ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

STATE OF ALASKA
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By
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PROGRESS REPORT

ANALYSIS OF NELCHINA CARIBOU RANGE

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(Printed May 1986)

PREFACE

The Nelchina caribou range study has been ongoing for over 30 years. Field work has been done on a regular basis, and was last reported on by Pegau in 1972. Since the Nelchina study is not a current Federal Aid project, reports will not be completed on a regular basis; however, additional Nelchina range work is anticipated for the future and occasional progress reports can be expected as the data are summarized and published.

This progress report has been published as a supplement to the 1984-85 Caribou Survey & Inventory report, to facilitate dissemination of data that may be important to managers of caribou ranges.

Survey-Inventory reports may be obtained from the Division of Game, ADF&G, P.O. Box 3-2000, Juneau, Alaska 99802.

Townsend, B., ed. 1986. Annual report of survey-inventory activities. Part XI. Caribou. Vol. XVI. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Prog. Rep. Proj. W-22-4. Job 3.0. Juneau 58pp.

PROGRESS REPORT

State: Alaska

Project No.: W-17-3 Project Title: Big Game Investigations

Job Title: Analysis of the Nelchina Caribou Range

Period Covered: 1 July 1983 - 30 June 1984
(Data from 1977-78 study included and summarized.)

SUMMARY

As a continuation of the Nelchina caribou range relationships study initiated in 1955 and last reported on in 1972, 38 range stations were examined during the summers of 1977 and 1983. Evaluations of plant species composition, height, percent cover, condition, and use were made for each site. Photos of sample plots were taken during all evaluations and compared for trend. Little use by caribou was apparent on other than primary lichen species. Lichen availability and condition varied greatly among portions of the Nelchina range. Much of the northern portion of the range plus the southwest corner, approximately one-third of the total area examined, provides good to very good lichen range but shows little utilization by caribou. A second one-third, encompassing the east-central and southern portions of the range, has received moderate winter use and exhibits poor to fair lichen production. The last one-third, encompassing much of the western uplands, with a history of near continuous heavy caribou use for over 30 years, supports a poor lichen standing crop. Examination of exclosures, on the other hand, indicated that this last area is potentially one of the best producers of lichens within the overall Nelchina range. Analysis of range condition over the past 25-30 years shows widespread lichen deterioration occurring throughout the 1960s. During the same period herd size increased, peaked, and began declining in apparent response to increased mortality from hunting and possibly also predation and winter severity. Lichen standing crop began increasing in the early 1970s as the population decline ceased and a herd increase was initiated. By 1983, with the herd continuing to slowly grow, increases in lichen standing crop in areas of substantial caribou use had in general come to a halt.

Lichen standing crop today substantially exceeds that available in 1970, and is about the same as seen in 1977, in all areas of the Nelchina range except in the western calving and summering grounds. While prior investigators have estimated that 25 years or more would be required for lichens to recover from the serious deterioration observed in the 1960s, in many areas we found substantial lichen recovery after approximately 10 years of relatively light use. With a fair to very good lichen standing crop throughout nearly two-thirds of the Nelchina range examined, and

with good calf production and survival within the Nelchina herd, the range presently is capable of supporting current caribou numbers. How various vascular plants, particularly sedges in winter and sedges, grasses, forbs and shrubs in spring and summer, are utilized by Nelchina caribou, has yet to be documented. We believe that ample quantities of various vascular plant types provide adequate forage during the calving and summering period in the heavily utilized western mountains. We recommend that most range stations be maintained and periodically examined and additional range evaluation sites be established in key calving, summering, and wintering areas. In addition, the relative use of various plants and the nutritional status of Nelchina caribou should be examined through analysis of collected rumen and/or fecal pellet samples and body condition measurements.

Key Words: Alaska, Rangifer, caribou, Nelchina, range, lichens.

CONTENTS

INTRODUCTION

Background

The Nelchina caribou (Rangifer tarandus) herd is one of the most accessible in the state. Its range is essentially surrounded by road systems, and is only a few hours drive by automobile from Anchorage and Fairbanks. Since 1956 over 100,000 Nelchina caribou have been harvested by hunters. Because of this strategic location and intense hunter demand, the Nelchina caribou herd has been extensively studied over the years. Study of Nelchina caribou range began in 1950.

From 1955 through 1960, 39 range stations were constructed to investigate relationships between the Nelchina caribou and their range (Fig. 1). These stations were re-examined in 1966, 1970, 1977, and 1983. Of the original stations, 38 presently exist.

Pegau (1972) synthesized early range findings by H. C. Hanson (1958) and R. O. Skoog (1959, 1962, 1968), with range station data collected in 1966 and 1970. In this paper we report the findings from range station examinations done during the summers of 1977 and 1983, and summarize and discuss range condition and trend from 1956-1983.

Objectives: 1977 and 1983

We continued the Nelchina caribou range study initiated by Skoog in 1955, examining the range stations established in a variety of range types, identifying and measuring changes in plant species composition and standing crop, and assessing range utilization by the caribou. Our objectives were to: 1) assess range condition and trend, 2) refine range carrying capacity estimates, and 3) develop a better understanding of caribou range use strategies.

ACKNOWLEDGMENTS

A number of individuals contributed to the 1983 range examination and the subsequent summary range report. Marianne See freely lent of her expertise in identifying lichens and assisted in examining a few range exclosures.

Jim Davis, Dave Klein, Bob Pegau, Steve Peterson, Ken Pitcher, and Marianne See all contributed their skills in editing this manuscript, and Kathleen Adler typed and proofed both text and tables. To all we express our appreciation.

STUDY AREA

Nelchina caribou range use prior to 1965 has been described by Skoog (1968). Since then a number of observers have delineated areas used by the Nelchina herd (Bos 1972, Pitcher 1982). The Nelchina range encompasses approximately 17,500 square miles. It is bounded on the south by the Glenn Highway and the Tazlina and Matanuska Rivers. On the west it is bounded by the Chickaloon, Talkeetna, Chulitna, and Upper Nenana Rivers. The north boundary is approximately the crest of the Alaska Range. To the east the boundary has varied from the Gakona and Chistochina Rivers, to the Copper, Nabesna, and Tok Rivers and on occasion across the Mentasta Mountains to the Chisana River (Fig. 1). A small Nelchina subherd is recognized as ranging over the upper portions of the Susitna and Nenana River drainages. This subherd mixes with the main herd on the Susitna and Talkeetna summer ranges but winters alone in the upper Susitna area. An extensive discussion of the topography and

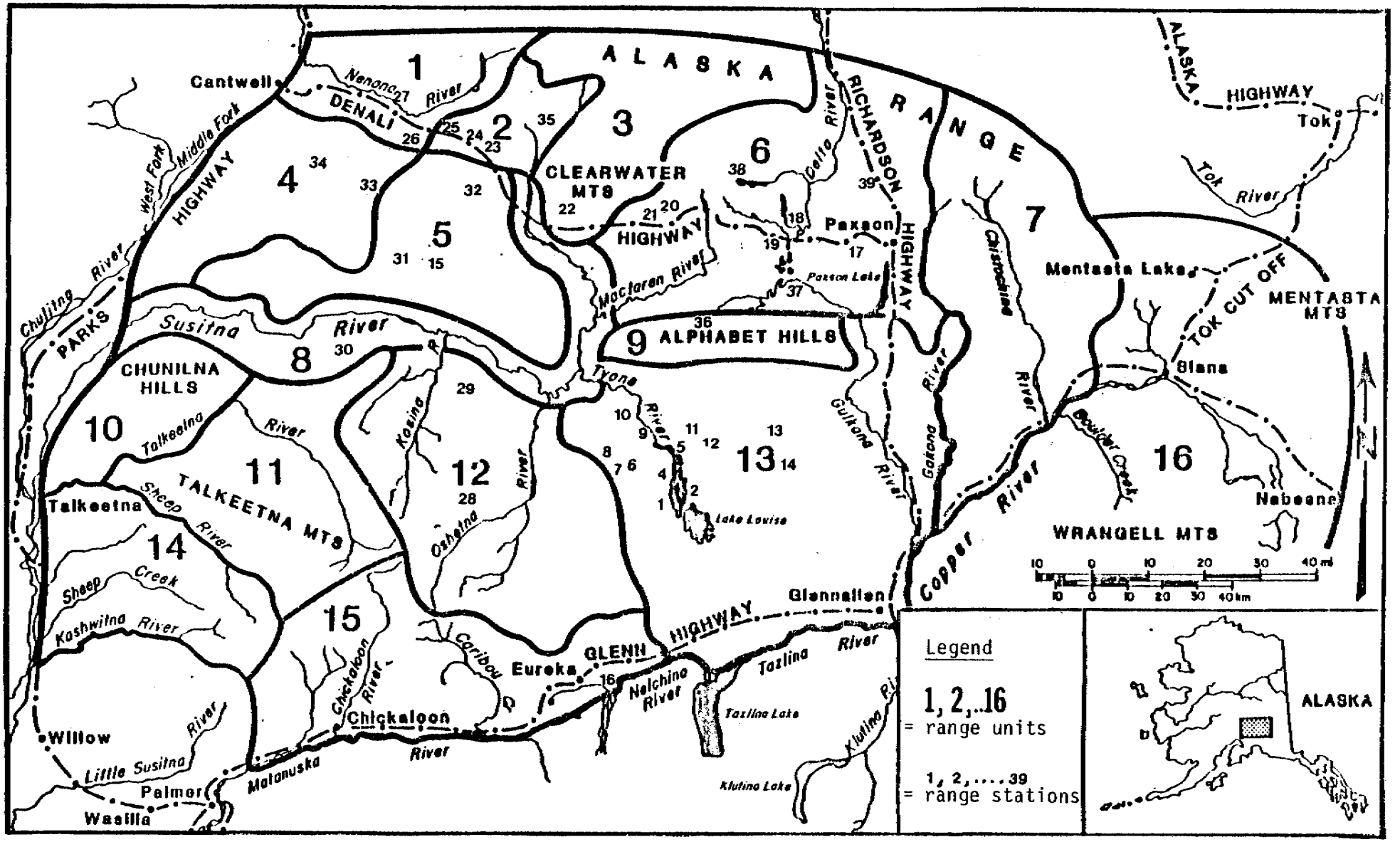


Fig. 1. Nelchina range stations and range units (modified from Pitcher, 1982).

climate has been presented by Skoog (1968). Pegau (1972) has briefly summarized topography, elevation, and snow conditions for the Nelchina Range and then described the 12 vegetation types originally designated by Skoog (1968).

METHODS

The methods utilized in 1977 and 1983 were those that had evolved from 1953 through 1966 and were the same as those employed in 1970.

Pegau (1972) has described the exclosures that were built at all range stations. The first 15 stations established in 1955 and 1956 were placed in traditional wintering areas and within vegetation types that were considered to be important to caribou. In 1960, 24 additional range stations were established in areas utilized by caribou at various times throughout the year.

At each station 2 plots measuring 5 x 20 feet were established. Plot A was fenced while Plot B, less than 100 yards away, was not. Each plot was divided into 5 4x5-foot subplots, and within these subplots the vegetation was measured within a centered 1-meter square quadrat. Originally 1 quadrat per plot was evaluated, but beginning in 1970, a second quadrat in each plot was analyzed (the remaining subplots were not sampled).

Evaluation at each plot included the following: 1) quadrats were photographed from established photopoints; 2) the vegetation within each quadrat was identified by species, genus, or family according to descriptions by Hale (1979), Hulten (1968), and See (1981); 3) vegetation was described as to approximate height, condition, and use; and 4) percent cover was determined using the modified Hult-Sernander method described by Hanson (1958). Using a 1-meter square divided into 16 equal parts, percent cover is estimated:

HULT-SERNANDER SCALE	PERCENT COVER OF THE SQUARE METER
1	less than 1/16
2	1/16 to 1/8
3	1/8 to 1/4
4	1/4 to 1/2
5	1/2 to 3/4
6	3/4 to 4/4

The following 4 range condition classes are those described by Hanson (1958) for wintering regions on the Nelchina range. These classes primarily reflect lichen condition, and are quoted from Hanson (1958):

> "Excellent Range Condition--Good cover (20 percent or more of the ground covered by lichens), all or almost all upright, 2.5 to 6 inches high. Usually Cladonia stellaris is present and may be the chief dominant in the lichen layer; usually much C. arbuscula and

C. rangiferina. No packing or fragmentation of lichens. No moss pedestals, no cut hummocks, few to no trails, few to no broken branches of shrubs, few to no exposed roots or lower branches of shrubs.

Good Range Condition--Good cover (20 per cent or more cover by lichens) but short (1 to 2.5 inches), or with fair cover (1020 per cent) and good height (2 to 5 inches). Usually much Cladonia arbuscula and C. angiferina and some C. stellaris. Packing and fragmentation of lichens slight. Few or no pedestals, or cut hummocks, or trails. Few to no broken branches, or exposed roots or lower branches.

Fair Range Condition--Good cover (20 percent or more cover by lichens) but short (1/2 to 1 inch), or with low cover (5 percent) and good height (2 to 4 inches). Usually little to no Cladonia stellaris, C. arbuscula usually common, little if any C. rangiferina, often much Stereocaulon. One half to most of the lichen cover packed and/or fragmented. Pedestals and/or cut hummocks and trails moderately numerous. Moderate numbers of scattered broken branches and exposed roots and lower branches.

Poor Range Condition--Good cover (20 percent or more cover by lichens) but short (about 1/2 inch), or with low cover (0 to 5 percent) and moderate height growth (1 to 2 inches). Usually no Cladonia stellaris, little if any C. rangiferina. Stereocaulon, Cladonia arbuscula, Cetraria nivalis, C. cucullata usually present. Often much Alectoria, and species such as Peltigera aphthosa, Thamnolia vermicularis, Cladonia pleurota, and C. uncialis. Most of lichen surface fragmented and packed. Pedestals and/or cut hummocks and trails numerous, some of the trails well worn (as deep as 5 inches or more). Many scattered broken branches, exposed roots and lower branches. Some of the shrubs may be entirely dead because of trampling and pawing. Mineral earth exposed in places and erosion may be occurring."

Hanson felt that lichens were very important in the winter diet of caribou but less important during the other seasons. As such he felt the classification should be modified to evaluate condition in calving, mid-summer, and early autumn regions of the range, when more attention should be given to vascular plants.

Skoog (1959) divided the Nelchina caribou range into 15 range units based primarily on topography, vegetation, and use patterns. Pitcher (1982) expanded this breakdown by adding a sixteenth range unit, a large area to the east of the Copper and Chistochina Rivers (Figure 1). The size, number of range stations within, and principle season of use of the various range units are listed in Table 1. Vegetation histories prior to 1977 and analyses for 1977 and 1983 work are presented for each range station in a range unit, followed by a summary for that range unit.

Percent cover, as determined by the modified Hult-Sernander method, was tabulated for all plant species identified at each range station (Appendix I). Based on the importance given to certain species of

Table 1. Comparison of range units utilized by the Nelchina caribou, Alaska.

Range unit	Area (mi2)	% of total	No. of range stations	Principal season of use (secondary season)
1	460	2.1	2	winter (summer)
2	270	1.3	4	winter (summer)
4	870	4.1	2	summer (winter)
5	1350	6.3	3	summer
6	1750	8.2	9	summer
8	720	3.4	1	summer (winter)
9	400	1.9	1	summer
12	1540	7.2	2	summer
13	3150	14.8	13	winter
15	1250	5.8	1	summer
Sampled Subtotal	11,760	55.1	38	
3	1430	6.7	0	summer
7	1340	6.3	0	winter
10	720	3.4	0	summer (winter)
11	1380	6.5	0	winter
14	360	4.0	0	summer
16	3850	18.0	0	winter
Unsampled Subtotal	9580	44.9	0	
Total	21,340	100.0	38	

preferred lichens ("reindeer" lichens) by prior investigators, and the literature on caribou-range relationships, a key component of the analysis effort was directed towards this group of plants. Reindeer lichens, for purposes of this report, include the following species: C. stellaris, C. arbuscula, and C. rangiferina.

Skoog (1959) used criteria for defining lichen succession stages that employed lichen cover and height in relation to dominant species. This definition can rank succession in one of up to 8 categories ranging from primary (I) to climax (V) stages (Table 2). Appendix II lists lichen succession stages for all stations examined in 1983. Table 3 averages these successional ratings for the range units.

Additionally, lichen percent cover was further utilized in comparing changes in lichen abundance over time relative to changes in caribou numbers. Table 4 gives the mean percent cover for all lichens and reindeer lichens by range units. Figures 2-6 graphically compare these parameters with estimated changes in Nelchina caribou herd size for the period 1957-1983. Both estimated caribou herd size and caribou seasonal distribution are from Pitcher (1982).

An index of relative availability of lichen standing crop was determined by multiplying percent lichen cover (decimal equivalent) by mean lichen height (in inches). This index was determined for all range stations (Appendix III). Long-term use and disturbance were characterized by subtracting the lichen standing crop index outside from that inside the exclosures (Appendix IV). In Table 5 standing crop inside versus outside the exclosures is compared by averaging differences in standing crop index values for the range units.

The photographs collected over the years for each range station were examined. The lichens observed in these photos were compared with tabulated data for lichen percent cover and condition (Appendix V). Finally, certain vascular plant species were evaluated for percent cover trend over the period 1962-1983. Percent cover changes for the 3 most common vascular plant species plus changes in total plant cover were summarized by range unit in Tables 6 through 9.

RESULTS

The physical condition of each range station in 1983 was briefly summarized (Appendix VI). Of the 38 stations visited, 17 (45%) were intact, 7 (19%) were slightly damaged, 11 (29%) were moderately damaged, and 3 (8%) were heavily damaged. Damage to exclosure fencing and quadrat stakes appeared to result primarily from moose and caribou. In addition, a few incidents of bear damage were noted. Human vandalism also occurred at a number of sites near access points on lakes or adjacent to roads. During the course of both 1977 and 1983 surveys, repairs on exclosures and plots were made.

Table 2. Lichen Succession Stages as Defined by Skoog (1959).

		% Lichen Cover*	Lichen Height (in inches)	Dominant Lichen Species
I	Primary	0-3	<1	bare ground, moss, crustose, Cladonia spp.
II[a] b	Early	2-4	0.5-1.5	Cladonia spp., Alectoria spp., Stereocaulon spp., Cetraria spp. Cornicularia spp.
III[a] b	Medial	3-5	1-3	Alectoria spp., Stereocaulon spp., Nephroma spp., Cetraria spp., Peltigera spp., Cladonia arbuscula, C. rangiferina
IV[a] b	Late	4-6	2-4	Cladonia stellaris, C. rangiferina C. arbuscula
V	Climax	5-6	4+	Cladonia stellaris, C. rangiferina

* Successional stages can be further divided into early (a) and late (b) components.

* According to the Hult-Sernander Scale:
  1 - <6.3%
  2 - 6.3 to 12.4%
  3 - 12.5 to 24%
  4 - 25 to 49%
  5 - 50 to 74%
  6 - 75%+

Table 3. Mean lichen succession stage for portions of the Nelchina caribou range, Alaska.

Area	Range unit	$\bar{x}$ Succession stage** A***	B	No. range stations	Principal Plant community(s)
West Denali	1 (Nenana River)	4.8	4.5	2	shrub; heath
	2 (Monahan Flat)	4.0	3.7	4	shrub; heath
	4W (Jack River)	4.0	4.0	1	shrub; heath
	4E (Brushkana Cr.)	5.0	4.0	1	heath
	5 (Watana Hills)	3.8	3.7	3	heath
Talkeetnas	8 (Susitna River)	4.0	3.0	1	white spruce
	12 (Eastern Talkeetna Mtns)	3.8	3.3	2	shrub; heath
	15 (Southern Talkeetna Mtns)	3.0	4.0	1	shrub; heath
East Denali	6W (Maclaren River)	2.9	2.9	4	shrub
	6E (Delta River)	4.5	4.4	5	shrub; heath
	9 (Alphabet Hills)	3.5	4.0	1	shrub; heath
Lake Louise	13 (Lake Louise Flat)	3.3	3.2	13	black spruce

** - A = inside exclosure
B = outside exclosure

*** Succession stages and numerical equivalents (Skoog, 1959)

I	Primary	1.0
IIa	Early	2.0
IIb		2.5
IIIa		3.0
IIIb	Medial	3.5
IVa		4.0
IVb	Late	4.5
V	Climax	5.0

Table 4. Changes in lichen percent cover at range stations, 1962-83, summarized for range units of the Nelchina caribou range, Alaska.

Range units		Principal season of use (secondary season)		% cover							
				A*				B			
				1962	1970	1977	1983	1962	1970	1977	1983
1 & 2	(Western Denali)	winter (summer)	L**	84	88	82	84	84	63	75	79
			RL	62	58	54	59	58	28	46	50
5 & 4E	(Brushkana/Watana)	summer	L	72	76	78	76	58	21	53	37
			RL	16	29	49	40	22	5	16	10
8 & 12	(Susitna/Eastern	summer	L	76	79	83	73	58	38	40	36
			RL	21	22	42	41	21	12	9	10
6E	(Eastern Denali)	summer	L	75	70	80	79	82	63	76	78
			RL	35	36	45	41	35	23	38	30
13	(Lake Louise)	winter	L	20	35	54	41	36	22	47	44
			RL	0	6	13	10	0	4	16	13

*A = inside exclosure
B = outside exclosure

**L = all lichens
RL = reindeer lichens (the following preferred species: Cladonia stellaris, C. arbuscula, C. rangiferina

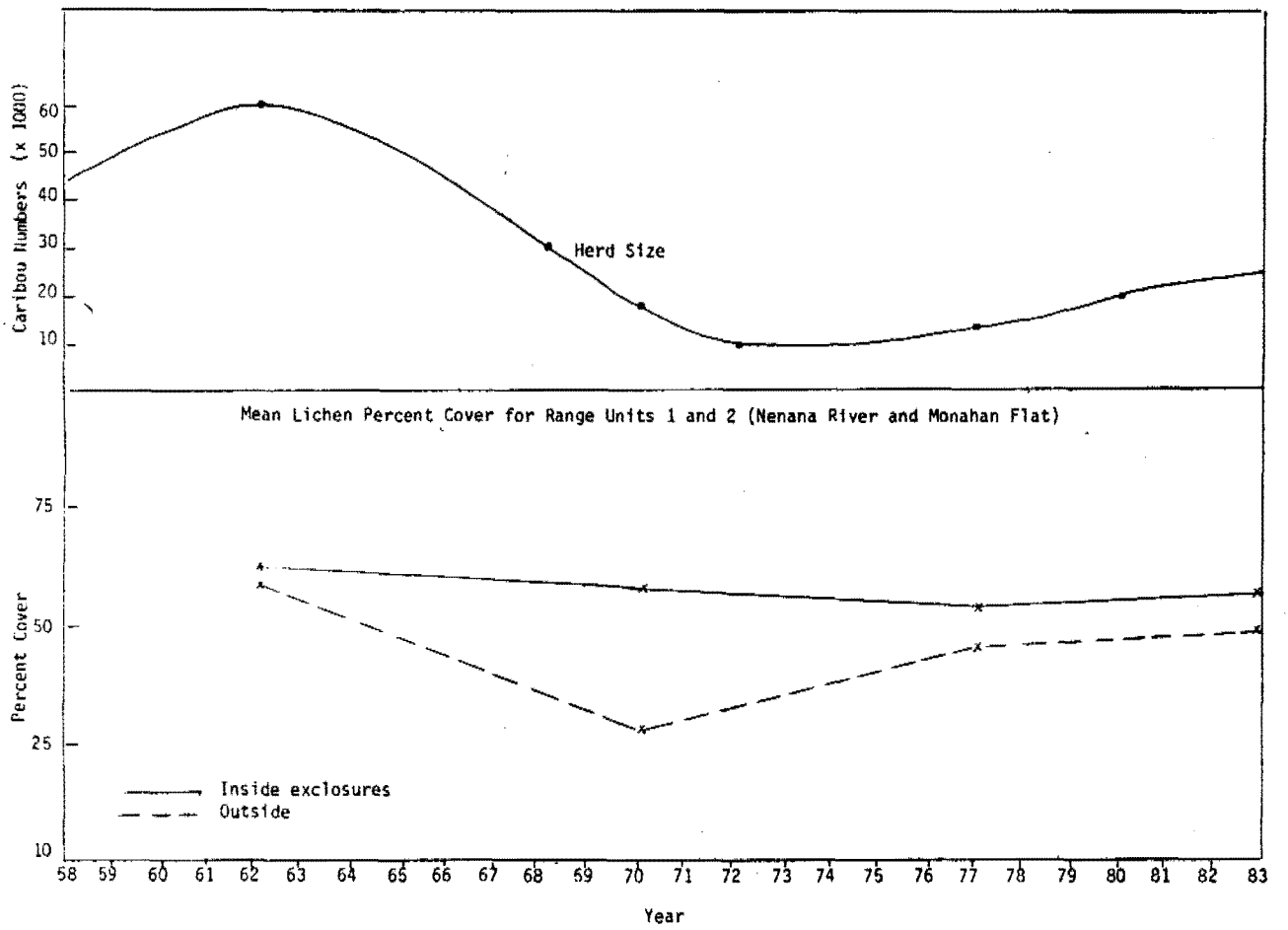
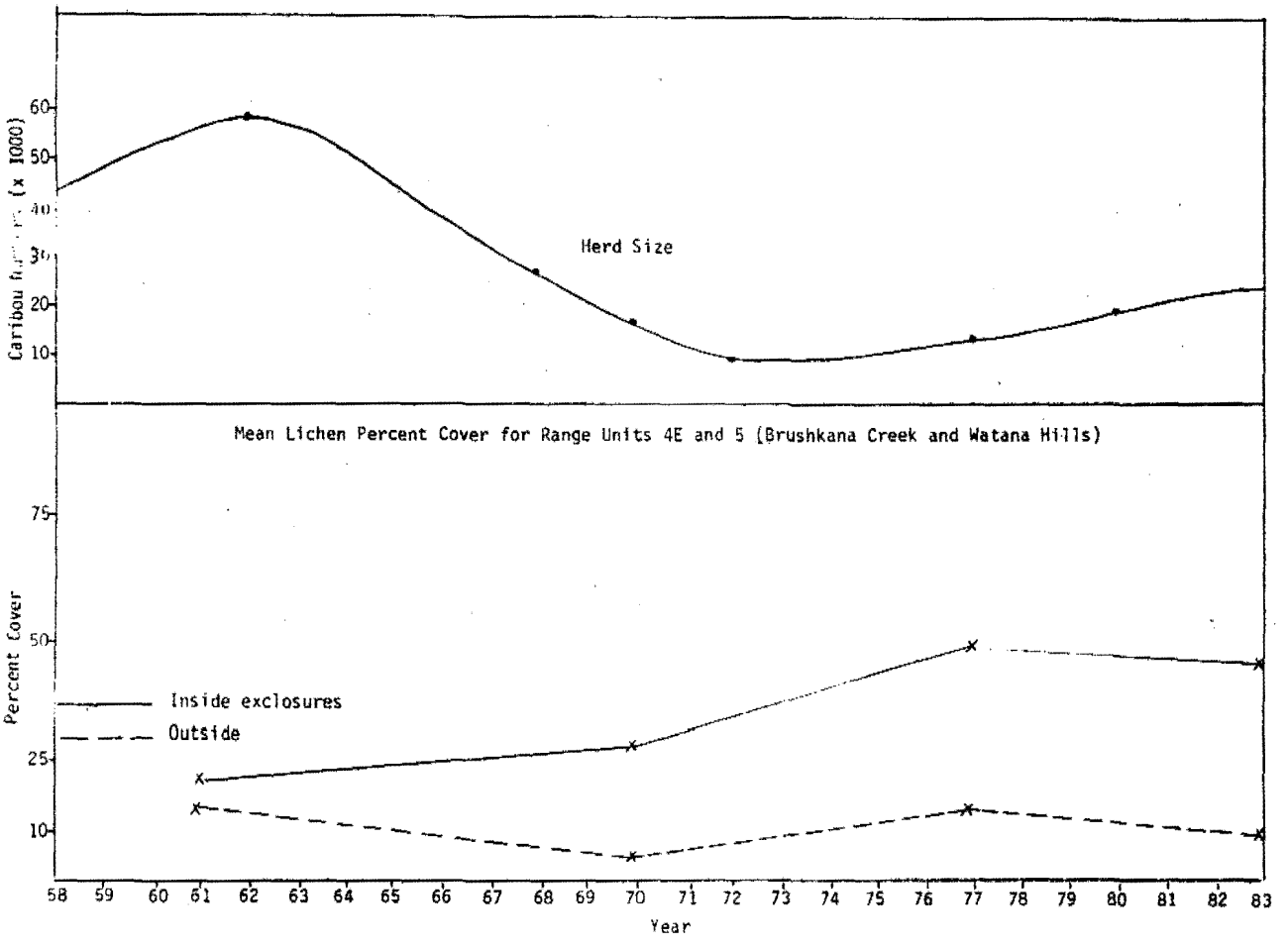


Fig. 2. Comparison of mean percent cover of preferred lichen species within a portion of the Nelchina range and changes in the estimated Nelchina caribou herd size, 1958-83, Alaska.



