Final Report
USDA Ecological Site Description
State-and-Transition Models
Major Land Resource Area 28A and 28B Nevada
February 2015

Tamzen K. Stringham[1]
Patti Novak-Echenique[2]
Paul Blackburn[3]
Cody Coombs[4]
Devon Snyder[5]
Amanda Wartgow[6]

Authors are [1]Professor, [5,6]Rangeland Ecologists, Dept. of Agriculture, Nutrition and Veterinary Sciences University of Nevada, Reno, NV, [2]State Rangeland Management Specialist, USDA-NRCS Reno, NV, [3]MLRA Soil Survey Leader, USDA-NRCS Elko, NV, and [4]Hazardous Fuels Program Manager, BLM, Ely, NV

Cite as:

Stringham, T.K., P. Novak-Echenique, P. Blackburn, C. Coombs, D. Snyder, and A. Wartgow. 2015. Final Report for USDA Ecological Site Description State-and-Transition Models, Major Land Resource Area 28A and 28B Nevada. University of Nevada Reno, Nevada Agricultural Experiment Station Research Report 2015-01. p. 1524.

Cooperators: USDA Natural Resource Conservation Service, USDA Agricultural Research Service, USDI Bureau of Land Management and Eureka County, NV.

Final Report submitted to USDA Agricultural Research Service as fulfillment of Agreement # 58-5370-2-211

Disturbance Response Group 20AB

Contents **Page**

DRG 20AB – Modal Site Alkali Silt Flat 028BY097NV

Ecological sites within DRG 20AB	729
Narrative	730
Modal State-and-Transition model	739
References	741
Additional STMs within DRG 20AB	743

Ecological Sites within Disturbance Response Group 20AB:
Modal Site: Alkali Silt Flat 028BY097NV

Group	Name	Site ID
20AB	**Alkali Silt Flat**	**028BY097NV**
	Alkali Silt Flat	028AY020NV

MLRA 28

Group 20

Disturbance Response Group (DRG) 20 consists of two ecological sites. Precipitation ranges from 5 to 8 inches. Slope gradients range from 0 to 2 percent. Elevations range from 4500 to 6000 feet. Production is about 350 pounds per acre for normal years. The soils on these sites are very deep formed in alluvium from mixed sources and lacustrine deposits. These soils are calcareous, strongly saline and moderately to very strongly alkaline. Water intake rates are moderately slow to slow and these soils are often ponded in the early spring. Available water capacity is reduced by salinity. The soil temperature regime is mesic and the soil moisture regime is typic aridic. The potential native plant community is dominated by sickle saltbush (*Atriplex falcata*). Bottlebrush squirreltail (*Elymus elymoides*) is the dominant perennial bunchgrass and Indian ricegrass (*Achnatherum hymenoides*) and western wheatgrass (*Pascopyrum smithii)* are also commonly found on these sites. Black greasewood (*Sarcobatus vermiculatus*) and green molly (*Bassia americana*) make up minor components of these sites.

Modal Site:
The Alkali Silt Flat (R028BY097NV) is the ecological site that represents this DRG; as it has the most acres mapped. This site occurs on lakeplains and alluvial flats. Slope gradients of 0 to 2 percent are most typical. Elevations are from 5400 to 6000 feet. Soils on this site are fine-textured, very deep and are formed in lacustrine deposits from mixed rock sources. Surface textures are silt loams, silty clay loams and sandy clay loams. Fine vesicular pores are common in the surface soils. These soils are moderately or strongly calcareous; very strongly alkaline in at least some part of the soil profile; and slightly to strongly saline. Water intake rates are slowed in the presence of soil horizons containing vesicular porosity and available water capacity is reduced by salinity. These soils are often ponded early in the spring with runoff from higher landscapes. The soils also have an inherently severe erosion potential because of low infiltration rates and slow permeability. The soil temperature regime is mesic and the soil moisture regime is typic aridic. The plant community is dominated by sickle saltbush, although black greasewood may dominate the visual aspect. Production ranges from 200 to 500 pounds per acre.

Disturbance Response Group 20 – ecological sites:

Alkali Silt Flat Modal	028BY097NV
Alkali Silt Flat	028AY020NV

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 invasives. 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).

