Alaska Department of Fish and Game
Division of Wildlife Conservation

Research Progress Report

Analysis of Nelchina Caribou Range - III

by

James W. Lieb

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SUMMARY

As a continuation of the Nelchina caribou range relationships study initiated in 1955 and last reported on in 1986, 39 range stations were examined during the summer of 1989. Three new range stations were established in the Talkeetna Mountains summer range in 1989. 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.

Lichen availability and condition varied greatly among portions of the Nelchina range sampled. Approximately 21% of the area evaluated, encompassing the northwest, northeast, and southwest corners provide good production of preferred lichen species. Another 2% of the range, also in the northwest quadrant was rated as fair. The remaining 77% exhibited poor lichen production. This represents a substantial decline in preferred lichen availability from that observed in 1983 when the range was rated as approximately 1/3 good condition, 1/3 fair and 1/3 poor.

The main Nelchina herd calves and spends at least some of the summer in the eastern portion of the Talkeetna Mountains. Within much of this core calving area, subjected to heavy use by caribou since at least the early 1950s, preferred lichen biomass has been virtually eliminated. In 1989 lichen standing crop here was lower than ever recorded. Examination of exclosures, on the other hand, indicated that this area is potentially one of the best producers of lichens within the overall Nelchina range. On much of the fall and winter range, standing crop estimates approximate the low levels recorded in the 1960s, and exceeded these levels in only a few range units: slightly on the Lake Louise Flat, and substantially only in the northwest and northeast corners of the range.

How vascular plants, particularly sedges, grasses, forbs, and shrubs are used by Nelchina caribou needs to be evaluated. Limited field observation suggests that ample quantities of various vascular plant types provide adequate forage during the calving period and the

early summer in the heavily utilized western mountains. Studies in the 1950s indicated that sedges were a major component of the winter diet of Nelchina caribou.

Analysis of overall range condition over the past 35 years shows widespread lichen deterioration occurred during the 1960s. During the same period herd size increased from roughly 15,000 in 1945 to a peak of possibly 70,000 in 1965, after which it began declining. As the population reached a low point of approximately 10,000 in the early 1970s, lichen standing crop began increasing. At the same time the NCH started to grow. By 1983, with the herd at 25,000 caribou and continuing to grow, lichens generally ceased to increase in areas of substantial caribou use.

While substantial lichen recovery was documented during the approximately 10 years of relatively light use (1970-1980), this early 1980s level of lichen growth probably represents only a small amount when compared with the estimated 50 years of lichen development occurring during the first half of this century. It took roughly 15 years (1953-1968) for 40,000-70,000 caribou to reduce a relatively high biomass lichen range to remnants. Today it has taken a herd of 25,000-45,000 caribou less than 10 years to reduce a relatively modest lichen range to approximately the same remnant level. With low lichen standing crop observed in nearly three-fourths of the Nelchina range, with the possibility of declining herd productivity and body condition, and with increased use of peripheral range and extension of winter range east into Canada, concern is growing as to whether the Nelchina range is capable of supporting current caribou numbers.

I recommend that most range stations be maintained and periodically examined and additional range evaluation sites be established in key calving and summering areas. In addition, I recommend that the winter range area of Game Management Units 11 and 12, increasingly utilized in the late 1980s and early 1990s, be described and examined for condition. I also recommend that we begin and continue to evaluate the relative and seasonal use of various plants. This can be done by direct observation and analysis of collected rumen/fecal pellet samples, and by evaluating the nutritional status of Nelchina caribou through body condition measurements.

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

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BACKGROUND

The Nelchina caribou (*Rangifer tarandus*) herd (NCH) 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 hunters have harvested over 110,000 Nelchina caribou. 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 herd and its range (Figure 1). These stations were re-examined in 1966, 1970, 1977, and 1983. Of the original 39 stations, 38 still exist.

Pegau (1972) compiled early range findings by H. C. Hanson (1958) and R. O. Skoog (1959, 1962, 1968), with range station data collected in 1960 and 1970. Lieb et al. (1986) reported the findings from range station examinations done during the summers of 1977 and 1983. The report summarized and discussed range conditions and trend from 1956-1983.

OBJECTIVES

I 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 use by the caribou. My 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 behavior.

Three additional range stations were built in the Talkeetna Mountains summer range in 1989, to provide better information on this area.

STUDY AREA

Nelchina caribou range use before 1965 was 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 mi^2. 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, as documented in recent years, across the Mentasta Mountains to east of 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 climate was presented by Skoog (1968). Pegau (1972) 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 used in 1989 were those that had evolved from 1953 through 1966 and were the same as those employed 1970 through 1983.

Pegau (1972) described the exclosures that were built at the original 39 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 used 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 five 4 x 5-foot subplots, and within these subplots the vegetation was measured within a centered 1-m^2 quadrant. Originally 1 quadrant/plot was evaluated, but beginning in 1970, a second quadrant in each plot was analyzed. The remaining subplots were not sampled.

Evaluation at each plot included the following: 1) quadrants were photographed from established photopoints; 2) the vegetation within each quadrant 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 according to the following scale:

Hult-Sernander Scale	Percent Cover of the Square Meter
t	trace
1	1 to 6%
2	7 to 13%
3	13 to 24%
4	25 to 49%
5	50 to 74%
6	75 to 100%

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% 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 exposed roots or lower branches of shrubs.

Good Range Condition - Good cover (20% or more cover by lichens) but short (1 to 2.5 inches), or with fair cover (10-20%) and good height (2 to 5 inches). Usually much *Cladonia arbuscula* and *C. rangiferina* and some *C. stellaris*. Packing and fragmentation of lichens slight. Few or no pedestals, or cut hummock, or trails. Few to no broken branches, or exposed roots or lower branches.

Fair Range Condition - Good cover (20% or more cover by lichens) but short (1/2 to 1 inch), or with low cover (5%) 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% or more cover by lichens) but short (about 1/2 inch), or with low cover (0-5%) 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 other seasons. As such, he felt the overall range 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). Table 1 lists the size, number of range stations within, and principle season of use of the various range units. Lieb et al. (1986) summarized vegetation histories before 1989 for each range station in a range unit.

Percent cover, as determined by the modified Hult-Sernander method, was tabulated for all plant species identified at each range station (Appendix A). Based on the importance given to certain species of preferred lichens (reindeer lichens) by prior investigators, and the literature on caribou-range relationships, a key component of the evaluation was

directed toward this group of plants. Reindeer lichens, for purposes of the report, include *C. stellaris, C. arbuscula,* and *C. rangiferina.*

Lichen percent cover was used in comparing changes in lichen abundance over time relative to changes in caribou numbers. Table 2 gives the mean percent cover for all lichens and reindeer lichens for specific range units. Figures 2-6 compare changes in mean percent cover of preferred lichen species with estimated Nelchina caribou herd size for the period 1957-1989. Both estimated caribou herd size and caribou seasonal distribution are from Pitcher (1982), Lieb (1987) and Lieb (1989).

An index of lichen standing crop was determined by multiplying percent lichen cover (decimal equivalent) by mean lichen height (inches). This index was determined for all range stations (Appendix B). Long-term use and disturbance were characterized by subtracting the lichen standing crop index outside from that inside the exclosures divided by the standing crop index inside (Appendix C). In Table 3 standing crop inside versus outside the exclosures is compared by averaging differences in standing crop index values for the range units. Condition and disturbance of lichens at each range station were rated. These ratings were averaged for various range units and compared from 1983 to 1989 (Table 4).

As a check, the photographs collected over the years for each range station were examined. These photos were compared with corresponding lichen percent cover and condition measurements. Table 5 summarizes changes in total plant cover for range units with at least 3 range stations.

All percent cover measurements are listed in Appendix A in order to provide continuity with information provided in past Nelchina caribou range reports.

RESULTS

The physical condition of each established range station visited in 1989 was briefly summarized (Appendix D). Of 39 stations visited, 18 (46%) were intact, 11 (28%) were slightly damaged, 6 (15%) were moderately damaged and 4 (10%) were heavily damaged. Damage to exclosure fencing and quadrant stakes appeared to result primarily from moose and caribou. A few incidents of damage by bears were noted. Human vandalism also occurred at a number of sites near access points on lakes or adjacent to roads. During the 1989 surveys, repairs on exclosures and plots were made. Sites where the quadrant vegetation within exclosures was substantially damaged were not included in the evaluation of undisturbed range development and condition.

In tabulating and analyzing the cover and condition data for range stations there was some concern that with 5 different investigators estimating cover and condition over the period 1957-1989, apparent changes might be a function of the observer rather than, or in

addition to, range ecology. From comparing plant species composition, standing crop data, and use data with the corresponding photographs taken at stations, most of the data collected by other investigators appears to closely represent my evaluations of the photographs.

Range Unit 1

There are 2 range stations in this unit in the northwest corner of the Nelchina caribou range: No. 26 - Denali Highway Mile 115 and No. 27 - Denali Highway Mile 123. Exclosures were built in 1960. Vegetation has been described by Hanson (1958) and by Skoog (1962). Lichen development and growth rates observed in this range unit suggest that much of the lichen habitat here is capable of supporting rapid growth and high standing crops of climax lichens when left undisturbed or disturbed only slightly. Lieb, et al. (1986) summarized historical records:

> 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 lichen found throughout this unit deteriorated during the 1960s. By 1966 *C. stellaris* mats had been greatly diminished. By the 1970s reduction in caribou use began to have a positive effect. Reindeer lichens showed vigorous recovery during the late 1970s but slowed some in the early 1980s, apparently in response to increased but light caribou use.

Use apparently continued to increase during the late 1980s in this unit (Table 3), resulting in lichen development stabilized at moderate levels. Inside the exclosures the 1989 percent cover for both total lichens and reindeer lichens increased to 121% and 164% of the respective 1962 lichen levels (existing shortly after the exclosures were built). Outside the exclosures percent cover, after declining drastically from the 1962 levels, has rebounded, increasing by 1989 to 97% and 90% respectively of the 1962 levels.

At Range Station 26 in 1989, total lichen standing crop inside this exclosure had an index of 3.20, a 27% increase over the 2.51 index determined in 1983. Percent cover of reindeer lichens increased during this same period from 50% to 80%. This development occurred even with the exclosure showing light use after having been breached by caribou. Lichen condition within this exclosure was rated as excellent, with a numerical condition rating of 4.0 given in both 1983 and 1989. The percent cover of reindeer lichen in this exclosure was the highest observed in any Nelchina exclosure in either 1983 or 1989. The total lichen standing crop here was the second highest recorded for an exclosure, and possibly might have developed the highest crop had it not been disturbed. Outside the Range Station 26 exclosure, total lichen standing crop index was 1.20 in 1989 and 1.15 in 1983. These lichen quantities, about 40% of that inside the exclosure, are the product of varying levels of caribou use from light to heavy over at least the last 15 years. In the face of increased, though rated as moderate, use from 1983 to 1989 both lichen standing crop and percent cover of reindeer lichens remained at about the same level or increased slightly.

At Range Station 27, total lichen standing crop index inside the exclosure was 2.87, a 17% increase over the 2.46 index recorded in 1983. Percent cover of reindeer lichens increased substantially from 52% in 1983 to 73% in 1989. Lichen condition within this exclosure was considered excellent and rated at 4.0 in 1989, an increase from 3.5 in 1983. Outside the exclosure lichen standing crop index was 2.10 in 1989, similar to the 2.05 index of 1983. From 1983 to 1989 reindeer lichen percent cover declined slightly from 49% to 44%. Lichen disturbance outside the exclosure was rated at 2.0 in 1989, a substantial increase over the 1.0 rating given in 1983.

Under moderate levels of disturbance, lichen condition in Range Unit 1 can be rated as good. We anticipate that if caribou use of this area continues to increase, lichen standing crop, percent cover and condition will begin or continue to decline.

Range Unit 2

There are 4 range stations in this unit: No. 23, Denali Highway Mile 94; No. 24, Denali Highway Mile 100; No. 25, Denali Highway 108; and No. 35, Monahan Lake. The exclosures were built in 1960. Vegetation in the unit has been described by Hanson (1958) and by Skoog (1962). This small range unit encompasses mostly level and poorly drained bottomland between the upper Susitna and upper Nenana rivers. Lieb, et al. 1986 summarized the historical records for this area:

> 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. 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 incomplete for the 1970s it appears probable that use of the area declined appreciably, and at disturbed sites lichens recovery proceeded. In the early 1980s, relatively light to moderate use slowed or stopped further lichen recovery in much of the unit.

By the late 1980s increased caribou use was observed in portions of this unit. This increased use resulted in declines in lichen quality and quantity throughout much of this area (Tables 2 and 4). Inside the exclosures that remained intact total lichen and reindeer lichens percent cover had increased steadily until 1989, to 184% and 273% of the respective 1962 lichen levels. Outside the exclosure these percentages increased from 1970 through 1983 to 196% and 156% respectively and then declined by 1989 to 148% and 78% of the 1962 levels. Lichen standing crop index outside exclosures in 1989 declined on the average to 67% of 1983 levels while inside exclosures, the index increased on the average to 120% of 1983 levels.

At Range Station 23 in 1989 a portion of the exclosure fence was found broken down, and moderate amounts of trampling by both caribou and moose had occurred inside. With very few lichens present inside this exclosure, standing crop index was 0.15 in 1983 and 0.01 in 1989, with only trace amounts of reindeer lichens present both years. Outside the exclosure more lichen growth existed. Standing crop index declined from 1.33 in 1983 to 0.83 in 1989. Percent cover for reindeer lichens declined from 32% in 1983 to 16% in 1989. Since the outside readings for 1989 were of newly established plots no definite conclusions were drawn concerning lichen changes at the site. Disturbance/use in this area appears, at the least, to equal that observed in 1983.

At Range Station 24 standing crop index for lichens inside the exclosure was 2.52 in 1989, increasing from 2.07 in 1983. Percent cover for reindeer lichens was 20% in 1983 increasing to 34% in 1989. Lichen condition here was excellent with numerical ratings of 3.5 in 1983 and 4.0 in 1989. Outside the exclosure standing crop index was 1.49 in 1983 and 0.78 in 1989. Percent cover for reindeer lichens was 21% in 1983 declining to 9% in 1989. Even though lichen condition was rated as 3.0 (good) and disturbance was rated as light to moderate in both 1983 and 1989, increased use has probably been a factor in the substantial decline in lichen quantity at this site.

At Range Station 25 standing crop index for lichens inside the exclosure was 1.08 in 1983 and 1.39 in 1989. Percent cover for reindeer lichens was 11% in 1983 increasing to 25% in 1989. Lichen condition increased from a rating of 2.5 in 1983 to 3.5 in 1989. With little if any disturbance inside the exclosure for many years, shrub birch is now appreciably denser and taller than outside. While lichen succession has proceeded at a measurable rate inside the exclosure, total lichen production has increased to only a minor degree. I suspect that this is partially a result of the undisturbed brush development inside the exclosure. Outside the exclosure lichen standing crop index was 1.07 in 1983 and 1.01 in 1989. Percent cover of reindeer lichens was 6% in 1983 and 4% in 1989. Disturbance was rated as 0.5 (light) in 1983 and increased to 1.5 (moderate) in 1989. While little if any change occurred from 1983 to 1989, at current or increased levels of caribou use, lichens can be expected to remain static or decline in quantity at this site.

At Range Station 35 standing crop index for lichens inside the exclosure was 0.29 in 1989, a slight decrease from 1983 when it was 0.37. Percent cover of reindeer lichen was 16% in 1983 and 12% in 1989. The exclosure was found broken down in 1989 and light to moderate disturbance had occurred inside. Outside the exclosure lichen standing crop index declined from 0.13 in 1983 to 0.02 in 1989. Percent cover of reindeer lichens was 4% in 1983 and 2% in 1989. Apparently an appreciable increase in use of the area by caribou has had a negative impact. From 1983 to 1989 lichen condition outside declined from fair (2.0) to poor (1.0) and disturbance increased from light (0.5) to moderate (1.5). The exclosure at this station has had major damage done to it twice over the past 20 years, providing insufficient time for substantial lichen recovery. Based on early records indicating good lichen production here, I believe this site is capable of substantially greater lichen production than our exclosure data suggest.

If caribou use remains at current levels or increases in Range Unit 2, lichen standing crop and condition can be expected to continue to decline.

Range Unit 4

There are 2 range stations in this unit: No. 33, Soule Lake and No. 34, Jack Lake. The exclosures were built in 1960. Skoog described the vegetation of this area in 1959 and in 1962. This northwestern unit is mostly mountainous summer and fall range for caribou. Lieb, et al (1986) summarized historical records indicating that:

> 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 NCH in the late 1960s demonstrated dramatically how reasonably good lichen 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, some of the unit in 1983 was fairly productive summer and fall range. The light but increasing use in the late 1970s and early 1980s probably allowed some recovery at heavily damaged sites, but continued recovery here will probably cease if use increases.

Caribou use has continued to increase through the 1980s in some portions of this range unit (Table 3). Areas where caribou concentrate in the summer and fall continue to support very low amounts of lichens. Without a substantial reduction in caribou use these areas will continue to have minimal lichen standing crop.

At Range Station 33, lichen standing crop index in 1989 was 1.15 inside the exclosure as compared to 1.02 in 1983. Reindeer lichen percent cover here declined from 33% in 1983 to 21% in 1989. The exclosure was found breached in 1989 and use within was classified as light. There is no reason to believe that had caribou not broken into the exclosure lichen quantity and succession would have substantially improved. Outside the exclosure standing crop index declined from 0.10 in 1983 to 0.02 in 1989. Percent cover of reindeer lichens likewise declined from 4% in 1983 to <1% in 1989. This translates to an increase in relative use (foraging and/or trampling) of available lichens from 90% in 1983 to 98% in 1989. The lichen recovery observed from the late 1970s into the early 1980s was reversed by the late 1980s, probably in response to increased caribou use. Without a substantial reduction in such use the site can be expected to continue to have very little if any lichen development.

At Range Station 34 in 1989, the lichen standing crop index was 1.26 similar to the 1.30 determination of 1983. Reindeer lichen percent cover was 31% in 1989, up from 21% in 1983. Lichen condition increased from a "good" rating of 3.0 to an "excellent" rating of

4.0. This exclosure may be another example of lichen mat expansion being limited by interspecific competition and micro-substrate and moisture conditions. Outside the exclosure, the standing crop index was 1.53 in 1983 and 1.50 in 1989. Percent cover of reindeer lichen was 26% in 1983 and 28% in 1989. Lichen condition assessments for this site declined from 3.0 in 1983 to 2.5 in 1989 while disturbance estimates increased from 0 to 1.5, suggesting increased use. With mostly static lichen development both inside and outside the exclosure it appears lichen have reached a competitive equilibrium with shrubs and mosses. Caribou use of this site appears minimal. Increased disturbance may primarily be the effect of recent trampling by moose and caribou passing through the area, but with little foraging by caribou.

Range Unit 5

There are 3 range stations in this unit: No. 15, Big Lake; No. 31, Deadman Lake; and No. 32, Butte Lake. Range Station 15 was built in 1956, while range stations 31 and 32 were built in 1960. Hanson (1958) has described Range Station 15 vegetation, and Skoog (1962) has described vegetation at the other 2 sites. Skoog (1968) felt that with preferred forage production high, this unit could be one of the most important for Nelchina caribou during summer and early fall. Lieb, et al (1986) summarized the historical records for this area:

> Hanson (1958) found lichen biomass 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. In spite of the heavy use, this unit may still have been reasonable summer range during this period. Some lichens plus various vascular plants, apparently important as summer 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.

By the late 1980s caribou use had increased from an estimated moderate level (rated at 0.55 in 1983) to a heavy level (rated at 1.77 in 1989). In 1989 percent cover of total lichens and reindeer lichens averaged 14 and 3 percent respectively, the lowest determined for this range unit over the 30-year period of range evaluation. The highest mean lichen percent cover was recorded with the first readings in 1962: 46% and 26% respectively.

At Range Station 15 in 1983 the exclosure protected a robust stand of near climax reindeer lichens. After a period of low caribou use and lichen recovery in the 1970s, by 1983 caribou use had increased and lichen recovery had ceased outside the exclosure. In

1989, standing crop index for lichens inside the exclosure was 1.55 as compared to 1.00 in 1983. Percent cover for reindeer lichens increased from 19% in 1983 to 27% in 1989. Lichen condition was rated as excellent (4.0), up from 3.0 in 1983. The established plots inside the exclosure under-represented lichen development in the exclosure as a whole: substantially greater lichen development occurred within most of the exclosure than portrayed at the two plots. Outside the exclosure standing crop index was 0.53 in 1983 and 0.43 in 1989. Percent cover of reindeer lichens was 14% in 1983 and 8% in 1989. Relative use increased from a "moderate" rating of 0.47 to a "heavy" rating of 0.72. During this same period lichen condition declined from a "fair" rating of 2.5 to 2.0, and disturbance at this site increased from a "moderate" rating of 1.5 to 2.0. If caribou use continues at the 1989 level or increases, the low standing crop of lichens in the Big Lake area can be expected to decline to even lower levels.

At Range Station 31 in 1989 the exclosure was found to have been breached by caribou. Lichen standing crop index inside was 0.70, about the same as the 1983 reading of 0.71. Percent cover of reindeer lichens increased from 8% in 1983 to 19% in 1989. Lichen condition was rated "fair" at 2.0 in 1983 and 1989. Apparently the caribou activity inside the exclosure was minimal and did not prevent at least some lichen development. Outside the exclosure the standing crop index in 1989 was 0.07 down from 0.18 in 1983. Percent cover of reindeer lichens declined from 8% in 1983 to a trace in 1989. Relative use increased from a "heavy" rating of 0.75 in 1983 to 0.90 in 1989. Lichen condition for the same period declined from a "moderate" (2.0) to "poor" (1.0). Apparently use levels at this site, either stable or increasing, are associated with disturbance levels even higher than recorded in 1983, resulting in lichen standing crops reduced to trace levels.

At Range Station 32 in 1989, the exclosure was found breached by caribou. Lichen standing crop index inside the exclosure was 0.86, about the same as the 1983 reading of 0.85. Percent cover of reindeer lichens in 1989 was 28%, up from 18% in 1983. In the face of an increased level of disturbance inside the exclosure, from light (0.5) in 1983 to heavy (3.0) in 1989, lichen standing crop did not increase. Successional development proceeded substantially.

Outside the exclosure the standing crop index averaged 0.12 in 1989, down from 0.30 in 1983. Percent cover of reindeer lichens also declined, from 6% in 1983 to 2% in 1989. Relative use increased from moderate (0.65) in 1983 to heavy (0.86) in 1989. Lichen condition at this site declined from fair (2.0) in 1983 to poor (1.0) in 1989. Much like at Range Station 31, caribou use at Butte Lake increased to a level where the modest lichen growth that occurred in the 1970s had been almost completely removed.

While Range Unit 5 may continue to provide reasonably good summer range when caribou are foraging on growing vascular plants, it can be expected to be of less value during other periods of the year because of the very low current levels of lichen growth.

Range Unit 6

There are nine range stations in this unit: No. 17, Denali Highway Mile 9; No. 18, Denali Highway Mile 18; No. 19, Denali Highway Mile 29; No. 20, Denali Highway Mile 47; No. 21, Denali Highway Mile 56; No. 22, Denali Highway Mile 65; No. 37, Dickey Lake; No. 38, Boulder Lake; and No. 39, Summit Lake. The exclosures were constructed in 1960 and the original readings of the vegetation were made by Skoog (1962). Much of this northeastern unit is unavailable as winter caribou range because of the heavy snow pack that persists late into spring. Over recent times variable numbers of caribou have used this unit during summer and fall. Lieb, et al. (1986) summarized historical records:

> Prior to the early 1960s forage lichens were abundant in many areas of this unit, especially in the central shrub birch region between the McClaren River and Tangle Lakes. 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. Still 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 some 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, this western portion of the unit supports fair to good expanses of reindeer lichen stands, which apparently received only light use in the early 1980s. 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 1970s in some areas and into the early 1980s in other areas.

In 1989, use of the eastern area was rated as light. Observations of large numbers of caribou using portions of Range Unit 6 were made during some falls in the late 1980s. Such use is not reflected in overall lichen changes in Range Unit 6 because only a couple of range stations were in the areas of use. For instance, Range Station 19, in an area of recent fall caribou use, saw lichen standing crop decline from 0.29 in 1983 to 0.05 in 1989, while Range Station 39 which has received little if any recent caribou use increased its standing crop from 1.71 in 1983 to 2.64 in 1989.

Overall range condition improved from fair in the early 1970s to good in the early 1980s. In 1989 overall condition was about the same as observed in 1983. Outside the exclosures average total lichen and reindeer lichen percent covers, after declining from 48% and 20% respectively in 1962 to 38% and 14% in 1970, increased slowly through the 1970s and

1980s to 52% and 24% in 1989. Inside the exclosures these percent covers increased slowly but continuously from 44% and 20% respectively in 1962 to 53% and 28% in 1989. While much of this northern uplands area received only light use recently and the lichens present here are in fairly good condition, about half of the area (the southwest portion) appears to have a moderate potential for stocking lichens. Until recently, available lichens were used substantially only in fall. With recent increases in use of the eastern portion of this range unit from late summer through early winter, range effects may soon be observable.

Range Unit 8

Range Station No. 30, Middle Fog Lake, is the only one in this unit. The exclosure was built in 1960. Skoog (1962) described the vegetation of this site. This unit forms an extended riparian band along the Susitna River between the eastern Talkeetna Mountains to the south and the Chulitna Mountains portion of the Talkeetna Mountains to the north. With only 1 range station within the unit, it is difficult to evaluate range condition and use on a unitwide basis. Lieb et al (1986) summarized historical records:

> Extensive movements between calving and summering areas during the late 1950s and early to mid-1960s were responsible for appreciable lichen deterioration in the vicinity of the range station at Fog Lakes. Apparently this use extended throughout a good deal of the central portion of Range Unit 8. With the decline in caribou numbers by the early 1970s, lichen condition began improving and continued to improve through 1983 in this area. Although herd size has appreciably increased, caribou apparently have not resumed using the immediate Fog Lakes area in numbers sufficient to suppress lichen recovery. We suspect adjacent 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 here. 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 a substantial degree - possibly the reason why lichen condition has continued to improve into the early 1980s.

Within the exclosure, percent cover for all lichens and reindeer lichens increased from 62% and 31% respectively in 1983 to 74% and 36% in 1989. Lichen condition improved during this period from a rating of 3.0 in 1983 to 4.0 in 1989. Outside the exclosure during the same time period percent cover for all lichens and for reindeer lichens remained fairly constant: 31% and 6% respectively in 1983 versus 32% and 7% in 1989.

Lichen condition declined from a rating of 2.0 in 1983 to 1.0 in 1989, suggesting a substantial increase in use at this site. Relative use based on the difference in standing crop inside versus outside the exclosure was heavy in both 1983 (0.76) and 1989 (0.88). The changes reflect the growth of the NCH, and the herd's continuous summer use of this and adjacent range units together with increasing fall and winter use of Range Unit 8.

