2006 UPDATED REPORT Jennifer Hrobak & Randi Jandt
Tanacross Shaded Fuel Break AA39 BLM – Alaska Fire Service

Fuel Reduction Project

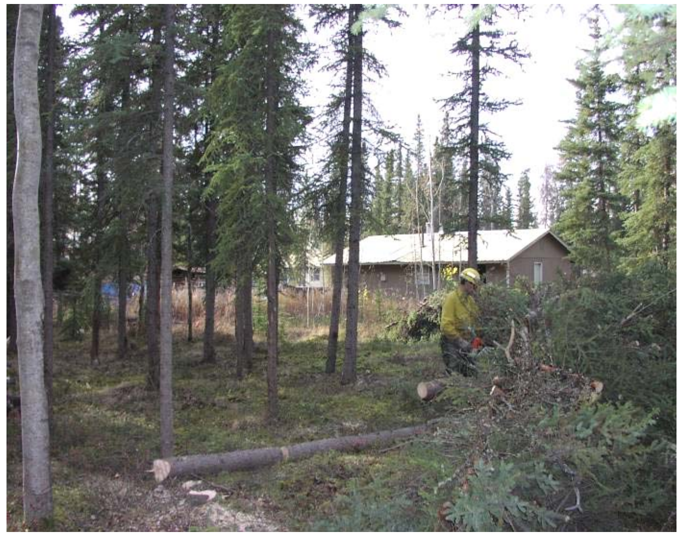

Figure 1. Hand crew thinning spruce stand and removing ladder fuels around Tanacross.

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. Additional acres were treated in 2005 and 2006. Pre-existing crown closure of primarily white spruce was 60-100% and treatment was intended to produce an open stand to reduce the impact of an oncoming wildfire and provide easier access for suppression efforts. 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 (Figure 1). The prescription was designed to minimize the risk of spreading disease and damage to remnant trees when cutting, piling, and burning slash piles.

Vegetation Cover

Three permanent transects, measuring 30m x 3m, were established in 2001 to monitor changes in understory vegetation cover. Though pre-treatment (2001) vegetation composition differed slightly between transects, the main understory components were low-bush cranberry (*Vaccinium vitis-idaea*) and feather moss (*Plueurozium schreberi* and *Hylocomium splendens*) (Tables 1A-1C). Other common species included crowberry (*Empetrum nigrum*), twinflower (*Linnaea borealis*), and willow (*Salix* species). After the treatment was completed, transects were monitored annually from 2002-2004 and again in 2006 to assess changes in cover. One of the most notable changes was loss of viability of the feather moss forest floor in the first two summers following thinning (Figure 2). Live moss cover comprised almost 50% of the ground cover in 2001, whereas by 2003 less than 5% was recorded as live and 22% of the forest floor was dead feather moss, creating a very dry, compact surface fuel type. Species diversity has also increased post-treatment with 2- 4 additional species identified on each transect. This is occurring within *Poaceae* (grass) family in particular. Four different species of grass were identified in 2004 including fescue (*Festuca altaica*), purple reedgrass (*Calamagrostis purpurascens*), boreal wildrye (*Elymus innovatus*), and brome grass (*Bromus marginatus*). An additional species, bluegrass (*Poa pratensis*), was identified in 2006.

Table 1A. Absolute cover (total cover, including overlaps of multiple species at a single spot) and relative cover (percentage of the total cover) in T-18 pre-treatment (2001) and 5 years post-treatment (2006).

