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Macrolichen Diversity in Noatak National Preserve, Alaska

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Abstract: We sampled macrolichens in Noatak National Preserve to help address the need to document lichen biodiversity in Arctic ecosystems and to initiate regional-scale monitoring in the face of climate change and air pollution. We used a stratified random sample to allow unbiased park-wide diversity estimates, along with an intensive sample in a limited area. The purpose of the intensive sample was to allow us to calculate a correction from diversity estimates based on a single person in a time-constrained method to a value that more closely approximates the “true” diversity of a plot. Our 88, 0.38-ha plots averaged 26 species of macrolichens in the sample, while our best estimate of the true average was 42 species per plot. Our raw estimate of gamma diversity (park-wide macrolichen species richness) was 209 species, with jackknife estimates adjusting this to 255 or 290 species, depending on the estimator. Overall beta diversity was rather high at 7.1, reflecting the considerable variation in lichen communities among topographic positions, rock chemistry, substrate pH, climate, and vegetation. The richest lichen communities were in conifer forests, low birch/ericaceous vegetation, dwarf shrub, and talus lichen cover. Sparse vegetation was the cover type with lowest lichen species richness, reflecting the frequency of bare rock in that cover type. The herbaceous cover type was the most heterogeneous in lichen communities, having a high gamma diversity, high beta diversity, but averaging rather low alpha diversity. Several notable species are among the 364 taxa reported here. *Leucocarpia biatorella* is reported as new to the American Arctic. *Cladonia libifera* and *C. jacutica* are newly reported for North America. A second location for *Rhizocarpon cumulatum* beyond the type locality was found. The range of *Parmelia squarrosa* is extended ca. 1500 km north of coastal southeast Alaska. The high landscape-level diversity and high beta diversity in Noatak National Preserve provide a rich biotic tapestry for detecting future changes in macrolichen communities.

Key words: adaptive sampling, Alaska, Bering Land Bridge National Preserve, *Cladonia jacutica*, *Cladonia libifera*, gamma diversity, International Biosphere Reserve, jackknife estimator, *Leucocarpia biatorella*, lichenized fungi, *Parmelia squarrosa, Rhizocarpon cumulatum*, Seward Peninsula, species-area curve, species diversity, species richness, stratified sampling, tundra.

INTRODUCTION

The 2.6 million hectare Noatak National Preserve is dominated in diversity by nonvascular species which have yet to be enumerated. Noatak is a designated International Biosphere Reserve (UNESCO 2007, http://www.unesco.org/mab/BRs.shtml). Studies in adjacent Gates of the Arctic National Park have shown that as much as 75% of the flora is nonvascular, with approximately 45% of the species represented by lichens (P. Neitlich and L. Hasselbach, unpublished ms.). As in South America (Rozzi et al. 2008), it is likely that nonvascular plants and lichens increase with latitude as a proportion of the total species diversity. We estimated that less than 10% of the probable lichen flora in Noatak had been documented, based on the list of 59 species in the National Park Service lichen database (Bennett and Wetmore 2007). Tundra lichens face threats of injury and/or extirpation from a variety of anthropogenic sources including climate change and associated increase of tall shrubs, air pollution, snowmobile and ATV use, and overuse of fragile areas by human visitors. Managers do not currently know what taxa or communities are most at risk or at what scale. Nevertheless, lichens are important to functioning in these ecosystems, given the abundance (and sometimes dominance) of lichens, their importance in food webs (e.g., Klein 1987, Moser et al. 1979, and many other studies cited by Holt et al. 2008a) and nutrient cycling (e.g., Gunther 1989; Weiss et al. 2005).

The lichen flora of Noatak National Preserve is of particular interest not only because it has been little studied, but also because it occupies an intermediate position in the subarctic between the relatively oceanic Seward Peninsula (Holt et al. 2007, 2008a, b) and more continental areas, such as Gates of the Arctic (Neitlich and Hasselbach 1998). It also includes a regional transition between nearly pure tundra and forested areas. A better understanding of the lichen flora of Noatak will improve our understanding of the oceanity of lichen species in northwest Alaska. For example, it was unknown to what extent the most oceanic species of the Seward Peninsula, such as *Cladonia subfurcata*, might penetrate inland.

Our objective was to provide a park-wide inventory for macrolichens in Noatak National Preserve, a basis for documenting future changes in lichen diversity. Additional objectives, to collect data from baseline lichen community plots for future monitoring and to describe the relationships between lichen communities and major landscape variables, are reported elsewhere (Holt et al. 2009).

STUDY AREA

Noatak National Preserve includes more than half of the Noatak River watershed, spanning tundra to forest habitats on a regional climatic gradient. The Noatak River runs west at about 68°N, draining the south slope of the western Brooks Range. The suboceanic western end is 60 km from the Chuckchi Sea. The east end abuts Gates of the Arctic National Park and Preserve and has a more continental climate. The gradient in continentality is rather subtle, with a January to July difference in average temperature ranging from 36°C in the west to 40°C in the upper Noatak valley (Manley and Daly 2005). Noatak is thus intermediate in geography, climate, and floristics between the Bering Land Bridge Preserve on the Seward Peninsula (Holt et al. 2007, 2008a, b) and Gates of the Arctic (Neitlich and Hasselbach 1998). The Noatak Valley is rimmed by mountains of both calcareous and noncalcareous rock. Large continental glaciers did not cover the landscape, although much of the area was glaciated by alpine glaciers (Hamilton 2003).

Noatak Preserve is also heavily used by animals, particularly the thousands of wild caribou that annually migrate through it. The Western Arctic Caribou Herd has numbered at between 400,000 and 490,000 animals during the decade preceding and including this study (Jim Dau, pers. comm., 2008). Numerous trails, droppings, and tracks were present. The preferred winter food by caribou, the "reindeer lichens", i.e., species such as *Cladonia rangiferina, C. arbuscula, C. mitis,* and especially *C. stellaris* are very scarce and usually in scrappy condition, except in places (cliff shelves, tops of big boulders) that are inaccessible to caribou. Also other terrestrial macrolichens are clearly suffering from caribou grazing and trampling.

METHODS

Sampling

Two basic kinds of sampling provided different kinds of data: an intensive sample in a limited area and a park-wide stratified random sample. The purpose of the intensive sample was to allow us to calculate a correction from diversity estimates based on a single person in a time-constrained method to a value that more closely approximates the "true" diversity of a plot. To do this, a group of five lichenologists sampled a diversity of cover types near a base camp near Copter Peak (68.4734°N, 161.4845°W). One lichenologist (Holt), the person who sampled all of the remaining plots, read the seven intensive plots independent of the other four lichenologists. Those four divided the lichen flora into four groups, each person focusing on only one group. Holt's data were then compared with our best estimate of the true lichen flora in each of the seven plots. This best estimate was made as the combination of Holt's data with the four others. These data were gathered over a five-day period in 2004. In addition, microlichens were collected incidentally by the group. Though not part of the formal plot sampling, these microlichen collections contributed to our understanding of the lichen flora of Noatak (see Floristic Sampling below).

We used two-stage adaptive sampling to attempt to focus our efforts on lichen-rich habitats in Noatak, while also providing coverage in other habitats. The first stage of sampling gave crude estimates of average macrolichen species richness in each cover type, the cover types based on remote sensing data. This stage included the 7 plots by the group of lichenologists, as well as 13 other plots by a single observer. The second stage of sampling added 68 more sample units such that the effort within a cover type was approximately proportional to lichen richness estimated in the first stage.

