TREMBLING ASPEN STANDS AS FIREBREAKS: WHAT OPTIONS ARE AVAILABLE FOR STIMULATING ASPEN STAND EXPANSION

CITY OF CRANBROOK

UBCM FUEL MANAGEMENT PILOT PROGRAM

ROBERT W. GRAY

R.W. GRAY CONSULTING, LTD.

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INTRODUCTION

Trembling aspen (*Populus tremuloides* Michx.) is the most widely distributed tree species in North America. Aspen forests are important for wildlife, livestock, water quality and quantity, timber resources, and recreation. As pure stands with high canopy closure aspen forests have been described by fire behavior specialists as having almost "asbestos-like" burning characteristics. The qualities of low flammability are associated with stand structure and its effect on the local fire environment. Closed-canopied stands of aspen exhibit a number of fuels and fire environment characteristics that affect fire behavior; most notably fire spread rate and fire intensity. Dense stands of aspen with high canopy closure inhibit wind movement at the surface and affect air temperature (cooling effect) and relative humidity (moistening effect). Surface fuels, mainly downed logs, branches and litter, and annual and perennial herbaceous fuels, grasses, forbs and shrubs, retain higher moisture content longer into the fire season (**Figure 1**).

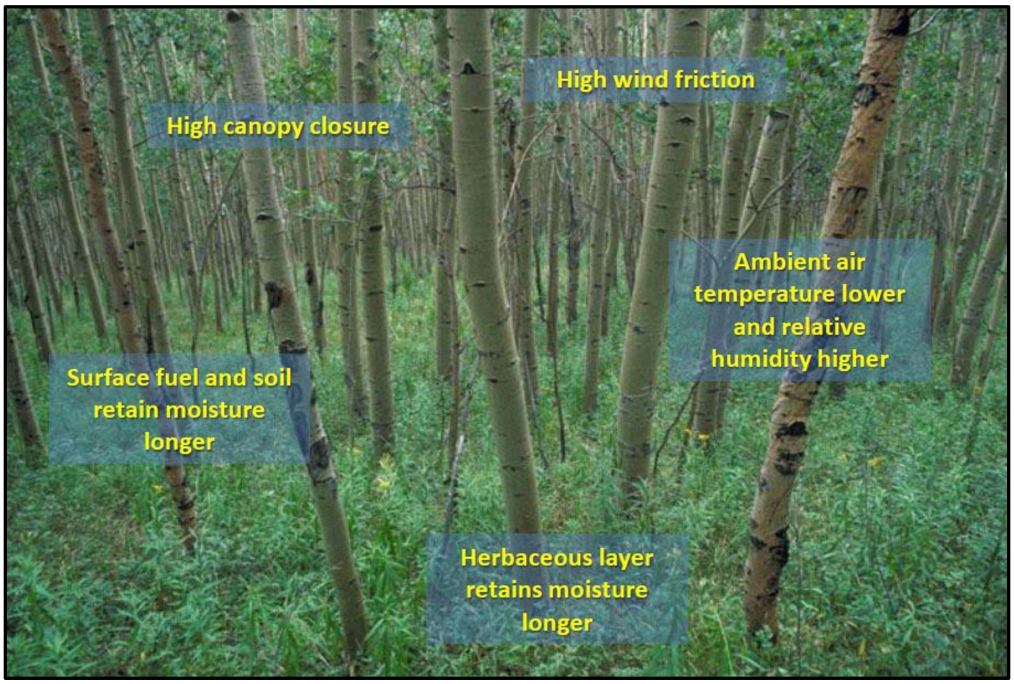

Figure 1. Aspen stands can significantly affect fire behavior by affecting fuel characteristics and the local fire environment.

Aspen's positive effects on fire behavior have made it a species of choice for fuel treatments in and around the wildland-urban interface throughout North America (Shepperd et al. 2006). Wherever ecologically appropriate, managers could plant aspen stands to function as fuelbreaks and firebreaks around their communities. As a wildfire advances toward the community the fire would encounter the aspen stand and drop from the crowns and proceed as a low intensity surface fire or even stop (Alexander and Lanoville 2004). Fire suppression crews would utilize these aspen stands as safety zones as well as anchors for suppression operations (**Figure 2**).

Figure 2. Fire suppression crew anchoring suppression operations in an aspen stand.

