Results

Campbell and Bartos (2001) recommended that actions for aspen ecosystem restoration should be large to help disperse ungulate pressures regardless of species. Generally, the hypothesis is that if herbivory is a significant problem, then sites with wildlife exclosures would reflect the potential number of stems per acre that a site could produce, and that those stems would likely be taller than unfenced or cattle excluded sites adjacent to the exclude-everything (control) sites, since they would not have been browsed down. Additionally, cattle excluded areas would reflect only herbivory from wildlife. Further, if wildlife utilization is too high or dense over an area, then unfenced areas would be at highest risk, because the stems found there would be subject to herbivory from wildlife and cattle.

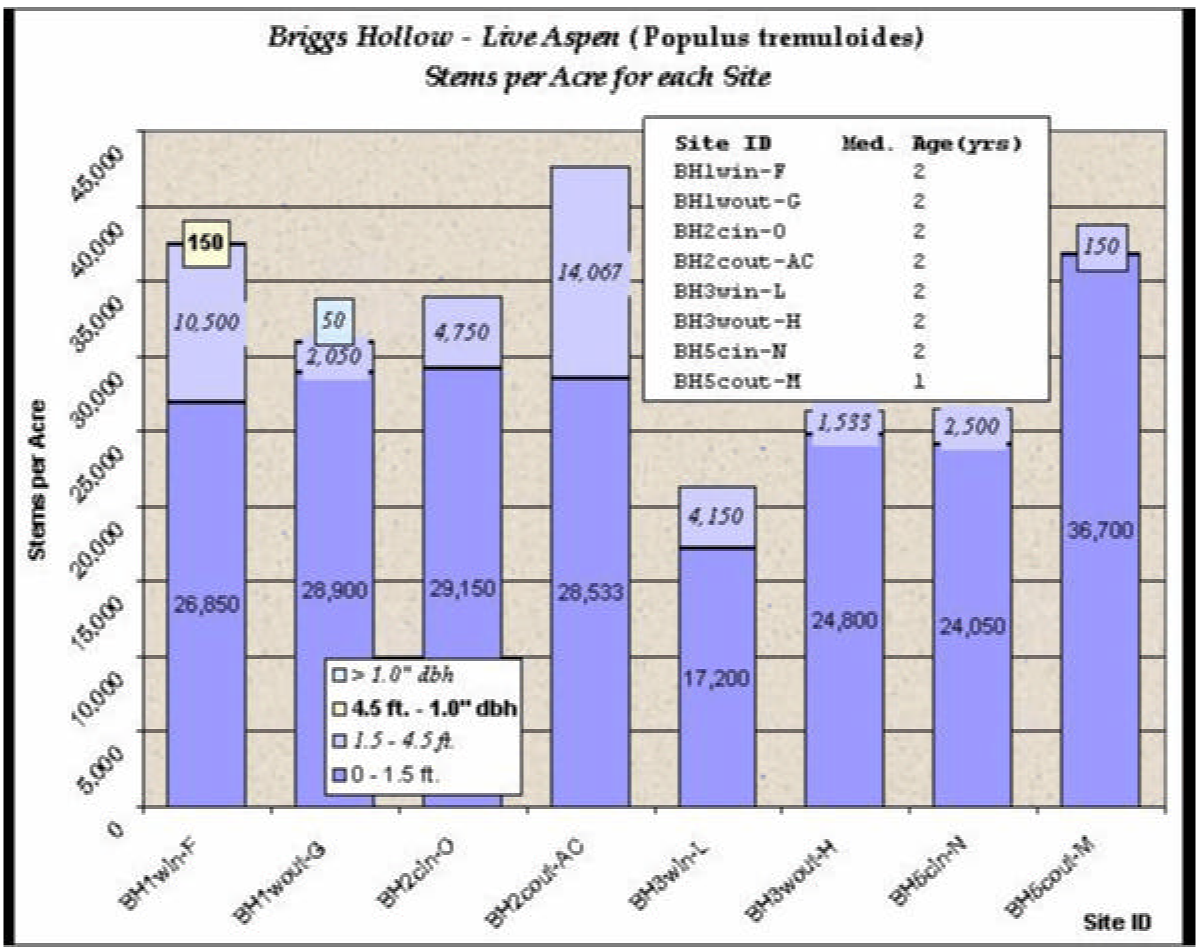
The mean number of stems per acre, percent damage by type, and the mean height of the dominant (tallest) stem per plot were calculated for each site using a commercially available spreadsheet, and then the results were graphed. Next, a variety of additional statistics were calculated using Systat 7.0 for Windows. These statistics include range, median, mean, standard error, standard deviation, variance, and two-sample t-tests. All t-tests reported in this text were two-sample t-tests, and will be referred to as t-tests for brevity. Prior to running the t-tests, significance was arbitrarily set at $P = 0.05$, or a 95% confidence interval. All statistical tests can be found in Appendix C.

Fishlake Plateau Subsection

Briggs Hollow

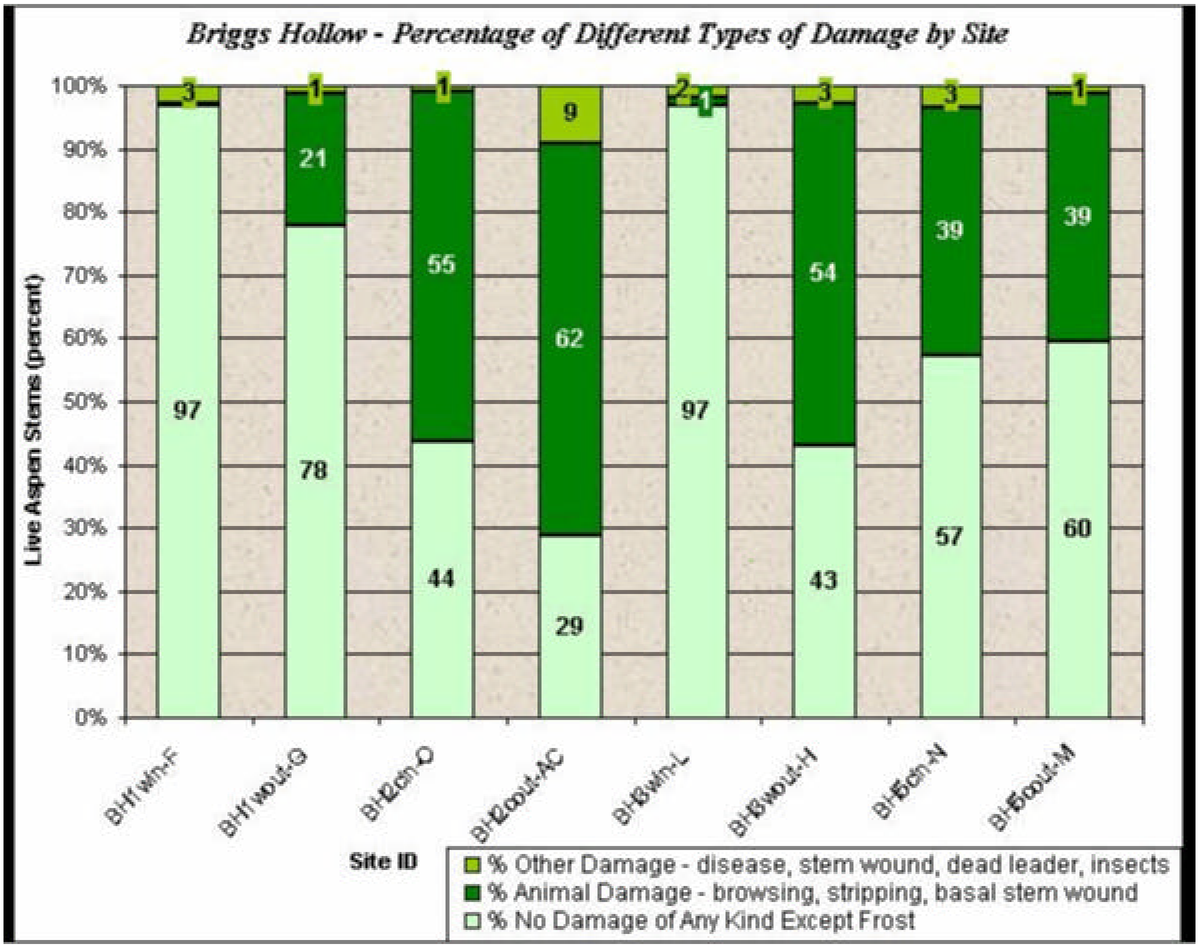
The four Briggs Hollow units sampled produced between 21,350 (BH3win-L) and 42,600 (BH2cout-AC) stems per acre. Since all units were treated in the winter through spring of 2000, all units had median ages of two years except, Briggs Hollow unit 5 (BH5cout-M). As can be seen in Figure 13, all sites had the largest number of stems in the smallest size class (0 to 1.5 ft or 45 cm). Additionally, the number of stems per acre did not follow what one would expect, if herbivory were impacting the regeneration. Only one unit, Briggs Hollow unit 1 (BH1win-F, BH1wout-G), shows what would be expected. However, when t-tests were run for each of the paired (inside/outside) sample sites, none of them was found to have significantly more stems inside the exclosures than outside.