The National Park Service's original GIS land cover type map of Noatak (Markon and Wesser

1998) contained 15 total land cover types. Based on previous knowledge of the area, experience in nearby Bering Land Bridge National Preserve (Holt et al. 2007, 2008a, b), and similarity or overlap in cover type labels, we reclassified the cover types into seven strata (Table 1).

Based on our preliminary data from Noatak in 2004, we adapted the sampling intensity for sampling each of the seven cover types for 2005. Sampling intensity was determined by a "rarity score". The rarity score, S_i, is a rarity-weighted species richness for plot *i*.

With a presence-absence data matrix **A** containing j = 1 to p species and i = 1 to n plots, and a rarity weight w_j for species j, the rarity score S_i for a plot is:

$$S_i = \sum_{j=1}^{p} a_{ij} \bullet w_j$$

where $w_j = 1 - \text{freq}_j / N$ and freq_j is the frequency of species j. In other words, freq_j is the fraction of plots in which species j occurs. The lowest possible value of S_i is zero, for a plot with no species, while the maximum possible is the sum of rarity weights of all species in a particular data set. For this data set the highest possible rarity score was 106.35.

Strata were then sampled in proportion to the average S_i in that stratum. In this way, strata with high species richness and high frequency of rare species were sampled more intensively. In the 2004 data, the lowest rarity weight for a species was 0.25 and the highest was 0.95. The highest rarity score, S_i, for a plot was 36.5 and the lowest was 0.9. Averaging the scores of plots within the same stratum produced overall scores for each of the seven strata, these ranging from 1.6 to 28.6 (Table 2). Based on the rarity scores and planning for 60 plots for 2005, we calculated the number of plots to sample in each stratum (Table 2).

To improve the spatial balancing of the sampling we divided the Preserve into four roughly equal-area geographic blocks (see map of blocks and plots in Holt et al. 2009, Fig. 1). The boundaries of these blocks coincided with Preserve boundaries and physiographic regions. Within each geographic block, points from each of the seven cover type were randomly located with a random point generator script in ArcGIS. To reduce the influence of misclassified pixels that are scattered throughout the landcover map, points of a particular cover type were retained if they were surrounded by a minimum of 8 cells of the same cover type. The number of plots was roughly equal in each geographic block, with each cover type represented proportionate to the total number of plots from that cover type. Including the 20 plots sampled in 2004, a total of 80 plots were selected. The formal stratified randomization scheme allows us to make inferences about park-wide values of species diversity.

Plots were circular and fixed-area with a 34.7-meter radius. Species were scored with a coarse abundance scale. These abundances were used in a lichen community analysis of Noatak Preserve (Holt et al. 2009).

We used thin layer chromatography for identification of some *Bryoria, Cladonia, Hypogymnia*, *Parmelia omphalodes* group, and *Stereocaulon*. All *Cladonia* identifications were based on voucher specimens with podetia, and strictly squamulose thalli were not recorded. UV light distinguished the two chemical species of *Thamnolia*, which was also collected from every site at which it occurred. Vouchers were deposited at OSC, H, the NPS Herbarium in Anchorage, Alaska, and the research herbaria of Rosentreter and Holt.

Diversity measures

We separated alpha, beta, and gamma diversity of macrolichens, following Whittaker (1972) and McCune and Grace (2002), using only the data collected in formal lichen plots while excluding opportunistic floristic sampling. Calculations were made for individual cover types (Table 2) as

Table 1. Reclassification of 15 land cover types determined by remote sensing into 7 sampling strata, with the percentage of area of Noatak National Reserve in each cover type.

Original Cover Types		Reclassified Cover Types		
Name	Area, %	No.	Reclassified Name	Area, %
Closed needleleaf forest	1.8	1	Conifer forest	9.9
Open needleleaf forest	4.5			
Needleleaf woodland	3.7			
Tall open and closed alder/willow	2.6	2	Alder-willow	18.0
Closed low shrub-alder/willow	4.5			
Open low shrub-alder/willow	11.0			
Closed low shrub-birch/ericaceous	1.8	3	Low birch/ericaceous	19.7
Open low shrub-birch/ericaceous	17.9			
Open low and dwarf shrub tussock tundra	18.9	4	Dwarf shrub	26.1
Dwarf shrub tundra/dwarf shrub peatland	7.2			
Open dwarf shrub- talus/lichen	3.9	5	Talus lichen	3.9
Moist or dry herbaceous	8.7	6	Herbaceous community	10.5
Wet herbaceous	1.8			
Sparsely vegetated	4.5	7	Sparse vegetation	11.9
Barren	7.3			

Table 2. Sampling intensity for cover types based on average rarity scores, *S*, calculated from a preliminary sampling in 2004, assuming 60 plots to be sampled in 2005.

Stratum (Cover Type)	2004 No. plots	*S*	Added plots in 2005	Total plots
1. Conifer Forest	2	18.2	9	11
2. Alder-Willow	3	15.4	8	11
3. Low Birch/Ericaceous	2	17.1	9	11
4. Dwarf Shrub	3	13.7	7	10
5. Talus Lichen	4	20.1	11	15
6. Herbaceous Community	3	28.6	15	18
7. Sparse Vegetation	3	1.6	1	4

Table 3. Localities that are frequently mentioned in the floristic list (App. 1), each sampled by a team of five lichenologists. "Q" designates plots part of the intensive lichen "quest" by the team. A, D, H, L, and S designate cover types (Table 2) by their first letter. Coordinates are in North American Datum, 1983.

Name	Description	Lat. °N	Long. °W	Elev., m
plot Q3-D2	Open low-and dwarf shrub (*Betula*) tundra, valley bottom	68.4727	-161.4745	433
plot Q3-S4	Barren talus slope with a few small *Salix*, mid slope	68.4808	-161.4833	688
plot Q3-H3	Dwarf shrub tundra, upper west slope, near ridgetop	68.4605	-161.4515	729
plot Q3-A5	Tall *Salix alaxensis* thickets, moist tundra, and creek bottom	68.4645	-161.4901	437
plot Q3-L2	*Dryas* – low birch tundra on flats of valley floor, heavily used by caribou	68.4735	-161.4640	423
plot Q3-L5	Patches of dwarf shrub tundra on talus, steep NE slope	68.4892	-161.5215	608
plot Q1-L2	Open dwarf shrub tundra on alluvial terrace, valley bottom	68.4725	-161.4496	442
Camp Copter	Campsite near informal airstrip, dwarf shrub and low shrub (*Betula*) tundra on alluvial terraces and valley bottom	68.4739	-161.9625	450
Low Rock Ridge	Low siliceous outcrop ridge protruding from alluvial terrace	68.4685	-161.4775	432
Outcrops Near Q3-H3	Outcrops near barren talus slope, mid slope	68.4808	-161.4833	688
Cyano-tundra near Q3-H5	Dwarf shrub tundra rich with cyanolichens on N facing slope	68.4633	-161.4546	640

well as for all cover types combined. Alpha diversity was measured as species richness per plot. Because our abundance scale for plot sampling (Holt et al. 2009) had only a few coarse intervals, use of evenness-weighted alpha diversity measures, such as the Shannon index, were inappropriate. Beta diversity expresses the amount of community variation among plots and was measured with Whittaker's beta = (gamma/alpha) – 1. Gamma diversity was measured as the total number of macrolichen species observed in our plots in the study area. Because gamma diversity is always underestimated by such sampling (Palmer 1990, 1995), we used nonparametric resampling (jackknife) methods in PC-ORD (McCune and Mefford 2006) to attempt to estimate the "true" park-wide macrolichen species richness. Both the first-order jackknife (Heltshe and Forrester 1983) and the second-order jackknife (Burnham and Overton 1979, Palmer 1991) are based on the number of rare species encountered, and are thus very sensitive to sampling error (Palmer 1990, 1995).