Range Unit 9

The single range station in this unit, No. 36 - Monsoon Lake, was constructed in 1960. Skoog (1962) described the area's vegetation. With only one range station in this area, the Alphabet Hills, it is difficult to evaluate caribou range condition and use on a unitwide basis. Lieb et. al (1986) summarizing historical records 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 stopped, and possibly reversed to a small degree as caribou numbers began increasing. Pitcher (pers. comm.) observed considerable late summer/fall use of the western portion of the Alphabet Hills in 1981 and 1984. In addition this range station, in a shrub birch type and in an area supporting high moose numbers, may show how moose browsing can help to promote lichen growth by keeping the shrub canopy open.

Changes in lichen standing crop from 1983 to 1989 were not substantial. Within the exclosure the index increased from 0.96 to 1.02, while outside it decreased from 0.93 to 0.85. While relative use increased from 0.03 to 0.17, it fell both years into the light use category. The growth of the NCH in the 1980s, increased summer use of the Alphabet Hills by bulls, combined with occasional movement of main herd cows through the area in late summer and fall, all coincides with heavier use observed at the Monsoon Lake exclosure. This area can be expected to continue to provide an area of moderate lichen availability for fall use by both resident bulls and transient portions of the main herd.

Range Unit 15

This unit is at the southern portion of the Nelchina Range. The single range station in this unit, No. 16, Glenn Highway Mile 130, was constructed in 1960. The vegetation at this site was described by Skoog (1962).

With only 1 range station in this unit, it is difficult to extrapolate findings very far from the immediate Eureka area. Lieb et. al. (1986) summarized historical records indicating that:

> The station was considered to be 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. Much of the area to the west of Caribou Creek (western half) consisted of large stands of meadow vegetation where lichens were scarce. This area was considered 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 much of the rest of the unit is uncertain. Beginning in 1980 and continuing through 1983 considerable numbers of the main NCH have summered in the northern one-third of the unit. Only with range work in this part of the unit can the effects of this recent use be evaluated.

Percent cover for all lichens and reindeer lichens inside the exclosure were 22% and 20%, respectively, in 1983 and 32% and 22% in 1989. In addition to this positive development, conditions improved from a rating of 3.0 in 1983 to 4.0 in 1989. The plots outside the exclosure supported a substantially higher coverage of lichens. Here, all lichen and reindeer lichen percent cover declined from 51% and 34%, respectively, in 1983 to 50% and 20% in 1989. At the same time condition remained about the same with a rating of 2.5. Much like the northern range units adjacent to the core calving area, this southern adjacent unit has begun to show effects of increased use from late summer through winter. These peripheral areas can be expected to decline in lichen stocks if the main NCH remains at its current population or increases in size and continues to maintain or expand its current range use pattern.

Range Unit 12

There are 5 range stations in this unit. Range stations No. 28, Black Lake and No. 29, Clarence Lake were built in 1960. Range Station 40, Upper Gilbert Island Lake; 41, Tsisi Lake; and 42, Crater Lake were established in 1989. Hanson (1958) and Skoog (1962) described the vegetation in this area. This unit includes the main calving grounds and a

good portion of the summering grounds of the Nelchina caribou. Lieb et al. (1986) summarized the historical information concerning this area:

> It has been used extensively by the main NCH 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, further lichen recovery ceased with a rebuilding of the main NCH. 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 were 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, feeding extensively 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 plant bases -- thus leaving little if any 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 an examination of the range earlier in the summer might resolve the question of the relative use of vascular plants at this time of year. Multiple summer visits to the same sites also might be of value. 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 summer or fall. An alternative explanation would involve caribou utilizing lichens continuously from the time they arrive in spring, in addition to their use of herbaceous vegetation.

The average lichen standing crop index for Range Unit 12 in 1983 was 1.60 inside exclosures and 0.48 outside. In 1989 this index was 1.94 inside and 0.17 outside. Lichens continued to grow inside exclosures and this development, relative to lichen standing crop throughout the Nelchina range, was considered to be at a medium level. Outside the exclosures a low standing crop of lichens declined to even lower levels. This differential within versus outside the exclosures translates to a relative use index of 0.70 (heavy) in 1983 and increased to 0.91 in 1989.

At both Range Stations 28 and 29 preferred species of lichens outside of the exclosures declined from 1983 to 1989 from low percent cover levels ($\bar{x}$ = >0.11) to trace amounts ($\bar{x}$ = <0.01). The three new range stations all have low lichen standing crop indexes, ranging from 0.01 to 0.31 and averaging 0.14, similar to the mean index of 0.17 for outside the long-term established range stations in this range unit.

Lichen stocks in this core calving area have apparently continued to decline and presently are practically non-existent throughout much of the area. This may be of little consequence to the biological well-being of the NCH if they continue to use this area only during the calving and summer periods, that time of the year when most nutritional needs are apparently met by green vascular plants.

Range Unit 13

Thirteen range stations are located in this unit: No. 1, Susitna Lake West; No. 2, Susitna Lake East; No. 4, Tyone Lake West; No. 5, Tyone Lake North; No. 6, Corky Lake East; No. 7, Corky Lake West; No. 8, Harris Lake; No. 9, Betty Anne Lake East; No. 10, Betty Anne Lake North; No. 11, Georgia Lake; No. 12, Gross Lake; No. 13, Janet (Minnesota) Lake; and No. 14, Springer (Deep) Lake. These stations were established from 1953 through 1956. Hanson (1958) described in detail the vegetation at all sites. Lieb et. al. (1986) summarized the historical records for this area, known as the Lake Louise Flat:

> During the early 1950s, and possibly earlier, caribou wintered in Range Unit 13 in high numbers, with the associated heavy use apparently responsible for deterioration of lichen condition. From 1955 to 1960 only a small portion of the herd spent the winter on the Flat. But for most of these years from about October to December thousands of caribou crossed 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. At most range stations lichen condition continued to deteriorate during the 1960s. 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 (1972) rated range condition as poor in 1970.
>
> Inside the exclosures, after 15 years of protection, lichen recovery was substantial with percent cover increasing on average to 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 climax lichen recovery over this range unit was not feasible, unless most of the caribou could be removed for a minimum of 15 years.

A number of additional factors were thought to play 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 fire effects might be responsible for the limited secondary succession of lichen species on the Flat. Pegau (1972) 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 (e.g., *C. gracilis, C. cornuta*) to reestablish. After 20 years the only lichen present in any numbers were secondary successional species. Observations of small amounts of *C. arbuscula* and *C. rangiferina* at Range Station 12, a 40 year old burn, suggested that 30-40 years were required for reindeer lichens to become substantially established.

The large quantities of sedges common to the Flat were considered to be an important 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) speculated that sedges appear to be able to withstand current levels of use. Since the Flat could not be considered a major wintering area based on lichen condition, the question of the role of sedges in the winter diet of Nelchina caribou is raised. But with only 1 range station in a representative sedge stand, little opportunity has existed for documenting use of and associated effects on sedges.

Beginning in about 1971-72, the NCH 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 successional development. By 1983 recovery had ceased, 7 stations showed slow declines in lichen cover and/or condition, 4 stations were approximately the same as in 1977, and 1 showed improvement. I assume that increased caribou use associated with recent herd increases and/or wintering in Range Unit 13 during the 1970s is partially responsible for halting lichen growth over much of the Flat. Increased trampling by moose may also have contributed to the current poor status of lichens in Range Unit 13, since moose coincidentally increased over much of this area during the late 1970s/early 1980s.

For all Range Unit 13 stations the 1977 to 1983 decline in percent cover of all lichens species averaged 8% and for reindeer lichens averaged 14%. For all lichens species, percent cover in 1983 was 7% higher than in 1957, 29% higher than in 1966 and 53% higher than in 1970. Cover for reindeer lichen species was 32% higher than in 1957 and 1966 and 22% higher than in 1970 (Table 4).

Mean lichen standing crop index in Range Unit 13 inside exclosures increased from 0.78 in 1983 to 0.94 in 1989. Outside exclosures the index declined from 0.37 to 0.25. These indices represent a low stocking of lichens, but within exclosures lichen crops in general were improving and approaching a "medium" status level, while outside lichens were declining to very low levels. The 1989 indices translate into a relative use rating of 0.73 (heavy use) up from a 1983 rating of 0.53 (moderate use).

Available lichen forage declined moderately from the peak 1977 levels (Table 4), and now approximate what was present during the high caribou numbers of the 1960s. What was rated as poor lichen condition by Pegau (1972) in 1970 and rated as fair in 1977 and 1983 must now (1989) be rated again as poor.

Range Station 10 at Betty Anne Lake is in a black spruce type area that was burned in 1952. This is the only range station set on a recently burned (<40 years) site within the Nelchina range. This site has been given special attention over the years in an attempt to evaluate successional development and reestablishment of both vascular plants and lichens in a spruce forest burn. Recovery of vascular plant cover, especially that of sprouting willows, had progressed substantially by 1970. Growth of secondary succession lichens was first observed in 1967. Climax lichen species were first noted within the exclosure in trace amounts in 1977. In 1983 secondary lichen species increased in cover but primary (reindeer) species were still only present in trace amounts. While secondary lichen development within the exclosure continued through 1989, reindeer lichen remained at trace levels. Since there is no pre-fire information for this site, we can only speculate whether after almost 40 years more time is needed for primary lichen development on burned sites similar to this one, or whether conditions peculiar to this site preclude the substantial development of reindeer lichens.

DISCUSSION

Historical Abundance of Nelchina Caribou

Vegetation studies of the Nelchina caribou range began in the mid-1950s. Only sketchy information exists for both the Nelchina range and Nelchina caribou numbers prior to this. Early records (Skoog 1968) suggest that the NCH was very large in the late 1800s and that it declined in numbers by the turn of the century and reached a low point by approximately 1910. Reports from then through the late 1940s suggest that the NCH

never exceeded 10,000-15,000 animals before 1945 (Watson and Scott, 1956). Apparently aided by intensive predator control the herd began increasing in size in the 1950s and reached a peak population size of about 70,000 in the mid-1960s (Siniff and Skoog, 1964). The herd then declined over approximately a 6-7 year period (1965-1972) to 10,000 or less caribou (McIlroy 1974). Beginning in 1973-1974 the NCH began again to increase in numbers, and was estimated at 25,000 in 1983 and 45,000 in 1991.

Historical Trends in Nelchina Lichen Range

Changes in range condition have been associated with these fluctuations in NCH size. Although not documented, we assume that during a period of possibly 50 years of low caribou numbers (from before 1900 to approximately 1950), range recovery was extensive and produced a high biomass of climax lichen cover in most places where potential for good lichen growth existed. Fires, common in portions of the Nelchina range before the fire suppression programs initiated in the 1950s, may have retarded recovery in some spruce lowlands. Over the 15-year period (1955-1969), while the NCH was increasing and then declining, range condition declined dramatically, reducing lichen cover to minor remnants of what existed before the early 1950s. From 1970 to at least 1977 range condition, defined primarily in terms of lichen condition, began to improve throughout most of the Nelchina caribou range. In 1977 with the NCH estimated at 14,000, increased lichen biomass was documented in most range units. By 1983, as herd size reached approximately 25,000, lichen recovery had slowed or stopped in many range units. Only in peripheral areas still receiving light caribou use did range recovery continue through 1983. Over the remainder of the 1980s, while the NCH continued to increase, available lichens declined in Range Units 4E, 5, 8, 9, 12, 13, and 15. In the core Range Units 4E, 5, 8 and 12 lichen biomass in 1989 was reduced to levels equal to or less than that recorded in the late 1960s. In the more peripheral units of 9, 13, and 15, lichen biomass declined substantially but still was at levels higher than recorded during and immediately after the 1960s NCH crash. In Range Units 1, 2, and 6E where caribou use apparently increased to varying degrees in the 1980s, range recovery ceased, with lichen levels in 1989 stabilized at approximately the same level recorded in 1983.

Looking at specific portions of the Nelchina range, Lieb et al. (1986) reported that in the Chulitna Mountains of the Upper Susitna area (Range Units 1, 2 and 4W) little if any use by the main NCH was observed before the mid- to late 1960s. Light to occasionally moderate use by small bands of resident caribou (upper Susitna sub-herd) occurred during the late 1970s and early 1980s. Range Unit 1 and much of Range Units 2 and 4W appeared to have recovered from moderate to heavy use in the late 1960s; lichens in general were rated in good condition in 1983. Use in these areas appears to have increased, and minor to moderate lichen declines were recorded in 1989 at all sites examined.

The main NCH calves and summers in the eastern portion of the Talkeetna Mountains, designated as Range Units 4E, 5, 8, and 12. As reported by Lieb et al. (1986), much of

this area has been subjected to continuous heavy use by caribou since at least the early 1950s. Early observations indicated that lichen cover throughout much of this area was already reduced to low levels by the late 1950s and continued to decline through 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 and lichen biomass began to decline again. Preferred lichen biomass in 1989 was practically nonexistent, much the same situation that existed in the late 1960s.

In the southern foothills of the Alaska Range (Range Units 6 and 9) mostly light summer and fall use by relatively small numbers of caribou occurred during the 1970s and early 1980s (Lieb et al., 1986). While the potential for good lichen growth in the western portion of this area appears not to be high, the eastern portion does provide some good lichen range. Use of the eastern area increased during the 1980s; as of 1989, lichen biomass had mostly stabilized at 1983 levels.

Range Unit 13, encompassing the Lake Louise Flat, has provided substantial winter range for the NCH over most of the past 40 years. Lieb et al. (1986), reported that heavy use in the 1950s reduced lichen abundance, and continued use by caribou migrating cross the Flat in the 1960s kept this lichen range in a deteriorated state. While some recovery occurred during the 1970s, increases in lichen biomass ceased by 1983 after the growing NCH resumed regular winter use of the area. Lichen abundance declined further during the mid- to late 1980s, as the NCH increasingly used the Flat from late summer through fall, before migrating east to winter in Range Units 7 and 16 (Copper, Nabesna and Tok river drainages) and further east in Canada.

Overall in 1989 approximately 21% of the range, encompassing the northwest, northeast, and southwest corners, was found to have good production of preferred lichen species. Another 2% of the range, also in the northwest corner, was rated as fair. The remaining 77% of the range exhibited poor lichen production. This is a substantial decline in preferred lichen availability from that observed in 1983, when the range was rated as approximate 1/3 good condition, 1/3 fair, and 1/3 poor.

By combining recent survey data on Nelchina caribou numbers and lichen range condition with corresponding earlier subjective observations on these two parameters, a first approximation model can be derived. This model compares caribou population and lichen range changes over the past 100 years (Fig. 7). With herd growth, lichens decline dramatically until reduced caribou density allows lichen range recovery to begin. Lichen recovery then proceeds until herd-growth pressure again exceeds the lichen range-growth capacity.

Seasonal Use of Nelchina Range and Types of Forage

Nelchina range condition is affected not only by overall changes in herd size but also by the amount of time caribou use a particular area. In most years, from November through

April, snow depth restricts animals to lowland areas of the Lake Louise Flat, the lower drainages of the Gulkana, Gakona, Chistochina and Copper rivers and lowlands to the east, south and west of traditionally recognized Nelchina caribou range. Occasionally winter conditions allow substantial numbers of caribou to winter in upland areas, such as the Tangle Lakes/eastern Denali Highway area, the Butte Lake/Brushkana Hills, etc. From May through October when deep snow no longer excludes caribou from the western and northern uplands, most of the NCH move into the western mountains; a few small sub-herds and summering NCH bull groups also use the northern mountains during this time.

Klein (1968) characterized summer range behavior 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 in combination with opportunity to range widely, are keys to the success of this behavior. During the long winter caribou enter a state of relative physiological dormancy where activity, metabolic rate, and nutrient content of forage are reduced. These changes coincide with the seasonal change in forage availability, from high-protein summer vegetation types to winter use of lichens and sedges of reduced protein and high carbohydrate content.

Forage selection by caribou has been investigated in a number of areas of Alaska and Canada. Most studies indicate that, when available, certain lichen species are highly preferred, especially in winter. There is often less agreement as to the importance and role of other types of forage. Pegau and Hemming (1972) indicated that caribou herds in a few locations in Alaska were apparently doing well on poor lichen range. Klein (pers. commun.) felt that this has only been documented in the Aleutian/Alaska Peninsula area where some vascular forage remains green in winter. Pegau and Hemming(1972) felt that it was important for the management of the NCH to know which plant species were being used. A different management program would be required if the herd relied heavily on relatively fast growing vascular plants as opposed to slow growing lichens.

Nutritional analyses indicate that preferred lichen species exceed 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% sedges. Fifty-six percent of the spring diet consisted of sedges. After calving, caribou shifted to deciduous shrubs. By mid-summer such shrubs made up 98% of the diet. Beginning in August the animals gradually shifted to 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 used 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 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.

Studies in the 1950s described some of the NCH food habits and seasonal changes in forage species selected (Chatelain 1951, 1952, Lensink 1954, Skoog, 1962). From late August through mid-September rumen sampling found lichen intake increasing from 10-15% to 30-50%, grass/sedge intake increasing from 1-2% to approximately 10%, and browse (primarily willow leaves) declining from 30-40% to 10-15%. From mid-September to mid-October there was a shift to heavy use of lakeside and riparian sedge species. From mid-October through December (early winter) diet varied individually from such extremes as 95% sedge to 75% lichen. On the Lake Louise Flat intake averaged 50% sedge and 30% lichen, while in the Upper Susitna area, where there was a much higher lichen stocking, it was 45% sedge and 45% lichen. This pattern changed little through the mid- to late winter period (January-mid April). Skoog (1962) concluded that the proportions of principle forage species in winter were primarily a function of relative abundance and availability.

As reported by Lieb et al. (1986), no work has been done on NCH diets since the early 1960s. Skoog (1968) indicated that large quantities of sedges were 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 one 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, I question whether winter use of vegetation types dominated by sedges or grasses can be easily evaluated during 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 into a ground layer by the following summer when evaluation occurs. If current winter range use by Nelchina caribou is to be fully evaluated, a range study undertaken during winter or immediately afterwards, before greenup, will be required.

Skoog (1968) and Pegau and Hemming (1972) indicated that they felt various vascular plants including forbs, grasses, sedges, and shrubs were important to Nelchina caribou during the calving and summer portions of the year. Although lichen condition was poor over most of the calving and summer range in the 1960s, these investigators considered this portion of the Nelchina range to be providing abundant good forage because they felt that the caribou were shifting primary use to various vascular plant species.

Changes in and use of vascular plants have been examined at range stations. Over the approximately 30-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 factored into willow changes over this period. Moose populations were relatively high when willows were declining in abundance, but had been reduced to a much lower level before willow recovery in the late 1960s/early 1970s.

Kuropat and Bryant (1980) reported that caribou of the Western Arctic Herd shift from one forage species to another as phenological development and growth progress through spring and summer. One important shift observed was from *Eriophorum* sp. floral heads to *Lupinus* spp. 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 not documented substantial caribou use of such vegetation types. Extensive use of vascular plant species in spring and summer probably is occurring, but the use of most such species is probably camouflaged by new growth. Most lichens, on the other hand, grow very slowly and may display utilization/ damage for a long period. Range evaluation from late June through September may be too late to detect selective use of vascular plants in May and early June.

Also, the area used primarily during spring had only 2 range stations until 1989. With 3 new stations the evaluation of spring and early summer use by Nelchina caribou should improve. Range Unit 12 should be examined in early summer.

Potential Influence of Range on Nelchina Caribou

There has been substantial disagreement over the years concerning how changes in range condition, 1955-1965, affected the NCH. Pegau and Hemming (1972) felt that range deterioration was a substantial factor in the decline of the herd in the 1960s, and after lichen stocks were decimated the range was unable to support the high caribou numbers. Skoog (1968) and Bergerud (1980) felt the NCH was not food limited during the 1960s because caribou move over great distances and use a wide variety of plant species.

There were also differences of opinion about the condition and disease status of NCH caribou during this period. While Skoog (1968) considered these animals to be healthy

and with a normal incidence of disease and parasites, Eide (pers. commun., 1986) reported an increased incidence of disease and declining body condition among hunter-killed caribou examined at check stations.

Some of these differences in opinion concerning the decline of the Nelchina herd in the 1960s may involve mixing primary and secondary effects. Range expansion by caribou herds is generally recognized as a response to changes in condition of traditional core range (Murie 1935, Skoog, 1968). Concurrent or subsequent changes in predation rates, hunter harvest rates, decline in herd productivity, and decline in body condition can be, wholly or in part, secondary effects resulting from the range expansion. Predation rates can increase because of exposure to more predators on peripheral range and to predators who, in response to new contact with caribou, modified their territories and feeding behavior. Hunter harvest rates can increase because of increased contact with caribou (along road systems) on peripheral range. Herd productivity and body condition may decline because of the increase in energy costs associated with increased movements, greater snow depths, and the abundance and availability of preferred forage species on peripheral range. When such secondary results of range expansion express themselves, the primary cause of herd size decline may best be assigned to the decline in core range condition. To what degree the Nelchina decline was a response to such an interplay of primary and secondary factors is not clear. Couturier, et al. (1990) similarly described the decrease in the George River caribou herd net recruitment as involving the negative effects of various factors. These included declining physical condition and increased energy expenditures associated with more extensive movements, the result of habitat deterioration.

Implications for Managing Nelchina Caribou

The general management objective for the NCH is to maintain herd size and productivity at levels compatible with reasonable range condition while allowing substantial human harvest. After the decline of the NCH in the late 1960s, a management plan was developed to restrict harvest and allow this herd to grow. In 1976 a management guideline was established by the Board of Game (BOG) to allow the herd to grow to 20,000 animals by restricting harvest to ≤5% of the herd. Lieb et al. (1988) indicated that this guideline was based on the premise that the 1960s decline was caused at least in part by emigration and/or reduced recruitment, density dependent responses to deteriorated lichen range. As herd size approached 20,000 animals in 1981, the herd size goal was re-evaluated. A revised goal of 30,000 adult caribou (38,000 - 40,000 total caribou) was adopted in 1983. This action was taken because of a growing consensus that mainland caribou herds were not normally food-limited at densities comparable to that found on the Nelchina range. Analyses by Bergerud (1978) and Doerr (1979) also suggested that increased human harvest and increased predation, in combination with severe winter conditions, was the major cause of the 1960s decline. When the 30,000 adult goal was reached in 1989, hunting regulations were modified in an attempt to increase the harvest to approximately 10%, a level expected to stabilize herd size.

As recently as 1988 some biologists recommended allowing the NCH to continue to grow until it reaches a herd size of 50,000 animals (Van Ballenberghe, pers. comm., 1988). The assumption behind these recommendations was that since the herd expanded in the 1950s to ±70,000 caribou, the Nelchina range has the capacity to support animal numbers approaching this level. Part of the rationale is that the range had a period of low caribou numbers which allowed range recovery during the 1970s and early 1980s. While in the early 1950s the Nelchina range probably had benefited from ±50 years of recovery time; in the early 1980s the range had only about 10 years to recover. 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. No changes in herd size over the 12-year period were described, and it is assumed that this population was maintained at approximately 2,000 during the study.

If, on the other hand, as the food habits studies of the 1950s suggest, a large portion of the NCH's normal winter diet consists of sedge and other vascular species, possibly the depletion of lichen stocks throughout much of the Nelchina range is not such a dire circumstance. Since reindeer lichens are highly preferred, the question remains whether there is a minimum lichen requirement for average winter conditions, and whether, under harsh winter conditions, more substantial lichen stocks are needed.

The maximum sustainable yield (MSY) of a large herbivore population such as the NCH can be generated at a population level 50-80% of the ecological carrying capacity (Caughley 1977). Ecological carrying capacity (K) is the equilibrium level that both the caribou population and its associated plant communities converge on after a number of corrective oscillations. Based on his analyses of historical population data Van Ballenberghe (1985) concluded that the Nelchina herd reached the 80,000 animal level in the 1960s and thus the MSY population should be 40,000-65,000 caribou. This conclusion is based on the assumption that 80,000 was K. Probably the maximum number of caribou in the mid-1960s did not equate to the ecological carrying capacity (K). Rather that population peak probably represented a substantial "overshoot" of K. Thus, if 60,000-80,000 caribou existed as a peak overshoot population for a few years in the 1960s, the K was more likely about 45,000-55,000, suggesting a MSY population level of 25,000-45,000 caribou.

The underlying premise behind efforts by ADF&G and the BOG to formulate herd size goals during the 1980s is that there is an optimum population level for caribou on the Nelchina range. The corollary to this assumption is that if we could determine what this was and stabilize the herd at this level with annual or biennial harvest adjustments, we could then maintain the NCH more or less at this level for a long period of time. While this may be a logical management goal, such an objective has never before been successfully accomplished with a caribou population. Caughley (1977) warned that when detailed information about population dynamics and associated environmental influences on a northern tundra "boom and bust" vertebrate population is not available it may be

unwise to manage and harvest on the basis of a MSY strategy intended to maintain a stable population size. All available evidence indicates that a major ecological characteristic of mainland caribou across North America is for their populations to cycle up and down in response to long term changes in their habitat/range. Our goal here may be particularly difficult or impossible to realize if, as it appears, we are attempting to stabilize the NCH above K, where environmental forces are directed at reducing caribou numbers. One reason we may fail is because our management is directed only at the animals instead of all major components of the ecological system. While we attempt to understand and manipulate the animal population, little is being done to manage the range relative to its role in caribou nutrition, physiology, and behavior.

Stability in a large-herbivore/plant community system is possible as long as the ecological carrying capacity has not been exceeded (Caughley, 1979). Below this threshold, there is no ecologically optimum population. Rather there is a continuous series of levels at which one can balance animal numbers against various measures of herd well-being, such as productivity and body condition. Optimum population becomes a management value judgement. Before addressing the question of optimum population, NCH managers should first be evaluating whether ecological carrying capacity currently is being exceeded? If it is, the herd can be expected to decline in the near future even if hunting harvest is reduced. If such indicators as productivity, recruitment, and body condition are declining, it is reasonable to conclude that the NCH is above K and the herd will decline in numbers.

Body condition of NCH caribou was evaluated in the late winters of 1987 and 1988, rated in general as fair (a mean 2.3 body condition score on a scale of 1 to 4 for 13 females) and considered to be normal for that time of year (Lieb et al 1989, 1991). Biologists who examined these animals saw no substantial change in condition from Nelchina caribou evaluated in the early 1980s. In 1987, it was recognized that a population of 30,000 Nelchina caribou was having a substantially negative effect on the lichen vegetation of much of its range. Lichens were expected to continue decreasing in quantity with either increased or stable herd size. There was substantial concern that if lichens are critically important to wintering Nelchina caribou, then the depletion of such lichens might lead to reduced body condition, increased incidence of disease, reduced productivity and survival, increased use of peripheral areas outside of the traditional Nelchina range, and possibly emigration.

After 5 more years, herd growth to 41,000 animals, and an additional range examination, a few of these expectations can be confirmed:

1) With increased herd size the lichen range has deteriorated further.

2) From 1980 to 1990 gross herd growth (annual rate of increase plus annual % herd harvested) decreased from 1.17 (1974-77) to 1.14 (1978-82) to 1.10 (1983-87).

Factors unrelated to range condition may have contributed to this decline in growth. One factor may be wounding loss associated with a continually increasing hunter harvest over this period. Another may be increasing predation from wolves whose numbers have been increasing over the latter half of this period.

