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Land Manager's Guide to Aspen Management in Oregon

Oregon State University Extension Service

Forest Restoration Partnership

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Contents

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Foreword

We are Kevin and Carol Westfall, residents of Klamath Falls, Oregon. We own property that is located northeast of Chiloquin at an elevation of 4,700 feet. This property consists of meadows interspersed with conifer stands and patches of aspen. The meadows, which make up about one-half of the acreage, are irrigated by two springs. The dominant tree species are lodgepole pine and ponderosa pine, with about 20 acres of quaking aspen.

The property appeals to us for a multitude of reasons. The meadows are well suited for livestock grazing, the timber is managed for both commercial and home firewood production, and there are many opportunities for outdoor recreation.

When we purchased the property, we were not aware of aspen's unique characteristics nor of its importance to the forest ecosystem. Aspen's value as a wildlife food source was one of the main reasons we decided to prioritize the enhancement of this species.

We have attended workshops, read articles, and received technical assistance from informed

resource professionals. All of this has helped guide us in our efforts.

Throughout the West, aspens have been declining for a number of years and for a variety of reasons. We encourage anyone with an interest in aspen to get involved in the management and enhancement of this valuable member of the natural world.

Kevin and Carol Westfall

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Tim Deboodt started working for the University of Wyoming Cooperative Extension Service in 1983 in Teton County. In 1987, he moved to Prineville, Oregon and is now a faculty member with the Oregon State University Extension Service, serving the central Oregon region by developing and delivering educational information related to rangelands, their use, and management. Programs include restoration of semiarid watersheds, range improvements, livestock grazing systems, and land management policy issues. Current research activities include the effects of western juniper control on watershed function and hydrology, water quality parameters as influenced by land management activities, and restoration of rangeland health using prescribed fire and other management practices.

Stephen Fitzgerald is the eastside silviculture and wildland fire education specialist for the Oregon State University Extension Service, stationed in Redmond, Oregon. He conducts extensive educational programming in forest management, wildland fire ecology, fuel reduction, and post-fire recovery. Much of his silviculture research work deals with improving forest health in eastside dry forests.

Ann Humphrey is a biologist who has been fortunate to spend the past 31 years working in a variety of ecological systems across the United States, from sage grasslands and ponderosa woodlands in Wyoming to tall grass prairies in Minnesota, old-growth forests in Washington, and seabird colonies in the northwestern Hawai'ian Islands. She has spent much of the past 5 years studying the Zumwalt Prairie in northeastern Oregon, where she recently collaborated with Wallowa Resources, a local nonprofit, to examine the effectiveness of aspen exclosures.

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Chapter 1

Introduction

Darin Stringer

Figure 1. Aspen are more than a splendid backdrop for trophy elk; they provide critical habitat for a broad range of wildlife. (Photo: Rocky Mountain Elk Foundation)

Quaking aspen (*Populus tremuloides*) is one of a few iconic trees that symbolize the spirit of the West. Though sparsely distributed throughout Oregon, aspen is an important species, providing a long history of benefits to both people and wildlife. "Quakies," as many call aspen, are well liked by ranchers, hunters, foresters, and city folk alike. Even so, this tree is declining throughout the West and has already disappeared from much of the landscape. Ensuring a future for aspen on working lands and wildlands will require efforts by landowners across the region.

Some may say, "Sure, aspen are pretty, but I've got plenty of other important things to do on my land. Why should I manage for aspen?" Aspen provide year-round benefits. In summer, the cool, humid understory of aspen groves provides refuge on hot, dry days. Basque sheepherders of years past knew this. Some of their camps are still identified by tree carvings or "arborglyphs" they inscribed on aspen trees (see page 7).

The shade and moist air created by aspen also provide a measurable benefit during fire season. Sometimes called "asbestos trees," aspen have been known to moderate fire behavior in some situations. Aspen also can enhance water flows by accumulating snowpack more readily than conifers. During autumn, aspen foliage colors the landscape. In the winter, aspen provide food for various types of wildlife.

Aspen are heavily used by wildlife. Quakies provide excellent hiding and thermal cover, fawning and calving ground, and forage for deer and elk (Figure 1). Bird use is often higher in aspen groves than on surrounding lands. Species such as ruffed grouse, beaver, bats, woodpeckers, and many neotropical migratory birds use aspen. These groves are so widely used that the Oregon Department of Fish and Wildlife lists aspen as a strategy habitat in its State Conservation Strategy. Groups such as the Rocky Mountain Elk Foundation, Ruffed Grouse Society, and Oregon Hunters Association are focusing major efforts and resources to enhance aspen.

The cool shade and abundant forage that attract wildlife also benefit livestock. Without active management, forage production can be reduced by as much as 70 percent or more when aspen are replaced by conifers. The grasses and flowers that comprise this forage also contribute to plant diversity, which in turn benefits insect pollinators, hummingbirds, and other beneficial critters (see page 2).

Whether your interest is wildlife, aesthetics, or general land stewardship, maintaining and enhancing aspen on your property requires active management.

If you are a landowner or a manager, this guide will help you improve management of your aspen by:

- Increasing your understanding of aspen biology and ecology
- Helping you set goals and objectives for stewarding aspen
- Demonstrating how to assess the condition of aspen groves and prioritize areas for treatment
- Describing various treatment options and tradeoffs and providing examples of completed projects
- Suggesting techniques to evaluate the effectiveness of treatments
- Listing available resources to assist in the management of aspen

A SMORGASBORD FOR WILDLIFE

Tom Rodhouse

When I think of a stringer of aspen running up a hillside in eastern Oregon, I envision it as one of the land's arteries, transporting nutrients and energy through the system. All kinds of wildlife use aspen stands, making their importance disproportionate to their acreage. Aspen stands are biological hotspots; they attract species that don't occur in the surrounding landscape. Warblers nest and stop over in aspen groves during migration, while elk find cover in aspen during summer and drop their calves there.

Figure 2. Aspen provide excellent habitat for cavity-nesting birds such as woodpeckers. (Photo: Jim Anderson)

Aspen stands are a particularly important resource for cavity-nesting birds and bats because of the structural characteristics of mature stands (Figure 2). The big trees, both living and dead ones, often are excavated by woodpeckers and insects. Their cavities in turn provide homes for dozens of other species.

One of the things that has always excited me about aspen ecology is its cascading effects through the food chain. Many types of insects feed on the leaves, in turn attracting insectivorous birds and bats. Porcupines like the soft bark, while rodents and shrews enjoy the abundant vegetation and insects in the understory. Next come the predators—weasels, hawks, and coyotes. It's a real smorgasbord for wildlife and a treat for anyone who loves critters!

Chapter 2

Ecology of Quaking Aspen

Stephen Fitzgerald

Figure 3. An aspen grove in autumn. (Photo: Stephen Fitzgerald)

Quick Facts about Quaking Aspen

Common names: Trembling aspen, mountain aspen, golden aspen, popple, poplar, trembling poplar

Family: Willow family (*Salicaceae*)

Age/Longevity: The above-ground portion of the tree is a short-lived "pioneer" species, generally 100 years old or less. Some individual trees have been aged to 220-plus years. Individual clones can be hundreds to thousands of years old.

Growth rate: Fast

Reproduction: Mostly from sprouts (vegetative reproduction); rarely from seed (sexual reproduction); grows in distinct stands or clones.

Successional role: Pioneer species

Geographic distribution of aspen

Quaking aspen (Figure 3) is one of the most widely distributed tree species in North America, as it can tolerate a wide range of environmental and site conditions (Perala 1990). In the United States, it is most common in Alaska and in the central to northern Rocky Mountain states; it is present to a lesser extent in the southern Rockies (Arizona and New Mexico). Aspen is also very widespread in the upper Midwest (Minnesota and Wisconsin) and in the eastern states. Aspen is also found in the Sierra Nevada Range in California (Figure 4, page 4).

In Oregon, aspen is not as widespread and is found in smaller, more distinct stands, primarily east of the Cascade Range. Ecologically, it is an important forest type within landscapes dominated by conifers and within areas of sagebrush and western juniper in the sagebrush steppe biome of central and eastern Oregon (Figure 5, page 4).

Habitats

Aspen grow on a variety of sites and soils. Shepperd et al. (2006) outline several physiological attributes that allow aspen to grow in a variety of situations:

- Tolerance of cold temperatures and a short growing season
- Vigorous sprouting, which allows stands to persist in environments with frequent disturbances, such as wildfire
- Ability to alter leaf morphology (size and shape) depending on moisture availability
- Ability to photosynthesize in low light conditions (Aspen's green bark has the ability to photosynthesize as well as to minimize transpiration water loss.)
- Tolerance of low soil-nutrient levels

Aspen typically grow where there is a high water table or along streams and creeks, slope bottoms, benches, and concave landforms that retain soil moisture (Shepperd et al. 2006). In arid areas, aspen are typically found where there is surface water in the form of seeps and springs. Throughout the boreal forest zone, aspen grow as a "pioneer species" on recently exposed glacial till (outwash) soils, which are low in nutrients. In Oregon, aspen grow on a variety of soil types, ranging from those dominated by volcanic deposits (ash and pumice) to more clayey soils.

Figure 4. Distribution of quaking aspen. (Source: U.S. Geological Survey)

Figure 5. Aspen clone in a sagebrush-western juniper plant community. (Photo: Stephen Fitzgerald)

Reproduction and establishment

Reproduction of aspen is primarily from sprouts arising from the root system of parent trees (vegetative reproduction). Sprouting is controlled by growth regulators (similar to hormones in animals) produced within the tree. The key growth regulators that control sprouting are cytokinin and auxin. Cytokinin is produced in the roots, and auxin is produced in the branch tips at the top of the tree. Cytokinin promotes sprouting from roots, while auxin suppresses root sprouting. When the above-ground part of the tree is killed by fire or cutting, auxin is no longer produced to counter or suppress the effects of cytokinin, allowing prolific sprouting to occur.

Although an aspen clone may produce some sprouts in any given year, sprouts erupt profusely following disturbances. Sprouts emerge from roots growing within 4 inches of the soil surface. It is not uncommon to have several hundred

thousand sprouts per acre. Leaves on new sprouts are often larger than those on mature trees, allowing for increased photosynthesis and fast growth (Shepperd et al. 2006).

Sprouts from the parent tree's root system have the exact genetic makeup as the parent tree, and the combination of parent and sprouts is referred to as a clone. Individual clones can be small and comprise just a few trees, or they can be quite large. One aspen clone in Utah covers 107 acres (Perala 1990). Large aspen stands may comprise one or more clones.

Although the above-ground tree stems within a clone are often less than 100 years old, a clone itself may be hundreds, if not thousands, of years old. One of the oldest known aspen stands is the Pando clone in Utah. It is estimated to be 80,000 years old, weighs more than 6,000 metric tons, and is considered one of the world's oldest living organisms. Thus, aspen may be one of the longest lived tree species (Mitton and Grant 1996).

Quaking aspen can also reproduce from seed (sexual reproduction). Quaking aspen is dioecious, meaning that individual trees are either male or female. Thus, trees comprising a distinct clone are either all male or all female. Although aspen produce large quantities of viable seeds that can be transported in the wind for miles, germination and establishment of new quaking aspen seedlings from seed is very rare in the western United States. It is unclear why. One explanation is that aspen seeds remain viable for a very short period of time (2 to 4 weeks) and require a moist mineral seedbed in which to germinate and grow—conditions that rarely coincide.

However, following the 1988 wildfires in Yellowstone National Park, aspen did regenerate from seed in some places that were long distances from existing stands. According to Romme et al. (1997), conditions were conducive for establishment following the fire: viable seed landed on mineral soil, the spring was moist and cool during germination, and the young seedlings did not get browsed immediately by deer and elk, allowing the trees to establish.

Growth and persistence

As young sprouts grow, they compete with one another for resources and light. Only the most vigorous sprouts survive. Sprout height growth is fastest during the first 20 years or so. Over a period of a few decades, sprouts "self-thin," creating stands with progressively fewer, but larger, stems per acre (Figure 6).

Because aspen usually resprout vigorously following disturbance, most stands are even aged. However, some stands are more uneven aged, which suggests that stands can perpetuate themselves in the absence of major disturbances. These stands may appear stable or in a climax state (Perala 1990).

Relationship to disturbance

Aspen has a strong association with periodic fire. Although wildfires often kill the above-ground portion of trees due to aspen's thin bark (Brown and DeByle 1989), fire rejuvenates older stands, which respond by producing an explosion of sprouts from the parent root system (Figure 7, page 6). The ability to resprout allows aspen to survive in an environment that historically was marked by frequent fire (Kauffman 1990).

Aspen's response to fire depends on the health and vigor of individual clones and on the severity of the fire (Bartos and Mueggler 1979; Bartos et al. 1991; Brown and DeByle 1989). Profuse sprouting occurs after moderate- to high-intensity fires; less sprouting occurs following light burns.

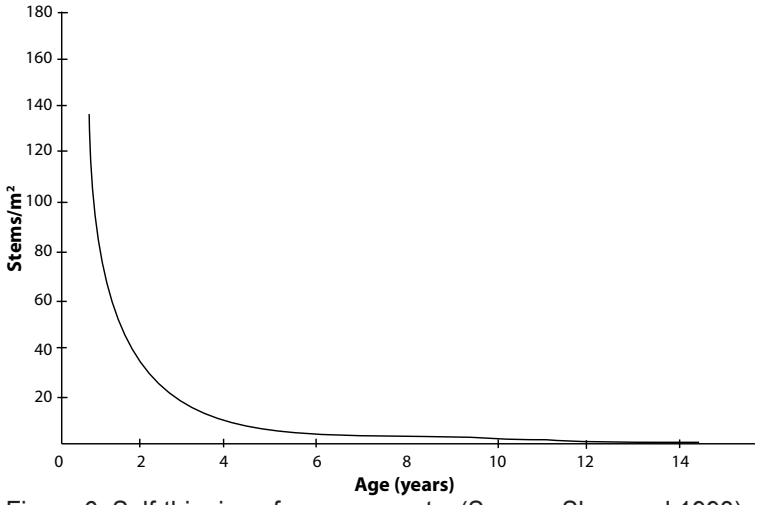


Figure 6. Self-thinning of aspen sprouts. (Source: Shepperd 1993)

Aspen decline and restoration

Across the West, aspen stands are in a widespread state of decline that seems to be accelerating. In Oregon, many aspen groves are in a severe state of decline and are made up primarily of older age classes (late successional). Aspen stands begin to deteriorate when large trees grow old in the absence of disturbance and begin to die and break off in windstorms. This creates gaps within the grove, but without appropriate conditions, little or no sprouting will occur to replace the declining overstory trees. Increased breakage from stem decay or insect attack in already weakened (nonvigorous) trees often accelerates or facilitates this process of decline.

Figure 7. Aspen sprouting following mortality of overstory trees by wildfire. (Photo: Stephen Fitzgerald)

Several factors, including a lack of disturbance (fire), invasion by conifers, heavy livestock use (browsing, soil compaction, and other associated impacts), and heavy browsing of sprouts by deer and elk, contribute to aspen's decline. Climate change may also be a factor or may become an increasingly important factor if predictions of increasing temperatures and changing precipitation patterns are realized.

In some areas, heavy grazing by livestock and browsing by elk have reduced aspen regeneration and abundance (Bartos and Campbell 1998). For example, in Yellowstone National Park, high elk populations and a lack of large predators had caused a decline in aspen abundance, particularly in meadows and in areas where elk tend to congregate. Reintroduction of wolves into Yellowstone has kept elk herds more on the move (through fear of predation), allowing aspen and other hardwoods to reestablish within these systems (Ripple and Larsen 2000).

In Oregon, aspen is often out-competed and replaced by conifer tree species due to the lack of periodic fire (DeByle et al. 1987; Bartos and Campbell 1998; Bates et al. 2006). In addition, due to the lack of periodic wildfire, fires today tend to burn hotter and can have greater detrimental effects, especially for stands already in a state of decline (i.e., in poor health).

Because of aspen's ecological importance in ecosystems across central and eastern Oregon, there is widespread interest in reversing its decline. Both private landowners and federal land management agencies, such as the U.S. Forest Service and the Bureau of Land Management, are interested in enhancing aspen.

Restoration of aspen has included cutting, burning, or a combination of the two, to rejuvenate declining aspen stands. In addition, fencing and other methods are often needed to exclude livestock, deer, and elk and to allow sprouts a chance to develop into mature trees and stands. To evaluate whether your aspen may need restoration, see Chapter 3. See Chapters 4 and 5 for management and treatment recommendations.

Insects, disease, and other damage

Aspen are highly susceptible to several insects and diseases. This is one factor that makes aspen so important to wildlife. Heart rot, fungi, and other diseases make the wood soft and easily excavated to create nest cavities for several bird and mammal species. These trees eventually fall to the ground, where they provide important ground nesting and travel habitat. Wildlife and livestock also find aspen very palatable. Appendix II provides an overview of aspen's most common insect, disease, and animal-damage problems in Oregon.

ARBORGLYPHS: A RECORD OF THE PAST

John Kaiser

If aspen is growing on your property, there is a chance that someone left a legacy of drawings on some of the older trees (Figure 8).

These drawings, called "arborglyphs" or "dendroglyphs," were made predominantly by Basque and Irish sheepherders from about 1920 through the 1950s in south-central Oregon. They were made with the point of a knife, nail, or similar sharp object. This sharp point cut lines into the thin bark of the aspen tree. As the tree healed, the lines expanded to reveal names, dates, drawings, messages, and maps. There are numerous arborglyphs because, during those decades, large numbers of sheep roamed all over the forest and were cared for by large numbers of herders. These men left their stories and experiences on the aspen trees.

These arborglyphs contain some fascinating stories. On the Fremont-Winema National Forests in eastern Oregon, we found an entire Shakespearean sonnet. Another carving tells of a young herder who lost his girl to another young man at a local dance.

Many of these tree writings are disappearing as the aspen trees age and fall over. Now is a critical time to conduct your aspen assessments and document these relics before they crumble back into the ground.

All is not lost. Perhaps you and your family will continue to "carve" names, dates, and messages on the white-barked trees, leaving your story for future generations to discover.

Figure 8. Arborglyphs found on the Fremont-Winema National Forests. (Photos: John Kaiser)

Chapter 3

Assessing Aspen Health

Darin Stringer

Figure 9. A healthy grove contains a range of sizes and ages of aspen, with few or no conifers. Groves with a dead and declining overstory should contain an abundant understory of young aspen. A vigorous native plant understory indicates an optimal condition. (Photo: Darin Stringer)

Why should I assess my aspen?

Knowing the extent, location, and condition of aspen on your land is a key first step toward enhancing this resource. As discussed in Chapter 2, many aspen groves in Oregon are especially at-risk and may be lost without swift action. Completing an assessment of your aspen provides information that will help you:

- Better understand the condition of the grove
- Determine what types of treatments, if any, are needed
- Create a baseline that will help you see trends over time and evaluate the effectiveness of management actions

What is a healthy condition for my aspen grove?

The condition of an aspen grove depends on a variety of site factors, including soils, aspect, elevation, topography, past and current management, and wildlife use. Climate conditions, such as precipitation and temperature, also influence aspen. Indicators of productive sites for aspen include deep, dark, organic topsoil; presence of tall aspen; and presence of vegetation indicative of abundant soil moisture.

On very productive sites, where soils and moisture are optimal, aspen trees can become quite large and vigorous. In contrast, sites with thin, rocky soils and limited moisture often contain trees that are much smaller, stunted, or unhealthy. General indicators of healthy aspen (Figure 9) include the following:

- **Aspen overstory**: An overstory of vigorous to declining aspen.
- **Young aspen understory**: Newly regenerated trees below or around the edges of a more mature overstory of aspen. Where overstory aspen are declining and dead, lack of a vigorous understory indicates very poor aspen health.
- **Aspen dominance**: An overstory and understory made up primarily or completely of aspen, with few competing conifers present. Conifers should generally comprise less than 10 percent of tree cover, although this percentage may be higher in riparian areas within ponderosa pine and mixed-conifer stands. Aspen should be free of juniper. Other native hardwoods are considered a healthy part of the plant community.
- **Native plant understory**: A diverse understory plant community free of noxious weeds. The understory should include a mix of native shrubs, grasses, sedges, rushes, and forbs (non-grass flowering plants). These conditions benefit wildlife and suggest grazing levels appropriate for aspen regeneration.

How do I assess my aspen?

With these standards in mind, you can locate and assess the condition of aspen on your land using the Aspen 3-Step Assessment Method. This chapter will guide you through steps 1 and 2. Chapter 4 covers step 3.

1. Locate and map aspen groves

Many landowners know where the larger aspen groves are on their property. To locate additional aspen, consider the site factors mentioned in Chapter 2 and start in these areas. For example, aspen often grow near springs, seeps, or streams; in areas of wet or poorly drained soils; or in meadow edges, rocky outcrops, and other areas where snow accumulates (Figure 10). U.S. Geological Survey (USGS) 1:24,000-scale topographic maps (also known as 7.5-minute quadrangles), U.S. Forest Service (USFS) maps, and Bureau of Land Management (BLM) maps often show locations of springs and other water, which will aid in your search. The former can be purchased at some outdoor sporting goods stores (e.g., REI), while the latter are available at local agency offices (see Chapter 7).

The color aerial photos available on Google Earth (http://www.earth.google.com) are an

ASSESSMENT: THE ASPEN 3-STEP

1. Locate and map aspen groves on your land
2. Assess condition of the grove(s)
3. Determine the need for actions to improve aspen health (Chapter 4)

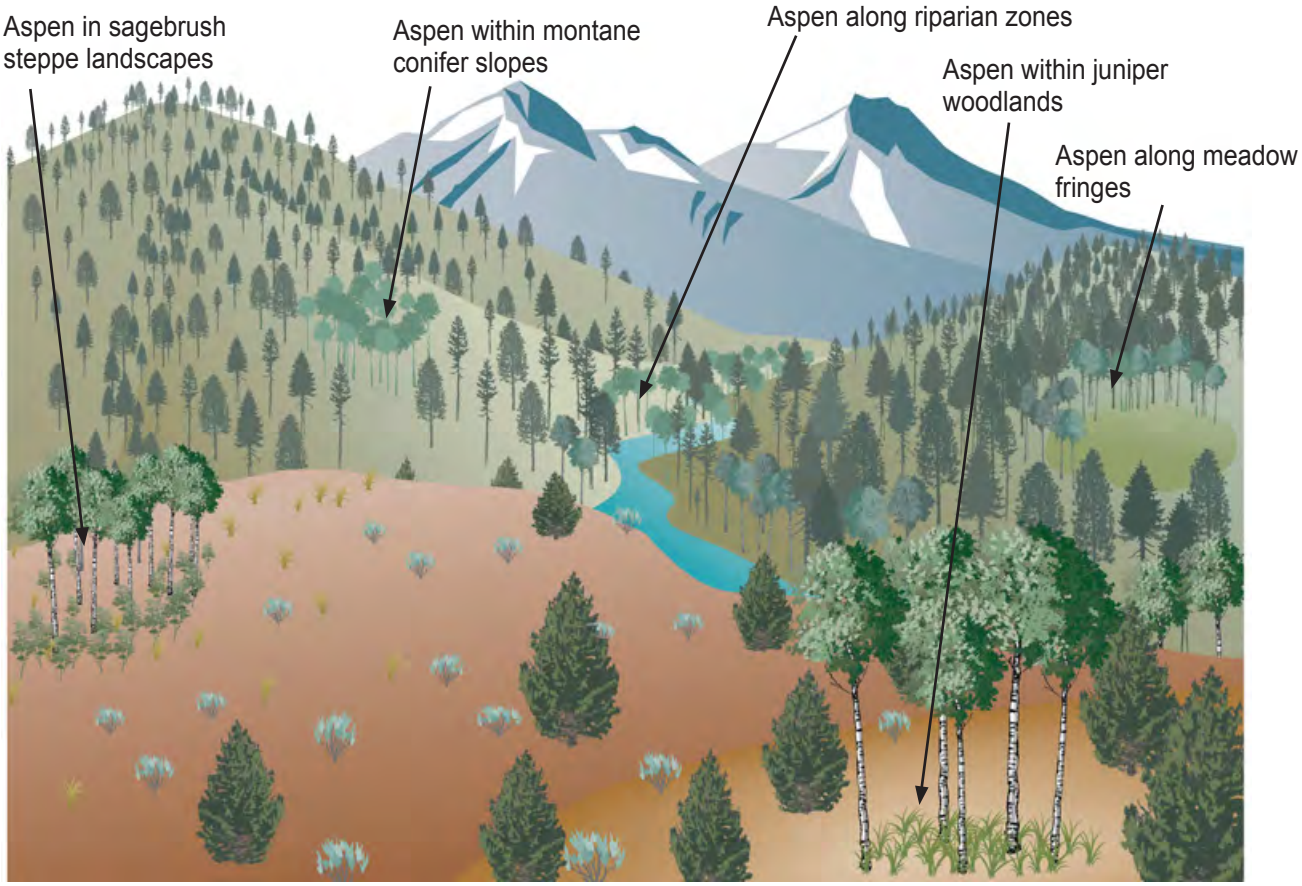


Figure 10. To locate aspen on your property, look around springs and seeps, streams, areas of wet and poorly drained soils, meadow edges, rocky outcrops, where road runoff accumulates, depressions, and areas where snow accumulates. (Illustration: Gretchen Bracher)

excellent way to search for patches of aspen. With this high-resolution imagery, you can locate groups of aspen and sometimes individual trees. Compared to conifers, aspen groves have a distinct lighter green color (Figure 11). However, aspen can be difficult to see if overtopped by conifers. Aspen that are heavily encroached may be difficult to locate using aerial imagery.