Species Name	Common Name	% Cover 2001 (PRE)	Relative % Cover	% Cover 2006 (YR5)	Relative % Cover
Vaccinium vitis-idaea	Low-bush cranberry	35	21.1	41	19.4
Rosa acicularis	Prickley rose	13	7.8	13	6.2
Salix species	Willow	11	6.6	9	4.3
Equisetum species	Horsetail	5	3.0	11	5.2
Pyrola species	Wintergreen	5	3.0	4	1.9
Geocaulon lividum	Bastard toadflax	4	2.4	9	4.3
Shepherdia canadensis	Soapberry	4	2.4	1	0.5
Linnaea borealis	Twinflower	3	1.8	5	2.4
Empetrum nigrum	Crowberry	3	1.8	3	1.4
Epiliobium angustifolium	Fireweed	2	1.2	3	1.4
Grass species		1	0.6	4	1.9
Carex species	Sedge	1	0.6	1	0.5
Lupinus arcticus	Lupine	1	0.6	1	0.5
Senecio vulgaris	Common groundsel	-	-	2	0.9
Pedicularis labradorica	Lousewort	-	-	1	0.5
Moss, dead		-	-	11	5.2
Moss, live		37	22.3	24	11.4
Litter		31	18.7	51	24.2
Wood		8	4.8	15	7.1
Tree bole		2	1.2	-	-
Lichen		-	-	2	0.9

Table 1B. Absolute cover (total cover, including overlaps of multiple species at a single spot) and relative cover (percentage of total cover) in T-19 pre-treatment (2001) and 5 years post-treatment (2006).

Species Name	Common Name	% Cover 2001 (PRE)	Relative % Cover	% Cover 2006 (YR5)	Relative % Cover
Vaccinium vitis-idaea	Low-bush cranberry	19	13.8	12	8.2
Geocaulon lividum	Bastard toadflax	7	5.1	-	-
Grass species		4	2.9	17	11.6
Linnaea borealis	Twinflower	5	3.6	1	0.7
Ledum palustre	Labrador tea	3	2.2	3	2.0
Buplerum triradiatum	Thorow wax	1	0.7	-	-
Epiliobium angustifolium	Fireweed	-	-	5	3.4
Equisetum species	Horsetail	-	-	2	1.4
Anemone species	Buttercups	-	-	1	0.7
Carex species	Sedge	-	-	1	0.7
Moss, live		76	55.1	13	8.8
Moss, dead		-	-	27	18.4
Lichen		6	4.3	-	-
Litter		15	10.9	57	38.8
Tree bole		2	1.4	-	-
Wood		-	-	7	4.8
Duff		-	-	1	0.7

Table 1C. Absolute cover (total cover, including overlaps of multiple species at a single spot) and relative cover (percentage of total cover) in T-20 pre-treatment (2001) and 5 years post-treatment (2006).

Species Name	Common Name	% Cover 2001 (PRE)	Relative % Cover	% Cover 2006 (YR5)	Relative % Cover
Vaccinium vitis-idaea	Low-bush cranberry	35	21.5	31	14.1
Empetrum nigrum	Crowberry	20	12.3	14	6.4
Geocaulon lividum	Bastard toadflax	8	4.9	1	0.5
Grass species		9	5.5	35	15.9
Linnaea borealis	Twinflower	7	4.3	4	1.8
Lupinus arcticus	Lupine	4	2.5	2	0.9
Buplerum triradiatum	Thorow wax	3	1.8	-	-
Shepherdia canadensis	Soapberry	2	1.2	1	0.5
Vaccinium uliginosum	Dwarf blueberry	2	1.2	4	1.8
Carex species	Sedge	2	1.2	-	-
Ledum palustre	Labrador tea	1	0.6	2	0.9
Pyrola species	Wintergreen	1	0.6	1	0.5
Salix species	Willow	1	0.6	-	-
Arctostaphylos uva-ursi	Bearberry	-	-	6	2.7
Aster species		-	-	1	0.5
Equisetum species	Horsetail	-	-	1	0.5
Moss, live		36	22.1	32	14.5
Moss, dead		-	-	10	4.5
Lichen		16	9.8	4	1.8
Litter		14	8.6	67	30.5
Wood		1	0.6	3	1.4
Tree bole		1	0.6	1	0.5

Figure 2. Grass cover in five year old thinning treatment (foreground) versus grass cover in adjacent recent treatment (background).