Developing aspen fuelbreaks is contingent on either planting aspen seedlings or using existing aspen clones and expanding them (vegetative reproduction). A mature, healthy aspen tree or clone can produce tens of thousands of suckers if the apical meristem dominance is interrupted (Bartos et al. 1991). The hormone auxin is produced in the apical meristem and translocated to the roots where it suppresses suckering. When the hormone is interrupted by disturbance to the apical meristem, cytokinins, which are located in the root tips, stimulate bud primordia on the roots to develop into a proliferation of suckers (Shepperd et al. 2006). A number of approaches have been used to expand aspen clones through suckering including push-felling trees with a bulldozer, felling trees, prescribed fire, and trenching around the base of trees (DeByle and Winokur 1985; Shepperd et al. 2006; Swanson et al. 2010).

A significant issue that prevents managers from aggressively pursuing the development of aspen fuelbreaks is ungulate browsing pressure on suckers. A wide range of wild and domestic ungulates, including elk, deer, moose, bighorn sheep, bison, cattle, sheep, goats and horses, browse aspen suckers whenever they are available. Domestic livestock will browse them up to 1.5 m in height while wild ungulates, especially elk, will browse them up to 4 m in height (Kota and Bartos 2010). Over time, the suckers will not be able to produce a single apically-dominant stem and will take on a short, multi-topped, bushy appearance (**Figure 3**). How to prevent ungulate damage to aspen suckers while they put on height growth is a significant financial issue confronting fire managers who wish to use aspen stands as fuelbreaks (Kota and Bartos 2010).

Figure 3. Typical growth form of an over-browed aspen sucker.

The City of Cranbrook is investigating the opportunity to develop a series of aspen fuelbreaks along the perimeter of the community as part of their Community Wildfire Protection Plan. Southeast of town in the Gold/Joseph Creek watershed is an area of mature aspen mixed with conifers on a parcel of City-owned land. Pilot Project funding from the Union of BC Municipalities Strategic Wildfire Prevention Program Initiative was applied to a project to test various methods to expand existing aspen clones and to measure the impact of ungulate browsing on the suckers.

METHODS

The Joseph Creek Aspen Restoration Unit is located southeast of Cranbrook in the Gold/Joseph Creek watershed (**Figure 4**). The unit is located at 49°26'16" N and 115°39'59" W. Elevation of the unit is 1,220 m. The site is classified as MSdk subzone under the provincial Biogeoclimatic classification system. Tree species found on the site include lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.), western larch (*Larix occidentalis* Nutt.), Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.), subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), and trembling aspen. An investigation of pre-settlement era stumps on the unit revealed a historical overstory tree density of 68 trees/ha. This mean density included only conifers as historical aspen stumps would have decomposed over the same time frame. Historical tree species included western larch, Douglas-fir and ponderosa pine (*Pinus ponderosa* Engel.). Two fire history studies were conducted in close proximity to the unit revealing a long history of frequent, low-severity fire on the unit (Gray and Daniels 2008). These historic fires would have caused continuous suckering of aspen on the unit.

