



Vegetation Composition and Structure - Baseline Monitoring in the Southwest Alaska Network

2011 Annual Summary Report

Natural Resource Technical Report NPS/SWAN/NRTR—2012/624



ON THE COVER

Monitoring plot near Turquoise Lake, Lake Clark National Park and Preserve, July 2011.
Photograph by: Andrew Shulstad, Southwest Alaska Network.

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Executive Summary

This report summarizes the results of baseline vegetation sampling in Lake Clark National Park and Preserve (LACL) and Katmai National Park and Preserve (KATM) in 2011. The plots will be revisited every five years, with a subset sampled for two consecutive years.

During the 2011 field season, we sampled 35 plots. Of those, we sampled thirteen new plots in LACL and eight in KATM. We also resampled 14 previously established plots. A total of 100 plots have now been established in the two parks, 27 of which are instrumented with soil temperature loggers. The temperature loggers are downloaded annually and will be used to monitor the timing and duration of freeze-thaw periods, snowpack development, and snowmelt.

Sixteen monitoring plots have been established within a 5-km radius of remote automated weather stations (RAWS) at Snipe Lake, Upper Coville, and Pfaff. Automated time-lapse cameras installed at Snipe, Upper Coville, and Contact Creek RAWS in August-September, 2010 were downloaded in June, 2011. The cameras will be used to monitor changes in phenology (e.g., leaf-out and senescence) and snowpack.

Plot variables were summarized within and across sites for the four vegetation types (closed spruce forest, spruce woodland, low shrub, dwarf shrub). Species richness was greatest at high elevations (>900 m), but only in LACL. Nonvascular species richness, as measured in nested frequency plots, was up to three times greater than for vascular species at a given site. Species of conservation concern included a rare lichen (*Cetrelia alaskana*) and three rare mosses (*Buxbaumia aphylla*, *Iwatsukiella leucotricha*, *Rhytidiopsis robusta*). No exotic species were found in monitoring plots.

Fourteen plots were resampled in 2010-2011. Summary statistics for these plots are compared across years as an estimate of interannual variability. Detection probabilities and sample sizes will be reviewed following repeat sampling in the 2012 field season.

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Introduction

Monitoring objectives for vegetation composition and structure are to document trends in the structure (e.g., height, density), composition (e.g., species richness and diversity), mortality and species turnover of selected mid- to late-successional vegetation types in the three largest parks in the SWAN (Lake Clark NPP (LACL), Katmai NPP (KATM), Kenai Fjords NP (KEFJ)). This report summarizes the results of vegetation sampling for the 2011 field season.

Methods

Sampling design and site selection

We have used a rotating panel design to establish and revisit sites (Miller et al. 2010a). Sample sites are drawn from a generalized random-tessellation stratified (GRTS) sample generated within access layers in a GIS, and new plots are surveyed for suitability prior to sampling. Here, ‘site’ refers to the larger area/community type, and ‘plot’ indicates the actual area sampled. Plots that cannot be accessed due to long travel times or unanticipated barriers are rejected (Appendix 1). In addition, we have sampled alpine and treeline sites that fell outside of the established access layers (GRTS population), but that nevertheless met accessibility criteria. We sampled 35 plots in LACL and KATM during the 2011 field season, 21 of which were new that year (Table 1).

In KATM, we established eight new plots in 2011 (Table 1). We established three new alpine plots east of Hammersly Lake, for a total of five alpine plots in that area (Figure 1a). We also established two new plots at Mirror Lake, one alpine and one subalpine (Figure 1c). Lastly, we established four alpine plots in the Pfaff Mine area (Figure 1b), which occurs in the headwaters of Moraine Creek and Battle Lake, in the Walatka Mountains subsection of the Alaska Peninsula Mountains Ecoregion (Boggs et al. 2003). The subsection is characterized by angular sedimentary and granitic mountains, and glacial features including cirques, arêtes, and horns. Alpine vegetation is dominated by crowberry (*Empetrum nigrum*), least willow (*Salix rotundifolia*), bog blueberry (*Vaccinium uliginosum*), and alpine bearberry (*Arctostaphylos alpina*).

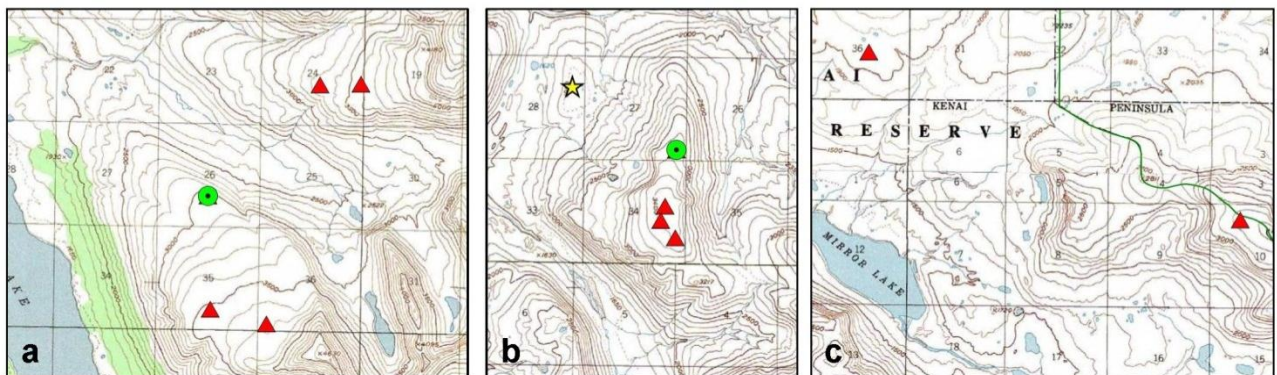


Figure 1. Alpine monitoring plots established in KATM in 2011: (a) Hammersly; (b) Pfaff; (c) Mirror Lake (includes one plot in mid-elevation tundra, north of the lake). Monitoring plots are indicated by red triangles, HOBO soil temperature loggers by green circles (installed at two plots in 2011), and RAWS by a yellow star. Two plots at Hammersly were established in 2010, but sampled in 2011. Scale: 1:32,000.

In LACL, we established thirteen new plots in 2011 (Table 1). We established two new plots at Lachbuna (Figure 2a), one alpine and one subalpine (treeline). Two alpine plots were established on the ridge south of Caribou Lakes (Figure 2b) and three in the tablelands south of Turquoise Lake (Figure 2d), for a total of six alpine plots at Turquoise (2010-2011; older plots not shown). We established four new plots in the Pear Lake area (Figure 2c), which occurs in the headwaters of the Chilikadrotna River, within the Rounded Volcanic Hills subsection of the Lime Hills Ecoregion (Spencer 2001). The subsection is characterized by isolated outcrops of old (40-70 million years bp), eroded volcanic plutons surrounded by glacial debris. Alpine vegetation is dominated by mountain avens (*Dryas octopetala*), small-awned sedge (*Carex microchaeta*) and exposed boulder fields and talus. Treeline occurs at approximately 700 m elevation. One new treeline plot was also established near the RAWS at Snipe Lake (Figure 2c), and one low elevation spruce woodland plot was established at Pickerel Lakes (not shown).

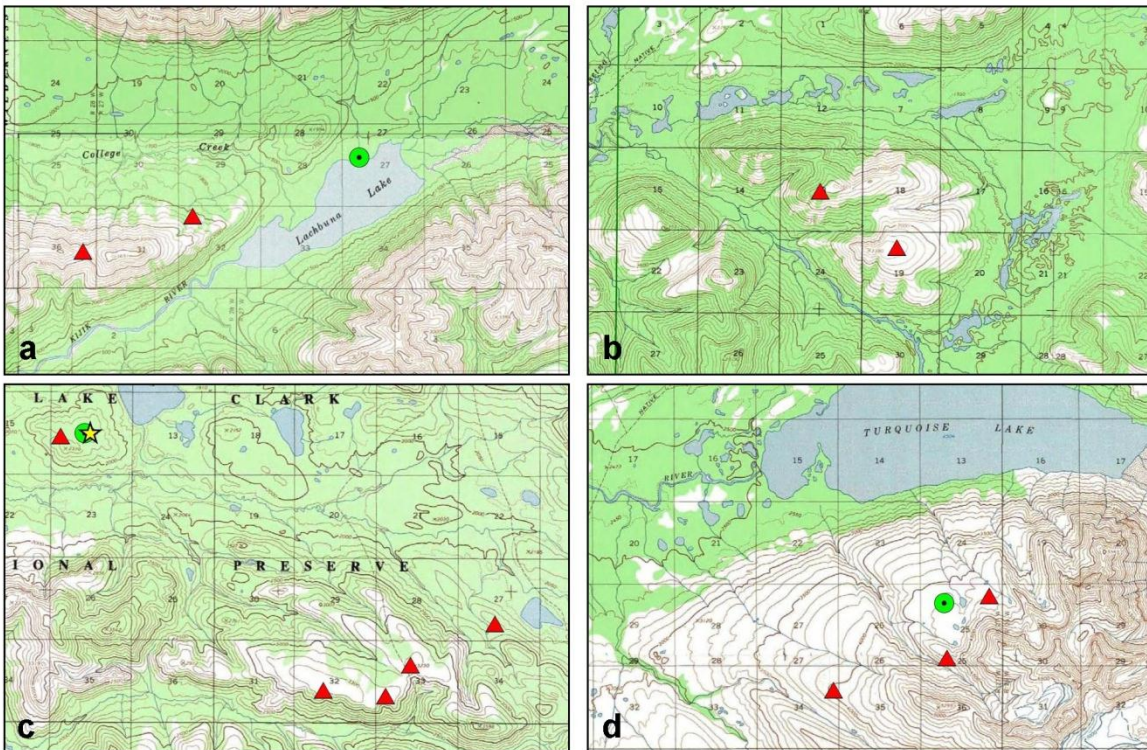


Figure 2. Alpine and treeline monitoring plots established in LACL in 2011: (a) Lachbuna; (b) Caribou Lakes; (c) Snipe (upper left) and Pear Lake (lower right); (d) Turquoise Lake. Symbols are as in Figure 1. HOB0 loggers were installed in 2010. Scale: 1:40,000.

A total of 100 plots have now been established in the two parks (2007-2011), 27 of which are instrumented with soil temperature loggers (Table 2), and 16 of which are within a 5-km radius of remote automated weather stations (RAWS) at Snipe Lake, Upper Coville, and Pfaff. Automated time-lapse cameras were installed at Snipe, Upper Coville, and Contact Creek RAWS in the fall of 2010. Plot descriptions for areas sampled between 2007 and 2010 have been included in previous reports (Miller et al. 2009, 2010b, 2011). Camp locations and access routes for areas sampled in 2011 are shown in Appendix 6.

Table 1. Plot locations and major vegetation types sampled in 2011. Datum = NAD83. The 35 plots are listed in ascending order by establishment date, elevation class and vegetation type. Previously sampled plots are listed first. A dagger (†) denotes a soil temperature logger.

Plot id	Establ.	Elevation class	Vegetation type	General location	Latitude (N)	Longitude (W)	Elevation (m)
KATM_2009_01_S996†	2009	<450 m	Beetle kill spruce	Brooks Camp	58.5481	-155.7835	22
KATM_2009_01_S999†	2009	<450 m	Beetle kill spruce	Coville Lake	58.7135	-155.5157	66
KATM_2009_01_S995†	2009	<450 m	Beetle kill spruce	Valley 10K Road	58.4955	-155.6619	79
KATM_2009_01_S038†	2009	<450 m	Spruce woodland	Nonvianuk Lake	59.0035	-155.6512	210
LACL_2010_01_S994	2010	<450 m	Spruce woodland	Lachbuna	60.4960	-154.0097	400
LACL_2007_02_006†	2007	450-900 m	Low shrub	Snipe Lake	60.6280	-154.3271	628
LACL_2010_02_999†	2010	450-900 m	Low shrub	Snipe Lake	60.6101	-154.3220	693
KATM_2009_02_048	2009	450-900 m	Dwarf shrub tundra	Mirror Lake	59.2535	-154.7328	569
KATM_2010_03_049	2010	>900 m	Dwarf shrub tundra	Hammersly Lake	58.8449	-155.0707	926
LACL_2010_03S_999†	2010	>900 m	Dwarf shrub tundra	Tanalian Mountain	60.2060	-154.2186	945
LACL_2010_03S_998	2010	>900 m	Dwarf shrub tundra	Lachbuna	60.4805	-154.0819	1003
LACL_2010_03S_001†	2010	>900 m	Dwarf shrub tundra	Turquoise Lake	60.7584	-153.9449	1252
LACL_2011_01_033	2011	<450 m	Spruce woodland	Pickrel Lakes	59.9437	-154.8039	107
LACL_2011_02_S999†	2011	450-900 m	Treeline spruce	Snipe Lake	60.6096	-154.3306	688
LACL_2011_02_S998	2011	450-900 m	Treeline spruce	Lachbuna	60.4869	-154.0484	539
LACL_2011_02_S997	2011	450-900 m	Treeline spruce	Lachbuna	60.4856	-154.0652	629
LACL_2011_02_S996	2011	450-900 m	Treeline spruce	Pear Lake	60.5770	-154.1746	710
KATM_2011_02_070	2011	450-900 m	Dwarf shrub tundra	Mirror Lake	59.2659	-154.7601	662
LACL_2011_03S_997	2011	>900 m	Dwarf shrub tundra	Lachbuna	60.4794	-154.1044	963
KATM_2011_03_003†	2011	>900 m	Dwarf shrub tundra	Pfaff	59.1022	-154.8078	973
LACL_2011_03S_004	2011	>900 m	Dwarf shrub tundra	Pear Lake	60.5697	-154.2048	986
LACL_2011_03S_005	2011	>900 m	Dwarf shrub tundra	Pear Lake	60.5643	-154.2137	991
KATM_2011_03_998	2011	>900 m	Dwarf shrub tundra	Mirror Lake	59.2430	-154.6571	1007
LACL_2011_03S_030	2011	>900 m	Dwarf shrub tundra	Caribou Lakes	60.4268	-154.5584	1021
LACL_2011_03S_027	2011	>900 m	Dwarf shrub tundra	Pear Lake	60.5653	-154.2361	1036
KATM_2011_03_009	2011	>900 m	Dwarf shrub tundra	Hammersly Lake	58.8607	-155.0405	1039
KATM_2011_03_032	2011	>900 m	Dwarf shrub tundra	Pfaff	59.0923	-154.8119	1055
KATM_2011_03_002	2011	>900 m	Dwarf shrub tundra	Pfaff	59.0899	-154.8079	1060
KATM_2011_03_001	2011	>900 m	Dwarf shrub tundra	Pfaff	59.0943	-154.8108	1062
KATM_2011_03_006	2011	>900 m	Dwarf shrub tundra	Hammersly Lake	58.8290	-155.0695	1076
LACL_2011_03S_055	2011	>900 m	Dwarf shrub tundra	Caribou Lakes	60.4365	-154.5859	1083
KATM_2011_03_022	2011	>900 m	Dwarf shrub tundra	Hammersly Lake	58.8271	-155.0542	1145
LACL_2011_03S_016	2011	>900 m	Dwarf shrub tundra	Turquoise Lake	60.7432	-153.9848	1235
LACL_2011_03S_007	2011	>900 m	Dwarf shrub tundra	Turquoise Lake	60.7597	-153.9287	1284
LACL_2011_03S_003	2011	>900 m	Dwarf shrub tundra	Turquoise Lake	60.7488	-153.9439	1356

Field sampling

Field methods and plot layout are described in detail in Miller et al. (2010a). At each field site, we established a 50 m × 50 m (0.25 ha) monitoring plot and intensively sampled the inner 30 m × 30 m. We recorded attributes related to forest condition (insects, pathogens, mortality) and site characteristics (slope, aspect, drainage). We measured the thickness of the litter, living mat (vegetation), and organic horizons, and depth to seasonal frost, where applicable.

Where applicable, we measured the diameter and height of all trees ≥ 12 cm diameter at breast height (DBH; 1.37 m), and the diameter of all saplings in the 30 m × 30 m plot. We estimated canopy cover at the plot center and four corners using a spherical densitometer, and cored trees at four points around the plot, at approximately 10-30 cm above the root crown, for estimation of age. Basal area and biomass calculations are outlined in Miller et al. (2010).

At all plots, we measured vascular and nonvascular species occurrence in nested quadrats (0.25 m²; 1 m²; 4 m²), and vascular species cover by point-intercept. Species cover was recorded in each of four height classes (<0.5 m; 0.5-1.0 m; >1-4 m; >4 m) along three 30 m transects. Percent cover by plant growth form (tree, shrub, dwarf shrub, forb, graminoid, lichen, moss), tree seedling counts, and substrate type were recorded using ocular estimates in the 4-m² quadrats. To date (2007-2011), we have re-measured understory species composition (vascular frequency and cover) in 14 plots (Table 3). We have re-measured nonvascular frequency in three plots.

Soil temperature logger installations and data downloads – KATM and LACL

Since 2009, we have installed soil temperature loggers (HOBO Pro v2; Onset Computer Corporation, Bourne, MA) at 27 plots in LACL and KATM (Table 2). In 2011, we downloaded fifteen existing HOBOs and installed five new ones (Snipe, Pfaff, Long Lake, Nonvianuk, Upper Coville). The loggers at Dumpling and Malone were damaged or missing and were not replaced. Due to late-season weather, we were unable to access and download all loggers in KATM.

Time-lapse camera downloads – KATM and LACL

Time-lapse cameras (Canon EOS 1000D) were installed at one RAWS station in LACL (Snipe) and two stations in KATM (Contact, Upper Colville) in August-September, 2010. The cameras were programmed to take four photos per day at 1-h intervals around 12:00 p.m. Images from the cameras capture green-up (start of growing season), leaf-fall (end of season), snow-on and snow-off dates. As of September 2011, we had acquired one full year of images from the Snipe Lake RAWS camera.

Moss collections – KATM and LACL

Since 2008, we have collected stair-step moss (*Hylocomium splendens*) at 81 plots in KATM and LACL. Ten samples were collected in LACL in 2011. Samples collected in 2008 (southern LACL) and 2009 (KATM) have been analyzed at the University of Minnesota Research Analytical Lab for elemental nitrogen (N), sulfur (S) and heavy metals (n=49). Total sulfur (S), total nitrogen (N), and nitrate (NO₃⁻) were determined by combustion with 10% HCl. Heavy metal concentrations (Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Zn) in solution were determined by ICP-AES. Analysis of samples collected in 2010-2011 is pending.

Table 2. HOBO temperature logger locations and status, 2007-2011. Datum = NAD83. The 27 plots are listed in ascending order by elevation class and vegetation type. Loggers that were downloaded in 2011 are indicated by an (*) after the installation date. Plots for which HOBOS are no longer installed are designated with an installation date of 'N/A.'

Plot id	Install	Elevation class	Vegetation type	General location	Latitude (N)	Longitude (W)	Elevation (m)
KATM_2009_01_S996	2009*	<450 m	Beetle-kill spruce	Brooks	58.5481	-155.7835	22
KATM_2009_01_S999	2009*	<450 m	Beetle-kill spruce	Coville	58.7135	-155.5157	66
KATM_2009_01_S995	2010*	<450 m	Beetle-kill spruce	Valley 10K Rd	58.4955	-155.6619	79
LACL_2010_01_S993	2010*	<450 m	Beetle kill spruce	Currant Creek	60.3051	-154.0020	80
LACL_2010_01_S995	2010*	<450 m	Beetle-kill spruce	Upper Tazimina	60.0383	-154.2407	225
LACL_2010_01_S997	2010*	<450 m	Beetle-kill spruce	Upper Tazimina	60.0418	-154.0166	225
LACL_2010_01_S999	2010*	<450 m	Beetle-kill spruce	Two Lakes	61.1366	-153.7335	350
LACL_2010_01_S998	2010*	<450 m	Beetle-kill spruce	Lachbuna	60.4958	-154.0056	400
KATM_2009_01_S050	2009*	<450 m	Spruce woodland	Naknek	58.7348	-156.3303	40
KATM_2009_01_S027	2011	<450 m	Spruce woodland	Long	58.4115	-156.2339	85
KATM_2009_01_S035	2010*	<450 m	Spruce woodland	Nonvianuk	59.0035	-155.6512	210
KATM_2009_01_S038	2011	<450 m	Spruce woodland	Nonvianuk	59.0035	-155.6511	210
LACL_2010_01_105	2010*	<450 m	Spruce woodland	Telaquana	60.9615	-154.0338	365
LACL_2010_02_092	2010*	450-900 m	Spruce woodland	Fishtrap	60.4836	-154.3276	510
LACL_2008_02_014	2008*	450-900 m	Spruce woodland	Snipe	60.6326	-154.3635	545
LACL_2008_02_048	2010	450-900 m	Spruce woodland	Lower Twin	60.6256	-153.9113	620
KATM_2009_02_050	2011	450-900 m	Dwarf shrub	Upper Coville	58.8070	-155.5679	465
KATM_2009_02_016	2009	450-900 m	Dwarf shrub	Emerald	59.0913	-155.1421	470
KATM_2009_02_003	2009	450-900 m	Dwarf shrub	Hammersly	58.8969	-155.1634	505
KATM_2009_02_S997	2009	450-900 m	Treeline	Upper Coville	58.8084	-155.5168	560
LACL_2007_02_006	2008*	450-900 m	Low shrub	Snipe	60.6279	-154.3271	630
LACL_2010_02_999	2011	450-900 m	Low shrub	Snipe	60.6101	-154.3220	695
LACL_2010_03S_999	2010*	>900 m	Dwarf shrub	Tanalian Mt.	60.2059	-154.2186	945
KATM_2011_03_003	2011	>900 m	Dwarf shrub	Pfaff	59.1022	-154.8078	973
LACL_2010_03S_001	2010*	>900 m	Dwarf shrub	Turquoise	60.7584	-153.9449	1250
KATM_2009_01_078	N/A	<450 m	Spruce woodland	Malone	58.3868	-156.1584	130
KATM_2009_02_S994	N/A	450-900 m	Dwarf shrub	Dumpling	58.5709	-155.8238	470

Table 3. Plots in which understory species composition (vascular) has been measured more than once between 2007-2011. Plots with repeat sampling of the nonvascular taxa are indicated with an asterisk (*).

plot	Years sampled				
	2007	2008	2009	2010	2011
LACL_2007_02_006*		X		X	X
KATM_2009_02_048*			X		X
KATM_2010_03_049				X	X
LACL_2007_02_002	X			X	
LACL_2007_02_005	X			X	
LACL_2007_02_017	X			X	
LACL_2008_02_006		X		X	
LACL_2008_02_014		X		X	
LACL_2008_02_048		X		X	
LACL_2008_02_049		X		X	
LACL_2010_01_S994*				X	X
LACL_2010_02_999				X	X
LACL_2010_03S_001				X	X
LACL_2010_03S_998				X	X

Summary statistics

Data were transposed and exported from MS Access tables using advanced queries to retain zero values. Plot variables (species occurrence in 4-m² quadrats; cover by growth form and height class) were summarized within and across plots using PROC SURVEYMEANS in SAS (SAS Institute, Cary, NC; Miller et al. 2010a). Relationships between species richness, elevation, and latitude were explored using simple linear regression. Summary statistics for a subset of variables (frequency, percent cover) were compared for plots that were resampled between 2007 and 2011 (Table 3).

Results and Discussion

Species composition

Species cover, recorded by point-intercept along transects, reflects variation in the abundance of major vascular species among communities and ecological subsections present in the two parks (Table 4; Appendix 2). For example, dwarf birch (*Betula nana*), a dominant shrub in spruce woodland and low shrub communities in LACL, is less abundant and of lower stature (<50 cm) in plots sampled in KATM. This is likely a reflection of the transition from a boreal system (e.g., Alaska Range and Lime Hills ecoregions) in LACL to the greater maritime influence (e.g., Bristol Bay ecoregion) in KATM (Miller et al. 2010b, 2011). Similarly, Alaska paper birch (*Betula neoalaskana*) is recorded in spruce woodland communities only in LACL (Table 4), although a hybrid birch (*B. nana* × *B. neoalaskana*) is common in KATM (data not shown). Species characterized by high constancy in cover (e.g., in spruce woodland: *Betula nana*, *Empetrum nigrum*, *Ledum palustre* ssp. *decumbens*, *Picea glauca*, *Vaccinium uliginosum*, *V. vitis-idaea*; Table 4) will be the most straightforward to monitor for changes in cover.

Table 4. Percent cover by species for selected vascular taxa and vegetation classes sampled in LACL and KATM (2009-2011). Cover was estimated by point-intercept along transects. Total cover >100% is due to layering within vegetation type. Cover by height class is shown for dwarf birch (*Betula nana*) and several tree species. Cover for all other species is shown for the ground layer (<50 cm). Species showing high constancy (CV ≤35%) are in boldface. See Appendix 2 for plot-level summaries.

Species	Beetle-kill white spruce (<450 m)				White spruce woodland (<450 m)				Alpine dwarf shrub (>900 m)			
	KATM (n=4)		LACL (n=4)		KATM (n=8)		LACL (n=10)		KATM (n= 9)		LACL (n=15)	
	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV
<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i>							0.8 (0.8)	1.00	0.1 (0.0)	0.65	1.5 (0.3)	0.24
<i>Anemone narcissiflora</i>											1.4 (0.4)	0.26
<i>Arctostaphylos alpina</i>	0.1 (0.1)	1.00			0.1 (0.1)	1.00	0.8 (0.6)	0.82				
<i>Artemisia arctica</i> ssp. <i>arctica</i>											0.2 (0.2)	0.80
<i>Betula nana</i> (<50 cm)					4.9 (0.9)	0.19	7.2 (2.0)	0.27				
<i>B. nana</i> (50 cm-100 cm)							8.6 (2.6)	0.30				
<i>B. nana</i> (1-4 m)							3.2 (1.2)	0.38				
<i>Betula neoalaskana</i> (<50 cm)	0.3 (0.2)	0.64	0.1 (0.1)	1.00			0.1 (0.1)	1.00				
<i>B. neoalaskana</i> (50-100 cm)	0.4 (0.3)	0.71	0.2 (0.2)	1.00			0.4 (0.4)	1.00				
<i>B. neoalaskana</i> (1-4 m)	16.1 (6.0)	0.37	2.8 (1.8)	0.66			<0.1 (0.0)	1.00				
<i>B. neoalaskana</i> (>4 m)	4.0 (1.7)	0.43	5.7 (5.7)	1.00								
<i>Calamagrostis canadensis</i>	4.1 (2.7)	0.65	12.9 (8.0)	0.62	<0.1 (0.0)	0.66	1.1 (0.3)	0.35				
<i>Carex microchaeta</i> ssp. <i>nesophila</i>									1.8 (0.4)	0.23	1.8 (0.4)	0.20
<i>Chamerion angustifolium</i>	2.3 (2.2)	0.94	0.6 (0.4)	0.57								
<i>Cornus suecica</i>	0.1 (0.1)	1.00	4.6 (4.2)	0.57			0.5 (0.4)	0.82				
<i>Diapensia lapponica</i>									2.1 (1.0)	0.48	6.3 (1.0)	0.17
<i>Dryas octopetala</i>											10.2 (3.6)	0.35
<i>Empetrum nigrum</i>	6.6 (2.5)	0.38	1.6 (0.9)	0.58	30.8 (2.3)	0.08	12.0 (4.8)	0.40	0.1 (0.1)	1.00	<0.1 (0.0)	1.00
<i>Festuca altaica</i>					0.2 (0.1)	0.66	2.1 (2.1)	1.00			0.1 (0.1)	1.00
<i>Ledum palustre</i> ssp. <i>decumbens</i>	0.1 (0.1)	1.00	2.8 (2.8)	1.00	6.9 (0.8)	0.13	30.3 (2.8)	0.09			0.3 (0.2)	0.67
<i>Loiseleuria procumbens</i>					0.7 (0.4)	0.67			0.1 (0.1)	1.00	1.3 (0.6)	0.47
<i>Minuartia arctica</i>											<0.1 (0.0)	1.00
<i>Oxytropis nigrescens</i> var. <i>nigrescens</i>									0.1 (0.1)	1.00	1.0 (0.6)	0.60
<i>Picea glauca</i> (<50 cm)	1.3 (0.3)	0.24	0.9 (0.6)	0.58	1.4 (0.3)	0.20	0.6 (0.2)	0.40				
<i>P. glauca</i> (50-100 cm)	0.3 (0.2)	0.64	0.2 (0.2)	1.00	1.9 (0.3)	0.16	1.9 (0.6)	0.30				
<i>P. glauca</i> (1-4 m)	1.9 (0.9)	0.49	5.9 (2.2)	0.36	3.8 (0.6)	0.16	2.9 (1.1)	0.37				
<i>P. glauca</i> (>4 m)	6.3 (3.6)	0.58	9.4 (4.1)	0.44	0.4 (0.3)	0.60	0.9 (0.4)	0.45				
<i>P. glauca</i> - snags (1-4 m)	13.8 (4.5)	0.33	4.3 (2.1)	0.49	2.5 (0.6)	0.26	0.2 (0.2)	1.00				
<i>P. glauca</i> - snags (>4 m)	15.0 (4.4)	0.29	6.1 (3.5)	0.58	0.2 (0.1)	0.53	0.2 (0.2)	1.00				
<i>Populus balsamifera</i> (<50 cm)												
<i>P. balsamifera</i> (50-100 cm)			0.1 (0.1)	1.00								
<i>P. balsamifera</i> (1-4 m)			0.6 (0.6)	1.00								
<i>P. balsamifera</i> (>4 m)			1.6 (0.9)	0.60								

Species	Beetle-kill white spruce (<450 m)				White spruce woodland (<450 m)				Alpine dwarf shrub (>900 m)			
	KATM (n=4)		LACL (n=4)		KATM (n=8)		LACL (n=10)		KATM (n=9)		LACL (n=15)	
	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV	Mean (SE)	CV
<i>Rhodiola integrifolia</i>									0.1 (0.1)	1.00	<0.1 (0.0)	1.00
<i>Salix arctica</i>					0.3 (0.1)	0.50			0.6 (0.4)	0.65	0.4 (0.2)	0.51
<i>Salix glauca</i>					0.5 (0.2)	0.53	0.1 (0.0)	0.51				
<i>Salix phlebophylla</i>									1.9 (0.8)	0.40	2.3 (0.7)	0.31
<i>Salix pulchra</i> (<50 cm)	0.1 (0.1)	1.00	0.1 (0.1)	1.00	0.9 (0.5)	0.53	0.4 (0.2)	0.58	<0.1 (0.0)	1.00		
<i>S. pulchra</i> (50-100 cm)	0.5 (0.3)	0.50	0.7 (0.7)	1.00	0.3 (0.2)	0.71	0.3 (0.2)	0.71				
<i>S. pulchra</i> (1-4 m)	2.8 (2.2)	0.80	1.5 (1.5)	1.00			0.2 (0.2)	1.00				
<i>Spiraea stevenii</i>	0.1 (0.1)	1.00	0.1 (0.1)	1.00	0.5 (0.2)	0.51	0.4 (0.1)	0.39				
<i>Vaccinium uliginosum</i>					4.1 (1.4)	0.33	10.9 (2.0)	0.18			0.6 (0.3)	0.59
<i>Vaccinium vitis-idaea</i>	15.0 (5.8)	0.38	4.8 (4.5)	0.94	10.3 (1.2)	0.12	14.1 (1.6)	0.11	0.2 (0.1)	0.69	1.0 (0.3)	0.30
<i>Viburnum edule</i>			1.2 (1.2)	1.00								

In LACL, a number of alpine taxa showed high constancy in cover across plots (e.g., *Anthoxanthum monticola* ssp. *alpinum* (= *Hierochloe alpina*), *Anemone narcissiflora*, *Carex microchaeta*, *Diappensia lapponica*, *Dryas octopetala*, *Salix phlebophylla*, *Vaccinium vitis-idaea*). In KATM, we sampled fewer alpine plots across a broader geographic area, and these KATM plots did not yield a consistent set of taxa that could be considered candidates for monitoring. To supplement the current data set, we recommend the establishment of additional alpine plots, particularly in KATM, to include a range of substrates and elevations.

Species occurrence, measured in nested frequency quadrats, captured differences in species richness among community types. Within-plot variation in species occurrence is shown in Appendix 3. A small number of species (e.g., *Anemone narcissiflora*, *Anthoxanthum monticola* ssp. *alpinum* (= *Hierochloe alpina*)) occurred at low frequency across all vegetation types. A second set of species, including *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Vaccinium uliginosum*, *Cladonia arbuscula* ssp. *beringiana*, *Dicranum scoparium*, *Polytrichum commune* ssp. *commune*, and *Hylocomium splendens* occurred in a high proportion of plots ($\geq 20\%$ frequency) across vegetation types. As with percent cover estimates, these widespread and relatively common species are expected to be good candidates for detecting changes in community composition through time, due to their high abundance and low sample variance. However, many of these species also have broad ecological tolerances, making them potentially more resilient to changing conditions than less common, more habitat-specific taxa.

Across the community types sampled, species richness increased with elevation and was highest in high elevation (44-124 species/plot; mean = 83 species/plot) and mid-elevation dwarf shrub plots (52-78 species/plot; Figure 3; Appendix 3). Richness was lowest in closed forest-beetle kill plots (27-63 species/plot). The richness estimates are conservative and the number of species present is likely higher at most sites, particularly for lichens and bryophytes which were only recorded in quadrats up to 1 m².

A similar pattern of increasing richness with elevation has been reported by the Central Alaska Network, which samples systematically across the elevation gradient using a two-stage grid (C. Roland, *personal communication*).

Species richness did not vary consistently with latitude in the communities we sampled. In alpine plots, richness increased with latitude, but this appeared to be an artifact of the composition of the southern (KATM) sites, a few of which were species-poor (Figure 4). These sites (e.g., Mirror, Hammersly) were located on cobble or boulder fields and had virtually no soil development and few if any vascular taxa. The lichen and bryophyte flora tended to be early successional, dominated by species such as *Melanelia hepatizon*, *Thamnolia subuliformis*, *Stereocaulon vesuvianum*, and *Polytrichum hyperboreum*. Vascular taxa were generally limited to one or more graminoids (e.g., *Carex microchaeta* ssp. *nesophila*, *Luzula arcuata* ssp. *unalaschcensis*) and diminutive forbs (e.g., *Cardamine bellidifolia*). In contrast, northern (LACL) sites had the greatest species numbers, represented largely by bryophytes and lichens (Figure 4a). The establishment of additional sites on a range of substrates across the latitudinal gradient, including more southern sites (e.g., on the ridge system northeast of Contact Creek), would help to resolve our understanding of the relationship, if any, between latitude and species richness in alpine communities.

Species richness was consistently low in the low-elevation woodland and closed forest sites, irrespective of latitude (Figure 4b).

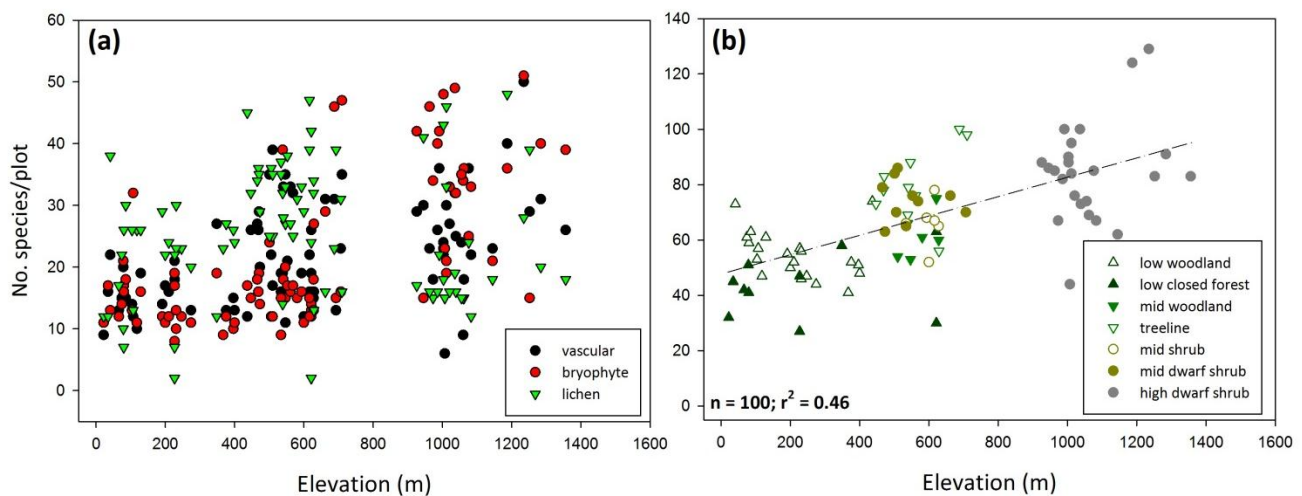


Figure 3. Vascular and nonvascular species richness as a function of elevation and vegetation type in LACL and KATM. Vegetation classes that occur between 700-900 m are a current data gap. (a) Number of species per functional group (vascular, bryophyte, lichen) per plot as estimated from nested frequency plots sampled in 2009-2011. (b) Total number of species (vascular + nonvascular) per plot, grouped by vegetation type. Low woodland and closed forest were sampled at elevations between 0-450 m. Treeline spruce, shrub, and dwarf shrub tundra were sampled between 450-900 m. High elevation dwarf shrub plots were sampled >900 m in LACL in 2010-2011 and in KATM in 2011.

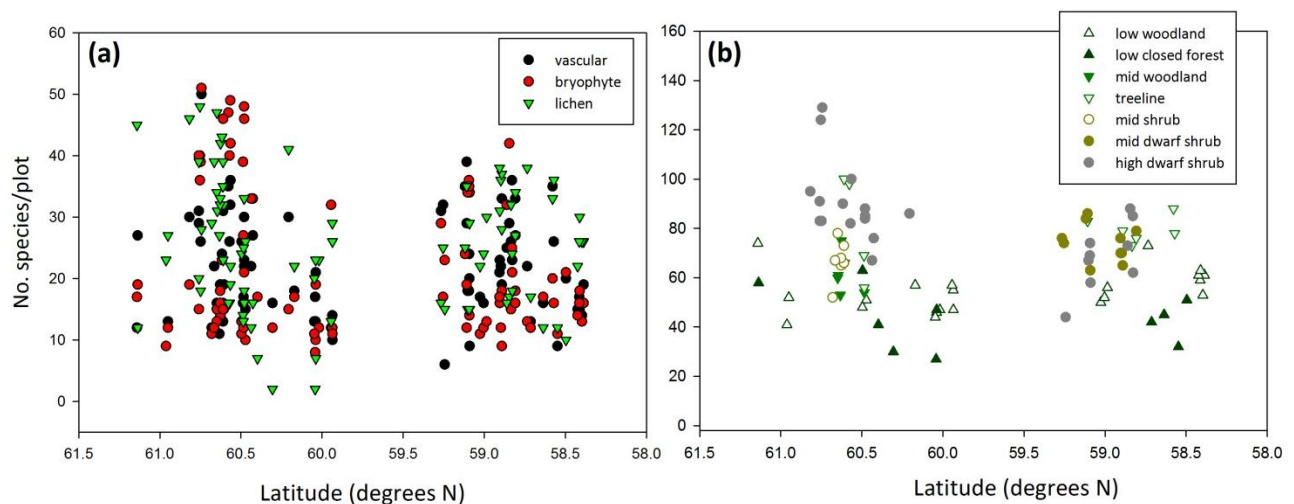


Figure 4. Vascular and nonvascular species richness arrayed along the latitudinal gradient, from north (LACL) to south (KATM). Symbols are as shown in Figure 3. Park boundaries create a gap in the distribution. (a) Number of species per functional group (vascular, bryophyte, lichen) per plot as estimated from nested frequency plots sampled in 2009-2011. (b) Total number of species (vascular + nonvascular) per plot, grouped by vegetation type. Low woodland and closed forest were sampled at elevations between 0-450 m. Treeline spruce, shrub, and dwarf shrub tundra were sampled between 450-900 m. High elevation dwarf shrub plots were sampled >900 m.

