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Long-term Soil Productivity Study: the Effects of Soil Compaction and Organic Matter Retention on Long-term Soil Productivity in British Columbia (EP1148): Updated Establishment Report

2019

BRITISH COLUMBIA

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S. Berch, C. Bulmer, M. Curran, W. Chapman, G. Hope, R. Kabzems, E. Lilles, M. Kranabetter, B. Miller, M. Murray, T. Philpott, B. Wallace, and K. Hannam

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ABSTRACT

The Long-term Soil Productivity (LTSP) study addresses two key factors—soil porosity and site organic matter—that potentially limit tree growth and site productivity in the timber-harvesting land base and that can be affected by forestry operations. These factors regulate basic site processes through their many roles; for example, in the exchange of water and gas, in creating physical restrictions on rooting, and in soil biological activity. The experimental design used in this study was a factorial combination of organic matter removal (stem only, whole tree, and tree+forest floor removal) and compaction (no compaction, light compaction, and heavy compaction) treatments, and included the major commercial tree species of interior British Columbia (lodgepole pine, hybrid white spruce, interior Douglas-fir, trembling aspen, and western white pine). This co-ordinated research network of 100+ field installations in Canada and the United States is being used to examine how these pulse changes affect soil processes that support vegetation growth and stand productivity. This report provides information on the LTSP sites in British Columbia so that future researchers can collaborate at forest productivity research sites where treatments are not confounded by other site disturbances, can directly assess compaction and organic matter loss, and can have a baseline comparison.

PREFACE

This establishment report on the Long-term Soil Productivity (LTSP) Study in British Columbia (Experimental Project 1148) is intended to preserve details of the procedures used and the data collected for the future researchers who will continue to remeasure soil conditions and tree growth over the full timber rotation. The report is also intended to serve other researchers who may see the value of the long-term soil productivity experimental design and the installations for ancillary studies related to the impacts of, and recovery from, forest soil disturbance over the long term.

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1 INTRODUCTION

Ongoing concerns about soil compaction from ground-based harvesting and the often confounding effects of organic matter removal inspired discussions among British Columbia (B.C.) Ministry of Forests research soil scientists regarding the establishment of long-term soil productivity studies. A working plan was completed in 1992 (Hope et al. 1992; Holcomb 1996). The study scientists worked closely with the United States Department of Agriculture (USDA) Forest Service during the development of their protocol. The resulting British Columbia sites closely align with the U.S. protocol and are included in the international network of experimental sites called the Long-term Soil Productivity (LTSP) Study (Powers et al. 1990; Powers 2006). The underlying assumption is that forest management practices that alter two main factors—soil porosity and site organic matter—can largely account for changes in site productivity (biomass production). In 1996, the first British Columbia LTSP establishment report based on nine installations was written (Trowbridge et al. 1996) but not published. This report updates that unpublished establishment report with the final five installations (Figure 1), and documents the methods used in the LTSP experimental sites established in British Columbia. Research results to date can be found in the list of LTSP publications in Appendix 1.

1.1 Study Objectives

The overall goals of the study are to investigate and demonstrate how soil compaction and organic matter removal affect forest productivity over the long term, and to gain an understanding of how the fundamental processes controlling productivity are affected by these factors. Specifically, the objectives (Hope et al. 1992) are to:

1. determine the effects of different levels of organic matter (above-ground biomass and forest floor) removal and soil compaction on long-term forest soil productivity over a range of sites and ecological conditions;
2. study the long-term effects of organic matter removal and soil compaction on soil nutrient status and physical properties;
3. identify causal relationships between long-term forest productivity and soil properties that are altered by soil disturbance;
4. investigate the influence of ecosystem unit on the effects of soil disturbance on long-term soil productivity;
5. provide research sites for detailed studies on forest soils, nutrient cycling, and forest productivity; and
6. provide sites that illustrate the effects of soil disturbance on forest productivity for extension and demonstration purposes.

Results from the LTSP study will provide information on a broad range of topics in resource management, including ongoing improvements to British Columbia's soil conservation framework, validation or revision of soil disturbance standards and criteria (e.g., soil disturbance types, soil disturbance hazard ratings for various soil and climate combinations), and assessment of intensive biomass harvesting on productivity and biodiversity. Because the international LTSP sites span a broad climatic range, they also inform our understanding of the effects of climate change on productivity.

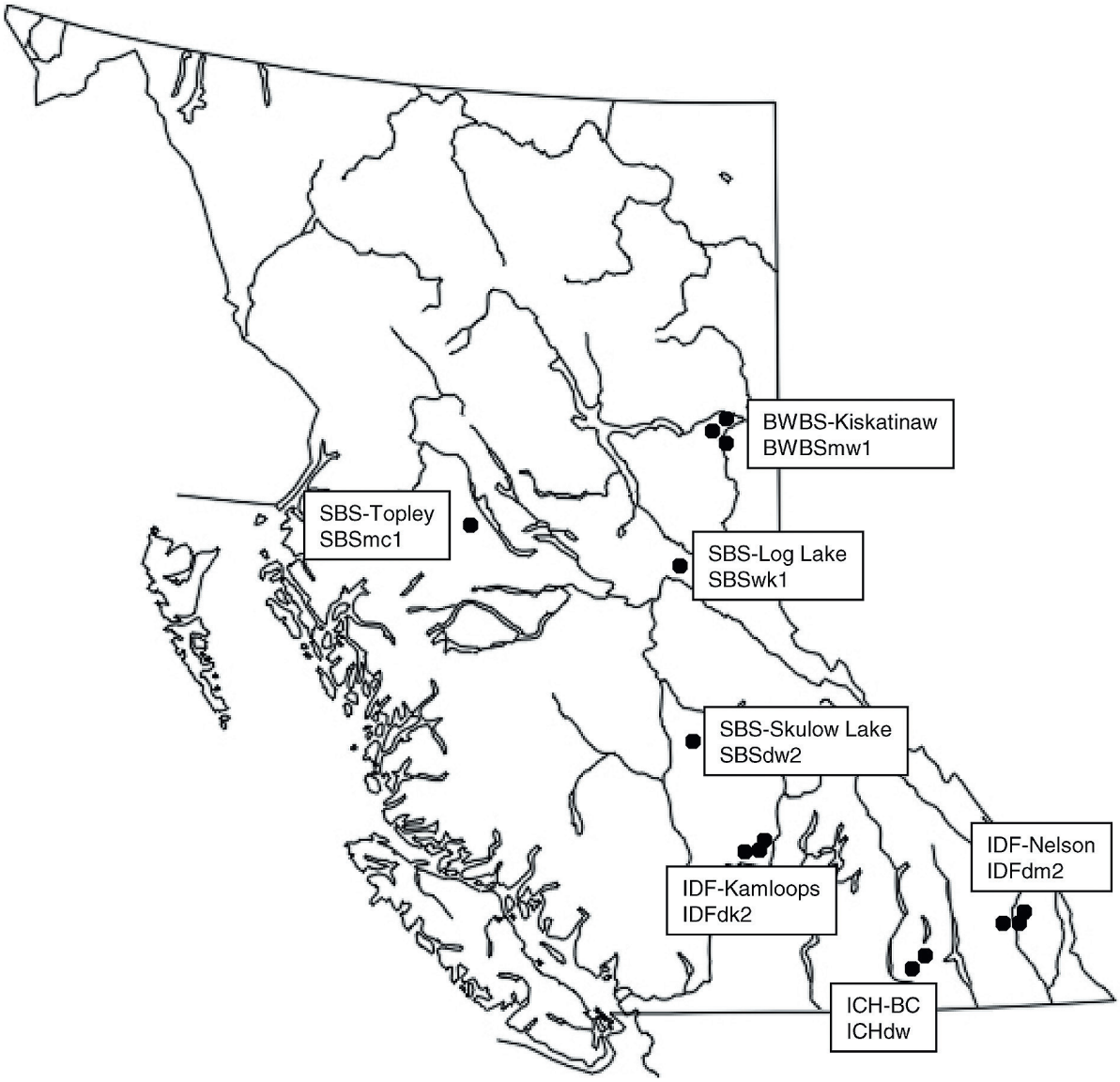

FIGURE 1 *Long-term Soil Productivity Study site locations in British Columbia, with ecosystem type.*

1.2 Core and Ancillary Studies

The core study on the two primary factors (soil porosity and site organic matter) has been established in four biogeoclimatic zones: Sub-boreal Spruce (SBS), Boreal White and Black Spruce (BWBS), Interior Douglas-fir (IDF), and Interior Cedar – Hemlock (ICH). Each site follows the experimental treatments and sampling protocols described by Hope et al. (1992), but there are some important differences in the implementation of the experimental design, soil sampling procedures, species regeneration, and vegetation management at some sites (see Section 5: Methods for more details). The current principal researcher for the British Columbia LTSP study is Marty Kranabetter and for each study site is as follows:

- SBS Topley – Erica Lilles
- SBS Log Lake – Brendan Miller
- SBS Skulow Lake – Tim Philpott
- BWBS Kiskatinaw – Richard Kabzems
- IDF Dairy Creek, Black Pines, and O'Connor Lake – Chuck Bulmer and Brian Wallace
- IDF Mud Creek, Emily Creek, and Kootenay East – Michael Murray
- ICH Rover Creek and McPhee Creek – Michael Murray

Within spatial and temporal limitations of the core study design and sites, the implementation of ancillary studies has been encouraged to complement the core study objectives. In addition, other studies have been co-located with the LTSP sites (e.g., rehabilitation, miniplot, and decomposition studies) to maximize comparison with the core treatments. A complete list of the publications that have resulted from these studies (to 2018) is provided in Appendix 1. Plot layouts and treatments, access notes, and pre-harvest soil descriptions are in Appendix 2.

2 STUDY AREAS

2.1 Biogeoclimatic Setting

The overall goal was to establish sites in a wide range of ecological conditions, representing the most common ecosystems in the interior of British Columbia. The SBS dominates the central interior of British Columbia, while the adjoining BWBS dominates the area northeast of the Rocky Mountains. The IDF and ICH typically occur in low- to mid-elevation forests in the southern interior of the province, although the ICH also occurs in west-central British Columbia. Historically, these zones have been the most utilized in terms of commercial timber harvesting and silvicultural practices in the interior of British Columbia. The descriptions that follow are taken from *Ecosystems of British Columbia* (Meidinger and Pojar 1991), which may be consulted for more detail.

2.1.1 Sub-boreal Spruce Zone The SBS occurs most commonly on the rolling mountainous and plateau landscapes of the Central Interior. Historically, the zone has been characterized by snowy, cold winters and short, warm, and moist summers. Mean annual temperature ranges from 1.7 to 5°C, with temperatures below 0°C for 4–5 months of the year and above 10°C for 2–5 months. Mean annual precipitation can range from 415 to 1650 mm, with

snow accounting for approximately 25–50% of total precipitation. Soils generally do not freeze below the snowpack in the SBS, except perhaps in the valley bottoms.

Climax tree species in the SBS are hybrid white spruce (*Picea engelmannii* × *glauca*) and subalpine fir (*Abies lasiocarpa*). Lodgepole pine (*Pinus contorta*) is a seral conifer that is common in maturing climax forests in the drier and more southern portions of the zone. Other seral tree species include Douglas-fir (*Pseudotsuga menziesii*), trembling aspen (*Populus tremuloides*), and common paper birch (*Betula papyrifera*). Black spruce (*Picea mariana*) generally occurs in wetter ecosystems but may occasionally occur on zonal upland sites. Zonal sites are typically represented by Luvisolic, Podzolic, or Brunisolic soils (Soil Classification Working Group 1998) developed on extensive and often deep deposits of coarse- to fine loamy-textured glacial till.

2.1.2 Boreal White and Black Spruce Zone The BWBS has very cold winters, frequently influenced by Arctic air masses, and very short but warm summers. It occurs primarily on the Alberta Plateau in the northeastern corner of the province, and in the valley bottoms and plains to the west in northern British Columbia and southern Yukon. The mean annual temperature is approximately -3 to 2°C. Temperatures remain below 0°C for 5–7 months of the year, and above 10°C for 2–4 months. Annual precipitation averages between 330 and 570 mm, with 35–55% as snow. Discontinuous permafrost can occur, and the soil may freeze below snowpack in the winters.

Climax tree species include white spruce (*Picea glauca*), black spruce, and subalpine fir. Seral species are trembling aspen, lodgepole pine, balsam poplar (*Populus balsamifera* ssp. *balsamifera*), tamarack (*Larix laricina*), and common and Alaska (*Betula neoalaskana*) paper birches. Luvisols and Brunisols are the dominant soils in upland forests, and often develop on widespread glaciolacustrine and glaciofluvial deposits, respectively.

2.1.3 Interior Cedar – Hemlock Zone The ICH is the most productive zone in the interior of British Columbia. It occurs on the lower slopes of the Columbia Mountains, the western side of the Rocky Mountains, much of the Shuswap and Quesnel Highlands, and just east of the Coast Mountains in west-central British Columbia. The climate is strongly influenced by air masses from the west that produce cool, wet winters and warm, dry summers. Mean annual temperatures range from 2 to 8.7°C; temperatures remain below 0°C for 2–5 months of the year and above 10°C for 3–5 months. Annual precipitation is between 500 and 1200 mm, with 25–50% falling as snow.

The ICH supports the highest diversity of tree species in the province. Climax species include western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), white spruce, Engelmann spruce (*Picea engelmanii*), hybrid spruce, and subalpine fir. Common seral species include western larch (*Larix occidentalis*), Douglas-fir, western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), lodgepole pine, trembling aspen, and paper birch. Humo-Ferric Podzols are the dominant soil type in zonal ecosystems, although Brunisolic and Orthic Gray Luvisols are common on mesic sites with finer-textured parent materials.

2.1.4 Interior Douglas-fir Zone The IDF occurs primarily on the rolling hills and valleys of the southern Interior Plateau and Rocky Mountain Trench and on the eastern slopes of the Coast Mountains as high as 1450 m above sea level. The climate, characterized by warm, dry summers and cool winters, is strongly influenced by the rainshadow effect of the Coast, Cascade, and Columbia Mountains. Mean annual temperatures range from 1.6 to 9.5°C. Temperatures remain below 0°C for 2–5 months of the year, and above 10°C for 2–5 months. Annual precipitation is between 300 and 750 mm but can exceed 1000 mm in the wettest subzones; 20–50% of the precipitation falls as snow. Considerable moisture deficits can occur during the fairly long growing season.

Douglas-fir is the most common climax tree species, and pure stands are common. Ponderosa pine occupy drier sites, while hybrid white spruce and western red cedar occur on wetter sites. Seral species include lodgepole pine, trembling aspen, and paper birch. Upland soils, developed over morainal deposits support Orthic, Brunisolic, or Dark Gray Luvisols and Eutric or Dystric Brunisols.

2.2 Experimental Sites

In the SBS, IDF-Kamloops, IDF-Nelson, and ICH experiments, the experimental design includes three separate sites, each of which represents a block in a randomized complete block design. For the SBS experiment, three sites were selected in zonal ecosystems (maturing seral to maturing climax stands) in three different subzones. For the IDF-Kamloops and IDF-Nelson experiments, three sites with predominantly zonal ecosystems and maturing seral to maturing climax stands were selected in one subzone. The IDF-Kamloops sites are located on acidic soils; the IDF-Nelson sites are located on calcareous soils. There are two sites in the ICH, one near Nelson and another near Castlegar, that form a complete experiment with a third USDA Forest Service site in Priest River, Idaho.[1] For the BWBS experiment, which has a completely randomized design and three replications, a single site in a seral aspen stand with zonal edaphic properties was selected.

Uniformity of stand structure, and soil and site properties that are critical to plant growth were important criteria in the site selection process. All sites have soil and site properties that are typical of the zonal biogeoclimatic conditions in the areas being represented. Within each site, understorey vegetation was relatively uniform prior to treatment application.

3 EXPERIMENTAL DESIGN

The core study design is a 3 × 3 factorial experiment (Table 1; Figure 2) with two factors (organic matter removal and soil compaction), each with three levels. This resulted in 27 experimental units for each complete replication of the experiment. For each experiment in the SBS, IDF, and ICH biogeoclimatic zones, which had randomized complete block designs, there were nine experimental units in each of three separate sites. For the BWBS experiment, which had a completely randomized design, there was one site with 27 experimental units.

1 Contact: Debbie Page-Dumroese, USDA Forest Service, Rocky Mountain Research Station, Moscow, Idaho.

TABLE 1 *Experimental treatments in the core British Columbia long-term soil productivity design*

Treatment			
Organic matter retention		Soil compaction	
Coding		Coding	
OM_1	Stem (boles) only removed	C_0	No compaction
OM_2	Stems and crowns removed	C_1	Intermediate compaction
OM_3	Stems, crown, and forest floor removed	C_2	Heavy compaction

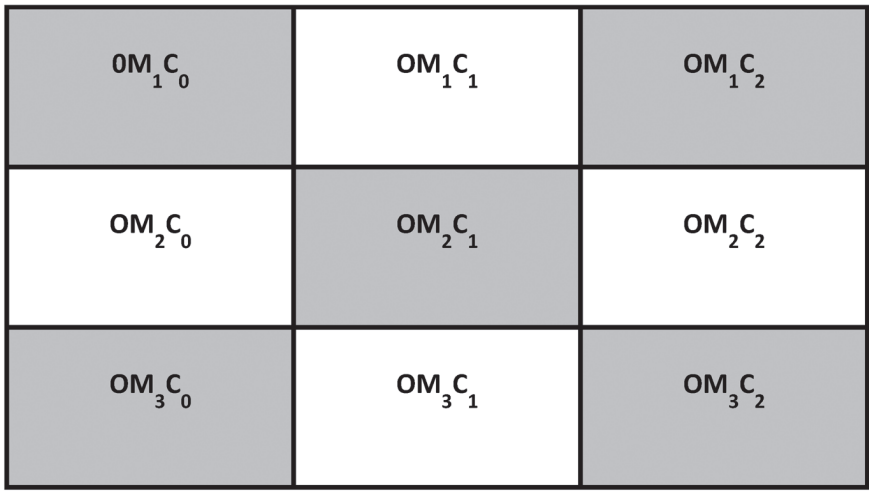

FIGURE 2 *Conceptual layout of the core long-term soil productivity design.*

At every site, the nine plots (27 at the BWBS site) were split into two, and each half was randomly assigned one of two commercial tree species. At the SBS sites, each half of the plot was planted to lodgepole pine or hybrid spruce. At the IDF (Kamloops and Nelson) sites, each half of the plot was planted to lodgepole pine or Douglas-fir. At the ICH sites, each half of the plot was planted to western white pine or Douglas-fir. At the BWBS sites, each half of the plot was planted to white spruce or allowed to naturally regenerate, by sprouting, with trembling aspen.

The British Columbia LTSP design differs from that of Powers et al. (1990) according to which plot is split into "vegetation control" (by repeated herbicide applications) and "no vegetation control." The Powers et al. (1990) approach was designed to permit the determination of net primary productivity and to assess the role of vegetation regrowth in the rehabilitation of the disturbed ecosystem. While acknowledging the validity of this approach, particularly in certain ecological and forest management settings, British Columbia LTSP researchers chose to not apply the vegetation control treatment for the following reasons:

- Due to the high installation costs and space restrictions, it was not possible to test both the tree species effect and the vegetation control effect; as a result, it was necessary to choose between the two.
- Differences in the response of commercially important tree species to alterations in soil and site conditions are of great interest.

- While the organic matter removal and soil compaction treatments can clearly be related to the results of some operational management practices, the complete suppression of natural vegetation by repeated herbicide application is not a common forestry practice in these ecosystems nor is it likely to be in the future.
- It was not the intention of the British Columbia researchers to eliminate any of the driving forces in the development of soil formation (i.e., plants, animals, parent material, climate, and time) from the experiment. Control of competing vegetation would largely remove one of the soil development factors (plants), except for that contributed by the crop species. Thus, the British Columbia experiments reflect an emphasis on ecosystem response to timber harvesting rather than on management for timber production.

One plot-sized area (i.e., > 1 ha) was left unharvested (termed the "uncut control") at each site. At the Topley site, all pre-treatment sample collections and measurements were conducted in the uncut control and in each experimental unit assigned to a treatment. At the other sites, pre-treatment analysis of the uncut controls was not done. However, the uncut controls were sampled at each of the IDF-Kamloops sites during the first-year post-treatment sampling.

4 METHODS

Methods are summarized below; however, working plans, progress and technical reports, and journal articles generated by the individual studies provide more complete details (see Literature Cited and Appendix 1). The general chronology for the experimental sites is presented in Table 2. Pre- and post-harvest sampling methods were sometimes different or were modified over time, depending on sampling location, stand structure, timing of treatments and planting, and other site factors or accumulated experience. Thus, methods are separated into pre- and post-treatment.

4.1 Pre-harvest Measurements and Sampling

4.1.1 Ecosystem selection and plot layout In each administrative unit (Forest Region), the principal researchers found suitable candidate areas that were scheduled to be harvested according to the Ministry of Forests Small Business Forest Enterprise Program based in Forest District offices or through local forest licensees. Suitable areas had to meet the ecological and size criteria specified in the working plan (Hope et al. 1992).

The total area required for nine treatment plots was approximately 3 ha. Where possible, the plots at each site were contiguous within the harvested block; this was not possible at Topley, Kiskatinaw, Dairy Creek, Black Pines, or McPhee Creek. Each plot was at least 40 × 70 m, with 5- to 10-m access trails around the perimeter of each plot. Plot locations were mapped on the harvesting plan and were semi-permanently marked by driving a metal pole into the ground at each plot corner to aid in plot relocation following harvesting. Trees nearest to the plot corners were painted, and lines between these points were flagged. Similar procedures were also conducted in the uncut control area at Topley.

TABLE 2 *General chronology for the long-term soil productivity sites*

	Log Lake	Topley	Skulow Lake	Kiskatinaw	Rover Creek	McPhee Creek
Site selection	1990	1991	1992	1993		
Pre-harvest sampling	1991	1992	1993	1 – 1994 2 and 3 – 1997	2001	2002
Harvesting in plots	January to February 1992	January to March 1993	March 1994	1 – January to February 1995 2 – 1998 3 – 1999	2002 (3 plots burned in 2004 and replaced in 2005)	2003
Treatment application	1992–1993	1993	1994	1 – 1995 2 – 1998 3 – 1999	2002	2003–2004
Year 1 post-treatment sampling and planting	1994	1994	1995	1 – 1995; 2 – 1998; 3 – 1999	2003	2004
Regenerating crop species	Hybrid spruce and lodgepole pine	Hybrid spruce and lodgepole pine	Hybrid spruce and lodgepole pine	White spruce and trembling aspen	Douglas-fir and western white pine	Douglas-fir and western white pine
Post-treatment chronology to year 50	Yr 5: 1998 Yr 10: 2003 Yr 15: 2008 Yr 20: 2013 Yr 30: 2023 etc. to Yr 50: 2043	Yr 5: 1998 Yr 10: 2003 Yr 15: 2008 Yr 20: 2013 Yr 30: 2023 etc. to Yr 50: 2043	Yr 5: 1999 Yr 10: 2004 Yr 15: 2009 Yr 20: 2014 Yr 30: 2024 etc. to Yr 50: 2044	Yr 5: 1 – 1999 2 – 2002 3 – 2003 Yr 10: 1 – 2004 2 – 2007; 3 – 2008 etc. to Yr 50: 1 – 2044 2 – 2047; 3 – 2048	Yr 5: 2007 Yr 10: 2012 Yr 15: 2017 Yr 20: 2022 Yr 30: 2032 etc. to Yr 50: 2052	Yr 5: 2008 Yr 10: 2013 Yr 15: 2018 Yr 20: 2023 Yr 30: 2033 etc. to Yr 50: 2053

	Dairy Creek	Black Pines	O'Connor Lake	Mud Creek	Emily Creek	Kootenay East
Site selection	1995	1995	1996			
Pre-harvest sampling	1997	1998	1999	1998	1999	2000
Harvesting in plots	January to February 1998	January to March 1999	February 2000	1999	2000	2001
Treatment application	1998	1999	2000	1999	2000	2001
Year 1 post-treatment sampling and planting	1999	2000	2001	2000	Pl – 2001 FD – 2002	2002
Regenerating crop species	Douglas-fir and lodgepole pine	Douglas-fir and lodgepole pine	Douglas-fir and lodgepole pine	Douglas-fir and lodgepole pine	Douglas-fir and lodgepole pine	Douglas-fir and lodgepole pine
Post-treatment chronology to year 50	Yr 5: 2003 Yr 10: 2008 Yr 15: 2013 Yr 20: 2018 Yr 30: 2028 etc. to Yr 50: 2048	Yr 5: 2004 Yr 10: 2009 Yr 15: 2014 Yr 20: 2019 Yr 30: 2029 etc. to Yr 50: 2049	Yr 5: 2005 Yr 10: 2010 Yr 15: 2015 Yr 20:2020 Yr 30: 2030 etc. to Yr 50: 2050	Yr 5: 2004 Yr 10: 2009 Yr 15: 2014 Yr 20: 2019 Yr 30: 2029 etc. to Yr 50: 2049	Yr 2: Pl – 2002 Fd – 2003 Yr 5: Pl – 2005 FD – 2006 Yr 10: Pl – 2010 FD – 2011 etc. to Yr 50: Pl – 2050 FD – 2051	Yr 5: 2006 Yr 10: 2011 Yr 15: 2016 Yr 20: 2021 Yr 30: 2031 etc. to Yr 50: 2051

4.1.2 Ecosystem descriptions Ecosystems were described by classifying sites, soils, and vegetation according to Luttmerding et al. (1990). Soil and site attributes were examined in at least three locations (modal pedon sampling) within each study area, usually in the access corridors between plots. Ecological descriptions for the SBS, BWBS, and IDF-Kamloops sites include modal soil pit descriptions, lists of plant species, and site indices for commercial tree species. The descriptions included here represent pre-treatment data only. Some descriptive site data are also presented in Table 3.

At the SBS and IDF-Kamloops sites, mineral soil samples were collected from the entire 0- to 20-cm depth. At the BWBS site, mineral soil was collected in 0- 10-cm and 10- 20-cm increments. To make the data comparable with the other sites, the results of bulk density determinations and chemical analyses from the soils collected at the two sample depths at the BWBS site were averaged to obtain an estimate of the values for the entire 0- 20-cm depth.