Most of the understory vegetation has gradually recovered from the initial thinning disturbance to within 5% of pre-treatment cover (Figure 3). However, average graminoid (grass/sedge) cover has steadily increased over the last 5 years, rising from less than 1% in 2002 (1 year post) to 19% in 2006 (5 years post), surpassing the pre-treatment average by 13% (Figure 3, Figure 2). Forest floor composition was most strongly impacted by the reduction in canopy. Feather moss appears to be rebounding, currently at 50% of its' original cover (Figure 4). Although the moss seems to be recovering, the dynamics of the ground fuels have changed. The organic layer, normally a thick mat of decomposing material, has been compacted to just a few centimeters above the soil. Furthermore, litter cover has nearly tripled at almost 60% cover, creating a mulch-like fuelbed.

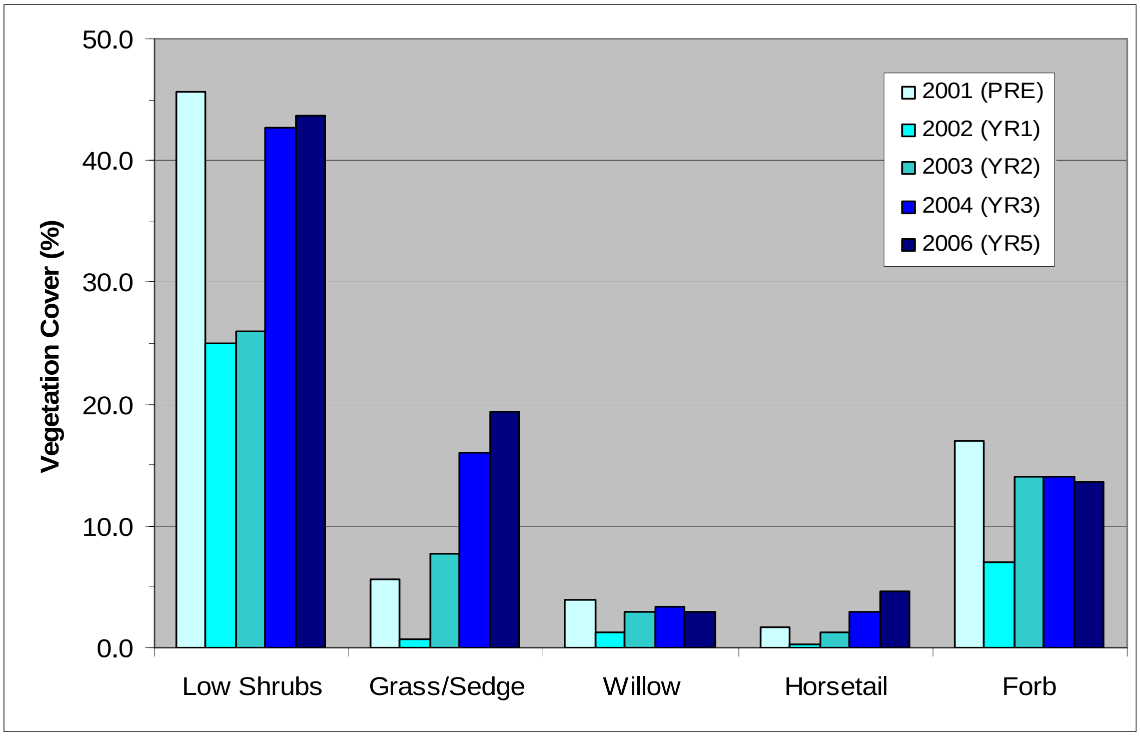

Figure 3. Average percent vegetation cover in 2001 (PRE) through 2004 (YR3) and 2006 (YR5). All sampling was conducted in late summer on three permanent transects (n=3).