Lichens and bryophytes comprised $\geq 65\%$ of total species richness at most plots (Figure 5; Appendix 3). An exception were low elevation closed spruce plots, where nonvascular species comprised on average 58% of total species richness (range = 37%-72%). In low and mid-elevation spruce woodland and mid-elevation shrub communities, the nonvascular component ranged from 73%-76%, and in alpine plots it was 68% of total richness (Figure 5). All lichens and bryophytes recorded to date have been sampled in 1-m² quadrats, and thus have been limited to terricolous (ground-dwelling) taxa. In 2012, we plan to sample arboreal (tree-dwelling) lichens in a subset of plots using USFS Forest Inventory and Analysis (FIA) protocols. These data will provide an additional measure of lichen diversity in forest and woodland communities.

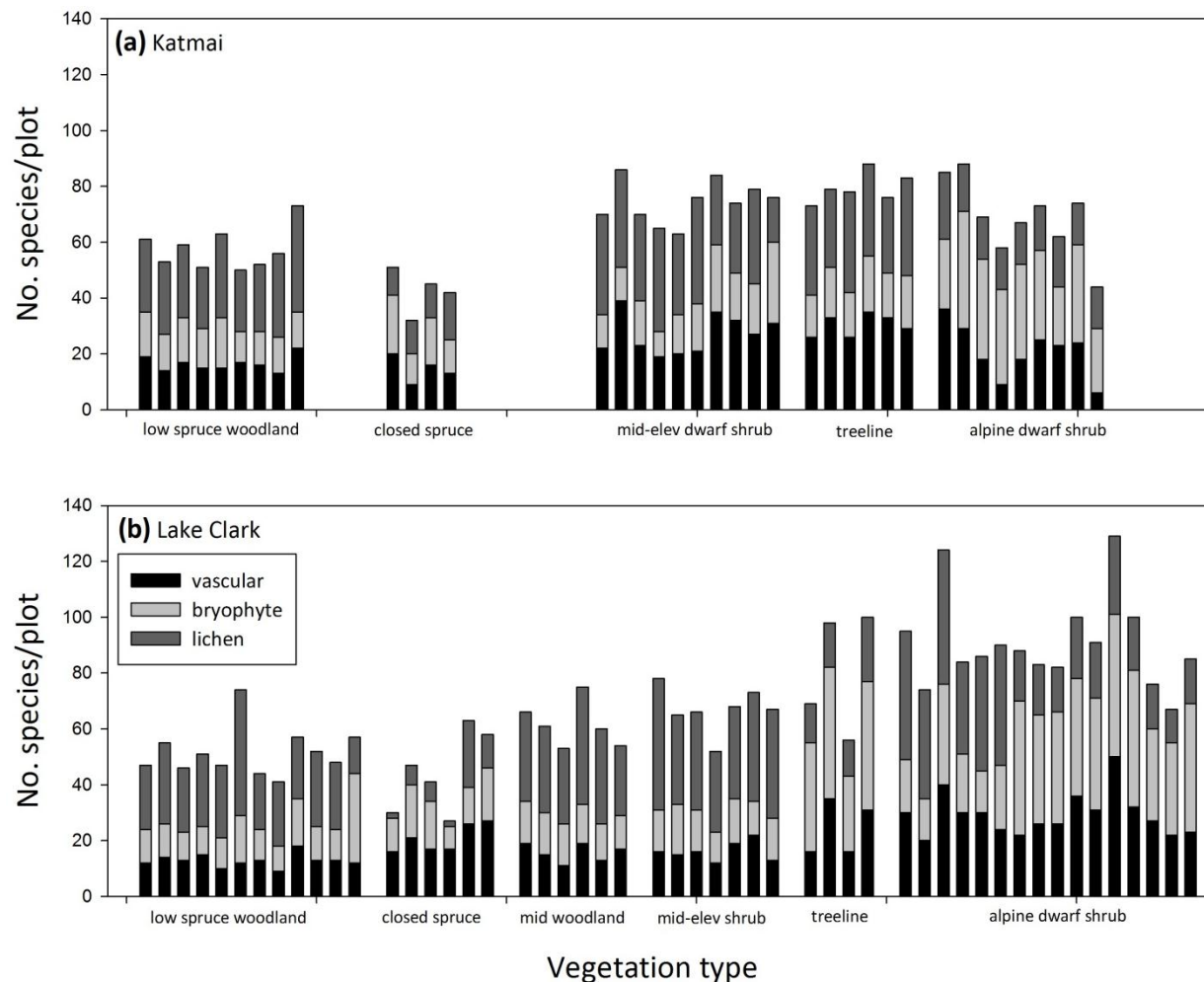


Figure 5. Contribution of vascular and nonvascular (bryophyte, lichen) taxa to overall species richness in selected vegetation types, in (a) KATM and (b) LACL. Low spruce woodland and closed spruce (0-450 m) were sampled in both parks. Mid-elevation dwarf shrub was sampled in KATM only. Mid-elevation spruce woodland and low shrub (>450-900 m) were sampled only in LACL. The contribution of nonvascular taxa to overall species richness was relatively constant across vegetation types, with the exception of low elevation closed spruce, in which nonvascular richness was relatively low. Total species richness increased with elevation in LACL, but not in KATM.

Interannual variability in cover and frequency estimates

Fourteen plots have been sampled at least twice between 2007 and 2011, and six have been sampled for two consecutive years (2010-2011). Estimates of vascular species richness by plot were similar though generally not identical across years (Pearson's product moment correlation: $n = 14$; $r = 0.83$; $P < 0.001$; Figure 6). Late emergence (e.g., as for *Lagotis glauca*, *Polygonum viviparum*), lack of identifiable features or inflorescences at the time of sampling (e.g., as in species of *Pedicularis* and many graminoids), and/or cryptic species (e.g., *Lloydia serotina*) were the most likely causes of species being overlooked in one year but captured in another. For vascular species that were detected in both years of sampling, differences in estimated frequency were generally less than 35% (Figures 7-8; Appendix 4). For nonvascular species, the differences ranged from 10% to greater than 100%, but for some of the less common taxa frequency estimates were much more consistent across years (Appendix 4). Species showing the greatest variability in frequency between years included herbaceous species - grasses, sedges and forbs - that may not have been detected due to late emergence (e.g., *Festuca altaica*, *Anthoxanthum monticola* ssp. *alpinum*, *Calamagrostis lapponica*, *Carex lugens*, *Arnica frigida*, *Petasites labradorica*), species that may have been difficult to identify early in the season due to late flowering (e.g., many grasses, including the above; sedges and willows), and/or taxa that were cryptic or could have been mistaken for another species (e.g., *Loisleuria procumbens*; Appendix 4).

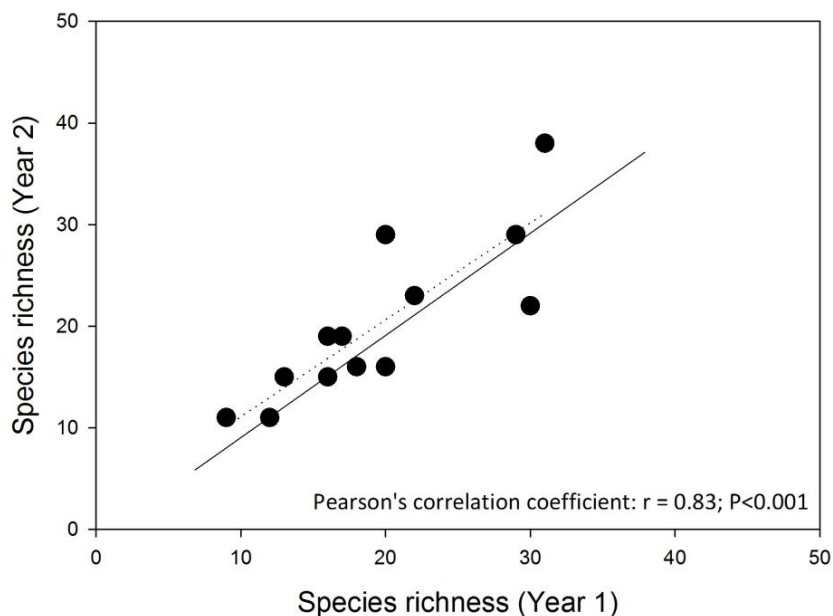


Figure 6. Estimated vascular species richness (number of species/plot) measured in individual plots across two years of sampling. The solid line indicates a hypothetical 1:1 relationship, in which species richness would be the same in years 1 and 2. Estimated species richness for most plots fell above or below the 1:1 line due to species detected in one but not both years. The best-fit line for the data is shown by the dotted line.

Cover estimates of vascular species recorded by point-intercept along transects showed year-to-year differences in estimated cover ranging from 0% to 500% (Figures 9-10; Appendix 5). Species that showed the highest constancy (lowest mean differences in percent cover) tended to be characterized by low stature and patchy to relatively continuous cover, often forming mats (e.g., *Betula nana*, *Diappensia lapponica*, *Empetrum nigrum*, and *Vaccinium uliginosum*; Appendix 5b). Species that showed greater year-to-year mean differences in cover tended to be much less abundant (e.g., cover of 5% or less: *Anemone narcissiflora*, *Anthoxanthum monticola* ssp. *alpinum*) or, if abundant, may have had small leaves and a more open growth form (e.g., not mat-forming: *Vaccinium vitis-idaea*). Several species appeared to have been misidentified in the field in one year of sampling, as suggested by the variation in their frequency estimates (e.g., *Louisleuria procumbens* misidentified as *Diappensia lapponica*; Appendix 4). Grasses and sedges consistently showed an 80% or more difference in cover between years due mainly to their low cover (i.e., vertically-arrayed leaves), but perhaps also to their later emergence, relative to the shrubs and dwarf shrubs. Species acronyms used in Figures 7-10 are as follows:

ANFR=*Antennaria friesiana*; ANMO9=*Antennaria monocephala*; ANMOA3=*Anthoxanthum monticola* ssp. *alpinum* (= *Hierochloa alpina*); ANNA=*Anemone narcissiflora*; ARAL2=*Arctostaphylos alpina*; ARARA2=*Artemisia arctica* ssp. *arctica*; ARFR2=*Arnica frigida*; BENA=*Betula nana*; CACA4=*Calamagrostis canadensis*; CALA6=*Calamagrostis lapponica*; CALA7=*Campanula lasiocarpa*; CALU2=*Carex lugens*; CAMIN=*Carex microchaeta* spp. *nesophila*; CHAN9=*Chamerion angustifolium*; DILA=*Diappensia lapponica*; DROC=*Dryas octopetala*; DROCA2=*Dryas octopetala* ssp. *alaskensis*; EMNI=*Empetrum nigrum*; FEAL=*Festuca altaica*; FEBR=*Festuca brachyphylla*; GEAL2=*Gentiana algida*; GEGL=*Gentiana glauca*; LAGL2=*Lagotis glauca*; LEPAD=*Ledum palustre* ssp. *decumbens*; LLSE=*Lloydia serotina*; LOPR=*Loiseleuria procumbens*; LUARU=*Luzula arcuata* ssp. *unalaschcensis*; LYLA5=*Lycopodium lagopus*; MIAR3=*Minuartia arctica*; OXNIN2=*Oxytropis nigrescens* var. *nigrescens*; PACY8=*Packera cymbalaria*; PECA2=*Pedicularis capitata*; PELA=*Pedicularis labradorica*; PELA14=*Pedicularis lanata*; PELA3=*Pedicularis langsдорffii*; PIGL=*Picea glauca*; POBA2=*Populus balsamifera*; POVI3=*Polygonum viviparum*; PRCU=*Primula cuneifolia*; RHCA5=*Rhododendron camtschaticum*; RHIN11=*Rhodiola integrifolia*; RUCH=*Rubus chamaemorus*; SAAR27=*Salix arctica*; SAFU=*Salix fuscescens*; SAGL=*Salix glauca*; SALIX=*Salix* sp.; SAPH=*Salix phlebophylla*; SAPU15=*Salix pulchra*; SABRF=*Saxifraga bronchialis* ssp. *funstonii*; STLOL7=*Stellaria longipes* ssp. *longipes*; TREUA=*Trientalis europaea* ssp. *arctica*; TRSP2=*Trisetum spicatum*; VAUL=*Vaccinium uliginosum*; VAVI=*Vaccinium vitis-idaea*.

For canopy cover estimates (Figures 9-10), the following codes indicate cover of woody species in different height classes: BENA1=*Betula nana* (<50 cm); BENA2=*B. nana* (50-100 cm); BENA3=*B. nana* (>1 m-4 m); PIGL1=*Picea glauca* (<50 cm); PIGL2=*P. glauca* (50-100 cm); PIGL3=*P. glauca* (>1 m-4 m); PIGL4=*P. glauca* (>4 m); SAPU2=*Salix pulchra* (50-100 cm); SAPU3=*S. pulchra* (>1 m – 4 m).

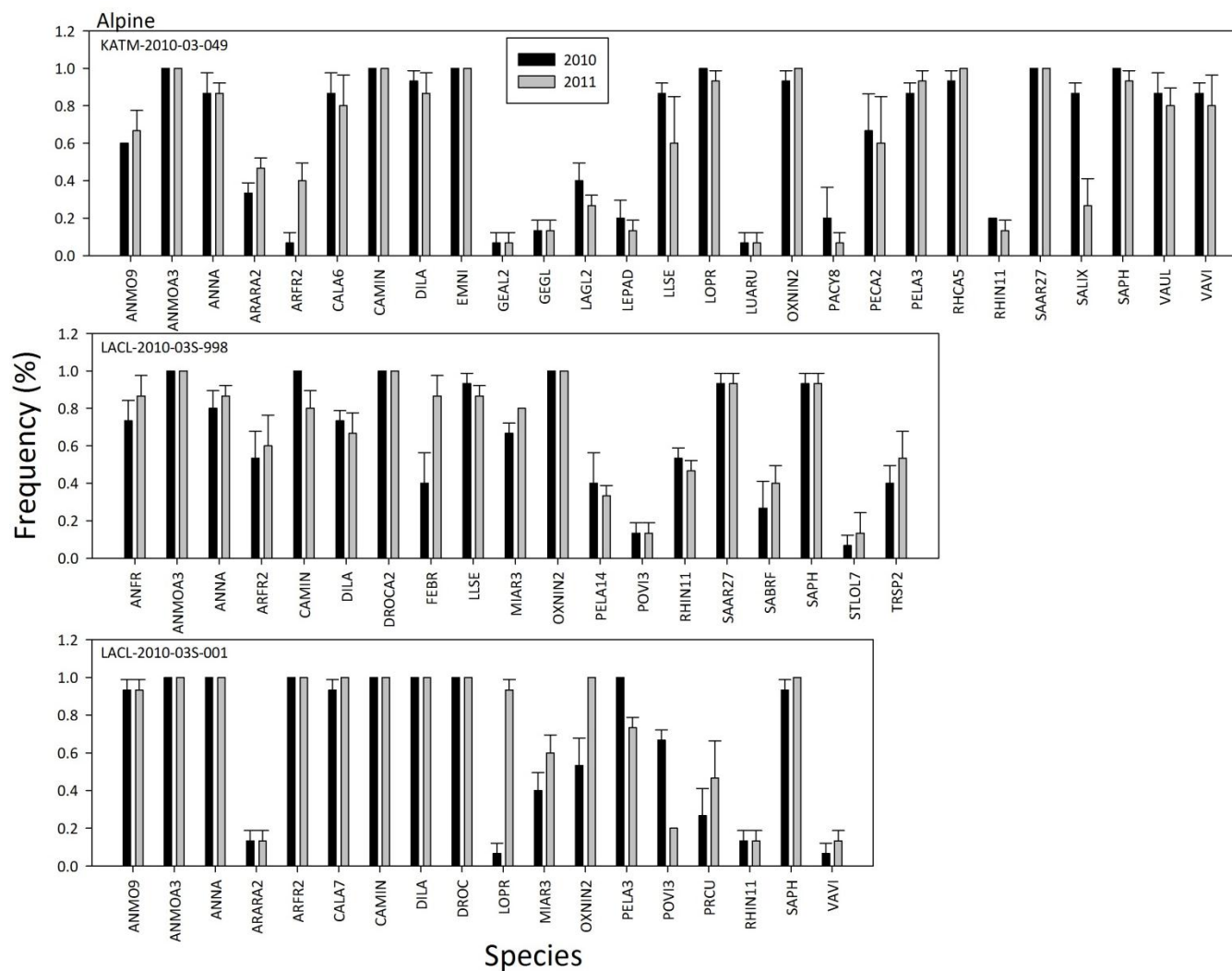


Figure 7. Frequency estimates for vascular species sampled at alpine plots in LACL and KATM in 2010 and 2011 (mean $\pm$ 1 SE). A frequency of 1.0 indicates that the species was present in every quadrat sampled (100% occurrence). Estimates are for frequency measured in 4-m² quadrats (n = 15 quadrats/plot); data are for species recorded in both years. Species codes (USDA-NRCS) are defined in the text.

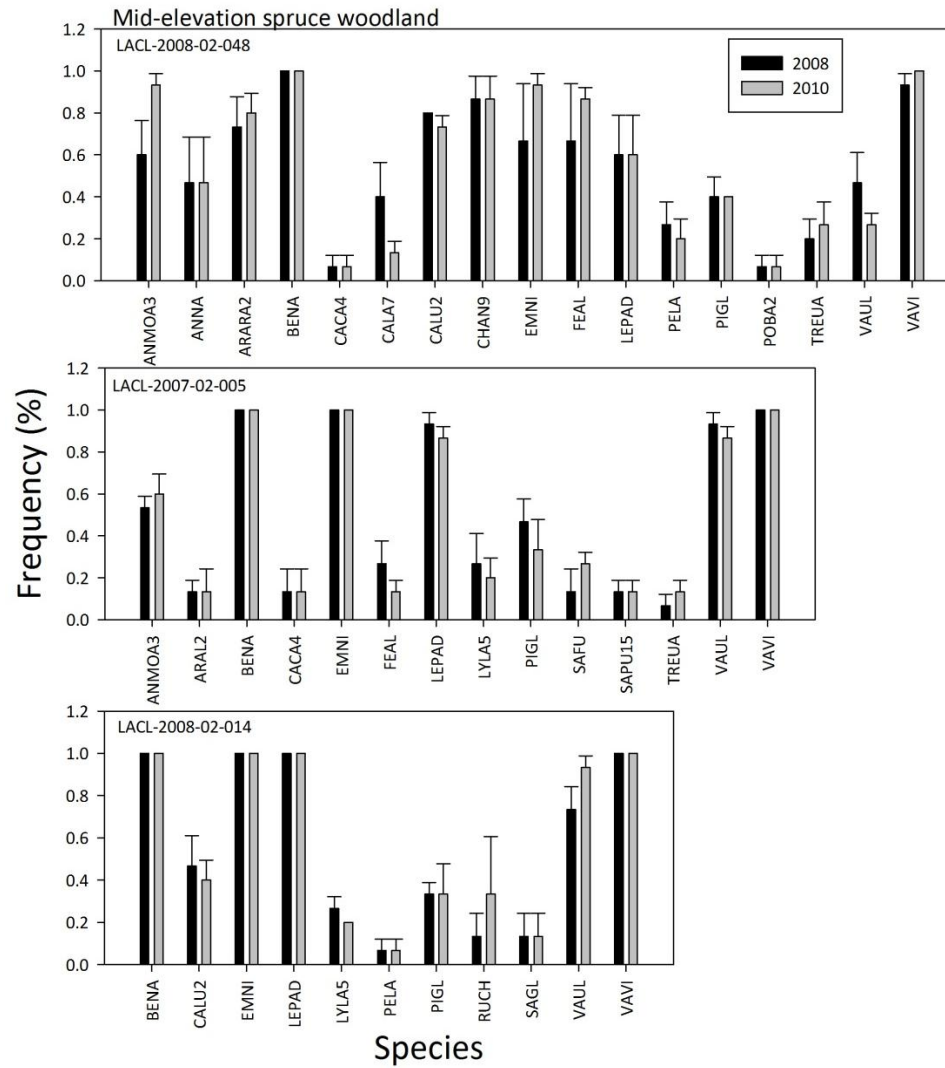


Figure 8. Frequency estimates for vascular species sampled at mid-elevation spruce woodland plots in LACL between 2007 and 2011 (mean $\pm$ 1 SE). Data are as described for Figure 7. Species codes (USDA-NRCS) are defined in the text.

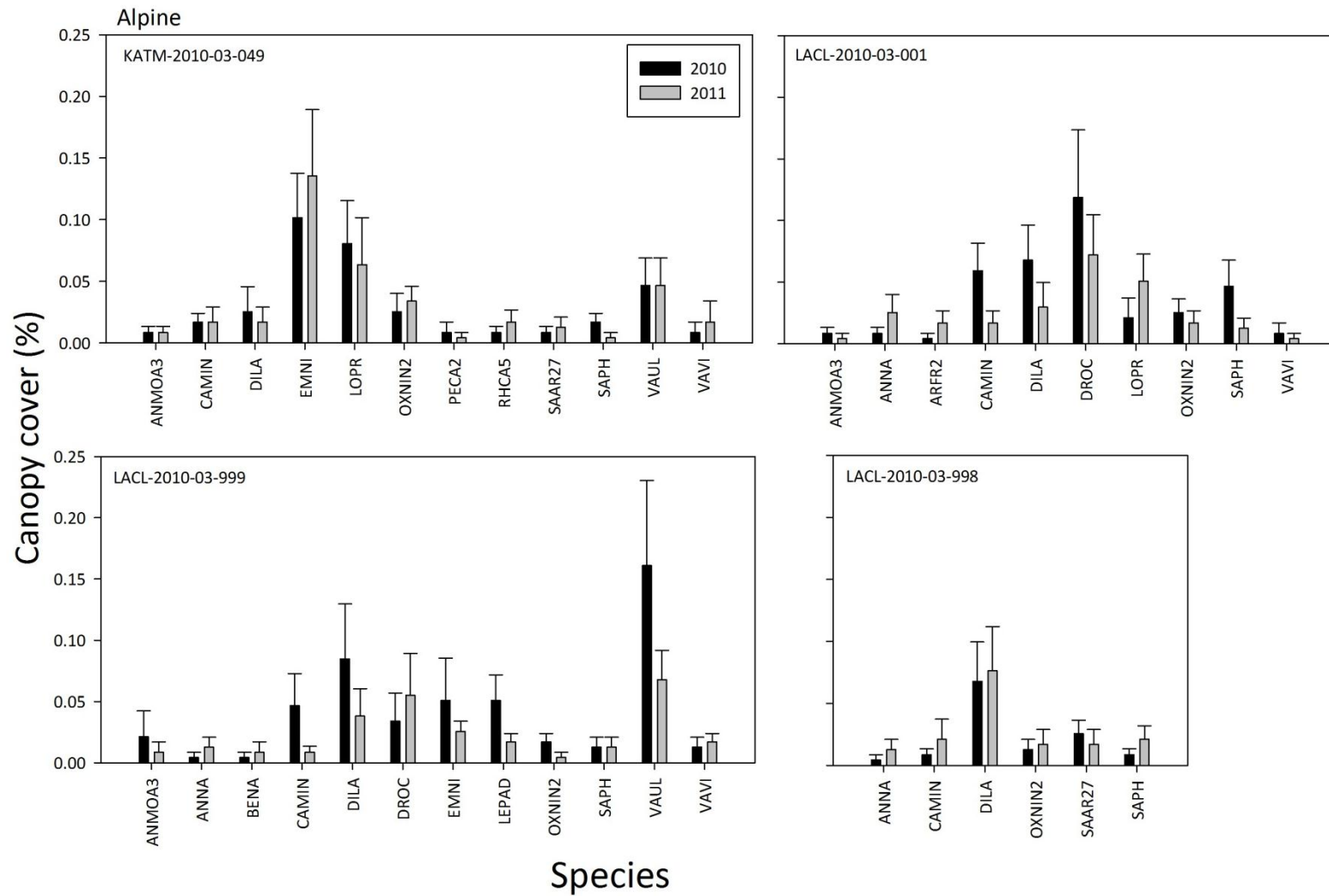


Figure 9. Percent cover estimates for vascular species sampled at alpine plots in LACL and KATM in 2010 and 2011 (mean $\pm$ 1 SE). Percent cover is estimated from point-intercept data along three 30-m transects. Data are for species recorded in both years; species found in only 1 year are not shown. Species codes (USDA-NRCS) are defined in the text.

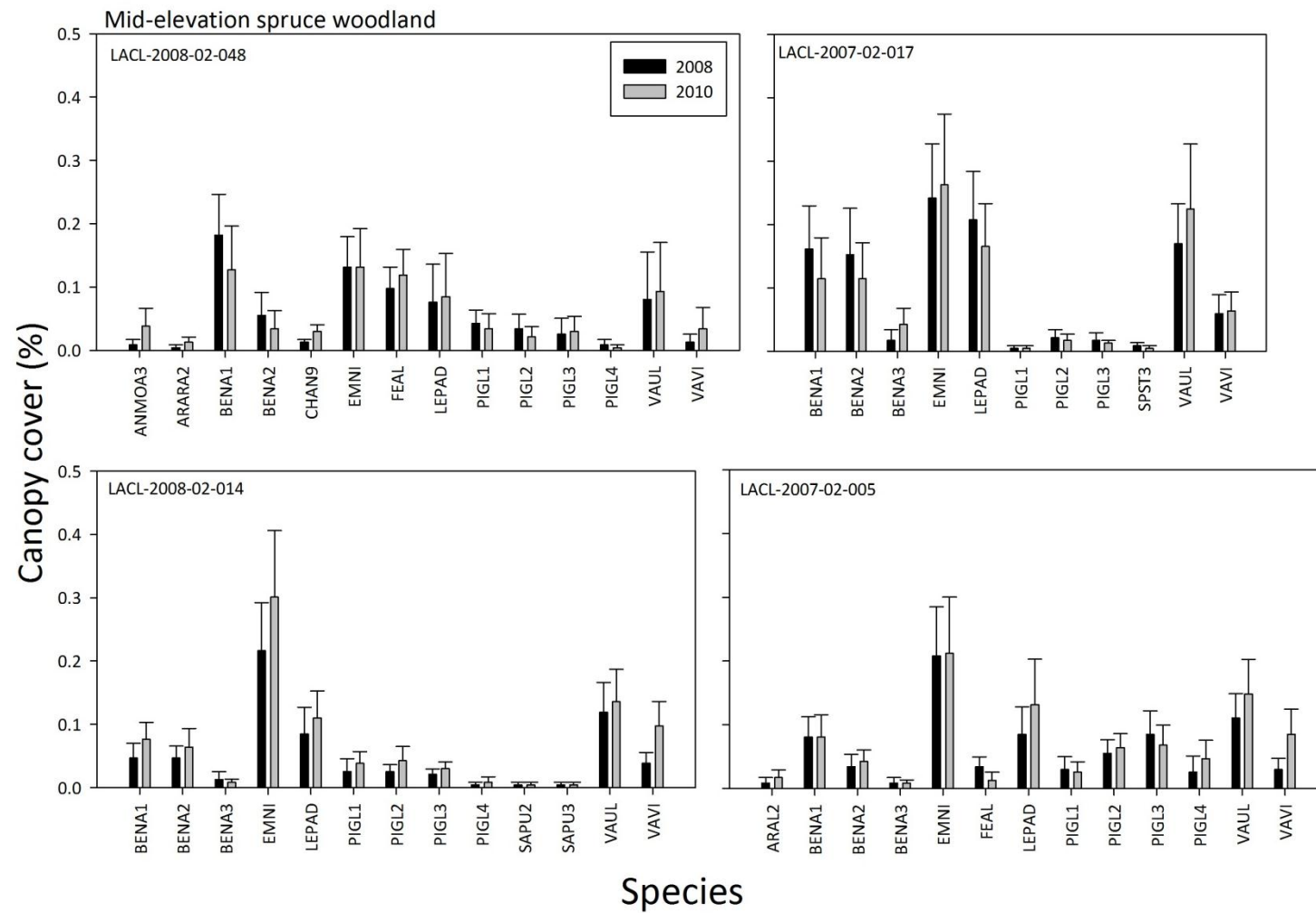


Figure 10. Percent cover estimates for vascular species sampled at mid-elevation spruce woodland plots in LACL between 2007 and 2011 (mean $\pm$ 1 SE). Data are for species recorded in both years; species found in only 1 year are not shown. Species codes (USDA-NRCS) are defined in the text.

Defoliator damage on shrubs in interior LACL and KATM

Defoliation of shrubs by at least three unidentified taxa was observed early in the growing seasons of 2010-2011 in interior LACL, from the Bonanza Hills to the little Mulchatna River (Miller et al. 2011). The damage was most pronounced on dwarf birch (*Betula nana*), but was also evident on a range of other species, including Labrador tea (*Ledum palustre* ssp. *decumbens*) and willow (*Salix* spp.).

At the request of NPS, State and Private Forestry (USFS-ADF) collected larvae at Snipe Lake in 2010 and 2011, but in both years arrived too late to collect viable pupae. In 2012, they will return to Snipe in early June and will transport larvae directly to their research facility at Kenai Lake to rear them to adults. Unfortunately, USFS-ADF was unable to map the extent of the damage in LACL in either year, but indicated that at the time of their visit in 2010 it extended west from Snipe, discontinuously along the Chilikondrotna and Mulchatna Rivers (K. Zogas, *pers. comm.*). It is unclear whether the outbreak in the Snipe Lake/Bonanza Hills area is related to the geometrid moth outbreak that began in the Anchorage area in 2010. Autumnal moths (*Epirrita autumnata*, *Eulithis distincta*, *Eulithis propulsata*) and Bruce spanworm (*Operophtera bruceata*) were responsible for the damage in Anchorage, but USFS entomologists have indicated that the organisms at Snipe appear to be different (K. Zogas, *pers. comm.*). We expect that the 2012 collections and aerial mapping effort should provide more information.

In KATM, alder (*Alnus viridis* ssp. *sinuata*) and birch (*Betula neoalaskana*) defoliation was reported in the vicinity of Brooks Camp, and more broadly across south-central Alaska, from the headwaters of the Susitna River to Ugashik Lake on the Alaska Peninsula (USFS 2012). In south-central Alaska, much of the alder defoliation has been attributed to a complex of native geometrid and tortricid defoliators. It is virtually impossible to distinguish among defoliators from the air, but no non-native sawflies were found in ground checks conducted outside the Kenai Peninsula or Matanuska-Susitna Valley (USFS 2012).

Winter soil temperatures and snow-season length

Soils were warmer during water year (WY) 2011 (October 1-September 30), as indicated by soil temperature data and number of degree-days of freezing soil temperatures at a mid-elevation site in LACL (Figure 11). Degree day is a quantitative index that is derived from daily temperature observations and reflects the difference between the measured temperature and a base temperature (in this case, 0 °C and -5 °C). Degree-days of freezing soil temperatures are summations of negative differences between the mean daily soil temperature and the base temperature. In WY 2010, there were 173 degree-days of sub-zero (<0 °C) soil temperatures and 45 degree-days of temperatures below -5 °C. In WY 2011, the counts were 165 and 20 degree-days of <0 °C and <-5 °C soil temperatures, respectively. Soils froze roughly two weeks later in WY 2011 than they did in WY 2010, although thaw dates were consistent across sites and years (Table 5).

In contrast to LACL, soils froze roughly a month earlier in KATM in WY 2011 than in WY 2010, resulting in a longer frozen season (Table 5). The earlier freezing date in KATM could have resulted from a thinner or later snowpack than that in LACL.

In LACL, soils near the Snipe RAWS began to cool rapidly around October 15, 2010, and approached 0 °C (0.1 °C) on November 6, 2010. In WY 2011, the Snipe RAWS time-lapse camera showed the continuous snow season running from October 25, 2010 (snow on) through May 3, 2011 (site mostly snow-free), a total of 190 days (Table 5). Soils at the Snipe did not freeze continuously until December 4, 2010. The freeze date thus occurred roughly 40 days after the snowpack established, and three weeks after a second storm that resulted in visible snow drifts. During the cool-down period, soils hovered between 0.1 and 0 °C for 28 days (November 6-December 4, 2010).

Soil thaw likewise lasted for approximately 25 days, lagging the snow-free date by 16 days. Of note is that the thaw date (May 19, 2011) closely coincided with the day that small lakes in Chilikadrotna River drainage were observed to be ice-free (May 20, 2011). We have requested RAWS ambient temperature and snow depth data (2009-2011) from the Western Regional Climate Center and in 2012 will start to use these data sets, plus soil temperature and photo time-series, to examine the timing of snowpack development, snowmelt, and freeze-thaw events at our sites.

Species of conservation concern

Four nonvascular species that are tracked as rare by the states and/or by the International Union for Conservation of Nature (IUCN) were collected in LACL and KATM during the 2011 field season (Figure 12). The collections will be archived at the University of Alaska Fairbanks Museum of the North (ALA). No exotic species were encountered in monitoring plots in 2011, although two exotic species, tall buttercup (*Ranunculus acris*) and common plantain (*Plantago major*), were collected at a hunter's camp on the north shore of Lachbuna Lake (LACL).

Rhytidiopsis robusta (G4; Alberta S3, British Columbia S4S5, Montana SNR) is a western North American endemic moss found in alpine/subalpine areas in the Pacific Northwest and southeast Alaska (Figure 12a). It is considered rare in the rest of the state. In southwest Alaska, it has been collected at Chisik Island, Mother Goose Lake, and a site NW of Dillingham. In 2011, we found it at one alpine site in KATM, where it occurred on thin mineral soil in a shaded snowmelt drainage above the Pfaff Mine landing strip (*J. Walton 16418*, NPS Accession Number KATM-00492, NPS Catalog Number 47835).

Iwatsukiella leucotricha (G4G5; Washington S1, Oregon S1, British Columbia S3S4, Alaska SNR) is a northern Pacific Rim moss, considered rare in the Pacific Northwest (Figure 12b). We found it at one coastal location in LACL, on the bases and branches of late-successional spruce near the Chinitna Bay ranger cabin (*J. Walton 15629*, NPS Accession Number LACL-00343, NPS Catalog Number 16570). Schofield (2002) reported it from Chisik Island, so it was not unexpected to find it at Chinitna. Material bearing sporophytes was common at the Chinitna Bay site, consistent with other recently discovered Cook Inlet populations. Outside of Cook Inlet, fertile plants have not been reported for North American populations.

Buxbaumia aphylla (G4G5; British Columbia S4S5, Washington S3, Oregon S2) is a moss that is considered widespread but is rarely collected due to its nearly microscopic gametophyte and only occasional production of its unique “bug on a stick” sporophyte (Figure 12c). It was collected from three mid-elevation sites in LACL, at Snipe Lake and Tanalian Mountain (*J. Walton 15876*,

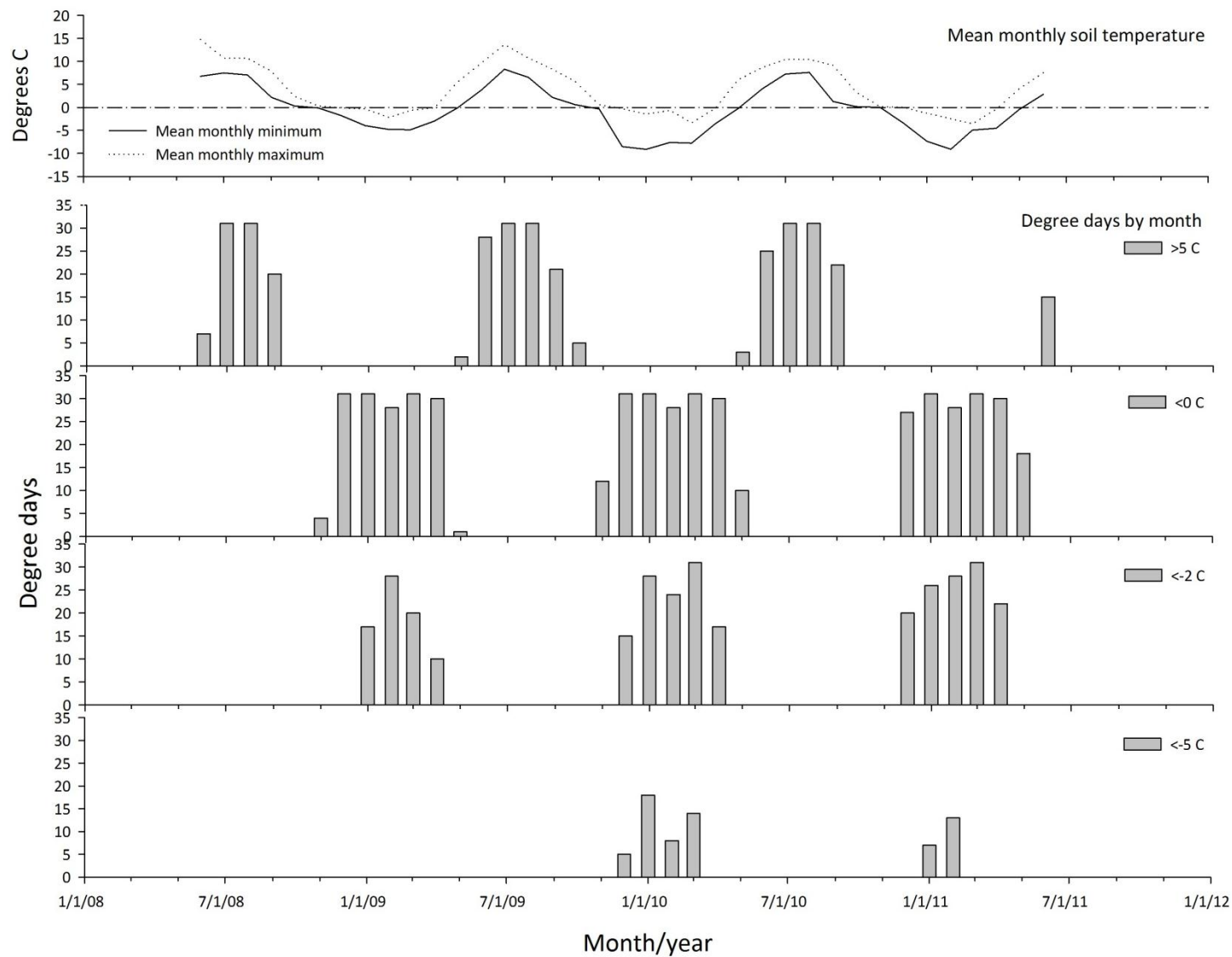


Figure 11. Monthly soil temperature means (°C) recorded at 10 cm depth at a mid-elevation low shrub site in LACL (2008-2011). Degree days are shown for the growing season (>5 °C), thaw season (0 °C), and for sub-zero soil conditions (-2 °C to -5 °C) across the three years.

