Observations From a Hold-Over Fire: Seven Mile Slough, 2011

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The conditions that allow a wildland fire to hold over the winter in the duff until spring are poorly known. After a smoke report on 9 May 2011 within the area burned by the 2010 Willow Creek Fire, I was able to investigate. The fire originated near 64° 41.669 × -147° 56.325 and was 0.3 acres at about 19:30, burning in a patch of closed, small diameter, dense spruce with deep feathermoss duff (Figure 1). The new fire was called Seven Mile Slough (Fire 071, F3NK).

Fire perimeter maps indicate this area originally burned from the northeast on 3 August 2010. At that time the fire burned around the stand of spruce, scorching some trees (Figure 1, a) but was apparently able to finger into it to catch the duff. The fire smoldered into the stand over the winter in the upper and lower duff layers just above the mineral soil (Figure 2, b and c). Trees that were under-burned fell over indicated by green tree crowns (Figure 1, b). Much of the smoldering duff extinguished over the winter but a pocket retained heat until 9 May when the live moss dried out enough to allow the fire to flame and reburn through the moss and downed trees (Figure 1, c).

On close inspection, areas of yellow feathermosses indicated where the fire had smoldered and scorched the live moss layer from below. Cutting these areas with a bread knife confirmed a layer of charred duff several inches thick (Figure 2).

The duff profile in the spruce stand averaged >25 cm (>9.8”) thick (the lower duff was still in ice; Table 3) and was probably on the order of a foot deep (Figures 6,7).

Four duff plugs were extracted in an area adjacent to the hold-over for moisture content analysis (Table 1). Moisture content was converted to an estimate of DMC and DC using the Lawson and Dalrymple (1996) equation. Duff moisture data do not necessarily represent moisture conditions experienced by the fire during the winter; during snow-melt a flush of water presumably percolated through the duff. Moisture data indicate that the upper duff layer was drier than the dead moss or lower duff layers, about 92%. Was the upper duff unusually dry for the time of year? The AFS fuel moisture database has no duff plug records from a similar date but mid- to late May upper duff moisture contents range 72-365% (Table 2). The minimum moisture content of 72% was measured at Nenana Ridge Rx Fire on 26 May 2010 which was also a year in which several other fires held over the winter: The 2009 Minto Flats South Fire reburned as the 2010 Toklat Fire and the 2009 Wood River 1 Fire reignited as the Clear Creek Buttes and Wood River Buttes Fires.

Observations from the Seven Mile Slough Fire provides some insight into how and where fires may over-winter. In this case it appears to be due to dry conditions in otherwise unremarkable mid- to lower duff layers. Several questions come to mind: Did the dense spruce canopy influence duff moisture through snow and/or rainfall interception? Why was duff moisture not replenished through percolation during spring thaw? Did dry duff insulate the permafrost, allowing it to remain frozen long enough to prevent saturation of the lower duff from lower ground moisture in the spring?

