2009 SUMMARY REPORT **R.R. Jandt 9/29/09**

Tanacross Shaded Fuel Break AA39

Fuel Reduction Project

Local residents, working with the village council and Alaska Fire Service, received federal funding to reduce the fire risk and hazard to private residential structures by modifying fuel structure and continuity of 66 acres around the community of Tanacross. Treatment was intended to produce a more open stand to slow the rate of spread and intensity of an accidental fire. At the same time, residents wanted to minimize the visual and ecological impact of the shaded fuel break by using hand crews to treat the area instead of heavy equipment (Fig. 1).

Figure 1. Hand crew thinning spruce stand and removing ladder fuels around Tanacross.

Vegetation Cover

Three permanent transects, measuring 30m x 3m, were established in 2001 to monitor changes in understory vegetation cover. Though vegetation composition differed slightly between transects, pre-treatment (2001) understory cover was dominated by heath shrub, such as low-bush cranberry (*Vaccinium vitis-idaea*) and live feather moss with some tall willows (*Salix bebbiana*, primarily). Other common species pre-treatment included crowberry (*Empetrum nigrum*), twinflower (*Linnaea borealis*), and bastard toadflax (*Geocaulon lividum*). White spruce (*Picea glauca*) was the dominant overstory tree. Transects were monitored from 2002-2004 and in 2009 to assess changes in cover type. The most notable change was loss of viability of the feather moss cover on the forest floor in the first two summers following the treatment (Fig. 2, 3). Live moss was almost 50% of the substrate (ground cover) in 2001, whereas by 2003 less than 5% was recorded as live and 22% of the substrate cover was dead feather moss. Species diversity (of forbs and grasses) also increased post-treatment.

Horsetail (*Equisetum* spp.) and grass/sedge cover exceeded pre-treatment values in all sample years. Graminoid cover increased from 6% (pre-) to 16% three years post-treatment and was 15% after 8 years (Fig. 2). Moss cover in 2009 was very different than pre-treatment, but feather moss appeared to be rebounding slowly (Fig. 2) while the dead moss which was so prominent in the first 2 years post-treatment was starting to decompose and be covered by the understory (Fig. 2, 3). Shrub cover was initially reduced after treatment, likely by the removal of some of the larger willows. Shrub cover, both of dwarf shrubs and taller willows appears to be increasing (Fig. 2) and may ultimately surpass pre-treatment levels.

