



# Soils, Vegetation, and Woody Debris Data from the 2001 Survey Line Fire and a Comparable Unburned Site, Tanana Flats Region, Alaska

By K.L. Manies, J.W. Harden, and T.N. Hollingsworth

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## Conversion Factors

### SI to Inch/Pound

Multiply	By	To obtain
Length		
centimeter (cm = $10^{-3}$ m)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
Area		
square meter (m <sup>2</sup> )	10.76	square foot (ft <sup>2</sup> )
Mass		
gram (g)	0.03527	Ounce (oz)
kilogram (kg = $10^3$ g)	2.2046	Pound (lb)

# Soils, Vegetation, and Woody Debris Data from the 2001 Survey Line Fire and a Comparable Unburned Site, Tanana Flats Region, Alaska

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By Kristen L. Manies<sup>1</sup>, Jennifer W. Harden<sup>1</sup> and Teresa N. Hollingsworth<sup>2</sup>

## Abstract

This report describes the collection and processing methodologies for samples obtained at two sites within Interior Alaska: (1) a location within the 2001 Survey Line burn, and (2) an unburned location, selected as a control. In 2002 and 2004 U.S. Geological Survey investigators measured soil properties including, but not limited to, bulk density, volumetric water content, carbon content, and nitrogen content from samples obtained from these sites. Stand properties, such as tree density, the amount of woody debris, and understory vegetation, were also measured and are presented in this report.

## Introduction

The Survey Line fire (B247) burned more than 45,000 hectares within the Tanana River floodplain, Alaska. Ignition was in late June of 2001, and the fire was declared out in the fall. This fire burned a variety of ecosystem types, including open black spruce [*Picea mariana* (Mill.) BSP] forest and wetter tussock-dominated systems. Fire affects carbon (C) storage of these ecosystems both directly (for example, fire emissions, loss of vegetation) and indirectly. Indirect effects include altering the soil temperature regime through changes in albedo and the loss of organic layers, which play an important role in soil insulation (O'Neill and others, 2002). Changes in soil temperature in turn affect decomposition rates (Wickland and others, 2010) and vegetative regrowth (Johnstone and others, 2010). To understand these effects, U.S. Geological Survey (USGS) investigators studied two forested sites, one that had burned and an unburned control. Other studies based on the Survey Line fire include changes in post-fire active layer depth (Hollingsworth, 2007) and testing the ability of remotely sensed data to determine burn severity (Epting and others, 2005).

## Site Descriptions

Both the burned and unburned sites were located in the Tanana Flats floodplain region; therefore, all sample names begin with the same two letters (TF), representing the region in which they were collected. The burn site was located within the perimeter of the Survey Line burn (TFSB), south of the Tanana River at 64.64692° N, 148.29767° W (WGS84 datum; fig. 1). A location near this site was classified as a moderate to moderately high burn severity by using the Composite Burn Index (Verbyla, 2007). Although much of the ground remained charred within the burn site at the time of

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<sup>1</sup>U.S. Geological Survey.

<sup>2</sup>U.S. Department of Agriculture, Forest Service.

sampling (spring and summer of 2002), there was recruitment of new vegetation, including, but not limited to, *Calamagrostis canadensis*, *Ditrichum* sp., *Eriophorum vaginatum*, *Ledum groenlandicum*, *Betula* sp., and *Vaccinium uliginosum* (fig. 2).

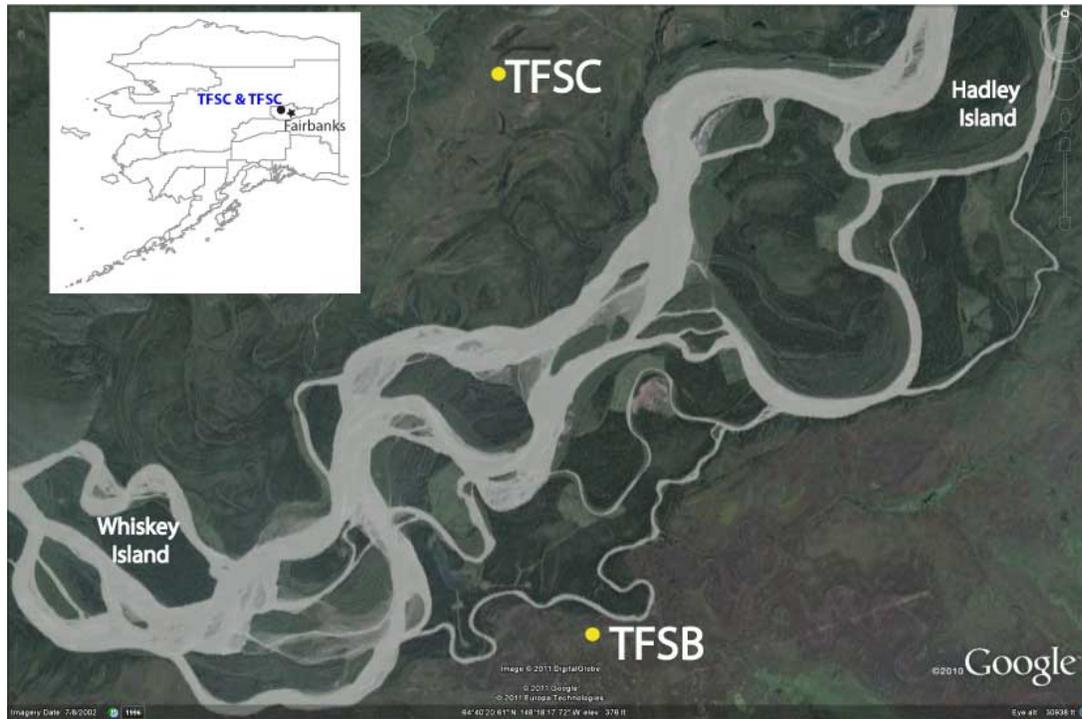


Figure 1. The location of the two study sites along the Tanana River, Alaska. TFSB is the Survey Line burn site. TFSC is the control site.