4.1.3 Timber volume and productivity Standing timber volume and size, and stand characteristics were estimated for all sites based on Ministry of Forests cruising procedures. Site index was estimated using procedures outlined in Thrower & Associates Ltd. (1991) for the Log Lake, Kiskatinaw, and Kamloops IDF sites and modified by Laing & McCulloch (1993) for the Skulow and Topley sites. Three standard cruise plots were completed in each treatment plot (and uncut control at Topley). In each plot, the five largest trees of each leading species (well-spaced throughout the plot and free of defects) were cut and bucked into sections for stem analyses. Determination of site index (metres from breast height at 50 years) was calculated for the leading tree species within each plot and across each site in order to compare plot and site productivity. For the ICH-BC sites, a full cruise of all standing trees was done, and all stumps were mapped following treatments.

Ministry of Forests regional pathologists visited each site (only the Dairy Creek site for the IDF-Kamloops experiment) to provide a visual assessment of pathological agents present. Evidence of pathogens was also noted during the cruise and stem analyses (and mapping of stumps at ICH-BC sites). During the selection of trees for stem analyses, roots were cored to observe any identifiable rots that may have been present at the base of each stem.

4.1.4 Forest floor and mineral soil properties Forest floors and mineral soils were sampled for analysis of chemical and physical properties prior to treatment application. The chemical properties measured in soils from all sites included total C, N, and S, anaerobically mineralizable N, available P (Bray P-1), pH, and exchangeable Ca, K, and Mg. Aeration porosity, bulk density, and mineral soil coarse fragment content were also measured. At the Log Lake and Topley sites, soil sampling methods closely followed the working plan (Hope et al. 1992), while at the Skulow, Kiskatinaw, and IDF-Kamloops sites there were some deviations from that plan, as outlined in Table 4. Where possible, samples for chemical properties were taken in the spring, following snowmelt, when soil moisture was expected to be close to field capacity. However, soil samples collected at the IDF-Kamloops sites were often at less than field capacity, and those at IDF-Nelson were taken following or during the wetter period in June.

Table 5 provides the mean pre-harvest forest floor properties for all British Columbia LTSP installations. Table 6 presents the mean pre-harvest mineral soil properties.

TABLE 3 *Environmental attributes of the long-term soil productivity sites*

	Log Lake	Topley	Skulow Lake	Kiskatinaw	Rover Creek	McPhee Creek
Biogeoclimatic unit	SBSwk1	SBSmc2	SBSdw2	BWBSmw1	ICHdw	ICHdw
Site series (series other than 01 are generally minor inclusions)	01/Sxw - Oak fern	01/Sxw - Huckleberry; 05/Sxw - Twinberry - Coltsfoot; 06/Sxw - Oak fern	01/SxwFd - Pinegrass 08/Sxw - Twinberry	01/At - Creamy peavine	01ab/CwFd - Falsebox	01ab/CwFd - Falsebox
Latitude, longitude	54°21′58″ N, 122°36′42″ W	54°36′35″ N, 126°18′39″ W	52°18′57″ N, 121°54′54″ W	55°58′29″ N, 120°28′03″ W	49°26′50″ N, 117°30′16″ W	49°18′54″ N, 117°36′03″ W
Elevation (m)	780–790	1100	1050	720	835	820
MAT, MAP, AH:M[a]	2.6°, 858 mm, 14.7	1.2°, 618 mm, 18.1	3.2°, 549 mm, 24.0	1.1°, 485 mm, 22.9	6.7°, 843 mm, 19.9	6.8°, 813 mm, 20.6
Slope and aspect	0–3% south	2–12% west	Level	4% south	0–5% west	0–15% west
Landform	Morainal blanket	Morainal blanket	Morainal blanket	Fluvial veneer/ lacustrine blanket	Eolian veneer/blanket over morainal blanket with some glaciofluvial	Eolian veneer over morainal blanket and some fractured bedrock
Soil classification of modal soil pedons (in order of dominance)	Gleyed Humo-Ferric Podzol, Gleyed Eluviated Dystric Brunisol	Orthic Gray Luvisol, Gleyed Gray Luvisol	Orthic Gray Luvisol	Gleyed Gray Luvisol, Orthic Luvic Gleysol	Orthic Dystric Brunisol	Orthic Dystric Brunisol
Predominant humus form	Hemimor	Hemimor	Hemimor	Hemimor	Hemimor (some lignomor)	Hemimor (some mormoder)
Soil texture	Silt loam over loam	Loam to clay loam	Loam	Silt loam over clay loam	Fine sandy loam	Fine sandy loam to silt loam
Coarse fragment content (%)	37–41	21–40	30–39	0	0–30	0–50
Dominant pre-harvest tree spp./approximate stand age	*Abies lasiocarpa, Pseudotsuga menziesii, Picea glauca × engelmannii*	*Pinus contorta, Abies lasiocarpa, Picea glauca × engelmannii*	*Pinus contorta, Picea glauca × engelmannii*	*Populus tremuloides, Picea glauca*	*Pseudotsuga menziesii, Larix occidentalis, Pinus contorta, Pinus ponderosa; Pinus occidentalis*	*Pseudotsuga menziesii, Larix occidentalis, Pinus contorta, Pinus ponderosa; Pinus occidentalis*
	140 years	140 years	112 years	100 years	Variable ages	Variable ages
Site index (m@50 yr)	Fd – 19.2; Sx – 18.5	Sx – 16.1; Pl – 15.7	Pl – 17.9	At – 18; Sx – 18	Fd – 22 (from SP)	Fd – 24
Net merchantable volume (m^3/ha)	417	390	142	280	500	600

TABLE 3 *(Continued)*

	Dairy Creek	Black Pines	O'Connor Lake	Mud Creek	Emily Creek	Kootenay East
Biogeoclimatic unit	IDFdk2	IDFdk2	IDFdk2	IDFdm2	IDFdm2	IDFdm2
Site series (series other than 01 are generally minor inclusions)	05/FdPl - Pinegrass - Feathermoss 01/FdPl - Pinegrass - Twinflower 06/SxFd - Dogwood - Gooseberry	01/FdPl - Pinegrass - Twinflower 05/FdPl - Pinegrass - Feathermoss 06/SxFd - Dogwood - Gooseberry	05/FdPl - Pinegrass - Feathermoss 01/FdPl - Pinegrass - Twinflower 06/YS $At - Snowberry - Rose	01/FdPl - Pinegrass - Twinflower 05/SxwAt - Sarsaparilla (on small part of rehab plot)	01/FdPl - Pinegrass - Twinflower	01/FdPl - Pinegrass - Twinflower
Latitude, longitude	50°51′10″ N, 120°25′10″ W	50°56′25″ N, 120°17′45″ W	50°53′40″ N, 120°21′10″ W	50°08′15″ N, 115°44′22″ W	50°08′42″ N, 115°58′38″ W	50°11′45″ N, 115°42″09″ W
Elevation (m)	1150	1180	1075	1025	1200	1065
MAT, MAP, AH:M[a]	4.0°, 453 mm, 30.9	3.7°, 466 mm, 29.3	4.3°, 450 mm, 31.8	4.4°, 455 mm, 31.7	3.7°, 513 mm, 26.8	3.9°, 479 mm, 29.1
Slope and aspect Landform	0–3% Morainal blanket	level Morainal blanket	2–12% west Morainal blanket	0–15% west Morainal blanket with some Glaciofluvial	0–10% west Morainal blanket and Glaciofluvial	2–15% west Morainal blanket
Soil classification of modal soil pedons (in order of dominance)	Brunisolic Gray Luvisol	Brunisolic Gray Luvisol	Brunisolic Gray Luvisol	Orthic Eutric Brunisol (calcareous in solum)	Orthic Eutric Brunisol	Orthic Eutric Brunisol (some Dystric due to surface pH)
Predominant humus form	Hemimor	Hemimor	Hemimor (Mormoder is secondary)	Hemimor (Vermimull on some plots)	Hemimor	Hemimor
Soil texture	Silt loam	Silt loam	Silt loam	Fine sandy loam to silt loam	Primarily fine sandy loam (silt loam)	Primarily silt loam
Coarse fragment content (%)	20	17	21	10–25 (15–50 in subsoil)	10–25 (15–50 in subsoil)	10–25 (15–50 in subsoil)
Dominant pre-harvest tree spp./approximate stand age	*Pseudotsuga menziesii, Picea glauca × engelmannii, Pinus contorta* 175 and 100 years	*Pseudotsuga menziesii, Pinus contorta* 210 and 120 years	*Pseudotsuga menziesii* 170 and 120 years	*Pseudotsuga menziesii, Larix occidentalis, Pinus contorta, Pinus ponderosa, Picea glauca × engelmannii* Variable ages	*Pseudotsuga menziesii, Larix occidentalis, Pinus contorta, Pinus ponderosa* Variable ages	*Pseudotsuga menziesii, Larix occidentalis, Pinus contorta, Pinus ponderosa, Picea glauca × engelmannii* Variable ages
Site index (m@50 yr)	Fd – 18.1; Pl – 18.0	Fd – 15.6; Pl – 14.7	Fd – 16.8; Pl – 14.3	Fd – 16	Fd – 14	Fd – 17
Net merchantable volume (m^3/ha)	327	448	407	240	120	350

[a] MAT = mean annual temperature; MAP = mean annual precipitation; AH:M = annual heat-moisture index.

TABLE 4 *Comparison of soil sampling methods among the long-term soil productivity sites*

Method	Log Lake[a] 1991	Topley[b] 1992	Skulow Lake[c] 1993	Kiskatinaw[d] 1994	Rover Creek	McPhee Creek
					2008	
Chemistry for mineral and forest floor – method and no. of samples	Stratified random – 25 locations/plot bulked to 5 composite samples/plot	Systematic – 25 locations bulked to 5 composite samples/plot	Systematic – 18 locations, 3 samples/location bulked to 1; total = 18 mineral samples: 9 forest floor/plot	Stratified random – 25 locations/plot bulked to 5 composite samples/plot; later, 30 stratified random samples/plot bulked to 6 composite samples	Same as IDF-Kamloops	
Chemistry – depth for mineral samples	0–20 cm	0–20 cm	0–20 cm	0–10, 10–20, and 20–30 cm; later, 0–10 cm and 10–20 cm only	0–10, 10–20, and 20–30 cm	
Chemistry – area or volume for forest floor	500 ml, bryophyte layer removed	15 × 15 cm template, bryophyte layer removed	20 × 20 cm template, 9 systematic locations, included twigs, cones, and mosses	200 cm^2, bryophyte layer removed	6 equal volume composite samples per plot from same transects, same criteria as Kamloops	
Density – mineral soil	10 random samples/plot, 0–20 cm, total and fine fraction	10 stratified random samples/plot, 0–20 cm, volume replacement (silicon chips) total and fine fraction	9 systematic locations/plot, 0–20 cm volume replacement (foam)	10 random samples/plot, 500 cm^3 core at 0, 10, 20, and 30 cm depths; 0–10, 10–20 only post treatment	6 randomly chosen samples per plot (16 pre-harvest at Rover Creek) – (one per transect)/0–10, 10–20, 20–30 using 10-cm cores, total and fine fraction	
Mass/density – forest floor	10 samples/plot, template (19.5 × 14 cm), volume replacement, average depth determined, medium and coarse roots removed	10 stratified random samples/plot, template (15 × 15 cm), volume replacement, also percent surface of forest floor, decaying log, and sound log determined, average depth determined	Determined from chemistry samples	10 samples/plot, 200 cm^2, average depth determined	6 samples/plot (same site as mineral soil density); 25 × 25 cm template, average depth based on 8 measures (corners and mid-points) (Maynard et al. 2014)	
Coarse fragment content	4 samples; 1 × 1 × 0.2 m sieved	4 samples; 1 × 1 × 0.2 m sieved, and also determined from bulk density samples	Determined from bulk density samples	Not determined (very few coarse fragments)	Determined through co-operative work with Canadian Forest Service in modal locations and from bulk density samples	
Moisture retention, aeration porosity, and hydraulic conductivity	5 random cores/plot (5 cm diameter × 2 cm height); 0 and 10 cm depths	(1993 before application of treatments) 5 random cores/plot (5 cm diameter × 2 cm height); 0 and 10 cm depths	5 systematic cores/plot (5 cm diameter × 2 cm height); 0 and 10 cm depths	5 random cores/plot (5 cm diameter × 2 cm height); 0, 10, and 20 cm depths	6 random locations (the physical sampling sites) with three depths: 0–2, 2–4, and 10–12 cm. All had 6-pt water retention during pre-treatment and post-treatment sampling.	

TABLE 4. *(Continued)*

Method	Dairy Creek	Black Pines	O'Connor Lake	Mud Creek	Emily Creek	Kootenay East
	1997–2005			1998–2000		
Chemistry for mineral and forest floor – method and number of samples	Stratified random (3 transects per split-plot) – 30 locations/plot bulked to 6 composite samples/plot/layer			Same as IDF-Kamloops		
Chemistry – depth for mineral samples	0–20 cm and 20–40 cm for pre-treatment; 0–20 cm only post-treatment			0–10 cm and 10–20 cm		
Chemistry – area or volume for forest floor	15 × 15 cm template, bryophyte layer removed, included decayed wood in forest floor			6 equal volume composite samples per plot from same transects, same criteria as IDF-Kamloops		
Density – mineral soil	12 stratified random samples/plot, 0–20 cm and 20–40 cm (pre-treatment), volume replacement (water), total and fine fraction			6 randomly chosen samples per plot (one per transect)/0–10 and 10–20 using 10-cm cores, total and fine fraction		
Mass/density – forest floor	6 samples/plot (same samples as for chemistry), template (15 × 15 cm), average depth determined, medium and coarse roots removed			6 samples per plot (same site as mineral soil density); 25 × 25 cm template, average depth based on 8 measures (corners and mid-points) (Maynard and Curran 2008)		
Coarse fragment content	Up to 4 samples (1 common sample per adjacent boundary); 25 cm × 25 cm × 0.2 m sieved, and also determined from bulk density samples			Determined through co-operative work with Canadian Forest Service in modal locations and from bulk density samples		
Moisture retention, aeration porosity, and hydraulic conductivity	5 random cores (subsampled from Db locations)/plot (5 cm diameter × 2 cm height); 0 and 10 cm depths; only one 6-pt water retention per plot/depth			6 random locations (the physical sampling sites) with 3 depths: 0–2, 2–4, and 10–12 cm; all had 6-pt water retention during pre-treatment and post-treatment sampling		

[a] Kranabetter et al. 1992; Kranabetter 1993; Sanborn 1995.
[b] Trowbridge and Macadam 1993.
[c] Chapman, B. 1995. Long-term productivity trial, Cariboo replicate: 1994 progress report. B.C. Min. For., Williams Lake, B.C. Draft rep.
[d] Kabzems, R. 1994. Aspen and white spruce Long-term Site Productivity Study in the BWBS. B.C. Min. For, Fort St. John, B.C. Draft work. plan; Kabzems 1995a, 1995b.

TABLE 5 *Pre-harvest forest floor properties for the British Columbia long-term soil productivity sites*

Site	Depth (cm)	BD[a] (kg/m³)	Mass (kg/m²)	C (%)	N (%)	C:N ratio	Min N (ppm)	Avail. P (ppm)	S (%)	CEC[b]	Ca	K	Mg	pH (H_2O)	pH ($CaCl_2$)
										(cmol/kg soil)					
Kiskatinaw	7.7	92	7.07	43.7	2.09	20.9	1120	216	0.222	n/a	97.0	3.6	18.2	n/a	5.53
Log Lake	7.8	112	7.10	36.4	1.11	33.0	280	101	0.122	41.1	32.3	2.2	3.8	4.42	4.10
Skulow Lake	5.2	82	5.18	37.5	1.21	31.3	339	200	0.099	76.6	27.3	3.9	17.2	5.02	4.61
Topley	7.5	114	6.64	48.4	1.41	34.5	401	93	0.151	109.7	32.1	3.2	6.5	4.44	4.08
Dairy Creek	5.0	123	6.12	47.9	1.46	33.8	711	133	0.141	75.4	64.7	2.3	7.0	5.28	4.79
Black Pines	4.1	134	5.45	43.4	1.25	35.6	469	87	0.122	83.1	73.0	2.4	5.8	5.45	4.90
O'Connor Lake	5.3	120	6.34	43.9	1.59	27.9	639	72	0.148	92.5	81.4	2.6	7.6	5.76	5.30
Mud Creek	2.2	112	1.76	43.8	1.35	34.0	541	88	0.101	81.9	64.7	2.8	13.2	5.66	5.21
Emily Creek	1.8	101	2.04	44.8	1.43	32.0	591	103	0.093	55.7	44.2	2.7	7.4	5.20	n/a
Kootenay East	3.1	125	3.35	48.3	1.49	33.1	542	120	0.143	81.4	66.8	3.1	10.2	5.47	5.09
Rover Creek	3.8	97	3.63	40.3	0.89	45.3	209	108	0.086	42.2	33.3	2.3	4.0	4.90	4.45
McPhee Creek	3.8	81	2.82	43.9	1.27	35.3	462	114	0.140	67.6	57.7	1.9	6.3	4.97	4.57

[a] BD: bulk density.
[b] CEC: cation exchange capacity.

TABLE 6 *Pre-harvest mineral soil properties (0–20 cm) for the British Columbia long-term soil productivity sites*

Site	Depth (cm)	BD[a] (kg/m³)	Mass (kg/m²)	C (%)	N (%)	C:N ratio	Min N (ppm)	Avail. P (ppm)	S (%)	CEC	Ca	K	Mg	pH (H_2O)	pH ($CaCl_2$)
										(cmol/kg soil)					
Kiskatinaw	n/a	1302	19.5	1.23	0.112	11.1	24.9	30	0.0102	n/a 5.28	0.39	1.47	n/a	4.96	
Log Lake	1580	1028	20.9	1.59	0.088	18.4	9.6	53	0.0055	22.8	2.30	0.16	0.42	4.72	4.31
Skulow Lake	1415	1147	19.3	1.12	0.083	13.3	15.9	14	0.0043	12.0	4.34	0.15	4.35	5.77	4.84
Topley	1429	1044	20.9	3.15	0.150	21.0	30.8	9	0.0133	23.7	9.06	0.24	3.05	5.12	4.61
Dairy Creek	1255	896	20.0	2.43	0.125	19.6	29.0	185	0.0086	10.2	7.86	0.50	1.38	5.67	4.89
Black Pines	1203	966	23.2	1.90	0.097	19.5	24.4	124	0.0083	9.7	7.95	0.48	0.86	5.66	4.98
O'Connor Lake	1238	943	20.5	2.18	0.132	16.5	29.4	80	0.0087	12.3	10.02	0.57	1.46	5.88	5.25
Mud Creek	n/a	n/a	n/a	2.75	0.125	21.8	41.4	16	0.0080	20.5	15.93	0.60	3.83	6.97	6.36
Emily Creek	1199	1006	19.5	1.71	0.092	18.0	46.7	27	0.0050	9.9	7.49	0.62	1.60	6.12	n/a
Kootenay East	1017	799	n/a	2.78	0.126	21.7	66.8	8	0.0073	23.3	18.46	0.62	4.05	6.87	6.43
Rover Creek	1096	1060	n/a	1.25	0.058	21.0	17.7	284	0.0045	2.3	1.75	0.16	0.18	5.70	5.01
McPhee Creek	794	637	n/a	3.03	0.161	19.0	38.1	171	0.0185	7.0	5.78	0.26	0.60	5.63	5.01

[a] BD = bulk density.
[b] AP = aeration porosity, averaged 0–10 cm.
[c] CEC = cation exchange capacity.

4.1.5 Native vegetation Pre-treatment vegetation species and percent cover are in Appendix 3. Plant species were listed somewhat differently at each site, as follows:

SBS and BWBS sites

At Log Lake, one floristic list with percent cover of species was compiled for the entire area occupied by the nine plots (Kranabetter et al. 1992), and the entire site was classified to one site series. At Skulow Lake, the site was mapped into two strata: drier (A) and wetter (B) (Chapman 1995[2]). Species cover was estimated in one subplot (400 m²) of each plot for stratum A, and in three subplots located randomly within stratum B. At Topley (Haeussler 1992, 1994; Trowbridge and Macadam 1993), and Kiskatinaw (Kabzems 1995a), vegetation cover was estimated within each plot. At Topley, site series (and/or complexes)

2 Chapman, B. 1995. Long term productivity trial, Cariboo replicate: 1994 progress report. B.C. Min. For., Williams Lake, B.C. Draft rep.

were mapped in every plot, including the uncut control area. All 27 plots at Kiskatinaw were classified to one site series.

Voucher specimens of unusual or difficult to identify bryophytes and vascular species found at Skulow Lake and Topley were pressed and mounted for future reference and stored at the Ministry of Forests and Range's herbariums in Williams Lake and Smithers, respectively.

IDF-Kamloops, IDF-Nelson IDF, and ICH sites

At the three IDF-Kamloops sites, three IDF-Nelson sites, and two ICH-BC sites, four circular 2.5-m radius subplots were established at a 45° angle and 15 m from all four corner posts in each of the nine treatment plots. Percent cover was recorded for all plant species in each subplot. Site series (often in complexes) were mapped separately from the vegetation data collected in each plot (Lloyd et al. 1990) and were updated for this report using the 2005 classification (D.A. Lloyd, MFLNRO, pers.comm., 2005), and in the Nelson area using Braumandl and Curran (1992).

4.2 Application of the Experimental Treatments

In order to establish a methodology for achieving the compaction and organic matter treatment combinations in a feasible and cost-effective manner, a pilot study was conducted in the Prince George Region (Hope and Homoky 1991). The compaction treatments were the most challenging aspect of the experiment, and considerable time and expense was spent developing a technique for applying them in a consistent and desirable way. Most of the machinery and manual methods tried in the pilot study proved to be less than desirable. However, the experience from the pilot study led the principal researchers to test the use of excavators with various buckets and hydraulic compaction plates (equipment used to compact soil or subgrade during building and road construction) at Log Lake. Following the successful application of treatments at Log Lake, similar procedures were followed at Topley, Skulow, and Kiskatinaw, and at the IDF-Kamloops and IDF-Nelson sites. At the ICH-BC sites, a rubber-tired skidder was used for compaction to enable a better comparison with the replicate at Priest River, Idaho, where logging equipment had been used for compaction; hand or excavator compaction plates were used to complete the areas around stumps.

Compaction and organic matter retention treatments were initiated on each site during the first summer following harvesting, except at Log Lake, where compaction treatments were completed the second summer following harvesting. At the Nelson sites, the rehabilitation treatments were conducted during the spring after treatment and before planting. The exact procedures varied slightly from site to site, but the following sections provide general details about the methods used. Refer to the individual progress reports for more detail (see Literature Cited and Appendix 1).

4.2.1 Harvesting and organic matter removal Silviculture prescriptions and logging plans (filed in regional research offices) provided details to the Forest District staff and harvesting contractors on how the operations were to be conducted in order to achieve the research goals. All harvesting was done in the winter, usually when there was a 30- to 50-cm snowpack. Trees were delimbed within each plot on the OM_1 plots. To avoid unwanted compaction and forest floor displacement, machine traffic was avoided whenever possible. At the SBS and IDF-Kamloops, IDF-Nelson, and ICH-BC sites, this was

accomplished by hand-felling and line skidding to the access corridors. However, at the Kiskatinaw site and a few plots at the Emily Creek site, a fellerbuncher entered the plots to cut the trees, and then positioned the stems so that the grapple skidder could remove them without entering the plots (Figure 3). Staff from the regional research or district offices was present during harvesting of the treatment plots to ensure that procedures were followed correctly.

Slash removal treatments (Figures 4, 5, and 6) were completed in the summer following harvesting, except at the Black Pines and O'Connor Lake sites near Kamloops, where an excavator entered the OM_2 (stem + slash removal)

FIGURE 3 *Kiskatinaw timber harvesting.*

FIGURE 4 *Kiskatinaw forest floor removal.*

FIGURE 5 *Topley OM_1.*

plots immediately after harvesting was completed (the plots were still covered in some snow) and removed most of the large slash that remained. Otherwise, slash was removed by hand to the access corridors for the OM_2C_0 plots (all OM_2 plots in the IDF-Kamloops sites); in the OM_1 C_1/C_2 plots (i.e., prior to application of compaction treatments at the IDF-Kamloops sites), OM_2 C_1/C_2 plots, and OM_3 C_1/C_2 plots, an excavator was used to move the slash to the centre or outside of the plots by piling the brush to the rear of the machine and then moving backward on top of the piles. On the Nelson sites, the slash was considered adequate to permit careful, supervised excavator traffic on all slash and forest floor removal plots. At no time did the machines travel on

FIGURE 6 *Topley OM_3.*

exposed mineral soil. The excavator carefully removed forest floor in the OM_3 treatment plots by gently rolling the forest floor backward and into small piles. Then, while keeping the bucket off the mineral soil interface, the excavator moved the piles of forest floor into the corridors. Where necessary, accumulations of organic matter left behind were subsequently removed by hand; for example, accumulations of organic matter around stumps at the Topley and IDF-Kamloops, IDF-Nelson, and ICH-BC sites.

The piles of organic material that had accumulated in the corridors were moved away from the experimental plots. At Log Lake, this material was piled in rows adjacent to the experimental area; at Skulow Lake, it was piled on a landing in the cutblock; and, at Topley, the material was spread over one of the landings off the cutblock. At the Kiskatinaw site, the organic materials removed from the soil surface in Plot No. 4 were moved 40 m away, put into a low berm, and seeded with *Elymus trachycaulum* (slender wheatgrass) and *Astragalus cicer* (cicer milk-vetch). For the other plots at the Kiskatinaw site, the accumulations of organic material were placed on the harvesting road and seeded to the same agronomic species. At Rover Creek, most organic material was trucked off-site at the contractor's expense for use as topsoil. At the IDF-Kamloops, IDF-Nelson, and McPhee ICH sites, the organic material was piled in buffer strips and in areas adjacent to the experimental area.

4.2.2 Compaction of the mineral soil Based on the trials at Log Lake, a compaction plate mounted to the arm of an excavator (Figure 7) was used to apply compaction treatments at every site except ICH-BC. In order to achieve the desired soil bulk density, a 2- to 3-cm impression into the mineral soil was created for the C_1 treatments at each site, and a 5-cm impression was created for the C_2 treatments.