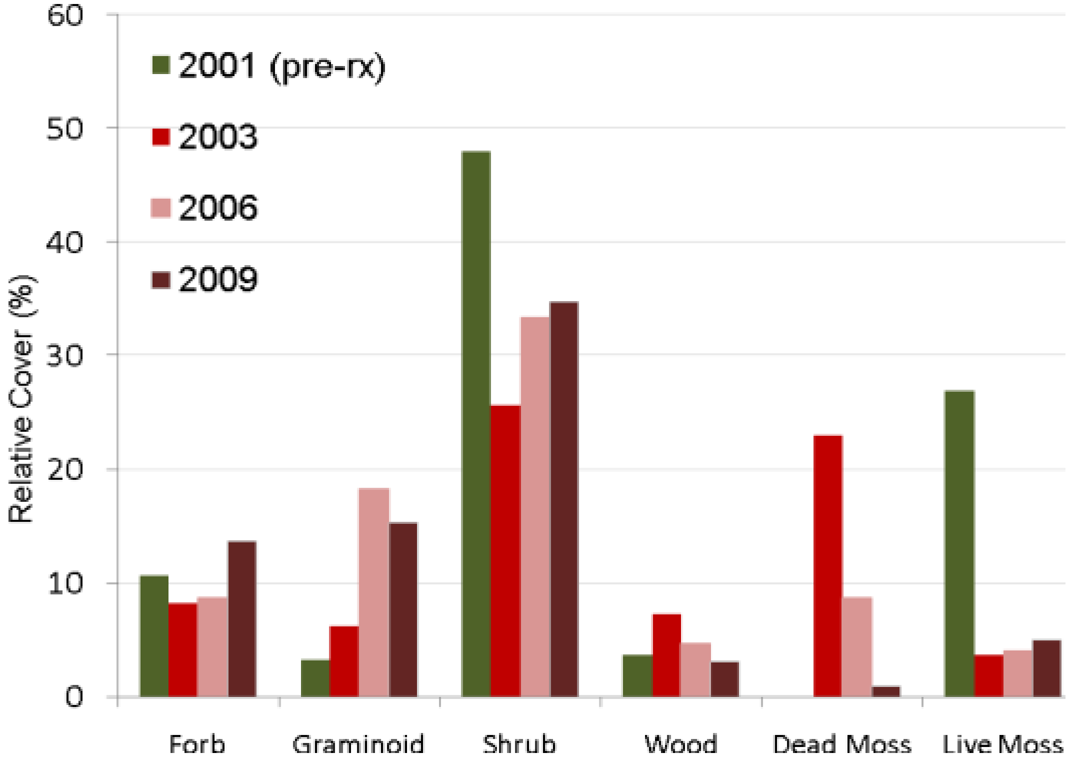


Figure 2. Average relative vegetation cover (%) in 2001 (PRE), 2003, 2006, and 2009. All sampling was conducted in July on three permanent transects (n=3).

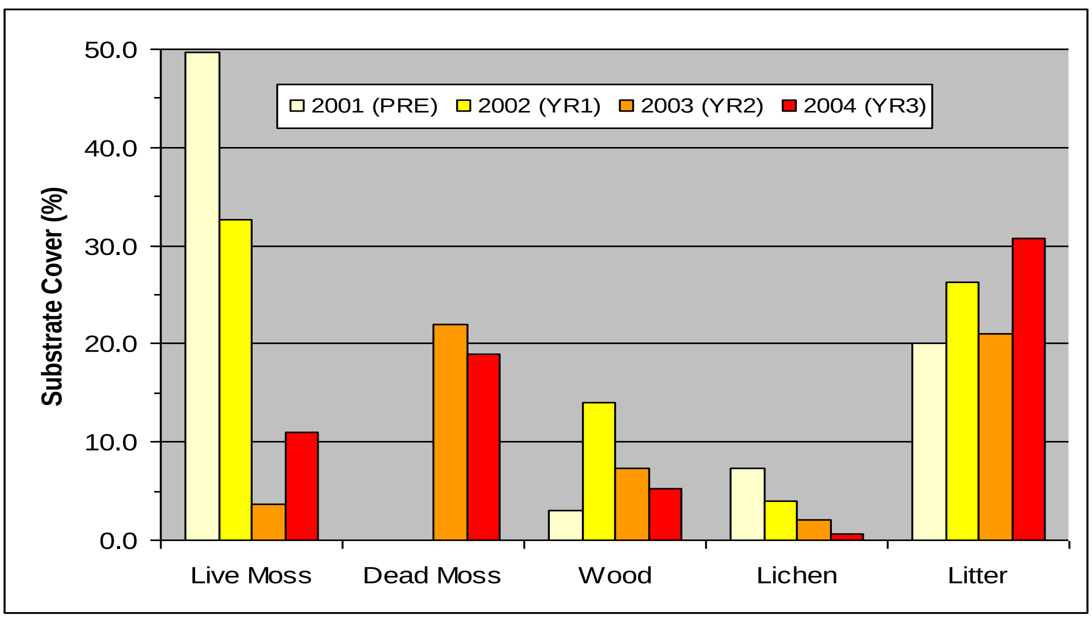


Figure 3. Average percent substrate cover in 2001 (PRE), 2002 (YR1), 2003 (YR2), and 2004 (YR3).

Woody Shrub Density

The primary large woody shrubs in the Tanacross unit were willow species, primarily Bebb (*Salix bebbiana*) and diamondleaf willow (*S. pulchra*). Shrub density was only monitored post treatment. Average shrub density increased from 433 shrubs/acre in 2002 (YR1) to 983 shrubs/acre in 2006 (YR5) within the thinned area. However, by 8 years post-treatment, willow density had decreased again to 317/acre, possibly as a result of browsing (Fig. 4). We also find shrub counts to be fairly challenging to keep consistent: when willows are grouped it is somewhat subjective to determine individuals. Stem counts can also be misleading, though, as a resprout can go from 1 large stem to many smaller stems, though still a single plant.