Figure 2. A photograph of the Tanana Flats Survey Line burn (TFSB) site, Tanana Flats region, Alaska, taken in August of 2002 (slightly more than a year post-burn).



**Figure 3.** A photograph of Tanana Flats Survey Line control (TFSC) site, Tanana Flats region, Alaska. The flagging marks a 1 m<sup>2</sup> plot used to determine vegetation cover.

The control site (TFSC) was located north of the Tanana River within the Bonanza Creek Experimental Forest, part of the Bonanza Creek Long-Term Ecological Research (LTER) program (fig. 1, appendix 1). TFSC is located at lat 64.69744° N., long 148.31917° W. (NAD83<sup>‡</sup> datum) and was sampled in the spring of 2002 and the summer of 2004. This site was also used for a study of the role of drainage on CO<sub>2</sub> and CH<sub>4</sub> exchange (Wickland and others, 2010). The vegetation is similar to TFSB, with the addition of tamarack (*Larix laricina*) and *Sphagnum* sp. (fig. 3).

Each site was visited two times, once in the late spring of 2002 to scout for sites and once at a later date for more intense soil sampling. During the first visit, one or more cores were taken at random locations within the general location of the site. On the subsequent sampling visit, perpendicular transects (in the shape of an 'L') were marked (typically with pink/black flagging). Along each transect, points were marked every 10 m. Soil descriptions and (or) samples were taken at these locations. All soil cores were processed similarly, regardless of when they were obtained. Vegetation measurements (TFSB site only) were also tied to the points along each transect. GPS locations and more detailed information regarding these sampling locations can be found in appendix 1.

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<sup>‡</sup>This report lists the datum used to collect the GPS coordinates, but for the level of precision used here it should be noted that the WGS84 and NAD83 datum are equal. In other words, if the alternate datum is used, the location would only be off by several feet.

## Soil-Sample Collection

At each site we dug soil pits and described soil horizons, following U.S. Department of Agriculture's Natural Resource Conservation Service (USDA-NRCS) (Staff, 1998) and Canadian (Committee, 1998) methodologies. We modified horizon codes according to the following scheme:

- L Live moss, which is green and generally contains some leaf and needle litter.
- D Dead moss, which is composed of undecomposed or slightly decomposed dead moss. This layer is characterized by fibric organic horizons that contain more moss than roots. This layer would be considered an O<sub>i</sub> horizon (U.S. soil system).
- F Fibric (Canadian soil system) or fibrous organic layers, which vary in degree of decomposition, but in which roots are more abundant than recognizable moss parts. Most of these layers would be considered O<sub>i</sub> horizons (U.S. soil system), or upper duff [U.S. Forest Service (USFS) system].
- M Mesic (Canadian soil system) organic layers, which are moderately decomposed, with few, if any, recognizable plant parts other than roots. These layers are generally considered O<sub>e</sub> horizons (U.S. soil system) or lower duff layers (USFS system).
- H Humic (Canadian soil system) or sapric organic layers, which are highly decomposed. These layers generally smear upon squeezing and contain no recognizable plant parts. H layers are generally considered O<sub>a</sub> horizons (U.S. soil system) or lower duff (USFS system).
- A Mineral soil that forms at the surface or below organic-soil horizons (U.S. and Canadian soil systems), containing less than 20 volume percent organic matter, as judged in the field.
- B Mineral soil that has formed below an A horizon (U.S. and Canadian soil systems), with little or none of its original lithologic structure.
- C Mineral soil that has been little affected by pedogenic processes (U.S. and Canadian soil systems).
- LT Litter layer (dead leaves, twigs).
- Se Sedge.
- WD Wood.

Horizon codes could be further described with a lowercase 'b', designating that the horizon had been burned, indicating anything from light scorching to deep charring, or an 'f', indicating that the horizon was frozen at the time of sampling. In general, soil was excavated to the depth of mineral soil; however, we were unable to reach mineral soil consistently at site TFSC, instead stopping once the soil was frozen, due to the early sampling date.

Each soil horizon was labeled with two numbers representing the soil-profile number and basal depth of the sample (in centimeters). A decimal point separates the profile number from the basal depth; for example, TFSB 3.19 denotes a sample from the Tanana Flats Survey Line fire burn site, profile 3, with a basal depth of 19 cm.

A subset of soil profiles was not only described, but also sampled by soil horizon. Samples were collected for bulk-density measurements, analytical purposes, and determination of moisture content. Samples were collected by either cutting out an area of known volume, or by using a corer of known volume (either a Makita corer, see Nadler and Wein (1998), or a SIPRE corer). Samples were placed in clean Ziploc bags or tins and shipped soon after collection to the USGS laboratory in Menlo Park, California.

## Understory Vegetation Measurements

At the Survey Line burn site (TF SB) a temporary plot was anchored to each point along the site's transects to measure percentage of cover of the understory vegetation. These plots were 120 cm<sup>2</sup>. Percentage of cover was quantified visually and assigned into one of eight categories: <1, 1–2, 2–5, 5–10, 10–25, 25–50, 50–75, or 75–100 percent (Hollingsworth and others, 2006).

## Stand-density and Woody-debris Measurements

Downed woody debris was measured by using the line-intersect method (Brown, 1974; Harmon and Sexton, 1996). Eighteen to twenty 20-m transects were located at each site. Fine woody debris (<7 cm diameter) was tallied into one of five size classes (diameters of 0.0–0.49, 0.50–0.99, 1.0–2.99, 3.0–4.99, and 5.0–6.99 cm) and its location was classified as either above ground or below ground (<50 or 50–99 percent buried by forest floor organic matter, respectively). For coarse woody debris (≥7 cm diameter), species, diameter (cm) at transect intersection, and decay class were also recorded. Data were converted to mass of wood per unit of ground area by using Nalder and others (1999) formulas and fuel-load multipliers (based on species and size class) for Southern Northwest Territories (black spruce) and Central Saskatchewan (tamarack). A summary of the findings can be found in table 1.

