Ecological site group R023XY908NV
Loamy 14-18 PZ Mountain Big Sagebrush and Mountain Brome

Last updated: 06/03/2024
Accessed: 06/30/2024

Key Characteristics

- Site does not pond or flood
- Landform other than dunes
- Surface soils are not clayey
- Sites are shrub or grass dominated
- [Criteria]MAP >10"
- Soil is moderately deep or deeper
- Site on other aspects or landforms
- Soils texture (PCS) loamy

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

Physiography

This group is on mountains slopes at elevations between 5,500 and 9,000 feet. Slopes are 5 to 65 percent.

Climate

The climate is classified as Cold Semi-Arid in the Koppen Classification System.

The area has a strong climate gradient, with annual precipitation ranging between 14 inches at lower elevations and 24 inches on upper mountain slopes. Precipitation falls as snow in the winter and rain in spring and fall. Summers are generally dry.

The frost-free period is 40 to 70 days. The mean annual air temperature is 40 to 45 °F.

Soil features

The soils in the group are generally 40 inches deep, with some as shallow as 35 inches. The textures are loamy-skeletal or ashy-skeletal, with gravelly surface textures. The soils are derived from volcanic residuum and colluvium.

Soil temperature regimes are generally frigid with some cryic map units. Taxonomically, these soils are Mollisols.

Commonly mapped soil series in this group include Bullump, Hastee, Aycab, and Tusel.

Vegetation dynamics

Ecological Dynamics and Disturbance Response:

An ecological site is the product of all the environmental factors responsible for its development. Each site has a set of key characteristics that influence its resilience to disturbance and resistance to invasives. According to Caudle et al. (2013), key characteristics include:

1. Climate factors such as precipitation and temperature.
2. Topographic characteristics such as aspect, slope, elevation, and landform.

3. Hydrologic processes such as infiltration and runoff.
4. Soil characteristics such as depth, texture, structure, and organic matter.
5. Plant communities and their functional groups and productivity.
6. Natural disturbance (fire, herbivory, etc.) regime.

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

The Great Basin sagebrush communities have high spatial and temporal variability in precipitation both among years and within growing seasons (MacMahon, 1980). Nutrient availability is typically low but increases with elevation and closely follows moisture availability. The invasibility of plant communities is often linked to resource availability. Disturbance changes resource uptake and increases nutrient availability, often to the benefit of non-native species; native species are often damaged and their ability to use resources is depressed for a time, but resource pools may increase from lack of use and/or the decomposition of dead plant material following disturbance (Whisenant, 1999; Miller et al., 2013). The invasion of sagebrush communities by cheatgrass (*Bromus tectorum*) is linked to disturbances (fire, abusive grazing) that result in fluctuations in resources (Beckstead & Augspurger, 2004; Chambers et al., 2007; Johnson et al., 2011).

The ecological sites in this group are dominated by deep-rooted, cool-season, perennial bunchgrasses and long-lived shrubs (at least 50 years old) 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 meters (Dobrowolski et al., 1990). Root length of mature sagebrush plants was measured to a depth of 2 meters in alluvial soils in Utah (Richards & Caldwell, 1987). These shrubs have a flexible generalized root system with development of both deep taproots and laterals near the surface (Comstock & Ehleringer, 1992).

Mountain big sagebrush (*Artemisia tridentata* ssp. vaseyana) and antelope bitterbrush (*Purshia tridentata*) 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 are the foundation of population maintenance (Noy-Meir, 1973). Survival of the seedlings depends on adequate moisture conditions. The factor that most limits establishment of bitterbrush seedlings is competition for water resources with the invasive species cheatgrass (Clements & Young, 2002).

The perennial bunchgrasses that are co-dominant with the shrubs include mountain brome (*Bromus marginatus*), needlegrasses, Idaho fescue (*Festuca idahoensis*), bluegrasses, and grass-like plants such as sedges. These species generally have somewhat shallower root systems than the shrubs on these sites; root densities of these species are often as high as or higher than those of shrubs in the upper 0.5 meters of the soil profile. The root systems of short-lived perennial grasses such as bluegrasses and mountain brome penetrate only the upper 40 centimeters of the soil, whereas the root systems of longer-lived perennial bunchgrasses can reach depths up to 160 centimeters (Spence, 1937). The general differences in root depth distributions between grasses and shrubs result in resource partitioning in these shrub/grass systems.

Periodic drought regularly influences sagebrush ecosystems, and drought duration and severity have increased throughout the 20th century in much of the Intermountain West. Major shifts away from historical precipitation patterns have the greatest potential to alter ecosystem function and productivity. Species composition and productivity can be altered by the timing of precipitation and water availability within the soil profile (Bates et al., 2006).