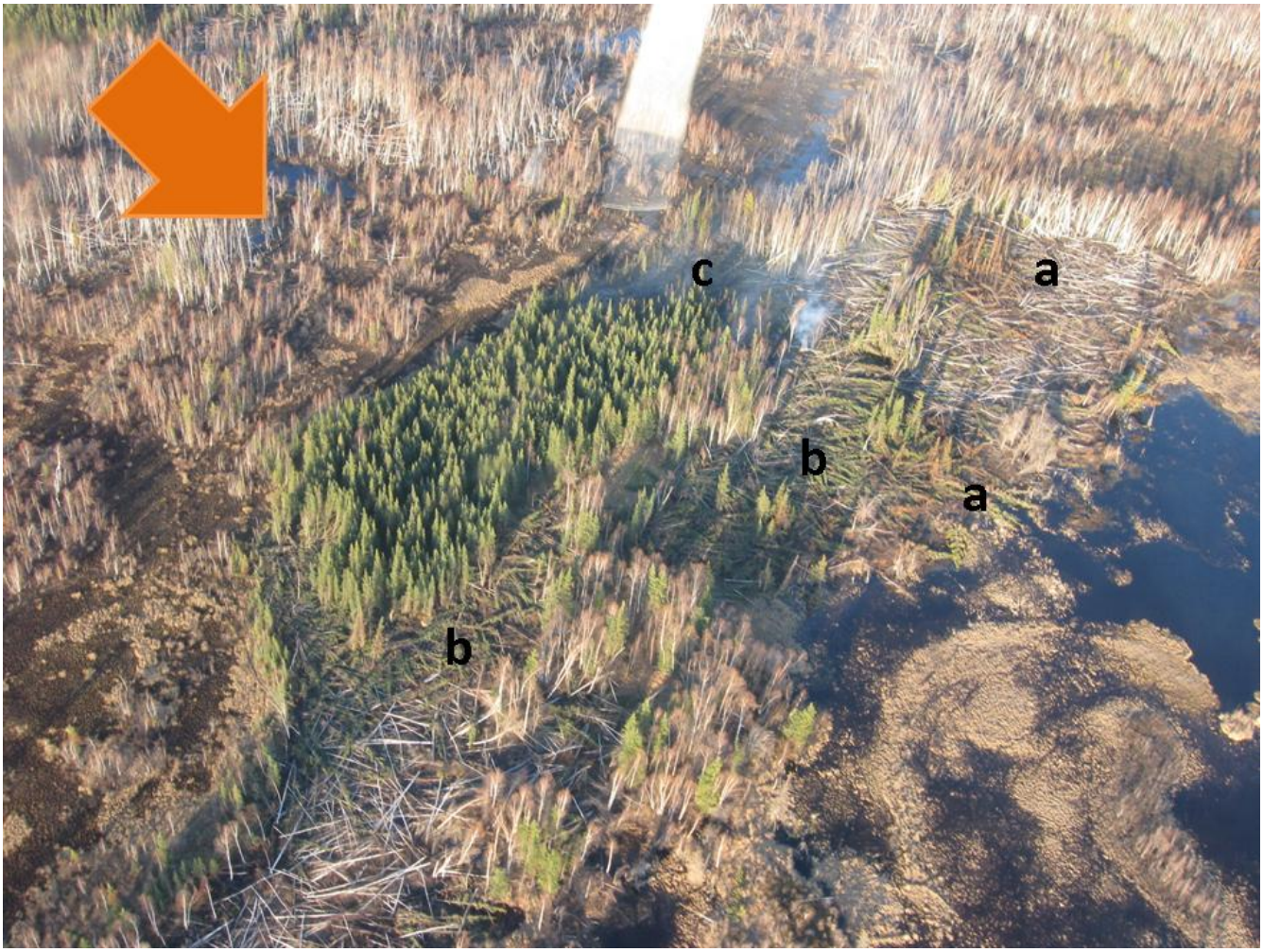

Figure 1. Aerial view of the Seven Mile Slough Fire at 20:49 on 9 May 2011. The Willow Creek Fire burned from the northeast (upper left in the image) on 3 August 2010 scorching trees (a) and smoldering into the spruce. Smoldering fire apparently burned the roots out under the spruce over the winter in the area of green tree crowns (b). Smoldering fire held over the winter at (c) and re-burned through the down (and still green) spruce.