Species-area curves were generated with PC-ORD 5 (McCune and Mefford 2006). Our sample of plots was subsampled to determine the average number of species as a function of size of the subsample. The data set was then partitioned to contrast plots with trees or shrubs to tundra. We then generated species-area curves for each partition of the data.

Floristic sampling
Three sources of data were combined to provide a first inventory of the lichen flora of Noatak National Preserve: (1) sampling of macrolichens and microlichens by five lichenologists near a base camp near Copter Peak, (2) a park-wide stratified random sample of macrolichens by Holt, and (3) incidental sampling of lichens along the Noatak River by two National Park Service employees, Tracy Wiese and Bruce Carter. In all 3678 collections or species observations were made.

Several localities received special attention by the team of lichenologists (Table 3), including the intensive plots described above and supplemental sites that both were convenient to study and held species of interest. These locations are referred to by name in the Results; otherwise plots are referred to by plot names in an Access database available from McCune, Holt, or the National Park Service.

RESULTS AND DISCUSSION

Estimates of total diversity
Species richness estimates from the single observer (Holt) sampling throughout the park were analyzed both unadjusted and adjusted to a "true" value. These adjustments were made by the strongly linear relationship ($r^2 = 0.98$) between estimates of the single observer in a time-limited sample and the "true" value for a subset of plots, as determined by a 5-person team of lichenologists. This allowed a simple correction factor between the single observer (x) and true species richness (y), $y = 1.67x$ (Figures 1 and 2).

Plots averaged 25 species of macrolichens in the sample with our best estimate of the true average being 41 species per plot (Table 4), including the adjustment given by the regression in Figure 1. These estimates apply to the whole park, based on stratified random sampling and weighting plot richness in particular cover types by the land area occupied by those cover types. Our raw estimate of gamma diversity from the single observer was 209 species, with jackknife estimates adjusting this to 255 or 290 species, depending on the estimator (Table 4, Fig. 2; see species list in Appendix 1). Overall beta diversity was rather high at 7.1, reflecting the considerable variation in lichen communities among topographic positions, rock chemistry, soil pH and depth, climate, and vegetation.

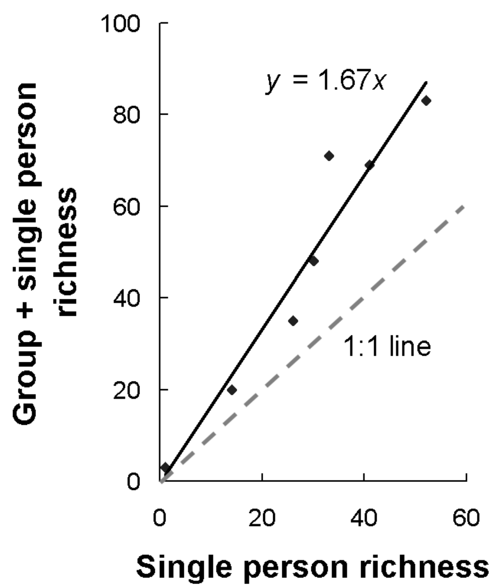

Figure 1. Relationship between macrolichen species richness estimates from a single observer versus that from our best estimate of the true species richness, combining the results of the single observer with those of four other lichenologists (Group + single person richness). The regression line (adjusted $r^2 = 0.98$, $N = 7$) was forced through the origin because an empty plot will have no species observations, regardless of the number of observers.

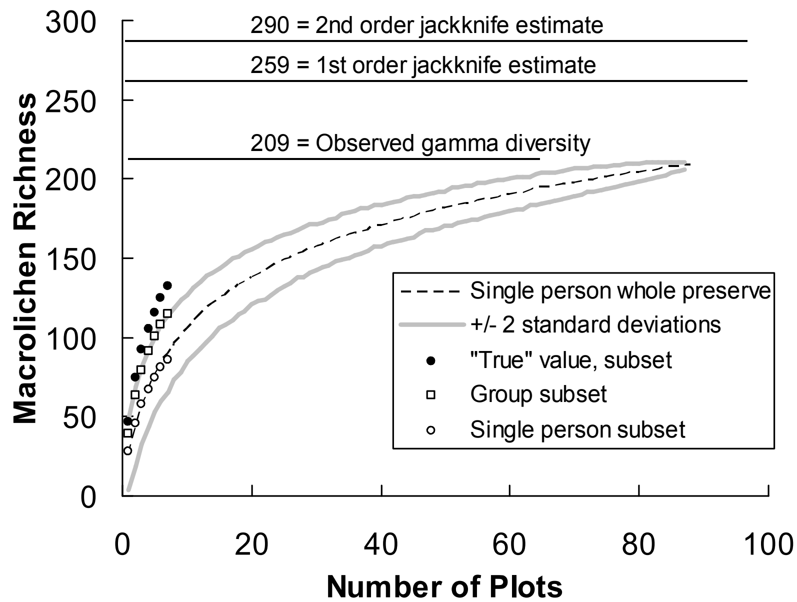

Figure 2. Species-area curve and estimates of gamma diversity for macrolichens in Noatak National Preserve. Curves show species-area relationships for the whole preserve based on repeated subsampling by a single person from a total of 88 plots. Gray lines show ± 2 standard deviations around that curve. Series of points on the left show species area relationships in a subset of plots visited by a team of four lichenologists ("Group subset"), the same single person as for the whole preserve ("Single person subset"), and the combined results from the group and the single person ("True value, subset").

Table 4. Estimates of total number of macrolichen species in Noatak National Preserve broken down by cover type and for the Preserve overall; *N* = number of plots. "Area weighted" estimates represent park-wide averages across cover types, weighted by their areas (Area%). Alpha diversity is measured by species richness; adjusted estimates incorporate the correction from single observer estimates to multiple-expert estimates. Whittaker's beta diversity (gamma/alpha – 1) expresses community heterogeneity among plots. Gamma diversity is the total number of species observed; Jack1 and Jack2 are jackknife estimates of the true gamma diversity, based on first-order and second-order jackknife estimators.

