Summary of the 2013 Western Arctic Caribou Herd Project in McCarthy's Marsh, Seward Peninsula Alaska

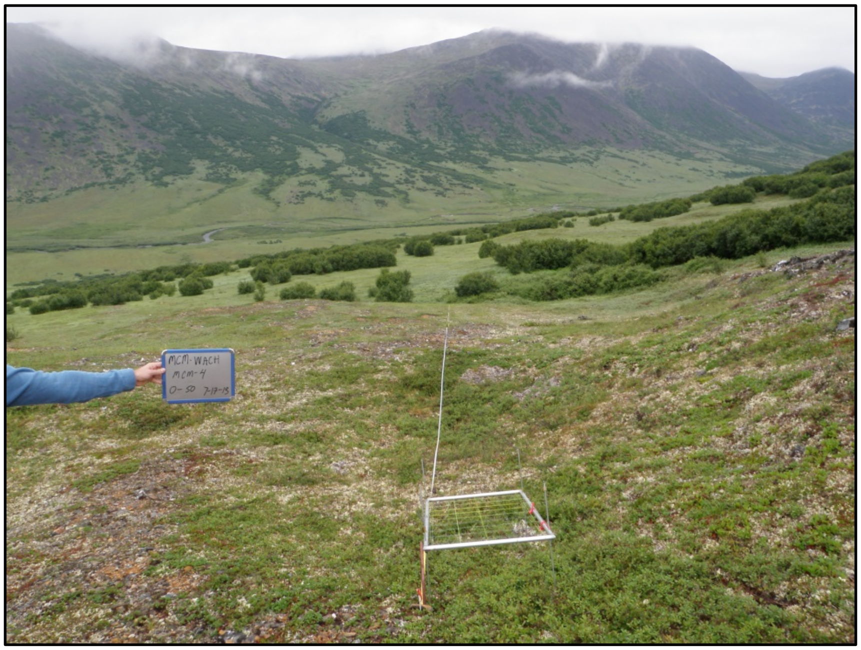

Photo: MCM4-Lava Creek transect photo by Justin R. Fulkerson

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NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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Introduction

The Western Arctic Caribou Herd (WACH) has increased dramatically in size over the last forty years, from approximately 75,000 animals in 1970 to 490,000 in 2003, and is now estimated at approximately 348,000 (Dau 2005, Joly *et al.* 2006). With the increase in population size the herd has increased the regional extent of its wintering grounds. The expansion in spatial extent of the wintering range and surge in population numbers has led to concern that the herd may be negatively impacting the vegetation (Joly *et al.* 2006). Additionally, this habitat experiences occasional tundra fires that have dramatic impacts on the vegetation. The vegetation communities that tend to be most impacted by fires are also those that caribou are particularly reliant on. The BLM and collaborators are therefore striving to understand the pace and trajectory of vegetation community assembly following disturbance by fire and by caribou grazing.

To assess the impacts of grazing by caribou (*Rangifer tardus granti*), 20 permanent range transects were established by the Bureau of Land Management (BLM) in 1981. These transects were located in the winter range of WACH, primarily in the Buckland River valley of the Seward Peninsula Alaska. Eighteen of these transects were located and reassessed between 1995 and 1996, and an additional seven transects were added to the study 1996, creating a total of 25 permanent transects (Joly *et al.* 2006). Transects closer to Buckland were revisited between August 12 and 23 of 2012 and the McCarthy's Marsh transects (Figure 1) were revisited from 15-17 July of 2013 by the Alaska Natural Heritage Program (Table 1). See Heitz and Carlson (2012) for a summary of 2012 findings. This report summarizes data collected from McCarthy's Marsh transects in 2013.

