Final Report
USDA Ecological Site Description
State-and-Transition Models
Major Land Resource Area 28A and 28B Nevada
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Moist Clay Slope

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Moist Clay Slope 20+ "(R028BY102NV)

Site Concept:
The Moist Clay Slope 20+" P.Z. ecological site occurs on concave mountain slopes on all exposures. Elevations range from 7000 to 9700 feet. Slopes range from 0 to 8 percent. Average annual precipitation for this site ranges from 17 to over 20 inches, and this site receives additional moisture in the form of run-on from adjacent slopes. Soils of this site are very deep and somewhat poorly drained. They are formed in quartzite with minor amounts of limestone parent material. The available water capacity is high and a seasonal high water table occurs below 20 inches. Surface soils are fine textured and an argillic horizon and a mollic epipedon. Rock fragments in the particle control section ranges from 5 to 20 percent. The soil temperature regime is cryic and the soil moisture regime is xeric. The common plant species include mountain silver sagebrush (*Artemisia cana ssp. viscidula)*, mountain snowberry (*Symphoricarpos oreophilus*), yellow rabbitbrush (*Chrysothamnus viscidifloris)*, currant (*Ribes spp*.), slender wheatgrass (*Elymus trachycaulus)*, muttongrass (*Poa fendleriana)*, Letterman's needlegrass (*Achnatherum lettermanii*) and a variety of perennial forbs. Annual production ranges from 600 to 1000 pounds per acre; normal year production is 800 pounds per acre.

Ecological Dynamics and Disturbance Response:

An ecological site is the product of all the environmental factors responsible for its development and it has a set of key characteristics that influence a site's resilience to disturbance and resistance to invasion. Key characteristics include 1) climate (precipitation, temperature), 2) topography (aspect, slope, elevation, and landform), 3) hydrology (infiltration, runoff), 4) soils (depth, texture, structure, organic matter), 5) plant communities (functional groups, productivity), and 6) natural disturbance regime (fire, herbivory, etc.) (Caudle et al. 2013). Biotic factors that that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

In the Great Basin, the majority of annual precipitation is received during the winter and early spring. This continental semiarid climate regime favors growth and development of deep-rooted shrubs and herbaceous cool season plants using the C3 photosynthetic pathway (Comstock and Ehleringer 1992). Winter precipitation and slow melting of snow results in deeper percolation of moisture into the soil profile. Herbaceous plants, more shallow-rooted than shrubs, grow earlier in the growing season and thrive on spring rains, while the deeper rooted shrubs lag in phenological development because they draw from deeply infiltrating moisture from snowmelt the previous winter. Periodic drought regularly influences sagebrush ecosystems and drought duration and severity has increased throughout the 20th century in much of the Intermountain West. Major shifts away from historical precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability within the soil profile (Bates et al 2006).

This ecological site is dominated by perennial bunchgrasses and long-lived shrubs with high root to shoot ratios. These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992). Perennial bunchgrasses generally have somewhat shallower root systems than shrubs in these systems, but root densities are often as high as or higher than those of shrubs in the upper 0.5 m but taper off more rapidly than

shrubs. General differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

Silver sagebrush (*Artemisia cana ssp. viscidula)* is a shrub that often forms colonies from a system of extensive rhizomes (Stubbendieck 1992). This subspecies primarily occurs in mountainous regions in areas of heavy, lingering snowpack (Beetle 1960). The root system of silver sagebrush consists of a taproot with lateral roots and rhizomes, usually located within a few inches of the soil surface. Rhizome length of plains silver sagebrush in Montana averaged 1.1 meters (3.4 feet). Silver sagebrush is the most vigorous sprouter of all sagebrush (Wright et al 1979). It is able to sprout from roots, rhizomes, and the root crown after disturbance (Ellison and Woolfolk 1937, Beetle 1960, Whitson 1999, Blaisdell 1982). It has been known to readily layer, meaning it can generate adventitious roots from branches touching soil (Beetle 1960, Blaisdell 1982). Silver sagebrush is also capable of reproducing by seeds (Whitson 1999). This shrub is typically evergreen but may shed leaves in cold winters (Beetle 1960).

Silver sagebrush is a host species for the sagebrush defoliator, Aroga moth (*Aroga websteri*) (Henry 1961, Gates 1964, Hall 1965,), but it remains unclear whether the moth causes significant damage or mortality to individual or entire stands of plants. Severe drought has been known to kill the crowns of entire stands of silver sagebrush, however, after release from drought it can rapidly regrow due to its vigorous sprouting ability (Ellison and Woolfolk 1937).

