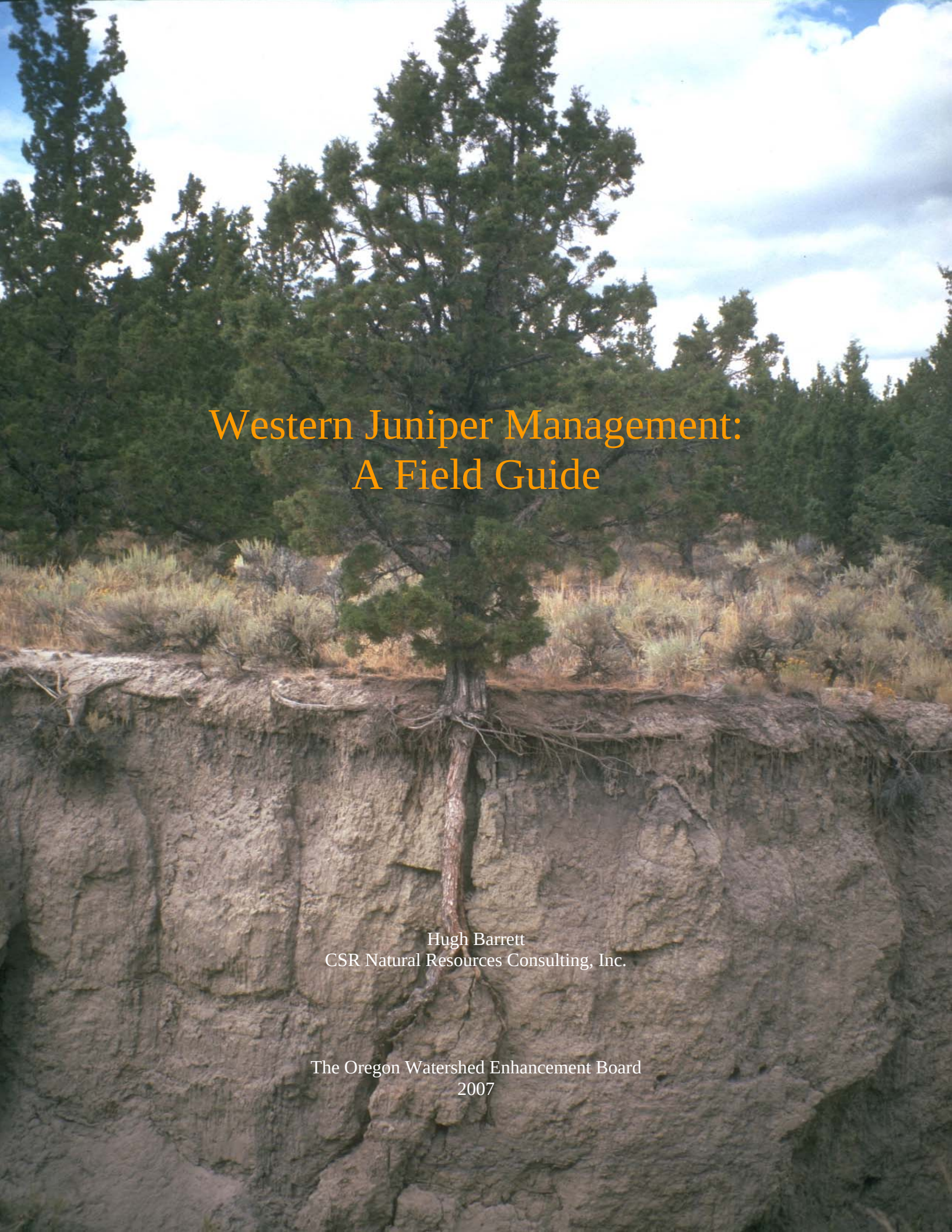

Western Juniper Management: A Field Guide

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The Oregon Watershed Enhancement Board
2007

Cover Photo:

The root system of a maturing juniper exposed by bank erosion in a deeply entrenched stream. Note the deep taproot and the extensive network of surface roots.

Sediment trapped on the up-slope side of sagebrush litter supports grass growth.

All photos provided by the author unless otherwise noted.

Acknowledgements

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Introduction and Overview

Introduction

This guide is intended for use by field staff of the Oregon Watershed Enhancement Board (OWEB), soil and water conservation districts (SWCDs), local watershed councils, state and federal agencies, landowners, and non-governmental organizations. It is meant to assist in determining the need for treatment and developing site-specific treatment alternatives for the management of western juniper (*Juniperus occidentalis)*. In addition, the guide includes suggestions for conducting pre-treatment inventories to refine project design and to lay the groundwork for monitoring the long-term effectiveness of juniper control projects. The guide focuses on the treatment of juniper that has expanded beyond its normal range in the last 130 years (the period since European settlement) and has encroached on sagebrush steppe, riparian areas, abandoned cropland, and other kinds of land.

The guide consists of five chapters and a set of appendices. Chapter 1 discusses the causes and effects of western juniper expansion in the arid environment and the methods, benefits, and cautions associated with its management. Chapter 2 offers information about organizing observations of current conditions in order to identify the need for treatment and prioritize treatment areas. As this material becomes more familiar, the user may be able to conduct a rapid reconnaissance of an area (pasture, ranch, drainage, watershed, or landscape) for treatment needs and priorities without intensive surveys.

Upon selection of a treatment site, refer to the guidance in Chapter 3 for conducting a pre-treatment inventory. The appendices provide further instruction, worksheets, and supporting information on this topic. Chapter 4 focuses the results of observation and pre-treatment inventory by examining treatment alternatives for the various site conditions. A dichotomous key presents descriptions of common site conditions, including phase of woodland succession, density of deep-rooted perennial grasses, and severity of erosion. By comparing the results of observations and the pre-treatment inventory with the descriptions in the key, the user of the guide can identify the appropriate statement and proceed to a discussion of treatment alternatives and other considerations for that particular condition to use in designing and carrying out the treatment.

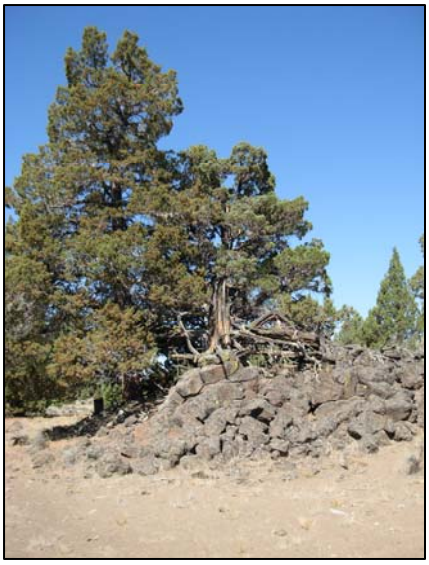
Chapter 5 discusses methods for quantitative (measured) and qualitative (observed) post-treatment effectiveness monitoring. Not all projects require follow-up monitoring, but comparing treatment results to pre-treatment levels of function and productivity is the best way to reveal the effectiveness and cost-benefit ratios of the project.

It is important to note that the level of ability and experience of every user of this guide will vary. Strict adherence to every step of this guide is not the aim; rather, the guide is

intended to help focus observations in directing treatment, to offer information about site treatment in the sustainable recovery and/or maintenance of ecological functions and processes, and to encourage the best possible level of documentation of site conditions according to the skill of the user.

Overview

Causes of Juniper Encroachment



Juniper does not tolerate fire. In the past, its distribution was limited primarily to landforms and soils that did not support fire and were isolated from historic fire return intervals. Lava blisters (top right), rimrock (center right), scree slopes, and boulder fields are typically the landforms where juniper is protected from fire. Relatively un-productive soils, like the pumice soils of central Oregon (bottom right), and the claypan soils of eastern Oregon, tend to support long-term juniper survival because of their limited production of fine fuels (typically grasses, which carry fire between trees) and ladder fuels (typically shrubs, which support flame lengths that reach into the tree canopy).

Now, however, the general reduction of fire in the landscape is allowing juniper to spread beyond its pre-European settlement extent and traditional habitats. In *The Biology, Ecology and Management of Western Juniper* (Miller et al. 2005), the authors state that western juniper woodlands now occupy about 3.7 million acres in Oregon, a ten-fold increase in the last 130 years. This expansion appears to be the result of a number of factors working in combination:

- increasingly sophisticated fire suppression;

- a period of wet, mild climatic conditions in the late 1800s and early 1900s coinciding with post-European settlement;

- the introduction of, and season-long grazing by, large numbers of domestic livestock beginning in the late 1800s. Uncontrolled livestock grazing reduced fine fuels and significantly reduced the frequency, extent and effect of naturally occurring fire; and

- increasing atmospheric carbon dioxide since the beginning of the industrial revolution.

Additionally, the cessation of aboriginal burning is considered to have had significant influence on the expansion of western juniper (Dr. Lee Eddleman, OSU Rangeland Ecologist, personal communication, 2002). Eddleman further notes the following primary mechanisms of seed dispersal supporting juniper expansion:

- Birds ingest seed, which is then dispersed throughout the environment.

- Overland flow and concentrated flow in rills, gullies, and ephemeral drainages contribute to the downslope transport of seed.

Effects of Juniper Encroachment

If allowed to encroach on sagebrush steppe communities, riparian areas, and other lands, juniper competes with native vegetation for water, space, sunlight, and available soil nutrients. Understanding the effects of juniper encroachment is an important step in the decision to take action and determine treatment objectives and methods. Effects may be biotic (i.e. biological, pertaining to plants or animals) and/or abiotic (i.e. physical, pertaining to soil, water, or air). The following abiotic and biotic effects of encroachment are significant:

- The percentage of rain and snow intercepted in the juniper canopy is equivalent to the percentage of juniper canopy cover (e.g. a juniper canopy of 20 percent equates to an interception of about 20 percent of the precipitation the site receives).

- Precipitation through-fall (i.e. water reaching the soil surface through the tree canopy) generally occurs only after rain events of 0.30 inches or more.

- Increasing juniper dominance on a site results in the die-off of shrubs and a reduction or die-off of native grasses and forbs. The ensuing loss of shrubs, grasses, and forbs reduces species richness and diversity and results in a loss of habitat value (cover, forage) for many wildlife species as well as a loss of forage for livestock.

- Increasing juniper dominance in stands of aspen (*Populus tremuloides*) and mountain mahogany (*Cercocarpus ledifolius*) often causes these important species to diminish and eventually die off.

- Reduction or die-off of vegetation in the canopy interspaces results in a loss of protective plant cover, which contributes to increased overland flow and soil erosion. According to Buckhouse and students (1980-83) and Miller et al. (2005), erosion rates can be as much as an order of magnitude higher on encroached sites than on similar sites without juniper encroachment.

- Sixty to 75 percent of annual precipitation in central and eastern Oregon occurs during the fall, winter, and spring. Through interception and the use of soil water, juniper hinders soil water moisture recharge and vegetation growth.

- Juniper is capable of using soil water during any month of the year. This characteristic is significant because native shrubs, perennial grasses, and forbs depend on soil water stored during the dormant period (fall, winter, and early spring) for initiation of growth in the spring.

- Canopy interception, diminished infiltration rates, overland flow, and increased juniper transpiration (the consumption of stored soil water) are believed, in certain soil and geologic settings, to result in a significant reduction of flows from seeps, springs, and streams.

Juniper roots fully occupy the upper horizons of this soil.

- The loss of species diversity diminishes the function of the basic ecological processes of nutrient cycling and energy flow.

- Juniper encroachment into sage grouse habitat provides perches for avian predators, often causing sage grouse to abandon the area.

Briefly stated, juniper encroachment and eventual dominance alter the hydrologic cycle, which is the ability of the soil to capture, store, and safely release water (Barrett, 1981) and alters nutrient cycling and energy flow, reducing a site's productive potential, biological diversity, wildlife habitat quality, and forage value.

Methods of Juniper Treatment

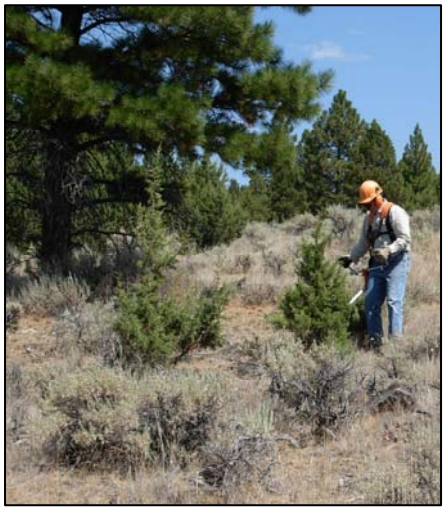
Two principal methods are commonly used to treat invasive stands of juniper: prescribed burning and mechanical treatment. Often a combination of mechanical treatment and prescribed fire most thoroughly controls juniper. Applied appropriately, these treatments promote the recovery of basic ecological functions and processes on degraded lands, or maintain those functions and processes on sites still in the early stages of encroachment. Selecting the method(s) to use in a juniper control project depends on site potential, current site conditions, treatment objectives, and other factors addressed in Chapter 4.

In addition, there are treatments that, while not directed at juniper, help to ensure a positive outcome of the initial juniper control. These include the use of herbicides to control undesirable vegetation that may be released by the treatment; seeding with grasses, forbs, and shrubs to restore site function and productivity; and the management of post-treatment grazing or other surface use.

Prescribed Burning - Fire is often used to control juniper, particularly on sites in the early and middle stages of encroachment. These are sites with adequate fine fuels and ladder fuels. Sites fully occupied by juniper are often "fire-proof" since tree spacing and the lack of fine and/or ladder fuels in the understory prevent fire spread. In this case, selective cutting of 25 to 35 percent of trees in a stand can increase ground fuels and permit fire to carry into most of the remaining juniper. Consideration of public safety, air quality, liability, erosion hazard, and site recovery is critical in designing and carrying out prescribed burning projects.

This spring burn created a patchy vegetation mosaic and set back juniper encroachment on this Phase 1 site.

Mechanical - Several mechanical methods are used to control juniper. Young, small-diameter trees can be hand-lopped or controlled with a brush-beater. Large-diameter trees are best controlled with chainsaws, dozers, feller-bunchers, pullers, mechanical shears and mulchers or other mechanical means.



The tractor mounted saw (above) can treat one to three acres per hour in this and similar juniper stands. The gas powered brush cutter (right) is effective in controlling young trees.

Chemical - Although herbicides are rarely used to control juniper, they can control aggressive, undesirable vegetation that proliferates following treatment (e.g. rabbitbrush, knapweed, cheatgrass, or medusahead). Consult with a licensed pesticide consultant before chemically treating juniper or other vegetation, and follow label instructions.

Biological - There are currently no known biological controls for juniper.

Seeding - In the later stages of juniper succession where juniper is the dominant vegetation, shrubs have usually died out, and grasses and forbs may lack the density to reoccupy the site following juniper control. If the density of deep-rooted perennial grasses is less than 2 plants per 10 square feet, plan to seed the appropriate species of grasses, forbs, and shrubs. Consult regional seeding guides or confer with a qualified rangeland management specialist or rangeland ecologist to select the appropriate native or introduced species, seed mixes,

Native seed, broadcast in the fall just prior to mechanical treatment resulted in successful seedling establishment the following year.

seeding rates, and seeding methods. When planning to seed, select plants that will sustain site functions and processes and meet land use objectives (e.g. requirements for livestock forage, wildlife habitat requirements, etc.).

Intermediate wheatgrass and dryland alfalfa were drilled after brush-beating this site.

The two methods of seeding are drilling and broadcasting. Where soil and topography permit, it is best to seed with a rangeland drill, grain drill, or Brillion seeder in order to achieve uniform seed distribution, seeding depth, and seed/soil contact (Whisenant 2001). On sites where drilling is not feasible, consider broadcasting seed before mechanical treatment or after burning. Incorporating the seed into the soil surface is essential to seeding success. The use of a spike-tooth harrow, animal hoof action, or the activities associated with mechanical control may be adequate to incorporate seed into the soil. When broadcasting seed, seeding rates should be increased by 1.5 to 2 times the recommended drilling rates.

To help ensure seeding success, the timing (season) of seeding should be based on soil texture. Where soil textures are medium (loamy) to coarse (sandy), seed in late summer or fall, allowing seeds to take full advantage of fall, winter, and spring precipitation for germination. Where soils contain high amounts clay and frost heaving is common, consider seeding in the spring after the danger of frost heaving has passed, sacrificing some moisture and time for establishment, but avoiding loss of seed to frost heaving (Dr. John Buckhouse, OSU Rangeland Hydrologist, personal communication, 2007). Keep in mind that seedings can take up to 5 years to establish, especially on dry sites. When checking for seeding success, look for root development of seeded plants as well as leaf emergence and growth.

Post-treatment Management - It is essential to carefully manage livestock grazing (through rest or deferral) or other surface uses (e.g. off-highway vehicle use) in the treated area that may negatively affect site hydrology, soil surface stability, native plant recovery, or the establishment of seeded species. Until full control of post-treatment management is ensured, do not proceed with project design or implementation.

Anticipating the Benefits of Treatment

The benefits to be expected from juniper control are proportionate to site potential, the degree of juniper encroachment, and the length of time the site has been subject to the effects of occupation. Compare the listed effects of juniper encroachment on page 2 with the following:

- Reducing the interception of precipitation can occur over varying periods of time depending on the treatment. Falling whole trees and leaving them on site may increase the interception of precipitation until leaf-fall and stem degradation occur (in about 3 years). Removing the tree boles and leaving a light to moderate scattering of branches (slash) will minimize this loss of interception. In addition, placing limbs in contact with the soil and providing retention/detention of overland flow increases the time available for infiltration to occur. Slash also moderates soil temperature and other microclimatic variables (humidity, air flow, etc.), improving conditions for seed germination and seedling establishment, and protection from grazing use.

- Reducing or removing juniper encourages establishment of seedings or the re-occupation of the site by native grasses, forbs, and shrubs where juniper competition for space, sunlight, soil water, and soil nutrients has diminished native plant community diversity, cover, density, and productivity.

- Re-occupation of the treatment area by native vegetation, or the establishment of seedings, will result in significant increases of herbaceous, deciduous, and semi-deciduous plant cover. This will reduce the amount of bare soil, increase surface litter and soil organic matter, improve infiltration of rainfall and snow-melt, reduce overland flow and soil erosion, and increase soil water retention.

- Removing the principal cause of dormant- and early-growing-season transpiration allows the soil's capacity to store water to be more fully utilized, thereby increasing the amount of soil water available to shrub and/or herbaceous plants for initiation of growth in the spring.

Right: Flows increased significantly at this spring after the upper watershed was treated.

- Re-occupation of the site by diverse and productive native plant communities will restore habitat values for many wildlife species and increase forage available for livestock grazing. Carefully designed seedings of introduced species can have similar beneficial effects.

The effects of juniper encroachment (left) become apparent when viewed in comparison with an adjacent, treated site at right (on same soil, aspect, slope and precipitation).

In summary, increasing the opportunity for precipitation to reach the soil surface and taking steps to protect the soil surface and detain overland flow can be expected to improve infiltration rates over time. Increased infiltration improves opportunities for the soil to meet its water holding capacity. When precipitation exceeds the soil's water holding capacity, surplus water may flow laterally beneath the soil surface, which can increase flows from seeps, springs, and streams or it may percolate into fractured bedrock, recharging groundwater. Removal of the principal cause of winter and early growing season transpiration and canopy interception of precipitation can increase soil water availability for native or seeded species when growth initiates in the spring.

The recovery of hydrologic function in the treatment area sets the stage for the recovery of other important ecological processes and a number of environmental and economic values such as watershed health, wildlife habitat, and livestock forage production.

Cautions

Do not proceed with the project application or project design without assurance that post-treatment management of livestock or similar use or disturbance will be carried out in a manner that promotes soil, hydrologic, and plant community recovery objectives. For example, livestock grazing management after treatment may entail temporary livestock exclusion (rest) or deferment, which may require temporary or permanent fencing and the identification of alternative feed sources. A grazing plan designed to promote plant community recovery or seeding establishment is essential.

When deciding on a treatment, the first consideration is human safety. On steep slopes, juniper tends to roll downhill when felled with chainsaws or other mechanical cutting devices. Since this and other possibilities can have potentially fatal consequences, tree fallers should be experienced, safety-conscious and should not work alone.

Private landowners intending to use fire for these purposes should be made aware of the importance of a sound burning prescription and of safety and liability issues. Bureau of Land Management, U.S. Forest Service, Oregon Department of Forestry, and Natural Resources Conservation Service (NRCS) personnel can often help prepare a prescribed burning plan and may assist in carrying out the burn as part of a larger project that includes adjacent public or state lands.

Problem plants occurring in significant amounts on the site before treatment will take advantage of the water, nutrients, space, and sunlight made available by the treatment. Aggressive annual grasses like cheatgrass (*Bromus tectorum*) and medusahead (*Teniantherum asperum*) may fully occupy the site following treatment and compete with desirable vegetation (i.e., vegetation that is part of the treatment objective). This is especially true when fire is used in the initial set of treatments in the mesic soil temperature regime (see local Soil Survey Report). Rabbitbrush (*Chrysothamnus spp.*), a native shrub is resistant to both fire and mechanical treatment and may also be released by these treatments and dominate the site. Check with a licensed pesticide consultant or a qualified rangeland management specialist to determine appropriate control measures. Contact local county weed offices or OSU Extension Service for information on local weeds and their control.

Do not attempt to predict changes in surface water yield (seep, spring, and stream flow) that may result from the treatment. Soil conditions and surface and bedrock geology vary too much to allow reliable forecasts of treatment effects. The project should be able to stand alone on the sustainable recovery and/or maintenance of basic ecological functions and processes and their associated environmental and economic benefits.

Retain old-growth juniper trees. Old-growth trees provide habitats for tree- and cavity-nesting birds, and they are prized for their aesthetic and historic value. Usually, they occur on the landforms and soils described earlier, where fire occurrence is rare. Occasionally, however, old-growth trees are found where they have escaped damage from historic and recent fires. Check the potential treatment site for the presence of old-

growth trees, basing the determination of "old-growth" on the following criteria listed in Miller et al. (2005): asymmetrical and rounded tops, spreading and sparse canopies, dead limbs and/or spiked tops, deeply furrowed reddish bark, and the presence of bright green arboreal lichens on the stem and branches. Trunk diameter does not necessarily indicate tree age; younger trees may have the stature and some features of old-growth trees but lack other characteristics.

This old-growth juniper (left) has escaped fire for centuries on the shallow soil of this ridgetop in central Oregon. The old-growth juniper (right) in the background stands in contrast to the younger teardrop-shaped tree on the right.

Juniper management is not juniper eradication. The number of trees left standing on site should be a function of: 1) the number of old-growth trees occurring on site; and 2) treatment objectives of site function (e.g. hydrology, soil stability, nutrient cycling, and energy flow), biological diversity, wildlife requirements, and landowner needs.

Chapter 2
Determining the Need for Treatment

Woodland Succession of Juniper

The full gradient of juniper encroachment extends from the period of seed introduction and germination, through stand maturation, to the full occupation of a site by juniper trees. The following phases of woodland succession described in Miller et al. (2005) serve as useful benchmarks along this gradient.