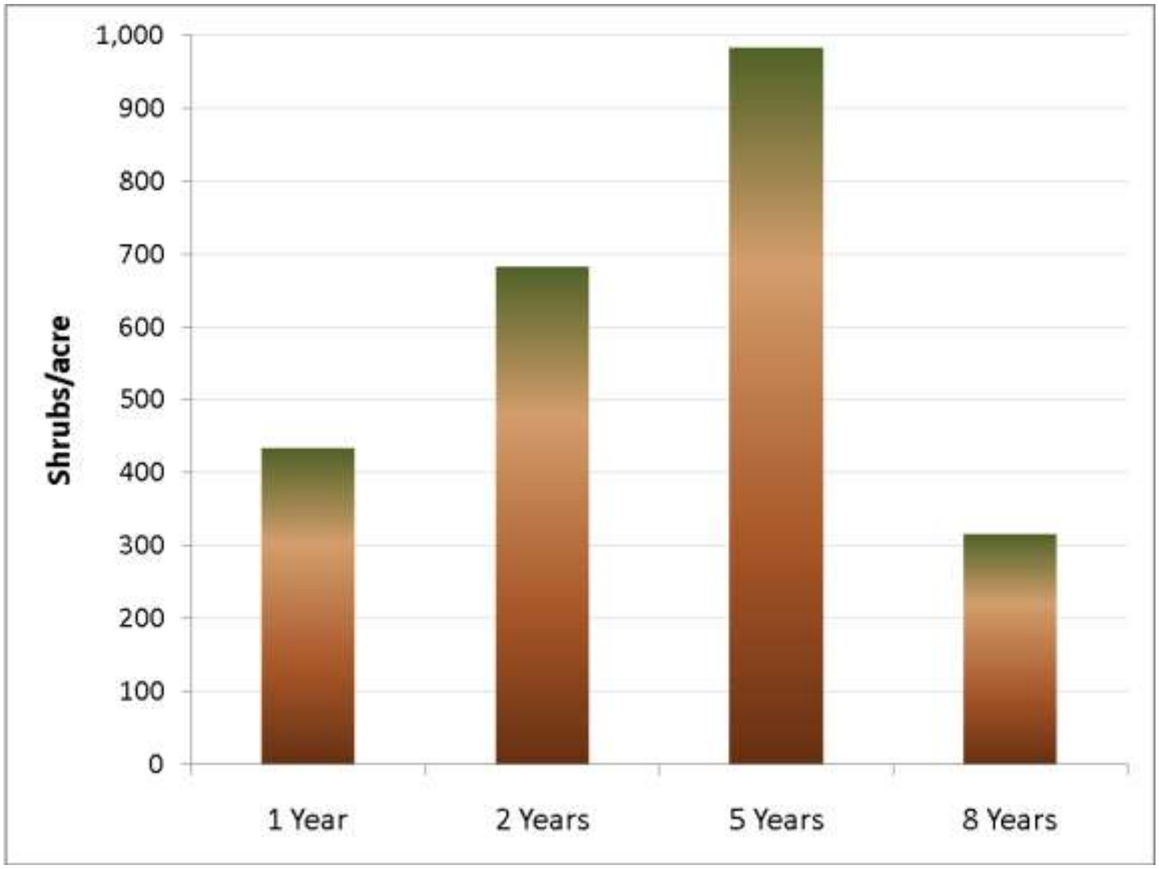


Figure 4. Density of willow shrub after treatment. Counts were of individuals or "clumps", rather than stems.

Table 1. Large woody shrub count and computed shrub density (shrubs/acre) for each 30-m x 3-m belt transect in 2002 (YR1) to 2009 (YR8).