Figure 13 - Briggs Hollow - Live Aspen Stems Per Acre



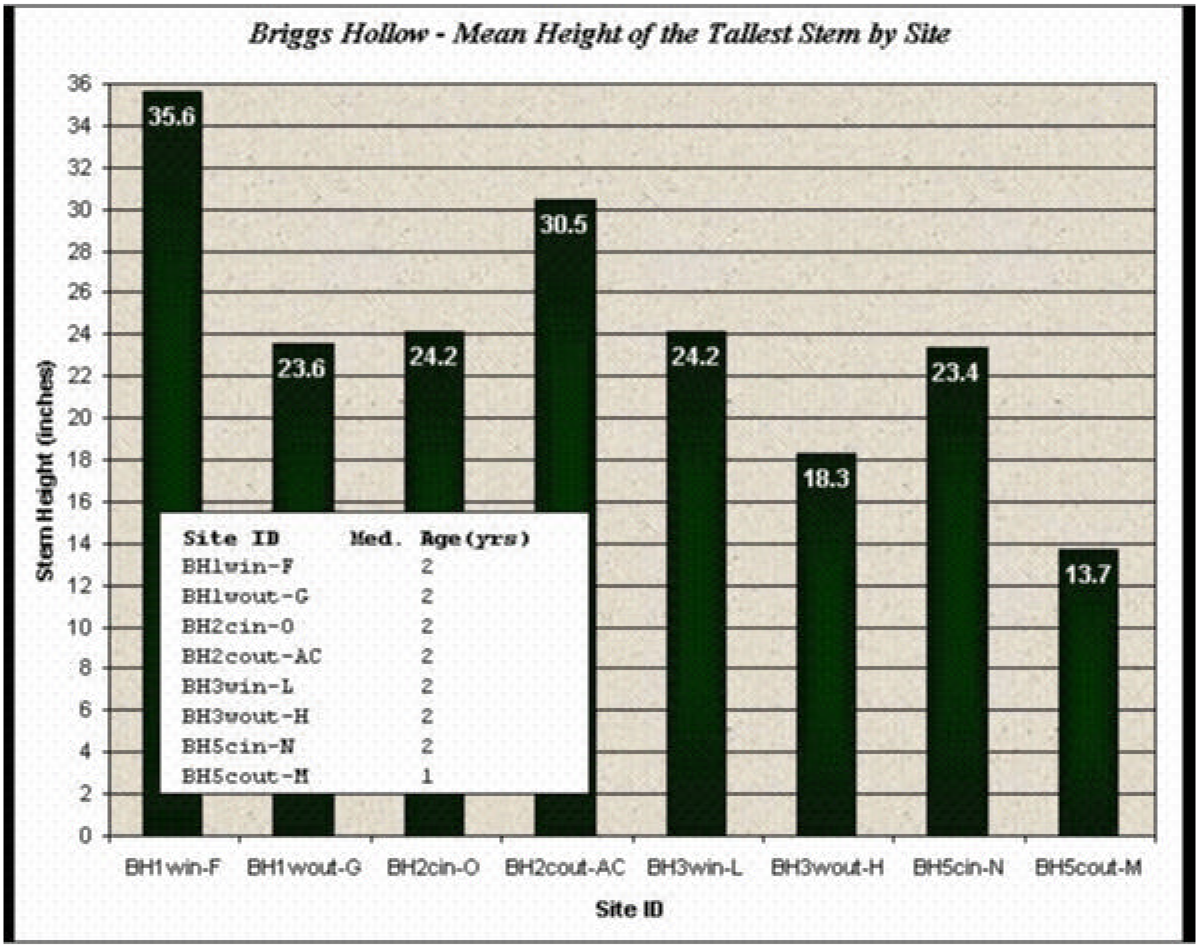
According to Figure 14, the percentages of the three damage classes do follow what one would expect, with the exception of Briggs Hollow unit 5 (BH5cin-N, BH5cout-M), which doesn't show much difference.

Figure 14 - Briggs Hollow - Damage Class Percentages



For each site means of the tallest (dominant) aspen stem found in each plot were calculated, then t-tests were used to compare inside and outside the exclosures for each harvest unit. With the exception of Briggs Hollow unit 2 (BH2cin-O, BH2cout-AC), all stems located inside exclosures were significantly taller than those outside. However all t-tests showed that there were significant differences in mean dominant stem heights between inside and outside the exclosures (P<0.0228).

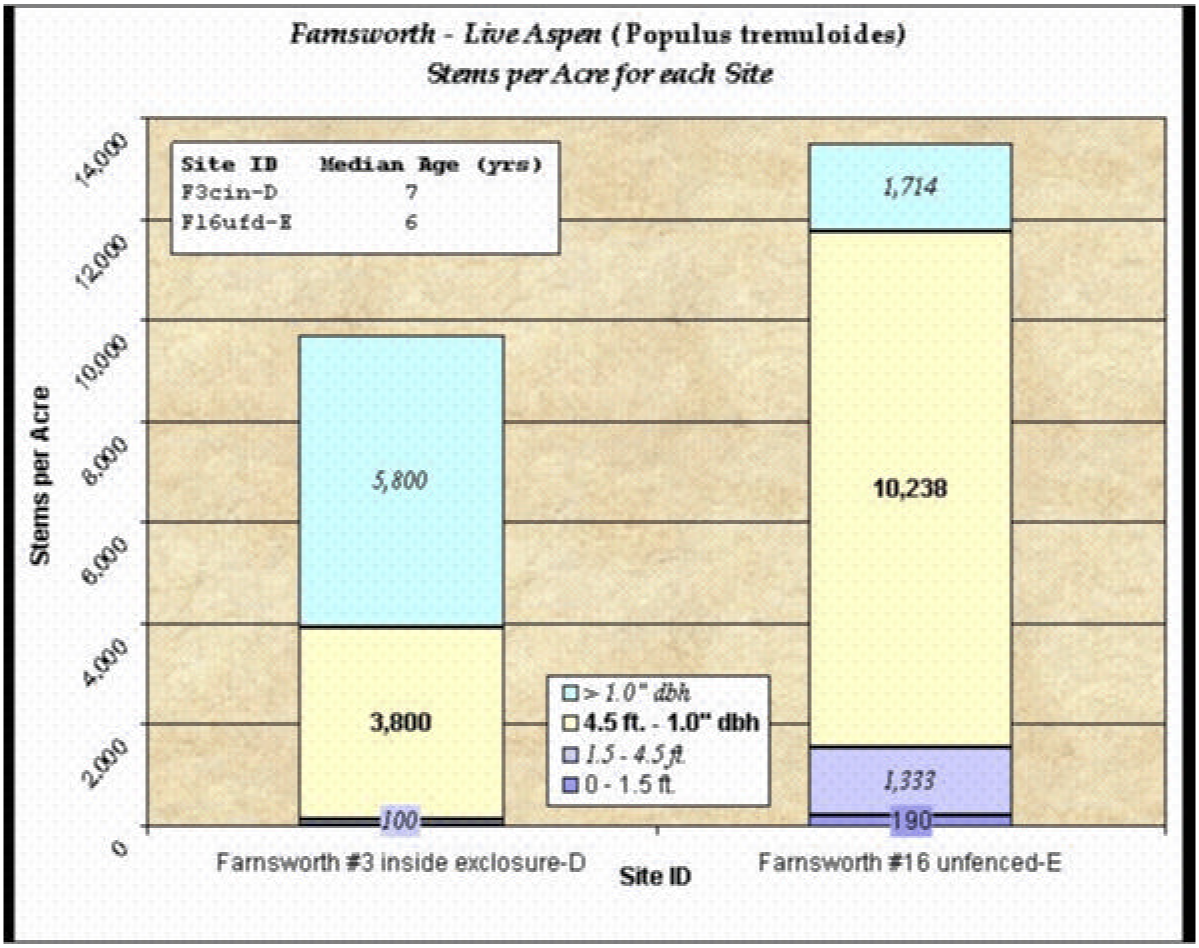
Figure 15 - Briggs Hollow - Mean Stem Height of the Dominant Aspen Stem in Each Plot