Phase I. This early stage of juniper encroachment involves an actively-expanding, open canopy of young trees (usually 40 years old or younger), exhibiting no die-off of lower limbs. The trees are a subordinate component of the plant community. Active recruitment is taking place (tree seedlings in the shrub layer). Grasses, forbs, and shrubs are able to express their full productive potential, apparently uninhibited by competition from juniper. In this stage, little or no observable change in plant community composition or in soil cover and overland flow can be attributed to juniper. Sometimes, however, excessive shrub canopy closure or heavy, long-term grazing use causes perennial grasses and forbs to be sparse or absent. In this phase, a number of treatment options are available for preventing further site degradation. See Chapter 4.

Phase I of Woodland Succession

Phase II. This mid-successional stage of juniper encroachment also entails an actively expanding canopy of trees now co-dominant in the plant community. In this phase, the maturing juniper may produce berries at moderate to high levels. Depending on several site factors including slope, soil depth, soil texture, and available water capacity of the soil profile, shrubs may die off as the network of shallow juniper roots begins to extend its occupation of the upper soil profile. On moisture-limited sites (those with shallow soils) or on steep slopes with high rates of overland flow (low infiltration rates), shrubs may exhibit stress or die-off as a result of competition. Moderately deep and deep soil

sites may retain their shrub, grass, and forb components and exhibit few biotic or abiotic effects. As the site progresses into the later stages of Phase II, shrubs may die off on shallow and moderately deep soils while grasses persist. In the mid to late-stage of succession, fewer treatment options will be effective in preventing further site degradation. Late Phase II and early Phase III constitute the period of transition when biotic and, in many cases, abiotic conditions worsen and the focus of treatment options changes from prevention to restoration or repair.

Phase II of Woodland Succession. Note shrub die-off.

Phase III. At this stage, occupation of the site by juniper is complete, and juniper and its effects dominate the site (above right). Full grow-out of the surface root network concludes; the tree's leader growth has slowed; berry production has declined and tree recruitment is limited. Biotic and abiotic conditions on the site are visibly degraded. Shrub die-off will likely exceed 75 percent. Understory plant production declines, as do species richness and diversity (lower right). In the tree interspaces, the loss of understory plant cover exposes bare soil, particularly on drier, harsher sites and those with an effective rooting depth of less than 20 inches. Soil organic matter declines, and raindrop impact promotes physical crusting of the soil surface, reducing infiltration rates and, on sloping sites, overland flow and soil erosion increase. Grasses like Idaho fescue (*Festuca idahoensis*), squirreltail (*Sitanion hystrix* syn. *Elymus elymoidies*), bluebunch wheatgrass (*Agropyron spicatum* syn. *Pseudorogneria spicata*), Thurber

needlegrass (*Stipa thurberiana* syn. *Achantherum thurberianum*), and others may persist on moderately deep and deep soils, especially on east- and north-facing slopes or high-elevation terraces and sites with higher precipitation (average annual precipitation over 14 inches). On slopes with southern and western exposures (harsh sites) throughout the range of juniper, the loss of understory vegetation is often most pronounced. Note, however, that under certain soil and site conditions, Idaho fescue may persist and in some cases increase in the northeast quadrant of the canopy of individual trees on some otherwise-harsh sites at mid-elevation. This phenomenon is believed to be a response by Idaho fescue to a favorable microclimate created in the shade cast by the tree.

Identifying the stand's current phase of woodland succession is an important step in making the decision to apply control measures and/or to identify high-priority areas for treatment when several opportunities exist.

Additional Factors to Consider: Physical and Biological Function

Combining observations of woodland succession with observations and measurements of specific abiotic and biotic factors of site function can provide the detail necessary to establish the need for treatment, to prioritize areas for treatment, and to select the appropriate treatment method(s) (U.S. Dept. of Interior 2005). These indicators include the following:

Hydrologic function - When functioning properly, the soil is able to capture most of the precipitation where it falls, to store water in the soil profile for growth of desirable vegetation without excessive loss to plant transpiration or evaporation, and to safely release that moisture in support of the vegetation. Where surplus water is available, it may recharge groundwater and/or provide additional water by lateral flow to meadows, seeps, springs, or streams. Conditions that contribute to impaired hydrologic function include the following:

1. Interception: In general, the percentage of juniper canopy cover equates to the percentage of precipitation intercepted by the trees (in storm events of less than 0.30 inches) and lost by the site through evaporation or sublimation. For example, in the 14 inch average annual rainfall zone, a 20 percent canopy cover of juniper can result in a loss to the site of 2.5 to 3 inches of precipitation annually, reducing the effective average annual precipitation of the site to less than 12 inches. Increasing juniper dominance is believed to accelerate the loss of stored soil water through untimely and excessive transpiration. Indicators of interception include shrub and forb die-off, reduced understory production, and increased bare soil.

2. Loss of infiltration: Shrub, forb, and grass cover declines with increasing juniper stand maturity and canopy closure. This situation is most apparent on shallow soils and on the harsher south- and west-facing slopes. The loss of plant cover, most pronounced in the canopy interspaces, exposes the soil

surface to increased solar radiation and the oxidation of soil organic matter. These conditions, combined with the effects of raindrop impact and the subsequent crusting of the soil surface, result in the loss of infiltration, the soil's ability to capture the precipitation it receives. The loss of the insulating properties of soil surface organic matter and plant cover may heighten the frequency and severity of frozen soil ("concrete" vs "open lattice") conditions, further reducing infiltration of winter rain or water from rain-on-snow events. Indicators of impaired infiltration include physical soil crusting, evidence of active overland flow (flow paths, debris dams, sediment deposition, and rills and gullies), evidence of shrub and forb die-off, and reduced understory productivity.

3. Overland flow and soil erosion: Unless the site is level or is in a position to receive and collect flow from adjacent sites, the loss of infiltration causes water to accumulate at the soil surface, increasing the potential for overland flow events and further loss of water from the site (see Interception, above). Along with soil particle displacement caused by raindrop impact on bare soil, overland flow can cause additional soil displacement and soil transport (erosion), thereby reducing the site's productive potential. Indications of overland flow and active erosion include pedestaled plants, lichen lines on rocks, active flow paths, debris (plant litter) dams with soil deposition, and rills and gullies.

Energy flow - Plants convert solar energy to chemical energy through photosynthesis and pass it through the food chain (via herbivores, carnivores, insects, and other organisms) until it is eventually dispersed through the environment in respiration and decomposition. Indications of optimum energy flow may include diverse and productive plant communities, wildlife populations, insect populations, and sustainable livestock enterprises. The most observable indicators of impaired energy flow include the following:

1. Loss of plant diversity: The plant community loses diversity, yielding to the dominance of vegetation that offers limited or minimal forage to herbivores (mammals, birds, and insects). An example is the conversion from a diverse sagebrush/bitterbrush, grass, and forb community to one dominated by juniper.

2. Long-term sequestration of chemical energy: Rather than progressing through the food chain via edible vegetation, chemical energy is retained in juniper wood, leaves and duff.

Nutrient cycling - Nutrient cycling involves the movement of essential elements and inorganic compounds between the reservoir pool (the soil) and the cycling pool (organisms) in an exchange between organisms and their immediate environment. Indicators of dysfunction in nutrient cycling include the following:

1. Loss of plant diversity: Limited diversity in plant community composition and in functional plant groups prevents full root occupancy of the soil profile. This condition reduces the uptake and surface availability of essential elements and inorganic compounds.

2. Change in surface litter: Plant litter and litter distribution change from mostly herbaceous and deciduous material distributed across the site to juniper duff concentrated beneath the trees. Slower litter decomposition in woodlands reduces nutrient availability.

3. Soil erosion: Erosion degrades and can remove the soil surface horizons along with its constituent organic matter, soil microbes, essential elements, and inorganic compounds.

4. Long-term sequestration of nutrients: The dominant vegetation—in this case, juniper—sequesters essential elements and inorganic compounds in the long term (see Energy Flow, above).

5. Loss of plant and animal productivity.

Habitats - The degree of function in the ecological processes described above (hydrologic function, energy flow, and nutrient cycling) determines the quality of habitats available to wildlife (as well as substrate for insects and media for soil organisms). When functioning properly, these processes usually support diverse and productive habitats. Indicators of a loss of habitat quality include loss of plant diversity and declining wildlife populations. Consider consulting with Oregon Department of Fish and Wildlife or U.S. Fish and Wildlife Service for assistance in determining wildlife habitat requirements.

Water features - Assuming climate, soil, and geologic conditions are suitable, a fully-functioning hydrologic cycle supports seep, spring, and stream flow and influences the quality, quantity, timing, and duration of those flows. Increasing juniper dominance may result in a loss of flow from these sources. Personal observations and interviews with landowners may identify if and where the potential for recovery of seep, spring, and stream flows exit.

In summary, identifying the need for, and prioritizing, juniper treatment should be based on sound and realistic objectives. For the project to be sustainable, its objective must be based on the maintenance or recovery of basic ecological functions, promoting site resilience and self-repair (Whisenant 2001).

Chapter 3
Pre-Treatment Inventory

Purpose of a Pre-Treatment Inventory

After identifying the treatment site, it is essential to conduct a pre-treatment inventory of the site. This inventory has the following objectives: 1) to determine the method(s) of juniper treatment most likely to succeed; 2) to identify additional treatments necessary for site recovery (e.g. seeding or weed control); 3) to establish post-treatment management requirements (e.g. grazing management, prescribed burning, fencing, or water development); and 4) to establish a baseline for monitoring change resulting from the treatment.

Components of a Pre-Treatment Inventory

At a minimum, the pre-treatment inventory should include information necessary for treatment design and long-term monitoring. (See Appendices 4 and 5 for the suggested photo point and inventory format.) Document the results of the inventory in this format and keep them in the project file. The results of the inventory should be used in selecting the appropriate treatments (see Chapter 4) and will provide baseline information for use in project effectiveness monitoring (see Chapter 5).

1. Identify the phase(s) of woodland succession in the treatment area. Using the guidance in Miller et al. (2005), listed in Chapter 2, determine the phase of woodland succession, identify where along the gradient of succession the site occurs. Do not limit your observations to tree density or tree size alone. To determine the stage of woodland succession, look for effects of juniper encroachment as well. These effects may be biotic (e.g. stressed or dying shrubs) or abiotic (e.g. bare soil).

2. Determine the ecological potential of the site(s) or plant association(s) in the treatment area. Consult with Natural Resources Conservation Service (NRCS) staff and/or obtain the applicable Soil Survey Report or NRCS Ecological Site Descriptions (ESD), NRCS (1990), for the area characteristics (such as climate, slope, and aspect) correlating to the soils. These sources contain the most specific information available for determining the potential vegetation for a treatment area. Keep in mind that erosion of the soil surface over time may have altered the site's potential to support the kinds, amounts, and proportions of plants described in the Soil Survey Report or ESD. Alternatively: 1) identify the existing shrub, grass, and forb species on the site that may be released by the treatment, 2) if available, observe the native vegetation on an adjacent treated or un-encroached area on the same or similar soil type (depth, texture, slope, and aspect) and/or 3) consult with a qualified rangeland ecologist, soil scientist, or rangeland management specialist for assistance in determining site potential.

3. Determine slope, soil depth, soil texture, and sub-surface soil restrictions. Identify surface and subsurface soil textures in relative terms such as coarse, medium, or fine textured, or by soil textural class (e.g. fine sandy loam, clay, etc.). Note subsurface restrictions to soil permeability or root growth (e.g. compaction or caliche layers, claypan, etc.) in the soil profile. Consider slope and soil texture in determining overland flow potential and erosion hazard.

4. Determine existing vegetation on the site. Identify the native trees, shrubs, grasses, forbs and seeded species (e.g. crested wheatgrass or Sherman big bluegrass etc.) on the site and record species composition by percent cover or relative abundance. In the same way, identify current and potential problem species on the site (e.g. knapweed, cheatgrass, medusahead, or rabbitbrush) that may increase following the treatment. See Appendix 5 for a suggested method for determining plant community cover.

5. Determine the density of deep-rooted perennial grasses on the site. In order to decide if seeding is necessary, measure or estimate the density (plants/sq. ft) of deep-rooted perennial grasses on the site. On harsh, low-precipitation Phase III sites, these measurements should be limited to the open interspaces of the tree canopy. Among the grasses to consider in this determination are the following: squirreltail (*Sitanion hystrix*), Thurber needlegrass (*Stipa thurberiana*), bluebunch wheatgrass (*Agropyron spicatum*), Idaho fescue (*Festuca idahoensis*), western wheatgrass (*Agropyron smithii*), prairie junegrass (*Koleria cristata*), and basin wildrye (*Elymus cinerius*). Do not consider Sandberg bluegrass (*Poa secunda*), a shallow-rooted perennial grass, in this determination (see Plant Guides, Appendix 6).

6. Observe soil surface conditions. Look for the following evidence of diminished infiltration rates: bare soil, physical crusting of the soil surface (capping), active flow paths, debris dams and sediment deposition, lichen lines, pedestaled plants, and active rill and/or gully erosion. See Herrick et al. 2005.

7. Identify existing and historic water features and meadows. Identify existing seeps, springs, streams (including perennial, intermittent, and ephemeral channels), and meadows within the treatment area or its zone of influence (e.g. downslope). If flow rates of these features are available, record them. Historic water features may be indicated on topographic maps or could be identified by the landowner and should be recorded on the treatment plan map. Remnant individuals of phreatophytic and hydrophytic (water-loving) plant communities like willow (*Salix spp.*), cattail (*Typha latifolia*), and Baltic rush (*Juncus balticus*) may also indicate historic water features and should be identified and recorded. Soil features including an organic (histic) soil surface, organic staining, evidence of iron oxidation, gleying, or mottling in the subsoil may also indicate historic water features.

8. Establish a photo point. Select a representative area within the treatment site to initiate the photographic record. Ideally, a photo point should be located in the vicinity of the measurement or observation of the plant community, tree density, and soil and site conditions in the planned treatment area. Wherever possible, include reference landmarks or permanent features (mountain peaks, rock outcrops, etc.) in the photographs. Record the location of the of the photo point on a topographic map, by legal description or GPS coordinates. See Appendix 4 (Herrick 2005) for a suggested method of establishing photo points.

Equipment needed:

Project folder or copies of project application
Topographic map
Shovel
GPS
Compass
Camera
Photo point ID card (see Appendix 4)
Clipboard, paper, pencil
Pre-treatment evaluation form (see Appendix 1)
100-foot tape
Line-intercept form (see Appendix 5)
Steel pin or welding rod
10 square foot hoop or frame
Plant guides

Chapter 4
Selecting Treatment Methods

The decision to treat juniper implies that long-term, site-specific, or landscape-scale objectives are established. Primary objectives might include maintaining or improving watershed health, increasing livestock forage production, restoring wildlife habitat, or harvesting wood for power generation or wood products. Whatever the case, the sustainable recovery and/or maintenance of the basic ecological functions and processes of the site (hydrologic function, nutrient cycling, and energy flow) should form the basis of any treatment or action.

A thoughtfully developed objective includes a vision of the treatment outcome. The objective should provide a description of the restored or recovering site; its degree of function; the short-, mid-, and long-term composition of the plant and animal communities that will occupy the site; and the expected site uses. Once identified, the specific elements of the objective will be of further help in selecting the method(s) of treatment needed to reach those defined conditions. Clearly describing the project objective will help refine specific treatment decisions.

General Key to Site Conditions for Determining Treatment Methods

Using the Key:
The following key enumerates common site conditions in the range of juniper in central and eastern Oregon. The first step in using the key is to determine the phase(s) of woodland succession in the area being considered for treatment. Proceed to the relevant section of the key and compare the results of observation and inventory with the descriptions of existing understory plant community composition and productivity and the density of deep-rooted perennial grasses. Within the appropriate section, identify the degree of active erosion on site. Finally, turn to the corresponding discussion on the pages immediately following the key.

Woodland succession in Phase I

All expected functional plant groups[1] represented; annual herbage production within, to somewhat below, normal range; density of deep-rooted perennial grasses greater than 2 plants per 10 square feet……...……1

Little to no evidence of overland flow and soil loss….....1a

Evidence of overland flow common; active rills and/or gullies present to common…...……..……1b

Shrubs dominate the site; density of deep-rooted perennial grasses less than 2 plants per 10 square feet……2

Little to no evidence of overland flow and soil loss……..2a

Evidence of overland flow common; active rills and/or gullies present to common..……...……2b

Woodland succession in Phase II or III

All expected functional plant groups represented; annual herbage production within normal range to significantly reduced; density of deep-rooted perennial grasses greater than 2 plants per 10 square feet...…...…….3

Little to no evidence of overland flow and soil loss…….…….3a

[1]Groupings of plants similar in growth form, structure, life cycle, etc. (e.g., deep-rooted perennial grasses, shallow-rooted perennial grasses, annual grasses, forbs, leguminous forbs, shrubs, trees). Expected functional plant groups are those described as part of a potential plant community in NRCS Ecological Site Descriptions. Other sources may include the local Soil Survey Report or Plant Association Guides for the area. Consult a qualified rangeland management specialist or rangeland ecologist for site-specific assistance.

Evidence of overland flow common; bare soil common; active rills and/or gullies present to common...…….…… 3b

Expected functional plant groups significantly diminished or absent

Skeletal remains of shrubs common; deep-rooted perennial grasses are the dominant understory vegetation beneath trees and in the canopy interspaces; density of deep-rooted perennial grasses greater than 2 plants per 10 square feet……...……..….4

Little to no evidence of overland flow and soil loss…….…..…4a

Evidence of overland flow common; bare soil common; active rills and/or gullies present to common...…….……4b

Skeletal remains of shrubs common; deep-rooted perennial grasses, if present, restricted to within the drip line of the trees or the canopy of shrubs; canopy interspaces bare or nearly so; density of deep-rooted perennial grasses less than 2 plants per 10 square feet...……..5

Little to no evidence of overland flow and soil loss……..……5a

Evidence of overland flow common; bare soil common; active rills and/or gullies present to common…...…….……5b

Discussion of Conditions and Treatment Alternatives

1. Woodland succession in Phase I; all expected functional plant groups represented; annual herbage production within, to somewhat below, normal range; density of deep-rooted perennial grasses greater than 2 plants per 10 square feet.

1a. Little to no evidence of overland flow and soil loss.

Treatment of a site in this stage of encroachment aims to prevent further site deterioration. It is the stage in which the greatest number of treatment options are available. Seeding should not be necessary.

Prescribed Burning

In most cases, adequate fine fuels and ladder fuels exist on site to carry fire among the trees and into the tree canopy. If livestock graze the site, consider withholding grazing during the year preceding the planned burning to allow the accumulation of fine fuels. Unless conditions are excessively dry, spring or winter burning can be expected to result in a patchy or mosaic burn. This type of burn will conserve the shrub component of the plant community but does not fully control the juniper on site.

Summer and fall burning (dry season) will remove all or most above-ground biomass in the treatment area. While this method is very effective in eliminating juniper from the site, it also removes the protection of plant cover and plant litter. This method dramatically increases the risk of overland flow and soil erosion during the following fall and winter, especially on slopes where soils exhibit low infiltration rates (e.g. clay or clay loam) or are prone to erosion (e.g. fine sandy loam, sandy loam, or loam).

In most cases, perennial grasses respond to the fire with increased production and density. Burning often produces a flush of forbs as well. Since most desirable shrubs (e.g. antelope bitterbrush and sagebrush) do not tolerate fire, the treatment will remove them. Depending on the site potential and seed source, it may take 15 years or longer for them to return to a level of co-dominance in the plant community. While burning creates habitat values for some wildlife species, it reduces them for other species, at least temporarily.

Using fire creates a risk of promoting an increase in undesirable plants. With the increase in available nutrients, water, and sunlight, annual grasses like cheatgrass and medusahead may proliferate, impeding the germination and establishment of deep-rooted perennial grasses. Cheatgrass may die off naturally as nutrients become scarce and existing perennial grasses recover, but medusahead may require early chemical treatment. Rabbitbrush (gray and green) responds aggressively after fire and, if widespread, may require chemical treatment.

To promote recovery of perennial grasses following burning, livestock grazing should be deferred during at least the first growing season after burning. Under certain circumstances, early spring grazing to control cheatgrass should be considered.

Mechanical Treatment

With any mechanical treatment, all green juniper leaf material must be removed; otherwise, rapid regrowth will occur. Several mechanical treatment methods can be used on this site. Individual trees can be removed with chainsaws, hand loppers (on trees with small diameters), or specialized machine-grubbers and shears or pullers. Another option, brush-beating, depends on the size of the main stem and machinery's capability. These methods can effectively carry out broad-scale treatment as long as all green leaf material is removed. Like fire, a brush beater will remove most desirable shrubs, and may invigorate shrubs like rabbitbrush. However, the thoughtful use of a brush beater may create a mosaic effect on the site that promotes site and landscape complexity.

Slope and surface stones limit the areas where brush-beating can be used. This method is best suited to level and moderately sloping areas, often on moderately deep and deep soils with few surface stones.

Unlike fire, mechanical treatments will miss many small juniper seedlings. Anticipate the need for additional treatment, or prescribed burning as a follow-up treatment, 10 to 15 years after the initial treatment if juniper is re-occupying the site.

1b. Evidence of overland flow common; active rills and/or gullies sometimes present.

This condition occurs on slopes and soils at risk for erosion. The current plant community production or composition may indicate the effects of improper grazing use or other surface disturbance. Soils may be shallow, contain a restrictive layer in the upper soil profile, and/or have erodible surface textures. Treatment of a site in this stage of encroachment should address the recovery of hydrologic function and consider overland flow originating on-site or upslope. Evidence of overland flow and active erosion indicate that burning may exacerbate this condition.

Prescribed Burning

Burning is not recommended on this site due to increased erosion hazard caused by the removal of existing plant cover and plant litter.

Mechanical Treatment

With any mechanical treatment, all green juniper leaf material must be removed; otherwise, rapid regrowth will occur. Several mechanical treatment methods can be used on this site. Individual trees can be removed with chainsaws, hand loppers (on trees with small diameters), or specialized machine-grubbers and shears or pullers. Another option, brush-beating, depends on the size of the main stem and machinery's capability. These methods can effectively carry out broad-scale treatment as long as all green leaf material is removed. Like fire, a brush beater will remove most

desirable shrubs, and it may invigorate shrubs like rabbitbrush. However, the thoughtful use of a brush beater may create a mosaic effect on the site that promotes site and landscape complexity.

Slope and surface stones limit the areas where brush-beating can be used. This method is best suited to level and moderately sloping areas, often on moderately deep and deep soils with few, if any, large surface stones.

Unlike fire, mechanical treatments will miss many small juniper seedlings. Anticipate the need for additional treatment, or prescribed burning as a follow-up treatment, 10 to 15 years after the initial treatment if juniper is re-occupying the site.

Brush-beating will result in the deposition of a large amount of woody and herbaceous plant material on the soil surface which will detain overland flow, trap sediment, and increase the time available for the infiltration of water. This method should correct overland flow and erosion problems in all but the most severe cases of gully erosion. Placing cut trees in gullies may trap sediment and prevent further down-cutting.

2. Woodland succession in Phase I; shrubs dominate the site; density of deep-rooted perennial grasses less than 2 plants per 10 square feet.

2a. Little to no evidence of overland flow or soil loss.

