Aspen Restoration in the Blue Mountains of Northeast Oregon

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Abstract—*In the Blue Mountains of northeast Oregon, quaking aspen is on the western fringe of its range. It exists as small, scattered, remnant stands of rapidly declining trees. Although little is known about the historic distribution of aspen in Oregon, it is believed that stands were once larger and more widely distributed. Decline of the species is attributed to fire suppression and browsing pressure from large ungulates. A landscape approach to restoring aspen is taken using a variety of techniques. Among these are construction of large herbivore exclosures, prescribed fire, establishment of new aspen stands using containerized planting stock, simulation of natural refugia, and use of genetic variation data to guide management decisions. Questions are raised on the social and economic costs of recovery efforts.*

Introduction

In the Blue Mountains of northeast Oregon, quaking aspen (*Populus tremuloides*) is on the western fringe of its range. It is most often found growing along stream corridors although it is occasionally seen on steep, rock outcrops and, to a much lesser extent, on dry, upland sites.

In the past decade, there has been increasing concern about the lack of successful regeneration in aspen stands. This has been attributed largely to fire suppression efforts as well as browsing pressure from both domestic livestock and large native ungulates, specifically both whitetail and mule deer (*Odocileus virginianus columbianus* and *Odocileus hemionus hemionus*) and elk (*Cervus elaphus nelsoni*).

The Role of Fire

Fire is an important component in both establishing new stands of aspen and in assisting aspen in maintaining its position on the landscape (Jones and DeByle 1985). Aspen seeds require exacting conditions for successful germination (McDonough 1985). These conditions include a mineral soil seedbed and an extended interval of optimum soil moisture. Fire exposes mineral soil by consuming forest floor litter and reducing or eliminating competing vegetation. Suppression of fires has limited the areas where new stands of aspen may become established.

Aspen is considered a shade-intolerant species (Baker 1949). In the Blue Mountains, conifers growing in the understory of aspen stands will eventually overtop the aspen canopy in the absence of fire or some other disturbance. In time, aspen will disappear from that location on the landscape. If, however, fire should consume both the conifer and aspen overstory, the aspen root system will often survive. Upon release from the apical dominance of the overstory trees, the root system responds by sending up thousands of suckers to reoccupy the site. The rapid initial growth rate of aspen, along with a fully established root system, allows it to outcompete other colonizing tree species for light, moisture, and

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nutrients. In this manner, a particular stand of aspen can maintain its position upon the landscape.

The Fall and Rise of Big Game Herds in Northeast Oregon

Browsing by large ungulates has contributed to the demise of aspen regeneration in many areas of the western United States (Bartos et al. 1991; DeByle 1985; Kay 1990; Kay and Bartos 2000; Smith et al. 1972). This may be due, in part, to a dramatic increase in herd size from pre-European settlement to the present (Kay 1994). The first homesteaders began settling northeast Oregon in the mid-1800s. Although no numbers are available for that period, game was said to have been "plentiful" (Hug 1961). However, Native Americans hunted herds for subsistence, and wild predators such as the wolf (*Canus lupus*) and the cougar (*Puma concolor*) also killed their share. One early settler in Union County, Oregon, was quoted as saying, "The Indian had his own game conservation programs that were effective, but white men paid little attention to them." As settlements grew, so did the hunting pressure. By the turn of the century, big game numbers had dwindled alarmingly. By 1909, elk were so scarce that the Oregon State Legislature put a ban on hunting elk that lasted until 1932 (Oregon Department of Fish and Wildlife 1992). In 1912 and 1913, 30 elk from Jackson Hole, Wyoming, were brought in to supplement the herd (Bailey 1936). These elk were placed in a protective enclosure known as "Billy Meadows" on the Imnaha National Forest where they thrived and grew in number.

With legislated protection from hunting, both introduced and native herds grew quickly. In 1916, elk only numbered in the hundreds on the Umatilla National Forest. By 1933, their numbers were estimated at 3,080 on the forest. During this same year, hunting of elk was reestablished due to complaints about competition between elk and domestic livestock. In spring of 2000, the Forest Service reported between 12,000 and 15,000 elk on the Umatilla National Forest (Charlie Gobar, Forest Biologist, personal communication).

Domestic Livestock

While deer and elk were struggling for their existence, domestic livestock numbers were on the rise. In the period between 1890 and 1912, rangelands were reported as being overgrazed by cattle and sheep (Hug 1961). This is not surprising considering that sheep flocks reached a peak population of 240,000 in Umatilla County alone (Bureau of the Census 1912). As cattle numbers increased, bands of sheep were eventually displaced from rangelands.