When you find an aspen tree, it's often not alone! Many aspen trees are actually remnants of a formerly larger aspen grove, now broken up into patches and individual trees. This condition is fairly common along riparian stringers, other draws, and in conifer-dominated stands. If you find aspen in a draw, search upstream and downstream along the creek. In forested settings, search in a circular pattern around the tree for at least 300 feet.

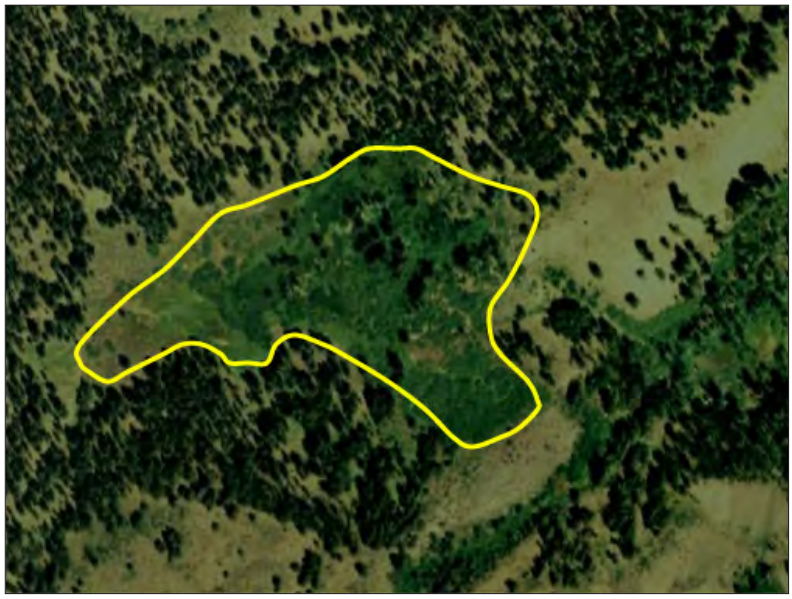


Figure 11. In aerial photos, aspen and other vegetation associated with wet areas (inside the yellow boundary) are easily distinguishable from surrounding coniferous forest, which appears darker green. (Photo: Google Earth)

Mark the locations of aspen on an ownership map, USGS, USFS, or BLM map, aerial photo, or printed Google Earth image. Alternatively, you can use a GPS unit to map the grove as a point or delineate the perimeter with a series of points. You can download these coordinates to a personal computer and use them to make digital maps and calculate acreages.

Once you have located aspen on your land, proceed to Step 2 to assess its condition.

2. Assess condition of the grove

We have developed the following two aspen assessment methods for use by private landowners:

- A complete (FULL) assessment involves installing two monitoring plots (permanent markers) within and near the aspen grove. You will take photographs and collect information in these plots to assess tree health, site resources, and site conditions (access, water resources, noxious weeds, etc.). We recommend completing a FULL assessment before implementing management actions, as it will provide a detailed baseline for evaluating changes following such actions. It takes 1 to 2 hours to complete a monitoring plot.
- A simplified (RAPID) assessment doesn't involve permanent plots. The RAPID assessment is a good option for landowners who want to survey their aspen quickly and for ownerships containing many aspen groves. The RAPID assessment usually takes less than 30 minutes to complete.

The remainder of this chapter consists of instructions, forms, and examples to help you complete your FULL or RAPID assessment.

Aspen Assessment Instructions, Forms, and Samples

To help you assess aspen on your property, this section contains the following:

A list of supplies and equipment needed to complete the FULL and RAPID Assessments is found in Appendix IV (page 79).

TIPS FOR SUCCESSFUL ASSESSMENT

- Having two people makes the process go much faster and is more fun.
- Make sure you have all gear and supplies before entering the field. Use the checklist on page 79.
- Thoroughly walk the aspen grove before drawing your map, to avoid having to redo your work.
- Take the time to install reference points for your photo points. You will thank yourself when trying to relocate the posts. Photo point posts are often difficult to find after treatments. If posts are damaged or removed, the reference points will be invaluable for relocating the plot.
- To better judge scale in your photos, use a 6-foot t-bar post painted with alternating 1-foot-long bars of brightly colored paint. Position this “scale bar” 10 feet from the photo point, so the picture will show the bar in the foreground.
- Look at each photo on the camera screen (most digital cameras have one) to make sure the quality is adequate.
- Before leaving the aspen grove, check the assessment form to make sure you have filled it out completely.
- Download and label your digital pictures immediately to avoid losing or misidentifying images.

Steps for completing the FULL Assessment

See Appendix IV (page 79) for equipment and supplies needed to complete the FULL Assessment.

1. After locating the grove, walk through it and observe its size and shape. Note the condition of the aspen (both overstory and understory), features of interest (roads, springs, streams, other wet areas, fences, noxious weeds), and other noteworthy characteristics. Pay special attention to grazing influence on aspen suckers. Identify the perimeter of the grove by finding the trees or suckers on the outer edge. Flagging this edge is recommended.
2. Draw the boundary of the grove on Map 1 (page 2 of the monitoring form). If desired, you can use a global positioning system (GPS) with mapping capability to accurately map the size and shape of the grove. Transfer the mapped boundary on the GPS screen to Map 1. Garmin GPS units that allow "tracks" to be recorded are one example.
3. Fill out the "General Aspen Grove Information" on page 1 of the assessment form. Estimate the grove size in acres (a GPS can be helpful). Record location by using the legal description, latitude/longitude/UTM coordinates from your GPS, or local features (e.g., "½ mile up Rd. 200 on the right next to spring").
4. Determine the location for a permanent outside photo point. This is a place outside the aspen grove that will provide a good vantage point for taking photos. It is helpful to place this point close to a tree or stump. Pound a 6-foot t-post into the ground at the photo point. Etch the words "Outside Photo Point," the date, and the name or number of the grove on an aluminum tag. Tie the tag to the post with thin wire or a zip tie. Tie a piece of colorful flagging to the t-post and spray paint the post to help identify it. Record the GPS position on page 1 of the assessment form. Draw the approximate position of the outside photo point on Map 1 (page 2).
5. Take a picture/s of the aspen grove while standing behind the post with your camera directly over the post.
6. Point a compass in the direction each photo is taken and record the azimuth (degrees in direction) of each photo on page 1. On Map 1, draw arrows from the photo point showing the direction (azumith) for each picture taken (see sample completed map). It is important to identify each photo so you can name it properly when you download the photos. One method is to record the picture number assigned by the camera. Another option is to write the photo point number, azumith, and date on a sheet of notebook paper or dry erase board and take a picture of this information after taking each photo point photo. When you download the photos, you will have two pictures for each: the photo of the grove and the photo of the recorded information.
7. Choose a nearby tree or stump to serve as a reference point to help you locate the outside photo point in the future. On another aluminum tag, etch the distance and azimuth from this point to the previously installed outside photo point (e.g., "30' @ 150° to outside photo point"). Record this information on page 1 of the assessment form. Nail this tag to the reference tree (at 4.5 feet) or stump. Spray paint a horizontal stripe above and below the tag with highly visible tree marking paint to help identify the tag during future monitoring.
8. Determine the location for the permanent inside photo point (photo point within the aspen grove). This point should provide a good view of changes over time and should be representative of the grove (e.g., a spot where conifers are to be removed).
9. Pound a 6-foot t-post into the ground at the inside photo point. Repeat step 4 above to label the post with a tag to identify the inside photo point.
10. Follow the instructions in steps 5 and 6 above to take photos from the inside photo point. Be sure to identify the photos as described in step 6.
11. Follow the instructions in step 7 above to create a reference point for your inside photo point.

12. Draw other notable features on Map 1 (page 2) of the assessment form (see the map key).
13. On Map 2 (page 2) of the assessment form, draw boundaries between different aspen condition classes and label with the codes from the Aspen Condition Classification Chart (page 23).
14. In the box below the map, describe the grove. See the sample on page 17 for details on how to complete the map and describe the grove. Try to include the following in your description:
    - Vegetation conditions
    - Condition of mature aspen and regeneration "suckers." Do they look healthy? Are they mature or younger? Note any damage such as defoliation, disease, animal browse, or antler rubbing.
    - Level of conifer encroachment, species, and sizes of conifers
    - Grazing level and browse/damage to aspen suckers (use visual aids on page 22)
    - Noxious weeds
    - Access to the grove
    - Known or suspected wildlife use
15. Download your photos and rename them for future reference. For example, the first image taken in north direction of the outside photo point could be labeled "Grove 1-Outside Plot-North."
16. Go to Chapter 4 to determine whether treatments are needed. Record the suggested management actions at the bottom of page 2 of the assessment form.

Additional measurements

The following measurements will allow you to quantify aspen suckers and their condition. To make these measurements, install one or two transects (tree measurement plots along a line) as follows:

1. From the inside photo point, choose a random direction for a transect line, or place the line intentionally through an area where you wish to monitor aspen suckers. One way to get a random line is to look at a watch with a second hand and multiply the seconds by 6. Standing at the inside photo point, turn the dial on your compass to this value, and use it as the direction for your transect line. The transect length should be 50 or 75 feet; use 50 feet if the grove is too small to contain a 75-foot transect. If your random direction puts the transect outside the grove, repeat the process until you get a line that is fully contained within the grove. Record the azimuth and length of the transect line on page 1 of the monitoring form.
2. Attach the end of a measuring tape to the t-bar at the inside photo point. Lay out the measuring tape along the transect line.
3. Pound a 6-foot t-post into the ground at the end point (either 50 feet or 75 feet). Etch an aluminum tag with the words "end point-transect 1" (or "end point-transect 2" if you do two plots) and tie it to the stake. Tie a piece of colorful flagging to the t-bar to help you locate the post.
4. Walk along the transect from the inside photo point to the transect end point and count aspen suckers within 1 yard on each side of the transect line (see diagram and photo on page 18). If any part of the plant intersects an imaginary line that extends 1 yard from the transect line, count the tree. If multiple stems arise from a single base stem (as occurs with clipped suckers), record all intersecting stems as one plant. Classify suckers according to the following size classes:
    - Less than 1.5 feet tall
    - 1.5 to 4.5 feet tall
    - More than 4.5 feet tall to 2 inches dbh (diameter at 4.5 feet)

    Record the total number of trees in each size class on page 1 of the assessment form.
5. Take a photo at the inside photo point facing the transect line. Take another photo at the end point facing the transect line back toward the inside photo point. Follow the instructions in step 6 of "Steps for completing the FULL assessment" to identify photos.

Aspen FULL Assessment Form (page 1 of 2)

General Aspen Grove Information			
Date:		Assessor:	
Aspen grove ID (name or #):			
Average slope (%):			
Grove size (acres):			
Outside Photo Point			
GPS position (lat/long or UTM):			
Reference point:		Azimuth/Distance to photo point (feet):	
Photo (azimuth/name):		Notes:	
Photo (azimuth/name):			
Photo (azimuth/name):			
Inside Photo Point			
GPS position (lat/long or UTM):			
Reference point:		Azimuth/Distance to photo point (feet):	
Photo/north (azimuth/name):		Notes:	
Photo/east (azimuth/name):			
Photo/south (azimuth/name):			
Photo/west (azimuth/name):			
Photo/overhead (name):			
Aspen Regeneration Transect 1			
Transect azimuth:		Transect length (feet):	
Tree size class	*# trees*	*Browse (light, mod, severe)*	*Damage (light, mod, severe)*
# Trees (< 1.5')			
# Trees (1.5–4.5')			
# Trees (>4.5' tall to <2" dbh)			
Photo (endpoint ⟶):		Photo (plot center ⟶):	
Aspen Regeneration Transect 2			
Transect azimuth:		Transect length (feet):	
Tree size class	*# trees*	*Browse (light, mod, severe)*	*Damage (light, mod, severe)*
# Trees (< 1.5')			
# Trees (1.5–4.5')			
# Trees (>4.5' tall to <2" dbh)			
Photo (endpoint ⟶):		Photo (plot center ⟶):	
Notes:			

Aspen FULL Assessment Form (page 2 of 2)

Map 1

Key for Map 1

- Stream
- Spring
- Reference point
- Outside photo point
- Inside photo point
- Road (4-wheel +)
- Transect line
- Grove boundary

Map 2

Describe aspen grove:

Needed management actions (from Aspen Management Options Flowchart, page 25):

Sample completed page 1 of FULL Assessment Form

General Aspen Grove Information

Date: 9-10-09	Assessor: John Appleseed
Aspen grove ID (Name or #): 1 - along northern end of Bull Meadow	
Average slope (%): 5-20%	
Grove size (acres): 3 acres	

Outside Photo Point

GPS position (lat/long or (UTM)): 702485	4886184
Reference point: 32" pine stump	Azimuth/Distance to photo point (feet): 200°/27'
Photo (azimuth/name): 35° IMG035	Notes: Photo point is in meadow near a large ponderosa pine stump.
Photo (azimuth/name): 340° IMG036	
Photo (azimuth/name):	

Inside Photo Point

GPS position (lat/long or (UTM)): 702474	4886199
Reference point: 20" pine tree	Azimuth/Distance to photo point (feet): 170°/20'
Photo/north (azimuth/name): 368 IMG037	Notes: Photo point is just south of a large aspen log in a grassy opening along the creek
Photo/east (azimuth/name): 90° IMG038	
Photo/south (azimuth/name): 180° IMG039	
Photo/west (azimuth/name): 270° IMG040	
Photo/overhead (name): IMG041	

Aspen Regeneration Transect 1

Transect azimuth: 95°		Transect length (feet): 75'	
Tree size class	*# trees*	*Browse (light, mod, severe)*	*Damage (light, mod, severe)*
# Trees (< 1.5')	𝍸 𝍸 𝍸 𝍸 IIII 24	moderate	Light
# Trees (1.5–4.5')	𝍸 IIII 9	moderate	severe
# Trees (>4.5' tall to <2" dbh)	Ø	—	—
Photo (endpoint →): IMG 050		Photo (plot center →): IMG 051	

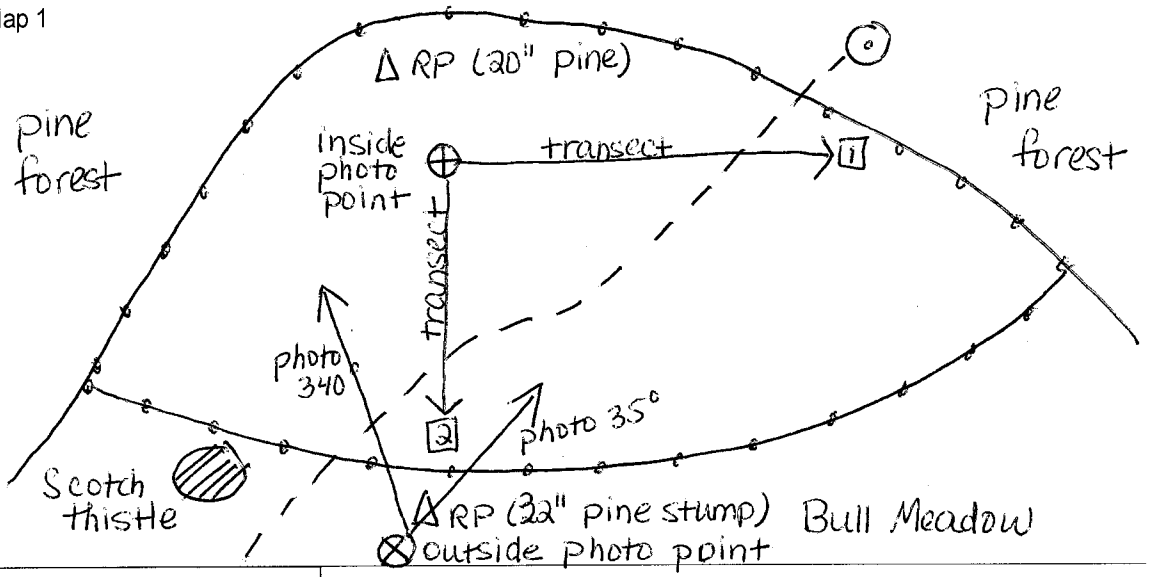
Aspen Regeneration Transect 2

Transect azimuth: 190°		Transect length (feet): 50'	
Tree size class	*# trees*	*Browse (light, mod, severe)*	*Damage (light, mod, severe)*
# Trees (< 1.5')	𝍸 𝍸 𝍸 𝍸 20	Light	Light
# Trees (1.5–4.5')	III 3	Light	Light
# Trees (>4.5' tall to <2" dbh)	𝍸 5	Light	Light
Photo (endpoint →): IMG 157		Photo (plot center →): IMG 158	

Notes: This is the largest grove on the ranch and is accessed only during dry season. There is a seasonal creek running through the grove. No livestock use this area. Elk browse above snow level. Suckers are growing well but sparse along transect 2.

Sample completed page 2 of FULL Assessment Form

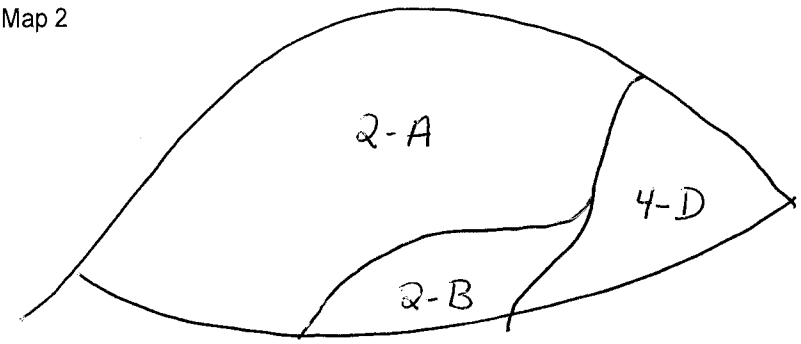
Map 1



Key for Map 1

- Stream
- Spring
- Reference point
- Outside photo point
- Inside photo point
- Road (4-wheel +)
- Transect line
- Grove boundary

Map 2



Describe aspen grove: A 3-acre grove. Overstory is mostly mature & declining aspen. About 1 acre (along east end) has many conifers overtopping the aspen, Suckering is heavy except in areas 2-B & 4-D. Browse is light to moderate (mostly elk).

Needed management actions (from Aspen Management Options Flowchart, page 25):
Remove all conifers from area 4-D. Assess suckering in 2 years in areas 4-D & 2-B. Consider big game fence if regeneration is poor. Remove Scotch thistle before flowering.

Aspen Regeneration Transect Diagram

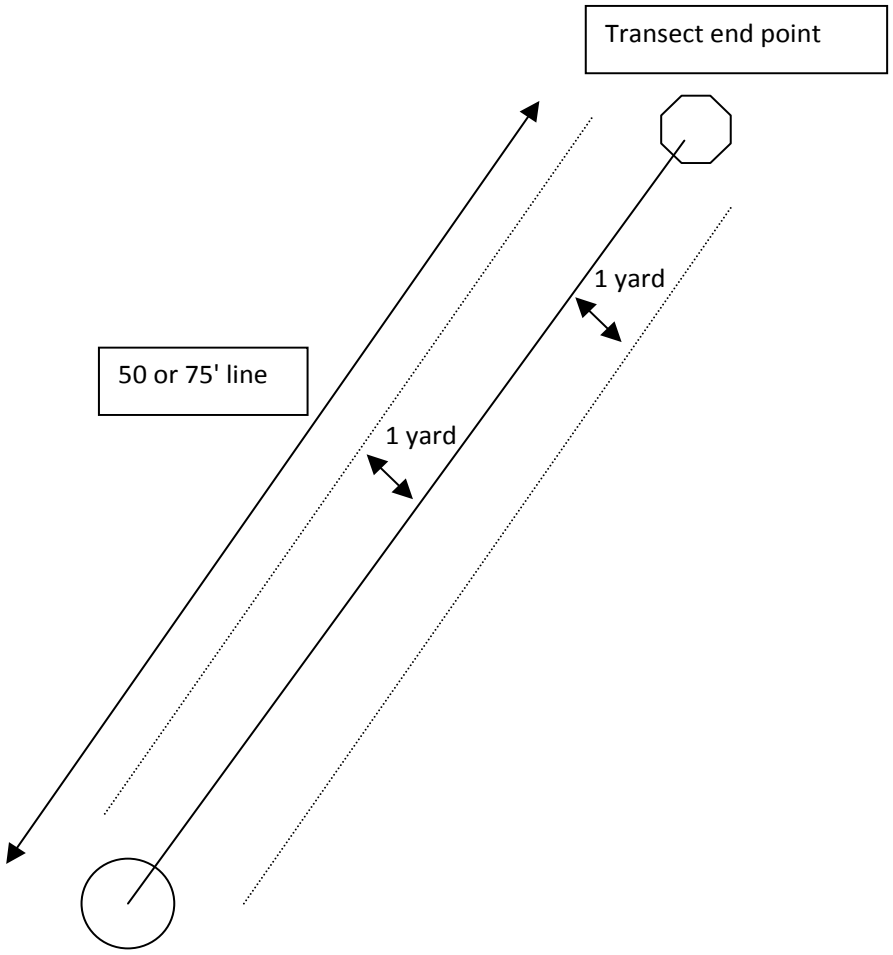


Figure 12. Count all aspen within 1 yard of both sides of the 50- or 75-foot-long transect line.

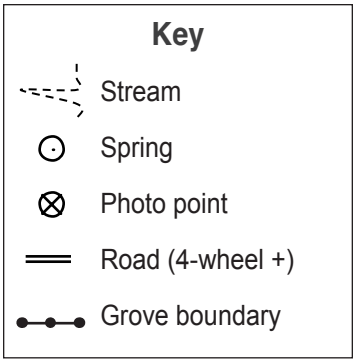
Steps for completing the RAPID Assessment

See Appendix IV (page 79) for equipment and supplies needed to complete the RAPID Assessment.