3) Since radio-collars were put on Nelchina caribou in 1981, wintering use of peripheral range has steadily increased. Most recently, much of the NCH spent approximately 5 months wintering from the Mentasta mountains east into Canada, an area 100-200 miles east of the traditional Lake Louise Flat winter range used by Nelchina caribou in the 1970s. It is generally recognized that, in response to overgrazing, caribou will shift wintering activities into areas from which they have been absent for many (±75) years (Banfield 1949). In the process, caribou regularly migrate 200-300 miles and have been recorded moving 850 miles. Fleischman (1991) reported that as Delta caribou moved into peripheral wintering areas in response to increasing herd size, these animals found available lichen biomass greatly increased (5-20x), and in turn increased lichen intake (as measured in fecal content) by 60-90%.

4) Some evidence suggests the body condition of Nelchina animals may have declined. Nelchina animals received condition scores lower than 3 other caribou herds examined for body condition in late winter/early spring 1990-1992 (Pitcher 1991, McCarthy 1992). Both different investigators and a different condition scoring system were used in these latest examinations, making it difficult to compare these findings with earlier evaluations. Since the other 3 caribou herds sampled were from a milder, more maritime climate than what the NCH normally experiences, this comparison may not be especially meaningful.

To promote and maintain lichen biomass on the traditional winter range at a moderate level a substantial reduction in herd size may be required, possibly as much as one-half of the current level. Any such herd reduction would reduce future harvest opportunity. This would be unpopular with a public that has enjoyed increasingly higher harvest levels in recent years. Two other management options that may be more politically feasible are: 1) allow the herd to slowly decrease in size to a lower level by maintaining a harvest that results in overall annual mortality exceeding annual recruitment; and 2) maintain the current herd size and monitor winter use of peripheral areas, body condition, population dynamics, disease, and emigration. Either of these latter 2 strategies will result in a Nelchina lichen range that will remain in poor condition with little opportunity for recover. Range condition probably would be acceptable if it could be demonstrated that a medium (35,000-50,000) size NCH can be maintained in fairly good health on lichen-deficient range.

As the NCH reached 60,000 or more caribou in the early 1960s, some observers felt herd vigor was declining. At that time Nelchina caribou population density was probably about 3/mi^2 depending on a conservative definition of their home range. These relatively high Nelchina herd numbers only existed for a few years before numbers declined. Today caribou density on the Nelchina range exceeds 2/mi^2. How long can the NCH continue to exist on a depleted lichen range at the level of 40,000 caribou? Without a reduction in herd size, can the NCH be maintained in a productive and healthy condition while relying heavily on vascular plant forage, in combination with behavior patterns directed at shifting use within the traditional Nelchina range and expanding use outside the range?

RECOMMENDATIONS

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

2. To better evaluate current caribou use on winter range, new range stations should be established in Range Units 7 and 16 (Gakona, Christochina, Upper Copper and Nabesna river drainages) where many Nelchina caribou have wintered in recent years.

3. 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 range evaluation and caribou observation effort should be planned and implemented during late spring and early summer.

4. To document the use and importance of sedges and other vascular plants to caribou on their wintering grounds, a range evaluation and caribou observation effort should be planned and implemented during winter.

5. 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 growth and 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. Determining the relationship between caribou numbers and species of plants utilized at various times of the year, and how shifts in use affect the condition of plant components of the Nelchina range, should be one of the goals of range evaluation in the future.

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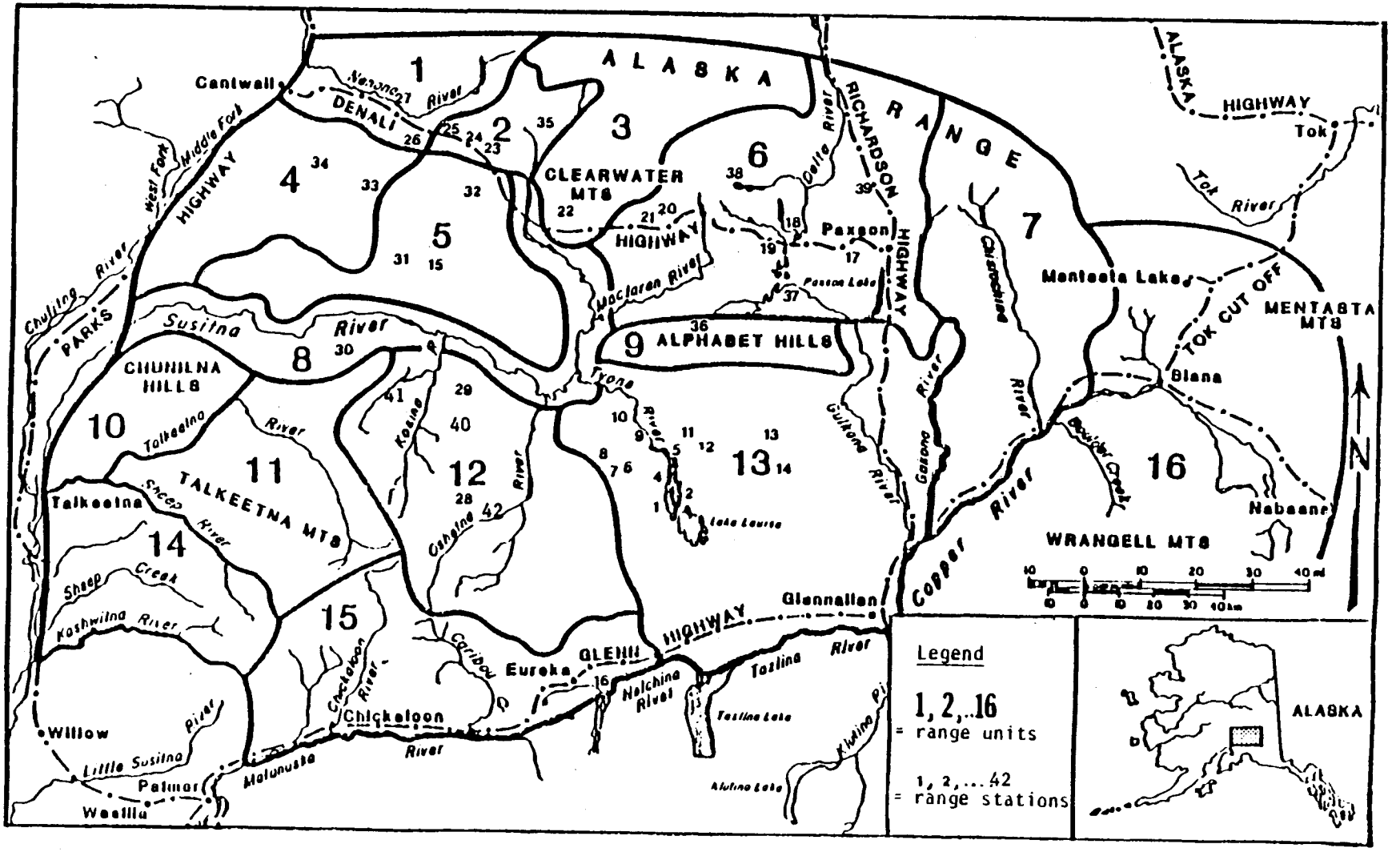

Figure 1. Nelchina range stations and range units (modified from Pitcher, 1982).

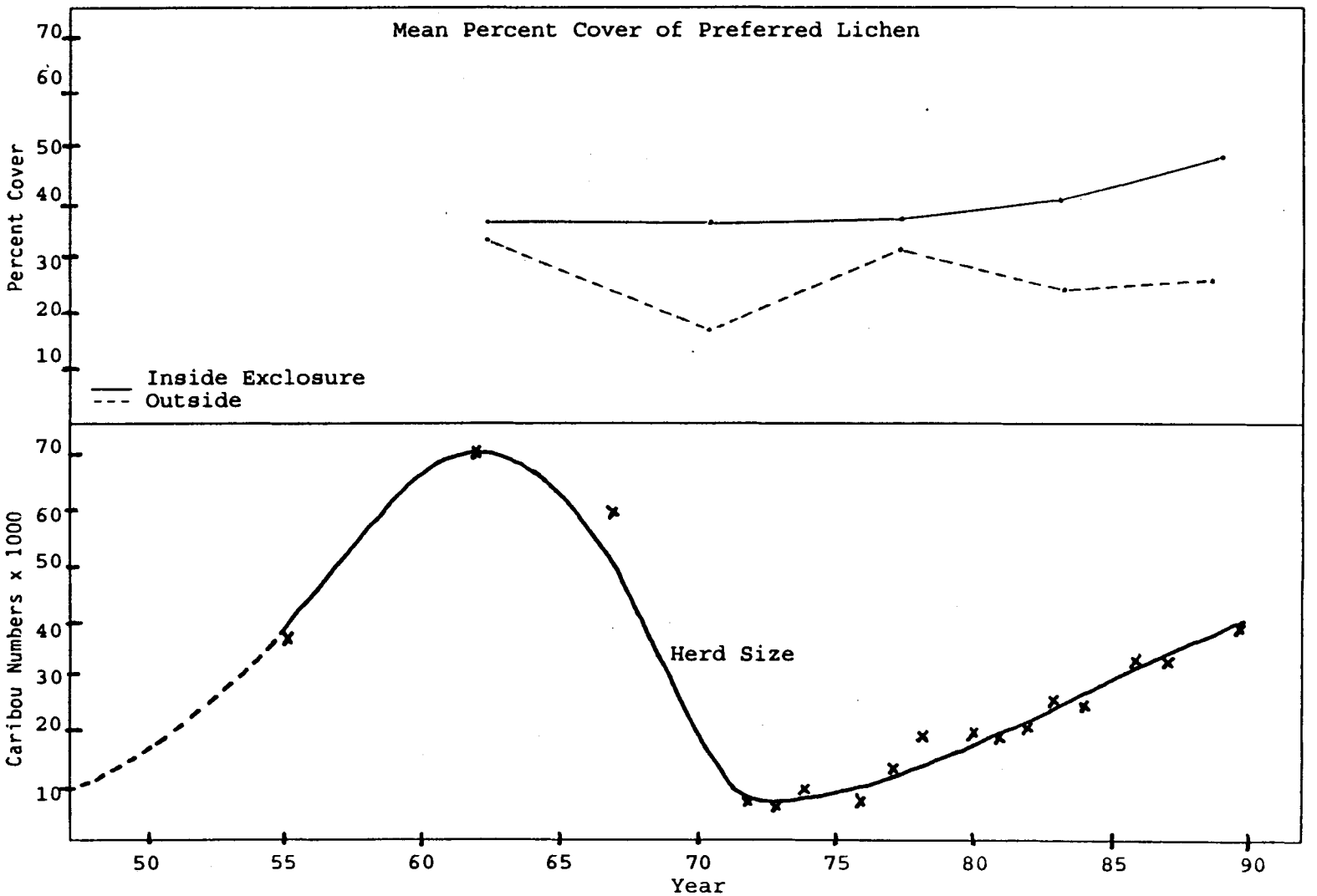

Figure 2. Comparison of mean percent cover of preferred lichen species within Nelchina Range Units 1 & 2 (upper Nenana River and Monahan Flat) and estimated Nelchina caribou herd size, 1962-1989, Alaska.

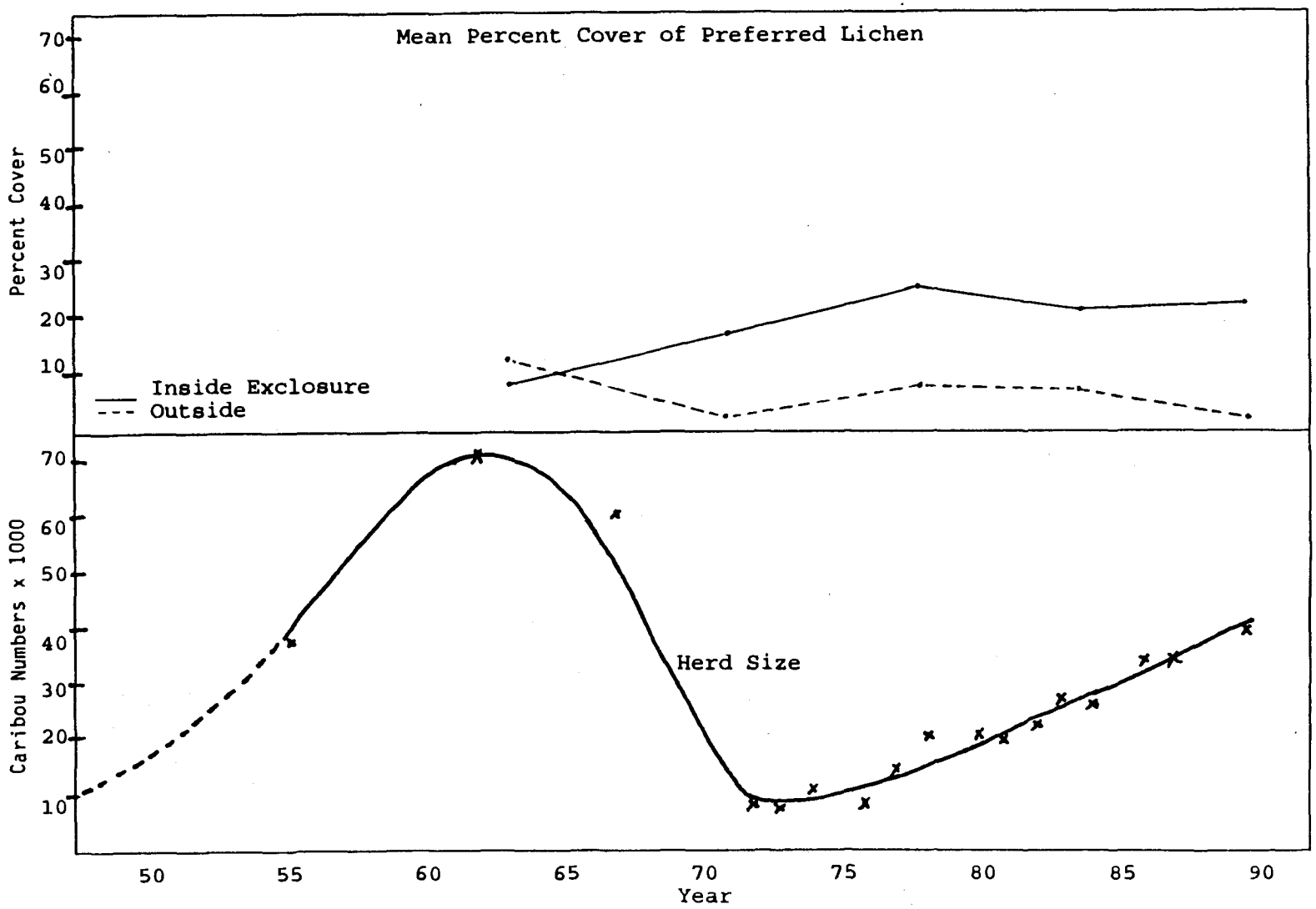

Figure 3. Comparison of mean percent cover of preferred lichen species within Nelchina Range Units 5 and 4E, Watana and Deadman Creeks) and estimated Nelchina caribou herd size, 1962-1989, Alaska.

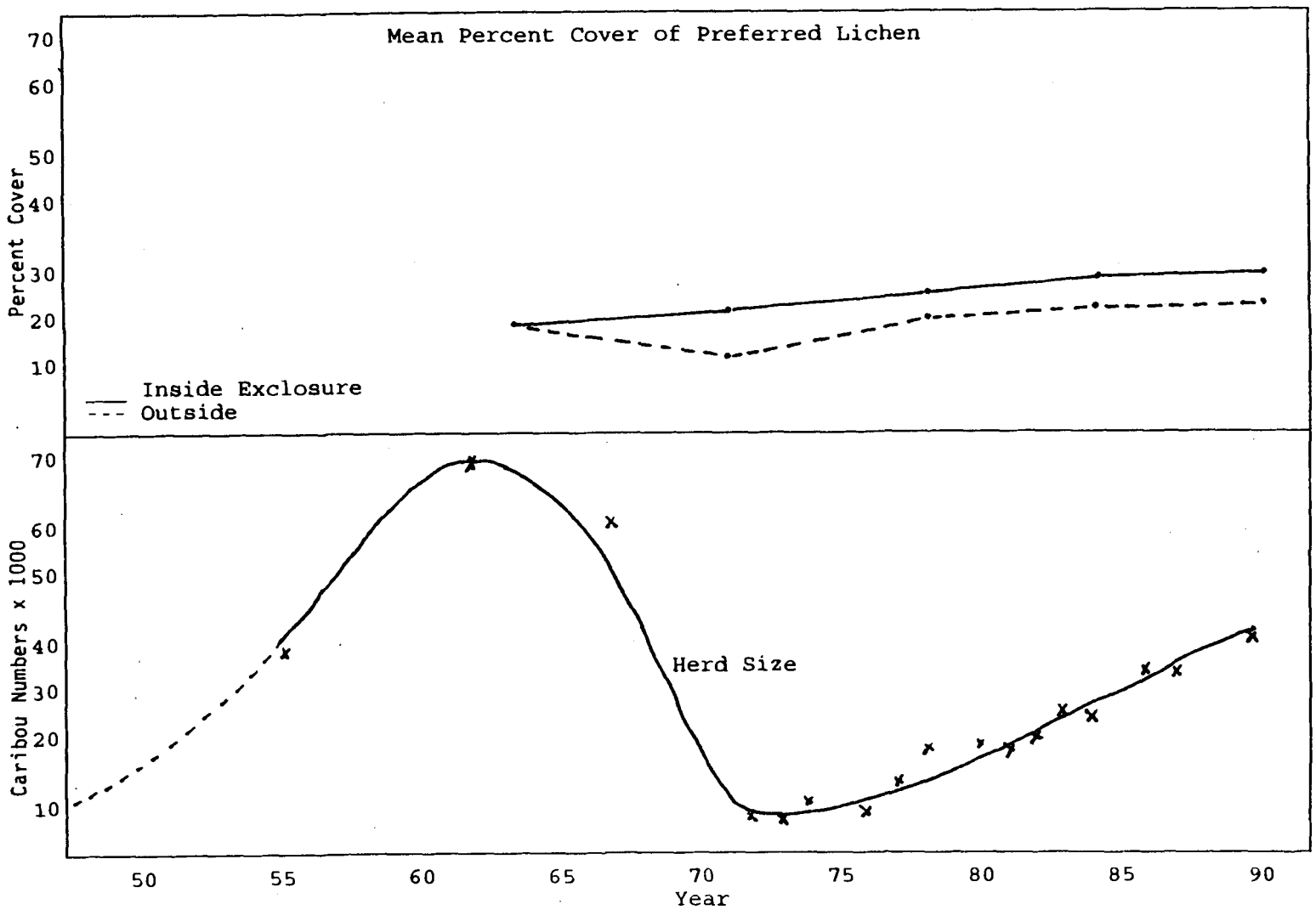

Figure 4. Comparison of mean percent cover of preferred lichen species within Nelchina Range Unit 6 (upper McClaren River and upper Gulkana River) and estimated Nelchina caribou herd size, 1962-1989, Alaska.

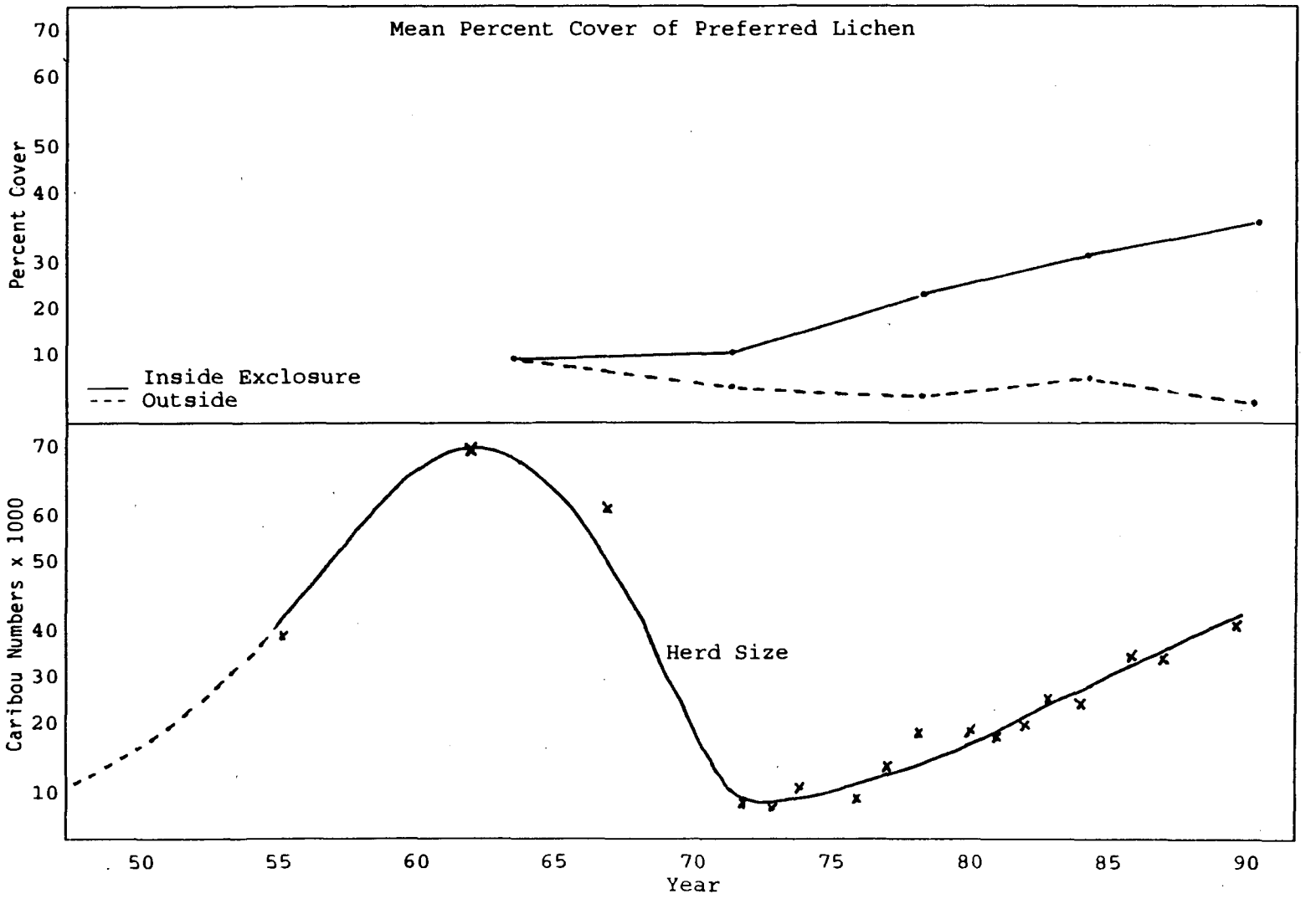

Figure 5. Comparison of mean percent cover of preferred lichen species within Nelchina Range Units 8 and 12 (upper Susitna River and eastern Talkeetna Mountains) and estimated Nelchina caribou herd size, 1962-1989, Alaska.

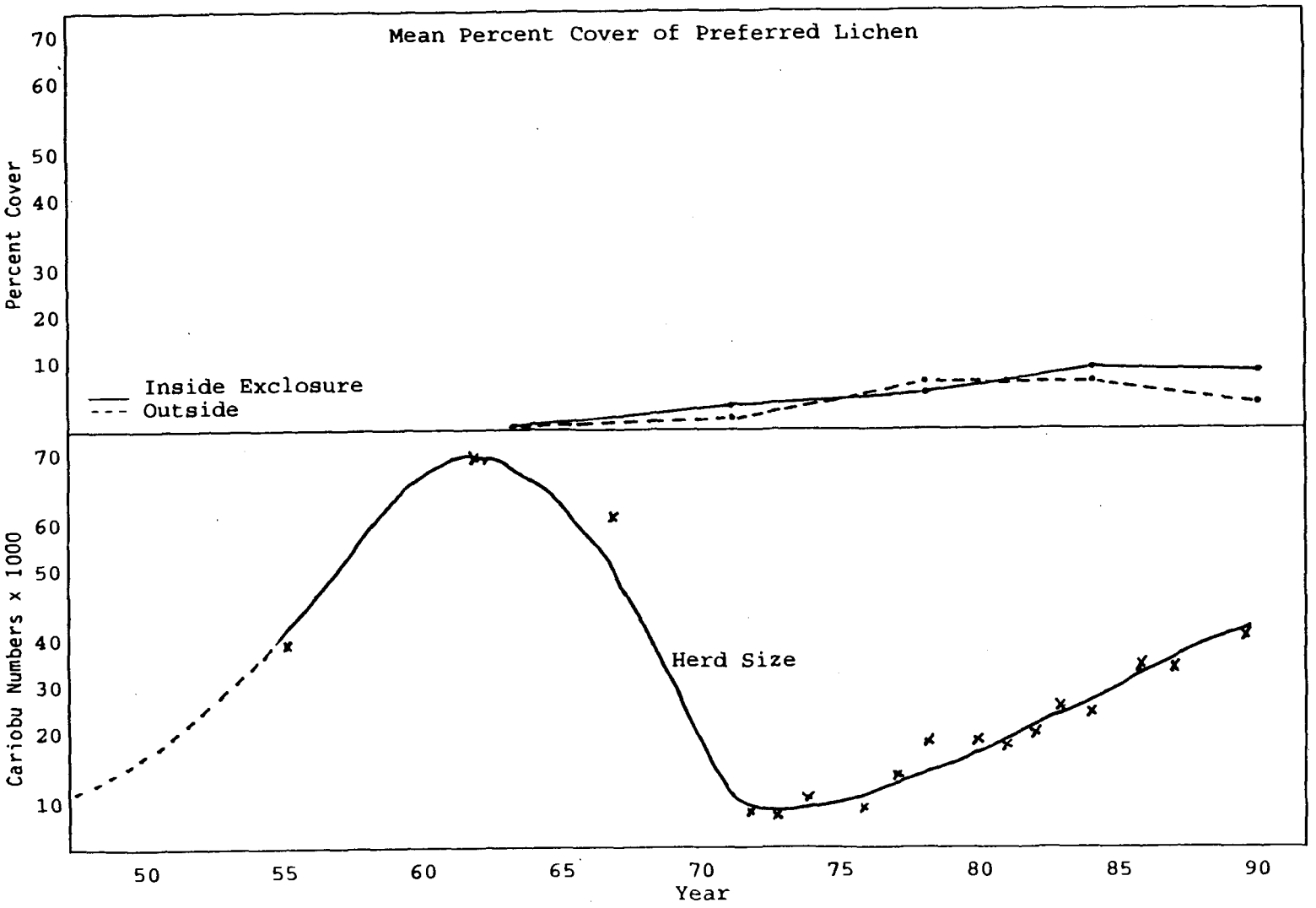

Figure 6. Comparison of mean percent cover of preferred lichen species within Nelchina Range Unit 13 (Lake Louise Flat) and estimated Nelchina caribou herd size, 1962-1989, Alaska.

