides (USDA-NRCS, 2016) in the underlying horizons. Characteristic vegetation is foxtail barley (Hordeum jubatum), western wheatgrass (Pascopyrum smithii), and povertyweed (Iva axillaris). Typically, shrubs are rare on this site, but some phases may support greasewood (Sarcobatus vermiculatus), Gardner's saltbush (Atriplex gardneri), and silver sagebrush (Artemisia cana).

Associated sites

FX052X99X092	**Saline Subirrigated (Ssb)** The Saline Subirrigated site is adjacent to the Alkali Flat site. It is in higher topographic positions, commonly in drainageways or on lake plains adjacent to depressions.
FX052X01X010	**Dense Clay (DC) Dry Grassland** The Dense Clay Dry Grassland site is on lake plains adjacent to the Alkali Flat site. It is in higher topographic positions that do not receive additional water rather than in depressions.
FX052X03X010	**Dense Clay (DC) Dry Shrubland** The Dense Clay Dry Shrubland site is on lake plains adjacent to the Alkali Flat site. It is in higher topographic positions that do not receive additional water rather than in depressions.
FX052X01X012	**Dense Clay Sodic (Dcsd) Dry Grassland** The Dense Clay Sodic Dry Grassland site is on lake plains adjacent to the Alkali Flat site. It is in higher topographic positions that do not receive additional water rather than in depressions.
FX052X03X012	**Dense Clay Sodic (Dcsd) Dry Shrubland** The Dense Clay Sodic Dry Shrubland site is on lake plains adjacent to the Alkali Flat site. It is in higher topographic positions that do not receive additional water rather than in depressions.

Similar sites

FX052X01X010	**Dense Clay (DC) Dry Grassland** Dense Clay Dry Grassland differs from the Alkali Flat site in that it does not receive additional moisture from surface runoff and does not contain accumulated salts in the upper 20 inches of soil. It is also well drained and does not pond water for long durations.
FX052X03X010	**Dense Clay (DC) Dry Shrubland** Dense Clay Dry Shrubland differs from the Alkali Flat site in that it does not receive additional moisture from surface runoff and does not contain accumulated salts in the upper 20 inches of soil. It is also well drained and does not pond water for long durations.
FX052X01X012	**Dense Clay Sodic (Dcsd) Dry Grassland** Dense Clay Sodic Dry Grassland differs from the Alkali Flat site in that it does not receive additional moisture from surface runoff. It is well drained and does not pond water for long durations.
FX052X03X012	**Dense Clay Sodic (Dcsd) Dry Shrubland** Dense Clay Sodic Dry Shrubland differs from the Alkali Flat site in that it does not receive additional moisture from surface runoff. It is well drained and does not pond water for long durations.
FX052X99X092	**Saline Subirrigated (Ssb)** Saline Subirrigated differs from the Alkali Flat site in that it is well drained and does not pond water for long periods of time. It receives additional moisture from ground water rather than surface water and supports more shrubs.
FX052X99X091	**Saline Overflow (Sov)** Saline Overflow differs from the Alkali Flat site in that it occurs in drainageways and flood plains rather than depressions. It is well drained and does not pond water for long durations even though it does receive additional moisture from surface runoff.

Table 1. Dominant plant species

Tree	Not specified
Shrub	Not specified
Herbaceous	Not specified

Legacy ID

R052XY003MT

Physiographic features

The Alkali Flat is an ecological site of limited extent occurring on playas, playettes, and lake plains.

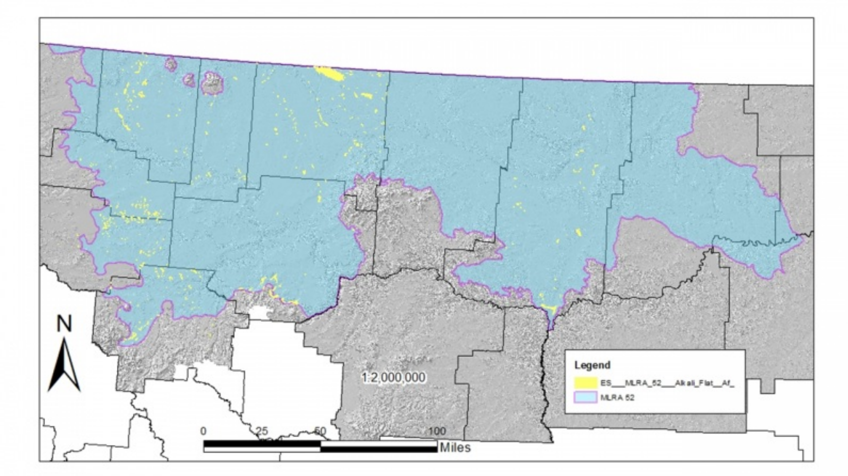

Figure 1. Figure 1. General distribution of the Alkali Flat ecological site by mapunit extent