Table 5. Soil freeze and thaw dates for selected sites in LACL and KATM for water years (WY) 2010 and 2011 (October 1-September 30). Frozen season is calculated as the number of days between freeze date and thaw date for a given WY. Numbers in parentheses following frozen season indicate the number of days during which the maximum air temperature was less than 0 °C, as recorded at a neighboring weather station (Coville RAWS, Snipe RAWS, Port Alsworth CRN; Lindsay 2011). The plot indicated by an asterisk (*) is located within 1 km of the Snipe RAWS; mean monthly soil temperature and degree-days are shown for this site in Figure 11.

In WY 2011, the time-lapse camera at the Snipe RAWS showed the continuous snow season running from October 25, 2010 (snow on) through May 3, 2011 (site mostly snow-free), a total of 190 days. Soil thaw date in WY 2011 roughly coincides with the day that small lakes in Chilikadrotna River drainage are observed to be ice-free (May 20, 2011).

Site	Elevation (m)	WY 2010		WY 2011		WY 2010 Frozen season (d)	WY 2011 Frozen season (d)
		Freeze date	Thaw date	Freeze date	Thaw date		
KATM <i>Coville – forest (KATM-2009-01-S999)</i>	66	12/11/2009	5/27/2010	11/10/2010	5/20/2011	167 (92)	190 (100)
LACL <i>*Snipe – low shrub (LACL-2007-02-006)</i>	630	11/18/2009	5/14/2010	12/4/2010	5/19/2011	177 (113)	166 (138)
<i>Snipe – woodland (LACL-2008-02-014)</i>	545	11/16/2009	ND	11/18/2010	5/21/2011	ND	184 (138)
<i>Upper Tazimina – forest (LACL-2010-01-S995)</i>	225	ND	ND	12/20/2010	6/5/2011	ND	167 (102)

NPS Accession Number LACL-00343, NPS Catalog Number 16463; *J. Walton 15890*, NPS Accession Number LACL-00343, NPS Catalog Number 16413; *J. Walton 16474*, NPS Accession Number LACL-00343, NPS Catalog Number 16477). The collections were found near treeline, in small, partially shaded depressions on soil and humus. They are thought to be the 6th and 7th known populations in Alaska (Sarah Stehn, *personal comm.*).

Cetrelia alaskana (G2G4; Alaska SNR, Northwest Territories SNR) is a rare foliose lichen known from Alaska, Northwest Territories, and one site in Russia (Figure 12d). In Alaska it appears to be rare to sporadically locally uncommon. It was collected from two alpine sites in LACL, on seasonally moist tundra near Pear Lake and Lachbuna Lake (*J. Walton 15927*, NPS Accession Number LACL-00343, NPS Catalog Number 6411; *J. Walton 16443*, NPS Accession Number LACL-00343, NPS Catalog Number 6410).



Figure 12. Rare nonvascular taxa found in 2011: a) *Rhytidiopsis robusta* (G4); b) *Iwatsukiella leucotricha* (G4G5); c) *Buxbaumia aphylla* (G4G5); *Cetrelia alaskana* (G2G4).

Modifications to the sampling design and methods

In 2011, we had a crew of a term biotech (GS-7), a seasonal biotech (GS-6), and PFT ecologist (GS-12), supplemented by intermittent help from other SWAN staff. In an effort to complete >1 plot/day in the alpine, we reduced the number of quadrats read for nonvascular frequency at a subset of plots in KATM. At these plots, we recorded vascular frequency in all 15 nested

quadrats, and nonvascular (lichen, bryophyte) frequency in 9 of the 15 quadrats. In the coming year, we will evaluate the efficacy of using fewer within-plot replicates. By decreasing the amount of time spent at a plot, we may be able to increase the number of plots sampled per day. This has the potential to increase not only sample size, but also efficiency, if we can spend less time hiking to plots and more time sampling in a given area.

As in KATM in 2009, we were unable to locate enough GRTS sites at treeline in LACL to provide adequate replication. The problem with treeline is twofold: (1) the landcover map does not accurately capture treeline, so many 'spruce' GRTS points identified as high elevation spruce were in fact dwarf shrub tundra (Appendix 1); and (2) upper treeline is by definition discontinuous and patchy, reducing the probability that a GRTS point will land in a location occupied by spruce. We established four treeline plots in LACL in 2011, maintaining spatial dispersion to the extent possible. However, because the treeline sites were subjectively chosen, we will treat the entire sample as targeted, and thus limit our area of inference accordingly.

Recommendations and Future Work

We have a baseline sample of 100 monitoring plots across the two parks, but we still have several data gaps. The current sampling population consists of broad vegetation classes including (1) low elevation white spruce woodland; (2) low elevation closed white spruce, including beetle-kill; (3) mid-elevation white spruce woodland (LACL only); (4) mid-elevation low shrub (LACL); (5) mid-elevation dwarf shrub (KATM); (6) treeline; and (7) alpine dwarf shrub tundra and barren sites. Due to access constraints and rarity on the landscape, undisturbed, low elevation closed white spruce (n=2), beetle-kill spruce (n=8), and treeline sites (n=12) are under-represented in the sample population. Most of these sites were established outside of the GRTS sample and should be supplemented by additional sites.

Other data gaps include sites representing a 700-900 m (approx. 2300-3000 ft.) elevation range, as well as specific vegetation types, such as low elevation mixed conifer-hardwood (*Picea glauca*-*Betula neoalaskana*) forest, low elevation black spruce (*Picea mariana*) woodland (LACL only), and low elevation low shrub-dwarf shrub tundra (KATM only). In 2010, we surveyed sites in the headwaters of the Chulitna River, near Lake 423 (as indicated on the 1:63,000 USGS quads) and upstream of the proposed Pebble mine site, which includes extensive black spruce woodland, as do areas around the southwestern shore of Lake Clark and northern sections of the park. Accessible, low-angle areas between 700-900 m in elevation are limited to areas near Hammersly, Battle Lake, and Pfaff in KATM; and limited areas near Pear, Turquoise, Square Lake, Lower Twin, Caribou Lakes, and Snipe Lake in LACL. The lower portion of this elevation zone is occupied by alder and/or moist herbaceous meadow; the upper portion by low shrub or dwarf shrub tundra.

In 2012, we will again base the crew out of Anchorage and resume plot remeasurement in both parks. Areas to be resampled in LACL will include low elevation spruce woodland and closed spruce stands at Two Lakes, Telaquana, Lachbuna, Pickerel Lakes, and Upper Tazimina, and mid-elevation plots near Snipe and Lachbuna. In KATM, we will revisit low elevation spruce at Nonvianuk, Malone, Long Lake, Lake Brooks, Lake Coville, and along the Valley of 10,000 Smokes Road. As a modification to our original measurements in 2009-2010, we will measure DBH on all stems greater than breast height so that we can post-stratify the sample based on diameter classes. Dr. Rosemary Sherriff, Humboldt State University, will join the crew in LACL and KATM to core five additional spruce woodland plots as part of a larger study looking at tree growth response to climate.

In the coming year, we plan to complete a SQL database that will house the data collected at vegetation monitoring plots. We spent most of 2011 editing and uploading tabular data into a working Access database, and both uploads and subsequent downloads indicated numerous errors in the data, introduced largely by modifications we had to make to ensure compatibility between the tabular files and the database. We will continue to work to clean up these errors and develop QC flags for data entry and uploads in 2012. Work in 2012 will focus on reducing redundancy in the data tables, developing advanced queries in SQL to deliver data with null values, and streamlining both data entry and retrieval.

In 2012, we plan to remeasure an additional 20 to 25 plots. The 2011 and 2012 re-measurement data will be used to quantify interannual variability in plot measurements (frequency, percent cover), develop precision estimates for frequency (i.e., determine number of plots required to achieve CVs of 35% or less), evaluate within-plot variance to see whether we can reduce the number of quadrats sampled for frequency, and estimate detection probabilities for vascular and nonvascular species. We will also evaluate error associated with ocular estimates of cover and determine whether to retain that measurement or drop it from the protocol. We plan to revise our methods for point-intercept with respect to insect-damaged and standing dead material, so that these qualifiers are less ambiguous in the field. We will also address these qualifiers in the database, making it possible to query both on a given species (e.g., BENA), and that species with a qualifier code (e.g., BENA_ID).

We also plan to increase the depth of soil temperature readings. Several soil temperature loggers were found to have been installed at a depth of less than 10 cm below the soil surface in 2011, and as a result the logged temperatures were highly variable, approximating ambient temperature. In 2012, we will re-install all loggers at a depth of 20 cm in order to buffer the thermistors from diurnal temperature fluctuations, and to better characterize soil temperature in the rooting zone.

To date, lichen and bryophyte collections from the monitoring plots, as well as opportunistic and historic collections (Berg 2006, *unpublished*; Schindler 1990), have yielded roughly 3,300 records. These collections will provide the basis for lichen inventories that will be initiated in KATM (2013) and LACL (2014) through a new CESU Task Agreement with Oregon State University (PI: Dr. Bruce McCune). Collections from 2009-2012 will be made available to the PIs prior to field work in 2013, with all notable collections then being sent to University of Alaska Fairbanks for archiving. Collections from the 2013-2014 inventories will likewise be housed at UAF following final determinations. At the recommendation of Dr. McCune, we will begin sampling arboreal lichens at a subset of forested and woodland GRTS plots in 2012, using the FIA lichen inventory plot protocol. These data will be used to extend the species lists at each plot, and we're investigating ways in which the data could be used in the future for community-level studies and/or to monitor long-term changes in air quality. In 2012, we will also survey 10-20 coastal forest plots in KEFJ to evaluate the potential for future monitoring. We will complete FIA lichen inventory plots at each site, as well as start a collection of lichens and bryophytes that can be used to plan a larger inventory, tentatively scheduled for FY 2015.

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Appendix 1. GRTS points selected in LACL (2008-2011) and KATM (2009-2011). Up to 121 sites were surveyed in each stratum. Closed spruce sites and a subset of treeline and alpine sites were sampled as targeted sites, independent of the GRTS population.

1a. LACL - GRTS – all classes, including spruce (0-450 m): target vegetation = white spruce woodland								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
1-001	1	15	1	60.008513	-154.684663	Pickerel Lakes	reject	access - too far
1-002	3	8	1	60.358969	-154.054731	Lake Clark	reject	not target veg
1-003	2	11	1	60.125934	-152.691242	Tuxedni Bay	reject	not target veg
1-004	2	6	1	60.420805	-153.807206	Lake Clark	reject	not target veg
1-005	0	7	1	60.953634	-154.015179	Lake Telaquana	reject	not target veg
1-006	1	8	1	60.993319	-154.059154	Lake Telaquana	reject	not target veg
1-007	3	15	1	59.946725	-154.701165	Pickerel Lakes	reject	not target veg
1-008	2	7	1	60.049755	-154.238525	Upper Tazimina Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
1-009	2	6	1	60.018599	-154.259359	Upper Tazimina Lake	accept	
1-010	2	14	1	60.947235	-154.251869	Lake 21 (Telaquana River)	reject	not target veg
1-011	1	6	1	60.222518	-154.444622	Lake Clark	reject	not target veg
1-012	3	7	1	59.94583	-154.811605	Pickerel Lakes	reject	not target veg
1-013	1	15	1	59.935421	-154.756945	Pickerel Lakes	reject	not target veg
1-014	2	7	1	59.936865	-154.688566	Pickerel Lakes	accept	
1-015	2	5	1	60.50141	-153.990308	Lachbuna Lake	reject	not target veg
1-016	2	10	1	60.233782	-154.232255	Lake Clark	reject	not target veg
1-017	2	14	1	60.952416	-154.200785	Lake 21 (Telaquana River)	reject	access - unsafe
1-018	0	15	1	60.794422	-152.770272	Summit Lake	reject	not target veg
1-019	3	6	1	59.942373	-154.712386	Pickerel Lakes	reject	not target veg
1-020	3	8	1	60.395342	-153.821559	Lake Clark	reject	not target veg
1-021	2	11	1	60.086282	-152.81242	Johnson River (Tuxedni Bay)	reject	not target veg
1-022	3	11	1	59.925637	-154.731412	Pickerel Lakes	reject	not target veg
1-023	2	19	1	60.940237	-154.265146	Lake 21 (Telaquana River)	reject	not target veg
1-024	3	7	1	60.039249	-154.262223	Upper Tazimina Lake	accept	
1-025	0	13	1	61.010498	-153.996277	Lake Telaquana	reject	not target veg
1-026	3	6	1	60.472162	-154.057112	Lachbuna Lake	accept	
1-027	2	7	1	59.935541	-154.735401	Pickerel Lakes	accept	
1-028	1	16	1	60.942447	-154.229054	Lake 21 (Telaquana River)	reject	not target veg
1-029	0	25	1	61.147518	-152.938939	Kenibuna Lake	reject	not target veg
1-030	2	7	1	61.141043	-153.851482	Two Lakes	accept	
1-031	3	7	1	60.038712	-154.262218	Upper Tazimina Lake	reject	<100 m from est. plot
1-032	4	25	1	60.959022	-153.740049	Lake Telaquana	reject	not target veg

1a. LACL - GRTS – all classes, including spruce (0-450 m): target vegetation = white spruce woodland								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
1-033	1	7	1	59.94373	-154.80401	Pickerel Lakes	accept	
1-034	0	20	1	60.404813	-153.023767	Crescent Lake	reject	not target veg
1-035	2	19	1	60.983657	-154.071374	Lake Telaquana	reject	not target veg
1-036	1	19	1	60.077096	-152.805177	Johnson River (Tuxedni Bay)	reject	not target veg
1-037	8	15	1	60.087413	-154.905467	Lake 423	reject	not target veg
1-038	2	7	1	60.047283	-154.268772	Upper Tazimina Lake	accept	
1-039	1	15	1	59.938862	-154.765104	Pickerel Lakes	reject	not target veg
1-040	1	19	1	60.985017	-153.997949	Lake Telaquana	reject	not target veg
1-041	5	15	1	59.931626	-154.715386	Pickerel Lakes	reject	not target veg
1-042	3	6	1	60.074207	-154.874271	Lake 423	reject	not target veg
1-043	2	6	1	60.978311	-154.015746	Lake Telaquana	reject	not target veg
1-044	1	15	1	59.935131	-154.760709	Pickerel Lakes	reject	not target veg
1-045	2	19	1	61.002719	-154.013532	Lake Telaquana	reject	not target veg
1-046	2	25	1	60.312196	-154.17397	Lake Clark	reject	not target veg
1-047	3	6	1	60.988766	-154.042456	Lake Telaquana	reject	not target veg
1-048	0	6	1	60.398846	-153.83465	Lake Clark	reject	not target veg
1-049	0	19	1	59.939509	-154.792055	Pickerel Lakes	reject	not target veg
1-050	1	19	1	60.105909	-154.907601	Lake 423	reject	not target veg
1-051	1	19	1	60.960336	-154.03408	Lake Telaquana	accept	
1-052	0	7	1	60.509187	-153.975506	Lachbuna Lake	reject	not target veg
1-053	3	7	1	61.145343	-153.859289	Two Lakes	<i>unconfirmed</i>	<i>evaluation needed</i>
1-054	1	8	1	60.940223	-154.011284	Lake Telaquana	reject	not target veg
1-055	1	19	1	60.992514	-154.060266	Lake Telaquana	reject	not target veg
1-056	0	8	1	60.948534	-154.03629	Lake Telaquana	reject	not target veg
1-057	0	25	1	60.387255	-153.793207	Lake Clark	reject	not target veg
1-058	1	8	1	59.948992	-154.728695	Pickerel Lakes	reject	not target veg
1-059	2	19	1	60.49846	-153.993596	Lachbuna Lake	reject	not target veg
1-060	1	19	1	60.971381	-154.248723	Lake 21 (Telaquana River)	reject	access - unsafe
1-061	0	20	1	61.155585	-152.941466	Kenibuna Lake	reject	not target veg
1-062	1	22	1	60.782092	-152.801703	Summit Lake	reject	not target veg
1-063	2	2	1	60.251525	-154.340057	Lake Clark	reject	not target veg
1-064	1	19	1	59.926068	-154.79658	Pickerel Lakes	reject	not target veg
1-065	1	6	1	59.936354	-154.781206	Pickerel Lakes	reject	not target veg
1-066	2	5	1	60.23635	-154.396431	Lake Clark	reject	not target veg
1-067	2	4	1	60.919084	-154.244987	Lake 21 (Telaquana River)	reject	not target veg
1-068	2	6	1	60.422948	-153.805554	Lake Clark	reject	not target veg

1a. LACL - GRTS – all classes, including spruce (0-450 m): target vegetation = white spruce woodland									
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason	
1-069	1	11	1	60.076228	-152.798175	Johnson River (Tuxedni Bay)	reject	not target veg	
1-070	3	6	1	60.35576	-154.021447	Lake Clark	reject	not target veg	
1-071	1	19	1	60.959519	-154.067985	Lake Telaquana	reject	not target veg	
1-072	1	20	1	61.157804	-152.916221	Kenibuna Lake	reject	not target veg	
1-073	1	8	1	60.370011	-152.861596	Crescent Lake	reject	not target veg	
1-074	0	6	1	60.221491	-154.430481	Lake Clark	reject	not target veg	
1-075	1	19	1	60.992795	-153.995723	Lake Telaquana	reject	not target veg	
1-076	1	19	1	59.94639	-154.807846	Pickereel Lakes	reject	not target veg	
1-077	4	13	1	60.247242	-154.202444	Lake Clark	reject	not target veg	
1-078	0	20	1	60.398632	-153.022313	Crescent Lake	reject	not target veg	
1-079	1	6	1	60.313308	-154.303105	Kijik Lake (Lake Clark)	reject	not target veg	
1-080	1	8	1	60.949742	-154.194655	Lake 21 (Telaquana River)	reject	not target veg	
1-081	3	6	1	60.109498	-154.892537	Lake 423	reject	not target veg	
1-082	19	5	1	60.40309	-153.799116	Lake Clark	reject	not target veg	
1-083	1	6	1	60.309089	-153.98982	Lake Clark	reject	not target veg	
1-084	0	19	1	60.960057	-154.064651	Lake Telaquana	reject	not target veg	
1-085	3	11	1	60.08835	-152.833994	Johnson River (Tuxedni Bay)	reject	not target veg	
1-086	1	8	1	60.924428	-154.256132	Lake 21 (Telaquana River)	reject	not target veg	
1-087	4	7	1	60.934116	-154.238437	Lake 21 (Telaquana River)	reject	not target veg	
1-088	2	6	1	60.174104	-154.29748	Lake Clark	accept		
1-089	2	7	1	61.128215	-153.903507	Two Lakes	reject	not target veg	
1-090	1	7	1	60.10322	-154.908609	Lake 423	reject	not target veg	
1-091	1	7	1	60.403421	-153.847193	Lake Clark	reject	not target veg	
1-092	0	19	1	60.312953	-154.207209	Lake Clark	reject	not target veg	
1-093	2	6	1	60.495774	-153.967297	Lachbuna Lake	reject	access - unsafe	
1-094	2	11	1	60.132923	-152.69259	Tuxedni Bay	reject	not target veg	
1-095	0	19	1	60.313229	-154.202308	Lake Clark	reject	not target veg	
1-096	1	7	1	60.9539	-154.031851	Lake Telaquana	reject	not target veg	
1-097	3	25	1	60.364013	-152.984056	Crescent Lake	reject	not target veg	
1-098	1	7	1	60.313636	-154.27532	Kijik Lake (Lake Clark)	reject	not target veg	
1-099	1	7	1	60.952025	-154.012955	Lake Telaquana	reject	not target veg	
1-100	1	20	1	60.415658	-153.03984	Crescent Lake	reject	not target veg	
1-101	2	11	1	60.067721	-152.748184	Johnson River (Tuxedni Bay)	reject	not target veg	
1-102	1	19	1	60.942858	-154.295167	Lake 21 (Telaquana River)	reject	not target veg	
1-103	4	11	1	60.047611	-152.693271	Johnson River (Tuxedni Bay)	reject	not target veg	
1-104	2	7	1	60.987162	-154.010188	Lake Telaquana	reject	not target veg	

1a. LACL - GRTS – all classes, including spruce (0-450 m): target vegetation = white spruce woodland								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
1-105	1	19	1	60.950147	-154.01351	Lake Telaquana	accept	
1-162						Two Lakes	<i>unconfirmed</i>	<i>evaluation needed</i>
1b. LACL - GRTS – all classes, including spruce (450-900 m): target vegetation = white spruce woodland; dwarf shrub - low shrub tundra								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
2-001	4	23	2	60.657612	-154.217677	Snipe Lake	reject	not target veg
2-002	1	18	2	60.437421	-154.508812	Caribou Lakes	reject	not target veg
2-003	1	19	2	60.771225	-154.071456	Turquoise Lake	reject	not target veg
2-004	1	19	2	60.681318	-153.695443	Upper Twin Lake	reject	not target veg
2-005	3	19	2	60.648122	-154.046963	Lower Twin Lake	accept	
2-006	1	14	2	60.610311	-154.381762	Snipe Lake	accept	
2-007	4	12	2	60.458318	-154.347143	Fishtrap Lake	reject	not target veg
2-008	1	14	2	60.599705	-154.19805	Snipe Lake	reject	access - too far
2-009	2	7	2	60.475861	-154.301882	Fishtrap Lake	reject	not target veg
2-010	2	15	2	60.74301	-154.13875	Square Lake	reject	access - unsafe
2-011	3	14	2	60.736655	-154.265129	Square Lake	reject	access - unsafe
2-012	10	14	2	60.463429	-154.341176	Fishtrap Lake	reject	not target veg
2-013	1	14	2	60.663995	-154.249663	Snipe Lake	reject	not target veg
2-014	1	14	2	60.632625	-154.363318	Snipe Lake	accept	
2-015	2	19	2	60.607465	-154.210742	Snipe Lake	reject	not target veg
2-016	3	13	2	60.627736	-154.27469	Snipe Lake	accept	
2-017	1	14	2	60.641785	-154.218671	Snipe Lake	reject	access - too far
2-018	3	6	2	60.490093	-154.399525	Fishtrap Lake	reject	not target veg
2-019	1	16	2	60.762523	-154.19463	Square Lake	reject	not target veg
2-020	2	14	2	60.728979	-154.205465	Square Lake	reject	access - unsafe
2-021	1	15	2	60.863365	-153.79901	Lake Telaquana	reject	not target veg
2-022	2	19	2	60.604244	-154.212371	Snipe Lake	reject	access - too far
2-023	3	13	2	60.754597	-154.068658	Turquoise Lake	reject	not target veg
2-024	2	13	2	60.769788	-154.177545	Square Lake	reject	not target veg
2-025	0	25	2	60.683192	-153.693772	Upper Twin Lake	reject	not target veg
2-026	2	7	2	60.482357	-154.274558	Fishtrap Lake	<i>unconfirmed</i>	<i>evaluation needed (sw)</i>
2-027	2	8	2	60.730265	-154.239138	Square Lake	reject	access - unsafe
2-028	1	25	2	60.770353	-153.846559	Turquoise Lake	reject	not target veg
2-029	2	7	2	60.491238	-154.259294	Fishtrap Lake	reject	not target veg
2-030	2	14	2	60.752415	-154.120566	Square Lake	reject	access - unsafe

1b. LACL - GRTS – all classes, including spruce (450-900 m): target vegetation = white spruce woodland; dwarf shrub - low shrub tundra									
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason	
2-031	2	14	2	60.741819	-154.227078	Square Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-032	4	15	2	60.643558	-153.94293	Lower Twin Lake	reject	not target veg	
2-033	1	19	2	60.761017	-154.097949	Turquoise Lake	reject	not target veg	
2-034	1	15	2	60.671528	-154.237051	Snipe Lake	reject	not target veg	
2-035	1	15	2	60.741123	-154.148127	Square Lake	reject	access - unsafe	
2-036	1	14	2	60.444875	-154.523699	Caribou Lakes	reject	not target veg	
2-037	1	19	2	60.67629	-154.028271	Lower Twin Lake	reject	not target veg	
2-038	1	7	2	60.636164	-154.342997	Snipe Lake	<i>unconfirmed</i>	<i>evaluation needed (sw)</i>	
2-039	1	20	2	60.478099	-154.372544	Fishtrap Lake	reject	not target veg	
2-040	1	15	2	60.767719	-154.101837	Turquoise Lake	reject	not target veg	
2-041	2	25	2	60.769817	-153.846561	Turquoise Lake	reject	not target veg	
2-042	0	14	2	60.664498	-154.267292	Snipe Lake	accept		
2-043	3	15	2	60.771781	-153.999068	Turquoise Lake	reject	not target veg	
2-044	1	19	2	60.462358	-154.637831	Caribou Lakes	reject	not target veg	
2-045	1	14	2	60.618076	-154.276808	Snipe Lake	reject	not target veg	
2-046	2	8	2	60.685936	-154.061347	Lower Twin Lake	reject	not target veg	
2-047	4	15	2	60.670123	-154.019452	Lower Twin Lake	reject	not target veg	
2-048	2	15	2	60.625302	-153.911057	Lower Twin Lake	accept		
2-049	0	15	2	60.680288	-154.088888	Lower Twin Lake	accept		
2-050	4	15	2	60.583382	-154.169931	Snipe Lake	reject	not target veg*	
2-051	3	15	2	60.75769	-154.197915	Square Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-052	0	14	2	60.626921	-154.279634	Snipe Lake	reject	not target veg	
2-053	1	6	2	60.485838	-154.386874	Fishtrap Lake	<i>unconfirmed</i>	<i>evaluation needed (sw)</i>	
2-054	1	16	2	60.784649	-154.04274	Turquoise Lake	reject	not target veg	
2-055	2	19	2	60.72315	-154.1497	Square Lake	reject	access - unsafe	
2-056	1	6	2	60.599139	-154.347002	Snipe Lake	reject	not target veg	
2-057	1	6	2	60.635877	-154.350698	Snipe Lake	reject	not target veg	
2-058	1	6	2	60.629409	-154.362181	Snipe Lake	<i>unconfirmed</i>	<i>evaluation needed (sw)</i>	
2-059	2	14	2	60.647458	-154.192287	Snipe Lake	reject	not target veg	
2-060	3	7	2	60.458741	-154.607659	Caribou Lakes	reject	not target veg	
2-061	3	16	2	60.805116	-154.229737	Square Lake	reject	not target veg	
2-062	1	15	2	60.670117	-154.044241	Lower Twin Lake	reject	not target veg	
2-063	2	14	2	60.758081	-154.073637	Turquoise Lake	reject	not target veg	
2-064	3	20	2	60.389517	-154.549025	Caribou Lakes	reject	not target veg	
2-065	1	15	2	60.765229	-154.176967	Square Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-066	0	19	2	60.484788	-154.378646	Fishtrap Lake	reject	not target veg	

1b. LACL - GRTS – all classes, including spruce (450-900 m): target vegetation = white spruce woodland; dwarf shrub - low shrub tundra									
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason	
2-067	1	15	2	60.755351	-154.136594	Turquoise Lake	reject	access - unsafe	
2-068	1	14	2	60.618412	-154.362058	Snipe Lake	reject	not target veg	
2-069	1	19	2	60.672604	-154.234856	Snipe Lake	reject	not target veg	
2-070	3	20	2	60.792112	-154.120714	Turquoise Lake	reject	not target veg	
2-071	1	14	2	60.450648	-154.486038	Caribou Lakes	reject	not target veg	
2-072	2	16	2	60.657233	-154.066799	Lower Twin Lake	reject	not target veg	
2-073	4	14	2	60.607749	-154.200298	Snipe Lake	reject	not target veg	
2-074	3	19	2	60.639496	-154.294602	Snipe Lake	reject	not target veg	
2-075	1	25	2	60.782706	-153.860319	Turquoise Lake	reject	not target veg	
2-076	1	14	2	60.766308	-154.172	Square Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-077	2	14	2	60.349693	-154.578902	Caribou Lakes	reject	not target veg	
2-078	2	6	2	60.599614	-154.370093	Snipe Lake	reject	not target veg	
2-079	3	14	2	60.593591	-154.156246	Snipe Lake	reject	access - too far	
2-080	1	14	2	60.7943	-154.056577	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-081	0	16	2	60.776338	-154.022832	Turquoise Lake	reject	not target veg	
2-082	1	15	2	60.667152	-154.077836	Lower Twin Lake	reject	not target veg	
2-083	0	14	2	60.783155	-154.208575	Square Lake	<i>unconfirmed</i>	<i>evaluation needed (ds)</i>	
2-084	3	6	2	60.641234	-154.353508	Snipe Lake	<i>unconfirmed</i>	<i>evaluation needed (sw)</i>	
2-085	1	25	2	60.736252	-154.183432	Square Lake	reject	access - unsafe	
2-086	1	14	2	60.604005	-154.192579	Snipe Lake	reject	access - too far	
2-087	1	6	2	60.449137	-154.653987	Caribou Lakes	reject	not target veg	
2-088	2	16	2	60.639702	-154.17518	Snipe Lake	reject	access - too far	
2-089	1	19	2	60.770146	-154.082505	Turquoise Lake	reject	not target veg	
2-090	2	7	2	60.597076	-154.312904	Snipe Lake	reject	not target veg	
2-091	1	15	2	60.764092	-154.220605	Square Lake	reject	not target veg	
2-092	2	6	2	60.48358	-154.327695	Fishtrap Lake	accept		

*check for suitability as treeline site in 2011

1c. LACL - GRTS – all classes (> 900 m): target vegetation = dwarf shrub tundra - fellfield									
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason	
3N-001	2	15	3	60.854235	-153.791865	Turquoise Lake	reject	access - too far	
3N-002	1	25	3	60.852079	-153.785231	Turquoise Lake	reject	access - too far	
3N-003	1	23	3	60.83052	-153.981904	Turquoise Lake	reject	not target veg	
3N-004	2	16	3	60.808231	-154.087028	Turquoise Lake	reject	not target veg	
3N-005	1	23	3	60.828904	-154.04612	Turquoise Lake	reject	not target veg	
3N-006	3	17	3	60.817915	-153.992979	Turquoise Lake	accept		

1c. LACL - GRTS – all classes (> 900 m): target vegetation = dwarf shrub tundra - fellfield								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
3S-001	4	16	3	60.758358	-153.944384	Turquoise Lake	accept	
3S-002	3	16	3	60.753269	-154.032757	Turquoise Lake	reject	not target veg
3S-003	5	16	3	60.749506	-153.943295	Turquoise Lake	accept	
3S-004	3	16	3	60.568841	-154.210491	Pear Lake	accept	
3S-005	3	14	3	60.564276	-154.213756	Pear Lake	accept	
3S-006	3	25	3	60.749512	-154.042141	Turquoise Lake	reject	not target veg
3S-007	2	18	3	60.759692	-153.928915	Turquoise Lake	accept	
3S-008	5	16	3	60.752736	-153.987471	Turquoise Lake	accept	
3S-009	3	16	3	60.747902	-154.044348	Turquoise Lake	reject	not target veg
3S-010	2	15	3	60.738786	-154.02943	Turquoise Lake	reject	not target veg
3S-011	2	16	3	60.759166	-153.953221	Turquoise Lake	reject	not target veg
3S-012	1	15	3	60.733156	-154.015627	Turquoise Lake	reject	not target veg
3S-013	3	15	3	60.733692	-154.017283	Turquoise Lake	reject	not target veg
3S-014	5	16	3	60.737977	-154.044886	Turquoise Lake	reject	not target veg
3S-015	3	16	3	60.753529	-153.941079	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-016	3	16	3	60.743348	-153.984714	Turquoise Lake	accept	
3S-017	4	17	3	60.733693	-153.988582	Turquoise Lake	reject	not target veg
3S-018	3	16	3	60.745226	-154.013976	Turquoise Lake	reject	not target veg
3S-019	1	16	3	60.754334	-153.942182	Turquoise Lake	reject	not target veg
3S-020	5	16	3	60.768807	-153.920607	Turquoise Lake	reject	not target veg
3S-021	4	16	3	60.754078	-153.991336	Turquoise Lake	reject	not target veg
3S-022	4	7	3	60.563997	-154.220343	Snipe Lake	reject	access - too far
3S-023	2	15	3	60.735033	-154.019491	Turquoise Lake	reject	not target veg
3S-024	4	16	3	60.754882	-153.985261	Turquoise Lake	reject	not target veg
3S-025	3	16	3	60.748172	-154.035513	Turquoise Lake	reject	not target veg
3S-026	5	16	3	60.743885	-153.985266	Turquoise Lake	reject	not target veg
3S-027	3	16	3	60.567183	-154.239583	Pear Lake	accept	
3S-028	4	25	3	60.568863	-154.195665	Snipe Lake	reject	access - too far
3S-029	5	16	3	60.754345	-153.986365	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-030	6	16	3	60.426764	-154.558401	Caribou Lakes	accept	
3S-031	3	16	3	60.754074	-154.032206	Turquoise Lake	reject	not target veg
3S-032	1	15	3	60.575529	-154.22152	Snipe Lake	reject	access - too far
3S-033	4	16	3	60.747371	-154.01729	Turquoise Lake	reject	not target veg
3S-034	3	16	3	60.569126	-154.198961	Snipe Lake	reject	access - too far
3S-035	3	16	3	60.757553	-153.942176	Turquoise Lake	<i>reject</i>	<i>175 m from est. plot - redundant</i>
3S-036	2	16	3	60.747097	-154.045451	Turquoise Lake	reject	not target veg

1c. LACL - GRTS – all classes (> 900 m): target vegetation = dwarf shrub tundra - fellfield								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
3S-037	2	18	3	60.75326	-153.939975	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-015</i>
3S-038	3	16	3	60.751396	-153.993546	Turquoise Lake	reject	not target veg
3S-039	1	16	3	60.425957	-154.558934	Caribou Lakes	reject	<100 m from est. plot
3S-040	3	17	3	60.743884	-153.983057	Turquoise Lake	reject	not target veg
3S-041	7	15	3	60.752464	-154.037174	Turquoise Lake	reject	not target veg
3S-042	4	16	3	60.757819	-153.938862	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-043	2	16	3	60.757825	-153.954327	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-044	2	16	3	60.734496	-154.018387	Turquoise Lake	reject	not target veg
3S-045	4	16	3	60.565595	-154.226943	Snipe Lake	reject	access - too far
3S-046	15	25	3	60.34556	-154.603917	Caribou Lakes	reject	access - too far
3S-047	1	15	3	60.735837	-154.021148	Turquoise Lake	reject	not target veg
3S-048	4	25	3	60.757017	-153.945491	Turquoise Lake	reject	not target veg
3S-049	4	16	3	60.733424	-154.017283	Turquoise Lake	reject	not target veg
3S-050	2	16	3	60.746293	-154.041032	Turquoise Lake	reject	not target veg
3S-051	14	17	3	60.758899	-153.956535	Turquoise Lake	reject	not target veg
3S-052	3	16	3	60.56532	-154.231333	Snipe Lake	reject	access - too far
3S-053	3	16	3	60.758626	-153.944384	Turquoise Lake	reject	<100 m from est. plot
3S-054	3	17	3	60.751925	-154.043249	Turquoise Lake	reject	not target veg
3S-055	16	16	3	60.436575	-154.585368	Caribou Lakes	accept	
3S-056	8	16	3	60.758615	-153.921737	Turquoise Lake	reject	not target veg
3S-057	4	15	3	60.752194	-154.043249	Turquoise Lake	reject	not target veg
3S-058	2	16	3	60.757826	-153.955432	Turquoise Lake	reject	not target veg
3S-059	2	16	3	60.564278	-154.212109	Snipe Lake	reject	access - too far
3S-060	2	16	3	60.755948	-153.955435	Turquoise Lake	reject	not target veg
3S-061	1	16	3	60.745488	-154.042136	Turquoise Lake	reject	not target veg
3S-062	3	16	3	60.749782	-154.035515	Turquoise Lake	reject	not target veg
3S-063	5	16	3	60.746031	-154.013424	Turquoise Lake	reject	not target veg
3S-064	3	16	3	60.747099	-154.036064	Turquoise Lake	reject	not target veg
3S-065	3	24	3	60.753806	-154.032758	Turquoise Lake	reject	not target veg
3S-066	3	14	3	60.572326	-154.211612	Snipe Lake	reject	access - too far
3S-067	3	16	3	60.760239	-153.952667	Turquoise Lake	reject	not target veg
3S-068	3	16	3	60.568245	-154.245632	Snipe Lake	reject	access - too far
3S-069	17	25	3	60.605657	-153.840741	Upper Twin Lake	<i>reject</i>	<i>evaluation needed</i>
3S-070	3	25	3	60.756212	-153.943283	Turquoise Lake	reject	not target veg
3S-071	4	16	3	60.755408	-153.944942	Turquoise Lake	reject	not target veg
3S-072	2	17	3	60.742543	-153.98361	Turquoise Lake	reject	not target veg