This condition commonly occurs on abandoned cropland where long-term tillage has removed native grasses and forbs and the soil's seed reservoir, and sagebrush and/or rabbitbrush have re-occupied the site. Sandberg bluegrass (*Poa secunda*) may be common. Where grazing has resulted in this condition, deep-rooted perennial grasses, bluebunch wheatgrass (*Agropyron spicatum*), or similar species will usually be found growing within the protection of remaining shrub canopy. Exotic annual grasses (e.g. cheatgrass or medusahead) and other weedy species (e.g. knapweed) may be abundant. Seeding that incorporates methods of competitive vegetation control is essential.

Prescribed Burning

If fine fuels and/or shrub spacing can adequately carry fire among the shrubs and trees, prescribed burning may be appropriate. This site is highly susceptible to the invasion or increase of annual grasses and other weedy species. It is essential to seed this site in order to control weeds and prevent erosion. After burning, drill seed with a rangeland-drill or, conditions allowing, with a grain drill or Brillion seeder. Broadcasting seed into cooled, un-crusted ash as soon as possible (within 1 to 2 weeks) may also be effective. Consider herbicide use if rabbit brush responds aggressively to burning.

Mechanical Treatment

With any mechanical treatment, all green juniper leaf material must be removed; otherwise, rapid regrowth will occur. Several mechanical treatment methods can be used on this site. Individual trees can be removed with chain saws, hand loppers (on trees with small diameters) or specialized machine-grubbers and shears or pullers. Another option, brush-beating, depends on the size of the main stem and the machinery's capability. These methods can effectively carry out broad-scale treatment as long as all green leaf material is removed. Like fire, a brush beater will remove most desirable shrubs, and it may invigorate shrubs like rabbitbrush. However, the thoughtful use of a brush beater may create a mosaic effect on the site that promotes site and landscape complexity.

Slope limits the areas where brush-beating can be used. This method is best suited to level and moderately sloping areas, often on moderately deep and deep soils with few large surface stones.

Unlike fire, mechanical treatments will miss many small juniper seedlings. Anticipate the need for additional treatment, or prescribed burning as a follow-up treatment, 10 to 15 years after the initial treatment if juniper is re-occupying the site.

The treatment of individual trees will result in incomplete juniper control and does not address the need to restore the grass and forb components of the plant community. This type of site requires seeding. If a brush beater is used, seed can be broadcast before the treatment or drilled following treatment with a rangeland drill. Consider herbicide use if rabbitbrush responds aggressively to brush-beating.

2b. Evidence of overland flow common; active rills and/or gullies sometimes present.

This condition is common where long-term heavy grazing use has occurred, or on abandoned cropland where long-term tillage has removed native grasses and forbs and the soil's seed reservoir, and sagebrush and/or rabbitbrush have re-occupied the site. Sandberg bluegrass (*Poa secunda*) may be common. Where grazing has resulted in this condition, deep-rooted perennial grasses, bluebunch wheatgrass (*Agropyron spicatum*), or similar species will commonly be found growing within the protection of remaining shrub canopy. Exotic annual grasses (e.g. cheatgrass, medusahead) and weedy species (e.g. knapweed) may be abundant. Seeding that incorporates methods of competitive vegetation control is essential.

Prescribed Burning

Burning is not recommended on this site due to increased erosion hazard caused by the removal of existing plant cover and plant litter. If burned, seeding is essential. After burning, drill seed with a rangeland-drill or, conditions allowing, with a grain drill or Brillion seeder. Broadcasting seed into cooled, un-crusted ash as soon as possible (within 1 to 2 weeks) may also be effective. Where annual precipitation is adequate (12-14 inches+), small amounts of quickly germinating annual grass varieties such as annual ryegrass (*Lolium* spp.) can be incorporated into the seeding

mix to provide over-winter cover on soils and slopes where the erosion hazard is moderate to severe.

Mechanical Treatment

With any mechanical treatment, all green juniper leaf material must be removed; otherwise, rapid regrowth will occur. Several mechanical treatment methods can be used on this site. Individual trees can be removed with chainsaws, hand loppers (on trees with small diameters), or specialized machine-grubbers and shears or pullers. Another option, brush-beating, depends on the size of the main stem and machinery's capability. These methods can effectively carry out broad-scale treatment as long as all green leaf material is removed. Like fire, a brush beater will remove most desirable shrubs, and it may invigorate shrubs like rabbitbrush. However, the thoughtful use of a brush beater may create a mosaic effect on the site that promotes site and landscape complexity.

Slope and surface stones limit the areas where brush-beating can be effectively used. This method is best suited to level and moderately sloping areas, often on moderately deep and deep soils with few large surface stones.

Unlike fire, mechanical treatments will miss many small juniper seedlings. Anticipate the need for additional treatment, or prescribed burning as a follow-up treatment, 10 to 15 years after the initial treatment if juniper is re-occupying the site.

Brush-beating will result in the deposition of a large amount of woody and herbaceous plant material on the soil surface which will detain overland flow, trap sediment, and increase the time available for the infiltration of water. This method will correct overland flow and erosion problems in all but the most severe cases of gully erosion. Placing cut trees in gullies may trap sediment and prevent further down-cutting.

3. Woodland succession in Phase II or III; all expected functional plant groups represented; annual herbage production within normal range to significantly reduced; density of deep-rooted perennial grasses greater than 2 plants per 10 square feet.

3a. Little to no evidence of overland flow and soil loss.

This condition commonly occurs on deep, productive soils on level to moderately sloping areas. Some shrub skeletons appear on the site. Most shrubs are alive but in a weakened condition. Grasses and forbs are common. The site is at or near the threshold between Phases II and III where, without treatment, conditions will deteriorate. Treatments on this site should address the prevention of further decline of ecological processes and the recovery of hydrologic function.

Prescribed Burning

This site is suited to the use of fire to control juniper if fine and ladder fuels are adequate. Consider excluding livestock during the year before burning to allow the accumulation of fine fuels. Three methods of burning are available: broadcast burning that relies on adequate amounts of fine and ladder fuels to carry the fire between the trees and into the canopy; broadcast burning after felling some trees (about 25 to 35 percent) that will serve as ladder fuels if shrub amounts are inadequate, or burning individual trees. Broadcast burning will remove shrubs from the plant community for 10 years or more. Burning individual juniper trees permits young trees that escape burning to persist and require future treatment. Hot fires (especially in Phase III stands) may damage seed in the soil seed reservoir and may kill much of the vegetation intended for growth after the fire. Where herbaceous plant mortality appears high (especially in hotly burned areas), consider seeding.

Mechanical Treatment

At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable vegetation. Dozing may also remove topsoil, which exposes the soil surface to erosion and/or invasion by weeds. Seeding should accompany dozing.

Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Usually, the downed trees are burned individually or in a broadcast burn. Cool/cold season burning results in less severe heat production, thereby reducing heating effects on the soil and on plants immediately beneath the tree. Extracting tree boles before burning will reduce soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, it provides a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs, and offers protection from grazing. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it may be considered a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site will scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps, and downed trees can be difficult and dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escape the treatment.

3b. Evidence of overland flow common; bare soil common; active rills and/or gullies sometimes present.

This condition occurs on slopes and soils at risk for erosion. The current plant community production or composition may indicate the effects of heavy grazing use or other surface disturbance. Soils may be shallow or contain a restrictive layer in the upper soil profile and/or have erodible surface textures. Treatment of a site in this stage of encroachment should address the recovery of hydrologic function and consider overland flow and erosion originating on site or on adjacent uplands. Evidence of overland flow and active erosion indicate that burning will exacerbate this condition.

Prescribed Burning

Burning is not recommended on this site due to increased erosion hazard caused by the removal of existing plant cover and plant litter. If burned, seeding is essential. Where annual precipitation is adequate (12-14 inches+), small amounts of quickly germinating annual grass varieties such as annual ryegrass (*Lolium spp.*) should be incorporated into the seeding mix to provide over-winter cover on soils and slopes with moderate to severe erosion hazard.

Mechanical Treatment

At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable vegetation. Dozing may also remove topsoil, which exposes the soil surface to erosion and/or invasion by weeds. Seeding should be planned after dozing.

Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning individual trees during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Cool/cold season burning results in less severe heat production, thereby

reducing heating effects on the soil and plants immediately beneath the tree. Extracting tree boles before will reduce soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, it provides a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs and offers protection from grazing. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it may be considered a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site will scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps and downed trees can be difficult and dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escaped the treatment.

Removing limbs from the tree bole and broadcasting them across the site ("lop and scatter") is recommended to detain overland flow, control erosion, and enhance seedling establishment.

Falling trees to lay on the slope contour may promote detention of overland flow.

4. Woodland succession in Phase II or III; expected functional plant groups significantly diminished or absent; skeletal remains of shrubs common; deep-rooted perennial grasses are the dominant understory vegetation beneath trees and in the canopy interspaces; density of deep-rooted grasses greater than 2 plants per 10 square feet.

4a. Little to no evidence of overland flow or soil loss.

These conditions typically occur at the upper elevations of the range of juniper distribution on terraces and benches with moderately deep and deep soils, and at lower elevations on north- and east-facing slopes where soils are often derived from pumice. Idaho fescue usually dominates the understory.

Prescribed Burning

The lack of shrubs (ladder fuels) in the understory makes burning of this site impractical. If, however, the stand is partially cut and the downed trees serve as ladder fuels, using fire is appropriate. Consider excluding livestock during the year before burning to allow the accumulation of fine fuels. Three methods of burning are available: broadcast burning that relies on adequate amounts of fine and ladder fuels to carry the fire between the trees and into the canopy, broadcast burning after felling some trees (about 25 to 35 percent) that will serve as ladder fuels if shrub amounts are inadequate, or burning individual trees. Both broadcast and individual burning methods have disadvantages. Broadcast burning will remove the remaining shrubs from the plant community for 10 years or more. Burning individual juniper trees permits young trees that escape burning to persist and require future treatment. Hot fires (especially in Phase III stands) may damage seed in the soil seed reservoir and may kill much of the vegetation intended for growth after the fire. Where herbaceous plant mortality appears high (especially in hotly burned areas), consider seeding.

Mechanical Treatment

At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable vegetation. Dozing may also remove topsoil, which exposes the soil surface to erosion and/or invasion by weeds. Seeding should follow dozing.

Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Usually, the downed trees are burned individually or in a broadcast burn. Cool/cold season burning results in less-severe heat production, thereby reducing heating effects on the

soil and plants immediately beneath the tree. Extracting boles reduces soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, it offers protection from grazing and may support a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it creates a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site may scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps, and downed trees is difficult and can be dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escaped the treatment.

4b. Evidence of overland flow common; bare soil common; active rills and/or gullies sometimes present.

These conditions typically occur at the upper elevations of the range of juniper distribution on terraces and benches with moderately deep and deep soils, and at lower elevations on north- and east-facing slopes. Idaho fescue usually dominates the understory. The evidence of overland flow and soil loss indicates site instability.

Prescribed Burning

Burning is not recommended on this site due to increased erosion hazard caused by the removal of existing plant cover and plant litter. If burned, seeding is essential. Where annual precipitation is adequate (12-14 inches+) small amounts of quickly germinating annual grass varieties such as annual ryegrass (*Lolium spp*.) should be incorporated into the seeding mix to provide over-winter cover on soils and slopes with moderate to severe erosion hazard.

Mechanical Treatment

At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable vegetation. Dozing may also remove topsoil, which

exposes the soil surface to erosion and/or invasion by weeds. Seeding should follow dozing.

Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Usually, the downed trees are burned individually or in a broadcast burn. Cool/cold season burning results in less-severe heat production, thereby reducing heating effects on the soil and plants immediately beneath the tree. Extracting boles before burning reduces soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, it provides a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs offers protection from grazing. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it creates a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site may scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps and downed trees is difficult and can be dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escaped the treatment.

Broadcast slash to detain overland flow, which traps sediment and improves infiltration. Placing cut trees in gullies may trap sediment and prevent further down-cutting.

Consider seeding significantly large areas of bare soil.

5. Woodland succession in Phase II or III; expected functional plant groups significantly diminished or absent; skeletal remains of shrubs common; deep-rooted perennial grasses, if present, restricted to within the drip line of the trees or the canopy of shrubs; canopy interspaces bare or nearly so; density of deep-rooted perennial grasses less than 2 plants per 10 square feet.

5a. Little to no evidence of overland flow or soil loss.

This condition is common in low- to mid-elevation sites on level to gently sloping terrain. Indian ricegrass (*Oryzopsis hymenoides*), Thurber needlegrass *(Stipa thurberiana*), and/or needleandthread (*Stipa comata*) may occur in the tree interspaces where soils are sandy or derived from pumice. Heavier textured soils (e.g. silt or silty clay) may support Sandberg bluegrass (*Poa secunda*). In the latter case, deep-rooted perennial grasses such as bluebunch wheatgrass (*Agropyron spicatum*) grow within the protection of the remaining shrub canopy. Exotic annual grasses (e.g. cheatgrass and medusahead) and weedy species (e.g. knapweed) may be abundant. Seeding that incorporates methods of competitive vegetation control (e.g. herbicides) is essential. Broadcasting slash should promote site recovery and may be necessary to prevent wind erosion on pumice or sandy soils.

Prescribed Burning

The feasible methods of treatment are burning individual trees and falling trees to serve as ground and ladder fuels in broadcast burning. However, consider the value of retaining slash for protection from grazing use and for the resulting microclimatic conditions that support the establishment of seeded species on this harsh site.

Mechanical Treatment

Seed to native or adapted species prior to treatment. At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable vegetation. Dozing may also remove topsoil, which exposes the soil surface to erosion and/or invasion by weedy species. Seeding should follow dozing.

Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Usually, the downed trees are burned individually or in a broadcast burn. Cool/cold season burning results in less-severe heat production, thereby reducing heating effects on the

soil and plants immediately beneath the tree. Extracting boles before burning will reduce soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, it provides a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs, and offers protection from grazing. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it creates a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site may scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps and downed trees is difficult and can be dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escaped the treatment.

5b. Evidence of overland flow common; bare soil common; active rills and/or gullies present.

This condition occurs on harsh, low- to mid-elevation sites and on south- and west-facing sites. It also arises on droughty soils of any slope or aspect. Active sheet, rill, and gully erosion are common. Seeding and broadcasting slash are essential to site recovery.

Prescribed Burning

Burning is not recommended on this site due to increased erosion hazard caused by the removal of existing plant cover and plant litter. If burned, seeding is essential. Where annual precipitation is adequate (12-14 inches+) small amounts of quickly germinating annual grass varieties such as annual ryegrass (*Lolium spp.*) should be incorporated into the seeding mix to provide over-winter cover on soils and slopes with moderate to severe erosion hazard.

Mechanical Treatment

Seed to native or adapted species prior to treatment. At this stage of succession, tree diameters limit mechanical methods to chainsaws and heavy machinery such as feller-bunchers, shears, and dozers. Dozing, along with often-associated pushing and piling, must be done with extreme care due to the great risk of eliminating desirable

vegetation. Dozing may also remove topsoil, which exposes the soil surface to erosion and/or invasion by weeds. Seeding should follow dozing.

Whole trees should be felled on the slope contour. Falling whole trees and leaving them on site is believed to increase the interception of rain and snow until leaves have fallen, a period of 2 to 4 years (Tim Deboodt, OSU Extension Rangeland Specialist, personal communication, 2006). This increase occurs because the area of ground covered by the length of the downed tree may be greater than the area of the crown diameter of the standing tree. The leaf fall beneath the downed tree creates a mulch mat that usually smothers plants. Burning individual trees during the first winter/early spring after cutting when soils are frozen or near field capacity will reduce the smothering problem and allow perennial grasses to recover. Cool/cold season burning results in less-severe heat production, thereby reducing heating effects on the soil and plants immediately beneath the tree. Extracting boles reduces soil heating during burning.

In treatment areas where the tree boles have been removed for firewood or wood products, slash usually remains. This material serves several useful purposes. It protects bare soil from raindrop impact, detains overland flow, and increases the time available for infiltration. In addition, provides a microclimate favorable to the germination and establishment of native grasses, forbs, and shrubs, and offers protection from grazing. Determining the amount of slash to leave on site should be based on the treatment objective. Too much slash may have the same smothering effect on understory vegetation as whole downed trees (but on a broader scale), and it is considered a fire hazard. The following rule of thumb can help determine the amount of slash to leave: Light enough for a cow or elk to walk through, or a little more if animal exclusion is the aim.

Skidding whole trees or tree boles off the site may scarify the soil surface. On sites with any appreciable slope, drag trees across the slope (rather than up- or down-slope) to avoid creating areas of concentrated overland flow and subsequent erosion and water loss. Consider seeding and spreading slash on skid trails to control erosion and weed invasion if the disturbance appears excessive. When skidding to a road or landing, begin cutting at the far end of the treatment area and drag the material out as it is felled. Skidding through slash, stumps and downed trees is difficult and can be dangerous. Follow-up burning may be necessary in 10 to 20 years to control young junipers that escaped the treatment.

Chapter 5
Monitoring the Effectiveness of Juniper Treatment

Purpose

Monitoring the effectiveness of any kind of land treatment or change in management is important in 1) determining the biotic and abiotic changes resulting from the treatment, 2) determining whether treatment effectively met the objective, and 3) learning from mistakes and oversights in order to incorporate new knowledge in the design and application of future treatments.

Monitoring the effects of a treatment requires a record of pre-treatment conditions. Chapter 3 contains a set of site parameters to observe, measure, and record before applying treatment. Appendix 1 is a suggested format for recording pre-treatment conditions.

After treatment, visit the site at least annually to assess the early effects of the treatment, such as seeding establishment and the response of grasses, forbs, and shrubs. Site visits also reveal any unanticipated effects or events, such as weed encroachment, juniper sprouting, erosion, or unplanned grazing. Record the results of the visit in the project folder and correct any problems found. Effectiveness monitoring, on the other hand, is best conducted over several years at predetermined intervals after the site has had adequate time to respond to treatment, usually within 2 to 4 years.

Quantitative Effectiveness Monitoring

Quantitative monitoring should be conducted by a qualified rangeland management specialist or rangeland ecologist with experience in soils and hydrology, rangeland vegetation, soil-plant-water relationships, and rangeland management techniques. For formats and instructions for post-treatment quantitative monitoring, see the appendices (Appendix 2 – Post-Treatment Evaluation, and Appendix 5 – Line-Point Intercept Method).

Equipment needed:

- Project folder or copies of project application, final report, and project notes
- Pre-treatment evaluation form (completed)
- Topographic map
- Shovel
- GPS
- Compass
- Camera
- Clipboard, pencil, paper
- Post-treatment evaluation form (see Appendix 3)
- 100-foot tape
- 10 ft^2 (1m^2) frame for estimating grass density

Line-point intercept form (see Appendix 4)
Photo point ID card (see Appendix 4)
Steel pin or welding rod

Qualitative Effectiveness Monitoring

On sites where quantitative monitoring is not feasible, the observer should complete as much of the Post-Treatment Evaluation (Appendix 2) as possible, record other observations, and take new photographs at the established photo points.

Equipment needed:

Project folder or copies of project application, final report, and project notes
Topographic map
Shovel
GPS
Compass
Camera
Clipboard, pencil, paper
10 ft^2 (1m^2) frame for estimating grass density
Pre-treatment evaluation form (completed)
Post-treatment evaluation form

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Appendix 1

OWEB Pre-Treatment Inventory – Juniper Treatment

General Information:
Applicant: _____
Address: _____
Phone: _____
Observer: _____ Date of inventory: _____

Treatment Site Characterization:
Location: legal description, latitude and longitude or UTM coordinates: _____
_____
Ecoregion: (Omernik) _____
Avg. annual ppt.: _____ Elevation: _____ Slope: _____% Aspect: _____
Landscape Position: (check applicable) Valley bottom ___ Riparian area ___
Alluvial fan ____ Toe slope ____ Side-slope ____ Ridge ___ Other (describe) _____
_____ _____
Dominant soil: _____ Depth _____ Texture: Surface _____
Sub-surface _____
NRCS Ecological Site or Plant Assoc.: _____
Soil limitations for management/treatment:_____
_____

Site Inventory:
Method of inventory: (check applicable) Measured _____ Estimated _____
Describe method(s) used: _____
Permanent plot established? (Y/N) ___ Photo point established? (Y/N) ___

Pre-Treatment Conditions: (attach copies of field notes and photos compiled during the inventory)
Phase(s) of woodland succession: _____
Pre-treatment foliar cover[1]: _____% Basal cover: _____%
Trees: _____% Forbs: _____% Stones/gravels: _____%
Shrubs: _____% Cryptogams: _____% Bare ground: _____%
Grasses/grass-likes: _____% Litter: _____%
Density of deep-rooted perennial grasses: _____/10 ft²
Weedy species (presence and abundance): _____
Evidence of overland flow? (Y/N) _____
Evidence of active soil erosion? (Y/N)_____ Kind:_____
Springs and/or seeps in, or downslope of treatment area? (Y/N) _____
Long-term measurement of flow? (Y/N)___ If yes, what were the flows?_____ gpm
Ephemeral, intermittent, or perennial streams in the stand's area of influence? (Y/N)___

[1] See Appendix 5 (Line-Point Intercept Method) for definitions of foliar and basal cover. See also Appendix 3 (Comparison Charts for Visual Estimation of Foliage Groundcover).

Appendix 1

Long-term measurement of flow? (Y/N) ___ If yes, what were the flows? _____ cfs
Grazed? (Y/N)___ Rest/Deferment? (Y/N) _____
Timing, duration and density of grazing use:
_____
_____

Other surface disturbances? (Y/N) _____ Describe: _____
_____

Planned Treatment Description:
Objective: _____
_____
_____
Planned timing of treatment: _____ Acres to be treated:_____
Planned method(s) of treatment, including follow-up: _____
_____
_____
_____
Slash disposal: (broadcast, pile, burn, remove, etc.)_____
_____
Seeding planned? (Y/N) ____ Method: _____
Species (including seeding rates) recommended: _____
_____

Notes:
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix 2

Post-Treatment Effectiveness Monitoring Report – Juniper Treatment

OWEB Grant #: _____

General Information:
Grantee: _____
Address: _____ Phone: _____
Reviewer: _____ Date of review: _____

Treatment Description:
Objective: (from grant application)
Date(s) of treatment: _____ Acres treated: _____ Time spent: _____
Method of treatment: _____
Slash disposal: (broadcast, piled, etc.) _____
Cost of initial treatment ($/ac): _____ (from final report) $_____
Post-treatment burn? (Y/N) ____ Date: _____ Method: _____
Seeded? (Y/N) ____ Date: _____ Method: _____
Species seeded: (include rates) _____
Costs ($/ac.): Burning: $ _____ Seeding: $_____

Treatment Evaluation:
Method of evaluation: (check applicable) Measured _____ Estimated _____
Describe method(s) used: _____
Permanent plot established? (Y/N) ___ Photo point established? (Y/N) ___

Results of Evaluation: (attach copies of field notes, photos and monitoring data compiled during the evaluation)
Post-treatment foliar[1] cover : _____% Basal[1] cover: _____%
Trees: _____% Forbs: _____% Stones/gravels: _____%
Shrubs: _____% Cryptogams: _____% Bare ground: _____%
Grasses/grass-likes: _____% Litter: _____%
Density of deep-rooted perennial grasses: _____/10 ft²
Weedy species (presence and abundance): _____
Evidence of overland flow? (Y/N) _____
Evidence of active soil erosion? (Y/N)_____ Kind:_____
Springs and/or seeps in, or downslope of treatment area? (Y/N) _____
Long-term measurement of flow? (Y/N)___ If yes, what were the flows?_____ gpm
Ephemeral, intermittent, or perennial streams in the stand's area of influence? (Y/N)___
Long-term measurement of flow? (Y/N) ___ If yes, what were the flows? _____ cfs

Grazed? (Y/N)___ Rest/Deferment? (Y/N) _____

[1] See Appendix 5 (Line-Point Intercept Method) for definitions of foliar and basal cover. See also Appendix 3 (Comparison Charts for Visual Estimation of Foliage Groundcover).