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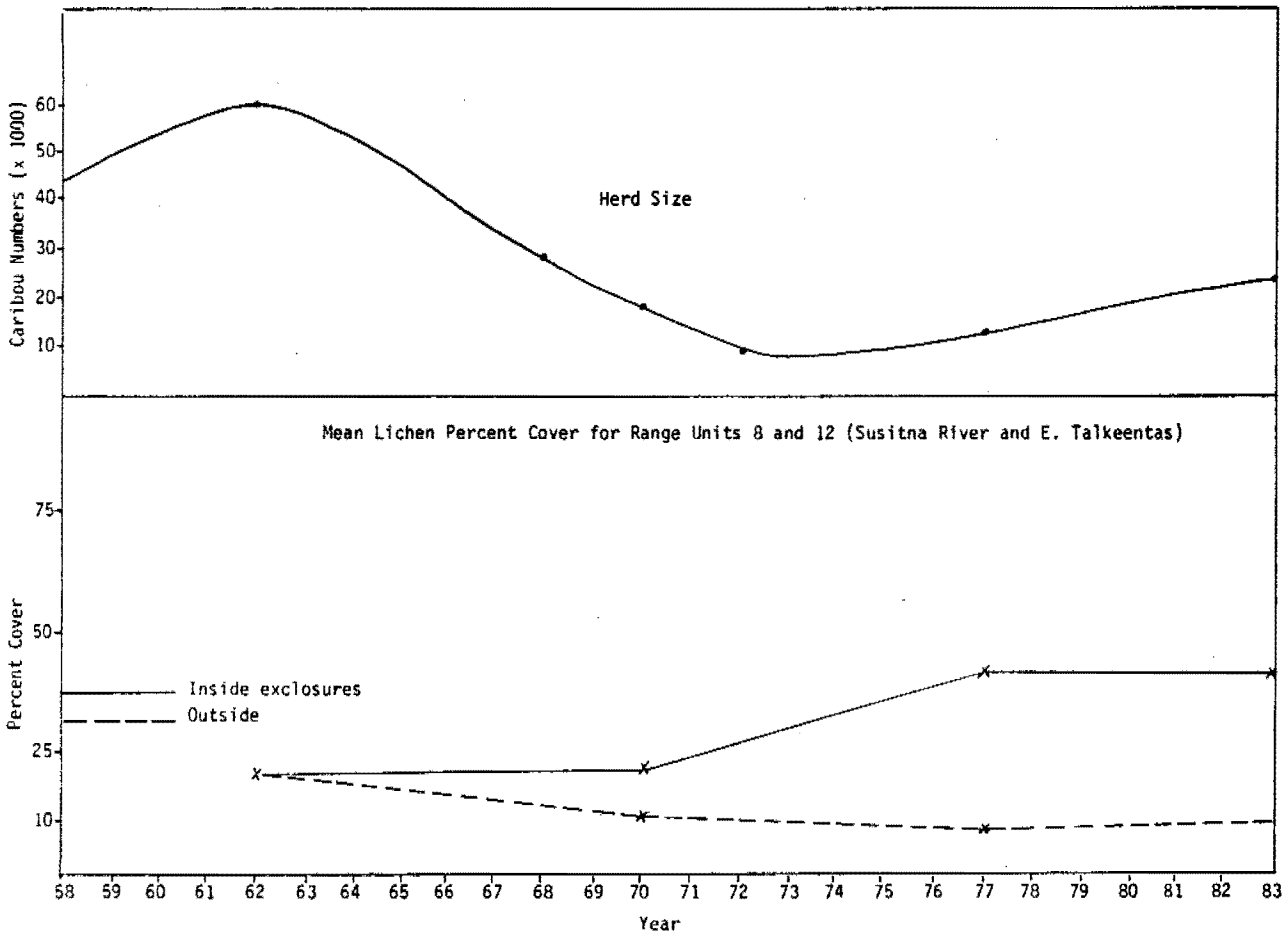

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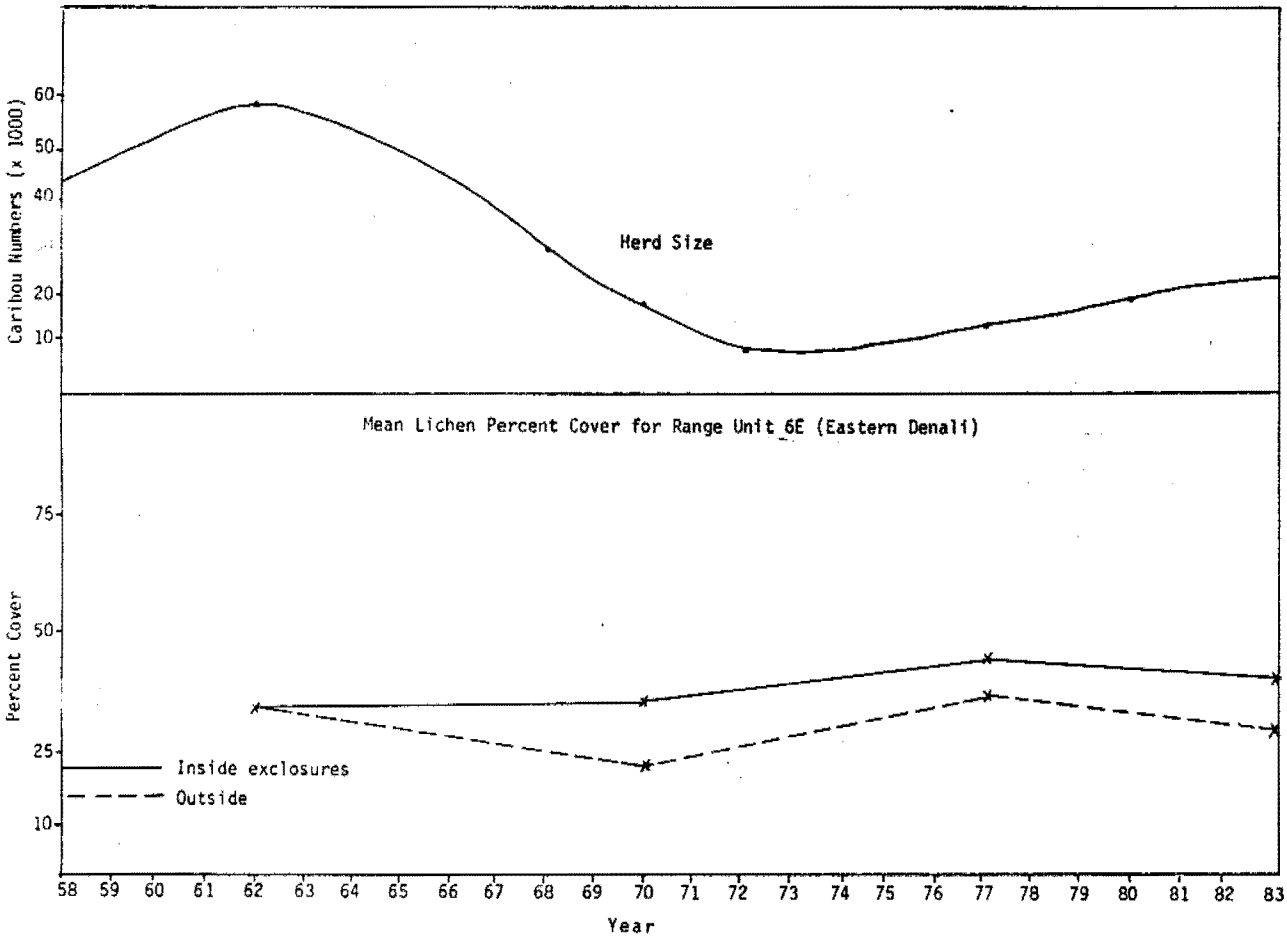

Fig. 5. Comparison of mean percent cover of preferred lichen species within a portion of the Nelchina range and changes in the estimated Nelchina caribou herd size, 1958-83, Alaska.

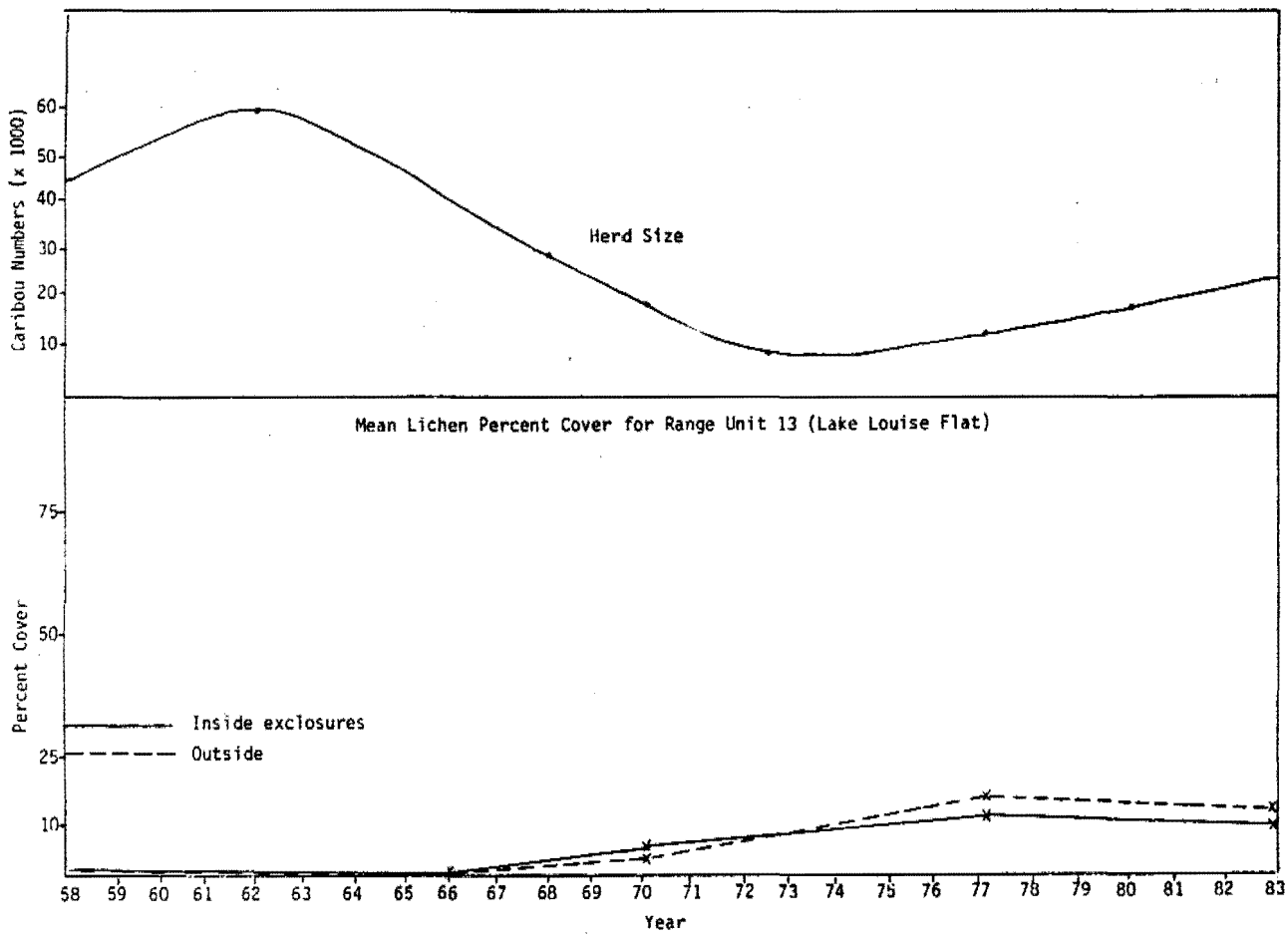

Fig. 6. Comparison of mean percent cover of preferred lichen species within a portion of the Nelchina range and changes in the estimated Nelchina caribou herd size, 1958-83, Alaska.

Table 5. Use at range stations, measured as the difference between lichen standing crop index inside versus outside exclosures and averaged for portions of the Nelchina range*, 1983, Alaska.

Range unit (RU)	Standing crop index** A-B***	Absolute use rating	Standing crop index** A-B for combined RUs	Absolute use rating	Standing crop index (A-B)/A	Relative use rating	Standing crop index (A-B)/A for combined RUs	Relative use rating
1 (Nenana R.)	0.88	M			0.30	M		
2 (Monahan Flat)	0.16	M	0.40	L	0.28	M	0.29	M
4E (Brushkana Cr.)	1.58	H			0.88	H		
5 (Watana Hills)	0.80	M	1.00	H	0.51	H	0.60	H
8 (Susitna R.)	1.27	H			0.52	H		
12 (E. Talkeetnas)	1.16	H	1.20	H	0.56	H	0.55	H
6W (Maclaren R.)	0.07	L			0.15	L		
6E (Delta R.)	0.39	L			0.20	L		
9 (Alphabet Hills)	0.04	L	0.28	L	0.03	L	0.17	L
13 (Lake Louise Flat)	0.45	L			0.26	M		

*Use rating	For A-B	For (A-B)/A
0 (none)	0	0
L (light)	.01-.49	.01-.24
M (moderate)	.50-.99	.25-.49
H (heavy)	1.00+	.50+

** Standing crop index: a measure of the quantity of lichens available, determined by multiplying proportion of lichen cover (decimal equivalent) by mean lichen height (in inches):

% cover x height: 0 - 0.5 = very low; 0.5 - 0.99 = low; 1.0 - 1.49 = med. low; 1.5 - 1.99 = medium; 2.0 - 2.49 = med. high; 2.5+ = high

*** A - inside exclosure
b - outside exclosure

Table 6. Changes in total plant percent cover at range stations, 1962-1983, summarized by range units and combinations of range units, Nelchina range, Alaska.

Range units	A*				B**			
	1962	1970	1977	1983	1962	1970	1977	1983
1 & 2 (Western Denali)	100	100	100	96	100	100	99	93
5 & 4E (Brushkana/Watana)	99	99	99	95	99	72	85	81
6E (Eastern Denali)	100	98	98	92	100	95	98	94
8 & 12 (Susitna/Talkeetna)	100	100	99	98	100	90	94	92
13 (Lake Louise)	87	98	99	97	91	82	99	92

*A = inside exclosure
**B = outside exclosure

Table 7. Changes in Betula glandulosa percent cover at range stations, 1962-1983, summarized by range units and combinations of range units, Nelchina range, Alaska.

Range units	A*				B**			
	1962	1970	1977	1983	1962	1970	1977	1983
1 & 2 (Western Denali)	16	7	12	11	18	17	18	10
5 & 4E (Brushkana/Watana)	6	9	9	4	5	8	8	5
6E (Eastern Denali)	16	14	15	6	14	12	16	7
8 & 12 (Susitna/Talkeetna)	19	21	23	14	40	34	44	29
13 (Lake Louise)	7	15	23	14	6	10	13	10

*A = inside exclosure
**B = outside exclosure

Table 8. Changes in Vaccinium uliginosum percent cover at range stations, 1962-1983, summarized by range units and combinations of range units, Nelchina range, Alaska.

Range units	A*				B**			
	1962	1970	1977	1983	1962	1970	1977	1983
1 & 2 (Western Denali)	10	9	7	10	1	3	3	3
5 & 4E (Brushkana/Watana)	12	22	17	12	9	21	2	11
6E (Eastern Denali)	7	8	7	6	7	13	10	8
8 & 12 (Susitna/Talkeetna)	12	16	16	8	26	34	38	10
13 (Lake Louise)	10	12	19	16	21	34	38	26

*A = inside exclosure
**B = outside exclosure

Table 9. Changes in Empetrum nigrum percent cover at range stations, 1962-1983, summarized by range units and combinations of range units, Nelchina range, Alaska.

Range units	A*				B*			
	1962	1970	1977	1983	1962	1970	1977	1983
1 & 2 (Western Denali)	11	7	6	6	10	13	7	8
5 & 4E (Brushkana/Watana)	6	12	20	10	8	9	14	17
6E (Eastern Denali)	5	2	4	6	3	6	5	4
8 & 12 (Susitna/Talkeetna)	4	7	7	4	13	12	20	11
13 (Lake Louise)	7	5	2	1	1	6	7	4

*A = inside exclosure
**B = outside exclosure

In tabulating and analyzing the cover and condition data for all the range stations there was some concern that with 5 different investigators estimating cover and condition over the period 1957-1983, apparent changes might to some degree be a function of observer bias rather than range ecology. However, from comparing plant species composition, standing crop data, and use data with the historical photographs taken at all stations, it appears that only in a few cases was there any question concerning the accuracy of cover or condition estimates (Appendix V).

RANGE UNIT 1

There are 2 range stations in this unit: Nos. 26 and 27. Exclosures were built in 1960. Vegetation has been described by Hanson (1958) and by Skoog (1962).

Range station 26 - Denali Hwy. Mile 115 (2,700 ft.)

This site was described by Skoog (1962) as a climax heath type with C. stellaris common. Lichen cover in 1962 was approximately 85% with plants growing to 6 inches in height. Range condition was rated as excellent. Caribou disturbance near this site was very slight. Skoog felt that this slight use probably occurred during the 2 winters of 1960-62. Records indicated that prior to this, caribou had not used the area in 20+ years. Skoog also indicated that this area has a deep snow cover in winter. In 1966 Alexander (1967) found the exclosure broken down and signs of both moose and caribou use within. There was an appreciable decline in lichen condition outside with less of a decline within. Apparently, even though broken down, the exclosure precluded some use. In 1970 Pegau (1972) indicated that reindeer lichens, while still 100% in cover inside the exclosure and in excellent condition, had declined to 28% outside. With almost all outside C. stellaris grazed, use was described as heavy. Pegau also noted that shrubs had increased in cover outside, possibly in response to reduced lichen competition.

In 1977 cover analysis showed a reversal in lichen development outside the exclosure. Reindeer lichens had increased to 50%. No appreciable use of the area by caribou was indicated. In 1983 an excellent lichen standing crop still existed inside the exclosure where reindeer lichen cover was rated 81%. Outside coverage for reindeer lichens was the same as in 1977: 50%. Very little caribou use was observed at this site. But apparently, with a past history of lichens being in even better condition and in having more complete cover than presently exists, the small amount of use in this area is sufficient to retard reindeer lichens from returning to a completely undisturbed state.

Range station 27 - Denali Hwy. Mile 123 (2,400 ft.)

Skoog (1962) described this site as a shrub birch type in an open spruce stand. Lichen condition was good, with plants to 6 inches tall. Caribou use, especially during the winter of 1961-62, was rated as

moderate, and some lichen disturbance was apparent outside the exclosure. Alexander (1967) indicated the exclosure fencing had collapsed and caribou had entered, damaging the lichen mats within. Lichen condition was still better inside versus outside. Pegau (1972) found that the outside plots showed heavy use by caribou. Lichens were appreciably scattered and a large percent of standing lichens were composed of apparently dead and dying plant parts. Inside the exclosure Pegau found lichen condition to be good, and saw little if any effect of the disturbance described in 1966. Percent cover for reindeer lichens inside the exclosure was 62% in 1962 and 50% in 1970, while outside this percent was 50% in 1962 and 28% in 1970. Pegau felt that disturbance in this area was due in part to trampling by both caribou and moose during snow-free periods. He also noted that since this site is relatively xeric with a sparse moss cover, lichens are more susceptible here to trampling (good moss cover will serve as a moisture reservoir and form a cushioning base for lichens.

In 1977 percent cover for reindeer lichens was the same inside the exclosure as found in 1970 (Pegau 1972). Outside the exclosure reindeer lichen development had been reversed with percent cover increasing from 28% in 1970 to 50% in 1977. Only a small amount of caribou use was recorded for the area. In 1983 growth of reindeer lichens showed improvement both inside and outside the exclosure. Inside percent cover increased to 81% while outside it increased to 62%. These increases were concurrent with light grazing and trampling by caribou and moose. This area apparently has not had the increase in caribou numbers seen recently in other areas of the Nelchina range.

Summary for range unit 1

This unit is in the northwest corner of the Nelchina caribou range. Historical records indicate that few if any caribou used this area prior to 1956. Since then substantial numbers of caribou wintered here until 1969. The abundant climax stands of lichens found throughout this unit deteriorated during the 1960s. By 1966 C. stellaris mats had been greatly reduced. By the late 1970s reduction in caribou use began to have an effect. Reindeer lichens showed vigorous recovery during the late 1970s but slowed some in the early 1980s. Light use by small bands of resident caribou apparently was sufficient to at least slow lichen recovery. Percent cover for lichens in general as observed at the range stations in 1983 was 85% of the near-pristine levels observed in 1960. For reindeer lichens in 1983, percent cover was 81% of that reported for 1960; this represented an increase from 41% in 1970 and 72% in 1977. While lichen stands have not yet recovered to levels observed in the early 1960s, they still must be rated as being in good to very good condition and probably capable of supporting greater numbers of caribou than presently use this area.

The exclosure at range station 26 provides an excellent example of high lichen standing crop under climax conditions--a standard against which lichen succession and condition throughout the Nelchina range can be measured.

RANGE UNIT 2

There are 4 range stations in this unit: Nos. 23, 24, 25, 35. The exclosures were built in 1960. Vegetation in the unit has been described by Hanson (1958) and by Skoog (1962).

Range station 23 - Denali Hwy. Mile 94 (3,000 ft.)

This site was described by Skoog (1962) as a typical bog lying in a poorly drained low basin adjacent to a creek, with a thick moss mat and with cloudberry (Rubus chamaemorus) common. Lichen cover was approximately 20% with some growth 3-6 inches in height. With this apparently being a deep snow area, Skoog felt it was understandable that little evidence of caribou use was observed. Few lichens occurred within the exclosure because of its location at an especially moist spot. Little if any change was seen at this site in 1970 and 1983 (no data were available for 1977), with only a trace of reindeer lichens recorded. Outside the exclosure reindeer lichen cover and condition did not change during this same period, with percent cover stabilized at approximately 11%. Pegau (1972) noted that some changes in secondary lichen composition apparently were occurring and he speculated that it might be associated with increasing soil moisture conditions. While Pegau found only minor use of this site by caribou in 1970, use and trampling were rated as moderate in 1983. And while such recent use is not reflected in percent cover changes, it probably is associated with a decline in lichen condition.

Range station 24 - Denali Hwy. Mile 100 (2,700 ft.)

This site was described by Skoog (1962) as a white spruce type with a moderately dense shrub birch understory. Much of this site was well drained with some interspersion of bog. Lichens were common with coverage approximating 60%, but of discontinuous distribution. C. stellaris mats were in excellent condition with plants 3-5 inches in height. While some caribou use was evident, lichens were primarily undisturbed. Alexander (1967) found that caribou had broken into the exclosure, but had inflicted little damage to the lichen mats. In 1970 little if any change in reindeer lichens inside the exclosure had occurred compared with conditions observed in 1962. These lichens continued to be rated as in very good condition with robust C. stellaris common. Lichens outside were less robust than those inside. Evidence of both grazing and trampling was observed. This use apparently occurred mostly since 1966 as Alexander (1967) made no note of it. Pegau (1972) noted that there were still large amounts of preferred lichen forage outside the exclosure in protected spots. He also noted that thick clumps of large shrub birch, as found near this site, tend to channel movements of animals through open areas, thus exaggerating the trampling effect. There were no data available for 1977. In 1983 percent cover for reindeer lichens both inside and outside the exclosure was approximately the same as reported for 1970: 37% inside and 28% outside. Use was rated as light, consisting of grazing and trampling by both caribou and moose. Good quantities of nearly undisturbed reindeer lichen mats outside suggest that this area continues to have light use, less than that seen for a short period in the late 1960s.

Range station 25 - Denali Hwy. Mile 108 (2,500 ft.)

Skoog (1962) described this site as a white spruce type with a heavy shrub birch understory, quite similar to station 24. Unlike station 24, this site was burned in the late 1930's. In 1961 lichens appeared to be recovering and were fairly abundant, covering 75 percent of the ground and being 2-4 inches tall. Most of these were early successional stage lichens. Only a minor amount of caribou use was evident, probably occurring in the winter of 1961-62. The dense shrub cover and heavy snow accumulations are at least in part responsible for this lack of use. In 1966 Alexander (1967) indicated that lichen cover was less outside than inside the exclosure. In 1970 Pegau (1972) found a decrease in shrub cover outside which he felt was associated with increased use by caribou and moose. Percent cover readings indicated a slight increase in reindeer lichens inside, from 20% in 1962 to 23% in 1970, and outside from 6% in 1962 to 11% in 1970. Pegau noted that the outside plots were both at protected spots, and in more open areas lichens tended to be disrupted and trampled, more accurately reflecting the increased use occurring in the late 1960s. No data were available for 1977. In 1983 percent cover for reindeer lichens was about the same outside the exclosure as reported in 1970. Use was rated as light for both caribou and moose, and apparently is sufficient to retard further reindeer lichen development. Inside the exclosure reindeer lichen coverage declined to 11%, while shrub birch growth was apparent. The birch inside was now appreciably denser and taller than outside. This site appears to provide an example of the need, under certain conditions, for some large animal travel and use to break down and hold back shrub growth in order to maintain lichen development.

Range station 35 - Monahan Lake (2,600 ft.)

This site was described by Skoog (1962) as a meadow type in a transition zone between a moist sedge-moss complex and a drier shrub birch type. Reindeer lichens were appreciably more abundant in the birch type, with good growth to 6 inches in height. In the transition zone lichen cover was approximately 37%. Reindeer lichens were not considered abundant, although those present were described as being in excellent condition. Use of the area by caribou was considered to be minimal and only a few examples of disturbed lichens could be found. In 1966 Alexander (1967) reported that part of the exclosure had been broken down, but there was no indication that caribou had been inside. In 1970 the exclosure was completely knocked down, with much trampling of the vegetation within (Pegau 1972). No cover readings were made. Pegau did indicate that a number of scattered and disrupted lichen mats were observed outside the exclosure, and he considered use to have appreciably increased from 1962. In 1977 the exclosure was repaired, but no data are available for that year. In 1983 it was apparent that some recovery had occurred since 1970. While lichen cover readings were not as high as reported in 1961, they probably were appreciably better than what would be expected from Pegau's description of destruction and use within the exclosure in 1970. Outside the exclosure percent cover readings were

approximately the same as reported in 1961. The light use by caribou and moose observed in 1983 supports the hypothesis that some lichen recovery in the area has occurred since 1970.

Summary for range unit 2

This is the smallest of the 16 range units, encompassing the mostly level and poorly drained bottom land between the upper Susitna and upper Nenana Rivers. With mostly light winter winds, relatively deep snow is common on the Monahan Flats. As a result, this area becomes a potentially important caribou range only during winters with less than normal snow levels. The description of the unit during the late 1950s indicated that excellent stands of nearly undisturbed lichens were common throughout the area and caribou use was practically nonexistent. Pegau (1972) indicated that sporadic light to moderate use by varying numbers of caribou during the 1960s resulted in an appreciable reduction in lichen cover throughout a considerable portion of the unit. Although data are skimpy for the 1970s it appears probable that use of the area declined appreciably, and at moderately to severely disturbed sites lichens began recovery. In the early 1980s, the relatively light to moderate use has slowed or stopped further lichen recovery in much of the unit. Today this winter range can be described as in fair to good condition.

RANGE UNIT 4

There are 2 range stations in this unit: Nos. 33 and 34. The exclosures were built in 1960. Skoog described the vegetation of this area in 1959 and in 1962.

Range station 33 - Soule Lake (3,300 ft.)

Skoog (1962) described this site as a heath type, with all vascular plants decumbent and usually less than 6 inches tall. Mosses were considered uncommon while lichens were abundant with an approximate cover of 75%. Growth was rated as good with plants averaging 2-3 inches in height. Reindeer lichens were the most common species present. Caribou use was considered to be light, with lichen mats relatively undisturbed except along a few migration trails through the area. By 1966 a marked reduction in lichen development outside the exclosure had occurred. In 1970 further regression was reported. Apparently large numbers of caribou had over these years been trampling and grazing this area during snow-free periods. While reindeer lichen cover inside the exclosure remained approximately the same over the period 1961-70, outside it declined from 62% to 3%. C. stellaris alone declined from an approximate cover rating of 60% in 1961 to 0 in 1970. The well-defined trails that Skoog described in 1961 were gone in 1970 as increased use by caribou moving through this area heavily impacted most vegetation types. Pegau (1972) noted that in the process of such heavy use the ground became more susceptible to frost action, resulting in extensive frost boil upheaval. Pegau considered this site to be one of the best examples around of the potential trampling effects of large numbers of caribou concentrating activity on an area. No data were available for 1977. In 1983 reindeer

lichen cover inside the exclosure was 59%, similar to prior ratings. Outside coverage for reindeer species was 3%, the same as reported in 1970. There was some indication that lichen development here had been reversed and was now showing a small amount of improvement. Use of the area by caribou was considered to be moderately heavy. Much of the surrounding area is highly disturbed with frost boils and bare ground common. Some of the disturbance attributed to caribou may actually be the result of frost action. Apparently, while there still is an appreciable amount of use of this area, it has declined sufficiently from former levels to allow some initial recovery of vascular and lichen plants.

Range station 34 - Jack Lake (3,400 ft.)

This site was described by Skoog (1962) as a dense shrub birch type with a heavy moss understory. In close proximity to this site are 3 other plant communities: heath, meadow, and willow types. Lichens were considered to be in excellent condition with 30 percent cover, and plants 2 to 5 inches in height. Very little disturbance of lichen mats was observed. In 1970 little if any change at this site was reported (Pegau 1972). Percent cover for reindeer lichens was still approximately 28% inside and 50% outside the exclosure. Pegau did note that where a disturbed area overlapped the edge of the exclosure, lichen recovery was noticeably more advanced inside than outside. This probably indicates minor amounts of use at this site over the years. No data were available for 1977. In 1983 percent cover for reindeer lichens was approximately the same both inside and outside the exclosure as recorded in 1970. Little if any use of this area was observed. While variable numbers of caribou have used the Jack Lake area over the years, apparently few have utilized this range station site.

Summary for range unit 4

This northwestern unit is mostly mountainous summer range for caribou. A small amount of winter range is found in the northern portion of the unit. Prior to the mid-1960s little use of this unit by caribou was recorded, and good lichen cover could be found throughout the area. Heavy use in some areas by large segments of the Nelchina caribou herd in the late 1960s demonstrated dramatically how reasonably good range can be quickly destroyed under such conditions. With the herd reductions of the early 1970s the use of this area declined to much lower levels - but still appreciably higher than described for the late 1950s. While scattered sites continue to show the effects of the severe damage done in the late 1960s, much of the unit today is fairly productive summer range. The light but increasing use in the late 1970s and early 1980s has probably allowed some recovery at heavily damaged sites, but continued recovery here will probably be slow if use increases.

RANGE UNIT 5

There are 3 range stations in this unit: Nos. 15, 31, 32. Range station 15 was built in 1956, while 31 and 32 were built in 1960. Hanson (1958) has described range station 15's vegetation, and Skoog (1962) has described vegetation at the other 2 sites.

Range station 15 - Big Lake (3,200 feet)

Hanson (1958) described this site as a heath type with shrub thickets occurring throughout the stand. Lichens were considered to be plentiful with cover near 100 percent and plants 1-2 inches in height. Use by caribou in this area during the prior 2-3 winters was considered heavy with some additional use occurring during summer. Considerable lichen deterioration involving extensive compaction and some shattering resulted, with range condition rated as fair. In 1966 McGowan (1966) indicated that lichens within the exclosure were much the same as described by Hanson--in excellent condition. Outside lichens were in poorer condition, with trampling damage widespread. McGowan suggested that this was at least in part the result of an observed July 1966 movement of a large herd of caribou at this site. In 1970 Pegau (1972) found lichens inside the exclosure to be still in excellent shape. He indicated that for the reindeer species percent cover was 37%. Outside lichens were mostly scattered and approximately 1/2 inch high. Reindeer lichens here were rated at 9% cover. The area was still being heavily utilized during the summer, with some use also occurring in the winter. Pegau noted that there had been a marked increase in shrubs throughout the area. This change may be a response to reduced competition by lichens. In 1977 lichens within the exclosure continued to flourish, while outside lichens showed some initial signs of recovery. Percent cover for reindeer lichens outside had increased from 9% in 1970 to 28% in 1977. Use had apparently declined to low levels during this period. In 1983 the exclosure continued to protect a near-climax stand of robust reindeer lichens. Outside the exclosure caribou use of the area had once again increased, and was rated as moderate. Reindeer lichen recovery outside had ceased, and percent cover had declined slightly.

Range station 31 - Deadman Lake (3,100 ft.)

Skoog (1962) described this site as a heath type with all vascular vegetation decumbent, a sparse moss cover, and lichen cover averaging 66%. Lichen growth, on the other hand, was poor with plants generally not exceeding 1/2 inch in height. Reindeer lichens were considered uncommon, averaging 11% cover. With rather heavy caribou use occurring over at least the previous 6 years, lichens had deteriorated from a near climax condition, and now early succession stage lichens, primarily Stereocaulon sp., were common. Skoog noted that, to compound the problem, this area is especially susceptible to disturbance, being open and exposed to appreciable wind action. An examination of the range in the Deadman Lake area in 1953 found reindeer lichens existing in great abundance and production (pounds/acre) very high. In both 1966 and 1970 the difference in lichen cover and condition was noticeably better inside versus outside the exclosure (Pegau 1972). While percent cover for reindeer lichens only increased from 11% in 1962 to 14% in 1970, outside the exclosure such cover declined from 11% to 5%. Pegau indicated that heavy use had continued throughout this area in the late 1960s. This use not only drastically affected lichens but also many vascular species. He noted that grasses and sedges were more vigorous inside the exclosure. No data were available for 1977. In 1983 the exclosure had partially

collapsed, with some indication of use within. Reindeer lichen cover was rated at 11%, down from the 1970 reading of 14%. Outside reindeer lichen cover was still rated at 5%, with very poor growth and extensive disturbance associated with moderate caribou use. While it is reasonable to assume that lichen recovery outside the exclosure probably began in the early 1970s in response to reduced caribou numbers throughout the Nelchina range, either such recovery has not progressed sufficiently to allow measurement or recent herd increases and associated use in the early 1980s have been sufficient to inhibit further recovery.

Range station 32 - Butte Lake (3,400 ft)

This site was described by Skoog (1962) as a Carex-heath type, poorly to moderately drained, and progressing successionally from a meadow type. Lichens were common with an average cover of 66%, but with poor growth, seldom exceeding 1 inch in height. While reindeer lichens were dominant at that time, secondary species appeared to be taking over. Heavy caribou use over a number of years had extensively damaged what once was probably a productive, nearly undisturbed lichen stand. Skoog observed much trampling, compression, and breakage of lichens and described this area as overused. He also indicated that if substantial winter use continued, then deterioration of lichens would also continue.