The Great Basin shrub communities have high spatial and temporal variability in precipitation, both among years and within growing seasons. Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The moisture resource supporting the greatest amount of plant growth is usually the water stored in the soil profile during the winter. The invasibility of plant communities is often linked to resource availability. Disturbance can decrease resource uptake due to damage or mortality of the native species and depressed competition or can increase resource pools by the decomposition of dead plant material following disturbance.

These salt-desert shrub communities are dominated by plants belonging to the family Chenopodiaceae. Chenopods possess morphological and physiological traits that permit accommodation of both climatological drought resulting from low levels of precipitation, and physiological drought caused by high salt content of soils.

*Atriplex s*pecies are considered medium to short-lived shrubs and possess a number of morphological and physiological traits that enable them to cope with drought. Some of these traits include: a) photosynthesis through the C_4 carboxylation pathway; b) production of leaf trichomes and accumulation of salt crystals on the leaf surface to increase reflectance; c) accumulation and synthesis of inorganic and organic solutes to maintain turgor; and 4) root association with endomycorrhizae that allows absorption of soil moisture at very low water potentials (Cibils, et al. 1998, Dobrowolski 1990, Newton and Goodin 1989). Two *Atriplex* species occur on this site: sickle saltbush and shadscale (*Atriplex confertifolia*). Sickle saltbush is a low-growing, evergreen, subshrub which is woody at the base and herbaceous above (Mozingo 1987). Shadscale is an evergreen, rigidly branched, spiny, compact rounded shrub (Perryman 2014).

Black greasewood is a deciduous, intricately branched, spreading or erect shrub (Mozingo 1987). It is classified as a phreatophyte (Eddleman 2002), and its distribution is well correlated with the distribution of groundwater (Mozingo 1987). Meinzer (1927) discovered that the taproots of black greasewood could penetrate from 20 to 57 feet below the surface. Romo (1984) found water tables ranging from 3.5-15 m under black greasewood dominated communities in Oregon. Black greasewood stands develop best where moisture is readily available, either from surface or subsurface runoff (Brown 1965). It is commonly found on floodplains that are either subject to periodic flooding, have a high water table at least part of the year, or have a water table less than 34 feet deep (Harr and Price 1972, Blauer et al. 1976, Branson et al. 1976, Blaisdell and Holmgren 1984, Eddleman 2002). Ganskopp (1986) reported that water tables within 9.8 to 11.8 inches of the surface had no effect on black greasewood in Oregon. However, a study, conducted in California, found that black greasewood did not survive six months of continuous flooding (Groeneveld and Crowley 1988, Groeneveld 1990). Black greasewood is usually a deep rooted shrub but has some shallow roots near the soil surface; the maximum rooting depth can be determined by the depth to a saturated zone (Harr and Price 1972).

The herbaceous component is sparse and depends on annual precipitation. This component includes both perennial deep-rooted and shallow-rooted bunchgrasses, perennial rhizomatous grasses and perennial forbs. The soils have low to negligible surface runoff and typically have a well-developed vesicular crust, thus vegetation productivity is enhanced in wet years when flooding and ponding can occur.

The ecological sites in this DRG have low resilience to disturbance and resistance to invasion. The primary disturbance on these sites is long-term drought, inappropriate grazing and soil disturbance (off-road vehicles, etc). Halogeton (*Halogeton glomeratus*), Russian thistle (*Salsola tragus)* and cheatgrass (*Bromus tectorum*) are most likely to invade disturbed sites. Four possible stable states have been identified for this DRG.

Fire Ecology:

Historically, salt-desert shrub communities had sparse understories and bare soil in intershrub spaces, making these communities somewhat resistant to fire (Young 1983, Paysen et al. 2000). They may burn only during high fire hazard conditions; for example, years with high precipitation can result in almost continuous fine fuels from the herbaceous component, increasing the fire hazard (West 1994, Paysen et al. 2000).

Sickle saltbush sprouts from the root and shows an ability to reproduce by root sprouts where soil is loose and friable (Nord et al. 1969) which may allow it to sprout after fire. Sickle saltbush has also been observed to have stem layering where branches are partially covered by soil (Nord et al. 1969, Blaisdell and Holmgren 1984) and the conditions are favorable. These plants have been observed to recover quickly after roadside burning (Nord et al. 1969), but the research is inconclusive on its response to wildfire. Shadscale, however, is intolerant of fire and is typically killed. Reestablishment is from seed (Simonin 2001).