Stand density was measured by using the point-center quarter (PCQ) method (Cottam and Curtis, 1956) for trees >3 m tall. The PCQ method records the distance of the closest tree in each of the four quadrants surrounding a point. These data are converted to density by first computing the mean area (MA) of the four trees:

$$MA = [(\sum d_i)/n]/c]^2, \quad (1)$$

where *MA* is the mean area per tree (m<sup>2</sup>/tree), *d<sub>i</sub>* is the distance (m) of the tree *i* from the center point, *n* is the number of trees, and *c* is a correction factor based on the number of trees per point (*4 trees*=1.00).

Overall density at the point is then calculated by using:

$$D = (1/MA) * (1,000 \text{ m}^2/\text{ha}), \quad (2)$$

where *D* is the relative density (trees/ha) and *MA* is mean area (m<sup>2</sup>/tree). Density of trees <3 m tall were measured using a 2 m circular plot centered around the same point used for the PCQ measurements.

Tree species, diameter at breast height (also known as DBH, defined as diameter at 1.37 m), diameter at the base, height to live (m), height to crown (m), and condition (live/dead) also were recorded for all trees. A summary of the findings can be found in table 2.

**Table 1.** Values for fine (<7 cm diameter) and coarse (≥7 cm diameter) woody debris, Tanana Flats, Alaska.

[Above- and below-ground debris is material that is <50 percent or ≥50 percent covered by organic soil, respectively.]

Site	Woody debris (kg/ha):				Total
	Fine debris (<7 cm)		Coarse debris (≥7 cm)		
	Above-ground	Below-ground	Above-ground	Below-ground	
TF SB	3216	86	845	0	4147
TF SC	159	0	0	0	159

**Table 2.** Summary of stand density values for trees >3 and <3 m, Tanana Flats, Alaska.

[BS, black spruce; TA, tamarack.]

Site	Height (m)	%BS	%TA	% live	Average density (tree/ha)	Stdev	N
TFSC	>3	53	47	54	1965	1839	17
	<3	41	41	90	7256	4256	17
TFSB	>3	100	0	0	1270	2092	20
	<3	98	2	0	2069	2522	20

## Soil-Sample Preparation and Drying

Upon the arrival of samples at the USGS laboratory, samples were inventoried using the field sheets. Any discrepancy between field descriptions and laboratory observations was resolved before sample preparation began. All samples were placed on open shelves in an isolated room and allowed to air-dry to a constant weight, as determined by weights measured at least one week apart. Temperature during air-drying ranged from 20° C to 30° C. After air-drying, samples were oven-dried for 48 hours in a forced-draft oven. Samples that were classified as organic-soil horizons (for example, moss, litter) were oven-dried at 65° C to avoid loss or alteration of organic matter by oxidation or decomposition. The remaining samples were oven-dried at 105° C.

After oven-drying, samples were thoroughly mixed and split into subsamples for analysis and archiving. (Archive fractions of most of the samples described here are available by contacting J. Harden at the U.S. Geological Survey in Menlo Park, Calif.). Samples were then processed in one of two ways, depending on horizon code. Mineral-soil samples were gently crushed using a mortar and pestle, with care to break only aggregates, and then sieved through a 2-mm screen. Soil particles that did not pass through the screen were removed, weighed, and saved separately; soil that passed through the screen was then ground by using a mortar and pestle to pass through a 60-mesh (0.246-mm) screen. The ground material was mixed and placed in a labeled glass sample bottle for subsequent analyses. Organic samples were weighed, and roots wider than 1 cm in diameter were removed, weighed, and saved separately. The remaining sample was then milled in an Udy Corp. (Fort Collins, Colo.) Cyclone mill to pass through a 0.5-mm screen. The milled sample was thoroughly mixed, and a representative sample was placed in a labeled glass sample bottle for analytical chemistry.

## Soil Laboratory Methods

### Total Carbon, Total Nitrogen, $\delta^{13}\text{C}$ , $\delta^{15}\text{N}$

Because carbonates tend not to exist in the study area, nearly all of the C can be considered organic. A Carlo Erba NA1500 elemental analyzer coupled to a Micromass Optima isotope ratio mass spectrometer (IRMS) in continuous flow mode was used to determine total C, total Nitrogen (N),  $\delta^{13}\text{C}$ , and  $\delta^{15}\text{N}$ . Samples were combusted in the presence of excess oxygen. The resulting sample gasses were swept in a continuous flow of helium through an oxidation furnace, followed by a reduction furnace, to yield  $\text{CO}_2$ ,  $\text{N}_2$ , and water vapor. Water was removed by a chemical trap, and  $\text{CO}_2$  and  $\text{N}_2$  were separated chromatographically before entering the Micromass Optima IRMS for the measurement of C, N,  $\delta^{13}\text{C}$ , and  $\delta^{15}\text{N}$ . Carbon and N were determined by integrating the major ion peaks (mass 44 for  $\text{CO}_2$  and mass 28 for  $\text{N}_2$ ). For reliable quantification of  $\delta^{15}\text{N}$ , 15-30  $\mu\text{g}$  N are generally needed, and few samples met this criterion. Thus, the  $\delta^{15}\text{N}$  data are not reported here; these data are available from the authors by

request. The  $\delta^{13}\text{C}$  data are reported as deviations in parts per thousand (‰) relative to a standard, here Vienna Pee Dee Belemnite (V-PDB).  $\delta^{13}\text{C}$  was calculated as:

$$\delta^{13}\text{C} \text{ ‰} = \left( \left( \frac{{}^{13}\text{C sample}/{}^{12}\text{C sample}}{{}^{13}\text{C standard}/{}^{12}\text{C standard}} \right) - 1 \right) * 1,000. \quad (1)$$

All samples were calibrated using ethylenediamine tetra-acetic acid (EDTA). The chemical formula for this compound corresponds to a C content of 41.09 percent and a N content of 9.59 percent. Two working standards were analyzed as unknown samples in all runs to check consistency and overall precision: a marine sediment standard (MESS-1), issued by the Chemistry Division of the Canadian National Research Council, and a river sediment standard (NBS 1645), issued by the National Bureau of Standards, now the National Institute of Standards and Technology (NIST). Certified values were obtained from Govindaraju (1989). Measured values of these working standards for the IRMS that ran these samples are shown in table 3.