1. After locating the grove, walk through it and observe its size and shape. Note the condition of the aspen (both overstory and understory), features of interest (roads, springs, streams, other wet areas, fences, noxious weeds), and other noteworthy characteristics. Pay special attention to grazing influence on aspen suckers. Identify the perimeter of the grove by finding the trees or suckers on the outer edge. Flagging this edge is recommended.
2. Draw the boundary of the grove on the assessment form. If desired, you can use a global positioning system (GPS) with mapping capability to accurately map the size and shape of the grove. Transfer the mapped boundary on the GPS screen to the form. Garmin GPS units that allow "tracks" to be recorded are one example.
3. Fill out the "General Aspen Grove Information" on the assessment form. Estimate the grove size in acres (a GPS can be helpful). Record location by using the legal description, latitude/longitude/UTM coordinates from your GPS, or local features (e.g., "½ mile up Rd. 200 on the right next to spring").
4. Draw other notable features on the assessment form (see items in the map key).
5. Take photos and label the position and direction where images were taken on the map. Make sure to rename your photos to avoid confusion during future monitoring.
6. On the map, draw boundaries between different aspen condition classes and label with the codes from the Aspen Condition Classification Chart (page 23).
7. In the box below the map, describe the aspen grove. See the sample map on page 21 for details on how to complete the map and describe the grove. Try to include the following in your description:
   - Vegetation conditions
   - Condition of mature aspen and regeneration "suckers." Do they look healthy? Are they mature or younger? Note any damage such as defoliation, disease, animal browse, or antler rubbing.
   - Level of conifer encroachment, species, and sizes of conifers
   - Grazing level and browse/damage to aspen suckers (use visual aids on page 22)
   - Noxious weeds
   - Access to the grove
   - Known or suspected wildlife use
8. Go to Chapter 4 to determine whether treatments are needed. Record suggested management actions at the bottom of the assessment form.

Aspen RAPID Assessment Form (page 1 of 1)

General Aspen Grove Information	
Date:	Assessor:
Aspen grove ID (name or #):	
Average slope (%):	Grove size (acres):



Describe aspen:

Needed management actions (from Aspen Management Options Flowchart, page 25):

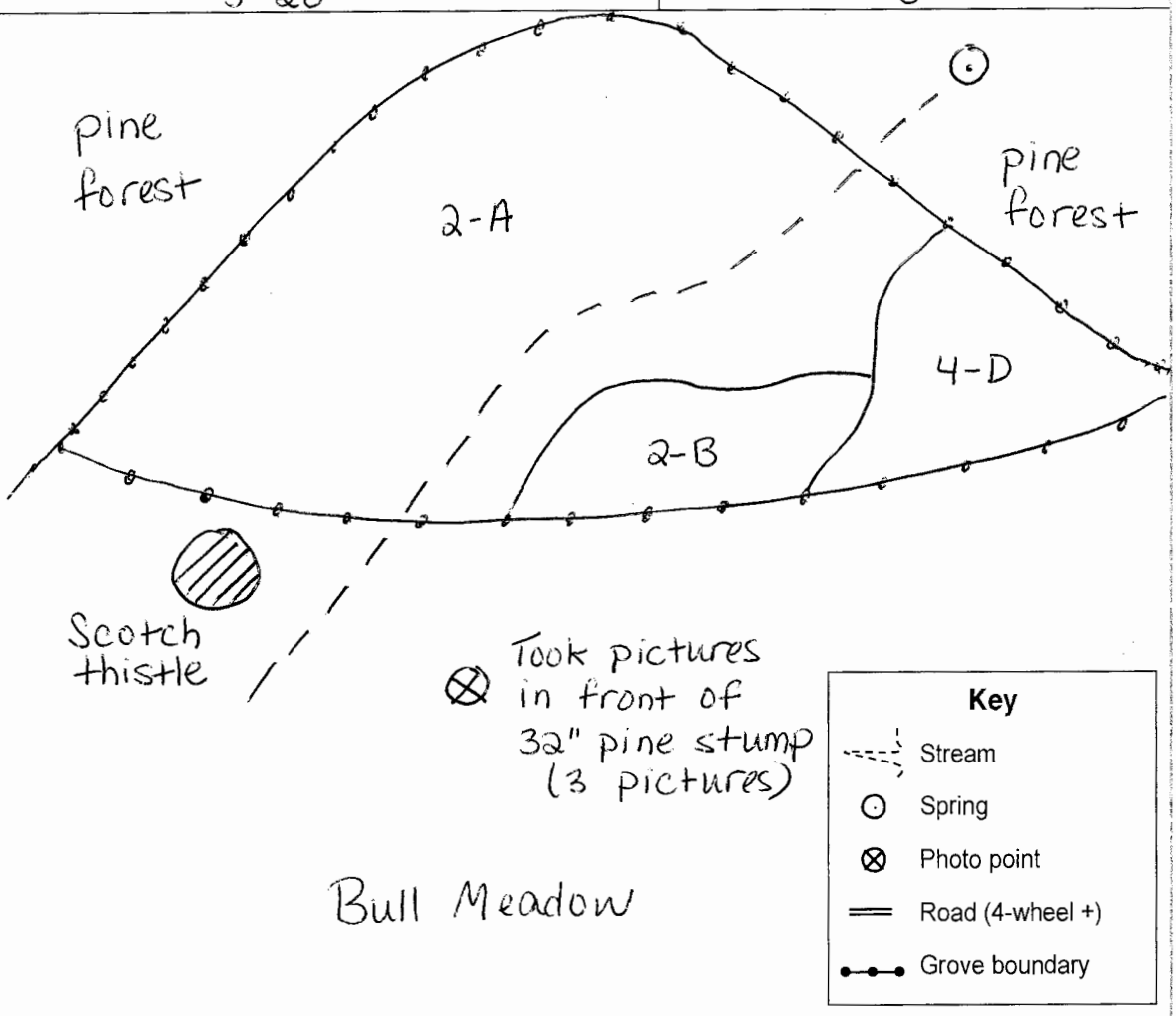
Sample Completed RAPID Assessment Form (page 1 of 1)

General Aspen Grove Information

Date: 9-1-09 | Assessor: John Appleseed

Aspen grove ID (Name or #): 1 north end of Bull Meadow

Average slope (%): 5-20 | Grove size (acres): 3



Describe aspen: A 3-acre grove with overstory mostly of mature & declining aspen. About 1 acre (4-D) has many conifers overtopping aspen. Suckering is heavy except in areas 2-B & 4-D. Browse is light to moderate (mostly by elk).

Management actions (from Aspen Management Options Flowchart, page 25):

Remove all conifers from area 4-D. Assess suckering in 2 years in areas 4-D & 2-B. Consider big game fence if regeneration is poor. Remove Scotch thistle before flowering.

Visual Aids
(use with both RAPID and FULL Assessments)

Level of browse

Figure 13. Light/moderate browse damage. Although the tree has been browsed, it continues to grow in height. (Photo: Darin Stringer)

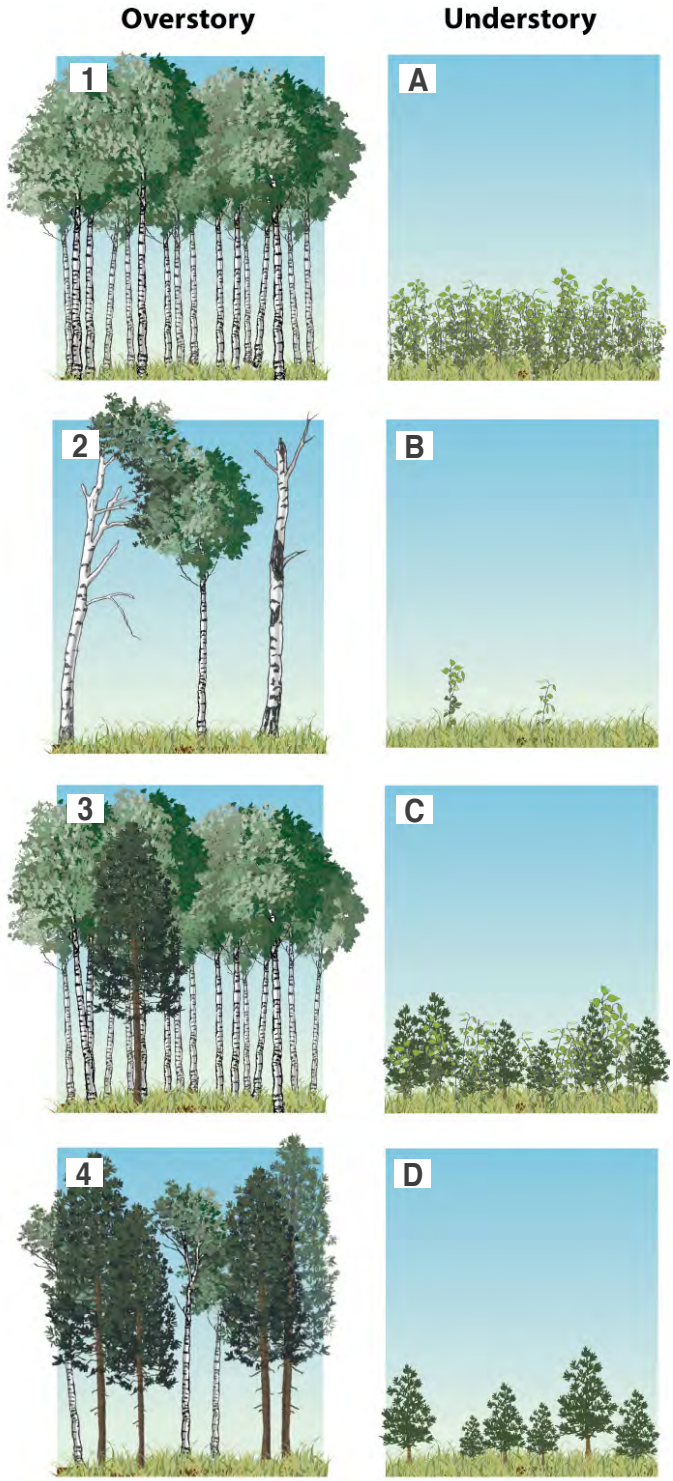
Figure 14. Severe browse damage of new suckers after a beaver cut the main stem. This tree has a hedged or pruned look and cannot grow above the ungulate browse level. (Photo: Darin Stringer)

Level of other damage

Figure 15. Light damage by antler rubbing. (Photo: Darin Stringer)

Figure 16. Severe damage by trampling. (Photo: Darin Stringer)

Aspen Condition Classification Chart (use with both RAPID and FULL Assessments)



Code 1

Healthy, well-stocked aspen overstory

Code A

Heavy to moderate aspen regeneration

Code 2

Aspen overstory declining or absent

Code B

Light or no aspen regeneration

Code 3

Aspen overstory with light conifer encroachment

Code C

Conifer and aspen regeneration

Code 4

Aspen overstory with moderate to heavy conifer encroachment

Code D

Conifer regeneration with no aspen

Figure 17. Aspen Condition Classification Chart. Use this chart to classify aspen as part of the FULL or RAPID Assessment. To use this chart, match the condition of the overstory and understory of your grove with the illustrations above. For example, a grove with a healthy overstory and moderate aspen regeneration would be labeled as 1-A on your map (page 2 of the FULL Assessment and page 1 of the RAPID Assessment).

Chapter 4

Identifying Actions to Improve Aspen Health

Darin Stringer

Figure 18. Where conifers threaten aspen, management actions may be needed to promote aspen suckering and free up aspen for growth. (Photo Darin Stringer)

In Chapter 3, we described how to assess the health of your aspen. In this chapter, you will learn how to evaluate the need for actions and appropriate treatments to improve the condition of your grove. Many aspen stands in Oregon require immediate action to restore health and vigor (Figure 18). The Aspen Management Options Flowchart (Figure 19, page 25) will guide you through this process and direct you to additional information to plan enhancement work. Start in the top left cell and answer each yes/no question to arrive at a recommended action. The key on pages 26–31 will guide you through the flowchart. If actions are recommended, go to the indicated page in Chapter 5 for additional guidance to design treatments.

Tips for Successful Evaluation of Treatment Need

- Time your assessment so you can effectively evaluate patterns and type of browse and understory plants. Fall is often a good time to evaluate browse. If possible, visit the grove during different times of the year.
- An aspen grove may require a range of treatments in different areas. Take the time to consider where to apply various needed actions.
- Detail desired treatments on the FULL or RAPID Assessment form map and describe in the "Needed management actions" box (page 15 or page 20).
- Have a resource professional, knowledgeable neighbor, or just another set of eyes to assist with the evaluation.

Aspen Management Options Flowchart

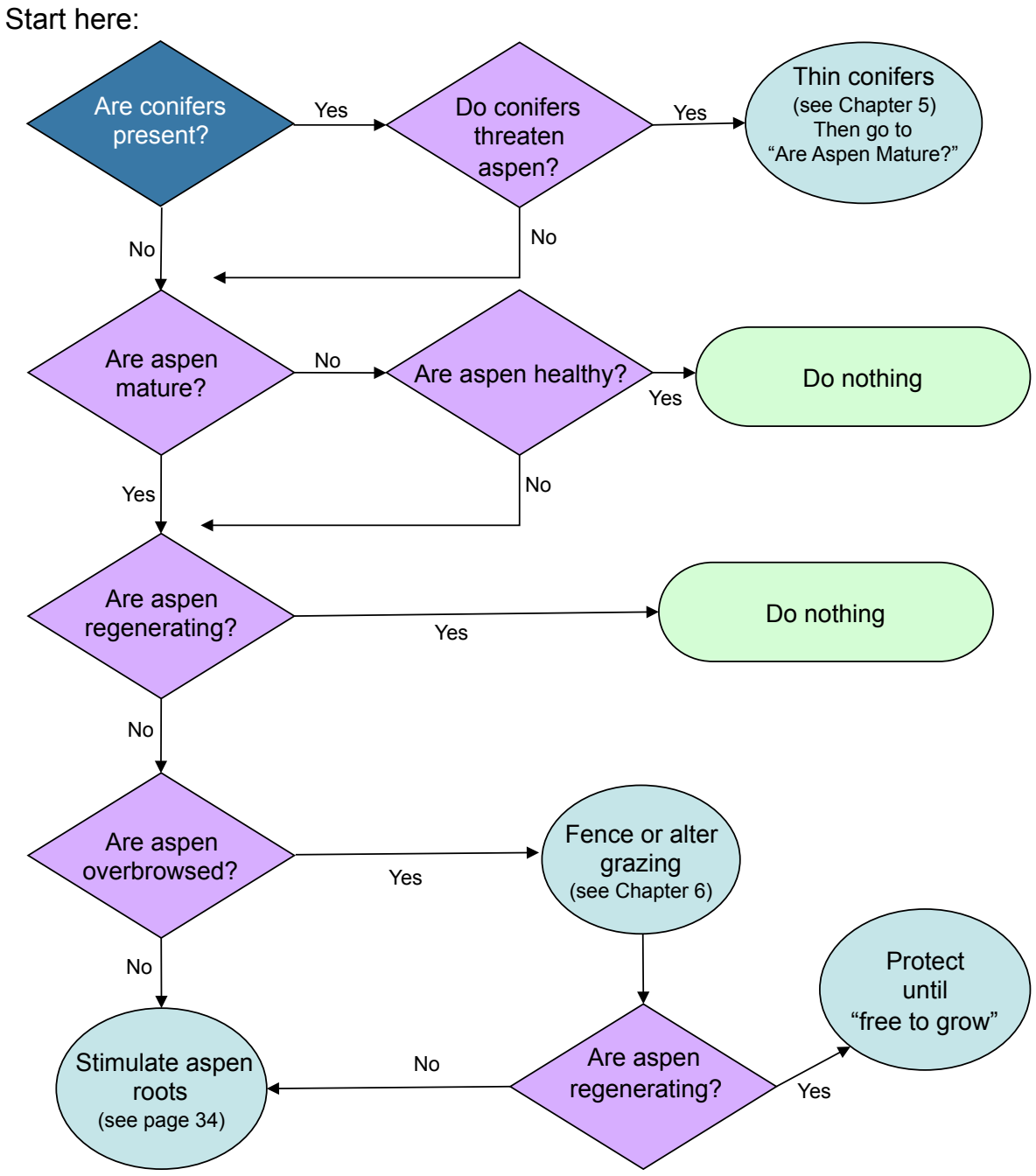


Figure 19. Aspen Management Options Flowchart. Use this chart to identify actions needed to enhance the aspen grove. Record these actions under "Needed management actions" on the RAPID Assessment form or on page 2 of the FULL Assessment form. See the key on pages 26–31. (Source: Modified from Mueggler 1989)

Key to Aspen Management Options Flowchart

Are conifers present?

If conifers occur in and/or around your aspen, answer "yes."

Do conifers threaten aspen?

The answer depends mainly on the conifer species, density, and size. If your aspen is encroached by junipers at any density, answer "yes." Juniper threaten the health of aspen in a number of ways:

- By shading aspen
- Through release of chemical compounds into the soil that may suppress growth of other plants
- By using large amounts of water that otherwise would be available to aspen and other desirable vegetation
- By shading understory plants, thus reducing plant diversity and grazing potential

While aspen do best in pure stands, a few scattered conifers are tolerable. Some old aspen groves have widely spaced, old-growth ponderosa pine stumps, indicating the two species can coexist. Ponderosa pine lets more light through its crown than do Douglas-fir and grand fir. If ponderosa pine cover does not exceed 10 percent, the grove is probably not immediately threatened. In a dense mature aspen grove, this proportion of conifers might represent five to seven 16-inch-dbh trees per acre (dbh, or diameter at breast height, is tree diameter at 4.5 feet).

While the impact of overtopping and shading by dense lodgepole and ponderosa pine, Douglas-fir, and grand fir is obvious, smaller conifers should also be viewed as a threat if density exceeds a few trees per acre. Seedling, sapling, and pole-size conifers shade understory aspen and other vegetation and take moisture otherwise available to the grove. It is easier to remove small conifers before they grow through the canopy. Early removal also reduces damage to aspen during falling.

Figures 20 and 21 show two typical scenarios where aspen are threatened by conifers. Condition classes refer to the Aspen Condition Classification Chart in Chapter 3 (page 23). Figure 22 (page 27) shows aspen stands encroached by conifers.

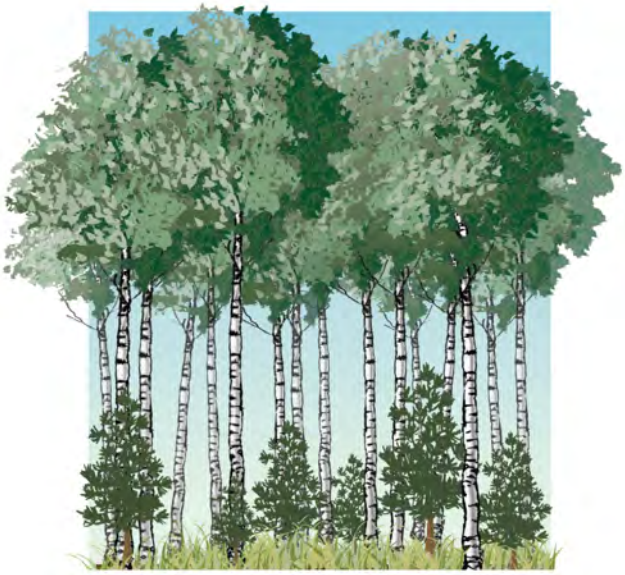


Figure 20. Aspen Condition Class 1-D—Healthy overstory, conifer regeneration without aspen regeneration. (Illustration: Gretchen Bracher)

Figure 21. Aspen Condition Class 4-D—Conifer encroachment of overstory, conifer regeneration without aspen regeneration. (Illustration: Gretchen Bracher)

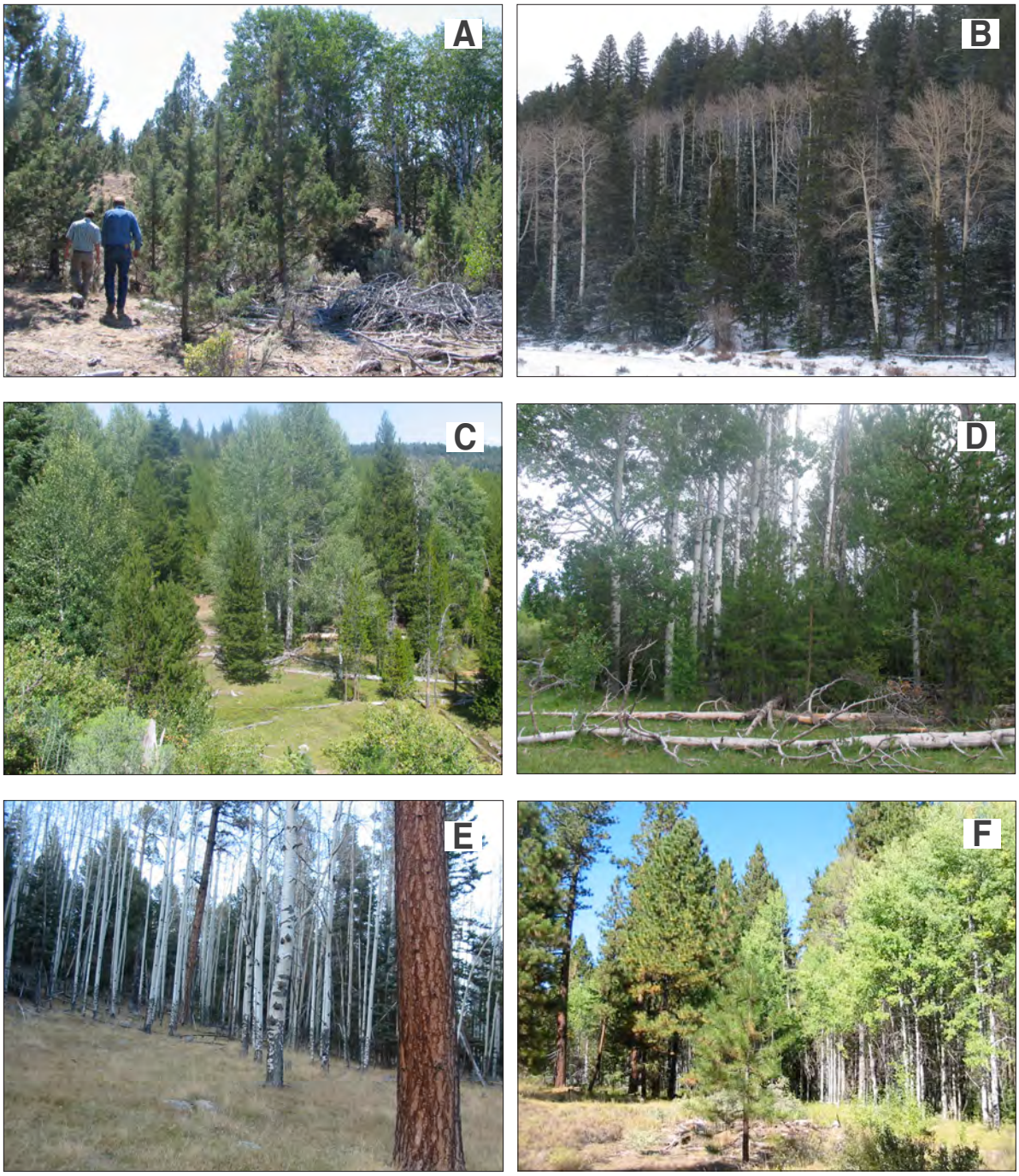


Figure 22. Do conifers threaten aspen? The answer is "yes" in plates A–D. Various conifers are heavily encroaching on aspen in Plates A (juniper), Plates B and C (mixed conifers), and Plate D (lodgepole pine). In these plates, conifers in both the understory and overstory threaten aspen. Plate E has a few widely scattered ponderosa pine that do not threaten the aspen. Plate F has a few pine saplings and clumps of more mature ponderosa pine, but aspen have room to grow and expand. (Photos: Darin Stringer)

Are aspen mature?

Compare the size and condition of your aspen to the photos below. Mature aspen (Figure 23) often have sparse leaf cover and thick, dark, furrowed bark at the base, an indicator of heart rot (conks). Snags and dead fallen trees are indicators of mature and declining aspen. In some extremely decadent groves (old, with failing health), there are no live remnants of the overstory. In this case, snags and large downed aspen indicate recent overstory decline.