Black greasewood may be killed by severe fires, but can resprout after low to moderate severity fires (Robertson 1983, West 1994). Sheeter (1968) reported that following a Nevada wildfire, black greasewood sprouts reached approximately 2.5 feet within 3 years. Grazing and other disturbance may result in increased biomass production due to sprouting and increased seed production, also leading to greater fuel loads (Sanderson and Stutz 1994, Paysen et al. 2000).

Bottlebrush squirreltail the dominant grass on this site, is considered more fire tolerant than other bunchgrasses due to its small size, coarse stems, and sparse leafy material (Britton et al. 1990a). Postfire regeneration occurs from surviving root crowns and from on- and off-site seed sources. Bottlebrush squirreltail has the ability to produce large numbers of highly germinable seeds, with relatively rapid germination (Young and Evans 1977) when exposed to the correct environmental cues. Early spring growth and ability to grow at low temperatures contribute to the persistence of bottlebrush squirreltail among cheatgrass dominated ranges (Hironaka and Tisdale 1973).

Western wheatgrass, the sub-dominant grass on this site, is a coarse-leaved, sod forming perennial grass (Wasser and Shoemaker 1982). It has good fire tolerance, likely due to its coarse leaves and rhizomatous growing structure (Wasser and Shoemaker 1982). In a study by White and Currie (1983), fall burning increased western wheatgrass but clipping and spring burning basal cover was similar to the untreated control plot.

Livestock/Wildlife Grazing Interpretations:

Productivity and grazing capacities are typically low for salt-desert shrub communities and these sites are typically used for winter range. Sickle saltbush, fourwing saltbush and shadscale provide valuable winter forage for livestock and wildlife on salt-desert rangelands (Ansley and Abernethy 1983). Black greasewood is browsed by cattle when green, but contains soluble oxalates that may cause poisoning and death if large quantities are consumed in a short time period (Blaisdell and Holmgren).

Bottlebrush squirreltail generally increases in abundance when moderately grazed or protected (Hutchings and Stewart 1953). In addition, moderate trampling by livestock in big sagebrush rangelands of central Nevada enhanced bottlebrush squirreltail seedling emergence compared to untrampled conditions. Heavy trampling however was found to significantly reduce germination sites (Eckert et al. 1987). Squirreltail is more tolerant of grazing than other perennial bunchgrasses but all bunchgrasses are sensitive to over utilization within the growing season.

Western wheatgrass is considered one of the most valuable wheatgrasses on rangelands. It often inhabits sites with high salinity and few other grass species (Dayton 1937). It is valuable forage for sheep, especially as a winter feed; it is also rated as a choice forage for elk and deer (Dayton 1937). Repeated spring and early summer grazing will decrease the cover of the more palatable species and increase the potential for serious soil erosion. Undesirable perennial species will increase and non-native annuals such as halogeton, Russian thistle and cheatgrass will invade. With grazing, saltbush will initially increase in the community and native perennial bunchgrasses will decrease. In a study by Fisser and Joyce (1983), saltbush remained the dominant vegetation in an exclosure protected from grazing for seven years. After sixteen years of protection from grazing the same exclosures exhibited an increase in perennial bunchgrasses and a subsequent decrease in sickle saltbush which was significantly correlated with precipitation combined with protection from grazing. They also found that 35 percent shrub removal during winter was acceptable for maintenance of the population, but severe overuse can cause a decrease in sickle saltbush and allow an increase in halogeton.

Inappropriate grazing during the winter while soils are wet may lead to soil compaction and reduced infiltration. Prolonged inappropriate grazing during any season leads to abundant bare ground, destruction of microbiotic crusts, and active wind and water erosion (Blaisdell and Holmgren 1984).

Salt-desert shrub communities are relatively simple in terms of structure and species diversity but they serve as habitat for several wildlife species including reptiles, small mammals, birds and large herbivores (Blaisdell and Holmgren 1984).

STM Narrative Group 20

Reference State 1.0: The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. This state has two community phases, one dominated by shrubs and grasses and the other dominated by shrubs. 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. This site is very stable, with little variation in plant community composition. Plant community changes would be reflected in production in response to drought or abusive grazing. Wet years will increase grass production, while drought years will reduce production. Shrub production will also increase during wet years.

Community Phase 1.1:
This community is dominated by sickle saltbush. Bottlebrush squirreltail is also an important species on this site. Black greasewood may be a significant component or dominant species. Community phase changes are primarily a function of long-term drought. Fire is infrequent and patchy due to low fuel loads.