As native ungulate herds recovered, the addition of domestic livestock onto the landscape contributed to a level of browse pressure that aspen stands may never have experienced before in their life history. Add to this the reduction of fire in the ecosystem and you have an environment that is hostile to the regeneration of aspen. This article addresses the aspen restoration work completed to date on the North Fork John Day Ranger District of the Umatilla National Forest.

Existing Conditions

The North Fork John Day Ranger Station, located in Ukiah, Oregon, lies at an elevation of 3,350 feet. Situated in a somewhat dry valley bottom, most of the area is used as pasture for cattle and horses. Powell (2000) describes this as the valley grasslands zone. An occasional clump of aspen may be found growing along stream courses that have been heavily degraded by livestock. As the elevation increases to 3,500 feet (these elevation bands are not absolute and vary across the Blue Mountains and within the District), open stands of ponderosa pine (*Pinus ponderosa*), juniper (*Juniperus communis*), and sagebrush (*Artimesia* spp.) are encountered (the woodlands/shrublands zone). Above this elevation, the land is primarily forested, the species composition being dictated by aspect and elevation. South and west aspects, between 3,500 and 5,000 feet, support dry forest stands of ponderosa pine (the dry forest zone). Western larch *(Larix occidentalis*) often grows on south exposures within volcanic ash inclusions. Douglas-fir (*Psuedotsuga menziesii*) and grand fir (*Abies grandis*) invade these sites in the absence of disturbance. On east and north faces within the same elevation band, mixed conifer stands of western larch, Douglas-fir, grand fir, lodgepole pine (*Pinus contorta),* western white pine (*Pinus monticola*), smaller amounts of ponderosa pine, and Engelmann spruce (*Picea engelmannii*) are found. Engelmann spruce is limited to stream corridors and areas of high water tables. These constitute the moist forest zone.

Above 5,500 feet, in the cold forest zone, subalpine fir (*Abies lasiocarpa*), Engelmann spruce, lodgepole pine, and occasionally whitebark pine (*Pinus albicaulis*) are the dominant tree species. Quaking aspen occurs throughout the elevation gradient, 3,300–6,000 feet, growing wherever adequate moisture exists, primarily along stream channels.

Aspen does not appear to be restricted to any particular plant association or soil type. It is found growing adjacent to arid scab flats, warm pine sites, stands of mixed conifers, cool spruce-fir forests, or interspersed with lodgepole pine. Most stands have a significant component of conifers. No stand of aspen is larger than 20 acres, the majority being less than an acre in size.

Although aspen seedlings have been found recently inside of the 1996 Bull and Tower Fire perimeters, most regeneration observed to date has been from root suckering. While root suckers are usually numerous beneath stands, very few are recruited into the sapling size class, or larger, due to herbivory from large ungulates. Cattle are responsible for browsing a portion of the suckers from June through September. However, the most intensive browsing occurs after the cattle have been removed from grazing allotments in late September. By this time of year, grasses have cured out and the tender leaves, as well as the protein-rich buds, of aspen are especially appealing to deer and elk. By mid-October, it becomes increasingly difficult to find a sucker that has not been browsed. In fact, many suckers have been observed with multiple years of browse damage. These seldom reach more than two feet high and eventually die out. As a result, stands have failed to successfully regenerate.

The overstories of most aspen stands on the District are even-aged. Nearly all mature trees have stem decays, making accurate age determination difficult. However, survey results estimate stands to range in age from 80 to 150 years. This would place initiation of most of the overstories somewhere between the mid-1800s to early 1900s, when overhunting was decimating native elk herds and possibly before livestock numbers had peaked. While aspen root systems may persist for thousands of years, aspen trees have an average lifespan of between 100 and 150 years in the Rocky Mountains, although stands occasionally survive beyond 200 years (Burns and Hondkala 1990; Jones and Schier 1985). If the same holds true for aspen in the Blue Mountains, then most of our aspen overstories are approaching the end of their natural life cycles. Several stands still appear to be vigorous but most are rapidly declining. Natural mortality from a wide host of insects and diseases, overtopping by conifers, and windthrow have contributed to the steady shrinking, or elimination, of stands across the district.