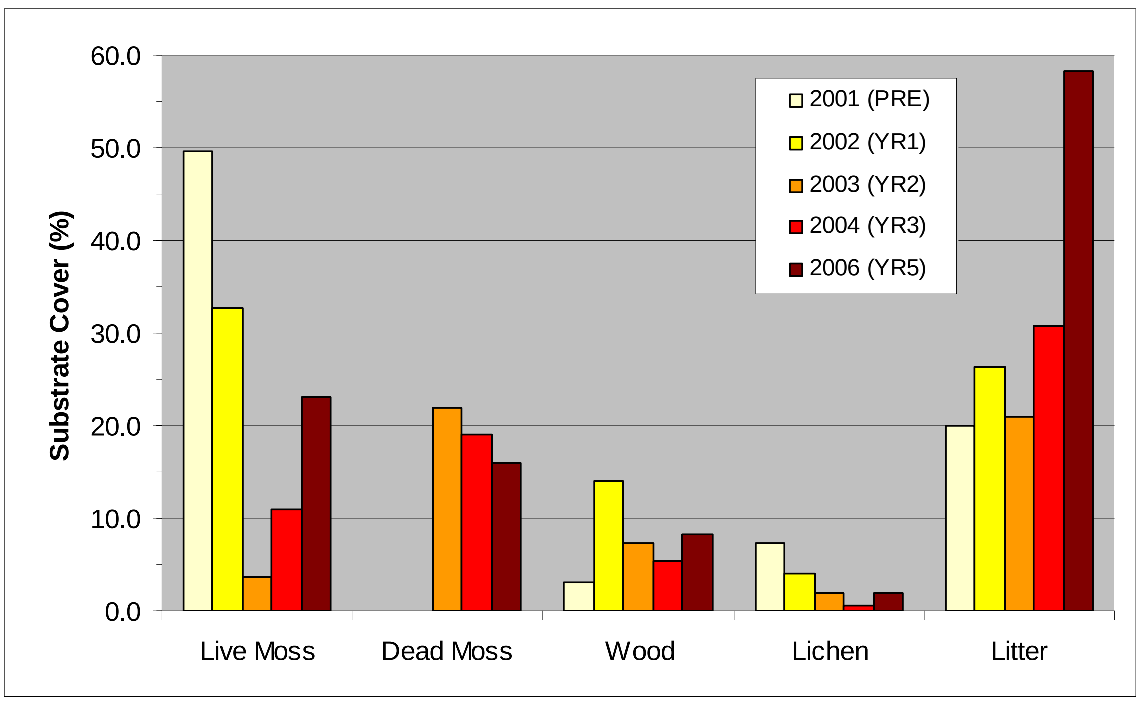

Figure 4. Average percent substrate cover in 2001 (PRE) through 2004 (YR3) and 2006 (YR5). All sampling was conducted in late summer on three permanent transects (n=3).

Shrub Density

Willow species, primarily Bebb willow (*Salix bebbiana*) and Diamondleaf willow (*S.x pulchra*) are the prevalent large woody shrubs in the Tanacross unit. Shrub density was only monitored post treatment. Willow regeneration, a combination of seeding and resprouting, has progressively increased every year in each transect. Average density has increased from 386 shrubs/acre in 2002 (YR1) to 876 shrubs/acre in 2006 (YR5) (Table 2).

Table 2. Large woody shrub stem count and shrub density (shrubs/acre) for 2002 (YR1), 2003 (YR2), 2004 (YR3), and 2006 (YR5).

Transect	2002 (YR1)		2003 (YR2)		2004 (YR3)		2006 (YR5)		% Change to 2006
	Stem Count	Shrubs/ acre	Stem Count	Shrubs/ acre	Stem Count	Shrubs/ acre	Stem Count	Shrubs/ acre	
T-18	14	623	21	935	-	-	28	1247	+100
T-19	1	45	2	89	3	134	11	490	+1001
T-20	11	490	12	534	16	712	20	890	+82
Average	**9**	**386**	**12**	**519**	**53**	**2360**	**20**	**876**	**+127**

Tree Density

White and black spruce (*Picea glauca, P. mariana*), aspen (*Populus tremuliodes*), and balsam poplar (*Populus balsamifera*) are present in the study area. Before thinning the 30m x 3m permanent plots contained an average of 8 "overstory" trees with diameter at breast height (DBH) ≥ 15.0 cm, 7 "pole" sized trees with DBH from 2.5-14.9 cm, and 90 "seedlings"(defined as trees <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—a density of 30 trees/acre compared to 298 trees/acre pre-treatment (Table 3). Overall tree density, excluding seedlings, was thus reduced by 65%, from 640 trees/acre to 220 trees/acre, which equates to 14' x 14' spacing. This exceeds the contract specifications, which called for 12' x 12' spacing.