			Alpha diversity		Beta	Gamma diversity		
Cover type	*N*	Area%	raw	adjusted	diversity	Raw	Jack1	Jack2
Conifer forest	11	1.5	28.7	48.0	2.8	109	136	160
Alder-willow	12	19.3	23.4	39.1	3.1	96	125	135
Low birch/ericaceous	12	18.9	28.8	48.2	2.3	96	130	152
Dwarf shrub	11	28.5	28.3	47.3	2.2	91	119	131
Talus lichen	16	5.0	30.1	50.4	3.3	128	171	196
Herbaceous	18	11.7	22.4	37.5	4.0	111	147	162
Sparse vegetation	8	15.2	15.9	26.6	3.5	72	110	132
Overall	88	100.0	25.7	43.0	7.1	209	255	290
Area weighted			25.0	41.8				

The richest lichen communities were in conifer forests, dwarf shrub, low birch/ericaceous vegetation, and talus lichen cover types, each averaging an estimated 47-50 macrolichen species per plot. (Table 4). Sparse vegetation was the cover type with lowest lichen species richness, reflecting the frequency of bare rock in that cover type. The herbaceous cover type was the most heterogeneous in lichen communities, having a high gamma diversity, high beta diversity, but averaging rather low alpha diversity (Table 4). The rather low average species richness in the herbaceous cover type contrasts with its relatively high species in our preliminary sample, meaning that our preliminary sample led us to “oversample” the herbaceous type, relative to the conifer forest, low birch, and dwarf shrub cover types.

In spite of all our sampling, Figure 2 suggests that many species remain to be discovered in Noatak Preserve. Based on the jackknife estimates, an additional 50-80 species of macrolichens are present in the Preserve. The effort to discover those additional species should follow the law of diminishing returns. Doubling the number of plots would certainly add numerous species, however floristic sampling based on scientific judgment of lichen-rich or otherwise interesting or unusual habitats, would more quickly reveal additional species. For example, future sampling could target areas such as natural refugia from caribou grazing, the oldest forests, canyon walls, and further sampling of lichen-rich talus slopes, the most species rich of our cover types.

Lichen diversity at Noatak is difficult to compare with other areas, because so few areas have comparable data. In fact, we know of only one other high-latitude regional study of lichen diversity that used a formal sampling framework that allows regional estimates of diversity. That was in Bering Land Bridge Preserve (BELA; Holt et al. 2008a,b). Similar to the present study, they used a stratified sample of 77 plots throughout BELA, including remotely sensed cover types that a preliminary sample showed to contain numerous lichens.

Although the average number of species in a plot was similar between Noatak and BELA, the landscape-level species richness was considerably higher for Noatak than for BELA (Figure 3). For example, samples of 75 plots averaged 140 species in BELA and 202 species in Noatak. The most obvious explanation for this difference might be that the presence of forested areas in Noatak greatly increase the diversity of substrates and microhabitats for lichens, while all of the BELA plots were treeless. Comparison of tundra and forest plots in Noatak demonstrate, however, that this explanation is insufficient (Figure 4). While including both tundra and forested plots increases landscape-level diversity, the difference is small compared to the difference between Noatak and BELA. For example, random samples of 30 plots averaged 150 species with no trees or shrubs present, 143 species with more than 5% cover of trees+shrubs, and 158 species when sampled from all plots. In contrast, random samples of 30 plots in BELA averaged only 115 species.

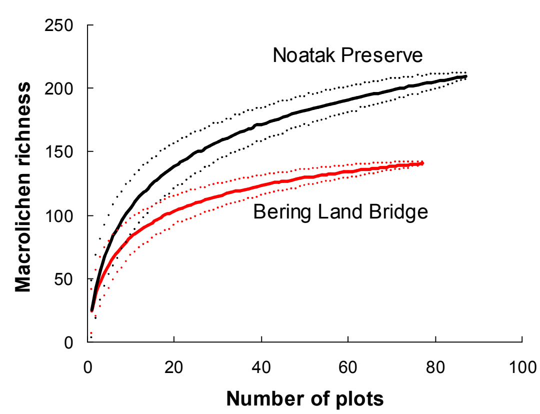

Figure 3. Species-area curves compared for Noatak and Bering Land Bridge National Preserves. Dotted lines show variability bands ± 2 standard deviations away from the average species richness for subsamples of a given size.

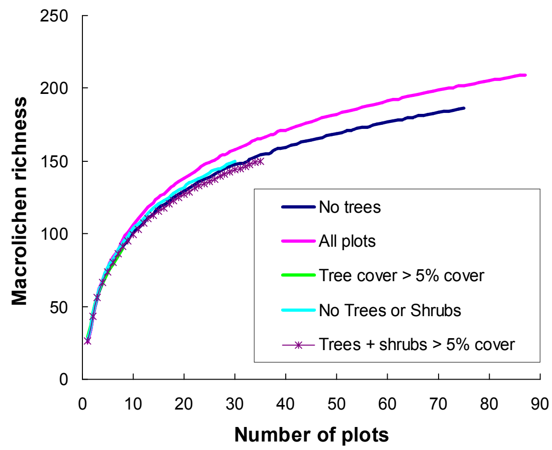

Figure 4. Comparison of species-area curves compared for Noatak National Preserve in groups of plots with different physiognomy of vegetation.

An alternative explanation is that the topographic, geologic, and climatic heterogeneity of Noatak results in higher landscape-level lichen diversity. Noatak is relatively mountainous and climatically variable, and has more calcareous rock, as compared to BELA, which mostly has flat to hilly topography, apart from a few mountainous areas, and only a small zone of calcareous rock. In addition, Noatak supplements the typical circumpolar flora of continental climates with a strong representation of oceanic floristic element, including species such as *Cladonia albonigra, Lobaria* spp, *Peltigera membranacea, P. neopolydactyla, Pseudocyphellaria crocata*, and *Ramalina roesleri.*

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APPENDIX 1. SPECIES LIST

We report 364 taxa. Nomenclature follows Esslinger (2008) with a few exceptions as noted. Frequency is stated when our information is sufficient to make a statement, based on both the park-wide stratified random sample, the intensive sampling near a base camp, and incidental sampling elsewhere in Noatak. Our limited sampling of crustose lichens does not allow a statement of abundance in most cases. Individual collection numbers and locations are given when only a few collections were made. The following frequency classes are applied to macrolichens, based on plot sampling: Very common (> 50% of plots), common (10-50%), occasional (3-9%), and uncommon (< 3% of plots). Taxa categorized as uncommon were shifted to "occasional" if our incidental sampling raised the total to four or more additional sites. We avoided the term "rare" because we considered our sampling insufficient to say which species are truly rare.

Alectoria nigricans – Uncommon.

A. ochroleuca – Common.

Allantoparmelia almquistii – Uncommon. McCune 27608, Low Rock Ridge. TLC: olivetoric acid.

A. alpicola – Uncommon. Holt 22788, plot SW-5d; medulla P+Y, not confirmed by TLC.

Anzina carneonivea – Uncommon. Ahti 63466; Low Rock Ridge.

Arctoparmelia centrifuga – Occasional.

A. incurva – Infrequent.

A. separata – The most common *Arctoparmelia* in Noatak.

Arthrorhaphis alpina – Common.

Asahinea chrysantha – Common.

A. scholanderi – Occasional.

Aspicilia sp.— Ahti 63843, plot Q3-A5.

A. caesiopruinosa – Rosentreter 15797, plot Q1-L2.

A. candida – McCune 27581, plot Q3-S4.

Aspilidea myrinii? – Wiese NM-1-04d, NM-1.

Bacidia?— Ahti 63947, plot Q3-L5.

Baeomyces carneus – Ahti 63335, plot Q3-D2.

B. placophyllus – Occasional.

B. rufus – Common.

Biatora vernalis – McCune 27557, Rosentreter 15836, plot Q3-L5;

Brodoa oroarctica – Uncommon. Holt 22968, plot NE-5a; cortex K+Y, medulla K-, KC+R, P+Y, UV+ faint; TLC: atranorin and physodic acid.