Restoration Efforts

Exclosures

In the late 1980s, district wildlife biologists became increasingly concerned with the loss of aspen habitat. They responded by building a number of livestock exclosures, constructed of native lodgepole pine, using a buck-and-pole design. The results were encouraging. Inside exclosures, suckers were released from browse pressure and exhibited rapid height growth (figure 1).

Believing that cattle grazing was the primary problem, the District experimented with the use of single-strand electric fencing. The fences were disassembled after cattle were removed from allotments in late September. This form of protection proved ineffective, indicating that aspen needed to be protected from native ungulates as well as cattle (Randy Fitzgerald, former District Range Conservationist, personal communication).

As a result, buck-and-pole fences evolved from an early 4-rail design to the current 6- or 7-rail design used today (figure 2). These fences are close to 7 feet tall and allow no more than 12 inches between rails, with no more than 8 inches between the ground and bottom rails. (Fence design specifications are available from the author at http://www.fs.fed.us/r6/uma/aspen.) This design has proved effective in deterring not only livestock but deer and elk as well. By contrast, it still allows smaller animals to move freely through the fenceline.

We recommend that exclosures be kept small—less than 0.5 acres is optimum, as animals tend to walk around small exclosures but often break down portions of large ones. We believe this happens most often during the winter when an animal would have to expend more energy walking through deep snow around the exclosure rather than through it.

Figure 1—Buck-and-pole livestock exclosure made from native lodgepole pine. Note the successful aspen regeneration inside the exclosure.

Figure 2—A large ungulate exclosure on Morsay Creek using the 6-rail design.

Prescribed Fire

Aspen often show a strong suckering response following prescribed or natural fires (Jones and DeByle 1985). In 1991, a prescribed fire was planned for a 20-acre stand of aspen that was heavily encroached upon by conifers. The conifers were felled the previous season to allow them to cure. The prescription aimed for a 60% kill of the aspen overstory. Leave trees were protected with heat-reflecting fire shelters and debris was pulled back from their bases. Ignition took place in the fall of 1991 because this area was too wet to burn in the spring. A positive suckering response was observed in 1992 followed by heavy herbivory that fall (Lea Baxter, District Silviculturist, personal communication). Within 2 years, nearly all of the suckers were eliminated. This indicated to us that aspen on the North Fork John Day Ranger District could not successfully regenerate without some form of protection from ungulate browsing.

Aspen Management Plan

In 1995, the members of a tri-forest Aspen Network met to discuss their successes and failures with aspen management. This group included biologists, silviculturists, range managers, reforestation technicians, botanists, and fire managers from the Malheur, Umatilla, and Wallowa-Whitman National Forests. They concluded that management plans were needed to focus aspen restoration efforts on individual districts.

The North Fork John Day Ranger District developed a plan that began by mapping and inventorying all stands and then using this information to prioritize stands for treatment (see figure 3). Accessible stands in the poorest condition were rated the highest priority for treatment. In addition to protecting existing stands, we are also interested in increasing their perimeters and establishing new sites. Monitoring the condition of all stands, as well as the success of applied treatments, is also of great importance.

Inventory results indicate that we have at least 300 small stands on the district. Clearly, not all these stands can be protected from loss, whether from natural decline, excessive browsing, or natural or prescribed fires. Therefore,

I. Inventory
- -mapping
- -surveys
- -database development

II. Protection
- -prioritize stands
- -construct exclosures

III. Enhancement
- -collect root segments for propagation
- -select sites for introduction of new stands
- -increase perimeters of existing stands
- -establish clone bank

IV. Monitoring

V. Education and Partnerships

Figure 3—The North Fork John Day Ranger District Aspen Management Plan.

another key element in the management plan is to establish a clone bank as a reservoir of genetic material. This will require collecting root sections from as many stands as is reasonable for propagation of containerized aspen. The containerized stock will be planted at the National Forest Native Hardwood Propagation Area in Clarno, Oregon.

Genetic Evaluation of Aspen Stands

Surveys of aspen stands across the district stimulated several questions about the historic distribution of aspen and relatedness of neighboring stands. In an attempt to answer some of these questions, we conducted a genetic study in 1997. Leaf samples taken from root suckers were randomly collected along linear transects within stands. However, clumps of aspen within a stand that appeared to be phenotypically unique were sampled even when it necessitated deviating from the transect. Samples were collected from 45 aspen stands within 20 drainages across the district. A total of 150 samples were sent to the National Forest Electrophoresis Laboratory in Placerville, California. These samples were prepared and analyzed following standard isozyme analysis procedures (Conkle et. al. 1982; Wendel and Wendel 1989). Samples were tested for genetic variation at 18 loci. The results are displayed in a series of dendrograms in figures 4–6.