1c. LACL - GRTS – all classes (> 900 m): target vegetation = dwarf shrub tundra - fellfield								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
3S-073	2	25	3	60.757017	-153.944939	Turquoise Lake	reject	not target veg
3S-074	3	16	3	60.748977	-154.036066	Turquoise Lake	reject	not target veg
3S-075	17	25	3	60.43717	-154.571706	Caribou Lakes	accept	
3S-076	3	16	3	60.566114	-154.237379	Snipe Lake	reject	access - too far
3S-077	4	18	3	60.569374	-154.212691	Snipe Lake	reject	access - too far
3S-078	3	16	3	60.75809	-153.944937	Turquoise Lake	reject	<100 m from est. plot
3S-079	4	16	3	60.758094	-153.956537	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-043</i>
3S-080	5	15	3	60.742271	-154.038267	Turquoise Lake	reject	not target veg
3S-081	2	16	3	60.755948	-153.953778	Turquoise Lake	reject	not target veg
3S-082	5	15	3	60.755418	-153.98526	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-029</i>
3S-083	6	16	3	60.751664	-153.994098	Turquoise Lake	reject	not target veg
3S-084	2	15	3	60.747365	-154.045451	Turquoise Lake	reject	not target veg
3S-085	4	16	3	60.570192	-154.20391	Snipe Lake	reject	access - too far
3S-086	4	16	3	60.758357	-153.94107	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-042</i>
3S-087	3	16	3	60.757552	-153.941624	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-042</i>
3S-088	1	25	3	60.574995	-154.219868	Snipe Lake	reject	access - too far
3S-089	12	16	3	60.758363	-153.957089	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-043</i>
3S-090	2	16	3	60.76184	-153.933882	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-091	1	17	3	60.75729	-153.956538	Turquoise Lake	reject	not target veg
3S-092	3	16	3	60.746834	-154.020603	Turquoise Lake	reject	not target veg
3S-093	2	16	3	60.755948	-153.955987	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-043</i>
3S-094	3	16	3	60.755943	-153.942731	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-095	1	15	3	60.736373	-154.023356	Turquoise Lake	reject	not target veg
3S-096	3	16	3	60.746563	-154.036063	Turquoise Lake	reject	not target veg
3S-097	3	17	3	60.752187	-153.940529	Turquoise Lake	reject	not target veg
3S-098	2	17	3	60.756485	-153.955986	Turquoise Lake	reject	not target veg
3S-099	4	14	3	60.570457	-154.206108	Snipe Lake	reject	access - too far
3S-100	3	16	3	60.75005	-154.035515	Turquoise Lake	reject	not target veg
3S-101	6	16	3	60.761582	-153.958741	Turquoise Lake	reject	not target veg
3S-102	4	16	3	60.760239	-153.953772	Turquoise Lake	reject	not target veg
3S-103	2	14	3	60.741734	-154.037714	Turquoise Lake	reject	not target veg
3S-104	2	16	3	60.751121	-154.043247	Turquoise Lake	reject	not target veg
3S-105	6	16	3	60.760508	-153.954324	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3S-106	4	16	3	60.564542	-154.214856	Snipe Lake	reject	access - too far
3S-107	6	16	3	60.76024	-153.955429	Turquoise Lake	<i>reject</i>	<i>redundant with 3S-105</i>
3S-108	5	16	3	60.756754	-153.958195	Turquoise Lake	<i>unconfirmed</i>	<i>evaluation needed</i>

1c. LACL - GRTS – all classes (> 900 m): target vegetation = dwarf shrub tundra - fellfield								
GRTS	Slope	LC	Elev Band	Latitude (NAD83)	Longitude (NAD83)	General Location	Accept/Reject	Reason
3S-109	4	25	3	60.757768	-153.866503	Turquoise Lake	reject	not target veg
3S-110	3	15	3	60.741736	-154.031089	Turquoise Lake	reject	not target veg
3S-111	4	25	3	60.575264	-154.219321	Snipe Lake	reject	access - too far
3S-112	3	16	3	60.751928	-154.03386	Turquoise Lake	reject	not target veg
3S-113	5	14	3	60.742271	-154.037163	Turquoise Lake	reject	not target veg
3S-114	5	16	3	60.743349	-154.004038	Turquoise Lake	reject	not target veg
3S-115	1	20	3	60.747364	-154.046555	Turquoise Lake	reject	not target veg
3S-116	2	16	3	60.755407	-153.942732	Turquoise Lake	reject	not target veg
3S-117	4	16	3	60.569375	-154.211593	Snipe Lake	reject	access - too far
3S-118	1	16	3	60.563735	-154.216498	Snipe Lake	reject	access - too far
3S-119	3	16	3	60.565852	-154.234083	Snipe Lake	reject	access - too far
3S-120	4	15	3	60.743347	-154.024465	Turquoise Lake	reject	not target veg
3S-121	6	25	3	60.615942	-154.011171	Lower Twin Lake	accept	

1d. KATM - GRTS – all classes, including spruce (450-900 m): target vegetation = dwarf shrub tundra								
GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
2-001	1	11	2	-154.983	58.74969	Murray	reject	not target veg
2-002	7	2	2	-155.092	58.74397	Murray	reject	not target veg
2-003	5	11	2	-155.163	58.89689	Hammersly	accept	
2-004	4	11	2	-155.175	58.91182	Hammersly	reject	access - unsafe
2-005	3	11	2	-155.087	59.11148	Emerald Lake	accept	
2-006	10	7	2	-155.106	58.90545	Hammersly	accept	
2-007	7	11	2	-155.085	58.79235	Hammersly	reject	not target veg
2-008	4	8	2	-155.148	58.89354	Hammersly	accept	
2-009	10	12	2	-155.159	58.9227	Hammersly	reject	access - unsafe
2-010	10	15	2	-155.004	58.76456	Murray	reject	not target veg
2-011	3	12	2	-155.09	58.79607	Murray	reject	not target veg
2-012	5	11	2	-155.184	59.01293	Nonvianuk-Kukaklek	reject	access - too far
2-013	7	13	2	-155.129	58.9082	Hammersly	reject	see notes
2-014	6	9	2	-155.014	58.76341	Murray	reject	not target veg
2-015	2	11	2	-155.164	58.90655	Hammersly	reject	not target veg
2-016	9	11	2	-155.144	59.093	Nonvianuk-Kukaklek	reject	access - too far
2-017	9	11	2	-155.494	58.82181	Upper Colville	reject	not target veg
2-018	3	11	2	-155.175	58.89732	Hammersly	reject	not target veg

1d. KATM - GRTS – all classes, including spruce (450-900 m): target vegetation = dwarf shrub tundra								
GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
2-019	4	8	2	-155.174	58.90539	Hammersly	reject	not target veg
2-020	9	13	2	-154.984	59.04225	Battle	reject	not target veg
2-021	9	17	2	-154.98	59.03342	Battle	reject	access - too far
2-022	7	8	2	-155.148	58.88844	Hammersly	reject	access - too far
2-023	5	11	2	-155.155	58.90743	Hammersly	accept	
2-024	9	15	2	-154.967	58.75008	Murray	reject	not target veg
2-025	10	12	2	-155.531	58.83024	Upper Colville	reject	not target veg
2-026	10	11	2	-154.971	59.03107	Battle	reject	access - too far
2-027	8	12	2	-155.126	58.8991	Hammersly	reject	not target veg
2-028	7	12	2	-155.109	58.9014	Hammersly	reject	not target veg
2-029	9	12	2	-155.176	58.87987	Hammersly	reject	not target veg
2-030	9	11	2	-155.236	59.01835	Nonvianuk-Kukaklek	reject	access - too far
2-031	3	8	2	-155.087	59.11093	Narrow Cove	reject	not target veg
2-032	7	18	2	-155.088	59.11817	Narrow Cove	accept	
2-033	2	10	2	-154.828	59.2701	Mirror	<i>accept</i>	<i>not sampled</i>
2-034	6	14	2	-155.069	58.75839	Murray	reject	not target veg
2-035	5	11	2	-155.161	58.81827	Hammersly	reject	access - too far
2-036	3	11	2	-155.19	58.90122	Hammersly	reject	not target veg
2-037	3	11	2	-155.138	58.91027	Hammersly	reject	access - too far
2-038	7	13	2	-155.109	58.88663	Hammersly	reject	not target veg
2-039	7	8	2	-155.205	58.88658	Hammersly	reject	not target veg
2-040	4	15	2	-154.997	58.7528	Murray	reject	not target veg
2-041	7	12	2	-155.098	58.89075	Hammersly	reject	not target veg
2-042	3	11	2	-155.206	59.01729	Nonvianuk-Kukaklek	reject	access - too far
2-043	4	9	2	-155.086	58.79342	Murray	reject	not target veg
2-044	6	12	2	-155.523	58.82899	Upper Colville	reject	not target veg
2-045	2	11	2	-155.096	58.81078	Hammersly	reject	not target veg
2-046	7	11	2	-155.174	58.89035	Hammersly	reject	not target veg
2-047	7	12	2	-155.162	58.82255	Hammersly	reject	not target veg
2-048	8	13	2	-154.733	59.2535	Mirror	accept	
2-049	4	11	2	-155.123	58.91926	Hammersly	reject	not target veg
2-050	6	11	2	-155.567	58.80699	Upper Colville	accept	
2-051	6	11	2	-154.727	59.25595	Mirror	reject	not target veg
2-052	7	12	2	-155.201	58.92634	Hammersly	reject	access – too far
2-053	9	7	2	-155.009	58.75808	Murray	reject	not target veg

1d. KATM - GRTS – all classes, including spruce (450-900 m): target vegetation = dwarf shrub tundra

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
2-054	2	11	2	-155.318	58.93379	Nonvianuk	reject	access – too far
2-055	6	15	2	-154.724	59.2522	Mirror	reject	not target veg
2-056	10	15	2	-155.095	58.74341	Murray	reject	not target veg
2-057	10	10	2	-155.323	58.93831	Nonvianuk	reject	access – too far
2-058	2	11	2	-155.286	58.93009	Nonvianuk	reject	access – too far
2-059	2	11	2	-155.171	58.89951	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
2-060	6	9	2	-155.508	58.81896	Upper Coville	reject	not target veg
2-061	5	11	2	-155.26	58.93088	Nonvianuk	reject	access – too far
2-062	10	11	2	-155.184	58.91656	Hammersly	reject	not target veg
2-063	1	11	2	-155.169	58.88262	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
2-064	6	12	2	-155.228	58.87804	Hammersly	reject	not target veg
2-065	8	18	2	-154.968	58.74416	Murray	reject	not target veg
2-066	9	12	2	-155.095	58.89937	Hammersly	reject	not target veg
2-067	10	17	2	-154.686	59.22664	Mirror	<i>unconfirmed</i>	<i>evaluation needed</i>
2-068	9	11	2	-154.988	59.03819	Battle	reject	access – too far
2-069	2	11	2	-155.522	58.81665	Upper Coville	reject	not target veg
2-070	9	11	2	-154.76	59.26595	Mirror	accept	
2-078	1	3	1	-156.158	58.38685	Malone	accept	

1e. KATM - GRTS – spruce only (0-450 m): target vegetation = white spruce woodland

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
1-S001	0	2	1	-155.947	58.4511	Brooks	<i>unconfirmed</i>	<i>evaluation needed</i>
1-S002	3	2	1	-156.08	58.39689	Malone	accept	
1-S003	2	2	1	-155.605	58.43115	Valley 10K Road	reject	not target veg
1-S004	9	3	1	-155.654	58.83141	Colville	reject	not target veg
1-S005	2	2	1	-155.58	59.06025	W Nonvianuk	reject	access - too far
1-S006	3	3	1	-155.67	59.05939	W Nonvianuk	reject	access - too far
1-S007	4	3	1	-155.562	58.67898	E Naknek	reject	not target veg
1-S008	6	3	1	-156.18	58.41347	Malone	accept	
1-S009	5	2	1	-155.742	58.99939	W Nonvianuk	reject	access - too far
1-S010	7	3	1	-155.283	58.64771	Jojo/Grosvenor	reject	not target veg
1-S011	2	3	1	-156.033	58.57356	S Naknek	reject	not target veg
1-S012	4	3	1	-156.234	58.42356	Long	accept	
1-S013	5	2	1	-155.688	58.45962	Valley 10K Road	reject	access - too far

1e. KATM - GRTS – spruce only (0-450 m): target vegetation = white spruce woodland								
GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
1-S014	3	2	1	-155.534	59.05839	W Nonvianuk	reject	access - too far
1-S015	7	3	1	-155.813	59.00753	W Nonvianuk	reject	not target veg
1-S016	4	2	1	-156.122	58.40693	Malone	<i>unconfirmed</i>	<i>evaluation needed</i>
1-S017	8	2	1	-155.684	59.03291	W Nonvianuk	reject	access - too far
1-S018	7	2	1	-155.568	58.44638	Valley 10K Road	reject	access - unsafe
1-S019	1	2	1	-155.654	58.46007	Valley 10K Road	reject	not target veg
1-S020	9	3	1	-155.492	59.04277	W Nonvianuk	reject	not target veg
1-S021	4	3	1	-156.081	58.4044	Malone	reject	not target veg
1-S022	7	3	1	-156.259	58.42607	Long	reject	not target veg
1-S023	0	2	1	-155.612	58.82093	Colville	reject	access - too far
1-S024	7	3	1	-155.546	59.05851	W Nonvianuk	reject	access - too far
1-S025	3	3	1	-155.691	59.05375	W Nonvianuk	reject	access - too far
1-S026	3	3	1	-155.58	58.68468	E Naknek	reject	not target veg
1-S027	4	3	1	-156.233	58.41148	Long	accept	
1-S028	6	2	1	-155.732	58.99764	W Nonvianuk	reject	access - too far
1-S029	1	2	1	-155.381	58.55649	Illiuk Arm	reject	not target veg
1-S030	9	2	1	-155.55	58.74599	Colville	reject	not target veg
1-S031	1	2	1	-156.141	58.58953	S Naknek	reject	not target veg
1-S032	6	2	1	-155.568	58.97798	W Nonvianuk	reject	access - too far
1-S033	2	3	1	-155.472	58.97187	W Nonvianuk	reject	access - too far
1-S034	10	3	1	-155.59	58.67193	E Naknek	reject	not target veg
1-S035	5	2	1	-155.651	59.02554	W Nonvianuk	accept	
1-S036	0	2	1	-155.622	58.96927	W Nonvianuk	reject	access - too far
1-S037	2	2	1	-155.646	58.45667	Valley 10K Road	reject	not target veg
1-S038	3	2	1	-155.651	59.00353	W Nonvianuk	accept	
1-S039	1	3	1	-155.873	58.98172	W Nonvianuk	reject	access - too far
1-S040	3	3	1	-155.338	58.64044	Jojo/Grosvenor	reject	access - too far
1-S041	1	2	1	-155.563	58.98368	W Nonvianuk	accept	
1-S042	0	2	1	-155.172	58.50944	Savonoski	reject	access - too far
1-S043	7	2	1	-156.007	58.58526	S Naknek	reject	access - too far
1-S044	7	2	1	-155.653	59.02336	W Nonvianuk	reject	access - too far
1-S045	2	2	1	-155.672	58.46063	Valley 10K Road	reject	access - too far
1-S046	10	2	1	-156.256	58.42881	Long	reject	access - too far
1-S047	4	3	1	-155.782	59.00287	W Nonvianuk	reject	access - too far
1-S048	7	2	1	-155.819	58.47044	Brooks	reject	access - too far

1e. KATM - GRTS – spruce only (0-450 m): target vegetation = white spruce woodland

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
1-S049	4	3	1	-156.195	58.40168	Malone	<i>unconfirmed</i>	<i>evaluation needed</i>
1-S050	0	2	1	-156.338	58.74213	N Naknek	accept	

1f. KATM-GRTS – spruce only (450-900 m): target vegetation = white spruce woodland (treeline)

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
2-S001	8	3	2	-155.962	58.80535	Idavain	reject	not target veg
2-S002	7	3	2	-155.497	58.84031	Upper Colville	reject	not target veg
2-S003	10	3	2	-155.193	58.92722	Hammersly	reject	access - too far
2-S004	10	3	2	-155.542	58.83386	Upper Colville	accept	
2-S005	9	3	2	-155.548	58.83138	Upper Colville	reject	not target veg
2-S006	10	3	2	-155.561	58.84787	Upper Colville	reject	not target veg
2-S007	8	3	2	-155.549	58.83084	Upper Colville	reject	not target veg
2-S008	10	3	2	-155.523	58.82362	Upper Colville	accept	
2-S009	9	3	2	-155.534	58.83423	Upper Colville	reject	not target veg
2-S010	8	3	2	-155.549	58.83111	Upper Colville	reject	see notes
2-S011	4	3	2	-155.545	58.84592	Upper Colville	reject	not target veg
2-S012	8	3	2	-155.961	58.80509	Idavain	reject	see notes
2-S013	9	3	2	-155.542	58.83413	Upper Colville	reject	see notes
2-S014	9	3	2	-155.875	58.58807	Dumpling	accept	
2-S015	7	3	2	-155.562	58.84759	Upper Colville	reject	not target veg
2-S016	8	3	2	-155.542	58.83038	Upper Colville	accept	
2-S017	9	3	2	-155.876	58.57999	Dumpling	accept	
2-S018	10	3	2	-155.567	58.84833	Upper Colville	reject	not target veg
2-S019	10	3	2	-155.517	58.82692	Upper Colville	reject	not target veg
2-S020	3	3	2	-155.9	58.58366	Dumpling	reject	not target veg
2-S021	5	3	2	-155.543	58.83386	Upper Colville	reject	see notes
2-S022	6	3	2	-155.568	58.84859	Upper Colville	reject	not target veg
2-S023	9	3	2	-155.577	58.56765	Dumpling	reject	see notes
2-S024	10	3	2	-155.193	58.92749	Dumpling	reject	see notes
2-S025	9	3	2	-155.548	58.83085	Upper Colville	reject	see notes
2-S026	9	3	2	-155.562	58.84786	Upper Colville	reject	not target veg
2-S027	9	3	2	-155.526	58.83433	Upper Colville	reject	not target veg
2-S028	10	3	2	-155.509	58.83103	Upper Colville	reject	not target veg
2-S029	4	3	2	-155.545	58.84565	Upper Colville	reject	not target veg

1f. KATM-GRTS – spruce only (450-900 m): target vegetation = white spruce woodland (treeline)

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
2-S030	0	3	2	-155.509	58.83077	Upper Colville	reject	not target veg
2-S031	5	3	2	-155.518	58.82664	Upper Colville	reject	not target veg
2-S032	10	3	2	-155.549	58.8311	Upper Colville	reject	see notes
2-S033	2	3	2	-155.543	58.83385	Upper Colville	reject	see notes
2-S034	8	3	2	-155.902	58.5831	Dumpling	reject	see notes
2-S035	7	3	2	-155.36	58.94383	S Nonvianuk	reject	access - too far
2-S036	9	3	2	-155.542	58.8344	Upper Colville	reject	see notes
2-S037	10	3	2	-155.877	58.58051	Dumpling	reject	see notes
2-S038	10	3	2	-155.194	58.92722	Hammersly	reject	access - too far
2-S039	9	3	2	-155.542	58.83065	Upper Colville	reject	see notes
2-S040	9	3	2	-155.876	58.57972	Dumpling	reject	see notes
2-S041	9	3	2	-155.542	58.83038	Upper Colville	reject	see notes
2-S042	8	3	2	-155.539	58.82988	Upper Colville	reject	see notes
2-S043	9	3	2	-155.588	58.38893	Valley 10K Road	reject	not target veg
2-S044	10	3	2	-155.526	58.83432	Upper Colville	reject	not target veg
2-S045	7	3	2	-155.36	58.9441	S Nonvianuk	reject	access - too far
2-S046	10	3	2	-155.577	58.56738	Illiuk Arm	reject	not target veg

1g. KATM - GRTS – all classes (>900 m): target vegetation = dwarf shrub tundra - fellfield

GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
3-001	6	18	3	-154.809	59.09498	Pfaff	accept	
3-002	7	18	3	-154.807	59.09016	Pfaff	accept	
3-003	9	18	3	-154.807	59.10224	Pfaff	accept	
3-004	10	11	3	-155.068	58.8282	Hammersly	reject	not target veg
3-005	3	18	3	-155.174	58.84526	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
3-006	10	11	3	-155.069	58.82926	Hammersly	accept	
3-007	6	11	3	-155.207	58.84066	Hammersly	reject	access - too far
3-008	6	18	3	-154.695	59.01808	Pirate Lake	<i>unconfirmed</i>	<i>evaluation needed</i>
3-009	9	17	3	-155.04	58.86118	Hammersly	accept	
3-010	8	11	3	-155.175	58.84579	Hammersly	<i>unconfirmed</i>	<100 m from 03-005
3-011	9	11	3	-155.049	58.83265	Hammersly	reject	not target veg
3-012	10	11	3	-155.07	58.84294	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
3-013	10	14	3	-155.047	58.8332	Hammersly	reject	not target veg
3-014	6	12	3	-155.048	58.83588	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>

1g. KATM - GRTS – all classes (>900 m): target vegetation = dwarf shrub tundra - fellfield								
GRTS	SLOPE	LC	ELEV_BND	POINT_X	POINT_Y	General Location	Accept/Reject	Reason
3-015	7	11	3	-155.048	58.83346	Hammersly	reject	not target veg
3-016	6	13	3	-155.206	58.84093	Hammersly	reject	access - too far
3-017	10	11	3	-155.049	58.8348	Hammersly	reject	not target veg
3-018	7	11	3	-155.047	58.80448	Murray	<i>unconfirmed</i>	<i>evaluation needed</i>
3-019	10	13	3	-155.174	58.84284	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
3-020	9	11	3	-155.047	58.83696	Hammersly	<i>unconfirmed</i>	135 m from 03-014
3-021	7	18	3	-154.807	59.09017	Pfaff	reject	<100 m from 03-002
3-022	10	17	3	-155.054	58.82643	Hammersly	accept	
3-023	8	11	3	-155.044	58.80316	Pfaff	accept	
3-024	10	11	3	-154.807	59.09446	Pfaff	reject	not target veg
3-025	6	12	3	-155.048	58.83481	Hammersly	<i>unconfirmed</i>	120 m from 03-014
3-026	10	17	3	-155.07	58.84241	Hammersly	<i>unconfirmed</i>	<100 m from 03-012
3-027	9	11	3	-155.049	58.83426	Hammersly	reject	not target veg
3-028	7	15	3	-155.048	58.83319	Hammersly	reject	not target veg
3-029	2	18	3	-154.773	59.08849	Pfaff	reject	access - too far
3-030	8	17	3	-155.071	58.82791	Hammersly	<i>unconfirmed</i>	130 m from 03-006
3-031	6	11	3	-155.175	58.84579	Hammersly	<i>unconfirmed</i>	<100 m from 03-005
3-032	7	17	3	-154.81	59.0931	Pfaff	accept	
3-033	4	18	3	-154.81	59.09605	Pfaff	<i>unconfirmed</i>	<i>evaluation needed</i>
3-034	5	13	3	-155.207	58.84066	Hammersly	reject	access - too far
3-035	10	18	3	-155.173	58.84366	Hammersly	<i>unconfirmed</i>	<i>evaluation needed</i>
3-036	6	11	3	-154.813	59.09577	Pfaff	<i>unconfirmed</i>	145 m from 03-033
3-037	7	11	3	-155.048	58.83373	Hammersly	reject	not target veg
3-038	3	11	3	-154.808	59.09284	Pfaff	reject	not target veg
3-039	7	11	3	-155.038	58.81261	Hammersly	reject	access - too far
3-040	7	18	3	-154.808	59.09498	Pfaff	reject	not target veg
3-041	7	11	3	-155.069	58.82739	Hammersly	<i>unconfirmed</i>	190 m from 03-006
3-042	9	11	3	-155.041	58.8609	Hammersly	reject	<100 m from 03-009
3-043	8	11	3	-154.809	59.09096	Pfaff	<i>unconfirmed</i>	130 m from 03-002
3-044	6	11	3	-155.048	58.83454	Hammersly	<i>unconfirmed</i>	150 m from 03-014
3-045	6	18	3	-155.049	58.83318	Hammersly	reject	not target veg
3-046	9	18	3	-155.048	58.83239	Hammersly	reject	not target veg
3-047	7	17	3	-155.051	58.7454	Murray	<i>unconfirmed</i>	<i>evaluation needed</i>
3-048	8	13	3	-155.223	58.84454	Hammersly	reject	access - too far
3-049	9	17	3	-155.07	58.84455	Hammersly	accept	

Appendix 2a. Within-plot variance in species cover for selected vegetation types in LACL (2011). Means ($\pm$ SE) are shown for a subset of species in each growth form. Cover is estimated by point-intercept along 30-m transects. Total cover >100% is due to layering within vegetation type. Cover by height class is shown only for white spruce (*Picea glauca*), but was recorded for all species. Species with high constancy in cover (CV $\leq$ 35%) are shown in boldface. Plots with an (*) represent >1 year of sampling.

2a.i. Low elevation (0-450 m) spruce woodland		
Lake Clark NPP	Plot ID	
Vascular species	01-S994*	01-033
Tree		
<i>Picea glauca</i> (<50 cm)	0.8 (0.8)	0.0
<i>P. glauca</i> (50 cm-1 m)	2.1 (1.3)	0.4 (0.4)
<i>P. glauca</i> (1-4 m)	7.6 (3.9)	2.1 (2.1)
<i>P. glauca</i> (>4 m)	2.5 (1.5)	0.0
<i>P. glauca</i> – snags (1-4 m)	0.0	0.0
<i>P. glauca</i> – snags (>4 m)	0.0	0.0
<i>Betula neoalaskana</i> (1-4 m)	0.0	1.7 (1.7)
<i>Populus balsamifera</i> (1-4 m)	0.0	0.0
Shrub		
<i>Alnus viridis</i> subsp. <i>sinuata</i>	0.0	0.0
<i>Betula nana</i> (<0.5 m; incl. damaged & dead)	13.1 (4.4)	4.2 (1.7)
<i>B. nana</i> (0.5-1.0 m)	10.2 (4.3)	2.1 (1.6)
<i>B. nana</i> 1-4 m)	10.2 (3.8)	1.7 (1.7)
<i>Ledum palustre</i> subsp. <i>decumbens</i>	19.5 (8.4)	35.2 (12.3)
<i>Rosa acicularis</i>	0.0	0.0
<i>Salix barclayi</i>	0.0	0.0
<i>Salix bebbiana</i>	0.0	0.0
<i>Salix glauca</i>	0.0	0.0
<i>Salix pulchra</i>	0.0	0.0
<i>Spiraea stevenii</i>	0.4 (0.4)	0.0
<i>Viburnum edule</i>	0.0	0.0
<i>Vaccinium uliginosum</i>	5.1 (3.6)	17.4 (8.1)
Dwarf shrub		
<i>Arctostaphylos alpina</i>	0.0	0.4 (0.4)
<i>Cornus suecica</i>	0.0	0.0
<i>Diapensia lapponica</i>	0.0	0.0
<i>Dryas octopetala</i>	0.0	0.0
<i>Empetrum nigrum</i>	1.7 (1.2)	10.2 (4.4)
<i>Loiseleuria procumbens</i>	0.0	0.0
<i>Rhododendron camtschaticum</i>	0.0	0.0
<i>Salix arctica</i>	0.0	0.0
<i>Salix phlebophylla</i>	0.0	0.0
<i>Salix reticulata</i>	0.0	0.0
<i>Vaccinium vitis-idaea</i>	3.8 (1.7)	27.5 (11.6)
Graminoid		
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	0.0	0.0

2a.i. Low elevation (0-450 m) spruce woodland		
Lake Clark NPP		
Vascular species	Plot ID 01-S994*	01-033
<i>Calamagrostis canadensis</i>	0.8 (0.5)	0.0
<i>Carex microchaeta</i> subsp. <i>nesophila</i>	0.0	0.0
<i>Festuca altaica</i>	0.0	0.4 (0.4)
Forb		
<i>Chamerion angustifolium</i>	0.4 (0.4)	0.0
<i>Equisetum arvense</i>	0.0	0.0
<i>Gymnocarpium dryopteris</i>	0.0	0.0

2a.ii. Mid elevation (450-900 m) low shrub		
Lake Clark NPP		
Vascular species	Plot ID 02-006*	02_999*
Tree		
<i>Picea glauca</i> (<50 cm)	0.0	0.0
<i>P. glauca</i> (50 cm-1 m)	0.0	0.0
<i>P. glauca</i> (1-4 m)	0.0	0.0
<i>P. glauca</i> (>4 m)	0.0	0.0
<i>P. glauca</i> – snags (1-4 m)	0.0	0.0
<i>P. glauca</i> – snags (>4 m)	0.0	0.0
<i>Betula neoalaskana</i> (1-4 m)	0.0	0.0
<i>Populus balsamifera</i> (1-4 m)	0.0	0.0
Shrub		
<i>Alnus viridis</i> subsp. <i>sinuata</i>	0.0	0.0
<i>Betula nana</i> (<0.5 m; incl. damage)	7.2 (4.8)	3.8 (2.5)
<i>B. nana</i> (0.5-1.0 m)	0.0	0.0
<i>B. nana</i> 1-4 m)	0.0	0.0
<i>Ledum palustre</i> subsp. <i>decumbens</i>	1.7 (1.1)	3.0 (1.4)
<i>Rosa acicularis</i>	0.0	0.0
<i>Salix barclayi</i>	0.0	0.0
<i>Salix bebbiana</i>	0.0	0.0
<i>Salix glauca</i>	0.0	0.4 (0.4)
<i>Salix pulchra</i>	0.6 (0.6)	0.0
<i>Spiraea stevenii</i>	0.6 (0.6)	0.0
<i>Viburnum edule</i>	0.0	0.0
<i>Vaccinium uliginosum</i>	5.1 (2.2)	15.3 (6.9)
Damage codes not included in 2011 estimates		
Dwarf shrub		
<i>Arctostaphylos alpina</i>	0.6 (0.6)	1.7 (1.2)
<i>Cornus suecica</i>	0.0	0.0
<i>Diapensia lapponica</i>	0.0	0.0
<i>Dryas octopetala</i>	0.0	0.0
<i>Empetrum nigrum</i>	27.9 (9.6)	16.9 (8.4)
<i>Loiseleuria procumbens</i>	0.8 (0.8)	1.3 (0.8)

2a.ii. Mid elevation (450-900 m) low shrub				
Lake Clark NPP				
Vascular species	Plot ID			
	02_006*		02_999*	
<i>Rhododendron camtschaticum</i>	0.0		0.0	
<i>Salix arctica</i>	0.0		0.0	
<i>Salix phlebophylla</i>	0.0		0.4 (0.4)	
<i>Salix reticulata</i>	0.0		0.0	
<i>Vaccinium vitis-idaea</i>	4.2 (1.8)		11.8 (4.8)	
Graminoid				
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	1.3 (0.8)		1.7 (1.2)	
<i>Calamagrostis canadensis</i>	0.0		0.4 (0.4)	
<i>Carex microchaeta</i> subsp. <i>nesophila</i>	0.0		0.0	
<i>Festuca altaica</i>	0.0		0.4 (0.4)	
Forb				
<i>Chamerion angustifolium</i>	0.0		0.0	
<i>Equisetum arvense</i>	0.0		0.0	
<i>Gymnocarpium dryopteris</i>	0.0		0.0	
2a.iii. Mid elevation (450-900 m) treeline spruce				
Lake Clark NPP				
Vascular species	Plot ID			
	02_S998	02_S996	02_S997	02_S999
Tree				
<i>Picea glauca</i> (<50 cm)	2.5 (2.5)	0.0	1.2 (1.2)	0.0
<i>P. glauca</i> (50 cm-1 m)	0.0	0.0	0.0	0.0
<i>P. glauca</i> (1-4 m)	0.4 (0.4)	0.0	0.0	0.0
<i>P. glauca</i> (>4 m)	0.0	0.0	0.0	0.0
<i>P. glauca</i> – snags (1-4 m)	0.0	0.0	0.0	0.0
<i>P. glauca</i> – snags (>4 m)	0.0	0.0	0.0	0.0
<i>Betula neoalaskana</i> (1-4 m)	0.0	0.0	0.0	0.0
<i>Populus balsamifera</i> (1-4 m)	0.0	0.0	0.0	0.0
Shrub				
<i>Alnus viridis</i> subsp. <i>sinuata</i>	0.0	0.0	0.0	
<i>Betula nana</i> (<0.5 m; incl. damaged & dead)	5.9 (3.1)	5.9 (3.5)	10.2 (4.2)	5.9 (3.8)
<i>B. nana</i> (0.5-1.0 m)	0.0	1.3 (0.7)	0.0	0.0
<i>B. nana</i> 1-4 m)	0.0	1.9 (1.0)	0.0	0.0
<i>Ledum palustre</i> subsp. <i>decumbens</i>	15.3 (5.7)	10.6 (4.8)	11.4 (4.2)	9.3 (4.9)
<i>Rosa acicularis</i>	0.0	0.0	0.0	0.0
<i>Salix barclayi</i>	0.0	0.0	0.0	0.0
<i>Salix bebbiana</i>	0.0	0.0	0.0	0.0
<i>Salix glauca</i>	0.4 (0.4)	1.3 (1.3)	0.0	0.0
<i>Salix pulchra</i>	0.0	0.0	0.0	0.0
<i>Spiraea stevenii</i>	0.0	0.0	0.0	0.0
<i>Viburnum edule</i>	0.0	0.0	0.0	0.0
<i>Vaccinium uliginosum</i>	13.6 (5.6)	30.1 (10.2)	27.1 (13.4)	9.3 (4.1)

2a.iii. Mid elevation (450-900 m) treeline spruce				
Lake Clark NPP	Plot ID			
Vascular species	02_S998	02_S996	02_S997	02_S999
Dwarf shrub				
<i>Arctostaphylos alpina</i>	3.4 (1.8)	0.4 (0.4)	0.4 (0.4)	1.3 (0.8)
<i>Cornus suecica</i>	0.0	0.0	0.0	0.0
<i>Diapensia lapponica</i>	0.0	0.0	0.0	0.8 (0.8)
<i>Dryas octopetala</i>	0.0	0.0	0.0	0.8 (0.8)
<i>Empetrum nigrum</i>	8.5 (3.5)	31.8 (11.8)	13.6 (5.7)	18.6 (11.4)
<i>Loiseleuria procumbens</i>	0.0	0.0	0.4 (0.4)	0.8 (0.8)
<i>Rhododendron camtschaticum</i>	0.0	0.0	0.0	0.0
<i>Salix arctica</i>	0.0	0.0	0.0	0.0
<i>Salix phlebophylla</i>	0.0	0.0	0.0	0.4 (0.4)
<i>Salix reticulata</i>	0.0	0.0	0.0	0.0
<i>Vaccinium vitis-idaea</i>	5.1 (1.7)	11.4 (3.9)	0.8 (0.4)	12.7 (6.0)
Graminoid				
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	0.4 (0.4)	0.0	0.0	2.5 (1.1)
<i>Calamagrostis canadensis</i>	0.0	0.0	0.0	0.0
<i>Carex microchaeta</i> subsp. <i>nesophila</i>	1.6 (1.0)	0.0	2.5 (1.1)	0.0
<i>Festuca altaica</i>	0.0	0.0	0.0	1.7 (0.7)
Forb				
<i>Chamerion angustifolium</i>	0.0	0.0	0.0	0.0
<i>Equisetum arvense</i>	0.0	0.0	0.0	0.0
<i>Gymnocarpium dryopteris</i>	0.0	0.0	0.0	0.0

[illegible]

Lake Clark NPP

[illegible]

Appendix 2b. Within-plot variance in species cover for selected vegetation types in KATM (2011). Means ($\pm$ SE) are shown for a subset of species in each growth form. Cover is estimated by point-intercept along 30-m transects. Total cover >100% is due to layering within vegetation type. Cover by height class is shown only for white spruce (*Picea glauca*), but was recorded for all species. Species with high constancy in cover (CV $\leq$ 35%) are shown in boldface. Plots with an (*) represent >1 year of sampling.

2b.i. Mid elevation (450-900 m) dwarf shrub tundra		
Katmai NPP		
Vascular species	Plot ID	
	02_048*	02_070
Tree		
<i>Picea glauca</i> (<50 cm)	0.0	0.0
<i>P. glauca</i> (50 cm-1 m)	0.0	0.0
<i>P. glauca</i> (1-4 m)	0.0	0.0
<i>P. glauca</i> (>4 m)	0.0	0.0
<i>P. glauca</i> – snags (1-4 m)	0.0	0.0
<i>P. glauca</i> – snags (>4 m)	0.0	0.0
<i>Betula neoalaskana</i> (1-4 m)	0.0	0.0
<i>Populus balsamifera</i> (1-4 m)	0.0	0.0
Shrub		
<i>Alnus viridis</i> subsp. <i>sinuata</i>	0.0	0.0
<i>Betula nana</i>	0.0	2.5 (0.8)
<i>Betula nana</i> (insect damaged)	0.0	0.0
<i>Betula nana</i> (standing dead)	0.0	0.0
<i>Ledum palustre</i> subsp. <i>decumbens</i>	0.0	0.0
<i>Rosa acicularis</i>	0.0	0.0
<i>Salix barclayi</i>	0.0	0.0
<i>Salix bebbiana</i>	0.0	0.0
<i>Salix glauca</i>	0.0	0.0
<i>Salix pulchra</i>	0.0	0.0
<i>Spiraea stevenii</i>	0.0	0.0
<i>Viburnum edule</i>	0.0	0.0
<i>Vaccinium uliginosum</i>	16.9 (5.8)	6.4 (3.2)
Dwarf shrub		
<i>Arctostaphylos alpina</i>	0.0	0.0
<i>Cornus suecica</i>	0.0	0.0
<i>Diapensia lapponica</i>	0.8 (0.8)	1.3 (0.4)
<i>Dryas octopetala</i>	0.0	0.4 (0.4)
<i>Empetrum nigrum</i>	28.8 (10.2)	17.3 (6.7)
<i>Loiseleuria procumbens</i>	0.4 (0.4)	2.5 (1.1)
<i>Rhododendron camtschaticum</i>	0.0	0.0
<i>Salix arctica</i>	1.7 (1.2)	0.0
<i>Salix phlebophylla</i>	1.7 (1.2)	2.1 (0.8)
<i>Salix reticulata</i>	0.0	0.0
<i>Vaccinium vitis-idaea</i>	1.3 (1.3)	0.8 (0.5)

2b.i. Mid elevation (450-900 m) dwarf shrub tundra		
Katmai NPP	Plot ID	
Vascular species	02_048*	02_070
Graminoid		
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	0.0	0.4 (0.4)
<i>Calamagrostis canadensis</i>	0.0	0.0
<i>Carex microchaeta</i> subsp. <i>nesophila</i>	7.2 (2.5)	5.9 (2.1)
<i>Festuca altaica</i>	0.0	0.0
Forb		
<i>Chamerion angustifolium</i>	0.0	0.0
<i>Equisetum arvense</i>	0.0	0.0
<i>Gymnocarpium dryopteris</i>	0.0	0.0

[illegible]

2b.ii. High elevation (>900 m) dwarf shrub tundra								
Katmai NPP								
Vascular species	Plot ID							
	03_006	03_049	03_001	03_002	03_003	03_009	03_022	03_032
<i>Empetrum nigrum</i>	0.0	13.6 (5.3)	0.0	0.0	0.0	0.8 (0.5)	0.0	0.0
<i>Loiseleuria procumbens</i>	0.0	6.3 (3.8)	8.1 (3.5)	0.0	0.0	0.8 (0.8)	0.0	
<i>Rhododendron camtschaticum</i>	0.0	1.7 (1.0)	0.8 (0.5)	0.0	0.8 (0.5)	0.0	0.0	0.0
<i>Salix arctica</i>	0.0	1.3 (0.8)	0.8 (0.5)	0.0	0.0	2.5 (1.1)	2.1 (0.8)	0.0
<i>Salix phlebophylla</i>	0.0	0.4 (0.4)	1.7 (0.7)	1.3 (0.8)	3.0 (1.4)	16.7 (13.7)	0.0	5.9 (2.6)
<i>Salix reticulata</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
<i>Vaccinium vitis-idaea</i>	0.0	1.7 (1.7)	0.8 (0.8)	0.0	0.0	0.0	0.0	0.4 (0.4)
Graminoid								
<i>Anthoxanthum monticola</i> subsp. <i>alpinum</i>	0.0	0.8 (0.5)	0.8 (0.5)	0.0	0.0	0.0	6.3 (5.9)	0.0
<i>Calamagrostis canadensis</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Carex microchaeta</i> subsp. <i>nesophila</i>	0.0	1.7 (1.2)	1.7 (0.7)	0.8 (0.8)	2.1 (1.1)	1.7 (1.0)	2.1 (0.8)	3.0 (2.4)
<i>Festuca altaica</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Forb								
<i>Chamerion angustifolium</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Equisetum arvense</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Gymnocarpium dryopteris</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 3a. Within-plot estimates (2011) of frequency for vascular and nonvascular species in Lake Clark National Park and Preserve. Frequencies were measured in 4-m² quadrats (n = 15) and are expressed as percent occurrence across quadrats, within a plot (e.g., 1.00 = 100% occurrence). A dagger (†) indicates species with ≥ 20% frequency across all plots within an elevation × vegetation class combination. (‡) indicates species with ≤ 1% frequency across all plots in an elevation × vegetation class combination. Plots marked with (*) were not sampled for lichen and bryophyte frequency in 2011; frequencies shown are from 2010.