Transect	2002 (YR1)		2003 (YR2)		2006 (YR5)		2009 (YR8)		% Change to 2008
	Count	Shrubs / acre	Count	Shrubs/ acre	Count	Shrubs/ acre	Count	Shrubs/ acre	
T-18	14	700	27	1,300	28	1,400	9	450	-36 %
T-19	1	50	2	100	11	550	3	150	+200 %
T-20	11	550	12	600	20	1,000	7	350	-36 %

Forest Cover

White and black spruce (*Picea glauca, P. mariana*), aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*) are present in the study area. Thinning reduced tree *canopy cover* by more than 50%. Pre-treatment cover averaged 63%, while post-treatment averaged 22% in 2002. The treatment essentially converted a closed needleleaf forest (defined by Viereck as >60% cover) to an open needleleaf forest (25-60% cover), even bordering an open woodland (defined as <10% cover). This represented a substantial modification of the vegetation community due to thinning. In the first years following treatment, a number of overstory trees demonstrating reddened or dropped foliage, woodpecker activity, sap bleeding at branches, frost cracks, or outright mortality. Northern spruce engraver beetle (*Ips perturbatus*) activity was heavy the summer after treatment in log decks salvaged for firewood and in standing trees. Traps were deployed in 2002-2003 with cooperation of the Alaska Department of Forestry to combat the beetle infestations. In localized areas, up to 25% of remnant trees showed severe damage or mortality, although none of the overstory trees in the permanent transects had died by 2009.

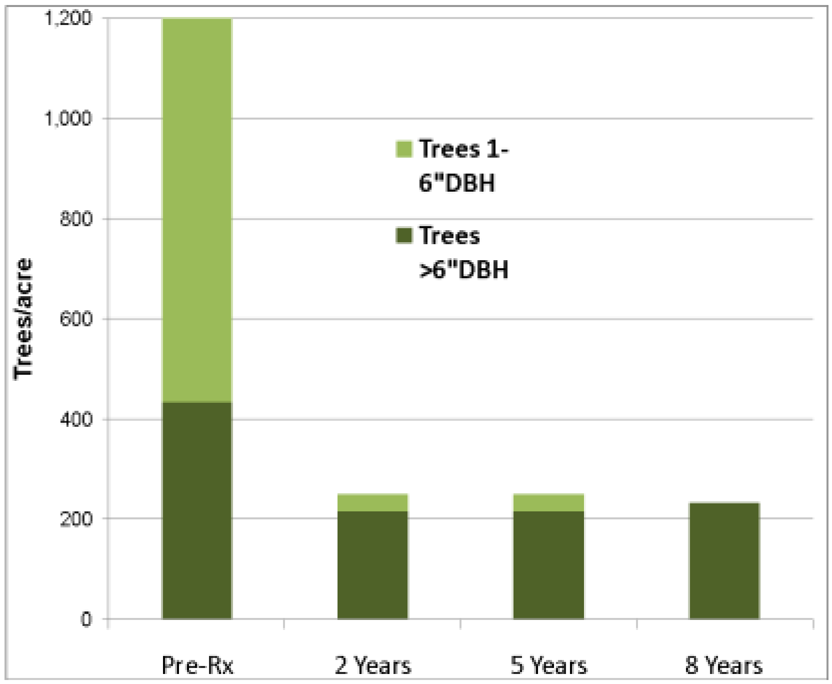
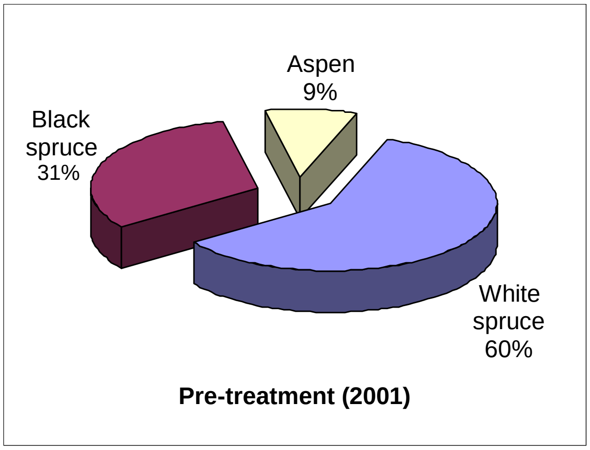


Figure 5. Density of overstory and pole-sized trees in fuel treatment transects before and 2, 5, and 8 years post-thinning.