For stands to be considered highly related, they need to have 94% of the sampled genes in common. The stands on the eastern portion of the district (figure 4) were not highly related. This was not surprising since most of these stands are isolated geographically. Stands that were located somewhat near to one another, such as Park Creek and Howard Creek, were found to share a larger proportion of genes in common.

Most of the aspen stands are situated on the western half of our district, referred to as the Western Route. Stands located within drainages on the

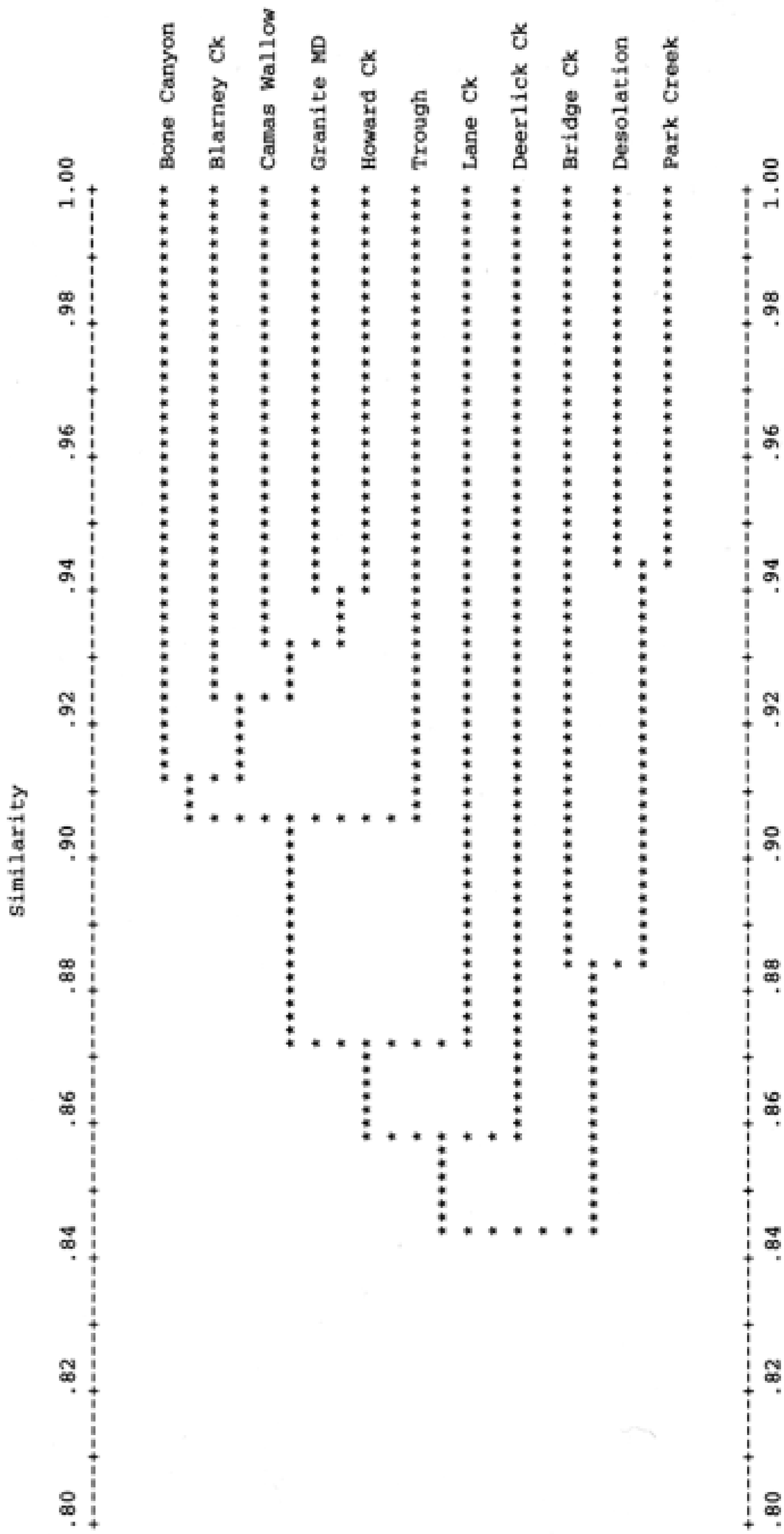

Figure 4—A dendrogram showing the results of isozyme analysis on aspen stands on the eastern half of the North Fork John Day Ranger District.