Native insect outbreaks are also important drivers of ecosystem dynamics in sagebrush communities. Climate is generally believed to influence the timing of insect outbreaks, especially outbreaks of a sagebrush defoliator called Aroga moth (Aroga websteri). Aroga moth infestations occurred in the Great Basin in the 1960s, the early 1970s, and have been ongoing in Nevada since 2004 (Bentz et al., 2008). Thousands of acres of big sagebrush (*Artemisia tridentata*) have been impacted, with partial to complete die-off observed. The Aroga moth can partially or entirely kill individual plants or entire stands of big sagebrush (Furniss & Barr, 1975).

Juniper may grow where these sites are adjacent to woodlands. An extended fire return interval and/or inappropriate grazing can facilitate juniper invasion. Eventually, juniper will dominate the site and out-compete sagebrush for water and sunlight, thus severely reducing both the shrub and herbaceous understory (Lett & Knapp, 2005; Miller & Tausch, 2001). Fescue and bluegrasses may remain underneath trees on north-facing slopes.

The ecological sites in this group have moderate to high resilience to disturbance and resistance to invasion. Resilience increases with elevation, northerly aspect, precipitation, and nutrient availability. Five possible stable states have been identified for the Loamy Slope 16+" ecological site. Differences in resilience to disturbance for the remaining ecological sites contained within this group are described at the end of this document.

Annual Invasive Grasses:

This group is highly resilient. However, both the Loamy 16+" and Loamy Slope 16+" sites were seen in annual states, with cheatgrass as the dominant plant (by weight). This group's elevation is 5,500 to 9,000 feet. This group is highly resilient due to its elevation and deep, productive soils. However, over time it may become more vulnerable to invasion by cheatgrass at lower elevations. High elevations in the Great Basin remain relatively uninvaded by cheatgrass (Bradley & Mustard, 2006) and exhibit low risk of invasion (Suring et al., 2005). However, climate change and local adaptations of cheatgrass at the "invasion edge" are creating more opportunities for invasion in areas previously undisturbed by these plants (Leger et al., 2009; Bradley, 2009). Cheatgrass invasions are being recorded at higher elevations (Mealor et al., 2012; Bradley, 2009). The risk of invasion should be considered in post-fire rehabilitation planning. Across a variety of elevations, healthy, native, perennial, herbaceous communities coupled with management practices that reduce litter and seed banks, are the most effective tools to reduce cheatgrass invasions (Chambers et al., 2007; Jones et al., 2015).

Cheatgrass is a cool-season annual grass that maintains an advantage over native plants in part because it is a prolific seed producer, able to germinate in the autumn or spring, tolerant of grazing, and increases with frequent fire (Klemmedson & Smith, 1964; Miller et al., 1999). Cheatgrass originated from Eurasia and was first reported in North America in the late 1800s (Mack & Pyke, 1983; Furbush, 1953).

Recent modeling and empirical work by Bradford and Lauenroth (2006) suggest 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.

Methods to control 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. Spraying with herbicide (Imazapic or Imazapic + glyphosate) and seeding with crested wheatgrass (*Agropyron cristatum*) and Sandberg bluegrass (*Poa secunda*) have been more successful at combating medusahead (Taeniatherum) 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 a higher likelihood of success when using introduced perennial bunchgrasses such as crested wheatgrass (Davies et al., 2015). Butler et al. (2011) tested four herbicides (Imazapic, Imazapic + glyphosate, rimsulfuron, and sulfometuron + Chlorsulfuron), using herbicide-only treatments, for suppression of cheatgrass, medusahead, and ventenata (*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. Herbicide-only treatments appeared to remove competition for established bluebunch wheatgrass (*Pseudoroegneria spicata*) by providing 100 percent control of ventenata and medusahead and greater than 95 percent control of cheatgrass. However, caution in using these 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 (J.L Vollmer & J. G. Vollmer, 2008). Mature medusahead and cheatgrass are very flammable and fire can be used to remove the thatch layer, consume standing vegetation, and even reduce seed levels.

When 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. J. L. Vollmer and J. G. 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 8 ounces per acre with or without surfactant. Sagebrush, regardless of species or rate of application, was not affected. However, many environmental variables were not reported in this study and managers should install test plots before broad scale herbicide application is initiated.

Fire Ecology:

Pre-settlement fire return intervals in mountain big sagebrush communities varied from 15 to 25 years (Burkhardt & Tisdale, 1969; Houston, 1973; Miller & Tausch, 2001). Mountain big sagebrush is killed by fire (Neuenschwander, 1980; Blaisdell et al., 1982) and does not resprout (Blaisdell, 1953). Post-fire regeneration starts from seed and will vary depending on site characteristics, seed sources, 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 to 20 years following fire, but establishment after severe fires may proceed more slowly and can take up to 50 years (Bunting et al., 1987; Ziegenhagen, 2003; Miller & Heyerdahl, 2008; Ziegenhagen & Miller, 2009).