Appendix 2

Timing and duration of grazing use: _____
_____
Other surface disturbances? (Y/N) _____ Describe: _____
_____

Conclusions:
Was the target species effectively controlled? (Y/N) _____ (If no, explain below)
Were the objectives of the project achieved? (Y/N) _____ (If no, explain below)

Notes: (include grantee's comments and observations, notes on further treatment needs, etc.)

Appendix 3

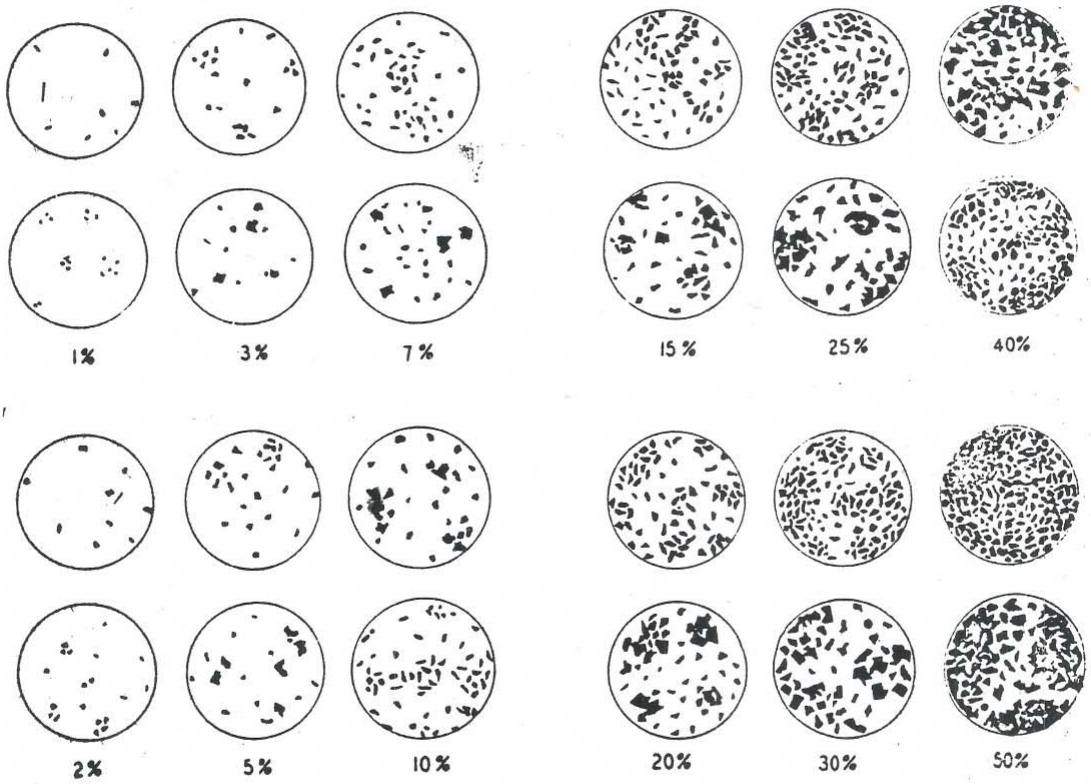
TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE — SOIL CONSERVATION SERVICE

Range - 19 — Spokane, Washington
Dennis R. Phillippi, Range Conservation Specialist — August 1977

COMPARISON CHARTS FOR VISUAL ESTIMATION OF (FOLIAGE) GROUNDCOVER

(BIRDS-EYE VIEW)



Definitions:

Canopy Cover = The proportion of the ground surface covered (or shadowed-birds-eye view) under live aerial parts of the plant.

Groundcover = The proportion of the ground surface covered (or shadowed) under live aerial parts of plants and mulch.

Reference:

Developed by Richard D. Terry and George V. Chilinger. Published by the Society of Economic Paleontologist and Minerologist in its Journal of Sedimentary Petrology 25 (3): 229-234, September 1955.

Appendix 4

Photo points

Use Photo points to qualitatively monitor how vegetation changes over time. Permanent photographs of a landscape are useful for detecting changes in vegetation structure and for visually documenting measured changes. Take at least one photo of each transect. If you take digital photos, be sure to print and store photos in plastic photo storage sheets. Slide the photo card (page 8) behind the photo in the plastic storage sheet. For more information on photo point monitoring, see the USFS Photo Point Monitoring Handbook (www.fs.fed.us/pnw/pubs/gtr526/).

Materials

- Tape measure (5 m (15 ft) minimum)
- Four 60 cm (2 ft) rebar stakes
- Four 60 cm (2 ft) 3/4-in PVC pipe
- Compass
- 35 mm or digital camera with a 50 mm-equivalent lens (1:1 ratio). If a wide angle, telephoto or zoom is used, be sure to record lens and camera information.
- Photo point (ID) board (chalk or whiteboard) or Photo point (ID) card (page 8) on a clipboard
- Thick marking pen
- One 1.5m (5 ft) long, 3/4-in diameter PVC pipe.

Standard methods (rule set)

1. Establish photo point

Rules

1.1 Drive center stake into ground, leaving less than 30 cm (1 ft) exposed.

1.2 Drive transect stakes into ground 5 m (15 ft) from center stake at 120° intervals to mark beginning of the three transects.

1.3 Cover stakes with 60 cm (3/4-in) PVC (optional for safety and visibility).

1.4 Mark the far end (50 m) of each transect with a stake if the location will be used for vegetation and/or soil measurements. Use same procedure described in 1.2 and 1.3.

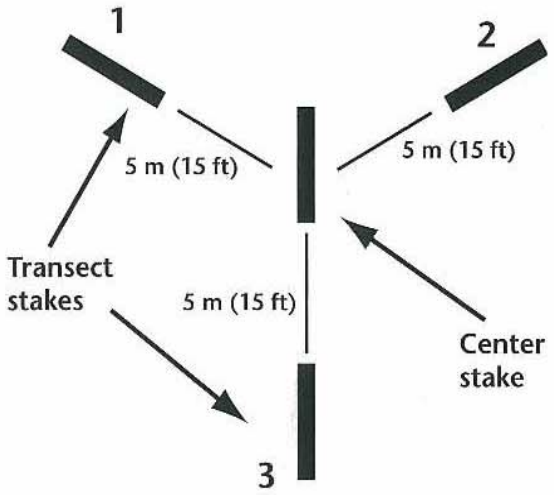


Figure 3. Transect stake locations for spoke design. Stakes mark beginnings of each transect. Base of stake located at bottom center of photo.

Ground cover photo option

Use each of the three transect stakes as one corner of a permanent plot (usually 1x1 m or 3x3 ft) and mark the other three corners with small stakes. Before taking the photo, mark the perimeter with a piece of rope or meter/yard sticks. Place the camera over the center of the plot at a standard height and take the photo.

Appendix 4

Figure 4. Photographer is at plot center and Photo point ID board marks beginning of one of the three transects.

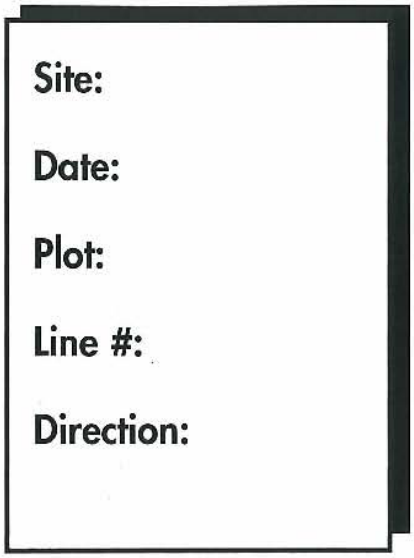


Figure 5. Photo point ID board.

2. Record photo information

Rules

2.1 Record date, location, precipitation and management history since the last photos were taken on a 7.5x12.5 cm (3x5 in) card or on one of the Short-Term Monitoring data forms (page 35 or 36).

3. Set up first photo

Rules

3.1 Remove PVC sleeve from center stake and replace with 1.5 m (5 ft) PVC pipe. Be sure that the pipe rests on the ground.

3.2 Label photo point ID board and lean it next to or hang it on the stake, marking the beginning of the first transect.

4. Take first photo (Fig. 4).

Rules

4.1 Set camera body on top of (1.5 m) center pole and point it down the first line.

4.2 Place bottom of nearest transect pole at the photo's bottom center.

4.3 Take photo.

5. Repeat Steps 3 and 4 for the other two photos.

Riparian note: At riparian sites, take two additional photos. Stand in mid-channel, hold camera 1.5 m (5 ft) above the ground and position bottom of viewfinder on a point located 5 m (15 ft) away. Take one photo facing upstream and one downstream.

Appendix 4

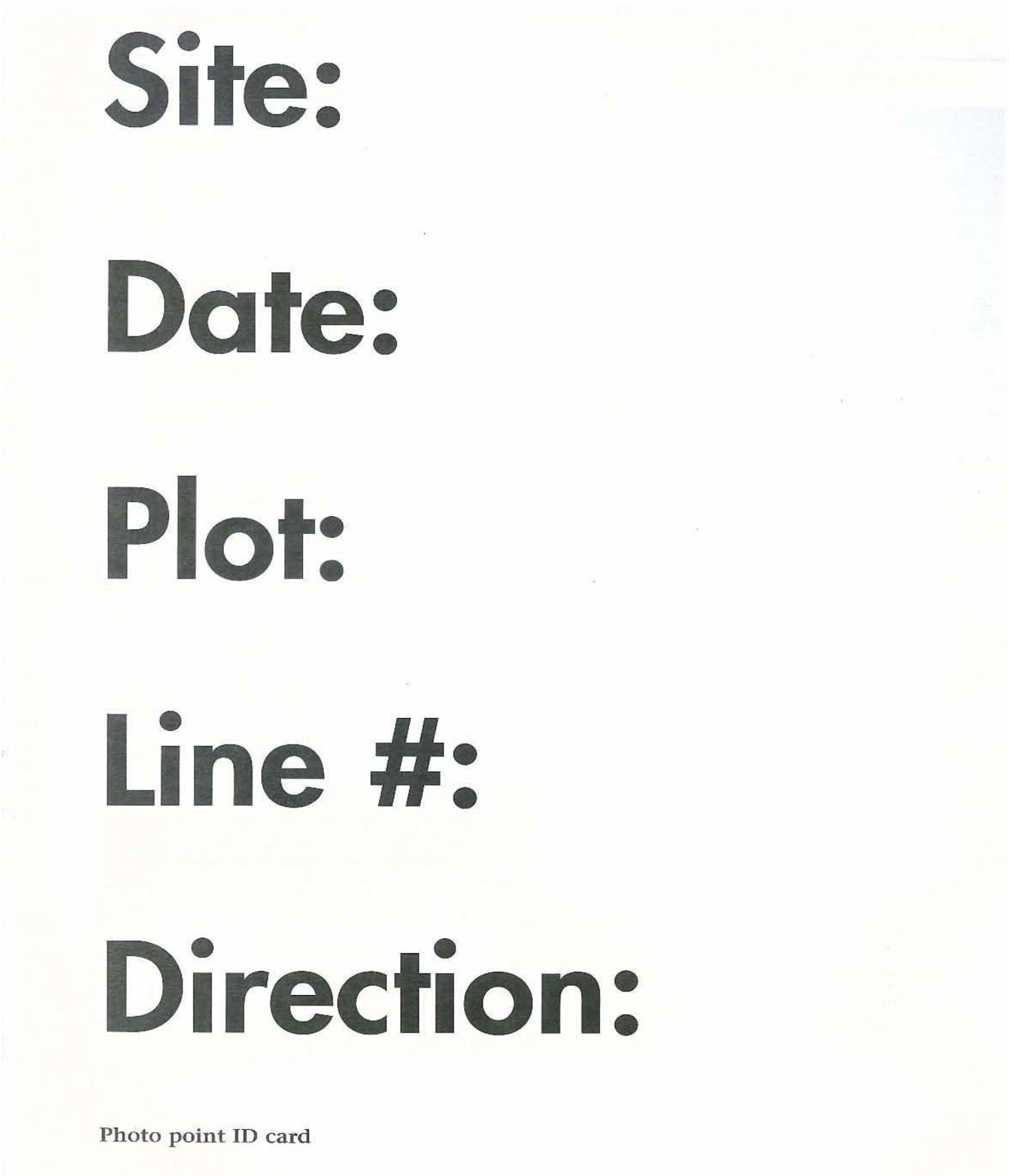


Photo point ID card

Appendix 5

Line-point intercept

Line-point intercept is a rapid, accurate method for quantifying soil cover, including vegetation, litter, rocks and biotic crusts. These measurements are related to wind and water erosion, water infiltration and the ability of the site to resist and recover from degradation. For a detailed discussion of this and other methods for measuring plant cover and/or composition, see Elzinga et al. 2001[2]. For alternative Line-point intercept methods (including height measurements) see Volume II.

Materials

- Measuring tape (length of transect)—if using a tape measure in feet, use one marked in tenths of feet.
- Two steel pins for anchoring tape
- One pointer—a straight piece of wire or rod, such as a long pin flag, at least 75 cm (2.5 ft) long and less than 1 mm (1/25 in) in diameter
- Clipboard, Line-Point Intercept Data Form (page 12) and pencil(s)

Standard methods (rule set)

1. Pull out the tape and anchor each end with a steel pin (Fig. 6).

Rules

1.1 Line should be taut.

1.2 Line should be as close to the ground as possible (thread under shrubs using a steel pin as a needle).

2. Begin at the "0" end of the line.
3. Working from left to right, move to the first point on the line. Always stand on the same side of the line.

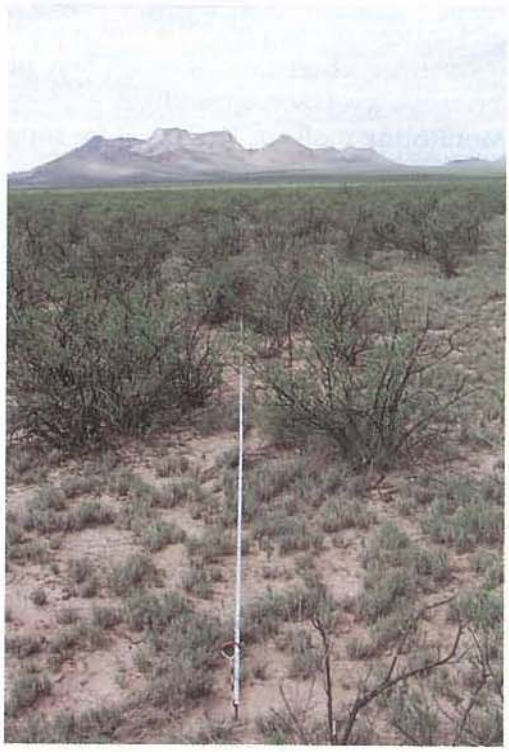


Figure 6. Transect line pulled taut.

4. Drop a pin flag to the ground from a standard height (__ cm (__in)) next to the tape (Fig. 7).

Rules

4.1 The pin should be vertical.

4.2 The pin should be dropped from the same height each time. A low drop height minimizes "bounces" off of vegetation but increases the possibility for bias.

4.3 Do not guide the pin all the way to the ground. It is more important for the pin to fall freely to the ground than to fall precisely on the mark.

Step-point or pace transect with pin (Semiquantitative alternative)

Use a pin flag dropped in front of your boot instead of the points on the tape.

Limitations:
Less accurate because it is difficult to walk a straight line, especially through shrubs. Using the toe of a boot instead of a pin creates additional errors because the boot often pushes plant canopies into interspaces. This leads to overestimates of plant canopy cover.

[2]Elzinga, C.L., D.W. Salzer, J.W. Willoughby and J.P. Gibbs. 2001. *Monitoring Plant and Animal Populations*, Blackwell Publishing. 368 pp.

4.4 A pair of lasers with a bubble level can be used instead of the pin. This tool is useful in savannas where canopy layers may be above eye level. See Appendix A (Monitoring tools) in Volume II for suppliers.

5. Once the pin flag is flush with the ground, record every plant species it intercepts.

Rules

5.1 Record the species of the first stem, leaf or plant base intercepted in the "Top canopy" column using the PLANTS database species code (http://plants.usda.gov/), a four-letter code based on the first two letters of the genus and species, or the common name.

5.2 If no leaf, stem or plant base is intercepted, record "NONE" in the "Top canopy" column.

5.3 Record all additional species intercepted by the pin.

5.4 Record herbaceous litter as "L," if present. Litter is defined as detached dead stems and leaves that are part of a layer that comes in contact with the ground. Record "W" for detached woody litter that is greater than 5 mm (or ~1/4 in) in diameter and in direct contact with soil.

5.5 Record each canopy species only once, even if it is intercepted several times.

5.6 If you can identify the genus, but not the species either use the PLANTS database genus code (http://plants.usda.gov) or record a number for each new species of that genus. ALWAYS define the genus portion of the code and the functional group at the bottom of the data form (*Artemisia* species = AR01).

5.7 If you *cannot* identify the genus, use the following codes:

AF# = Annual forb (also includes biennials)
PF# = Perennial forb
AG# = Annual graminoid
PG# = Perennial graminoid
SH# = Shrub
TR# = Tree

If necessary, collect a sample of the unknown off the transect for later identification.

Figure 7. Point falling on bare soil (NONE/S).

5.8 Canopy can be live or dead, but only record each species once. Be sure to record all species intercepted.

6. Record whether the pin flag intercepts a plant base (Fig. 8) or one of the following in the "Soil surface" column.

R = Rock (> 5 mm or ~1/4 inch in diameter)
BR = Bedrock
EL = Embedded litter
D = Duff
M = Moss
LC = Lichen crust on soil (lichen on rock is recorded as "R")
S = Soil that is visibly unprotected by any of the above

Rules

6.1 For unidentified plant bases, use the codes listed under 5.7.

6.2 Record embedded litter as "EL" where removal of the litter would leave an indentation in the soil surface or would disturb the soil surface. Record duff as "D" where there is no clear boundary between litter and soil and litter is not removed during typical storms (occurring annually).

6.3 Additional categories may be added, such as "CYN" = dark cyanobacterial crust.

Appendix 5

Table 2. Sample data form for examples illustrated below. Points 1 and 2 show the first two points on a line. In Point 1, the pin flag is touching dead fescue, live bluegrass, clover, live fescue, litter and a rock. Record fescue only once, even though it intercepts the pin twice. In Point 2, the flag touches fescue, then touches litter and finally the fescue plant base. Table 2 shows how to record these two points on the data form.

Pt.	Top canopy	Lower canopy layers			Soil surface
		Code 1	Code 2	Code 3	
1	Fescue	Bluegrass	Clover	L	R
2	Fescue	L			Fescue
3	Fescue	L			S
etc.					

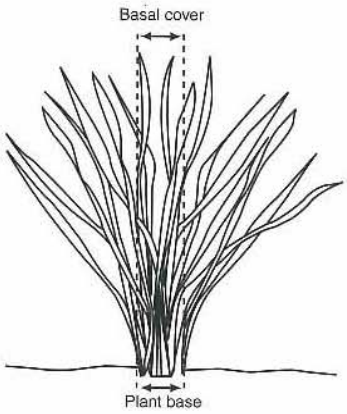
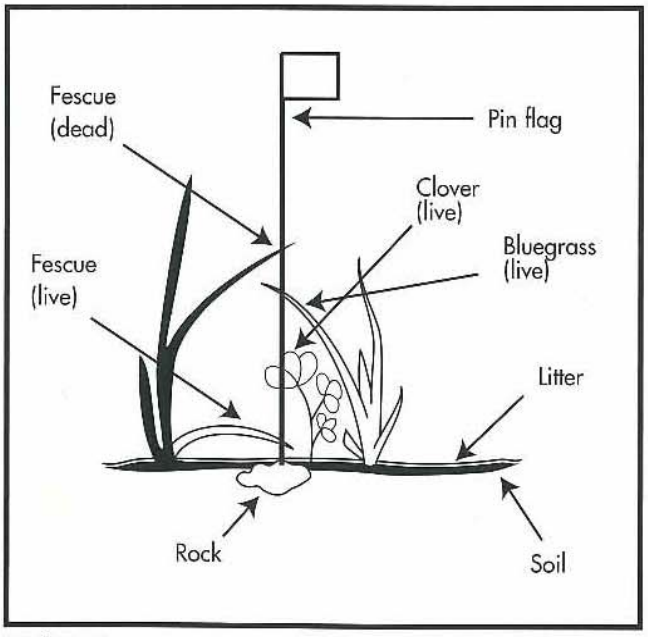
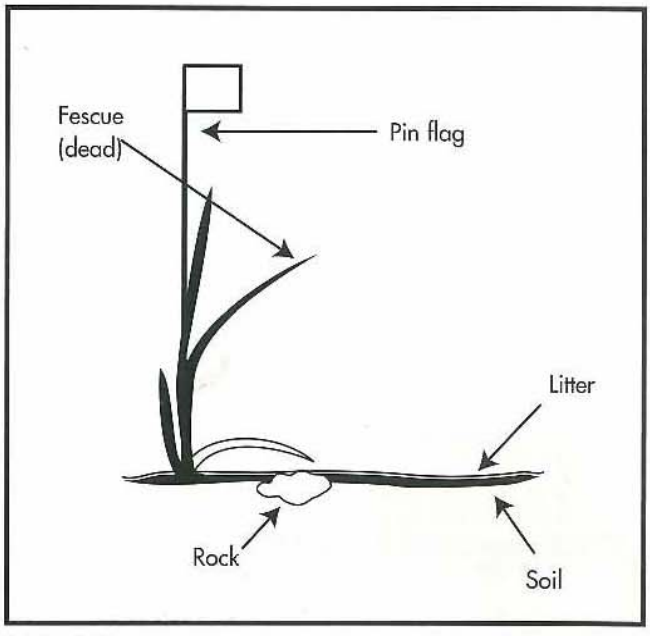


Figure 8. Area defined as plant base and included as basal cover.



Point 1



Point 2

Riparian note: Line-point intercept collected perpendicular to the channel is often used to monitor riparian zone width. A modified point intercept method is used to monitor "greenline" vegetation along the channel's edge (Vol. II, Chapter 13).

Appendix 5

Page _____ of _____ Shaded cells for calculations

Plot: _____ Line #: _____ Observer: _____ Recorder: _____

Direction: _____ Date: _____ Intercept (Point) Spacing Interval = _____ cm (___ in)

Pt.	Top canopy	Lower canopy layers			Soil surface	Pt.	Top canopy	Lower canopy layers			Soil surface
		Code 1	Code 2	Code 3				Code 1	Code 2	Code 3	
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					

% canopy (foliar) cover = ____ canopy pts (1st col) x 2 = ____ %

% bare ground* = ____ pts (w/NONE over S) x 2 = ____ %

% basal cover = ____ plant base pts (last col) x 2 = ____ %

Top canopy codes: Species code, common name, or NONE (no canopy).