At each site, the OM_3 treatments were used to determine the amount of pressure and the time required for the operator to achieve the desired level of compaction; these parameters varied with the soil conditions at each site (e.g., soil moisture and coarse fragment content). The pressure plate was used

FIGURE 7 *Kiskatinaw soil compaction.*

to compact in the front and to the sides of the excavator, which then moved backward across the plot in order to compact the entire area.

At the IDF-Nelson sites, compaction depth and degree were estimated by the supervising soil scientist while the operator varied tamping pressure and time in response to forest floor presence. At these sites, the objective was to achieve mineral compaction similar to a heavily used skid trail at the edge of a landing (C3) or similar to a main skid trail away from the landing (C2).

At the ICH-BC sites, compaction was achieved using a rubber-tired skidder with a 1818-kg (4000-lb) concrete block attached to the back. The skidder repeatedly drove back and forth across the block in an overlapping pattern until the desired compaction was achieved (e.g., approximately 10 cycles each way [40- to 70-m dimensions] for moderate compaction and 20 cycles for heavy compaction). Compaction around stumps was completed with "jumping jack" hand compactors at Rover Creek and with an excavator compacting plate at McPhee.

Compaction treatments were applied directly on top of the forest floor. This contrasts with the procedure followed at some of the U.S. Forest Service LTSP sites where the forest floor was first removed and then replaced following compaction. Such a procedure was not feasible at the British Columbia study sites because of the abundant network of roots within the forest floor. When calibrating the machine and operator to the amount of mineral soil impression (compaction) required, a small portion of forest floor was lifted in order to place a survey rod at the mineral soil surface and then was replaced after measurements were completed. The survey level and rod were used to compare the elevation of the undisturbed mineral soil surface with that of the mineral soil after compaction in the following manner: the survey rod was placed on the undisturbed mineral soil surface, elevation was measured, compaction was applied, and the spot was resurveyed immediately afterward. After sufficient repetition of this procedure, the operator became accustomed to uniformly compacting to the desired impression, taking into account the soil properties within each plot. Throughout this procedure, one

or more researchers or district staff were on hand to monitor and assist the machine operators, thereby ensuring the consistency of compaction treatments across plots.

In the OM_1 treatments, slash was moved into rows within the plot prior to application of the compaction treatments, which left a corridor of bare forest floor for the excavator to compact and travel through. At the Log Lake and Topley sites, long or large pieces of snags and slash were bucked into 1- to 3-m lengths to facilitate moving them by hand. Large pieces were not bucked up at the Kiskatinaw and Kamloops–IDF sites. Instead, the largest pieces were moved by extending the arm of the excavator as far as it could reach into the plots; some further removal of pieces was done by hand. When compaction of these corridors was completed, the slash was moved back onto the compacted areas so that the excavator could treat the remaining regions of the plot. Following this step, the slash was redistributed as uniformly as possible across the entire treatment plot. At the Nelson sites, the excavator moved slash back onto the plots with the assistance of hand crews.

Post-treatment bulk densities are in Appendix 4.

4.2.3 Tree planting and establishment Seedlings were planted during the spring following treatment application at each site (see Table 4).

SBS and BWBS sites

Seedling heights and condition were assessed at the end of the first growing season at the Topley, Log Lake, and Skulow Lake sites, and dead seedlings were replaced with seedlings that were transplanted from the buffer areas around plots or from the adjacent cutblock. At Kiskatinaw, the height, root collar diameter, and condition of planted white spruce seedlings and the height and abundance of naturally regenerated trembling aspen, balsam poplar, paper birch, and white spruce were monitored.

IDF-Kamloops sites

For the first 3 years after planting at the IDF-Kamloops sites, dead seedlings were replaced with trees that had originally been planted adjacent to the treatment plots. The survival of Douglas-fir seedlings continued to be poor at Dairy Creek and O'Connor Lake, so these sites were replanted with fresh seedling stock in years 5 and 7, respectively.

IDF-Nelson and ICH-BC sites

The Nelson sites (IDF and ICH) followed the same measurement cycle as Kamloops, with Douglas-fir replanting done in the IDF when Mud Creek was in year 5, and with white pine in the ICH when Rover Creek was in year 3 and at McPhee in year 6. In addition, three plots burned during a wildfire at Rover Creek in year 1 and were replaced in year 3 under an additional funding grant. (Selkirk College, one collaborator on this site, replanted the burned plots and is continuing to monitoring tree growth on them.)

4.2.4 Control of competing vegetation Where necessary to ensure seedling survival, competing vegetation was controlled manually every year until free-growing status was achieved by brushing within a 1-m radius of each planted seedling. Residues generated during brushing were left on the surface of the

forest floor. At the IDF-Nelson sites, aspen is not equally distributed, so it has been manually removed annually on the few plots where it exists. Post–free-growing vegetation control was carried out as required on all plots to allow unimpeded growth of measurement trees and maintain their status as a reliable bioassay of site productivity.

On the ICH-BC sites, half of each plot was randomly assigned to brush control (to be consistent with the USDA Forest Service Priest River replicate). Manual brushing was conducted each year in late spring or early summer to reduce competing vegetation on these sites so that they would be comparable to the level of control achieved at Priest River.

4.3 Post-treatment Sampling

4.3.1 Slash loading Slash loading was determined on OM1 plots (three plots per site except at Kiskatinaw, where there were nine plots) within 3 years of logging (Table 7). Three triangles per plot were surveyed at most sites using the line-intercept method described in Trowbridge et al. (1986). At the Nelson sites, four randomly located transects were used because the slash loading was oriented largely in one direction following harvest or slash replacement.

To estimate nutrient removals in harvested biomass, samples of fresh deadfall corresponding to the slash size classes quantified during the slash loading surveys (Trowbridge et al. 1986) were collected in 1996 from unharvested areas adjacent to the Topley and Skulow Lake sites. At the Log Lake (collected in 1996) and Kiskatinaw (collected in 2008) sites, samples were collected during the summer from trees that had been felled the previous winter in an adjacent stand. During harvesting at the IDF-Kamloops sites, branch and stem samples were collected from a single dominant or codominant Douglas-fir and lodgepole pine tree within each plot; composite samples were collected from spruce and subalpine fir trees across the site. The samples from Dairy Creek were lost in transit to the analytical laboratory, but additional samples were collected from a recently harvested cutblock nearby.

4.3.2 Forest floor and mineral soil properties Core properties such as soil chemistry and bulk density were measured intensively during the establishment and immediate post-treatment period (year 0, year 1, year 5, and year 10). At this point, given the costs and destructive sampling involved with

TABLE 7 *Post-harvest slash loads (average across OM_1 treatment) by long-term soil productivity site*

Site	0.1–0.5 cm (T/ha)	0.6–1.0 cm (T/ha)	1.1–3.0 cm (T/ha)	3.1–5.0 cm (T/ha)	5.1–7.0 cm (T/ha)	+7.0 cm (T/ha)	All (T/ha)
Kiskatinaw	0.1	0.6	3.6	3.9	4.3	24.8	37.3
Log Lake	0.9	1.8	2.8	2.8	2.8	36.2	46.9
Skulow Lake	0.3	0.7	1.9	2.1	1.7	14.1	20.8
Topley	0.9	1.2	3.9	1.3	2.2	17.4	26.8
Dairy Creek	1.4	2.1	4.5	3.3	4.3	44.1	59.8
Black Pines	1.1	2.0	6.0	6.1	6.1	53.5	74.8
O'Connor Lake	1.5	2.7	5.2	5.7	5.0	25.0	45.1
Mud Creek	0.5	1.2	5.9	6.5	6.2	56.7	77.0
Emily Creek	0.8	2.2	5.7	5.6	8.2	44.1	66.6
Kootenay East	0.8	2.5	5.3	2.4	3.1	37.9	52.1
Rover Creek	0.7	3.1	9.4	9.5	4.0	16.0	42.9
McPhee Creek	0.8	3.4	8.0	4.9	8.8	32.7	58.6

these core properties, the sampling has been reduced to every 10 years for the duration of the study. Soils were sampled according to a few changes in the pre-harvest soil sampling procedures at some sites (Table 5, but also refer to individual researchers for further details). Post-treatment soil analyses included the previously recorded chemistry (total C, N, and S, anaerobically mineralizable N, available P, pH, and exchangeable Ca, K, and Mg), along with exchangeable Al, Fe, Na, and Mn. Aeration porosity proved to be difficult and expensive to measure, so was not routinely monitored at all sites.

4.3.3 Microclimate Near-surface air temperatures, and soil temperature at the surface, mineral soil interface, and several depths in the mineral soil were monitored using data recorders and thermistors or thermocouples installed at the centre of plots, within the split-plot buffer areas (between the two tree species) of selected treatment combinations.

4.3.4 Native vegetation Post-treatment vegetation response was monitored at many of the LTSP sites, and included percent cover, distribution, vigour, mean height, and regeneration strategy of each species. For the SBS sites, vegetation was assessed at years 1, 5, 10, and 20, while at Kiskatinaw it was assessed in years 2, 4, 7, and 10. The IDF-Kamloops and all Nelson sites follow a similar chronology. Standing live biomass of competing vegetation and seedlings was collected at year 5 at the ICH-BC and IDF-Nelson sites and at year 10 at Mud Creek.

4.3.5 Tree response Crop tree growth response (height and diameter at root collar or 1.3 m as trees mature) will be measured every 5 years on the 100 numbered trees per split-plot. Notes on tree health and mortality will also be collected. Foliar nutrients will be measured on the same schedule, and will include Al, B, C, Ca, Cu, Fe, K, Mg, Mn, N, P, S, and Zn, along with foliar mass (100 needles). Initially, the sampling intensity of foliage was low, with one bulked sample per split-plot; this increased to three samples per split-plot by year 15 at most sites.

4.4 Data Storage System

Because of the large scale and long-term nature of the LTSP program, a comprehensive system for the naming, formatting, and storage of data files was developed (Macadam and Kranabetter 1996). The purpose of the system is to provide long-term security for data, facilitate the processing and analysis of data, and provide all researchers with convenient access to all LTSP data files and documents. The system was designed to accommodate files from all B.C. Ministry of Forests LTSP sites, including the following:

- results of all pre- and post-treatment sampling and measurements, including files of cruise plot and site index data, results of sampling for soil chemical and physical properties, crop tree measurements and foliar chemistry, vegetation descriptions, and microclimate data
- data from ancillary studies
- files of raw data, calculated data (e.g., for bulk density), and treatment means
- SAS programs for the processing and analysis of core experimental data
- document files of working plans, establishment reports, and progress reports (these often contain useful tables and figures)

4.5 Data Analysis

As described in the working plan, the experiments at most sites are based on a randomized block design or a completely randomized design (Kiskatinaw); the treatments consist of a 3 × 3 factorial arrangement within a split-plot design, with the third factor (tree species) in split-plots. Statistical analysis of the overall experiment, in terms of the effects of organic matter removal and soil compaction on crop tree response, soil chemical and physical properties (particularly over the long term), and other variables of interest are based on the ANOVA model in the working plan (Hope et al. 1992). Soil properties that correlate with productivity are identified using multiple regression and multivariate techniques.

Suggested approaches to statistical analyses are described in Hope et al. (1992) and Macadam and Kranabetter (1996); model SAS programs for the calculation of summary statistics are included in the latter report. Actual data analyses can be found in the LTSP papers listed in Appendix 1.

4.6 Sample Storage

Soil chemistry (mineral soil and forest floor) and foliar samples are archived. For access to samples, contact LTSP researchers.

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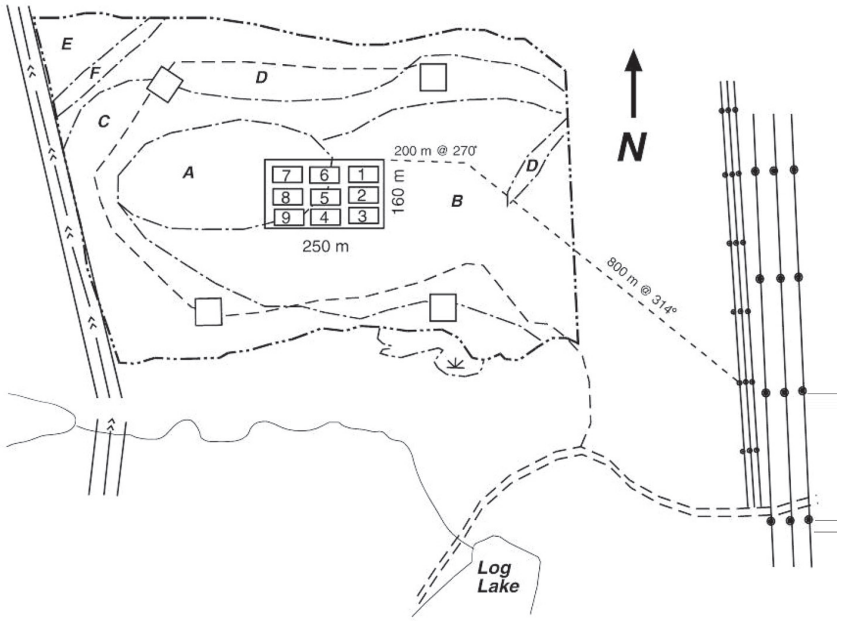
Plot layouts and treatments, and access notes

Log Lake 54°22′0.73″ N, 122°36′35.01″ W

Log Lake



Plot	Treatment
1	OM_1C_0
2	OM_3C_1
3	OM_1C_1
4	OM_2C_0
5	OM_2C_2
6	OM_2C_1
7	OM_3C_0
8	OM_1C_2
9	OM_3C_2

Access notes

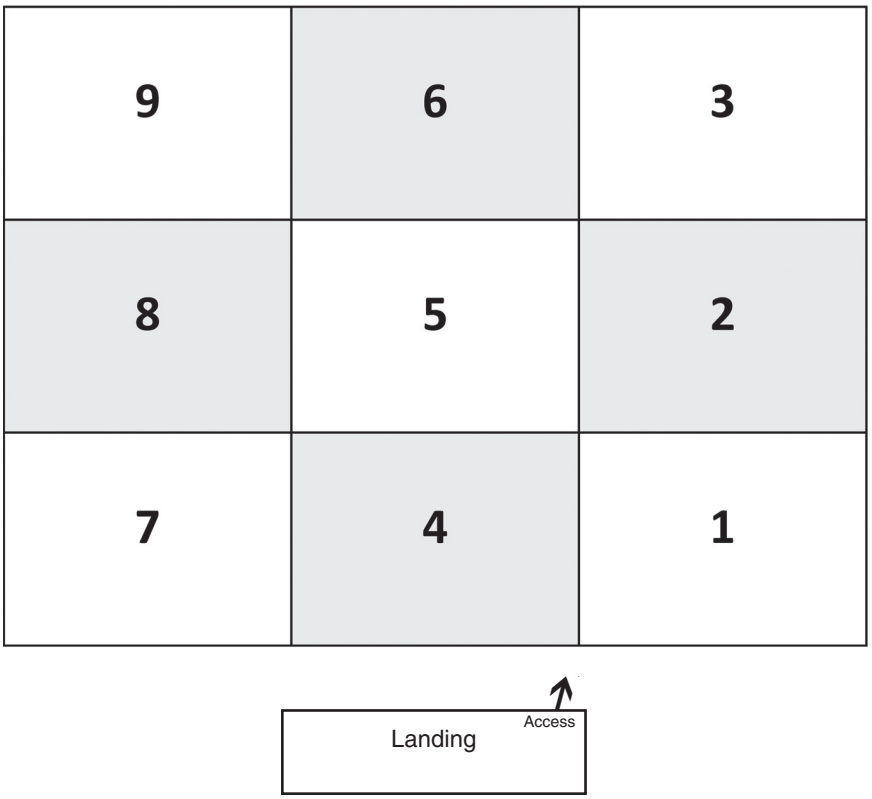
North on Hwy 97 (toward Mackenzie) for 54.2 km (starting 0 from bridge), turn right on Chuchinka-Log Lake Forest Service Road.

Follow Forest Service Road for 3.4 km past lake to the (quite brushy) access road on the left.

Follow access road for 1.2 km; you should see a landing for parking on the right at 54°21′850″ N, 122°36′973″ W.

Follow skid trail up and to the right for about 200 m to the start of plots at 54°21′951″ N, 122°36′800″ W.

Skulow Lake 52°19′0.36″ N, 121°54′49.40″ W



Plot	Treatment
1	OM_1C_0
2	OM_2C_2
3	OM_3C_2
4	OM_1C_1
5	OM_2C_0
6	OM_1C_2
7	OM_3C_0
8	OM_3C_1
9	OM_2C_1

Access notes

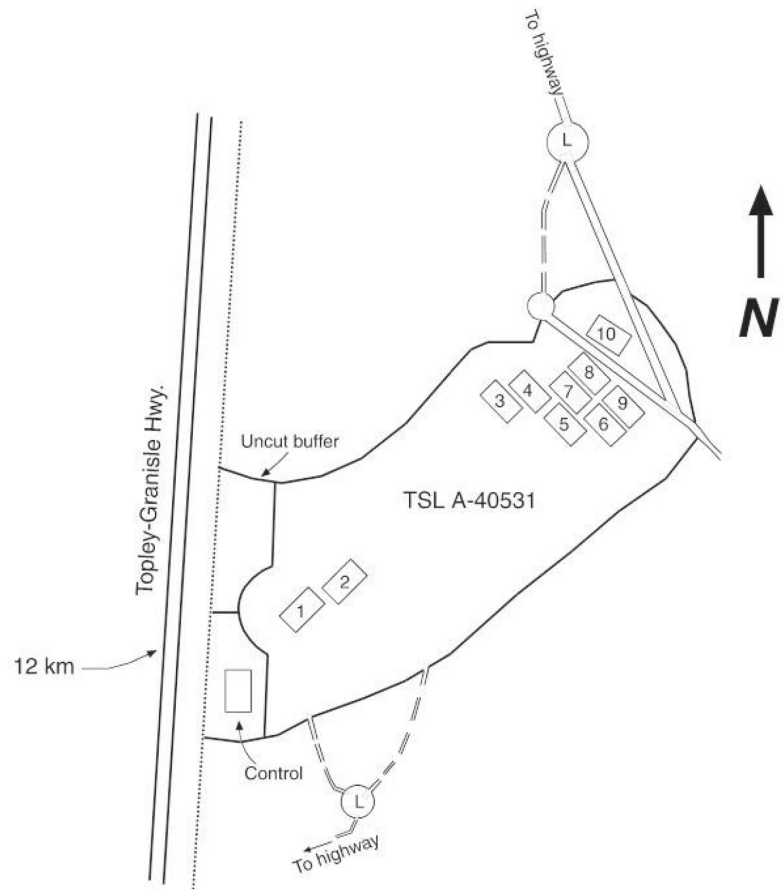
From Williams Lake (main intersection on highway), drive south on Hwy 97 for approximately 13 km to left turnoff for 150 Mile House (Horsefly–Likely Road).

Drive another 4.1 km; turn left onto Likely Rd (not Horsefly Road on the right).

Drive another 20 km to Skulow Lake; access road is on the left with large yellow gate right near the start. Need key from regional office to access site.

Drive approximately 1 km straight into plots. Parking lot at 52°18′914″ N, 121°54′861″ W.

Topley 54°36′40.83″ N, 126°18′26.49″ W



Plot	Treatment
1	OM_2C_1
2	OM_2C_2
3	OM_1C_2
4	OM_3C_1
5	OM_1C_0
6	OM_1C_1
7	OM_3C_2
8	OM_2C_0
9	OM_3C_0

Access notes

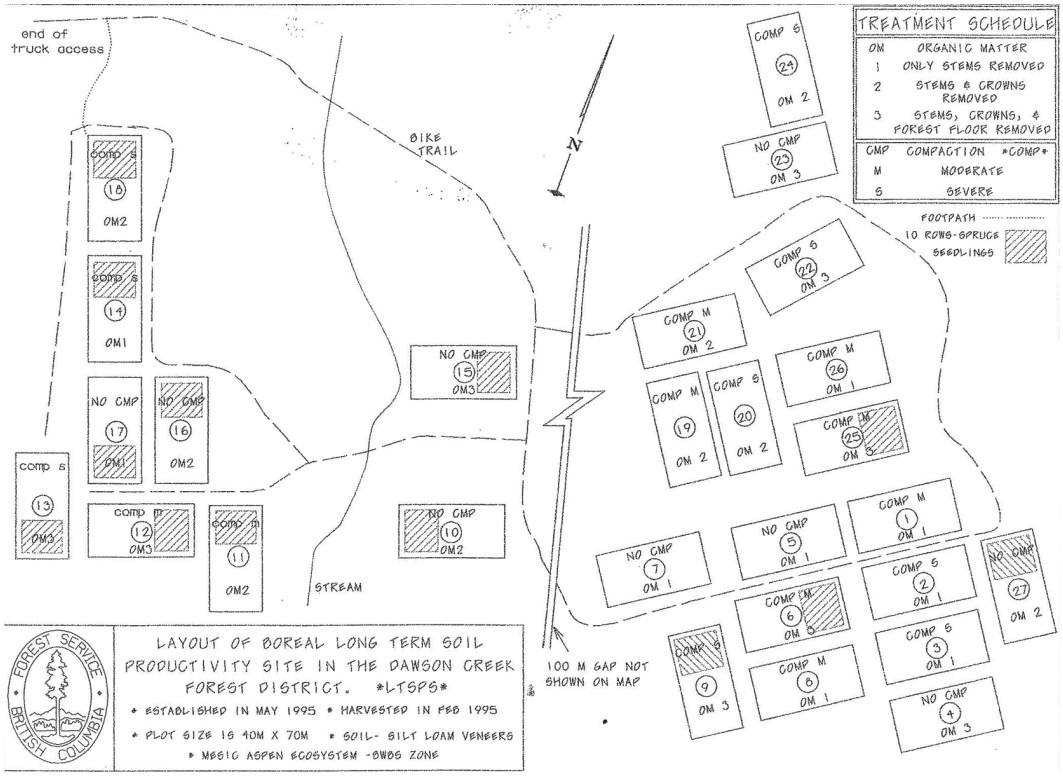
From Topley, drive 13.7 km on Granisle Hwy to Granisle Forest Service Road on the right.

Drive along the Forest Service Road for 1.9 km to the pullout on the right at 54°36′725″ N, 126°18′427″ W (there is one other road at about 0.5 km that turns sharp left, but ignore it and keep straight). Plots are down slope about 50 m.

For the lower plots (1 and 2), return to Granisle Hwy, turn left toward Topley, and drive 2.2 km to 54°36′483″ N, 126°19′136″ W. Park on the edge of the road (not much room); the entrance to the forest is flagged.

Follow the trail through the woods, about 100 m, and follow flagging to plots at 54°36′503″ N, 126°18′949″ W.

Kiskatinaw 55°58′28.77″ N, 120°28′4.76″ W



Plot	Year[a]	Treatment	Plot	Year[a]	Treatment	Plot	Year[a]	Treatment
1	1995	OM_1C_1	10	1998	OM_2C_0	19	1999	OM_2C_1
2	1995	OM_1C_2	11	1998	OM_2C_1	20	1999	OM_2C_2
3	1995	OM_1C_2	12	1998	OM_3C_1	21	1999	OM_2C_1
4	1995	OM_3C_0	13	1998	OM_3C_2	22	1999	OM_3C_2
5	1995	OM_1C_0	14	1998	OM_1C_2	23	1999	OM_3C_0
6	1995	OM_3C_2	15	1998	OM_3C_0	24	1999	OM_2C_2
7	1995	OM_1C_0	16	1998	OM_2C_0	25	1999	OM_3C_1
8	1995	OM_1C_1	17	1998	OM_1C_0	26	1999	OM_1C_1
9	1995	OM_2C_2	18	1998	OM_2C_2	27	1999	OM_2C_0

[a] Year treatment was applied.

Access notes

From Dawson Creek, go 34 km north on Highway 97; turn right (east) on Road 64 (Old Alaska Highway).

Proceed east for 2 km, then turn left (north) at Road 24.

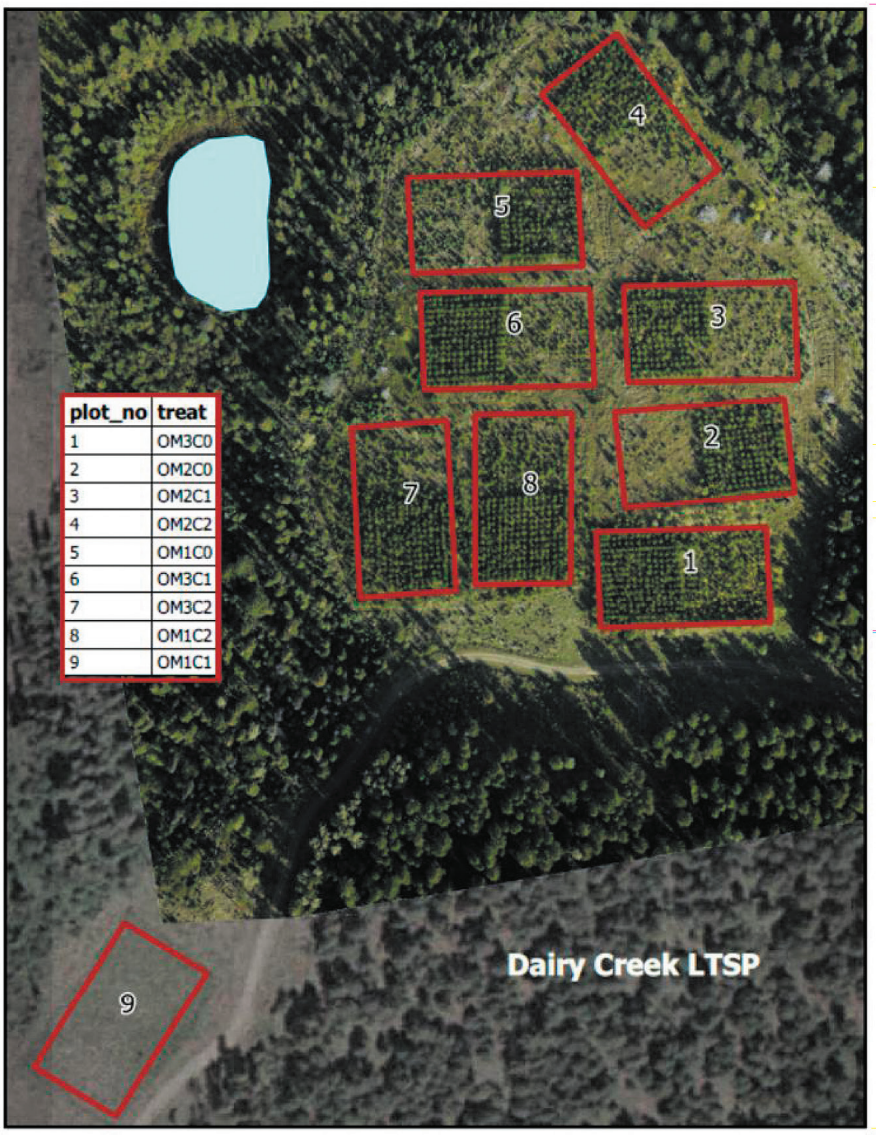
Follow the main gravel road approximately 5 km (in a northeast direction) to a four-way intersection; turn right (southeast) onto Boyscout Road and drive for 800 m, then turn left (east) on gravel Road 224.