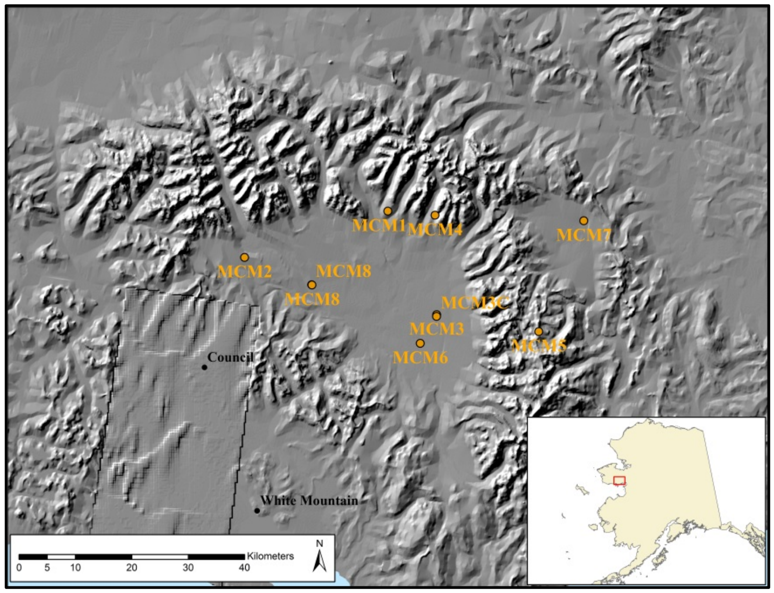

Figure 1. McCarthy's Marsh transect sites.

Methods

Ten transects were sampled using the point intercept method described by Floyd and Anderson (1987). A 1.0 m × 0.5 m sampling frame was strung every 10 cm along both axes to create 50 intercept points. The frame was placed every 4 m along a 50 m transect, for a total of 12 frames per transect (Figure 2). The first

Table 1. Field crew members and participation dates.

Crew member	Position	Affiliation	Field Dates
Justin Fulkerson	Botanist	AKNHP	15-17 Aug
Brian Heitz	Botanist	AKNHP	15-17 Aug
Randi Jandt	Senior Ecologist	AKNHP	15-17 Aug
Timm Nawrocki	Botanist	AKNHP	16-17 Aug

plant species or non-vegetative object observed under the string intercept point was recorded. If a lichen species was encountered as a secondary canopy layer, it was recorded as a second 'hit'.

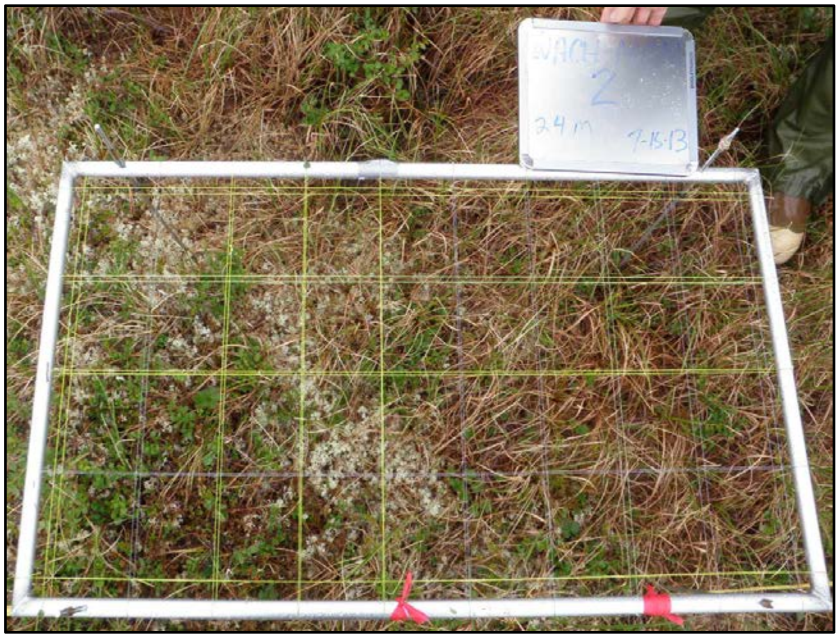

Figure 2. Overhead view of sampling frame at 24 m of MCM2.

For transect MCM 8-Control, there were two readings of the transect with the first performed on July 15 and the second on July 17. The end stake (50m) was found but the start (0m) could not be found as there were missing stakes and the fuel can plot marker was about 6 m away from GPS start point. The original transect, as described by Randi Jandt, was a 'continuous' transect line from 0m of 'MCM-8 Control' to '50m MCM-8 Burn' but with a gap between the transects. The start point was best estimated from GPS, photos, and transect azimuth on July 15 for the first reading and markers left in place. A second attempt to find the start stake (0m) was made on July 17 at the end of the field work, but the start stake could not be found. A second reading of the transect was performed on July 17 with a different 0m starting point than the first reading on July 15. This second start point was 1 m to the right (North) of the first reading. This second transect reading appeared to make a better 'continuous' transect line with the paired MCM8-Burned transect and appears more accurate based on old photos. Therefore we recommend using the July 17 data as the control transect rather than the July 15 data. A rebar and magnets were left in place at the transect start (0m).

