Fire Ecology, Forest Dynamics, and Vegetation Distribution on Square Butte, Chouteau County, Montana

Prepared for:

U.S. Bureau of Land Management
Lewistown District Office

By:

Elizabeth Crowe

Montana Natural Heritage Program
Natural Resource Information System
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By:

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Executive Summary

Square Butte is a singular landscape feature of southern Chouteau County in central Montana, an eroded remnant of Tertiary volcanic activity. Most of the land area on the butte is managed by the U. S. Department of the Interior, Bureau of Land Management (BLM) and has been designated an Area of Critical Environmental Concern (ACEC). The BLM partnered with the Montana Natural Heritage Program to conduct a survey of biological resources there, focusing on vegetation distribution and fuel loads in forested stands.

Forest, shrubland and grassland vegetation was pre-mapped into units using large-format aerial photos. Field surveys were conducted through approximately 65% of the BLM-managed portion of the butte to verify map unit boundaries and designations, to refine vegetation type assignment and to determine fuel loads. Fuel loads were estimated through the use of fuel models. No plant species of concern were sited.

Most of the vegetation on the butte consists of a mosaic of seral stages of two forested habitat types (41%) and two woodland (forest-shrubland-grassland-rock outcrop) complexes (43%). Pure shrubland and herbaceous habitat types are a minor component (9%) within the ACEC boundary.

The primary stochastic ecological disturbance process on Square Butte is wildfire. The vegetation map (Figure 7) produced portrays the distribution of vegetative communities and units that are primarily a result of the last several hundred years of fire history.

While the vegetation is not unusual or unique, it does portray an interesting history of fires and forest succession unaltered by commercial timber cutting and road-building activities. Unroaded and unharvested forested areas are becoming increasingly rare in the United States, and Square Butte's designation as an Area of Critical Environmental Concern allows for future protection, study and enjoyment of a relatively natural landscape and its inherent processes.

ACKNOWLEDGMENTS

Many thanks to Steve Cooper for co-conducting field surveys and for invaluable assistance in the mapping and interpretation of vegetation and the preparation of this report.

Thanks to Judy and Hugh Turek for generously allowing us to camp on their property during fieldwork and to both the Tureks and the Meissners for allowing us access to Square Butte through their property.

Thanks to the Ft. Benton Office of the U.S.D.A. Farm Services Administration and the Natural Resources Conservation Service for assisting us in obtaining topographic maps and large-format aerial photos of Square Butte for use in the field.

Thanks to Coburn Currier for assistance in preparing the final report and to Greg Kudray for reviewing the manuscript.

Though this report has profited from the support and contributions of many people, any errors of commission or omission rest with the author. This project was supported by an assistance agreement with the Bureau of Land Management.

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INTRODUCTION

Square Butte is a singular landscape feature of southern Choteau County in central Montana (Figure 1, following page). It is an eroded remnant of Tertiary volcanic activity, an outlier of the same formation comprising the Highwood Mountains to the west. The butte rises about 1700 feet above the surrounding prairie between the towns of Stanford and Geraldine, and its distinctive flat-topped profile can be seen for miles around (Figure 2). Most of the land area on the butte is managed by the U. S. Department of the Interior, Bureau of Land Management (BLM) and has been designated an Area of Critical Environmental Concern (ACEC).

In preparation for the upcoming development of a management plan for Square Butte, the BLM requested that the Montana Natural Heritage Program (MNHP) conduct a survey of biological resources that occur there, focusing on vegetation. This report by the Heritage Program documents vegetative community distribution and fuel loads in forested communities. A previous survey in 1993 by Peter Lesica, under contract to the Helena Office of The Nature Conservancy, revealed no populations of plant species of concern (Lesica, personal communication 2003).

Figure 2. Looking north from south of Arrow Creek

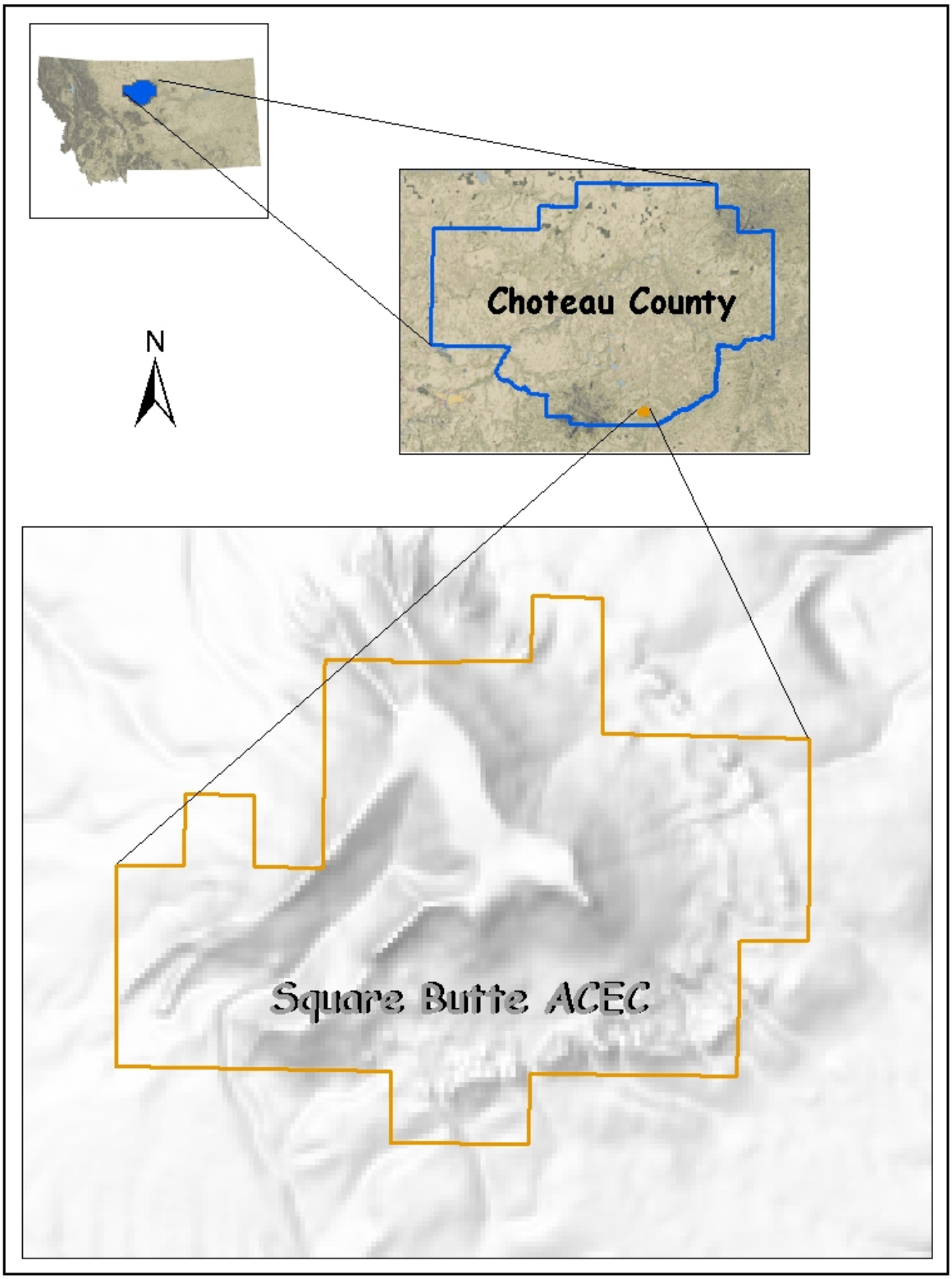


Figure 1. Location of Square Butte in central Montana

STUDY AREA

Soils and Geology

Soils on the top and upper slopes of the butte are mapped as the Elve-Rock Outcrop Complex, 25-70% slopes, although the top of the butte is quite flat with less than 2% slope (Figure 3). The Elve series is forested, has a drainage class of somewhat excessively and has moderately rapid permeability in the upper 150 cm of soil. The series comprises Ustic Eutrocryepts (young, poorly developed soils with high base saturation and cold temperatures) with a loamy-skeletal particle-size class. The sides and most of the lower slopes of the butte, rich with rock fins and tall rock faces, are mapped as the Rock Outcrop-Belain Complex, 15-45% slopes. The Belain series is classified as a sandy ecological site with a drainage class of well-drained and moderate to moderately rapid permeability in the upper 61 cm of the profile. Impermeable bedrock is found at 50-100 cm depth in the profile. The series comprises Typic Haplustolls (soils with minimal horizon development below the mollic epipedon, which has a favorable amount of organic matter and high base saturation) with a coarse-loamy particle-size class. Other miscellaneous soil map units are described below in descriptions of associated vegetation map unit. Soil map unit information was obtained from the Soil Survey Geographic (SSURGO) and National Soil Information System databases (USDA-NRCS 2003a&b).

All soils are classified as having an ustic moisture regime, which means that soil moisture is present at times suitable for plant growth. All but the Elve series have a frigid temperature regime, which has a mean annual temperature of less than 8° C and a mean summer temperature of greater than 15° C. The Elve series has a cryic temperature regime, which has the same mean annual temperature and a mean summer temperature of less than 15° C.

Square Butte is a laccolith of igneous rock that formed during the Eocene between layers of Upper Cretaceous sedimentary sandstones and shales (Alt and Hyndman 1986). The core of the butte, comprising the upper geologic stratum and the rock fins that stretch to the southwest, is syenite, a medium- to coarse-grained rock that is light-colored and composed primarily of potassium feldspars. The underlying dark stratum is shonkonite and comprises most of the flanks of the butte including the rock outcrop-rich areas on the southern and western sides of the butte. Shonkonite is alkalic and composed of more than 50% mafic minerals (Vuke et al. 2002). Square Butte is an outlier of the same formation that created the Highwood Mountains to the west.

The syenite unit corresponds roughly to the mapped extent of the Elve-Rock Outcrop Complex soil map unit, and the shonkonite unit corresponds roughly to the mapped extent of the Rock Outcrop-Belain Complex soil map unit.

Climate

The study area has a semi-arid (annual average precipitation of about 16 inches), temperate continental climate, typified by a cold, dry winter and a hot summer with the bulk of precipitation coming in late spring and early summer, peaking in May (see Figure 4). Moisture is brought into the area in the spring from the Gulf of Mexico on easterly winds from the Midwest (Harding 1983). Arctic cold invasions commonly occur several times during the winter, bringing with them snow and strong northerly winds. Chinooks are also a common winter occurrence, interrupting the winter cold and bringing warm, dry westerly winds (Montana Water Resources Board 1964). Precipitation is lowest from October through March.

Climate summaries are from Geraldine, which is approximately 7 miles north of Square Butte and 2500 ft. lower in elevation. Given the average rate of adiabatic cooling, temperatures are probably 7-8 degrees (C) cooler on top of the butte and the frost-free period is probably late May through September. Figure 5 shows average monthly snowfall at the Geraldine weather station. The steep aspects on the butte flanks shade the north and east sides, allowing for retention of snow late

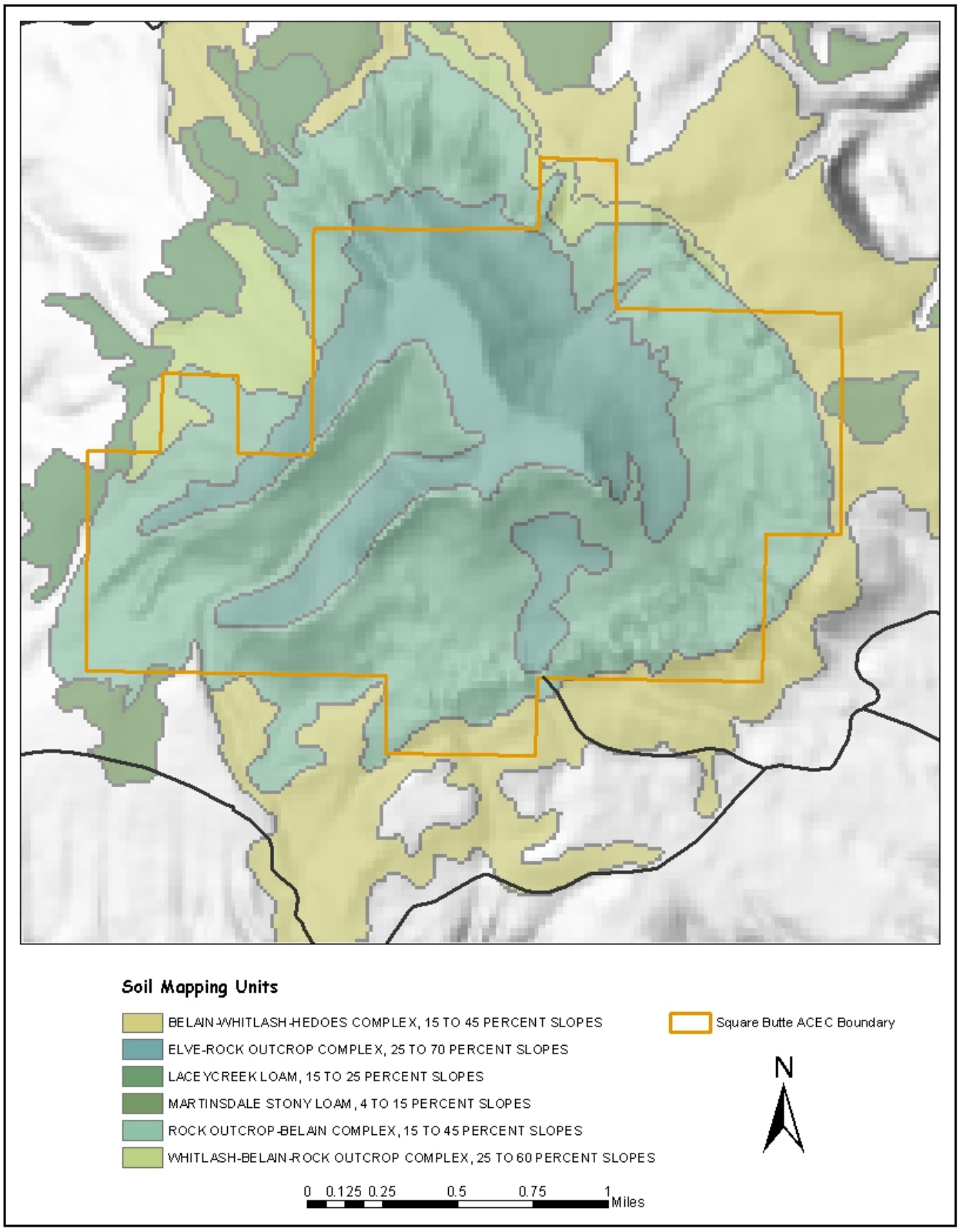


Figure 3. Soil map units on Square Butte from Choteau County Soil Survey

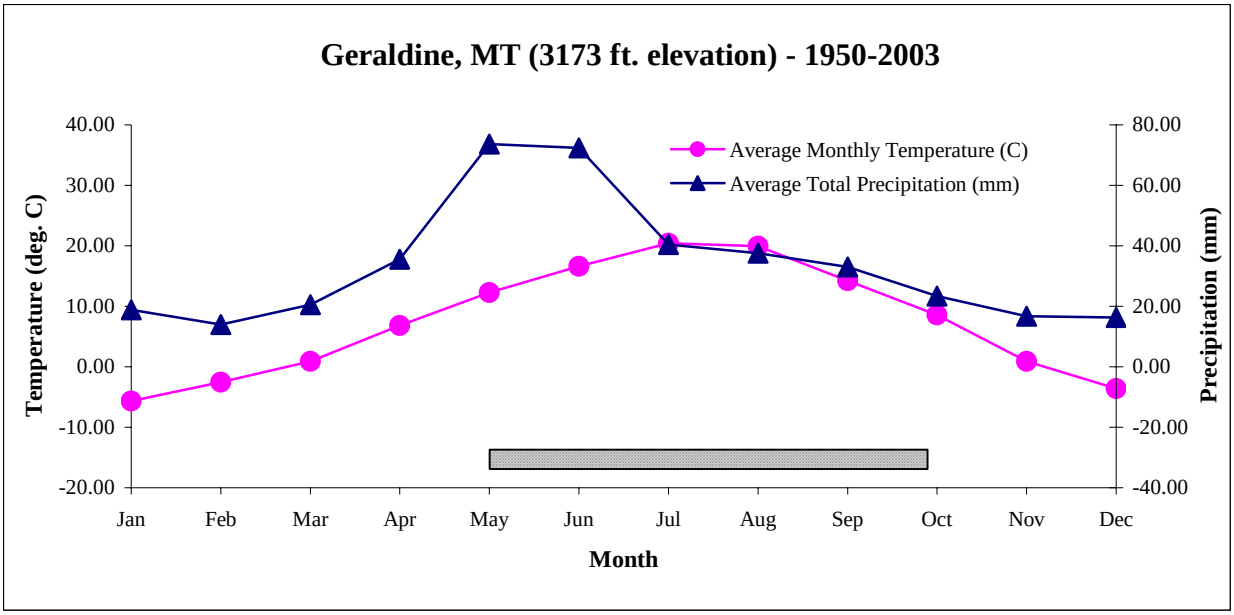


Figure 4. Walter-type climate diagram showing average monthly temperature and precipitation (Western Regional Climate Center 2003).

The hatched bar across the bottom shows growing season length or the number of frost-free days where the mean daily minimum temperature is above 0 degrees C. The title bar shows the weather station location, elevation and the period of observation; axes are expressly scaled (precipitation is twice temperature) to reveal putative periods of drought and precipitation in excess of evapotranspirational demand.

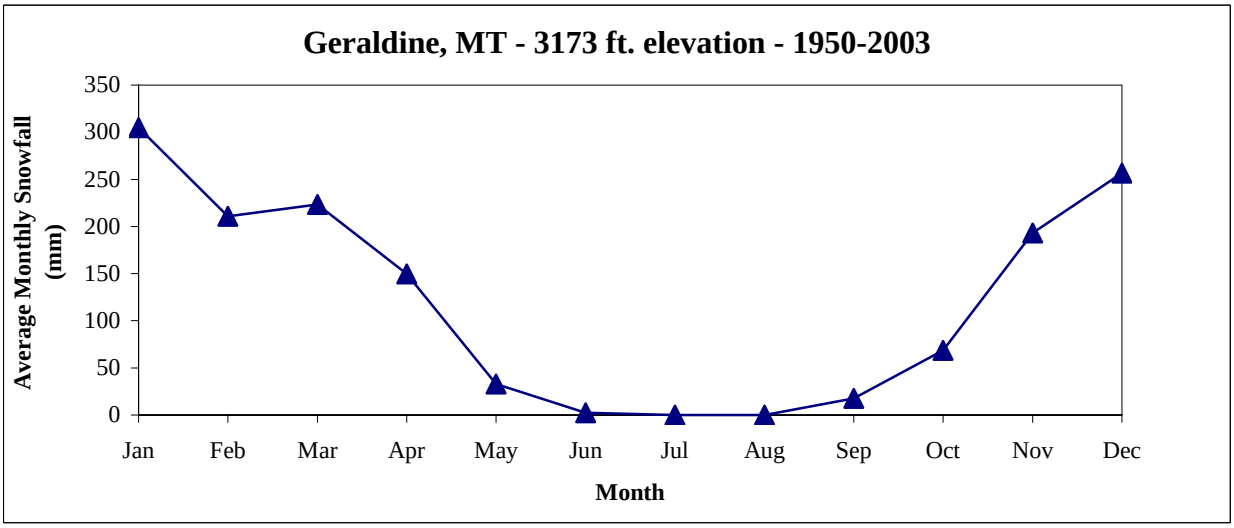


Figure 5. Average monthly snowfall

in spring and thus elevating soil moisture during the north and east sides of the numerous tall rock outcrops surrounding the butte, providing extra soil moisture in these protected locations as well.