Farnsworth

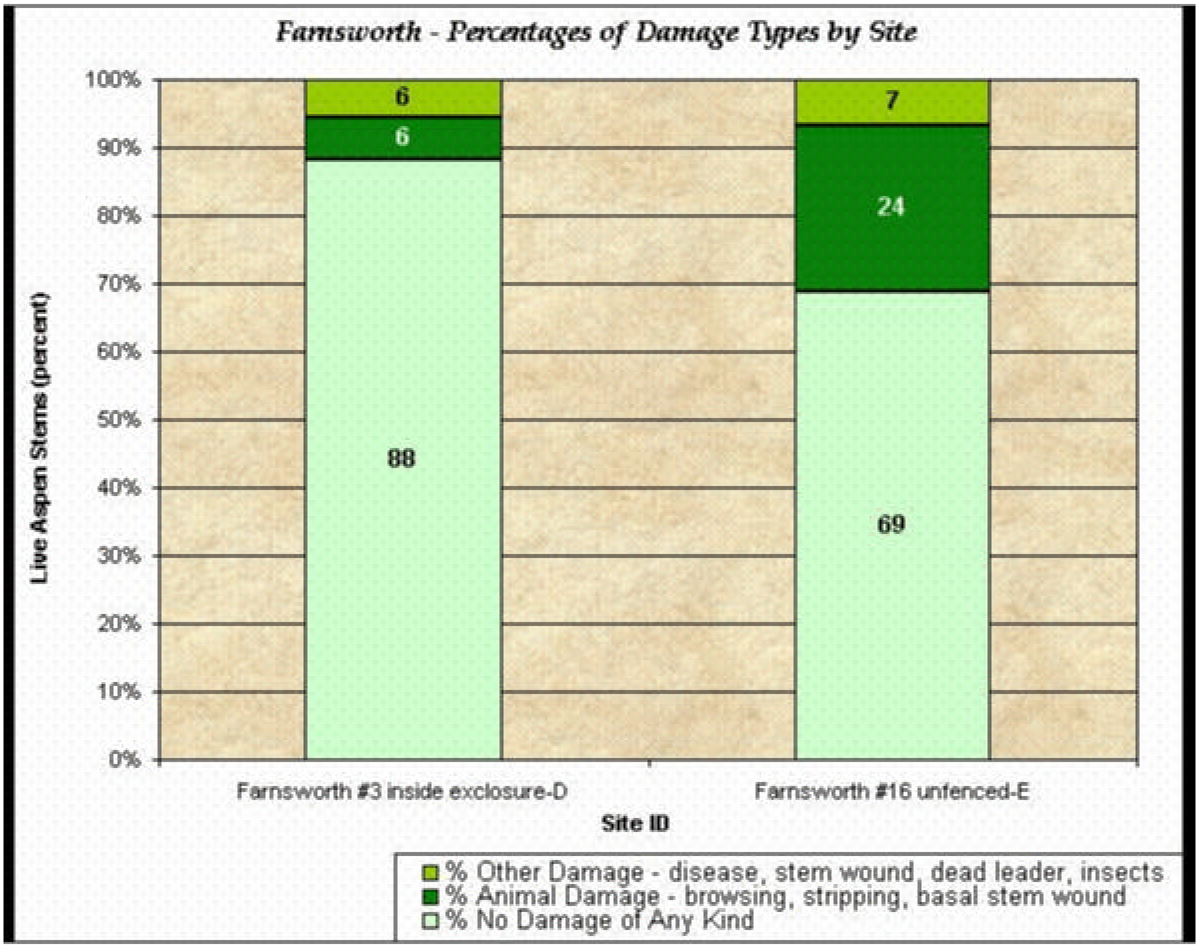
As can be seen in Figure 16, Farnsworth unit 16 produced more stems per acre than Farnsworth unit 3 at 13,475 and 9,700 stems respectively. When two-sample t-tests were calculated comparing the mean number of stems per plot, no significance was found. The graph also shows that size classes 3 and 4 (see Table 2) represented the bulk of the regenerated stems.

Figure 16 - Farnsworth - Live Aspen Stems Per Acre



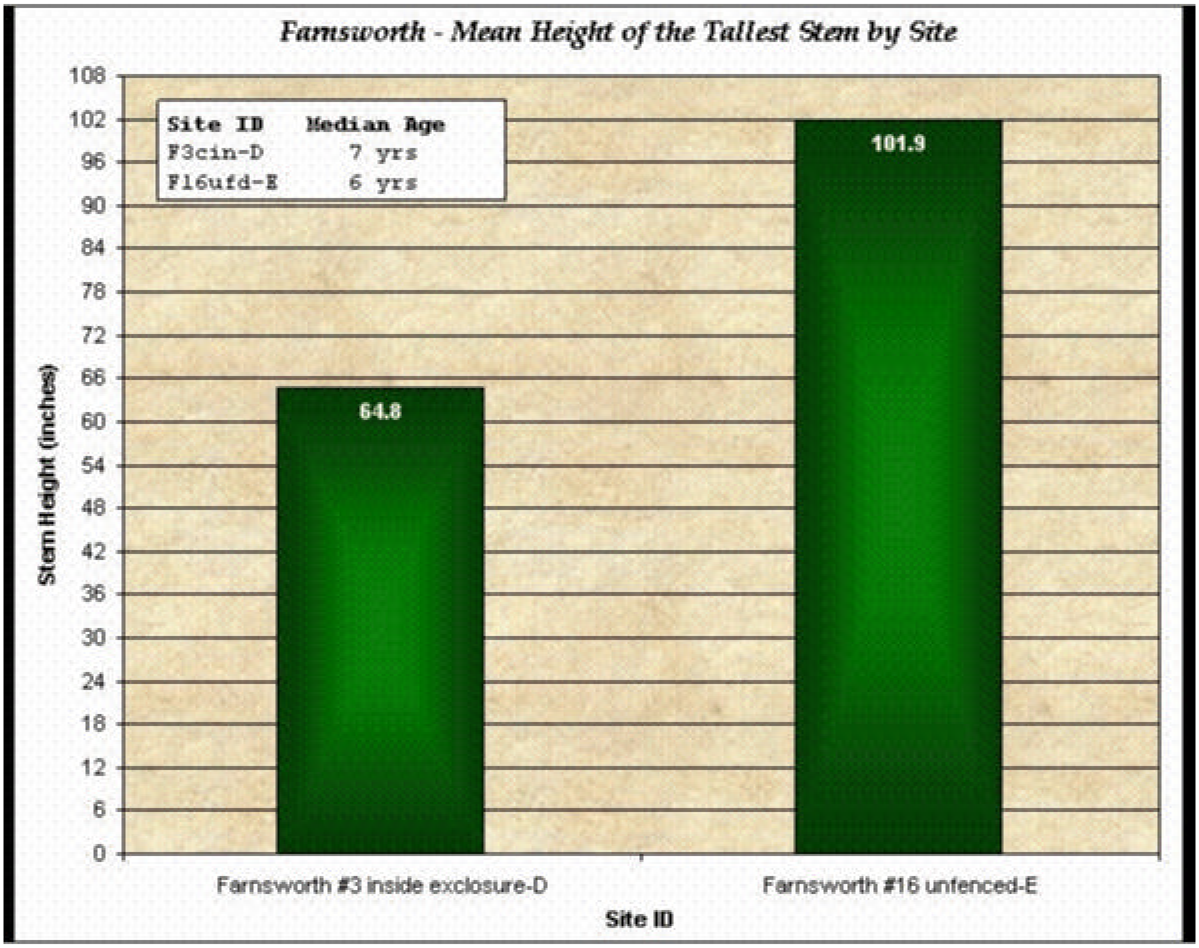
Like Briggs Hollow, the Farnsworth unit inside the cattle exclosure (#3) also received less animal damage than the unfenced unit (#16), though both units had fewer than half of their stems damaged by animals.