Alkali Silt Flat (028BY097NV) Phase 1.1 T. Stringham May 2012


Alkali Silt Flat (028BY097NV) Phase 1.1 T. Stringham May 2012


Alkali Silt Flat (028BY097NV) Phase 1.1 T. Stringham May 2012

Community Phase Pathway 1.1a: Long-term drought and/or herbivory would reduce the perennial grasses on this site.

Community Phase 1.2:
Long-term drought will favor shrubs over perennial bunchgrasses. However, long-term drought will result in an overall decline in the plant community, regardless of functional group. Sickle saltbush and other shrubs dominate the overstory, squirreltail and other grasses are reduced to trace amounts.

Community Phase Pathway 1.2a: Time, lack of disturbance and recovery from long-term drought would allow the vegetation to increase and bare ground would eventually decrease.

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 halogeton and cheatgrass.
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 two 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. 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 is dominated by sickle saltbush. Bottlebrush squirreltail is also an important species on this site. Black greasewood may be a significant component of the plant community. Community phase changes are primarily a function of long-term drought. Fire is infrequent and patchy due to low fuel loads. Non-native annual species are present.

Community Phase Pathway 2.1a: Inappropriate grazing and/or long-term drought would decrease the production on these sites.

Community Phase 2.2:
Long-term drought will initially favor shrubs over bunchgrasses; however long-term drought will result in an overall decline in the plant community regardless of functional group. Unpalatable shrubs such as sickle saltbush increase with inappropriate grazing while squirreltail and shadscale decline. Bare ground increases along with annual weeds.

Community Phase Pathway 2.1a: Release from long-term drought and/or growing season grazing pressure allows recovery of bunchgrasses.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0:
Trigger: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses and decrease sickle saltbush.
Slow variables: Long-term decrease in deep-rooted perennial grass density.

Threshold: Loss of deep-rooted perennial bunchgrasses changes nutrient cycling, nutrient redistribution, and reduces soil organic matter.

T2B: Transition from Current Potential State 2.0 to Eroded State 4.0:

Trigger: Contiguous inappropriate grazing management and/or soil disturbing treatments.
Slow variables: Increased bare ground and/or increase amount of non-native annual species.
Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community.

Shrub State 3.0: This state consists of one community phase. This site has crossed a biotic threshold and site processes are being controlled by shrubs.

Community Phase 3.1:

Perennial grasses like bottlebrush squirreltail and western wheatgrass are reduced and the site is dominated by sickle saltbush, black greasewood, shadscale and other shrubs. Annual non-native species may be present to increasing. Bare ground is significant.

T3A: Transition from Shrub State 3.0 to Eroded State 4.0:

Trigger: Contiguous inappropriate grazing management and/or soil disturbing treatments.
Slow variables: Increase in bare ground, increased production and cover of non-native annual species.
Threshold: Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and saltbush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

Eroded State 4.0: This site consists of one community phase. Abiotic factors including soil redistribution and erosion, soil temperature, soil crusting and sealing are primary drivers of ecological condition within this state. Soil moisture, soil nutrients and soil organic matter distribution and cycling are severely altered due to degraded soil surface conditions.

Community Phase 4.1:

Sickle saltbush and other shrubs may be the dominant species but are only present in patches, and are not contributing to site function. Regeneration of herbaceous species is not evident. Invasive plants (halogeton, Russian thistle) are sporadic and associated on mounds bordering playettes. Bare ground may be abundant, especially during low precipitation years. Soil erosion, soil temperature and wind are driving factors in site function.