Bryocaulon divergens – Common in tundra.

Bryonora castanea – plots Q3-H3 and plot Q3-L5.

Bryoria fuscescens – Uncommon. Forest.

B. implexa – Uncommon. Holt 23178, plot NW-1e, thallus P+Y.

B. lanestris – Occasional. Forest.

B. nitidula – Occasional in tundra.

B. simplicior – Uncommon. Holt 23272, plot SW-2a; Holt 23588b, plot SW-1c; soralia P-.

B. trichodes – Uncommon. Holt 23581, plot SW-1c, Holt 23588a, plot SW-1c; medulla P+O, occurring in forests with *B. fuscescens* and *B. lanestris*.

Buellia chloroleuca – McCune 27530, plot Q3-A5; on wood; thallus KC+ orange; *B. zahlbruckneri* T. Schauer and sensu Imshaug.

B. notabilis – McCune 27500, plot Q3-H3.

B. punctata – Rosentreter 15748, plot Q3-L2.

Caloplaca sp. – Ahti 63946, plot Q3-L5; Ahti 63994, plot Q1-L2.

C. ammiospila (= *Caloplaca cinnamomea*) –

Apparently fairly common on tundra sod.

C. citrina – Ahti 63817b, plot Q3-A5.

C. holocarpa – McCune 27533, plot Q3-A5.

C. jungermanniae – Occasional.

C. phaeocarpella? – Ahti 63919, plot Q3-L2; on *Vaccinium uliginosum*.

C. saxicola – Wiese AT-1.

C. stillicidiorum – Probably frequent. *C. stillicidiorum* was not recognized for North America by Wetmore (2007), instead being lumped under *C. cerina*. Considering the recent molecular evidence suggesting overly broad species concepts in some species groups in *Caloplaca* (Arup 2009), it seems prudent, however, to keep these separate until a detailed study is made.

C. tetraspora – Ahti 63811a, plot Q3-H3; Ahti 63817, plot Q3-A5; McCune 27546a, plot Q3-L2.

C. tiroliensis – Ahti 63282a, Camp Copter.

Candelariella sp.

Catapyrenium cinereum

Cetraria andrejevii– Occasional.

C. commixta– Uncommon. Holt 22332, plot 04-L2.

C. cucullata – Very common. Note: because well-defined genera in *Cetraria* s. l. have proved difficult to establish, we apply a broad view of *Cetraria* here, but exclude *Coelocaulon*.

C. delisei – Common.

C. ericetorum – Occasional.

C. fastigiata – Uncommon. Holt 23153, plot NW-6a; Holt 23361, plot SE-2a.

C. inermis – Occasional (one specimen verified by A. Thell).

C. islandica – Very common. Both ssp. *crispiformis* and ssp. *islandica* are present, but the latter is less common.

C. kamczatica – Common.

C. laevigata – Very common.

C. nigricans – Common.

C. nivalis – Very common.

C. orbata – Uncommon. Holt 22937, plot SE-2b.

C. pinastri – Common on woody plants.

C. sepincola – Common on woody plants.

C. subalpina – Neitlich 2683, plot Q3-D2.

C. tilesii – Common in calcareous tundra.

Cetrelia alaskana – Uncommon; Holt 21966, Camp Copter; Holt 22897, plot NE-6c; McCune 27518, Neitlich 2759, 2760, 2778, Rosentreter 15859, cyanolichen-rich tundra near plot Q3-H3.

Cladonia acuminata – Occasional; UV-, P+Y, K-, KC-. *Cladonia norrlinii* of North American authors is the psoromic acid chemotype of *C. acuminata*. But in its original sense, *C. norrlinii* is a homotypic synonym of *C. acuminata*. TLC of Wiese AK-1-05: atranorin, psoromic acid, unknown Rf 4-5 in solvent B'.

C. alaskana – Uncommon. Ahti 63455, Low Rock Ridge; Ahti 63789, plot Q3-H3; Holt 22336a, plot 04-L2.

C. albonigra – Occasional; eleven specimens verified by TLC (chemotype 2 of Brodo and Ahti 1996, 4-*O*-methylcryptochlorophaeic, merochlorophaeic, and cryptochlorophaeic acids (all major), along with several minor unknowns and accessory minor fumarprotocetraric and protocetraric acids). These compounds were best discriminated in Culberson and Johnson's (1982) solvent system B'. Recognizable by the *chlorophaea*-like cups, UV+ medulla and blackening bases of podetia, *C. albonigra* has previously not been recognized in the Alaskan Arctic, but is common along the Pacific coast from Oregon to coastal southeast Alaska.

C. amaurocraea – Very common.

C. arbuscula – Very common but not abundant.

C. bacillaris – Uncommon. Holt 23310, plot NE-4b; thallus K-, KC-, P-.

C. bacilliformis – Occasional; thallus P-, K- or faint Y, KC+Y, UV-; wet areas (near streams or in moss mats, rarely in forests.

C. bellidiflora – Occasional.

C. borealis – Common.

C. botrytes – Uncommon.

C. cariosa – Occasional.

C. cenotea – Common.

C. chlorophaea – Common; 18 specimens confirmed by TLC.

C. coccifera – Common; 16 specimens confirmed by TLC (containing zeorin).

C. coniocraea – Uncommon. Holt 22353, plot 04-W4; Holt 23558, plot SW-1b

C. cornuta ssp. *cornuta* – Common.

C. cornuta ssp. *groenlandica* – Uncommon.

C. crispata – Common; 18 specimens confirmed by TLC.

C. crispata var. *cetrariiformis* – Common; most of *C. crispata* in Noatak is var. *cetrariiformis* (no 'cups').

C. crispata var. *crispata* – Uncommon.

C. cryptochlorophaea – Occasional; five specimens confirmed by TLC.

C. cyanipes– Common.

C. decorticata – Occasional.

C. deformis– Occasional.

C. digitata – Uncommon. Holt 23418, plot NE-6b; Holt 23529, plot NW-3b

C. ecmocyna ssp. *intermedia* – Uncommon. Holt 21719, plot Q3-D2. TLC: atranorin and fumarprotocetraric acid.

C. fimbriata – Common in forests, occasional in tussock tundra.

C. furcata – Occasional. Ten collections from Noatak, two of these verified by Ahti.

C. gracilis – Common.

C. gracilis ssp. *elongata* – Uncommon.

C. grayi– Occasional; five specimens confirmed by TLC.

C. jacutica Ahti – This member of the *C. verticillata* group was recently segregated by Ahti (2007). Although much of our material was too scrappy to be definitive, Ahti 63326 represents *C. jacutica*. This species is whitish, has a very rough surface, and is previously known from the Russian side of the Bering Sea (Ahti 2007).

C. kanewskii – Occasional.

C. libifera Savicz – Occasional; new to North America. Five collections from Noatak; also known from three specimens from Bering Land Bridge National Preserve. This is a widespread, often overlooked, primarily East Asian, continental, calciphile, which was described from Yakutia. It is also known from Krasnoyarsk Territory to Mongolia, Buryatia and Chita Region, at least. It resembles *C. pocillum*, but the podetia are more elongate, rather narrow-cupped, with brownish tinge, blackening necrotic bases. Flat schizidia develop on distal surface of podetia.