Mountain snowberry (*Symphoricarpos oreophilus*) is top-killed by fire, but resprouts after fire from rhizomes (Leege & Hickey, 1971; Noste & Bushey, 1987). Snowberry has been noted to regenerate well and exceed pre-burn biomass in the third season after fire (Merrill et al., 1982). Currant (Ribes sp.), a minor component of this ecological site group, sprouts weakly from the root crown and usually regenerates from seeds stored in the soil after fire. It is susceptible to fire mortality and rarely survives fire (Crane & Fischer, 1986). If balsamroot (Balsamorhiza sp.) or mule-ears (Wyethia sp.) are common before fire, these plants will increase after fire or heavy grazing (Wright, 1985).

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

Mountain brome, the dominant grass found on these sites, is a robust, coarse-stemmed, short-lived perennial bunchgrass that can grow 1 to 5 feet tall (USDA, 1988; Tilley et al., 2004). It is commonly seeded after wildfires due to its ability to establish quickly and reduce erosion (Tilley et al., 2004). Mountain brome significantly decreases after burning (Nimir & Payne, 1978).

Idaho fescue's 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 severely damaged by fire in all seasons (Wright et al., 1979). Rapid burns leave little damage to root crowns, and production of new tillers corresponds with the onset of fall moisture (Johnson et al., 1994). However, Wright et al. (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. Idaho fescue is generally more sensitive to fire than another prominent grasses on these sites such as bluebunch wheatgrass (Conrad & Poulton, 1966). However, Robberecht and Defossé (1995) suggested the latter is more sensitive. They observed culm and biomass reduction of bluebunch wheatgrass following fires of moderate severity, whereas Idaho fescue required high fire severity for a similar reduction in culm and biomass production. Also, given the same fire severity treatment, post-fire culm production initiated earlier and more rapidly in Idaho fescue (Robberecht & Defossé, 1995).

Cheatgrass is likely to invade this group where vectors are present. Invasion is more likely in areas with abnormal disturbance (livestock gathering areas, areas with heavy recreation use) or after fire. Invasive annual grasses displace desirable perennial grasses, reduce livestock forage, and accumulate large fuel loads that foster frequent fires (Davies & 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 & Vitousek, 1992; Brooks et al., 2004). While historical fire return intervals are estimated at 15 to 100 years for sagebrush systems, areas dominated by cheatgrass are estimated to have a fire return interval of 3 to 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 can take advantage of high nitrogen availability following fire because of their higher growth rates and increased seedling establishment relative to native perennial grasses (Monaco et al., 2003).

Livestock/Wildlife Grazing Interpretations:

A study of fecal samples from ungulates in Montana showed that big horn sheep, mule deer, and elk all consumed mountain big sagebrush in small amounts in winter, while cattle displayed no sign of sagebrush use (Kasworm et al., 1984). This same study found that juniper, mostly creeping juniper (*Juniperus horizontalis*), constituted half of the diet of mule deer and approximately one-sixth of the late winter diets of elk and bighorn sheep. Sheehy and Winward (1981) studied preferences of mule deer and sheep in a controlled experiment. Several different varieties of sagebrush were brought into a pen and the animals' preferences were measured. The sagebrush varieties used include:

1. Basin big sagebrush (*Artemisia tridentata* ssp. tridentata)
2. Black sagebrush (*Artemisia nova*)
3. Silver sagebrush (formerly Bolander silver sagebrush; *Artemisia cana* ssp. bolanderi)
4. Big sagebrush (formerly foothill big sagebrush; *Artemisia tridentata* ssp. xericensis)
5. Low sagebrush (*Artemisia arbuscula*)
6. Mountain big sagebrush
7. Wyoming big sagebrush (*Artemisia tridentata* ssp. wyomingensis)

Deer showed the most preference for low sagebrush, mountain and foothill sagebrush, and Bolander silver sagebrush. They showed the least preference for black sagebrush. Sheep showed the highest preference for low sagebrush, medium preference for black sagebrush, and least preference for Wyoming and basin big sagebrush. In a study by Personius et al. (1987), mountain big sagebrush was the most preferred sagebrush taxon by mule deer.

Mountain brome increases with grazing (Leege et al., 1981). A study by Mueggler (1967) found that mountain brome increased in herbage production when clipped in June. When clipped in July, mountain brome increased due to reduced competition from forb species. The study also found that after 3 successive years of clipping, mountain brome started to show adverse effects. Mountain brome is a highly valuable winter forage for elk (Kufeld, 1973).