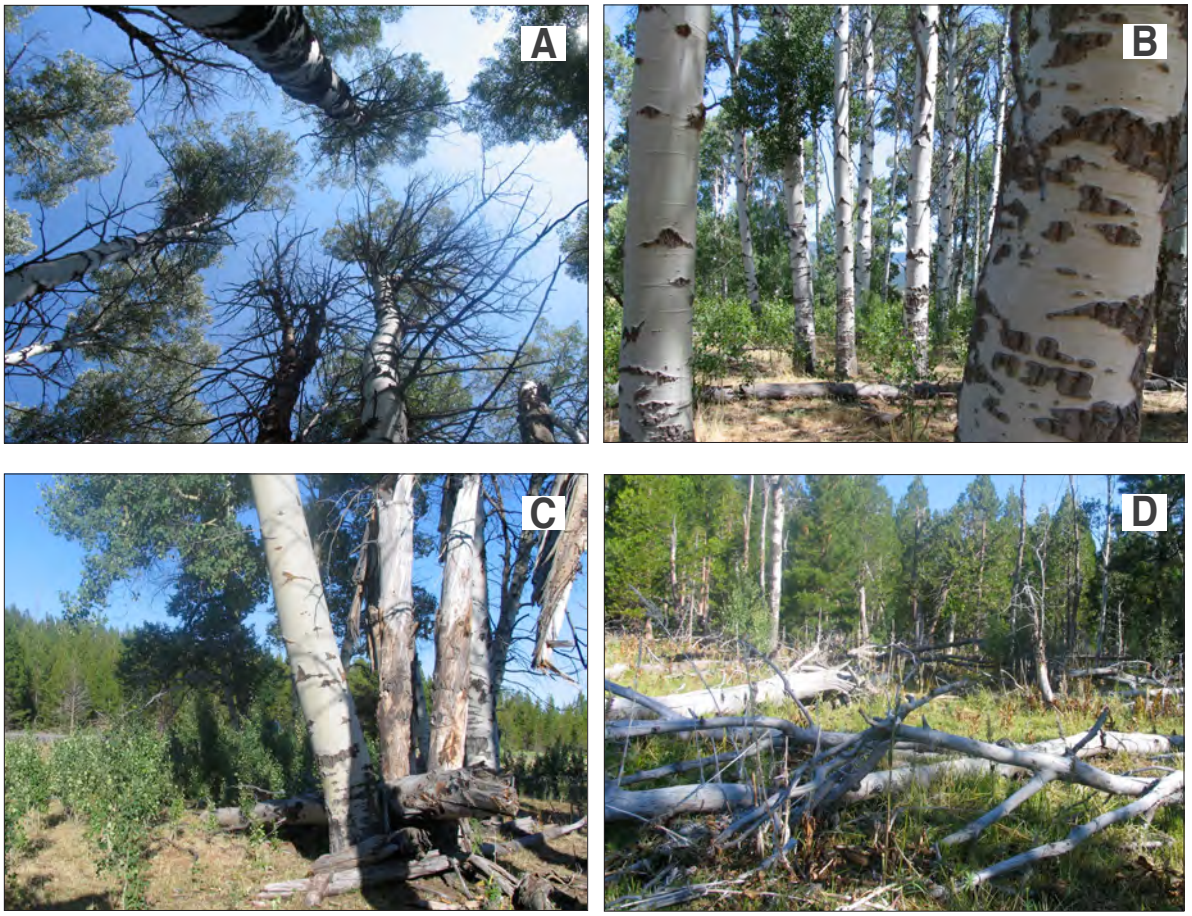


Figure 23. Are aspen mature? The answer is "yes" in all plates. Indicators of maturity include large live, declining, and dead aspen (Plates A–C), rough and furrowed bark (Plate B), and downed and dead aspen (Plates B–D). (Photos: Darin Stringer)

Are aspen healthy?

Healthy younger groves are usually densely spaced with vigorous aspen (typically less than 10' x 10' average tree spacing). If aspen density is low (greater than 30' x 30' average spacing), or if most trees look stunted, are sparsely covered with leaves, or have other signs of decline, answer "no." See Figure 24.

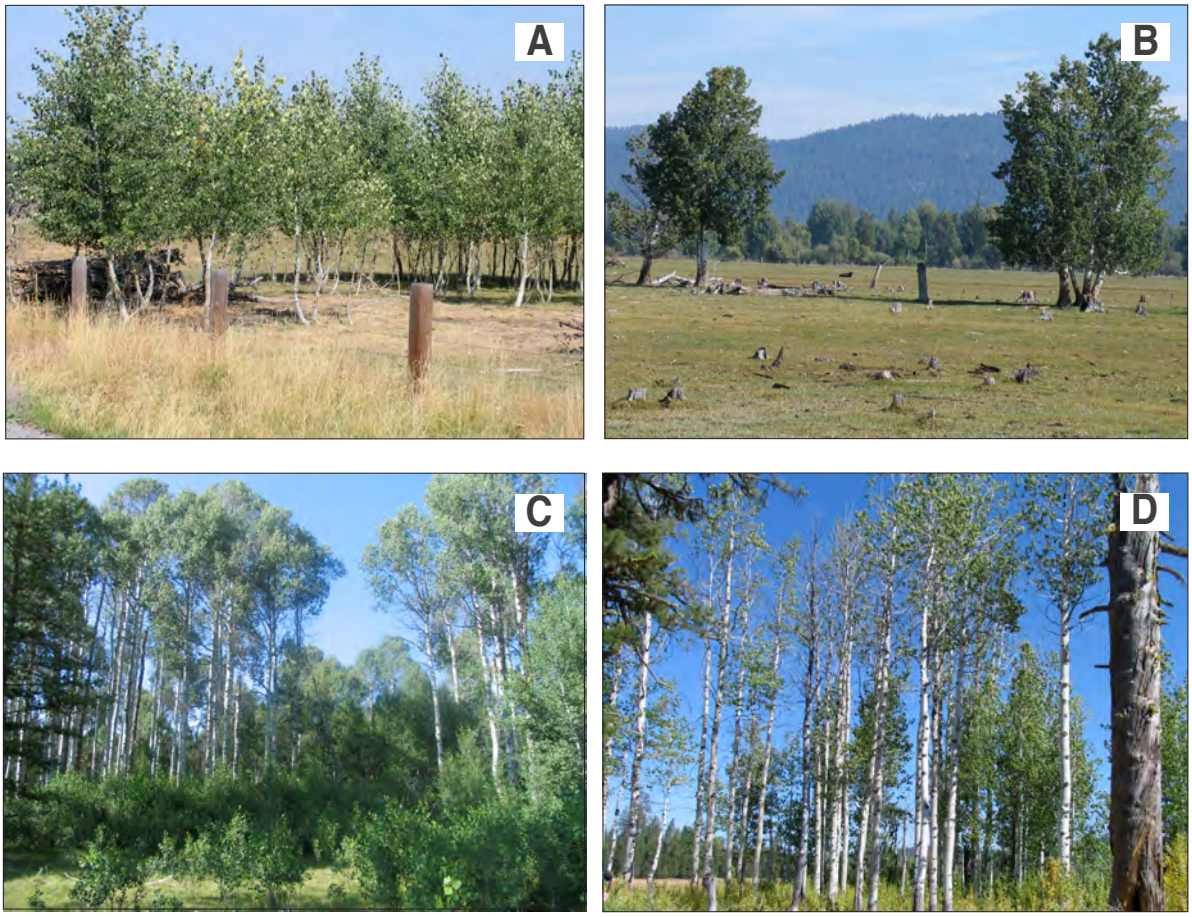


Figure 24. Are aspen healthy? The answer is "yes" in Plates A and C. Aspen in these plates are dense and have full crowns (branches with leaves covering at least 30 percent of total height). Plate C also has two distinct age classes of aspen. Plate B aspen have full crowns, but tree stocking is very sparse, and suckering is absent. The aspen in Plate D have sparse crowns, a sign of poor vigor. (Photos: Darin Stringer)

Are aspen regenerating?

Groves with successful aspen regeneration have abundant new suckers. Aspen are either large enough to withstand animal browse and damage or are not being utilized excessively. Regenerating aspen are under the canopy of mature declining trees or in openings around the outer edge of the grove. See Figure 25.

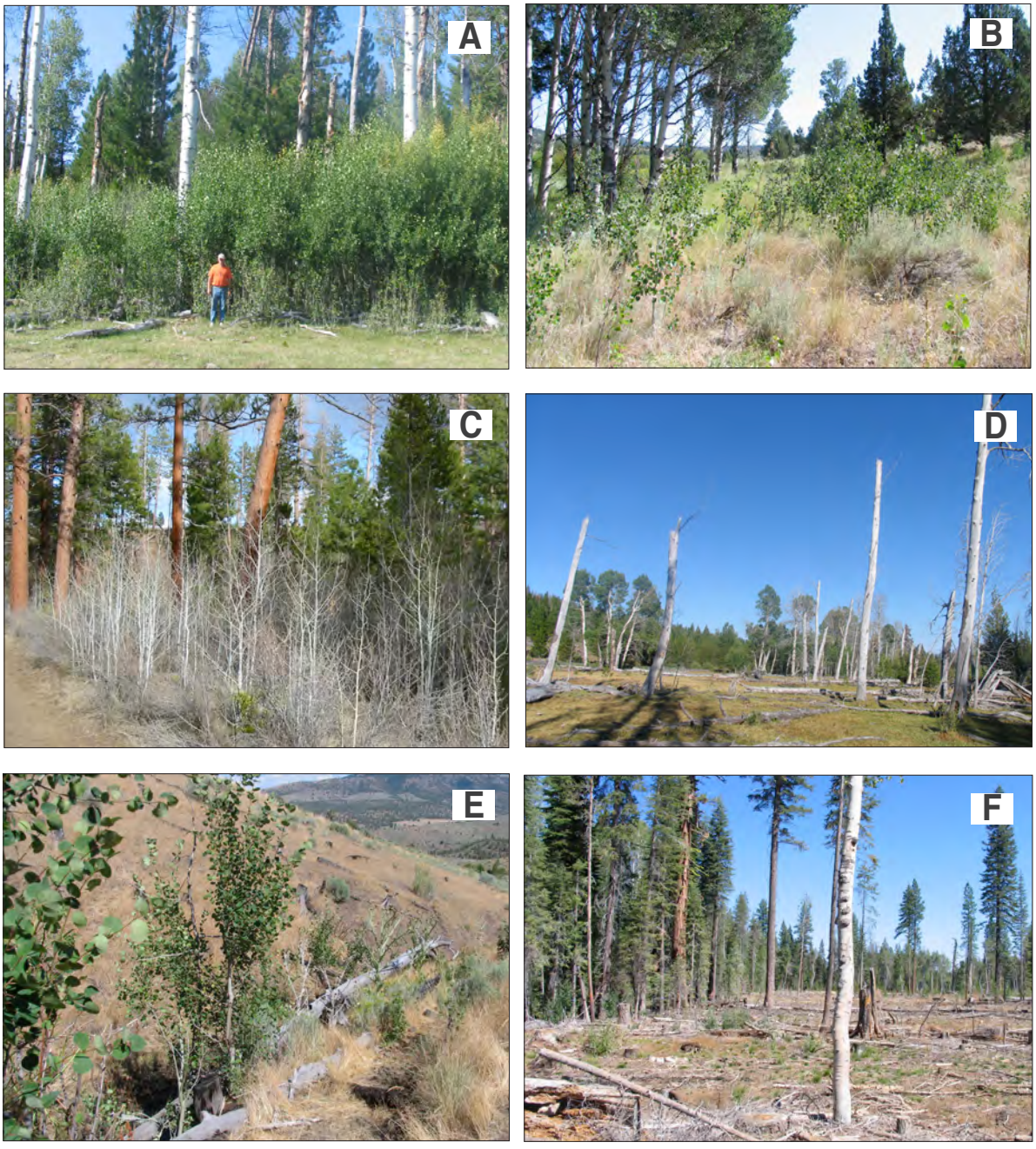


Figure 25. Are aspen regenerating successfully? The answer is "yes" in Plates A, B, and C. Although the overstory in Plate A is declining, aspen regeneration is dense and "free to grow" (large enough to resist browse). Suckering in Plate B is moderate, but stems are only lightly browsed. The aspen suckers in Plate C are dense and largely unimpacted by browse. Aspen in Plates D–F have not successfully regenerated. New suckering in the highly decadent grove in Plate D is almost nonexistent. Aspen suckers in Plate E are healthy and vigorous, but tree stocking is very sparse. Conifers were removed to stimulate aspen in Plate F, but suckering is sparse. (Photos: Darin Stringer)

Are aspen overbrowsed?

Overbrowsed aspen cannot grow in height because the new growth is eaten repeatedly. Heavily browsed aspen are easy to identify (Figure 26). The terminal leader (top of the main stem, where height growth occurs) and side branches have been repeatedly clipped and are resprouting. Often, leaves are found only below the dead stems and branches. Young suckers are often flat-topped at a uniform height. Heavily browsed aspen often show signs of damage from antler rubbing and trampling. Lightly or moderately browsed aspen are able to grow, but their shape and rate of growth may be altered.

Aspen with a history of overbrowsing followed by decreased use often have a clump of dead stems; a lower branch has become the leader and is growing vertically as the tree top. These aspen would not be classified as overbrowsed if they are currently gaining height and are not being browsed.

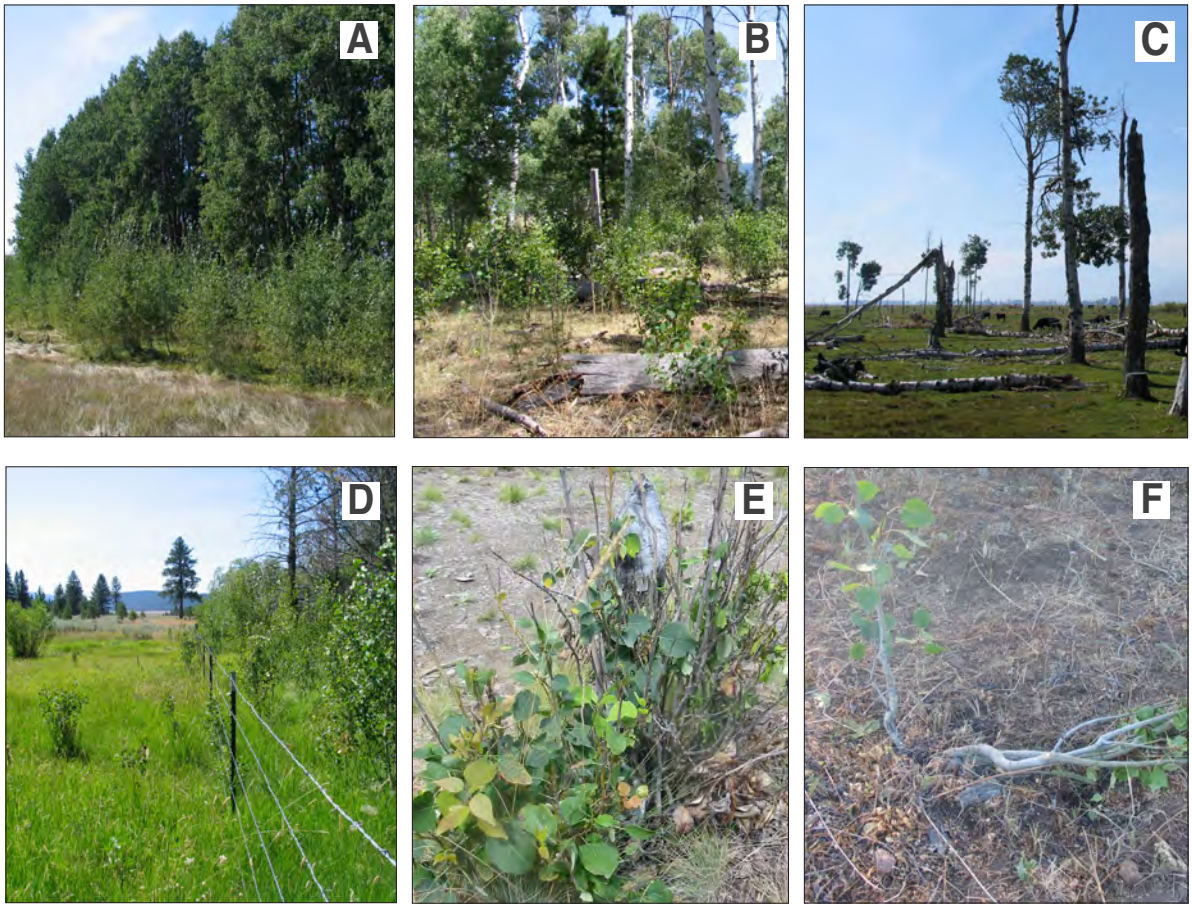


Figure 26. Are aspen overbrowsed? Aspen in Plate A have very light or no browse, as indicated by full-crowned suckers, rapid height growth, and uneven heights of trees. The aspen in Plate B are being browsed, as evidenced by the uniform height of suckers. (Growth is not occurring above snow level.) If aspen are being maintained in shrub form and cannot grow, the site is overbrowsed. Plate C shows severe overbrowsing. This aspen grove has endured sustained heavy browsing, and suckering has slowed. In Plate D, overbrowsing has prevented successful suckering of aspen on the left side of the fence. The main stem in Plate E was cut by a beaver, and new suckers have been severely browsed. Plate F shows severe damage by trampling and should be considered overbrowsed. (Photos: Darin Stringer)

Chapter 5

Enhancing Your Aspen Through Management Practices

Figure 27. On many sites, a key step in aspen enhancement is removal of competing conifers. (Photo: Darin Stringer)

Darin Stringer

Three Simple Aspen Enhancement Steps

1. **Remove** competing conifers
2. **Reduce** browse on aspen suckers
3. **Restore** native understory vegetation

Achieving and maintaining desired aspen conditions (as described in Chapter 3) involves three key strategies:

- Releasing (freeing up) existing aspen from competing conifers (Figure 27)
- Regenerating suckers to add new age classes
- Rejuvenating the cover and vigor of native understory plants

The forces and conditions that promoted aspen in the past (fire, beaver, etc.) have been reduced or eliminated from many sites. Noxious weeds and intensive sustained browse have reduced aspen's ability to perpetuate itself. In light of these realities, active stewardship of most aspen groves is required. Using tools such as the FULL or RAPID Assessment (Chapter 3) and the Aspen Management Options Flowchart (Chapter 4), you can assess the health of your aspen, determine the need for action, and develop strategies. Where active stewardship is warranted, you have three sets of management options:

- Removal of conifers to stimulate suckering and free up existing aspen
- Reduction of browse (by fencing and/or modified grazing practices) to protect young aspen

- Restoring and maintaining a native, diverse, and vigorous understory plant community through a range of treatments, including fencing, herbicide application, seeding, and controlled grazing

This chapter provides guidance on how to implement successful aspen enhancement. Here we focus on conifer removal and understory restoration. Chapter 6 discusses how to protect aspen from browse and overgrazing.

Figure 28. Noxious weeds such as Canada thistle can reduce aspen suckering and plant diversity. (Photo: Darin Stringer)

Removal of conifers

If your assessment determines conifer removal is necessary, design a plan that addresses what trees to take, the type of equipment to use, slash and log disposal, timing, and how to protect site resources such as riparian areas and soils. Equally important is to ensure that new suckers emerging after thinning are able to grow without heavy browsing. Strategies will vary, depending on site factors, management objectives, and financial considerations. The Conifer Management Options Flowchart (Figure 29, page 35) contains recommended treatments and can help you plan appropriate actions. The key on page 36 will guide you through the flowchart. Management options are described in detail on pages 37–40.

Additional resources

See Appendix I for information on how to obtain copies of the following resources.

- *Western Juniper Field Guide: Asking the Right Questions to Select Appropriate Management Actions*
- *Biology, Ecology, and Management of Western Juniper*
- *Oregon Forest Industry Directory*, a web-based directory
- *Oregon's Forest Protection Laws: An Illustrated Manual*

Restoring the understory

Aspen are typically found on wet areas, and aspen canopies cast much less shade than conifers, allowing more sunlight to reach the understory. As a result of these factors, the plant communities living under an aspen canopy are often diverse, unique, and productive. Maintaining and enhancing these native grasses, sedges, flowers, and shrubs will contribute to high wildlife use and favorable grazing conditions.

The greatest threats to these desired plants are invading conifers and noxious weeds. Juniper have reduced soil moisture in many rangeland aspen groves, increasing the presence of more drought-tolerant upland plants such as rabbitbrush and sagebrush. Prolonged intensive grazing by livestock can lead to increased noxious weeds if grasses and sedges are overutilized. Stewardship actions intended to help aspen (e.g., conifer removal, fire) often stimulate noxious weeds, which thrive in disturbed and open areas.

Noxious weeds such as Canada, bull, and Scotch thistle and cheatgrass are frequent invaders (Figure 28). In some cases, noxious weeds may thwart aspen suckering by crowding out and overtopping young trees.

The level of stewardship you commit to enhancing your aspen understory will vary with objectives and available resources. A simplified

management approach would seek to minimize noxious weeds and prevent overgrazing. A more complex strategy would work toward restoring the native plant community.

Additional treatments

If you are unable to successfully regenerate aspen suckers within 3 to 5 years using the methods in this chapter, and the grove lacks healthy older trees, the grove may be at risk of dying. Treatments to encourage suckering include:

- Ripping the soil with a caterpillar-type dozer with rear-mounted subsoiler
- Cutting mature aspen stems
- Using prescribed fire

The above techniques have been used successfully in other regions of the country. However, our experience with ripping and cutting of mature aspen to stimulate new suckers is very limited in the Pacific Northwest. Managers in Oregon have more experience using prescribed burning or have examined the effects of wildfire on aspen. In many cases, fire has been observed to increase suckering. The blackened ground and reduction of the tree canopy caused by fire increases soil temperatures, while the killing of mature aspen stimulates growth hormones, which cause suckering. These changes result in the regeneration of new aspen.

In the case of a severely decadent aspen grove, managers should weigh the risk of doing nothing vs. attempting treatments for which results are unpredictable and possibly undesirable. If the loss of the grove seems imminent, trying these "emergency room" treatments is a reasonable strategy. Before undertaking such action, follow these recommendations:

- Clearly understand the risk of loss of the grove by following the assessment steps in this manual.
- Consult with natural resource specialists to help design treatments.
- Consider the use of fire as a treatment of choice. Before using fire, consult with the Oregon Department of Forestry regarding rules and planning.
- Regardless of treatment, consider treating a small area first and monitoring the results. Don't put all your eggs in one basket, especially if there are few.

Three Steps to a Healthier Aspen Understory

1. Assess the types and condition of existing plants, including weeds. What conditions are desired? What factors are affecting vegetation?
2. Employ practices that enhance desired conditions, such as:
   - Minimizing disturbance during conifer removal
   - Treating noxious weeds early and frequently
   - Fencing to protect aspen suckers (Fencing may also help native plants recover.)
   - Seeding to reestablish desired plants after weeds have been controlled on heavily degraded sites
3. Monitor your results and adjust your actions based on what is working.