Figure 17 - Farnsworth - Damage Class Percentages



When the mean heights of the tallest stems were calculated and graphed (Figure 18), Farnsworth unit 16 was found to have taller dominant stems, and when a two-sample t-test was completed, they were found to be significantly different. This result was not originally expected.

Figure 18 - Farnsworth - Mean Stem Height of the Dominant Aspen Stem in Each Plot



Monroe Mountain Subsection

On Monroe Mountain, fenced units produced more stems per acre than unfenced units and the fenced ones sustained less animal damage. Additionally, fenced units produced taller ramets than unfenced units on a site by site basis.

In this discussion of the Monroe Mountain Subsection, the Oldroyd Fire will be covered separately, because its treatments are the different fire intensities, and the herbivory effects are all due to wildlife, since cattle had not been released on the site since the fire.

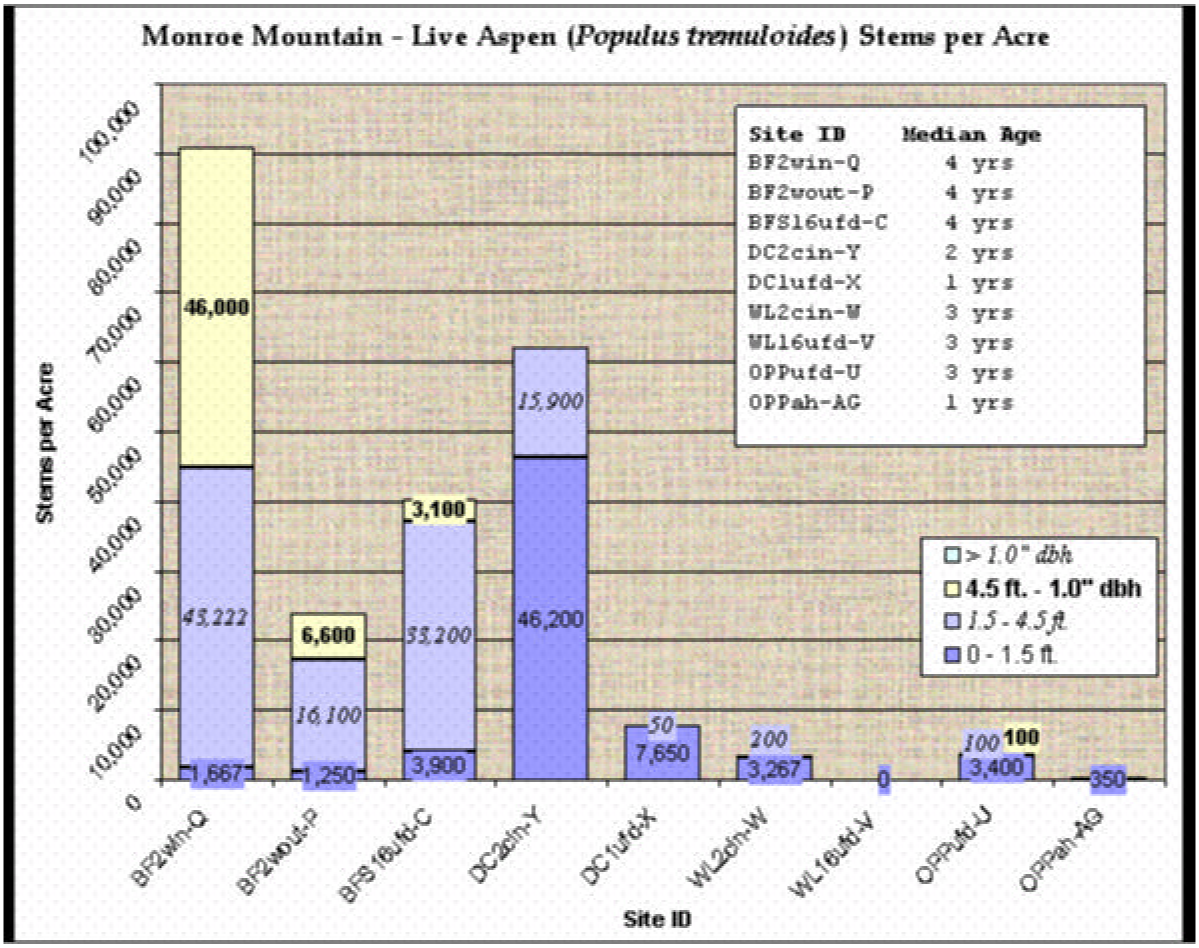
Burnt Flat was sampled in three areas, one of which was a small-area wildlife exclosure (BF2win-Q) located within a larger unfenced aspen harvest unit (BF2wout-P). T-tests showed that the fenced site produced significantly more stems per acre that either of the unfenced units (P < 0.0012). Additionally, when the two unfenced units were pooled, there still remained a significant difference (P = 0.0004).

Even though Dry Creek Unit 2 was fenced a couple of weeks prior to being sampled, this site produced significantly more stems per acre (P = 0.0001). There are several reasons for this, which will be covered in the discussion section of this paper.

It is important to note that in early June, prior to sampling the unfenced White Ledge unit (WL16ufd-V), a few stems had been found on the site, but the sampling was done about a month after that visit. The graph shows that the site was devoid of aspen suckers at the time of sampling. However, the adjacent cattle excluded site did produce a few stems (about 3,467 stems/acre). Since the unfenced unit produced no suckers, Systat could not calculate significance for the t-test, however, it is apparent to this researcher that fencing had an affect.

The two Oldroyd private property units (OPPufd-U & OPPah-AG) have not been grazed by cattle during the time following the harvest, thus the only animal damage they received would be from wildlife, which was in the area (spotted by the researcher) at the time of sampling. OPPufd-U produced significantly more (P = 0.0312) stems than OPPah-AG.