Slender wheatgrass (*Elymus trachycaulus)* is a perennial bunchgrass that tends to be short lived, however it spreads well by natural reseeding (Monsen et al. 2004). It is widely used in restoration seedings (Monsen et al. 2004). Slender wheatgrass tends to persists for a longer time than other perennial grasses when subjected to heavy grazing (Monsen et al. 1996, Monsen et al. 2004).

Letterman's needlegrass (*Achnatherum lettermanii*) is a densely tufted, perennial bunchgrass with a fibrous root system. It reproduces by seed and is considered an aggressive seed producer (Taylor 2000).

This ecological site has high resilience to disturbance and resistance to invasion. Resilience increases with elevation, aspect, increased precipitation, and increased nutrient availability. Long-term disturbance response may be influenced by small differences in landscape topography. Two possible alternative stable states have been identified for this site.

Fire Ecology:
Fire return intervals for silver sagebrush largely depend on the fire intervals of surrounding vegetation communities. Usually this silver sagebrush ecological site is a smaller pocket in a large landscape of mountain big sagebrush (*Artemisia tridentata var. vasayena*). Thus, fire return intervals for silver sagebrush are probably similar to those estimated for mountain big sagebrush. Pre-settlement fire return intervals in mountain big sagebrush communities varied from 15 to 25 years (Burkhardt and Tisdale 1969, Houston 1973, Miller and Tausch 2001).

Seedling establishment can occur in the years after fire if the growing season is favorably wet (Wambolt et al. 1989). Silver sagebrush has spreading rhizomes underground and sprouts or layers after fire (Beetle 1960, Cronquist 1994, Blaisdell 1982). Survival and resprouting ability of silver sagebrush is considerably greater in the spring versus the fall (White and Currie 1983). As burn intensity increases, regrowth of silver sagebrush plants decreases. (White and Currie 1983). Density of silver sagebrush may remain the same or may increase after fire (Winward 1985).

The effect of fire on bunchgrasses relates to culm density, culm-leaf morphology, and the size of the plant. The initial condition of bunchgrasses within the site along with seasonality and intensity of the fire all factor into the individual species response. For most forbs and grasses the growing points are located at or below the soil surface providing relative protection from disturbances which decrease above ground biomass, such as grazing or fire. Thus, fire mortality is more correlated to duration and intensity of heat which is related to culm density, culm-leaf morphology, size of plant and abundance of old growth (Young 1983, Wright 1971).

Fire effects on forbs depend on season of burning. Fall burning does not affect most forbs because they are typically dry by then (Wright and Bailey 1982).

Livestock and Wildlife Grazing Interpretations:
Silver sagebrush is one of the most palatable and nutritious sagebrush species for wildlife (Sheehy and Winward 1981). Its forage value is good to excellent for cattle and sheep, however cattle tend to preferentially graze the grasses under the shrubs. Thus, silver sagebrush generally increases with excessive cattle grazing and decreases under browsing pressure from domestic sheep (Stubbendieck et al. 1992). Pronghorn, cattle, and feral horses were all observed preferentially utilizing a silver sagebrush basin throughout June and July in northern California (Salwasser and Shimamoto 1984). In fall and winter feeding trials, silver sagebrush was among the most preferred sagebrush species for mule deer and sheep (Sheehy and Winward 1981).

Slender wheatgrass is palatable and nutritious for livestock. It is also grazed by wild ungulates and used for cover by small birds and mammals (Tilley et al. 2011, Hallsten et al. 1987). Letterman's needlegrass also provides valuable forage for both livestock and wildlife (Taylor 2000).

State and Transition Model Narrative for this Ecological Site:

Reference State 1.0: The Reference State 1.0 is a representation of the natural range of variability under pristine conditions. The reference state has three general community phases: a shrub-grass dominant phase, a perennial grass dominant phase and a shrub dominant phase. State dynamics are maintained by interactions between climatic patterns and disturbance regimes. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Plant community phase changes are primarily driven by fire, periodic long-term drought and/or insect or disease attack.