Go east for 2.6 km on Road 224 and turn right (south) at the four-way intersection and drive approximately 2 km south and east to reach LTSP site with Plot 15 on the west site of the road.

Comments

Note that the bike trail is now an all-weather road leading to natural gas wells and pipeline facilities south of the LTSP site.

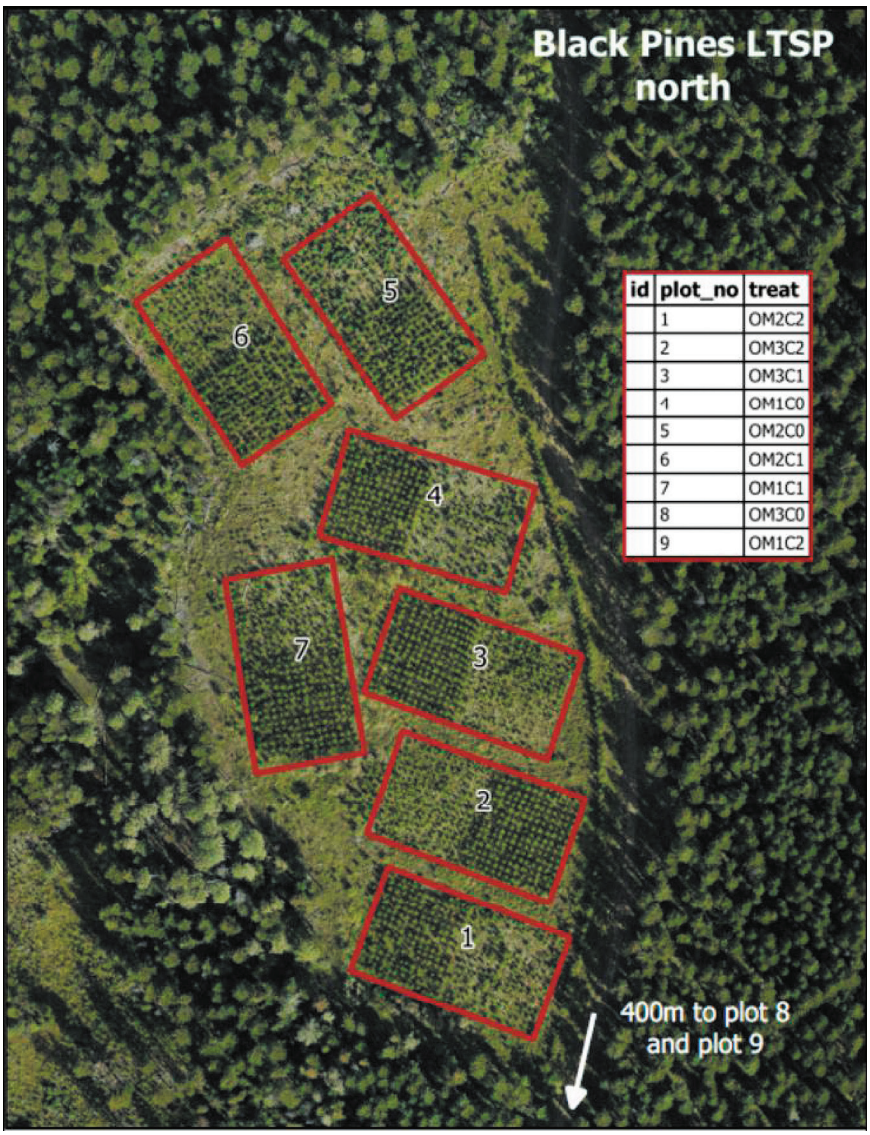
Dairy Creek 50°51′12.01″ N, 120°25′24.31″ W



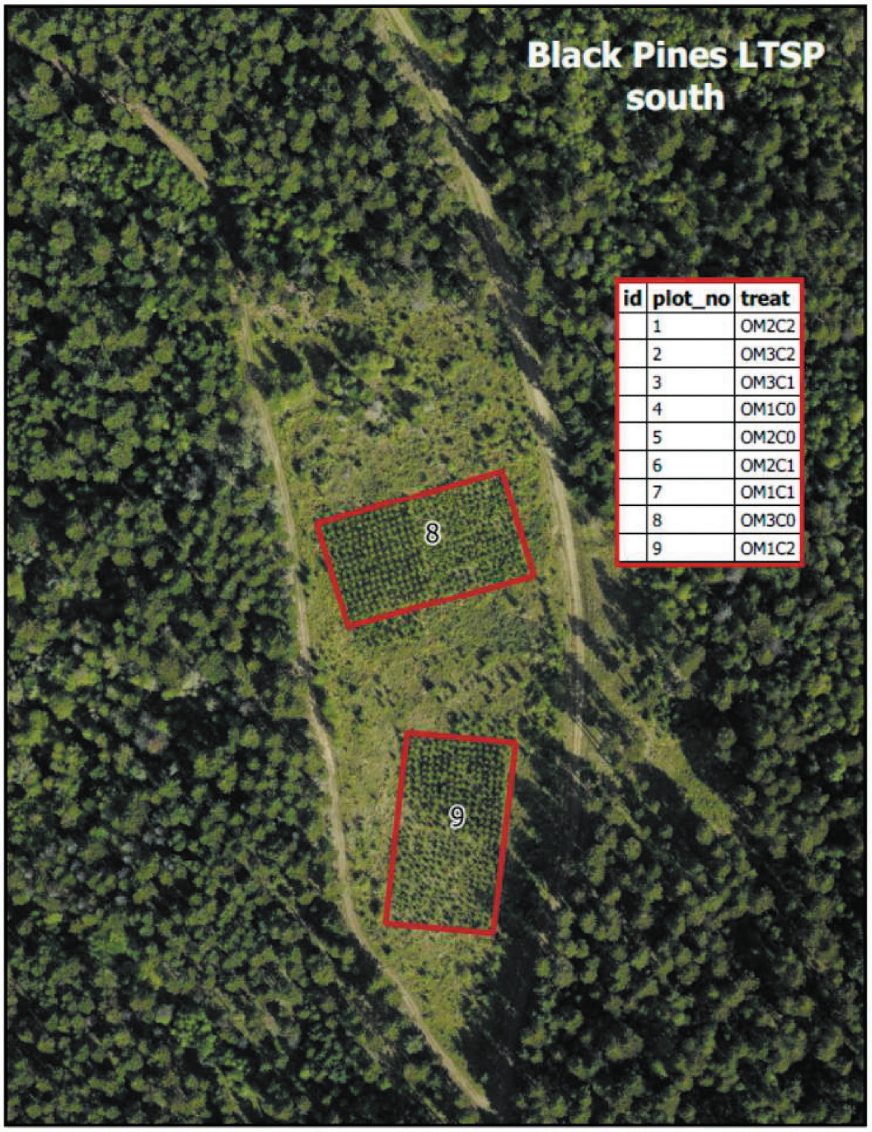
plot_no	treat
1	OM3C0
2	OM2C0
3	OM2C1
4	OM2C2
5	OM1C0
6	OM3C1
7	OM3C2
8	OM1C2
9	OM1C1

Access notes
Travel north on the Lac du Bois Road until McQueen Lake.
Turn off to McQueen Lake Centre and Isobel Lake.
Keep on Lac du Bois Road approximately 16.9 km.
Turn right off Lac du Bois Road onto Dairy Creek Road.
Go up Dairy Creek Road approximately 4 km.

Black Pines 50°56′22.59″ N, 120°17′50.13″ W



id	plot_no	treat
	1	OM2C2
	2	OM3C2
	3	OM3C1
	4	OM1C0
	5	OM2C0
	6	OM2C1
	7	OM1C1
	8	OM3C0
	9	OM1C2



id	plot_no	treat
	1	OM2C2
	2	OM3C2
	3	OM3C1
	4	OM1C0
	5	OM2C0
	6	OM2C1
	7	OM1C1
	8	OM3C0
	9	OM1C2

Access notes

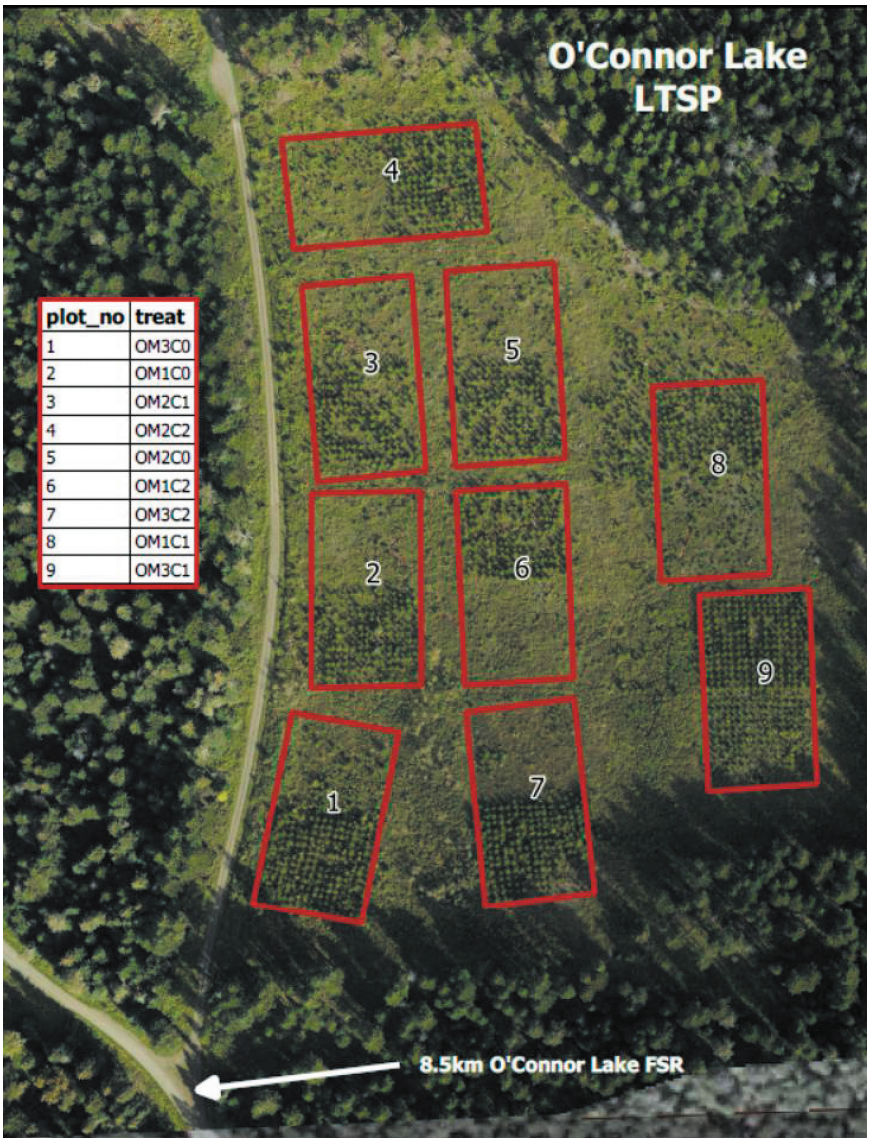
KM

0.0 Centre of Highway 5 bridge over South Thompson River (at Kamloops), heading north.
4.8 At second set of lights, turn left onto Halston Street connector.
7.5 Veer right up onto road above, and then veer right again along Westsyde Road.
24.9 O'Connor Lake Forest Service Road on left.
28.5 Turn left off Westsyde Road onto Jamieson Creek Forest Service Road.
30.6 Turn right up Black Pines Road, just past 2 km on the Jamieson Creek Road.*
36.9 Go to right at Y.
39.1 Keep to left.
39.6 Veer left (new road goes to right).
40.6 Turn left.
40.9 LTSP block is on right.
41.1 The gate into plots 1–7 is on the right.
41.7 The gate into plots 8 and 9 is on the right-hand side of road.

Comments

*Remember to bring the gate key between September 10 and April 30.

O'Connor Lake 50°53′44.01″ N, 120°21′7.63″ W

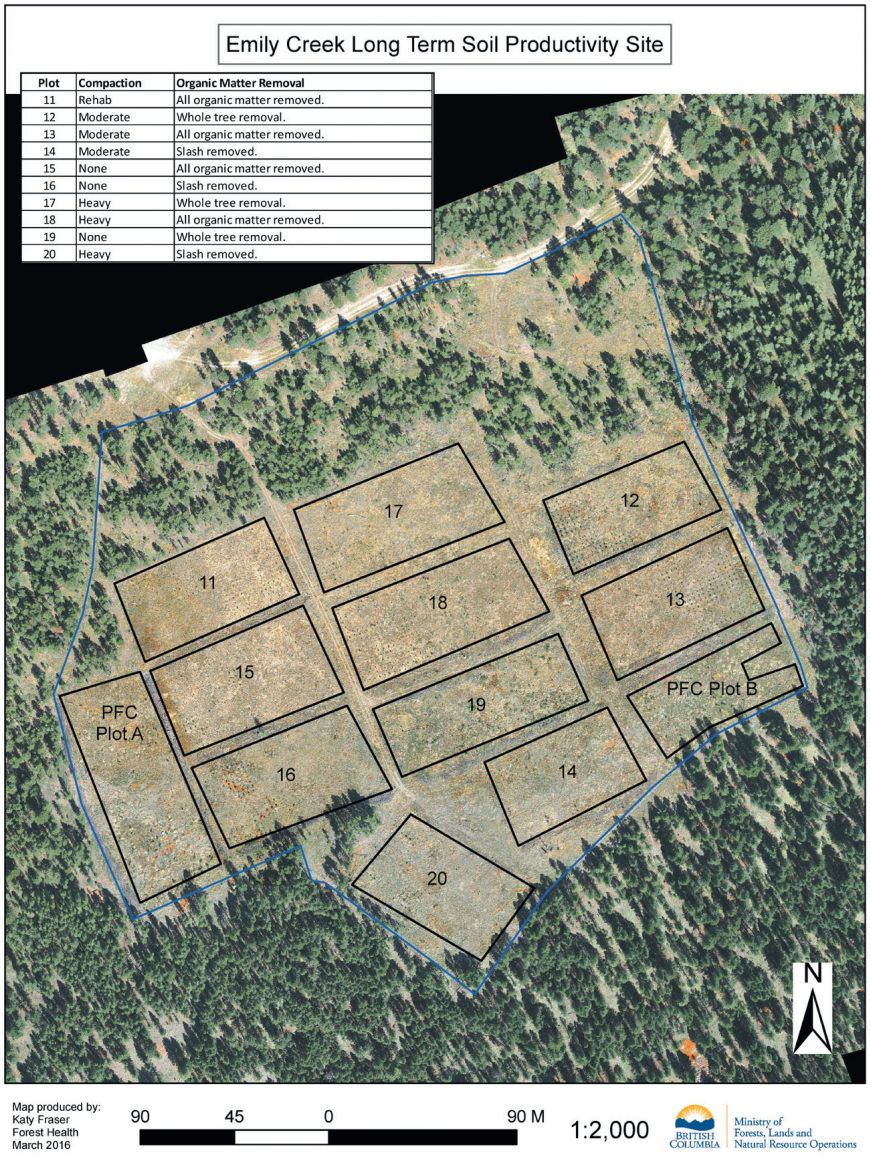


plot_no	treat
1	OM3C0
2	OM1C0
3	OM2C1
4	OM2C2
5	OM2C0
6	OM1C2
7	OM3C2
8	OM1C1
9	OM3C1

Access notes

KM	
0.0	Centre of Highway 5 bridge over South Thompson River (at Kamloops), heading north.
4.8	At second set of lights, turn left onto Halson Street connector.
7.5	Veer right up onto road above, and then veer right again along Westsyde Road.
24.9	Turn left off Westsyde Road onto O'Connor Lake Forest Service Road (FSR).
33.5	Turn right (north), just past 8 km sign, onto Venn Creek Road.
33.6	The site is on the right-hand side of the road (east).

Emily Creek 50°8′45.93″ N, 115°58′32.60″ W



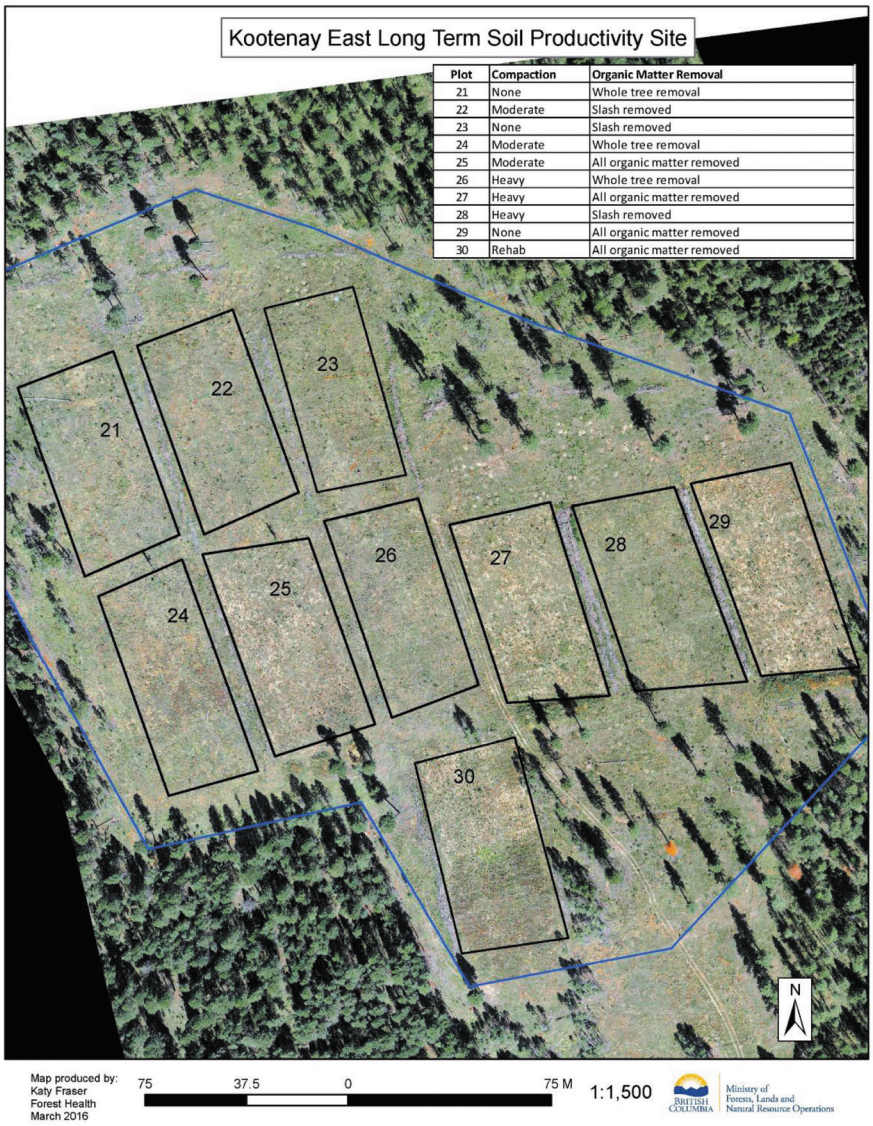
Plot	Compaction	Organic Matter Removal
11	Rehab	All organic matter removed.
12	Moderate	Whole tree removal.
13	Moderate	All organic matter removed.
14	Moderate	Slash removed.
15	None	All organic matter removed.
16	None	Slash removed.
17	Heavy	Whole tree removal.
18	Heavy	All organic matter removed.
19	None	Whole tree removal.
20	Heavy	Slash removed.

Access notes

UTM 11 U 572968 5555291

Drive Hwy 95 to north of Canal Flats. Go up the hill and stay in passing lane. Turn left near the top of the hill and follow the road (Blue Lake Forestry Centre is also indicated). After about 2 km, you merge on the main Findlay Forest Service Road. Follow through canyon, watching for trucks to about 13 km. Take the right up Whitetail Forest Service Road, then take the next right up Lower Emily. Follow about 1 km to the landing area at the top of the hill. Turn left and go through a few cross-ditches, then take the left and drive to the end of the road. The compound is on your left. (Leave the truck outside. Do not park or stop on dry grass due to fire hazard.)

Kootenay East 50°11′48.02″ N, 115°42′5.25″ W



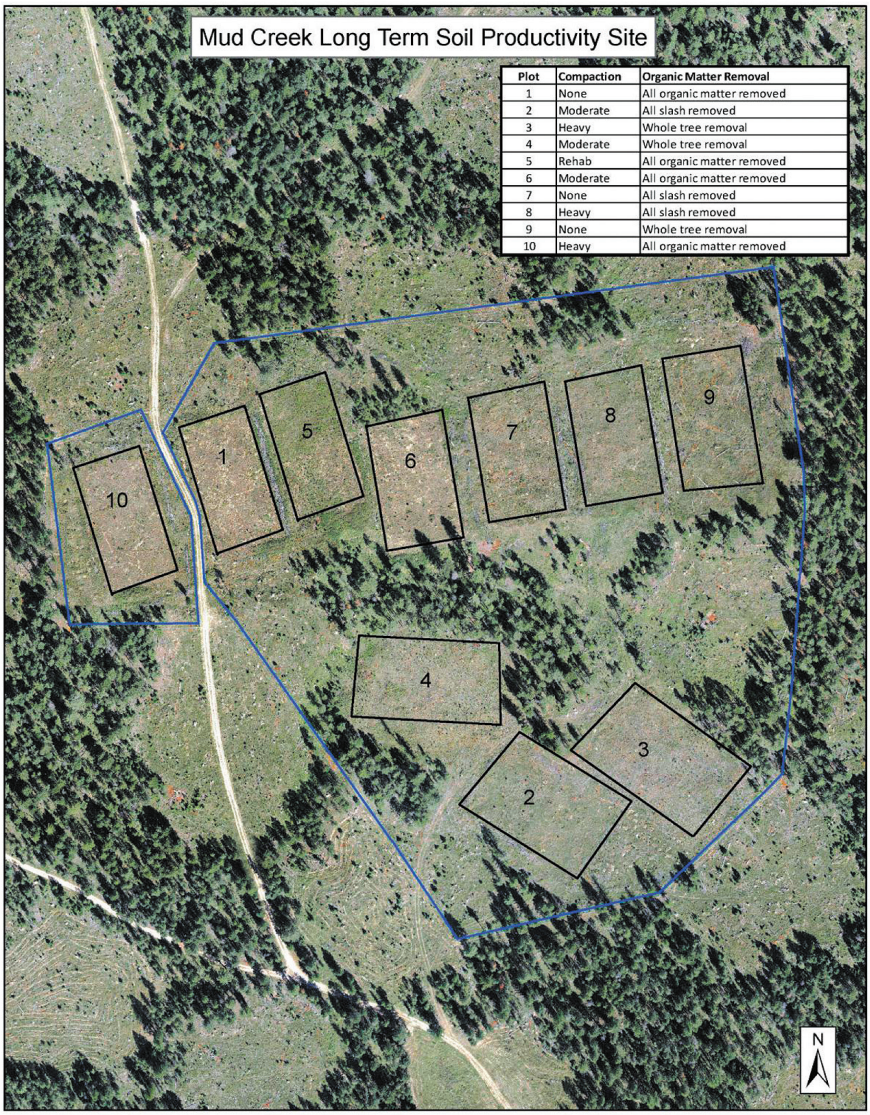
Plot	Compaction	Organic Matter Removal
21	None	Whole tree removal
22	Moderate	Slash removed
23	None	Slash removed
24	Moderate	Whole tree removal
25	Moderate	All organic matter removed
26	Heavy	Whole tree removal
27	Heavy	All organic matter removed
28	Heavy	Slash removed
29	None	All organic matter removed
30	Rehab	All organic matter removed

Access notes

UTM 11 U 592602 5561098

Drive up Whiteswan Forest Service Road to 10 km. At major intersection, turn left onto Kootenay Bypass and drive northwest (this is a one-way road; do not turn around) for 6.6 km. Turn right up Kootenay Eastside Forest Service Road. Go about 800 m to top of hill, then park on that landing above the ditch line. The plots are right above you (you will see the fence). To drive out, DO NOT go back the same way: Kootenay Bypass is a one-way industrial road. Drive right off the landing, down the main road you crossed (which joins Kootenay Bypass), which you follow right to the bridge across Kootenay River, then turn left onto Kootenay Forest Service Road, which you follow right into Canal Flats. Radio frequency is 157.56. Watch for trucks.