Figure 19 - Monroe Mountain - Live Aspen Stems Per Acre



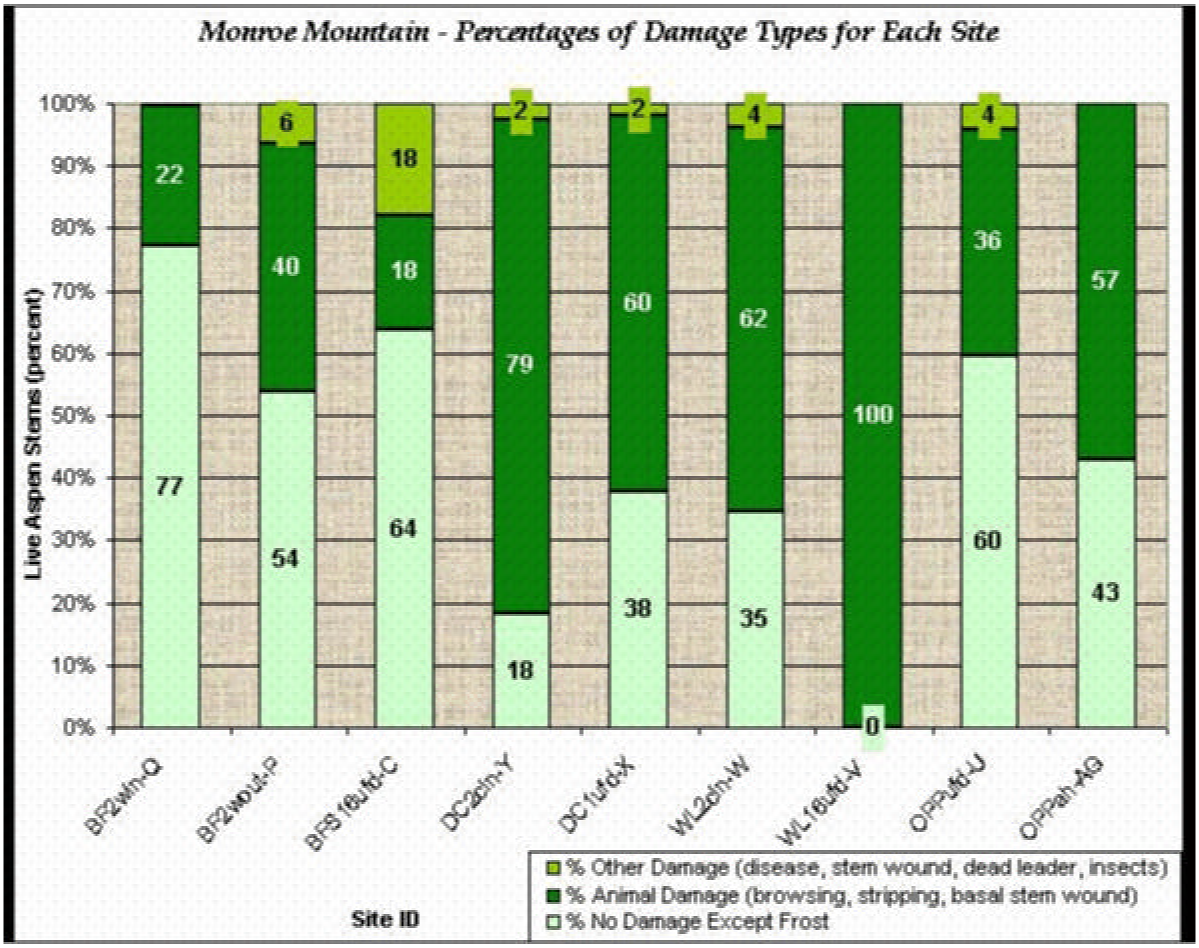
Burnt Flat's three sites all had greater than 50% no damage, but BF2wout-P had the highest amount of animal damage at 40%. It appears that between inside and outside the adjacent units (BF2win-Q, BF2wout-P), this difference may be significant. However, the difference between BF2win-Q and BFS16ufd-C is probably not significant.

Both of the Dry Creek sites received the majority of their damage from animals, and less than half of the stems were without damage. These sites were not adjacent to each other, but were less than a half mile apart. There appears to be an interaction between the number of stems produced and the percentage of damage from animals.

White Ledge is an unusual site in that the unfenced unit produced no stems, so there was no absolute way of assessing damage. However, since the site should have produced stems, as can be evidenced by the adjacent cattle excluded site having produced stems, all damages were assigned to have been caused by animals. This was also given because at the time of sampling, there was almost no plant life in any of the White Ledge treatment areas. Additionally, thirteen of the twenty plots sampled contained some type of animal sign, such as prints, burrowing activity or most commonly animal droppings. It is important to note that following the cutting treatment, the forest ecologist noted that the site produced over 10,000 stems per acre.

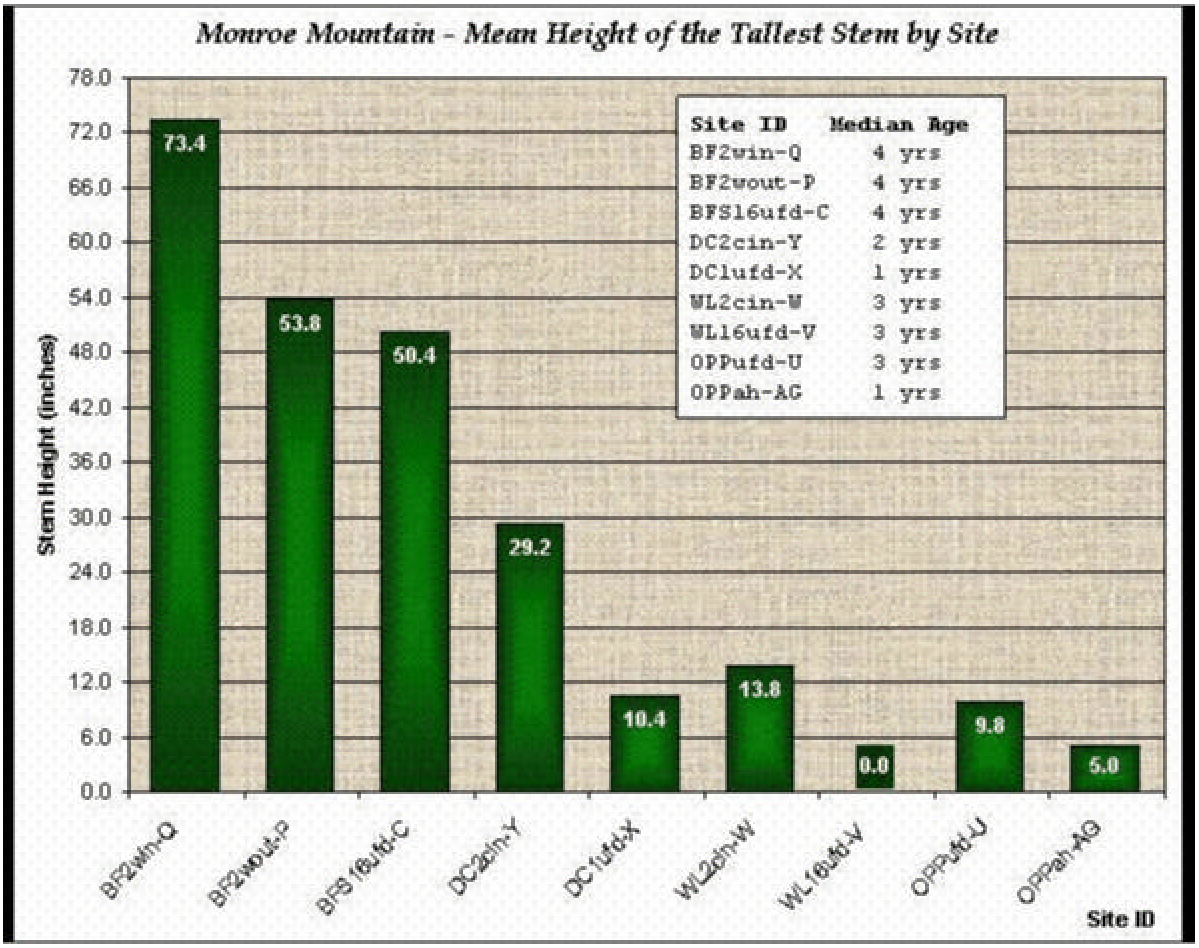
The two Oldroyd private property sites received differing amounts of damage. Specifically, the selective harvest (OPPufd-U) aspen stems received about 36% of their damage from animals, but this site was generally more densely vegetated with immature conifers acting as natural exclosures for the young aspen suckers. The aspen harvest (OPPah-AG) was clearcut leaving no protection for the few stems found there. Fifty-seven percent of those found had shown signs of animal damage. Additionally, only two of the twenty plots sampled didn't contain any wildlife sign (typically pellet mounds).