Idaho fescue tolerates light to moderate grazing (Ganskopp & Bedell, 1981). It is moderately resistant to trampling damage (Cole, 1987). However, Idaho fescue decreases under heavy grazing by livestock (Eckert & Spencer, 1986, 1987) and wildlife (Gaffney, 1941). Bunchgrasses, in general, best tolerate light grazing after seed formation. Britton et al. (1979) observed the effects of harvest date on basal area of five bunchgrasses in eastern Oregon, including Idaho fescue, and found grazing from August to October (after seed set) has the least impact on these bunchgrasses. Heavy grazing during the growing season will reduce perennial bunchgrasses and increase sagebrush (Laycock, 1967). Abusive grazing by cattle or horses will likely increase sagebrush, rabbitbrush, and some forbs such as arrowleaf balsamroot (*Balsamorhiza sagittata*) and mule-ears (Wyethia sp.). Annual non-native weedy species such as cheatgrass and mustards may invade.

References:

Beckstead, J., and Augspurger, C. K. 2004. An experimental test of resistance to cheatgrass invasion: limiting resources at different life stages. Biological Invasions 6(4):417-432.

Bentz, B., D. Alston, and T. Evans. 2008. Great Basin Insect Outbreaks. In: J. Chambers, N. Devoe, A. Evenden (eds.). Collaborative Management and Research in the Great Basin -- Examining the issues and developing a framework for action Gen. Tech. Rep. RMRS-GTR-204. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO. Pages 45-48.

Blaisdell, J. P. 1953. Ecological effects of planned burning of sagebrush-grass range on the Upper Snake River Plains. Technical Bulletin No. 1975. Washington, DC: U.S. Department of Agriculture. 39 p.

Blaisdell, J. P., R. B. Murray, and E. D. McArthur. 1982. Managing Intermountain rangelands-- sagebrush- grass ranges. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Gen. Tech. Rep. INT-134. 41 p.

Bradford, J. B., and W. K. Lauenroth. 2006. Controls over invasion of *Bromus tectorum*: The importance of climate, soil, disturbance and seed availability. Journal of Vegetation Science 17(6):693-704.

Bradley, B. A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15(1):196-208.

Bradley, B. A., and Mustard, J. F. 2006. Characterizing the landscape dynamics of an invasive plant and risk of invasion using remote sensing. Ecological Applications 16(3):1132-1147.

Brooks, M. L., C. M. D'Antonio, D. M. Richardson, J. B. Grace, J. E. Keeley, J. M. Ditomaso, R. J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of Invasive Alien Plants on Fire Regimes. BioScience 54(7):677-688.

Burkhardt, J. W. and E. W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. Journal of Range Management 22(4):264-270.

Butler, M., R. Simmons, and F. Brummer. 2011. Restoring Central Oregon Rangeland from Ventenata and Medusahead to a Sustainable Bunchgrass Environment – Warm Springs and Ashwood. Central Oregon Agriculture Research and Extension Center. COARC 2010. Pages 77-82.

Clements, C. D. and J. A. Young. 2002. Restoring antelope bitterbrush. Rangelands 24(4):3-6.

Comstock, J. P. and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado Plateau. The Great Basin Naturalist 52(3):195-215.

Crane, M. F., and W. C. Fischer. 1986. FIre Ecology of the Forest Habitat Types of Central Idaho. Gen. Tech. Rep. INT-218. USDA-Forest Service, Intermountain Research Station, Ogden, UT. 86 p.

D'Antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

Davies, K. W., and D. D. Johnson. 2008. Managing medusahead in the intermountain west is at a critical threshold. Rangelands 30(4):13-15.

Davies, K. W., C. S. Boyd, D. D. Johnson, A. M. Nafus, and M. D. Madsen. 2015. Success of seeding native compared with introduced perennial vegetation for revegetating medusahead-invaded sagebrush rangeland. Rangeland Ecology & Management 68(3):224-230.

Davies, K. W., and T. J. Svejcar. 2008. Comparison of medusahead-invaded and noninvaded Wyoming big sagebrush steppe in southeastern Oregon. Rangeland Ecology and Management 61(6):623-629

Dobrowolski, J. P., M. M. Caldwell, and J. H. Richards. 1990. Basin hydrology and plant root systems. Pages 243-292 in C. B. Osmond, L. F. Pitelka, and G. M. Hidy (eds.). Plant biology of the basin and range. Springer-Verlag, New York.

Furbush, P. 1953. Control of Medusahead on California Ranges. Journal of Forestry 51(2):118-121.