Mud Creek 50°8′17.90″ N, 115°44′14.82″ W



Plot	Compaction	Organic Matter Removal
1	None	All organic matter removed
2	Moderate	All slash removed
3	Heavy	Whole tree removal
4	Moderate	Whole tree removal
5	Rehab	All organic matter removed
6	Moderate	All organic matter removed
7	None	All slash removed
8	Heavy	All slash removed
9	None	Whole tree removal
10	Heavy	All organic matter removed

Map produced by:
Katy Fraser
Forest Health
March 2016

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1:2,332

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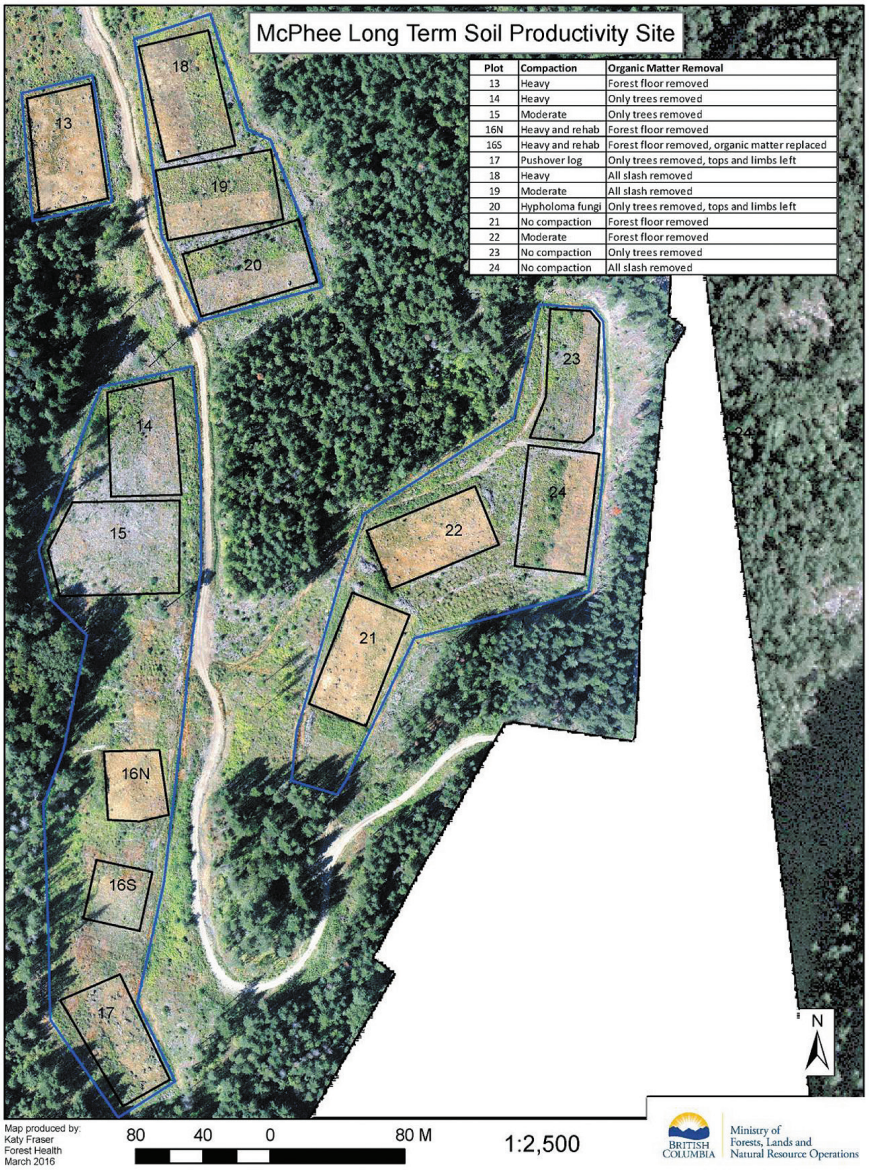
Access notes

UTM 11 U 590002 5554730

Drive up Whiteswan Forest Service Road to the top of a slight hill at about 3.5–3.75 km. Turn left onto Mud North. Follow for about 800 m, staying on the main road, and then take the main, well-travelled right fork. You will see the compound at the top of the hill.

McPhee Creek 49°19′4.41″ N, 117°36′1.12″ W



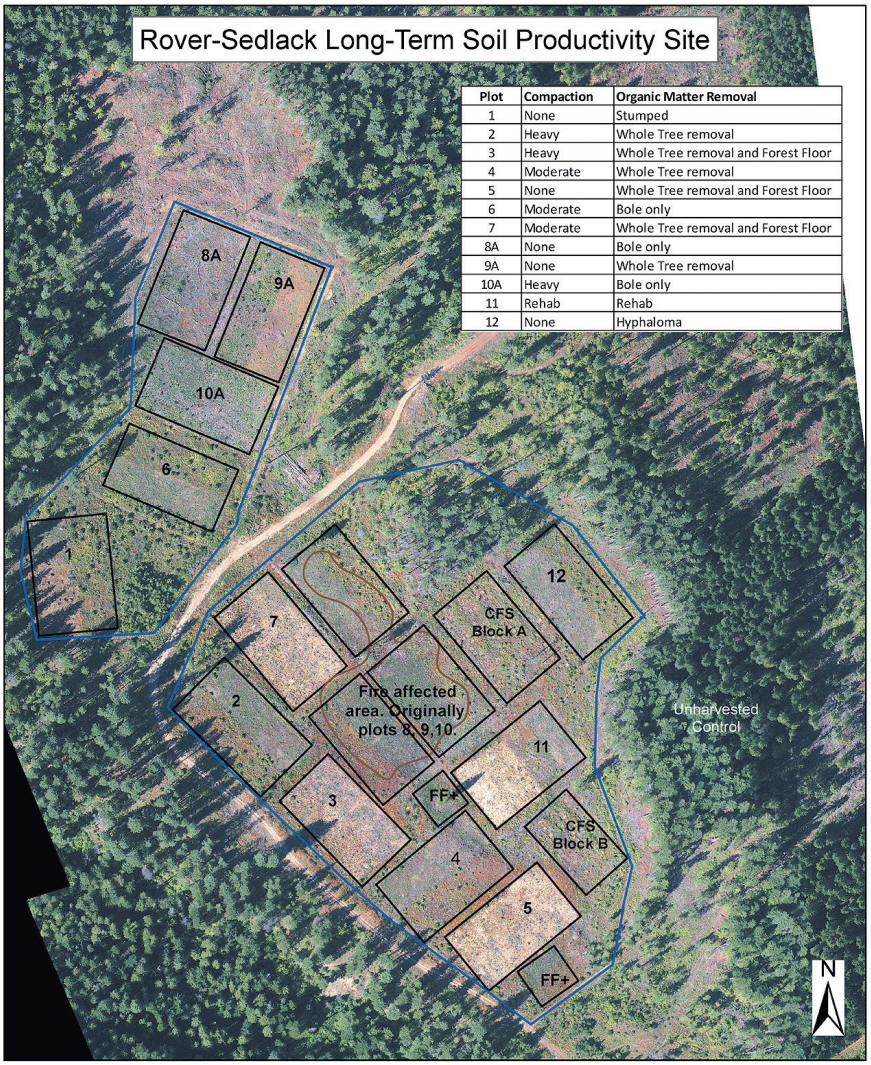
Plot	Compaction	Organic Matter Removal
13	Heavy	Forest floor removed
14	Heavy	Only trees removed
15	Moderate	Only trees removed
16N	Heavy and rehab	Forest floor removed
16S	Heavy and rehab	Forest floor removed, organic matter replaced
17	Pushover log	Only trees removed, tops and limbs left
18	Heavy	All slash removed
19	Moderate	All slash removed
20	Hypholoma fungi	Only trees removed, tops and limbs left
21	No compaction	Forest floor removed
22	Moderate	Forest floor removed
23	No compaction	Only trees removed
24	No compaction	All slash removed

Access notes

UTM 11 U: 456347 5462801

Located above the Castlegar airport. From the Park & Ride lot near the Brilliant Bridge on Highway 3A, take Ootischenia Road to the east, then south. Drive 1 km and take the left onto Corrigan Way. Drive 0.3 km and take the left on Aaron Road. Drive uphill about 0.6 km and turn right onto the dirt road. Drive about 2 km and then take the right at the fork. Drive another 2.3 km to LTSP fencing.

Rover Creek 49°26′57.35″ N, 117°30′16.15″ W



Plot	Compaction	Organic Matter Removal
1	None	Stumped
2	Heavy	Whole Tree removal
3	Heavy	Whole Tree removal and Forest Floor
4	Moderate	Whole Tree removal
5	None	Whole Tree removal and Forest Floor
6	Moderate	Bole only
7	Moderate	Whole Tree removal and Forest Floor
8A	None	Bole only
9A	None	Whole Tree removal
10A	Heavy	Bole only
11	Rehab	Rehab
12	None	Hyphaloma

Map Produced by
Katy Fraser
Forest Health
March 2016

100 50 0 100 M

1:2,500

Ministry of Forests, Lands and Natural Resource Operations

Access notes

UTM 11 U: 463428 5477261

From Highway 6 between Castlegar and Bonnington, take Blewett Road south. Cross two bridges over the Kootenay Canal. After the second bridge, drive about 150 m and take a right onto Rover Creek Forest Service Road. Drive uphill about 1.7 km and turn right. The old broken gate is about 61 m from Rover Creek Road. Drive past the gate to 0.75 km, where tall fencing is seen. Park here.

Pre-harvest soil descriptions

Log Lake: No. 1 (in outside buffer adjacent to plot 6)
Classification: Orthic Humo-Ferric Podzol

Horizon	Depth (cm)	Description
L	8–7	Litter; abundant, medium and coarse horizontal roots; abundant, very fine and fine horizontal and oblique roots; abrupt, wavy boundary; 0–1 cm thick
F	7–2	Partially decomposed organic matter; abundant, medium and coarse horizontal roots; abundant, very fine and fine horizontal and oblique roots; abrupt, wavy boundary; 3–6 cm thick
H	2–0	Decomposed organic matter; abundant, medium and coarse horizontal roots; abundant, very fine and fine horizontal and oblique roots; abrupt, wavy boundary; 0–2 cm thick
Ae	0–12	Grayish brown (10YR 5/2 m); gravelly silt loam; weak, medium platy; friable; plentiful, very fine and fine oblique roots; plentiful, medium horizontal roots; abrupt, irregular boundary; 5–15 cm thick
Bf	12–25	Dark yellowish brown (10YR 3/6 m); gravelly loam; moderate, medium subangular blocky; friable; few, very fine and fine, oblique, and plentiful, medium oblique roots; gradual, wavy boundary; 11–17 cm thick
Bm1	25–40	Yellowish brown (10YR 5/6 m); gravelly loam; moderate, coarse subangular blocky; friable; few, very fine and fine, oblique, and few, medium oblique roots; gradual, wavy boundary; 13–17 cm thick
Bm2	40–65	Yellowish brown (10YR 5/4 m); gravelly loam; strong, medium subangular block; firm; very few, fine oblique roots; gradual, wavy boundary; 20–30 cm thick
C	65–95+	Olive brown (2.5Y 4/4 m); gravelly silt loam; massive, firm

Horizon	Al_p [a] (%)	Fe_p [a] (%)	C (%)	N (%)	pH ($CaCl_2$)	Sand (%)	Clay (%)
Ae	0.04	0.10	0.78	0.05	3.67	34.5	7.7
Bf	0.64	0.95	2.14	0.11	4.23	34.6	22.8
Bm1	0.33	0.36	0.95	0.06	4.32	42.8	20.0
Bm2	0.12	0.10	0.27	0.02	4.17	41.3	21.8
C	0.05	0.05	0.16	0.02	4.11	41.4	8.3

[a] Al_p and Fe_p = pyrophosphate extractable Al and Fe.

Log Lake: No. 2 (in outside buffer, east of plot 2)
Classification: Gleyed Eluviated Dystric Brunisol

Horizon	Depth (cm)	Description
L	10–9	Litter; abundant, very fine, fine, medium, and coarse horizontal roots; abrupt, wavy boundary; 1 cm thick
F	9–1	Partially decomposed organic matter; abundant, very fine, fine, medium, and coarse horizontal roots; abrupt, wavy boundary; 2–10 cm thick
H	1–0	Decomposed organic matter; abundant, very fine, fine, medium, and coarse horizontal roots; abrupt, wavy boundary; 1 cm thick
Ae	0–5	Light brownish gray (10YR 6/2 d); gravelly loam; weak, medium granular; loose; plentiful, fine, oblique, and plentiful, medium horizontal roots; clear, wavy boundary; 1–8 cm thick
Bm1	5–17	Dark yellowish brown (10YR 4/6 m); gravelly loam; weak, medium granular; friable; few, fine, oblique, and plentiful, medium oblique roots; clear, wavy boundary; 10–20 cm thick
Bm2	17–35	Dark yellowish brown (10YR 4/4 m); gravelly loam; moderate, medium subangular blocky; friable; few, fine and medium oblique roots; clear, irregular boundary; 10–20 cm thick
Bm3	35–55	Yellowish brown (10YR 5/4 m); gravelly loam; strong, medium subangular blocky; firm; few, fine oblique roots; clear, wavy boundary; 10–25 cm thick
Btjg	55–85+	Yellowish brown (10YR 5/4 m); gravelly loam; common, medium distinct, strong brown (7.5YR 4/6) mottles; strong, medium subangular blocky; firm

Note: Not sampled for chemistry.

Log Lake: No. 3 (in outside buffer, south of plot 4)
Classification: Eluviated Dystric Brunisol

Horizon	Depth (cm)	Description
L	5–4	Litter; abundant, very fine and fine oblique and medium and coarse horizontal roots; abrupt, wavy boundary; 1 cm thick
F	4–0.5	Partially decomposed organic matter; abundant, very fine and fine oblique and medium and coarse horizontal roots; abrupt, wavy boundary; 3–5 cm thick
H	0.5–0	Decomposed organic matter; abundant, very fine and fine oblique and medium and coarse horizontal roots; abrupt, wavy boundary; 0–1 cm thick
Ae	0–10	Pale brown (10YR 6/3 m); gravelly silt loam; weak, medium platy; very friable; plentiful, fine and very fine oblique, and abundant medium and coarse horizontal roots; abrupt, wavy boundary; 4–15 cm thick
Bm1	10–23	Dark yellowish brown (10YR 4/6 m); gravelly loam; moderate fine and medium subangular blocky; friable; few, very fine and fine, oblique, and plentiful, medium and coarse oblique roots; gradual, wavy boundary; 10–15 cm thick
Bm2	23–45	Yellowish brown (10YR 5/6 m); gravelly loam; moderate, fine and medium subangular blocky; friable; few, very fine and fine, oblique, and plentiful, medium and coarse oblique roots; clear, wavy boundary; 20–30 cm thick
Bm3	45–70	Yellowish brown (10YR 5.5/4 m); gravelly loam; strong, medium, and coarse subangular blocky; firm; very few, very fine and fine, and few, medium and coarse oblique roots; clear, wavy boundary; 20–30 cm thick
C	70–80+	Olive brown (2.5Y 4/4 m); gravelly loam; massive; firm

Horizon	Al_p [a] (%)	Fe_p [a] (%)	C (%)	N (%)	pH ($CaCl_2$)	Sand (%)	Clay (%)
Ae	0.04	0.15	0.75	0.04	4.16	41.3	7.6
Bm1	0.16	0.31	0.62	0.04	4.41	37.6	15.6
Bm2	0.15	0.18	0.38	0.03	4.38	43.9	18.1
Bm3	0.13	0.12	0.25	0.04	4.41	42.9	18.1
C	0.06	0.10	0.20	0.01	4.39	40.6	15.7

[a] Al_p and Fe_p = pyrophosphate extractable Al and Fe.

Log Lake: No. 4 (in outside buffer, west of plot 8)
Classification: Orthic Gleysol

Horizon	Depth (cm)	Description
L	10–9	Litter; abundant, very fine and fine, oblique, and medium and coarse horizontal roots; abrupt, wavy boundary; 1 cm thick
F	9–2	Partially decomposed organic matter; abundant, very fine and fine, oblique, and medium and coarse horizontal roots; abrupt, wavy boundary; 7–9 cm thick
H	2–0	Decomposed organic matter; abundant, very fine and fine, oblique, and medium and coarse horizontal roots; abrupt, wavy boundary; 1–2 cm thick
Ae	0–12	Brown (10YR 5/3 m), dark brown (10YR 3/3 m); gravelly loam; weak, medium platy; friable; abundant, very fine and fine oblique, and medium and coarse horizontal roots; abrupt, wavy boundary; 5–14 cm thick
Bm	12–40	Dark yellowish brown (10YR 4/4 m); gravelly loam; weak, medium subangular blocky; friable; plentiful, very fine and fine, oblique, and medium and coarse horizontal roots; clear, wavy boundary; 20–30 cm thick
Btjg	40–65	Brown (10YR 5/3 m); gravelly loam; many, coarse distinct, dark yellowish brown (10YR 4/6 m) mottles; moderate, medium subangular blocky; firm; very few, very fine, fine, medium, and coarse oblique roots; gradual, wavy boundary; 20–30 cm thick
Cg	65+	Yellowish brown (10YR 5/4 m); gravelly loam; many, coarse, prominent, yellowish red (5YR 4/6) mottles; massive, firm

Horizon	Al_p [a] (%)	Fe_p [a] (%)	C (%)	N (%)	pH ($CaCl_2$)	Sand (%)	Clay (%)
Ae	0.09	0.19	1.12	0.07	4.01	48.0	11.4
Bm	0.20	0.21	0.93	0.06	4.19	44.5	15.3
Btjg	0.26	0.17	0.59	0.06	4.23	38.9	19.5
C	0.10	0.11	0.34	0.03	4.03	39.6	22.4

[a] Al_p and Fe_p = pyrophosphate extractable Al and Fe.

Skulow Lake

Pit established June 16, 2015 (data from previous description were lost) in mature pine/spruce forest with pine dead from mountain pine beetle attack

Slope: essentially 0

Geographic co-ordinates: 574248.71m E, 5796462.99m N Zone 10U 320 m southeast of LTSP

Classification: Orthic Gray Luvisol

Horizon	Depth (cm)	Description[a]
L	6–5	
F	5–0	
Ae	0–8	10YR 5/4(m), 7.5 YR 6/2(d); structure granular, medium, moderate; horizon boundary gradual; texture gravelly sandy loam; concretions few, medium, durinodes
Bm	8–16	10YR 3/4(m), 10 YR 4/4(d); structure fine, angular blocky, moderate; horizon border wavy; texture gravelly loam; concretions few, medium, durinodes
Bt	16–27	10YR 4/4(m), 2.5Y 5/4(d); structure angular blocky, fine, moderate; horizon boundary wavy, gradual; texture gravelly sandy clay loam; concretions few, medium, durinodes
BC	27–55	2.5Y 4/4(m), 10YR 7/1(d); mottles many, medium, distinct, reddish yellow; structure granular, medium, moderate; horizon boundary wavy, gradual; texture gravelly sandy clay loam; concretions few, medium, durinodes
Ck[b]	55–90+	2.5Y 5/2(m), 10 YR 6.2(d); mottles many, medium, distinct, reddish yellow; structure angular blocky, fine, moderate; strongly calcareous, deposits along cracks in soil; horizon boundary wavy; texture gravelly sandy clay loam; concretions few, medium, durinodes

[a] Soil too wet to properly do structure.

[b] Bottom not reached.

Note: Not sampled for chemistry.

Topley: Soil pit No. 1
Location: north outside boundary of "control" plot in uncut buffer
Classification: Hemimor/Orthic Gray Luvisol over morainal blanket

Horizon	Depth (cm)	Description
S/L	(8–7)	Bryophyte layer with individual particles of coniferous litter; abrupt, smooth boundary; slightly dry
Fm1	7–6	Origin mostly moss; abrupt, smooth boundary; slightly dry; compact matted, firm, fibrous; plentiful, medium horizontal roots; gray mycelia
Fm2	6–2	Moss, needles, and leaves; abrupt, smooth boundary; slightly dry; compact matted, firm, fibrous; plentiful, medium horizontal roots; abundant white and yellow mycelia
Fw	2–0	Clear, broken; slightly dry; blocky, loose; plentiful to abundant fine, few to many coarse horizontal and random roots
Bm	0–2	10YR 4/4 (m); loam; loose, friable, slightly sticky and plastic; abundant, medium, horizontal in matrix and plentiful, fine, oblique inped roots; 15% c.f.; abrupt, wavy boundary; 1–3 cm thick
Ae	2–12	10YR 5/3 (m); loam to clay loam; slightly hard, sticky and plastic; plentiful, medium, horizontal in matrix and few, coarse, horizontal exped roots; 35% c.f.; abrupt, wavy boundary; 5–18 cm thick
Bt	12–40+	10YR 3/3 (m); clay loam; hard, sticky and plastic; few medium horizontal roots; 35% c.f.

Horizon	Total C (%)	C/N ratio	CEC	exch. Ca	exch. K	exch. Mg	Total N (%)	Min N (ppm)	Avail. P (ppm)	pH (CaCl)
			(cmol/kg soil)							
Fm1	53.54	32.13	89.44	28.70	8.53	6.58	1.67	–	–	–
Fm2	47.28	36.07	86.45	20.50	6.63	5.99	1.31	99.4	238.9	4.25
Bm	3.08	25.17	17.11	4.36	0.24	1.48	0.12	9.5	19.8	3.83
Ae	0.70	13.80	7.91	1.99	0.12	0.72	0.05	2.9	5.7	3.95
Bt	0.97	16.00	11.40	2.51	0.13	0.93	0.06	4.1	2.4	4.05

Topley: Soil pit No. 2

Location: in poorly drained receiving area below Plot 3, in Moder soil fauna study plot (not representative of the LTSPS treatment plots)

Classification: Leptomoder/Orthic Humic Gleysol on shallow downslope sediment over morainal blanket

Horizon	Depth (cm)	Description
S/L	(11–10)	Leafy mosses, decaying wood, and herbaceous materials; very thin and sometimes discontinuous
Fm	10–8	Partly decomposed mosses and vascular plant tissues; abrupt smooth boundary; moist; slightly matted and felty, fibrous; cream coloured mycelia
Fz	8–1	Partly decomposed mosses and plant tissues; abrupt smooth boundary; moist; non-matted, friable; common fecal pellets random and in clusters
Hi	1–0	Mostly frass and mineral particles intermixed; clear smooth boundary; moist; loose, friable, and granular; abundant fecal pellets
Ah-1	0–22	10YR 2/1 (m); loam; charcoal common, random; clear smooth boundary 18–25 cm thick
Ah-2	22–40	10YR 3/1 (m); clay loam; 20% c.f. mostly cobbles; charcoal common, random; clear smooth boundary 15–22 cm thick
Bg	40–50+	10YR 3/1 (m); clay loam to clay; few, medium, distinct 7.5YR 5/8 mottles; massive, very firm; 25% c.f.mostly cobbles

Horizon	Total C (%)	C/N ratio	CEC	exch. Ca	exch. K	exch. Mg	Total N (%)	Min N (ppm)	Avail. P (ppm)	pH (CaCl)
			(cmol/kg soil)							
Fm	46.76	26.90	118.00	57.70	3.97	14.80	1.74	482.2	59.8	4.83
Fz	42.24	26.23	142.10	63.57	0.93	16.53	1.61	317.0	10.8	4.83
Hi	38.50	25.84	146.90	61.81	0.69	16.31	1.49	382.9	6.6	4.74
Ah1	11.88	15.75	83.08	33.64	0.55	11.21	0.75	122.2	3.4	4.49
Ah2	6.86	14.50	64.94	28.06	0.56	9.39	0.47	41.7	1.7	4.49
Bg	4.63	14.60	48.92	23.63	0.59	7.61	0.32	15.3	1.9	4.49

Topley: Soil pit No. 3
Location: in corridor between plots 8 and 9
Classification: Hemimor/Orthic Gray Luvisol on morainal blanket

Horizon	Depth (cm)	Description
S/L	(8–6)	Layer of bryopyhtic vegetation with individual particles of coniferous and herbaceous vegetation; slightly dry; abrupt smooth boundary
Fm	6–0	Partly decomposed mosses and vascular plant tissues; abrupt smooth boundary; moist; compact matted, felty, fibrous; common white and gray mycelia; common random charcoal
Bm	0–2	10YR 3/2 (m); loam; moderate to strong, fine to medium granular; loose, slightly sticky; abundant fine, random roots, and medium and coarse horizontal roots; 15% c.f.; 3–8 cm thick
Ae	2–20	10YR 5/3(m); loam; moderate, medium, subangular blocky to weak, medium, platy; slightly hard, slightly sticky; plentiful fine random and plentiful medium horizontal roots; 25% c.f.; 15–20 cm thick
AB	20–38	10YR 5/3 (m); loam; moderate to strong, medium, subangular blocky; slightly hard and slightly sticky; few fine and coarse random roots; slight porous; few thin clay films in voids/channels and on ped faces; 30% c.f.; 16–20 cm thick
Bt	38–55	10YR 4.5/3 (m); clay loam; common fine to medium faint 10YR 5/6 mottles; common fine to medium distinct mottles 10YR 5/6; massive to strong coarse subangular blocky; hard, very sticky; no rooting; slightly porous; many moderately thick clay films in voids/channels and on c.f. and ped faces; 30% c.f.

Horizon	Total C (%)	C/N ratio	CEC	exch. Ca	exch. K	exch. Mg	Total N (%)	Min N (ppm)	Avail. P (ppm)	pH (CaCl)
			(cmol/kg soil)							
Fm	53.66	36.97	97.19	18.61	3.73	3.33	1.45	253.1	90.9	3.45
Bm	6.91	22.93	37.30	5.42	0.31	1.45	0.30	29.8	8.3	3.44
AB	0.93	10.22	9.77	1.82	0.10	0.72	0.09	1.4	1.3	3.93
Ae	1.34	16.50	12.43	2.44	0.15	0.92	0.08	12.4	2.5	3.72
Bt	0.45	8.80	11.14	4.94	0.13	1.85	0.05	0.0	2.0	4.28

Topley: Soil pit No. 4
Location: intersection between plots 7, 4, and 5
Classification: Hemimor/Gleyed Gray Luvisol on morainal blanket

Horizon	Depth (cm)	Description
S/L	(10–8)	Mixed bryophytes with random individual litter particles
Fm1	8–5	Marginally decomposed mosses, and vascular plant tissues; abrupt smooth boundary; slightly dry; compact matted, felty, fibrous/tenacious; few fine to medium horizontal roots; common white and gray mycelia
Fm2	5–0	Partly decomposed plant materials, abrupt smooth boundary, moist, compact matted, felty, fibrous/tenacious; plentiful fine to medium horizontal roots; common white and gray mycelia; common random medium charcoal at mineral interface
Bm1	0–3	10YR 2.5/3 (m); loam; moderate to strong granular; abundant fine to medium horizontal roots; 10% c.f.; 2–5 cm thick
Bm2	3–10	10YR 3/3 (m); loam; moderate medium subangular blocky to weak medium granular; plentiful to medium horizontal roots; 15% c.f.; 6–9 cm thick
Ae	10–26	10YR 4/2 (m); loam to clay loam; moderate medium subangular blocky to moderate medium platy; few fine and medium oblique roots; 20% c.f.; 10–16 cm thick
Bt	26–50+	10YR 4/3 (m); clay loam; few medium distinct 7.5YR 5/6 mottles; massive to moderately strong, medium to coarse subangular blocky; hard, sticky; very few fine to medium oblique roots; 20% c.f.