In 1966 and 1970 percent cover for lichens outside the exclosure declined, from 14% in 1962 to 3% in 1970 (Pegau 1972). Use by caribou continued to be classified as heavy. No data are available for 1977. In 1983 lichen cover outside was approximately the same as recorded in 1970, with condition still quite poor. As at the prior station (Range Station 31) some minor recovery may have occurred during the early 1970s but documentation is not available. With current moderate levels of use, further recovery cannot be expected. Inside the exclosure reindeer lichen cover increased from 14% in 1970 to 37% in 1983 in spite of some fence damage and possible lichen use.

Summary for range unit 5

Skoog (1968) considered this unit to be one of the most important for the Nelchina caribou where preferred forage production is high and use during summer and early fall heavy. Hanson (1958) found lichen production from sampling sites to be approximately 5,000 pounds/acre in the early 1950s. He considered lichen cover and conditions to be good to excellent throughout much of the area. Beginning in 1955, heavy use was reported. By 1957, lichens of late successional stage were showing appreciable damage at many sites. During the 1960s this unit received some of the heaviest use reported anywhere on the Nelchina range, with lichen cover declining continually until about 1970. Skoog (1968) felt that in spite of the heavy use this unit remained a good summer range with abundant available forage. Only the reindeer lichens show severe damage from grazing while other lichens and various vascular plants apparently important as forage remained abundant and in good condition. During the 1970s, with greatly reduced caribou numbers and use, lichen degradation was reversed and recovery began. By the early 1980s recovery

had stopped. Mean percent cover for all lichens in 1983 was 52% of their 1962 level compared with 63% of that level in 1977 and 27% in 1970. Reindeer lichens in 1983 were 24% of their 1962 level compared with 41% of that level in 1977 and 14% in 1970. Primary lichens were rated in poor condition.

RANGE UNIT 6

There are 9 range stations in this unit: Nos. 17, 18, 19, 20, 21, 22, 37, 38, 39. The exclosures were constructed in 1960 and the original readings of the vegetation were made by Skoog (1962).

Range station 17 - Denali Hwy. Mile 9 (3,400 ft.)

Skoog (1962) described this site as a heath type on a rocky subsoil with decumbent vascular plants associated with wind exposure. Lichen cover was about 80% with plants 1-3 inches in height. Reindeer lichens, including C. stellaris, were the most common species. Winter use by caribou was evident with caribou pellets and disrupted lichen mats fairly common. Alexander (1967) did not detect differences between vegetation inside versus outside the exclosure. In 1970 Pegau (1972) found only small changes from conditions observed in 1962, but did report better lichen development inside the exclosure. Based on the number of newly sprouting lichens, he speculated that lichen development inside should probably continue to improve. Outside the exclosure lichens appeared shorter and more scattered. He noted that throughout the area lichen height seldom exceeded 2 inches where the ground was elevated and exposed to the wind. Unlike Skoog, Pegau felt that caribou use is probably restricted to snow-free and early winter periods. Such use was significant enough to retard lichen recovery outside the exclosure. In both 1977 and 1983 percent cover for lichens in general, and reindeer species in particular, were approximately the same as reported in 1970. Reindeer cover inside was about 35%, while outside the figure was 18%. Apparently lichen development has stabilized inside the exclosure, while outside light to moderate amounts of caribou use and trampling have maintained lichen development at a lower level.

Range station 18 - Denali Hwy. Mile 26 (3,250 ft.)

This site was described by Skoog (1962) as a shrub birch type of rather dense growth with a heavy moss understory and generally poor to moderate drainage. Lichen growth was good with 2-4 inch high plants and percent cover approximately 40%. Reindeer lichens were the most common species. With such a dense shrub cover there was no evidence of caribou use. In 1970 there was no appreciable change in lichen development reported for this site (Pegau 1972). Pegau felt this site was typical of the extensive shrub stands found in this range unit. He noted that lichens tended to be scattered in clusters. He speculated that the only use of this area by caribou would be during spring or fall migrations. In 1977 lichen cover readings were lower than for 1970, both inside and outside the exclosure. No caribou use was recorded. If this is a real change, it may be related to competition with some of the vascular plant

species, possibly in conjunction with changes in precipitation cycles. In 1983, reindeer lichen development was approximately the same as recorded in 1977: approximately 6% inside and 9% outside. While overall lichen cover may not have changed much over the past 20 years, reindeer lichens apparently have regressed, at least inside the exclosure. Either this is a site-specific phenomenon associated with plant interaction and possibly changes in moisture conditions, or the exclosure has reduced disturbance to shrub and/or heath species to the extent necessary for their competitive dominance to be expressed.

Range station 19 - Denali Hwy. Mile 29 (3,700 ft.)

Skoog (1962) described this site as a fescue-willow stand with moderate drainage and extensive moss cover. Lichens were relatively scarce with a percent cover of approximately 14% and plants 1-3 inches tall. Skoog felt that this site resembled a meadow but was successionally developing towards a drier shrub type. Caribou use was not observed. In 1970 little if any difference in vegetation inside versus outside the exclosure was seen (Pegau 1972). Lichens, while robust, occurred only in scattered clusters. Pegau felt that any use was probably restricted to late spring/early summer when grasses and forbs were succulent, and to the fall when caribou may move through the area. In 1977 slight reductions in percent cover were recorded for both lichens in general and reindeer species in particular, both inside and outside the exclosure. In 1983 little if any change in lichen development was observed when compared with 1977 observations. Overall, lichen development for the 20-year period of examinations has not changed. In 1983 this site was described as being in a "moist sink" and not really typical of the area when compared with surrounding expanses of shrub birch associated with relatively good reindeer lichen development.

Range station 20 - Denali Hwy. Mile 47 (3,150 ft.)

This site was described by Skoog (1962) as a shrub birch stand on fairly well-drained, deep soil. A fescue-willow type occurred, intermixed with the birch and was considered by Skoog to be invading the site. Moss cover was heavy while lichens were abundant, ranging from 80% cover in the open fescue areas to 40% in the near vicinity of shrub birch. Reindeer lichens were fairly abundant and Skoog felt that they were expanding throughout the area. The genus Stereocaulon was also common. Little evidence of caribou use was observed. In 1970 lichen development was rated approximately the same as in 1962 (Pegau 1972). Pegau felt the shrubs were very dense and would restrict use of the area by caribou. In 1977, lichen readings were again quite similar to those made at the prior examinations. Little if any use by caribou was observed. In 1983 evidence of some caribou and moose activity was observed. In addition there was no appreciable change in lichens within the exclosure, yet there was an obvious reduction of reindeer lichen cover outside--from 14% to approximately 5%. The observed recent ungulate use of this site may be responsible for the lichen reduction.

Range station 21 - Denali Hwy. Mile 56 (2,950 ft.)

Skoog (1962) described this stand as at a transition site between a fescue-willow type and a willow type. This was a fairly moist site (as compared with a more typical fescue site) containing an abundance of grass, forbs and moss, with lichens relatively scarce. Lichen cover was approximately 7%, with Stereocaulon most abundant. Reindeer lichen development was beginning on the drier hummocks. No caribou use was observed. In 1970 Pegau (1972) indicated that in general few changes had occurred since 1962. He emphasized how profuse forbs were. He also indicated there was no real difference from inside to outside the exclosure. Reindeer lichen cover had increased both inside and out, from a trace to 3%. There was still no evidence of caribou use. In 1977 and 1983 only minor changes in vegetation were observed. In both years there were increases in lichens in general and secondary lichens in particular, going from 9% (1970) to 11% (1977) to 18% (1983) inside the exclosure, while outside, going from 20% (1970 and 1977) to 33% (1983). No change in reindeer lichens was observed inside or outside in 1977 and 1983. No caribou use was recorded in 1977 while in 1983 a minor amount of caribou sign was observed and some evidence of moose use was seen. Possibly the lack of reindeer lichen development observed in recent years is a byproduct of recent ungulate use of this area.

Range station 22 - Denali Hwy. Mile 65 (3,400 ft.)

This site was described by Skoog (1962) as a shrub birch stand at the base of a moderately steep south-facing slope. He indicated that this site acted as a catch basin for runoff and salts. Both birch and alder shrubs were dense. Lichens were almost totally absent. Skoog considered this site to be atypical of the shrub birch type. In 1970 no appreciable changes in vegetation were recorded (Pegau 1972). No lichen development had occurred, and no use by caribou was observed. Pegau felt that some use by moose might be expected here. In 1977 and 1983 there still had been no changes in vegetation. Lichens were still absent in the established plots. Some secondary lichens were observed adjacent to the site in 1983. No sign of either caribou or moose was recorded in either 1977 or 1983.

Range station 37 - Dickey Lake (3,000 ft.)

Skoog (1962) described this site as a shrub birch type, with dwarf birch scattered sparsely over the area and heath species occurring in abundance. Lichen cover was rated as poor with heights of 1/2-3/4 inch predominating. Stereocaulon sp. was the most common species. Caribou use was described as moderate to heavy. Skoog felt that such use was responsible for lichen degeneration throughout the area and that continued use would preclude any recovery. In 1970 Pegau (1972) noted how different lichen growth was inside versus outside the exclosure. Inside, recovery was starting with Stereocaulon common and forming upright and dense clusters. Outside lichens were quite scattered and fragmented and seldom over 1/4 inch in length. Even the vascular vegetation outside now showed the adverse effects of past heavy ungulate use. Pegau indicated

that caribou use was currently light to moderate at this site. In 1977 recovery of lichens in general, and reindeer lichen in particular, had continued inside the exclosure and also had begun outside. Little if any use by caribou was observed. By 1983, percent cover of reindeer lichens had increased inside from 6% to 9% and outside from 9% to 14%. Light use was recorded for this area, in spite of large numbers of caribou reported in adjacent areas in the fall of 1981 and 1982. Stereocaulon sp. was still the dominant species throughout the area, indicating that this site is probably still at a relatively early successional stage with a number of years still needed to develop good reindeer lichen mats.

Apparently there was an appreciable decline in caribou use of this area in the early 1970s, accounting for a recovery of lichens. This change in use may be a function of a decline in overall Nelchina caribou numbers that occurred during the late 60s and early 1970s, or a shift in areas of use.

Range station 38 - Boulder Lake (3,900 ft.)

This site was described by Skoog (1962) as a fescue-willow type, with shrub birch common in less moist areas and grasses common throughout. Lichen cover was good, in large part consisting of reindeer lichens 1-3 inches tall. Range condition was rated at good to excellent. Skoog noted that deep snow cover acted to preclude caribou use during winter. He found little evidence of caribou use at any time of the year. In 1970 Pegau (1972) reported that this area supported excellent lichens that had been utilized very little if at all. He found no obvious difference in vegetation within versus outside the exclosure, and felt, with C. stellaris so common, that lichens at this site were in near climax condition. He also noted that with a shallow substrate, a relatively thin moss layer and fairly widely dispersed shrubs, this area is prone to being seriously damaged by any sustained heavy grazing or trampling. No data are available for 1977. In 1983 there was no appreciable change in percent cover for lichens inside the exclosure, although it appeared that someone or something had been inside disturbing and trampling lichens. Outside, some caribou sign was observed, with use described as light. In addition there was a fair amount of localized trampling, probably associated with use of horses in the area. Lichen cover outside declined from 81% in 1970 to approximately 50% in 1983. This change appears to be in large part localized and an anomaly resulting from people camping and keeping horses close to this range station site.

Range station 39 - Summit Lake (3,300 ft.)

Skoog (1962) described this site as a heath type, on a well drained plateau exposed to moderate to severe winds. Shrub birch is common and lichen growth is good with plants 2-4 inches high covering approximately 85% of the ground. Reindeer lichens are dominant. The area was used extensively by caribou during the winter of 1961-62, resulting at many places in disrupted and compacted lichens. Skoog felt that because of the open, exposed nature of this area, it could not withstand heavy caribou use. In 1966 Alexander (1967) found recent heavy use outside the

exclosure and described appreciable lichen deterioration. In 1970 lichens inside were described as robust and in good condition with coverage approximately 62% for reindeer lichens, up from 50% in 1962 (Pegau 1972). Outside, C. stellaris had disappeared from all but protected spots. Percent cover for reindeer lichens was 28%, down from 50% in 1962. Use was described as moderate to heavy. By 1977 conditions had been reversed, with improved lichen condition and minimal use of the area by caribou. Inside the exclosure reindeer lichens were rated at 100% cover, obviously near or at the climax successional stage. Outside reindeer lichen cover was 81%, with C. stellaris once again common throughout the immediate area. Evidence of use by caribou or moose was not observed. In 1983 lichen cover and condition inside the exclosure were approximately the same as for 1977. Outside reindeer lichen cover was recorded as 50%, down appreciably from 1977. C. stellaris was still common throughout the area. Use by caribou was rated as light, and may be responsible for the reindeer lichen regression.

Summary for range unit 6

This northeastern unit is largely unavailable as winter caribou range because of the typically heavy snowfall and snow pack that persists late into the spring. Over recent times variable numbers of caribou have used this unit during the summer and fall. Early reports by Hanson (1958) and Skoog (1962) indicated that forage lichens were abundant in many areas of this unit, especially in the central shrub birch region between the McClaren River and Tangle Lakes.

Prior to the early 1960s, use throughout the unit was primarily light and occurred during the summer and fall. During the 1960s use increased during the winter to moderate and even heavy levels in certain areas of the unit, especially to the east of Tangle Lakes. Pegau (1972) reported that lichen condition deteriorated due to such use. He still felt that the unit as a whole provided considerable quantities of good summer and fall forage. Range examinations in 1977 and 1983 found a number of the stations located in vegetation types supporting little or no lichen development. In the western half of the unit, which apparently supports abundant near-climax lichen stands, typically in the shrub birch type, 3 of 4 stations were of the fescue-willow type. Since these sites supported few lichens and had practically no caribou use, the data collected here were not considered representative. Based on casual observations, throughout this western portion of the unit there are good expanses of reindeer lichen stands which apparently are receiving only light use, at the most.

In the eastern portion of range unit 6 most of the moderate to heavy use recorded in the late 1960s had subsided by the early 1970s. Lichen recovery occurred through the late 70s in some areas and into the early 1980s in other areas. Currently, use of the eastern area is considered to be light, primarily occurring during summer and fall. Range condition has improved from fair in the early 1970s to good in the early 1980s. Mean percent cover for lichens in general in 1983 is 85% of the 1960

level compared with 73% of that level in 1970 and 90% in 1977. Reindeer lichens were 86% of the 1960 level versus 66% of that level in 1970 and 111% in 1977.

RANGE UNIT 9

The single range station in this unit, No. 36, was constructed in 1960. Skoog (1962) has described the vegetation of the area.

Range station 36 - Monsoon Lake (3,000 ft.)

This site was reported by Skoog (1962) as shrub birch type in a drainage bottom, with white spruce sparsely scattered through the area. Lichen growth was good with reindeer species predominating. Caribou were using the area only to a small extent. Skoog felt that the shrub cover played a major role in protecting lichens by impeding caribou movements and grazing in the area. Skoog also noted that caribou use throughout this area is concentrated on the more open upper ridge areas, and use of the bottoms is made primarily by migrating animals. In 1966 Alexander (1967) indicated that lichen cover and condition were approximately the same inside and outside the exclosure. In 1970 Pegau (1972) found heavy use of outside lichens and described appreciable deterioration of a former good lichen stand. Percent cover for reindeer lichens declined from 37% to 18%. Pegau felt that this was a deep snow area in winter and thus the use observed was summer use and/or spring and fall migratory use. Inside, reindeer lichen coverage was about the same as in 1962. In 1977 percent cover both within and outside the exclosure increased over prior readings, from 23% to 50% inside and from 18% to 37% outside. Use by caribou was considered to be very light. In 1983 a fair amount of caribou activity in the area was apparent and use was rated as light to moderate. In addition, a moderate amount of trampling by moose was observed. As a result, reindeer lichen coverage outside the exclosure declined again to approximately 18%. This use may be a direct function of the recent increases in the size of the Nelchina caribou herd. It should be noted that the percent cover for reindeer lichens also declined inside the exclosure to approximately 14%. With no evidence to indicate that the exclosure had been broken into or that lichens had been disturbed, this appears to be either an edaphic response or competitive displacement by other plant species. One speculation is that without the physical disturbance of the shrub overstory (especially dwarf birch) by moose and possibly also by caribou, lichens are displaced, possibly due to increased humidity, decreased light availability and temperature changes (M. See, pers. commun.).

Summary for range unit 9

With only one range station located in the northwestern corner of this range unit, it is difficult to evaluate caribou range conditions and use on a unit-wide basis. Skoog (1959) indicated that during the late 1950s the western half of the unit had received much more use than the eastern portion. Range condition was considered to be fair in the west and good to excellent in the east. Pitcher (1983) indicated that the

main herd or appreciable portions of it have not summered in unit 9 since the mid-1960s. Small numbers of bulls do summer throughout the unit. Pegau (1972) found that a large portion of the herd was passing through the western portion of the unit in the fall. Even though these caribou seldom remained in the unit for a long period of time, appreciable damage to lichen cover was observed. In 1970 range condition was considered to be poor in some areas of the western portion of this unit.

Based on the 1977 and 1983 findings from the range station at Monsoon Lake, it would appear that with the decline in caribou numbers in the early 1970s lichens began to recover, probably throughout the western portion of the unit. By the early 1980s this recovery was probably inhibited, and possibly reversed to a small degree as caribou numbers began climbing. Pitcher (pers. commun.) observed considerable late summer/fall use of the western portion of the Alphabet Hills in 1981 and 1984.

RANGE UNIT 8

There is 1 range station in this unit: No. 30. The exclosure was built in 1960. Skoog (1962) has described the vegetation of this site.

Range station 30 - Middle Fog Lake (2,200 ft.)

This site was described by Skoog (1962) as a heath type which included low shrub birch. Lichen cover was approximately 75 percent. Skoog indicated that most primary lichen species were being replaced by secondary species such as Stereocaulon sp. Most lichens were compacted or scattered, and broken plants were common. Skoog considered the area to be overgrazed, with minimal amounts of lichen forage remaining. In 1966 Alexander (1967) indicated that there had been little change in conditions inside or outside the exclosure. By 1970 recovery had started inside the exclosure with reindeer lichen cover increasing from 6% to 11% (Pegau 1972). Outside, the range had continued to deteriorate with reindeer lichen cover declining from 6% to 2%. Continued use involved caribou moving back and forth through this area between calving and summer grounds in range units 12 and 5. In addition some winter use has occurred in the past. Pegau suggested that the abundant sedges in this unit may take the brunt of winter grazing. He noted that sedges appear to be resistant to damage from winter use.

In 1977 cover for lichens showed improvement inside, increasing from 11% to 18%, and outside, increasing slightly from 2% to 3%. Use of the area had declined. In 1983 lichen recovery was still progressing, with reindeer lichen cover inside now 50% and outside 11%. Caribou use was described as light. Apparently overall increases in the Nelchina caribou herd in the 1980s have yet to cause an increase in use sufficient to adversely affect positive lichen recovery.

Summary for range unit 8

This unit forms an extended riparian band along the Susitna River between the main Talkeetna Mountains to the south and the Chulitna Mtns. portion of the Talkeetnas to the north. With only 1 range station within

the unit, it is difficult to evaluate range condition and use on a unit-wide basis. Apparently extensive movements between calving and summering areas during the late 1950s and 1960s were responsible for appreciable lichen deterioration in the vicinity of the range station at Fog Lakes. Skoog (1962) and Pegau (1972) felt that this use extended throughout a good deal of the central portion of range unit 8. With the decline in caribou numbers in the early 1970s, lichen condition began improving and continued to improve through 1983 in the Fog Lakes area. Although herd size has appreciably increased, caribou apparently have not resumed using the Fog Lakes area in numbers sufficient to suppress lichen recovery. We suspect other areas in this range unit have felt the effects of increased caribou numbers, since the main herd has continued in the 1980s to calve and summer in adjacent areas. We also suggest that Pegau may have underestimated winter use of the Fog Lakes area in the 1960s. Pitcher (1982) indicated that appreciable wintering in range unit 5, adjacent to range unit 8, occurred throughout this period. Skoog (1959) described heavy winter use near Fog Lakes in 1958 based on 914 feeding craters per 10,000 m^2. Sedges were determined to be the principal winter forage from examining craters and from stomach samples. This winter use, suspended in the early 1970s, apparently has not resumed to any appreciable degree--possibly the reason why lichen condition has continued to improve into the early 1980s.

RANGE UNIT 12

There are 2 range stations in this unit: No. 28 and 29. The exclosures were built in 1960. Hanson (1958) and Skoog (1962) have described the vegetation in this area.

Range station 28 - Black Lake (3,500 ft.)

Skoog (1962) described this site as a shrub birch type surrounded on 3 sides by a Carex-Salix-Betula bog. In 1957 this area was described as having a low density of lichens, with heavy use by caribou in spring and summer (Hanson 1958). Existing lichens formed a thin layer 1 inch or less in thickness, with disturbance commonly observed. The condition of lichens and other vascular plants was progressively deteriorating. Skoog (1962) indicated that secondary succession stage lichens covered about 75% of the ground. Few reindeer lichens were present. Skoog found no evidence that there had been any "good lichen growth" in recent times. He indicated that there was relatively little winter caribou use evident in the area.

In 1966 Alexander (1967) found no differences in the vegetation inside versus outside the exclosure. In 1970 overall lichen cover outside the exclosures declined from 62% in 1962 to 40% in 1970, while reindeer species remained at approximately 6 percent cover (Pegau 1972). Pegau felt the dense shrub cover of the area was a factor in caribou use remaining relatively light. Inside the exclosure reindeer lichens increased from 6% in 1962 to 18% in 1970. In 1977 reindeer lichen development progressed inside the exclosure with cover increasing to 28% while outside it increased to 11%. Use, while probably less than what

was occurring prior to 1970, was still appreciable. Within the exclosure reindeer lichen cover increased to 57% by 1983. Lichen cover outside the exclosure in 1983 was approximately the same as recorded in 1977. Use was described as light with some trampling. With recent increases in the Nelchina caribou herd, associated use of this area would be expected to fairly severely affect lichens. This exclosure may not accurately represent the use pattern in the area due to its proximity to a cabin. In recent years caribou have utilized this area extensively during summer months with thousands of caribou observed adjacent to Black Lake.

Range station 29 - Clarence Lake (2,900 ft.)

This site was described by Skoog (1962) as a shrub birch type with shrubs occurring in moderate density. Lichen cover was low and appeared to have declined from former years. Caribou had overgrazed much of this area and the lichen mat was trampled, fragmented, and compressed. While reindeer lichens were still dominant, secondary species were common and increasing. This description can be compared with a 1953 report indicating that there was good lichen cover and a higher production of forage lichens in this area (Chatelain 1953). In 1966 Alexander (1967) found no appreciable vegetation change inside or outside the exclosure from that observed in 1962. In 1970 the condition of lichens inside the exclosure improved, with increased vigor and plant height observed (Pegau 1972). Percent cover for reindeer lichens was approximately the same inside as that reported for 1962. Outside use was classified as moderate and lichen condition had deteriorated from 1962. Percent cover for reindeer lichens outside declined from 60% in 1962 to 28% in 1970. In 1977 percent cover for reindeer lichens inside the exclosure increased from 50% to 62% while outside cover declined to 14%. Apparently even with declining caribou numbers, moderate use of this area continued and was sufficient for the decline in lichen condition to continue. In 1983 percent cover for reindeer lichen inside the exclosure was rated at 50%. Since comparison of photos for these years indicates no decline in reindeer lichens, we conclude that there probably has been little if any change inside the exclosure and that a near climax state of succession has been reached. Outside the exclosure, percent cover declined to 9%. Use was still rated as moderate.

Summary for range unit 12

This unit includes the main calving grounds and a good portion of the summering grounds of the Nelchina caribou. It has been used extensively by the main Nelchina herd every year during the summer since at least the early 1950s. As a result of such use range condition for lichens has been poor for at least 30 years. During the extremely high caribou numbers of the 1960s lichen condition and cover deteriorated greatly. With herd reduction in the early 1970s the decline in the condition of lichens was reversed and a few years of recovery occurred. By the 1980s future lichen recovery had been inhibited in conjunction with a rebuilding of the main Nelchina herd. Mean percent cover for all lichens in 1960 was 58%, 38% in 1970, 40% in 1977 and 35% in 1983.

Both Skoog (1959) and Pegau (1972) indicated that during the late spring and early summer when the caribou concentrate in range unit 12, forbs and graminoids are the principle forage plant groups utilized. With such herbaceous vegetation in abundance throughout much of the unit, they felt there were few if any forage concerns for that time of year. Both Pitcher (pers. commun.) and the authors of this report have observed caribou throughout the range unit in early summer, extensively feeding on willow (Salix spp.) buds and leaves. Murie (1944) noted that the rhythmic stripping motions produce a head-bobbing pattern that can commonly be seen among grazing Denali caribou bands in early summer. Pitcher (pers. commun.) observed caribou taking marsh vegetation. Pegau (pers. commun.) found caribou grazing on sedges during the summer and observed them grasping and pulling complete leaves out of the bases of shoots--thus leaving no sign of their feeding activity. During mid-summer when we examined the 2 range stations, little if any use of forbs was detected. Use of graminoids was minimal. Possibly the range would have to be examined earlier in the summer to resolve the question of the relative use of vascular plants at this time of year. Since lichens have been and continue to be heavily used in this range unit, another question is whether there may be a shift in use to lichens some time in early to mid-summer. The alternative explanation would involve caribou utilizing lichens continuously from the time they arrive in spring, in addition to their use of herbaceous vegetation.

RANGE UNIT 13

There are 13 range stations in this unit: Nos. 1, 2, and 4-14. During the period 1953 through 1956 all of these stations were established. Hanson (1958) has described in detail the vegetation at all sites.

Range station 1 - Susitna Lake West (2,400 ft.)

This site is classified as a spruce-shrub birch-heath stand that burned in the early 1950s. In 1957 Hanson (1958) discussed the vegetation of this site, describing the polygons with "mound-like centers" common throughout range unit 13. He felt that with relatively low lichen cover this site should be considered poor in range condition. He did indicate that new lichen growth was observed and commented that "recovery is proceeding," apparently referring to post-fire changes. Pegau (1972) felt after examining this site in 1970 that relatively little change had occurred inside the exclosure since 1957, and outside lichen cover had decreased, probably in response to continued or increased use of this area by caribou during the 1960s. When this site was examined in 1977 it was described as having few lichens. Inside plots showed somewhat greater secondary lichen development than outside but with no difference in reindeer lichen cover measured. Outside lichens showed heavy use and trampling by caribou and/or moose. In 1983 this site was described as having few lichens, with those present being moderately utilized. Moose sign was observed at and adjacent to the site. A few well developed C. arbuscula mats were inside the exclosure but not in the examined plots.

While this site has been consistently described over the years as having low potential for lichen development, there has been an appreciable increase in percent cover of reindeer lichens inside the exclosure (but not inside the sample plots). This site apparently does have the potential for producing some reindeer lichens. Outside the exclosure, with varying but appreciable caribou use over the years, there has been little opportunity for lichen development to improve.

Range station 2 - Susitna Lake East (2,400 ft.)

Hanson (1958) classed the vegetation at this site as being a bog type, characterized by poor drainage, standing water, and extensive moss and sedge development. There has been an almost complete absence of lichens over the period 1957 to 1983 (see Appendix I). In both 1970 and 1977 cover analysis suggested the expansion of sedge inside the exclosure. Pegau (1972) suggested that the sedges at such sites as these may be utilized by caribou from summer through early winter. When this site was examined in the summer of 1983, no such use was detected.

Range station 4 - Tyone Lake West (2,500 ft.)

Hanson (1958) described this site as a fairly dense black spruce - heath stand, burned many years ago, and characterized by polygon hummocks with moderately dense lichen cover. Pegau (1972) described the site as a well developed lichen stand in an open spruce type. Hanson considered this to be one of the best sites for lichen production in Range Unit 13 in 1953. At the same time he estimated lichen disturbance at this site to be approximately 85% (85% of lichens observed were fragmented and/or scattered) and rated range condition at poor to fair. He noted that much of the disturbance appeared to involve trampling. Furthermore he indicated that by 1956 recovery from "earlier heavy use" was taking place (possibly based on changes occurring between 1953 and 1955). By 1970 recovery of lichens inside the exclosure had proceeded, with reindeer lichens now accounting for approximately 11% of total cover compared with none in 1957 (Pegau 1972). Outside the exclosure there had been very little if any lichen recovery. It appears that the sporadic use that occurred over the past 15 years since 1955 was sufficient to disrupt and prevent reindeer lichens from recovering (even though there was no longer the heavy use that occurred prior to 1955). In 1977 reindeer lichen development inside the exclosure had progressed, with a percent cover of approximately 40%. Outside the exclosure sign of recent caribou use and moose trampling were observed. At the same time percent cover ratings indicated a substantial recovery of both lichens in general and reindeer lichens in particular. In 1983 the exclosure was found crushed in and much of the lichens within highly disturbed. Outside the exclosure lichen recovery had ceased, with substantial use and trampling observed. Percent cover for lichens was now lower than that seen in 1977. The lichen growth seen from 1970 to 1977 and the subsequent decline from 1977 to 1983 may relate to shifts in use over this time period or may more directly be a function of overall changes in Nelchina herd size.

Range station 5 - Tyone Lake North (2,500 ft.)

This site was classified as a black spruce stand burned over in the mid-1920s, with an understory of vascular plants, including shrubs, heath, and sedge. In 1957 Hanson (1958) indicated that the moss mat and shrub/heath cover was so dense that lichens only occurred in protected sites underneath certain shrubs. With an average Hult-Sernander percent cover score of 1.5, lichen condition was rated as poor. In 1970, Pegau (1972) found that lichens had remained relatively unchanged for at least the past 15 years, with only very small and scattered clumps of lichens occurring at the site. Very little use of the area was apparent. In 1977 we found that caribou had broken into the exclosure, although with little apparent effect on the few lichens present. Outside the exclosure there was some indication that reindeer lichen development had appreciably advanced with a mean percent cover of approximately 10%, up from 2% in 1970. At the same time caribou use on these lichens was rated as moderate. In 1983 caribou apparently had once again been inside the exclosure, causing some disturbance. Still lichen development was better inside (at other than the 2 examined plots, where few lichens existed) than outside. The small amount of lichen matting outside had been moderately used. Percent cover for reindeer lichens in 1983 was 6%, down from 10% in 1977. This may relate to a shift in use or overall increased utilization associated with a growing caribou herd.

Range station 6 - Corky Lake East (2,700 ft.)

This site was originally described as a spruce type with high lichen cover that averaged approximately 75%; disturbance of lichens averaged 40%. Hanson (1958) listed range condition as poor because most lichens were short, compacted, and at least partially shattered. McGowan (1966) indicated almost no change in species of vegetation or percent cover from that seen in 1957. By 1970 lichen recovery inside the exclosure was apparent (Pegau 1972). Outside, in the face of continued moderate use, lichens in general had deteriorated. At the same time reindeer species were developing, with percent cover increasing from 0 to 3%. In light of the level of disruption to lichen mats, Pegau rated condition here as poor. In 1977 the area inside the exclosure showed continued recovery with reindeer lichens now covering approximately 50% and C. stellaris showing up for the first time. Outside, condition continued to be described as deteriorating. At the same time lichen composition continued to shift towards reindeer lichens with their cover now rated as approximately 25%. In 1983 there were indications that caribou had gotten inside the exclosure, probably causing minor disruption to lichen mats. Caribou and moose sign was plentiful throughout the area. Outside use of lichens was still described as heavy. Use of sedges and grasses was rated as light and trampling by moose moderate. Even with such lichen use and disturbance, percent cover for reindeer lichens did not decline, indicating the importance of considering plant height, condition, and use in addition to percent cover. It should also be noted that under moderate to heavy lichen use over at least 10 years, successional development towards a climax state appeared to proceed at a steady rate. Five examinations of the site over a 25-year period all described use as

moderate to heavy. Possibly the lichen growth initially observed in 1970 and maintained through 1983 is related to subtle changes in caribou use that gross quadrat examinations failed to reveal.