The late spring and summer months bring thunderstorms, and as the vegetation dries out in the early growing season. Snow is also retained on July and August, forest and rangelands are susceptible to fires (Lotan and Fuguay 1983). Square Butte's relative height and exposure, rising as it does from the surrounding plains, make it quite susceptible to lightening strikes, which initiate most fires on the butte.

METHODS

Field survey

Field surveys were initiated from the east and south sides of the butte, as those are the only locations with private access to Federal land. Surveys were necessarily limited in scope since access was limited to day trips, and foot travel to the top and around the sides is slow due to abundant rock outcropping and steep slopes. Approximately, 25% of the ACEC was explored on foot and another 40% was surveyed via vantage points from the top of the butte.

The protocol used for forested vegetation and fuel load surveys was the BLM's Forest Vegetation Information System (FORVIS) (Williams 1999), which is a process of pre-mapping stands or vegetation units on aerial photos, walking through a subset of each type of pre-mapped unit and recording information on: 1) tree canopy composition, species cover, height, age, and disturbances; 2) cover of understory trees (less than 6 ft. in height), shrubs, grasses and forbs; 3) snags and logs; 4) fuels; and 5) slope, aspect and elevation of the unit. Large-scale black and white aerial photos (obtained from Farm Services Administration office in Ft. Benton) were used for pre-mapping vegetation units on accessible portions of the butte. Vegetation units were mapped on mylar overlays. Rather than running fuels transects, sites were compared to photo guides for appraising downed woody fuels and assigning fuel models to map unit polygons (Fischer 1981a and 1981b). The fuels models used in these photo guides are from the National Fire Danger Rating System (NFDRS) (Deeming et al. 1978) and Fire Behavior Fuel Models, also known as Stylized Fuel Model (SFM) (Albini 1976). Photos were also taken for later comparison and reassessment and where the photo guides were not applicable to the vegetation being sampled. Walk-through surveys were conducted in 14% of the mapped forested units within the ACEC boundary. Figure 6 shows the traverse points, photos points and vegetation plots/walk-through surveys that were recorded via GPS for use in vegetation map unit development.

Data taken in shrublands and grasslands followed Heritage Program rapid ecological assessment–plant community information protocol. A 380 m^2 circular plot is located on a representative site in the community. Data taken are: canopy cover (Daubenmire 1959) of all vascular plant species, ground cover, elevation, aspect, slope, soil parent material and surface soil texture. All plant taxonomy follows Kartesz (1999).

We searched for plant species of concern along our survey routes. None were sighted. The nesting location of a pair of falcons was recorded (Figure 6). Species identification was uncertain.

Data Management and Vegetation Mapping

Fuel model assignments were re-checked using photos taken at photo points and vegetation plots in forested vegetation units and re-assigned if necessary.

Vegetation units were mapped (Figure 7) through heads-up digitizing in ArcView 3.2 (ESRI, 380 New York St., Redlands, CA 92373-8100) using the 1:24000 digital orthoquads (DOQs) and 1:24000 topographic maps as base layers. Units drawn on original mylar overlays were adjusted as needed based on notes from traverse points, data from vegetation plots and FORVIS walk-through data and through interpretation of vegetation textures and patterns on the DOQs that were indistinct on the large-format photos used in the field. In addition, vegetation units that had not been pre-mapped (due to the poor quality of portions of the aerial photos) were digitized. Unit correlations were extrapolated based on visible vegetation patterns, topography, soil map units, geologic map units and through professional ecological knowledge and experience.

Vegetation types were compared to existing plant association descriptions. The Natural Heritage central database of vegetation associations (NatureServe 2002) was first consulted and where

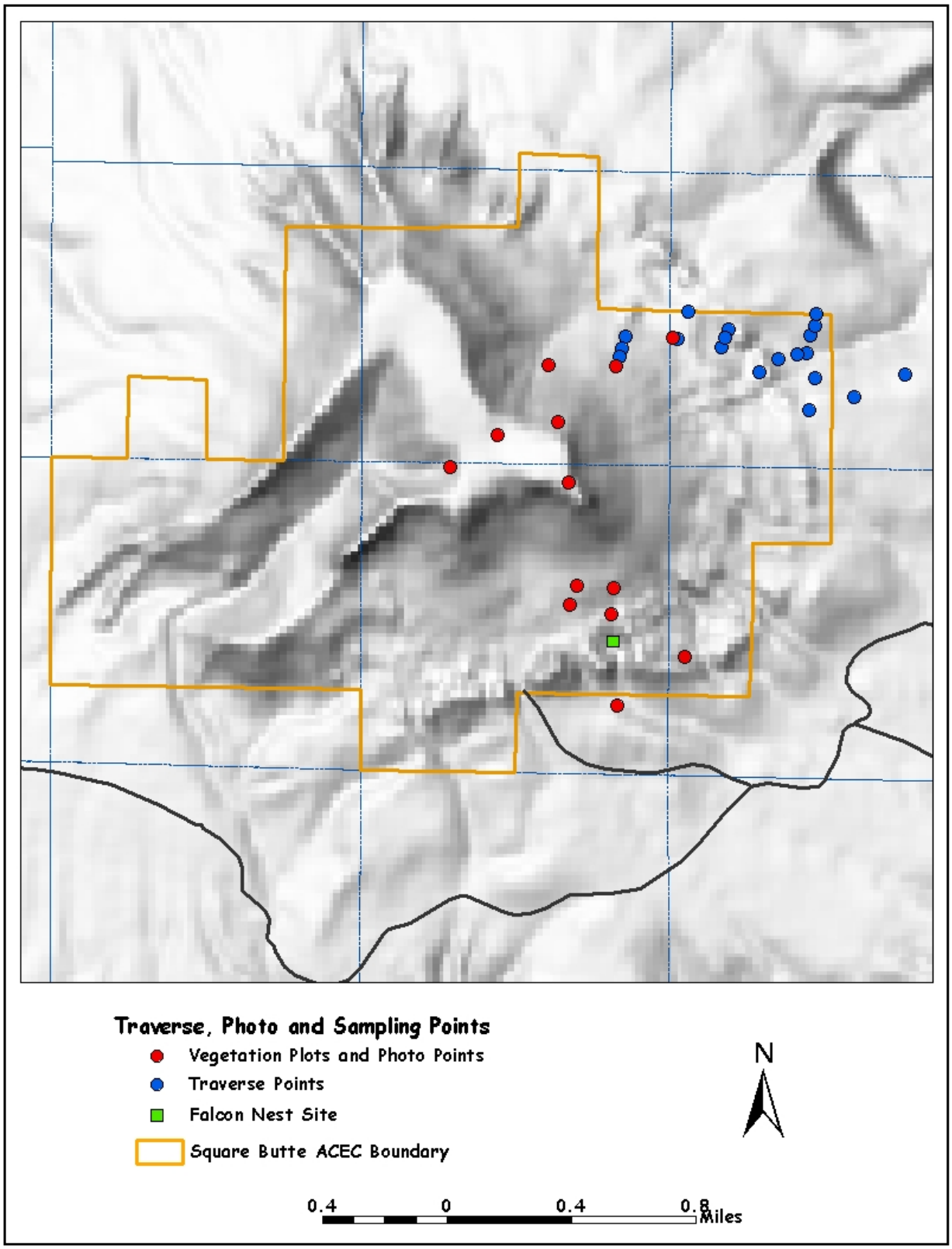


Figure 6. Locations of traverse points, photo points, vegetation plot/walk-through surveys and used for mapping and describing vegetation

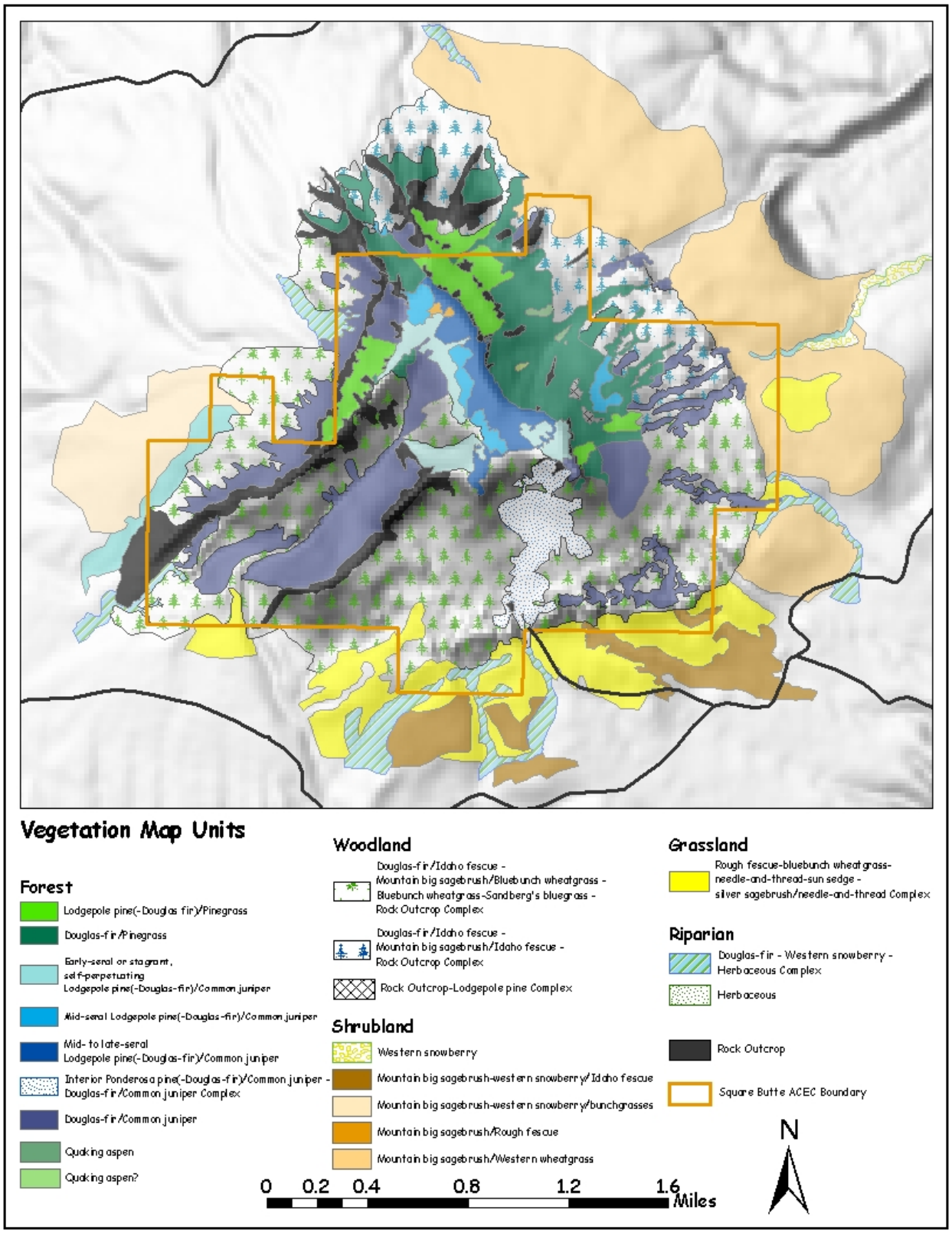


Figure 7. Map of vegetation units on Square Butte

descriptions were inconsistent with the vegetation of the butte or simply non-existent, new plant associations were written based on other more local classifications (Pfister et al. 1977; Mueggler and Stewart 1980; Hansen and Hoffman 1988) and field data collected. Plant association descriptions are in Appendix B.

RESULTS AND DISCUSSION

Most of the vegetation on the butte consists of a mosaic of seral stages of two forested habitat types (41%) and two woodland (forest-shrubland-grassland-rock outcrop) complexes (43%). Pure shrubland and herbaceous habitat types are a minor component (9%) within the ACEC boundary.

The primary stochastic ecological disturbance process on Square Butte is wildfire. The vegetation map (Figure 7) portrays the distribution of vegetative communities and units that are primarily a result of the last several hundred years of fire history. Drought cycles are a more constant and gradual disturbance factor that results in temporary fluctuations in density and cover of individual species. The impact of drought cycles can only be interpreted through temporal comparisons of aerial photography and field data and was not within the scope of this project. Chinooks in the winter and hail and heavy rainstorms in the summer are more regular disturbances to which communities have adapted.

A discussion of the autecological adaptations of major trees, shrubs and graminoids to fire is given below. Descriptions of the vegetative units and the plant associations found within them follow.

Species Adaptations to Fire

Trees

Interior ponderosa pine (*Pinus ponderosa* var. *scopulorum*)
Mature Interior ponderosa pine is highly resistant to fire; it is better adapted than any other conifer on the study site to survive surface fires. The adaptive features are open crowns, self-pruning branches, thick, insulating, relatively inflammable bark, thick bud scales, tight needle bunches that enclose and protect meristems, high foliar moisture and a deep rooting habit. Mature trees can survive a considerable amount of scorching. Surface fires can kill seedlings and saplings depending on fire severity and stand structure. Trees growing singly, however, can acquire fire resistance traits rapidly (within 6-10 years). The nutrient-enriched mineral seedbeds that are created by fires are favorable for Ponderosa pine seedling germination.
Severe surface or crown fires can kill interior ponderosa pine of all age and size classes. Scorching of buds, rather than simply scorching of needles, affects the survivability of trees following fires. Trees that are scorched in the summer are less likely to survive than trees scorched in the spring or fall (Fischer and Clayton 1983; Agee 1993; Howard 2003).

Limber pine (*Pinus flexilis*)
Young limber pines are highly susceptible to even low severity fires. Older trees develop thick bark at the base and are more resistance to scorch. Trees generally grow on harsh, isolated sites with sparse ground fuels and, thus, are often protected from fires. Regeneration is entirely from seed dispersed primarily by birds (especially Clark's nutcrackers) and small mammals (Fischer and Clayton 1983; Johnson 2001).

Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*)
Rocky Mountain Douglas-fir seedlings, saplings and poles are susceptible to fire because they have thin bark and are filled with resin. Mature trees can survive moderately severe surface fires due to the thick, corky bark on the lower part of the bole. Fine twigs and buds are highly susceptible to fire, and crown damage will kill trees. Also, branches are generally low growing and can draw surface flames up into the crown. Mature trees are less resistant to fire than ponderosa pine, but more resistant than lodgepole pine. Mineral soils exposed by burning provide a good seedbed, though seed dispersal is restricted to within a few hundred yards of seed trees (Fischer and Clayton 1983; Steinberg 2002).

Rocky Mountain lodgepole pine (*Pinus contorta* ssp. *latifolia*)
Rocky Mountain lodgepole pine is especially well adapted to fire. This species produces serotinous cones that persist on the tree for many years and which will open and release seeds after being heated by fires. Individual trees in a stand will bear predominantly serotinous or non-serotinous

cones. In stands that have developed following stand-replacing fires, lodgepole pine trees will likely produce mostly serotinous cones. This is not always the situation, though, as other factors can also favor the predominance of serotinous or non-serotinous cones. Seedlings will readily and very successfully germinate on the bare mineral seedbeds created by fires, especially severe, stand-replacing fires. Seedlings are highly adapted to thrive in open, sunny conditions, unlike the other conifers in the study area. Seedlings and saplings are highly susceptible to fires even of low severity. Older poles and mature trees can withstand low severity fires. Seed dispersal is primarily by wind. Most seeds are dispersed within 200 ft. of source trees, although seedlings have been reported from a few kilometers away from seed sources (Fischer and Clayton 1983; Anderson 2003).

Shrubs

Bearberry (*Arctostaphlyus uva-ursi*)
Bearberry is a sprouting species that is best suited to short fire cycles with low fuel buildup and low fire intensities. It sprouts from latent buds on the root crown. As duff builds up on sites in later seral stages, the crown migrates up into the duff and is vulnerable to ground fires (Crane 1991).

Birchleaf spiraea (*Spiraea betulifolia*)
Birchleaf spiraea is rarely killed by fire. It is often top-killed but will resprout from its root crown and from rhizomes. Canopy cover of this species often increases a few years after a fire (Habeck 1991).

Common juniper (*Juniperus communis*)
Common juniper is susceptible to fire, having thin bark and resinous (and this highly flammable) foliage. Plants will not resprout, but occasionally portions of a lightly-burned plant may survive. Postfire recovery of this species is slow. Postfire establishment is from seeds stored in the soil or brought in by animals. Birds are the most common dispersal agent. Seed viability and germination is relatively poor (Tirmenstein 1999a).

Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*)
Mountain big sagebrush is highly susceptible to fire, will be killed by even low severity fires and will not sprout from the crown after being top-killed. Postburn seedling establishment may take many years depending on burn and site conditions, preburn seed crop and availability of seed sources. It often takes 15-20 years before sagebrush returns to preburn densities after fire (Wambolt et al 2001). Regeneration is by wind-dispersed seed (Johnson 2000).

Silver sagebrush (*Artemisia cana*)
Silver sagebrush will resprout strongly following fire from its root crown and rhizomes. Some seedling establishment may occur after fires either from seeds produced by post-fire sprouts or from seeds brought into the site by wind, water or animals (Howard 2002).

Western snowberry (*Symphoricarpos occidentalis*)
Western snowberry sprouts vigorously from the root crown and rhizomes following fires. High severity fires, however, can kill plants entirely (Esser 1995).

Wood's rose (*Rosa woodsii*)
Wood's rose is moderately fire tolerant and often resprouts well from root crowns and rhizomes after low- to moderate-severity fires. On rare occasions, it will germinate from off-site seed sources (Tesky 1992).

Graminoids

Bluebunch wheatgrass (*Pseudoregnaria spicata*)
Burning generally favors bluebunch wheatgrass, which will resprout from root crowns following top-kill. Burning also stimulates flowering and seedset. Fires that burn during dry years may have cause greater mortality. Generally this species will recover its prefire abundance within a couple of years following burning (Zlatnik 1999a).

Idaho fescue (*Festuca idahoensis*)
Idaho fescue can survive low severity fires. Fires of moderate to high severity can cause abundant mortality, since they will burn within the fine, dense leaves at the base of the plant, which can kill part or all of the root crown. This grass is more susceptible to fire than rough fescue or bluebunch wheatgrass (Zouhar 2000).

Needle-and-thread (*Hesperostipa comata*)
Needle-and-thread can survive fires well if burned in late summer. If plants are older and dead culm remnants and litter from past years have built up, fires may burn hotter and reach the growing points lower in the plant, resulting in higher mortality. Fire will topkill plants and resprouting will occur from root crowns (Zlatnik 1999b).

Pinegrass (*Calamagrostis rubescens*)
Pinegrass is highly resistant to fire and is rarely, if ever, eliminated from a site. Its rhizomes are buried in mineral soil and thus will survive severe fires that consume the duff layer. After topkill, it will sprout from the rhizomes, and repeated fires promote an increase in cover. Seedlings can establish from off-site sources and surviving plants will flower profusely for several years following fires (Matthews 2000).

