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Bunchgrass Plant Communities of the Blue and Ochoco Mountains: A Guide for Managers

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Cover photograph: Bluebunch wheatgrass near Bean Creek, Hells Canyon National Recreation Area.

Unless otherwise noted, all photographs were taken by Charles G. Johnson.

Abstract

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A classification of bunchgrass vegetation is presented for the Malheur, Ochoco, Umatilla, and part of the Wallowa-Whitman National Forests. It includes grassland vegetation as well as shrubland and forest land where the herbaceous layer is dominated by bunchgrasses. It is based on potential vegetation, with the plant association as the basic unit. Diagnostic keys and descriptions are presented for each type. Descriptions include information about plant species occurrence, environment and soils, states and transitions, forage productivity, management considerations, and relationships to other classifications.

Keywords: Blue Mountains, Ochoco Mountains, plant association, plant ecology, range management, steppe.

Contents

Introduction

This management guide is provided for use in determining the bunchgrass plant associations and plant community types encountered on lands administered by the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests (NF) within the Pacific Northwest Region (Region 6). Classification of new plots along with bunchgrass plots included in *Plant Associations of the Blue and Ochoco Mountain*s (Johnson and Clausnitzer 1992) provide the basis of this study. The purpose of this publication is to provide the field investigator with floristic indicator species that are diagnostic of a particular environment and potential vegetation.

Successional relationships and disturbance effects are portrayed by using the state-and-transition approach (Westoby et al. 1989), following the current trend in scientific thinking. This way of describing vegetation change on rangelands has largely replaced the successional model, in which ecological status was described as late seral, mid seral, or early seral based on an assumed successional pathway toward potential natural vegetation. The successional model in turn provided an alternative to the earlier condition classes of "good," "fair," and "poor" based on suitability for domestic livestock grazing. To assist in conversion to the state-and-transition model, the user might consider the phases in a state-and-transition model as analogous to seral stages or condition classes, and the transitions as multiple pathways between them resulting from succession or disturbance by grazing, fire, and so forth.

What Is a Bunchgrass?

Grasses belong to the grass family Poaceae (Gramineae). Bunchgrasses are those grasses that have the characteristic growth habit of a clump, tuft, or bunch, in contrast to sod-forming grasses that spread via stolons or rhizomes. Bunchgrasses have fibrous root systems that occupy a belowground area approximating the aboveground foliar canopy. Studies by John Ernst Weaver (1915) gave us the first overall picture of the bunchgrass plant—above and below ground—by exhuming them carefully. The rooting depths of our principal bunchgrasses are linked to the environments they occupy. Following are key bunchgrasses (see apps. A and B for a full list of scientific and common names of species) and a description of their adaptations to some of the harshest sites in eastern Oregon:

Sandberg's bluegrass (*Poa sandbergii,* syn. *P. secunda*)—This plant relies on lateral roots (3 to 5 in long) to utilize surface soil moisture, with deep roots extending down only 8 in. The root structure explains the plant's ability to occupy droughty scabland sites. Surface soil moisture is depleted more rapidly than moisture in deeper layers, and thus Sandberg's bluegrass usually matures and dries up earlier than more deep-rooted bunchgrasses (Sauer and Uresk 1976). Short stature and a brief green period make this grass highly resistant to grazing.

Idaho fescue (*Festuca idahoensis*)—This deep-rooted bunchgrass extends to an average depth of 18 in. Because this is not a great depth for bunchgrass, Idaho fescue requires relatively moist sites.

Prairie junegrass (*Koeleria cristata* syn. *K. macrantha*)—Similar to Idaho fescue in site requirements, the roots of this grass extend downward about 15 in.

Bluebunch wheatgrass (*Agropyron spicatum,* syn. *Pseudoroegenaria spicata*)—This tenacious bunchgrass has roots that extend to an average depth of 4 ft, allowing it to occupy some of the driest and hottest sites in eastern Oregon. Bluebunch wheatgrass is a very nutritious grass that is relished by livestock and wildlife. It is, however, easily damaged if grazed heavily during its period of active growth (Blaisdell and Pechanec 1949, Miller et al. 1986).

Most bunchgrasses in our region are cool-season grasses; they accomplish most of their growth during cooler, moister weather before the summer drought. Most cool-season grasses are able to grow in the fall if rains occur, go dormant during the winter, then resume growth in early spring. They complete their yearly growth and go to seed before the extreme drought of late summer begins. Warm-season grasses, which grow mainly during midsummer, occur at low elevations in the Hells Canyon region (see Johnson and Simon 1987) but were not recorded on the plots used in this study.

History of Bunchgrasses and Livestock Grazing in the Pacific Northwest

Early European explorers gave vivid accounts of the bunchgrass landscape they encountered prior to the arrival of European settlers (the following quotes are from McArdle and Costello 1936). In 1841 Commander Wilkes wrote from north central Oregon: "These hills, as well as the country nearer at hand, were covered with a natural hay or bunchgrass, which affords very nutritious food for cattle." Captain Fremont wrote when passing through eastern Oregon in 1843: "The mountains were covered with good bunchgrass." Granville Stuart wrote

> We crossed the Rocky Mountain Divide on the 10th day of October, 1857. As soon as we had crossed the divide a wonderful change appeared in the country. Instead of the gray sagebrush covered plains of Snake River, we saw smooth rounded hills and sloping benchland covered with yellow bunchgrass that waved in the wind like a field of grain.

Grazing by domesticated livestock in the Blue Mountains began with Indian horses in the 1700s, but widespread impacts began with expansion of cattle and sheep ranching after 1870 (Galbraith and Anderson 1971, Humphrey 1943). Numbers of cattle and sheep peaked around 1900. This was a time of true open range, with no government regulation of numbers of animals, season of use, or which livestock owners were entitled to use the land. Today we still observe areas with grazing-resistant and invasive weedy species on sites that we believe should support bunchgrass vegetation; these are former livestock driveways or bedding areas from the early 1900s. Livestock numbers declined after 1906 as the USDA Forest Service began to regulate grazing through its allotment system. Livestock grazing, primarily by cattle, continues to this day on most bunchgrass-dominated plant communities in the Blue Mountains.

Study Area

The Blue and Ochoco Mountains of eastern Oregon are part of the Blue Mountains physiographic province (Orr and Orr 1999). This broad area includes the Ochoco Mountains to the west; the Strawberry, Aldrich, and Greenhorn Mountains in the southern part of the Blue Mountains; the Elkhorn Mountains and the tristate uplands of the northern Blue Mountains; and the Wallowa Mountains on the east end of the province (fig. 1). The Blue Mountains segment is a northeast- to southwest-trending axis of geologically old mountains that extend south from Pomeroy, Washington, 200 mi to the south near Burns, Oregon. A 50-mile-long spur begins west of Ukiah, Oregon, with an east-west axis toward Fossil, Oregon. The Ochoco Mountains are another east-west trending axis of ridges that begin west of the Aldrich Mountains near Dayville, Oregon, and culminate north of Prineville, Oregon. The study was conducted on USDA Forest Service-administered land, including the mountains and intervening canyons in the Malheur, Ochoco, Umatilla, and Wallowa-Whitman NF. Additional plots were installed on the Crooked River National Grasslands between Prineville and Madras, Oregon.

The study area was divided into four segments to assist in portraying the distribution of vegetation as described in this management guide. These segments are as follows with key physiographic features listed:

1. Northern Blue Mountains—North of Interstate 84 (running between La Grande and Pendleton)
   - High points—Oregon Butte (6,401 ft) and Mount Emily (6,064 ft)
   - Low points—Tucannon River, Umatilla River, Wenaha River
2. Central Blue Mountains—South of Interstate 84 and north of U.S. Highway 26 (running between Unity and John Day).
   - High points—Vinegar Hill (8,131 ft) and Rock Creek Butte (9,106 ft)
   - Low points—Powder River, Grande Ronde River, North Fork John Day River
3. Southern Blue Mountains—South of U.S. Highway 26
   - High points—Strawberry Mountain (9,038 ft) and Fields Peak (7,363 ft)
   - Low points—South Fork John Day River, Malheur River
4. Ochoco Mountains
   - High points—Round Mountain (6,753 ft) and Spanish Peak (6,885 ft)
   - Low points—Crooked River

Physiography and Geology

The study area is dominantly an extensive lava plateau at elevations of 3,500 to 6,500 ft, punctuated by a few deep canyons, with elevations as low as 2,000 ft, and mountains rising to about 9,000 ft. Most bunchgrass communities here occur over volcanic rocks that erupted during the Cenozoic Era—primarily basalt, but also andesite and rhyolite. Interbedded in these volcanic rocks are some relatively thin layers of tuffaceous sedimentary rocks. Locally in the southern half of the study area, the older sedimentary and metasedimentary rocks that occur beneath the volcanics are exposed. These consist mostly of graywacke, shale, and argillite deposited in a marine environment. Included with these sedimentary rocks in a few places are ultramafic rocks, including serpentine, that originated as deep ocean crust. These ultramafic rocks occur in environments with bunchgrass vegetation in the Strawberry Mountains and in the vicinity of Mine Ridge southwest of Unity, Oregon. One large area of granitic rock also occurs in the study area—the Bald Mountain batholith—which is centered in the vicinity of Anthony Lakes, northwest of Baker City, Oregon. This high-elevation area has only incidental occurrences of bunchgrass vegetation. (This section is based on Orr and Orr 1999 and Walker and McLeod 1991.)

Climate

The climate of bunchgrass plant communities in the Blue Mountain region is temperate and semiarid (USDA NRCS 2004a, Western Regional Climate Center 2004). Precipitation is highly seasonal, with most arriving between November and June; drought conditions are common in late summer. Temperatures generally decrease with increasing elevation, although low temperature extremes in all seasons tend to occur at moderate elevations on valley bottoms surrounded by higher terrain. Summer highs are typically in the high 70s and 80s °F, and lows in the 40s. Winter highs average in the 30s °F and lows in the teens. Summer

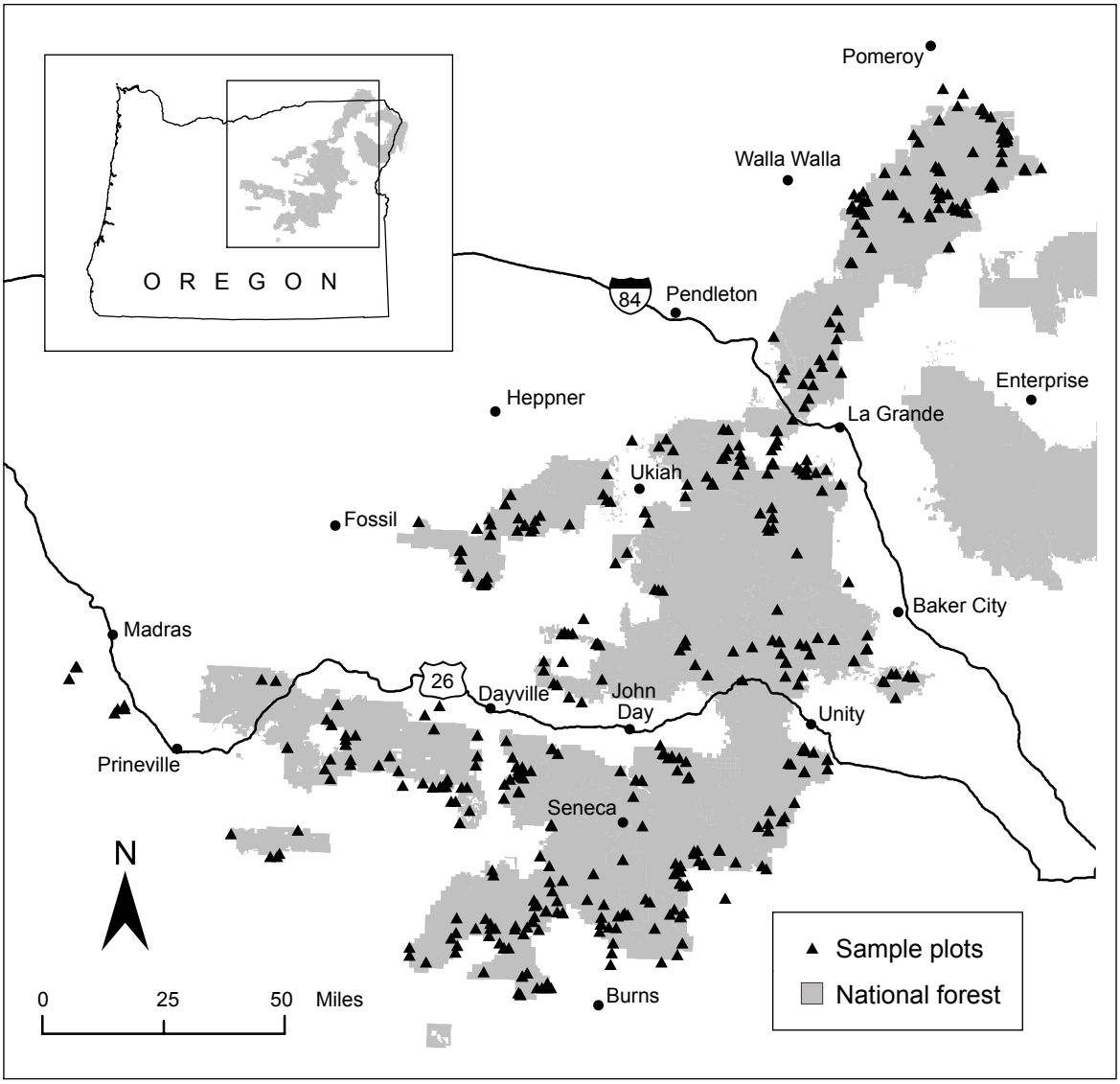


Figure 1—Location of the study area.

temperatures in the 90s °F are not unusual, and winter temperatures occasionally fall below 0 °F. The lowest temperature ever recorded in Oregon or Washington (-54 °F) was recorded at both Seneca and Ukiah, not far from our bunchgrass study plots. Precipitation is generally lower in the south and at lower elevations in our study area. At lower elevations (2,000 to 3,000 ft in the north and 4,500 to 5,000 ft in the south), where bunchgrass communities occur on a variety of sites, annual precipitation averages between 10 and 20 in. Stations at higher elevations in the vicinity of bunchgrass communities have annual precipitation of 20 to 40 in, but effective precipitation on sites where bunchgrass communities actually occur is typically reduced by wind, which removes snow in winter, and intense solar radiation on steep southerly aspects, which greatly increases evaporation.

Daubenmire (1956) investigated in detail the relationship of climate to several of the vegetation series that are classified here. The zone dominated by sagebrush with bluebunch wheatgrass is generally drier and has colder winters than bluebunch wheatgrass areas without sagebrush, although no simple statistic defines that boundary. The transition from the sagebrush to ponderosa pine zone occurs at mean annual precipitation values of about 15 in. The bluebunch wheatgrass and Idaho fescue zones show considerable overlap in precipitation, but the latter are consistently cooler (which reduces drought severity) and in some cases have higher precipitation also. The July mean temperature in all of Daubenmire's bluebunch wheatgrass zone stations was greater than 70 °F, as opposed to less than 70 °F in the fescue zone. Note that local site characteristics often allow a vegetation type to occur outside of its zone as determined by the macroclimate.

Soils

Soils of bunchgrass plant communities are a mixture of loess, volcanic ash, and weathered bedrock. The parent materials are noncalcareous, and basalt is the most common lithology. Most soils have little or no stone-free loamy material at the surface, and coarse fragments increase with depth, reaching bedrock or extremely gravelly/cobbly material within about 2 ft of the surface. A common soil class is Lithic Argixerolls, which are soils with a brown surface layer rich in organic matter from herbaceous understory plants (a mollic epipedon), a seasonally dry (xeric) moisture regime, a clay-enriched subsoil horizon (an argillic horizon), and bedrock near the surface (a lithic contact). Where bedrock is very close to the surface, one or both of the horizons mentioned above may be missing, resulting in Lithic Haploxerolls (soils where the clay subsoil is thin or absent) or Lithic Xerorthents (soils where both the clay subsoil and brown surface layer are thin or absent). For more information on these soil classification terms see USDA NRCS (1998).

On level to gently sloping sites with shallow soils, both the clay-rich subsoil and underlying bedrock retard infiltration of spring meltwater, resulting in temporary soil saturation. However, as a result of the dry summer climate and the low available water capacity of these soils, soil moisture is depleted during the summer. These strongly contrasting soil moisture conditions present a special challenge for plants, and the result is sparse vegetation of stiff or low sagebrush (*Artemisia rigida* or *A. arbuscula*), Sandberg's bluegrass (*Poa sandbergii*), onespike oatgrass (*Danthonia unispicata*), and occasionally rushes (*Juncus* spp.).

On soils with better drainage, thanks to a sloping surface, well-fractured bedrock, or gravelly colluvial parent material, spring saturation is not a problem, but summer depletion of soil moisture is ubiquitous. Plant communities are strongly dependent on the severity of drought as determined by the interaction between macroclimate (i.e., precipitation and temperature), soil climate/microclimate (as determined by slope aspect and steepness, and wind deflation of snow), and soil moisture-holding capacity. Thus a plant species may be restricted to deeper soils near the climatically dry limit of its range.

Vegetation Overview

Climate, elevation, aspect, soils, and disturbance all influence vegetation. In the Blue and Ochoco Mountains, temperature and moisture are fundamental determinants of where plant species grow. The bunchgrass vegetation series can be arrayed according to their moisture and temperature adaptations from "cool, moist" to "hot, dry" as follows:

FOREST
- Ponderosa pine/bunchgrass
  - Western juniper/bunchgrass

SHRUBLANDS
- Mountain mahogany/bunchgrass
  - Bitterbrush/bunchgrass
    - Mountain big sagebrush/bunchgrass
      - Low sagebrush/bunchgrass
        - Stiff sagebrush/bunchgrass

GRASSLANDS
- Green fescue (subalpine)
  - Idaho fescue (subalpine)
    - Idaho fescue (montane)
      - Bluebunch wheatgrass
        - Onespike oatgrass
          - Sandberg's bluegrass

The temperature and moisture environment for plant growth is determined by the combination of climate (strongly influenced by elevation) and local soil/site conditions. For example, a site at low elevation with very shallow soils will be dry for most of the growing season and might support stiff sagebrush or Sandberg's bluegrass series vegetation. A site at higher elevation, on a deeper soil, or on north aspects is cooler and moister and may sustain ponderosa pine or Idaho fescue series vegetation.

Plant Association Concept

In this study we sampled existing vegetation and the environmental attributes of each site to help identify the potential natural vegetation, which in turn was used to define plant associations. **Existing vegetation** is the plant cover, floristic composition, and vegetation structure occurring at a given location at the current time (Winthers et al. 2004). **Potential natural vegetation** (PNV) is that plant community that would become established if all successional sequences were completed without human interference under the present environmental and floristic conditions, including those created by man (Winthers et al. 2004). **Historical vegetation** is that vegetation believed to have existed in the study area prior to the impact made by Euro-Americans beginning about 1850 (USDA Forest Service 2003). Prior to the arrival of Euro-Americans, the primary disturbance agents on bunchgrass sites were fire (including fire caused by Native Americans), wild ungulates, small animals, insects, diseases, and slope-driven soil movements. As a result of these disturbance factors, historical vegetation did not consist entirely of late-successional vegetation; in other words, historical vegetation is not synonymous with PNV. Instead the historical vegetation landscape generally contained a mix of vegetation communities resulting from disturbance events. The **historical**

range of variability represents this mix of different seral conditions that are believed to have occurred in the historical vegetation.

This publication uses the conventions for classifying potential vegetation that have been in use in Region 6 of the Forest Service for several decades. The **plant association**, the fundamental unit of classification, is identified by determining the potential vegetation of a site. Plant associations are named by using both dominant late-seral overstory species and other species that indicate environmental conditions such as moisture supply and temperature. A plant association includes the relatively rare pristine late-seral vegetation for which it is named **and** all the disturbed and early seral vegetation that would succeed to it.

This definition differs somewhat from the usage of "plant association" in the National Vegetation Classification System (Jennings et al. 2003) and the USDA Forest Service *Terrestrial Ecological Unit Inventory Technical Guide* (Winthers et al. 2004), where plant associations are units in the classification of existing vegetation. Our concept of a plant association is similar to the "habitat type" concept used in Forest Service Northern Region (Region 1) (Pfister and Arno 1980). The habitat type is a unit of land classified as capable of supporting a specific plant association.

The **plant community type** is a less formal vegetation type, simply an aggregation of plant communities with floristic and structural similarities (Society for Range Management 1989). We established plant community types to describe (1) highly disturbed communities where the PNV could not be determined, and (2) possible plant associations where our sample size was too small to adequately understand the range of variation.

Series are aggregations of plant associations and plant community types based on the dominant overstory plants. For example, bunchgrass vegetation that occurs with an overstory of big sagebrush is placed in the big sagebrush series.

The concept of potential natural vegetation can become confusing where communities have been greatly altered from the historical condition. Two problematic situations are particularly common: (1) juniper invasion and (2) replacement of bunchgrasses by introduced species such as cheatgrass. In the first case, many sites that historically were treeless will succeed to juniper woodland if a seed source is available and they are protected from fire. We classify shrubland or herbland vegetation into shrubland or herbland plant associations if they currently have few or no trees, even if they could theoretically support junipers. Once junipers have become established, we classify the vegetation into a juniper plant association, even if historically junipers were absent (and we note the latter fact in the plant association description). Secondly, in some cases, severe disturbance combined with invasion by nonnative plants has produced communities that no longer would succeed naturally back to the PNV. If the PNV can be determined, these communities are classified into a plant association. In a few cases where the PNV cannot be identified, we have established plant community types to accommodate them.

State-and-Transition Concept

This study portrays the condition and successional status of vegetation by the state-and-transition model (Westoby et al. 1989). According to this model, the vegetation present on a given site is determined by complex interactions of the history of disturbance, climate, management, and availability of propagules (e.g., seed). Vegetation is modeled as a set of states or phases, and transitions describe how vegetation can change from one state to another. Examples of transition agents include fire, succession, grazing, and invasion by exotic plant species. This model has largely superseded the range succession model (Dyksterhuis 1949) in range management.

In current usage, "phases" are separated from one another by transitions, most of which are reversible. Phases are separated into "states" when a transition crosses an ecological threshold that is nearly irreversible (Laycock 1991, Stringham and Kreuger 2001). For example, overgrazing may reduce cover by native grasses somewhat, but after a change in grazing regime the bunchgrasses might recover their former dominance; the pristine and somewhat degraded communities would then be considered two phases of a single state. If degradation were to proceed to the point where the native grasses were eliminated and were replaced by highly competitive exotic grasses that would persist even if grazing ceased, then a threshold would be crossed and transition to a new state would have occurred.

Phases and States

Plant associations were subdivided into phases and states that represent significantly different cases from the perspective of ecology and management. For a given plant association we typically recognized four phases of vegetation as follows:

A Relatively pristine vegetation close to the hypothetical PNV. For some shrubland plant associations with adequate data we were able to subdivide the A phase into a transient postfire phase (A1) and a late-successional phase with larger and older shrubs (A2).

B Vegetation that has been moderately altered by grazing, such that certain grazing-sensitive species have been affected but are still present in substantial amounts.

C Vegetation that has been greatly altered by grazing but still retains native species in sufficient amounts that they could presumably recover to approximate the PNV phase given sufficient time. Some plant associations had

more than one phase of this kind (C1, C2, etc.): e.g., a phase where bunchgrasses have been partly replaced by exotic annuals vs. a phase where they have been partly replaced by grazing-resistant perennial forbs. The authors believe that C phases represent communities in peril of crossing a threshold into a new state via loss of native species, invasion of other species, or soil erosion.

