Final Report for USFS Crooked River National Grassland

State-and-Transition Models

for

Selected Disturbance Response Groups in

Major Land Resource Area B10 Oregon

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Introduction to MLRA B10

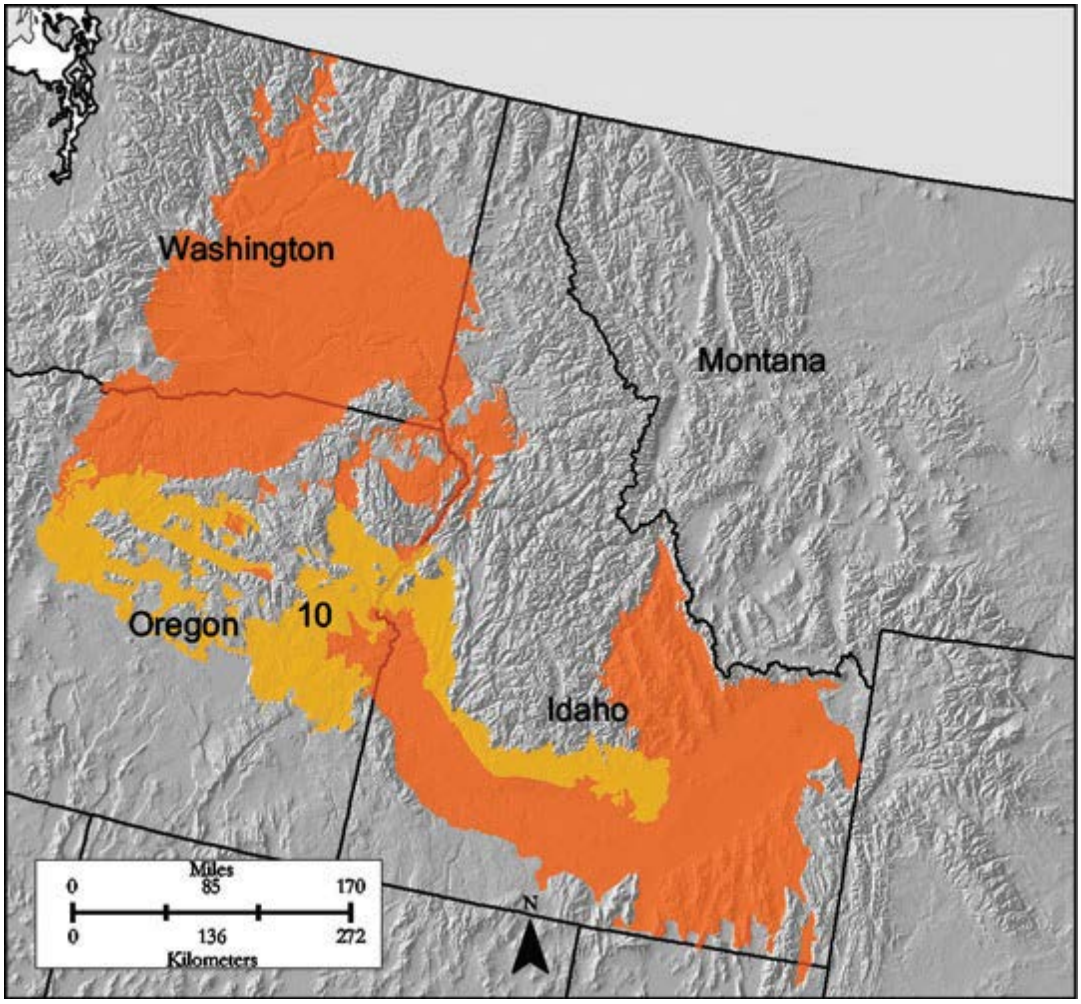


Figure 1: Location of MLRA 10 Land Resource Region B

MLRA B10 is located in Oregon (71 percent) and Idaho (29 percent). It makes up about 17,515 square miles (45,385 square kilometers) in Idaho, Oregon, Washington, and a small portion of Utah. Almost all of this MLRA is in the Columbia Plateaus Province of the Intermontane Plateaus. The western half of this area is in the Walla Walla Plateau Section, which is an area of rolling plateaus with young, incised valleys. A portion on the west edge of Idaho is in the Payette Section, which also is a young area of dissected plateaus. The eastern one-quarter of the MLRA is in two different physiographic provinces. The north half is in the Northern Rocky Mountains Province of the Rocky Mountain System, and the south half is in the Snake River Plain Section of the Intermontane Plateaus. A small area connecting the Oregon and Idaho parts of the MLRA is in the Harney Section of the Intermontane Plateaus. It is a young lava plateau with some evidence of recent volcanism. Small areas of the central portion of the MLRA are in the Blue Mountain Section, which is a dissected volcanic plateau in a complex of mountains. This MLRA is typified by gently rolling to steep hills, plateaus, and low mountains. Elevation ranges from 1,300 to 6,600 feet (395 to 2,010 meters), increasing from west to east.

Geology

The geology of this MLRA varies widely in age and lithology. It ranges from raw young lava flows at Craters of the Moon National Monument, Idaho, to very old Cretaceous rocks at John Day Fossil Beds National Monument, Oregon. The part of the area in southwest and south-central Idaho consists of basalt flows from the Columbia and Idaho Batholiths. The flows in the east half are cut by Yellowstone volcanics. Some Paleozoic sediments occur in the east. Deep alluvial deposits are in valleys along the major streams and on fans adjacent to the mountains. Lithologies include basalt, rhyolite, schist, granite, graywacke, limestone, sandstone, and tuff.

Climate

The average annual precipitation is 8 to 16 inches (205 to 405 millimeters) in most of this area. It increases from west to east and with elevation. It is as much as 41 inches (1,040 millimeters) at the higher elevations along the northern border of the area. Precipitation is evenly distributed throughout fall, winter, and spring but is low in summer. Some high-intensity, convective thunderstorms occur during the growing season. Winter precipitation is primarily snow. The average annual temperature is 36 to 53 degrees F (2 to 12 degrees C). The freeze-free period averages 140 days and ranges from 60 to 220 days, decreasing from west to east and with elevation.

Soils

The dominant soil order in this MLRA is Mollisols. Aridisols are of minor extent. The soils in the area have a mesic or frigid soil temperature regime, a xeric or aridic soil moisture regime, and mixed or smectitic mineralogy. They are very shallow to very deep, well drained, and clayey or loamy. Haploxerolls formed in residuum (Bakeoven series) and colluvium (Lickskillet, Rockly, and Westbutte series) on hills, plateaus, and mountains. Palexerolls (Simas series) formed in mixed loess and colluvium on hills. Argixerolls formed in ash (Tub series), in aeolian sediments (Madras series), in residuum (Deshler, Gem, Merlin, Reywat, and Waterbury series), and in residuum mixed with alluvium, colluvium, or loess (Ateron, McCarey, Riggins, Ruckles, and Vitale series) on hills, plateaus, and mountains. Argixerolls also formed in mixed alluvium and colluvium on fan terraces, hills, and mountains (Simonton series).

Land Use

Nearly half of the MLRA is federally owned and managed by the Bureau of Land Management. The rest is mainly in farms or ranches. Most of the area is used for livestock grazing. Irrigated agriculture occurs along the major rivers and in the Deschutes Basin in Oregon. Both irrigated and nonirrigated agriculture occur on the Camas Prairie in Idaho. Alfalfa and small grains are the dominant crops. Specialty crops, such as mint, carrots, onions, and fruits, can be grown in local areas. The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, loss of nutrients, streambank erosion, mass movement of soil caused by overuse of irrigation water, conservation of soil moisture, and preservation of water quality.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, nutrient management, critical area plantings, and streambank stabilization. Conservation practices on rangeland and pasture generally include prescribed grazing, spring development, watering facilities, wells, pipelines, fencing, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production and forage quality. Renovation of old pastures may include chiseling, disking, and applying fertilizer.

Disturbance Response Groups included in this report

MLRA B10 Disturbance Response Groups on Crooked River National Grassland					
Group	MLRA	SubMLRA	Site ID	Site Name	Acreage
2A	10	A	010XA019OR	Shrubby Loam 8-12 (modal)	9249
2A	10	A	010XA002OR	Juniper shrubby pumice hills 8-10	2587
2A	10	A	010XA022OR	Juniper Lava Blisters 8-10	382
2A	10	A	010XA024OR	Pumice North 8-10	917
2A	10	A	010XA027OR	Juniper Pumice Flat 8-10	180
2B	10	A	010XA009OR	Juniper Shrubby Pumice Flat 10-12	798
2B	10	A	010XA023OR	Juniper Shrubby Lava Blisters 10-12	916
2B	10	A	010XA025OR	Juniper Shallow North (modal)	6248
2B	10	A	010XA083OR	Juniper Shrubby North 10-12	1684
4	10	A	010XA001OR	Loamy Plains 8-10	20316
4	10	A	010XA018OR	Juniper Shrubby Loam 10-12 (modal)	25673
4	10	A	010XA007OR	Juniper Pumice South 9-12	11446
4	10	B	010XB022OR	JD Clayey 9-12 PZ	
4	10	B	010XB025OR	JD Sandy Loam 9-12	726
4	10	B	010XB044OR	JD Droughty South 9-12	
5	10	B	010XB027OR	JD Clayey 12-16 (modal)	4062
5	10	B	010XB045OR	JD Clayey South 12-16	846
5	10	B	010XB070OR	JD North 12-16	1520

Group 2A Preface

Group 2A note regarding the validity of this state and transition model and associated narrative:

Model is a Tier 1 model requiring additional field validation of States. The model was prepared with six States: Reference, Current Potential, Shrub State, Annual State, Tree State, and Seeded State. Typically, states and community phases are not described without evidence of existence. Evidence can be local knowledge translated to the STM developer or actual observational or quantifiable data. CRNG personnel provided data for one transect (C38) determined to be located in DRG 2A. Data indicated a Tree State with a Sandberg bluegrass and sixweeks fescue understory. Medusahead was measured at 3% foliar cover and will likely increase without active management.

The remaining States need to be verified either through CRNG personnel knowledge of this DRG or through field visits to locations exhibiting characteristics of these ecological states. I have concerns that the Shrub State may not exist within this DRG. Possibly the sagebrush / bitterbrush component never increases to a level where it dominates site resources. In addition, I did not include a Farmed State as it seemed unlikely given the soils correlated to these sites, however, farming was wide spread at time of settlement and may have occurred on the ecological sites within this DRG. Is there evidence of this activity occurring on any of the ecological sites within this group on the CRNG?

Group 2A

Group 2A represents sites on the lower end of the precipitation range (8-10pz) with the modal community designated as Pumice Flat 8-10pz. Elevation ranges from 2000 to 4000 feet with the average range of 2500 to 3700 feet. The majority of the sites are classified as non-aspect with the exception of the one north aspect site. Slope ranges from 0 to 65 percent with the majority of the sites occurring on slopes of less than 20 percent. The soils range from shallow to deep, are well drained and with sandy loam surface layers. They are generally formed in pumice ash over basalt bedrock. Soil temperatures are mesic with a xeric moisture regime. The potential native plant communities for all sites in this group have an old growth juniper component of 1 to 10 percent of composition by weight. However, the majority of sites are characterized as having up to 5 percent western juniper *(Juniperus occidentalis)* cover. The understory is comprised of two species of sagebrush; Wyoming big sagebrush (*Artemisia tridentata spp*. *wyomingensis*) and basin big sagebrush (*Artemisia tridentata spp. tridentata)*. Sagebrush cover ranges from 5 to 15 percent of plant community composition. The herbaceous component is dominated by either, needle and thread (*Hesperostipa comata)*, or bluebunch wheatgrass *(Pseudoroegneria spicata)*, with the exception of the Pumice North site that is dominated by Idaho fescue (*Festuca idahoensis)*.

Group 2A Ecological Sites

R010XA002OR JUNIPER SHRUBBY PUMICE HILLS 8-10 (Pumice Hills 8-10)
R010XA003OR DROUGHTY JUNIPER FAN 8-10
R010XA019OR SHRUBBY LOAM 8-12 (Droughty 8-12)
R010XA022OR JUNIPER LAVA BLISTERS 8-10 (Lava Blisters 8-10)
R010XA024OR PUMICE NORTH 8-10 PZ
R010XA027OR JUNIPER PUMICE FLAT 8-10 (Pumice Flat 8-10) MODAL for MLRA B10 Group 2A

Sites on Crooked River National Grassland

R010XA019OR SHRUBBY LOAM 8-12 (Droughty 8-12) MODAL for CRNG Group 2A
R010XA022OR JUNIPER LAVA BLISTERS 8-10 (Lava Blisters 8-10)
R010XA024OR PUMICE NORTH 8-10
R010XA002OR JUNIPER SHRUBBY PUMICE HILLS 8-10 (Pumice Hills 8-10)
R010XA027OR JUNIPER PUMICE FLAT 8-10 (Pumice Flat 8-10)

*() Previous Ecological site names

Modal Site for CRNG:

The Shrubby Loam 8-12” (R010XA019OR) ecological site is the modal site for this group as it has the most acres mapped in the Crooked River National Grassland (CRNG). This site occurs on gentle hills and the tops or slopes of low ridges. The annual precipitation ranges primarily from 8 to 12 inches and somewhat higher in a few locations. Precipitation occurs mainly between the months of October and June mostly in the form of rain. The soil temperature regime is mesic. Moisture regime is aridic. The soils of this site are shallow to moderately deep, well drained and coarse to medium textured. The potential native plant community is dominated by bluebunch wheatgrass. Wyoming big sagebrush and antelope bitterbrush *(Purshia tridentata)* make up the shrub component of the community. Sandberg bluegrass

(Poa secunda), Thurber's needlegrass *(Achnatherum thurberianum)* and prairie Junegrass *(Koeleria macrantha)* are common on these sites. Old growth western juniper are scattered throughout the site.

Model Site for MLRA B10:

The Juniper Pumice Flat 8-10" (R010XA027OR) ecological site is the modal site for this group as it has the most acres mapped in this MLRA. This site occurs on nearly level plains and gentle slopes of low hills. The annual precipitation ranges from 8 to 10 inches which occurs mainly between the months of November and June, mostly in the form of rain and snow. The soil temperature regime is mesic. The soils of this site are shallow to moderately deep or deep, well drained and sandy loam (medium) textured. They are generally formed in pumice ash over basalt bedrock. Permeability is moderately rapid and the available water holding capacity is 1 to 7 inches for the profile. The potential for wind erosion is high. The potential plant community is dominated by an open stand of juniper. The understory is composed of two distinct communities. Under the trees and within influence of the crown the plant community is dominated by Idaho fescue. The interspaces are dominated by basin big sagebrush and needle and thread grass. Minor components include Indian ricegrass (*Achnatherum hymenoides*), western needlegrass (*Achnatherum occidentale*), and Thurber's needlegrass.

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 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

The ecological sites in this DRG include deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). Tap roots of antelope bitterbrush have been documented from 4.5 to 5.4m in length (McConnell 1961). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, 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.

In the central Oregon, John Day ecological province, the majority of annual precipitation is received during the winter and spring months with about 28% arriving during the April through June period and 58% during November through March (Anderson et al. 1998). 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 great potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability with the soil profile (Bates et al. 2006).

Variability in plant community composition and production is influenced by soil surface texture and depth to the argillic horizon. Thurber's needlegrass will increase on course textured soils, whereas Idaho fescue favors a loamy soil surface, and a weak argillic horizon occurring within 8 to 12 inches of the surface will promote production of bluebunch wheatgrass. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth infestations, juniper encroachment and grazing.

Wyoming big and basin big sagebrush along with antelope bitterbrush are generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The Crooked River Grasslands sagebrush / grass 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. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007).

The introduction of annual weedy species, like cheatgrass and medusahead (*Taeniatherum caput-medusae)*, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush and or western juniper will increase and the understory bunchgrass community will decline as competition for limited resources increases. Inappropriate grazing management can facilitate the increase in the shrub community and decrease in the perennial bunchgrasses and forbs.

Western Juniper

During the past 140 years, western juniper has been expanding within its geographic range at unprecedented rates compared to any other time period during the Holocene (Miller et al. 2005) and density of western juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Western juniper woodlands in eastern Oregon with more than 10 percent canopy cover increased from 456,000 acres in 1936 to 2.2 million acres in 1988 (Gedney et al. 1990, Miller et al. 2005). Causes for expansion of western juniper into sagebrush ecosystems include changes in the wildfire return interval, historic livestock grazing, and climate influences (Bunting 1994). Mean fire return intervals prior to European settlement in mountain big sagebrush (*Artemisia tridentata ssp.*

vaseyana) ecosystems were 15 to 25 years (Burkhardt and Tisdale 1976, Young and Evans 1981, Miller and Rose 1999), frequent enough to inhibit the encroachment of western juniper into these big sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity.

An increase in juniper crown density causes a decrease in understory perennial vegetation and an increase in bare ground (Bates et al. 2000, Miller et al. 2000). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010). Additionally, as understory plant communities become depleted and soil resources become less available the opportunity for invasion by non-native annual species such as cheatgrass and medusahead increases. The highest risk for weed invasion in juniper encroached sagebrush communities are in the warmer (mesic soil temperature) lower elevation sites (Miller et al. 2005). With annual species in the understory wildfire can become more frequent and increase in intensity. Following fire, soil water and available nutrients generally increase, at least for a short period of time (Blank et al. 1994). Increases in nutrients, particularly nitrogen, enhance the growth of cheatgrass and increases the period of dominance (Miller et al. 2005). Once established, non-native annual species, especially cheatgrass, can shift the seasonality of fire to the active growing period of native perennials (Whisenant 1990). With frequent wildfires these plant communities can convert to annual grasslands with a sprouting shrub and juvenile tree overstory (Tausch 1999).

Nutrient and litter distribution are altered when juniper invades and dominates sagebrush sites. Soil calcium (Ca) and potassium (K) were found to increase under mature western juniper trees in central Oregon whereas nitrogen (N) and organic matter concentrations were highest under juvenile (< 40 yr.) old tree canopies (Doescher et. al. 1987). Changes in soil nutrient and organic matter distribution may have implications for plant community response post-fire or post-treatment.

Annual Invasive Grasses

The species most likely to invade these sites are cheatgrass and medusahead. Both species are cool-season annual grasses that maintain an advantage over native plants in part because they are prolific seed producers, able to germinate in the autumn or spring, tolerant of grazing and increase with frequent fire (Klemmedson and Smith 1964, Miller et al. 1999). Medusahead and cheatgrass originated from Eurasia and both were first reported in North America in the late 1800s (Mack and Pyke, 1983; Furbush 1953). Pellant and Hall (1994) found 3.3 million acres of public lands dominated by cheatgrass and suggested that another 76 million acres were susceptible to invasion by winter annuals including cheatgrass and medusahead. By 2003, medusahead occupied approximately 2.3 million acres in 17 western states (Rice 2005). In the Intermountain West, the exponential increase in dominance by medusahead has largely been at the expense of cheatgrass (Harris 1967, Hironaka 1989). Medusahead matures 2-3 weeks later than cheatgrass (Harris 1967) and recently, James et al. (2008) measured leaf biomass over the growing season and found that medusahead maintained vegetative growth later in the growing season than cheatgrass. Mangla et al. (2011) also found medusahead had a longer period of growth and more total biomass than cheatgrass and hypothesized this difference in relative growth rate may be due to the ability of medusahead to maintain water uptake as upper soils dry compared to co-occurring species, especially cheatgrass. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008). Harris (1967) reported cheatgrass roots to have a relatively poorly developed endodermis layer to insulate against hot dry soils, while medusahead roots have thicker cell walls, which allow it to conduct water throughout very dry soil horizons. Recent modeling and empirical work by Bradford and Lauenroth (2006) suggests that seasonal patterns of precipitation input and

temperature are also key factors determining regional variation in the growth, seed production, and spread of invasive annual grasses. Collectively, the body of research suggests that the continued invasion and dominance of medusahead onto native grasslands and cheatgrass infested grasslands will continue to increase in severity because conditions that favor native bunchgrasses or cheatgrass over medusahead are rare (Mangla et al. 2011). Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency.

Methods to control medusahead and cheatgrass include herbicide, fire, grazing, and seeding of primarily non-native wheatgrasses. Mapping potential or current invasion vectors is a management method designed to increase the cost effectiveness of control methods. A study by Davies et al. (2013), found an increase in medusahead cover near roads. Cover was higher near animal trails than random transects but the difference was less evident. This implies that vehicles and animals aid the spread of the weed; however, vehicles are the major vector of movement. Spraying with herbicide (Imazapic or Imazapic + glyphosate) and seeding with crested wheatgrass and Sandberg bluegrass has been found to be more successful at combating medusahead and cheatgrass than spraying alone (Sheley et al. 2012). Where native bunchgrasses are missing from the site, revegetation of medusahead or cheatgrass invaded rangelands has been shown to have a higher likelihood of success when using introduced perennial bunchgrasses such as crested wheatgrass (Davies et al. 2015). Butler et al. (2009) tested four herbicides (Imazapic, Imazapic + glyphosate, rimsulfuron and sulfometuron + Chlorsulfuron) only treatments for suppression of cheatgrass, medusahead and ventenata (North Africa grass, *Ventenata dubia*) within residual stands of native bunchgrass. Additionally, they tested the same four herbicides followed by seeding of six bunchgrasses (native and non-native) with varying success (Butler et al. 2009). Herbicide only treatments appeared to remove competition for established bluebunch wheatgrass by providing 100% control of ventenata and medusahead and greater than 95% control of cheatgrass (Butler et al. 2009) however caution in results is advised as only one year of data was reported. Prescribed fire has also been utilized in combination with the application of pre-emergent herbicide to control medusahead and cheatgrass (Vollmer and Vollmer 2008). Mature medusahead or cheatgrass is very flammable and fire can be used to remove the thatch layer, consume standing vegetation, and even reduce seed levels. Furbush (1953) reported that timing a burn while the seeds were in the milk stage effectively reduced medusahead the following year. He further reported that adjacent unburned areas became a seed source for reinvasion the following year. In considering the combination of pre-emergent herbicide and prescribed fire for invasive annual grass control it is important to assess the tolerance of desirable brush species to the herbicide being applied. Vollmer and Vollmer (2008) tested the tolerance of mountain mahogany (*Cercocarpus montanus*), antelope bitterbrush and multiple sagebrush species to three rates of Imazapic and the same rates with methylated seed oil as a surfactant. They found a cheatgrass control program in an antelope bitterbrush community should not exceed Imazapic at 8oz/ac with or without surfactant (Vollmer and Vollmer 2008). Sagebrush, regardless of species or rate of application was not affected. However, many environmental variables were not reported and managers should install test plots before broad scale herbicide application is initiated.

Ecological Resilience and Resistance: Summary

The ecological sites in this DRG have low to moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. However, the invasion ecology of medusahead increases the risk of conversion to an annual state substantially. Six alternative stable states have been identified for the modal model of this DRG, however there are some differences between ecological sites (see Potential Resilience Differences below).

Fire Ecology of Plant Species

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. Fire typically occurs past the end of the growing season for most forbs and grasses therefore the growing points are generally located at or below the soil surface providing relative protection from disturbances that remove above ground biomass. 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 plant material (Wright 1971, Young 1983, Davies et al. 2009). Furthermore, (Boyd and Davies 2012) found that bunchgrasses under shrub canopies burned more than 40% hotter than interspace counterparts leading to mortality rates greater than 73% (Boyd et al. 2015). Thus, fire severity is a function of seasonality and intensity along with the amount of biomass within the bunchgrass and surrounding the bunchgrass.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage from fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, interspace or shrub canopy location, fire severity, fire intensity and post-fire soil moisture availability.

The fine leaves and densely tufted growth form make Thurber's needlegrass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). However, there appears to be no detrimental effect of fall burning on Thurber's needlegrass (Davies and Bates 2008, Ellsworth and Boone 2010). Spring and early summer burning may result in a reduction in grass density (Ellsworth and Boone 2010, Wright and Klemmedson 1965, Uresk et al. 1976, Uresk et al. 1980). Although timing of fire highly influences the response and mortality of Thurber's needlegrass, smaller bunch sizes are less likely to be damaged by fire (Wright and Klemmedson 1965). Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire prescribed in May, June, and November were found to cause high mortality in addition to reducing basal area and yield of Thurber's needlegrass (Britton et al. 1990). Interspace or shrub canopy location is also an important parameter in mortality.

Idaho fescue response to fire varies with condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all seasons (Wright et al. 1979). Initial mortality may be high (in excess of 75%) on severe burns, but usually varies from 20 to 50% (Barrington et al. 1989). Rapid burns have been found to leave little damage to root crowns, and new tillers are produced with onset of fall moisture (Johnson et al. 1994). However, Wright and others (1979) found the dense, fine leaves of Idaho fescue provided enough fuel to burn for hours after a fire had passed, thereby killing or seriously injuring the plant regardless of the intensity of the fire (Wright et al. 1979). Idaho fescue is commonly reported to be more sensitive to fire than the other prominent grass on this site, bluebunch wheatgrass (Conrad and Poulton 1966). However, Robberecht and Defossé (1995) suggested the latter was more sensitive. They observed culm and biomass reduction with moderate fire severity in bluebunch wheatgrass, whereas a high fire severity was required for this reduction in Idaho fescue. Also, given the same fire severity treatment, post-fire culm production was initiated earlier and more rapidly in Idaho fescue (Robberecht and Defossé 1995).

Junegrass was found to be relatively resistant to the effects of fire other than during the growing season where burning reduced basal area by 42% (Britton et al. 1990). Similarly, needle and thread is a fine leaf grass and is considered sensitive to fire in the growing season (Akinsoji 1988, Bradley et al. 1992, Miller et al. 2013). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needle and thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle and thread is often present in the post-burn community.

Sandberg bluegrass has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass. Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community.

Antelope bitterbrush is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), however sprouting ability is highly variable and has been attributed to genetics, plant age, phenology, soil moisture and texture and fire severity (Blaisdell and Mueggler 1956, Blaisdell et al. 1982, Clark et al. 1982, Cook et al. 1994). Bitterbrush sprouts from a region on the stem approximately 1.5 inches above and below the soil surface; the plant rarely sprouts if the root crown is killed by fire (Blaisdell and Mueggler 1956). Low intensity fires may allow for bitterbrush to sprout; however, community response also depends on soil moisture levels at time of fire (Murray 1983). Lower soil moisture allows more charring of the stem below ground level (Blaisdell and Mueggler 1956), thus sprouting will usually be more successful after a spring fire than after a fire in summer or fall (Murray 1983, Busse et al. 2000, Kerns et al. 2006). The factor that most limits establishment of bitterbrush seedlings is competition for water resources with invasive annual species (Clements and Young 2002).

In many basin big sagebrush communities, changes in fire frequency occurred along with fire suppression, livestock grazing and OHV use. Few if any fire history studies have been conducted on basin big sagebrush; however, Sapsis and Kauffman (1991) suggest that fire return intervals in basin big sagebrush are intermediate between mountain big sagebrush (15 to 25 years) and Wyoming big sagebrush (50 to 100 years). Fire severity in big sagebrush communities is described as "variable" depending on weather, fuels, and topography. However, fire in basin big sagebrush communities are typically stand replacing (Sapsis and Kauffman 1991). Basin big sagebrush does not sprout after fire. Because of the time needed to produce seed, it is eliminated by frequent fires (Bunting et al. 1987). Basin big sagebrush reinvades a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore, regeneration of basin big sagebrush after stand replacing fires is difficult and dependent upon proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984).

Wyoming big sagebrush is easily killed by fire (Blaisdell 1953). Pre-European settlement fire return intervals for Wyoming big sagebrush vary depending on study source and location from 50-100 years (Wright and Bailey 1982), 100-240 years (Baker 2006), and most recently, Baker (2011) summarized five sources of fire interval estimates and found 200-350 years to be the most common estimate. Wyoming big sagebrush only regenerates from seed. Repeated fires may eliminate the onsite seed source; reinvasion into these areas may be extremely slow (Bunting et al. 1987). Reestablishment after fire may require 50-120 or more years (Baker 2006). Even then, up to 25 years after fire, Wyoming big sagebrush

typically has less than 5% of pre-fire cover (Baker 2011). However, the introduction and expansion of cheatgrass has dramatically altered the fire regime (Balch et al. 2013), therefore altering restoration potential of Wyoming big sagebrush communities (Evans and Young 1978).

Western juniper is intolerant of fire and historically was located in areas with minimal understory due primarily to soil characteristics; therefore fire was very infrequent, and when it did occur it was low intensity. With the increased suppression of wildfire and introduction of livestock grazing which reduces ground fuels and understory competition, regeneration and establishment of western juniper has expanded into sites previously dominated by big sagebrush (Burns and Honkala 1990). The expansion of western juniper has been well documented. In the Steens mountain range of south eastern Oregon, the expansion of western juniper coincides with Euro-American settlement. Probable causes include climate, altered fire frequencies and grazing of flammable ground fuels (Miller and Rose 1995). Fire resistance depends on age of the tree: seedlings, saplings and poles are highly vulnerable to fire. Mature trees have some resistance to fire due to lack of fuels near the trunk, relatively thick bark, and foliage which is fairly high above the ground (Burns and Honkala 1990).

The grasses likely to invade this site are cheatgrass and medusahead. These invasive grasses displace desirable perennial grasses, reduce livestock forage, and accumulate large fuel loads that foster frequent fires (Davies and Svejcar 2008). Invasion by annual grasses can alter the fire cycle by increasing fire size, fire season length, rate of spread, numbers of individual fires, and likelihood of fires spreading into native or managed ecosystems (D'Antonio and Vitousek 1992, Brooks et al. 2004). While historical fire return intervals are estimated at 15 to 100 years, areas dominated with cheatgrass are estimated to have a fire return interval of 3-5 years (Whisenant 1990). The mechanisms by which invasive annual grasses alter fire regimes likely interact with climate. For example, cheatgrass cover and biomass vary with climate (Chambers et al., 2007) and are promoted by wet and warm conditions during the fall and spring. Invasive annual species have been shown able to take advantage of high N availability following fire through higher growth rates and increased seedling established relative to native perennial grasses (Monaco et al. 2003).

Livestock /Wildlife Grazing Interpretations

This group of ecological sites are suitable for grazing. Grazing management considerations include timing, duration and intensity of grazing along with past farming history and other disturbances that may have changed the resiliency and resistance of the ecological site. In addition, many wildlife species are dependent on the sagebrush ecosystem including the sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Despite low palatability, big sagebrush is eaten by sheep, cattle, goats, and horses. Chemical analysis indicates that the leaves of big sagebrush equal alfalfa meal in protein, have a higher carbohydrate content, and yield twelvefold more fat (USDA-Forest Service 1937). Antelope bitterbrush is an important shrub species to a variety of animals, such as domestic livestock, antelope, deer, and elk. Bitterbrush is critical browse for mule deer, as well as domestic livestock, antelope, and elk (Wood 1995, Clements and Young 2002). Antelope bitterbrush is most commonly found on soils which provide minimal restriction to deep root penetration such as coarse textured soil, or finer textured soil with high stone content (Driscoll 1964). Grazing tolerance of antelope bitterbrush is dependent on site conditions (Garrison 1953).

Bluebunch wheatgrass is moderately grazing tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975,

Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Idaho fescue tolerates light to moderate grazing (Ganskopp and Bedell 1980) and is moderately resistant to trampling (Cole 1987, USDA Forest Service 1937). Idaho fescue has been found to decrease under heavy, repeated grazing by livestock (Eckert and Spencer 1986, Eckert and Spencer 1987 Mueggler 1984) and wildlife (Gaffney 1941). However, more recent research by Jaindl et al. (1994) suggests Idaho fescue exhibits overcompensation to single defoliation events (i.e., cumulative total dry weight, including removed tissue, of the defoliated plants is greater than the total dry weight of the control plants) depending on the physiological stage of growth at the time of the grazing event. Jaindl et al. (1994) reported overcompensation occurred for plants defoliated during the boot to anthesis stage. The ability to overcompensate following grazing is a function of available soil moisture and length of growing season therefore season of grazing must be considered. Additionally, Idaho fescue exhibits moderate to high palatability increasing the likelihood of repeated defoliation thus decreasing the opportunity for compensatory gain.

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. However, if medusahead is present cheatgrass may be replaced by this more competitive and less palatable species (Mangla et al. 2011).

Inappropriate grazing practices can be tied to the success of medusahead, however, eliminating grazing will not eradicate medusahead if it is already present (Wagner et al. 2001). Sheley and Svejcar (2009) reported that even moderate defoliation of bluebunch wheatgrass resulted in increased medusahead density. They suggested that disturbances such as plant defoliation limit soil resource capture, which creates an opportunity for exploitation by medusahead. Avoidance of medusahead by grazing animals allows medusahead populations to expand. This creates seed reserves that can infest adjoining areas and cause changes to the fire regime. Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008).

State and Transition Model Narrative Group 2A

Reference State 1.0:
The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The reference state has 3 general community phases; a shrub-grass dominant with scattered old growth western juniper phase, a perennial grass dominant phase and a shrub-western juniper 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 drought and/or insect or disease attack.

Community Phase 1.1:
This community is dominated by bluebunch wheatgrass, Wyoming big sagebrush, antelope bitterbrush and Sandberg bluegrass. Western juniper trees are mostly old growth and are scattered throughout the site. Forbs and other grasses make up smaller components.

Community Phase Pathway 1.1a:
Fire will reduce the overstory of juniper, reduce sagebrush and bitterbrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts. Old growth juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 1.1b:
Time and lack of disturbance such as fire allows for juniper and/or sagebrush and bitterbrush to increase. Chronic drought, herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing juniper and/or sagebrush to increase.

Community Phase 1.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community. Bluebunch wheatgrass and other perennial bunchgrasses dominate. Depending on fire severity, patches of intact Wyoming big sagebrush and/or bitterbrush may remain. Antelope bitterbrush and rabbitbrush (*Ericameria nauseosa* or *Chrysothamnus viscidiflorus*) may be sprouting depending on extent of damage and on available soil moisture post burn. Old growth juniper trees exhibit some resistance to fire and with ground fire will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 1.2a:
Time and lack of disturbance will allow juniper and/or sagebrush and bitterbrush to increase.

Community Phase 1.3:
Western juniper, sagebrush and bitterbrush increase in the absence of disturbance. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory. Young western juniper increases and may influence the understory vegetation.

Community Phase Pathway 1.3a:
Fire will reduce the overstory of juniper, reduce sagebrush and bitterbrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush and bitterbrush cover to trace amounts. Old growth juniper trees

exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

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, medusahead, ventenata, mustards, and bur buttercup (*Ceratocephala testiculata*).
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, residual dry matter accumulation, and adaptations for seed dispersal.

Community Phase 2.1:

This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Bluebunch wheatgrass, Wyoming big sagebrush, antelope bitterbrush and Sandberg bluegrass dominate the site. Forbs and other shrubs and grasses make up smaller components of this site. Old growth western juniper is scattered throughout the community.

Community Phase Pathway 2.1a:

Fire reduces the shrub and young western juniper overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush and/or bitterbrush cover to trace amounts. Old growth juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced. Annual non-native species are likely to increase after fire.

Community Phase Pathway 2.1b:

Time and lack of disturbance allows for young juniper and sagebrush and bitterbrush to increase. Shrubs may become decadent. Chronic drought, herbivory, or combinations of these reduces fine fuels and leads to a reduced fire frequency, allowing Wyoming big sagebrush and/or antelope bitterbrush to dominate the site. Inappropriate grazing management may hasten the decline of the perennial bunchgrass understory; while the grazing tolerant Sandberg bluegrass may increase in the understory.

Community Phase 2.2:

This community phase is characteristic of a post-disturbance, early to mid-seral community where perennial bunchgrasses dominate. Annual non-native species are present. Sagebrush and/or bitterbrush may be present in trace amounts depending on fire severity. Antelope bitterbrush may sprout after fire. Perennial and/or annual forbs may be a significant component for several years. Annual non-native species are stable or increasing within the community. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 2.2a:
Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush and bitterbrush allows the shrub component to recover. The establishment of Wyoming big sagebrush can take many years. Western juniper will increase.

Community Phase 2.3 (At Risk):
This community is at risk of crossing a threshold to another state. Sagebrush and/or juniper dominate the overstory, young juniper increases and perennial bunchgrasses in the understory are reduced, either from competition with the overstory or from inappropriate grazing, or from both. Annual non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

Community Phase Pathway 2.3a:
A low severity fire will reduce young juniper, sagebrush and bitterbrush in the overstory. Fires would typically burn in a mosaic pattern on the landscape leaving patches of intact shrubs and old growth juniper and allowing for an increase in perennial grasses. A high severity fire would significantly reduce the brush/tree overstory and lead to an early to mid-seral bunchgrass and forb community. Alternatively, a change in grazing management that reduces shrubs will also allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush/tree treatments with minimal soil disturbance will also decrease juniper and shrubs and release the perennial understory. Annual non-native species are present and may increase in the community.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0

Trigger: To Community Phase 3.1: Repeated, chronic, growing season grazing and/or a decrease in the fire return interval will decrease or eliminate deep rooted perennial bunchgrasses and favor shrub and young tree growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush and bitterbrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Brush treatments coupled with inappropriate grazing management will reduce shrub overstory, decrease perennial bunchgrasses and facilitate an increase in Sandberg bluegrass.
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 Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire or failed rehabilitation treatments involving activities such as tree removal or seeding. To Community Phase 4.2: Inappropriate grazing

management that decreases perennial bunchgrasses and facilitates the expansion of non-native annual grasses; competitive increase in medusahead through lack of active management.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T2C: Transition from Current Potential State 2.0 to Tree State 5.0

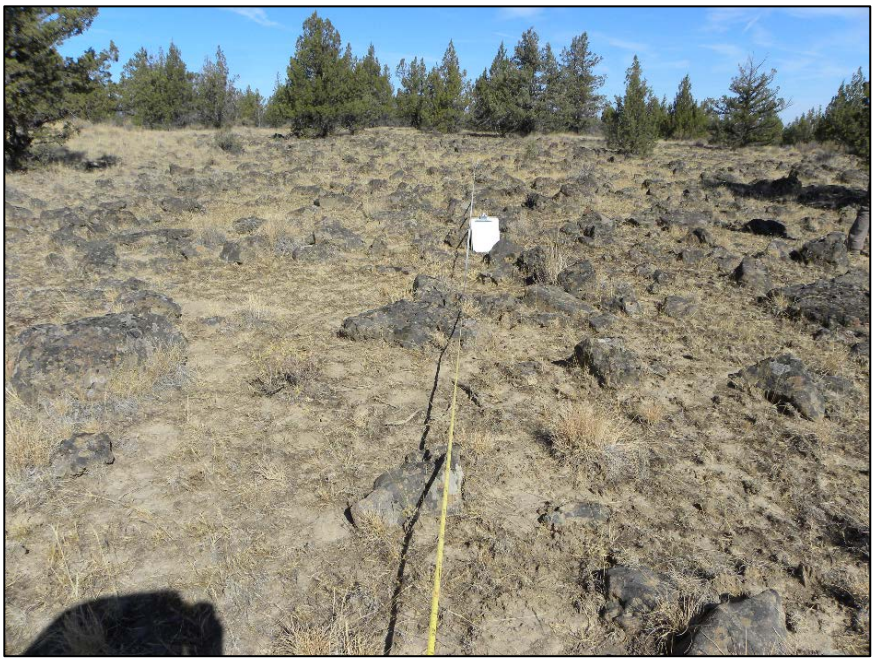
Trigger: Time and lack of disturbance or management action allows for juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Shrub State 3.0:

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses, changes in the historic fire regime or long-term drought favoring shrub establishment. Grazing tolerant Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Basin big sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed (3.1). In both community phases, bare ground may be significant with soil redistribution occurring between interspace and shrub locations. Western juniper increases and may begin to influence the understory vegetation.

Community Phase 3.1 (At-Risk)

Decadent Wyoming big sagebrush and/or antelope bitterbrush dominates the overstory. Rabbitbrush may be a significant component. Understory may be dominated by Sandberg bluegrass and/or sixweeks fescue (*Vulpia octoflora*). Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Old growth juniper is present but scattered and young juniper will likely increase without management action. Bare ground is significant. Annual non-native species stable to increasing.



Plot C38 Community phase 3.1

Community Phase Pathway 3.1a:
Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for Sandberg bluegrass and/or sixweeks fescue to dominate the site.

Community Phase 3.2 (At Risk):
Rabbitbrush and/or Sandberg bluegrass and/or sixweeks fescue dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Scattered old growth juniper may be present. Phase 3.2 may be created by fire from 3.1 or directly from the Current Potential State 2.3.

Community Phase Pathway 3.2a:
Time without disturbance allows sagebrush and/or bitterbrush to mature and become dominant overstory. Western juniper may increase.

T3A: Transition from Shrub State 3.0 to Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire and/or failed rehabilitation treatment or combination of both. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species and/or competitive increase in medusahead through lack of active management. May be combined with higher than normal spring precipitation.
Slow variables: Increased production and cover of non-native annual species. Increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

T3B: Transition from Shrub State 3.0 to Tree State 5.0

Trigger: Time and a lack of disturbance or management action allows for juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

R3A: Restoration from Shrub State 3.0 to Current Potential State 2.0

Tree and brush management such as mowing, chaining, mastication; coupled with seeding of deep-rooted native bunchgrasses. Restoration attempts causing soil disturbance may initiate a transition to an annual state.

R3B: Restoration from Shrub State 3.0 to Seeded State 6.0

Tree and brush management such as mowing, chaining, mastication; coupled with seeding of deep rooted non-native wheatgrasses. Restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Herbicide may be necessary for control of non-native annual grasses.

Annual State 4.0:

This community is characterized by the dominance of annual non-native species such as cheatgrass, medusahead and tansy mustard (*Descurainia pinnata*) in the understory. Old growth juniper is present but scattered. Depending on transition, young juniper may be increasing. Sagebrush, bitterbrush, and/or rabbitbrush may dominate the overstory.

Community Phase 4.1:

Annual non-native plants such as cheatgrass and medusahead or mustards dominate this site. Old growth juniper is present but scattered. Shrubs may be present in trace amounts.

Community Phase Pathway 4.1a:

Time and lack of fire allows for the sagebrush and bitterbrush to establish or sprouting shrubs such as rabbitbrush to increase. Young juniper may increase. The probability of sagebrush establishment is extremely low.

Community Phase 4.2:

Rabbitbrush is typically the dominant overstory shrub if fire preceded development of the community. Sagebrush may be the dominant overstory shrub if inappropriate grazing was the threshold driver to 4.2. Annual non-native species, likely cheatgrass, medusahead and mustards, dominate the understory.

Community Phase Pathway 4.2a:

Fire reduces/eliminates overstory brush component and allows for annual non-native species to dominate the site. Old growth juniper present but scattered. Saplings and poles reduced.

R4A: Restoration from Annual State 4.0 to Seeded State 6.0

Seeding of deep-rooted bunchgrasses; may be coupled with tree/brush management and/or herbicide. Probability of success is low. Non-native perennial species such as crested wheatgrass

may have a higher likelihood of success due to their ability to compete with annual species such as cheatgrass.

Tree State 5.0:
This state is characterized by a dominance of young juniper (<100 years old) in the overstory. Wyoming big sagebrush, bitterbrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community Phase 5.1 (At Risk):
Western juniper dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrasses may be found under tree canopies and interspaces. Sandberg bluegrass or sixweeks fescue may be dominate grass species particularly in the interspace areas. Sagebrush is stressed and dying. Annual non-native species are present, particularly under tree canopies. Bare ground interspaces are large and connected.

Community Phase Pathway 5.1a: Time and lack of disturbance or management action allows juniper to mature and dominate site resources.

Community Phase 5.2 (At Risk):
Western juniper dominates the site and tree leader growth is minimal. Trace amounts of sagebrush and/or bitterbrush may be present however dead skeletons will be more numerous than living brush. Deep-rooted bunchgrasses may or may not be present. Sandberg bluegrass, sixweeks fescue or mat forming forbs may be present in varying amounts. Annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Bare ground interspaces are large and connected. Soil redistribution may be increasing.

Community Phase Pathway 5.2a:
Tree stand thinning treatments for fuels management or other resource values

T5A: Transition from Tree State 5.0 to Annual State 4.0
Trigger: Catastrophic fire causing a stand replacement event will transition to Annual State 4.0. Inappropriate tree removal practices with soil disturbance will also cause a transition to the Annual State 4.0.
Slow variables: Increased production and cover of non-native annual species under tree canopies.
Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact nutrient cycling and distribution.

R5A: Restoration from Tree State 5.0 to Shrub State 3.0
This restoration is recommended for Phase 5.1 only due to the lack of understory in 5.2.
Tree removal practices with minimal soil disturbance.

R5B: Restoration from Tree State 5.0 to Seeded State 6.0

Tree removal and seeding of desired non-native wheatgrass species. Tree removal practices with minimal soil disturbance are recommended. Probability of success declines with increased presence of non-native annual species. Herbicide treatment may be necessary.

Seeded State 6.0:
This state has three community phases; a grass-dominated phase; a grass-shrub phase and a shrub dominated phase. The state is characterized by the dominance of seeded introduced wheatgrass species. Other seeded species including sagebrush, bitterbrush, and native and non-native forbs may be present.

Community Phase 6.1:
Introduced wheatgrass species and other non-native species dominate the community. Rabbitbrush and other sprouting shrubs may increase. Native and non-native seeded forbs may be present. Trace amounts of rabbitbrush and/or sagebrush may be present, especially if seeded. Annual non-native species present. Old growth juniper may be present.

Community Phase Pathway 6.1a:
Time without disturbance allows shrub species to reestablish. This may be coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.2:
Big sagebrush and/or rabbitbrush and seeded wheatgrass species are codominant. Sandberg bluegrass and/or sixweeks fescue may increase. Annual non-native species may be present. Young juniper may be increasing.

Community Phase Pathway 6.2a:
Low severity fire and/or brush management will reduce the brush and juniper overstory and allow seeded wheatgrass species to become dominant.

Community Phase Pathway 6.2b:
Absence of fire over time allows shrub species to become dominant. This may be coupled with inappropriate grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.3 (At Risk):
Sagebrush, antelope bitterbrush and/or rabbitbrush dominate. Wheatgrass vigor and density reduced. Annual non-native species stable to increasing. Sandberg bluegrass and/or sixweeks fescue may be increasing. Juniper may be present. This community phase is at risk of crossing a threshold to the Shrub State or Tree State without disturbance or treatment. If annual non-natives are present, the site could transition to the Annual State with fire.

Community Phase Pathway 6.3a:
Fire eliminates/reduces the overstory of sagebrush and bitterbrush and decreases young juniper which allows for the understory perennial grasses to increase. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. Brush treatments with minimal soil disturbance will also

decrease sagebrush and bitterbrush and release the perennial understory. Targeted herbicide treatments of rabbitbrush may be necessary. Annual non-native species respond well to fire and may increase post-burn.

Community Phase Pathway 6.3b:
Low severity fire leading to a mosaic pattern in the grass-shrub community. A change in grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Targeted herbicide treatments of rabbitbrush may be necessary. Annual non-native species are present and may increase in the community.

T6A: Transition from Seeded State 6.0 to Annual State 4.0
Trigger: To Community Phase 4.1: Catastrophic fire, likely from 6.3.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T6B: Transition from Seeded State 6.0 to Shrub State 3.0
Trigger: To Community Phase 3.1: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and/or sixweeks fescue and favor shrub growth and establishment. To Community Phase 3.2 from 6.3: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass.
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.

T6C: Transition from Seeded State 6.0 to Tree State 5.0
Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Potential Resilience Differences with other Ecological Sites

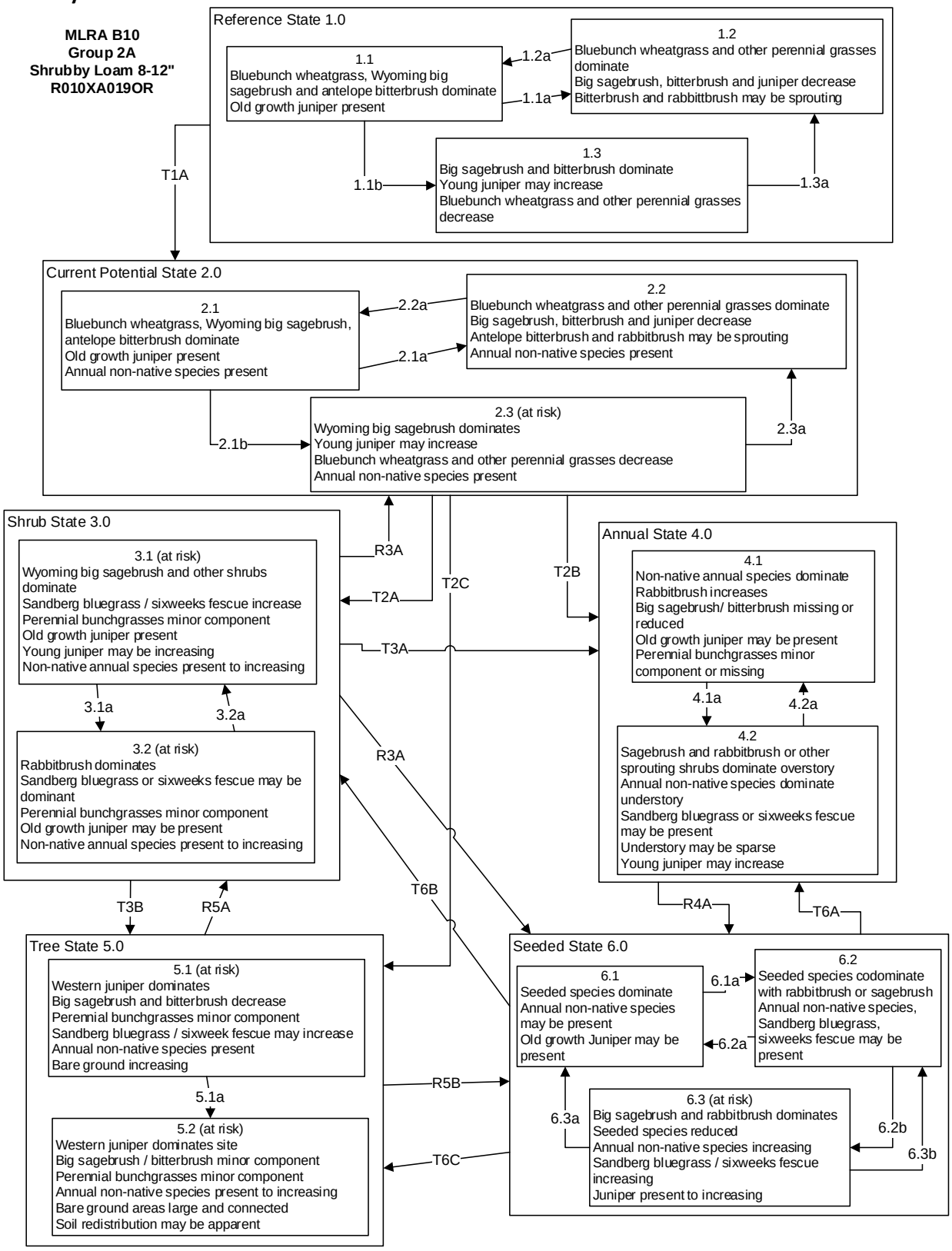
Juniper Lava Blisters 8-10" (R010XA022OR):
This site occurs on lava flows and lava blisters or small knolls dispersed across lava plains. Slopes typically range from 0 to 15 percent, although the steep sides of blisters may approach 60 percent in places. The soil temperature regime is mesic. The soils of this site are shallow with sandy loam surface layers dominated by volcanic ash. The potential native plant community is dominated by an open stand of old growth juniper but is extremely variable due to the amount of rock on the surface. The understory is sparse but consists of Wyoming big sagebrush, buckwheat (*Eriogonum* spp.), bluebunch wheatgrass and Sandberg bluegrass. Other perennial grasses and forbs make up minor components. Historically this site was protected from fires due to the sparse vegetation and rocky soil surface. Where neighboring sites have infilled with young trees this site has at higher risk of fire. With the introduction of non-native annual species, these sites may be able to sustain and carry a ground fire. Due to the soils of this site it is **not likely to have a seeded state**. Some seeded species may be present due to aerial seedings. STM includes a shrub state, tree state and annual state. **STM needs to be verified.**

Pumice North 8-10" (R010AX024OR):
This site is similar to the modal site for the Crooked River Grasslands Shrubby Loam 8-12" and will likely exhibit a similar state-and-transition model. **STM needs to be verified**.

Juniper Shrubby Pumice Hills 8-10" (R010XA002OR):
This site occurs on flat to gentle slopes and swales in uplands, dry basins, drainage terraces, fans or slopes adjacent to bottomlands. The soil temperature regime is mesic. The soils of this site are moderately deep to deep, well or excessively drained and have sandy textured surfaces. Subsoils are sandy and sometimes gravelly. They are generally formed in isolated deposits of volcanic ash. Permeability is moderately rapid. The potential native plant community is dominated by an open stand of juniper and **needle and thread**. Other prominent grasses include Indian ricegrass, Thurber's needlegrass, Sandberg bluegrass and bluebunch wheatgrass. Idaho fescue is usually present in high precipitation zones but restricted to areas beneath the tree canopy if present in low precipitation areas. Bitterbrush and big sagebrush are also present. This site exhibits similar states as the modal site and will likely exhibit a similar state-and-transition model. **STM needs to be verified**.

Juniper Pumice Flat 8-10" (R010XA027NV):
This site occurs on nearly level plains and gentle slopes of low hills. The soil temperature regime is mesic. The soils of this site are moderately deep or deep, well drained and sandy loam (medium) textured. They are generally formed in pumice ash over basalt bedrock. Permeability is moderately rapid. The potential for wind erosion is high. The potential native plant community is dominated by an open stand of juniper. Idaho fescue dominates under tree canopies. Interspaces between trees are dominated by mountain and basin big sagebrush and needle and thread grass. Indian ricegrass, western needlegrass and Thurber's needlegrass make up minor components. This is the most productive of the ecological sites within this disturbance response group. As such it has a shrub state and the potential for an increase in western juniper resulting in a tree state. With the introduction of non-native annual species this site can transition to an annual state. The possibility of wind erosion/redistribution of the soil is high on these sites, particularly following fire and other disturbances where the herbaceous community may be reduced. Potential for an **eroded state** exists and should be verified. **STM needs to be verified.**

Shrubby Loam 8-12” Modal Model



MLRA B10
Group 2A
Shrubby Loam 8-12"
R010XA019OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub and tree overstory.
1.3a: Low severity fire resulting in a mosaic pattern: high severity fire significantly reduces shrub cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush, bitterbrush and young juniper facilitating perennial bunchgrass understory.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub overstory.
2.3a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.