**Table 3.** Statistics of analyses for working standards run on the isotope ratio mass spectrometer, 2001-2008. [Certified values: MESS-1, 2.99 percent C; NBS-1645, 0.08 percent N; SRM-1547, 2.94 percent N]

Standard	%C			%N			$^{13}\text{C}$		
	Average	Stdev.	N	Average	Stdev.	N	Average	Stdev.	N
MESS-1	3.02	0.15	49	0.18	0.01	49	-25.64	0.14	49
NBS-1645	5.21	0.39	53	0.09	0.01	55	-22.29	0.27	53
SRM-1547	46.57	2.00	398	2.83	0.15	389	-26.81	0.30	134

## Particle-Size Analyses

A limited number of mineral-soil samples were selected for particle-size analyses. The laboratory of Dr. T. Fenton, Iowa State University, processed these samples by conventional pipette analyses (Walter and others, 1978). Owing to the large amounts of organic matter, some of the samples were washed in 35 percent hydrogen peroxide three times. Even after these treatments, some organic matter persisted, skewing the results toward overestimation of the sand fraction. The samples for which organic matter may have been problematic in particle size analyses are indicated in the Notes column of the *Tanana\_Physical* file.

## Elemental Analyses

Elemental concentrations within the samples were analyzed for 40 major, minor, and trace elements by using inductively coupled plasma-atomic emission spectrometry (ICP-AES). These samples were run by the USGS Research Chemistry Core Support, supervised by Paul Lamothe. Samples were ashed (550 °C) and then pretreated with nitric acid and hydrogen peroxide and brought to dryness at low temperature (to help reduce the organic content and reduce reactivity). Samples were then digested using a mixture of hydrochloric, nitric, perchloric, and hydrofluoric acids at low temperatures. This final solution was introduced into the ICP-AES, where the elemental emission signals were measured simultaneously for the 40 elements. For more information regarding this procedure, calibration techniques, and its detection limits, see Briggs (2002).

## Dataset Descriptions

Seven downloadable files contain the soil data collected from the sites described in this report. Appendix 2, Tanana File Descriptions, describes in more detail the data within the following Microsoft Excel files.

- *Tanana\_Physical* contains physical descriptions of the samples, such as volumetric field moisture, bulk density, and particle size.
- *Tanana\_Chemistry* contains C, N, and  $\delta^{13}\text{C}$ , and elemental analysis measurements for samples on which these analyses were run.
- *Tanana\_Field* contains the field descriptions and height above mineral-soil values.
- *Tanana\_Transects* contains descriptions for horizons within soil profiles that were not sampled (only described).
- *Tanana\_Vegetation* includes the percentage of cover of different understory species found around the TFSB plots.
- *Tanana\_Density* contains data pertaining to the trees measured for stand density (both PCQ and 2m plot methods).
- *Tanana\_Woody\_Debris* contains the data recorded for the woody-debris measurements.

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## Appendix 1. Sample-site Descriptions

This appendix describes the locations of each site sampled within this report. The following text gives general directions to each site and explains how the sites were set up.

Each site was visited two times. The first visit was in the late spring of 2002 to scout for sites (the reconnaissance visit). At this time one or more cores were taken randomly within the general location of the site. Later, these general locations were visited again and perpendicular transects (in the shape of an 'L') were set up (typically with pink/black flagging). At this time, more intensive sampling occurred, and 1 m<sup>2</sup> plots used to describe vegetation were placed along the transects, 10 m apart. Directions and GPS coordinates are provided for each sample site, but not each plot.

### TFSB (Survey Line Burn)

Cores taken during site reconnaissance by helicopter in May 2002 were located at approximately lat 64.6480° N., long 148.2958° W. (NAD27 Alaska datum). All other cores were taken at the long-term location. This site was accessed by boat from the Tanana River. The boat was parked at approximately lat 64.64913° N., long 148.29828° W. (NAD83 datum). From there a GPS instrument was used to navigate to approximately lat 64.64913° N., long 148.29828° W. (WGS84 datum; see footnote on page 4). This location was the junction of the two transects, along which vegetation plots were placed every 10 m. Soil samples were taken from one of the four corners of each vegetation plot (profiles numbers greater than or equal to eight and divisible by four). The other three corners of the moss plots were described without sampling (see the *Tanana\_Transects* file). Transects to measure woody debris and stand density were located along either side of the soil-sampling transects.

### TFSC (Survey Line Control)

One core was taken during site reconnaissance (May 2002) and was obtained at approximately lat 64.6964° N., long 148.3205° W. (NAD27 Alaska datum). All other cores were taken at the long-term TFSC site. Directions to this site are as follows: with mileage based on setting the odometer to zero at Airport Rd. on the Parks Highway, continue on the Parks Highway for 17.8 miles; turn left into the Long-Term Ecological Research (LTER) site (a dirt road); stay on the main road until 22.4 miles; take the left fork in the road; at 22.7 miles, turn right; at 23.1 miles the road splits again and the left fork continues to the river, veer right; park at approximately lat 64.69918° N., long 148.33193° W. (NAD83 datum); use a GPS instrument to navigate to approximately lat 64.69744° N., long 148.31917° W. (NAD83 datum). This area is the site of other LTER research projects, so there may be established trails that will get you close to this location.

