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CARIBOU REPORT

by
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Volume XII
Project Progress Report
Federal Aid in Wildlife Restoration
Projects W-17-2, Jobs 3.1R, 3.3R, 3.4R, 3.5R and 3.6R (2nd half)
and W-17-3, Jobs 3.1R, 3.3R, 3.4R, 3.5R and 3.6R (1st half)

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: James E. Hemming and personnel of the U. S. Bureau of Land Management

Project No.: W-17-2 & W-17-3 Project Title: Big Game Investigations

Job No.: 3.1R Job Title: Techniques for Aerial Photo Censusing of Caribou

Period Covered: January 1, 1970 to December 31, 1970

SUMMARY

In 1971 field work to develop an census technique for caribou was completed. The resulting aerial photo-direct count-extrapolation technique was applied to the Nelchina caribou herd in 1967 and the Arctic caribou herd in 1970 with very good results. In lieu of a final job report a paper describing this technique is being submitted to the Journal of Wildlife Management.

BACKGROUND

Aerial census techniques for caribou have been used for many years with limited success. Past studies have employed transect sampling or stratified random sampling (Banfield, et al., 1955; Watson and Scott, 1956; Skoog, 1962; Siniff and Skoog, 1964). Perhaps the greatest limitation of previous techniques is that in most cases the range of the estimated total population exceeds the estimated annual increment. The result is that population estimates using existing techniques have only limited application when intensive management plans are required. In 1967 a project was initiated to develop a better technique for censusing caribou.

OBJECTIVES

To develop a reliable technique for censusing caribou.

PROCEDURES

1. Precensus - Extensive aerial reconnaissance via fixed-wing aircraft to locate and delineate the entire female segment of the population during the calving period.

2. Direct count of post-calving segment - During the period of post-calving concentration, major groups of animals were photographed at 1500 feet above mean terrain to provide stereo photos at a scale of 1:3000. All females in peripheral areas were counted simultaneously via helicopter. Strict coordination was required to prevent overlap between aerial photo and helicopter operations, i.e., duplicate counting.

3. Composition counts of post-calving segment - A helicopter was used to reach optimum ground positions (no composition counts were done from the air). With the aid of a 20-40X spotting scope each animal was classified according to genital characteristics. At times it was necessary for the helicopter to make a low pass over resting animals in order to get them on their feet, so that calves were not missed by counters. These data were used to compute the percentage of bulls, yearlings and calves in the post-calving segment.

4. Computations for photo area - All animals on the aerial photographs were counted using standard procedures for aerial photo interpretation. The relative number of bulls, yearlings, and calves obtained from the spring composition counts were subtracted from the total number of animals tallied on the photographs. The total of cows from the photographs was then added to total cows counted directly in peripheral areas to compute total cows in the herd.

5. Composition counts during rut period - The same methods were employed as described in No. 3. Since both sexes and all age classes are most randomly distributed during the rut period the fall counts yield the true composition of the herd. By applying the fall bull:cow, yearling:

cow, and calf:cow ratios to the total number of cows from spring tallies an estimate of the minimum population size can be obtained. If any cows are missed during the spring counts the population estimate will be low.

FINDINGS

The Arctic caribou herd is Alaska's largest. In order to test the aerial photo-direct count census technique a census of the Arctic herd was scheduled for July 1970. All previous information about the Arctic herd was reviewed in 1969 and aerial surveys were conducted to verify the location of calving areas, post-calving concentration areas and rutting areas.

In early June 1970 regular aerial surveys were conducted to determine when the animals would be properly clumped for a photo mission. After calving the animals drifted southwest toward Point Hope. They formed increasingly larger masses toward the end of the month and by 29 June essentially all of the calving group was concentrated along the coast between Cape Lisburne and the mouth of the Pitmegea River and south to the Ipewik River. The photo mission commenced on 30 June and composition counts began on 1 July.

A total of 179,843 caribou was tallied from photographs in addition to 10,380 counted in peripheral areas. Composition counts from 1-3 July of 26,252 caribou revealed a bull:cow ratio of 58:100, a yearling:cow ratio of 37:100, and a calf:cow ratio of 48:100. Subtracting the number of bulls, yearlings and calves from the photo counts revealed a total cow population of 97,394.

In the fall, composition counts of 6238 caribou were made in the area between Bettles and Selawik. The area had been pre-flown via fixed-wing aircraft just prior to the count to determine the distribution and relative abundance of animals in each area. In order to reduce sampling bias each major area containing caribou was sampled plus peripheral areas with only scattered animals. This sample revealed a bull:cow ratio of 64:100 and a calf:cow ratio of 44:100. The yearling group was lumped with the adults because it is not possible to adequately identify this age class in October.

Ideally the percentage of yearlings in the herd should be obtained from late winter composition counts just before the onset of the spring migration. However, since this could not be accomplished in 1970 the percentage of yearlings from the July composition counts was used to compute the total number of yearlings, realizing that they probably were not fully represented in the post-calving group.

The results of the 1970 census are shown in Table 1.

Table 1. Composition of the Arctic caribou herd of 1970.

Age and Sex	Number
Females (over 24 months)	97,000
Males (over 24 months)	62,000
Yearlings (both sexes)	36,000
Calves (both sexes)	47,000
Total Population	242,000

RECOMMENDATIONS

This technique appears to provide a useful tool for management. A minimum estimate of a caribou herd plus a quantitative measure of yearling survival and hunter harvest are the basic ingredients for proper management. Each of Alaska's caribou herds should be measured as soon as possible. Where herds are heavily cropped by hunters, a regular census schedule should be established. A four-year inverval between censuses, supplemented by annual measurement of yearling survival and hunter harvest should be adequate. It should not be necessary to conduct further research on techniques of caribou census. However, we do need a better understanding of seasonal stratification and segregation to insure that our composition counts are accurate.

In lieu of a final Job Report a paper describing this technique is being submitted to the Journal of Wildlife Management.

LITERATURE CITED

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Robert E. Pegau

Project Nos.: W-17-2 & W-17-3 Project Title: Big Game Investigations

Job No.: 3.3R Job Title: Caribou Investigations - Analysis of Range

Period Covered: January 1, 1970 to December 31, 1970

SUMMARY

The Nelchina caribou range includes a wide variety of habitats due to the diversity of terrain features and vegetation types. Within this range caribou are able to obtain a high quality diet during most of the brief summer. The diversity of terrain also provides relief to caribou from flying insect harassment during the summer.

Range Unit 12 is the focal point of the Nelchina herd as it contains the principal calving and summer range. Unit 5 is also an important summer range. These two units have received the most continuous use in recent years and their vegetation has continued to deteriorate in the last 10 years. The condition of lichens in Units 1, 2 and 4 began to degenerate with two to three years of winter use and has declined substantially in the last 10 years. Unit 13 has only been used sporadically by caribou for the past 15 years. Inside of 15-year-old exclosures lichens are just starting to recover and most are about 1 inch or less in length. Outside of the exclosures, lichens are in poor condition and have continued to deteriorate, as have several of the vascular species.

Shrubs are increasing on the Nelchina range, due both to use of the lichens by caribou and a general drying of the range.

Studies of winter utilization have shown that caribou utilize only small portions of the total range. Trampling by caribou and moose has been an important factor in supressing lichen growth and has contributed to their poor condition. Apparently lichens on the Nelchina range require long periods of total protection, possibly 25 years or more, to reach their climax condition, yet it only takes five to eight years of use to destroy climax lichen stands.

The Nelchina caribou range is a finite unit and its condition is continuing to decline even though Nelchina caribou now winter in new areas near the Wrangell Mountains. The lichen flora of this range cannot withstand the present numbers of caribou and moose. A determination of whether the Nelchina caribou herd can and will utilize sedges or other vascular species, to a greater extent, as a winter diet should be undertaken.

CONTENTS

BACKGROUND

Considerable effort, time and money have been expended in the last 20 years in an attempt to develop an understanding of the Nelchina caribou herd's effect on its range. Reports have detailed some of the findings, but a considerable amount of data have remained unpublished. Both the published and unpublished data have not been synthesized to date. During 1970, an effort was made to reexamine the vegetation at all exclosure stations previously established on the Nelchina range and it was determined that a thorough review and presentation of all range data obtained on this range would be apropos. My involvement in this undertaking has been the reexamination of vegetation in the exclosures during 1970 and 1971 and the consolidation of previous investigators' work, particularly that of Drs. Herbert C. Hanson and Ronald O. Skoog. A serious handicap to a thorough review of data collected by previous investigators has been the lack of a comprehensive filing system for all data collected. Some of the most important data that have not been located include species composition and cover readings from 1958, 1959 and 1960 field studies; and analyses of several vegetation stands, undertaken by Hanson, that should

be in a rough draft form. Also lacking was a description of the technique for the line-point method used to evaluate vegetation in Range Stations 1-15 in 1966, and the herbarium specimens collected in conjunction with the vegetative analysis at the Range Stations in 1955, 1956, 1961, 1962 and 1966. Hopefully, the missing items will be located, which will enable a more detailed and accurate assessment of the Nelchina range in the future.

OBJECTIVES

To provide basic life history information required for management of Alaska's caribou populations and to test techniques needed in measuring the status, trend and utilization of caribou and their associated habitat. To determine the caribou-range relationships of the Nelchina range.

PROCEDURES

The vegetation in permanent quadrats of 38 Range Stations within the Nelchina caribou range was reexamined utilizing the modified Hult-Sernander scale of Hanson (1958). Color photographs, mostly stereo pairs, were taken of all quadrats to aid in the evaluation. A review of previous range investigations on the Nelchina range was conducted, and pertinent unpublished data are presented.

FINDINGS

The Nelchina caribou herd has always been considered one of the most important herds in Alaska because of its ready access from populated areas. Road systems almost totally bound the Nelchina range and animals periodically are accessible from the road systems. Detailed studies of this herd have been more intensive than with any other caribou herd in Alaska. Range examinations have been conducted sporadically since 1950, and a considerable volume of data has been obtained by several different investigators. Unfortunately, most of the studies have been rather intermittent, as personnel working on the projects seldom continued longer than three or four years. In 1969, it was decided that before continuing range studies on the Nelchina range, a review of all work that had been accomplished to date should be made and guidelines for future range studies be established. This report represents the effort to condense and compile all the data that have been obtained, some of which have been presented in several segment reports and some that have never been published.

One of the principal problems encountered in this undertaking has been the unavailability of data collected previously. Numerous references were encountered, indicating data had been collected, but my attempts to

locate these data were unsuccessful. One of the most serious omissions is the procedure that was outlined and used for the vegetative analysis of Range Stations 1-15, conducted in 1966. Vegetation in these exclosures was analyzed using both the modified Hult-Sernander scale and the line-point quadrat method which was used when the exclosures were first established. Preliminary analysis of the data by myself and correspondence with the principal investigator who conducted the work (Terry McGowan), indicated that the technique used in 1966 was somewhat different from the technique used originally. Therefore, I was unable to interpret the 1966 data accurately.

A filing system has now been set up for all of the Nelchina range work, by range units, as recommended by Hanson (1958) and Skoog (1959).

HISTORY OF INVESTIGATIONS

One of the initial attempts to determine caribou-range relationships was in 1950 (Chatelain, 1953) when it was determined that the main winter forage plants of the Nelchina herd were lichens and sedges with small amounts of dwarf birch *(Betula nana)*, cranberry *(Vaccinium vitis-idaea)* and moss also utilized. Two principal winter vegetation types used by caribou were recognized: a lichen type and a sedge type that occurred along the edges of lakes and ponds.

One of the pecularities of caribou, that of moving to new areas after grazing only a small portion of an area, was recognized. A group of 1/10 acre transects was examined in an area that the caribou had recently vacated, to determine the amount of area that had been pawed and grazed by the caribou before they moved to a new site. Along the margins of lakes and ponds in the sedge type, 5 percent had been grazed. In the lichen type, 8 percent was covered with feeding craters. Lack of food appeared to have had little influence on movement. No measurement of snow conditions was taken, but vegetative samples were taken in areas that appeared similar.

There were few range studies until 1953 when the first attempt at a large-scale investigation was undertaken. The Nelchina range was divided into three major areas on the basis of forest cover types. This analysis was continued in 1954 and the vegetation was sampled at a total of 18 locations. Five of the sites were classified as above timberline, ten as below timberline and three as lowlands. A total of 1,068 meter-square quadrats was examined, of which 122 were clipped, the vegetation sorted by species and then weighed. The results were tabulated by frequency of occurrence, average density, and forage production (Skoog, 1957). These surveys formed the basis for further studies, notably site selection for the exclosures constructed in 1955 and 1956.

A noteworthy observation of the effect of caribou on their range was reported by Schaller and Courtright (1953). On July 9 and 10, 1953 a herd of approximately 3,500 caribou was in the vicinity of Clarence

Lake. Schaller and Courtright noted plants had been browsed but "the main destruction to the vegetation, however, seemed to be caused not by grazing or browsing, but by trampling." The effect of trampling on vegetation has seldom been considered in range examinations. Reindeer investigations by Palmer and Rause (1945) and Pegau (1970a) have shown that trampling can constitute a major portion of the apparent use of vegetation. The effect of trampling by both moose and caribou became quite apparent when reexamining some of the exclosures in 1970.

During 1955 and 1956, fifteen exclosures were constructed on the Lake Louise Flat where the Nelchina herd had traditionally wintered. At each range station, two similar plots, 5' x 20', were delineated. Plot A was fenced to exclude all large animals. Plot B was left open to normal grazing by all animals. The vegetation in the plots was analyzed by a line-point method (which is described in the TECHNIQUES USED section). A measure of the effects of caribou use on the range was the desired end product of these studies. Results of these examinations were analyzed and presented by Skoog (1957).

The small size of these exclosures has often been criticized. Stoddard and Smith (1955) remarked that the minimum size of exclosures should be at least one-fourth acre and preferably larger. Costello and Turner (1941) listed several factors that can influence improperly constructed exclosures and some of the misinterpretations that can be obtained from vegetative response. This is certainly true if the objective is to determine quantitative data on carrying capacity from these small exclosures, as there are several unknown factors (forage availability, snow depth, icing, accurate enumeration of animals utilizing a site for a known length of time, etc.) that negate obtaining carrying capacity estimates by the classical means. These exclosures can provide qualitative information on the effects of caribou and other animals on the range at different intensities of grazing and use patterns, successional stages of the vegetation protected from and exposed to grazing, and other factors that are useful in the management of a caribou herd.

The disadvantage of their small size is offset somewhat by the fact that they were built to provide data on the ground vegetation (lichens, mosses, sedges, grasses, and dwarf shrubs) rather than the taller shrubs and trees, and that all plots are at least three to five feet from the fence. The effect of the fence on micro-climate has not been determined, but during 1970, when a considerable change in the vegetation was noticeable at several of the Range Stations, there were no instances where the fence had an obvious effect on the vegetation. Skoog (1957) remarked that at the time of his winter examinations of the exclosures, he could not detect any difference in snow accumulation due to the fence. In my own observations of six exclosures in the Nome area, as well as two in the Selawik and Kobuk valleys, I have not noticed any indication that the fence influences snow depth, melt, runoff or growth of the vegetation.

One of the most thorough examinations of the Nelchina range was conducted by a party led by Dr. Herbert C. Hanson. His ecological reconnaissance, conducted during the summer of 1957, has been used as

the basis for delineating the Range Units and as ground work for subsequent range studies. He presented an extensive discussion of the vegetation and ecology of the Nelchina caribou range (Hanson, 1958). He described 11 major vegetation types and reported detailed discussions and data for most of these types. Seventy-eight stands were examined and descriptions of 22 of these stands were published in his report. There are tabulations of 12 additional stands (in a MS report) in the caribou files in Anchorage. The locations of the other stands are listed but, unfortunately, these data have not been located.

The Nelchina range was divided into nine range units for analysis. At the conclusion of his work, Hanson (1958) listed several recommendations for future range investigations. Data for most of the vegetation types are quite complete and anyone planning range examinations should thoroughly review his publication to obtain a good ecological background of the Nelchina area. Dr. Hanson used a modified Hult-Sernander scale for vegetation analysis and developed association tables to facilitate comparison of the Nelchina range data with similar phytosociological studies conducted, both in Europe and North America.

During the winter of 1957-58, two sites on the Upper Talkeetna River and near Fog Lakes were examined to determine the area that had been grazed and what plants were being utilized. Again, the total area actually used by caribou was quite small, 0.7 percent to 2.2 percent.

In 1959, Skoog further divided the Nelchina range into 15 range units. These units were established on the basis of vegetation types, topography and patterns of use by caribou. An evaluation of six of the units was presented, based primarily on lichen condition from data collected in 1957 and 1958. Skoog (1959) also ranked lichens according to degree of importance depending on their palatability to caribou. Skoog felt that there was insufficient information available at that time to develop a range condition classification system, as he considered the role of sedges in the winter diet to be higher than had been normally considered. He did develop a lichen succession classification.

In 1959 there was a transition from federal to state management and, consequently, work was limited. Transects were again examined to determine effects of caribou on winter range on the Talkeetna River area, which appeared to be heavily used. About 6 percent of the area examined had been disturbed. Data concerning the winter range use were presented in Federal Aid Report W-6-R-1, (Skoog, 1960). The consistently small use of the areas examined led Skoog to question whether caribou were the main factor responsible for range deterioration. He felt that possibly natural phenomena, such as fire, plant succession, frost action, etc., were the chief factors.

In 1960, 24 more exclosures were constructed on major caribou wintering areas (Skoog, 1960). No attempt was made to do the vegetation analysis that year, as construction of as many exclosures as possible was desired. Another crew conducted a survey on the main winter range at the head of the Talkeetna River. The survey showed that nine months of heavy use,

during three winters, by approximately 20,000 caribou had resulted in destruction of 9 percent of the lichen cover and light grazing of an additional 18 percent (Skoog and Keough, 1961). In 1961 and 1962 vegetation in the exclosures constructed during 1960 was examined. A fenced plot and an unfenced control plot, each containing 2 meter-square quadrats, were established at each Range Station. The vegetation was analyzed by the modified Hult-Sernander method recommended by Dr. Hanson. The data were not presented at that time, due to lack of comparative information. All vegetation readings from the exclosures are presented in this report. The exclosures were examined and maintenance performed where necessary in 1962. It was apparent that moose and frost action were going to be major maintenance problems, necessitating frequent checks of the exclosures. Moose have been found to be one of the chief causes of destruction of exclosures, based on examinations conducted since their construction, and also in exclosures within the range of the Arctic caribou herd (Hemming and Pegau, 1970).

A project designed to determine the distribution of the major plant communities was completed in 1963 after several delays. During the fall, vegetation assumes its autumnal colors and certain species have very distinctive colors. This enables the rapid determination of vegetation types by an aerial survey. The data were presented by Skoog (1964) and were tabulated for statistical analysis with the results to be published. However, to date, the statistical analysis has not been undertaken. Range work in 1965 was limited to repair and maintenance of the exclosures.

Stations 1-15, which were established in 1955 and 1956, were reexamined in 1966. Quantitative comparisons were not attempted until the data could be examined by a range ecologist. The readings obtained in 1966 are presented in this report. However, this does not include the line-point method utilized, as it did not appear to be similar to the method utilized in 1955 and 1956 when the vegetation was first examined. Glenn (1967) stated that there was not a noticeable difference between the fenced and unfenced plots at that time. He felt that it would be difficult to attribute any change in the condition of vegetation to animal use, as he was uncertain that the exclosures were in fact representative. Some of the exclosures were photographed in 1967 and the vegetation in permanent Quadrats 32 and 33 were analyzed. Range work was then postponed until a review could be made of what had been accomplished and a suggested program for further study developed.

TECHNIQUES USED

During the 1953 and 1954 range survey, vegetation was analyzed by placing transect lines in stands that appeared to be typical of the range site as a whole. Random transect lines were laid out and within meter-square quadrats the vegetation was visually estimated to determine the plant cover by species or group. Approximately 16 meter-square quadrats within a mile were examined. In every tenth quadrat, the vegetation was clipped to ground level, sorted by species, air-dried and weighed to

ascertain the forage production for each location. A total of 65 transect lines, which included 1,068 meter-square quadrats of which 122 were clipped to determine forage production, were examined during the study.

The exclosures constructed in 1955 and 1956 were established in an area that had traditionally been a caribou wintering range. These exclosures were in plant communities that were considered to be important to caribou. Each station consisted of two plots measuring 5 by 20 feet, with the vegetation in the two plots being as similar as possible. Plot A was fenced to exclude caribou and other large animals. Plot B was not fenced. The distance between the two plots was less than 100 yards. Vegetation was examined by a point-quadrat method where a minimum of five equally spaced lines were placed parallel to the long axis of the plot. Each 20-foot line was divided into 100 equally spaced points 0.2 feet apart. All plants that were intercepted by a pinpoint descending from each point were recorded. Each species was recorded once at each sample point. The height of shrubs at each point was noted and all plants were recorded by species or major groups. Data were then tabulated as percent coverage by the plant species or groups and frequency of occurrence, and were presented in Federal Aid Report W-3-R-11, pp. 130-131, (Skoog, 1957). Black-and-white photographs of the vegetation were taken in each plot. Unfortunately, black-and-white photographs do not permit distinction of the species as well as color photographs. It is recommended that color film be used in the future.

The following formula has been used by Hanson (1950 and 1951) and Pegau (1968a) to determine the species composition.

$$\frac{\text{Total intercepts for a species}}{\text{Total intercepts all vegetation}} \times 100 - \text{bare ground}$$

It gives a more accurate indication of plant cover than the original method, as it is multiplied by the percent of herbage coverage. The above formula has been used to retabulate the data of 1955 and 1956 and results are presented herein, with the discussion of each Range Station. With the method used for analyzing data presented by Skoog (1957), bare ground was considered on a percentage with all other species, rather than being subtracted from 100 to give the actual plant coverage. This method tends to overestimate total plant coverage, since more than one intercept of the vegetation can be recorded at one point. Over a total of 100 hits usually are obtained, leading to an overestimation of the cover.

Hanson (1958) was the first to recommend that the line-point method not be used for permanent quadrats. Pegau (1968a) conducted several studies utilizing various methods of recording vegetation in line-point quadrats used on the same transects. Twenty permanent line-point transects were delineated in heath, willow and meadow stands. The transects were examined and then reexamined four days later, in early August, to determine if the same readings were obtained. On the second reading, tabulation of the total vegetative cover differed from the first reading by -11 to +19 percent with a mean of 3.25 percent. This means that the procedure alone accounts for a variation that ranges from minus 11 to plus 19 percent

of the previous reading. Some of the causes for these differences were that shrubs might be the only plant hit during one of the readings, if the tape was then displaced by 1/4", the pin could descend through the same shrub without hitting a leaf or stem, and could then hit bare ground underneath the shrub. This would cause the amount of bare ground recorded to increase by 1 percent with a corresponding decrease in plant cover recorded. It was found that the displacement of a line by a 1/4" or more often caused an apparent change in the species composition. Tundra is resilient, particularly where there is a heavy moss layer, and the entire moss layer would be moved towards wherever the investigator stepped. The line-point method does not appear to be a useful technique for permanent quadrats, although it could be used for determining botanical composition in an area. However, some caution should be exercised, as Goodall (1952) and Greig-Smith (1964) report that the angle, size, distribution and number of pins and the angle, width, and length of leaves, life form and growth form of the plants all effect the accuracy of an estimate when a point-quadrat method is used.

In the 1957 ecological reconnaissance of the Nelchina caribou range Hanson (1958) used a modified Hult-Sernander scale for estimating cover of each species in meter-square quadrats. The scale is as follows:

1 = Vegetation covers less than 1/16 of the square meter
2 = " " between 1/16 to 1/8 of the square meter
3 = " " " 1/8 to 1/4 " " " "
4 = " " " 1/4 to 1/2 " " " "
5 = " " " 1/2 to 3/4 " " " "
6 = " " " 3/4 to 4/4 " " " "

Ten, meter-square quadrats located in a typical part of each stand were used for the analysis. Stands were described by association tables and general features of the vegetation were noted. Among the characteristics examined were numbers and kinds of species present, total cover, cover of species according to the Hult-Sernander scale, frequency, height, vitality, life forms, constancy and dominance. The slope, exposure, altitude, soil moisture, drainage, condition of the vegetation, effects of caribou and other animals, frost action, solifluction, invasion of species, successional status, and other features were recorded. Most stands were also photographed in color and black-and-white. Soil profiles were examined and the pH was determined by personnel at the Alaska Agriculture Experiment Station. Numerous plant specimens were collected for positive identification and most are now deposited in the Anchorage herbarium. This is one of the most extensive collections of plants from the Nelchina range and most have been identified by recognized authorities.

In the summer of 1958, Skoog (1959) examined several transects to determine lichen distribution and condition and to measure utilization by caribou. Lichen cover and height were recorded by species or groups from square-meter quadrats. This led to formation of a system of classification according to palatability and growth form. Transects

were spaced one-half to three miles apart and located in vegetation that was characteristic of the area. Two, meter-square quadrats separated by 100 feet of measuring tape were laid out. The amount of ground disturbance by caribou, other animals, frost action, etc., along the 100' tape was recorded in tenths of a foot. The data from these studies, plus those obtained by Hanson (1958) were used to delineate the 15 range units mentioned earlier.

Plant associations used by caribou in winter were studied in the Talkeetna River Basin. Aerial reconnaissance flights were made periodically to determine the most extensively used areas, then on-the-ground examinations using 10, meter-square quadrats spaced 20 meters apart, were run across the main portion of the area that had been utilized. Within the quadrats the area of each caribou feeding crater was recorded in square meters and the plants occurring in each quadrat were listed by species. Data on the vegetation type, elevation, snow depth, and plant condition were also noted.

The vegetation in exclosures constructed in 1960 was examined by the use of four quadrats, each one square meter in size. The exclosure size was the same as those built in 1955 and 1956. Vegetation in each quadrat was analyzed by the Hult-Sernander scale and a complete description of the stand was recorded.

During the fall of 1963, the distribution of major plant communities in the Nelchina range was determined (Skoog, 1964). As a result of the autumnal color changes of vegetation plant communities are readily discernible from the air. For example, willows *(Salix* spp.*)* turn bright yellow and shrub birch *(Betula glandulosa)* turn reddish brown. Thus, the willow-lined drainages stand out conspicuously amongst the shrub birch stands. With this technique Skoog (1964) first established the east-west and the north-south base lines, using U. S. Geological quadrangle maps. Twenty-mile segments were designated along each base line and each segment was divided into 20 points, each one mile apart. In each segment one of the 20 points was chosen by use of random numbers as the starting point for a transect lying perpendicular to the base line. These transects were drawn on maps of the Nelchina area (scale 1:250,000) and were flown by two Department of Fish and Game personnel in a Supercub. As the observer flew along the transect he recorded the vegetation type occurring every 15 seconds at a point on the ground determined by sighting along two fixed points on the airplane. The two sets of data so obtained, north-south transects and east-west transects, provided a quantitative measure of the distrubution of the major plant communities. The time of passing certain land marks was recorded on the maps in order to provide a measure of true ground speed and so permit the actual plotting of each point on the map. Thus, to a certain extent, the actual locations of the major communities were determined as well. Transects totaling 3,582 miles were flown and 9,442 sample points were obtained during the analysis. These data are presented in Tables 4-8 in Federal Aid Report W-6-R-5 (Skoog, 1964).

In 1966 the first 15 exclosures were reexamined and vegetation was analyzed by both the line-point method and the modified Hult-Sernander scale. Unfortunately, the description of the procedures used in the line-point method are no longer in the files. In analyzing the data, it became apparent that the technique was somewhat different than that which was used in 1955 and 1956, when the exclosures were first examined. The data could not be accurately interpreted by myself to allow direct comparison with the previous data. Correspondence with T. McGowan, who was the principal investigator, indicated that both overstory and understory were recorded in 1966 so that a plant species could be hit more than once at each location, and bare ground could be recorded, even though a plant species in the overstory was recorded at the same point. Until the exact procedure that was used in 1966 has been determined, analysis of those particular data will be deferred.

During 1967 the vegetation in Range Stations 1, 2, 4, 5, 11, 12 and 13 was photographed using black-and-white, color, and infra-red color film. This was a trial examination of infra-red film which appeared to have some potential for identifying species, due to their distinctive colors.

In the summer of 1970, 33 of the stations were reexamined and the vegetation analyzed according to the Hult-Sernander scale. Five stations were examined in 1971. All readings, except the 1966 point-quadrat methods, are presented in this report.

RUMEN ANALYSIS

The analysis of caribou rumen contents has been attempted sporadically since 1953. Several problems have been encountered, the principal one being that the major portion of each rumen sample is composed of plant fragments that have been too small to identify. One of the first attempts to examine a large number of rumens was by Chatelain (1953). Thirty-eight rumens were collected in the fall and the identification of plant species was restricted to the larger fragments. Lichens, grasses, sedges, willows and shrub birch constituted 90 percent of the material identified. In 1954, 88 more rumens collected in the fall were examined and a good narrative of the results was presented by Lensink (1954). Again lichens, grasses, sedges, willows and shrub birch were the principal items identified.

Courtright (1957, 1959a, 1959b) reviewed caribou rumen analysis and the problems associated with obtaining representative data. He demonstrated several trends in which procedure influenced the various plant groups that could be identififed according to the size mesh of the screen being used to separate the samples. A technique was not developed that enabled the identification of the bulk of the sample; that being the small fragments. Although a "good" technique of caribou rumen analysis has not yet been developed, the findings of Courtright can be summarized to a degree. Shrub birch and blueberry occur in rumens throughout the year

and willows may be important in the summer. *Dryas octopetala* occurs rather commonly in most rumen samples. Lichens of the genus *Cladonia* are the most heavily utilized followed by members of the genera *Cetraria* and *Stereocaulon*.

Recent literature describes a technique in which the plant cells are identified with the aid of a microscope. All plant material is ground to a uniform size and placed on a microscope slide, then the fragments are identified. Myers and Vaughan (1965), Ward and Keith (1962), Williams (1962), Hayden (1966), Malechek (1966), Sparks (1968) and Sparks and Malechek (1968) described this technique which merits serious consideration because it provides a method for identifying the bulk of a rumen sample.

THE NELCHINA RANGE

Skoog (1968) and Hanson (1958) have presented extensive descriptions of the Nelchina caribou range. This range encompasses about 17,500 square miles. It is bounded roughly on the south by the Glenn Highway and the Tazlina and Matanuska rivers. On the west, the Alaska Railroad and the Lower Susitna, Chulitna and Upper Nenana rivers form the boundary. The north boundary is approximated by the summit of the Alaska Range, and the east by the Copper River and eastern drainages of the Chistochina River. Skoog (1968) described the terrain as:

> "varying from spruce-covered lowlands and basins with numerous lakes and streams, to long, gentle, bush-covered slopes of scattered hills and foothills, to alpine sedge-meadows and tundra, to steep rugged mountains. The intricate drainage system produces an especially complex physiography, with wide variations in elevation, slope, and exposure."

The Nelchina caribou herd has normally remained within these boundaries but there has been extensive use of the area to the northeast and northwest since the early 1960s which has continued to the present. A detailed discussion of the topography and climate is presented in Skoog's thesis (1968).

The principal caribou habitat lies above timberline in elevations between 3,000 feet and 5,000 feet. Because the Nelchina range has such varied topography, a multitude of micro-climates exists. One factor of particular importance is wind, which can influence caribou distribution during the peak period of flying insect harassment--summer months. Caribou seek out areas with some wind which aids their attempts to avoid the insect torment. Snow conditions, of course, would be quite varied and the depth of accumulation, as well as icing and layering, determines which areas can be utilized during the winter months. Little information has been obtained about snow conditions, distribution of snow accumulations, etc., and an appraisal of carrying capacity would be misleading

without accurate information concerning the snow cover distribution. The value of the multitude of habitat conditions is amply presented by Klein (1970a, 1970b). He demonstrates several factors that enhance the nutritive quality of range by causing the vegetation to reach its greatest nutritive quality over a prolonged period. He also describes how reindeer and caribou can obtain a progressively better quality diet. Their feeding habits enable them to select the highest quality forage available on the range.

Vegetation of the Nelchina range is very similar to other tundra and taiga regions in the northern hemisphere. Black spruce and white spruce occur throughout, at elevations below 3,000 feet, with scattered trees extending to 3,500 feet. The largest area of spruce cover occurs in the southeastern quadrat in the Lake Louise Flat area. Interspersed among the spruce communities are stands of aspen-poplar, meadow, water sedge and bog. Shrub birch is the co-dominant with spruce at elevations between 3,000 feet and 3,500 feet. Willows occur on most drainages, and fescue grass is commonly found in association with the shrub birch type. The heath type is normally found above timberline and is a very important vegetation type in the ecology of the Nelchina herd. Heaths usually occur from 3,000 feet upward on dry, well-drained sites. The meadow type occurs on sites with poor drainage up to considerable heights in the mountains; however, the majority occurs below 4,000 feet.

Hanson (1958) considered eleven vegetation types in his report, and Skoog (1968) later modified this to include 12 types, which are the designations used in this report. In an effort to consolidate and facilitate comparisons of all vegetative studies on the Nelchina range, the different names used by the principal investigators are presented in Table 1. Also listed are the names of community types that are used throughout this report and which are compared with those of Hanson's and Skoog's. This report follows primarily the nomenclature suggested by Skoog, with a few minor changes. The principal one involves converting his dwarf birch type to shrub birch, as this is the common name of *Betula glandulosa*, which is the principal constituent, rather than *Betula nana*, which is dwarf birch. Shrub birch is more descriptive of the growth form of birch on the Nelchina range.

1. The Spruce Type

Black spruce *(Picea mariana)* and white spruce *(Picea glauca)* occur throughout the Nelchina range below 3,000 feet with white spruce occurring on well-drained soils and black spruce on poorly-drained soils. The topography within spruce stands is usually level, but they also occur on gently sloping lands and occasionally on steep slopes near rivers. Heaths occur scattered throughout, as do some lichens. Fire has been a most important component of the ecology of the spruce communities, being responsible for several successional stages. Vegetation cover usually ranges from 97 to 100 percent within the community. A thick carpet of mosses and lichens is quite often found and vascular plant constants (species occurring in 80 percent of more of the stands) include shrub

Table 1. Designation of plant communities within the Nelchina range as used by different investigators.

This Report	Hanson (1958)	Skoog (1968)
Spruce	Spruce	Spruce
Shrub birch	Glandular birch	Dwarf birch
Heath	Dwarf heath shrub	Heath
Willow	Willow	Willow
Meadow	Alpine meadow	Meadow
Water sedge	Sedge	Water sedge
Fescue grass	Fescue	Altai Fescue, fescue grass
Bluejoint grass	-	Bluejoint grass
Bog	Bog	Bog
Aspen-poplar	Aspen	Aspen-poplar
Alder	-	Alder
White birch	-	White birch

birch, blueberry *(Vaccinium uliginosum)*, cranberry, narrow-leaved Labrador tea *(Ledum decumbens)*, crowberry *(Empetrum nigrum)*, *Salix pulchra*, felt-leaf willow *(Salix alaxensis)*, cloudberry *(Rubus chamaemorus)* and coltsfoot *(Petasites* spp.*)*. In those stands examined by Hanson, lichen cover averaged 3.1, the plants usually being 1/2 to 1 inch tall and matted on polygon centers. Taller forms occurred in depressions, but often they would be unavailable for winter use because of snow accumulation. The principal lichen species were *Stereocaulon* spp., *Cladonia arbuscula*, *C. rangiferina* and the funnel form *Cladonias*, such as *C. coccifera* and *C. pleurota*. *Peltigera aphthosa* and *Nephroma arcticum* occur in more moist sites. Caribou utilize the spruce type primarily during early winter, feeding on the fruticose lichens and some of the vascular plants, particularly sedges in the bog and water sedge type which occured scattered throughout the spruce type. Hanson considered the range condition, based on lichens, as usually rating poor with a few stands that rated as high as good. Several successional stages in the spruce type contribute to a diversity of species, soil conditions, and plant growth. Historically, this type has been one of the most important areas for wintering caribou herds and has provided considerable forage.

2. The Shrub Birch Type

The shrub birch community is one of the most prevalent plant associations on the Nelchina range and is found in a wide variety of habitats. It has a wide tolerance to moisture, temperature and substrate conditions. Usually it is the dominant type on burned ranges within the spruce type and is the major type between 3,000 and 4,000 feet. The height of these shrubs is usually between 1/2 to 6 feet and the density of the principal species (shrub birch) varies considerably. Constants in this type include shrub birch, blueberry, cranberry, narrow-leaved Labrador tea, crowberry, *Salix pulchra*, and *Festuca altaica*. Hanson found that mosses averaged 3.7 in cover while the lichens averaged 4.4. Lichen height ranged from 1/2 to 2 inches in heavily grazed stands and 4 to 6 inches in lightly grazed areas. Dominant species included *Cladonia rangiferina*, *C. alpestris* and *C. arbuscula*, plus a wide diversity of other species. Hanson rated the shrub birch type for winter range condition from excellent to fair and for spring or summer use from good to fair, with the overall range condition as good. Skoog states that in the summer the leaves of shrub birch are avidly eaten by caribou. However, within this type lichens are the principal winter forage; due to the density and height of the shrub birch, most of the understory vegetation is unavailable in late winter because of deep accumulations of snow. Skoog felt it was resistant to grazing and thus, a good indicator of caribou-range relationships.

Hanson (1958) stated that deterioration of the shrub birch type was characterized by compacting and disintegration of the lichen-moss layer, decumbent short growth and the shattering of lichens with the formation of moss pedestals and breaking of moss hummocks which expose roots and the lower branches of shrubs. Pieces of shrub branches are scattered about with numerous nipped branches. The presence of caribou trails is followed by a change in the species composition of mosses and lichens. Deterioration can occur rapidly with two or three years of heavy use.

As heavy use continues, the taller lichens, such as *Cladonia alpestris*, *C. rangiferina* and *C. arbuscula*, are replaced by shorter and more decumbent forms, such as *C. gracilis*, *C. deformis*, *C. cornuta*, *C. gonecha*, *Cetraria* spp. and others. Mosses, such as *Pleurozium schreberi* and *Hylocomium splendens*, are replaced by *Polytrichum* spp., *Rhacomitrium lanuginosum* and *Dicranum fuscescens*. Hanson further describes several intermediate stages of plant succession in the shrub birch type.

3. The Heath Type

Heath occurs primarily above 3,000 feet. It is widely distributed, usually occurring on well-drained, rocky, or gravelly soils, often in close association with the shrub birch type. This community tends to replace the shrub birch type in the more xeric sites. An alpine dryas type, generally considered in most alpine vegetation studies, was not delineated by either Hanson or Skoog and is not included in this report. From the air, it is extremely difficult to differentiate the alpine dryas from the heath type and, accordingly, the former has been consolidated with the heath type. *Dryas octopetala* becomes the dominant plant and usually occurs on very dry, rocky soils above 4,000 feet. Within the heath type dominant species include: blueberry, cranberry, crowberry, narrow-leaved Labrador tea, and *Cassiope tetragona*. Hanson described three subtypes, based mainly on drainage and soil stability. The mosses were not as abundant (cover of 1 to 4.8), nor as tall in the heath type as in the spruce or shrub birch types. Lichen cover was usually good (2.2 to 6.0), and heights ranged from 1 to 4 inches. As lichens are a particularly important component of the caribou's winter diet, and since this type is one of the most accessible to caribou in the wintertime, it is especially important to the Nelchina herd. It is vulnerable to over-utilization because of the shallow soil development and erosion resulting from wind and animal use once the vegetative mat is disrupted.