Table 3. Average live overstory (DBH ≥ 15.0 cm) and pole-sized (DBH 2.5-14.9 cm) tree density (trees/acre) by species in 2001 (pre-treatment) and 2006 (five years post-treatment).

	Overstory			Pole		
Species	**2001 (PRE)**	**2006 (YR3)**	**Change**	**2001 (PRE)**	**2006 (YR3)**	**Change**
White spruce	193	119	-39 %	268	30	-89 %
Black spruce	45	0	-100 %	30	0	-100 %
Aspen	89	74	-17 %	0	0	0 %
Poplar	15	0	-100 %	0	0	0%
Total	**341**	**193**	**-44 %**	**298**	**30**	**-90%**

Seedling density was initially reduced from 4376 seedlings/acre in 2001 to only 1378 seedlings/acre one year after treatment (2002). Regeneration has steadily increased to 3597 seedlings/acre since 2002 and will probably continue to do so until a mid-canopy layer is established or until the forest floor no longer supports seeding/resprouting to occur. Interestingly, species composition has also changed where aspen seedlings now represent 73% of the population, the majority of which are resprouts, versus only 8% pre-treatment (Figure 5). This is indicative of a potential future stand conversion in certain areas from a closed white spruce/black spruce mix to an open hardwood (aspen) stand (Figure 6).

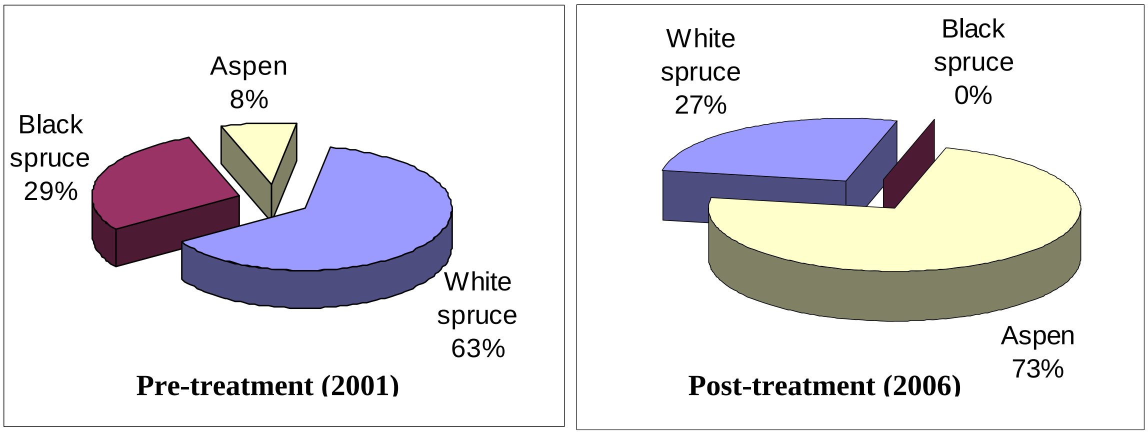

Figure 5. Average seedling species composition pre-treatment (2001) and post-treatment (2006).

Since 2002, we have observed a number of overstory trees demonstrating reddened or dropped foliage, woodpecker activity, sap bleeding at branches, frost cracks, and some mortality. Northern spruce engraver (*Ips perturbatus*) beetle 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. Damage and mortality of remnant trees will continue to be monitored and the causes ascertained. Expansion of the fuel break in 2005 and 2006 (Figure 2) may incite further engraver beetle infestation and mortality as remnant trees in the original fuel treatment have been weakened. Additional traps have been installed in efforts to prevent this occurrence. Additionally, leaf miner and aphid activity has been high on aspen seedlings which may also lead to some mortality, though none has been observed at this time (Figure 6).