3a.i. Low elevation (<450 m) spruce woodland Lake Clark NPP		Plot ID	
		01_S994	01_033
Vascular species			
<i>Andromeda polifolia</i> L.			0.20
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng	0.13		
<i>Arctous alpina</i> (L.) Niedenzu			0.33
<i>Betula nana</i> L.†	1.00		0.87
<i>Betula nana</i> L. x <i>Betula neoalaskana</i> Sarg.			0.13
<i>Calamagrostis canadensis</i> (Michx.) Beauv.	0.87		
<i>Chamerion angustifolium</i> (L.) Holub subsp. <i>angustifolium</i>	0.07		
<i>Cornus suecica</i> L.	0.13		
<i>Empetrum nigrum</i> L.†	0.20		0.93
<i>Festuca altaica</i> Trin.			0.40
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén†	0.80		0.93
<i>Lupinus nootkatensis</i> Donn ex Sims			0.33
<i>Petasites frigidus</i> (L.) Franch.	0.13		
<i>Picea glauca</i> (Moench) Voss†	0.40		0.27
<i>Rubus chamaemorus</i> L.	0.60		
<i>Salix bebbiana</i> Sarg.			0.13
<i>Salix pulchra</i> Cham.	0.07		
<i>Spiraea stevenii</i> (C.K. Schneid.) Rydb.	0.13		0.13
<i>Trientalis europaea</i> L. subsp. <i>arctica</i> (Fisch. ex Hook.) Hultén	0.13		
<i>Vaccinium uliginosum</i> L.†	0.67		0.80
<i>Vaccinium vitis-idaea</i> L.†	1.00		1.00
Lichens			
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.33		0.33
<i>Cetraria laevigata</i> Rass.†	0.40		0.73
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	0.67		1.00
<i>Cladonia amaurocraea</i> (Flörke) Schaerer	0.07		0.13
<i>Cladonia borealis</i> S. Stenroos			0.07
<i>Cladonia cenotea</i> (Ach.) Schaerer	0.07		
<i>Cladonia cervicornis</i> subsp. <i>verticillata</i> (Hoffm.) Ahti			0.07
<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Sprengel†	0.40		0.20
<i>Cladonia cornuta</i> (L.) Hoffm. subsp. <i>cornuta</i>	0.47		0.13
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i> †	0.60		
<i>Cladonia gracilis</i> subsp. <i>turbinata</i> (Ach.) Ahti	0.07		
<i>Cladonia gracilis</i> subsp. <i>vulnerata</i> Ahti†	0.60		0.80
<i>Cladonia macrophylla</i> (Schaerer) Stenh.			0.07
<i>Cladonia phyllophora</i> Hoffm.	0.07		0.07

**3a.i. Low elevation (<450 m) spruce woodland
Lake Clark NPP**

	Plot ID	
	01_S994	01_033
<i>Cladonia pleurota</i> (Flörke) Schaerer	0.07	
<i>Cladonia scabriuscula</i> (Delise) Nyl.		0.13
<i>Cladonia squamosa</i> Hoffm.		0.07
<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda		0.27
<i>Cladonia stygia</i> (Fr.) Ruoss†	0.93	1.00
<i>Cladonia sulphurina</i> (Michaux) Fr.		0.07
<i>Cladonia uncialis</i> (L.) F. H. Wigg.	0.07	0.53
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell		1.00
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell		0.13
<i>Hypogymnia physodes</i> (L.) Nyl.		0.13
<i>Lobaria linita</i> (Ach.) Rabenh.		0.07
<i>Nephroma arcticum</i> (L.) Torss.		0.13
<i>Parmeliopsis ambigua</i> (Wulfen) Nyl.	0.87	0.13
<i>Parmeliopsis hyperopta</i> (Ach.) Arnold†	0.80	0.20
<i>Peltigera aphthosa</i> (L.) Willd.†	0.33	0.67
<i>Peltigera leucophlebia</i> (Nyl.) Gyelnik	0.20	
<i>Peltigera malacea</i> (Ach.) Funck	0.13	0.40
<i>Peltigera polydactyla</i> (Necker) Hoffm.	0.20	0.13
<i>Peltigera scabrosa</i> Th. Fr.†	0.60	0.47
<i>Stereocaulon paschale</i> (L.) Hoffm.	0.07	0.33
<i>Tuckermannopsis sepincola</i> (Ehrh.) Hale†	0.93	0.67
<i>Vulpicida pinastri</i> (Scop.) J.-E. Mattsson & M. J. Lai	0.93	0.07
Bryophytes		
<i>Aulacomnium palustre</i> (Hedwig) Schwaegr.	0.80	
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwaegr.	0.53	
<i>Dicranum scoparium</i> Hedwig	0.13	0.86
<i>Dicranum undulatum</i> Bridel	0.13	0.29
<i>Hypnum plicatulum</i> (Lindberg) Jaeg.		0.07
<i>Hylocomium splendens</i> (Hedwig) Schimper in B.S.G.	0.87	0.07
<i>Pleurozium schreberi</i> (Bridel) Mitten†	0.80	0.43
<i>Polytrichum commune</i> Hedwig var. <i>commune</i>	0.93	0.07
<i>Pohlia cruda</i> (Hedwig) Lindberg	0.07	0.07
<i>Polytrichum hyperboreum</i> R. Brown		0.07
<i>Polytrichum piliferum</i> Hedwig		0.07
<i>Polytrichum strictum</i> Bridel†	0.93	0.36
<i>Ptilidium ciliare</i> (L.) Hampe		0.43
<i>Ptilium crista-castrensis</i> (Hedwig) De Not.	0.07	0.07
<i>Sanionia uncinata</i> (Hedwig) Loeske	0.07	0.07
<i>Sphagnum girgensohnii</i> Russow	0.47	
<i>Sphagnum russowii</i> Warnstorf	0.13	

3a.ii. Mid-elevation (450-900 m) treeline spruce Lake Clark NPP				
	Plot ID			
	02_S996	02_S997	02_S998	02_S999
Vascular species				
<i>Antennaria monocephala</i> DC.				0.07
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng†	0.60	0.20	0.67	0.87
<i>Anemone narcissiflora</i> L.	0.13		0.20	0.53
<i>Arctous alpina</i> (L.) Niedenzu†	0.33	0.67	0.93	0.47
<i>Artemisia arctica</i> Less. subsp. <i>arctica</i>				0.20
<i>Arnica frigida</i> C.A. Mey. Ex Iljin	0.07	0.07		0.07
<i>Betula nana</i> L.†	0.93	1.00	1.00	1.00
<i>Bistorta plumosa</i> (Small) Greene	0.07	0.33		
<i>Calamagrostis canadensis</i> (Michx.) Beauv.				0.07
<i>Calamagrostis lapponica</i> (Wahlenb.) Hartm.	0.53	0.40		0.53
<i>Campanula lasiocarpa</i> Cham.	0.20			
<i>Carex lugens</i> T. Holm	0.87			1.00
<i>Carex microchaeta</i> subsp. <i>nesophila</i> (Holm) E. Murr.		1.00	0.93	
<i>Carex</i> L.	0.13			
<i>Cornus suecica</i> L.	0.07			
<i>Diapensia lapponica</i> L.	0.20	0.20		0.13
<i>Dryas octopetala</i> L.	0.07			0.13
<i>Empetrum nigrum</i> L.†	1.00	0.87	0.73	1.00
<i>Festuca altaica</i> Trin.	0.20			0.33
<i>Festuca brevissima</i> Jurtsev	0.13			
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén†	1.00	1.00	1.00	0.93
<i>Linnaea borealis</i> L.	0.13			0.13
<i>Loiseleuria procumbens</i> (L.) Desv.†	0.27	0.40	0.47	0.53
<i>Lycopodium alpinum</i> L.				0.13
<i>Lycopodium lagopus</i> (Laestadius ex C. Hartman) Zinserl. ex Kuzen	0.07			0.13
<i>Orthilia secunda</i> (L.) House	0.07	0.07		0.07
<i>Oxytropis nigrescens</i> (Pall.) Fisch. ex DC. var. <i>nigrescens</i>	0.07			0.07
<i>Pedicularis capitata</i> Adams	0.07			
<i>Pedicularis labradorica</i> Wirsing	0.13		0.20	0.27
<i>Picea glauca</i> (Moench) Voss		0.13	0.40	0.20
<i>Poa arctica</i> R. Br.	0.07			0.07
<i>Rubus chamaemorus</i> L.	0.07			0.07
<i>Salix arctica</i> Pall.	0.13		0.13	
<i>Sanguisorba canadensis</i> L.				0.07
<i>Salix glauca</i> L.	0.47	0.60	0.33	
<i>Salix phlebophylla</i> Andersson	0.07			0.20
<i>Salix pulchra</i> Cham.	0.33		0.07	
<i>Spiraea stevenii</i> (C.K. Schneid.) Rydb.	0.20		0.07	0.13
<i>Stellaria longipes</i> Goldie sens strict.	0.07			
<i>Trientalis europaea</i> L. subsp. <i>arctica</i> (Fisch. ex Hook.) Hultén				0.07
<i>Trisetum spicatum</i> (L.) K. Richt.	0.07			
<i>Vaccinium uliginosum</i> L.†	1.00	0.93	0.93	1.00
<i>Vaccinium vitis-idaea</i> L.†	1.00	1.00	1.00	1.00

3a.ii. Mid-elevation (450-900 m) treeline spruce Lake Clark NPP				
	Plot ID			
	02_S996	02_S997	02_S998	02_S999
Lichens				
<i>Alectoria ochroleuca</i> (Hoffm.) A. Massal.	0.13	0.07	0.33	0.13
<i>Asahinea chrysantha</i> (Tuck.) W. L. Culb. & C. F. Culb.	0.07			0.07
<i>Bryocaulon divergens</i> (Ach.) Kärnefelt	0.13	0.13	0.27	0.27
<i>Bryoria nitidula</i> (Th. Fr.) Brodo & D. Hawksw.			0.13	
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.80	0.67	0.40	0.93
<i>Cetraria kamczatica</i> Savicz	0.07	0.07	0.07	0.13
<i>Cetraria laevigata</i> Rass†	0.47	1.00	0.93	0.47
<i>Cetraria nigricans</i> Nyl.	0.07			
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	0.93	1.00	1.00	1.00
<i>Cladonia amaurocraea</i> (Flörke) Schaerer†	0.20	0.27	0.40	0.27
<i>Cladonia bellidiflora</i> (Ach.) Schaerer	0.40		0.07	0.33
<i>Cladonia borealis</i> S. Stenroos	0.67	0.07	0.20	0.47
<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Sprengel	0.47		0.07	0.53
<i>Cladonia cornuta</i> (L.) Hoffm. subsp. <i>cornuta</i>	0.47			0.40
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i>	0.47	0.13	0.27	0.87
<i>Cladonia cyanipes</i> (Sommerf.) Nyl.	0.13			0.07
<i>Cladonia deformis</i> (L.) Hoffm.	0.40			0.33
<i>Cladonia gracilis</i> subsp. <i>elongata</i> (Jacq.) Vainio		0.07	0.13	
<i>Cladonia gracilis</i> subsp. <i>turbinata</i> (Ach.) Ahti	0.40			0.20
<i>Cladonia gracilis</i> subsp. <i>vulnerata</i> Ahti	0.67	0.13	0.27	0.20
<i>Cladonia macroceras</i> (Delise) Hav.	0.13		0.13	0.27
<i>Cladonia macrophylla</i> (Schaerer) Stenh.				0.07
<i>Cladonia maxima</i> (Asahina) Ahti				0.73
<i>Cladonia phyllophora</i> Hoffm.	0.27		0.07	0.80
<i>Cladonia pleurota</i> (Flörke) Schaerer	0.20		0.07	0.33
<i>Cladonia pyxidata</i> (L.) Hoffm.	0.07			
<i>Cladonia scabriuscula</i> (Delise) Nyl.			0.07	
<i>Cladonia squamosa</i> Hoffm.	0.47		0.33	0.27
<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda†	0.67	0.47	0.20	0.80
<i>Cladonia stygia</i> (Fr.) Ruoss†	0.80	1.00	0.93	0.47
<i>Cladonia sulphurina</i> (Michaux) Fr.	0.07			0.07
<i>Cladonia uncialis</i> (L.) F. H. Wigg.†	0.53	0.40	0.67	0.67
<i>Dactylina arctica</i> (Richardson) Nyl.	0.13	0.20		0.07
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell†	0.93	1.00	1.00	1.00
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell†	0.47	0.40	0.40	0.40
<i>Gowardia nigricans</i> (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen	0.07	0.13	0.27	0.07
<i>Lobaria linita</i> (Ach.) Rabenh.	0.47		0.07	0.40
<i>Melanohalea septentrionalis</i> (Lyngé) O. Blanco et al.	0.20	0.07		0.07
<i>Nephroma arcticum</i> (L.) Torss.	0.13		0.13	
<i>Nephroma expallidum</i> (Nyl.) Nyl.	0.13			
<i>Parmeliopsis ambigua</i> (Wulfen) Nyl.	0.13			0.20
<i>Parmeliopsis hyperopta</i> (Ach.) Arnold	0.33		0.13	0.07
<i>Peltigera aphthosa</i> (L.) Willd.†	0.73	0.67	0.27	0.87
<i>Peltigera leucophlebia</i> (Nyl.) Gyelnik			0.40	0.07
<i>Peltigera malacea</i> (Ach.) Funck	0.73	0.07	0.27	0.53
<i>Peltigera polydactyla</i> (Necker) Hoffm.	0.40		0.20	0.07

**3a.ii. Mid-elevation (450-900 m) treeline spruce
Lake Clark NPP**

	Plot ID 02_S996	02_S997	02_S998	02_S999
<i>Peltigera scabrosa</i> Th. Fr.	0.47	0.27	0.07	0.13
<i>Psoroma hypnorum</i> (Vahl) Gray	0.70			0.40
<i>Sphaerophorus globosus</i> (Hudson) Vainio	0.07	0.07	0.33	0.40
<i>Stereocaulon paschale</i> (L.) Hoffm.†	0.93	0.40	0.60	1.00
<i>Thamnolia subuliformis</i> (Ehrh.) W. L. Culb. / <i>T. vermicularis</i> (Sw.) Ach. ex Schaerer†	0.60	0.20	0.47	0.73
<i>Tuckermannopsis sepincola</i> (Ehrh.) Hale	0.53		0.33	0.27
<i>Vulpicida pinastri</i> (Scop.) J.-E. Mattsson & M. J. Lai	0.20	0.07	0.13	0.27
Bryophytes				
<i>Anastrophillum minutum</i> (Schreb.) R. M. Schust. var. <i>minutum</i>		0.08	0.13	
<i>Aulacomnium palustre</i> (Hedwig) Schwaegr.	0.07			0.07
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwaegr.	0.40	0.38		0.13
<i>Buxbaumia aphylla</i> Hedwig				0.13
<i>Cephalozia bicuspidata</i> (L.) Dumort. ssp. <i>bicuspidata</i>		0.08		
<i>Dicranum fuscescens</i> Turner var. <i>fuscescens</i>			0.47	0.33
<i>Dicranum groenlandicum</i> Bridel†	0.60	0.38	0.60	0.73
<i>Dicranum scoparium</i> Hedwig	0.73	0.08		0.53
<i>Dicranum undulatum</i> Bridel			0.13	0.07
<i>Hypnum plicatulum</i> (Lindberg) Jaeg.	0.07			0.07
<i>Hylocomium splendens</i> (Hedwig) Schimper in B.S.G.	0.80	0.23	0.07	0.27
<i>Lophozia ventricosa</i> (Dicks.) Dumort. var. <i>ventricosa</i>				0.07
<i>Pleurozium schreberi</i> (Bridel) Mitten	0.13	0.38	0.20	0.33
<i>Polytrichum commune</i> Hedwig var. <i>commune</i> †	0.73	0.31	0.80	0.87
<i>Pohlia cruda</i> (Hedwig) Lindberg			0.07	0.20
<i>Polytrichum hyperboreum</i> R. Brown	0.13		0.07	0.20
<i>Polytrichum juniperinum</i> Hedwig		0.23		0.13
<i>Pohlia nutans</i> (Hedwig) Lindberg	0.53	0.08		0.20
<i>Polytrichum piliferum</i> Hedwig			0.07	0.07
<i>Polytrichum strictum</i> Bridel	0.47	0.08	0.07	0.27
<i>Pogonatum urnigerum</i> (Hedwig) P. Beauvois				0.07
<i>Ptilium crista-castrensis</i> (Hedwig) De Not.	0.20		0.07	0.13
<i>Racomitrium lanuginosum</i> (Hedwig) Bridel	0.13	0.08		0.13
<i>Rhytidium rugosum</i> (Hedwig) Kindberg	0.13	0.08	0.07	0.20
<i>Sanionia uncinata</i> (Hedwig) Loeske	0.07			0.07
<i>Sphagnum girgensohnii</i> Russow	0.07		0.07	

**3a.iii. Mid elevation (450-900 m) low shrub
Lake Clark NPP**

	Plot ID 02_006	02-999*
Vascular species		
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng†	0.73	0.73
<i>Anemone narcissiflora</i> L.		0.13
<i>Arctous alpina</i> (L.) Niedenzu	0.07	0.60
<i>Artemisia arctica</i> Less. subsp. <i>arctica</i>		0.20
<i>Betula nana</i> L.†	1.00	0.93
<i>Calamagrostis lapponica</i> (Wahlenb.) Hartm.†	0.27	0.93

**3a.iii. Mid elevation (450-900 m) low shrub
Lake Clark NPP**

	Plot ID 02_006	02-999*
<i>Carex lugens</i> T. Holm†	0.87	1.00
<i>Diapensia lapponica</i> L.		0.07
<i>Empetrum nigrum</i> L.†	0.93	0.80
<i>Festuca altaica</i> Trin.		0.33
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén†	1.00	1.00
<i>Loiseleuria procumbens</i> (L.) Desv.	0.20	0.13
<i>Lycopodium lagopus</i> (Laestadius ex C. Hartman) Zinserl. ex Kuzen	0.07	
<i>Orthilia secunda</i> (L.) House	0.07	
<i>Oxytropis nigrescens</i> (Pall.) Fisch. ex DC. var. <i>nigrescens</i>		0.07
<i>Petasites frigidus</i> (L.) Franch.	0.07	0.13
<i>Pedicularis labradorica</i> Wirsing†	0.20	0.27
<i>Picea glauca</i> (Moench) Voss	0.47	0.13
<i>Poa arctica</i> R. Br.		0.07
<i>Rubus chamaemorus</i> L.	0.20	
<i>Salix glauca</i> L.		0.07
<i>Salix phlebophylla</i> Andersson		0.07
<i>Salix pulchra</i> Cham.	0.33	0.13
<i>Trientalis europaea</i> L. subsp. <i>arctica</i> (Fisch. ex Hook.) Hultén		0.07
<i>Vaccinium uliginosum</i> L.†	1.00	1.00
<i>Vaccinium vitis-idaea</i> L.†	0.67	1.00
Lichens		
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.67	1.00
<i>Cetraria laevigata</i> Rass.	0.60	
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	0.93	1.00
<i>Cladonia amaurocraea</i> (Flörke) Schaerer	0.13	0.40
<i>Cladonia bellidiflora</i> (Ach.) Schaerer†	0.33	0.20
<i>Cladonia cenotea</i> (Ach.) Schaerer	0.07	
<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Sprengel†	0.33	0.67
<i>Cladonia cornuta</i> (L.) Hoffm. subsp. <i>cornuta</i> †	0.20	0.40
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i> †	0.33	0.87
<i>Cladonia deformis</i> (L.) Hoffm.	0.07	0.13
<i>Cladonia gracilis</i> subsp. <i>turbinata</i> (Ach.) Ahti	0.07	0.40
<i>Cladonia gracilis</i> subsp. <i>vulnerata</i> Ahti†	0.87	0.60
<i>Cladonia macrophylla</i> (Schaerer) Stenh.	0.07	
<i>Cladonia pleurota</i> (Flörke) Schaerer	0.33	0.13
<i>Cladonia squamosa</i> Hoffm.	0.07	0.07
<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda	0.13	0.33
<i>Cladonia stygia</i> (Fr.) Ruoss†	0.80	0.80
<i>Cladonia sulphurina</i> (Michaux) Fr.†	0.20	0.27
<i>Cladonia uncialis</i> (L.) F. H. Wigg.†	0.40	0.87
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell†	0.87	0.93
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell	0.13	0.20
<i>Lobaria linita</i> (Ach.) Rabenh.	0.07	0.07
<i>Melanohalea septentrionalis</i> (Lyngé) O. Blanco et al.	0.13	
<i>Nephroma arcticum</i> (L.) Torss.	0.13	0.20
<i>Parmeliopsis ambigua</i> (Wulfen) Nyl.	0.73	

3a.iii. Mid elevation (450-900 m) low shrub Lake Clark NPP			Plot ID 02_006	02-999*
<i>Parmeliopsis hyperopta</i> (Ach.) Arnold			0.80	
<i>Parmelia sulcata</i> Taylor			0.07	
<i>Peltigera aphthosa</i> (L.) Willd.†			0.40	0.33
<i>Peltigera britannica</i> (Gyelnik) Holt.-Hartw. & Tønsberg			0.07	
<i>Peltigera leucophlebia</i> (Nyl.) Gyelnik			0.07	0.20
<i>Peltigera malacea</i> (Ach.) Funck			0.07	0.27
<i>Peltigera polydactyla</i> (Necker) Hoffm.†			0.27	0.13
<i>Peltigera scabrosa</i> Th. Fr.			0.13	0.27
<i>Stereocaulon paschale</i> (L.) Hoffm.†			0.40	1.00
<i>Thamnolia subuliformis</i> (Ehrh.) W. L. Culb. / <i>T. vermicularis</i> (Sw.) Ach. ex Schaerer†			0.27	0.87
<i>Tuckermannopsis sepincola</i> (Ehrh.) Hale†			1.00	0.20
<i>Vulpicida pinastri</i> (Scop.) J.-E. Mattsson & M. J. Lai†			0.87	0.20
Bryophytes				
<i>Anastrophyllum minutum</i> (Schreb.) R. M. Schust. var. <i>minutum</i>			0.07	
<i>Aulacomnium palustre</i> (Hedwig) Schwaegr.			0.27	
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwaegr.†			0.33	0.47
<i>Buxbaumia aphylla</i> Hedwig			0.07	
<i>Dicranum groenlandicum</i> Bridel†			0.53	0.67
<i>Dicranum scoparium</i> Hedwig†			0.67	0.93
<i>Dicranum undulatum</i> Bridel			0.13	0.07
<i>Hypnum plicatulum</i> (Lindberg) Jaeg.			0.07	0.27
<i>Hylocomium splendens</i> (Hedwig) Schimper in B.S.G.†			0.53	0.40
<i>Lophozia ventricosa</i> (Dicks.) Dumort. var. <i>ventricosa</i>			0.13	
<i>Plagiothecium laetum</i> Bruch, Schimper & W. Gumbel			0.07	
<i>Pleurozium schreberi</i> (Bridel) Mitten†			0.87	0.13
<i>Polytrichum commune</i> Hedwig var. <i>commune</i> †			0.73	1.00
<i>Polytrichum juniperinum</i> Hedwig			0.07	
<i>Pohlia nutans</i> (Hedwig) Lindberg†			0.20	
<i>Polytrichum strictum</i> Bridel†			0.33	0.20
<i>Ptilidium ciliare</i> (L.) Hampe			0.07	
<i>Ptilium crista-castrensis</i> (Hedwig) De Not.†			0.20	0.20
<i>Racomitrium lanuginosum</i> (Hedwig) Bridel			0.07	
<i>Sanionia uncinata</i> (Hedwig) Loeske			0.07	
<i>Sphagnum girgensohnii</i> Russow			0.07	

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL Lake Clark NPP											
	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
Vascular species											
<i>Androsace chamaejasme</i> Wulfen ssp.				0.27	0.07		0.27	0.20			
<i>lehmanniana</i> (Spreng.) Hultén											
<i>Anemone</i> L.					0.40						
<i>Antennaria friesiana</i> (Trautv.) Ekman†	0.27	0.87	0.47	1.00	0.87	0.73	0.20	1.00		0.20	
<i>Antennaria monocephala</i> DC.†	0.93		0.93		0.93	0.67	0.87		0.60	0.20	0.67

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.67
<i>Anemone narcissiflora</i> L.†	1.00	0.87	1.00	1.00	1.00	1.00	1.00	0.87	0.13	0.07	1.00
<i>Antennaria</i> Gaertn.†	0.47		0.73			0.40	0.40		0.60	0.93	
<i>Artemisia arctica</i> Less. subsp. <i>arctica</i> †	0.13	0.07	0.53	0.07	0.60	0.27	0.40		0.07		0.87
<i>Arnica frigida</i> C.A. Mey. Ex Iljin†	1.00	0.60	0.53	0.27	0.07	0.87	1.00	0.67		0.73	0.47
<i>Astragalus umbellatus</i> Bunge‡					0.07						
<i>Bistorta plumosa</i> (Small) Greene					0.13		0.20				
<i>Bistorta vivipara</i> (Linnaeus) Delarbre†	0.20	0.13	0.93	0.67	0.87	0.33	0.67	0.87			
<i>Bupleurum americanum</i> J.M. Coult. & Rose								0.13			
<i>Carex capillaris</i> L.							0.13				
<i>Calamagrostis lapponica</i> (Wahlenb.) Hartm.											1.00
<i>Campanula lasiocarpa</i> Cham.†	1.00		1.00	1.00	1.00	1.00	1.00	0.93	0.93	0.93	
<i>Cassiope lycopodioides</i> (Pall.) D. Don‡						0.07					
<i>Carex misandra</i> R. Br.							0.33			0.07	
<i>Carex microchaeta</i> subsp. <i>nesophila</i> (Holm) E. Murr.†	1.00	0.80	1.00	1.00	1.00	1.00	1.00	0.93	1.00	1.00	1.00
<i>Cassiope tetragona</i> (L.) D. Don									0.93		
<i>Campanula uniflora</i> L.							0.07	0.13			
<i>Chamerion latifolium</i> (L.) Holub‡							0.07				
<i>Diapensia lapponica</i> L.†	1.00	0.67	1.00	1.00	1.00	1.00	1.00	0.87	1.00	1.00	0.80
<i>Dryas octopetala</i> L.†	1.00		1.00	1.00	1.00	1.00	1.00	1.00	0.20		
<i>Dryas octopetala</i> subsp. <i>alaskensis</i> (Porsild)† Hultén		1.00								1.00	1.00
<i>Empetrum nigrum</i> L.							0.07		0.47		0.13
<i>Festuca altaica</i> Trin.							0.20				
<i>Festuca brachyphylla</i> Schult. ex Schult. & Schult. f.		0.87						0.80			
<i>Festuca</i> L.	0.20			0.13	0.13		0.20				
<i>Gentiana algida</i> Pall.							0.20				
<i>Gentiana glauca</i> Pall.	0.07				0.13	0.67	0.40		0.27		0.13
<i>Huperzia selago</i> (L.) Bernh.	0.07		0.07		0.60	0.67	0.33		0.40		
<i>Kobresia myosuroides</i> (Vill.) Fiori				0.07			0.13	0.07			
<i>Lagotis glauca</i> Gaertn.‡							0.07				
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén†		0.07		0.20	1.00	0.07	0.07	0.07	0.87	0.47	0.33
<i>Lloydia serotina</i> (L.) Rchb.†		0.87	0.80		1.00	0.33	0.20	0.67	0.27	0.67	0.93
<i>Loiseleuria procumbens</i> (L.) Desv.†	0.93				0.60	0.87	0.13		1.00	0.20	
<i>Luzula arcuata</i> (Wahlenb.) Sw.†			0.07	0.07							
<i>Luzula arcuata</i> (Wahlenb.) Sw. ssp. <i>unalaschensis</i> (Buchenau) Hultén			0.33	0.67	0.33		0.67		0.13	0.07	0.40
<i>Luzula kjellmaniana</i> Miyabe & Kudo		1.00						0.67			
<i>Luzula</i> DC.	0.13							0.33			
<i>Minuartia arctica</i> (Stev.) Aschers. & Graebn†	0.60	0.80	0.33	0.27		0.53	0.47	0.53	0.13	0.60	0.40
<i>Minuartia macrocarpa</i> (Pursh) Ostenf.					0.20		0.20				
<i>Oxytropis campestris</i> (L.) DC. var. <i>jordalii</i> (A.E. Porsild) S.L. Welsh								0.80			
<i>Oxytropis maydelliana</i> Trautv.					0.47		0.07				

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Oxytropis nigrescens</i> (Pall.) Fisch. ex DC. var. <i>nigrescens</i> †	1.00	1.00	1.00	1.00	1.00	0.87	0.93	1.00	0.80	1.00	1.00
<i>Packera cymbalaria</i> (Pursh) W.A. Weber & A. Löve						0.07	0.13	0.80			
<i>Pedicularis capitata</i> Adams†	0.07		0.07	0.40	0.73		0.60	0.40	0.13		
<i>Pedicularis</i> L.		0.33		0.20				0.07			
<i>Pedicularis lanata</i> Cham. & Schldl.†			0.80			0.53	0.20		0.47	0.07	0.40
<i>Pedicularis langsdoeffii</i> Fisch. ex Stev.	0.73				0.40						
<i>Pedicularis sudetica</i> Willd. ssp. <i>pacifica</i> Hultén			1.00								
<i>Pedicularis verticillata</i> L.			0.67	0.07		0.07	0.53	0.20			
<i>Poa</i> L.‡						0.07					
<i>Poa pratensis</i> L. subsp. <i>alpigena</i> (Fries. ex Blytt) Hiitonen					0.20		0.33	0.20			0.13
<i>Poa pseudoabbreviata</i> Rosh.								0.13			
<i>Primula cuneifolia</i> Ledeb.†	0.47				0.67	0.60	0.47				
<i>Primula cuneifolia</i> Ledeb. subsp. <i>saxifragifolia</i> (Lehm.) W.W. Sm. & G. Forrest†				0.07							
<i>Rhodiola integrifolia</i> Raf. subsp. <i>integrifolia</i> †	0.13	0.47	0.67			0.27	0.27		0.07	0.07	0.80
<i>Salix arctica</i> Pall.†	0.93	0.93	1.00	0.53	0.20	0.73	0.87	0.87	0.07		
<i>Saxifraga bronchialis</i> L.		0.40									0.27
<i>Salix</i> L.‡	0.07										
<i>Saxifraga nelsoniana</i> D. Don subsp. <i>nelsoniana</i>					0.33		0.07				
<i>Salix phlebophylla</i> Andersson†	1.00	0.93	1.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00	1.00
<i>Salix reticulata</i> L.‡							0.07				
<i>Salix rotundifolia</i> Trautv.	0.20		0.33			0.40			0.13		
<i>Silene acaulis</i> (L.) Jacq.‡							0.07				
<i>Stellaria longipes</i> Goldie subsp. <i>longipes</i>		0.13									
<i>Tofieldia coccinea</i> Richards.					0.27		0.07	0.07			
<i>Trisetum spicatum</i> (L.) K. Richt.†		0.53		0.67	0.27		0.53	1.00			
<i>Vaccinium uliginosum</i> L.†	0.07			0.07	0.33	0.47	0.07	0.13	0.60	0.13	0.53
<i>Vaccinium vitis-idaea</i> L.†	0.13				1.00	0.67	0.33		1.00	0.27	0.87
Lichens											
<i>Allantoparmelia alpicola</i> (Th. Fr.) Essl.†		0.33				0.73	0.20		0.13	1.00	0.10
<i>Alectoria ochroleuca</i> (Hoffm.) A. Massal.†	0.80	0.89	1.00	0.93	0.93	0.80	0.73	1.00	0.07	1.00	0.50
<i>Arctocetraria andrejevii</i> (Oksner) Kärnefelt & Thell†							0.07				
<i>Arctoparmelia separata</i> (Th. Fr.) Hale	0.87		0.87	0.07		0.27	0.47	0.13			
<i>Asahinea chrysantha</i> (Tuck.) W. L. Culb. & C. F. Culb.	0.80	0.78	0.87	1.00	1.00	0.80	0.73	0.87		0.80	0.60
<i>Asahinea scholanderi</i> (Llano) W.L. Culb. & C.F. Culb.†	0.07		0.27			0.53	0.27			0.73	
<i>Baeomyces placophyllus</i> Ach.								0.13			
<i>Bryocaulon divergens</i> (Ach.) Kärnefelt†	0.60	0.89	1.00	1.00	0.73	0.33	0.60	0.93		1.00	0.40
<i>Bryoria nitidula</i> (Th. Fr.) Brodo & D. Hawksw.		0.11		0.20		0.07		0.13		0.07	
<i>Cetraria aculeata</i> (Schreb.) Fr.	0.07						0.07	0.87			

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Cetrelia alaskana</i> (C.F. Culb. & W.L. Culb.) W.L. Culb. & C.F. Culb.		0.11						0.53			0.10
<i>Cetrariella delisei</i> (Bory ex Schaerer) Kärnefelt & Thell†					0.07						
<i>Cetraria ericetorum</i> subsp. <i>reticulata</i> (Räsänen) Kärnefelt†	0.40	0.89	0.13	0.20	0.40		0.80	0.67	0.67	0.33	0.10
<i>Cetrariella fastigiata</i> (Delise ex Nyl.) Kärnefelt & Thell			0.13			0.13	0.13		0.27		
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.33		0.60	0.93	1.00	0.93	0.33	0.33	0.13	0.53	0.90
<i>Cetraria kamczatica</i> Savicz†	0.33	0.44	0.20	0.20	1.00	0.40	0.73	0.13	0.93	0.67	0.90
<i>Cetraria laevigata</i> Rass.				0.07	0.27			0.13			
<i>Cetraria muricata</i> (Ach.) Eckfeldt†		0.11									
<i>Cetraria nigricans</i> Nyl.†	0.93	0.44	0.93	0.47	1.00	1.00	0.80	0.40	1.00	1.00	0.70
<i>Melanelia agnata</i> (Nyl.) Thell†							0.07				
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	0.60	0.89	0.73	1.00	1.00	1.00	0.93	0.80	1.00	0.87	0.90
<i>Cladonia amaurocraea</i> (Flörke) Schaerer		0.33	0.13	0.20	0.40	0.07	0.13	0.40	0.07		0.20
<i>Cladonia bellidiflora</i> (Ach.) Schaerer				0.13		0.13	0.07		0.27		0.30
<i>Cladonia borealis</i> S. Stenroos†	0.67	0.78	0.93	0.93	0.93	1.00	0.87	0.87	1.00	0.73	0.90
<i>Cladonia cervicornis</i> subsp. <i>verticillata</i> (Hoffm.) Ahti			0.07	0.40	0.13	0.07		0.13	0.07	0.07	
<i>Cladonia chlorophaea</i> (Flörke ex Sommerf.) Sprengel	0.07				0.53			0.07			
<i>Cladonia cornuta</i> subsp. <i>groenlandica</i> (E. Dahl) Ahti					0.13						
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i>		0.11		0.20	0.60		0.13	0.07	0.40	0.07	0.30
<i>Cladonia gracilis</i> subsp. <i>elongata</i> (Jacq.) Vainio							0.20		0.13		
<i>Cladonia macroceras</i> (Delise) Hav.†	0.13	0.67	0.93	0.60	1.00	0.80	0.87	0.67	1.00	0.53	0.90
<i>Cladonia macrophylla</i> (Schaerer) Stenh.						0.20			0.13		0.20
<i>Cladonia nipponica</i> Asahina†						0.07					
<i>Cladonia phyllophora</i> Hoffm.	0.07		0.13	0.40	0.53	0.07	0.13	0.20		0.07	0.40
<i>Cladonia pleurota</i> (Flörke) Schaerer†											0.10
<i>Cladonia pyxidata</i> (L.) Hoffm.†	0.27	0.11	0.20	0.93	0.33	0.47	0.20	0.67	0.33	0.20	0.80
<i>Cladonia squamosa</i> Hoffm.		0.11		0.20	0.07		0.07		0.27		0.20
<i>Cladonia stellaris</i> (Opiz) Pouzar & Vězda				0.07	0.13						0.20
<i>Cladonia stygia</i> (Fr.) Ruoss	0.07								0.20		0.20
<i>Cladonia sulphurina</i> (Michaux) Fr.†		0.11									
<i>Cladonia uncialis</i> (L.) F. H. Wigg.†	0.40	0.89	0.07	0.73	1.00	0.07	0.60	0.40	0.47	0.07	0.90
<i>Dactylina arctica</i> (Richardson) Nyl.†		0.67	0.40	0.67	1.00	0.40	0.53	0.60	0.07		0.90
<i>Dactylina ramulosa</i> (Hook.) Tuck.†	0.60	0.33	0.73	0.47	0.80	0.27	0.27	0.20	0.67	0.47	0.50
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell†	0.13	1.00	0.67	1.00	1.00	0.13	0.67	0.93		0.33	0.90
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell†	0.93	0.89	0.93	1.00	1.00	1.00	0.87	1.00	0.93	0.93	0.90
<i>Gowardia nigricans</i> (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen†	0.07	0.89	0.60	0.67	0.87	0.80	0.80	0.73	1.00	0.80	0.90
<i>Hypogymnia subobscura</i> (Vainio) Poelt†	0.27	1.00	0.67	0.93	0.40	0.07	0.33	1.00		0.13	0.10