The GPS location noted above was taken at the junction of the two sampling transects. Vegetation plots were located along the transects every 10 m. Samples were taken from one corner of the plots. Along one transect these plots were located within 2–3 m of flux chambers already set up within the site (Wickland and others, 2010; Wickland and others, 2006). Transects to measure woody debris and stand density were located along either side of the soil-sampling transects.

## Appendix 2. Tanana File Description

The following section contains brief descriptions of the data within the files associated with this report. These files are available at <http://pubs.usgs.gov/of/2014/1049/>. Unavailable or inapplicable data are indicated by a dash (—). Additional information on these sites, as well as sampling and analyses, are presented in the main report.

### Tanana\_Physical

This file contains physical descriptions of the samples, such as volumetric field moisture, bulk density, and particle size.

Sample ID	Sample identification: The first four characters indicate the site sampled. The number that follows these four characters indicates the soil profile within the site. A decimal point separates the profile number from the basal depth of the sample (in cm).
Depth	Indicates the basal depth, in cm, of the sampling increment.
Field horizon code	Horizon type of the sample, as defined in the field. L, live moss; D, dead moss; F, fibric organic matter (OM); M, mesic OM; H, humic OM; A, A mineral soil horizon; B, B mineral soil horizon; C, C mineral soil horizon; LT, litter; Se, sedge; WD, wood. A lower case 'b' before a horizon code indicates the sample showed evidence of burning (for example, scorched, charred). A lower case 'f' before a horizon code indicates the sample was frozen at the time of sampling.
Sample description	A brief description of the sample.
Date sampled	Date the sample was taken (month/day/year).
Thickness	Thickness of the soil horizon (cm).
>2 mm in sample	Dry weight percentage (%) of soil particles not passing through a 2 mm sieve after gentle crushing.
>1 cm in sample	Dry weight percentage (%) of roots larger than 1 cm in diameter in the sample.
Bulk density (<2 mm)	Grams of oven-dried soil per cubic centimeter. Calculated by subtracting the weight of the soil particles greater than 2 mm and roots greater than 1 cm diameter from the total bulk density (see next column). No volume adjustment has been made for the fractions removed.
Total bulk density	Grams of oven-dried soil per cubic centimeter for the entire soil sample with no fractions excluded.
Vol.Fld. Moisture	Volumetric Field Moisture: the percentage of water in the sample, by volume.
Convert from AD to OD	Percentage, by weight, of moisture remaining in a sample after air-drying to constant weight as determined by oven-drying the sample. These data can be used to convert carbon and nitrogen content from an oven-dry to an air-dry basis using the following equation: $\text{Bulk Density}_{\text{air-dry}} = \text{Bulk Density}_{\text{oven dry}} / (1 - (\text{Covert}_{\text{AD to OD}}/100))$
Sand	Percentage, by weight of soil particles greater than 0.05 mm in the sample remaining after removal of particles greater than 2 mm and roots greater than 1 cm diameter.

Coarse silt	Percentage, by weight, of soil particles ranging in size from 0.02 to 0.05 mm in the sample remaining after removal of particles greater than 2 mm and roots greater than 1 cm diameter.
Fine silt	Percentage, by weight, of soil particles ranging in size from 0.002 to 0.020 mm in the sample remaining after removal of particles greater than 2 mm and roots greater than 1 cm diameter.
Clay	Percentage, by weight, of soil particles less than 0.002 mm in the sample remaining after removal of particles greater than 2 mm and roots greater than 1 cm diameter.
Notes	OM+ indicates that residual organic matter in the sample may have skewed particle-size results toward increased sand and (or) coarse silt; OM indicates residual organic matter in sample, but likely not enough to skew particle-size results.

### Tanana\_Chemistry

This file contains C, N,  $\delta^{13}\text{C}$ , and elemental analysis measurements for samples on which these analyses were run.

Sample ID	Sample identification: The first four characters indicate the site sampled. The number that follows these four characters indicates the soil profile within the site. A decimal point separates the profile number from the basal depth of the sample (in cm).
Basal depth	Indicates the basal depth, in cm, of the sampling increment.
Field horizon code	Horizon type of the sample, as defined in the field. L, live moss; D, dead moss; F, fibric organic matter (OM); M, mesic OM, H, humic OM; A, A mineral soil horizon; B, B mineral soil horizon; C, C mineral soil horizon; LT, litter; Se, sedge; WD, wood. A lower case 'b' before a horizon code indicates the sample showed evidence of burning (for example, scorched, charred). A lower case 'f' before a horizon code indicates the sample was frozen at the time of sampling.
Sample description	A brief description of the sample.
%C	Percentage, by weight, of carbon in an oven-dried soil sample with material greater than 2 mm or 1 cm diameter removed.
%N	Percentage, by weight, of nitrogen in an oven-dried soil sample with material greater than 2 mm or 1 cm diameter removed.
$\delta^{13}\text{C}$	Per mil (‰) value of $\delta^{13}\text{C}$ relative to Pee Dee Belemnite.
Al	Percentage, by weight, of aluminum in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ca	Percentage, by weight, of calcium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Fe	Percentage, by weight, of iron in a soil sample with material greater than 2 mm or 1 cm diameter removed.
K	Percentage, by weight, of potassium in a soil sample with material greater than 2 mm or 1 cm diameter removed.

Mg	Percentage, by weight, of magnesium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Na	Percentage, by weight, of sodium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
P	Percentage, by weight, of phosphorus in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ti	Percentage, by weight, of titanium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ag	Parts per million of silver in a soil sample with material greater than 2 mm or 1 cm diameter removed.
As	Parts per million of arsenic in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Au	Parts per million of gold in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ba	Parts per million of barium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Bi	Parts per million of bismuth in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Cd	Parts per million of cadmium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ce	Parts per million of cerium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Co	Parts per million of cobalt in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Cr	Parts per million of chromium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Cu	Parts per million of copper in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Eu	Parts per million of europium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ga	Parts per million of gallium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ho	Parts per million of holmium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
La	Parts per million of lanthanum in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Li	Parts per million of lithium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Mn	Parts per million of manganese in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Mo	Parts per million of molybdenum in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Nb	Parts per million of niobium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Nd	Parts per million of neodymium in a soil sample with material greater than 2 mm or 1 cm diameter removed.