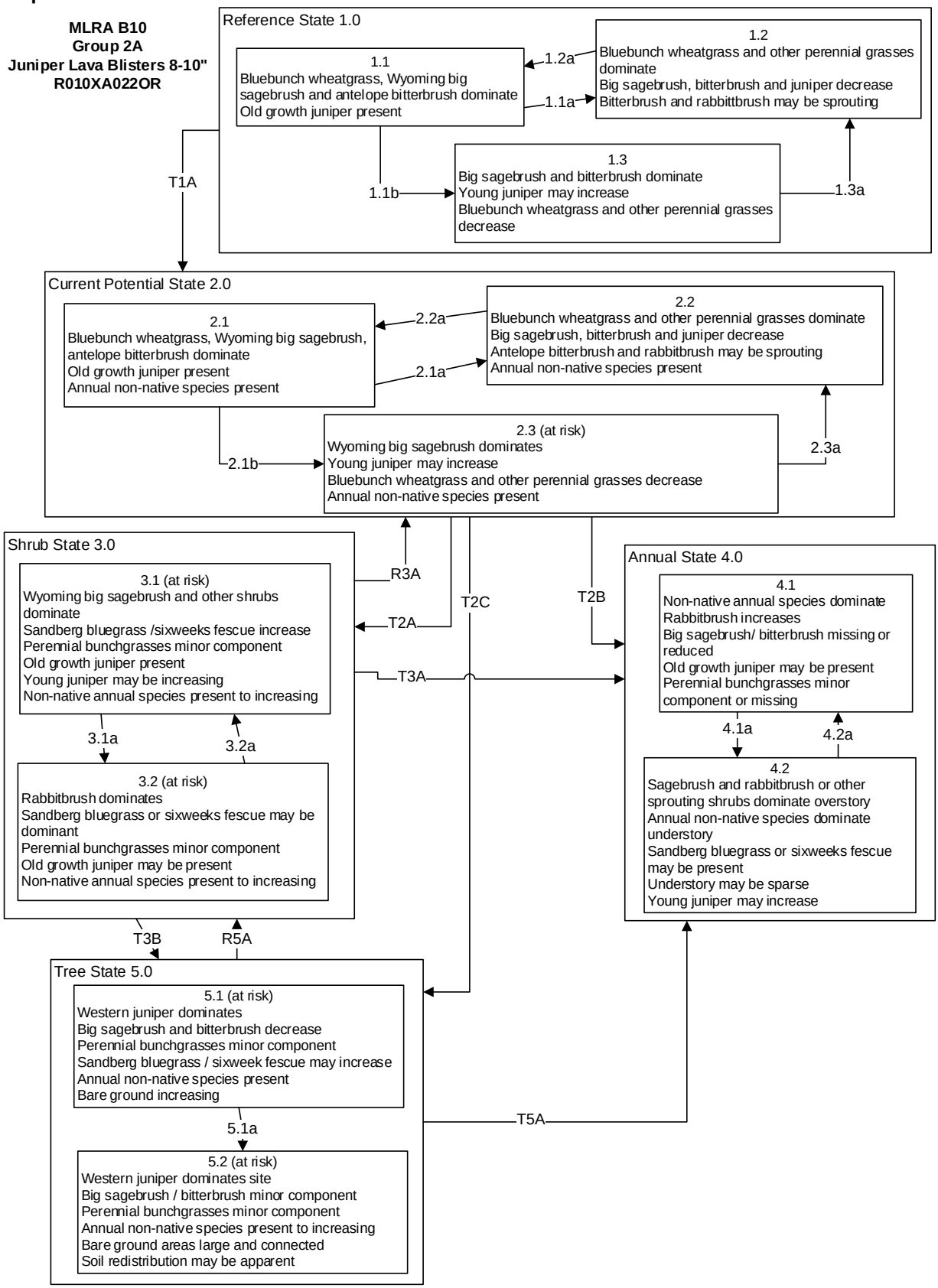
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Lava Blisters 8-10



MLRA B10
Group 2A
Juniper Lava Blisters 8-10"
R010XA022OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub and tree overstory.
1.3a: Low severity fire resulting in a mosaic pattern: high severity fire significantly reduces shrub cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush, bitterbrush and young juniper facilitating perennial bunchgrass understory.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub overstory.
2.3a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species.

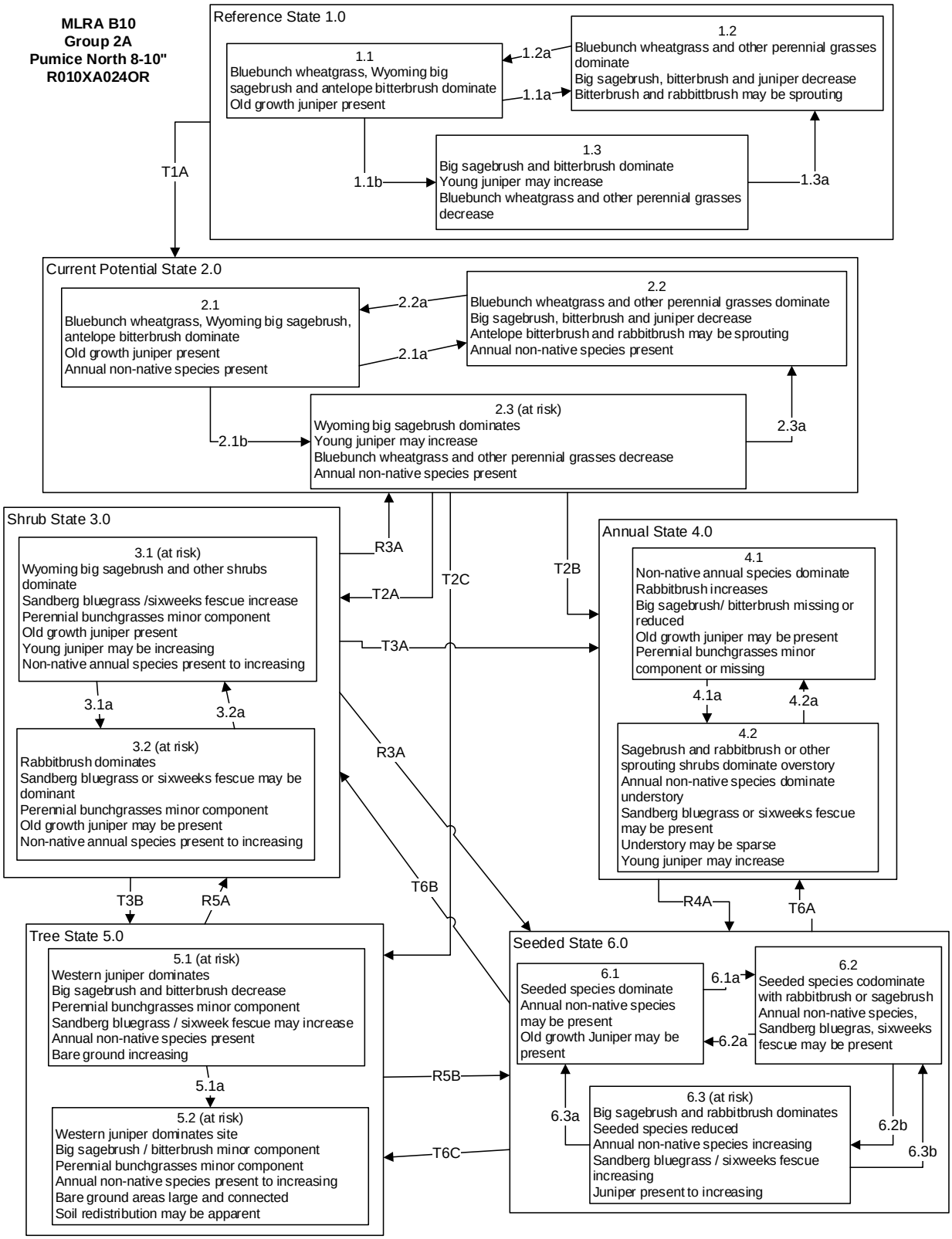
Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).

Pumice North 8-10”



MLRA B10
Group 2A
Pumice North 8-10"
R010XA024OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub and tree overstory.
1.3a: Low severity fire resulting in a mosaic pattern: high severity fire significantly reduces shrub cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush, bitterbrush and young juniper facilitating perennial bunchgrass understory.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub overstory.
2.3a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1)
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community

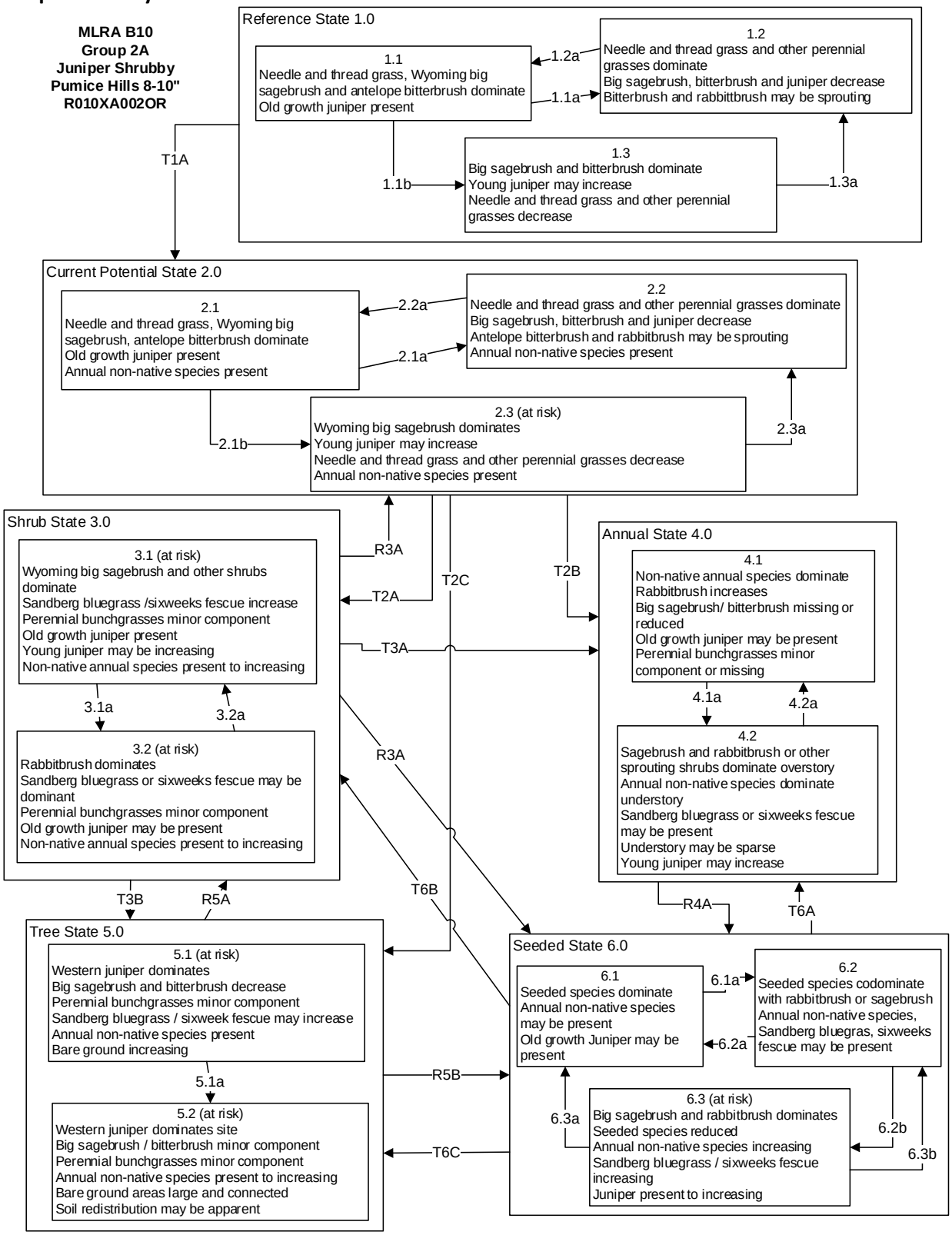
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Shrubby Pumice Hills 8-10”



MLRA B10
Group 2A
Juniper Shrubby Pumice Hills 8-10"
R010XA002OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub and tree overstory.
1.3a: Low severity fire resulting in a mosaic pattern: high severity fire significantly reduces shrub cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush, bitterbrush and young juniper facilitating perennial bunchgrass understory.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub overstory.
2.3a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.

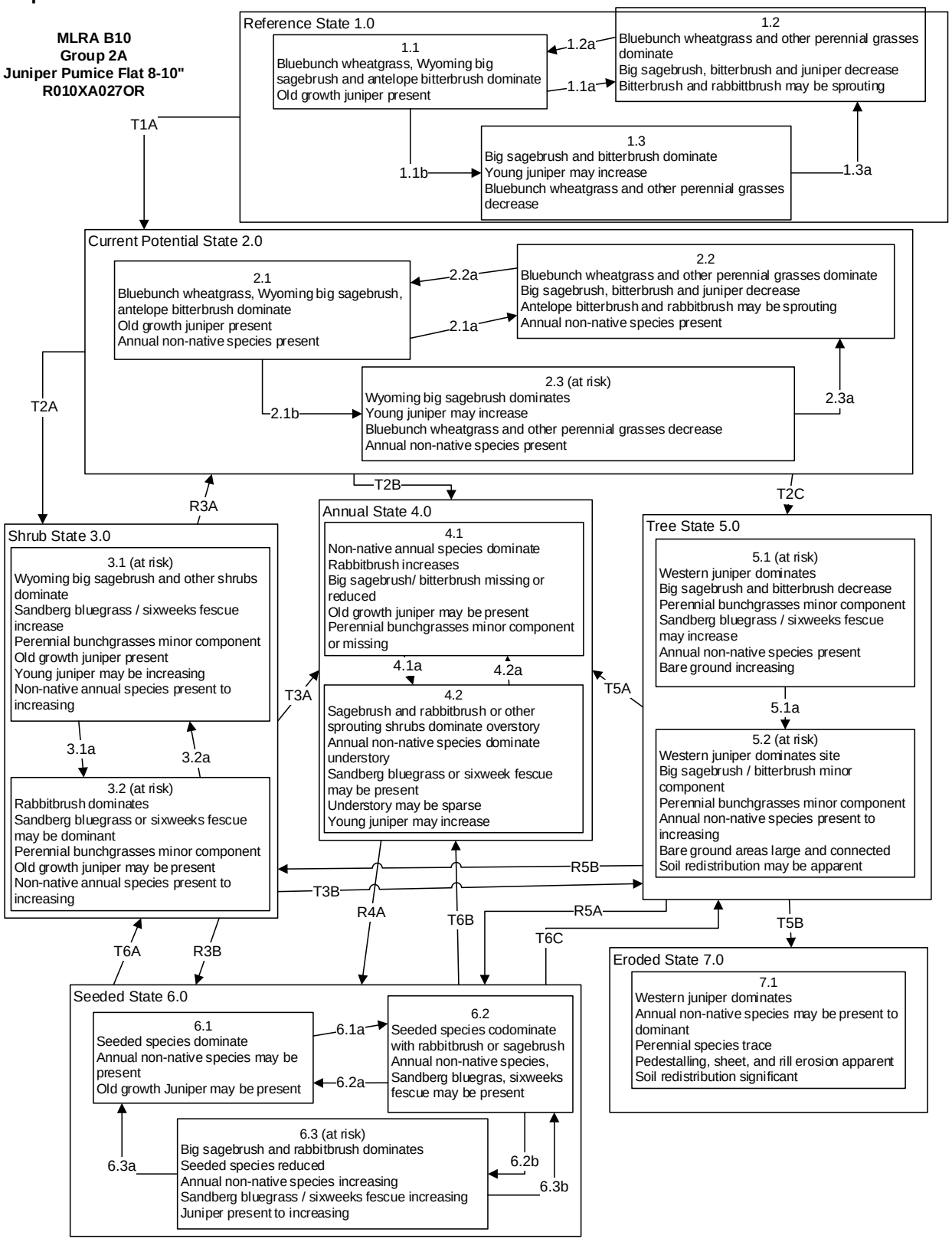
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1)

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Pumice Flat 8-10”



MLRA B10
Group 2A
Juniper Pumice Flat 8-10"
R010XA027OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub and tree overstory.
1.3a: Low severity fire resulting in a mosaic pattern: high severity fire significantly reduces shrub cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush, bitterbrush and young juniper facilitating perennial bunchgrass understory.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub overstory.
2.3a: Low severity fire (ground fire) resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1)

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; bare ground allows for excess soil movement (to 7.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Group 2B Preface

Group 2B note regarding the validity of this state and transition model and associated narrative:

Like Group 2A, this model is a Tier 1 model requiring additional field validation of States. The model was prepared with six States: Reference, Current Potential, Shrub State, Annual State, Tree State, and Seeded State. Typically, states and community phases are not described without evidence of existence. Evidence can be local knowledge translated to the STM developer or actual observational or quantifiable data. CRNG personnel provided data for three transects determined to be located in DRG 2B (Appendix C). These transects (A16, A37, B36) were all in the Current Potential state because of the presence of non-native annuals like *Draba verna* and cheatgrass. One site had significant cheatgrass cover (19%) and is at risk of transitioning to an annual state if the site burns without active management.

The remaining States need to be verified either through CRNG personnel knowledge of this DRG or through field visits to locations exhibiting characteristics of these ecological states. I did not include a Farmed State as it seemed unlikely given the soils correlated to these sites, however, farming was wide spread at time of settlement and may have occurred on the ecological sites within this DRG. Is there evidence of this activity occurring on any of the ecological sites within this group on the CRNG?

Group 2B

Group 2B represents similar sites to group 2A however with a higher precipitation range (9-12pz) with the modal community defined by Shrubby Pumice Flat 10-12pz. The elevation for these sites ranges from 2000 to 4500 feet. Slopes range from 0 to 15 percent but may be 60 percent on steep side slopes. The dominant vegetation for this group is characterized by an overstory of old growth western juniper (*Juniperus occidentalis*) widely spaced. The understory is made up of mountain big sagebrush (*Artemisia tridentata ssp. vaseyana)* and antelope bitterbrush (*Purshia tridentata*) with Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) the dominant herbaceous vegetation. Needle and thread grass (*Hesperostipa comata*), Sandberg bluegrass, (*Poa secunda*) and big bluegrass (*Poa ampla*) are also present on these sites. Forbs such as buckwheat (*Eriogonum* spp.), yarrow (*Achillea millefolium*), and desert parsley (*Lomatium* spp.) make up minor components.

Group 2B Ecological Sites

R010XA009OR JUNIPER SHRUBBY PUMICE FLAT 10-12 PZ (Pumice Flat 10-12) MODAL for MLRA B10 Group 2B
R010XA021OR SHALLOW PUMICE HILLS 10-12 PZ
R010XA023OR JUNIPER SHRUBBY LAVA BLISTERS 10-12 PZ (Lava Blisters 10-12)
R010XA025OR SHALLOW NORTH 10-12 PZ
R010XA026OR PUMICE NORTH 10-12 PZ
R010XA083OR JUNIPER SHRUBBY NORTH 9-12 PZ (Sandy North 10-12)

Sites on the CRNG

R010XA025OR JUNIPER SHALLOW NORTH 10-12 PZ (Shallow North 10-12) MODAL for CRNG Group 2B
R010XA009OR JUNIPER SHRUBBY PUMICE FLAT 10-12 PZ (Pumice Flat 10-12)
R010XA023OR JUNIPER SHRUBBY LAVA BLISTERS 10-12 PZ (Lava Blisters 10-12)
R010XA083OR JUNIPER SHRUBBY NORTH 9-12 PZ (Sandy North 10-12)

*() Previous Ecological site names

Modal Site for CRNG:

The Juniper Shallow North 10-12” (R010XA025OR) ecological site is the modal for this group as it has the most acres mapped on the CRNG. These sites occur on exposed lava flows and lava blisters or small knolls dispersed across lava plains. Slope range from 0 to 15 percent although the steep side slopes of blisters may approach 60 percent in places. The soil temperature regime is mesic. The soils of this site are shallow or very shallow with sandy loam surface layers dominated by volcanic ash. Subsoils have cobbly or gravelly sandy loam textures and are well drained. They are generally found on lava flows which have created an uneven land surface. Pumice ash soil fills rock fractures and pockets on the lava in which plants take root. The understory is sparse but consists of mountain big sagebrush, Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, and shrubby buckwheat (*Eriogonum microthecum)*. Other perennial grasses and forbs make up minor components. Historically this site was protected from fires due to the sparse vegetation and rocky soil surface.

Modal Site for MLRA B10:

The Pumice Flat 10-12” (R010XA009OR) ecological site is the modal site for this group as it has the most acres mapped in MLRA B10. It occurs on the north slopes of buttes, ridges and canyons. Annual

precipitation ranges from 9 to 12 inches. The soil temperature regime is mesic. The soils of this site are shallow, skeletal, well drained and medium textured. They are generally formed in volcanic ash and the underlying colluvium or residuum. Permeability is moderate and the available water holding capacity is 1 to 3 inches for the profile. The potential for wind erosion is high. The potential native plant community is dominated by old growth western juniper, mountain big sagebrush, Idaho fescue, bluebunch wheatgrass and Sandberg bluegrass.

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 2013). Biotic factors that that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

The ecological sites in this DRG include deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). Tap roots of antelope bitterbrush (have been documented from 4.5 to 5.4m in length (McConnell 1961). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, 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.

In the central Oregon John Day ecological province, the majority of annual precipitation is received during the winter and spring months with about 28% arriving during the April through June period and 58% during November through March (Anderson et al. 1998). 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 great potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability with the soil profile (Bates et al. 2006).

Variability in plant community composition and production is influenced by soil surface texture and depth to the argillic horizon. Idaho fescue favors a loamy soil surface whereas bluebunch wheatgrass will increase as stoniness increases or with the presence of a weak argillic horizon occurring within 8 to 12 inches. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or

when there is an increase in ash in the upper soil profile. The amount of sagebrush in the plant community is dependent upon disturbances like fire and western juniper encroachment.

Mountain sagebrush is generally a long-lived species therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The Crooked River Grasslands sagebrush / grass 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. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007).

The introduction of annual weedy species, like cheatgrass and medusahead (*Taeniatherum caput-medusae)*, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush and or western juniper will increase and the understory bunchgrass community will decline as competition for limited resources increases. Inappropriate grazing management can facilitate the increase in the shrub community and decrease in the perennial bunchgrasses and forbs.

Western Juniper

During the past 140 years, western juniper has been expanding within its geographic range at unprecedented rates compared to any other time period during the Holocene (Miller et al. 2005) and density of western juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Western juniper woodlands in eastern Oregon with more than 10 percent canopy cover increased from 456,000 acres in 1936 to 2.2 million acres in 1988 (Gedney et al. 1990, Miller et al. 2005). Causes for expansion of western juniper into sagebrush ecosystems include changes in the wildfire return interval, historic livestock grazing, and climate influences (Bunting 1994). Mean fire return intervals prior to European settlement in mountain big sagebrush ecosystems were 15 to 25 years (Burkhardt and Tisdale 1976, Young and Evans 1981, Miller and Rose 1999), frequent enough to inhibit the encroachment of western juniper into these big sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity.

An increase in juniper crown density causes a decrease in understory perennial vegetation and an increase in bare ground (Bates et al. 2000, Miller et al. 2000). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010). Additionally, as understory plant communities become depleted and soil resources become less available the opportunity for invasion by non-native annual species such as cheatgrass and medusahead increases. The highest risk for weed invasion in juniper encroached sagebrush communities are in the warmer (mesic soil temperature) lower elevation sites (Miller et al. 2005). With annual species in the understory wildfire can become more frequent and increase in intensity. Following fire, soil water and available nutrients generally increase, at least for a short period of time (Blank et al. 1994). Increases in

nutrients, particularly nitrogen, enhance the growth of cheatgrass and increases the period of dominance (Miller et al. 2005). Once established, non-native annual species, especially cheatgrass, can shift the seasonality of fire to the active growing period of native perennials (Whisenant 1990). With frequent wildfires these plant communities can convert to annual grasslands with a sprouting shrub and juvenile tree overstory (Tausch 1999).

Nutrient and litter distribution are altered when juniper invades and dominates sagebrush sites. Soil calcium (Ca) and potassium (K) were found to increase under mature western juniper trees in central Oregon whereas nitrogen (N) and organic matter concentrations were highest under juvenile (< 40 yr.) old tree canopies (Doescher et. al. 1987). Changes in soil nutrient and organic matter distribution may have implications for plant community response post-fire or post-treatment.

Annual Invasive Grasses

The species most likely to invade these sites are cheatgrass and medusahead. Both species are cool-season annual grasses that maintain an advantage over native plants in part because they are prolific seed producers, able to germinate in the autumn or spring, tolerant of grazing and increase with frequent fire (Klemmedson and Smith 1964, Miller et al. 1999). Medusahead and cheatgrass originated from Eurasia and both were first reported in North America in the late 1800s (Mack and Pyke, 1983; Furbush 1953). Pellant and Hall (1994) found 3.3 million acres of public lands dominated by cheatgrass and suggested that another 76 million acres were susceptible to invasion by winter annuals including cheatgrass and medusahead. By 2003, medusahead occupied approximately 2.3 million acres in 17 western states (Rice 2005). In the Intermountain West, the exponential increase in dominance by medusahead has largely been at the expense of cheatgrass (Harris 1967, Hironaka 1989). Medusahead matures 2-3 weeks later than cheatgrass (Harris 1967) and recently, James et al. (2008) measured leaf biomass over the growing season and found that medusahead maintained vegetative growth later in the growing season than cheatgrass. Mangla et al. (2011) also found medusahead had a longer period of growth and more total biomass than cheatgrass and hypothesized this difference in relative growth rate may be due to the ability of medusahead to maintain water uptake as upper soils dry compared to co-occurring species, especially cheatgrass. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008). Harris (1967) reported cheatgrass roots to have a relatively poorly developed endodermis layer to insulate against hot dry soils, while medusahead roots have thicker cell walls, which allow it to conduct water throughout very dry soil horizons. Recent modeling and empirical work by Bradford and Lauenroth (2006) suggests that seasonal patterns of precipitation input and temperature are also key factors determining regional variation in the growth, seed production, and spread of invasive annual grasses. Collectively, the body of research suggests that the continued invasion and dominance of medusahead onto native grasslands and cheatgrass infested grasslands will continue to increase in severity because conditions that favor native bunchgrasses or cheatgrass over medusahead are rare (Mangla et al. 2011). Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency.

Methods to control medusahead and cheatgrass include herbicide, fire, grazing, and seeding of primarily non-native wheatgrasses. Mapping potential or current invasion vectors is a management method designed to increase the cost effectiveness of control methods. A study by Davies et al. (2013), found an increase in medusahead cover near roads. Cover was higher near animal trails than random transects but the difference was less evident. This implies that vehicles and animals aid the spread of the weed; however vehicles are the major vector of movement. Spraying with herbicide (Imazapic or Imazapic +

glyphosate) and seeding with crested wheatgrass and Sandberg bluegrass has been found to be more successful at combating medusahead and cheatgrass than spraying alone (Sheley et al. 2012). Where native bunchgrasses are missing from the site, revegetation of medusahead or cheatgrass invaded rangelands has been shown to have a higher likelihood of success when using introduced perennial bunchgrasses such as crested wheatgrass (Davies et al. 2015). Butler et al. (2009) tested four herbicides (Imazapic, Imazapic + glyphosate, rimsulfuron and sulfometuron + Chlorsulfuron) only treatments for suppression of cheatgrass, medusahead and ventenata (North Africa grass, *Ventenata dubia*) within residual stands of native bunchgrass. Additionally, they tested the same four herbicides followed by seeding of six bunchgrasses (native and non-native) with varying success (Butler et al. 2009). Herbicide only treatments appeared to remove competition for established bluebunch wheatgrass by providing 100% control of ventenata and medusahead and greater than 95% control of cheatgrass (Butler

et al. 2009) however caution in results is advised as only one year of data was reported. Prescribed fire has also been utilized in combination with the application of pre-emergent herbicide to control medusahead and cheatgrass (Vollmer and Vollmer 2008). Mature medusahead or cheatgrass is very flammable and fire can be used to remove the thatch layer, consume standing vegetation, and even reduce seed levels. Furbush (1953) reported that timing a burn while the seeds were in the milk stage effectively reduced medusahead the following year. He further reported that adjacent unburned areas became a seed source for reinvasion the following year. In considering the combination of pre-emergent herbicide and prescribed fire for invasive annual grass control it is important to assess the tolerance of desirable brush species to the herbicide being applied. Vollmer and Vollmer (2008) tested the tolerance of mountain mahogany (*Cerocarpus montanus*), antelope bitterbrush and multiple sagebrush species to three rates of Imazapic and the same rates with methylated seed oil as a surfactant. They found a cheatgrass control program in an antelope bitterbrush community should not exceed Imazapic at 8oz/ac with or without surfactant (Vollmer and Vollmer 2008). Sagebrush, regardless of species or rate of application was not affected. However, many environmental variables were not reported and managers should install test plots before broad scale herbicide application is initiated.

Ecological Resilience and Resistance: Summary

The ecological sites in this DRG have moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. However, the invasion ecology of medusahead increases the risk of conversion to an annual state substantially. Six alternative stable states have been identified for this DRG.

Fire Ecology of Plant Species

Fire is believed to be the dominant disturbance force in natural big sagebrush communities. Several authors suggest pre-settlement fire return intervals in mountain big sagebrush communities varied from 15 to 25 years (Burkhardt and Tisdale 1969, Houston 1973, and Miller and Tausch 2000). Kitchen and McArthur (2007) suggest a mean fire return interval of 40 to 80 years for mountain big sagebrush communities. The range from 15 to 80 years is probably more accurate and reflects the differences in elevation and precipitation where mountain big sagebrush communities occur. On a landscape scale, multiple seral stages were represented in a mosaic reflecting periodic reoccurrence of fire and other disturbances (Crawford et al. 2004). Post-fire hydrologic recovery and resilience is primarily influenced by pre-fire site conditions, fire severity, and post-fire weather and land use that relate to vegetation recovery. Fire adaptation by herbaceous species is generally superior to the dominant shrubs, which are typically killed by fire. Sites with low abundances of native perennial grasses and forbs typically have

reduced resiliency following disturbance and are less resistant to invasion or increases in cheatgrass (Miller et al. 2013).

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. Fire typically occurs past the end of the growing season for most forbs and grasses therefore the growing points are generally located at or below the soil surface providing relative protection from disturbances that remove above ground biomass. 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 plant material (Wright 1971, Young 1983, Davies et al. 2009). Furthermore, (Boyd and Davies 2012) found that bunchgrasses under shrub canopies burned more than 40% hotter than interspace counterparts leading to mortality rates greater than 73% (Boyd et al. 2015). Thus, fire severity is a function of seasonality and intensity along with the amount of biomass within the bunchgrass and surrounding the bunchgrass.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage from fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, interspace or shrub canopy location, fire severity, fire intensity and post-fire soil moisture availability.

Idaho fescue response to fire varies with condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all seasons (Wright et al. 1979). Initial mortality may be high (in excess of 75%) on severe burns, but usually varies from 20 to 50% (Barrington et al. 1989). Rapid burns have been found to leave little damage to root crowns, and new tillers are produced with onset of fall moisture (Johnson et al. 1994). However, Wright and others (1979) found the dense, fine leaves of Idaho fescue provided enough fuel to burn for hours after a fire had passed, thereby killing or seriously injuring the plant regardless of the intensity of the fire (Wright et al. 1979). Idaho fescue is commonly reported to be more sensitive to fire than the other prominent grass on this site, bluebunch wheatgrass (Conrad and Poulton 1966). However, Robberecht and Defossé (1995) suggested the latter was more sensitive. They observed culm and biomass reduction with moderate fire severity in bluebunch wheatgrass, whereas a high fire severity was required for this reduction in Idaho fescue. Also, given the same fire severity treatment, post-fire culm production was initiated earlier and more rapidly in Idaho fescue (Robberecht and Defossé 1995).

The fine leaves and densely tufted growth form make Thurber's needlegrass (*Achnatherum thurberianum*) susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). However, there appears to be no detrimental effect of fall burning on Thurber's needlegrass (Davies and Bates 2008, Ellsworth and Boone 2010). Spring and early summer burning may result in a reduction in grass density (Ellsworth and Boone 2010, Wright and Klemmedson 1965, Uresk et al. 1976, Uresk et al. 1980). Although timing of fire highly influences the response and mortality of Thurber's needlegrass, smaller bunch sizes are less likely to be damaged by fire (Wright and Klemmedson 1965). Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire prescribed in May, June, and November were found to cause high mortality in addition to reducing basal area and yield of Thurber's needlegrass (Britton et al. 1990). Interspace or shrub canopy location is also an important parameter in mortality.

Junegrass (*Koeleria macrantha*) was found to be relatively resistant to the effects of fire other than during the growing season where burning reduced basal area by 42% (Britton et al. 1990). Similarly, needle and thread is a fine leaf grass and is considered sensitive to fire in the growing season (Akinsoji 1988, Bradley et al. 1992, Miller et al. 2013). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needle and thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle and thread is often present in the post-burn community.

Sandberg bluegrass has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass. Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community.

Mountain big sagebrush is killed by fire (Neunschwander 1980, Blaisdell et al. 1982) and does not resprout (Blaisdell 1953). Post-fire regeneration occurs from seed and will vary depending on site characteristics, seed source, and fire characteristics. Mountain big sagebrush seedlings can grow rapidly and may reach reproductive maturity within 3 to 5 years (Bunting et al. 1987). Mountain big sagebrush may return to pre-burn density and cover within 15-20 years following fire, but establishment after severe fires may proceed more slowly (Bunting et al. 1987).

Western juniper is intolerant of fire and historically was located in areas with minimal understory due primarily to soil characteristics; therefore fire was very infrequent, and when it did occur it was low intensity. With the increased suppression of wildfire and introduction of livestock grazing which reduces ground fuels and understory competition, regeneration and establishment of western juniper has expanded into sites previously dominated by big sagebrush (Burns and Honkala 1990). The expansion of western juniper has been well documented. In the Steens mountain range of south eastern Oregon, the expansion of western juniper coincides with Euro-American settlement. Probable causes include climate, altered fire frequencies and grazing of flammable ground fuels (Miller and Rose 1995). Fire resistance depends on age of the tree: seedlings, saplings and poles are highly vulnerable to fire. Mature trees have some resistance to fire due to lack of fuels near the trunk, relatively thick bark, and foliage which is fairly high above the ground (Burns and Honkala 1990).

The grasses likely to invade this site are cheatgrass and medusahead. These invasive grasses displace desirable perennial grasses, reduce livestock forage, and accumulate large fuel loads that foster frequent fires (Davies and Svejcar 2008). Invasion by annual grasses can alter the fire cycle by increasing fire size, fire season length, rate of spread, numbers of individual fires, and likelihood of fires spreading into native or managed ecosystems (D'Antonio and Vitousek 1992, Brooks et al. 2004). While historical fire return intervals are estimated at 15 to 100 years, areas dominated with cheatgrass are estimated to have a fire return interval of 3-5 years (Whisenant 1990). The mechanisms by which invasive annual grasses alter fire regimes likely interact with climate. For example, cheatgrass cover and biomass vary with climate (Chambers et al., 2007) and are promoted by wet and warm conditions during the fall and spring. Invasive annual species have been shown able to take advantage of high N availability following fire through higher growth rates and increased seedling established relative to native perennial grasses (Monaco et al. 2003).

Livestock /Wildlife Grazing Interpretations

This group of ecological sites are suitable for grazing. Grazing management considerations include timing, duration and intensity of grazing along with other disturbances that may have changed the

resiliency and resistance of the ecological site. In addition, old growth juniper stands provide habitat for a variety of plant and animal species. Bird surveys indicate that the highest abundance and diversity of songbirds occur in shrub steppe communities adjacent to old-growth stands (Miller et al. 1998). Many wildlife species are dependent on the sagebrush ecosystem including the sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Despite low palatability, big sagebrush is eaten by sheep, cattle, goats, and horses. Chemical analysis indicates that the leaves of big sagebrush equal alfalfa meal in protein, have a higher carbohydrate content, and yield twelvefold more fat (USDA-Forest Service 1937).

Idaho fescue, the co-dominant bunchgrass on this ecological site, tolerates light to moderate grazing (Ganskopp and Bedell 1980) and is moderately resistant to trampling (Cole 1987, USDA Forest Service 1937). Idaho fescue has been found to decrease under heavy, repeated grazing by livestock (Eckert and Spencer 1986, Eckert and Spencer 1987 Mueggler 1984) and wildlife (Gaffney 1941). However, more recent research by Jaindl et al. (1994) suggests Idaho fescue exhibits overcompensation to single defoliation events (i.e., cumulative total dry weight, including removed tissue, of the defoliated plants is greater than the total dry weight of the control plants) depending on the physiological stage of growth at the time of the grazing event. Jaindl et al. (1994) reported overcompensation occurred for plants defoliated during the boot to anthesis stage. The ability to overcompensate following grazing is a function of available soil moisture and length of growing season therefore season of grazing must be considered. Additionally, Idaho fescue exhibits moderate to high palatability increasing the likelihood of repeated defoliation thus decreasing the opportunity for compensatory gain.

Bluebunch wheatgrass, the co-dominant bunchgrass in the community, is moderately grazing tolerant however is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967b, Anderson and Scherzinger 1975, Britton et al. 1990a). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949)). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Junegrass, a common species on this ecological site, has been found to tolerant to defoliation as long as sufficient soil moisture remains for regrowth (Britton et al. 1990). Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass, thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

Thurber's needlegrass, a minor component of this plant community, is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in

management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

Needle-and-thread grass is most commonly found on warm/dry soils (Miller et al. 2013). It is not grazing tolerant and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants (Smoliak et al. 1972). With the reduction in competition from deep rooted perennial bunchgrasses, shallower rooted grasses such as Sandberg bluegrass and forbs may increase (Smoliak et al. 1972).

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. However, if medusahead is present cheatgrass may be replaced by this more competitive and less palatable species (Mangla et al. 2011).

Inappropriate grazing practices can be tied to the success of medusahead, however, eliminating grazing will not eradicate medusahead if it is already present (Wagner et al. 2001). Sheley and Svejcar (2009) reported that even moderate defoliation of bluebunch wheatgrass resulted in increased medusahead density. They suggested that disturbances such as plant defoliation limit soil resource capture, which creates an opportunity for exploitation by medusahead. Avoidance of medusahead by grazing animals allows medusahead populations to expand. This creates seed reserves that can infest adjoining areas and cause changes to the fire regime. Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008).

State and Transition Model Narrative Group 2B

Reference State 1.0:
The Reference State 1.0 is a representative of the natural range of variability under pristine conditions. The reference state has 3 general community phases; a shrub-grass dominant with scattered old growth western juniper phase, a perennial grass dominant phase and a shrub-western juniper 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 drought and/or insect or disease attack.

> **Community Phase 1.1:**
> This community is co-dominated by Idaho fescue and bluebunch wheatgrass, mountain big sagebrush, and Sandberg bluegrass. Western juniper trees are mostly old growth and are scattered throughout the site. Forbs and other grasses make up smaller components.

Community Phase Pathway 1.1a:
Fire will decrease the overstory of juniper, reduce sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts. Old growth juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 1.1b:
Time and lack of disturbance such as fire allows for juniper and/or sagebrush to increase. Chronic drought, herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing juniper and/or sagebrush to increase.

Community Phase 1.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community. Bluebunch wheatgrass and other perennial bunchgrasses dominate. Idaho fescue is more susceptible to fire and may be reduced in the community. Depending on fire severity, patches of intact mountain sagebrush may remain. Rabbitbrush (*Ericameria nauseosa* or *Chrysothamnus viscidiflorus*) may be sprouting. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 1.2a:
Time and lack of disturbance will allow juniper and/or sagebrush to increase.

Community Phase 1.3:
Juniper and sagebrush increase in the absence of disturbance. Decadent sagebrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory. Young western juniper increases and may influence the understory vegetation.

Community Phase Pathway 1.3a:
Fire will reduce the overstory of juniper and sagebrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts. Old growth juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

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, mustards, and bur buttercup (*Ceratocephala testiculata*).
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, residual dry matter accumulation, and adaptations for seed dispersal.

Community Phase 2.1:
This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Bluebunch wheatgrass, Idaho fescue, mountain big sagebrush, and Sandberg bluegrass dominate site. Forbs and other shrubs and grasses make up smaller components of this site.

Plot A37 Juniper Shrubby North 9-12" Community Phase 2.1

Community Phase Pathway 2.1a:
Fire reduces the overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce overstory cover to trace amounts. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced. Annual non-native species are likely to increase after fire.

Community Phase Pathway 2.1b:
Time and lack of disturbance allows for young juniper and mountain big sagebrush to increase. Sagebrush may become decadent. Chronic drought reduces fine fuels and leads to a reduced fire

frequency, allowing juniper and mountain big sagebrush to dominate the site. Inappropriate grazing management may hasten the decline of the perennial bunchgrass understory; while the grazing tolerant Sandberg bluegrass may increase in the understory.

Community Phase 2.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community where annual non-native species are present. Young juniper and mountain big sagebrush are present in trace amounts; perennial bunchgrasses dominate the site. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced. Depending on fire severity, patches of intact sagebrush may remain. Rabbitbrush may be sprouting. Perennial forbs may be a significant component after fire. Annual non-native species are stable or increasing within the community.

Community Phase Pathway 2.2a:
Time and lack of disturbance and/or grazing management that favors the establishment and growth of western juniper and mountain big sagebrush. The establishment of sagebrush can take many years. Western juniper may increase.

Community Phase Pathway 2.2b:
Tree/shrub removal treatment or prescribed burning in the presence of annual grass species will reduce shrub canopy may cause a shift to Phase 2.4. A subsequent year with precipitation that is favorable to nonnative annual grasses may speed up this pathway.

Community Phase 2.3 (At Risk):
This community is at risk of crossing a threshold to another state. Sagebrush dominates the overstory, young juniper increases and perennial bunchgrasses in the understory are reduced, either from competition with the overstory or from inappropriate grazing, or from both. Annual non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from grazing, drought, and fire.

Plot B36 Juniper Shrubby North 9-12” Community Phase 2.3

Community Phase Pathway 2.3a:
A low severity fire will reduce young juniper and sagebrush the overstory. Fires would typically burn in a mosaic pattern on the landscape leaving patches of intact shrubs and old growth juniper and allowing for an increase in perennial grasses. A high severity fire would significantly reduce the brush/tree overstory and lead to an early to mid-seral bunchgrass and forb community. Alternatively, a change in grazing management that reduces shrubs will also allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush/tree treatments with minimal soil disturbance will also decrease juniper and shrubs and release the perennial understory. Annual non-native species are present and may increase in the community.

Community Phase Pathway 2.3b:
Annual precipitation highly influences the density and cover of non-native annual species. A year with higher than normal precipitation during the germination and growth period of non-native annual species will cause populations to increase and become codominant in the understory. Tree/shrub removal treatment that disturb the soil surface, inappropriate grazing management, or prescribed burning in the presence of annual grass species may cause a shift to Phase 2.4.

Community Phase 2.4 (At Risk):
This community is at risk of crossing into an Annual State. Native bunchgrasses and/or native shrubs are still dominant; however, annual non-native species such as cheatgrass or medusahead may be codominant in the understory. Annual production and abundance of these annuals may increase drastically in years with above average spring precipitation. Seeded species may be present. If the site is coming from Phase 2.2, sagebrush may only be a minor component. Western juniper may be present to increasing. Disturbances that damage native shrubs and grasses increase the risk of transitioning into an Annual State.

Community Phase Pathway 2.4a:
Rainfall patterns favoring perennial bunchgrass production transition this community phase to Phase 2.2. Less than normal early spring precipitation followed by higher than normal late spring/ early summer precipitation will increase perennial bunchgrass production.

Community Phase Pathway 2.4b:
Rainfall patterns favoring perennial bunchgrass production transition this community phase to Phase 2.3. Less than normal early spring precipitation followed by higher than normal late spring / early summer precipitation will increase perennial bunchgrass production. Shrubs will remain if present.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0
Trigger: To Community Phase 3.1: Repeated, chronic, growing season grazing and/or reduction in the historical fire return interval will decrease or eliminate deep rooted perennial bunchgrasses and favor shrub and young tree growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Brush treatments coupled with inappropriate grazing management will reduce shrub overstory, decrease perennial bunchgrasses and facilitate an increase in Sandberg bluegrass.
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 Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire or failed rehabilitation treatments involving activities such as tree removal or seeding. To Community Phase 4.2: Inappropriate grazing management that decreases perennial bunchgrasses and facilitates the expansion of non-native annual grasses; competitive increase in medusahead through lack of active management.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T2C: Transition from Current Potential State 2.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Shrub State 3.0:

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses, changes in the historic fire regime or long-term drought favoring shrub establishment. Grazing tolerant Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Mountain big sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed (3.1). In both community phases, bare ground may be significant with soil redistribution occurring between interspace and shrub locations. Western juniper increases and may begin to influence the understory vegetation.

Community Phase 3.1 (At Risk):

Decadent mountain big sagebrush dominates the overstory. Rabbitbrush may be a significant component. Sandberg bluegrass may dominate understory. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Old growth juniper is present but scattered and young juniper will likely increase without management action. Bare ground is significant. Annual non-native species stable to increasing.

Community Phase Pathway 3.1a:

Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for Sandberg bluegrass the site. Rabbitbrush may dominate overstory.

Community Phase 3.2 (At Risk):

Rabbitbrush and/or Sandberg bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Scattered old growth juniper may be present. Phase 3.2 may be created by fire from 3.1 or directly from the Current Potential State 2.3.

Community Phase Pathway 3.2a:
Time without disturbance allows sagebrush establish and mature and become dominant overstory. Western juniper may increase.

T3A: Transition from Shrub State 3.0 to Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire and/or failed rehabilitation treatment or combination of both. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species and/or competitive increase in medusahead through lack of active management. May be combined with higher than normal spring precipitation.
Slow variables: Increased production and cover of non-native annual species. Increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

T3B: Transition from Shrub State 3.0 to Tree State 5.0

Trigger: Time and a lack of disturbance or management action allows for juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs

R3A: Restoration from Shrub State 3.0 to Current Potential State 2.0

Tree and brush management such as mowing, chaining, mastication; coupled with seeding of deep-rooted native bunchgrasses. Restoration attempts causing soil disturbance may initiate a transition to an annual state.

R3B: Restoration from Shrub State 3.0 to Seeded State 6.0

Tree and brush management such as mowing, chaining, mastication; coupled with seeding of deep rooted non-native wheatgrasses. Restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Herbicide may be necessary for control of non-native annual grasses.

Annual State 4.0:

This community is characterized by the dominance of annual non-native species such as cheatgrass, medusahead and tansy mustard in the understory. Old growth juniper is present but scattered. Depending on transition young juniper may be increasing. Sagebrush and/or rabbitbrush may dominate the overstory.

Community Phase 4.1:

Annual non-native plants such as cheatgrass and medusahead or mustards dominate this site. Old growth juniper is present but scattered. Shrubs may be present in trace amounts.

Community Phase Pathway 4.1a:
Time and lack of fire allows for the sagebrush and bitterbrush to establish or sprouting shrubs such as rabbitbrush to increase. Young juniper may increase. The probability of sagebrush establishment is extremely low.

Community Phase 4.2:
Rabbitbrush is typically the dominant overstory shrub if fire preceded development of the community. Sagebrush may be the dominant overstory shrub if inappropriate grazing was the threshold driver to 4.2. Annual non-native species, likely cheatgrass, medusahead and mustards, dominate the understory.

Community Phase Pathway 4.2a:
Fire reduces/eliminates overstory brush component and allows for annual non-native species to dominate the site. Old growth juniper present but scattered. Saplings and poles reduced.

R4A: Restoration from Annual State 4.0 to Seeded State 6.0:
Seeding of deep-rooted bunchgrasses; may be coupled with tree/brush management and/or herbicide. Probability of success is low. Non-native perennial species such as crested wheatgrass have a higher likelihood of success due to their ability to compete with annual species such as cheatgrass.

Tree State 5.0:
This state is characterized by a dominance of young juniper (<100 years old) in the overstory. Big sagebrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community Phase 5.1 (At Risk):
Juniper dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Idaho fescue may be found under tree canopies with trace amounts of forbs in the interspaces. Sagebrush is stressed and dying. Annual non-native species are present under tree canopies. Bare ground interspaces are large and connected.

Community Phase Pathway 5.1a:
Time and lack of disturbance or management action allows juniper to further mature and dominate site resources.

Community Phase 5.2 (At Risk):
Juniper dominates the site and tree leader growth is minimal; annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Deep rooted perennial bunchgrasses may or may not be present however Sandberg bluegrass may dominate the interspaces. Mat forming forbs may be present in trace amounts. Bare ground interspaces are large and connected. Soil redistribution is evident.

Community Phase Pathway 5.2a:
Tree stand thinning treatments for fuels management or other resource values.

T5A: Transition from Tree State 5.0 to Annual State 4.0
Trigger: Catastrophic fire causing a stand replacement event will transition Annual State 4.0. Inappropriate tree removal practices with soil disturbance will cause a transition to the Annual State 4.
Slow variables: Increased production and cover of non-native annual species under tree canopies.
Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact nutrient cycling and distribution.

R5A: Restoration from Tree State 5.0 to Shrub State 3.0
This restoration is recommended for Phase 5.1 only due to the lack of understory in 5.2.
Tree removal practices with minimal soil disturbance.

R5B: Restoration from Tree State 5.0 to Seeded State 6.0
Tree removal and seeding of desired cultivated species. Tree removal practices that minimize soil disturbance are recommended. Probability of success declines with increased presence of non-native annual species. Herbicide treatment may be necessary.

Seeded State 6.0:
This state has three community phases; a grass-dominated phase; a grass-shrub phase and a shrub dominated phase. The state is characterized by the dominance of seeded introduced wheatgrass species. Other seeded species including sagebrush, bitterbrush, and native and non-native forbs may be present.

Community Phase 6.1:
Introduced wheatgrass species and other non-native species dominate the community. Rabbitbrush and other sprouting shrubs may increase. Native and non-native seeded forbs may be present. Trace amounts of big sagebrush may be present, especially if seeded. Annual non-native species present. Old growth juniper may be present.

Community Phase Pathway 6.1a:
Time without disturbance allows shrub species to reestablish. This may be coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.2:
Big sagebrush and/or rabbitbrush and seeded wheatgrass species are codominant. Sandberg bluegrass may increase. Annual non-native species may be present. Young juniper may be increasing.

Community Phase Pathway 6.2a:

Low severity fire and/or brush management will reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

Community Phase Pathway 6.2b:
Absence of fire over time coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance and an increase in juniper.

Community Phase 6.3 (At Risk):
This community phase is at-risk of crossing a threshold to another state. Big sagebrush dominates. Rabbitbrush may be a significant component. Wheatgrass vigor and density reduced. Annual non-native species stable to increasing. Young juniper may be present to increasing.

Community Phase Pathway 6.3a:
Fire eliminates/reduces the overstory of sagebrush and decreases young juniper which allows for the understory perennial grasses to increase. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Targeted herbicide treatments of rabbitbrush may be necessary. Annual non-native species respond well to fire and may increase post-burn.

Community Phase Pathway 6.3b:
Low severity fire leading to a mosaic pattern in the grass-shrub community. A change in grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Targeted herbicide treatments of rabbitbrush may be necessary. Annual non-native species are present and may increase in the community.

T6A: Transition from Seeded State 6.0 to Annual State 4.0
Trigger: To Community Phase 4.1: Catastrophic fire, likely from 6.3.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T6B: Transition from Seeded State 6.0 to Shrub State 3.0
Trigger: To Community Phase 3.1: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2 from 6.3: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass.
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.