Table 2. Representative physiographic features

Landforms	(1) Till plain > Playa (2) Lake plain > Playa (3) Till plain > Moraine > Playette
Ponding duration	Brief (2 to 7 days) to long (7 to 30 days)
Ponding frequency	Occasional to frequent
Elevation	2,000–4,600 ft
Slope	0–2%
Ponding depth	1–12 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

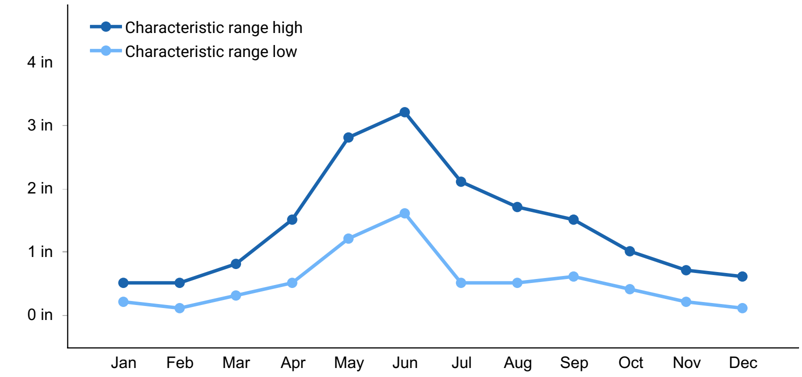

Figure 2. Monthly precipitation range

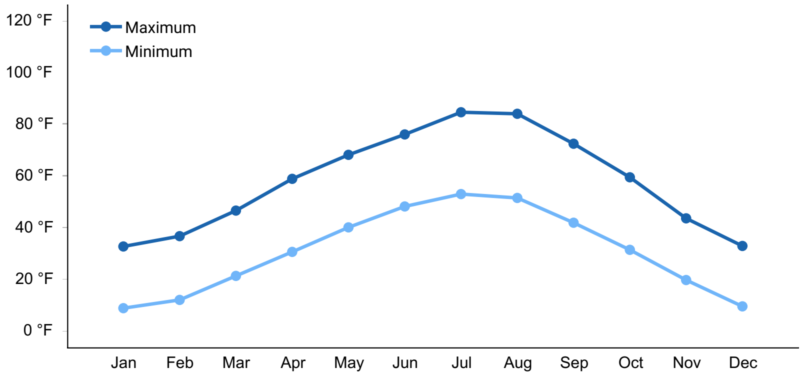

Figure 3. Monthly average minimum and maximum temperature

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

This is a depressional recharge site that receives additional moisture via surface runoff from surrounding uplands. The site receives sufficient moisture for it to pond water for long durations during the growing season. Due to the extremely slow infiltration rate, water is generally lost to evapotranspiration before it can infiltrate below the soil profile; therefore, ground-water recharge is unlikely. The soil remains wet long enough to inhibit upland plant growth, but the site does not support hydrophytic vegetation. The site is episaturated, and a groundwater table is typically not present.

Soil features

The Alkali Flat concept covers about 50,000 acres in MLRA 52. Soil series that best represent the central concept for this ecological site are Bigsag and Wheatbelt. The Bigsag series is in the Halaquepts great group, and the Wheatbelt series is in the Epiaquerts great group. Bigsag is in the fine family, meaning it contains between 35 and 60 percent clay in the particle-size control section. Wheatbelt is in the very-fine family, meaning it contains more than 60 percent clay in the particle-size control section. The parent material for these series is typically clayey glaciolacustrine deposits but may also be clayey alluvium. The Wheatbelt soil exhibits strong shrink-swell characteristics in the subsurface horizons, as evidenced by slickensides (USDA-NRCS, 2016). The minerology for both soils is smectitic. The Bigsag and Wheatbelt soils and all other soils in this site concept receive additional moisture from surface runoff. High clay content of the soils causes low infiltration which causes ponding for long durations. They also contain accumulated salts that inhibit plant growth. The surface horizon lacks enough organic matter to have a mollic epipedon. The soil moisture regime for this ecological site concept is aquic, which means that the soils are saturated within 40 inches (100 cm) of the mineral soil surface for some time during the year. These soils have a frigid soil temperature regime (Soil Survey Staff, 2014).