Caribou diet in northern and western Alaska is largely composed of fruticose lichens (eg. *Cladina rangiferina, Cladina mitis/arbuscula, Cladina stellaris, Cetraria cucullata*) (Swanson and Barker 1992).We therefore made an effort to evaluate lichen abundance and utilization of the plot. Lichen height was measured once **r**andomly in one of four quadrats in the sampling frame to the nearest 0.5 cm. Utilization was recorded as classes ranging from 0 (no utilization) to 8 (extreme utilization), as described in the Cover Classes for Lichen Utilization booklet provided by the BLM that is adapted from Swanson and Barker (1992).

Soil temperature, soil moisture, active layer depth, and active layer restriction type were measured 1 m to the right of the transect at 5 m intervals for 10 measurements total. Soil temperature and soil moisture were measured between tussocks at a depth of 12 cm and 10 cm, respectively. Soil pH and the dominant soil texture were recorded at the 5 m and 45 m transect mark. Photos were taken at the transect start (0m to 50m view) and of each cardinal direction (0°, 90°, 180°, and 360°) at the 0m start. Overview (Figure 2) and side view (Figure 3) photos of the sampling frame at each sampling point were taken, along with a transect end (50m to 0m) view (Appendix A). Site descriptions of plot markers, transect azimuth and slope, area slope and aspect, macrotopography, and visible disturbances were recorded. Viereck classification of transect vegetation was determined from point frame data because the data captured on the Transect Description Form did not include a percentage of cover for the dominant species which is needed for vegetation classification. Original scanned data sheets, spreadsheet data, and template data sheets are in Appendix B.

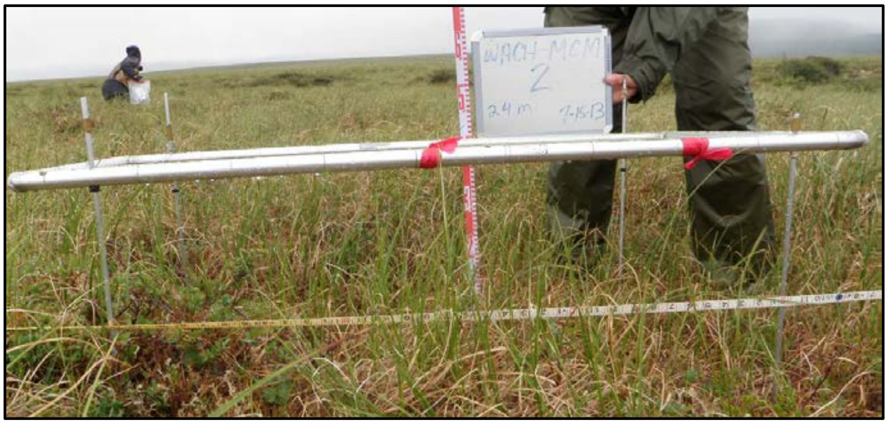

Figure 3. Side view of sampling frame at 24m of MCM2.

Unknown and vouchered taxa were later identified deposited at the University of Alaska Anchorage Herbarium (UAAH). Thirty specimens were collected for McCarthy's Marsh transects and included with the Buckland 2012 specimens (Appendix C). Specimen label information can also be accessed online at the CPNWH website (http://www.pnwherbaria.org/). Data summarized originate from Excel spreadsheets and not FFI (FEAT/FIREMON Integrated, *see below*). Since previous years (pre-2013) data appear inconsistent in current Excel spreadsheet form, only MCM 2013 data was summarized for this report. Each species was categorized in the following vegetative classes: lichen, graminoid, shrub, forb, moss, or non-vegetated. Non-vegetated cover included barren, litter, rock, water, mud, and wood. Percent cover of each vegetated class was calculated for all transects and summarized. These summaries exclude the "second hit" lichens as the "second hit" was not recorded on every point therefore the incorporation of these data would introduce bias to the dataset.

