Aspen Response to Prescribed Fire, Mechanical Treatments, and Ungulate Herbivory

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Abstract—Land management agencies in northwestern Wyoming have implemented vegetation treatment programs to stimulate aspen (Populus tremuloides) regeneration. Treated clones are susceptible to extensive browsing from elk (Cervus elaphus) concentrated on adjacent supplemental feedgrounds, wintering moose (Alces alces shirasi), and livestock. We sampled eight treated (mechanical cutting and prescribed fire) aspen clones (stands) to determine treatment response 3-9 years post-treatment. A sampling design was tested for monitoring pre- and post-treatment stem densities. Total aspen sucker densities ranged from 3,480 to 29,688 stems/acre (8,600 to 73,360 stems/ha). Two 9-year-old treatments and one 7-year-old treatment achieved > 1,000 stems > 10 ft in height/acre (> 2,710 stems > 3.1 m/ha), the objective for successful clone reestablishment. Mean annual leader growth was 7.2 inches (18.3 cm) and ranged from 4.9 to 12.9 inches (12.4 to 32.8 cm). Treated clones are all expected to reestablish successfully. Stem density, clone homogeneity, and plot size influenced sampling efficiency.

Introduction

Aspen (Populus tremuloides) is found throughout Wyoming’s major mountain ranges. The larger stands occur in the Sierra Madre, Wind River, and Gros Ventre mountain ranges (Merrill et al. 1996). Total acreage in Wyoming is estimated at 338,000 acres (Green and Van Hooser 1983). However, it is also estimated the historical acreage (100–150 years previous) was at least double the present. The successional replacement of aspen with conifers, shrubs and herbaceous vegetation continues today (Debyle and Winokur 1985; Bartos and Campbell 1998). Factors contributing to aspen decline and lack of regeneration include fire suppression, livestock grazing, wild ungulate browsing, and natural succession (Krebill 1972; Bartos and Campbell 1998; Gruell and Loope 1974; Meuggler 1989; Romme et al. 1995).

Aspen communities are recognized for their multiple values, including recreation, scenic vistas, water yield, water quality, wood products, habitat for an array of wildlife species, forage for wild and domestic ungulates, and landscape diversity (Bartos and Campbell 1998; Debyle and Winokur 1985). A minimum of 140 mammal and bird species utilize aspen habitat types in Wyoming (Dieni and Anderson 1997). The decline of aspen communities in the West, and throughout the state of Wyoming, is a concern for ecologists and resource managers. Recently, fire managers have also become concerned with the loss of the “asbestos forest type” (Fechner and Barrows 1976). Healthy aspen stands provide natural firebreaks which reduce fire intensity and severity, allowing fire managers additional control options.

Successful aspen regeneration in the West occurs almost exclusively through vegetative propagation (Debyle and Winokur 1985). Reproduction is clonal.

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in nature (Barnes 1966) and generally enhanced with disturbances that kill overstory trees and preclude auxin transfer to the roots, thus stimulating suckering (Deyle and Winokur 1985). Management activities that kill or stress overstory trees (e.g., prescribed burning, clear-cutting, herbicide treatments) mimic natural disturbances and enhance aspen regeneration.

The appropriateness of implementing such management actions in areas of intense ungulate herbivory has been questioned. Aspen enhancement projects located near supplemental elk feeding sites (feedgrounds) in northwest Wyoming have resulted in varying levels of success. Krebill (1972) concluded that natural aspen recruitment of 653 stems/acre (1,614 stems/ha) in the Gros Ventre was not sufficient to replace overstory mortality given impacts from herbivory. Hart (2000) re-examined aspen stands evaluated by Krebill and concluded that “herbivory and disease, superimposed on successional events, may be exerting negative effects on the distribution of aspen.” Bartos et al. (1994) concluded that a prescribed burn treatment of aspen near elk (Cervus elaphus) feedgrounds in the Gros Ventre drainage may have hastened the demise of decadent aspen clones. However, other prescribed burns in the same area that lacked intense herbivory were successful (Bartos et al. 1991). Dieni et al. (2000) concluded that aspen regeneration through clear-cutting on the U.S. Fish and Wildlife Service’s National Elk Refuge may have hastened their demise as a result of excessive elk herbivory. Kilpatrick and Abendroth (2000) emphasize aspen treatment site selection. They suggest the following factors, alone or in combination, may contribute to outcome following aspen treatment: site aspect, site distance from concentrations of wintering ungulates and elk feedgrounds, supplemental elk feeding regime, aspen community type, stand vigor, soil type, fire intensity/severity, and level of human disturbance to wildlife.