Horizon	Total C (%)	C/N ratio	CEC	exch. Ca	exch. K	exch. Mg	Total N (%)	Min N (ppm)	Avail. P (ppm)	pH (CaCl)
			(cmol/kg soil)							
Fm1	52.59	30.88	105.60	38.91	3.41	6.04	1.70	386.5	84.9	na
Fm2	47.29	32.07	126.90	41.81	1.46	6.25	1.48	158.8	38.3	3.57
Bm1	4.95	21.77	34.02	17.96	0.24	4.90	0.23	81.4	3.8	4.64
Bm2	1.11	15.57	11.74	6.94	0.09	2.02	0.07	24.6	1.3	4.76
Ae	0.67	11.00	9.11	5.25	0.06	1.60	0.06	10.8	0.6	4.64
Bt	0.39	6.50	8.14	4.96	0.07	1.47	0.06	0.5	0.7	4.91

Kiskatinaw: Soil pit No. 1 (between plots 6 and 9)

Horizon	Depth (cm)	Description
L	8–7	Litter
Fq	7–4	Partially decomposed organic matter; loose, friable material; plentiful fine and plentiful coarse roots; fungal mycelia make up 35% of volume
H	4–0	Decomposed organic matter, some mineral soil mixing; plentiful fine and plentiful coarse roots
Ahj	0–2	Yellowish brown (10YR 5/4); silt loam; weak–moderate, fine granular; abundant very fine, abundant coarse roots; discontinuous horizon, 0–2 cm thick
Ae1	0–8	Light gray (10YR 7/2) with many medium diffuse brownish yellow (10YR 6/6) mottles; silt loam; moderate–strong, very fine platy; abundant very fine, abundant medium roots; clear smooth boundary 2 cm thick
Ae2	28–25	Light gray (10YR 7/2) with many medium diffuse reddish yellow (10YR 6/8) mottles; silt loam; moderate–strong, fine platy and moderate, fine subangular blocky; plentiful fine, plentiful medium roots; abrupt smooth boundary, 1 cm thick, with accumulation of gravel and stones
IIBt	25–33	Grayish brown (2.5Y 5/2) with many medium diffuse strong brown (7.5YR 5/6) mottles; clay; strong, medium, subangular blocky; few fine, very few medium roots; gradual smooth boundary 2 cm thick
BC1	33–68	Dark gray (10YR 4/1) with common medium prominent brown (7.5YR 4/4) mottles; clay; strong, moderately coarse, subangular blocky, very few medium, very few fine roots; diffuse, smooth boundary
BC2	68–94+	Dark gray (10YR 4/1) with common medium prominent brown (7.5YR 4/4) mottles; silty clay; strong, coarse subangular blocky; very few medium, very few fine roots

Kiskatinaw: Soil pit No. 2 (at southwest corner of plot 1)

Horizon	Depth (cm)	Description
L	7–6	Litter
Fq	6–3	Partially decomposed organic matter; loose, friable material
H	3–0	Decomposed organic matter, some mineral soil mixing; plentiful fine and plentiful coarse roots at mineral soil–organic interface
Ahj	0–4	Brown (7.5YR 4/4); silt loam; moderate–strong, fine granular; abundant very fine, abundant coarse roots; clear, wavy boundary
Ae1	4–8	Light gray (10YR 7/2) with many medium diffuse brownish yellow (10YR 6/6) mottles; silt loam; moderate–strong, very fine platy; abundant very fine, abundant medium roots; clear smooth boundary
Ae2	8–22	Light gray (10YR 7/2) with many medium diffuse reddish yellow (10YR 6/8) mottles; silt loam; moderate–strong, fine platy and moderate, fine subangular blocky; plentiful fine, plentiful medium roots; abrupt smooth boundary
IIBt	22–33	Grayish brown (2.5Y 5/2) and dark gray (10YR 4/1) with many medium diffuse strong brown (7.5YR 5/6) mottles; clay; strong, medium, subangular blocky; few fine, very few medium roots; gradual smooth boundary
BC1	33–58	Dark gray (10YR 4/1) with common medium prominent brown (7.5YR 4/4) mottles; clay; strong, moderately coarse, subangular blocky; very few medium, very few fine roots; diffuse, smooth boundary
BC2	58–88+	Dark gray (10YR 4/1) with common medium prominent brown (7.5YR 4/4) mottles; clay; strong, coarse subangular blocky; very few medium, very few fine roots

Kiskatinaw: Soil pit No. 3 (between plots 8 and 9, southern edge)

Horizon	Depth (cm)	Description
L	5–4	Litter
Fq	4–0.5	Partially decomposed organic matter; loose, friable material
H	0.5–0	Decomposed organic matter, some mineral soil mixing; plentiful fine and plentiful coarse roots at mineral soil–organic interface
Ahj	0–2	Brown (10YR 4/3); silt loam; moderate–strong, fine granular; plentiful fine, abundant medium roots; clear, broken boundary
Ae1	2–12	Pale yellow (2.5Y 7/3) and brown (7.5YR 5/4); loam; moderate–strong, very fine platy; plentiful fine roots; clear smooth boundary
Ae2	12–24	Pale yellow (2.5Y 7/3) with few medium diffuse very pale brown (10YR 7/4) mottles; silt loam; moderate–strong, very fine platy and weak, fine subangular blocky; plentiful fine, plentiful medium roots; abrupt smooth boundary
IIBt	24–29	Grayish brown (10YR 4.5/2) with common medium diffuse yellowish brown (10YR 5/4) mottles; clay; moderate, medium, prismatic; very few fine roots; clear smooth boundary
BC1	29–54	Very dark gray (7.5YR 3/0) with few medium prominent brown (10YR 5/3) mottles; clay; moderate–strong, coarse, prismatic and medium subangular blocky; very few fine, very few coarse roots; diffuse, smooth boundary
BC2	54–85+	Dark gray (10YR 4/1); clay; weak, coarse subangular blocky; very few fine roots

Kiskatinaw: Soil pit No. 4 (between plots 3 and 8)

Horizon	Depth (cm)	Description
L	7–6	Litter
Fq	6–4.5	Partially decomposed organic matter; loose, friable material
H	4.5–0	Decomposed organic matter, some mineral soil mixing; plentiful fine and plentiful coarse roots at mineral soil–organic interface
Ahj	0–2	Brown (10YR 5/3); silt loam; weak–moderate, fine–medium, granular; abundant fine, plentiful medium roots; clear, broken boundary
Ae1	2–14	Light gray (10YR 7/2) and with common fine yellow (10YR 7/6) mottles; silt loam; strong, fine platy; plentiful fine, plentiful medium roots; clear smooth boundary
Ae2	14–34	Light gray (10YR 7/2) with many medium diffuse yellowish brown (10YR 6/6) mottles; silt loam; strong, fine platy and weak–moderate, –fine medium subangular blocky; few fine, plentiful coarse roots; abrupt smooth boundary
IIBt	34–55	Yellowish brown (10YR 5/6); clay loam; moderate–strong, medium, subangular blocky; few fine roots; gradual smooth boundary
BC1	55–72	Very dark gray (10YR 3/0); clay; moderate–strong, medium, prismatic and moderate medium–coarse subangular blocky; very few medium roots; gradual smooth boundary
BC2	72–85+	Dark gray (10YR 4/1); clay; weak, coarse subangular blocky; very few fine roots

Dairy Creek: No.1 (southwest corner of plot 9 outside plot)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L/S	5–4	Litter and some moss
Fm	4–0	Origin mostly litter; moderately compact matted, firm, fibrous; abundant fine and very fine roots; abundant white mycelia
Ae	0–4	Brown (10YR 5/3 m); silt, 0% c.f.; moderate, coarse subangular blocky; friable; abundant coarse horizontal, and plentiful, medium horizontal roots
Bm	4–11	Dark yellowish brown (10YR 4/6 m); silt loam, 0% c.f.; moderate coarse subangular blocky; friable; plentiful coarse and medium horizontal roots; charcoal at lower boundary
IIBA	11–21	Dark yellowish brown (10YR 3/4 m); gravelly loam, 25% c.f.; moderate coarse subangular blocky; friable; moderate medium subangular blocky; friable; plentiful fine, and few medium horizontal roots
IIBt	21–43	Dark yellowish brown (10YR 3/4 m); gravelly sandy clay loam, 60% c.f.; weak coarse subangular blocky; friable; plentiful fine and very fine horizontal roots; common thin clay films on upper surfaces of coarse fragments
IIBC	43–65+	Dark grayish brown (2.5Y 3.5/2 m); gravelly loam (–sandy loam), 60% c.f.; weak coarse subangular blocky; friable; plentiful medium, oblique, and few random very fine roots; few thin clay films on ped faces

Note: Not sampled for chemistry.

Dairy Creek: No.2 (southwest corner of plot 3, outside plot)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L	3.5–3	Litter
Fm	3–0	Origin mostly litter; moderately compact matted, friable, fibrous; abundant fine and very fine roots; common white mycelia
Ae	0–2	Light brownish gray (10YR 6/2 d); silt loam 5% c.f.; weak, medium subangular blocky; friable; plentiful coarse and very fine horizontal roots
Bm	2–15	Dark yellowish brown (10YR 4/6 m); silt loam 10% c.f.; moderate, coarse subangular blocky; friable; abundant coarse and medium horizontal roots
IIBA	15–23	Brown (10YR 5/2 m); gravelly loam, 35% c.f.; weak to moderate, coarse angular blocky; hard; plentiful, fine and very fine, random roots
IIBt	23–50	Brown (10YR 4/2.5 m); gravelly loam, 40% c.f.; moderate, coarse, angular blocky; firm; plentiful medium, horizontal, and few, fine random roots; common thin clay films on ped faces
IIBC	50–70	Dark brown (10YR 4/2.5 m); gravelly loam, 45% c.f.; weak to moderate, coarse, subangular blocky; friable; few fine, random roots
IICgj	70–81+	Dark grayish brown (10YR 4/2 m); gravelly loam, 45% c.f.; few, medium faint, dark yellowish brown (10YR 4.5/6) mottles; weak to moderate, coarse, subangular blocky; friable

Note: Not sampled for chemistry.

Dairy Creek: No. 3 (west side of plot 4)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L/S	5–4	Litter and some mosses
Fm	4–0	Origin mostly litter; moderately compact matted, pliable, fibrous and acerose; abundant fine and very fine roots; common white mycelia
Ae	0–10	Gravelly silt loam, 25% c.f.; abundant medium horizontal roots; abrupt, wavy boundary; 0–2 cm thick
Bm	10–23	Dark yellowish brown (10YR 3/4 m); gravelly silt loam; moderate very coarse subangular blocky; friable; abundant medium horizontal roots, and plentiful fine horizontal roots
BA	23–45	Brown (10YR 4/3 m); gravelly loam, 40% c.f.; weak to moderate, medium subangular blocky; friable; plentiful, very fine and few fine random roots
Bt	45–70	Dark yellowish brown (10YR 35/3 m); gravelly loam, 40% c.f.; moderate, coarse angular blocky; friable; few, very fine random roots; many thin clay films on ped faces
BC	70–80+	Dark brown (10YR 3/3 m); gravelly loam, 40% c.f.; moderate, medium subangular blocky; friable; common, faint, medium mottles

Note: Not sampled for chemistry.

Dairy Creek: No. 4 (between southwest corner of plot 6 and north edge of plot 8)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L	5–4	Litter and some mosses
Fm	4 – 0.5	Origin mostly litter; moderately compact matted, fibrous, and acerose; abundant fine and very fine roots; common white mycelia; charcoal at lower boundary
H	0.5–0	Discontinuous and patchy
Aej	0–1	Silt loam, 5% c.f.
Bm	1–10	Brown (10YR 4/3 m); silt loam, 5% c.f.; moderate, very coarse subangular blocky; friable; abundant medium and coarse horizontal roots
BA	10–18	Dark brown (10YR 3/3 m); gravelly loam, 40% c.f.; weak to moderate, coarse subangular blocky; friable; abundant coarse and medium horizontal roots
Bt	18–36	Dark grayish brown (10YR 4/2 m); gravelly loam, 30% c.f.; weak to moderate, coarse subangular blocky; firm; plentiful fine, and few medium horizontal roots; many thin clay films on ped faces
BC	36–50	Very dark grayish brown (10YR 3/2 m); gravelly loam, 40% c.f.; moderate, medium subangular blocky; friable; very few, very fine roots
BCgj	50–56+	Dark brown (10YR 3/2.5 m); gravelly loam; common, coarse, faint, dark yellowish brown (10YR 3/6) mottles

Note: Not sampled for chemistry.

Black Pines: No.1 (between southeast edge of plot 2 and southwest edge of plot 3)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
Lv	4.5–4	Litter, crusty, acerose
Fm	4–0	Origin mostly litter; moderately compact matted, resilient, fibrous, and slightly felty; abundant fine and very fine, and plentiful medium horizontal roots; common white mycelia; abrupt lower boundary
Ae	0–1.5	Light brownish gray (10YR 6/2 d); fine sandy loam, 2% c.f.; weak to moderate, medium subangular blocky; very friable; plentiful coarse and fine horizontal roots; clear boundary
Bm	1.5–7	Light yellowish brown (10YR 6/5 d and 7.5YR 5/6m); silt loam (to fine sandy loam), 5% c.f.; moderate medium subangular blocky; friable; abundant medium and fine horizontal roots; abrupt boundary
IIBm	7–12	Light yellowish brown (10YR 6/5 d); fine sandy loam (to silt loam), 15% c.f.; moderate medium subangular blocky; friable; plentiful medium and fine horizontal roots; gradual boundary
IIIBA	12–27	Pale brown (10YR 6/3 d); gravelly loam, 40% c.f.; moderate coarse subangular blocky; friable; moderate coarse subangular blocky; hard; plentiful medium and few fine horizontal roots; common thin clay films on ped faces; gradual boundary
IIIBt	27–55	Light yellowish brown (10YR 6/4 d); gravelly loam (to clay loam), 35% c.f.; weak to moderate medium angular blocky; very hard; plentiful medium and few fine horizontal roots; common thin clay films on ped faces
IIIBCgj	55–78+	Yellowish brown (10YR 5.5/4 m); gravelly loam (to clay loam), 30% c.f.; weak to moderate medium subangular blocky; very hard; very few fine and very fine horizontal roots; common, medium, faint, yellowish brown (10YR 5/6) mottles; few thin clay films on ped faces

Note: Not sampled for chemistry.

Black Pines: No. 2 (between northeast corner of plot 3 and northwest corner of plot 4)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
Lv	4.5–4	Litter, crusty, acerose
Fm	4–0	Origin mostly litter; moderately compact matted, resilient, felty, and fibrous; abundant fine and very fine roots; common white mycelia; abrupt, wavy boundary
Ae	0–1.5	Light brownish gray (10YR 6.5/2 d); fine sandy loam, 2% c.f.; abundant medium and plentiful very fine horizontal roots; 0.5–2 cm thick
Bm	1.5–14	Pale brown (10YR 6/3 d); silt loam (- fine sandy loam), 5% c.f.; moderate, medium subangular blocky; friable; abundant coarse and medium horizontal roots
IIBm	14–21	Brown (10YR 6/4 d and 7.5YR 4/4 m); gravelly silt loam, 20% c.f.; moderate, medium subangular blocky; friable; abundant medium and plentiful fine horizontal roots
IIIBA	21–36	Yellowish brown (10YR 5/4 m); gravelly loam, 25% c.f.; moderate, coarse, subangular blocky; very hard; few fine and medium horizontal roots
IIIBt	36–52	Yellowish brown (10YR 5/4 m); gravelly loam (-clay loam), 25% c.f.; moderate, fine, subangular blocky; very hard; very few fine and medium horizontal roots
IIIBtgj	52–58+	Yellowish brown (10YR 5.5/4 m); gravelly clay loam, 25% c.f.; common, medium distinct, yellowish brown (10YR 5/5 m) mottles; subangular blocky; very hard; very few, very fine random roots

Note: Not sampled for chemistry.

Black Pines: No. 3 (between south side [70 m] of plot 6 and north side [70 m] of plot 5)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L/S	3.5–3	Litter and some mosses; acerose
Fm	3–0	Origin mostly litter; compact matted; abundant very fine roots; common white mycelia
Ae	0–2	Yellowish brown (10YR 5/4 d); fine sandy loam; plentiful fine horizontal roots
Bm	2–11	Brown (10YR 5/2.5 d); silt loam, 5% c.f.; weak to moderate, medium subangular blocky; soft; abundant medium and plentiful fine horizontal roots; 5–12 cm thick
IIBA	11–18	Pale brown (10YR 6/3 d); gravelly loam, 20% c.f.; weak to moderate, coarse subangular blocky; very hard; plentiful, very fine and few coarse horizontal roots
IIBt	18–42	Light yellowish brown (2.5Y 6/3 d); gravelly clay loam, 30% c.f.; moderate, coarse angular blocky; very hard; very few, very fine horizontal roots; many thin clay films in pores and on ped faces
IIBCgj	42–64+	Olive brown (2.5Y 4/3.5 d); gravelly loam, 40% c.f.; moderate, medium subangular blocky; firm; faint, dark yellowish brown (10YR 4/4 m) mottles

Note: Not sampled for chemistry.

Black Pines: No. 4 (between west side of plot 8 and northeast corner of plot 9)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L	3.0–2.5	Litter (needles and fine branches) and some grass
Fm	2.5–0	Origin mostly litter; loose, fibrous, and acerose; abundant fine and very fine roots; common white mycelia (evidence of fauna around large roots); abrupt lower boundary
Aej	0–0.5	
Bm	0.5–6	Brown (7.5YR 4.5/6 m); fine sandy loam, 5% c.f.; weak, fine subangular blocky; very friable; abundant coarse and medium horizontal roots; 5–11 cm thick
IIBm	6– 16	Dark yellowish brown (10YR 4/5 m); gravelly sandy loam, 20% c.f.; moderate to strong, medium subangular blocky; friable; abundant coarse and medium horizontal roots
IIBA	16–27	Light yellowish brown (10YR 6/4 m); gravelly loam, 20% c.f.; moderate, coarse subangular blocky; firm; plentiful fine and very fine horizontal roots
IIBt	27–50	Yellowish brown (10YR 5/4 m); gravelly loam, 25% c.f.; moderate, medium angular blocky; firm; few, very fine oblique roots; many thin clay films on ped faces
IIBC	50–58+	Light olive brown (2.5Y 5/3 m); gravelly loam, 30% c.f.; weak to moderate, fine angular blocky; firm; very few, very fine vertical roots

Note: Not sampled for chemistry.

O'Connor Lake: No. 1 (between east side of plot 1 and west side of plot 7)
Classification: Leptomoder/Gleyed Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L/S	5–4.5	Litter and some mosses
Fa	4.5–3	Origin mostly litter; reddish brown; weak compact matted, pliable, acerose, and slightly leafy; plentiful very fine roots
Fz	3–0	Black; friable; fibrous and slightly greasy; very few white mycelia associated with roots; common to abundant fauna droppings; abundant fine and very fine roots
Bm	0–8	Dark yellowish brown (10YR 4.5/6 m); silt loam, 5% c.f.; weak to moderate coarse subangular blocky; friable; plentiful medium and fine horizontal roots; gradual, wavy boundary; 7–10 cm thick
AB	8–28	Yellowish brown (10YR 5/4 m); gravelly silt loam, 20% c.f.; weak to moderate coarse subangular blocky; friable; plentiful medium and fine horizontal roots; gradual, wavy boundary; 16–22 cm thick
Bt	28–46	Dark grayish brown (10YR 4/2 m); gravelly loam, 35% c.f.; moderate very coarse subangular blocky; friable; moderate coarse subangular blocky; firm; plentiful medium and few fine horizontal roots; many thin clay films in all pores and on all ped faces; clear, wavy boundary; 16–22 cm thick
Btgj	46–70	Very dark grayish brown (10YR 3/2 m); gravelly loam, 40% c.f.; weak to moderate coarse subangular blocky; friable; few fine and very fine oblique roots; common, medium, distinct, brown (10YR 4/3) mottles; many thin clay films in pores and on some ped faces
BCgj	70–75+	Very dark grayish brown (10YR 3/2 m); gravelly loam (to clay loam), 50% c.f.; weak to moderate medium subangular blocky; friable; very few, very fine oblique roots; mottled but difficult to record

Note: Not sampled for chemistry.

O'Connor Lake: No. 2 (between east side of plot 3 and west side of plot 5)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
Lv	4.5–4	Needles, slightly compact
Fm	4–0	Origin mostly litter; reddish black; weak compact matted, friable; acerose and slightly fibrous; plentiful fine and very fine roots, many at interface with mineral soil; few white mycelia; abrupt, wavy boundary
Bm	0–9	Dark yellowish brown (10YR 4/4 m); silt loam (–fine sandy loam), 5% c.f; friable; abundant medium, and plentiful fine horizontal roots; 8–11 cm thick
Bm2	9–15	Dark yellowish brown (10YR 4/4 m); gravelly silt loam, 25% c.f.; moderate, coarse subangular blocky; friable; abundant medium and plentiful fine horizontal roots; 5–7 cm thick
IIAB	15–38	Brown (10YR 4/3 m); gravelly loam, 25% c.f.; weak, medium, subangular blocky; firm; plentiful medium and few fine horizontal roots; few thin clay films in pores and channels; 21–27 cm thick
IIBt	38–75	Very dark grayish brown (10YR 3/2 m); gravelly loam (–clay loam), 25% c.f.; weak to moderate, coarse, subangular blocky; firm; few faint mottles around coarse fragments; few medium and fine horizontal roots; many thin clay films in all pores and on all ped faces
IIBC	75–95+	Dark brown (10YR 3/2.5 m); gravelly loam, 35% c.f.; weak to moderate, very coarse, subangular blocky; friable; very few fine roots

Note: Not sampled for chemistry.

O'Connor Lake: No. 3 (between south side [70 m] of plot 4 and northwest corner of plot 5)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
L/S	4–3.5	Litter and some mosses; compact
Fm	3.5–0	Origin mostly litter; moderately compact matted; resilient; fibrous; abundant medium fine and very fine roots; common white mycelia
Bm	0–8	Dark yellowish brown (10YR 4/4 m); silt loam, 5% c.f.; weak coarse subangular blocky; friable; abundant medium and plentiful fine horizontal roots; clear, wavy boundary; 2–10 cm thick
IIBm	8–17	Dark yellowish brown (10YR 4/4 m); gravelly silt loam, 50% c.f.; weak, coarse subangular blocky; friable; abundant medium and fine horizontal roots; clear, wavy boundary; 8–15 cm thick
IIAB	17–26	Brown (10YR 4.5/3 m); gravelly silt loam (- loam), 30% c.f.; weak to moderate, very coarse subangular blocky; firm; plentiful fine and medium horizontal roots; gradual, wavy boundary; 8–16 cm thick
IIBt	26–58	Dark grayish brown (10YR 3.5/2 m); gravelly loam, 35% c.f.; weak to moderate, very coarse subangular blocky; firm; plentiful medium and few fine horizontal roots; many thick clay films in pores and on ped faces
IIBtgj	58–68	Very dark grayish brown (10YR 3/1.5 m); gravelly loam, 35% c.f.; weak to moderate, very coarse subangular blocky; firm; few medium horizontal roots; common, fine, faint, very dark grayish brown (10YR 3/2 m) mottles; many thick clay films in pores and on some ped faces
IIBCgj	68–75+	Very dark grayish brown (10YR 3/1.5 m); gravelly loam (–clay loam), 40% c.f.; moderate, medium subangular blocky; firm; few faint mottles; few thin clay films in pores and channels

Note: Not sampled for chemistry.

O'Connor Lake: No. 4 (between south side of plot 8 and north side of plot 9)
Classification: Hemimor/Brunisolic Gray Luvisol

Horizon	Depth (cm)	Description
Lv	3–2.5	Litter; weakly matted
Fm	2.5–0	Origin mostly litter; moderately compact matted; pliable; fibrous and acerose; plentiful fine and very fine horizontal roots; common, clustered white mycelia
Bm1	0–3	Dark yellowish brown (7.5YR 4/4 m); fine sandy loam, 5% c.f.; very friable; abundant coarse and plentiful medium horizontal roots
IIBm2	3–21	Dark yellowish brown (10YR 4/4 m); gravelly silt loam, 15% c.f.; weak, very fine subangular blocky; very friable; abundant coarse and plentiful medium horizontal roots; 14–21 cm thick
IIAB	21– 36	Dark brown (10YR 3/2.5 m); gravelly loam, 35% c.f.; moderate, very fine subangular blocky; friable; plentiful very fine and few coarse horizontal roots; 13–16 cm thick
IIBt	36–65+	Very dark grayish brown (10YR 3/2 m); gravelly loam, 20% c.f.; strong, very coarse, subangular blocky; firm; few very fine and very few fine horizontal roots; many thin clay films in pores and on ped faces; 24–32 cm thick

Note: Not sampled for chemistry.