> **Community Phase 1.1:** This community is dominated by silver sagebrush. Slender wheatgrass and Letterman's needlegrass are a significant understory component. Nevada bluegrass is present.
>
> **Community Phase Pathway 1.1a:** Fire will reduce the overstory of silver sagebrush for a period of time and allow perennial grasses and forbs to increase.
>
> **Community Phase Pathway 1.1b:** Time and lack of disturbances such as fire, long-term drought, or Aroga moth infestation allow silver sagebrush to increase and dominate. Herbivory may also cause a decline in perennial bunchgrasses and fine fuels, leading to a reduced fire frequency and allowing silver sagebrush to dominate the site.

Community Phase 1.2:
Perennial bunchgrasses such as slender wheatgrass and Letterman's needlegrass dominate. Silver sagebrush, snowberry, and rabbitbrush will sprout soon after fire.

Community Phase Pathway 1.2a: Time and lack of disturbances such as fire, long-term drought, or Aroga moth infestation allow silver sagebrush to increase.

Community Phase 1.3: Silver sagebrush increases in the absence of disturbance and is dominant. Deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory.

Community Phase Pathway 1.3a: Fire will reduce the overstory of silver sagebrush for a period of time and allow perennial grasses and forbs to increase.

T1A: Transition from Reference State 1.0 to Current Potential State 2.0:
Trigger: This transition is caused by the introduction of non-native annual plants, such as cheatgrass and mustards.
Slow variables: Over time the annual non-native species will increase within the community.
Threshold: Any amount of introduced non-native species causes an immediate decrease in the resilience of the site. Annual non-native species cannot be easily removed from the system and have the potential to significantly alter disturbance regimes from their historic range of variation.

Current Potential State 2.0: This state is similar to the Reference State 1.0 with three similar community phases. Ecological function has not changed, however the resiliency of the state has been reduced by the presence of invasive weeds. Non-natives may increase in abundance but will not become dominant within this State. These non-natives can be highly flammable and can promote fire where historically fire had been infrequent. Negative feedbacks enhance ecosystem resilience and contribute to the stability of the state. These feedbacks include the presence of all structural and functional groups, low fine fuel loads, and retention of organic matter and nutrients. Positive feedbacks decrease ecosystem resilience and stability of the state. These include the non-natives' high seed output, persistent seed bank, rapid growth rate, ability to cross pollinate, and adaptations for seed dispersal.

Community Phase 2.1: This community phase is similar to the Reference State Community Phase 1.1, but non-native species are present in trace amounts. Silver sagebrush is dominant. Slender wheatgrass and Letterman's needlegrass are a significant understory component. Nevada bluegrass is present.

Community Phase Pathway 2.1a: Fire will reduce the overstory of silver sagebrush for a period of time and allow perennial grasses and forbs to increase. Annual non-native species are likely to increase after fire.

Community Phase Pathway 2.1b: Time and lack of disturbances such as fire, long-term drought, or Aroga moth infestation allow silver sagebrush to increase and dominate. Inappropriate grazing management reduces the perennial bunchgrasses and fine fuels, leading to a reduced fire frequency and allowing silver sagebrush to dominate the site.

Community Phase 2.2:
This community phase is characteristic of a post-disturbance, early seral community where annual non-native species are present. Perennial bunchgrasses such as slender wheatgrass and Letterman's needlegrass dominate. Silver sagebrush, snowberry, and rabbitbrush will sprout soon after fire. Annual non-native species are stable or increasing within the community.

Community Phase Pathway 2.2a: Time and lack of disturbances such as fire, long-term drought, or Aroga moth infestation allow silver sagebrush to increase. Grazing management that favors the growth of sagebrush will allow the shrub component to increase.

Community Phase 2.3 (at-risk): This community is at risk of crossing a threshold to another state. Silver sagebrush increases in the absence of disturbance and is dominant. Deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from inappropriate grazing management, or both. Annual non-natives species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, long-term drought, and fire.

Moist Clay Slope (R028BY102NV) Phase 2.3. T. Stringham, July 2012.

Moist Clay Slope (R028BY102NV) Phase 2.3. T. Stringham, July 2012.

Community Phase Pathway 2.3a: Fire will reduce the overstory of silver sagebrush for a period of time and allow perennial grasses and forbs to increase. Annual non-native species are present and may increase in the community.