In this current study, our primary objective was to quantify aspen regeneration post-treatment (mechanical clearing and prescribed burn) at two different areas in northwest Wyoming. Eight post-treatment sites were sampled within the two areas. Both areas are near supplemental elk feedgrounds where herbivory levels could potentially impede aspen regeneration. A secondary objective was to test the accuracy and efficiency of our aspen sampling methodology.

Study Area

This study deals with aspen sampling at eight post-treatment and five pre-treatment sites located south and east of Jackson, Wyoming (tables 1 and 3).

Two post-treatment sites were sampled at the Bryon Flats area located on the Bridger-Teton National Forest approximately 6 miles (9.6 km) southeast of Hoback Junction, Wyoming. Sites are on the east side of Willow Creek, a tributary of the Hoback River. One site was clear-cut in 1994 and the other prescribed burned during the fall of 1995. General treatment goals were to reduce conifer densities, promote aspen suckering, and set back succession. The Wyoming Game & Fish Department operates the Camp Creek supplemental elk feedground approximately 2 miles northwest of the treated sites where 600-1000 elk are fed baled hay during the winter months (December – April). A relatively small moose (Alces alces shiras) population utilized the area rear-round. Mule deer (Odocoileus hemionus) utilized the area during the spring – fall. The sites also received summer cattle grazing.

Six post-treatment aspen sites were sampled during 2000 at the Soda Lake site, approximately 7 miles (11.3 km) north of Pinedale, Wyoming.
Wyoming Game and Fish Department operates an elk supplemental feedground near Soda Lake. Approximately 800-1,000 elk were historically fed on the north side of Soda Lake until 1993, 1-2 miles (1.6-3.2 km) from the monitored sites. After 1993 the feeding site was relocated south of Soda Lake, which extended the distance to the sampled sites 2-4 miles (3.2-6.4 km). Moose utilized the area year-round and mule deer inhabited the area during spring and fall.

Five pre-treatment aspen sites were sampled during 2001, at the Fremont/Pinyon Ridge site near Pinedale. Two of the sites were located on the north end of Fremont Ridge, approximately 7 miles (11.3 km) north of Pinedale. The remaining three sites were located on Pinyon Ridge, approximately 35 miles (56 km) north of Pinedale.

Methods

A pilot sampling methodology was utilized to evaluate efficiency in acquiring sufficient samples to provide sucker density data sets with 80% confidence and 20% error. These statistical parameters were recommended to land managers for monitoring the success of treatments designed to enhance aspen regeneration (Winward et al. 2000). In addition to density, height and annual leader growth also were monitored. Sampling steps for our study reported here were (see also figure 1):

- Randomly establish a permanent photo point with a 5 ft steel post near the center of the clone/stand. Record GPS coordinates.
- Take photos in the four cardinal directions.
- Select a random azimuth from the permanent photo point.
- Select a random pace distance.
Select circular plot size. Recommend 1/50 to 1/100 acre (1/124-1/247 ha) for pre-treatment mature tree densities estimated at 150-250 trees/acre (370-618 trees/ha). Recommend 1/100-1/500 acre (1/247-1/1,236 ha) plot size for post-treatment densities of 4,000-15,000 stems/acre, (9,884-37,065 stems/ha) respectively. Also, increase the plot size with increased stand/clone heterogeneity.

Proceed along random azimuth from permanent photo point sampling plots at the random pace intervals. Record within plots: (a) height of stems by 1 ft class (e.g., <1, 1-2, ...>10)/plot, (b) number of stems/plot, (c) annual leader growth on two to three dominant leaders of random suckers/plot.

Stop proceeding along random azimuth when a different community type or ecotone is encountered.

Select a new random azimuth that intercepts the stand/clone, and select a new random pace.