Furniss, M. M. and W. F. Barr. 1975. Insects affecting important native shrubs of the northwestern United States Gen. Tech. Rep. INT-19. Intermountain Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service. Ogden, UT. 68 p.

Ganskopp, D. C., and T. E. Bedell. 1981. As assessment of vigor and production of range grasses following drought. Journal of Range Management 34(2):137-141.

Johnson, B. G.; Johnson, D. W.; Chambers, J. C.; Blank, B. R. 2011. Fire effects on the mobilization and uptake of nitrogen by cheatgrass (*Bromus tectorum* L.). Plant and Soil 341(1-2):437-445.

Johnson, C. G., R. R. Clausnitzer, P. J. Mehringer, and C. Oliver. 1994. Biotic and abiotic processes of eastside ecosystems: The effects of management on plant and community ecology, and on stand and landscape vegetation dynamics. PNW-GTR-322. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Jones, R. O., Chambers, J. C., Board, D. I., Johnson, D. W., and Blank, R. R. 2015. The role of resource limitation in restoration of sagebrush ecosystems dominated by cheatgrass (*Bromus tectorum*). Ecosphere 6(7):1-21.

Klemmedson, J. O., and J. G. Smith. 1964. Cheatgrass (Bromus Tectorum L.). The botanical review 30(2):226-262.

Leger, E. A., Espeland, E. K., Merrill, K. R., and Meyer, S. E. 2009. Genetic variation and local adaptation at a cheatgrass (*Bromus tectorum*) invasion edge in western Nevada. Molecular Ecology 18(21):4366-4379.

Lett, M. S., and A. K. Knapp. 2005. Woody plant encroachment and removal in mesic grassland: Production and composition responses of herbaceous vegetation. American Midland Naturalist 153(2):217-231

Mack, R. N., and D. Pyke. 1983. The Demography of Bromus Tectorum: Variation in Time and Space. Journal of Ecology 71(1):69-93.

MacMahon, J. A. 1980. Ecosystems over time: succession and other types of change. In: Waring, R., (ed.) Proceedings—Forests: fresh perspectives from ecosystem analyses. Biological Colloquium. Corvallis, OR: Oregon State University. Pages 27-58.

Mealor, B. A., Cox, S., and Booth, D. T. 2012. Postfire Downy Brome (*Bromus tectorum*) Invasion at High Elevations in Wyoming. Invasive Plant Science and Management 5(4):427-435.

Miller, H. C., Clausnitzer, D., and Borman, M. M. 1999. Medusahead. In: R. L. Sheley and J. K. Petroff (eds.). Biology and Management of Noxious Rangeland Weeds. Corvallis, OR: Oregon State University Press. Pages 272-281.

Miller, R. F., and Tausch, R. J. 2001. The Role of Fire in Juniper and Pinyon Woodlands: A Descriptive Analysis. In: Galley. K. M. and T. P. Wilson (eds.), Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management; Tallahassee, FL: Tall Timbers Research Station, San Diego, CA, USA. Pages 15-30.

Miller, R. F., J. C. Chambers, D. A. Pyke, F. B. Pierson, and C. J. Williams. 2013. A review of fire effects on vegetation and soils in the Great Basin region: response and ecological site characteristics. Gen. Tech. Rep. RMRS-GTR-308. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 126 p.

Monaco, T. A., Mackown, C.T., Johnson, D.A., Jones, T.A., Norton, J.M., Norton, J.B., and Redinbaugh, M.G. 2003. Nitrogen effects on seed germination and seedling growth. Journal of Range Management 56(6):646-653.

Noste, N. V. and C. L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. Gen. Tech. Rep. INT-239. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 22 p.

Sheley, R. L., E. A. Vasquez, A. Chamberlain, and B. S. Smith. 2012. Landscape-scale rehabilitation of medusahead (*Taeniatherum caput-medusae*)-dominated sagebrush steppe. Invasive Plant Science and Management 5(4):436-442.

Spence, L. E. 1937. Root studies of important range plants of the Boise river watershed. Journal of Forestry 35(8):747-754.

Suring, L. H., Wisdom, M. J., Tausch, R. J., Miller, R. F., Rowland, M. M., Schueck, L., and Meinke, C. W.2005. Modeling threats to sagebrush and other shrubland communities. In: M. J. Wisdom, M. M. Rowland and L. H. Suring (eds.). Habitat threats in the sagebrush ecosystems: methods of regional assessment and applications in the Great Basin (p. 114-149). Lawrence, Kansas, USA: Alliance Communications Group.

Tilley, D. J., D. Ogle, L. St. John, L. Holzworth, W. Crowder, and M. Majerus. 2004. Mountain Brome. USDA NRCS plant guide. USDA NRCS Plant Materials Center. USDA NRCS Idaho State Office, Idaho. 5 p.