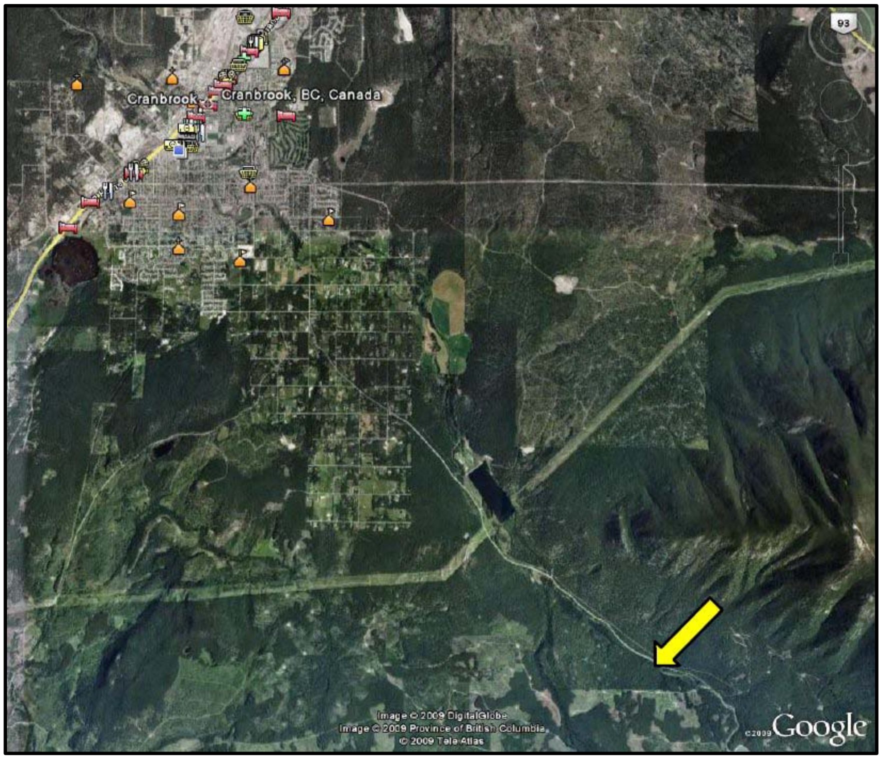

Figure 4. Location of the aspen firebreak study unit.

There are a number of methods for vegetatively regenerating aspen, including stem girdling, root trenching, push-falling, and planting root cuttings. In the aspen firebreak study we chose to test stem girdling and root trenching. Typically in stem girdling experiments or operations the unit is prescribed burned under adequate fire severity conditions to girdle the mature trees and release the cytokinins that enable suckering (**Figure 5**). Over the years a large volume of research has gone into studying fire effects on aspen that has enabled fire management staff to develop burn prescriptions that meet the objective of stimulating root suckering without overly damaging the plant (Brown and Simmerman 1986; Brown and DeByle 1987; Hungerford 1988; Brown and DeByle 1989; Bartos et al. 1991). Light to moderate intensity surface fire that consumes surface litter is often all that is needed to girdle even large diameter mature trees. In the case of the aspen firebreak study a prescribed burn was first planned for the fall of 2008 to affect half of the unit; however, fire conditions in the province at the time of the prescribed burn were such that approval for the burn was denied. A spring burn was planned for the following spring (2009); however an adequate burn window did not materialize. Instead of waiting for another possible burning opportunity to arise it was decided that we would simply use a chainsaw to girdle the trees as a proxy for burning.

Figure 5. Prescribed burning is often used to girdle mature aspen and stimulate root suckering.

The other experimental treatment was root trenching (**Figure 6**) which was applied to the other half of the unit. Root trenching consists of running a piece of machinery equipped with a long, sharp blade or tooth around the perimeter of individual trees or groups of trees. The tooth or blade is extended approximately 50 cm into the soil where it severs the main lateral roots extending out from the base of the tree. In our case we used a distance of 5 m out from the base of each tree or patch of trees. The concept is to sever the main lateral roots from the apical meristem thereby releasing cytokinins and stimulating the severed root material to sucker.

Figure 6. A montage of the root trenching process on the aspen firebreak unit. The upper left image is of the backhoe with the cutting blade attached to the bottom of the bucket. The upper right and lower left images are of the blade being pulled through the ground around the base of the aspen trees. The image in the lower right is of the resulting trench with the ruler indicating the width of the trench. A large number of severed roots are visible in the image.

Figure 7 shows the two experimental treatments (root trenching on the left and girdling on the right) and the location of the four 1 hectare monitoring plots. Monitoring focused on quantifying the effect of each treatment on aspen suckering. In realizing that a further confounding influence on aspen suckering was ungulate browse we located two plots in each treatment unit: a fenced plot and an unfenced plot. The fenced plots were enclosed inside a 3 m elk-proof fence while the unfenced plot had the plot perimeter established but there was no impediment to browsing. Plots were intentionally located where we could capture a large number of mature aspen trees. Once the plots were established we mapped the location of each live tree and downed log (if still alive) in each of the four plots as well as live, downed trees within close proximity to the plots. Live trees and downed logs were to be the source of future suckers following treatment as well as providing a measure of pre-treatment stand density. We also recorded DBH and crown ratio. The crown ratio gave us a measure of pre-treatment canopy closure. Fenced plots were inspected monthly for damage and repaired immediately so that we could prevent any possible browsing impacts.

Effects of the treatments were measured in the fall of 2010 providing one full year of aspen response. Five 1/100 ha subplots were established in each of the four plots with one plot at plot center and four plots located on the cardinal bearings. Within each subplot we measured density, height and browse damage.