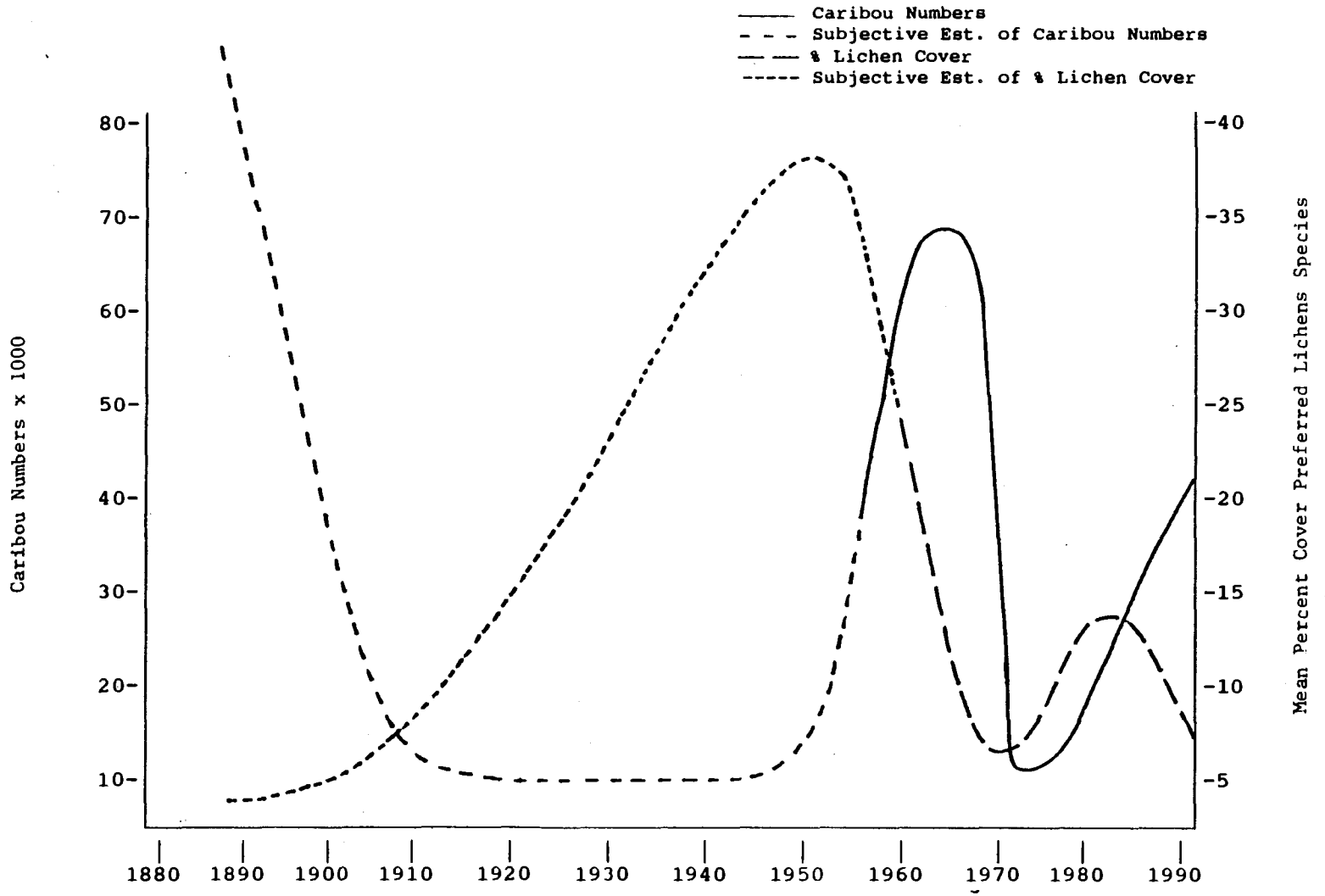

Figure 7. First Approximation Model of Nelchina caribou population and lichen range changes, 1890-1990.

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

Range unit	Area (mi2)	% of total	Number of range stations	Principle 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	5	summer
13	3150	14.8	13	winter
15	1250	5.8	1	
Sampled Subtotal	11,760	55.1	41	
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	9,580	44.9	0	
Total	21,340	100.0	41	

Table 2. Changes in lichen percent cover at range stations, 1962-1989, summarized for specific range units of the Nelchina caribou range, Alaska.

Range units	Principal season of use (secondary season)		% Cover									
			Inside Exclosure					Outside Exclosure				
			1962	1970	1977	1983	1989	1962	1970	1977	1983	1989
1 & 2 (Western Denali)	winter (summer)	L*	49	54	57	65	71	49	38	53	49	50
		RL	36	36	38	41	54	34	17	32	25	27
5 & 4E (Brushkana/ Watana	summer	L	42	46	44	47	50	34	13	30	24	14
		RL	9	18	27	23	24	13	3	9	8	3
8 & 12 (Susitna/ Talkeetna)	summer	L	44	48	46	57	74	34	23	22	28	21
		RL	12	13	24	31	36	12	7	5	9	4
6E (Eastern Denali)	summer	L	44	43	45	51	53	48	38	43	50	52
		RL	20	22	25	28	28	20	14	21	23	24
13 (Lake Louise)	winter	L	12	21	30	33	33	22	13	26	25	19
		RL	3	4	7	11	10	5	2	9	9	5

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

Table 3. Lichen Standing Crop Index and use at range stations, 1989, averaged for portions of the Nelchina range, Alaska*.

Range Unit (RU)	Standing crop index** A***	B	Standing crop index for combined RUs A	B	Relative Use (A-B)/A	Use rating	Relative Use (A-B)/A for combined RUs	Use rating
1 (Nenana R.)	3.04	1.65	2.06	1.02	.46	moderate	.50	moderate
2 (Monahan Flat)	1.40	0.60			.57	moderate		
4E (Brushkana Cr.)	1.15	0.02	1.19	0.19	.98	heavy	.84	heavy
5 (Watana Hills)	1.21	0.28			.77	heavy		
8 (Susitna River)	2.59	0.32	2.16	0.22	.88	heavy	.90	heavy
12 (E. Talkeetna)	1.94	0.17			.91	heavy		
6W (Maclaren River)	0.23	0.18			.22	light		
6E (Delta River)	1.93	1.58	1.70	1.40	.18	light	.18	light
9 (Alphabet Hills)	1.02	0.85			.17	light		
13 (Lake Louise Flats)	0.94	0.25			.73	heavy		

*(A-B/A - Use rating
.01→.33 = light
.34→.66 = moderate
.67+ heavy

**Standing crop index: a measure of the quantity of lichens present, determined by multiplying percent lichen cover (decimal equivalent) by mean lichen height (in inches): 0.01 - 0.99 = low
1.00 - 1.99 = medium
2.00 - 2.99 = high
3.00+ = very high

***A - inside exclosure
B - outside exclosure

Table 4. Lichen condition and disturbance at range stations 1983 and 1989, averaged for portions of the Nelchina range, Alaska.

Range unit	Condition*/Disturbance**			
	Inside Exclosure		Outside Exclosure	
	1983	1989	1983	1989
1	3.8/0	4.0/0.3	2.8/0.8	3.0/2.0
2	2.8/0	3.2/0.3	2.2/0.7	2.2/1.3
1 & 2	3.2/0	3.5/0.3	2.4/0.7	2.5/1.6
4E	3.0/0	3.0/0.5	1.0/3.0	1.0/3.0
5	2.0/0.8	2.7/1.7	2.0/3.0	1.3/2.3
4E & 5	2.3/0.5	2.8/1.4	1.7/3.0	1.3/2.5
8	3.0/0	4.0/0.5	2.0/1.0	1.0/3.0
12	2.8/0	4.0/0	1.8/1.8	1.0/2.0
8 & 12	2.9/0	4.0/0.2	1.9/1.5	1.0/2.3
6W	2.0/0	3.0/0	2.0/0	2.0/1.0
6E	2.8/0.2	3.0/0.5	2.7/1.0	2.5/1.5
9	2.5/0	4.0/0	2.5/1.5	4.0/1.0
6E & 9	2.8/0.1	3.3/0.3	2.7/1.1	3.0/1.3
13	2.6/0.8	2.4/1.1	1.8/2.0	1.0/2.4

* Condition of lichens rated from 4 to 1, with 4 indicating climax to near climax conditions with robust development of reindeer lichen mats and 1 indicating few reindeer lichens, only in protected spots.

4.0→3.4 = excellent
3.3→2.6 = good
2.5→1.8 = fair
1.7→1.0 = poor

** Disturbance of lichens rated from 0 to 3 with 0 indicating no apparent disturbance and 3 indicating most to all lichens damaged and broken.

0.1→1.0 = light
1.1→2.0 = moderate
2.1→3.0 = heavy

Table 5. Changes in total plant percent cover at range stations, 1962-1989, summarized by range units and combinations of range units, Nelchina range, Alaska.

	Inside Exclosure					Outside Exclosure				
Range Units	1962	1970	1977	1983	1989	1962	1970	1977	1983	1989
1 & 2 (Western Denali)	100	100	100	99	99	100	100	99	96	99
5 & 4E (Brushkana/Watana)	99	99	99	97	90	99	72	85	85	75
6E (Eastern Denali)	100	98	98	97	97	100	95	98	97	98
8 & 12 (Susitna/Talkeetna)	100	100	99	98	99	100	90	94	94	95
13 (Lake Louise)	87	98	99	96	96	91	82	99	94	95

APPENDIX A: Percent cover of plant species for Nelchina range stations.

Percent cover of plant species - modified Hult-Sernander method

Station 1: Susitna Lake West.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	85	85	100	100	100	100	100	100	95	100	100	100	100	100	95	100	100	100	95	100
Hult-Sernander scale for:[b]																				
MOSS:	4	4	4	6	3	4	5	6	4	4	3	2	4	5	3	2	3	6	3	4
SHRUBS/FORBS:																				
Betula glandulosa	3	3	5	6	2	t	4	5	2	3	3	1	3	4	4	2	2	3	2	t
Ledum decembens	4	5	5	6	3	4	6	5	2	3	4	4	4	4	3	3	3	4	3	3
Empetrum nigrum	3	4	4	3	1	-	-	-	-	-	1	1	2	1	2	2	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	2	2	1	2
V. vitis-idaea	3	4	4	5	2	t	1	3	1	3	3	3	3	4	2	t	3	4	2	t
Rosa acicularis	1	t	1	1	1	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	t	2	4	1	-	-	-	-	-	1	-	-	-	-	-
Picea glauca	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1	-	-	-
Petasites frigidus	-	-	-	-	1	t	3	2	2	t	1	1	2	1	1	t	2	2	1	2
Rubus chamaemorus	1	-	2	1	t	t	1	1	1	t	1	t	1	1	-	t	2	1	t	t
Epilobium angustifolium	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. latifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Pyrola grandiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxycoccus microcarpus	-	1	-	-	-	t	-	-	-	t	t	-	-	-	t	-	1	1	t	-
Picea mariana	-	-	-	-	t	-	-	-	-	t	-	-	-	2	-	t	-	3	2	t
Arctostaphylos spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEDGE GRASS:																				
Calamagrostis inexpansa	1	1	1	-	-	-	3	-	-	-	1	1	1	-	-	-	1	-	-	-
Eriophorum vaginatum	-	-	-	1	-	-	1	1	-	-	3	4	5	4	-	-	4	5	-	-
Carex spp.	-	-	-	-	1	t	-	-	1	t	-	-	-	-	3	4	-	-	3	4
Arctogrostis spp.	-	-	-	1	-	-	-	2	-	-	-	-	-	1	-	-	-	1	-	-
Gramineae	-	-	-	-	t	-	-	-	t	-	-	-	-	-	t	2	-	-	t	2

Station 1: Susitna Lake West (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. rangiferina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. arbuscula	-	-	-	1	1	2	-	-	-	t	-	-	-	1	-	t	-	1	1	-
C. amaurocraea	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	t	-	1	t	-
C. uncialis	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	t	-	-	t	-
Peltigera spp.	-	-	2	3	-	-	2	2	-	3	-	-	1	1	-	-	1	2	-	-
P. aphthosa	-	-	-	-	2	3	-	-	1	-	-	-	-	-	3	3	-	-	2	t
P. malacea	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-
MISCELLANEOUS:																				
Equisetum arvense	t	t	1	1	1	-	-	-	-	-	1	t	1	-	-	t	-	-	-	-
fungi	-	-	-	-	1	t	-	-	-	-	-	-	-	-	t	-	-	-	t	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 2: Susitna Lake East.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	100	95	100	95	85	90	100	90	85	96	92	90	100	90	95	95	100	90	90
Hult-Sernander scale for:[b]																				
MOSS:	6	2	6	6	4	4	1	6	3	3	6	5	4	6	3	2	6	6	3	3
SHRUBS/FORBS:																				
Betula nana	1	2	3	3	2	2	-	-	t	t	2	1	2	2	1	2	2	2	1	t
Empetrum nigrum	2	1	2	2	2	2	1	-	-	-	2	1	2	4	1	t	-	-	-	-
Ledum decumbens	1	1	3	2	2	t	1	1	1	t	1	2	1	3	1	t	1	1	1	t
Salix pulchra	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	2	2	2	1	2	1	3	3	2	t	2	2	2	1	1	t	2	1	t	t
V. vitis-idaea	1	1	1	1	1	t	-	-	1	t	1	1	1	1	1	t	-	-	t	-
Andromeda polifolia	2	1	2	2	1	t	-	1	1	-	1	1	1	1	t	t	1	1	1	t
Oxycoccus microcarpus	1	1	1	2	-	t	-	-	-	t	1	3	1	1	t	-	1	1	-	t
Rubus chamaemorus	2	2	1	-	1	t	2	1	t	t	1	-	1	1	t	t	-	-	-	-
Spiraea beauverdiana	-	-	-	-	-	-	-	1	-	-	-	-	-	-	t	-	-	-	-	-
SEDGE GRASS:																				
Carex rotundata	3	4	4	-	-	-	5	-	-	-	5	5	6	-	-	-	5	-	-	-
C. spp.	-	-	-	-	3	4	-	-	5	5	-	2	-	1	5	6	-	1	5	6
Eriophorum angustifolium	1	-	1	5	-	-	2	6	-	-	1	1	2	6	-	-	2	6	-	-
LICHENS:																				
Cladonia amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	t	t	-	-	-	-	-	-	-	-	-	-
C. multifida	-	-	-	-	-	-	-	-	t	t	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																				
Lycopodium clavatum	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
fungi	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station 2: Susitna Lake East (continued).

[a] A = inside exclosure, B = outside exclosure.
[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 4: Tyone Lake West.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	85	100	100	90	85	85	100	95	95	No DATA	75	90	100	80	70	85	100	95	90
Hult-Sernander scale for:[b]																				
MOSS:	2	1	1	6	1	1	1	6	2	3		1	1	6	3	2	1	6	2	4
SHRUBS/FORBS:																				
Betula glandulosa	-	-	1	1	1	-	-	-	-	t		1	-	1	-	-	-	-	-	t
Picea mariana	2	3	3	4	3	-	-	-	2	2		-	-	t	-	t	-	t	1	-
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-		-	-	-	-	t	-	t	-	t
Ledum decumbens	1	1	2	2	1	t	1	1	1	2		2	2	3	2	t	2	2	2	t
Salix spp. (prostate type)	-	-	-	-	-	-	-	-	-	-		-	1	1	-	-	2	1	-	-
S. arctica	-	-	-	-	-	-	-	-	-	-		-	-	-	1	t	-	-	1	-
Vaccinium uliginosum	-	-	-	-	-	t	1	1	1	t		3	4	4	3	2	4	4	2	4
V. vitis-idaea	1	1	1	3	1	t	1	2	2	2		2	1	2	1	t	1	1	1	t
Rosa acicularis	-	-	-	-	-	-	1	1	t	-		-	-	-	-	-	-	-	-	-
Rubus chamaemorus	1	t	-	-	-	t	1	1	t	t		1	1	1	1	t	1	1	1	1
Andromeda polifolia	-	-	-	-	-	-	-	-	-	-		-	-	1	1	-	-	-	1	-
Petasites frigidus	-	-	-	1	1	-	-	-	-	2		-	-	-	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	-	2	-	-	-	-		-	-	-	-	-	-	-	-	-
SEDGE GRASS:																				
Calamagrostis inexpansa	-	-	-	-	-	-	-	-	-	-		t	1	1	-	-	-	-	-	-
Carex bigelowii	2	-	3	3	-	-	3	3	-	-		1	1	1	-	-	2	3	-	-
C. spp.	-	-	-	-	2	2	-	-	1	2		-	-	-	1	2	-	-	3	3

Station 4: Tyone Lake West (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	-	-	-	-	t	t	1	1	1	t	NO	-	-	t	t	-	-	1	1	-
C. rangiferina	-	-	2	3	1	1	-	1	1	t	DATA	-	1	1	1	t	1	1	1	t
C. arbuscula	-	-	3	5	2	3	1	3	2	3		-	1	4	3	3	1	2	1	2
C. amaurocraea	-	-	-	1	-	-	1	1	-	t		-	1	1	-	-	1	1	-	-
C. uncialis	-	-	2	1	1	t	1	1	1	t		-	1	1	1	t	1	1	t	t
C. gracilis	-	-	2	2	-	3	1	2	1	2		-	1	2	1	3	-	1	t	t
C. crispata	-	-	1	1	-	t	1	1	-	t		-	-	1	1	t	-	1	-	t
C. cornuta	-	-	1	1	-	-	1	t	-	t		-	-	-	-	-	-	-	-	-
C. spp. (cup type)	-	-	2	-	-	-	-	-	-	-		-	-	-	-	t	1	-	-	t
C. goneche	-	-	-	-	1	t	-	-	t	t		-	-	-	t	-	-	-	-	-
C. coccifera	-	-	-	-	-	-	-	-	t	-		-	-	-	t	t	-	-	-	-
C. bellidiflora	-	-	-	-	t	t	-	1	t	-		-	-	1	-	t	-	-	-	t
C. pleurota	-	-	-	-	t	t	-	-	1	t		-	-	-	t	-	-	-	t	-
Peltigera malacea	-	-	-	-	t	-	-	-	-	-		-	-	-	1	t	-	-	-	-
P. aphthosa	-	-	-	-	-	-	-	-	-	2		-	-	-	-	-	-	-	1	t
P. canina	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	1	t
Cetraria islandica	-	-	-	-	-	-	-	-	-	-		-	1	-	-	-	-	-	-	-
C. nivalis	-	-	-	-	-	-	-	-	-	-		-	1	1	t	-	1	1	t	t
C. cucullata	-	-	-	1	1	t	-	1	1	t		-	-	1	1	t	-	1	t	t
Stereocaulon paschale	-	-	3	4	2	2	3	4	3	3		-	3	4	2	1	2	2	t	t
MISCELLANEOUS:																				
Equisetum arvense	-	-	-	1	-	-	-	-	-	-		-	-	-	t	t	-	1	t	t
fungi	-	-	-	-	1	t	-	-	1	t		-	-	1	-	-	-	-	1	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 5: Tyone Lake, North.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	95	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	5	5	6	6	4	5	-	6	3	4	5	4	5	6	2	4	-	6	4	6
SHRUBS/FORBS:																				
Betula glandulosa	2	1	1	3	1	t	-	1	t	t	1	2	2	3	2	t	-	-	-	t
Empetrum nigrum	1	2	1	2	1	2	-	-	-	-	-	-	-	-	-	-	-	1	1	2
Ledum decumbens	3	3	4	4	2	1	3	2	2	2	1	2	4	2	2	3	3	3	2	2
Oxycoccus microcarpus	1	2	-	3	t	2	-	-	t	t	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	1	1	2	4	1	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-
S. pulchra	2	2	1	4	1	t	4	5	2	2	2	1	1	2	1	1	-	-	-	-
Vaccinium uliginosum	3	3	2	3	2	2	4	5	3	3	6	5	6	5	4	2	5	5	3	3
V. vitis-idaea	3	2	3	4	1	1	-	3	2	2	4	4	5	6	2	3	2	5	3	2
Petasites frigidus	1	-	-	t	t	t	1	1	1	1	1	1	-	-	1	2	1	1	1	1
Rubus chamaemorus	1	1	2	1	1	2	1	1	1	2	-	-	-	-	-	t	-	1	1	t
Pedicularis spp.	-	-	-	1	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	t
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	-	-
C. spp.	-	-	-	-	1	2	-	-	2	2	-	-	-	-	1	t	-	-	2	2
Gramineae	-	-	-	-	-	-	-	-	t	-	-	-	-	-	t	-	-	-	-	-

Station 5: Tyone Lake, North (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia arbuscula	-	-	-	-	-	t	-	-	-	-	-	-	-	1	1	t	1	3	2	2
C. rangiferina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	t
C. gracilis	-	-	-	-	-	-	-	-	-	t	-	-	1	-	t	t	1	-	t	t
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	t
C. bellidiflora	-	-	-	-	-	-	-	-	-	t	-	-	-	t	1	t	-	1	t	t
Cetraria islandica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	t	t
Peltigera aphthosa	-	-	-	-	-	-	-	-	-	2	-	-	1	2	1	2	1	2	2	t
P. canina	-	-	-	-	1	t	-	-	-	t	-	-	-	-	1	t	-	-	2	t
Stereocaulon spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t
MISCELLANEOUS:																				
Equisetum scirpoides	1	-	-	-	-	t	-	-	-	-	1	-	-	-	-	-	-	-	-	t
fungi	-	-	-	-	t	-	-	-	1	-	-	-	-	-	t	-	-	-	1	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 6: Corky Lake East.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B3	B3	B2	B2	B4	B4
Total Cover (%)	100	90	100	98	95	80	100	100	100	100	96	90	90	100	95	80	90	100	90	55
Hult-Sernander scale for:[b]																				
MOSS:	2	2	2	6	1	2	5	6	1	3	4	5	5	6	2	3	4	6	1	2
SHRUBS/FORBS:																				
Betula glandulosa	-	-	-	-	-	-	-	t	t	t	-	-	-	-	3	2	-	1	t	t
Ledum decembens	1	1	2	2	1	2	3	3	2	t	2	2	4	2	1	-	4	2	-	-
Picea mariana	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	t	t	-
Salix pulchra	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	t	-	-	-	-
Vaccinium uliginosum	2	2	2	3	1	1	2	4	2	3	1	1	3	4	3	2	4	3	1	1
V. vitis-idaea	1	1	1	2	1	t	2	4	1	1	1	1	1	3	1	t	2	3	1	t
Petasites frigidus	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-	-	-	-
Rubus chamaemorus	1	1	-	t	t	-	-	-	-	t	1	1	2	1	t	t	2	1	1	-
Pedicularis spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	-
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t
SEDGE GRASS:																				
Calamagrostis inexpansa	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	-	2	-	-	-
Carex rotundata	2	2	3	3	-	-	4	5	-	-	1	2	3	3	-	-	3	3	-	-
C. spp.	-	-	-	-	2	2	-	-	3	3	-	-	-	-	3	2	-	-	3	3
Eriophorum vaginatum	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-

Station 6: Corky Lake East (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B3	B3	B2	B2	B4	B4
LICHENS:																				
Cladonia stellaris	-	-	-	1	1	-	1	-	1	-	-	-	-	-	t	-	-	-	t	-
C. arbuscula	-	-	2	4	3	2	1	3	1	t	-	-	1	3	2	2	1	4	4	2
C. rangiferina	-	-	1	2	1	t	1	4	1	t	-	-	1	1	3	t	1	1	2	t
C. amaurocraea	-	-	1	1	-	-	-	1	t	-	-	-	-	1	-	-	1	1	-	-
C. uncialis	-	-	2	1	1	t	2	2	1	t	-	-	2	1	1	t	-	1	1	t
C. gracilis	-	-	1	3	1	t	2	2	1	t	-	-	1	1	1	t	-	1	t	t
C. crispata	-	-	1	1	t	t	-	-	t	t	-	-	-	t	-	t	-	t	1	t
C. cornuta	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	-	-	t	-	-	-	t	t	-	-	-	-	-	t	-	-	t	t
C. pleurota	-	-	1	1	1	t	2	-	1	t	-	-	2	1	t	t	-	t	t	t
Cetraria nivalis	-	-	1	2	1	2	-	t	-	-	-	-	-	-	1	t	-	-	1	t
C. islandica	-	-	1	1	t	t	1	1	1	t	-	-	1	1	1	t	1	1	t	t
C. cucullata	-	-	-	1	t	t	-	1	t	t	-	-	1	1	t	t	-	1	t	t
Stereocaulon spp.	-	-	4	6	4	4	4	5	4	4	-	-	-	3	3	3	2	5	3	3
Peltigera aphthosa	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	2	1	2	-	-
P. malacea	-	-	-	-	-	t	-	-	-	t	-	-	-	-	t	2	-	-	-	-
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 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 7: Corky Lake, West.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B3	B3	B2	B2	B4	B4
Total Cover (%)	99	95	100	100	90	NO DATA	95	100	95	NO DATA	98	85	40	95	95	NO DATA	95	100	90	NO DATA
Hult-Sernander scale for:[b]																				
MOSS:	2	2	3	6	1		6	6	2		3	2	1	5	1		4	6	3	
SHRUBS/FORBS:																				
Betula glandulosa	-	-	-	1	1		-	-	t		-	-	-	t	2		-	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	2		4	5	2	
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	-	
C. spp.	-	-	-	-	3		-	-	2		-	-	-	-	3		-	-	2	

Station 7: Corky Lake West (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B3	B3	B2	B2	B4	B4
LICHENS:																				
Cladonia stellaris	-	-	1	1	t		-	t	t		-	-	-	-	t		-	t	1	
C. arbuscula	-	-	1	1	2		1	4	2		-	-	1	1	1		1	2	1	
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 spp.	-	-	-	1	-		-	1	-		-	-	-	-	-		-	1	-	
Stereocaulon paschale	-	-	4	6	4		3	5	3		-	-	2	3	4		2	5	2	
Peltigera aphthosa	-	-	-	-	1		-	-	1		-	-	-	-	-		-	-	-	
P. malacea	-	-	-	-	-		-	-	1		-	-	-	-	1		-	-	1	
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 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 8: Harris Lake

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	97	95	98	99	95	100	100	100	95	100	97	80	40	80	90	85	100	100	95	100
Hult-Sernander scale for:[b]																				
MOSS:	3	3	5	6	1	3	5	6	1	4	2	1	1	5	1	2	4	6	2	3
SHRUBS/FORBS:																				
Picea mariana	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	t	-	t
Betula glandulosa	1	1	2	2	1	t	1	2	1	1	-	-	1	1	1	-	4	4	1	t
Empetrum nigrum	2	2	3	3	2	3	-	-	-	-	1	-	-	-	1	t	5	6	3	3
Ledum decumbens	2	2	4	4	3	1	5	5	3	1	1	1	-	1	t	t	-	3	3	3
Oxycoccus microcarpus	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	2	2	3	3	1	2	-	-	t	-	2	2	3	3	2	3	3	4	2	2
V. vitis-idaea	2	1	1	4	1	2	2	4	2	2	1	2	2	1	1	2	3	3	1	2
Petasites frigidus	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	-	3	2	1	2
Rubus chamaemorus	2	1	2	1	1	t	4	5	2	2	1	1	1	t	t	t	2	1	1	t
SEDGE GRASS:																				
Calamagrostis inexpansa	1	1	2	-	-	-	1	2	-	-	1	2	-	1	-	-	-	1	-	-
Carex bigelowii	1	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. spp.	-	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	t
Gramineae	-	-	-	-	-	-	-	-	1	2	-	-	-	-	1	t	-	-	1	t