T6C: Transition from Seeded State 6.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

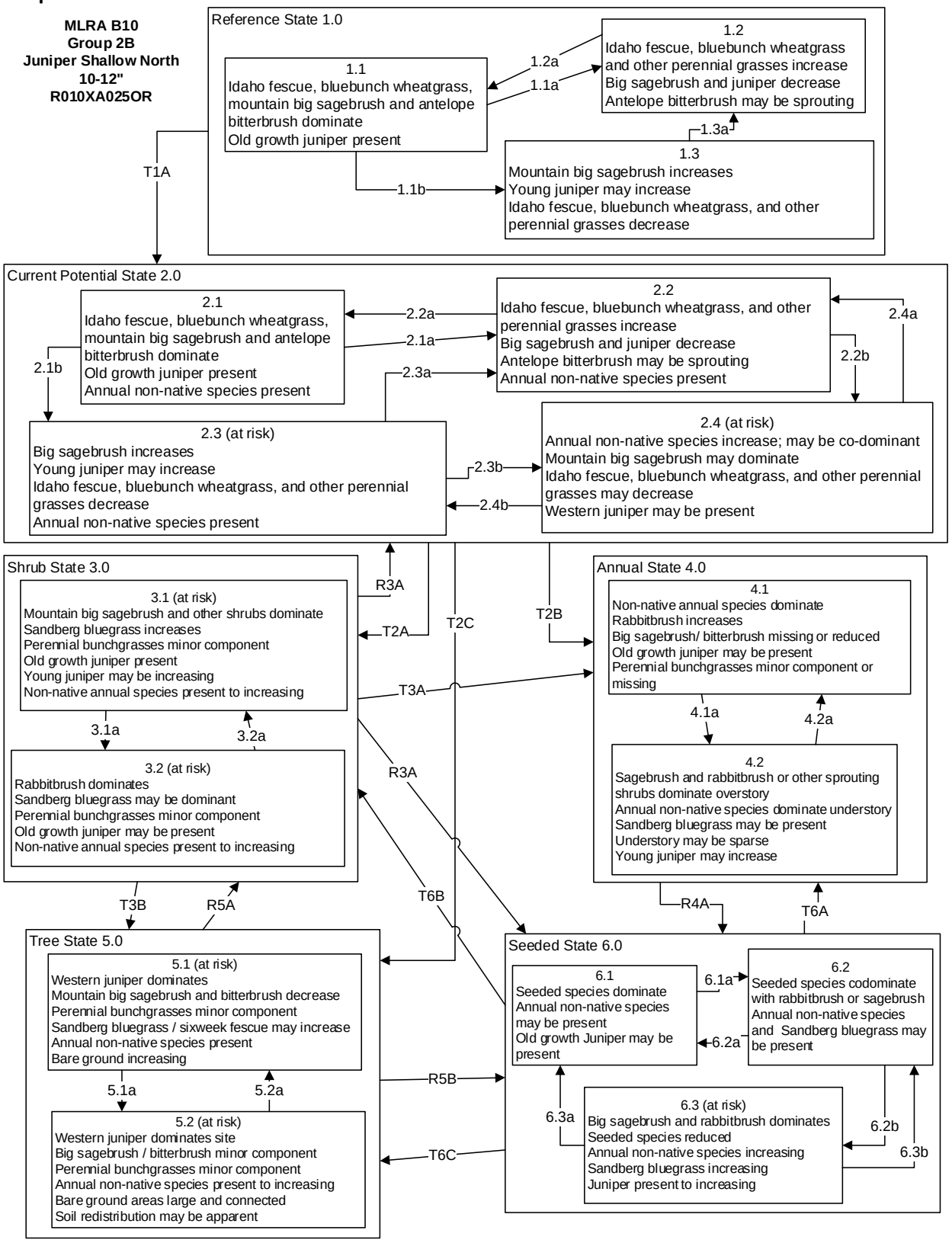
Potential Resilience Differences with other Ecological Sites

Juniper Shrubby Pumice Flat 10-12" (R010XA009OR):
This site occurs on level to gentle uplands. The elevation range is 2500 to 4000 feet. The precipitation ranges from 10 to 12 inches which occurs mainly between the months of October and June. The soil temperature regime is mesic. The soils of this site are typically moderately deep to deep, somewhat excessively drained and coarse textured. They are generally formed in volcanic ash. Permeability is rapid and the available water holding capacity is 3 to 6 inches for the profile. The potential for water or wind erosion is slight to moderate dependent on slope. This site has **higher cover of antelope bitterbrush** but still has mountain big sagebrush. **Idaho fescue and needle and thread grass** are the dominant grasses. Western juniper is present on this site and historically was limited to old growth trees widely spaced. Idaho fescue increases in density under tree canopies while needle and thread and other grasses dominate the interspaces. Where this site occurs adjacent to pine forests, needle and thread grass is reduced in the interspaces and Idaho fescue dominates. **This model has the same states and phases as the modal site with slight variations in plant species.**

Juniper Shrubby Lava Blisters 10-12" (R010XA023OR):
This site occurs on exposed lava flows and lava blisters or small knolls dispersed across lava plains. Slopes range from 0 to 15 percent although the steep side slopes of blisters may approach 60 percent in places. Elevation ranges from 2800 to 4200 feet. The annual precipitation ranges from 10 to 12 inches which occurs mainly in the months of November and June. The soil temperature regime is mesic. The soils of this site are shallow to very shallow with sandy loam surface layers dominated by volcanic ash. Subsoils may have cobbly or gravelly sandy loam texture and are well drained. They are generally found on lava flows which have created a very uneven land surface. Pumice ash soils fills rock fractures and pockets on the lava in which plants take root. Permeability is rapid and the available water holding capacity is 1 to 3 inches for the profile. The potential for water or wind erosion is high. The potential native plant community is dominated by an open stand of juniper. The understory is dominated by mountain big sagebrush and antelope bitterbrush with an understory of bluebunch wheatgrass and Sandberg bluegrass. Thurber's needlegrass, Idaho fescue, big bluegrass, Indian ricegrass (*Achnatherum hymenoides*) and other perennial grasses are also common. **This model has the same states, phases, and plant species as the modal site.**

Juniper Shrubby North 9-12" (R010XA083OR):
This site occurs on gentle to moderately steep north aspects of buttes, ridges and canyons. Elevation ranges from 2800 to 4500 feet. Annual precipitation ranges from 9 to 12 inches which occurs mainly between the months of November and June. The soil temperature regime is mesic. The soils of this site are moderately deep to deep, well drained and coarse textured. They are generally formed in volcanic ash and colluvium. Permeability is moderate and the available water capacity is 3 to 6 inches for the profile. The grasses on this site are primarily Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass and Thurber's needlegrass. This site has **higher cover of antelope bitterbrush** but still has mountain big sagebrush. Western juniper is present on this site as old growth trees widely spaced. **This model has the same states and phases as the modal site with slight variations in plant species.**

Juniper Shallow North 10-12” Modal Model



MLRA B10
Group 2B
Juniper Shallow North 10-12"
R010XA025OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire (ground fire) resulting in a mosaic pattern
1.1b: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.2a: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.3a: Low severity fire resulting in a mosaic pattern.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

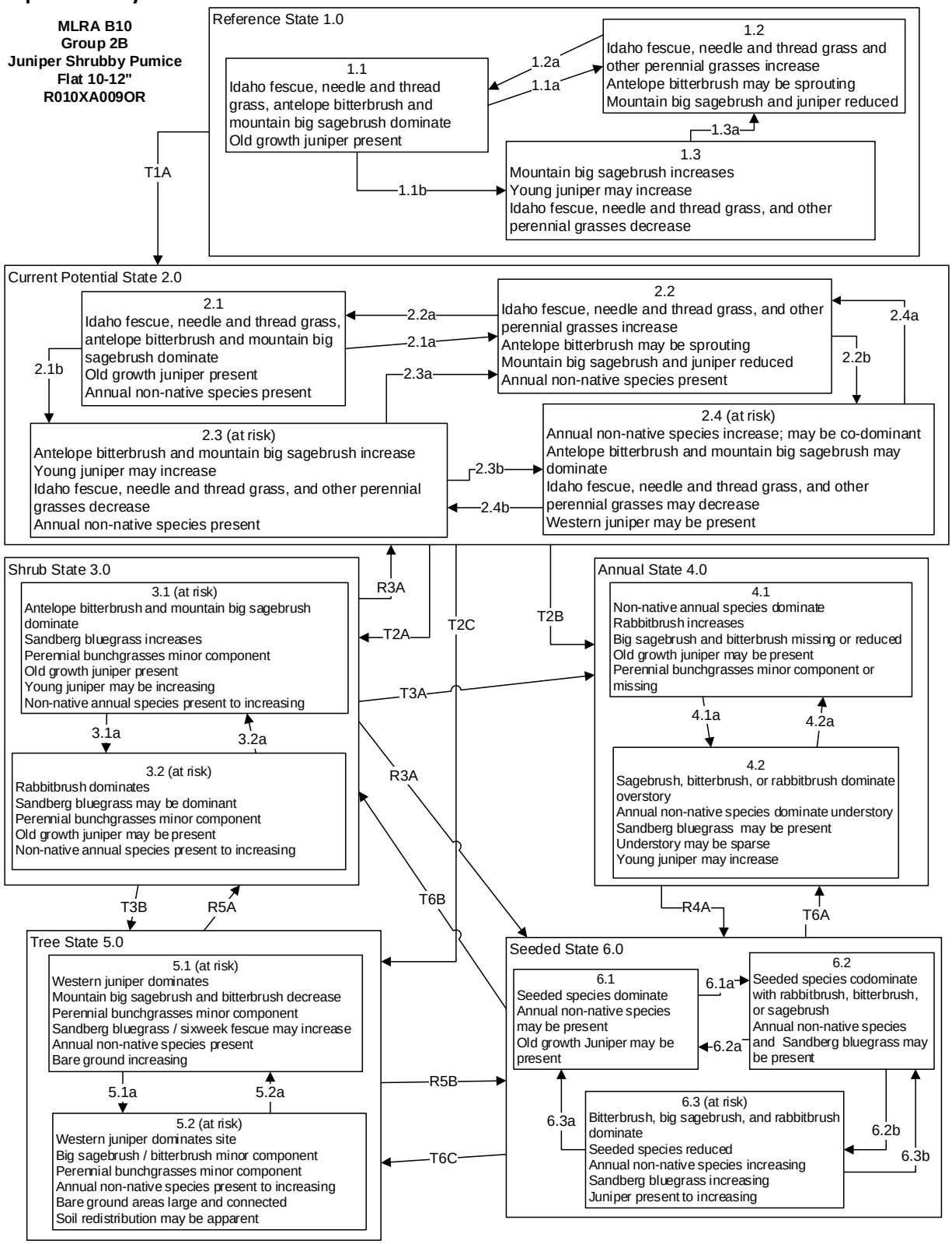
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Shrubby Pumice Flat 10-12”



MLRA B10
Group 2B
Juniper Shrubby Pumice Flat
10-12"
R010XA009OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire (ground fire) resulting in a mosaic pattern
1.1b: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.2a: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.3a: Low severity fire resulting in a mosaic pattern.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

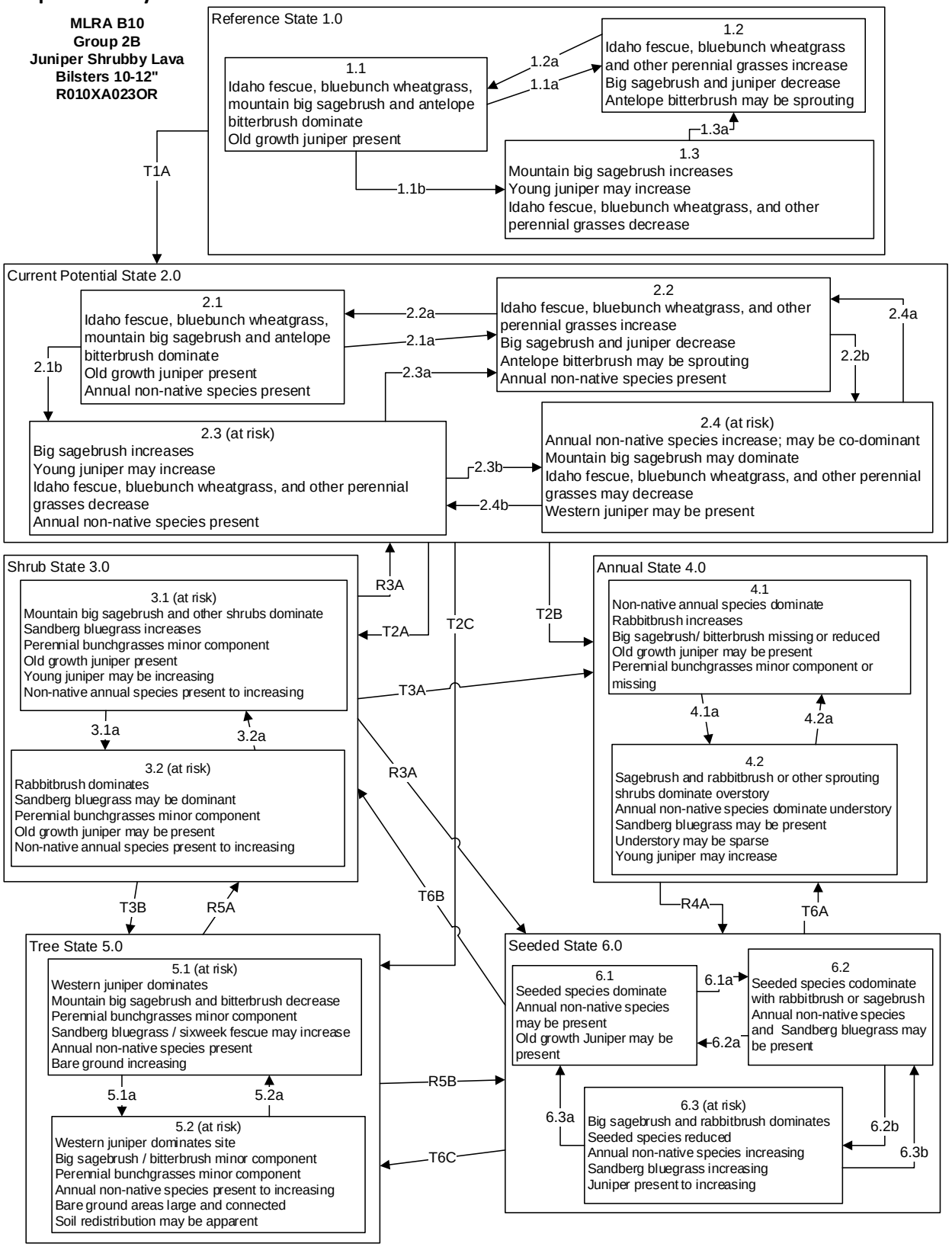
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Shrubby Lava Blisters 10-12”



MLRA B10
Group 2B
Juniper Shrubby Lava Bilsters 10-12"
R010XA023OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire (ground fire) resulting in a mosaic pattern
1.1b: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.2a: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.3a: Low severity fire resulting in a mosaic pattern.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

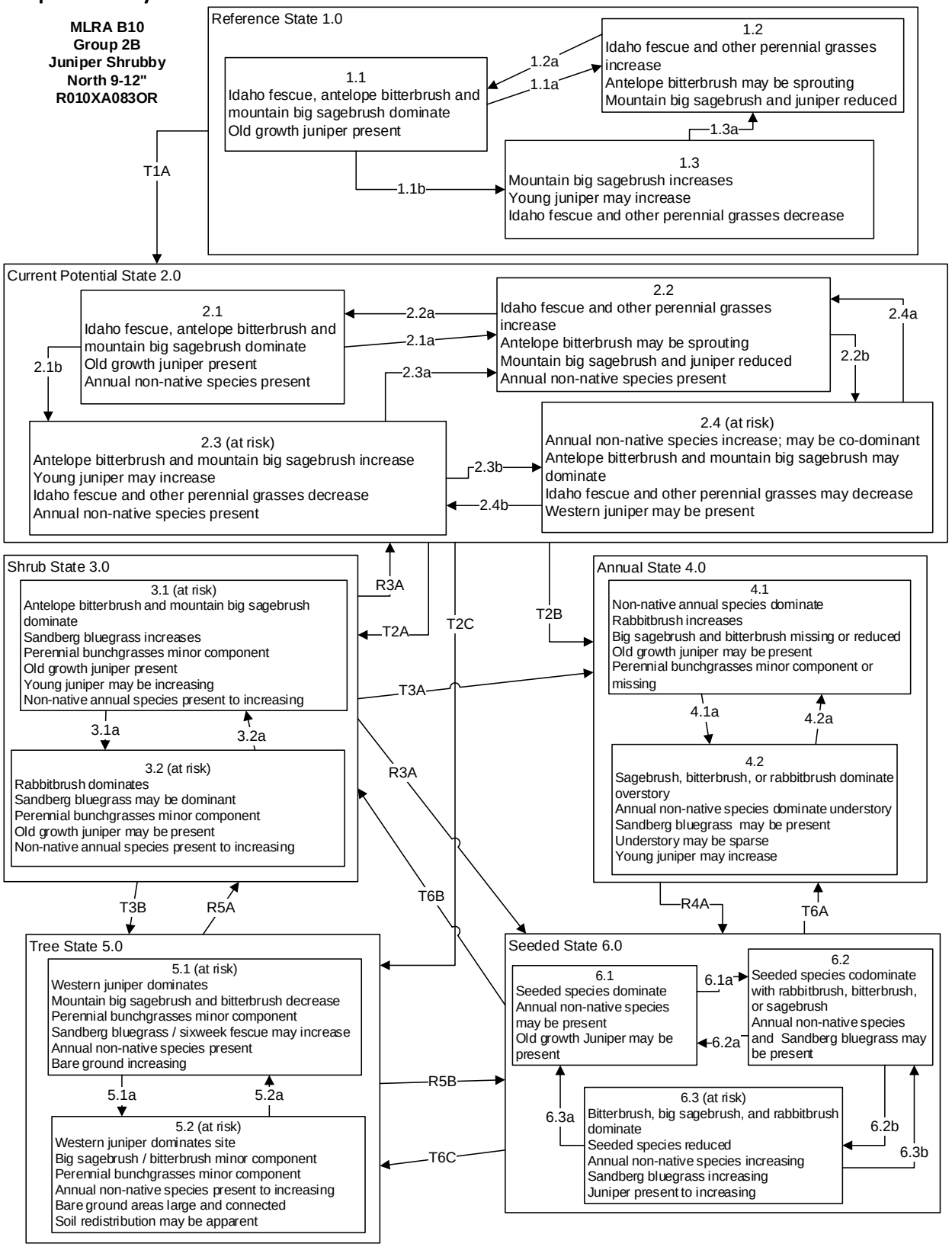
Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Juniper Shrubby North 9-12”



MLRA B10
Group 2B
Juniper Shrubby North 9-12"
R010XA083OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire (ground fire) resulting in a mosaic pattern
1.1b: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.2a: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.3a: Low severity fire resulting in a mosaic pattern.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).
Restoration R3B: Shrub removal treatments and seeding of desired cultivated species. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species; may be coupled with brush management (to 6.1).

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal (from 5.1 to 3.1).
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 6.1).

Seeded State 6.0 Community Phase Pathways
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management facilitating shrubs.
6.2a: Fire and/or shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management facilitating shrub establishment.
6.3a: Fire and/or other shrub reduction treatments.
6.3b: Shrub management, low severity fire and/or Aroga moth would decrease the shrub community.

Transition T6A: Catastrophic fire, likely from 6.3 (4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses likely from 6.3 (to 4.2).
Transition T6B: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1). Severe fire likely from 6.3 (to 3.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Group 4

Group 4 consists of 13 sites with a precipitation range of 8 to 12 inches. There are six non-aspect sites, six south aspect sites and one north aspect site. The slope ranges from 0 percent to 90 percent with the average slope ranging between 8.5 and 45 percent. Elevation ranges from 1000 to 4000 feet with an average elevation range between 1531 and 3146 feet. Soil temperature is mesic. The ecological sites within this group exhibit xeric to aridic moisture regimes. This site generally has soils 30 to 60 inches deep with a surface texture of stony clay loam, silty clay loam, or stony loam approximately 5 inches thick. The subsurface texture is a cobbly clay loam about 20 inches thick. This soil is moderately well drained with a slow permeability class. This DRG is composed of ecological sites dominated by deep-rooted perennial grasses with a sub-dominant overstory of basin big sagebrush (*Artemisia tridentata spp. tridentata*) or Wyoming big sagebrush (*Artemisia tridentata spp*. *wyomingensis*). Five of the sites may have a minor component of old growth western juniper (*Juniperus occidentalis*) in the reference plant community. Ground cover is 50 to 60 percent and average production of all 13 sites ranges from 500 to 1000 lbs.

Group 4 Ecological Sites

R010XA001OR LOAMY PLAINS 8-10 PZ (Droughty loam 8-10")
R010XA005OR DROUGHTY SOUTH 9-11 PZ
R010XA007OR JUNIPER PUMICE SOUTH 9-12 PZ (South 10-12")
R010XA014OR CINDERY HILLS 10-12 PZ
R010XB022OR JD CLAYEY 9-12 PZ MODAL for MLRA B10 Group 4
R010XB023OR JD SHALLOW 9-12 PZ
R010XB025OR JD SANDY LOAM 9-12 PZ
R010XB035OR JD SHALLOW NORTH 9-12 PZ
R010XB041OR JD CLAYEY SOUTH 9-12 PZ
R010XB044OR JD DROUGHTY SOUTH 9-12 PZ
R010XB051OR JD SHALLOW SOUTH 9-12 PZ
R010XB052OR JD DROUGHTY SHALLOW SOUTH 9-12 PZ
R010XA018OR JUNIPER SHRUBBY LOAM 10-12 PZ (Loamy 10-12")

Sites on the CRNG

R010XA018OR JUNIPER SHRUBBY LOAM 10-12 PZ (Loamy 10-12") MODAL for CRNG Group 4
R010XA001OR LOAMY PLAINS 8-10 PZ (Droughty loam 8-10")
R010XA007OR JUNIPER PUMICE SOUTH 9-12 PZ (South 10-12")
R010XB025OR JD SANDY LOAM 9-12 PZ
R010XB022OR JD CLAYEY 9-12 PZ
~~R010XB042OR DROUGHTY SOUTH 9-12~~ (ESIS indicates "inactive", utilize R010XB044OR)
R010XB044OR JD DROUGHTY SOUTH 9-12 PZ

*() Previous Ecological site names

Group 4 Modal Site for CRNG:

The Juniper Shrubby Loam 10-12" (R010XA018OR) ecological site is the modal site for this group as it has the most acres mapped in the CRNG. This site occurs on plateaus, ridgetops and gently sloping to undulating uplands. This site is found on slopes from 0 to 20 percent. Elevation ranges from 2000 to

4000 feet. Annual precipitation ranges from 10 to 12 inches which occurs mainly between the months of October and June. The soils of this site are shallow to moderately deep, well drained and medium textured. They are generally formed from loess and the underlying bedrock. Permeability is slow. The potential for wind erosion is low on these soils in reference condition, however disturbance of the soil by plowing or disking breaks soil structure and increases the risk of wind erosion. The potential native plant community is dominated by an open stand of old growth western juniper, antelope bitterbrush (*Purshia tridentata*), big sagebrush, bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*). Sandberg bluegrass (*Poa secunda*) and Thurber's needlegrass (*Achnatherum thurberianum*) are sub-dominants while other species such as prairie Junegrass (*Koeleria macrantha*) are often present but minor components in the community. Wide varieties of forbs occur, but are overall a minor component in the plant community.

Group 4 Modal Site for MLRA B10:

The Clayey 9-12" (R010XB022OR) ecological site is the modal site for this group as it has the most acres mapped in this MLRA. This site occurs on low elevation terraces and tablelands with slopes ranging from 0 to 12 percent. Elevations range from 1300 to 3000 feet. Annual precipitation ranges from 9 to 12 inches most of which occurs in the form of rain from November to May. Localized, occasionally severe convective storms occur during the summer. The soils of this site are typically moderately deep and well drained. The surface layer is clay or stony loam about 5 inches thick. There can be an abruptic textural change at 4 to 12 inches. Depth to bedrock or sediment pan is usually 30 to 60 inches. Permeability is slow to moderately slow. The soils have a mesic temperature regime and a xeric to aridic moisture regime. The reference plant community is dominated by bluebunch wheatgrass with Thurber's needlegrass also common. Basin big sagebrush is the dominant overstory shrub and old growth western juniper may be present on the site.

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 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

The ecological sites in this DRG include deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). Tap roots of antelope bitterbrush have been documented from 4.5 to 5.4m in length (McConnell 1961). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, 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.

In the central Oregon, John Day ecological province, the majority of annual precipitation is received during the winter and spring months with about 28% arriving during the April through June period and 58% during November through March (Anderson et al. 1998). 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 great potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability with the soil profile (Bates et al. 2006).

Variability in plant community composition and production is influenced by soil surface texture and depth. Thurber's needlegrass will increase on gravelly soils, whereas Idaho fescue will increase with loamy soil surfaces, and a weak argillic horizon will promote production of bluebunch wheatgrass. Production generally increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances like fire, Aroga moth infestations, juniper encroachment and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile.

Basin big sagebrush and Wyoming big sagebrush along with antelope bitterbrush are generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The Crooked River Grasslands sagebrush / grass 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. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing) that have resulted in fluctuations in resources (Chambers et al. 2007).

The introduction of annual weedy species, like cheatgrass and medusahead (*Taeniatherum caput-medusae)*, may cause an increase in fire frequency and eventually lead to an annual state. Conversely, as fire frequency decreases, sagebrush and or western juniper will increase and the understory bunchgrass community will decline as competition for limited resources increases. Inappropriate grazing management can facilitate the increase in the shrub community and decrease in the perennial bunchgrasses and forbs.

Western Juniper

During the past 140 years, western juniper has been expanding within its geographic range at unprecedented rates compared to any other time period during the Holocene (Miller et al. 2005) and

density of western juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Western juniper woodlands in eastern Oregon with more than 10 percent canopy cover increased from 456,000 acres in 1936 to 2.2 million acres in 1988 (Gedney et al. 1990, Miller et al. 2005). Causes for expansion of western juniper into sagebrush ecosystems include changes in the wildfire return interval, historic livestock grazing, and climate influences (Bunting 1994). Mean fire return intervals prior to European settlement in mountain big sagebrush ecosystems were 15 to 25 years (Burkhardt and Tisdale 1976, Young and Evans 1981, Miller and Rose 1999), frequent enough to inhibit the encroachment of western juniper into these big sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity.

An increase in juniper crown density causes a decrease in understory perennial vegetation and an increase in bare ground (Bates et al. 2000, Miller et al. 2000). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010). Additionally, as understory plant communities become depleted and soil resources become less available the opportunity for invasion by non-native annual species such as cheatgrass and medusahead increases. The highest risk for weed invasion in juniper encroached sagebrush communities are in the warmer (mesic soil temperature) lower elevation sites (Miller et al. 2005). With annual species in the understory wildfire can become more frequent and increase in intensity. Following fire, soil water and available nutrients generally increase, at least for a short period of time (Blank et al. 1994). Increases in nutrients, particularly nitrogen, enhance the growth of cheatgrass and increases the period of dominance (Miller et al. 2005). Once established, non-native annual species, especially cheatgrass, can shift the seasonality of fire to the active growing period of native perennials (Whisenant 1990). With frequent wildfires these plant communities can convert to annual grasslands with a sprouting shrub and juvenile tree overstory (Tausch 1999).

Nutrient and litter distribution are altered when juniper invades and dominates sagebrush sites. Soil calcium (Ca) and potassium (K) were found to increase under mature western juniper trees in central Oregon whereas nitrogen (N) and organic matter concentrations were highest under juvenile (< 40 yr.) old tree canopies (Doescher et. al. 1987). Changes in soil nutrient and organic matter distribution may have implications for plant community response post-fire or post-treatment.

Annual Invasive Grasses

The species most likely to invade these sites are cheatgrass and medusahead. Both species are cool-season annual grasses that maintain an advantage over native plants in part because they are prolific seed producers, able to germinate in the autumn or spring, tolerant of grazing and increase with frequent fire (Klemmedson and Smith 1964, Miller et al. 1999). Medusahead and cheatgrass originated from Eurasia and both were first reported in North America in the late 1800s (Mack and Pyke, 1983; Furbush 1953). Pellant and Hall (1994) found 3.3 million acres of public lands dominated by cheatgrass and suggested that another 76 million acres were susceptible to invasion by winter annuals including cheatgrass and medusahead. By 2003, medusahead occupied approximately 2.3 million acres in 17 western states (Rice 2005). In the Intermountain West, the exponential increase in dominance by medusahead has largely been at the expense of cheatgrass (Harris 1967, Hironaka 1989). Medusahead matures 2-3 weeks later than cheatgrass (Harris 1967) and recently, James et al. (2008) measured leaf biomass over the growing season and found that medusahead maintained vegetative growth later in the growing season than cheatgrass. Mangla et al. (2011) also found medusahead had a longer period of growth and more total biomass than cheatgrass and hypothesized this difference in relative growth rate may be due to the ability of medusahead to maintain water uptake as upper soils dry compared to co-

occurring species, especially cheatgrass. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008). Harris (1967) reported cheatgrass roots to have a relatively poorly developed endodermis layer to insulate against hot dry soils, while medusahead roots have thicker cell walls, which allow it to conduct water throughout very dry soil horizons. Recent modeling and empirical work by Bradford and Lauenroth (2006) suggests that seasonal patterns of precipitation input and temperature are also key factors determining regional variation in the growth, seed production, and spread of invasive annual grasses. Collectively, the body of research suggests that the continued invasion and dominance of medusahead onto native grasslands and cheatgrass infested grasslands will continue to increase in severity because conditions that favor native bunchgrasses or cheatgrass over medusahead are rare (Mangla et al. 2011). Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency.

Methods to control medusahead and cheatgrass include herbicide, fire, grazing, and seeding of primarily non-native wheatgrasses. Mapping potential or current invasion vectors is a management method designed to increase the cost effectiveness of control methods. A study by Davies et al. (2013), found an increase in medusahead cover near roads. Cover was higher near animal trails than random transects but the difference was less evident. This implies that vehicles and animals aid the spread of the weed; however, vehicles are the major vector of movement. Spraying with herbicide (Imazapic or Imazapic + glyphosate) and seeding with crested wheatgrass and Sandberg bluegrass has been found to be more successful at combating medusahead and cheatgrass than spraying alone (Sheley et al. 2012). Where native bunchgrasses are missing from the site, revegetation of medusahead or cheatgrass invaded rangelands has been shown to have a higher likelihood of success when using introduced perennial bunchgrasses such as crested wheatgrass (Davies et al. 2015). Butler et al. (2009) tested four herbicides (Imazapic, Imazapic + glyphosate, rimsulfuron and sulfometuron + Chlorsulfuron) only treatments for suppression of cheatgrass, medusahead and ventenata (North Africa grass, *Ventenata dubia*) within residual stands of native bunchgrass. Additionally, they tested the same four herbicides followed by seeding of six bunchgrasses (native and non-native) with varying success (Butler et al. 2009). Herbicide only treatments appeared to remove competition for established bluebunch wheatgrass by providing 100% control of ventenata and medusahead and greater than 95% control of cheatgrass (Butler et al. 2009) however caution in results is advised as only one year of data was reported. Prescribed fire has also been utilized in combination with the application of pre-emergent herbicide to control medusahead and cheatgrass (Vollmer and Vollmer 2008). Mature medusahead or cheatgrass is very flammable and fire can be used to remove the thatch layer, consume standing vegetation, and even reduce seed levels. Furbush (1953) reported that timing a burn while the seeds were in the milk stage effectively reduced medusahead the following year. He further reported that adjacent unburned areas became a seed source for reinvasion the following year. In considering the combination of pre-emergent herbicide and prescribed fire for invasive annual grass control it is important to assess the tolerance of desirable brush species to the herbicide being applied. Vollmer and Vollmer (2008) tested the tolerance of mountain mahogany (Cerocarpus montanus), antelope bitterbrush and multiple sagebrush species to three rates of Imazapic and the same rates with methylated seed oil as a surfactant. They found a cheatgrass control program in an antelope bitterbrush community should not exceed Imazapic at 8oz/ac with or without surfactant (Vollmer and Vollmer 2008). Sagebrush, regardless of species or rate of application was not affected. However, many environmental variables were not reported and managers should install test plots before broad scale herbicide application is initiated.

Historical Farming

The legacy effects of the dryland farming era, 1880's – 1930's, are still seen today within MLRA B10 and specifically within Crooked River National Grasslands (USDA Forest Service 2016). Practices included removal of deep-rooted bunchgrasses and sagebrush (USDA Forest Service 1989), plowing and harrowing of soil (Morris 2011), and planting of annual crops (Morris 2012, US Forest Service 1989). Dust storms, water erosion, and organic matter oxidation resulting from these practices (Schillinger et al. 2010) led to the complete or partial loss of organic matter and nutrient value in the topsoil (Bracken et al. 1940, Bradley 1910, Schillinger et al. 2010, USDA Forest Service 2004, Williams el al. 2009). By the 1930s inadequate rainfall and poor economic conditions led to farm failure, and government policies including the Resettlement Act and Bankhead Jones Farm Tenant Act that facilitated the federal government purchase of land for rehabilitation (USDA Forest Service 2016). During the late 1930's and early 1940's, approximately 63,000 acres were planted to either crested wheatgrass (*Agropyron cristatum*) or beardless bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *inerme)* in an effort to provide soil stabilization (USDA Forest Service 2004). In 1954, management of the acquired lands were transferred from the Soil Conservation Service to the Forest Service (USFS) and in 1960 became known as the Crooked River National Grasslands. In the 1960's the USFS continued reseeding the farmed acres and spraying herbicides to control shrubs. In the 1970's reseeding was phased out and fire was introduced as a management tool.

The management activities of the farming era followed by abandonment of farmed fields often led to accelerated wind and water erosion of soil. Additionally, on some areas plow pan compaction layers resulting from repeated plowing are still present today. Lasting effects on the soil also include diminished soil stability (Bullock, Kemper and Nelson 1988), altered structure, reduced moisture and nutrient retention, and lower infiltration potential (Schnitzer and Khan 1975). Recognizing and acknowledging the legacy effects of the farming era on the landscape of the CRNG is important in development of appropriate management plans.

Ecological Resilience and Resistance: Summary

The ecological sites in this DRG have moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. However, ecological sites that have experience legacy farming and associated soil erosion or changes in soil structure will exhibit reduced resilience to disturbance and resistance to invasion. Eight alternative stable states have been identified for this DRG.

Fire Ecology of Plant Species

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. Fire typically occurs past the end of the growing season for most forbs and grasses therefore the growing points are generally located at or below the soil surface providing relative protection from disturbances that remove above ground biomass. 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 plant material (Wright 1971, Young 1983, Davies et al. 2009). Furthermore, (Boyd and Davies 2012) found that bunchgrasses under shrub canopies burned more than 40% hotter than interspace counterparts leading to mortality rates greater than 73% (Boyd et al. 2015). Thus, fire severity is a function of seasonality and intensity along with the amount of biomass within the bunchgrass and surrounding the bunchgrass.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage from fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.

Idaho fescue response to fire varies with condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all seasons (Wright et al. 1979). Initial mortality may be high (in excess of 75%) on severe burns, but usually varies from 20 to 50% (Barrington et al. 1989). Rapid burns have been found to leave little damage to root crowns, and new tillers are produced with onset of fall moisture (Johnson et al. 1994). However, Wright and others (1979) found the dense, fine leaves of Idaho fescue provided enough fuel to burn for hours after a fire had passed, thereby killing or seriously injuring the plant regardless of the intensity of the fire (Wright et al. 1979). Idaho fescue is commonly reported to be more sensitive to fire than the other prominent grass on this site, bluebunch wheatgrass (Conrad and Poulton 1966). However, Robberecht and Defossé (1995) suggested the latter was more sensitive. They observed culm and biomass reduction with moderate fire severity in bluebunch wheatgrass, whereas a high fire severity was required for this reduction in Idaho fescue. Also, given the same fire severity treatment, post-fire culm production was initiated earlier and more rapidly in Idaho fescue (Robberecht and Defossé 1995).

The fine leaves and densely tufted growth form make Thurber's needlegrass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). However, there appears to be no detrimental effect of fall burning on Thurber's needlegrass (Davies and Bates 2008, Ellsworth and Boone 2010). Spring and early summer burning may result in a reduction in grass density (Ellsworth and Boone 2010, Wright and Klemmedson 1965, Uresk et al. 1976, Uresk et al. 1980). Although timing of fire highly influences the response and mortality of Thurber's needlegrass, smaller bunch sizes are less likely to be damaged by fire (Wright and Klemmedson 1965). Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire prescribed in May, June, and November were found to cause high mortality in addition to reducing basal area and yield of Thurber's needlegrass (Britton et al. 1990).

Needle and thread is a fine leaf grass and is considered sensitive to fire (Akinsoji 1988, Bradley et al. 1992, Miller et al. 2013). In a study by Wright and Klemmedson (1965), season of burn rather than fire intensity seemed to be the crucial factor in mortality for needle and thread grass. Early spring season burning was seen to kill the plants while August burning had no effect. Thus, under wildfire scenarios needle and thread is often present in the post-burn community.

Sandberg bluegrass, a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass. Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community.

Antelope bitterbrush is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), however sprouting ability is highly variable and has been attributed to genetics, plant age, phenology, soil moisture and texture and fire severity (Blaisdell and Mueggler 1956, Blaisdell et al. 1982, Clark et al. 1982, Cook et al. 1994).

Bitterbrush sprouts from a region on the stem approximately 1.5 inches above and below the soil surface; the plant rarely sprouts if the root crown is killed by fire (Blaisdell and Mueggler 1956). Low intensity fires may allow for bitterbrush to sprout; however, community response also depends on soil moisture levels at time of fire (Murray 1983). Lower soil moisture allows more charring of the stem below ground level (Blaisdell and Mueggler 1956), thus sprouting will usually be more successful after a spring fire than after a fire in summer or fall (Murray 1983, Busse et al. 2000, Kerns et al. 2006). The factor that most limits establishment of bitterbrush seedlings is competition for water resources with invasive annual species (Clements and Young 2002).

In many basin big sagebrush communities, changes in fire frequency occurred along with fire suppression, livestock grazing and OHV use. Few if any fire history studies have been conducted on basin big sagebrush; however, Sapsis and Kauffman (1991) suggest that fire return intervals in basin big sagebrush are intermediate between mountain big sagebrush (15 to 25 years) and Wyoming big sagebrush (50 to 100 years). Fire severity in big sagebrush communities is described as "variable" depending on weather, fuels, and topography. However, fire in basin big sagebrush communities are typically stand replacing (Sapsis and Kauffman 1991). Basin big sagebrush does not sprout after fire. Because of the time needed to produce seed, it is eliminated by frequent fires (Bunting et al. 1987). Basin big sagebrush reinvades a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore, regeneration of basin big sagebrush after stand replacing fires is difficult and dependent upon proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984).

Western juniper is intolerant of fire and historically was located in areas with minimal understory due primarily to soil characteristics; therefore fire was very infrequent, and when it did occur it was low intensity. With the increased suppression of wildfire and introduction of livestock grazing which reduces ground fuels and understory competition, regeneration and establishment of western juniper has expanded into sites previously dominated by big sagebrush (Burns and Honkala 1990). The expansion of western juniper has been well documented. In the Steens mountain range of south eastern Oregon, the expansion of western juniper coincides with Euro-American settlement. Probable causes include climate, altered fire frequencies and grazing of flammable ground fuels (Miller and Rose 1995). Fire resistance depends on age of the tree: seedlings, saplings and poles are highly vulnerable to fire. Mature trees have some resistance to fire due to lack of fuels near the trunk, relatively thick bark, and foliage which is fairly high above the ground (Burns and Honkala 1990).

The grasses likely to invade this site are cheatgrass and medusahead. These invasive grasses displace desirable perennial grasses, reduce livestock forage, and accumulate large fuel loads that foster frequent fires (Davies and Svejcar 2008). Invasion by annual grasses can alter the fire cycle by increasing fire size, fire season length, rate of spread, numbers of individual fires, and likelihood of fires spreading into native or managed ecosystems (D'Antonio and Vitousek 1992, Brooks et al. 2004). While historical fire return intervals are estimated at 15 to 100 years, areas dominated with cheatgrass are estimated to have a fire return interval of 3-5 years (Whisenant 1990). The mechanisms by which invasive annual grasses alter fire regimes likely interact with climate. For example, cheatgrass cover and biomass vary with climate (Chambers et al., 2007) and are promoted by wet and warm conditions during the fall and spring. Invasive annual species have been shown able to take advantage of high N availability following fire through higher growth rates and increased seedling established relative to native perennial grasses (Monaco et al. 2003).

Livestock/Wildlife Grazing Interpretations

This group of ecological sites are suitable for grazing. Grazing management considerations include timing, duration and intensity of grazing along with past farming history and other disturbances that may have changed the resiliency and resistance of the ecological site. In addition, many wildlife species are dependent on the sagebrush ecosystem including the sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Despite low palatability, big sagebrush is eaten by sheep, cattle, goats, and horses. Chemical analysis indicates that the leaves of big sagebrush equal alfalfa meal in protein, have a higher carbohydrate content, and yield twelvefold more fat (USDA-Forest Service 1937). Antelope bitterbrush is an important shrub species to a variety of animals, such as domestic livestock, antelope, deer, and elk. Bitterbrush is critical browse for mule deer, as well as domestic livestock, antelope, and elk (Wood 1995, Clements and Young 2002). Antelope bitterbrush is most commonly found on soils which provide minimal restriction to deep root penetration such as coarse textured soil, or finer textured soil with high stone content (Driscoll 1964). Grazing tolerance of antelope bitterbrush is dependent on site conditions (Garrison 1953).

Bluebunch wheatgrass is moderately grazing tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975, Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass, thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

Needle-and-thread grass is most commonly found on warm/dry soils (Miller et al. 2013). It is not grazing tolerant and will be one of the first grasses to decrease under heavy grazing pressure (Smoliak et al. 1972, Tueller and Blackburn 1974). Heavy grazing is likely to reduce basal area of these plants (Smoliak et al. 1972). With the reduction in competition from deep rooted perennial bunchgrasses, shallower rooted grasses such as Sandberg bluegrass and forbs may increase (Smoliak et al. 1972).

Idaho fescue tolerates light to moderate grazing (Ganskopp and Bedell 1980) and is moderately resistant to trampling (Cole 1987, USDA Forest Service 1937). Idaho fescue has been found to decrease under heavy, repeated grazing by livestock (Eckert and Spencer 1986, Eckert and Spencer 1987 Mueggler 1984) and wildlife (Gaffney 1941). However, more recent research by Jaindl et al. (1994) suggests Idaho fescue exhibits overcompensation to single defoliation events (i.e., cumulative total dry weight, including removed tissue, of the defoliated plants is greater than the total dry weight of the control plants) depending on the physiological stage of growth at the time of the grazing event. Jaindl et al. (1994) reported overcompensation occurred for plants defoliated during the boot to anthesis stage. The ability to overcompensate following grazing is a function of available soil moisture and length of growing

season therefore season of grazing must be considered. Additionally, Idaho fescue exhibits moderate to high palatability increasing the likelihood of repeated defoliation thus decreasing the opportunity for compensatory gain.

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. However, if medusahead is present cheatgrass may be replaced by this more competitive and less palatable species (Mangla et al. 2011).

Inappropriate grazing practices can be tied to the success of medusahead, however, eliminating grazing will not eradicate medusahead if it is already present (Wagner et al. 2001). Sheley and Svejcar (2009) reported that even moderate defoliation of bluebunch wheatgrass resulted in increased medusahead density. They suggested that disturbances such as plant defoliation limit soil resource capture, which creates an opportunity for exploitation by medusahead. Avoidance of medusahead by grazing animals allows medusahead populations to expand. This creates seed reserves that can infest adjoining areas and cause changes to the fire regime. Medusahead replaces native vegetation and cheatgrass directly by competition and suppression and native vegetation indirectly by an increase in fire frequency. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008).

State and Transition Model Narrative Group 4

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 3 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 drought and/or insect or disease attack.

Community Phase 1.1:
This community is dominated by bluebunch wheatgrass, Idaho fescue, antelope bitterbrush and/or basin big sagebrush. Forbs and other grasses make up smaller components. Western juniper is described in the site concept and may or may not be present.

Community Phase Pathway 1.1a:
Fire reduces or eliminates the overstory of shrubs and allows for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush cover to trace amounts.

Community Phase Pathway 1.1b:
Time and lack of disturbance such as fire allows for sagebrush and/or bitterbrush to increase and become decadent. Chronic drought, excessive herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing big sagebrush to dominate the site.

Community Phase 1.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community. Bluebunch wheatgrass, Idaho fescue and other perennial bunchgrasses dominate. Depending on fire severity, patches of intact sagebrush and/or bitterbrush may remain. Antelope bitterbrush and yellow rabbitbrush (*Chrysothamnus viscidiflorus*) may be sprouting depending on extent of damage and on available soil moisture post burn. Old growth juniper trees exhibit some resistance to fire and with ground fire will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 1.2a:
Time and lack of disturbance will allow sagebrush to increase.

Community Phase 1.3:
Sagebrush and/or bitterbrush increase in the absence of disturbance. Decadent sagebrush and/or bitterbrush dominates the overstory and the deep-rooted perennial bunchgrasses in the understory are reduced either from competition with shrubs and/or from herbivory. Young western juniper increases and may also start to influence the understory vegetation.

Community Phase Pathway 1.3a:
A low severity fire will reduce the sagebrush and bitterbrush overstory resulting in a perennial bunchgrass – shrub mosaic. Western juniper seedlings, saplings and poles will be reduced. A high severity fire will significantly reduce shrub and juniper cover and will promote an early- to mid-seral bunchgrass community.

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, medusahead, ventenata, mustards, and bur buttercup (*Ceratocephala testiculata*).
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 non-native 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, residual dry matter accumulation, and adaptations for seed dispersal.

Community Phase 2.1:
This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Bluebunch wheatgrass, Idaho fescue, antelope bitterbrush and/or basin big sagebrush dominate the site. Forbs and other shrubs and grasses make up smaller components of this site. Western juniper is described in the site concept and may or may not be present.

Plot A43 Juniper Shrubby Loamy 10-12" Community Phase 2.1

Community Phase Pathway 2.1a:
Fire reduces the shrub and young western juniper overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity and result in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush and/or bitterbrush cover to trace amounts. Annual non-native species are likely to increase after fire.

Community Phase Pathway 2.1b:
Time and lack of disturbance allows for shrubs to increase and become decadent. Chronic drought, herbivory, or combinations of these reduces fine fuels and leads to a reduced fire frequency, allowing basin big sagebrush to dominate the site. Inappropriate grazing management may hasten the decline of the perennial bunchgrass understory; while the grazing tolerant Sandberg bluegrass may increase in the understory.

Community Phase 2.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community where perennial bunchgrasses dominate. Annual non-native species are present. Sagebrush and/or bitterbrush may be present in trace amounts depending on fire severity. Antelope

bitterbrush may sprout after fire. Perennial forbs may be a significant component for several years. Annual non-native species are stable or increasing within the community. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Community Phase Pathway 2.2a:
Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush and bitterbrush allows the shrub component to recover. The establishment of basin big sagebrush can take many years.

Community Phase Pathway 2.2b:
Annual precipitation highly influences the density and cover of non-native annual species. A year with higher than normal precipitation during the germination and growth period of non-native annual species will cause populations to increase and become sub- to co-dominant in the understory. This shift to Phase 2.4 typically occurs within the first two to four years following a fire, prescribed or wildfire, triggered by spring precipitation that is favorable to non-native annual grass production. Tree or shrub treatments coupled with soil disturbance and higher than normal spring precipitation may also elicit a temporary increase in non-native annual species production.

Community Phase 2.3 (At Risk):
This community is at risk of crossing a threshold to another state. Sagebrush and/or bitterbrush dominate the overstory and perennial bunchgrasses in the understory are reduced from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush (*Ericameria nauseosa* or *Chrysothamnus viscidiflorus*) may be a significant component. Sandberg bluegrass may increase and become co-dominant with deep rooted bunchgrasses. Western juniper may be present and without management or fire will likely increase. Bare ground interspace increase in size and connectivity. Annual non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from inappropriate grazing, drought, and fire.

A07. State 2.3 (at risk of transitioning to tree state)

Community Phase Pathway 2.3a:
A low severity fire will reduce the sagebrush overstory and allow perennial grasses to dominate. Annual non-native species are present and may increase in the community. High severity fire, following a wet spring, significantly reduces the brush/tree overstory and leads to an early to mid-seral bunchgrass and forb community. Alternatively, a change in grazing management that reduces shrubs will also allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush/tree treatments with minimal soil disturbance will also decrease sagebrush/juniper and release the perennial understory.

Community Phase Pathway 2.3b:
Annual precipitation highly influences the density and cover of non-native annual species. A year with higher than normal precipitation during the germination and growth period of non-native annual species will cause populations to increase and become co-dominant in the understory. Tree/shrub removal treatments that disturb the soil surface, inappropriate grazing management causing further decline in perennial grasses, or prescribed or wildland fire in the presence of annual grass species may cause a shift to Phase 2.4.

Community Phase 2.4 (At Risk):
This community is at risk of crossing into an Annual State. Native bunchgrasses and/or native shrubs are still dominant; however, annual non-native species such as cheatgrass or medusahead may be codominant in the understory. Annual production and abundance of these annuals may increase drastically in years with above average spring precipitation. Seeded species may be present. If the site is coming from Phase 2.2, sagebrush and/or bitterbrush may only be a minor component. Western juniper may be present to increasing. Disturbances that damage native shrubs and grasses increase the risk of transitioning into an Annual State.

Plot A45 Juniper Shrubby Loam 10-12" Community Phase 2.2

Plot C37 Juniper Shrubby Loam 10-12" Community Phase 2.4

Community Phase Pathway 2.4a:
Rainfall patterns favoring perennial bunchgrass production transition this community phase to Phase 2.2. Less than normal early spring precipitation followed by higher than normal late spring/ early summer precipitation will increase perennial bunchgrass production.

Community Phase Pathway 2.4b:

Rainfall patterns favoring perennial bunchgrass production transition this community phase to Phase 2.3. Less than normal early spring precipitation followed by higher than normal late spring / early summer precipitation will increase perennial bunchgrass production. Shrubs will remain if present.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0

Trigger: To Community Phase 3.1: Repeated, chronic, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush and bitterbrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Brush treatments coupled with inappropriate grazing management will reduce shrub overstory, decrease perennial bunchgrasses and facilitate an increase in Sandberg bluegrass.
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 Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire or failed rehabilitation treatments involving soil disturbing activities such as drilling, disking, or plowing. To Community Phase 4.2: Inappropriate grazing management that decreases perennial bunchgrasses and facilitates the expansion of non-native annual grasses; competitive increase in medusahead through lack of active management.
Slow variables: Increased production and cover of non-native annual species; increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T2C: Transition from Current Potential State 2.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Shrub State 3.0:

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses or the abandonment of farm fields without rehabilitation seedings. Grazing tolerant Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Basin big sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed (3.1). Abandoned farm fields typically develop a rabbitbrush overstory with early to mid-seral grasses or weeds in the

understory. Plow pans and soil loss may have reduced site resilience (3.2). In both community phases, bare ground may be significant with soil redistribution occurring between interspace and shrub locations. Western juniper increases and may begin to influence the understory vegetation.

Community Phase 3.1:
Basin big sagebrush dominates the site and may be decadent. Antelope bitterbrush may be a significant component. Bare ground is significant. Understory may be dominated by Sandberg bluegrass. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Annual non-native species stable to increasing. Old growth juniper may be present and young juniper will likely increase without management action.

B29 JD Clayey 9-12 PZ. Community Phase 3.1

Community Phase Pathway 3.1a:
Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for Sandberg bluegrass to dominate the site.

Community Phase 3.2:
Rabbitbrush and/or Sandberg bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Phase 3.2 may be created by fire from 3.1 or directly from the farmed State 8.0.

B02 JD Clayey 9-12 PZ. Community Phase 3.2

Specie Composition Analysis

Grizzly Allotment, Cluster 14, May 1957

Specie	Common Name	1957 Average
FEID	Idaho Fescue	0.0
CRAC	Hawksbeard	0.3
SIHY	Bottlebrush Squirreltail	45.3
POSE	Sandberg Bluegrass	19.0
AGS	Bentgrass	8.3
PHMU2	Phacelia	0.0
ERIOG	Buckwheat	2.0
LOMAT	Lomatium	0.3
ACMI	Yarrow	4.0
?		1.0
TRAGO	Goatsbeard	1.0
CHR	Rabbitbrush	18.7
JUOC	Western Juniper	0.0
		100

See Appendix D

Grizzly Allotment: Condition and Trend Cluster 14 Established May 22, 1957. Located approximately 1.5 miles SE of the Grizzly BPA Substation. Legal Location: T 13 S R 14 E Sec 1 SWSW. Located on a flat aspect at approximately 2400 ft. elevation. Lamonta soil. Abandoned farm field. Community Phase 3.2 in 1957.

Community Phase Pathway 3.2a:
Time without disturbance allows sagebrush and/or bitterbrush to mature and become dominant overstory. Western juniper may increase.

T3A: Transition from Shrub State 3.0 to Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire and/or failed rehabilitation treatment or combination of both. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species and/or competitive increase in medusahead through lack of active management. May be combined with higher than normal spring precipitation.
Slow variables: Increased production and cover of non-native annual species. Increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

T3B: Transition from Shrub State 3.0 to Tree State 5.0

Trigger: Time and a lack of disturbance or management action allows for western juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

T3C: Transition from Shrub State 3.0 to Eroded State 7.0

Trigger: To Community Phase 7.2: historic farm field that was or was not seeded for stabilization and converted to shrub state coupled with inappropriate grazing management and reduced resiliency caused by changed soil properties (plow pans, A horizon erosion).
Slow variables: Over time perennial grass and forb cover decreases, bare ground increases, water flow paths become long and connected. Pedestaled plants increase.
Threshold: Soil erosion processes dominate site; rills, sheet erosion, blow outs, bare ground areas are apparent. Vegetation is not regenerating.

R3A: Restoration from Shrub State 3.0 to Current Potential State 2.0

Brush management such as mowing, coupled with seeding of deep-rooted native bunchgrasses. If non-native annual grasses are present, restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Targeted herbicide treatments may be necessary to facilitate this restoration pathway. Likelihood of seeding success declines rapidly with increasing cover / density of medusahead (Young et al. 1999).

R3B: Restoration from Shrub State 3.0 to Seeded State 6.0

Brush management such as mowing, coupled with seeding of deep rooted non-native wheatgrasses. If non-native annual grasses are present, restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Targeted herbicide treatments may be necessary to facilitate this restoration pathway.

Annual State 4.0:

This community is characterized by the dominance of annual non-native species such as cheatgrass, medusahead, and tansy mustard in the understory. Sagebrush, bitterbrush, and/or rabbitbrush may dominate the overstory.

Community Phase 4.1 (At Risk):

Annual non-native plants such as cheatgrass and medusahead dominate the site. Shrubs may be present in trace amounts.

Plot C34 JD Clayey 9-12 PZ Community Phase 4.1

Community Phase Pathway 4.1a:
Time and lack of fire allows for the sagebrush and bitterbrush to establish or sprouting shrubs such as rabbitbrush to increase. The probability of sagebrush establishment is extremely low.

Community Phase 4.2:
Rabbitbrush is typically the dominant overstory shrub if fire preceded development of the community. Sagebrush may be the dominant overstory shrub if inappropriate grazing was the

threshold driver to 4.2. Annual non-native species, likely cheatgrass, medusahead and mustards, dominate the understory.

Plot GR4-1 JD Clayey 9-12 PZ Community Phase 4.2

Community Phase Pathway 4.2a: Fire reduces/eliminates overstory brush component and allows for annual non-native species to dominate the site.

R4A: Restoration from Annual State 4.0 to Seeded State 6.0

Seeding of deep-rooted bunchgrasses. Targeted herbicide treatments are necessary to facilitate this restoration pathway. The probability of success is extremely low.

Tree State 5.0:

This state is characterized by a dominance of western juniper in the overstory. Basin big sagebrush, antelope bitterbrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community Phase 5.1:

Western juniper dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrasses may be found under tree canopies and interspaces. Sandberg bluegrass may be dominate grass species particularly in the interspace areas. Sagebrush is stressed and dying. Annual non-native species are present, particularly under tree canopies. Bare ground interspaces are large and connected.

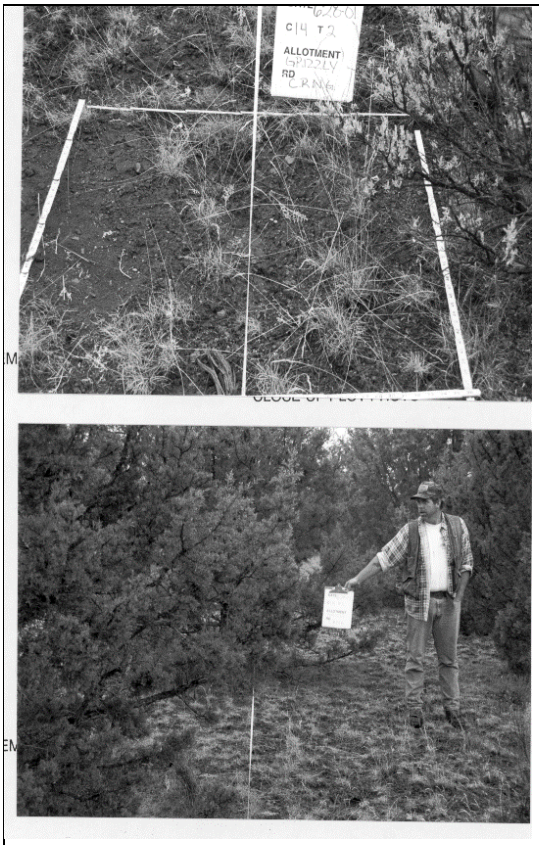
Plot A08 Juniper Shrubby Loam 10-12" Community Phase 5.1

Community Phase Pathway 5.1a:
Time and lack of disturbance or management action allows western juniper to further mature and dominate site resources.