Conifer Management Options Flowchart

Start here:

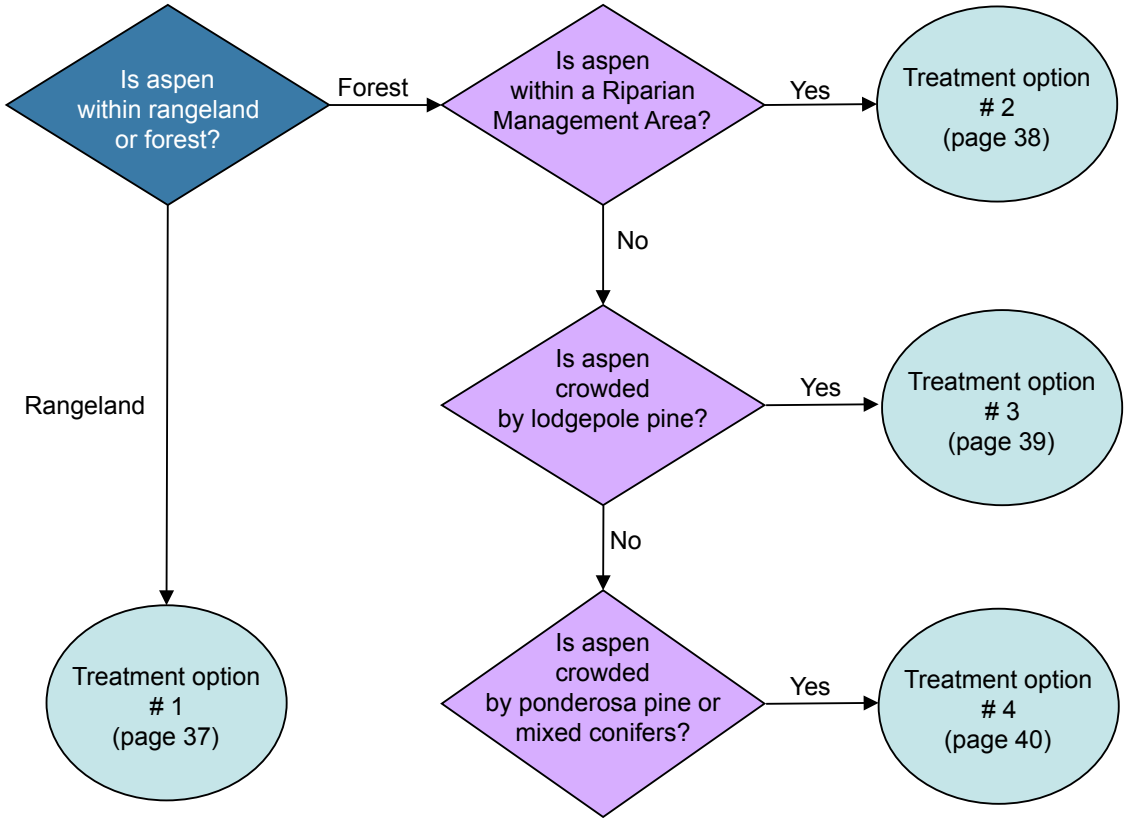


Figure 29. Conifer Management Options Flowchart. Use this flowchart to identify appropriate actions to enhance aspen where the grove is encroached by conifers. See the key on page 36.

Key to Conifer Management Options Flowchart

Are aspen within rangeland or forest?

Rangelands are areas that are generally too dry to support conifers other than juniper. Aspen on rangelands occur mostly around and below seeps and springs, where snowpack accumulates, and along seasonal creeks. Juniper also thrive in many of these environments and can quickly crowd out aspen and deplete soil moisture. If aspen are growing on rangeland, go to Treatment Option #1 (page 37).

The presence of other conifers, including ponderosa and lodgepole pine, grand fir, incense-cedar, Engelmann spruce, and Douglas-fir, indicates forested aspen. If these species are present, go to "Is aspen in a Riparian Management Area?" Note, however, that sites crowded by juniper and ponderosa pine are often considered rangeland if juniper is the dominant species.

Are aspen within a Riparian Management Area (RMA)?

Since aspen typically occur in wet areas, they may occur within a riparian area. Riparian aspen are close to a natural open body of water—a stream, river, lake, spring, seep, or wetland. Distinguishing upland aspen from riparian aspen is important for two reasons: (1) Management practices in riparian areas may differ from those on upland sites in order to protect water and associated resources, and (2) the Oregon Department of Forestry (ODF) may regulate actions within Riparian Management Areas (RMAs) under the Oregon Forest Practices Act (OFPA).

The size and type of the water source, presence of fish, and distance of aspen from the body of water or wetland determine whether ODF riparian rules apply. Refer to pages 21–35 of *Oregon's Forest Protection Laws: An Illustrated Manual* (see Appendix I) and contact your local ODF stewardship forester to learn more about riparian rules. If you determine that your aspen are within an RMA, go to Treatment Option #2 (page 38).

Are aspen crowded by lodgepole pine?

If conifer competition with aspen is entirely by lodgepole pine, go to Treatment Option #3 (page 39).

Are aspen crowded by ponderosa pine or mixed conifers?

If conifer competition with aspen is exclusively by ponderosa pine or includes a mix of species such as Douglas-fir, ponderosa pine, Engelmann spruce, lodgepole pine, grand or white fir, and incense-cedar, go to Treatment Option #4 (page 40).

Tips for Conifer Removal in Aspen Groves

- Conifers should be less than 5 percent cover on most aspen sites.
- Start where aspen are most threatened by conifers, especially where the main aspen canopy is decadent.
- Clumping retained conifers will reduce competition with aspen.
- If using logging equipment, conduct work when soils are dry, frozen, or covered with snow.
- Minimize damage to young aspen during felling.

Figure 32 (page 41) illustrates several conifer control methods.

TREATMENT OPTION #1
(ASPEN ENCROACHED BY JUNIPER ON RANGELANDS)

In nearly all cases, juniper is the invader in established aspen groves on rangeland. By creating shade and removing soil water, juniper can kill aspen quickly. Species such as sagebrush, rabbitbrush, and cheatgrass often replace a more diverse, productive understory that grew below the aspen when moisture was more abundant.

Prescriptions: On rangelands where juniper has encroached on aspen, it is usually appropriate to cut all juniper (Figure 30). Old-growth juniper, however, are very uncommon in aspen stands, and should be left if possible. Remove all other juniper within and at least 100 feet beyond the farthest aspen. If aspen are surrounded by juniper-invaded rangeland, consider clearing juniper from large areas above the aspen to increase water availability.

Methods: Juniper is usually removed by cutting with chainsaws. When sawing juniper, it is important to cut below the lowest live branch to prevent resprouting. Cut material can be hand piled and burned in the winter, broadcast burned, or left on-site. Well-placed, small piles are a good way to control fire and reduce damage to existing aspen. Leaving cut juniper in place can deter browse. However, too much slash impedes human and wildlife access, is unsightly, and remains a fire hazard.

Figure 30. Aspen grove before (A) and after (B) cutting and piling of juniper. Piles will be burned in the winter, and suckering will be monitored. If browse is heavy, fencing may be needed. (Photos: Darin Stringer)

Burning juniper may stimulate aspen suckering, but it may increase invasive weeds and kill existing aspen if the fire is too hot. Fire may be most useful where aspen are highly decadent and suckering is scarce. Plan the use of fire carefully to maintain control and to minimize killing new suckers. To avoid killing new suckers, burn juniper soon after cutting, before new suckers emerge. (See Case Study 3, page 51.)

In some cases, particularly where juniper is dense and large and markets exist nearby, you might consider removal with logging equipment. This practice may minimize fire damage to aspen by reducing fuels, but it can increase weeds if ground disturbance is heavy.

Markets for cut trees: Juniper logs are sometimes used for firewood or to make posts, rough lumber, or animal bedding. Distance to markets often prevents utilization. Refer to the Oregon Forest Industry Directory website, local Extension office, or local ODF stewardship forester for information on markets.

Riparian areas*:* In riparian areas not protected by the Oregon Forest Practices Act, removal of juniper will benefit not only aspen but other native plants as well. Once established, these plants will provide much better cover and wildlife benefits. You might consider leaving a few juniper to help stabilize soils in steep draws and on the streambank, especially if soils are exposed and other vegetation is lacking.

Large juniper-removal projects*:* If aspen release is part of a juniper-reduction project that exceeds 120 contiguous acres in a single ownership, you must file a Notification of Operation with ODF. You may also be required to have a Permit to Operate Power Driven Machinery (PDM). Contact the local ODF Stewardship Forester to assist with determining whether a notification, PDM, or both, is required.

TREATMENT OPTION #2
(ASPEN WITHIN RIPARIAN MANAGEMENT AREAS)

Aspen within forested riparian areas commonly are crowded by conifers (Figure 31). While aspen do best in full sunlight, maintaining some conifers within these zones is usually beneficial to watershed functions and wildlife. Oregon Forest Practices Act (OFPA) rules require retention of some conifers within state-designated Riparian Management Areas (RMAs). The rules dictate the number of trees and understory plants that must be retained and where equipment use and cutting can occur. These rules are designed to maintain shading of streams, reduce erosion and sedimentation in water bodies, provide dead wood, and protect fish and wildlife habitat. The number of conifers depends on the type of water feature, harvest type, and geographic region. The minimum number of conifers required usually allows enough sunlight to reach the understory and permits aspen to regenerate. If the rules are likely to reduce the effectiveness of your aspen enhancement activities, you can submit an "alternate plan" to ODF along with your Notification of Operation application.

Figure 31. Use extra care and consult the Oregon Forest Practices Act Rules before removing conifers in riparian areas. (Photo: Darin Stringer)

Prescriptions: Below is an example of aspen enhancement plans within an RMA. A second example is found on page 39. Both meet OFPA rules and achieve landowner objectives.

Methods: See Treatment Option #4, page 40.

Markets for cut trees: See Treatment Option #4, page 40.

Example 1: A landowner wants to remove lodgepole pine and grand fir that are shading her dense, mature, 1-acre aspen grove along a creek. The creek is designated by the state as Small Type F (fish bearing). The RMA width for this creek is 50 feet. The landowner is required by law to leave:

- All understory vegetation within 10 feet of the high-water level
- All trees within 20 feet of the high-water level
- All trees that lean over the channel and grow in the RMA
- All snags and down wood in the channel and RMA
- At least 50 square feet of tree basal area per 1,000 feet of buffer length within the RMA (40 square feet per 1,000 feet must be conifers)

Solution: The landowner, with the help of an ODF stewardship forester, calculates that leaving the required 40 square feet of conifer basal area per 1,000 feet of stream (about 20 19-inch-dbh trees within the RMA) will allow her to remove most of the conifers within the aspen grove. She also determines that leaving all trees within 20 feet of the high-water level will not substantially affect the aspen. To minimize impacts to soils, she conducts the harvest when there is snow cover and the ground is frozen. Since no cattle graze within the RMA, and deer and elk numbers are low, she is not concerned about browse to new suckers, but plans to monitor conditions annually.

TREATMENT OPTION #2—CONTINUED (ASPEN WITHIN RIPARIAN MANAGEMENT AREAS)

Example 2: A landowner wants to remove nearly all the lodgepole pine that are shading a ½-acre decadent mature grove of aspen along the edge of a seasonally wet pasture. He has determined the area was an aspen grove but has been seriously encroached by lodgepole over the past 50 years. Upon submitting his Notification of Operation permit application, he learns the pasture is designated as significant wetland and requires a 100-foot RMA. Within this RMA he is required to leave:

- All understory plants, snags, and down wood
- One-half of the trees by species and size

Solution: He realizes that leaving half the lodgepole will not provide enough release to his aspen, will reduce new suckering, and will maintain seed sources for more conifers. He prepares and submits an "alternate plan" to ODF that explains his objectives, prescription, and monitoring plan to ensure he can establish a new grove of aspen. This plan removes all lodgepole to a distance of 100 feet beyond the aspen grove perimeter. He also describes his logging method, which will avoid harvesting under wet conditions and will stay out of the wetland. He decides to avoid late-season grazing in this area for 3 to 5 years to prevent livestock browse to new aspen suckers until aspen are well established.

TREATMENT OPTION #3 (ASPEN WITH LODGEPOLE PINE ENCROACHMENT OUTSIDE RMA)

Lodgepole pine is a common invader of aspen groves. It tolerates perched water tables, can germinate and survive in cold pockets, produces frequent cone crops, and begins producing seed in about 15 to 20 years. Frequent fire favored aspen on most sites, because aspen produce suckers from roots and quickly reestablish after fire. Mountain pine beetles and fire may eventually reset conditions to favor aspen. However, because the risk of fire is unacceptable to most landowners, and because aspen may be lost before disturbance occurs naturally, active management to remove the lodgepole is recommended.

Prescriptions: Removal of all lodgepole within the aspen grove is usually advised. Partial cutting of lodgepole would require continuous removal of new pine regeneration from the remaining seed source.

Methods: See Treatment Option #4, page 40.

Markets for cut trees: See Treatment Option #4, page 40.

TREATMENT OPTION #4 (ASPEN WITH PONDEROSA PINE OR MIXED-CONIFER ENCROACHMENT OUTSIDE RMA)

Aspen are occasionally found within ponderosa pine stands, and these conifers often grow within aspen groves where soils are better drained. Widely scattered, large, old ponderosa pine stumps are sometimes found in aspen groves, suggesting the two species can coexist. Ponderosa pine cast less shade than other conifers. However, on many sites pines have become far too dense and are replacing aspen.

On more productive forested sites, aspen have been invaded by a mix of conifer species. While more moisture may be available to aspen on these sites, conifers can quickly crowd and replace aspen.

Prescriptions: Ponderosa pine is a desirable species for many landowners. Aspen groves can thrive with a few scattered pine. Keep in mind, however, that aspen are a very minor part of the landscape (usually less than 1 percent), while ponderosa pine is often very common. Removal of ponderosa pine in small areas to benefit aspen is reasonable if pine is common on other parts of your ownership.

There are numerous approaches to working in mixed-conifer stands. As in other conifer-crowded areas, these strategies are based on the assumption that the vast majority or all of the conifers should be removed. Given that only a few conifers per acre (at the most) should be retained, the healthiest and largest trees—regardless of species—are usually retained. Ponderosa pine and Douglas-fir are often the species retained because they live longer and typically are the oldest conifers in the grove.

Methods: Conifers can be felled with a chainsaw or with mechanized logging equipment. Cut trees are piled and burned or removed for sale. Due to the small size of most aspen groves, commercial logging is usually not feasible, unless cutting coincides with a larger harvest operation. Where commercial logging is not practical, hand falling, piling, and burning is a good practice. Leaving material on the ground ("lop and scattering") costs less than piling and provides a barrier to ungulates. If some utilization is desired, larger trees can be removed for firewood or on-site milling of rough-cut lumber.

Another option in aspen groves crowded by seedling/sapling and small pole-size conifers is to masticate them with a brush-cutting head mounted on a wheeled or tracked machine. This treatment leaves scattered wood chips and ground slash, which break down rapidly on wet sites. Fire historically maintained aspen dominance on many sites and may be a good way to control conifers and stimulate aspen suckering, but it must be carefully planned and executed to achieve desired results.

Markets for cut trees: There are only a few sawmills in eastern Oregon, making it challenging to sell logs. Conifers such as pine and fir are often marketable to sawmills when trees are at least 10 inches dbh, but species and size requirements vary with the mill. Consult the Oregon Forest Industry Directory website or your local ODF stewardship forester for information on local markets.

Example: A landowner has a 2-acre grove of aspen in a 400-acre stand of ponderosa pine. Pines have heavily crowded out the aspen. She noticed a few large, old pine stumps in the grove. She has determined that the area has been an aspen grove for at least 150 years and that only a few large pines existed around the aspen prior to fire exclusion.

Solution: The landowner removes 90 percent of the conifers within the grove, leaving 4 clumps, each containing 1 to 4 of the largest ponderosa pines. She also removes most conifers to about 100 feet beyond the aspen to allow expansion of the grove. She determines that this density of pine is similar to the "historic condition," is less than 5 percent cover (as recommended in this manual), and should give aspen room to expand.

Figure 32. Conifer control methods. A–Mastication with a rubber-tracked skid steer; B–Hand cutting and piling; C–Lop and scattering of conifers; D–Abundant aspen suckering after fire; E–Mechanized logging with a feller-buncher (note the excellent condition of aspen due to careful cutting and yarding practices). (Photos A and B: Darin Stringer. Photo C: Ochoco National Forest. Photo D: David Burton. Photo E: Jennifer Ebert)

Case Study 1
Aspen Enhancement on the Deschutes National Forest

Jim Lowrie

Overview

Land management agencies such as the U.S. Forest Service have recently placed an emphasis on maintaining and restoring historic aspen stands, particularly in the western states. Many stands have been extirpated (wiped out) due to conifer competition, domestic livestock impacts, high deer and elk concentrations, insect or disease infestations, and lack of grove/landscape disturbance factors such as wildfire.

Aspen distribution on the Deschutes National Forest in central Oregon is limited, and many of the sites are extremely dry and harsh. Stands are generally small and often difficult to locate due to the dominance of coniferous forests. The Bend-Ft. Rock District has two aspen grove types: those that occupy narrow corridors along streams and rivers and those in association with lava and other rock outcrops where precipitation runoff is concentrated.

In 2001, the Forest initiated a multi-year survey to locate and assess aspen stands across the Deschutes (see "Methods," page 45). Three years of surveys have resulted in the identification and prioritization of restoration opportunities.

Two project proposals—Ryan Ranch and Deschutes Aspen—were developed by the District after the surveys were complete. Both areas are southwest of Bend, Oregon, along the Deschutes River (Figure 33, page 43). The sites represent both grove types, but the larger stands are within the river's riparian zone.

The aspen grove in the Ryan Ranch project is approximately 10 acres. The Deschutes Aspen project is in the same vicinity as Ryan Ranch and consists of a 25-acre grove east of the river and a 3-acre grove on the river's west bank (Figure 34, page 44). There is no road access to the grove east of the river. This is an important consideration where equipment use would be advantageous or if poor access increases the cost of treatment.

Environmental analysis was done for each project to meet the regulatory requirements of the National Environmental Policy Act, Endangered Species Act, the Deschutes National Forest Land and Resource Management Plan, and other requirements for activities affecting public lands. Both projects are within the Deschutes River Wild and Scenic River Corridor. An interdisciplinary team of Forest Service specialists developed the project specifics, including mitigation measures. Public notification and inputs were an important part of this process. The projects were approved and were partially implemented as of summer 2009.

Goals and objectives

The U.S. Forest Service Bend-Ft. Rock District Deschutes Aspen Enhancement Project goals were to:

- Implement treatments within and adjacent to aspen stands to allow for the regeneration and expansion of aspen.
- Prevent loss of aspen groves and meadows from conifer encroachment.
- Improve the condition of aspen for wildlife resources.

This project was designed with three objectives:

- Provide wildlife habitat for a wide diversity of species.
- Use prescribed fire to restore meadows and enhance vegetative diversity.
- Enhance riparian-dependent resource values such as meadows, willows, and other native vegetation.

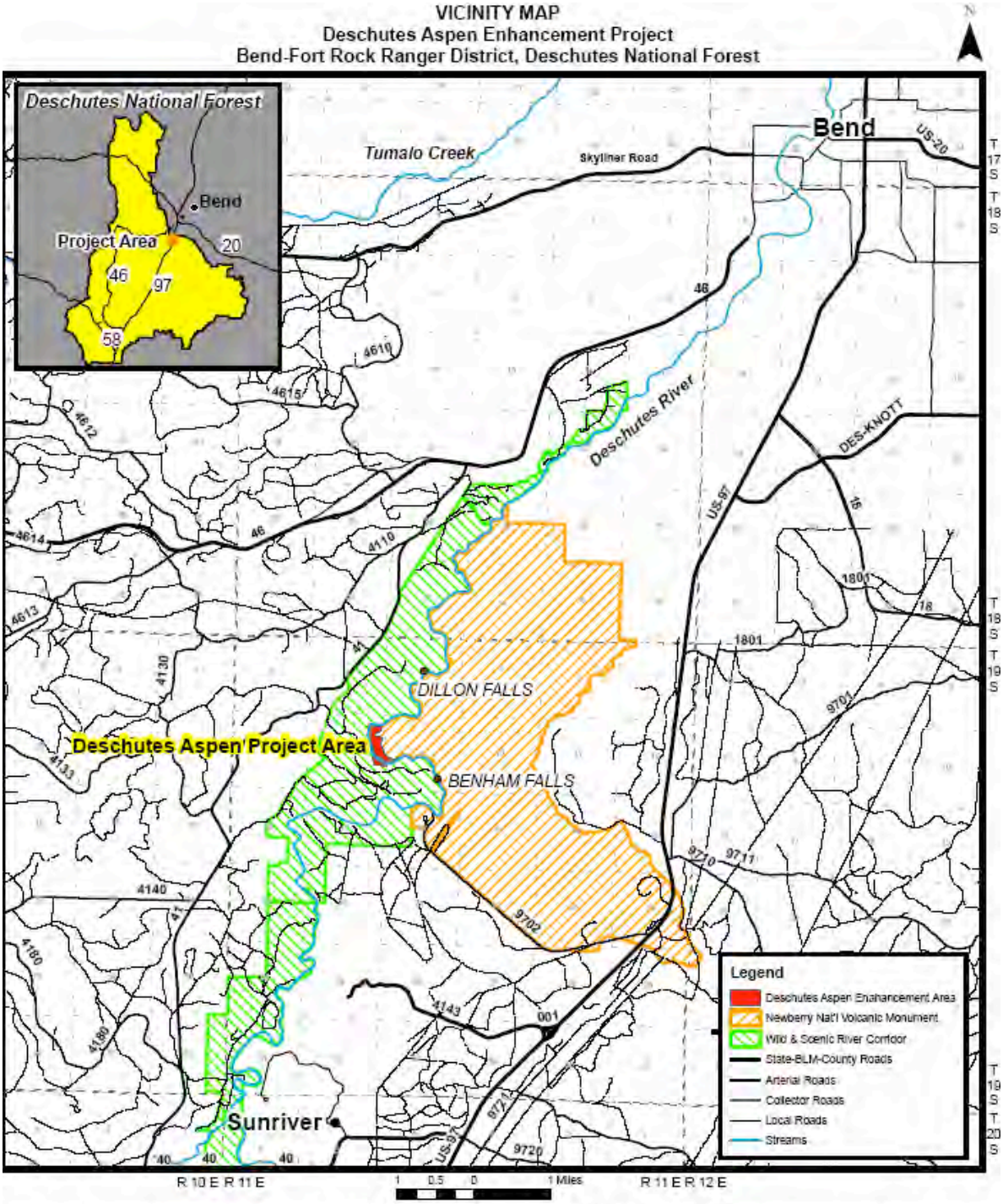


Figure 33. Vicinity map of United States Forest Service Deschutes Aspen Enhancement Project, Bend-Ft. Rock Ranger District, Deschutes National Forest.

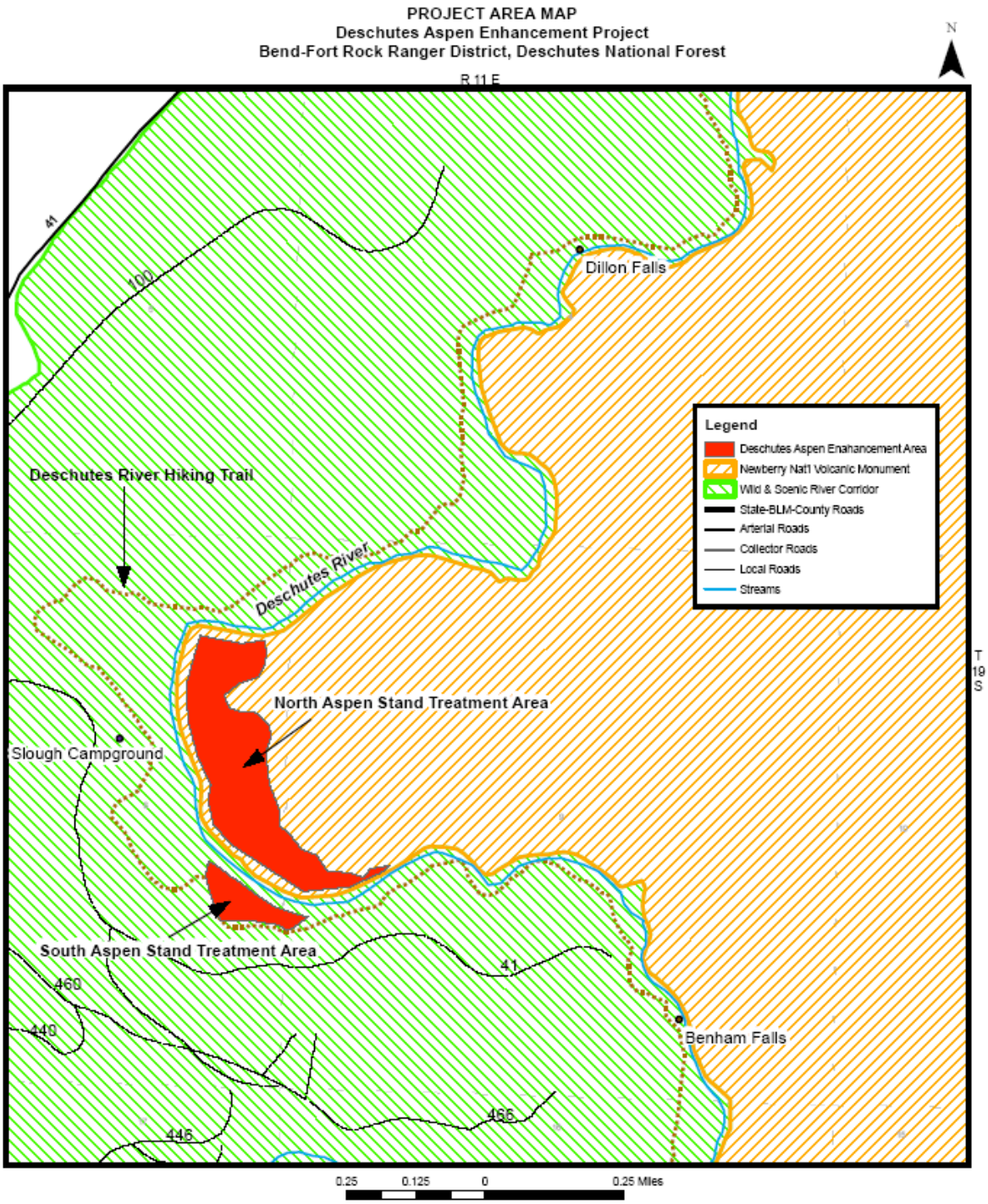


Figure 34. Project area map of United States Forest Service Deschutes Aspen Enhancement Project, Bend-Ft. Rock Ranger District, Deschutes National Forest.