Ni	Parts per million of nickel in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Pb	Parts per million of lead in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Sc	Parts per million of scandium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Sn	Parts per million of tin in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Sr	Parts per million of strontium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Ta	Parts per million of tantalum in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Th	Parts per million of thorium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
U	Parts per million of uranium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
V	Parts per million of vanadium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Y	Parts per million of yttrium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Yb	Parts per million of ytterbium in a soil sample with material greater than 2 mm or 1 cm diameter removed.
Zn	Parts per million of zinc in a soil sample with material greater than 2 mm or 1 cm diameter removed.

## Tanana\_Field

This file contains the field descriptions of sampled soil profiles. (Descriptions of soil profiles which were not sampled, and only described in the field, can be found in the *Tanana\_Transects* file.)

Sample ID	Sample identification: The first four characters indicate the site sampled. The number that follows these four characters indicates the soil profile within the site. A decimal point separates the profile number from the basal depth of the sample (in cm).
Basal depth	Indicates the basal depth, in cm, of the sampling increment.
Field horizon code	Horizon type of the sample, as defined in the field. L, live moss; D, dead moss; F, fibric organic matter (OM); M, mesic OM; H, humic OM; A, A mineral soil horizon; B, B mineral soil horizon; C, C mineral soil horizon; LT, litter; Se, sedge; WD, wood. A lower case 'b' before a horizon code indicates the sample showed evidence of burning (for example scorched, charred). A lower case 'f' before a horizon code indicates the sample was frozen at the time of sampling.
Sample description	A brief description of the sample.
Roots	Root abundance and size using conventions of USDA-ARS (Staff, 1998).

Lab pH	The pH of the sample, determined in the lab, by using a LaMotte pH kit.
Moist Munsell color	Color of moist soil based on the Munsell soil color chart. If the word dry is written after the color then the color was identified dry (not moist).
Von Post or Texture class	If organic soil, the classification was made by using the von Post scale of humification (Damman and French, 1987). If mineral soil, the soil-texture was determined by following conventions of the USDA-ARS (Staff, 1998).
Plasticity	Plasticity was determined following the conventions of the USDA-ARS (Staff, 1998).
Stickiness	Stickiness was determined following the conventions of the USDA-ARS (Staff, 1998).
Firmness	Moist consistence was determined following the conventions of the USDA-ARS (Staff, 1998).
Structure	Grade, size, strength, and type of soil structure were determined following the conventions of the USDA-ARS (Staff, 1998).
Height above mineral	Height of each basal depth above the mineral-soil boundary; therefore, the bottom organic layer is at zero and all mineral horizons are negative numbers.

## Tanana\_Transects

This file contains descriptions of the soil profiles that were not sampled, but were described in the field.

Sample ID	Sample identification: The first four characters indicate the site sampled. The number that follows these four characters indicates the soil profile within the site. A decimal point separates the profile number from the basal depth of the sample (in cm).
Basal depth	Indicates the basal depth, in cm, of sampling increment.
Field horizon code	Horizon type of the sample, as defined in the field. L, live moss; D, dead moss; F, fibric organic matter (OM); M, mesic OM; H, humic OM; A, A mineral soil horizon; B, B mineral soil horizon; C, C mineral soil horizon; LT, litter; Se, sedge; WD, wood. A lower case 'b' before a horizon code indicates the sample showed evidence of burning (for example scorched, charred). A lower case 'f' before a horizon code indicates the sample was frozen at the time of sampling.
Sample description	A brief description of the sample.
Plot description	Information regarding where the profile was along the transect, who did the description, the date it was described, and the depth of any water and permafrost found.
Roots	Root abundance and size determined by using conventions of the USDA-ARS (Staff, 1998).
Moist Munsell color	Color of moist soil based on the Munsell soil color chart. If the word dry is written after the color, then the color was identified dry (not moist).
Von Post or texture	If organic soil, the classification was made by using the von Post scale of humification (Damman and French, 1987). If mineral soil, the soil-texture was determined by following conventions of the USDA-ARS (Staff, 1998).
Plasticity	Plasticity was determined following the conventions of the USDA-ARS

	(Staff, 1998).
Stickiness	Stickiness was determined following the conventions of the USDA-ARS (Staff, 1998).
Firmness	Moist consistence was determined following the conventions of the USDA-ARS (Staff, 1998).
Structure	Grade, size, strength, and type of soil structure were determined following the conventions of the USDA-ARS (Staff, 1998).
Height above mineral	Height of each basal depth above the mineral soil-boundary; therefore, the bottom organic layer is at zero and all mineral horizons are negative numbers.

## Tanana\_Understory

This file contains cover values percentages for different understory species found around the TFSB plots.

Plot ID	Where the plot was located, based on the distance from the junction of the two transect and the general direction the transect traveled. These are the same locations where soil samples/descriptions occurred.
<i>Betula nana</i>	Percentage cover range of <i>Betula nana</i> .
<i>Calamagrostis canadensis</i>	Percentage cover range of <i>Calamagrostis canadensis</i> .
<i>Chamaedaphne calyculata</i>	Percentage cover range of <i>Chamaedaphne calyculata</i> .
<i>Corydalis sempervirens</i>	Percentage cover range of <i>Corydalis sempervirens</i> .
<i>Ditrichum sp.</i>	Percentage cover range of <i>Ditrichum sp.</i>
<i>Epilobium angustifolium</i>	Percentage cover range of <i>Epilobium angustifolium</i> .
<i>Eriophorum vaginatum</i>	Percentage cover range of <i>Eriophorum vaginatum</i> .
<i>Ledum groenlandicum</i>	Percentage cover range of <i>Ledum groenlandicum</i> .
<i>Luzula rufescens</i>	Percentage cover range of <i>Luzula rufescens</i> .
<i>Marchantia polymorpha</i>	Percentage cover range of <i>Marchantia polymorpha</i> .
<i>Stellaria longipes</i> (?)	Percentage cover range of <i>Stellaria sp.</i> , what is thought to be <i>Stellaria longipes</i> .
<i>Picea mariana</i> (seedlings)	Percentage cover range of <i>Picea mariana</i> seedlings.