FFI Data Entry

To provide a standardized and uniformed dataset for the WACH project, all available data was entered into a software tool for ecological monitoring, FFI (FEAT/FIREMON Integrated): Ecological Monitoring Utilities (version 1.04.02.23). This software provides a protocol of data entry and analysis. Since this project started in 1981, all transect vegetation data, plot description data, and lichen utilization information has been entered into FFI from scanned copies of the original data sheets. Due to time constraints, soil data collected in 2012 for the Buckland and MCM transects were not entered into FFI. Also Daubenmire ocular estimation of vegetation cover in 1995 was not entered, but the point intercept frame was entered. Data predating the 2013 visits were not extracted for statistical analysis in this summary report.

Data was entered according to FFI Data Instructions (Appendix D) and the instructions were edited by AKNHP staff with 'track changes' to note necessary clarification and/or important changes in the data entry procedures. Plant names have changed since the start of the WACH project in 1981; therefore current 2014 accepted taxonomic plant names were entered in FFI. Name changes were listed and a scanned copy of the data sheet documenting these taxonomic notes as are provided in Appendix D. The only major disturbance recorded was on Transect-22 in 2005 where a fire had occurred an unknown number of years prior. Burn severity and comments on 'charred' and 'burned' vegetation data were entered as appropriate in FFI (*see* Appendix D). Data sheets across all years had inconsistent Utilization Values that included "Historical Utilization" and/or separate "Current Utilization". To make Utilization Evidence and Utilization Range consistent, only 'Current Utilization' was entered into the UV1 and UV2 fields for the Surface Fuels Protocol. Any Utilization that was marked as "Historical" or "HX" was noted in the comments section with its appropriate values (e.g., "3 HX" would be entered '0' for Utilization Evidence and Utilization Range but '3-Historical' in the comments column).

Results

Vegetation

Across all transects, shrubs (dwarf shrub and low shrub) had the highest mean canopy cover of 38.1% with a range of 26.5% to 49.3%, followed by graminoids with a mean cover of 32.0% and range of 5.7% to 54.2% (Figure 4; Appendix E). Lichen canopy cover ranged from 1.0% to 37.9%, with a mean of 18.2%. Non-vegetation cover ranged from 1.8% to 12% with a mean of