Before thinning the 3m x 30m permanent plots contained an average of 9 "overstory" trees with $\geq$ 6" (15 cm) diameter at breast height (DBH), 15 trees with DBH between 1"-6", and 90 small trees < 1" (2.5 cm) DBH. White spruce was the most frequently encountered species, representing 57% of the overstory and 90% of the pole-sized trees. After thinning, plots averaged 4 overstory trees (white spruce and aspen), and less than 1 pole-sized tree. Overall tree density (>1" DBH) was thus reduced by 80%, from 1,062 trees/acre to 230 trees/acre which equates to 14' x 14' spacing. This exceeded the contract specifications, which called for 12' x 12' spacing.

Small trees and seedlings were initially reduced from about 90 to 31 per plot (1,500/acre) in 2002 but quickly recovered to an average of 70 per plot (3,533/acre) in 2 years. Species composition also changed with aspen representing 73% of the small tree population in 2004, due to resprouting and seeding (Fig. 6). After 8 years, seedlings numbered 5,867/ac: 45% white spruce and 55% aspen. Proliferation of white spruce seedlings was responsible for most of the increase, indicating they are finding suitable germination conditions in the treated stands. Black spruce and birch seedlings were not found in the plots. These species did not seem to reproduce as well in the post-treatment conditions. Since almost all of the black spruce overstory was removed by the treatment and semiserotinous cones likely remained closed until piled and burned, seedfall of black spruce may have been minimal on the sites.



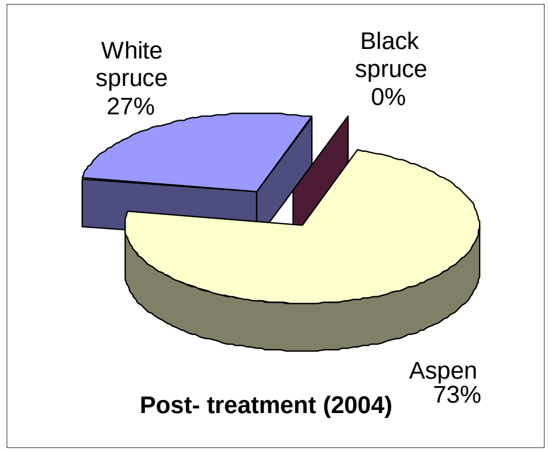


Figure 6. Average seedling and small tree (<1" DBH) species composition pre-treatment (2001) and post-treatment (2004).

Down Woody Fuel Loading

Woody debris is less important as a component of hazardous fuels in boreal forests than in temperate forests of the continental U.S. Under natural conditions, small woody debris and needlecast duff are quickly incorporated into the live moss layer of the forest floor. Large fuels (downed aspen and white spruce), which contributed 80% of the pre-treatment 1000-hr loading in the Tanacross stand, were removed by thinning crews reducing the 1000-hr component initially (Fig. 7). However, 1-hr fuels increased in all three transects post thinning with accumulation of twig debris from thinning. Total down woody fuel loading in the treatment area (not counting piles intended for firewood) was relatively unchanged, although it was beginning to decline by 2008 as fine woody debris was incorporated into duff (Fig. 8). The initial increase in lighter, faster-drying dead woody fuels along with dead moss in the first 2-3 years post-treatment would likely bring a transient increase in ignition potential and rate of spread in the treated stand. Also, firewood log decks remained scattered throughout the treated areas even 8 years after thinning, which would definitely contribute to fire hazard, although we did not attempt to inventory these.

Figure 7. Large 1000-hr woody debris in transect 19 pre-treatment versus 1-hr and 10-hr accumulation post-treatment (2004).