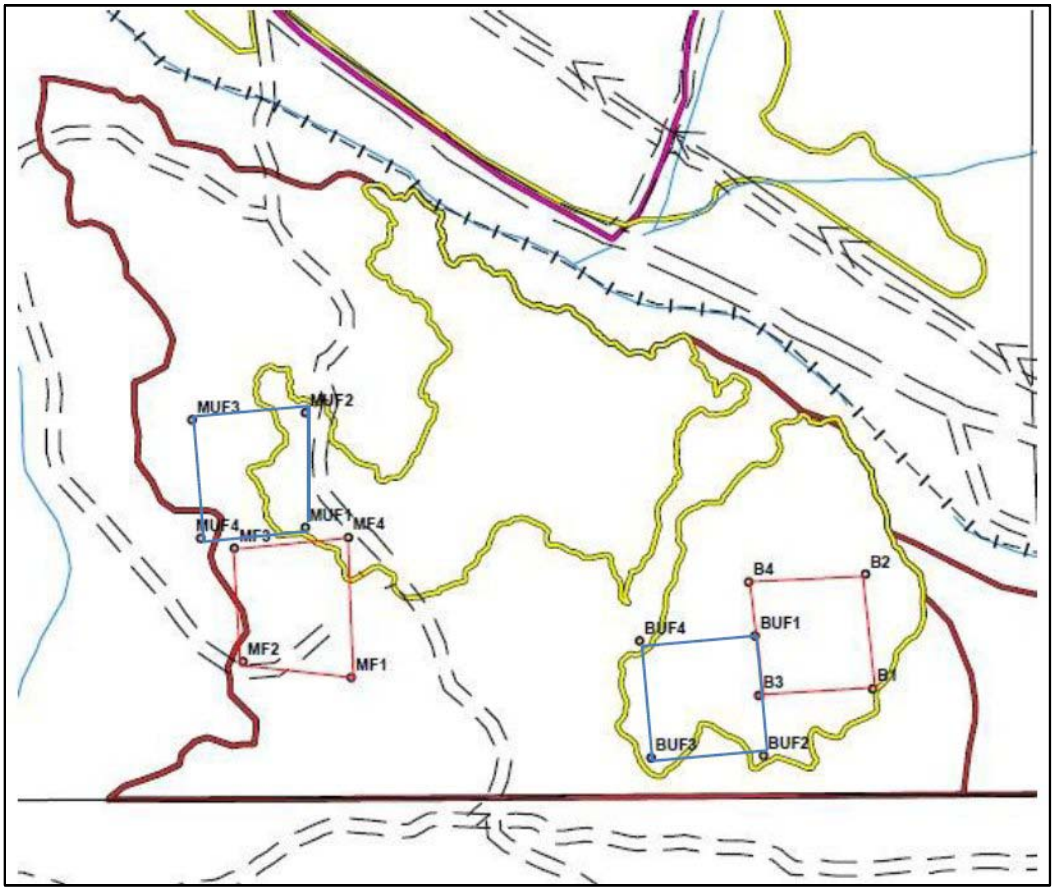

Figure 7. Map of the 4 monitoring plot locations in the aspen firebreak unit. The two red plots are fenced while the two blue plots are not.

RESULTS

The burn/fence unit had the highest pre-treatment density of aspen of the four treatments with 61 trees, while the burn/no fence had the lowest at 27 (**Table 1**). The two trenched plots had similar densities with 35 trees in the trench/fence plot and 48 trees in the trench/no fence plot.

Table 1. Stand density pre- and post-treatment by treatment unit in the aspen firebreak study.

	Burn/Fence	Burn/No Fence	Trench/Fence	Trench/No Fence
Pre-treatment	61	27	35	48
Post-treatment	10,800	11,600	21,600	5,440

All treatments resulted in a significant increase in aspen density over pre-treatment conditions (**Table 1**). The highest density increase was measured in the trench/fence unit, followed by the burn/no fence unit, burn/fence, and finally trench/no fence units (**Figure 8**). Between the two treatments, the burn/no fence treatment produced a 7% (11,600 sph versus 10,800 sph) increase in density versus the burn/fence treatment, while the trench/fence treatment produced an almost 400% increase in density (21,600 sph versus 5,440 sph) over the trench/no fence treatment.