Rough fescue (*Festuca campestris*)
Rough fescue is well adapted to surviving fires by resprouting from root crowns following topkill. If litter has accumulated or stubble has built up at the base of the plant, however, fires may be severe and succeed in killing plants. Fires that burn during the growing season have more adverse effects on plants than fires that burn at the beginning or end of the growing season (Tirmenstein 2000).

Sun sedge (*Carex inops* ssp. *heliophila*)
Sun sedge tolerates fire very well, depending on the season of burning. Spring fires tend to be less favorable to survival than summer fires. Plants are top-killed and resprout from rhizomes following fire (Ahlenslager 1988).

Western wheatgrass (*Pascopyrum smithii*)
Cover of western wheatgrass usually changes very little or even increases following fire. The height of plants may be reduced but density increases. Where western wheatgrass is part of a mountain big sagebrush community, reduction of mountain big sagebrush (through firekill) allows western wheatgrass to utilize more soil resources (Tirmenstein 1999b).

Plant Associations and Vegetation Map Units

Forest

Soil textures of forested or forest-non-forest complex map units are coarser than in herbaceous and shrubland units, ranging from coarse-loamy to loamy-skeletal. All soils are derived from residuum or colluvium from igneous parent materials and all have minimally developed subsoil horizons. The Fire Ecology Group characteristics that are described for each plant association within a vegetation map unit follow Fischer and Clayton (1983).

Douglas-fir/Pinegrass Association

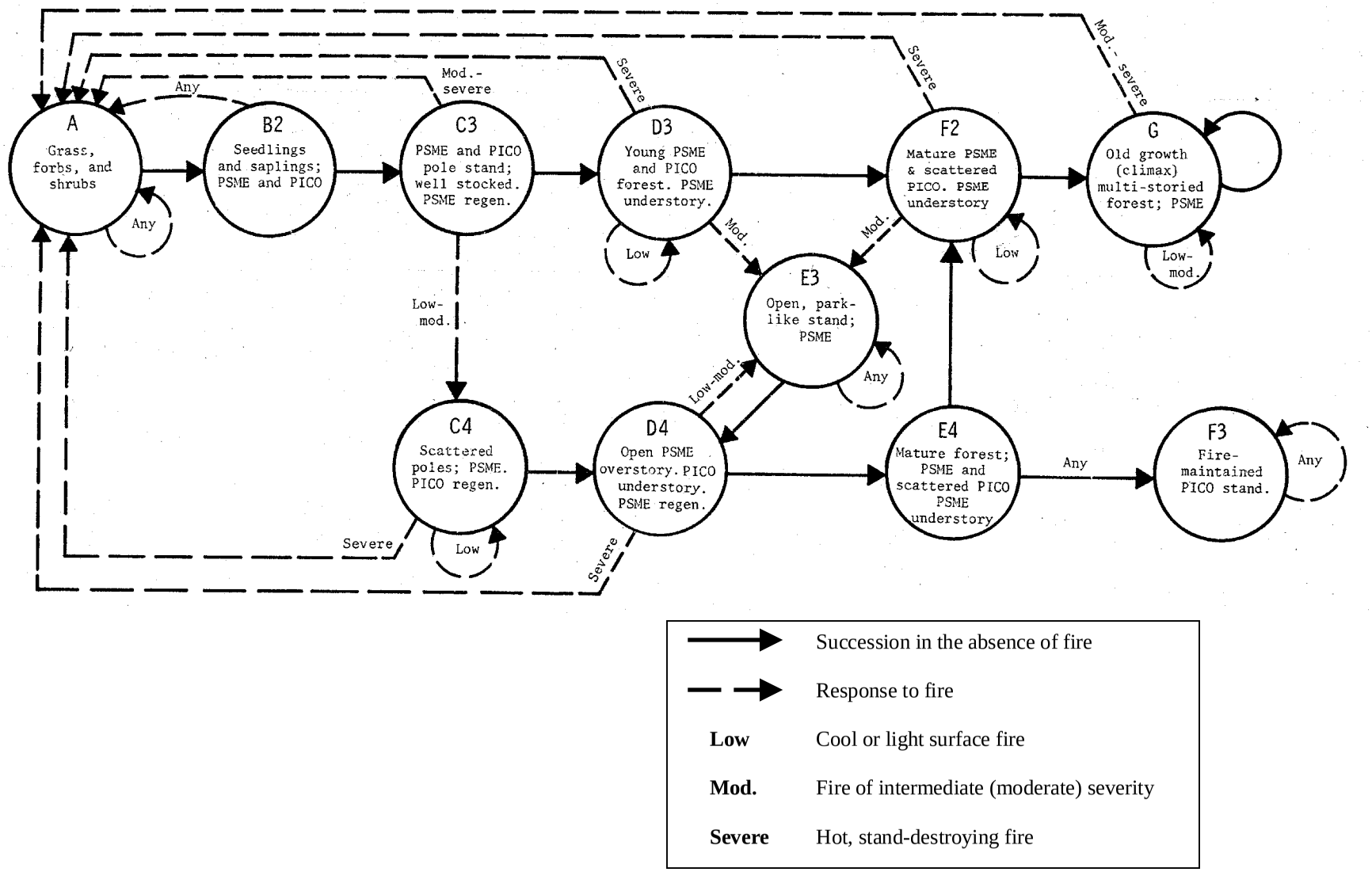
(this association follows the Douglas fir/Pinegrass Habitat Type, Pinegrass phase as described by Pfister et al. 1977)

The association belongs to Fire Ecology Group 6: moist Douglas-fir habitat types (Figure 8). Characteristics of this group include a fairly long average fire frequency interval of 42 years. Fire acts as both a thinning and a stand replacement disturbance agent. Average downed dead fuel loans are 13 tons/acre but can be much heavier. In stands dominated by lodgepole pine, fuel conditions tend to be less hazardous because ladder fuels are much less prevalent (Fischer and Clayton 1983). Two units were mapped within this association and are described below:

Mid- to late-seral Douglas-fir/Pinegrass Map Unit

This map unit covers approximately 180 acres and occurs on northeast-, and north-facing slopes. In this unit lodgepole pine may still have fairly high cover but Douglas-fir is at least co-dominant in the overstory. Stands in polygons surveyed in this map unit are in the C3 stage of the successional model for Fire Ecology Group 6 (see Figure 8). C3 stands have a mix of pole-sized (approximately 90 years old) Douglas-fir and lodgepole pine with predominantly Douglas-fir regeneration. There appears to be quite a bit of mid- to late-seral Douglas-fir/pinegrass on the north and northeast side of the butte intermixed with mid-seral

Figure 8. Successional model for sites in Fire Ecology Group 6 that support both Douglas-fir and lodgepole pine (reproduced from Fischer and Clayton (1983))



lodgepole pine (Douglas-fir)/pinegrass that has a dominance of lodgepole pine from more recent fires. These mid- to late- seral stands will develop into monotypic Douglas-fir if future fires are low to moderate intensity ground fires that do not move up into the crowns. Figure 8 shows possible successional pathways under different future fire frequencies and severities. With relatively frequent low to moderate severity fire the undergrowth will be more open and pinegrass and elk sedge cover will become more dominant over other low shrubs and herbaceous species.

FORVIS data were taken within one polygon of this map unit. The NFDRS fuel model is H/G and the SFM is 8/10 (Figure 9a-d). Photos and fuel model data were taken within another polygon of this map unit. At this location the NFDRS fuel model is C/H and the SFM model is 2/8 (Figure 9e-g). Overall the fuel models for this unit are H and 8. Fuel loads are approximately 8 tons/acre. There are pockets of denser, younger trees and pockets of more open pole-sized trees. Rock cover is about 20%, and ground fuels are not dense.

Mid-seral Lodgepole Pine (-Douglas-fir)/Pinegrass Map Unit.

This map unit covers approximately 66 acres and is found on northeast- and northwest-facing slopes. None of the polygons in this unit were surveyed in the field and were mapped entirely from interpretation of the DOQs. Lodgepole pine forms nearly a monoculture in the tree overstory and trees are probably pole-size. There may be some scattered Douglas-fir poles. Regeneration layer composition is unknown, but since these polygons have abundant Douglas-fir seed sources nearby, there is probably Douglas-fir regeneration. This unit is probably either in the C3 stage or the F3 stage of the successional model for Fire Ecology Group 6 (see Figure 8). The F3 stage is a fire-maintained lodgepole pine stand. These heavily stocked, nearly monocultural lodgepole pine stands are susceptible to pine beetle outbreaks. Significant mortality from beetle-kill would allow Douglas-fir to establish a greater presence in stands. If fires do not occur in these units for at least a couple of decades and subsequently are not of high severity, Douglas-fir may grow old enough to be resistant to low and moderate intensity fires; stands will start moving toward a late-seral condition dominated by Douglas-fir in the overstory. However, fires of practically any severity that occur within the next decade or so will likely kill most of the Douglas-fir that is currently established and the stand will remain dominated by lodgepole pine.

Although polygons in this unit were not visited, the fuel models can be estimated from visitation of dense Lodgepole pine (Douglas-fir)/Common juniper map units and would probably be G/H and 8/10. Thus, fuel loads may be about 10-12 tons/acre.

Douglas fir/Common juniper Association

This association belongs in two Fire Ecology Groups. Five units were mapped. Four of these units occur on the top of the butte, on the north side of tall rock outcrops or on east-, northeast-, west- or northwest-facing slopes and have abundant lodgepole pine, which puts them in Fire Ecology Group 7 (Figure 10). One map unit that occurs on south-facing slopes comprises stands that have interior Ponderosa pine rather than lodgepole pine and belongs to Fire Ecology Group 4 (Figure 11). This association has a relatively sparse shrub and herbaceous understory unless stands are spatially dispersed by the right combination of disturbances and open areas develop between patches of pole-sized and/or mature trees.

In Fire Ecology Group 7, lodgepole pine is often the dominant, and sites are frequently in a mid-seral stage of succession and seldom reach a near climax condition. Fischer and Clayton (1983) state that “periodic wildfires seem to recycle the stands before a substantial amount of mature lodgepole pine dies out”, and lodgepole pine can form a monotypic overstory. Downed, dead woody fuels average 15 tons/acre, but may greatly exceed this value. Fuels 3 inches or more in diameter comprise a large proportion of the fuel load and this proportion increases with an overall increase in the total fuel load. The most important live fuel component is the occurrence of dense patches or stands of young lodgepole pine. These stands often have intermingled crowns and large crown ratios with lower branches close to the ground. Fire periodicity in this group ranges from less than 100 years to about 500 years. Intervals between fires

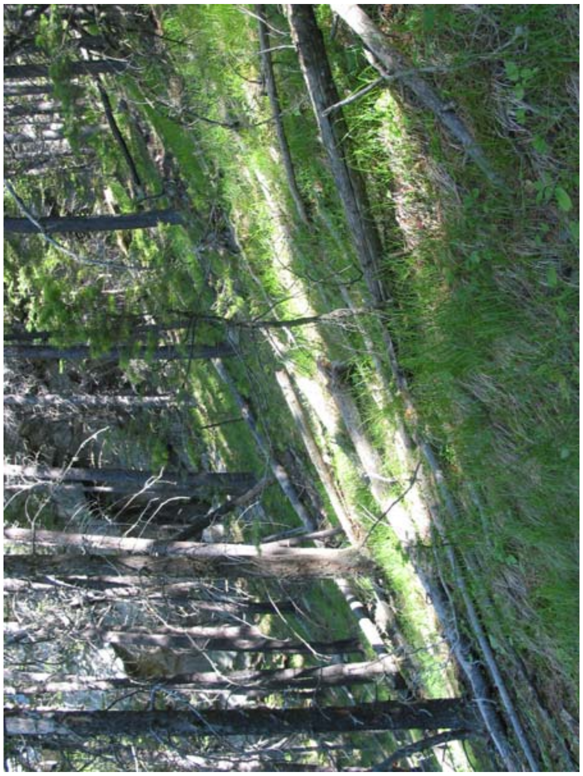
Figure 9a-g. Mid- to late-seral Douglas-fir/Pinegrass map unit

a

b

c

d



g

e

f

Figure 10. Successional model for sites in Fire Ecology Group 7 in which lodgepole pine is a dominant seral species (reproduced from Fischer and Clayton (1983))

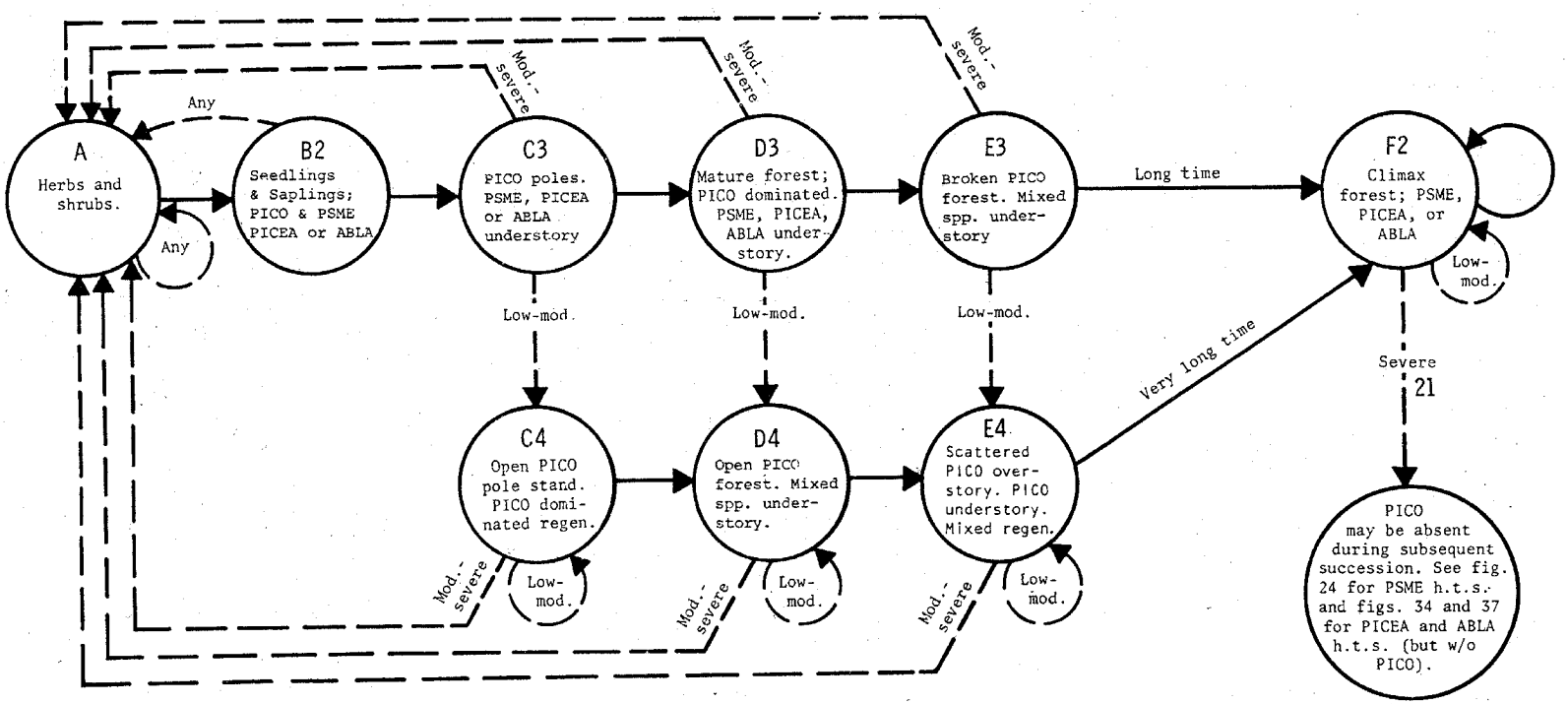
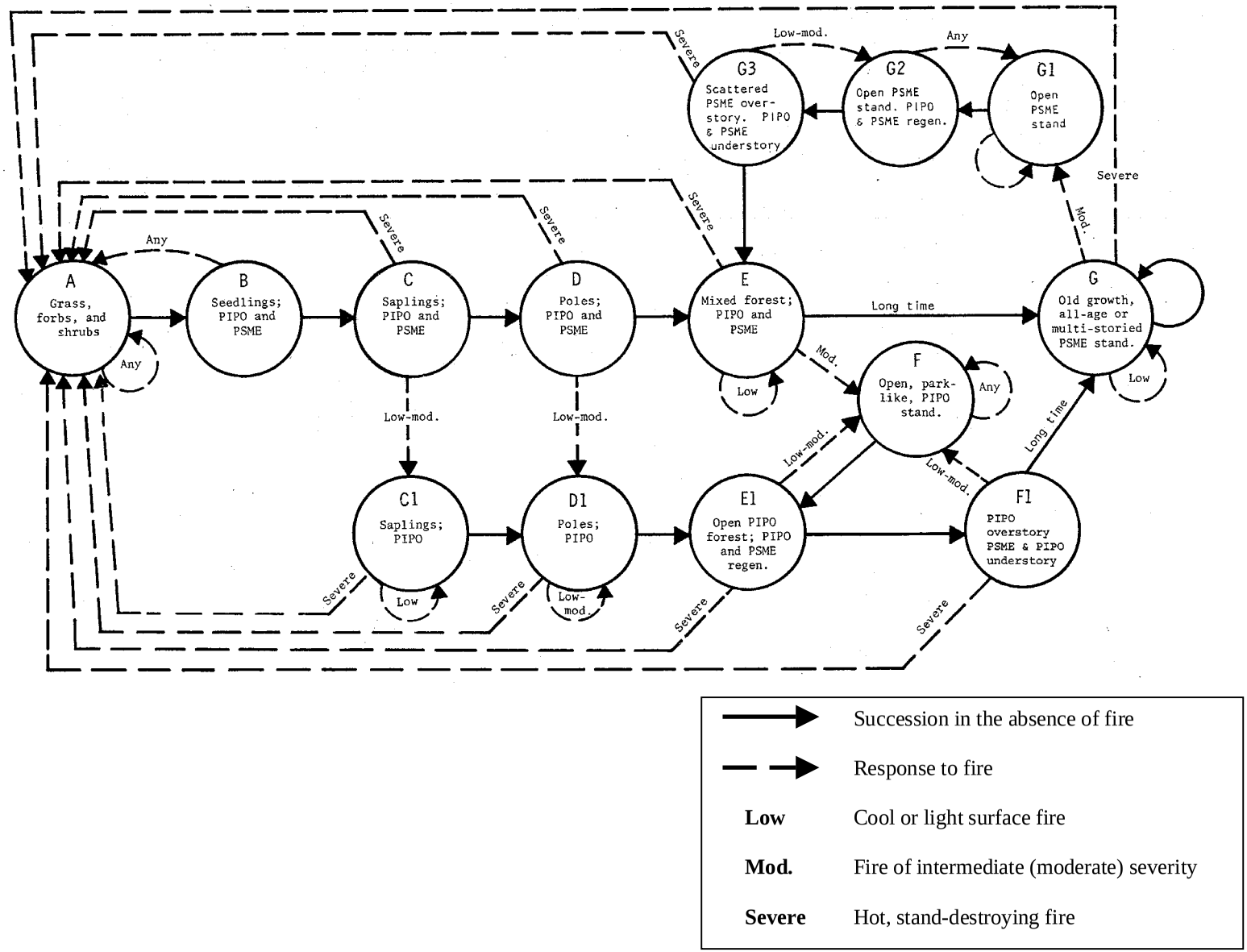


Figure 11. Successional model for sites in Fires Ecology Group 4 in which Ponderosa pine is a dominant seral species (reproduced from Fischer and Clayton (1983))



may be very short. The proportion of lodgepole pine often increases with each successive fire. Dense lodgepole pine stands are often broken up by pine bark beetle attacks, allowing Douglas-fir to increase in cover. A subsequent long fire-free interval then allows the dominance of Douglas-fir over lodgepole pine in the tree overstory (Fischer and Clayton 1983; Agee 1993).