Surface textures found on this site are commonly clay or silty clay. The upper 4 inches of soil contains more than 45 percent clay. The underlying horizons typically contain 50 to 80 percent clay and have clay textures. The surface horizon typically contains about 1 percent organic matter, and moist colors vary from olive gray (5Y 5/2) to gray (5Y 5/1). Calcium carbonate equivalent is typically less than 15 percent throughout the soil profile. Soil pH classes are moderately alkaline to strongly alkaline in all horizons. The soil depth class for this 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) Glaciolacustrine deposits (2) Alluvium
Surface texture	(1) Clay (2) Silty clay
Drainage class	Poorly drained
Soil depth	60–72 in
Available water capacity (0-40in)	3.6–4.8 in
Calcium carbonate equivalent (0-5in)	0–14%
Electrical conductivity (0-20in)	4–16 mmhos/cm
Sodium adsorption ratio (0-20in)	13–20
Soil reaction (1:1 water) (0-40in)	7.9–9

Ecological dynamics

The information in this ecological site description, including the state-and-transition model (STM), 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 Alkali Flat provisional ecological site in MLRA 52 Dry Grassland consists of five states: The Frequently Ponded State (1.0), the Occasionally Ponded State (2.0), the Altered State (3.0), the Cropland State (4.0), and the Post-Cropland State (5.0). Plant communities associated with this site evolved under the combined influences of climate, grazing, and hydrology. 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).

Native grazers also shaped these plant communities. American bison (Bison bison) were the dominant historic grazer, but pronghorn (Antilocarpa americana), elk (Cervus canadensis), and deer (Odocoileus spp.) were also common. Small mammals such as prairie dogs (Cynomys spp.), and ground squirrels (Urocitellus spp.) were an important influence at the landscape scale (Salo et al., 2004) but most likely did not have significant influence on this site. Grasshoppers and periodic outbreaks of Rocky Mountain locusts (Melanoplus spretus; Lockwood, 2004) also played an important role in the ecology of these communities.

The historic ecosystem also experienced relatively frequent 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 mixedgrass ecosystem is resilient to fire and the historic fire return interval had neutral or slightly positive effects on the plant community (Vermeire et al., 2011, 2014). Fires occasionally occurred in wetlands (Higgins, 1986); however, it is thought that fire was not a significant factor on the Alkali Flat ecological site due to the lack of vegetation and the typically wet conditions. Due to the generally inhospitable nature of the site, invasive species do not appear to be a major concern. Less desirable species such as foxtail barley may become more prevalent during wet cycles, but they do not appear to dominate the ecological dynamics of the site over the long term.

Hydrology is the major ecological driver for this site. Length of inundation is thought to have the greatest effect on species composition and production. The two major factors influencing length of inundation appear to be seasonal precipitation and landscape position (primarily micro-topography) within the depression. Natural patterns of soil movement by wind or water create complex micro-topography within the depression. The Frequently Ponded State occurs primarily near the center of the depression. The lowest micro-topographic positions experience the longest inundation and can pond for more than 7 days. This amount of inundation is sufficient to eliminate wheatgrasses and result in a foxtail barley/povertyweed plant community. In some areas, ponding duration is so long that nearly all vegetation is killed. During dry years, these low topographic positions may only pond for 7 days or less, allowing species such as western wheatgrass to recolonize the site. Similarly, areas of slightly higher micro-topography experience shorter ponding periods and support more vegetation. The Occasionally Ponded State typically occurs near the edges of the depression where micro-topography is higher still. Ponding is less frequent and persists for 7 days or less. These areas are dominated by wheatgrass species and produce significantly more herbage than lower positions closer to the center of the depression. Shrubs remain rare in this phase. Further reduction of ponding duration can result in a plant community dominated by wheatgrasses and shrubs such as greasewood and Gardner's saltbush. These communities are generally at the farthest margins of the depression where micro-topography is highest and ponding is occasional and of brief duration. During above-average precipitation cycles, areas in and around the center of the depression will be inundated long enough to transition to a foxtail barley/povertyweed plant community. During extremely wet years, all areas of the depression can flood. This may shift most, if not all, communities back to the Wet Phase, depending on the duration and severity of flooding. Periods of extended drought (approximately 3 years or more) can result in expansion of rhizomatous wheatgrass communities and a reduction of the Wet Phase community.