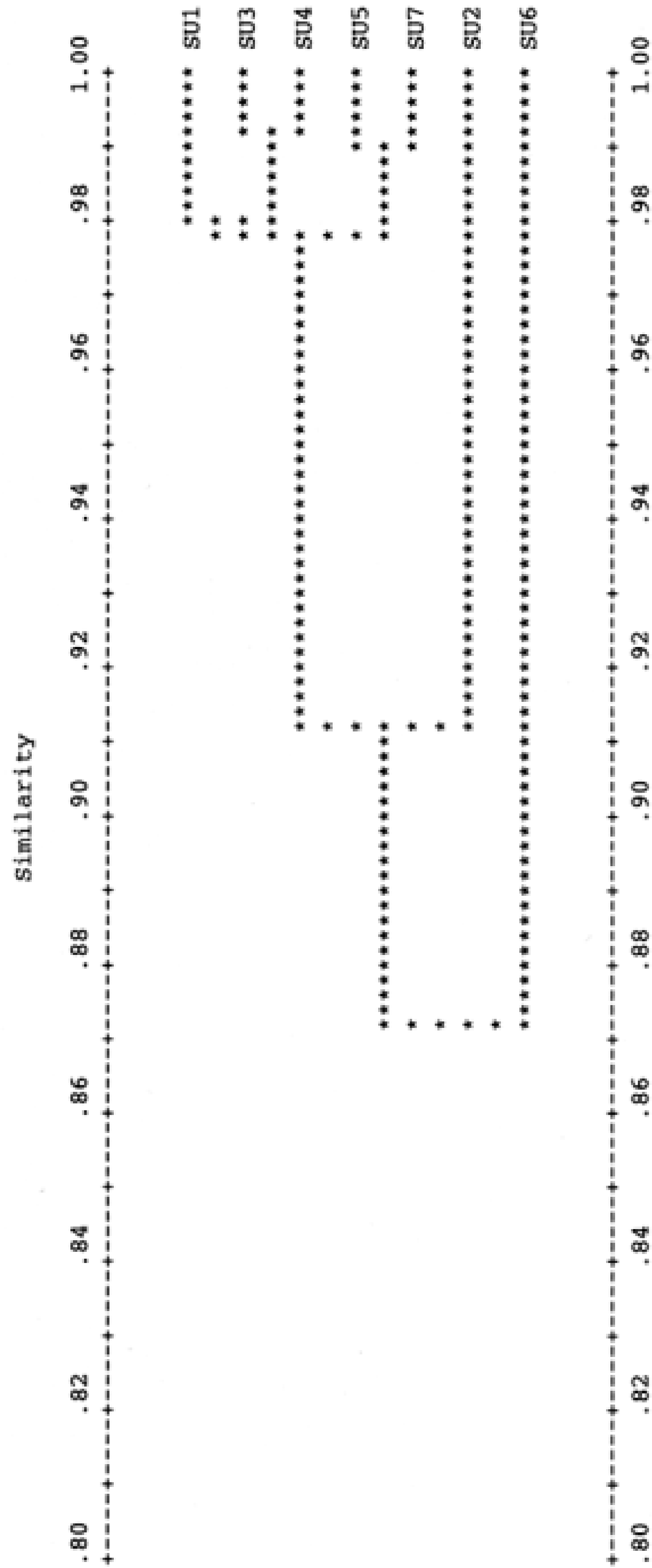

Figure 5—A dendrogram showing the results of isozyme analysis on aspen stands sampled along Sugarbowl Creek.