Figure 6. Dense aspen regeneration in 2006 and leaf miner activity indicated by silvery leaves near T-18.

Canopy Cover

The 14 x 14' thinning treatment reduced tree canopy cover by more than 50%. Pre-treatment cover averaged 63%, while post-treatment averaged 22% (Table 4). 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 represents a substantial modification of the overstory vegetation due to thinning.

Table 4. Canopy cover pre- and one year post-treatment determined by densiometer on random meander lines near the permanent transects.

# Hits	Transect 18 n=30 PRE/POST	Transect 19 n=40 PRE/POST	Transect 20 n=35 PRE/POST
White Spruce	18 / 7	17 / 5	18 / 7
Aspen	4 / 1	4 / 0	3 / 2
Balsam Poplar	1 / 0	0 / 0	0 / 0
Black Spruce	0 / 0	0 / 0	0 / 0
Total	23 / 8	21 / 5	21 / 9
Total Canopy (Pre-)	77%	52.5%	60%
Conifer Cover	*60%*	*42.5%*	*51%*
Total Canopy (Post-)	26.7%	12.5%	25.7%
Conifer Cover	*23.3%*	*12.5%*	*20%*

Down Woody Fuel Loading

Woody debris is a less important 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. Now that the thick organic mat has essentially been eliminated within the treatment, woody debris can play a more significant role if accumulations are high enough to impact surface fire behavior. Down woody fuel loading in the treated area fluctuated from year to year. In general, large 1000-hr fuels (>3" diameter) were gathered and removed during construction of the fuel break. Smaller fuels (≤ 3"diameter) have accumulated from pruning branches and dragging slash along with dead and broken branches falling to the ground post-treatment. Overall, 1-hr, 10-hr, and 100-hr fuel loadings have increased while 1000-hr fuel loading has decreased in the time since treatment (Table 5, Figure 7).

Table 5. Average down woody fuel loading (tons/acre) (n = 3).

Year	**1-hr (0 - 0.25")**	**10-hr (0.25 – 1")**	**100-hr (1 – 3")**	**1000-hr (> 3")**	**Total**
PRE (2001)	0.1	0.4	0.0	2.2	**2.7**
YR1 (2002)	0.5	0.8	0.5	0.0	**1.8**
YR2 (2003)	0.5	0.8	0.4	1.0	**2.7**
YR3 (2004)	0.6	0.7	0.4	0.0	**1.7**
YR5 (2006)	0.2	0.7	1.2	0.3	**2.4**
Change to 2006	**+0.1**	**+0.4**	**+1.2**	**-1.9**	**-0.3**

Figure 7. Large 1000-hr woody debris in transect 19 pre-treatment versus 1-hr and 10-hr accumulation post-treatment (YR3).

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. 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 under 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 (Figure 8).

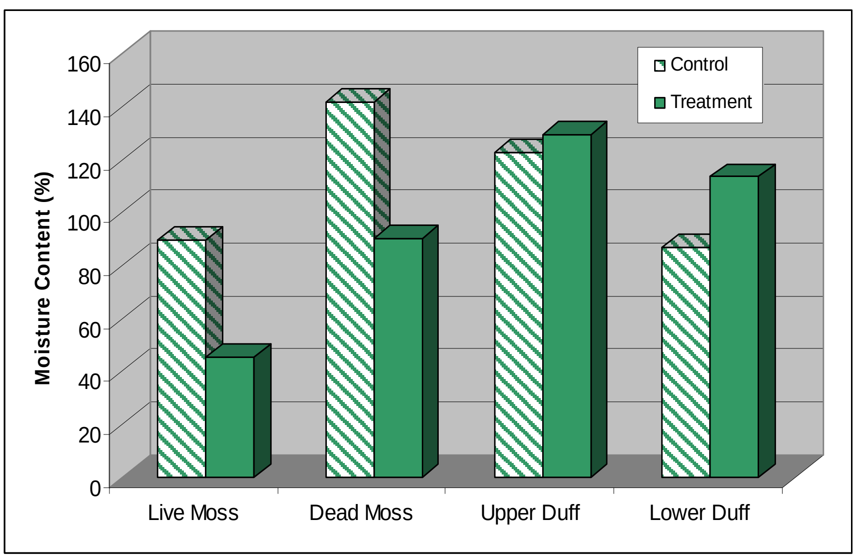

Figure 8. Average moisture content (% by weight) in treatment and adjacent "control" or unthinned areas. Samples were collected from May 5, 2003 through July 24, 2003 by US Fish and Wildlife Service technician Esther Horschel (n = 8 paired samples per stratum).