This site is most commonly rangeland and is grazed by livestock. The Frequently Ponded State typically does not receive extensive livestock use due to the wetness and sparse vegetation. However, the Occasionally Ponded State can provide reasonably good forage for livestock. It is hypothesized that improper grazing of this state can result in a reduction in the cover and vigor of the cool-season rhizomatous wheatgrasses and an increase in foxtail barley and unpalatable forbs such as povertyweed. 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. Proper grazing practices, combined with normal precipitation patterns, will likely improve cover and vigor of wheatgrasses over time. Because the Altered state and its ecological dynamics have not been conclusively documented, it is considered hypothetical until further investigation can be completed

The Alkali Flat ecological site is poorly suited to cropland. Regardless, portions of it have been converted to cropland. Cereal grains such as wheat and barley are, at best, marginally successful on this site. Crop production usually ceases within a few years due to low yields and large input costs. When this site is taken out of production, the site is either allowed to revert back to native vegetation or is seeded with perennial species. Sites left to undergo natural plant succession after cultivation can, over several decades, support western wheatgrass communities similar to the native state. Sites reseeded with perennial species typically take several years to establish. Once established, the site is likely to persist with this cover type unless it is inundated by a severe flood.

The STM diagram 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: Frequently Ponded State
The Frequently Ponded State contains two community phases. This state evolved under the combined influences of climate, hydrology, and soil chemistry, with hydrology having the greatest influence on cover and production. In general, this state is subjected to frequent long-duration ponding, although subtle micro-topography can influence specific ponding duration in localized areas. In some areas, ponding is long enough that nearly all vegetation is killed and the site is virtually barren. Typically, vegetation is characterized by mid-statured cool-season rhizomatous grasses, foxtail barley, and povertyweed.

Community Phase 1.1: Wet Phase
The Wet Phase is typically ponded for more than 7 days. Vegetation is typically dominated by foxtail barley and povertyweed although some areas are virtually barren. Rhizomatous wheatgrasses and shrubs are typically absent. Typically, this phase is near the center of depressions and occupies the lowest micro-topography on the landscape. In above-average precipitation years, this phase may expand to adjacent micro-high positions.

Community Phase 1.2: Dry Phase
The Dry Phase is typically ponded for 7 days or less. In this phase foxtail barley is in decline and has been largely replaced by rhizomatous wheatgrasses. Forbs such as povertyweed comprise approximately 10 percent of the total annual production. Shrubs such as greasewood and Gardner’s saltbush are rare. Typically, this phase is near the center of depressions and occupies the higher micro-topography positions in this area. During drought, this phase may expand to adjacent micro-low positions.

Community Phase Pathway 1.1a
Below-average precipitation can shift the Wet Community Phase (1.1) to the Dry Community Phase (1.2). This favors a decrease in foxtail barley and an increase in rhizomatous wheatgrasses.

Community Phase Pathway 1.2a
Normal or above-average precipitation can shift the Dry Community Phase (1.2) to the Wet Community Phase (1.1). These factors favor a decrease in rhizomatous wheatgrasses and an increase in foxtail barley.

Transition T1A
Prolonged drought (approximately 3 years or more), soil deposition, or a combination of these factors transition the Frequently Ponded State (1) to the Occasionally Ponded State (2). The Frequently Ponded State (1) transitions to the Occasionally Ponded State (2) when ponding frequency is reduced. Rhizomatous wheatgrasses become common and contribute significantly to production.

State 2: Occasionally Ponded State
The Occasionally Ponded State consists of two community phases. The dynamics of this state are driven by the combined influences of climate, hydrology, and grazing, with hydrology having the greatest influence on cover and production. The site is dominated by rhizomatous wheatgrasses while foxtail barley has been nearly eliminated. Shrubs are typically rare but do become common in the driest phase. Typical vegetation is western wheatgrass, thickspike wheatgrass (*Elymus lanceolatus*), greasewood, and Gardner’s saltbush. This state typically occurs near the edges of the depression where micro-topography is high. Severe flooding events can transition this state to the Frequently Ponded State.