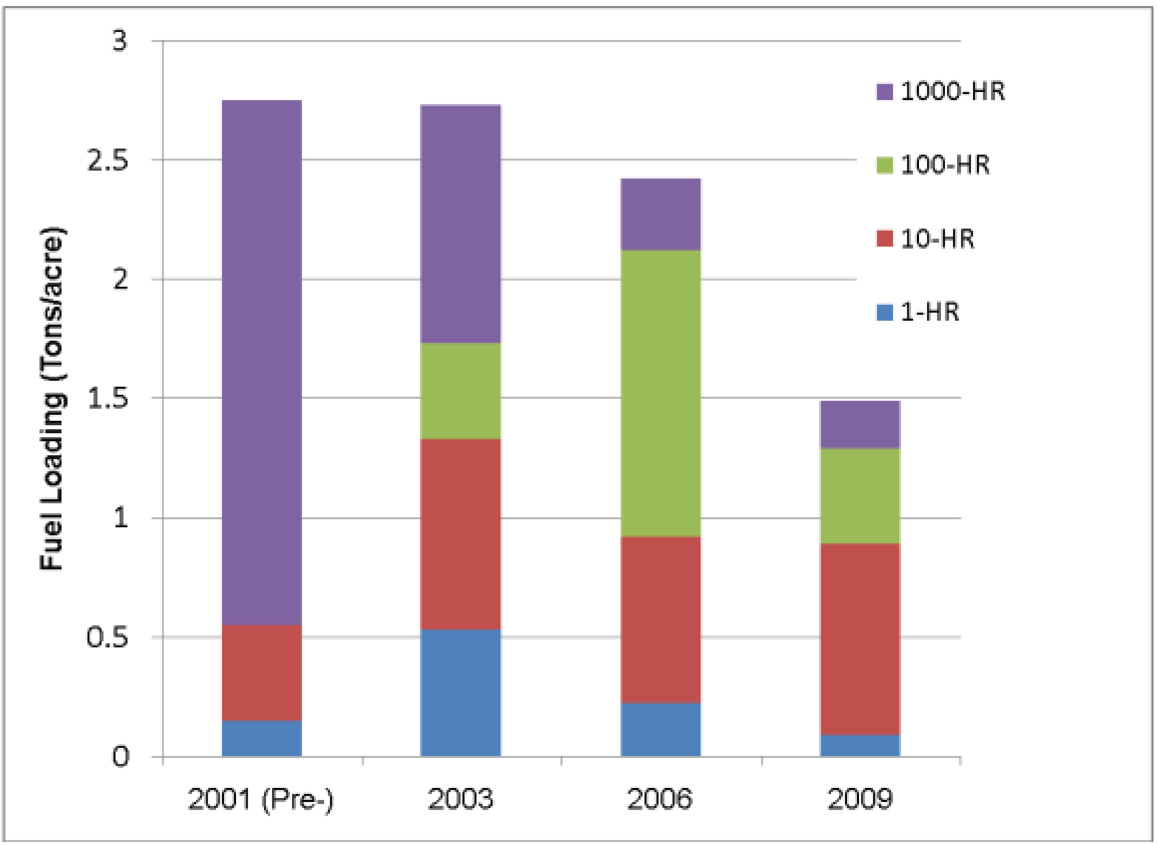


Figure 8. Change in downed woody fuel loadings over time in Tanacross fuel treatment transects (n = 3).

Forest Floor Moisture Sampling

Forest floor mosses are the primary surface fire fuel in boreal spruce forests. Moisture conditions in this layer, which can be 20-40 cm thick, determine potential for ignition and spread of forest fires. The biomass in forest floor moss and duff far exceeds that usually present in natural stands. An average white spruce stand may have moss/litter fuel loadings of 4 tons/acre[1] and upper/lower duff loadings of 30 tons/acre[1], far exceeding down and woody fuel loadings (see above). Duff moisture samples were collected in the fuel treatments during the summers of 2002-2003 in the treated and in adjacent "control" areas (Jandt, et al 2005). The forest floor tended to be dryer near the surface in thinned units in both years. Live and dead moss layers were found to be 49% and 36% drier, respectively, in thinned areas two years after treatment. However, upper and lower duff layers (approximately 7-15 cm deep) exhibited the opposite effect, with post-treatment stand samples averaging slightly higher moisture contents than controls (Figure 9). Drier conditions within superficial duff layers in the fuel break are attributed to increased solar radiation and more wind effect in opened stands. Summer rainfall in 2003 and 2004 was below average and may have contributed to feather moss mortality seen in the vegetation transects, however, what rain there was penetrated into the forest floor in opened stands due to reduced canopy interception.