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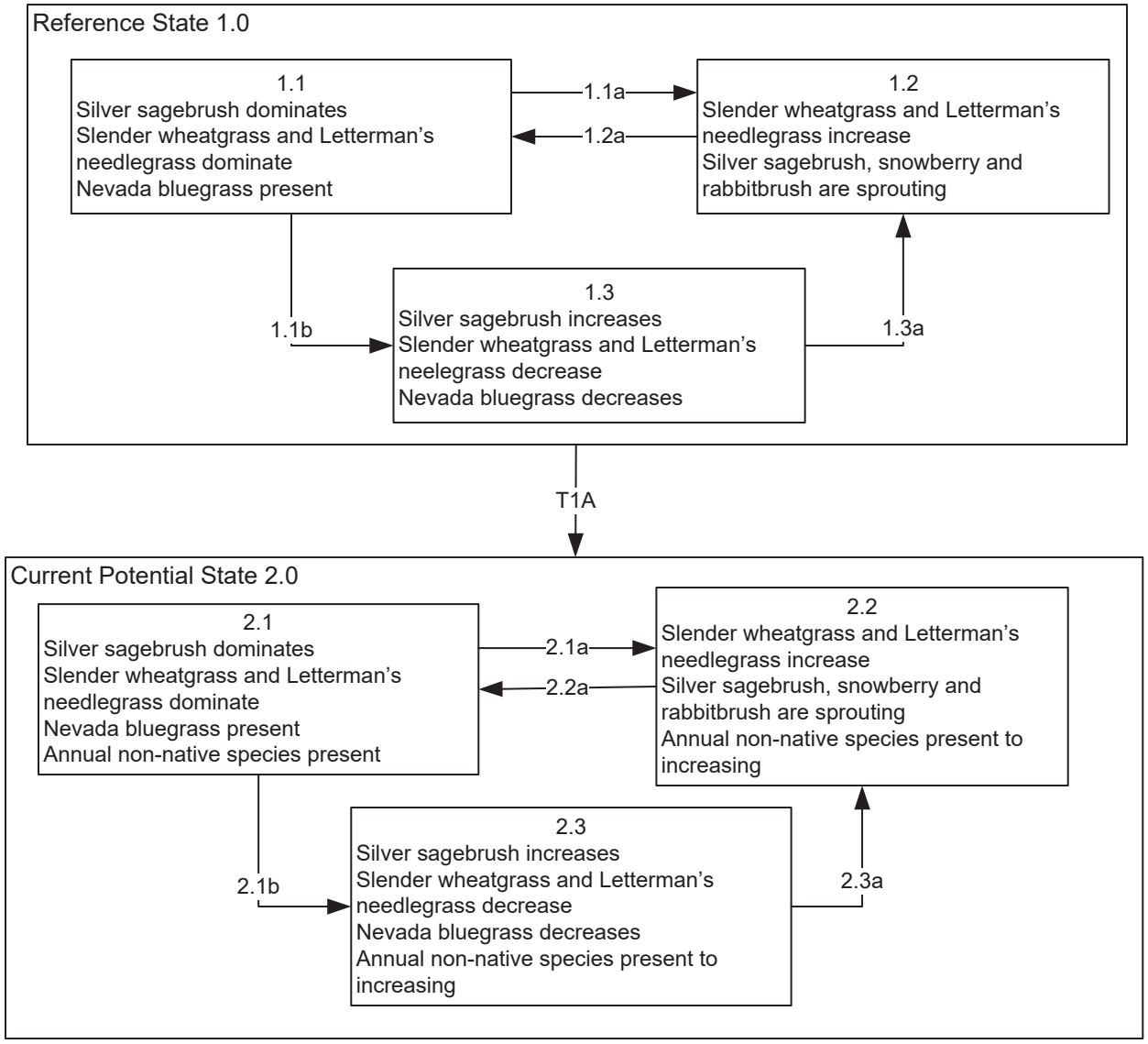
Moist Clay Slope
028BY102NV



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Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community, dominated by grasses and forbs.
1.1b: Time and lack of disturbances such as fire or drought. Excessive herbivory may also decrease perennial understory.
1.2a: Time and lack of disturbance allows for shrub regeneration.
1.3a: High severity fire significantly reduces sagebrush cover leading to early/mid-seral community.

Transition T1A: Introduction of non-native species such as cheatgrass.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire creates grass/sagebrush mosaic; high severity fire significantly reduces sagebrush cover and leads to early seral community dominated by grasses and forbs; non-native annual species present.
2.1b: Time and lack of disturbances such as fire or drought. Inappropriate grazing management may also reduce perennial understory.
2.2a: Time and lack of disturbance allows for regeneration of sagebrush.
2.3a: High severity fire significantly reduces sagebrush cover leading to leads to early seral community dominated by grasses and forbs.

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