Continue the above procedure until the required sample size and statistical reliability is achieved using the following formula (e.g., 80% reliability with 20% error).

\[ N = \left( \frac{t}{2} \right)^2 \times \frac{s^2}{(P \times M)^2} \]

- \( N \) = required sample size
- \( t \) = t table value for desired confidence level (e.g., 80%, 90\% C.I.)
- \( s \) = standard deviation
- \( P \) = percent error (e.g., 20\% = 0.20)
- \( M \) = mean # stems/plot

Bartos and Winward (2000) recommend the following post-treatment conditions for successful aspen clone reestablishment: >1,000 stems/acre (2,471 stems/ha), >10 ft (3.1 m) in height within 10 years post-treatment. They also suggest mean sucker height should increase by 1-ft/year (0.31 m/year).
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post-treatment. The above recommendations were transformed into objectives for our aspen treatments.

Areas of mixed-aged aspen and conifers selected for this study were considered to be “at risk” as described by Bartos and Campbell (1998) and were sampled with the above detailed procedure.

Results

Three of the treated sites, SLSCBurn, SLEXBurn, and WCCut, achieved means of >1,000 stems >10 ft in height/acre (>2,471 >3.1 m stems/ha) (figure 2). The fall 1991 Soda Lake Spring Creek prescribed burn (2,200 >10 ft stems/acre; 10,100 mean total stems/acre; figures 2 and 3) was located at the highest elevation and greatest distance from the Soda Lake elk supplemental feedground near Pinedale, Wyoming. Elk herbivory appears to be light during fall and early winter when elk are migrating through the site towards the feedground. Snow depths and human disturbance (winter recreation) are suspected to preclude heavier elk herbivory levels. Cattle use of this site is also considered to be light or moderate during the growing season.

Figure 2—Mean and one standard deviation for stem densities of aspen suckers >10 ft in height at time of sampling.

Figure 3—Mean total aspen stems per acre by treatment. Error bars indicate P = .8 confidence interval.
The fall 1991 Soda Lake exclosure prescribed burn (SLEXBurn), located near Pinedale, Wyoming, was the second site appearing to meet the regeneration objectives (figure 2). It is situated at a lower elevation than the above site and is adjacent to the boundary between the Wyoming Game and Fish Department and the USFS. The 8-ft fence surrounding the exclosure was elk and livestock-proof, excluding all herbivory. Mean stems >10 ft (3.1 m) in height and mean total stems were 1,760 and 10,133 stems/acre (4,349 and 25,038 stems/ha) respectively.

The third site having greater mean sucker density and height was the Willow Creek mechanical cutting treatment (WCCut), located near Jackson, Wyoming. It received light wild ungulate herbivory despite being within 2 miles (3.2 km) of a supplemental feedground. Possible reasons for the light herbivory use were location of the site away from a major elk migration route to the Camp Creek supplemental elk feedground and human disturbance from winter recreation. Moose are thought to be responsible for most of the herbivory occurring on the site. Moose are more tolerant of human disturbance than elk and their droppings were evident at the site. Mean total aspen stems and those >10 ft in height were 4,480 and 1,700 stems/acre (11,070 and 4,200 stems/ha) respectively (figures 2 and 3).

The remainder of the treatments with >7 growing seasons had total mean sucker densities ranging from 4,039 to 6,367 stems/acre (9,980-75,732 stems/ha). The Burnt Lake Forest Service mechanical cutting site had 29,688 stems/acre (73,359 stems/ha) after its third growing season. All densities were within the 850-19,951 stems/acre (2,100-49,300 stems/ha) reported by others (Bartos et al. 1994; Patton and Avant 1970; Brown and DeByle 1987; Brown and DeByle 1989; Bartos et al. 1991; Kilpatrick and Abendroth 2000).

The median height class of aspen suckers nine years post-treatment ranged from 4-5 ft (1.2-1.5 m) to 5-6 ft (1.5-1.8 m) (figure 5). The median height classes for the Willow Creek burn (six years post-treatment) and mechanical cutting (seven years post-treatment) were 5-6 ft (1.5-1.8 m) and 6-7 ft (1.8-2.2 m) respectively. Median height class for the Burnt Lake mechanical cutting was 1-2 ft (0.3-0.6 m), three years post-treatment.