Station 8: Harris Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia arbuscula	-	-	3	4	1	1	2	4	2	2	-	-	1	2	3	2	2	2	1	2
C. rangiferina	-	-	3	4	2	2	2	5	1	2	-	-	1	t	1	t	-	2	1	1
C. amaurocraea	-	-	1	1	1	t	3	3	1	t	-	-	1	1	t	-	-	-	t	t
C. uncialis	-	-	2	1	1	t	-	-	-	-	-	-	1	2	2	t	1	1	1	t
C. gracilis	-	-	2	3	1	2	1	2	t	t	-	-	-	2	1	2	-	2	1	1
C. crispata	-	-	1	1	1	t	-	1	-	-	-	-	-	-	2	1	-	-	-	-
C. cornuta	-	-	1	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	1	1	t	t	-	-	-	-	-	-	-	-	1	t	1	t	1	-
C. pleurota	-	-	-	-	-	t	-	-	-	-	-	-	-	-	3	-	-	-	-	-
C. stellaris	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
C. spp. (brown cup-like similar to amaurocraea)	-	-	-	1	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-
C. spp. (nonpowdery)	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. spp. (cup-type)	-	-	1	t	-	-	-	t	-	-	-	-	1	2	-	-	-	t	-	-
Cetraria cucullata	-	-	1	1	1	t	1	1	1	t	-	-	-	1	1	t	1	-	1	t
C. islandica	-	-	2	1	1	t	1	1	1	1	-	-	1	1	1	t	-	1	t	t
Stereocaulon paschale	-	-	3	2	1	1	-	1	t	t	-	-	2	3	3	3	1	3	1	1
Peltigera aphthosa	-	-	2	-	-	t	-	-	1	1	-	-	-	-	1	2	2	-	1	t
P. malacea	-	-	2	-	1	-	1	-	1	t	-	-	-	-	1	t	1	-	1	-
P. spp.	-	-	-	1	-	t	-	1	-	-	-	-	-	1	-	-	-	3	-	t
Nephroma arcticum	-	-	-	-	-	-	2	2	1	-	-	-	-	-	-	-	1	t	1	2
Dactylina acrticum	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	t	t	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
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	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	98	95	No Data	97	80	70	No Data	100	95	95	83	80	No Data	100	100	100	No Data	96	95	95
Hult-Sernander scale for:[b]																				
MOSS:	3	3		6	1	t		5	2	4	2	1		6	1	3		6	1	3
SHRUBS/FORBS:																				
Picea mariana	-	-		-	-	-		3	1	t	1	-		1	t	-		-	-	-
Betula glandulosa	2	2		2	1	t		-	-	-	-	-		-	-			-	-	t
Empetrum nigrum	-	-		t	-	-		t	-	-	-	-		-	-	2		-	-	t
Ledum decumbens	1	1		2	2	t		2	1	t	-	3		1	1	2		3	2	t
Rosa acicularis	-	-		-	t	t		2	1	1	1	-		1	1	-		-	-	-
Vaccinium uliginosum	3	2		4	3	2		3	3	2	3	3		5	4	3		5	3	3
V. vitis-idaea	1	1		2	1	t		2	2	3	1	1		2	2	1		2	1	t
Petasites frigidus	1	1		1	-	-		2	1	1	1	1		1	2	t		t	t	t
Rubus chamaemorus	-	-		-	-	-		1	1	-	1	1		1	1	t		t	-	t
Oxycoccus microcarpus	-	-		t	-	-		-	-	-	-	-		-	-	-		-	-	-
SEDGE GRASS:																				
Calamagrostis inexpansa	1	1		-	-	-		-	-	-	1	1		-	-	-	-	-		
C. canadensis	-	-		1	-	-		1	-	-	-	-		3	-	-		t	-	-
C. spp	-	-		-	-	-		-	-	-	-	-	-	-	-	2		-	-	-
Carex spp.	-	-		-	t	t		-	1	t	-	-		-	2	2		-	t	2

Station 9: Betty Ann Lake East (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:			No				No						No				No			
Cladonia stellaris	-	-	Data	1	1	t	Data	t	t	-	-	-	Data	1	t	-	Data	1	1	-
C. arbuscula	-	-		3	2	1		4	2	t	-	-		4	2	2		3	2	2
C. rangiferina	-	-		1	t	-		4	1	1	-	-		2	1	t		2	1	t
C. uncialis	-	-		2	1	-		3	1	-	-	-		2	1	-		2	1	t
C. gracilis	-	-		1	1	2		1	1	t	-	-		1	1	2		1	1	2
C. gonecha	-	-		-	1	-		1	-	-	-	-		t	t	-		1	1	t
C. amaurocraea	-	-		1	t	-		1	1	-	-	-		1	t	-		1	1	t
C. crispata	-	-		1		t		1	-	t	-	-		1	1	-		1	1	-
C. pleurota	-	-		-	1	-		-	1	-	-	-		-	t	-		-	1	-
Cetraria cucullata	-	-		1	1	t		t	t	t	-	-		t	t	t		1	1	t
C. islandica	-	-		t	1	t		1	1	t	-	-		1	1	t		t	-	1
Stereocaulon spp.	-	-		5	2	4		5	2	3	-	-		5	4	2		4	2	2
Peltigera canina	-	-		-	-	t		1	1	-	-	-		2	2	1		t	1	t
Nephroma arctica	-	-		-	-	-		-	-	-	-	-		-	-	3		-	-	2
Miscellaneous:																				
Equisetum sylvaticum	-	-		1	1	2		-	-	-	-	-		-	-	2		-	-	2

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed; t (trace) = <0.5%; 1 = 0.5 to 6.2%; 2 = 6.3 to 12.4%; 3 = 12.5 to 24.9%; 4 = 25 to 49.9%; 5 = 50 to 704.95%; 6 = 75 to 100%

*B1 and B2 plot stakes gone; attempted to replace in same spots from photos and ground hole locations

Percent cover of plant species - modified Hult-Sernander method

Station 10: Betty Ann Lake North.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	50	75	95	100	95	100	No Data	No Data	100	100	50	85	100	100	100	60	50	100	90	70
Hult-Sernander scale for:[b]																				
MOSS:	-	5	5	6	1	1			3	1	3	5	6	5	2	3	3	6	1	3
SHRUBS/FORBS:																				
Betula glandulosa	-	-	1	t	1	t			4	2	-	-	1	1	1	t	3	4	2	t
Ledum decumbens	1	2	3	4	3	4			3	3	1	1	1	2	1	1	4	4	3	3
Rosa acicularis	-	1	-	t	-	t			1	t	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	2	2	3	5	4	t			-	-	3	5	4	5	3	t	-	-	1	t
Spiraea beauverdiana	-	-	-	-	-	-			-	t	-	-	1	-	-	-	-	t	-	t
Vaccinium uliginosum	2	2	2	4	2	3			1	2	3	4	5	6	4	2	4	6	3	2
V. vitis-idaea	-	-		-	-	-			-	-	-	-	-	-	-	-	-	-	-	-
Epilobium angust folium	1	1	1	t	t	t			-	-	-	-	-	-	-	-	-	-	-	-
Petasites frigidus	-	-	-	-	-	-			-	-	1	1	-	t	t	t	1	t	t	-
Pyrola secunda	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-	t	-	-
Rubus chamaemorus	1	-	-	-	-	-			-	-	-	-	-	-	-	-	-	t	t	-
Picea mariana	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	2	t
Empetrum nigrum	-	-	-	-	-	-			-	-	-	-	-	-	2	-	-	-	-	-
SEDGE GRASS:																				
Calamagrostis canadensis	1	1	-	t	-	-			-	-	1	1	1	t	-	-	1	t	-	-
Festuca altaica	-	-	-	-	-	-			-	-	-	-	1	-	-	-	-	-	-	-
Carex spp.	-	-	-	-	t	-			t	-	-	-	-	-	-	t	-	-	1	t

Station 10: Betty Ann Lake North (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:							No	No												
Cladonia gracilis	-	-	2	4	2	4	Data	Data	2	3	-	-	1	1	1	3	1	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	t
C. amaurocraea	-	-	-	-	t	-			-	-	-	-	-	-	-	-	-	-	t	-
C. gonecha	-	-	-	-	1	-			-	-	-	-	-	-	-	-	-	-	-	-
C. crispata	-	-	-	-	-	t			-	-	-	-	-	-	1	-	-	-	-	t
C. arbuscula	-	-	-	t	t	t			-	-	-	-	-	-	t	-	-	-	-	t
Stereocaulon spp.	-	-	-	-	-	t			1	t	-	-	-	-	1	-	-	-	-	t
Peltigera aphthosa	-	-	-	t	t	t			-	-	-	-	-	-	t	-	-	-	-	t
P. canina.	-	-	1	-	1	t			-	-	-	-	1	-	t	-	1	-	1	-
P. spp.	-	-	-	2	-	-			-	-	-	-	-	2	-	-	-	3	-	-
Cetraria cucullata										t										
Cladonia uncialis										t										t
Cetraria islandica																				t
MISCELLANEOUS:																				
Equisetum sylvaticum	2	2	2	1	1	t			t	t	1	1	1	1	1	t	2	1	1	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 11: Georgia Lake.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	95	100	100	100	100	100	100	95	90	100	95	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6	6	6	2	3	6	6	1	3	6	5	5	6	2	4	6	6	3	4
SHRUBS/FORBS:																				
Betula glandulosa	1	2	2	3	t	t	-	t	-	t	-	-	-	1	1	-	-	-	-	t
Ledum decembens	4	5	5	6	4	3	3	4	3	4	3	3	4	3	3	4	5	5	3	3
Spiraea beauverdiana	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	t	1	1	-	t
Vaccinium uliginosum	1	1	-	1	t	t	3	2	3	t	-	-	2	1	1	-	-	-	t	t
V. vitis-idaea	4	4	4	5	3	3	2	4	1	1	4	4	4	4	3	2	4	4	1	3
Oxycoccus microcarpus	-	-	-	-	-	t	-	1	-	2	-	-	-	-	-	t	-	-	-	-
Petasites frigidus	-	-	-	-	-	t	2	4	-	-	1	1	1	1	-	t	1	-	-	1
Rubus chamaemorus	2	2	3	2	-	-	1	1	-	2	2	1	1	1	-	t	-	1	-	t
Epilobium angustifolium	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-	t
SEDGE GRASS:																				
Calamagrostis inexpansa	1	1	2	1	-	-	2	2	-	-	1	1	2	2	-	-	2	2	-	-
Gramineae	-	-	-	-	t	t	-	-	t	2	-	-	-	-	1	2	-	-	4	3

Station 11: Georgia Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia arbuscula	-	-	2	2	2	4	2	4	3	2	-	-	1	1	1	2	2	3	1	t
C. rangiferina	-	-	1	2	1	t	2	2	1	t	-	-	-	1	1	t	1	1	1	t
C. amaurocraea	-	-	2	1	1	t	-	-	1	t	-	-	1	1	-	t	1	1	-	-
C. gracilis	-	-	1	t	1	1	2	1	1	1	-	-	-	-	1	t	-	1	1	1
C. bellidiflora	-	-	-	-	-	-	-	-	-	t	-	-	1	-	-	-	-	-	-	-
C. crispata	-	-	-	1	-	t	-	-	1	t	-	-	-	1	-	t	-	1	-	t
C pleurota	-	-	-	-	-	-	-	-	t	t	-	-	-	-	-	t	-	-	-	t
Cetraria cucullata	-	-	1	-	1	t	1	-	1	1	-	-	-	-	1	-	-	1	1	t
C. islandica	-	-	-	1	1	1	-	1	1	1	-	-	-	1	1	t	-	1	1	t
Stereocaulon paschale	-	-	-	-	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-
Peltigera aphthosa	-	-	1	-	-	t	1	-	2	-	-	-	1	-	3	2	1	-	1	2
P. malacea	-	-	1	-	-	-	1	-	-	-	-	-	-	-	t	t	1	-	1	-
P. spp	-	-	-	2	-	-	-	1	-	-	-	-	-	2	-	-	-	2	-	-
Nephroma arcticum	-	-	-	-	-	2	1	2	1	-	-	-	-	-	-	-	-	-	-	-
C. stellaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
MISCELLANEOUS:																				
Equisetum silvaticum	1	1	1	1	t	1	3	3	1	t	1	1	3	1	1	t	2	1	1	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 12: Gross Lake.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	80	80	80	90	90	100	100	95	100	100	100	100	100	100	95	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	4	4	4	6	3	3	5	6	4	3	4	4	6	6	2	3	6	6	1	3
SHRUBS/FORBS:																				
Picea mariana	-	-	-	-	-	-	-	1	4	t	-	-	1	-	-	-	-	-	-	-
Betula glandulosa	1	1	2	2	1	t	4	4	2	t	2	2	2	2	1	t	2	4	1	t
Ledum decembens	1	1	2	1	1	2	4	4	1	2	2	2	4	4	3	3	3	4	3	1
Rosa acicularis	1	1	-	t	-	-	-	1	-	t	-	-	-	-	-	-	-	-	t	t
Salix alaxensis	-	-	-	4	-	-	5	6	2	3	-	-	-	-	-	-	2	4	1	2
S. pulchra	-	-	-	-	t	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
S. myrtillifolia	3	3	4	4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	3	3	3	1	2	3	-	2	3	2	3	4	4	3	3	2	3	5	3	3
V. vitis-idaea	1	1	1	1	1	t	2	4	3	2	2	3	2	2	1	2	1	2	1	2
Pedicularis labradorica	-	-	-	-	-	-	-	-	-	-	1	-	-	-	t	-	-	-	t	-
Petasites frigidus	1	-	-	-	-	t	1	1	1	2	1	1	2	1	1	1	4	4	1	2
Rubus chamaemorus	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	t	-	-	-	t
Empetrum nigrum	-	-	-	-	t	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	-	-
C. spp.	-	-	-	-	3	3	-	-	2	3	-	-	-	-	-	t	-	-	1	2
Gramineae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-

Station 12: Gross Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
C. arbuscula	-	-	2	3	3	3	-	-	1	t	-	-	2	4	2	3	-	1	1	t
C. rangiferina	-	-	1	1	1	t	-	-	-	-	-	-	1	1	1	t	-	1	-	-
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	t	-	1	-	t
C. uncialis	-	-	-	1	t	-	-	-	-	-	-	-	1	1	1	t	-	-	t	-
C. gracilis	-	-	1	1	t	1	-	1	-	t	-	-	-	1	1	1	-	-	t	-
C. crispata	-	-	1	1	t	t	-	-	-	-	-	-	-	-	1	2	-	-	-	t
C. pleurota	-	-	-	-	1	-	-	-	t	-	-	-	-	-	1	t	-	-	-	-
C. spp (cup-type)	-	-	-	1	-	t	-	-	-	t	-	-	1	-	t	t	-	-	-	t
Stereocaulon paschale	-	-	1	1	1	2	-	-	-	-	-	-	-	t	1	t	-	-	t	t
Cetraria cucullata	-	-	-	1	t	t	-	-	-	-	-	-	1	1	t	t	-	-	-	-
Peltigera aphthosa	-	-	-	-	1	1	2	-	3	3	-	-	1	-	1	2	1	-	2	3
P. malacea	-	-	2	-	-	t	2	-	1	-	-	-	1	-	1	2	2	-	1	1
P. spp.	-	-	-	1	-	-	-	3	-	t	-	-	-	2	-	-	-	3	-	t
MISCELLANEOUS:																				
Equisetum scirpoides	1	1	-	-	-	t	-	-	-	t	1	1	1	-	-	-	-	1	-	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 13: Janet Lake.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	99	95	98	99	95	100	100	100	100	100	99	95	100	100	95	80	90	100	95	100
Hult-Sernander scale for:[b]																				
MOSS:	4	4	4	6	1	t	5	6	2	2	3	3	5	6	2	2	4	6	3	3
SHRUBS/FORBS:																				
Betula glandulosa	1	1	1	3	2	1	-	-	-	t	-	-	5	5	2	2	-	1	-	t
Ledum decumbens	3	4	4	5	3	2	4	5	4	3	1	1	3	4	2	3	4	4	3	5
Rosa acicularis	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	t	3	6	1	2	-	-	4	5	2	2	-	-	-	-
Vaccinium uliginosum	3	4	4	5	4	3	3	4	1	2	3	3	5	6	4	3	4	5	4	2
V. vitis-idaea	2	2	2	2	2	3	3	4	3	1	1	1	5	4	3	t	1	3	1	t
Epilobium angustifolium	-	-	-	-	-	t	-	-	-	2	1	1	-	-	-	t	1	t	-	t
Petasites frigidus	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	t	-	-	-	-
Rubus chamaemorus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis spp.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	t	-	t
SEDGE GRASS:																				
Calamagrostis inexpansa	1	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	t	-	-
Carex spp.	-	-	-	-	-	-	-	-	-	t	-	-	-	-	2	-	-	-	t	t

Station 13: Janet Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia arbuscula	-	-	3	4	3	3	1	1	1	1	-	-	1	1	1	t	1	3	2	t
C. uncialis	-	-	2		1	-	-	-	-	t	-	-	-	t	-	t	1	1	1	t
C. gracilis	-	-	4	4	2	t	2	1	1	t	-	-	-	t	1	1	1	1	2	2
C. crispata	-	-	1	1	1	t	-	-	1	t	-	-	-	1	1	1	-	1	1	t
C. cornuta	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	1	t	1	t
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-
C. macrophylla	-	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-
C. pleurota	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
C. gonecha	-	-	-	-	t	3	-	-	t	t	-	-	-	-	-	t	-	-	-	-
Cetraria islandica	-	-	1	1	1	2	1	1	1	t	-	-	-	-	-	t	1	t	1	t
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t
Stereocaulon tomentosum	-	-	1	1	1	t	1	1	1	t	-	-	1	-	-	-	-	1	t	t
Peltigera aphthosa	-	-	2	-	2	2	2	-	2	3	-	-	2	-	2	3	-	-	3	3
P. pulverulenta	-	-	1	-	-	-	2	-	-	3	-	-	-	-	-	-	2	-	1	2
P. spp.	-	-	-	1	-	-	-	4	-	-	-	-	-	1	-	2	-	3	-	t
Nephroma arcticum	-	-	2	-	2	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																				
Equisetum silvaticum	1	-	-	-	-	-	-	-	-	t	-	-	1	1	1	-	1	-	1	t
E. scirpoides	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 14: Springer Lake.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A3	A2	A2	A2	A4	B1	B1	B1	B1	B1	B3	B2	B2	B2	B4
Total Cover (%)	100	100	100	100	95	100	100	100	100	85	100	100	100	100	90	85	100	100	95	80
Hult-Sernander scale for:[b]																				
MOSS:	3	2	4	6	2	1	5	6	3	2	3	3	4	6	2	4	5	6	4	t
SHRUBS/FORBS:																				
Picea mariana	3	2	(dead)	-	-	t	1	t	1	-	-	-	-	-	-	-	2	4	1	t
Betula glandulosa	-	-	-	-	1	-	4	4	2	-	2	2	2	3	1	-	-	-	-	-
Ledum decembens	1	1	1	1	1	1	5	3	1	t	2	3	4	4	1	2	2	3	1	2
Rosa acicularis	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	-	-	-	-	-
Salix alaxensis	-	-	-	-	-	-	3	4	2	-	-	-	-	-	-	-	-	-	-	-
S. pulchra	-	-	-	-	-	-	-	-	-	-	1	1	1	1	t	-	2	3	1	-
Vaccinium uliginosum	4	4	4	5	3	4	2	3	2	4	3	5	5	5	3	3	4	4	3	4
V. vitis-idaea	2	2	2	3	2	1	5	5	3	3	1	1	-	3	1	t	1	3	1	3
Petasites frigidus	-	-	-	-	-	-	-	-	-	-	1	1	-	1	1	-	1	2	1	-
Rubus chamaemorus	-	-	-	-	-	-	-	-	-	-	1	1	1	1	t	-	-	-	-	-
Pedicularis spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	-	-
SEDGE GRASS:																				
Calamagrostis inexpansa	1	1	-	t	-	t	1	-	1	-	1	1	-	1	t	t	4	3	1	t
Carex bigelowii	-	-	-	-	-	t	-	-	-	-	-	-	1	-	1	-	-	-	1	-
Eriophorum vaginatum	-	-	-	-	-	t	-	-	-	-	-	-	-	t	-	t	-	-	-	t

Station 14: Springer Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A3	A2	A2	A2	A4	B1	B1	B1	B1	B1	B3	B2	B2	B2	B4
LICHENS:																				
Cladonia arbuscula	-	-	4	5	3	4	3	4	1	3	-	-	2	3	2	3	1	3	1	1
C. rangerferina	-	-	1	1	2	2	1	1	1	t	-	-	-	-	1	t	1	t	-	t
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
C. uncialis	-	-	-	t	1	1	-	t	1	t	-	-	2	1	1	t	-	1	-	t
C. gracilis	-	-	3	2	2	1	1	1	1	1	-	-	1	1	1	1	1	1	1	t
C. crispata	-	-	2	2	1	t	-	1	t	t	-	-	-	t	1	t	-	-	-	t
C. pseudorangiformis	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. spp. (cup type)	-	-	-	-	t	t	-	-	-	-	-	-	-	1	-	t	-	-	t	t
Cetraria islandica	-	-	-	-	-	t	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Stereocaulon paschale	-	-	1	1	t	t	1	1	1	2	-	-	-	-	t	t	1	1	1	t
Peltigera aphthosa	-	-	-	-	-	t	2	2	1	-	-	-	2	2	-	2	-	-	1	2
P. malacea	-	-	2	1	1	t	-	-	1	t	-	-	1	1	1	t	2	2	-	t
Cetraria nivalis	-	-	-	t	1	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																				
Equisetum scirpoides	-	-	-	1	-	-	-	1	-	t	1	1	2	2	1	t	1	1	1	-
E. silvaticum	-	-	-	-	-	t	-	-	-	-	1	1	1	-	-	-	1	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 15: Big Lake.

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	99	95	70	99	95	100	80	96	95	90
Hult-Sernander scale for:[b]																				
MOSS:	2	2	2	5	2	t	2	5	3	t	1	1	1	6	3	3	-	6	2	1
SHRUBS/FORBS:																				
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	t	1	t
Betula glandulosa	3	5	5	5	2	3	-	1	1	2	2	3	4	4	3	2	1	1	1	t
Empetrum nigrum	2	2	3	5	2	2	4	4	3	4	2	2	2	2	3	1	2	3	2	4
Ledum decumbens	2	1	1	1	1	2	2	3	3	2	1	1	3	3	2	2	3	3	1	3
Loiseleuria procumbens	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	t	-	-	-	-
Vaccinium uliginosum	3	4	5	4	2	2	4	4	3	3	3	3	5	6	3	3	4	5	2	2
V. vitis-idaea	2	2	1	1	1	1	1	2	1	t	1	1	1	3	2	t	-	1	1	t
Salix pulchra	3	3	3	3	2	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedicularis capitata	-	-	-	-	-	-	-	-	-	-	1	-	1	t	-	1	-	-	1	t
Polygonum bistorta	2	1	1	1	1	t	2	1	1	2	1	1	-	t	t	t	1	1	1	t
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	t	-	-	1	t	-	-	-	-	2	2	-	-	1	1
Gramineae	-	-	-	-	t	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-

Station 15: Big Lake (continued).