In Fire Ecology Group 4, frequent fires can maintain Ponderosa pine-dominated mid-seral stands. Douglas-fir is often abundant in the regeneration layer, but low to moderate severity fires will kill these Douglas-fir seedlings and saplings, maintaining the Ponderosa pine overstory. Where fire is absent for moderate to long intervals and Douglas-fir are able to mature and develop more fire-resistance, a mixed Douglas-fir-Ponderosa pine overstory can develop. Only with a very long fire-free interval can Douglas-fir become dominant in all tree layers (Fischer and Clayton 1983; Agee 1993). Five units were mapped within this association and are described below:

Early-seral Lodgepole pine (-Douglas-fir)/Common juniper and stagnant Lodgepole pine/Common juniper Map Unit

This map unit covers approximately 56 acres and occurs on top of the butte. Stands in polygons surveyed in this map unit are in the B1 stage of the successional model for Fire Ecology Group 7 (see Figure 10). The herbaceous layer is extremely sparse. Common juniper cover is scattered. In these stagnant stands lodgepole pine has become a monoculture or near monoculture as a result of frequent, stand-replacing fires (Figure 12a&b). Douglas-fir is absent or nearly absent, and rapid and dense lodgepole pine re-establishment preempts Douglas-fir re-establishment. The dense growth pattern and high susceptibility of lodgepole to fire has created a stand-replacing burn cycle that has repeated over many decades or centuries. This cycle may only be broken when the stand experiences a long fire-free interval, a bark beetle attack thins the lodgepole, and Douglas-fir slowly reestablished from the edges of the stand toward the center. This scenario is unlikely in the stagnant stands that were surveyed on top of the butte. Lightning-caused fires are undoubtedly too frequent and bole diameters of stagnated lodgepole pine are not large enough to attract bark beetles.

FORVIS data were taken in one stand on top of the butte. Fuel models for this site are G and 10. The stocking level is very high (estimated 4000-5000 trees/acre), and trees are short (about 20 ft. tall) and of small diameter (about 2-3”). The stand age, however, is about 110 years. Fuels models and loads in early seral, heavily stocked, young stands may be similar, since there is usually an abundance of downed logs: fallen snags from previous fires.

In early seral stands, which were visited but not sampled, lodgepole pine forms a nearly monospecific overstory of saplings and poles. The regeneration is mixed Douglas-fir and lodgepole pine. Future stand structure and composition will be determined by pine bark beetle and fire disturbances. Possible successional pathways for these stands are shown in Figure 10.

Mid-seral Lodgepole pine (-Douglas-fir)/Common juniper Map Unit

This map unit covers approximately 32 acres and occurs on top of the butte and on the east slope. Stands in polygons surveyed in this map unit are in the C3 stage of the successional model for Fire Ecology Group 7 (see Figure 10). C3 stands have a mix of pole-sized Douglas-fir and lodgepole pine with predominantly Douglas-fir regeneration. Given low severity fires and especially if a pine bark beetle outbreak causes abundant lodgepole pine mortality, these sites may become more dominated by Douglas-fir. With the frequency of lightning caused fires on top of the butte, however, these stands may well be replaced fairly frequently. Figure 10 shows possible successional pathways under different future fire frequencies and severities. Common juniper is easily killed by fire and may be slow to re-establish on sites.

FORVIS data were collected in two polygons in this map unit, one on the eastern flank of the butte and one on top of the butte. In the eastern flank polygon, the NFDRS fuel model is G and the SFM is 10 (Figure 13a-c). Fuel loads are approximately 13 tons per acre, most of which is in the 3+ inches size class. The stand is fairly uniform in structure and composition and is approximately 100-105

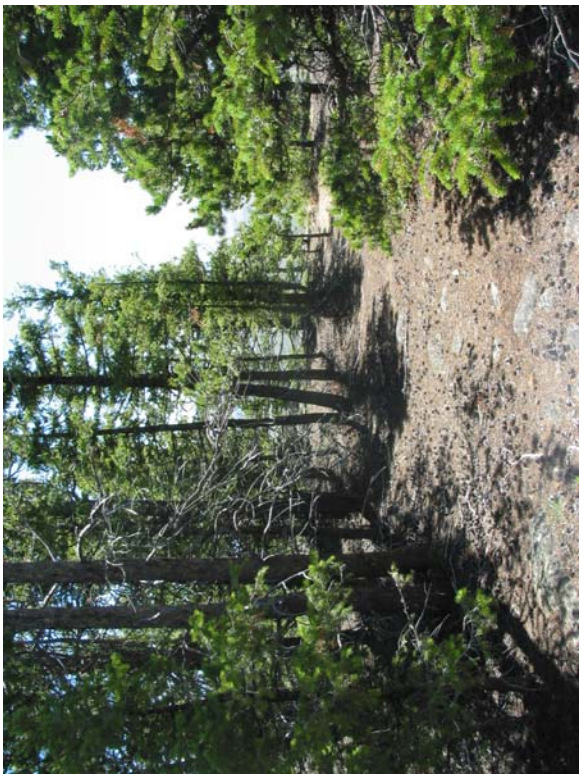
Figure 12a&b. Stagnant Lodgepole pine/Common juniper

a

b

Figure 13a-e. Mid-seral Lodgepole pine (-Douglas-fir)/Common juniper

a



d

e

b

c

years old and 60-70 ft. in height. Common juniper cover is 2%, herbaceous cover is very low, and a layer of pine needles covers much of the ground. In the butte top polygon, the stand is open with abundant bare ground and rock and very little herbaceous cover. Common juniper cover is 3% and herbaceous cover is just a trace. The height of the tree canopy is about 25-30 ft. tall, and the stand is approximately 120-125 years old. Growing conditions are obviously harsher on this site than on the butte flanks. The NFDRS fuel model is C/H and the SFM model is 2/8 (Figure 13d&e). Fuel loads are approximately 3-4 tons/acre.

Mid- to late-seral Lodgepole pine(-Douglas-fir)/Common juniper Map Unit

This map unit covers approximately 59 acres, occurs on top of the butte and is in Fire Ecology Group 7. This unit comprises a much more open, multi-aged and multi-layered coniferous overstory and a much denser shrub and herbaceous understory. The best-fitting successional stage in Figure 10 for this unit is E3, in which lodgepole pine is not completely dominant in the overstory. It appears, however, that fires burning through this unit have created a mosaic of small clusters of older trees and openings, and that stand development in this unit does not fit this successional model particularly well. This broken stand structure may be a result of a history of low to moderate severity burns. In addition, the mosaic of shallow and deep soils that typify the Elve-Rock Outcrop soil map unit on top of the butte would limit the establishment of a contiguous forest unit.

FORVIS data were taken in this unit. Fuel models are H and 8 (Figure 14a-c). Fuel loads are difficult to estimate but are low. Tree canopy layers were approximately 35 ft., 15 ft. and 5-8 ft. tall and the stand is approximately 60 years old. Lodgepole pine and Douglas-fir are the dominant conifers. Interior Ponderosa pine and limber pine are also present in trace amounts. Common juniper and bearberry cover are each 20%. Forb and graminoid cover total about 30-40% and include rosy pussytoes (*Antennaria rosea*), silky lupine (*Lupinus sericeus*), asters (*Aster* spp.), Sandberg's bluegrass (*Poa secunda*), prairie junegrass (*Koeleria macrantha*), spearleaf stonecrop (*Sedum lanceolatum*), Virginia strawberry (*Fragaria virginiana*), bluebell bellflower (*Campanula rotundifolia*), yarrow (*Achillea millifolium*), bearded wheatgrass (*Elymus caninus*), field locowood (*Oxytropis campestris*), slender mountain sandwort (*Arenaria capillaris*), common gaillardia (*Gaillardia aristata*), Rocky Mountain goldenrod (*Solidago multiradiata*), bluebunch wheatgrass (*Pseudoregnaria spicata*), and woolly groundsel (*Packera cana*).

Mid-seral interior Ponderosa pine(-Douglas-fir)/Common juniper - Douglas-fir/Common juniper Complex Map Unit

This map unit covers approximately 76 acres and occurs on the southern flank of the butte. The boundary of this unit corresponds more or less to a polygon of the Elve-Rock Outcrop soil map unit and is a complex of mid- (to possibly late)-seral stands with abundant Ponderosa pine as a dominant, co-dominant or sub-dominant species in the tree canopy. Part of this unit was surveyed and found to have a co-dominant Ponderosa pine-Douglas-fir overstory canopy (approximately 109 years ole and 55 ft. tall) with Ponderosa pine dominated understory and regeneration layers. It corresponds most closely to stage E of Fire Ecology Group 4 (Figure 11). The shrub and herbaceous layers were sparse but species rich. Common juniper cover was 5-10%. Graminoid and forb species present include: Ross' sedge (*Carex rossii*), narrowleaf and maiden blue-eyed Mary (*Collinsia linearis* and *C. parviflora*), needle-and-thread (*Hesperostipa comata*), feathery false-Solomon's seal (*Smilacina racemosa*), meadow deathcamas (*Zigadensus venenosus*), hairy false goldenaster (*Heterotheca villosa*), spreading dogbane (*Apocynum androsaemifolium*), field chickweed (*Cerastium arvense*) and arrowleaf balsamroot (*Balsamorhiza sagittata*).

Fuel models for this unit are H and 8 and fuel loads are approximately 6-7 tons/acre (Figure 15a-c). Live fuels may be more of a hazard in small clumps of trees where regeneration and pole-sized trees may act as ladder fuels. The ground layer of duff is broken up by about 20% rock cover.

Douglas-fir/Common juniper Map Unit

Polygons in this unit, which covers approximately 317 acres, were mapped through interpretation of

Figure 14a-c. Mid- to late-seral Douglas-fir/Common juniper

a

b

c

Figure 15a-c. Mid-seral Interior Ponderosa pine (-Douglas-fir)/Common juniper

a

b

c

DOQs and extrapolation of site characteristics from other field surveyed units of Douglas fir/common juniper. It is likely that most of the polygons are in a mid-seral lodgepole pine-dominated stage or have a mixed lodgepole pine-Douglas-fir co-dominant overstory canopy with a sparse, scattered common juniper dominated shrub-herbaceous layer. This unit was inaccessible to field survey for this project.

Quaking aspen Communities and Map Units

This mapping unit covers approximately 3.5 acres, and polygons are along east/northeast-facing drainages. Both polygons were mapped in the field. There may be more aspen stands on the butte that could neither be seen in the field nor on the DOQs. Neither polygon was visited so specific associations are not identified, and there are no stand or fuels data.

Woodland

The woodland units are complexes of: forest stringers or small stands growing on the protected north or east side of large rock outcrops, abundant rock outcrop, and stands of mountain big sagebrush with bunchgrasses or, on the shallowest soils, just bunchgrasses. The majority of land area in these complexes occurs within the Rock Outcrop-Belain Complex soil map unit. The Rock Outcrop-Lodgepole pine unit occurs within the Elve-Rock Outcrop Complex soil map unit. Both of these soil map units were described above.

These woodland complexes will not carry ground fires well because of their sparse and scattered fuels. Rock outcrop and grass- and shrub-dominated vegetative communities occupy most of the ground area in these units. The forested pockets of these units may burn with high intensity if fuels have built up, and, under favorable wind conditions, can carry fire through the transfer of embers to other dense vegetation.

Douglas-fir/Idaho fescue - Mountain big sagebrush/Idaho fescue - Rock Outcrop Complex Map Unit

This map unit covers approximately 98 acres and occurs on the northern and eastern flanks of the butte (Figure 16a&b). The presence of Idaho fescue is indicative of higher soil moisture and lower soil temperature than locations where it is absent and bluebunch wheatgrass is the sole, dominant large bunchgrass (Daubenmire 1970). Soils are also somewhat deeper here as well, which is probably an artifact of the greater abundance of vegetation on this east side of the butte because of the higher soil moisture. On deeper soil sites, the mountain big sagebrush stands may be successional to Douglas-fir forest given a lack of fire. Mountain big sagebrush is typically a shrub associate in the Douglas-fir/Idaho fescue Association and was found scattered at low cover through the Douglas-fir stands in this unit. Common juniper was also present.

The Douglas-fir/Idaho fescue Association belongs to Fire Ecology Group 5, which comprises cool, dry Douglas-fir types. Douglas-fir dominates the tree canopy in all stages of succession in this group and is often the only conifer present. Limber pine was also seen in this map unit. On these northeast- and east-facing slopes, stands may become overstocked, and undergrowth may be sparse (see Figures 16c&d). The mean fire return interval estimated for this group is 35-40 years (Fischer and Clayton 1983). Estimated fuel models for this association in this map unit are H and 8 (Figure 16c&d). Fuel loads are probably 6-7 tons/acre. These stands are probably in the C stage of the successional model for this fire group (see Figure 17).

Low to moderate severity fires in this complex will kill the mountain big sagebrush and thin the Douglas-fir stands, favoring the expansion of Idaho fescue cover.

Douglas-fir/Idaho fescue-Mountain big sagebrush/Bluebunch wheatgrass-Bluebunch wheatgrass-Sandberg's bluegrass-Rock Outcrop Complex Map Unit

This map unit covers approximately 760 acres and occurs on the southern and western flanks of the butte among abundant rock outcrop "goblins" and cliffs (Figure 18a-c). Idaho fescue is found only in the shelter of the patches of Douglas-fir canopy. In the non-forested areas of the unit soils are warmer and drier, and bluebunch wheatgrass is the dominant large bunchgrass. See the above map

Figure 16a-d. Douglas-fir/Idaho fescue – Mountain big sagebrush/Idaho fescue – Rock Outcrop Complex

a

c

b

d

Figure 17. Successional model for sites in Fire Ecology Group 5 (reproduced from Fischer and Clayton (1983))

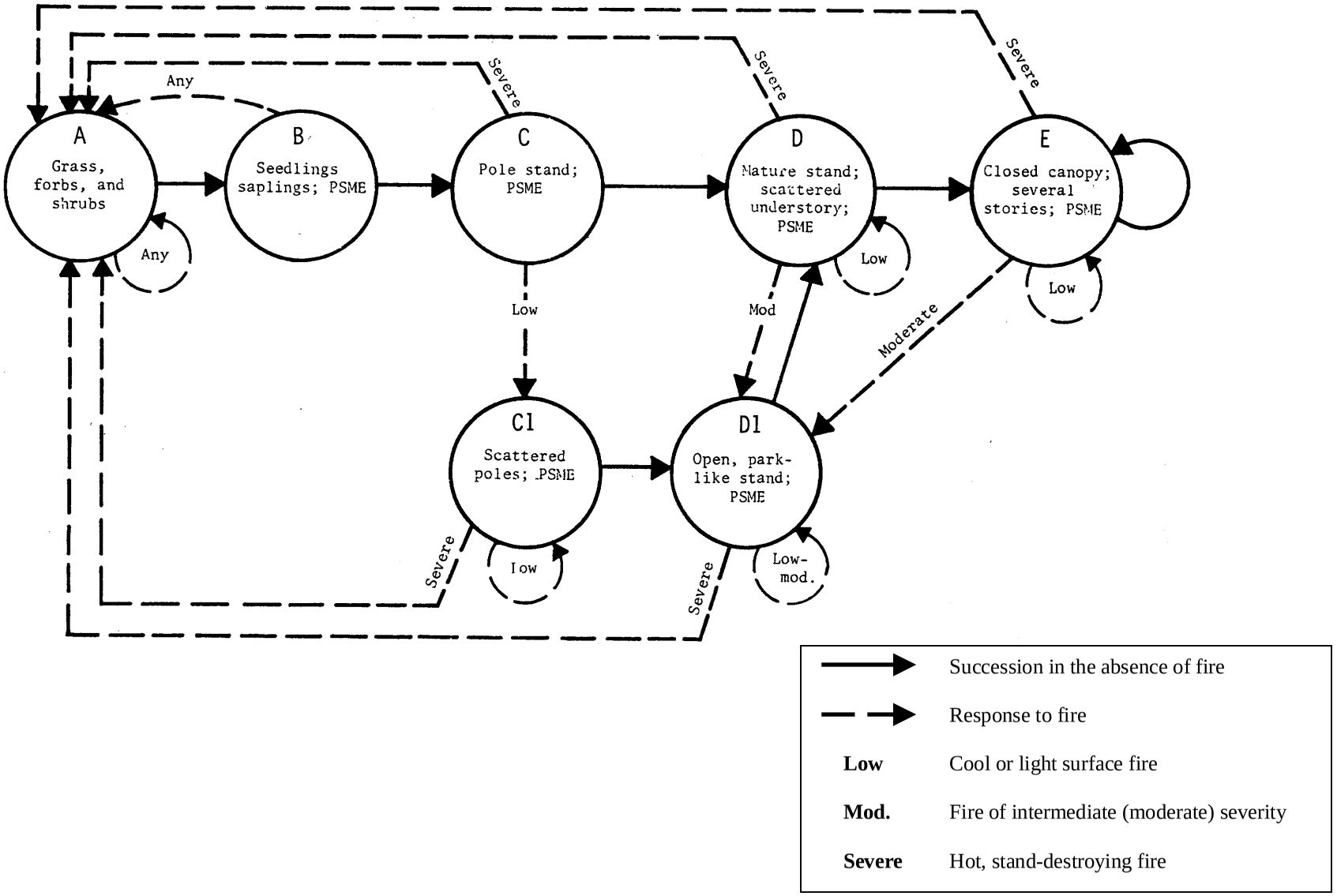
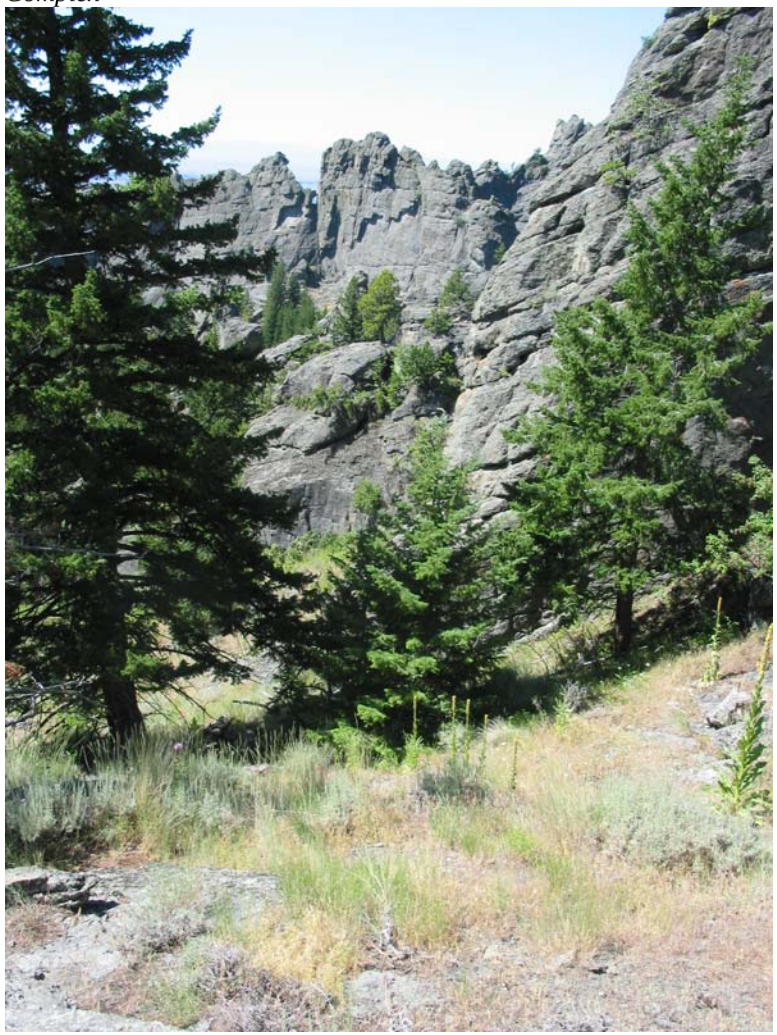


Figure 18a-c. Douglas-fir/Idaho fescue – Mountain big sagebrush/Bluebunch wheatgrass – Bluebunch wheatgrass-Sandberg's bluegrass – Rock Outcrop Complex



a

b

c

unit description for a discussion of the Douglas-fir/Idaho fescue Association. Fuel models and fuel loads are uncertain for this association in this unit. The successional stage is D (see Figure 17).