Community Phase 2.1: Grassland Community Phase
The Grassland Community Phase is dominated by rhizomatous wheatgrasses, such as western and thickspike wheatgrass. This phase is typically ponded occasionally for 7 days or less. Production is significantly greater than in the Frequently Ponded State. Forbs such as povertyweed comprise about 5 percent of the total production. Shrubs such as greasewood and Gardner’s saltbush are rare. The estimated species composition of this phase is as follows:

Percent composition by weight
Rhizomatous Wheatgrass 90%
Other Native Grasses 2%
Perennial Forbs 5%

Shrubs/Subshrubs 3%

Estimated Annual Production (lbs/ac)*
Low - 600
Representative Value - 700
High - 800
*estimate based on current observation – subject to revision

Community Phase 2.2: Grass/Shrub Community Phase
The Grass/Shrub Community Phase is characterized by a greater abundance of shrubs, particularly greasewood. This phase generally occurs at the farthest margins of the depression where ponding frequency and duration are the shortest. It is estimated that this phase occasionally ponds for 3 to 5 days. This phase is not well understood, and more investigation is needed.

Transition T2A
Severe flooding, soil erosion, or a combination of these factors can transition the Occasionally Ponded State (2) to the Frequently Ponded State (1).

Transition T2B
Improper grazing practices weaken the resilience of the Occasionally Ponded State (2) and drive its transition to the Altered State (3). This transition occurs when rhizomatous wheatgrasses become rare and exhibit poor vigor. Unpalatable species such as foxtail barley and povertyweed become common. This transition is hypothesized and has not yet been documented in the field.

Transition T2C
Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Occasionally Ponded State (2) to the Cropland State (3).

State 3: Altered State
It is hypothesized that improper grazing management will transition the Occasionally Ponded State (2) to the Altered State (3). Vigor and production of rhizomatous wheatgrasses is reduced while unpalatable species, such as foxtail barley and povertyweed, are common. Because this state and its ecological dynamics have not been conclusively documented, it is considered hypothetical until further investigation can be completed.

Transition T3A
Severe flooding, soil erosion, or a combination of these factors can transition the Occasionally Ponded State (2) to the Frequently Flooded State (1).

Transition T3B
It is hypothesized that proper grazing management will transition the Altered State (3) to the Occasionally Ponded State (2). This transition is hypothesized and has not yet been documented in the field.

Transition T3C
Tillage or application of herbicide followed by seeding of cultivated crops, such as winter wheat, spring wheat, and barley, transitions the Altered State (3) to the Cropland State (4).

State 4: Cropland State
The Cropland State (4) occurs when land is put into cultivation. Major crops in MLRA 52 include winter wheat, spring wheat, and barley. This site is poorly suited to crops, and cereal grain production is generally short lived.

Transition T4A
Severe flooding, soil erosion, or a combination of these factors can transition the Cropland State (4) to the Frequently Flooded State (1).

Transition T4B
The transition from the Cropland State (4) to the Post-Cropland State (5) occurs with the cessation of cultivation. The site may also be seeded to perennial forage species such as western wheatgrass.

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
In the absence of active management, the site can re-vegetate naturally and, over time, potentially return to a perennial grassland community with rhizomatous wheatgrasses. Shortly after cropland is abandoned, annual forbs invade the site (Samuel and Hart, 1994). The site is highly susceptible to erosion due to the absence of perennial species. Eventually, these pioneering annual species are replaced by perennial species such as western wheatgrass and foxtail barley.

Phase 5.2: Perennial Grass Phase
When the site is seeded to perennial forage species, this community phase can persist for several decades. Very few species are suitable for this site, and seedings frequently take several years to establish. Reseeding is sometimes necessary to ensure adequate stand density. This phase is typically managed for hay, seed production, grazing, or wildlife habitat. The most common plant community in this phase is a monoculture of western wheatgrass. Severe flooding can inundate these areas and transition the site back to the Frequently Ponded State (1).

Transition 5A
Severe flooding, soil erosion, or a combination of these factors can transition the Post-Cropland State (5) to the Frequently Flooded State (1).