Methods

Assessment

In large, complex landscapes such as a national forest, the first task is to locate all of the aspen stands. Remote-sensing technologies, including satellite photography and standard aerial photography or infrared images, may be utilized in conjunction with ground surveys. On the Deschutes National Forest, the assessment included the following:

- Measurement of acreage, including both the aspen grove and the associated areas that have potential for aspen or evidence of past occupancy
- Narrative description of each grove, including location, general condition, topography, insect/disease infestations, wildlife use/observations, amount and condition of regeneration, conifer competition, understory species, and management recommendations
- Identification of vegetation plots. The number of plots varied according to grove size. Within each plot, aspen were classified as seedlings, saplings, mature, and old-growth trees. Diameter at breast height (dbh), height, and density per acre were recorded for each category. The same data were collected for conifers.
- Assignment of a unique number to each grove
- Mapping via Geographical Information System (GIS). Maps showed contour lines, roads, drainages, township/range/section, scale, etc.

The common factor adversely affecting the stands selected for treatment was conifer competition. A secondary factor was the impact of deer and elk browsing; both areas are within low-elevation winter ranges for these species. Livestock do not utilize these areas.

Treatments

Restoration work was initiated on both projects in the fall of 2008. Work continued during 2009 in the Ryan Ranch portion because of its better access and the opportunity to utilize equipment in the operation.

The Ryan Ranch project also included additional aspects of habitat enhancement: meadow restoration by prescribed fire and willow enhancement through conifer reduction and caging.

Treatment was accomplished using chainsaws to fell the competing conifers. On Ryan Ranch, trees up to 10 inches dbh were cut. On the Deschutes Aspen portion, the limit was 12 inches dbh because of the grove's proximity to the river and concerns about visual impacts. The latter project allowed girdling of trees from 10–21 inches in diameter. Cutting larger trees was of concern because of the potential for visual impacts and impact of heavy equipment. Visual resources are a significant factor in the management of wild and scenic river corridors.

Figure 35 shows the Ryan Ranch site before treatment. Cut materials were skidded to a nearby road using a small loader (see Figures 36–38, page 46). Access on the road is controlled by a gate, and permits were issued to commercial firewood vendors to salvage the larger material.

Figure 35. Dense conifer grove before treatment, with remnant aspen trees within the grove. (Photo: Jim Lowrie)

Figure 36. Conifer thinning operation. (Photo: Jim Lowrie)

Figure 37. Landing area during conifer thinning operation. (Photo: Jim Lowrie)

Figure 38. Thinned aspen grove. (Photo: Jim Lowrie)

Because the grove on the east side of the Deschutes River is accessible only by watercraft, access is more difficult. On that site, the fallen trees were lopped and scattered. Slash piling was done only where the material could block or hinder the movement of wildlife through a migration corridor. Reclamation of secondary products was not feasible on this site. See Figures 39 and 40.

Figure 39. Conifer-encroached aspen grove before treatment. (Photo: Jim Lowrie)

Figure 40. Conifer-encroached riparian area. (Photo: Jim Lowrie)

Costs

Total costs for the treatments are not yet known, as the work is incomplete. A number of variables influence unit costs, including:

- Number and size of conifers cut
- Disposition of slash
- Access and travel time
- Terrain
- Value of secondary products
- Experience of fallers and equipment operators
- Post-treatment grove/sucker protection measures
- Mitigation measures

For example, leaving slash on-site has the advantage of reducing treatment cost. It also creates a potential barrier to livestock and big game that might browse new suckers. However, heavy slash could reduce soil temperatures and the suckering response.

The use of cages on selected aspen suckers is generally cheaper than fencing the entire grove, but will protect a limited number of trees. Where livestock and/or big game browsing is likely, treating larger acreages can spread out browsing impacts but increases costs.

As noted, the Ryan Ranch grove is on level terrain near a road, allowing skidding of the larger material. This reduced hand labor for lopping or piling the slash and provided a secondary product. Using a skidder increased the costs of this project, especially since we did not sell any of the removed trees. A private landowner could offset treatment costs by selling commercial timber or firewood.

Conclusions

When identifying priority stands for treatments, managers must address many variables. Several treatment methods are available, including prescribed fire, conifer removal, fencing to exclude livestock and/or big game, caging of regeneration, etc. Methods must be appropriately applied to ensure success. Post-treatment actions such as fencing and caging may significantly increase costs, but sometimes are required to ensure survival of regeneration.

Additional observations

Research has documented that stands that are very decadent may need to be clearcut or burned intensely enough to kill all of the overstory trees. Suckering is inhibited by the movement of hormones from overstory trees to the roots. Provided that the root systems are still viable, removal of overstory trees is generally the most effective way to stimulate suckering.

Future projects

The Deschutes National Forest plans to do additional surveys to ensure that all aspen stands are located. Surveys will include identification of sites where stands have been extirpated. Remnant boles are generally the best indicator of these sites and can usually be readily distinguished from those of conifer species. Reestablishing these sites with transplants is possible due to advances in genetic testing to better match the site with appropriate stock.

The Forest will also develop a broad Forest-wide management strategy. Organizations such as the Rocky Mountain Elk Foundation no longer support funding partial treatments that lack a well-planned, landscape-scale management approach for their consideration. Given the high value of aspen habitats and their broad-scale disappearance, there is some urgency in developing future strategies to restore these important habitats.

Partners and acknowledgments

The Rocky Mountain Elk Foundation was very interested in both the aspen and meadow components of the Ryan Ranch project and contributed funding for the work. This project proposal occurred prior to the current policy of promoting a landscape-scale approach for aspen management.

Central Oregon Fire Management Services (U.S. Forest Service, Deschutes and Ochoco National Forests) contributed both the fallers and equipment for the Ryan Ranch project due to the value of reducing future wildfire hazards. They also provided the fallers for the Deschutes Aspen Project grove.

Case Study 2
Enhancing Aspen Woodlands on the Fremont-Winema National Forests

Amy Markus

Overview

On the Fremont-Winema National Forest, aspen woodlands provide extremely valuable habitat for a variety of wildlife species. Aspen woodlands tend to be small—often less than a few acres—and can be associated with both riparian and upland habitats. The dominant threat to these stands is the encroachment of conifers and juniper due to fire exclusion. These species compete with aspen for sunlight and water.

As part of the analysis and planning for this project, a wildlife biologist mapped and assessed aspen groves. The assessment found that many aspen stands were declining due to conifer and juniper encroachment. This case study describes the treatment of an aspen grove in the Bridge Creek Project, approximately 10 miles southwest of Silver Lake, Oregon.

Goals and objectives

The U.S. Forest Service has a number of goals related to aspen:

- Effectively implement treatments within and adjacent to aspen stands to allow for the regeneration and expansion of aspen.
- Reintroduce fire through prescribed burning to stimulate aspen regeneration.
- Prevent loss of aspen groves from conifer encroachment.
- Improve the condition of aspen for wildlife resources.

This project was designed with three objectives:

- Provide wildlife habitat for a wide diversity of species.
- Enhance riparian-dependent resource values.
- Improve vegetative diversity.

Methods

Assessment

Assessment included the following steps:

1. Identify and map each aspen grove.
2. Evaluate the potential threats to each aspen grove, including conifer encroachment, livestock or big game browsing, and hydrologic modifications.
3. Provide a recommendation for treatment.
4. Digitize the aspen stands into GIS.

Treatment

Within the project area, aspen was restored by thinning encroaching conifers and juniper through commercial logging and/or a service contract. All treatments were designed to significantly reduce the stocking of conifers and to open the canopy for aspen release and expansion (Figures 41 and 42, page 49).

Wildlife Habitat in Aspen

Aspen woodlands provide high species richness, or diversity, in both the vegetative and wildlife communities. Several cavity-nesting birds, such as red-naped sapsuckers, flickers, and nuthatches, nest in aspen because it is susceptible to various heartwood decays. Several songbirds, including vireos, warblers, and flycatchers, use aspen for nesting and foraging. Aspen also provide valuable habitat for other wildlife such as grouse and big game.

Figure 41. Prethinning—Although present, aspen are barely visible due to conifer encroachment. (Photo: Amy Markus)

Figure 42. Post-thinning—All conifers less than 9-inch dbh were thinned with a lop-and-scatter slash treatment. The aspen are now visible. (Photo: Amy Markus)

Commercial logging techniques were not feasible on some of the aspen stands due to the following factors: (1) excessive negative impacts to riparian areas from large equipment, (2) steep slopes prohibiting the use of tractor-based logging equipment, or (3) distance of the aspen grove from the road. Where commercial logging was not feasible, noncommercial thinning and slash treatment was accomplished through a service contract.

As an example, we will describe treatment of one aspen grove on Bridge Creek. Treatment of this grove was accomplished in 2008 through a service contract. When the unit was flagged and mapped with GPS, the boundary of the treatment unit was extended beyond the existing aspen by 50–100 feet to allow for expansion of the aspen grove. All conifers less than 9 inches dbh and all junipers that did not exhibit old-growth characteristics were thinned with chainsaws.

After the trees were felled, the contract crew did a "lop and scatter" treatment, which involved cutting the boles of the trees into 8-foot lengths and limbing the trees to reduce slash and debris to no higher than about 18 inches from the ground. This treatment compresses the fuel loading left on-site and reduces the potential for wildfire. This grove will be treated with prescribed burning in the next 1 to 3 years.

This unit totaled 81 acres, and the cost was $208 per acre. The total cost for the unit was $16,848.

To date, only the aspen stands identified for treatment through a service contract have been treated. The aspen stands within commercial logging units will be treated in the next 1 to 3 years. The commercial logging treatments will be more aggressive in reducing conifer densities because of the ability to remove the trees from the site. Aspen restoration through commercial logging can benefit wildlife habitat, while also providing an economic return and offsetting the cost of the habitat-restoration work.

Monitoring

Monitoring includes established pre- and post-treatment photo points.

Challenges and successes

Challenges: Due to the small size of aspen woodlands, it can be difficult to map aspen at a large scale. Aspen is not easily detected with remote sensing capabilities, so the most effective method of mapping is by walking or driving through the area. This can be expensive, and small aspen stands that are hidden by encroaching conifers are often not detected.

Successes: Thinning encroaching conifers and juniper beyond the existing aspen grove

(by 50–100+ feet) provided an area for the aspen to expand. Thinning effectively reduced conifer stocking levels, opened the tree canopy, and provided more sunlight for the aspen.

Conclusions

- The most effective time to identify and map aspen is in the fall when the leaves are in color. At this time, it is easier to identify small aspen stands that blend in with conifers and juniper.
- If conifers and juniper are left on the ground, the slash can deter cattle from grazing within the aspen grove.
- To effectively treat aspen in the long term, treatments need to substantially reduce the density of conifers and juniper.
- Conifer and juniper removal was found to be an effective tool for enhancing aspen stands for wildlife.

Partners and acknowledgments

This project was funded by the U.S. Forest Service and by dollars available through the Secure Rural Schools and Community Self-Determination Act of 2000 (Title II). Partners include the Lake County Watershed Council and private landowners.

Case Study 3
Restoration of Aspen Woodlands Invaded by Western Juniper

Rob Sharp, Jon D. Bates, and Kirk W. Davies

Overview

Quaking aspen woodlands are important plant communities in the Great Basin of the western United States. Although they occupy relatively small areas within a vast landscape, aspen woodlands provide essential habitat for many wildlife species and often contain a high diversity of understory shrub and herbaceous species. Western juniper woodlands are rapidly replacing lower elevation (below 6,800 feet) quaking aspen stands throughout the northern Great Basin. Over the past 100 years, fire exclusion has resulted in juniper encroachment or replacement of aspen woodlands.

Figure 43. Aspen invaded by juniper, Steens Mountain, Oregon. (Photo: Jon Bates)

The study site was located in Kiger Creek Canyon on Steens Mountain, in southeastern Oregon (Figure 43).

Goals and objectives

The purpose of this research project was to evaluate the effectiveness of selective cutting and prescribed fire as western juniper control treatments used to restore aspen stands. Specific objectives were the following:

- Test the effectiveness of treatments at removing juniper ranging in size from seedlings to mature trees.
- Measure treatment effectiveness at stimulating aspen recruitment.
- Evaluate the response of shrub and herbaceous layers to treatment.

Methods

The two juniper-control treatments involved cutting one-third of the mature juniper trees, followed by either early-fall burning (FALL) or early-spring burning (SPRING). Treatments were located next to untreated woodlands (CONTROL).

Each treatment was applied to five plots. Because of a lack of fine fuels and relatively high fuel-moisture contents, selective cutting of juniper was done to increase surface fuels (0–6 feet) in order to carry fire through the aspen stands, kill remaining juniper, and stimulate aspen regeneration. Trees were cut in winter and spring, 2001. The FALL treatment was burned in mid-October, 2001. The SPRING treatment was burned in mid-April, 2002.

Sites were assessed in June–July of 2000, 2002–2006, and 2008. Sampling included measurement of cover and density of juniper, aspen, shrubs, and herbaceous species, as well as understory diversity.

Costs

Costs for removing juniper were $80/acre because of difficult access to sites. Burn prescriptions cost less than $25/acre.

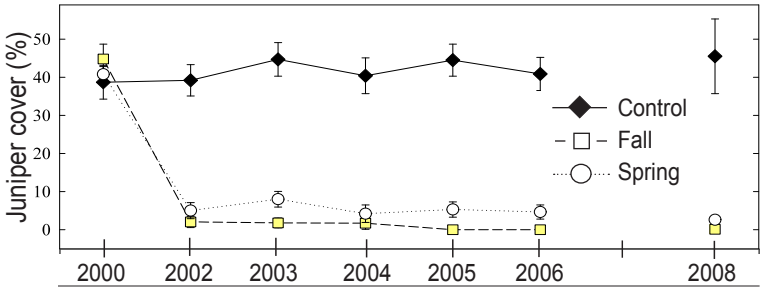


Figure 44. Juniper cover in aspen stands prior to (2000) and after treatments, Kiger Canyon, Steens Mountain, Oregon. Data are average plus or minus statistical standard errors.

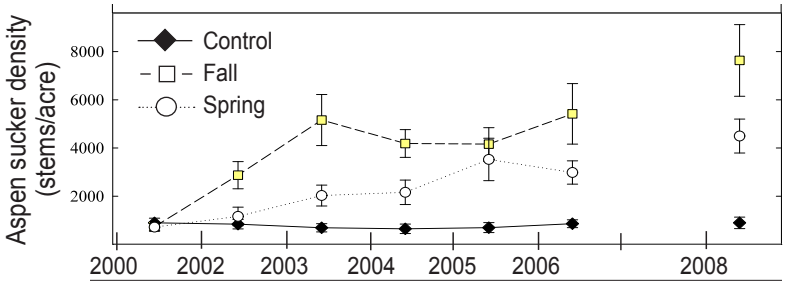


Figure 45. Aspen sucker density (< 2-inch diameter at 3 feet). Data are average plus or minus statistical standard errors.

Results

The FALL treatment was a severe grove-replacement fire that eliminated all remaining juniper trees and seedlings, killed above-ground aspen, caused a loss of most understory species, and resulted in high exposure of mineral soil. The SPRING treatment was a less severe fire that thinned the overstory and resulted in a substantial increase in herbaceous cover and diversity.

Results were as follows.

Juniper cover: The severe FALL fire eliminated all juniper trees and seedlings (Figure 44). In the SPRING treatment, 80 percent of the mature juniper trees that remained after cutting were killed. However, 50 percent of juveniles (less than 3 feet tall) survived. These juveniles exceed 300 per acre.

Suckering and aspen cover: The severe fires in the FALL treatment favored aspen resprouting (Figure 45). By 2008, aspen suckering had increased about nine-fold compared to the CONTROL. In the SPRING treatment, aspen suckering had increased five-fold (4,500 ± 700 stems/acre) (Figures 46–48). Sucker density was about twice as great in the FALL treatment as in the SPRING treatment.

Figure 46. Aspen regeneration. (Photo: Jon Bates)

Figure 47. Aspen regenerating under burned juniper. (Photo: Jon Bates)

Figure 48. Aspen sprouting after cutting and burning juniper. (Photo: Jon Bates)

Aspen cover was greater in the FALL treatment than in the CONTROL plots (Figure 49). By 2008, aspen cover did not differ between FALL and SPRING treatments.

Herbaceous cover: FALL-burned plots had less herbaceous cover than those burned in the SPRING (Figure 50). Cover in FALL-burned plots was composed of weedy annuals (native and nonnative). In 2006, cheatgrass made up 60 percent of total herbaceous cover in the FALL treatments.

Herbaceous cover increased 330 percent in the SPRING treatment. No mortality of bunchgrasses occurred, and the number of species observed increased by 50 percent by the fifth year after fire. Perennial forb diversity was highest in the SPRING treatment. Herbaceous composition was primarily composed of native perennial grasses and forbs. It is estimated that livestock forage increased about 10-fold.

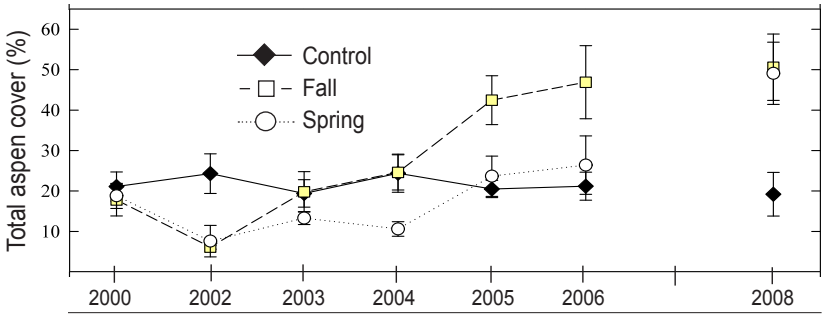


Figure 49. Aspen cover before and after treatments, Kiger Canyon, Steens Mountain, Oregon. The CONTROL was greater than the treatments for dominant and subcanopy aspen until 2006. Data are average plus or minus statistical standard errors.

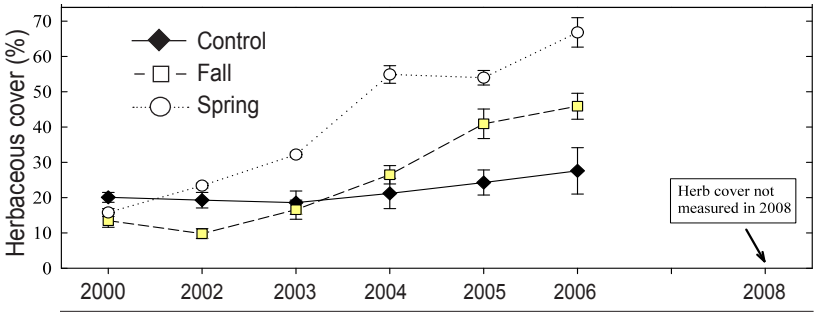


Figure 50. Herbaceous cover. Data are average plus or minus statistical standard errors.

Conclusions

Cut and FALL burn

Cutting combined with FALL fire was the most effective method for removing remaining juniper and stimulating greater aspen suckering. The effectiveness of this treatment at removing juniper indicates that aspen will dominate the overstory for at least the next 80–100 years. The cutting of one-third of overstory juniper was more than adequate to eliminate remaining live juniper with the FALL fire treatment. This suggests that cutting levels could potentially be reduced when combined with fall fire.

Native perennial forbs and grasses were largely eliminated with the FALL fire. Cut trees increase heat fluxes into the soil and cause higher mortality of perennials. In these lower elevation aspen stands, nonnative weeds are of concern in early succession, as they increase rapidly before native perennials can reestablish. Therefore, reseeding of herbaceous perennials should be considered.

What has been surprising is a steady increase of cheatgrass in the FALL treatment. Cheatgrass is unlikely to persist, however, as Kentucky bluegrass that survived the fire has slowly increased and will likely reoccupy the sites.

Cut and SPRING burn

If the objective is to rapidly increase the herbaceous component and moderately increase aspen suckering, spring burning is recommended. Spring burning may also be useful in aspen communities where the understory is depleted and managers desire more rapid recovery of this vegetation group.

However, the SPRING treatment can be considered only a temporary interruption of the development to juniper woodland. The gaps created by cutting and fire disturbance will provide an opportunity for juniper saplings and seedlings to reoccupy these sites. Thus, although the SPRING treatment has prolonged aspen site occupancy, young junipers will grow quickly and result in codominance of the overstory by aspen and juniper within 40 years. Given growth rates of juniper, these stands could be redominated by juniper in about 60–80 years.

After spring burning, follow-up management should be considered to remove juniper that are missed in initial treatments and prevent early return and domination by juniper. Reburning or cutting sites within 10–20 years likely would remove junipers without damaging aspen and herbaceous recovery.

When sites are burned in spring (or winter), preparatory cutting levels could exceed 50 percent to increase the chance of removing a higher percentage of both mature and juvenile junipers by fire. This level of cutting probably would not negatively impact the understory when the site is burned, as long as herbaceous vegetation is largely dormant and soils and ground surface litter are frozen and/or at field capacity.

An advantage of spring burning is that the fire can be confined to the treatment area with little risk of escape. This treatment might be useful in other forested systems (e.g., ponderosa pine or other encroaching conifer species) and in stands adjacent to areas of management concern (e.g., mountain big sagebrush habitat, riparian zones, structures, residential areas). For example, it may be desirable to protect areas such as sagebrush grassland in order to avoid negative impacts to wildlife dependent on these communities.

Partners and acknowledgments

The Bureau of Land Management-Burns District provided the opportunity to conduct the study and applied the fall burn treatment. Fred Otley and family were most generous in providing use of their summer cabin during sampling periods. Many student summer range technicians assisted in the collection of field data, and ARS range technicians Claire Poulson and Lori Zeigenhagen assisted in the spring fire applications. Thank you all for your contributions.

Case Study 4
Effectiveness of Fenced Exclosures in Aspen Restoration: An Examination of Several Fence Types

Ann Humphrey

Overview

In May 2000, the Blue Mountains Habitat Restoration Project (BMHRP) began efforts to restore aspen habitat in the Blue Mountains Ecoregion, Wallowa County, Oregon (Sallabanks et al. 2002).

The study area is located in northeastern Oregon, in the south-central portion of Wallowa County (Figure 51). It is in the Blue Mountains Ecoregion and encompasses portions of the Wallowa Mountain foothills, the Zumwalt Prairie, and the lower Wallowa Valley. The study area is bounded on the west by the town of Wallowa, on the south by the foothills of the Wallowa Mountains, on the east by the Imnaha River, and on the north by a line running west from the town of Imnaha to the town of Wallowa.