In a severely disturbed plot of the alpine dryas type near Unalakleet, recovery after nearly 40 years was only minimal (Pegau, 1970b). Hanson considered the successional order of species for the heath type to be *Alectoria* spp., *Cornicularia divergens* and *Stereocaulon paschale* followed by *Cetraria nivalis*, *C. cucullata*, *Cladonia arbuscula* and other species, and finally by *Cladonia alpestris* and *C. rangiferina* which become dominant. Range condition usually rated excellent for winter use because of the abundance of lichens and the presence of several heaths and sedges. The low shrubs and normally thin snow cover increase availability to grazing. Heavy use of this vegetation type leads to rapid deterioration; recovery is slow.

4. The Willow Type

Willows are common throughout the Nelchina range, usually occurring along streams, lakes, other drainageways and depressions. Felt-leaf willow is most prevalent along the border of streams and on disturbed sites. *Salix pulchra* is usually found with shrub birch and *S. scouleriana* with aspens (*Populus tremuloides*). *S. pulchra*, *S. barclayi* and *S. lanata*, usually occur on poorly drained areas. Willows range from prostrate forms

to small trees. Numerous other plants are interspersed and the soil is relatively unstable. Willows are able to survive fire and produce new shoots in a comparatively short time. Forbs are numerous in the willow type, as well as some grasses, particularly *Calamagrostis canadensis* and *Festuca altaica*.

Mosses are numerous, especially on damp sites, and can occur to considerable depth in the understory. However, forage lichens are usually scarce. Willows are very important forage plants for both caribou and moose as they provide the first major sources of green vegetation in the early summer. They are an important component of the summer range but are almost entirely avoided in the winter by caribou. However, they are a very important winter type for moose.

5. The Meadow Type

The meadow type consists almost entirely of herbaceous plants and mosses. Shrubs and lichens are scarce. It occurs sporadically below timberline near lakes and ponds. Principal species include *Carex aquatilis*, *C. saxatilis* and *Eriophorum angustifolium*, with several other grasses and sedges. In higher elevations and in drier conditions, the dominant species of sedges usually are *Carex bigelowii*, *C. membranacea*, *C. misandra* and *C. scirpoidea*. The meadow type is an important year-round forage producer and its value as winter forage has probably been underrated.

6. The Water Sedge Type

This type occurs adjacent to the several hundreds of ponds and lakes that are scattered throughout the Nelchina range, especially in Range Unit 13. *Carex aquatilis* is the dominant plant, often forming almost pure stands, but occasionally intermixed with some of the cotton grasses (*Eriophorum* spp.) and *C. rotundata*. The water sedge type may occur in a narrow zone around the periphery of the lakes. It grades into the bog type in some areas. It is important as fall and early winter range.

7. The Fescue Grass Type

Large grass tussocks, herbs, and willows give this type its distinctive appearance. It is usually found on level to gently sloping land at elevations of 3,000 to 4,300 feet, often occurring between shrub birch and willow stands. Fescue appears to invade mineral soils and disturbed sites replacing mosses, lichens and shrubs. After the tussocks are established, mosses fill the interspaces and then forbs, shrubs and lichens become established on this turf. Constants include *Carex montanensis*, *Artemisia arctica*, *Anemone narcissiflora*, *Antennaria monocephala*, *Salix pulchra*, *S. reticulata* and cranberry. Fescue occurs on essentially the same substrates as the shrub birch and at similar elevations, but is restricted to the level or gently sloping lands.

The similarity of the soil profiles makes it difficult to determine the key factors which determine whether the site will be covered with

shrub birch or fescue grass. Mosses are abundant, cover of 4.0 to 6, and form layers of 1 to several inches thick. Hanson found that lichen density varied from .5 to 3.6, but was usually scattered in distribution. The fescue type serves primarily as a spring and summer range because of the variety of herbaceous plants. It rates poor as winter range because of little lichen cover. However, robust lichens occasionally occur in this type and Skoog considered it more important as a winter range than was indicated by Hanson.

8. The Bluejoint Grass Type

Bluejoint *(Calamagrostis canadensis)* is widespread, occurring primarily on severely disturbed areas and on open well-drained sites below timberline. In several parts of the western portion of Range Units 10 and 14, it forms pure stands. Usually it is an early successional species that is relatively transitory. The caribou utilize it somewhat in early summer, before the grass becomes mature, otherwise very little use is made of the type.

9. The Bog Type

A very thick moss mat, usually *Sphagnum* spp., is characteristic of the bog type. The bog type occurs in poorly-drained areas and usually is hummocky with a high moisture content in the moss substrate. Permafrost usually is near the surface. Other vascular plants are usually scattered throughout and consist primarily of bog rosemary *(Andromeda polifolia)*, cloudberry, and some of the heath shrubs. The sedges *(Carex bigelowii, C. rotundata, Eriophorum vaginatum* and *E. angustifolium)*, also occur throughout in the bog type. Lichens are very limited in the bogs, but where they occur, the fruticose types will often be in very large clumps. In general, there is little lichen forage and, therefore, this type is of relatively little importance to caribou.

10. The Aspen-Poplar Type

The aspen-poplar type usually occurs below 3,000 feet on well-drained hills or where the soil has a high sand, gravel and stone content. It usually represents one of the secondary successional stages following fire. Skoog (1968) states that, "although both frequently occur together, one usually dominates the stand: quaking aspen *(Populus tremuloides)* on well-drained forest soils, particularly along south facing slopes; and balsam poplar *(Populus balsamifera)* on the shallow gravelly soils of stream beds, flood plains, alluvial fans, glacial moraines, and eskers and rocky substrates on disturbed slopes."

Aspen usually invades burned areas and poplar occurs as a pioneer species. Shrubs usually form the understory and mosses may be abundant. However, fruticose lichens usually are scarce. The stand provides very little caribou forage, but it can be important for moose.

11. The Alder Type

Thickets of alder *(Alnus* spp.*)* occur throughout the Nelchina range, primarily in the western portion below 3,500 feet. Alders usually occur on rocky substrates or on steep slopes. Very few plant species occur in this type and, quite often, only the alder is present. Caribou almost completely avoid the alder type as alder is apparently unpalatable. The dense, extremely tangled growth form of alder makes movement through alder thickets difficult. Snow becomes very deep in alder thickets. Skoog did report an observation of caribou eating dried alder leaves during one winter.

12. The White Birch Type

White birch *(Betula papyrifera)* occurs sporadically and is most common in the far western part of the Nelchina range. On well-drained sites the understory is similar in species composition to that in the spruce type. Mosses and forage lichens are usually much less abundant than in the spruce type and there is little use of this type by caribou.

The *Dryas-Kobresia* and mountain sage types of Hanson have very limited distribution and are not considered a major type on the Nelchina range. The largest single type that is not represented in this report is the alpine Dryas type which can be recognized easily from the ground but, unfortunately, becomes almost indistinguishable from the air. Further vegetative analysis of the Nelchina range may include separation of the alpine Dryas from the heath type, where it is presently lumped. Hanson did not use the alder, bluejoint grass, or white birch types, as they occur primarily in the western portion of the range in a region that he did not investigate. They occur in large enough stands and are important enough to enumerate, although they are of relatively minor importance as a major forage producing type for caribou.

The spruce type is dominant, comprising about 30 percent of the total land cover of the Nelchina range. It is followed by shrub birch and heath types, which together occupy about 29 percent of the Nelchina range. Skoog (1968) states:

> "of the total range, approximately 18% supports no vegetative growth (i.e. as represented by the major vegetation types). Another 4% consists of vegetation types not utilized by caribou (alder, aspen-poplar, bluejoint grass, and white birch). To this add a 12% figure for burned areas, and it becomes evident that about one-third of the range furnishes little or no food to caribou. The area of most importance to the Nelchina herd totals about 12,000 square miles. This is a figure which seems most appropriate for discussing carrying capacity."

With the recent shift of the Nelchina herd outside of the "normal" boundaries during winter, a carrying capacity figure would be unrealistic,

based on current knowledge. There is no information of the vegetative types outside of the fifteen range units.

Several vegetation studies have included unidentified plant specimens which are usually given a number and all references to the species are by that number. Unfortunately most of the herbarium specimens have not been relocated and identification of the original species cannot be definitely determined. However, from the 1955-56 studies there are small collections of lichen specimens in the herbarium and these have been identified as follows:

	1955		1956
AIa1	*Cetraria nivalis*	1.	*Cladonia amaurocraea*
AIa2	*Cetraria cucullata* and *C. islandica*	2.	*Cladonia arbuscula*
AIb2	*Cladonia rangiferina*	3.	*Nephroma arcticum*
AIb3	*Cladonia rangiferina*	4.	*Stereocaulon* spp.
AIc	*Stereocaulon* spp.	5.	*Cladonia* (funnel-form)
B1	*Cladonia amaurocraea*	6.	*Cetraria islandica*
		7.	*Cladonia crispata*
		8.	*Cetraria nivalis*
		9.	*Cetraria richardsonii*
		10.	*Dactylina arctica*

On data sheets of the range examinations conducted in 1955, AIb3 is referred to as *Sphaerophorus globosus*; however, the sample that is in the herbarium is a specimen of *Cladonia rangiferina*. In 1970, those stations where AIb3 was recorded to have occurred in 1955, were reexamined, *Sphaerophorus globosus* was usually totally absent; however, *Cladonia rangiferina* was usually abundant. Apparently they were separating a darker form of *Cladonia rangiferina* rather than a specimen of *Sphaerophorus globosus* as AIb3.

To minimize confusion, I have taken the liberty of changing all references of *Cladonia sylvatica* in prior studies to *C. arbuscula*, which is now the accepted name. And I have also used the vegetation type designation I have proposed, even in direct quotations from Hanson (1958) or Skoog (1968).

Hanson noted that most of the birch on the Nelchina range was *Betula glandulosa* rather than *B. nana*, as it had often been referred to in previous studies. *Betula glandulosa* was the most common form encountered by Skoog and myself, although *Betula nana* surely occurs at the higher elevations. The two species commonly form hybrids. For the management studies of the Nelchina range, it should be considered one species, *Betula glandulosa*.

There have been several specimens of grasses and sedges that were unidentified and supposedly were in the herbarium. These have not been relocated so I have followed Dr. Hanson's designations on species identifications for most of these stations. I have tried to consolidate the

species, based on Dr. Hanson's identification, but some sedges and grasses from 1955, 1956, 1961, 1962 and 1966 may have been different than those indicated. I have tried to consolidate the species by their best identification. Skoog (1959) developed a grouping of lichens according to their palatability and/or growth form to which he refers throughout some of his studies. They are presented in Table 2. These will be referred to occasionally in this report. He also developed a table of stages of lichen succession which he considered more appropriate than trying to determine range condition based on lichens alone and, therefore, it is presented in Table 3, since the stages are referred to occasionally in this report and they provide a good understanding of some of the successional stages of lichen condition.

RANGE UNITS

Because the Nelchina caribou range is too large and varied to discuss as a single entity Skoog, in 1959, divided the range into 15 range units based on topography, vegetation, use patterns, and other characteristics (Fig. 1). All vegetation analyses conducted on the Nelchina range are herein reported according to the various range units. A discussion of the vegetation in each range unit is presented. Skoog (1959, 1968) presents detailed descriptions of the topography, vegetation, boundaries and history of caribou use for each range unit. A brief summary of each range unit is included herein. For detailed descriptions, Skoog (1959, 1968) should be reviewed.

Table 4, taken primarily from Table 20 of Skoog's thesis (1968), shows the seasonal distribution of the Nelchina caribou herd by range units during the last several years. It has been updated by inclusion of information from segment reports, for the years 1965-70. As can be seen in this concise tabulation, calving almost always occurs in Range Unit 12, with occasional occurrence in adjacent units. Summer movements are generally into Range Unit 5 (the Deadman Lake area), with continued use being made of Unit 12. Thereafter the caribou shift around to the winter range, primarily in the Talkeetna Mountains Unit 1 and in recent years outside of the "normal" Nelchina range near the Wrangell Mountains. Skoog (1968) presents a much more detailed description of caribou movements in his thesis and more detailed discussion of use will be presented with the analysis of each range unit.

Unit #1 - Upper Nenana River

This unit lies in the northwest corner of the Nelchina range. Skoog (1959) delineated it as follows: "It is bounded on the west by the Alaska Railroad, on the south by the Jack River, and its East Fork, on the east by Seattle Creek and the main stem of the Nenana River, and on the north by the divide separating the drainage of the upper segment of the Nenana River from that of Yanert Fork." The unit encompasses about 460 square miles, which is approximately 3 percent of the total Nelchina range. The altitude ranges from 2,100 feet to 7,000 feet. Seventy-one percent of

Table 2. Lichens occurring on the Nelchina Caribou Range. These are grouped, for the purpose of range analysis, according to their form and/or their palatability to caribou.

Group I: Fruticose - High Palatability

Cladonia alpestris	*Cladonia rangiferina*
C. mitis	*C. arbuscula*

Group II: Fruticose - High-Medium Palatability

Cladonia amaurocraea	*Cetraria cucullata*
C. crispata	*C. delisei*
C. gracilis	*C. islandica*
C. uncialis	*C. nivalis*

Group III: Fruticose - Low-Medium Palatability

Cladonia cornuta	*Cetraria richardsonii*
C. deformis	*Dactylina arctica*
C. degenerans	*Stereocaulon* spp.
C. ecmocyma	*Thamnolia vermicularis*

Group IV: Fruticose - Low Palatability (Funnel-like Cladonias)

Cladonia coccifera, etc.

Group V: Fruticose - Most Not Palatable

Alectoria ochroleuca	*Cornicularia divergens*
Cetraria nigricans	*Sphaerophorus globosus*

Group VI: Foliose - Mostly Not Palatable

Cetraria chrysantha	*Parmelia* spp.
C. spp.	*Peltigera* spp.
Lobaria linita	*Sticta* spp.
Nephroma spp.	*Umbilicaria* spp.

Group VII: Crustose - Not Palatable

Group VIII: Fruticose - Medium to High Palatability (Epiphytes)

Alectoria jubata	*Usnea* spp.
Evernia spp.	

Table 3. Lichen succession stages (Skoog, 1959).

Stage I: Primary

a) DRY SITES -

Lichen Cover:	0 to 3.
Average Height:	0 to 1/2 inches.
Dominants:	Bare ground, crustose lichens, and funnel-shaped lichens (*Cladonia coccifera*, etc.).
Associated Species:	*Alectoria ochroleuca*, *Cornicularia divergens*, *Cetraria nigricans*, *Sphaerophorus globosus*, and various foliose lichens (mostly on rock).

b) DAMP SITES -

Lichen Cover:	0 to 3.
Average Height:	0 to 1 inch.
Dominants:	Sedge marsh, sphagnum, moss, crustose lichens, and *Cladonia gracilis*.
Associated Species:	*Cetraria cucullata*, *Cladonia degenerans*, and various foliose lichens.

Stage II: Early

a) DRY SITES -

Lichen Cover:	2 to 4.
Average Height:	1/2 to 1 inch.
Dominants:	*Alectoria ochroleuca*, *Cornicularia divergens*. *Cetraria nivalis*, and funnel-shaped lichens (*Cladonia coccifera*, etc.).
Associated Species:	*Sphaerophorus globosus*, *Cetraria nigricans*, *C. islandica*, *C. richardsonii*, *Thamnolia vermicularis*, *Cladonia degenerans*, *C. arbuscula* and *Stereocaulon* spp.

b) DAMP SITES -

Lichen Cover:	2 to 4.
Average Height:	1/2 to 1-1/2 inches.
Dominants:	*Cladonia gracilis*, *C. uncialis*, *C. deformis*, *Cetraria cucullata*, *C. delisei*, and various foliose lichens.
Associated Species:	*Cladonia rangiferina*, *C. arbuscula*, *Cetraria islandica* and *C. richardsonii*.

Table 3 (Continued). Lichen succession stages (Skoog, 1959).

c) MESIC SITES -

Lichen Cover:	2 to 4.
Average Height:	1/2 to 1 inch.
Dominants:	*Cladonia gracilis*, *C. degenerans*, funnel-shaped lichens (*C. coccifera*, *C. pleurota*, *C. deformis*, etc.), *Cetraria nivalis*, *C. cucullata* and *Stereocaulon* spp.
Associated Species:	*Cladonia uncialis*, *C. cornuta*, *C. amaurocraea*, *C. arbuscula*, *C. rangiferina*, *Cetraria islandica*, *C. richardsonii*, *Thamnolia vermicularis*, *Dactylina arctica*, *Peltigera* spp. and *Nephroma* spp.

Stage III: Medial

a) DRY SITES -

Lichen Cover:	3 to 5.
Average Height:	1 to 2 inches.
Dominants:	*Alectoria ochroleuca*, *Cetraria islandica*, *C. nivalis*, *Cladonia arbuscula* and *Stereocaulon* spp.
Associated Species:	*Cornicularia divergens*, *Cetraria richardsonii*, *C. chrysantha*, *Dactylina arctica*, *Cladonia rangiferina* and *C. alpestris*.

b) DAMP SITES -

Lichen Cover:	3 to 5.
Average Height:	1 to 3 inches.
Dominants:	*Cladonia uncialis*, *C. rangiferina* and *C. arbuscula* (neither, nor both, predominating), *Cetraria cucullata*, *C. islandica*, *C. delisei*, *Peltigera* spp. and *Nephroma* spp.
Associated Species:	*Stereocaulon* spp., *Thamnolia vermicularis*, *Dactylina arctica*, *Cetraria richardsonii*, *Cladonia amaurocraea*, *C. deformis*, *C. gracilis* and *C. alpestris*.

c) MESIC SITES -

Lichen Cover:	3 to 5.
Average Height:	1 to 3 inches.
Dominants:	*Cladonia uncialis*, *C. gracilis*, *C. arbuscula* and *C. rangiferina* (neither, nor both, predominating), *Cetraria cucullata*, *C. nivalis*, *C. islandica*, and *Stereocaulon* spp.
Associated Species:	*Cladonia amaurocraea*, *C. cornuta*, *C. deformis*, *C. alpestris*, *Cetraria richardsonii*, *Dactylina arctica*, *Thamnolia vermicularis*, *Peltigera* spp. and *Nephroma* spp.

Table 3 (Continued). Lichen succession stages (Skoog, 1959).

Stage IV: Late	
Lichen Cover:	4 to 6.
Average Height:	2 to 4 inches.
Dominants:	*Cladonia alpestris*, *C. rangiferina*, and *C. arbuscula*.
Associated Species:	*Alectoria ochroleuca*, *Cornicularia divergens*, *Dactylina arctica*, *Stereocaulon* spp., *Cetraria islandica*, *C. nivalis*, *C. cucullata*, *Peltigera* spp. and *Nephroma* spp.
Stage V: Climax	
Lichen Cover:	5 to 6.
Average Height:	Over 4 inches.
Dominants:	*Cladonia alpestris* or *C. alpestris* and *C. rangiferina*.
Associated Species:	*Cladonia arbuscula*, *Alectoria ochroleuca*, *Cetraria nivalis* and *C. cucullata*.

FIG. 1: Nelchina Range Units

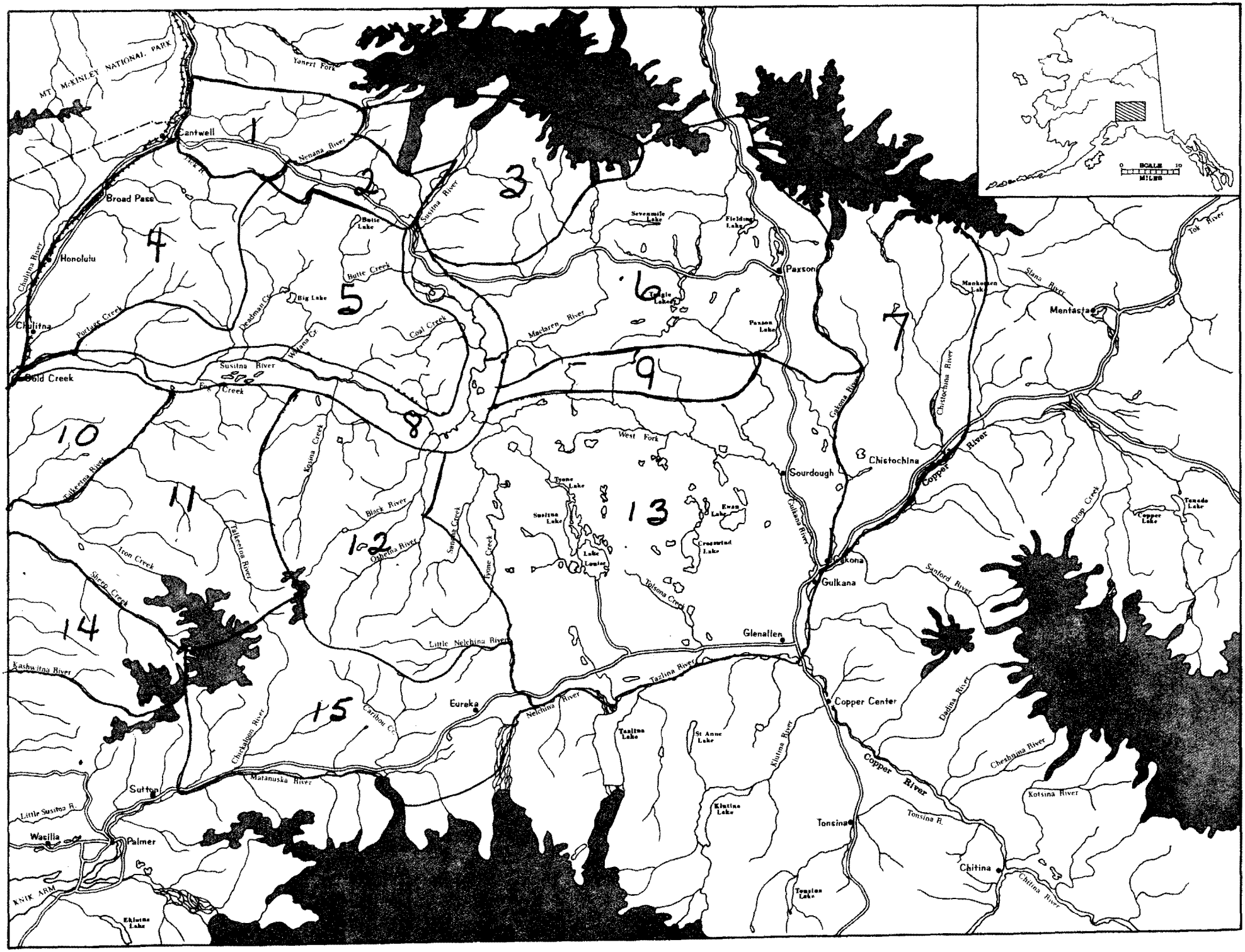

Table 4. Seasonal distribution of Nelchina caribou by range units (from Skoog, 1968).

Early 1930's:	Information available suggests that northwest portion of range was used extensively in winter.
Late 1930's:	Shift in winter range-use southward to Talkeetna Mts., probably including portions of Units 12 and 13.
Early 1940's:	Shift in fall and winter range-use northward, presumably to Units 1, 2, 5 and 6.

	DISTRIBUTION AS RECORDED BY RANGE UNITS[a]				
Year	May-June	Jul-Aug	Sept-Oct	Nov-Dec	Jan-Mar
1948-49			12,15	13	12,13
1949-50	12	5,12	12/5,15	13	5
1950-51	12		12,15	13,15	12/15
1951-52	12	12/5	13/5,12	13	13/12
1952-53	12	12/5,15	13/9,12	13/12,15	13
1953-54	12	5,12	5/12,13	13	13
1954-55	12	5	5,6	5,6	13
1955-56	12	12,15	12,15/6	6,12,13	5,12/6,9
1956-57	12	5,12/15	5,6	5,6,9/NE	5/1,6,11
1957-58	12	5,12	5,6/13,15	5/15	11/2,5,15
1958-59[b]	12	5,12	5,13/11,12, 13	11,15/5, 13,14	11,15/1,5,6, 13
1959-60	12	5,12	12,15/6	5,13/1,6	1,11/5,13
1960-61	12	5,9/6,12	13,15/5,11	13/5,11	5,11/1,2,13
1961-62	12	5,9/6,12	12,13/6,15	5,6,13,E	1,6,E/2,5, 11,NW,NE
1962-63[b]	12	5/12	13,15/6,12	5,13/1,15	1,NW,13/2,5, 11,15
1963-64	12	5/12	5,13/6,12	5,13/6	1,NW,E/5,6,11
1964-65[b,c]	1,5,12	5,12	5,9,13/6	2,6,13/5	1,NW,E/5,6

Table 4 (Continued). Seasonal distribution of Nelchina caribou by range units.

Year	DISTRIBUTION AS RECORDED BY RANGE UNITS[a] May-June	Jul-Aug	Sept-Oct	Nov-Dec	Jan-Mar
1965-66	11,12/8	5	6,7,13/5,9	13,E,NE/15	13,E,NE/15
1966-67	11,12/8	4,5	6,11,13/9	E,4,11,13/1 6,8	E,4,13/1,6, 8,11
1967-68	12	4,12/5	6,13	6,7,13/9,15	E,2,4,13/1, 11,15
1968-69	12	5/6	6,13/9	7,13/6	E,11,13/2,8

[a] Units supporting major segments of the herd; Units listed after "/" supported less significant numbers.

[b] Calving activity distributed widely. April omitted: period of major movements, highly variable.

[c] Permanent egress may have taken place from the Mentasta area in fall of 1965. E, NE, NW = direction of range-use outside "normal" range.

this unit lies above 3,000 feet with 60 percent between 3,000 and 5,000 feet. Skoog described snowfall as being relatively heavy, although strong winds cause many areas of ground above timberline to be blown free of snow much of the winter. As can be seen from Table 5, shrub birch and heath are the principal vegetation types in this unit, followed by willow, spruce and meadow. The ruggedness of this unit is shown by the amount of bare ground (20 percent). Nonproductive areas make up one-fourth of the unit. However, Skoog (1959) remarked that there were excellent stands of *Cladonia alpestris*, 6-8 inches high, south of the Denali Highway. In 1968 he stated that:

> "forage lichens are abundant in the heath and shrub birch types, especially in the southern half of the unit. In that section climax *Cladonia alpestris* (6-8 inches high) dominates numerous heath stands to the extent of actually suppressing the growth of associated shrubs. Lichens are much less numerous on the northern half but sedges are abundant. The unit as a whole contains abundant forage for wintering caribou."

The principal vegetative knowledge of this unit results from the work conducted by Hanson (1958 and unpubl.), determinations of vegetation types by aerial surveys, two exclosures-Range Stations 26 and 27, and two permanent Quadrats, #32 and #33. Several vegetation stands were examined by Hanson. He described some of the heath stands on pages 34-37 of his report (Hanson, 1958). He subdivided the type into three subtypes, A, B and C. In A, the dominant plant, was *Cassiope tetragona* and in the others the dominants were blueberry, crowberry, narrow-leaved Labrador tea, cranberry, alpine bearberry *(Arctostaphylos alpina)* and *Carex bigelowii*. Usually the subtype A was located on moderate to steep sites which were well-drained and on north-facing slopes. *Cassiope tetragona* is often found on slopes where snow remains late in the summer. Subtype B is the more widespread and is found on gentle slopes often with poor drainage and active solifluction. Hanson also delineated a subtype C, the dominant plants being crowberry, cranberry, blueberry, narrow-leaved Labrador tea, and alpine azalea *(Loiseleuria procumbens)*. These sites are moderately steep to well-drained and usually exposed to winds. Hanson presents a good comparison of soil profiles within the three subtypes. Lichen cover was usually good, height ranging from 1 to 4 inches. Range condition was usually graded excellent for winter use because of the abundance of lichens, especially the *Cladonia* species, and usually there was a thin cover of snow so that the plants were available during the winter. Hanson states that heavy use of the heath type leads to its rapid deterioration. Recovery is slow because the sites are exposed to winds and sunlight, causing rapid evaporation and poor runoff retention in stands of subtypes A and C. There are four stands in Hanson's MS Report that are not included in his 1958 report. The narratives of these stands are quoted in their entirety and the vegetation analysis from Stands 60, 61 and 68 are presented in Tables 6 and 7.

Table 5. Percent composition by vegetation types in Unit #1.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	2.9
2. Aspen-Poplar	0.4
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass *(Calamagrostis)*	-
5. Shrub Birch	15.0
6. Fescue Grass *(Festuca)*	2.2
7. Heath	28.5
8. Meadow (Sedge-Grass-Forb)	6.6
9. Water Sedge *(Carex aquatilis)*	0.4
10. Spruce	9.9
11. White Birch	-
12. Willow	8.8
13. Glacier	2.6
14. Bare Ground	20.1
15. Water	2.6

Table 6. Shrub birch stands, 22.5 miles east of Cantwell, (from Hanson, 1958).

Stand No.	60		61	
Number of Vascular Species in Stand	14		17	
Species	Aver. Cover	Frequ. %	Aver. Cover	Frequ. %
Total Cover	100	-	100	-
Moss	1.9	90	4.8	100
Betula glandulosa	1.4	60	3.2	90
Empetrum nigrum	1.4	100	1.1	80
Ledum decumbens	1.8	100	1.6	90
Rubus chamaemorus	0.2	20	0.4	40
Salix pulchra	-	-	0.3	20
Vaccinium uliginosum	1.3	100	2.3	80
V. vitis-idaea	1.0	100	1.0	90
Spiraea beauverdiana	-	-	0.8	60
Arctagrostis latifolia	0.1	10	-	-
Hierochloe alpina	0.6	50	0.1	10
Calamagrostis canadensis	-	-	0.8	80
Festuca altaica	-	-	0.1	10
Carex bigelowii	1.0	100	0.3	30
Artemisia arctica	-	-	0.4	40
Cornus canadensis	0.1	10	0.2	20
Lycopodium annotinum	0.1	10	-	-
Pedicularis spp.	-	-	-	-
Polygonum bistorta plumosum	0.7	70	0.4	40
Lichens	6.0	100	4.8	100

Table 7. White spruce climax, Stand 68, 23 miles east of Cantwell, (from Hanson, 1958).

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover, %	100	100	100	100	100	100	100	100	100	100	100	-
Arctostaphylos alpina	-	1	-	-	1	-	-	-	1	-	0.3	30
Betula glandulosa	1	1	4	1	-	-	-	2	-	-	0.9	50
Empetrum nigrum	1	2	1	1	3	3	1	2	2	3	1.9	100
Ledum decumbens	-	-	1	3	1	1	1	2	1	-	1.0	70
Picea glauca	-	-	3	6	4	4	-	5	-	5	2.7	60
Potentilla fruticosa	1	1	-	-	-	-	-	-	-	-	0.2	20
Rubus chamaemorus	-	-	-	-	-	1	1	1	1	-	0.4	40
Rubus stellatus	1	-	-	-	-	-	1	-	-	-	0.2	20
Salix alaxensis	-	-	-	-	-	1	4	1	-	-	0.3	30
S. pulchra	-	-	-	-	-	-	1	-	-	-	0.1	10
S. reticulata	2	2	1	1	1	-	1	-	-	-	0.8	60
Spiraea beauverdiana	-	-	-	-	-	-	-	1	-	-	0.1	10
Vaccinium uliginosum	3	3	4	5	1	4	2	2	2	4	3.0	100
V. vitis-idaea	1	1	1	1	1	2	1	3	1	3	1.5	100
Calamagrostis canadensis	-	-	-	-	-	1	1	-	-	1	0.3	30
Carex bigelowii	1	1	2	1	3	2	2	1	2	1	1.6	100
Festuca altaica	1	1	1	-	-	-	-	-	-	-	0.3	30
Cornus canadensis	-	-	1	-	-	1	1	-	1	-	0.4	40
Dodecatheon frigidum	1	-	-	-	1	1	1	-	-	-	0.4	40
Equisetum sylvaticum	-	1	-	-	-	-	-	-	1	-	0.2	20
Pedicularis labradorica	1	-	-	-	-	-	-	-	-	-	0.1	10
Petasites sagittatus	-	-	-	-	-	1	1	-	-	1	0.3	30
Polemonium acutiflorum	1	-	-	-	-	-	-	-	-	-	0.1	10
Polygonum bistorta plumosum	1	-	-	-	-	-	-	-	-	-	0.1	10
Saussurea angustifolia	1	1	1	1	-	-	-	-	-	-	0.4	40
Thalictrum alpinum	1	-	-	-	-	-	-	-	-	-	0.1	10
Mosses	6	6	5	3	4	6	6	6	3	5	5.0	100
Lichens	3	2	2	4	4	3	1	3	6	3	3.1	100

"Stand 60 - Shrub Birch

This is located on a north-facing slope of about 5°, on the south side of the road about 22.5 miles east of Cantwell, altitude 2,700 feet, lat. 63°21', long. 148°18'. Analysis was made on Aug. 28, 1957. This open *Betula glandulosa*-Heath stand, rich in lichens, is similar to the vegetation that covers much area in this region, alternating with the taller and denser *Betula glandulosa* type similar to that in Stand 61, which is adjacent to Stand 60. The chief shrubs were *Betula glandulosa* 0.5-4 feet high, *Ledum decumbens* 3-8 inches, *Vaccinium uliginosum* 3-8 inches, *Empetrum nigrum* 0.5-2 inches, and *Vaccinium vitis-idaea*. The stand showed much similarity to Stand 57 in the Heath type. The chief herbs were *Polygonum bistorta plumosum* and *Hierochloe alpina*.

The substratum was gravelly and rocky, with much organic matter in the upper part of the profile. Frost boils were scattered infrequently. Living lichens and occasional mosses, 2-4 inches thick, were underlaid by a 1-2 inch layer of dead lichens, and beneath this was a thin layer of partly decayed moss. This indicates that organic matter in the profile was formed largely from moss and that lichens followed the moss. The 0-2 inch horizon in the soil profile consisted of dark reddish brown organic matter with little if any silt; 2-5 inches, sand and gravel with many stones and little fine material, dark brown because of organic material from above; 5-12 inches, dark brown sand and gravel with many stones and very little fine material; 12-26 inches, compact, olive gray sand with much gravel and many stones, extremely compact at bottom. The pH varied from 4.4 at 0-2 inches to 5.9 at 12-26 inches. Roots were extremely numerous at 0-2 inches, the working depth was at 14 inches.

Mosses had an average cover of only 1.9, while lichens had the high cover of 6.0. The cover and height (up to about 5 inches) of the lichens were evidently suppressing mosses and dwarf heath shrubs. This seems to account for the small number of species and the sparseness of the cover of the species that were present. The shrub species that were present manage to survive because of their continued apical growth. The chief lichens were *Cladonia alpestris*, v. ab., 3-5 inches; *C. rangiferina*, v. ab., 3-5 inches; *C. arbuscula*, v. ab., 3-5 inches; *Cetraria richardsonii* freq., mostly in tracks left by caribou or moose; and *Stereocaulon* spp. inf.-sc. The decaying moss layer at the base of the lichens, and sufficient organic material in the soil, seem to indicate that these are required for good growth of the climax type of lichens. The vegetation in this stand appears

to be climax, the kind that can be expected as the final stage in similar sites. This stand can be used as a standard to measure stage of succession, range condition for winter grazing, and intensity of use by caribou.

Several thousand caribou wintered in this general region, westward to Cantwell during the winter of 1956-57. This use is indicated by scattered droppings, tracks, beginnings of trails, a few broken moss hummocks, and some packed-down lichens. The range condition was rated as Excellent. Large migrations from McKinley Park through the Cantwell vicinity into and through this area are reported to have ceased about 27 years ago. It seems probable that this stand was heavily used during these migrations, because of being on the migration route. If the stand had been heavily used at that time the recovery has been excellent in a period of 25-27 years."

"Stand 61 - Shrub Birch

Stand 61 is located on a north to northeast-facing slope of about 5° at an altitude of 2700 feet, 22.5 miles east of Cantwell, Lat. 63°21', Long. 148°18'. This is a fairly open and medium to tall *Betula glandulosa* stand. *B. glandulosa* averaged about 5 feet tall (2-6 feet), and some *Betula* hybrids were up to 8 feet tall. The shrubs were dispersed as moderately dense clumps to scattered individuals up to 12 feet apart. This stand appears to be typical of similar stands on stony subsoil that alternate with more open stands of shorter shrubs on sandy, gravelly sites (see adjoining Stand No. 60). These strips are about 30-60 feet wide and extend up and down the slopes in this vicinity.

The surface was covered with a layer, of mosses and lichens, underlain by a partly decomposed layer of mostly moss and some lichens, with numerous roots in the lower part. The living and dead lichens and moss, with intertwined roots, formed a compact carpet. In places this carpet had grown over boulders, or had been pushed up by them. The 0-2 inch horizon consisted of organic matter with very little silt; at 0.5 to 2-14 inches the loam soil was found between stones and boulders up to 1 x 2 x 2 feet in size; at 14-24 inches, sandy loam and much gravel and stones up to 1 x 2 x 2 inches; and at 24-32 inches, sand with much gravel and small stones, becoming very compact at 28 inches. The drainage was excellent, but the large quantity of organic material near the surface retained much of the moisture. The pH varied from 4.5 at 0-2 inches to 5.5 at 14-32 inches. Roots were very numerous to 14 inches and the working depth was at about 14 inches.

A number of species, including *Ledum decumbens*, *Empetrum nigrum* (2-12 inches high) and *Spiraea beauverdiana*,

were more abundant on the lower part of the slope; while some, such as *Vaccinium uliginosum*, usually 6-8 inches high, were more abundant on the upper part. *Calamagrostis canadensis* was scattered. *Salix pulchra* 2-4.5 feet high and several herbs were widely scattered. Mosses and lichens were both abundant, and the basal parts of shrubs were buried in them. The chief kinds of lichens were *Cladonia rangiferina* 3-5 inches high, very abundant, with best growth under or close to shrubs; *C. arbuscula* 3-4 inches high, abundant; *C. alpestris*, 3-4 inches high, abundant; the last two with best growth in openings between the shrubs; *Peltigera aphthosa* infrequent; and *Cetraria richardsonii* infrequent. The lichens seemed to be increasing in cover and vigor, especially evident in clumps of *Cladonia alpestris* in openings. Apparently caribou have made little or no use of this stand for a number of years. The range condition was excellent.

It appears that the site on which this stand is located may have been a stone stripe at one time, similar to those at higher elevations at the present time. The large and small stones originally on the surface were invaded by mosses and by some kinds of lichens; organic material accumulated between the stones; and other species invaded. In time fruticose lichens and heath shrubs invaded the layer of decomposing mosses and other vegetation, covering up the stones. At present there appears to be some suppression of heath shrubs by the vigorous growth of the lichens."