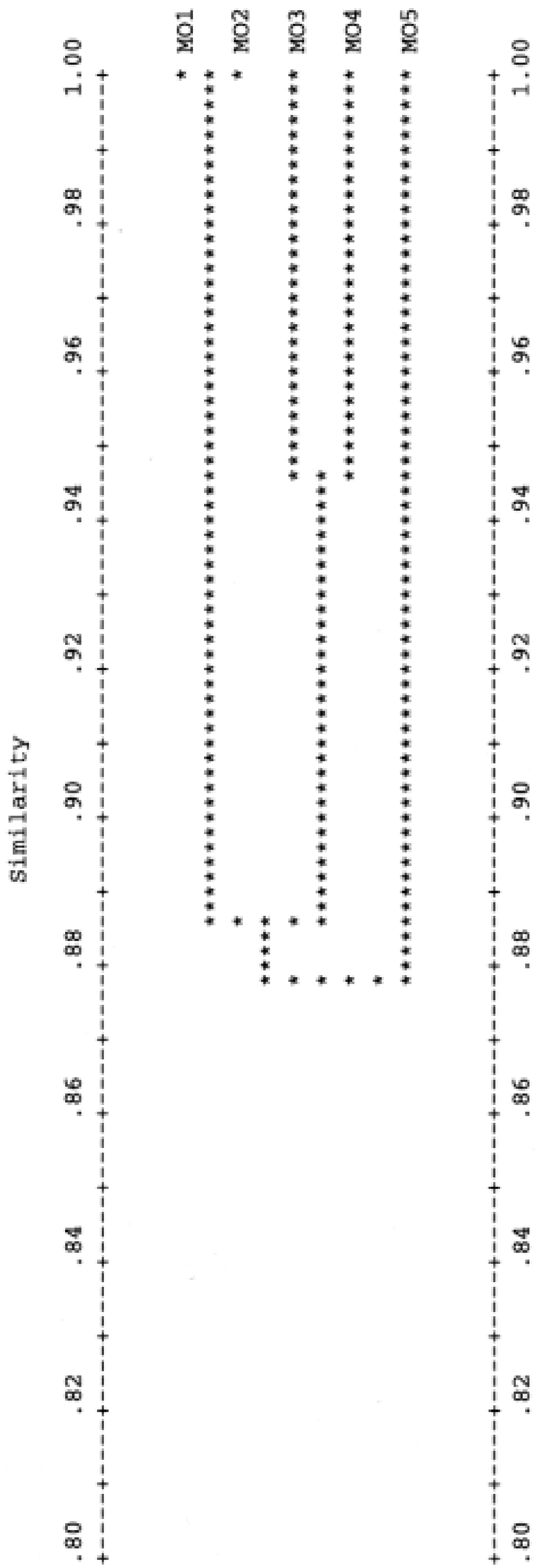

Figure 6—A dendrogram showing the results of isozyme analysis on aspen stands sampled along Morsay Creek.

Western Route generally showed a high degree of relatedness. In the Sugarbowl drainage, several stands were tightly clustered (figure 5). Sugarbowl aspen stands 1–4 (SU1-SU4), although not genetically identical, shared more than 94% of the genes sampled. This suggests that these stands are strongly related and may have sprouted from seed during the same establishment event. By contrast, SU6 was highly unique. Managers can use this information to allocate limited resources to protecting those stands that will maximize genetic diversity across the landscape.

Figure 6 illustrates the relatedness of stands in the Morsay drainage. Of notable interest is that Morsay 1 (MO1) and Morsay 2 (MO2) shared 100% of their sampled genes, indicating that these stands are, in fact, the same clone. Looking at a map of the Morsay drainage (figure 7), one can see that the clone consists of four fragmented stands. This suggests that at one time, these stands comprised one very large clone, derived from an extensive root system. This is probably an ancient clone, existing perhaps for thousands of years, with high reproductive success and the potential to be a reservoir for somatic mutations (Tuskan et al. 1996). This would also be a stand prioritized for restoration efforts. However, one could protect only one of the four stands sampled and still protect the genetic material contained within all.

While most stands proved to be a single clone, numerous stands contained multiple clones, adding a level of diversity we had not expected to find.

Isozyme analysis was found to be a useful tool for determining both landscape distribution patterns and relatedness of aspen. The analysis is also useful for assisting a manager in allocating resources for preserving genetic diversity.

Aspen Propagation

In 1998, the district began efforts to artificially regenerate aspen. In the fall of 1998, root segments 0.5 to 1.0 inch in diameter were collected from dormant

Figure 7—A map of the aspen stands sampled along Morsay Creek. Stands that are related are displayed in the same color.