Figure 20 - Monroe Mountain - Damage Class Percentages



Burnt Flat's two unfenced sites (BF2wout-P, BFS16ufd-C) both produced significantly shorter aspen stems than the wildlife excluded site ($P < 0.0013$). The same was also true for Dry Creek ($P < 0.0001$). White Ledge's significance could not be calculated, because there weren't any stems in the unfenced unit to compare against the fenced one. Still, it appears to be significant if only intuitively. Oldroyd private property's two treatments, in spite of their differences in median age, were not significantly different in height ($P = 0.2874$), however, both sites were harvested in the summer of 1996.

Figure 21 - Monroe Mountain - Mean Stem Height of the Dominant Aspen Stem in Each Plot



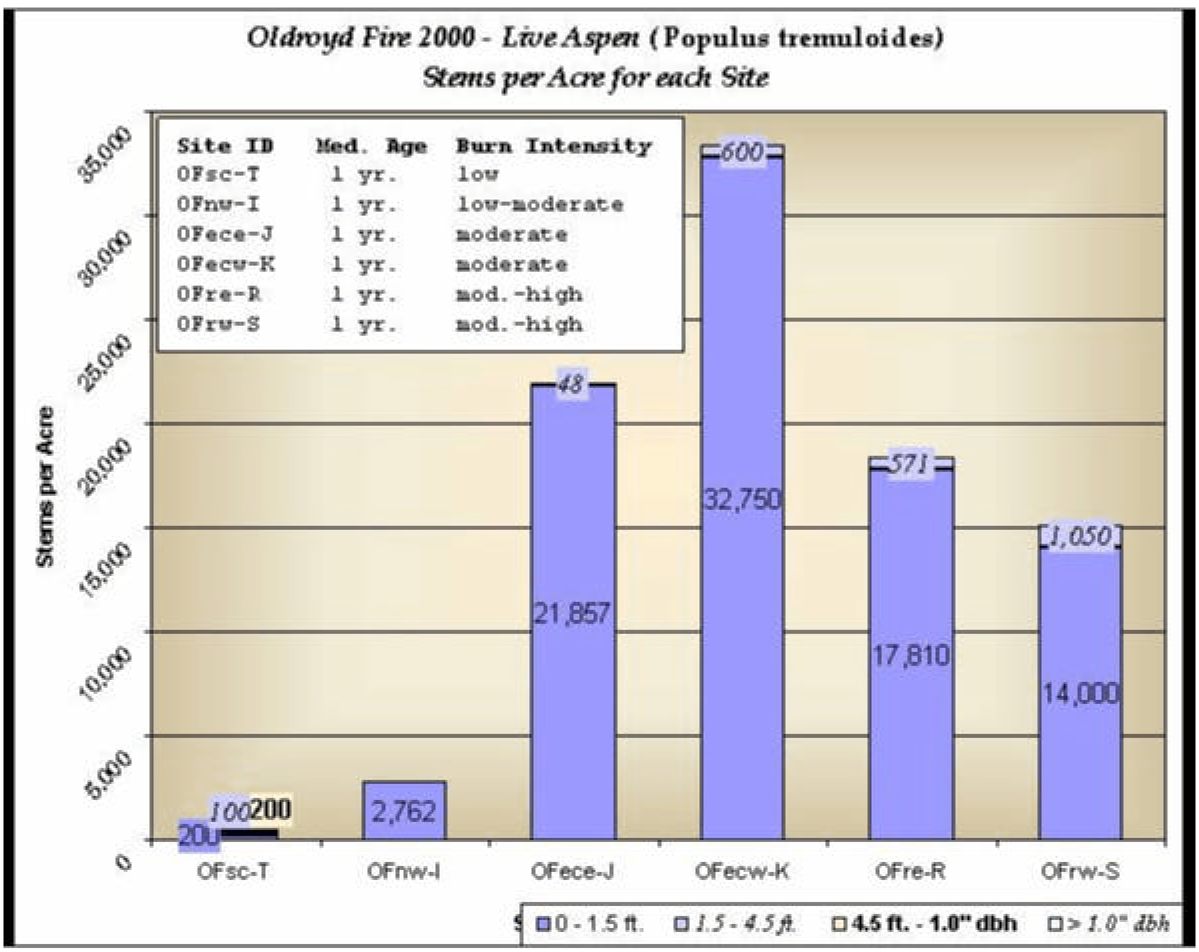
Oldroyd Fire

As noted earlier in the "Treatments" section of this paper, burn intensities varied from low (OFsc-T), low to moderate (OFnw-I), moderate (OFece-J, OFecw-K), and moderate to high (OFre-R, OFrw-S). Burn intensities were determined by the BAER report (Fishlake National Forest 2000).

I ran an ANOVA (analysis of variance), to study the effects of burn intensity on the number of stems per acre. I did this because when simple means were graphed, I noticed that there might be a correlation. I also wondered if moderate burn intensity produced similar amounts of suckering (number of live stems per acre) as clearcutting, since the moderate intensity burn areas produced the most suckers.