Community Phase 5.2 (At Risk):
Western juniper dominates the site and tree leader growth is minimal. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Deep-rooted bunchgrasses may or may not be present. Sandberg bluegrass or mat forming forbs may be present in varying amounts. Annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Bare ground interspaces are large and connected. Soil redistribution is evident. Site is at risk of transitioning to an Eroded State 7.0.

B06 JD Clayey 9-12 PZ Community Phase 5.2

Community Phase Pathway 5.2a:
Tree stand thinning treatments for fuels management or other resource values.



June 28, 2001

Specie Composition Analysis
Grizzly Allotment, Cluster 14, June 2001

Specie	Common Name	1957 Average	2001 Average
FEID	Idaho Fescue	0.0	0.3
CRAC	Hawksbeard	0.3	0.0
SIHY	Bottlebrush Squirreltail	45.3	1.0
POSE	Sandberg Bluegrass	19.0	87.7
AGS	Bentgrass	8.3	0.0
PHMU2	Phacelia	0.0	2.3
ERIOG	Buckwheat	2.0	0.7
LOMAT	Lomatium	0.3	0.3
ACMI	Yarrow	4.0	3.3
?		1.0	0.0
TRAGO	Goatsbeard	1.0	0.0
CHR	Rabbitbrush	18.7	0.7
JUOC	Western Juniper	0.0	3.7
		100	100

See Appendix D

Grizzly Allotment: Condition and Trend Cluster 14 T2. Established May 22, 1957. Re-photographed June 28, 2001. Located approximately 1.5 miles SE of the Grizzly BPA Substation. Legal Location: T 13 S R 14 E Sec 1 SWSW. Located on a flat aspect at approximately 2400 ft. elevation. Grizzly Allotment: Cluster 14. June 28, 2001. Community Phase 5.2.

T5A: Transition from Tree State 5.0 to Annual State 4.0

Trigger: Catastrophic fire causing a stand replacement event will transition to Annual State 4.0. Inappropriate tree removal practices with soil disturbance will also cause a transition to the Annual State 4.0.

Slow variables: Increased production and cover of non-native annual species under tree canopies.

Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact nutrient cycling and distribution.

T5B: Transition from Tree State 5.0 to Eroded State 7.0

Trigger: Time and lack of disturbance allows for tree competition to eliminate herbaceous understory.

Slow variables: Bare ground interspaces large and connected; water flow paths long and continuous; sheet erosion evident; understory sparse.

Threshold: Soil redistribution and erosion is significant and linked to vegetation mortality evidenced by pedestalling and burying of herbaceous species and/or lack of recruitment in the interspaces.

R5A: Restoration from Tree State 5.0 to Seeded State 6.0

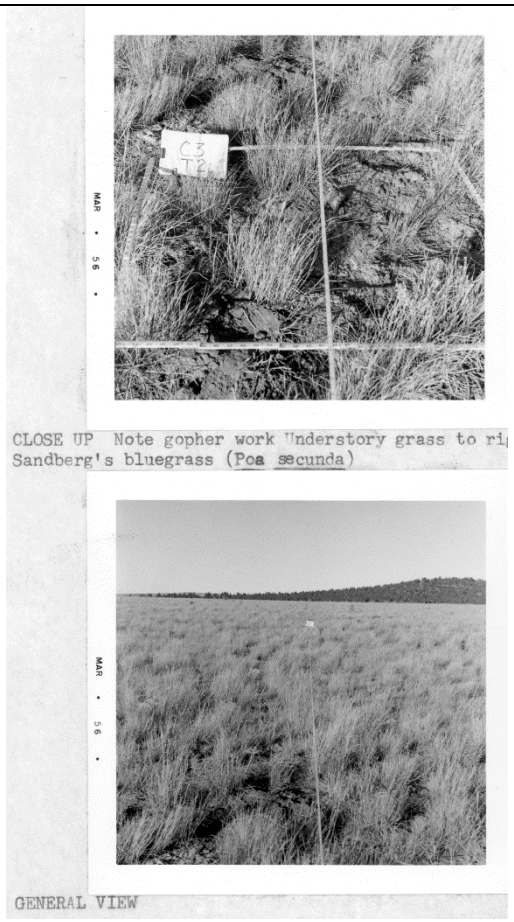
Tree removal and seeding of desired non-native wheatgrass species. Tree removal practices with minimal soil disturbance are recommended. Probability of success declines with increased presence of non-native annual species. Herbicide treatment may be necessary.

R5B: Restoration from Tree State 5.0 to Shrub State 6.0

This restoration is recommended for Phase 5.1 only due to the lack of understory in 5.2. Tree removal practices with minimal soil disturbance.

Seeded State 6.0:

This state has three community phases; a grass-dominated phase; a grass-shrub phase and a shrub dominated phase. The state is characterized by the dominance of seeded introduced wheatgrass species. Other seeded species including sagebrush, bitterbrush, and native and non-native forbs may be present. A change in site resilience and resistance due to presence of plow pan and loss of top soil during farming era may be present.



Specie Composition Analysis
Grizzly Allotment, Cluster 3, March 1956

Specie	Common Name	1956 Average
AGCR	Crested Wheatgrass	84.7
SIHY	Bottlebrush Squirreltail	0.3
POSE	Sandberg Bluegrass	0.3
POBU	Bulbous Bluegrass	0.0
MED	Alfalfa	14.0
ASCOII	Idaho Milkvetch	0.0
PHMU2	Phacelia	0.0
ERIG	Buckwheat	0.0
ACMI	Yarrow	0.0
SENEC	Ragwort	0.0
ARTR	Sagebrush	0.0
CHR	Rabbitbrush	0.7
		100

See Appendix D

Grizzly Allotment 1956. Crested wheatgrass and ladak alfalfa. Coordinates 44.466073°, -121.024251°. Community Phase 6.1.

Community Phase 6.1:
Introduced wheatgrass species and other non-native species such as dryland alfalfa dominate the community. Native and non-native seeded forbs may be present. Trace amounts of basin big sagebrush and/or rabbitbrush may be present, especially if seeded. Annual non-native species may be present.

Community Phase Pathway 6.1a:
Time without disturbance allows shrub species to reestablish. This may be coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.2:
Sagebrush and seeded wheatgrass species are codominant. Annual non-native species stable to increasing.

Community Phase Pathway 6.2a:
Low severity fire and/or brush management will reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

Community Phase Pathway 6.2b:
Absence of fire over time allows shrub species to become dominant. This may be coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance. Sandberg bluegrass may increase.

Community Phase 6.3 (At Risk):
Sagebrush and/or antelope bitterbrush dominate. Rabbitbrush may be a significant component but still sub-dominant to sagebrush. Wheatgrass vigor and density reduced. Annual non-native species stable to increasing. Sandberg bluegrass may be increasing. Juniper may be present. This community phase is at risk of crossing a threshold to the Shrub State or Tree State without disturbance or treatment. If annual non-natives are present, the site could transition to the Annual State with fire.

Community Phase Pathway 6.3a:
Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses to increase. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species respond well to fire and may increase post-burn.

Community Phase Pathway 6.3b:
Low severity fire leading to a mosaic pattern in the grass-shrub community. A change in grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

T6A: Transition from Seeded State 6.0 to Shrub State 3.0
Trigger: To Community Phase 3.1: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2 from 6.3: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass.
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.

T6B: Transition from Seeded State 6.0 to Annual State 4.0
Trigger: To Community Phase 4.1: Catastrophic fire, likely from 6.3.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T6C: Transition from Seeded State 6.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Eroded State 7.0:
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. A plow pan may be present in the near surface sub-soil that functions to truncate rooting depth of herbaceous plants and water percolation and storage. Western juniper dominates the overstory and herbaceous species may be present in trace amount particularly under tree canopies. Regeneration of trees or herbaceous species is not evident.

Community Phase 7.1:
From Tree State 5.2: Western juniper dominates the overstory and herbaceous species may be present in trace amount particularly under tree canopies. Dead sagebrush skeletons are prominent. Regeneration of trees or herbaceous species is not evident. Annual non-native species present primarily under tree canopies. Bare ground interspaces are large, connected and characterized by evidence of soil movement. Redistribution of soil from interspaces to tree canopy areas is evident.

Community Phase 7.2:
From Shrub State 3.2: Basin big sagebrush or rabbitbrush dominate overstory or Sandberg bluegrass is dominant without shrubs. Seeded, deep-rooted bunchgrasses are trace component. Rill erosion is evident and top soil redistribution and accumulation along fence lines and other obstructions may be present. Plow pan in the near surface subsoil is present. Herbaceous species rooting depths are restricted.

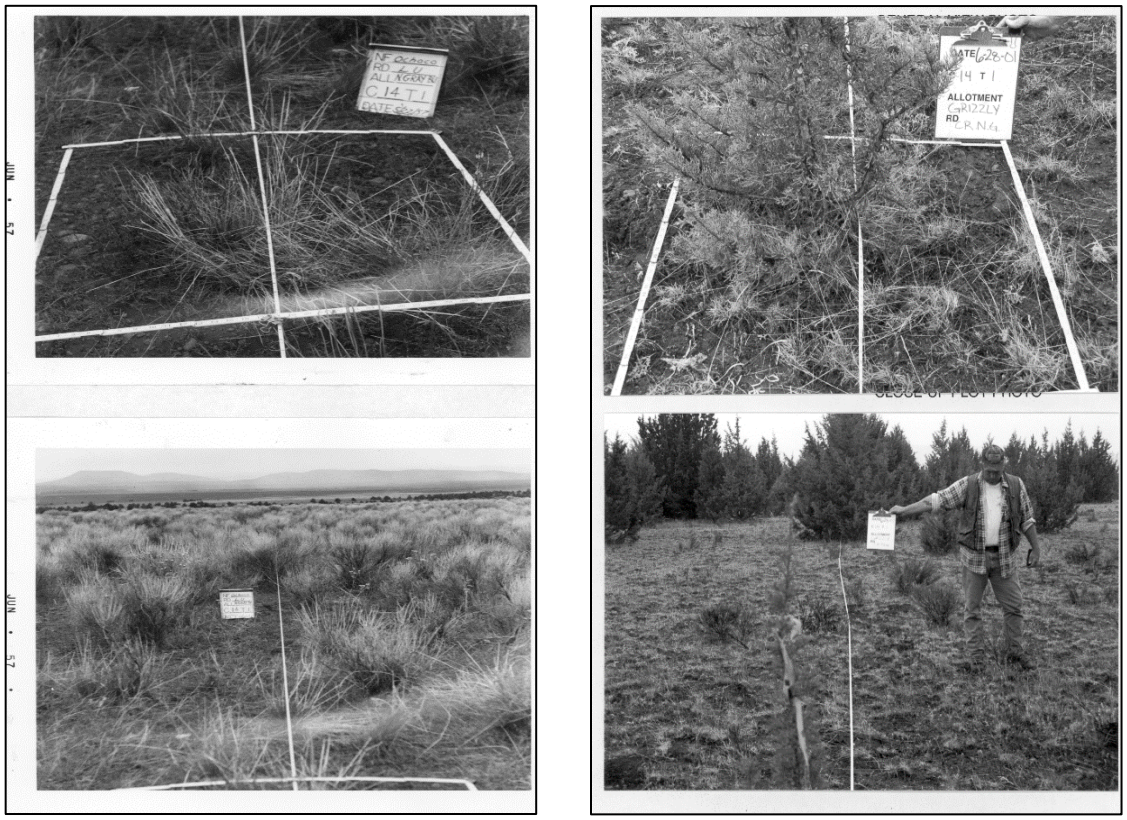
Farmed State 8.0:
This state is a historical state representing the active farming of this site in the late 1800s and early 1900s. The site would be dominated by cereal grains and would require annual harvests and plantings to be maintained. It is known that many acres of sagebrush rangeland was homesteaded and converted into dryland farmland during the late 1800s. While these practices have ceased in the rangelands discussed in this report, the effects on the landscape are still visible today (Morris 2012). The Farmed State is included in this model to help visualize the changes in the Reference plant community initiated during the farming era. In some cases, where farming practices were not employed, the transition from the Reference plant community (T1A) may have been a slow transition caused by multiple direct and indirect effects, but in the case of T1B, the transition occurred because of a drastic change in land use. Both transitions have been documented on the Grasslands and can be visited at coordinates 44.466073°, -121.024251° within the Grizzly Allotment (See Appendix D). The area offers an example of unfarmed Juniper Shrubby Loam 10-12” R010XA018OR alongside a farmed field that was converted to a crested wheatgrass seeding in the 1950s. Fence line contrast.

Community Phase 8.1 (At Risk):

Site is actively maintained with annual plowing and planting of dryland crops such as annual cereal grains.

T8A: Transition from Farmed State 8.0 to Shrub State 3.0

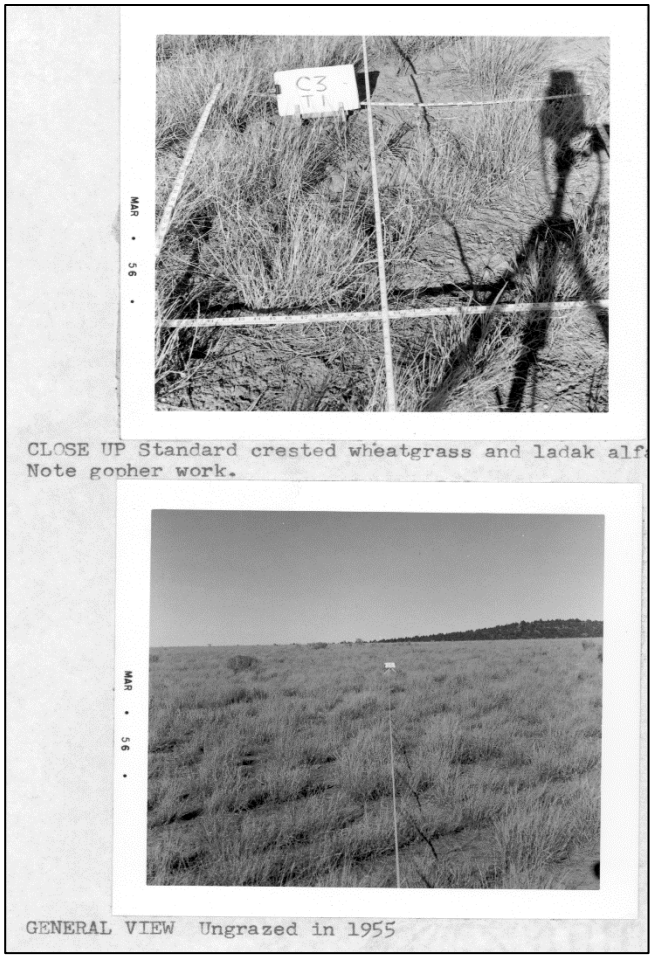
Trigger: Field abandonment (Daubenmire 1975, Rickard and Sauer 1982).
Slow variables: Annual cereal grains or other crops die off. Early seral species (annual grasses and forbs) establish first, but rabbitbrush will become the dominant species over time.
Threshold: Cessation of plowing allows other native and nonnative plant species to establish. Loss of native deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community

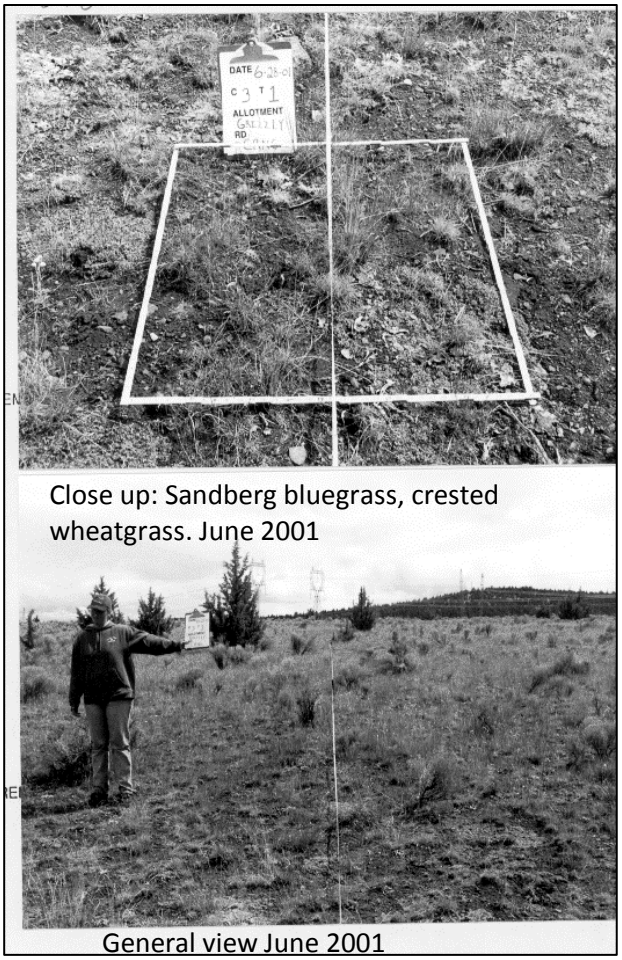


Grizzly Allotment. Abandoned farm field. Not seeded. On the left, dominated with rabbitbrush in 1957. Transitioned to Tree State with Sandberg bluegrass understory by 2001 (right).

R8A: Restoration Pathway from Farmed State 8.0 to Seeded State 6.0

Active farming ceases. Site is drill seeded with crested wheatgrass or other wheatgrass species. Seeded States originating from Farmed States may have compromised soil properties such as plow pans, loss of A horizon etc. that decreases the resiliency of the established seeding to grazing, drought and other disturbances. The case study documented in photographs below (data in Appendix D) demonstrates the loss of the seeded deep-rooted bunchgrass, crested wheatgrass, likely a result of chronic spring grazing and a significant plow pan preventing deep root development and water infiltration. Understanding the history of use helps improve our understanding of the triggers and multiple causes of ecological thresholds.





Close up: Sandberg bluegrass, crested wheatgrass. June 2001

General view June 2001

Close up: Sandberg bluegrass, crested wheatgrass. Note soil erosion. Sept. 2006
Photo credit: T. Stringham

General View: Note drill rows dominated by Sandberg bluegrass. Sept. 2006.
Photo credit: T. Stringham

Grizzly Allotment. Coordinates 44.466073°, -121.024251°. Farmed, abandoned, and seeded to crested wheatgrass. Photo in 1955 shows established seeding. Repeat photo in 2001 and data indicate site has transitioned to a Shrub State with Sandberg bluegrass understory. See Appendix D for complete analysis.

Potential Resilience Differences with other Ecological Sites

Loamy Plains 8-10" R010XA001OR:
This site occurs on plateaus, ridgetops and gently sloping areas. The elevation ranges from 1000 to 3000 feet. The annual precipitation ranges from 8 to 10 inches which occurs mainly between the months of October and June, mostly in the form of rain. The soil temperature regime is mesic. The soils of this site are shallow to moderately deep and well drained. They have loam or sandy loam surface textures and subsoils that range from sandy loam to clay. They are generally formed in colluvium and/or semi-consolidated sediments with additions of ash. Permeability is moderate and the available water holding capacity is 3 to 6 inches for the profile. The potential for wind erosion is high. The potential native plant community is dominated by **bluebunch wheatgrass** and Sandberg bluegrass. A sparse stand of western juniper and basin big sagebrush dominate the overstory. Antelope bitterbrush, Idaho fescue and Indian ricegrass (*Achnatherum hymenoides)* are also found on these sites.

Juniper Pumice South 9-12" R010XA007OR:
This site occurs on moderately steep south facing slopes of canyons, buttes, and ridges. Slopes range from 15 to 65 percent, but are typically from 30 to 60 percent. Elevations range from 2500 to 4500 feet. The annual precipitation ranges from 9 to 12 inches which occurs mainly between the months of October and June, mostly in the form of snow and spring-fall rains. The soils of this site have sandy loam surface layers and loam subsoils. They are usually stony to very stony on the surface and throughout the profile. Colluvial rock material limits the effective depth to less than 30 inches. Depth to bedrock ranges from 10 to 40 inches. Permeability is moderate to rapid and the available water holding capacity is 2 to 6 inches for the profile. The potential for water erosion is high. The potential native plant community is dominated by **bluebunch wheatgrass**. Western juniper dominates the overstory. **Basin big sagebrush and mountain big sagebrush** are dominant shrubs. Antelope bitterbrush is also common. Thurber's needlegrass, bottlebrush squirreltail (*Elymus elymoides*) and Sandberg bluegrass make up minor components of the community.

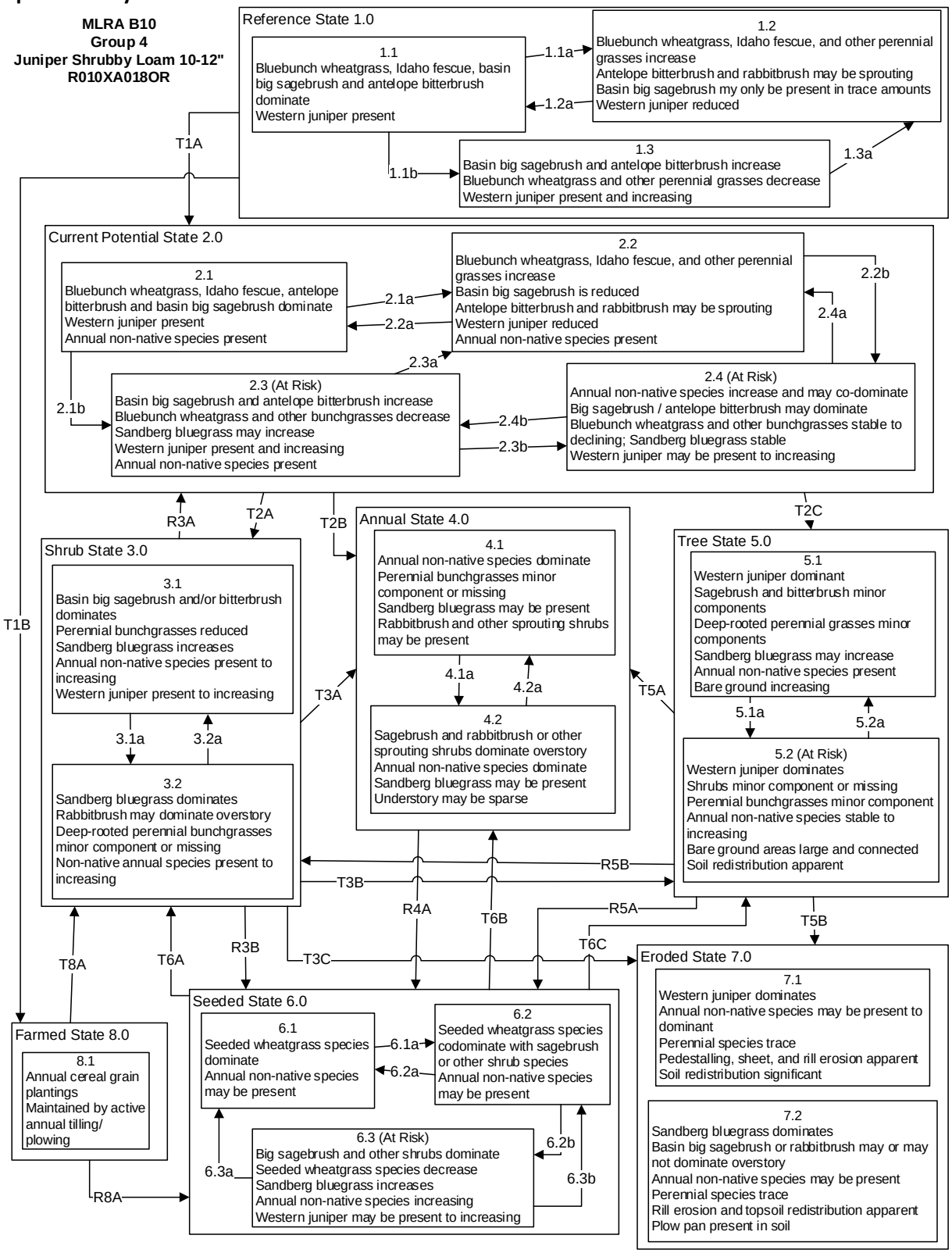
JD Clayey 9-12" R010XB022OR:
This site occurs on low elevation terraces and tablelands with slopes ranging from 0 to 12 percent. Elevations range from 1,300 to 3,000 feet. Annual precipitation ranges from 9-12 inches, with most occurring as rain from November through April. Localized, occasionally severe, convectional storms occur during the summer. Soils on this site are moderately deep to deep and are moderately well-drained. The soil surface layer is a stony clay loam, silty clay loam, or very stony loam to about 5 inches. Depth to bedrock is usually 30-60 inches. The potential for erosion is moderate to severe. The potential native plant community is dominated by **bluebunch wheatgrass**. Thurber's needlegrass is also common on this site. Basin big sagebrush is the dominant shrub. Antelope bitterbrush is not listed in the site concept so will not be included in the model. Western juniper is listed as a minor component in the site concept.

JD Sandy Loam 9-12 PZ R010XB025OR:
This site occurs on low elevation terraces and gentle slopes. Slopes range from 2 to 15 percent. Elevation ranges from 1300 to 2400 feet. Mean annual precipitation is 12 inches. Soils on this site are very deep and well drained. Surface textures are sandy loams. The soils are generally aridic. This site is dominated by **needle and thread and bluebunch wheatgrass**. Sand dropseed (*Sporobolus cryptandrus*), Indian ricegrass, basin wildrye *(Leymus triticoides)* and other grasses make up minor components. Basin big sagebrush is the dominant shrub. Western juniper is not listed on the ecological site description and was likely limited to sites occurring adjacent to woodlands or other juniper invaded sites. **Western**

juniper is not included in the Reference State 1.0 or Current Potential 2.1 or 2.2 of this site's model. Antelope bitterbrush is not found on this site.

JD Droughty South 9-12 PZ R010XB044OR:
This site occurs on hills and terraces on slopes ranging from 15 to 60 percent. Elevation ranges from 1300 to 2400 feet. Mean annual precipitation is 12 inches. Soils on this site have cobbles and are generally aridic. This site is dominated by **Thurber's needlegrass and bluebunch wheatgrass** and will have more bluebunch wheatgrass on sites where there is more clay and less gravel in the soil. Indian ricegrass, Sandberg bluegrass, and sand dropseed are more minor grass components. Basin big sagebrush is the dominant shrub. Western juniper is listed in the ecological site as a minor component, so it would only be present as a sparse overstory. **Antelope bitterbrush is not present on this site.**

Juniper Shrubby Loam 10-12” Modal Model



MLRA B10
Group 4
Juniper Shrubby Loam 10-12"
R010XA018OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

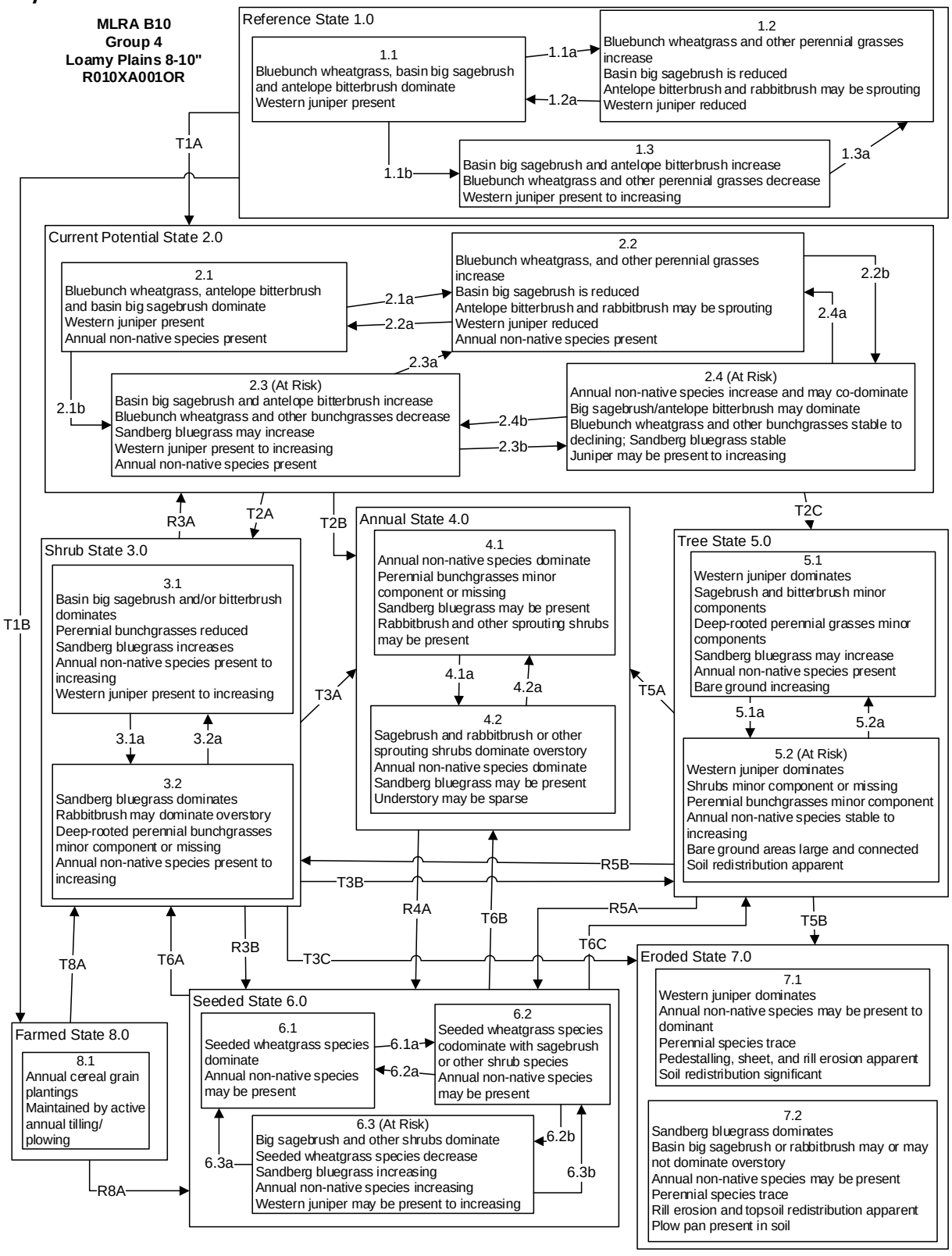
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

Loamy Plains 8-10”



MLRA B10
Group 4
Loamy Plains 8-10"
R010XA001OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

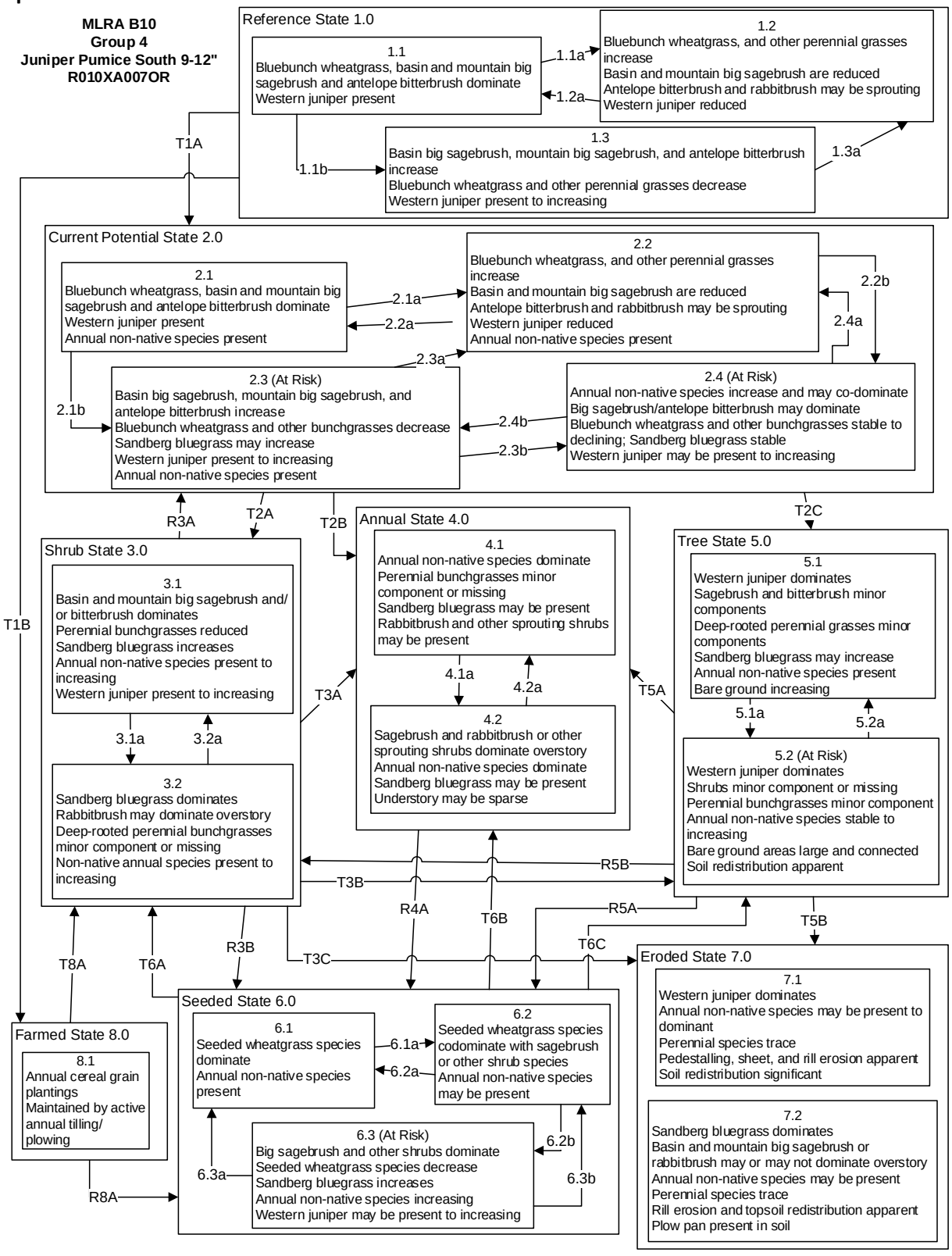
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

Juniper Pumice South 9-12”



MLRA B10
Group 4
Juniper Pumice South 9-12"
R010XA007OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

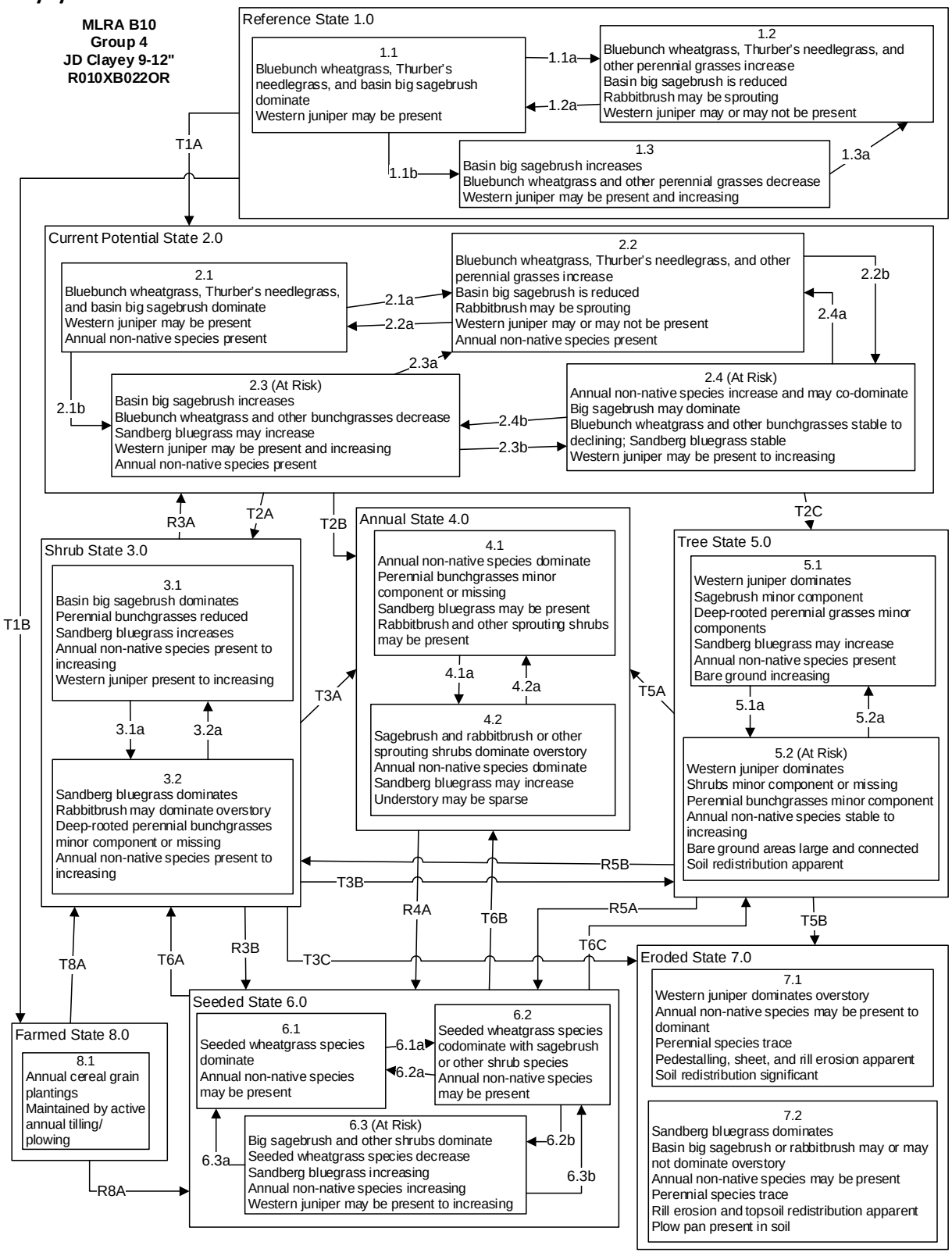
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

JD Clayey 9-12”



MLRA B10
Group 4
JD Clayey 9-12"
R010XB022OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

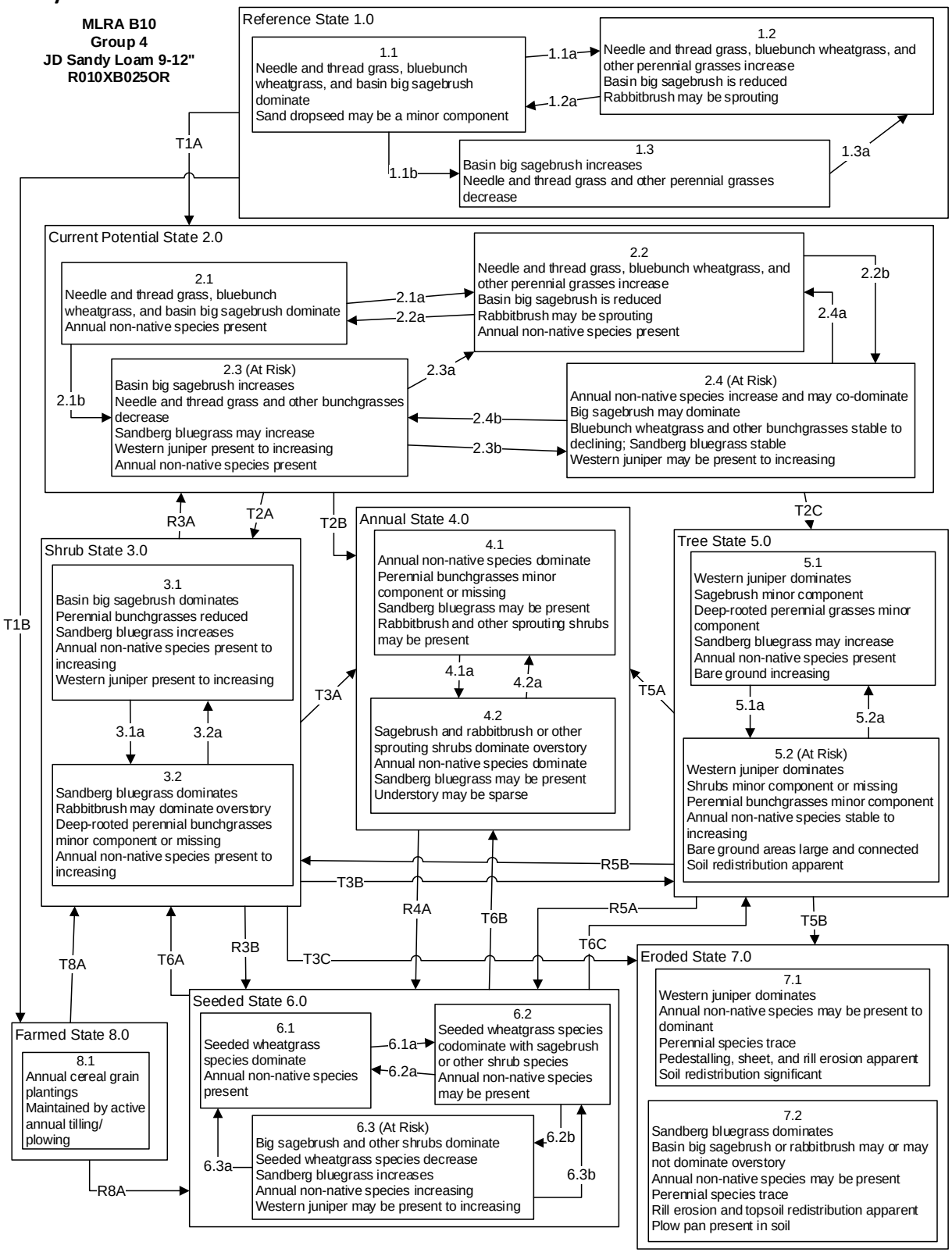
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

JD Sandy Loam 9-12”



MLRA B10
Group 4
JD Sandy Loam 9-12"
R010XB025OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

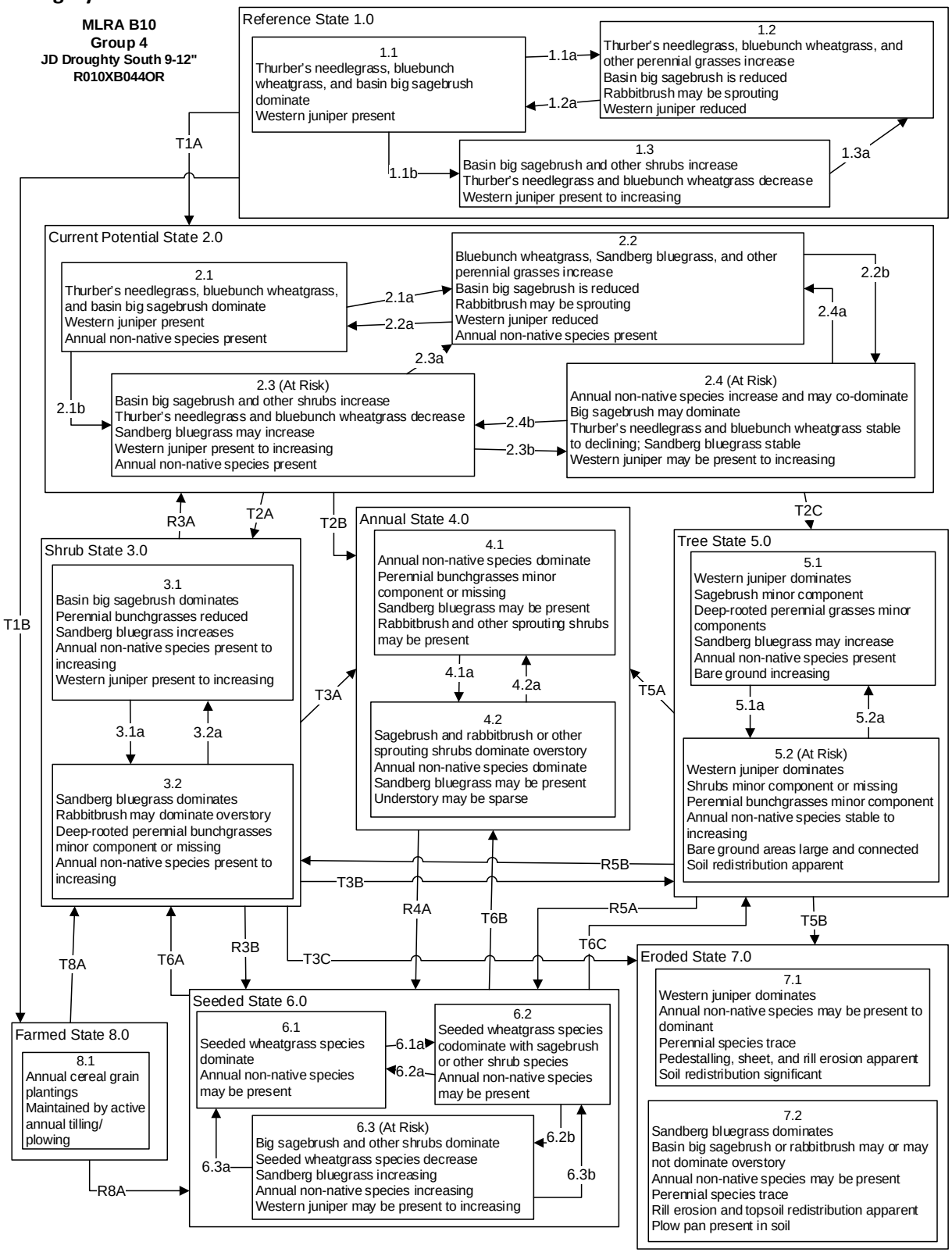
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

JD Droughty South 9-12”



MLRA B10
Group 4
JD Droughty South 9-12"
R010XB044OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance (from 5.1 to 3.1)

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with grazing management that favors shrub growth.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with grazing management that favors shrub growth.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

Group 5

There are 13 ecological sites in group 5. Four sites exhibit a north aspect, three have south aspects and six are not associated with a particular aspect. Landforms vary from rolling uplands and plateaus to low elevation terraces and benches. Slopes range from 0 to 70 percent with an average range of 8 to 45 percent. Soil temperature is primarily mesic with a few sites exhibiting frigid regimes. Moisture regimes vary from xeric to aridic. Elevation ranges from 1300 to 4800 feet with an average elevation range of 2046 to 3692 feet. Basin big sagebrush (*Artemisia tridentata spp. tridentata*) is the primary shrub species on the majority of sites. Eight of thirteen sites do not have a western juniper (*Juniperus occidentalis*) component as part of the reference plant community however the remaining five sites recognize a minor component of old growth trees may occur. Antelope bitterbrush (*Purshia tridentata*) occurs on a number of sites as dominant or sub-dominant in the shrub community. Bluebunch wheatgrass (*Pseudoroegneria spicata*) dominates the understory on eight sites and is also a component of the community on the remaining five sites that are dominated by Idaho fescue (*Festuca idahoensis*) or Thurber's needlegrass (*Achnatherum thurberianum)*.

Group 5 Ecological Sites

R010XB013OR JD SHRUBBY LOAM 12-16
R010XB030OR JD LOAMY 12-16 MODAL for MLRA B10 Group 5
R010XB031OR JD SHALLOW 12-16
R010XB033OR JD SHALLOW NORTH 12-16
R010XB034OR JD LOAMY 9-12 MODAL for MLRA B10 Group 5
R010XB045OR JD CLAYEY SOUTH 12-16
R010XB047OR JD SHALLOW SOUTH 12-16
R010XB048OR JD LOAMY SOUTH 12-16
R010XB053OR JD DROUGHTY FAN 9-12
R010XB063OR JD NORTH 9-12
R010XB064OR JD DROUGHTY NORTH 9-12
R010XB070OR JD NORTH 12-16
R010XB027OR JD CLAYEY 12-16

Sites on the CRNG

R010XB027OR JD CLAYEY 12-16 MODAL for CRNG Group 5
R010XB045OR JD CLAYEY SOUTH 12-16
R010XB070OR JD NORTH 12-16

Group 5 Modal Site within CRNG:
The JD Clayey 12-16 (R010XB027OR) ecological site is the modal site for this group as it has the most acres mapped on the CRNG. This ecological site is a non-aspect site which occurs on flat to rolling topography. Soil temperature regime is primarily mesic and soil moisture regime is xeric (12-16 inches). Soils typical of this ecological site have surface textures that are clay loam to silty clay loam with an influence of ash and are moderately deep to deep (40-60 inches) and well drained. The surface layer varies from 6 to 13 inches thick and the subsoil is gravelly or cobbly clay up to 40 inches deep. Gravels, cobbles, and larger rocks are common in most soils that this site occurs on. The reference plant community is strongly dominated by cool season, deep-rooted bunchgrasses that are maintained by low intensity wildfire. Shrubs such as basin big sagebrush and antelope bitterbrush occur in minor amounts in the reference state but can increase in the absence of fire or with disturbance favoring shrub

establishment. Western juniper also occurs as a minor component on this ecological site and can increase significantly with fire suppression substantially altering plant composition and production.

Group 5 Modal Sites for MLRA B10:
There are two modal sites identified for this DRG; the JD Loamy 12-16 and the JD Loamy 9-12 ecological sites. The JD Loamy 12-16 PZ modal site exhibits soils that were formed from alluvium, colluvium and loess. They are moderately deep to deep. The surface texture is typically silt loam or loam over a loamy or clay loam subsoil. Depth to bedrock is 30 to 60 inches. Permeability is moderate. The JD Loamy 9-12 PZ modal site soils are typically deep to very deep. The soil originated from basalt parent material formed from alluvium, colluvium, and loess. The surface texture consists of stony, gravelly and ashy loam with a loamy subsurface texture group. The soil is well drained and has moderately slow to slow permeability with a mesic soil temperature and aridic moisture regime. The potential native plant community for both sites is dominated by bluebunch wheatgrass with Idaho fescue, Thurber's needlegrass and Sandberg bluegrass (*Poa secunda)* also common. The Loamy 9-12 ecological site has a larger shrub component; however basin big sagebrush is the dominant shrub on both sites.

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 2013). Biotic factors that influence resilience include site productivity, species composition and structure, and population regulation and regeneration (Chambers et al. 2013).

The ecological sites in this DRG include deep-rooted cool season perennial bunchgrasses and long-lived shrubs (50+ years) with high root to shoot ratios. The dominant shrubs usually root to the full depth of the winter-spring soil moisture recharge, which ranges from 1.0 to over 3.0 m (Dobrowolski et al. 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards and Caldwell 1987). Tap roots of antelope bitterbrush have been documented from 4.5 to 5.4m in length (McConnell 1961). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock and Ehleringer 1992).

The perennial bunchgrasses generally have somewhat shallower root systems than the shrubs, 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.

In the central Oregon, John Day ecological province, the majority of annual precipitation is received during the winter and spring months with about 28% arriving during the April through June period and 58% during November through March (Anderson et al. 1998). 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 great potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability with the soil profile (Bates et al. 2006).

Variability in plant community composition and production is influenced by soil surface texture and depth. Idaho fescue will increase with loamy soil surfaces, and a weak argillic horizon will promote production of bluebunch wheatgrass. Thurber's needlegrass typically increases on gravelly soils, however with precipitation increases combined with increases in surface horizon thickness available soil water typically increases providing a competitive advantage to bluebunch wheatgrass and Idaho fescue. In general, production increases with soil depth. The amount of sagebrush in the plant community is dependent upon disturbances like fire, juniper encroachment, and grazing. Sandberg bluegrass more easily dominates sites where surface soils are gravelly loams or when there is an increase in ash in the upper soil profile.

Basin big sagebrush and antelope bitterbrush are generally long-lived; therefore it is not necessary for new individuals to recruit every year for perpetuation of the stand. Infrequent large recruitment events and simultaneous low, continuous recruitment is the foundation of population maintenance (Noy-Meir 1973). Survival of the seedlings is dependent on adequate moisture conditions.

The Crooked River Grasslands sagebrush / grass 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. The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) has been linked to disturbances (fire, abusive grazing, off road vehicles) that have resulted in fluctuations in resources (Chambers et al. 2007). Whereas, medusahead has been documented to replace native vegetation and cheatgrass directly by competition and suppression. Medusahead litter has a slow decomposition rate, because of high silica content, allowing it to accumulate over time and suppress competing vegetation (Bovey et al. 1961, Davies and Johnson 2008). The introduction of annual weedy species, like cheatgrass and medusahead (*Taeniatherum caput-medusae)*, may cause an increase in fire frequency and eventually lead to an annual state (Davies and Svejcar 2008). Conversely, as fire frequency decreases, sagebrush and or western juniper will increase and the understory bunchgrass community will decline as competition for limited resources increases. Inappropriate grazing management can facilitate the increase in the shrub community and decrease in the perennial bunchgrasses and forbs.

Western Juniper

During the past 140 years, western juniper has been expanding within its geographic range at unprecedented rates compared to any other time period during the Holocene (Miller et al. 2005) and density of western juniper has increased since the middle of the nineteenth century (Tausch 1999, Miller and Tausch 2000). Western juniper woodlands in eastern Oregon with more than 10 percent canopy cover increased from 456,000 acres in 1936 to 2.2 million acres in 1988 (Gedney et al. 1990, Miller et al. 2005). Causes for expansion of western juniper into sagebrush ecosystems include changes in the wildfire return interval, historic livestock grazing, and climate influences (Bunting 1994). Mean fire

return intervals prior to European settlement in mountain big sagebrush ecosystems were 15 to 25 years (Burkhardt and Tisdale 1976, Young and Evans 1981, Miller and Rose 1999), frequent enough to inhibit the encroachment of western juniper into these big sagebrush cover types (Miller and Tausch 2000). Thus, trees were isolated to fire-safe areas such as rocky outcroppings and areas with low-productivity.

An increase in juniper crown density causes a decrease in understory perennial vegetation and an increase in bare ground (Bates et al. 2000, Miller et al. 2000). The potential for soil erosion increases as the woodland matures and the understory plant community cover declines (Pierson et al. 2010). Additionally, as understory plant communities become depleted and soil resources become less available the opportunity for invasion by non-native annual species such as cheatgrass and medusahead increases. The highest risk for weed invasion in juniper encroached sagebrush communities are in the warmer (mesic soil temperature) lower elevation sites (Miller et al. 2005). With annual species in the understory wildfire can become more frequent and increase in intensity. Following fire, soil water and available nutrients generally increase, at least for a short period of time (Blank et al. 1994). Increases in nutrients, particularly nitrogen, enhance the growth of cheatgrass and increases the period of dominance (Miller et al. 2005). Once established, non-native annual species, especially cheatgrass, can shift the seasonality of fire to the active growing period of native perennials (Whisenant 1990). With frequent wildfires these plant communities can convert to annual grasslands with a sprouting shrub and juvenile tree overstory (Tausch 1999).

Nutrient and litter distribution are altered when juniper invades and dominates sagebrush sites. Soil calcium (Ca) and potassium (K) were found to increase under mature western juniper trees in central Oregon whereas nitrogen (N) and organic matter concentrations were highest under juvenile (< 40 yr.) old tree canopies (Doescher et. al. 1987). Changes in soil nutrient and organic matter distribution may have implications for plant community response post-fire or post-treatment.