D Vegetation that has been altered by loss of native species and invasion of exotics to the point that succession back to the original PNV is now unlikely and a new state has been established. For some plant associations there are more than one of these phases (D1, D2, etc.), depending on what invasive species has gained dominance.

Thus A, B, and C represent different phases within a single state (fig. 2). Transitions between them are caused by heavy grazing, succession, and fire, and are believed to be reversible. The D phases are separated by an ecological threshold from the others and thus belong to a different state. This threshold is formed by loss of native species, invasion of exotic plants, soil erosion, or some combination of these factors. There may also be thresholds separating some of the D phases from one another, but we have not studied these transitions in detail.

Fire Regimes and Fire Effects

Fire has historically been an important natural disturbance process in bunchgrass communities and remains so today. Historical fire frequency is difficult to determine in bunchgrass vegetation because of the lack of trees that could provide a record of fires. Fire effects and postfire succession in this region are fairly well known thanks to local monitoring (see Johnson 1998b, Swanson 2005, and USDA Forest Service 2005 for more information)

Ponderosa Pine Forest

Considerable fire history work has been done in ponderosa pine forests, including locally in the Blue Mountains (Heyerdahl et al. 2001). These studies generally agree that ponderosa pine forests historically had frequent light underburns, with a return interval of about 10 to 20 years (Heyerdahl et al. 2001) or even less (Brown and Smith 2000). However, nearly all of these studies have been in more mesic pine communities, such as those with an understory of pinegrass (*Calamagrostis rubescens*), elk sedge (*Carex geyeri*), or snowberry (*Symphoricarpos* spp.), and not in pine forests with a bunchgrass understory. The exception is Miller and Rose's (1999) study in south-central Oregon of fire scars on scattered pines in bunchgrass ecosystems that were being invaded by juniper. This study showed fire-return intervals of 12 to 15 years, i.e., not unlike the moister pine sites. Note that such short fire-return intervals would make survival of young pines a very rare event. A few investigators believe that methodological problems have led us to underestimate fire-return intervals in pine, and that they could actually have been much longer (e.g., Baker and Ehle 2001).

The frequent light underburns of pines probably caused little tree mortality except for seedlings and saplings, but consumed much of the understory biomass. Fire effects on the understory vegetation are similar to those of analogous treeless vegetation types discussed below.

Juniper Woodlands

Available evidence suggests that low-severity underburns are not common in these woodlands and that most fires kill the trees (Baker and Shinneman 2004). Juniper woodlands in our study area include (1) woodlands that contain old trees and probably existed before the change in fire regimes that accompanied European settlers and (2) woodlands that are the result of postsettlement juniper invasion (Burkhardt and Tisdale 1969, Miller and Rose 1995, Young and Evans 1981).

The juniper woodlands where juniper has probably been present for many centuries contain old trees and are primarily in environments with little fuel because of shallow, droughty soils. In our classification, these are the JUOC/CELE3/FEID-AGSP, JUOC/ARAR8/FEID, JUOC/ARRI2, and JUOC/AGSP types. Historically, fires in these types were probably not only rare but quite variable in frequency and severity. We presume that fire-return intervals were at least 50 years, because shorter return intervals would have eliminated the junipers (Burkhardt and Tisdale 1976). The juniper types that have resulted from recent invasion are typically on deeper soils with more productive herbaceous layer and hence more fuels: the JUOC/PUTR2/FEID-AGSP and JUOC/FEID-AGSP types. These sites historically had fires frequent enough to exclude junipers; mean fire return intervals may have been as low as 12 to 15 years (Miller and Rose 1999). Reduction of fine fuels by juniper competition may have made the vegetation less able to carry fires today than before juniper invasion (Petersen 2004).

Shrublands

We can subdivide our shrublands into two groups based on their fuel characteristics and historical fire regimes: (1) those with relatively dense herbaceous understory and historically frequent fires and (2) those with light fuels and rare fires. The former group includes most of our bitterbrush and big sagebrush plant associations. Historical fire return intervals as low as 12 to 15 years have been estimated for mountain big sagebrush steppe (Miller and Rose 1999). Given the rate of sagebrush regeneration, this fire frequency would

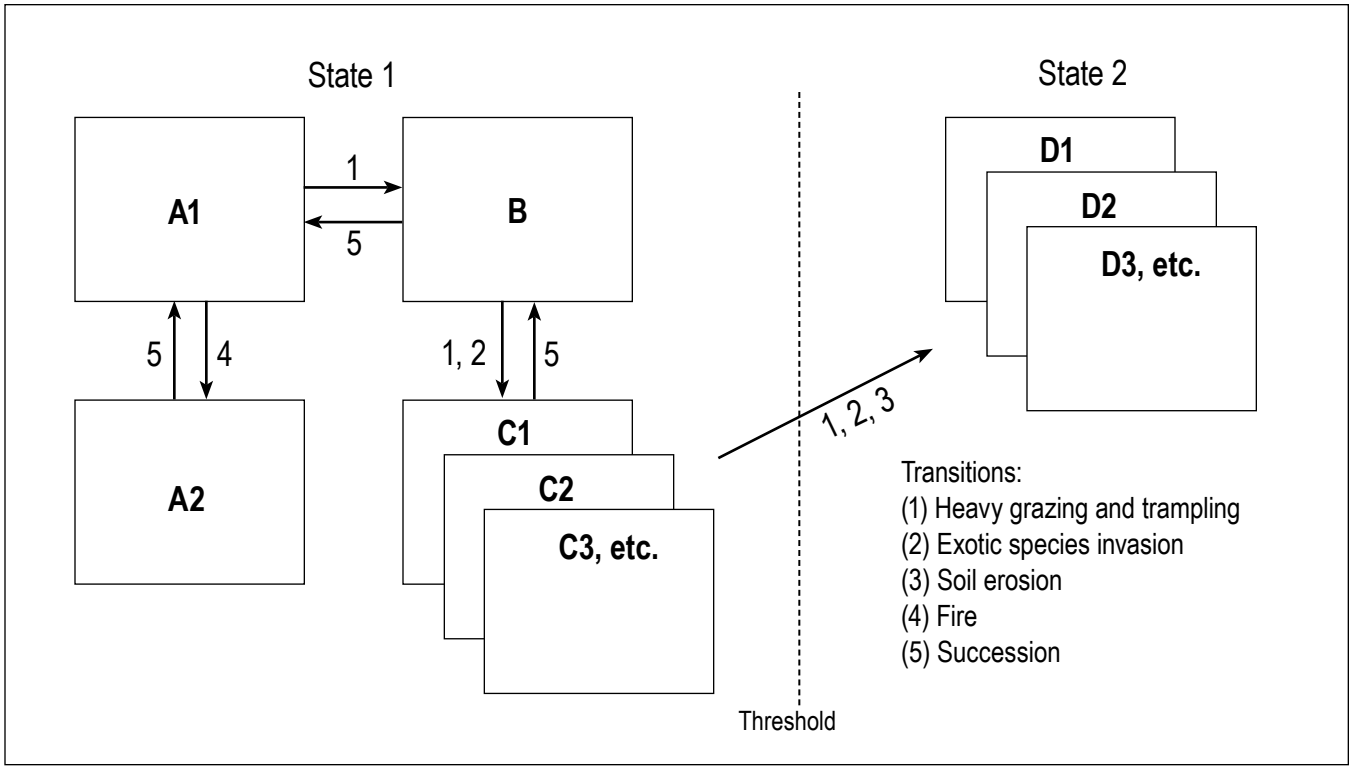


Figure 2—Generalized state-and-transition diagram used in this study. Boxes symbolize phases and arrows are transitions between them. The A, B, and C phases result from increasing grazing-related degradation that is probably reversible by natural succession. The D phases are in a second "state" separated from the first state by an ecologic threshold. Transitions to D phases are caused by loss of native species, invasion of exotic species, and soil erosion; they are probably not reversible by natural succession.

have resulted in widespread grassland communities with little sagebrush. A longer fire return interval of 20 to 70 years has also been suggested for sagebrush steppe (Brown and Smith 2000).

The second group includes all plant associations in the mountain mahogany (CELE3), stiff sagebrush (ARRI2), and low sagebrush (ARAR8) series, plus PUTR2/ERDO, ARTRV/AGSP-POSA12, and ARTR4/POSA12-DAUN. Fires were historically (and remain today) infrequent and patchy in these communities because the poor soils produce little fuel.

Mountain mahogany, sagebrush, and bitterbrush are readily killed by fire, although in some environments bitterbrush shows limited ability to resprout (Clark et al. 1982, Driscoll 1963) and mature mountain mahogany can survive some light fires (Arno and Wilson 1986). All three species recolonize burned areas by seed, generally seed carried from surviving plants by wind (mountain mahogany and sagebrush) or by animals (bitterbrush). Thus the rate of shrub recolonization depends on the size and severity of the burn, and weather for seed production and seedling survival in postfire years. Our monitoring of big sagebrush communities after fire shows that under good conditions, this shrub can reestablish 10 percent canopy cover as early as 10 years after complete kill by fire. Our limited observations of bitterbrush and mountain mahogany suggest much slower recovery of these species.

Response of the herbaceous layer of shrublands to fire is like that of grasslands described below, with one important exception. When the shrub canopy is very dense, e.g., in big sagebrush with canopy cover of 50 percent or more, fires can burn very hot and cause more death of herbaceous plants than would otherwise occur. We have observed Idaho fescue eliminated from a site by severe fire in dense sagebrush, creating openings for weedier grass and forb species to expand.

Grasslands

Historical fire frequencies in grasslands of the study area remain largely unknown. There is consensus that fires were frequent (return intervals less than 35 years) and consumed most aboveground plant parts (Brown and Smith 2000). Our observations of modern fires show that patchy and light fires are not unusual in grasslands, especially on low-biomass types.

Plant associations of the Idaho fescue series contain enough biomass to burn nearly every year, but actual fires were not nearly this frequent because of low flammability of the vegetation early in the season and lack of ignitions (Agee 1996). Our monitoring shows that Idaho fescue is often suppressed for a few years after the fire, after which

it regains its former cover; other species in Idaho fescue communities return to prefire cover in the first postfire season. There is a flush of annual plants on some sites in the first year after fire, but annuals subsequently decline to prefire levels.

Response of bluebunch wheatgrass series vegetation to fire is even weaker, with plants typically regaining their prefire covers in postfire year 1. Occasionally bluebunch wheatgrass is suppressed a little and Sandberg's bluegrass or annual forbs increase after fire, but effects are subtle and transient.

Some grassland types on very poor soils (AGSP-ERUM, AGSP-CYTEF, ERDO-POSA12, DAUN-LOLE2, and POSA12-DAUN) produce little biomass and probably had less continuous and less frequent fires than the other grassland types. Our limited monitoring suggests that, as in the case of the other grassland types, post- and prefire vegetation are very similar.

The Spread or Decline of Woody Plants

As mentioned above, juniper has become more widespread than it was in the past. Juniper expansion in our area began in the late 1800s and continues today (Miller and Rose 1999). The main causes of juniper expansion are exclusion of fire, introduction of domestic livestock (which reduces fuels for fires and reduces vegetation that competes with juniper), and possibly an unusually moist climate during some recent decades. Burkhardt and Tisdale (1969) believe that juniper could potentially colonize any site that currently supports big sagebrush and Idaho fescue. Competition by junipers usually causes thinning of understory vegetation, especially shrubs (Miller et al. 2000). This effect has been linked to increased soil erosion in ecosystems invaded by junipers (Petersen 2004). As mentioned above, our JUOC/PUTR2/FEID-AGSP and JUOC/FEID-AGSP types have resulted from juniper invasion. The presence of a few seedling junipers in several of our big sagebrush types (ARTRV/AGSP-POSA12, ARTRV/FEID-AGSP, and ARTRV/FEID-KOCR) suggests that local juniper invasion of these types is likely in the future.

Big sagebrush is widely believed to be denser today than it was prior to settlement by Europeans. Likely reasons for this increase include fire suppression and removal of grass competition by livestock grazing. Controversy over this issue has been heated (see, e.g., Welch and Criddle 2003). There is little information about presettlement sagebrush densities; however, one study of old photographs in Wyoming and Idaho showed changes since the 1870s in sagebrush abundance to be variable and localized (Johnson 1986). Owing to the lower fire frequency today than in the past, there is probably proportionally less area of low-density, postfire regenerating sagebrush communities in our study area today than there was historically.

Some woody species of bunchgrass ecosystems have experienced declines owing to browsing by wildlife and livestock, notably bitterbrush (*Purshia tridentata*) and mountain mahogany (*Cercocarpus ledifolius*). Seedlings of these species are quite rare in our study area, and existing plants are often old and severely hedged, or (in the case of mountain mahogany) defoliated up to the height that animals can reach. These species are long lived and quite tolerant of defoliation once they are established (Garrison 1953), but recruitment of new plants is needed because productivity of individual plants drops off (after about 80 years in the case of bitterbrush) and older plants gradually die off (McConnell and Smith 1977). At least a temporary reduction in densities of all the large ungulates that feed on them—livestock, deer, and elk—will probably be needed at some point to ensure the survival of the next generation of these plants.

Newcomers to Bunchgrass Communities

Bunchgrass plant communities in the Western United States have undergone major changes as a result of the introduction of plants from Eurasia. These newcomers are mostly annuals that colonize disturbed soil. Among the most important are the annual bromegrasses, including cheatgrass (*Bromus tectorum*) and several other species (*B. japonicus, B. mollis, B. brizaeformis*, and *B. commutatus*). These grasses were introduced in the late 1800s, and by about 1930 had colonized most of the Pacific Northwest and intermountain region (Mack 1981). They are cool-season grasses with a winter-annual life cycle: seeds germinate in the fall and grow until forced into dormancy by cold weather, then resume growth in the spring, flower, and produce seed before dying in early to mid summer (Klemmedson and Smith 1964). Cheatgrass and its relatives have displaced native annual grasses such as the annual fescues, as well as bluebunch wheatgrass, which was more successful at colonizing disturbed soil without such a strong competitor as cheatgrass (Mack 1981).

Cheatgrass is highly palatable to livestock when green and can be kept in check to some degree by spring grazing (Daubenmire 1940). Unfortunately, heavy spring and early summer grazing will also weaken native perennial bunchgrasses, and if grazing pressure is subsequently decreased, cheatgrass will outcompete the native grasses to fill any new gaps.

Cheatgrass is known to invade sagebrush communities and increase fuels and fire frequency, resulting in annual grasslands that are perpetuated by fire (Young and Evans 1978). We have not observed this cheatgrass-fire cycle in our study area. Flushes of annual plants (including annual bromes like cheatgrass) sometimes occur in the first year

after fires in our bunchgrass communities, but our observations to date show cover by annuals declining back to prefire levels within a year or two after the initial postfire flush without greatly altering the fire regime. Our densest stands of annual bromes occur in communities of the bluebunch wheatgrass and Idaho fescue series that have been highly disturbed by grazing and trampling, or in a few cases, by tillage on abandoned farm fields.

Another aggressive introduced annual grass has appeared in bunchgrass communities of our area, *Ventenata dubia*. We have even observed it to displace cheatgrass on some of our plots. Ventenata forms a dense thatch that probably inhibits reestablishment of native bunchgrasses. It is short, wiry, and unpalatable to livestock. Ventenata appears to be spreading in our area, and the limits to conditions it can tolerate are still unknown.

Medusahead (*Elymus caput-medusae*) is another invasive annual grass that has infested large areas in the Pacific Northwest but occurs only in a few places in our study area. Medusahead expansion here remains a possibility, at least locally on the disturbed, clay-rich soils that it prefers (Dahl and Tisdale 1975).

Many introduced perennial grasses are also present in our study area, some that were seeded onto burned areas or degraded rangeland, and some that have spread on their own. The only one that occurs widely in bunchgrass communities in our study area is Kentucky bluegrass (*Poa pratensis*). This grass is occasionally present in the more mesic bunchgrass plant associations, i.e., those containing Idaho fescue. This grass is highly tolerant of close grazing and can invade overgrazed sites if sufficient soil moisture is present (Daubenmire 1972, Mack and Thompson 1982). Intermediate or pubescent wheatgrass (*Agropyron intermedium*) is also present at scattered locations in mesic bunchgrass communities, but it does not appear to have spread far beyond where it was originally seeded.

Indicator Species

The habitat needs of plant species are evident by the environments in which they persist. Some species require stable conditions, others thrive on recurring instability. Some species have adapted to a particular locale owing to long-term climatic conditions of the area; others have colonized and thrived owing to changes in the microclimate of a particular site.

Plants that designate thresholds of environmental changes along gradients are called **indicator plants**. The indicator plants selected to define the plant community type or the plant association are those deemed to be the most diagnostic of a particular environment, i.e., those that have a high fidelity and constancy to the type. Although they do not necessarily indicate the sum of all environmental conditions, they are considered the best candidates of the associated flora within a classified type to indicate the occurrence and distribution of that vegetation unit.

The indicator species selected are those sought by field investigators to help determine proper assignment to a given plant association or plant community type. These indicator plants appear in the keys and in the names of the plant associations and community types. Information on identification of these plants may be found in Johnson (1998a).

Sampling and Field Methods

Sampling of bunchgrass plots used in this study began in 1956 by Fred Hall (Hall 1973) and continued with the senior author's fieldwork from the 1980s until 2004. Beginning in 1993, the rangelands of the Blue Mountains were systematically covered to more adequately sample vegetation of varying types and conditions. In 1999 and 2000, this study was extended to include vegetation in the Ochoco Mountains. To assist in interpreting changes over time (trend), many Parker Three-Step Condition and Trend (Parker 1951) sites were used for plot locations. A total of 487 plots were sampled.

At each sample site a 375-m^2 (72 ft in diameter) circular reconnaissance plot was established. Within this area, a total plant species list was derived. Next the canopy coverage was estimated to the nearest 5 percent for all species on the list. Additionally ground surface cover was estimated for bare ground, bedrock, rock, gravel, erosion pavement, mosses, lichens, and litter. Site environmental attributes were examined and noted as well. These included elevation (feet), aspect (degrees), slope (percent), lithology, soil depth, position, and slope shape.

Photopoints were established at each plot by locating a steel angle iron stake at the plot center. From this location, varying views were taken by using 35mm single lens reflex cameras employing color slide film and black and white print film.

The plots were intended for repeated monitoring. Therefore, reference markers and information necessary for relocation are provided for each sample location. Plot locations were described on plot cards and marked on U.S. Geological Survey quadrangle maps. Reference signs placed at the site and on adjacent points of access lead the investigator to the plot center stake. In the office, the plot locations were digitized from the topographic maps and the resulting coordinates stored in the plot database and geographic information system.

Classification and Data Analysis Methods

The present study is a refinement of previous studies (Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987). We incorporated most of the plots used in Hall (1973) and Johnson and Clausnitzer (1992); addition of new data allowed us to more than double the previous sample size. Thirty-seven types defined by the previous publications adequately represented plots from this study and were incorporated unchanged, except that we describe them here by using more data or data specific to this study area. The other 33 types are new and represent either subdivisions of types that were overly broad in Johnson and Clausnitzer (1992) (the FEID-AGSP, AGSP-POSA12, and POSA12-DAUN types) or communities that had not been encountered previously. We used multivariate statistical techniques (nonmetric multidimensional scaling, cluster analysis, and TWINSPAN; McCune and Grace 2002) to explore subdivision of previous broad types. The groups produced by these objective techniques were controlled by abundant species that had little indicator value (e.g., cheatgrass), and tended to group together plots with disturbed vegetation from a wide variety of environmental conditions. Thus, we found it more useful to define new types subjectively by using species with known environmental requirements as indicators. Knowledge of the indicator species was derived from the senior author's field experience and Johnson and Simon (1987). Association tables were constructed by using tentative indicator plants; the proposed new types were examined for floristic homogeneity, similarity in site conditions (soils and setting), and similarity in response to disturbance. The choice of indicator species and their order in the key was then adjusted to produce types that better met these three criteria; this process was continued iteratively until the resulting types met the criteria to the authors' satisfaction.

After a plant association was defined, it was further subdivided into phases by a similar process: subjective iterative refinement of association tables. We preferred this to multivariate methods both because of the small sample sizes involved and because we could define the phases based on species with a known response to the transition factors involved. For example, because large native bunchgrasses decrease with grazing pressure, we emphasized the sum cover of these grasses in defining many of the phases.

Use of the Management Guide

This management guide is organized with dichotomous keys and vegetation type descriptions for the determination of a plant association or a plant community type in the field.

Cover Percentages

The keys employ foliar cover percentages. This requires the user to accurately estimate the percentage of cover of a particular plant species in a fixed area, or plot. Indicator plant species are used as the best community representatives of the environment within the community. It is therefore critical that the investigator knows the flora and is able to estimate foliar cover.

Trees and shrub indicator plants are generally used to indicate their respective types if present at 10 percent or more cover. Most grass, sedge, rush, and forb indicators are used if present at 5 percent cover or more. Some indicator plants are extremely sensitive representatives of their environment and are used at cover as low as 1 percent.

Estimating Cover

The table below is provided to help the field investigator in making ocular estimates of abundance (crown canopy cover) of indicator plants for use in determining the proper vegetation type using the keys.

Canopy cover (%)	Plot size[a]			
	375 m^2		1/10 acre	
	x[b]	r[c]	x	r
1	1.94 m (6.36 ft)	1.09 m (3.58 ft)	6.6 ft (2.01 m)	3.72 ft (1.13 m)
5	4.33 m (14.20 ft)	2.44 m (8 ft)	14.76 ft (4.5 m)	8.33 ft (2.54 m)
10	6.12 m (20.07 ft)	3.45 m (11.32 ft)	20.87 ft (6.37 m)	11.78 ft (3.59 m)

[a] Radius of 375 m^2 circular plot is 10.93 m (35.85 ft); radius of 1/10-acre circular plot is 11.32 m (37.24 ft).
[b] x is the dimension of one side of a square equal to the coverage in percent.
[c] r is the radius of a circular area equal to the coverage in percent.

Format of the Vegetation Type Descriptions

Headings—

Plant associations and plant community types are named by using the dominant species of the PNV followed by the subordinate indicator species of a different life form. An example is "mountain big sagebrush/Idaho fescue-bluebunch wheatgrass." The life forms of different "layers" are separated by a slash (/). In this example, the sagebrush (a shrub) is differentiated from the fescue-bunchgrass (herb). When plants are used to name a vegetation type from the same layer and life form, a hyphen (-) is employed. In the example, the two bunchgrasses are separated by a hyphen as they are both herbs.

The names of the vegetation types are provided in three formats:

- Common names (mountain big sagebrush/Idaho fescue-bluebunch wheatgrass)
- Scientific names (*Artemisia tridentata* spp. *vaseyana*/ *Festuca idahoensis-Agropyron spicatum*)
- Database codes (ARTRV/FEID-AGSP)

All scientific names follow Hitchcock and Cronquist (1973). All computer codes follow the PLANTS National Database (USDA NRCS 2004b). All plant species encountered in the study are listed in appendixes A and B with scientific name, common name, PLANTS database code, and the former code from USDA Forest Service Region 6.

Photos—

A representative image of the plant community was selected for most major vegetation types. The reference pole used is 1 m tall and segmented into decimeters to assist in visualizing the size of the vegetation.

Distribution—

The range of the vegetation type in the Blue and Ochoco Mountains.

Environmental features—

The elevation range, slope percentage, aspect, slope shape, slope orientation, and rock type from sampled plots.