Range station 7 - Corky Lake West (2,700 ft.)

This site was described by Hanson (1958) as an open stand of black spruce with a fairly dense understory of heath species. Lichens composed 73% of the quadrats originally sampled, with 60% of these lichens at least partially damaged. Hanson felt that this site was quite representative of the plant species composition most common in the southeastern quarter of the Nelchina caribou range. Lichen disturbance appeared to involve a fair amount of trampling by caribou, and secondarily, frost action. Cladonia rangiferina and C. arbuscula were abundant under shrubs but scarce and shattered in more open areas.

In 1966 an area of lichen mat was described as dying; otherwise little change from 1956 was observed (McGowan 1966). In 1970 some of the lichens appeared to be moribund (Pegau 1972). The exclosure had been partially damaged and caribou may have been inside. Pegau indicated that while both overall lichen cover and percent cover of C. stellaris had decreased inside, C. arbuscula and C. rangiferina had increased their coverage. He also suggested that the dense lichen mat inside the exclosure, even with some disturbance in evidence, may be crowding out the Vaccinium vitis-idaea.

Outside the exclosure, lichens were less dense, and from 1966 to 1970 declined even further in coverage from 62% to 28%. In 1970 remaining lichens were scattered, in poor condition, and heavily utilized. Overall, both within and outside the exclosure, undisturbed lichens appeared to be small and lacking in vigor. The limited level of lichen recovery within the exclosure may be the result of caribou disturbance. Outside, continuous levels of moderate to heavy caribou use have caused a reduction in cover and condition. In 1977 reindeer lichen cover within the exclosure had increased from 6% to 40%, while outside it had increased from 3% to 11%. Vaccinium vitis-idaea had also increased to former percent cover levels. Recent caribou and moose sign was observed at the site. In 1983 the exclosure had been pushed in, a moderate amount of caribou and moose disturbance was apparent within, and lichen cover had appreciably decreased. Outside the exclosure, caribou and moose sign were common, and use of lichens was described as moderate. Lichen cover was approximately the same as reported for 1977. The overall increase in caribou numbers observed in the early 1980s may be responsible for inhibiting lichen growth at this site.

Range station 8 - Harris Lake (2,700 ft.)

Hanson (1958) described this site as a moderately dense black spruce-heath stand, with lichens composing about one-third of the total cover and with about 11% of the lichens damaged. Range condition was rated as poor to fair with lichens short (up to 1 inch) and somewhat compacted. Where protected, lichens were up to 2 inches tall. Lichen

cover was 3.7 on the Hult-Sernander scale with Stereocaulon sp. the most abundant species. This site had received heavy caribou use in the past, but some recovery had occurred during the late 1950s. McGowan (1966) indicated that the lichen condition had deteriorated outside the exclosure. In addition willows were heavily browsed. He felt that much of the lichen damage was due to trampling effects by caribou and moose. Inside the exclosure lichen cover had increased. By 1970, lichen recovery inside had progressed dramatically with condition rated at very good; the reindeer lichen cover increased from 0 to 28% (Pegau 1972). Shrub cover had also increased. The best reindeer lichen growth appeared to be associated with the more moist and organically rich sites while Stereocaulon appeared to flourish on the drier sites. Outside lichens were scattered and moribund except in protected spots. Heavy use by caribou and moose continued to cause the deterioration of not only lichens but also of many of the vascular species, with about 50% of the ground bare. In 1977 some improvement outside was apparent, with bare ground now estimated at 20% and lichen cover improved. Inside, lichen recovery continued, with lichen mats described as lush and reindeer lichens measuring up to 5 inches high. In 1983 the exclosure was broken down, with moderate amounts of trampling and use within by both caribou and moose. Outside, moderate use of lichens was recorded, with both caribou and moose sign apparent. Cover for lichens in general, and reindeer lichens in particular, was approximately the same as recorded in 1977.

Range station 9 - Betty Ann Lake East (2,500 ft.)

This site was first described by Hanson (1958) as an open black spruce stand burned many years ago, with a hummocky understory covered in large part by mats of short, living and dead lichens--chiefly Stereocaulon. In protected spots taller (2-4 inches) reindeer lichens could occasionally be found. Range condition was classified as fair. Hanson suggested that compacted lichens were the result of trampling by caribou during the winter. McGowan (1966) indicated practically no change from Hanson's 1956 description. In 1970 the exclosure was described as being completely destroyed, apparently by caribou (Pegau 1972). No vegetation analysis was attempted. Pegau felt some recovery had commenced inside the exclosure. Outside, very heavy use by caribou and possibly moose also had greatly reduced lichen cover and condition. In 1977 the exclosure was repaired. It was noted that within the exclosure, protected lichens under scrub spruces were lush and averaged 2-1/2 inches in height. Outside the exclosure, use by caribou was heavy and lichen cover was rated as poor. In 1983 the exclosure was again broken down, with moderate to heavy grazing and trampling by both caribou and moose. Outside the exclosure, caribou and moose sign was common, with moderate amounts of use and trampling of lichens throughout the area. Reindeer lichen cover declined from 37% in 1977 to 14% in 1983.

Range station 10 - Betty Ann Lake North (2,500 ft.)

Hanson (1958) described this site as a spruce type that burned in 1952. Because many pre-fire spruce were still standing and willow sprouting was common, the fire intensity was rated as light. Hanson felt that

prior to the fire this site was probably quite similar to that on which range station 9 was established. Much of the mounded portions of hummocks were bare except for grass and horsetail. Only scattered remnants of lichens were found. Winter range condition for caribou was rated as poor. Conditions were good for moose though, because of the abundance of sprouting willow. Hanson felt that the 3-inch organic layer in this area should promote a relatively rapid recovery of lichens. McGowan (1966) indicated that although little disturbance was apparent, animals may have gotten inside the exclosure. By 1970 recovery of vascular plants was apparent, while lichens showed only a minor increase both inside and outside of the exclosure (Pegau 1972). The exclosure had been seriously damaged, apparently by moose. Even so, the small amount of lichen mats within was in better condition than that outside. Unlike Hanson, Pegau (1972) felt that organic mat damage from fire had precluded appreciable lichen development. Although the growth of secondary lichens had been initiated between years 6-15, no preferred forage lichen species had been established. Pegau expected such preferred species would come in the next 5 years. Outside the exclosure, moderate to heavy grazing and trampling continued, with fewer lichens and less total cover observed. In 1977 inside plots showed both an overall increase in lichen cover as well as the initial presence of C. arbuscula. Outside, use and trampling by caribou and moose were apparent. At the same time the growth of secondary lichen species had progressed with lichen cover increasing from about 10% to 35%. Other vascular vegetation also had increased in cover. In 1983 lichen mat development had proceeded appreciably inside the exclosure, although reindeer lichens still only occurred in trace amounts. Outside the exclosure moose and caribou sign was common. Both shrub and heath species throughout the burn area have grown and increased in cover since 1977. At the same time moose browsing of willow was rated as heavy. Lichen cover was approximately the same as that determined in 1977. Trace amounts of C. arbuscula were observed in 1 outside plot.

Range station 11 - Georgia Lake (2,500 ft.)

Widely scattered spruce occur at this old burn site together with a fairly dense cover of shrub and heath species (Hanson 1958). Lichens composed about 10% of the cover in the late 50s, with a height of only about 1 inch. Range condition was rated as poor. Reindeer lichens occurred in only trace amounts and were not in the established plots. Hanson felt that lichen condition was beginning to improve. McGowan (1966) described moderate amounts of caribou use in the area and rated outside vegetation as being 10% disturbed. In 1970 lichen growth in general and reindeer lichen growth in particular showed appreciable gains both inside and outside the exclosure (Pegau 1972). Pegau described scattered mats in the exclosure as being very robust (2-3 inches) and luxuriant. Moderate ungulate use was observed outside. In protected areas reindeer lichen development comparable to that seen inside was described, while in open areas lichens were small and scattered. In 1977 both inside and outside plots showed continued gains in lichen cover, with reindeer species increasing from 14% in 1977 to 28% in 1983 inside, and from 6% to 11% outside. In 1983 recent caribou sign plus some moose sign was seen at the site. Percent cover inside was approximately the

same in 1983 as in 1977 while outside cover for reindeer lichens had declined to 3%. In addition, inside lichens were in a robust, undisturbed condition while outside they were broken and scattered. Apparently this difference is the result of a recent increase in caribou use of the area.

Range station 12 - Gross Lake (2,500 ft.)

This site is described by Hanson (1958) as a spruce type that had been burned in the early 1920's. Lichen cover was rated at approximately 25 percent. Hanson felt that recovery from the fire was almost complete (in 35 years). Range condition was rated as poor, with packed lichen layers 0.5 to 1.0 inch thick. Shattered mats occurred. Hanson felt that lichen succession had been occurring at a relatively slow rate. McGowan (1966) described 20% bare ground inside the exclosure, corresponding to what Hanson described earlier as frost boils covered with crustose lichens. Apparently further frost action had disrupted the initial lichen growth. In 1970 bare ground was still approximately 20% (Pegau 1972). Within the exclosure in those areas where the soil is fairly stable the growth of lichens has been substantial since 1956, while where frost boils are still active the moss and vascular plants normally associated with lichen development have not been established. Unlike Hanson, Pegau, after viewing 1957 photos of this site, felt that lichen range condition back then was relatively good. While overall percent lichen cover hadn't changed in 1970, reindeer lichen growth did occur, with percent cover increasing from 0% in 1966 to approximately 7% in 1970. Pegau also noted that there has been an appreciable increase in shrub cover since 1956, especially inside the exclosure. In 1977 some new lichen growth was described both inside and outside the exclosure. At the same time most of the lichen mats did not appear to be vigorous. In 1983 moderate amounts of use and trampling by caribou and moose were observed. In addition caribou got inside the exclosure, causing minor amounts of disturbance. Even so, lichen percent cover did not decline and lichens here were more robust in condition than those outside. Reindeer lichen cover outside the exclosure declined from 11% in 1977 to 6% in 1983. This latter decline probably reflects an overall increase in use of this area, possibly associated with Nelchina caribou herd growth in recent years.

Range station 13 - Janet (Minnesota) Lake (2,500 ft.)

Hanson (1958) described this site as a former spruce stand burned in the late 20s to early 30s, and now covered primarily by heath species. Lichens were fairly common with cover averaging 25%. They formed a short (0.5 to 1.0 inch) layer in most open areas with taller lichens under shrubs. Hanson considered reindeer lichens to be scarce, and range condition poor. Heavy use had occurred in past years but was much reduced over the past couple of winters. Hanson felt this site was at a mid-successional stage following recovery from fire. A good portion of plant cover in the areas came from crustose lichens. Little if any change in plant cover was described in 1966 (McGowan 1966). By 1970 changes were observed, with appreciable increases in the cover of shrubs

and in successionally later-stage species of lichens, including C. arbuscula and C. uncialis (Pegau 1972). Outside the exclosure, shrub cover had increased to such a degree that Pegau felt this would prevent the development of appreciable lichen cover. In addition, extensive caribou and moose use was apparent. Although percent cover was about the same as for 1966, lichen condition in 1970 was described as deteriorating with extensive disturbance and scattering of mats. In 1977 reindeer lichen cover had increased inside the exclosure in spite of extensive shrub and heath growth: from 11% in 1970 to 20% in 1977. Outside, ungulate sign was common and lichens were disturbed. Still, percent cover outside also showed an increase in reindeer lichens, from 3% to 11%. Like Pegau, we felt that with the extensive shrub and heath development at this site, future lichen production was probably limited. In 1983 lichen cover inside the exclosure was approximately the same as recorded for 1977. Very likely complete recovery from the fire that Hanson described had occurred by this time. Outside the exclosure, there was extensive use and trampling by caribou and moose. Reindeer lichen cover declined from 11% to 6%. This reversal in lichen recovery may have resulted from an increase in use associated with recent increases in the Nelchina caribou herd.

Range station 14 - Springer (Deep) Lake (2,300 ft.)

This site was described by Hanson (1958) as a spruce type burned in the early 1920s. Spruce was regenerating well, and lichen cover was approximately 25%. Range condition was rated at poor to fair with lichens primarily forming packed layers 0.5 to 1.0 inch deep. Some lichen disturbance was apparent. Unlike the more typical silt/clay soil type common to this range unit, this well-drained site had a high sand/gravel content, and thus was more susceptible to drought conditions. McGowan (1966) indicated little if any vegetative change from that described in 1957. In 1970 Pegau (1972) recorded appreciable increases in reindeer lichens both within and outside the exclosure. Ungulate use of the area was described as moderate, and lichen damage was considered to be less severe here as compared with many other stations in the unit. Pegau felt that recovery from the effects of the early fire was complete. He also suggested that a combination of moss understory for holding moisture and shrub overstory provided the conditions necessary to nurture lichens at a site prone to frequent drying and drought. In 1977 reindeer lichen cover increased both inside and outside the exclosure: from 28% to 50% inside and from 6% to 18% outside. In addition to being less abundant, lichens outside were also described as being shorter. It appeared that the exclosure had been broken into, but little damage was observed. In 1983 the exclosure had been broken down with extensive caribou grazing and trampling inside. Outside, reindeer lichen cover had declined to 11%--possibly in association with increased caribou numbers throughout the area. Moose browsing of willows was described as being heavy.

Summary for range unit 13

Skoog (1968) indicated that during the early 1950s, and possibly in previous years, caribou wintered in range unit 13 in high numbers, with the associated heavy use responsible for the deterioration of lichen

condition. From 1955 to 1960 only a small portion of the herd spent the winter on the Flat. But Skoog noted that for most of these years during the period from October to December thousands of caribou were crossing this unit on their way east to wintering areas. Pegau (1972) indicated that this pattern of migrational use continued to 1970 and appeared to be sufficient to suppress any lichen recovery. In fact, at many range stations lichen condition continued to deteriorate during the 1960s. Pegau felt this was especially true at range stations 6, 7, and 8 which were closer to the calving grounds where the caribou concentrated. For the Flat in general Pegau rated range condition as poor in 1970.

After 15 years of protection inside the exclosures, lichen recovery was apparent, with percent cover increasing on the average 65% for all lichens and 55% for reindeer species. At the same time Pegau indicated that practically no recovery of C. stellaris was observed. Based on observed changes inside versus outside the exclosures, Pegau speculated that appreciable lichen recovery over this range unit was not feasible, unless most of the caribou could be removed for a minimum of 15 years.

Both Skoog (1962) and Pegau (1972) felt that additional factors played important roles in the range ecology of this area. Moose activity was thought to contribute significantly to lichen damage on the flats. Skoog found that 56% of the spruce type in range unit 13 had burned in recent times and speculated that effects of fire might be responsible for the limited growth of secondary succession lichen species growth on the Flat. Pegau felt that the effect of fire on range unit 13 lichens has been spotty, and where lichens occur on a dense moss mat, they would be moist and resistant to burn damage. Since range station 10 had experienced a recent fire, it was a good subject for studying recovery from fire. Approximately 10 years was required at this site for the first lichens to reestablish. After 20 years the only lichens present were secondary successional species. Observations of range station 12, an older burn, demonstrated that 30-40 years were required for reindeer lichens (e.g., C. arbuscula and C. rangiferina) to recover.

Skoog (1962) considered the large quantities of sedges common to the Flat to be a valuable late fall/winter forage for Nelchina caribou. During the winter of 1960-61 Skoog observed caribou feeding extensively on sedges adjacent to ponds, sloughs, and lakes. Pegau (1972) noted that with only 1 station in a representative sedge stand, little opportunity has existed for documenting use of and associated effects on sedges. He speculated that sedges appear to be able to withstand current levels of use. Pegau felt that since the Flat cannot be considered a major wintering area based on lichen conditions, it was important to determine the role of sedges in the winter diet of Nelchina caribou.

Pitcher (1982) indicated that beginning in about 1971-72, the Nelchina herd again began to winter in significant numbers in range unit 13. This use continued each year until 1982. During this same period herd size declined from an estimated 20,000 in 1970 (and an earlier estimate of 60,000 in 1962) to 10,000 in 1972, after which the herd began to slowly increase again, reaching 14,000 in 1977 and 25,000 in 1983. While these population and use changes were occurring, lichen

responses were documented. In 1977, 10 of 12 range stations showed increases in lichen cover and positive changes in successional stage. By 1983 this phase of recovery had come to an end, with 7 stations showing slow declines in lichen cover and/or condition, 4 stations approximately the same as in 1977, and 1 showing improvement. One can reasonably assume that increased caribou use associated with recent herd size increases and/or wintering in range unit 13 during the decade of the 70s is at least in part responsible for halting lichen growth over much of the Flat. Moose numbers coincidentally increased over much of the Nelchina caribou range during the late 1970s/early 1980s. The increased amount of trampling associated with such changes in moose numbers may have contributed to the current status of lichens in range unit 13.

For all range stations the 1977 to 1983 decline in percent cover for lichens in general amounted to 8% on the average and for reindeer lichens 14% on the average. Lichen cover in 1983 was still higher than during the period 1957 to 1970; for lichens in general, percent cover in 1983 was 7% higher than 1957, 29% higher than 1966 and 53% higher than 1970; for reindeer species only, cover was 32% higher than 1957 and 1966 and 22% higher than 1970 (Table 4).

Apparently, while available lichen forage has declined slightly from 1977 levels, there is still appreciably more than what was present during the high caribou numbers of the 1960s. What was rated as poor by Pegau in 1970 can probably be rated as fair in 1983. It should be noted that Pegau's estimate of the amount of time needed for appreciable lichen recovery in this area was exaggerated. Instead of 15 years, both lichens in general and reindeer lichens in particular recovered appreciably in 6-7 years of relatively low caribou numbers. Even the highly preferred climax species, C. stellaris, which was not observed at any range unit 13 station in 1970, showed up in appreciable amounts both inside and outside exclosures at 4 range stations in 1977 and at 5 in 1983.

RANGE UNIT 15

The single range station in this unit, No. 16, was constructed in 1960. The vegetation at this site was described by Skoog (1962).

Range station 16 - Glenn Hwy. Mile 130 (3,250 ft.)

This is a white spruce type in a climax successional stage near timberline. Skoog (1962) indicated that reindeer lichens covered approximately 65% of the ground, with Stereocaulon common in some open areas. Very little disturbance of the lichen cover was evident. In 1970 cover readings both inside and outside approximated those for 1962 (Pegau 1972). No grazing was evident at the station site. Lichen condition was very good with most mats robust and dense, with lichen height over 2 inches. In areas of dense shrubs reindeer lichens appeared to be replacing Stereocaulon. Pegau felt that the station was in an unusually dense shrub stand that restricted grazing. In more open adjacent areas there had been some moderate grazing in the recent past, as Stereocaulon at such spots was common. Pegau indicated that summer

use by small groups of caribou bulls was common in this area, and movements through the area by portions of the Nelchina herd occurred in fall and early winter. In 1977 cover for reindeer lichens within the exclosure had increased from 36% to 53%, while outside lichen cover was approximately the same as found with previous readings. A small amount of disturbance was apparent in one of the outside plots. Pegau also indicated that the outside plots were not representative of the area to the south of the station where caribou use was rated as moderate and Stereocaulon is abundant. In 1983 cover for reindeer lichens was 62% outside the exclosure, approximately the same as recorded for 1970 and 1977. The high level of lichen production was maintained even though ungulate use at this site appeared to have increased recently. The effect of moose trampling was noticeable, while use by caribou was rated as light. Inside the exclosure reindeer lichen cover declined from 53 to 36 percent. With the protection provided to the shrub species, these may be competitively crowding out some of the lichens. We suggest, along with Pegau, that this site may not be representative of areas further to the south. The light use here could be attributed to the closeness of this station to the Glenn Highway, and/or it could be related to the site's density of shrubs.

Summary for range unit 15

This unit is at the southern boundary of the Nelchina Range. With only 1 range station within this unit, it is difficult to extrapolate findings very far from the immediate Eureka area. Skoog (1968) felt that the station was representative of the eastern one-third of the unit which contained extensive stands of climax successional stage lichens. Pegau (1972) expanded this extrapolation to include the eastern half of the unit. He indicated that use takes place primarily during the summer, by bull groups, with portions of the main herd moving through the eastern half in the fall.

Skoog (1959) found that much of the area to the west of Caribou Creek (western half) consisted of large stands of meadow vegetation where lichens were scarce. He considered this area to be primarily summer range.

Findings from 1977 and 1983 support the premise that the area around Eureka has changed little from the early 1970s and still has good to excellent lichen condition. Whether this is still true for most of the eastern half of the unit is questionable. Beginning in 1980 and continuing through 1983 considerable numbers of the main Nelchina herd have summered in the northern one-third of the unit. Only with some range work in this part of the unit can the effects of this recent use be evaluated.

DISCUSSION

Since the last Nelchina caribou range report, the Nelchina caribou herd has experienced a major decline in numbers followed by a substantial recovery. The herd increased to at least 60,000 in 1962 and then declined to approximately 10,000 in 1972 (McIlroy, 1974). From 1973

through 1983 the decline was reversed and the herd increased to approximately 25,000. In association with these fluctuations in numbers have come changes in Nelchina range condition and trend. In approximately 1970, range condition, defined primarily in terms of lichen condition, apparently began to improve throughout most of the Nelchina range. In 1977, with an estimated population of 14,000 caribou, lichen condition was improving to varying degrees in most areas of the Nelchina range, except in the traditional calving and post-calving aggregation areas. In the early 1980s, as the caribou herd size approached 20,000, lichen recovery slowed or stopped in range units 2, 4, 9 and 13. Units 6 and 15 received light caribou use, and range recovery continued through 1983.

In the Chulitna Mountains/Upper Susitna area little if any use by the main Nelchina herd had been observed prior to the mid- to late 1960s. Light to occasionally moderate use by small bands of resident caribou (upper Susitna sub-herd) occurred during the 1970s and 1980s. As a result, range unit 1, and much of range units 2 and 4 have recovered from the moderate to heavy use of the 1960s and today lichens can be rated in good condition.

The main body of the Nelchina herd calves and summers in the eastern portion of the Talkeetna Mountains designated as range units 12 and 5, and in small portions of units 8 and 4. Much of this area has been subjected to continuous heavy use by caribou since at least the early 1950s. Early observations indicate that lichen cover throughout much of this area was already reduced to low levels by the late 1950s and continued to decline throughout the 1960s. Deterioration was severe enough that the respite provided by reduced herd numbers in the 1970s allowed only minor lichen recovery. By the early 1980s gains had been reversed. Today, lichen condition remains poor in this area.

In the southern foothills of the Alaska Range (range units 6 and 9) relatively small numbers of caribou were associated with mostly light summer and fall use throughout the 1970s and early 1980s. Much of the lichen damage in the eastern portion of Unit 6, resulting from heavy winter use in the 1960s, was reversed in the past decade with substantial recovery common. Today most of this portion of the range is in good condition and capable of supporting substantially more caribou than presently use the area.

The spruce taiga of the Lake Louise Flat in range unit 13 has, over the past 25 years, provided substantial winter range for the Nelchina herd. Heavy use in the 1950s left reduced lichen levels. Continued regular use by caribou migrating across the Flat in the 1960s kept this lichen range in a deteriorated state. Some recovery was seen during the 1970s. By 1983 much of this growth had been stopped by increased use associated with herd growth and with a return to substantial winter use of the area during the late 1970s. Today range condition is considered poor to fair.

In total, Nelchina range stations indicate that approximately one-third of the Nelchina Range, encompassing the northern rim units plus the southwest corner, provides good to very good range in terms of

production of preferred lichen species. A second one-third encompassing the central and southeastern Lake Louise Flat can be rated as poor to fair. The remaining western one-third, with a history of nearly continuous heavy use for over 30 years, exhibits poor lichen production. Nelchina caribou range condition in general relates to the extent of use by the main body of the herd. For the bulk of the year, animals are primarily restricted by snow depth to the lowlands of the Lake Louise Flat and lower reaches of the Gakona, Chistochina and Copper River drainages. During the summer when deep snows no longer exclude caribou from the western and northern uplands, the main body of Nelchina caribou traditionally moves to the western mountains, with the northern mountains remaining relatively little-used and in good range condition.

For the Nelchina range in 1983, the Talkeetna Mtns. calving grounds area showed the greatest percent cover of lichens (rated 5.0 out of 6.0 Hult-Sernander scale) inside exclosures, followed closely by the Chulitna Mtns. (4.6) and southeastern foothills of the Alaska Range country (4.8). The Watana Mtns. summer range was rated 3.8 followed by the Lake Louise Flat with 3.1. The least productive portion of the range was the western portion of range unit 6 rated at 1.8. The evaluation of this last area may be the least accurate as most of the range stations available for evaluating potential lichen production were at sites that appeared to be unrepresentative of the overall area. After examining much of the range along the Denali Highway during the summer of 1983, it was concluded that an open shrub birch type supporting extensive lichen stands was more representative of the Central Denali than the closed brush and wet sink sites at which most range stations were established.

Pegau (1972), after evaluating the Nelchina Range in 1970, concluded that range condition was poor and that there were too many caribou on the range. He suggested that unless the population was reduced, the Nelchina herd might crash in a manner similar to that of the reindeer herd on St. Matthew Island. Pegau apparently assumed that the Nelchina herd was at or near 60,000 animals. This number was based in large part on a 1967 survey which estimated herd size at 64,000 (Hemming and Glenn, 1968). However, surveys done shortly after Pegau's study suggested that the 1967 survey resulted in an unrealistically high population estimate. McIlroy (1974) and Bos (1975) estimated the herd to number approximately 65,000 adults in 1962, and indicated the herd probably began declining in the mid-1960s, numbering approximately 33,000 in 1968, 20,000 in 1970 and 7,000 in 1972. There is little if any evidence to support the suggestion that range condition was responsible for the population decline that occurred during the late 1960s and early 1970s. Bos (1972) suggested that the population decline involved levels of predation and hunting that exceeded annual production, possibly in combination with emigration of animals to other ranges. VanBallenberghe (1985) suggested that in addition to high levels of hunting mortality, poor calf survival associated with severe snow conditions during the winters of 1964, 1965, 1966, and 1971 was a major factor in the Nelchina caribou decline.

The range deterioration observed in 1970 was the cumulative result of heavy use throughout the 1960s. This range destruction probably ceased by 1970. The range lands were grazed by 30,000-60,000+ caribou

from approximately 1955 to 1968. Because Pegau was not aware of a possible reduction in the herd, his assumption in his 1972 report that range condition was continuing to decline was incorrect. In fact, we can now conclude that range recovery was probably already occurring at the time of his report.

Klein (1968) characterized summer range strategy of caribou as utilizing a variety of habitats and numerous forage plants available over a brief arctic/boreal summer during which rapid growth and fat deposition occur. Highly selective feeding behavior of caribou, in combination with the opportunity to range over wide areas, are the keys to the success of this strategy. During the long winter caribou enter a state of relative physiological dormancy where activity and food intake are reduced and metabolic rates drop to a relatively low level. This switch in nutritional strategies coincides with the seasonal change in forage availability, from high-protein summer vegetation types to winter use of lichens and sedges of low protein and high carbohydrate content.

Various authors have discussed the forage selection patterns of caribou in many parts of Alaska and Canada. Most references indicate that, when available, certain lichen species are of primary importance and highly preferred, especially in winter, but there is often less agreement as to the importance and role of other types of forage. Klein (1982) indicated that while lichens may not be absolutely essential for caribou in winter, they are typically preferred when available. More recently, Klein (pers. commun.) indicated that the limited evidence available suggests that barren ground caribou on native ranges do not do well in winter without a high proportion of lichens in their diet. Nutritional analysis suggests that preferred lichen species are highly digestible, exceeding most other plants in digestibility. Thompson and McCourt (1981) found that the fall and winter diet of caribou in the Porcupine Herd consisted of 67% lichens and 29% mosses. Fifty-six percent of the spring diet consisted of sedges. After calving there was a shift to deciduous shrubs. By mid-summer such shrubs made up 98% of the diet. Beginning in August there was a gradual shift towards the fall/winter diet. This shift was completed by late September. White and Trudell (1980) found that caribou from the Western Arctic Herd used winter habitat associated with high lichen biomass, while in summer, caribou utilized areas with high levels of deciduous shrubs and/or lichens. Boertje (1984) described seasonal changes in diet for the Denali caribou herd, which occupies a range immediately to the west of Nelchina range units 1 and 4: Spring diets contained 41% Salix spp. leaves, 25% lichens, 16% forbs, and 12% graminoids; summer diet contained 46% Salix spp. leaves, 17% lichens, 10% forbs, 10% graminoids, and 12% mushrooms; autumn diet consisted of 43% lichens, 9% forbs, 14% graminoids, 10% mushrooms, and 5% mosses; winter diet consisted of 62% lichens, 7% forbs, 11% graminoids, and 10% mosses. Much of the Denali range apparently has an abundance of preferred lichen species. Murie (1935) emphasized that for a period in May and early June, both willows and dwarf birch made up the bulk of food eaten by caribou in the Denali area.

In the Nelchina the exact role and importance of forage plants for caribou, other than preferred lichen species, have yet to be documented. Skoog (1968) found large quantities of sedges available in range unit 13 and described his observations of caribou concentrations wintering there and feeding on sedges. Pegau (1972) suggested that since lichen condition was poor on the Lake Louise Flat, sedges may play an important role in the winter diet of Nelchina caribou. Since there is only 1 range station set in a sedge-type, there has been little opportunity to evaluate sedge in the context of the caribou range exclosure study. In addition, we question whether winter use of vegetation types dominated by sedges or grasses can be easily evaluated during the summer. Any such winter use would be of the dried/cured portion of these plants. If not eaten, most of this plant material would have disintegrated or been compressed onto the ground layer by the following summer when evaluation occurs. If winter range use by Nelchina caribou is to be fully evaluated, a range study undertaken during the winter or immediately afterwards, before greenup, will be required.

Both Skoog (1968) and Pegau (1972) indicated that they felt various vascular plants including forbs, grasses, sedges, and shrubs were important to the Nelchina caribou during both the calving (pre- and post-greenup) and summer portions of the year. Although lichen condition is poor over most of the calving and summer range, these investigators considered this portion of the Nelchina Range to be providing an abundance of good forage because they felt that the caribou were shifting use to various vascular plant species in addition to continued use of at least some lichens.

We examined changes in and use of vascular plants at range stations. Over the approximately 25-year period of this study, total cover remained near 100% within all intact exclosures. Total cover outside exclosures remained at a similar level at most range stations. In range units 4E, 5, 8, 12, and 13, total cover declined from 96% to 81% between approximately 1960 and 1970, then recovered to its former level by 1977. All 3 of the vascular plant species most common to the range stations, Betula glandulosum, V. uliginosum, and Empetrum nigrum, increased slightly in cover within exclosures in range units where these species appeared to have been previously subjected to browsing and/or trampling. Outside the exclosures within these same areas, all 3 species increased substantially in cover during the 1960s after which percent cover stabilized or declined. These changes may in part be a response to increasing use of more preferred plants such as lichens, forbs, graminoids, and willows by a growing caribou population. While Salix species did not occur at range stations in substantial numbers, the limited data available indicated that willows declined outside exclosures until 1970, increased by 1977, after which percent cover either leveled off or declined. Moose population dynamics probably played a role in willow changes over this period.