USDA, Forest Service. 1988. Range Plant Handbook. Dover Publications, Inc., New York, NY. Reprint. Originally Published: Washington D. C. Government Printing Office, 1937. 816 p.

Vollmer, J. L., and J. G. Vollmer. 2008. Controlling cheatgrass in winter range to restore habitat and endemic fire

United States Department of Agriculture, Forest Service. RMRS-P-52. Pages 57-60

Whisenant, S., 1999. Repairing Damaged Wildlands: a process-orientated, landscape-scale approach (Vol. 1). Cambridge, UK: Cambridge University Press. 312 p

Wright, H. A. 1985. Effects of fire on grasses and forbs in sagebrush-grass communities. In: K. D. Sanders and J. Durham, (eds.). Rangeland Fire Effects: A Symposium. 1984, November 27-29. USDI-BLM, Boise, ID. Pages 12-21.

Wright, H. A., C. M. Britton, and L. F. Neuenschwander. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: a state-of-the-art review. Gen. Tech. Rep. INT-58, Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Ogden, UT.

Young, R. P. 1983. Fire as a vegetation management tool in rangelands of the Intermountain region. In: Monsen, S.B. and N. Shaw (eds). Managing Intermountain rangelands—improvement of range and wildlife habitats: Proceedings. 1981, September 15-17; Twin Falls, ID; 1982, June 22-24; Elko, NV. Gen. Tech. Rep. INT-157. Ogden, UT. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Pages 18-31.

Ziegenhagen, L. L. 2003. Shrub reestablishment following fire in the mountain big sagebrush (*Artemisia tridentata* Nutt. ssp. vaseyana (Rydb.) Beetle) alliance. M.S. Oregon State University.

Major Land Resource Area

MLRA 023X
Malheur High Plateau

Subclasses

- F023XY070NV–PIAL/ARTRV/BRMA4
- R023XY019NV–LOAMY 16+ P.Z.
- R023XY048NV–GRANITIC SLOPE 16+ P.Z.
- R023XY065NV–LOAMY SLOPE 16+ P.Z.
- R023XY318OR–LOAMY 12-16 PZ
- R023XY320OR–JUNIPER SOUTH SLOPES 12-16 PZ
- R023XY404OR–DEEP NORTH 12-18 PZ
- R023XY501OR–SHALLOW LOAM 16-25 PZ
- R023XY502OR–LOAMY 25-35 PZ
- R023XY503OR–OPEN SLOPES 25-35 PZ
- R023XY504OR–SUBALPINE LOAMY 35-40 PZ
- R023XY505OR–SUBALPINE THIN SURFACE 35-40 PZ
- R023XY509OR–SUBALPINE SLOPES 16-35 PZ

Correlated Map Unit Components

21501505, 21501427, 21501467, 21501202, 21501537, 21501527, 21501196, 21501260, 21501395, 21501302, 21501454, 21501398, 21582071, 21589397, 21589858, 21589462, 21589695, 21589877, 21589881, 21590065, 21589645, 21589758, 21589856, 21590028, 21590795, 21590804, 21590732, 21590486, 21590316, 21604435, 21604134, 21729399, 21729140, 21729136, 21729314, 21728946, 21729135, 21728974, 21730123, 21729855, 21729600, 21729308, 21729625, 21729015, 21729012, 21729517, 21729566, 21729569, 22170527, 22170777, 22170517, 22171018, 22171014, 22171063, 22170510, 22170893, 22171015, 22171019, 22171159, 22171157, 22170507, 22170978, 22171248, 22170918, 22170699, 22170906, 22176889, 22177000, 21590295