Mud Creek: Soil pit No. 1
Classification: Orthic Eutric Brunisol (map 82J Kananaskis Lakes)

Horizon	Depth (cm)
LFH	2–0
Ae	0–2
Bm	2–18
BCk	18–28
Ck	28–60+

Mud Creek: Soil pit No. 2
Classification: Orthic Eutric Brunisol (map 82J Kananaskis Lakes)

Horizon	Depth (cm)	Description
LFH	1–0	
Ae	0–3	
Bm	3–22	Distinct; silty; very plastic (20-cm worm); charcoal throughout; quite dry below Bm
BCk	22–36	Strongly calcareous; subangular blocky, small, weak; wavy boundary (began at 18 cm on two sides)
Ck	36+	

Emily Creek: Soil pit No. 1
Classification: Orthic Eutric Brunisol (map 82K Lardeau)

Horizon	Depth (cm)	Description
LFH	None	
Ah	None	
Bm1	0–9	Stone-free
Bm2	9–19	Stone-free
Bm3	19–40	Strong; occasional carbonate coatings on rocks at 31 cm
Ck	40–69+	Gravelly; strongly calcareous; all rocks with carbonate undercoating after 40–45 cm

Emily Creek: Soil pit No. 2
Classification: Orthic Eutric Brunisol (map 82K Lardeau)

Horizon	Depth (cm)	Description
LFH	2–0	
Ah	0–2	
Bm1	2–16	Appears to be veneer, aeolian; rock-free to 16 cm
Bm2	16–28	Very weak; few, faint mottles; partly cemented?
Bm3	28–48	Strong
BCk	48–59	Strong; strongly calcareous
Ck	59–69+	Strong; strongly calcareous

Kootenay East: Soil pit No. 1
Classification: Orthic Eutric Brunisol (map 82J Kananaskis Lakes)

Horizon	Depth (cm)
LFH	4–0
Bm1	0–9
Bm2	9–22
BCk	22–27
Ck	27–50+

Kootenay East: Soil pit No. 2
Classification: Orthic Eutric Brunisol (map 82J Kananaskis Lakes)

Horizon	Depth (cm)	Description
LFH	2–0	
Bm1	0–8	
Bm2	8–24	
BCk	24–35	Strong carbonates
Ck	35+	

Rover Creek
Classification: Orthic Dystric Brunisol (map Trail 82F/SW)

Horizon	Depth (cm)
LFH	5–0
Ah	0–6
Bm	6–23
Bc	23–32
C	32–100+

McPhee Creek
Classification: Orthic Dystric Brunisol (map Trail 82F/SW)

Horizon	Depth (cm)	Description
LFH	4–0	Rotten log
Ah	0–4	Discontinuous; single grain; non-plastic; non-sticky; gradual boundary with Bm
Bm	4–27	Coarse angular blocky, breaking into medium; strong; non-plastic, non-sticky; gradual boundary with Bc
Bc	27–50	Less sand than Bm; medium angular blocky; moderate; non-plastic to slightly plastic; slightly sticky
R	50+	

Log Lake

Floristic list	(% Cover)
Trees	
Pseudotsuga menziesii	20
Picea glauca × *engelmannii*	11
Abies lasiocarpa	50
Pinus contorta	3
Betula papyrifera	2
Shrubs and Herbs	
Rubus parviflorus	3
Viburnum edule	0.5
Spiraea betulifolia	0.5
Amelanchier alnifolia	0.5
Sorbus scopulina	0.1
Vaccinium membranaceum	7
Lonicera involcrata	0.5
Rosa acicularis	1
Ribes lacustre	0.5
Aralia nudicaulis	15
Cornus canadensis	45
Rubus pedatus	5
Veratrum viride	3
Clintonia uniflora	8
Streptopus roseus	3
Tiarella unifoliata	3
Gymnocarpium dryopteris	5
Lycopodium annotinum	0.5
Orthilia secunda	1
Tiarella trifoliata	2
Galium triflorum	0.1
Linnaea borealis	1
Osmorhiza chilensis	0.1
Goodyera oblongifolia	0.5
Viola sp. *(glabella?)*	0.5
Disporum hookeri	8
Smilacina racemosa	0.5
Calamagrostis canadensis	0.1
Elymus glaucus	0.1
Corallorhiza maculata	0.1
Mosses and lichens	
Brachythecium spp.	5
Rhytidiadelphus triquetrus	5
Pleurozium schreberi	10
Ptilium crista-castrensis	50

Skulow Lake

A stratum

Floristic list (across nine plots)	(% Cover)
Trees	
Pinus contorta var. *latifolia*	58
Picea glauca × *engelmannii*	9.5
Pseudotsuga menziesii var. *glauca*	1 .5
Populus balsamifera spp. *trichocarpa*	0.75
Populus tremuloides	2.5
Shrubs	
Salix spp.	7.5
Amelanchier alnifolia	1
Viburnum edule	0.025
Rosa acicularis	8.45
Lonicera involucrata	0.5
Shepherdia canadensis	19.25
Sorbus scopulina	0.2
Juniperus communis	0.2
Spiraea betulifolia	2.25
Herbs	
Viola adunca	0.1
Lathyrus ochroleucus	6
Lathyrus nevadensis	0.025
Pyrola asarifolia	0.2
Pyrola chlorantha	0.5
Arnica cordifolia	5
Lilium columbianum	2.5
Castilleja miniata	3
Antennaria neglecta	5.5
Aster conspicuus	1.75
Aster ciliolatus	3
Fragaria virginiana	1.75
Arctostaphylos uva-ursi	14.25
Galium boreale	1
Agoseris glauca	0.75
Petasites palmatus	0.075
Calamagrostis rubescens	28.25
Achillea millefolium	2
Melampyrum lineare	0.75
Geocaulon lividum	10.75
Linnaea borealis	21.5
Cornus canadensis	28
Epilobium angustifolium	2.5
Lycopodium complanatum	7.25
Lycopodium annotinum	2.25
Chimaphila umbellata	0.75
Clintonia uniflora	2.75
Platanthera orbiculata	0.5
Platanthera obtusata	0.05
Vaccinium caespitosum	11.5
Hieracium spp.	75
Rubus pubescens	01
Oryzopsis asperifolia	25
Mahonia aquifolium	2
Calypso bulbosa	2
Vicia americana	0.5
Thalictrum occidentale	1.25
Festuca occidentalis	0.5
Corallorhiza maculata	0.5

Skulow Lake
A stratum *(Continued)*

Goodyera oblongifolia	0.075
Coeloglossum viride	0.1
Carex concinnoides	0.5
Vaccinium membranaceum	0.05
Vaccinium myrtilloides	0.01
Smilacina stellata	0.01
Gymnocarpium dryopteris	0.02
Mosses and lichens	
Splachnum luteum	0.02
Ptilium crista-castrensis	0.1
Brachythecium spp.	0.2
Cladina mitis	0.2
Peltigera aphthosa	2.75
Aulacomnium palustre	0 2
Dicranum polysetum	6.5
Pleurozium schreberi	34
Ptilidium pulcherrimum	0.01
Polytrichum juniperinum	0.1

Skulow Lake
B stratum

Floristic list	(% Cover)
Trees	
Pinus contorta var. *latifolia*	38.75
Picea glauca x *engelmannii*	24
Pseudotsuga menziesii var. *glauca*	0.2
Populus balsamifera spp. *trichocarpa*	7
Populus tremuloides	1
Shrubs	
Salix spp.	32.25
Amelanchier alnifolia	1.25
Viburnum edule	1
Rosa acicularis	11
Lonicera involucrata	17
Herbs	
Viola adunca	0.1
Lathyrus ochroleucus	3
Lathyrus nevadensis	0.025
Pyrola asarifolia	1.05

Skulow Lake
B stratum *(Continued)*

Pyrola chlorantha	0.025
Lilies columbianum	0.75
Castilleja miniata	2
Aster ciliolatus	4
Mitella nuda	1.75
Fragaria virginiana	8.5
Arctostaphylos uva-ursi	1.25
Galium boreale	5.25
Petasites palmatus	5.75
Calamagrostis rubescens	9
Calamagrostis canadensis	1.75
Achillea millefolium	2
Geocaulon lividum	7.25
Linnaea borealis	9.25
Cornus canadensis	23.25
Epilobium angustifolium	3
Clintonia uniflora	0.075
Platanthera orbiculata	0.2
Platanthera obtusata	0.1
Vaccinium caespitosum	13
Hieracium spp.	2.25
Rubus pubescens	16.75
Oryzopsis asperifolia	0.75
Vicia americana	0.2
Calypso bulbosa	0.1
Corallorhiza maculata	0.2
Lycopodium annotinum	0.1
Carex lasiocarpa (?)	0.75
Mosses and lichens	
Ptilium crista-castrensis	11.75
Dicranum fuscescens	1
Cladina mitis	0.2
Peltigera aphthosa	8.5
Aulacomnium palustre	41.5
Dicranum polysetum	8.25
Pleurozium schreberi	20

Topley

Species	Stratum[a]	Plot (% Cover)											
		Control[b]	1	2	3	4	5	6	7	8	9	10	Mean
Trees													
Pinus contorta	A1	2% 2 3				0.8% 1 2		1% 1 3		1% 1 3	2% 2 3	3% 2 3	0.9% 1 3
	A2	20% 4 2	30% 4 2	28% 4 2	22% 4 2	9% 2 2	8% 2 2	13% 4 2	7% 2 2	25% 4 2	15% 4 2	20% 4 2	18% 4 2
	A3	1% 2 1	3% 2 1	3% 2 1	4% 2 1	1% 2 1	1% 2 1	1% 2 1	1% 2 1			1% 2 1	1.5% 2 1
	A	23% 4 2	32% 4 2	30% 4 2	25% 4 2	10% 2 2	9% 2 2	15% 4 2	8% 2 2	26% 4 2	17% 4 2	24% 4 2	20% 4 2
	B1						0.2% 1 1		0.1% 1 1				+ 1 1
	B2											+ 1 1	+ 1 1
	B						0.2% 1 1		0.1% 1 1			+ 1 1	+ 1 1
	All	23% 4 2	32% 4 2	30% 4 2	25% 4 2	10% 2 2	9% 2 2	15% 4 2	8% 2 2	26% 4 2	17% 4 2	24% 4 2	20% 4 2
Abies lasiocarpa	A2	18% 4 2	15% 4 2	14% 4 2	22% 4 2	25% 4 2	18% 4 2	22% 4 2	25% 4 2	22% 4 2	25% 4 2	25% 4 2	21% 4 2
	A3	12% 7 2	8% 7 2	8% 7 2	8% 7 2	13% 7 2	8% 7 2	12% 7 2	12% 7 2	10% 7 2	8% 7 2	10% 7 2	10% 7 2
	A	25% 7 2	22% 7 2	20% 7 2	28% 7 2	35% 7 2	25% 7 2	30% 7 2	35% 7 2	30% 7 2	30% 7 2	30% 7 2	28% 7 2
	B1	15% 6 2	8% 4 2	10% 4 2	8% 6 2	10% 7 2	10% 7 2	10% 7 2	10% 4 2	15% 7 2	12% 7 2	10% 7 2	11% 7 2
	B2	15% 6 2	3% 4 2	5% 6 2	5% 6 2	5% 6 2	7% 6 2	15% 7 2	10% 7 2	5% 6 2	15% 6 2	7% 6 2	8% 6 2
	B	25% 6 2	11% 4 2	14% 6 2	12% 6 2	14% 7 2	15% 7 2	20% 7 2	18% 7 2	19% 6 2	25% 6 2	16% 6 2	17% 6 2
	D		+ 5 2				+ 2 1						+ 5 2
	All	42% 7 2	30% 7 2	32% 7 2	32% 7 2	42% 7 2	37% 7 2	45% 7 2	50% 7 2	45% 7 2	45% 7 2	45% 7 2	40% 7 2
Picea glauca × engelmannii	A1	1% 1 2	8% 2 3	2% 2 3	1% 2 3	1% 1 3			2% 2 3	2% 2 3	2% 2 3		2% 2 3
	A2	11% 4 2	10% 4 2	14% 4 2	15% 4 2	18% 4 2	18% 4 2	8% 4 3	15% 4 3	12% 4 3	10% 4 2		12% 4 2
	A3	6% 2 1	1% 2 1	1% 2 1	3% 2 2	5% 2 1	5% 2 2	4% 2 2	3% 2 2		3% 2 2		3% 2 2
	A	16% 4 2	18% 4 2	16% 4 2	17% 4 2	22% 4 2	22% 4 2	12% 4 3	20% 4 3	14% 2 3	15% 4 2		16% 4 2
	B1	5% 2 1	1% 2 1	2% 2 1	3% 2 1	1% 2 1	1% 2 1	1% 2 1	2% 2 1			0.1% 1 1	1% 2 1
	B2		+ 2 1				+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1
	B	5% 2 1	1% 2 1	2% 2 1	3% 2 1	1% 2 1	1% 2 1	1% 2 1	2% 2 1	+ 2 1	+ 2 1	0.1% 1 1	1% 2 1
	All	20% 4 2	19% 4 2	18% 4 2	20% 4 2	23% 4 2	23% 4 2	13% 4 3	22% 4 3	14% 4 3	15% 4 3	0.1% 1 1	17% 4 2
Populus balsamifera ssp. *trichocarpa*	A2					0.5% 1 1	2% 1 2						0.2% 1 2
Populus tremuloides	A2					0.2% 1 1							+ 1 1
All trees	**A**	**60%**	**65%**	**60%**	**62%**	**60%**	**50%**	**55%**	**62%**	**60%**	**50%**	**50%**	**58%**
Shrubs													
Alnus viridis	B1	3% 5 2	2% 5 2			2% 3 2	2% 3 2	1% 5 2	2% 5 2	3% 5 3	2% 3 3	3% 5 3	1.8% 5 2
	B2	+ 2 2	0.5% 2 1	1% 5 1	+ 2 1	0.2% 5 1	0.5% 5 1	0.2% 5 1	0.1% 5 1	0.5% 3 2	+ 3 2	1% 2 2	0.3% 5 1
	B	3% 5 2	2.5% 5 2	1% 5 1	+ 2 1	2.2% 5 2	2.5% 5 2	1.2% 5 2	2.1% 5 2	3.5% 5.3	2% 3 3	4% 5 2	2.2% 5 2
Vaccinium membranaceum	B2	10% 7 2	10% 7 2	2% 6 1	7% 7 2	8% 7 2	10% 7 2	12% 6 2	10% 6 2	10% 6 2	15% 7 2	15% 7 2	10% 7 2
Lonicera involucrata	B2	4% 7 1	1% 4 1	0.3% 5 1	3% 5 1	7% 5 1	15% 7 1	5% 5 1	10% 7 1	5% 7 1	1% 5 1	0.5% 2 1	5% 5 1
Rubus parviflorus	B2	7% 5 1	0.5% 3 1	+ 5 1	5% 5 2	7% 5 2	10% 7 2	3% 5 2	5% 5 2	5% 5 2	2% 5 1	+ 3 1	4% 5 2
Ribes lacustre	B2	1% 5 1	0.2% 5 1	+ 5 1	1% 5 1	0.5% 5 1	2% 5 2	1% 5 1	1% 5 1	0.5% 5 2	0.2% 5 2	+ 2 2	0.7% 5 1
Sorbus scopulina	B2	0.1% 5 1	+ 5 1	+ 5 1	0.1% 5 1	0.3% 5 1	0.5% 7 1	+ 5 1	+ 5 1	0.1% 5 1	+ 5 1	+ 5 1	0.1% 5 1
Viburnum edule	B2	+ 5 1	+ 2 1	+ 2 1	+ 5 1	+ 2 1	+ 2 1	+ 5 1	+ 2 1	+ 2 1	+ 5 1	+ 5 1	+ 2 1
Sorbus sitchensis	B2	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1	+ 2 1

Topley *(Continued)*

Species	Stratum[a]	Plot (% Cover)											
		Control[b]	1	2	3	4	5	6	7	8	9	10	Mean
Rosa acicularis	B2		+ 3 1		+ 3 1				+ 3 1				+ 3 1
Spiraea betulifolia	B2						+ 5 2		+ 3 1				+ 5 1
Amelanchier alnifolia	B2								+ 1 1				+ 1 1
Menziesia ferruginea	B2			+ 1 1									+ 1 1
All shrubs (incl. tree spp.)	**B**	**50%**	**22%**	**18%**	**30%**	**30%**	**45%**	**35%**	**40%**	**38%**	**40%**	**30%**	**34%**
Herbs and dwarf shrubs													
Cornus canadensis	C	20% 7 3	15% 7 3	10% 7 3	15% 7 3	15% 7 3	15% 7 3	15% 7 3	15% 7 3	15% 7 3	20% 7 3	17% 7 3	16% 7 3
Rubus pedatus	C	2% 7 2	2% 7 2	1% 7 2	5% 7 2	5% 7 2	5% 7 2	5% 7 2	6% 7 2	5% 7 2	5% 7 2	3% 7 2	4% 7 2
Linnaea borealis	C	2% 7 2	1% 6 2	1% 6 2	1% 7 2	1% 7 2	0.3% 7 2	1% 7 2	2% 7 2	2% 7 2	2% 7 2	0.3% 7 2	1% 7 2
Lycopodium annotinum	C	2% 6 3	1% 6 3	1% 6 3	0.1% 6 3	0.3% 6 3	0.3% 6 3	0.3% 6 3	0.5% 6 3	1% 6 3	3% 6 3	1% 6 3	1% 6 3
Vaccinium caespitosum	C	3% 5 2	+ 5 2	+ 5 2	+ 5 2	+ 5 2	+ 6 2	0.1% 6 2	0.1% 6 2	+ 5 1	+ 5 2	0.1% 5 2	0.3% 5 2
Orthilia secunda	C	0.5% 6 2	0.1% 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	0.5% 6 2	0.1% 6 2	0.2% 6 2	0.2% 6 2	0.1% 6 2	0.2% 6 2
Tiarella trifoliata	C	+ 5 2	+ 5 2	+ 5 2	+ 5 2	+ 2 2	+ 6 2	+ 5 2	1% 5 2	1% 5 2	+ 4 2	+ 4 2	0.2% 5 2
Aster foliaceous	C	+ 5 2	+ 5 2	+ 3 2	0.1% 6 2	0.1% 6 2	0.1% 6 2	0.3% 6 2	0.1% 6 2	0.1% 6 2	+ 6 2	+ 6 2	0.1% 6 2
Arnica cordifolia	C	+ 5 2	1% 6 2	+ 5 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	0.2% 6 2	0.1% 6 2	+ 3 2	0.1% 6 2
Epilobium angustifolium	C	+ 5 1	+ 3 1	+ 5 1	+ 5 1	0.1% 6 2	0.3% 6 1	+ 6 1	0.1% 6 1	0.1% 6 1	0.1% 6 1	0.1% 4 1	0.1% 6 1
Festuca occidentalis	C	+ 5 2	+ 5 2	+ 3 2	+ 5 2	+ 6 2	+ 5 2	+ 5 2	+ 5 2	+ 5 2	+ 5 2	+ 3 2	+ 5 2
Petasites palmatus	C	+ 5 1	+ 5 2	0.1% 5 2	+ 5 2	+ 6 1	+ 6 1	+ 6 2	+ 5 2	+ 5 1	+ 5 2	+ 2 1	+ 5 2
Pyrola chlorantha	C	+ 2 2	+ 5 2	+ 5 2	+ 5 2	+ 6 2	+ 6 2	+ 5 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 5 2
Listera cordata	C	+ 7 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 4 2	+ 7 2	+ 4 2
Moneses uniflora	C	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2	+ 2 2
Mitella nuda	C		0.1% 6 2	+ 5 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2
Gymnocarpium dryopteris	C		1% 5 2	0.5% 5 2			2% 5 2	+ 5 2	1% 5 3	3% 5 3	+ 5 2	1% 3 3	0.8% 5 2
Actaea rubra	C		+ 3 2	+ 3 2	+ 5 2	+ 5 2	+ 5 3	+ 3 3	0.3% 5 3	1% 5 3	+ 1 3		0.1% 5 3
Equisetum arvense	C	+ 2 1			+ 2 1		+ 2 2	2% 5 2	+ 5 2		+ 2 2		0.2% 5 2
Streptopus amplexifolius	C		+ 2 2	+ 2 2		+ 2 1		+ 2 1	+ 2 1	+ 2 2	+ 2 2	+ 2 2	+ 2 2
Galium triflorum	C		+ 3 2	+ 3 2	+ 5 3	+ 5 3	+ 5 3		+ 3 2	+ 2 3			+ 5 3
Rubus pubescens	C	+ 3 2	+ 5 2	+ 3 2	+ 5 2	+ 5 2	+ 5 2			+ 2 2			+ 5 2
Pyrola asarifolia	C		+ 3 2	+ 3 2		+ 5 2	+ 5 2		+ 3 1			+ 3 1	+ 3 2
Osmorhiza spp.	C			+ 2 2		+ 2 2	+ 2 2		+ 2 2	+ 2 2		+ 2 2	+ 2 2
Empetrum nigrum	C	2% 6 2					+ 5 2	+ 3 2				+ 3 2	0.2% 5 2
Sanguisorba canadensis	C	+ 5 2	+ 5 2	+ 5 2	1% 5 2						+ 3 2		0.1% 5 2
Viola orbiculata	C			+ 3 2			+ 5 2			+ 5 1	+ 5 2		+ 5 2
Cinna latifolia	C			+ 3 2						+ 2 1		+ 2 1	+ 2 1
Calamagrostis canadensis	C					+ 5 1	+ 5 1		+ 3 1				+ 5 1
Goodyera oblongifolia	C		+ 3 2				+ 3 2		+ 3 3				+ 3 2
Equisetum sylvaticum	C	+ 2 1	+ 2 2								+ 2 2		+ 2 2

Topley *(Continued)*

Species	Stratum[a]	Plot (% Cover)											
		Control[b]	1	2	3	4	5	6	7	8	9	10	Mean
Unidentified grass # 1	C					+ 5 1	+ 1 1	+ 1 1					+ 1 1
Gaultheria hispidula	C	+ 3 2						+ 3 2					+ 3 2
Aquilegia formosa	C	+ 2 2				+ 3 2							+ 3 2
Geocaulon lividum	C	+ 5 2											+ 5 2
*Athyrium filix-femina**	C										+ 3 1		+ 3 1
*Hieracium albiflorum**	C											+ 3 2	+ 3 2
Listera caurina	C	+ 3 3											+ 3 3
Platanthera obtusata	C			+ 3 2									+ 3 2
Schizachne purpurascens	C	+ 3 1											+ 3 1
Veratrum viride	C									+ 3 2			+ 3 2
Corallorhiza maculata	C					+ 3 2							+ 3 2
Anemone lyallii	C					+ 2 2							+ 2 2
Lycopodium complanatum	C	+ 1 2											+ 1 2
Calypso bulbosa	C									+ 1 1			+ 1 1
All herbs and dwarf shrubs	**C**	**30%**	**20%**	**15%**	**20%**	**20%**	**20%**	**22%**	**25%**	**27%**	**30%**	**20%**	**23%**
Mosses, liverworts, and lichens													
Pleurozium schreberi	D	50% 8 3	45% 8 3	40% 8 3	40% 8 3	40% 8 3	45% 8 3	45% 8 3	40% 8 3	45% 8 3	50% 8 3	60% 8 3	45% 8 3
Ptilium crista-castrensis	D	30% 6 3	35% 8 3	40% 8 3	40% 8 3	35% 8 3	30% 8 3	30% 8 3	40% 8 3	30% 8 3	30% 8 3	20% 6 3	33% 8 3
Hylocomium splendens	D	3% 6 2	5% 6 3	10% 6 3	1% 6 3	2% 6 3	5% 6 3	3% 6 3	5% 6 3	0.5% 6 2	1% 6 2	5% 6 2	4% 6 3
Peltigera aphthosa	D	5% 6 3	1% 6 3	1% 6 3	3% 6 3	2% 6 3	1% 6 3	3% 6 3	1% 6 3	1% 6 3	2% 6 3	3% 6 3	2% 6 3
Dicranum fuscescens	D	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	0.1% 6 2	0.1% 6 2	0.1% 6 2	0.1% 6 2	+ 6 2
Barbilophozia lycopodioides	D	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	+ 6 2	0.1% 6 2	0.1% 6 2	0.1% 6 2	0.1% 6 2	+ 6 2
Brachythecium hylotapetum-type	D			+ 5 2					1% 5 2	3% 5 2	+ 5 1	+ 5 1	0.8% 5 2
Nephroma arcticum	D	1% 6 3	+ 5 3	+ 5 3				+ 5 3			+ 3 3		0.2% 5 3
Aulacomium palustre	D		+ 5 2							+ 5 2	+ 5 2	+ 5 2	+ 5 2
Cladina rangiferina	D	+ 5 2			+ 3 1	+ 3 1		+ 3 1					+ 3 1
Sphagnum girgensohnii	D			+ 5 1							+ 5 1	+ 5 1	+ 5 1
Plagiomnium medium	D			+ 5 1			+ 5 1			+ 3 2			+ 5 1
Brachythecium curtum-type	D						+ 5 2					+ 3 1	+ 5 2
Rhytidiadelphus triquetrus	D					+ 3 2			+ 3 2				+ 3 2
Polytrichum juniperinum	D											+ 5 2	+ 5 2
Peltigera canina	D					+ 3 2							+ 3 2
Cladonia spp.	D					+ 3 2							+ 3 2
All bryophytes and lichens	**D**	**85%**	**83%**	**85%**	**80%**	**75%**	**78%**	**78%**	**85%**	**77%**	**80%**	**85%**	**81%**
Epiphytic/epixylic species													
Parmelia sulcata	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1

Topley *(Concluded)*

Species	Stratum[a]	Plot (% Cover)											
		Control[b]	1	2	3	4	5	6	7	8	9	10	Mean
Hypogymnia physodes	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Hypogymnia enteromorpha	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Parmeliopsis ambigua	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Parmeliopsis hyperopta	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Alectoria sarmentosa	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Bryoria lanestris	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Ptilidium pulcherrimum	S	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1
Eurhynchium pulchellum	S					2 1	2 1						2 1
Dicranum fuscescens	S	3 1	3 1	3 2	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1
Cladonia spp.	S	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1	3 1
Barbilophozia hatcheri	S			3 1	3 1	3 1	3 1						3 1
Lophosia ventricosa	S			3 1	3 1	3 1	3 1						3 1
Polytrichum juniperinum	S		3 1	3 1	3 1								3 1
Mnium spinulosum	S				3 1								3 1
Brachythecium curtum-type	S				4 1				3 1				4/3 1
Rhizomnium nudum	S				4 1								4 1

[a] Stratum from Luttmerding et al. (1990).

[b] The three values recorded in each column are:

1. Percent cover (ranges from 0.1 to 99%); "+" was assigned a value of 0.01%.
2. Distribution code from Luttmerding et al. (1990).
3. Vigour: 1 = poor; 2 = fair; 3 = good.

For Stratum S (atypical substrates), the two values recorded are substrate code (2 = epiphytic [growing on other plants]; 3 = epixylic [growing on decaying wood]; 4 = episolic [growing on bare soil]); and abundance code (1 = covering < 25% of the substrate).

* Invaded areas disturbed during diameter-limit logging.