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Leptogium lichenoides</i> (L.) Zahlbr.‡		0.11									
<i>Lobaria linita</i> (Ach.) Rabenh.†		1.00	0.20	0.87	1.00		0.73	1.00			0.70
<i>Melanelia hepatizon</i> (Ach.) Thell / <i>M. commixta</i> (Nyl.) Thell†	1.00	0.56	1.00	0.07	0.20	0.73	0.60	0.53	0.87	0.53	0.80
<i>Melanelia panniformis</i> (Nyl.) Essl.	0.07					0.13					
<i>Melanelia stygia</i> (L.) Essl.†	0.13	0.11	0.47			0.53	0.13		0.60	0.93	
<i>Nephroma arcticum</i> (L.) Torss.											0.20
<i>Nephroma expallidum</i> (Nyl.) Nyl.		0.44			0.07			0.53			0.20
<i>Parmelia omphalodes</i> (L.) Ach. subsp. <i>omphalodes</i> †	0.93	1.00	1.00	0.93	0.60	0.40	0.73	1.00		0.73	0.70
<i>Peltigera aphthosa</i> (L.) Willd.†	0.07	0.33	0.13	0.60	0.47		0.33	1.00			
<i>Peltigera didactyla</i> (With.) J. R. Laundon	0.07	0.33	0.07		0.07		0.07	0.13			
<i>Peltigera leucophlebia</i> (Nyl.) Gyelnik											0.60
<i>Peltigera malacea</i> (Ach.) Funck			0.07	0.40	0.53		0.07	0.33			
<i>Peltigera neopolydactyla</i> (Gyelnik) Gyelnik											0.40
<i>Peltigera polydactyla</i> (Necker) Hoffm.		0.33					0.07				
<i>Peltigera praetextata</i> (Flörke ex Sommerf.) Zopf†								0.07			
<i>Peltigera rufescens</i> (Weiss) Humb.		0.11		0.13	0.07		0.07				
<i>Peltigera scabrosa</i> Th. Fr.					0.07		0.07	0.07			
<i>Phaeophyscia constipata</i> (Norrlin & Nyl.) Moberg		0.33									
<i>Protopannaria pezizoides</i> (Weber) P. M. Jørg. & S. Ekman		0.33						0.20			0.10
<i>Psoroma hypnorum</i> (Vahl) Gray†		0.67	0.20	0.67	0.87		0.47	1.00			0.80
<i>Pseudephebe minuscula</i> (Nyl. ex Arnold) Brodo & D. Hawksw.		0.78							0.40	0.87	
<i>Pseudephebe pubescens</i> (L.) M. Choisy†	1.00	0.44	0.93	0.27		0.73	0.67	0.20	0.40	1.00	0.30
<i>Solorina crocea</i> (L.) Ach.	0.07	0.11	0.13				0.20	0.40			
<i>Sphaerophorus globosus</i> (Hudson) Vainio†	1.00	1.00	1.00	1.00	1.00	0.87	0.87	1.00	1.00	1.00	0.80
<i>Sticta arctica</i> Degel.		0.33		0.13				0.40			0.40
<i>Stereocaulon paschale</i> (L.) Hoffm.†		0.22	0.07	0.73	0.60		0.27	0.27			0.70
<i>Stereocaulon sterile</i> (Savicz) Lamb ex Krog						0.13					
<i>Stereocaulon tomentosum</i> Fr.					0.27			0.53			
<i>Thamnolia subuliformis</i> (Ehrh.) W. L. Culb. / <i>T. vermicularis</i> (Sw.) Ach. ex Schaerer†	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm. var. <i>hyperborea</i> †	0.60	0.11				0.60	0.07		0.67	0.93	
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm. var. <i>radicicula</i> (J.E. Zetterst.) Hasselrot†						0.07					
<i>Umbilicaria proboscidea</i> (L.) Schrader†	0.87	0.33	0.67			0.87	0.67		0.60	0.93	0.20
<i>Umbilicaria torrefacta</i> (Lightf.) Schrader†	0.27	0.78	0.93			0.20	0.53	0.07	0.33	0.13	0.50
<i>Vulpicida tilesii</i> (Ach.) J.-E. Mattsson & M. J. Lai							0.07	0.40			0.10
Bryophytes											
<i>Abietinella abietina</i> (Hedw.) Fleisch.		0.22			0.07						
<i>Anastrophyllum minutum</i> (Schreb.) R. M. Schust. var. <i>minutum</i>		0.11	0.07	0.13	0.73	0.13	0.13	0.20			0.33

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	Plot ID										
	03S_001*	03S_998	03S_003	03S_004	03S_005	03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Andreaea rupestris</i> Hedwig†	0.53		0.47		0.07	0.80	0.40		0.73	0.20	0.11
<i>Anthelia juratzkana</i> (Limpr.) Trevis.†	0.07		0.20	0.07	0.20	0.60	0.53	0.33	0.47	0.27	
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwaegr.					0.87		0.40	0.33			
<i>Barbula convoluta</i> Hedwig var. <i>convoluta</i> ‡								0.07			
<i>Bartramia ithyphylla</i> Bridel		0.33									0.11
<i>Blepharostoma trichophyllum</i> (L.) Dumort. subsp. <i>trichophyllum</i> ‡							0.07				
<i>Bucklandiella heterosticha</i> (Hedwig) Bednarek-Ochyra & Ochyra in R. Ochyra et al.						0.13		0.07	0.07		
<i>Ceratodon purpureus</i> (Hedwig) Bridel subsp. <i>purpureus</i>	0.07				0.13						
<i>Conostomum tetragonum</i> (Hedwig) Lindberg†			0.20	0.47	0.60	0.07	0.47	0.47			0.11
<i>Dicranoweisia crispula</i> (Hedwig) Milde		0.11	0.13	0.07			0.20			0.13	0.22
<i>Dicranum fuscescens</i> Turner var. <i>fuscescens</i> ‡											0.11
<i>Dicranum groenlandicum</i> Bridel†		0.89	0.80	0.93	1.00	0.47	0.53	0.93	0.20	0.27	1.00
<i>Dicranum scoparium</i> Hedwig					0.20		0.13		0.13		
<i>Dicranum undulatum</i> Bridel‡					0.07						
<i>Diplophyllum taxifolium</i> (Wahlenberg) Dumortier†			0.13	0.13	0.20	0.80	0.40	0.20	0.20	0.47	
<i>Encalypta raptocarpa</i> Schwägrichen		0.44		0.20				0.13			
<i>Gymnomitrium concinnum</i> (Lightf.) Corda						0.33	0.07			0.20	
<i>Gymnomitrium corallioides</i> Nees†		0.22	0.60		0.07	1.00	0.40	0.40	0.67	0.53	
<i>Hylocomium splendens</i> (Hedwig) Schimper in B.S.G.					0.53		0.40	0.20			0.11
<i>Hypnum plicatum</i> (Lindberg) Jaeg.		0.33		0.07	0.20		0.07	0.13			0.33
<i>Lophozia sudetica</i> (Nees ex Huebener) Grolle var. <i>sudetica</i>							0.67				
<i>Lophozia ventricosa</i> (Dicks.) Dumort. var. <i>ventricosa</i> †			0.40		0.07	0.93			0.40		0.22
<i>Marsupella commutata</i> (Limpr.) Bernet‡			0.07								
<i>Mnium spinulosum</i> Bruch & Schimp.‡		0.11									
<i>Nardia scalaris</i> (Schrader) Gray		0.22	0.07			0.07					
<i>Niphotrichum ericoides</i> (Bridel) Bednarek-Ochyra & Ochyra in R. Ochyra et al.					0.13						
<i>Oligotrichum falcatum</i> Steere‡						0.07					
<i>Oligotrichum hercynicum</i> (Hedwig) Lamarck & A. P. DeCandolle							0.07		0.07	0.20	
<i>Oligotrichum parallelum</i> (Mitten) Kindberg‡						0.07					
<i>Paraleucobryum enerve</i> (Thedenius) Loeske			0.13			0.33					
<i>Pleurozium schreberi</i> (Bridel) Mitten‡											0.11
<i>Pogonatum urnigerum</i> (Hedwig) P. Beauvois†		0.56	0.73	0.07		0.87	0.20	0.60	0.33	0.47	
<i>Pohlia cruda</i> (Hedwig) Lindberg								0.20			0.11
<i>Pohlia crudoides</i> (Sull. & Lesq.) Broth.						0.13					
<i>Pohlia nutans</i> (Hedwig) Lindberg			0.60		0.27	0.20	0.07		0.33		
<i>Polytrichum commune</i> Hedwig var. <i>commune</i>							0.13				0.44
<i>Polytrichum hyperboreum</i> R. Brown†		0.78	0.60	0.87	1.00	0.40	0.93	0.80	0.93	0.80	1.00
<i>Polytrichum piliferum</i> Hedwig†		0.78	0.53	0.80	0.53	0.53	0.53	0.87	0.87	0.80	0.67

3a.iv. High elevation (>900 m) dwarf shrub tundra - LACL

	03S_001*	03S_998	03S_003	03S_004	03S_005	Plot ID 03S_007	03S_016	03S_027	03S_030	03S_055	03S_997
<i>Polytrichum strictum</i> Bridel				0.20	0.33		0.07				
<i>Ptychostomum creberrimum</i> (Taylor) J. R. Spence & H. P. Ramsay				0.67							
<i>Racomitrium lanuginosum</i> (Hedwig) Bridel†			0.73	0.33	0.33	1.00	0.87	0.53	0.33	0.67	
<i>Rhytidium rugosum</i> (Hedwig) Kindberg†		0.89		0.73	0.93		0.27	0.93			0.33
<i>Sanionia uncinata</i> (Hedwig) Loeske		0.33					0.20				
<i>Scapania cuspiduligera</i> (Nees) Müll. Frib.‡		0.11									
<i>Schistochilopsis incisa</i> (Schrader) Konstantinova var. <i>incisa</i>		0.11	0.67	0.07				0.07			
<i>Syntrichia norvegica</i> F. Weber‡		0.11									
<i>Tetralophozia setiformis</i> (Ehrh.) Schljakov							0.07		0.07		
<i>Tetraplodon mnioides</i> (Hedwig) Bruch & Schimper in P. Bruch, W. P. Schimper & W. Gümbel‡							0.07				
<i>Tomentypnum nitens</i> (Hedwig) Loeske‡							0.07				
<i>Tortella tortuosa</i> (Hedwig) Limpricht var. <i>tortuosa</i>								0.13			

Appendix 3b. Within-plot estimates of frequency (2011) for vascular and nonvascular species in Katmai National Park and Preserve.

Frequencies were measured as described above for Appendix 3a. A dagger (†) indicates species with $\geq 20\%$ frequency across all plots within an elevation $\times$ vegetation class combination. ‡ indicates species with $\leq 1\%$ frequency across all plots in an elevation $\times$ vegetation class combination.

3b.i. Mid elevation (450-900 m) dwarf shrub tundra Katmai NPP		Plot ID	
		02_048	02_070
Vascular species			
<i>Antennaria friesiana</i> (Trautv.) Ekman			0.07
<i>Antennaria monocephala</i> DC.†		0.07	0.60
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng†		0.80	0.93
<i>Anemone narcissiflora</i> L.†		0.40	0.93
<i>Andromeda polifolia</i> L.		0.07	
<i>Artemisia arctica</i> Less. subsp. <i>arctica</i> †		1.00	0.93
<i>Arnica frigida</i> C.A. Mey. Ex Iljin		0.07	
<i>Betula nana</i> L.†		0.07	0.47
<i>Bistorta</i> (Linnaeus) Scopoli			0.07
<i>Bistorta vivipara</i> (Linnaeus) Delarbre†		0.27	0.13
<i>Cardamine bellidifolia</i> L.		0.07	
<i>Calamagrostis canadensis</i> (Michx.) Beauv.		0.07	
<i>Calamagrostis lapponica</i> (Wahlenb.) Hartm.†		0.87	0.40
<i>Cassiope lycopodioides</i> (Pall.) D. Don		0.27	
<i>Carex circinata</i> C. A. Mey.		0.13	
<i>Carex microchaeta</i> subsp. <i>nesophila</i> (Holm) E. Murr.†		1.00	1.00
<i>Carex</i> L.		0.07	
<i>Diapensia lapponica</i> L.†		0.87	1.00
<i>Dryas octopetala</i> L.			0.13
<i>Empetrum nigrum</i> L.†		1.00	1.00
<i>Gentiana algida</i> Pall.			0.07
<i>Gentiana glauca</i> Pall.†		0.47	0.33
<i>Harrimanella stelleriana</i> (Pall.) Coville		0.20	
<i>Huperzia selago</i> (L.) Bernh.†		0.20	0.20
<i>Lagotis glauca</i> Gaertn.		0.07	0.07
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén			0.07
<i>Lloydia serotina</i> (L.) Rchb.		0.07	
<i>Loiseleuria procumbens</i> (L.) Desv.†		0.73	1.00
<i>Luzula arcuata</i> (Wahlenb.) Sw.†		0.47	0.27
<i>Lupinus nootkatensis</i> Donn ex Sims		0.07	
<i>Minuartia arctica</i> (Stev.) Aschers. & Graebn†		0.20	0.60
<i>Oxytropis nigrescens</i> (Pall.) Fisch. ex DC. var. <i>nigrescens</i> †		0.07	1.00
<i>Pedicularis capitata</i> Adams		0.07	0.13
<i>Pedicularis langsдорffii</i> Fisch. ex Stev.†			0.47
<i>Poa</i> L.		0.20	
<i>Primula cuneifolia</i> Ledeb.†		0.40	0.33
<i>Rhododendron camtschaticum</i> Pall.		0.73	0.60
<i>Rhodiola integrifolia</i> Raf. subsp. <i>integrifolia</i> †		0.53	0.13
<i>Salix arctica</i> Pall.†		0.73	0.27
<i>Salix phlebophylla</i> Andersson†		1.00	1.00

3b.i. Mid elevation (450-900 m) dwarf shrub tundra Katmai NPP		
	Plot ID 02_048	02_070
<i>Salix rotundifolia</i> Trautv.	0.27	
<i>Salix stolonifera</i> Coville†	0.60	
<i>Vaccinium uliginosum</i> L.†	1.00	0.93
<i>Vaccinium vitis-idaea</i> L.†	0.73	0.87
Lichens		
<i>Arctocetraria andrejevii</i> (Oksner) Kärnefelt & Thell	0.11	
<i>Baeomyces rufus</i> (Hudson) Rebent.		0.07
<i>Cetraria ericetorum</i> subsp. <i>reticulata</i> (Räsänen) Kärnefelt†	0.89	
<i>Cetrariella fastigiata</i> (Delise ex Nyl.) Kärnefelt & Thell†	1.00	0.33
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.33	0.67
<i>Cetraria kamczatica</i> Savicz†	0.44	0.53
<i>Cetraria nigricans</i> Nyl.†	0.11	0.27
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	1.00	0.67
<i>Cladonia amaurocraea</i> (Flörke) Schaerer		0.07
<i>Cladonia stygia</i> (Fr.) Ruoss		0.07
<i>Cladonia bellidiflora</i> (Ach.) Schaerer†	0.89	0.67
<i>Cladonia borealis</i> S. Stenroos†	0.56	0.60
<i>Cladonia cervicornis</i> subsp. <i>verticillata</i> (Hoffm.) Ahti		0.07
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i> †	0.78	0.53
<i>Cladonia macroceras</i> (Delise) Hav.†	1.00	0.67
<i>Cladonia phyllophora</i> Hoffm.		0.13
<i>Cladonia pyxidata</i> (L.) Hoffm.		0.13
<i>Cladonia squamosa</i> Hoffm.		0.13
<i>Cladonia uncialis</i> (L.) F. H. Wigg.†	0.89	1.00
<i>Dactylina ramulosa</i> (Hook.) Tuck.		0.13
<i>Gowardia nigricans</i> (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen		0.20
<i>Lobaria linita</i> (Ach.) Rabenh.	0.22	0.07
<i>Melanelia hepaticum</i> (Ach.) Thell / <i>M. commixta</i> (Nyl.) Thell†		0.47
<i>Nephroma arcticum</i> (L.) Torss.		0.07
<i>Peltigera polydactyla</i> (Necker) Hoffm.†	0.11	0.27
<i>Peltigera scabrosa</i> Th. Fr.	0.22	0.07
<i>Psoroma hypnorum</i> (Vahl) Gray	0.11	0.07
<i>Sphaerophorus globosus</i> (Hudson) Vainio†		0.33
<i>Stereocaulon botryosum</i> Ach.	0.11	
<i>Stereocaulon paschale</i> (L.) Hoffm.	0.44	
<i>Stereocaulon sterile</i> (Savicz) Lamb ex Krog†		0.33
<i>Stereocaulon vesuvianum</i> Pers.		0.07
<i>Thamnolia subuliformis</i> (Ehrh.) W. L. Culb. / <i>T. vermicularis</i> (Sw.) Ach. ex Schaerer†	0.89	1.00
<i>Umbilicaria cylindrica</i> (L.) Delise ex Duby	0.11	
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm. var. <i>hyperborea</i>	0.11	
Bryophytes		
<i>Anthelia juratzkana</i> (Limpr.) Trevis.†	0.60	0.20
<i>Anastrophyllum minutum</i> (Schreb.) R. M. Schust. var. <i>minutum</i>		0.13
<i>Andreaea rupestris</i> Hedwig†	0.50	0.33
<i>Bucklandiella heterosticha</i> (Hedwig) Bednarek-Ochyra & Ochyra in R. Ochyra et al.†	0.70	

**3b.i. Mid elevation (450-900 m) dwarf shrub tundra
Katmai NPP**

	Plot ID	
	02_048	02_070
<i>Conostomum tetragonum</i> (Hedwig) Lindberg†	0.60	0.13
<i>Diplophyllum albicans</i> (Linnaeus) Dumortier		0.27
<i>Dicranum groenlandicum</i> Bridel†		1.00
<i>Dicranum scoparium</i> Hedwig†	0.80	
<i>Gymnomitrium corallioides</i> Nees†	0.20	0.33
<i>Lophozia ventricosa</i> (Dicks.) Dumort. var. <i>ventricosa</i>	0.10	
<i>Marsupella apiculata</i> Schiffn.†	0.40	0.07
<i>Oligotrichum hercynicum</i> (Hedwig) Lamarck & A. P. DeCandolle	0.10	
<i>Polytrichum commune</i> Hedwig var. <i>commune</i> †	0.50	0.07
<i>Polytrichum hyperboreum</i> R. Brown†	0.50	0.87
<i>Pohlia nutans</i> (Hedwig) Lindberg†	0.10	0.27
<i>Polytrichum piliferum</i> Hedwig†	0.30	0.40
<i>Polytrichum strictum</i> Bridel		0.20
<i>Pogonatum urnigerum</i> (Hedwig) P. Beauvois	0.20	
<i>Ptilium crista-castrensis</i> (Hedwig) De Not.		0.07
<i>Racomitrium lanuginosum</i> (Hedwig) Bridel†	0.50	0.87
<i>Sphagnum compactum</i> Lamarck & de Candolle	0.10	
<i>Sphagnum girgensohnii</i> Russow†		0.33

**3b.ii. High elevation (>900 m) dwarf shrub tundra
Katmai NPP**

	Plot ID								
	03_006	03_049	03_001	03_002	03_003	03_009	03_022	03_032	03_998
Vascular species									
<i>Androsace chamaejasme</i> Wulfen ssp. <i>lehmanniana</i> (Spreng.) Hultén		0.13							
<i>Antennaria friesiana</i> (Trautv.) Ekman		0.33					0.07		
<i>Antennaria monocephala</i> DC.†	1.00	0.67	0.21		0.13	0.53	0.20	0.33	
<i>Anthoxanthum monticola</i> (Bigelow) Veldkamp subsp. <i>alpinum</i> (Sw. ex Willd.) Soreng†	0.80	1.00	0.29		0.27	1.00	0.53	0.93	
<i>Anemone narcissiflora</i> L.	0.67	0.87							
<i>Artemisia arctica</i> Less. subsp. <i>arctica</i> †	1.00	0.47	0.14		0.07	1.00	0.27	0.93	
<i>Arnica frigida</i> C.A. Mey. Ex Iljin†	0.80	0.40				0.07	0.67	0.07	0.14
<i>Bistorta vivipara</i> (Linnaeus) Delarbre	1.00		0.07				0.13	0.13	
<i>Cardamine bellidifolia</i> L.†	0.13		0.29	0.36	0.40	0.40		0.13	0.43
<i>Calamagrostis lapponica</i> (Wahlenb.) Hartm.†	1.00	0.80	0.36	0.07	0.80	1.00	0.87	0.80	
<i>Cassiope lycopodioides</i> (Pall.) D. Don‡									0.14
<i>Carex microchaeta</i> ssp. <i>nesophila</i> (Holm) E. Murr.†	1.00	1.00	1.00	0.93	1.00	1.00	1.00	1.00	0.57
<i>Diapensia lapponica</i> L.†	0.87	0.87	1.00	0.79	1.00	0.40	0.27	1.00	
<i>Dryas octopetala</i> subsp. <i>alaskensis</i> (Porsild) Hultén‡							0.07		
<i>Empetrum nigrum</i> L.†	1.00	1.00	0.07		0.27	1.00	0.47	0.27	
<i>Gentiana algida</i> Pall.	0.13	0.07							
<i>Gentiana glauca</i> Pall.†	0.67	0.13				0.47	0.53	0.20	
<i>Harrimanella stelleriana</i> (Pall.) Coville							0.27		
<i>Huperzia selago</i> (L.) Bernh.	0.40								
<i>Lagotis glauca</i> Gaertn.	0.87	0.27					0.27		
<i>Ledum palustre</i> subsp. <i>decumbens</i> (Ait.) Hultén	0.13	0.13			0.27	0.20			
<i>Lloydia serotina</i> (L.) Rchb.†	1.00	0.60	0.07	0.07	0.13	0.53	0.53	0.33	
<i>Loiseleuria procumbens</i> (L.) Desv.†	0.27	0.93			0.13	0.33	0.07		

3b.ii. High elevation (>900 m) dwarf shrub tundra Katmai NPP									
	03_006	03_049	03_001	03_002	Plot ID 03_003	03_009	03_022	03_032	03_998
<i>Luzula arcuata</i> (Wahlenb.) Sw. ssp. <i>unalaschcensis</i> (Buchenau) Hultén†	1.00	0.07	1.00	0.79	1.00	1.00	1.00	0.80	0.71
<i>Minuartia arctica</i> (Stev.) Aschers. & Graebn†	0.73		0.14	0.14	0.80			0.27	
<i>Oxytropis nigrescens</i> (Pall.) Fisch. ex DC. var. <i>nigrescens</i> †	1.00	1.00	0.21		1.00	0.27		0.27	
<i>Packera cymbalaria</i> (Pursh) W.A. Weber & A. Löve	0.47	0.07							
<i>Pedicularis capitata</i> Adams	0.07	0.60							
<i>Pedicularis langsdoeffii</i> Fisch. ex Stev.†	0.87	0.93	0.14		0.47			0.33	
<i>Pedicularis verticillata</i> L.‡								0.07	
<i>Poa</i> L.‡	0.07								
<i>Poa pseudoabbreviata</i> Rosh.‡			0.07						
<i>Potentilla</i> L.	0.87								
<i>Primula cuneifolia</i> Ledeb.	0.67					0.07		0.07	
<i>Rhododendron camtschaticum</i> Pall.†	0.53	1.00			0.53	0.47		0.07	
<i>Rhodiola integrifolia</i> Raf. subsp. <i>integrifolia</i> †	1.00	0.13	0.57	0.29	0.07	0.93	0.80	0.87	
<i>Salix arctica</i> Pall.†	1.00	1.00				0.67	1.00	0.07	
<i>Salix</i> L.		0.27							
<i>Salix phlebophylla</i> Andersson†	1.00	0.93	1.00	0.86	1.00	0.93	0.67	1.00	0.14
<i>Salix pulchra</i> Cham.	0.13					0.13			
<i>Salix reticulata</i> L.	0.80								
<i>Salix rotundifolia</i> Trautv.‡						0.07			
<i>Salix stolonifera</i> Coville	0.27					0.47	0.20		
<i>Trisetum spicatum</i> (L.) K. Richt.	0.33						0.07		
<i>Vaccinium uliginosum</i> L.†	0.80	0.80				0.13	0.07	0.13	
<i>Vaccinium vitis-idaea</i> L.		0.80	0.21			0.07		0.53	
Lichens									
<i>Allantoparmelia alpicola</i> (Th. Fr.) Essl.†		0.40	0.80	0.93	1.00	0.11		0.71	
<i>Alectoria ochroleuca</i> (Hoffm.) A. Massal.				0.20	0.53			0.43	
<i>Asahinea chrysantha</i> (Tuck.) W. L. Culb. & C. F. Culb.		0.27	0.07	0.07	0.33				
<i>Asahinea scholanderi</i> (Llano) W.L. Culb. & C.F. Culb.			0.13	0.40	0.20				
<i>Bryocaulon divergens</i> (Ach.) Kärnefelt		0.20		0.33	0.27			0.14	
<i>Bryoria nitidula</i> (Th. Fr.) Brodo & D. Hawksw.‡					0.07				
<i>Cetraria ericetorum</i> subsp. <i>reticulata</i> (Räsänen) Kärnefelt†		0.27	0.87	0.20	0.40			0.86	
<i>Cetrariella fastigiata</i> (Delise ex Nyl.) Kärnefelt & Thell†	1.00	0.27	0.20	0.07	0.27	1.00	0.25	0.29	
<i>Cetraria islandica</i> subsp. <i>crispiformis</i> (Räsänen) Kärnefelt†	0.67	0.93	0.07	0.80	0.07	1.00	0.25		0.73
<i>Cetraria kamczatica</i> Savicz		0.60	0.07					0.43	
<i>Cetraria nigricans</i> Nyl.†		0.47	1.00	1.00	1.00	0.33		1.00	0.27
<i>Cladonia arbuscula</i> subsp. <i>beringiana</i> Ahti / <i>C. arbuscula</i> subsp. <i>mitis</i> (Sandst.) Ruoss†	0.56	1.00	0.40	0.67	0.73	1.00	0.38	0.86	0.27
<i>Cladonia amaurocraea</i> (Flörke) Schaerer†	0.44	0.07	0.33	0.47	0.53	0.22	0.25	0.57	0.07
<i>Cladonia stygia</i> (Fr.) Ruoss		0.20		0.07					
<i>Cladonia bellidiflora</i> (Ach.) Schaerer†		0.13	0.60	0.53	0.20	0.78		0.14	0.53
<i>Cladonia borealis</i> S. Stenroos†	1.00	0.67	0.93	0.60	0.40	1.00	0.75	0.86	0.07
<i>Cladonia cervicornis</i> subsp. <i>verticillata</i> (Hoffm.) Ahti†	0.11	0.07	0.33	0.40	0.27	0.11	0.13	0.29	0.13
<i>Cladonia crispata</i> (Ach.) Flotow var. <i>crispata</i> †	0.11	0.40	0.67	0.80	0.53	0.33		0.86	0.20
<i>Cladonia cyanipes</i> (Sommerf.) Nyl.‡		0.07							
<i>Cladonia gracilis</i> subsp. <i>elongata</i> (Jacq.) Vainio†			0.67	0.60	0.60			0.57	0.33
<i>Cladonia gracilis</i> subsp. <i>turbinata</i> (Ach.) Ahti‡							0.13		
<i>Cladonia gracilis</i> subsp. <i>vulnerata</i> Ahti	0.44	0.13					0.13		

3b.ii. High elevation (>900 m) dwarf shrub tundra Katmai NPP									
	03_006	03_049	03_001	03_002	Plot ID 03_003	03_009	03_022	03_032	03_998
<i>Cladonia macilenta</i> Hoffm.‡							0.13		
<i>Cladonia macroceras</i> (Delise) Hav.†	0.78	1.00	0.47		0.20	1.00	0.50	0.43	0.67
<i>Cladonia nipponica</i> Asahina		0.20							
<i>Cladonia phyllophora</i> Hoffm.	0.56	0.13	0.07						0.20
<i>Cladonia pyxidata</i> (L.) Hoffm.	0.33		0.20	0.07		0.11	0.25	0.29	
<i>Cladonia squamosa</i> Hoffm.			0.47	0.13		0.33		0.71	
<i>Cladonia sulphurina</i> (Michaux) Fr.						0.22	0.13		
<i>Cladonia uncialis</i> (L.) F. H. Wigg.†	0.11	1.00	0.93	0.47	1.00	0.89		0.86	0.07
<i>Dactylina ramulosa</i> (Hook.) Tuck.		0.20	0.27	0.27	0.13	0.22		0.43	
<i>Flavocetraria cucullata</i> (Bellardi) Kärnefelt & Thell†		0.60	0.20	0.13	0.33	0.33		0.14	
<i>Flavocetraria nivalis</i> (L.) Kärnefelt & Thell					0.13				
<i>Gowardia nigricans</i> (Ach.) P. Halonen, L. Myllys, S. Velmala, & H. Hyvärinen†		0.80	0.87	0.87	1.00			1.00	0.27
<i>Hypogymnia subobscura</i> (Vainio) Poelt‡					0.07				
<i>Lobaria linita</i> (Ach.) Rabenh.	0.11	0.07	0.13					0.14	
<i>Melanelia hepatizon</i> (Ach.) Thell / <i>M. commixta</i> (Nyl.) Thell†	0.33	0.33	0.93	0.93	0.93	0.89	1.00	1.00	0.67
<i>Melanelia stygia</i> (L.) Essl.†			0.80	0.93	0.87	0.33		0.86	0.07
<i>Nephroma expallidum</i> (Nyl.) Nyl.‡								0.14	
<i>Parmelia omphalodes</i> (L.) Ach. subsp. <i>omphalodes</i> †		0.33	0.67	0.47	0.67	0.11		0.29	
<i>Peltigera aphthosa</i> (L.) Willd.‡		0.07							
<i>Peltigera didactyla</i> (With.) J. R. Laundon						0.33			
<i>Peltigera leucophlebia</i> (Nyl.) Gyelnik	0.67								
<i>Peltigera malacea</i> (Ach.) Funck	0.22	0.07				0.11			
<i>Peltigera neckeri</i> Hepp ex Müll. Arg.	0.33								
<i>Peltigera polydactyla</i> (Necker) Hoffm.		0.13				0.22		0.29	
<i>Protopannaria pezizoides</i> (Weber) P. M. Jørg. & S. Ekman	0.11	0.07					0.13		
<i>Psoroma hypnorum</i> (Vahl) Gray†	0.56	0.33	0.07	0.07		0.44	0.50	0.57	
<i>Pseudephebe minuscula</i> (Nyl. ex Arnold) Brodo & D. Hawksw.†		0.13	0.20	0.80	0.73				
<i>Pseudephebe pubescens</i> (L.) M. Choisy†		0.80	1.00	1.00	1.00	0.56	0.63	1.00	0.07
<i>Solorina crocea</i> (L.) Ach.			0.07			0.22		0.14	0.33
<i>Sphaerophorus globosus</i> (Hudson) Vainio†		0.87	1.00	0.73	1.00			1.00	
<i>Stereocaulon glareosum</i> (Savicz) H. Magn.							0.50		0.73
<i>Stereocaulon paschale</i> (L.) Hoffm.‡	0.11								
<i>Stereocaulon sterile</i> (Savicz) Lamb ex Krog								0.57	
<i>Stereocaulon tomentosum</i> Fr.	0.44	0.07							
<i>Stereocaulon vesuvianum</i> Pers.†	0.11	0.20	0.60	0.60	0.27	0.78			0.53
<i>Thamnolia subuliformis</i> (Ehrh.) W. L. Culb. / <i>T. vermicularis</i> (Sw.) Ach. ex Schaerer†	1.00	0.67	1.00	0.93	1.00	1.00	0.63	0.86	0.93
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm. var. <i>hyperborea</i> †	0.22	0.80				0.56	0.88		0.73
<i>Umbilicaria hyperborea</i> (Ach.) Hoffm. var. <i>radicula</i> (J.E. Zetterst.) Hasselrot		0.07				0.11			
<i>Umbilicaria proboscidea</i> (L.) Schrader†		0.40	1.00	1.00	1.00	0.89	0.38	1.00	0.13
<i>Umbilicaria torrefacta</i> (Lightf.) Schrader†	0.22	0.20	0.73	0.60	0.80	0.89	0.75	0.43	0.53
Bryophytes									
<i>Anthelia juratzkana</i> (Limpr.) Trevis.†	1.00		0.07	0.13	0.33	0.11	1.00	0.14	0.20
<i>Anastrophylum minutum</i> (Schreb.) R. M. Schust. var. <i>minutum</i>	0.11	0.13				0.33	0.13		
<i>Andreaea rupestris</i> Hedwig†	0.89	0.27	0.73	0.93	0.67	1.00	1.00	0.71	1.00
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwaegr.		0.13							
<i>Blepharostoma trichophyllum</i> (L.) Dumort. subsp. <i>trichophyllum</i>	0.33								

**3b.ii. High elevation (>900 m) dwarf shrub tundra
Katmai NPP**

	03_006	03_049	03_001	03_002	Plot ID 03_003	03_009	03_022	03_032	03_998
<i>Bucklandiella heterosticha</i> (Hedwig) Bednarek-Ochyra & Ochyra in R. Ochyra et al.			0.13	0.07	0.07		0.25		0.67
<i>Cephalozia bicuspidata</i> (L.) Dumort. ssp. <i>bicuspidata</i> †						0.11			
<i>Cephalozia divaricata</i> (Sm.) Schiffn. var. <i>divaricata</i>				0.13			0.63		
<i>Conostomum tetragonum</i> (Hedwig) Lindberg	0.33	0.07	0.27	0.07		0.22	0.13	0.14	
<i>Diplophyllum albicans</i> (Linnaeus) Dumortier					0.33			0.43	
<i>Dicranoweisia crispula</i> (Hedwig) Milde	0.33		0.07				0.50		0.20
<i>Dicranum groenlandicum</i> Bridel†	0.67	0.47	0.67	0.20	0.07	0.44	0.38	0.86	0.20
<i>Dicranum scoparium</i> Hedwig		0.13							
<i>Diplophyllum taxifolium</i> (Wahlenberg) Dumortier†	0.44		0.13	0.27		0.22	0.13		0.80
<i>Gymnomitrium concinnatum</i> (Lightf.) Corda	0.33		0.13			0.33	0.63		
<i>Gymnomitrium coralloides</i> Nees†	0.11	0.67	0.93	0.67	1.00	1.00		1.00	
<i>Hypnum plicatulum</i> (Lindberg) Jaeg.								0.29	
<i>Hylocomium splendens</i> (Hedwig) Schimper in B.S.G.	0.67	0.20							
<i>Lophozia sudetica</i> (Nees ex Huebener) Grolle var. <i>sudetica</i>					0.60			0.43	0.13
<i>Lophozia ventricosa</i> (Dicks.) Dumort. var. <i>ventricosa</i>			0.47						
<i>Marsupella apiculata</i> Schiffn.		0.07			0.07	0.11			0.67
<i>Marsupella commutata</i> (Limpr.) Bernet†	0.11								
<i>Nardia scalaris</i> (Schrader) Gray					0.13				
<i>Niphotrichum ericoides</i> (Bridel) Bednarek-Ochyra & Ochyra in R. Ochyra et al.	0.11						0.13		
<i>Oligotrichum hercynicum</i> (Hedwig) Lamarck & A. P. DeCandolle	0.11		0.07	0.07	0.67		0.75	0.14	
<i>Paraleucobryum enerve</i> (Thedenius) Loeske	0.33								
<i>Pleurocladula albescens</i> (Hook.) Grolle							0.25		
<i>Polytrichum commune</i> Hedwig var. <i>commune</i>	0.11	0.07				0.11			0.20
<i>Pohlia cruda</i> (Hedwig) Lindberg	0.22	0.13		0.20		0.44			
<i>Pohlia crudoides</i> (Sull. & Lesq.) Broth.								0.29	
<i>Polytrichum hyperboreum</i> R. Brown†	0.78	0.67	0.87	0.73	0.80	0.89	0.75	1.00	0.47
<i>Pohlia nutans</i> (Hedwig) Lindberg									0.13
<i>Polytrichum piliferum</i> Hedwig†	0.33	0.40	0.87	0.27	0.80	0.89	0.38	1.00	0.33
<i>Pogonatum urnigerum</i> (Hedwig) P. Beauvois				0.20	0.13		0.13	0.14	0.07
<i>Ptilidium ciliare</i> (L.) Hampe		0.13							
<i>Racomitrium lanuginosum</i> (Hedwig) Bridel†	1.00	0.87	1.00	1.00	1.00	0.67	0.88	1.00	0.07
<i>Rhytidium rugosum</i> (Hedwig) Kindberg	0.22								
<i>Sanionia uncinata</i> (Hedwig) Loeske	0.89	0.07					0.13		
<i>Scapania curta</i> (Mart.) Dumort.									0.80
<i>Schistochilopsis incisa</i> (Schrader) Konstantinova var. <i>incisa</i> †	0.11								
<i>Sphagnum compactum</i> Lamarck & de Candolle†	0.11								
<i>Tetralophozia setiformis</i> (Ehrh.) Schljakov†		0.20	0.40	0.87	0.07	0.11		0.43	

Appendix 4. Frequencies (means $\pm$ 1 SE) estimated for vascular plants and common lichens and bryophytes across two sampling events (Year 1; Year 2). Frequencies shown are estimated from 4-m² quadrats and are sorted by plot. Species codes (USDA-NRCS) are indicated in parentheses after taxonomic name. Interannual differences in frequency equal to or greater than 100% are indicated in boldface.