"Stand 68 - Spruce

This climax stand is in the northwestern corner of the region, about 23 miles east of Cantwell, in the Nenana River drainage basin. The altitude is about 2500 feet, Lat. 63°20', and Long. 148°17'. The white spruce trees were moderately dense and reproduction was occurring. The tallest trees were 60-70 feet high, somewhat taller than in Stand 54 on Tyone River. The trees were spaced about 10 to 30 feet apart. The surface was very irregular with depressions as deep as 2-3 feet, often containing water. Old logs were covered with vegetation, especially *Hylocomium splendens*, forming hummocks a foot or more high and 5 x 8 feet in area. The soil profile revealed a dark reddish brown organic layer to a depth of 4 inches. Below this horizon were horizons of dark reddish brown loam (4-6 inches), very dark gray brown sandy loam with scattered stones (6-9.5 inches), and dark gray brown sand with silt, gravel, and stones (9.5-18 inches). Large stones were scattered throughout the profile below the organic layer. The pH varied from 6.0 to 6.1, 6.4 and 6.8 in the various horizons. No reaction was obtained with 20% HCl. Roots were extremely numerous in the 0-4 inch organic layer, and the working depth was 12 inches.

The chief shrubs, as indicated in Table 7, were *Vaccinium uliginosum*, *V. vitis-idaea*, *Empetrum nigrum* and *Ledum decumbens*. *Betula glandulosa* and *Salix* spp., 3-10 feet high, were scattered. Forbs were sparse, but mosses were very abundant. Wetter spots had a dense cover of sedges, especially *Carex bigelowii*. Lichens were abundant in openings that are not too moist, but they were scarce in the moister spots and in the densest parts of the forest. The most common kinds of lichens were *Cladonia arbuscula*, *C. rangiferina* (both 3-4 inches high), *C. gracilis*, *Nephroma arcticum* and *Cetraria islandica*. The lichens on the whole were in good condition as there had been no deterioration by caribou, fire, or other disturbance. Range condition (caribou winter range) was Fair to Good.

This stand differed chiefly from Stand 54 in being moister and in not having suffered from ground fire, as apparently Stand 54 had."

"Stand 69 - Spruce

This is located 24 miles east of Cantwell on a southeast-facing slope of 5° or less, at an altitude of 2500 feet, Lat. 63°20', Long. 148°16'. This stand was burned over many years ago, as indicated by charred wood and earth immediately beneath the lichens, and by a fire scar on an 18-foot spruce tree. White spruce trees, usually less than 10 feet tall, were widely scattered. *Betula glandulosa*, 4-6 feet tall, was fairly dense. Other vascular species were much less abundant than usual in the Spruce type. The chief species were *Vaccinium uliginosum*, *V. vitis-idaea*, *Festuca altaica*, *Carex bigelowii*, *Artemisia arctica* and *Cornus canadensis*. *Salix pulchra* was scarce. Total number of vascular species was 19.

Moss hummocks, a foot or more high and 1-3 feet across, were common. Moss cover was 4.7. Rocks, pushed up by frost action, were scattered on the surface. Depressed frost boils were present between many of the hummocks. The organic layer was one inch deep. Below this was loam at 1-6 inches, sandy loam at 6-16 inches, and sand at 16-24 inches. Stones were scattered between 2 and 6 inches and were numerous with much gravel below 6 inches. Very compact silt occurred at 24-26 inches. Drainage was excellent to 24 inches. The pH increased progressively from 4.5 at 0.1 inch to 6.1 at 24-26 inches. Roots were very numerous to 6 inches, and the working depth was at 14 inches. The soil conditions appear to have been more favorable for the growth of herbaceous vascular species than for the dwarf heath shrubs.

Lichens were usually scattered in clumps or mats. The cover averaged 4.6, covering nearly half of the surface, and the height was 2-4 inches.

The chief species between the shrubs were *Stereocaulon* spp. very abundant; *Cladonia gonecha* very abundant; *C. arbuscula* very abundant; *C. gracilis* abundant; *C. rangiferina* abundant; *C. amaurocraea* infrequent; *C. alpestris* scarce; *Cetraria cucullata* infrequent; *C. richardsonii* infrequent; and *Peltigera aphthosa* frequent. Under the shrubs *Nephroma arcticum* was abundant; *Peltigera aphthosa* frequent, *P. pulverulenta* frequent. Caribou have used this stand very little, if any. The range condition was rated fair to good. The bunchy nature of the lichen distribution and the kinds of species present, particularly the sparseness of *Cladonia alpestris* and the abundance of *C. gonecha* and *C. gracilis*, indicate that fire has interfered with the succession of lichens. In recent years the rate has been rapid."

There are two exclosures and two unfenced permanent quadrats located in Range Unit #1.

Range Station 26: Mile 115 Denali Highway, Heath Type

The exclosure was constructed in 1960 and the vegetation examined on 9/3/62. It is at an elevation of 2,700 feet, with a 10° north-facing slope. The stand is in a heath type of climax *Cladonia alpestris*, according to Skoog (1968), with the dominant heaths being narrow-leaved Labrador tea, blueberry, cranberry, crowberry, and *Cassiope tetragona*. Shrub birch is scattered and of the decumbent growth form and is possibly *Betula nana*. The lichen cover at the time of establishment was 80 to 90 percent with excellent growth, 3 to 6 inches high. *Cladonia alpestris* was the most common species. *C. rangiferina*, *Cetraria nivalis*, *C. cucullata* and *Alectoria ochroleuca* were common as well. *Cladonia arbuscula* was scattered throughout. The lichens had been disturbed only slightly by caribou and this use probably occurred during the two winters of 1960-62. These were the first years that caribou had used the region for 20 years or more. *Sphagnum* occurs in moist sites, as does a *Carex*, and Skoog (1968) noted that the site probably had a deep snow cover in the winter.

Two, one-meter square quadrats were established inside the exclosure and two outside as well. Photographs of these quadrats were taken in both black-and-white and color. Unfortunately, the camera malfunctioned and the roll of color film was inadvertently destroyed so that there were no slides of Station 26 when the vegetation was originally examined. The black-and-white photos of the quadrats are available and are in the files. In July 1967, Alexander (1967) noted that the south and north ends of the exclosure were broken down and that caribou had possibly entered. He also indicated that moose had forced their heads through the east and west side, browsing on some of the willows within reach. The exclosure

was repaired at that time. The damage to vegetation appeared relatively minor, but it should be remembered that animals had evidently been inside this exclosure at one time. At that time Alexander indicated that there was a very noticeable difference between the lichen growth inside the exclosure, compared to that outside. Table 8 shows the original readings of vegetation in 1962 and at the time of the next reading, which was in 1970. Quadrats A1 and A2 are within the exclosure; Quadrats B1 and B2 are outside and accessible to grazing by all herbivores. The most obvious change has been in *Cladonia alpestris*, which has decreased from a 5 to a 3 rating on the Hult-Sernander scale in Quadrat B1 and from a 6 to a 2 in B2. A comparison of the photos shows that the decrease was very marked, especially in quadrat B2. In 1970 the lichens were scattered outside the exclosure and were not as upright nor as luxuriant as they were in the photos of 1962. Almost all of the *Cladonia alpestris* had been grazed so that only the lower, gray portion of the podetia remained. This is a characteristic Skoog (1968) used to delineate heavy use of *Cladonia alpestris* by caribou. There were some moss pedestals evident outside which indicates that heavy use has been made of this area by caribou in recent winters.

Inside the exclosure the lichen growth was very luxuriant and abundant showing that this stand was typical climax *Cladonia alpestris* which was described by Skoog as occurring in several locations in this unit. The vigor of lichens outside the exclosure, however, was noticeably reduced and the effects of use, especially of *Cladonia alpestris* which occurred during the 1960's, is remarkable. Comparison of the readings and of photos indicate only a small change inside of the exclosure. There has been a slight increase in cover of the shrubs, particularly narrow-leaved Labrador tea. Outside the exclosure, shrubs have increased in cover to a greater extent, evidently due to the reduced competition from lichens.

Range Station 27: Mile 123.9 Denali Highway, Shrub Birch Type

This exclosure is located in a shrub birch stand, in an open spruce type at an elevation of 2,400 feet. It is on a relatively level slope. The lichen cover in 1962 was good, 3 to 6 inches tall and composed of several species. The lichen mat was dry and cracked. *Cladonia alpestris* and *C. rangiferina* were fairly abundant. *Stereocaulon* spp., *Cladonia gracilis*, *C. uncialis*, *Cetraria cucullata*, *C. nivalis* and *C. richardsonii* were common to abundant. Caribou had used the area to a moderate extent, especially during the winter of 1961-62, and some of the lichen cover outside of the exclosure was disturbed. However, large amounts of forage remained in 1962 at the time of the initial reading. Alexander (1967) indicated that when he examined it in July 1967 the exclosure had collapsed and been entered by caribou. The lichen cover inside of the exclosure had been damaged to a great extent. He indicated at that time the lichen cover outside of the exclosure had evidently received extensive use because of the difference in condition between lichens outside and inside of the exclosure.

Table 8. Station 26: Mile 115, Denali Highway, heath type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Plant Cover	100	100	100	100	100	100	100	100
Moss	2[b]	3	1	3	2	4	2	3
Betula glandulosa	2/10[c]	1/6	-	-	-	-	-	-
Ledum decumbens	2/8	4/4	1/6	4/5	4/6	5/5	3/6	5/6
Vaccinium uliginosum	3/6	3/5	3/6	2/4	t[d]	1/4	-	1/4
V. vitis-idaea	1	-	1	1	2	1	2	2
Empetrum nigrum	3	3	1	1	1	2	-	-
Arctostaphylos alpinum	-	-	-	-	2	3	-	-
Lycopodium selago	-	-	-	-	t	-	-	-
Polygonum bistorta	-	1	t	1	-	-	-	-
Calamagrostis lapponica	-	-	-	-	-	1	-	1
Hierochloe alpinum	-	-	-	1	2	3	1	1
Carex	-	-	-	-	-	-	1	2
Lichens	6/4	6/3	6/4	6/3	6/4	5/3	6/4	4/2
Cladonia alpestris	5/4	6/3	6/4	6/3	5/4	3/2	6/4	2/2
C. rangiferina	3/5	1/3	1/3	1/3	3/4	2/3	2/3	1/2
C. arbuscula	1/4	-	1/2	-	1/2	-	t	1/3
C. gracilis	1/2	1/3	1/2	-	t	-	t	-
C. uncialis	1/2	-	1/2	-	-	-	-	-
Cetraria nivalis	2/2	1/2	2/2	1/2	1/2	1/3	1/2	1/2
C. cucullata	2/3	1/3	1/3	1/3	2/3	1/3	2/3	1/2
C. islandica	1/2	1/3	t	1/2	t	1/2	t	1/2
C. richardsonii	t	1/3	t	-	t	-	1/3	1/3
Stereocaulon paschale	t	-	t	1/2	1/2	-	-	-
Dactylina arctica	-	-	t	-	-	-	-	-
Thamnolia vermicularis	t	1	-	-	-	-	-	-
Alectoria ochroleuca	-	-	-	-	t	-	t	-
Peltigera aphthosa	1	1	-	-	-	-	-	-
Nephroma arcticum	3	3	-	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Table 9. Station 27: Mile 124, Denali Highway, shrub birch type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total plant cover	100	100	100	100	100	100	100	98
Moss	2[b]	3	3	3	1	2	1	2
Betula glandulosa	3/36	2/30	4/44	3/44	t[d]	-	4/42	3/49
Vaccinium uliginosum	2/3[c]	2/6	2/4	2/4	t	1/3	1/4	1/3
V. vitis-idaea	t	1	t	1	t	1	t	1
Empetrum nigrum	-	-	-	-	1	1	2	2
Ledum decumbens	2/6	3/7	-	-	2/5	1/6	1/3	1
Calamagrostis lapponica	-	1	-	1	-	1	-	-
Hierochloe alpinum	1	1	t	1	t	-	-	t
Lichens	6/3	6/3	6/3	6/3	6/3	6/1	6/3	6/1
Cladonia alpestris	3/3	4/3	3/3	2/3	4/3	1/1	2/3	3/2
C. rangiferina	4/3	2/2	3/3	3/3	3/3	3/1	4/3	3/1
C. arbuscula	2/3	3/3	4/3	3/3	1/3	1/1	1/2	2/1
C. gracilis	3/2	2/3	2/3	1/3	1/2	1/2	t	-
C. uncialis	2/2	1/3	1/1	-	t	1/1	-	1/1
C. crispata	-	1/2	-	2/2	-	-	-	-
C. degenerans	-	-	t	1/1	-	-	-	-
C. deformis	-	-	t	-	-	1/1	-	-
Cetraria cucullata	2/2	1/3	2/2	2/3	2/2	1/2	1/2	1/1
C. islandica	t	1/2	1/2	1/2	t	2/2	t	1/1
C. richardsonii	-	2/2	-	2/3	-	2/2	-	1/1
C. nivalis	t	-	1/1	1/2	1/1	1/1	1/1	1/1
Stereocaulon paschale	3/2	3/3	2/2	1/3	3/2	2/2	3/2	2/1
Peltigera pulverulenta	-	-	-	1	-	1	-	2
P. aphthosa	-	-	-	-	-	1	-	-
Nephroma arcticum	-	-	-	-	-	1	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Outside of the exclosure there has been a continued decrease in most species of lichens. The photographs show that lichen cover in 1962, when the vegetation was examined, had already begun to show the use that had occurred in the previous winter. This exclosure was constructed in 1960, prior to much local range use by caribou. By 1970, the outside plots reflected heavy range use by caribou. Lichens were lying about, scattered, and some shrub birch plants were showing the effects of the continued heavy grazing, especially in Quadrat B2. Although total lichen cover in the outside quadrats remained relatively high, a large percent of it was composed of podetia that were possibly morbid and would not regenerate in the near future. There were several moss pedestals exposed and, throughout the outside, the lichens were scattered about.

Within the exclosure, lichen growth was very luxuriant and robust, which indicates that if animals had been inside, they must have only been in for a short period of time, as lichen condition continues to be good. There is one photograph taken in 1967 which shows the prominent difference in lichen growth. From the distance at which the photograph was taken the yellowish color of the lichens was apparent within the exclosure. The exclosure appears to have been placed on an old game trail and the recovery inside has been negligible in the past eight years. With the recent resumption of winter use by caribou, the lichen cover outside has been disrupted. Destruction of plants outside the exclosure can probably be attributed to trampling by caribou and moose during snow-free periods rather than entirely by grazing. This exclosure is presently more xeric than Station 26 which demonstrates that lichens on this type of site are extremely susceptible to trampling. There is a relatively sparse moss cover, so lichens occur directly on the soil and there is not enough moss to act as a moisture reservoir, or to provide a cushioning from trampling.

Permanent Quadrats 32 and 33 - Mile 115 Denali Highway

These two quadrats were established by Skoog in climax lichen stands and were left open to grazing. There were no fenced plots in conjunction with these two quadrats. They were located on a north-facing slope approximately 400 to 500 yards from the Denali Highway. They were established primarily to help determine the effects of grazing on climax stands of *Cladonia alpestris*. These quadrats were reexamined in 1967 by Alexander and, at that time, he noted that the stakes marking the original quadrats had been tampered with. He reestablished two quadrats at each one of the original permanent quadrats and presented vegetative readings for them. In 1970 we were unable to locate any of the stakes for permanent Quadrat 33 and the stakes for permanent Quadrat 32 had obviously been tampered with. They could not be realigned according to Alexander's diagram so very little useful information can be obtained directly from these two quadrats. The original readings and Alexander's readings are in the file and they give some description of the vegetation. They will not be presented here since no comparative information can be obtained from these quadrats. Permanent Quadrat 32 was located in the lee of a small bench where, during the winter, snow accumulation is very deep and the vegetation is unavailable to caribou.

Quadrat 33, however, was on the top of a knoll which is windswept and available for winter grazing. In 1957 the lichen cover was 100 percent, of which 50 percent was *Cladonia alpestris*. In 1967, when Alexander reexamined them, the cover was 61 percent in one plot and 63 percent in the other, of which only 8 and 7 percent, respectively, were *Cladonia alpestris*. At the same time, however, Quadrat 32, which lies in a lee of the bench remained almost unchanged. In 1970 the lichen cover near Quadrat 32 was very robust and strikingly different from that on the adjacent knolls. It reflects very well the spotty use by caribou and how, in slight depressions where snow accumulates, the vegetation becomes unavailable for winter grazing. These quadrats also show the increase in winter use by caribou in Unit 1, which has brought about the reduction of the lichen cover, especially *Cladonia alpestris*. Photographs taken in 1970 are in the files and show the little secluded stands of very robust *Cladonia alpestris* adjacent to the heavily utilized knolls. Unfortunately, stakes of the two quadrats have been tampered with by people. However, this type of range station merits further consideration for future range studies as there is almost no expense involved and no maintenance required, such as with exclosures. They could provide very useful data for determining range condition and trend.

Skoog (1961) stated that during the winter of 1960-61 several thousand caribou wintered in the region during January and slowly drifted toward the Monahan Flat. They were scattered primarily over the Reindeer Hills, which are just east of the railroad, and over slopes adjacent to Brushkana and Wells creeks, mostly above timberline. The heath and shrub birch types were the principal types used and contain the best stands of lichens. There was also some use made of the meadow type. In his description of caribou use of Range Unit 1 Skoog (1968) said:

> "Caribou have utilized the area in varying numbers every year since 1956-57, usually arriving in December or January and departing in April. Occasionally some of the adult bulls have remained until late summer. Prior to 1956 this unit had laid fallow, so to speak, 20 years or more. At some time before the mid-1930s, the reindeer herd being grazed there (from about 1923-1933) was abandoned and caribou movements into the area from the west had ceased (about 1932). Hadwen and Palmer (1922) commented upon the excellent forage for reindeer in this region (including Broad Pass to the immediate southwest)."

As indicated in Table 4, caribou have continued to use this unit throughout the 1960s, however, to a lesser degree in the late 1960s. The preliminary work that was conducted in Range Unit 1 during the late 1950s and early 1960s by Skoog shows that some of the best lichen stands reported for the Nelchina range occurred in this region, and little use had been made of the area for 20-25 years. During that period of time, recovery was excellent, as several stands of climax *Cladonia alpestris* were found throughout the unit, particularly in the southern half. The heath and shrub birch types dominated and they contained abundant forage

for wintering caribou. Some of Hanson's (1958) descriptions, particularly of Stand 60, showed that these were climax stands, as the moss cover was reduced and there was a very dense, tall lichen cover so that lichens appeared to be suppressing the mosses and shrubs. Moss fragments were abundant in the A1 horizon of the soil profile. The other stands that he examined showed this same good growth in several different types.

By 1967, at both Range Stations 26 and 27, there was a very evident deterioration of the range outside of the exclosures, reflecting the resumption of utilization by caribou in the early 1960s. Within a five-year period, from 1962 to 1967, rapid destruction of the lichen cover and, especially of *Cladonia alpestris*, had occurred. Scattered, disrupted lichen stands, with numerous gray podentia (the decadent portions of *Cladonia alpestris*), were common in 1967 and clearly showed that *Cladonia alpestris* cannot withstand continued heavy utilization. It deteriorates rapidly under moderate caribou use, as shown in other studies, particularly those of Skuncke (1969). It is unfortunate that the exclosures have been entered by animals at various times, yet it is remarkable that the lichen condition inside the exclosures showed no evidence of this use in 1970. Alexander noted some disruption in Station 27, yet by 1970 there was very little noticeable damage.

Station 27, which occurs on a drier substrate, shows the tendency of secondary lichen species to recover their condition the most promptly. The two stations show that with disruption of the lichen cover, shrubs were stimulated to increase their growth. There was little noticeable change in the other vascular plants. Skoog (1968) considered that this range unit contained abundant forage, but in the restricted areas of the exclosures and permanent Quadrats 32 and 33, it appears that a rapid deterioration of the lichen cover occurred in Range Unit 1 within the last eight years.

Unit #2 - Monahan Flat

This unit lies just east of Unit #1. The boundaries, as described by Skoog (1959) are as follows: "The southern boundary follows the timberline (about 3100 feet) eastward, mostly south of the Denali Highway, from Seattle Creek to the mouth of Valdez Creek, the eastern boundary proceeds along the east bank of the Susitna River to the foot of Susitna Glacier; and the northern boundary continues westward across the foot of West Fork Glacier to the head of the Nenana River."

Unit #2 contains about 270 square miles, or 1.5 percent of the Nelchina Range. Almost the entire unit lies below 3,000 feet (250 square miles). It is mostly level and poorly drained and its elevation ranges from 2,600 to 3,200 feet. Table 10 shows the composition by vegetation types within Unit #2. Shrub birch, meadow, and spruce are the dominant types, with large stands of willow. Its poor drainage is reflected by the fact that 12 percent of the unit is covered by water.

Snowfall is similar to Unit #1, but there is less wind, therefore, persistent snow cover is somewhat deeper. In 1959, according to Skoog,

Table 10. Percent composition by vegetation types in Unit #2.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	-
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	1.3
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	22.4
6. Fescue Grass (*Festuca*)	4.5
7. Heath	2.5
8. Meadow (Sedge-Grass-Forb)	15.4
9. Water Sedge (*Carex aquatilis*)	3.9
10. Spruce	23.1
11. White Birch	-
12. Willow	12.2
13. Glacier	-
14. Bare Ground	2.5
15. Water	12.2

the lichen growth was good, covering about 60 percent on the area. The dominant species were *Cladonia alpestris*, *C. arbuscula*, *C. rangiferina*, *C. uncialis*, *C. gracilis* and *Cetraria cucullata*, with some podetia of *Cladonia rangiferina* measuring up to 10 inches in length.

Hanson did considerable work in this unit, particularly along the Denali Highway, which is close to the southern border and is fairly characteristic of the unit as a whole. Hanson (1958) presented the readings for Stands 56, 57, 58 and 62 which were in a heath type and are presented in Table 8 of his report. However, the narratives concerning these stands were not included in his report. They are presented herein as are the narratives from three additional stands that only appear in his rough draft. The latter includes Stands 59 and 63 which are in a shrub birch type and Stand 67 in a spruce type.

"Stand 56

The heath stand, rich in lichens, is located on a gentle, 5-10° north-facing slope about 42 miles east of Cantwell, south of the Denali Highway, altitude about 3100 feet, lat. 63°14', long. 147°47'. It was apparently in climax condition when analyzed on Aug. 23, 1957. This stand is located on a large solifluction terrace, which appeared to be active, as indicated by flow earth and seepage in the soil profile trench, and also by apparently recently covered stems in places at the bottom of the moderately steep bank at the lower side of the terrace. The terrace is at the base of a ridge from which drainage water is received. Similar stands on other terraces occur in this vicinity. The vegetation on the terrace was in the form of longitudinal strips parallel with the slope. Lichen-heath strips, up to about 40 feet wide, were separated by more bog-like strips, 6-20 feet wide, in which *Carex*, *Cassiope tetragona*, *Tofieldia* and *Androsace* were more abundant than in the lichen-heath strips. The bog-like strips were hummocky. The hummocks were 3-4 inches high, 1-2 feet in diameter, and separated by depressions which were usually 4-12 inches wide. Moss was abundant in the depressions. Cracks, 3-8 inches wide and 3-6 inches deep below the lichen mat, and occupied by mosses, *Carex*, et. al., occurred occasionally at right angles to the slope on the lichen-heath strips. It seems that these cracks may have been caused by solifluction.

The 0-3 inch layer in the soil profile consisted of dark reddish brown loam, very rich in organic matter. The 3 - 10.5 inch horizon was variable, dark brown sandy loam to loam rich in organic matter. The 10.5 - 39 inch horizon was also variable, dark brown to olive gray silty sand, almost liquid flow earth beginning at 12 inches, very compact at bottom, filled with water to 10 inches from the top in a few hours. The pH varied from 4.8 at 0-3 inches to 5.8 in the bottom layer.

Lichen growth was excellent, 6 in cover, and 1 - 3.5 inches high. The chief species was *Cladonia alpestris*. Other prominent species were *C. rangiferina*, *C. arbuscula*, *Stereocaulon* spp., *Dactylina arctica*, *Alectoria* spp., *Cetraria islandica* and *C. nivalis*. *Alectoria* spp. and *C. nivalis* were more abundant on exposed spots than elsewhere. The lichens appeared to be suppressing the shrubs. The most abundant shrubs were *Vaccinium uliginosum* with cover of 1.5 and only 1-3 inches high, *Ledum decumbens* cover 1.0 and height 1-2 inches, *Empetrum nigrum* cover 1.3 and height 0.5 - 1.5 inches, *Cassiope tetragona* cover 1.1, *Loiseleuria procumbens* cover 1.1, and *Betula glandulosa* cover 0.0 and only 1-4 inches high. *Carex bigelowii* with cover of 1.1 was only 3 - 4.5 inches high. The total number of vascular species in the stand was 24.

Very little use has been made of this area by caribou. Only a few stragglers were seen in this vicinity. The range condition for winter use was rated Excellent; for spring or summer use Fair, because of the sparseness of the more desirable forage plants for these seasons."

"Stand 57

This Heath stand, rich in lichens, is located on the north and west slopes (10-30°) of a low hill, south of the Denali Highway, about 42 miles east of Cantwell, altitude 3150 feet, lat. 63°14', long. 147°47'. It is characteristic on well-drained ground of many slopes and ridges in this vicinity, in contrast to Stand 56 on solifluction slopes, and Stand 58 on more level, frost-mosaic sites. Analysis was made on Aug. 24, 1957.

The vegetation was apparently climax, or near climax, for the lichens appeared to be suppressing vascular plants. The chief vascular species were *Empetrum nigrum* 0.5 - 2 inches high, *Vaccinium vitis-idaea* 0.5 - 1 inch, *V. uliginosum* 0.5 - 4 inches, *Loiseleuria procumbens*, *Arctostaphylos alpina* 1-2 inches, and *Ledum decumbens* 1-3 inches. Clumps of *Betula glandulosa*, 6-24 inches high, were scattered. Decumbent *Salix arctica* was abundant around ground squirrel dens. *Carex bigelowii* was the chief herb, with cover of 0.9. The total number of vascular species was 16. The moss cover, 1.0, was less than usual.

The soil profile was as follows: 0-5 inches, dark brown organic layer with small amount of silt; 5-11 inches, dark brown sandy loam with interspersed pebbles and stones; 11-16 inches, dark brown sand with gravel particles and small stones; 16-25 inches, olive gray sand with much gravel and many stones, many large boulders

at 25 inches. Roots extremely numerous to numerous in the 0-5 inch layer, working depth at 9 inches. The pH varied from 4.6 at 0-5 inches to 6.6 in the bottom layer.

Lichens formed a cover of 5.8 and 1-4 inches thick. The chief species were *Cladonia alpestris*, v. ab., *C. rangiferina* ab., *C. arbuscula* ab., *Cetraria nivalis* ab., and *C. cucullata* ab. *Stereocaulon* sp. was abundant in a few spots. *Alectoria nigricans*, *A. ochroleuca* and *Cornicularia divergens* were usually abundant in disturbed spots, especially those caused by ground squirrels, and on frost boils.

Caribou have used this area little, if at all. The range condition rated Excellent winter use."

"Stand 62

This Heath stand, rich in lichens, was located on a gentle northerly slope of about 5° below some low hills, about 46.5 miles east of Cantwell on the north side of the road. The altitude was about 3100 feet, lat. 63°12', long. 147°39'. Analysis was made on Aug. 26, 1957. Mounds with firm surfaces were about a foot higher than the depressions which were wet and often contained water. Depressed frost boils were scattered. Frost action and solifluction were active.

In the soil profile the 0-2 inch horizon consisted of organic material with some silt; 2-12 inches, chiefly sand with some silt; 12-28 inches, dark brown sandy silt, active flow earth; a buried surface horizon at 24-25 inches. The soil profile was highly variable. A frost boil at one end of the trench had many stones on the surface, few below. Under the frost boil was gray silty sand. The working depth of roots was 16 inches.

The chief shrubs were *Empetrum nigrum* with cover of 1.6, *Loiseleuria procumbens* 1.5, *Ledum decumbens* 1.2 and 1-4 inches high, *Arctostaphylos alpina* 1.2, *Vaccinium vitis-idaea* 1.0, and *V. uliginosum* 0.9 and 2-6 inches high. *Betula glandulosa* was very sparse and usually only 4-6 inches high. The chief forbs were *Carex bigelowii* with cover of 1.0 and *Calamagrostis canadensis* 0.5. The total number of vascular species was 18.

Mosses had moderate cover, 2.0. Lichens were abundant, cover 5.7, and formed a mat about 2-4 inches thick. The chief species were *Cladonia alpestris* com. and v. ab., *C. rangiferina* com. and ab., *C. arbuscula* com. and ab., *Cetraria cucullata* com. and freq., *C. nivalis* inf., *C. richardsonii* sc., *Stereocaulon* sp. inf., and *Thamnolia vermicularis* sc.

The range condition was rated Excellent."

"Stand 59

This is located on a nearly flat bench, near a small lake and near Stands 56-58, 42 miles east of Cantwell, altitude 3100 feet, lat. 63°14', long. 147°47'. This low *Betula glandulosa-Vaccinium uliginosum* stand rich in lichens was very spongy because of the thick mat of vegetation, 4-6 inches deep in the depressions and about 2 inches on low mounds. The latter were 3-6 inches higher than the depressions, and 1-2 feet in diameter. *Betula glandulosa* was moderately abundant with average cover of 2.0. *Vaccinium uliginosum* was very abundant, cover 3.0. The following additional species contributed significantly to the cover; *Vaccinium vitis-idaea* 1.4, *Ledum decumbens* 1.1, *Empetrum nigrum* 1.0, *Carex bigelowii* 1.1, *Rubus chamaemorus* 0.6, and *Andromeda polifolia* 0.6, *Salix* spp. was scarce. The total number of vascular species in the stand was 15.

Mosses were abundant with average cover of 3.3. Lichens were very abundant, cover 5.0, and height 3-5 inches. The most common species were *Cladonia arbuscula*, ab.; *Cetraria cucullata*, ab.; *Cladonia rangiferina*, ab.; *C. alpestris*, inf.; *Cetraria nivalis*, on mounds, sc.; and *Dactylina arctica*, sc.

This stand had been used very little, if at all, by caribou. A few were seen in the vicinity. The range condition was rated Excellent. If not utilized the condition will probably become even better for *Cladonia alpestris* will very likely increase in abundance and in height."

"Stand 63

This stand is located on a north-facing slope of 5° or less on the south side of the Denali Highway, 40 miles east of Cantwell, altitude 3200 feet, lat. 63°15.5', long. 147° 49'. Analysis was made on Aug. 26, 1957. This is a polygon complex similar to Stands 27, 28 and 29, but with shorter shrubs and more sedge and grass in the borders. The centers vary from 6 x 15 to 30 x 45 feet, the borders are 6-8 feet wide. On somewhat steeper slopes the polygons become elongated parallel with the slope, apparently caused by solifluction, as in Stand 56. The borders were filled with a mass of living and decomposing moss, dwarf shrubs, and sedge, often higher than the firm centers with a dense cover of lichens and scattered sedges and dwarf heath shrubs. The centers have depressed active frost boils, 4-15 inches lower than the surrounding low tufts of lichens and heath plants.

The chief shrubs were *Betula glandulosa*, 4-12 inches high and 1.6 in cover; *Ledum decumbens*, 1-6 inches high, 1.8 in cover; *Vaccinium uliginosum*, 1.6 inches and 1.2; *V. vitis-idaea*, 1.8 inches cover; and *Empetrum nigrum*, 1.1 in cover. Other less abundant shrubs were *Arctostaphylos alpina*, *Cassiope tetragona*, *Loiseleuria procumbens*, *Diapensia lapponica*, and *Salix arctica*. *Salix pulchra*, 6-24 inches tall, was scarce. *Carex bigelowii* had a cover of 2.1, and *Calamagrostis canadensis* was rather sparse with cover of 0.7.

The site is exposed to the wind and frost action is occurring actively. In the soil profile the 0-2 inch horizon consisted of organic material, with little or no silt; 2-4 inches, sandy loam with some gravel and small stones; 4-11 inches, sandy silt, active flow earth; 11-20 inches, silty sand with gravel and stones, active flow material; 20-24 inches, dark brown loam, a former surface horizon. The pH was 6.0 at 2-4 inches, 5.6 at 4-11 inches, and 6.1 at 11-20 inches. Roots were numerous to 2 inches and the working depth was at 21 inches.

Mosses, cover only 1.5, and lichens, cover 5.0, formed a mat 1-3 inches thick over the surface except on stones and frost boils. The chief lichens were *Stereocaulon* sp., v. ab., *Cladonia alpestris* ab., *C. arbuscula* ab., *Alectoria ochroleuca* ab., *A. nigricans* ab., *Cladonia rangiferina* ab., *Cetraria richardsonii* sc., *C. nivalis* ab., *C. cucullata* freq. *Aulocomnium turgidum* was a common moss. While the kinds of species and cover of lichens were not equal to the best stand, they seem to be maximum, or climax, for the site. The range condition was rated Excellent.

Invaders on frost boils were *Rhacomitrium lanuginosum*, *Arctostaphylos alpina*, *Carex capillaris*, *Juncus biglumis*., *Diapensia lapponica obovata*, *Ledum decumbens*, *Loiseleuria procumbens*, *Calamagrostis canadensis*, and *Empetrum nigrum*."

"Stand 67

This was located about 33 miles east of Cantwell at an altitude of 2550 feet, Lat. 63°17', Long. 148°0'. Analysis was made on Aug. 28, 1957. The trees up to 60 feet tall and 12-15 inches d.b.h., in this white spruce stand were apparently very sparse before being burned over many years ago. A few snags were still standing and dead trunks and branches were scattered over the ground. This stand was on a slope, varying from nearly flat to about 10-15°, facing west and northwest. Living white spruce were 1-20 feet tall and widely scattered. The chief species forming the cover were *Vaccinium uliginosum* about 1 foot high, *V. vitis-idaea*, and *Betula glandulosa* 1-8 feet tall in open to dense aggregations. Other prominent

species were *Ledum decumbens*, *Empetrum nigrum*, *Calamagrostis canadensis*, and *Epilobium angustifolium*. The total number of vascular species was 22.

The organic layer was about 6 inches thick containing charred wood in the surface inch. A layer of loam and below it sandy loam made up the profile to a depth of 18.5 inches. Gravel and stones were numerous throughout. The pH varied from 4.2 at 4-6 inches to 5.7 at 10 - 18.5 inches. Roots were very numerous to 6 inches and the working depth was at 15 inches.

Mosses were very abundant, cover, 5.5. The lichens moderately abundant, cover 2.2, have not recovered from fire. The range condition was poor. The chief kinds of lichens were *Cladonia* spp. similar to *C. pleurota*. Less abundant were *Stereocaulon* sp., *Nephroma arcticum*, *Peltigera aphthosa*, *Cetraria cucullata*, *Cladonia amaurocraea*, and *C. arbuscula*. The lichens, especially the last three, appeared to be increasing rapidly in cover and height. The large amount of organic matter in the soil and the good cover of moss appear to be favorable for a rapid rate of succession."

Skoog (1968) described the vegetation in Unit 2 in the following terms: "Spruce occupies nearly 1/4 of the area, but the stands are open and sparsely timbered. Shrub birch is abundant in all the spruce stands and is the dominant type over another 1/4 of the area. Meadow, Willow, Fescue grass, and Water Sedge are important types, also. Bog is more abundant than what is indicated in Table 10 because the transects fell outside the main areas supporting this vegetation type. The *Cladonia* forage lichens are abundant throughout, even in the Bog type and of excellent growth, generally (i.e., 4-6 inches high). Only the Meadow and Water Sedge are without these lichens and some portions of the Spruce. Abundant winter forage is available for caribou use."

There are 4 Range Stations located in the Monahan Flat; these are Numbers 23, 24, 25 and 35.

Range Station 23: Mile 94.4 Denali Highway, Bog Type

The exclosure is south of the Denali Highway about 300 yards at an elevation of about 3,000 feet with a relatively gentle slope. It was established in 1960 and read in 1962. At the time of the initial reading, Skoog described the Station as having 100 percent cover of mosses, primarily *Sphagnum*. Narrow leaved Labrador tea and blueberry were abundant with cranberry *Oxycoccus microcarpus*, and cloudberry being common as well. *Carex*, (*C. podocarpa*?), occurred throughout. The lichen cover was only 15 to 25 percent but of good growth, 3 to 6 inches in height. The

main species were *Cladonia rangiferina*, *C. gracilis*, *C. amaurocraea* and *Cetraria cucullata*. There was little evidence of caribou use which he felt was strange because caribou had been wintering in the vicinity. There was a possibility that it lies in an area of deep snow. The stand was poorly drained, being situated in a low basin. The moss mat was very thick. It is typical bog type where the *Sphagnum* mat is quite thick. The readings of 1962 and 1970 are presented in Table 11. There has been very little change in the shrub species, although cloudberry did seem to be more prevalent, particularly inside the exclosure. This exclosure still is in a depression adjacent to a creek and is probably more moist than the surrounding area outside. Cloudberry was apparently stimulated by the increased bog conditions. Inside the exclosure there has been a reduction of lichens, and it appears that the increase of the cloudberry has lead to this decrease. A very striking reduction of *Cetraria cucullata*, as well as the other lichens, has occurred outside in Quadrat B1. For the exclosures as a whole, lichen cover both inside and outside is decreasing. This is very likely due to changing moisture conditions and some use by caribou. There were few available lichens in this type and the indicated decrease cannot be attributed to caribou use, as there has been a decrease of lichens inside the exclosure as well.

Range Station 24: Mile 100 Denali Highway, Spruce Type

The exclosure is about 160 yards north of the Denali Highway, at an elevation of 2,700 feet, on a gentle slope. The white spruce stand is moderately dense. Trees are 15 to 40 feet high with a d.b.h. of 5 to 14 inches. In 1962 there was a moderately heavy undercover of shrub birch, 3 to 5 feet high. Narrow-leaved Labrador tea and crowberry were abundant with a heavy carpet of mosses; sedges were common. The site was well drained, but there were interspersed boggy areas. Lichens were common, covering about 60 percent of the ground, but they were discontinuous in distribution. Excellent clumps of *Cladonia alpestris* and *C. rangiferina*, 3 to 5 inches tall, were present. *C. gracilis*, *C. uncialis*, *Cetraria islandica* and *Stereocaulon* spp. were common. For the most part, the lichen mat was undisturbed in 1962, but there was some evidence of use by caribou at that time. Alexander indicated in 1967 that caribou had entered the north side of the exclosure, but that there was very little damage to the lichen cover. Table 12 shows the vegetation reading in 1962, when the quadrats were established and a subsequent reading in 1970. Throughout the plot, there has been a decrease in shrub birch, with most of the remaining shrubs being fairly stable over the 8-year period. Lichen growth inside the exclosure showed little change since 1962, based on either the photographs or Hult-Sernander scale.

Lichens inside of the exclosure continue to remain in excellent condition, as indicated by Skoog (1968). It appeared that caribou had used this area only slightly up until the early 1960s, because lichens are showing good recovery in several old game trails. *Cladonia alpestris* has reached the climax condition inside of the exclosure.