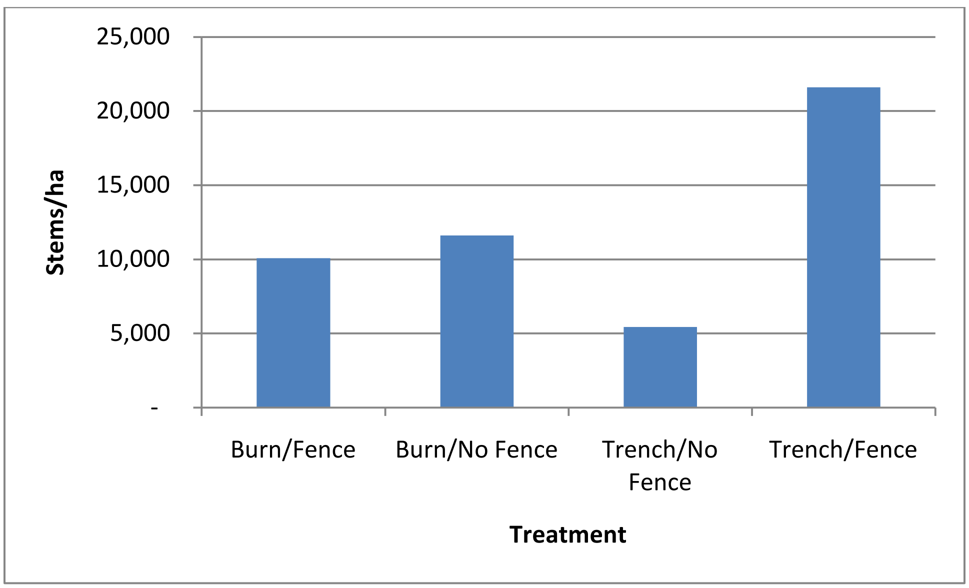

Figure 8. Post-treatment aspen density by treatment type.

The mean height of suckering aspen following treatment (**Figure 9**) also produced highly variable results, with the burn/fence unit producing the tallest mean heights, followed by the burn/no fence unit, trench/fence, and trench/no fence units. Within treatments, the burn/fence aspen suckers were 42% taller than the burn/no fence suckers, while in the trenched units the trench/fence suckers were 24% taller than suckers in the trench/no fence unit. Mean maximum sucker heights were highest in the burn/fence unit, followed by the trench/fence unit, burn/no fence unit, and finally the trench/no fence unit (**Figure 10**). Mean minimum sucker heights were highest in the burn/fence unit, followed by the burn/no fence unit, trench/no fence unit, and finally the trench/fence unit (**Figure 11**).

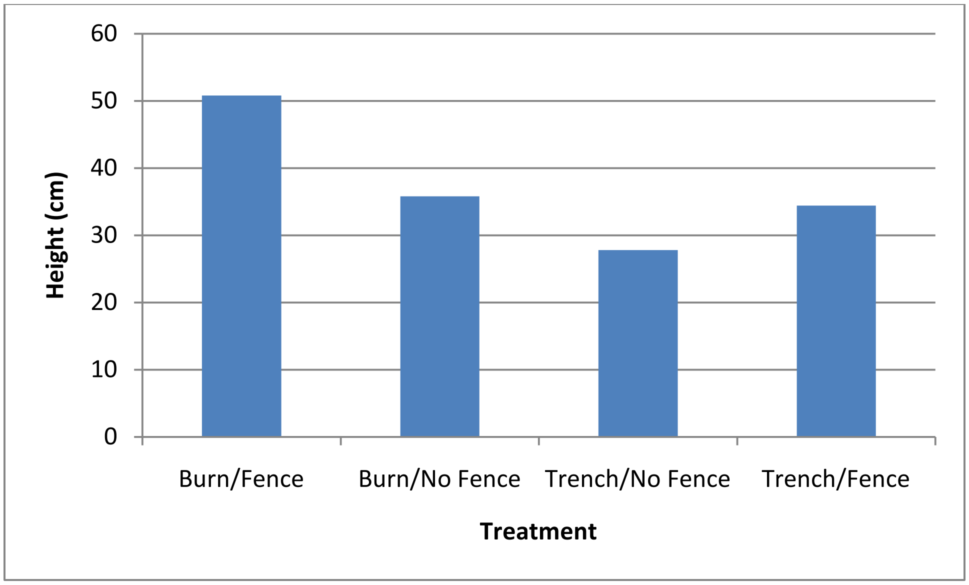

Figure 9. Post-treatment mean height of aspen by treatment type.