Plot id	Vascular species	Freq – Year 1	SE	Freq – Year 2	SE	%Diff
KATM_2009_02_048	<i>Antennaria monocephala</i> (ANMO9)	0.1333	0.0545	0.0667	0.0545	0.50
KATM_2009_02_048	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.5333	0.1442	0.8	0.0944	-0.50
KATM_2009_02_048	<i>Anemone narcissiflora</i> (ANNA)	0.3333	0.1442	0.4	0.1635	-0.20
KATM_2009_02_048	<i>Andromeda polifolia</i> (ANPO)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_02_048	<i>Artemisia arctica</i> (ARARA2)	1	0	1	0	0.00
KATM_2009_02_048	<i>Betula nana</i> (BENA)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_02_048	<i>Carex circinata</i> (CACI5)	0.0667	0.0545	0.1333	0.0545	-1.00
KATM_2009_02_048	<i>Campanula lasiocarpa</i> (CALA7)	0.8	0.0944	0.8667	0.0545	-0.08
KATM_2009_02_048	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	1	0	1	0	0.00
KATM_2009_02_048	<i>Diappensia lapponica</i> (DILA)	0.9333	0.0545	0.8667	0.0545	0.07
KATM_2009_02_048	<i>Empetrum nigrum</i> (EMNI)	1	0	1	0	0.00
KATM_2009_02_048	<i>Gentiana glauca</i> (G EGL)	0.2667	0.0545	0.4667	0.0545	-0.75
KATM_2009_02_048	<i>Harrimanella stelleriana</i> (HAST3)	0.0667	0.0545	0.2	0	-2.00
KATM_2009_02_048	<i>Lagotis glauca</i> (LAGL2)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_02_048	<i>Loiseleuria procumbens</i> (LOPR)	0.7333	0.109	0.7333	0.0545	0.00
KATM_2009_02_048	<i>Luzula arcuata</i> (LUAR5)	0.6	0.0944	0.4667	0.1442	0.22
KATM_2009_02_048	<i>Lupinus nootkatensis</i> (LUNO)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_02_048	<i>Minuartia arctica</i> (MIAR3)	0.2667	0.0545	0.2	0.0944	0.25
KATM_2009_02_048	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_02_048	<i>Polygonum viviparum</i> (POVI3)	0.2667	0.0545	0.2667	0.0545	0.00
KATM_2009_02_048	<i>Primula cuneifolia</i> (PRCU)	0.4	0.0944	0.4	0.0944	0.00
KATM_2009_02_048	<i>Rhododendron camtschaticum</i> (RHCA5)	0.4667	0.1965	0.7333	0.0545	-0.57
KATM_2009_02_048	<i>Rhodiola integrifolia</i> (RHIN11)	0.4	0.1635	0.5333	0.2376	-0.33
KATM_2009_02_048	<i>Salix arctica</i> (SAAR27)	0.7333	0.1442	0.7333	0.0545	0.00
KATM_2009_02_048	<i>Salix phlebophylla</i> (SAPH)	1	0	1	0	0.00
KATM_2009_02_048	<i>Salix rotundifolia</i> (SARO2)	0.2	0.0944	0.2667	0.109	-0.33
KATM_2009_02_048	<i>Salix stolonifera</i> (SAST2)	0.0667	0.0545	0.6	0.1635	-8.00
KATM_2009_02_048	<i>Vaccinium uliginosum</i> (VAUL)	1	0	1	0	0.00
KATM_2009_02_048	<i>Vaccinium vitis-idaea</i> (VAVI)	0.6667	0.0545	0.7333	0.0545	-0.10
KATM_2009_03_049	<i>Antennaria monocephala</i> (ANMO9)	0.6	0	0.6667	0.109	-0.11
KATM_2009_03_049	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	1	0	1	0	0.00
KATM_2009_03_049	<i>Anemone narcissiflora</i> (ANNA)	0.8667	0.109	0.8667	0.0545	0.00
KATM_2009_03_049	<i>Artemisia arctica</i> ssp. <i>arctica</i> (ARARA2)	0.3333	0.0545	0.4667	0.0545	-0.40
KATM_2009_03_049	<i>Arnica frigida</i> (ARFR2)	0.0667	0.0545	0.4	0.0944	-5.00
KATM_2009_03_049	<i>Calamagrostis lapponica</i> (CALA6)	0.8667	0.109	0.8	0.1635	0.08
KATM_2009_03_049	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	1	0	1	0	0.00
KATM_2009_03_049	<i>Diappensia lapponica</i> (DILA)	0.9333	0.0545	0.8667	0.109	0.07
KATM_2009_03_049	<i>Empetrum nigrum</i> (EMNI)	1	0	1	0	0.00
KATM_2009_03_049	<i>Gentiana algida</i> (GEAL2)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_03_049	<i>Gentiana glauca</i> (G EGL)	0.1333	0.0545	0.1333	0.0545	0.00
KATM_2009_03_049	<i>Lagotis glauca</i> (LAGL2)	0.4	0.0944	0.2667	0.0545	0.33
KATM_2009_03_049	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.2	0.0944	0.1333	0.0545	0.33
KATM_2009_03_049	<i>Lloydia serotina</i> (LLSE)	0.8667	0.0545	0.6	0.2498	0.31

Plot id	Vascular species	Freq – Year 1	SE	Freq – Year 2	SE	%Diff
KATM_2009_03_049	<i>Loiseleuria procumbens</i> (LOPR)	1	0	0.9333	0.0545	0.07
KATM_2009_03_049	<i>Luzula arcuata</i> ssp. <i>unalaschcensis</i> (LUARU)	0.0667	0.0545	0.0667	0.0545	0.00
KATM_2009_03_049	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.9333	0.0545	1	0	-0.07
KATM_2009_03_049	<i>Packera cymbalaria</i> (PACY8)	0.2	0.1635	0.0667	0.0545	0.67
KATM_2009_03_049	<i>Pedicularis capitata</i> (PECA2)	0.6667	0.1965	0.6	0.2498	0.10
KATM_2009_03_049	<i>Pedicularis langsдорфii</i> (PELA3)	0.8667	0.0545	0.9333	0.0545	-0.08
KATM_2009_03_049	<i>Rhododendron camtschaticum</i> (RHCA5)	0.9333	0.0545	1	0	-0.07
KATM_2009_03_049	<i>Rhodiola integrifolia</i> (RHIN11)	0.2	0	0.1333	0.0545	0.33
KATM_2009_03_049	<i>Salix arctica</i> (SAAR27)	1	0	1	0	0.00
KATM_2009_03_049	<i>Salix</i> spp. (SALIX)	0.8667	0.0545	0.2667	0.1442	0.69
KATM_2009_03_049	<i>Salix phlebophylla</i> (SAPH)	1	0	0.9333	0.0545	0.07
KATM_2009_03_049	<i>Vaccinium uliginosum</i> (VAUL)	0.8667	0.109	0.8	0.0944	0.08
KATM_2009_03_049	<i>Vaccinium vitis-idaea</i> (VAVI)	0.8667	0.0545	0.8	0.1635	0.08
LACL_2007_02_002	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.6	0.2498	0.9333	0.0545	-0.56
LACL_2007_02_002	<i>Anemone narcissiflora</i> (ANNA)	0.2667	0.109	0.2	0.0944	0.25
LACL_2007_02_002	<i>Arctostaphylos alpina</i> (ARAL2)	0.6	0.0944	0.5333	0.0545	0.11
LACL_2007_02_002	<i>Betula nana</i> (BENA)	0.8667	0.0545	0.8667	0.0545	0.00
LACL_2007_02_002	<i>Carex lugens</i> (CALU2)	0.8	0.0944	0.7333	0.109	0.08
LACL_2007_02_002	<i>Empetrum nigrum</i> (EMNI)	0.2667	0.1442	0.4667	0.109	-0.75
LACL_2007_02_002	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	0.9333	0.0545	0.07
LACL_2007_02_002	<i>Loiseleuria procumbens</i> (LOPR)	0.2667	0.218	0.0667	0.0545	0.75
LACL_2007_02_002	<i>Lycopodium lagopus</i> (LYLA5)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2007_02_002	<i>Pedicularis labradorica</i> (PELA)	0.0667	0.0545	0.2667	0.0545	-3.00
LACL_2007_02_002	<i>Picea glauca</i> (PIGL)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2007_02_002	<i>Salix glauca</i> (SAGL)	0.2667	0.1442	0.2667	0.1442	0.00
LACL_2007_02_002	<i>Salix phlebophylla</i> (SAPH)	0.1333	0.109	0.2667	0.1442	-1.00
LACL_2007_02_002	<i>Salix pulchra</i> (SAPU15)	0.2	0.1635	0.3333	0.0545	-0.67
LACL_2007_02_002	<i>Vaccinium uliginosum</i> (VAUL)	0.8	0.1635	0.8	0.1635	0.00
LACL_2007_02_002	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2007_02_005	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.5333	0.0545	0.6	0.0944	-0.13
LACL_2007_02_005	<i>Arctostaphylos alpina</i> (ARAL2)	0.1333	0.0545	0.1333	0.109	0.00
LACL_2007_02_005	<i>Betula nana</i> (BENA)	1	0	1	0	0.00
LACL_2007_02_005	<i>Calamagrostis canadensis</i> (CACA4)	0.1333	0.109	0.1333	0.109	0.00
LACL_2007_02_005	<i>Empetrum nigrum</i> (EMNI)	1	0	1	0	0.00
LACL_2007_02_005	<i>Festuca altaica</i> (FEAL)	0.2667	0.109	0.1333	0.0545	0.50
LACL_2007_02_005	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.9333	0.0545	0.8667	0.0545	0.07
LACL_2007_02_005	<i>Lycopodium lagopus</i> (LYLA5)	0.2667	0.1442	0.2	0.0944	0.25
LACL_2007_02_005	<i>Picea glauca</i> (PIGL)	0.4667	0.109	0.3333	0.1442	0.29
LACL_2007_02_005	<i>Salix fuscescens</i> (SAFU)	0.1333	0.109	0.2667	0.0545	-1.00
LACL_2007_02_005	<i>Salix pulchra</i> (SAPU15)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2007_02_005	<i>Trientalis europaea</i> ssp. <i>arctica</i> (TREUA)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2007_02_005	<i>Vaccinium uliginosum</i> (VAUL)	0.9333	0.0545	0.8667	0.0545	0.07
LACL_2007_02_005	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2007_02_006	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.2667	0.0545	0.7333	0.0545	-1.75
LACL_2007_02_006	<i>Arctostaphylos alpina</i> (ARAL2)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2007_02_006	<i>Betula nana</i> (BENA)	0.8667	0.0545	1	0	-0.15
LACL_2007_02_006	<i>Carex lugens</i> (CALU2)	0.8667	0.0545	0.8667	0.0545	0.00
LACL_2007_02_006	<i>Empetrum nigrum</i> (EMNI)	0.9333	0.0545	0.9333	0.0545	0.00
LACL_2007_02_006	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	1	0	0.00

Plot id	Vascular species	Freq – Year 1	SE	Freq – Year 2	SE	%Diff
LACL_2007_02_006	<i>Loiseleuria procumbens</i> (LOPR)	0.0667	0.0545	0.2	0.0944	-2.00
LACL_2007_02_006	<i>Lycopodium lagopus</i> (LYLA5)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2007_02_006	<i>Petasites frigidus</i> (PEFR5)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2007_02_006	<i>Pedicularis labradorica</i> (PELA)	0.1333	0.0545	0.0667	0.0545	0.50
LACL_2007_02_006	<i>Picea glauca</i> (PIGL)	0.2667	0.1442	0.4667	0.1442	-0.75
LACL_2007_02_006	<i>Rubus chamaemorus</i> (RUCH)	0.4	0.1635	0.2	0.1635	0.50
LACL_2007_02_006	<i>Salix pulchra</i> (SAPU15)	0.3333	0.109	0.3333	0.109	0.00
LACL_2007_02_006	<i>Vaccinium uliginosum</i> (VAUL)	1	0	1	0	0.00
LACL_2007_02_006	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	0.6667	0.2726	0.33
LACL_2007_02_017	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.8	0.0944	0.4667	0.1442	0.42
LACL_2007_02_017	<i>Betula nana</i> (BENA)	1	0	0.8667	0.0545	0.13
LACL_2007_02_017	<i>Carex lugens</i> (CALU2)	0.0667	0.0545	0.6	0.1635	-8.00
LACL_2007_02_017	<i>Empetrum nigrum</i> (EMNI)	1	0	0.9333	0.0545	0.07
LACL_2007_02_017	<i>Festuca altaica</i> (FEAL)	0.2	0.0944	0.2667	0.0545	-0.33
LACL_2007_02_017	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	0.9333	0.0545	0.07
LACL_2007_02_017	<i>Lycopodium lagopus</i> (LYLA5)	0.3333	0.0545	0.4	0.0944	-0.20
LACL_2007_02_017	<i>Picea glauca</i> (PIGL)	0.2667	0.1442	0.2667	0.0545	0.00
LACL_2007_02_017	<i>Rubus chamaemorus</i> (RUCH)	0.2	0.0944	0.3333	0.0545	-0.67
LACL_2007_02_017	<i>Salix pulchra</i> (SAPU15)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2007_02_017	<i>Spiraea stevenii</i> (SPST3)	0.4667	0.0545	0.1333	0.109	0.71
LACL_2007_02_017	<i>Vaccinium uliginosum</i> (VAUL)	1	0	0.9333	0.0545	0.07
LACL_2007_02_017	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2008_02_006	<i>Arctostaphylos alpina</i> (ARAL2)	0.2	0.0944	0.2667	0.0545	-0.33
LACL_2008_02_006	<i>Betula nana</i> (BENA)	0.6	0.2498	0.9333	0.0545	-0.56
LACL_2008_02_006	<i>Carex lugens</i> (CALU2)	0.6	0.0944	0.4	0	0.33
LACL_2008_02_006	<i>Chamerion angustifolium</i> (CHAN9)	0.1333	0.0545	0.0667	0.0545	0.50
LACL_2008_02_006	<i>Empetrum nigrum</i> (EMNI)	0.3333	0.1442	0.4667	0.0545	-0.40
LACL_2008_02_006	<i>Festuca altaica</i> (FEAL)	0.1333	0.109	0.6	0.1635	-3.50
LACL_2008_02_006	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	0.8667	0.0545	0.13
LACL_2008_02_006	<i>Lycopodium lagopus</i> (LYLA5)	0.3333	0.1442	0.3333	0.1442	0.00
LACL_2008_02_006	<i>Pedicularis capitata</i> (PECA2)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2008_02_006	<i>Picea glauca</i> (PIGL)	0.4	0.0944	0.2667	0.0545	0.33
LACL_2008_02_006	<i>Rubus chamaemorus</i> (RUCH)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2008_02_006	<i>Salix glauca</i> (SAGL)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2008_02_006	<i>Spiraea stevenii</i> (SPST3)	0.2	0.0944	0.0667	0.0545	0.67
LACL_2008_02_006	<i>Vaccinium uliginosum</i> (VAUL)	0.8667	0.0545	0.8667	0.0545	0.00
LACL_2008_02_006	<i>Vaccinium vitis-idaea</i> (VAVI)	0.6667	0.2726	1	0	-0.50
LACL_2008_02_014	<i>Betula nana</i> (BENA)	1	0	1	0	0.00
LACL_2008_02_014	<i>Carex lugens</i> (CALU2)	0.4667	0.1442	0.4	0.0944	0.14
LACL_2008_02_014	<i>Empetrum nigrum</i> (EMNI)	1	0	1	0	0.00
LACL_2008_02_014	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	1	0	0.00
LACL_2008_02_014	<i>Lycopodium lagopus</i> (LYLA5)	0.2667	0.0545	0.2	0	0.25
LACL_2008_02_014	<i>Pedicularis labradorica</i> (PELA)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2008_02_014	<i>Picea glauca</i> (PIGL)	0.3333	0.0545	0.3333	0.1442	0.00
LACL_2008_02_014	<i>Rubus chamaemorus</i> (RUCH)	0.1333	0.109	0.3333	0.2726	-1.50
LACL_2008_02_014	<i>Salix glauca</i> (SAGL)	0.1333	0.109	0.1333	0.109	0.00
LACL_2008_02_014	<i>Vaccinium uliginosum</i> (VAUL)	0.7333	0.109	0.9333	0.0545	-0.27
LACL_2008_02_014	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2008_02_048	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.6	0.1635	0.9333	0.0545	-0.56

Plot id	Vascular species	Freq – Year 1	SE	Freq – Year 2	SE	%Diff
LACL_2008_02_048	<i>Anemone narcissiflora</i> (ANNA)	0.4667	0.218	0.4667	0.218	0.00
LACL_2008_02_048	<i>Artemisia arctica</i> (ARARA2)	0.7333	0.1442	0.8	0.0944	-0.09
LACL_2008_02_048	<i>Betula nana</i> (BENA)	1	0	1	0	0.00
LACL_2008_02_048	<i>Calamagrostis canadensis</i> (CACA4)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2008_02_048	<i>Campanula lasiocarpa</i> (CALA7)	0.4	0.1635	0.1333	0.0545	0.67
LACL_2008_02_048	<i>Carex lugens</i> (CALU2)	0.8	0	0.7333	0.0545	0.08
LACL_2008_02_048	<i>Chamerion angustifolium</i> (CHAN9)	0.8667	0.109	0.8667	0.109	0.00
LACL_2008_02_048	<i>Empetrum nigrum</i> (EMNI)	0.6667	0.2726	0.9333	0.0545	-0.40
LACL_2008_02_048	<i>Festuca altaica</i> (FEAL)	0.6667	0.2726	0.8667	0.0545	-0.30
LACL_2008_02_048	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.6	0.1888	0.6	0.1888	0.00
LACL_2008_02_048	<i>Pedicularis labradorica</i> (PELA)	0.2667	0.109	0.2	0.0944	0.25
LACL_2008_02_048	<i>Picea glauca</i> (PIGL)	0.4	0.0944	0.4	0	0.00
LACL_2008_02_048	<i>Populus balsamifera</i> (POBA2)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2008_02_048	<i>Trientalis europaea</i> ssp. <i>arctica</i> (TREUA)	0.2	0.0944	0.2667	0.109	-0.33
LACL_2008_02_048	<i>Vaccinium uliginosum</i> (VAUL)	0.4667	0.1442	0.2667	0.0545	0.43
LACL_2008_02_048	<i>Vaccinium vitis-idaea</i> (VAVI)	0.9333	0.0545	1	0	-0.07
LACL_2008_02_049	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.8667	0.0545	0.9333	0.0545	-0.08
LACL_2008_02_049	<i>Betula nana</i> (BENA)	1	0	1	0	0.00
LACL_2008_02_049	<i>Calamagrostis canadensis</i> (CACA4)	0.9333	0.0545	1	0	-0.07
LACL_2008_02_049	<i>Campanula lasiocarpa</i> (CALA7)	0.6	0.0944	0.4667	0.0545	0.22
LACL_2008_02_049	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	1	0	1	0	0.00
LACL_2008_02_049	<i>Festuca altaica</i> (FEAL)	1	0	1	0	0.00
LACL_2008_02_049	<i>Picea glauca</i> (PIGL)	0.2	0.0944	0.2	0.0944	0.00
LACL_2008_02_049	<i>Trientalis europaea</i> ssp. <i>arctica</i> (TREUA)	0.7333	0.109	0.8	0.0944	-0.09
LACL_2008_02_049	<i>Vaccinium vitis-idaea</i> (VAVI)	0.7333	0.1442	0.8	0.1635	-0.09
LACL_2010_01_S994	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_01_S994	<i>Betula nana</i> (BENA)	1	0	1	0	0.00
LACL_2010_01_S994	<i>Calamagrostis canadensis</i> (CACA4)	0.9333	0.0545	0.8667	0.109	0.07
LACL_2010_01_S994	<i>Chamerion angustifolium</i> (CHAN9)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2010_01_S994	<i>Cornus suecica</i> (COSU4)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_01_S994	<i>Empetrum nigrum</i> (EMNI)	0.2	0.0944	0.2	0.0944	0.00
LACL_2010_01_S994	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.8667	0.0545	0.8	0.1635	0.08
LACL_2010_01_S994	<i>Petasites frigidus</i> (PEFR5)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_01_S994	<i>Picea glauca</i> (PIGL)	0.3333	0.0545	0.4	0.0944	-0.20
LACL_2010_01_S994	<i>Rubus chamaemorus</i> (RUCH)	0.5333	0.0545	0.6	0	-0.13
LACL_2010_01_S994	<i>Spiraea stevenii</i> (SPST3)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2010_01_S994	<i>Vaccinium uliginosum</i> (VAUL)	0.7333	0.109	0.6667	0.0545	0.09
LACL_2010_01_S994	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2010_02_999	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.9333	0.0545	0.7333	0.1442	0.21
LACL_2010_02_999	<i>Anemone narcissiflora</i> (ANNA)	0.1333	0.109	0.1333	0.109	0.00
LACL_2010_02_999	<i>Arctostaphylos alpina</i> (ARAL2)	0.5333	0.109	0.6	0.0944	-0.13
LACL_2010_02_999	<i>Artemisia arctica</i> (ARARA2)	0.2	0.0944	0.2	0.1635	0.00
LACL_2010_02_999	<i>Betula nana</i> (BENA)	0.9333	0.0545	0.9333	0.0545	0.00
LACL_2010_02_999	<i>Calamagrostis lapponica</i> (CALA6)	0.2	0.1635	0.9333	0.0545	-3.67
LACL_2010_02_999	<i>Carex lugens</i> (CALU2)	1	0	1	0	0.00
LACL_2010_02_999	<i>Diappensia lapponica</i> (DILA)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2010_02_999	<i>Empetrum nigrum</i> (EMNI)	0.9333	0.0545	0.8	0.0944	0.14
LACL_2010_02_999	<i>Festuca altaica</i> (FEAL)	0.2	0.1635	0.3333	0.1965	-0.67
LACL_2010_02_999	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	1	0	1	0	0.00

Plot id	Vascular species	Freq – Year 1	SE	Freq – Year 2	SE	%Diff
LACL_2010_02_999	<i>Loiseleuria procumbens</i> (LOPR)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_02_999	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2010_02_999	<i>Petasites frigidus</i> (PEFR5)	0.1333	0.109	0.1333	0.109	0.00
LACL_2010_02_999	<i>Pedicularis labradorica</i> (PELA)	0.2667	0.1442	0.2667	0.1442	0.00
LACL_2010_02_999	<i>Picea glauca</i> (PIGL)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2010_02_999	<i>Poa arctica</i> ssp. <i>arctica</i> (POARA2)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2010_02_999	<i>Salix glauca</i> (SAGL)	0.1333	0.0545	0.0667	0.0545	0.50
LACL_2010_02_999	<i>Salix pulchra</i> (SAPU15)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2010_02_999	<i>Vaccinium uliginosum</i> (VAUL)	1	0	1	0	0.00
LACL_2010_02_999	<i>Vaccinium vitis-idaea</i> (VAVI)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Antennaria monocephala</i> (ANMO9)	0.9333	0.0545	0.9333	0.0545	0.00
LACL_2010_03S_001	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Anemone narcissiflora</i> (ANNA)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Artemisia arctica</i> (ARARA2)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_03S_001	<i>Arnica frigida</i> (ARFR2)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Campanula lasiocarpa</i> (CALA7)	0.9333	0.0545	1	0	-0.07
LACL_2010_03S_001	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Diappensia lapponica</i> (DILA)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Dryas octopetala</i> (DROC)	1	0	1	0	0.00
LACL_2010_03S_001	<i>Loiseleuria procumbens</i> (LOPR)	0.0667	0.0545	0.9333	0.0545	-12.99
LACL_2010_03S_001	<i>Minuartia arctica</i> (MIAR3)	0.4	0.0944	0.6	0.0944	-0.50
LACL_2010_03S_001	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.5333	0.1442	1	0	-0.88
LACL_2010_03S_001	<i>Pedicularis langsdoorii</i> (PELA3)	1	0	0.7333	0.0545	0.27
LACL_2010_03S_001	<i>Polygonum viviparum</i> (POVI3)	0.6667	0.0545	0.2	0	0.70
LACL_2010_03S_001	<i>Primula cuneifolia</i> (PRCU)	0.2667	0.1442	0.4667	0.1965	-0.75
LACL_2010_03S_001	<i>Rhodiola integrifolia</i> (RHIN11)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_03S_001	<i>Salix phlebophylla</i> (SAPH)	0.9333	0.0545	1	0	-0.07
LACL_2010_03S_001	<i>Vaccinium vitis-idaea</i> (VAVI)	0.0667	0.0545	0.1333	0.0545	-1.00
LACL_2010_03S_998	<i>Antennaria friesiana</i> (ANFR)	0.7333	0.109	0.8667	0.109	-0.18
LACL_2010_03S_998	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	1	0	1	0	0.00
LACL_2010_03S_998	<i>Anemone narcissiflora</i> (ANNA)	0.8	0.0944	0.8667	0.0545	-0.08
LACL_2010_03S_998	<i>Arnica frigida</i> (ARFR2)	0.5333	0.1442	0.6	0.1635	-0.13
LACL_2010_03S_998	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	1	0	0.8	0.0944	0.20
LACL_2010_03S_998	<i>Diappensia lapponica</i> (DILA)	0.7333	0.0545	0.6667	0.109	0.09
LACL_2010_03S_998	<i>Dryas octopetala</i> ssp. <i>alaskensis</i> (DROCA2)	1	0	1	0	0.00
LACL_2010_03S_998	<i>Festuca brachyphylla</i> (FEBR)	0.4	0.1635	0.8667	0.109	-1.17
LACL_2010_03S_998	<i>Lloydia serotina</i> (LLSE)	0.9333	0.0545	0.8667	0.0545	0.07
LACL_2010_03S_998	<i>Minuartia arctica</i> (MIAR3)	0.6667	0.0545	0.8	0	-0.20
LACL_2010_03S_998	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	1	0	1	0	0.00
LACL_2010_03S_998	<i>Pedicularis lanata</i> (PELA14)	0.4	0.1635	0.3333	0.0545	0.17
LACL_2010_03S_998	<i>Polygonum viviparum</i> (POVI3)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_03S_998	<i>Rhodiola integrifolia</i> (RHIN11)	0.5333	0.0545	0.4667	0.0545	0.12
LACL_2010_03S_998	<i>Salix arctica</i> (SAAR27)	0.9333	0.0545	0.9333	0.0545	0.00
LACL_2010_03S_998	<i>Saxifraga bronchialis</i> (SABRF)	0.2667	0.1442	0.4	0.0944	-0.50
LACL_2010_03S_998	<i>Salix phlebophylla</i> (SAPH)	0.9333	0.0545	0.9333	0.0545	0.00
LACL_2010_03S_998	<i>Stellaria longipes</i> ssp. <i>longipes</i> (STL0L7)	0.0667	0.0545	0.1333	0.109	-1.00
LACL_2010_03S_998	<i>Trisetum spicatum</i> (TRSP2)	0.4	0.0944	0.5333	0.1442	-0.33

Plot id	Lichen species	Freq - Year 1	SE	Freq - Year 2	SE	%Diff
LACL_2010_01_S994	<i>Cetraria laevigata</i> (CELA60)	0.4667	0.1091	0.4000	0.0945	0.14
LACL_2010_01_S994	<i>Cladonia arbuscula</i> ssp. <i>beringiana</i> (CLAARBB)	0.6000	0.0945	0.6667	0.1966	-0.11
LACL_2010_01_S994	<i>Cladonia stygia</i> (CLASTY)	0.7333	0.0545	0.9333	0.0545	-0.27
LACL_2010_01_S994	<i>Cladonia cornuta</i> ssp. <i>cornuta</i> (CLCOC3)	0.2000	0.0000	0.4667	0.1091	-1.33
LACL_2010_01_S994	<i>Cladonia gracilis</i> ssp. <i>vulnerata</i> (CLGRV)	0.8667	0.0545	0.6000	0.0000	0.31
LACL_2010_01_S994	<i>Parmeliopsis ambigua</i> (PAAM60)	0.6667	0.1091	0.8667	0.1091	-0.30
LACL_2010_01_S994	<i>Parmeliopsis hyperopta</i> (PAHY61)	0.4667	0.0545	0.8000	0.0000	-0.71
LACL_2010_01_S994	<i>Peltigera scabrosa</i> (PESC60)	0.6000	0.0945	0.6000	0.0000	0.00
LACL_2010_01_S994	<i>Tuckermannopsis sepincola</i> (TUSE60)	0.8000	0.0945	0.9333	0.0545	-0.17
LACL_2010_01_S994	<i>Vulpicida pinastri</i> (VUPI)	0.7333	0.1443	0.9333	0.0545	-0.27
LACL_2007_02_006	<i>Cetraria islandica</i> (CEISC)	0.1333	0.0545	0.6667	0.0545	-4.00
LACL_2007_02_006	<i>Cetraria laevigata</i> (CELA60)	0.7333	0.1091	0.6000	0.0945	0.18
LACL_2007_02_006	<i>Cladonia arbuscula</i> ssp. <i>beringiana</i> (CLAARBB)	0.7333	0.0545	0.9333	0.0545	-0.27
LACL_2007_02_006	<i>Cladonia stygia</i> (CLASTY)	0.7333	0.1443	0.8000	0.0945	-0.09
LACL_2007_02_006	<i>Cladonia gracilis</i> ssp. <i>vulnerata</i> (CLGRV)	0.8000	0.1636	0.8667	0.1091	-0.08
LACL_2007_02_006	<i>Flavocetraria cucullata</i> (FLCU)	0.8667	0.0545	0.8667	0.0545	0.00
LACL_2007_02_006	<i>Parmeliopsis ambigua</i> (PAAM60)	0.4667	0.1443	0.7333	0.0545	-0.57
LACL_2007_02_006	<i>Parmeliopsis hyperopta</i> (PAHY61)	0.5333	0.1091	0.8000	0.0945	-0.50
LACL_2007_02_006	<i>Tuckermannopsis sepincola</i> (TUSE60)	0.7333	0.0545	1.0000	0.0000	-0.36
LACL_2007_02_006	<i>Vulpicida pinastri</i> (VUPI)	0.7333	0.1443	0.8667	0.0545	-0.18

Plot id	Bryophyte species	Freq - Year 1	SE	Freq - Year 2	SE	%Diff
LACL_2010_01_S994	<i>Aulacomnium palustre</i> (AUPA70)	0.7333	0.0545	0.8000	0.0945	-0.09
LACL_2010_01_S994	<i>Aulacomnium turgidum</i> (AUTU70)	0.6000	0.0945	0.5333	0.1091	0.11
LACL_2010_01_S994	<i>Dicranum scoparium</i> (DISC71)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_01_S994	<i>Dicranum undulatum</i> (DIUN8)	0.1333	0.0545	0.1333	0.0545	0.00
LACL_2010_01_S994	<i>Hylocomium splendens</i> (HYSP70)	0.6000	0.0000	0.8667	0.0545	-0.44
LACL_2010_01_S994	<i>Pleurozium schreberi</i> (PLSC70)	0.7333	0.1443	0.8000	0.0945	-0.09
LACL_2010_01_S994	<i>Polytrichum commune</i> var. <i>commune</i> (POCOC5)	0.6667	0.1443	0.9333	0.0545	-0.40
LACL_2010_01_S994	<i>Polytrichum strictum</i> (POST70)	0.7333	0.1091	0.9333	0.0545	-0.27
LACL_2010_01_S994	<i>Ptilium crista-castrensis</i> (PTCR70)	0.0667	0.0545	0.0667	0.0545	0.00
LACL_2010_01_S994	<i>Sphagnum girgensohnii</i> (SPGI70)	0.3333	0.1443	0.4667	0.0545	-0.40
LACL_2007_02_006	<i>Aulacomnium palustre</i> (AUPA70)	0.2667	0.1443	0.2667	0.0545	0.00
LACL_2007_02_006	<i>Aulacomnium turgidum</i> (AUTU70)	0.2667	0.1091	0.3333	0.0545	-0.25
LACL_2007_02_006	<i>Dicranum groenlandicum</i> (DIGR71)	0.2667	0.1091	0.5333	0.0545	-1.00
LACL_2007_02_006	<i>Dicranum scoparium</i> (DISC71)	0.4000	0.1889	0.6667	0.0545	-0.67
LACL_2007_02_006	<i>Hylocomium splendens</i> (HYSP70)	0.6000	0.0945	0.5333	0.0545	0.11
LACL_2007_02_006	<i>Pleurozium schreberi</i> (PLSC70)	0.6667	0.0545	0.8667	0.0545	-0.30
LACL_2007_02_006	<i>Polytrichum commune</i> var. <i>commune</i> (POCOC5)	0.6667	0.0545	0.7333	0.1091	-0.10
LACL_2007_02_006	<i>Pohlia nutans</i> (PONU70)	0.2667	0.0545	0.2000	0.0945	0.25
LACL_2007_02_006	<i>Polytrichum strictum</i> (POST70)	0.3333	0.0545	0.3333	0.0545	0.00
LACL_2007_02_006	<i>Ptilium crista-castrensis</i> (PTCR70)	0.0667	0.0545	0.2000	0.1636	-2.00

Appendix 5a. Percent cover (means $\pm$ 1 SE) of vascular plants estimated by point-intercept across two sampling events (Year 1; Year 2). Data are sorted by plot. Species codes (USDA-NRCS) are indicated in parentheses after taxonomic name. Year-to-year differences in percent cover equal to or greater than 100% are indicated in boldface.

Plot id	Vascular species	%Cover – Year 1	SE	%Cover – Year 2	SE	%Diff
LACL_2010_03S_999	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.021186	0.021186	0.008475	0.008475	0.60
LACL_2010_03S_999	Anemone narcissiflora (ANNA)	0.004237	0.004237	0.012712	0.008114	-2.00
LACL_2010_03S_999	Betula nana (BENA) - <50 cm	0.004237	0.004237	0.008475	0.008475	-1.00
LACL_2010_03S_999	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	0.04661	0.026235	0.008475	0.004893	0.82
LACL_2010_03S_999	<i>Diappensia lapponica</i> (DILA)	0.084746	0.044843	0.038136	0.022288	0.55
LACL_2010_03S_999	<i>Dryas octopetala</i> (DROC)	0.033898	0.022949	0.055085	0.034162	-0.63
LACL_2010_03S_999	<i>Empetrum nigrum</i> (EMNI)	0.050847	0.034597	0.025424	0.008475	0.50
LACL_2010_03S_999	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.050847	0.020758	0.016949	0.006919	0.67
LACL_2010_03S_999	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.016949	0.006919	0.004237	0.004237	0.75
LACL_2010_03S_999	<i>Salix phlebophylla</i> (SAPH)	0.012712	0.008114	0.012712	0.008114	0.00
LACL_2010_03S_999	<i>Vaccinium uliginosum</i> (VAUL)	0.161017	0.069367	0.067797	0.02397	0.58
LACL_2010_03S_999	<i>Vaccinium vitis-idaea</i> (VAVI)	0.012712	0.008114	0.016949	0.006919	-0.33
LACL_2010_03S_998	Anemone narcissiflora (ANNA)	0.004237	0.004237	0.012712	0.008114	-2.00
LACL_2010_03S_998	Carex microchaeta ssp. nesophila (CAMIN)	0.008475	0.004893	0.021186	0.016042	-1.50
LACL_2010_03S_998	<i>Diappensia lapponica</i> (DILA)	0.067797	0.031709	0.076271	0.03562	-0.12
LACL_2010_03S_998	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.012712	0.008114	0.016949	0.011985	-0.33
LACL_2010_03S_998	<i>Salix arctica</i> (SAAR27)	0.025424	0.010941	0.016949	0.011985	0.33
LACL_2010_03S_998	Salix phlebophylla (SAPH)	0.008475	0.004893	0.021186	0.010664	-1.50
LACL_2010_03S_001	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.008475	0.004893	0.004237	0.004237	0.50
LACL_2010_03S_001	Anemone narcissiflora (ANNA)	0.008475	0.004893	0.025424	0.014678	-2.00
LACL_2010_03S_001	Arnica frigida (ARFR2)	0.004237	0.004237	0.016949	0.009786	-3.00
LACL_2010_03S_001	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	0.059322	0.022422	0.016949	0.009786	0.71
LACL_2010_03S_001	<i>Diappensia lapponica</i> (DILA)	0.067797	0.02853	0.029661	0.020025	0.56
LACL_2010_03S_001	<i>Dryas octopetala</i> (DROC)	0.118644	0.054922	0.072034	0.032731	0.39
LACL_2010_03S_001	Loiseleuria procumbens (LOPR)	0.021186	0.016042	0.050847	0.021881	-1.40
LACL_2010_03S_001	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.025424	0.010941	0.016949	0.009786	0.33
LACL_2010_03S_001	<i>Salix phlebophylla</i> (SAPH)	0.04661	0.021186	0.012712	0.008114	0.73
LACL_2010_03S_001	<i>Vaccinium vitis-idaea</i> (VAVI)	0.008475	0.008475	0.004237	0.004237	0.50
LACL_2010_02_999	<i>Arctostaphylos alpina</i> (ARAL2)	0.016949	0.016949	0.016949	0.011985	0.00
LACL_2010_02_999	<i>Betula nana</i> (BENA) - insect damage	0.118644	0.047437	0.012712	0.008114	0.89
LACL_2010_02_999	<i>Empetrum nigrum</i> (EMNI)	0.139831	0.062802	0.169492	0.084463	-0.21
LACL_2010_02_999	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.131356	0.050077	0.029661	0.014473	0.77
LACL_2010_02_999	<i>Loiseleuria procumbens</i> (LOPR)	0.008475	0.004893	0.012712	0.008114	-0.50
LACL_2010_02_999	<i>Vaccinium uliginosum</i> (VAUL)	0.309322	0.103185	0.152542	0.069883	0.51
LACL_2010_02_999	<i>Vaccinium vitis-idaea</i> (VAVI)	0.139831	0.056373	0.118644	0.048436	0.15
LACL_2010_01_S994	<i>Betula nana</i> (BENA) - insect damage	0.105932	0.035536	0.105932	0.035536	0.00
LACL_2010_01_S994	<i>Calamagrostis canadensis</i> (CACA4)	0.008475	0.004893	0.008475	0.004893	0.00
LACL_2010_01_S994	<i>Empetrum nigrum</i> (EMNI)	0.016949	0.011985	0.016949	0.016949	0.00
LACL_2010_01_S994	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.194915	0.083465	0.194915	0.083751	0.00
LACL_2010_01_S994	<i>Picea glauca</i> (PIGL) - 1-4 m	0.084746	0.047437	0.076271	0.039447	0.10
LACL_2010_01_S994	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.04661	0.023337	0.021186	0.012712	0.55
LACL_2010_01_S994	<i>Picea glauca</i> (PIGL) - >4 m	0.029661	0.029661	0.025424	0.014678	0.14
LACL_2010_01_S994	<i>Vaccinium uliginosum</i> (VAUL)	0.059322	0.053821	0.050847	0.035955	0.14