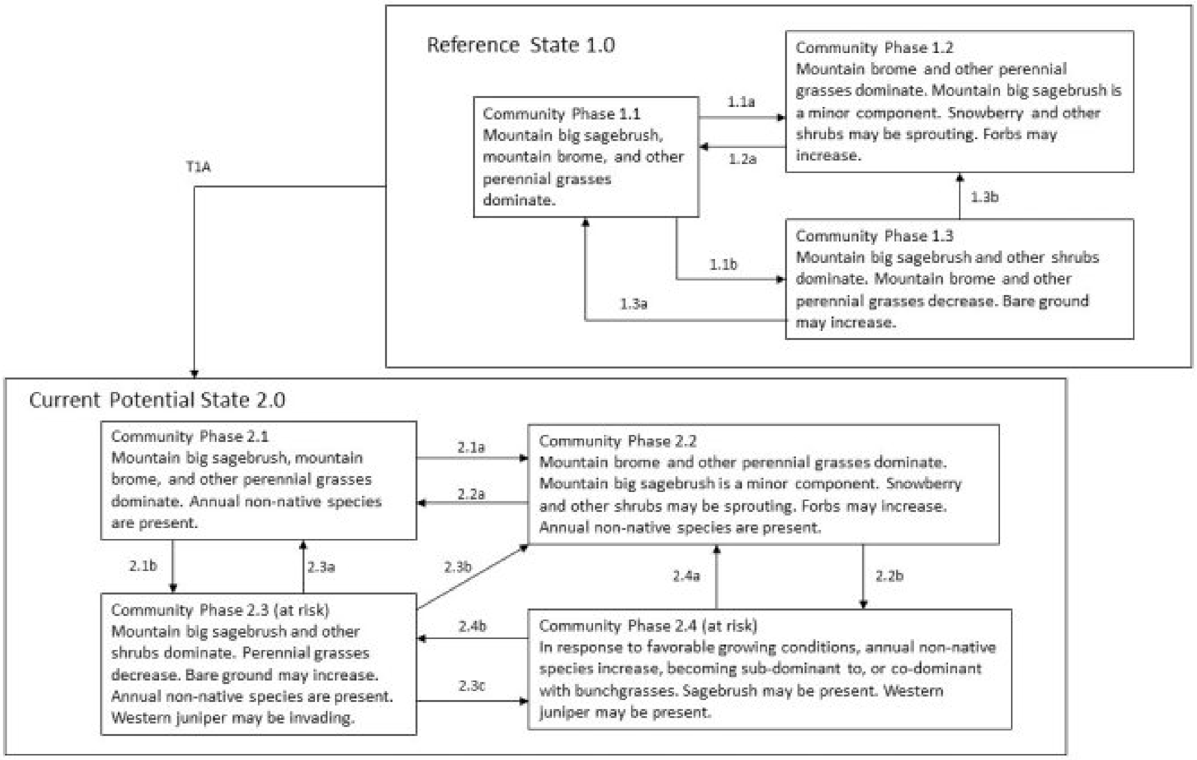
Stage

Provisional

Contributors

T Stringham (UNR under contract with BLM)
DMP

State and transition model



Reference State 1.0 Community Phase Pathways
1.1a: Low-severity fire creates a grass/sagebrush mosaic. High-severity fire significantly reduces sagebrush and leads to an early- or mid-seral community dominated by grasses and forbs.
1.1b: Time and lack of disturbance, such as fire, facilitate this pathway. Excessive herbivory may also reduce perennial understory.
1.2a: Time and lack of disturbance allow shrubs to reestablish.
1.3a: Low-severity fire, herbivory, or a combination of the two reduce sagebrush.
1.3b: High-severity fire significantly reduces sagebrush, resulting in an early- or mid-seral community dominated by grasses and forbs.

Transition T1A: This transition occurs following the introduction of non-native annual species.

Current Potential State 2.0 Community Phase Pathways
2.1a: Low-severity fire creates a grass/sagebrush mosaic. High-severity fire significantly reduces sagebrush, resulting in an early- or mid-seral community dominated by grasses and forbs. Non-native species are present.
2.1b: Time and lack of disturbance, such as fire, facilitate this pathway. Inappropriate grazing management may also reduce the perennial understory.
2.2a: Time and lack of disturbance allow shrubs to reestablish.
2.2b: This pathway occurs when late spring moisture favors the germination and production of non-native, annual grasses. This pathway typically occurs 3 to 5 years post-fire and the resulting plant community may be a transitory plant community.
2.3a: Low-severity fire, herbivory, brush management with minimal soil disturbance, or a combination thereof creates a sagebrush/grass mosaic
2.3b: High-severity fire significantly reduces sagebrush, resulting in an early- or mid-seral community. Brush management with minimal soil disturbance reduces black sagebrush.
2.3c: This pathway occurs when late spring moisture favors the germination and production of non-native, annual grasses. This may be a transitory plant community.
2.4a: This pathway occurs when rainfall patterns and growing season conditions favor perennial bunchgrass production and reduced cheatgrass production.
2.4b: This pathway occurs when rainfall patterns and growing season conditions favor perennial bunchgrass production and reduced cheatgrass production.

Citations

Bates, J.D., T. Svejcar, R.F. Miller, and R.A. Angell. 2006. The effects of precipitation timing on sagebrush steppe vegetation. Journal of Arid Environments 64:670–697.

Bunting, S.C., B.M. Kilgore, and C.L. Bushey. 1987. Guidelines for Prescribe burning sagebrush-grass rangelands in the Northern Great Basin. General Technical Report INT-231. USDA Forest Service Intermountain Research Station, Ogden, UT. 33.