Current annual growth of dominant leaders did not meet the management objective of 12 inches/ year (30.5 cm/year). Mean annual leader growth rate ranged from 4.9-12.9 inches (12.4-32.8 cm) and averaged 7.2 inches (18.3 cm) across all treatments (figure 4). Bartos et al. (1991) documented similar results with average sucker heights increasing 0.8-8.6 inches/year (2.0-22.0 cm/yr) on burned sites near Jackson, Wyoming.

The pre- and post-treatment sample size required to meet the statistical objective of 80% confidence ± 20% error ranged from 15-29 and 5-57 plots, respectively (tables 2 and 3). Stem density, homogeneity of the sampled clone/stand, and plot size influenced the minimum sample size.

Figure 4—Current annual growth of dominant aspen leaders by treatment site (black bars). Blue bars represent the mean.
Figure 5—Height of aspen suckers 3-9 years post-treatment at eight different sites in Wyoming.
Successful management-induced aspen regeneration is quite variable within some areas of the West. Resource managers have attempted to enhance aspen regeneration in northwestern Wyoming since the early 1970s. Many factors such as clone vigor, community type, fire intensity/severity, herbivory by wild and domestic ungulates, aspect, elevation, soil type, and moisture regimes have influenced their success. In northwest Wyoming, 25,000 elk are fed supplemental winter rations at 23 different locations. Thus, elk herbivory alone can significantly influence aspen regeneration near these feeding locations. In some areas, successful regeneration cannot be accomplished without clone or stand protection with fencing. Other aspen treatment sites, such as the ones monitored in this study, appear to have promise. Continued monitoring, short and long-term, will help managers identify factors influencing the success of treatments and make appropriate adjustments.

Two of the nine-year (SLSCBurn, SLEXBurn) and one of the seven-year (WCCut) post-treatment sites appear as though they are approaching 10-year post-treatment regeneration objectives. Three of the nine-year post-treatment sites (SLFSBurn, SLGFBurn, SLGFCut) may take longer than 10 years to reach proposed objectives of >1,000 >10 ft stems/acre (>2,710 stems >3.1 m/ha). The six-year (WCBurn) and three-year (BLCut) post treatment sites appear to be regenerating successfully but will need continued monitoring prior to making conclusions. All eight treated sites have maintained more than adequate sucker densities for successful clone reestablishment.

Dominant leader growth was only slightly more than half of the management objective. Severe drought conditions during 2000 and 2001 may have resulted in reduced leader growth. Few clones appear to be averaging 1 ft growth per year despite light to moderate ungulate herbivory. Continued monitoring over the next two to four years is recommended to further assess drought effects and evaluate management objectives for successful clone reestablishment.

Both wild and domestic herbivory continue to be an important factor in clone reestablishment. Three of the sites sampled (SLEXBurn, SLGBurn, and SLFSBurn), were close to each other but received different levels of herbivory. The SLEXBurn was fenced and received no wild or domestic ungulate herbivory. It had the greatest sucker stem density and height of the three sites. The SLGBurn received only wild ungulate herbivory and was intermediate in density and height. Moving the Soda Lake supplemental elk feedground an additional 1.5 miles (2.4 km) from this treatment site in 1993 appears to have reduced elk herbivory levels on aspen. The SLFSBurn received both domestic

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and wild ungulate herbivory and had the lowest relative density and sucker height.

Developing an efficient, repeatable, and statistically reliable sampling methodology is important for evaluation of aspen regeneration efforts. The methodology developed in this study to monitor aspen density and height within pre- and post-treatment sites worked well. However, for non-randomly distributed individuals, frequency and density estimates are affected by plot size (Bonham 1989), and an alternative would be to adopt a standard plot size and vary the number of plots to address heterogeneity in particular stands. Also, we will in the future not vary the pace length of each random transect segment since this varies the sampling intensity in different parts of the stand, but instead maintain a uniform pace length. Development of a photo key for estimating pre- and post-treatment stem densities would help in selecting an appropriate plot size for each stand.

References