Annual Invasive Grasses

The species most likely to invade these sites are cheatgrass and medusahead. Both species are cool-season annual grasses that maintain an advantage over native plants in part because they are prolific seed producers, able to germinate in the autumn or spring, tolerant of grazing and increase with frequent fire (Klemmedson and Smith 1964, Miller et al. 1999). Medusahead and cheatgrass originated from Eurasia and both were first reported in North America in the late 1800s (Mack and Pyke, 1983; Furbush 1953). Pellant and Hall (1994) found 3.3 million acres of public lands dominated by cheatgrass and suggested that another 76 million acres were susceptible to invasion by winter annuals including cheatgrass and medusahead. By 2003, medusahead occupied approximately 2.3 million acres in 17 western states (Rice 2005). In the Intermountain West, the exponential increase in dominance by medusahead has largely been at the expense of cheatgrass (Harris 1967, Hironaka 1989). Medusahead matures 2-3 weeks later than cheatgrass (Harris 1967) and recently, James et al. (2008) measured leaf biomass over the growing season and found that medusahead maintained vegetative growth later in the growing season than cheatgrass. Mangla et al. (2011) also found medusahead had a longer period of growth and more total biomass than cheatgrass and hypothesized this difference in relative growth rate may be due to the ability of medusahead to maintain water uptake as upper soils dry compared to co-occurring species, especially cheatgrass. Harris (1967) reported cheatgrass roots to have a relatively poorly developed endodermis layer to insulate against hot dry soils, while medusahead roots have thicker cell walls, which allow it to conduct water throughout very dry soil horizons. Recent modeling and empirical work by Bradford and Lauenroth (2006) suggests that seasonal patterns of precipitation input and temperature are also key factors determining regional variation in the growth, seed

production, and spread of invasive annual grasses. Collectively, the body of research suggests that the continued invasion and dominance of medusahead onto native grasslands and cheatgrass infested grasslands will continue to increase in severity because conditions that favor bluebunch wheatgrass or cheatgrass over medusahead are rare (Mangla et al. 2011).

Methods to control medusahead and cheatgrass include herbicide, fire, grazing, and seeding of primarily non-native wheatgrasses. Mapping potential or current invasion vectors is a management method designed to increase the cost effectiveness of control methods. A study by Davies et al. (2013), found an increase in medusahead cover near roads. Cover was higher near animal trails than random transects but the difference was less evident. This implies that vehicles and animals aid the spread of the weed; however vehicles are the major vector of movement. Spraying with herbicide (Imazapic or Imazapic + glyphosate) and seeding with crested wheatgrass and Sandberg bluegrass has been found to be more successful at combating medusahead and cheatgrass than spraying alone (Sheley et al. 2012). Where native bunchgrasses are missing from the site, revegetation of medusahead or cheatgrass invaded rangelands has been shown to have a higher likelihood of success when using introduced perennial bunchgrasses such as crested wheatgrass (Davies et al. 2015). Butler et al. (2009) tested four herbicides (Imazapic, Imazapic + glyphosate, rimsulfuron and sulfometuron + Chlorsulfuron) only treatments for suppression of cheatgrass, medusahead, and ventenata (North Africa grass, *Ventenata dubia*) within residual stands of native bunchgrass. Additionally, they tested the same four herbicides followed by seeding of six bunchgrasses (native and non-native) with varying success (Butler et al. 2009). Herbicide only treatments appeared to remove competition for established bluebunch wheatgrass by providing 100% control of ventenata and medusahead and greater than 95% control of cheatgrass (Butler et al. 2009) however caution in results is advised as only one year of data was reported. Prescribed fire has also been utilized in combination with the application of pre-emergent herbicide to control medusahead and cheatgrass (Vollmer and Vollmer 2008). Mature medusahead or cheatgrass is very flammable and fire can be used to remove the thatch layer, consume standing vegetation, and even reduce seed levels. Furbush (1953) reported that timing a burn while the seeds were in the milk stage effectively reduced medusahead the following year. He further reported that adjacent unburned areas became a seed source for reinvasion the following year. In considering the combination of pre-emergent herbicide and prescribed fire for invasive annual grass control it is important to assess the tolerance of desirable brush species to the herbicide being applied. Vollmer and Vollmer (2008) tested the tolerance of mountain mahogany (*Cerocarpus montanus*), antelope bitterbrush and multiple sagebrush species to three rates of Imazapic and the same rates with methylated seed oil as a surfactant. They found a cheatgrass control program in an antelope bitterbrush community should not exceed Imazapic at 8oz/ac with or without surfactant (Vollmer and Vollmer 2008). Sagebrush, regardless of species or rate of application was not affected. However, many environmental variables were not reported and managers should install test plots before broad scale herbicide application is initiated.

Historical Farming

The legacy effects of the dryland farming era, 1880's – 1930's, are still seen today within MLRA B10 and specifically within Crooked River National Grasslands (USDA Forest Service 2016). Practices included removal of deep-rooted bunchgrasses and sagebrush (USDA Forest Service 1989), plowing and harrowing of soil (Morris 2011), and planting of annual crops (Morris 2012, US Forest Service 1989). Dust storms, water erosion, and organic matter oxidation resulting from these practices (Schillinger et al. 2010) led to the complete or partial loss of organic matter and nutrient value in the topsoil (Bracken et al. 1940, Bradley 1910, Schillinger et al. 2010, USDA Forest Service 2004, Williams el al. 2009). By the 1930s inadequate rainfall and poor economic conditions led to farm failure, and government policies including the Resettlement Act and Bankhead Jones Farm Tenant Act that facilitated the federal

government purchase of land for rehabilitation (USDA Forest Service 2016). During the late 1930's and early 1940's, approximately 63,000 acres were planted to either crested wheatgrass (*Agropyron cristatum*) or beardless bluebunch wheatgrass (*Pseudoroegneria spicata* ssp. *inerme)* in an effort to provide soil stabilization (USDA Forest Service 2004). In 1954, management of the acquired lands were transferred from the Soil Conservation Service to the Forest Service (USFS) and in 1960 became known as the Crooked River National Grasslands. In the 1960's the USFS continued reseeding the farmed acres and spraying herbicides to control shrubs. In the 1970's reseeding was phased out and fire was introduced as a management tool.

The management activities of the farming era followed by abandonment of farmed fields often led to accelerated wind and water erosion of soil. Additionally, on some areas plow pan compaction layers resulting from repeated plowing are still present today. Lasting effects on the soil also include diminished soil stability (Bullock, Kemper and Nelson 1988), altered structure, reduced moisture and nutrient retention, and lower infiltration potential (Schnitzer and Khan 1975). Recognizing and acknowledging the legacy effects of the farming era on the landscape of the CRNG is important in development of appropriate management plans.

Ecological Resilience and Resistance: Summary
The ecological sites in this DRG have moderate resilience to disturbance and resistance to invasion. Increased resilience increases with elevation, aspect, increased precipitation and increased nutrient availability. However, ecological sites that have experience legacy farming and associated soil erosion or changes in soil structure will exhibit reduced resilience to disturbance and resistance to invasion. Eight alternative stable states have been identified for this DRG.

Fire Ecology of Plant Species
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. Fire typically occurs past the end of the growing season for most forbs and grasses therefore the growing points are generally located at or below the soil surface providing relative protection from disturbances that remove above ground biomass. 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 plant material (Wright 1971, Young 1983, Davies et al. 2009). Furthermore, (Boyd and Davies 2012) found that bunchgrasses under shrub canopies burned more than 40% hotter than interspace counterparts leading to mortality rates greater than 73% (Boyd et al. 2015). Thus, fire severity is a function of seasonality and intensity along with the amount of biomass within the bunchgrass and surrounding the bunchgrass.

Fire will remove aboveground biomass from bluebunch wheatgrass but plant mortality is generally low (Robberecht and Defossé 1995) because the buds are underground (Conrad and Poulton 1966) or protected by foliage. Uresk et al. (1976) reported burning increased vegetative and reproductive vigor of bluebunch wheatgrass. Thus, bluebunch wheatgrass is considered to experience slight damage from fire but is more susceptible in drought years (Young 1983). Plant response will vary depending on season, fire severity, fire intensity and post-fire soil moisture availability.

Idaho fescue response to fire varies with condition and size of the plant, season and severity of fire, and ecological conditions. Mature Idaho fescue plants are commonly reported to be severely damaged by fire in all seasons (Wright et al. 1979). Initial mortality may be high (in excess of 75%) on severe burns, but usually varies from 20 to 50% (Barrington et al. 1989). Rapid burns have been found to leave little damage to root crowns, and new tillers are produced with onset of fall moisture (Johnson et al. 1994).

However, Wright and others (1979) found the dense, fine leaves of Idaho fescue provided enough fuel to burn for hours after a fire had passed, thereby killing or seriously injuring the plant regardless of the intensity of the fire (Wright et al. 1979). Idaho fescue is commonly reported to be more sensitive to fire than the other prominent grass on this site, bluebunch wheatgrass (Conrad and Poulton 1966). However Robberecht and Defossé (1995) suggested the latter was more sensitive. They observed culm and biomass reduction with moderate fire severity in bluebunch wheatgrass, whereas a high fire severity was required for this reduction in Idaho fescue. Also, given the same fire severity treatment, post-fire culm production was initiated earlier and more rapidly in Idaho fescue (Robberecht and Defossé 1995).

The fine leaves and densely tufted growth form make Thurber's needlegrass susceptible to subsurface charring of the crowns (Wright and Klemmedson 1965). However, there appears to be no detrimental effect of fall burning on Thurber's needlegrass (Davies and Bates 2008, Ellsworth and Boone 2010). Spring and early summer burning may result in a reduction in grass density (Ellsworth and Boone 2010, Wright and Klemmedson 1965, Uresk et al. 1976, Uresk et al. 1980). Although timing of fire highly influences the response and mortality of Thurber's needlegrass, smaller bunch sizes are less likely to be damaged by fire (Wright and Klemmedson 1965). Burning has been found to decrease the vegetative and reproductive vigor of Thurber's needlegrass (Uresk et al. 1976). Fire prescribed in May, June, and November were found to cause high mortality in addition to reducing basal area and yield of Thurber's needlegrass (Britton et al. 1990).

Squirreltail (*Elymus elymoides*), a minor component of this ecological site, has been found to be tolerant of mid-summer burning (Wright 1971). The open morphological structure of squirreltail precludes buildup of dead plant material reducing the burning time and subsequently the amount of heat transmitted to the growing points. Thus, squirreltail may increase in this ecological site following summer wildfires.

Sandberg bluegrass, also a minor component of this ecological site, has been found to increase following fire likely due to its low stature and productivity (Daubenmire 1975). Sandberg bluegrass may retard reestablishment of deeper rooted bunchgrass. Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community.

Antelope bitterbrush is moderately fire tolerant (McConnell and Smith 1977). It regenerates by seed and resprouting (Blaisdell and Mueggler 1956, McArthur et al. 1982), however sprouting ability is highly variable and has been attributed to genetics, plant age, phenology, soil moisture and texture and fire severity (Blaisdell and Mueggler 1956, Blaisdell et al. 1982, Clark et al. 1982, Cook et al. 1994). Bitterbrush sprouts from a region on the stem approximately 1.5 inches above and below the soil surface; the plant rarely sprouts if the root crown is killed by fire (Blaisdell and Mueggler 1956). Low intensity fires may allow for bitterbrush to sprout; however, community response also depends on soil moisture levels at time of fire (Murray 1983). Lower soil moisture allows more charring of the stem below ground level (Blaisdell and Mueggler 1956), thus sprouting will usually be more successful after a spring fire than after a fire in summer or fall (Murray 1983, Busse et al. 2000, Kerns et al. 2006). The factor that most limits establishment of bitterbrush seedlings is competition for water resources with invasive annual species (Clements and Young 2002).

In many basin big sagebrush communities, changes in fire frequency occurred along with fire suppression, livestock grazing and OHV use. Few if any fire history studies have been conducted on basin big sagebrush; however, Sapsis and Kauffman (1991) suggest that fire return intervals in basin big sagebrush are intermediate between mountain big sagebrush (15 to 25 years) and Wyoming big

sagebrush (50 to 100 years). Fire severity in big sagebrush communities is described as "variable" depending on weather, fuels, and topography. However, fire in basin big sagebrush communities are typically stand replacing (Sapsis and Kauffman 1991). Basin big sagebrush does not sprout after fire. Because of the time needed to produce seed, it is eliminated by frequent fires (Bunting et al. 1987). Basin big sagebrush reinvades a site primarily by off-site seed or seed from plants that survive in unburned patches. Approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent shrub (Goodrich et al. 1985) with maximum seed dispersal at approximately 108 feet (33 m) from the parent shrub (Shumar and Anderson 1986). Therefore regeneration of basin big sagebrush after stand replacing fires is difficult and dependent upon proximity of residual mature plants and favorable moisture conditions (Johnson and Payne 1968, Humphrey 1984).

Western juniper is intolerant of fire and historically was located in areas with minimal understory due primarily to soil characteristics; therefore fire was very infrequent, and when it did occur it was low intensity. With the increased suppression of wildfire and introduction of livestock grazing which reduces ground fuels and understory competition, regeneration and establishment of western juniper has expanded into sites previously dominated by big sagebrush (Burns and Honkala 1990). The expansion of western juniper has been well documented. In the Steens mountain range of south eastern Oregon, the expansion of western juniper coincides with Euro-American settlement. Probable causes include climate, altered fire frequencies and grazing of flammable ground fuels (Miller and Rose 1995). Fire resistance depends on age of the tree: seedlings, saplings and poles are highly vulnerable to fire. Mature trees have some resistance to fire due to lack of fuels near the trunk, relatively thick bark, and foliage which is fairly high above the ground (Burns and Honkala 1990).

The grasses likely to invade this site are cheatgrass and medusahead. These invasive grasses displace desirable perennial grasses, reduce livestock forage, and accumulate large fuel loads that foster frequent fires (Davies and Svejcar 2008). Invasion by annual grasses can alter the fire cycle by increasing fire size, fire season length, rate of spread, numbers of individual fires, and likelihood of fires spreading into native or managed ecosystems (D'Antonio and Vitousek 1992, Brooks et al. 2004). While historical fire return intervals are estimated at 15 to 100 years, areas dominated with cheatgrass are estimated to have a fire return interval of 3-5 years (Whisenant 1990). The mechanisms by which invasive annual grasses alter fire regimes likely interact with climate. For example, cheatgrass cover and biomass vary with climate (Chambers et al., 2007) and are promoted by wet and warm conditions during the fall and spring. Invasive annual species have been shown able to take advantage of high N availability following fire through higher growth rates and increased seedling established relative to native perennial grasses (Monaco et al. 2003).

Livestock/Wildlife Grazing Interpretations

This group of ecological sites are suitable for grazing. Grazing management considerations include timing, duration and intensity of grazing along with past farming history and other disturbances that may have changed the resiliency and resistance of the ecological site. In addition, many wildlife species are dependent on the sagebrush ecosystem including the sage sparrow, pygmy rabbit and the sagebrush vole. Dobkin and Sauder (2004) identified 61 species, including 24 mammals and 37 birds, associated with the shrub-steppe habitats of the Intermountain West. Despite low palatability, big sagebrush is eaten by sheep, cattle, goats, and horses. Chemical analysis indicates that the leaves of big sagebrush equal alfalfa meal in protein, have a higher carbohydrate content, and yield twelvefold more fat (USDA-Forest Service 1937). Antelope bitterbrush is an important shrub species to a variety of animals, such as domestic livestock, antelope, deer, and elk. Bitterbrush is critical browse for mule deer, as well as

domestic livestock, antelope, and elk (Wood 1995, Clements and Young 2002). Antelope bitterbrush is most commonly found on soils which provide minimal restriction to deep root penetration such as coarse textured soil, or finer textured soil with high stone content (Driscoll 1964). Grazing tolerance of antelope bitterbrush is dependent on site conditions (Garrison 1953).

Bluebunch wheatgrass is moderately grazing tolerant and is very sensitive to defoliation during the active growth period (Blaisdell and Pechanec 1949, Laycock 1967, Anderson and Scherzinger 1975, Britton et al. 1990). Herbage and flower stalk production was reduced with clipping at all times during the growing season; however, clipping was most harmful during the boot stage (Blaisdell and Pechanec 1949). Tiller production and growth of bluebunch was greatly reduced when clipping was coupled with drought (Busso and Richards 1995). Mueggler (1975) estimated that low vigor bluebunch wheatgrass may need up to 8 years rest to recover. Although an important forage species, it is not always the preferred species by livestock and wildlife.

Idaho fescue tolerates light to moderate grazing (Ganskopp and Bedell 1980) and is moderately resistant to trampling (Cole 1987, USDA Forest Service 1937). Idaho fescue has been found to decrease under heavy, repeated grazing by livestock (Eckert and Spencer 1986, Eckert and Spencer 1987 Mueggler 1984) and wildlife (Gaffney 1941). However, more recent research by Jaindl et al. (1994) suggests Idaho fescue exhibits overcompensation to single defoliation events (i.e., cumulative total dry weight, including removed tissue, of the defoliated plants is greater than the total dry weight of the control plants) depending on the physiological stage of growth at the time of the grazing event. Jaindl et al. (1994) reported overcompensation occurred for plants defoliated during the boot to anthesis stage. The ability to overcompensate following grazing is a function of available soil moisture and length of growing season therefore season of grazing must be considered. Additionally, Idaho fescue exhibits moderate to high palatability increasing the likelihood of repeated defoliation thus decreasing the opportunity for compensatory gain.

Thurber's needlegrass is an important forage source for livestock and wildlife in the arid regions of the West (Ganskopp 1988). Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Sheep, however, have been observed to graze the leaves closely, leaving stems untouched (Eckert and Spencer 1987). Heavy grazing during the growing season has been shown to reduce the basal area of Thurber's needlegrass (Eckert and Spencer 1987), suggesting that both seasonality and utilization are important factors in management of this plant. A single defoliation, particularly during the boot stage, was found to reduce herbage production and root mass, thus potentially lowering the competitive ability of this needlegrass (Ganskopp 1988).

Reduced bunchgrass vigor or density provides an opportunity for Sandberg bluegrass expansion and/or cheatgrass and other invasive species to occupy interspaces, leading to increased fire frequency and potentially an annual plant community. Sandberg bluegrass increases under grazing pressure (Tisdale and Hironaka 1981) and is capable of co-existing with cheatgrass. Excessive sheep grazing favors Sandberg bluegrass; however, where cattle are the dominant grazers, cheatgrass often dominates (Daubenmire 1970). Thus, depending on the season of use, the grazer and site conditions, either Sandberg bluegrass or cheatgrass may become the dominant understory with inappropriate grazing management. However, if medusahead is present cheatgrass may be replaced by this more competitive and less palatable species (Mangla et al. 2011).

Inappropriate grazing practices can be tied to the success of medusahead, however, eliminating grazing will not eradicate medusahead if it is already present (Wagner et al. 2001). Sheley and Svejcar (2009) reported that even moderate defoliation of bluebunch wheatgrass resulted in increased medusahead

density. They suggested that disturbances such as plant defoliation limit soil resource capture, which creates an opportunity for exploitation by medusahead. Avoidance of medusahead by grazing animals allows medusahead populations to expand. This creates seed reserves that can infest adjoining areas and cause changes to the fire regime. Medusahead has a high silica content which may contribute to its resistance to decomposition (Bovey et al. 1961), and the accumulation of the thatch layer.

State and Transition Model Narrative Group 5

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 3 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 drought and/or insect or disease attack.

Community Phase 1.1:
This community is dominated by bluebunch wheatgrass, Idaho fescue, basin big sagebrush and antelope bitterbrush. Forbs and other grasses make up smaller components. Western juniper is not described in the site concept so is not listed in the Reference State.

Community Phase Pathway 1.1a:
Fire will decrease or eliminate the overstory of sagebrush and/or bitterbrush and allow for the perennial bunchgrasses to dominate the site. Fires will typically be low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring may be more severe and reduce sagebrush and/or bitterbrush cover to trace amounts.

Community Phase Pathway 1.1b:
Time and lack of disturbance such as fire allows for sagebrush and/or bitterbrush to increase and become decadent. Chronic drought, excessive herbivory, or combinations of these will cause a decline in perennial bunchgrasses and fine fuels leading to a reduced fire frequency and allowing big sagebrush and/or bitterbrush to dominate the site.

Community Phase 1.2:
This community phase is characteristic of a post-disturbance, early to mid-seral community. Bluebunch wheatgrass, Idaho fescue and other perennial bunchgrasses dominate. Depending on fire severity, patches of intact sagebrush and/or bitterbrush may remain. Antelope bitterbrush and rabbitbrush may be sprouting depending on extent of damage and on available soil moisture post burn.

Community Phase Pathway 1.2a:
Time and lack of disturbance will allow sagebrush and/or bitterbrush to increase.

Community Phase 1.3:

Sagebrush and other shrubs increase in the absence of disturbance. Decadent sagebrush and/or bitterbrush dominates the overstory and the deep-rooted perennial bunchgrasses are reduced either from competition with shrubs and/or from herbivory.

Community Phase Pathway 1.3a:
A low severity fire will reduce the sagebrush and/or bitterbrush overstory resulting in a perennial bunchgrass – shrub mosaic. A high severity fire will significantly reduce shrub and juniper cover and will promote an early- to mid-seral bunchgrass community.

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, medusahead, ventenata, mustards, and bur buttercup (*Ceratocephala testiculata*).
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, residual dry matter accumulation, and adaptations for seed dispersal.

Community Phase 2.1:
This community phase is similar to the Reference State Community Phase 1.1, with the presence of non-native species in trace amounts. Bluebunch wheatgrass, Idaho fescue, antelope bitterbrush and/or basin big sagebrush dominate the site. Forbs and other shrubs and grasses make up smaller components of this site. Western juniper may be present.

Community Phase Pathway 2.1a:
Fire reduces the shrub overstory and allows for perennial bunchgrasses to dominate the site. Fires are typically low severity resulting in a mosaic pattern due to low fuel loads. A fire following an unusually wet spring or a change in management favoring an increase in fine fuels may be more severe and reduce sagebrush and/or bitterbrush cover to trace amounts. Western juniper, if present, will be significantly reduced. Annual non-native species are likely to increase after fire.

Community Phase Pathway 2.1b:
Time and lack of disturbance allows for shrubs to increase and become decadent. Chronic drought, herbivory, or combinations of these reduces fine fuels and leads to a reduced fire frequency, allowing basin big sagebrush and/or bitterbrush to dominate the site. Inappropriate

grazing management may hasten the decline the perennial bunchgrass understory; while the grazing tolerant Sandberg bluegrass may increase depending on grazing management.

Community Phase 2.2:
This community phase is characteristic of a post-disturbance, early- to mid-seral community where perennial bunchgrasses dominate. Annual non-native species are present. Sagebrush and/or bitterbrush may be present in trace amounts depending on fire severity. Antelope bitterbrush may sprout after fire. Perennial forbs may be a significant component for several years. Annual non-native species are stable or increasing within the community. Old growth western juniper trees exhibit some resistance to fire and will likely remain in the community. Juniper seedlings, saplings and poles will be reduced.

Plot B32 JD Clayey 12-16" Community Phase 2.2

Community Phase Pathway 2.2a:
Time and lack of disturbance and/or grazing management that favors the establishment and growth of sagebrush and/or bitterbrush allows the shrub component to recover. The establishment of basin big sagebrush can take many years.

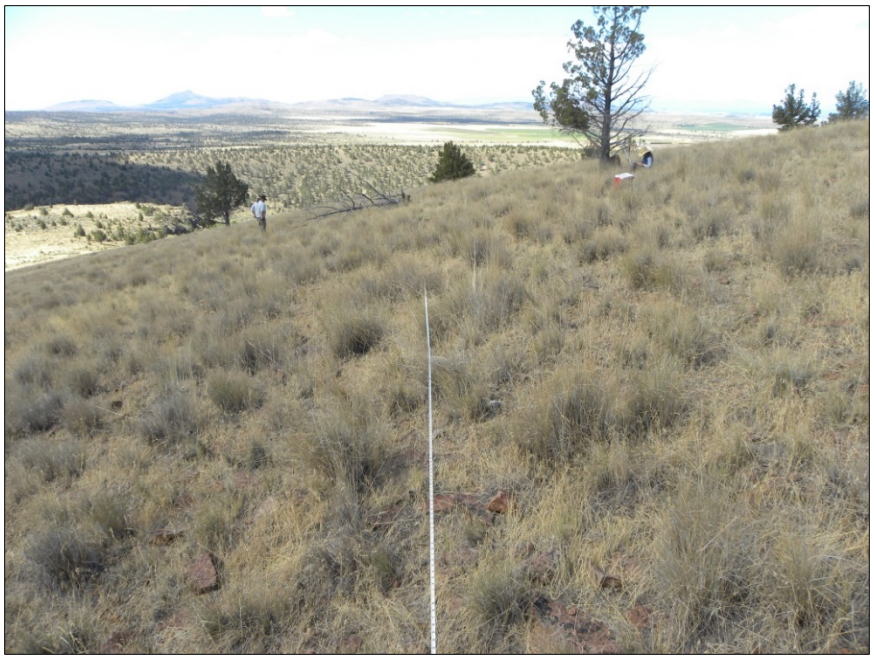
Community Phase Pathway 2.2b:
Annual precipitation highly influences the density and cover of non-native annual species. A year with higher than normal precipitation during the germination and growth period of non-native annual species will cause populations to increase and become sub- to co-dominant in the understory. This shift to Phase 2.4 typically occurs within the first two to four years following a fire, prescribed or wildfire, triggered by spring precipitation that is favorable to non-native annual grass production. Tree or shrub treatments coupled with soil disturbance and higher than normal spring precipitation may also elicit a temporary increase in non-native annual species production.

Community Phase 2.3 (At Risk):
This community is at risk of crossing a threshold to another state. Sagebrush and/or bitterbrush dominate the overstory and perennial bunchgrasses in the understory are reduced, either from competition with shrubs or from inappropriate grazing, or from both. Rabbitbrush may be a significant component. Sandberg bluegrass may increase and become co-dominant with deep rooted bunchgrasses. Western juniper may be present and without management or fire will likely increase. Annual non-native species may be stable or increasing due to lack of competition with perennial bunchgrasses. This site is susceptible to further degradation from inappropriate grazing, drought, and fire.

Community Phase Pathway 2.3a:
A low severity fire will reduce the sagebrush overstory and allow perennial grasses to dominate. Annual non-native species are present and may increase in the community. Alternatively, a change in grazing management that reduces shrubs will also allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush/tree treatments with minimal soil disturbance will also decrease sagebrush/juniper and release the perennial understory.

Community Phase Pathway 2.3b:
Annual precipitation highly influences the density and cover of non-native annual species. A year with higher than normal precipitation during the germination and growth period of non-native annual species will cause populations to increase and become codominant in the understory. Tree/shrub removal treatment that disturb the soil surface, inappropriate grazing management, or prescribed burning in the presence of annual grass species may cause a shift to Phase 2.4.

Community Phase 2.4 (At Risk):
This community is at risk of crossing into an Annual State. Native bunchgrasses and/or native shrubs are still dominant; however, annual non-native species such as cheatgrass or medusahead may be co-dominant in the understory. Annual production and abundance of these annuals may increase drastically in years with above average spring precipitation. Medusahead litter accumulation may smother desirable herbaceous seedlings and further facilitate maintenance of this community phase. If the site is coming from Phase 2.2, sagebrush and/or bitterbrush may only be a minor component. Western juniper may be present to increasing. Seeded species may also be present. Disturbances that damage desirable shrubs and grasses increase the risk of transitioning into an Annual State.



Plot B35 JD Clayey South 12-16" Community Phase 2.4

Community Phase Pathway 2.4a:
Rainfall patterns favoring perennial bunchgrasses transition this site to Phase 2.2. Less than normal spring precipitation followed by higher than normal summer precipitation will increase perennial bunchgrass production. Target dormant season grazing may facilitate a reduction in annual species and an increase in perennial bunchgrass (Schmelzer et al. 2014).

Community Phase Pathway 2.4b:
Rainfall patterns favoring perennial bunchgrass production transition this community phase to Phase 2.3. Less than normal early spring precipitation followed by higher than normal late spring / early summer precipitation will increase perennial bunchgrass production. Shrubs will remain if present.

T2A: Transition from Current Potential State 2.0 to Shrub State 3.0

Trigger: To Community Phase 3.1: Repeated, chronic, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2: Severe fire will remove sagebrush and bitterbrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass. Brush treatments coupled with inappropriate grazing management will reduce shrub overstory, decrease perennial bunchgrasses and facilitate an increase in Sandberg bluegrass.
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 Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire or failed rehabilitation treatments involving soil disturbing activities such as drilling, disking, or plowing. To Community Phase 4.2: Inappropriate grazing management that decreases perennial bunchgrasses and facilitates the

expansion of non-native annual grasses; competitive increase in medusahead through lack of active management.
Slow variables: Increased production and cover of non-native annual species; increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Loss of deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T2C: Transition from Current Potential State 2.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Shrub State 3.0:

This state is a product of many years of heavy grazing during time periods harmful to perennial bunchgrasses or the abandonment of farm fields without rehabilitation seedings. Grazing tolerant Sandberg bluegrass will increase with a reduction in deep rooted perennial bunchgrass competition and become the dominant grass. Basin big sagebrush dominates the overstory and rabbitbrush may be a significant component. Sagebrush cover exceeds site concept and may be decadent, reflecting stand maturity and lack of seedling establishment due to competition with mature plants. The shrub overstory and Sandberg bluegrass understory dominate site resources such that soil water, nutrient capture, nutrient cycling and soil organic matter are temporally and spatially redistributed (3.1). Abandoned farm fields typically develop a rabbitbrush overstory with early to mid-seral grasses or weeds in the understory. Plow pans and soil loss may have reduced site resilience (3.2). In both community phases, bare ground may be significant with soil redistribution occurring between interspace and shrub locations. Western juniper increases and may begin to influence the understory vegetation.

Community Phase 3.1 (At Risk):

Basin big sagebrush dominates the site and may be decadent. Antelope bitterbrush may be a significant component. Bare ground is significant. Understory may be dominated by Sandberg bluegrass. Deep-rooted perennial bunchgrasses may be present in trace amounts or absent from the community. Annual non-native species may be present to increasing but are not dominant in the understory. Old growth juniper may be present and young juniper will likely increase without management action.

B04 JD Clayey 12-16 Community Phase 3.1

Specie Composition Analysis
Lone Pine Allotment - Cluster 18, May 1958

Specie	Common name	1958 Average
POAM	Poa ampla	0.0
FEID	Idaho Fescue	0.7
KOCR	Junegrass	0.0
STIPA	Needlegrass	2.3
SIHY	Bottlebrush Squirreltail	3.0
POSE	Sandberg Bluegrass	64.7
BRCA	California Brome	0.0
ARAC2	Rockcress	0.0
ANLU	Pussytoes	0.3
ACMI	Yarrow	1.0
LOMAT	Lomatium	7.3
Unk Forb		0.3
ERO	Buckwheat	0.0
ERO	Buckwheat	0.0
AGOS	Agoseris	0.3
ARTR	Sagebrush	10.0
CHRYS	Rabbitbrush	4.7
PUTR	Bitterbrush	5.3
		100

See Appendix D

Lone Pine Allotment – Cluster 18 T3. The legal location is T 13 S R 14 E Section 21 NWNW. Community Phase 3.1.

Community Phase Pathway 3.1a:
Fire, heavy fall grazing causing mechanical damage to shrubs, and/or brush treatments with minimal soil disturbance, will greatly reduce the overstory shrubs to trace amounts and allow for Sandberg bluegrass to dominate the site.

Community Phase 3.2:
Rabbitbrush and/or Sandberg bluegrass dominates the site; annual non-native species may be present but are not dominant. Trace amounts of sagebrush may be present. Phase 3.2 may be created by fire from 3.1 or directly from the farmed State 8.0.

Community Phase Pathway 3.2a:
Time without disturbance allows sagebrush and/or bitterbrush to mature and become dominant overstory. Western juniper may increase.

T3A: Transition from Shrub State 3.0 to Annual State 4.0
Trigger: To Community Phase 4.1: Catastrophic fire and/or failed rehabilitation treatment or combination of both. To Community Phase 4.2: Inappropriate grazing management in the presence of annual non-native species and/or competitive increase in medusahead through lack of active management. May be combined with higher than normal spring precipitation.
Slow variables: Increased production and cover of non-native annual species. Increased production and cover of medusahead as a percentage of the non-native total annual grass production and total cover.
Threshold: Increased, continuous fine fuels modify the fire regime by changing intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture spatially and temporally thus impacting nutrient cycling and distribution.

T3B: Transition from Shrub State 3.0 to Tree State 5.0
Trigger: Time and a lack of disturbance or management action allows for western juniper to dominate site. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources.
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

T3C: Transition from Shrub State 3.0 to Eroded State 7.0
Trigger: To Community Phase 7.2: historic farm field that was or was not seeded for stabilization and converted to shrub state coupled with inappropriate grazing management and reduced resiliency caused by changed soil properties (plow pans, A horizon erosion).
Slow variables: Over time perennial grass and forb cover decreases, bare ground increases, water flow paths become long and connected. Pedestaled plants increase.
Threshold: Soil erosion processes dominate site; rills, sheet erosion, blow outs, bare ground areas are apparent. Vegetation is not regenerating.

R3A: Restoration from Shrub State 3.0 to Current Potential State 2.0
Brush management such as mowing, coupled with seeding of deep-rooted native bunchgrasses. If non-native annual grasses are present, restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Targeted herbicide treatments may be necessary to

facilitate this restoration pathway. Likelihood of seeding success declines rapidly with increasing cover / density of medusahead (Young et al. 1999).

R3B: Restoration from Shrub State 3.0 to Seeded State 6.0

Brush management such as mowing, coupled with seeding of deep rooted non-native wheatgrasses. If non-native annual grasses are present, restoration attempts causing soil disturbance will likely initiate a transition to an annual state. Targeted herbicide treatments will likely be necessary to facilitate this restoration pathway.

Annual State 4.0:

This community is characterized by the dominance of annual non-native species such as cheatgrass, medusahead, and tansy mustard in the understory. Sagebrush, bitterbrush, and/or rabbitbrush may dominate the overstory.

Community Phase 4.1:

Annual non-native plants such as cheatgrass and medusahead dominate the site. Shrubs may be present in trace amounts.

Plot GR5-2 JD Clayey 12-16” Community Phase 3.1

Community Phase Pathway 4.1a:

Time and lack of fire allows for the sagebrush and bitterbrush to establish or sprouting shrubs such as rabbitbrush to increase. The probability of sagebrush establishment is extremely low.

Community Phase 4.2:

Rabbitbrush is typically the dominant overstory shrub if fire preceded development of the community. Sagebrush may be the dominant overstory shrub if inappropriate grazing was the threshold driver to 4.2. Annual non-native species, likely cheatgrass, medusahead and mustards, dominate the understory.

Community Phase Pathway 4.2a:
Fire reduces/eliminates overstory brush component and allows for annual non-native species to dominate the site.

R4A: Restoration from Annual State 4.0 to Seeded State 6.0
Seeding of deep-rooted bunchgrasses; may be coupled with brush management and/or herbicide. The probability of success is extremely low.

Tree State 5.0:
This state is characterized by a dominance of western juniper in the overstory. Basin big sagebrush and/or antelope bitterbrush and perennial bunchgrasses may still be present, but they are no longer controlling site resources. Soil moisture, soil nutrients and soil organic matter distribution and cycling have been spatially and temporally altered.

Community Phase 5.1:
Western juniper dominates the overstory and site resources. Trees are actively growing with noticeable leader growth. Trace amounts of bunchgrasses may be found under tree canopies. Sandberg bluegrass and mat forming forbs may be dominant in the interspaces. Sagebrush is stressed and dying. Annual non-native species are present under tree canopies. Bare ground interspaces are large and connected.

Community Phase Pathway 5.1a:
Time and lack of disturbance or management action allows western juniper to further mature and dominate site resources.

Community Phase 5.2 (At Risk):
Western juniper dominates the site and tree leader growth is minimal. Trace amounts of sagebrush may be present however dead skeletons will be more numerous than living sagebrush. Bunchgrasses may or may not be present. Sandberg bluegrass or mat forming forbs may be present in trace amounts. Annual non-native species may be the dominant understory species and will typically be found under the tree canopies. Bare ground interspaces are large and connected. Soil redistribution is evident. Site is at risk of transitioning to Eroded State 7.0.

T5A: Transition from Tree State 5.0 to Annual State 4.0
Trigger: Catastrophic fire causing a stand replacement event will transition Annual State 4.0. Inappropriate tree removal practices with soil disturbance will cause a transition to the Annual State 4.
Slow variables: Increased production and cover of non-native annual species under tree canopies.
Threshold: Closed tree canopy with non-native annual species dominant in the understory changes the intensity, size and spatial variability of fires. Changes in plant community composition and spatial variability of vegetation due to the loss of perennial bunchgrasses and sagebrush truncate energy capture and impact nutrient cycling and distribution.

T5B: Transition from Tree State 5.0 to Eroded State 7.0
Trigger: Time and lack of disturbance allows for tree competition to eliminate herbaceous understory.

Slow variables: Bare ground interspaces large and connected; water flow paths long and continuous; sheet erosion evident; understory sparse.
Threshold: Soil redistribution and erosion is significant and linked to vegetation mortality evidenced by pedestalling and burying of herbaceous species and/or lack of recruitment in the interspaces.

R5A: Restoration from Tree State 5.0 to Seeded State 6.0

Tree removal and seeding of desired non-native wheatgrass species. Tree removal practices with minimal soil disturbance are recommended. Probability of success declines with increased presence of non-native annual species. Herbicide treatment may be necessary.

R5B: Restoration from Tree State 5.0 to Shrub State 6.0

This restoration is recommended for Phase 5.1 only due to the lack of understory in 5.2.
Tree removal practices with minimal soil disturbance.

Seeded State 6.0:

This state has three community phases; a grass-dominated phase; a grass-shrub phase and a shrub dominated phase. The state is characterized by the dominance of seeded introduced wheatgrass species. Other seeded species including sagebrush, bitterbrush, and native and non-native forbs may be present. A change in site resilience and resistance due to presence of plow pan and loss of top soil during farming era may be present.

Community Phase 6.1:

Introduced wheatgrass species and other non-native species such as dryland alfalfa dominate the community. Native and non-native seeded forbs may be present. Trace amounts of basin big sagebrush and/or rabbitbrush may be present, especially if seeded. Annual non-native species may be present.

Community Phase Pathway 6.1a:

Time without disturbance allows shrub species to reestablish. This may be coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.2:

Sagebrush and seeded wheatgrass species are codominant. Annual non-native species stable to increasing.

Community Phase Pathway 6.2a:

Low severity fire and/or brush management will reduce the sagebrush overstory and allow seeded wheatgrass species to become dominant.

Community Phase Pathway 6.2b:

Absence of fire over time coupled with grazing management that promotes a reduction in perennial bunchgrasses and facilitates shrub dominance.

Community Phase 6.3 (At Risk):

Sagebrush and/or antelope bitterbrush dominate. Rabbitbrush may be a significant component but still sub-dominant to sagebrush. Wheatgrass vigor and density reduced. Annual non-native

species stable to increasing. Juniper may be present. This community phase is at risk of crossing a threshold to another state. Site may transition to the Shrub State or Tree State without disturbance or treatment. If annual non-natives are present, the site could transition to the Annual State with fire.

Plot B04 JD Clayey 12- 16" Community Phase 6.3 (At Risk)

Community Phase Pathway 6.3a:
Fire eliminates/reduces the overstory of sagebrush and allows for the understory perennial grasses to increase. Fires will typically be low severity resulting in a mosaic pattern due to low fine fuel loads. A fire following an unusually wet spring or change in management favoring an increase in fine fuels, may be more severe and reduce the shrub component to trace amounts. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species respond well to fire and may increase post-burn.

Community Phase Pathway 6.3b:
Low severity fire leading to a mosaic pattern in the grass-shrub community. A change in grazing management that reduces shrubs will allow for the perennial bunchgrasses in the understory to increase. Heavy late-fall/winter grazing may cause mechanical damage and subsequent death to sagebrush, facilitating an increase in the herbaceous understory. Brush treatments with minimal soil disturbance will also decrease sagebrush and release the perennial understory. Annual non-native species are present and may increase in the community.

T6A: Transition from Seeded State 6.0 to Shrub State 3.0

Trigger: To Community Phase 3.1: Repeated, heavy, growing season grazing will decrease or eliminate deep rooted perennial bunchgrasses, increase Sandberg bluegrass and favor shrub growth and establishment. To Community Phase 3.2 from 6.3: Severe fire will remove sagebrush overstory, decrease perennial bunchgrasses and enhance Sandberg bluegrass.
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.

T6B: Transition from Seeded State 6.0 to Annual State 4.0

Trigger: To Community Phase 4.1: Catastrophic fire, likely from 6.3.
Slow variables: Increased production and cover 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. Increased, continuous fine fuels from annual non-native plants modify the fire regime by changing intensity, size and spatial variability of fires.

T6C: Transition from Seeded State 6.0 to Tree State 5.0

Trigger: Time and lack of disturbance or management action allows for western juniper to dominate. This may be coupled with grazing management that favors tree establishment by reducing understory herbaceous competition for site resources
Slow variables: Over time the abundance and size of trees will increase.
Threshold: Trees dominate ecological processes and number of shrub skeletons exceed number of live shrubs.

Eroded State 7.0:

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. A plow pan may be present in the near surface sub-soil that functions to truncate rooting depth of herbaceous plants and water percolation and storage. Western juniper dominates the overstory and herbaceous species may be present in trace amount particularly under tree canopies. Regeneration of trees or herbaceous species is not evident.

Community Phase 7.1:

From Tree State 5.2: Western juniper dominates the overstory and herbaceous species may be present in trace amount particularly under tree canopies. Dead sagebrush skeletons are prominent. Regeneration of trees or herbaceous species is not evident. Annual non-native species present primarily under tree canopies. Bare ground interspaces are large, connected and characterized by evidence of soil movement. Redistribution of soil from interspaces to tree canopy areas is evident.

Plot B14 JD Clayey South 12-16" Community Phase 7.1

Community Phase 7.2:
From Shrub State 3.2: Basin big sagebrush or rabbitbrush dominate overstory or Sandberg bluegrass is dominant without shrubs. Seeded, deep-rooted bunchgrasses are trace component. Rill erosion is evident and top soil redistribution and accumulation along fence lines and other obstructions may be present. Plow pan in the near surface subsoil is present. Herbaceous species rooting depths are restricted.

Farmed State 8.0:
This state is a historical state representing the active farming of this site in the late 1800s and early 1900s. The site would be dominated by cereal grains and would require annual harvests and plantings to be maintained. It is known that many acres of sagebrush rangeland was homesteaded and converted into dryland farmland during the late 1800s. While these practices have ceased in the rangelands discussed in this report, the effects on the landscape are still visible today (Morris 2012). The Farmed State is included in this model to help visualize the changes in the Reference plant community initiated during the farming era. In some cases, where farming practices were not employed, the transition from the Reference plant community (T1A) may have been a slow transition caused by multiple direct and indirect effects, but in the case of T1B, the transition occurred because of a drastic change in land use. Both transitions have been documented on the Grasslands and can be visited at coordinates 44.466073°, -121.024251° within the Grizzly Allotment (See Appendix D). The area offers an example of unfarmed Juniper Shrubby Loam 10-12" R010XA018OR alongside a farmed field that was converted to a crested wheatgrass seeding in the 1950s. Fence line contrast.

Community Phase 8.1 (At Risk):
Site is actively maintained with annual plowing and planting of dryland crops such as annual cereal grains.

T8A: Transition from Farmed State 8.0 to Shrub State 3.0

Trigger: Field abandonment (Daubenmire 1975, Rickard and Sauer 1982).
Slow variables: Annual cereal grains or other crops die off. Early seral species (annual grasses and forbs) establish first, but rabbitbrush will become the dominant species over time.
Threshold: Cessation of plowing allows other native and nonnative plant species to establish. Loss of native deep-rooted perennial bunchgrasses and shrubs truncates, spatially and temporally, nutrient capture and cycling within the community

R8A: Restoration pathway from Farmed State 8.0 to Seeded State 6.0

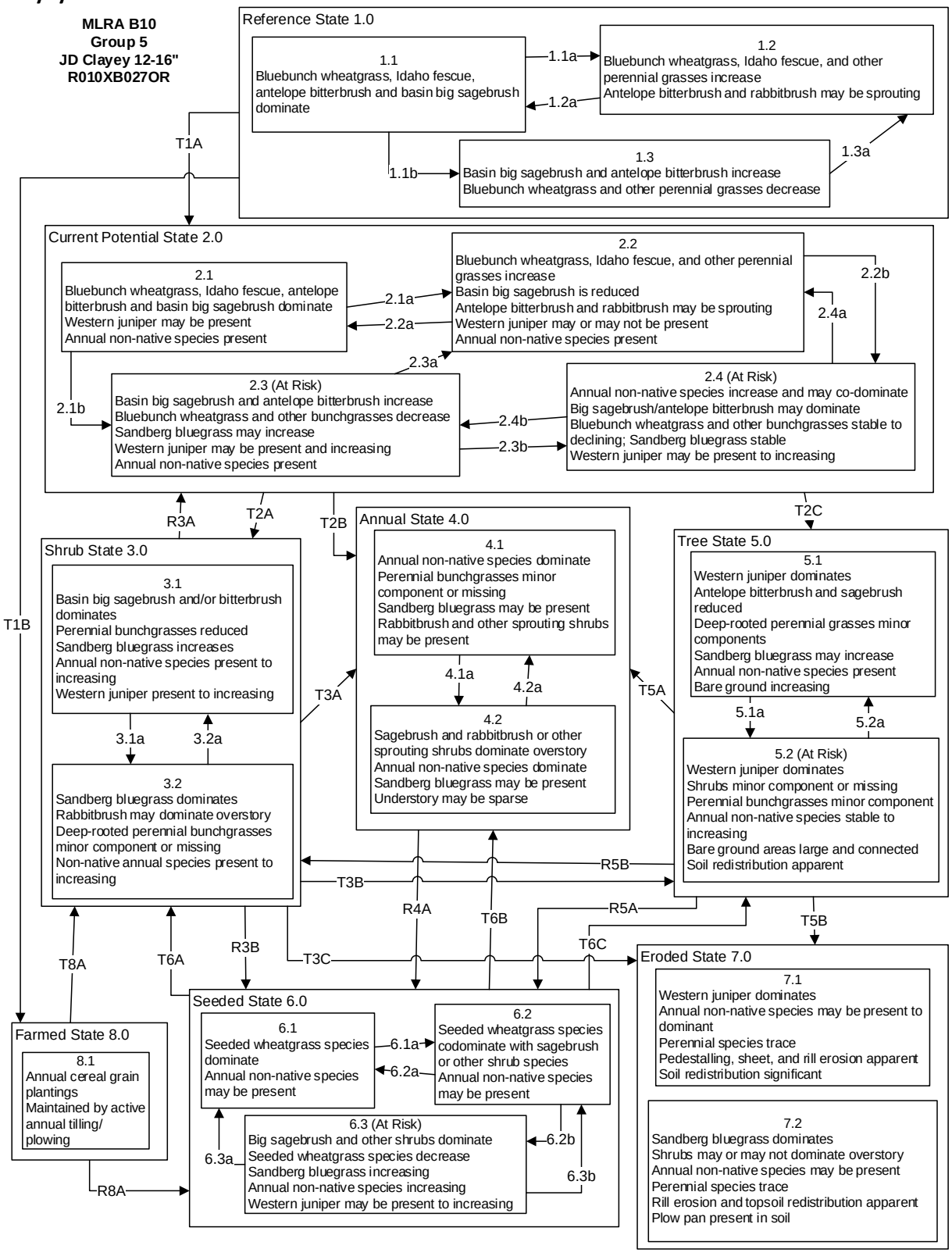
Active farming ceases. Site is drill seeded with crested wheatgrass or other wheatgrass species. Seeded States originating from Farmed States may have compromised soil properties such as plow pans, loss of A horizon etc. that decreases the resiliency of the established seeding to grazing, drought and other disturbances. The case study documented in photographs below (See Appendix D) demonstrates the loss of the seeded deep-rooted bunchgrass, crested wheatgrass, likely a result of chronic spring grazing and a significant plow pan preventing deep root development and water infiltration. Understanding the history of use helps improve our understanding of the triggers and multiple causes of ecological thresholds.

Potential Resilience Differences with other Ecological Sites

JD Clayey South 12-16" (R010BX045OR):
This site occurs on south exposures of terraces, tablelands, and upper canyons. Slopes range from 12 to 70 percent. Elevation varies from 2100 to 4000 feet. The annual precipitation ranges from 12 to 16 inches, most of which occurs in the form of snow during the months of November through March. Localized, occasionally severe convection storms occur during the summer. The soil temperature regime is mesic with a mean annual air temperature of 50 degrees F. The soils of this site are typically moderately deep to very deep and well drained. The surface layer is a cobbly clay loam about 8 inches thick. The subsoil is a cobbly clay loam about 25 inches thick. Depth to bedrock is 30 to 60 inches. The potential native plant community is dominated by bluebunch wheatgrass and **does not have Idaho fescue**. Sandberg bluegrass, antelope bitterbrush and basin big sagebrush are also common throughout the site. Bitterbrush may have higher cover than sagebrush. **This site has the same model as the modal site but with different subdominant grasses and with more antelope bitterbrush. It has Western juniper in the reference state.**

JD North 12-16" (R010BX070OR):
This site occurs on north exposures of terraces, tablelands, and rolling uplands. It is typically on slopes with northerly aspects. Slopes range from 12 to 70 percent. Elevations range from 2100 to 4000 feet. The annual precipitation ranges from 12 to 16 inches, most of which occurs in the form of snow during the months of November through March. Localized, occasionally severe convection storms occur during the summer. The soil temperature regime is mesic. The soils of this site are typically moderately deep to deep and well-drained. Typically the surface layer is clay loam or silty clay loam about 8 inches thick. The subsoil is a cobbly clay loam about 25 inches thick. Depth to bedrock or sediments is 30 to 60 inches. Permeability is moderate. The available water holding capacity is about 4 to 6 inches for the profile. The potential for erosion is moderate to severe. The dominant grass on this site is **Idaho fescue**, with bluebunch wheatgrass subdominant. Basin big sagebrush is the dominant shrub. **Western juniper is not written in the site concept for this ecological site. This site has the same model as the modal site but without Western Juniper in the reference state.**

JD Clayey 12-16” Modal Model



MLRA B10
Group 5
JD Clayey 12-16"
R010XB027OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and/or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance.

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with inappropriate grazing management.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with inappropriate grazing management.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

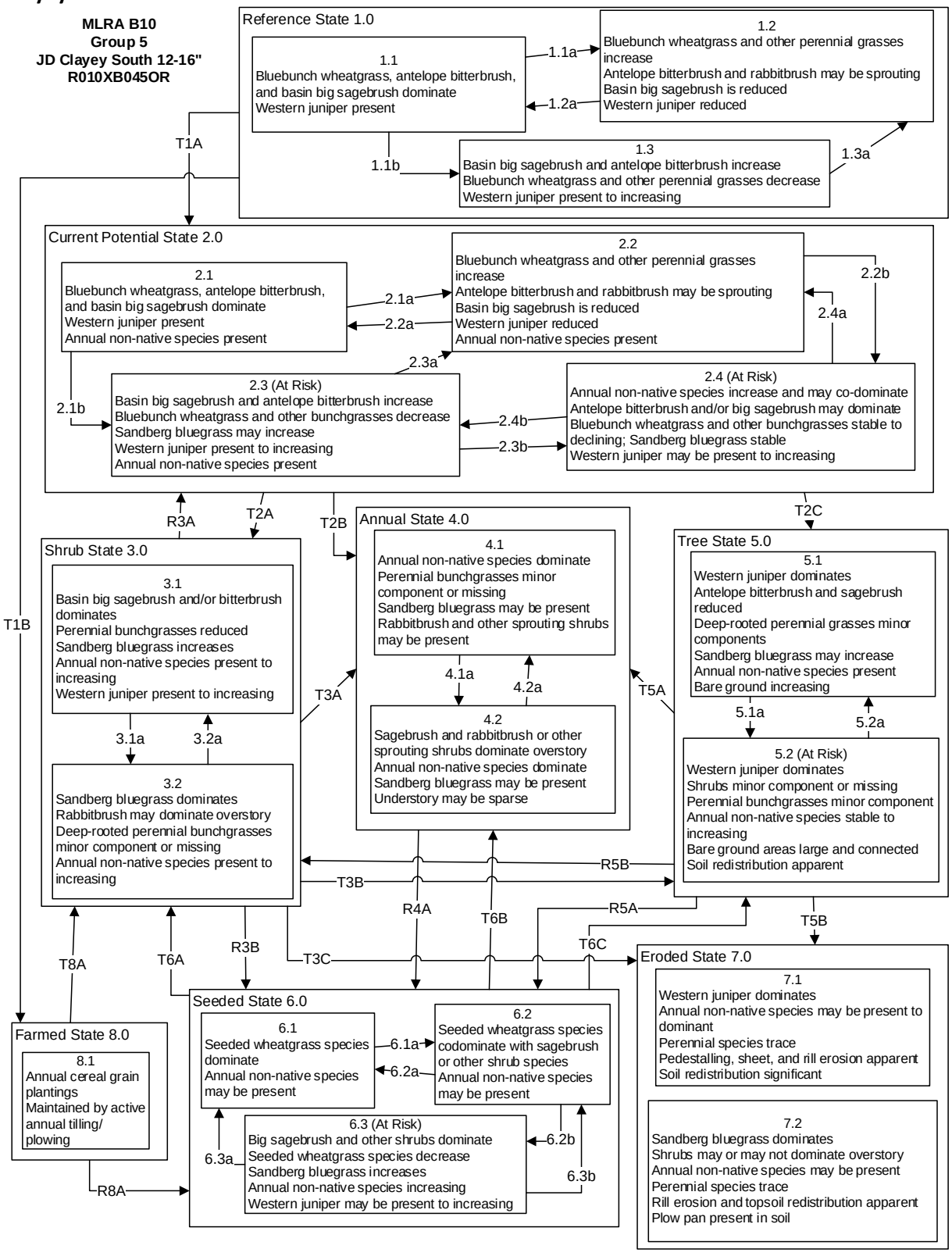
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

JD Clayey South 12-16”



MLRA B10
Group 5
JD Clayey South 12-16"
R010XB045OR

Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and/or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance.