C. luteoalba – Occasional.

C. macroceras – Common.

C. macrophylla – Common.

C. macrophyllodes – Uncommon. Holt 23577, plot SW-1c. TLC: atranorin and fumarprotocetraric acid.

C. metacorallifera – Uncommon; confirmed by TLC.

C. mitis – Common.

C. nipponica – Uncommon.

C. nitens Ahti – Uncommon. Holt 23025, plot NE-2a. This recently described, primarily East Asian species, is common on the Russian side of the Bering Sea. Previously it was reported from a single locality in North America (Bering Land Bridge National Preserve, Holt 20364a in Ahti 2007).

C. phyllophora – Common.

C. pleurota – Common.

C. pocillum – Common.

C. rangiferina – Very common but sparse.

C. scabriuscula – Occasional. Not seen by Ahti.

C. squamosa – Occasional.

C. stellaris var. *stellaris* – Occasional and sparse.

C. stellaris var. *aberrans* – Occasional, but more frequent than var. *stellaris*.

C. stricta – Common.

C. stygia – Common.

C. subfurcata – Common.

C. sulphurina – Common.

C. symphycarpa – Occasional; six specimens, three with TLC: atranorin, fumarprotocetraric and protocetraric acids. We use "*symphycarpa*" rather than "*symphycarpia*" because in a recheck by Ahti of the original spelling used by Flörke, "*symphycarpa*" turned out to be correct, although "*symphycarpia*" is present in a specimen which apparently represents original material. Included here is an apparently undescribed species with short, erect, easily browned squamules and short, thick podetia (infrequent) with atranorin alone; it is also widespread in mountain tundras of the Yukon and District of Mackenzie in Canada (seen by T. Ahti).

C. thomsonii – Uncommon. Ahti 63324x, 63347c, plot Q3-D2; Ahti 63912, 63913, plot Q3-L2.

C. trassii – Uncommon; previously reported from North America by Ahti (1998); most of the early records of *C. stricta* belong here. Ahti 63315, 63334, 63345, 63918, plot Q3-D2; Holt 22274, plot 04-H2; Holt 23044, plot NE-4a.

C. uliginosa (Ahti 1998) – Uncommon. Ahti 63341a, plot Q3-D2.

C. uncialis – Common.

C. verticillata (including Holt specimens under *C. cervicornis*). – Uncommon. Our scrappy collections in many cases did not allow a definite identification. In part they represent the recently described *C. jacutica* (see above).

C. wainioi – Uncommon.

Coccocarpia erythroxyli – Uncommon. Holt 21801, plot Q3-H3; Holt 23120, plot SW-4b; cyanolichen rich tundra near plot Q3-H3, Ahti 63821, McCune 27521, Neitlich, 2756, 2757, Rosentreter 15858, 15862.

Coelocaulon aculeatum – Uncommon. Holt 21791, plot Q3-H3; Neitlich 2743, plot Q3-H3.

C. muricatum – Common, much more common than *C. aculeatum* in Noatak.

Collema bachmanianum – Uncommon. McCune 27544b, plot Q3-L2.

C. callopismum – Uncommon. Wiese K-01-09c, K-01.

C. ceraniscum – Uncommon. Ahti 63931e, plot Q3-L2.

C. cristatum – Uncommon. Holt 23336, plot SE-5a.

C. furfuraceum – Uncommon. Holt 23566, plot SW-1b.

C. fuscovirens – Common in calcareous areas.

C. polycarpon – Uncommon. McCune 27579, plot Q3-S4.

C. tenax – Common, especially in calcareous areas.

C. undulatum – Occasional. Rosentreter 15878, Camp Copter; 15814, Plot Q3-A5; 15837, 15840, Plot Q3-L5; Holt 23338b, Plot SE-5A.

Dactylina arctica – Common. Both subspecies *arctica* and subspecies *beringica* are frequent on tundra.

D. ramulosa – Common on tundra.

Dibaeis baeomyces – Occasional.

Diploschistes muscorum

D. scruposus

Ephebe hispidula – Holt 23476, plot NE-5c.

Epilichen scabrosus – Common on *Baeomyces*.

Evernia divaricata – Occasional in tundra; Holt 22692, 22733, 23415

E. mesomorpha – Occasional in forested areas.

E. perfragilis – Occasional.

Farnoldia hypocrita – McCune 27582, plot Q3-S4.

F. jurana – McCune 27565, plot Q3-L5.

Fuscopannaria praetermissa – Occasional.

Helocarpon crassipes – Wiese K-01-08.

Hypogymnia bitteri – Common in forested areas.

H. physodes – Common in forested areas.

H. subobscura – Common in tundra.

Lecanora dispersa – Wiese K-05-02a.

L. epibryon – Fairly common in tundra.

L. fuscescens – Ahti 63922,plot Q3-L2.

L. luteovernalis – Rosentreter 15888, Camp Copter, mixed with *Pertusaria*; ?Wiese K-03-05, Wiese K-06-04

L. symmicta s.l. (or a *Pyrrhospora* species) – McCune 27560, Rosentreter 15854 plot Q3-L5.

Lecidea albohyalina – McCune 27532, plot Q3-A5.

L. diapensiae – Restricted to dead parts of *Diapensia lapponica*.

L. lactea – Wiese AT-1. (= norstictic acid chemotype of *L. lapicida*)

L. plana – McCune 27512b, plot Q3-H3.

L. ramulosa – Rosentreter 15890, Camp Copter.

Lecidella euphorea – McCune 27534, plot Q3-A5.

L. wulfenii – McCune 27546b, plot Q3-L2.

Leciophysma finmarkicum – Occasional on rock.

Lempholemma sp. – Ahti 63817d, plot Q3-A5.

Lepraria diffusa – Rosentreter 15867, Camp Copter.

Leptogium arcticum – Uncommon. Holt 23328b, plot NE-5b.

L. lichenoides – Occasional.

L. saturninum – Common on shrub bark.

L. schraderi – Uncommon. Wiese AK-1-09

Leucocarpia biatorella (Vezda 1969) – Rosentreter 15835b, plot Q3-L5; new to the American Arctic; only recently reported from North America (Buck and Harris 2001, from New Mexico). Otherwise known from high elevations in Europe and from Fennoscandia.

Lichenomphalia umbellifera – Rosentreter 15778, plot Q3-H3.

Lobaria kurokawae – Occasional in tundra.

L. linita – Common.

L. pseudopulmonaria – Occasional; Holt 22191, plot 04-H3; Holt 23139, plot NW-1b; Holt 23292, plot NE-5b.

L. pulmonaria – Uncommon. Holt 23565, plot SW-1b.

L. scrobiculata – Occasional.

Lopadium coralloideum – Rosentreter 15792, plot Q1-L2

L. pezizoideum – Apparently common.

Masonhalea richardsonii – Common.

Massalongia carnosa – Occasional.

Megaspora verrucosa – Occasional.

Melanelia agnata – Uncommon. McCune 27617, Camp Copter; TLC: alectoronic acid.

M. disjuncta – Uncommon. Ahti 63483, Low Rock Ridge.

M. hepatizon – Occasional.

M. panniformis – Occasional.

M. sorediata – Occasional.

M. stygia – Common.

M. tominii – Uncommon. Neitlich 2723, plot Q3-H3.

Melanohalea septentrionalis – Occasional.