Ground fuels are patchy and inconsistent, and most fires would burn in smaller mosaic patterns. Under extreme conditions of dryness and high winds, fires could potentially burn large areas of vegetation in this unit through the movement of embers from patch to patch of Douglas-fir. The location and coverage of the three components of this complex vary over time and small fires kill sagebrush and/or Douglas-fir leaving bluebunch wheatgrass to dominate sites until the woody species become re-established.

Rock outcrop - Lodgepole pine Complex Map Unit

This is a small unit (approximately 3 acres) that occurs on the east side of the butte. The rock outcrop is too small to map without the addition of the adjacent scattered lodgepole pine. These sites have probably burned in the recent past and lodgepole pine has re-established on them.

Shrubland

The mountain big sagebrush map units occur mainly on the lower northern and eastern flanks of the butte and on north- and east-facing slopes on the southern and western flanks of the butte. On the south side of the butte, sagebrush was found on the eastern flanks of alluvial fans.

Mountain big sagebrush/Western wheatgrass Map Unit

This vegetation map unit (of approximately 98 acres within the ACEC boundary) occurs primarily (68%) on the Belain-Whitlash-Hedoes Complex soil map unit, which comprises moderately deep to deep Haplustolls with weakly developed subsoils (cambic horizons). The remainder of the unit area occurs on a variety of other soils, primarily deep loams. Fires will kill the mountain big sagebrush leaving western wheatgrass and bluebunch wheatgrass dominant on the site. It may take decades for mountain big sagebrush to re-establish. More research is needed regarding succession of mountain big sagebrush: it appears to require considerably more time to attain pre-burn cover than it does in southwestern Montana.

Mountain big sagebrush/Rough fescue Map Unit

This is a minor unit (approximately 2 acres within the ACEC boundary) that was only mapped in a small opening on top of the butte in the Elve-Rock Outcrop Complex soil map unit. The Elve series is very deep and mostly supports forested communities (as described above). This community (Figure 19) is probably located on a transition area of shallower soil than the surrounding forest. Fires will kill the mountain big sagebrush leaving rough fescue and bluebunch wheatgrass dominant on the site. It may take decades for mountain big sagebrush to re-establish.

Mountain big sagebrush-western snowberry/Idaho fescue Map Unit

This is a minor unit (approximately 6 acres within the ACEC boundary) that was mapped on alluvial fans on the southern and southeastern flanks of the butte on the east-facing slopes of alluvial fans and stream valleys. The primary soil map unit is Farnuf-Reeder Loams, which comprise Typic Argiustolls and are moderately deep to very deep and well drained. The presence of western snowberry and Idaho fescue indicate the presence of higher soil moisture than the surrounding This association may occur in other locations around the butte where soil moisture accumulates within a mountain big sagebrush or grassland landscape.

Mountain big sagebrush-western snowberry/bunchgrasses Map Unit

This is also a minor unit (approximately 18 acres within the ACEC boundary) that was mapped on the west side of the butte based entirely on interpretation of the DOQs as this site could not be visited in the field. Field reconnaissance is needed to determine its accuracy. The primary soil map units on which it occurs are the Work-Absarokee Stony Loams and Laceycreek Loams.

Western snowberry Map Unit

This association occurs on private lands outside of the ACEC boundary on steep (and generally short) north- and east-facing slopes adjacent to streams

Figure 19. Mountain big sagebrush/Rough fescue Association

Figure 20. Needle-and-thread-sun sedge Association

Figure 21. Rough fescue-bluebunch wheatgrass Association

where soil moisture accumulates. It was interpreted on DOQs.

Grassland

Rough fescue-Bluebunch wheatgrass-Needle-and-thread-Sun sedge-Prairie sandreed-Silver sage/Needle-and-thread Complex Map Unit

This map unit covers approximately 76 acres (within the ACEC boundary) and occurs on the south side of the butte and in a couple of locations on the east side where the surrounding prairie meets the toeslopes of the butte. It is a complex mosaic of several different associations that are too small to map individually including: Needle-and-thread/Sun sedge (Figure 20), Prairie sandreed/Needle-and-thread, Prairie sandreed/Sun sedge, Rough fescue-bluebunch wheatgrass (Figure 21) and Silver sage/Needle-and-thread. The location of individual associations is determined by site conditions. The association descriptions in Appendix B describe these different site conditions.

Although overgrazing can have serious adverse effects on species composition and cover, most of these grasslands, both on public and adjacent private lands appear to be in good to excellent condition. The rough fescue-bluebunch wheatgrass sites are especially notable: the individual rough fescue plants are tall and vigorous. The biggest threat to the vegetation in this map unit is invasive plant species. Numerous invasive patches of smooth brome (*Bromus inermis*) were noted. In one Needle-and-thread/Sun sedge community sampled, cheatgrass (*Bromus tectorum*) cover was 70-80%.

Riparian

No riparian units were sampled during the field surveys. Streams are intermittent at best and adjacent riparian areas support intermittent reaches of true riparian plant communities (e.g. red-osier dogwood (*Cornus sericea* ssp. *sericea*), mockorange (*Philadelphus lewisii*), long-beak sedge (*Carex sprengelii*), etc.). Two general units were mapped using the DOQs in riparian zones on the butte. They are not definitive and should be field-checked if more detailed information on riparian units is desired. Vegetation types were not correlated to described associations. Riparian associations (except for coniferous overstory species) are well adapted to, and in some cases dependent upon, disturbance. Most if not all riparian species will resprout or rapidly re-seed following flood, sedimentation and/or fire events that topkill or entirely kill plants.

Douglas-fir/Western snowberry-Mixed riparian shrub-Mixed herbaceous Complex Map Unit

This unit (approximately 19 acres within the ACEC boundary) contains a complex of Douglas-fir/Common snowberry communities on drier forested sites and mixed riparian shrub or mixed riparian herbaceous communities on wetter sites (Figure 22a&b).

Herbaceous

This unit (approximately 23 acres within the ACEC boundary) probably contains stands of Baltic rush (*Juncus balticus*), various sedge (*Carex* spp.), and bulrush (*Scirpus* spp.), California oatgrass (*Danthonia californica*) and common spikerush (*Eleocharis palustris*) communities. Kentucky bluegrass (*Poa pratensis*) may dominate heavily grazed sites.

Figure 22a&b. Douglas-fir/Western snowberry – Mixed riparian shrub – Mixed herbaceous Complex

a

b

CONCLUSIONS AND RECOMMENDATIONS

Square Butte is a unique feature on the central Montana landscape. It is visually striking and invites people to make the arduous hike from the grassland prairie to the Douglas-fir forests at the top. Views of the surrounding landscape are spectacular, and the rock "goblins" and sheer cliffs are remarkable. While the vegetation is not unusual or unique, it does portray an interesting history of fires and forest succession unaltered by commercial timber cutting and road-building activities. Unroaded and unharvested forested areas are becoming increasingly rare in the United States, and Square Butte's designation as an Area of Critical Environmental Concern allows for future protection, study and enjoyment of a relatively natural landscape and its inherent processes.

The largest potential threat to native vegetation populations and community integrity is the invasion of weedy forbs and non-native pasture grasses, e.g. smooth brome (*Bromus inermis*) and crested wheatgrass (*Agropyron cristatum*), into the grasslands and shrublands on the buttes.

A future survey for peregrine falcons, which have a state rank of S2B, is recommended along the south and west flanks of the butte where the highest cliffs are. A pair of falcons was sighted at the southern end of the butte. The pair appeared to be prairie falcons but identification was uncertain.

The report's vegetation map serves as a working base that could be refined through the use of better quality, color aerial photos and more field surveys if access to the north, west and southwest portions of the butte can be obtained. A refinement of the map and further assessment of fuel loads will allow for better predictions of potential fire intensity and severity, and may provide the information needed to determine the potential movement of fire from public to surrounding private lands. Fortunately, the forested stands appear to be in natural successional stages with normal fuel loads and of natural patch sizes compared to many low elevation stands in the western U. S. where fire suppression and timber management has left stands in unnatural states and patch sizes with high fuel loads.

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APPENDIX A. GLOBAL/STATE RANK DEFINITIONS

HERITAGE PROGRAM RANKS

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

GLOBAL RANK DEFINITIONS (NatureServe 2003)

G1	Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction
G2	Imperiled because of rarity and/or other factors making it vulnerable to extinction
G3	Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations
G4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery
G5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery
T1-5	**Infraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank

STATE RANK DEFINITIONS

S1	At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state
S2	At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state
S3	Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas
S4	Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern
S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

COMBINATION RANKS

G#G# or S#S#	**Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

QUALIFIERS

NR	Not ranked
Q	**Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

X	**Presumed Extinct**—Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	**Possibly Extinct**—Species known from only historical occurrences, but may never-the-less still be extant; further searching needed
U	**Unrankable**—Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	**Hybrid**—Entity not ranked because it represents an interspecific hybrid and not a species
?	**Inexact Numeric Rank**—Denotes inexact numeric rank
C	**Captive or Cultivated Only**—Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	**Accidental**—Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	**Zero Occurrences**—Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	**Potential**—Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	**Reported**—Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	**Synonym**—Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	**Breeding**—Rank refers to the breeding population of the species in Montana
N	**Nonbreeding**—Rank refers to the non-breeding population of the species in Montana

APPENDIX B. ASSOCIATION DESCRIPTIONS

TABLE OF CONTENTS

PSEUDOTSUGA MENZIESII/CALAMAGROSTIS RUBESCENS FOREST

Douglas-fir/Pinegrass Forest
Global Rank: G5 State Rank: S5
Element Code: CEGL000429

ELEMENT CONCEPT

Central Montana Summary: The *Pseudotsuga menziesii/Calamagrostis rubescens-Calamagrostis rubescens* phase (Pfister et al. 1977) best describes this association as it occurs on Square Butte. This association is common on moderately dry mountain slopes from about 4400 to 7000 ft. elevation. It occurs on northerly aspects at lower elevations and southerly aspects at higher elevations. The *Calamagrostis rubescens* phase of this association occurs at higher elevations (5300-7000 ft.) than the other, drier and warmer phases. Soils are generally gravelly silts to sandy loams and are acidic. Surface rock is about 2-3% cover, and duff depth averages 4 cm. In the *Calamagrostis rubescens* phase *Pinus contorta* ssp. *latifolia* is the only commonly-occurring seral tree species, and it is often a major component of stands. *Pinus flexilis* or *Pinus albicaulis* may occasionally occur at low cover. Sites in this phase are generally too cold to support *Pinus ponderosa.* Shrub cover is usually low in this association, although *Arctostaphylos uva-ursi* and *Spiraea betulifolia* are occasionally well represented. Other shrubs that may occur in stands include *Berberis repens, Juniperus communis. Calamagrostis rubescens* usually forms a distinctive, bright green herbaceous layer that is uniform in height (as this species rarely flowers except after fire). *Carex geyeri* is often abundant and may dominate the herbaceous layer. The most abundant forbs are *Arnica cordifolia* and *Thalictrum occidentale*. Other forbs that occur occasionally at low cover include: *Disporum trachycarpum, Galium boreale, Pyrola secunda,* and *Smilacina racemosa.*

Central Montana Environment: This association is common on moderately dry mountain slopes from about 4400 to 7000 ft. elevation. It occurs on northerly aspects at lower elevations and southerly aspects at higher elevations. The *Calamagrostis rubescens* phase of this association occurs at higher elevations (5300-7000 ft.) than the other, drier and warmer phases. Soils are generally gravelly silts to sandy loams and are acidic. Surface rock is about 2-3% cover, and duff depth averages 4 cm.

Central Montana Vegetation: In the *Calamagrostis rubescens* phase *Pinus contorta* ssp. *latifolia* is the only commonly occurring seral tree species, and it is often a major component of stands. *Pinus flexilis* or *Pinus albicaulis* may occasionally occur at low cover. Sites in this phase are generally too cold to support *Pinus ponderosa.* Shrub cover is usually low in this association, although *Arctostaphylos uva-ursi* and *Spiraea betulifolia* are occasionally well represented. Other shrubs that may occur in stands include *Berberis repens, Juniperus communis. Calamagrostis rubescens* usually forms a distinctive, green herbaceous layer that is uniform in height (as this species rarely flowers except after fire). *Carex geyeri* is often abundant and may dominate the herbaceous layer. The most abundant forbs are *Arnica cordifolia* and *Thalictrum occidentale*. Other forbs that occur occasionally at low cover include: *Disporum trachycarpum, Galium boreale, Pyrola secunda,* and *Smilacina racemosa.*

Central Montana Dynamics: Fire is the major disturbance factor affecting stand development and successional dynamics. Frequent and/or moderate to high severity fires favor the dominance of early- and mid-seral *Pinus contorta*-dominated stands. If fires are infrequent and/or of low severity, a mature overstory of *Pseudotsuga menziesii* can develop, and subsequent low severity fires will maintain an open, park-like stand (Fischer and Clayton 1983). *Calamagrostis rubescens* is well-adapted to and is rarely killed by fire and flowers profusely (and can re-seed on bare soil) following even high severity fires (Matthews 2000).

ELEMENT DISTRIBUTION

Nations: CA, US
States/Provinces & Ranks: BC:S3?, ID:S4?, MT:S5, OR:S3, UT:S2?, WA:S5, WY:S4?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Clausnitzer and Zamora 1987, Cole 1982, Collins et al. 1984, Cooper et al. 1987, Daubenmire 1952, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Hall 1973, Horton 1971, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Johnston 1987, Mauk and Henderson 1984, McLean 1970, Ogilvie 1962, Pfister et al. 1977, Steele et al. 1981, Steele et al. 1983, Terwilliger et al. 1979, Williams and Lillybridge 1983, Williams and Lillybridge 1985, Williams and Smith 1990, Williams et al. 1990, Zamora 1983

Authors: E. Crowe, Montana Natural Heritage Program

Confidence: 1

***PSEUDOTSUGA MENZIESII/JUNIPERUS COMMUNIS* FOREST**
Douglas-fir/Common Juniper Forest
Global Rank: G4 State Rank: S4
Element Code: CEGL000439

ELEMENT CONCEPT

Central Montana Summary: This forest association occurs mostly from 5300 to 6800 ft. elevation. It is found on flats to gently sloping north-facing slopes on decomposed granite or limestone. The general environment is cool and dry and soils are excessively well-drained. On colder sites with granitic substrates *Pinus contorta* is a persistent seral species on colder sites and succession to *Pseudotsuga menziesii* is slow. On warmer sites, *Pinus ponderosa* var. *scopulorum* may be a dominant seral species. *Pinus flexilus* may also be present, especially on calcareous sites, generally at low cover. *Juniperus communis* is the dominant undergrowth species. *Juniperus horizontalis* may also be present. *Arctostaphylos uva-ursi* and *Spiraea betulifolia* are usually present in small amounts. Grasses and forbs are generally sparse when stands are young and dominated by *Pinus contorta*. Herbaceous cover can be much higher in more open multi-aged stands. Commonly occurring forbs are *Arnica cordifolia*, *Aster conspicuus*, *Fragaria virginiana*, and *Achillea millifolium.*
Global Summary: This forest association occurs in central and eastern Idaho, southwestern Montana, western Wyoming and north-central Colorado. These forests occupy moderate to steep slopes (11-51%), on exposed rocky slopes and ridgetops, at lower to mid elevations of the forested zone, from 6500-9300 elevation. *Pseudotsuga menziesii* is the dominant tree species in the overstory and often in the understory as well. *Pinus flexilis, Pinus contorta*, or *Pinus albicaulis* are occasionally present on drier sites, *Populus tremuloides* on moister sites. The low-shrub layer is dominated by near-continuous to large patches of *Juniperus communis*. Other shrubs include *Symphoricarpos oreophilus, Shepherdia canadensis, Mahonia repens, Ribes* spp., and *Juniperus horizontalis*. The herbaceous cover is generally depauperate, with less than 10% cover of grasses or forbs. Forb species typically provide less than 5% cover and include *Arnica cordifolia, Astragalus miser, Packera streptanthifolia (= Senecio streptanthifolius),* and *Achillea millefolium var. occidentalis (= Achillea lanulosa).* Grass species also contribute less than 5% herb canopy cover and include *Muhlenbergia montana, Danthonia parryi, Bouteloua gracilis*, or *Festuca arizonica*.

Central Montana Environment: This forest association occurs in central mostly from 5300 to 6800 ft. elevation. It is found on flats to gently sloping north-facing slopes on decomposed granite or limestone. The general environment is cool and dry or excessively well-drained.
Global Environment: These forests occupy moderate to steep slopes (11-51%), on exposed rocky slopes and ridgetops, at lower to mid elevations of the forested zone, from 6500-9300 elevation. Bare rock can be as much as 40% , often encrusted with lichens; litter depth is usually less than 6 cm.

Global Vegetation: *Pseudotsuga menziesii* is the dominant tree species in the overstory and often in the understory as well. *Pinus flexilis, Pinus contorta*, or *Pinus albicaulis* are occasionally present on drier sites, *Populus tremuloides* on moister sites. The low-shrub layer is dominated by near-continuous to large patches of *Juniperus communis*. Other shrubs include *Symphoricarpos oreophilus, Shepherdia canadensis, Mahonia repens, Ribes* spp., and *Juniperus horizontalis*. The herbaceous cover is generally depauperate, with less than 10% cover of grasses or forbs. Forb species typically provide less than 5% cover and include *Arnica cordifolia, Astragalus miser, Packera streptanthifolia (= Senecio streptanthifolius), Achillea millefolium var. occidentalis (= Achillea lanulosa), Galium boreale (= Galium septentrionale), Geranium caespitosum, Hymenoxys richardsonii, Antennaria* spp., *Thalictrum fendleri, Maianthemum stellatum, Oxytropis lambertii*, or *Solidago* sp. Grass species also contribute less than 5% herb canopy cover and include *Muhlenbergia montana, Danthonia parryi, Bouteloua gracilis*, or *Festuca arizonica*.
Central Montana Vegetation: On colder sites with granitic substrates *Pinus contorta* is a persistent seral species and succession to *Pseudotsuga menziesii* is slow. On warmer sites, *Pinus ponderosa* var. *scopulorum* may be a dominant seral species. *Pinus flexilus* may also be present, generally at low cover. *Juniperus communis* is the dominant undergrowth species. *Juniperus horizontalis* may also be present. *Arctostaphylos uva-ursi* is usually present in small amounts. Grasses and forbs are generally sparse in

cover when stands are young and dominated by *Pinus contorta*. Herbaceous cover can be much higher in more open multi-aged stands. Commonly occurring forbs are *Arnica cordifolia*, *Aster conspicuus*, *Fragaria virginiana*, and *Achillea millifolium*.