Kiskatinaw

Species	Plot (% cover)																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Mean
Trees																												
Populus tremuloides	30	40	40	40	35	30	40	45	45	35	40	30	40	30	25	30	40	40	40	30	30	35	35	35	35	40	35	35
Pinus contorta	1	2	1	1	1	3																						0.5
Populus balsamifera	1		0.5			0.5						1			4												3	0.5
Picea glauca	5				3	4						5		1	4		5						15					2
Tall shrubs (2–10 m)																												
Alnus incana	0.5		0.5																									
Populus balsamifera	0.1	0.1		0.1		2			0.1	4	1					0.5				0.1	0.1	1	0.1		2	2	1	0.5
Populus tremuloides	0.1			0.1						1	1	2	1	2	1	2	4	0	5	3	2	1	2	3	3	2	4	1
Betula papyrifera	0.1				1																					0.5		0.1
Picea glauca			0.1	0.1	1	0.5	0.1	0.5	0.5	0.5		2	3	1	2		0.1		0.5	1	1	1	1	6	2	3	0.5	1
Low shrubs (0.5–2 m)																												
Picea glauca	0.5	0.1	0.1	0.1	0.5	0.1	1	0.1																				0.1
Populus tremuloides	1	2	2	2	1	0.5	2	2	0.5															1				0.5
Populus balsamifera	0.1	1	0.1	0.1		0.5									0.1											0.1		0.1
Amelanchier alnifolia		0.5	1	1	1		0.5	1	0.5			0.1	1	1	1	0.1	1	0.1		0.5	0.5	1		2	1		0.5	0.5
Shepherdia canadensis	5	5	6	7	7	3	6	10	3		1	0.5	8	12	1	6	8	6	0.1	9	4	9	1	2	6	3	6	5
Ribes lacustre	2	2	1	1	2	0.5	1	1	1																			0.5
Ribes oxyacanthoides										0.5	1	2	3	0.1	2	1	0.5	0.1	2	1	0.5	2	6	3	3	2	2	1
Rosa acicularis	5	6	8	10	12	9	8	10	8	12	10	7	7	3	14	1	5	10	11	6	7	6	9	6	11	6	8	8
Lonicera involucrata	2	0.5	0.5	1	1	0.5	1	0.5	0.5	1	3	2	5	1	3	1	1	1	1	0.5	1	1	2	2	1	0.5	1	1
Cornus stolonifera	0.5	0.1	0.1	0.1	1		1		0.1	1	0.5	1	0.5	1	1		1	1	2	0.1	1	1	3	1	1	0.5	2	1
Viburnum edule	2	3	5	4	3	3	4	3	3	0.5	2	4	2	1	4	3	3	1	5	4	3	3	1	2	2	3	5	3
Symphoricarpos albus	0.5	0.5								0.5	1	2	2	1	0.5	0.5	1	0.5	1	1	0.1	3	2	1	1		2	0.5
Lonicera dioica	0.1										1				0.5	1	0.1		1			0.1	1	0.5				0.5
Salix spp.	0.1	0.1	0.1	0.1	0.1	0.1		0.1		0.1								1	1	1	0.1	0.5	0.5		0.5	2	4	0.5
Rubus idaeus	0.1	0.1								0.1	1	1	1	1	1	2	0.5	0.1	0.1	0.1	0.5	1	1		0.1	1	0.5	0.5
Ribes triste		0.5								0.5	1	0.5		0.1		2	0.1	0.1	2	0.1	1	0.5	0.1	1	1	0.1	1	0.5
Herbs and grasses																												
Aster conspicuus	10	3	4	2	3	3	3	3	4	6	4	3	3	9	3	3	4	7	4	4	3	3	5	9	4	7	2	4
Arnica cordifolia	2	2	1	1	1	1	1	1	1	0.1					0.5	0.5	0.5					0.5		0.1				0.5
Epilobium angustifolium	12	15	10	12	8	10	10	10	8	6	5	4	7	5	7	4	5	10	7	4	5	6	7	5	7	3	4	7
Cornus canadensis	6	9	8	9	8	8	8	6	8		3	7	5	2	4	3	3	5	3	8	3	2	10	5	5	5	3	5
Lathyrus ochroleucus	3	3	3	4	4	7	5	8	4	0.5	2	2	1	2	2	2	4	2	3	3	1	1	1	2	2	1	2	3

Kiskatinaw *(Continued)*

	Plot (% cover)																											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**Mean**
Calamagrostis canadensis	3	6	10	12	12	10	12	12	12	5	8	8	5	5	6	7	11	5	10	6	19	8	6	6	10	10	9	9
Elymus glauca	1	1	3	2	2	1	3	4	4	2				0.5				0.5	1			0.5						1
Equisetum pratense	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.1	0.1					1				1										0.1
Galium triflorum	0.5			0.1	0.5					0.5	0.5	0.5	1	0.5			0.5	0.1		< 0.1	0.5	0.1	1	1	0.1	0.1	1	0.5
Galium boreale	0.5	1	0.5	0.5	1	0.5	1	2	1	1	1	1	3	3	1	2	2	2	2	2	1	1	2	2	2	2	2	2
Actea rubra	0.1	0.5	0.5	0.1	0.5	0.5	0.5	0.1	0.1	0.5	1	1	1		2	0.1	0.1	1	1		1	0.5	0.5	1	1	2	1	0.5
Heracleum lanatum	1	0.1		0.1	1	0.1	0.1		0.5	8	9	5	5	4	5	4	5	5	5	4	11	2	4	2	5	2		3
Fragaria virginiana	2	3	3	3	3	2	3	2	3	1	3	2	4	4	2	1	3	5	3	2	2	3	2	3	2	1	3	3
Rubus pedatus (*pubescens* in data files)	1	1	1	2	3	2	3	2	3	1	3	2	2	3	3	2	6	2	3	3	2	2	4	6	2	5	3	3
Linnaea borealis	0.5	0.5	0.5	1	2	0.1	0.5	1	2		4		2	0.1			0.5	1				2	0.1	1	0.1			0.5
Petasites palmatus	4	5	4	5	4	2	3	4	3	0.5	1	1	3	3	0.5	2	2	2	2	3	1	1	2	2	2	3	1	2
Pyrola asarifolia	0.5	0.5	0.5	2	2	2	2	1	1	0.5	3	1	1	4	1	2	4	5	2	6	0.5	4	2	3	2	4	1	2
Smilacina racemosa (not in data files)	0.5	0.1	0.1	0.1	0.5	0.5	0.5	< 0.1	0.5																			
Osmorhiza depauperata	0.1	0.1	0.1	0.1	0.1		0.1	0.1		< 0.1				0.1			1	1		0.5	< 0.1	0.1	1	2	0.1	0.1	0.5	0.5
Vicia americana	2	2	2	2	3	2	2	3	2	1	1	0.5	1	1	1	2	1	2	1	1	1	0.5	1	1	1	1	3	2
Achillea millefolium	0.1		0.1			0.1		0.1	0.1				0.1	< 0.1				< 0.1		0.5					0.5		0.5	0.1
Aster ciliolatus	0.1	0.1						0.1			0.1			0.5		1	0.1	< 0.1	0.5	0.1			1	1		0.1	1	0.1
Aralia nudicaulis						6						1				2						2						0.5
Platanthera orbiculata	0.1		0.1												0.5		< 0.1											
Astragalus americanus	0.1	0.1	0.5	0.1				2			0.5					1	0.1											0.1
Agropyron trachycaulum (not in data files)		0.1	0.1	0.1				1	1																			
Thalictrum venulosum			0.1						1	5	1	2	1		4	1	1								2			1
Bromus inermis			0.1	0.1					0.1	0.5	0.5	0.5	0.1	0.5	0.5	0.1	< 0.1	2		0.1			0.1	1				0.1
Delphinium glaucum				0.1						1		< 0.1										2		0.5				0.1
Coeloglossum viride				0.1	0.1																							
Solidago canadensis				0.5				0.1		9				3	1		1	0.1	2	1	1	2	3	6		2	1	1
Sonchus arvensis								0.1			0.1								0.1	0.5	0.1		1	0.1	0.5	1	1	0.1
Pterospora andromedea								0.1																				
Spirea betulifolia						0.1			0.1		1			2		1	1	0.5		0.5	2	0.5	2		3			0.5

Kiskatinaw *(Continued)*

Species	Plot (% cover)																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Mean
Lotus trifolium hybridum (not in data files)							< 0.1																					
Maianthemum canadense							0.1				0.1		2	0.1	1	1				0.5	0.5		1		0.5		0.5	0.1
Maianthemum racemosa	0.5	0.1	0.1	0.1	0.5	0.5	0.5	0.1	0.5	2	1	0.5		0.5	1	0.1		0.5	0.5	0.1	2		1	1	0.5	1	1	0.5
Mertensia paniculata	2	5	4	2	3	2	2	4	2	2	4	3	4	3	5	3	3	2	5	4	6	5	5	6	5	4	6	4
Mitella nuda											0.1		0.5				0.1		0.5		0.1	0.5	1		1		0.5	0.1
Orthilia secunda							0.1				0.1	0.1	0.1	0.1		0.5		0.1		0.1			0.5	1		0.1	0.5	0.1
Equisetum sylvaticum										0.1	0.5	0.1	0.5		0.5	0.5	1	< 0.1	0.5	1	0.5	0.5	1	2	1	1	1	0.5
Viola canadensis										1	1	1	1	0.1	2	0.1	2	0.5	0.5	0.1	1	0.1	< 0.1	1			0.5	0.5
Elymus trachycaulus		0.1	0.1	0.1				1	1	1	0.1		0.1		0.1	0.5	0.1	0.5	0.1	0.1	0.5	0.5	1	1				0.5
Mosses (only on dead wood)																												
Hylocomium	0.5			0.5	0.5	0.5	0.5	0.5	0.5				0.1	1					0.5		0.1			2		0.1		0.5
Rhytidiadelphus	0.1																											

Dairy Creek

	Plot mean (% cover)								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Trees									
Abies lasiocarpa	3	4	24		6	13	8		
Picea engelmanni × glauca	18		11	23	4	13	10	3	20
Pinus contorta	8		1		2	1	23	21	3
Populus tremuloides									
Pseudotsuga menziesii	15	24	18	5		5		11	5
Shrubs (tall and low)									
Abies lasiocarpa	14	18	5	25	25	24	25	56	5
Picea engelmannii × glauca	1	5		4	2	0.1	1	1	
Populus tremuloides									
Pinus contorta		1	6						
Pseudotsuga menziesii	5	6	1			0.5			10
Amelanchier alnifolia							1		1
Mahonia aquifolium	0.5	0.5	0.5	1	0.1	1	0.5	0.5	1
Paxistima myrsinites		1	0.5	0.5	2	0.5	1	5	
Ribes lacustre	0.5	1	0.5	0.1		0.1	2	1	4
Rosa acicularis	1	2	2	1	1	2	3	2	0.5
Rubus idaeus							1		1
Rubus parviflorus	0.5	0.1	0.5		3	0.5	0.5	0.5	0
Shepherdia canadensis		7		0.5	1	1	0.5	1	0.1
Spirea betufolia	1	1	2	0.5	2	0.5	2	2	
Symphoricarpos albus			0.1				1	1	2
Salix spp.		0.1						0.5	
Vaccinium membranaceum		0.1	0.5	0.1	0.5	0.5	0.5	0.5	
Herbs and grasses									
Antennaria racemosa		0.5					3		0.1
Arnica cordifolia	1	2	0.5	2	1	0.5	2	2	1
Aster conspicuus	0.5	0.5	0.5	0.5	1	0.1	0.5	0.5	0.1
Bromus vulgaris		0.5	0.5			0.5	1	0.5	2
Calamagrostis rubescens	15	12	16	1	1	6	12	3	4
Carex spp.	1		1			1			
Chimaphila umbellata	0.1	0.5	0.1	0.1	0.5	0.1		0.1	0.5
Disporum trachycarpum	0.5		0.1			0.5	0.1	0.1	0.1
Elymus glauca	0.5	0.5	1	0.5				0.5	
Festuca occidentalis	3	0.5	3	0.5	0.5	3	0.5	1	4
Fragaria virginianum	1	2	0.5	1		0.5	3	2	2
Galium triflorum	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2
Goodyera oblongifolia	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5
Hieracium albiflorum	0.1	0.5	0.5	0.5	0.5	2	0.5	0.1	0.1
Lathyrus ochroleucus	0.5	0.5	0.5	0.1	0.5		0.5	0.5	0.5
Lilium columbianum							0.5	0.5	0.1
Linnaea borealis	1	4	1	0.1	0.5	1	3	1	
Lupinus arcticus	1	4	1	0.1	0.5	1	3	1	
Maianthemum racemosum					0.1				
Orthilia secunda	0.5	0.5	1	0.5	1	1	2	2	2
Osmorhiza chilensis	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1
Taraxacum officinale	0	0.5	0.1						0.1
Thalictrum occidentale			0.1	0.5	0.1	0.1	2	0.5	1
Vicia americana		0.1							
Viola spp.	0.5	0.5	0.1	0.5	0.5	0.5	1	0.5	1
Clintonia uniflora					0.1		0.1	0.1	0.1
Cornus canadensis	7	1	3	3	4	2	5	7	7
Erigeron peregrinus		0.5	0.5	0.5		0.1			0.5
Moneses uniflora			0.1	0.1		0.1			0.5
Pedicularis bracteosa	0.1	0.5	1	0.5	0.1	0.5	0.5	0.5	0.5
Pyrola chlorantha	0.1		0.5	0.1		0.1			

Dairy Creek *(Continued)*

	Plot mean (% cover)								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mosses, liverworts, and lichens									
Brachythecium spp.		1	0.1	2	0.5	3	5	9	4
Cladonia spp.		0.5	0.1	0.5	0.1		1	0.1	0.5
Dicranum spp.	0.5	1	0.5	0.1	2	1		3	3
Mnium spinulosum	1	0.5	0.5	9	2	0.5	0.5	4	
Peltigera spp.	0.5	0.1	1	0.5	1	0.5	0.5	0.5	0.5
Pleurozium schreberi	17	2	19	34	45	17	30	29	30
Ptilium crista-castrensis	3		2	6	8	1	5	5	0.5
Rhytidiadelphus triquetrus	3		2	6	8	1	5	5	0.5

Black Pines

	Plot mean (% cover)								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Trees									
Abies lasiocarpa									5
Picea engelmannii × glauca	10	13		4		4	3		
Pinus contorta		6	7	5			8		
Populus tremuloides									
Pseudotsuga menziesii	18	23	18	36	43	35	15	28	44
Shrubs (tall and low)									
Abies lasiocarpa	6				3		3		
Picea engelmannii × glauca						1	9		
Populus tremuloides				0.1					
Pinus contorta									
Pseudotsuga menziesii	1	1	2	0.5	7	1	18	11	2
Amelanchier alnifolia	0.1	1	0.5	4	3	1		0.5	1
Mahonia aquifolium	6	1	2	2	3	1	1	2	3
Paxistima myrsinites	2	5	9	5	5	5	4	0.1	2
Ribes lacustre	3		0.5	0.1		0.5			
Rosa acicularis	4	2	3	3	1	4	5	2	1
Rubus idaeus						0.1			
Rubus parviflorus	1	0.1	0.5	0.1		0.5	0.5	0.5	0.1
Shepherdia canadensis	2	1	13	4	3	1	4	20	20
Spirea betufolia	2	2	1	3	2	2	3	10	3
Symphoricarpos albus		1	0.1	0.5		7	2	2	2
Salix spp.							1	0.5	
Vaccinium membranaceum	0.5	3	0.5		0.5	0.5	3		2
Herbs and grasses									
Antennaria racemosa	1	3	3	0.5				1	2
Arnica cordifolia	2	4	1	2	1	3	5	5	4
Aster conspicuus	1	1	0.5	0.5	2	1	1	1	0.1
Bromus vulgaris	2	1	1	1	1	0.5	0.1	2	0.5
Calamagrostis rubescens	19	16	14	8	13	13	23	15	10
Carex spp.	1	0.5							1
Chimaphila umbellate	4	6	3	2	2	3		6	2
Disporum trachycarpum		0.1		0.1		0.1		0.1	0.1
Elymus glauca				0.1					
Festuca occidentalis	0.5	0.5	0.5	2	1	1	1	5	1
Fragaria virginianum	1	0.5	0.5						
Galium triflorum	0.5	0.1	0.5	0.5	0.1	0.1	0.1	0.5	0.1
Goodyera oblongifolia	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5
Hieracium albiflorum	0.5	0.5	1	0.5	0.5	0.5	1	0.5	0.5
Lathyrus ochroleucus	0.5	0.1	0.5	0.1	0.1	0.1	0.1	0.5	0.5
Lilium columbianum		0.1	0.1	0.5	0.1		0.1		
Linnaea borealis	7	10	9	7	4	5	11	15	5
Lupinus arcticus	0.5	4	2	0.5	0.5	1	2	1	3
Maianthemum racemosum				0.1	0.1	0.5	0.1		
Orthilia secunda	0.5	0.5	1	0.5	1	0.5	1	0.5	0.5
Osmorhiza chilensis	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Taraxacum officinale	0.1	0.1	0.1			0.1		0.1	0.1
Thalictrum occidentale	0.5	0.5	0.1	0.5	0.5	0.5		0.5	0.1
Vicia americana	0.1	0.1				0.1		0.5	0.1
Viola spp.	1	0.5	0.1	0.1	0.5	1			0.1
Cerastium arvense	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.1
Gentianella amarella	0.1	0.1	0.1	0.1	0.1	0.1			
Mosses, liverworts, and lichens									
Brachythecium spp.		0.5		2	0.5	2	5	1	3
Cladonia spp.	0.5	0.1	0.5		0.1	0.5	0.1	0.1	0.5
Dicranum spp.	0.5	1							
Mnium spinulosum	1	0.5	1	1	1	0.5	1	0.1	
Peltigera spp.	0.5	0.5	0.5	1	1	0.5	0.6	0.5	0.1
Pleurozium schreberi	20	10	15	10	32	7	50	4	7
Ptilium crista-castrensis	0.5	1	0.5	1	4	1	0.5		0.1
Rhytidiadelphus triquetrus	0.1	0.5	0.1	1	0.6	0.1	0.1		0.5

O'Connor Lake

	Plot mean (% cover)								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Trees									
Abies lasiocarpa								6	
Picea engelmannii × glauca		2	0.1	1	0.1			8	
Pinus contorta	5								
Populus tremuloides	20						4		
Pseudotsuga menziesii	37	44	65	23	23	43	48	43	73
Shrubs (tall and low)									
Abies lasiocarpa	6				3		3		
Populus tremuloides	0.1								
Pseudotsuga menziesii	0.1		1	10	12	0.5	0.1	2	5
Amelanchier alnifolia	2	6	1	1	1	2	1	1	1
Mahonia aquifolium	1	1	4	4	7	4	2	4	5
Paxistima myrsinites				0.1	0.5			0.1	0.1
Ribes lacustre	1	4	1	2	0.5	0.1	0.1		1
Rosa acicularis	3	2	4	2	5	6	7	4	4
Rubus idaeus	0.1		0.1		0.1	0.1	0.1	0.1	0.1
Rubus parviflorus		2.5				2		0.1	
Shepherdia canadensis	2	1	14	4	3	1	4	20	20
Spirea betufolia			1	0.5	2		3	2	1
Symphoricarpos albus	22	36	7	15	9	15	27	12	12
Salix spp.				0.5					
Herbs and grasses									
Antennaria racemosa		0.1	0.5	0.1	1				
Arnica cordifolia			10	3	2	2	4	4	2
Aster conspicuus	2	2	3	3	5	4	1	4	5
Bromus vulgaris				0.1	0.1				
Calamagrostis rubescens	8	16	9	7	11	14	12	13	10
Carex spp.							0.1		
Chimaphila umbellata	1	0.5	0.1	1	1		0.1	0.1	0.1
Disporum trachycarpum	0.1	0.1	0.1	0.5	0.1	0.1		0.1	0.1
Elymus glauca	1	5	0.5	0.5	0.5	1	0.5		0.5
Festuca occidentalis				0.1	0.1		0.5		
Fragaria virginianum	2	2	5	1	3	2	0.5	2	1
Galium triflorum	1	2	0.1	0.5	0.5	0.5	0.5	0.1	0.1
Goodyera oblongifolia	0.1	0.1	0.5	0.5	0.1	0.1	0.1	0.1	0.1
Hieracium albiflorum	0.1		0.1	0.5	0.1	0.1	0.1	0.5	
Lathyrus ochroleucus	0.5	1		0.5	1	1	0.5	0.5	0.5
Lilium columbianum	0.5	0.1	0.1		0.1	0.5	0.1	0.5	0.1
Linnaea borealis	3	10	3	5	4	6	4	4	3
Maianthemum racemosum	0.1	0.5	0.5	0.1	0.1	0.1	0.5	0.5	0.5
Orthilia secunda	1	1	0.5	0.5	0.1	0.1	0.5		0.1
Osmorhiza chilensis	7	3	1	1	1	1	1	2	1
Taraxacum officinale	0.1		0.1		0.5	0.1	0.1		0.1
Thalictrum occidentale	3	4	1	1	0.5	2	2	2	0.5
Vicia americana	0.1			1	0.5	0.1	0.1	0.5	0.5
Viola spp.	1	3	1	0.5	0.5	2	8		0.1
Adenocaulon bicolor	0.1	1			0.1	0.1	0.1		
Epilobium angustifolium			0.1			0.1	0.1	0.5	0.1
Maianthemum stellata	5	1			0.1	0.1	2	0.1	
Mosses, liverworts, and lichens									
Brachythecium spp.			0.5	1	0.1	4	0.5	0.1	
Cladonia spp.	2	0.1	0.1						
Dicranum spp.	0.1	0.5	1	0.5	1	1	0.5	1	1
Mnium spinulosum	2	5	1	0.5	1	1	1	0.1	0.1
Peltigera spp.			0.1	0.1	0.5	0.5	0.1	0.1	
Pleurozium schreberi	8	9	8	18	18	9	12	11	4
Ptilium crista-castrensis	1	1	0.1	1	0.1	0.1	0.1	0.5	
Rhytidiadelphus triquetrus	1	2			0.1	0.5	0.1		0.1

Emily Creek

Species	Cover (%)
Trees	
Pseudotsuga menziesii	2.5
Shrubs	
Arctostaphylos uva-ursi	3.8
Juniperus communis	1.0
Rosa acicularis	0.5
Shepherdia canadensis	2.3
Forbs	
Achillea millefolium	0.5
Agoseris glauca	0.5
Allium cernum	0.5
Antennaria microphylla	1.3
Antennaria neglecta	0.8
Arnica cordifolia	3.3
Artemisia campestris	0.5
Aster foliaceus	0.5
Astragalus miser	1.8
Fragaria virginiana	1.5
Gentiannela amarella	0.5
Heuchera cylindrica	0.5
Hieracium albiflorum	0.5
Hieracium scouleri	0.5
Lomatium triternatum	0.5
Oxytropis campestris	1.0
Penstemon confertus	0.7
Pyrola chlorantha	0.5
Taraxacum officinale	0.5
Grasses	
Achnatherum richardsonii	0.5
Calamagrostis rubescens	4.4
Carex spp.	0.7
Festuca campestris	2.2
Festuca idahoensis	0.5
Oryzopsis asperifolia	0.5
Poa compressa	0.5

Kootenay East

Species	Cover (%)
Trees	
Pinus contorta	5.0
Pseudotsuga menziesii	48.8
Shrubs	
Amelanchier alnifolia	0.5
Arctostaphylos uva-ursi	0.5
Juniperus communis	3.5
Mahonia aquifolium	0.5
Rosa acicularis	0.6
Shepherdia canadensis	3.0
Spiraea betulifolia	4.0
Symphoricarpos albus	1.5
Forbs	
Achillea millefolium	0.5
Allium cernum	0.5
Antennaria microphylla	0.5
Antennaria neglecta	0.8
Aster conspicuus	1.0
Aster foliaceus	0.5
Aster laevis	0.5
Astragalus miser	0.5
Galium boreale	0.5
Gentiannela amarella	0.5
Hedysarum sulphurescens	0.5
Lilium philadelphicum	1.0
Lithospermum ruderale	0.5
Senecio vulgaris	0.5
Taraxacum officinale	0.5
Viola adunca	0.5
Grasses	
Calamagrostis rubescens	3.5
Carex spp.	0.5
Elymus glaucus	0.5

Mud Creek

Species	Cover (%)
Trees	
Pinus contorta	0.8
Pseudotsuga menziesii	1.8
Shrubs	
Acer glabrum	1.0
Amelanchier alnifolia	3.3
Arctostaphylos uva-ursi	5.1
Mahonia aquifolium	1.3
Rosa acicularis	1.5
Shepherdia canadensis	0.5
Spiraea betulifolia	4.3
Symphoricarpos albus	2.0
Forbs	
Achillea millefolium	0.5
Allium cernum	0.5
Antennaria microphylla	0.5
Antennaria neglecta	0.5
Arnica cordifolia	0.5
Aster conspicuus	0.5
Aster laevis	0.6
Aster spp.	0.5
Astragalus miser	0.7
Calochortus apiculatus	0.5
Fragaria virginiana	0.5
Hedysarum sulphurescens	0.5
Lithospermum ruderale	0.5
Penstemon confertus	0.5
Taraxacum officinale	0.5
Viola adunca	0.5
Grasses	
Calamagrostis rubescens	3.8
Carex spp.	2.4
Festuca campestris	0.9
Pseudoroegneria spicata	0.5

APPENDIX 4 Post-treatment bulk density (fine fraction < 2 mm) for the British Columbia Long-term Soil Productivity sites

Site	OM_1C_0	OM_1C_1	OM_1C_2	OM_2C_0	OM_2C_1	OM_2C_2	OM_3C_0	OM_3C_1	OM_3C_2
Kiskatinaw	1.29	1.34	1.38	1.22	1.40	1.39	1.44	1.52	1.50
Log Lake	1.02	1.56	1.37	1.14	1.41	1.52	1.11	1.28	1.38
Skulow Lake	1.31	1.42	1.50	1.33	1.34	1.59	1.34	1.45	1.75
Topley	1.25	1.46	1.40	1.11	1.53	1.35	1.51	1.59	1.46
Dairy Creek	1.14	1.36	1.38	1.29	1.51	1.58	1.19	1.66	1.54
Black Pines	1.15	1.40	1.43	1.23	1.31	1.41	1.48	1.58	1.56
O'Connor Lake	1.19	1.42	1.42	1.34	1.54	1.54	1.34	1.68	1.29
Mud Creek	0.74	0.72	0.79	0.74	0.82	0.71	0.84	0.81	0.80
Emily Creek	0.44	0.48	0.65	0.91	0.62	0.61	0.78	0.84	0.73
Kootenay East	0.34	0.40	0.43	0.47	0.47	0.54	0.50	0.46	0.48
Rover Creek	1.07	1.35	1.30	1.07	1.41	1.39	1.28	1.45	1.50
McPhee Creek	0.62	1.03	1.03	0.64	0.99	0.82	0.92	1.05	1.27