Year	57	66	70	77	83	89	70	77	83	89	57	66	70	77	83	89	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A1	A2	A2	A2	A2	B1	B1	B1	B1	B1	B1	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	-	-	2	3	1	2	3	2	2	3	-	-	1	1	1	1	1	1	1	t
C. rangerferina	-	-	3	3	1	2	2	4	1	1	-	-	1	1	1	t	1	1	1	t
C. arbuscula	-	-	3	3	2	2	2	4	2	2	-	-	1	3	2	1	1	4	2	1
C. amaurocraea	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	t	1	t	-	t
C. uncialis	-	-	1	t	t	-	2	1	t	-	-	-	-	1	t	t	1	1	1	-
C. gracilis	-	-	1	-	1	2	1	t	1	1	-	-	-	-	1	2	-	t	t	1
C multifida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t
C. gonecha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	t	t
Cetraria nivalis	-	-	-	-	-	-	1	2	1	t	-	-	1	1	t	t	1	1	1	t
C. richardsonii	-	-	-	t	t	t	1	t	1	t	-	-	1	t	1	1	-	1	1	t
C cucullata	-	-	1	1	1	2	1	2	1	t	-	-	1	1	1	1	1	1	t	t
C. islandica	-	-	1	1	1	2	1	t	1	1	-	-	1	1	1	t	1	t	t	t
Stereocaulon paschale	-	-	-	-	t	-	1	1	1	t	-	-	-	2	1	1	-	1	1	t
Dactylina arctica	-	-	1	t	1	1	1	1	1	t	-	-	-	t	1	t	-	t	1	t
Thamolia vermicularis	-	-	1	1	1	t	1	1	1	1	-	-	1	1	1	1	1	1	1	1
Alectoria nigricans	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	t	-	-	-	t
A ochroleuca	-	-	-	-	-	-	1	t	-	t	-	-	-	t	-	t	1	t	-	t
Sphaerophorus globosus	-	-	-	-	-	-	1	t	-	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 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 16: Eureka Summit.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	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	1	t	6	4	6	4	3	6	4	6	2	3	3	2	6	1	3
SHRUBS/FORBS:																				
Betula glandulosa	6	5	6	3	2	5	5	6	3	1	5	4	6	3	2	3	4	6	1	1
Empetrum nigrum	2	2	1	2	3	2	3	3	2	3	1	4	1	2	-	-	-	-	-	2
Vaccinium uliginosum	3	3	4	2	t	4	4	5	1	1	3	4	4	3	3	3	4	5	3	1
V. vitis-idaea	2	2	2	1	2	1	2	3	2	3	1	3	3	2	t	t	1	3	1	2
Cornus canadensis	1	1	1	1	1	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
SEDGE GRASS:																				
Festuca altaica	2	4	4	3	3	3	3	4	3	3	1	1	2	1	3	2	3	3	2	2
LICHENS:																				
Cladonia stellaris	t	-	-	-	-	t	-	-	1	1	1	4	-	2	1	4	-	1	-	-
C. arbuscula	t	-	1	1	t	-	1	-	-	2	2	2	2	1	1	2	4	2	3	3
C. rangiferina	5	5	6	4	4	2	2	3	1	1	4	4	5	3	3	3	2	4	3	1
C. gracilis	1	1	-	1	-	2	1	-	1	-	t	1	1	1	t	t	-	1	-	t
C. unicialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C. amaurocraea	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
C. deformis	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-
Cetraria cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t	-	1	-	-

Station 16: Eureka Summit (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Stereocaulon spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	2	4	4	3	3
Peltigera aphthosa	-	-	-	-	1	-	-	-	1	2	3	3	-	2	3	1	2	-	1	1
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 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 17: Mile 9 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	98	90	95	100	100	98	95	90	80	100	98	93	90	90	100	95	NO DATA	90	100
Hult-Sernander scale for:[b]																				
MOSS:	2	2	2	1	t	4	3	1	1	1	3	2	3	1	t	3	3		1	2
SHRUBS/FORBS:																				
Betula glandulosa	1	1	1	1	1	3	2	2	1	2	1	2	2	1	2	2	2		1	t
Salix glauca	2	2	2	2	t	-	-	-	-	-	-	-	-	-	-	1	1		1	t
S. reticulata	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Ledum decumbens	-	1	1	1	1	2	2	2	1	1	-	1	2	1	t	1	1		1	t
Vaccinium uliginosum	1	-	1	1	1	2	2	1	2	1	3	3	3	2	2	3	4		2	3
V. vitis-idaea	t	1	1	1	t	t	1	1	1	t	t	1	t	t	t	t	1		1	t
Cassiope tetragona	3	3	3	3	3	2	1	2	1	2	3	2	3	1	2	2	2		1	2
Empetrum nigrum	3	2	1	2	2	3	2	3	2	3	1	2	2	1	2	2	3		1	2
Dryas octopetala	1	1	1	1	t	1	1	1	t	t	2	2	3	1	1	1	1		1	t
Diapensia lapponica	3	2	3	1	3	2	1	1	t	1	2	1	1	1	t	1	-		1	2
Tofieldia pusilla	t	t	1	-	t	-	-	-	1	-	-	-	-	-	-	-	-		-	-
Polygonum bistorta	t	-	1	1	t	t	-	t	t	t	1	1	1	1	t	1	1		1	t
Pedicularis laboradorica	-	t	-	-	t	t	-	-	t	1	-	1	-	1	-	t	1		-	t
P. verticillata	-	-	-	-	-	-	-	-	-	-	1	-	-	-	t	-	-		-	t
P. spp.	-	-	t	-	-	-	-	-	t	-	-	-	t	1	-	-	-		-	-
Loiseleuria procumbens	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
SEDGE GRASS:																				
Hierochloe alpina	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-	-	-		-	-
Carex spp.	t	1	t	t	-	1	1	1	1	t	-	-	-	-	t	2	3		1	t
Gramineae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-		-	-

Station 17: Mile 9 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	5	3	5	3	3	3	3	2	1	3	4	2	2	2	1	4	4	NO	2	1
C. arbuscula	t	2	1	1	1	t	2	1	1	t	t	1	2	1	t	t	2	DATA	1	t
C. gracilis	t	-	1	1	1	1	1	1	1	1	1	1	1	1	2	t	2		2	3
C. unicialis	t	t	-	1	t	t	1	t	1	1	t	-	-	1	t	1	1		1	t
C. crispata	-	-	-	t	t	-	1	-	t	-	-	-	-	t	1	-	-		-	t
C. macrophylla	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-		-	-
C. cornuta	-	-	-	t	t	-	-	-	t	t	-	-	-	t	-	-	-		1	-
C. spp. "cup type"	-	t	-	-	t	-	1	-	-	-	-	-	-	-	t	-	1		-	t
C. rangiferina	-	-	-	1	t	-	-	-	1	t	-	-	-	1	t	-	-		1	1
Cetraria cucullata	1	1	1	1	t	2	1	1	1	t	1	1	1	t	t	1	1		1	t
C. nivalis	2	1	2	1	1	3	2	3	1	1	2	2	1	t	t	2	3		1	1
C. islandica	t	1	1	1	t	1	1	1	1	t	t	1	1	1	t	t	2		1	t
C. richardsonii	1	1	1	1	1	1	1	1	1	t	t	1	1	1	t	1	2		1	t
C. nigricans	t	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-
Stereocaulon paschale	1	2	2	1	3	2	3	3	1	1	2	3	3	2	2	2	2		2	3
Dactylina arctica	t	1	1	1	t	t	1	1	t	t	t	-	t	1	t	1	2		1	t
Thamnolia vermicularis	1	-	1	1	t	1	-	1	1	t	1	1	1	1	1	t	-		t	t
Sphaerophorus globosus	-	-	-	-	-	-	-	-	-	-	t	1	1	1	t	-	-		-	-
Cornicularia divergens	1	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-		-	-
Alectoria nigricans	-	1	-	-	-	-	-	-	-	t	-	-	-	-	t	-	-		-	t
A. ochroleuca	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-		-	-
Nephroma expallidum	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-		-	-
Peltigera apthtosa	-	-	-	1	t	-	-	-	t	-	-	-	-	-	2	-	-		1	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 18: Mile 26 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	98	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6	5	4	4	6	6	5	3	4	6	6	5	4	4	6	6	6	4	4
SHRUBS/FORBS:																				
Betula glandulosa	4	5	5	3	3	5	5	5	2	3	5	5	5	3	2	5	3	2	1	t
Ledum decumbens	2	1	1	1	t	-	-	1	1	1	3	4	3	3	2	2	2	2	1	t
Vaccinium uliginosum	1	4	2	2	1	2	3	2	2	1	2	3	2	3	1	3	3	2	1	t
V. vitis-idaea	1	1	1	1	t	t	1	1	1	t	1	2	1	1	t	1	1	1	1	t
Empetrum nigrum	4	4	4	3	4	3	2	4	3	4	4	5	3	3	3	3	4	4	3	4
Spiraea beauverdiana	2	-	1	t	t	-	-	-	-	t	-	-	-	-	t	-	-	-	-	t
Cornus canadensis	2	1	2	1	t	1	1	1	1	t	1	1	1	1	t	1	1	1	1	t
Rubus chamaemorus	1	1	1	t	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	t
SEDGE GRASS:																				
Carex spp.	2	3	1	2	1	3	3	2	2	1	2	2	1	2	t	2	3	1	2	1
LICHENS:																				
Cladonia stellaris	-	-	-	-	-	-	-	-	-	-	t	1	1	t	t	t	-	-	t	-
C. rangiferina	3	3	1	1	t	3	3	2	1	1	2	3	2	2	1	1	1	1	1	t
C. arbuscula	1	1	1	t	1	1	1	1	1	t	1	2	1	1	2	2	2	1	1	2
C. gracilis	1	1	1	-	-	1	1	1	1	t	2	1	1	1	2	t	1	1	t	t
C. unicialis	-	-	-	-	-	-	-	-	-	-	1	1	-	t	-	1	1	t	1	-
C. crispata	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-
C. cornuta	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetraria islandica	1	1	1	-	-	1	1	1	1	-	1	1	t	1	t	t	1	t	1	t
Nephroma arcticum	-	-	-	-	-	2	2	1	-	t	-	-	-	-	-	-	-	-	-	-
Peltigera apthtosa	3	3	2	2	3	t	2	1	2	3	-	-	-	-	-	-	-	-	-	t
P. pulverulenta	-	2	-	-	-	-	-	1	-	t	3	4	-	-	-	2	4	1	-	3
P. canina	-	-	-	1	t	-	-	-	1	t	-	-	-	-	t	-	-	-	2	t

Station 18: Mile 26 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
MISCELLANEOUS:																				
fungi	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	t
Equisetum arvense	-	-	-	-	-	-	-	-	-	-	-	1	t	1	t	1	1	2	2	2

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 19: Mile 29 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	95	100	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6	4	4	5	6	6	5	4	5	6	6	6	4	5	6	6	6	4	6
SHRUBS/FORBS:																				
Loiseleuria procumbens	1	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	1	2	-
Rubus articus	1	1	1	1	t	2	2	2	2	t	2	1	1	2	-	1	1	1	1	t
Artemisia arctica	2	3	3	3	t	2	3	2	2	t	3	3	3	3	t	3	3	3	3	1
Sedum roseum	1	2	1	1	t	1	2	2	2	t	2	2	2	2	t	2	2	2	1	t
Lupinus arcticus	-	-	-	-	-	-	-	-	-	t	1	2	3	1	-	-	-	-	1	t
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	t	-	-	-	-	-
Aconitum delphinifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Antennaria monocephala	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	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	t	2	3	2	2	t	1	3	2	2	t	1	2	1	2	t
Gramineae	-	-	-	4	4	-	-	-	3	4	-	-	-	3	3	-	-	-	3	3

Percent cover of plant species - modified Hult-Sernander method

Station 20: Mile 47 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6	6	5	6	6	6	6	5	6	6	6	6	5	6	6	6	6	5	6
SHRUBS/FORBS:																				
Betula glandulosa	5	4	5	1	t	4	4	4	2	t	5	4	4	2	2	5	5	3	2	2
Salix pulchra	4	3	3	2	t	1	2	1	1	2	2	2	2	1	t	2	1	1	2	t
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	t
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	t	t	1	t	1	-	-	-	t	-	-
Rubus articus	1	1	1	1	-	1	1	-	-	-	1	2	1	1	t	2	2	1	1.	t
Cornus canadensis	t	-	t	-	-	-	-	-	-	-	-	-	-	-	-	1	-	t	-	-
Polemonium acutiflorum	1	1	1	1	-	1	-	-	-	-	1	-	t	t	-	-	1	t	t	-
Stellaria longipes	-	-	-	-	-	t	1	-	-	-	1	1	-	-	t	-	-	-	-	-
Pyrola minor	-	-	t	t	t	t	-	t	t	t	-	-	-	-	-	-	-	t	-	-
Artemisia arctica	1	2	1	1	-	t	1	t	t	-	2	2	1	1	-	1	1	t	t	-
Veronica wormskjoldii	-	-	-	-	-	-	-	t	-	-	-	-	t	-	-	t	-	-	-	-
SEDGE/GRASS																				
Festuca altaica	3	2	1	1	t	t	1	t	1	t	-	-	-	-	-	1	2	-	2	t
Calamagrostis canadensis	-	1	-	t	-	-	-	-	1	-	t	2	1	2	t	1	1	1	t	-
Poa arctica	t	-	-	-	-	t	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Carex spp.	t	1	t	-	t	1	2	t	1	t	1	2	1	1	t	1	1	1	1	t
Juncus castaneus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	1	-	-
LICHENS:																				
Cladonia stellaris	1	1	t	t	-	-	-	-	t	-	t	1	t	-	t	1	2	1	1	t
C. rangiferina	1	1	1	t	t	t	2	1	2	t	2	2	2	1	2	2	2	1	1	t
C. arbuscula	1	1	-	1	t	1	1	1	1	t	2	2	2	1	1	1	1	1	t	-
C. unicialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
C. gracilis	-	-	-	t	t	-	1	1	-	t	t	-	1	1	t	-	-	t	-	-
C. gonecha	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-

Station 20: Mile 47 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS (con't):																				
C. deformis	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-
Cetraria islandica	t	1	-	-	t	1	1	1	1	t	2	1	1	1	t	t	1	-	t	-
Stereocaulon paschale	1	1	t	t	1	-	-	-	-	-	1	1	1	1	t	1	1	t	-	-
Peltigera aphthosa	2	3	2	3	1	2	2	1	1	2	1	-	1	-	t	1	2	1	2	1
P. pulverulenta	-	-	-	-	-	-	1	-	-	-	-	3	-	-	-	-	1	-	-	-
P. canina	-	-	-	1	-	-	-	-	2	t	-	-	-	2	t	-	-	-	1	-
MISCELLANEOUS:																				
fungi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 21: Mile 56 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	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	2	1	3	4	2	2	1	6	6	5	3	5	6	6	4	3	2
SHRUBS/FORBS:																				
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-	-
Betula glandulosa	-	-	-	-	-	-	-	-	-	-	-	-	1	t	t	t	-	t	-	-
Salix pulchra	-	-	-	-	-	-	-	1	1	t	2	2	1	-	t	-	-	-	-	-
S. glauca	5	5	4	2	3	2	3	4	2	3	4	5	4	3	2	4	4	3	3	3
S. reticulata	-	-	-	-	t	-	-	t	-	-	t	1	1	1	t	t	1	t	1	2
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	t	1	t	1	t	1	1	t	t	-
V. vitis-idaea	-	-	-	-	-	-	-	-	-	-	-	1	t	t	-	-	1	t	t	-
Potentilla fruticosa	-	-	-	-	t	-	-	-	-	1	-	1	1	1	t	-	-	-	-	t
P. diversifolia	t	-	-	1	-	-	-	-	1	t	1	1	t	1	t	-	1	t	1	-
Cornus canadensis	-	-	-	1	-	t	-	t	1	-	-	-	-	-	-	-	-	-	-	-
Rubus arcticus	1	1	1	1	t	t	-	t	1	t	2	1	t	t	t	-	-	-	-	t
Epilobium angustifolium	t	2	1	1	t	1	2	1	1	t	-	1	1	t	t	-	-	t	-	t
Aconitum delphinifolium	1	1	t	1	-	t	-	1	1	t	t	1	t	1	t	t	-	-	2	t
Sanguisorba sitchensis	1	2	1	1	t	2	3	1	1	t	1	2	1	1	t	1	1	1	1	t
Sedum roseum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Swertia perennis	-	-	-	-	t	t	-	1	t	t	1	1	-	-	t	1	1	t	t	t
Pyrola minor	1	-	t	-	-	1	1	1	1	t	t	-	t	t	t	t	-	t	t	-
Veronica wormskjoldii	t	-	-	-	t	1	-	-	-	-	t	-	-	-	t	t	-	t	t	t
Valeriana capitata	-	1	-	-	-	-	-	t	t	-	-	1	1	1	-	-	-	1	t	-
Stellaria laeta	t	-	-	-	t	1	2	t	1	t	-	-	-	-	-	t	-	-	-	-
Thalictrum alpinum	-	-	t	-	1	-	-	1	t	-	t	1	t	1	t	1	1	1	1	2
Solidago multiradiata	2	2	2	1	-	2	1	1	1	-	2	3	2	1	t	2	2	1	1	-
Artemisia arctoca	1	2	1	1	t	1	3	1	1	1	1	2	1	1	t	2	2	1	1	-
Senecio lugens	-	3	-	1	t	-	2	-	1	-	-	-	1	t	t	-	1	1	1	-
Antennaria monocephala	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	1	-	-	-	-

Station 21: Mile 56 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
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	-	-	-	-	-	-	-	-	-
Carex spp.	2	1	1	2	3	1	1	t	2	2	3	2	2	1	3	2	1	1	t	3
Hierochloe alpinum	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-
Trisetum spicatum	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-
Luzula multiflora	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
Gramineae	-	-	-	4	5	-	-	-	3	5	-	-	-	2	3	-	-	-	3	3
LICHENS:																				
Cladonia arbuscula	t	1	1	1	t	t	-	t	1	-	-	1	-	t	t	t	1	1	1	1
C. rangiferina	-	-	t	-	t	-	1	t	-	-	-	1	t	-	-	-	1	t	1	-
C. uncialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
C. gracilis	-	-	t	1	t	-	1	t	1	t	-	1	-	-	t	t	1	1	1	t
C. verticillata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
C. stellaris	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-
Cetraria islandica	-	1	1	1	1	-	1	t	-	-	-	1	1	-	1	-	1	1	1	t
C. cucullata	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Stereocaulon paschale	1	1	2	1	1	1	1	t	1	t	1	1	1	1	t	3	3	3	4	3
Peltgera aphthosa	-	1	1	1	t	-	1	1	1	-	-	-	-	1	-	t	1	-	1	-
P. canina	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Lobaria linita	-	-	-	-	-	-	1	t	-	-	-	-	-	-	t	t	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 22: Mile 65 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	No DATA	100	100	100	100	NO DATA	100	100	100	100	NO DATA	100	100	100	100	NO DATA
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

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 23: Mile 94 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B3
Total Cover (%)	100	100	NO DATA	100	100	100	100	NO DATA	100	100	100	100	NO DATA	100	100	100	NO DATA	100	100
Hult-Sernander scale for:[b]																			
MOSS:	6	6		2	3	6	6		3	3	6	6		4	6	6		1	2
SHRUBS/FORBS:																			
Betula glandulosa	1	2		1	3	2	3		2	2	1	2		t	1	1		3	2
Ledum decumbens	2	4		2	t	4	5		2	-	3	3		3	2	3		3	4
Vaccinium uliginosum	5	5		3	2	5	3		3	t	3	1		t	-	-		-	2
V. vitis-idaea	2	2		1	t	3	2		2	t	3	4		2	2	3		2	2
Empetrum nigrum	1	1		2	2	1	1		2	2	-	-		-	-	-		-	-
Spiraea beauverdiana	-	1		t	2	-	-		t	-	-	-		t	-	-		-	t
Oxycoccus microcarpus	1	1		1	-	1	-		1	-	1	-		-	1	-		-	-
Rubus chamaemorus	3	4		3	3	4	6		4	3	3	5		2	4	4		3	2
Andromeda polifolia	-	-		-	-	-	-		-	-	-	-		-	1	-		-	-
Pedicularis labradorica	-	1		t	t	-	-		1	t	-	-		-	-	-		-	-
SEDGE/GRASS:																			
Carex spp.	1	2		1	3	3	4		3	5	t	1		2	3	4		-	-
LICHENS:																			
Cladonia rangiferina	-	-		-	-	-	-		-	-	3	3		2	t	1		3	2
C. arbuscula	-	-		-	-	t	-		-	-	-	-		2	-	-		3	1
C. gracilis	1	-		-	-	2	-		1	-	1	1		t	3	1		2	1
C. amaurocraea	1	-		-	-	2	-		-	-	t	-		-	t	1		-	-
C. unicialis	-	-		-	-	-	-		-	-	-	-		-	-	-		t	-
C. gonecha	-	-		-	-	-	-		-	-	-	-		-	-	-		1	t
Cetraria islandica	t	-		-	-	t	-		-	-	1	1		t	t	1		-	-
C. cucullata	1	-		t	t	2	1		t	-	3	1		1	2	1		2	2
C. richardsonii	-	-		1	-	1	-		-	-	-	-		-	-	-		-	-

Station 23: Mile 94 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B3
LICHENS: (con't)																			
Dactylina arctica	1	1	NO	1	-	1	1	NO	t	-	-	-	NO	-	-	-	No	-	-
Peltigera pulverulenta	-	1	DATA	1	-	-	-	DATA	t	-	t	1	DATA	1	1	1	DATA	-	t
Thamnolia spp.	-	-		-	-	-	-		-	-	-	-		t	-	-		t	-
Stereocaulon spp.	-	-		-	-	-	-		-	-	-	-		-	-	-		1	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
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	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	No DATA	95	100	100	100	NO DATA	100	100	100	100	NO DATA	90	95	100	100	NO DATA	90	90
Hult-Sernander scale for:[b]																				
MOSS:	6	6		1	t	6	6		3	3	6	6		2	3	6	6		3	3
SHRUBS/FORBS:																				
Picea glauca	-	-		-	t	1	1		-	-	-	-		-	-	-	-		-	-
Betula glandulosa	1	t		-	-	3	2		3	t	2	2		1	-	5	4		1	2
Vaccinium uliginosum	-	-		-	-	1	2		2	1	1	1		1	t	-	-		-	-
V. vitis-idaea	1	1		1	t	2	2		1	t	1	1		t	t	2	2		1	t
Ledum decumbens	4	4		1	2	3	3		3	2	2	2		1	t	4	4		3	4
Empetrum nigrum	2	2		1	2	4	2		2	1	2	3		2	4	4	4		2	2
Cornus canadensis	-	1		-	-	1	1		1	t	-	-		-	-	t	1		1	-
Rubus chamaemorus	-	-		-	-	t	-		-	-	-	-		1	t	-	-		-	-
SEDGE GRASS:																				
Carex spp.	1	1		t	t	2	1		1	t	2	2		1	1	3	3		1	-
LICHENS:																				
Cladonia stellaris	3	3		2	3	1	1		1	t	2	2		1	1	-	1		t	t
C. rangiferina	2	2		1	2	4	4		3	4	3	3		2	t	3	2		1	2
C. arbuscula	1	1		1	t	1	1		1	t	2	1		2	t	3	2		2	2
C. Crispata	-	1		1	-	-	-		-	-	-	-		t	-	-	-		1	t
C. gracilis	2	1		2	1	1	-		1	-	2	1		2	2	1	1		2	2
C. cornuta	-	1		1	-	-	-		t	-	-	-		-	-	-	-		-	-
C. uncialis	-	-		-	-	-	-		t	-	-	1		t	-	-	-		1	-
C. gonecha	t	1		t	t	-	-		-	-	-	-		-	-	-	1		1	t
C. pleurota	-	-		-	-	-	-		-	-	-	-		t	-	-	-		1	t
Cetraria islandica	2	2		2	2	t	1		1	t	1	1		1	t	1	1		1	t
C. richardsonii	1	1		1	1	1	-		-	-	2	2		1	t	-	-		-	-
C. nigricans	-	-		-	-	-	-		-	-	-	-		t	-	-	-		1	t
Peltigera pulverulenta	2	1		-	-	2	3		-	3	2	3		-	t	1	-		-	t
P. canina	-	-		1	t	-	-		3	-	-	-		1	-	-	-		1	2

Station 24: Mile 100 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS (con't):																				
P. aphthosa	-	-	NO	-	t	-	-	NO	-	-	-	-	NO	-	-	-	-	NO	1	t
Nephroma arcticum	4	4	DATA	3	3	-	-	DATA	-	-	2	2	DATA	1	1	-	-	DATA	-	-
Thamnolia vermicularis	-	-		t	t	-	-		-	-	-	-		-	t	-	-		-	-
Stereocaulon spp.	-	-		-	2	-	-		-	2	-	-		-	1	-	-		t	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 25: Mile 108 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	No DATA	100	100	100	100	NO DATA	95	100	100	100	NO DATA	90	100	100	100	NO DATA	100	100
Hult-Sernander scale for:[b]																				
MOSS:	5	5		4	3	5	6		2	3	4	5		2	3	5	5		3	4
SHRUBS/FORBS:																				
Picea glauca	-	-		-	-	-	-		-	-	-	-		-	-	2	2		1	1
Betula glandulosa	5	4		2	t	6	5		3	3	6	4		2	2	4	1		1	-
Vaccinium uliginosum	4	4		3	3	1	2		1	2	4	4		2	2	4	3		2	3
V. vitis-idaea	1	1		1	t	2	2		1	t	3	4		1	t	2	1		2	2
Ledum decumbens	-	-		-	-	3	4		2	2	2	3		2	1	1	-		1	1
Empetrum nigrum	-	-		-	-	3	3		2	3	-	-		-	-	3	2		1	3
Salix pulchra	-	-		-	-	3	3		1	t	-	-		-	-	-	-		-	-
Cornus canadensis	t	1		1	t	1	1		1	t	t	1		1	t	1	1		1	t
SEDGE GRASS:																				
Festuca altaica	t	1		-	-	t	2		-	-	-	-		-	-	-	-		-	-
Carex spp.	-	-		1	t	-	-		1	t	-	-		-	-	-	-		-	-
Gramineae	-	-		-	-	-	-		1	t	-	-		-	-	-	-		-	-
LICHENS:																				
Cladonia stellaris	1	2		-	2	-	1		-	-	-	-		-	-	-	1		-	-
C. rangiferina	3	3		3	4	1	1		1	t	1	1		1	t	1	1		1	t
C. arbuscula	2	2		1	1	1	1		1	t	t	1		1	t	2	2		1	2
C. gracilis	3	1		2	t	3	1		1	t	3	4		2	3	2	2		1	t
C. uncialis	2	1		t	-	-	-		t	-	t	1		1	-	2	1		1	-
C. cornuta	-	-		t	-	-	2		-	-	-	1		t	-	-	1		-	-
C. deformis	-	-		-	-	1	1		-	-	1	1		-	-	1	1		-	-
C. crispata	-	-		-	-	-	-		-	t	-	-		1	t	-	-		1	t
C. gonecha	-	-		-	-	-	-		-	t	-	-		1	t	-	-		t	t
Cetraria islandica	2	2		1	t	1	1		1	-	-	1		1	1	1	1		1	t
C. cucullata	1	1		t	t	-	-		-	-	t	1		-	-	-	-		-	t
C. richardsonii	t	1		1	t	-	-		-	-	-	-		-	t	t	-		-	t

Station 25: Mile 108 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Stereocaulon paschale	2	2	NO	1	t	1	1	NO	1	t	1	2	NO	2	3	1	2	NO	1	2
Thamnolia vermicularis	t	-	DATA	-	-	-	-	DATA	-	-	t	-	DATA	-	-	t	-	DATA	-	-
Peltigera aphthosa	1	-		3	3	2	3		1	2	1	1		1	2	1	2		1	2
P. malacea	2	-		2	t	2	2		-	3	-	2		2	2	2	3		1	1
P. canina	-	-		1	-	-	-		1	-	-	-		-	-	-	-		-	-
Nephroma arcticum	1	-		-	-	-	-		-	-	-	-		-	-	-	-		-	-
MISCELLANEOUS:																				
Lycopodium selago	-	-		-	-	-	-		-	-	-	-		-	-	1	2		-	-
fungi	-	-		-	-	-	-		-	-	-	-		-	-	-	-		1	t

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 26: Mile 115 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	98	95	100	100	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	2	3	t	1	t	1	3	1	1	t	2	4	1	1	t	2	3	1	1	t
SHRUBS/FORBS:																				
Betula glandulosa	2	1	1	2	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ledum decumbens	2	4	3	3	2	1	4	2	1	1	4	5	3	3	3	3	5	4	4	4
Vaccinium uliginosum	3	3	2	3	2	3	2	2	2	2	t	1	1	1	1	-	1	1	1	t
V. vitis-idaea	1	-	1	1	t	1	1	1	1	t	2	1	1	1	2	2	2	2	2	2
Empetrum nigrum	3	3	2	2	1	1	1	2	1	t	1	2	1	1	2	-	-	-	1	t
Arctostaphylos alpinum	-	-	-	-	-	-	-	-	-	-	2	3	2	2	3	-	-	-	1	t
Polygonum bistorta	-	1	t	-	-	t	1	t	-	t	-	-	-	-	-	-	-	-	-	-
SEDGE GRASS:																				
Calamagrostis lapponica	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	1	t	-	-
Hierochloe alpinum	-	-	-	-	-	-	1	t	-	-	2	3	1	-	-	1	1	1	-	-
Carex spp.	-	-	t	t	t	-	-	-	-	-	-	-	-	1	t	1	2	1	2	1
Gramineae	-	-	-	t	-	-	-	-	-	-	-	-	-	1	t	-	-	-	-	t
LICHENS:																				
Cladonia stellaris	5	6	5	4	5	6	6	6	4	6	5	3	4	3	3	6	2	4	4	4
C. rangiferina	3	1	2	2	1	1	1	1	2	t	3	2	2	1	3	2	1	3	2	3
C. arbuscula	1	-	1	2	t	1	-	1	1	t	1	-	1	1	2	t	1	1	2	1
C. gracilis	1	1	1	1	t	1	-	1	1	t	t	-	t	1	t	t	-	t	1	t
C. unicialis	1	-	-	1	-	1	-	-	1	-	-	-	-	1	-	-	-	-	1	-
C. crispata	-	-	-	-	t	-	-	-	-	t	-	-	-	-	-	-	-	-	1	-
C. cornuta	-	-	-	t	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
C. gonecha	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
Cetraria nivalis	2	1	1	1	t	2	1	2	1	t	1	1	1	1	t	1	1	1	1	t
C. cucullata	2	1	1	1	t	1	1	1	1	-	2	1	1	1	t	2	1	1	1	t
C. islandica	1	1	1	1	-	t	1	1	1	t	t	1	t	t	t	t	1	t	t	t