Dynamics: *Juniperus communis* is easily eliminated by fire (Steele et al. 1981). Frequent fires and/or fires of moderate to high severity favor the dominance of *Pinus contorta*, which may persist as an overstory monoculture for long periods of time.

ELEMENT DISTRIBUTION

Range: This forested association occurs in central and eastern Idaho, southwestern Montana, western Wyoming and north-central Colorado.
Nations: US
States/Provinces & Ranks: CO:S1S2, ID:S3, MT:S4, WY:S3S4

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Pfister et al. 1977, Steele et al. 1981

Authors: G. Kittel, NatureServe, Western Conservation Science; E. Crowe, Montana Natural Heritage Program

Confidence: 1

***PSEUDOTSUGA MENZIESII*/*FESTUCA IDAHOENSIS* WOODLAND**
Douglas-fir/Idaho fescue Woodland
Global Rank: G4 State Rank: S4
Element Code: CEGL0000900

ELEMENT CONCEPT

Montana Summary: This association is found on a variety of aspects on relatively dry soils formed from a variety of calcareous and noncalcareous parent materials. Surface soils average about 30% gravel content, range from sandy loam to silt in texture and are acidic. Ground cover has an average of 9% rock 9% bare soil. Duff depth averages 2.5 cm. *Pseudotsuga menziesii* is the dominant overstory tree. *Pinus ponderosa* is the most prominent seral species, and *Pinus flexilus* may be present in small amounts. Understory vegetative cover is moderate, dominated by *Festuca idahoensis* and *Pseudoregnaria spicata*. *Artemisia tridentata* ssp. *vaseyana* is a common shrub associate. Most old growth stands in this association will have an open structure with varying understories depending on the stand's fire history. The dominance of *Pinus ponderosa* vs. *Pseudotsuga menziesii* in a mid-seral stand oftens depends on the dominance of either species before the last stand-replacing fire. If fire is absent for a long period of time, *Pseudotsuga menziesii* will be dominant. Frequent fire will maintain an open, parklike stand of *Pinus ponderosa*. Less frequent fires will often result in a codominance of *Pseudotsuga menziesii* and *Pinus ponderosa* (Fischer and Clayton 1983). *Artemisia tridentata* spp. *vaseyana* is very susceptible to fire and may not re-establish for years or decades after a fire. High severity fires can cause abundant mortality in *Festuca idahoensis* (Zouhar 2000). *Pseudoregnaria spicata* is much less susceptible to fire, will resprout from root crowns following topkill, and is often stimulated to flower and set seed following low to moderate severity fires (Zlatnik 1999).

Montana Environment: This association is found on a variety of aspects on relatively dry soils formed from a variety of calcareous and noncalcareous parent materials. Surface soils average about 30% gravel content, range from sandy loam to silt in texture and are acidic. Ground cover has a average of 9% rock 9% bare soil. Duff depth averages 2.5 cm.

Montana Vegetation: *Pseudotsuga menziesii* is the dominant overstory tree. *Pinus ponderosa* is the most prominent seral species, and *Pinus flexilus* may be present in small amounts. Understory vegetative cover is moderate, dominated by *Festuca idahoensis* and *Pseudoregnaria spicata*. *Artemisia tridentata* ssp. *vaseyana* is a common shrub associate.

Montana Dynamics: Most old growth stands in this association will have an open structure with varying understories depending on the stand's fire history. The dominance of *Pinus ponderosa* vs. *Pseudotsuga menziesii* in a mid-seral stand often depends on their relative proportions prior to the last stand-replacing fire. If fire is absent for a long period of time, *Pseudotsuga menziesii* will be dominant. Frequent fire will maintain an open, parklike stand of *Pinus ponderosa*. Less frequent fires will often result in a codominance of *Pseudotsuga menziesii* and *Pinus ponderosa* (Fischer and Clayton 1983). *Artemisia tridentata* spp. *vaseyana* is very susceptible to fire and may not re-establish for years or decades after a fire. High severity fires can cause abundant mortality in *Festuca idahoensis* (Zouhar 2000). *Pseudoregnaria spicata* is much less susceptible to fire, will resprout from root crowns following topkill, and is often stimulated to flower and set seed following low to moderate severity fires (Zlatnik 1999).

ELEMENT DISTRIBUTION

Nations: US
States/Provinces & Ranks: ID:S3, MT:S4, WA:S2, WY:S1

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Johnston 1987, Pfister et al. 1977, Steele et al. 1983

Author: E. Crowe, Montana Natural Heritage Program

Confidence: 1

***SYMPHORICARPOS OCCIDENTALIS* SHRUBLAND**
Western Snowberry Shrubland
Global Rank: G4G5 State Rank: S4/S5
Element Code: CEGL001131

ELEMENT CONCEPT

Montana Summary: This western snowberry shrubland is found in the western tallgrass and northern Great Plains of the United States and Canada. Stands occur in mesic depressions and swales, typically surrounded by upland grassland communities. The soils are silts and loams. This type usually has three distinct vegetation layers, a shrub layer (approximately 80 cm tall), a graminoid-dominated layer (approximately 30 cm tall), and a forb-dominated layer (<20 cm tall). *Symphoricarpos occidentalis* is the predominant species in the shrub layer and at times forms almost monospecific stands. *Rosa woodsii* commonly occurs interspersed with the *Symphoricarpos occidentalis*. Other shrubs, such as *Rhus aromatica* and *Prunus virginiana*, often occur as thickets on the fringe of this community. *Rhus aromatica* and *Prunus virginiana* can reach 2 m or more. The herbaceous layer is poorly represented where the shrubs are dense, although *Poa pratensis* occurs in many stands. Common forbs include *Artemisia ludoviciana, Solidago* spp., and *Achillea millefolium*. Vines, such as *Parthenocissus vitacea*, are often found climbing through the shrubs. This type is frequently observed in heavily grazed meadows and prairies.

Montana Environment: This community is found in mesic swales, depressions, ravines and floodplains. Some examples of this community experience intermittent and brief flooding. The soils are fertile and well-drained to imperfectly drained silts and loams. The upper soil horizon is usually deep, although a thin layer of sand may be present if the site has been recently flooded (Jones and Walford 1995).

Montana Vegetation: Throughout its range this community is dominated by shrubs approximately 1 m tall. Shrub cover is typically greater than 50%, and in places it can approach 100%. These shrubs form dense clumps that exclude most other species. The rhizomatous *Symphoricarpos occidentalis* is usually strongly dominant, but *Rhus aromatica* (or *Rhus trilobata*) and *Prunus virginiana* can be locally abundant and can grow to 2-3 m in places. *Toxicodendron rydbergii* may also be present. Herbaceous species and smaller shrubs are most abundant at the edges of this community and in gaps between the clumps of taller shrubs where the shading is less complete. *Rosa woodsii* is a typical smaller shrub. Common graminoids include *Pascopyrum smithii* and *Poa pratensis*. *Achillea millefolium, Artemisia ludoviciana, Galium boreale,* and *Solidago* spp. are common forbs of this community. Woody vines sometimes occur, including *Parthenocissus vitacea*.

Montana Dynamics: Stands may occasionally be flooded (Jones and Walford 1995). *Symphoricarpos occidentalis* seems to thrive in disturbed areas (Hansen and Hoffman 1988), especially those subject to disturbance by fire and cattle grazing. Intensive cattle grazing virtually eradicates native graminoids from stands leaving a thicket of *S. occidentalis* that apparently is more dense than stands with less grazing pressure. Grazing pressure also favors the non-native pasture grasses such as *Poa pratensis* and *Bromus inermis*.

GRank & Reasons: G4G5 (96-02-01). This type is common throughout the northern Great Plains. Historically, it may never have been very extensive. It has been observed to grow out from forest or woodland edges and shade out the grasses. It is tolerant of both grazing and fire (Hansen and Hoffman 1988), and is under no threat from human activities. In some cases, heavily grazed pastures may favor this types. Many examples are somewhat weedy; thus the type is not demonstrably secure.

Comments: This type often occurs in heavily disturbed areas in conjunction with exotic species such as *Poa pratensis* and *Cirsium arvense*. Because it occurs in mesic swales, depressions, ravine bottoms and floodplains, some stands are occasionally flooded whereas others are just very moist. Thus it tends to fall on both sides of the upland/wetland division.

ELEMENT DISTRIBUTION

Range: This alliance occurs in riparian areas in the northern Great Plains and the foothills of the Rocky Mountains. The alliance is found from southern Saskatchewan, Canada, south through Montana and the Dakotas, and into eastern Wyoming and Colorado.
Nations: CA, US
States/Provinces: CO IA? MB? MT ND NE SD SK WY

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Caicco and Wellner 1983, Cooper et al. 1999, Driscoll et al. 1984, Hironaka et al. 1983

Authors: E. Crowe, Montana Natural Heritage Program

Confidence: 2

ARTEMISIA TRIDENTATA SSP. *VASEYANA*/*FESTUCA IDAHOENSIS* SHRUB HERBACEOUS VEGETATION

Mountain Big Sagebrush/Idaho Fescue Shrub Herbaceous Vegetation
Global Rank: G5 State Rank: S4
Element Code: CEGL001533

ELEMENT CONCEPT

Montana Summary: This association is found primarily in the southwestern portion of Montana and near the eastern front of the Rocky Mountains. It usually occurs on mountain slopes of less than 40% slope. Soils are primarily Mollisols and with moderate water-holding capacities. pHs range from slightly acid to neutral. Vegetation and litter normally cover the soil surface well. The dominant shrub *Artemisia tridentata* ssp. *vaseyana*. *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* and *Artemisia frigida* are minor associations on drier microsites. Grasses dominant the herbaceous layer, the most abundant being *Festuca idahosensis*. *Pseudoregnaria spicata*, *Poa secunda* and *Koeleria macrantha* have high constancy in this association. Commonly occurring forbs include *Geum triflorum*, *Antennaria microphylla*, *Phlox* spp., *Lupinus sericeus*, *Erigeron* spp. and *Arenaria congesta*. Overgrazing of this associations causes a reduction in the more palatable grasses, such as *Festuca idahoensis* and *Pseudoregnaria spicata*, and forb and shrub cover will tend to increase.

Montana Environment: This association is found primarily in the southwestern portion of Montana and near the eastern front of the Rocky Mountains. It usually occurs on mountain slopes of less than 40% slope. Soils are primarily Mollisols and with moderate water-holding capacities. pHs range from slightly acid to neutral. Vegetation and litter normally cover the soil surface well.

Montana Vegetation: The dominant shrub *Artemisia tridentata* ssp. *vaseyana*. *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* and *Artemisia frigida* are minor associations on drier microsites. Grasses dominant the herbaceous layer, the most abundant being *Festuca idahosensis*. *Pseudoregnaria spicata*, *Poa secunda* and *Koeleria macrantha* have high constancy in this association. Commonly occurring forbs include *Geum triflorum*, *Antennaria microphylla*, *Phlox* spp., *Lupinus sericeus*, *Erigeron* spp. and *Arenaria congesta*.

Montana Dynamics: Overgrazing of this associations causes a reduction in the more palatable grasses, such as *Festuca idahoensis* and *Pseudoregnaria spicata*, and forb and shrub cover will tend to increase.

ELEMENT DISTRIBUTION

Nations: CA? US
States/Provinces: AB?, BC?, CA?, CO:S3S4, ID:S4, MT:S4, NV:S3?, OR:S3, UT?, WA:S?, WY:S3S4

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Bramble-Brodahl 1978, Daubenmire 1970, Despain 1973, Driscoll et al. 1984, Francis 1983, Hess 1981, Hess and Wasser 1982, Hironaka et al. 1983, Hurd 1961, Jensen et al. 1988, Johnston 1987, Komarkova 1986, Lewis 1971, Lewis 1975, Mooney 1985, Mueggler and Stewart 1980, Sabinske 1978, Smith 1966, Strong 1980, Terwilliger and Smith 1978, Tiedemann et al. 1987, Tweit and Houston 1980

Author: E. Crowe, Montana Natural Heritage Program

Confidence: 1

ARTEMISIA TRIDENTATA SSP. *VASEYANA/FESTUCA CAMPESTRIS* SHRUB HERBACEOUS VEGETATION

Mountain Big Sagebrush/Prairie Fescue Shrub Herbaceous Vegetation
Global Rank: G3Q State Rank: S?
Element Code: CEGL001531

ELEMENT CONCEPT

Summary: This big sagebrush shrub prairie type is found in Montana, Washington, southwestern Alberta, and adjacent British Columbia. Stands in Montana are usually found north of 46o latitude and between 3400 and 6400 feet on southerly exposures with less than 40% slope, as well as alluvial flats. Precipitation within this zone ranges from 15 to more than 40 inches per year. Moderately deep soils are derived from a variety of parent materials. Its distribution outside Montana includes lower elevation sites (to 2000 feet) within the Okanogan Valley (Washington) and the Colville country north of Spokane. The high productivity of this type results in comparatively little (<20%) exposed rock or soil. The vegetation description is based primarily on Montana occurrences. This association usually occurs as large patches in a mosaic with fescue grasslands and *Pseudotsuga menziesii*- or *Pinus flexilis*-dominated forests. Shrub layer dominance (10-30% canopy cover, average 20%) by *Artemisia tridentata ssp. vaseyana* characterizes the upper elevation examples of this type. *Artemisia tridentata ssp. wyomingensis* has been noted as a canopy dominant in lower elevation occurrences associated with central Montana ranges isolated within the Great Plains. As little as 5% canopy cover of the highly palatable *Festuca campestris* may be diagnostic for the type, but generally it dominates the herbaceous layer, ranging in canopy cover from 10% to as much as 70-80% on the least disturbed, most mesic sites. Other important and high constancy (>75%) grasses are *Festuca idahoensis, Koeleria macrantha, Pseudoroegneria spicata,* and *Poa cusickii*; the cover of *Pseudoroegneria spicata* and *Festuca idahoensis* may exceed that of *Festuca campestris* on more intensively grazed sites. On overgrazed sites this type may be recognized by scattered remnant clumps of *Festuca campestris*. The forb layer is generally both diverse and abundant, constituting upwards of 20% of the standing crop biomass; those of high constancy include *Arenaria congesta, Eriogonum umbellatum, Antennaria microphylla, Geranium viscosissimum,* and *Cerastium arvense*.

Environment: Within Montana this type is usually found north of 46 degrees latitude between 3400 and 6400 feet on southerly exposures with less than 40% slope, as well as alluvial flats (Mueggler and Stewart 1980). Precipitation within this zone ranges from 15 to more than 40 inches per year. Moderately deep soils are derived from a variety of parent materials. Its distribution outside Montana includes lower elevation sites (to 2000 feet) within the Okanogan Valley (Washington) and the Colville country north of Spokane. This type's high productivity results in comparatively little (<20%) exposed rock or soil.

Vegetation: With the following description based primarily on Montana occurrences, this association usually occurs as large patches in a mosaic with fescue grasslands and *Pseudotsuga menziesii*- or *Pinus flexilis*-dominated forests. Shrub layer dominance (10-30% canopy cover, average 20%) by *Artemisia tridentata ssp. vaseyana* characterizes the upper elevation examples of this type. *Artemisia tridentata ssp. wyomingensis* has been noted as a canopy co-dominant in lower elevation occurrences associated with central Montana ranges isolated within the Great Plains. Mueggler and Stewart (1980) recognized as little as 5% canopy cover of the highly palatable *Festuca campestris* as diagnostic for the type, but generally it dominates the herbaceous layer, ranging in canopy cover from 10% to as much as 70-80% on the least disturbed, most mesic sites. Other important and high constancy (>75%) grasses are *Festuca idahoensis, Koeleria macrantha, Pseudoroegneria spicata,* and *Poa cusickii*; the cover of *Pseudoroegneria spicata* and *Festuca idahoensis* may exceed that of *Festuca campestris* on more intensively grazed sites. On overgrazed sites this type may be recognized by scattered remnant clumps of *Festuca campestris*. The forb layer is generally both diverse and abundant, constituting upwards of 20% of the standing crop biomass; those of high constancy include *Arenaria congesta, Eriogonum umbellatum, Antennaria microphylla, Geranium viscosissimum,* and *Cerastium arvense*.

Dynamics: The herbaceous component of this type is well adapted to periodic burning, but *Artemisia tridentata* is very fire sensitive and must reestablish by seed; in some cases has been noted to require at least 10 years to regain a foothold in the community and longer yet to reach its former coverage.

Similar Associations:

- *Artemisia tridentata* / *Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001530)--occurs primarily outside the range limits of *Artemisia tridentata* / *F. campestris* (although there is some overlap in northwestern Montana), but the abiotic settings and species composition of the two types are very similar.

GRank & Reasons: G3Q (99-12-13). Stipulating the particular subspecies of *Artemisia tridentata* that is diagnostic for this plant community is crucial to establishing the significance of its association with environment/habitat (and hence its rank).

Comments: This syntaxon, as now defined, potentially constitutes a combination of vegetation types recognized by the following dominant shrub taxa, *Artemisia tridentata ssp. vaseyana, Artemisia tridentata ssp. wyomingensis*, and even *Artemisia tridentata ssp. tridentata*, in the most mesic bottomland sites; each subspecies deserves to be recognized, whenever possible, at the association level. Mueggler and Stewart (1980), the most authoritative source for this syntaxon, were well aware that several big sagebrush taxa were involved and that this variability probably accounted for the broad elevational range (3600-6400 feet) exhibited by the type. *Artemisia tridentata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001530) occurs within the range limits of *Artemisia tridentata / Festuca campestris*, and the abiotic settings and species composition of the two types are very similar, with *A. tridentata / F. campestris* reflecting slightly more mesic conditions.

ELEMENT DISTRIBUTION

Nations: US
States/Provinces & Ranks: MT:S4, UT?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hodgkinson and Young 1973, McNab and Avers 1994, Mueggler and Stewart 1980, Willms et al. 1985

Authors: S.V. Cooper, NatureServe, Western Conservation Science

Confidence: 2

***ARTEMISIA TRIDENTATA* SSP. *VASEYANA*/*PSEUDOROEGNERIA SPICATA* SHRUBLAND**
Mountain Big Sagebrush/Bluebunch Wheatgrass Shrubland
Global Rank: G5 State Rank: S?
Element Code: CEGL001030

ELEMENT CONCEPT

Summary: This association occurs on various exposures on gentle to steep slopes from 4000-8000 ft. elevation. It is found on shallow to moderately deep soils formed from a variety of parent materials. Rock cover on the soil surface is high (approximately 30%-70%) and bare soil cover is moderately high (approximately 10%-20%). Surface horizons have a loamy to sandy clay texture. *Artemisia tridentata* ssp. *vaseyana* is the dominant shrub with 10-40% canopy cover. Scattered *Chrysothamnus nauseosus* plants are usually present. The subshrubs, *Artemisia frigida* and *Gutierrezia sarothrae* are common in most stands. Grass canopy cover is generally 40-70%. *Pseudoroegneria spicata* is the dominant species; *Stipa comata, Bouteloua gracilis* and *Poa secunda* are other common species. Forb canopy cover is 10-30%, and diversity is low to moderate. *Opuntia polyacantha, Phlox muscoides* and *Erigeron compositus* are common species. Mosses and lichens are often common.