Kuropat and Bryant (1980) indicated that 1 of the forage selection patterns of the Western Arctic herd involves shifting from 1 forage species to another as phenological development and growth form accelerate in spring and summer. One important shift observed was from Eriophorum sp. floral heads to Lupinus sp. floral heads to Salix spp. leaves. Such

highly selective foraging behavior, characterized by shifts among plant species, may also be the strategy for Nelchina caribou spring/summer range use. But recent summer examinations of Nelchina range stations have failed to show substantial caribou use of any vegetation types other than lichens. Extensive use of vascular plant species probably is still occurring. It is quite possible that for many vascular species eaten at this time of year, the use is quickly camouflaged by continued new growth. Most lichens, on the other hand, grow very slowly and may display damage for a long period. If much of the selective use by caribou occurs early in the Nelchina area (during calving, in May and early June), range evaluation from late June through September may be too late to detect such a pattern. It should also be remembered that the area primarily utilized during spring has only 2 range stations. To evaluate spring and early summer use by Nelchina caribou, range unit 12 must be examined early in the summer, and a number of sites in addition to range stations 28 and 29 should be visited.

Various authors have discussed the adverse effects of fire on lichens. Since fire is usually restricted to timbered areas, range units 13 and 7 are the principal portions of the Nelchina range where concern has been expressed. Skoog (1968) indicated that 56% of range unit 13 had burned over the recent past. Pegau (1972) suggested that lichens may have little chance for full recovery in this unit, in part because of fire. Our latest range evaluations indicate that with moderate levels of caribou use, primary lichen recovery on the Lake Louise Flat can occur in 30-40 years after fire. Klein (1982) indicated that fire is essential to the long-term productivity of boreal forest and accounts for much of the habitat diversity of most caribou winter ranges. Old forest stands show reduced lichen productivity. When viewed on a short-term basis (<50 years) fire may destroy lichens and other vegetation types, and thus temporarily reduce an area's potential for supporting caribou. Over the long term however (100+ years), fire is essential for maintaining vegetative diversity and forage production for caribou. Miller (1980) found on caribou winter range in Saskatchewan that standing crops of lichens reach maximum levels in approximately 40 years post-fire.

Pegau (1972) discussed in detail how sensitive lichens are to mechanical disturbance and how the length of time required for recovery is proportional to the degree of disturbance. Lichens usually grow at a rate of < 1/4 inch per year. Various authors have found that depleted lichen ranges under complete protection recover in 20 to 40 years (Skoog 1968, Pegau 1972, Miller 1980). Skuncke (1969) found C. stellaris recovered in 6-8 years if only the top halves of individual lichen plants were grazed. After fragmentation of most of the lichens, recovery took 8-14 years. When all apparently living material was removed, no recovery was apparent after 15 years.

Gaare (1978) described Norwegian winter ranges where lichen biomass declined from 700 to 80 gm/m^2, after which herd size was reduced 80% by hunting (from 15,000 to 2,000 head). Lichens returned to a 150 gm/m^2 level in 12 years. Stocking rates and changes in herd size over the 12-year period were not described.

In 1970, based on lichen changes observed in the 15-year-old Nelchina exclosures, Pegau (1972) speculated that much of the Nelchina range needed near total protection for at least 25 years to recover to levels similar to those reported by Hanson (1958) and Skoog (1962) for the late 1950s. Based on our more recent range evaluations, we estimate that lichens can recover in less time. On the Lake Louise Flat, an area with less potential for lichen production, both lichens in general and reindeer lichens in particular recovered over the period 1970-1977 to levels exceeding those that existed in 1957. In 1977 C. stellaris, which was not observed inside or outside any range unit 13 exclosure in 1970, showed up in appreciable amounts both inside and outside exclosures at 4 of 12 range stations. Based on Skuncke's (1969) findings, although C. stellaris was not observed in any range unit 13 plots in 1970, perhaps small numbers of individual plants or living plant parts may have been present, hidden among other vegetation.

Pegau (1972) emphasized the damaging role that both caribou and moose play in trampling lichens. He felt that trampling by large groups of caribou destroys more lichens than the associated feeding. Little if any effort has been directed over the past 30 years of this range study toward determining the importance of trampling of lichens by moose, especially in the shrub and spruce types where moose often concentrate. Apparently a large moose population existed on the Nelchina range during the early 1960s, when severe range deterioration occurred. A much lower moose population existed in the mid-1970s when range recovery was occurring, and moose numbers were increasing in the early 1980s as range recovery slowed. The role that moose may play in Nelchina lichen ecology and in overall range ecology has yet to be determined.

Both Skoog (1959) and Pegau (1972) concluded that even when caribou discontinue use of deteriorated range or when caribou numbers decline appreciably, restoration of previously heavily used areas can still be suppressed by even small amounts of sporadic use. This is in part the basis for Pegau's speculation that appreciable lichen recovery even after a reduction in herd size could not be expected in the immediate future. This recovery hypothesis depends on how heavy the prior use was and how light the current use is. We found that at a number of previously moderate to heavily used sites lichen recovery was proceeding even though regular light grazing was occurring. On the other hand, we visited a few sites which had been very heavily used in the past and at which current relatively light levels of use were suppressing recovery.

At a number of range stations throughout the Nelchina range, various investigators have commented on how various shrub and/or heath species have increased in cover during periods when lichen cover was declining. After noting how lichens in undisturbed shrub-dominated vegetation appear to remain in equilibrium for long periods of time, Pegau (1972) speculated on competition between vegetation types and whether once established, dense shrub or heath stands could suppress lichen growth or recovery. If such plant interactions are important on the Nelchina range, then fire may not only be beneficial in the spruce type but also in shrub types. Also, moose activity may not only play a potentially

negative role through trampling damage to lichens but also a potentially beneficial role in retarding and suppressing shrub development. On the other hand, under some conditions, lichens in near climax stands can suppress the growth of vascular plants, and lichens in various stages of development can benefit from microenvironmental humidity levels maintained by adjacent shrubs (Klein, pers. commun.).

As noted above, Pegau (1972) and others have indicated that there are caribou herds in a few locations in Alaska apparently doing well on poor lichen range. Klein (pers. commun.) felt that this has only been documented in the Aleutian/Alaska Peninsula area where at least some vascular forage remains green in winter. To what degree Nelchina caribou utilize vascular plants has not been documented. Pegau felt that the answer to this question was important for the management of this herd. A different management program would be required if the herd relied heavily on seral vascular plants requiring relatively short periods of time to grow and develop than if the herd was primarily dependent on lichens requiring a much longer time to reach near-climax condition. However, the importance of keying a management program to such foraging strategies assumes that an attempt is being made to maintain herd size close to what the range can support (carrying capacity). There is little evidence to demonstrate how many caribou the Nelchina range can support. Even when the herd reached 60,000 or more caribou in the early 1960s, no substantial reduction in herd condition or productivity was documented (although some observers felt herd vigor was declining). Bergerud (1980) suggests that dispersal and forage capacity begin to limit caribou population growth at a density of approximately 10 caribou per mi^2. At the peak herd level in the late 1960s, the Nelchina caribou population density was possibly as high as 3/mi^2, depending on a conservative definition of their home range. The relatively high Nelchina herd numbers were only maintained for a relatively few years before increased levels of hunting and natural mortality brought numbers back down. Possibly the important question is, how long can the Nelchina range support high caribou numbers before caribou foraging strategies, involving shifts in use of various plant types, and shifts in use of home range, can no longer compensate for declining range condition. Determining the relationship between caribou numbers (both when stable and when fluctuating) and species of plants utilized at various times of the year, and how shifts in use affect the condition of all plant components of the Nelchina range, should be the focus of range evaluation in the future.

RECOMMENDATIONS

1. If the Nelchina caribou herd either continues to grow or is maintained at its current population level, 25 of the existing range stations should continue to be periodically examined to identify and measure changes in the range and in range use by the caribou.

2. Level of caribou use at range stations is in part dependent on present home range patterns. Some of the range stations are located in areas little utilized by caribou in recent years. Such stations serve little purpose in evaluating use. Until such time that surveys and

radiotracking efforts indicate appreciable use of these areas is occurring, evaluation of the following 14 range stations could be discontinued: Nos. 1, 2, 5, 7, 16, 18, 19, 20, 21, 22, 23, 25, 27, 38. Periodic maintenance of fencing at these as well as other exclosures should continue. Occasional examination of the exclosures at the above 14 range stations may contribute to a fuller understanding of range succession and change in the absence of caribou.

3. To better evaluate caribou use on traditional calving and summering grounds approximately 4-8 new range stations should be established in range units 8, 12, and 15 (Talkeetna Mtns.).

4. To better evaluate current caribou use on winter range approximately 3-4 new range stations should be established in range units 7 and 16 (Gakona, Chistochina, and Upper Copper River drainages) where many Nelchina caribou have wintered in recent years.

5. To document the use and importance of vascular plants to caribou on their calving and summering grounds, and to assess any selective shifting of use between forage species at this time of year, a special range evaluation and caribou observation effort should be planned and implemented during late spring and early summer in range units 8, 12, and 15.

6. To document the use and importance of sedges and other vascular plants to caribou on their wintering grounds, a special range evaluation and caribou observation effort should be planned and implemented during winter in range units 7, 13, and 16.

7. It is very important that good photographs be taken at all established photopoints. Special effort should be made to duplicate the direction and angle from which prior photos were made. In addition, to ensure proper exposures, a minimum of 3-4 photos (with a range of exposures) should be taken at each photopoint.

8. To add to our knowledge of the relative use of various plant species and of the nutritional status of Nelchina caribou, rumen and/or fecal pellet samples and body condition measurements should be collected from caribou at various times of the year. Samples should be analyzed by microhistological technique for percent composition by plant species, and if possible, nutritional composition.

9. Exclosures at key range sites that have over the years been repeatedly broken into, should be rebuilt using stout fencing materials to minimize the possibility of future caribou and moose damage. Range stations 7, 8, and 9 should be rebuilt first, followed by range stations 4, 14, 31, and 35.

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Appendix I

Tables of percent cover of plant species for Nelchina range stations.

Percent cover of plant species - modified Hult-Sernander method

Station 1: Susitna Lake West (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	1	-	-	3	-	-	1	1	1	-	-	1	-	-
Eriophorum vaginatum	-	-	-	1	-	1	1	-	3	4	5	4	-	4	5	-
Gramineae	-	-	-	-	t	-	-	t	-	-	-	-	t	-	-	t
Carex spp.	-	-	-	-	1	-	-	2	-	-	-	-	3	-	-	3
Arctogrostis sp.	-	-	-	1	-	-	2	-	-	-	-	1	-	-	1	-
LICHENS:																
Cladonia stellaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. rangiferina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. arbuscula	-	-	-	1	1	-	-	-	-	-	-	1	-	-	1	1
C. amaurocraea	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	t
C. uncialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
Peltigera spp.	-	-	2	3	-	2	2	-	-	-	1	1	-	1	2	-
P. aphthosa	-	-	-	-	3	-	-	2	-	-	-	-	3	-	-	2
P. malacea	-	-	-	-	2	-	-	1	-	-	-	-	1	-	-	1
MISCELLANEOUS:																
Equisetum arvense	t	t	1	1	1	-	-	-	1	t	1	-	-	-	-	-
fungi	-	-	-	-	1	-	-	-	-	-	-	-	t	-	-	t

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 2: Susitna Lake East.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	100	95	100	95	90	100	90	96	92	90	100	90	95	100	90
Hult-Sernander scale for:[b]																
MOSS:	6	2	6	6	5	1	6	3	6	5	4	6	3	6	6	3
SHRUBS/FORBS:																
Betula nana	1	2	3	3	2	-	-	t	2	1	2	2	1	2	2	1
Empetrum nigrum	2	1	2	2	2	1	-	-	2	1	2	4	1	-	-	-
Ledum decumbens	1	1	3	2	2	1	1	1	1	2	1	3	1	1	1	1
Salix pulchra	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	2	2	2	1	2	3	3	2	2	2	2	1	1	2	1	t
V. vitis-idaea	1	1	1	1	1	-	-	1	1	1	1	1	1	-	-	t
Andromeda polifolia	2	1	2	2	1	-	1	1	1	1	1	1	t	1	1	1
Oxycoccus microcarpus	1	1	1	2	-	-	-	-	1	3	1	1	t	1	1	-
Rubus chamaemorus	2	2	1	-	1	2	1	t	1	-	1	1	t	-	-	-
Spiraea beauverdiana	-	-	-	-	-	-	1	-	-	-	-	-	t	-	-	-
SEDGE/GRASS:																
Carex rotundata	3	4	4	-	-	5	-	-	5	5	6	-	-	5	-	-
C. spp.	-	-	-	-	3	-	-	5	-	2	-	1	5	-	1	5
Eriophorum angustifolium	1	-	1	5	-	2	6	-	1	1	2	6	-	2	6	-

Percent cover of plant species - modified Hult-Sernander method

Station 2: Susitna Lake East (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia amaurocraea	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-
C. pleurota	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-
C. multifida	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Lycopodium clavatum	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
fungi	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 4: Tyone Lake, West.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	85	100	100	80	85	100	90	NO DATA	75	90	100	80	85	100	90
Hult-Sernander scale for:[b]																
MOSS:	2	1	1	6	2	1	6	3		1	1	6	3	1	6	3
SHRUBS/FORBS:																
Betula glandulosa	-	-	1	1	1	-	-	-		1	-	1	-	-	-	-
Picea mariana	2	3	3	4	4	-	-	3		-	-	t	-	-	t	2
Arctostaphylos alpina	-	-	-	-	-	-	-	-		-	-	-	-	-	t	-
Ledum decumbens	1	1	2	2	2	1	1	1		2	2	3	2	2	2	3
Salix spp. (prostrate type)	-	-	-	-	-	-	-	-		-	1	1	-	2	1	-
Salix arctica	-	-	-	-	-	-	-	-		-	-	-	1	-	-	1
Vaccinium uliginosum	-	-	-	-	-	1	1	2		3	4	4	3	4	4	3
V. vitis-idaea	1	1	1	3	1	1	2	3		2	1	2	1	1	1	2
Rosa acicularis	-	-	-	-	-	1	1	t		-	-	-	-	-	-	-
Rubus chamaemorus	1	t	-	-	-	1	1	t		1	1	1	1	1	1	1
Andromeda polifolia	-	-	-	-	-	-	-	-		-	-	1	1	-	-	1
Petasites frigidus	-	-	-	1	2	-	-	-		-	-	-	-	-	-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	-	-	-	-	-	-	-	-		t	1	1	-	-	-	-
Carex bigelowii	2	-	3	3	-	3	3	-		1	1	1	-	2	3	-
Carex spp.	-	-	-	-	3	-	-	2		-	-	-	1	-	-	4

Percent cover of plant species - modified Hult-Sernander method

Station 4: Tyone Lake, West (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia stellaris	-	-	-	-	t	1	1	1	NO	-	-	t	t	-	1	1
C. rangiferina	-	-	2	3	2	-	1	1	DATA	-	1	1	1	1	1	1
C. arbuscula	-	-	3	5	3	1	3	3		-	1	4	3	1	2	1
C. amaurocraea	-	-	-	1	-	1	1	-		-	1	1	-	1	1	-
C. uncialis	-	-	2	1	1	1	1	1		-	1	1	1	1	1	t
C. gracilis	-	-	2	2	-	1	2	2		-	1	2	1	-	1	t
C. crispata	-	-	1	1	-	1	1	-		-	-	1	1	-	1	-
C. cornuta	-	-	1	1	-	1	t	-		-	-	-	-	-	-	-
C. spp. (cup-type)	-	-	2	-	-	-	-	-		-	-	-	-	1	-	-
C. goneche	-	-	-	-	1	-	-	t		-	-	-	t	-	-	-
C. coccifera	-	-	-	-	-	-	-	t		-	-	-	t	-	-	-
C. bellidiflora	-	-	-	-	t	-	1	t		-	-	1	-	-	-	-
C. pleurota	-	-	-	-	t	-	-	1		-	-	-	t	-	-	t
Peltigera malacea	-	-	-	-	t	-	-	-		-	-	-	1	-	-	-
P. aphthosa	-	-	-	-	-	-	-	-		-	-	-	-	-	-	1
P. canina	-	-	-	-	-	-	-	-		-	-	-	-	-	-	2
Cetraria islandica	-	-	-	-	-	-	-	-		-	1	-	-	-	-	-
C. nivalis	-	-	-	-	-	-	-	-		-	1	1	t	1	1	t
C. cucullata	-	-	-	1	1	-	1	1		-	-	1	1	-	1	t
Stereocaulon paschale	-	-	3	4	3	3	4	4		-	3	4	2	2	2	t
MISCELLANEOUS:																
Equisetum arvense	-	-	-	1	-	-	-	-		-	-	-	t	-	1	t
fungi	-	-	-	-	1	-	-	1		-	-	1	-	-	-	1

a. A = inside exclosure, B = outside exclosure.

b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 5: Tyone Lake, North.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	100	100	100	98	100	100	100	100	95	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	5	5	6	6	5	-	6	4	5	4	5	6	3	-	6	4
SHRUBS/FORBS:																
Betula glandulosa	2	1	1	3	2	-	1	t	1	2	2	3	3	-	-	-
Empetrum nigrum	1	2	1	2	2	-	-	-	-	-	-	-	-	-	1	1
Ledum decumbens	3	3	4	4	3	3	2	3	1	2	4	2	3	3	3	2
Oxycoccus microcarpus	1	2	-	3	t	-	-	t	-	-	-	-	-	-	-	-
Salix alaxensis	1	1	2	4	2	2	1	-	-	-	-	-	-	-	-	-
S. pulchra	2	2	1	4	2	4	5	3	2	1	1	2	2	-	-	-
Vaccinium uliginosum	3	3	2	3	3	4	5	4	6	5	6	5	5	5	5	3
V. vitis-idaea	3	2	3	4	1	-	3	3	4	4	5	6	3	2	5	3
Petasides frigidus	1	-	-	t	t	1	1	2	1	1	-	-	1	1	1	1
Rubus chamaemorus	1	1	2	1	2	1	1	1	-	-	-	-	-	-	1	1
Pedicularis sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	-	1	-	-	-	-	1	1	2	2	-	1	-	-
Carex bigelowii	2	1	4	5	-	5	4	-	1	1	2	1	-	3	3	-
Gramineae	-	-	-	-	-	-	-	t	-	-	-	-	t	-	-	-
Carex spp.	-	-	-	-	2	-	-	3	-	-	-	-	1	-	-	2

Percent cover of plant species - modified Hult-Sernander method

Station 5: Tyone Lake, North (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia arbuscula	-	-	-	-	-	-	-	-	-	-	-	1	1	1	3	2
C. rangiferina	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1
C. gracilis	-	-	-	-	-	-	-	-	-	-	1	-	t	1	-	t
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
C. bellidiflora	-	-	-	-	-	-	-	-	-	-	-	t	1	-	1	t
Cetraria islandica	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	t
Peltigera aphthosa	-	-	-	-	-	-	-	-	-	-	1	2	1	1	2	2
P. canina	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	2
Stereocaulon sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
MISCELLANEOUS:																
Equisetum scirpoides	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
fungi	-	-	-	-	t	-	-	1	-	-	-	-	t	-	-	1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 - 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 6. Corky Lake East.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	90	100	98	95	100	100	99	96	90	90	100	90	90	100	85
Hult-Sernander scale for:[b]																
MOSS:	2	2	2	6	1	5	6	2	4	5	5	6	2	4	6	1
SHRUBS/FORBS:																
Betula glandulosa	-	-	-	-	-	-	t	t	-	-	-	-	4	-	1	t
Ledum decumbens	1	1	2	2	2	3	3	3	2	2	4	2	1	4	2	-
Picea mariana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t
Salix pulchra	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Vaccinium uliginosum	2	2	2	3	2	2	4	3	1	1	3	4	3	4	3	1
V. vitis-idaea	1	1	1	2	1	2	4	1	1	1	1	3	1	2	3	1
Petasites frigidus	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-
Rubus chamaemorus	1	1	-	t	t	-	-	-	1	1	2	1	t	2	1	1
Pedicularis sp.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	-	-	-	-	-	-	-	-	1	1	2	1	-	2	-	-
Carex rotundata	2	2	3	3	-	4	5	-	1	2	3	3	-	3	3	-
Carex spp.	-	-	-	-	3	-	-	4	-	-	-	-	3	-	-	4
Eriophorum vaginatum	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 6. Corky Lake East (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia stellaris	-	-	-	1	2	1	-	1	-	-	-	-	t	-	-	t
C. arbuscula	-	-	2	4	4	1	3	1	-	-	1	3	2	1	4	5
C. rangiferina	-	-	1	2	1	1	4	1	-	-	1	1	3	1	1	3
C. amaurocraea	-	-	1	1	-	-	1	t	-	-	-	1	-	1	1	-
C. uncialis	-	-	2	1	1	2	2	1	-	-	2	1	1	-	1	1
C. gracilis	-	-	1	3	1	2	2	1	-	-	1	1	1	-	1	t
C. crispata	-	-	1	1	t	-	-	t	-	-	-	t	-	-	t	1
C. cornuta	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	-	-	t	-	-	t	-	-	-	-	-	-	-	t
C. pleurota	-	-	1	1	1	2	-	1	-	-	2	1	t	-	t	t
Cetraria nivalis	-	-	1	2	2	-	t	-	-	-	-	-	1	-	-	1
C. islandica	-	-	1	1	t	1	1	1	-	-	1	1	1	1	1	t
C. cucullata	-	-	-	1	t	-	1	t	-	-	1	1	t	-	1	t
Stereocaulon spp.	-	-	4	6	5	4	5	5	-	-	-	3	3	2	5	4
Peltigera aphthosa	-	-	-	1	-	-	1	-	-	-	-	-	1	1	2	-
P. malacea	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
MISCELLANEOUS:																
Equisetum scirpoides	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
fungi	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 7. Corky Lake, West.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	99	95	100	100	90	95	100	95	98	85	40	95	90	95	100	80
Hult-Sernander scale for:[b]																
MOSS:	2	2	3	6	1	6	6	2	3	2	1	5	2	4	6	4
SHRUBS/FORBS:																
Betula glandulosa	-	-	-	1	1	-	-	t	-	-	-	t	4	-	t	-
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	-	t	1	1	-
Ledum decumbens	1	1	4	2	2	-	3	3	-	-	-	-	t	3	1	1
Vaccinium uliginosum	3	2	2	3	2	5	5	4	3	3	3	3	3	4	5	3
V. vitis-idaea	2	2	1	2	t	1	3	1	2	2	1	1	1	2	3	1
Petasites frigidus	1	1	1	1	t	1	t	1	-	-	-	-	-	-	1	t
Pyrola minor	1	-	-	1	-	-	-	-	1	-	-	t	-	-	-	-
Rubus chamaemorus	1	1	1	1	1	1	1	1	1	-	-	-	t	2	2	1
Picea sp.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Oxycoccus microcarpus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Carex podocarpa	2	2	3	4	-	4	4	-	2	2	2	2	-	4	5	-
Carex spp.	-	-	-	-	3	-	-	2	-	-	-	-	4	-	-	3

Percent cover of plant species - modified Hult-Sernander method

Station 7. Corky Lake, West (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia stellaris	-	-	1	1	t	-	t	t	-	-	-	-	t	-	t	1
C. arbuscula	-	-	1	1	2	1	4	2	-	-	1	1	2	1	2	2
C. rangiferina	-	-	1	2	1	1	3	2	-	-	-	1	1	1	2	1
C. amaurocraea	-	-	1	1	t	2	1	t	-	-	-	1	-	1	2	t
C. uncialis	-	-	2	5	t	2	3	t	-	-	1	4	t	-	2	1
C. gracilis	-	-	2	2	1	1	1	1	-	-	1	1	1	1	1	1
C. crispata	-	-	-	1	1	1	1	t	-	-	-	2	t	1	1	t
C. gonecha	-	-	1	1	t	-	1	t	-	-	-	1	t	-	1	t
C. spp. (cup-type)	-	-	-	-	t	1	-	t	-	-	-	-	t	2	-	1
Cetraria nivalis	-	-	-	-	t	-	-	-	-	-	1	1	-	-	t	t
C. islandica	-	-	1	1	1	1	1	1	-	-	-	1	1	1	1	1
C. cucullata	-	-	-	1	t	1	1	t	-	-	1	t	t	-	1	t
Peltigera sp.	-	-	-	1	-	-	1	-	-	-	-	-	-	-	1	-
Stereocaulon paschale	-	-	4	6	4	3	5	3	-	-	2	3	5	2	5	3
Peltigera aphthosa	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-
P. malacea	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	2
Cladonia bellidiflora	-	-	-	1	-	-	-	-	-	-	-	-	-	-	t	-
Cladonia cornuta	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Equisetum scirpoides	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-

a. A = inside exclosure, b = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 8. Harris Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	97	95	98	99	95	100	100	90	97	80	40	80	85	100	100	90
Hult-Sernander scale for:[b]																
MOSS:	3	3	5	6	2	5	6	2	2	1	1	5	1	4	6	3
SHRUBS/FORBS:																
Picea mariana	-	-	-	-	-	-	1	1	-	-	-	-	-	-	t	-
Betula glandulosa	1	1	2	2	2	1	2	1	-	-	1	1	1	4	4	2
Empetrum nigrum	2	2	3	3	3	-	-	-	1	-	-	-	1	5	6	4
Ledum decumbens	2	2	4	4	4	5	5	4	1	1	-	1	t	-	3	4
Oxycoccus microcarpus	1	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	2	2	3	3	2	-	-	t	2	2	3	3	2	3	4	3
V. vitis-idaea	2	1	1	4	1	2	4	3	1	2	2	1	1	3	3	1
Petasites frigidus	-	-	-	-	1	-	-	-	1	-	-	-	-	3	2	1
Rubus chamaemorus	2	1	2	1	1	4	5	3	1	1	1	t	t	2	1	1
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	2	-	-	1	2	-	1	2	-	1	-	-	1	-
Carex bigelowii	1	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
C. spp.	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Gramineae	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	1

Percent cover of plant species - modified Hult-Sernander method

Station 8. Harris Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia arbuscula	-	-	3	4	2	2	4	3	-	-	1	2	3	2	2	2
C. rangiferina	-	-	3	4	3	2	5	1	-	-	1	t	1	-	2	1
C. amaurocraea	-	-	1	1	1	3	3	1	-	-	1	1	t	-	-	t
C. uncialis	-	-	2	1	1	-	-	-	-	-	1	2	2	1	1	1
C. gracilis	-	-	2	3	2	1	2	t	-	-	-	2	1	-	2	1
C. crispata	-	-	1	1	1	-	1	-	-	-	-	-	2	-	-	-
C. cornuta	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	1	1	t	-	-	-	-	-	-	-	1	1	t	1
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
C. stellaris	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
C. sp. (brown cup-like similar to amaurocraea)	-	-	-	1	-	-	t	-	-	-	-	-	-	-	-	-
C. sp. (nonpowdery gonecha)	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
C. spp. (cup-type)	-	-	1	t	-	-	t	-	-	-	1	2	-	-	t	-
Cetraria cucullata	-	-	1	1	1	1	1	1	-	-	-	1	1	1	-	1
C. islandica	-	-	2	1	1	1	1	1	-	-	1	1	1	-	1	t
Stereocaulon paschale	-	-	3	2	2	-	1	t	-	-	2	3	3	1	3	2
Peltigera aphthosa	-	-	2	-	-	-	-	1	-	-	-	-	1	2	-	1
P. malacea	-	-	2	-	1	1	-	1	-	-	-	-	1	1	-	2
P. spp.	-	-	-	1	-	-	1	-	-	-	-	1	-	-	3	-
Nephroma arcticum	-	-	-	-	-	2	2	1	-	-	-	-	-	1	t	2
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 9: Betty Ann Lake East.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	98	95	NO DATA	97	85	NO DATA	100	95	83	80	NO DATA	100	100	NO DATA	96	95
Hult-Sernander scale for:[b]																
MOSS:	3	3		6	2		5	3	2	1		6	1		6	2
SHRUBS/FORBS:																
Picea mariana	-	-		-	-		3	3	1	-		1	2		-	-
Betula glandulosa	2	2		2	2		-	-	-	-		-	-		-	-
Empetrum nigrum	-	-		t	-		t	-	-	-		-	-		-	-
Ledum decumbens	1	1		2	3		2	2	-	3		1	1		3	3
Rosa acicularis	-	-		-	t		2	2	1	-		1	1		-	-
Vaccinium uliginosum	3	2		4	4		3	4	3	3		5	4		5	4
V. vitis-idaea	1	1		2	1		2	3	1	1		2	2		2	2
Petasites frigidus	1	1		1	-		2	2	1	1		1	2		t	t
Rubus chamaemorus	-	-		-	-		1	1	1	1		1	1		t	-
Oxycoccus microcarpus	-	-		t	-		-	-	-	-		-	-		-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1		-	-		-	-	1	1		-	-		-	-
C. canadensis	-	-		1	-		1	-	-	-		3	-		t	-
Carex spp.	-	-		-	t		-	2	-	-		-	2		-	t

Percent cover of plant species - modified Hult-Sernander method

Station 9: Betty Ann Lake East (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:			NO			NO					NO			NO		
Cladonia stellaris	-	-	DATA	1	2	DATA	t	t	-	-	DATA	1	t	DATA	1	1
C. arbuscula	-	-		3	3		4	3	-	-		4	2		3	3
C. rangiferina	-	-		1	t		4	2	-	-		2	1		2	1
C. uncialis	-	-		2	1		3	1	-	-		2	1		2	1
C. gracilis	-	-		1	1		1	1	-	-		1	1		1	1
C. gonecha	-	-		-	1		1	-	-	-		t	t		1	1
C. amaurocraea	-	-		1	t		1	1	-	-		1	t		1	1
C. crispata	-	-		1	1		1	-	-	-		1	1		1	2
C. pleurota	-	-		-	1		-	1	-	-		-	t		-	1
Cetraria cucullata	-	-		1	1		t	t	-	-		t	t		1	1
C. islandica	-	-		t	1		1	1	-	-		1	1		t	-
Stereocaulon sp.	-	-		5	3		5	3	-	-		5	4		4	3
Peltigera canina	-	-		-	-		1	1	-	-		2	2		t	1
MISCELLANOUS:																
Equisetum sylvaticum	-	-		1	1		-	-	-	-		-	-		-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 10. Betty Ann Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	50	75	95	100	95	NO DATA	NO DATA	100	50	85	100	100	95	50	100	85
Hult-Sernander scale for:[b]																
MOSS:	-	5	5	6	2			4	3	5	6	5	3	3	6	1
SHRUBS/FORBS:																
Betula glandulosa	-	-	1	t	1			5	-	-	1	1	2	3	4	3
Ledum decumbens	1	2	3	4	4			4	1	1	1	2	2	4	4	4
Rosa acicularis	-	1	-	t	-			1	-	-	-	-	-	-	-	-
Salix alaxensis	2	2	3	5	5			-	3	5	4	5	4	-	-	1
Spiraea beauverdiana	-	-	-	-	-			-	-	-	1	-	-	-	t	-
Vaccinium uliginosum	2	2	2	4	3			2	3	4	5	6	5	4	6	4
V. vitis-idaea	-	-	3	3	3			3	1	1	3	3	3	2	4	3
Epilobium angustifolium	1	1	1	t	t			-	-	-	1	t	1	1	t	t
Petasites frigidus	-	-	-	-	-			-	1	1	-	t	t	1	t	t
Pyrola secunda	-	-	-	-	-			-	-	-	-	-	-	-	t	-
Rubus chamaemorus	1	-	-	-	-			-	-	-	-	-	-	-	t	t
Picea mariana	-	-	-	-	-			-	-	-	-	-	-	-	-	3
Empetrum nigrum	-	-	-	-	-			-	-	-	-	-	3	-	-	-
SEDGE/GRASS:																
Calamagrostis canadensis	1	1	-	t	-			-	1	1	1	t	-	1	t	-
Festuca altaica	-	-	-	-	-			-	-	-	1	-	-	-	-	-
Carex spp.	-	-	-	-	t			t	-	-	-	-	-	-	-	1