Lower canopy layers codes: Species code, common name, L (herbaceous litter), W (woody litter, >5 mm (~1/4 in) diameter).

Unknown Species Codes:

- AF# = annual forb
- PF# = perennial forb
- AG# = annual graminoid
- PG# = perennial graminoid
- SH# = shrub
- TR# = tree

Soil Surface (do not use litter):

Species Code (for basal intercept)

- R = rock fragment (>5 mm (~1/4 in) diameter)
- BR = bedrock, M = moss
- LC = visible lichen crust on soil
- S = soil without any other soil surface code
- EL = embedded litter (see page 10)
- D = duff

**Bare ground occurs ONLY when Top canopy = NONE, Lower canopy layers are empty (no L), and Soil surface = S.*

Appendix 5

Line-point intercept indicator calculations

Canopy cover (as calculated here) does not include bare spaces within a plant's canopy.

1. Percent canopy (foliar) cover

Rules

1.1 Count the total number of canopy intercepts in the "Top canopy" column and record this number in the blank provided.

1.2 Canopy intercepts include all points where a plant is recorded in the "Top canopy" column. Do not include points that have a "NONE" in the "Top canopy" column.

1.3 Multiply the number of canopy intercepts (from 1.1) by 2* and record your "% canopy cover" in the blank provided.

2. Percent bare ground

Rules

2.1 Count the total number of points along the line that have bare ground and record this number in the blank provided.

2.2 Bare ground occurs **only** when:

A. There are no canopy intercepts (NONE is recorded in the "Top canopy" column).

B. There are no litter intercepts ("Lower canopy layers" columns are empty).

C. The pin only intercepts bare soil ("S" recorded in the "Soil surface" column).

2.3 Multiply the number of bare ground hits (from 2.1) by 2* and record your "% bare ground" in the blank provided.

3. Percent basal cover

Rules

3.1 Count the total number of plant basal intercepts in the "Soil surface" column and record this number in the blank provided.

3.2 Plant basal intercepts occur anytime the pin intercepts a live or dead plant base (Species code recorded in "Soil surface" column).

3.3 Multiply the number of basal intercepts (from 3.1) by 2* and record your "% basal cover" in the blank provided.

---

*For 50 points per line. Multiply by 1 for 100 points per line. Multiply by 4 for 25 points per line.

Appendix 5

Table 3. Line-point intercept data form example showing a 50-point line and associated indicator calculations.

Page 1 of 1 — Shaded cells for calculations

Plot: 3 Line #: 2 Observer: Jane Smith Recorder: David Patrick

Direction: 120° Date: 10/15/2002 Intercept (Point) Spacing Interval = 100 cm (___ in)

Pt.	Top canopy	Lower canopy layers Code 1	Code 2	Code 3	Soil surface	Pt.	Top canopy	Lower canopy layers Code 1	Code 2	Code 3	Soil surface
1	BOER				BOER	26	PRGL	BOER			S
2	BOER				S	27	NONE	L			S
3	SPO1	BOER			S	28	BOER				LC
4	BOER				S	29	SPO1	BOER			S
5	NONE				S	30	YUEL	L			S
6	BOER				S	31	BOER				S
7	NONE	L			S	32	NONE				R
8	NONE				S	33	BOER				S
9	BOER				S	34	NONE	L			S
10	BOER	L			S	35	BOER				S
11	BOER	L			S	36	BOER	L			BOER
12	BOER				S	37	BOER	L			S
13	NONE				S	38	BOER	L			S
14	BOER				S	39	NONE				S
15	NONE	L			S	40	NONE	L			S
16	NONE				R	41	BOER				S
17	BOER				S	42	PRGL	SPO1			S
18	BOER				BOER	43	PRGL				S
19	NONE				R	44	SPO1				S
20	BOER				S	45	NONE				S
21	BOER				S	46	BOER				S
22	SPO1				S	47	BOER				BOER
23	BOER	L			S	48	BOER	L			S
24	NONE	L			S	49	NONE	L			S
25	NONE	L			S	50	BOER	GUSA			S

% canopy (foliar) cover = 34 canopy pts (1st col) x 2 = 68 %

% bare ground* = 5 pts (w/NONE over S) x 2 = 10 %

% basal cover = 4 plant base pts (last col) x 2 = 8 %

Top canopy codes: Species code, common name, or NONE (no canopy).

Lower canopy layers codes: Species code, common name, L (herbaceous litter), W (woody litter, >5 mm (~1/4 in) diameter).

Unknown Species Codes:

AF# = annual forb
PF# = perennial forb
AG# = annual graminoid
PG# = perennial graminoid
SH# = shrub
TR# = tree

Soil Surface (do not use litter):

Species Code (for basal intercept)

R = rock fragment (>5 mm (~1/4 in) diameter)
BR = bedrock, M = moss
LC = visible lichen crust on soil
S = soil without any other soil surface code
EL = embedded litter (see page 10)
D = duff

**Bare ground occurs ONLY when Top canopy = NONE, Lower canopy layers are empty (no L), and Soil surface = S.*

Appendix 5

Line-point intercept basic interpretation

Increases in **canopy cover** are correlated with increased resistance to degradation. **Basal cover** is a more reliable long-term indicator. Basal cover is less sensitive to seasonal and annual differences in precipitation and use. Increases in **bare ground** nearly always indicate a higher risk of runoff and erosion.

Where species composition changes may be occurring, calculate basal and canopy cover for each major species. Canopy cover usually is used for shrubs, trees and sometimes grasses. Basal cover is used for perennial grasses. When calculating single species canopy cover, be sure to include each time the species is intercepted, regardless of whether it is in the top or lower canopy layer.

Use these indicators together with the indicators from the **Gap intercept** and the **Soil stability test** to help determine whether observed erosion changes are due to loss of cover, changes in the vegetation's spatial distribution, or reduced soil stability. Use these indicators together with the **Belt transect** to track changes in species composition. For more information about how to interpret these indicators, please see Chapter 17 in Volume II.

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Typical effect on each attribute of an increase in the indicator value			
Indicator	Soil and site stability	Hydrologic function	Biotic integrity
Canopy cover (%)	+	+	+
Bare ground (%)	−	−	−
Basal cover (%)	+	+	+

Appendix 6

Basin Wildrye

Leymus cinereus (Scribn. & Merr.) A. Love

Also known as giant wildrye or Great Basin wildrye, this **Native bunchgrass** is the largest cool-season perennial bunchgrass native to the western United States. It does well as a pioneer plant and can establish seedlings in disturbed areas such as road cuts, mine tailings, and rodent burrow castings.

Plant Characteristics

Inflorescence of *Leymus cinereus*, July 8, 2000, Big Pine Lakes Trail, Beyond Bridge, Inyo County, California. Photo © 2000 Larry Blakely (Calphotos).

Cultivars:
Magnar (*Leymus cinereus)*
Aberdeen Plant Materials Center, 1979

Trailhead (*Leymus cinereus)*
Bridger, Montana, PMC, 1991

VEGETATIVE CHARACTERISTICS

Culms and leaves: Coarse bunchgrass with erect culms up to 2 m (6.5 ft) tall, with basal diameters of 0.6-1.2 m (2 to 4 ft).
Leaves 38-64 cm (15-25 in) long, 2 cm (0.8 in.) wide , very tough, smooth, grayish-green, with well-developed auricles at the base of some blades, and ligules 3-7 mm.
Inflorescence: Stiff erect seed spikes 10-29 cm (4-11.5 in) long, with 16 to 35 nodes. 2 to 7 spikelets per node with 3-7 florets each with short-awned lemmas and very narrow glumes.
Roots: Extensive soil-binding, fibrous root system, found to reach depths of up to 200 cm (79 in) in disturbed soil in one study, spreading to 100 cm (39 in).

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Inhabits a wide variety of deep soil soils, including fine-textured, calcareous clay soils with claypan layers around 43 cm (17 in) deep, and sandy to gravelly soils. Most common on deep soils with high water-holding capacities, especially on silty and clayey soils. Though it may grow on poorly-drained soils, it is intolerant of shallow soils, and is not vigorous on deep coarse soils. May also be abundant on sites with high potassium concentrations, and tolerates low to moderate levels of saline and sodic soil conditions and slightly acidic soils..
Moisture/temperature requirements: Grows best in areas with average annual precipitation of 19 cm (8 in) to above 51 cm (20 in), though can grow at sites with only 13 cm (5 in). Found mostly near gullies, watercourses, and high water tables at water-limited sites. Will tolerate short periods of winter flooding, but not long periods of inundation. Tolerant of partial shade in shrublands and woodlands. Grows at locations with 3-4 frost-free months, and at elevations from 790-3000 m (2590-9840 ft) elevation range-wide.

A very isolated roadside patch of *Leymus cinereus,* May 8, 2004, Lower Desert of Crooked River National Grassland (Road #63), Jefferson County, Oregon. This site was in the shadow of northwest-facing rimrock. Other plant species present included bitterbrush, mountain big sagebrush, bitter cherry, green and gray rabbitbrush, several species of lomatium, bluebunch

Appendix 6

Management Considerations

Basin Wildrye
Leymus cinereus (Scribn. & Merr.) A. Love

UTILIZATION

Forage and Palatability: Readily grazed by all classes of livestock in early spring, when it produces abundant early growth. Considered a desirable feed for cattle and horses in winter, when its tall stature and stiff stems keep accessible in deep snow. Holds nutrient value well at maturity.
Wildlife Use: Considered excellent cover habitat for small animals and birds, excellent nesting cover for upland birds, and excellent standing winter feed and cover for big game animals.

PLANTING

Growth Season and Seedling Establishment: Cool season long-lived perennial. The best seeding results are obtained from seeding in very early spring on heavy to medium-textured soils and in late fall on medium to light-textured soils. Establishes slowly with fair seedling vigor. Stands may take 2 to 5 years to fully establish.
Propagation: Reproduces primarily by seed and to some extent by tillers and short rhizomes. Not considered weedy or invasive. Most seedings do not spread from original plantings, or if so, slowly.

This dense stand of *Leymus cinereus* grows in a riparian zone that drains off the north slope of Gray Butte, Crooked River Grassland, Jefferson County, Oregon (just below the intersection of Routes 57 and 9620). Juniper had been cut to approximately 50 feet on either side of the channel. Mountain big sagebrush and bitterbrush were dense away from the channel, which maintained a very low but detectable flow on the date the photo was taken.

DISTURBANCE

Response to Competition: Does not establish well when planted with aggressive non-native species.
Response to Grazing: Especially sensitive to early spring grazing. New stands should only be grazed after plants reach 25 cm (10 in) tall.
Response to Fire: Coarseness of foliage resists prolonged burning, protecting the buried basal growing points from sustained heating. More likely to survive and resprout following late season fire, when the plant is dormant, than at any other point in the growing season.
Response to Drought: Established stands can tolerate prolonged periods of drought.

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Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Big Sagebrush

Artemesia tridentata Nutt.

At least 4 or 5 subspecies of this **Native shrub** have been identified. Those described here are: *A. tridentata* ssp. *tridentata* (Beetle & Young) Welsh - basin big sagebrush, *A. tridentata* ssp. *vaseyana* (Rydb.) Bovin - mountain big sagebrush; and *A. tridentata* ssp. *wyomingensis* Beetle & Young-Wyoming big sagebrush. Though each subspecies may occur in distinct in pure stands, introgression may blur the distinctions at contact points.

Artemesia tridentata ssp *vaseyana* (top photo), May 22 2004, growing near the summit of Grizzly Mountain, Crooked River National Grassland, Crook County, Oregon. Note the flower stalks that all arise from the top of the shrub, resulting in a rather flat-topped profile. A close-up view of the foliage (below) shows leaves intermediate between the long, relatively narrow and wedge-shaped *A. t. tridentata* and the shorter bell-shaped *A. t. wyomingensis*. This specimen was growing on the west-facing slope at just below 1697 m (5600 ft), in association with *juniperus occidentalis* and *Pinus ponderosa.*

VEGETATIVE CHARACTERISTICS

	A. t. tridentata	*A.t. wyomingensis*	*A.t. vaseyana*
Form and structure	Erect, rounded or somewhat spreading crown, 1-2 m (3 to 10 ft), often with a thick single trunk. Occasionally a dwarf shrub or treelike to 5 m (16 ft).	Rounded uneven crown 46-76 cm (18 to 30 in) tall, main stem usually branched at or near ground level into 2 or more substems.	Flat-topped compact crown, generally < 76 cm (30 in) height.
Leaves	Long, wedge-shaped, much longer than wide, leaf margins straight.	Short, broad at the tip, tapering sharply at the base, leaf margins inrolled.	Leaves intermediate in shape, leaf margins straight.
	Persistent leaves 3-lobed, deciduous leaves non-lobed, 1 – 3 cm long		
Stems	Grayish shredding bark on older stems, young twigs densely hairy		

Appendix 6

GENERAL HABITAT CONSIDERATIONS

	A. t. tridentata	*A .t. wyomingensis*	*A .t. vaseyana*
Soil Types and Conditions	Generally occurs on deep, well-drained, and generally fertile soils. Intolerant of alkaline conditions.	Occurs on frigid, mesic, and xeric soils of silty, clayey, skeletal, and mixed textures. Tends to grow on shallowest, most well-drained, and hottest soils relative to the other 2 subspecies.	Moderately deep, well-drained, slightly acid to slightly alkaline soils, variable in texture, though finer textures are favored.
Moisture requirements	250-460 mm (10 to 18 in) per year. Frequently coincides with high water tables or deep moisture accumulations.	200-300 mm (7-12 in) per year. Most precipitation occurs as rain.	Characterized by late-melting winter snow cover and summer moisture. Tends to occupy soils that are wetter and cooler than those occupied by A . t. wyomingesnsis.

A very robust *Artemesia tridentata* ssp *tridentata* (top photo), May 8 2004, growing near the marina at Lake Billy Chinnok, The Cove Pallisades State Park, Jefferson County, Oregon. The specimen is in excess of 2 m in height. *Balsamorhiza sagittata* grows in the foreground.

Prepared by Stephen Dowlan, May, 2004

Appendix 6

VEGETATIVE CHARACTERISTICS

	A. t. tridentata	*A .t. wyomingensis*	*A .t. vaseyana*
Forage and Palatability	Least palatable. May serve as emergency food during severe winter weather, but it is not usually sought out by livestock or wildlife. May be heavily used, particularly during winter when preferred taxa are not available.	Second most palatable. Regional differences in ungulate use of *A. t. wyomingensis* relative to other big sagebrush subspecies. Moderately palatable to cattle and domestic sheep. Heavily browsed by pronghorn fall through spring, by rabbits and hares in winter, and by sage grouse.	Most palatable. Described as a highly preferred and nutritious winter forage for mule deer. USDA "Hobble Creek" cultivar is a highly preferred sagebrush that exceeds most other winter forage values in energy, protein, phosphorus, and carotene.
	In general, big sagebrush is highly digestible and nutritious, though levels of crude terpenoids can reduce palatability. Though eaten by domestic sheep and cattle, big sagebrush subspecies have generally been considered to be of low palatability to domestic livestock.		
Wildlife Use	Poor to good cover value for pronghorn, bighorn sheep, elk, mule deer, small mammals, non game birds, and upland game birds. Provides important cover for sage grouse.	Provides cover for pronghorn , bighorn sheep, rabbits and hares, shrub-nesting birds, and some ground-nesting birds including sage grouse. Cover of mature shrubs is especially important to pronghorn fawns and sage grouse broods.	Fair to good cover value for pronghorn, bighorn sheep, elk, mule deer, small mammals, non game birds, and upland game birds.

Artemisia tridentata ssp. *wyomingensis,* Washoe County, Nevada. Photos Copyright © 2000 Gary A. Monroe (Calphotos).

Appendix 6

PLANTING

	A. t. tridentata	*A .t. wyomingensis*	*A .t. vaseyana*
Growth Season	Evergreen. New leaf production begins in spring. Smaller unlobed ephemeral leaves produced in late winter and early spring and retained until onset of summer drought. Larger lobed perennial leaves develop slowly from late spring until July, retained until second summer.		
Establishment	Emergence of seedlings on burned soil reduced compared to emergence of the other 2 subspecies.	Particularly recommended on dry upland sites where other shrubs are difficult to establish. Seedling growth is slow compared to growth of other subspecies.	Addition of topsoil increases plant cover in one study.
	Wind is the primary dispersal agent, although animal and water dispersal can also occur. Germination may occur during winter or even late fall at mild winter sites , but at cold winter sites, may be delayed until snowmelt. Seedling survival often depends on precipitation. Seedlings under mature sagebrush plants are more likely to survive, and survival tends to be lower in grazed and unsheltered areas. Reestablishment may be inhibited in areas that lose sagebrush cover due to frequent fire and become dominated by nonmycorrhizal species (such as cheatgrass).		
Propogation	Plants 2 to 3 years of age are capable of producing viable seed. Approximately 90% of big sagebrush seed is dispersed within 9 m (30 ft) of the parent shrub. Grows rapidly and spreads readily from seed. Can be broadcast-seeded or drilled, however, it is important to select site-specific seed. Seedlings can be easily transplanted. Wild plants are best moved while dormant in winter. *A. t. vaseyana* can reproduce vegetatively by layering.		

DISTURBANCE

Response to Grazing: All three subspecies are likely to increase under heavy grazing, though *A. t. wyomingensis* will increase relatively less than the other two.

Response to Fire: None of the three subspecies resprout after fire.

Response to Drought: Drought delays reestablishment of stands after fire or other disturbance. *A .t. wyomingensis* is the most drought tolerant of the 3 major subspecies. Drought conditions favor establishment of this subspecies over perennial bunchgrasses.

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Appendix 6

Antelope Bitterbrush
Purshia tridentata (Pursh) DC

This **Native shrub** is an early colonizer on disturbed sites, perhaps aided by its nitrogen-fixing capacity. In areas where antelope bitterbrush dominates and natural regeneration is not occurring, old, decadent antelope bitterbrush may be the climax community.

Plant Characteristics

Close-up of *Purshia tridentata* leaves and flowers, May 8, 2004, Lower Desert, Crooked River National Grassland, Rd. # 63, Jefferson County, Oregon. Photo by Stephen Dowlan.

VEGETATIVE CHARACTERISTICS

Form and Stature: Shrub with two common ecotypes, both present throughout its range: multiple-stemmed, decumbent plants, and single-stemmed, columnar plants. Decumbent form is more prevalent at higher elevations. Plants may reach 3.6-4.5 m (12-15 ft) in height, but usually grow to 0.9-1.2 m (3-4 ft).
Leaves and Stems: Deciduous, wedge-shaped with 3 -toothed tips, silvery-greenish above andgreyish below, hairy to wooly. Leaf edges usually rolled under. Branches rigid, bark gray or brown, twigs covered with dense wooly hairs.
Inflorescence: Numerous solitary flowers, bright yellow and funnel-shaped, with 5 deciduous petals on a hairy and glandular calyx.
Roots: Long taproot or taproots reach up to 4.5-5.4 m (15-18 ft), with a few shallow roots. Sometimes has nitrogen-fixing root nodules, a result of a symbiotic association with *Frankia* spp. actinomycetes.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Common on well-drained, permeable, coarse-textured soils and on finer-textured soils with high stone content, including lava outcrops. Frequent on highly calcareous, fine-textured sedimentary soils, but also occurs on loamy sand and silty loams. Soil pH ranges from slightly acidic to basic, but it does not tolerate saline soils.
Moisture/temperature requirements: Found on all slopes and aspects from 900-3,000 m (3,100-10,000 ft) elevation. Average annual precipitation varies from 300-910 mm (12-36 in) and usually falls as winter snow. Survives on rocky and arid sites due to its long taproot or taproots. Seedlings can tolerate extremely high surface soil temperatures.

Stand of of flowering *Purshia tridentata* and *Artemesia tridentata* ssp. *vaseyana,* May 23, 2004, riparian area on the north slope of Gray Mountain , Crooked River National Grassland, Rd. # 57, Jefferson County, Oregon. Juniper had been removed from a buffer of 50 ft on either side of the scour channel, and the area was fenced to exclude cattle grazing. Photo by Stephen Dowlan.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Antelope Bitterbrush
Purshia tridentata (Pursh) DC

UTILIZATION

Forage and Palatability: Palatability good to very good for all types of livestock and wildlife in almost all areas. Browsed extensively by pronghorn, mule deer, elk, bighorn sheep, and moose. Preferred by cattle from mid-May through June and again in September and October. Domestic livestock may compete with mule deer for browse in late summer, fall, and/or winter. Winter use is greatest during periods of deep snow. Seed is a large part of the diets of rodents, especially deer mice and kangaroo rats.
Wildlife Use: Provides good cover for sage grouse when 30.5 cm (12 in) or shorter. Generally considered to be good cover for mule deer and for pronghorn, though decadent fire-excluded stands over 0.6 m (2 ft) tall are no longer as valuable.

PLANTING

Growth Season and Seedling Establishment: Cool season shrub. Flowers from early spring to July. Fruits ripen from July-September, depending on elevation. Establishment of plants from planted seeds is difficult and requires optimum seedbed preparations, including good weed control. Fall seeding is most likely to succeed, with seed that is 2-3 years old and planted to a depth of 3.8 cm (0.5-1 in). Propagation from stem cuttings or containerized plants may be more successful. Seedlings grow rapidly. Because ecotypal variation, it is important that the ecotype selected as a seed source matches the intended environment.
Propagation: Reaches seed-bearing age in 8 to 10 years, depending on local site conditions. Achenes fall beneath parent plants when mature and dry. Seeds are dormant and require cool-moist stratification or damage to the seedcoat by mechanical scarification, chemical treatment, or soaking in aerated water for 1 to 2 weeks to break dormancy. Artificial seeding processes that do not bury the seed are rarely successful because conditions needed for germination do not usually exist for long on the soil surface. Rodent caches are often crucial to natural regeneration. Decumbent plants may layer. Highly self-incompatible.

DISTURBANCE

Response to Grazing: Cattle grazing that removes competition from perennial grasses may favor bitterbrush. Browsing may increase vigor of older plants, though heavy use by domestic sheep may eliminate young plants from stands. Old plants tend to put more energy into seed production than twig/canopy production unless stimulated by browsing.
Response to Fire: Highly susceptible to fire kill. Some ecotypes sprout following fire, (from dormant buds encircling an aboveground root crown, from calluses of meristematic tissue beneath the bark, or from dormant buds on a belowground lignotuber). Very young and very old plants (younger than 5 or older than 40-60 years) do not sprout well.
Response to Drought: Drought resistence varies with ecotype, though the long taproot ensures excellent resistance in fractured rock and other deep substrates.

Purshia tridentata leaves and flowers, May 8, 2004, Lower Desert, Crooked River National Grassland, Rd. # 63, Jefferson County, Oregon. Photo by Stephen Dowlan.

Sources:

1. Parish, R, R. Coupe and D. Lloyd. 1996. Plants of southern interior British Columbia and the inland Northwest. B. C. Ministry of Forests and Lone Pine Press, Auburn, WA.