Environment: This association occurs on various exposures on gentle to steep slopes from 4000-8000 ft. elevation. It is found on shallow to moderately deep soils formed from a variety of parent materials. Rock cover on the soil surface is high (approximately 30%-70%) and bare soil cover is moderately high (approximately 10%-20%). Surface horizons have a loamy or sandy clay texture.

Vegetation: *Artemisia tridentata* ssp. *vaseyana* is the dominant shrub with 10-40% canopy cover. Scattered *Chrysothamnus nauseosus* plants are usually present. The subshrubs, *Artemisia frigida* and *Gutierrezia sarothrae* are common in most stands. Grass canopy cover is generally 40-70%. *Pseudoroegneria spicata* is the diagnostic and usually the dominant species; *Hesperostipa comata* (*Stipa comata*), *Bouteloua gracilis, Koeleria macrantha* and *Poa secunda* are the most common grasses. Forb canopy cover is 10-30%, and diversity is low to moderate. *Opuntia polyacantha, Phlox muscoides* and *Erigeron compositus* are common species. Mosses and lichens are often common.

Dynamics: Heavy grazing results in a decrease in *Pseudoregnaria spicata*, and an increase in *Bouteloua gracilis, Koeleria macrantha* and *Poa secunda*. *Artemisia tridentata* ssp. *vaseyana* also usually increases with heavy grazing because seedlings have more available establishment sites. Fires result in a decrease in *Artemisia tridentata* ssp. *vaseyana*, which is readily killed by fire, an increase in grasses and forb cover is said to occur following fire, as a basic tenent of range science, but this response has been seriously questioned of late (Welch and Criddle 2003). All of the major grass species in this association are well adapted to fire.

ELEMENT DISTRIBUTION

Nations: US
States/Provinces & Ranks: CO:S2?, ID:S4, MT:S?, NV:S4, OR:S3, UT?, WY:S2

ELEMENT SOURCES

References: Baker 1983, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bramble-Brodahl 1978, Cooper et al. 1999, Current 1984, Driscoll et al. 1984, Hironaka et al. 1983, Jensen et al. 1988, Lewis 1975, Mooney 1985, Mueggler and Stewart 1980, Smith 1966, Terwilliger and Smith 1978

Authors: S. Cooper, C. Jean, E. Crowe, Montana Natural Heritage Program

Confidence: 1

ARTEMISIA CANA SSP. *CANA*/*HESPEROSTIPA (=STIPA) COMATA* SHRUB HERBACEOUS VEGETATION

Plains Silver Sagebrush/Needle-and-Thread Shrub Herbaceous Vegetation
Global Rank: G3 State Rank: S3
Element Code: CEGL001553

ELEMENT CONCEPT

Summary: This shrub prairie association, which generally is found in small patches (less than 1 hectare), occurs in the northwestern Great Plains. In Montana, it is found on benches to gently inclined slopes (30% maximum recorded) in the vicinity of breaklands. Similar habitats (old river terraces, badlands, ravine sideslopes and valley walls) support its occurrence in Alberta. Sites occur on various parent materials, but mostly well-drained, often sandy, glacial drift and sandy alluvium. *Artemisia cana* is decidedly the dominant shrub with canopy coverages to 50%, but averaging around 25%, which places it on the cusp of being a true shrub type. *Artemisia frigida* is the only other shrub/subshrub with greater than 50% constancy and its cover does not exceed 3%. A number of graminoids have high constancy, including *Bouteloua gracilis, Carex filifolia, Koeleria macrantha*, and *Poa secunda (= Poa sandbergii)*, but only *Hesperostipa comata (= Stipa comata)* exhibits both 100% constancy and the highest cover values (averaging 38%). Forbs constitute an insignificant component, virtually none occurring in greater than trace amounts. Those exceeding 50% constancy are *Sphaeralcea coccinea*, *Pediomelum argophyllum (= Psoralea argophylla)*, and *Gaura coccinea*. This association is hypothesized to represent the driest environment capable of supporting *Artemisia cana*. Occasional fire probably has reduced *Artemisia* spp. cover and density to low levels and maintains the shrub herbaceous community structure.

Environment: This type is found on benches to gently inclined slopes (30% maximum recorded value) of rolling prairie, steeper ravine slopes, and all manner of topography in the vicinity of breaklands. It occurs on various parent materials but mostly well-drained, often sandy, glacial drift. The ground cover is highly variable with some sites (putatively overgrazed) having a sward of *Selaginella densa* and lichens, while others have 70% litter and trace amounts of *Selaginella densa*; only one plot had as much as 10% exposed soil, gravel and rock (combined cover).

Vegetation: *Artemisia cana* (probably *Artemisia cana ssp. cana* (Shultz 1984)) is decidedly the dominant shrub with canopy coverages ranging to 50% on heavily grazed sites, but averaging 27%; *Artemisia frigida* is the only other shrub/subshrub with greater than 50% constancy and its cover generally does not exceed 3%. A number of graminoids have high constancy, including *Bouteloua gracilis, Carex filifolia, Koeleria macrantha*, and *Poa secunda (= Poa sandbergii)*, but only *Hesperostipa comata (= Stipa comata)* exhibits both 100% constancy and the highest cover values (averaging 38%). *Muhlenbergia cuspidata* and *Calamovilfa longifolia* had rather high cover on some sites. Forbs constitute an insignificant component, occurring in trace amounts; those exceeding 50% constancy are *Sphaeralcea coccinea, Pediomelum argophyllum (= Psoralea argophylla)* and *Gaura coccinea*. This association is hypothesized to represent the driest environment capable of supporting *Artemisia cana*; most often this association grades to upland range sites dominated by *Hesperostipa comata (= Stipa comata)* and *Bouteloua gracilis* and to the *Artemisia cana / Pascopyrum smithii* association that occupies more mesic positions on lower floodplain terraces.

Dynamics: The relatively high cover of *Artemisia cana* may be the result of an altered fire regime. During presettlement time, when fires were more frequent, this type might not have attained these shrub densities.

Similar Associations:
- Artemisia cana ssp. cana / Calamovilfa longifolia Shrub Herbaceous Vegetation (CEGL001555)
- Artemisia cana ssp. cana / Pascopyrum smithii Shrub Herbaceous Vegetation (CEGL001556)

GRank & Reasons: G3 (99-12-06). This small patch type currently has a narrowly circumscribed geographic distribution, though it may be expected to occur in Saskatchewan and North Dakota. Habitats

with the potential to support this type appear to be relatively abundant, but the type itself is comparatively uncommon. Though embedded in primarily agricultural landscapes, the proximity of this type to breaklands/badlands probably lessens the chances of its being sacrificed to the plow. This type's affinity for well drained benches and gently inclined landforms in a primarily agricultural landscape puts it at a moderate risk for agriculture conversion. Fortunately this landform also occurs in breakland and badland environments less desirable for agriculture, thus lessening the chances of this uncommon type being converted to agriculture. Its graminoid composition renders it only moderately attractive to cattle, and the scarcity of forbs decrease its value as sheep range.

Comments: In their vegetation key to this type, DeVelice et al. (1995) allow for the occasional dominance of *Bouteloua gracilis* and/or *Calamovilfa longifolia*, in lieu of *Hesperostipa comata (= Stipa comata)* (which is by far the usual case), to be indicative of the association. The cover of *Artemisia cana* ranges widely, spanning the values defining shrub herbaceous and shrubland categories. The type is described as shrub herbaceous because the preponderance of stands exhibited *A. cana* cover of less than 25%, though the average cover just exceeded this value (these observations are based on Montana data alone). This type could probably be combined with *Artemisia cana ssp. cana / Calamovilfa longifolia* Shrub Herbaceous Vegetation (CEGL001555) without compromising the ecological information embedded in either type. This type is less moist than the *Artemisia cana ssp. cana / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001556), which contains rhizomatous wheatgrasses and/or *Nassella viridula* as dominants. In Wyoming's Cheyenne River Basin, stands of *Artemisia cana / Bouteloua gracilis - Calamovilfa longifolia* Shrub Herbaceous Vegetation (not in USNVC) (renamed *Artemisia cana ssp. cana / Calamovilfa longifolia* association by Thilenius et al. (1995), G.P. Jones pers. comm.) occur on well-drained sand dunes and lack, or have low coverages of, *Pascopyrum smithii*, but support *Hesperostipa comata* as 100% constant; *Hesperostipa comata* coverages approach those of the named diagnostic grasses. At least two plots of the the association under consideration (CEGL001553) have *Calamovilfa longifolia* dominant and could be allocated to (CEGL001555).

ELEMENT DISTRIBUTION

Range: This association is well documented from Montana and Alberta, Canada. The same or a closely analogous type occurs in Wyoming, and some permutation of the type is to be expected in northwestern North Dakota and Saskatchewan.
Nations: CA, US
States/Provinces & Ranks: AB:S?, MT:S3, ND?, SK?, WY:S?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, Thilenius et al. 1995

Authors: S.V. Cooper and C. Jean, NatureServe, Western Conservation Science

Confidence: 1

***FESTUCA CAMPESTRIS-PSEUDOROEGNERIA SPICATA* HERBACEOUS VEGETATION**
Rough Fescue-Bluebunch Wheatgrass Herbaceous Vegetation
Global Rank: G4 State Rank: S4
Element Code: CEGL001629

ELEMENT CONCEPT

Summary: *Festuca campestris - Pseudoroegneria spicata* Herbaceous Vegetation is found in the northwestern Great Plains on both level topography and steep slopes of all degrees of inclination and aspects. Soils are loamy and moderately deep. This midgrass community is fairly arid and heavily dominated by *Festuca campestris (= Festuca scabrella). Pseudoroegneria spicata* is abundant while *Festuca idahoensis* is common. Other graminoids that may be found are *Bouteloua gracilis, Muhlenbergia cuspidata*, and *Hesperostipa comata (= Stipa comata)*. Forbs may include *Heterotheca villosa, Liatris punctata*, and *Lupinus sericeus*. The short shrubs *Artemisia frigida* and *Gutierrezia sarothrae* are also common.

Environment: This community has been described in Montana between 900-1800 m (3000-4000) on both level topography and steep slopes of all aspects (Mueggler and Stewart 1980). Soils are predominantly loamy and moderately deep.

Vegetation: This midgrass community is heavily dominated by *Festuca campestris (= Festuca scabrella). Pseudoroegneria spicata* is abundant while *Festuca idahoensis* is common. Other graminoids that may be found are *Bouteloua gracilis, Muhlenbergia cuspidata*, and *Hesperostipa comata (= Stipa comata)*. Forbs may include *Heterotheca villosa, Liatris punctata*, and *Lupinus sericeus*. The short shrubs *Artemisia frigida* and *Gutierrezia sarothrae* are also common.

ELEMENT DISTRIBUTION

Range: This community is found in Montana.
Nations: CA? US
States/Provinces & Ranks: AB?, MT:S4, ND?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Mueggler and Stewart 1980

Authors: J. Drake, NatureServe, Western Conservation Science

Confidence: 1

***PSEUDOROEGNERIA SPICATA-PASCOPYRUM SMITHII* HERBACEOUS VEGETATION**
Bluebunch Wheatgrass-Western Wheatgrass Herbaceous Vegetation
Global Rank: G4 State Rank: S4
Element Code: CEGL001675

ELEMENT CONCEPT

Summary: This grassland association is found in the northern Great Plains and in the eastern foothills of the northern U.S. Rocky Mountains. Stands generally grow on slopes with shallow soils. *Pseudoroegneria spicata* dominates the vegetation, and rhizomatous wheatgrasses (*Pascopyrum smithii* or *Elymus lanceolatus*) are abundant. Forbs and shrubs contribute little cover.

Environment: Stands of this grassland association grow over a broad elevation range, from 2600 feet in Great Plains to 7500 feet in the foothills of the Rocky Mountains. They occur on slopes, from gentle alluvial fans to slopes as steep as 40%, facing all aspects. Substrates are glacial deposits, alluvium, limestone, and calcareous sandstones. Soils usually are shallow, may contain a substantial volume of coarse fragments, and belong to sandy clay loam, loam, or clay loam textural classes. The sites often are exposed to strong, persistent winds.

Vegetation: Grasses contribute most of the cover and production. *Pseudoroegneria spicata* dominates (usually strongly). The rhizomatous wheatgrasses *Pascopyrum smithii* or *Elymus lanceolatus* (or both) are secondary species, but the rhizomatous wheatgrasses may codominate with *Pseudoroegneria spicata*. *Hesperostipa comata (= Stipa comata), Koeleria macrantha,* and *Poa secunda* usually are present in smaller amounts, but *Hesperostipa comata* often codominates in west-central Montana (Jorgensen 1979). *Bouteloua gracilis* is absent or is a minor species. *Nassella viridula (= Stipa viridula)* contributes substantial cover in some stands, especially in the Great Plains but also in some foothills stands (Mueggler and Stewart's (1980) *Stipa viridula* phase). Stands in the foothills often contain *Poa cusickii, Leucopoa kingii,* and *Calamagrostis montanensis*. In southeastern Montana (Hansen and Hoffman 1988) and northeastern Wyoming (Terwilliger et al. 1979a), *Bouteloua curtipendula* may also occur in the vegetation. Forbs contribute little cover or production, but a number of species may be present, including *Ambrosia psilostachya* (in Great Plains stands), *Draba oligosperma, Erigeron compositus, Stenotus acaulis (= Haplopappus acaulis), Heterotheca villosa, Sphaeralcea coccinea, Phlox hoodii, Tragopogon dubius*, and *Vicia americana*. The subshrubs *Artemisia frigida* and *Gutierrezia sarothrae* usually are present in small amounts. Shrubs generally are absent or are present only as scattered individuals, but Tweit and Houston (1980) note that *Tetradymia canescens* may be common and *Chrysothamnus* spp. may form a distinct shrub layer in disturbed stands.

Similar Associations:
- *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation (CEGL001677)--rhizomatous wheatgrasses are absent or contribute little cover.

Comments: The inclusion of Hansen and Hoffman's (1988) stand number 25 from southeastern Montana extends the range of variability in vegetation found in this association. That stand contains *Bouteloua curtipendula* as an important species, and its inclusion in this association may be inappropriate. Similarly, it is unclear how much *Bouteloua gracilis* and *Carex filifolia* should be allowed in the vegetation for a stand to be placed into this association.

In *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation (CEGL001677), rhizomatous wheatgrasses are absent or contribute little cover

ELEMENT DISTRIBUTION

Range: This association has been described from western and central Montana (Jorgensen 1979, Mueggler and Stewart 1980, Cooper et al. 1995), northeastern Montana (DeVelice et al. 1995), southeastern Montana (Hansen and Hoffman 1988), northwestern and west-central Wyoming (Tweit and Houston 1980), and apparently from northeastern Wyoming (Terwilliger et al. 1979a).

Nations: US
States/Provinces & Ranks: MT:S4, WY:S3

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Cooper et al. 1995, DeVelice et al. 1995, Driscoll et al. 1984, Hansen and Hoffman 1988, Hansen et al. 1984, Johnston 1987, Jorgensen 1979, Mueggler and Stewart 1980, Terwilliger et al. 1979, Tweit and Houston 1980

Authors: NatureServe, Western Conservation Science

Confidence: 1

***PSEUDOROEGNERIA SPICATA-POA SECUNDA* HERBACEOUS VEGETATION**
Bluebunch Wheatgrass-Sandberg Bluegrass Herbaceous Vegetation
Global Rank: G4? State Rank: S4?
Element Code: CEGL001677

ELEMENT CONCEPT

Summary: Throughout its geographic range this is a bunch grassland with minor cover of forbs and, often, sparse shrubs. *Pseudoroegneria spicata* dominates or codominates the vegetation, *Poa secunda* and *Koeleria macrantha* usually are present in substantial amounts, and *Festuca idahoensis* is absent or present in very small amounts. The common shrubs are *Ericameria nauseosa (= Chrysothamnus nauseosus), Chrysothamnus viscidiflorus*, and *Artemisia tridentata* (subspecies unknown). Stands of this association occupy loamy, rocky, often shallow soils on slopes and ridges, generally around the edges of basins and in the foothills of the mountains. This association was at one time common throughout its wide geographic range, but much of it in Washington and Oregon has been converted to agricultural fields. In many of the remaining stands, the cover of *Pseudoroegneria spicata* has decreased and the cover of *Hesperostipa comata (= Stipa comata)* and shrubs have increased, and exotics (especially *Bromus tectorum, Tragopogon* spp., and *Alyssum* spp.) have become common members of the vegetation; these changes are attributed in large part to livestock grazing.

Environment: Stands of this association grow on well-drained, often shallow, and frequently gravelly or rocky soils generally of loam, silt loam, or sandy loam textural classes. Sites usually are ridges and slopes (and sometimes alluvial fans) of any aspect, although southerly and westerly aspects are most common in the northwestern (British Columbia, Washington, Idaho) and northern (Montana) parts of the geographic range. In Wyoming and Colorado, many of the sites supporting this association are windswept slopes and ridges. This association grows over a very broad elevational range, from 700-2800 feet in the northwestern part of the range, 3000-7500 feet in the north-central part, and 9400-10,000 feet in central Colorado.