Percent cover of plant species - modified Hult-Sernander method

Station 10. Betty Ann Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:						NO	NO									
Cladonia gracilis	-	-	2	4	3	DATA	DATA	3	-	-	1	1	2	1	1	2
C. cornuta	-	-	1	1	-			-	-	-	-	1	t	1	1	-
C. spp. (cup-type)	-	-	2	4	-			-	-	-	-	1	-	1	3	-
C. pleurota	-	-	-	-	t			-	-	-	-	-	1	-	-	t
C. amaurocraea	-	-	-	-	t			-	-	-	-	-	-	-	-	t
C. gonecha	-	-	-	-	1			-	-	-	-	-	-	-	-	-
C. crispata	-	-	-	-	-			-	-	-	-	-	1	-	-	-
C. arbuscula	-	-	-	t	t			-	-	-	-	-	t	-	-	-
Stereocaulon sp.	-	-	-	-	-			1	-	-	-	-	1	-	-	-
Peltigera aphthosa	-	-	-	-	2			1	-	-	2	-	3	-	-	2
P. canina	-	-	1	-	1			-	-	-	1	-	t	1	-	1
P. spp.	-	-	-	2	-			-	-	-	-	2	-	-	3	-
MISCELLANEOUS:																
Equisetum sylvaticum	2	2	2	1	1			t	1	1	1	1	1	2	1	1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 11. Georgia Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	100	100	100	95	100	100	100	100	95	90	100	95	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	6	6	6	6	3	6	6	2	6	5	5	6	3	6	6	4
SHRUBS/FORBS:																
Betula glandulosa	1	2	2	3	t	-	t	-	-	-	-	1	3	-	-	-
Ledum decumbens	4	5	5	6	5	3	4	4	3	3	4	3	4	5	5	4
Spiraea beauverdiana	-	-	-	-	-	-	-	-	1	1	-	1	-	1	1	-
Vaccinium uliginosum	1	1	-	1	t	3	2	4	-	-	2	1	2	-	-	t
V. vitis-idaea	4	4	4	5	4	2	4	1	4	4	4	4	4	4	4	2
Oxycocccus microcarpus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Petasites frigidus	-	-	-	-	-	2	4	-	1	1	1	1	-	1	-	-
Rubus chamaemorus	2	2	3	2	-	1	1	-	2	1	1	1	-	-	1	-
Epilobium angustifolium	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	2	1	-	2	2	-	1	1	2	2	-	2	2	-
Gramineae	-	-	-	-	1	-	-	1	-	-	-	-	2	-	-	5

Percent cover of plant species - modified Hult-Sernander method

Station 11. Georgia Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia arbuscula	-	-	2	2	3	2	4	4	-	-	1	1	1	2	3	1
C. rangiferina	-	-	1	2	1	2	2	1	-	-	-	1	1	1	1	1
C. amaurocraea	-	-	2	1	1	-	-	2	-	-	1	1	-	1	1	-
C. gracilis	-	-	1	t	1	2	1	1	-	-	-	-	1	-	1	1
C. bellidiflora	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
C. crispata	-	-	-	1	-	-	-	1	-	-	-	1	-	-	1	-
C. pleurota	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-
Cetraria cucullata	-	-	1	-	1	1	-	1	-	-	-	-	1	-	1	1
C. islandica	-	-	-	1	1	-	1	1	-	-	-	1	1	-	1	1
Stereocaulon paschale	-	-	-	-	-	2	1	1	-	-	-	-	-	-	-	-
Peltigera aphthosa	-	-	1	-	-	1	-	3	-	-	1	-	4	1	-	1
P. malacea	-	-	1	-	-	1	-	-	-	-	-	-	t	1	-	2
P. spp.	-	-	-	2	-	-	1	-	-	-	-	2	-	-	2	-
Nephroma arcticum	-	-	-	-	-	1	2	1	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Equisetum silvaticum	1	1	1	1	t	3	3	1	1	1	3	1	1	2	1	2

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 12. Gross Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	80	80	80	85	100	100	95	100	100	100	100	95	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	4	4	4	6	3	5	6	4	4	4	6	6	3	6	6	2
SHRUBS/FORBS:																
Picea mariana	-	-	-	-	-	-	1	4	-	-	1	-	-	-	-	-
Betula glandulosa	1	1	2	2	1	4	4	2	2	2	2	2	2	2	4	2
Ledum decumbens	1	1	2	1	1	4	4	1	2	2	4	4	4	3	4	4
Rosa acicularis	1	1	-	t	-	-	1	-	-	-	-	-	-	-	-	t
Salix alaxensis	-	-	-	4	-	5	6	2	-	-	-	-	-	2	4	3
S. pulchra	-	-	-	-	t	-	-	1	-	-	-	-	-	-	-	-
S. myrtillifolia	3	3	4	4	3	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	3	3	3	1	2	-	2	3	3	4	4	3	4	3	5	4
V. vitis-idaea	1	1	1	1	1	2	4	3	2	3	2	2	2	1	2	1
Pedicularis labradorica	-	-	-	-	-	-	-	-	1	-	-	-	t	-	-	t
Petasites frigidus	1	-	-	-	-	1	1	1	1	1	2	1	1	4	4	2
Rubus chamaemorus	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Empetrum nigrum	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
Spiraea beauverdiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	1	-	-	-	-	-	1	1	2	1	-	1	2	-
Hierochloe alpina	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-
Carex bigelowii	2	3	4	4	-	3	2	-	-	-	-	-	-	4	2	-
Gramineae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
Carex spp.	-	-	-	-	3	-	-	2	-	-	-	-	-	-	-	1

Percent cover of plant species - modified Hult-Sernander method

Station 12. Gross Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia stellaris	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
C. arbuscula	-	-	2	3	3	-	-	1	-	-	2	4	3	-	1	1
C. rangiferina	-	-	1	1	1	-	-	-	-	-	1	1	1	-	1	-
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-
C. uncialis	-	-	-	1	t	-	-	-	-	-	1	1	1	-	-	t
C. gracilis	-	-	1	1	t	-	1	-	-	-	-	1	1	-	-	t
C. crispata	-	-	1	1	t	-	-	-	-	-	-	-	1	-	-	-
C. pleurota	-	-	-	-	1	-	-	t	-	-	-	-	1	-	-	-
C. spp. (cup-type)	-	-	-	1	-	-	-	-	-	-	1	-	t	-	-	-
Cetraria cucullata	-	-	-	1	t	-	-	-	-	-	1	1	t	-	-	-
Stereocaulon paschale	-	-	1	1	1	-	-	-	-	-	-	t	1	-	-	t
Peltigera aphthosa	-	-	-	-	1	2	-	3	-	-	1	-	1	1	-	3
P. malacea	-	-	2	-	-	2	-	1	-	-	1	-	1	2	-	1
P. spp.	-	-	-	1	-	-	3	-	-	-	-	2	-	-	3	-
MISCELLANEOUS:																
Equisetum scirpoides	1	1	-	-	-	-	-	-	1	1	1	-	-	-	1	-

a. A = inside exlosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 13. Janet Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	99	95	98	99	95	100	100	100	99	95	100	100	90	90	100	90
Hult-Sernander scale for:[b]																
MOSS:	4	4	4	6	1	5	6	3	3	3	5	6	2	4	6	3
SHRUBS/FORBS:																
Betula glandulosa	1	1	1	3	2	-	-	-	-	-	5	5	3	-	1	-
Ledum decumbens	3	4	4	5	4	4	5	6	1	1	3	4	3	4	4	4
Rosa acicularis	1	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	3	6	2	-	-	4	5	4	-	-	-
Vaccinium uliginosum	3	4	4	5	4	3	4	2	3	3	5	6	4	4	5	4
V. vitis-idaea	2	2	2	2	2	3	4	4	1	1	5	4	3	1	3	1
Epilobium angustifolium	-	-	-	-	-	-	-	-	1	1	-	-	-	1	t	-
Petasites frigidus	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	-
Rubus chamaemorus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	-	t	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	-	-	-	-	-	-	-	1	1	-	1	-	-	t	-
Carex spp.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	t

Percent cover of plant species - modified Hult-Sernander method

Station 13. Janet Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia arbuscula	-	-	3	4	3	1	1	1	-	-	1	1	1	1	3	2
C. uncialis	-	-	2	1	1	-	-	-	-	-	-	t	-	1	1	1
C. gracilis	-	-	4	4	2	2	1	1	-	-	-	t	1	1	1	2
C. crispata	-	-	1	1	1	-	-	1	-	-	-	1	1	-	1	1
C. cornuta	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	1
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-
C. macrophylla	-	-	1	t	-	-	-	-	-	-	-	-	-	-	t	-
C. pleurota	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	-	-	t	-	-	t	-	-	-	-	-	-	-	-
Cetraria islandica	-	-	1	1	1	1	1	1	-	-	-	-	-	1	t	1
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Stereocaulon tomentosum	-	-	1	1	1	1	1	1	-	-	1	-	-	-	1	t
Peltigera aphthosa	-	-	2	-	2	2	-	3	-	-	2	-	2	-	-	3
P. pulverulenta	-	-	1	-	-	2	-	-	-	-	-	-	-	2	-	1
P. spp.	-	-	-	1	-	-	4	-	-	-	-	1	-	-	3	-
Nephroma arcticum	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Equisetum silvaticum	1	-	-	-	-	-	-	-	-	-	1	1	1	1	-	1
E. scirpoides	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 14. Springer Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%):	100	100	100	100	95	100	100	100	100	100	100	100	85	100	100	90
Hult-Sernander scale for:[b]																
MOSS:	3	2	4	6	2	5	6	4	3	3	4	6	3	5	6	5
SHRUBS/FORBS:																
Picea mariana	3	2	- (dead)	-	-	1	t	2	-	-	-	-	-	2	4	2
Betula glandulosa	-	-	-	-	1	4	4	3	2	2	2	3	2	-	-	-
Ledum decumbens	1	1	1	1	1	5	3	2	2	3	4	4	2	2	3	2
Rosa acicularis	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-
Salix alaxensis	-	-	-	-	-	3	4	3	-	-	-	-	-	-	-	-
S. pulchra	-	-	-	-	-	-	-	-	1	1	1	1	t	2	3	2
Vaccinium uliginosum	4	4	4	5	3	2	3	3	3	5	5	5	4	4	4	4
V. vitis-idaea	2	2	2	3	2	5	5	4	1	1	-	3	2	1	3	2
Petasites frigidus	-	-	-	-	-	-	-	-	1	1	-	1	1	1	2	1
Rubus chamaemorus	-	-	-	-	-	-	-	-	1	1	1	1	t	-	-	-
Pedicularis sp.	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-
SEDGE/GRASS:																
Calamagrostis inexpansa	1	1	-	t	-	1	-	1	1	1	-	1	t	4	3	2
Carex bigelowii	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1
Eriophorum vaginatum	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 14. Springer Lake (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS:																
Cladonia arbuscula	-	-	4	5	3	3	4	2	-	-	2	3	3	1	3	1
C. rangiferina	-	-	1	1	2	1	1	1	-	-	-	-	1	1	t	-
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
C. uncialis	-	-	-	t	1	-	t	1	-	-	2	1	1	-	1	-
C. gracilis	-	-	3	2	2	1	1	1	-	-	1	1	1	1	1	1
C. crispata	-	-	2	2	1	-	1	t	-	-	-	t	1	-	-	-
C. pseudorangiformis	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
C. spp. (cup type)	-	-	-	-	t	-	-	-	-	-	-	1	-	-	-	t
Cetraria islandica	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Stereocaulon paschale	-	-	1	1	t	1	1	1	-	-	-	-	t	1	1	1
Peltigera aphthosa	-	-	-	-	-	2	2	2	-	-	2	2	-	-	-	1
P. malacea	-	-	2	1	1	-	-	1	-	-	1	1	2	2	2	-
Cetraria nivalis	-	-	-	t	1	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Equisetum scirpoides	-	-	-	1	-	-	1	-	1	1	2	2	1	1	1	2
E. silvaticum	-	-	-	-	-	-	-	-	1	1	1	-	-	1	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.05%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 15. Big Lake.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	99	95	70	99	95	80	96	90
Hult-Sernander scale for:[b]																
MOSS:	2	2	2	5	3	2	5	3	1	1	1	6	3	-	6	3
SHRUBS/FORBS:																
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-	-	1	-	-	t	1
Betula glandulosa	3	5	5	5	3	-	1	1	2	3	4	4	3	1	1	1
Empetrum nigrum	2	2	3	5	3	4	4	3	2	2	2	2	3	2	3	3
Ledum decumbens	2	1	1	1	2	2	3	3	1	1	3	3	2	3	3	2
Loiseleuria procumbens	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-
Vaccinium uliginosum	3	4	5	4	3	4	4	3	3	3	5	6	3	4	5	3
V. vitis-idaea	2	2	1	1	2	1	2	1	1	1	1	3	2	-	1	1
Salix pulchra	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
Pedicularis capitata	-	-	-	-	-	-	-	-	1	-	1	t	-	-	-	1
Polygonum bistorta	2	1	1	1	1	2	1	1	1	1	-	t	t	1	1	1
SEDGE/GRASS:																
Calamagrostis inexpansa	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Hierochloe alpina	-	-	-	1	-	-	1	-	1	1	1	-	-	2	-	-
Carex podocarpa	1	1	2	1	-	1	1	-	-	1	4	4	-	2	2	-
C. spp.	-	-	-	-	1	-	-	1	-	-	-	-	2	-	-	2
Gramineae	-	-	-	-	t	-	-	t	-	-	-	-	-	-	-	-
LICHENS:																
Cladonia stellaris	-	-	2	3	2	3	2	2	-	-	1	1	1	1	1	1
C. rangiferina	-	-	3	3	2	2	4	1	-	-	1	1	1	1	1	1

Percent cover of plant species - modified Hult-Sernander method

Station 15. Big Lake. (continued).

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
LICHENS: (continued)																
C. arbuscula	-	-	3	3	3	2	4	2	-	-	1	3	2	1	4	3
C. amaurocraea	-	-	1	-	-	-	-	-	-	-	-	-	-	1	t	-
C. uncialis	-	-	1	t	t	2	1	t	-	-	-	1	t	1	1	1
C. gracilis	-	-	1	-	1	1	t	1	-	-	-	-	1	-	t	t
C. multifida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
C. gonecha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
Cetraria nivalis	-	-	-	-	-	1	2	1	-	-	1	1	t	1	1	1
C. richardsonii	-	-	-	t	t	1	t	1	-	-	1	t	1	-	1	1
C. cucullata	-	-	1	1	1	1	2	1	-	-	1	1	1	1	1	t
C. islandica	-	-	1	1	1	1	t	1	-	-	1	1	1	1	t	t
Stereocaulon paschale	-	-	-	-	t	1	1	1	-	-	-	2	1	-	1	1
Dactylina arctica	-	-	1	t	1	1	1	1	-	-	-	t	1	-	t	1
Thamolia vermicularis	-	-	1	1	1	1	1	1	-	-	1	1	1	1	1	1
Alectoria nigricans	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
A. ochroleuca	-	-	-	-	-	1	t	-	-	-	-	t	-	1	t	-
Sphaerophorus globosus	-	-	-	-	-	1	t	-	-	-	-	1	-	-	t	t
Peltigera canina	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
MISCELLANEOUS:																
fungi	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 16. Eureka Summit.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	4	2	6	2	6	4	6	5	6	4	6	3	3	2	6	2
SHRUBS/FORBS:																
Betula glandulosa	6	5	6	4	5	5	6	4	5	4	6	4	3	4	6	1
Empetrum nigrum	2	2	1	3	2	3	3	3	1	4	1	3	-	-	-	-
Vaccinium uliginosum	3	3	4	3	4	4	5	2	3	4	4	4	3	4	5	4
V. vitis-idaea	2	2	2	2	1	2	3	3	1	3	3	3	t	1	3	1
Cornus canadensis	1	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Festuca altaica	2	4	4	4	3	3	4	4	1	1	2	2	2	3	3	3
LICHENS:																
Cladonia stellaris	t	-	-	-	t	-	-	1	1	4	-	3	4	-	1	-
C. arbuscula	t	-	1	1	-	1	-	-	2	2	2	2	2	4	2	4
C. rangiferina	5	5	6	5	2	2	3	2	4	4	5	4	3	2	4	4
C. gracilis	1	1	-	1	2	1	-	1	t	1	1	1	t	-	1	-
C. uncialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
C. amaurocraea	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-
C. deformis	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-
Cetraria cucullata	-	-	-	-	-	-	-	-	-	-	-	-	t	-	1	-

Percent cover of plant species - modified Hult-Sernander method

Station 16. Eureka Summit. (continued)

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Stereocaulon spp.	-	-	-	-	-	-	-	-	-	-	-	1	2	4	4	4
Peltigera aphthosa	-	-	-	-	-	-	-	1	3	3	-	3	1	2	-	2
P. spp.	1	-	1	-	1	1	1	-	1	-	4	-	-	-	1	-
MISCELLANEOUS:																
fungi	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 17. Mile 9 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	98	90	85	100	98	95	80	100	98	93	80	100	95	NO DATA	80
Hult-Sernander scale for:[b]																
MOSS:	2	2	2	1	4	3	1	2	3	2	3	2	3	3		2
SHRUBS/FORBS:																
Betula glandulosa	1	1	1	1	3	2	2	2	1	2	2	2	2	2		2
Salix glauca	2	2	2	3	-	-	-	-	-	-	-	-	1	1		1
S. reticulata	-	-	2	-	-	-	-	-	-	-	-	-	-	-		-
Ledum decumbens	-	1	1	1	2	2	2	2	-	1	2	1	1	1		1
Vaccinium uliginosum	1	-	1	1	2	2	1	3	3	3	3	3	3	4		3
V. vitis-idaea	t	1	1	1	t	1	1	1	t	1	t	t	t	1		1
Cassiope tetragona	3	3	3	4	2	1	2	2	3	2	3	2	2	2		2
Empetrum nigrum	3	2	1	3	3	2	3	3	1	2	2	2	2	3		2
Dryas octopetala	1	1	1	1	1	1	1	t	2	2	3	2	1	1		1
Diapensia lapponica	3	2	3	2	2	1	1	t	2	1	1	1	1	-		2
Tofieldia pusilla	t	t	1	-	-	-	-	1	-	-	-	-	-	-		-
Polygonum bistorta	t	-	1	1	t	-	t	t	1	1	1	1	1	1		1
Pedicularis laboradorica	-	t	-	-	t	-	-	t	-	1	-	1	t	1		-
P. verticillata	-	-	-	-	-	-	-	-	1	-	-	-	-	-		-
Pedicularis spp.	-	-	t	-	-	-	-	t	-	-	t	1	-	-		-
Loiseleuria procumbens	-	-	2	-	-	-	-	-	-	-	-	-	-	-		-
SEDGE/GRASS:																
Hierochloe alpina	-	-	-	-	-	-	-	-	1	2	1	-	-	-		-
Gramineae	-	-	-	-	-	-	-	-	-	-	1	-	-	-		-
Carex spp.	t	1	t	t	1	1	1	1	-	-	-	-	2	3		2

Percent cover of plant species - modified Hult-Sernander method

Station 17. Mile 9 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																
Cladonia stellaris	5	3	5	4	3	3	2	2	4	2	2	3	4	4		3
C. arbuscula	t	2	1	2	t	2	1	2	t	1	2	1	t	2		1
C. gracilis	t	-	1	1	1	1	1	1	1	1	1	2	t	2		3
C. uncialis	t	t	-	1	t	1	t	1	t	-	-	1	1	1		1
C. crispata	-	-	-	t	-	1	-	t	-	-	-	t	-	-		-
C. macrophylla	-	-	-	-	-	1	-	-	-	-	-	-	-	-		-
C. cornuta	-	-	-	t	-	-	-	t	-	-	-	t	-	-		1
C. spp. "cup type"	-	t	-	-	-	1	-	-	-	-	-	-	-	1		-
C. rangiferina	-	-	-	1	-	-	-	1	-	-	-	1	-	-		1
Cetraria cucullata	1	1	1	1	2	1	1	1	1	1	1	t	1	1		1
C. nivalis	2	1	2	2	3	2	3	1	2	2	1	t	2	3		1
C. islandica	t	1	1	1	1	1	1	1	t	1	1	1	t	2		1
C. richardsonii	1	1	1	2	1	1	1	1	t	1	1	1	1	2		2
C. nigricans	t	-	-	t	-	-	-	-	-	-	-	-	-	-		-
Stereocaulon paschale	1	2	2	2	2	3	3	2	2	3	3	3	2	2		3
Dactylina arctica	t	1	1	1	t	1	1	t	t	-	t	1	1	2		1
Thamnolia vermicularis	1	-	1	1	1	-	1	1	1	1	1	1	t	-		t
Sphaerophorus globosus	-	-	-	-	-	-	-	-	t	1	1	1	-	-		-
Cornicularia divergens	1	-	-	-	t	-	-	-	-	-	-	-	-	-		-
Alectoria nigricans	-	1	-	-	-	-	-	-	-	-	-	-	-	-		-
A. ochroleuca	-	-	-	2	-	1	-	-	-	-	-	-	-	-		-
Nephroma expallidum	-	-	-	-	-	-	-	-	-	-	-	1	-	-		-
Peltigera apthtosa	-	-	-	1	-	-	-	t	-	-	-	-	-	-		1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 18. Mile 26 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	98	100	100	100	100	100	100	100	100	100	100	100	95
Hult-Sernander scale for:[b]																
MOSS:	6	6	5	5	6	6	5	4	6	6	5	4	6	6	6	5
SHRUBS/FORBS:																
Betula glandulosa	4	5	5	4	5	5	5	3	5	5	5	5	5	3	2	2
Ledum decumbens	2	1	1	2	-	-	1	1	3	4	3	3	2	2	2	1
Vaccinium uliginosum	1	4	2	3	2	3	2	3	2	3	2	3	3	3	2	2
V. vitis-idaea	1	1	1	1	t	1	1	1	1	2	1	1	1	1	1	1
Empetrum nigrum	4	4	4	4	3	2	4	4	4	5	3	3	3	4	4	4
Spiraea beauverdiana	2	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1
Rubus chamaemorus	1	1	1	t	1	1	1	1	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Carex spp.	2	3	1	3	3	3	2	3	2	2	1	2	2	3	1	3
LICHENS:																
Cladonia stellaris	-	-	-	-	-	-	-	-	t	1	1	t	t	-	-	t
C. rangiferina	3	3	1	1	3	3	2	2	2	3	2	2	1	1	1	1
C. arbuscula	1	1	1	t	1	1	1	1	1	2	1	1	2	2	1	1
C. gracilis	1	1	1	-	1	1	1	1	2	1	1	1	t	1	1	t
C. uncialis	-	-	-	-	-	-	-	-	1	1	-	t	1	1	t	1
C. crispata	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	1

Percent cover of plant species - modified Hult-Sernander method

Station 18. Mile 26 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (cont.)																
C. cornuta	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Cetraria islandica	1	1	1	-	1	1	1	1	1	1	t	1	t	1	t	1
Nephroma arcticum	-	-	-	-	2	2	1	-	-	-	-	-	-	-	-	-
Peltigera aphthosa	3	3	2	3	t	2	1	3	-	-	-	-	-	-	-	-
P. pulverulenta	-	2	-	-	-	-	1	-	3	4	-	-	2	4	1	-
P. canina	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	3
MISCELLANEOUS:																
fungi	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-
Equisetum arvense	-	-	-	-	-	-	-	-	-	1	t	1	1	1	2	3

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 19. Mile 29 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	95	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	6	6	4	4	6	6	5	4	6	6	6	4	6	6	6	4
SHRUBS/FORBS:																
Loiseleuria procembens	1	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	t	-	1	2
Rubus arcticus	1	1	1	1	2	2	2	2	2	1	1	2	1	1	1	1
Artemisia arctica	2	3	3	3	2	3	2	2	3	3	3	3	3	3	3	3
Sedum roseum	1	2	1	1	1	2	2	2	2	2	2	2	2	2	2	1
Lupinus arcticus	-	-	-	-	-	-	-	-	1	2	3	1	-	-	-	1
Senecio lugens	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
Polemonium acutiflorum	2	1	1	1	2	1	1	1	1	1	1	1	2	1	1	1
Anemone narcissiflora	t	1	-	-	-	1	1	1	t	1	-	-	t	2	1	1
A. parviflora	-	1	1	1	t	1	t	t	-	-	t	t	-	-	-	-
Aconitum delphinifolium	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
Antennaria monocephala	-	-	-	-	-	-	-	-	-	-	-	-	t	-	1	1
SEDGE/GRASS:																
Festuca altaica	5	5	5	-	5	5	4	-	5	5	4	-	3	5	3	-
Calamagrostis canadensis	-	-	-	-	-	1	1	-	t	1	1	-	t	1	1	-
Carex spp.	2	3	3	2	2	3	2	2	1	3	2	2	1	2	1	2
Gramineae	-	-	-	4	-	-	-	3	-	-	-	3	-	-	-	3

Percent cover of plant species - modified Hult-Sernander method

Station 19. Mile 29 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																
Cladonia stellaris	-	-	-	-	t	-	t	-	-	-	-	-	-	-	-	-
C. rangiferina	2	2	t	1	t	-	t	1	t	1	t	-	t	1	1	1
C. arbuscula	t	-	-	t	t	1	1	1	2	2	1	1	3	3	2	2
C. gracilis	1	1	t	-	1	2	1	-	1	1	t	-	1	2	1	1
C. uncialis	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
C. crispata	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetraria islandica	1	1	1	1	1	2	1	2	1	2	1	1	1	2	2	1
Stereocaulon paschale	t	-	t	-	-	-	-	-	t	1	1	1	1	3	2	1
Thamnolia vermicularis	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	1
Peltigera canina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
P. spp.	-	-	-	-	-	-	-	-	-	-	t	-	t	-	t	-
Nephroma arcticum	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	t
MISCELLANEOUS:																
Lycopodium selago	-	-	-	-	-	-	-	-	-	-	-	-	t	1	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 20. Mile 47 Denali Highway. (continued)

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																
Cladonia stellaris	1	1	t	t	-	-	-	t	t	1	t	-	1	2	1	1
C. rangiferina	1	1	1	t	t	2	1	2	2	2	2	1	2	2	1	1
C. arbuscula	1	1	-	1	1	1	1	1	2	2	2	1	1	1	1	t
C. uncialis	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
C. gracilis	-	-	-	t	-	1	1	-	t	-	1	1	-	-	t	-
C. gonecha	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
C. deformis	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-
Cetraria islandica	t	1	-	-	1	1	1	1	2	1	1	1	t	1	-	t
Stereocaulon paschale	1	1	t	t	-	-	-	-	1	1	1	1	1	1	t	-
Peltigera aphthosa	2	3	2	3	2	2	1	1	1	-	1	-	1	2	1	2
P. pulverulenta	-	-	-	-	-	1	-	-	-	3	-	-	-	1	-	-
P. canina	-	-	-	1	-	-	-	2	-	-	-	2	-	-	-	1
MISCELLANEOUS:																
fungi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 21. Mile 56 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	3	4	2	3	3	4	2	3	6	6	5	4	6	6	4	3
SHRUBS/FORBS:																
Empetrum nigrum	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-
Betula glandulosa	-	-	-	-	-	-	-	-	-	-	1	t	t	-	t	-
Salix pulchra	-	-	-	-	-	-	1	2	2	2	1	-	-	-	-	-
S. glauca	5	5	4	3	2	3	4	3	4	5	4	4	4	4	3	3
S. reticulata	-	-	-	-	-	-	t	-	t	1	1	1	t	1	t	1
Vaccinium uliginosum	-	-	-	-	-	-	-	-	t	1	t	1	1	1	t	t
V. vitis-idaea	-	-	-	-	-	-	-	-	-	1	t	t	-	1	t	t
Potentilla fruticosa	-	-	-	-	-	-	-	-	-	1	1	2	-	-	-	-
P. diversifolia	t	-	-	1	-	-	-	1	1	1	t	1	-	1	t	1
Cornus canadensis	-	-	-	1	t	-	t	1	-	-	-	-	-	-	-	-
Rubus arcticus	1	1	1	1	t	-	t	1	2	1	t	t	-	-	-	-
Epilobium angustifolium	t	2	1	2	1	2	1	1	-	1	1	t	-	-	t	-
Aconitum delphinifolium	1	1	t	1	t	-	1	2	t	1	t	2	t	-	-	2
Sanguisorba sitchensis	1	2	1	1	2	3	1	2	1	2	1	1	1	1	1	1
Sedum roseum	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
Swertia perennis	-	-	-	-	t	-	1	t	1	1	-	-	1	1	t	t
Pyrola minor	1	-	t	-	1	1	1	1	t	-	t	t	t	-	t	t
Veronica wormskjoldii	t	-	-	-	1	-	-	-	t	-	-	-	t	-	t	t
Valeriana capitata	-	1	-	-	-	-	t	t	-	1	1	1	-	-	1	t

Percent cover of plant species - modified Hult-Sernander method

Station 21. Mile 56 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
SHRUBS/FORBS: (continued)																
Stellaria laeta	t	-	-	-	1	2	t	1	-	-	-	-	t	-	-	-
Thalictrum alpinum	-	-	t	-	-	-	1	t	t	1	t	1	1	1	1	1
Solidago multiradiata	2	2	2	1	2	1	1	1	2	3	2	2	2	2	1	1
Artemisia arctica	1	2	1	1	1	3	1	2	1	2	1	1	2	2	1	1
Senecio lugens	-	3	-	1	-	2	-	1	-	-	1	t	-	1	1	1
Antennaria monocephala	-	-	-	-	-	-	-	-	t	-	-	-	1	-	-	-
SEDGE/GRASS:																
Festuca altaica	4	5	5	-	4	5	4	-	4	5	4	-	4	5	5	-
Calamagrostis canadensis	-	2	1	-	-	2	1	-	-	-	t	-	-	-	-	-
Poa arctica	t	-	-	-	3	-	-	-	t	-	-	-	-	-	-	-
Gramineae	-	-	-	5	-	-	-	4	-	-	-	3	-	-	-	3
Carex spp.	2	1	1	3	1	1	t	3	3	2	2	2	2	1	1	t
Hierochloe alpinum	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-
Trisetum spicatum	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-
Luzula multiflora	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
LICHENS:																
Cladonia arbuscula	t	1	1	1	t	-	t	1	-	1	-	t	t	1	1	1
C. rangiferina	-	-	t	-	-	1	t	-	-	1	t	-	-	1	t	1
C. uncialis	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
C. gracilis	-	-	t	1	-	1	t	1	-	1	-	-	t	1	1	1
C. verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C. stellaris	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Cetraria islandica	-	1	1	1	-	1	t	-	-	1	1	-	-	1	1	1
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 21. Mile 56 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (cont)																
Stereocaulon paschale	1	1	2	1	1	1	t	1	1	1	1	1	3	3	3	4
Peltigera aphthosa	-	1	1	1	-	1	1	1	-	-	-	1	t	1	-	1
P. canina	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Lobaria linita	-	-	-	-	-	1	t	-	-	-	-	-	t	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 50 to 75%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 22. Mile 65 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	5	6	6	5	6	6	6	5	6	6	6	6	6	6	6	6
SHRUBS/FORBS:																
Betula glandulosa	6	5	5	5	6	6	6	4	6	6	6	5	6	4	3	4
Vaccinium uliginosum	5	5	3	5	4	5	4	4	6	5	6	4	6	6	6	6
V. vitis-idaea	3	2	1	2	1	1	1	2	1	2	2	1	2	1	1	2
Ledum decumbens	2	3	1	3	1	1	t	1	2	3	2	2	2	3	1	2
Empetrum nigrum	2	2	1	2	-	-	1	1	1	3	1	2	2	1	t	2
Spiraea beauverdiana	1	-	1	-	3	2	2	3	2	1	1	1	2	1	1	2
Rosa acicularis	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus canadensis	1	2	1	1	1	2	1	1	2	2	1	2	1	2	1	1
Linnaea borealis	-	2	1	1	-	-	1	t	t	1	1	1	1	1	t	-
SEDGE/GRASS:																
Calamagrostis canadensis	1	-	t	-	t	-	t	-	t	-	t	-	t	1	t	-
Gramineae	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
LICHENS:																
Cladonia gracilis	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Equisetum silvaticum	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
E. variegatum	1	-	1	-	1	-	1	-	1	-	t	-	t	-	-	-
E. spp.	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Lycopodium selago	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
- = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 23. Mile 94 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
Total cover (%)	100	100	NO DATA	100	100	100	NO DATA	100	100	100	NO DATA	100	100	NO DATA	100
Hult-Sernander scale for:[b]															
MOSS:	6	6		3	6	6		3	6	6		6	6		1
SHRUBS/FORBS:															
Betula glandulosa	1	2		1	2	3		2	1	2		1	1		3
Ledum decumbens	2	4		3	4	5		2	3	3		2	3		3
Vaccinium uliginosum	5	5		4	5	3		3	3	1		-	-		-
V. vitis-idaea	2	2		1	3	2		2	3	4		2	3		2
Empetrum nigrum	1	1		3	1	1		2	-	-		-	-		-
Spiraea beauverdiana	-	1		t	-	-		t	-	-		-	-		-
Oxycoccus microcarpus	1	1		2	1	-		1	1	-		1	-		-
Rubus chamaemorus	3	4		4	4	6		4	3	5		4	4		3
Andromeda polifolia	-	-		-	-	-		-	-	-		1	-		-
Pedicularis labradorica	-	1		t	-	-		1	-	-		-	-		-
SEDGE/GRASS:															
Carex spp.	1	2		2	3	4		3	t	1		3	4		-
LICHENS:															
Cladonia rangiferina	-	-		-	-	-		-	3	3		t	1		3
C. arbuscula	-	-		-	t	-		-	-	-		-	-		3
C. gracilis	1	-		-	2	-		1	1	1		3	1		2
C. amaurocraea	1	-		-	2	-		-	t	-		t	1		-
C. uncialis	-	-		-	-	-		-	-	-		-	-		t
C. gonecha	-	-		-	-	-		-	-	-		-	-		1
Cetraria islandica	t	-		-	t	-		-	1	1		t	1		-
C. cucullata	1	-		t	2	1		t	3	1		2	1		2
C. richardsonii	-	-		1	1	-		-	-	-		-	-		-

Percent cover of plant species - modified Hult-Sernander method

Station 23. Mile 94 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
LICHENS: (cont.)			NO DATA				NO DATA				NO DATA			NO DATA	
Dactylina arctica	1	1		1	1	1		t	-	-		-	-		-
Peltigera pulverulenta	-	2		2	-	-		t	t	1		1	1		-
Thamnolia spp.	-	-		-	-	-		-	-	-		-	-		t
Stereocaulon spp.	-	-		-	-	-		-	-	-		-	-		1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

c. New quadrat - established when stakes marking location of original quadrat(s) could not be located.