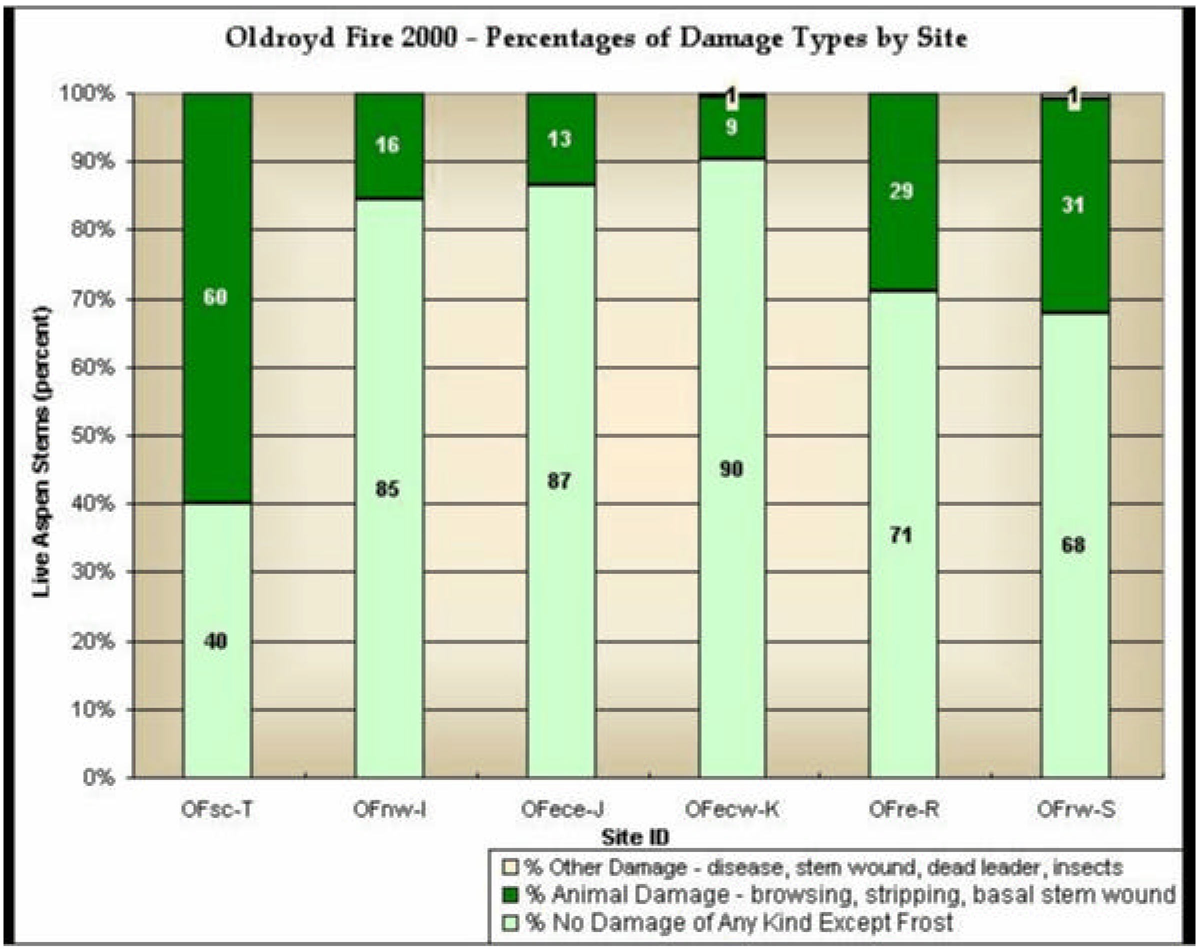
According to the ANOVA results, burn intensity may have (P = 0.0538) a significant affect on the number of stems produced initially following a fire. I also ran t-tests comparing low to low-moderate, low-moderate to moderate, and moderate to moderate-high on number of live stems per acre. I found no significant differences between low and low-moderate, nor between moderate and moderate-high. There was only a difference between low-moderate and moderate (P=0.0073). I did not compare low to moderate or moderate-high, because I was only interested in determining if there were subtle differences between the burn intensity types, rather than obvious ones.

Figure 22 - Oldroyd Fire - Live Aspen Stems Per Acre



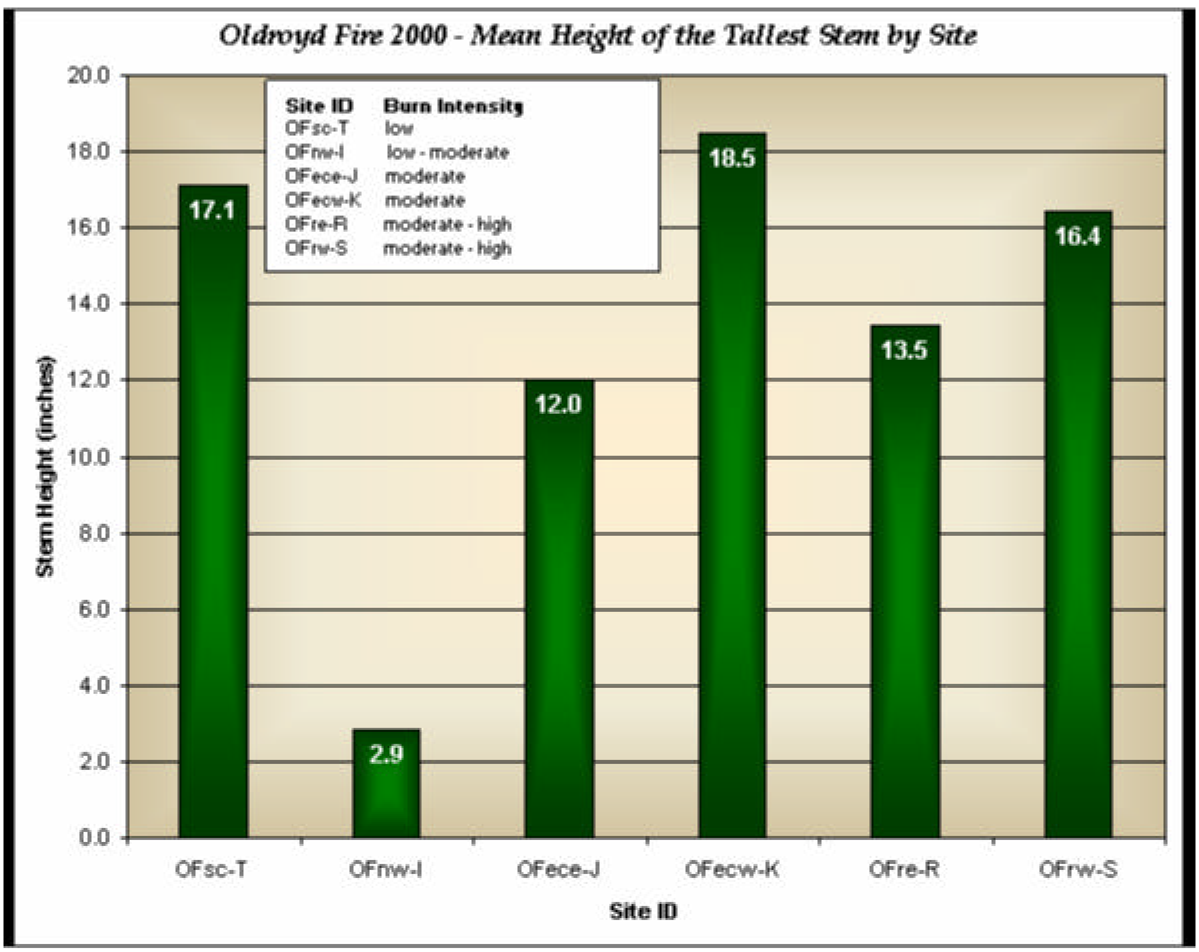
As far as damage goes, only the low intensity burn area (OFsc-T) had greater than 50% of its damage from animals, though there were a lot fewer stems to be sampled in that site, so the small sample site may have magnified the impact of animal browsing. The remaining sites all showed higher percentages of healthy, undamaged stems. However, damage accumulates as stems grow, and these stems were only in their first year of growth. When in the field, I observed that it was common to see stems that had been pulled completely out of the ground by foraging wildlife. In most cases, the animal sign found in the area was from elk.

Figure 23 - Oldroyd Fire - Damage Class Percentages



When OFsc-T was sampled, most of the stems found there were advance regeneration, meaning that the stems were there before the fire. This has the result of confounding the impact of fire intensity on stem heights. Also, since the fire didn't burn as hot, the stems found there didn't die, even though there was fire scaring on trees within the plots. I also ran an ANOVA to study the effects of burn intensity on the height of the dominant stem in each plot. According to the ANOVA results, fire intensity had a significant ($P < 0.0001$) affect on stem heights. When I ran t-tests to compare low to low-moderate, low-moderate to moderate, and moderate to moderate-high, I found that stems in the moderate and moderate-high intensity areas were not significantly different ($P = 0.8419$); however, there was significant difference ($P < 0.0001$) between low and low-moderate stem heights, and low-moderate and moderate stem heights.

Figure 24 - Oldroyd Fire - Mean Stem Height of the Dominant Aspen Stem in Each Plot



As mentioned above, I had noticed that the moderate burn intensity areas had produced the most suckers and that these sites produced about the same amount of suckers as areas that had been clearcut. Of the areas sampled for regeneration, only the Briggs Hollow and Dry Creek aspen clearcuts were treated in the same year as the Oldroyd Fire. Of the clearcut areas on the Monroe Mountain Subsection, only the cattle exclosure of Dry Creek was not so heavily browsed that the regeneration was almost gone, but only 10 sample plots were surveyed. The only other sites clearcut in 2000 that had been fenced were the Briggs Hollow units. Even though Briggs Hollow is on the Fishlake Plateau Subsection, I pooled the fenced Briggs Hollow and Dry Creek sites to make the clearcut treatment sample set.