<i>Polemonium acutiflorum</i>	Percentage cover range of <i>Polemonium acutiflorum</i> .
<i>Polytrichum juniperinum</i>	Percentage cover range of <i>Polytrichum juniperinum</i> .
<i>Salix sp.</i>	Percentages cover range of <i>Salix sp.</i>
Unkown	Percentages cover range of unknown vegetation.
<i>Vaccinium uliginosum</i>	Percentages cover range of <i>Vaccinium uliginosum</i> .
<i>Vaccinium vitis-idaea</i>	Percentages cover range of <i>Vaccinium vitis-idaea</i> .

### Tanana\_Density

This file contains data pertaining to tree-stand density. There are four worksheets in this file: 2-m plot data for each site and point-center quarter (PCQ) data for each site. The column heading for the 2-m plot data are as follows:

Site	The plot number (sequentially assigned) where the data were taken.
Species	Tree species found (BS, black spruce; TA, tamarack)
DBH	The diameter (cm) of the tree taken at breast height (1.37 m). A dash indicates that the tree was shorter than 1.37 m.
Diam at base	The diameter (cm) at the base of the tree.
Ht to live	The height (m) to the live portion of the tree. This value, in relation to the height to crown (next column), gives an idea of tree health.
Ht to crown	The height (m) to the crown of the tree.
Condition	The condition of the tree: L, live; D, dead; S, dead snag.
Notes	Notes regarding the condition of the tree or measurements.

The column headings for the PCQ data are as follows:

Location	The plot number (sequentially assigned) where the data were taken.
Tree	Tree number (1-4)
Species	Tree species found (BS, black spruce; TA, tamarack)
DBH	The diameter (cm) of the tree taken at breast height (1.37 m). A dash indicates that the tree was shorter than 1.37 m.
Diam at base	The diameter (cm) at the base of the tree.
Ht to live	The height (m) to the live portion of the tree. This value, in relation to the height to crown (next column), gives an idea of tree health.
Ht to crown	The height (m) to the crown of the tree.
Distance	Distance (m) from the center point to the tree.
Condition	The condition of the tree: L, live; D, dead; S, dead snag.
Avg Dist	Average distance for all four trees at a point.

Mean area	Mean area taken up by the trees measured, as described by Cottam and Curtis (1956), where the average distance is divided by a correction factor (0.50 for one tree, 0.66 for two trees, 0.81 for three trees, and 1.00 for four trees), and this value is squared.
Density	Density (trees/hectare) for the trees found at the point, as described by Cottam and Curtis (1956), where density is the 1/Mean Area. This value is multiplied by 10,000 to convert from meters to hectares.
Notes	Notes regarding the condition of the tree or measurements.

## Tanana\_Woody\_Debris

This file contains data pertaining to the woody-debris measurements. There are five worksheets in this file. The two worksheets with the data for fine woody debris are labeled *TFSC* <7 and *TFSB* <7 and follow this format:

Site	Transect number measured.
Type	Above, aboveground woody debris, <50% covered by organic soil; roots above, tree root <50% covered by organic material; below, belowground woody debris, 50-99% covered by organic soil; roots below, tree root 50-99% covered by organic soil.
Size class	The diameter (cm) of fine woody debris is classified into one of several size classes: 1 is 0.0–0.49 cm; 2 is 0.50–0.99 cm; 3 is 1.0–2.99 cm; 4 is 3.0–4.99 cm; and 5 is 5.0–6.99 cm.
Sect. 1	Observations found for that size class for section 1 of the transect.
Sect. 2	Observations found for that size class for section 2 of the transect.
Sect. 3	Observations found for that size class for section 3 of the transect.
Sect. 4	Observations found for that size class for section 4 of the transect.
All Sect.	The sum of observations for all sections on a transect.
Per 1m	The total number of observations for that size class divided by the number of meters on a transect (usually 20 m).
TA Mult.	Tamarack fuel-load multiplier, which combines the effects of specific gravity, the tilt angle of the woody debris, and the mean squared diameter on the conversion of the number of intercepts to fuel load (see Nalder and others, 1999; this value is taken from table 6 for the Central Saskatchewan region, for the appropriate size class).
BS Mult.	Black spruce multiplier, which combines the effects of specific gravity, the tilt angle of the woody debris, and the mean squared diameter on the conversion of the number of intercepts to fuel load (see Nalder and others, 1999; this value is taken from Table 6 for the Central Saskatchewan region, for the appropriate size class).
% TA	Percentage of the stand that is tamarak, as determined by the point-center-quarter method.
% BS	Percentage of the stand that is black spruce, as determined by the point-center-quarter method.
TA (kg/ha)	Amount of tamarack fine woody debris (kg/ha).
BS (kg/ha)	Amount of black spruce fine woody debris (kg/ha).

Total (kg/ha)	Tamarack plus black spruce fine woody debris (kg/ha).
All sizes	Total fine woody debris for that transect (both tree species and all size classes).