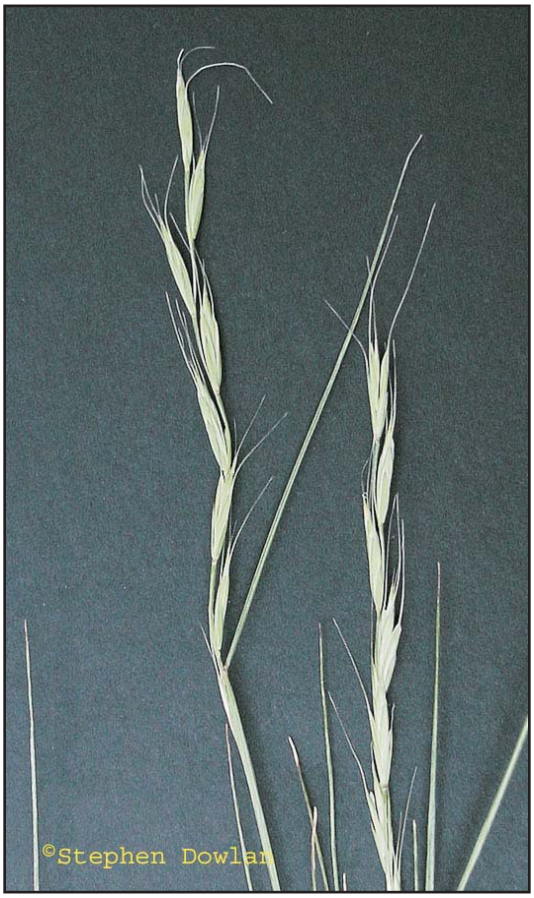
2. Zlatnik, Elena. (1999, January). Purshia tridentata. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

Appendix 6

Bluebunch Wheatgrass

Pseudoroegneria spicata (Pursh) A. Löve

There are two subspecies of this long-lived **native bunchgrass**; *Pseudoroegneria spicata* ssp. *spicata,* which has divergent awns, and *P. spicata* ssp. *inerme* (beardless bluebunch wheatgrass), which lacks divergent awns. The two subspecies are conterminous and hybridize. Bluebunch wheatgrass is also known to cross with *Elytrigia repens (*quackgrass), *Elymus lanceolatus (*thickspike wheatgrass) and *Elymus elymoides* (bottlebrush squirreltail).



Inflorescence of *Pseudoregneria spicata* ssp *spicata*, displaying seed awns that are not yet divergent, or "bent." Note the wavy appearence of of the stalk. This pressed specimen was collected on May 5, 2004, on the saddle between Gray Butte and Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan

VEGETATIVE CHARACTERISTICS

Culms and leaves: Highly variable, erect culms 30-100 cm (12-30 in) tall. Leaves are lax, flat to inrolled, 4-6 mm (0.16-0.24 in) wide, and green to blue. Leaf sheaths are generally smooth and hairless. Reproductive stems are erect, slender, and sometimes wiry, with a wavy floral stalk. Auricles are pointed and semi-clasping or nearly lacking.
Inflorescence: A single spike 7.5-20 cm (3 to 8 in) long. Seeds have a bristle or awn, except for beardless type in which awn is lacking.
Roots: Extensive, may reach over 2 m (6.6 ft) in depth, with a lateral spread of up to 51 cm (20 in), with a heavy endodermis that prevents desiccation in dry soil conditions.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Requires excellent drainage on medium to coarse textured soils at least 25 cm (10 in) deep. Will tolerate fairly clayey, sandy, and thin rocky sites. Does not tolerate extended inundation, highly acidic, or salty sites.
Moisture/temperature requirements: Most abundant within 20-51 cm (8 to 20 in) annual precipitation, though will tolerate as little as 15 cm (6 in) and as high as 89 cm (35 in). Cold tolerant and moderately shade tolerant. Elevation ranges from 150-3048 m (500-10,000 ft).

This robust stand of Bluebunch Wheatgrass was photographed on May 20, 2004 the middle north slope of Pine Ridge in a recently burned area, Crooked River National Grassland, Jefferson County, Oregon on May 20, 2004. Photo by Stephen Dowlan.

Cultivars:
Antone (*Pseudoroegneria spicata* ssp. *spicata)* from RMRS Shrub Sciences Laboratory, 2003.
Columbia (*Pseudoroegneria spicata)* fromUSDA-ARS Forage & Range Research Laboratory, for release in 2004.
Goldar (*P. spicata* ssp. *spicata*) from Idaho-Utah AES, ARS and the Aberdeen, ID Plant Materials Center, 1989.
Whitmar (*P. spicata* ssp. *inermis*) from the Oregon-Washington AES and Aberdeen, ID Plant Materials Center, 1946.
P-7 (*Pseudoroegneria spicata)* fromUSDA-ARS Forage & Range Research Laboratory, 2001

Appendix 6

Management Considerations

Bluebunch Wheatgrass

Pseudoroegneria spicata (Pursh) A. Löve

UTILIZATION

Forage and Palatability: Palatable to all classes of livestock and wildlife, though not necessarily the most preferred species. Older plants lose palatability. Can be used for hay, though more suitable as range pasture.
Wildlife Use: Preferred feed for elk, deer and antelope at various times of the year. Does not generally provide sufficient cover for ungulates, though stands will be well-used if sufficient cover is nearby.

PLANTING

Growth Season and Seedling Establishment: Cool season long-lived perennial. Requires a firm weed-free seedbed. Seeding results are best in very early spring on heavy to medium textured soils - late fall on medium to light textured soils. Though suitable for seed mixes, should not be mixed with strongly competetive introduced species.
Propagation: Mostly by seed, but may also spread via tillers when moisture is above 46 cm (18 in). Does not flower or produce seeds every year. Seedling stablishment is often poor, though seeds may germinate under a broad range of conditions. Will germinate under appropriate fall conditions. Not considered weedy or invasive.

DISTURBANCE

Response to Competition: Well-established cheatgrass and medusahead roots are able to grow at colder temperatures and can continue to grow through the winter, utilizing all available soil moisture. Introduced wheatgrass species can recover from defoliation more rapidly and with greater canopy cover, and extract moisture from deeper underground. Though not very resistent to knapweed species invasion, established stands can effectively resist cheatgrass invasion.
Response to Grazing: Easily overgrazed. New stands can be grazed after 2 growing seasons, and after flower initiation. Spring grazing should occur no more than 1 out of 3 years, should be delayed until flowers are halfway emerging from the protecting leaf, and no more than 40% utilization should occur during rapid growth. No more than 60% utilization should occur after seed ripens.
Response to Fire: Very tolerant. Plants are generally undamaged or even invigorated by summer and fall fires. Some mortality occurs from spring fires.
Response to Drought: Very tolerant.

Inflorescence of *Pseudoregneria spicata* ssp *spicata*, May 20, 2004, north slope of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan

Sources:

1. Native Seed Network Plant Material Profiles (P-7, Antone, and Columbia Bluebunch Whetagrass). http://www.nativeseednetwork.org/resources/pm_list.php [Accessed May 30 2004]

2. Ogle, D. (2002, Feb.) Bluebunch Wheatgrass, *Pseodoregeneria spicata*. In: Plant Materials Program Web site, http://plants.usda.gov Accessed January, 2004

3. Parish, R, R. Coupe and D. Lloyd. 1996. Plants of southern interior British Columbia and the inland Northwest. B. C. Ministry of Forests and Lone Pine Press, Auburn, WA.

4. Zlatnik, E. (1999, March). Pseudoroegneria spicata. In:Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [Accessed January, 2004]

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Bottlebrush Squirreltail

Elymus elymoides (Raf.) Swezey

Native bunchgrass - This mid seral species is excellent for use in reclamation sites that are in poor condition. It also has a very high potential for use as a conservation and range improvement plant. It is sometimes called bristlegrass, bushtail, or foxtail.

Plant Characteristics

Infloresence of *Elymus elymoides* collected on May 23, 2004, in Crooked River National Grassland, just west of the intersection of U.S. Highway 26 and Rd #57, Jefferson County. The plant was growing along the road, but was not as common more than 50 feet in from the roadside. Photo by Stephen Dowlan.

VEGETATIVE CHARACTERISTICS

Culms and leaves: Densely-tufted bunchgrass with erect culms, 10 -60 cm (4.5-24.5 in). tall. Leaves flat to rolled, with finely hairy surfaces. Auricles claw-like on some blades, short ligules.
Inflorescence: Bristly seed spikes 2-17 cm (0.8-6.7 in) long. 2-3 spikelets per node, breaking apart easily. Narrow glumes and lemmas extend into long (3-10 cm.) spreading awns. Mature heads twist, giving it a bottlebrush or squirreltail appearance.
Roots: Fibrous roots penetrate to 100 cm (39.4 in) or more, spreading laterally to 40 cm (16 in).

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Inhabits a wide variety of well-drained soil types. Widely distributed on dry, gravelly soils, tolerant of saline and alkaline soils. Also found on clayey soils undifferentiated, disturbed, shallow and stony soils, and loose, ashy soil. Not common within wet areas, as along watercourses and irrigation canals.
Moisture/temperature requirements: Very broad ecological amplitude, found in areas with 20-51+ cm (8-20+ in) annual precipitation. and elevations to 3485 m (11,500 ft). Optimal soil temperature for root and shoot growth in the Great Basin occurs at approximately 25°C (77° F) soil temperature, though has shown continuous root growth down to 5° C (41° F).

Foliage of *Elymus elymoides,* May 9 2004, on the northwest flank of Pine Ridge along Rd # 57, Crooked River National Grassland, Jefferson County, Oregon. Note the pubescent blades and culms. This plant was not yet flowering. Photo by Stephen Dowlan.

Prepared by Stephen Dowlan, May, 2004.

Cultivars:
Joe Tam Creek (*Elymus elymoides* ssp. *californicus)* from USDA-ARS Forage & Range Research Laboratory, 2003.
Fish Creek (*Elymus elymoides* ssp. *elymoides)* from USDA-ARS Forage & Range Research Laboratory, 2003.

Appendix 6

Management Considerations

UTILIZATION

Forage and Palatability: Considered moderately palatable to livestock when green in spring or in winter when awns are not present. Mature awns may damage the mouth, eyes, and ears of grazing animals, producing inflammation.
Wildlife Use: Eaten by mule deer, pronghorn, ground squirrels, cottontails and jackrabbits. Generally considered poor cover for deer, elk and pronghorn.

PLANTING

Growth Season and Seedling Establishment: Cool season short-lived perennial grass. Phenology highly variable with phenotype, elevation, and moisture/temperature regime. Dry seeds require a period of afterippening, which widens environmental conditions conducive to germination. Moderate trampling may enhance seedling germination.
Propagation: Can produce large numbers of seeds with relatively rapid germination. Also regenerates from surviving root crown. Vegetative propagation is nonexistent. Dispersed by long reflexed awns and disarticulating mature inflorescence which is carried along the ground by wind catching the awns.

DISTURBANCE

Response to Competition: Early spring growth and ability to grow at low temperatures contributes to the persistence and ability to invade rangelands dominated by cheatgrass, medusahead, and Japanese brome. Studies suggest that, under proper management, a successional sequence of cheatgrass to medusahead to bottlebrush squirreltail- dominated sites is possible for northern Great Basin areas receiving greater than 279 mm (11 in) of precipitation. Seeds from plants of lower elevations have a greater probability of autumn germination than cheatgrass. Will readily establish in pinyon-juniper tree litter when a fermentation layer is not present.
Response to Grazing: Most vulnerable to heavy grazing in early spring, when root carbohydrate reserves are lowest. Most tolerant to herbage removal at seed maturity. Winter grazing has a relatively minor effect on crown cover. Generally avoided when awns are present and other species are available.
Response to Fire: Low density above ground plant tissue produces a quick, hot flame, transferring little heat to growing points below the soil surface . Though generally top-killed by fire, its small size and low density of coarse fuel per unit of basal area make it relatively fire tolerant.
Response to Drought: Very tolerant.

Comparison of infloresences *Taeniatherum caput-medusae* (left) and *Elymus elymoides* (right). Both pressed specimens were collected on May 23, 2004, in Crooked River National Grassland, just off U.S Highway 26. Note the shorter awns of the glumes below the longer awns of the lemmas for *T. caput-medusae*. The awns of the lemmas and glumes of *E. elymoides* appear to be more-or-less equal in length, and the spike is usually longer. Photo by Stephen Dowlan

Bottlebrush Squirreltail

Elymus elymoides (Raf.) Swezey

Sources:

1. Native Seed Network Plant Material Profiles (Fish Creek Squirreltail and Toe Jam Squirreltail). http://www.nativeseednetwork.org/resources/pm_list.php Accessed May 30 2004

2. Pratt, M, J. Bowns, R. Banner and A. Rasmussen. 2002. Squirreltail. In: Range plants of Utah, Utah State University Extension, http://extension.usu.edu/rangeplants/Grasses/squirreltail.htm. Accessed January, 2004.

3. Simonin, Kevin A. (2001, March). *Elymus elymoides*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

Appendix 6

Cheatgrass
Bromus tectorum L.

The introduction of this **annual** to North America probably occurred independently at least several times, by both intentional and unintentional means. It has since spread into adjacent rangeland, where it was adapted to local environmental conditions. Its rapid expansion into the intermountain west has coincided with a period of excessive livestock grazing in an ecosystem comprised of native plants that apparently did not evolve with heavy grazing pressure

Plant Characteristics

Culm of *Bromus tectorum* collected on May 8 2004 at Haystack Reservoir, Crooked River National Grassland, Jefferson County, Oregon. Note the fine hairs that are typical of leaves and culms of this species. Photo by Stephen Dowlan.

HISTORICAL NOTES

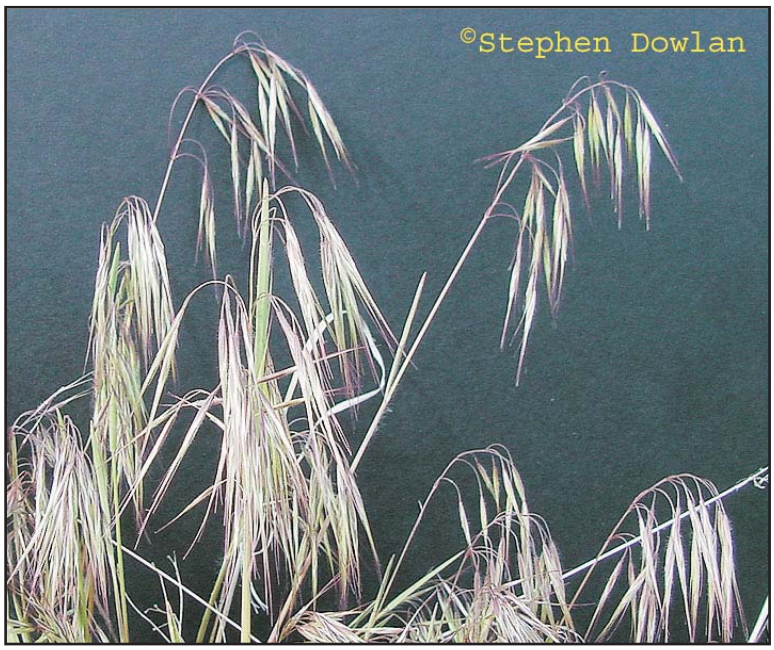
Introduced into the U.S. from the Mediterranean region in packing materials and possibly as a contaminatnt of seed crops. Spread rapidly in the late 1800s and early 1900s, associated with heavy livestock use, homesteading, and cultivation of winter wheat. Became the dominant grass over entire PNW counties by the 1930s. It occurs in all 50 states and parts of Canada and Mexico.

VEGETATIVE CHARACTERISTICS

Culms and leaves: Soft, short-hairy throughout, with solitary stems (or a few-stemmed tuft) 10-60 cm (4-24 in) tall. Leaf blades are up to 20 cm (8 in) long, relatively flat, 2-5 mm. (0.07-0.20 in) wide and long-cilliate near the base, auricles lacking Membranous ligules 1-2 mm. (0.04-0.08 in) long, fringed at the top .
Inflorescence: A soft and drooping much-branched open panicle, 5-20 cm (2-8 in) long with up to 8 spikelets 2.5-5 cm (1-2 in) long (including awns), becoming dull red-purple at maturity.
Roots: Finely divided, fibrous, with an average of 7 main roots that grow rapidly, spreading laterally and vertically. Can penetrate 86-152 cm (34-60 in) or more, but mostly concentrated in the top 30 cm (12 in) of soil.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Grows in almost any type of soil, but does best on deep loamy or coarse-textured soils. Medusahead is more likely to dominate on fine-textured soils. Can grow on calcareous and saline soils. Thrives and often dominates under conditions of increased nitrogen availability
Moisture/temperature requirements: Adapted to a variety of climatic conditions. Found in communities that receive 150 mm (6 in) of annual precipitation, and in high-elevation coniferous forests that exceed 640 mm (25 in). Tends to be most invasive in areas receiving 30-56 cm (12 to 22 in) that peaks in late winter or early spring. Extremely cold tolerant, as indicated by plants surviving winter lows of -23° C (-10 ° F), with only very slight injury to leaves. Has been found up to 4000 m (13,000 ft) elevation in the United States.



Inflorescence of very robust *Bromus tectorum* collected on May 8 2004 at Haystack Reservoir, Crooked River National Grassland, Jefferson County, Oregon. Plants growing on the the bank of the reservoir recieved abundant moisture, and were over 50 cm tall. Photo by Stephen Dowlan.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Cheatgrass
Bromus tectorum L.

UTILIZATION

Forage and Palatability: Palatable to all classes of livestock when green (usually for about 6 weeks early spring). Quality and palatability declines as plants dry. In warm dry regions, can provide important winter range for cattle. Dry cheatgrass herbage can greatly increase mouth infections in cattle , and the sharp seeds can cause severe eye injuries.
Wildlife Use: Used for forage by bighorn sheep, mule deer and pronghorn at various times of the year, as well as several small mammals and grasshoppers. Also a major component in the diet of many upland game birds, especially chukar.

PLANTING

Growth Season and Seedling Establishment: Cool season annual. Recruitment is usually concentrated in late summer and autumn, but can occur at any time. Establishment is favored at low temperatures compared to cultivars of crested and bluebunch wheatgrass. Grows in a narrow range of soil temperatures, with growth starting just above freezing and stopping when soil temperatures exceed 15° C (60° F). Germination is inhibited on sites with well-developed biological soil crusts (which prevent seed burial) and low plant litter, though crusts are no barrier to root development after germination.

Proliferation results from cultivation and subsequent land abandonment, excessive livestock grazing, overstory removal, and repeated fires, acting singly or interacting. A prolific seed producer (25-400 seeds per plant) which generally produces so many seeds that subsequent plant density is more related to the number of available sites in the seedbed capable of supporting germination. Can produce enough seed to perpetuate itself even in unfavorable years. Production of 2 successive sets of inflorescences in a single growing season is fairly common. Seeds fall to the soil surface near the parent plant, or are spread short distances by wind or water. Long-distance dispersal is facilitated by humans and wild and domestic animals. Plants in in sparse populations following fire can produce abundant tillers, each supporting many flowers, which produce large seed crops.

DISTURBANCE

Eradication and Control: Eradication is not a reasonable goal in most situations. In areas where desirable perennial species are still abundant, control measures must consider the needs of these species. Control strategies must include replacement with desirable perennials, and caution must be exercised so that favorable conditions for medusahead establishment are not created.
Response to Tilling: Must be 10-15 cm (4-6 in) deep in order to bury seeds and prevent germination. Multiple treatments are usually necessary.
Response to Competition: High densities can lead to complete community type conversions (perennial bunchgrass, sagebrush, salt-desert shrub, or pinyon-juniper communities to cheatgrass monocultures). May simply be a part of the understory at low densities. Bottlebrush squirreltail, a cold season native perennial, appears compete well with cheatgrass after fire.
Response to Grazing: Can tolerate repeated grazing, heavy trampling, and manuring, though it can (practically) be eliminated by uniform heavy spring grazing, though this is also likely to reduce or eliminate native perennial bunchgrasses as well. Once it is present, removal of livestock increases cheatgrass seed production. Cattle grazing can reduce the accumulation of cheatgrass litter, reducing the fire hazard on a site.
Response to Chemicals: Paraquat can be applied for at the vegetative growth or dough stage for at least two years, or Glyphosphate can be applied for three consecutive years for control. Damage to desirable perennials must be avoided.
Response to Fire: Highly flammable in spring and summer after maturation. A strong competitor in postfire environments, often producing an abundant seed crop. When fire frequency continues to increase so that all perennial shrubs, grasses, and forbs are excluded, cheatgrass competition prevents their reestablishment. Use of less flammable species as a barrier (greenstripping) to continuous fuels can be effective in disrupting an established cheatgrass/wildfire cycle.
Response to Drought: Causes rapid depletion of soil moisture, suppressing perennial bunchgrasses, but even small young plants usually manage to produce a few seeds.
Response to Biological Control: As of 1998, no biological control agents (insects or fungi) were approved for use.

Sources:

1. Mosely, J. C., S. C. Bunting and M. E. Manoukian. 1999. Cheatgrass. In: Biology and management of noxious rangeland weeds (R. L. Shelby and J. K. Petroff, Eds.) Oregon State University Press, Corvallis, OR.

2. Neese, E. 2000. Downy Brome (*Bromus tectorum*). In: Plant Materials Program Web site, http://plants.usda.gov/ Accessed January, 2004

3. Zouhar, Kris. (2003, January). *Bromus tectorum*. In:Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004.

Appendix 6

Crested Wheatgrass
Agropyron cristatum (L.)

This **Introduced bunchgrass** readily crosses with desert wheatgrass (*A. desertorum*) to produce fertile hybrids, the most common of which is called 'Hycrest.' Some systematists do not consider crested and desert wheatgrass to be distinct species.

Plant Characteristics

Inflorescence of *Agropyron cristatum*, May 20, 2004, south slope of Grizzly Mountain, Crooked River National Grassland, Crook County, Oregon. Photo by Stephen Dowlan

VEGETATIVE CHARACTERISTICS

Culms and leaves: Bunchgrass with erect culms, 25-100 cm (10-40 in) tall, leafy, in a dense tuft. . Leaves flat, smooth below, slightly coarse above and vary in width from 2 - 6 mm (0.08-0.24 in).
Inflorescence: Seed spikes 3.8-7.6 cm (1.5 to 3 in) long. Spiklets flattened, closely overlapping, located (flatwise) at a slight angle on the rachis of flower stem. Lemmas generally narrow to a short awn, glumes firm, keeled, tapering into a short bristle.
Roots: Finely branched and fibrous, penetrate up to 2.4m (8 ft) though most roots extend a depth of 1 m (3.3 ft).

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Will grow on a wide range of soil types, though vigor and production are reduced in loose sandy soils, heavy clays, and saline soils (d*esertorum* type is more tolerant of saline conditions). Can withstand moderate periodic flooding in the spring, but will not tolerate long periods of inundation, poorly drained soils or excessive irrigation. Can survive on extremely shallow soils. Does not establish well in crusted or fine-textured soil.
Moisture/temperature requirements: Thrives in 305-406 mm (12-16 in) annual precipitation. Very cold tolerant, grows in areas with frost-free periods less than 140 days. Elevation range-wide 600-2740 m (1900-9040 ft).