aspen and sent to the J. Herbert Stone Nursery in Medford, Oregon. Root segments were washed in a large tub containing a 10% alcohol solution, wrapped in Kimwipes, and stored under refrigeration (Johann Visser, Culturist, personal communication). In February 1999, root segments were placed in wooden containers measuring 2 feet x 3 feet x 6 inches. Drainage holes were drilled into the base of the containers. The containers were then filled with a 1-inch layer of pure perlite, followed by a 3- to 4-inch layer comprised of 40% peat, 40% vermiculite, and 20% perlite. Root segments were placed on top of the latter layer and covered with approximately a quarter-inch of the same. The containers were placed in a greenhouse maintained at 70 to 75 °F. Sprouting took place within 10 days to 2 weeks. As root suckers emerged, they were excised, dipped in a commercial rooting enhancer containing IBA (indole butyric acid), and placed in individual D-40 (40 cubic inches) containers or in 1-gallon pots. These were grown in a mist chamber under a 24-hour photoperiod (during the day a layer of shade cloth was placed over the chamber to reduce sunlight by 50%), at 90% relative humidity and 78 °F. Suckers were fertilized with a solution containing a 21-5-20 formulation of nitrogen, phosphorous, and potash and trace amounts of micronutrients. When suckers appeared to be growing vigorously, they were placed in a greenhouse and grown for 2–3 weeks, or until approximately 10 inches tall. After the danger of hard frosts had passed, containers were moved outside for the remainder of the growing season. Once suckers had completely hardened off and entered dormancy in late fall, containers were moved into freezer storage until they were needed for outplanting the following spring.

In May 2000, the containerized aspen were planted in three types of locations: (1) in unoccupied portions of aspen exclosures to increase the perimeter of the existing stand, (2) between existing aspen stands within a drainage to encourage connectivity, or (3) where no aspen stands were known to previously exist. For the most part, a given genotype was planted back into the same drainage from which it was collected. However, some areas were planted with a mix of clones from neighboring drainages to increase diversity as well as the potential for sexual reproduction.

Sugarbowl Creek Aspen Restoration Project

The Sugarbowl drainage contains a string of remnant stands of aspen as well as the skeletons of former stands, noted by down or standing dead aspen trees. Sugarbowl Creek is heavily degraded by livestock use. Stream banks are severely eroded and support few native hardwoods or aquatic plants. The Sugarbowl Creek Aspen Restoration project has two objectives: (1) restore aspen stands to improve wildlife habitat and (2) improve stream bank stabilization. Several management strategies are in place to achieve these ends (figure 8). First, a series of exclosures were built to protect existing stands. The fences were constructed of lodgepole pine using the buck-and-pole design or with black plastic deer-deterrent fencing. The latter is attached to existing lodgepole pine, used as living fenceposts, wherever possible. Competing conifers have been felled and piled, or lopped and scattered, within protected aspen stands. Burning these felled conifers may encourage root suckering (Maini and Horton 1966), however, it is not our intention to kill the overstory aspen. Between existing stands, aspen has been interplanted to encourage connectivity (stands identified as “IP” in figure 8). Buck-and-pole fences were constructed around these new sites during the summer of 2000. Root ripping in stands that are reluctant to sucker may also be attempted.

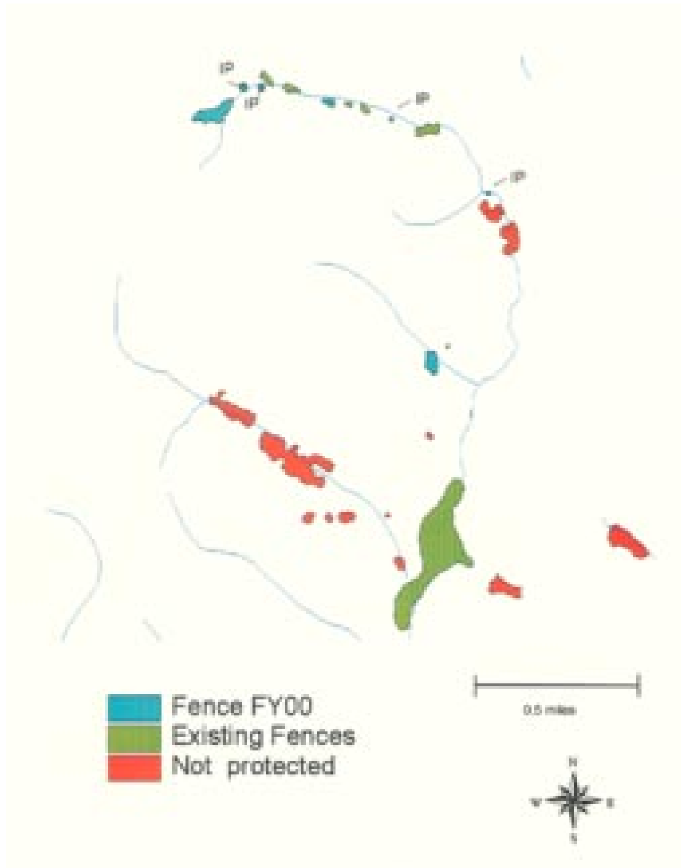

Figure 8—A map of the stands in the Sugarbowl Creek Aspen Restoration Project. Stands labeled with "IP" are areas interplanted with containerized aspen in May 2000 and fenced in July 2000.