Lichens inside of the exclosure were much more luxuriant and robust than those outside. A considerable amount of use outside appears to be

Table 11. Station 23: Mile 94.4, Denali Highway, bog type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6	6	6	6	6	6	6	6
Betula glandulosa	1/12[c]	2/15	2/10	3/7	1/10	2/16	1/8	1/6
Ledum decumbens	2/5	4/6	4/4	5/5	3/4	3/4	2/4	3/4
Vaccinium uliginosum	5/6	5/4	5/6	3/6	3/4	1/4	–	–
V. vitis-idaea	2	2	3	2	3	4	2	3
Empetrum nigrum	1	1	1	1	–	–	–	–
Spiraea beauverdiana	–	1/7	–	–	–	–	–	–
Oxycoccus microcarpus	1	1	1	–	1	–	1	–
Rubus chamaemorus	3	4	4	6	3	5	4	4
Andromeda polifolia	–	–	–	–	–	–	1	–
Pedicularis labradorica	–	1	–	–	–[d]	–	–	–
Carex	1	2	3	4	t	1	3	4
Lichens	3/2	2/2	4/3	1/1	5/4	4/3	4/3	2/2
Cladonia rangiferina	–	–	–	–	3/4	3/3	t	1/2
C. arbuscula	–	–	t	–	–	–	–	–
C. gracilis	1/2	–	2/3	–	1/3	1/3	3/3	1/2
C. amaurocraea	1/2	–	2/2	–	t	–	t	1/2
Cetraria islandica	t	–	t	–	1/2	1/3	t	1/2
C. cucullata	1/2	–	2/3	1/1	3/3	1/3	2/3	1/2
C. richardsonii	–	–	1/3	–	–	–	–	–
Dactylina arctica	1/2	1/2	1/2	1/1	–	–	–	–
Peltigera pulverulenta	–	2	–	–	t	1	1	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Table 12: Station 24: Mile 100, Denali Highway, white spruce type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6	6	6	6	6	6	6	6
Picea glauca	–	–	1/12	1/16	–	–	–	–
Betula glandulosa	1/36[c]	dead	3/48	2/40	2/36	2/18	5/60	4/62
Vaccinium uliginosum	–	–	1/10	2/12	1/4	1/3	–	–
V. vitis-idaea	1	1	2	2	1	1	2	2
Ledum decumbens	4/10	4/12	3/10	3/5	2/10	2/8	4/8	4/7
Empetrum nigrum	2	2	4	2	2	3	4	4
Cornus canadensis	–	1	1	1	–	–	t	–
Rubus chamaemorus	–	–	t	–	–	–	–	–
Carex	1	1	2	1	2	2	3	3
Lichens	6/3	6/4	5/3	6/3	6/3	5/3	5/3	4/3
Cladonia alpestris	3/3	3/3	1/3	1/3	2/3	2/3	–	1/3
C. rangiferina	2/3	2/4	4/3	4/3	3/3	3/3	3/3	2/3
C. arbuscula	1/3	1/4	1/3	1/3	2/3	1/3	3/3	2/3
C. crispata	–	1/3	–	–	–	–	–	–
C. gracilis	2/3	1/3	1/3	–	2/3	1/2	1/3	1/3
C. cornuta	–	1/3	–	–	–	–	–	–
C. uncialis	–	–	–	–	–	1/2	–	–
C. gonecha	t[d]	1/2	–	–	–	–	–	1/2
Cetraria islandica	2/3	2/4	t	1/3	1/3	1/3	1/3	1/2
C. richardsonii	1/4	1/4	1/3	–	2/3	2/3	–	–
Stereocaulon paschale	1/2	1/3	1/2	2/3	1/2	2/3	–	1/3
Peltigera pulverulenta	2	1	2	3	2	3	1	–
Nephroma arcticum	4	4	–	–	2	2	–	–

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

from both grazing and trampling. It is very likely that trampling by moose and caribou has led to a large amount of the deterioration outside. The site is near several large shrub birch bushes which tend to channel movements of the animals through the open areas and it is on these sites that the lichen cover has been severely disrupted. This use has evidently occurred since 1967, as Alexander did not note a difference in 1967. Robust lichens occur in scattered locations outside the exclosure, particularly underneath large shrubs in protected sites, as exemplified by Quadrat B2. Quadrat B1 is more exposed to grazing and the movements of animals and shows a deterioration of the lichen cover and shrubs. Within there are numerous broken branches of shrub birch lying about. There are still large amounts of lichen forage outside of the exclosure, mostly in protected areas. This exclosure amply demonstrates the effect of fencing off an area to the movement of large animals (both moose and caribou), as it is apparent that in the area where the animals move the lichen cover has been disrupted the most. There has been considerable grazing of the lichens, especially *Cladonia alpestris*, as there are large amounts of the gray, lower portions of the podetia, which remain scattered throughout the outside area.

Range Station 25: Mile 108 Denali Highway, Spruce Type

The exclosure lies 90 yards south of the Denali Highway at an elevation of 2,500 feet, on a level slope. It is located in a white spruce stand with a heavy shrub birch understory. The birch is dense and 5 to 6 feet tall. The exclosure was constructed in 1960 and the initial reading of the vegetation was conducted in 1962. Spruce 20 to 30 feet high were common in 1962 and 1970. The site appeared to have been burned, possibly 20 to 30 years before 1962, with an additional ground fire within 15 to 20 years, according to Skoog's notes. Blueberry and cranberry occur throughout, with crowberry and narrow-leaved Labrador tea more sporadic in distribution. In 1962 *Festuca altaica* appeared to be invading open areas. The entire stand was well drained. Lichens appeared to be recovering from the fires and were fairly abundant, covering about 75 percent of the ground and being 2 to 4 inches tall. Several species were present in 1962. There was only slight evidence of caribou use, which had probably occurred in the winter of 1961-62. The shrub birch cover was so dense that there was probably little winter use of the area due to heavy accumulation of snow. In a later examination Alexander (1967) noted a difference in the lichen cover. The principal difference in the readings from 1962 to 1970 (Table 13) was the decrease in shrub birch cover. There was a moderate decrease inside the exclosure, as well as the greater decrease outside. The other shrubs remained fairly stable. The photographs show lichen growth inside the exclosure to be very good, still consisting of several species. These are principally secondary lichens, such as *Cladonia gracilis*, *C. cornuta*, *Cetraria islandica* and *Stereocaulon paschale*, rather than the preferred fruticose type such as *Cladonia rangiferina*, *C. alpestris* and *C. arbuscula*. Both quadrats B1 and B2, outside of the exclosure, lie adjacent to heavy stands of shrub birch and there is very little use of the lichens in these protected sites. Therefore, lichen growth in the control quadrats appears very similar to growth inside of the exclosure. Station 25 is

Table 13. Station 25: Mile 108, Denali Highway, spruce type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	5	5	5	6	4	5	5	5
Picea glauca	-	-	-	-	-	-	2/36	2/72
Betula glandulosa	5/48	4/56	6/60	5/72	6/48	4/48	4/48	1/54
Vaccinium uliginosum	4/8	4/6	1/8	2/6	4/10	4/8	4/10	3/7
V. vitis-idaea	1	1	2	2	3	4	2	1
Ledum decumbens	-	-	3/12	4/9	2/10	3/10	1/4	-
Empetrum nigrum	-	-	3	3	-	-	3	2
Salix pulchra	-[d]	-	3/48	3/38	-	-	-	-
Cornus canadensis	t	1	1	1	t	1	1	1
Lycopodium selago	-	-	-	-	-	-	1	2
Festuca altaica	t	1	t	2	-	-	-	-
Lichens	6/2	6/3	5/3	4/3	4/3	5/3	5/2	5/3
Cladonia alpestris	1/2	2/3	-	1/2	-	-	-	1/2
C. rangiferina	3/2	3/3	1/2	1/3	1/3	1/3	1/2	1/3
C. arbuscula	2/2	2/3	1/2	1/3	t	1/3	2/2	2/3
C. gracilis	3/2	1/3	3/3	1/3	3/3	4/3	2/3	2/3
C. uncialis	2/2	1/3	-	-	t	1/2	2/2	1/2
C. cornuta	-	-	-	2/2	-	1/2	-	1/2
C. deformis	-	-	1/2	1/2	1/2	1/2	1/2	1/2
Cetraria islandica	2/2	2/2	1/3	1/3	-	1/2	1/2	1/3
C. cucullata	1/2	1/3	-	-	t	1/2	-	-
C. richardsonii	t	1/3	-	-	-	-	t	-
Stereocaulon paschale	2/2	2/2	1/2	1/3	1/2	2/3	1/2	2/3
Thamnolia vermicularis	t	-	-	-	t	-	t	-
Peltigera aphthosa	1	-	2	3	1	1	1	2
P. malacea	2	-	2	2	-	2	2	3
Nephroma arcticum	1	-	-	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

quite similar to No. 24. Within the exclosure, the lichens are generally quite luxuriant, vigorous and upright, mostly 3 to 4 inches in length. Outside on the more open sites, the lichens have been disrupted and trampled, yet there are several protected areas, such as in Quadrats B1 and B2 in which lichen growth was very good. They are principally secondary species and reflect the recent occurrence of ground fire which, according to Skoog (1968), occurred 25 to 30 years ago. Shrub birch outside of the exclosure appeared partially dead, reflecting increased use of the stand by caribou and moose. Much of the disturbance to the lichen mat outside of the exclosure can be attributed to movements of moose.

Range Station 35: Monahan Lake, Meadow Type

This station is at the eastern end of Monahan Lake, at 2,600 feet, on a level plain. It was constructed in 1960 and its vegetation examined in 1961. In 1967 Alexander stated that the east side had been broken down but there was no indication that caribou entered the exclosure. In 1970 the exclosure was totally destroyed. All four sides had been knocked down and it appeared that animals became entangled in the wire so that the vegetation was thoroughly destroyed by trampling. This damage was most likely caused by a moose. The readings from 1961 are presented (Table 14) as this was one of the few stations in the meadow type. Skoog indicated that the station was in a transition zone between a sedge-*Sphagnum* complex and a shrub birch type. The former contained many species of forbs and sedges while the latter contained relatively few. Forage lichens were most abundant in the birch type but the lichen cover only rated about 4, although growth was good, 3 to 6 inches tall. The sedge-*Sphagnum* complex was meadow-like and quite wet.

The transition zone indicated a stage in succession from a moist site on which the sedges and *Sphagnum* were being replaced by other mosses, lichens, heaths and shrub birch as the site became drier. In 1962 Skoog stated that lichens of Group I, mostly *C. rangiferina*, and Group II, mostly *C. gracilis*, were common and of excellent growth. Some of the *C. rangiferina* measured up to 8 inches, but they were not abundant, the cover being 4 or less. The area has been minimally used by caribou and the lichens have been disturbed in only a few scattered locations. In 1970, use of the area was noticeable. There were several instances of scattered, disrupted lichen stands. However, accurate determinations could not be made, since the exclosure itself had been destroyed. Skoog (1968) states that:

> "In spite of the forage abundance, caribou generally avoid Monahan Flat as a wintering area (probably because of the snow depth), although sporadic use occurs in some winters by various numbers of animals. During the winters of 1960-61, when the snow level even at Summit failed to reach 20 inches, the caribou were present on the Flat in large numbers reaching about 15,000 animals for several weeks in January. As a whole this unit can be classed as an important winter range for caribou,

Table 14. Station 35: Monahan Lake, Transition type between shrub birch and sedge meadow. Readings of 8/3/61.

Quadrat[a]	A1	A2	B1	B2
Total Cover	100[b]	100	100	100
Moss	6[b]	6	6	6
Betula glandulosa	1/10[c]	3/14	3/18	3/12
Salix reticulata	2[c]	1	-	-
Salix spp.	t[d]	-	-	t
Vaccinium uliginosum	3/6	4/8	3/8	4/6
V. vitis-idaea	t	t	1	t
Ledum decumbens	2/5	3	3/8	4/5
Empetrum nigrum	3	3	2	2
Oxycoccus microcarpus	1	1	t	2
Rubus chamaemorus	t	t	-	-
Petasites frigidus	1	t	-	-
Equisetum arvense	t	1	-	-
Carex spp.	4	3	3	1
Lichens	4/2	5/3	4/2	2
Cladonia alpestris	t	2/3	t	-
C. rangiferina	2/3	3/4	2/3	-
C. arbuscula	2/3	1/3	t	t
C. uncialis	-	1/3	2/2	t
Cetraria islandica	1/3	1/3	1/2	-
Stereocaulon spp.	1/2	1/2	2/2	-
Peltigera spp.	-	1	t	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

at least during periods when the snow level has not reached the restricting depth."

The use described by Skoog has remained similar, with only scattered numbers of caribou occurring each winter. However, it is apparent from the exclosure studies, particularly Stations 24 and 25, that there has been a marked reduction of the lichen cover in the last 8 to 10 years. At Station 24 this reduction has occurred in the last 3 years. The use that is being made of the area is restricted to certain sites, generally the more open areas in the shrub birch stands.

Skoog (1959) described the Monahan Flat as being composed primarily of vegetation that has advanced or is advancing from a marsh and bog condition. Excellent lichen growth covered most of the area at that time and was composed primarily of Group I and Group II lichens, 2 to 4 inches in height. He considered it to be in a stage IIIb with regard to lichens. At that time less than 1 percent of the ground showed evidence of disturbance by caribou. He considered it to be progressing to a climax stage at that time. Range use in the winter of 1960-61, by ten to fifteen thousand animals, was restricted primarily to the meadow, shrub birch, and bog types. The animals were scattered thinly over the area so that even with the large number of animals the total use of the Unit was relatively light. Lichens and sedges appeared to be the primary types of plants grazed. Because of the sporadic use and generally small number of animals that have wintered in this unit, the resultant rapid rate of range deterioration indicates that a major part of the destruction was caused by the movement of the animals through the area. This is particularly evident along the southern portion of the unit. In all descriptions by both Hanson and Skoog, prior to the 1960s, lichen condition was excellent, particularly along the southern part of the Unit. All of Hanson's heath stands were considered to be in excellent condition and were usually climax stands of *Cladonia alpestris*, showing almost no use. In Stand 59, which is in a shrub birch type, the mosses and lichens were abundant, 3 to 5 inches in length, primarily *Cladonia arbuscula*, *Cetraria cucullata* and *Cladonia rangiferina*, and he felt that there would be an increase in *Cladonia alpestris*. In Stand 67, a spruce stand which had burned several years ago, the lichens had only started recovery. This was the only stand that Skoog considered to be in poor condition.

The stations in this unit reflect the extent to which lichens can be damaged, particularly the more palatable forms, by relatively small numbers of caribou over a few years. Unfortunately, there is not reliable information on use prior to 1950 because by the late 1950s, this unit would have been considered to be in excellent range condition. Now there appear to be several places where the condition has deteriorated markedly.

Unit #3 - Clearwater Mountains

This unit, as described by Skoog (1959):

"...encompasses the mountainous terrain lying in the northcentral portion of the range, immediately east

of Unit 2. The area is bounded on the west by the east and north boundaries of Unit 2; on the south and the east by the 4,000 foot (approximately) contour level running from Valdez Creek south, east, northeast, and north to the foot of Black Rapids Glacier and on the north by a line running up the latter glacier and across the upper portions of Susitna and West Fork glaciers to the Nenana Glacier."

There are 1,430 square miles in the unit, which amounts to 8.2 percent of the Nelchina range. Forty-two percent of the unit lies above 5,000 feet. Elevation ranges from 2,800 feet on the Susitna River to 8,000 feet in the mountains. Snowfall is heavy throughout the area and the snow remains late in the spring. However, there are high winds and most areas above 5,000 feet are normally blown free of snow. Table 15 shows the composition of vegetation types, as determined from the aerial surveys, and reveals that heath is the principal vegetation type followed by meadow, shrub birch and willow. Up to 50 percent of the unit is unproductive, consisting of water, bare ground and glaciers. There has been very little on-the-ground examination of the vegetation in this unit. Skoog (1968) reported that forage lichens are abundant in the heath and shrub birch types. He also stated that caribou rarely enter the Clearwater Mountains during the winter. There is sporadic use during the summer, fall, and early winter. However, he felt that there was excellent summer range in the southern half, although the use by caribou still remains almost negligible.

Unit #4 - Chulitna Mountains

This unit is in the northwest corner of the range, south of Unit #1. The Alaska Railroad is the western boundary; the southern boundary starts at Chulitna, bears due east to Portage Creek, and continues up that creek and then easterly, excluding the drainages of Devil Creek, but including that of Clark Creek, to Tsusena Creek. The eastern boundary continues north from that point along the divide between the drainages of the Tsusena and Deadman creeks, and between those of Soule and Brushkana creeks to the head of the East Fork of Jack River. The northern boundary adjoins the southern one of Unit #1. The unit encompasses 870 square miles or 5 percent of the total Nelchina Range. Elevation ranges from 1,400 to 6,600 feet. Within the unit 44 percent lies above 4,000 feet and only 26 percent below 3,000 feet. Snow conditions are similar to Unit #3. Up to 1/4 of the unit is non-vegetated (Table 16), the remainder is primarily heath, meadow and shrub birch.

Skoog (1959) reported that lichen growth in the Jack River and Soule Creek areas was good to excellent with *Cladonia alpestris* and *C. rangiferina* of 3 to 5 inches being dominant. He also stated that aerial surveys indicate most of the valleys of the unit contain similar luxuriant lichen stands. The only range studies conducted in the unit have been aerial surveys of vegetation types and examination of two exclosures.

Table 15. Percent composition by vegetation types in Unit #3.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	0.9
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	6.5
6. Fescue Grass (*Festuca*)	1.9
7. Heath	23.2
8. Meadow (Sedge-Grass-Forb)	11.1
9. Water Sedge (*Carex aquatilis*)	-
10. Spruce	0.6
11. White Birch	-
12. Willow	5.5
13. Glacier	20.6
14. Bare Ground	28.6
15. Water	1.1

Table 16. Percent composition by vegetation types in Unit #4.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	5.9
2. Aspen-Poplar	0.7
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass (*Calamagrostis*)	0.1
5. Shrub Birch	9.3
6. Fescue Grass (*Festuca*)	0.9
7. Heath	32.9
8. Meadow (Sedge-Grass-Forb)	13.4
9. Water Sedge (*Carex aquatilis*)	0.4
10. Spruce	4.8
11. White Birch	-
12. Willow	5.9
13. Glacier	0.4
14. Bare Ground	23.6
15. Water	1.7

Range Station 33: Soule Lake, Heath Type

Station 33 lies about 100 yards south of Soule Lake at an elevation of 3,600 feet, on a gentle slope. It is in a heath type composed primarily of *Cassiope tetragona*, crowberry, blueberry, *Dryas octopetala* and cranberry. In 1961 the vegetation was described as being made up of heaths that were all decumbent and usually less than 6 inches tall. There were numerous small tussocks of *Festuca altaica*, *Hierochloe alpina*, *Carex* spp. and mosses. The mosses were not common; their cover was probably less than 25 percent. The area was well drained. Lichens were abundant with an average cover of more than 75 percent; growth was good, over 2 inches tall. Groups I and II were the dominants. At that time caribou use had not been great and the lichen mat was relatively undisturbed in the valley bottom, except for deep migration trails through the area. Large quantities of forage lichens were available. By 1970, the lichens were severely damaged. Of particular note was that *Cladonia alpestris* in both Quadrats B1 and B2 in 1961, rated a 5 by the Hult-Sernander scale, and was totally absent in 1970 (Table 17). Tracks and caribou pellets were very common throughout the area and numerous small frost boils were exposed. Evidently, as the vegetative mat was disrupted, the soil became more susceptible to frost action. The uneven nature of the vegetative cover probably speeded up the destruction of the cover. Whenever caribou step on the side of a grass or sedge tussock they tend to cut into the tussock or the ground with their hooves, as opposed to stepping on level ground where their weight is distributed more evenly. Both Glenn (1967) and Alexander (1967) noted that in 1966 and 1967, the lichen growth was noticeably better inside the exclosure than outside. Table 17 and the photos show the marked reduction of lichens outside the exclosure. It is almost certain that this is entirely due to trampling by large numbers of caribou in the area during snow-free periods. It is interesting to note that Skoog (1959) reported well-defined migration trails in the area. These are no longer obvious as the concentration of caribou that moved through in 1966 disrupted the entire area. Photos of Quadrats B1 and B2 show the large amount of bare ground which usually occurs on the sides of grass and sedge tussocks.

A view of this area instills an appreciation of the potential of caribou to affect their habitat by trampling. This location is undoubtedly an unusual case, but several of the other stations, notably in Units 1 and 2, reflect this effect, but to a lesser magnitude, which probably approximates more closely the normal. In view of Skoog's (1968) study of winter utilization where only .7 percent to 8 percent of an area was found to be grazed before caribou move on to new areas, and similar studies of reindeer in the Soviet Union by Makhaeva (1963) and in Sweden by Skuncke (1969), it is apparent that the lichens destroyed by trampling may exceed the damage caused by grazing.

Caribou movements during snow-free periods may have the greatest effect on habitat. A measurement of the effect of reindeer grazing and trampling on lichens during the summer is reported by Pegau (1970a). A group of 500 reindeer passed once over a previously ungrazed meadow type in which lichens composed 30 percent of the vegetation. Approximately 27 percent of the lichens were dislodged, and 8 percent were broken into

Table 17. Station 33: Soule Lake, heath type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	99	100	97	95	100	60	99	50
Moss	2[b]	4	1	3	3	1	2	1
Cassiope tetragona	2	3	t	-	t	1	1	-
Empetrum nigrum	1	2	-	-	1	1	2	3
Salix arctica	t[d]	1	t	1	t	1	t	1
Vaccinium uliginosum	t	1/1[c]	1/1	2/1	1/1	-	1/1	-
V. vitis-idaea	t	-	t	-	t	1	t	1
Dryas octopetala	2	2	2	2	3	3	1	2
Diapersia lapponica	1	1	1	1	-	-	1	-
Loiseleuria procumbens	2	1	-	4	-	-	-	-
Antennaria spp.	t	-	t	-	t	1	t	-
Pedicularis labradorica	t	-	t	1	t	1	t	-
Lycopodium alpinum	-	-	t	-	t	-	t	-
Artemisia arctica	1	-	t	-	t	-	1	-
Anemone narcissiflora	t	2	t	1	t	1	t	1
Festuca altaica	2	3	1	-	2	2	2	2
Hierochloe alpina	t	2	t	2	t	2	t	3
Carex	t	1	t	1	t	2	-	3
Lichens	6/2	6/2	6/1	5/1	6/2	3/1	6/2	2/1
Cladonia alpestris	5/2	4/2	2/2	4/2	5/2	-	5/2	-
C. rangiferina	1/2	2/2	t	1/1	t	1/1	t	1/1
C. arbuscula	1/2	-	1/1	-	1/2	1/1	t	-
C. uncialis	t	1/1	1/1	1/1	1/2	1/1	1/2	1/1
C. gracilis	1/2	2/2	t	1/1	2/2	-	2/2	-
Cetraria islandica	1/2	2/2	1/1	2/2	2/2	1/1	2/1	1/1
C. nivalis	1/2	1/1	2/1	2/1	1/1	-	-	-
C. nigricans	-	-	-	2/1	-	-	-	-
C. richardsonii	t	1/2	t	1/1	-	-	-	1/1
Stereocaulon paschale	-	-	t	-	t	-	t	-
Dactylina arctica	t	1	t	-	t	-	t	-
Thamnolia vermicularis	1/1	1/1	1/1	-	1/1	-	t	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

segments less than 1/2 inch long during dry weather conditions when the lichens were particularly brittle. Almost all of the damage was done by trampling as dry, brittle lichens are not palatable to reindeer.

Station 34: Jack River Lake, Shrub Birch Type

Station 34 is located about 85 yards from the eastern shore of Jack River Lake at an elevation of 3,400 feet on a west facing slope of 3°. Skoog described the vegetation in 1961 as being complex, with four major types in close juxtaposition: shrub birch, heath, meadow and willow. As a result, plant species not normally found in a particular type occur where not expected. The shrub birch is most often found on slightly elevated sites. Heath occurs on open, gentle slopes, meadows in poorly drained sites and willow along the numerous drainages. The Station occurs in shrub birch type. The shrub birch is rather dense with a heavy moss undercover. Relatively few vascular species are present. The lichens are more diverse, usually in excellent condition (2 to 5 inches, 30 percent cover). There was very little disturbance of the lichen mat when the exclosure was established in 1961. Table 18 shows the vegetation readings in 1961 and 1970. There was little change in either the vascular or lichen species inside or outside the exclosure. One difference noted was that Quadrat A2 is located so that its eastern 1/3 is on an old game trail; recovery of the lichens was noticeably more advanced than outside the exclosure.

Lichens in open areas within the heath type showed much more evidence of use than at the exclosure, or at Plot B which is in a dense stand of shrub birch. Snow cover would be much heavier in the shrub birch stand than the heath areas. Also, caribou usually travel in open areas rather than through dense brush in the summer. Therefore, lichens in the heath type are subjected more to damage from trampling and grazing.

The station at Soule Lake shows the effects of large scale caribou movements in restricted areas more dramatically than any vegetation station on the Nelchina range. Shortly after the exclosure was constructed, caribou started using the Soule Creek Pass in increasing numbers. The summer movements of caribou in 1966 were unusual in that the calving segment and bull and yearling segments of the population joined near Deadman Lake and remained together most of the summer (Glenn, 1967). Glenn stated that on July 7, 1966 he saw almost the entire Nelchina caribou herd in the vicinity of the exclosure at Soule Lake. The destruction of habitat was remarkable, appearing as if most of the area had been plowed or spaded. The Soule Creek area is a very narrow pass, mostly less than 1/2 mile wide and bordered by very steep mountains. Therefore, caribou tend to concentrate through the small restricted area.

Skoog (1968) described snow conditions as being such as to exclude most large herbivores from the southern 3/4 of the Unit. Caribou winter activity has been restricted largely to the northern portion, although in the summer the animals can be found throughout. He felt that there was excellent summer range for the caribou and in the northern portion limited good winter range. Use has continued to be primarily during early winter, with some animals found throughout the late summer and

Table 18. Station 34: Jack Lake, shrub birch type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6	6	4	5	5	5	5	5
Betula glandulosa	5/24[c]	5/24	1/36	1/30	4/15	4/18	6/36	6/36
Vaccinium uliginosum	-	1/4	3/8	4/10	-	-	-	1/4
V. vitis-idaea	1	1	1	1	2	2	t[d]	-
Empetrum nigrum	-	-	1	2	-	-	-	-
Salix spp.	-	-	-	-	t	-	-	-
Cornus canadensis	1	1	t	2	-	1	-	-
Hierochloe alpina	1	1	t	1	1	2	1	1
Carex	-	1	-	1	-	1	-	2
Lichens	4/3	4/2	6/3	5/2	6/2	5/2	6/3	6/3
Cladonia alpestris	1/3	1/2	t	2/1	2/2	-	-	1/1
C. rangiferina	1/3	2/2	2/1	3/2	2/2	3/2	4/3	4/3
C. arbuscula	2/3	2/2	3/1	2/2	3/2	3/2	4/3	2/2
C. uncialis	1/2	-	t	1/2	2/2	2/2	1/2	-
C. amaurocraea	-	2/2	-	1/1	-	1/1	-	1/1
C. gracilis	1/3	-	1/2	1/2	1/2	1/2	2/3	2/3
C. deformis	-	-	-	-	t	-	t	1/1
Cetraria islandica	1/3	1/2	1/2	1/2	1/2	-	1/2	1/2
C. nivalis	-	-	-	-	t	-	-	-
C. cucullata	t	1/2	t	-	1/2	1/2	t	1/2
C. richardsonii	-	-	3/4	3/3	1/3	1/3	-	-
Stereocaulon paschale	-	-	2/1	2/3	2/2	2/3	-	-
Peltigera malacea	-	-	2	2	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

early fall in this range unit. There are scattered localized areas of very severely damaged vegetation, as represented by Station 33 and some use throughout the heath type. It appears that, in combination, the deep snow cover of the southern portion and the disruption of the lichen cover in the northern portion, the total available lichen forage is very low during winter. It remains a good summer range; however, it is during the summer when the greatest damage to the vegetative cover occurs.

Unit #5 - Deadman Lake

This unit lies adjacent to the right bank of the Upper Susitna River in the northwest corner of the Nelchina range. It is bounded on the west by Unit 4, on the south and east by timberline and on the north by Unit 2. It includes 1,350 square miles, which is 7.7 percent of the Nelchina range. The elevation of this unit ranges from 2,400 to 5,800 feet in the mountains. About 58 percent of the unit lies between 3,000 and 5,000 feet. Skoog (1968) considered Unit 5 one of the most important range units in the ecology of Nelchina caribou in terms of year-round use. The animals are found here throughout the year, but it serves principally as summer, fall, and early winter range. Snowfall is of moderate depth, relatively level, rarely exceeding 25 inches, according to Skoog (1968). The principal vegetation types in the unit are almost equal amounts of heath and shrub birch, followed by meadow, willow, fescue grass, and spruce. Less than 5 percent is nonproductive areas (Table 19).

Ground examinations indicated that lichen growth had been good to excellent in the past, but has recently deteriorated, probably due to excessive use by caribou (Skoog, 1959). The preferred lichens, such as *Cladonia alpestris*, *C. rangiferina* and *C. arbuscula* were in poor condition and being replaced by secondary types such as *Cladonia uncialis*, *C. gracilis*, *Cetraria cucullata* and *C. nivalis*. There were isolated patches of good lichen growth. Three exclosures are located in this unit.

Range Station 15: Big Lake, Heath Type

Station #15 was constructed and the original vegetation reading made in September 1956. It is located at the north end of Big Lake which is adjacent to Deadman Lake. It lies about 150 yards east of the lake at an elevation of 3,200 feet. In 1956 the vegetation was described as predominantly fruticose lichens, blueberry, mosses and sedges. The surrounding area was all above timberline and contained similar vegetation. Willow and shrub birch thickets occurred throughout with mesophytic plants occurring in poorly-drained areas. Lichens were plentiful throughout the region.

Hanson (1958) examined the vegetation in and around Station 15 and described the stand as a:

> "*Betula glandulosa*-Heath stand rich in lichens which has numerous small hummocks, consisting mostly of moss and peat, 2-8 inches high to 12 inches across. They were from a foot to several feet apart and the

Table 19. Percent composition by vegetation types in Unit #5.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	1.9
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	26.4
6. Fescue Grass (*Festuca*)	7.0
7. Heath	26.8
8. Meadow (Sedge-Grass-Forb)	18.6
9. Water Sedge (*Carex aquatilis*)	1.1
10. Spruce	5.1
11. White Birch	-
12. Willow	8.6
13. Glacier	-
14. Bare Ground	3.2
15. Water	1.3

ground between was fairly firm, probably caused in part at least, by caribou trampling during the past two winters.

The chief shrubs were *Betula glandulosa*, 2-10 inches high, moderately abundant; *Vaccinium uliginosum*, 1-4 inches high, abundant; *V. vitis-idaea*, 0.5-1 inch, freq.; *Empetrum nigrum* 0.5-1 inch; moderately abundant; *Ledum decumbens*, 1-2 inches, moderately abundant; *Arctostaphylos alpina* infrequent; *Salix pulchra*, 4-9 inches, infrequent. Sparsely distributed shrubs were *Salix reticulata*, *Diapensia lapponica obovata*, *Andromeda polifolia*, *Cassiope tetragona*, and *Loiseleuria procumbens*. The chief herbs were *Polygonum bistorta plumosum*, average cover 1.1; *Hierochloe alpina* 0.5, and *Pedicularis capitata*. The total number of species in the stand was 19. The concentration of caribou has been heavy in this stand during the past 2-3 winters, and some use has also been made of it during the summers.

Large stones were scattered over the surface. The 0-4 horizon in the soil profile consisted of dark reddish brown organic material with very little silt; 4-8 or 13 inches, dark reddish brown loam rich in organic matter with numerous small stones and rocks up to one foot in diameter; 8 or 13 inches to 30 inches, sand with very little silt but much gravel and many stones. The pH varied from 5.3 at 0-4 inches to 5.4 below that. The working depth of the roots was at 18 inches.

Mosses were moderately abundant having an average cover of only 1.9. Much of the moss was dead and many hummocks were broken and shattered tufts were scattered on the ground. The lichens had high cover, 6.0, and were packed into a fairly firm layer 1-2 inches thick. They were not badly shattered. The chief lichens were *Cladonia alpestris*, *C. rangiferina*, *Cetraria* spp., *Stereocaulon* spp., and *Alectoria ochroleuca*.

Dead plants and branches of *Betula* and *Carex*, exposed basal parts of branches of shrubs, and shattered moss hummocks indicate that considerable deterioration has occurred during the past 2-3 years. Presumably this stand was similar to Stand 60, prior to heavy use. This may be inferred from the moderate abundance of *Cladonia alpestris* and *C. rangiferina* in the stand in 1957. The dead moss on the surface, the hummocks, the deep layer of organic material and penetration of organic material to 13 inches, and the presence of some species such as *Sphagnum* sp., *Salix reticulata*, and *Andromeda polifolia* indicate that this site was once moister and supported more lush vegetation than at present. The range condition was rated as fair."

Table 20 shows the vegetative readings inside and outside the exclosure from 1956 to 1970. In 1956 it was examined using the line-point method and in Plot A inside the exclosure, 700 points were examined; in Plot B outside of the exclosure, 500 points were examined. In 1957 Hanson

Table 20. Station 15: Big Lake, heath type.

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line-pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line-pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	29	29	29	29b	Plot B	30	30	30	30b
Total Cover	100%	100[b]	100	100	100	100	99	95	70	80
Moss	8.0	2	2	2	2	5.9	1	1	1	-
Arctostaphylos alpina	t[d]	-	-	-	-	1.6	-	-	-	-
Betula glandulosa	3.2	3/6[c]	5/6	5/7	-	t	2/3	3/4	4/8	1/3
Empetrum nigrum	4.0	2	2	3	4	7.8	2	2	2	2
Ledum decumbens	2.8	2/2	1	1/2	2/2	3.1	1/2	1	3/3	3/3
Loiseleuria procumbens	-	-	-	-	-	-	-	-	1	-
Vaccinium uliginosum	13.0	3/3	4/3	5/6	4/5	7.4	3/2	3/2	5/5	4/3
V. vitis-idaea	2.1	2	2	1	1	3.6	1	1	1	-
Salix pulchra	1.0	3/5	3.8	3/12	-	-	-	-	-	-
Calamagrostis inexpansa	-	-	-	-	-	-	1	-	-	-
Hierochloe alpina	-	-	-	-	-	-	1	1	1	2
Carex podocarpa	5.2	1	1	2	1	7.2	-	1	4	2
Pedicularis capitata	-	-	-	-	-	-	1	-	1	-
Polygonum bistorta	2.1	2	1	1	2	t	1	1	-	1
Lichens	58.6	6	6	6	6	62.6	6	3	4	3
Cladonia alpestris		-	-	2	3		-	-	1	1
C. rangiferina	53.0	-	-	3	2	52.0	-	-	1	1
C. arbuscula		-	-	3	2		-	-	1	1
C. amaurocraea	-	-	-	1	-	-	-	-	-	1
C. uncialis	-	-	-	1	2	-	-	-	-	1

Table 20 (Continued).

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line-pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line-pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	29	29	29	29b	Plot B	30	30	30	30b
C. gracilis	-	-	-	1	1	-	-	-	-	-
Cetraria nivalis	3.3	-	-	-	1	6.8	-	-	1	1
C. richardsonii	0.8	-	-	-	1	1.2	-	-	1	-
C. cucullata	-	-	-	1	1	-	-	-	1	1
C. islandica	-	-	-	1	1	-	-	-	1	1
Stereocaulon paschale	1.0	-	-	-	1	2.2	-	-	-	-
Dactylina arctica	0.5	-	-	1	1	-	-	-	-	-
Thamnolia vermicularis	-	-	-	1	1	-	-	-	1	1
Alectoria nigricans	-	-	-	-	-	-	-	-	1	-
A. ochroleuca	-	-	-	-	1	-	-	-	-	1
Sphaerophorus globosus	-	-	-	-	1	-	-	-	-	-

a A - inside exclosure, B - Outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

established a one-meter square quadrat in one corner of each plot and these readings are presented for 1956, 1966 and 1970. In 1970 another meter square quadrat was established in each plot at the opposite end from the original quadrat. In 1957 Hanson described Quadrat 29, in Plot A of Station 15, as containing two prominent hummocks about 3 inches high, covered with moss, lichens, blueberry, cranberry, and crowberry. The mat was broken down on the edges. The layer of lichens was looser than outside of the exclosure and 1-1/2 inches thick. *Cladonia alpestris* and *C. rangiferina* were in better condition than those plants outside. He noted that in Quadrat 30, in Plot B, the layer of lichens was about 1-1/2 inches thick and they were somewhat more compact and less upright than those in Plot A. Rounded forms of *Cladonia alpestris*, were not as large nor as numerous and with *C. rangiferina* were less upright. The lichens had a pressed down appearance. Moss hummocks 1-1/2 to 2 inches high were breaking down along the edges and most of the moss looked dead. Scattered over the quadrat were several dead shoots of *Carex* and clumps of moss and broken branches of birch. The shrub birch in the center of the quadrat had several dead branches and most of the blueberry branches had been nipped off. Lower branches of some blueberry, formerly covered, were exposed.

In 1966 McGowan indicated that Quadrat 29 in Plot A was in an excellent lichen stand, mostly covered by creeping, prostrate shrub birch. Otherwise it was the same as described by Hanson (1958). Plot B, Quadrat 30, in 1966 was composed of lichens that were mostly broken fragments and 1/3 of the birch twigs were dead, with numerous twigs broken off. The plot appeared dry compared to Plot A and showed the effects of trampling and/or browsing. This was the result of a very large caribou movement (observed July 30, 1966) crossing Deadman Creek moving east around the north end of Big Lake, which very likely passed through Plot B. In 1970 the lichen growth was noticeably better inside the exclosure than outside. The vascular plants also appeared to be in better condition inside the exclosure. Table 20 and a comparison of the photographs taken in 1956, with those from 1970, also show a large increase in the shrub growth in the entire stand. There were still a few moss hummocks exposed, but inside of the exclosure *Cladonia alpestris* and *Cetraria nivalis* were the most abundant and appeared to be recovering very well. Most averaged 2 inches in length and were robust and luxuriant. Unfortunately, this station lies close to a popular fishing camp and it was apparent that someone had tampered with the stakes of Quadrat 30 in Plot B. The exact location of Quadrat 30 could not be definitely determined, although it appeared from the position of the stakes and old photographs that the reading obtained in 1970 was on an area similar to that included previously in Quadrat 30. Another plot was established outside in the same general vicinity so that between the two plots 30 and 30b, read in 1970, a good approximation of the original quadrat should have been obtained. Lichens outside were mostly scattered and occurred only in protected spots, such as under shrubs. The shrub growth was denser outside, as it was in a more moist area. Most lichens were only one-half to one-quarter inch in length, broken and trampled. The heavy use noted in 1957 and in 1966 was still very evident. However, recovery with complete protection inside the exclosure had increased. The most noticeable characteristic of the entire area was the marked

increase of shrubs. This area continues to be heavily utilized during the summer, with some winter use.

