Guidelines for Juniper Management

Oregon-Washington BLM

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Guidelines for juniper management offer guidance in achieving resource management plan (RMP) goals, meeting standards for rangeland health, and fulfilling the fundamentals of rangeland health. Guidelines are applied in accordance with the capabilities of the ecological site under current and expected climate and with the consultation, cooperation, and coordination with stakeholders and the interested public.

General Guidelines

1. Involve diverse interests in assessing the need for, planning, and monitoring juniper treatments.
2. Assessment and monitoring are essential to the management of juniper woodlands encroaching into sagebrush-steppe and the densification of former juniper savannas, especially in areas where additional resource problems exist or issues arise. Monitoring should proceed using a standardized approach to information collection in order to accurately identify critical and specific problems or issues. Monitoring should be interdisciplinary in nature, using a variety of resource specialists, managers, and knowledgeable land users and apply the core indicators and protocols from the Bureau's Assessment, Inventory and Monitoring (AIM) strategy (Toevs et al. 2011).
3. Priority for treatment and monitoring should be given to those areas that are ecologically at-risk where probability of success and benefits can be maximized given existing budgets and workloads.

Juniper Management Guidelines

Consistent with RMP direction, base juniper management on ecological site capability in order to:

a. Promote adequate vegetative ground cover, including standing plant material and litter, to support infiltration, conserve soil moisture storage, and stabilize soils with native species preferred;

b. Promote subsurface soil conditions that support permeability rates appropriate to the climate and soils;

c. Improve or restore riparian-wetland functions, including debris and sediment capture, groundwater recharge, streambank stability, and channel morphology appropriate to the climate and landform;

d. Promote the appropriate soil organisms to support the hydrologic cycle, nutrient cycle, and energy flow;

e. Promote opportunities for seedling establishment of desirable species suitable to the ecological site when climate conditions and growing space allow;

f. Improve or restore water quality;

g. Promote diverse native or predominantly native plant communities appropriate to the ecological site under current and expected climate and that fully occupy the potential rooting volume of the soil;

h. Improve or restore habitats for sagebrush obligate species such as greater sage-grouse, sage sparrow, pygmy rabbit, and pronghorn antelope;

i. Use non-native plant species in post-treatment seedings where insufficient native species seed is available or where native species are not capable of maintaining or achieving properly functioning conditions with respect to the hydrologic cycle, nutrient cycle, and energy flow. Follow up by reintroducing native plant species within 10-15 years, as appropriate; and

j. Consider the need for facilitated migration of different ecotypes or plant species from other climates and seed zones where changing climate conditions adversely affect the ability of local historical ecotypes and species to persist.

These guidelines provide a consistent approach for evaluating landscapes and stands for treatment and learning from those treatments. The process should be scalable, responsive to shifting land management priorities, and rooted in sound ecological science. These guidelines consist of five parts:

1) Identifying priority areas in the larger landscape,
2) Evaluating juniper stands for treatment,
3) Identifying treatment options,
4) Monitoring treatment effectiveness and land health response, and
5) Applying adaptive management principles to treatments.

The accompanying science document provides background and supporting information suitable for incorporation by reference into project NEPA files and effects analyses. If the guidelines and science document function as intended, they will provide a consistent and transparent approach for allocating budgets and designing programs of work, streamline the NEPA process at the project scale, and aid in answering the “why here, why now” question.

Identify Landscape Priorities

Given that resources are limited, begin by prioritizing the District or Resource Area landscapes. Prioritization can occur at both scales if finer resolution data are available. A review of the applicable resource management plan (RMP) direction may highlight areas on which to focus and to avoid. The initial prioritization could include areas where project planning under NEPA is already underway or completed. Subsequent prioritizations can be used to develop out-year funding requests for planning, implementation and monitoring. Prioritizing the larger landscape should be feasible using existing data in GIS.

1. Map existing juniper extent

   Several maps exist on existing juniper extent, including those prepared by Districts or in connection with existing NEPA analyses. Both The Nature Conservancy and Ecotrust have developed statewide maps that may be useful.