M. trabeculata – Uncommon, herb-rich tundra.

Micarea sp. – Ahti 63481, Low Rock Ridge; McCune 27479, plot Q3-D2.

M. incrassata – Wiese K-02-03.

M. ternaria – McCune 27553, plot Q3-L5; Wiese KAL-01

Multiclavula vernalis – Common.

Mycobilimbia sp. – McCune 27585, outcrops near plot Q3-S4; dark brown convex apothecia.

M. berengeriana – Rosentreter 15736, plot Q3-D2.

M. carneoalbida – Ahti 63817a,plot Q3-A5.

M. hypnorum – Common.

M. obscurata? – McCune 27525, plot Q3-A5.

Mycoblastus alpinus – Ahti 63817e, plot Q3-A5.

Naetrocymbe punctiformis – McCune 27535, plot Q3-A5 (nonlichenized).

Nephroma arcticum – Occasional.

N. bellum – Common.

N. expallidum– Common.

N. helveticum – Occasional on woody plants.

N. parile – Common.

Ochrolechia androgyna – Ahti 63971, plot Q3-L5.

O. frigida – Ahti 63338, plot Q3-D2; sorediate f. *lapuensis* (Vainio) Tønsberg; otherwise the typical form is common.

O. gyalectina– Ahti 63531, outcrops near plot Q3-S4.

O. inaequatula – Ahti 63967, plot Q3-L5.

O. upsaliensis – Rosentreter 15728, plot Q3-D2; Wiese NM-1-10.

Ophioparma ventosa s. lat. – Occasional.

Orphniospora moriopsis – Ahti 63932, plot Q3-L2; McCune 27607, Low Rock Ridge.

Pannaria conoplea – Uncommon. Holt 23172, 23185, plot NW-1e; Holt 23552, plot SW-1b; Rosentreter 15779, plot Q3-H3.

Parmelia omphalodes – Common, on rocks and soil. Specimens similar in morphology to *Parmelia skultii* Hale were analyzed by TLC; none contained norstictic acid, and all had at least a few laminal pseudocyphellae. Although *P. skultii* is to be expected in Noatak, we had no collections of it.

P. saxatilis – Uncommon.

P. squarrosa – Uncommon; Holt 22437a, plot 04-F2. Surprisingly disjunct from known locations in coastal southeast Alaska and Hudson Bay (Thomson 1984, Brodo et al. 2001), this specimen is well developed and typical. The specimen was from a branch in a *Picea* forest with wet understory and high diversity of vascular plants, 61.2155°N -162.0786°W, 210 m.

P. sulcata – Common.

Parmeliopsis ambigua – Occasional.

P. hyperopta – Occasional.

Peltigera aphthosa – Very common.

P. canina – Common.

P. collina – Uncommon. Holt 21842, plot Q3-A5.

P. didactyla – Occasional.

P. extenuata– Common.

P. horizontalis– Occasional.

P. kristinssonii – Occasional.

P. lepidophora – Occasional.

P. leucophlebia – Common.

P. malacea – Common.

P. membranacea – Occasional.

P. neckeri – Uncommon. Holt 23214, plot NW-1c.

P. neopolydactyla – Common.

P. occidentalis – Probably common, earlier included in *P. polydactylon* or *P. neopolydactyla*. Ahti 63310, plot Q3-D2, conf. O. Vitikainen; ?Ahti 63815, plot Q3-A5; McCune 27483, plot Q3-D2, det. Miadlikowska.

P. polydactylon s. lat. – Common. Perhaps s. str. unlikely to exist in the area.

P. ponojensis – Occasional.

P. praetextata – Occasional. Holt 22344, plot 04-W4; Holt 22372, plot 04-D1.

P. rufescens– Common.

P. scabrosa – Common.

P. venosa – Occasional.

Pertusaria alaskensis – McCune 27502, plot Q3-H3.

P. bryontha – Common. Ahti 63797, plot Q3-H3; Ahti 63945, McCune 27556, plot Q3-L5.

P. dactylina – Apparently common.

P. geminipara –Common.

P. oculata – Ahti 63308x, Camp Copter.

P. panyrga – Very common.

P. sommerfeltii – Ahti 63579, Camp Copter.

P. subdactylina – Rosentreter 15834, plot Q3-L5; Wiese K-01-02.

Phaeophyscia constipata – Uncommon. Holt 23484, plot NE-5c.

P. kairamoi – Uncommon. Ahti 63561, McCune 27594a, outcrops near plot Q3-S4, det. T. Esslinger.

P. sciastra – Uncommon. McCune 27594b, outcrops near plot Q3-S4, det. T. Esslinger.

Physcia aipolia – Occasional on woody plants.

P. caesia – Occasional. Some individuals were dark gray with a dark brown lower surface, resembling *Phaeophyscia*. Too dark to yield a positive K test, these specimens can be have a prosoplectenchymatous lower cortex that distinguishes them from *Phaeophyscia*.

P. dubia – Uncommon. McCune 27593, outcrops near plot Q3-S4.

P. phaea – Uncommon. Holt 23339, plot SE-5a, det. T. Esslinger.

Physconia muscigena – Occasional.

Pilophorus cereolus – Occasional. Holt 22262, plot 04-H2; Holt 22297, plot 04-L2.

P. robustus – Occasional. Holt 22872, plot NE-3c; Holt 23351, plot SE-2a.

P. vegae – Uncommon. Ahti 63798, plot Q3-H3.

Placidium norvegicum – Rosentreter 15884, Camp Copter.

Placopsis cribellans – Rosentreter 15785, plot Q3-H3

P. gelida –Rosentreter 15775, 15780, plot Q3-H3.

P. lambii – Ahti 63805, McCune 27503, plot Q3-H3.

Placynthiella icmalea – Apparently common.

P. oligotropha – Rosentreter 15917, Low Rock Ridge.

P. uliginosa – Occasional.

Placynthium asperellum – McCune 27492b, plot Q3-H3.

P. nigrum – Common in calcareous areas.

Pleopsidium sp. – Ahti 63607x, Camp Copter.

Polyblastia terrestris – McCune 27564, plot Q3-L5; Wiese 01-09a.

Polychidium muscicola – Apparently common.

Porpidia sp. – Ahti 63954, plot Q3-L5.

P. crustulata – Ahti 63795, plot Q3-H3.

P. flavocaerulescens – Ahti 63605, Camp Copter; Wiese NM-1-17.

P. grisea – McCune 27609a, Low Rock Ridge.

P. speirea – McCune 27536, plot Q3-L2.

P. superba – McCune 27537, plot Q3-L2; McCune 27539b, plot Q3-L2.

P. thomsonii – McCune 27538, plot Q3-L2; McCune 27563, plot Q3-L5.

P. tuberculosa – Wiese NM-1-07.

Protoblastenia rupestris – Rosentreter 15889, Camp Copter.

Protoparmelia badia – Ahti 63843a, plot Q3-A5.

Pseudephebe pubescens – Common.

Pseudocyphellaria crocata – Uncommon. Holt 23179, plot NW-1e.

Psora cerebriformis – Ahti 63553, outcrops near Q3-S4.

P. decipiens – Rosentreter 15873, Camp Copter; Wiese K-05-03.

P. himalayana – Rosentreter 15886, Camp Copter; Rosentreter 15893b, 15894b, outcrops near Q3-S4.

P. rubiformis – Rosentreter 15892, outcrops near Q3-S4.

Psoroma hypnorum – Common.