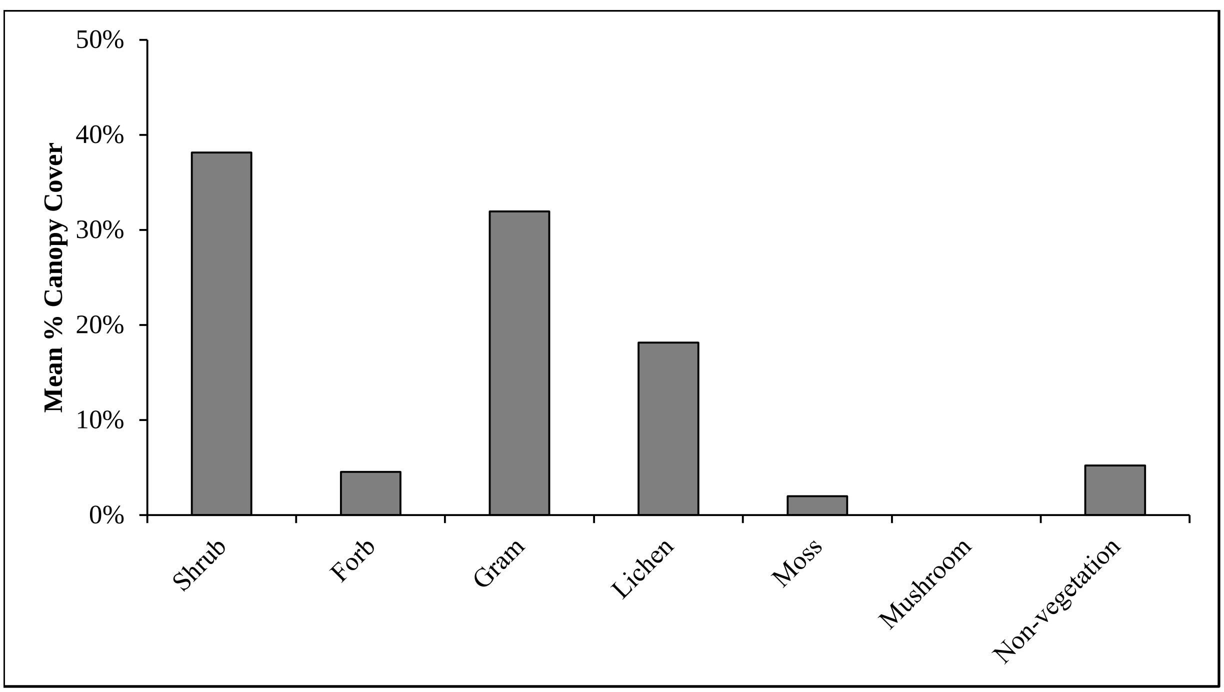

Figure 4. Mean percent canopy cover for all McCarthy's Marsh transects in 2013.

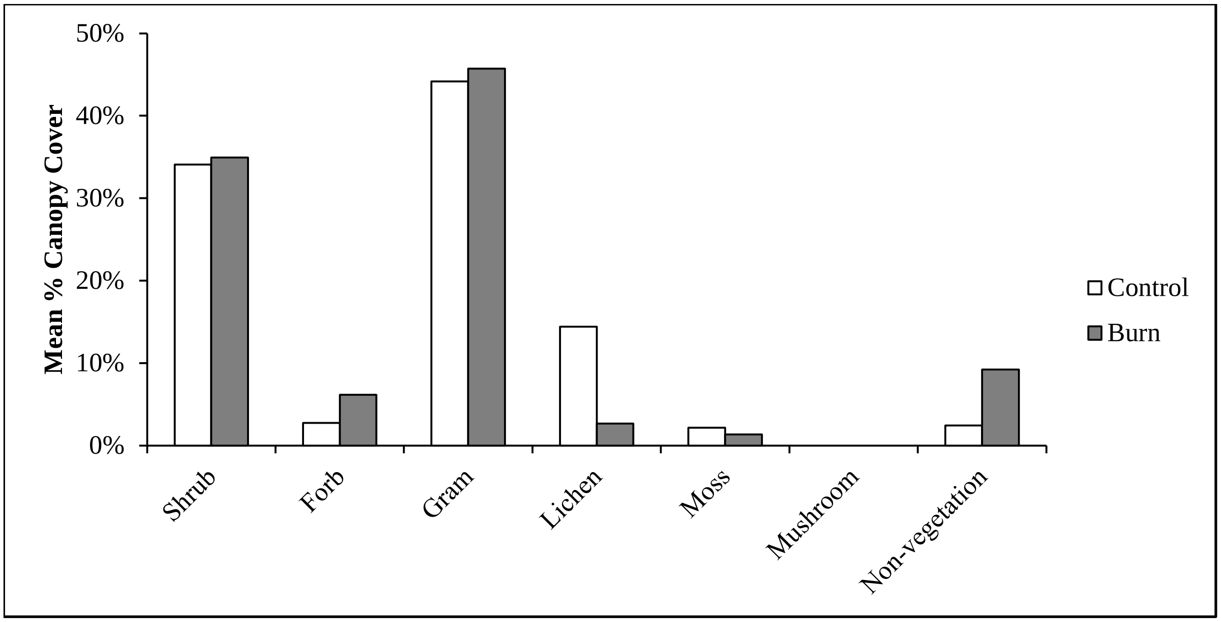

Figure 5. Mean percent canopy cover of unburned (control) and burned McCarthy's Marsh transects in 2013.

5.2%. Forb canopy cover ranged from 0.5% to 8.2% with a mean of 4.6%, Mean canopy cover for mosses (including liverworts) among transects was 2.0% and ranged from 0.5% to 3.5%. No fleshy mushrooms were recorded.

A comparison of burned transects (MCM-3B, MCM-8B) with the paired unburned transect (MCM-3C, MCM-8C), shows that the paired sites differ in forb, lichen, and non-vegetation canopy cover (Figure 5; Appendix E). Average forb canopy cover was higher in burned sites with 6.1% canopy cover compared to 2.75% in the unburned sites. Lichen canopy cover is markedly lower in burn sites with 2.65% mean canopy cover compared to 14.42% mean canopy cover in the unburned sites. Lastly, non-vegetation is markedly higher in burned sites with 9.23% mean canopy cover compared to 2.42% mean canopy cover in the unburned sites.