Station 26: Mile 115 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
C. richardsonii	t	1	1	t	t	t	-	-	1	-	t	-	t	-	t	1	1	t	1	t
Stereocaulon paschale	t	-	t	-	t	t	1	t	t	-	1	-	t	1	t	-	-	-	-	-
Dactylina arctica	-	-	-	-	-	t	-	t	-	-	-	-	-	-	-	-	-	-	-	-
Thamnolia vermicularis	t	1	t	t	t	-	-	t	-	-	-	-	-	t	-	-	-	-	t	t
Alectoria ochroleuca	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	t	-	-	-	-
Peltigera aphthosa	1	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nephroma arcticum	3	3	3	2	t	-	-	t	-	-	-	-	-	-	-	-	-	-	-	-
MISCELLANEOUS:																				
Lycopodium selago	-	-	-	-	-	-	-	-	-	-	t	-	-	t	-	-	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 27: Mile 124 Denali Highway.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	95	100	100	100	95	95	100	100	98	98	95	100
Hult-Sernander scale for:[b]																				
MOSS:	2	3	1	1	t	3	3	1	1	t	1	2	1	2	t	1	2	1	1	t
SHRUBS/FORBS:																				
Betula glandulosa	3	2	2	3	1	4	3	4	1	t	t	-	-	-	-	4	3	2	3	t
Vaccinium uliginosum	2	2	2	1	2	2	2	1	1	2	t	1	1	1	t	1	1	1	-	t
V. vitis-idaea	t	1	1	1	1	t	1	1	t	t	t	1	1	1	2	t	1	1	1	t
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	1	1	-	-	t	2	2	1	1	2
Ledum decumbens	2	3	2	3	t	-	-	-	-	-	2	1	1	2	3	1	1	-	-	-
SEDGE GRASS:																				
Calamagrostis lapponica	-	1	-	-	-	-	1	-	-	-	-	1	t	-	-	-	-	-	-	-
Hierochloe alpinum	1	1	1	-	-	t	1	1	-	-	t	-	-	-	-	-	t	-	-	-
Carex spp.	-	-	-	1	t	-	-	-	1	t	-	-	-	1	t	-	-	-	-	-
LICHENS:																				
Cladonia stellaris	3	4	4	3	5	3	2	3	4	3	4	1	3	4	3	2	3	3	4	3
C. rangiferina	4	2	2	3	3	3	3	2	2	4	3	3	3	2	2	4	3	4	3	3
C. arbuscula	2	3	2	3	t	4	3	3	2	3	1	1	1	3	2	1	2	2	3	1
C. gracilis	3	2	1	2	t	2	1	1	1	1	1	1	2	2	3	t	-	1	2	3
C. unicialis	2	1	t	1	-	1	-	1	t	-	t	1	1	t	-	-	1	1	t	-
C. crispata	-	1	-	t	t	-	2	1	t	-	-	-	-	t	t	-	-	t	-	t
C. degenerans	-	-	-	-	-	t	1	-	-	t	-	-	-	-	-	-	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	-	-
C. deformis	-	-	-	t	-	t	-	-	1	t	-	1	-	1	-	-	-	-	t	-
C. gonecha	-	-	-	t	-	-	-	-	-	-	-	-	-	-	t	-	-	-	t	t
Cetraria cucullata	2	1	1	1	t	2	2	t	1	t	2	1	t	1	t	1	1	1	1	2
C. islandica	t	1	1	1	t	1	1	1	1	t	t	2	2	1	1	t	1	1	1	t

Station 27: Mile 124 Denali Highway (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
C. richardsonii	-	2	1	1	t	-	2	1	1	1	-	2	1	2	2	-	1	1	2	3
C. nivalis	t	-	1	t	t	1	1	1	1	1	1	1	1	1	1	1	1	1	1	t
Stereocaulon paschale	3	3	3	2	2	2	1	1	1	2	3	2	1	1	t	3	2	2	1	1
Peltigera pulverulenta	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	2	2	-	-
P. aphthosa	-	-	-	-	-	-	-	-	-	-	-	1	-	1	t	-	-	t	1	t
P. canina	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-
P. malacea	-	-	-	1	t	-	-	-	1	-	-	-	-	-	-	-	-	-	2	t
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-
Nephroma arcticum	-	-	-	-	-	-	-	t	-	t	-	1	1	1	-	-	-	-	t	t
MISCELLANEOUS																				
fungi	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 28: Black Lake.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A3[c]	A2	A2	A2	A2	A4[c]	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B5[c]
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	NO DATA	100	100
Hult-Sernander scale for:[b]																			
MOSS:	6	6	6	3	4	6	6	6	2	3	6	6	6	4	6	6		4	5
SHRUBS/FORBS:																			
Betula glandulosa	4	4	3	3	2	5	5	6	4	2	5	4	5	1	5	6		2	2
Ledum decumbens	-	-	-	-	-	-	-	-	t	-	-	-	-	4	-	-		-	2
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		3	-
V. vitis-idaea	3	3	3	2	3	5	5	3	2	2	2	2	2	2	4	5		2	1
SEDGE GRASS:																			
Hierochloe alpina	3	4	3	-	-	3	4	3	-	-	2	3	1	-	1	2		-	-
Carex spp.	-	-	-	1	t	-	-	-	t	t	-	-	-	t	-	-		1	1
Gramineae	-	-	-	1	t	-	-	-	1	t	-	-	-	t	-	-		2	t
LICHENS:																			
Cladonia rangiferina	2	1	2	1	t	1	1	3	2	1	1	1	1	-	2	1		t	t
C. arbuscula	1	3	2	4	t	t	3	3	3	3	1	2	3	t	1	1		3	t
C. unicialis	1	1	3	t	3	3	1	2	t	3	3	1	1	t	1	1		t	t
C. amaurocraea	t	1	t	-	-	t	1	t	-	-	t	1	t	t	-	-		-	-
C. gracilis	t	1	1	t	t	t	-	t	t	t	1	1	1	t	t	-		1	t
C. deformis	-	-	-	-	-	t	-	-	-	-	t	1	1	-	t	-		-	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-		t	t
Cetraria islandica	t	1	1	1	t	t	-	1	1	t	t	1	t	t	1	1		-	-
C. cucullata	1	1	2	1	t	t	1	t	1	t	1	2	1	t	1	1		1	t
C. richardsonii	2	2	2	2	t	1	1	2	2	t	1	2	2	-	2	2		2	t
C. nivalis	-	-	-	t	-	-	-	-	-	t	-	-	-	-	-	-		t	-
Stereocaulon paschale	3	2	2	2	1	2	1	2	2	2	1	1	1	-	t	-		2	-
Thamnolia vermicularis	1	-	1	1	t	t	1	1	1	t	t	-	1	-	t	1		1	-
Peltigera pulverulenta	2	2	1	-	3	-	2	2	-	t	1	1	1	2	2	2		-	2

Station 28: Black Lake(continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A3[c]	A2	A2	A2	A2	A4[c]	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B5[c]
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	NO DATA	100	100
P. canina	-	-	-	1	-	-	-	-	2	-	-	-	-	t	-	-		1	t
P. aphthosa	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-		-	t
Dactylina arctica	-	-	-	-	-	-	-	t	t	-	-	-	-	t	-	-		-	t
MISCELLANEOUS																			
fungi	-	-	-	1	t	-	-	-	1	-	-	-	-	-	-	-		-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

[c] New quadrat established when stakes marking location of iriginal quadrat could not be located.

Percent cover of plant species - modified Hult-Sernander method

Station 29: Clarence Lake.

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	95	100	100	98	90	90	90	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	5	6	6	3	2	5	5	6	3	1	5	5	6	4	4	5	6	6	4	4
SHRUBS/FORBS:																				
Betula glandulosa	2	2	2	1	t	-	1	1	2	t	6	4	5	3	2	3	4	5	2	3
Ledum decumbens	3	4	3	2	2	2	3	4	2	2	3	4	4	3	2	3	4	4	1	1
Vaccinium uliginosum	4	5	5	3	1	3	3	3	2	2	5	5	5	1	2	4	5	5	2	2
V. vitis-idaea	3	1	3	1	1	2	2	3	1	t	4	3	2	1	1	3	3	4	1	t
Empetrum nigrum	1	-	-	1	1	-	-	-	-	-	4	3	2	2	2	-	3	5	2	4
Salix pulchra	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	1	2	1	t
SEDGE GRASS:																				
Hierochloe alpina	-	2	-	-	-	-	-	-	-	-	-	1	2	-	-	-	1	1	-	-
Festuca altaica	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Carex spp.	t	-	-	1	t	2	2	2	1	1	1	1	-	1	1	-	1	t	1	t
Gramineae	-	-	-	t	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-
LICHENS:																				
Cladonia stellaris	-	-	t	-	t	-	-	t	1	t	-	-	t	-	t	-	-	-	-	-
C. rangiferina	3	2	4	2	2	5	3	5	2	2	5	3	3	t	t	4	2	2	1	t
C. arbuscula	2	3	3	3	2	1	3	4	4	3	2	2	1	1	t	t	2	1	1	t
C. gracilis	1	2	3	2	3	2	2	4	1	2	t	2	3	2	3	1	1	1	1	1
C. cornuta	-	-	-	-	-	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-
C. unicialis	t	-	-	1	t	t	-	-	1	2	-	1	1	t	t	1	-	t	-	-
C. gonecha	-	2	1	t	t	-	2	1	1	2	-	-	-	1	-	-	-	-	-	-
C. deformis	t	-	-	-	-	-	-	-	-	-	-	1	1	t	t	-	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-	-	-
Cetraria cucullata	2	2	3	1	1	3	2	3	2	2	t	2	2	1	t	1	1	1	1	t
C. islandica	2	1	1	t	1	1	1	1	1	t	1	1.	1	1	t	t	1	1	1	t
Stereocaulon spp.	2	4	5	3	4	t	1	3	2	1	-	-	-	-	t	t	-	-	-	-
Peltigera canina	-	-	-	t	t	-	-	-	-	-	-	-	-	1	t	-	-	-	1	-

Station 29: Clarence Lake (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
P. aphthosa	-	-	-	-	-	-	-	-	1	t	-	-	-	-	-	-	-	-	-	-
P. spp.	t	-	1	-	-	-	1	1	-	-	-	1	t	-	-	t	1	t	-	-
Dactylina arctica	-	-	-	t	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	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 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 30: Middle Fog Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	98	100	97	95	95	100	100	98	95	100	100	90	96	95	100	100	50	80	75	75
Hult-Sernander scale for:[b]																				
MOSS:	5	5	1	2	t	1	3	t	1	t	5	3	t	2	t	4	1	1	2	t
SHRUBS/FORBS:																				
Betula glandulosa	1	2	2	2	t	1	1	2	1	1	2	1	2	1	t	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	3	3	3	2	2	4	5	5	2	t	3	3	4	3	1
V. vitis-idaea	1	1	1	t	t	2	2	2	2	2	3	4	4	2	t	2	3	4	2	3
Ledum decumbens	t	1	1	1	t	t	-	2	1	2	1	1	1	1	t	1	-	-	-	-
Empetrum nigrum	1	1	1	1	2	3	4	4	2	2	-	-	2	2	4	4	4	4	3	4
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-	1	1	1	2	4	-	-	-	-	-
Rubus chamaemorus	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-	-	-
Picea spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-
SEDGE GRASS:																				
Carex spp.	t	-	-	-	-	-	-	-	-	-	t	1	1	1	t	-	-	-	-	t
Hierochloe alpina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	1	-	-	-
Festuca altaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
LICHENS:																				
Cladonia stellaris	t	1	1	1	3	t	-	1	1	2	-	-	-	-	-	-	-	-	-	-
C. rangiferina	1	1	1	3	2	1	1	2	1	2	2	1	1	t	-	1	-	t	t	t
C. arbuscula	2	2	3	4	3	1	1	2	2	3	2	1	1	2	t	1	-	1	1	3
C. cornuta	-	1	t	-	t	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-
C. unicialis	3	1	2	1	t	1	1	1	1	t	1	1	2	1	t	1	1	1	t	t
C. amaurocraea	-	1	t	-	t	-	-	t	-	-	-	1	-	-	-	-	-	-	-	-
C. gracilis	t	1	1	2	3	1	-	1	1	2	2	1	2	1	3	t	-	1	1	t
C. macrophylla	-	2	1	t	-	-	-	-	-	-	-	-	-	1	-	-	-	-	t	-
C. crispata	-	-	-	1	-	-	-	-	1	t	-	-	t	t	t	-	-	-	-	-
C. bellidiflora	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	1	t
C. goneche	-	-	-	t	t	-	-	-	-	-	-	-	-	t	-	-	-	-	t	-

Station 30: Middle Fog Lake (continued).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
C. spp. (cup-like)	-	-	1	-	-	-	-	t	-	-	-	-	1	-	-	-	-	1	-	-
Cetraria cucullata	1	2	1	1	t	t	1	1	t	t	1	1	1	1	t	1	-	1	1	t
C. nivalis	1	1	1	1	t	t	-	t	t	t	t	-	-	-	-	t	1	1	1	t
C. islandica	1	1	1	1	t	t	2	1	1	t	t	1	1	1	t	t	-	t	-	t
C. richardsonii	t	-	t	1	t	t	1	1	1	1	-	-	-	-	-	-	-	t	t	-
Stereocaulon paschale	4	4	3	3	3	4	4	4	2	3	3	2	4	2	3	3	1	2	2	2
Thamnolia vermicularis	t	-	1	1	t	t	-	t	t	t	t	-	t	t	-	t	-	1	-	t
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	t	-	t	1	t	t	-	-	-	t
Cornicularia divergens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-
Sphaerophorus globosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t	1	1	1	-
Peltigera aphthosa	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	t	t
P. canina	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
P.spp.	-	-	-	-	-	-	-	-	-	-	t	-	t	-	2	-	-	t	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 31: Deadman Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	98	98	NO DATA	96	90	96	90	NO DATA	90	70	98	80	NO DATA	75	65	100	45	NO DATA	NO DATA	NO DATA
Hult-Sernander scale for:[b]																				
MOSS:	1	3		1	t	t	3		1	t	1	1		1	-	1	1			
SHRUBS/FORBS:																				
Betula glandulosa	-	-		-	-	2	1		1	t	-	-		-	t	3	2			
Vaccinium uliginosum	3	4		3	2	2	3		1	t	2	4		2	t	1	3			
V. vitis-idaea	t	1		1	t	t	-		1	t	t	-		1	t	t	1			
Ledum decumbens	2	4		1	2	t	2		1	t	1	-		1	t	1	1			
Loiseleuria procumbens	4	4		1	1	3	3		1	1	1	1		1	1	4	3			
Diapensia lapponica	-	-		2	1	1	1		1	1	-	-		1	1	2	-			
Arctostaphylos alpina	-	-		-	-	1	1		1	t	-	-		-	-	-	-			
Empetrum nigrum	1	1		1	t	-	-		-	-	3	3		3	4	-	-			
Polygonum bistorta	-	-		-	-	-	-		1	-	-	-		-	-	t	-			
Tofieldia pusilla	-	-		-	-	t	-		-	t	-	-		-	-	1	2			
Pedicularis labradorica	-	-		-	-	t	-		-	-	-	-		-	-	-	-			
P. spp.	-	-		-	-	-	-		1	-	-	-		-	-	-	-			
SEDGE GRASS:																				
Calamagrostis lapponica	-	2		-	-	-	1		2	-	-	1		-	-	-	-			
Hierochloe alpina	-	1		-	-	-	3		-	-	1	2		-	-	t	2			
Festuca altaica	3	-		-	-	2	2		-	-	-	-		-	-	-	-			
Carex spp.	1	2		2	2	t	-		1	2	1	2		1	2	1	4			
Gramineae	-	-		2	-	-	-		-	-	-	-		1	-	-	-			
LICHENS:																				
Cladonia stellaris	2	1		2	3	t	-		1	t	3	1		1	t	1	-			
C. rangiferina	t	2		1	t	t	2		-	-	1	1		1	-	t	-			
C. unicialis	2	1		1	-	2	1		1	-	1	-		1	t	2	-			
C. gracilis	t	1		1	t	t	1		1	t	-	-		1	t	1	-			
C. coccifera	-	-		1	t	-	-		1	t	-	-		1	t	-	-			

Station 31: Deadman Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS			NO					NO					NO					NO	NO	NO
C. arbuscula	2	2	DATA	1	2	1	1	DATA	1	2	1	1	DATA	1	t	1	-	DATA	DATA	DATA
C. crispata	-	-		1	-	-	-		1	-	-	-		-	-	-	-			
C. goneche	-	-		1	-	-	-		-	t	-	-		-	-	-	-			
Cetraria Islandica	t	1		1	t	t	-		1	2	t	1		1	t	t	1			
C. nivalis	1	4		2	2	2	4		3	3	1	2		1	t	1	1			
C. cucullata	t	-		-	-	t	1		-	-	t	-		-	-	t	1			
C. richardsonii	1	1		1	1	1	-		1	t	t	1		1	t	1	-			
C. nigricans	t	-		1	2	2	3		1	2	-	-		1	-	t	1			
Stereocaulon paschale	2	3		2	2	t	2		1	t	1	1		2	3	1	1			
Thamnolia vermicularis	t	-		1	t	1	2		1	t	t	-		1	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	1			
A. nitidula	-	-		-	t	-	-		1	1	-	-		-	-	-	-			
Lobaria linita	-	-		-	-	-	-		-	-	-	-		-	-	1	-			

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 32: Butte Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B5
Total Cover (%)	100	100	NO DATA	100	90	100	100	NO DATA	100	100	100	100	NO DATA	NO DATA	95	100	90	NO DATA	95	85
Hult-Sernander scale for:[b]																				
MOSS:	5	5		1	2	5	6		1	3	5	5			4	4	4		3	3
SHRUBS/FORBS:																				
Betula glandulosa	-	-		-	-	-	1		1	t	1	2			1	1	1		-	-
Salix reticulata	t	1		t	-	-	-		-	-	2	2			1	1	2		1	2
S. pulchra	-	-		-	-	3	2		1	t	-	-			-	-	-		1	2
Vaccinium uliginosum	1	2		2	t	-	-		1	t	2	1			2	2	2		2	2
V. vitis-idaea	1	1		2	t	4	5		2	2	t	1			t	t	2		1	t
Ledum decumbens	1	3		2	t	2	2		1	2	1	1			t	t	1		1	t
Empetrum nigrum	1	1		1	t	3	3		2	2	2	2			2	1	-		2	2
Arctostaphylos alpina	1	3		1	-	3	3		2	3	-	-			-	-	-		-	-
Dryas octopetala	-	-		-	-	-	-		-	-	-	-			-	-	1		1	1
Andromeda polifolia	-	-		-	-	-	-		-	-	t	-			-	-	-		-	-
Pyrola grandiflora	-	-		-	-	-	-		-	-	-	-			-	-	1		-	-
Polygonum bistorta	t	-		t	-	t	-		1	t	t	-			-	t	-		1	t
Pedicularis labradorica	-	-		-	t	-	-		-	-	t	1			-	t	1		1	-
Saussurea angustifolia	-	-		-	-	-	-		-	-	t	-			-	t	-		-	t
SEDGE/GRASS:																				
Carex spp.	4	4		1	2	4	4		2	3	6	6			4	4	6		2	2
LICHENS:																				
Cladonia rangiferina	3	2		t	t	1	1		1	t	2	1			t	3	1		t	t
C. arbuscula	1	2		3	4	t	2		2	3	1	1			t	t	1		1	1
C. unicialis	1	2		t	-	1	1		t	-	3	-			-	3	1		t	-
C. gracilis	1	1		1	t	t	1		t	t	1	-			t	t	-		t	t
C. pleurota	-	-		t	-	-	-		-	-	-	-			-	-	-		t	-
C. coccifera	-	-		t	t	-	-		t	-	-	-			-	-	-		-	t
Cetraria cucullata	1	2		1	t	1	2		2	1	2	1			t	1	-		1	t

Station 32: Butte Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B4[c]	B2	B2	B2	B3[c]	B5[c]
C. nivalis	1	1	NO	1	1	t	-	NO	-	t	t	-	NO	NO	1	1	NO	-	t	t
C. islandica	t	2	DATA	1	-	t	1	DATA	1	t	1	-	DATA	DATA	t	-	DATA	-	1	t
C. richardsonii	t	1		1	t	t	1		1	t	-	-			t	t		-	1	t
Stereocaulon paschale	-	1		2	3	-	1		1	t	-	-			-	t		-	t	t
Thamnolia vermicularis	1	-		1	t	t	-		1	-	1	-			1	t		-	1	t
Sphaerophorus globosus	t	1		1	t	-	-		-	-	-	-			-	t		1	-	-
Dactylina arctica	t	-		t	t	-	-		1	t	-	-			-	-		-	1	t
Cornicularia divergens	1	-		1	t	-	-		-	t	-	-			-	1		1		-
Alectoria ochroleuca	1	1		1	2	-	-		1	-	-	-			-	-		1	-	t
Peltigera aphthosa	-	-		-	-	t	-		1	t	-	-			t	-		-	1	1

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

[c] New quadrat - established when stakes marking location of original quadrat could not be found.

Percent cover of plant species - modified Hult-Sernander method

Station 33: Soule Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	99	100	NO DATA	95	85	97	95	NO DATA	90	80	100	60	NO DATA	70	55	99	50	NO DATA	80	45
Hult-Sernander scale for:[b]																				
MOSS:	2	4		1	t	1	3		1	t	3	1		2	t	2	1		1	t
SHRUBS/FORBS:																				
Cassiope tetragona	2	3		1	3	t	-		1	t	t	1		1	t	1	-		-	-
Empetrum nigrum	1	2		1	2	-	-		-	t	1	1		2	3	2	3		4	3
Salix arctica	t	1		1	t	t	1		1	1	t	1		2	t	t	1		1	1
Vaccinium uliginosum	t	1		t	t	1	2		2	1	1	-		1	1	1	-		1	t
V. vitis-idaea	t	-		t	t	t	-		1	t	t	1		1	t	t	1		1	t
Dryas octopetala	2	2		1	2	2	2		2	3	3	3		3	2	1	2		2	2
Diapensia lapponica	1	1		1	t	1	1		1	t	-	-		1	t	1	-		1	t
Loiseleuria procumbens	2	1		1	t	-	4		1	-	-	-		-	-	-	-		-	-
Antennaria spp.	t	-		-	t	t	-		-	t	t	1		-	-	t	-		-	-
Pedicularis labradorica	t	-		-	t	t	1		-	t	t	1		-	t	t	-		-	-
Anemone narcissiflora	t	2		1	t	t	1		1	1	t	1		1	t	t	1		1	t
Artemesia altaica	1	-		-	-	t	-		-	t	t	-		-	-	1	-		-	t
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	t	1		1	t	t	2		1	2	-	3		1	t
Gramineae	-	-		1	1	-	-		1	1	-	-		2	t	-	-		3	1
LICHENS:																				
Cladonia stellaris	5	4		4	3	2	4		3	3	5	-		1	t	5	-		1	t
C. rangiferina	1	2		2	2	t	1		-	-	t	1		t	t	t	1		-	-
C. arbuscula	1	-		1	t	1	-		1	t	1	1		1	t	t	-		1	-
C. unicialis	t	1		1	-	1	1		1	t	1	1		1	t	1	1		1	t
C. gracilis	1	2		1	2	t	1		1	2	2	-		1	2	2	-		1	t
C. goneche	-	-		1	t	-	-		-	-	-	-		-	-	-	-		-	-

Station 33: Soule Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2?
LICHENS (continued):																				
C. pleurota	-	-	NO	1	-	-	-	NO	1	t	-	-	NO	1	t	-	-	NO	1	-
Cetraria islandica	1	2	DATA	1	2	1	2	DATA	1	t	2	1	DATA	1	t	2	1	DATA	1	t
C. nivalis	1	1		1	t	2	2		2	1	1	-		-	-	-	-		-	-
C. nigricans	-	-		1	t	-	2		2	3	-	-		1	t	-	-		1	t
C. richardsonii	t	1		1	t	t	1		1	2	-	-		1	t	-	1		1	-
Stereocaulon paschale	-	-		-	t	t	-		1	t	t	-		-	t	t	-		t	t
Dactylina arctica	t	1		t	t	t	-		1	t	t	-		-	t	t	-		-	-
Thamnolia vermicularis	1	1		1	t	1	-		1	1	1	-		1	t	t	-		1	t
Miscellaneous:																				
Lycopodium alpinum	-	-		-	-	t	-		-	-	t	-		-	-	t	-		-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 34: Jack Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	62	70	77	83	89	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]	B3	B4[c]	B4
Total Cover (%)	100	100	NO DATA	90	100	100	100	NO DATA	100	100	100	100	NO DATA	100	100	NO DATA	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6		3	4	4	5		4	3	5	5		5	5		1	t	2	3
SHRUBS/FORBS:																				
Betula glandulosa	5	5		5	4	1	1		1	1	4	4		6	6		-	t	4	3
B. nana	-	-		-	-	-	-		-	-	-	-		-	-		1	-	-	-
Vaccinium uliginosum	-	1		1	t	3	4		1	3	-	-		-	1		2	2	-	-
V. vitis-idaea	1	1		1	t	1	1		t	t	2	2		t	-		1	t	1	t
Empetrum nigrum	-	-		-	-	1	2		3	3	-	-		-	-		3	3	-	-
Salix spp.	-	-		-	-	-	-		-	-	t	-		-	-		-	-	-	-
Cornus canadensis	1	1		1	1	t	2		-	-	-	1		-	-		-	t	1	t
Diapensia lapponica	-	-		-	-	-	-		-	-	-	-		-	-		1	-	-	-
Dryas octopetala	-	-		-	-	-	-		-	-	-	-		-	-		-	2	-	-
SEDGE/GRASS:																				
Hierochloe alpina	1	1		-	-	t	1		-	-	1	2		1	1		-	-	-	-
Carex spp.	-	1		-	t	-	1		-	t	-	1		-	2		1	t	-	t
Gramineae	-	-		1	t	-	-		1	t	-	-		-	-		2	t	2	2
LICHENS:																				
Cladonia stellaris	1	1		1	-	t	2		1	2	2	-		-	1		1	t	2	t
C. rangiferina	1	2		2	-	2	3		2	2	2	3		4	4		1	2	3	3
C. arbuscula	2	2		2	4	3	2		2	2	3	3		4	2		1	1	2	3
C. unicialis	1	-		t	t	t	1		1	-	2	2		1	-		1	t	t	-
C. amaurocraea	-	2		t	t	-	1		-	-	-	1		-	1		-	-	-	-
C. gracilis	1	-		t	t	1	1		1	t	1	1		2	2		1	2	1	2
C. deformis	-	-		-	-	-	-		-	-	t	-		t	1		-	-	-	-
C. crispata	-	-		1	t	-	-		-	t	-	-		-	-		1	-	1	-
C. coccifera	-	-		-	-	-	-		-	-	-	-		-	-		-	t	t	-

Station 34: Jack Lake (Con't.).