Plot id	Vascular species	%Cover – Year 1	SE	%Cover – Year 2	SE	%Diff
LACL_2010_01_S994	<i>Vaccinium vitis-idaea</i> (VAVI)	0.038136	0.017471	0.038136	0.017471	0.00
LACL_2008_02_049	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.016949	0.006919	0.021186	0.021186	-0.25
LACL_2008_02_049	<i>Betula nana</i> (BENA) - <50 cm	0.508475	0.171318	0.461864	0.154317	0.09
LACL_2008_02_049	<i>Calamagrostis canadensis</i> (CACA4)	0.033898	0.015472	0.021186	0.021186	0.38
LACL_2008_02_049	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	0.025424	0.010941	0.067797	0.02397	-1.67
LACL_2008_02_049	<i>Festuca altaica</i> (FEAL)	0.021186	0.008114	0.076271	0.032822	-2.60
LACL_2008_02_049	<i>Vaccinium vitis-idaea</i> (VAVI)	0.008475	0.008475	0.021186	0.008114	-1.50
LACL_2008_02_048	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.008475	0.008475	0.038136	0.028	-3.50
LACL_2008_02_048	<i>Artemisia arctica</i> (ARARA2)	0.004237	0.004237	0.012712	0.008114	-2.00
LACL_2008_02_048	<i>Betula nana</i> (BENA) - <50 cm	0.182203	0.063935	0.127119	0.069367	0.30
LACL_2008_02_048	<i>Betula nana</i> (BENA) - 50-100 cm	0.055085	0.036203	0.033898	0.02853	0.38
LACL_2008_02_048	<i>Chamerion angustifolium</i> (CHAN9)	0.012712	0.004237	0.029661	0.010664	-1.33
LACL_2008_02_048	<i>Empetrum nigrum</i> (EMNI)	0.131356	0.048126	0.131356	0.060866	0.00
LACL_2008_02_048	<i>Festuca altaica</i> (FEAL)	0.097458	0.034162	0.118644	0.040936	-0.22
LACL_2008_02_048	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.076271	0.059724	0.084746	0.068149	-0.11
LACL_2008_02_048	<i>Picea glauca</i> (PIGL) - <50 cm	0.042373	0.021327	0.033898	0.02397	0.20
LACL_2008_02_048	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.033898	0.022949	0.021186	0.016042	0.38
LACL_2008_02_048	<i>Picea glauca</i> (PIGL) - 1-4 m	0.025424	0.025424	0.029661	0.024341	-0.17
LACL_2008_02_048	<i>Picea glauca</i> (PIGL) - >4 m	0.008475	0.008475	0.004237	0.004237	0.50
LACL_2008_02_048	<i>Vaccinium uliginosum</i> (VAUL)	0.080508	0.074965	0.09322	0.077207	-0.16
LACL_2008_02_048	<i>Vaccinium vitis-idaea</i> (VAVI)	0.012712	0.012712	0.033898	0.033898	-1.67
LACL_2008_02_014	<i>Betula nana</i> (BENA) - <50 cm	0.04661	0.023337	0.076271	0.026349	-0.64
LACL_2008_02_014	<i>Betula nana</i> (BENA) - 50-100 cm	0.04661	0.018791	0.063559	0.029661	-0.36
LACL_2008_02_014	<i>Betula nana</i> (BENA) - 1-4 m	0.012712	0.012712	0.008475	0.004893	0.33
LACL_2008_02_014	<i>Empetrum nigrum</i> (EMNI)	0.216102	0.075917	0.300847	0.105024	-0.39
LACL_2008_02_014	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.084746	0.042089	0.110169	0.042373	-0.30
LACL_2008_02_014	<i>Picea glauca</i> (PIGL) - <50 cm	0.025424	0.020174	0.038136	0.018791	-0.50
LACL_2008_02_014	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.025424	0.010941	0.042373	0.022422	-0.67
LACL_2008_02_014	<i>Picea glauca</i> (PIGL) - 1-4 m	0.021186	0.008114	0.029661	0.010664	-0.40
LACL_2008_02_014	<i>Picea glauca</i> (PIGL) - >4 m	0.004237	0.004237	0.008475	0.008475	-1.00
LACL_2008_02_014	<i>Salix pulchra</i> (SAPU15) - 50-100 cm	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2008_02_014	<i>Salix pulchra</i> (SAPU15) - 1-4 m	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2008_02_014	<i>Vaccinium uliginosum</i> (VAUL)	0.118644	0.047437	0.135593	0.051316	-0.14
LACL_2008_02_014	<i>Vaccinium vitis-idaea</i> (VAVI)	0.038136	0.017471	0.097458	0.038758	-1.56
LACL_2008_02_006	<i>Arctostaphylos alpina</i> (ARAL2)	0.021186	0.016042	0.063559	0.063559	-2.00
LACL_2008_02_006	<i>Betula nana</i> (BENA) - <50 cm	0.190678	0.079912	0.105932	0.038136	0.44
LACL_2008_02_006	<i>Betula nana</i> (BENA) - 50-100 cm	0.144068	0.055572	0.050847	0.018307	0.65
LACL_2008_02_006	<i>Betula nana</i> (BENA) - 1-4 m	0.025424	0.025424	0.012712	0.008114	0.50
LACL_2008_02_006	<i>Empetrum nigrum</i> (EMNI)	0.055085	0.023337	0.059322	0.031329	-0.08
LACL_2008_02_006	<i>Festuca altaica</i> (FEAL)	0.025424	0.016228	0.038136	0.017471	-0.50
LACL_2008_02_006	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.338983	0.145638	0.271186	0.153948	0.20
LACL_2008_02_006	<i>Picea glauca</i> (PIGL) - <50 cm	0.021186	0.012712	0.004237	0.004237	0.80
LACL_2008_02_006	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.021186	0.016042	0.016949	0.016949	0.20
LACL_2008_02_006	<i>Picea glauca</i> (PIGL) - 1-4 m	0.016949	0.016949	0.025424	0.020174	-0.50
LACL_2008_02_006	<i>Picea glauca</i> (PIGL) - >4 m	0.008475	0.008475	0.004237	0.004237	0.50
LACL_2008_02_006	<i>Salix glauca</i> (SAGL) - 50-100 cm	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2008_02_006	<i>Salix glauca</i> (SAGL) - 1-4 m	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2008_02_006	<i>Vaccinium uliginosum</i> (VAUL)	0.131356	0.045043	0.144068	0.048188	-0.10
LACL_2008_02_006	<i>Vaccinium vitis-idaea</i> (VAVI)	0.09322	0.032084	0.15678	0.056797	-0.68

Plot id	Vascular species	%Cover – Year 1	SE	%Cover – Year 2	SE	%Diff
LACL_2007_02_017	<i>Betula nana</i> (BENA) - <50 cm	0.161017	0.068324	0.114407	0.064679	0.29
LACL_2007_02_017	<i>Betula nana</i> (BENA) - 50-100 cm	0.152542	0.072901	0.114407	0.056797	0.25
LACL_2007_02_017	<i>Betula nana</i> (BENA) - 1-4 m	0.016949	0.016949	0.042373	0.025424	-1.50
LACL_2007_02_017	<i>Empetrum nigrum</i> (EMNI)	0.241525	0.085973	0.262712	0.11168	-0.09
LACL_2007_02_017	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.207627	0.075917	0.165254	0.06722	0.20
LACL_2007_02_017	<i>Picea glauca</i> (PIGL) - <50 cm	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2007_02_017	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.021186	0.012712	0.016949	0.009786	0.20
LACL_2007_02_017	<i>Picea glauca</i> (PIGL) - 1-4 m	0.016949	0.011985	0.012712	0.004237	0.25
LACL_2007_02_017	<i>Spiraea stevenii</i> (SPST3)	0.008475	0.004893	0.004237	0.004237	0.50
LACL_2007_02_017	<i>Vaccinium uliginosum</i> (VAUL)	0.169492	0.063039	0.224576	0.102252	-0.32
LACL_2007_02_017	<i>Vaccinium vitis-idaea</i> (VAVI)	0.059322	0.029762	0.063559	0.029661	-0.07
LACL_2007_02_006	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.025424	0.010941	0.012712	0.008114	0.50
LACL_2007_02_006	<i>Arctostaphylos alpina</i> (ARAL2)	0.004237	0.004237	0.008475	0.004893	-1.00
LACL_2007_02_006	<i>Betula nana</i> (BENA) - insect damage	0.110169	0.042373	0.016949	0.011985	0.85
LACL_2007_02_006	<i>Empetrum nigrum</i> (EMNI)	0.347458	0.120744	0.279661	0.095504	0.20
LACL_2007_02_006	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.169492	0.065278	0.016949	0.011985	0.90
LACL_2007_02_006	<i>Loiseleuria procumbens</i> (LOPR)	0.025424	0.016228	0.008475	0.008475	0.67
LACL_2007_02_006	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2007_02_006	<i>Picea glauca</i> (PIGL) - 1-4 m	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2007_02_006	<i>Salix pulchra</i> (SAPU15) - <50 cm	0.004237	0.004237	0.004237	0.004237	0.00
LACL_2007_02_006	<i>Vaccinium uliginosum</i> (VAUL)	0.148305	0.075917	0.050847	0.021881	0.66
LACL_2007_02_006	<i>Vaccinium vitis-idaea</i> (VAVI)	0.101695	0.042089	0.042373	0.017641	0.58
LACL_2007_02_005	<i>Arctostaphylos alpina</i> (ARAL2)	0.008475	0.008475	0.016949	0.011985	-1.00
LACL_2007_02_005	<i>Betula nana</i> (BENA) - <50 cm	0.080508	0.031991	0.080508	0.034856	0.00
LACL_2007_02_005	<i>Betula nana</i> (BENA) - 50-100 cm	0.033898	0.019571	0.042373	0.017641	-0.25
LACL_2007_02_005	<i>Betula nana</i> (BENA) - 1-4 m	0.008475	0.008475	0.008475	0.004893	0.00
LACL_2007_02_005	<i>Empetrum nigrum</i> (EMNI)	0.207627	0.077168	0.211864	0.088206	-0.02
LACL_2007_02_005	<i>Festuca altaica</i> (FEAL)	0.033898	0.015472	0.012712	0.012712	0.62
LACL_2007_02_005	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.084746	0.043212	0.131356	0.071366	-0.55
LACL_2007_02_005	<i>Picea glauca</i> (PIGL) - 1-4 m	0.084746	0.037262	0.067797	0.031709	0.20
LACL_2007_02_005	<i>Picea glauca</i> (PIGL) - 50-100 cm	0.055085	0.021186	0.063559	0.022288	-0.15
LACL_2007_02_005	<i>Picea glauca</i> (PIGL) - <50 cm	0.029661	0.020025	0.025424	0.016228	0.14
LACL_2007_02_005	<i>Picea glauca</i> (PIGL) - >4 m	0.025424	0.025424	0.04661	0.028843	-0.83
LACL_2007_02_005	<i>Vaccinium uliginosum</i> (VAUL)	0.110169	0.038214	0.148305	0.054209	-0.35
LACL_2007_02_005	<i>Vaccinium vitis-idaea</i> (VAVI)	0.029661	0.017471	0.084746	0.039749	-1.86
LACL_2007_02_002	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.008475	0.004893	0.050847	0.024948	-5.00
LACL_2007_02_002	<i>Arctostaphylos alpina</i> (ARAL2)	0.008475	0.008475	0.050847	0.018307	-5.00
LACL_2007_02_002	<i>Betula nana</i> (BENA) - <50 cm	0.114407	0.042302	0.012712	0.008114	0.89
LACL_2007_02_002	<i>Empetrum nigrum</i> (EMNI)	0.012712	0.008114	0.012712	0.008114	0.00
LACL_2007_02_002	<i>Festuca altaica</i> (FEAL)	0.012712	0.012712	0.012712	0.012712	0.00
LACL_2007_02_002	<i>Ledum palustre</i> ssp. <i>decumbens</i> (LEPAD)	0.144068	0.058099	0.199153	0.070011	-0.38
LACL_2007_02_002	<i>Vaccinium uliginosum</i> (VAUL)	0.088983	0.034856	0.139831	0.054209	-0.57
LACL_2007_02_002	<i>Vaccinium vitis-idaea</i> (VAVI)	0.169492	0.072901	0.258475	0.087628	-0.52
KATM_2010_03_049	<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i> (ANMOA3)	0.008475	0.004893	0.008475	0.004893	0.00
KATM_2010_03_049	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	0.016949	0.006919	0.016949	0.011985	0.00
KATM_2010_03_049	<i>Diappensia lapponica</i> (DILA)	0.025424	0.020174	0.016949	0.011985	0.33
KATM_2010_03_049	<i>Empetrum nigrum</i> (EMNI)	0.101695	0.035955	0.135593	0.053598	-0.33
KATM_2010_03_049	<i>Loiseleuria procumbens</i> (LOPR)	0.080508	0.034856	0.063559	0.038136	0.21
KATM_2010_03_049	<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i> (OXNIN2)	0.025424	0.014678	0.033898	0.011985	-0.33

Plot id	Vascular species	%Cover – Year 1	SE	%Cover – Year 2	SE	%Diff
KATM_2010_03_049	<i>Pedicularis capitata</i> (PECA2)	0.008475	0.008475	0.004237	0.004237	0.50
KATM_2010_03_049	<i>Rhododendron camtschaticum</i> (RHCA5)	0.008475	0.004893	0.016949	0.009786	-1.00
KATM_2010_03_049	<i>Salix arctica</i> (SAAR27)	0.008475	0.004893	0.012712	0.008114	-0.50
KATM_2010_03_049	<i>Salix phlebophylla</i> (SAPH)	0.016949	0.006919	0.004237	0.004237	0.75
KATM_2010_03_049	<i>Vaccinium uliginosum</i> (VAUL)	0.04661	0.022288	0.04661	0.022288	0.00
KATM_2010_03_049	<i>Vaccinium vitis-idaea</i> (VAVI)	0.008475	0.008475	0.016949	0.016949	-1.00
KATM_2009_02_048	<i>Carex microchaeta</i> ssp. <i>nesophila</i> (CAMIN)	0.059322	0.020174	0.072034	0.025306	-0.21
KATM_2009_02_048	<i>Diappensia lapponica</i> (DILA)	0.012712	0.008114	0.008475	0.008475	0.33
KATM_2009_02_048	<i>Empetrum nigrum</i> (EMNI)	0.266949	0.090053	0.288136	0.102399	-0.08
KATM_2009_02_048	<i>Salix arctica</i> (SAAR27)	0.004237	0.004237	0.016949	0.011985	-3.00
KATM_2009_02_048	<i>Vaccinium uliginosum</i> (VAUL)	0.161017	0.064355	0.169492	0.058304	-0.05
KATM_2009_02_048	<i>Vaccinium vitis-idaea</i> (VAVI)	0.008475	0.004893	0.012712	0.012712	-0.50

Appendix 5b. Mean difference (means $\pm$ 1 SE) in cover for selected vascular species, as estimated across two sampling events (Year 1; Year 2). Means and SEs are estimated from values shown in Appendix 5a. Sample size (n = no. plots with 2 years of cover data) is shown for each species. Species with a mean difference in cover of less than 50% (Year 1 – Year 2) are expected to be the best candidates for monitoring, as measurement error and/or interannual variability in cover appear to be relatively low.

Vascular species	Mean difference in % cover	SE	n
<i>Anemone narcissiflora</i>	2.00	0.00	3
<i>Anthoxanthum monticola</i> ssp. <i>alpinum</i>	1.48	0.74	7
<i>Arctostaphylos alpina</i>	1.80	0.86	5
<i>Betula nana</i> - <50 cm	0.46	0.13	8
<i>Betula nana</i> - 50-100 cm	0.38	0.07	5
<i>Betula nana</i> - 1-4 m	0.58	0.32	4
<i>Betula nana</i> - insect damage	0.58	0.29	3
<i>Carex microchaeta</i> ssp. <i>nesophila</i>	0.82	0.27	6
<i>Diappensia lapponica</i>	0.38	0.08	5
<i>Empetrum nigrum</i>	0.16	0.05	12
<i>Festuca altaica</i>	0.79	0.47	5
<i>Ledum palustre</i> ssp. <i>decumbens</i>	0.41	0.10	10
<i>Loiseleuria procumbens</i>	0.69	0.25	4
<i>Oxytropis nigrescens</i> ssp. <i>nigrescens</i>	0.44	0.10	4
<i>Picea glauca</i> - <50 cm	0.33	0.14	5
<i>Picea glauca</i> - 50-100 cm	0.31	0.09	7
<i>Picea glauca</i> - 1-4 m	0.23	0.06	7
<i>Picea glauca</i> - >4 m	0.60	0.15	5
<i>Salix arctica</i>	1.28	0.86	3
<i>Salix phlebophylla</i>	0.74	0.31	4
<i>Vaccinium uliginosum</i>	0.30	0.07	12
<i>Vaccinium vitis-idaea</i>	0.78	0.17	14

Appendix 6. 2011 field season logistics: Campsite locations and routes to plots

Personnel

Amy Miller (AM) – Ecologist, SWAN
Claudette Moore (CM) – Ecologist, SWAN
Michael Shephard (MS) – Program Manager, SWAN
Andrew Shulstad (AS) – Biological Science Technician, SWAN
James Walton (JW) – Biological Science Technician, SWAN
Leslie Witter (LW) – Biological Science Technician, SWAN

Flight services and aircraft used

Lake Clark National Park and Preserve, Port Alsworth – Cessna 185 on floats
Lake Clark Air, Port Alsworth – Cessna 206 on floats
Katmai National Park and Preserve, King Salmon – DHC-2 Beaver on floats
Katmai National Park and Preserve, King Salmon – Cessna 185 on wheels
Katmai Air, King Salmon - Cessna 207 on floats

Lake Clark National Park and Preserve

Snipe Lake

Personnel: AM, AS, JW

Access to survey area: Snipe Lake – Cessna 206 on floats, mid-lake landing and take-off due to shallow areas around shoreline.

Camp location: Snipe Lake Ranger Cabin, (NAD 83) 60.622, -154.316.

Hiking: The terrain is primarily rolling spruce woodland with low to moderate density shrub cover (*Betula*, *Salix*).

Weather and environmental conditions: Rain and cool temperatures most days.

Safety considerations: Bear and moose activity around Snipe Lake. Some slick, rocky areas around shoreline. Recommended footwear includes rubber boots and hiking shoes.

Phenology observations: Extensive *Betula nana* and some *Salix* spp. damage due to defoliating caterpillar spp.

General notes: Each plot was easily surveyed within a 10-h day (including travel time).

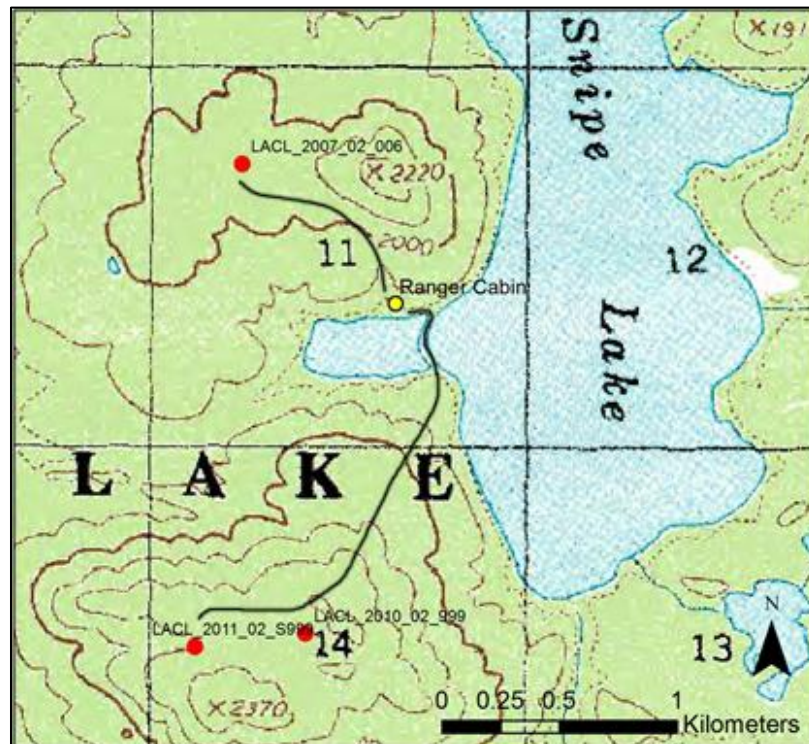


Figure A6-a. GRTS plots surveyed (●) near Snipe Lake. The Ranger cabin (shown in yellow) is located on the west-central part of Snipe Lake, along the north shore of a much smaller unnamed lake. Black lines indicate general route of travel to access plots.

Pear Lake

Personnel: AM, AS, JW

Access to survey area: Pear Lake – A Cessna 206 on floats can land with three people and gear plus pilot at this small lake, but only one person with partial gear plus pilot can take-off. When leaving the plot we shuttled each person with partial gear to nearby Snipe Lake and from there proceeded on to our next destination. Additionally, a Cessna 185 was used to shuttle one person plus gear.

Camp location: Campsite was located on a gravelly beach, NAD83 60.5796, -154.1648.

Hiking: Terrain is primarily spruce-shrub woodland around lake and dwarf shrub tundra at higher elevations.

Weather and environmental conditions: Cool temperatures, morning fog, and light rain most days.

Safety considerations: Recommended footwear includes rubber boots and hiking shoes.

General notes: Most plots were surveyed within a 10-h day (including travel time).

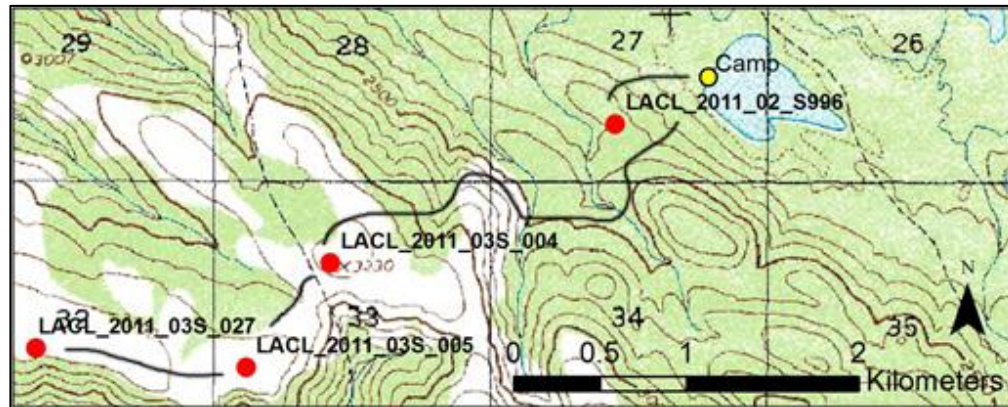


Figure A6-f. GRTS plots surveyed (●) near Pear Lake. The campsite (shown in yellow) was on gravel along the western shoreline. Black lines indicate general route of travel to access plots.

Turquoise Lake

Personnel: AM, AS, JW

Access to survey area: Turquoise Lake – Cessna 206 on floats, mid-lake landing and take-off due to shallow areas around shoreline.

Camp location: Camp was on gravel beach, (NAD83) 60.779, -153.989.

Hiking: The terrain is primarily low shrub around the lakeshore, and dwarf shrub alpine tundra at higher elevations.

Weather and environmental conditions: Cool temperatures, morning fog, and light wind most days.

Safety considerations: Recommended footwear includes rubber boots and hiking shoes.

General notes: Because of longer travel times to some plots due to steeper slopes, and high species richness (nonvascular), survey times were ≥ 10 h (including travel time).

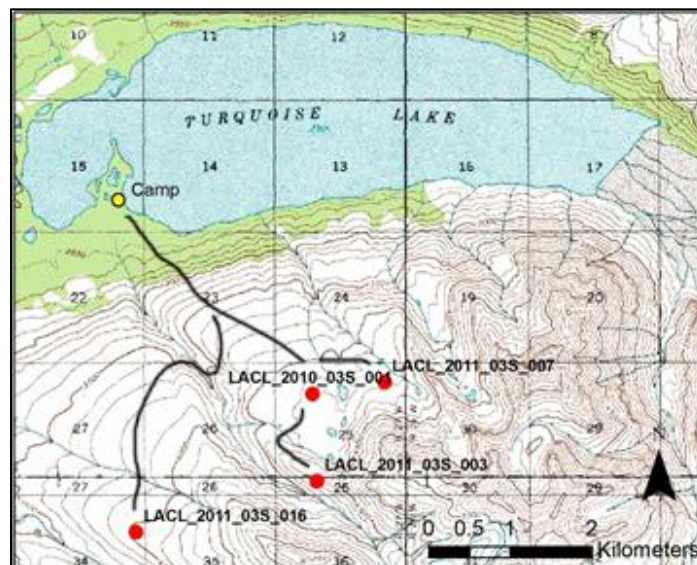


Figure A6-b. GRTS plots surveyed (●) near Turquoise Lake. The campsite is located on small peninsula on the southwest side of the lake. Black lines indicate general route of travel to access plots.

Lachbuna Lake

Personnel: MS, JW

Access to survey area: Lachbuna Lake – Cessna 206 on floats, a mid-lake landing was required due to shallow areas around lake shoreline.

Camp location: Hunter's camp in cove just north of the mouth of College Creek, NAD83 60.484, -154.033.

Hiking: Terrain is primarily rolling spruce woodland to spruce forest with low to moderately dense shrub cover (*Betula nana*). Small creek crossing required to access plot to east.

Weather and environmental conditions: Cool temperatures and light to moderate rain and wind most days.

Safety considerations: Moose sign observed throughout area; creek crossing can be done in rubber boots upstream of outlet if water-level is low enough. Recommended footwear includes rubber boots and hiking shoes.

Phenology observations: Nearly 100% of spruce was covered with *Chrysomyxa ledicola* (orange tree rust) within the area.

General notes: Each plot was easily surveyed within a 10-h day (including travel time). Plan on a full 10-h day for upper ridgeline plots (LACL_2010_01_098 and LACL_2010_03S_997).

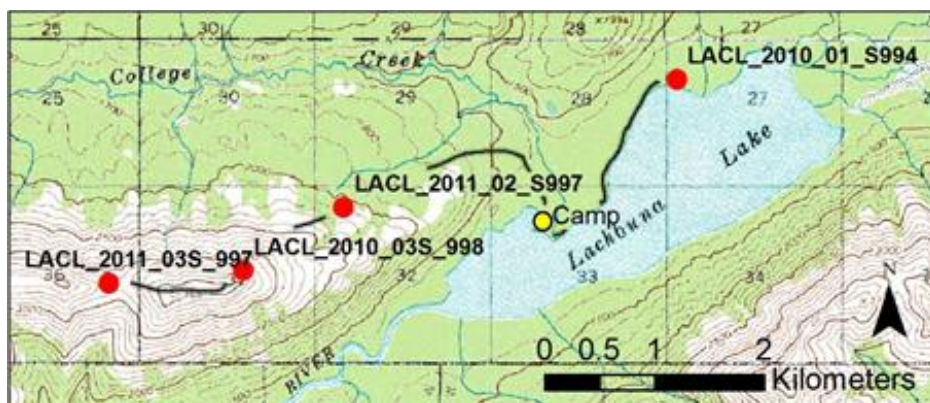


Figure A6-e. GRTS plots surveyed (●) near Lachbuna Lake. An old hunters camp adjacent to College Creek was used as the campsite. Black lines indicate general route of travel to access plots.

Pickeral Lakes

Personnel: AS, JW, LW

Access to survey area: Pickeral Lake – Cessna 206 on floats. The lake is shallow around the shoreline so a mid-lake landing and take-off is required. The safest place to beach the plane is along the southwest corner of the lake, NAD 83, 59.948, -154.758.

Hiking: Terrain is primarily rolling spruce woodland and wetland with low to moderately dense shrub cover (*Betula nana*).

Weather and environmental conditions: Cool temperatures throughout the survey day.

Safety considerations: Moose and bear sign observed throughout area. Rubber boots and hiking shoes are recommended.

General notes: Navigation around wetlands is required to/from plot, but the plot was easily surveyed within a 10-h day (including travel time).

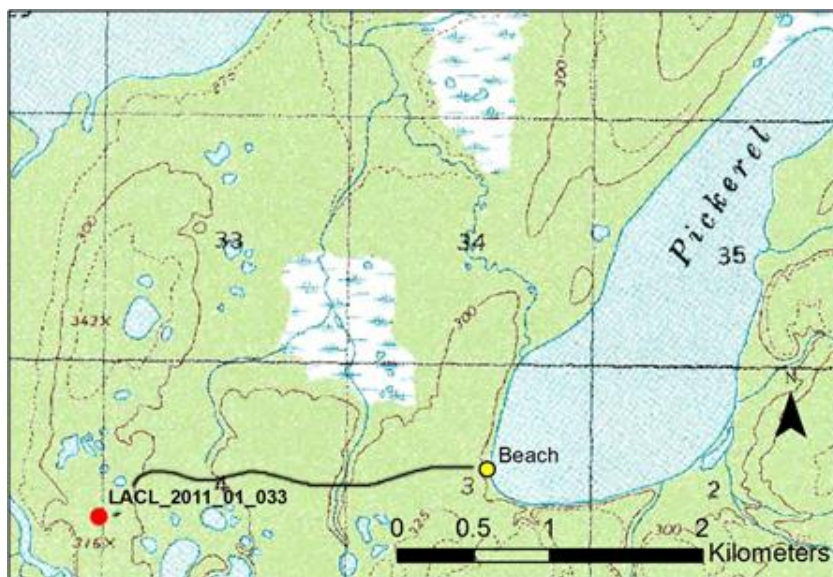


Figure A6-j. GRTS plot surveyed near Pickeral Lakes (●). The southwest beach area was considered the safest place to park the aircraft. Site visit was a day trip; no camp site was established. Black line indicate general route of travel to access plot.

Port Alsworth

Personnel: AS, JW, LW

Access to survey area: Daytrip from Port Alsworth.

Hiking: Primarily trail-based. Terrain is rolling spruce – birch woodland with low to moderate shrub cover. Steep bedrock and mesic meadow on the mid-slopes of Tanalian Mountain also encountered.

Weather and environmental conditions: Cool temperatures and mild to moderate rain and wind.

Safety considerations: Tanalian Mountain can get very windy and cold any time of year. Trail is steep and slick in places when wet. Take care on the descent. Recommended footwear includes sturdy hiking boots or shoes.

General notes: Due to longer travel times due to the steep ascent and descent, plan on at least a 10-12h work day (including travel time).

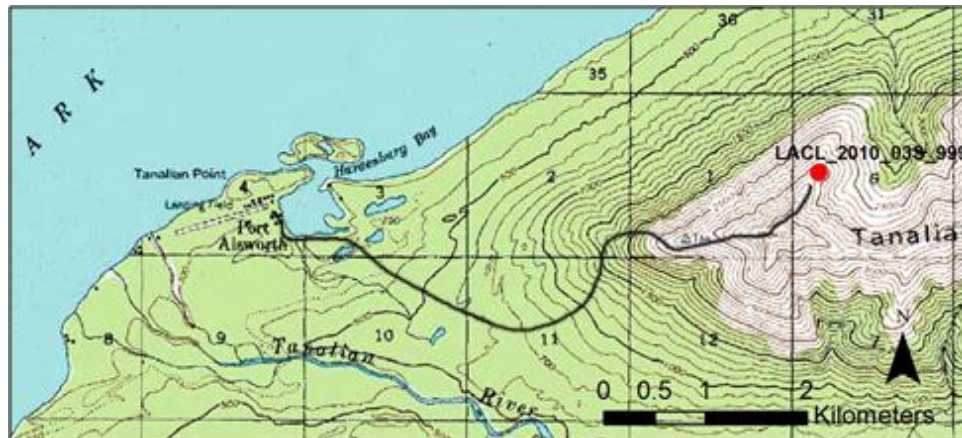


Figure A6-I. GRTS plot surveyed (●) near Port Alsworth. Black line indicate general route of travel to access plot.

Caribou Lakes

Personnel: AM, AS, JW

Access to survey area: Caribou Lake – Cessna 206 on floats, mid-lake landing and take-off required. If water levels are low in lake (early season) then take-off zone can be reduced, which may require multiple ferry trips to remove personnel and gear.

Camp location: Old hunters camp, NAD83 60.4501, -154.5424.

Hiking: Terrain is rolling spruce-shrub woodland around lake, and dwarf shrub tundra and fellfield at upper elevations.

Weather and environmental conditions: Cool temperatures and mild to moderate rain and moderate to strong winds.

Safety considerations: Due to the topographic position of the surrounding hills, the area tends to experience moderate to strong winds, so be prepared for colder conditions at all elevations. Recommended footwear includes sturdy hiking boots or shoes.

General notes: Due to longer travel times due to the steep ascent and descent, plan on at least a 10-12h work day (including travel time).

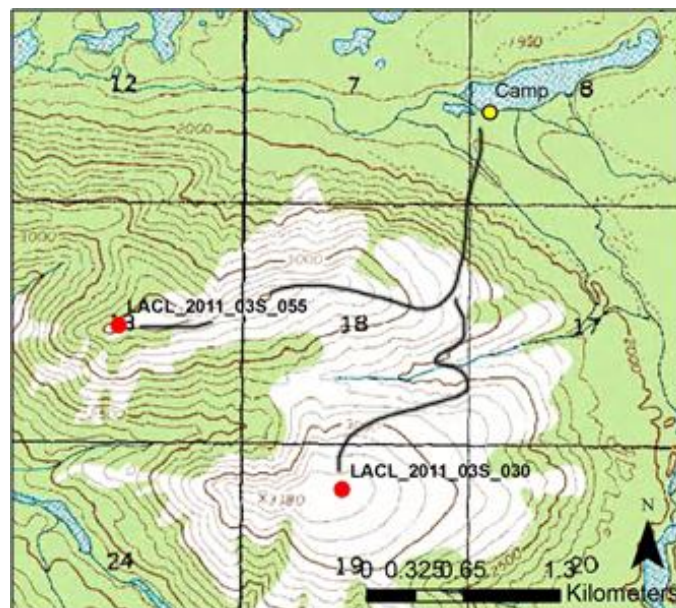


Figure A6-f. GRTS plots surveyed (●) near Caribou Lakes. Campsite was an old hunters camp along southwest shoreline. Black lines indicate general route of travel to access plots.

Katmai National Park and Preserve

Mirror Lake

Personnel: AM, AS, JW

Access to survey area: Mirror Lake – DHC-2 Beaver on floats, mid-lake landing and take-off due to lake size.

Camp location: On dwarf shrub tundra, NAD83 59.240, -154.757.

Hiking: The terrain is primarily low shrub and dwarf shrub tundra, with some fellfield and scree areas at higher elevations.

Weather and environmental conditions: Light wind and cool temperatures most days.

Safety considerations: Active brown bear activity along shoreline as well as upslope from lake. Recommended footwear includes rubber boots and hiking shoes. Camp was located on a pocket (small cove) of the shoreline that provided some protection from wind for beach landings.

General notes: Each plot was easily surveyed within a 10-h day (including travel time).

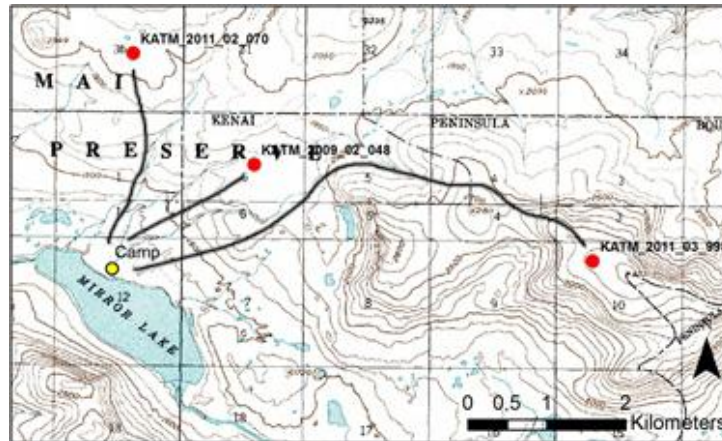


Figure A6-f. GRTS plots surveyed (●) near Mirror Lake. Campsite was on dwarf shrub tundra along northern shoreline. Black lines indicate general route of travel to access plots.

Pfaff

Personnel: AM, JW

Access to survey area: Pfaff Mine landing strip - Cessna 185 on wheels

Camp location: Sheltered depression in alder at north end of airstrip.

Hiking: The terrain is primarily dwarf shrub tundra, with fellfield and scree at higher elevations.

Weather and environmental conditions: Light to moderate wind, rain, morning fog, and cool temperatures most days.

Safety considerations: Brown bear activity throughout area. Recommended footwear includes rubber boots and hiking shoes.

General notes: Each plot was easily surveyed within a 10-h day (including travel time).

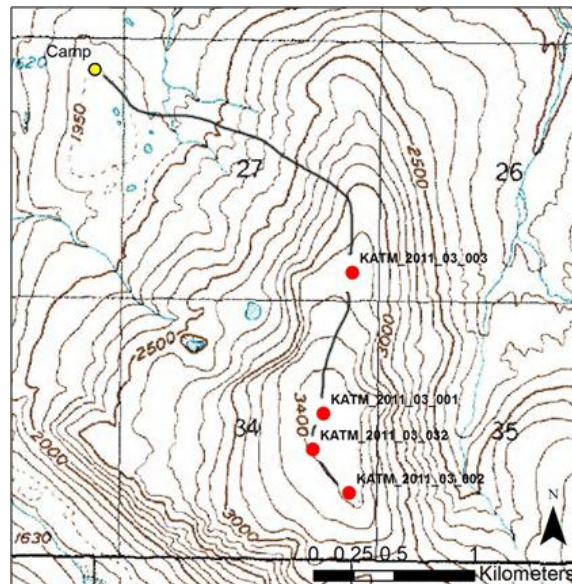


Figure A6-f. GRTS plots surveyed (●) near Pfaff landing strip. Campsite was in alder in a small, sheltered depression at the NW end of the airstrip. Black lines indicate general route of travel to access plots.

Hammersly

Personnel: AM, CL, AS, JW

Access to survey area: Hammersly Lake – Cessna 207 on floats and DHC-2 Beaver on floats.

Camp location: Dwarf shrub tundra along NE shoreline, just N of creek, NAD83 58.864355, -155.146413, elev. 488 m.

Hiking: The terrain is primarily shrub and alder at lower elevations, with dwarf shrub tundra and fellfield at higher elevations. There is a large alder stand that must be navigated in order to reach all plots, which may increase travel time depending on group size and navigation “success.” Stay on the W side of the alder stand, then wrap NNE around the toe of the ridge to reach a small creek and opening that will provide easy access to the ridge. Access to plot KATM-2011-03-009 requires a stream crossing that may be difficult in high water. In July 2011, it was thigh knee- to thigh-deep. Carry trekking poles and river shoes.

Weather and environmental conditions: Light wind, rain, morning fog, and cool temperatures most days.

Safety considerations: Brown bear activity throughout area. Recommended footwear includes rubber boots and sturdy hiking shoes.

General notes: Each plot was easily surveyed within a 10-h day (including travel time).

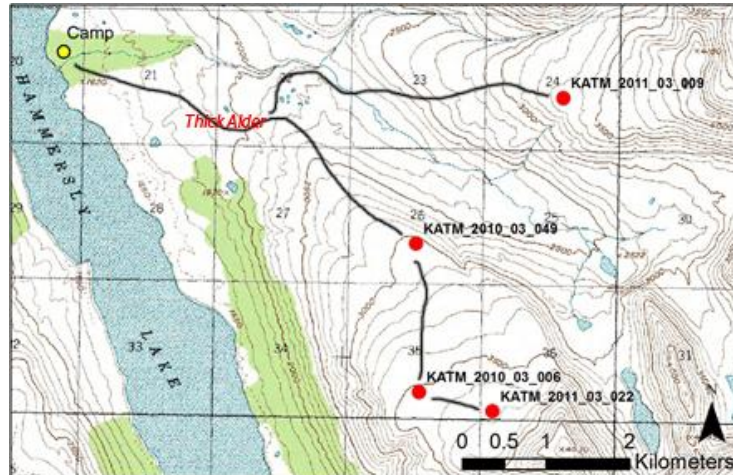


Figure A6-f. GRTS plots surveyed (●) near Hammersly Lake. Campsite (shown in yellow) was in dwarf shrub tundra along northeastern shoreline. Black lines indicate general route of travel to access plots.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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