These maps have been prepared using some method of remote sensing or remote sensing combined with modeling. The early stages of Phase 1 juniper, before tree crowns have sufficiently emerged from sagebrush crowns to change spectral or reflectance values, is notoriously difficult to identify through remote sensing methods. Buffer the existing extent by 50-60 m to account for the early stages of Phase 1 juniper. Juniper tends to spread in a more-or-less circular pattern with an average spread distance of 50-70 m from berry-producing trees, although distances in excess of 100 m have been observed.

Maps of existing juniper extent also quickly become outdated. Remote sensing and modeling methods remain the most cost-efficient method for tracking juniper extent. At present, the most promising avenues for periodically updating maps of juniper extent include use of NAIP imagery and LiDAR.

2. Estimate potential juniper cover

   Potential juniper cover is related to elevation, slope steepness, and aspect (Davies et al. 2010). Use the following equation to estimate potential juniper cover for each pixel:

   $-49.62 + 1.69 \cos(\text{aspect}) + 0.90 (\text{slope}) + 0.05 (\text{elevation}) - 1.32 (\text{slope} * \cos(\text{aspect}))$

   Slope – degrees[1]

   Elevation – meters

   Cos(aspect) – the cosine of aspect in degrees

   However, because this equation explains only about 40% of the variation in juniper cover, the results should be binned into the following suggested categories:

   - Low = <5%
   - Moderate = 5 – 20%
   - High = 20 – 40%
   - Very High = >40%

3. Identify priorities for site-specific investigation.

   The prioritization guidance below may also indicate the need for plan maintenance to deal with areas where juniper treatment may be desirable, but where existing RMP direction constrains action. The following is a list of considerations to apply in determining where on the larger landscape juniper treatments may be warranted. Higher priority landscapes would be those where opportunities exist to maintain or improve rangeland health and ecosystem function, meet multiple management priorities, and that have the least number of constraints.

High Priority Areas

- Priority and general sage-grouse habitat (or the replacement designations) – if needed as a tie breaker, priority habitat should be higher priority than general habitat.
- Invasive annual grass concerns – give higher priority to areas where treatment could increase resistance to annual grass invasion or spread and lower priority where disturbance tends to promote annual grass invasion and spread. Soil texture and general

[1] Slope percent = tan(degrees)

soil temperature are indicators of invasibility with spread more likely on coarser-textured and warmer soils.

- Ecosystem benefits – focus on potential for improved hydrologic function, maintenance or enhancement of native plant communities and enhanced carbon storage. Give higher priority to areas where treatment could protect or enhance hydrologic function (capture, storage and safe release of water) or would protect or enhance healthy native plant communities and treatments are relatively inexpensive with at least a moderate probability of success. Give lower priority to areas where hydrologic function or plant communities are sufficiently degraded to require expensive restoration treatments with a low or highly uncertain probability of success.

Moderate Priority Areas

- Other threatened, endangered, and sensitive species
- Opportunity for biomass removal – distance from population centers should be the primary consideration as juniper biomass opportunities strongly depend on the price of alternative fuels for heating or electricity generation and haul costs, and will limit the usable haul distance. Accessibility and site workability (slope steepness, soil characteristics, etc.) are considerations as well.
- Wildland-urban interface – this consideration applies to actual population centers and structures as opposed to what may have been identified in a community wildfire protection plan. Some communities have designated a much larger area or the entire county based on the need to protect or enhance the community economic base, such as healthy lands for grazing. Healthy lands that support grazing and recreational opportunities such as hunting and hiking, are already covered by the high priority factors.
- Accessibility – generally, higher priority areas would be those that can use existing roads and trails, lower priority areas would be sites that could require construction of new permanent or temporary roads. Effectively closing or obliterating temporary roads has proven very difficult in many rangeland settings.
- Unique/limited habitat types – higher priority areas would be sites where juniper management could protect or maintain habitat types that are typically limited in distribution or are unique, such as riparian areas and aspen stands.

Low Priority Areas

These factors can be used as “tie breakers” but should not be primary drivers of determining where juniper treatments may be warranted.