The worksheet with the data for coarse woody debris is labeled >7 All and follows this format:

Site	Transect number measured.
Transect #	On which transect the coarse wood was measured.
# of sections	Number of sections within that transect.
Sp	Species of coarse wood
Line #	Section or line # (for relocation)
Decay class	The >7 cm pieces were recorded as one of five decay classes: (1) Bark and wood intact, knife unable to penetrate samples; (2) wood beginning to get mealy, still hard for knife to penetrate sample; (3) wood mealy throughout, knife can penetrate sample somewhat; (4) wood can be broken into pieces, knife easily penetrates sample; (5) sample no longer holds shape and splits into small pieces. Debris that was decay classes 1–3 was assumed to be sound. Debris that was decay classes 4–5 was assumed to rotten. This cutoff can be manipulated within the spreadsheet by adjusting the decay class value at which debris changes to “rotten” (see cell AB4).
Location	A, above ground, <50% covered by organic soil; B = belowground, 50-99% covered by organic soil.
Diam (cm)	Diameter (in cm) of the coarse wood.
Diam (m)	Calculated by converting previous column to meters.
Diam <sup>2</sup> (m)	Calculated by squaring previous column.
BS Above sound	Calculated based on if-then statements. If species, decay class, and location (above/below) match, the diam <sup>2</sup> value gets placed into this column. This value is summed for each transect (subsequent rows, labeled <i>Sum of diam<sup>2</sup></i> ) and then converted to coarse wood inventory ( <i>I</i> , kg/ha) by using the following formula: $I = (G * 1.234 * \sum(\text{diam}^2)) / (\# \text{ sections} * 5 \text{ m}) * 1,000 \text{ g/kg} * 10,000 \text{ m/ha}$ , where <i>G</i> is <i>G</i> factor (g/cm <sup>3</sup> ) and 1.234 is a constant to convert volume to kg/m <sup>2</sup> . The <i>G</i> factors for sound wood are based on size class 5 values for each species for the Southern Northwest Territories (Nalder and others, 1999). See the description in the <i>Decay</i> column for more information regarding the decay classes used and the distinction between sound and rotten wood.
BS Above rotten	Calculated based on if-then statements. If species, decay class, and location (above/below) match, the diam <sup>2</sup> value gets placed into this column. This value is summed for each transect (subsequent rows, labeled <i>Sum of diam<sup>2</sup></i> ) and then converted to coarse wood inventory ( <i>I</i> , kg/ha) by using the following formula: $I = (G * 1.234 * \sum(\text{diam}^2)) / (\# \text{ sections} * 5 \text{ m}) * 1,000 \text{ g/kg} * 10,000 \text{ m/ha}$ , where <i>G</i> is <i>G</i> factor (g/cm <sup>3</sup> ) and 1.234 is a constant to convert volume to kg/m <sup>2</sup> . The <i>G</i> factors for rotten wood are obtained from two samples of decaying wood from Thompson, Manitoba, based on thoughts that values by Brown (1974) are too high (M. Harmon, oral commun.). See the description of the <i>Decay</i> column for more information regarding the decay classes used and the distinction between sound and rotten wood.
BS Below sound	Calculated based on if-then statements. If species, decay class, and location

	(above/below) match, the $diam^2$ value gets placed into this column. This value is summed for each transect (subsequent rows, labeled <i>Sum of diam<sup>2</sup></i> ) and then converted to coarse wood inventory ( <i>I</i> , kg/ha) by using the following formula: $I = (G * 1.234 * \sum(diam^2)) / (\# \text{ sections} * 5 \text{ m}) * 1,000 \text{ g/kg} * 10,000 \text{ m/ha}$ , where <i>G</i> is <i>G</i> factor ( $g/cm^3$ ) and 1.234 is a constant to convert volume to $kg/m^2$ . The <i>G</i> factors for sound wood are based on size class 5 values for each species for the Southern Northwest Territories (Nalder and others, 1999). See the description in the <i>Decay</i> column for more information regarding the decay classes used and the distinction between sound and rotten wood.
BS Below rotten	Calculated based on if-then statements. If species, decay class, and location (above/below) match, the $diam^2$ value gets placed into this column. This value is summed for each transect (subsequent rows, labeled <i>Sum of diam<sup>2</sup></i> ) and then converted to coarse wood inventory ( <i>I</i> , kg/ha) by using the following formula: $I = (G * 1.234 * \sum(diam^2)) / (\# \text{ sections} * 5 \text{ m}) * 1,000 \text{ g/kg} * 10,000 \text{ m/ha}$ , where <i>G</i> is <i>G</i> factor ( $g/cm^3$ ) and 1.234 is a constant to convert volume to $kg/m^2$ . The <i>G</i> factors for rotten wood are obtained from two samples of decaying wood from Thompson, Manitoba, based on thoughts that values by Brown (1974) are too high (M. Harmon, oral commun.). See the description of the <i>Decay</i> column for more information regarding the decay classes used and the distinction between sound and rotten wood.
TA Above sound	Calculations for above-ground, sound, tamarack woody debris. See explanation for BS Above sound for more information.
TA Above rotten	Calculations for above-ground, rotten, tamarack woody debris. See explanation for BS Above rotten for more information.
TA Below sound	Calculations for below-ground, sound, tamarack woody debris. See explanation for BS Below sound for more information.
TA Below rotten	Calculations for below-ground, rotten, tamarack woody debris. See explanation for BS Below rotten for more information.
Unknown Above sound	Calculations for above-ground, sound woody debris of an unknown species. See explanation for BS Above sound for more information.
Unknown Above rotten	Calculations for above-ground, rotten woody debris of an unknown species. See explanation for BS Above rotten for more information.
Unknown Below sound	Calculations for below-ground, sound woody debris of an unknown species. See explanation for BS Below sound for more information.
Unknown Below rotten	Calculations for below-ground, rotten woody debris of an unknown species. See explanation for BS Below rotten for more information.
Above Total (kg/ha)	Total above ground coarse woody debris (kg/ha).
Below Total (kg/ha)	Total below ground coarse woody debris (kg/ha).
All Total (kg/ha)	Total coarse woody debris (kg/ha).