Percent cover of plant species - modified Hult-Sernander method

Station 24. Mile 100 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	NO DATA	90	100	100	NO DATA	100	100	100	NO DATA	85	100	100	NO DATA	85
Hult-Sernander scale for:[b]																
MOSS:	6	6		2	6	6		3	6	6		3	6	6		4
SHRUBS/FORBS:																
Picea glauca	-	-		-	1	1		-	-	-		-	-	-		-
Betula glandulosa	1	t		-	3	2		3	2	2		1	5	4		3
Vaccinium uliginosum	-	-		-	1	2		2	1	1		1	-	-		-
V. vitis-idaea	1	1		1	2	2		1	1	1		t	2	2		2
Ledum decumbens	4	4		2	3	3		3	2	2		1	4	4		4
Empetrum nigrum	2	2		2	4	2		2	2	3		3	4	4		3
Cornus canadensis	-	1		-	1	1		1	-	-		-	t	-		1
Rubus chamaemorus	-	-		-	t	-		-	-	-		1	-	-		-
SEDGE/GRASS:																
Carex spp.	1	1		t	2	1		1	2	2		1	3	3		1
LICHENS:																
Cladonia stellaris	3	3		3	1	1		1	2	2		2	-	1		t
C. rangiferina	2	2		2	4	4		3	3	3		3	3	2		2
C. arbuscula	1	1		1	1	1		1	2	1		3	3	2		3
C. crispata	-	1		1	-	-		-	-	-		t	-	-		1
C. gracilis	2	1		3	1	-		1	2	1		3	1	1		3
C. cornuta	-	1		1	-	-		t	-	-		-	-	-		-
C. uncialis	-	-		-	-	-		t	-	1		t	-	-		1
C. gonecha	t	1		t	-	-		-	-	-		-	-	1		1
C. pleurota	-	-		-	-	-		-	-	-		t	-	-		1

Percent cover of plant species - modified Hult-Sernander method

Station 24. Mile 100 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (cont.)			NO DATA				NO DATA				NO DATA				NO DATA	
Cetraria islandica	2	2		3	t	1		1	1	1		1	1	1		2
C. richardsonii	1	1		1	1	-		-	2	2		1	-	-		-
C. nigricans	-	-		-	-	-		-	-	-		t	-	-		1
Peltigera pulverulenta	2	1		-	2	3		-	2	3		-	1	-		-
P. canina	-	-		1	-	-		3	-	-		2	-	-		1
P. aphthosa	-	-		-	-	-		-	-	-		-	-	-		1
Nephroma arcticum	4	4		4	-	-		-	2	2		2	-	-		-
Thamnolia vermicularis	-	-		t	-	-		-	-	-		-	-	-		-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 25. Mile 108 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	NO DATA	100	100	100	NO DATA	95	100	100	NO DATA	80	100	100	NO DATA	100
Hult-Sernander scale for:[b]																
MOSS:	5	5		4	5	6		3	4	5		3	5	5		4
SHRUBS/FORBS:																
Picea glauca	-	-		-	-	-		-	-	-		-	2	2		4
Betula glandulosa	5	4		2	6	5		5	6	4		3	4	1		1
Vaccinium uliginosum	4	4		3	1	2		2	4	4		3	4	3		3
V. vitis-idaea	1	1		1	2	2		1	3	4		1	2	1		3
Ledum decumbens	-	-		-	3	4		3	2	3		3	1	-		1
Empetrum nigrum	-	-		-	3	3		3	-	-		-	3	2		2
Salix pulchra	-	-		-	3	3		2	-	-		-	-	-		-
Cornus canadensis	t	1		1	1	1		1	t	1		1	1	1		1
SEDGE/GRASS:																
Festuca altaica	t	1		-	t	2		-	-	-		-	-	-		-
Carex spp.	-	-		1	-	-		1	-	-		-	-	-		-
Gramineae	-	-		-	-	-		1	-	-		-	-	-		-
LICHENS:																
Cladonia stellaris	1	2		-	-	1		-	-	-		-	-	1		-
C. rangiferina	3	3		3	1	1		1	1	1		1	1	1		1
C. arbuscula	2	2		1	1	1		1	t	1		1	2	2		2
C. gracilis	3	1		2	3	1		2	3	4		3	2	2		2
C. uncialis	2	1		t	-	-		t	t	1		1	2	1		1
C. cornuta	-	-		t	-	2		-	-	1		t	-	1		-

Percent cover of plant species - modified Hult-Sernander method

Station 25. Mile 108 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
C. deformis	-	-	NO	-	1	1	NO	-	1	1	NO	-	1	1	NO	-
C. crispata	-	-	DATA	-	-	-	DATA	-	-	-	DATA	2	-	-	DATA	1
C. gonecha	-	-		-	-	-		-	-	-		1	-	-		t
Cetraria islandica	2	2		1	1	1		1	-	1		1	1	1		1
C. cucullata	1	1		t	-	-		-	t	1		-	-	-		-
C. richardsonii	t	1		1	-	-		-	-	-		-	t	-		-
Stereocaulon paschale	2	2		1	1	1		1	1	2		3	1	2		2
Thamnolia vermicularis	t	-		-	-	-		-	t	-		-	t	-		-
Peltigera aphthosa	1	-		3	2	3		2	1	1		1	1	2		2
P. malacea	2	-		2	2	2		-	-	2		3	2	3		2
P. canina	-	-		1	-	-		1	-	-		-	-	-		-
Nephroma arcticum	1	-		-	-	-		-	-	-		-	-	-		-
MISCELLANEOUS:																
Lycopodium selago	-	-		-	-	-		-	-	-		-	1	2		-
fungi	-	-		-	-	-		-	-	-		-	-	-		1

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 26. Mile 115 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	98	100	100	100	95	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	2	3	t	1	1	3	1	1	2	4	1	2	2	3	1	1
SHRUBS/FORBS:																
Betula glandulosa	2	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Ledum decumbens	2	4	3	3	1	4	2	2	4	5	3	4	3	5	4	4
Vaccinium uliginosum	3	3	2	3	3	2	2	3	t	1	1	2	-	1	1	1
V. vitis-idaea	1	-	1	1	1	1	1	1	2	1	1	2	2	2	2	2
Empetrum nigrum	3	3	2	2	1	1	2	2	1	2	1	1	-	-	-	1
Arctostaphylos alpinum	-	-	-	-	-	-	-	-	2	3	2	3	-	-	-	1
Polygonum bistorta	-	1	t	-	t	1	t	-	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Calamagrostis lapponica	-	-	-	-	-	-	-	-	-	1	t	-	-	1	t	-
Hierochloe alpinum	-	-	-	-	-	1	t	-	2	3	1	-	1	1	1	-
Carex spp.	-	-	t	t	-	-	-	-	-	-	-	1	1	2	1	2
Gramineae	-	-	-	t	-	-	-	-	-	-	-	2	-	-	-	-
LICHENS:																
Cladonia stellaris	5	6	5	4	6	6	6	5	5	3	4	4	6	2	4	4
C. rangiferina	3	1	2	2	1	1	1	3	3	2	2	1	2	1	3	2
C. arbuscula	1	-	1	2	1	-	1	2	1	-	1	2	t	1	1	2
C. gracilis	1	1	1	1	1	-	1	1	t	-	t	1	t	-	t	1
C. uncialis	1	-	-	1	1	-	-	1	-	-	-	1	-	-	-	1
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
C. cornuta	-	-	-	t	-	-	-	t	-	-	-	-	-	-	-	-
C. gonecha	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 26. Mile 115 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (cont.)																
Cetraria nivalis	2	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1
C. cucullata	2	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1
C. islandica	1	1	1	1	t	1	1	1	t	1	t	t	t	1	t	t
C. richardsonii	t	1	1	t	t	-	-	1	t	-	t	-	1	1	t	1
Stereocaulon paschale	t	-	t	-	t	1	t	t	1	-	t	1	-	-	-	-
Dactylina arctica	-	-	-	-	t	-	t	-	-	-	-	-	-	-	-	-
Thamnolia vermicularis	t	1	t	t	-	-	t	-	-	-	-	t	-	-	-	t
Alectoria ochroleuca	-	-	-	-	-	-	-	-	t	-	-	-	t	-	-	-
Peltigera aphthosa	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Nephroma arcticum	3	3	3	2	-	-	t	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
Lycopodium selago	-	-	-	-	-	-	-	-	t	-	-	t	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 27. Mile 124 Denali Highway.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	90	100	100	95	95	100	98	98	95
Hult-Sernander scale for:[b]																
MOSS:	2	3	1	1	3	3	1	1	1	2	1	2	1	2	1	1
SHRUBS/FORBS:																
Betula glandulosa	3	2	2	3	4	3	4	3	t	-	-	-	4	3	2	3
Vaccinium uliginosum	2	2	2	1	2	2	1	2	t	1	1	1	1	1	1	-
V. vitis-idaea	t	1	1	1	t	1	1	t	t	1	1	1	t	1	1	1
Empetrum nigrum	-	-	-	-	-	-	-	-	1	1	-	-	2	2	1	1
Ledum decumbens	2	3	2	3	-	-	-	-	2	1	1	2	1	1	-	-
SEDGE/GRASS:																
Calamagrostis lapponica	-	1	-	-	-	1	-	-	-	1	t	-	-	-	-	-
Hierochloe alpinum	1	1	1	-	t	1	1	-	t	-	-	-	-	t	-	-
Carex spp.	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-
LICHENS:																
Cladonia stellaris	3	4	4	3	3	2	3	5	4	1	3	4	2	3	3	4
C. rangiferina	4	2	2	3	3	3	2	3	3	3	3	2	4	3	4	3
C. arbuscula	2	3	2	3	4	3	3	3	1	1	1	3	1	2	2	3
C. gracilis	3	2	1	2	2	1	1	2	1	1	2	2	t	-	1	2
C. uncialis	2	1	t	1	1	-	1	t	t	1	1	t	-	1	1	t
C. crispata	-	1	-	t	-	2	1	t	-	-	-	t	-	-	t	-
C. degenerans	-	-	-	-	t	1	-	-	-	-	-	-	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 27. Mile 124 Denali Highway (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (cont.)																
C. deformis	-	-	-	t	t	-	-	1	-	1	-	1	-	-	-	t
C. gonecha	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	t
Cetraria cucullata	2	1	1	1	2	2	t	1	2	1	t	1	1	1	1	1
C. islandica	t	1	1	1	1	1	1	1	t	2	2	1	t	1	1	1
C. richardsonii	-	2	1	1	-	2	1	2	-	2	1	2	-	1	1	2
C. nivalis	t	-	1	t	1	1	1	1	1	1	1	1	1	1	1	1
Stereocaulon paschale	3	3	3	2	2	1	1	1	3	2	1	1	3	2	2	1
Peltigera pulverulenta	-	-	-	-	-	1	-	-	-	1	-	-	-	2	2	-
P. aphthosa	-	-	-	-	-	-	-	-	-	1	-	1	-	-	t	1
P. canina	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
P. malacea	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Nephroma arcticum	-	-	-	-	-	-	t	-	-	1	1	1	-	-	-	t
MISCELLANEOUS:																
fungi	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 28. Black Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
Total cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	NO DATA	100
Hult-Sernander scale for:[b]															
MOSS:	6	6	6	3	6	6	6	2	6	6	6	6	6		4
SHRUBS/FORBS:															
Betula glandulosa	4	4	3	3	5	5	6	4	5	4	5	5	6		2
Ledum decumbens	-	-	-	-	-	-	-	t	-	-	-	-	-		-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-		3
V. vitis-idaea	3	3	3	2	5	5	3	2	2	2	2	4	5		2
SEDGE/GRASS:															
Hierochloe alpina	3	4	3	-	3	4	3	-	2	3	1	1	2		-
Gramineae	-	-	-	1	-	-	-	1	-	-	-	-	-		2
Carex spp.	-	-	-	1	-	-	-	t	-	-	-	-	-		1
LICHENS:															
Cladonia rangiferina	2	1	2	1	1	1	3	2	1	1	1	2	1		t
C. arbuscula	1	3	2	4	t	3	3	3	1	2	3	1	1		3
C. uncialis	1	1	3	t	3	1	2	t	3	1	1	1	1		t
C. amaurocraea	t	1	t	-	t	1	t	-	t	1	t	-	-		-
C. gracilis	t	1	1	t	t	-	t	t	1	1	1	t	-		1

Percent cover of plant species - modified Hult-Sernander method

Station 28. Black Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
LICHENS: (continued)															
C. deformis	-	-	-	-	t	-	-	-	t	1	1	t	-	NO	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	DATA	t
Cetraria islandica	t	1	1	1	t	-	1	1	t	1	t	1	1		-
C. cuculiata	1	1	2	1	t	1	t	1	1	2	1	1	1		1
C. richardsonii	2	2	2	2	1	1	2	2	1	2	2	2	2		2
C. nivalis	-	-	-	t	-	-	-	-	-	-	-	-	-		t
Stereocaulon paschale	3	2	2	2	2	1	2	2	1	1	1	t	-		2
Thamnolia vermicularis	1	-	1	1	t	1	1	1	t	-	1	t	1		1
Peltigera pulverulenta	2	2	1	-	-	2	2	-	1	1	1	2	2		-
P. canina	-	-	-	1	-	-	-	2	-	-	-	-	-		1
P. aphthosa	-	-	-	-	-	-	-	1	-	-	-	-	-		-
Dactylina arctica	-	-	-	-	-	-	t	t	-	-	-	-	-		-
MISCELLANEOUS:															
fungi	-	-	-	1	-	-	-	1	-	-	-	-	-		-

a. A = inside exclosure, B = outside exclosure.

b. - = not observed
t (trace) = < 0.05%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

c. New quadrat - established when stakes marking location of original quadrat(s) could not be located.

Percent cover of plant species - modified Hult-Sernander method

Station 29. Clarence Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	98	90	85	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	5	6	6	3	5	5	6	3	5	5	6	4	5	6	6	5
SHRUBS/FORBS:																
Betula glandulosa	2	2	2	1	-	1	1	2	6	4	5	3	3	4	5	3
Ledum decumbens	3	4	3	2	2	3	4	2	3	4	4	3	3	4	4	2
Vaccinium uliginosum	4	5	5	3	3	3	3	2	5	5	5	1	4	5	5	3
V. vitis-idaea	3	1	3	1	2	2	3	1	4	3	2	1	3	3	4	1
Empetrum nigrum	1	-	-	1	-	-	-	-	4	3	2	2	-	3	5	3
Salix pulchra	-	-	-	-	-	-	-	-	2	1	-	-	-	1	3	1
SEDGE/GRASS:																
Hierochloe alpina	-	2	-	-	-	-	-	-	-	1	2	-	-	1	1	-
Festuca altaica	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-
Gramineae	-	-	-	t	-	-	-	-	-	-	-	t	-	-	-	-
Carex spp.	t	-	-	1	2	2	2	1	1	1	-	1	-	1	t	1
LICHENS:																
Cladonia stellaris	-	-	t	-	-	-	t	1	-	-	t	-	-	-	-	-
C. rangiferina	3	2	4	2	5	3	5	2	5	3	3	t	4	2	2	1
C. arbuscula	2	3	3	3	1	3	4	4	2	2	1	1	t	2	1	1
C. gracilis	1	2	3	2	2	2	4	1	t	2	3	2	1	1	1	1
C. cornuta	-	-	-	-	-	1	t	-	-	-	-	-	-	-	-	-
C. uncialis	t	-	-	1	t	-	-	1	-	1	1	t	1	-	t	-
C. gonecha	-	2	1	t	-	2	1	1	-	-	-	1	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 29. Clarence Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (continued)																
Cladonia deformis	t	-	-	-	-	-	-	-	-	1	1	t	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-
Cetraria cucullata	2	2	3	1	3	2	3	2	t	2	2	1	1	1	1	1
C. islandica	2	1	1	t	1	1	1	1	1	1	1	1	t	1	1	1
Stereocaulon sp.	2	4	5	3	t	1	3	2	-	-	-	-	t	-	-	-
Peltigera canina	-	-	-	t	-	-	-	-	-	-	-	1	-	-	-	1
P. aphthosa	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
P. sp.	t	-	1	-	-	1	1	-	-	1	t	-	t	1	t	-
Dactylina arctica	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																
fungi	-	-	-	t	-	-	-	1	-	-	1	-	-	-	1	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3% to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 30. Middle Fog Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	98	100	97	95	100	100	98	95	100	90	96	95	100	50	80	70
Hult-Sernander scale for:[b]																
MOSS:	5	5	1	2	1	3	t	2	5	3	t	3	4	1	1	2
SHRUBS/FORBS:																
Betula glandulosa	1	2	2	2	1	1	2	2	2	1	2	2	-	-	-	-
Vaccinium uliginosum	-	-	-	-	3	3	3	3	4	5	5	3	3	3	4	3
V. vitis-idaea	1	1	1	t	2	2	2	3	3	4	4	3	2	3	4	2
Ledum decumbens	t	1	1	1	t	-	2	2	1	1	1	1	1	-	-	-
Empetrum nigrum	1	1	1	1	3	4	4	3	-	-	2	3	4	4	4	3
Arctostaphylos alpina	-	-	-	-	-	-	-	-	1	1	1	3	-	-	-	-
Rubus chamaemorus	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-
Picea sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
SEDGE/GRASS:																
Carex spp.	t	-	-	-	-	-	-	-	t	1	1	1	-	-	-	-
Hierochloe alpina	-	-	-	-	-	-	-	-	-	-	-	-	t	1	-	-
Festuca altaica	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
LICHENS:																
Cladonia stellaris	t	1	1	1	t	-	1	1	-	-	-	-	-	-	-	-
C. rangiferina	1	1	1	3	1	1	2	2	2	1	1	t	1	-	t	t
C. arbuscula	2	2	3	4	1	1	2	3	2	1	1	3	1	-	1	1
C. cornuta	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-	-
C. uncialis	3	1	2	1	1	1	1	1	1	1	2	1	1	1	1	t
C. amaurocraea	-	1	t	-	-	-	t	-	-	1	-	-	-	-	-	-

Percent cover of plant species - modified Hult-Sernander method

Station 30. Middle Fog Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2*	B2	B2	B2
LICHENS: (cont.)																
C. gracilis	t	1	1	2	1	-	1	2	2	1	2	2	t	-	1	1
C. macrophylla	-	2	1	t	-	-	-	-	-	-	-	1	-	-	-	t
C. crispata	-	-	-	1	-	-	-	1	-	-	t	t	-	-	-	-
C. bellidiflora	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	1
C. goneche	-	-	-	t	-	-	-	-	-	-	-	t	-	-	-	t
C. spp. (cup-like)	-	-	1	-	-	-	t	-	-	-	1	-	-	-	1	-
Cetraria cucullata	1	2	1	1	t	1	1	t	1	1	1	1	1	-	1	1
C. nivalis	1	1	1	1	t	-	t	t	t	-	-	-	t	1	1	1
C. islandica	1	1	1	1	t	2	1	1	t	1	1	1	t	-	t	-
C. richardsonii	t	-	t	1	t	1	1	1	-	-	-	-	-	-	t	t
Stereocaulon paschale	4	4	3	3	4	4	4	3	3	2	4	3	3	1	2	2
Thamnolia vermicularis	t	-	1	1	t	-	t	t	t	-	t	t	t	-	1	-
Dactylina arctica	-	-	-	-	-	-	-	-	t	-	t	1	t	-	-	-
Cornicularia divergens	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-
Sphaerophorus globosus	-	-	-	-	-	-	-	-	-	-	-	-	t	1	1	1
Peltigera aphthosa	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	t
P. canina	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
P. sp.	-	-	-	-	-	-	-	-	t	-	t	-	-	-	t	-

* Quadrat damaged by bears prior to 1967.

a. A = inside exclosure, B = outside exclosure.

b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 31. Deadman Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	98	98	NO DATA	95	96	90	NO DATA	85	98	80	NO DATA	70	100	45	NO DATA	NO DATA
Hult-Sernander scale for:[b]																
MOSS:	1	3		1	t	3		1	1	1		1	1	1		
SHRUBS/FORBS:																
Betula glandulosa	-	-		-	2	1		1	-	-		-	3	2		
Vaccinium uliginosum	3	4		3	2	3		2	2	4		2	1	3		
V. vitis-idaea	t	1		1	t	-		1	t	-		1	t	1		
Ledum decumbens	2	4		1	t	2		1	1	-		1	1	1		
Loiseleuria procumbens	4	4		1	3	3		1	1	1		1	4	3		
Diapensia lapponica	-	-		2	1	1		2	-	-		1	2	-		
Arctostaphylos alpina	-	-		-	1	1		1	-	-		-	-	-		
Empetrum nigrum	1	1		1	-	-		-	3	3		3	-	-		
Polygonum bistorta	-	-		-	-	-		1	-	-		-	t	-		
Tofieldia pusilla	-	-		-	t	-		-	-	-		-	1	2		
Pedicularis labradorica	-	-		-	t	-		-	-	-		-	-	-		
P. sp.	-	-		-	-	-		1	-	-		-	-	-		
SEDGE/GRASS:																
Calamagrostis lapponica	-	2		-	-	1		3	-	1		-	-	-		
Hierochloe alpina	-	1		-	-	3		-	1	2		-	t	2		
Festuca altaica	3	-		-	2	2		-	-	-		-	-	-		
Gramineae	-	-		2	-	-		-	-	-		1	-	-		
Carex spp.	1	2		2	t	-		1	1	2		1	1	4		

Percent cover of plant species - modified Hult-Sernander method

Station 31. Deadman Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																
Cladonia stellaris	2	1	NO DATA	2	t	-	NO DATA	1	3	1	NO DATA	1	1	-	NO DATA	NO DATA
C. rangiferina	t	2		1	t	2		-	1	1		1	t	-		
C. uncialis	2	1		1	2	1		1	1	-		1	2	-		
C. gracilis	t	1		1	t	1		1	-	-		1	1	-		
C. coccifera	-	-		1	-	-		1	-	-		1	-	-		
C. arbuscula	2	2		1	1	1		1	1	1		1	1	-		
C. crispata	-	-		1	-	-		1	-	-		-	-	-		
C. gonecha	-	-		1	-	-		-	-	-		-	-	-		
Cetraria islandica	t	1		1	t	-		1	t	1		1	t	1		
C. nivalis	1	4		2	2	4		4	1	2		1	1	1		
C. cucullata	t	-		-	t	1		-	t	-		-	t	1		
C. richardsonii	1	1		1	1	-		1	t	1		1	1	-		
C. nigricans	t	-		1	2	3		2	-	-		1	t	1		
Stereocaulon paschale	2	3		2	t	2		1	1	1		2	1	1		
Thamnolia vermicularis	t	-		1	1	2		1	t	-		1	t	-		
Dactylina arctica	-	-		-	-	-		-	t	-		-	1	-		
Sphaerophorus globosus	1	2		-	t	-		1	t	1		-	t	1		
Cornicularia divergens	t	-		-	t	1		-	-	-		-	t	1		
Alectoria ochroleuca	1	1		-	1	2		1	-	-		-	1	1		
A. nitidula	-	-		-	-	-		1	-	-		-	-	-		
Lobaria linita	-	-		-	-	-		-	-	-		-	1	-		

a. A = inside exclosure, B = outside exclosure.

b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 32. Butte Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
Total cover (%)	100	100	NO DATA	98	100	100	NO DATA	100	100	100	NO DATA	100	90	NO DATA	95
Hult-Sernander scale for:[b]															
MOSS:	5	5		2	5	6		2	5	5		4	4		4
SHRUBS/FORBS:															
Betula glandulosa	-	-		-	-	1		1	1	2		1	1		-
Salix reticulata	t	1		t	-	-		-	2	2		1	2		2
S. pulchra	-	-		-	3	2		2	-	-		-	-		2
Vaccinium uliginosum	1	2		3	-	-		1	2	1		2	2		3
V. vitis-idaea	1	1		3	4	5		3	t	1		t	2		1
Ledum decumbens	1	3		3	2	2		1	1	1		t	1		1
Empetrum nigrum	1	1		2	3	3		3	2	2		1	-		3
Arctostaphylos alpina	1	3		1	3	3		3	-	-		-	-		-
Dryas octopetala	-	-		-	-	-		-	-	-		-	1		2
Andromeda polifolia	-	-		-	-	-		-	t	-		-	-		-
Pyrola grandiflora	-	-		-	-	-		-	-	-		-	1		-
Polygonum bistorta	t	-		t	t	-		1	t	-		t	-		1
Pedicularis labradorica	-	-		-	-	-		-	t	1		t	1		1
Saussurea angustifolia	-	-		-	-	-		-	t	-		t	-		-
SEDGE/GRASS:															
Carex spp.	4	4		2	4	4		3	6	6		4	6		3

Percent cover of plant species - modified Hult-Sernander method

Station 32. Butte Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]
LICHENS:														NO	
Cladonia rangiferina	3	2		t	1	1		2	2	1		3	1	DATA	t
C. arbuscula	1	2		4	t	2		3	1	1		t	1		2
C. uncialis	1	2		t	1	1		t	3	-		3	1		t
C. gracilis	1	1		1	t	1		t	1	-		t	-		t
C. pleurota	-	-		t	-	-		-	-	-		-	-		t
C. coccifera	-	-		t	-	-		t	-	-		-	-		-
Cetraria cucullata	1	2		1	1	2		3	2	1		1	-		1
C. nivalis	1	1		2	t	-		-	t	-		1	1		t
C. islandica	t	2		1	t	1		1	1	-		t	-		1
C. richardsonii	t	1		1	t	1		1	-	-		t	-		1
Stereocaulon paschale	-	1		3	-	1		1	-	-		t	-		t
Thamnolia vermicularis	1	-		1	t	-		1	1	-		t	-		1
Sphaerophorus globosus	t	1		1	-	-		-	-	-		t	1		-
Dactylina arctica	t	-		t	-	-		1	-	-		-	-		1
Cornicularia divergens	1	-		1	-	-		-	-	-		1	1		-
Alectoria ochroleuca	1	1		2	-	-		1	-	-		-	1		-
Peltigera aphthosa	-	-		-	t	-		2	-	-		-	-		2

a. A = inside exclosure, B = outside exclosure.

b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

c. New quadrat - established when stakes marking location of original quadrat(s) could not be located.

Percent cover of plant species - modified Hult-Sernander method

Station 33. Soule Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	99	100	NO DATA	90	97	95	NO DATA	90	100	60	NO DATA	60	99	50	NO DATA	70
Hult-Sernander scale for:[b]																
MOSS:	2	4		1	1	3		1	3	1		2	2	1		1
SHRUBS/FORBS:																
Cassiope tetragona	2	3		2	t	-		1	t	1		1	1	-		-
Empetrum nigrum	1	2		2	-	-		-	1	1		2	2	3		4
Salix arctica	t	1		1	t	1		1	t	1		2	t	1		1
Vaccinium uliginosum	t	1		t	1	2		2	1	-		1	1	-		1
V. vitis-idaea	t	-		t	t	-		1	t	1		1	t	1		1
Dryas octopetala	2	2		2	2	2		2	3	3		3	1	2		2
Diapensia lapponica	1	1		1	1	1		1	-	-		1	1	-		1
Loiseleuria procumbens	2	1		1	-	4		1	-	-		-	-	-		-
Antennaria spp.	t	-		-	t	-		-	t	1		-	t	-		-
Pedicularis labradorica	t	-		-	t	1		-	t	1		-	t	-		-
Anemone narcissiflora	t	2		1	t	1		1	t	1		1	t	1		1
Artemesia altaica	1	-		-	t	-		-	t	-		-	1	-		-
SEDGE/GRASS:																
Festuca altaica	2	3		-	1	-		-	2	2		-	2	2		-
Hierochloe alpina	t	2		-	t	2		-	t	2		-	t	3		-
Carex spp.	t	1		-	t	1		1	t	2		1	-	3		1
Gramineae	-	-		2	-	-		1	-	-		2	-	-		3

Percent cover of plant species - modified Hult-Sernander method

Station 33. Soule Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:			NO				NO				NO				NO	
Cladonia stellaris	5	4	DATA	5	2	4	DATA	3	5	-	DATA	1	5	-	DATA	1
C. rangiferina	1	2		3	t	1		-	t	1		t	t	1		-
C. arbuscula	1	-		2	1	-		1	1	1		1	t	-		1
C. uncialis	t	1		1	1	1		1	1	1		1	1	1		1
C. gracilis	1	2		1	t	1		1	2	-		1	2	-		1
C. gonecha	-	-		1	-	-		-	-	-		-	-	-		-
C. pleurota	-	-		1	-	-		1	-	-		1	-	-		1
Cetraria islandica	1	2		2	1	2		1	2	1		1	2	1		1
C. nivalis	1	1		1	2	2		2	1	-		-	-	-		-
C. nigricans	-	-		1	-	2		2	-	-		1	-	-		1
C. richardsonii	t	1		1	t	1		1	-	-		1	-	1		1
Stereocaulon paschale	-	-		-	t	-		1	t	-		-	t	-		t
Dactylina arctica	t	1		t	t	-		1	t	-		-	t	-		-
Thamnolia vermicularis	1	1		1	1	-		1	1	-		1	t	-		1
MISCELLANEOUS:																
Lycopodium alpinum	-	-		-	t	-		-	t	-		-	t	-		-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 34. Jack Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]	B4[c]
Total cover (%)	100	100	NO DATA	90	100	100	NO DATA	100	100	100	NO DATA	100	100	NO DATA	100	100
Hult-Sernander scale for:[b]																
MOSS:	6	6		3	4	5		4	5	5		5	5		1	2
SHRUBS/FORBS:																
Betula glandulosa	5	5		5	1	1		1	4	4		6	6		-	4
B. nana	-	-		-	-	-		-	-	-		-	-		1	-
Vaccinium uliginosum	-	1		1	3	4		1	-	-		-	1		2	-
V. vitis-idaea	1	1		1	1	1		t	2	2		t	-		1	1
Empetrum nigrum	-	-		-	1	2		3	-	-		-	-		3	-
Salix spp.	-	-		-	-	-		-	t	-		-	-		-	-
Cornus canadensis	1	1		1	t	2		-	-	1		-	-		-	1
Diapensia lapponica	-	-		-	-	-		-	-	-		-	-		1	-
SEDGE/GRASS:																
Hierochloe alpina	1	1		-	t	1		-	1	2		1	1		-	-
Carex spp.	-	1		-	-	1		-	-	1		-	2		1	-
Gramineae	-	-		1	-	-		1	-	-		-	-		2	2
LICHENS:																
Cladonia stellaris	1	1		1	t	2		1	2	-		-	1		1	2
C. rangiferina	1	2		2	2	3		2	2	3		4	4		1	3
C. arbuscula	2	2		2	3	2		2	3	3		4	2		1	2
C. uncialis	1	-		t	t	1		1	2	2		1	-		1	t
C. amaurocraea	-	2		t	-	1		-	-	1		-	1		-	-
C. gracilis	1	-		t	1	1		1	1	1		2	2		1	1
C. deformis	-	-		-	-	-		-	t	-		t	1		-	-
C. crispata	-	-		1	-	-		-	-	-		-	-		1	1

Percent cover of plant species - modified Hult-Sernander method

Station 34. Jack Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	62	70	77	83	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]	B4[c]
LICHENS: (continued)																
Cladonia coccifera	-	-	NO DATA	-	-	-	NO DATA	-	-	-	NO DATA	-	-	NO DATA	-	t
C. gonecha	-	-		-	-	-		-	-	-		-	-		t	-
C. sp. (cup -like)	-	-		-	-	-		-	-	-		-	-		t	-
Cetraria islandica	1	1		1	1	1		1	1	-		1	1		1	t
C. nivalis	-	-		-	-	-		-	t	-		-	-		-	-
C. cucullata	t	1		2	t	-		1	1	1		t	1		1	1
C. richardsonii	-	-		-	3	3		1	1	1		-	-		1	-
Stereocaulon paschale	-	-		-	2	2		2	2	2		-	-		5	1
Peltigera malacea	-	-		-	2	2		-	-	-		-	-		-	-
P. sp. (no spots)	-	-		1	-	-		1	-	-		-	-		-	-
Thamnolia vermicularis	-	-		-	-	-		-	-	-		-	-		t	t

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

c. New quadrat - established when stakes marking loation of original quadrat(s) could not be located.