- Special emphasis areas (ACECs, RNAs, Wild and Scenic Rivers, etc.) – consider including any special emphasis areas where juniper treatment would protect or maintain the purpose for which the special emphasis area was established.
- Lands with Wilderness Characteristics – consider including any Lands with Wilderness Characteristics identified for protection of their wilderness characteristics in a land use plan where juniper treatment could reduce the risk of invasive plant dominance following a natural disturbance, such as fire. Although, strictly speaking, natural events should be the primary determinant of conditions in Lands with Wilderness Characteristics identified

for protection in a land use plan, takeover of such areas by non-native invasive plants is widely considered undesirable. As with Wilderness Study Areas, treatment options are generally restricted by the need to preserve wilderness characteristics, such as the unroaded nature of the sites and limited or no evidence of deliberate manipulation of the vegetation. These restrictions also apply to all Lands with Wilderness Characteristics identified within the Southeast Oregon and Lakeview RMP Areas until the ongoing Plan Amendments are finalized as per Settlement Agreement provisions.

Evaluate Juniper Stands

The primary target of these guidelines are sites that typically did not support juniper. However, juniper stand densities may have increased as well, indicating such stands should be considered for treatment. The intent is to not treat old juniper, except where individual trees pose a hazard to public safety or key infrastructure, such as power lines.

1. Identify the ecological site

   Determine the ecological site for each location and review the NRCS ecological site description. If available, use the most recent ecological site inventory to determine the ecological site. Appendix A lists ecological sites where some juniper should be expected. Cross-walk ecological sites with soils maps. Carefully consider the likelihood of success where soils are shallow, have limited water holding capacity, have low productivity, or are rated as highly erosive.

2. Characterize the extent, if any, of old juniper

   The presence, density, and location of old juniper trees provide clues as to the historical plant community structure and the degree of encroachment or stand densification. Old juniper trees typically have two or more of the following characteristics (Miller et al. 2005):

   a. Flattened, rounded, or uneven top
   b. Spreading crown
   c. Large branches near the base of the tree (open stands only)
   d. Large dead branches, missing bark, and abundant light green lichen
   e. Thick fibrous bark with well-developed vertical furrows
   f. Leader growth in the upper ¼ of the tree usually less than 1 in/yr (leaders difficult to identify)

   The stature and form of old juniper trees varies, depending on site characteristics. Generally, as effective precipitation and soil moisture holding capacity decreases, tree spacing increases, stature decreases, crown width increases, and the probability of large branches close to the ground increases.

   Historical juniper stands also had more than one formation, depending on site characteristics and disturbance history (Miller et al. 2005).

   - Widely scattered individual old trees with canopy cover $\leq$20% – juniper savanna
   - Evenly and well distributed old trees with canopy cover >20% - juniper woodland

- Old trees concentrated in area/microsite generally protected from fire (rocky site, very sandy soils, etc.)

3. Assess hydrologic functioning

   Use the standard procedures for evaluating the departure from reference condition for hydrologic functioning based on NRCS rangeland health reference sheets for each ecological site. Key factors are:

   a. Amount of bare ground
   b. Height and extent of pedestals and terrecettes
   c. Evidence and distance of litter movement
   d. Number and extent of rills and gullies
   e. Evidence of wind scour, blowouts, or deposition
   f. Presence, absence, and extent of biological soil crust
   g. Surface soil aggregate stability, structure, and organic matter content
   h. Presence and thickness of a compaction layer

4. Assess vegetation condition

   Use standard procedures for estimating departure from reference conditions for key species or plant functional group abundance and distribution based on NRCS rangeland health reference sheets for each ecological site.

   a. Functional/structural group diversity and condition relative to ecological site capability
   b. Extent of decadence and mortality of key species or plant functional groups
   c. Litter amount
   d. Above ground annual production relative to ecological site capability and type of year
   e. Invasive plants presence and extent
   f. Reproductive capability of key perennial species

   Due to species diversity and varying ability to identify species, plant functional groups are often used to characterize the herbaceous vegetation. When using plant functional groups as the basis for evaluating vegetation condition, the following groups are suggested:

   - Deep-rooted perennial grasses[2]
   - Shallow-rooted perennial grasses
   - Annual grasses
   - Perennial forbs

[2] NRCS group number is associated with dominance/abundance; e.g., species listed in group 1 are the dominant species, while species in groups 2 and 3 are subdominant. Note, however, that plant groups in ecological site descriptions are not standardized between major land resource areas

- Annual forbs

5. Estimate long-term carbon storage potential

   In general, carbon storage potential increases as effective soil depth and precipitation increases. This section is intended to demonstrate that BLM has considered the implications of our actions or inactions on carbon sequestration and storage, although the potential for either in rangeland systems is quite small relative to forest systems, both on an acre-for-acre and total potential basis.