Desolation Watershed Aspen Restoration Project

The Desolation Watershed Aspen Restoration project involves protection of existing stands as well as the establishment of aspen on a new site. In 1996, the Bull Fire burned a portion of the Skinner Creek drainage (figure 9). This drainage contained no stands of mature aspen. We postulated that if the aspen stands in surrounding areas were producing seed, the Skinner Creek drainage would be an ideal area for colonization of new aspen stands. In 1998, we selected a site for establishing a new stand using artificial regeneration. While laying out the proposed fence corridor, we actually located two new aspen seedlings within the selected site. Careful excavation of the root systems revealed that these seedlings were not attached to a pre-existing aspen root. This confirmed our theory that aspen seed would drift into this area following a fire.

Root segments were collected from the surrounding stands in Howard Creek and Bull Prairie in October 1998. These were used for the propagation of containerized aspen. In the fall of 1999, a buck-and-pole fence was constructed on the site on Skinner Creek (figure 10). In the spring of 2000, containerized aspen were planted inside of the exclosure. The success of this project will be closely monitored.

Natural Refugia

During the stand inventory process, it was noted that, on occasion, suckers grew into larger size classes whenever they could escape herbivory. Stands adjacent to heavily trafficked roads were often avoided by elk and, in these locations, clumps of sapling-sized aspen were observed. Areas of natural refugia include rock outcrops, piles of fallen trees, or jackstraw. This has also been observed by Ripple and Larsen (in press) in Yellowstone National Park.

Figure 9—A map showing the aspen stands in the Desolation Watershed and the area burned by the 1996 Bull Fire. The location of the Skinner Creek aspen establishment site is highlighted in green.

In areas with difficult access, or where funds are lacking for fencing projects, we have attempted to simulate natural refugia by placing jackstrawed debris around existing aspen suckers. In a stand on Thompson Creek, we felled several conifers, at a stump height of 3.5 to 4.0 feet, leaving a hinge of holding wood to hang up the butt end of the tree. Wherever possible, we would fell four trees to form a box around the selected sucker. These resulting areas of jackstraw

Figure 10—The Skinner Creek exclosure located within the Bull Fire perimeter.

presented an obstacle approximately 6 to 12 feet on a side and 4 to 5 feet in height. In our experience, animals moving through a stand generally avoid small areas of jackstraw. This is not the case for extensive areas of jackstraw, which cannot be as easily avoided. In fact, large areas of jackstraw often attract large native ungulates, as they can provide desirable security habitat.

Conclusions

Without some sort of human intervention, aspen will quickly disappear from the landscape in the Blue Mountains of northeast Oregon. A number of techniques are available to the land manager to protect and enhance existing stands of aspen. However, they provide a "Band-Aid" approach to treating symptoms of a much larger, ecosystem-scale problem. The situation is much graver than merely the loss of aspen habitat. In fact, we are losing all of our native hardwoods from the landscape including black cottonwood (*Populus balsamifera*), mountain mahogany (*Cercocarpus ledifolius*), bitterbrush (*Purshia tridentata*), a multitude of willows (*Salix* spp.), and other woody vegetation.

Landscape-scale solutions are necessary. These include the reintroduction of fire, the careful management of livestock grazing within aspen stands, and a reduction in herd sizes of native ungulates. Not only are these solutions costly in economic terms, they are also politically sensitive issues.

It has been well established by the scientific community that wildfire is a natural and necessary part of ecosystem cycles (Agee 1993; Caraher et al. 1992; Gast et al. 1991; Powell 2000). The repercussions of the Yellowstone National Park (1988) and Los Alamos (2000) fires, however, are still with us. We can never guarantee the public that our prescribed fires, or the natural fires that we allow to burn, will not escape proposed control lines and threaten the public domain. Yet fire is a vital component in most ecosystem restoration plans.

Likewise, the sale of game tags provides an important source of revenue to state wildlife programs. People enjoy seeing abundant wildlife, especially deer and elk, when they recreate on public lands. Hunters desire successful hunts and prefer to bag trophy-size animals. There will always be tremendous opposition to restricting hunts or significantly reducing herd sizes.

The bottom line is that effective ecosystem restoration comes with a hefty price tag. Is society willing to pay that price?

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