Inflorescence of *Agropyron cristatum*, May 20, 2004, south slope of Grizzly Mountain, Crooked River National Grassland, Crook County, Oregon. Photo by Stephen Dowlan

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Crested Wheatgrass
Agropyron cristatum (L.)

Management Considerations

UTILIZATION

Forage and Palatability: Palatable to livestock and wildlife and is a desirable feed in spring and in the fall (if it re-grows enough). Used for cattle and horse winter forage with if protein is supplemented. **Wildlife Use:** Birds and small rodents eat crested wheatgrass seeds; deer, antelope and elk graze it, especially in spring and fall. Upland game and song birds utilize stands for nesting.

PLANTING

Growth Season and Seedling Establishment: Cool season long-lived perennial. Greens-up 2-4 weeks earlier than native bunchgrass species.Best seeding results in very early spring on heavy to medium textured soils - late fall on medium to light textured soils. **Propagation:** Mostly by seed, but may also spread via tillers. Not considered weedy or invasive. Generally heavy seed producer. Seeds dispersed close to mother plant. May be rhizomatous when moisture exceeds 36 cm (14 in).

DISTURBANCE

Response to Competition: Germinates early and grows rapidly in cool temperatures, resulting in good resistance to competition from winter annuals. However, rhizomatous native grasses that propagate without setting seed compete well with crested wheatgrass. Heavy seeding in mix with native species may still result monoculture. May discourage establishment of native bunchgrasses, especially in arid and heavily grazed areas. Stand mortality is apparently virtually unknown except due to extreme drought at critical phenological stages.
Response to Grazing: Withstands heavy grazing pressure (65% use and greater) once stands are established. Spring/fall deferment or grazing rotations recommended. Six inches of new growth should be attained in spring before grazing is allowed in established stands Three inches of stubble should remain at the end of the grazing season.
Response to Fire: Burns quickly, usually with little heat transfer into the soil, resulting in little damage to tillers and root systems. May be favored by late summer fire, though spring fire can decrease yields for up to several years.
Response to Drought: Very tolerant.

Sources:
1. Ogle, D. (2002, Feb.) Crested Wheatgrass (cristatum type), *Agropyron cristatum*. In: Plant Materials Program Web site, http://plants.usda.gov/ Accessed January, 2004
2. Parish, R, R. Coupe and D. Lloyd. 1996. Plants of southern interior British Columbia and the inland Northwest. B. C. Ministry of Forests and Lone Pine Press, Auburn, WA.
3. Zlatnik, E. (1999, February). Agropyron cristatum. In:Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

New growth with previous year's culms of *Agropyron cristatum*, May 6, 2004, Grizzly Allotment, Crooked River National Grassland, Crook County, Oregon. Photo by Stephen Dowlan

Cultivars:
Douglas (former USSR, Iran and Turkey) is suitable for roadsides.

Ephraim (Turkey) is rhizomatous in areas of high precipitation, and is suitable for disturbed areas, mine spoils, roadsides and turf applications.

Parkway is suitabled for hay and pasture.

Hycrest (central Asia/former USSR) is easier to establish than either parent type, and is more productive during the establishment period than either parent.

Appendix 6

Diffuse Knapweed
Centaurea diffusa Lam.

First recorded in North America in 1907 in an alfalfa field in Bingen, Washington, this **non-native forb** originated in grasslands and shrub steppes of the eastern Mediterranean and western Asia. All of the knapweds introduced from Eurasia represent a threat to pastures and rangelands. Expansion of distribution has been very rapid since 1989.

Plant Characteristics

Inflorescence of *Centaurea diffusa*, August 1 1984, California. Photo © 2001 California Dept. of Food & Agriculture, Botany. Photographer Craig Thornsen. (Calphotos).

Flower of *Centaurea diffusa*, July 1 2002, Greenhorn Rd., Siskiyou County, California. Photo © 2002 Molly Elizabeth Bagley (Calphotos)

VEGETATIVE CHARACTERISTICS

Form and Stature: Short-lived annual, biennial, or perennial forb with upright erect stems and numerous spreading branches, growing from 0.3-0.9 m (1-3 ft) tall. Plants have a ball-shaped appearence, and have a tumble weed-like behavior when broken.
Leaves and Stems: Deeply divided basal leaves on short stalks form rosettes. Stalkless stem leaves become progressively smaller and less divided toward the upper stem.
Inflorescence: Flower heads are urn-shaped, 3-6 mm (0.12-0.24 in) in diameter and 8-11 mm (0.32-0.43 in) long , solitary or in clusters of 2 or 3 at the ends of branches. Yellowish-green bracts are edged with a fringe of spines, with a longer 1.5-4 mm (0.06-0.16 in), erect spine at the tip. Flowers range from white to rose-purple or lavender.
Roots: Large taproot.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions - Commonly found on well-drained sandy or gravelly loams or loamy fine sands with coarse fragments from 0 to over 80%. Less competitive on shallow soils <38 cm (<15 in) deep and very coarse textured soils such as sand or loamy coarse sand, although it may thrive on these sites when disturbance removes other vegetation.
Moisture/Temperature Requirements -Tolerant of a wide range of precipitation and temperature conditions, but does best in semiarid and arid conditions. Most competitive in areas receiving 305-432 mm (12-17 in) of annual precipitation. Not tolerant of flooded or waterlogged conditions (can be eliminated by irrigation), or heavy shade. Found on all aspects and slope positions, from sea level to 1515 m (5000 ft) in Washington.

Centaurea diffusa, September 13 1972, Washoe County, Nevada. Photo © 2001 California Dept. of Food & Agriculture, Botany (Calphotos)

Prepared by Stephen Dowlan, June, 2004.

Appendix 6

Management Considerations

Diffuse Knapweed
Centaurea diffusa Lam.

UTILIZATION

Forage and Palatability: Though rosettes of the 1st year's growth are nutritious and edible, cattle cannot utilizethem because they are too closeto the ground. Mature plants are coarse and fibrous, and the spines on the bracts may be very irritating or even cause injury to the mouths and digestive tracts of animals. Grazed by deer and domestic sheep, elk and cattle, at least through the bolting stage. Provides important forage for white-tailed deer, mule deer, and elk in the winter and early spring in some areas, though the impact of this level of consumption is not well known. Palatability is probably closely related to availability relative to other forage plants .
Wildlife Use: Provides a source of pollen and nectar for honey bees during mid to late summer when other sources are in short supply. Sometimes eaten by pest grasshoppers during outbreaks, which can reduce seed production. Birds and rodents, including chipmunks, use diffuse knapweed seeds for food, and probably cache some seed for later use. No cover data is available.

PLANTING

Growth Season and Seedling Establishment: Disturbances as small as rodent burrows and hailstorms may result in conditions suitable for knapweed establishment. Seeds germinate in the fall or spring. Seedling mortality is highest during the summer and is largely related to moisture availability. Crowding of plants can result in higher seedling mortality. Some early-germinating seeds flower the first year (from July to September). A few seeds produced from newly-established but isoalted plants can maintain and expand new populations. Seed dispersal is mainly by wind. Dispersal over longer distances results from plants that are broken off at ground level and tumble in the wind, dispensing seeds individually from the the seedheads. Vehicles of all kinds and waterways become mechanisms for dispersal when seed is moved away from the parent plant in this manner.

DISTURBANCE

Eradication and Control: Well entrenched populations must be approached with a commited, long-term, site-specific integrated management strategy that may include a combination of proper grazing management, herbicides, biological control, and prevention. Eradication has been successful for recently-established small populations.
Response to Hand Pulling: Removal of the taproot 5-10 cm (2-4 in) below the crown is effective for scattered plants, though it may need to be repeated 3-5 times in order to be effective.
Response to Mowing: Though not a control method, mowing can reduce seed production and alter phenological development. Can produce viable seed even if cut on the same day that florets emerge from the bud.
Response to Competition: Successfull invasion can occur in 'natural' rangelands and pastures.

Response to Grazing: Timing is critical (more than class of animal) in order to suppress knapweeds without damaging desirable forage species. Knapweed must be grazed when it is green and succulent at the bolting stage, but after desirable species present have entered dormancy.
Response to Chemicals: Herbicides are one of the most effective control methods in reseeding programs. Several herbicides are registered for control on rangelands. Best results are usually obtained during the rosette stage.
Response to Fire: Sprouts from the root crown after top-kill. The large perennial taproot may ensure survival fire if the root crown is not killed, even if burned during the bolting stage. Also large quantities of seed may survive fire. Closely related knapweed species do not carry fire as readily as grasses, such that dense infestations may reduce the fire return interval at a given site.
Response to Drought: Once established as rosettes, plants are very drought resistant.
Response to Biological Control: Twelve insect species have been established in the western U.S. for control of knapweed species. Effectiveness depends on site characteristics.

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1. Roche, B. F., and C. T. Talbott Roche. 1999. Diffuse Knapweed. In: Biology and management of noxious rangeland weeds (R. L. Shelby and J. K. Petroff, Eds.) Oregon State University Press, Corvallis, OR.

2. Whitson, T. D. (Ed.). 2000. Weeds of the west. Western Society of Weed Science, Newark, CA.

3. Zouhar, Kris. 2001. *Centaurea diffusa*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory Accessed June 2004

Appendix 6

Gray Rabbitbrush
Chrysothamnus nauseosus (Pall.) Britt.

Also called rubber rabbitbrush, this **native shrub** is described as the most complex and widespread species within the genus *Chrysothamnus*. Two separate series are recognized within *C. nauseosus*, a gray form and a green form. Numerous subspecies, races and ecotypes have also been identified, though morphological characteristics may be difficult to observe, and overlapping characteristics have been noted.

Plant Characteristics

Foliage of *Chrysothamnus nauseosus*, May 8 2004, Lower Desert of Crooked River National Grassland, Jefferson County, Oregon. Note that the gray-green leaves are linear and not twisted, as in the brighter green leaves of *Chrysothamnus viscidiflorus.* Photo by Stephen Dowlan

VEGETATIVE CHARACTERISTICS

Form and Stature: Native shrub growing from 31-229 cm (12-90 in), with several flexible erect stems branching from a compact base. Certain populations have been reported to reach heights of 3.3-3.6 m (10-12 ft).
Leaves and Stems: Sessile, alternate, simple, linear to filiform blades 2-6 cm (0.79-2.36 in) long and 0.5-2 mm (0.02-0.07 in). wide, straight, with dense grayish velvety hairs on both surfaces. Twigs flexible, yellowish-green, covered with dense felt-like tomentum, trunk gray-brown with small fissures, bark fibrous and and somewhat shredded.
Inflorescence: Flower heads borne in terminal cymes 5-6 cm (1.96-2.36 in) tall and wide, each with 4 series of 4-5 yellowish bracts with 5 disk flowers and a yellowish-green corolla. Floral crown is rounded.
Roots: Main taproot is deep, with less well-developed roots extending laterally.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Soil type varies with subspecies. Soils tend to be dry, well-drained, and medium to coarse-textured, ranging from moderately acidic to strongly alkaline. Also commonly grows on dry, sandy, gravelly or heavy clay. Has fair tolerance for alkaline soils.
Moisture/temperature requirements: Varies with subspecies. Generally favors sunny, open sites throughout a wide variety of habitats including open plains, valleys, drainage ways, foothills, and mountains. Particularly common on disturbed sites, and will grow on poor or productive soils. Grows at elevations between sea level to 3203 m (10,500 ft). Cold hardy to -40° C (-40° F) when mature, and tolerant of both moisture and salt stress.

Flowers of Chrysothamnus nauseosus, October 1 1959, Yosemite National Park, Big Oak Flat Road, Tuolumne County, California. *Photo by Charles Webber,* © 1998 California Academy of Sciences. Source: CalPhotos.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

UTILIZATION

Forage and Palatability: Forage value varies greatly among subspecies and ecotypes. Though all subspecies are considered to be slightly toxic to livestock, nutritional value may be fair to good. Fruit and flowers tend more palatable than other parts of the plant, and palatability of all subspecies is generally highest in fall and winter. New leaders may be preferred by some browsers. White or gray subspecies such as *C. nauseosus* ssp. *salicifolius* and *C. n.* ssp. *albicaulis* are more palatable to wildlife and livestock than are the green subspecies .
Wildlife Use: Provides good nesting cover for sage grouse and some species of songbirds, and cover for small mammals. All subspecies are generally considered to be poor cover for elk, deer, and adult pronghorn.

PLANTING

Growth Season and Seedling Establishment: Warm season short-lived (approximately 12-13 years) shrub. Well suited for revegetating disturbed sites such as road cuts, strip mines, and depleted rangelands due to its prolific seed production and relatively high germination rate. Establishment during dry years is unlikely because seedlings do not persist unless late spring rains replenish soil moisture. Once plants are established, growth is rapid. Establishment by direct seeding in late fall and winter is good to fair. Massive establishment will not occur if other species (especially perennial grasses) have already taken advantage of the site potential. Shrub control measures such as chaining may stimulate sprouting.
Propagation: Regenerates by abundant windblown seed and by resprouting after defoliation. Can become weedy or invasive.

Chrysothamnus nauseosus, May 23 2004, Road # 57, north slope of Pine Ridge, Crooked River National Grassland, Crook County, Oregon. Photo by Stephen Dowlan

Gray Rabbitbrush

Chrysothamnus nauseosus (Pall.) Britt.

DISTURBANCE

Response to Grazing: Regrows rapidly after nearly complete defoliation by spring-browsing. Commonly increases on degraded rangelands as more palatable species are removed.
Response to Fire: Due to high resin content, both foliage and stems may be consumed, top-killing the plant even with relatively high moisture content. Potential for damage to the plant is influenced by the proximity of other shrubs, which contribute additional fuel results and higher fire intensity. Regenerates after fire by sprouting and by establishing from off-site seed. Release from competition stimulates green rabbitbrush to produce large numbers of viable achenes that are widely dispersed by wind..
Response to Drought: Well adapted to drought. Flowers during summer in all but the most extreme drought years.

Sources:

1. Ball, D. A., et al. 2000. Weeds of the west (ninth edition). Western Society of Weed Science, Western U.S. Land Grant Universities and the University of Wyoming.

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Appendix 6

Green Rabbitbrush
Chrysothamnus viscidiflorus (Hook.) Nutt.

Also called low rabbitbrush and Douglas rabbitbrush, this **native shrub** is one of the most widely distributed shrubs on rangelands throughout western North America. Several subspecies and varieties with somewhat different geographic distributions, habitat preferences, and morphologies have been recognized.

Plant Characteristics

Foliage o*f Chrysothamnus viscidiflorus,* May 8 2004, Lower Desert (Road # 63), Crooked River National Grassland, Jefferson County, Oregon. Note the spiral appearence to the leaves and the greenish color of the bark, in contrast to the straight leaves and whitsh bark of *Chrysothamnus nauseosus*. Photo by Stephen Dowlan.

VEGETATIVE CHARACTERISTICS

Form and Stature: Low shrub growing from 0.3-1.1 m (1 to 3.6 ft) with many brittle, erect stems branching from a compact base.
Leaves and Stems: Alternate simple linear to lanceolate blades 1-4 cm (0.39-1.57 in) long and 2-7 mm (0.07-0.28 in) wide, glabrous,and spirally twisted. Twigs stiff, brittle, striate, greenish, trunk bark light brown and shredded.
Inflorescence: Flower heads borne in terminal cymes 5-6 cm (1.96-2.36 in) tall and wide, each with 5 series of 3-5 yellowish bracts with 4-6 disk flowers with yellow corollas. Floral crown moderately rounded to flat-topped.
Roots: Main taproot reaches at least 0.6 m (1.9 ft) deep, with many major secondary roots extending laterally.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Prefers dry, well-drained medium to coarse-textured soils. Has fair tolerance for salty conditions and will grow on alkaline soils. Exhibits an affinity for calcium.
Moisture/temperature requirements: Grows on open ridges, on slopes, and along drainageways. Most commonly found at elevations between 790 and 3,350 m (2,600 and 11,000 ft) The three subspecies overlap in range but have somewhat different ecological requirements, with *Chrysothamnus viscidiflorus* ssp. *puberulus* generally occuring at lower elevations on dry plains, valleys, and foothills, particularly on poorer soils and in disturbed areas.

Foliage of *Chrysothamnus nauseosus*, May 8 2004, Lower Desert of Crooked River National Grassland, Jefferson County, Oregon. Note that the gray-green leaves are linear and not twisted, as in the brighter green leaves of *Chrysothamnus viscidiflorus.* Photo by Stephen Dowlan

Appendix 6

Green Rabbitbrush

Chrysothamnus viscidiflorus (Hook.) Nutt.

Management Considerations

UTILIZATION

Forage and Palatability: Though nutritional value is poor to fair at best, palatability varies from poor to good, depending on season, locality and subspeices. *Chrysothamnus viscidiflorus* ssp. *lanceolatus* is good for pronghorn, elk, mules deer, and some small mammals, and poor to fair for domestic livestock. Use increases in late fall and early winter after more palatable species have been depleted. Mature or partially-mature plants are generally preferred to green, immature ones.
Wildlife Use: Provides important cover for pronghorn fawns, nesting cover for sage grouse and some species of songbirds, and cover for small mammals. Generally considered to be poor cover for elk, deer, and adult pronghorn.

PLANTING

Growth Season and Seedling Establishment: Warm season short-lived (approximately 12-13 years) shrub. Well suited for revegetating disturbed sites such as road cuts, strip mines, and depleted rangelands due to its prolific seed production and relatively high germination rate. Establishment during dry years is unlikely, when seedlings do not persist if late spring rains replenish soil moisture. Once plants are established, growth is rapid. Establishment by direct seeding in late fall and winter is good to fair. Massive establishment will not occur if other species (especially perennial grasses) have already taken advantage of the site potential.
Propagation: Regenerates by abundant windblown seed, and by resprouting after defoliation. Can become weedy or invasive. Shrub control measures such as chaining may stimulate sprouting.

DISTURBANCE

Response to Grazing: Regrows rapidly after nearly complete defoliation by spring-browsing. Commonly increases on degraded rangelands as more palatable species are removed.
Response to Fire: Due to high resin content, both foliage and stems may be consumed, top-killing the plant even with relatively high moisture content. Potential for damage to the plant is influenced by the proximity of other shrubs, which contribute additional fuel results and higher fire intensity. Regenerates after fire by sprouting and by establishing from off-site seed. Release from competition stimulates green rabbitbrush to produce large numbers of viable achenes that are widely dispersed by wind.
Response to Drought: Well adapted to drought. Flowers during summer in all but the most extreme drought years.

Inflorescence of Chrysothamnus viscidiflorus ssp. *viscidiflorus,* August 8 2003 Ridge of the White Mountains, Inyo County, California. Photo © 2003 Christopher L. Christie (CalPhotos).

Sources:

1. Ball, D. A., et al. 2000. Weeds of the west (ninth edition). Western Society of Weed Science, Western U.S. Land Grant Universities and the University of Wyoming.

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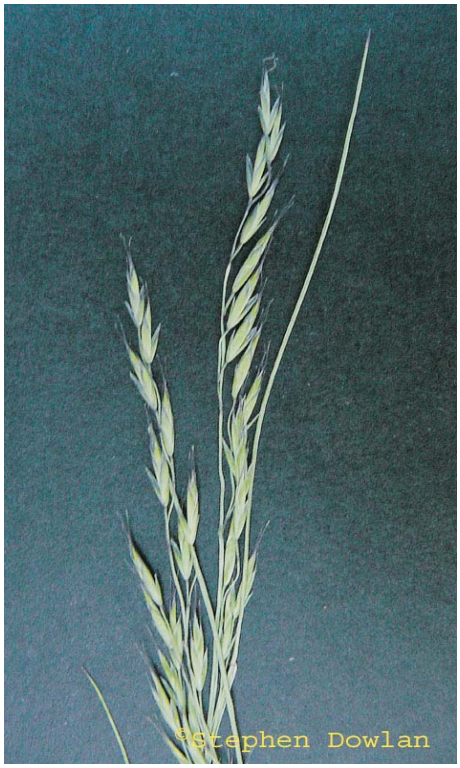
Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Idaho Fescue
Festuca idahoensis (Elmer)

The roots of this long-lived **native bunchgrass** are infected with vesicular-arbuscular mycorrhizae, which may offer some competitive advantage over non-mycorrhizal plants, allowing it to thrive on nutrient-poor soils or extreme environmental conditions.

Plant Characteristics



Inflorescence of *Festuca idahoensis,* collected on May 9 2004 on the west flank of Pine Ridge, Crooked River National Grassland, Jeferson County, Oregon. Though superficially similar, inflorescence of *Poa ampla* was notably purple (and florets lack awns) when this specimen was collected. Photo by S. Dowlan.

VEGETATIVE CHARACTERISTICS

Culms and leaves: Densely-tufted bunchgrass 0.3-1 m (1-3.3 ft) tall. Leaves bluish-green, narrow, rough in texture and mostly basal. Blades 12.7-25.4 cm (5-10 in) long. Sheath collars indistinct, auricles either small or absent. Ligule is less than 2 mm (0.07 in) long, truncate, and has a ciliate membrane.
Inflorescence: Slender, narrow, dense panicle, 7-15 cm (2.8-5.9 in) long, ascending with spreading lower branches. Spikelets with 4 to 7 florets, with visible rachilla joints. 2-5 mm (0.07-0.20 in) lawn extends from the tip of the lemma.
Roots: Extensive, reaching depths of 40 cm (15.7 in) in one study, though the majority of the root system is typically in the top 10 cm (3.9 in) of the soil profile in well-drained situations. Tough, fine, fibrous roots are characteristically black in color.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Found on a variety of parent materials and soil depths, but is most productive on well-drained, loamy to sandy soils. Not tolerant of high water tables or flooding.
Moisture/temperature requirements: Grows on many landforms, elevations, and aspects. Occurs at elevations from 300-4000 m (990-13,200 ft) in the western U.S. Thrives in areas of 380 mm (15 in) mean annual precipitation or greater, but is also found in areas with lower precipitation. In more xeric areas, it usually occupies the cooler, moister microsites on north and east aspects. May be a dominant or co-dominant species on cool moist microsites protected from wind, where there is more snow retention and less moisture loss than on less protected sites. Has excellent cold tolerance.

Cultivars:
Joseph (*Festuca idahoensis)* from Idaho Agricultural Experiment Station, 1983.

Nezpurs (*Festuca idahoensis)* from Idaho Agricultural Experiment Station, 1983.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Idaho Fescue
Festuca idahoensis (Elmer)

UTILIZATION

Forage and Palatability: Generally considered to be an excellent forage species for all grazing livestock and wildlife species. Particularly useful for late-season grazing, since it begins to senesence later in the growing season than most other range forage plants. Less palatable after drying, when it becomes tough and harsh. The foliage cures well and is preferred by livestock in late fall, and when accessible, in winter.
Wildlife Use: In addition to providing forage for virtually all grazing species, it provides fair to good cover for upland game birds, non-game birds, and small mammals, though the effects vary by location, and may be site-specific.