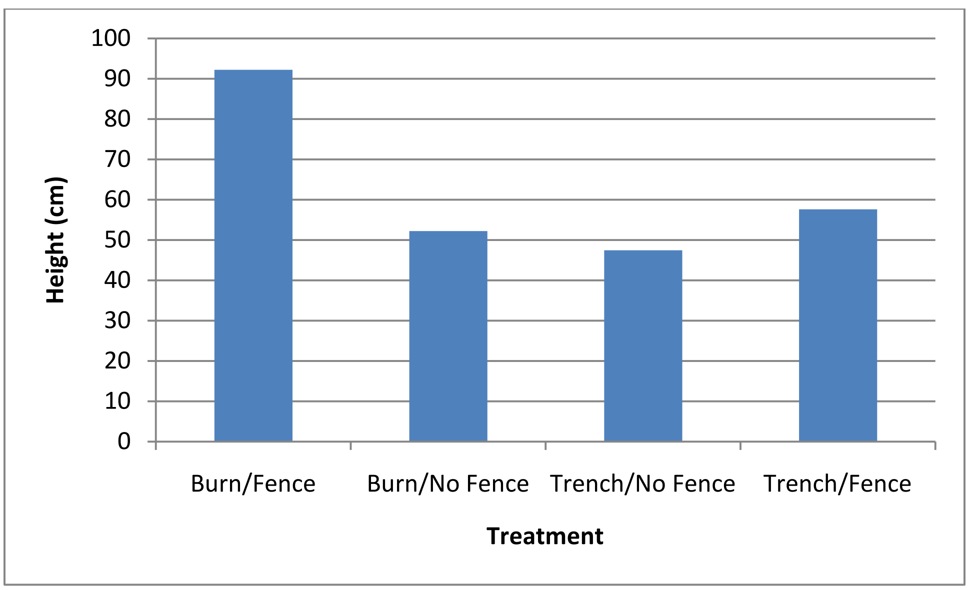

Figure 10. Post-treatment mean maximum height of aspen by treatment type.

DISCUSSION

Both treatments, girdling and trenching, produced significant increases in aspen density over pre-treatment conditions. The trench/fence treatment produced the most suckers followed by the two burn proxy treatments, and finally the trench/no fence. These results cannot be considered indicative of what managers could expect to see if they apply these treatments. The four treatment plots had variable densities to begin with and various level s of aspen health which would also be confounding variables when assessing sucker response. The trend however is positive that either trenching or burning/girdling will produce a large number of suckers.

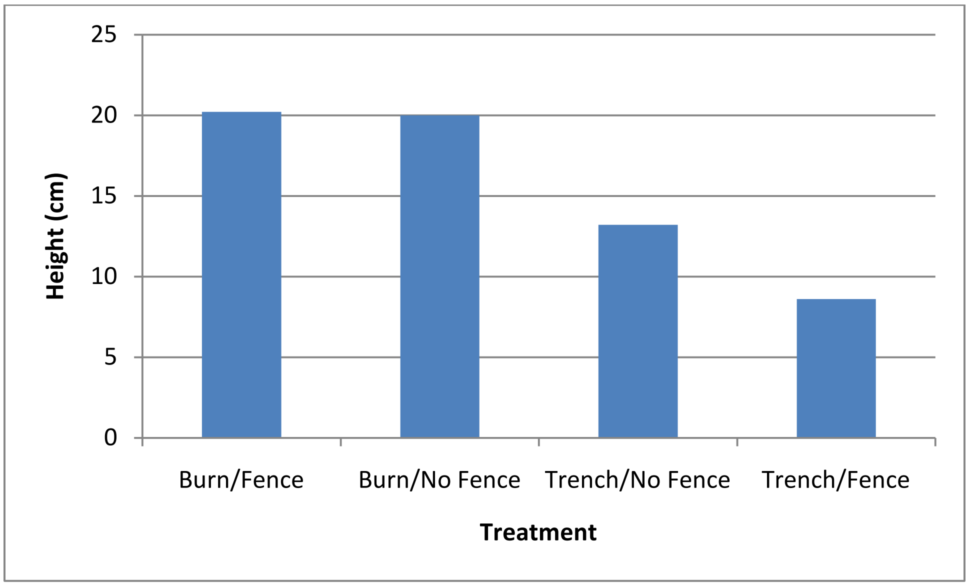

Figure 11. Post-treatment mean minimum height of aspen by treatment type.

Of significance from an aspen firebreak perspective is the effect of browsing on aspen sucker height. The two fenced treatments exhibit the best combinations of density and height, with the burn/fence unit exhibiting the greatest mean height and greatest mean maximum height, while the greatest density was produced on the trench/fence unit. In the case of the two unfenced units all aspen suckers showed signs of browse with some suckers showing extensive damage. These two units generally exhibited lower density and much lower height growth. In order to encourage aspen suckering and grow it rapidly in height in order to take advantage of its fire-retarding potential it is obvious that the suckers have to be protected from browse damage.

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