Caudle, D., H. Sanchez, J. DiBenedetto, C. Talbot, and M. Karl. 2013. Interagency Ecological Site Handbook for Rangelands.

Chambers, J.C., B.A. Bradley, C.S. Brown, C. D'Antonio, M.J. Germino, J.B. Grace, S.P. Hardegree, R.F. Miller, and D.A. Pyke. 2013. Resilience to Stress and Disturbance, and Resistance to Bromus tectorum L. Invasion in Cold Desert Shrublands of Western North America. Ecosystems 17:360–375.

Chambers, J.C., B.A. Roundy, R.R. Blank, S.E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by Bromus tectorum?. Ecological Monographs 77:117–145.

Cole, D.N. 1987. Effects of three seasons of experimental trampling on five montane forest communities and a grassland in Western Montana, USA. Biological Conservation 40:219–244.

Conrad, C.E. and C.E. Poulton. 1966. Effect of a Wildfire on Idaho Fescue and Bluebunch Wheatgrass. Journal of Range Management 19:138–141.

Eckert, R.E. and J.S. Spencer. 1986. Vegetation Response on Allotments Grazed under Rest-Rotation Management. Journal of Range Management 39:166.

Eckert, R.E. and J.S. Spencer. 1987. Growth and Reproduction of Grasses Heavily Grazed under Rest-Rotation Management. Journal of Range Management 40:156.

Gaffney, W.S. 1941. The Effects of Winter Elk Browsing, South Fork of the Flathead River, Montana. The Journal of Wildlife Management 5:427–453.

Houston, D.B. 1973. Wildfires in Northern Yellowstone National Park. Ecology 54:1111–1117.

Kufeld, R.C. 1973. Foods Eaten by the Rocky Mountain Elk. Journal of Range Management 26:106–113.

Laycock, W.A. 1967. How Heavy Grazing and Protection Affect Sagebrush-Grass Ranges. Journal of Range Management 20:206–213.

Leege, T.A. and W.O. Hickey. 1971. Sprouting of Northern Idaho Shrubs after Prescribed Burning. The Journal of Wildlife Management 35:508–515.

Leege, T.A., D.J. Herman, and B. Zamora. 1981. Effects of Cattle Grazing on Mountain Meadows in Idaho. Journal of Range Management 34:324–328.

Merrill, E.H., H.F. Mayland, and J.M. Peek. 1982. Shrub Responses after Fire in an Idaho Ponderosa Pine Community. The Journal of Wildlife Management 46:496–502.

Miller, R.F. and E.K. Heyerdahl. 2008. Fine-scale variation of historical fire regimes in sagebrush-steppe and juniper woodland: an example from California, USA. International Journal of Wildland Fire 17:245–254.

Mueggler, W.F. 1967. Response of Mountain Grassland Vegetation to Clipping in Southwestern Montana . Ecology 48:942–949.

Neuenschwander, L.F. 1980. Broadcast Burning of Sagebrush in the Winter. Journal of Range Management 33:233–236.

Nimir, M.B. and G.F. Payne. 1978. Effects of Spring Burning on a Mountain Range. Journal of Range Management 31:259–263.

Noy-Meir, I. 1973. Desert Ecosystems: Environment and Producers. Annual Review of Ecology and Systematics 4:25–51.

Personius, T.L., C.L. Wambolt, J.R. Stephens, and R.G. Kelsey. 1987. Crude Terpenoid Influence on Mule Deer Preference for Sagebrush. Journal of Range Management 40:84–88.

Richards, J.H. and M.M. Caldwell. 1987. Hydraulic lift: Substantial nocturnal water transport between soil layers by Artemisia tridentata roots. Oecologia 73:486–489.

Robberecht, R. and G.E. Defosse. 1995. The Relative Sensitivity of Two Bunchgrass Species to Fire. International Journal of Wildland Fire 5:127–134.

Sheehy, D.P. and A.H. Winward. 1981. Relative Palatability of Seven Artemisia Taxa to Mule Deer and Sheep. Journal of Range Management 34:397–399.

Whisenant, S.G. 1990. Changing fire frequencies on Idaho's Snake River plains: ecological and management implications. Pages 4–10 in , , , and , editors. Symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. INT-276.. US Department of Agriculture, Forest Service.

Wright, H.A. 1971. Why Squirreltail Is More Tolerant to Burning than Needle-and-Thread. Journal of Range Management 24:277–284.

Ziegenhagen, L.L. and R.F. Miller. 2009. Postfire Recovery of Two Shrubs in the Interiors of Large Burns in the Intermountain West, USA. Western North American Naturalist 69:195–205.