PLANTING

Growth Season and Seedling Establishment: Cool season long-lived perennial. Initiates growth March through April, depending on moisture, aspect, temperature, etc., and matures mid to late summer. Suitable for planting year-round. Slow to establish (2-3 years). Seedling emergence is greater when seedbed is weed-free and seed is protected with mulch or is mixed with an earlier seral, rapid-developing grass.
Propagation: Mostly by seed, but may also spread by tillers. Seed production and viability varies considerably among and within ecotypes. Seeds are produced in all but the driest years. If root crowns survive defoliation, tillering may result in a rapid increase in size of Idaho fescue plants in non-competitive environments.

DISTURBANCE

Response to Competition: Well-established stands can resist or prevent invasion of cheatgrass and other weeds, but presence of annual weeds will suppress seedling establishment.
Response to Grazing: Can withstand some heavy grazing and trampling, although it will decrease or succumb to continued heavy grazing, especially during dry years. Since it produces succulent herbage earlier than other associated perennial species, it is especially susceptible to overgrazing in early spring. Should not be grazed by livestock during the growing season every 3 to 4 years to maintain stand vigor. Minimum 2-3 inch stubble height should remain after grazing.Grazing should be deferred at least 2, and preferably 3 years following fire for plants to achieve full recovery.
Response to Fire: Fairly tolerant of light to moderate burning in fall, though may not survive severe fires. Burning at 10-25 year intervals probably have neutral to negative effects. May re-establish from seed after fire if temperatures are low enough to allow for seed survival.
Response to Drought: Fairly tolerant. Its ability to germinate in fall and grow at least intermittently through winter may facilitate sufficient development for dormancy prior to drought conditions.

Pressed specimen of *Festuca idahoensis,* collected on May 9 2004, west flank of Pine Ridge, Crooked River Grassland, Jefferson County, Oregon. Note the black roots, easily distinguishing Idaho fescue from any superficially similar species. Photo by Stephen Dowlan.

Sources:

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Appendix 6

Medusahead

Taeniatherum caput-medusae (L) Nevski

Medusahead and cheatgrass (*Bromus tectorum*), another **non-native invasive annual** species, overlap in distribution and habitat requirements. Each can replace other herbaceous vegetation and share dominance with the other.

Plant Characteristics

Inflorescence of *Taeniatherum caput-medusae,* May 23 2004, along Highway 26 just north of the intersection with Rd. # 55. This clay-soil site is along a roadside next to a hayfield. Photo by Stephen Dowlan

VEGETATIVE CHARACTERISTICS

Culms and leaves: An annual bunchgrass with ascending culms branching from the base, decumbent to erect, 20-50 cm (8-20 in) tall. Blades are more or less involute, narrow, 1-2.5 mm (0.04-0.10 in) broad, short, 3-6 cm (1.18-2.36 in) long, glabrous, with margins sometimes ciliate, and auricles are very short and inconspicuous.
Inflorescence: Very bristly, small spikes 1.5-4 cm (0.59-1.57 in) long (excluding the long, spreading awns). Spikelets 2 to 3 per node, awns straight and compressed when green, becoming twisted and erratically spread. The longer of the 2 types of awns contains barbs that point upward. Plants in dense stands usually produce 1 spike; in open areas the number of spikes per plant typically increases to 3 to 5.
Roots: Finely divided, fibrous, with main roots that grow rapidly downward before spreading laterally. Plants germinating in fall can have roots that reach 100 cm (40 in) depth by early February.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Tends to dominate disturbed areas on soils with high moisture-holding capacities, slow percolation rates, well-developed profiles, and those receiving run-off from infested areas. More likely than cheatgrass to be dominant on sites fine-textured soils, especially soils high in montmorillonite clay.
Moisture/temperature requirements: Generally found in areas below 1364 m (4500 ft) elevation that receive fall, winter, and spring moisture followed by dry summers. Occurs in areas with annual precipitation of 25-100 cm (10 to 40 in), with an upper limit of precipitation approximately 127 cm (50 in). More limited by extreme cold temperatures than cheatgrass, and conversely, moderate temperatures may encourage medusahead.

Comparison of infloresences *Taeniatherum caput-medusae* (left) and *Elymus elymoides* (right). Both pressed specimens were collected on May 23, 2004, in Crooked River National Grassland, just off U.S Highway 26. Note the shorter awns of the glumes below the longer awns of the lemmas for *T. caput-medusae*. The awns of the lemmas and glumes of *E. elymoides* appear to be more-or-less equal in length, and the spike is usually longer. Photo by Stephen Dowlan

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Medusahead
Taeniatherum caput-medusae (L) Nevski

Management Considerations

UTILIZATION

Forage and Palatability: May be used by grazing animals for only a brief period in spring (mostly by sheep) when green and tender, though not preferred, perhaps due to very high silica content of the herbage. Animals may need to be forced to feed on it. Long barbed awns of mature plants can cause injury to the eyes, noses, and mouths of grazing animals.
Wildlife Use: Less palatable to grazing species than cheatgrass. Seeds appear to be largely indigestible to chukar and other wild birds. Little cover value in monoculture stands.

PLANTING

Growth Season and Seedling Establishment: Cool season annual. Matures later than other annual species. Seeds may germinate in fall, winter, or spring, though fall germination is most common. Seedlings from all seasons produce seeds by early summer. Germination rates are often over 90%. Establishment favored when plant litter covers the soil surface. Plant density after establishment may range from 500 plants per square foot to 2000 plants per square foot on very favorable valley bottom soils.

A prolific seed producer (up to 6,000 seeds per square foot) from well established stands. Seed maintains viability in litter and soil for at least 1 year, and stiff barbs pointing in 1 direction enable the seeds to work through litter into soil. Plants produce tillers, but very few leaves. Seeds dispersed long distances primarily from the coats and intestinal tracts of grazing animals, and short distances by wind and water.

DISTURBANCE

Eradication and Control: As with cheatgrass, proliferation results from cultivation and subsequent land abandonment, excessive livestock grazing, overstory removal, and repeated fires, acting singly or interacting, especially on finer textured soils. It is critical to use site-adaptive, aggressive and easy-to-establish species to replace medushead's dominance.
Response to Tilling: Plowing after spring germination has resulted in up to a 95% reduction at some sites. Best if combined with herbicides or burning.
Response to Competition: Maintenance of good stands of perennial vegetation helps to prevent medusahead invasion, though attempts to establish stands of perennial grasses without first eliminating competition by medusahead (or other non-native annual grasses) are generally unsuccessful. Among native grasses, only bottlebrush squirreltail (*Elymus elymoides*) has demonstrated an ability to invade established stands of medusahead. Medusahead has potential for successionally replacing cheatgrass on fine textured soils in the 28 cm (11in) and above precipitation zone.
Response to Grazing: Poor grazing management practices may accelerate the rate of spread. Livestock avoid medusahead when more palatable forage is available, leading to an abundance of soil-stored medusahead seed. Heavy spring grazing during the green stage has been reported to assist in its control, but animals must be removed after the seed head forms to limit seed dispersal.
Response to Chemicals: Two spring treatments (one month apart) of glyphosphate (at levels that do not damage bottlebrush squirreltail) can be effective, especially if combined with burning. Soil application of atrazine (late fall) or bromacil (early spring or fall) can selectively kill medusahead in stands of perennial grasses. Atrazine will also kill Sandberg bluegrass. Foliar application of dalapon are effective when applied in the vegetative stage, with control rates as high as 100%. All herbicide treatments are usually more effective when combined with other methods.
Response to Fire: Fire kills mature medusahead plants, though immature plants may be only top-killed by early-season fire, and regenerate by tillering. Fire also destroys many viable medusahead seeds, but sufficient numbers remain uninjured that reduction in plant density is usually temporary. Extreme build-up of long-lived litter results in hotter, more frequent fires, after which stands become established from the seed bank and from seed dispersed from off-site sources. Single burns in late May and early June, when seeds are immature and associated annuals have cured, promote a light but intense fire that can arrest seed development that may result in nearly complete elimination of medusahead for the next several years observed.
Response to Drought: Large seedbank and fall germination results in high potential for regeneration of stands after drought.
Response to Biological Control: As of 1998, no biological control agents (insects or fungi) were approved for use. Root pathogens are being investigated.

This dense stand of *Taeniatherum caput-medusae* is emerging from a dense mat of litter from the previous year in "Lickskillet very stony loam" soil (Site 2), Crooked River National Grassland, Jefferson County, Oregon, May 9 2004. Photo by Stephen Dowlan.

Appendix 6

Medusahead

Taeniatherum caput-medusae (L) Nevski

HISTORICAL NOTES

Medusahead was introduced into the United States from the Mediterranean region of Eurasia in the late 1880s and spread rapidly in the 1930s. The first known herbarium specimen for the U.S. was collected near Roseburg, Oregon, in 1887.

Newly emerging inflorescences of *Taeniatherum caput-medusae in* "Lickskillet very stony loam" soil (Site 2), Crooked River National Grassland, Jefferson County, Oregon, May 9 2004. Photo by Stephen Dowlan.

This dense mat of litter of *Taeniatherum caput-medusae* from the previous growing season in "Lickskillet very stony loam" soil (Site 2), Crooked River National Grassland, Jefferson County, Oregon, October 24, 2003. Photos by Stephen Dowlan.

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Appendix 6

Prairie Junegrass
Koeleria macrantha
(Ledeb.) J.A. Shultes

Native bunchgrass - The species is called junegrass because it flowers for only a brief period in June.

Plant Characteristics

Koeleria macrantha collected May 9 2004, west flank of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan.

VEGETATIVE CHARACTERISTICS

Culms and leaves: Erect bunchgrass 46-66 cm (8- 26 in) tall, growing in small bunches 5-15 cm (2-6 in) in diameter. Leaves bluish-green, mostly basal, sometimes slightly pubescent, blades narrow, 3.8-12.7 cm (1.5 to 5 in) long, flat to rolled and curly when dry Leaves and sheaths prominently veined. Ligules short, less than 1.6 mm (0.06 in), membranous, collar-shaped, finely toothed at margin. Auricles absent.
Inflorescence: Dense, narrow, spike-like panicle, 2.5-13 cm (1-5 in) long, seedstalks nearly leafless, often finely pubescent just below the seedhead. Spikelets about 3.2 mm (0.13 in) long, with 2-4 florets, glumes and lemmas glabrous, awnless, or awn-pointed.
Roots: Maximum rooting depth averages between 33-75 cm (13-29.5 in). Root density decreases after 30 cm (11.8 in), with the greatest concentration within the upper 3 cm (1.2 in). Lateral spread ranges from 15-20 cm (5.9-7.9 in) near the soil surface .

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Occurs on many soil types across a very wide range. Primarily found in deep, medium to moderately fine textured soils with moderate to high water holding capacity, though can grow on rocky soils at high elevations.
Moisture/temperature requirements: Annual precipitation requirements range from 41-53 cm (16-21 in) with 70% occurring during the growing season. Preferred sites are cool, semi-arid, infertile grasslands and rock outcrops. Normally found at elevations between 1524-2438 m (5,000 to 8,000 ft).

Koeleria macrantha, May 9 2004, west flank of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. At this site, plants were well -scattered, though not uncommon. Photo by Stephen Dowlan.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Prairie Junegrass

Koeleria macrantha (Ledeb.) J.A. Shultes

UTILIZATION

Forage and Palatability: Rapid development provides good early-spring forage for all classes of livestock and wildlife, though scattered distribution of plants usually means that forage production is low. Less palatable during seed production, but cures well for fall forage. Distribution in high elevation rocky sites provides good forage where other grass species may be less available.
Wildlife Use: Short stature and scattered distribution provides minimum coverage for larger birds and mammals.

PLANTING

Growth Season and Seedling Establishment: Cool season perennial. Rapid growth takes place in early spring, with maximum leaf growth taking place the first half of May. Some studies suggest that obtaining seed from plants within similar environments (i.e. elevation, climate), may be critical for re-establishing vigorous populations. Has demonstrated an ability to recolonize areas that have been subjected to severe water stress.
Propagation: Reproduces primarily by seed and by resprouting from residual plant, and has the ability to germinate under periods of water stress. Presence of mycorrhizae may have a significant positive effect on seedling emergence.

Koeleria macrantha collected May 9 2004, west flank of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan.

DISTURBANCE

Response to Competition: Ability to suppress invasive annuals has been reported as variable. Direct seeding and seedling transplant produced poor results. Reestablishing populations through greenhouse propagation and transplant within an area overrun by annuals has been successful.
Response to Grazing: Responds well to grazing if 7.6 cm (3 in) stubble is maintained. In general, grazing conducted August through October is sustainable, if adequate moisture is available. Does not do well under season-long heavy grazing pressure.
Response to Fire: Usually burns quickly, transferring little heat below the soil surface. Small stature and coarse-textured foliage aid in protection of meristimatic tissue.Late spring burns are most likely to cause greater damage to plants. Usually returns to preburn frequency in 2-5 years.
Response to Drought: Leaves are drought resistant and persist under dry conditions. The species played a leading role in recolonizing bare soil of mid-continental grasslands after the droughts of 1933 to 1940.

Sources:

1. Pratt, M, J. Bowns, R. Banner and A. Rasmussen. 2002. Junegrass. In: Range plants of Utah, Utah State University Extension, http://extension.usu.edu/rangeplants/Grasses/junegrass.htm. Accessed January, 2004.

2. Simonin, Kevin. (2000, June). *Koeleria macrantha*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

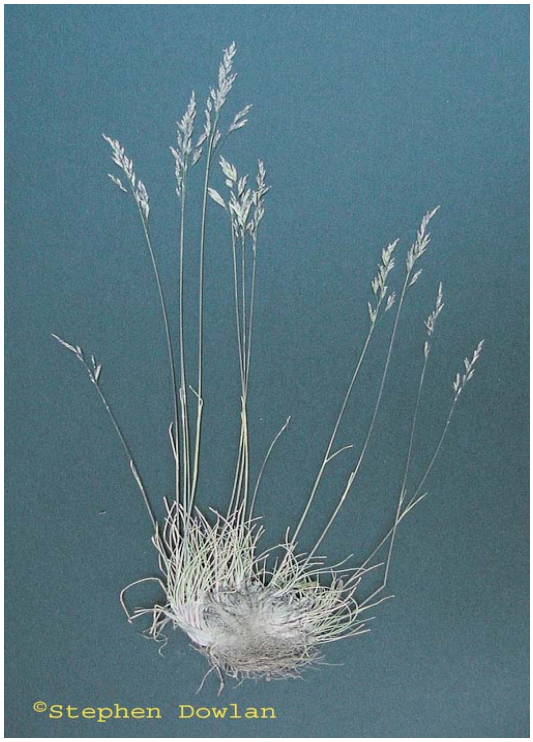
Appendix 6

Sandberg Bluegrass

Poa secunda J. Presl

Several forms, variously considered ecotypes, forms, or cultivars, are recognized within this species complex. Sandberg bluegrass hybridizes with Wheeler bluegrass (*P. nervosa*) and Kentucky bluegrass (*P. pratensis*).

Plant Characteristics



Pressed specimen of *Poa secunda*, collected May 9 2004 on the west slope of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Note the low stature of the foliage, in contrast to *Poa ampla*. Photo by Stephen Dowlan

VEGETATIVE CHARACTERISTICS

Culms and leaves: Ranges from small tufts with only 1 or 2 culms to a tussock up to 0.3 m (1 ft) in diameter, with numerous fine basal leaves 20-41 cm (8-16 in) long. Leaves smooth, deep blue-green, and folded, with keel-shaped tips typical of bluegrasses.
Inflorescence: A narrow panicle up to 20 cm (8 in) long. Flower spikelets do not have a web of hairs at the base, as in Kentucky bluegrass (*Poa pratensis*).
Roots: Shallow, strong and fibrous, occasionally developing short rhizomes.

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Thrives on a variety of usually well-drained and often shallow soils, from moderately coarse sands to fine clays and rocky soils. Tolerates coarse sands and dense clays, and weakly acidic and alkaline soils, but not saline conditions, high water tables, or early spring flooding.
Moisture/temperature requirements: Wide range of tolerance for moisture conditions, though most abundant within 38-51 cm (15-20 in) annual precipitation. Very cold tolerant. Becomes shaded out with canopy closure in any plant community in which it occurs.

Poa secunda grows in the rows in which *Agropyron cristatum* was seeded and is now declining at Restoration Site 3. As a result of soil transported off-site, many individual plants appear to be "pedestaled" upon close inspection. Photo by Stephen Dowlan.

Cultivars:

Canbar (*Poa secunda)* from Pullman Plant Materials Center, 1979.

Sherman big bluegrass (*Poa secunda)* from Pullman Plant Materials Center, 1945.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Sandberg Bluegrass

Poa secunda J. Presl

UTILIZATION

Forage and Palatability: One of the earliest spring grasses to green-up, it provides excellent early spring forage for cattle or sheep. Remains choice for a relatively short time in comparison to other bunchgrasses, providing limited use as summer forage for horses and cattle. Generally avoided when headed. Cured foliage used by horses, cattle and sheep in fall. Produces little foliage in drought years.
Wildlife Use: Good palatability for deer in spring, excellent for elk year-round. Very high consumption of seeds by Townsed's ground squirrels. Chosen by upland game birds (especially pheasants) because of earlier of spring growth than other dryland grasses.

PLANTING

Growth Season and Seedling Establishment: A relatively short-lived cool season perennial, completes spring growth earlier than many other perennial grasses. Cessation of growth coincides with depletion of soil moisture in the top 10 cm (4 in) of soil. Leaves begin growing again in fall as soon as rains begin. Seedling establishment is favored over deeper-rooted perennials in areas receiving frequent light rains or where soil moisture is otherwise limited.
Propagation: Regenerates by tillering and by seed. Produces significant amounts of seed in most years. Wind pollinated or self-fertile.

DISTURBANCE

Response to Competition: Often increases when competition from other species is reduced after fire. Often occurs with cheatgrass (*Bromus tectorum*) (one or the other will be favored by kind and class of grazing animal, and with site conditions). Shallow roots and drought tolerance allow it to effectively intercept moisture from light rains.
Response to Grazing: Generally increases, but can be overgrazed or damaged due to trampling. New stands can be grazed after at least 2 growing seasons, when well-rooted. Spring and fall grazing recommended, but spring regrowth should occur before dormancy. Fall grazing after green-up should leave at least 15 cm (6 in) of stubble.
Response to Fire: Very tolerant when dormant, usually unharmed or only slightly damaged. Fire often increses tillering, resulting in increased post-fire cover. Fire damage increases with pedestaled plants, or when litter accumulates (especially with larger, older plants).
Response to Drought: Very tolerant, but may produce very little foliage.

Inflorescence of a pressed specimen of *Poa secunda*, collected May 9 2004 on the west slope of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan

Sources:

1. Howard, Janet L. 1997. *Poa secunda.* In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

2. Native Seed Network Plant Material Profiles (Canbar and Sherman big bluegrass). http://www.nativeseednetwork.org/resources/pm_list.php Accessed May 30 2004

3. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Accessed January, 2004

Appendix 6

Thurber Needlegrass
Achnatherum thurberianum (Piper) Barkworth

Native bunchgrass - Synonomous with *Stipa thurberiana*, this species can hybridize with Indian ricegrass (*A. hymenoides*).

Plant Characteristics

VEGETATIVE CHARACTERISTICS

Culms and leaves: Densely tufted bunchgrass with erect culms 30-60 cm (12-24 in) tall, and involute blades 10-25 cm (4-10 in) long and 1-2 mm (0.04-0.07 in) wide. The culms are narrow, erect, and few flowered. Crown typically acquires a circular appearance, as the plant dies from the center outward.
Inflorescence: Panicle 7-24 cm (3-9 in) long with single-flowered spikelets with sharp calluses and awned lemmas.
Roots: Maximum reported rooting depth (Idaho) of 61 cm (24 in).

GENERAL HABITAT CONSIDERATIONS

Soil Types and Conditions: Occurs on a variety of soil types , most of which are dry and coarse textured.
Moisture/temperature requirements: Often found on arid hillsides from 366-2225 m (1200-7300 ft), often on north and east slopes where there is more moisture and less variation in temperature. Annual precipitation ranges from 236-290 mm (9.3-11.5 in).

Pressed specimen of *Achnatherum thurberianum,* collected on May 9 2004 on the west flank of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Note the long hairs at the base of the very long awn, not yet geniculate (bent) by this date, distinguishing this from other needlegrass species that might occur in the area. When this awn is rehydrated, it twists in a manner that helps to "drill" the seed into the soil, a phenomenon which can be easily recreated in-hand. Photo by Stephen Dowlan.

Prepared by Stephen Dowlan, May, 2004.

Appendix 6

Management Considerations

Thurber Needlegrass
Achnatherum thurberianum (Piper) Barkworth

UTILIZATION

Forage and Palatability: Considered valuable forage for livestock and wildlife, including many small grazing mammal species. Most palatable in the spring and early summer while plants are young and succulent. At maturity, the leaves become somewhat tough. Although the seeds are apparently not injurious, grazing animals avoid them when they begin to mature. Early season growth may be preferred by pronghorn fawns. Remains green after most of the grasses have dried-up.
Wildlife Use: Provides protective cover to many small and medium-sized animals, including sage grouse. Associated with high numbers of passerine and near-passerine birds in some areas.

PLANTING

Growth Season and Seedling Establishment: Begins annual growth in early spring. Largely dormant in summer, continues growth after autumn rains longer than many associated grasses (October). Seed germination rate and seedling viability are considered to be low. However, seed is undesirable to livestock, allowing a large proportion to mature, resulting in fairly good reproduction rates even in grazed or burned areas. Standard and deep furrow seeding treatments appear to produce better seedling frequency than in broadcast treatments.

Propagation: Reproduces from seeds and tillers, though regeneration is usually by seed on sites where stands have been been killed by fire. Produces ripe seed mid to late July.

DISTURBANCE

Response to Competition: Cheatgrass is a highly successful competitor with seedlings, and other native perennial grasses may recover more quickly after disturbance at the expense of this species.
Response to Grazing: Decreases under heavy grazing during the growing season. A single defoliation, particularly during the boot state, can reduce subsequent herbage production and lower competitive ability. Grazing systems which allows seed production, trampling of plant seed, and a non-use period may increase the establishment of new plants in interspaces. Infloresence generally avoided by grazers, allowing good seed production even when plants are defoliated after seed set.
Response to Fire: Burning has generally been found to decrease vegetative and reproductive vigor. Abundant dead material, which is sometimes present, contributes to fire damage regardless of season, and above ground vegetation is often consumed by fire. Surviving plants may show reduced vigor for many years, though seed stalk production may be enhanced in survivors. Fall prescribed burning is recommended.
Response to Drought: High tolerance.

Achnatherum thurberianum, May 9 2004, the west flank of Pine Ridge, Crooked River National Grassland, Jefferson County, Oregon. Photo by Stephen Dowlan.

Sources:

1. Archer, Amy J. July 2000. *Achnatherum thurberianum*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Accessed January, 2004

2. Hitchcock, A.S., and A. Chase. 1971. Manual of the grasses of the United States . Vol. 1 (second revised edition by Agnes Chase). Dover Publications, New York, NY.

3. USDA, NRCS. 2004. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.
Accessed January, 2004

Jim Hancock (left) and Dan Tippy of the Bureau of Land Management, Prineville assess treatment options on this mixed-stage juniper stand, encroaching into a low sage/Idaho fescue site in central Oregon.

Run-off from recent rains yielded this sediment from the bare soils of the juniper stand.