Soils—

A brief description of the soils from sampled plots.

Vegetation composition—

A description of the vegetation based on principal plant species found and the percentage composition of those plants from sampled plots.

States and transitions—

A listing of the phases and states derived from the classification process.

Management considerations—

Provides the species response to major disturbance activities (grazing, browsing, fire).

Relationship to other studies—

The relationship of this vegetation type to other similar classified vegetation types published in the Pacific Northwest.

Table of principal species—

A table containing a species list selected from the complete list of species found for a vegetation type. Only the primary species necessary for the description and the keys are listed. Mean cover values in percentages and the range of cover values in percentages are provided for the selected species. Mean cover was computed only for the plots where the plant was present. Constancy is the percentage of plots on which the species was found.

Table of ground surface features—

Mean percentage of cover and the range of cover values are provided for the ground surface features beneath the higher plants. Bare ground, bedrock, rock, gravel, erosion pavement, mosses and lichens, and litter are the ground surface features.

Table of environmental features—

Sample size (e.g., n = 10), means, and ranges are given for elevation, aspect, slope, and soils from sampled plots. Geologic information, slope position, and microrelief are summarized. In shrub/grass and grassland communities, herbage productivity is often provided. Soil available water capacity is computed for the upper 40 in of soil.

Keys for Determining the Bunchgrass Plant Associations and Plant Community Types

The keys that follow were derived to assist in determining the plant association or plant community type that best fits a particular site.

Limitations in the Use of the Keys

1. The keys are based on 490 sampled plots located in the Blue and Ochoco Mountains. This large geographic area contains a wide range of plant communities and environments. Not all the environmental variation was sampled. Therefore, the classification may not describe the vegetation occurring on some sites.
2. The natural stands have been, and some continue to be, highly modified. Sites exhibiting severe disturbances have been incorporated into this study. However, the keys are based mainly on less disturbed vegetation exemplified by phases A and B rather than C and D. Highly disturbed communities where introduced species have replaced the native species may be difficult to classify.

Rules for Use of the Keys

1. Select portions of stands demonstrating stability. On sites where disturbances have been severe resulting in vegetation of exotic species or earlier seral stages (phases C and D), try to select an adjacent, less disturbed area with the same soil and site conditions for determining the proper plant association or plant community type.
2. First use the "Key to Series" to determine the series and proceed to the proper key. Then choose the correct alternative by comparing choices 1a and 1b and follow the correct lead. For example, if a shrub community lacks mountain mahogany, 1b is chosen and the user is directed to lead 5. Proceed down through the key until the kind of vegetation encountered on the site is reached. Then turn to the page number provided and review the type description to verify the accuracy of the identification.

Key to Series

1a. Trees present with cover equal to or exceeding 10 percent **2**

1b. Trees absent or present with cover less than 10 percent **4**

2a. Ponderosa pine (PIPO) present and reproducing with total cover equal to or exceeding 10 percent ..... **See ponderosa pine series key**, p. 13

2b. Ponderosa pine absent or present with cover less than 10 percent **3**

3a. Western juniper (JUOC) present and reproducing with total cover equal to or exceeding 10 percent ..... **See western juniper series key**, p. 13

3b. Western juniper absent or present with cover less than 10 percent **4**

4a. Shrubs present with cover equal to or exceeding 10 percent ..... **See shrubland series key**, p. 14

4b. Shrubs absent or present with cover less than 10 percent ..... **See grassland series key**, p. 16

Key to Ponderosa Pine Series Vegetation

Ponderosa pine (PIPO) must be present and successfully reproducing; total cover must equal or exceed 10 percent.

1a. Squaw apple (PERA4) present with cover equal to or exceeding 10 percent ..... **PIPO/PERA4**, p. 29

1b. Squaw apple absent or with cover less than 10 percent **2**

2a. Mountain mahogany (CELE3) present with cover equal to or exceeding 10 percent **3**

3a. Mountain snowberry (SYOR2) associated with western juniper (JUOC) ..... **PIPO-JUOC/CELE3-SYOR2**, p. 29

3b. Mountain snowberry absent or with cover less than 10 percent **4**

4a. Idaho fescue and bluebunch wheatgrass present with cover equal to or exceeding 5 percent ..... **PIPO/CELE3/FEID-AGSP**, p. 18

4b. Wheeler's bluegrass (PONEW) present with cover equal to or exceeding 5 percent ..... **PIPO/CELE3/PONEW**, p. 20

2b. Mountain mahogany absent or with cover less than 10 percent **5**

5a. Bitterbrush (PUTR2) present with cover equal to or exceeding 5 percent **6**

6a. Idaho fescue and bluebunch wheatgrass present with cover equal to or exceeding 5 percent ..... **PIPO/PUTR2/FEID-AGSP**, p. 21

6b. Bluebunch wheatgrass cover greater than 5 percent; Idaho fescue absent or with cover less than 5 percent ..... **PIPO/PUTR2/AGSP-POSA12**, p. 22

5b. Bitterbrush absent or with cover less than 5 percent **7**

7a. Mountain big sagebrush (ARTRV) present with cover equal to or exceeding 10 percent ..... **PIPO/ARTRV/FEID-AGSP**, p. 24

7b. Mountain big sagebrush absent or with cover less than 10 percent **8**

8a. Idaho fescue (FEID) present with cover equal to or exceeding 10 percent ..... **PIPO/FEID**, p. 26

8b. Idaho fescue absent or with cover less than 10 percent ..... **PIPO/AGSP**, p. 28

Key to Western Juniper Series Vegetation

Western juniper (JUOC) must be present with cover equal to or exceeding 10 percent.

1a. Mountain mahogany (CELE3) present with cover equal to or exceeding 10 percent ..... **JUOC/CELE3/FEID-AGSP**, p. 30

1b. Mountain mahogany absent or with cover less than 10 percent **2**

2a. Bitterbrush (PUTR2) present with cover equal to or exceeding 10 percent ..... **JUOC/PUTR2/FEID-AGSP**, p. 32

2b. Bitterbrush absent or with cover less than 10 percent **3**

3a. Low sagebrush (ARAR8) present with cover equal to or exceeding 5 percent ..... **JUOC/ARAR8/FEID**, p. 34

3b. Low sagebrush absent or with cover less than 5 percent **4**

4a. Stiff sagebrush (ARRI2) present with cover equal to or exceeding 5 percent ..... **JUOC/ARRI2**, p. 36

4b. Stiff sagebrush absent or with cover less than 5 percent **5**

5a. Idaho fescue (FEID) present with cover equal to or exceeding 5 percent ..... **JUOC/FEID-AGSP**, p. 35

5b. Idaho fescue absent or with cover less than 5 percent ..... **JUOC/AGSP**, p. 36

Key to Shrubland Vegetation

Shrub cover by diagnostic species must equal or exceed 10 percent.

1a. Mountain mahogany (CELE3) present with cover equal to or exceeding 10 percent **2**

2a. Idaho fescue (FEID) present with cover equal to or exceeding 5 percent ..... **CELE3/FEID-AGSP**, p. 37

2b. Idaho fescue absent or with cover less than 5 percent **3**

3a. Bluebunch wheatgrass (AGSP) present with cover equal to or exceeding 5 percent **4**

4a. Bitterbrush (PUTR2) present with cover equal to or exceeding 10 percent ..... **CELE3-PUTR2/AGSP**, p. 38

4b. Bitterbrush absent or with cover less than 10 percent ..... **CELE3/AGSP**, p. 38

3b. Bluebunch wheatgrass absent or with cover less than 5 percent ..... **CELE3/PONEW**, p. 39

1b. Mountain mahogany absent or with cover less than 10 percent **5**

5a. Mountain snowberry (SYOR2) present on mounds with cover equal to or exceeding 10 percent; Mountain big sagebrush absent ..... **SYOR2**, p. 57

5b. Mountain snowberry absent or with cover less than 10 percent **6**

6a. Bitterbrush (PUTR2) present with cover equal to or exceeding 10 percent **7**

7a. Mountain big sagebrush (ARTRV) present with cover equal to or exceeding 10 percent **8**

8a. Idaho fescue (FEID) cover greater than 5 percent; bluebunch wheatgrass (AGSP) absent ..... **PUTR2-ARTRV/FEID**, p. 42

8b. Bluebunch wheatgrass codominant with Idaho fescue .. **PUTR2-ARTRV/FEID-AGSP**, p. 39

7b. Mountain big sagebrush absent or with cover less than 10 percent **9**

9a. Idaho fescue (FEID) and bluebunch wheatgrass (AGSP) cover greater than 5 percent ..... **PUTR2/FEID-AGSP**, p. 41

9b. Idaho fescue and bluebunch wheatgrass cover less than 5 percent ..... **PUTR2/ERDO**, p. 42

6b. Bitterbrush absent or with cover less than 10 percent **10**

10a. Mountain big sagebrush (ARTRV) present with cover equal to or exceeding 5 percent **11**

11a. Mountain snowberry (SYOR2) present with cover equal to or exceeding 10 percent **12**

12a. Mountain brome (BRCA5) present with cover equal to or exceeding 5 percent ..... **ARTRV-SYOR2/BRCA5**, p. 48

12b. Mountain brome absent or with cover less than 5 percent ..... **ARTRV-SYOR2**, p. 48

11b. Mountain snowberry absent or with cover less than 5 percent **13**

13a. Mountain brome (BRCA5) present with cover equal to or exceeding 5 percent ..... **ARTRV/BRCA5**, p. 49

13b. Mountain brome absent or with cover less than 5 percent **14**

14a. Squaw apple (PERA4) present with cover greater than 10 percent ..... **ARTRV-PERA4**, p. 49

14b. Squaw apple absent or with cover less than 10 percent **15**

15a. Giant wild rye (ELCI2) present with cover greater than 5 percent ..... **ARTRV/ELCI2**, p. 49

15b. Giant wild rye absent or with cover less than 10 percent **16**

16a. Prairie junegrass (KOCR) present with cover equal to or exceeding 5 percent ..... **ARTRV/FEID-KOCR**, p. 43

16b. Prairie junegrass absent or with cover less than 5 percent **17**

17a. Idaho fescue (FEID) present with cover equal to or exceeding 5 percent ..... **ARTRV/FEID-AGSP**, p. 45

17b. Idaho fescue absent or with cover less than 5 percent ..... **ARTRV/AGSP-POSA12**, p. 47

10b. Mountain big sagebrush absent or with cover less than 5 percent **18**

18a. Low sagebrush (ARAR8) present with cover equal to or exceeding 10 percent **19**

19a. Idaho fescue (FEID) present with cover equal to or exceeding 5 percent ..... **ARAR8/FEID-AGSP**, p. 50

19b. Idaho fescue absent or with cover less than 5 percent **20**

20a. Bluebunch wheatgrass (AGSP) present with cover equal to or exceeding 5 percent ..... **ARAR8/AGSP**, p. 52

20b. Bluebunch wheatgrass absent or with cover less than 5 percent ..... **ARAR8/POSA12**, p. 54

18b. Low sagebrush absent or with cover less than 10 percent **21**

21a. Stiff sagebrush (ARRI2) present with cover equal to or exceeding 10 percent **22**

22a. Sandberg's bluegrass (POSA12) present with cover equal to or exceeding 5 percent ..... **ARRI2/POSA12**, p. 55

22b. Sandberg's bluegrass absent or with cover less than 5 percent ..... **ARRI2/PEGA**, p. 57

21b. Stiff sagebrush absent or with cover less than 10 percent **23**

23a. Threetip sagebrush (ARTR4) present with cover equal to or greater than 10 percent ..... **ARTR4/POSA12-DAUN**, p. 57

23b. Creeping Oregon-grape (BERE) present with cover equal to or exceeding 10 percent ..... **BERE/AGSP-APAN2**, p. 57

Key to Grassland Vegetation

Trees and shrubs are absent or their cover is less than 10 percent.

1a. Grasslands above 6,000 ft in elevation (subalpine grasslands) **2**

1b. Grasslands below 6,000 ft in elevation **13**

2a. Green fescue (FEVI) present with cover equal to or exceeding 5 percent **3**

3a. Parry's rush (JUPA) present with cover equal to or exceeding 5 percent ..... **FEVI-JUPA**, p. 58

3b. Parry's rush absent or with cover less than 5 percent **4**

4a. Lupines (LUPIN) present with cover equal to or exceeding 10 percent ..... **FEVI-LULA3**, p. 58

4b. Lupines absent or cover is less than 10 percent **5**

5a. Penstemons (PENST) present with cover equal to or exceeding 10 percent ..... **FEVI-PENST**, p. 58

5b. Penstemons absent or cover is less than 10 percent **6**

2b. Green fescue absent or with cover less than 5 percent **7**

7a. Idaho fescue (FEID) present with cover equal to or exceeding 5 percent **8**

8a. Red avens (GETR) present with cover equal to or exceeding 5 percent ..... **FEID-GETR**, p. 58

8b. Red avens absent or with cover less than 5 percent **9**

9a. Cymopterus (CYTEF) present with cover equal to or exceeding 1 percent ..... **FEID-AGSP-CYTEF**, p. 59

9b. Cymopterus absent **10**

10a. Cusick's frasera (FRALC2) present with cover equal to or exceeding 3 percent ..... **FEID-AGSP-FRALC2**, p. 60

10b. Cusick's frasera absent or cover is less than 3 percent **11**

7b. Idaho fescue absent or relict (less than 5 percent) **11**

11a. Oniongrass (MEBU) present at cover of 5 percent or greater ..... **MEBU-STOC2**, p. 61

11b. Oniongrass absent or cover less than 5 percent; western needlegrass (STOC2) present at a cover of 5 percent or greater ..... **STOC2-SIHY (Alpine)**, p. 61

12a. Idaho fescue (FEID) present at cover of 5 percent or greater **13**

12b. Idaho fescue absent or with cover less than 5 percent **19**

13a. Prairie junegrass (KOCR) present at cover of 1 percent or greater on mounds ..... **FEID-KOCR (Mound)**, p. 62

13b. Prairie junegrass present (but not on mounds) **14**

14a. Prairie junegrass present at cover of 5 percent or greater ..... **FEID-KOCR (Ridge)**, p. 64

14b. Prairie junegrass absent or with cover less than 5 percent **15**

15a. Lupines (LUPIN) present at cover of 5 percent or greater ..... **FEID-AGSP-LUPIN**, p. 66

15b. Lupines absent or with cover less than 5 percent **16**

16a. Arrowleaf balsamroot (BASA3) present with cover of 5 percent or greater ..... **FEID-AGSP-BASA3**, p. 67

16b. Arrowleaf balsamroot absent or with cover less than 5 percent **17**

17a. Phloxes (PHLOX) present at cover of 5 percent or greater ..... **FEID-AGSP-PHLOX**, p. 69

17b. Phloxes absent or with cover less than 5 percent **18**

18a. Bluebunch wheatgrass (AGSP) present with cover greater than 5 percent ..... **FEID-AGSP**, p. 71

18b. Bluebunch wheatgrass cover less than 5 percent ..... **FEID-DAUN**, p. 72

19a. Bluebunch wheatgrass (AGSP) present at cover of 5 percent or greater **20**

19b. Bluebunch wheatgrass absent or with cover less than 5 percent **32**

20a. Mountain brome (BRCA5) present with cover of 5 percent or greater ..... **AGSP-BRCA5**, p. 87

20b. Mountain brome absent or with cover of less than 5 percent **21**

21a. Lupines (LUPIN) present with cover of 5 percent or greater ..... **AGSP-POSA12-LUPIN**, p. 73

21b. Lupines absent or with cover of less than 5 percent **22**

22a. Arrowleaf balsamroot (BASA3) present with cover of 5 percent or greater ..... **AGSP-POSA12-BASA3**, p. 75

22b. Arrowleaf balsamroot absent or with cover less than 5 percent **23**

23a. Creamy buckwheat (ERHE2) present with cover of 5 percent or greater ..... **AGSP-POSA12-ERHE2**, p. 77

23b. Creamy buckwheat absent or with cover less than 5 percent **24**

24a. Blue Mountain milkvetch (ASRE5) present with cover of 5 percent or greater ..... **AGSP-POSA12-ASRE5**, p. 78

24b. Blue Mountain milkvetch absent or with cover less than 5 percent **25**

25a. Bighead clover (TRMA3) present with cover of 5 percent or greater ..... **AGSP-POSA12-TRMA3**, p. 80

25b. Bighead clover absent or with cover less than 5 percent **26**

26a. Skullcap (SCAN3) present with cover of 5 percent or greater ..... **AGSP-POSA12-SCAN3**, p. 82

26b. Skullcap absent or with cover less than 5 percent **27**

27a. Dogbane (APAN2) present with cover of 5 percent or greater ..... **AGSP-POSA12-APAN2**, p. 83

27b. Dogbane absent or with cover less than 5 percent **28**

28a. Onespike oatgrass (DAUN) present with cover of 5 percent or greater ..... **AGSP-POSA12-DAUN**, p. 84

28b. Onespike oatgrass absent or with cover less than 5 percent **29**

29a. Sandberg's bluegrass (POSA12) present with cover of 5 percent or greater ..... **AGSP-POSA12**, p. 86

29b. Sandberg's bluegrass absent or relict (cover less than 5 percent) **30**

30a. Sulfur-flower buckwheat (ERUM) present with cover of 5 percent or greater ..... **AGSP-ERUM**, p. 88

30b. Sulfur-flower buckwheat absent or with cover of less than 5 percent **31**

31a. Cymopterus (CYTEF) present with cover of 5 percent or greater ..... **AGSP-CYTEF**, p. 88

31b. Cymopterus absent or with cover of less than 5 percent **32**

32a. Douglas' buckwheat (ERDO) present with cover of 5 percent or greater ... **ERDO-POSA12**, p. 88

32b. Douglas' buckwheat absent or with cover of less than 5 percent **33**

33a. Bulbous bluegrass (POBU) present with cluster tarweed ..... **POBU-MAGL2**, p. 88

33b. Bulbous bluegrass and/or tarweed absent or at cover of less than 5 percent **34**

34a. Slenderfruit lomatium (LOLE2) and rushes (JUNCUS) present with onespike oatgrass dominant ..... **DAUN-LOLE2**, p. 89

34b. Slenderfruit lomatium and rushes absent; Sandberg's bluegrass dominant ..... **POSA12-DAUN**, p. 91

Ponderosa Pine Series

Ponderosa pine/mountain mahogany/Idaho fescue-bluebunch wheatgrass plant association

Pinus ponderosa/Cercocarpus ledifolius/Festuca idahoensis-Agropyron spicatum

PIPO/CELE3/FEID-AGSP CPS234 N = 9

Alkali Creek, Emigrant Creek RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on andesite, basalt, pumice, and tuff. Elevations ranged from 4,250 to 5,950 ft (mean 4,900 ft). Slopes were moderately steep (mean 23 percent). Sample sites were on northerly and southerly aspects on convex and concave surfaces. Positions ranged from shoulders to backslopes to footslopes. Soils had a sandy loam or silt loam surface layer up to 12 in thick (sometimes absent) over very to extremely gravelly loamy soil, with bedrock at a depth of 1 to 2 ft. Soil pH was slightly acid, and available water capacity was low. One study profile had a silty clay loam subsoil over bedrock at 2 ft, and moderate available water capacity.

	Mean	Range
Elevation (feet)	4,900	4,250–5,950
Slope (percent)	23	18–50
Soil pH (n = 5)		6.2–6.8
Soil available water capacity (inches, n = 5)		1.5–6 (low to moderate)
Depth to bedrock (inches, n = 9)		12–25
Herbage (pounds/acre, n = 6)	428	303–740
Aspect (number of plots)	NW (5), NE (0), SE (3), SW (1)	
Lithology	Andesite, basalt, pumice, tuff	
Position	Shoulder, backslope, footslope, summit	
Slope shape	Convex, concave	

Ground surface features—

	Phase			
	A (n = 5)	B (n = 2)	C (n = 2)	A + B range
			Cover (%)	
Bare ground	3	8	4	0–12
Bedrock	3	0	11	0–8
Rock	9	6	20	0–20
Gravel	0	7	0	0–14
Pavement	0	0	11	0
Mosses and lichens	10	9	2	0–11
Litter	75	70	52	

Vegetation composition—

This is the warmest and driest of the PIPO/CELE3 plant associations. The other PIPO/CELE3 plant associations are more mesic, with either elk sedge or Wheeler's bluegrass associated. Ponderosa pine is always present in this association. Western juniper and Douglas-fir may occur as incidental trees. Mountain mahogany is the dominant shrub, with mountain big sagebrush and bitterbrush often associated. Grasses are the most abundant herbaceous plants. Idaho fescue and bluebunch wheatgrass codominate, with Sandberg's bluegrass and bottlebrush squirreltail often present. Forb composition is usually weak with low coverages. Often present are yarrow, pale agoseris, arrowleaf balsamroot, creamy buckwheat, and phlox.

States and transitions—

Three phases were defined as follows:

A Idaho fescue is dominant over bluebunch wheatgrass. Disturbances have been either minimal or of short duration.

B Bluebunch wheatgrass has increased to codominance with Idaho fescue. Disturbances from severe burns, ungulate overuse, or climatic change promoting warmer, drier microsite conditions promote this stage.

C Bluebunch wheatgrass dominates over all other herbaceous plants. Continued site disturbances that are frequent or of long duration promote this phase.

Management considerations—

This type is highly valued as deer winter range. Moderate to severe burns kill mountain mahogany, and ungulate browsing of mountain mahogany may prevent regeneration. The bunchgrasses are promoted by light to moderate burns.

Principal species—

Species	Code	Phase A (n = 5)	Phase B (n = 2)	Phase C (n = 2)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
ponderosa pine	PIPO	17/100	34/100	12/100	10–45
Douglas–fir	PSME	2/20	–	3/100	0–2
western juniper	JUOC	8/60	12/100	8/50	0–15
Shrubs:					
mountain mahogany	CELE3	29/100	15/100	15/100	5–60
mountain big sagebrush	ARTRV	8/100	5/50	0	1–15
bitterbrush	PUTR2	3/60	6/100	1/50	0–8
wax currant	RICE	15/20	0	2/50	0–15
Grasses:					
Idaho fescue	FEID	33/100	12/100	2/50	10–38
bluebunch wheatgrass	AGSP	7/100	10/100	25/100	4–15
prairie junegrass	KOCR	4/40	0	0	0–4
Sandberg's bluegrass	POSA12	17/80	4/100	8/100	0–30
bottlebrush squirreltail	SIHY	2/80	0	0	0–5
Forbs:					
common yarrow	ACMIL	2/60	1/100	2/100	0–2
pale agoseris	AGGL	2/60	0	0	0–3
arrowleaf balsamroot	BASA3	2/60	0	0	0–2
hawksbeards	CREPI	13/60	1/50	0	0–35
creamy buckwheat	ERHE2	2/65	1/100	1/50	0–3
phloxes	PHLOX	2/40	1/50	0	0–2

Overgrazing tends to promote creamy buckwheat, squirreltail, and annuals. An excellent community for visualizing the effects of ungulate use in this type may be found on the Emigrant Creek Ranger District (RD) above Devine Canyon at the Larsen Spring cattle exclosure (erected in 1963). Here deer use the bitterbrush inside the exclosure, while seedlings and saplings of mountain mahogany occur abundantly beside the older shrubs inside the exclosure. Few bitterbrush and mountain mahogany are present outside the exclosure, where domestic and wild ungulates browse them heavily.

Relationship to other studies—

This plant association was previously classified in the Blue and Ochoco Mountains (Johnson and Clausnitzer 1992).