Pyrenopsis grumulifera – McCune 27539c, plot Q3-L2; McCune 27541, plot Q3-L2.

Ramalina almquistii – Uncommon. Holt 21991, plot 04-B3; Holt 22909, plot SE-6b; Wiese AT-1-06

R. pollinaria – Uncommon. Holt 22992, plot NE-5a.

R. roesleri – Occasional in forested areas.

R. sinensis – Occasional; Holt 22010, plot 04-B5; Holt 23551a, plot SW-1b; Holt 23586b, plot SW-1c.

R. thrausta – Uncommon. Holt 22446, plot 04-F2; Holt 23586a, plot SW-1c.

Rhizocarpon chioneum – Wiese K-03-06

R. cinereovirens – McCune 27539a, plot Q3-L2.

R. cumulatum – Wiese K-01-07. This is apparently the first location beyond the type locality (Thomson 1998). East side of Kavachurak Creek , ca. 13 km miles from mouth of creek on gravelly herbaceous knoll with lichen, sedges, and *Dryas* (67.80491°N 156.7081°W, 568 m) The type locality is on the Pitmeaga River on the north slope of Alaska. According to Feuerer (1991) this may be a *Buellia*.

R. eupetraeoides – McCune 27606, Low Rock Ridge.

R. eupetraeum – McCune 27609b, Low Rock Ridge.

R. expallescens? – McCune 27562, plot Q3-L5.

R. geographicum s. lat. – Common.

R. rubescens – Wiese NM-1-04b.

Rimularia limborina – McCune 27501, plot Q3-H3.

Rinodina bischoffii – Wiese K-05.

R. mniaraea – McCune 27531, plot Q3-A5; McCune 27610b, Low Rock Ridge; Rosentreter 15700, plot Q3-D2.

R. olivaceobrunnea – McCune 27510, plot Q3-H3.

R. roscida – McCune 27580, plot Q3-S4; McCune 27610a, Low Rock Ridge.

R. septentrionalis – Wiese AK-1-03b.

R. turfacea – Common. Ahti 63794f, plot Q3-H3; McCune 27592, outcrops near Q3-S4.

Ropalospora lugubris – Wiese AT-1.

Sarcogyne? – Ahti 63843c, plot Q3-A5.

Sarcosagium campestre – Rosentreter 15835, plot Q3-L5, on organic matter.

Siphula ceratites – Rosentreter 15883, Camp Copter.

Solorina bispora – Common.

S. saccata – Uncommon. Ahti 63943, plot Q3-L5.

S. spongiosa – Uncommon. Holt 22855, plot NE-2c; Holt 22867, plot SE-5b.

Sphaerophorus fragilis – Occasional. Ahti 63477, Rosentreter 15906, Low Rock Ridge; Rosentreter 15897b Camp Copter.

S. globosus – Common.

Stereocaulon alpestre? – Ahti 63308a, Camp Copter.

S. alpinum – Common.

S. apocalypticum – Occasional.

S. arcticum – Uncommon. Holt 22726 plot SV2.

S. arenarium –Uncommon. Holt 22717, 22723, plot SV2; McCune 27505, plot Q3-H3. TLC: porphyrilic acid.

S. botryosum – Occasional. TLC: porphyrilic acid.

S. glareosum – Uncommon. Holt 21855, plot Q3-L2; Holt 23382, plot SE-3b. TLC: lobaric acid.

S. groenlandicum – Occasional. Five specimens with TLC containing miriquidic acid.

S. intermedium – Uncommon. Holt 22242a, plot 04-H2. TLC: lobaric acid.

S. paschale – Common. TLC: lobaric acid.

S. rivulorum – Uncommon. McCune 27489, plot Q3-H3. TLC: lobaric acid.

S. spathuliferum – Uncommon. Holt 23604, plot SV2, TLC: stictic acid complex.

S. subcoralloides – Common. TLC: lobaric acid.

S. symphycheilum – Occasional. TLC: lobaric acid.

S. tomentosum – Occasional. TLC: stictic acid complex. Includes *S. alpestre* (Flot.) Dombr. (or *S. tomentosum* var. *alpestre* Flot.) Ahti 63308a, Camp Copter. This species group needs more work.

S. vesuvianum – Occasional. TLC: stictic acid complex.

Sticta arctica – Occasional. Ahti 63343a, plot Q3-D2; Holt 23121, plot SW-4b; Holt 23444, plot SE-4a; McCune 27517, Neitlich 2758, cyanolichen-rich tundra near plot Q3-H3.

Syzygospora bachmannii (nonlichenized, lichenicolous fungus) – Ahti 63309a, plot Q3-D2, on *Cladonia gracilis* ssp. *elongata*; Ahti 63314, plot Q3-D2, on *Cladonia crispata* var. *crispata*; Ahti 63347e, plot Q3-D2, on *Cladonia gracilis* cf. ssp. *elongata*.

Thamnolia subuliformis – Common. Multiple collections were made at each plot and checked with UV light. *Thamnolia vermicularis* is more common in Bering Land Bridge Preserve (BELA) than in Noatak, while *T. subuliformis* is more common Noatak. This accords with the observation that *T. vermicularis* is a more coastal species than *T. subuliformis* in the southern portion of its range in North America (McCune and Geiser 2009). *Thamnolia subuliformis* also appeared to be more associated with calcareous substrates, while *T. vermicularis* was more associated with acidic, wet lowland habitats dominated by low shrubs.

T. vermicularis – Common.

Thrombium epigaeum – Rosentreter 15717, plot Q3-D2.

Toninia aromatica – Rosentreter 15875, Camp Copter.

Trapeliopsis granulosa – Apparently fairly common.

Tremolecia atrata – Ahti 63591, Camp Copter.

Umbilicaria arctica – Uncommon. McCune 27495, plot Q3-H3.

U. caroliniana – Uncommon, but perhaps underrepresented in the sample. Holt 22784, plot SW-5b; Neitlich 2653, Low Rock Ridge.

U. cylindrica – Uncommon, but perhaps underrepresented in the sample. Holt 22276, plot 04-H2; Holt 23275, plot NE-5b.

U. deusta – Uncommon. Holt 22263, plot 04-H2.

U. hyperborea var. *hyperborea* – Uncommon. Wiese NM-1-16a; Holt 23401, plot NE-7a.

U. hyperborea var. *radicicula* – Occasional.

U. phaea – Uncommon. Ahti 63934, plot Q3-L2.

U. polyphylla – Uncommon. Holt 22694a, plot NW-5a.

U. proboscidea – Common.

U. torrefacta – Common.

Varicellaria rhodocarpa – Apparently common.

Vestergrenopsis elaeina – McCune 27491, 27492a, plot Q3-H3.

Xanthomendoza borealis – Uncommon. McCune 27514, Neitlich 2781, bird perches on knob of volcanic rock above plot Q3-H3.

Xanthoparmelia coloradoensis – Uncommon. Neitlich 2774, 2775, plot Q3-H3.

Xanthoria elegans – Common. Wiese K-04-01; Wiese K-04-03.

X. polycarpa – Uncommon. Holt 22009, plot 04-B5.

X. sorediata – Uncommon. Rosentreter 15914, Low Rock Ridge.