State and transition model

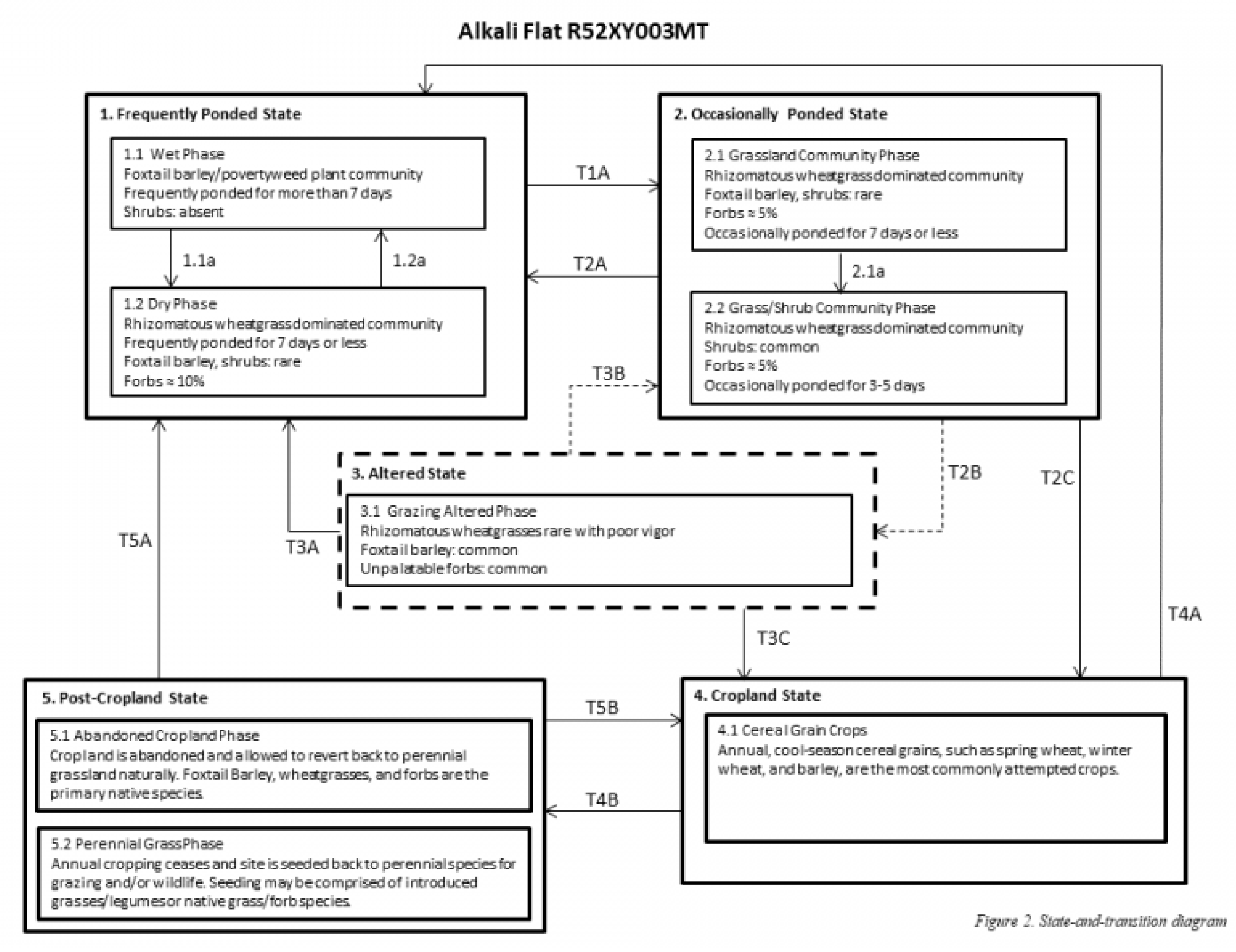

Figure 2. State-and-transition diagram

Alkali Flat
R52XY003MT

Legend

- 1.1a below average precipitation
- 1.2a normal or above average precipitation
- T1A prolonged period of below average precipitation, soil deposition, or a combination of these factors
- 2.1a soil deposition/development, decreased ponding duration
- T2A severe flooding, soil erosion, or a combination of these factors
- T2B improper grazing management
- T3B proper grazing management combined with normal precipitation
- T2C, T3C, T5B conversion to cropland
- T4A cessation of annual cropping
- T3A, T4A, T5A severe flooding, soil erosion, or a combination of these factors

Figure 3. State-and-transition legend

Inventory data references

Two medium-intensity plots and two low-intensity plots were available for this site. These plots were used in conjunction with a review of the scientific literature and professional experience to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in this ecological site description.

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Approval

Scott Brady, 6/26/2019

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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	
Approved by	
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):**

---

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):**

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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:**