Elevations in the study area range from approximately 3,000 to 6,000 feet. Average annual precipitation for Wallowa County is 13 inches, although precipitation ranges from 9 inches (Baker City) to 100 inches (the Wallowa Mountains). At a coarse scale, the landscape is composed of conifer-dominated foothills, bunchgrass prairie, and riparian forest/shrub lands. Lands are under both private and federal ownership, with most federal lands being managed by the U.S. Forest Service.

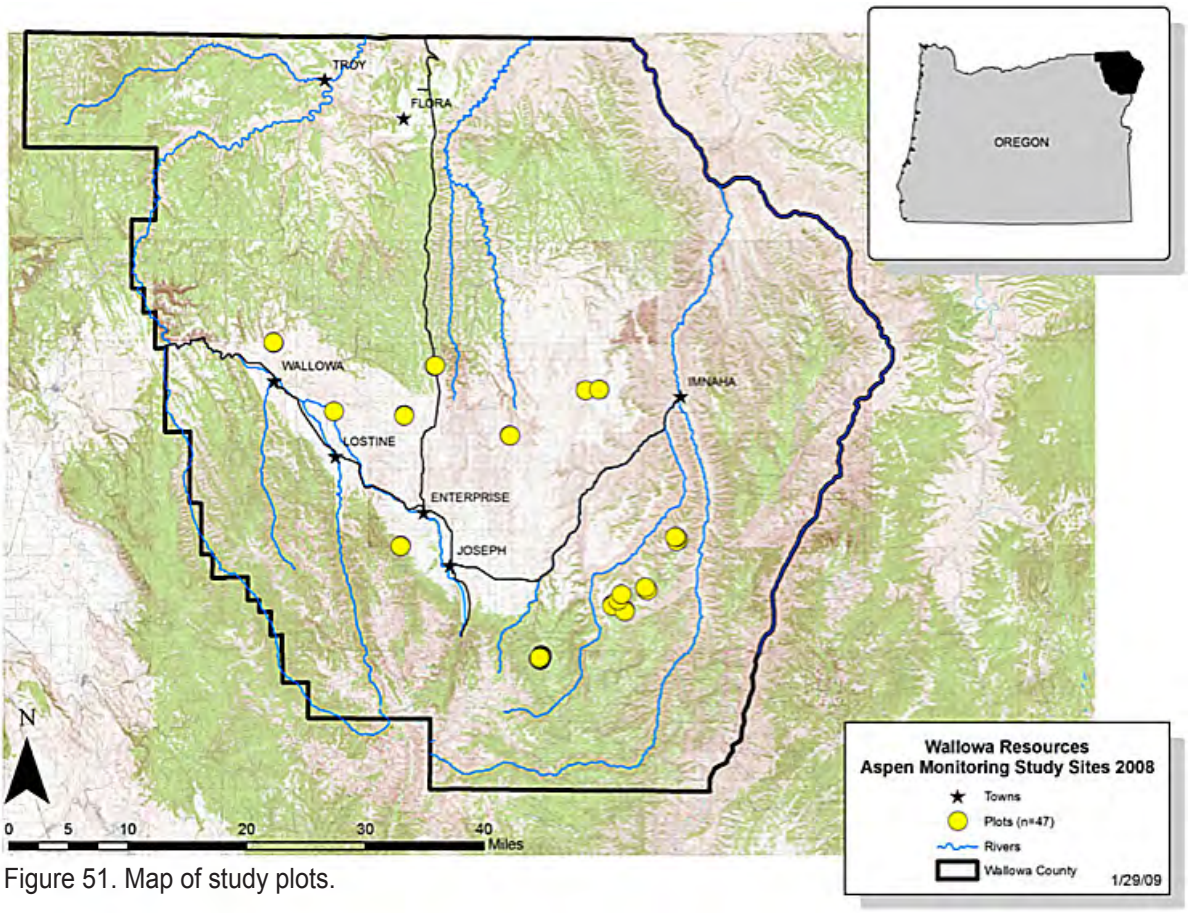


Figure 51. Map of study plots.

Goals and objectives

Our primary objectives were to compare:

- Change in aspen regeneration at selected original monitoring plots between 2000/2001 and 2008
- The level of browsing and current aspen regeneration in exclosures constructed of five fence types and in unfenced aspen stands

Methods

The main strategy of these aspen restoration efforts has been to protect aspen stands from browsing by large ungulates: domestic cattle (*Bos* spp.), elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), and white-tailed deer (*Odocoileus virginianus*). This strategy has been carried out by building fenced exclosures and small wire cages in aspen stands.

During the initial phase of the BMHRP, in 2000 and 2001, monitoring of study plots was begun in order to document baseline conditions prior to building the exclosures. Exclosures were built from 2000–2005 using five types of fence: barbed wire, buck and pole, outrigger, poletop panel, and woven wire. As of 2005, 51 exclosures had been built, ranging in size from 0.3 acre to 27.99 acres. We examined 19 exclosures and 5 unfenced stands. We also documented aspen regeneration inside one small wire cage.

In 2008, we revisited these study plots and established new plots within additional fenced exclosures and unfenced stands. At this time we did the following:

- Documented aspen response in fenced exclosures over time
- Compared the effectiveness of five types of exclosures at excluding browsers and supporting aspen regeneration.

Fence types

Fencing costs given below are estimates for constructed fence on average terrain.

- **Barbed wire**: This category refers to both four- and five-strand fences (Figure 52). These fences were approximately 40 inches tall. Approximate cost: $2.00–$2.50/foot.
- **Outrigger**: These fences were approximately 52 inches tall and consisted of a four-strand barbed wire fence with an "outrigger" attached to every post (Figure 53). The outrigger was a short piece of t-post bent to a 45° angle. Three strands of tape were strung from the outriggers along the length of the fence, creating an arm that angled approximately 20 inches outside of the exclosure, making the fence wider at the top. No cost estimate obtained.

Figure 52. Barbed wire fence type. (Photo: N. Christoffersen)

Figure 53. Outrigger fence type. (Photo: N. Christoffersen)

Figure 54. Woven wire fence type. (Photo: N. Christoffersen)

Figure 55. Buck and pole fence type. (Photo: N. Christoffersen)

Figure 56. Poletop panel fence type. (Photo: N. Christoffersen)

- **Woven wire**: These fences were approximately 94 inches tall and were constructed of two strips of woven wire attached to wood and metal posts (Figure 54). Approximate cost: $7.00–$11.00/foot.
- **Buck and pole**: These fences were constructed from wood rails with angled wood buck supports and were approximately 65 inches tall (Figure 55). Approximate cost: $9.00–$14.00/foot.
- **Poletop panel**: These fences were roughly the same height and shape as the buck and pole fences, but wire panel was substituted for the rails (Figure 56). Instead of two wood buck supports, one was wood and the other was a metal t-post. Welded wire panels were stapled to the bucks from ground level up to a wooden rail that ran above the panel between bucks. Approximate cost: $7.00–$9.00/foot.
- **Cages**: Cages consisted of a single welded wire panel joined at both ends to make a small circle (61.4-inch radius) approximately 50 inches tall (Figure 57). Cages were secured to the ground with stakes. Approximate cost: $7.00–$9.00/foot.

An unfenced grove is shown in Figure 58 (page 58).

Figure 57. Panel cage. Note difference in aspen regeneration in foreground and in cage. (Photo: N. Christoffersen)

To examine regeneration over time, we revisited the study plots in 2008 and compared the number of "tall stems" (aspen more than 4.4 feet tall) present then to those present in 2000–2001.

To determine the effectiveness of different exclosure types, we looked at the amount of browse and aspen regeneration (specifically the number of recruitment stems). We defined recruitment stems as those stems whose tips (terminal leaders) had escaped the reach of elk (more than 8.2 ft), our tallest browser (Keigley and Frisina 1998; M. Hansen, personal communication). These recruitment stems had a high potential to become a "tree," and thus were used as an indicator of successful regeneration. Browse was measured not just for the current year (2008) but for the past 3 years (using methods from Keigley and Frisina 1998).

We also examined the effectiveness of a small cage inside a barbed wire exclosure. Both the cage and the exclosure were built in 2004. We counted all aspen stems within the cage and categorized them by size class. We established a similar size plot outside and adjacent to the cage, and counted and categorized aspen stems inside it for comparison.

Figure 58. Unfenced aspen grove on Zumwalt Prairie (Photo: Ann Humphrey)

Results

Looking at regeneration over time, we found that the number of tall stems in the high fence type exclosures (woven, poletop, buck and pole, and outrigger) increased after the exclosures were built (12.3 more stems on average). However, the number of tall stems in low fence type (barbed wire) exclosures and in the unfenced stands did not change significantly over the 8-year study period.

In comparing different fence types, we found that the percentage of recruitment stems varied with fence type. Within fence type, there also was a great deal of variation.

No fence type excluded all browsing! The poletop panel exclosure had the least amount of browse (2 percent), and barbed wire fence exclosures had the most (more than 50 percent) (Figure 59).

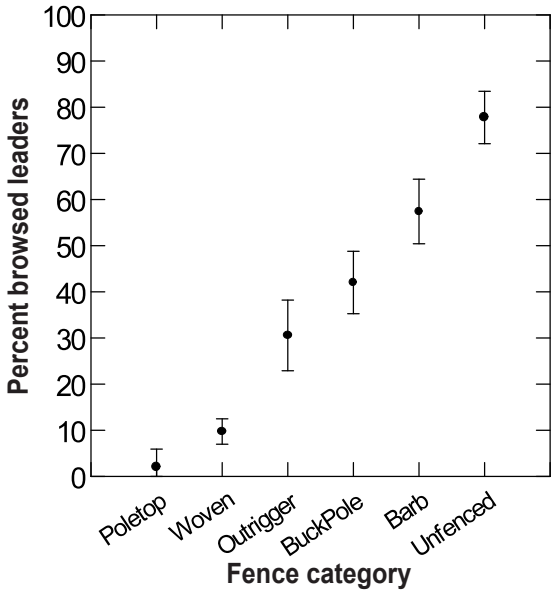


Figure 59. Percent browsed leaders by treatment. Percent browsed leaders was calculated per plot from total leaders examined, then pooled by treatment. Points indicate mean percent; bars represent standard deviation.

In the cage comparison, the cage, which was located in a barbed wire exclosure, kept out deer and cattle; the barbed wire exclosure excluded only cattle. There were many more tall stems inside the cage than outside (Table 1, page 59). Similar responses were also observed at cages in other locations throughout the study area, both inside and outside of exclosures.

Table 1. Number of stems by height class inside and outside cage plot.

Stem height (cm)*	# in cage plot	# in plot outside cage
>250	31 (45%)	0
201–250	12 (18%)	0
151–200	6 (9%)	0
136–150	2 (3%)	0
101–135	4 (6%)	1 (1%)
51–100	13 (19%)	60 (78%)
0–50	0 (0%)	16 (21%)
TOTAL	68	77

*100 cm = 39 in

Effectiveness of fence types

Woven wire fence type: This was the tallest fence in the study (94 inches). It was the second most effective fence in terms of reducing browse. (Only 9 percent of all leaders examined were browsed.) We suspect that this browsing must have occurred after a tree fell on the fence and allowed access to the exclosure. Repairs proved to be more difficult than with other types because of the height of the posts and the extra effort needed to dig deep holes and install them. Furthermore, there was some concern, based on anecdotal observations, that this fence type may have presented a hazard for birds (G. Franz, personal communication).

Buck and pole fence type: This was one of the taller fence types (65 inches), but it did not perform as well as expected based on height alone. Substantial amounts of browse were documented in buck and pole exclosures (42 percent of all leaders examined). While this amount of browse was significantly less than in unfenced stands, it may have been too much browse, on average, to allow for regeneration in some locations. However, response within this fence type varied; some exclosures were able to support regeneration. To be most effective, buck and pole fences may need fortification; one buck and pole exclosure was reinforced by adding woven wire along the ground and stapling it to the bottom two rails to keep deer out. This substantially reduced browse in the years following the improvement.

Poletop panel fence type: This fence type was represented by only one exclosure; however, the two study plots were similar, allowing for valid comparison to other fence types. Poletop panel was roughly the same height as the buck and pole fence type (65 inches). The single poletop panel exclosure had the least amount of browse of all fence types (2 percent of all leaders examined). However, since this result is based on only one exclosure, it should be viewed with cautious optimism. We recommend further experimentation with this fence type. At this single exclosure, built in 2001, some of the welded wires broke loose, and there was concern about how long this fence type might last under heavy snow loads.

Outrigger fence type: This fence type was poorly represented, with only one exclosure, and the two plots in this exclosure varied greatly in their ability to support vegetation. This fence type was clearly effective in excluding cattle; however, deer were observed several times inside the exclosure. In the initial fence design, the outrigger portion consisted of three strands of tape; however, over time this outrigger deteriorated and was replaced with one strand of smooth wire, which was broken at the time of this study. Circumstantial evidence suggested it was difficult to maintain the outrigger portion.

Barbed wire fence type: This fence type was intended to exclude cattle, not deer or elk. Barbed wire fence exclosures were no different, statistically, than unfenced stands in terms of tall stem regeneration, stem recruitment, or

amount of browse. More than half of the examined aspen leaders (57 percent) were browsed in barbed wire fence exclosures. However, the variability among exclosures was great; one of the most productive plots, as measured by the number of tall stems and recruitment stems, was in a barbed wire fence exclosure. In general, however, this fence type did not provide enough protection from wild browsers (deer and elk) to successfully promote regeneration.

Wire panel cage: Cages were placed around clusters of aspen stems, either inside or outside of exclosures. The cage examined here was effective in providing protection from all large browsers, and it allowed for successful regeneration at a very small scale inside the cage.

Conclusions

- No fence type excluded all browsing. Low fences kept out cattle, but deer and elk jumped over them. High fences prevented leaping, but unless wire extended to the ground, they allowed for sneaking under or between fence rails.
- Fence height alone did not predict effectiveness at excluding browsers. The most successful fence type (poletop panel) had two key elements that might account for its success: (1) sufficient height (approximately 65 inches) to prevent browsers from easily jumping over it, and (2) protection at the ground level (a wire panel) to prevent browsers (especially deer) from sneaking under the fence. A strong visual presence (wood pole top) may further discourage attempts by browsers to break through the exclosures, thereby reducing fence damage. Because we sampled only one poletop panel exclosure, we recommend more use of and further evaluation of this type.
- Our findings supported the notion that excluding all browsers, not just cattle, was the most effective strategy to support regeneration.
- Exclosure location played a large role in determining successful regeneration. The variability of aspen regeneration within exclosures, even within a fence type, was great. In some locations, presumably those with good growing conditions and good grove vigor, successful regeneration occurred even with browsing pressure. Conversely, the presence of exclosures did not always result in aspen regeneration. At some locations, additional restoration efforts (e.g., root scarification, burning or chopping down mature aspen) may be needed to stimulate regeneration inside exclosures.
- Regular inspection and maintenance of any exclosure is necessary. Damage to fences from windfall allowed browsers to enter an otherwise effective exclosure. It did not take long for a browser to undo years of protection.

Partners and acknowledgments

This case study is based on Final Report: The Monitoring Portion of ODFW Grant T-16, Project E-33-42.

This study was funded by the U.S. Fish and Wildlife Service and the Oregon Department of Fish and Wildlife (ODFW) through an ODFW Conservation Strategies grant. Additional funding came from The Nature Conservancy's Northeast Oregon office in Wallowa County. A special thanks to the private landowners who allowed access to their property; we appreciate their interest in aspen and the actions they are taking to maintain this special resource in Wallowa County.

Chapter 6

Incorporating Livestock and Aspen Management

Figure 60. Grazing in aspen stands should be carefully planned and implemented. (Photo: Nicole Strong)

Tim Deboodt

Aspen stands throughout Oregon are in an ongoing state of decline (Cobb and Vavra 2003; Shirley and Erickson 2001). Reasons for this decline are many, but key factors are lack of fire, encroachment by conifers, and excessive herbivory by livestock and large native ungulates—deer and elk (Shirley and Erickson 2001; DeByle 1985; Messmer 1999; Bates et al. 2006).

Kay (1994) speculated that increased herbivory may be due in part to a dramatic increase in herd size from pre-European settlement to present. The combination of domestic livestock and wildlife browsing has contributed to a higher level of browse pressure than that experienced by aspen stands in the past.

European settlers entering northeast Oregon in the mid-1800s reported that game was plentiful (Hug 1961). By the turn of the century, elk numbers were so low that the Oregon Legislature banned hunting of elk. That ban lasted until 1932. On the Umatilla National Forest, elk numbers in 1933 were estimated to be 3,080. Meanwhile, sheep, cattle, and horse numbers grew from the late 1800s to the early 1900s, reaching hundreds of thousands.

Today there has been a significant reduction in livestock numbers. However, elk and deer populations have grown and are now relatively stable. In the spring of 2000, elk numbers on the Umatilla National Forest were between 12,000 and 15,000 head (Shirley and Erickson 2001). Reported complaints about elk and livestock forage competition have risen.

Herbivory in aspen

Herbivory, the consumption of plants, is done by many species of animals and insects. Herbivores that utilize aspen include cattle, sheep, elk, deer, moose, beavers, gophers, wood borers, leafminers, etc. Utilization of aspen and terminal buds tends to be greater when sites are used by multiple species: cattle and sheep, cattle and deer, cattle and elk, or deer and elk.

Animals select areas to graze based on forage quality and quantity, comfort, and security. As a result, aspen stands cannot be viewed as discrete types when dealing with impacts of grazing and browsing (DeByle 1985).

Aspen stands in Oregon are small, particularly when compared to the aspen forests of the Rocky Mountains and Canadian provinces. In addition, these stands are small in comparison to the surrounding area available for grazing/browsing. However, aspen communities are known for their forage productivity. Cobb and Vavra (2003) reported that aspen communities can produce more than 1,750 lb of forage/acre. Jones et al. (2009) report that aspen communities at times produce more forage than neighboring meadow communities. Aspen stands can contain up to

10 times more forage than conifer stands, and the diverse grasses, forbs, and shrubs that grow in these areas are a valuable resource for livestock and wildlife (Salmon et al. 2007). Young aspen sprouts are nutritious and, when available, can make up a substantial portion of livestock and big game diets (Mueggler 1985). Thus, these sites are especially attractive to livestock and wildlife.

Cattle utilize aspen primarily early in the season. As the growing season progresses, cattle diets consist primarily of herbaceous species (grasses). However, following fire, use of aspen suckers by cattle has been shown to be significant in August. Sheep will browse aspen regardless of season.

The season of use by elk and deer is primarily fall and winter. Deer diets can be made up of as much as 74 percent trees and shrubs. Snow depths generally force deer out of aspen stands during the winter, but elk, being larger, are able to remain throughout most of the winter months.

Any of these herbivores, when out of balance, can have a pronounced negative impact on restoration success. Understanding the impact of herbivory by livestock and wildlife is necessary as management and restoration activities are planned. When implementing aspen restoration activities, one must plan to deal with grazing pressures on aspen sprouts and saplings.

Effects of livestock herbivory on aspen

Cobb and Vavra (2003) summarize the effects of livestock herbivory on aspen. Cattle stocking rates resulting in utilization levels of 50–60 percent of the palatable forage have negligible effects on aspen stands, regardless of whether stands are comprised of mature or young suckers. The greatest impact by cattle is trampling of the suckers while seeking shade. Repeated sucker damage progressively deteriorates the grove, opening it up for disease and ultimately leaving a few decadent trees and eventual grove loss.

Similar levels of grazing by sheep will directly damage and kill aspen suckers. Sheep browsing in the early sapling stage reduces growth, vigor, and numbers. Repeated overbrowsing will eliminate aspen regeneration and eventually the grove.

Shepperd and Fairweather (1994) reported on elk damage on a site in Arizona that had been fenced for 5 years after clearcutting. When the fence was removed, the grove stem density averaged 20,240 stems/acre, with dominant stems over 9.8 feet in height. By the end of the first year following fence removal, elk had caused severe damage to the grove by breaking the stems to reach the terminal foliage.

Elk also tend to "bark" mature trees during winter. Barking is the process of gnawing or stripping off the bark for food. Smaller mammals such as rabbits, mice, and porcupines also bark trees. Excessive barking can girdle trees, directly killing them or providing opportunities for fungi to infect the tree.

Grazing management principles

Livestock owners and land managers can control livestock impacts on aspen restoration activities and aspen grove health by controlling animal numbers (density), animal type and/or class (sheep vs. cattle, yearlings vs. cow/calf), timing (season), frequency of use, and length of the grazing period. Grazing systems, management tools (such as location of water and salt), and control of animals (through fences or herding) address these factors.

Rules of thumb established as far back as 1919 state that aspen suckers need to be greater than 3.9 feet tall for terminal leaders to escape sheep utilization; suckers need to be greater than 4.9 feet tall for terminal leaders to escape browsing by cattle. Terminal leader height for elk exceeds 6.6 feet (Sampson 1919; Jones et al. 2009).

When rehabilitating an aspen grove, it may take 4 or 5 years for trees to exceed browse height for sheep and cattle. For elk and deer, it may take 6 to 8 years for saplings to exceed browse height. As a result, if animal exclusion is necessary, temporary fences need to last long enough to protect the restoration treatment.

Designing a grazing system

A well-defined and implemented grazing plan will alleviate environmental concerns with respect to livestock grazing and help to maintain pasture and range health. A well-designed plan can also

improve or maintain forage production while optimizing plant and animal performance.

Grazing plans should strive to achieve livestock performance objectives and be based on the physiological and reproductive requirements of plants. Most forages are adapted to grazing but can be stressed by grazing. Individual plant response to grazing depends on:

- Whether the species is native or domesticated
- Number of times the plant is grazed (frequency)
- Amount of plant material left after grazing (stubble height, a function of grazing intensity)
- Amount of rest the plant is given following grazing, coupled with the amount of moisture and nutrients available

Elements of a beneficial grazing plan include:

- Site-specific grazing strategies
- Grazing schedules based on the physical and biological characteristics of the site
- Grazing schedules that provide periodic rest from grazing during periods of critical growth. Rest promotes plant vigor, reproduction, and productivity.
- Grazing schedules that prevent the increase and spread of invasive plants, while promoting conditions that facilitate the establishment and maintenance of desirable plants

One approach is "prescription grazing." Arthur Bailey, professor emeritus from Edmonton, Alberta and now a private consultant, defines prescription grazing as a process that involves planning, implementation, monitoring, and revisions where necessary.

In short, prescription grazing is a site-specific, well-developed grazing management plan. Just as a doctor would prescribe medicine or a treatment plan for an ailment, range managers prescribe or design a grazing plan to meet landowner/land objectives while addressing resource issues or problems (ailments). Prescribed management scenarios differ from one another because of differing objectives and site characteristics. Bailey sums it up this way: "The cardinal rule in developing objectives for prescribed grazing is to realize what grazing can and cannot accomplish."

A variety of grazing systems are available (see sidebar, page 64). Continuous grazing works well for managers who do not wish to invest much and do not expect much in return from grazing livestock. However, continuous grazing may result in resource degradation over time. If you wish to optimize forage and livestock performance, more sophisticated grazing systems are required.

When determining the timing, frequency, duration, and intensity of livestock grazing, consider the following:

- Maintain adequate plant cover and leaf material in order to promote photosynthesis, water infiltration, soil moisture conservation, and soil stability.
- Optimize energy and nutrient cycles by using sunlight, water, and nutrients from different zones in the canopy and soil. Plant structure provides habitat for numerous wildlife species, including browse and nesting sites.
- Dormant-season grazing makes use of the previous year's production. Remove livestock before current-year grass growth begins. Spring grazing should be initiated after grass growth has begun (green-up).
- Reduce the length of grazing periods (number of days per pasture) to encourage leaf regrowth and replenishment of carbohydrate reserves before the next grazing season.