6. Consider the role of critical socio-economic factors

   These factors should be used to fine-tune landscape priorities or refine project design:

   - Presence of wildland-urban interface that would need protection from wildfire (critical infrastructure such as transmission lines and electronic sites or homes, businesses, and any associated outbuildings)
   - Opportunities for cooperative management with adjoining landowners/managers
   - Presence of one or more Conservation Opportunity Areas (ODFW 2006)
   - Presence of major energy transmission corridors
   - Potential impacts to recreation users, changes in types of recreational uses, or changes in levels of established recreation uses
   - Potential to mitigate energy development elsewhere, such as installation of new pipelines or power line corridors
   - Existing road and trail networks that could support treatments
   - Opportunities for biomass removal (material available, workability of site, etc.)

Identify Treatment Options

Use the following key adapted from one developed by the Oregon Watershed Enhancement Board (OWEB) to determine the range of treatment options. Most options consist of some combination of prescribed burning and mechanical treatments. Chemical treatment should become an option in the near future, so is covered here as either a primary or secondary treatment. No known biological treatment options exist. Removal of all green material or complete death of the tree crown is necessary to assure mortality.

<u>Phase I Juniper Woodland.</u> Juniper trees present, but shrubs and herbs dominate ecological processes. All expected plant functional groups represented as described in the appropriate ecological site description (ESD) reference sheets.

> Shrubs and herbs co-dominant; density of deep-rooted perennial grasses greater than two to five plants[3] per square meter or 10 square feet. Invasive species may be present.
>
> Little or no evidence of overland flow and soil loss……………………………1a

[3] As low as two plants per square meter on highly productive sites; as many as five plants per square meter on low productivity sites.

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 two to five plants[3] per square meter or 10 square feet. Invasive species may be present.

Little or no evidence of overland flow and soil loss…………………………….1c

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

Phase II Juniper Woodland. Juniper trees co-dominant with shrubs and herbs and all three influence ecological processes on the site.

Density of deep-rooted perennial grasses greater than two to five plants[3] per square meter or 10 square feet. Invasive species may be present.

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

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

Density of deep-rooted perennial grasses less than two to five plants[3] per square meter or 10 square feet. Invasive species may be present to common.

Little or no evidence of overland flow and soil loss…………………………….2c

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

Phase III Juniper Woodland. Trees are the dominant vegetation and the primary influence on ecological processes on the site. Expected plant functional groups significantly diminished or absent; skeletal remains of shrubs common.

Deep-rooted perennial grasses are the dominant understory vegetation beneath trees and interspaces. Density of deep-rooted perennial grasses greater than two to five[3] plants per square meter or 10 square feet. Invasive species may be common.

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

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

Deep-rooted perennial grasses, if present, restricted to near the dripline of trees or within the canopy of shrubs; density less than two to five plants[3] per square meter or 10 square feet. Interspaces bare or nearly so. Invasive species likely common.

Little or no evidence of overland flow and soil loss…………………………….3c

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

Treatment options for addressing just the juniper are very similar within a given phase. However, condition of the shrubs and herbaceous community and erosion status may affect how treatments are conducted or what additional treatments are needed to address plant community restoration needs, invasive plant concerns, and hydrologic function.

Phase I Juniper Woodland

Treatment of a site in this encroachment phase aims to prevent further site deterioration. As shrub density increases, deep-rooted perennial grasses become confined to the crowns of shrubs. Treatment options include:

- Broadcast burning
- Cutting individual trees
- Cutting plus jackpot burning
- Brush-beating/mastication
- Spot application of herbicides

Broadcast burning should be avoided in sage-grouse habitat and often is not necessary in this phase to control juniper. If individual trees are cut and left, branches that extend more than 4 feet off the ground should be cut off as well. Brush beating/mastication should focus on individual juniper trees and on creating small openings in denser clumps or groups of trees.

Condition 1a. This condition is the least departed and often does not require additional treatment to deal with invasive species, plant community diversity, or hydrologic function. Some spot seeding may be warranted following prescribed burning if invasive species are present and if mortality of perennial grasses was greater than expected.