Percent cover of plant species - modified Hult-Sernander method

Station 35. Monahan Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	NO DATA	NO DATA	100	100	NO DATA	NO DATA	100	100	NO DATA	NO DATA	98	100	NO DATA	NO DATA	100
Hult-Sernander scale for:[b]																
MOSS:	6			3	6			2	6			5	6			5
SHRUBS/FORBS:																
Betula glandulosa	1			1	3			3	3			4	3			2
Salix reticulata	2			2	1			1	-			-	-			-
S. pulchra	-			-	-			-	-			-	-			1
S. spp.	t			-	-			-	-			-	-			-
Vaccinium uliginosum	3			2	4			3	3			3	4			3
V. vitis-idaea	t			1	t			1	1			1	t			1
Ledum decumbens	2			1	3			3	3			3	4			4
Empetrum nigrum	3			3	3			2	2			4	2			2
Oxycoccus microcarpus	1			1	1			1	t			1	2			1
Rubus chamaemorus	t			-	t			-	-			-	-			-
Petasites frigidus	1			1	t			-	-			-	-			-
Anemone parviflora	-			-	-			-	-			1	-			1
SEDGE/GRASS:																
Carex spp.	4			5	3			3	3			3	1			1
LICHENS:																
Cladonia stellaris	t			1	2			2	t			1	-			-
C. rangiferina	2			1	3			3	2			2	-			-
C. arbuscula	2			2	1			1	t			-	t			1
C. uncialis	-			-	1			1	2			1	t			1
C. gracilis	-			1	-			-	-			1	-			1

Percent cover of plant species - modified Hult-Sernander method

Station 35. Monahan Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (continued)																
Cetraria islandica	1			-	1			1	1			-	-			-
Stereocaulon spp.	1			1	1				2			1	-			1
Peltigera spp.	-			-	1			1	t			1	-			-
MISCELLANEOUS:																
Equisetum arvense	t			1	1			1	-			-	-			-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 36. Monsoon Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	95	100	99	100	100	100	100
Hult-Sernander scale for:[b]																
MOSS:	6	6	6	5	6	6	6	5	6	5	6	4	6	6	6	3
SHRUBS/FORBS:																
Betula glandulosa	5	5	6	3	5	6	6	3	3	2	4	1	6	5	6	4
Vaccinium uliginosum	2	2	2	1	3	4	3	2	2	3	4	3	3	4	5	3
V. vitis-idaea	1	1	3	1	2	2	2	1	1	1	2	1	4	4	4	3
Empetrum nigrum	-	-	-	-	-	-	-	-	1	1	1	1	3	2	3	2
Ledum decumbens	3	3	2	1	2	3	3	1	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Festuca altaica	2	1	-	-	1	1	-	-	2	2	2	-	1	2	-	-
Hierochloe alpina	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Calamagrostis lapponica	-	2	2	-	-	2	2	-	-	2	2	-	-	1	1	-
Gramineae	-	-	-	2	-	-	-	2	-	-	-	2	-	-	-	2
LICHENS:																
Cladona stellaris	t	-	-	-	-	-	-	-	3	1	2	2	1	1	1	1
C. rangiferina	4	3	5	3	2	2	4	2	3	2	3	1	4	3	4	3
C. arbuscula	2	1	1	1	1	-	1	1	2	1	3	1	1	1	1	1
C. uncialis	-	-	t	-	2	-	1	1	1	2	1	1	-	-	1	-
C. gracilis	t	-	1	1	1	-	t	1	t	1	2	1	t	-	3	1
C. deformis	-	-	-	-	-	-	t	-	1	1	1	-	-	-	t	-
C. amaurocraca	-	-	-	-	-	-	-	-	-	-	1	-	-	-	t	-
C. gonecha	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1

Percent cover of plant species - modified Hult-Sernander method

Station 36. Monsoon Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (continued)																
Cladonia cornuta	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Cetraria islandica	2	1	-	1	2	2	2	2	3	2	2	1	2	1	1	1
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Stereocaulon paschale	-	-	-	-	-	-	-	-	2	1	4	2	-	-	1	1
Peltigera aphthosa	2	2	4	2	3	2	3	2	t	-	1	1	2	-	1	1
P. malacea	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 37. Dickey Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	95	100	100	100	95	100	98	100	90	100	100	100	85	100	98
Hult-Sernander scale for:[b]																
MOSS:	4	5	6	4	6	6	6	3	5	4	6	4	4	4	6	2
SHRUBS/FORBS:																
Betula glandulosa	6	5	6	3	-	-	-	-	5	4	5	3	t	1	2	t
Vaccinium vitis-idaea	5	3	5	3	3	4	3	3	6	4	5	3	3	4	5	3
Ledum decumbens	2	2	5	3	2	1	2	3	2	2	2	3	3	2	3	3
Pedicularis labradorica	-	-	-	t	-	-	1	t	1	-	1	2	-	1	1	1
Epilobium angustifolium	t	1	t	-	-	-	-	-	-	-	-	-	1	1	t	-
Dryas octopetala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
SEDGE/GRASS:																
Hierochloe alpina	3	4	5	-	2	3	3	-	2	2	2	-	2	4	4	-
Calamagrostis lapponica	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-
Gramineae	-	-	-	t	-	-	-	t	-	-	-	t	-	-	-	t
Carex spp.	-	-	-	3	-	-	-	2	-	-	-	1	-	-	-	1
LICHENS:																
Cladonia stellaris	t	-	-	t	-	1	-	-	t	-	t	t	-	-	-	t
C. rangiferina	t	1	1	1	-	-	1	1	1	-	1	1	t	-	1	t
C. arbuscula	t	-	1	2	t	1	2	2	t	1	2	3	t	-	2	2
C. uncialis	t	-	1	t	1	1	1	t	1	-	1	t	3	1	1	t
C. gracilis	2	1	1	2	1	1	3	2	2	1	2	1	2	1	1	t

Percent cover of plant species - modified Hult-Sernander method

Station 37. Dickey Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS: (continued)																
Cladonia deformis	t	1	1	-	1	2	2	-	t	-	-	-	t	-	1	-
C. degenerans	1	-	1	1	1	-	1	-	1	1	1	-	1	-	1	-
C. gonecha	-	-	-	t	-	-	-	1	-	-	1	1	-	-	-	1
C. crispata	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	1
Cetraria nivalis	-	-	-	t	t	-	-	-	t	-	-	-	1	-	1	-
C. cucullata	t	1	1	1	t	1	2	2	t	1	-	1	1	-	1	1
C. islandica	1	1	1	1	1	-	2	1	1	-	1	1	t	1	t	-
C. richardsonii	-	-	-	-	-	-	-	-	t	-	1	1	t	-	1	1
Stereocaulon paschale	1	1	1	2	1	2	5	4	2	1	3	3	4	3	6	5
Peltigera aphthosa	1	2	3	3	-	-	-	-	1	-	1	2	-	-	t	-
P. malacea	2	1	-	2	-	-	-	1	-	-	-	1	-	-	-	1
MISCELLANEOUS:																
Lycopodium sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 38. Boulder Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	95	NO DATA	85	100	100	NO DATA	85	99	90	NO DATA	90	100	100	NO DATA	NO DATA
Hult-Sernander scale for:[b]																
MOSS:	6	4		3	5	2		3	5	2		2	4	5		
SHRUBS/FORBS:																
Salix pulchra	2	2		1	-	-		-	3	3		3	4	3		
S. reticulata	1	1		2	-	-		-	t	1		-	t	-		
S. arctica	2	2		t	1	1		-	1	-		-	1	1		
Vaccinium vitis-idaea	t	1		t	t	1		1	t	1		t	t	-		
Antennaria spp.	t	-		t	1	1		1	t	-		t	t	1		
Artemisia arctica	1	1		-	1	2		-	1	2		-	1	2		
Anemone narcissiflora	t	1		-	t	1		1	1	1		t	1	1		
Gentiana glauca	t	-		1	t	-		1	-	-		1	t	1		
Pedicularis lanata	-	-		t	t	1		t	-	-		-	-	-		
Polygonum bistorta	-	-		-	-	-		-	-	1		-	-	-		
Empetrum nigrum	-	-		-	-	-		2	-	-		-	-	-		
Unidentified forb	-	1		-	-	1		-	-	-		-	-	-		
SEDGE/GRASS:																
Hierochloe alpina	1	2		-	1	2		-	1	1		-	1	1		
Festuca altaica	2	1		-	2	1		-	3	3		-	2	2		
Carex spp.	1	2		3	2	2		3	1	2		2	1	2		
Gramineae	-	-		t	-	-		t	-	-		t	-	-		
LICHENS:																
Cladonia stellaris	4	4		4	4	3		3	5	4		3	4	4		
C. arbuscula	t	2		3	t	1		3	t	1		2	-	1		
C. rangiferina	3	3		2	1	1		1	1	1		1	2	2		

Percent cover of plant species - modified Hult-Sernander method

Station 38. Boulder Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
C. uncialis	2	1	NO DATA	1	1	-	NO DATA	1	1	-	NO DATA	1	1	-	NO DATA	NO DATA
C. gracilis	2	1		t	1	1		t	1	-		t	2	1		
C. crispata	-	-		-	-	1		-	-	1		-	-	-		
C. cornuta	-	1		-	-	1		t	-	-		t	-	-		
C. spp. (funnel-form)	-	1		-	-	1		-	-	1		-	-	1		
Cetraria islandica	1	2		1	3	1		1	1	1		1	1	2		
C. cucullata	-	-		t	1	1		1	-	-		t	-	-		
C. nivalis	-	1		1	1	1		1	t	-		-	t	-		
C. richardsonii	1	1		1	t	1		t	t	1		1	1	2		
Dactylina arctica	t	1		1	t	1		1	1	2		t	t	1		
Thamnolia vermicularis	1	1		t	1	-		t	t	-		t	1	1		
Stereocaulon spp.	-	-		-	-	-		-	1	1		1	-	-		

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 39. Summit Lake.

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
Total cover (%)	100	100	100	100	100	100	100	100	100	98	100	98	100	100	100	98
Hult-Sernander scale for:[b]																
MOSS:	4	3	3	1	4	3	4	2	4	2	4	2	3	4	3	2
SHRUBS/FORBS:																
Betula glandulosa	-	1	-	1	3	4	3	3	4	4	4	3	-	1	1	1
Ledum decumbens	-	1	t	1	2	3	2	2	2	3	2	1	1	2	1	2
Vaccinium uliginosum	2	3	2	1	4	4	4	3	3	4	4	3	1	2	1	2
V. vitis-idaea	1	1	1	1	1	1	1	2	1	2	2	2	1	1	2	2
Arctostaphylos alpina	1	2	2	2	-	-	t	-	-	-	-	-	1	3	2	3
Salix pulchra	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	1
S. reticulata	1	1	1	t	1	1	-	-	-	-	-	-	-	-	-	-
S. arctica	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	t
Salix sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Empetrum nigrum	-	-	-	-	-	-	1	-	2	2	2	2	1	2	1	1
Polygonum bistorta	1	2	1	1	1	1	1	1	1	2	1	1	t	1	1	t
Pedicularis sudetica	-	1	-	t	t	-	-	-	t	1	-	t	t	2	1	t
Pedicularis sp. (yellow root)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Pedicularis sp. (curly leaf)	-	-	t	-	-	-	t	-	-	-	-	-	-	-	t	-
Gentiana glauca	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-
SEDGE/GRASS:																
Luzula parviflora	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-
Hierochloe alpina	t	-	t	-	t	-	t	-	1	-	1	-	1	2	1	-
Festuca altaica	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Calamagrostis canadensis	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
Carex spp.	2	3	2	1	2	2	2	1	1	1	1	1	1	3	3	2
Gramineae	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	t

Percent cover of plant species - modified Hult-Sernander method

Station 39. Summit Lake (continued).

Year	62	70	77	83	62	70	77	83	62	70	77	83	62	70	77	83
Quadrat[a]	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																
Cladonia stellaris	3	4	5	5	4	4	5	4	3	2	3	3	4	3	4	4
C. arbuscula	3	1	4	4	2	1	4	2	3	1	4	2	2	1	3	3
C. rangiferina	2	3	3	3	2	3	4	2	2	2	3	2	2	2	4	3
C. uncialis	1	-	1	t	1	1	1	t	1	1	1	t	2	1	1	1
C. gracilis	t	-	2	1	1	1	2	2	1	1	2	1	1	1	1	1
C. cornuta	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
C. crispata	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
C. sp. (funnel-form)	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Cetraria islandica	1	1	1	1	1	1	1	1	t	1	1	1	t	1	t	t
C. cucullata	1	1	1	1	1	1	1	1	t	1	1	1	t	1	t	t
C. richardsonii	1	1	1	1	1	1	t	-	1	2	1	1	1	1	1	1
Alectoria ochroleuca	1	3	2	3	t	-	1	-	-	-	-	-	t	-	-	-
Thamnolia vermicularis	1	1	1	1	t	-	1	t	t	1	t	t	t	1	1	1
Stereocaulon sp.	1	2	3	3	2	2	3	2	2	3	4	3	2	4	4	3
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Peltigera aphthosa	-	-	-	-	1	1	1	1	1	3	1	2	-	-	1	-
P. malacea	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2
P. sp.	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
MISCELLANEOUS:																
fungi	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

a. A = inside exclosure, B = outside exclosure.
b. - = not observed
t (trace) = < 0.5%
1 = 0.5 to 6.3%
2 = 6.3 to 12.5%
3 = 12.5 to 25%
4 = 25 to 50%
5 = 50 to 75%
6 = 75 to 100%

Appendix II

Table of estimated lichen succession stages
for the Nelchina range stations, 1983

Estimated lichen succession stages for the Nelchina range stations, 1983*.

Range station	Succession stage** derived from: $\bar{x}$ % Lichen cover (stage)	$\bar{x}$ Lichen height in inches (stage)	Species comp.	$\bar{x}$ Succession stage	Succession stage derived from: $\bar{x}$ % Lichen cover (stage)	$\bar{x}$ Lichen height in inches (stage)	Species comp.	$\bar{x}$ Succession stage
	A***				B			
1	22 (I-III)	2.5 (III-IV)	III	IIIa	19 (I-III)	2.5 (III-IV)	III	IIIa
2	<1 (I)	2.1 (III-IV)	I	I	<1 (I)	2.1 (III-IV)	I	I
4	70 (III-V)	2.5 (III-IV)	IV	IVa	35 (II-IV)	2.1 (III-IV)	IV	IVa
5	2 (I)	2.5 (III-IV)	III	IIb	21 (I-III)	2.5 (III-IV)	III	IIIa
6	92 (IV-V)	2.9 (III-IV)	IV	IVa	80 (IV-V)	1.3 (II-III)	IV	IVa
7	55 (III-V)	2.1 (III-IV)	IV	IVa	69 (III-V)	2.1 (III-IV)	IV	IVa
8	51 (III-V)	3.4 (IV)	III	IIIb	75 (III-V)	1.3 (II-III)	IV	IVa
9	65 (III-V)	1.7 (III)	IV	IVa	72 (III-V)	1.7 (III)	IV	IVa
10	29 (II-IV)	2.5 (III-IV)	III	IIIa	27 (II-IV)	2.5 (III-IV)	III	IIIa
11	59 (III-V)	2.5 (III-IV)	III	IIIb	40 (II-IV)	2.4 (III-IV)	III	IIIa
12	27 (II-IV)	3.4 (IV)	III	IIIa	33 (II-IV)	2.4 (III-IV)	III	IIIa
13	47 (II-IV)	2.5 (III-IV)	III	IIIa	36 (II-IV)	2.4 (III-IV)	III	IIIa
14	42 (II-IV)	2.5 (III-IV)	IV	IVa	26 (II-IV)	2.1 (III-IV)	III	IIIa
15	48 (II-IV)	2.7 (III-IV)	IV	IVa	44 (II-IV)	2.6 (III-IV)	IV	IVa
16	43 (II-IV)	4.0 (IV-V)	IV	IIIa	94 (IV-V)	2.5 (III-IV)	IV	IVa
17	76 (IV-V)	3.0 III-IV)	IV	IVb	81 (IV-V)	2.0 (III-IV)	IV	IVb
18	32 (II-IV)	3.7 (IV)	III	IIIb	26 (II-IV)	2.2 (III-IV)	III	IIIa
19	11 (I-II)	2.2 (III-IV)	III	IIIa	18 (II-III)	2.2 (III-IV)	III	IIIa
20	26 (II-IV)	2.2 (III-IV)	IV	IVa	21 (II-III)	2.2 (III-IV)	IV	IVa
21	17 (II-III)	2.4 (III-IV)	III	IIIa	29 (II-IV)	2.5 (III-IV)	III	IIIb
22	3 (I)	2.0 (III-IV)	I	I	0 (I)	--	I	I
23	9 (I-II)	2.5 (III-IV)	III	IIIa	60 (III-V)	2.5 (III-V)	III	IIIb
24	76 (IV-V)	3.2 (IV)	IV	IVa	84 (IV-V)	3.0 (III-IV)	IV	IVa
25	53 (III-V)	3.0 (III-IV)	IV	IVa	69 (III-V)	2.2 (III-IV)	III	IIIa
26	91 (IV-V)	3.2 (IV)	V	V	69 (III-V)	2.4 (III-IV)	IV	IVb
27	94 (IV-V)	3.2 (IV)	IV	IVb	100 (IV-V)	2.5 (III-IV)	IV	IVb

Estimated lichen succession stages for the Nelchina range stations, 1983* (continued).

Range station	Succession stage** derived from: $\bar{x}$ % Lichen cover (stage)	$\bar{x}$ Lichen height in inches (stage)	Species comp.	$\bar{x}$ Succession stage	Succession stage derived from: $\bar{x}$ % Lichen cover (stage)	$\bar{x}$ Lichen height in inches (stage)	Species comp.	$\bar{x}$ Succession stage
	A***				B			
28	68 (III-V)	2.7 (III-IV)	III	IIIb	48 (II-IV)	2.5 (III-IV)	III	IIIb
29	71 (III-V)	3.0 (III-IV)	IV	IVa	21 (II-III)	2.2 (III-IV)	III	IIIa
30	85 (IV-V)	3.0 (III-IV)	IV	IVa	47 (II-IV)	2.5 (III-IV)	III	IIIa
31	74 (III-V)	1.8 (III)	IV	IVa	42 (II-IV)	0.8 (I-II)	IV	IVa
32	83 (IV-V)	2.5 (III-IV)	III	IIIb	33 (II-IV)	2.5 (III-IV)	III	IIIa
33	82 (IV-V)	2.2 (III-IV)	V	V	27 (II-IV)	0.8 (I-II)	IV	IVa
34	44 (II-IV)	2.7 (III-IV)	IV	IVa	69 (III-V)	3.0 (III-IV)	IV	IVa
35	32 (II-IV)	2.4 (III-IV)	IV	IVa	20 (I-III)	1.8 (III)	IV	IVa
36	41 (II-IV)	3.4 (IV)	III	IIIb	45 (II-IV)	3.0 (III-IV)	IV	IVa
37	71 (III-V)	2.5 (III-IV)	IV	IVa	76 (IV-V)	2.5 (III-IV)	IV	IVa
38	68 (III-V)	2.5 (III-IV)	IV	IVb	42 (II-IV)	2.5 (III-IV)	IV	IVb
39	91 (IV-V)	2.9 (III-IV)	V	V	89 (IV-V)	2.9 (III-IV)	IV	IVb

* After Skoog, 1959.

** Succession stages:
I = Primary
II = Early
III = Medial
IV = Late
V = Climax

With these stages further broken into early (a) and late (b) components.

*** A = inside exclosure
B = outside exclosure

Appendix III

Table of lichen standing crop for Nelchina caribou range stations, 1983.

Lichen standing crop index for Nelchina caribou range stations, 1983.

Range station	Standing crop index* A**	Standing crop index* B
1	.55 = low	.48 = very low
2	.01 = very low	.01 = low
4	1.75 = medium	.74 = low
5	.05 = very low	.53 = low
6	2.67 = high	1.04 = med. low
7	1.16 = med. low	1.45 = med. low
8	1.73 = med.	.98 = low
9	1.51 = med.	1.22 = med. low
10	.73 = low	.68 = low
11	1.48 = med. low	.96 = low
12	.92 = low	.79 = low
13	1.18 = med. low	.86 = low
14	1.05 = med. low	.49 = very low
15	1.30 = med. low	1.14 = med. low
16	1.72 = med.	2.35 = med. high
17	2.28 = med. high	1.62 = med.
18	1.18 = med. low	.57 = low
19	.24 = very low	.40 = very low
20	.57 = low	.46 = very low
21	.41 = very low	.73 = low
22	.06 = very low	0 = very low
23	.23 = very low	1.50 = med.
24	2.43 = med. high	2.52 = high
25	1.59 = med.	1.52 = med.
26	2.91 = high	1.65 = med.
27	3.01 = high	2.50 = high
28	1.84 = med.	1.20 = med. low
29	2.13 = med. high	.46 = very low
30	2.45 = med. high	1.18 = med. low
31	1.33 = med. low	.34 = very low
32	2.08 = med. high	.83 = low
33	1.80 = med.	.22 = very low
34	1.19 = med. low	2.07 = med. high
35	.77 = low	.36 = very low
36	1.39 = med. low	1.35 = med. low
37	1.78 = med.	1.90 = med.
38	1.70 = med.	1.05 = med. low
39	2.64 = high	2.58 = high

* Standing crop index: a measure of the quantity of lichen available, determined by multiplying proportion lichen cover (decimal equivalent) by mean lichen height (in inches):

< 0.5 = very low
0.5 - 0.99 = low
1.0 - 1.49 = med. low
1.5 - 1.99 = medium
2.0 - 2.49 = med. high
2.5+ = high

** A = inside exclosure, B = outside exclosure

Appendix IV

Table of use of Nelchina range stations, measured as the difference between lichen standing crop index inside versus outside exclosures.

Use at Nelchina range stations, measured as the difference between lichen standing crop index inside versus outside exclosures*

Range unit	Range station	A-B*** (Absolute use)	Use rating	$\frac{A-B}{A}$ (Relative use)	Use rating
1	26	1.26	H	.43	M
	27	0.51	M	.17	L
2	23	-1.27	0	0	0
	24	-0.09	0	0	0
	25	0.07	L	.30	M
	35	0.41	L	.53	H
4E	33	1.58	H	.88	H
4W	34	-0.88	0	0	0
5	15	0.16	L	.12	L
	31	0.99	M	.74	H
	32	1.25	H	.60	H
6	17	0.66	M	.38	M
	18	0.61	M	.27	M
	19	-0.16	0	0	0
	20	0.11	L	.19	L
	21	-0.32	0	0	0
	22	0.06	0	0	0
	37	-0.12	0	0	0
	38	0.65	M	.38	M
	39	0.06	L	.02	L
9	36	0.04	L	.03	L
8	30	1.27	H	.52	H
12	28	0.64	M	.34	M
	29	1.67	H	.78	H
15	16	-0.63	0	0	0
13	1	0.07	L	.13	L
	2	0	0	0	0
	4	1.01	H	.58	H
	5	-0.48	0	0	0
	6	1.63	H	.61	H
	7	-0.29	0	0	0
	8	0.75	M	.43	M
	9	0.29	L	.19	L
	10	0.05	L	.07	L
	11	0.52	M	.35	M
	12	0.13	L	.14	L
	13	0.32	L	.27	M
	14	0.56	M	.53	H

* Use rating	A-B	A-B/A
	0	0
L (light) =	.01-.49	.01-.24
M (moderate) =	.05-.99	.25-.49
H (heavy) =	1.00+	.50+

** A = inside exclosure
B = outside exclosure

*** A-B = standing crop index inside minus standing crop index outside exclosure.

Appendix V

Table of comparison of range station photos taken in 1957, 62, 66, 70, 77 and 83 to determine whether these support corresponding lichen percent cover and condition readings.

Comparison of range station photos taken in 1957, 62, 66, 70, 77, and 83 to determine whether these support corresponding lichen percent cover and condition readings.

Range unit	Range station	Evaluation of photo support at plot*, ** A	B	Comments
1	26	++	++	
	27	+	++	
2	23	0	++	"A" photos not good enough to evaluate
	24	-	+	
	25	+	++	
	35	0	0	Photos not good enough to evaluate
4	33	0	++	"A" photos not good enough to evaluate
	34	++	++	
5	15	++	++	
	31	++	++	
	32	0	0	Photos not good enough to evaluate
6	17	-	-	
	18	++	-	
	19	-	-	Sedge photos
	20	0	0	Shrub photos
	21	0	0	Shrub photos
	22	0	0	Shrub photos
	37	++	++	
	38	+	+	
	39	++	++	
8	30	++	++	
9	36	0	++	"A" photo not good enough to evaluate
12	28	++	-	
	29	-	+	
13	1	0	0	Photos not good enough to evaluate
	2	0	0	Photos not good enough to evaluate
	4	++	-	
	5	0	0	Photos not good enough to evaluate
	6	++	++	
	7	++	++	
	8	++	++	
	9	++	++	
	10	0	0	Shrub photos
	11	0	0	Photos not good enough to evaluate
	12	++	++	
	13	++	++	
	14	+	0	"B" photos not good enough to evaluate
15	16	0	+	"A" photos not good enough to evaluate
Totals	++	16	18	
	+	4	4	
	-	4	5	
	0	14	11	

* A = inside exclosure, B = outside exclosure

** ++ = complete support of readings; + = partial support of readings; - = no support of readings; 0 = no photo analysis

Appendix VI

Table of condition of Nelchina caribou range stations, 1983

Percent cover of plant species - modified Hult-Sernander method

Station 1: Susitna Lake West.

Year	57	66	70	77	83	70	77	83	57	66	70	77	83	70	77	83
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2
Total cover (%)	85	85	100	100	100	100	100	90	100	100	100	100	95	100	100	95
Hult-Sernander scale for:[b]																
MOSS:	4	4	4	6	4	5	6	5	3	2	4	5	3	3	6	3
SHRUBS/FORBS:																
Betula glandulosa	3	3	5	6	3	4	5	3	3	1	3	4	4	2	3	2
Ledum decumbens	4	5	5	6	4	6	5	3	4	4	4	4	3	3	4	3
Empetrum nigrum	3	4	4	3	1	-	-	-	1	1	2	1	2	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1
V. vitis-idaea	3	4	4	5	3	1	3	2	3	3	3	4	2	3	4	2
Rosa acicularis	1	t	1	1	1	-	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	2	4	2	-	-	-	-	1	-	-	-
Picea glauca	-	-	-	-	-	-	-	-	1	1	1	-	-	1	-	-
Petasites frigidus	-	-	-	-	1	3	2	3	1	1	2	1	1	2	2	1
Rubus chamaemorus	1	-	2	1	t	1	1	1	1	t	1	1	-	2	1	t
Epilobium angustifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. latifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrola grandiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxycoccus microcarpus	-	1	-	-	-	-	-	-	t	-	-	-	t	1	1	t
Picea mariana	-	-	-	-	t	-	-	-	-	-	-	2	-	-	3	2
Arctostaphylos sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Condition of Nelchina caribou range stations, 1983.

Nelchina range unit	Range station	Habitat type	Exclosure	Plots
1	26	heath	intact	intact
	27	shrub/heath	slightly damaged	intact
2	23	heath	slightly damaged	all stakes missing - replaced A1, A2, & set B3
	24	shrub/heath	slightly damaged	intact
	25	shrub/heath	intact	intact
	35	shrub/heath	slightly damaged	intact
4	33	heath	intact	intact
	34	shrub/heath	intact	all B stakes missing - set B3, B4
5	15	shrub/heath	intact	intact
	31	heath	moderately damaged	B2 stakes missing
	32	heath	slightly damaged	all B stakes missing - set B3
6	17	shrub/heath	intact	B2 stake missing - replaced
	18	shrub/heath	intact	intact
	19	sedge	slightly damaged	intact
	20	shrub/sedge	intact	intact
	21	sedge	intact	intact
	22	shrub/heath	intact damaged	intact
	37	shrub/heath	slightly damaged	intact
	38	shrub/sedge	slightly damaged	some A & B stakes missing - replaced A1, A2, B1
	39	shrub/heath	intact	intact
8	30	white spruce/heath	intact	intact
9	36	shrub/heath	intact	intact
12	28	shrub/heath	intact	all stakes missing - replaced A1, A2, & set B3
	29	shrub/heath	intact	intact
13	1	black spruce/moss	intact	intact
	2	black spruce/bog	intact	intact
	4	black spruce/heath	heavily damaged	intact
	5	black spruce/heath	slightly damaged	intact
	6	black spruce/sedge	slightly damaged	B1, B2 missing - set B3, B4
	7	black spruce/heath	heavily damaged	B1, B2 missing - set B3, B4
	8	black spruce/heath	moderately damaged	intact
	9	black spruce/heath	heavily damaged	intact
	10	black spruce/heath	intact	intact
	11	black spruce/heath	intact	some A & B stakes missing - replaced A2, B1
	12	black spruce/heath	slightly.damaged	intact
	13	black spruce/heath	intact	intact
	14	black spruce/heath	moderately damaged	intact
15	16	white spruce/heath	intact	intact