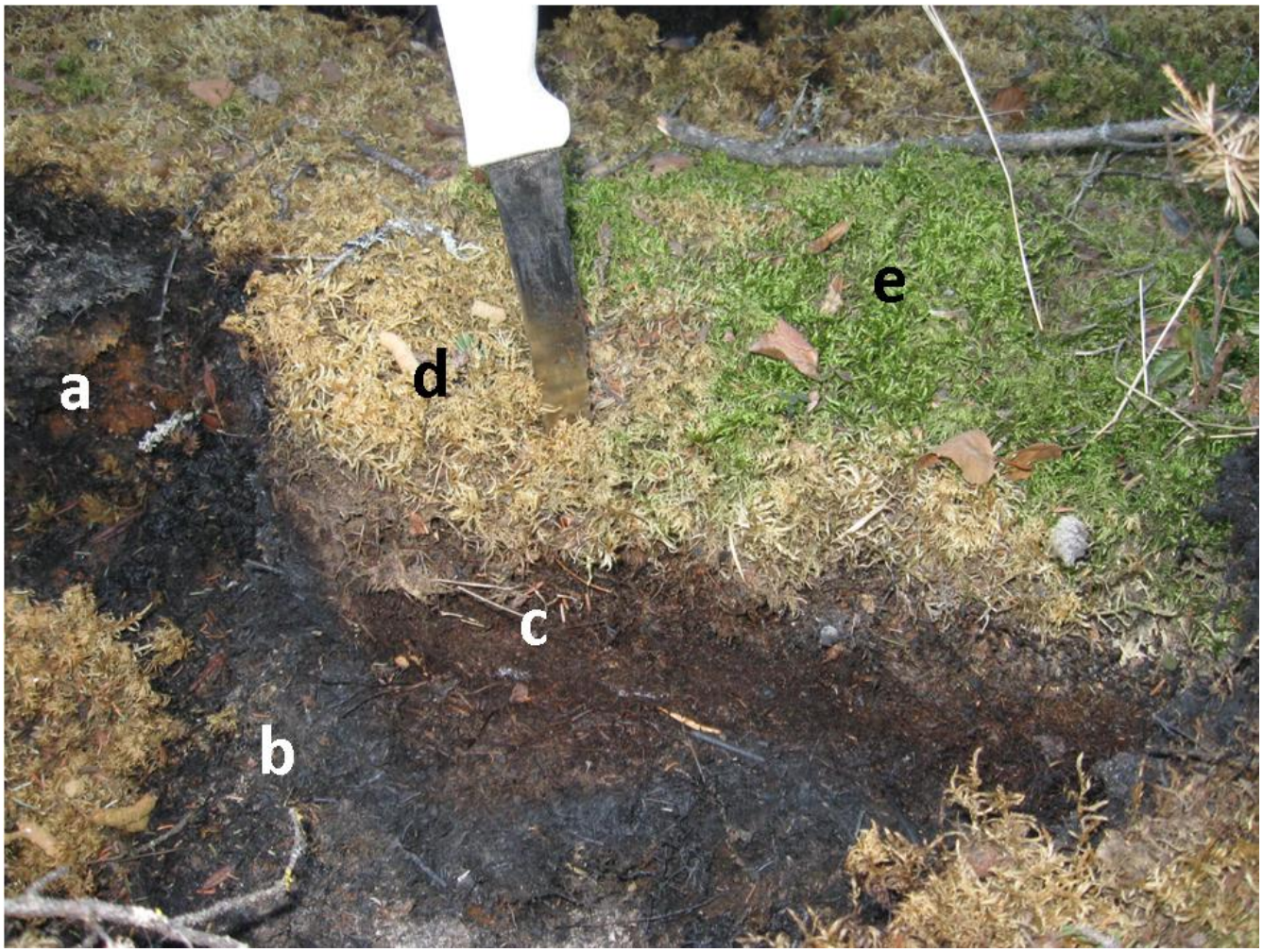

Figure 2. Duff profile. The fire held over in the bottom of the duff profile just above the mineral soil (a) leaving a layer of char here (b). Live feathermoss (e) over the smoldering areas was scorched and killed by heat (d).

Figure 3. Areas of smoldering combustion in mixed birch and spruce. The fire eventually extinguished here.

Figure 4. Areas of smoldering combustion in fairly dense spruce. It appears the fire held over in duff similar to this.

Figure 5. Trees felled from below by smoldering duff consumption over the winter. Note the green crowns and deep ash.

Figure 6. Duff plug showing the live moss, dead moss, and upper duff layers. The steel blade on the bread knife is 9-3/4" (25 cm).

Figure 7. Duff plug showing the live moss, dead moss, and upper duff layers. The steel blade on the bread knife is 9-3/4" (25 cm).

Table 1. Fuel moisture data.

Gravimetric Moisture, DMC, and DC				
Layer	Mean	Max	Min	Count
Live Moss	--	--	--	--
Dead Moss	137	187	76	4
Upper Duff	96	116	77	6
Lower Duff	338	434	241	2
DMC	47	40	59	
DC	435	384	495	

Table 2. Upper duff moisture contents for mid-May from the AFS fuel moisture database.

FWW JFS FUEL TREATMENT		
	5/23/2003	226
	5/23/2008	101
NENANA RIDGE RX		
	5/28/2008	365
	5/29/2009	157
	5/26/2010	72
TANACROSS		
	5/15/2003	189
	5/21/2003	201
SEVEN MILE SLOUGH		
	5/9/2011	92

Table 3. Duff layer dimensions, metric (top) and English (bottom) units.

Depth Layer	**Mean (cm)**	Max	Min	Count
Live Moss	2.5	4	2	4
Dead Moss	6.3	12	3	4
Upper Duff	16.3	20	12	4
Lower Duff	The bottom of the lower duff was iced.			

Depth Layer	**Mean (inches)**	Max	Min	Count
Live Moss	1.0	1.6	0.8	4
Dead Moss	2.5	4.7	1.2	4
Upper Duff	6.4	7.9	4.7	4
Lower Duff	The bottom of the lower duff was iced.			

References

Lawson, B.D. and G.N. Dalrymple. 1996. Ground-truthing the Drought Code: Field verification of overwinter recharge of forest floor moisture. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. FRDA Report 268, Copublished by the BC Ministry of Forests