Vegetation: As would be expected for an association whose geographic range includes such a broad range of climates and of historic grazing regimes, the composition of the vegetation varies, but a number of traits are constant. Throughout, this is a bunch grassland with minor cover of forbs and, often, sparse shrubs. *Pseudoroegneria spicata* dominates or codominates the vegetation; *Poa secunda* and *Koeleria macrantha* usually are present in substantial amounts, and *Festuca idahoensis* is absent or present in very small amounts. *Hesperostipa comata (= Stipa comata)* often is present in substantial amounts and may codominate, due (at least in part of the range) to prolonged grazing. *Bromus tectorum, Tragopogon* spp., and *Alyssum* spp. also are common members of the vegetation, due at least in part to disturbance. The common shrubs are *Ericameria nauseosa (= Chrysothamnus nauseosus), Chrysothamnus viscidiflorus*, and *Artemisia tridentata* (subspecies unknown). In southern British Columbia (Tisdale 1947), eastern Washington (Daubenmire and Daubenmire 1968), and northeastern Oregon (Poulton 1955, Anderson 1956), the undisturbed vegetation of this type consists of *Pseudoroegneria spicata* and *Poa secunda*, with few other vascular plants (*Lomatium macrocarpum, Draba verna, Artemisia frigida, Gutierrezia sarothrae*, and a number of annuals), and substantial cover of epigeous cryptogams. *Hesperostipa comata* is present in most stands and may codominate with *Pseudoroegneria spicata*, as a result of heavy grazing. In western Idaho (Tisdale 1986), xeric sites support open vegetation with little *Poa secunda* and with *Opuntia polyacantha, Phacelia heterophylla*, and *Scutellaria angustifolia*. Stands on more mesic sites are denser and usually contain *Balsamorhiza sagittata, Lomatium triternatum*, and *Lupinus sericeus*. In Utah (Christensen 1963, Christensen and Welch 1963), *Gutierrezia sarothrae* is a common but minor species; *Hesperostipa comata* and *Achnatherum hymenoides (= Oryzopsis hymenoides)* are now common and often contribute substantial cover, apparently in stands disturbed by prolonged grazing. Montana stands (Mueggler and Stewart 1980, Cooper et al. 1995) often contain *Artemisia frigida, Gutierrezia sarothrae, Achillea millefolium, Phlox hoodii, Stenotus acaulis (= Haplopappus acaulis),* and a number of other forbs; *Hesperostipa comata* or *Hesperostipa spartea (= Stipa spartea)* often codominate with *Pseudoroegneria spicata*, apparently even in stands that have not been markedly disturbed. In northwestern Wyoming (Tweit and Houston 1980), the vegetation is much like that in Montana (but without *Hesperostipa spartea*), while

in central Wyoming (Williams 1961, Fisser 1964) and northeastern Wyoming (Terwilliger et al. 1979a), nearer to the eastern edge of the geographic range, *Bouteloua gracilis, Rhus trilobata, Pascopyrum smithii*, and *Carex filifolia* may be present as minor species. In Colorado (Hess and Wasser 1987), species present in greater than trace amounts are *Achillea millefolium, Arenaria fendleri, Oxytropis lambertii, Potentilla gracilis*, and *Taraxacum officinale*.

Similar Associations:
- *Pseudoroegneria spicata - Balsamorhiza sagittata - Poa secunda* Herbaceous Vegetation (CEGL001662)
- *Pseudoroegneria spicata - Poa secunda* Lithosolic Herbaceous Vegetation (CEGL001678)
- *Pseudoroegneria spicata - Pascopyrum smithii* Herbaceous Vegetation (CEGL001675)--rhizomatous wheatgrasses (*Pascopyrum smithii* or *Elymus lanceolatus*) are subdominant or codominant and clearly contribute more cover than does *Poa secunda*.
- *Pseudoroegneria spicata* - Cushion Plants Herbaceous Vegetation (CEGL001666)--contains a substantial amount of *Pseudoroegneria spicata* and often contains *Poa secunda*, but forbs generally provide more cover than do the grasses.
- *Pseudoroegneria spicata - Poa fendleriana* Herbaceous Vegetation (CEGL001676)--relationship is unclear.

Comments: Relationships between this association and several others are unclear. *Pseudoroegneria spicata - Balsamorhiza sagittata - Poa secunda* Herbaceous Vegetation (CEGL001662) from Idaho and Oregon, apparently taken from Tisdale's (1986) *Agropyron spicatum / Poa secunda / Balsamorhiza sagittata* habitat type of western Idaho, is included here. *Pseudoroegneria spicata - Poa secunda* Lithosolic Herbaceous Vegetation (CEGL001678) of Idaho, Oregon, and Washington may be based on the lithosolic phase of Daubenmire and Daubenmire's (1968) habitat type; this association presently includes that vegetation. If these types are to be considered separate associations, clear distinctions must be made between them.

In *Pseudoroegneria spicata - Pascopyrum smithii* Herbaceous Vegetation (CEGL001675), rhizomatous wheatgrasses (*Pascopyrum smithii* or *Elymus lanceolatus*) are subdominant or codominant and clearly contribute more cover than does *Poa secunda*. Similarly, in *Pseudoroegneria spicata - Hesperostipa comata* Herbaceous Vegetation (CEGL001679), *Hesperostipa comata* is subdominant or codominant and clearly contributes more cover than does *Poa secunda*. *Pseudoroegneria spicata* - Cushion Plant Herbaceous Vegetation (CEGL001666) contains a substantial amount of *Pseudoroegneria spicata* and often contains *Poa secunda*, but forbs generally provide more cover than do the grasses. The relationship between this association and the *Pseudoroegneria spicata - Poa fendleriana* Herbaceous Vegetation (CEGL001676) is unclear.

ELEMENT DISTRIBUTION

Range: This association has been described from British Columbia, Washington, Oregon, Idaho, Utah, Colorado, Wyoming, and Montana.
Nations: CA, US
States/Provinces & Ranks: BC:S?, CO:S1S2, ID:S?, MT:S4?, OR:S1, UT:S2S4, WA:S2, WY:S2

ELEMENT SOURCES

References: Anderson 1956, Bourgeron and Engelking 1994, Christensen 1963, Christensen and Welsh 1963, Cooper et al. 1995, Daubenmire 1970, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Fisser 1964, Fisser et al. 1965, Hall 1973, Hess and Wasser 1982, Johnson and Simon 1987, Johnston 1987, Kleiner 1968, Mueggler and Stewart 1980, Poulton 1955, Price and Brotherson 1987, Stoddart 1941, Terwilliger et al. 1979, Tisdale 1947, Tisdale 1986, Tweit and Houston 1980, Williams 1961

Authors: NatureServe, Western Conservation Science

Confidence: 1

CALAMOVILFA LONGIFOLIA-CAREX INOPS SSP. *HELIOPHILA* HERBACEOUS VEGETATION

Prairie Sandreed - Sun Sedge Herbaceous Vegetation
Global Rank: G3 State Rank: S3?
Element Code: CEGL001471

ELEMENT CONCEPT

Summary: This prairie sandreed grassland is found in the northwestern Great Plains of the United States and Canada. Stands typically occur on gentle slopes but can also be found on flat land or moderate to steep slopes. Soils are thin sands, sandy loams, and loamy sands, in places derived from sandstone. Moisture levels may be high deeper in the soil profile. Most stands of this community are not very large. The vegetation is dominated by graminoids, with two strata, one of mid to tall grasses, the other of dense short sedges. Shrubs are uncommon. In the taller grass layer, the most abundant species is *Calamovilfa longifolia*. Other species found in this layer include *Koeleria macrantha*, *Schizachyrium scoparium*, and *Hesperostipa comata* (= *Stipa comata*). *Pascopyrum smithii* may be present on some stands with finer soil textures. The short graminoid layer is composed chiefly of *Carex filifolia* and *Carex inops* ssp. *heliophila*, which may have high cover values. Other upland Carices, such as *Carex duriuscula*, as well as *Bouteloua gracilis* and *Muhlenbergia pungens*, may also be present. Forb species diversity is moderate but they do not contribute greatly to the cover. The forbs that are typical of this community include *Artemisia dracunculus, Artemisia frigida, Artemisia ludoviciana, Chenopodium album, Chenopodium leptophyllum, Lathyrus* spp., *Liatris punctata, Lygodesmia juncea, Phlox hoodii*, and *Psoralidium lanceolatum*.

Environment: Stands are found on gently rolling uplands with little to moderate slopes (typically between 0 and 20%, but occasionally as high as 39%) (Hirsch 1985, Hansen and Hoffman 1988). The soils are sand, sandy loam, or loamy sand and there is rarely substantial soil horizon development (Hanson and Whitman 1938). The parent material is sandstone (USFS 1992). Moisture levels may be high deep in the profile.

Vegetation: The vegetation structure is somewhat open, with cover averaging 65% in parts of its range (USFS 1992). The vegetation is dominated by graminoids, with two strata, one of mid to tall grasses, the other of dense short sedges. In the taller grass layer, the most abundant species is *Calamovilfa longifolia*. Other species found in this layer include *Koeleria macrantha*, *Schizachyrium scoparium*, and *Hesperostipa comata* (= *Stipa comata*). *Pascopyrum smithii* may be present on some stands with finer soil textures. The short-graminoid layer is composed chiefly of *Carex filifolia* and *Carex inops* ssp. *heliophila*, which may have high cover values. Other upland Carices, such as *Carex duriuscula* (= *Carex eleocharis*), as well as *Bouteloua gracilis* and *Muhlenbergia pungens*, may also be present. Forb species diversity is moderate, but they do not contribute greatly to the cover (Hanson and Whitman 1938, USFS 1992). The forbs that are typical of this community include *Artemisia dracunculus*, *Artemisia frigida* (considered a shrub by some authors), *Artemisia ludoviciana, Chenopodium album, Chenopodium leptophyllum, Lathyrus* spp., *Liatris punctata, Lygodesmia juncea, Phlox hoodii*, and *Psoralidium lanceolatum*. Shrubs are uncommon. When shrubs are present they are short shrubs such as *Yucca glauca*, *Rosa* spp., and *Artemisia frigida* (considered a forb by some authors).

Similar Associations:
- Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation (CEGL001473)

GRank & Reasons: G3 (96-02-01). No occurrences have been documented, but the community is reported in 3 ecoregional subsections in Wyoming, Montana, North Dakota, South Dakota, and Saskatchewan. It is a very uncommon community in Badlands National Park, South Dakota.

Comments: The name of this association should probably be changed to *Calamovilfa longifolia - Carex inops* ssp. *heliophila - Carex filifolia* Herbaceous Vegetation. *Carex filifolia* occurs on a wider variety of substrates than does *Carex inops* ssp. *heliophila*, which is more restricted to lighter sands. Steve Cooper (pers. comm. 1998) also notes that *Carex filifolia* occurs farther north and west in Montana than does *Carex*

inops ssp. *heliophila*. In Montana, *Carex inops* ssp. *heliophila* also occurs on shales that have been weathered to sand particles. In North Dakota, this type is restricted to the western part of the state.

ELEMENT DISTRIBUTION

Range: This prairie sandreed grassland is found in the northwestern Great Plains of the United States and Canada, ranging from the western Dakotas to Montana and Saskatchewan.
Nations: CA US
States/Provinces & Ranks: MT:S3?, ND:SU, SD:S?, SK:S?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen 1985, Hansen and Hoffman 1988, Hansen et al. 1984, Hanson and Whitman 1938, Hirsch 1985, USFS 1992

Authors: K. Hirsch, mod. J. Drake and D. Faber-Langendoen, NatureServe, Western Conservation Science

Confidence: 2

CALAMOVILFA LONGIFOLIA-HESPEROSTIPA COMATA HERBACEOUS VEGETATION

Prairie Sandreed-Needle-and-Thread Herbaceous Vegetation
Global Rank: G3 State Rank: S3
Element Code: CEGL001473

ELEMENT CONCEPT

Summary: This prairie sandreed grassland community type occurs in the central and northern Great Plains region of the United States. Stands occur on stabilized sand dunes, as well as in interdunal valleys, colluvial sands, and, less commonly, silty terraces of intermittent streams. Soils are medium to fine sands formed either from eolian or colluvial processes. The vegetation has an open canopy, dominated by mid to tall grasses. *Calamovilfa longifolia* and *Hesperostipa comata* (= *Stipa comata*) are the most conspicuous and dominant grasses. Other common grasses include *Bouteloua gracilis*, *Koeleria macrantha*, *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Sporobolus cryptandrus*. The type may grade into stands dominated by *Pascopyrum smithii* and *Nassella viridula* (= *Stipa viridula*) at the base of slopes. *Andropogon hallii* or *Hesperostipa spartea* (= *Stipa spartea*) may also be present. Sedges are rare, but could include *Carex inops* ssp. *heliophila*. Forb diversity ranges from low to moderate, depending on the site. Dry valley sand prairies may be particularly forb-rich. Silty terraces of intermittent streams may contain *Artemisia frigida*, *Artemisia ludoviciana*, *Gutierrezia sarothrae*, *Psoralidium tenuiflorum*, and *Yucca glauca*. Shrubs are scattered and infrequent to absent, with *Rhus trilobata* the most common species. These areas are highly susceptible to invasion by exotic brome grasses (*Bromus japonicus*, *Bromus squarrosus*, *Bromus tectorum*) and may be quite weedy.

Environment: Stands occur on stabilized sand dunes, as well as in interdunal valleys or draws, colluvial sands, and, less commonly, silty terraces of intermittent streams. Soils are medium to fine sands formed either from eolian or colluvial processes. For example, in Nebraska stands occur below sandstone outcrops and escarpments. More rarely, stands occur on floodplain terraces of intermittent streams, where soils are moderately deep, poorly drained, silty loams and loams (Heerwagen 1958, USDI 1979, Barnes et al. 1984, Steinauer and Rolfsmeier 2000).

Vegetation: The vegetation has an open canopy, dominated by mid to tall grasses. *Calamovilfa longifolia* is the most conspicuous grass. Other common grasses include *Bouteloua gracilis*, *Koeleria macrantha*, *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Sporobolus cryptandrus*, and *Hesperostipa comata* (= *Stipa comata*). *Pascopyrum smithii* (= *Agropyron smithii*) and *Nassella viridula* (= *Stipa viridula*) may occur on more level sites at the base of slopes (Barnes et al. 1984, Steinauer and Rolfsmeier 2000). *Andropogon hallii* may also be present. Sedges are rare but could include *Carex inops* ssp. *heliophila*. Forb diversity ranges from low to moderate, depending on the site. Dry valley sand prairies may be particularly forb-rich. Silty terraces of intermittent streams may contain *Artemisia frigida*, *Artemisia ludoviciana*, *Gutierrezia sarothrae*, *Psoralidium tenuiflorum*, and *Yucca glauca* (Steinauer and Rolfsmeier 2000). Shrubs are scattered and infrequent to absent, with Rhus trilobata the most common species. These areas are highly susceptible to invasion by exotic brome grasses (*Bromus japonicus*, *Bromus squarrosus*, *Bromus tectorum*) and may be quite weedy (Heerwagen 1958, USDI 1979, Steinauer and Rolfsmeier 2000).

Dynamics: Blowouts caused by drought and wind may occur in this type. The type probably represents a later successional stage. Earlier stages may be dominated by *Andropogon hallii* (e.g., *Andropogon hallii* - *Calamovilfa longifolia* Herbaceous Vegetation (CEGL001467)). Heavy grazing may increase the likelihood of blowouts.

Similar Associations:
- *Calamovilfa longifolia* - *Carex inops* ssp. *heliophila* Herbaceous Vegetation (CEGL001471)

GRank & Reasons: G3 (96-02-01). No occurrences have been documented, but the community is reported in 2 ecoregional sections in Wyoming, Colorado, and Nebraska. It is restricted primarily to stabilized sand dunes, as well as in interdunal valleys or draws, colluvial sands, and intermittent streams,

but it has a moderately wide distribution in the central to northern Great Plains. Stands are typically less than a few hectares in size, but larger stands are found in interdunal valleys in Nebraska, some reaching 100 acres or more (G. Steinauer pers. comm. 1999). In Nebraska, this community can be heavily grazed and subsequently invaded by exotic species (Steinauer and Rolfsmeier 2000).

Comments: This type may perhaps be differentiated from other types, such as *Calamovilfa longifolia - Carex inops* ssp. *heliophila* Herbaceous Vegetation (CEGL001471), by the absence or low abundance of *Carex filifolia* and *Carex inops* ssp. *heliophila*, though why those species are not abundant in this type is not clear. Further floristic comparisons need to be made to help make the distinction clear between that type and this type. Some floristic variability is to be expected in this type, based on successional patterns following dune blowouts. Steve Kettler (pers. comm. 1998) says they don't have this type in Colorado. It sounds like a version of a locally described *Andropogon hallii - Stipa comata* type, of which Colorado is also not very confident. Kettler suspects that a lot of the variation in grass dominance is from different management (grazing) over the years. The silty terrace stands are reported from the White River drainage in northwestern Nebraska and Badlands National Park, South Dakota (Von Loh et al. 1999, Steinauer and Rolfsmeier 2000).

ELEMENT DISTRIBUTION

Range: This prairie sandreed grassland community type occurs in the central and northern Great Plains region of the United States, ranging from Colorado and Nebraska, north to Wyoming and South Dakota.
Nations: CA? US
States/Provinces & Ranks: AB?, CO?, NE:S?, SD:S?, WY:S3

ELEMENT SOURCES

References: Barnes et al. 1984, BLM 1979, Bourgeron and Engelking 1994, CDM Consultants n.d., Driscoll et al. 1984, Heerwagen 1958, Johnston 1987, Mine Reclamation Consultants 1977, Steinauer and Rolfsmeier 2000, Von Loh et al. 1999

Authors: G. Steinauer and S. Rolfsmeier, mod. D. Faber-Langendoen, NatureServe, Western Conservation Science

Confidence: 2

***HESPEROSTIPA COMATA-CAREX INOPS* SSP. *HELIOPHILA* HERBACEOUS VEGETATION**
Needle-and-Thread-Sun Sedge Herbaceous Vegetation
Global Rank: G4 State Rank: S4
Element Code: CEGL001701

ELEMENT CONCEPT

Square Butte Summary: This association occurs at approximately 4000-4200 ft. elevation on fine sandy loam soils developed on alluvial fans and toeslopes from extrusive igneous parent materials. Aspects are southwesterly, and slopes are gentle to moderate. Coverage of *Hesperostipa comata* averages 35-40%, while coverage of *Carex inops* spp. *heliophila* averages about 5%. Other herbaceous species are *Pascopyrum smithii*, *Carex filifolia*, *Lepidium* spp., *Lupinus sericeus*, *Cisium undulatum*, *Artemisia ludoviciana*, and *Heterotheca villosa*. Needle-and-thread can survive fires well if burned in late summer. If plants are older and dead culm remnants and litter from past years have built up, fires may burn hotter and reach the growing points lower in the plant, resulting in higher mortality. Fire will topkill plants and resprouting will occur from root crowns. *Bromus tectorum* interferes with the reestablishment of *Hesperostipa comata* on sites that have been severly burned (Zlatnik 1999) and can become the dominant graminoid. Sites that have been heavily grazed have abundant *Bromus tectorum* and increased cover of *Pascopyrum smithii* and reduced amounts of *Hesperostipa comata* and *Carex inops* spp. *heliophila.*

Square Butte Environment: This association occurs at approximately 4000-4200 ft. elevation on fine sandy loam soils developed on alluvial fans and toeslopes from extrusive igneous parent materials. Aspects are southwesterly, and slopes are gentle to moderate.

Square Butte Vegetation: Coverage of *Hesperostipa comata* averages 35-40%, while coverage of *Carex inops* spp. *heliophila* averages about 5%. Other herbaceous species are *Pascopyrum smithii*, *Carex filifolia*, *Lepidium* spp., *Lupinus sericeus*, *Cisium undulatum*, *Artemisia ludoviciana*, and *Heterotheca villosa*.

Square Butte Dynamics: Needle-and-thread can survive fires well if burned in late summer. If plants are older and dead culm remnants and litter from past years have built up, fires may burn hotter and reach the growing points lower in the plant, resulting in higher mortality. Fire will topkill plants and resprouting will occur from root crowns. *Bromus tectorum* interferes with the reestablishment of *Hesperostipa comata* on sites that have been severly burned (Zlatnik 1999) and can become the dominant graminoid. Sites that have been heavily grazed have abundant *Bromus tectorum* and increased cover of *Pascopyrum smithii* and reduced amounts of *Hesperostipa comata* and *Carex inops* spp. *heliophila.*

ELEMENT DISTRIBUTION

Nations: US
States/Provinces & Ranks: MT:S4, WY:S?

ELEMENT SOURCES

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen 1985, Hansen and Hoffman 1988

Authors: E. Crowe, Montana Natural Heritage Program

Confidence: 1