Range Station 31: Deadman Lake, Heath Type

This station was established in August 1961 at an elevation of 3,100 feet with an east 3° slope. It is at the west end of Deadman Lake about 50 yards from the shore. A general examination of the vegetation in the Deadman Lake area was conducted in 1953 and this vegetative reading is presented in Table 21. Unfortunately, lichen species were not considered at that time. Instead, they were lumped together. Of special interest was the very high frequency of occurrence and density and the extremely high production figure in pounds/per acre of the fruticose lichens. This included all lichen material to ground level. These figures should be kept in mind when considering the vegetative readings that were taken during the late '50s and in 1970 at Deadman Lake. The shrubs had almost as high a plant coverage reading, but the production was considerably less than for the fruticose lichens. Skoog described the site in 1961 as follows:

> "The surface seemed well drained, but the site is underlain by a silty flow of soil. All vegetation is decumbent and the species are few in number. The heaths are dominant consisting of *Loiseleuria procumbens*, *Diapensia lapponica*, *Empetrum nigrum*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum decumbens* and *Arctostaphylos alpina*. Associated grasses are *Hierochloe alpina* and *Festuca* (61-011). Mosses are few. The lichen cover is rather good, averaging at least 66%, but the growth is poor, generally 1/2 inch or less. The Groups I and II lichens are not abundant and many different species are present. Group V lichens are common and these are a good indication of the poor lichen cover present. Caribou usage has been rather heavy during the past six years and lichens on this site have suffered greatly in large extent due to the lack of protection - being exposed to wind and rain and caribou alike. There are no shrubs to act as a buffer. The lichen mat is depressed, scattered, disrupted and many places dead in appearance. Little lichen forage remains. The lichens are regressing from a stage consisting of mostly Groups I and II to one of the lower groups containing the *Stereocaulons* and funnel-form lichens."

Alexander stated that in 1967 there was a difference in the vegetation inside the exclosure compared to that outside. In 1970, when the vegetation was examined, there was a noticeable difference between the vegetation inside the exclosure and outside, although it was not great. There had still been very little recovery of the lichen growth, although *Cetraria nivalis* seemed to be more abundant. It had changed from a 1 to a 4 reading in Quadrat A1 and from a 2 to a 4 reading in Quadrat A2 (Table 22). Outside it had not changed much. It appeared that *Cetraria nivalis* was starting to recover inside the exclosure, but all lichen

Table 21. Unit 5: Plant composition as determined by visual estimation of plant cover and forage production in meter-square quadrats, 1953.

Species	Deadman Lake o	Deadman Lake d	lbs/acre
Date	7/16-20/53		
Total Quadrats	64		
Lichens:			
Foliose	11	1	8.0
Fruticose	91	41	4985.6
Woody:			
Arctostaphylos alpina	25	2	29.4
Betula nana	6	5	21.4
Cassiope spp.	22	2	73.1
Empetrum nigrum	63	7	335.5
Ledum spp.	41	1	8.9
Loiseleuria procumbens	39	4	318.5
Potentilla fruticosa	8	0.4	-
Salix spp.	58	6	19.6
Vaccinium uliginosum	84	7	125.8
V. vitis-idaea	70	3	17.8
Sedge-Grass	88	6	31.2
Herbs	47	2	18.7
Moss	78	14	442.5
Other:			
Equisetum spp.	3	0.2	-
Lycopodium spp.	3	0.2	2.7
Bare	2	0.1	

o Occurrence - percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
T Trace.

Table 22. Station 31: Deadman Lake, heath type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	98[b]	98	96	90	98	80	100	45
Moss	1[d]	3	t	3	1	1	1	1
Betula glandulosa	-	-	2/7	1/5	-	-	3/6	2/5
Vaccinium uliginosum	3/3[c]	4/6	2/4	3/3	2/2	4/4	1/3	3/3
V. vitis-idaea	t	1	t	-	t	-	t	1
Ledum decumbens	2/2	4/4	t	2/2	1/2	-	1/2	1
Loiseleuria procumbens	4	4	3	3	1	1	4	3
Diapensia lapponica	-	-	1	1	-	-	2	-
Arctostaphylos alpina	-	-	1	1	-	-	-	-
Empetrum nigrum	1	1	-	-	3	3	-	-
Polygonum bistorta	-	-	-	-	-	-	t	-
Tofieldia pusilla	-	-	t	-	-	-	1	2
Pedicularis labradorica	-	-	t	-	-	-	-	-
Calamagrostis lapponica	-	2	-	1	-	1	-	-
Hierochloe alpina	-	1	-	3	1	2	t	2
Festuca altaica	3	-	2	2	-	-	-	-
Carex	1	2	t	-	1	1	1	1
Carex	-	-	-	1	-	2	-	4
Lichens	5/1	6/2	6/1	5/1	5/1	4/1	5/1	3/1
Cladonia alpestris	2/1	1/1	t	-	3/1	1/1	1/1	-
C. rangiferina	t	2/1	t	2/1	1/1	1/1	t	-
C. arbuscula	2/1	2/2	1/1	1/1	1/1	1/1	1/1	-
C. uncialis	2/1	1/2	2/1	1/1	1/1	-	2/1	-
C. gracilis	t	1/1	t	1/1	-	-	1/1	-

Table 22 (Continued).

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Cetraria islandica	t	1/2	t	-	t	1/1	t	1/1
C. nivalis	1/1	4/1	2/1	4/1	1/1	2/1	1/1	1/1
C. cucullata	t	-	t	1/1	t	-	t	1/1
C. richardsonii	1/2	1/2	1/2	-	t	1/1	1/2	-
C. nigricans	t	-	2/1	3/1	-	-	t	1/1
Stereocaulon paschale	2/1	3/2	t	2/1	1/1	1/1	1/1	1/1
Thamnolia vermicularis	t	-	1/1	2/1	t	-	t	-
Dactylina arctica	-	-	-	-	t	-	1/2	-
Sphaerophorus globosus	1/1	2/1	t	-	t	1	t	1/1
Cornicularia divergens	t	-	t	1/1	-	-	t	1/1
Alectoria ochroleuca	1/1	1/1	1/1	2/1	-	-	1/1	1/1
Lobaria linita	-	-	-	-	-	-	1	-

a A - inside exclosure, B- outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

growth was still limited and very little recovery had occurred. Outside, the lichens were very scattered and showed the effects of heavy use in this area. The only upright forms were located under shrubs or very close to rocks and other protected sites. *Cetraria nivalis* again seemed to be withstanding the pressure the best of any species. Shrub growth had changed somewhat both inside and outside of the exclosure with narrow-leaved Labrador tea and blueberry showing the biggest increase. A comparison of the photographs taken in 1961 and 1970 and the vegetation readings in Table 22 show that the total cover has decreased, particularly in Quadrat B2. The continued heavy use in this area is markedly affecting vegetation cover, especially the lichens. Grasses and sedges are more vigorous inside the exclosure than outside.

Range Station 32 - Nadiwen Lake (Butte Lake), Carex-Heath Type

Station 32 was built in 1960 and the vegetation was read in August 1961. The station lies on the west side of Nadiwen Lake about 60 yards from shore, where the elevation is 3,400 feet with an east 2° slope. It is in a *Carex*-Heath type, which in 1961 appeared to be progressing from a meadow type and is poor to moderately drained. The description of the 1961 reading by Skoog was as follows:

> "*Carex* (61-001) is the dominant flowering plant, but the heaths in combination are equally abundant. *Salix* (61-012, probably *S. pulchra*) occurs sporadically. *S. reticulata* is common and a ground willow (*Salix* 61-013) is fairly common in places. *Sphagnum* occurs sporadically and mosses are abundant. Shrub birch and all the heaths are decumbent types, generally less than 6 inches. A variety of forbs are present, mostly moisture tolerant species. Lichens are common with an average cover of about 66%, but of poor growth about 1 inch. Groups I and II are dominant, the latter the more abundant. Groups III and V seem to be invading. The growth probably has been good in the past, but heavy caribou use in recent years has damaged the cover extensively. The lichens are trampled and depressed in appearance, broken and many appear dead. Moss pedestals are common. Overuse is evident on the site and it is expected that the forage lichens will become less and less numerous as the winter use continues. The sedge, however, may be utilized in winter also, and the plant occurs in sufficient quantities to furnish much forage."

When examined in 1967 and 1970 the vascular species appeared to have changed very little. Lichens, however, were showing some differences. Outside they have continued to decrease, going from 5 to 2 in Quadrat B1 and from 5 to 3 in Quadrat B2 (Table 23). Inside the exclosure limited recovery was apparent. The site is somewhat moist and lichen growth probably would not become very dense. Outside the exclosure there was considerable signs of caribou use and all lichens appeared to be very heavily used.

Table 23. Station 32: Butte Lake, Carex-heath type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100	100	100	100	100	100	100	90
Moss	5[b]	5	5	6	5	5	4	4
Betula glandulosa	-[d]	-	-	1/4	1/5	2/4	1/4	1/3
Salix reticulata	t	1	-	-	2	2	1	2
S. pulchra	-	-	3/5	2/6	-	-	-	-
Vaccinium uliginosum	1/3[c]	2/3	-	-	2/3	1/4	2/3	2/2
V. vitis-idaea	1	1	4	5	t	1	t	2
Ledum decumbens	1/1	3/3	2/2	2/4	1/3	1/3	t	1/3
Empetrum nigrum	1	1	3	3	2	2	1	-
Arctostaphylos alpina	1	3	3	3	-	-	-	-
Dryas octopetala	-	-	-	-	-	-	-	1
Andromeda polifolia	-	-	-	-	t	-	-	-
Pyrola grandiflora	-	-	-	-	-	-	-	1
Polygonum bistorta	t	-	t	-	t	-	t	-
Pedicularis labradorica	-	-	-	-	t	1	t	1
Saussurea angustifolia	-	-	-	-	t	-	t	-
Carex	4	4	4	4	6	6	4	6
Lichens	5/1	6/1	3/1	4/1	5/1	2/1	5/1	3/1
Cladonia rangiferina	3/1	2/1	1/1	1/1	2/1	1/1	3/1	1/1
C. arbuscula	1/1	2/1	t	2/1	1/1	1/1	t	1/1
C. uncialis	1/1	2/1	1/1	1/1	3/1	-	3/1	1/1
C. gracilis	1/1	1/1	t	1/1	1/1	-	t	-
Cetraria cucullata	1/1	2/1	1/1	2/1	2/1	1/1	1/1	-
C. nivalis	1/1	1/1	t	-	t	-	1/1	1/1
C. islandica	t	2/1	t	1/1	1/1	-	t	-
C. richardsonii	t	1/1	t	1/2	-	-	t	-
Stereocaulon paschale	-	1/1	-	1/1	-	-	t	-
Thamnolia vermicularis	1/1	-	t	-	1/1	-	t	-
Sphaerophorus globosus	t	1/1	-	-	-	-	t	1
Dactylina arctica	t	-	-	-	-	-	-	-
Cornicularia divergens	1/1	-	-	-	-	-	1/1	1
Alectoria ochroleuca	1/1	1/1	-	-	-	-	-	1
Peltigera aphthosa	-	-	t	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

d Trace.

The vegetation in Unit 5 showed the effects of continued heavy use over a period of years. All three exclosures continue to show a decrease in lichen cover outside and it was noted at the time of construction in 1961 that these areas were already showing the effects of trampling by caribou.

During the winter of 1960-61 the main bulk of the herd, in excess of 20,000 animals, wintered in this unit. They concentrated primarily to the north of Butte Lake and in the Upper Butte Creek area. Heath, shrub birch and meadow were the chief types utilized and Skoog felt that sedges were at least as important as lichens as a food item. Caribou occur throughout the year in Unit 5, especially during the summer, fall and early winter. Numerous game trails exist indicating the heavy use that had occurred over the period of years. Skoog (1959) indicated that the lichen growth had been good to excellent in the past, but had deteriorated due to the excessive use by caribou. The forage lichens, *Cladonia alpestris*, *C. rangiferina* and *C. arbuscula* were relatively poor, being replaced by such species as *Cladonia uncialis*, *C. gracilis*, *Cetraria cucullata* and *C. nivalis*. There were some sections of good growth. He considered the lichen growth at that time to be poor and the lichens were regressing under heavy caribou use. Of 2,100 linear feet of ground examined by transects, 110.6 feet, or 5.3 percent, showed evidence of caribou disturbance which suggested 5 percent of the ground cover had been damaged by caribou in the area.

The vegetation at Station 15 (Big Lake) was especially noteworthy because it was probably quite similar to the vegetation that occurred at Deadman Lake in the early 1950s where in 1953, 41 percent of the area was covered by lichens and almost 5,000 pounds per acre of fruticose lichens were available. The shrubs were of about equal abundance. Since that time, at both Deadman Lake and Big Lake, shrubs have increased dramatically. Evidently some of the heaviest use was in the period from 1956 through the early 1960s, as in 1956, when the exclosure was constructed at Big Lake, the lichen cover was still relatively intact and plentiful throughout. By 1961 disruption of the lichen cover was noted. Since that time the shrubs have increased considerably and lichen cover has continued to decline. *Cetraria nivalis* seems to be the species most capable of withstanding continued pressure. In 1957, at Station 15, *Cladonia alpestris* was already showing the effects of the heavy use that probably had occurred after 1953 (Hanson (1958) felt that it occurred from 1955 to 1957). This use has continued to 1970. This unit receives some of the heaviest year-round use of any unit in the Nelchina range and a considerable number of animals are present during snow-free periods when the lichens are most susceptible to trampling. In 1970 certain areas of the unit appeared to be overused, as far as lichens go, but the vascular plants, particularly sedges, were still very abundant and offered considerable forage. However, there was some indication, particularly at Stations 15 and 31, that on drier sites, damage to the vascular plants has also occurred.

Skoog (1968) felt that in spite of heavy utilization, the unit remained an excellent summer and winter range with abundant forage. He felt that it served as an outstanding laboratory for studying the effects

of heavy range use by caribou. This use has not been particularly detrimental, except to the primary forage lichens.

Range Unit 6: Tangle Lakes

This unit composes most of the northeast quadrat of the Nelchina range. Skoog (1959) described the boundaries as:

> "On the west by Unit 3 and by the limit of spruce (approximately) from about Mile 65 on the Denali Highway southward across Clearwater Creek and the Maclaren River to about the 3200 feet contour level of the Alphabet Hills. The southern boundary continues eastward at that level, drops to the Middle Fork of the Gulkana River near Gulkana Lake, continues to the outlet of that lake and then swings east and south around Round Top Mountain to the mouth of Excelsior Creek on the Gakona River. The eastern and northern boundaries are marked by Unit 3 and by a line running from the foot of Black Rapids Glacier due east to the head of Jarvis Creek, then southward across Castner, Cantwell, and Gakona glaciers, and down the Gakona River to Excelsior Creek."

This unit encompasses 1,750 square miles or 10 percent of the Nelchina range. It consists mostly of gentle slopes and rolling terrain, except for the rugged mountains that occur in the northeast corner. Elevation ranges from 2,300 feet to 8,000 feet with 2/3 of the area between 3,000 and 5,000 feet. The region has been heavily glaciated in the past and there are numerous moraines and eskers present. Snowfall is heavy and persists late in the spring. The aerial survey of vegetation types (Table 24) showed that shrub birch and heath types were predominant, with willow, spruce, meadow and fescue grass being common. About 20 percent of the area is nonproductive. Skoog described lichen growth in 1959 as varying from fair to excellent with very luxuriant stands of *Cladonia alpestris* between the Maclaren River and Tangle Lakes. The area east of Tangle Lakes had been disturbed by recent caribou usage. The northern portion is poorly drained and lichens are not abundant.

This unit has had some of the most extensive vegetation surveys of any in the Nelchina range, particularly the survey by Hanson in 1957 and examinations of several exclosures in the unit. There have been other periodic ground examinations of the vegetation. Hanson (1958) described three willow stands and they are presented in Tables 14 and 15 of his report. There is also a description of a Balsam poplar stand in his report. Hanson described the shrub birch type in detail in his report, calling it the glandular birch type.

Table 25 is a consolidation of information from the shrub birch stands that he examined in Unit 6. Two of these were presented in his report, the others were in a rough draft form and are presented here for the first time. Additional narratives for each stand are available in the files. In addition to those species listed in Table 25, other species

Table 24. Percent composition by vegetation types in Unit #6.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	2.5
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	0.4
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	27.8
6. Fescue Grass (*Festuca*)	6.5
7. Heath	12.9
8. Meadow (Sedge-Grass-Forb)	7.3
9. Water Sedge (*Carex aquatilis*)	1.4
10. Spruce	8.7
11. White Birch	-
12. Willow	9.2
13. Glacier	4.5
14. Bare Ground	13.1
15. Water	5.7

Table 25. Unit 6: Shrub birch type, 10 quadrats per stand (from Hanson, 1957).

Location:	9 Mi. Denali		14 Mi. Denali		16 Mi. Denali		16 Mi. Denali		27 Mi. Denali		27 Mi. Denali	
Stand Number:	32		29		27		28		14		17	
Species	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %
Total Cover	97		98		92		99		99		100	
Betula glandulosa	1.8	90	2.2	90	1.3	90	3.4	100	3.0	100	3.8	100
Diapensia lapponica	0.3	20	0.2	20	0.5	40	-	-	-	-	-	-
Dryas octopetala	0.3	20	0.4	40	0.3	20	-	-	-	-	-	-
Empetrum nigrum	0.6	40	0.4	30	1.7	70	0.9	80	2.6	100	3.7	100
Ledum decumbens	1.3	80	0.6	40	0.4	40	2.9	100	0.4	20	1.3	90
Salix arctica	0.1	10	0.9	50	0.5	40	-	-	-	-	-	-
S. pulchra	-	-	0.7	30	-	-	2.2	80	1.0	70	0.4	30
S. glauca	-	-	-	-	0.1	10	1.4	50	-	-	-	-
Vaccinium uliginosum	1.3	100	1.3	80	2.3	90	2.7	100	1.9	70	0.6	30
V. vitis-idaea	1.5	100	1.7	100	1.1	100	2.0	100	2.2	100	2.0	100
Calamagrostis canadensis	0.6	60	1.0	100	0.4	40	0.9	90	0.4	60	0.7	90
Festuca altaica	-	-	-	-	0.2	20	-	-	0.7	100	0.7	90
Hierochloe alpina	1.0	100	0.5	50	0.9	90	-	-	0.5	50	-	-
Carex bigelowii	-	-	2.3	100	-	-	1.5	100	0.3	30	0.3	30
Anemone narcissiflora	0.8	80	-	-	0.1	10	-	-	0.7	60	0.6	60
Artemisia arctica	-	-	-	-	0.1	10	-	-	0.4	40	0.4	40
Pedicularis labradorica	-	-	0.2	20	0.4	40	0.1	10	0.2	20	-	-
P. capitata	0.2	20	0.3	30	0.1	10	-	-	-	-	-	-
Polygonum bistorta	-	-	0.8	80	0.1	10	1.2	90	-	-	-	-
Moss	2.9	100	4.6	100	2.1	100	5.3	100	4.2	100	5.9	100
Lichens	5.0	100	4.9	100	5.1	100	2.9	100	5.5	100	3.4	100

that occurred in one or two stands include *Arctostaphylos alpina*, *Cassiope tetragona*, *Salix reticulata*, *Chamaedaphne calyculata*, *Loiseleuria procumbens*, *Spiraea beauverdiana*, *Festuca brachyphylla*, *Carex capillaris*, *C. montanensis*, *Poa arctica*, *Luzula multiflora*, *L. nivalis* and *Lycopodium alpinum*. The forbs were usually widely scattered, as can be seen in Table 25. The following forbs occurred in only one or two stands, usually comprising a small percent: *Antennaria monocephala*, *Arenaria arctica*, *A. macrocarpa*, *Arnica latifolia*, *Campanula lasiocarpa*, *Cornus canadensis*, *Gentiana glauca*, *Ligusticum mutellinoides*, *Lloydia serotina*, *Lupinus arcticus*, *Parrya nudicaulis*, *Pedicularis lanata*, *Petasites frigidus*, *Polygonum viviparum*, *Pyrola minor*, *Saussurea angustifolia*, *Stellaria laeta* and *Tofieldia pusilla*.

The shrub birch type usually occurs in wide expanses on rolling hills and plateaus between 3,000 and 4,000 feet. Lichens are common and often of very luxuriant growth, but as seen in the exclosures in this type, they are seldom used. The tall shrubs were usually very dense and restrict caribou movements. Snow tends to accumulate during most winters and lichens are unavailable as winter forage. Hanson (1958) indicated that moderate to heavy use during the spring would improve the quality of this type as a spring and summer range. Heavy use in the winter results in rapid deterioration of the shrub birch type.

Hanson (1958) described the fescue grass type and presented the data from one representative stand. However, there were several other descriptions in his rough draft and they are all consolidated and presented in Table 26. This type contains numerous forbs and plants that occurred in only one or two of the stands, including *Betula glandulosa*, *Spiraea beauverdiana*, *Dryas octopetala*, *Loiseleuria procumbens*, *Poa arctica*, *Carex brunnescens*, *Lycopodium selago*, *Arnica lessingii*, *Lupinus arctica*, *Sibbaldia procumbens*, *Stellaria longipes*, *Trientalis europaea*, *Castilleja pallida*, *C. hyperborea*, *Viola langsdorffii*, *Pedicularis langsdorffii*, *Epilobium angustifolium*, *Rumex arctica*, *Sanguisorba sitchensis*, *Valeriana capitata* and *Veronica wormskjoldii*.

The fescue grass type occurs in large areas adjacent to shrub birch and willow stands, especially along the Denali Highway. It is a seral stage and lichens are seldom abundant. It is a good to excellent spring and summer caribou range, but is a poor winter range.

In July 1959 Skoog conducted ground examinations along the Richardson Highway noting the vegetation types. He made comments about the vegetation at each 5-mile interval. This information was written up as field notes which are presented here according to the proper unit, so that a comparison of vegetation from 1959 to present is more meaningful. The field notes are quoted according to Skoog's notations. These range checks were along the east side of the Richardson Highway, proceeding north and starting at the boundary near Meiers Lake.

> "Mile 170.5. Spruce type - scattered trees. Undergrowth as described previously - Willow, Shrub Birch, and Heath. Many large rocks on the ground; heavy moss cover. Lichen cover heavy - cover of 4 or 5. Mostly foliose, however, (*Peltigera*

Table 26. Unit 6: Fescue grass type, 10 quadrats per stand (from Hanson, 1957).

Location:	28 Mi. Denali		28 Mi. Denali		36 Mi. Denali		36 Mi. Denali		36 Mi. Denali		57 Mi. Denali	
Stand Number:	21		13		18		19		25		10	
Species	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %
Total Cover	99	-	100	-	97	-	100	-	97	-	99	-
Cassiope tetragona	-	-	-	-	0.1	10	0.5	20	0.3	20	-	-
Empetrum nigrum	0.2	20	0.7	30	0.2	10	0.8	30	-	-	-	-
Salix pulchra	2.5	90	1.7	80	0.2	20	-	-	-	-	-	-
S. reticulata	-	-	-	-	1.0	60	2.1	70	0.2	10	-	-
S. polaris	-	-	0.1	10	2.0	100	1.6	100	2.3	100	-	-
Vaccinium uliginosum	1.1	100	0.5	30	-	-	-	-	-	-	-	-
V. vitis-idaea	0.8	80	1.1	100	1.0	100	1.0	100	0.7	70	-	-
Calamagrostis canadensis	-	-	0.2	20	-	-	-	-	0.6	60	2.4	100
Festuca altaica	2.7	100	2.1	100	2.2	100	2.2	100	2.0	100	2.1	100
Hierochloe alpina	-	-	0.1	10	0.4	40	0.2	20	0.3	30	-	-
Carex bigelowii	-	-	1.0	90	0.9	90	0.8	80	0.9	80	1.6	80
C. montanensis	1.1	100	0.1	10	0.2	20	0.9	90	1.1	90	1.8	90
Luzula multiflora	0.2	20	-	-	-	-	0.3	30	0.2	20	-	-
L. parviflora	-	-	-	-	0.3	30	-	-	0.1	10	0.1	10
Lycopodium alpinum	0.8	60	1.5	90	1.5	100	0.6	50	-	-	-	-
Aconitum delphinifolium	0.9	80	-	-	-	-	0.4	30	-	-	1.2	100
Anemone narcissiflora	1.9	100	1.9	100	1.3	100	1.7	100	1.9	100	-	-
Antennaria monocephala	0.6	50	0.9	80	1.2	100	0.8	80	1.0	100	-	-
Artemisia arctica	2.2	100	2.2	100	1.6	100	1.7	100	1.7	100	2.9	100
Campanula lasiocarpa	0.6	50	0.2	20	0.9	90	0.8	80	0.2	20	-	-

Table 26 (Continued).

Location:	28 Mi. Denali		28 Mi. Denali		36 Mi. Denali		36 Mi. Denali		36 Mi. Denali		57 Mi. Denali	
Stand Number:	21		13		18		19		25		10	
Species	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %	Ave. C.	Freq. %
Dodecatheon frigidum	-	-	-	-	0.6	50	0.7	50	0.4	30	-	-
Gentiana glauca	0.5	50	0.3	30	0.5	50	0.5	50	0.7	70	-	-
Polemonium acutiflorum	0.5	50	0.3	30	-	-	-	-	-	-	1.3	100
Polygonum viviparum	-	-	0.1	10	0.4	40	-	-	0.9	90	-	-
P. bistorta	-	-	-	-	0.2	20	0.9	90	1.0	100	-	-
Pyrola minor	0.9	90	0.8	80	0.3	30	0.3	30	0.4	40	-	-
Sedum roseum	-	-	-	-	0.4	50	0.2	20	0.3	30	0.9	70
Solidago multiradiata	0.8	50	0.4	40	0.9	70	0.4	40	-	-	-	-
Stellaria laeta	0.1	10	0.3	30	-	-	0.1	10	-	-	0.7	80
Mosses	5.9	100	4.3	100	3.5	100	5.6	100	5.3	100	4.0	100
Lichens	4.0	100	419	100	4.2	100	3.6	100	4.6	100	0.5	70

and *Nephroma*) and *Stereocaulon*. Some *Cladonia uncialis* and *Cetraria nivalis*. Area probably typical of Spruce type as it nears timberline.

Area between. Scattered Spruce, Willow, Shrub Birch, and Heaths dominant.

Mile 175. Spruce type - very thin density here. Numerous dead snags standing, but not thick, indicating scattered Spruce before the fire also. Fire twenty-thirty years old. Shrub Birch dominant here, Willow common. Lichens are common - cover of 3 or 4, but mostly foliose, *Stereocaulon*, *Cladonia gracilis*, and funnel-shaped *Cladonias*. Generally of 1-2 inches height. This site is well drained. *Festuca* a common species here.

Area between. Spruce type - has become more dense; appears to be mostly black spruce. Willow and Shrub Birch common.

Mile 180. Spruce type - mostly white. Well drained site. Willow and Shrub Birch abundant as is Heath. Alder frequent. Lichens scarce - cover of 1. Foliose, *Stereocaulon*, *Cladonia gracilis*, and *C. arbuscula* are the most common types. Little evidence of fire - none within past thirty years or so.

Area between. The above extends all along the east side of the highway to Mile 185.

Mile 185. Spruce type - well drained - mostly white. Thick Willow-Shrub Birch undergrowth. Lichens as described for previous site."

The following day he started at the Black Rapids Roadhouse at Mile 227 and proceeded to Paxson at Mile 186. The range examination was along the east side of the Richardson Highway.

"Mile 225. Climax white spruce (d.b.h. 3 inches - 4 inches) with understory of Alder. A few trees of Poplar and some of Willow. Ground cover rock, moss, crowberry, and blueberry. A few *Peltigera* lichens, and some *Cetraria nivalis*.

Area between. Road is climbing now to Isabel Pass. This stretch lies close to timberline. White spruce (mature but stunted) are scattered. Thick understory of Alder.

Mile 220. Spruce type, scattered, with thick understory of Alder. Scattered Willow. Ground cover rock, heath, and moss. Few lichens - mostly *Peltigera*.

Area between. Essentially the same but with Willow replacing Alder after Mile 218. Spruce does seem to be reproducing. Rocky substrata attributable to outwash of stream and glaciers. Poplar common.

Mile 215. Spruce-Willow type on rocky, gravelly site - outwash of streams. Ground cover of moss, grass, and heaths. Lichens scarce, as before.

Area between. Spruce drops out pretty much after Mile 212. Alder-Willow type covers much of slopes, interspersed with Sedge Meadow and Heath types. Even the Heath, however, seems to lack fair lichen growth.

Mile 210. Alder-Willow complex on rolling, moraine-like ground. Ground cover of grass and heath. No lichens to speak of.

Area between. Alder-Willow continued, along the steep slopes east of road to Mile 208. Then Spruce entered once more for 1 1/2 miles. Remaining 1 1/2 miles were mainly Sedge Meadow, with Alder and Spruce interspersed. Shrub Birch dominant now. *Stereocaulon* the main lichen.

Mile 205. Shrub Birch-Heath, with Willow. Heaths consist of blueberry, crowberry, low-bush cranberry, and alpine bearberry. Moss and sedge common. Lichens scarce, with a cover of about 1 or 2, consisting of *Stereocaulon* and *Cetraria cucullata*, with a bit of *C. islandica* and *Dactylina arctica*. *Peltigera* common.

Area between. Mostly Dwarf Birch-Heath; with white spruce and willow as major species. Lichens continue poor.

Mile 200. Shrub Birch-Heath, with abundant willow. Similar to Mile 205.

Area between. Shrub Birch, Willow communities, with sedge a common representative. Lichens seemingly poor throughout.

Mile 194.5. Shrub Birch-Willow-Heath. Blueberry thick (heavy with berries); crowberry and low-bush cranberry abundant; *Ledum*, common to abundant. Lichens with a cover of 5 or 6. *Stereocaulon* and *Cladonia alpestris* dominant (each a cover of 3); secondary species are *Cladonia rangiferina*, *C. arbuscula*, and *C. uncialis*; common species are *Cetraria cucullata*, *C. nivalis*, and *C. richardsonii*; occasional *Peltigera* and *Cladonia gracilis*. Succession advancing nicely. Little caribou sign.

Area between. Similar vegetation.

Mile 190. Similar to last site checked, but lichens less dense (cover of 3 or 4)."

Skoog also examined the vegetation from Mile 45 on the Denali Highway to the west fork of the Maclaren River and described it as follows:

"Shrub Birch vegetation types predominate here, interspersed with the Festuca-Willow. Lichen growth is excellent throughout, consisting of good growths of *Cladonia alpestris*, *C. arbuscula*, and *C. rangiferina* - 3 inches-5 inches high. The area shows little sign of use by caribou, with few areas where broken branches were noted or where the lichen mat itself was disrupted or disturbed by pawing. No winter droppings of caribou were noted. Total ground cover of the forage lichens present probably rates a 5 or 6."

Several exclosures are located in this unit primarily along the Denali Highway, but also near some of the major lakes in the unit. These exclosures were constructed in 1960 and the original reading of the vegetation was in 1962. During 1970 the vegetation was reexamined at all locations except Boulder and Summit lakes.

Range Station 17: Mile 9 Denali Highway, Heath Type

This exclosure lies 195 yards south of the Denali Highway at an elevation of 3,400 feet, on a north 1-2° slope. It is in a heath stand on a small bench of a north-facing slope. The vegetation was described by Skoog in 1962 as follows:

"The site is exposed to wind and the plants are decumbent. There is a rocky subsoil. Heaths are abundant, notably *Cassiope tetragona*, *Dryas octopetala*, crowberry, *Diapensia lapponica*, and blueberry. The lichen cover was good, covering about 80% which is 1-3 inches tall. Group I species most common, mostly *Cladonia alpestris*. Various other species invading disturbed and wind exposed sections of ground, notably *Cetraria cucullata*, *C. nivalis*, *C. richardsonii*, and *Stereocaulon*. Winter use by caribou evident by the disrupted sections of the lichen cover. Caribou pellets common."

Alexander (1967) examined all the exclosures in Unit 6 in July 1967 and only at Station 39, at Summit Lake, did he note a difference between the vegetation inside and outside the exclosures. In 1970 the vegetation was reexamined. Table 27 indicates results of the readings for both 1962 and 1970. As can be seen from this table and a comparison of the photographs taken in 1962 and 1970, small change has taken place in the 8-year period.

Lichen growth inside of the exclosure was noticeably better than outside. This was particularly true towards the edges of the exclosure. The center, where the plots are located, is a little more elevated and exposed more to wind action. The best lichen growth was in protected areas around shrubs. Their height seldom exceeds 2 inches but they were in good condition. In Quadrat A2 there were numerous small squamules developing on the moss mound and lichen growth will probably become better developed. In Plot B, outside of the exclosure, most of the lichens were under 1 inch in size and scattered from both use and wind action. There are several isolated clumps of good lichen growth in protected areas, particularly around *Cassiope tetragona*.

Table 27. Station 17: Mile 9.1 Denali Highway, heath type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	98	100	98	100	98	100	95
Moss	2	2	4	3	3	2	3	3
Betula glandulosa	1/10[c]	1/5	3/14	2/13	1/8	2/6	2/15	2/20
Salix glauca	2/18	2/30	-	-	-	-	1/8	1/7
Ledum decumbens	-	1/2	2/6	2/4	-	1/5	1/4	1/2
Vaccinium uliginosum	1/2[d]	-	2/4	2/4	3/4	3/3	3/6	4/2
V. vitis-idaea	t	1	t	1	t	1	t	1
Cassiope tetragona	3	3	2	1	3	2	2	2
Empetrum nigrum	3	2	3	2	1	2	2	3
Dryas octopetala	1	1	1	1	2	2	1	1
Diapensia lapponica	3	2	2	1	2	1	1	-
Tofieldia pusilla	t	t	-	-	-	-	-	-
Polygonum bistorta	t	-	t	-	1	1	1	1
Pedicularis labradorica	-	t	t	-	-	1	t	1
P. verticillata	-	-	-	-	1	-	-	-
Hierochloe alpina	-	-	-	-	1	2	-	-
Carex	t	1	1	1	-	-	2	3
Lichens	6/2	6/2	6/1	6/1	6/2	5/1	6/2	6/1
Cladonia alpestris	5/2	3/2	3/1	3/1	4/2	2/1	4/2	4/1
C. arbuscula	t	2/2	t	2/1	t	1/1	t	2/2
C. gracilis	t	-	1/1	1/1	1/2	1/1	t	2/1
C. uncialis	t	t	t	1/1	t	-	1/1	1/1
C. crispata	-	-	-	1/1	-	-	-	-
C. macrophylla	-	-	-	1/1	-	-	-	-
C. spp. "cup type"	-	t	-	1/1	-	-	-	1/1
Cetraria cucullata	1/1	1/1	2/1	1/1	1/1	1/1	1/1	1/1
C. nivalis	2/1	1/1	3/1	2/1	2/1	2/1	2/1	3/1
C. islandica	t	1/1	1/2	1/1	t	1/1	t	2/1
C. richardsonii	1/3	1/3	1/3	1/1	t	1/1	1/3	2/2
C. nigricans	t	-	-	-	-	-	-	-

Table 27 (Continued).

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Stereocaulon paschale	1/1	2/1	2/1	3/1	2/1	3/1	2/1	2/1
Dactylina arctica	t	1/1	t	1/1	t	-	1/1	2/1
Thamnolia vermicularis	1/2	-	1/2	-	1/2	1/1	t	-
Sphaerophorus globosus	-	-	-	-	t	1/1	-	-
Cornicularia divergens	1/1	-	t	-	-	-	-	-
Alectoria nigricans	-	1/2	-	-	-	-	-	-
A. ochroleuca	-	-	-	1/1	-	-	-	-

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

d Trace.

The exclosure may be influenced by snow depth as it is within 20 feet of a terrace and snow depth might be deeper than normal, although no one has noted this being the case. Use by caribou is probably restricted to snow-free periods, or in early winter before the snow accumulates significantly. The stand appears typical of the area and there is a definite difference between lichen growth inside and outside of the exclosure. In 1962, when this vegetation was first examined, the lichens had received some use as reported in the original description. Since that time, the lichens have been able to recover fairly well inside the exclosure. However, outside, lichens continue to be mostly scattered, due to both use and wind action.

Range Station 18: Mile 26 Denali Highway, Shrub Birch Type

This exclosure is 150 yards north of the highway at an elevation of 3,250 feet on a level plain. The stand is in a shrub birch type of rather dense growth, medium height 3 to 4 feet. Skoog described the site in 1962 as having:

> "heavy moss undercover, generally poor to moderately drained site, probably wetter in the past. *Sphagnum* is scattered about with *Carex* spp. being common. Narrow-leaved Labrador tea, blueberry, cranberry, all are common. *Cornus canadensis* abundant. Lichen growth is good 2-4 inches but covers only about 30-50% of the ground. *Cladonia arbuscula* and *C. rangiferina* are the most abundant species. *C. gracilis*, *C. uncialis*, and *Cetraria islandica* are common as are the foliose lichens, *Peltigera aphthosa* and *Nephroma arcticum*. No evidence of caribou grazing. Dense shrub birch would protect lichens to a great extent."

In 1970 there was no noticeable difference in either the vascular plants or lichens at this exclosure. It was apparent that the area received little caribou use in either the summer or winter because of the dense shrub birch stands. Table 28 shows the vegetation readings in 1962 and 1970. The site is typical of the large shrub birch stands in the area. Shrubs were 4 to 5 feet tall and there was a very heavy moss mat as an understory. The lichens were scattered and usually clustered wherever they were found, most were 2 to 3 inches above the moss layer. Probably the only use made of the area by caribou would be early in the summer and during the fall migrations. The dense shrub cover severely restricts their movements.

Range Station 19: Mile 29 Denali Highway, Fescue-Willow Type

Station 19 is at an elevation of 3,700 feet with a 1 to 2° north-facing slope. The exclosure was constructed in 1960 and the first vegetation reading was accomplished in 1962 by Skoog. A description of the station at that time was as follows:

> "Exclosure lies in a Fescue-Willow stand with moderate drainage and a heavy carpet of moss, nearly 100%. Tussocks of moss and Fescue are a common feature. Sedge (*Carex* spp.)

Table 28. Station 18: Mile 26.1 Denali Highway, in medium height, shrub birch type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6	6	6	6	6	6	6	6
Betula glandulosa	4/60[c]	5/62	5/48	5/58	5/48	5/43	5/60	3/55
Ledum decumbens	2/8	1/7	-	-	3/10	4/8	2/8	2/7
Vaccinium uliginosum	1/8	4/6	2/4	3/4	2/8	3/5	3/6	3/6
V. vitis-idaea	1	1	t[d]	1	1	2	1	1
Empetrum nigrum	4	4	3	2	4	5	3	4
Spiraea beauverdiana	2/10	-	-	-	-	-	-	-
Cornus canadensis	2	1	1	1	1	1	1	1
Rubus chamaemorus	1	1	1	1	-	-	-	-
Equisetum arvense	-	-	-	-	-	1	1	1
Carex	2	3	3	3	2	2	2	3
Lichens	4/3	4/3	4/3	5/4	4/3	5/3	4/3	5/2
Cladonia alpestris	-	-	-	-	t	1/2	t	-
C. rangiferina	3/3	3/3	3/3	3/4	2/3	3/3	1/3	1/3
C. arbuscula	1/3	1/3	1/3	1/3	1/3	2/4	2/3	2/3
C. gracilis	1/3	1/3	1/3	1/3	2/3	1/3	t	1/2
C. uncialis	-	-	-	-	1/3	1/2	1/3	1/2
C. crispata	-	-	-	-	-	-	-	1/1
C. cornuta	-	-	-	1/3	-	-	-	-
Cetraria islandica	1/2	1/2	1/2	1/4	1/2	1/3	t	1/2
Nephroma arcticum	-	-	2	2	-	-	-	-
Peltigera aphthosa	3	3	t	2	-	-	-	-
P. pulverulenta	-	2	-	-	3	4	2	4

a A - inside exclosure, B - outside exclosure.
b Cover by modified hult-Sernander scale.
c Average height in inches.
d Trace.

and *Artemisia arctica* are abundant. *Ledum*, *Lupinus* and *Polemonium* are common. The forbs are abundant but scattered in distribution. Lichens are not numerous, cover of 2 or 3 at most with an average growth of 1-3 inches. *Cladonia gracilis*, *C. arbuscula*, *Cetraria islandica* are the most common species. The site resembles meadow in many respects."