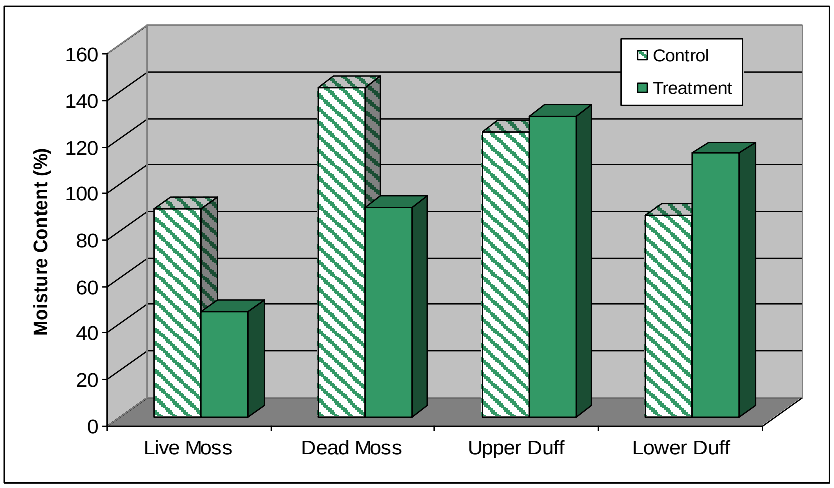


Figure 9. Average moisture content (% by weight) in treatment and adjacent "control" or unthinned areas. Samples were collected from May 5, 2003 through July 24, 2003 by US Fish and Wildlife Service technician Esther Horschel (n = 8 paired samples per stratum).

Active Layer Depth

Ten active layer depth measurements were collected along each 30-m transect. We expected increases in active layer depth under the opened canopy due to more solar radiation, and disturbance of ground cover. Surprisingly, the frost layer was closer to the surface in 2002, averaging 42 cm in depth versus 55 cm under untreated conditions (Figure 10). This could be due to reduction in thaw, duff compaction, or reduced snow cover. Depth to permafrost has since increased incrementally, slowly approaching (but still less than) pre-treatment depths.

[1] Ottmar, R.D. and R.E. Vihnanek. 1998. Stereo photo series for quantifying natural fuels. Vol. 2: black spruce and white spruce types in Alaska. PMS 831. Boise, ID: NWCG, NIFC. 65 p.