Condition 1b. The density of deep-rooted perennial grasses should be sufficient to provide for site recovery, but invasive species, if present, are likely assume dominance in areas that are eroding. Additional spot herbicide treatments followed by seeding with competitive species are more likely needed in this condition than in condition 1a.

Conditions 1b and 1d. Placement of cut or masticated/shredded material where overland flow or active rills and gullies are present can trap sediment and increase infiltration. Chipped or shredded material produced by brush beating/mastication or similar method may also tie up site nitrogen, disfavoring invasive annual grasses. Spot seeding of eroding areas prior to placing the cut or shredded material may improve establishment of desired species.

Conditions 1c and 1d. These conditions are most likely to require some seeding and possibly some herbicide use to control invasive species after treatment. Seed mixes should include species able to compete with the specific invasive(s) present.

Phase II Juniper Woodland

Most shrubs are alive but in a weakened condition. Grasses and forbs remain relatively common, however as shrub or tree density increases, grasses become confined to driplines of trees and within crowns of shrubs. The site can be at or near the threshold between Phases II and III where, without treatment, conditions will deteriorate. Treatments should address the prevention of further decline of ecological processes and the recovery of hydrologic function.

Treatment options include:

- Broadcast burning
- Cutting trees
- Partial cutting and broadcast burning

- Cutting and jackpot burning
- Cutting, piling and pile burning
- Uprooting trees individually or by chaining
- Broadcast application of herbicides

Sage-grouse habitat may still be present in the early part of Phase II; use broadcast burning and broadcast application of herbicide cautiously to limit the loss of sagebrush. If cut material is piled and burned, the number, size, and spacing of piles should limit the amount of sagebrush likely to be killed by lethal heating and reduce the risk of invasive plants dominating burn spots and serving as infection courts. Invasive plant spread risks increase as tree density increases and approaches Phase III, especially where the understory is in decline.

Condition 2a. Broadcast burning with high survival of existing deep-rooted perennial grasses can be successful on sites in this condition. Seeding or spraying herbicides to control invasive species should not be necessary.

Condition 2b. Broadcast burning in this condition starts to become problematic and is less likely to succeed in controlling or eliminating juniper. Partial cutting to create a more continuous fuelbed followed by broadcast burning is more likely to succeed. Invasive species may increase in areas of bare soil, requiring spot applicable of herbicides and spot seeding.

Conditions 2b and 2d. Placement of cut or uprooted trees, branches or tops into active rills and gullies can trap sediment and increase infiltration. In areas where recent overland flow is noted placement of cut branches can serve the same purpose. Spot seeding of eroding areas prior to placing the cut or uprooted material may improve establishment of desired species.

Conditions 2c and 2d. Seeding likely will be necessary where erosion is actively occurring to promote recovery of healthy plant communities and hydrologic function. Where invasive species are common, herbicide or biopesticide treatment and use of seed mixes with competitive species likely will be necessary once the juniper is removed.

Phase III Juniper Woodland

Expected functional plant groups significantly diminished or absent. Skeletal remains of shrubs are common. On sites with deeper soils, deep-rooted perennial grasses, most often Idaho fescue, are the dominant understory vegetation beneath trees and in the canopy interspaces. On shallower soils, deep-rooted perennial grasses die out as canopy density increases, leaving primarily shallow-rooted grasses, annual grasses, or considerable bare ground. Invasive annual grasses become increasingly common, particularly in the dripline of trees.

Treatment options include:

- Partial cutting and broadcast burning
- Cutting individual trees
- Cutting and jackpot burning
- Cutting, piling and burning
- Uprooting trees individually or by chaining

Condition 3a. Idaho fescue or possibly other species provide sufficient fuelbed to carry fire, but only an underburn may result with limited juniper mortality. As such, broadcast burning in the absence of partial cutting to create a fuelbed capable of carrying fire into juniper crowns is not recommended. The presence of perennial grasses should allow for recovery of hydrologic function, but recovery of a healthy plant community may also require seeding.