Ponderosa pine/mountain mahogany/Wheeler's bluegrass plant association

Pinus ponderosa/Cercocarpus ledifolius/Poa nervosa var. *wheeleri*

PIPO/CELE3/PONEW CPS233 N = 7

Fred Hall

Emigrant Butte, Emigrant Creek RD, Malheur NF.

Distribution—

Ochoco Mountains.

Environmental features—

This vegetation type is found on rhyolitic tuffs in the Ochoco Mountains. Elevations ranged from 5,125 to 5,425 ft (mean 5,304 ft). Slopes were usually gentle (mean 5 percent). Sampled sites were on northerly and southerly slopes with either convex or straight shape. Slope positions were ridgetops or shoulders of ridges. Soils were shallow to moderately deep over rhyolite.

	Mean	Range
Elevation (feet)	5,304	5,125–5,425
Slope (percent)	5	2–15
Herbage (pounds/acre, n = 7)	129	60–200
Aspect (number of plots)	NW (3), NE (0), SE (2), SW (2)	
Lithology	Argillite	
Position	Shoulder, ridgetop	
Slope shape	Convex, linear/planar	

Ground surface features—

	Phase A (n = 3)	Phase B (n = 4)	A + B range
		Cover (%)	
Bare ground	2	3	0–5
Bedrock	2	0	0–5
Rock	2	2	0–5
Gravel	0	0	0
Pavement	5	5	0–10
Mosses and lichens	1	1	0–5
Litter	88	89	

Vegetation composition—

Western juniper is usually associated in a forest savannah growing above the mountain mahogany and bitterbrush shrubs. Grasses dominate over forbs, with Wheeler's bluegrass the most prominent. Ross' sedge was always found; Idaho fescue and western needlegrass were frequently present. Forb diversity and cover were low. Groundsels, hawkweeds, and lomatiums were the most frequent forbs.

Principal species—

Species	Code	Phase A (n = 3)	Phase B (n = 4)	A + B range
		Cover (%)/constancy (%)		*Cover (%)*
Trees:				
ponderosa pine	PIPO	28/100	42/100	23–50
western juniper	JUOC	18/67	9/75	0–25
Shrubs:				
mountain mahogany	CELE3	18/100	17/100	10–30
bitterbrush	PUTR2	12/100	6/100	1–25
Grasses and grasslikes:				
Wheeler's bluegrass	PONEW	15/100	10/100	8–15
Idaho fescue	FEID	2/67	2/50	0–2
bottlebrush squirreltail	SIHY	5/33	1/100	0–5
western needlegrass	STOC2	1/100	1/50	0–1
Ross' sedge	CARO5	4/100	7/100	1–15
Forbs:				
lomatiums	LOMAT	1/100	1/50	0–1
groundsels	SENEC	3/100	2/100	1–6
western hawkweed	HIAL	2/67	1/25	0–2

States and transitions—

Two phases were defined as follows:

A Wheeler's bluegrass cover is ≥15 percent. Disturbances minimal or of short duration.

B Wheeler's bluegrass cover is <15 percent. Disturbances of moderate severity or duration.

Management considerations—

Moderate and severe burns may cause extensive mortality to both mountain mahogany and bitterbrush. Disturbances from domestic livestock and fires tend to promote juniper, bottlebrush squirreltail, western needlegrass, and yarrow. Intensive use may severely retard the recruitment of young mountain mahogany plants. This community is heavily used by wild ungulates in winter rangelands. Herbage production is extremely low (mean 129 lb/ac). Bitterbrush and mountain mahogany provide key fall and winter browse.

Relationship to other studies—

This plant association was previously classified and described in the Ochoco Mountains (Johnson and Clausnitzer 1992).

Ponderosa pine/bitterbrush/Idaho fescue-bluebunch wheatgrass plant association

Pinus ponderosa/Purshia tridentata/Festuca idahoensis-Agropyron spicatum

PIPO/PUTR2/FEID-AGSP CPS226 N = 7

Powder River canyon, Baker RD, Wallowa-Whitman NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on basalts and rhyolites. Elevations ranged from 4,000 to 5,260 ft (mean 4,710 ft). Slopes were gentle to steep (mean 11 percent). Sampled sites were on northerly and southerly aspects on convex, straight, or undulating surfaces and on all slope positions. Soils had 6 to 16 in of loamy surface over very to extremely gravelly or cobbly subsoil. One profile had silty clay loam subsoil over weathered bedrock at 32 in. Soil available water capacity was low to moderate, and pH was nearly neutral except for some acid soil near the surface.

	Mean	Range
Elevation (feet)	4,699	4,000–5,260
Slope (percent)	11	2–30
Soil pH (n = 2)		5.2–6.8
Soil available water capacity (inches, n = 2)		3.5–8 (low to moderate)
Depth to bedrock or extremely gravelly soil (inches, n = 5)		6–32
Herbage (pounds/acre, n = 4)	281	132–545
Aspect (number of plots)	NW (1), NE (1), SE (0), SW (2)	
Lithology	Basalt, rhyolite	
Position	Ridgetops and all slope positions	
Slope shape	Convex, straight, undulating	

Ground surface features—

	Phase A (n = 5)	Phase C (n = 2)	A + B range
	Cover (%)		
Bare ground	9	2	1–25
Bedrock	0	0	0
Rock	4	15	1–5
Gravel	1	1	0
Pavement	6	9	0
Mosses and lichens	5	4	0–5
Litter	75	69	

Vegetation composition—

Ponderosa pine forms an open forest over a shrub layer dominated by bitterbrush. Western juniper may be associated. Herbaceous vegetation is dominated by grasses. Idaho fescue is always present and usually abundant. Other grasses usually present at low coverages in these communities are bluebunch wheatgrass, Sandberg's bluegrass, and bottlebrush squirreltail. Forbs occur at low coverages.

States and transitions—

Only one phase was defined where vegetation has been relatively undisturbed. More severe or frequent disturbances could provide additional phases where increases would occur by rabbitbrush, needlegrass, squirreltail, annual grasses, and yarrow.

Principal species—

Species	Code	Phase A (n = 5)	Phase C (n = 2)	A + B range
		Cover (%)/constancy (%)		*Cover (%)*
Trees:				
ponderosa pine	PIPO	19/100	21/100	5–41
western juniper	JUOC	18/40	41/100	0–25
Shrubs:				
bitterbrush	PUTR2	14/100	0	5–25
green rabbitbrush	CHVI8	1/40	0	0–1
creeping Oregon grape	BERE	1/40	0	0–1
mountain mahogany	CELE3	6/40	0	0–10
Grasses:				
Idaho fescue	FEID	29/100	20/100	20–40
bluebunch wheatgrass	AGSP	2/80	4/100	0–4
prairie junegrass	KOCR	2/60	0	0–5
Sandberg's bluegrass	POSA12	4/80	2/100	0–10
bottlebrush squirreltail	SIHY	1/60	0	0–1
Forbs:				
common yarrow	ACMIL	3/80	0	1–5
basalt milkvetch	ASFI	5/20	12/100	0–5
twin arnica	ARSO2	5/40	0	0–5
western hawkweed	HIAL	1/40	0	0–1
western groundsel	SEIN2	2/40	0	0–3

Management considerations—

These communities are a valuable part of deer winter range in the southern Blue and Ochoco Mountains. Bitterbrush is highly nutritious. Overbrowsing severely hedges bitterbrush shrubs, retards recruitment of juvenile bitterbrush seedlings, and imperils the future existence of bitterbrush. Light- to moderate-severity fires enhance ponderosa pine vitality. Bitterbrush will be retarded if fire occurs when soils are too dry. A good example of this plant association is found in the Sumpter Three-Way Exclosure at the west end of McEwan Valley on the Baker Ranger District of the Wallowa-Whitman NF.

Relationship to other studies—

This is a widespread plant association in the Pacific Northwest first classified by Daubenmire and Daubenmire (1968) in eastern Washington. It was subsequently described by Pfister et al. (1977) in Montana, Steele et al. (1981) in central Idaho, Clausnitzer and Zamora (1987) in northern Washington, Volland (1976) and Hopkins (1979a, 1979b) in central Oregon, and by Johnson and Clausnitzer (1992) in the Blue and Ochoco Mountains.

Ponderosa pine/bitterbrush/bluebunch wheatgrass-Sandberg's bluegrass plant association

Pinus ponderosa/Purshia tridentata/Agropyron spicatum-Poa sandbergii

PIPO/PUTR2/AGSP-POSA12 CPS229 N = 3

Jackie Creek, Emigrant Creek RD, Malheur NF.

	Mean	Range
Elevation (feet)	4,927	4,700–5,210
Slope (percent)	32	20–45
Herbage (pounds/acre, n = 2)	280	150–440
Aspect (number of plots)	NW (0), NE (1), SE (1), SW (1)	
Lithology	Basalt, argillite, tuff	
Position	All slope positions	
Slope shape	Convex, concave	

Ground surface features—

	Phase			
	A (n = 1)	B (n = 1)	D (n = 1)	A + B range
		Cover (%)		
Bare ground	5	1	3	1–5
Bedrock	0	0	0	0
Rock	11	20	1	11–20
Gravel	0	40	3	0–40
Pavement	0	0	0	0
Mosses and lichens	1	0	0	0–1
Litter	83	39	90	

Distribution—

Southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on basalt, volcanic tuff, and argillite. Elevations ranged from 4,700 to 5,210 ft (mean 4,927 ft). Slopes were moderately steep (mean 32 percent). Sampled sites were on northerly and southerly aspects on convex and concave surfaces. All slope positions were represented. The one soil profile studied consisted of very to extremely gravelly sandy loam, with bedrock at a depth of 16 in. Available water capacity was very low and pH nearly neutral.

Vegetation composition—

This is the warmest and driest of the PIPO/PUTR2 plant associations. Ponderosa pine is always present and dominant over a shrub layer of bitterbrush. Western juniper is usually present. Grasses dominate the forbs in the herbaceous layer. Bluebunch wheatgrass, fleabanes, and yarrow are prominent.

Principal species—

Species	Code	Phase A (n = 1)	Phase B (n = 1)	Phase D (n = 1)	A + B range
		Cover (%) / constancy (%)			*Cover (%)*
Trees:					
ponderosa pine	PIPO	12/100	15/100	30/100	12–15
western juniper	JUOC	3/100	—	9/100	0–3
Shrubs:					
bitterbrush	PUTR2	21/100	5/100	15/100	5–21
creeping Oregon grape	BERE	1/100	3/100	0	1–3
Grasses:					
bluebunch wheatgrass	AGSP	31/100	10/100	0	10–31
Sandberg's bluegrass	POSA12	1/100	1/100	5/100	1–1
Forbs:					
common yarrow	ACMIL	2/100	0	1/100	0–2
fleabanes	ERIGE2	8/100	0	1/100	0–8
tailcup lupine	LUCA	0	0	10/100	0–1
penstemons	PENST	0	1/100	1/100	0–1

States and transitions—

Three phases were defined as follows:

A High cover of bitterbrush and bluebunch wheatgrass (both >15 percent).

B Bitterbrush cover is <15 percent.

C Bluebunch wheatgrass <5 percent or absent; bare ground is >10 percent.

Management considerations—

Bitterbrush is highly valued deer winter range in the southern Blue and Ochoco Mountains. Browsing can be severe and impede vitality of the plants. Fire can damage bitterbrush plants if a severe burn occurs when soils are dry. Overgrazing in this driest of ponderosa pine/bitterbrush associations can eliminate bluebunch wheatgrass. Sandberg's bluegrass, yarrow, lupines, and penstemons will increase with heavy grazing pressure.

Relationship to other studies—

This plant association was first described as an incidental community type in the Wallowa Mountains (Johnson and Simon 1987). It was then described as a plant association by Lillybridge et al. (1995) in the eastern Cascades of Washington. This is the first description of this plant association in the Blue and Ochoco Mountains.

Ponderosa pine/mountain big sagebrush/Idaho fescue-bluebunch wheatgrass plant association

Pinus ponderosa/Artemisia tridentata/Festuca idahoensis-Agropyron spicatum

PIPO/ARTRV/FEID-AGSP CPS131 N = 7

Lonesome Exclosure, Gilbert Ridge, Emigrant Creek RD, Malheur NF.

Distribution—

Southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on basalt, andesite, argillite, and dacite. Elevations ranged from 4,500 to 5,550 ft (mean 5,029 ft). Slopes were gentle to moderately steep (5 to 40 percent). Sampled sites were on northerly and southerly aspects on convex and straight surfaces. Plots were on backslope and footslope locations.

	Mean	Range
Elevation (feet)	5,029	4,500–5,550
Slope (percent)	21	5–40
Herbage (pounds/acre, n = 4)	420	300–620
Aspect (number of plots)	NW (0), NE (4), SE (0), SW (3)	
Lithology	Basalt, andesite, argillite, dacite, rhyolite	
Position	Backslope, footslope, summit	
Slope shape	Convex, straight	

Ground surface features—

	Phase				
	A (n = 2)	B (n = 3)	C1 (n = 1)	C2 (n = 1)	A + B range
			Cover (%)		
Bare ground	6	13	0	0	0–40
Bedrock	0	9	5	5	0–20
Rock	4	12	15	20	0–35
Gravel	0	1	0	0	0–3
Pavement	0	7	0	0	0–15
Mosses and lichens	4	1	0	0	0–8
Litter	86	57	80	75	

Vegetation composition—

These communities are a savannah with ponderosa pine cover of less than 20 percent; western juniper cover generally less than 10 percent; and a shrub layer dominated by sagebrush (generally about 25 percent cover). Bunchgrasses dominate the herbaceous layer. Idaho fescue and bluebunch wheatgrass codominate, with Sandberg's bluegrass usually associated at lower cover levels. Forbs are few, with yarrow, creamy buckwheat, and narrowleaf pussytoes the most common.

States and transitions—

Four phases were defined as follows:

A Deep-rooted bunchgrasses (Idaho fescue and bluebunch wheatgrass) with combined cover ≥25 percent. A balance between sagebrush and these bunchgrasses is maintained by periodic fire and light to moderate grazing pressure.

B Deep-rooted bunchgrasses with combined cover <25 percent. This represents an imbalance between sagebrush and the bunchgrasses owing to lack of fire or to overgrazing.

C1 Dominated by annual bromes (especially cheatgrass). A loss of dominance by Idaho fescue and bluebunch wheatgrass owing to severe overgrazing and ground disturbance.

C2 Dominated by bluegrasses (*Poa sandbergii* and *Poa nervosa*). Fescue and wheatgrass have lost dominance owing to soil compaction, soil loss, and overgrazing.

Principal species—

Species	Code	Phase A (n = 2)	Phase B (n = 3)	Phase C1 (n = 1)	Phase C2 (n = 1)	A + B range
		Cover (%)/constancy (%)				*Cover (%)*
Trees:						
ponderosa pine	PIPO	23/100	10/100	18/100	1/100	5–23
western juniper	JUOC	1/50	7/67	13/100	15/100	0–8
Shrubs:						
mountain big sagebrush	ARTRV	18/100	23/100	10/100	25/100	10–30
creeping Oregon grape	BERE	2/50	0	0	0	0–2
mountain mahogany	CELE3	1/50	0	0	1/100	0–1
green rabbitbrush	CHVI8	2/100	3/67	1/100	3/100	0–5
bitterbrush	PUTR2	0	3/67	0	3/100	0–5
wax currant	RICE	6/50	1/33	4/100	0	0–6
Grasses:						
bluebunch wheatgrass	AGSP	8/100	12/100	10/100	1/100	5/20
Idaho fescue	FEID	38/100	9/100	2/100	5/100	8–50
prairie junegrass	KOCR	10/50	1/33	0	0	0–10
Sandberg's bluegrass	POSA12	8/50	8/100	5/100	20/100	0–10
Forbs:						
common arrow	ACMIL	6/50	3/100	1/100	2/100	0–6
narrowleaf pussytoes	ANST2	2/50	2/33	0	2/100	0–2
creamy buckwheat	ERHE2	2/100	1/100	1/100	0	1–2
groundsel	SENEC	2/100	1/33	8/100	2/100	0–2

Management considerations—

Light to moderate fires tend to reduce juniper and big sagebrush without harming ponderosa pine and bunchgrasses. Plants commonly found in this plant association that tend to increase with disturbances to the ground surface are rabbitbrush, creamy buckwheat, yarrow, bluegrasses, and annual bromes. These communities are high in layer diversity with resultant wildlife species habitat diversity. However, heavy use by ungulates (especially cattle and elk) can degrade these communities with compaction to the soils and overuse of bunchgrasses and a resultant loss in plant vigor. Rabbitbrush, cheatgrass, and bluegrasses often increase as a result.

Relationship to other studies—

Volland's (1976) classification in the central Oregon pumice zone contains a PIPO/PUTR2-ARTRV/FEID-AGSP plant association that is floristically similar to this association. Johnson and Clausnitzer (1992) classified and described this plant association for the Blue and Ochoco Mountains.

Ponderosa pine/Idaho fescue plant association

Pinus ponderosa/Festuca idahoensis

PIPO/FEID CPG112 N = 22

Sugar Creek, Paulina RD, Ochoco NF.

	Mean	Range
Elevation (feet)	4,592	3,800–5,300
Slope (percent)	15	1–80
Soil pH (n = 13)		6.2–7.2
Soil available water capacity (inches, n = 14)		2–10 (low to high)
Depth to bedrock or extremely gravelly soil (inches, n = 15)		12–40+
Herbage (pounds/acre, n = 18)	347	200–497
Aspect (number of plots)		NW (5), NE (5), SE (5), SW (7)
Lithology		Basalt, rhyolite, tuff, andesite, peridotite, serpentine
Position		Summit and all slope positions
Slope shape		Convex, concave, straight

Ground surface features—

	Phase			
	A (n = 11)	B (n = 9)	C (n = 2)	A + B range
			Cover (%)	
Bare ground	7	3	6	0–40
Bedrock	2	2	0	0–12
Rock	4	3	2	0–15
Gravel	1	0	1	0–10
Pavement	2	1	0	0–16
Mosses and lichens	1	2	0	0–10
Litter	83	89	91	0–10

Distribution—

Throughout the Blue and Ochoco Mountains.

Environmental features—

This plant association was found on basalt, andesite, rhyolite, tuff, peridotite, and serpentine rocks. Elevations ranged from 3,800 to 5,300 ft (mean 4,592 ft). Slopes were generally gentle to moderate (mean 15 percent). Sampled sites were found on all aspects. Soils consisted of a loamy surface layer 6 to 18 in thick, over very to extremely gravelly loamy soil. Bedrock occurred in some profiles, at depths as shallow as 12 in but often not within 40 in of the surface. Available water capacity varied greatly, and soil pH was slightly acid to nearly neutral.

Vegetation composition—

Idaho fescue dominates beneath ponderosa pine. Western juniper may be associated. Shrubs are absent or present at low coverage; mountain big sagebrush and bitterbrush are the most common. Other bunchgrasses frequently found with fescue are bluebunch wheatgrass, prairie junegrass, and Sandberg's bluegrass. As this type approaches Douglas-fir and grand fir forest, elk sedge may occur on moister microsites within the fescue community. The most common forb is yarrow. Also frequent are fleabanes, pussytoes, hawkweeds, and lupines.

States and transitions—

Three phases were defined as follows:

A Idaho fescue cover >25 percent.

B Idaho fescue cover 15 to 25 percent; annuals present in minor amount.

C Idaho fescue cover <15 percent; annuals (e.g., annual bromes) and bulbous bluegrass cover ≥10 percent; perennial forbs (e.g., twin arnica) may be abundant also.

Principal species—

Species	Code	Phase A (n = 11)	Phase B (n = 9)	Phase C (n = 2)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
ponderosa pine	PIPO	29/100	32/100	28/100	7–60
western juniper	JUOC	1/55	7/67	0	0–33
Shrubs:					
mountain big sagebrush	ARTRV	2/36	5/11	0	0–7
bitterbrush	PUTR2	1/45	2/56	0	0–4
Grasses and grasslikes:					
Idaho fescue	FEID	36/100	21/100	10/100	15–60
bluebunch wheatgrass	AGSP	10/91	4/67	16/100	0–31
cheatgrass	BRTE	0	1/22	10/50	0–1
prairie junegrass	KOCR	1/55	3/22	2/100	0–4
Sandberg's bluegrass	POSA12	2/55	1/67	1/50	0–15
elk sedge	CAGE2	4/64	6/22	0	0–6
Forbs:					
common yarrow	ACMIL	3/100	2/89	3/100	0–7
hawksbeards	CREPI	1/55	1/33	0	0–2
pussytoes	ANTEN	2/55	1/44	22/100	0–8
fleabanes	ERIGE2	3/55	1/33	1/50	0–5
lupines	LUPIN	2/55	1/44	1/50	0–20

Phase B is probably produced by moderate grazing pressure. Overgrazing can take the association to phase C where weedy annual grasses or perennial forbs increase to the detriment of the bunchgrasses. Fires of light to moderate severity do not harm the pines or Idaho fescue, whereas severe fires can eliminate both.

Management considerations—

Prescribed burns can promote new pines and young bunchgrass plants. These communities are especially valuable to grazing ungulates in the early spring when the fescue plants are preferred because of their succulence.

Relationship to other studies—

PIPO/FEID was first described in eastern Washington by Daubenmire and Daubenmire (1968), in the Blue Mountains by Hall (1973), in Montana by Pfister et al. (1977), in central Idaho by Steele et al. (1981), in northern Idaho by Cooper et al. (1991), in northern Washington by Clausnitzer and Zamora (1987), in the Wallowa and Seven Devils Mountains by Johnson and Simon (1987), and in the Blue and Ochoco Mountains by Johnson and Clausnitzer (1992).

Ponderosa pine/bluebunch wheatgrass plant association

Pinus ponderosa/Agropyron spicatum

PIPO/AGSP CPG111 N = 10

Fred Hall

Deep Creek canyon, Whitman Unit, Wallowa-Whitman NF.

Distribution—

Occurs throughout the Blue Mountains; most prominent in the northern Blues.

Environmental features—

This plant association occurs on basalts, andesites, and volcanic tuff. Elevations ranged from 2,175 to 4,940 ft (mean 4,164 ft). Slopes were moderate (mean 24 percent). Sampled sites were mostly on convex surfaces. Soils consisted of a surface layer of gravelly to very gravelly loamy soil, overlying extremely gravelly soil or weathered bedrock at a depth of 8 to 18 in. Available water capacity was low to moderate, and soil pH slightly acid to neutral.

	Mean	Range
Elevation (feet)	4,164	2,175-4,940
Slope (percent)	24	4–50
Soil pH (n = 3)		6.4–7.0
Soil available water capacity (inches, n = 8)		1–5 (low to moderate)
Depth to bedrock or extremely gravelly soil (inches, n = 8)		8–18
Herbage (pounds/acre, n = 9)	390	200–750
Aspect (number of plots)	NW (0), NE (3), SE (5), SW (2)	
Lithology	Basalt, andesite, tuff	
Position	Summit, all slope positions	
Slope shape	Convex	

Ground surface features—

	Phase A + B (n = 10)
	Cover (%)
Bare ground	3
Bedrock	10
Rock	9
Gravel	0
Pavement	2
Mosses and lichens	1
Litter	75

Vegetation composition—

Ponderosa pine occurs in open savannah over a bluebunch wheatgrass-dominated herbaceous layer. Western juniper may be present. Bitterbrush and common snowberry are infrequent and have low cover in this type. Bunchgrasses often associated with the bluebunch wheatgrass are Sandberg's bluegrass and Idaho fescue. Elk sedge may be a component on mesic microsites adjacent to Douglas-fir or grand fir forests. The most common forb is yarrow. Fleabanes, western hawkweed, tailcup lupine, and creamy buckwheat often occur.