However, upper and lower duff layers (approximately 7-15 cm deep) exhibited the opposite effect, with post-treatment stand samples averaging slightly higher moisture content than controls. 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. Additional duff sampling should be conducted to determine further changes in moisture dynamics.

Active Layer Depth

Ten active layer depth measurements were collected along each 30m 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 9). This could be attributed to reduction in thaw, duff compaction, or reduced snow cover. Depth to permafrost had increased in 2003 and 2004, slowly approaching (but still less than) pre-treatment depths, and then decreased slightly in 2006.

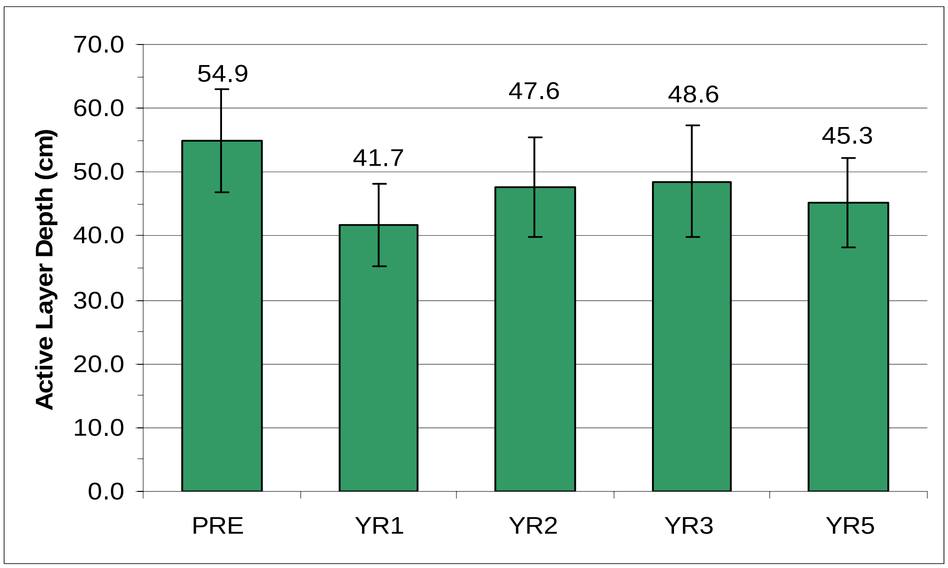

Figure 9. Average active layer depths (cm) from 2001 (pre-treatment) to 2006 (YR5).

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, the 14 x 14' spacing thinning treatment has changed surface fuel dynamics by increasing grass cover, moss mortality, adding fine down woody fuels, and reducing moss moisture content. If the stand continues along this successional vector, increasing flashy fuel accumulation and continuity, intense surface fires could become a potential threat to the community in the future. However, developing hardwood cover, as evidenced by resprouts and seedlings observed, could also change the future fuel dynamic as they begin to contribute to the overall canopy 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 is such a novel fuel type we can only speculate on its ignition and fire spread capability. **Continued monitoring of fuelbed evolution post-treatment is highly recommended to follow the observed changes.**

Using the most recent modeling tools to describe potential for changes in fire behavior on similar shaded fuelbreak treatments yielded mixed results. Treated and control plots 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 (E. Horschel, unpublished data; 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 increased at all 3 sites, due to reductions in crown bulk density and removal of ladder fuels. These modeled results have not yet been substantiated by field experiments, but similar fire risk trade-offs are expected 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.**

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