Alkali Silt Flat (028AY020NV) Phase 4.1 T. Stringham April 2013

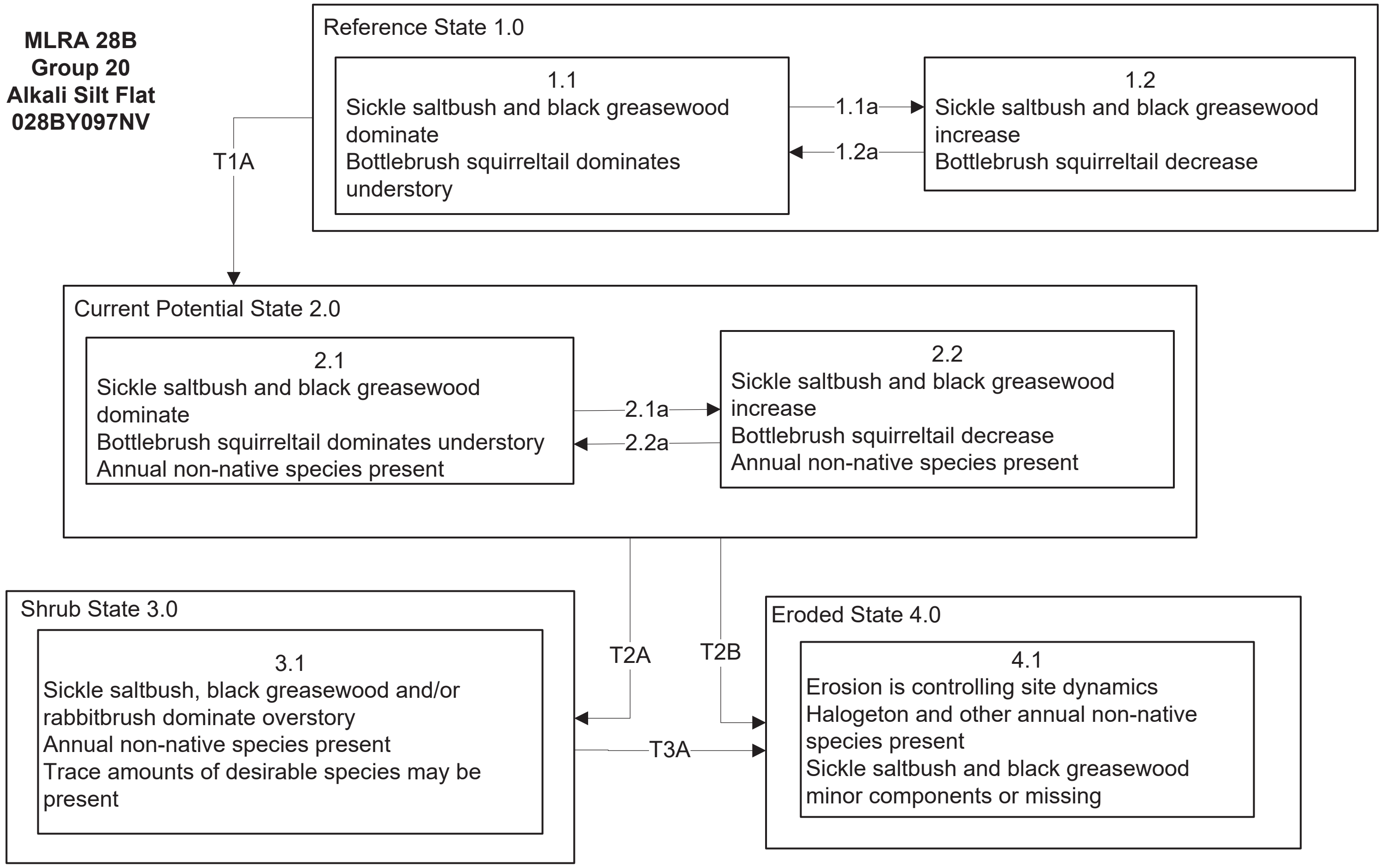

Alkali Silt Flat (028AY020NV) Phase 4.1 T. Stringham April 2013


Alkali Silt Flat (028AY020NV) Phase 4.1 T. Stringham April 2013

Potential Resilience Differences with other Ecological Sites:

Alkali Silt Flat (028AY020NV): This site is dominated by sickle saltbush and bottlebrush squirreltail. Indian ricegrass and green molly make up minor components on this site. Production ranges from 200 to 300 pounds per acre. Resilience and resistance to invasion would be similar to the modal site.

Historically, it is theorized green molly (*Bassia americana*) occupied monotypic stands in saline soils and declined in abundance from 1950-1970 following the increase in sheep numbers on desert ranges (Esplin et al. 1937). Green molly is not highly valued as a range plant but is palatable and nutritious as winter forage for sheep (Esplin et al. 1937). In a study in Utah by Cook and Stoddart (1953), green molly provided up to eight percent of the diet of range sheep, and was utilized at 95 percent. Green molly is also an important forage species for jackrabbits (Clark 1979).