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	62	70	77	83	89	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B2	B2	B2	B3[c]	B3	B4[c]	B4
LICHENS (continued):																				
C. gonecha	-	-	NO	-	-	-	-	NO	-	-	-	-	NO	-	-	NO	t	t	-	t
C. spp. (cup-like)	-	-	DATA	-	-	-	-	DATA	-	-	-	-	DATA	-	-	DATA	t	-	-	-
Cetraria islandica	1	1		1	-	1	1		1	t	1	-		1	1		1	t	t	1
C. nivalis	-	-		-	t	-	-		-	-	t	-		-	-		-	t	-	-
C. cucullata	t	1		2	t	t	-		1	t	1	1		t	1		1	t	1	t
C. richardsonii	-	-		-	-	3	3		1	1	1	1		-	-		1	t	-	t
Stereocaulon paschale	-	-		-	-	2	2		2	2	2	2		-	-		4	4	1	t
Peltigera malacea	-	-		-	-	2	2		-	t	-	-		-	-		-	-	-	-
P. spp. (no spots)	-	-		1	-	-	-		1	-	-	-		-	-		-	-	-	-
Thamnolia vermicularis	-	-		-	-	-	-		-	-	-	-		-	-		t	t	t	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

[c] New quadrat - established when stakes marking location of original quadrat could not be found.

Percent cover of plant species - modified Hult-Sernander method

Station 35: Monahan Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	NO DATA	NO DATA		100	95	100	NO DATA	NO DATA	100	100	100	NO DATA	NO DATA	100	100	100	NO DATA	NO DATA	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6				2	3	6			2	4	6			4	4	6			4	5
SHRUBS/FORBS:																				
Betula glandulosa	1				1	t	3			2	t	3			1	1	3			1	t
Salix reticulata	2				1	2	1			1	2	-			-	-	-			-	-
S. pulchra	-				-	-	-			-	1	-			-	-	-			1	t
S. spp.	t				-	-	-			-	-	-			-	-	-			-	-
Vaccinium uliginosum	3				1	2	4			3	3	3			2	3	4			2	2
V. vitis-idaea	t				1	t	t			1	t	1			1	t	t			1	t
Ledum decumbens	2				1	t	3			3	2	3			2	3	4			3	2
Empetrum nigrum	3				2	2	3			2	2	2			3	2	2			1	2
Oxycoccus microcarpus	1				1	t	1			1	1	t			1	2	2			1	2
Rubus chamaemorus	t				-	t	t			-	-	-			-	t	-			-	-
Petasites frigidus	1				1	t	t			-	-	-			-	-	-			-	-
Anemone parviflora	-				-	-	-			-	-	-			1	-	-			1	-
SEDGE/GRASS:																				
Carex spp.	4				4	3	3			3	2	3			2	2	1			1	t
LICHENS:																				
Cladonia stellaris	t				1	t	2			2	t	t			1	t	-			-	-
C. rangiferina	2				1	2	3			3	2	2			1	1	-			-	-
C. arbuscula	2				1	2	1			1	t	t			-	t	t			1	t
C. unicialis	-				-	-	1			1	-	2			1	-	t			1	-
C. gracilis	-				1	t	-			-	t	-			1	t	-			1	t
C. islandica	1				-	t	1			1	t	1			-	t	-			-	-
Stereocaulon paschale	1				1	t	1			-	t	2			1	t	-			1	t
Peltigera spp.	-				-	-	1			1	t	t			1	t	-			-	-

Station 35: Monahan Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS (continued):																				
NephRoma arcticum		NO DATA	NO DATA		t	-	NO DATA	NO DATA				NO DATA	NO DATA				NO DATA	NO DATA		
MISCELLANEOUS:																				
Equisetum arvense	t			1	1	1			1	1	-			-	-	-			-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 36: Monsoon Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	95	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	6	6	6	5	4	6	6	6	4	4	6	5	6	4	5	6	6	6	3	4
SHRUBS/FORBS:																				
Betula glandulosa	5	5	6	1	2	5	6	6	1	2	3	2	4	1	t	6	5	6	2	t
Vaccinium uliginosum	2	2	2	1	2	3	4	3	2	1	2	3	4	3	3	3	4	5	3	2
V. vitis-idaea	1	1	3	1	t	2	2	2	1	1	1	1	2	1	t	4	4	4	3	3
Empetrum nigrum	-	-	-	-	-	-	-	-	-	-	1	1	1	1	t	3	2	3	2	3
Ledum decumbens	3	3	2	1	t	2	3	3	1	2	-	-	-	-	-	-	-	-	-	-
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	-	-
Carex spp.	-	-	-	-	t	-	-	-	-	t	-	-	-	-	t	-	-	-	-	t
Gramineae	-	-	-	2	t	-	-	-	2	t	-	-	-	2	t	-	-	-	2	t
LICHENS:																				
Cladonia stellaris	t	-	-	-	-	-	-	-	-	-	3	1	2	2	3	1	1	1	1	t
C. rangiferina	4	3	5	3	3	2	2	4	2	2	3	2	3	1	t	4	3	4	3	3
C. arbuscula	2	1	1	1	t	1	-	1	1	1	2	1	3	1	t	1	1	1	1	t
C. unicialis	-	-	t	-	t	2	-	1	1	-	1	2	1	1	t	-	-	1	-	-
C. gracilis	t	-	1	1	t	1	-	t	1	1	t	1	2	1	t	t	-	3	1	2
C. deformis	-	-	-	-	-	-	-	t	-	-	1	1	1	-	-	-	-	t	-	-
C. amaurocraea	-	-	-	-	-	-	-	-	-	-	-	-	1	-	t	-	-	t	-	t
C. gonecha	-	-	-	-	-	-	-	1	1	-	-	-	-	1	t	-	-	-	-	-
C. coccifera	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	1	-
Cladonia cornuta	-	-	-	1	t	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	1	-
Cetraria islandica	2	1	-	1	t	2	2	2	2	2	3	2	2	1	1	2	1	1	1	t
C. cucullata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Station 36: Monsoon Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS (continued):																				
Stereocaulon paschale	-	-	-	-	-	-	-	-	-	-	2	1	4	2	3	-	-	1	1	t
Peltigera aphthosa	2	2	4	2	2	3	2	3	2	2	t	-	1	1	1	2	-	1	1	2
P. malacea	2	-	-	-	t	-	1	-	-	-	-	-	-	-	t	-	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 37: Dickey Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	95	100	100	100	100	95	100	100	100	100	90	100	100	100	100	85	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	4	5	6	3	2	6	6	6	3	2	5	4	6	3	2	4	4	6	2	1
SHRUBS/FORBS:																				
Betula glandulosa	6	5	6	2	2	-	-	-	-	-	5	4	5	2	3	t	1	2	t	t
Vaccinium vitis-idaea	5	3	5	2	2	3	4	3	3	3	6	4	5	2	2	3	4	5	3	2
Ledum decumbens	2	2	5	2	1	2	1	2	3	3	2	2	2	2	2	3	2	3	3	3
Pedicularis labradorica	-	-	-	t	-	-	-	1	t	-	1	-	1	1	-	-	1	1	1	-
Epilobium angustifolium	t	1	t	-	-	-	-	-	-	-	-	-	-	-	-	1	1	t	-	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	-	-	-	-	-	-	-
Carex spp.	-	-	-	2	2	-	-	-	2	1	-	-	-	1	2	-	-	-	1	2
Gramineae	-	-	-	t	-	-	-	-	t	-	-	-	-	t	-	-	-	-	t	-
LICHENS:																				
Cladonia stellaris	t	-	-	t	-	-	1	-	-	-	t	-	t	t	-	-	-	-	t	-
C. rangiferina	t	1	1	1	t	-	-	1	1	1	1	-	1	1	t	t	-	1	t	t
C. arbuscula	t	-	1	1	2	t	1	2	2	3	t	1	2	2	t	t	-	2	2	2
C. unicialis	t	-	1	t	1	1	1	1	t	t	1	-	1	t	2	3	1	1	t	t
C. gracilis	2	1	1	1	1	1	1	3	2	1	2	1	2	1	3	2	1	1	t	t
C. deformis	t	1	1	-	-	1	2	2	-	t	t	-	-	-	-	t	-	1	-	-
C. degenerans	1	-	1	1	t	1	-	1	-	-	1	1	1	-	-	1	-	1	-	-
C. gonecha	-	-	-	t	-	-	-	-	1	-	-	-	1	1	t	-	-	-	1	-
C. crispata	-	-	-	-	t	-	-	-	-	t	-	-	-	t	t	-	-	-	-	t
C. pleurota	-	-	-	-	-	-	-	-	t	t	-	-	-	-	-	-	-	-	1	-
Cetraria nivalis	-	-	-	t	t	t	-	-	-	t	t	-	-	-	t	1	-	1	-	-
C. cucullata	t	1	1	1	1	t	1	2	2	1	t	1	-	1	t	1	-	1	1	2

Station 37 Dickey Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS (continued):																				
C. islandica	1	1	1	1	t	1	-	2	1	2	1	-	1	1	t	t	1	t	-	t
C. richardsonii	-	-	-	-	-	-	-	-	-	-	t	-	1	1	1	t	-	1	1	t
Stereocaulon paschale	1	1	1	1	1	1	2	5	4	4	2	1	3	2	2	4	3	6	4	4
Peltigera aphthosa	1	2	3	2	3	-	-	-	-	t	1	-	1	1	3	-	-	t	-	-
P. malacea	2	1	-	1	3	-	-	-	1	t	-	-	-	1	2	-	-	-	1	t
MISCELLANEOUS:																				
Lycopodium spp.	-	-	-	1	t	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 38: Boulder Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B3[c]	B2	B2	B2	B2	B2
Total Cover (%)	100	95	NO DATA	90	NO DATA	100	100	No DATA	90	55	99	90	NO DATA	90	80	100	100	NO DATA	NO DATA	NO DATA
Hult-Sernander scale for:[b]																				
MOSS:	6	4		3		5	2		3	t	5	2		2	1	4	5			
SHRUBS/FORBS:																				
Salix pulchra	2	2		1		-	-		-	-	3	3		3	t	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	t	1		t	t	t	-			
Antennaria spp.	t	-		t		1	1		1	t	t	-		t	2	t	1			
Artemisia arctica	1	1		-		1	2		-	t	1	2		-	2	1	2			
Anemone narcissiflora	t	1		-		t	1		1	t	1	1		t	t	1	1			
Gentiana glauca	t	-		1		t	-		1	-	-	-		1	t	t	1			
Pedicularis lanata	-	-		t		t	1		t	t	-	-		-	-	-	-			
Polygonum bistorta	-	-		-		-	-		-	t	-	1		-	-	-	-			
Empetrum nigrum	-	-		-		-	-		2	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	1	2		2	1	1	2			
Gramineae	-	-		t		-	-		t	t	-	-		t	t	-	-			
LICHENS:																				
Cladonia stellaris	4	4		4		4	3		3	3	5	4		3	4	4	4			
C. arbuscula	t	2		3		t	1		3	1	t	1		2	2	-	1			
C. rangiferina	3	3		2		1	1		1	t	1	1		1	t	2	2			
C. unicialis	2	1		1		1	-		1	t	1	-		1	-	1	-			
C. gracilis	2	1		t		1	1		t	t	1	-		t	t	2	1			
C. crispata	-	-		-		-	1		-	t	-	1		-	t	-	-			

Station 38: Boulder Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B3	B2	B2	B2	B2	B2
LICHENS (continued):																				
C. cornuta	-	1		-		-	1		t	-	-	-		t	-	-	-			
C. spp. (funnel-form)	-	1		-		-	1		-	-	-	1		-	-	-	1			
Cetraria islandica	1	2		1		3	1		1	t	1	1		1	t	1	2			
C. cucullata	-	-		t		1	1		1	t	-	-		t	-	-	-			
C. nivalis	-	1		1		1	1		1	1	t	-		-	-	t	-			
C. richardsonii	1	1		1		t	1		t	-	t	1		1	t	1	2			
Dactylina arctica	t	1		1		t	1		1	1	1	2		t	t	t	1			
Thamnolia vermicularis	1	1		t		1	-		t	t	t	-		t	t	1	1			
Stereocaulon spp.	-	-		-		-	-		-	-	1	1		1	t	-	-			

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

[c] New quadrat-established when stakes marking location of original quadrat could not be found.

Percent cover of plant species - modified Hult-Sernander method

Station 39: Summit Lake

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
Total Cover (%)	100	100	100	100	100	100	100	100	100	100	100	98	100	100	100	100	100	100	100	100
Hult-Sernander scale for:[b]																				
MOSS:	4	3	3	1	t	4	3	4	1	t	4	2	4	1	t	3	4	3	1	t
SHRUBS/FORBS:																				
Betula glandulosa	-	1	-	1	t	3	4	3	2	1	4	4	4	2	2	-	1	1	1	t
Ledum decumbens	-	1	t	1	t	2	3	2	1	3	2	3	2	1	1	1	2	1	1	2
Vaccinium uliginosum	2	3	2	1	t	4	4	4	2	3	3	4	4	2	3	1	2	1	1	t
V. vitis-idaea	1	1	1	1	t	1	1	1	1	t	1	2	2	1	t	1	1	2	1	t
Arctostaphylos alpina	1	2	2	1	1	-	-	t	-	t	-	-	-	-	t	1	3	2	2	2
Salix pulchra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	1	-
S. reticulata	1	1	1	t	t	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
S. arctica	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	t
S. spp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Empetrum nigrum	-	-	-	-	-	-	-	1	-	t	2	2	2	1	2	1	2	1	1	t
Polygonum bistorta	1	2	1	1	t	1	1	1	1	t	1	2	1	1	t	t	1	1	t	t
Pedicularis sudetica	-	1	-	t	t	t	-	-	-	-	t	1	-	t	t	t	2	1	t	t
P. spp. (yellow root)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
P. spp. (curly leaf)	-	-	t	-	-	-	-	t	-	-	-	-	-	-	-	-	-	t	-	-
Gentiana glauca	-	-	-	t	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	t	2	2	2	1	1	1	1	1	1	t	1	3	3	1	1
Gramineae	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	t	-

Station 39: Summit Lake (Con't.)

Year	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89	62	70	77	83	89
Quadrat[a]	A1	A1	A1	A1	A1	A2	A2	A2	A2	A2	B1	B1	B1	B1	B1	B2	B2	B2	B2	B2
LICHENS:																				
Cladonia stellaris	3	4	5	4	4	4	4	5	3	3	3	2	3	2	2	4	3	4	3	3
C. arbuscula	3	1	4	3	3	2	1	4	1	2	3	1	4	1	2	2	1	3	2	3
C. rangiferina	2	3	3	2	3	2	3	4	1	3	2	2	3	1	3	2	2	4	2	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	1	2	1	1	1	1	2	1	2	1	1	1	1	1
C. cornuta	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
C. crispata	-	-	-	-	-	-	-	-	-	-	-	-	-	t	t	-	-	-	-	-
C. pleurota	-	-	-	-	-	-	-	-	-	-	-	-	-	t	-	-	-	-	-	-
C. sp. (funnel-form)	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cetraria islandica	1	1	1	1	t	1	1	1	1	1	t	1	1	1	t	t	1	t	t	t
C. cucullata	1	1	1	1	t	1	1	1	1	t	t	1	1	1	t	t	1	t	t	t
C. richardsonii	1	1	1	1	t	1	1	t	-	-	1	2	1	1	t	1	1	1	1	t
Alectoria ochroleuca	1	3	2	2	1	t	-	1	-	t	-	-	-	-	-	t	-	-	-	-
Thamnolia vermicularis	1	1	1	1	t	t	-	1	t	-	t	1	t	t	t	t	1	1	1	t
Stereocaulon spp.	1	2	3	2	3	2	2	3	1	1	2	3	4	2	3	2	4	4	2	2
Dactylina arctica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Peltigera aphthosa	-	-	-	-	-	1	1	1	1	t	1	3	1	1	t	-	-	1	-	t
P. malacea	-	-	-	-	-	-	-	-	-	-	-	-	-	1	t	-	-	-	1	1
P. spp.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-
MISCELLANEOUS																				
fungi	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-

[a] A = inside exclosure, B = outside exclosure

[b] - = not observed
t (trace) = <0.5%
1 = 0.5 to 6.2%
2 = 6.3 to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 40. Upper Gilbert Island Lake

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
Total cover (%)	95	75	70	75
Hult-Sernander scale for:[b]				
MOSS:	t	t	1	3
SHRUBS/FORBS:				
Caseopea tetragona	-	-	3	3
Salix reticulata	1	2	2	t
Vaccinium uliginosum	-	-	-	t
V. vitis-idea	t	t	t	1
Diapensia lapponica	-	t	3	t
Artemisia arctica	-	-	-	t
Polygonum bistorta	-	-	-	-
Salix spp.	t	t	-	-
Betula glandulosa	-	-	-	-
Anemone narcissiflora	t	t	t	-
Gentiana glauca	-	t	t	-
Empetrum nigrum	5	4	-	-
Arctostaphylos alpina	-	-	1	-
Antennaria monocephala	-	t	t	-
SEDGE/GRASS:				
Carex spp.	3	2	2	2
Gramineae	-	-	-	-
LICHENS:				
Cladonia stellaris	t	t	t	t
C. arbuscula	t	t	t	1
C. rangiferina	-	-	t	t

Station 40. Upper Gilbert Island Lake (Cont.)

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
LICHENS (contiued):				
C. gracilis	t	t	t	t
C. crispata	-	-	-	t
C. uncialis	-	-	-	-
C. spp. (cup type)	t	t	t	t
C. bellidiflora	-	t	-	t
Cetraria nivalis	t	t	t	t
C. cucullata	-	t	t	t
C. richardsonii	t	t	1	1
Cetraria islandica	t	-	t	t
Cetraria penastri	t	-	-	t
Thamnolia vermicularis	t	t	t	2
Dactylina arctica	t	-	t	t
Stereocaulon spp.	t	t	-	1
C. coccifera	-	t	-	t
Alectoria nigricans	t	-	t	-
MISCELLANEOUS:				
fungi	t	-	-	-

[a] A = inside exclosure, B = outside

[b] - = not observed
t (trace) = <0.5%
1 = 0.5% to 6.2%
2 = 6.3% to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 41. Tsisi Lake

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
Total cover (%)	100	100	80	90
Hult-Sernander scale for:[b]				
MOSS:	3	4	3	2
SHRUBS/FORBS:				
Betula glandulosa	-	-	-	-
Vaccinium uliginosum	4	3	2	2
V. vitis-idea	3	3	t	2
Empetrum nigrum	-	2	-	-
Dryas octopetala	-	-	3	-
Salix spp.	-	-	t	-
Arctostaphylos alpina	3	2	2	4
Anemone narcissiflora	t	t	t	t
Diapensia lapponica	t	-	-	-
Pedicularis capitata	-	-	-	-
SEDGE/GRASS:				
Carex spp.	2	1	1	2
Gramineae	-	-	-	-
LICHENS:				
Cladonia rangiferina	-	t	t	t
C. arbuscula	t	t	1	1
C. uncialis	t	t	t	t
C. crispata	t	-	t	t
C. gracilis	t	t	t	t
Cetraria cuccullata	t	t	t	t
C. islandica	t	t	t	t

Station 41. Tsisi Lake (Con't.)

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
C. nivalis	-	t	t	t
C. Richardsonii	2	1	-	t
C. nigricans	-	-	t	t
Alectoria nigricans	-	t	t	2
Alectoria spp.	t	-	t	t
Stereocaulon spp.	t	t	2	t
Peltigera malacea	t	t	2	t
P. spp.	-	-	-	-
Thamnolia vermicularis	t	t	2	1
Dactylina arctica	t	t	t	t
Nefhroma arcticum	-	t	-	-

[a] A = inside exclosure, B = outside

[b] - = not observed
t (trace) = <0.5%
1 = 0.5% to 6.2%
2 = 6.3% to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Percent cover of plant species - modified Hult-Sernander method

Station 42. Crater Lake

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
Total cover (%)	60	60	65	55
Hult-Sernander scale for:[b]				
MOSS:	2	3	3	3
SCRUBS/FORBS:				
Betula glandulosa	-	-	-	-
Vaccinium uliginosum	-	-	-	-
V. vitis-idea	t	t	t	t
Salix reticulata	2	3	2	2
Salix spp.	-	-	t	-
Polygonum bistorta	t	t	t	t
Pedicularis capitata	t	t	t	t
Anemone narcissiflora	t	t	t	t
Arctostaphylos alpina	t	t	t	t
Artemisia arctica	t	t	t	-
Gentiana glauca	t	t	t	t
Sedum rosea	t	-	-	t
Antennaria monocephala	t	t	1	t
SEDGE/GRASS:				
Carex spp.	3	3	3	3
Gramineae	-	-	-	-
LICHENS:				
Cladonia arbuscula	1	t	t	t
C. crispata	t	t	t	t
C. uncialis	t	t	-	-
C. gracilis	t	t	-	t

Station 42. Crater Lake (Con't.)

Year	89	89	89	89
Quadrat[a]	A1	A2	B1	B2
C. rangiferina	t	t	-	-
C. coccifera	t	t	t	t
Cetraria nivalis	t	-	t	t
C. islandica	t	-	t	t
C. richardsonii	1	t	t	t
Thamnolia vermicularis	2	2	1	2
Nephroma arcticum	-	t	1	-
Dactylina arctica	t	t	t	t
Stereocaulon paschale				
S. tomentosum	t	t	t	t
Peltigera malacea	-	-	t	-
MISCELLANEOUS:				
fungi	t	-	t	-

[a] A = inside exclosure, B = outside

[b] - = not observed
t (trace) = <0.5%
1 = 0.5% to 6.2%
2 = 6.3% to 12.4%
3 = 12.5 to 24.9%
4 = 25 to 49.9%
5 = 50 to 74.9%
6 = 75 to 100%

Lichen standing crop index for Nelchina range stations, 1989.

Range Unit	Range Station	Standing crop index Inside Exclosure	Standing crop index Outside Exclosure
1	26	3.20 very high	1.20 medium
	27	2.87 high	2.10 high
2	23	0.01 low	0.83 low
	24	2.52 high	0.78 low
	25	1.39 medium	1.01 medium
	35	0.29 low	0.02 medium
4	33	1.15 medium	0.02 low
	34	1.26 medium	1.50 medium
5	15	1.55 medium	0.43 low
	31	0.70 low	0.07 low
	32	0.86 low	0.12 low
6	17	1.04 medium	1.08 medium
	18	0.60 low	0.58 low
	19	0.01 low	0.05 low
	20	0.23 low	0.18 low
	21	0.05 low	0.15 low
	37	1.40 medium	1.01 medium
	38	0.63 low	0.62 low
	39	3.35 very high	2.64 high
8	30	2.59 high	0.32 low
9	36	1.02 medium	0.85 low
12	28	1.47 medium	0.18 low
	29	2.41 high	0.15 low
	40	0.01 low	0.20 low
	41	0.13 low	0.31 low
	42	0.11 low	0.10 low
13	1	0.59 low	0.21 low
	2	0.01 low	0.01 low
	4	1.75 medium	0.41 low
	5	0.60 low	0.28 low
	6	0.38 low	0.20 low
	8	0.43 low	0.48 low
	9	0.78 low	0.63 low
	10	0.78 low	0.32 low
	11	1.02 medium	0.16 low
	12	0.53 low	0.71 low
	13	1.23 medium	0.24 low
	14	0.83 low	0.18 low
15	16	0.96 low	1.00 medium

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

0.02-0.99 = low
1.00-1.99 = medium
2.00-2.99 = high
3.00+ = very high

APPENDIX C

Use at Nelchina range stations, measured as the difference between lichen standing crop index inside (A) versus outside (B) exclosures divided by the standing crop index inside*, 1989

Range Unit	Range Station	A-B** A (Relative use)	Use rating
1	26	.63	moderate
	27	.27	light
2	23	-0.82	no information
	24	.69	heavy
	25	.27	light
	35	.93	heavy
4E	33	.98	heavy
4W	34	-0.19	no information
5	15	.72	heavy
	31	.90	heavy
	32	.86	heavy
6	17	-0.04	no information
	18	.03	light
	19	-4.00	no information
	20	.22	light
	21	-2.00	no information
	37	.28	light
	38	.02	light
	39	.21	light
8	30	.88	heavy
9	36	.17	light
12	28	.88	heavy
	29	.94	heavy
13	1	.64	moderate
	2	0	none
	4	.77	heavy
	5	-3.67	no information
	6	.47	moderate
	8	-0.12	no information
	9	.19	light
	10	.59	moderate
	11	.84	heavy
	12	-0.34	no information
	13	.80	heavy
	14	.78	heavy
15	16	-0.04	no information

*Use rating = (A-B)/A

light = .01-.33

moderate = .34-.66

heavy = .67+

no information = because either the integrity of the exclosure had been substantially compromised or because standing crop differences reflected site specific ecological differences as opposed to use differences.

APPENDIX D
Condition of Nelchina range stations, 1989*

Nelchina Range Unit	Range Station	Habitat type	Exclosure	Plots
1	26	heath	slightly damaged	intact
	27	shrub/heath	intact	intact
2	23	heath	moderately damaged	all stakes missing-replaced A1, A2, B3 and set 4
	24	shrub/heath	intact	intact
	25	shrub/heath	intact	intact
	35	shrub/heath	moderately damaged	intact
4	33	heath	slightly damaged	B2 missing, replaced
	34	shrub/heath	intact	intact
5	15	shrub/heath	intact	intact
	31	heath	moderately damaged	intact
	32	heath	moderately damaged	all stakes missing-replaced A1, A2, and set B4, B5
6	17	shrub/heath	intact	intact
	18	shrub/heath	slightly damaged	intact
	19	sedge	intact	intact
	20	shrub/sedge	intact	intact
	21	sedge	slightly damaged	intact
	22	shrub/heath	(not examined)	
	37	shrub/heath	slightly damaged	intact
	38	shrub/heath	moderately damaged	A1 and B2 missing
	39	shrub/heath	intact	intact
8	30	white spruce/ heath	slightly damaged	intact
9	36	shrub/heath	intact	intact
12	28	shrub/heath	intact	all stakes missing-replaced A1, A2 and set B4, B5
	29	shrub/heath	intact	intact
	40	heath	(new)	
	41	heath	(new)	
	42	sedge	(new)	

Nelchina Range Unit	Range Station	Habitat type	Exclosure	Plots
13	1	black spruce/ moss	intact	intact
	2	black spruce/ bog	intact	intact
	4	black spruce/ heath	heavily damaged	A1, A2 reset
	5	black spruce/ heath	slightly damaged	intact
	6	black spruce/ sedge	slightly damaged	intact
	7	black spruce/ heath	(not examined)	
	8	black spruce/ heath	heavily damaged	intact
	9	black spruce/ heath	heavily damaged	A1, B2, B2 missing and replaced
	10	black spruce/ heath	intact	intact
	11	black spruce/ heath	moderately damaged	intact
	12	black spruce/ heath	slightly damaged	intact
	13	black spruce/ heath	slightly damaged	intact
	14	black spruce/ heath	heavily damaged	set new plots, A3, A4, B3, B4
15	16	white spruce/ heath	intact	intact

*All damaged exclosures repaired or rebuilt. Exclosures rebuilt: 4, 8, 9, 14, 32