Skoog felt that the stand was advancing from a meadow type to the drier fescue-willow type. Caribou use was not evident and the exclosure lies in an area of heavy snowfall.

In 1970 there was little difference between the vegetation inside and outside of the exclosure. This is reflected in Table 29. However, the fescue mounds inside the exclosure appeared to be larger than in Plot B. The mosses have not filled out the interspaces between the tussocks. The stand appears very typical of a fescue-herb association within a large willow stand. Lichens, where they occurred, generally were in clusters, often robust, 2 to 3 inches high, but scattered in distribution. Comparison of the photographs taken in 1962 and 1970 of Quadrat A2 showed that the interspaces seemed to be filling more with herbaceous vegetation. Outside in Quadrats B1 and B2 of Plot B, there was some lichen growth through the moss mounds. The mosses were very deep and covered several fescue hummocks. There was no sign of use by caribou. Use of the fescue-willow type is probably restricted to late spring and early summer when the grasses and forbs are more succulent. Some use occurs in the fall when caribou are moving through the area, otherwise, there is little use of the sparse lichens.

Range Station 20: Mile 47.3 Denali Highway, Shrub Birch Type

Range Station 20 was constructed in 1960 and the first vegetation examination was conducted in 1962 by Skoog. It is at an elevation of 3,150 feet with a 1° north-facing slope and lies about 95 yards north of the highway. Skoog (1962) described it as follows:

"The exclosure is in a Shrub Birch stand of medium height 4-5 feet, which alternates with a Fescue-Willow type which appears to be the invader. All openings between the shrub birch have a Fescue-Willow association, as a result species occurring in one type also are present to a certain extent in the other. The site seemed well drained with a rather deep soil. Moss cover is heavy, easily rating a 6 in cover. Lichens are abundant in the open Fescue areas, covering 75-90% of the ground, but are much less common in the Shrub Birch covering 30-50% of the ground. Group I lichens seem to be invading strongly, all three *Cladonias* being present and about equally abundant with an average height 3-4 inches. Cover by lichens was 25-60% depending on site. *Stereocaulon*, *Nephroma* and *Cetraria islandica* are common. There is little evidence of use by caribou."

Table 29. Station 19: Mile 29 Denali Highway, fescue-willow type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6	6	6	6	6	6	6	6
Lycopodium selago	-	-	-	-	-	-	t	1
Loiseleuria procumbens	1	-	t	-	-	-	-	-
Vaccinium uliginosum	-	-	-	-	-	-	t	-
Rubus arcticus	1	1	2	2	2	1	1	1
Artemisia arctica	2	3	2	3	3	3	3	3
Sedum roseum	1	2	1	2	2	2	2	2
Lupinus arcticus	-	-	-	-	1	2	-	-
Senecio lugens	-	-	t	-	-	-	-	-
Polemonium acutiflorum	2	1	2	1	1	1	2	1
Anemone narcissiflora	t[d]	1	-	1	t	1	t	2
A. parviflora	-	1	t	1	-	-	-	-
Aconitum delphinifolium	-	-	-	-	-	-	t	-
Antennaria monocephala	-	-	-	-	-	-	t	-
Festuca altaica	5	5	5	5	5	5	3	5
Calamagrostis canadensis	-	-	-	1	t	1	t	1
Carex	2	3	2	3	1	3	1	2
Lichens	2/2[c]	4/2	2/2	4/2	2/2	3/1	4/2	5/3
Cladonia alpestris	-	-	t	-	-	-	-	-
C. rangiferina	2/2	2/2	t	-	t	1/1	t	1/2
C. arbuscula	t	-	t	1/2	2/2	2/2	3/2	3/3
C. gracilis	1/2	1/2	1/2	2/2	1/2	1/1	1/2	2/3
C. uncialis	-	-	1/2	1/2	-	-	-	-
C. crispata	-	1/2	-	-	-	-	-	-
Cetraria islandica	1/2	1/3	1/2	2/2	1/1	2/2	1/2	2/2
Stereocaulon paschale	t	-	-	-	t	1/2	1/2	3/3
Thamnolia vermicularis	-	-	t	-	-	-	-	-
Peltigera spp.	-	-	-	-	-	-	t	-
Nephroma arcticum	-	-	-	-	-	1/2	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

In 1970 there was no discernible difference between the vegetation inside and outside the exclosure. The shrubs were very dense and would restrict the use by and movements of caribou. Lichen patches were scattered, but where they occurred they were usually very luxuriant, 2 to 3 inches in height. Table 30 indicates that there has been very little change in the past eight years. There was no indication of caribou use. The dense shrubs would restrict movements during snow-free periods and the snow would tend to accumulate during the winter. Use is likely to be at a very minimum at this site.

Range Station 21: Mile 56.25 Denali Highway, Fescue-Willow Type

This station is at an elevation of 2,950 feet with a 2 to 3° north-facing slope, about 170 yards north of the Denali Highway. It was constructed in 1960 and the vegetation examined in 1962. At that time it was described by Skoog as follows:

> "Exclosure lies in a Fescue-Willow stand at a transition site between that type and Willow close to Clearwater Creek. The site is more moist than the usual Fescue site and contains more forbs and less lichens. There is a thick grass and moss cover. The principal species are *Festuca altaica* and *Poa arctica*. Lichens are scarce with a cover of less than 15% generally. *Stereocaulon* is the most abundant. It and *Cladonia arbuscula* are invading the drier hummocks. No caribou usage evident. *Solidago multiradiata* and *Sanguisorba itchensis* are the most abundant forbs with *Aconitum delphinifolium* being common."

In 1970, when the site was reexamined, it was noted that the east side of the exclosure was located on a small spring creek so that the soil and vegetation will probably never become stable. Forbs were profuse. There was no evident difference between the vegetation in 1962 and 1970, nor was there any noticeable difference between inside and outside the exclosure (Table 31). Use by caribou was not evident and this station is similar to the previous two. It probably receives little caribou use.

Range Station 22: Mile 65 Denali Highway, Shrub Birch Type

This exclosure was constructed in 1960 and the vegetation examined in 1962. It is at an elevation of 3,450 feet on a level plain. The stand is considered to be a typical shrub birch stand. It was described by Skoog in 1962 as follows:

> "Exclosure lies in a Shrub Birch stand on a small shelf at the base of a moderately steep, 30°, south-facing slope. The soil is poorly drained and rather deep as a result of run-off down the slope. The shelf acts as a catch basin of salts. Shrub birch is dense, 4-6 feet high. Moss covered nearly the entire area and is thick. Narrow-leaved Labrador tea, blueberry, cran-

Table 30. Station 20: Mile 47.3 Denali Highway, shrub birch of medium height.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	6[c]	6	6	6	6	6	6	6
Betula glandulosa	5/48	4/60	4/48	4/62	5/48	4/60	5/48	5/58
Salix pulchra	4/15	3/30	1/12	2/15	2/15	2/24	2/10	1/18
Empetrum nigrum	-	-	-	-	-	-	1	1
Vaccinium uliginosum	-	-	-	-	t	1	-	-
Rubus arcticus	1[d]	1	1	1	1	2	2	2
Cornus canadensis	t	-	-	-	-	-	1	-
Polemonium acutiflorum	1	1	1	-	1	-	-	1
Stellaria longipes	-	-	t	1	1	1	-	-
Pyrola minor	-	-	t	-	-	-	-	-
Artemisia arctica	1	2	t	1	2	2	1	1
Veronica wormskjoldii	-	-	-	-	-	-	t	-
Festuca altaica	3	2	t	1	-	-	1	2
Calamagrostis canadensis	-	1	-	-	t	2	1	1
Poa arctica	t	-	t	-	1	-	-	-
Carex	t	1	1	2	1	2	1	1
Juncus castaneus	-	-	-	-	-	-	t	-
Lichens	3/3	3/3	3/3	3/3	4/3	4/3	3/3	3/2
Cladonia alpestris	1/3	1/2	-	-	t	1/2	1/3	2/2
C. rangiferina	1/3	1/3	t	2/3	2/3	2/3	2/3	2/3
C. arbuscula	1/3	1/3	1/3	1/3	2/3	2/3	1/3	1/2
C. uncialis	-	-	-	-	-	-	1/3	1/3
C. gracilis	-	-	-	1/2	t	-	-	-
C. gonecha	-	-	-	1/1	-	-	-	-
C. deformis	-	-	-	-	t	-	-	-
Cetraria islandica	t	1/2	1/3	1/3	2/2	1/3	t	1/2
Stereocaulon paschale	1/3	1/3	-	-	1/2	1/3	1/2	1/3
Peltigera aphthosa	2	3	2	2	1	-	1	2
P. pulverulenta	-	-	-	1	-	3	-	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Table 31. Station 21: Mile 56 Denali Highway, fescue-willow type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	3	4	3	4	6	6	6	6
Empetrum nigrum	–	–	–	–	–	1/4	–	–
Betula glandulosa	–	–	–	–	–	–	t	–
Salix pulchra	–	–	–	–	2/15	2/12	–	–
S. glauca	5/10[c]	5/10	2/12	3/12	4/10	5/13	4/10	4/10
S. reticulata	–	–	–	–	t	1	t	1
Vaccinium uliginosum	–	–	–	–	t	1/4	1	1/3
V. vitis-idaea	–	–	–	–	–	1	–	1
Potentilla fruticosa	–[d]	–	–	–	–	1/6	–	–
P. diversifolia	t	–	–	–	1	1	–	1
Cornus canadensis	–	–	t	–	–	–	–	–
Rubus arcticus	1	1	t	–	2	1	–	–
Epilobium angustifolium	t	2	1	2	–	1	–	–
Aconitum delphinifolium	1	1	t	–	t	1	t	–
Sanguisorba sitchensis	1	2	2	3	1	2	1	1
Sedum roseum	–	–	–	–	–	–	t	–
Swertia perennis	–	–	t	–	1	1	1	1
Pyrola minor	1	–	1	1	t	–	t	–
Veronica wormskjoldii	t	–	1	–	t	–	t	–
Valeriana capitata	–	1	–	–	–	1	–	–
Stellaria laeta	t	–	1	2	–	–	t	–
Thalictrum alpinum	–	–	–	–	t	1	1	1
Solidago multiradiata	2	2	2	1	2	3	2	2
Artemisia arctica	1	2	1	3	1	2	2	2
Senecio lugens	–	3	–	2	–	–	–	1
Antennaria monocephala	–	–	–	–	t	–	1	–
Festuca altaica	4	5	4	5	4	5	4	5
Calamagrostis canadensis	–	2	–	2	–	–	–	–
Poa arctica	t	–	3	–	t	–	–	–

Table 31 (Continued).

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Hierochloe alpinum	-	-	-	-	t	-	-	-
Trisetum spicatum	-	-	-	-	t	-	-	-
Carex	2	1	1	1	3	3	2	1
Luzula multiflora	-	-	-	-	-	1	-	-
Lichens	1/1	2/2	1/1	2/2	1/1	1/2	3/1	4/3
Cladonia arbuscula	t	1/2	t	-	-	1/2	t	1/2
C. rangiferina	-	-	-	1/3	-	1/2	-	1/2
C. uncialis	-	-	-	-	-	-	t	-
C. gracilis	-	-	-	1/2	-	1/1	t	1/2
C. verticillata	-	-	-	-	-	-	-	1/2
Cetraria islandica	-	1/2	-	1/2	-	1/2	-	1/3
C. cucullata	-	-	-	-	-	-	-	1/2
Stereocaulon paschale	1/1	1/2	1/1	1/2	1/1	1/2	3/1	3/3
Peltigera aphthosa	-	1	-	1	-	-	t	1
Lobaria linita	-	-	-	1	-	-	t	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

berry and *Spiraea beauverdiana* are abundant. *Equisetum variegatum* and *Cornus canadensis* are common. Lichens are almost totally absent. *Peltigera* spp. occur in a similar type on nearby slope. *Alnus* spp. is adjacent to the stand. Site certainly is non-typical insofar as the Shrub Birch type is concerned. Interesting for plant succession study however."

As can be seen from Table 32, lichen growth was negligible at this range station. Shrubs, primarily shrub birch and alders, were very dense and tall. Several dead stems on the birch were noticeable outside the exclosure. Inside, most of the birch appeared to be in a vigorous condition. The snow would undoubtedly be extremely deep during the winter. There probably is little, if any, use of the area by caribou. However, it might be used somewhat by moose.

Range Station 37: Dickey Lake, Shrub Birch Type

This station is at an elevation of 3,000 feet with no slope, in a shrub birch type of medium height, on top of an esker or glacial moraine. It was constructed in 1960 and the vegetation examined in 1961. At that time it was described by Skoog as:

"The major type is Shrub Birch of medium height 1-3 feet, the birch being scattered rather sparsely over the area. Heaths are abundant, predominantly cranberry and narrow-leaved Labrador tea. Blueberry is rare and crowberry uncommon. *Hierochloe alpina* is the common grass, but *Festuca altaica* seems to be invading. The site is well drained and quite dry with few plant species present. The lichen cover is rather poor with an average cover of about 4 with a height of 1/2 to 3/4 inch. Groups I and II are poorly represented, *Stereocaulon* is the common invader. The lichen mat is brittle and broken, containing many species. Caribou use has been moderate to heavy and the effect has been significant. The dryness of the site plus the lack of protective shrubs, (widely scattered and of low height), probably have contributed to the rapid deterioration of the lichen cover and also will inhibit rapid recovery."

Table 33 and the comparison of the photographs shows the marked difference of the lichen growth inside and outside of the exclosure. Lichens outside of the exclosure were seldom over half to a quarter inch in length and were quite scattered and fragmented. Inside, recovery was starting to occur, primarily *Stereocaulon* and *Cladonia gracilis*. They were still rather small and somewhat scattered. However, inside the exclosure, they were mostly upright and dense. Use outside was very noticeable, affecting both the vascular and nonvascular plants. Cover has been reduced in both of the outside plots and the vegetation was less vigorous than when the plots were first established. The continued use of the area is sufficient to retain the lichens in a poor condition and

Table 32. Station 22: Mile 65 Denali Highway, shrub birch type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	100	100	100
Moss	5[c]	6	6	6	6	6	6	6
Betula glandulosa	6/48	5/56	6/48	6/52	6/36	6/43	6/48	4/42
Vaccinium uliginosum	5/14	5/19	4/14	5/12	6/14	5/18	6/14	6/13
V. vitis-idaea	3	2	1	1	1	2	2	1
Ledum decumbens	2/10	3/13	1	1/12	2/10	3/11	2/10	3/18
Empetrum nigrum	2	2	-	-	1	3	2	1
Spiraea beauverdiana	1/10	-	3/18	2/15	2/14	1	2/14	1
Rosa acicularis	-	1/13	-	-	-	-	-	-
Cornus canadensis	1	2	1	2	2	2	1	2
Linnaea borealis	-[d]	2	-	-	t	1	1	1
Lycopodium selago	t	-	-	-	-	-	-	-
Equisetum silvaticum	-	1	-	1	-	-	-	-
E. variegatum	1	-	1	-	1	-	t	-
Calamagrostis canadensis	1	-	t	-	t	-	t	1
Lichens	-	1/2	-	-	-	-	-	-
Cladonia gracilis	-	1/2	-	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Table 33. Station 37: Dickey Lake, shrub birch type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	95	100	95	100	90	100	85
Moss	4	5	6	6	5	4	4	4
Betula glandulosa	6/24[c]	5/24	-	-	5/17	4/24	t	1/2
Vaccinium vitis-idaea	5	3	3	4	6	4	3	4
Ledum decumbens	2/6	2/5	2/5	1/6	2/10	2/8	3/5	2/4
Pedicularis labradorica	-[d]	-	-	-	1	-	-	1
Epilobium angustifolium	t	1	-	-	-	-	1	1
Hierochloe alpina	3	4	2	3	2	2	2	4
Calamagrostis lapponica	-	-	-	-	-	1	-	-
Lichens	4/1	3/1	4/1	4/1	4/1	2/1	6/1	4/1
Cladonia alpestris	t	-	-	1/1	t	-	-	-
C. rangiferina	t	1/1	-	-	1/1	-	t	-
C. arbuscula	t	-	t	1/1	t	1/1	t	-
C. uncialis	t	-	1/1	1/1	1/1	-	3/1	1/1
C. gracilis	2/1	1/1	1/1	1/1	2/1	1/1	2/1	1/1
C. deformis	t	1/1	1/1	2/1	t	-	t	-
C. degenerans	1/1	-	1/1	-	1/1	1/1	1/1	-
Cetraria nivalis	-	-	t	-	t	-	1/1	-
C. cucullata	t	1/1	t	1/1	t	1/1	1/1	-
C. islandica	1/1	1/1	1/1	-	1/1	-	t	1/1
C. richardsonii	-	-	-	-	t	-	t	-
Stereocaulon paschale	1/1	1/1	1/1	2/1	2/1	1/1	4/1	3/1
Peltigera aphthosa	1	2	-	-	1	-	-	-
P. malacea	2	1	-	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

also cause them to deteriorate further. With complete protection some recovery was starting after nine years. This area receives some use by caribou throughout the year.

Range Station 38: Boulder Lake, Fescue-Willow Type

This station is at an elevation of 3,900 feet with an east-facing 3° slope in a fescue-willow type. It was constructed in 1960 and the vegetation was examined in 1961. The vegetation was reexamined in 1971. In 1961 it was described by Skoog as follows:

> "Station lies on a shelf above the Lake in a Fescue-Willow type, the willow probably being *Salix pulchra* (61-004). Shrub birch is common near the Lake and in more moist areas, but uncommon on this dry well drained site. Blueberry is rare and cranberry rather thinly scattered. Grasses (*Festuca altaica* and *Hierochloe alpina*) are common, as are a number of forbs. Two prostrate willows, *Salix reticulata* and *S.* spp. (61-005) are common. The lichen cover is good, 1-3 inches and consists predominantly of Group I and Group II lichens, probably approaching a climax condition. There is little evidence of grazing. This location can be considered as good to excellent range for winter forage. A deep snow cover in winter, however, acts to retard caribou utilization."

The station lies in an excellent lichen stand, however, there has been little use by caribou. Evidently, snow conditions are unfavorable during most of the winter. It is surprising that the good lichen stand has almost not been utilized at all to date. Comparison of the photographs and the readings shows that there has been almost no use of the vegetation and there is no noticeable difference of the vegetation. *Cladonia alpestris* is becoming dominant in the area and appears to be near a climax condition.

The moss mat is not very thick and old moss pedestals are common, as well as some old fescue tussocks. This area will be very susceptible to heavy grazing or trampling due to the shallow and uneven nature of the substrate. Lichen growth is good, although a wide variety of species are present. The shrubs, primarily *Salix pulchra*, are dispersed so that all of the ground vegetation will be available for grazing.

Inside the exclosure in Quadrat A1 there are two small old moss pedestals that are being covered with lichens. The lichen growth is excellent. Table 34 shows the vegetative readings from 1961 to 1971.

Range Station 39: Summit Lake, Heath Type

This station is at an elevation of 3,300 feet with an east 2 to 3° slope and was constructed in 1960. The vegetation was examined in 1962 and it was described by Skoog as:

Table 34. Station 38: Boulder Lake, fescue-willow type.

Year	1961	1971	1961	1971	1961	1971	1961	1971
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100	95	100	100	99	90	100	100
Moss	6[b]	4	5	2	5	2	4	5
Salix pulchra	2	2	-	-	3[c]	3	4	3
S. reticulata	1	1	-	-	t	1	t	-
S. arctica	2	2	1	1	1	-	1	1
Vaccinium vitis-idaea	t	1	t	1	t	1	t	-
Hierochloe alpina	1	2	1	2	1	1	1	1
Festuca altaica	2	1	2	1	3	3	2	2
Carex spp.	1	2	2	2	1	2	1	2
Antennaria spp.	t	-	1	1	t	-	t	1
Artemisia arctica	1	1	1	2	1	2	1	2
Anemone narcissiflora	t	1	t	1	1	1	1	1
Gentiana glauca	t	-	t	-	-	-	t	1
Pedicularis lanata	-	-	t	1	-	-	-	-
Polygonum bistorta	-	-	-	-	-	1	-	-
Unidentified forb	-	1	-	1	-	-	-	-
Lichens	6	6	6	6	6	5	6	6
Cladonia alpestris	4	4	4	3	5	4	4	4
C. arbuscula	t	2	t	1	t	1	-	1
C. rangiferina	3	3	1	1	1	1	2	2
C. uncialis	2	1	1	-	1	-	1	-
C. gracilis	2	1	1	1	1	-	2	1
C. crispata	-	-	-	1	-	1	-	-
C. cornuta	-	1	-	1	-	-	-	-
C. spp. (funnel-form)	-	1	-	1	-	1	-	1
Cetraria islandica	1	2	3	1	1	1	1	2
C. cucullata	-	-	1	1	-	-	-	-
C. nivalis	-	1	1	1	t	-	t	-
C. richardsonii	1	1	t	1	t	1	1	2
Dactylina arctica	t	1	t	1	1	2	t	1
Thamnolia vermicularis	1	1	1	-	t	-	1	1
Stereocaulon spp.	-	-	-	-	1	1	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

"Lying in a Heath type on an exposed sloping shelf of rolling plateau-like area which rises to the west of Summit Lake. Shrub birch is common, but of decumbent form. *Carex* spp. (probably *podocarpa*) is common to abundant. Narrow-leaved Labrador tea, blueberry, cranberry and crowberry are common heaths. *Salix reticulata* and alpine bearberry are common. Site is well drained and exposed to winds. Lichen growth is good, 2-4 inches covering 80-90% of the ground. Many species present, but *Cladonia alpestris* and *C. rangiferina* are dominant. *Alectoria ochroleuca* is fairly common as are *C. uncialis*, *Stereocaulon* and *Cetraria cucullata*. Area was used extensively last winter (1961-62) by caribou and that use is obvious from disrupted, packed appearance of lichens in many places. Area could not withstand heavy caribou use because of the exposure."

In 1967 Alexander noted that the lichens outside of the exclosure were heavily used in contrast to those inside the exclosure. The lichen cover has not been able to withstand increased grazing pressure by caribou and has deteriorated rapidly. In 1971 there was a striking difference in the vegetation inside and outside of the exclosure (Table 35). Inside the lichens were robust and in good condition. The difference is noticeable a long distance from the exclosure, mainly due to the *Cladonia alpestris* that is almost entirely missing outside of the exclosure except in protected sites.

All unprotected sites outside show the effects of considerable uses. There is, however, good cover in protected sites, particularly under shrubs. Under several shrubs *Cladonia alpestris* has managed to retain its original density.

Quadrat B1 occurs in a protected site under a shrub and the vegetation is similar to when the quadrat was established except that *C. alpestris* has been reduced.

Skoog (1959) stated that the shrub birch type could withstand greater use than most other types. In the Tangle Lakes unit, lichen cover was over 50 percent and consisted mostly of Groups I and II, averaging 1 to 3 inches in height. There were some localized areas of moderate caribou use, but on the whole the area would be classed in Stage IIIc. Transects covering 1,100 feet show that 2 percent of the area had been utilized by caribou. There was still a considerable amount of lichen forage present and he felt that it was progressing toward a climax stage. In 1968 he stated that, "As a whole the forage lichens are abundant, especially in the deep snow areas west of Tangle Lakes where lush stands of *Cladonia alpestris* and *C. rangiferina* occur in the Shrub Birch and Fescue grass types. To the east of Tangle Lakes, however, the lichen cover shows evidence of the deterioration due to the heavy use during the past 10 years." As can be seen from Table 4, use by caribou has remained fairly consistent throughout the '60s. In Unit 6 they occurred in moderate numbers during the fall and then in increasing numbers in the wintertime in some areas, particularly during the early '60s. Most use has been in

Table 35. Station 39: Summit Lake, heath type.

Year	1962	1971	1962	1971	1962	1971	1962	1971
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	98	100	100
Moss	4	3	4	3	4	2	3	4
Betula glandulosa	-	1	3	4	4	4	-	1
Ledum decumbens	-	1	2	3	2	3	1	2
Vaccinium uliginosum	2	3	4	4	3	4	1	2
V. vitis-idaea	1	1	1	1	1	2	1	1
Arctostaphylos alpina	1	2	-	-	-	-	1	3
Salix pulchra	-	-	-	-	-	-	1	2
S. reticulata	1	1	1	1	-	-	-	-
S. arctica	-	1	-	-	-	-	-	-
Empetrum nigrum	-	-	-	-	2	2	1	2
Hierochloe alpina	t	-	t	-	1	-	1	2
Festuca altaica	-	-	-	-	-	1	-	-
Calamagrostis canadensis	-	-	-	-	-	1	-	1
Carex spp.	2	3	2	2	1	1	1	3
Polygonum bistorta	1	2	1	1	1	2	t	1
Pedicularis sudetica	-	1	t	-	t	1	t	2
Lichens	6	6	6	5	6	5	6	6
Cladonia alpestris	3	4	4	4	3	2	4	3
C. arbuscula	3	1	2	1	3	1	2	1
C. rangiferina	2	3	2	3	2	2	2	2
C. uncialis	1	-	1	1	1	1	2	1
C. gracilis	t	-	1	1	1	1	1	1
C. cornuta	-	-	-	1	-	-	-	-
C. spp. (funnel-form)	-	1	-	1	-	-	-	-
Cetraria islandica	1	1	1	1	t	1	t	1
C. cucullata	1	1	1	1	t	1	t	1
C. richardsonii	1	1	1	1	1	2	1	1
Alectoria ochroleuca	1	3	t	-	-	-	t	-
Thamnolia vermicularis	1	1	t	-	t	1	t	1
Stereocaulon spp.	1	2	2	2	2	3	2	4
Peltigera aphthosa	-	-	1	1	1	3	-	-
P. spp.	-	-	-	-	-	1	-	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

the eastern half of the unit during the winter, but caribou are scattered throughout the unit during the summer and fall. Usually in the winter major portions of the unit are unused due to deep snow accumulations.

The deep snow and the dense cover of tall shrubs reduce the use as a winter range. Vegetative studies of Hanson (1958) indicated that it was the shrub birch, heath and fescue grass stands that contained the excellent stands of lichens; usually reflecting limited use of the stands by caribou. However, there were localized areas that had received moderate use in the shrub birch, heath and fescue grass types. Considerable forage lichens were present, especially in the shrub birch and heath stands. Lichen cover usually ranged between 4 and 5, quite often being 2 to 4 inches in length. *Cladonia alpestris* and *C. rangiferina* were the most abundant species. The willow type contains mostly herbs and is not a very good winter range; however, it does provide good summer forage.

From Skoog's studies, we note that the eastern portion of Unit 6 contained several good stands of lichens, again usually restricted to the shrub birch stands. In the alder and spruce stands in the northern portion of the unit, there was very little lichen growth and what occurred was in poor condition. The most luxuriant stands of lichens occurred in the Maclaren River area west of the Tangle Lakes. The lack of use of most of this unit is reflected at almost all of the Range Stations that were built. Although several stations contain very good lichen stands, almost all of them show no use. The exception to this is Station 17 in a heath type which is exposed to use by caribou and has a much less dense stand of shrubs that would provide protection for the lichens. These lichens are exposed to both the elements and caribou. Evidently at Station 39 there has been a marked decrease in the lichen cover, with a moderate increase in use near Summit Lake during the early 1960s. The stand is in a heath type also, which is exposed and apparently cannot withstand heavy use. It appears that even though summer surveys of the unit indicate large stands of the most palatable form of lichens exist, most of these stands are unavailable to caribou throughout most of the winter due to the deep snows and density of the large shrubs. In those few areas that are exposed to grazing there has been a deterioration of the range during the last ten years. This unit still provides a considerable amount of good summer and early fall forage.

Range Unit 7: Chistochina River

This unit is located in the far northeastern corner of the Nelchina range. It is bounded on the west by the Gakona River, on the south by the Copper River, on the east by the divide separating the Chistochina River drainage from that to the east and on the north by the Alaska Range. There are 1,340 square miles in the unit comprising 7.7 percent of the range. Altitudes range from 1,500 feet near Gakona on the south to 10,000 feet in the mountains. Nearly one-half of the unit lies below 3,000 feet. Table 36 shows the composition of vegetation types and, as is indicated, almost one-half of the unit is made up of the spruce type with a small percent of shrub birch, heath and bog. About 20 percent of the area is nonproductive. Lichen growth is not very abundant because the area is rather poorly drained. The only area examined on the ground was in the

Table 36. Percent composition by vegetation types in Unit #7.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	0.6
2. Aspen-Poplar	1.3
3. Bog (Heath-Moss-Sedge)	5.6
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	7.7
6. Fescue Grass (*Festuca*)	0.7
7. Heath	6.4
8. Meadow (Sedge-Grass-Forb)	1.7
9. Water Sedge (*Carex aquatilis*)	2.7
10. Spruce	49.0
11. White Birch	-
12. Willow	4.2
13. Glacier	5.6
14. Bare Ground	10.4
15. Water	4.1

vicinity of Mankomen Lake, in the northeast section, and lichens were in fair condition. In 1954, 48 square meter quadrats were examined and 4 were clipped in the Mankomen Lake area. Results of the vegetation readings are summarized in Table 37. It can be seen that lichen density and production were very low overall. The only other on-the-ground work in the area has been by Hanson, who examined one stand at the north end of Mankomen Lake. His rough draft narrative is available and is quoted here in its entirety:

> "Stand 72 is located on a 5-10° slope at the north end of Mankomen Lake, about 38 miles east of Paxson, altitude 3100 feet, Lat. 62°58', Long. 144°30'. Analysis was made on Sept. 4, 1957. Charcoal in the soil indicated the stand had burned over many years ago. This was a low to medium tall *Betula glandulosa-Vaccinium uliginosum* stand rich in lichens. *Betula* was about 2 feet high (1-5 feet), and spaced from 6-10 feet apart to clumps with overlapping branches with average cover of 2.5. *Salix pulchra*, cover 1.2, ranged from 0.5 to 5 feet high, and 10 to 15 feet or more apart. *Vaccinium uliginosum* was abundant, 2.8 in cover, and 6-8 inches high. Other species contributing appreciably to the cover were *Vaccinium vitis-idaea*, 1.1; *Empetrum nigrum*, 1.1; *Carex bigelowii*, 1.0; and *Festuca altaica*, 0.8. *Picea glauca*, up to 15 feet high, was widely scattered. The total number of vascular species was only 12.
>
> The surface of the ground in the openings was covered with 1.5 inch layer of partly decayed vegetation. The soil profile was well developed to a depth of 15.5 inches. Layers were distinguished as follows: 0-3 inches, very dark gray brown organic material with moderate amount of silt, scattered stones, and a few pieces of charred wood; 3-9 inches, dark reddish brown loam; 9-11.5 inches, dark brown loam with much gravel and many small stones; 11.5-15.5 inches, very dark gray brown sandy loam with much gravel and small stones; 15.5-26 inches, dark gray brown sand with small amount of silt and many stones and gravel particles. The soil at 9-14 inches showed a moderate flow tendency, but there was no seepage. The acidity decreased from 4.9 at 0-3 inches to 5.3 at 15.5-26 inches. Working depth of the roots was at 15.5 inches.
>
> Mosses were abundant, cover 3.8. They formed hummocks, 2-3 feet apart, usually about 6 inches high, some to 1 foot, and ranged in area from 6 x 6 inches to 1 x 2 feet.
>
> Lichens were abundant, 5.2 in cover, and 2-4 inches high. The chief species were *Cladonia arbuscula* and *C. rangiferina*. Spots of *C. alpestris* were scattered, but they indicated that rate of invasion was good. Other lichens were *Thamnolia vermicularis* freq., *Cladonia gonecha* freq., *Cetraria cucullata* inf., and *C. islandica* inf. The range condition was rated Good. Only a few caribou have been

Table 37. Unit 7: Plant composition as determined by visual estimation of plant cover and forage production in meter-square quadrats, 1954.

Species	Mankomen Lake o	Mankomen Lake d	lbs/acre
Date	7/24-8/3/54		
Total Quadrats	48		4
Lichens:			
Foliose	44	3	7.1
Fruticose	48	2	644.2
Woody:			
Andromeda sp.	10	T	5.4
Arctostaphylos alpina	8	0.3	-
Betula glandulosa	65	0.5	154.3
Empetrum nigrum	31	2	219.5
Ledum spp.	13	0.1	8.9
Oxycoccus microcarpus	10	T	0.8
Picea spp.	8	T	-
Potentilla fruticosa	21	0.1	16.1
Rosa acicularis	8	T	-
Salix spp.	73	1	-
Spirea beauverdiana	2	T	-
Vaccinium uliginosum	42	0.7	45.5
V. vitis-idaea	52	0.4	8.9
Sedge-Grass	100	11	1063.5
Herbs	88	0.1	25.0
Moss	98	64	2336.6
Other:			
Equisetum spp.	50	0.3	-
Lycopodium spp.	2	T	-
Bare	2	2	

o Occurrence - percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
T Trace.

ranging in this area. There were no broken hummocks and only a few trails. Considerable organic matter has accumulated in the soil so the soil conditions are good for increased growth of lichens. The profile showed an abundance of *Cetraria cucullata* in the 1.5 inch layer of partly decomposed vegetation on the surface, indicating a greater abundance of this species in an earlier stage of lichen succession."

Spruce occurs primarily in the southern portion of the unit. In the northern half, shrub birch and heaths are dominant and forage lichens are more abundant. However, work done in 1954, as well as Hanson's, indicates that lichen production is not very abundant in this unit. Hanson's study of the one stand indicated that the Group I lichens were in the process of becoming the dominants, replacing some of the secondary species. This unit has received more use during the 1960s, with the eastward movement of the Nelchina herd to new winter ranges. Skoog (1968) described caribou use as:

"being sporadic although frequently large numbers have moved through during late fall and early winter as part of the major movement patterns associated with the Lake Louise Flat. In 1961-62 a major portion of the herd wintered in the Mentasta Mountains far to the east and these animals traversed the lower portion of this Unit during early winter and early spring. Scattered groups of adult bulls frequently spend the summer and fall in the highlands to the north. The northern portion is suitable for summer use, also for early winter use before the snow becomes an inhibitory factor. The southern portion is good for early winter use by caribou."

He felt that it contained sufficient quantities of sedges for late winter forage as well. The unit has continued to receive heavier use as the animals primarily move through it getting to the Wrangell Mountain areas where they have been wintering in larger numbers during the 1960s. It is particularly important that ground examinations be conducted in this unit, particularly near Mankomen Lake where there is available comparative data from the examinations in 1954 and 1957. It is very likely that the lichen forage has been reduced as, based on available descriptions, it was primarily in the stage of recovering from previous fires and caribou use. The recent increased use probably has caused a deterioration of the lichen cover.

Unit 8: Upper Susitna Bottomland

According to Skoog (1959) this unit:

"extends along both sides of the Susitna River from the Alaska Railroad upstream to the mouth of Valdez Creek. The boundaries on both sides of the River follow timberline (approximately) with certain exceptions that are delineated in the description of

the boundaries of adjoining Units. The Units adjoining this one are 2, 3, 4, 5, 6, 9, 10, 11, 12, and 13."

The unit contains 720 square miles or 4.1 percent of the total Nelchina range. Its altitude ranges from 800 feet to 3,000 feet with an average of about 2,400 feet. It lies entirely below timberline. The principal vegetation type (Table 38), is spruce which covers over three-quarters of the area. The rest is made up of water and several vegetation types each comprising about 2 percent. Snowfall and wind are moderate and the banks of the river are snow-free early in the spring. Skoog described the lichens as being poor to fair. The spruce tends to be too thick and the ground too damp over much of the area to support good lichen growth. Almost all of the vegetation examinations have been conducted in the Fog Lakes region. Hanson (1958) described one stand in a heath type in this region (Table 39) and his rough draft is quoted entirely:

"This *Empetrum nigrum-Arctostaphylos alpina* Dwarf Heath stand is located on the upper part of the bank above one of the Fog Lakes on a north-facing slope of 5-35°. The altitude is 2,200 feet, Lat. 62°47', Long. 148°29'. The site is exposed to the wind and probably there is little or no snow cover in the winter. Large stones were scattered over the surface. Drainage on and below the surface was good. The large amount of organic matter in the soil indicates that the vegetation was more luxuriant at one time than at present. The presence of charred material in the soil indicates also that the stand was burned over at one time. Apparently the site is too xeric at present for invasion of spruce.

The well developed soil profile was as follows: 0-2 inches, dark reddish brown organic material with very little if any silt; 2-2.5 inches, pinkish gray organic matter, apparently decomposed lichens; 2.5-11 inches, dark reddish brown loam, rich in organic matter, with pieces of charred material and occasional stones; 11-20 inches, dark brown to brown sandy loam, with much gravel and many small stones. The pH was unusually low, 3.9 at 0-2 inches and at 2-2.5 inches; 4.5 at 2.5-11 inches; and 5.5 at 11-20 inches. Roots were extremely numerous in the 0-2 inch layer, well branched throughout, and the working depth was at 17-18 inches.

Only 12 species occurred in this stand. The chief vascular species were *Empetrum nigrum*, *Arctostaphylos alpina*, *Vaccinium vitis-idaea*, *Calamagrostis canadensis*, and *Ledum decumbens*. Moss hummocks were small, 1-3 inches high, and usually broken. Lichens were mostly only one inch high and the cover was medium, 3.9. The chief species were *Stereocaulon* spp., *Cladonia arbuscula*, *Cetraria cucullata*, *C. nivalis*, *Alectoria nigricans*, *A. ochroleuca*, *Cetraria islandica*, *Cladonia rangiferina*, and *C. alpestris*, the last

Table 38. Percent composition by vegetation types in Unit #8.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	1.8
2. Aspen-Poplar	2.0
3. Bog (Heath-Moss-Sedge)	2.2
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	2.6
6. Fescue Grass (*Festuca*)	-
7. Heath	0.6
8. Meadow (Sedge-Grass-Forb)	0.6
9. Water Sedge (*Carex aquatilis*)	2.2
10. Spruce	78.5
11. White Birch	2.0
12. Willow	2.2
13. Glacier	-
14. Bare Ground	0.2
15. Water	5.1

Table 39. Stand 76, *Empetrum nigrum* - *Arctostaphylos alpina* dwarf heath, on exposed site on south side of one of Fog Lakes. September 5, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover, Percent	100	100	100	100	100	100	100	100	99	99	100	
Arctostaphylos alpina	3		4	2	4	4	1	4	3	4	2.9	100
Betula glandulosa		2									0.2	10
Empetrum nigrum	3	2	2	4	4	4	1	3	4	2	2.9	100
Ledum decumbens		1	1	3	2	3	1		1		1.2	70
Picea mariana											x	
Salix myrtillifolia											x	
Vaccinium uliginosum	1			1	1		1	1	1		0.6	60
Vaccinium vitis-idaea	2	1	1	1	3	2	2	1	1	1	1.5	100
Calamagrostis canadensis	1	1	1	1	1	1	1	1	1	1	1.0	100
Carex bigelowii					1						0.1	10
Hierochloe alpina		1	1								0.2	20
Cornus canadensis			1								0.1	10
Sphagnum					4						0.4	10
Mosses	1	4	3	3	1	1	4	2	1	3	2.3	100
Lichens	5	4	4	3	2	4	4	4	4	5	3.9	100

being scarce in moist spots between shrubs. The site was apparently too exposed for good development of lichens. Similar stands occur on the same kind of sites in this vicinity. The range condition was rated Poor to Fair."