Principal species—

Species	Code	Phase A + B (n = 10)
		Cover (%)/constancy (%)
Trees:		
ponderosa pine	PIPO	20/100
western juniper	JUOC	3/40
Shrubs:		
bitterbrush	PUTR2	2/40
common snowberry	SYAL	2/40
Grasses and grasslikes:		
bluebunch wheatgrass	AGSP	31/100
Idaho fescue	FEID	4/60
Wheeler's bluegrass	PONEW	4/30
Sandberg's bluegrass	POSA12	7/90
elk sedge	CAGE2	5/50
Forbs:		
common yarrow	ACMIL	5/80
serrate balsamroot	BASE2	2/30
fleabanes	ERIGE2	2/40
creamy buckwheat	ERHE2	1/50
western hawkweed	HIAL	1/40
lomatiums	LOMAT	1/30
tailcup lupine	LUCA	10/40
false agoseris	MITR5	2/30

States and transitions—

AB The deep-rooted bluebunch wheatgrass dominates over the other bunchgrasses. Perennial forbs occur at coverages of 5 percent or less.

C Sandberg's bluegrass, lupines, and yarrow have increased owing to grazing disturbance.

Management considerations—

Fire is often discontinuous in these communities. Fire return intervals are 8 to 10 years. Burning maintains bunchgrass vigor. Ungulates use these communities in spring and early summer for forage and in late summer for shading beneath the trees. Ungulates can degrade these sites if trampling causes displacement of bunchgrass plants on steep slopes early in the growing season when soils are saturated with rains and snowmelt.

Relationship to other studies—

This plant association was first described by Daubenmire and Daubenmire (1968) in eastern Washington, in the Blue Mountains by Hall (1973), in Montana by Pfister et al. (1977), in central Idaho by Steele et al. (1981), in north Idaho by Cooper et al. (1991), in northern Washington by Clausnitzer and Zamora (1987), in the Wallowa and Seven Devils Mountains by Johnson and Simon (1987), and in the Blue and Ochoco Mountains by Johnson and Clausnitzer (1992).

Ponderosa pine/squaw apple plant community type

Pinus ponderosa/Peraphyllum ramosissimum

PIPO/PERA4 CPS8 N = 2

This community was found in the central and southern Blue Mountains at relatively low elevations (below 4,500 ft). These are transitional communities between nonforest and forest sites. They contain a rich shrub component beneath a savannah of ponderosa pine and western juniper. Squaw apple is dominant with bitterbrush, snowberries, and mountain mahogany often associated. Elk sedge and the bunchgrasses occur together as members from adjacent forest and nonforest, respectively. Bluebunch wheatgrass and bottlebrush squirreltail are often prominent. Creamy buckwheat is the most frequent forb. Squaw apple has a relatively restricted and sporadic distribution in northeastern Oregon.

Ponderosa pine-western juniper/mountain mahogany-mountain snowberry plant community type

Pinus ponderosa-Juniperus occidentalis/Cercocarpus ledifolius-Symphoricarpos oreophilus

PIPO-JUOC/CELE3-SYOR2 CPC212 N = 2

This community was found in the southern Blue Mountains at moderate elevations (4,700 to 5,100 ft). The one soil studied was very shallow (4 in of gravelly sandy loam over bedrock), with very low available water capacity and neutral pH. These are transitional communities between open sagebrush-grasslands and forests. Ponderosa pines are scattered (10 percent overstory cover) over a shrubland dominated by mountain mahogany and mountain snowberry. Three bunchgrasses dominate the herbaceous vegetation: Idaho fescue, bluebunch wheatgrass, and prairie junegrass. Forbs are scant with yarrow and arrowleaf balsamroot the most frequently found. Mule deer (*Odocoileus hemionus*) heavily browse mountain mahogany shrubs.

Western Juniper Series

Western juniper/mountain mahogany/Idaho fescue-bluebunch wheatgrass plant association

Juniperus occidentalis/Cercocarpus ledifolius/Festuca idahoensis-Agropyron spicatum

JUOC/CELE3/FEID-AGSP CJS41 N = 4

Birch Creek exclosure, Blue Mountain RD, Malheur NF.

	Mean	Range
Elevation (feet)	4,903	4,240–5,270
Slope (percent)	26	12–40
Herbage (pounds/acre, n = 4)	368	240–540
Aspect (number of plots)	NW (2), NE (0), SE (0), SW (2)	
Lithology	Basalt, rhyolite, argillite	
Position	Summit, shoulder, backslope	
Slope shape	Convex	

Ground surface features—

	Phase			
	A (n = 1)	B (n = 2)	D (n = 1)	A + B range
		Cover (%)		
Bare ground	5	8	17	5–10
Bedrock	3	9	0	3–15
Rock	20	12	4	5–20
Gravel	0	0	0	0
Pavement	60	8	6	0–60
Mosses and lichens	5	14	4	0–30
Litter	7	49	68	

Distribution—

Southern Blue and Ochoco Mountains.

Benchmark site—

Birch Creek Three-Way Exclosure, Blue Mountain RD, Malheur NF. Established in 1961.

Environmental features—

This plant association was found on basalt, rhyolite, and argillite. Elevations of sample plots ranged from 4,240 to 5,270 ft (mean 4,903 ft). Slopes were moderate to steep (mean 26 percent). Plots occurred on westerly aspects on convex surfaces. Slope positions were on summits, shoulders, and backslopes. The one soil profile studied in detail had 8 in of very to extremely gravelly sandy loam over bedrock at a depth of 8 in; other brief investigations confirmed that soils were very shallow and had very low available water capacity.

Vegetation composition—

Western juniper forms a savannah over mountain mahogany and bunchgrasses. Idaho fescue requires the shading and moisture retention provided by the overtopping junipers. Forbs are few and have low coverage. Needlegrasses are the dominant invasive species and increase with disturbance. Communities in this association usually contain old-growth juniper and reflect long-term juniper occupancy.

States and transitions—

Three phases were defined as follows:

A Idaho fescue dominates over other bunchgrasses, with cover >25 percent.

B Bluebunch wheatgrass dominates over other bunchgrasses, with cover >25 percent; needlegrasses occur and often codominate with fescue.

D Needlegrasses dominate over other bunchgrasses.

Principal species—

Species	Code	Phase A (n = 1)	Phase B (n = 2)	Phase D (n = 1)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
western juniper	JUOC	10/100	25/100	10/100	10–30
Shrubs:					
mountain mahogany	CELE3	35/100	18/100	20/100	15–35
bitterbrush	PUTR2	0	1/50	1/100	0–1
Grasses:					
bluebunch wheatgrass	AGSP	5/100	25/100	0	5–25
soft brome	BRMO2	0	3/50	0	0–3
cheatgrass	BRTE	0	5/100	0	0–5
Idaho fescue	FEID	25/100	8/100	0	5–25
prairie junegrass	KOCR	0	3/100	1/100	0–3
Sandberg's bluegrass	POSA12	5/100	8/100	14/100	5–10
needlegrasses	STIPA	0	13/100	34/100	0–20
Forbs:					
common yarrow	ACMIL	1/100	2/100	2/100	1–3
pussytoes	ANTEN	0	2/100	1/100	0–2
stonecrops	SEDUM	3/100	1/100	29/100	0–3

As the transition occurs from A to B to D, Sandberg's bluegrass increases owing to the effect of disturbances by grazing and drought. Soil surface disturbance promotes the invasion and subsequent increase by needlegrasses. Herbage levels declined from phase A (450 lb/ac) to B (390 lb/ac) to D (240 lb/ac) on sampled plots. This decline mirrors the change from the larger, denser fescue and wheatgrass plants to the smaller, less dense bluegrass and needlegrass plants prominent in stage D.

Management considerations—

This community is important for providing habitat edge and cover for wildlife (mammals and birds). The juxtaposition of these communities on the landscape increases habitat diversity. Fires may severely damage juniper and mahogany owing to their susceptibility to moderate and severe burns. Wild browsers and livestock have prevented recruitment of young mountain mahogany plants in many places.

Relationship to other studies—

Western juniper/mountain mahogany/Idaho fescue-bluebunch wheatgrass was previously described as an incidental community in the Blue and Ochoco Mountains by Johnson and Clausnitzer (1992). The findings of this study change the status of the vegetation to plant association.

Western juniper/bitterbrush/Idaho fescue-bluebunch wheatgrass plant association

Juniperus occidentalis/Purshia tridentata/Festuca idahoensis-Agropyron spicatum

JUOC/PUTR2/FEID-AGSP CJS321 N = 13

Skookum Exclosure, Heppner RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Benchmark sites—

Three exclosures contain excellent examples of this plant association:

- Skookum Three-Way Exclosures (established 1945); Heppner RD, Umatilla NF
- Dry Creek Three-Way Exclosures (established 1939); Blue Mountain RD, Malheur NF
- Antelope Springs Exclosure (established 1955); Blue Mountain RD, Malheur NF

Environmental features—

This plant association was found on basalt, andesite, argillite, rhyolite, dacite, and pumice. Elevations ranged from 3,650 to 5,140 ft (mean 4,253 ft). Slopes were gentle to steep (mean 12 percent). Plots occurred on all aspects on convex, straight, and undulating surfaces. Plot locations were on all slope positions. Brief soil investigations suggest that soils have shallow to moderate depth (6 to 22 in, n = 10).

	Mean	Range
Elevation (feet)	4,253	3,650–5,140
Slope (percent)	12	3–45
Herbage (pounds/acre, n = 7)	546	300–813
Aspect (number of plots)	NW (2), NE (4), SE (4), SW (3)	
Lithology	Basalt, andesite, argillite, rhyolite, dacite, pumice	
Position	Summit, shoulder, slopes	
Slope shape	Convex, straight, undulating	

Ground surface features—

Species	Phase A (n = 4)	B (n = 4)	C1 (n = 2)	C2 (n = 2)	D (n = 1)	A + B range
			Cover (%)			
Bare ground	18	24	58	30	25	1–50
Bedrock	0	1	0	0	0	0–3
Rock	2	11	20	8	0	0–30
Gravel	2	3	5	5	10	0–10
Pavement	11	2	0	8	0	0–35
Mosses and lichens	1	2	1	4	0	0–4
Litter	66	57	16	45	65	

Vegetation composition—

These communities consist of a tree-shrub-bunchgrass-forb mosaic beneath an open juniper savannah. Three bunchgrasses are prominent: Idaho fescue, bluebunch wheatgrass, and Sandberg's bluegrass. Forbs are subordinate to the bunchgrasses; yarrow, blepharipappus, and red avens are plants frequently associated in the community. These deeper soil sites may have been free of western juniper prior to the decreased fire frequency and heavy grazing of the postsettlement period.

States and transitions—

Five phases were recognized:

A Idaho fescue cover of at least 20 percent; bare soil covers <35 percent of the ground surface.

B Idaho fescue cover of <20 percent or bare ground >35 percent.

C1 Bitterbrush and Idaho fescue each with cover <5 percent; annual grasses and forbs prominent.

C2 Bitterbrush still present with 10 percent cover or more, but Idaho fescue is very weak (<5 percent cover) or absent.

D Introduced perennial grasses have replaced Idaho fescue and bluebunch wheatgrass.

Animal use has determined the composition and cover of bunchgrasses in these communities. Livestock seek shade under the junipers and can destroy the fescue, which is then replaced by annual plants, especially cheatgrass and Japanese brome. Prolonged heavy grazing combined with browsing of the bitterbrush component results in phase C1. Where severity or duration of bitterbrush browsing has been less severe but fescue has been impacted, phase C2 results. Phase D results when the deep-rooted bunchgrasses (FEID, AGSP) are overgrazed to the point where natural recolonization is not possible and land managers have seeded exotic grasses.

Principal species—

Species	Code	Phase A (n = 4)	Phase B (n = 4)	Phase C1 (n = 2)	Phase C2 (n = 2)	Phase D (n = 1)	A + B range
		Cover (%)/constancy (%)					*Cover (%)*
Trees:							
western juniper	JUOC	13/100	17/100	4/100	8/100	11/100	10–38
Shrubs:							
bitterbrush	PUTR2	14/100	12/100	2/100	18/100	20/100	3–20
Grasses:							
bluebunch wheatgrass	AGSP	14/100	15/100	15/100	12/100	1/100	1–30
annual bromes	BROMU	5/25	4/50	11/100	8/100	1/100	0–15
Idaho fescue	FEID	25/100	18/100	2/100	0	0	10–35
prairie junegrass	KOCR	2/50	2/50	0	3/50	0	0–3
Sandberg's bluegrass	POSA12	8/100	8/100	5/100	4/100	10/100	3–20
Forbs:							
common yarrow	ACMIL	4/100	6/100	5/100	1/100	3/100	1–15
blepharipappus	BLSC	6/50	3/50	22/100	2/100	0	0–10
tall annual willowherb	EPPA2	1/25	0	5/50	10/100	0	0–1
sulphur-flower buckwheat	ERUM	1/50	1/50	0	0	0	0–1
red avens	GETR	3/50	1/25	0	0	0	0–5
phloxes	PHLOX	2/25	4/50	3/50	2/100	1/100	0–5

Management considerations—

The bitterbrush-bunchgrass mix provides for high-quality wildlife habitat. These communities are heavily used by livestock and big game animals for shade. They are also primary deer winter range. Deer use is high for bedding and for browse (bitterbrush and juniper). Retention of viable populations of bitterbrush and bunchgrasses is desirable for biological diversity. Fire usually reduces the fire-sensitive juniper and bitterbrush; fire will promote bunchgrasses if adequate amounts remain to colonize the openings created by the death of juniper and bitterbrush. Most of these sites probably represent postsettlement juniper invasion, and juniper density may continue to increase in the future. Juniper density could increase to the point where shrubs are nearly eliminated.

Relationship to other studies—

This plant association was originally described by Volland (1976) in the central Oregon pumice area. It was subsequently described by Johnson and Clausnitzer (1992) for the Blue and Ochoco Mountains.

Western juniper/low sagebrush/Idaho fescue plant association

Juniperus occidentalis/Artemisia arbuscula/Festuca idahoensis

JUOC/ARAR8/FEID CJS112 N = 3

South Fork of Wind Creek, Paulina RD, Ochoco NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on basalts and andesites at elevations ranging from 4,400 to 4,890 ft (mean 4,588 ft). Slopes were gentle (mean 5 percent). Plots occurred on southerly aspects on convex and straight surfaces. The one soil profile studied consisted of loam and gravelly loam, over bedrock at a depth of 12 in, with low available water capacity and neutral pH.

	Mean	Range
Elevation (feet)	4,588	4,400–4,890
Slope (percent)	5	4–5
Herbage (pounds/acre n = 3)	550	350–800
Aspect (number of plots)	NW (0), NE (0), SE (2), SW (0)	
Lithology	Basalt, andesite	
Position	Summit, shoulder, backslope	
Slope shape	Convex, straight	

Vegetation composition—

Western juniper forms a savannah over low sagebrush and bunchgrasses. The principal bunchgrasses are bluebunch wheatgrass, Idaho fescue, and Sandberg's bluegrass. These communities often were adjacent to low sagebrush/Idaho fescue-bluebunch wheatgrass (ARAR8/FEID-AGSP) communities or low sagebrush/Sandberg's bluegrass (ARAR8/POSA12) communities. These communities usually contain old-growth juniper and reflect long-term occupancy by the species.

Ground surface features—

	Phase	
	A (n = 2)	C (n = 1)
	Cover (%)	
Bare ground	11	40
Bedrock	3	0
Rock	4	15
Gravel	3	15
Pavement	0	0
Mosses and lichens	1	1
Litter	78	29

Principal species—

Species	Code	Phase A (n = 2)	Phase C (n = 1)
		Cover (%)/constancy (%)	
Trees:			
western juniper	JUOC	19/100	19/100
Shrubs:			
low sagebrush	ARAR8	20/100	20/100
Grasses:			
bluebunch wheatgrass	AGSP	25/100	1/100
Idaho fescue	FEID	16/100	15/100
Sandberg's bluegrass	POSA12	18/100	11/100

States and transitions—

Two phases were recognized:

A Bluebunch wheatgrass, Idaho fescue, and Sandberg's bluegrass combined cover >50 percent.

C Combined cover of the three bunchgrasses is <50 percent; bare ground >20 percent.

The transition from phase A to C occurs as a result of heavy grazing by domestic livestock.

Management considerations—

Juniper affords shade to livestock and wild ungulates. The juniper/low sagebrush/fescue community has high value to grazing animals and browsing animals. Deer relish the succulent leaders of the sagebrush. The mix of bunchgrasses provides a diverse offering to grazing animals.

Relationship to other studies—

The JUOC/ARAR8/FEID plant association was first described by Hopkins (1979b) on the Fremont NF in south-central Oregon. This type was previously described as a plant community for the Blue and Ochoco Mountains (Johnson and Clausnitzer 1992).

Western juniper/Idaho fescue-bluebunch wheatgrass plant association

Juniperus occidentalis/Festuca idahoensis-Agropyron spicatum

JUOC/FEID-AGSP CJG111 N = 8

Shake Table, Blue Mountain RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Benchmark sites—

Kelly Creek Butte (proposed research natural area), Heppner RD, Umatilla NF; Shaketable (proposed research natural area), Blue Mountain RD, Malheur NF

Environmental features—

This plant association was found on andesite and rhyolite. Elevations ranged from 3,050 to 5,850 ft (mean 4,651 ft). Slopes were gentle to steep (mean 27 percent). Plots occurred primarily on westerly aspects on summits, shoulders, and backslopes. Brief soil investigations suggested shallow to moderately deep soils (10 to 30 in, n = 3).

	Mean	Range
Elevation (feet)	4,651	3,050–5,850
Slope (percent)	27	5–70
Herbage (pounds/acre, n = 7)	619	300–948

Aspect (number of plots)	NW (3), NE (1), SE (0), SW (4)
Lithology	Andesite, rhyolite
Position	Summit, shoulder, backslope
Slope shape	Convex, straight, undulating

Vegetation composition—

Western juniper forms a savannah with bunchgrasses. The four principal bunchgrasses (Idaho fescue, bluebunch wheatgrass, prairie junegrass, Sandberg's bluegrass) dominate the herbaceous layer. The most common forbs are yarrow, red avens, and tailcup lupine. Adjacent vegetation is often of thinner soil communities (stiff sage/Sandberg's bluegrass; Sandberg's bluegrass-onespike oatgrass). These deeper soil sites may have been free of western juniper prior to the decreased fire frequency and heavy grazing of the postsettlement period.

Ground surface features—

	Phase			
	A (n = 3)	B (n = 4)	C (n = 1)	A + B range
		Cover (%)		
Bare ground	6	12	15	0–20
Bedrock	1	0	0	0–4
Rock	22	18	30	0–65
Gravel	0	5	0	0–10
Pavement	0	0	10	0
Mosses and lichens	14	12	0	3–25
Litter	57	53	45	

Principal species—

		Phase			
Species	Code	A (n = 3)	B (n = 4)	C (n = 1)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
western juniper	JUOC	22/100	27/100	8/100	8–45
Shrubs:					
wax currant	RICE	1/33	2/50	0	0–4
Grasses:					
bluebunch wheatgrass	AGSP	16/100	10/100	10/100	3–30
cheatgrass	BRTE	1/33	9/75	3/100	0–15
Idaho fescue	FEID	37/100	20/100	5/100	15–50
prairie junegrass	KOCR	5/33	4/50	0	0–5
Sandberg's bluegrass	POSA12	6/67	9/100	7/100	0–20
Forbs:					
common yarrow	ACMIL	4/100	1/50	1/100	0–10
arrowleaf balsamroot	BASA3	3/33	2/100	0	0–5
tall annual willowherb	EPPA2	0	2/50	0	0–3
creamy buckwheat	ERHE2	5/33	3/25	0	0–5
red avens	GETR	6/67	0	0	0–10
tailcup lupine	LUCA	6/67	8/75	0	0–20

States and transitions—

Three phases were defined as follows:

A Idaho fescue, bluebunch wheatgrass, and prairie junegrass cover total ≥50 percent.

B Idaho fescue, bluebunch wheatgrass, and prairie junegrass cover total 20 to 49 percent.

C Idaho fescue, bluebunch wheatgrass, and prairie junegrass cover total <20 percent.

Livestock seeking shade and grazing impact the bunchgrasses. In phase B, a reduction in cover of large bunchgrasses and increase in Sandberg's bluegrass is attributed

to grazing pressure. In phase C, Idaho fescue has been nearly eliminated by grazing. Forbs that tend to increase with disturbance are yarrow, tailcup lupine, and creamy buckwheat.

Management considerations—

Fire usually kills young juniper. Grazing animals use these communities for shade and forage. Deer use the areas beneath juniper trees for rest and shade. Chukar (*Alectoris chukar*) and quail (*Callipepla californica*) use these communities as well. Most of these sites probably represent postsettlement juniper invasion, and juniper density may continue to increase in the future.

Relationship to other studies—

A juniper/bunchgrass plant association was described by Hall (1973) for the Blue Mountains. Johnson and Simon (1987) described this plant association for the Wallowa Mountains and canyon lands of the Snake and Imnaha Rivers in northeastern Oregon. Johnson and Clausnitzer (1992) described this plant association for the Blue and Ochoco Mountains.

Western juniper/stiff sagebrush plant community type

Juniperus occidentalis/Artemisia rigida

JUOC/ARRI2 CJS811 N = 2

Western juniper is scattered over a xeric shrubland of stiff sagebrush with bunchgrasses strongly associated. Juniper averaged 11 percent cover; sagebrush averaged 13 percent. These communities usually contain old-growth juniper and reflect long-term occupancy by the species. The two principal bunchgrasses are bluebunch wheatgrass and Sandberg's bluegrass. In the plot that was lightly impacted by grazing, the cover of each grass was 20 percent, and with heavier grazing disturbance both bunchgrasses declined. Forbs frequently occurring were narrowleaf stonecrop, low pussytoes, bighead clover, penstemons, and phlox.

These communities were found in the central and southern Blue Mountains on basalt and andesite. Sites were rocky (mean cover 50 percent), with gentle slopes (mean 6 percent), and convex slope shape. The one soil studied had 10 in of gravelly to very gravelly loamy material over bedrock, very low available water capacity, and slightly acid pH. These are hot, dry sites where spring moisture is slight and drought severely limits plant growth.

Western juniper/stiff sagebrush communities are often ecotonal between ponderosa pine forests or savannahs and stiff sagebrush/Sandberg's bluegrass scablands. Grazing and browsing animals use the juniper for shading and the sagebrush for browse. Heavy use of the sagebrush will cause hedging of the shrub and possible mortality. Heavy traffic and trampling accelerate frost heaving and soil erosion of the scabland soils. Herbage ranged from 75 to 275 lb/ac (mean 175 lb/ac), the lowest of any juniper community type.

Western juniper/bluebunch wheatgrass plant community type

Juniperus occidentalis/Agropyron spicatum

JUOC/AGSP CJG113 N = 3

Western juniper is scattered over a xeric grassland composed of bluebunch wheatgrass and Sandberg's bluegrass. The juniper cover averages 12 percent. The bunchgrasses are thinly scattered in a rocky-gravelly landscape (bluebunch wheatgrass average cover 17 percent; Sandberg's bluegrass cover 8 percent). Other herbaceous plants are relatively few and have low cover. Sparse fuels suggest rare fires and possibly long-term juniper occupancy of these sites rather than recent juniper invasion.