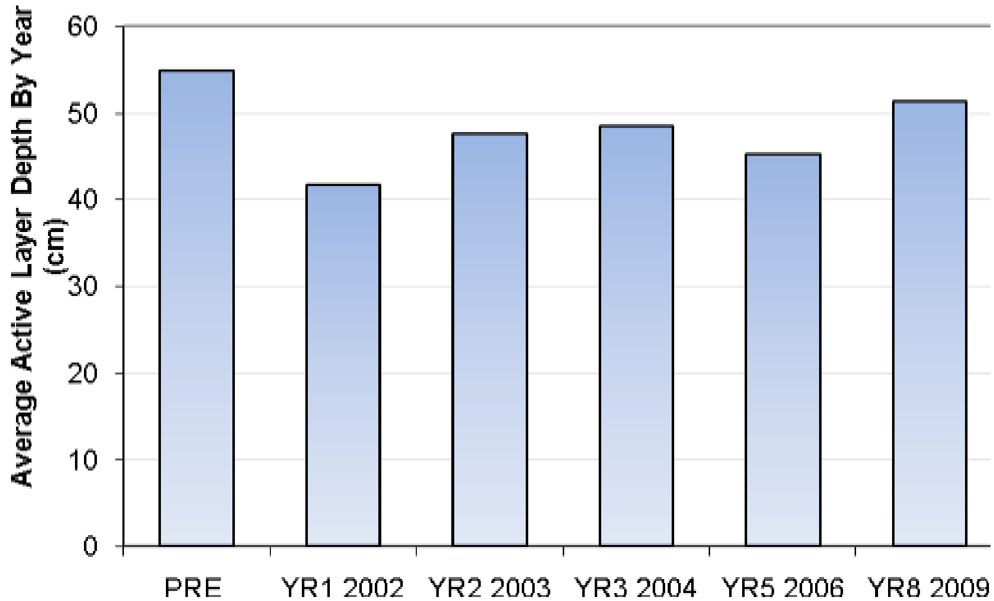


Figure 10. Average active layer depths (cm) from 2001 (pre-treatment) to 2009 (YR8).

Conclusion

The Tanacross shaded fuel break project successfully opened the canopy, eliminated ladder fuels, and removed large down woody debris around homes in the community. These efforts aid suppression efforts by providing easier access, and theoretically reducing potential for crown fire development or incursion into the treated areas. However, thinning changed surface fuel dynamics by inducing moss mortality, adding fine down woody fuels, reducing moss moisture content and increasing grass cover. By the third summer, the dead moss layer was matted and starting to decay into fibrous material reminiscent of mulch barriers used for ornamental shrubs. This was such a novel fuel type we can only speculate on its ignition and fire spread capability. Initial increases in flashy fuel accumulation represent a potential threat to the community in the immediate post-treatment years. However, developing hardwood cover, as evidenced by aspen resprouts and seedlings observed, will also change the future fuel dynamic as they begin to contribute to the overall canopy cover. After 8 years, hardwood and white spruce regeneration are both noticeable in the understory and dead moss concentrations have decomposed or been incorporated into the duff. Although grass has increased in the understory, we have not seen an invasion of mat-forming perennial grasses like *Calamagrostis canadensis* which have caused problems in southcentral Alaska. Rather, we have seen a diverse flora of bunch grasses develop. Experience with experimental burning of thinned stands in 2009[2] demonstrated that the high live moisture content of grasses during mid-summer makes them resistant to the propagation of surface fire.

Using the agency modeling tools to describe potential for changes in fire behavior on similar shaded fuelbreak treatments yielded mixed results. Treated and control plots

[2] See www.firescience.gov, Quantifying the Effects of Fuels Reduction Treatments on Fire Behavior and Post-Fire Vegetation Dynamics, Project 06-1-2-39.

from fuel demonstration sites in black spruce in Fairbanks, Delta, and Nenana were analyzed using NEXUS 2.0 (Scott and Burgan, www.fire.org) and BEHAVE for differences in predicted fire behavior. Given 90th-percentile (hot and dry) weather passive crown fire and torching behavior were predicted on both treatment and control sites in Fairbanks and Nenana (Horschel 2007, Theisen 2003). Only at Delta, with higher wind component, was a change from active crown fire to passive crowning realized by the model. Rates of surface spread almost doubled for all three demonstration units due to slight increase in surface wind speed in the thinned stands (1-4 mph greater in treatments). On the other hand, critical flame length required to initiate crowning also increased at all 3 sites, due to reductions in crown bulk density and removal of ladder fuels. Field experiments under more moderate burning conditions in 2009 yielded better results than models, with little surface spread into thinned units (see previous footnote). Fire risk trade-offs are expected to be similar at Tanacross and will continue to change over time and the fuel complex changes and evolves following treatment. **Our findings and the model results reinforce the importance of not marketing shaded fuelbreaks to the public as a passive defense but rather an improved setting in which to set up an active suppression defense (using wetline, sprinklers, further fuel reduction, etc.) against fire incursion. Continued monitoring of fuelbed evolution post-treatment is highly recommended to follow the observed changes.**

Literature Cited

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