During the winter of 1958 an area near the Fog Lakes that had been utilized heavily for a short period of time was sampled (Skoog, 1959). Two transects, each 1500 meters long and containing 50 ten-meter square quadrats, were examined to determine the plant species present and area that was being grazed.

Table 40 shows the plant species and proportions that were broken up in the feeding craters. The area was considered heavily used and within the sample portion of 10,000 square meters, there were 914 feeding craters, averaging .24 square meter per plot or approximately 1 for every 11 square meters. The total area actually disturbed by pawing amounted to 2.2 percent of the sampled portion. From the examination it became apparent that sedges were a principal winter forage and that they were seldom damaged by digging of the feeding crater. A visual inspection of stomach samples from four caribou that were taken in the vicinity also indicated that sedges were an important winter forage item.

Table 41 is a summary of the data obtained in the Fog Lakes region.

Range Station 30: Fog Lakes, Heath Type

Station 30 was established in 1960 and its vegetation examined in 1961. It is located on the middle lake, the one with the island, at Fog Lakes. It lies on a small knoll along the south shore of the lake about 45 yards from the shore, at an elevation of 2,200 feet. It was described in 1961 by Skoog as:

"being on a wind-exposed knoll above the lake and encompasses a low Shrub Birch-Heath stand containing few species. Heaths are dominant, mostly narrow-leaved Labrador tea, blueberry, cranberry, crowberry, and alpine bearberry. Mosses are common but not thick nor abundant. The area once contained a good lichen growth as evidenced by 1-2 inch layer of decayed lichens in the subsurface soil. At present cover is still about 75%, but the lichens have been compacted and the Group I and II species replaced mainly by *Stereocaulon*. Most other lichens are compacted, scattered and broken. The area definitely has been overgrazed. The exposure of the site to wind and the lack of tall shrubs for protection are main factors aiding the rapid deterioration under heavy use. Not much forage remains at this site."

In 1967 Alexander indicated that there was no apparent difference between the vegetation inside and outside the exclosure. He also took photographs of damage by bears to the stakes of Plot B. They had been dug up and bent over. Quadrat B2 was severely damaged. Quadrat B1

Table 40. Frequency of plants occurring in pawed-out plots made by caribou feeding in a sedge-heath vegetation type in the Fog Lakes region - examined March 22-24, 1958.

Total Pawed-Out Plots Examined - 57

Plants	Plots w/Plant		Plots w/Broken-Uprooted Plants	
	No.	Percent	No.	Percent*
Woody:	57	100.0	47	82.5
Arctostaphylos alpina	23	40.4	0	0.0
Cassiope tetragona	15	26.3	6	40.0
Diapensia lapponica	3	5.3	2	66.7
Dryas sp.	2	3.5	0	0.0
Empetrum nigrum	49	86.0	41	83.7
Ledum decumbens	1	1.8	0	0.0
Loiseleuria procumbens	4	7.0	1	25.0
Salix reticulata	7	12.3	0	0.0
S. sp.	7	12.3	0	0.0
Vaccinium uliginosum	11	19.3	3	27.3
V. vitis-idaea	37	64.9	6	16.2
Lichens:		93.0	43	81.1
Cetraria islandica	22	38.6	14	63.6
C. nivalis	4	7.0	2	50.0
C. richardsonii	5	8.8	1	20.0
Cladonia alpestris	15	26.3	9	60.0
C. rangiferina	29	50.9	24	82.8
C. arbuscula	46	80.7	34	73.9
C. spp.	11	19.3	4	36.4
Dactylina arctica	19	33.3	11	57.9
Sedge: *Carex* spp.	51	89.5	3	5.9
Grass	12	21.1	4	33.3
Moss	48	84.2	22	45.8
Other: *Lycopodium* sp.	4	7.0	0	0.0

* Of the plots that actually contained the plant.

Table 41. Summarized data of range utilization by feeding caribou, as determined by the examination of feeding areas during the winter of 1957-58.

Items Tabulated	Fog Lakes
Dates Examined	March 22-24, 1958
Snow Cover	10" - 15", Old
Slope	3-5 Degrees
Vegetation Type	Sedge-Heath
Total Quadrats	100
Total Feeding Area Examined	10,000 square meters
Total Pawed-Out Plots	914
Plot Density: One Plot for Every	11 square meters
Average No. of Plots/Quadrat	9
Area of Plots: Total	218.85 square meters
Ave. Plot	0.24 square meters
Percent of Total Area Utilized	2.2
Total Pawed-Out Plots Checked for Plants	57
Plots w/Broken-Uprooted Plants	
No.	52
Percent	91.2

sustained moderate damage. The vegetation readings are presented in Table 42, and it can be seen that vegetation in Quadrat B2 was recovering somewhat from the bear damage, but still was not a good reflection of the use of the area. Quadrat B1 showed little effect although the stakes were bent over. Lichen growth inside and outside of the exclosure is quite different and a comparison of photographs from 1961 and 1970 indicated that recovery had started inside the exclosure. Still it was primarily *Stereocaulon paschale* and *Cladonia uncialis* inside the exclosure. Most of it was about 1 inch in height but it was rather dense and starting good recovery as compared to outside of the exclosure. In nine years time those lichens that were present had started some recovery under complete protection while outside, the range had continued to deteriorate. The species composition of lichens remained quite similar to what it was at the time of establishment, but they were more luxuriant. The continued sporadic use of the area primarily as the caribou are moving from one unit to another during the summer, as well as some winter use, has caused the lichens to deteriorate as was noted in 1961. Skoog (1968) described caribou use as being:

> "limited largely to transient animals because the Unit lies across many of the migration paths. Occasionally they will spend time in the area, especially on the snow-free areas during early spring. Mostly, however, the thick spruce and wet conditions are not qualities that normally attract caribou. Heavy trails criss-cross the main migration points and the animals do graze somewhat during their passage through. In winter, the ice along the upper half of the river becomes an "avenue" followed by the migrating animals."

Caribou use will probably remain as described by Skoog, since the principal calving area is Unit 12, and one of the principal summering areas, Unit 5, is adjacent to this unit. Some winter use has occurred in the past, but it was usually quite sporadic. Sedges were very abundant and appeared to take the major brunt of the caribou grazing. Sedges appear to be quite resistant to winter use as they were seldom destroyed, as is common for the shrubs and lichens. In the stands that were examined in the late 1950s by Hanson, there were good lichen stands, although they were only about one inch high and were primarily secondary types. The range condition was poor to fair. Station 30 was established where lichens were once abundant, but were primarily *Stereocaulon* spp., and the area was definitely overgrazed. By 1970 the lichens inside, primarily *Stereocaulon aschale* and *Cladonia uncialis*, showed good signs of recovery. However, they were still mostly between 1 and 2 inches tall but were very luxuriant and in good condition. Evidently this recovery started between 1967 and 1970, as Alexander did not note the difference in 1967. Unfortunately, an accurate determination of the use outside of this station cannot be obtained from Plot B, but a general examination of the outside vegetation indicates that it has deteriorated somewhat since 1961.

Table 42. Station 30: Fog Lake, heath type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2*
Total Cover	98[b]	100	100	100	100	90	100	50
Moss	5[b]	5	1	3	5	3	4	1
Betula glandulosa	1/15[c]	2/18	1/15	1/12	2/10	1/5	-	-
Vaccinium uliginosum	-	-	3/8	3/8	4/8	5/10	3/8	3/10
V. vitis-idaea	1	1	2	2	3	4	2	3
Ledum decumbens	t[d]	1/4	t	-	1/3	1/4	1/2	-
Empetrum nigrum	1	1	3	4	-	-	4	4
Arctostaphylos alpina	-	-	-	-	1	1	-	-
Rubus chamaemorus	-	-	-	-	t	-	-	-
Carex	t	-	-	-	t	1	-	-
Hierochloe alpina	-	-	-	-	-	-	t	1
Festuca altaica	-	-	-	-	-	-	t	-
Lichens	6/1	6/1	5/1	6/1	5/1	4/1	4/1	2/1
Cladonia alpestris	t	1/1	t	-	-	-	-	-
C. rangiferina	1/1	1/1	1/1	1/1	2/1	1	1/1	-
C. arbuscula	2/1	2/1	1/1	1/1	2/1	1	1/1	-
C. cornuta	-	1/1	-	-	-	-	-	-
C. uncialis	3/1	1/1	1/1	1/1	1/1	1	1/1	1
C. amaurocraea	-	1/1	-	-	-	1	-	-
C. gracilis	t	1/2	1/1	-	2/1	1	t	-
C. macrophylla	-	2/1	-	-	-	-	-	-
Cetraria cucullata	1/1	2/2	t	1/1	1/1	1	1/1	-
C. nivalis	1/1	1/1	t	-	t	-	t	1
C. islandica	1/1	1/1	t	2/1	t	1	t	-
C. richardsonii	t	-	t	1/2	-	-	-	-
Stereocaulon paschale	4/1	4/1	4/1	4/2	3/1	2	3/1	1
Thamnolia vermicularis	t	-	t	-	t	-	t	-
Dactylina arctica	-	-	-	-	t	-	t	-
Cornicularia divergens	-	-	-	-	-	-	t	-
Sphaerophorus globosus	-	-	-	-	-	-	t	1
Peltigera sp.	-	-	-	-	t	-	-	-

* Quadrat damaged by bears prior to 1967.

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

d Trace.

Unit 9: Alphabet Hills

The Alphabet Hills are in the east central portion of the Nelchina range, south of Tangle Lakes and north of Lake Louise Flat. The boundary that encircles the hills is timberline (approximately) and is at about the 3,200 foot contour level. There are 400 square miles in the unit amounting to 2.3 percent of the range. The altitude ranges from 2,600 to 5,400 feet. Almost 3/4 of the unit lies between 3,000 and 4,000 feet. Snowfall and wind are of moderate intensity and the ground usually becomes free of snow early in the spring. Spruce, shrub birch, and heath are the principal vegetation types in this unit (Table 43). Skoog (1959), in describing the vegetation said:

> "the western half of the unit has received much more use than the eastern portion. Lichen growth to the west consists primarily of the secondary lichens and exhibits a disrupted, trampled appearance. That to the east consists of good (2-3 inch) stands of *Cladonia alpestris*, *C. rangiferina*, and *C. arbuscula* and is more erect and vigorous."

In 1953, 48 quadrats near Monsoon Lake were examined for species composition and 12 were clipped to determine production. The data are presented in Table 44. Lichens were fairly abundant with moderate production. Hanson in 1957 examined one stand at the western end of Monsoon Lake. The narrative of his rough draft is available and it is here quoted in its entirety:

> "This climax *Betula glandulosa* stand is located on a south-facing slope of about 5-10° at the west end of Monsoon Lake at an altitude of 3100 feet, Lat. 62°50', Long. 146°40'. *Betula* averaged about 5 feet tall, ranging from 2 to 8 feet. The branches usually overlapped, but often the shrubs were 4 to 8 feet apart. *Vaccinium uliginosum*, 3-15 inches high, was abundant. Hummocks, formed by mosses, were 1-6 feet broad and up to 15 inches high. *Ledum decumbens*, about 8 inches high, was moderately abundant. There were no indications of fire on the surface. White spruce trees were widely scattered on the edges of this stand.
>
> Soil profile: 0-2.5 inches, organic material; 2.5-3.5 inches, loam with many partly decayed moss stems; 3.5-4.5 inches, sandy loam, with small pieces of charred wood; 4.5-8.5 inches, sand, some silt, much gravel, many stones; 8.5-12.5 inches, sand with much gravel and many stones; 12.5-22 inches, sand with some gravel and many stones; 22-26 inches, coarse sand and gravel with many stones. The pH varied from 4.3 in the surface horizon to 5.9 below 12.5 inches. Roots were extremely numerous at 0-2.5 inches and the working depth was at 15 inches.
>
> The lichens, 3-5 inches high, were chiefly in openings between the shrubs. The cover was good, averaging 4.5. The

Table 43. Percent composition by vegetation types in Unit #9.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	0.5
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	23.0
6. Fescue Grass (*Festuca*)	1.4
7. Heath	19.8
8. Meadow (Sedge-Grass-Forb)	4.9
9. Water Sedge (*Carex aquatilis*)	0.5
10. Spruce	35.6
11. White Birch	-
12. Willow	6.7
13. Glacier	-
14. Bare Ground	5.8
15. Water	1.8

Table 44. Unit 9: Plant composition as determined by visual estimation of plant cover and forage production in meter-square quadrats, 1953.

Species	Monsoon Lake o	Monsoon Lake d	lbs/acre
Date	8/5-10/53		
Total Quadrats	48		12
Lichens:			
Foliose	56	3	38.36
Fruticose	92	40	2560.61
Woody:			
Arctostaphylos alpina	17	0.6	7.13
A. uva-ursi	6	0.5	-
Betula glandulosa	67	3	16.05
Empetrum nigrum	71	5	314.05
Ledum spp.	79	6	117.77
Oxycoccus microcarpus	8	0.1	t
Populus spp.	2	t	-
Rosa acicularis	6	0.1	0.89
Salix spp.	42	3	49.07
Spirea beauverdiana	23	0.8	8.02
Vaccinium uliginosum	79	7	151.67
V. vitis-idaea	94	4	123.12
Sedge-Grass	85	4	32.11
Herbs	77	3	24.98
Moss	92	30	1238.37
Other:			
Fungi	2	t	t
Lycopodium sp.	10	0.2	21.41

o Occurrence - percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

chief species were *Cladonia rangiferina*, *C. arbuscula*, and *C. alpestris*. Other species were *Stereocaulon* (infrequent), *Cetraria cucullata* (scarce), *Thamnolia vermicularis* (scarce), *Cetraria richardsonii* (infrequent), *C. islandica* (infrequent), and *Peltigera aphthosa* (frequent). Recent use of lichens by caribou has been fairly heavy, as indicated by detached and broken branches of shrubs, the numerous trails, a few exposed roots, fairly numerous broken moss hummocks, and scattered clumps of lichens, apparently dropped after having been lifted from the ground. Some signs of pawing were evident.

This stand shows early effects of use by caribou. The range condition was rated as Fair to Good. The soil profile indicated that mosses, especially *Polytrichum* spp., play a very important part in building up the organic matter which precedes good growth of lichens such as *Cladonia alpestris*."

Range Station 36: Monsoon Lake, Shrub Birch Type

This station lies in a shrub birch type about 70 yards from the west end of the lake, at an elevation of 3,000 feet. It was constructed in 1960 and the vegetation read in 1961. The vegetation was described by Skoog in 1961 as:

"White spruce are thinly scattered in the stand. The vegetation at this end of the Lake lies in the bottom between hills and probably has built up from a more moist situation with abundant sedges. Near the lake the ground is quite moist with sedge, *Petasites*, *Sphagnum*, and other moisture tolerant plants. Hummocks measuring 1' x 2' x 1 1/2' to 10' x 6' x 2' of *Sphagnum* and moss are a common feature upon which grow heaths and shrub birch. Generally the *Sphagnum* and sedge become less abundant and the ground drier away from the Lake. Lichens begin to fill in the space between the shrub birch; *Cladonia rangiferina* near the base; and *Cladonia arbuscula* and *C. alpestris* in the open areas. *Cetraria islandica* is a common species as well. Moss covered nearly 100% of the ground. The lichen growth is quite good. Groups I and II predominate with foliose lichens common. The area has been used by caribou only to a small extent, judging from the good lichen growth (2-4"), as contrasted with the adjacent areas where the lichens have been trampled and broken to a great extent. Suspect that the Shrub birch cover has been a major factor in protecting the lichens, aside from the fact that caribou normally utilize the ridge more in their grazing. At present the area is used mostly by caribou on the move and many trails are a common feature."

In 1967 Alexander indicated that there was no visible difference between inside and outside the exclosure. In 1970 there was a very marked difference between the growth of lichens inside and outside (Table 45). The use of lichens in Plot B and other areas outside has evidently been

Table 45. Station 36: Monsoon Lake, shrub birch type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100[b]	100	100	100	100	95	100	100
Moss	6	6	6	6	6	5	6	6
Betula glandulosa	5/48[c]	5/44	5/48	6/46	3/48	2/48	6/36	5/40
Vaccinium uliginosum	2/7	2/6	3/7	4/7	2/5	3/8	3/7	4/8
V. vitis-idaea	1	1	2	2	1	1	4	4
Empetrum nigrum	-	-	-	-	1	1	3	2
Ledum decumbens	3/9	3/7	2/4	3/5	-	-	-	-
Festuca altaica	2	1	1	1	2	2	1	2
Hierochloe alpina	-	-	-	-	-	1	-	-
Calamagrostis lapponica	-	2	-	2	-	2	-	1
Lichens	5/3	4/3	5/2	4/2	6/2	4/1	5/2	4/2
Cladonia alpestris	t[d]	-	-	-	3/2	1/1	1/2	1/2
C. rangiferina	4/3	3/3	2/3	2/2	3/3	2/1	4/3	3/2
C. arbuscula	2/3	1/3	1/2	-	2/2	1/1	1/2	1/1
C. uncialis	-	-	2/3	-	1/1	2/1	-	-
C. gracilis	t	-	1/2	-	t	1/1	t	-
C. deformis	-	-	-	-	1/1	1/1	-	-
Cetraria islandica	2/3	1/3	2/3	2/2	3/1	2/1	2/2	1/2
C. cucullata	-	-	-	-	-	-	-	1/1
Stereocaulon paschale	-	-	-	-	2/1	1/1	-	-
Peltigera aphthosa	2	2	3	2	t	-	2	-
P. malacea	2	-	-	1	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

very heavy since 1967. A comparison of the photos of 1961 and 1970 show a striking deterioration of the very good stand of lichens that occurred in 1961. There has been little change in the shrubs or other vascular plants over the interim period. It is apparent that the use has been heavier recently. A major portion of this could be summer use because, with the dense shrub cover, snow would be quite deep during the winter time. The station lies along a principal route of movement of animals to and from their wintering range. This continued use is starting to detrimentally effect the growth of lichens.

Caribou have used the area sporadically throughout the last several years, both summer and winter. It is primarily during the fall that the major portion of the herd passes through the area moving to their wintering ground. Seldom do they remain in the unit for long periods of time. This movement of large numbers of animals is starting to seriously affect the vegetation as the lichen cover in the vicinity of Monsoon Lake demonstrates. The western portion of the unit has shown some evidence of trampling since the first reports, but the eastern portion supposedly was in excellent condition. In 1953, lichens were fairly abundant but showed only a moderate production and sedges were low in the vicinity of Monsoon Lake. In the shrub birch stand that Hanson (1958) describes, the lichen cover was very good and consisted primarily of the Group I lichens (the most palatable and preferred lichens). There was scattered evidence of recent use. In 1959 when Skoog examined the area, the lichen growth varied from poor to excellent, averaging 1 to 2 inches in height. About 5 percent of the 600 linear feet of transects examined, showed evidence of damage by caribou. It contained much lichen forage at that time. Both moose and caribou use the area and the use during the snow-free period by these animals has led to the deterioration of lichen condition noted in 1970.

Unit 10: Chunilna Hills

This unit is bounded on the west by the Alaska Railroad, on the south and east by the Talkeetna River and Prairie Creek and on the north by the 3,000 foot contour level just south of the Susitna River. Elevation ranges from 400 feet near the mouth of the Talkeetna River to 4,500 feet, and 70 percent is below 3,000 feet. There are 730 square miles (which is 4.2 percent of the Nelchina range) in Unit 10. Snow cover is usually moderate to heavy, but winds are of moderate intensity and snow dissipates early in the spring. Table 46 shows that a quarter of the unit is composed of the heath type. Alder, spruce and meadow are also common types in this unit. In spite of the relatively low elevation, over half of it lies above timberline. No ground examinations have been reported in this unit, but Skoog (1968) stated that aerial observations revealed good stands of lichens are present. Many seemed to be climax stages of *Cladonia alpestris*. Use by caribou has been limited to a few wandering bands for several years. Although the unit appears to be used only to a minor extent by caribou, Skoog (1968) reported that the abundance of lichens, sedges and grasses causes the unit to be a potentially important winter and summer range.

Table 46. Percent composition by vegetation types in Unit #10.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	16.5
2. Aspen-Poplar	1.0
3. Bog (Heath-Moss-Sedge)	0.8
4. Bluejoint Grass (*Calamagrostis*)	2.3
5. Shrub Birch	2.5
6. Fescue Grass (*Festuca*)	-
7. Heath	25.3
8. Meadow (Sedge-Grass-Forb)	15.3
9. Water Sedge (*Carex aquatilis*)	-
10. Spruce	19.5
11. White Birch	6.5
12. Willow	6.3
13. Glacier	-
14. Bare Ground	2.0
15. Water	2.0

Unit 11: Talkeetna River

Skoog (1959) described the unit as "encompassing the drainage of the upper portions of the Talkeetna River. It is bounded on the west by Unit 10 and Sheep Creek, and on the south by Sheep Creek and the divide separating the drainages of the Talkeetna River and Kosina Creek and on the north by Unit 8 (timberline at about 3000 feet)." There are 1,380 square miles which comprise 7.9 percent of the Nelchina range. Elevation ranges from 500 feet to well over 8,000 feet of which 52 percent lies above 4,000 feet. Snow cover is heavy but the frequent winds expose several of the ridgetops. Most of the unit is above timberline and heath predominates (Table 47). Bare ground is a major feature due to the ruggedness of the terrain. Meadow, spruce, shrub birch are common vegetation types. The vegetation has been examined primarily in the wintertime and Skoog (1968) stated that lichen growth seemed rather discontinuous and consisted largely of secondary lichens. During the winter of 1957-58 the upper Talkeetna River was examined where the caribou had been grazing. Table 48 shows the vegetation that was present in the feeding craters. It was noted that caribou trails were common along the riverbed and through timbered areas; however, little feeding activity was noticed. Most of the grazing occurred near or in the heath type above timberline and mostly on slopes of 15-25°. It was one of these sites that was examined that winter. It can be noted that lichens, heaths, and sedges were the dominant plants. It appeared that lichens were the primary food item and sedges the secondary. *Cladonia arbuscula* and *C. rangiferina* were the most abundant species, but they were not particularly luxuriant. Heaths were comprised of crowberry, blueberry and narrow-leaved Labrador tea and cranberry; however, very little evidence of browsing of these plants was noted. Stomach samples from seven caribou indicated that lichens and sedges were the principal forage with some shrub birch leaves and other twigs being present.

Skoog continued the winter utilization studies from 1958 through 1960. The Upper Talkeetna River area was selected as it was being used fairly extensively at that time. Prior to 1956 it had been relatively untouched by caribou and it appeared to be a good area to examine to determine the effects of caribou use. In the winter of 1959-60 Skoog examined the area between Clear Creek and the main stem of the Talkeetna River where caribou were feeding primarily in the meadow and heath types. At that time lichens appeared to be scarce. He noted that in the feeding craters, the vascular plants included alpine bearberry, shrub birch, crowberry, narrow-leaved Labrador tea, willow, blueberry and cranberry. The sedges and grasses that were present were unidentified and were lumped into one group. Lichens included *Cetraria islandica, C. cucullata, C. nivalis, C. richardsonii, Cladonia rangiferina, C. arbuscula and C. uncialis*; all of poor growth (less than one inch tall) and spotty distribution. On 5,000 square meters of surface area examined, there were 681 feeding craters, one for every 7 square meters of surface. The craters totaled about 306 square meters or 6 percent of the total area examined. This was an area of heavy use so it appeared that caribou did not cause much damage to the total vegetative cover. The main food items appeared to be sedges and lichens. Table 49 is a comparison of the feeding crater data obtained in 1958 and 1960. In the summer of 1960, Skoog continued

Table 47. Percent composition by vegetation types in Unit #11.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	5.5
2. Aspen-Poplar	0.3
3. Bog (Heath-Moss-Sedge)	-
4. Bluejoint Grass (*Calamagrostis*)	0.5
5. Shrub Birch	9.5
6. Fescue Grass (*Festuca*)	0.2
7. Heath	35.4
8. Meadow (Sedge-Grass-Forb)	10.4
9. Water Sedge (*Carex aquatilis*)	0.2
10. Spruce	11.3
11. White Birch	1.1
12. Willow	3.6
13. Glacier	2.5
14. Bare Ground	18.1
15. Water	1.4

Table 48. Frequency of plants occurring in pawed-out plots made by caribou feeding in a lichen-heath vegetation type on the upper Talkeetna River - examined February 15, 1958.

Total Pawed-Out Plots Examined - 86

Plants	Plots w/Plant		Plots w/Broken-Uprooted Plants	
	No.	Percent	No.	Percent*
Woody:	86	100.0	37	43.0
Arctostaphylos alpina	11	12.8	0	0.0
Betula glandulosa	11	12.8	1	9.1
Cassiope tetragona	27	31.4	5	18.5
Empetrum nigrum	75	87.2	36	48.0
Ledum decumbens	41	47.7	12	29.3
Salix reticulata	8	9.3	0	0.0
S. sp.	6	7.0	1	16.7
Vaccinium uliginosum	74	86.0	18	24.3
V. vitis-idaea	37	43.0	2	5.4
Lichens:	86	100.0	85	98.8
Cetraria cucullata	42	48.8	40	95.2
C. islandica	34	39.5	32	94.1
Cladonia alpestris	32	37.2	32	100.0
C. rangiferina	72	83.7	68	94.4
C. arbuscula	83	96.5	83	100.0
Dactylina arctica	13	15.1	11	84.6
Sedge: *Carex* sp.	56	65.1	0	0.0
Moss	72	83.7	19	26.4
Other: *Lycopodium* sp.	36	41.8	0	0.0

* Of the plots that actually contained the plant.

Table 49. Comparison of winter feeding areas examined on the Upper Talkeetna River, Unit 11.

Date examined	2/15/58	4/2/60
Snow cover	4-12" old	16-30" old
Slope	15-20°	10-15°
Vegetation type	Heath	Sedge meadow and heath
Total quadrats	0	50
Total area examined	3,400 square meters	5,000 square meters
Total feeding craters	86	681
Crater density: one for every	40 square meters	7 square meters
Area of craters: Total	24.14 square meters	305.96 square meters
Average	0.29 square meters	0.45 square meters
Percent of total area utilized	0.7	6.1
Degree of use	Moderate	Heavy

this study in the Upper Talkeetna area to determine the effects of winter use on the vegetative mat once the snow cover was gone. Six hundred one-meter square quadrats and 100 foot transects were examined in 22 different vegetation stands to obtain data on the plant species' frequency and cover. Seven stands of heath, 5 sedge meadow, 3 shrub birch, 2 spruce, 2 fescue, 2 willow, and one early successional stage of lichens were examined. An attempt was made to measure the effects of three years of intensive caribou grazing by the use of 100-foot transects by designating the use of the lichen cover as either light or heavy. Nine thousand feet of transects across the main lichen areas were examined and 2,448 feet, or 27 percent of the total, were recorded as being disturbed by caribou. Of that, 1,609 feet, or 18 percent was considered light grazing and the remaining 839 feet, or 9 percent, was classified as heavy use. The areas that were classified as light probably would produce new growth provided they are not disturbed for 3 to 5 years (Skuncke 1969, Andreev 1954). Those areas that were classified as heavy appeared to have been essentially destroyed and it seems likely several years will be required for them to recover. There was very little evidence of heavy use in the meadow type which covers about 10 percent of the region and was an important source of winter forage. Skoog (1961) stated that 9 months of winter use, (i.e. 3 winters of 3 months each) by over 20,000 caribou on an area of about 100 square miles (i.e. about one animal per three acres), had resulted in 9 percent of the lichen forage being destroyed and 18 percent grazed lightly. This indicated that under continued heavy use of such intensity, the range probably would deteriorate rapidly. However, the buffering effect of the meadow could not be determined. Unfortunately, a large amount of descriptive vegetational data should be available from the meter square quadrats, but these data apparently are no longer in the files and cannot be reported herein. They would be very useful in describing and comparing the vegetation with the other range units.

Caribou use was very light prior to the winter of 1956-57. Since that time, however, it has been used frequently as a wintering area by a large number of animals. Usually only small bands occur in the summer. Although Skoog (1961) demonstrated that continued use over a short period of time led to deterioration of the lichen cover, there is little information to indicate any severe damage to the vascular plants.

Unit 12: Oshetna River

This unit is in the central portion of the range and encompasses the main calving and summering grounds of the Nelchina caribou. It is bounded on the west by Unit 11 and on the south by the divide that separates the Oshetna River and Flat Creek from Caribou Creek. The eastern boundary is a line running northward from the bend of the Little Nelchina River, to the mouth of Daisy Creek, continuing down Tyone Creek to the spruce line (approximately) and following that westward almost to the Oshetna River and northward to a point about six miles upstream from the mouth of the Oshetna River. The northern boundary is timberline which approximates the 3,000 foot contour level. This unit encompasses 1,540 square miles, which is 8.8 percent of the total Nelchina range. Altitude ranges from 2,000 feet to 7,600 feet, with 45 percent of the unit above 4,000 feet.

Snow depth is moderate to heavy and snow cover persists late into the spring, especially in the northern portion. The principal vegetation types are shrub birch, heath, meadow and spruce (Table 50). Skoog (1959) stated that lichen cover throughout the area generally was poor, consisted mostly of secondary species and occured primarily in the shrub birch and heath types. The poor growth resulted from both poor drainage and heavy use by caribou in the past. The unit has been the site of the main calving activity in the spring for a long period. Heavy trails interlace the region and most of the herd spends much of the summer in Unit 12. Only a few animals are present in the winter except for transient groups which pass through.

Table 50. Percent composition by vegetation types in Unit #12.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	0.1
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	0.1
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	31.6
6. Fescue Grass (*Festuca*)	7.2
7. Heath	23.8
8. Meadow (Sedge-Grass-Forb)	11.6
9. Water Sedge (*Carex aquatilis*)	0.6
10. Spruce	9.2
11. White Birch	-
12. Willow	5.6
13. Glacier	0.6
14. Bare Ground	8.0
15. Water	1.6

Hanson examined several stands in this unit during the summer of 1957 and he presented the data for a shrub birch type in the upper Tyone Creek in Table 6 of his report (Hanson 1958). Table 8 contains a heath type in upper Tyone Creek and Table 11 covers a fescue type in upper Tyone Creek. He also described two other stands in his rough draft of a shrub birch type. These are presented in Table 51.

Since this unit is the principal calving and summering area and probably shows greater deterioration of the range, particularly of the lichen cover, Hanson's descriptions are included verbatim to enable a better understanding of the vegetation in the unit.

"Stand 5

This *Cassiope tetragona*-Heath stand is located on a steep northerly facing slope of 25-40° in the calving range on the south side of Tyone Creek at an altitude of about 4000 feet, Lat. 62°11', Long. 147°11'. Analysis was made on June 29, 1957.

As shown in Table 52, the number of vascular species was high, 35. The chief species were *Cassiope tetragona* 4-6 inches high, *Loiseleuria procumbens*, *Vaccinium vitis-idaea*, *V. uliginosum*, *Empetrum nigrum*, *Equisetum scirpoides*, *Salix arctica*, *Hierochloe alpina*, *Arnica lessingii*, and *Pedicularis capitata*. *Betula glandulosa* and taller species of *Salix*, up to 2 feet high, were widely scattered. The stand was conspicuous from a distance because of its dark greenish brown color.

Except in bare spots the living cover on the surface was up to 2 inches high, and the decaying vegetation about 0.5 inch thick. The soil profile was as follows: 0-1.5 inches, dark reddish brown, organic matter; 1.5-4.5 inches, dark brown loam with a few small stones and gravel particles; 4.5-10 inches, dark brown loam with numerous pebbles and stones; 10-24 inches, mostly stones with very little soil between them. The pH was 5.1 at 1.5-4.5 inches, 5.9 at 4.5-10 inches. The roots were very numerous to 18 inches. There was no effervescence at any layer with 20 percent HCl.

The moss cover, 2.6, was moderate. The chief species were *Hylocomium splendens*, *Pleurozium schreberi*, *Polytrichum strictum*, and *Dicranum fuscescens*. The lichen cover was also moderate, 2.2. The lichens were much shattered by caribou trampling apparently. Many species were present, including the following, in approximate order of abundance.

Nephroma arcticum	*Sphaerophorus globosus*
Cladonia rangiferina	*Cladonia amaurocraea*
Cetraria cucullata	*Thamnolia vermicularis*
Dactylina arctica	*Cetraria richardsonii*

Table 51. Unit 11: Summary of 10 quadrats per stand by Hanson (1958) in a shrub birch type.

Location:	East End of Black Lake		Upper Tyone Creek	
Stand:	78		6	
Species:	Aver. Cover	Frequ. %	Aver. Cover	Frequ. %
Total Cover	97.7	-	100	-
Arctostaphylos alpina	-	-	0.7	20
Betula glandulosa	2.3	100	2.9	100
Empetrum nigrum	2.0	80	1.7	60
Ledum decumbens	-	-	0.2	10
Loiseleuria procumbens	0.1	10	-	-
Salix arctica	-	-	0.1	10
S. pulchra	0.2	20	0.1	10
Vaccinium uliginosum	0.5	40	0.6	40
V. vitis-idaea	1.3	100	2.6	100
Calamagrostis canadensis	0.8	80	0.1	10
Festuca altaica	2.0	100	0.1	10
Hierochloe alpina	0.5	50	2.0	100
Carex bigelowii	0.9	90	-	-
C. montanensis	-	-	0.9	80
C. podocarpa	-	-	0.2	10
Anemone narcissiflora	0.1	10	1.2	90
Antennaria monocephala	0.3	30	0.2	10
Arnica lessingii	-	-	0.2	20
Artemisia arctica	0.4	40	-	-
Gentiana glauca	0.1	10	0.4	40
Pedicularis capitata	-	-	0.1	20
P. labradorica	0.3	30	0.6	60
Polygonum bistorta	-	-	0.5	40
Stellaria laeta	-	-	0.1	10
Mosses	3.1	100	3.8	100
Lichens	3.0	100	3.7	100

Table 52. Stand 5, *Cassiope tetragona* - dwarf heath on calving range, at about altitude 4000 feet, upper part of Tyone Creek. June 29, 1957 (from Hanson, 1958).

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover	80	80	78	70	92	75	80	85	40	95	77.5	-
Arctostaphylos alpina	1	3	2	-	-	-	-	3	-	1	1.0	50
Betula glandulosa	-	1	1	-	-	-	-	-	-	1	0.3	30
Cassiope tetragona	3	3	3	2	2	2	3	3	2	2	2.5	100
Dryas octopetala	-	-	-	-	-	-	2	-	-	-	0.2	10
Empetrum nigrum	3	3	3	3	2	-	1	2	2	-	1.9	80
Ledum decumbens	3	1	2	1	1	-	1	1	1	-	1.1	80
Loiseleuria procumbens	1	2	2	3	4	3	3	2	3	3	2.6	100
Salix arctica	1	1	-	-	1	1	1	1	1	3	1.0	80
Salix glauca angustifolia	1	1	-	-	-	-	-	-	-	-	0.2	20
Salix reticulata	-	-	-	-	-	-	-	-	-	1	0.1	10
Vaccinium uliginosum	1	-	3	1	3	2	3	3	2	1	1.9	90
Vaccinium vitis-idaea	3	3	3	2	2	1	2	2	1	2	2.1	100
Carex bigelowii	-	-	-	-	-	x	-	-	-	-	0.1	10
Carex podocarpa	-	-	-	x	1	1	-	-	x	1	0.3	50
Festuca altaica	x	-	-	-	-	-	-	-	-	-	0.1	10
Hierochloe alpina	-	1	1	1	1	1	2	-	1	2	1.0	80
Luzula confusa	1	-	-	-	-	-	-	1	-	-	0.2	20
Anemone narcissiflora interior	-	1	-	-	-	-	-	-	-	1	0.2	20
Antennaria monocephala	-	-	-	-	-	-	1	-	-	-	0.1	10
Arnica lessingii	1	1	1	1	2	2	-	-	2	-	1.0	70
Equisetum scirpoides	1	2	2	2	2	1	2	2	1	-	1.5	90
Lycopodium selago	-	-	-	-	-	1	-	-	-	-	0.1	10
Petasites frigidus	-	-	-	-	-	1	-	-	1	1	0.3	30
Polygonum bistorta plumosum	1	-	-	1	1	-	1	-	x	2	0.6	60
Senecio sp.	-	-	-	-	-	-	-	-	-	1	0.1	10
Mosses	4	3	4	2	4	2	1	2	2	2	2.6	100
Lichens	3	2	2	2	3	2	3	2	1	2	2.2	100

Cladonia arbuscula *Cetraria nivalis*
Stereocaulon paschale *Cladonia gracilis*
Peltigera aphthosa

Caribou had formed numerous trails and erosion was occurring in places. The range condition for use during spring and summer was rated Fair. The basis for this classification is the spottiness of the herbage cover, erosion in places, and the large percentage of apparently less desirable forage species (for spring and summer grazing) making up the cover."

"Stand 6

This is located on a slightly rolling hilltop near Tyone Creek at an altitude of 4100 feet, about the upper limit of this type, Lat. 62°11', Long. 147°22'. Analysis was made on June 29, 1957. In this low *Betula glandulosa* - *Hierochloe alpina* - Heath stand, *Betula* had an average cover of 2.9 and *Hierochloe* 2.0. Other major species were *Vaccinium vitis-idaea*, 2.6; *Anemone narcissiflora interior*, 1.2; *Empetrum nigrum* 1.7; *Carex montanensis*, 0.9; *Arctostaphylos alpina*, 0.7; *Pedicularis labradorica*, 0.6; and *Vaccinium uliginosum*, 0.6. The total number of vascular species was 27. This stand showed considerable resemblance to a Meadow type, because of the abundance of herbs.

The fresh and decomposing litter, including mosses and lichens, on the surface was about one inch thick. The soil profile had the following layers: 0-0.5 inches, dark reddish brown organic material; 0.5-3.5 inches, fine sandy silt, reddish brown with some grayish brown spots; 3.5-11 inches, variable, sandy loam to sandy silt with intermixed gravel and stones; 11-21 inches, mostly stones and gravel with very little fine material between. The pH was 5.1 at 0.5-3.5 inches, 5.4 at 3.5-11 inches. Roots were numerous in the lower part of the litter and in the organic layer, the working depth was at 12 inches.

Mosses were abundant, 3.8 in cover. The chief kinds were *Hylocomium splendens*, *Pleurozium schreberi*, *Dicranum fuscescens*, and *Polytrichum strictum*. Lichens were abundant, 3.7 in cover. The chief kinds were *Cladonia arbuscula*, *C. rangiferina*, *C. gracilis*, *C. amaurocraea*, *Cetraria cucullata*, *C. richardsonii*, *C. nivalis*, *Nephroma arcticum*, *Peltigera aphthosa*, *Stereocaulon paschale*, *Dactylina arctica*, and *Thamnolia vermicularis*. In openings between the shrubs, the lichens were greatly shattered. Many cows and calves have frequented this area during the calving season. The range condition for spring and summer use was rated Good because of the variety and abundance of vascular species."

There are two exclosures in this unit, one at Black Lake and the other at Clarence Lake. Both were constructed in 1960.