Condition 3b. This condition is more likely on steeper slopes where use of heavy equipment is not feasible. Seeding into eroding areas is likely needed to reestablish both hydrologic function and plant community diversity. Where invasive annual grasses are present, seeding with competitive species combined with an herbicide/biopesticide treatment may be necessary. Placement of cut trees, branches or tops into eroding areas can help trap sediment and increase infiltration.

Conditions 3c and d. Condition 3c may occur on gentler slopes and 3d on steeper slopes. Restoration of either condition can be quite difficult and expensive, with a low probability of success. Initial treatments should focus on restoring hydrological function. Burning in either condition is not recommended except as needed to protect homes, other structures, and critical infrastructure. Partial cutting with placement of cut material in eroding areas may be the most feasible treatment. Invasive species can easily become dominant following treatment or wildfire. Seeding with competitive species and herbicides/biopesticides may halt further decline in condition 3c, but where extensive erosion has already occurred in condition 3d, determining appropriate seed mixes can be difficult. In both conditions, use of non-native cultivars may be required to compete with invasive species, although seed mixes should also include native species. Follow-up seeding or planting of native species may be necessary once the site stabilizes.

Additional Treatment Considerations

Prescribed Burning. Burning when live fuel moistures are high and dead fuel moistures are low typically results in a patchy or mosaic burn. Burning under these conditions leaves more shrubs but also leaves some juniper, usually necessitating additional treatment in the future. Burning when both live and dead fuel moistures are low often removes most or all above-ground biomass in the treatment area. While burning under these conditions is very effective in eliminating juniper from the site, it also removes the protection of plant cover and plant litter until regrowth can occur.

Postfire herbaceous response often depends on soil moisture at the time of the burn, subsequent precipitation amount and timing, and degree or duration of prolonged smoldering that kills meristems. In most cases, perennial grasses respond to the fire with increased production and density. Burning often produces a flush of forbs as well. Since antelope bitterbrush and big sagebrush do not tolerate fire, burning will remove them. Sprouting may occur from antelope bitterbrush if soil moisture was high during burning. Depending on the site potential and seed source, return of mature shrubs to co-dominance may take 15 years or longer.

Annual grasses such as cheatgrass and medusahead may spread given the increase in available nutrients, water, and sunlight. If severe drought immediately follows the burn or if utilization levels are too high before perennial grasses recover, invasive annual grasses may take site dominance. Otherwise, cheatgrass may assume temporary dominance (1-3 yr) until existing perennial grasses recover. Whether other annual grasses respond the same way as cheatgrass is not known. Under conditions that allow a high degree of control over livestock, early spring grazing to control cheatgrass may be successful. Medusahead, on the other hand, may require early chemical or biopesticide treatment. Sprouting shrubs such as rabbitbrush (gray and green) can spread rapidly after fire.

Removal of some cut trees can reduce the impacts from subsequent burning. Both Burns and Lakeview Districts report minimal spread of invasive grasses by burning when cut trees are cured but retain most needles, soils are frozen, and the ground is snow-covered. Slash disposal through piling and burning of limbs and tops may be necessary following removal of boles to reduce subsequent wildfire risks.

Mechanical Treatment. With any mechanical treatment, removal of all green juniper material is required to avoid regrowth. Whether and what type of equipment may be used depends on slope steepness, site rockiness, soil erodibility, and operator and equipment capability. Masticators/brush beaters will remove desirable shrubs, may invigorate sprouting shrubs, and often miss small juniper seedlings. However, the thoughtful use of a masticator may create a mosaic effect on the site that promotes site and landscape complexity. Anticipate the need for additional treatment 10 to 15 years after the initial treatment if juniper is re-occupying the site.

Mastication/brush beating will result in the creation 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. In addition, the shredded material may tie up site nitrogen, potentially disfavoring invasive annual grasses. Placing cut trees in gullies may trap sediment and prevent further down-cutting.

Uprooting trees using dozers or chaining remains controversial due to past practices that resulted in considerable compaction and soil displacement. These methods require that trees be completely uprooted, usually requiring at least two passes in different directions when chaining, but if done properly, no more than two passes are necessary.