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with inappropriate grazing management.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with inappropriate grazing management.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

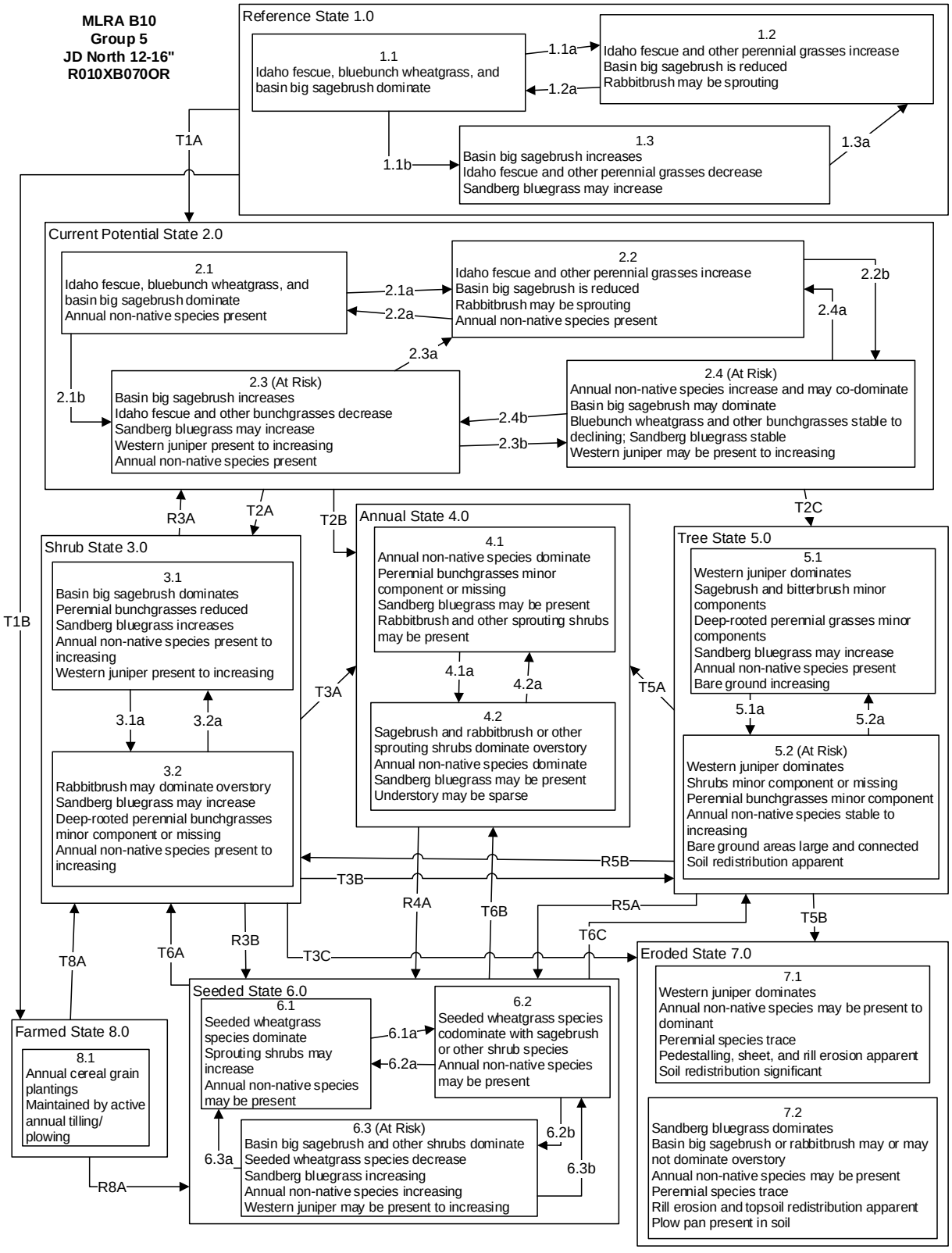
Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

JD North 12-16”



MLRA B10
Group 5
JD North 12-16"
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Reference State 1.0 Community Phase Pathways:
1.1a: Low severity fire resulting in a mosaic pattern; high severity fire leads to early/mid-seral community dominated by grasses and forbs, lacking sagebrush.
1.1b: Time and lack of disturbance such as fire facilitates an increase in the shrub overstory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
1.3a: Low severity fire resulting in a mosaic pattern; high severity fire significantly reduces brush cover and leads to community dominated by grasses and forbs.

Transition T1A: Introduction of non-native plants.
Transition T1B: Inversion tillage / plowing and harrowing of soil to plant annual crops such as cereal grains.

Current Potential State 2.0 Community Phase Pathways:
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic inappropriate grazing and/or reduction in the fire interval reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression western juniper trees may increase.
Transition T2B: Catastrophic fire and/or soil disturbing treatments (plowing, drill seeding, etc.) (to 4.1). Inappropriate grazing management in the presence of non-native annual species or competitive increase in medusahead through lack of active management (to 4.2). With fire suppression juniper may increase.
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Shrub State 3.0 Community Phase Pathways:
3.1a: Fire or brush treatments with minimal soil disturbance.
3.2a: Time and lack of disturbance allows for sagebrush and/or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/or failed rehabilitation treatment or combination (to 4.1). Inappropriate grazing management in the presence of annual non-native grasses or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).
Transition T3C: Inappropriate grazing management coupled with damaged dynamic soil properties from historic farming (plow pan, A horizon thickness) reduces herbaceous cover; bare ground increases, flow paths become long and connected (to 7.2).

Restoration R3A: Shrub management and seeding of native species coupled with minimal soil disturbance. Herbicide may be necessary (to 2.1 or 2.2).
Restoration R3B: Shrub management and seeding of desired species coupled with minimal soil disturbance. Herbicide may be necessary (to 6.1).

Annual State 4.0 Community Phase Pathways:
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs increase. Western juniper may be present.
4.2a: Fire.

Restoration R4A: Herbicide of annual species and seeding of desired species (to 6.1).

Tree State 5.0 Community Phase Pathways:
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt (to 4.1).
Transition T5B: Time without disturbance allows for trees to outcompete understory; Bare ground allows for excess soil movement.

Restoration R5A: Tree removal and seeding of desired species; herbicide may be necessary (from 5.1 to 6.1).
Restoration R5B: Tree removal with minimal soil disturbance.

Seeded State 6.0 Community Phase Pathways:
6.1a: Time and lack of disturbance allows for shrubs to reestablish, may be coupled with inappropriate grazing management.
6.2a: Fire and/or other shrub management practices.
6.2b: Time and lack of disturbance allows for maturation of shrub community, may be coupled with inappropriate grazing management.
6.3a: Fire and/or other shrub management practices.
6.3b: Fire and/or other shrub management with minimal soil disturbance would reduce the shrub community.

Transition T6A: Chronic, heavy growing season grazing will decrease bunchgrasses, increase Sandberg bluegrass and shrubs (to 3.1).
Severe fire, likely from 6.3 (to 3.2).
Transition T6B: Catastrophic fire, likely from 6.3 (to 4.1). Inappropriate grazing facilitates decrease in bunchgrasses and increase in non-native annual grasses, likely from 6.3 (to 4.2).
Transition T6C: Time without disturbance allows for maturation of tree community, likely from 6.3 (to 5.1).

Eroded State 7.0 Community Phase Pathways: None

Farmed State 8.0 Community Phase Pathways: None

Transition T8A: Time without tillage allows native shrubs to reestablish (likely to 3.2).

Restoration R8A: Seeding of desired species such as crested wheatgrass (to 6.1).

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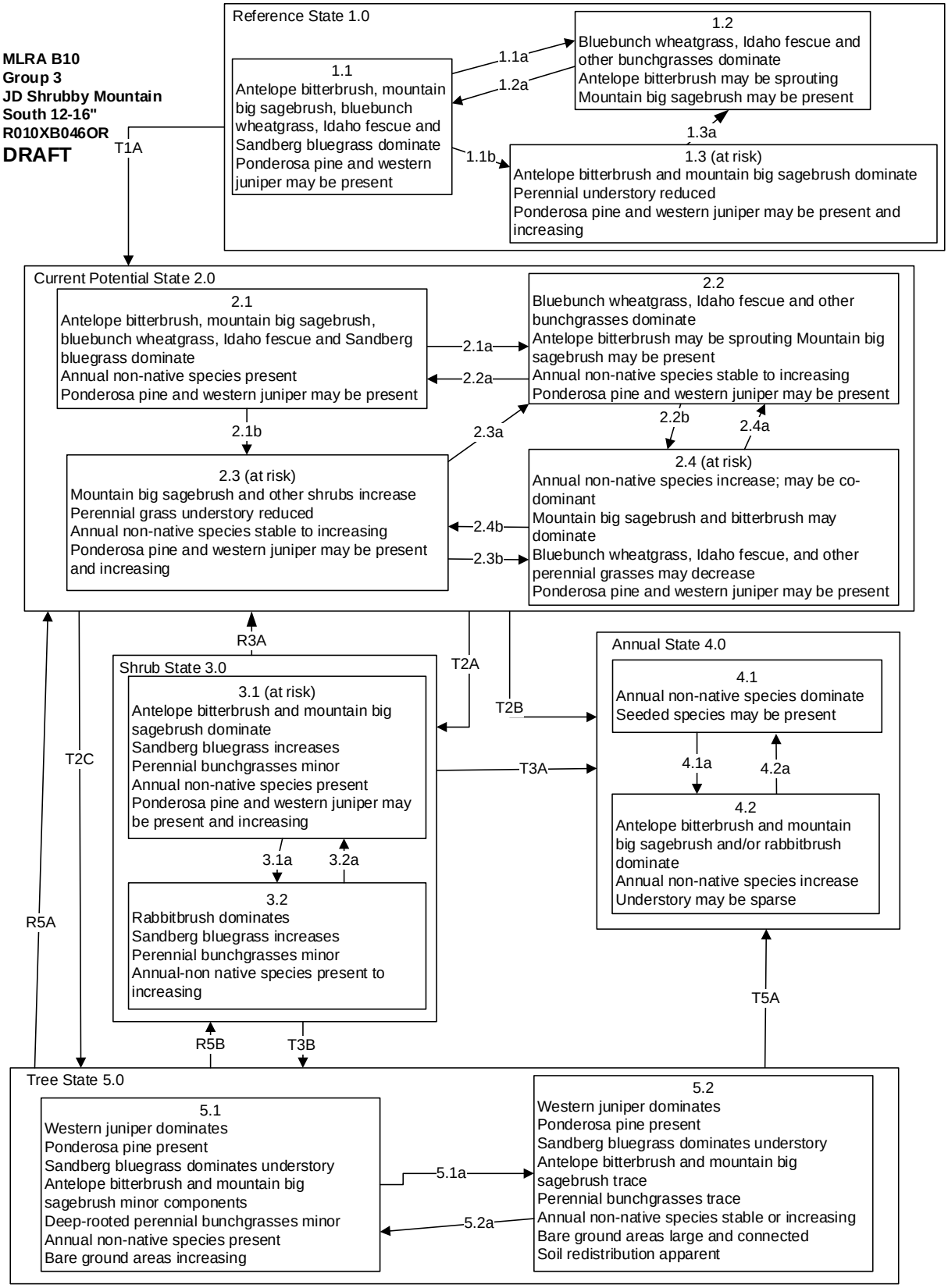
Appendices

Appendices Contents

Appendix A: Models for Group 3 and 6

These models are considered “tier 1” draft models. They will require field verification and significant edits before they can be considered final models.


MLRA B10
Group 3
JD Shrubby Mountain
South 12-16"
R010XB046OR
DRAFT
Reference State 1.0
1.1
Antelope bitterbrush, mountain big sagebrush, bluebunch wheatgrass, Idaho fescue and Sandberg bluegrass dominate
Ponderosa pine and western juniper may be present
1.2
Bluebunch wheatgrass, Idaho fescue and other bunchgrasses dominate
Antelope bitterbrush may be sprouting
Mountain big sagebrush may be present
1.3 (at risk)
Antelope bitterbrush and mountain big sagebrush dominate
Perennial understory reduced
Ponderosa pine and western juniper may be present and increasing
1.1a
1.2a
1.1b
1.3a
T1A
Current Potential State 2.0
2.1
Antelope bitterbrush, mountain big sagebrush, bluebunch wheatgrass, Idaho fescue and Sandberg bluegrass dominate
Annual non-native species present
Ponderosa pine and western juniper may be present
2.2
Bluebunch wheatgrass, Idaho fescue and other bunchgrasses dominate
Antelope bitterbrush may be sprouting Mountain big sagebrush may be present
Annual non-native species stable to increasing
Ponderosa pine and western juniper may be present
2.3 (at risk)
Mountain big sagebrush and other shrubs increase
Perennial grass understory reduced
Annual non-native species stable to increasing
Ponderosa pine and western juniper may be present and increasing
2.4 (at risk)
Annual non-native species increase; may be co-dominant
Mountain big sagebrush and bitterbrush may dominate
Bluebunch wheatgrass, Idaho fescue, and other perennial grasses may decrease
Ponderosa pine and western juniper may be present
2.1a
2.2a
2.1b
2.3a
2.2b
2.4a
2.4b
2.3b
R3A
T2A
T2B
T2C
T3A
R5A
Shrub State 3.0
3.1 (at risk)
Antelope bitterbrush and mountain big sagebrush dominate
Sandberg bluegrass increases
Perennial bunchgrasses minor
Annual non-native species present
Ponderosa pine and western juniper may be present and increasing
3.2
Rabbitbrush dominates
Sandberg bluegrass increases
Perennial bunchgrasses minor
Annual-non native species present to increasing
3.1a
3.2a
Annual State 4.0
4.1
Annual non-native species dominate
Seeded species may be present
4.2
Antelope bitterbrush and mountain big sagebrush and/or rabbitbrush dominate
Annual non-native species increase
Understory may be sparse
4.1a
4.2a
T5A
R5B
T3B
Tree State 5.0
5.1
Western juniper dominates
Ponderosa pine present
Sandberg bluegrass dominates understory
Antelope bitterbrush and mountain big sagebrush minor components
Deep-rooted perennial bunchgrasses minor
Annual non-native species present
Bare ground areas increasing
5.2
Western juniper dominates
Ponderosa pine present
Sandberg bluegrass dominates understory
Antelope bitterbrush and mountain big sagebrush trace
Perennial bunchgrasses trace
Annual non-native species stable or increasing
Bare ground areas large and connected
Soil redistribution apparent
5.1a
5.2a

MLRA B10
Group 3
JD Shrubby Mountain
South 12-16"
R010XB046OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire (ground fire) resulting in a mosaic pattern
1.1b: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.2a: Time and lack of disturbance such as fire. Drought, herbivory or combinations would also reduce the perennial understory.
1.3a: Low severity fire resulting in a mosaic pattern.

Transition T1A: Introduction of non-native plants.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory allowing the perennial understory to increase; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to community dominated by grasses and forbs.
2.1b: Time and lack of disturbance such as fire leads to increased shrub and or juniper overstory and decreased perennial grass understory; may be coupled with drought and / or inappropriate grazing management.
2.2a: Time and lack of disturbance such as fire allows for regeneration of the shrub community.
2.2b: Rainfall pattern favoring annual species production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.3a: Low severity fire resulting in a mosaic pattern, brush treatments/tree thinning would also reduce the overstory; high severity fire significantly reduces sagebrush and bitterbrush cover and leads to early/mid-seral community dominated by grasses and forbs.
2.3b: Rainfall pattern favoring annual non-native grass production (higher than normal spring precipitation); tree/shrub removal or prescribed /wildland fire coupled with higher than normal spring precipitation.
2.4a and 2.4b: Rainfall pattern favoring perennial bunchgrass production and reduced non-native annual grass production (less than normal spring with higher than normal early summer).

Transition T2A: Chronic, inappropriate grazing management reduces perennial grasses and allows for an increase in shrub/tree species (to 3.1). Fire or brush treatment/tree thinning; may be coupled with inappropriate grazing management (to 3.2). With fire suppression, western juniper trees will increase.
Transition T2B: Catastrophic fire, failed rehabilitation attempt or combination (to 4.1), inappropriate grazing management in the presence of non-native annuals or competitive increase in medusahead through lack of active management (to 4.2).
Transition T2C: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (5.1).

Shrub State 3.0 Community Phase Pathways
3.1a: Fire (ground fire) or brush/tree removal treatments.
3.2a: Time and lack of disturbance allows for sagebrush and / or bitterbrush to recover. Western juniper may increase.

Transition T3A: Catastrophic fire and/ or failed rehabilitation treatment or combination of both (to 4.1).Inappropriate grazing management in the presence of annual non-native species and / or competitive increase in medusahead through lack of active management (to 4.2).
Transition T3B: Time and lack of disturbance allows for maturation of the tree community. May be combined with inappropriate grazing management (to 5.1).

Restoration R3A: Shrub and tree reduction treatments and seeding of desired native species (6.1).

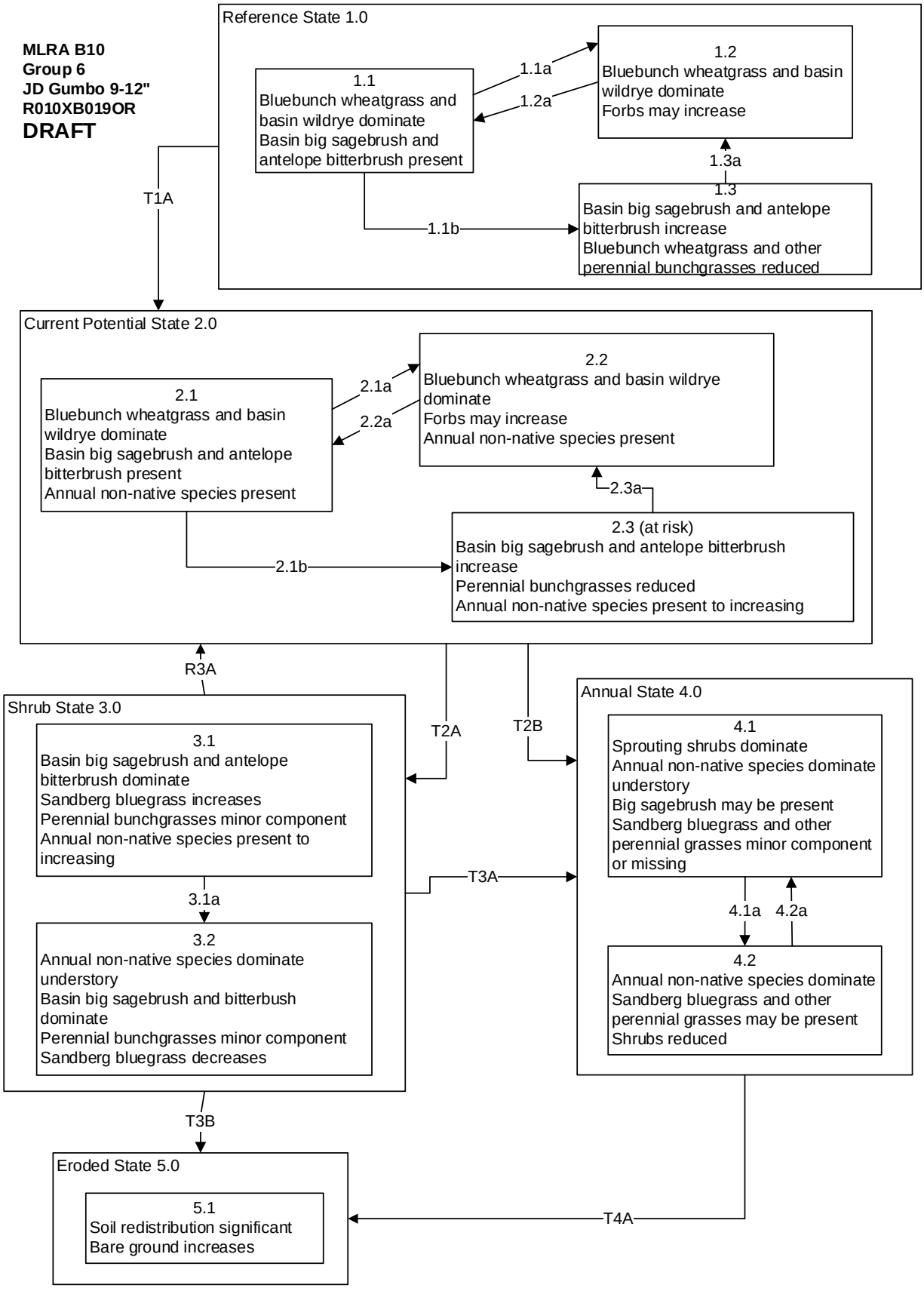
Annual State 4.0 Community Phase Pathways
4.1a: Time and lack of disturbance allows for sagebrush, bitterbrush or sprouting shrubs to increase. Western juniper may increase.
4.2a: Fire.

Tree State 5.0 Community Phase Pathways
5.1a: Time and lack of disturbance allows for maturation of tree community.
5.2a: Tree stand thinning treatments for fuels management or other resource values.

Transition T5A: Catastrophic fire, multiple fires, failed rehabilitation attempt or inappropriate tree removal treatment (to 4.1).

Restoration R5A: Juniper stand thinning or removal with seeding of desired native species.
Restoration R5B: Juniper stand removal and seeding of desired cultivated species: herbicide may be necessary (from 5.1 to 3.1).

MLRA B10
Group 6
JD Gumbo 9-12"
R010XB019OR
DRAFT



MLRA B10
Group 6
JD Gumbo 9-12"
R010XB019OR

Reference State 1.0 Community Phase Pathways
1.1a: Low severity fire Aroga moth infestation creates sagebrush/grass 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 disturbance such as fire or drought. Excessive herbivory may also decrease perennial understory.
1.2a: Time and lack of disturbance such as fire allows for regeneration of sagebrush.
1.3a: Low severity fire or Aroga moth infestation creates sagebrush/grass mosaic.

Transition T1A: Introduction of non-native annual species.

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

Transition T2A: Time and lack of disturbance and/or inappropriate grazing management (3.1).
Transition T2B: Catastrophic fire, multiple fires and/or soil disturbing treatments (4.1), inappropriate grazing management in the presence of annual non-native species (4.2).

Shrub State 3.0 Community Phase Pathways
3.1a: Inappropriate grazing management may be combined with heavy spring precipitation.

Transition T3A: Catastrophic fire and/or soil disturbing treatments (4.1). Inappropriate grazing management in the presence of annual non-native species (4.2).
Transition T3B: Catastrophic fire and/or soil disturbing treatments. Long term inappropriate grazing management (5.1)

Restoration R3A: Shrub removal/management with minimal soil disturbance coupled with seeding of desired species (2.1 or 2.2).

Annual State 4.0 Community Phase Pathways
4.1a: Fire.
4.2a: Time and lack of disturbance (unlikely to occur).

Transition T4A: Drought, fire, inappropriate grazing management or combinations will reduce the cover of annual non-native species and increase bare ground and the potential for erosion.

Eroded State 5.0 Community Phase Pathways
None.

Appendix B: Site Correlations

Spreadsheet of site correllations

Crooked River National Grasslands 2015 Site Visits: soil-site correllations and notes

PLOT ID	SOIL FAM CLASS @ PLOT	DEPTH-in	Final plot ESD_ID	GRP*	Post-Field trip State/Phase	Comments - J David	State Determinations by T. Stringham from 2015 data
A01	Vitritorrandic ArgixerollS; c-sk, smec, mesic	30	10XB064OR	5	2.2	Question appropriateness of placing this ES (64 and 70) in group 5. These north slopes do not respond to disturbance in the same way as other ES in this group. They are far less prone to go to annuals. Maybe need to split group 5 based on north slopes. Dry, moderately deep, loam over clay, North facing 50% hill slope. Veg matches. Burned 2004ish. Shrubs limited primarily TECA2 and CHVI. Deep perennial grasses dense and vigorous.	State 2.2
A01	NO DOC (NOT PRESENT)			5			
A07	Aridic Argixerolls; lo/lo-sk, mxd,sa,mesic,vsh	8	10XB023OR	4	2.3	Dry, shallow, loam over clay. (hard to find, no description available for JD Shallow 9-12). However what we need for this site is a JD Clayey 9-12 (10XB022) but shallow. It is assumed that the listed but not described 10XB023 JD Shallow 9-12 would provide this. Adequate deep rooted perennial grasses (DRPG) to place in 2.0, however recent juniper and shrub cover has decreased DRPG density resulting in at risk phase.	State CP at risk to Tree State (2.3)
A08	Aridic Haploxerolls; lo, mxd,sa,mesic,sh	15	10XA018OR	4	3.1	Gently sloping upland, dry, almost moderately deep (17 inches was probably 20 inches + pre 20s drought) loam over loam. High shrub density, PUTR/ARTR codominant. Juniper and annual grasses (AG) increasing.	Tree/Pose State 5.1 Phase II
A15	Aridic Argixerolls; c-sk, mxd,sa,mesic,sh	19	10XB022OR	4	5.2	Dry, almost moderately deep (19 inches but significant signs of active erosion, widespread rilling) loam over clay, western aspect upland hill slope. Remnant PUTR onsite (not consistent with 10XB022 but only ES which matches soils). Debated on whether to place in eroded state. Juniper canopy closure has almost eliminated shrubs and DRPGs. Invasive annuals limited. POSE dominates understory.	Tree State 5.1 Data indicates 27% foliar cover DRPG; Notes indicate excessive bare ground
A16	Vitritorrandic Haploxerolls;co-lo,,mxd,sa,m	42+	10XA083OR	2B	2.3	Dry, deep, loam over loam north slope. Although adequate DRPGs to stay in 2.0, western juniper increase is reducing DRPG and shrubs, placing the site in the at risk phase.	State 2.3 at risk of Tree State
A37	Vitritorrandic Haploxerolls;co-lo,,mxd,sa,m	54	10XA083OR	2B	2.3	Dry, deep, loam over loam north slope. Although adequate DRPGs to stay in 2.0, wester juniper increase is reducing DRPG and shrubs, placing the site in the at risk phase.	State 2.1 transitioning to 2.3
A37	NO DOC (NOT PRESENT)						
A43	Aridic Argixerolls; fi-lo,mxd,sa,mesic	25	10XA018OR	4	2.1	Dry, moderately deep, loam over loam relatively flat plateau. Balance of sage/perennials and old juniper	Current potential State 2.1
A44	Aridic Lithic Argixerolls; c-sk,smec,sa,mesic	18	08XY140OR		Put in DRG 4 *TKS*	Trouble placing this to ESD. Trying to find a scab (skeletal shallow loam) therefore what group do we place this in. NO STM for MLRA 08X	Put in DRG 4: State 2.3 at risk of Tree State or Annual State with fire
A45	Aridic Lithic Argixerolls; loamy,mxd,mesic	16	10XA018OR	4	2.2	Assume narrative on ESD correct, numbers on depth mislabeled. Is shallow. Perennial grasses adequate (mostly Thurber's) to place in 2.0. Increased annuals.	CP 2.4 at risk to Annual State 4.1
B02	Abruptic Argiduridic Durixerolls; fine, smec, mesic	35	10XB022OR	4	3.2	Dry, moderately deep, loam over clay gently sloping upland. Seeded species minimal remnant. Post seeding (hist) and fire over 500 rabbit brush plants in belt.	State 3.2 Shrub/pose
B04	Palexerollic Durixerolls; c-sk. smec, sa, mesic	25	10XB027OR	5	6.3	Higher elevation (12-16) moderately deep, loam over clay, gently sloping upland. AGCR present but declining. Shrubs ARTR, PUTR, CHNA nearly co dominant. Juniper increasing. BRTE and TACA8 increasing.	State 3.1 at risk to Annual State
B05	Haplic Durixerolls; c-sk, smec, mesic	21	10XB022OR	4	6.1	Gently sloping upland, dry (Lower precip than XB027) loam over clay. Old farm field seeded to sheep fescue and bluebunch wheatgrass, which vigorously persist. Recently burned, rabbit brush dominant shrub. Annual grasses present but background.	State 6.1 dominated by Sheep fescue. Not preferred by cattle or horses.
B06	Aridic Lithic Argixerolls; clayey, smec, sa, mesic	18	10XB022OR	4	5.2	Gently sloping dry moderately deep upland, loam over clay. This is an old field that was seeded. Eroded seeding of crested wheatgrass and dryland alfalfa. Was a 6.0 (seeded that has transitioned to tree 5.0). Currently cover of dog hair juniper is resulting in almost complete loss of shrubs and DRPG.	Tree State 5.2
B14A	Vitritorrandic Argixerolls; fine, smec, mesic	>34	10XB045OR	5	Eroded	Two pits were dug on this site. One within the eroded (general) area and one under a juniper canopy where soil has been retained or accumulated. The ash cap in the "retained" area is 5 to 7 inches deeper than in the eroded area. Active erosion is occurring on the site with no/little indication of livestock use, but heavy use by elk (directly across the fence from a private alfalfa field. This is a dry, moderately deep southwestern slope, loam over clay. POSE dominates the understory. Juniper cover has increased to the point very few shrub and DRPG occur on the site. Although the transect only displays a background level of AGs, large patches of medusahead occupy the area a stones throw down slope from this site.	Eroded State from previous farm field. 7.1
B14B	Calcic Argixerolls; c-sk, smec, mesic	38	10XB045OR	5	Eroded		Eroded State from previous farm field 7.1

B29	Abruptic Argiduridic Durixerolls; fine, smec, mesic	22	**10XB022OR**	**4**	**3.1**	Loam over clay, 9-12 precip. Moderately deep, gently sloping upland. Juniper thinning has occurred on the site very recently. Limited deep root perennial grasses. ARTR dominate w/ POSE understory.	**State 3.1**
B32	Vitrandic Argixerolls; c-sk, smec, mesic	22	**10XB027OR**	**5**	**2.2**	Moderately deep, loam over clay, gently sloping, higher elevation (12-16). Old field, seeded species persisting well. Good stand of DRPG (seeded). Rx fire prior to 2001. More rabbitbrush than ARTR. Juniper seedlings starting to show up.	**State 2.2 at risk to Pose State. Fire removed sage.**
B35	Lithic Argixerolls; c-sk, smec., mesic	15	**10XB047OR**	**5**	**2.2**	Higher elevation (12-16) shallow, loam over clay, on relatively steep (25%) southeast facing slope. Top end of a 20-25 year old wildfire. Shrubs minimal, basically good stand of PSSPS and ACTH, with solid presence of BRTE.	**State 2.4 at risk to Annual**
B36	Vitritorrandic Haploxerolls;co-lo,,mxd,sa,m	60+	**10XA083OR**	**2B**	**3.1**	Deep to very deep ashy loam on slight north slope (5%). Dry. DRPG present but limited. BRTE constant throughout CHVI/ARTR codominant with PUTR present. Small juniper increasing.	**2.3 at risk of Annual State. 10% bunchgrass cover; 11% sagebrush; 19% cheatgrass.**
B38	Aridic Argixerolls; fi-lo,mxd,sa,mesic	22	**10XB022OR**	**4**	**7.1**	Dry, moderately deep, flat, loam over clay. Old field was seeded to AGCR. Thurber's present persistent, wind erosion active (dunelettes), driving perennial species present. However, wind erosion appears to be driving species composition only allowing ACTH to establish. Remnant or anthropogenic soil present in adjacent rock corral associated with homestead.	**Data: 9% sagebrush; 19% Pose; 7% ACTH; 2% Juoc so either Shrub/pose or Eroded State. If Eroded State need to have one driven by farming legacy and one from tree invasion.**
B45	Aridic Argixerolls; fi-lo,mxd,sa,mesic	28	**10XA018OR**	**4**	**2.2**	Dry, moderately deep, flat, loam. Recent (2012ish) wildfire although of low intensity/severity. Only 1 juniper in belt. PUTR and rabbit brush co dominant, ARTR present. Thurber's and Squirrel tail adequate DRPG to place in 2.0.	**CP 2.4 at risk to Annual State 4.1**
B48	Argiduridic Durixerolls; c-sk,mxd, mesic, vsh	10	**10XB023OR**	**5**	**2.2**	Dry, shallow, loam over clay. (hard to find, no description available for JD Shallow 9-12). However what we need for this site is a JD Clayey 9-12 (10XB022) but shallow. It is assumed that the listed but not described 10XB023 JD Shallow 9-12 would provide this. This was difficult to place into state as it seems balanced between 2.0 and 4.0. We believe the limited DRPG will increase and AGs decrease over time, however, drought or another fire would tip the balance the other direction.	**State 4.1 Annual State**
B52	Argiduridic Durixerolls; c,mxd, mesic, shallow	17	**10XB022OR**	**4**	**6.3**	Dry, almost moderately deep (Concern about soil depth at 17), nearly flat, loam over clay. In the 9-12 precip. Seeded species present but declining with Art dominant. Rx fire evident but prior to 2001. AG s solid presence.	**Pose is dominate with ARTRT. State 3.1.**
C01	Argiduridic Durixerolls; lo,mxd, mesic, shallow	12	**10XB023OR**	**4**	**6.3**	Dry, shallow, loam over clay. (hard to find, no description available for JD Shallow 9-12). However what we need for this site is a JD Clayey 9-12 (10XB022) but shallow. It is assumed that the listed but not described 10XB023 JD Shallow 9-12 would provide this.	**Pose is dominate with ARTRT. State 3.1.**
C34	Abruptic Argiduridic Durixerolls; fi,smec,m	20	**10XB022OR**	**4**	**Plowed**	Dry, moderately deep, gently sloping loam over clay. Was farmed seeded. AGCR grazed out or didn't establish. Shrubs dominate. Since plowed state is coming we didn't place. We would have placed in 3.0 otherwise. Visited during our field trip.	**Annual State 4.1**
C37	Aridic Argixerolls; fi-lo,mxd,sa,mesic	21	**10XB022OR**	**4**	**6.3**	Dry, moderately deep, nearly flat, loam over clay. Old farm field was seeded. Seeded species present but limited. ACTH present as dominant DRPG although shrub cover influencing. ARTR dominant but rabbit brushs significant density. AG s present may be increasing.	**CP 2.4 at risk to Annual State 4.1**
C38	Aridic Lithic Argixerolls; lo-sk,smec,sa,mesic	14	**08XY140OR**	**2A**		Trouble placing this to ESD. Trying to find a scab (dry skeletal shallow loam) therefore what group do we place this in. NO STM	**State 5.1 or 5.2 depending on amount of bareground. Goes in the Loamy 8-10 group**
GR4-1	Abruptic Argiduridic Durixerolls; fi,smec,m	20	**10XB022OR**	**4**	**4.2**	Dry, moderately deep, nearly flat, loam over clay. Old farm field. Shrubs minimal to none. Annuals dominate	**Annual State 4.2 TACA**
GR5-1	Abruptic Argiduridic Durixerolls; fi,smec,m	26	**10XB027OR**	**5**	**5.2**	Higher elevation (12-16), deep, loam over clay, 10% west facing slope. Juniper over predominantly annuals. Almost all shrubs and DRPG missing.	**Tree State 5.2 / Annual understory**
GR5-2	Abruptic Argiduridic Durixerolls; fi,smec,m	21	**10XB027OR**	**5**	**3.1**	This may be 10XB023OR it is questionable whether this is high enough elevation to place into 10XB027OR (moving from 9-12 to 12-16). West facing moderately deep, loam over clay. Old field, seeded to AGCR which is present but very limited. Annuals, particularly TACA8 dominate the understory.	**State 4.2 Annual State TACA8**
Highlighted yellow if the T. Stringham state call differs from the CRNG crew state call							
	10XB023OR no longer exists. These sites need to be re-corellated to another ecological site.						

Appendix C: Data summaries by plot (2015 data)

DRG 4 Sites Visited in 2015: Plot Summaries

A07

10XB064OR, State 2.3 at risk of transitioning to tree state. Total understory annual production in 2015 was 559.077 lb/ac. There were 50.59 trees/ac.

Annual Production	A07	
Species Code	lb/ac	% of Total
PUTR2	239.23	43%
ARTRT	77.26	14%
KOMA	5.50	1%
POSE	30.72	5%
ELEL5	18.66	3%
PSSP6	30.09	5%
ACTH7	39.30	7%
FEID	29.93	5%
BRTE	37.18	7%
VUOC	1.00	0%
ALDE	1.00	0%
LAGL	1.00	0%
DESO	1.00	0%
DRVE	37.80	7%
PLMA	1.00	0%
EPBR	1.00	0%
TRDU	1.00	0%
ERFI	1.00	0%
LOMAT	3.40	1%
ALLIUM	1.00	0%
LOTR	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A07**	**ACTH7 (Foliar)**	**2.00%**
		ALDE (Foliar)	**2.00%**
		ARTRT (Foliar)	**4.00%**
		ASFI (Foliar)	**1.00%**
		BRTE (Foliar)	**4.00%**
		DRVE2 (Foliar)	**7.00%**
		FEID (Foliar)	**3.00%**
		JUOC (Foliar)	**11.00%**
		POSE (Foliar)	**11.00%**
		PSSP6 (Foliar)	**7.00%**
		PUTR2 (Foliar)	**7.00%**
		VUOC (Foliar)	**1.00%**
		ZIVE (Foliar)	**1.00%**

A08

10XA018OR, State 5.1. Total understory annual production in 2015 was 131.88 lb/ac. There were 77.56 trees/ac.

Annual Production	A08	
Species Code	lb/ac	% of Total
PUTR	1.20	1%
ERNA10	39.00	30%
CHVI	0.99	1%
ARTRT	1.62	1%
TACA8	1.00	1%
BRTE	19.23	15%
VUOC	1.00	1%
POSE	48.91	37%
AGCR	1.00	1%
POBU	7.03	5%
ACMI	5.50	4%
ERST	2.40	2%
ALDE	1.00	1%
DRVE	1.00	1%
LAGL	1.00	1%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A08**	**ACTH7 (Foliar)**	**1.00%**
		ARTRT (Foliar)	**4.00%**
		BRTE (Foliar)	**4.00%**
		DRVE2 (Foliar)	**2.00%**
		ERNA10 (Foliar)	**4.00%**
		JUOC (Foliar)	**14.00%**
		POBU (Foliar)	**1.00%**
		POSE (Foliar)	**14.00%**
		PUTR2 (Foliar)	**6.00%**

A15

10XB022OR, State 5.1. Total understory annual production in 2015 was 228.389 lb/ac. There were 60.70 trees/ac.

Annual Production	A15	
Species Code	lb/ac	% of Total
CHVI	6.00	3%
FEID	4.07	2%
ELEL5	1.28	1%
PSSP6	36.01	16%
POSE	31.39	14%
ACTH	32.64	14%
VUOC	1.00	0%
BRTE	1.00	0%
TACA8	1.00	0%
POBU	1.00	0%
ACMI	1.00	0%
LUPINE	74.86	33%
PHHO	15.96	7%
LOGR	2.44	1%
CRAC	0.80	0%
LOTR	1.00	0%
ASFI	1.00	0%
AF	1.00	0%
TRDU	1.00	0%
DRVE	1.00	0%
ALDE	12.95	6%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A15**	**ACTH7 (Foliar)**	**3.00%**
		ALDE (Foliar)	**4.00%**
		ASCO11 (Foliar)	**1.00%**
		JUOC (Foliar)	**16.00%**
		LUPIN (Foliar)	**2.00%**
		POSE (Foliar)	**13.00%**
		PSSP6 (Foliar)	**4.00%**
		PUTR2 (Foliar)	**1.00%**
		VUOC (Foliar)	**3.00%**

A43

10XA018OR, State 2.1. Total understory annual production in 2015 was 224.148 lb/ac. There were 23.61 trees/ac.

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A43**	**ACTH7 (Foliar)**	**8.00%**
		ARTRT (Foliar)	**1.00%**
		ARTRW8 (Foliar)	**5.00%**
		BRTE (Foliar)	**7.00%**
		DRVE2 (Foliar)	**1.00%**
		ELEL5 (Foliar)	**1.00%**
		FEID (Foliar)	**12.00%**
		JUOC (Foliar)	**8.00%**
		KOMA (Foliar)	**5.00%**
		POSE (Foliar)	**3.00%**
		PSSP6 (Foliar)	**11.00%**
		PUTR2 (Foliar)	**1.00%**
		VUOC (Foliar)	**8.00%**

Annual Production	**A43**	
Species Code	lb/ac	% of Total
ELEL5	0.88	0%
KOMA	27.21	12%
ACTH	73.54	33%
FEID	47.52	21%
PSSP6	44.55	20%
POSE	7.20	3%
VUOC	8.20	4%
BRTE	1.00	0%
TACA8	1.00	0%
POBU	2.80	1%
CAMA	1.00	0%
BLSC	1.00	0%
ANDI2	2.25	1%
DRVE	1.00	0%
LOTR	1.00	0%
MIGR	1.00	0%
PHLI	1.00	0%
ACMI	1.00	0%
LAGL	1.00	0%

A44

Called 08XY140OR in the field but labeled with DRG 4 in the office, State 2.3. Total understory annual production in 2015 was 205.319 lb/ac. There were 57.33 trees/ac.

Annual Production	A44	
Species Code	lb/ac	% of Total
FEID	22.99	11%
PSSP5	127.67	62%
ACTH	12.85	6%
ELEL5	7.38	4%
POSE	3.97	2%
BRTE	7.56	4%
VUOC	8.10	4%
BRJA	2.10	1%
ERLI	1.00	0%
PLMA	1.00	0%
ACMI	1.00	0%
LONU	0.40	0%
BLSC	0.90	0%
CRAC	0.40	0%
LAGL	1.00	0%
DRVE	1.00	0%
ALDE	1.00	0%
LOCA4	1.00	0%
EPMI	1.00	0%
TRMA4	1.00	0%
COLI	1.00	0%
MIGR	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A44**	**ACTH7 (Foliar)**	**6.00%**
		BRTE (Foliar)	**10.00%**
		DRVE2 (Foliar)	**1.00%**
		ELEL5 (Foliar)	**1.00%**
		EPMI (Foliar)	**1.00%**
		JUOC (Foliar)	**19.00%**
		LOMAT (Foliar)	**1.00%**
		POSE (Foliar)	**5.00%**
		PSSP6 (Foliar)	**8.00%**
		VUOC (Foliar)	**8.00%**

A45

10XA018OR, State 2.4 at risk of transitioning to 4.1. Total understory annual production in 2015 was 433.287 lb/ac. There were 3.37 trees/ac.

Annual Production	A45	
Species Code	lb/ac	% of Total
ACTH	103.82	24%
ELEL5	26.98	6%
POSE	46.62	11%
KOMA	3.08	1%
ARTRT	0.40	0%
CHVI	77.88	18%
ERCI	1.00	0%
BRTE	121.36	28%
VUOC	2.96	1%
TRDU	1.00	0%
LUPINE	1.00	0%
EPBR	1.00	0%
ERFI	3.66	1%
TACA8	1.00	0%
MAGR	1.00	0%
ERST	1.00	0%
LOMAT	1.00	0%
AGGL	0.70	0%
PHHO	7.92	2%
CAMA	3.33	1%
ACMI	4.06	1%
DRVE	1.00	0%
CRAC	1.00	0%
BLSC	14.40	3%
COLI	5.14	1%
ERVI	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**A45**	**ACTH7 (Foliar)**	**14.00%**
		ARTRT (Foliar)	**2.00%**
		BASA3 (Foliar)	**1.00%**
		BRTE (Foliar)	**31.00%**
		ELEL5 (Foliar)	**2.00%**
		EPBR3 (Foliar)	**1.00%**
		POSE (Foliar)	**9.00%**
		PSSP6 (Foliar)	**5.00%**
		VUOC (Foliar)	**4.00%**

B02

10XB022OR, State 3.2. Total understory annual production in 2015 was 498.166 lb/ac. There were 13.49 trees/ac.

Annual Production	B02	
Species Code	lb/ac	% of Total
PSSP5	65.59	13%
AGCR	21.44	4%
ELEL5	16.20	3%
POSE	125.78	25%
POBU	1.00	0%
BRTE	96.63	19%
VUOC	1.00	0%
LOGR	11.50	2%
LOTR	1.00	0%
EPBR3	1.00	0%
LAGL	1.00	0%
DRVE	1.00	0%
ACMI	2.20	0%
CRAC	19.58	4%
TRDU	9.24	2%
ALDE	2.20	0%
LUPU	1.00	0%
MAGR3	2.85	1%
CHDO	2.80	1%
ERCI	1.00	0%
ANDE2	1.00	0%
ERST	12.64	3%
CHVI	48.87	10%
CHNA	14.28	3%
BLSC	1.00	0%
ERFI	36.36	7%

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 4	B02	ACMI2 (Foliar)	1.00%
		AGCR (Foliar)	8.00%
		BRTE (Foliar)	6.00%
		CHVI8 (Foliar)	2.00%
		ERCI6 (Foliar)	1.00%
		ERNA10 (Foliar)	3.00%
		LAGL5 (Foliar)	2.00%
		MESA (Foliar)	2.00%
		POSE (Foliar)	20.00%
		PSSP6 (Foliar)	3.00%
		PUTR2 (Foliar)	4.00%
		TACA8 (Foliar)	1.00%
		TRDU (Foliar)	1.00%
		VUOC (Foliar)	1.00%

B05

10XA018OR, State 5.1. Total understory annual production in 2015 was 354.230 lb/ac. There were 43.84 trees/ac.

Annual Production	B05	
Species Code	lb/ac	% of Total
PSSP6	20.50	6%
FEOV	274.07	77%
POSE	16.33	5%
POBU	6.00	2%
VUOC	3.00	1%
PHHO	1.00	0%
EPBR3	2.00	1%
LOGR	1.00	0%
CRAC	3.00	1%
LUPIN	0.45	0%
DRVE	9.00	3%
ASFI	1.20	0%
ANDE2	14.00	4%
CHNA	0.68	0%
ERST	1.00	0%
BRTE	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**B05**	**ANDI2 (Foliar)**	**1.00%**
		ERNA10 (Foliar)	**4.00%**
		FEID (Foliar)	**41.00%**
		JUOC (Foliar)	**1.00%**
		LUPIN (Foliar)	**1.00%**
		POBU (Foliar)	**1.00%**
		POSE (Foliar)	**4.00%**

B06

10XB022OR, State 5.2. Total understory annual production in 2015 was 218.061 lb/ac. There were 185.48 trees/ac.

Annual Production	B06	
Species Code	lb/ac	% of Total
FEID	1.00	0%
POBU	0.93	0%
POSE	50.84	23%
BRTE	0.28	0%
VUOC	1.00	0%
CRAC	1.00	0%
DRVE	1.00	0%
ALDE	1.00	0%
ANDI2	154.74	71%
LUPU	1.00	0%
PLMA	1.00	0%
ASCU	1.00	0%
ERFI	3.26	1%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**B06**	**AGCR (Foliar)**	**1.00%**
		ALDE (Foliar)	**1.00%**
		ANDI2 (Foliar)	**5.00%**
		JUOC (Foliar)	**23.00%**
		POSE (Foliar)	**17.00%**
		VUOC (Foliar)	**1.00%**

B29

10XB022OR, State 3.1. Total understory annual production in 2015 was 493.899 lb/ac. There were 74.19 trees/ac.

Annual Production	B29	
Species Code	lb/ac	% of Total
ARTR	360.86	73%
ELEL5	9.01	2%
FEID	24.30	5%
PSSP5	5.28	1%
POSE	44.67	9%
BRTE	2.20	0%
VOUC	7.08	1%
LAGL	1.00	0%
CRAC	1.00	0%
LOGR	1.00	0%
ERST	1.00	0%
LUPIN	1.00	0%
ANDI2	13.84	3%
ASPU	1.00	0%
DRVE	1.00	0%
PHHO	7.67	2%
ACMI	10.00	2%
AF	1.00	0%
ALDE	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 4	B29	ALDE (Foliar)	1.00%
		ANDI2 (Foliar)	1.00%
		ARTRT (Foliar)	7.00%
		DRVE2 (Foliar)	1.00%
		JUOC (Foliar)	5.00%
		POSE (Foliar)	15.00%
		VUOC (Foliar)	7.00%

B38

10XB022OR, State 3.1, possibly eroded state. Total understory annual production in 2015 was 1003.228 lb/ac. There were 57.33 trees/ac.

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**B38**	**ACTH7 (Foliar)**	**7.00%**
		ARTRT (Foliar)	**2.00%**
		ARTRW8 (Foliar)	**6.00%**
		BRTE (Foliar)	**4.00%**
		DRVE2 (Foliar)	**1.00%**
		ELEL5 (Foliar)	**1.00%**
		ERNA10 (Foliar)	**2.00%**
		JUOC (Foliar)	**2.00%**
		LOTR2 (Foliar)	**1.00%**
		POBU (Foliar)	**6.00%**
		POSE (Foliar)	**15.00%**
		VUOC (Foliar)	**5.00%**

Annual Production	**B38**	
Species Code	lb/ac	% of Total
CHNA	1.12	0%
CHVI	7.56	1%
ACTH	598.31	60%
ELEL5	41.47	4%
POSE	128.64	13%
POBU	160.91	16%
BRTE	20.02	2%
VUOC	22.40	2%
ANDI2	5.04	1%
DRVE	0.00	0%
ERSP3	2.56	0%
ALDE	0.00	0%
ERFI	11.20	1%
ACMI	1.00	0%
TRDU	1.00	0%
LOTR	1.00	0%
BLSC	1.00	0%

B45

10XA018OR, State 2.4 at risk of transitioning to the annual state. Total understory annual production in 2015 was 911.771 lb/ac. There were 3.37 trees/ac.

Annual Production	B45	
Species Code	lb/ac	% of Total
PUTR	22.54	2%
ACTH	331.11	36%
ELEL5	259.77	28%
POSE	2.90	0%
BRTE	170.28	19%
TACA8	1.00	0%
VUOC	38.91	4%
PHLI	1.00	0%
AGGR	12.63	1%
ERVI	1.00	0%
TRDU	32.67	4%
LASE	1.00	0%
EPBR	2.56	0%
AF	1.00	0%
ACMI	24.53	3%
DRVE	1.00	0%
COLI	6.18	1%
BORA5	1.00	0%
CAMA	0.70	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**B45**	**ACTH7 (Foliar)**	**24.00%**
		BRTE (Foliar)	**31.00%**
		CHVI8 (Foliar)	**1.00%**
		ELEL5 (Foliar)	**7.00%**
		EPBR3 (Foliar)	**3.00%**
		POSE (Foliar)	**1.00%**
		PSSP6 (Foliar)	**5.00%**
		PUTR2 (Foliar)	**9.00%**
		TACA8 (Foliar)	**3.00%**
		TRDU (Foliar)	**2.00%**
		VUOC (Foliar)	**4.00%**

B48

10XB023OR*, State 4.1. Total understory annual production in 2015 was 889.415 lb/ac. There was one 4”-tall ponderosa pine on site, but no other trees.

*site identification needs verification because 10XB023 no longer exists in NRCS ESIS and the soils associated with it have likely been recorrellated

Annual Production	B48	
Species Code	lb/ac	% of Total
ERNA10	1.00	0%
ACTH	12.83	1%
PSSP5	297.31	33%
ELEL5	2.19	0%
POSE	0.30	0%
BRTE	373.23	42%
TACA8	4.00	0%
VUOC	0.70	0%
SIAL	5.40	1%
RUCR	0.57	0%
TRDU	4.50	1%
MAGR	1.00	0%
EPBR	89.95	10%
LASE	17.47	2%
ERVI	4.80	1%
PHHA	18.72	2%
AMSI	51.35	6%
COLI	1.00	0%
DRVE	1.00	0%
ERCI	1.11	0%
TRMA4	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 5	B48	ACTH7 (Foliar)	1%
		AMSIN (Foliar)	1%
		BRTE (Foliar)	39%
		EPBR3 (Foliar)	23%
		ERNA10 (Foliar)	1%
		ERVI5 (Foliar)	1%
		MAGR3 (Foliar)	3%
		PSSP6 (Foliar)	7%
		TACA8 (Foliar)	4%
		VUOC (Foliar)	3%

B52

10XB022OR, State 3.1. Total understory annual production in 2015 was 357.751 lb/ac. There were 40.47 trees/ac.

Annual Production	B52	
Species Code	lb/ac	% of Total
ERNA10	94.10	26%
POSE	175.76	49%
AGCR	58.59	16%
ACTH	1.00	0%
BRTE	13.40	4%
VUOC	1.00	0%
DRVE	1.00	0%
ASTRA	1.00	0%
ACMI	2.20	1%
ERFI	0.40	0%
LUPIN	1.00	0%
ANDI2	7.31	2%
ALDE	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**B52**	**AGCR (Foliar)**	**3.00%**
		ARTRT (Foliar)	**8.00%**
		BRTE (Foliar)	**5.00%**
		ELEL5 (Foliar)	**1.00%**
		ERNA10 (Foliar)	**4.00%**
		JUOC (Foliar)	**3.00%**
		POSE (Foliar)	**6.00%**

C01

10XB023OR*, State 3.1. Total understory annual production in 2015 was 795.852 lb/ac. There were 33.72 trees/ac.

*site identification needs verification because 10XB023 no longer exists in NRCS ESIS and the soils associated with it have likely been recorrellated

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**C01**	**ACMI2 (Foliar)**	**1.00%**
		AGCR (Foliar)	**1.00%**
		ANDI2 (Foliar)	**1.00%**
		ARTRT (Foliar)	**17.00%**
		BRTE (Foliar)	**1.00%**
		ERFI2 (Foliar)	**4.00%**
		ERNA10 (Foliar)	**1.00%**
		ERST4 (Foliar)	**2.00%**
		JUOC (Foliar)	**4.00%**
		LAGL5 (Foliar)	**2.00%**
		LUPIN (Foliar)	**1.00%**
		POBU (Foliar)	**1.00%**
		POSE (Foliar)	**14.00%**
		PUTR2 (Foliar)	**1.00%**
		VUOC (Foliar)	**2.00%**

Annual Production	**C01**	
Species Code	lb/ac	% of Total
ARTRT	601.76	76%
ERNA10	17.82	2%
AGCR	7.44	1%
PSSP5	42.76	5%
POBU	1.73	0%
BRTE	6.83	1%
VUOC	1.00	0%
TECA8	1.00	0%
POSE	35.69	4%
ELEL5	1.62	0%
TRDU	1.00	0%
EPBR	1.00	0%
LOGR	1.00	0%
ERST	2.62	0%
LUPIN	1.00	0%
LAGL	1.00	0%
ACMI	1.00	0%
DRVE	1.00	0%
ASTRA	1.00	0%
ERFI	39.51	5%
ANDI2	21.48	3%
CRAC	6.10	1%
ASCU	0.50	0%

C34

10XB022OR, State 4.1. Total understory annual production in 2015 was 270.952 lb/ac. There 91.05 trees/ac.

Annual Production	C34	
Species Code	lb/ac	% of Total
ARTRT	86.57	32%
JUOC	1.00	0%
ELEL5	24.37	9%
POSE	45.86	17%
ACTH	1.00	0%
BRTE	62.05	23%
VOUC	8.93	3%
TACA8	1.40	1%
POBU	3.40	1%
BRJA	1.00	0%
COLI	1.00	0%
EPMI	1.00	0%
PLMA	1.00	0%
LAGL	1.00	0%
ASFI	4.60	2%
ALIUM	1.00	0%
LUPIN	14.67	5%
CRAC	1.00	0%
ACMI	3.00	1%
ALDE	1.00	0%
DRVE	1.00	0%
BLSC	4.10	2%
MAGR3	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**C34**	**ARTRT (Foliar)**	**9.00%**
		BLSC (Foliar)	**1.00%**
		BRTE (Foliar)	**17.00%**
		ELEL5 (Foliar)	**5.00%**
		JUOC (Foliar)	**2.00%**
		LUPIN (Foliar)	**1.00%**
		POSE (Foliar)	**12.00%**
		VUOC (Foliar)	**11.00%**

C37

10XB022OR, State 2.4 at risk of transitioning to 4.1. Total understory annual production in 2015 was 762.243 lb/ac. There were 3.37 trees/ac.