MLRA 28B
Group 20
Alkali Silt Flat
028BY097NV
Reference State 1.0
1.1
Sickle saltbush and black greasewood dominate
Bottlebrush squirreltail dominates understory
1.1a
1.2a
1.2
Sickle saltbush and black greasewood increase
Bottlebrush squirreltail decrease
T1A
Current Potential State 2.0
2.1
Sickle saltbush and black greasewood dominate
Bottlebrush squirreltail dominates understory
Annual non-native species present
2.1a
2.2a
2.2
Sickle saltbush and black greasewood increase
Bottlebrush squirreltail decrease
Annual non-native species present
T2A
T2B
Shrub State 3.0
3.1
Sickle saltbush, black greasewood and/or rabbitbrush dominate overstory
Annual non-native species present
Trace amounts of desirable species may be present
T3A
Eroded State 4.0
4.1
Erosion is controlling site dynamics
Halogeton and other annual non-native species present
Sickle saltbush and black greasewood minor components or missing

MLRA 28B
Group 20
Alkali Silt Flat
028BY097NV

Reference State 1.0 Community Phase Pathways
1.1a: Drought and/or excessive herbivory would reduce some perennial grasses and some shrubs
1.2a: Release from drought and/or time and lack of disturbance

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

Current Potential State 2.0 Community Phase Pathways
2.1a: Prolonged drought and/or inappropriate grazing management
2.2a: Release from drought and/or lack of disturbance

Transition T2A: Inappropriate grazing management may be combined with drought.

Transition T2B: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), severe drought, and/or inappropriate grazing management

Transition T3A: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), severe drought, and/or inappropriate grazing management

References:

Ansley, J. R. and R. H. Abernethy. 1983. Overcoming seed dormancy in Gardner saltbush (*Atriplex gardneri (moq.)* D. Dietr) as a strategy for increasing establishment by direct seeding. Pp 152-158. *In* Tiedemann, Arthur R.; McArthur, Durrant E.; Stutz, Howard C.; Stevens, Richard; Johnson, Kendall L., compilers. Proceedings- Symposium on the Biology of *Atriplex* and Related Chenopods. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Provo, Utah.

Blaisdell, J. P. and R. C. Holmgren. 1984. Managing Intermountain Rangelands - Salt-desert Shrub Ranges. General Technical Report INT-163, USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Caudle, D.J., M. DiBenedetto, M. Karl, H. Sanchez, and C. Talbot. 2013. Interagency Ecological Site Handbook for Rangelands. Available at: http://jornada.nmsu.edu/sites/jornada.nmsu.edu/files/InteragencyEcolSiteHandbook.pdf. Accessed 4 October 2013.

Chambers, J., B. Bradley, C. Brown, C. D'Antonio, M. Germino, J. Grace, S. Hardegree, R. Miller, and D. Pyke. 2013. Resilience to stress and disturbance, and resistance to *Bromus tectorum* L. Invasion in Cold Desert Shrublands of Western North America. Ecosystems 17:1-16.

Cibils, A.F., D.M. Swift, and E.D. McArthur. 1998. Plant Herbivore Interactions in Atriplex: Current State of Knowledge. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Gen. Tech. Rept. RMRS-GTR-14. 31pp.

Clark, W.R. 1979. Population Limitation of Jackrabbits: an Examination of the Food Hypothesis. All Graduate Thesis and Dissertations. Paper 3502. Available at: http://digitalcommons.usu.edu/etd/3502

Cook, C. W. and L.A. Stoddart, L. A. 1953. Bulletin No. 364 - The Halogeton Problem in Utah. *UAES Bulletins.* Paper 322. Available at: http://digitalcommons.usu.edu/uaes_bulletins/322

Dayton, W. 1937. Range Plant Handbook. USDA, Forest Service. Bull.

Dobrowolski, J.P., M.M. Caldwell, and J.H. Richards. 1990. Basin Hydrology and Plant Root Systems. *In:* Osmond, C.B., L.F. Pitelka, and G.M. Hidy (eds). Plant Biology of the Basin and Range. Berlin, Heidelberg, Springer-Verlag: 243-292.