Seven species were encountered on McCarthy Marsh transects that were not recorded in 2005. The species previously unrecorded included: *Eriophorum chamissonis* (formerly *E. russeolum*), *Carex scirpoidea*, *Carex vaginata*, *Silene acaulis*, *Polemonium acutiflorum*, *Bistorta plumosa*, and *Astragalus umbellatus*.

Lichen Utilization

Across unburned transects, mean lichen height was 2.41 cm and ranged from 1.67 cm to 4.04 cm. In the two burned transects the mean lichen height was 1.87 cm with plot MCM-3B having a height of 2.21 cm and plot MCM-8B having a height of 1.54 cm. Mean Utilization across all transects was 0.37, ranging from 0 to 1.75 (Appendix E). Half of all transects recorded no utilization. These null utilization values correspond with trace to slight impacts, specifically there is little to "no appreciable disturbance to the lichen cover" or "slight grazing" (Swanson and

Barker 1992). At the burned paired sites, some caribou utilization was observed at both control transects but not at the burned transects.

Table 2. Soil textures at McCarthy's Marsh transects.

Dominant soil type	# of occurrences	Number of sites
Clay	4	2
Loam	3	2
Peat	7	4
Rubble	2	1
Block-angular	2	1

Soil

Soil texture was variable across transects, but peat was the most frequently encountered soil type followed by clay (Table 2; Appendix F). Permafrost was the most frequently encountered lower boundary layer except at sites MCM-1 and MCM-4 where rock formed the lower boundary (Appendix F). Additionally, MCM-5 had a mixed boundary layer of permafrost and rock. Average Active Boundary Soil Depth across all transects was 33.48 cm and ranged from 12.9 to 66.3 cm. Average soil temperature across all sites was 5.47°C and ranged from 3.51°C (MCM-7) to 9.86°C (MCM-4) (*summarized in* Appendix F). The average soil pH across transects was 4.9 and ranged from 4.15 (MCM-3B) to 6.05 (MCM-7) (*summarized in* Appendix F).

Discussion

Seven of the ten WACH McCarthy's Marsh transects were classified as Tussock Tundra and across all transects average cumulative shrub and graminoid cover occupied 70% of the top canopy. Burned transects had nearly equal shrub and graminoid canopy cover as unburned transects did, suggesting that fire disturbance has little effect on the shrub and graminoid cover 36 and 44 years after fire disturbance (MCM-3B and MCM-8B, respectively). However, shrub and graminoid canopy cover was likely greatly reduced in years shortly after fire. The nearly equal canopy cover of shrubs and graminoids in burned and unburned transects might be attributable to the quicker growth rate of shrubs and graminoids. Compared with vascular plants, growth rates of lichens are slow, and reestablishment of late-seral lichen (e.g. *Cladina stellaris* and *Cladina rangiferina*) communities following large scale disturbances occurs over decades. Other factors such as caribou utilization and climate change are also likely contributing to the differences in vegetation cover in burned and unburned areas. For example, latitudinal shrub expansion patterns have been observed in northern Alaska and circumpolar arctic regions (Sturm *et al*. 2001a, Tape *et al*. 2006). A cyclic dynamic feed has been found with the shrub expansion where shrubs increase the snow retention resulting in warmer soil temperatures, which increase nutrient turnover rates and promote further shrub growth (Sturm *et al.* 2001b, Tape *et al*. 2006). Greater shrub and graminoid canopy cover can induce greater lichen height but also reduce lichen abundance and diversity (Swanson 1996, Holt *et al.* 2008). The application of multivariate statistical methods, such as ordination, would be useful to identify both general and specific patterns of vegetation change over time, but are outside the scope of this summary.

In arctic ecosystems, lichens contribute nearly half of the botanical diversity and a large portion of the biomass (Neitlich and Hasselbach 2001), and ground-dwelling lichens constitute the majority of diet for western arctic caribou during winter. Lichen was markedly lower on transects that experienced a burn in comparison with the paired unburned sites. Lichen was greatest at the alpine sites, except for one lowland tussock tundra site (MCM-2). Estimates of caribou utilization indicate low use in recent years of this area with half of all plots having no detectible utilization. The lack of utilization in McCarthy's Marsh burned plots is consistent with other work and likely relates to reduced lichen abundance (*see* Gustine and Parker 2008).