Falling whole trees and leaving them on site may increase the interception of rain and snow until needles have fallen. However, the resulting litter and duff buildup may smother plants. Prineville District and the Crooked River National Grasslands have had some success at increasing the establishment of native grasses when crowns are left unburned and invasive species are minimal or absent. Where invasive species are common, the increased nitrogen provided by the decaying needles will likely favor those species. In addition, branches more than 4 feet off the ground provide suitable perch sites for sage-grouse avian predators; leaving intact downed trees is not recommended in sage-grouse habitat.

Opportunities may be present to remove some or most trees for firewood, biomass, or specialty furniture, depending on site accessibility, haul distances, and prices for the product and the equipment needed to harvest, process, and transport any wood products. In treatment areas where the tree boles have been removed the remaining slash can be scattered to protect bare soil from raindrop impact, detain overland flow, and increase 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 depends on whether post-treatment grazing by cattle or elk is desired or not. Seeding and spreading slash on skid trails can control erosion and weed invasion if the disturbance appears excessive.

Herbicides. Herbicides are rarely used to control juniper and is most feasible when the trees are under six feet tall. Herbicide use may be more selective and cause less disturbance than mechanical treatments or fire. Herbicide use on BLM-managed lands is restricted to the control of non-native invasive plants, such as cheatgrass, medusahead and other noxious weeds. Additionally, it may be used on native plants, such as juniper and rabbitbrush, when the action is designed to achieve specific habitat goals specified in recovery plans, conservation strategies or conservation agreements for Federally listed or other Special Status Species (BLM 2010). Site specific NEPA is required to authorize application of herbicides on BLM lands. Herbicides may be needed to control invasive plants before or after juniper treatments to meet management objectives.

Monitor Treatment Effectiveness and Ecosystem Response

Monitoring is critical to applying adaptive management and becoming critical to support subsequent NEPA analyses, protests, appeals, and litigation. However, monitoring is not research; statistical robustness is not necessary. Monitoring is intended to identify trends and discover unexpected outcomes (both positive and negative) that may warrant more intensive analysis or actual research. Statistically robust data collection and analysis should be reserved for controversial projects and projects involving new management techniques. Assistance in designing monitoring for these types of projects usually is available from the Agricultural Research Service, Natural Resources Conservation Service, Oregon Watershed Enhancement Board, and Oregon State University.

A manageable monitoring program has the following characteristics:

- Is applied to some projects, but not every project,
- Can be applied to only portions of projects need monitoring (selection of sites can be biased to address particular locations of concern),
- Is inexpensive,
- Is multidisciplinary,
- Takes advantage of existing plots such as range condition plots when possible,
- Uses established protocols and data standards, and
- Measures only the elements relevant to the project/program objectives.

Districts should use AIM protocols (Technical Note 440, MacKinnon et al. 2011) for monitoring shrubs, grasses and forbs and a variant of Forest Inventory and Analysis (FIA) tree density protocols for measuring trees. The tree density protocol can be found in Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems: Volume II (Herrick et al. 2005). Key tree characteristics to measure are species and height for seedlings and saplings; and species, diameter, and tree height for larger trees. Tree cover should be measured along the same transects used as part of the AIM protocols. Subplot 1 for the tree density protocols should be located at plot center for the AIM plot. Herbaceous and shrub data should be entered into the AIM database or its successor once it is available, following the established data standards. If there is a desire or need to model potential treatment effects using the Forest Vegetation Simulator prior to treatment, an inventory using standard stand exam protocols may be more appropriate.

See Chapter 7 of Monitoring and Measuring Plant Populations (Elzinga et al. 1998) for more information on sampling design. This publication along with Technical Note 440 and the ARS Monitoring Manual Volume II have been posted on the Juniper Guidelines SharePoint site at http://teamspace/or/sites/climatechange/JuniperGuidelines/Pages/default.aspx. Users of these guidelines are strongly encouraged to post field test results along with any recommendations to the Juniper Guidelines SharePoint site or its successor.

Apply Adaptive Management Techniques

It is not enough to implement treatments, even using these guidelines. We need to know how well the guidelines do or do not work, how well the actual treatments applied did or did not work, and what sort of variation there is across the state. To that end, we added a section to the Juniper Guidelines SharePoint site (http://teamspace/or/sites/climatechange/JuniperGuidelines/Pages/default.aspx) that will allow anyone to upload monitoring reports. Users may also send comments and suggestions for improvements to these guidelines as field experience highlights what works and what does not.

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