To assess the differences between clearcutting and the moderate and moderate-high burn intensities on the number suckers produced, I ran t-tests comparing the fenced clearcut units to the Oldroyd Fire moderate and then moderate-high burn intensity sites. I hypothesized that there shouldn't be any significant difference ($P > 0.05$) between clearcutting and moderate intensity burn sites, but that there should be ($P < 0.05$) with the moderate-high intensity burn sites. The t-test confirmed the hypothesis ($P = 0.5363$) that there is no significant difference between the two treatments. Additionally, when the moderate-high burn plots were compared with the clearcut plots, significant difference ($P = 0.0018$) was noted.

Tushar Mountains Subsection

In spite of the fact that the Grindstone Flat exclosures were installed the year following the Pole Creek Fire, there was no statistical difference found between any of the three sites sampled on the number of live stems produced, nor in the heights of the dominant stems. The three sites (wildlife excluded, cattle excluded, grazed by all) received progressively more animal damage, but the damage didn't seem to be enough to impact the number of stems produced nor the height of the dominant stems.

Rigger Park, on the other hand, did show some significant difference between the sites sampled. This was determined by setting RPufd-B, the unsalvaged and sloped site, as the control for the area, since all the Rigger Park and Baker Springs sites were located within walking distance of each other. All of the Rigger Park sites, except unit 5 (RPH3ufd-AD), received 3 - 6% of their damage from animals and over half of their stems were healthy. Of the three salvage units sampled, only units 1 (when RPH1ufd-AB and RPH2ufd-AF were pooled) and 5 (RPH3ufd-AD) produced significantly ($P < 0.0533$) fewer live stems per acre than RPufd-B. Additionally, all sample sites except the Baker Spring unit (RPH4ufd-AE) had significantly ($P<0.0139$) shorter dominant stems than the control (RPufd-B) site.

Figure 25 - Pole Creek Fire - Live Aspen Stems Per Acre

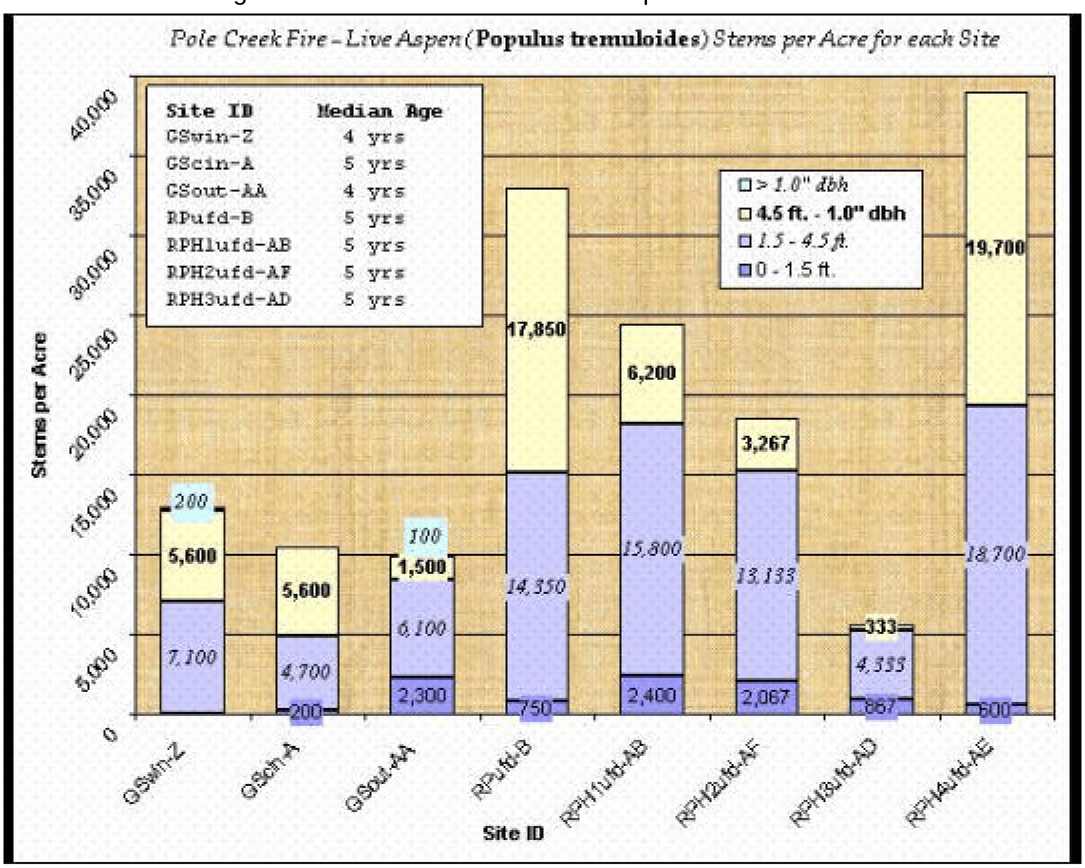


Figure 26 - Pole Creek Fire - Damage Class Percentages

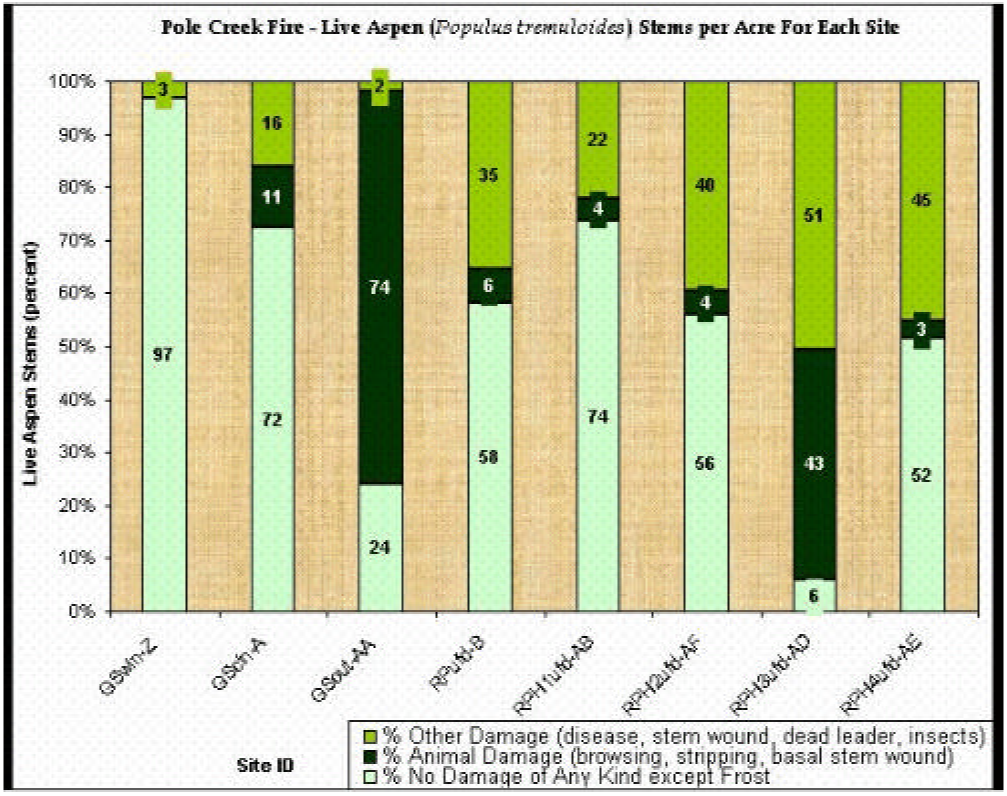


Figure 27 - Pole Creek Fire - Mean Stem Height of the Dominant Aspen Stem in Each Plot