These communities were found in the southern Blue and Ochoco Mountains. Sites were found on basalt and andesite, where rock cover averaged 33 percent and gravel 12 percent. Elevations ranged from 3,990 to 4,515 ft (mean 4,235 ft). Slopes were moderately steep (mean 24 percent). Plots occurred on southerly aspects on convex surfaces, at shoulder and backslope positions. The one soil investigated was just 4 in thick. These are hot, dry sites where spring moisture is slight and drought strongly limits plant growth.

These communities receive highest use in late winter to early spring when bunchgrasses green up and are available for forage before adjacent grasslands. Elk (*Cervus elaphus*) and deer are attracted to these communities when winter snow is receding from the mountain rangelands. Herbage ranged from 250 to 375 lb/ac (mean 312 lb/ac).

Shrubland Series

Mountain mahogany/Idaho fescue-bluebunch wheatgrass plant association

Cercocarpus ledifolius/Festuca idahoensis-Agropyron spicatum

CELE3/FEID-AGSP SD4111 N = 5

Capps Mountain, Emigrant Creek RD, Malheur NF.

Distribution—

Blue and Ochoco Mountains (more frequent in central and southern Blue Mountains).

Environmental features—

This plant association was found on basalt, rhyolite, and tuff. Elevations ranged from 4,550 to 5,290 ft (mean 4,931 ft). Slopes were gentle to moderately steep (mean 14 percent). Plots occurred on northerly and southerly aspects on convex surfaces. Plots were on summit, shoulder, and footslope positions. The one soil studied consisted of very to extremely gravelly silt loam over bedrock at a depth of 15 in. Available water capacity was very low and the pH slightly acid.

	Mean	Range
Elevation (feet)	4,931	4,550–5,290
Slope (percent)	14	4–35
Herbage (pounds/acre, n = 2)	345	280–410
Aspect (number of plots)	NW (1), NE (2), SE (2), SW (0)	
Lithology	Basalt, rhyolite, tuff	
Position	Summit, shoulder, footslope	
Slope shape	Convex	

Ground surface features—

	Phase			
	A (n = 1)	B (n = 2)	C (n = 2)	A + B range
		Cover (%)		
Bare ground	1	14	14	1–15
Bedrock	10	8	2	0–15
Rock	10	5	4	1–10
Gravel	0	0	0	0
Pavement	0	4	0	0–8
Mosses and lichens	8	16	0	6–25
Litter	71	36	65	35–60

Vegetation composition—

Mountain mahogany, in relatively dense stands (up to 65 percent cover), dominates over bunchgrasses. Western juniper and ponderosa pine may be present as incidental species. Idaho fescue is always present as the dominant deep-rooted bunchgrass in relatively undisturbed vegetation. Other grasses commonly occurring with fescue are bluebunch wheatgrass, bottlebrush squirreltail, and Wheeler's and Sandberg's bluegrasses. The most common forbs are yarrow, western hawkweed, western groundsel, and fleabanes.

States and transitions—

Three phases were defined as follows:

A Idaho fescue and bluebunch wheatgrass cover totals >45 percent.

B Idaho fescue and bluebunch wheatgrass cover totals <45 percent; cover of bluegrasses >20 percent but little annual grass.

C Idaho fescue and bluebunch wheatgrass cover totals <30 percent and cheatgrass cover is ≥25 percent.

Large bunchgrasses decrease and bluegrasses increase with moderate ungulate trampling and traffic in these stands, resulting in phase B. Further heavy ungulate use continues to diminish the perennial grass cover and leads to dense stands of cheatgrass (phase C).

Principal species—

Species	Code	Phase A (n = 1)	Phase B (n = 2)	Phase D (n = 2)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
western juniper	JUOC	0	5/50	0	0–5
Shrubs:					
mountain mahogany	CELE3	45/100	40/100	68/100	14–65
gray rabbitbrush	CHNA2	10/100	1/50	0	0–10
Grasses:					
bluebunch wheatgrass	AGSP	20/100	0	6/100	0–20
rattlesnake brome	BRBR7	0	0	7/50	0
cheatgrass	BRTE	5/100	0	32/100	0–5
Idaho fescue	FEID	30/100	32/100	11/100	23–40
prairie junegrass	KOCR	1/100	5/50	4/100	0–5
Wheeler's bluegrass	PONEW	1/100	25/50	1/50	0–25
Sandberg's bluegrass	POSA12	3/100	44/50	10/50	0–3
bottlebrush squirreltail	SIHY	1/100	4/100	5/50	1–8
Forbs:					
common yarrow	ACMIL	1/100	1/100	2/100	1–1
fleabanes	ERIGE2	0	2/50	1/100	0–3
creamy buckwheat	ERHE2	0	2/50	1/50	0–2
western hawkweed	HIAL	5/100	0	1/50	0–5
western groundsel	SEIN2	3/100	10/50	4/50	0–10

Management considerations—

These communities add to the overall landscape diversity within the coniferous forest and the sagebrush rangeland of the Blue and Ochoco Mountain landscapes. Mountain mahogany is preferentially browsed by deer, elk, and pronghorns (*Antilocapra americana*). There is very little recruitment of mountain mahogany owing to the heavy use of these stands by browsing ungulates. High lines or skirting of the mature shrub canopies can weaken the mature shrubs and lead to mortality. The dense thickets of mahogany provide excellent winter cover for deer. Moderate and severe fire usually kills mountain mahogany, and then regeneration is often severely curtailed by herbivory. If bunchgrass cover was low before the fire, weedy or invasive species may colonize the site after fire.

Relationship to other studies—

Hall (1973) included CELE3/FEID-AGSP in a mountain mahogany-grass plant community type in the Blue Mountains. Three mountain mahogany plant community types were described in the Snake River canyon by Johnson and Simon (1987). This plant association was previously described in the Blue and Ochoco Mountains by Johnson and Clausnitzer (1992).

Mountain mahogany-bitterbrush/bluebunch wheatgrass plant community type

Cercocarpus ledifolius-Purshia tridentata/Agropyron spicatum

CELE3-PUTR2/AGSP SD4115 N = 1

This community type was probably more common in the Blue Mountains prior to the introduction of domestic livestock and the high deer populations of the 1950s. Here bitterbrush is dominant beneath an open mahogany stand. It is present today owing to exclusion of ungulates beginning in 1961 at Birch Creek Three-Way Exclosure on the Blue Mountain RD of the Malheur NF. The xeric site (soil of gravelly sandy loam just 6 in deep) does not support Idaho fescue. The bunchgrasses that codominate here are bluebunch wheatgrass, Thurber's needlegrass, and Sandberg's bluegrass.

Mountain mahogany/bluebunch wheatgrass plant community type

Cercocarpus ledifolius/Agropyron spicatum

CELE3/AGSP SD4112 N = 3

These communities are found on southerly, steep slopes (mean 63 percent) on basalt and rhyolite outcrops. Extremely gravelly or stoney material occurs within 10 in of the surface. These sites are too dry for fescue establishment. The predominant bunchgrasses are bluebunch wheatgrass and Sandberg's bluegrass. The mountain mahogany stands are open (mean cover 14 percent). Snowberries (both common and mountain) are usually associated. Common forbs are yarrow, creamy buckwheat, and lanceleaf stonecrop. This community occurs on Chicken Hill in the central Blue Mountains of the La Grande RD, Wallowa-Whitman NF.

Mountain mahogany/Wheeler's bluegrass plant community type

Cercocarpus ledifolius/Poa nervosa wheeleri

CELE3/PONEW SD4114 N = 1

This community in the southern Blue Mountains contains a high cover of Wheeler's bluegrass (60 percent) beneath a dense stand of mountain mahogany (60 percent). Few forbs are represented. The only other bunchgrasses are bluebunch wheatgrass, western needlegrass, and Sandberg's bluegrass. The site is high in elevation for mountain mahogany (6,050 ft). The soil consists of very to extremely gravelly silt loam over bedrock at 18 in.

Bitterbrush-mountain big sagebrush/Idaho fescue-bluebunch wheatgrass plant association

Purshia tridentata-Artemisia tridentata var. *vaseyana/Festuca idahoensis-Agropyron spicatum*

PUTR2-ARTRV/FEID-AGSP SD3124 N = 6

Cougar Creek Exclosure, Prairie City RD, Malheur NF.

Distribution—

Southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on rhyolite and volcanic sandstone. Elevations of sample plots ranged from 4,600 to 5,450 ft (mean 5,103 ft). Slopes were gentle to moderate (mean 7 percent). Plots occurred primarily on southerly slopes on straight surfaces near ridgetops. Soils depths were 9 to 24 in (n = 3). The one profile studied in detail had clay-rich subsoil and neutral pH.

	Mean	Range
Elevation (feet)	5,103	4,600–5,450
Slope (percent)	7	2–20
Herbage (pounds/acre, n = 1)	380	
Aspect (number of plots)	NW (0), NE (0), SE (5), SW (1)	
Lithology	Rhyolite, volcanic sandstone, tuff	
Position	Summit	
Slope shape	Straight	

Ground surface features—

	Phase				
	A (n = 1)	B (n = 2)	C (n = 1)	D (n = 2)	A + B range
	Cover (%)				
Bare ground	15	14	40	18	13–15
Bedrock	0	2	0	0	0–4
Rock	0	8	1	1	0–10
Gravel	0	0	1	5	0–1
Pavement	0	0	0	0	0
Mosses and lichens	2	0	15	0	0–2
Litter	50	40	3	63	

Vegetation composition—

Bitterbrush is always associated with mountain big sagebrush as a codominant. Bunchgrasses dominate the herbaceous layer. Always present in relatively undisturbed vegetation are Idaho fescue, prairie junegrass, bluebunch wheatgrass, and Sandberg's bluegrass. Prominent forbs are yarrow, creamy buckwheat, and fleabanes. Ponderosa pine and western juniper may occur as incidental species at low cover. These shrublands are often adjacent to mountain big sagebrush communities.

States and transitions—

Three phases were defined as follows:

A Bitterbrush cover >5 percent; Idaho fescue and bluebunch wheatgrass cover total >25 percent.

B Bitterbrush cover >5 percent; Idaho fescue and bluebunch wheatgrass cover total <25 percent.

C Bitterbrush cover >5 percent; Idaho fescue absent; Sandberg's bluegrass is the dominant bunchgrass; bare ground >30 percent.

D Bitterbrush cover <5 percent.

Principal species—

Species	Code	Phase A (n = 1)	Phase B (n = 2)	Phase C (n = 1)	Phase D (n = 2)	A + B range
		Cover (%)/constancy (%)				*Cover (%)*
Trees:						
western juniper	JUOC	0	1/50	1/100	0	0–1
ponderosa pine	PIPO	0	4/50	0	0	0–4
Shrubs:						
mountain big sagebrush	ARTRV	20/100	9/100	30/100	28/100	9–20
mountain mahogany	CELE3	0	3/50	0	0	0–3
bitterbrush	PUTR2	15/100	12/100	25/100	2/100	8–16
mountain snowberry	SYOR2	0	2/50	0	0	0–2
Grasses:						
bluebunch wheatgrass	AGSP	10/100	10/100	10/100	5/100	9–10
Idaho fescue	FEID	25/100	2/100	0	18/100	1–25
prairie junegrass	KOCR	3/100	2/100	0	1/100	1–3
Sandberg's bluegrass	POSA12	5/100	8/100	15/100	10/100	2–15
bottlebrush squirreltail	SIHY	0	2/50	1/100	1/100	0–2
Forbs:						
common yarrow	ACMIL	1/100	4/100	10/100	1/100	1–6
fleabanes	ERIGE2	6/100	5/100	0	1/50	1–6
creamy buckwheat	ERHE2	1/100	2/100	1/100	10/50	1–2

With overgrazing, phase A will shift toward phase B with diminished cover by fescue and wheatgrass. As degradation of the bunchgrass community continues, phase C can be attained where the shallow-rooted Sandberg's bluegrass dominates the deep-rooted bunchgrasses and Idaho fescue is relict or absent. With ungulate overbrowsing, bitterbrush is weakened and juvenile plants are killed resulting in relict PUTR2 as portrayed in phase D.

Management considerations—

Bitterbrush is killed by moderately severe to severe burns when soil moisture is low and roots are consumed. Bitterbrush and mountain big sagebrush can be regenerated by using prescribed fire if burns are accomplished at the time soil moisture is adequate to protect the roots from extreme heat. Bitterbrush-sagebrush/bunchgrass communities are highly desired as winter-spring range for wildlife (especially deer). Mule deer are principal users of bitterbrush during winter. Domestic livestock use is focused on the bunchgrass component, but bitterbrush is hedged when livestock use is heavy. Regeneration of bitterbrush has been seriously compromised in many areas by combined browsing of livestock and wildlife.

Relationship to other studies—

This is the first description of PUTR2-ARTRV/FEID AGSP as a plant association.

Bitterbrush/Idaho fescue-bluebunch wheatgrass plant association

Purshia tridentata/Festuca idahoensis-Agropyron spicatum

PUTR2/FEID-AGSP SD3111 N = 7

Shake Table, Blue Mountain RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found on basalt and rhyolite. Elevations of sample plots ranged from 3,690 to 4,700 ft (mean 4,199 ft). Slopes were gentle to moderately steep (mean 11 percent). Plots occurred primarily on southwesterly slopes on convex surfaces and on all slope positions. Soils consisted of a surface layer of loamy material about 5 in thick over a clay-rich layer (sometimes stoney), with bedrock or extremely gravelly soil 10 to 30 in below the surface. Available water capacity was low to moderate, and soil pH was slightly acid to neutral.

	Mean	Range
Elevation (feet)	4,199	3,690–4,700
Slope (percent)	11	3–35
Soil pH (n = 5)		6.2–7.3
Soil available water capacity (inches, n = 4)		2–7 (low to moderate)
Depth to bedrock or extremely gravelly soil (inches, n = 8)		10–30
Herbage (pounds/acre, n = 2)	470	437–502
Aspect (number of plots)	NW (2), NE (1), SE (0), SW (4)	
Lithology	Basalt, tuff	
Position	Summit, shoulder, backslope, footslope	
Slope shape	Convex, straight	

Ground surface features—

	Phase			
	A (n = 3)	B (n = 2)	C (n = 2)	A + B range
		Cover (%)		
Bare ground	18	45	32	3–50
Bedrock	2	0	0	0–4
Rock	4	2	0	0–5
Gravel	0	0	0	0
Pavement	5	2	0	0–15
Mosses and lichens	2	0	0	0–4
Litter	30	42	28	

Vegetation composition—

Bitterbrush occurs with bunchgrass-dominated herbaceous layer. Idaho fescue, bluebunch wheatgrass, and Sandberg's bluegrass are always present in relatively undisturbed vegetation. Onespike oatgrass may be a component on shallow soil inclusions within the site. Prominent forbs are yarrow, hawksbeard, blepharipappus, and cryptantha. Ponderosa pine and western juniper may occur at low cover in this association. Bitterbrush/bunchgrass shrublands are often adjacent to scablands, grasslands, juniper/bitterbrush, or pine-juniper/bitterbrush communities.

States and transitions—

Three phases were defined as follows:

A Idaho fescue and bluebunch wheatgrass cover total >25 percent.

B Idaho fescue and bluebunch wheatgrass cover total <25 percent or bare ground is >30 percent.

C Sandberg's bluegrass is the dominant bunchgrass; bare ground is >30 percent; annuals have >50 percent cover.

With overgrazing, phase A will shift toward phase B with diminished cover by fescue and wheatgrass and an increase in bare ground. As degradation of the bunchgrass community continues, the shallow-rooted Sandberg's bluegrass and annuals (e.g., blepharippaus, annual bromes) dominate over the deep-rooted bunchgrasses (phase C).

Principal species—

Species	Code	Phase A (n = 3)	Phase B (n = 2)	Phase C (n = 2)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Trees:					
ponderosa pine	PIPO	3/33	1/50	0	0–3
western juniper	JUOC	2/33	8/50	0	0–5
Shrubs:					
bitterbrush	PUTR2	14/100	18/100	6/100	10–25
gray rabbitbrush	CHNA2	0	5/50	0	0–5
Grasses:					
bluebunch wheatgrass	AGSP	23/100	12/100	6/100	10–30
rattlesnake brome	BRBR7	1/33	0	1/50	0–1
hairy brome	BRCO4	1/33	0	0	0–1
Japanese brome	BRJA	0	0	18/100	0
soft brome	BRMO2	0	0	1/50	0
cheatgrass	BRTE	3/33	0	0	0–3
onespike oatgrass	DAUN	6/67	1/50	0	0–10
Idaho fescue	FEID	15/100	12/100	0	3–25
prairie junegrass	KOCR	1/33	1/50	0	0–1
Sandberg's bluegrass	POSA12	9/100	8/100	18/100	1–15
bottlebrush squirreltail	SIHY	1/33	0	10/100	0–1
ventenata	VEDU	0	5/50	0	0–5
Forbs:					
common yarrow	ACMIL	5/100	0	8/100	0–5
tapertip onion	ALAC4	1/33	3/50	0	0–3
blepharipappus	BLSC	10/33	10/50	22/100	0–10
tapertip hawksbeard	CRAC2	8/67	0	3/50	0–10
cryptantha	CRYPT	10/33	2/100	0	0–10
tall annual willowherb	EPPA2	1/33	1/50	22/100	0–1
creamy buckwheat	ERHE2	15/33	0	28/100	0–15
spurred lupine	LULA3	0	0	5/100	0

Management considerations—

Bitterbrush is killed by moderately severe to severe burns when soil moisture is low and roots are consumed. Bitterbrush can be regenerated by using prescribed fire if soil moisture is adequate to protect the roots from extreme heat. Bitterbrush/bunchgrass communities are highly desired as winter-spring range for wildlife (especially deer). Mule deer are principal users of bitterbrush during winter. Domestic livestock use is focused on the bunchgrass component, but bitterbrush is hedged when livestock use is heavy. Regeneration of bitterbrush has been seriously compromised in many areas by combined browsing of livestock and wildlife.

Relationship to other studies—

Daubenmire (1970) was the first ecologist to describe this vegetation with his PUTR2/FEID habitat type in central Washington. Hall (1973) classified a bitterbrush/bunchgrass plant community type in the southern Blue and Ochoco Mountains. Johnson and Simon (1987) described a PUTR2/FEID-AGSP plant association in the Wallowa Mountains. Johnson and Clausnitzer (1992) described the PUTR2/FEID-AGSP plant association of the Blue and Ochoco Mountains.

Bitterbrush-mountain big sagebrush/Idaho fescue plant community type

Purshia tridentata-Artemisia tridentata var. *vaseyana/Festuca idahoensis*

PUTR2-ARTRV/FEID SD3125 N = 1

This mesic bitterbrush community was found below Bald Butte on the old Snow Mountain RD, Ochoco NF (now the Emigrant RD, Malheur NF). Here bitterbrush was codominant with mountain big sagebrush. The bitterbrush was vigorous, with growth from 4 to 7 ft tall. Associated with the fescue were other mesic graminoids (e.g., mountain brome, giant wildrye, and elk sedge). The only prominent forb was western groundsel.

Bitterbrush/Douglas' buckwheat plant community type

Purshia tridentata/Eriogonum douglasii

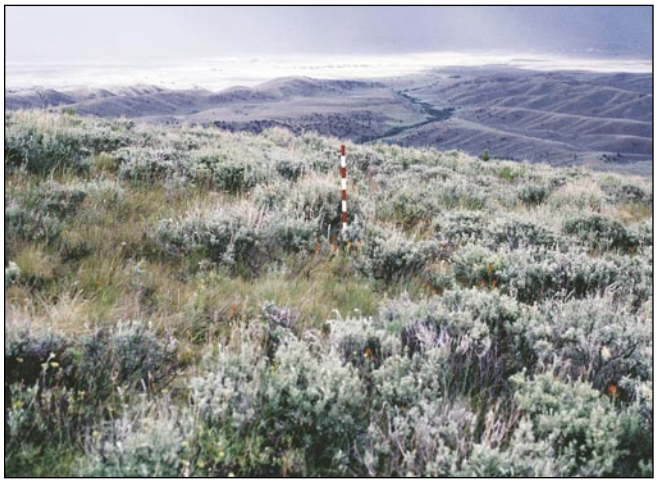
PUTR2/ERDO SD3126 N = 1

The bunchgrasses associated with bitterbrush in this community were relict owing to intense overgrazing over a long time. This community was dominated by Douglas' buckwheat and desert yellow daisy. The site had lost soil to surface erosion as attested by an erosion pavement of 65 percent. Soil depths averaged only 2.25 in. It was not possible to assign this plot to a bitterbrush plant association.

Mountain big sagebrush/Idaho fescue-prairie junegrass plant association

Artemisia tridentata var. *vaseyana/Festuca idahoensis-Koeleria cristata*

ARTRV/FEID-KOCR SD2929 N = 17



Bull Run Rock, Prairie City RD, Malheur NF.

Distribution—

Central and southern Blue Mountains.

Environmental features—

This plant association was found on basalt, andesite, rhyolite, tuff and graywacke. Elevations of sample plots ranged from 4,200 to 5,980 ft (mean 4,995 ft). Slopes were gentle to moderate (mean 16 percent). Plots occurred on all aspects; mainly on summits, shoulders, and backslopes; and primarily on convex or straight surfaces. Soils consisted of a sandy loam or silt loam surface, with increasing gravel content with depth and bedrock at a depth of more than 22 in. Available water capacity was low to moderate and pH slightly acid to neutral.

	Mean	Range
Elevation (feet)	4,995	4,200–5,980
Slope (percent)	16	1–50
Soil pH (n = 6)		6.4–7.2
Soil available water capacity (inches, n = 6)		2–7 (low to moderate)
Depth to bedrock (inches, n = 14)		22–40+
Herbage (pounds/acre, n = 12)	667	275–1,621
Aspect (number of plots)	NW (3), NE (4), SE (4), SW (6)	
Lithology	Basalt, andesite, rhyolite, tuff, graywacke	
Position	Summit, backslope, shoulder, footslope	
Slope shape	Convex, concave, straight	

Ground surface features

	Phase					
	A1 (n = 3)	A2 (n = 6)	B (n = 3)	C (n = 2)	D (n = 3)	A + B range
	Cover (%)					
Bare ground	17	15	20	5	27	3–25
Bedrock	2	0	0	0	2	0
Rock	9	1	5	8	8	0–2
Gravel	0	1	13	2	0	0–5
Pavement	2	5	0	8	3	0–20
Mosses and lichens	4	4	2	0	4	0–11
Litter	36	74	56	73	66	

Vegetation composition—

The bunchgrasses—Idaho fescue, prairie junegrass, and bluebunch wheatgrass—dominated beneath the sagebrush. Frequently associated with them were Sandberg's bluegrass and bottlebrush squirreltail. A diverse group of forbs occurred within the herbaceous layer. Prominent were yarrow, fleabanes, creamy buckwheat, tailcup lupine, and phlox. This is a highly productive community; herbage production averaged 667 lb/ac (the highest of all big sagebrush/bunchgrass plant associations), with one site producing over 1,600 lb/ac.

States and transitions—

Four phases were defined as follows:

A1 Sagebrush cover <10 percent; fescue, junegrass, and wheatgrass total cover >35 percent.

A2 Sagebrush cover >10 percent but <50 percent; fescue, junegrass, and wheatgrass total cover >35 percent; forb cover low to moderate.

B Sagebrush cover >10 percent and <50 percent; fescue, junegrass, and wheatgrass total cover 20 to 35 percent; rich in forbs (lupines, paintbrushes, balsamroot).