Eckert, R. E., Jr., F. F. Peterson, and F. L. Emmerich. 1987. A study of factors influencing secondary succession in the sagebrush [*Artemisia* spp. L.] type. *In:* G. W. Frazier, R.A. Evans [eds.]Proceedings: Seed and seedbed ecology of rangeland plants. U. S. Department of Agriculture, Agricultural Research Service, Tucson, A.Z. p. 149-168

Esplin, A. C., J.E. Greaves, and L.A. Stoddart. 1937. Bulletin No. 277 - A Study of Utah's Winter Range: Composition of Forage Plants and Use of Supplements. *UAES Bulletins.* Paper 239. http://digitalcommons.usu.edu/uaes_bulletins/239

Fisser, H. G. and L. A. Joyce. 1983. Atriplex/Grass and forb relationships under no grazing and shifting precipitation patterns in north-central Wyoming. Page 87 *In:* Tiedemann, Arthur R.; McArthur, Durrant E.; Stutz, Howard C.; Stevens, Richard; Johnson, Kendall L., compilers. Proceedings- Symposium on the Biology of *Atriplex* and Related Chenopods. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Provo, Utah.

Hodgkinson, H. S. 1987. Relationship of saltbush species to soil chemical properties. Journal of Range Management 40:23-26.

Hutchings, S. S. and G. Stewart. 1953. Increasing forage yields and sheep production on Intermountain winter ranges. Circular No. 925. U.S. Department of Agriculture, Washington, D.C.

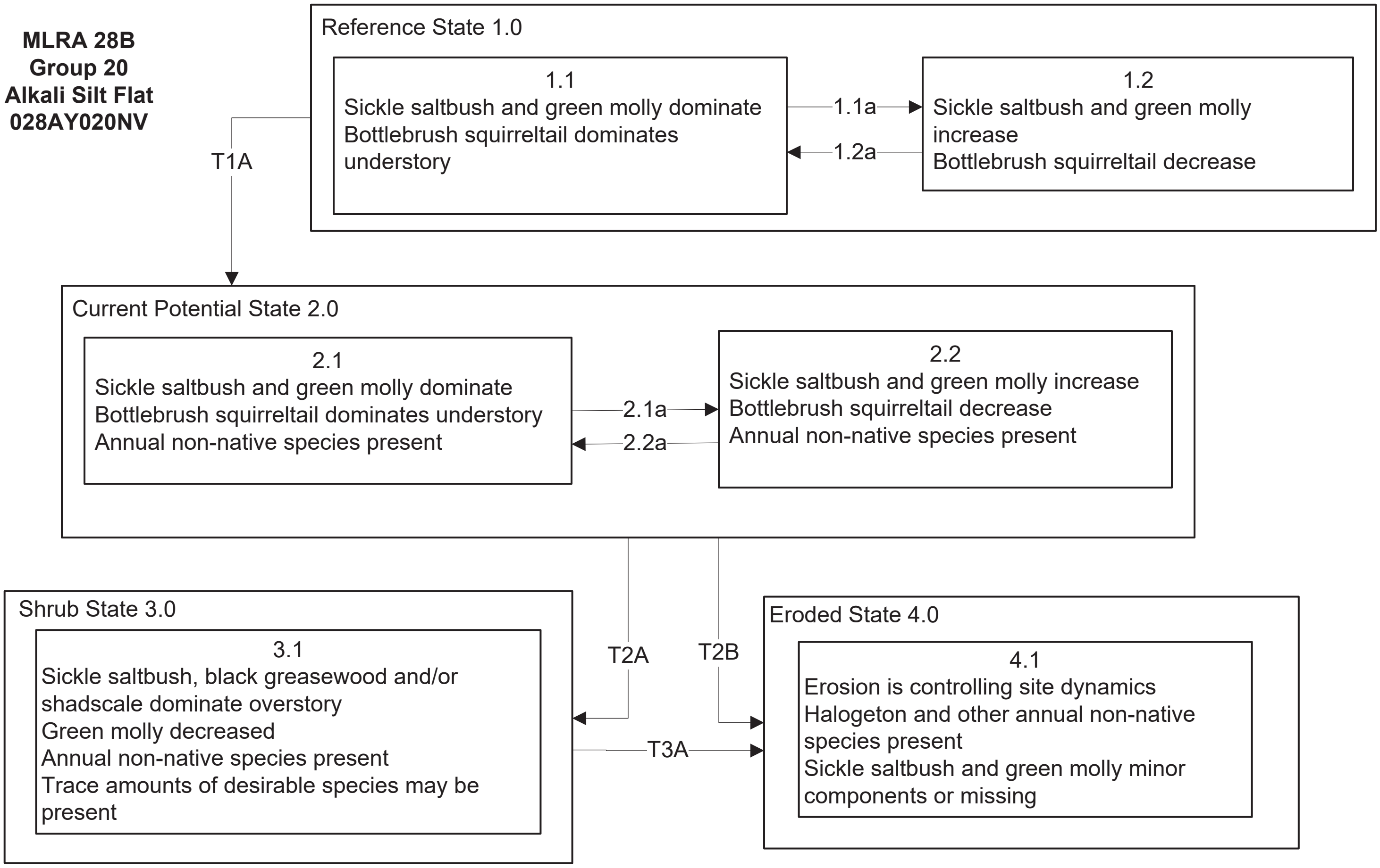
Mozingo, H.N. 1987. Shrubs of the Great Basin. University of Nevada Press, Reno, NV. 342p.