Specific to grazing livestock in the presence of aspen, consider the following points:

- Prescription grazing of aspen by livestock is an effective and relatively inexpensive best management practice for aspen in a number of resource-management scenarios.
- Cattle and sheep often graze aspen and other brush species as part of their diet. Carefully planned and executed grazing systems can either enhance aspen regeneration or suppress aspen and enhance grass production.
- In spring, new growth of aspen stems is easily sheared by cattle, but by August the young stems have hardened and cattle rarely eat them. By late summer, cattle use is generally limited to aspen leaves.
- Deferral of cattle grazing is appropriate in the first year of a new, regenerating aspen cut.

- Aspen regeneration (sprouts) should be protected from all large herbivore browsing until trees are taller than browse height.
- Spring cattle grazing can be accommodated in 4- or 5-year old aspen cuts that have well-established aspen saplings (above browse height).

Case Study 4 (page 55) looks at the effectiveness of several types of fences at reducing browse damage by both livestock and wildlife.

Conclusions

In eastern Oregon, aspen do not exist in the large, extensive stands (several hundred acres) common to the Rocky Mountains, Great Basin, or Canadian provinces. Aspen are typically found in isolated upland stands where soil and moisture conditions are favorable (perched water tables) or as stringers along stream corridors (Cobb and Vavra 2003). Managing herbivory on scattered small stands dispersed across the landscape is challenging. Before implementing an aspen-recovery project, be sure to understand post-treatment concerns about livestock and wildlife utilization of new sprouts. Grove protection will probably be necessary for the first 4 or 5 years if elk are not present and for up to 10 years if elk are anticipated to be in the area.

Grazing management systems can be developed to meet the needs of healthy aspen and productive ranches. Grazing should be limited during the early spring and late summer. Grazing systems that utilize some form of pasture rotation and rest periods will result in healthy range, sustained or improved site productivity, and better animal performance.

TYPES OF GRAZING SYSTEMS

Continuous grazing: A method of grazing livestock on a unit of land that permits unrestricted and uninterrupted grazing throughout the time period when grazing is allowed. Generally, this means that livestock are in a single pasture through more than one plant-growth period.

Deferred-rotational grazing: Grazing management of more than one pasture that involves delaying grazing in one pasture until seed maturity, then deferring other pastures in subsequent years.

Rest-rotational grazing: A grazing system in which one pasture receives a year of non-use. Most rest-rotation systems use three or four pastures.

Intensive grazing management: Grazing management that attempts to control the duration and timing of grazing. Management capital (labor, time, and other resources) is increased to optimize the production of both the land and the livestock.

Chapter 7

Where Do You Go from Here?

Planning and Getting Help

Figure 61. Landowner and Master Woodland Manager Maureen Kirby shows her management plan to neighbors as part of a field tour. (Photo: Nicole Strong)

Nicole Strong

Planning

The previous chapters illustrated why and how you might conduct an aspen restoration project. But before you jump in the truck with your chainsaw and fence posts, there are a few steps you can take to make success more likely.

Bounce your ideas off someone

Start with your neighbors and other ranchers or woodland owners. They often have great practical experience and know who the local contractors are. You might consider attending an aspen restoration field tour or workshop (Figures 61 and 62). Valuable experiences are shared at these events. Getting together with groups such as the Oregon Small Woodlands Association or Oregon State University Extension Service is a great way to get practical tips on aspen management, as well as to make new friends!

Your neighbors may be private landowners, the U.S. Forest Service, or Bureau of Land Management. Don't shy away from contacting your area district office of state and federal agencies. Many agencies are working on aspen restoration, and an area wildlife biologist or forester may be willing to visit with you. Oregon Department of Forestry stewardship foresters, Oregon Department of Fish and Wildlife biologists, and OSU Extension foresters are available to help.

Figure 62. A group of landowners and agency professionals head out to Kevin Westfall's field site near Chiloquin, Oregon. (Photo: Nicole Strong)

Have you written a management plan?

A plan will lay out your vision for your restoration project to anyone who will be working with you, such as technical professionals, contractors, and family members. A plan may be required if you want to receive funds from a cost-share program.

There are many management plan templates, but four elements are essential to any plan:

- A statement of goals and objectives
- A description of your property
- A description of what you intend to do on your property to reach your goals and objectives
- A plan to monitor, or measure, your success

As of 2010, The Oregon Department of Forestry and NRCS offer cost-share funds to hire help in writing a management plan. Another resource is the OSU Extension Service, which offers management planning classes.

Have you planned for monitoring?

Just as you assessed your grove prior to taking management actions, you will want to keep checking on your project after treatment to ensure that you are meeting your goals. If you received technical assistance, monitoring may be required. If so, check with your resource professional to see whether specific protocols are required.

Not every project is successful. Monitoring may help you identify potential problems and prevent you from repeating them. Sometimes, unexpected events occur, such as a storm, pest outbreak, or invasion by unwanted plant species. If you experience undesired changes, you may need to adjust your management practices.

Goals often are achieved, however! Monitoring your success is a way to keep in touch with your property after the planning process is complete. Monitoring is often the most rewarding part of a restoration project. You will be able to see what you have accomplished through your hard work and careful planning. The landscape developments that occur, as well as sightings of new aspen seedlings or wildlife, are very satisfying. Simply writing down or taking a picture the day you saw a nuthatch making a nest is fun and will create a record for your children or grandchildren to enjoy.

How to monitor?

There is more than one way to monitor your project, just as there is more than one way to assess it. The best method for your situation will depend on your comfort in collecting data, as well as on your interest and time. Choose a method that will give you relevant information and that you will stick with. Options include the following:

- If you established plots as described in Chapter 3, you can revisit those sites, collect the same data using the same methods, and take photos. Time-sequence photos are a great way to tell your story.
- If you are not interested in collecting data, or feel you don't have time, simply taking photos and keeping a journal (somewhere handy, such as in your truck) is a good way to keep track of your progress and the returns on your investment of time and money.

What to monitor?

One of the challenges of monitoring is choosing the indicators of desired change. At a minimum, you will want to set monitoring goals that help you determine whether the project has achieved your desired production, ecological, economic, or social (e.g., recreation) goals.

Once you have identified the goals you want to monitor, you must select the indicators used to measure success or failure. An indicator is simply a unit of information measured over time that documents changes in a specific condition. A good indicator is measurable, precise, consistent, and sensitive to changing conditions. When choosing indicators, ask yourself the following questions:

- Are they relevant for the site and treatment?
- Are they sensitive to change within your time frame? You can see an increased number of regenerating seedlings within 1 to 5 years, while it takes 10 to 70 years to create a multistructured forest grove that will house woodpeckers.
- Are they measurable with your available methods and time?
- Are individual indicators integrated so that the whole suite of indicators provides a reasonable picture of change?

The key is to pick indicators that are important to you and your property management goals. A good place to start is to review your short-term,

mid-term, and long-term goals and reword them to serve as monitoring statements.

For example, let's say your long-term goal is to "create a two-aged healthy aspen grove as a legacy for future generations." Based on an assessment, you learn that there is significant conifer encroachment and no regeneration. An immediate goal could be to "within 5 years, increase regeneration of aspen trees within the designated patch."

If you were to just thin out the conifers, you might miss the fact that heavy elk browse is occurring. Thus, although there is now sufficient light to produce aspen regeneration, your goals cannot be met without further intervention (in this case fencing).

In the example above, you would want to measure regeneration success. Checking up on the site to see whether aspen are regenerating and whether they are being browsed will help ensure that you meet your goal of creating future aspen stands.

What if you removed conifers with the goal of increasing forage for late-season cattle grazing? You could measure forb height before and after treatment or measure forage weight in small plots before and after treatment. You also could monitor livestock indicators of increased forage production, the most obvious being weight gain.

Help is available

We are very lucky in Oregon to have one of the strongest forestry and natural resources programs in the country. The following agencies, groups, and individuals are available to help you make decisions and find technical and financial assistance for your aspen restoration project.

USDA Natural Resources Conservation Service

NRCS, as well as your local Soil and Water Conservation District (SWCD), can help with conservation planning and practices that maintain and improve soil, water, and other natural resources that support productive and profitable agricultural and forestry operations. Look for the nearest NRCS office in your phone book's federal government pages or visit http:// www.or.nrcs.usda.gov/

To find the SWCD in your area, contact the Oregon Association of Conservation Districts at 650 Hawthorne Ave., Suite 130, Salem, OR 97301; 503-566-9157; http://www.oacd.org/

Oregon State University Extension Service

Extension foresters, most of them based in county Extension offices, give classes, tours, and workshops for woodland owners. Extension also has more than 100 how-to publications in print and online and maintains websites with even more resources. Find the Extension forester nearest you via the phone book's county government pages, or visit http://extensionweb.forestry.oregonstate.edu

Oregon Department of Fish and Wildlife

The Oregon Department of Fish and Wildlife has several regional offices throughout the state. Their Conservation Strategy includes aspen woodlands as a strategy habitat. Individual wildlife or Conservation Strategy biologists can help you enhance your property for fish and wildlife. Visit http://www.dfw.state.or.us/agency/directory/regional_offices.asp

Oregon Department of Forestry

ODF stewardship foresters give technical forestry assistance and advice. They also administer the Forest Practices Rules. They can advise on options for managing your forest and on how to comply with rules and laws. Find the ODF forester nearest you via the phone book's state government pages, or visit http://www.oregon.gov/ODF/

Oregon Small Woodland Association

This not-for-profit group provides useful information and a forum for forest owners to share with one another. OSWA also represents forestland owners to the general public and before legislative bodies and regulatory agencies. Contact OSWA at 775 32nd St. NE, Suite C, Salem, OR 97301; 503-588-1813; http://www.oswa.org/

Professional forestry consultants

A good forestry consultant will help ensure that harvesting, marketing, reforestation, and other forestry activities and related contracts are done right and serve your interests. Hiring a professional forester can be the best option, particularly when substantial timber values or other economic

considerations are involved. Ask Extension foresters, ODF foresters, and fellow forestland owners for references to qualified consultants.

United States Forest Service and Bureau of Land Management

The Forest Service was established in 1905 and is an agency of the U.S. Department of Agriculture. The Forest Service manages public lands in national forests and grasslands encompassing 193 million acres.

The Bureau of Land Management (BLM) is part of the Department of the Interior. The BLM manages grasslands and shrub steppe in eastern Oregon and Washington as well as aspen, ponderosa pine, juniper, and white fir forests.

Fifty-one percent of all forestland in Oregon is publicly owned. Thus, chances are good that you have a nearby public land neighbor. You can contact the district office nearest you and ask whether they are doing any aspen restoration. You could then schedule a time to visit their site or to meet and learn from their experience.

Oregon Forest Service website: http://www.fs.fed.us/r6/pdx/forests.shtml#oregon

Oregon BLM website: http://www.blm.gov/or/st/en.html

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Appendix II

Insect, Disease, and Animal Damage

Stephen Fitzgerald

Insects

The most common insect pests of aspen include defoliators, which consume entire leaves or portions of leaves; leafminers; scale insects; and wood borers.

Examples of defoliating insects include satin moth, fall webworm, various species of tent caterpillars, and the large aspen tortrix. Of these, satin moth (a nonnative insect) and large aspen tortrix are the most serious, as they can defoliate entire trees and stands (Schmitt 2000). Satin moth outbreaks have been observed periodically in northeast Oregon (Schmitt 2000). Although outbreaks of large aspen tortrix have not been observed in Oregon, this insect has a broad range that includes all western states.

Two species of leafminers, the aspen blotchminer and the aspen leafminer, are the most common in aspen. Adult moths of both species lay eggs on leaves when foliage is unfolding in the spring. Larvae feed and pupate inside the leaf. Adult moths emerge in late summer and overwinter in bark crevices. Aspen blotchminer creates brown blotches between leaf veins. The aspen leafminer creates winding or meandering tunnels inside the leaf, which are quite striking in appearance.

The oystershell scale is a sucking insect that attaches itself to branches and to the main stem (trunk) of aspen trees. The insect inside the tiny oyster-like scale pierces the aspen's thin bark and sucks or extracts food from the tree's sap stream. Adult scale insects mate and lay eggs in the spring. After hatching, the young insects are briefly mobile (crawler stage) and can move to other portions of the tree. Once stationary, they develop the characteristic thick oystershell that protects them from predators and insecticide sprays.

Common wood borers that attack aspen include the poplar borer and the bronze poplar borer. Adults feed on the foliage or tender shoots in early spring and then mate. Females lay eggs in bark crevices or areas of rough or wounded bark. Within a few weeks, larvae hatch and bore into the tree to complete their life cycle, which takes 1 to 2 years. Aspen trees with injuries caused by other insects, animals, or wind are more likely to become infested with wood borers. These wounds also facilitate entry of decay and canker diseases (Schmitt 2000).

Figure 63. Slight weeping from a wood borer entrance hole in aspen. (Photo: Stephen Fitzgerald)

Other wood borers commonly found on ornamental quaking aspen have the potential to infest native aspen stands. These species include the poplar-and-willow borer (an introduced insect), American hornet moth, and western poplar clearwing borer.

All of the borers mentioned above create an entrance hole that weeps or drip sap down the stem (Figure 63). Often there is boring dust (frass) mixed with the sap at the entrance hole.

Diseases

Aspen is subject to a host of leaf and shoot diseases. Most leaf diseases build up over a 2- to 3-year period and cause premature leaf drop and reduced tree vigor. Trees typically rebound when the leaf disease subsides and has run its course. Rarely do trees die.

One of the more common leaf diseases of aspen in Oregon is Marssonina leaf spot/blight. This leaf disease builds up under favorable weather conditions such as moist spring weather. The leaves in heavily infected stands begin to turn yellow and drop in early August. Spores develop in leaves on the ground and infect new leaves as they are flushing and expanding in the spring of the following year.

Another leaf disease is shepherd's crook of aspen. This disease causes twigs (and attached leaves) to die, turn black, and droop, creating the appearance of a "shepherd's crook." Damage is most severe on seedlings and saplings (Schmitt 2000).

Conifer-aspen rust, another important disease, spends part of its life cycle on Douglas-fir, larches, and pines and part on aspen. Orange spots on aspen leaves in the fall help identify this disease. This leaf rust causes premature leaf drop when infection levels are high.

Canker diseases are common in aspen, attacking the stem and leaving a sunken area of dead bark. The canker enlarges over time, killing the tree or predisposing it to damage by other agents and wind. Five common canker diseases in aspen are Cytospora, Hypoxylon, Ceratocystis, Cryptosphaeria, and sooty-bark canker. Cytospora canker is opportunistic; it often attacks weakened trees or bark that has been injured by frost, sunscald, or browsing. Hypoxylon canker kills stems and branches. It can kill small trees within 2 to 4 years. Ceratocystis canker is usually slow growing, taking years to kill individual trees. Cryptosphaeria canker is much more aggressive and can kill trees within a few years (Shepperd et al. 2006). Sooty-bark canker is fairly common in aspen stands of the Blue and Wallowa mountains (Schmitt 2000).

The most common stem decay of aspen in Oregon is aspen trunk rot, which increases over time as stands mature. This disease causes extensive internal decay, which predisposes trees and stands to wind breakage. You know this disease is present when you see the common "shelf fungi" or "conk" protruding from the tree trunk. This stem decay allows wildlife species, such as woodpeckers, to more easily excavate cavities. These cavities are in turn used by other wildlife after the woodpeckers vacate. Another common stem decay is heart rot. This stem decay is difficult to identify, but it causes similar decay as aspen trunk rot.

Aspen is also susceptible to a couple of root and butt rots. In northeast Oregon, Armillaria root disease causes root mortality and decay. White mottled rot has been identified in the Blue and Wallowa mountains. This disease can infect tree roots through wounds and cause root mortality and decay (Schmitt 2000). Trees infected with these root and butt rots are much more susceptible to windthrow.

Animal damage

The most common animal problems are browsing damage by elk, deer, and domestic livestock. Restoration efforts should include strategies to reduce browsing pressure (see Case Study 4 and Chapter 6). In some stands, antler rubbing by deer and elk causes significant damage to sprouts and young trees, allowing entry of stem decays and canker diseases. Elk will also eat aspen bark, damaging the stem and creating points of entry for diseases. Other common problems include sapsucker damage (horizontal holes that encircle or partially encircle the main stem) and beaver damage to aspen adjacent to streams, rivers, and lakes.

Other injuries

Sunscald damage looks similar to that caused by cankers. Young trees with thin, green bark are susceptible to damage when suddenly exposed to direct sunlight (when an adjacent tree dies or blows down). The increased heating on the exposed side kills the bark and creates a longitudinal wound on the south to west side of the tree. Sunscald predisposes aspen trees to canker and stem decays.

Wind can break off all or portions of healthy trees, allowing entry of stem decays that further weaken the tree. Mature and over-mature aspen stands may already contain significant stem rot, such as from trunk rot fungus, which predisposes trees to wind breakage.

Because of its thin bark, aspen is also susceptible to wildfire; above-ground portions of trees are easily killed by fire.

Table A-1. Common insects, diseases, and animal damage of quaking aspen.

Type of Insect	Common Name	Scientific Name
Defoliators	Western tent caterpillar	*Malacasoma californicum*
	Satin moth	*Leucoma salicis*
	Fall webworm	*Hyphantria cunea*
	Large aspen tortrix	*Choristoneura conflictana*
Leafminers	Aspen blotchminer	*Lithocolletis tremuloidiella*
	Aspen leafminer	*Phyllocnistis populiella*
Stem scales	Oystershell scale	*Lepidosaphes ulmi*
Wood borers	Poplar borer	*Saperda calcarata*
	Bronze poplar borer	*Agrilus liragus*
	Poplar-and-willow borer	*Cryptorhynchus lapathi*
	American hornet moth/Cottonwood crown borer	*Sesia tibialis*
	Western poplar clearwing	*Paranthrene robiniae*
Type of Disease	**Common Name**	**Scientific Name**
Leaf	Marssonina leaf spot/blight	*Marssonina populi*
	Shepherd's crook of aspen	*Venturia macularis*
	Conifer-aspen rust	*Melampsora medusa*
Stem cankers	Hypoxylon canker	*Hypoxylon mammatum*
	Cytospora canker	*Cytospora chrysosperma*
	Ceratocystis, Black, or Target canker	*Ceratocystis fimbriata*
	Cryptosphaeria canker	*Cryptosphaeria populina*
	Sooty-bark canker	*Encoelia pruinosa*
Stem decays	Aspen trunk rot	*Phellinus tremulae*
	Heart rot	*Peniophora rufa*
Root rots	Armillaria root disease	*Armillaria sinapina*
	White mottled butt rot	*Ganoderma applanatum*
Type of Damage	**Common Name**	**Scientific Name**
Distinct horizontal holes on tree stem	Red-naped sapsucker Red-breasted sapsucker	*Sphyrapicus nuchalis* *Sphyrapicus ruber*
Tree partially gnawed or tree is completely felled	Beaver	*Castor canadensis*
Sprout tips and branches appear to be clipped or browsed	Mule deer Elk Livestock (cattle and sheep)	*Odocoileus hermionus* *Cervus canadensis nelsoni*
Antler rubbing or shredding of bark on sprouts and young trees	Mule deer Elk	*Odocoileus hermionus* *Cervus canadensis nelsoni*
Bark removed or stripped off	Elk Moose	*Cervus canadensis nelsoni* *Alces alces shirasi*

Appendix III

Glossary

Aspen release—Allowing aspen to grow or thrive by thinning or cutting competing vegetation.

Basal area—The cross-section area of a tree stem in square feet, commonly measured at breast height (4.5 feet above ground) and inclusive of bark, usually computed by using diameter at breast height, or tallied through the use of a basal area factor angle gauge. The basal area factor is the number of units of basal area per acre (or per hectare) represented by each tree. The formula for basal area = (3.1416 x DBH^2)/(4 x 144). This formula simplifies to: basal area = 0.005454 x DBH^2.

Cambium—Layer of cells between the inner bark and the wood of a tree, which repeatedly subdivides to form new wood and bark cells.

Clone—A group of genetically identical cells or organisms derived from a single cell or individual by some kind of asexual reproduction.

Decadent—In terms of trees, refers to old trees in a state of decay.

Diameter at breast height (dbh)—Standard measurement of a tree's diameter, usually taken at 4.5 feet above the ground.

Disturbance—In ecology, a temporary change in average environmental conditions that causes a pronounced change in an ecosystem. Ecological disturbances include fires, flooding, windstorm, and insect outbreaks, as well as human actions such as forest clearing and the introduction of exotic species.

Extirpation—Local extinction of a species in a specific area, although it still exists elsewhere.

Forage—Plant material (mainly plant leaves and stems) eaten by grazing livestock.

Geographic Information System (GIS)—An information processing technology to input, store, manipulate, analyze, and display spatial resource data to support decision making. Generally, an electronic medium for processing map information, typically used with manual processes to make specific decisions about the land base and its resources.

Girdle—A method of killing trees by cutting through the cambium of the stem, thus interrupting the flow of water and nutrients.

Heartwood—The older, inactive central wood of a tree or woody plant; usually darker and denser than the surrounding sapwood.

Herbaceous vegetation—Low-growing, non-woody plants (including wildflowers and ferns) in a forest understory.

Herbivory—The consumption of living plant tissue by animals.

Midstory—The trees that form the middle layer in a forest of more than one vertical layer or canopy.

Monitoring—The act of observing something (and sometimes keeping a record of it). In this case, monitoring refers to observing the effects of treatments on your land to see if you are meeting your goals and objectives.

Overstory or canopy—The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

Perched water table—A water table, usually of limited area, maintained above the normal free water elevation by the presence of an intervening impermeable layer.

Pioneer species—The first species to populate an area in the process of primary succession.

Riparian zone or riparian area—The interface between land and a water body, such as a stream, pond, or lake. Plant communities in this area are called riparian vegetation.

Self-thin—The process whereby individual trees within a grove die due to competition for space, sun, and water.

Silviculture—The art and science of growing forest trees.

Species richness—Simple counts of the number of species in a given area.

Succession—The natural replacement of one plant (or animal) community by another over time in the absence of disturbance.

Sucker—Shoot or cane that grows from a bud at the base of a tree or shrub or from its roots.

Terminal leader—Top central branch of a tree, providing straight, uniform growth.

Understory—The level of forest vegetation beneath the canopy.

Uneven-aged management—The application of actions to simultaneously maintain continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products.

Ungulate—A hoofed mammal adapted for running; mostly large herbivores, including deer, cattle, gazelles, horses, elk, and antelope.

Watershed—A region defined by patterns of stream drainage. A watershed includes all of the land that contributes water to a particular stream or river.

Wildlife habitat—The native environment of an animal. Habitats ideally provide all of the elements needed for life and growth: food, water, cover, and space.

Appendix IV

Supplies and Equipment Needed to Complete FULL and RAPID Assessments

Supplies/Equipment	Assessment type	Supplier*
Aluminum tags and wire or zip ties	FULL	Terratech (http://www.terratech.net; 800-321-1037), other suppliers
Aluminum nails	FULL	Hardware store
Tree marking paint	FULL	Terratech, other suppliers
Colorful flagging (orange, pink)	FULL	Terratech, other suppliers
Orange or red spray paint for t-bar posts	FULL	Hardware store
Compass	FULL/RAPID	Terratech, other suppliers
RAPID Aspen Assessment Form (1 page)	RAPID	Aspen manual (page 20)
FULL Aspen Assessment Form (2 pages)	FULL	Aspen manual (pages 14–15)
Instructions for completing assessment	FULL/RAPID	Aspen manual (pages 12–13 or 19)
Clipboard	FULL/RAPID	Many suppliers
Pencil	FULL/RAPID	Many suppliers
GPS (Global Positioning System) and spare batteries	FULL/RAPID (optional)	Many suppliers
6' cattle fence t-bar posts	FULL	Farm supply store
Post pounder or sledgehammer	FULL	Hardware store
Hammer	FULL	Hardware store
Digital camera	FULL/RAPID	Many suppliers
75' measuring tape	FULL	Terratech, other suppliers
Yardstick	FULL	Many suppliers
Dry erase board and marker or notebook paper	FULL (optional)	Many suppliers

**Mention of specific products, services, and suppliers does not imply endorsement by Oregon State University or the OSU Extension Service. No discrimination is intended against products, services, and suppliers not mentioned.*