C Sagebrush cover dense (≥50 percent); fescue, junegrass, and wheatgrass total cover <20 percent.

D Sagebrush cover low and Idaho fescue with little or no cover, but cover by junegrass and wheatgrass is fairly high (>30 percent).

Sagebrush density increases with lack of periodic fire and overgrazing. Phase A1 represents the community where fire has reduced the sagebrush cover and stimulated bunchgrasses. Phase A2 portrays a fairly dense stand of sagebrush where lack of fire has contributed to an increase in sagebrush but moderate grazing has not reduced the bunchgrass

Principal species—

Species	Code	Phase A1 (n = 3)	A2 (n = 6)	B (n = 3)	C (n = 2)	D (n = 3)	A + B range
		Cover (%)/constancy (%)					*Cover (%)*
Shrubs:							
mountain big sagebrush	ARTRV	6/100	26/100	32/100	55/100	5/100	6–35
green rabbitbrush	CHVI8	1/100	1/67	1/33	1/50	1/67	0–2
gray horsebrush	TECA2	1/33	1/33	1/33	0	1/33	0–1
Grasses:							
bluebunch wheatgrass	AGSP	8/100	12/50	6/67	12/100	31/100	0–30
Idaho fescue	FEID	26/100	28/100	22/100	6/100	1/33	10–40
prairie junegrass	KOCR	14/100	8/100	11/100	10/100	10/100	1–20
Sandberg's bluegrass	POSA12	23/100	5/83	8/100	5/50	12/67	0–38
bottlebrush squirreltail	SIHY	1/100	9/33	1/33	1/50	2/100	0–10
needlegrasses	STIPA	1/33	2/17	0	5/50	0	0–2
Forbs:							
common yarrow	ACMIL	2/67	2/83	4/100	3/100	3/100	0–5
arrowleaf balsamroot	BASA3	0	2/17	12/67	1/100	1/33	0–15
paintbrushes	CASTI2	0	8/33	25/33	2/100	0	0–25
tapertip hawksbeard	CRAC2	1/33	1/17	1/67	1/50	0	0–1
fleabanes	ERIGE2	5/67	3/67	2/67	4/100	10/33	0–5
creamy buckwheat	ERHE2	2/100	2/100	1/67	13/100	2/100	0–5
tailcup lupine	LUCA	2/67	5/50	16/100	15/50	1/33	0–40
phloxes	PHLOX	4/67	2/67	1/33	0	0	0–6
western groundsel	SEIN2	1/33	10/17	1/67	1/50	0	0–10

cover. Phase B is forb rich from increased grazing pressures. Phase C portrays a more degraded condition where heavy grazing and fire exclusion have tipped the balance further in favor of sagebrush and have further reduced the fescue cover. Phase D is probably caused by grazing or severe fire that nearly eliminated fescue but not bluebunch wheatgrass.

Management considerations—

Mountain big sagebrush is damaged by fires of late summer when moisture is low in the soil. Cool burns when soils are moist allow some sagebrush to survive. Bunchgrasses are stimulated by light and moderate burns. Severe burns in communities with dense sagebrush can do serious damage to Idaho fescue and allow colonization of the site by more disturbance-adapted species, such as western needlegrass. Needlegrasses are also promoted by overgrazing. Forbs that increase in these communities from disturbance are yarrow, paintbrushes, tailcup lupine, and creamy buckwheat.

Relationship to other studies—

This is the first description of ARTRV/FEID-KOCR as a plant association.

Mountain big sagebrush/Idaho fescue-bluebunch wheatgrass plant association

Artemisia tridentata var. *vaseyana/Festuca idahoensis-Agropyron spicatum*

ARTRV/FEID-AGSP SD2911 N = 44

Marking Corrals Basin, Emigrant Creek RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Benchmark sites—

Duck Creek Exclosure (1950), Jake Green Exclosure (1963), and Skookum Spring Exclosure (1963)—all on Emigrant Creek RD, Malheur NF.

Environmental features—

This plant association was found on basalt, andesite, rhyolite, tuff, serpentine, and graywacke. Elevations of sample plots ranged from 4,520 to 7,650 ft (mean 5,615 ft). Slopes were gentle to steep (mean 19 percent). Plots occurred on all aspects (majority on southerly aspects); on summits, shoulders and backslopes; and on mostly convex surfaces. Soils consisted of a sandy loam or silt loam surface, with gravel content increasing with depth and extremely gravelly material at a depth of 12 to 40 in. Available water capacity was moderate and pH slightly acid to neutral.

	Mean	Range
Elevation (feet)	5,615	4,520–7,650
Slope (percent)	19	2–55
Soil pH (n = 8)		6.0–7.0
Soil available water capacity (inches, n = 8)		4–6.5 (moderate)
Depth to bedrock or extremely gravelly soil (inches, n = 20)		12–40
Herbage (pounds/acre, n = 16)	654	256–1,050
Aspect (number of plots)	NW (10), NE (6), SE (11), SW (17)	
Lithology	Basalt, rhyolite, tuff, andesite, serpentine, graywacke	
Position	Backslopes, shoulders, summits	
Slope shape	Mostly convex	

Ground surface features

	Phase							
	A1 (n = 11)	A2 (n = 1)	B (n = 12)	C1 (n = 3)	C2 (n = 13)	C3 (n = 2)	D (n = 2)	A + B range
	Cover (%)							
Bare ground	11	21	15	5	25	38	16	1–35
Bedrock	1	0	0	0	1	0	0	1–5
Rock	5	1	3	3	3	0	1	1–30
Gravel	8	37	8	8	10	34	26	1–40
Pavement	7	0	10	0	2	0	0	0–55
Mosses and lichens	1	2	1	2	1	0	0	0–5
Litter	53	19	50	53	30	5	58	

Vegetation composition—

Mountain big sagebrush forms an open shrubland with bunchgrasses dominating in the herbaceous layer. Green rabbitbrush is often associated. Idaho fescue is the most prominent bunchgrass. Usually present with it are bluebunch wheatgrass, prairie junegrass, and Sandberg's bluegrass. Forbs associated with high frequency are yarrow, creamy buckwheat, hawksbeards, fleabanes, and lupines. Herbage production is similar to the ARTRV/FEID-KOCR plant association.

States and transitions—

Seven phases were defined as follows:

A1 Sagebrush cover <20 percent; sum of fescue, wheatgrass, and junegrass cover >25 percent.

A2 Sagebrush cover <5 percent; bunchgrass cover low (postburn).

B Sagebrush cover 20 to 50 percent; sum of fescue, wheatgrass, and junegrass cover >25 percent.

C1 Sagebrush cover dense (>50 percent).

C2 Sagebrush cover moderately dense (10 to 50 percent); sum of fescue, wheatgrass, and junegrass cover <25 percent; high in forbs or bare ground.

C3 Sagebrush cover <5 percent; sum of fescue, wheatgrass, and junegrass cover <10 percent; high percentage of bare ground and gravel (60 to 80 percent) after fire in a dense sagebrush stand.

D Sagebrush cover low (<10 percent); needlegrass and creamy buckwheat dominant over the bunchgrasses (fifth year after a burn of dense sagebrush).

Sagebrush density increases with lack of periodic fire and overgrazing. Phase A1 represents the ARTRV/FEID-AGSP community where fire has periodically reduced sagebrush and favored bunchgrasses. Phase A2 portrays the first

Principal species—

Species	Code	Phase A1 (n = 11)	A2 (n = 1)	B (n = 12)	C1 (n = 3)	C2 (n = 13)	C3 (n = 2)	D (n = 2)	A + B range
		Cover (%)/constancy (%)							*Cover (%)*
Shrubs:									
mountain big sagebrush	ARTRV	7/100	1/100	29/100	63/100	25/100	0	6/100	1–50
gray rabbitbrush	CHNA2	0	0	1/25	0	3/31	0	1/50	0–1
green rabbitbrush	CHVI8	1/82	0	3/67	3/33	12/69	10/50	0	0–15
bitterbrush	PUTR2	2/45	0	2/50	0	1/15	0	0	0–10
mountain snowberry	SYOR2	1/9	0	0	0	0	1/50	2/100	0–1
Grasses:									
bluebunch wheatgrass	AGSP	18/73	5/100	11/92	7/100	7/85	5/100	6/100	0–40
mountain brome	BRCA5	2/27	5/100	0	2/100	2/15	5/50	7/100	0–5
Idaho fescue	FEID	24/100	7/100	29/100	25/100	12/96	3/100	1/100	3–60
prairie junegrass	KOCR	2/73	4/100	2/58	1/67	3/46	0	0	0–5
Sandberg's bluegrass	POSA12	8/91	4/100	10/83	5/100	9/92	6/100	1/50	0–53
bottlebrush squirreltail	SIHY	1/64	0	2/33	1/33	3/38	2/100	0	0–5
western needlegrass	STOC2	1/27	1/100	3/8	0	6/15	3/50	15/100	0–3
Forbs:									
common yarrow	ACMIL	5/91	1/100	2/92	2/67	2/85	4/100	1/100	0–30
pale agoseris	AGGL	1/18	0	0	0	1/15	1/100	1/100	0–1
pussytoes	ANTEN	6/55	2/100	1/42	1/100	1/38	0	0	0–15
arrowleaf balsamroot	BASA3	3/9	0	6/33	35/33	5/23	1/50	2/100	0–20
paintbrushes	CASTI2	3/18	1/100	1/17	10/100	10/31	1/50	1/50	0–3
narrowleaf collomia	COLI2	3/27	2/100	1/17	1/67	1/8	2/50	1/100	0–5
hawksbeards	CREPI	1/91	2/100	1/58	1/33	1/69	1/100	1/100	0–5
fleabanes	ERIGE2	3/91	3/100	2/58	0	2/69	1/100	1/100	0–5
creamy buckwheat	ERHE2	8/100	5/100	4/83	15/100	8/85	3/100	16/100	0–15
wayside gromwell	LIRU4	0	0	1/25	1/33	1/38	1/100	2/100	0–1
lupines	LUPIN	7/64	10/100	13/50	10/100	18/69	8/100	2/100	0–20
wiry knotweed	POMA9	1/18	1/100	0	0	1/8	3/100	2/100	0–1
western groundsel	SEIN2	1/27	1/100	3/58	10/33	3/62	15/50	0	0–5

year after the fire in a phase A1. Phase B portrays a moderate stand of sagebrush where lack of fire and overgrazing have contributed to an increase in sagebrush and a decline in bunchgrasses. Phase C1 portrays the community where the lack of fire and overgrazing have contributed to a dominance by sagebrush over all other plants. In phase C2, overgrazing and trampling by livestock have reduced bunchgrasses and favored forbs and bare ground. Phase C3 portrays the post-burn community (first year after the burn of a C1 community). Phase D is the same community the fifth year following the burn, after several new plants have gained dominance.

Management considerations—

Mountain big sagebrush is damaged by fires of late summer when soil moisture is low. Cool burns when soils are moist allow some sagebrush to survive. Bunchgrasses are stimulated by light and moderate burns. Severe burns in communities with dense sagebrush can do serious damage to Idaho fescue and allow colonization of the site by more disturbance-adapted species, such as western needlegrass. Sandberg's bluegrass and needlegrasses increase with overgrazing. Forbs that increase in these communities from disturbances are yarrow, paintbrushes, tailcup lupine, and creamy buckwheat.

Relationship to other studies—

Schlatterer (1972) described ARTRV/FEID and ARTRV/AGSP in south-central Idaho, Hopkins (1979b) classified a big sagebrush/bunchgrass plant association in south-central Oregon that is similar to this type, Mueggler and Stewart (1980) described ARTRV/FEID and ARTRV/AGSP habitat types in Montana, Hall (1973) incorporated ARTRV/FEID and ARTRV/AGSP in the ARTRV/bunchgrass plant community type in the Blue Mountains, Hironaka et al. (1983) described the ARTRV/FEID habitat type for southern Idaho, and Johnson and Simon (1987) classified ARTRV/FEID in northeast Oregon. Johnson and Clausnitzer (1992) described this plant association for the Blue and Ochoco Mountains.

Mountain big sagebrush/bluebunch wheatgrass-Sandberg's bluegrass plant community type

Artemisia tridentata var. *vaseyana/Agropyron spicatum-Poa sandbergii*

ARTRV/AGSP-POSA12 SD2918 N = 8

Capps Mountain, Emigrant Creek RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant community type was found on basalt, rhyolite, and tuff. Elevations of sample plots ranged from 2,730 to 5,290 ft (mean 4,564 ft). Slopes were gentle to steep (mean 17 percent). Plots mainly on southerly aspects; on summits, shoulders, and backslopes; and on mostly convex surfaces. Brief soil investigations (n = 4) suggest shallow soils, with bedrock or very gravelly material within 6 in of the surface.

	Mean	Range
Elevation (feet)	4,564	2,730–5,290
Slope (percent)	17	1–45
Herbage (pounds/acre; n = 2)	650	450–850
Aspect (number of plots)	NW (1), NE (1), SE (3), SW (3)	
Lithology	Basalt, rhyolite, tuff	
Position	Summit, shoulder, backslope, footslope	
Slope shape	Mostly convex	

Ground surface features—

	Phase	
	C1 (n = 1)	C2 (n = 7)
	Cover (%)	
Bare ground	20	25
Bedrock	0	0
Rock	0	10
Gravel	10	10
Pavement	0	4
Mosses and lichens	1	3
Litter	69	58

Vegetation composition—

Mountain big sagebrush forms an open shrubland with bunchgrasses dominating beneath in the herbaceous layer. Green and gray rabbitbrushes are often associated. Severely browsed, decadent bitterbrush was present on several plots, as were juniper seedlings. Bluebunch wheatgrass is the most prominent bunchgrass. Sandberg's bluegrass and bottlebrush squirreltail are associated. Forbs with high frequency are yarrow, creamy buckwheat, and hawksbeards. Idaho fescue is present only as an incidental species. Herbage production appears to be similar to the mountain big sagebrush/bunchgrass plant associations (mean 650 lb/ac; n = 2).

Principal species—

		Phase	
Species	Code	C1 (n = 1)	C2 (n = 7)
		Cover (%)/constancy (%)	
Shrubs:			
mountain big sagebrush	ARTRV	65/100	16/100
gray rabbitbrush	CHNA2	0	2/71
green rabbitbrush	CHVI8	1/100	5/51
bitterbrush	PUTR2	0	2/71
Grasses:			
bluebunch wheatgrass	AGSP	20/100	17/100
cheatgrass	BRTE	0	9/43
Idaho fescue	FEID	0	2/57
prairie junegrass	KOCR	0	1/43
Sandberg's bluegrass	POSA12	10/100	6/86
bottlebrush squirreltail	SIHY	0	6/43
Forbs:			
common yarrow	ACMIL	1/100	1/43
hawksbeard	CREPI	1/100	1/43
creamy buckwheat	ERHE2	1/100	2/57

States and transitions—

Two phases were defined as follows:

C1 Sagebrush cover dense (>50 percent).

C2 Sagebrush cover less dense (<50 percent); bluebunch wheatgrass cover <25 percent; bare ground >20 percent.

Phase C1 portrays the community where overgrazing and lack of fire have contributed to a dominance by sagebrush over all other plants. In phase C2, overgrazing and trampling by ungulates have probably reduced grass cover and increased bare ground, but sagebrush has not expanded into the gaps. Droughty conditions on this type may hinder sagebrush expansion. The amount of wheatgrass cover that is possible under ideal conditions on this type is not yet known. It is possible that our phase C2 may represent a

combination of site limitations (droughty soil) and only moderate degradation by grazing.

Management considerations—

Mountain big sagebrush is damaged by fires of late summer when moisture is low in the soil. Cool burns when soils are moist allow some sagebrush to survive. Bunchgrasses are stimulated by light and moderate burns. With overgrazing, Sandberg's bluegrass and needlegrasses are promoted. Forbs that increase in these communities from disturbances are yarrow, tailcup lupine, and creamy buckwheat.

Relationship to other studies—

Schlatterer (1972) described ARTRV/AGSP in south-central Idaho, Hironaka et al. (1983) described an ARTRV/AGSP habitat type for southern Idaho, Mueggler and Stewart (1980) described an ARTRV/AGSP habitat type in Montana, and Hall (1973) incorporated ARTRV/AGSP in the ARTRV/bunchgrass plant community type in the Blue Mountains. This is the first description of the ARTRV/AGSP plant community type for the Blue and Ochoco Mountains.

Mountain big sagebrush-mountain snowberry/mountain brome plant community type

Artemisia tridentata var. *vaseyana-Symphoricarpos oreophilus/Bromus carinatus*

ARTRV-SYOR2/BRCA5 SD2917 N = 1

This plant community type was found in the northern Blue Mountains at 5,000 ft elevation on Columbia River basalts. It also occurs in the northern Wallowa Mountains (Johnson and Simon 1987). Mountain snowberry dominated mountain big snowberry. The herbaceous layer was composed of forbs that had increased owing to ungulate disturbance. Creamy buckwheat, lanceleaf stonecrop, and woodrush pussytoes were the dominant forbs. The prominent grass was mountain brome. Bluebunch wheatgrass was relict. These communities are adjacent to Douglas-fir/mountain snowberry forest on canyon shoulders adjacent to Idaho fescue-bluebunch wheatgrass grasslands.

Mountain big sagebrush-mountain snowberry plant community type

Artemisia tridentata var. *vaseyana-Symphoricarpos oreophilus*

ARTRV-SYOR2 SD2919 N = 4

This plant community was found in the central and southern Blue Mountains and in the Ochoco Mountains, on granodiorite, rhyolite, volcanic sandstone, and chert. Elevations of sample plots ranged from 4,100 to 6,400 ft (mean 5,468 ft). Slopes were moderate to steep (mean 31 percent). Plots principally occurred on southerly aspects; on summits and backslopes; and on convex, straight, and undulating surfaces.

Mountain big sagebrush and mountain snowberry codominate an open shrubland. Bunchgrasses occurring with high frequency are Idaho fescue, mountain brome, bluebunch wheatgrass, and Sandberg's bluegrass. Creamy buckwheat, western hawkweed, and Indian paintbrushes are always found in the herbaceous layer. Other forbs frequently found are arrowleaf balsamroot, tailcup lupine, sticky cinquefoil, and Bolander's yampah.

Sagebrush density increases with lack of periodic fire and with overgrazing. Mountain big sagebrush is damaged by fires of late summer when moisture is low in the soil. Cool burns when soils are moist allow some sagebrush to survive. Mountain snowberry resprouts vigorously after moderate burns. Bunchgrasses are stimulated by light and moderate burns. With overgrazing, Kentucky bluegrass and bulbous bluegrass invade. Green rabbitbrush also increases following severe grazing in these communities.

Mountain big sagebrush/mountain brome plant community type

Artemisia tridentata var. *vaseyana/Bromus carinatus*

ARTRV/BRCA5 SS4914 N = 3

This plant community was found on basalts in the central and southern Blue Mountains, and in the Ochoco Mountains. Elevations of sample plots ranged from 5,090 to 6,800 ft (mean 6,130 ft). Slopes were moderate (mean 17 percent). Aspects were southwesterly. Soils were loamy to gravelly loamy material over bedrock at a depth of 1 to 2 ft and had low water-holding capacity.

Mountain big sagebrush cover averaged 42 percent. Common snowberry was usually associated. The bunchgrass associated on deep soils between the shrubs is mountain brome. Tailcup lupine, western hawkweed, and creamy buckwheat are often associated with the brome. Western needlegrass can increase with ungulate disturbance.

Hironaka et al. (1983) described an ARTRV/BRCA5 habitat type occurring between 7,000 and 9,500 ft elevation in southern Idaho.

Mountain big sagebrush-squaw apple plant community type

Artemisia tridentata var. *vaseyana/Peraphyllum ramosissimum*

ARTRV-PERA4 SD3010 N = 1

Squaw apple occurs in plant associations with ponderosa pine in the central Blue Mountains (Johnson and Clausnitzer 1992) and with mountain snowberry in the southern Wallowa Mountains (Johnson and Simon 1987). The sagebrush-squaw apple plant communities occur on the northern edge of the Great Basin at the southern extreme of the Blue Mountains. This plot is on Moffit Table at 4,500 ft elevation on Drinkwater basalt. Here mountain big sagebrush was codominant with squaw apple at 20 percent cover each. Bitterbrush was also well represented (10 percent cover). Bunchgrasses were nicely represented by Idaho fescue, bluebunch wheatgrass, bottlebrush squirreltail, and Sandberg's bluegrass. Spurred lupine was the most prominent forb.

Mountain big sagebrush/giant wildrye plant community type

Artemisia tridentata var. *vaseyana/Elymus cinereus*

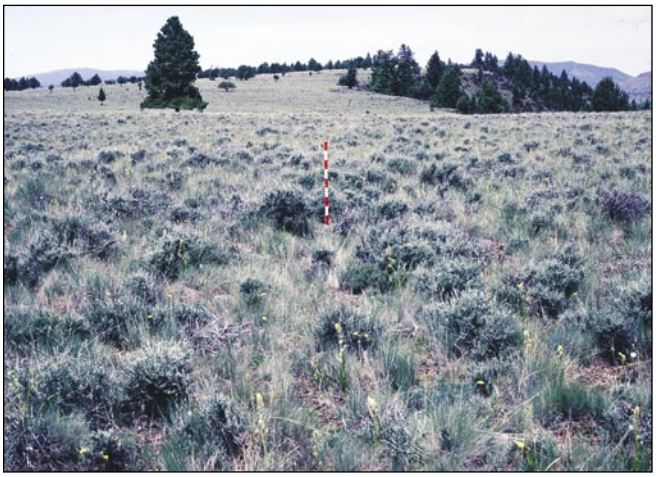
ARTRV/ELCI2 SD3011 N = 1

This plant community was found on welded tuffs in the southern Blue Mountains. Mountain big sagebrush formed an open shrubland with giant wildrye, bluebunch wheatgrass, and Sandberg's bluegrass. With severe overgrazing, these communities become weedy, with cheatgrass and western needlegrass increasing. Bluebunch wheatgrass and wildrye will both decline with overuse of these sites.

Low sagebrush/Idaho fescue-bluebunch wheatgrass plant association

Artemisia arbuscula/Idaho fescue-Agropyron spicatum

ARAR8/FEID-AGSP SD1911 N = 21



Shake Table, Blue Mountain RD, Malheur NF.

Distribution—

Central and southern Blue Mountains; Ochoco Mountains.

Benchmark site—

Shaketable (proposed research natural area), Blue Mountain Ranger District, Malheur NF.

Environmental features—

This plant association was found on basalt, andesite, rhyolite, and volcanic tuff. Elevations of sample plots ranged from 4,060 to 6,900 ft (mean 5,124 ft). Slopes were gentle (mean 5 percent). Plots occurred primarily on southerly slopes on mostly flat surfaces on summits, shoulders, and backslopes. Soils consisted of a loamy surface layer, sometimes gravelly to very gravelly, over a very to extremely gravelly clay loamy subsoil, with bedrock at 8 to 24 in. Soils are prone to perching (pooling) of excess water over the clayey subsoil in the spring, followed by depletion of soil water during the summer drought.