Annual Production	C37	
Species Code	lb/ac	% of Total
ACTH	159.32	21%
POSE	10.66	1%
POCU	1.44	0%
ELEL5	1.53	0%
PSSP5	252.00	33%
BRTE	181.78	24%
TACA8	1.00	0%
VUOC	1.00	0%
POBU	13.63	2%
ARTRW	82.50	11%
CHVI	2.52	0%
DRVE	1.00	0%
ERST	20.52	3%
ERCI	1.00	0%
ERFI	18.72	2%
ASFI	7.20	1%
ERLA	0.63	0%
PHLI	1.00	0%
BLSC	1.00	0%
LUPIN	1.00	0%
LAGL	2.80	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 4	**C37**	**ACMI2 (Foliar)**	**1.00%**
		ACTH7 (Foliar)	**9.00%**
		ARTRT (Foliar)	**9.00%**
		BRTE (Foliar)	**13.00%**
		DRVE2 (Foliar)	**2.00%**
		ELEL5 (Foliar)	**1.00%**
		ERFI2 (Foliar)	**1.00%**
		ERNA10 (Foliar)	**7.00%**
		ERST4 (Foliar)	**1.00%**
		POBU (Foliar)	**5.00%**
		POSE (Foliar)	**4.00%**
		PSSP6 (Foliar)	**9.00%**

GR4-01

10XB022OR, State 4.2 (Medusahead). Total understory annual production in 2015 was 264.299 lb/ac. There were 3.37 trees/ac.

Annual Production	GR4-01	
Species Code	lb/ac	% of Total
ELEL5	1.40	1%
AGCR	6.50	2%
POBU	1.00	0%
POSE	42.56	16%
VEDU	49.95	19%
TACA8	68.05	26%
BRTE	1.92	1%
ACMI	2.70	1%
MAGR3	1.00	0%
COAR	53.93	20%
ERFI	9.09	3%
ALDE	1.00	0%
LOMAT	1.00	0%
TRDU	7.34	3%
DRVE	1.00	0%
BLSC	14.16	5%
EPBR	0.70	0%
CRAC	1.00	0%

Site	Plot	Indicator	% Cover
DRG 4	**GR4-01**	**AGCR (Foliar)**	**1.00%**
		BLSC (Foliar)	**3.00%**
		BRTE (Foliar)	**4.00%**
		COAR4 (Foliar)	**7.00%**
		POBU (Foliar)	**1.00%**
		POSE (Foliar)	**3.00%**
		TACA8 (Foliar)	**13.00%**
		TRDU (Foliar)	**2.00%**
		VEDU (Foliar)	**25.00%**

DRG 5 Sites Visited in 2015: Plot Summaries

A01

10XB064OR, State 2.2. Total understory annual production in 2015 was 717.368 lb/ac. There were no trees on site.

Annual Production	A01	
Species Code	lb/ac	% of Total
PSSP6	273.01	38%
FEID	270.83	38%
POSE	39.02	5%
KOMA	16.46	2%
BRTE	14.40	2%
VUOC	1.00	0%
TECA2	6.60	1%
CHVI	15.50	2%
ASCO11	17.00	2%
DRVE	1.00	0%
ACMI	23.56	3%
ERHE	2.50	0%
LOTR	1.70	0%
CAMA	1.00	0%
PHHO	19.89	3%
PACA15	3.30	0%
ANDI2	1.00	0%
CRAC	4.20	1%
ERPU	1.00	0%
TRDU	4.40	1%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 5	**A01**	**ACMI2 (Foliar)**	**1.00%**
		ASAT (Foliar)	**1.00%**
		CHVI8 (Foliar)	**1.00%**
		DRVE2 (Foliar)	**2.00%**
		ELEL5 (Foliar)	**1.00%**
		ERHE2 (Foliar)	**2.00%**
		FEID (Foliar)	**31.00%**
		KOMA (Foliar)	**3.00%**
		LOTR2 (Foliar)	**1.00%**
		PHHO (Foliar)	**1.00%**
		POSE (Foliar)	**8.00%**
		PSSP6 (Foliar)	**25.00%**
		TRDU (Foliar)	**1.00%**

B04

10XB027OR, State 3.1 at risk of transitioning to the annual state. Total understory annual production in 2015 was 117.623lb/ac. There were 50.59 trees/ac.

Annual Production	B04	
Species Code	lb/ac	% of Total
CHVI	0.92	1%
ERNA10	1.00	1%
ARTRT	12.08	10%
ACTH	9.00	8%
ELEL5	4.13	4%
AGCR	18.72	16%
POSE	29.01	25%
PUTR	6.58	6%
VOUC	1.00	1%
BRTE	18.67	16%
TACA8	2.20	2%
BRJA	1.00	1%
POBU	1.00	1%
LOMA	3.06	3%
LOMAT	1.00	1%
RECI	1.00	1%
TRDU	1.00	1%
BLSC	0.96	1%
LOGR	0.30	0%
ALDE	1.00	1%
DRVE	1.00	1%
COLI	1.00	1%
ZIVE	1.00	1%

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 5	B04	AGCR (Foliar)	1.00%
		ALDE (Foliar)	2.00%
		ARTRT (Foliar)	2.00%
		BRAR5 (Foliar)	1.00%
		BRTE (Foliar)	16.00%
		DRVE2 (Foliar)	2.00%
		ERNA10 (Foliar)	3.00%
		JUOC (Foliar)	3.00%
		LUPIN (Foliar)	1.00%
		POSE (Foliar)	11.00%
		PUTR2 (Foliar)	15.00%
		TACA8 (Foliar)	5.00%

B14 A/B

Two soil pits were dug on this site. Examine plot photos to see soil differences (left photo has ash cap, in the right photo it has eroded). Unsure where the vegetation transect was in relation to the soil pits.

10XB045OR, State 7.1. Total understory annual production in 2015 was 139.056 lb/ac. There were 124.78 trees/ac.

Annual Production	B14	
Species Code	lb/ac	% of Total
ERGR	0.40	0%
ANDI1	6.48	5%
ERST	11.31	8%
ALDE	9.50	7%
DRVE	7.00	5%
BRASSICA	1.00	1%
CRAC	1.00	1%
POSE	21.66	16%
BRTE	5.28	4%
ACTH	10.13	7%
VUOC	6.00	4%
PHHO	32.19	23%
PSSP	24.00	17%
LOGR	1.00	1%
ASCU4	2.10	2%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 5	**B14B**	**AAFF (Foliar)**	**2.00%**
		ACTH7 (Foliar)	**4.00%**
		ANDI2 (Foliar)	**3.00%**
		ASCU4 (Foliar)	**2.00%**
		FEID (Foliar)	**2.00%**
		JUOC (Foliar)	**3.00%**
		POSE (Foliar)	**7.00%**

B32

10XB027OR, State 2.2. There were 2.67 trees/ac.

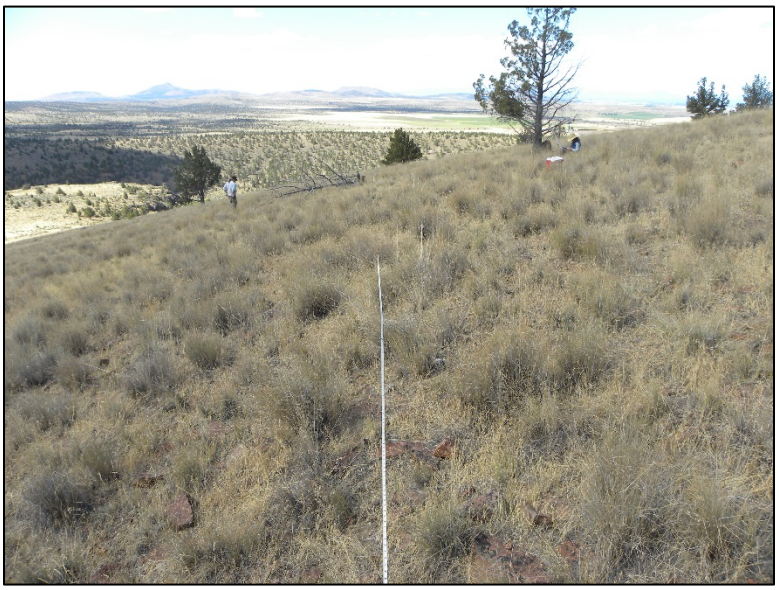
Production data needs to be reviewed and entered by CRNG staff.

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 5	B32	AAFF (Foliar)	1%
		ACMI2 (Foliar)	1%
		ACTH7 (Foliar)	1%
		ANDI2 (Foliar)	6%
		ARTRT (Foliar)	1%
		ASCU4 (Foliar)	3%
		ASFI (Foliar)	1%
		BRTE (Foliar)	10%
		CHVI8 (Foliar)	1%
		FEID (Foliar)	1%
		MAGR3 (Foliar)	1%
		POSE (Foliar)	15%
		PSSP6 (Foliar)	23%
		TACA8 (Foliar)	1%
		VUOC (Foliar)	1%

B35

10XB045OR, State 2.4 at risk of transitioning to annual state. There were 3.37 trees/ac.

Production data needs to be reviewed and entered by CRNG staff.



Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
DRG 5	B35	ACTH7 (Foliar)	7%
		ARTRT (Foliar)	2%
		BRTE (Foliar)	29%
		POSE (Foliar)	7%
		PSSP6 (Foliar)	14%
		VUOC (Foliar)	7%

GR5-01

10XB027OR, State 4.2 (Medusahead). Total understory annual production in 2015 was 586.126 lb/ac. There were 74.19 trees/ac.

Annual Production	GR5-01	
Species Code	lb/ac	% of Total
ASLO	1.00	0%
ERFI	1.00	0%
CRAC	1.00	0%
ERST	1.00	0%
BLSC	1.00	0%
LOMAT	1.00	0%
ALDE	1.00	0%
DRVE	1.00	0%
EPBR3	1.00	0%
POSE	15.86	3%
ELEL5	4.14	1%
POCU	1.00	0%
DAUN	6.57	1%
VEDU	204.27	35%
TACA8	226.95	39%
BRJA	1.00	0%
VUOC	116.34	20%
BRTE	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 5	**GR5-01**	**BRAR5 (Foliar)**	**1%**
		BRTE (Foliar)	**2%**
		DAUN (Foliar)	**1%**
		ELEL5 (Foliar)	**2%**
		JUOC (Foliar)	**28%**
		PUTR2 (Foliar)	**2%**
		TACA8 (Foliar)	**10%**
		TECA2 (Foliar)	**1%**
		VEDU (Foliar)	**28%**
		VUOC (Foliar)	**7%**

GR5-02

10XB027OR, State 4.2 (Medusahead). Total understory annual production in 2015 was 369.906 lb/ac. There were 13.49 trees/ac.

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
DRG 5	**GR5-02**	**ACMI2 (Foliar)**	**1%**
		AGCR (Foliar)	**2%**
		ALDE (Foliar)	**1%**
		ARTRT (Foliar)	**2%**
		BRTE (Foliar)	**1%**
		EPBR3 (Foliar)	**5%**
		ERST4 (Foliar)	**1%**
		GAPO (Foliar)	**1%**
		POSE (Foliar)	**2%**
		PUTR2 (Foliar)	**7%**
		TACA8 (Foliar)	**24%**

Annual Production	**GR5-02**	
Species Code	lb/ac	% of Total
PUTR	120.00	32%
ARTRT	108.60	29%
CRAC	1.00	0%
MAGR6	1.00	0%
ASFI	0.48	0%
ERST	14.82	4%
DRVE	1.00	0%
ERCI	1.00	0%
PHHO	26.46	7%
COAR	6.92	2%
ALDE	1.00	0%
TRDU	1.00	0%
LOMAT	1.00	0%
LAGL	3.40	1%
ERPB3	16.15	4%
COLI	1.00	0%
POBU	1.00	0%
VUOC	1.00	0%
BRTE	12.67	3%
TACA8	34.50	9%
BRJA	2.80	1%
ELEL5	1.00	0%
POSE	3.30	1%
ACTH	6.00	2%
AGCR	2.80	1%

Other Sites Visited in 2015: Plot Summaries

A16 – Group 2B

Group 2B, 10XA83OR, State 2.3 at risk of transitioning to the Tree state. Total understory annual production in 2015 was 117.623lb/ac. There were 323.75 trees/ac.

Annual Production	A16	
Species Code	lb/ac	% of Total
PUTR	11.05	5%
JUOC	1.00	0%
ARTRW	1.00	0%
POSE	28.22	14%
ACTH	5.99	3%
PSSP6	17.53	9%
FEID	63.30	31%
VUOC	1.00	0%
BRTE	5.00	2%
POBU	1.00	0%
ANDI2	35.50	17%
ERST	12.81	6%
PHHO	7.76	4%
ASFI	7.98	4%
ALDE	1.00	0%
DRVE	1.00	0%
LAGL	1.00	0%
CAMA	1.00	0%
LOTR	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
Other Site	**A16**	**ACTH7 (Foliar)**	**1%**
		ALDE (Foliar)	**1%**
		ASFI (Foliar)	**1%**
		CHVI8 (Foliar)	**1%**
		DRVE2 (Foliar)	**2%**
		FEID (Foliar)	**6%**
		JUOC (Foliar)	**16%**
		POSE (Foliar)	**14%**
		PSSP6 (Foliar)	**6%**
		PUTR2 (Foliar)	**2%**

A37– Group 2B

Group 2B, 10XA83OR, State 2.1, transitioning to 2.3. There were 343.98 trees/ac.

Production data needs to be reviewed and entered by CRNG staff.

Line Point Intercept Foliar Cover - 2015			
Site	Plot	Indicator	% Cover
Other Sites	A37	ARTRT (Foliar)	3%
		DRVE2 (Foliar)	5%
		FEID (Foliar)	20%
		JUOC (Foliar)	9%
		POSE (Foliar)	20%
		PSSP6 (Foliar)	9%

B36– Group 2B

Group 2B, 10XA83OR, State 2.3 at risk of transitioning to the annual state. Total understory annual production in 2015 was 384.450 lb/ac. There were 74.19 trees/ac.

Annual Production	B36	
Species Code	lb/ac	% of Total
PUTR	110.40	29%
ARTRT	1.00	0%
TECA2	3.68	1%
ERNA10	1.00	0%
CHVI	33.09	9%
PSSP5	86.22	22%
ACTH	48.27	13%
FEID	16.74	4%
POSE	3.16	1%
ELEL5	19.00	5%
VUOC	1.00	0%
BRTE	46.69	12%
COLI	1.00	0%
LOTR	1.00	0%
DRVE	1.00	0%
LOGR	1.00	0%
PHLI	1.00	0%
ERSI2	7.20	2%
PLTE	1.00	0%
ASFI	1.00	0%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
Other Sites	**B36**	**ACTH7 (Foliar)**	**3%**
		ARTRT (Foliar)	**5%**
		ARTRW8 (Foliar	**11%**
		BRTE (Foliar)	**19%**
		CHVI8 (Foliar)	**6%**
		DRVE2 (Foliar)	**2%**
		ERNA10 (Foliar)	**1%**
		FEID (Foliar)	**1%**
		LOTR2 (Foliar)	**1%**
		POSE (Foliar)	**1%**
		PSSP6 (Foliar)	**5%**

C38 – Group 2A

Group 2A, 08XY140OR, State 3.1 at risk of transitioning to the annual state. Total understory annual production in 2015 was 92.529 lb/ac. There were 16.86 trees/ac.

Annual Production	C38	
Species Code	lb/ac	% of Total
ACTH	2.80	3%
ELEL5	1.60	2%
POCU	15.00	16%
POSE	12.83	14%
TACA8	4.40	5%
BRTE	1.00	1%
VUOC	33.70	37%
VEDU	1.00	1%
COLI	1.00	1%
LAGL	1.00	1%
EPBR	1.00	1%
DRVE	1.00	1%
LOMAT	1.00	1%
BLSC	0.20	0%
ANDI2	14.73	16%

Line Point Intercept Foliar Cover - 2015			
Site	**Plot**	**Indicator**	**% Cover**
Other Sites	**C38**	**ACTH7 (Foliar)**	**1%**
		ANDI2 (Foliar)	**2%**
		DRVE2 (Foliar)	**2%**
		JUOC (Foliar)	**12%**
		POSE (Foliar)	**8%**
		TACA8 (Foliar)	**3%**
		VUOC (Foliar)	**23%**

Appendix D: Historical monitoring reports

This appendix includes 3 reports circa 2003 related to a monitoring and photo point project completed in the Crooked River National Grassland. There are two data summary reports, one for Lone Pine and one for Grizzly. We have the following data for each allotment: species composition summaries in excel, photos from the 1950s and early 2000s, and historical AUM data in excel format.

Also included in the electronic file are transect data for additional monitoring points on CRNG.

The related data and additional photographs can be found in Appendix E, online at http://www.cabnr.unr.edu/resources/mlra.aspx .

Contact Devon Snyder (devonsnyder@cabnr.unr.edu) or Tamzen Stringham (tstringham@cabnr.unr.edu) directly for access to these data.

DEPARTMENT OF RANGELAND RESOURCES

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Glen Adams
Range Conservationist
USFS, Crooked River Grasslands
Madras, OR

Dear Glen:

Attached is the requested discussion on the ecological significance of Sandberg's bluegrass in rangeland restoration efforts. The discussion is a professional opinion and not based on any data.

I appreciate your interest in maintaining and promoting the long-term, positive, relationship that exists between the Crooked River National Grasslands and OSU Dept. of Rangeland Resources. Thank you for your willingness to share your knowledge and that of your staff with the students from OSU. CRNG participation in the OSU field trips greatly enhances the student's learning experience.

Sincerely,

Tamzen Stringham
Asst. Professor
Dept. of Rangeland Resources
Oregon State University
(541) 737-0923 Office
Tamzen.Stringham@oregonstate.edu

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In order to have a meaningful discussion on the potential repair of degraded or damaged rangelands it is necessary to describe the framework I use for assessment of function and determination of possible repair strategies. Fully functioning (healthy) ecosystems have autogenic or built-in repair mechanisms that are inherent to the physical attributes and the pre-degraded biotic components of the system. Damage to the ecosystem through any number of, or combinations of disturbances can override the systems capacity for self-repair. After crossing the self-repair threshold, active intervention is required to restart the natural recovery processes of the damaged ecosystem. Therefore, the framework I ascribe to for development of repair strategies is (1) process-oriented; (2) seeks to initiate plant-driven repair; and (3) considers landscape position and interactions. The first step in this approach is to assess the current function level of the three primary ecological processes (hydrologic cycle, nutrient cycle and energy capture). The next step focuses on identifying the controlling factors in regards to the functionality of the primary processes. For example, a sagebrush-steppe community dominated by deep-rooted, perennial bunchgrasses and 10 to 20 % cover of sagebrush is likely being controlled by the biotic community. The plant community is providing adequate protection of the soil from raindrop impact, for litter additions to soil OM, for root turnover throughout the soil profile, for energy capture throughout the growing season and for season-long nutrient cycling. The site is capable of self-repair. However, if juniper were to encroach, overtime the control of the primary processes would shift from the current biotic community to juniper. As this shift occurs, bareground increases, herbaceous litter decreases, species begin to decline in number and vigor, root turnover declines, energy capture and nutrient cycling are truncated both spatially and temporally. The outcome is a reduction or degradation in the level of function of the primary ecological processes. The resistance and resilience of the ecosystem declines and the ability to self-repair after disturbance is reduced. As degradation continues the site could cross a physical threshold referred to as the abiotic threshold. If this occurs site processes are being controlled by the physical environment. Once the controlling factors have been identified then the third step is to assess what resources are currently on site that could be manipulated to stop the negative and promote the positive and, in addition, what resources may need to be brought in to assist in the repair process. Most rangeland repair strategies focus on establishing a specified suite of plant species rather than on the repair of processes and they view the improvement program as the endpoint rather than the tool for promoting plant-driven repair.

In the assessment of the current functionality of the primary processes on the site in question there are a number of resources I prefer to use. These are; (1) soil map; (2) ecological site description; (3) climate data; (4) local knowledge; (5) history; (6) shovel; (7) Interpreting

Indicators of Rangeland Health (Pellant et al. 2000) and; (8) my brain. In developing repair strategies I prefer the ecological framework described above with the use of agronomic techniques to promote site function not to establish some pre-determined group of species.

Crooked River National Grasslands Discussion

On September 23, 2003 a group of rangeland scientists and professionals visited the CRNG with the primary purpose of identifying project sites for the OSU Rangeland Resources course titled Wildland Restoration and Ecology. The group included me, Dr. Lee Eddleman (OSU Rangeland Resources), Tim Deboodt (OSU Extension), Pat Shaver (NRCS Grazing Land Institute), Tory Kurtz (CRNG). During this trip we visited a number of areas that had been farmed and abandoned and subsequently seeded to Crested wheatgrass and alfalfa. The majority of the areas we visited were on one of two soil map units: LaC (Lamonta) and GrD (Gribble). The ecological site descriptions associated with these soil map units are Loamy 10-12 and John Day Clayey 12-16 respectively. Tory Kurtz provided the group with the CRNG condition and trend data within the Grizzly and Lone Pine allotments. We visited a number of these locations.
I will summarize our discussion at the C&T cluster #3 located with a Loamy 10-12 ecological site on Lamonta soil.

Summary of Cluster 3# Location

This site is located approximately 1 mile SW of the BPA Substation. According to the CRNG historical records the site was plowed and seeded in 1947 to crested wheatgrass (Agcr) and alfalfa. The C&T data indicate that Agcr composed 84.7% of the stand in 1955, 96.7% in 1961 and 28.7% in 2001. Sandberg's bluegrass (Pose) has increased from < 1% in 1955 and 1961 to 47.0% today. In addition, Bulbous bluegrass (Pobu) composes 18.3% of the current day community. Both Pose and Pobu are shallow-rooted, early season, perennial plants. Although the historical record does not mention shrub control, the lack of sagebrush (< 1%) indicates shrubs were most likely sprayed at some point in time. Recently, juniper has been cut on this site. The ecological site description for this location indicates the historic plant community was dominated by bluebunch wheatgrass at 30-45% and Idaho Fescue at 15-30% with less than 10% Sandberg's bluegrass and up to 5% Thurber's needlegrass. In addition, up to 20% of the community should be made up of bitterbrush and big sagebrush.

A number of shallow soil pits were dug and a cemented ash layer (tuff) was found within 20 inches of the surface. This soil feature tends to favor Idaho fescue over bluebunch wheatgrass and sagebrush over bitterbrush. In addition, the risk factor for juniper invasion is lower than on soil underlain with fractured basalt or non-cemented ash. Drill rows are evident and appear to run primarily downslope. It is interesting to note that Sandberg's bluegrass is dominating on the mini-ridge lines between the rows. Much discussion ensued concerning this pattern of plants on top of the "ridges" and bareground in the depressions. The consensus of the group was as Sandberg's became the dominate the site's ability to retain soil declined (shallow mat-rooted, small stature plant) and 2 to 4 inches of soil has been lost through both water and wind erosion. The group recognized historic soil erosion prior to crested wheatgrass and after abandonment had occurred, however, the opinion was the domination of Sandberg's bluegrass has further facilitated soil erosion.

A Rangeland Health Assessment was conducted on the site with the following results.

	Rangeland Health Attributes	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to slight
S	Soil/Site Stability (Indicators 1-6, 8, 9 & 11)			**X**		
H	Hydrologic Function (Indicators 1-5, 7-11 &14)			**X**		
B	Biotic Integrity (Indicators 8-9 & 11-17)			**X**		

The assessment indicates that the site exhibits moderate departure from expected function. The hydrologic cycle was historically impacted by the agronomic disturbance to the soil and has continued to degrade as shallow-rooted, early-season, grasses have replaced the deeper-rooted crested wheatgrass. Soil pits showed a significant mat-type layer of Pose roots within the top 2 to 4 inches of the soil both beneath plants and throughout the interspace. This type of rooting structure indicates the site is fully occupied by Pose and seedling establishment of other species would be difficult. In addition, water flow paths are developing and Sandberg's bluegrass is pedestaled in many places. Soil pavement is evident and indicates soil loss has occurred. The temporal scale of energy capture has been substantially shortened and below ground nutrient cycling has been seriously truncated. Sandberg's bluegrass produces little above ground biomass and what it does produce decomposes rapidly. The role of litter on the soil surface; protection from raindrop impact, moderation of soil temperature, increased retention of soil water, safe sites for seed germination; has been greatly reduced as the site has degraded to Sandberg bluegrass domination. The increase in Sandberg's bluegrass has set up a positive feedback loop that promotes the Sandberg bluegrass community at the expense of deep rooted perennials. In other words, Pose is controlling site processes. The decrease in the ability of the site to capture, store and safely release water to plants has effectively dried the site out. Sandberg's bluegrass is an early season grower that can utilize water in the near surface profile before the seedlings of Idaho fescue or bluebunch wheatgrass begin growth. In the event that the deep-rooted bunchgrass seedlings have the opportunity to begin growth the probability of survival beyond July, due to increased soil temperature and decreased soil moisture, is quite low. The consensus of the group in regards to repair strategies was to focus on increasing soil water availability to plants both spatially and temporally through reduction in Pose domination and an increase in deep-rooted perennial plants. Specific seeding mixes were not discussed but concern was raised over probability of seeding failure if late seral native plants were the only option.

Gribble Soil

The primary difference between the Gribble and Lamonta soil units, from a plants perspective, is in the depth to and type of restrictive layers. The Gribble soil tends to be deeper than the Lamonta and is underlain with fractured basalt instead of ash. The potential native plant

communities are quite similar, however, bitterbrush, juniper, and bluebunch wheatgrass prefer the Gribble soil over the Lamonta. On the sites we visited that had been farmed and abandoned and subsequently seeded to crested wheatgrass and alfalfa the same issues with Sandberg's bluegrass were noted. However, additional concerns on these sites included cheatgrass, medusahead and juniper. Some areas, where the soil had rock in the near surface profile, had significant residual stands of native, deep-rooted bunchgrasses. Repair strategies under these conditions would initially focus on weed control, Sandberg's bluegrass and juniper manipulation. Seeding to deep-rooted species in the future would certainly need to be considered.

The above discussion is solely an opinion and is not supported by research data from these sites. The opinion is based on discussions and qualitative investigations in the field by a team of experienced rangeland scientists and professional managers.

I would be happy to discuss this opinion further with those parties interested in the ecology of the Crooked River National Grasslands.

Tamzen Stringham
Asst. Professor

Grizzly Allotment

Grizzly Allotment Condition & Trend Cluster Summary

2003

The Grizzly Allotment is located in the southwestern corner of the grasslands. The Grizzly BPA substation is located on the northern end of the allotment. Grizzly Mountain is to the east of the allotment. Most of the allotment is relatively flat with rolling hills to the north. Much of the allotment was seeded to Crested Wheatgrass.

The allotment is approximately 8836 acres in size. The allotment varies in elevation from 3000 to 3400 feet. Precipitation usually varies between 8 and 12 inches/year. Most of the precipitation occurs as snow in the winter. Storm patterns vary depending on the year.

This year, 2001, is a drought year as was year 2000. This drought affects the cluster results. Litter and plant specie readings are affected negatively by the drought. Many forbs were dried out by the time the transects were read. Therefore, when considering the results of the clusters it is important to factor in the drought.

Parts of this allotment were dryland farmed during the homestead era at the turn of the last century. The homesteaders left the land in the 1930's through the relocation act. After that period the SCS seeded parts of this allotment to Crested Wheatgrass or Whitmar (Beardless Bluebunch Wheatgrass). These seeding took place in the 1930's, 40's and 50's. In addition to these seedings, parts of the allotment have been treated chemically for shrub control and fire and chainsaw cutting have been used to control juniper. The allotment has been grazed consistently over this the period since seeding.

The allotment has permitted 250 cow/calf pairs for 7 months and 10 bulls for 3 months for 2355 animal unit months. The allotment is approximately 8836 acres in size. The present stocking rate is 3.75 acres/AUM. The allotment is grazed under a 10 pasture deferred grazing system. Sometimes pastures are re-grazed depending on the re-growth.

There are 5 Condition and Trend clusters located on this allotment. Cluster 3, Cluster 16 and Cluster 17 are located on an old Crested Wheatgrass seedings, Cluster 14 is located on an abandoned farm field that was never re-seeded, and Cluster 21 is located on a native bunchgrass site.

The primary questions that arises from the analysis of the Condition and Trend Clusters are: 1. What is a realistic Desired Future Condition for the abandoned homestead sites? Is it a site dominated by Rabbitbrush or Sagebrush, a site dominated by Crested Wheatgrass (deep-rooted introduced specie), Sandberg Bluegrass (shallow-rooted native specie), or Bluebunch Wheatgrass (deep-rooted native species)? 2. What timeframe is acceptable to achieve our Desired Future Condition? 3. At what cost can we afford to excel the advancement of succession to our Desired Future Condition?

In my opinion the stagnated/reduced Crested Wheatgrass sites should be considered for rehabilitation to a Sagebrush Steppe, as was probably the historical condition.

Following are summaries by cluster. Below each cluster heading will be four discussions. The first is a discussion of the history of the cluster including location, elevation, aspect, soils, plant association, etc. The second is a discussion of the Plant Specie Composition, the third is a discussion of Soil Stability based on an analysis of the "Transect Hits", and the fourth is a discussion is based on the Tradition

Range Inventory methods used and discusses Decreaser, Palatable Increaser, Increaser, and Invader plant specie categories.

Note: The Condition and Trend Clusters are comprised of three 100-foot transects. These transects are permanently located on the ground with angle-iron stakes that were established and marked in the 1950's for the most part. When read a steel tape is stretched between the iron stakes. At each 1-foot mark along the tape a sample is taken. "Hits" are what actually lies beneath the "1-foot" mark (i.e. a plant, Bare Soil, Rock, Litter, etc.). Composition data is gathered from Plant Hits and the nearest plant when the Hit is not a plant but Bare Soil or another non-plant Hit. When completed the Cluster provides 300 sample points from which the data are generated from.

Condition & Trend Cluster #3 Summary

Loamy 10-12, Lamonta Soil, Farmed site

Joe Mohan established Cluster # 3 on 9/29/55. The cluster is located approximately 1 mile south west of the BPA Substation. It's legal is T 13S R 14E Section 2 SW NW. The topography is flat. The elevation is approximately 3200 feet.

The plant association is CJS2-91 Western Juniper/Gray Rabbitbrush-Big Sagebrush /Crested Wheatgrass.

The soils were described in 1955 as follows:

0-4"	Dark brown clay loam, very fine textured, sprinkles with small reddish rocks
5-7"	Yellow sandy loam, coarse texture
8-13"	Brownish-yellow clay
14"	Yellowish-brown sandy loam, medium textured
15"	Parent material, rock volcanic

This site was farmed during the homestead era. Topsoil loss occurred during and after the farming era before the SCS re-seeded the site. Topsoil movement is obvious at the edge of the fields. The site was seeded in 1947 to Crested Wheatgrass and Ladak Alfalfa. The rows were 12 inches apart. The site was un-grazed or rested in 1955.

1. Plant Specie Composition Analysis

Specie Composition Analysis
Grizzly Allotment, Cluster 3

Specie	Common Name	1956 Average	1961 Average	2001 Average
AGCR	Crested Wheatgrass	84.7	96.7	28.7
SIHY	Bottlebrush Squirreltail	0.3	0.0	0.0
POSE	Sandberg Bluegrass	0.3	0.3	47.0
POBU	Bulbous Bluegrass	0.0	0.0	18.3
MED	Alfalfa	14.0	1.7	0.0
ASCOII	Idaho Milkvetch	0.0	0.0	0.3
PHMU2	Phacelia	0.0	0.0	0.7
ERIG	Buckwheat	0.0	0.0	3.0
ACMI	Yarrow	0.0	0.0	0.3
SENEC	Ragwort	0.0	0.7	0.0

ARTR	Sagebrush	0.0	0.0	0.3
CHR	Rabbitbrush	0.7	0.7	1.3
		100	100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the numbers above are derived from a sample of 300 on or near the transect tape.

This old Crested Wheatgrass seeding has changed from a Sagebrush steppe site before homesteading, to a farmed site during the homestead era (1890's-1930's), to a Crested Wheatgrass seeded site in 1947, to a site dominated by Sandberg Bluegrass (shallow rooted native perennial grass) in 2001. Today the site still has some Crested Wheatgrass (29% plant composition), but is dominated by Sandberg and Bulbous Bluegrass. Bulbous Bluegrass was seeded during the SCS era (1930-1950's) and persists today on some sites. It fills a similar niche as Sandberg Bluegrass. It is also a shallow rooted perennial grass. Today we have more forbs and the shrub canopy has developed to a canopy of Rabbitbrush with some Sagebrush.

The primary concern with this site is not plant cover so much as the lack of deep-rooted perennial grasses such as Bluebunch Wheatgrass, Idaho Fescue or introduced species such as Crested Wheatgrass. Rabbitbrush dominates the shrub canopy. Sagebrush would be more desirable.

How long will a Crested Wheatgrass seeding last? On all of the Crested Wheatgrass sites I ask this question. I believe it depends on the initial success of the seeding, grazing management, soil/fertility potential, effects of past droughts, etc.

An observation by a long-term permittee who grew up adjacent to seeded areas of the grasslands is: he has noticed that whenever we have experienced a drought that Crested Wheatgrass density has been reduced, that Crested Wheatgrass plants have not sustained drought well.

Successionally the site has progressed from a monoculture of Crested Wheatgrass to a site dominated shallow-rooted perennial grasses, some forbs and rabbitbrush. I estimate the site to be in a low-mid seral stage of succession. This site would be a good candidate for rehabilitation, as it appears stagnated and moving very slowly toward a site dominated by native deep-rooted perennials and sagebrush.

The NRCS Range Inventory we are awaiting should cast more information on this site and its potential.

2. Soil Stability Discussion

Transect Hits:

	1955	1961	2001	Change (1955 to 2001)
All Plants	18	22	19	+1
Forage Plants	18	21	18	0
Rock	5	3	1	-4
Litter	41	20	36	-5
Pavement	7	9	24	+17
Bare soil	29	45	18	-11
Moss	0	0	2	+2

This analysis provides good information as to soil stability as it is an analysis of the actual reading at each 1-foot mark on the tape. The sample was 300 points. Therefore form this analysis we can estimate ground cover and/or soil stability.

It is interesting that the number of Hits on plants has not changed but the plant specie has changed from a site dominated by Crested Wheatgrass to one dominated by Sandberg and Bulbous Bluegrass.

The amount of litter has not changed significantly (41 to 36 Hits in 2001). Bare Soil Hits has decreased by 11 Hits. At the same time Erosion Pavement has increased by 17 Hits. This would indicate erosion. Upon analysis of the chart above it is noted that the readings in 1961 were worse than in 2001. This could be the result of a fire prior to the 1961 reading that would have reduced the amount of litter, possibly increased the amount of Erosion Pavement, and exposed more Bare Soil. When comparing year 2001 to year 1961 most indicators show improved soil stability conditions.

3. Traditional Range Inventory Discussion

Composition:

		1955	1961	2001	Change
Decreaser's (Most Desirables)	18	21	6	-12	
Palatable Increaser's (Intermediates)		0	0	11	+11
Unpalatable Increaser's (Least Desirables)		0	1	1	+1
Invader's		0	0	0	0
Total		100	100	100	

As mentioned above, Bulbous and Sandberg Bluegrass have replaced Crested Wheatgrass to some extent. This chart displays this change clearly. As Crested Wheatgrass is a Decreaser and Bulbous and Sandberg Bluegrass are Palatable Increaser's. The missing component are native deep-rooted perennial grasses.

Condition & Trend Cluster #14 Summary

West, Wilkins, Abbott, and Boysen established this Cluster on the 22nd of May 1957. The Cluster is located approximately 1 ½ miles southeast of the Grizzly BPA Substation. The legal location is T 13 S R 14 E Sec 1 SWSW. The Cluster is located on a flat aspect approximately 2400 feet in elevation.

The Plant Association is CJS2-26 Western Juniper/Big sagebrush/Bluebunch Wheatgrass-Idaho Fescue, Flat.

This is a very interesting Cluster. When it was established in 1957 Rabbitbrush dominated the site. It had been an abandoned farm field. Unlike most other farmed areas on the Grasslands, this site was never re-seeded. I believe it was acquired after the period when most of the re-seeding was done. It was a very difficult Cluster to locate as the aspect has completely changed since 1957. In 1957 the site was a Rabbitbrush/weed site and was an obvious abandoned farm field; today it is a Western Juniper-Sandberg Bluegrass site with almost a closed canopy of Western Juniper. The steel fence posts that witness the transects were actually been lifted into the air and are tangled in the center of a juniper. Note the photos for the change.

1. Plant Specie Composition Analysis

Specie Composition Analysis
Grizzly Allotment, Cluster 14

Specie	Common Name	1957 Average	2001 Average

FEID	Idaho Fescue	0.0	0.3
CRAC	Hawksbeard	0.3	0.0
SIHY	Bottlebrush Squirreltail	45.3	1.0
POSE	Sandberg Bluegrass	19.0	87.7
AGS	Bentgrass	8.3	0.0
PHMU2	Phacelia	0.0	2.3
ERIOG	Buckwheat	2.0	0.7
LOMAT	Lomatium	0.3	0.3
ACMI	Yarrow	4.0	3.3
?		1.0	0.0
TRAGO	Goatsbeard	1.0	0.0
CHR	Rabbitbrush	18.7	0.7
JUOC	Western Juniper	0.0	3.7
		100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the numbers above are derived from a sample of 300 on or near the transect tape.

As mentioned above, this site was altered from its original condition when it was farmed at the turn to the century. I assume that originally it was a Big Sagebrush site. It was not re-seeded, therefore succession moved forward to today. Today Western Juniper dominates the site. There is an 18% plus canopy cover of Western Juniper on the site today. Note the photos. As Western Juniper has become the dominant plant on the site, the shrubs have disappeared. A few live shrub plants occur today along with skeletons of Big Sagebrush and Rabbitbrush.

In 1957 the dominant grass was Bottlebrush Squirreltail; today it is Sandberg Bluegrass. I am not sure of the significance of this change. Idaho Fescue was noted in 2001. That is a positive change. There has been slight changes in forb composition on the site.

In conclusion, succession is advancing. The site is still in a low-mid seral condition. The site has changed in potential from Big Sagebrush to a Western Juniper site. This is a concern as the Juniper site is less production from a grass, forb and shrub standpoint.

2. Soil Stability Discussion

Hits:

	1957	2001	Change (1957 to 2001)
All Plants	17	18	+1
Forage Plants	5	19	+14
Rock	2	1	-1
Litter	28	28	0
Pavement	12	21	+9
Bare soil	30	20	-10
Moss	11	12	+1

There has been little change in soil stability. A reduced number of Hits on Bare Soil is offset by an increase in Erosion Pavement. After being on and doing this analysis I would expect the soil stability as

measured by ground cover to continue to decline as juniper cover increases and production of all other species decline. Therefore I estimate the trend to be downward.

3. Traditional Range Inventory Discussion

Composition:

		1957	2001	Change (1957 to 2001)
Decreaser's (Most Desirables)	0	1	+1	
Palatable Increaser's (Intermediates)		73	88	+15
Unpalatable Increaser's (Least Desirables)		27	11	-16
Invader's		0	0	0
Total		100	100	

From a traditional range inventory view point the site is improving in condition as indicated by the increase in Palatable Increaser's and the decrease in Unpalatable Increaser's. While these two categories have improved, the composition of Decreaser's has not changed significantly.

This would be a good site to consider rehabilitation with a possible return to a sagebrush steppe if the soils have not been too destroyed during the homesteader era.

Condition & Trend Cluster #16 Summary

This Cluster is located approximately 1 mile southwest of the Grizzly BPA Substation. The legal location is T13S R14E Sec 2 NWSW. The elevation is 3200 feet and the terrain is flat.

This site was an abandoned homestead that was farmed from around the turn of the century into the 1930's. The site was re-seeded to Crested Wheatgrass in 1954. The soils are relatively heavy from 13" to 18" deep.

1. Plant Specie Composition Analysis

Specie Composition Analysis
Grizzly Allotment, Cluster 16

Specie	Common Name	1957 Average	2001 Average
AGCR	Crested Wheatgrass	59.3	24.0
AGIN	Intermediate Wheatgrass	0.7	0.0
SIHY	Bottlebrush Squirreltail	1.3	0.0
POSE	Sandberg Bluegrass	0.0	52.7
POBU	Bulbous Bluegrass	0.0	14.7
MED	Alfalfa	13.3	1.0
LUPIN	Lupine	0.3	0.3
ASTRA	Vetch	5.3	0.0
ASCO11	Idaho Milkvetch	0.0	1.3
ERLI	Daisy	0.0	3.3
TAOF	Dandelion	1.0	0.0
TRAGO	Goatsbeard	0.0	1.7
ACMI	Yarrow	0.0	0.7
CONVO	Morning Glory	0.7	0.0

CROC	Hawksbeard	14.7	0.0
CHR	Rabbitbrush	3.3	0.3
		100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the numbers above are derived from a sample of 300 on or near the transect tape.

The aspect has changed little 1957. Today there are a few Western Junipers encroaching the site. Big sagebrush or any sagebrush for that matter have not returned to the site in any significance. Rabbitbrush has actually declined in % composition over the years.

The most significant change has been a decline in Crested Wheatgrass and an increase in Bluegrass species. Alfalfa has dropped almost entirely from the composition. Forbs such as Goatsbeard, Hawksbeard and Astragalus have also dropped from the composition. Bulbous Bluegrass has increased over-time along with Sandberg Bluegrass.

In conclusion, as Crested Wheatgrass has declined, it has been replaced by shallow-rooted native perennials. The site is lacking deep-rooted native species such as Bluebunch Wheatgrass.

2. Soil Stability Discussion

Hits:

	1957	2001	Change (1957 to 2001)
All Plants	3	31	+28
Forage Plants	2	21	+19
Rock	5	0	-5
Litter	45	20	-25
Pavement	1	15	+14
Bare soil	46	34	-12
Moss	0	0	0

There have been some significant soil stability changes over the past 40 years. The number of direct Hits on plants has increased significantly from 4 Hits in 1957 to 31 Hits in 2001. At the same time Litter Hits have declined by 25 Hits. This decline in litter is more than offset by the increase in Plant Hits and the decline in Bare Soil (from 46 down to 34 Hits). Therefore the soil is significantly more stable today than it was in 1957 with less bare soil exposed to the elements.

3. Traditional Range Inventory Discussion

Composition:

		1957	2001	Change
Decreaser's (Most Desirables)	73	25	-53	
Palatable Increaser's (Intermediates)		1	67	+66
Unpalatable Increaser's (Least Desirables)		26	8	-18
Invader's		0	0	0
Total		100	100	

This chart demonstrates the decline in Crested Wheatgrass and increase in Palatable Increaser's such as the Poa species. At the same time the less desirable increasers have decreased. These changes would

indicate a move toward native species, and advancement in succession and general upward trend. This is assuming that Crested Wheatgrass is not our desired future condition. The site is still lacking native deep-rooted perennial grasses.

This may be a site that would make a good candidate for rehabilitation to a native plant community.

Condition & Trend Cluster #17 Summary

Joe Mohan established this cluster on the 22nd of May 1957. This cluster is located ¼ mile north of the Grizzly BPA Substation. It is located at 3200 feet elevation. The terrain is flat. The plant association is CJS2-91 Western Juniper/Gray Rabbitbrush-Big sagebrush/Crested Wheatgrass.

This site was an abandoned farm field that was seeded by the SCS in the 1930's-1950's. After seeding and rest the pasture has been grazed consistently to date.

1. Plant Specie Composition Analysis

Specie Composition Analysis
Grizzly Allotment, Cluster 17

		1957	1966	2001
Specie	Common Name	Average	Average	Average
AGCR	Crested Wheatgrass	87.0	64.3	18.7
SIHY	Bottlebrush Squirreltail	0.3	0.3	0.0
POSE	Sandberg Bluegrass	0.0	0.0	20.0
POBU	Bulbous Bluegrass	0.0	0.0	41.0
MASAL	?	0.3	0.0	0.0
CHDO	Douglas Dustymaiden	0.0	0.0	0.3
LUPIN	Lupine	0.7	8.0	0.0
LULE2	Pacific Lupine	0.0	0.0	1.3
ASTRA	Vetch	0.0	1.0	0.0
ERFI	Daisy	0.0	0.0	3.3
TRAGO	Goatsbeard	6.7	0.0	0.0
ACMI	Yarrow	0.0	0.0	3.0
CROC	Hawksbeard	0.0	0.0	0.3
CHR	Rabbitbrush	5.0	26.3	12.0
HER	?	0.3	0.0	0.0
		100	100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the above numbers are derived from a sample of 300 on or near the transect tape.

The primary change over the past 40 years has been a decline in Crested Wheatgrass and an increase in Sandberg and Bulbous Bluegrass. This is a natural change in succession as the site advances from an artificial seeded site to a site dominated by native species. Overtime the shrub canopy has increased and then decreased in % composition of Rabbitbrush. This could be the result of past fire. There has been a change from pioneer forbs to more persistent perennial forbs.

2. Soil Stability Discussion

Hits:

	1957	1966	2001	Change (1957 to 2001)
All Plants	12	21	24	+3
Forage Plants	11	10	19	+8
Rock	0	0	0	0
Litter	25	17	41	+16
Pavement	4	0	6	+2
Bare soil	59	62	25	-34
Moss	0	0	4	+4

Significant changes have occurred over the past 40 years. The most significant change has been a decrease in Bare Soil by 34 Hits and an increase in Litter by 16 Hits. At the same time there has been a slight increase on Hits on All Plants. In conclusion, the soil stability has improved and/or the trend is upward.

3. Traditional Range Inventory Discussion

Composition:

		1957	1987	2001	Change
Decreaser's (Most Desirables)	87	64	19	-68	
Palatable Increaser's (Intermediates)		0	1	61	+61
Unpalatable Increaser's (Least Desirables)		13	35	20	+7
Invader's		0	0	0	0
Total		100	100	100	

As indicated above, Decreaser's (Crested Wheatgrass) are decreasing while Palatable Increaser's (Bluegrasses) are increasing. It is important to note that the Decreaser's tallied above are in reality Introduced Decreaser's or introduced species such as Crested Wheatgrass. How long they will persist as introduced specie is unknown. Trend is difficult to ascertain as we are dealing with a seeded site.

Condition & Trend Cluster #21 Summary

G.W. George established this cluster on the 14th of May 1958. It is located in the South Weigand Pasture of the Grizzly allotment. When it was established it was located in the North Gray Butte allotment. Over time the boundaries have changed. The legal location is T 13 S R 14 E Section 16 SW SW. The topography is flat (less than 10% slope). The elevation is approximately 3480 feet. The precipitation in this zone is approximately 10 inches/year. The soils at the time of the first reading consisted of 12 inches of topsoil with a restrictive layer at 13 inches. There is an impervious layer or hardpan at 25 inches depth.

At the time of the first reading of this cluster the "range type" was typed as 5 Bitterbrush – Bluebunch wheatgrass. At this time it is typed as CJS2-26 Western Juniper/Big Sagebrush/Bluebunch Wheatgrass-Idaho Fescue, Flat. The cluster includes 3 – 100 foot transects. Samples were taken at each foot along the 100 foot transect. Year 2001 is a very poor precipitation year on the grasslands as was Year 2000. Our vegetation production is significantly lower than an average year. Last winters moisture was very low to non-existent while spring moisture was also very low. Therefore, conclusions drawn must be tempered by this very poor precipitation year.

1. Plant Specie Composition Analysis

Specie Composition Analysis
Grizzly Allotment, Cluster 21

		1958	2001
Specie	Common Name	Average	Average
AGSP	Bluebunch Wheatgrass	13.3	22.7
FEID	Idaho Fescue	20.3	23.3
KOCR	Junegrass	1.3	0.7
STIPA	Needlegrass	0.7	0.0
SIHY	Bottlebrush Squirreltail	1.0	7.0
POSE	Sandberg Bluegrass	58.0	31.7
POBU	Bulbous Bluegrass	0.0	0.3
ARAC2	Arenaria	0.0	2.7
ERLI	Daisy	0.0	0.7
ERIOG	Buckwheat	0.0	2.7
PHLOX	Phlox	1.0	0.0
ACMI	Yarrow	0.3	2.7
BRCA	California Brome	0.0	0.3
VUOC	Six weeks fescue	0.0	0.7
PUTR	Bitterbrush	1.7	2.7
ARTR	Sagebrush	0.0	1.3
CHR	Rabbitbrush	2.3	0.7
		100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the numbers above are derived from a sample of 300 on or near the transect tape.

There have been positive changes over the past 40+ years as indicated by the increase in Idaho Fescue and Bluebunch Wheatgrass and the decrease of Sandberg Bluegrass. In addition, there has been an increase in forb production along with Sagebrush and Bitterbrush % composition.

The 1958 photos indicate Western Juniper encroachment to the site. The 2001 photos display an increase in Western Juniper and the results of fire on a portion of the site. The photos indicate that where fire occurred the site has improved significantly in grass production. The recent presence of fire would lend to an increase in forb production.

From a plant specie viewpoint, the trend on this site is stable to slightly upward.

2. Soil Stability Discussion

Hits:

	1958	2001	Change
All Plants	22	19	-3
Forage Plants	20	14	-6
Rock	9	1	-8
Litter	35	51	+16
Pavement	4	12	+8
Bare soil	24	14	-10
Moss	6	3	-3

Analyzing the Transect Hits I come to the following assumptions: Significant changes occur in the decrease in hits on rock and bare soil and the increased number of Hits on Litter and Pavement.

The past level of grazing is apparently providing more plant material available to cover soil than before. The increase in erosion pavement could indicate wind and or water erosion over the past 43 years, leaving pavement. Another possibility could be in the reading of the transects; confusing rock for pavement and vice versa. The decrease in hits on all plants and moss may be from the two dry years we are experiencing at this time.

3. Traditional Range Inventory Discussion

Composition:

	1958	2001	Change
Decrease's (Most Desirables)	37	49	+12
Palatable Increasers (Intermediates)	59	39	-20
Unpalatable Increaser (Least Desirables)4	11	+7	
Invaders	N.A.	1	+1
Total	100	100	

While there has been an increase in the % composition of Decreaser's, there has also been a decrease in the % composition of the Palatable Increasers. The primary Decrease's are Bluebunch Wheatgrass and Idaho Fescue. Over the past 43 years the % composition of the Bluebunch Wheatgrass has increased by 10% and Idaho fescue has increased by 3 %. Together they have increased by 13%. This may be a significant improvement.

Perennial forb composition has changed slightly. In 1958 forb composition was 1% while in 2001 it was 9% of the plant composition. Identification of forbs during a drought such as we are experiencing is difficult. Perennial forbs are important part of the composition, as antelope and other wildlife prefer forbs during various time of the year.

The shrub canopy has changed over the years. In 1958, 4 % of the composition was shrubs, which were made up of Bitterbrush and Rabbitbrush. In 2001, 5% of the composition was comprised of shrubs. The primary difference being in the % Bitterbrush and Sagebrush being higher in 2001 than in 1958. This would also be a positive trend. According to the transects information and the photos, juniper was just entering the area in the 50's while in 2001 juniper is a major part of the tree canopy.

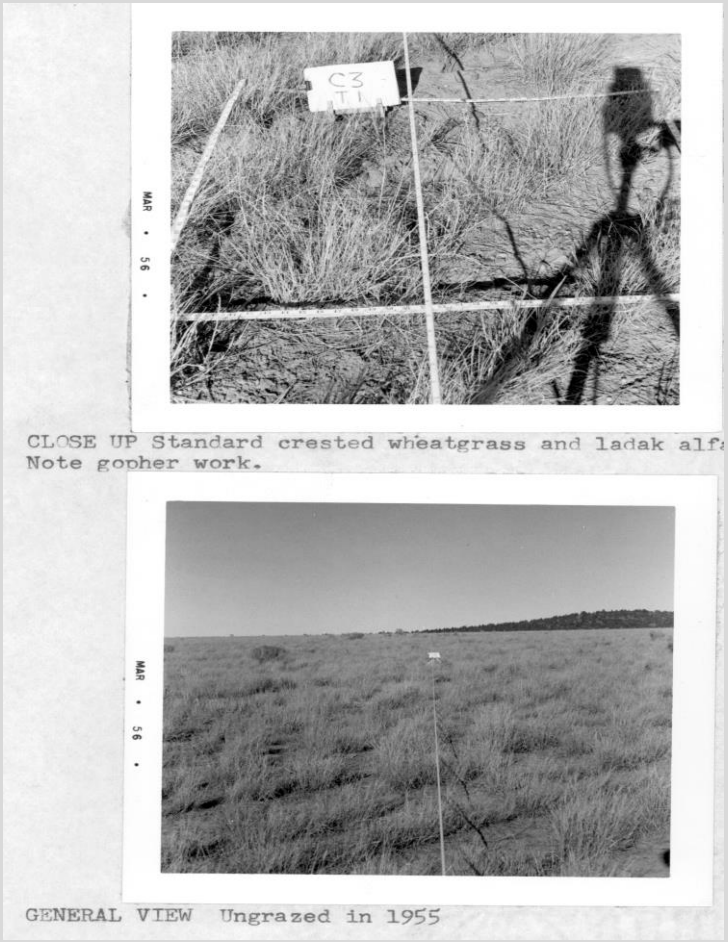
No range condition ratings are discussed here. Trend is a matter of movement in the plant composition to dominance by native perennial species. This appears to be the situation on this site, although slightly. Another indicator of trend would be the presence of Sandberg Bluegrass. In 1958, 58 % of the composition was Sandburg bluegrass, while in 2001 it was 30 % of the composition. I believe this is a positive trend as Sandberg Bluegrass is a shallow-rooted native perennial grass with a very short growing period compared to other perennial grasses.

In conclusion, I believe this site to be stable with a slight upward movement as indicated by species composition. This present condition could be negated by the increasing presence of juniper and the negative effects that it could bring.