Newton, R.J. and J.R. Goodin. 1989. Moisture stress adaptation in shrubs. *In*: McKell, C.M., [ed.] The Biology and Utilization of Shrubs. Academic Press, New York. p. 365-378.
Nord, E. C., D. R. Christensen, and A. P. Plummer. 1969. *Atriplex* species [or Taxa] that spread by root sprouts, stem layers, and by seed. Ecology 50:324-326.
Paysen, T. E., R. J. Ansley, J. K. Brown, G. J. Gottfried, S. M. Haase, M. G. Harrington, M. G. Narog, S. S. Sackett, and R. C. Wilson. 2000. Fire in western shrubland, woodland, and grassland ecosystems. Wildland fire in ecosystems: Effects of Fire on Flora. Gen. Tech. Rep. RMRS-GTR-42-vol 2:121-159.
Perryman, B. 2014. A Field Guide to Nevada Shrubs. Indigenous Rangeland Management Press. Lander, Wyoming
Robertson, J. 1983. Greasewood (*Sarcobatus vermiculatus* (Hook.) Torr.). Phytologia 54:309-324.
Sanderson, S. C. and H. C. Stutz. 1994. Woody chenopods useful for rangeland reclamation in western North America. *In:* S. B. Monsen, S. G. Kitchen [eds.]Proceedings-- ecology and management of annual rangelands. Gen. Tech. Rep. INT-GTR-313. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Boise, ID. P. 374-378
Sheeter, G.R. 1968. Secondary succession and range improvements after wildfire in northeastern Nevada. Thesis. Reno, NV: University of Nevada. 203 p.
Simonin, Kevin A. 2001. Atriplex confertifolia. *In*: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/.
Wasser, C. H. and J. W. Shoemaker. 1982. Ecology and culture of selected species useful in revegetating disturbed lands in the West. FWS/OBS-82/56. Fish and Wildlife Service, US Department of the Interior.
West, N. E. 1994. Effects of fire on salt-desert shrub rangelands. *In:* S. B. Monsen, S. G. Kitchen [eds.]Proceedings--Ecology and Management of Annual Rangelands Gen. Tech. Rep. INT-GTR-313. USDA, Forest Service, Intermountain Research Station, Boise, ID
White, R. S. and P. O. Currie. 1983. Prescribed burning in the Northern Great Plains: Yield and cover responses of 3 forage Species in the mixed grass prairie. Journal of Range Management 36:179-183.
Young, R. P. 1983. Fire as a vegetation management tool in rangelands of the intermountain region. *In* S.B. Monsen, N. Shaw [eds.] Proceedings: Managing intermountain rangelands - improvement of range and wildlife habitats Gen. Tech. Rep. INT-GTR-157. U.S. Department of Agriculture, Forest Service. P. 18-31.

Group 20AB:
Additional State - and -Transition Models:

Name	Site ID
Alkali Silt Flat	028AY020NV

MLRA 28B
Group 20
Alkali Silt Flat
028AY020NV



Reference State 1.0 Community Phase Pathways
1.1a: Drought and/or excessive herbivory would reduce some perennial grasses and some shrubs
1.2a: Release from drought and/or time and lack of disturbance

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

Current Potential State 2.0 Community Phase Pathways
2.1a: Prolonged drought and/or inappropriate grazing management
2.2a: Release from drought and/or lack of disturbance

Transition T2A: Inappropriate grazing management may be combined with drought.

Transition T2B: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), severe drought and/or inappropriate grazing management

Transition T3A: Soil disturbing treatments (drill seeding, roller chopper, Lawson aerator etc.), severe drought and/or inappropriate grazing management