If the shrub and graminoid develop a new upper canopy layer over time, as suggested by the increased growth rate in the burned plots, the lower canopy structure of lichen, forbs, and mosses may not be lost in future data collection since the current point frame methodology only captures the uppermost canopy layer. Indeed, field observations often found shrub or graminoid canopy cover to be the overstory layer but lichen and/or forbs abundant in the lower canopy layer. This was the reasoning for Jandt and Joly to measure a "second hit" if lichen was present in the lower canopy layer. Having lichen height measurements may artificially inflate lichen abundance as lichen height can increase with shrub canopy cover, yet still diminish in abundance and diversity (Swanson 1996, Holt *et al.* 2008). Depending on the assumptions of the data interpretation, future plot frame readings may want to consider line-point intercept or other methods to capture the entire vegetation profile rather than the uppermost top layer only.

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Appendix A. WACH Photos

On USB Mass Storage Device

Appendix B. Data Sheets and Summary

On USB Mass Storage Device

Appendix C. Herbarium Vouchers

On USB Mass Storage Device

Appendix D. Data Entry in FFI

On USB Mass Storage Device

Appendix E. Vegetation Summary

Table 3. Summary of 2013 average percent canopy cover of primary cover classes, average Utilization, and average lichen height in McCarthy Marsh transects.

	Forb	Gram	Lichen	Shrub	Moss	Non-Veg	Utilization	Lichen Height (cm)
MCM-1	4.3%	17.5%	24.5%	49.3%	0.5%	3.8%	0	3.58
MCM-2	2.7%	34.5%	31.5%	26.5%	2.2%	2.7%	0	3.64
MCM-3C	2.3%	54.2%	10.2%	30.0%	0.8%	2.5%	1.75	1.42
MCM-3B	6.7%	44.8%	1.0%	33.8%	1.7%	12.0%	0	2.21
MCM-4	0.5%	5.7%	37.9%	48.0%	0.5%	7.5%	0.75	2.25
MCM-5	8.2%	6.8%	32.8%	40.3%	3.5%	8.5%	0	1.67
MCM-6	7.5%	31.8%	13.2%	39.8%	3.0%	4.7%	0.083	4.04
MCM-7	4.7%	43.5%	7.5%	39.3%	3.2%	1.8%	1	1.85
MCM-8C	3.2%	34.2%	18.7%	38.2%	3.5%	2.3%	0.083	3.25
MCM-8B	5.6%	46.6%	4.3%	36.0%	1.0%	6.5%	0	1.54

Appendix F. Site Description Summary

Table 4. Summary of Transect Site Descriptions and Soil Layer for McCarthy's Marsh transects in 2013.

	Viereck Classification	**Macrotopography**	**Elev. (m)**	**Transect Slope (%)**	**Avg. Soil Temp (°C)**	**Avg. Soil pH**	**Soil Texture**	**Boundary Layer**	**Avg. Active Layer Depth (cm)**
MCM-1	2D2B Vaccinium Dwarf Shrub Tundra	Plateau	296	5	6.23°	5.6	Blocky, angular	80% Rock, 20% Permafrost	66.3
MCM-2	3A2D Tussock Tundra	Shoulder slope	179	0	4.96°	4.25	Peat	Permafrost	29
MCM-3C	3A2D Tussock Tundra	Nonpatterned	51	0	5.62°	5.6	Loamy	Permafrost	31.4
MCM-3B	3A2D Tussock Tundra	Nonpatterned	50	0	5.15°	4.15	Peat	Permafrost	37.9
MCM-4	2D2B Vaccinium Dwarf Shrub Tundra	Upper slope	350	26	9.86°	4.75	Rocky-Sandy-Loamy	Rock	12.9
MCM-5	2D1C Dryas-Lichen Dwarf Shrub Tundra	Plateau	645	0	5.37°	5.3	Rubbly	60% Rock, 40% Permafrost	30.3
MCM-6	3A2D Tussock Tundra	Flat	49	0	4.84°	4.2	Peat	Permafrost	33.4
MCM-7	3A2D Tussock Tundra	Nonpatterned	165	0	3.9°	6.05	Clayey	Permafrost	30.6
MCM-8C	3A2D Tussock Tundra	Flat	69	0	3.51°	4.6	Loamy	Permafrost	33
MCM-8B	3A2D Tussock Tundra	Flat	69	0	5.22°	4.25	Clayey	Permafrost	30