	Mean	Range
Elevation (feet)	5,124	4,060–6,900
Slope (percent)	5	1–15 (40)
Soil pH (n = 9)		6.2–7.6
Soil available water capacity (inches, n = 7)		1.5–4 (very low to low)
Depth to bedrock (inches, n = 16)		8–24
Herbage (pounds/acre, n = 18)	502	100–1,380
Aspect (number of plots)	NW (5), NE (5), SE (4), SW (7)	
Lithology	Basalt, andesite, rhyolite, tuff	
Position	Summit, shoulder, backslope	
Slope shape	Mostly flat, convex	

Ground surface features—

	Phase					
	A (n = 5)	B (n = 7)	C (n = 5)	D1 (n = 3)	D2 (n = 1)	A + B range
			Cover (%)			
Bare ground	9	17	35	3	1	0–25
Bedrock	5	1	1	0	0	0–20
Rock	14	4	14	23	15	0–35
Gravel	0	2	3	7	0	0–5
Pavement	9	6	4	17	0	0–25
Mosses and lichens	3	1	0	2	2	0–10
Litter	55	43	23	25	80	

Vegetation composition—

Low sagebrush shrubs occur with herbaceous vegetation dominated by bunchgrasses. Idaho fescue and Sandberg's bluegrass are always present. Other prominent grasses are bluebunch wheatgrass, prairie junegrass, and bottlebrush squirreltail. Onespike oatgrass may occur as inclusions on thinner soils within the site. Bitterbrush frequently occurs as an incidental species (<5 percent cover). Common forbs found are phlox, fleabanes, yarrow, pussytoes, and serrate balsamroot.

States and transitions—

Five phases were defined as follows:

A Idaho fescue and bluebunch wheatgrass cover total >35 percent.

B Idaho fescue and bluebunch wheatgrass cover total 25 to 35 percent; bare ground cover <30 percent.

C Idaho fescue and bluebunch wheatgrass cover total <25 percent or bare ground cover >30 percent.

D1 Idaho fescue and bluebunch wheatgrass cover total ≤5 percent; few annuals.

D2 Idaho fescue relict or absent; the annual grass *Ventenata dubia* dominates.

With overgrazing, phase A will shift toward phase B with diminished cover by Idaho fescue and bluebunch wheatgrass. As degradation of the bunchgrass community continues, phase C is reached where a high percentage of ground surface is nonvegetated. Phase D is attained when overgrazing reduces the deep-rooted bunchgrasses to a stage where restoration of Idaho fescue or bluebunch wheatgrass cannot result without intervention by managers. Idaho fescue is relict or absent in phase D2 and annuals dominate.

Management considerations—

Fires are uncommon in ARAR8/FEID-AGSP communities because of low fuel levels. Low sagebrush plants are killed or severely damaged by fire, and the plant will not

Principal species—

Species	Code	Phase A (n = 5)	Phase B (n = 7)	Phase C (n = 5)	Phase D1 (n = 3)	Phase D2 (n = 1)	A + B range
		Cover (%)/constancy (%)					*Cover (%)*
Shrubs:							
low sagebrush	ARAR8	21/100	29/100	30/100	23/100	40/100	11–50
bitterbrush	PUTR2	4/60	2/57	2/60	0	5/100	0–7
Grasses:							
bluebunch wheatgrass	AGSP	16/80	13/43	3/80	1/67	5/100	0–25
onespike oatgrass	DAUN	5/20	1/29	1/40	6/67	0	0–5
Idaho fescue	FEID	28/100	24/100	15/100	3/100	1/100	8–40
prairie junegrass	KOCR	1/60	1/43	2/60	1/33	1/100	0–2
Sandberg's bluegrass	POSA12	11/100	14/100	8/100	14/100	1/100	5–30
bottlebrush squirreltail	SIHY	1/40	2/57	4/80	1/33	0	0–1
Forbs:							
common yarrow	ACMIL	1/60	2/71	1/60	1/67	1/100	0–3
narrowleaf pussytoes	ANST2	1/20	7/14	1/40	1/33	1/100	0–7
sandworts	ARENA	1/40	4/43	1/20	1/33	0	0–10
serrate balsamroot	BASE2	2/40	1/43	1/40	1/67	0	0–2
hawksbeards	CREPI	1/40	2/14	1/20	1/33	0	0–2
fleabanes	ERIGE2	3/60	1/43	2/20	0	0	0–3
woolly goldenweed	HALA3	1/20	1/43	2/40	1/33	0	0–1
lupines	LUPIN	1/40	2/29	10/20	0	0	0–2
microseris	MICRO6	2/40	2/29	1/40	1/33	0	0–3
phloxes	PHLOX	6/80	5/43	5/80	2/67	1/100	0–10

sprout from the roots or stem base. Late summer and early fall burns may damage fescue when soils are dry. Burning at this time of the year promotes bluebunch wheatgrass and annuals. These communities are key habitats for sage grouse. Low sagebrush provides important browse for mule deer and pronghorns in spring and fall.

Relationship to other studies—

Hall (1973) described ARAR8/FEID-AGSP as a low sagebrush/bunchgrass plant community type in the Blue and Ochoco Mountains. Volland (1976) described a low sagebrush/Idaho fescue plant community type for the national forests of central and south-central Oregon; Hopkins (1979a) described a low sagebrush/Idaho fescue-bottlebrush squirreltail plant community type for the Winema NF in south-central Oregon. In Montana, Mueggler and Stewart (1980) described ARAR8/FEID and ARAR8/AGSP habitat types. Hironaka et al. (1983) classified ARAR8/FEID as a habitat type in western Idaho. Johnson and Clausnitzer (1992) described the ARAR8/FEID-AGSP plant association for the Blue and Ochoco Mountains.

Low sagebrush/bluebunch wheatgrass plant association

Artemisia arbuscula/Agropyron spicatum

ARAR8/AGSP SD1924 N = 8

Fred Hall

Near Bald Butte, Emigrant Creek RD, Malheur NF.

Distribution—

Ochoco Mountains.

Environmental features—

This plant association was found on basalt and andesite. Elevations of sample plots ranged from 4,550 to 5,200 ft (mean 4,906 ft). Slopes were gentle (mean 7 percent). Plots occurred primarily on southwesterly slopes on mostly flat surfaces on summits, shoulders, backslopes, and footslopes. Soils consisted of a loamy surface layer, sometimes gravelly to very gravelly, over an extremely gravelly clay loamy subsoil, with bedrock at 8 to 18 in. Soils are prone to perching of excess water over the clayey subsoil in the spring, followed by depletion of soil water during the summer drought.

	Mean	Range
Elevation (feet)	4,906	4,550–5,200
Slope (percent)	7	2–12
Soil pH (n = 8)		6.3–7.0
Soil available water capacity (inches, n = 8)		1–2.5 (very low to low)
Depth to bedrock (inches, n = 8)		8–18
Herbage (pounds/acre, n = 8)	423	330–520
Aspect (number of plots)	NW (0), NE (1), SE (0), SW (7)	
Lithology	Basalt, andesite	
Position	Summit, shoulder, backslope, footslope	
Slope shape	Convex, flat	

Ground surface features—

	Phase A (n = 3)	Phase B (n = 3)	Phase C (n = 2)	A + B range
		Cover (%)		
Bare ground	13	16	25	9–24
Bedrock	2	15	9	2–16
Rock	12	9	21	4–19
Gravel	0	0	0	0
Pavement	9	4	6	3–12
Mosses and lichens	6	7	14	0–11
Litter	58	49	25	

Vegetation composition—

Low sagebrush shrubs occur with herbaceous vegetation dominated by bunchgrasses. Bluebunch wheatgrass and Sandberg's bluegrass are always present. Idaho fescue is absent or incidental at low cover (<5 percent). Other common grasses are prairie junegrass, and bottlebrush squirreltail. Onespike oatgrass may occur as inclusions on thinner soils within the site. Bitterbrush frequently occurs as an incidental species (<5 percent cover). Forbs commonly found are yarrow, tapertip onion, low pussytoes, sulfurflower buckwheat, bighead clover, and lomatiums.

States and transitions—

Three phases were defined as follows:

A Bluebunch wheatgrass cover >30 percent.

B Bluebunch wheatgrass cover 15 to 30 percent; bare ground usually <20 percent.

C Bluebunch wheatgrass cover <15 percent; bare ground usually >20 percent.

With overgrazing, phase A will shift toward phase B with diminished cover by wheatgrass. As degradation continues, wheatgrass declines toward 5 percent cover with an increase in bare ground (phase C).

Management considerations—

Fires are uncommon in ARAR8/FEID-AGSP communities because of low fuel levels. Low sagebrush plants are killed or severely damaged by fire, and the plant will not sprout from the roots or stem base. These communities are key habitats for sage grouse. Low sagebrush provides important browse for mule deer and pronghorns in spring and fall.

Principal species—

Species	Code	Phase A (n = 3)	Phase B (n = 3)	Phase C (n = 2)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Shrubs:					
low sagebrush	ARAR8	20/100	23/100	18/100	5–29
bitterbrush	PUTR2	2/67	3/100	5/50	0–4
Grasses:					
bluebunch wheatgrass	AGSP	32/100	20/100	7/100	19–33
onespike oatgrass	DAUN	0	1/67	2/100	0–1
Idaho fescue	FEID	2/33	3/33	2/50	0–3
prairie junegrass	KOCR	1/100	1/67	0	0–1
Sandberg's bluegrass	POSA12	9/100	7/100	6/100	5–12
bottlebrush squirreltail	SIHY	1/33	1/100	2/100	0–2
Forbs:					
common yarrow	ACMIL	3/100	1/67	1/50	0–4
pale agoseris	AGGL	2/33	1/33	2/50	0–2
tapertip onion	ALAC4	2/67	1/100	2/50	0–2
low pussytoes	ANDI2	2/67	2/67	1/50	0–3
scabland fleabane	ERBL	1/33	1/33	1/50	0–1
Sulfur–flower buckwheat	ERUM	1/67	1/33	1/50	0–1
lomatium	LOMAT	4/100	1/33	4/100	0–7
false agoseris	MITR5	1/33	2/67	2/50	0–2
phlox	PHLOX	0	2/100	4/50	0–3
Douglas' campion	SIDO	1/67	1/33	1/50	0–1
bighead clover	TRMA3	2/67	2/67	1/50	0–4

Relationship to other studies—

In Montana, Mueggler and Stewart (1980) described an ARAR8/AGSP habitat type. Hironaka et al. (1983) described an ARAR8/AGSP habitat type in western Idaho. This is the first description of ARAR8/AGSP for the Ochoco Mountains.

Low sagebrush/Sandberg's bluegrass plant association

Artemisia arbuscula/Poa sandbergii

ARAR8/POSA12 SD9221 N = 4

Fred Hall

Aldrich Mountain, Blue Mountain RD, Malheur NF.

Distribution—

Southern Blue and Ochoco Mountains.

Environmental features—

This plant association was found on basalt and andesite. Elevations of sample plots ranged from 4,520 to 6,950 ft (mean 5,455 ft). Slopes were gentle (mean 4 percent). Plots occurred primarily on southwesterly slopes on mostly flat surfaces on summits and shoulders. Brief soil investigations (n = 3) indicate shallow soils, with bedrock at a depth of about 10 in.

	Mean	Range
Elevation (feet)	5,455	4,520–6,950
Slope (percent)	4	1–8
Herbage (pounds/acre, n = 3)	158	100–250
Aspect (number of plots)	NW (0), NE (0), SE (1), SW (3)	
Lithology	Basalt, andesite	
Position	Summit, shoulder	
Slope shape	Flat, convex	

Ground surface features—

	Phase		
	A + B (n = 3)	D (n = 1)	A + B range
	Cover (%)		
Bare ground	13	30	5–20
Bedrock	2	0	0–3
Rock	50	30	30–60
Gravel	0	0	0
Pavement	15	25	0–40
Mosses and lichens	8	2	5–15
Litter	12	10	

Vegetation composition—

Low sagebrush/Sandberg's bluegrass shrublands are rocky sites with herbaceous vegetation in low cover. Bluebunch wheatgrass and Idaho fescue may be present with incidental cover (<5 percent). Sandberg's bluegrass is always present as the dominant herbaceous plant. Other grasses commonly found are bottlebrush squirreltail and onespike oatgrass. Forbs of common occurrence are dwarf yellow fleabane, bighead clover, and sandworts.

States and transitions—

Two phases were defined as follows:

AB Sandberg's bluegrass cover >5 percent; bare ground <25 percent.

D Sandberg's bluegrass cover <5 percent; bare ground >25 percent.

With overgrazing of phase AB, Sandberg's bluegrass declines and is replaced by forbs and bare ground. As degradation continues (phase D), Sandberg's bluegrass cover declines to negligible levels such that its regeneration would be difficult, and increase in bare ground leaves the soil vulnerable to erosion.

Principal species—

Species	Code	Phase A + B (n = 3)	Phase D (n = 1)	A + B range
		Cover (%)/constancy (%)		*Cover (%)*
Shrubs:				
low sagebrush	ARAR8	12/100	3/100	5–20
Grasses:				
bluebunch wheatgrass	AGSP	2/33	1/100	0–2
onespike oatgrass	DAUN	1/33	1/100	0–1
Idaho fescue	FEID	2/67	0	0–3
Sandberg's bluegrass	POSA12	10/100	1/100	6–15
bottlebrush squirreltail	SIHYH	5/67	3/100	0–8
Forbs:				
sandworts	ARENA	2/67	1/100	0–4
dwarf yellow fleabane	ERCH4	2/67	3/100	0–3
phlox	PHLOX	2/67	1/100	0–2
bighead clover	TRMA3	2/67	0	0–2

Management considerations—

Fires rarely impact ARAR8/POSA12 communities because of the rocky site with scattered plant cover. These sites are affected most in spring when soils are saturated from snowmelt and bluegrass is heavily used by wild ungulates. Elk are key users of these sites when early spring provides only bluegrass for available forage. These communities are key habitats for sage grouse. Low sagebrush provides important browse for mule deer and pronghorns in spring and fall.

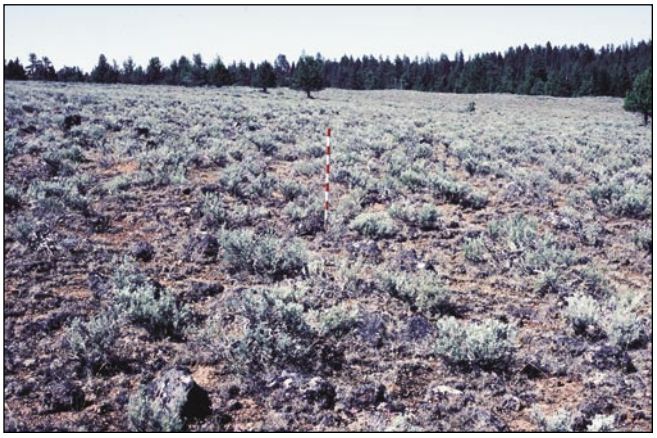
Relationship to other studies—

Hopkins (1979a) described a low sagebrush/Sandberg's bluegrass-onespike oatgrass plant community type on the Fremont NF in south-central Oregon that is esentially the same as this plant association. Hironaka et al. (1983) described ARAR8/POSA12 as a habitat type found in southern Idaho. This is the first description of ARAR8/POSA12 for the Blue and Ochoco Mountains.

Stiff sagebrush/Sandberg's bluegrass plant association

Artemisia rigida/Poa sandbergii

ARRI2/POSA12 SD9111 N = 30



Rocky Flat, Heppner RD, Umatilla NF.

Distribution—

Northern, central, and southern Blue Mountains; Ochoco Mountains.

Environmental features—

This plant association was found primarily on basalt and andesite, but also on tuff and rhyolite. Elevations of sample plots ranged from 4,000 to 5,550 ft (mean 4,729 ft). Slopes were gentle (mean 6 percent). Plots occurred on all aspects (primarily on southerly slopes) and mostly on flat surfaces of summits and shoulders. Soils consisted of a loamy surface layer a few in thick or absent, over gravelly to extremely clay loam, underlain by bedrock within 10 in of the surface. The water-holding capacity of these soils is very low.

	Mean	Range
Elevation (feet)	4,729	4,000–5,550
Slope (percent)	6	0–30
Soil pH (n = 21)		6.0–6.8
Soil available water capacity (inches, n = 19)		0.5–1.5 (very low)
Depth to bedrock (inches, n = 25)		3–9
Herbage (pounds/acre, n = 25)	176	80–303
Aspect (number of plots)	NW (4), NE (2), SE (15), SW (9)	
Lithology	Basalt, andesite, tuff, rhyolite	
Position	Summit, shoulder, backslope	
Slope shape	Flat, convex	

Ground surface features—

	Phase			
	A (n = 10)	B (n = 15)	C (n = 5)	A + B range
	Cover (%)			
Bare ground	12	19	39	0–33
Bedrock	16	5	7	0–45
Rock	22	23	20	8–50
Gravel	2	7	2	0–25
Pavement	8	16	8	0–45
Mosses and lichens	7	9	8	0–20
Litter	10	9	1	

Vegetation composition—

Stiff sagebrush/Sandberg's bluegrass shrublands occur on rocky sites where sagebrush is scattered over herbaceous vegetation at low cover levels. Sandberg's bluegrass is always present as the dominant herbaceous plant. Bluebunch wheatgrass, bottlebrush squirreltail, and onespike oatgrass are commonly found growing with the bluegrass. Idaho fescue may be present at incidental cover (<5 percent). Forbs of common occurrence are tapertip onion, yarrow, low pussytoes, false agoseris, lanceleaf stonecrop, bighead clover, phloxes, and lomatiums. Herbage productivity is lowest of any shrubland type (mean 176 lb/ac).

States and transitions—

Three phases were defined as follows:

A Sum of cover of bunchgrasses, mosses, and lichens, minus bare ground, is >10 percent.

B Sum of cover of bunchgrasses, mosses, and lichens, minus bare ground, is between 0 and 10 percent.

C Sum of cover of bunchgrasses, mosses, and lichens, minus bare ground, is <0 percent.

With overgrazing, bunchgrasses decline and soil cryptogamic crusts are destroyed, exposing bare soil. If the process progresses far enough, there will be less herbaceous vegetative cover than exposed bare soil (phase C).

Principal species—

Species	Code	Phase A (n = 10)	Phase B (n = 15)	Phase C (n = 5)	A + B range
		Cover (%)/constancy (%)			*Cover (%)*
Shrubs:					
stiff sagebrush	ARRI2	16/100	15/100	20/100	4–25
low sagebrush	ARAR8	2/20	1/13	3/20	0–4
Grasses:					
bluebunch wheatgrass	AGSP	5/40	2/33	0	0–8
onespike oatgrass	DAUN	5/50	3/73	6/60	0–10
Idaho fescue	FEID	3/30	1/33	1/20	0–4
Sandberg's bluegrass	POSA12	20/100	12/100	14/100	3–30
dwarf squirreltail	SIHYH	1/60	2/73	3/80	0–7
needlegrasses	STIPA	0	1/20	2/60	0–1
Forbs:					
common yarrow	ACMIL	1/30	1/33	2/40	0–1
tapertip onion	ALAC4	2/40	2/33	8/40	0–3
Tolm's onion	ALTO	1/10	3/27	3/40	0–6
low pussytoes	ANDI2	2/50	2/40	3/20	0–3
narrowleaf pussytoes	ANST2	1/20	0	6/40	0–1
serrate balsamroot	BASE2	4/20	2/13	2/40	0–7
Indian paintbrushes	CASTI2	2/30	2/20	1/40	0–3
fleabanes	ERIGE2	1/10	1/40	3/20	0–1
lomatiums	LOMAT	3/70	4/87	4/60	0–19
false agoseris	MITR5	2/80	2/60	1/80	0–3
phloxes	PHLOX	6/40	2/33	1/20	0–20
lanceleaf stonecrop	SELA	3/50	4/40	8/40	0–7
bighead clover	TRMA3	7/90	8/53	9/40	0–20

Management considerations—

Fires are infrequent and light in ARRI2/POSA12 communities owing to the rocky site with scattered plant cover. Deer and elk are key users of these sites in early spring when only bluegrass is available as green forage. Adverse impacts may occur at this time because soils are saturated from snowmelt: ungulate traffic results in trampling damage to the herbaceous plants and soils. Sagebrush is frequently hedged from winter use by mule deer. These communities are key habitats for sage grouse. When stiff sagebrush invades deeper soil sites, fire can be employed to eradicate it.

Relationship to other studies—

Stiff sagebrush/Sandberg's bluegrass has been described by many ecologists. Daubenmire (1942, 1970) was first to classify and describe an ARRI2/POSA12 habitat type in eastern Washington. Others that followed were Hall (1973) in the Blue Mountains, Hironaka et al. (1983) in central Idaho, Tisdale (1986) in the Snake River Canyon of central Idaho, Johnson and Simon (1987) in the Wallowa Mountains and canyons of northeastern Oregon, and Johnson and Clausnitzer (1992) in the Blue and Ochoco Mountains.

Stiff sagebrush/Gairdner's penstemon plant community type

Artemisia rigida/Penstemon gairdneri

ARRI2/PEGA SD9141 N = 2

These communities occur on basalt rock in the southern Blue Mountains at elevations ranging from 5,400 to 5,900 ft elevation. Soils are very shallow, with bedrock just a few inches below the surface. Stiff sagebrush cover ranged from 15 to 20 percent over a flat landscape where rock cover ranged from 50 to 80 percent. Bunchgrasses were scant with no cover greater than 5 percent. Sandberg's bluegrass and bottlebrush squirreltail were present. Gairdner's penstemon was the herbaceous plant with highest cover (mean 4 percent). Other forbs present were onions, scabland fleabane, sulfur-flower buckwheat, and Hood's phlox.

Threetip sagebrush/Sandberg's bluegrass-onespike oatgrass plant community type

Artemisia tripartita/Poa sandbergii-Danthonia unispicata

ARTR4/POSA12-DAUN SD2401 N = 1

This community occurs on Miller Flat in the southern Blue Mountains. It is on andesite at 5,170 ft elevation. Rock and gravel dominated the ground surface (65 percent cover), with threetip sagebrush the most dominant plant (20 percent cover). Two shallow-rooted bunchgrasses, Sandberg's bluegrass and onespike oatgrass, were the dominant herbaceous plants with a cover of 10 percent each. The only forbs with cover over 5 percent were lomatiums (*L. nudicaule* and *L. macrocarpum*). Sagebrush branches had been browsed by mule deer.

Mountain snowberry mounds plant community type

Symphoricarpus oreophilus

SYOR2 SM32 N = 1

This plant community type occurs in the northern Wallowa Mountains (Johnson and Simon 1987). It was found in the northern Blue Mountains at 4,800 ft elevation on mounds overlying Columbia River basalts. Mountain snowberry dominated over an herbaceous layer composed of forbs that had increased owing to ungulate disturbance. Creamy buckwheat formed large mats and sticky cinquefoil, slender cinquefoil, foothill daisy, and lupine were present with a "weedy" apperance. Bunchgrasses were relict. Present at low cover were mountain brome and prairie junegrass. Kentucky bluegrass had invaded. These communities are adjacent to Douglas-fir forest and intermediate to mounded/scabland sites where Idaho fescue-prairie junegrass and stiff sagebrush/Sandberg's bluegrass occur.

Creeping Oregon grape/bluebunch wheatgrass-spreading dogbane plant community type

Berberis repens/Agropyron spicatum-Apocynum androsaemifolium

BERE/AGSP-APAN2 GB4915 N = 1

This community was found on a steep (65 percent), southwest-facing slope in the southern Blue Mountains. Calcareous argillite gravels dominated the site. Plants were sparse with only those deep-rooted species capable of anchoring in a shifting talus slope. Spreading dogbane is well adapted with rhizomatous roots for shifting gravel slopes. Creeping Oregon grape stabilizes the slope. Bluebunch wheatgrass was able to sink deep roots and to establish on the xeric, hot site. The most common forb was broom buckwheat—a shifting slope dweller of reknown.

Continue to Part B