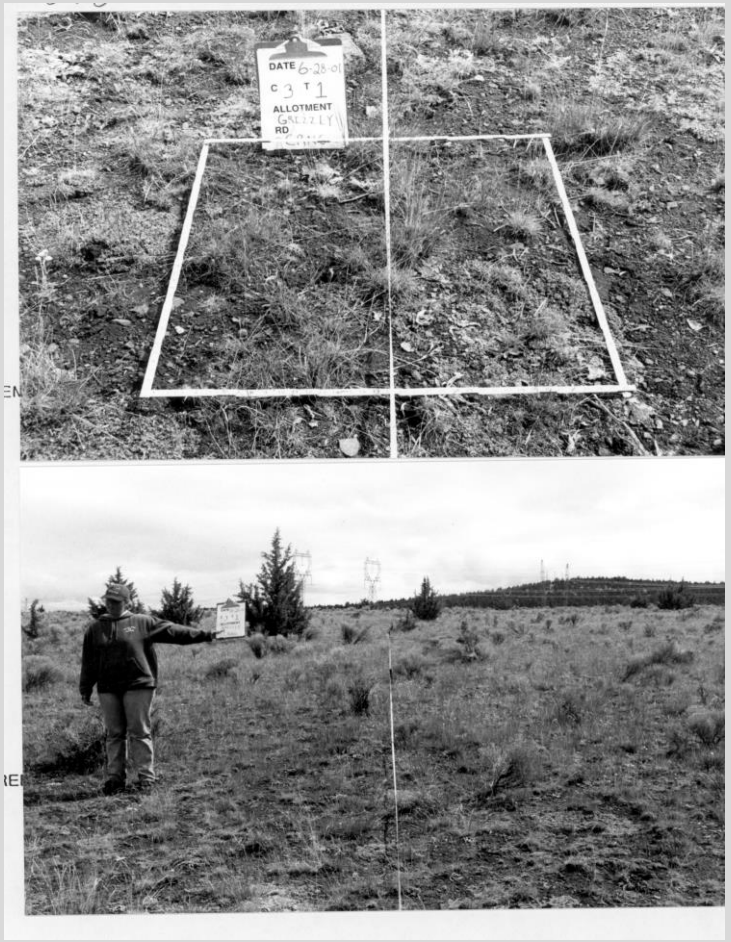
This site is moderately to heavily grazed annually. Sometime in the past 20 years the site was burned.

Historical Photos – Grizzly Allotment

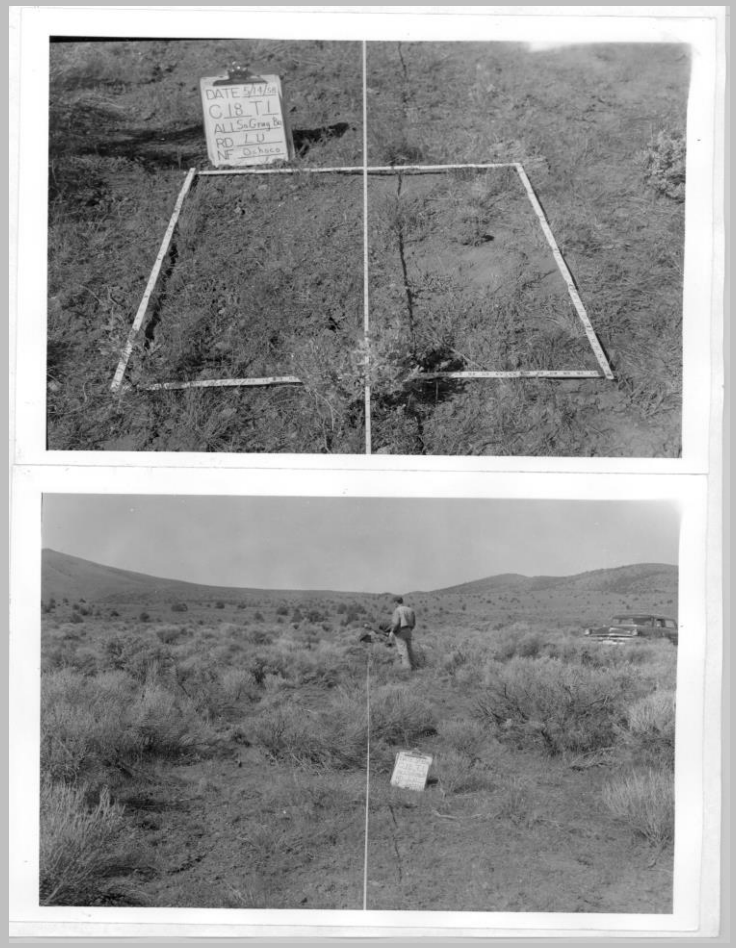
Grizzly C3 T1, 1955



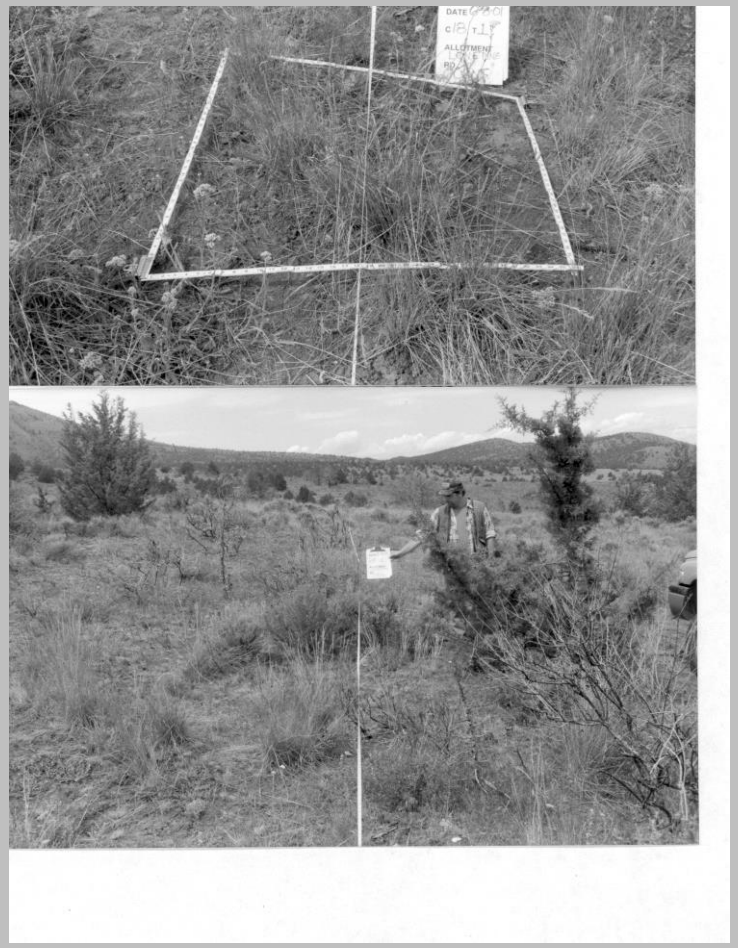
Grizzly, C3 T1 2001



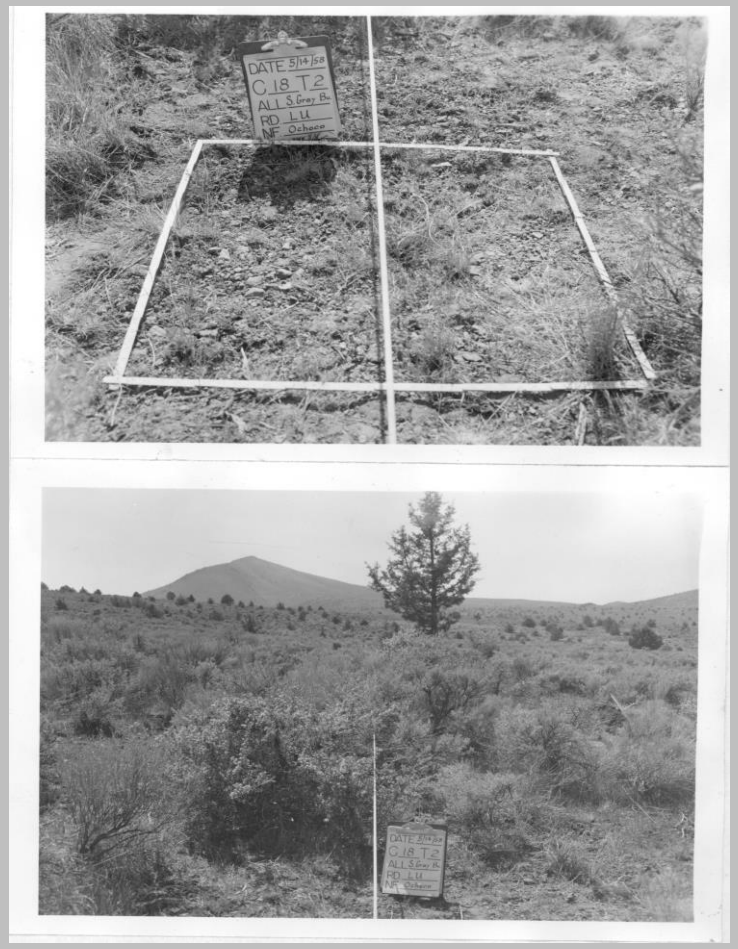
Lone Pine C18 T1, 1958



Lone Pine C18 T1, 2001



Lone Pine C18 T2, 1958



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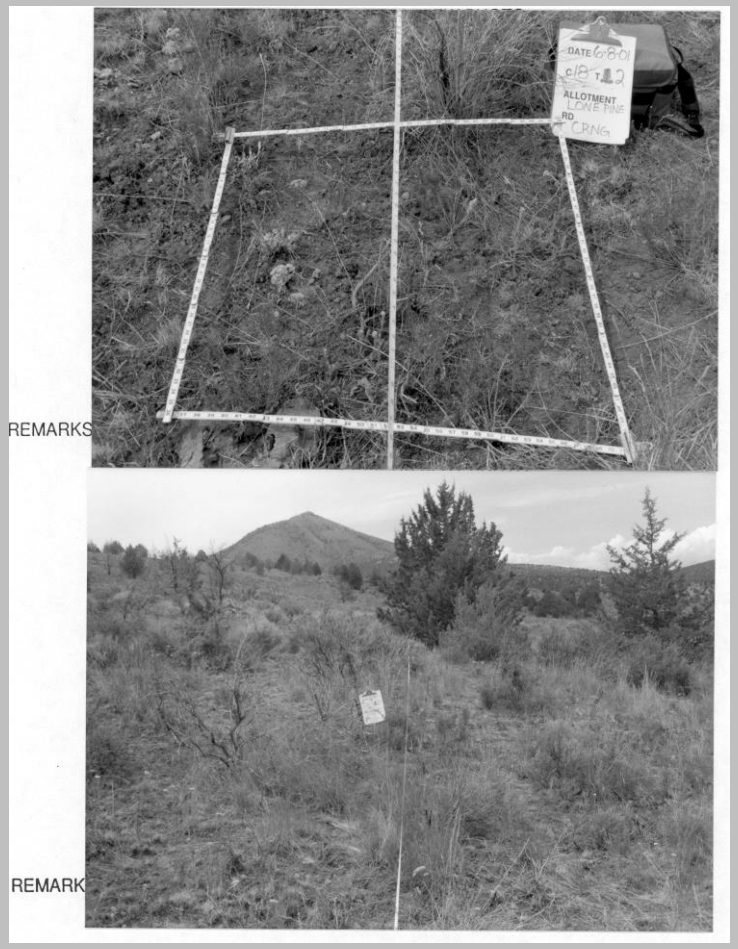
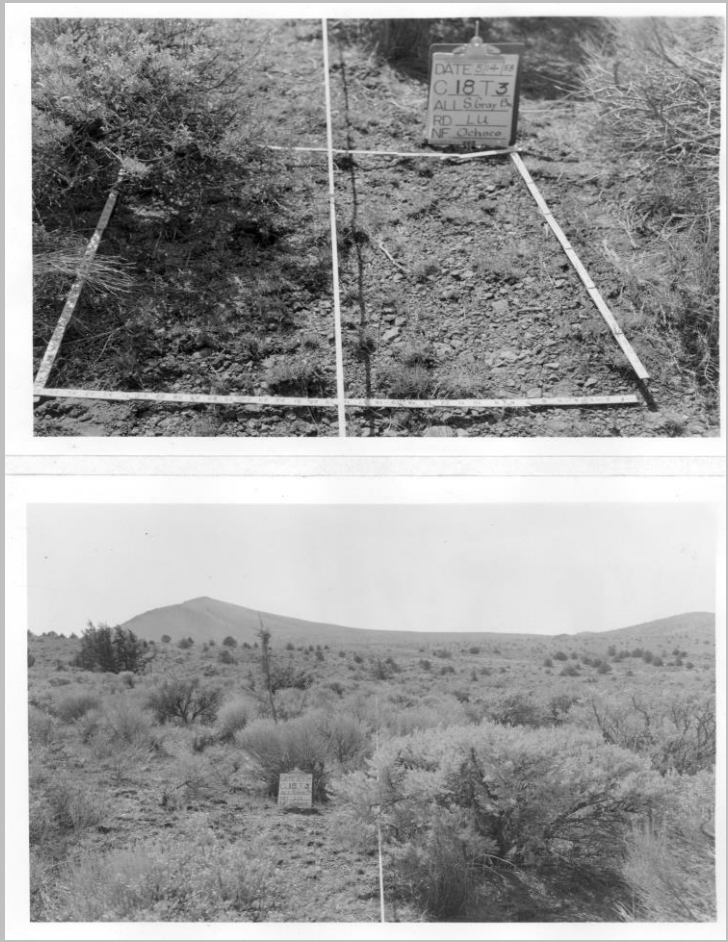
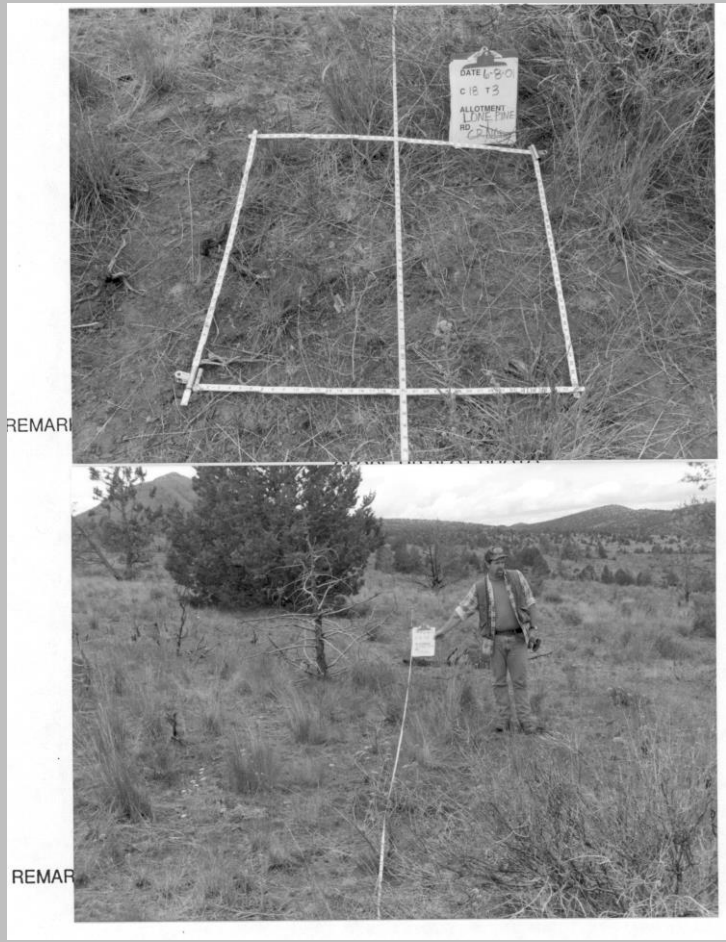


Lone Pine C18 T3, 1958



Lone Pine C18 T3, 2001



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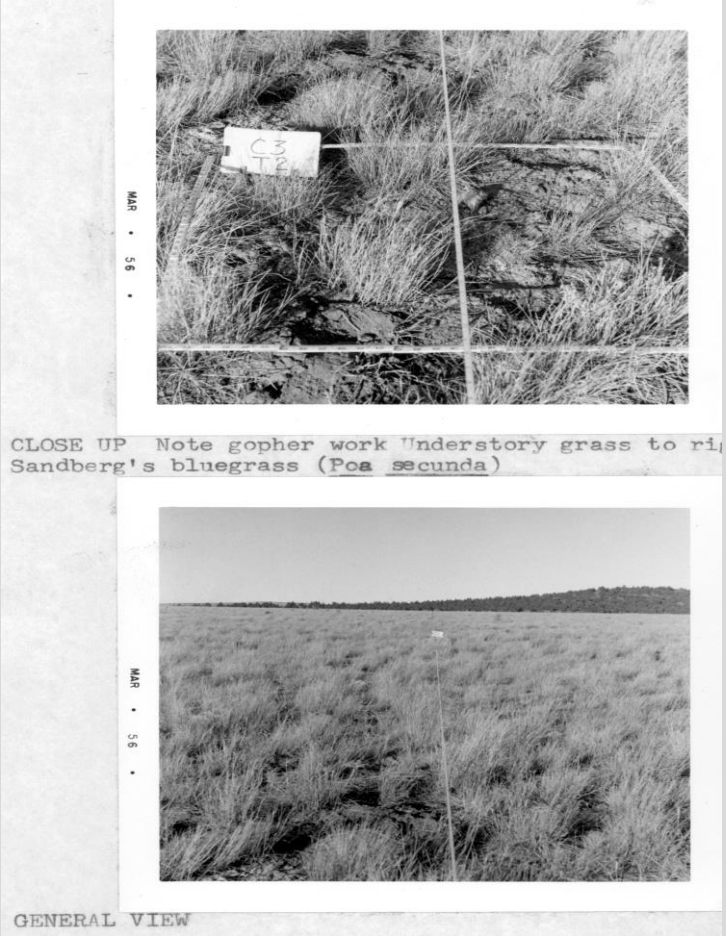

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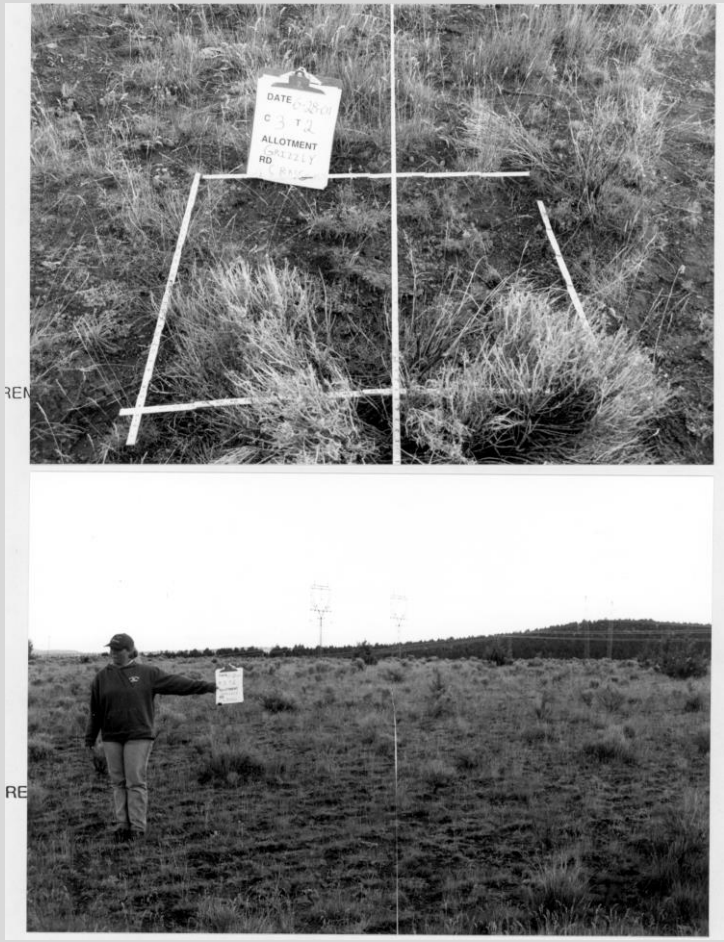

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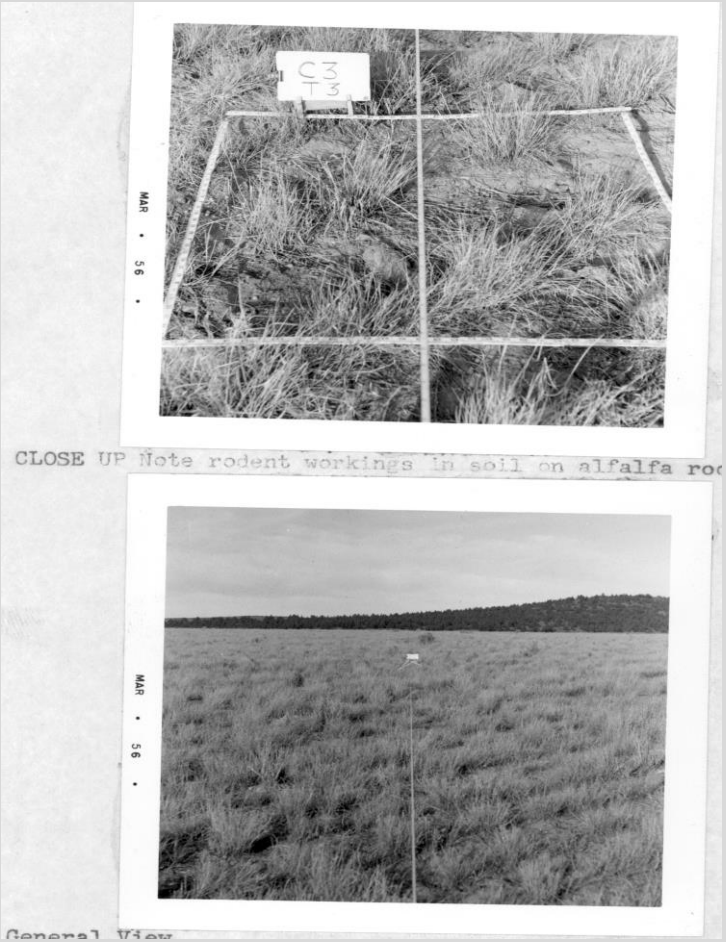

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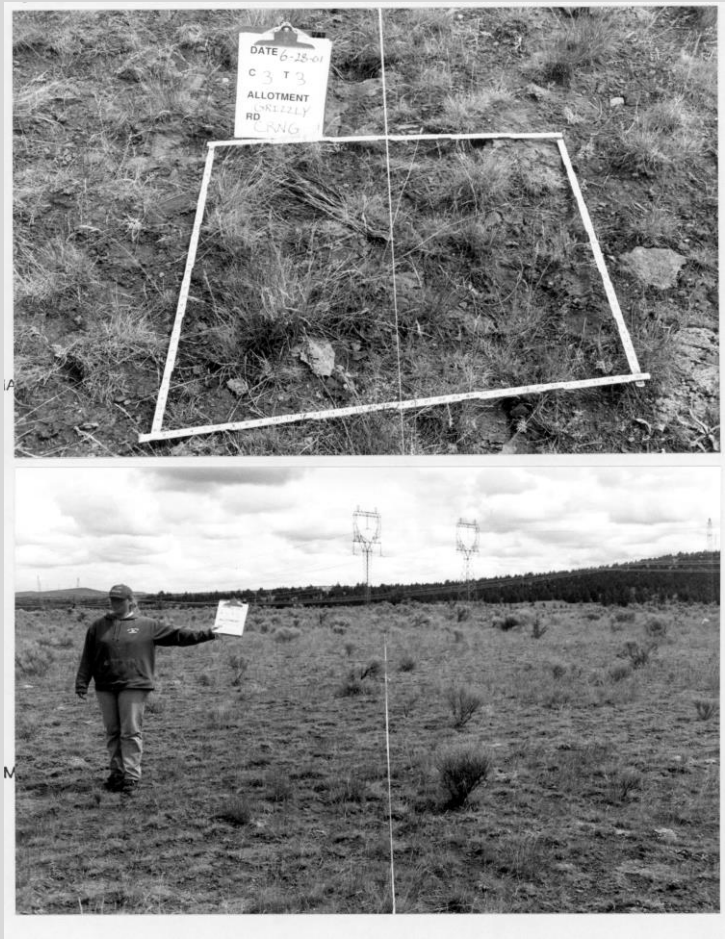
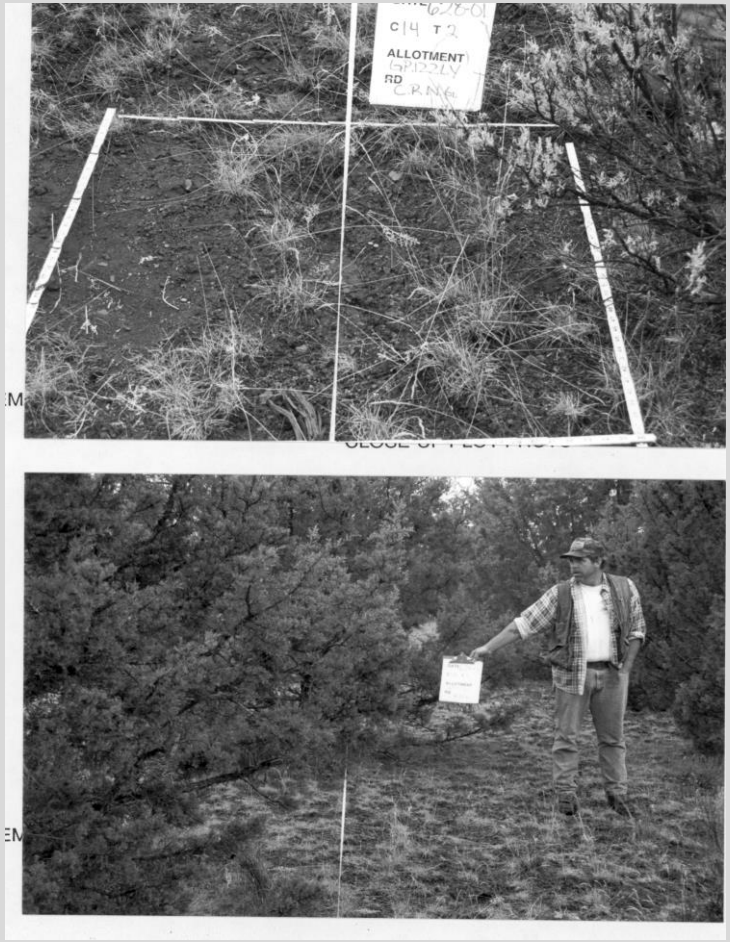


Grizzly C14 T1, 1957

Grizzly C14 T1, 2001

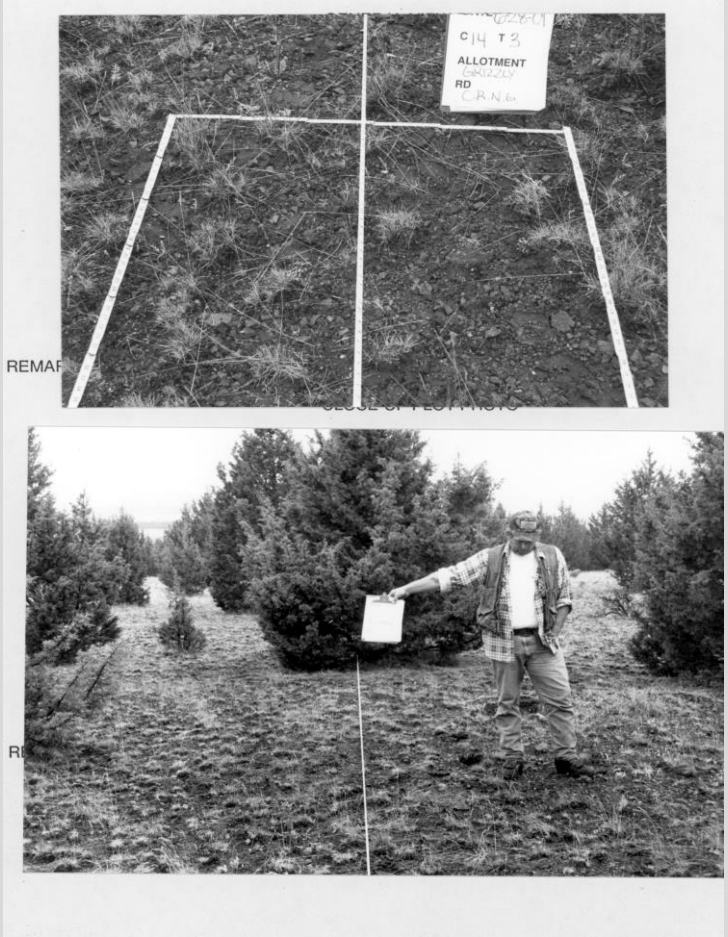
Grizzly C14 T2, 1957

Grizzly C14 T2, 2001



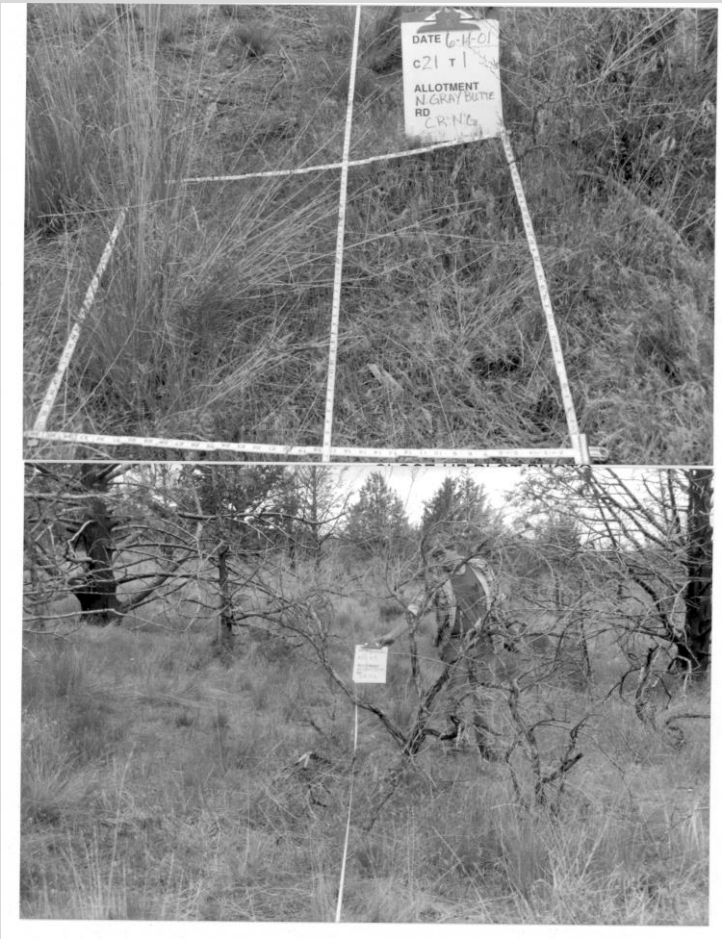
Grizzly C14 T3, 1957

Grizzly C14 T3, 2001



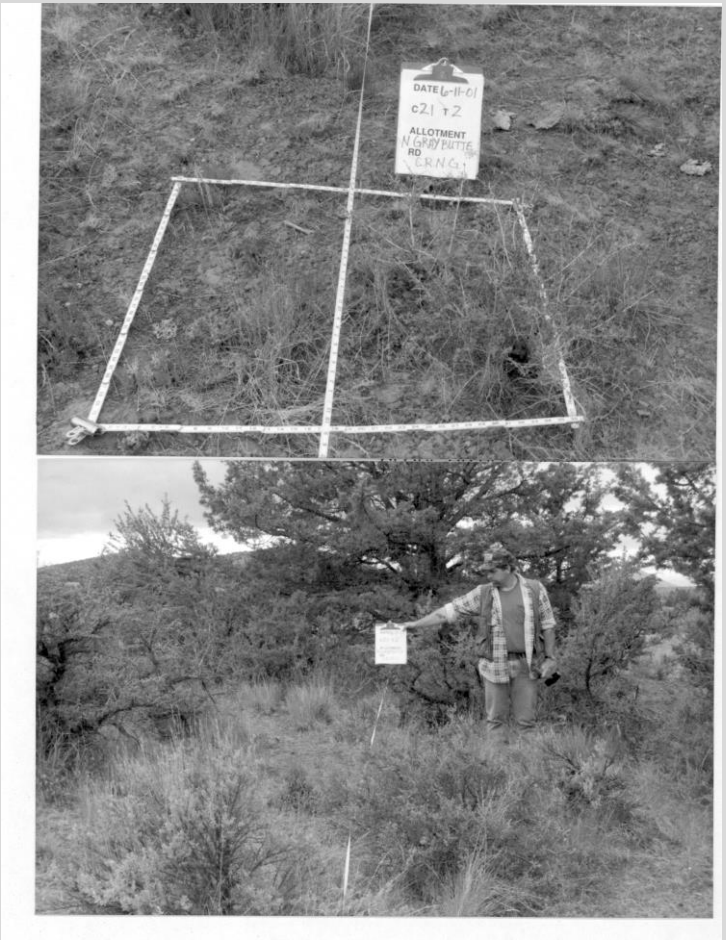
Grizzly C21 T1, 1958

Grizzly C21 T1, 2001



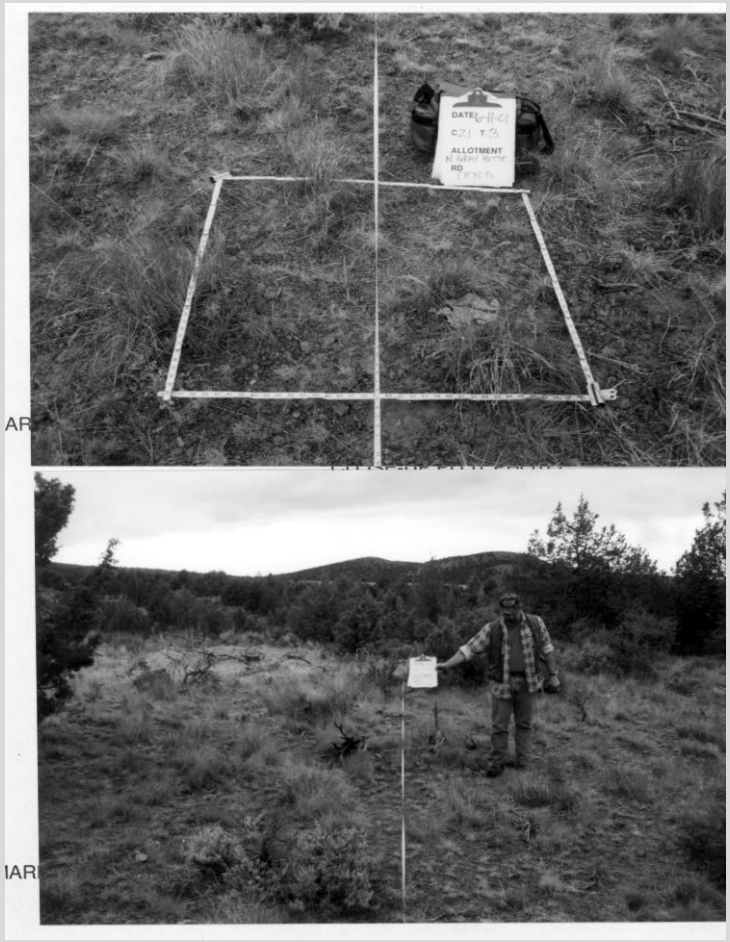
Grizzly C21 T2, 1958

Grizzly C21 T2, 2001



Grizzly C21 T3, 1958

Grizzly C21 T3, 2001



Lone Pine Allotment

Lone Pine Allotment Cluster #18 Condition & Trend Summary

2003

The Lone Pine Allotment is located in the southern end of the grasslands. Gray Butte is the most prominent topographic feature on the allotment. Over half of the allotment is characterized by buttes and rolling hills. A significant riparian area exists on the allotment, Lone Pine Flat. It is assumed that at one time this flat was a meadow. Parts of the allotment were seeded to Crested Wheatgrass.

The allotment is approximately 8720 acres in size. The allotment varies in elevation from 3000 to 6000 feet. Precipitation usually varies between 8 and 12 inches/year. Most of the precipitation occurs as snow in the winter. Storm patterns vary depending on the year.

This year, 2001, is a drought year as was year 2000. This drought affects the cluster results. Litter and plant specie readings are affected negatively by the drought. Many forbs were dried out by the time the transects were read. Therefore, when considering the results of the clusters it is important to factor in the drought.

Parts of this allotment were dryland farmed during the homestead era at the turn of the last century. The homesteaders left the land in the 1930's through the relocation act. After that period the SCS seeded parts of this allotment to Crested Wheatgrass or Whitmar (Beardless Bluebunch Wheatgrass). These seeding took place in the 1930's, 40's and 50's. In addition to these seedings, parts of the allotment have been treated chemically for shrub control and fire and chainsaw cutting have been used to control juniper. The allotment has been grazed consistently over this the period since seeding.

The allotment has permitted 200 cow/calf pairs for 7 months and 8 bulls for 3 months for 1884 animal unit months. The allotment is approximately 8720 acres in size. The present stocking rate is 4.6 acres/AUM. The allotment is grazed under a 10 pasture deferred grazing system.

Following are summaries by cluster. Below each cluster heading will be four discussions. The first is a discussion of the history of the cluster including location, elevation, aspect, soils, plant association, etc. The second is a discussion of the Plant Specie Composition, the third is a discussion of Soil Stability based on an analysis of the "Transect Hits", and the fourth is a discussion is based on the Tradition Range Inventory methods used and discusses Decreaser, Palatable Increaser, Increaser, and Invader plant specie categories.

Note: The Condition and Trend Clusters are comprised of three 100-foot transects. These transects are permanently located on the ground with angle-iron stakes that were established and marked in the 1950's for the most part. When read a steel tape is stretched between the iron stakes. At each 1-foot mark along the tape a sample is taken. "Hits" are what actually lies beneath the "1-foot" mark (i.e. a plant, Bare Soil, Rock, Litter, etc.). Composition data is gathered from Plant Hits and the nearest plant when the Hit is not a plant but Bare Soil or another non-plant Hit. When completed the Cluster provides 300 sample points from which the data are generated from.

Condition & Trend Cluster #18 Summary

Foster established this cluster on the 14th of May 1958. It is located in the Burn Pasture of the Lone Pine Allotment. The legal location is T 13 S R 14 E Section 21 NWNW. The Cluster is located at the northern base of (*Pine Ridge tks*) Gray Butte at the 3600-foot elevation.

The precipitation in this zone is approximately 10 inches/year.

The cluster is located in the CJS2-12 Western Juniper/Big Sagebrush/Idaho Fescue-Bluebunch Wheatgrass, N slope. *Bluebunch miss-identified; correct = Poa Ampla (big bluegrass tks).*

1. Plant Specie Composition Analysis

Specie Composition Analysis
Lone Pine Allotment - Cluster 18

Specie	Common Name	1958 Average	2001 Average
AGSP	Bluebunch Wheatgrass	0.0	10.0
FEID	Idaho Fescue	0.7	21.7
KOCR	Junegrass	0.0	0.7
STIPA	Needlegrass	2.3	0.0
SIHY	Bottlebrush Squirreltail	3.0	3.0
POSE	Sandberg Bluegrass	64.7	30.7
BRCA	California Brome	0.0	6.0
ARAC2	Rockcress	0.0	2.7
ANLU	Pussytoes	0.3	0.7
ACMI	Yarrow	1.0	10.7
LOMAT	Lomatium	7.3	0.0
? Forb		0.3	0.0
ERO	Buckwheat	0.0	5.3
AGOS	Agoseris	0.3	0.0
ARTR	Sagebrush	10.0	3.7
CHRYS	Rabbitbrush	4.7	2.3
PUTR	Bitterbrush	5.3	2.7
		100	100

The above chart displays plant species encountered within the transect area by percent composition. At each 1-foot mark along the transect tape a reading is taken, if no plant is hit then the nearest plant within a 180 degree arc in front of the sample point is recorded for composition purposes. Therefore the numbers above are derived from a sample of 300 on or near the transect tape.

Significant positive changes have occurred over the past 40 + years on this site. In addition to grazing, the site has been prescribe burned over the past 10 years. Significant vegetation changes include the decline in % composition of Sandberg Bluegrass (65% in 1958 to 31 % in 2001). As Sandberg Bluegrass has decreased, Idaho Fescue (1% in 1958 to 22% in 2001) and ~~Bluebunch Wheatgrass~~ *Poa Ampla* (0% in 1958 to 10% in 2001) have increased significantly in % composition. *(Note: there is Agsp present but Poa Ampla is a larger percent of the plant community).*

All three shrub species (Rabbitbrush, Bitterbrush and Sagebrush) have decreased. This change is probably the result of prescribe fire. All three species still exist on the site.

From a successional viewpoint, the trend on this site is upward, but is being maintained with prescribe fire.

2. Soil Stability Discussion

Hits:

	1958	2001	Change
All Plants	26	18	-8
Forage Plants	11	12	+1
Rock	7	2	-5
Litter	27	45	+18
Pavement	22	9	-13
Bare soil	11	26	+15
Moss	5	0	-5

The increase in Bare Soil and decrease in Moss Hits is probably a short-term result from the prescribe fire that occurred during the past few years. Litter Hits are up, which is a positive indicator.

3. Traditional Range Inventory Discussion

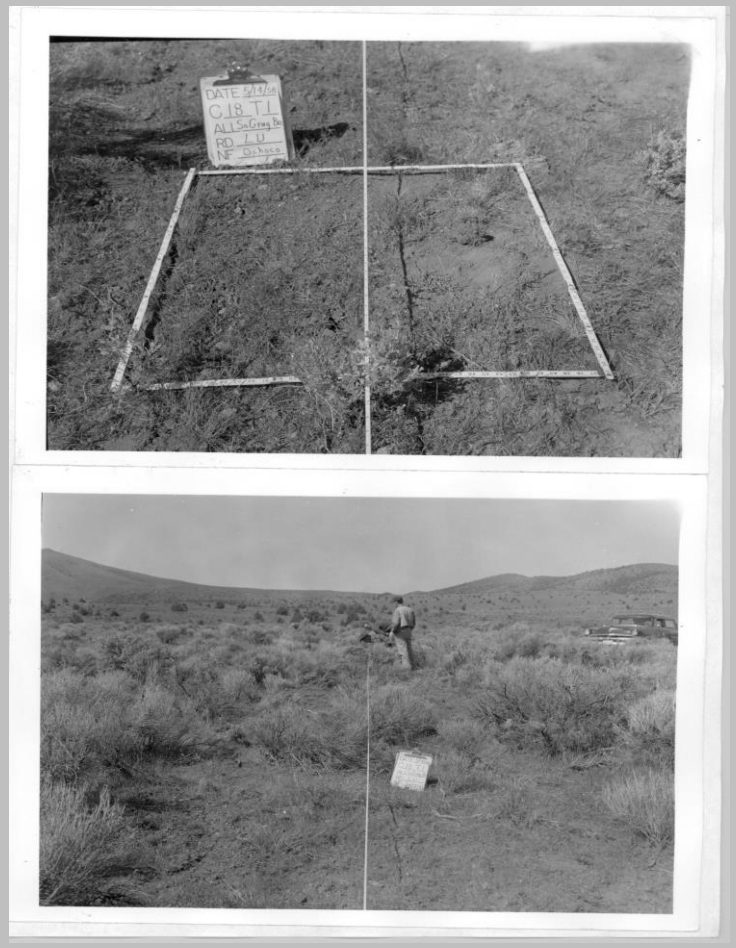
Composition:

	1958	2001	Change
Decrease's (Most Desirables)	6	35	+29
Palatable Increasers (Intermediates)	70	40	-30
Unpalatable Increaser (Least Desirables)	24	25	+1
Invaders	0	0	0
Total	100	100	

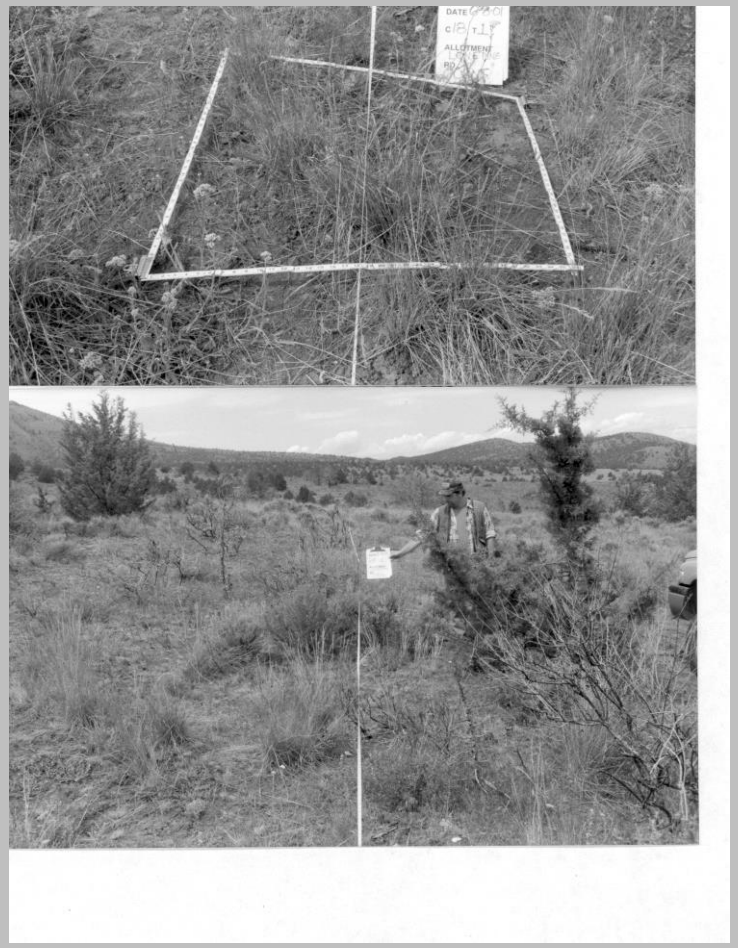
The composition changes are significant here, as Decreaser's have increased while Palatable Increaser's have decreased. This is positive trend.

Historical Photos – Lone Pine Allotment

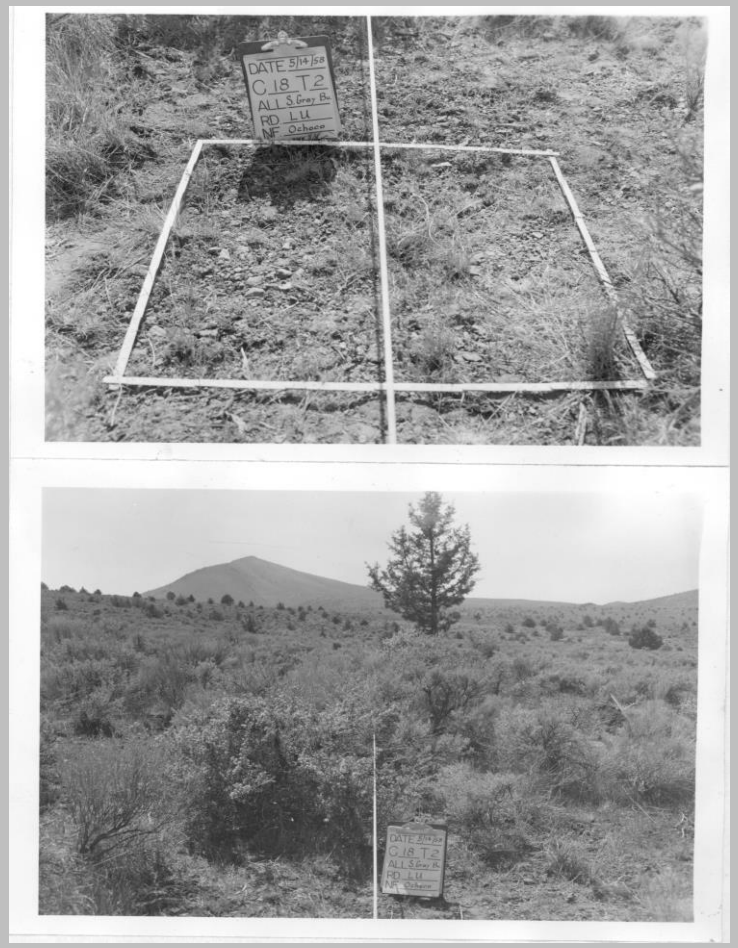
Lone Pine C18 T1, 1958



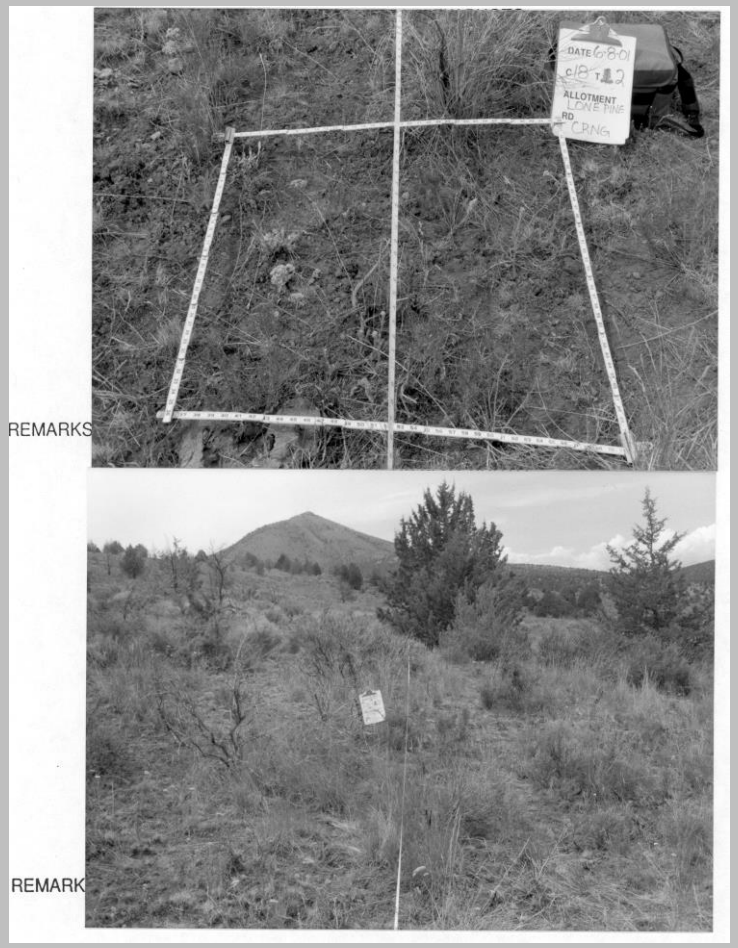
Lone Pine C18 T1, 2001



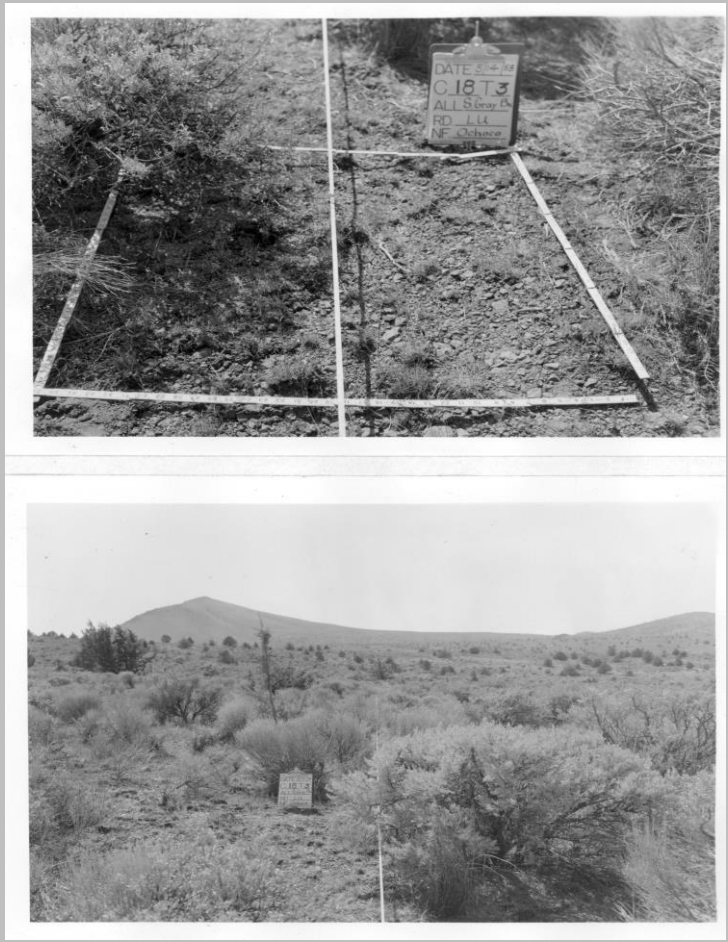
Lone Pine C18 T2, 1958



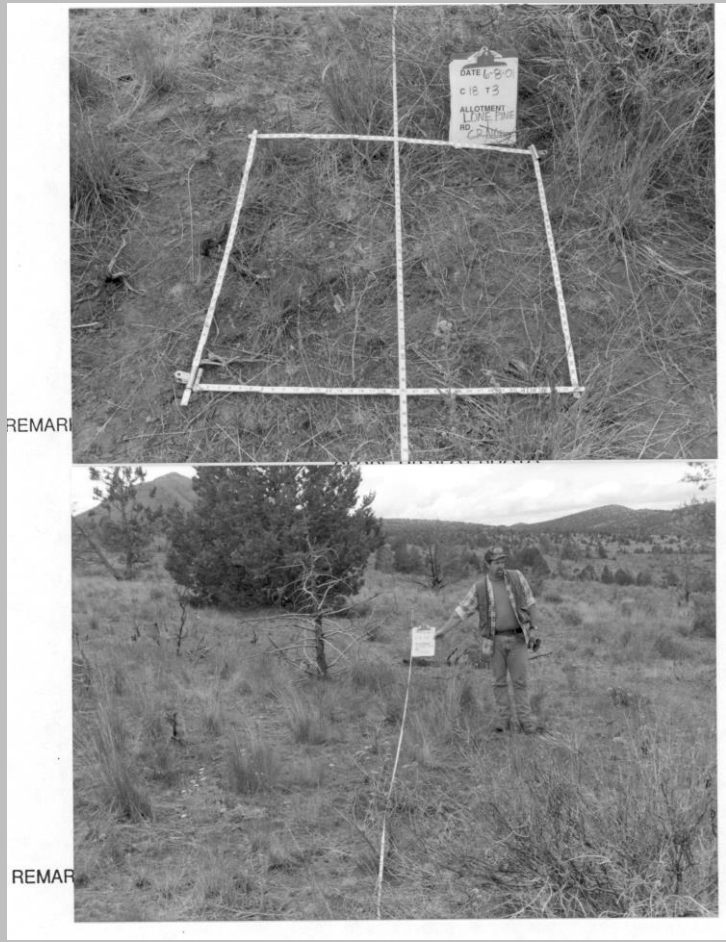
Lone Pine C18 T2, 2001



Lone Pine C18 T3, 1958



Lone Pine C18 T3, 2001



Appendix E: Electronic data

"electronic appendix" : DIMA, photos, production sheets, all field note data, and PDFs of many of the references used in this report

See http://www.cabnr.unr.edu/resources/mlra.aspx or contact Devon Snyder (devonsnyder@cabnr.unr.edu) or Tamzen Stringham (tstringham@cabnr.unr.edu) directly for access to these data.