Station 28: Black Lake, Shrub Birch Type

The exclosure lies 50 yards from the eastern shore of Black Lake at an elevation of 3,500 feet in a shrub birch stand on a 2° west facing slope. In 1953 a general examination of the vegetation near Black Lake was conducted and the readings are presented in Table 53. As can be seen, lichens at that time were at a low density and only about 695 pounds per acre of fruticose types were available. However, the other vascular species were somewhat numerous. Hanson examined one stand in 1957 on the east end of Black Lake in the general area of the exclosure and the description in his rough draft is presented herein, as well as the vegetation analysis of the 10 quadrats that are summarized in Table 49.

> "The entire slope showed much use by caribou, in spring and early summer. Much trailing has taken place. *Betula glandulosa* was about one-third less dense than in Stand 4. Grasses and sedges were somewhat more dense, but forbs were less numerous than in Stand 4. *Betula* averaged 4.5 feet tall (2-6 feet) with overlapping branches, or spaced as much as 12-15 feet apart. *Salix pulchra* was widely scattered, 1-4 feet high. *Vaccinium uliginosum*, 3-12 inches high, was sparse. *V. vitis-idaea* and *Empetrum nigrum* were the most abundant low shrubs. *Betula* and other shrubs usually had hummocks, up to one foot high, at the base. *Sphagnum* hummocks, up to 18 inches high, were sparse.
>
> Bunches of *Festuca altaica* were numerous and vigorous, with many seed stalks, up to one foot high. *Calamagrostis canadensis* had leaves up to one foot high, but seed stalks were lacking. *Carex bigelowii* and *Hierochloe alpina* added to the grassy cover on openings between the shrubs. Many basal stems and roots of shrubs were exposed, and dead plants and broken branches were scattered. There were many broken hummocks, remnants of hummocks, and clumps of dead moss. These openings, often with much mineral soil on the surface, were packed and hard. Many stones were also exposed. It appears that *Festuca altaica* increases and the shrubs decrease on this mineral soil. Is it possible that overuse of the *Betula* type at this altitude, or higher, and in sandy to loam soils may in time change it into the Fescue type?
>
> The organic layer in the soil was about one inch thick, except in places where the mineral soil was exposed. The 1-10 inch horizon consisted of dark brown to dusky red loam to sand; 15-17 inches sand with many gravel particles and small stones; 17-30 inches, similar to above but with slightly larger stones. The pH increased gradually from 5.2 at 1-10

Table 53. Unit 12: Plant composition as determined by visual estimation of plant cover and forage production from clipped quadrats in meter-square quadrats, 1953.

Species	Black Lake o	Black Lake d	lbs/acre
Date	7/1-6/53		
Total Quadrats	65		8
Lichens:			
Foliose	20	2	50.85
Fruticose	77	15	695.91
Woody:			
Arctostaphylos alpina	11	2	130.26
A. uva-ursi			2.67
Betula glandulosa	23	3	9.81
Cassiope spp.	23	2	269.44
Dryas spp.	18	4	59.77
Empetrum nigrum	49	7	489.81
Ledum spp.	12	0.7	15.16
Loiseleuria procumbens	6	0.6	86.54
Potentilla fruticosa	14	0.7	7.13
Rosa acicularis	2	t	-
Salix spp.	72	14	14.27
Spiraea beauverdiana	5	0.1	-
Vaccinium uliginosum	46	5	84.75
V. vitis-idaea	45	3	29.44
Sedge-Grass	100	19	134.72
Herbs	62	3	7.13
Moss	92	29	4193.34
Other:			
Equisetum spp.	6	0.1	-
Lycopodium sp.	12	1	12.49
Bare:	6	0.6	

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

inches to 5.8 at 17-30 inches. Roots were extremely numerous in the organic layer, and moderately numerous to the working depth at 20 inches. The depth to which dark soil was found indicates that the vegetation in this stand at one time was much more luxuriant than at present.

The lichens on the hard-packed openings were greatly shattered and formed a thin layer, an inch or less in thickness. The most abundant were *Stereocaulon* spp. and *Cladonia* spp., the latter similar to *C. coccifera* and *C. pleurota*. *Cetraria nivalis* and *Dactylina arctica* were scarce. The most common under dense shrubs were *Cladonia rangiferina*, 1-2 inches high, and *C. arbuscula*. Other species occurring sparsely were *Cetraria cucullata*, *C. richardsonii*, *Cladonia alpestris*, and *Peltigera aphthosa*.

The range condition for spring and summer use by caribou was rated as Fair. Considerable forage was available, but the rate of deterioration of the shrubs and the lichen-moss layer was rapid. Herbaceous forage was apparently increasing. As winter range, the condition was Poor."

In 1962 the vegetation was described by Skoog as:

"A Shrub Birch stand of low to medium height encompassing a small knoll of about 100 feet in diameter. Immediately surrounding this knoll on all sides except the Lake on the west side is a *Carex-Salix-Betula* bog. About 100 yards to the east the *Betula* type begins again on the side of a well-drained hill. There are few species in this stand, only 8 recorded plus lichens and mosses. Shrub birch, cranberry and *Hierochloe alpina* are the most abundant vascular plants. Mosses cover about 100% of the ground; lichens about 75% but are of low growth. Group I lichens are not abundant. Group II and III predominate with many species present. It is doubtful that the site has had good lichen growth in recent times as there is no evidence, even under shelter of the birch. Comparatively little caribou use evident; it is not an important wintering area. Most use occurs during early summer after the calving period primarily by transient animals."

In 1967 Alexander did not notice a difference in the vegetation inside and outside of the exclosure. In 1970 there was a very slight change in the vegetation inside as compared to outside. A comparison of the photographs and of the plot readings (Table 54) indicate that the lichen cover outside the exclosure has been reduced somewhat. Due to the dense shrub cover, use has remained relatively light. Inside the exclosure the lichens are upright but not very dense. In Quadrat A1 approximately 40 percent of the shrub birch appeared to be dead.

Plot B is in taller birches but use of the entire area is still relatively light, and there has not been much noticeable change except in Quadrat B2 where the lichen cover has been reduced.

Table 54. Station 28: Black Lake, dwarf birch type.

Year	1962	1970	1962	1970	1962	1970	1962	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100	100	100	100	100	100	100	100
Moss	6[b]	6	6	6	6	6	6	6
Betula glandulosa	4/15[c]	4/18	5/15	5/16	5/18	4/26	5/15	6/24
Vaccinium vitis-idaea	3	3	5	5	2	2	4	5
Hierochloe alpina	3	4	3	4	2	3	1	2
Lichens	6/1	5/1	5/1	5/1	5/1	5/1	5/2	3/1
Cladonia rangiferina	2/1	1/1	1/1	1/1	1/1	1/1	2/2	1/1
C. arbuscula	1/1	3/1	t	3/1	1/1	2/1	1/1	1/1
C. uncialis	1/1	1/1	3/1	1/1	3/1	1/1	1/1	1/1
C. amaurocraea	t[d]	1/1	t	1/1	t	1/1	-	-
C. gracilis	t	1/1	t	-	1/1	1/1	t	-
C. deformis	-	-	t	-	t	1	t	-
Cetraria islandica	t	1/1	t	-	t	1/1	1/1	1/1
C. cucullata	1/1	1/1	t	1/1	1/1	2/1	1/1	1/2
C. richardsonii	2/2	2/1	1/2	1/1	1/3	2/1	2/3	2/2
Stereocaulon paschale	3/1	2/1	2/1	1/1	1/1	1/1	t	-
Thamnolia vermicularis	1	-	t	1/1	t	-	t	1
Peltigera pulverulenta	2	2	-	2	1	1	2	2

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

Use over the last 10 years has not changed appreciably and there has been just a small change in the condition of the lichens. Even with total protection inside the exclosure, the condition of lichens was such that it will require a considerable time for recovery of the lichen cover. However, this unit should be considered principally a spring and summer range and lichens are of little importance at that time. Principal emphasis should be placed on the vascular species which have shown little reaction, except that the shrubs appear to be continually dying off inside as well as outside of the exclosure.

Range Station 29: Clarence Lake, Shrub Birch Type

A general vegetative reconnaissance was conducted in 1953 and 1954 in the Clarence Lake region and the data are presented in Table 55. As can be seen, there was good lichen cover at that time, and particularly in 1953, there was very high productivity of the fruticose lichens indicated (4,930 pounds). Although the 1954 productivity estimate was smaller, it indicates that at that time the area was not being heavily used by the spring and summer calving segment.

Station 29 was constructed in 1960 and the vegetation examined in 1961. Hanson (1958) described one stand in the Clarence Lake region which, however, is not in exactly the same location as the exclosures. It is in a similar type and is included for general information.

> "This was a moderately dense *Betula glandulosa*-Heath stand. *Betula* was usually about 4 feet high, maximum about 6 feet. Usually the branches overlapped, but in places the shrubs were 6-8 feet apart. The chief heath shrubs were *Vaccinium uliginosum*, *V. vitis-idaea*, and *Ledum decumbens*, 4-8 inches high. *Arctagrostis latifolia* was scattered and *Carex bigelowii* and *Hierochloe alpina* were very sparse. There were only 8 vascular species in the stand.
>
> The 0-1 inch layer in the soil profile consisted of organic matter and a few fragments of charred wood. Old stems of *Polytrichum sp.* were very numerous. The 1-5 inch layer was loam, rich in organic matter; 5-8 inches, sand with many gravel particles; 8-18.5 inches, similar to above but containing 1 or 2 cemented layers, 1-1.5 inches thick, apparently cemented by iron and organic material; 18.5-35 inches, sand. The pH at 0-1 inch was 4.0, changing gradually to 5.2 at 18.5-35 inches. Under the shrubs, roots were extremely numerous to 5 inches, under the openings - to 3 inches. The working depth was unusually shallow, 6.5-8.5 inches. Roots did not penetrate the cemented layers. The abundance of partly decayed moss under the lichens indicated the importance of such a layer in producing good growth of lichens, and indicated the succession that occurred since the last fire.
>
> Considerable trailing in fall and late winter, and some

Table 55. Unit 12: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square 1953 and 1954.

Species	Clarence Lake o	Clarence Lake d	Clarence Lake o	Clarence Lake d	lbs. per acre	
Date	7/7-15/53		7/2-14/54		8	7
Total Quadrats	65		80		8	7
Lichens:						
Foliose	13	2	40	2	-	105.3
Fruticose	81	39	100	37	4930.29	2293.9
Woody:						
Andromeda sp.	3	0.2	4	t	-	6.2
Arctostaphylos alpina	16	2	11	1	25.87	85.6
A. uva-ursi	2	t	-	-	-	-
Betula glandulosa	73	4	85	0.9	50.85	297.1
Cassiope spp.	14	0.5	11	0.2	-	141.8
Dryas spp.	-	-	1	t	-	-
Empetrum nigrum	58	6	83	3	370.26	557.6
Ledum spp.	70	4	78	1	82.97	389.0
Loiseleuria procumbens	6	0.4	4	2	47.28	-
Oxycoccus microcarpus	-	-	6	t	-	8.0
Picea spp.	2	0.1	-	-	-	-
Potentilla fruticosa	5	0.3	-	-	-	-
Rosa acicularis	-	-	1	t	-	-
Salix spp.	45	6	24	0.2	4.46	20.5
Spiraea beauverdiana	11	0.3	5	t	2.67	7.1
Vaccinium uliginosum	84	8	91	3	95.46	667.4
V. vitis-idaea	77	4	95	2	42.82	281.0
Sedge-Grass	95	9	86	2	60.66	74.9
Herbs	53	1	20	0.1	18.73	12.5
Moss	86	18	96	26	1092.05	565.6
Other:						
Equisetum spp.	6	0.1	-	-	-	-
Fungi	-	-	1	t	-	-
Lycopodium sp.	8	0.2	4	0.1	-	-
Bare:	2	t	-	-	-	-

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

year-long use by caribou, are indicated by well defined old trails, 3-5 inches deep and a foot wide, in which most of the vegetation was dead and much mineral soil was exposed. New trails were also being made. Detached branches were scattered over the ground. Exposed roots and lower branches and broken margins of moss hummocks occurred also.

Open spots were well covered with mostly horizontal and partly fragmented lichens, 0.5-2 inches high. The chief kinds were *Cladonia arbuscula* and *C. rangiferina*, much of the latter dead. *Stereocaulon* sp., infrequent to abundant, appeared to be increasing. *Cetraria islandica* was frequent, *C. cucullata* infrequent, *C. richardsonii* infrequent. Lichens under shrubs were rather sparse 2-3 inches high, consisting of *Cladonia arbuscula*, *C. rangiferina*, *Cetraria cucullata*, *C. islandica*, and *Thamnolia vermicularis*. The range condition, for winter, spring, or summer use, rated Fair."

Skoog described the vegetation at the station in 1961 as:

"Shrub Birch type of low to medium height. The stand encompasses a rock strip comparatively well drained and contains few species. The heaths dominate, blueberry, cranberry, narrow-leaved Labrador tea, and crowberry being about equally abundant, and shrub birch is only 10-20 inches high in most spots, compared with the stands nearby where the birch reaches 4-5 feet. The difference seems to be one of drainage. The high birch occurring on the more poorly drained sites. The lichen cover on the low birch stand is not good, but probably has been in the past. Caribou have overgrazed most of these stands throughout the area and the lichen mat is trampled, fragmented and depressed with many bare spots evident. Moss pedestals are a common feature. Group I lichens (*Cladonia rangiferina* and *C. arbuscula*) still predominate, although of poor growth, generally less than one inch high and much of it dead in appearance. Group II lichens (*Cetraria cucullata*, *C. islandica* and *Cladonia gracilis*) are common and probably becoming more numerous. *Stereocaulon* spp. are invading. Decayed lichens in the top soil indicate a good former growth of lichens. The low birch type covers perhaps 30% of the area, while the high 60%, and Heath the remaining 10%. Few lichens occur in high birch which is moist and poorly drained."

In 1967 Alexander indicated no noticeable differences between the vegetation inside and outside the exclosure. In 1970 there was little noticeable change in the vegetation inside and outside the exclosure, as can be seen in Table 56 and comparison of the photographs. There is a slight increase in some shrubs. The growth of lichens inside appeared to be progressing well. They were mostly upright and luxuriant and about 2 inches in length. There are a few localized areas of disturbed lichens indicating previous heavy use. Outside, in the vicinity of the exclosure, only moderate use was noted. However, there were localized spots of heavy

Table 56. Station 29: Clarence Lake, shrub birch type.

Year	1961	1970	1961	1970	1961	1970	1961	1970
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100	100	100	100	100	98	100	100
Moss	5[b]	6	5	5	5	5	5	6
Betula glandulosa	2/11[c]	2/24	–	1/12	6/20	4/36	3/20	4/36
Ledum decumbens	3/7	4/6	2/5	3/6	3/5	4/6	3/5	4/6
Vaccinium uliginosum	4/7	5/7	3/5	3/6	5/14	5/10	4/10	5/10
V. vitis-idaea	3	1	2	2	4	3	3	3
Empetrum nigrum	1	–	–	–	4	3	–	3
Salix pulchra	–	–	–	–	2/20	1/27	–	1/27
Carex	t[d]	–	2	2	1	1	–	1
Hierochloe alpina	–	2	–	–	–	1	–	1
Festuca altaica	2	–	–	–	–	–	2	–
Lichens	5/1	6/2	6/1	6/2	5/2	5/1	5/1	4/1
Cladonia rangiferina	3/1	2/2	5/1	3/2	5/2	3/1	4/1	2/1
C. arbuscula	2/1	3/2	1/1	3/2	2/2	2/1	t	2/1
C. gracilis	1/1	2/1	2/1	2/2	t	2/1	1/1	1/1
C. cornuta	–	–	–	1/1	–	–	–	–
C. uncialis	t	–	t	–	–	1/1	1/1	–
C. gonecha	–	2/2	–	2/2	–	–	–	–
C. deformis	t	–	–	–	–	1/1	–	–
Cetraria cucullata	2/1	2/2	3/1	2/1	t	2/1	1/1	1/1
C. islandica	2/1	1/2	1/1	1/1	1/1	1/1	t	1/1
Stereocaulon sp.	2/1	4/2	t	1	–	–	t	–
Peltigera sp.	t	–	–	1	–	1	t	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

use of the lichen cover. Neither Range Stations 28 nor 29 show much effect of the continued heavy use during the calving season in this unit. Both stations appeared to have been used only moderately in the last few years and little effect was noticeable in the vegetation.

Hanson's (1958) extensive surveys and those conducted in 1953 and 1954 indicated that there were several areas where the lichen cover had been severely disrupted. However, since it is primarily a late spring and early summer range, principal consideration should be given to the herbaceous vegetation and at most sites there is usually a wide variety of species providing considerable amounts of forage. Skoog (1959) stated that, in general, the area was Stage 2 of the successional stages with a few sections having good growth of Groups I and II lichens. The caribou use the region extensively and there are numerous deep trails. The ground cover has been damaged in many places. In these sites various sedges, grasses and forbs take hold and provide abundant summer forage. The unit contains little lichen forage and, from all appearances, the growth of lichens seems to be regressing. Continued heavy use probably will keep the lichens from developing. Unfortunately, there have not been continued surveys in the main calving areas and the exclosures seem not to be the best indicators of the vegetation of the unit as a whole. The unit is utilized to a small extent in winter but it remains mostly as described by Hanson and Skoog.

Range Unit 13: Lake Louise Flat

This unit is the largest unit in the Nelchina range and comprises most of the southeast portion. Unit 12 and the Little Nelchina River bound it on the west, the Nelchina and Tazlina rivers on the south, the Copper and Gakona rivers on the east, and on the north it is bounded by Units 6, 8 and 9. There are 3,140 square miles or 18 percent of the Nelchina range in this unit. The elevation ranges from 1,600 feet to 3,400 feet. Over 95 percent lies below 3,000 feet. Snowfall and winds are light to moderate and the ground becomes free of snow early in the spring. It is characterized by numerous lakes and ponds with poor drainage. The spruce type comprises over 3/4 of the unit. Aspen-poplar, water sedge, bog and shrub birch are other principal vegetation types (Table 57). Water covers over 8 percent of the unit. Fire has been an important ecological component in the flora of the unit and the growth of lichens is mostly poor to fair due to the poor drainage, heavy caribou use, and frequent fires.

On most stands the lichen cover is comprised primarily of secondary species, usually *Stereocaulon spp.* The lichen mat is trampled and its height is usually less than 1 to 2 inches. This area was the major wintering ground from early in the 1930s until the mid 1950s. It rates mostly in a poor condition, as far as lichen forage is concerned. However, very large quantities of nutritious sedges are available and utilized in fall and early winter. Since it was the major wintering ground, it received considerable attention and numerous vegetative studies have been conducted in the unit.

Table 57. Percent composition by vegetation types in Unit #13.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	-
2. Aspen-Poplar	1.7
3. Bog (Heath-Moss-Sedge)	5.5
4. Bluejoint Grass *(Calamagrostis)*	-
5. Shrub Birch	1.1
6. Fescue Grass *(Festuca)*	0.1
7. Heath	-
8. Meadow (Sedge-Grass-Forb)	-
9. Water Sedge *(Carex aquatilis)*	4.7
10. Spruce	76.2
11. White Birch	-
12. Willow	2.0
13. Glacier	-
14. Bare Ground	0.1
15. Water	8.6

During 1953 and 1954 seven sites in this unit were examined to determine the species composition and forage production. Most of these were at lakes where exclosures were subsequently established. Therefore, the readings will be presented in conjunction with the individual Range Stations. Two sites are not near exclosures. Their readings are presented in Table 58. However, no plots were clipped at the Lake Louise road site so forage production figures are available only at Sourdough. Lichens are only moderately abundant and *Ledum* spp., blueberry and the sedge-grass were comparatively numerous. In 1957 Hanson examined several stands in this unit, particularly at each exclosure station of which 14 were constructed during 1955 and 1956. He also described several other stands in this region (Hanson, 1958). Each stand that was examined at a specific range station will be described with the particular exclosure in this report. There were also a few other stands at other locations that were only described in narrative form in his rough draft. They are not presented herein because of the numerous stands reported from this unit by either Hanson (1958) or with individual range stations. He presented a very good description of the spruce type in his report and of the different conditions that exist in this type, usually in regard to the effects of fire. Since it is discussed in detail in his report, it is not reiterated here. For the unit as a whole he states (Hanson, 1958):

> "The lichen growth on the Lake Louise Flat varies greatly in area occupied and in height, because of fire, heavy winter use by caribou until the winter of 1954-55, and because of unsuitable habitats. In a large part of the area of the Flat the lichens rate only Condition Poor, or a low Fair. In open spruce or scrub birch stands, not burned recently, scattered through the Flat the condition is Good, and in the vicinity of the Glenn Highway the condition is Good to Excellent. The herbaceous and woody vegetation in the Flat is composed of a great variety of species in vigorous condition."

In 1959 Skoog described the vegetation at 5-mile intervals on the Richardson Highway, starting at Mile 130 and going north. The following is his description of the vegetation given in a rough draft form:

> "Mile 130. Spruce vegetation type - black plus some white. Poorly drained, heavy carpet of moss; much *Vaccinium* spp., *Ledum*, sedge, *Empetrum*, *Potentilla fruticosa*, *Arctostaphylos alpina*, *Petasites* and *Sphagnum*; *Rubus* also common. Lichens scarce - cover of less than 2 - consisting mostly of *Peltigera* and *Cladonia gracilis*; a few scattered patches of *Cladonia arbuscula* (2-3 inches). Traces of an old fire present - scarred white spruce trunks and scarred ground.
>
> Area between. Mostly Spruce, with some Aspen-Poplar stands.
>
> Mile 135. Spruce type - similar to above in all species present. Fire twenty-thirty years ago at least, judging from

Table 58. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1953.

Species	Lake Louise Road o	Lake Louise Road d	Sourdough o	Sourdough d	lbs. per acre
Date	6/18-25/53		8/15-24/53		
Total Quadrats	34		80		20
Lichens:					
Foliose	71	7	85	12	223.05
Fruticose	91	25	93	19	1075.99
Woody:					
Alnus sp.	6	t	-	-	-
Andromeda sp.	-	-	4	0.2	.89
Arctostaphylos alpina	35	2	15	0.7	16.95
A. uva-ursi	6	2	6	0.6	14.27
Betula glandulosa	59	0.2	78	12	49.96
Empetrum nigrum	76	11	16	8	56.20
Ledum spp.	94	4	95	14	208.77
Oxycoccus microcarpus	-	-	16	0.2	t
Picea spp.	15	t	10	0.5	1.78
Populus sp.	3	t	16	6	.89
Potentilla fruticosa	9	t	10	0.3	5.35
Rosa acicularis	15	0.1	13	0.3	1.78
Salix spp.	71	3	48	3	58.88
Spiraea beauverdiana	-	-	6	0.1	0.89
Vaccinium uliginosum	94	14	86	10	235.54
V. vitis-idaea	56	3	93	9	-
Sedge-Grass	71	9	90	7	92.78
Herbs	76	0.7	53	2	16.05
Moss	91	8	86	21	1143.01
Other:					
Equisetum spp.	18	0.5	19	0.1	0.89
Fungi	-	-	3	0.1	-
Lycopodium sp.	3	0.1	1	t	-
Bare	-	-	1	0.1	-

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

the few old snags remaining. Lichen cover of 1 or less, but better than last site. Lush patches of *Cetraria islandica*, *Cladonia arbuscula*, *C. uncialis*, *C. rangiferina*, and *C. gracilis* - all 2 inches - 4 inches high.

Area between. Mostly spruce as above but with white spruce more common than previously. Apparently this area was a white spruce forest before the fire, and then was replaced by black spruce. Aspen-Poplar stands occur in patches, mostly near the road.

Mile 140. Spruce as before but white spruce is common. Similar species as before. Lichen similar to Mile 135, but lacking the *Cetraria islandica;* cover about 2. Much standing dead stuff here; a later fire perhaps, yet seems as advanced as other sites.

Area between. Vegetation as described thus far; no clumps of Aspen-Poplar sighted; quite a bit of Willow noted, and Spruce particularly black in most sections, but white interspersed just about everywhere.

Mile 145. Spruce, as before, but with white and black about equally abundant. Many dead snags standing yet; ground seems more scarred than at previous sites. Similar species present. Much Willow, lichen cover about 2, consists mostly of trumpet shaped *Cladonias* and *Cladonia gracilis*. *Cladonia arbuscula* and *Cetraria islandica* of good growth (3-4 inches) in scattered patches.

Area between. Spruce type continues; trees rather small, probably most are less than twenty years old. Much willow still present. Many dead snags. Aspen-Poplar interspersed here and there amidst the spruce.

Mile 150. Spruce type again - black and white about equal in abundance. Similar species to those mentioned thus far. Lichen cover disrupted - about 1 in cover - consisting mostly of *Peltigera* and trumpet-like *Cladonias*, plus lush patches of *Cladonia arbuscula*, *C. rangiferina*, and *C. uncialis*. Fire at least twenty-thirty years ago.

Area between. Spruce type continued - mostly black spruce "muskeg" country. Willows common; Aspen-Poplar infrequent.

Mile 155. Spruce type - mostly black "muskeg", but with some white. Same plant species as noted before. Heavy moss carpet. Lichens fairly common - cover of 3 - mostly *Peltigera* and *Cladonia gracilis*, and *C. degenerans (?)*. *Cladonia arbuscula* and *C. uncialis* common and of good growth, 3-4 inches.

Area between. This terrain is higher than previous but still of the Spruce type. Most of ground well drained, however, and white spruce is more common than black. Willow is abundant; Spruce scattered; Shrub Birch abundant.

Mile 160. Spruce type - white more common than black, both rather scarce here. Willow and Shrub Birch the dominant plants, plus the Heaths. Heavy carpet of moss and *Sphagnum*. Lichens few, cover of 1. Mostly *Peltigera* and *Cladonia gracilis*. Old burn.

Area between. Spruce type. Black has become dominant again. Trees rather scattered, Willow and Shrub Birch most numerous.

Mile 165. Spruce type - thinly scattered trees. Willow and Shrub Birch brush rather thick. Heavy moss cover. Some Spruce thirty-forty years old in appearance. Lichens sparse, cover of 1. *Cladonia arbuscula* and *C. rangiferina* of good growth (3 inches), but scattered; *Cetraria islandica* infrequent but of 3-4 inch growth. Old burn (thirty-forty years?).

Area between. Scattered Spruce with heavy willow-shrub birch undergrowth as described above.

Mile 170.5. Spruce type - Scattered trees. Undergrowth as described previously - Willow, Shrub Birch, and Heath. Many large rocks on the ground; heavy moss cover. Lichen cover heavy (4 or 5). Mostly foliose, however, *(Peltigera* and *Nephroma)* and *Stereocaulon*. Some *Cladonia uncialis* and *Cetraria nivalis*. Area probably typical of Spruce type as it nears timberline.

Area between. Scattered Spruce. Willow, Shrub Birch, and Heaths dominant."

The most extensive range examinations have been conducted in conjunction with the 14 range stations located in this Unit. They were concentrated in this unit because in the mid 1950s, the Flat was the principal wintering ground of the Nelchina caribou herd. Since that time the Nelchina herd has shifted to the east and west during the winter.

Range Station 1: West Shore of Susitna Lake, Spruce Type

The original vegetation reading by the line-point method was taken in 1955 at the same time the exclosure was constructed. In 1957 Hanson set up a one square meter quadrat inside the exclosure and one outside, numbering them Quadrats 1 and 2. The exclosure is at an elevation of about 2,400 feet in a spruce-shrub birch-heath stand that burned several years ago. Hanson (1958) described the stand as:

"Black and white spruces from a foot to about 20 feet tall, growing in small clumps or as single plants 20 or more feet apart, were scattered.

The mound-like centers of the polygons, 1-2.5 feet above the bottoms of the border depressions, varied from 2 x 4 to about 4 x 12 feet in area. They were covered with short growth of lichens, mosses, and short heath shrubs such as *Vaccinium uliginosum*, *V. vitis-idaea*, and *Ledum decumbens*, *Calamagrostis canadensis*, *Equisetum sylvaticum*, and others. The mounds have evidently been built up by frost action. Frostboils on the surface of some of the mounds indicated that the process is continuing. The depressions 3-12 feet wide, were filled with mosses, *Sphagnum spp.*, and shrubs. The numerous *Betula glandulosa* and scattered willows, 3-6 feet tall, were taller in the depressions than on the mounds. Other species contributing significantly to the usually dense shrub layer were *Ledum groenlandicum*, *Eriophorum vaginatum*, *Rubus chamaemorus*, and *Empetrum nigrum*. *Petasites frigida* and *Oxycoccus microcarpus* were also present. The total number of vascular species was 22.

The soil profile, extending from the top of a mound to the bottom of a depression, showed indications of active upward movement of silty material into the mound. The organic layer was 0.5-2.5 inches thick on the mound, 4-7 inches thick in the depression. Under the organic layer on the mound was a granular silt loam layer; 2.5-5.0 inches thick, underlaid by compact silt loam and silt, showing flow tendency, to the permafrost at 30 inches. Under the organic layer in the depression a very wet loam extended to depth varying from 9 to 13 inches, underlain by compact silt loam and silt to about 15 inches where permafrost was encountered. Water accumulated to depth of 7 inches in an hour in the part of the trench below the depression. Neither gravel nor rock was present in the profile. The pH varied from 5.5 near the surface to 6.5 close to permafrost. Roots were numerous in the mound to 5 inches, in the depression to 10-13 inches. The working depth in the mound was 12 inches, and a few roots extended to permafrost.

The range condition was poor because of the low cover and short height of the lichens. Lichen cover was 2.3, moss cover 3.0. The chief species were *Cladonia arbuscula*, *C. rangiferina*, *Stereocaulon paschale*, *Cetraria cucullata*, and *Nephroma arcticum*, the last mostly under spruce trees and shrubs. Recovery is proceeding, as shown by much upright growth."

In 1957 and 1966 the vegetation in the two quadrats was examined with the modified Hult-Sernander scale. In 1966 it was also examined by the line-point method, as were all the rest of the stations, but I am unable to interpret the data as they appear to have been collected in a different manner than in 1955. Hanson noted in Quadrat #1 in Plot A

that the hummocks on the north side of the quadrat were about 10 to 12 inches higher than on the south side and extend along the east side of the quadrat to the southeast corner. The southwest corner is 14 to 15 inches lower than the tops of the hummocks in the northeast corner. Most of the hummocks in the northeast corner are covered with dead vegetation and the plants continued to die. Of Quadrat 2 in Plot B, he remarked that a hummock occupied most of the eastern half of the quadrat. The top of the hummock was 14 inches above the depression in the northeast corner. A large tussock of *Eriophorum* apparently was dying on the south side of the hummock. Another large tussock, 6 inches high by 8 inches across was on the west side of the quadrat. Station No. 1 was reexamined in 1971. Two new quadrats (1b and 2b) were established in the opposite corners of Plots A and B from the present quadrats. There has been relatively little change from '57 to 1971 inside the exclosure. Outside, however, lichen cover has apparently decreased under continued use. Overall, shrubs, particularly *Betula glandulosa* and *Ledum decumbens*, have increased as is characteristic of several portions of the Nelchina range (Table 59).

Range Station 2: East Side of Susitna Lake, Bog Type

This exclosure was contructed and the vegetation was examined in 1955. It lies 200 yards south of the lake and in 1957, when Hanson established the square meter quadrats inside and outside the exclosure, he classed the vegetation as being a bog type. The description in his rough draft narrative states that:

> "the drainage was poor and the dominant plants include *Andromeda polifolia*, *Betula glandulosa*, *Ledum decumbens*, *Rubus chamaemorus*, *Vaccinium uliginosum*, *V. vitis-idaea*, *Carex rotundata*, *Eriophorum vaginatum*, *Sphagnum* sp., and mosses. The total number of vascular species was 21.
>
> The soil profile of a hummock consisted of reddish brown peat saturated with water to a depth of 2 feet, as deep as the soil trench was dug. It filled up quickly with water to near the top. Permafrost was encountered, by means of a prod, at 32 inches. The pH was 5.6.
>
> This bog is surrounded by low black spruce forest which contains much *Betula glandulosa* and dwarf heath shrubs. The surface is very irregular because of the hummocks of moss and *Sphagnum* a foot or more high, covered with a dense growth of *Rubus chamaemorus*, *Betula*, *Vaccinium*, and other heath shrubs. Sedges occupy the depressions. Tussocks of *Eriophorum vaginatum* were about one foot tall and 4-12 inches in diameter. Lichens were sparse but they increased in cover and height as the hummocks become larger and are invaded by black spruce. The range condition for winter use by the caribou probably rates poor because of the scarcity of lichens."

The quadrats were reexamined in 1966 and in 1971.

Table 59. Station 1: West side of Susitna Lake, spruce type.

Year	1955	1957	1966	1971		1955	1957	1966	1971	
Method	Line-pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line-pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	1	1	1	1b	Plot B	2	2	2	2b
Total Cover	93.8%	85	85	100	100	94.6%	100	100	100	100
Moss	31.0	4[b]	4	4	5	26.5	3	2	4	3
Betula glandulosa	10.0	3	3	5	4	12.7	3	1	3	2
Ledum decumbens	15.9	4	4	5	6	14.4	4	4	4	3
L. groenlandicum	3.8	1	3	2	2	2.6	1	-	1	1
Empetrum nigrum	1.4	3	4	4	-	1.9	1	1	2	-
Vaccinium uliginosum	0.3	-	-	-	-	1.0	-	-	-	2
V. vitis-idaea	10.0	3	4	4	1	11.8	3	3	3	3
Rosa aciclaris	tc	1	t	1	-	-	-	-	-	-
Salix alaxensis	1.4	-	-	-	2	0.7	-	-	-	-
Picea glauca	t	-	-	-	-	0.4	1	1	1	1
Calamagrostis inexpansa	0.5	1	1	1	3	1.0	1	1	1	1
Eriophorum vaginatum	5.9	-	-	-	1	5.4	3	4	5	4
Equisetum arvense	0.6	t	t	1	-	0.5	1	t	1	-
Petasites frigidus	0.6	-	-	-	3	0.4	1	1	2	2
Rubus chamaemorus	0.9	1	-	2	1	1.5	1	t	1	2
Epilobium angustifolium	t	-	-	-	-	-	-	-	-	-
E. latifolium	0.3	-	-	-	-	-	-	-	-	-
Pyrola grandiflora	t	-	-	-	-	t	-	-	-	-
Linnaea borealis	t	-	-	-	-	-	-	-	-	-
Oxycoccus microcarpus	-	-	1	-	-	1.1	t	-	-	1
Lichens	10.3	1	1	2	2	12.5	2	t	1	3
Cladonia alpestris		-	-	-	-		-	-	-	-
C. rangiferina	2.8	-	-	-	-	4.0	-	-	-	-
C. arbuscula	-	-	-	-	-		-	-	-	-
C. amaurocraea		-	-	1	-		-	-	-	1
Peltigera spp.	7.5	-	-	2	2	8.4	-	-	1	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Trace.

Table 60 shows a complete absence of lichens at this station. In 1955 a difference of 14 percent of total cover (78 percent in Plot A to 92 percent in Plot B) is indicated and this is almost entirely due to the larger amount of moss in Plot B. The bog type is characterized by very thick moss cover and very small amounts of lichen forage. There has been little change in the quadrats, although in 1966 in Quadrat 3 inside the exclosure, McGowan indicated a rather large decrease in the moss cover. This site is probably only used during summer and early winter when the vascular plants, especially the sedges, which comprise nearly 40 percent of the stand, are available.

Station 3: Southwest Shore of Tyone Lake, Spruce Type

This station is about 1-1/2 miles southeast of Tyone Village. It was established and the vegetation was read in 1955. Hanson described the vegetation in 1957 in his field notes as:

> "It is a Black Spruce-Willow-Heath stand. Black spruce trees were up to about 25 feet high, averaging 15-16 feet, and 5-30 feet apart. Dead spruce stems were scattered. Willows were up to 10 feet high, *Betula glandulosa* to 5 feet. The chief heath shrubs were *Vaccinium uliginosum* 2-15 inches, *V. vitis-idaea*, *Ledum decumbens* 2-10 inches, *L. groenlandicum* up to 15 inches. *Calamagrostis canadensis*, *Carex bigelowii*, and *Rubus chamaemorus* were some of the more abundant of the scattered species. The total number of vascular species was 20.
>
> The broad, firm, low, mound-like centers of polygons, covered mostly with lichens (0.5 inches or less high) and scattered heath shrubs, occupied much less area than the depressions, which are about a foot deep and 6-30 feet wide. The latter were filled with mosses, (cover 4.6), heath shrubs, *Betula*, *Salix spp.*, and scattered *Carex*. Moss hummocks, from a few inches to 2 feet across on centers of mounds, were disintegrating.
>
> The organic layer, 3 inches thick, was underlaid by loam to 5.5 inches, and silt between 5.5 and 34 inches. The last horizon showed flow movement, and seepage of water began at depth of 15 inches. The pH varied from 5.9 in the 3-5.5 inch layer to 6.9 below. Roots were extremely numerous to 3 inches and the working depth was at 13 inches.
>
> The range condition was rated Poor to Fair. The lichens, 2.0 in cover, were packed and partly shattered; only a few were upright. Chief species were *Stereocaulon sp.*, *Cladonia rangiferina*, and *Peltigera aphthosa*. Cracks were usually prominent in the lichen layer. Broken-off branches of shrubs were scattered on the polygon centers."

Unfortunately, this station was destroyed by a large caribou migration in 1958. Although the readings from 1955 and 1957 are in the file, the descriptions of the quadrats would be of limited value in this report,

Table 60. Station 2: East side of Susitna Lake, bog type.

Year	1955	1957	1966	1971		1955	1957	1966	1971	
Method	Line-pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line-pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	3	3	3	3b	Plot B	4	4	4	4b
Total Cover	78%	100	100	95	90	92.4%	96	92	90	95
Moss	20.1	6[b]	2	6	1	40.9	6	5	4	6
Betula nana	2.1	1	2	3	-	2.5	2	1	2	2
Empetrum nigrum	0.7	2	1	2	1	0.7	2	1	2	-
Ledum decumbens	1.2	1	1	3	1	0.8	1	2	1	1
Salix pulchra	-	1	-	-	-	-	-	-	-	-
Vaccinium uliginosum	5.4	2	2	2	3	2.6	2	2	2	2
V. vitis-idaea	0.6	1	1	1	-	0.3	1	1	1	-
Carex rotundata	39.4	3	4	4	5	16.1	5	5	6	5
C. spp.	-	-	-	-	-	18.8	-	2	-	-
Eriophorum angustifolium	2.6	1	-	1	2	2.6	1	1	2	2
Lycopodium clavatum	-	-	-	-	-	-	1	-	-	-
Andromeda polifolia	0.9	2	1	2	-	4.6	1	1	1	1
Oxycoccus microcarpus	0.5	1	1	1	-	1.8	1	3	1	1
Rubus chamaemorus	4.5	2	2	1	2	0.4	1	-	1	-
Fungi	-	1	-	-	-	-	-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.

since there are several other exclosures in similar settings throughout the unit which are described elsewhere in this report.

Range Station 4: West Side of Tyone Lake, Spruce Type

The exclosure was constructed in 1955 and the vegetation also examined at that time. The station lies about 75 yards southwest of the lake marker at an elevation of 2,500 feet. In 1953 the vegetation was examined near Tyone Lake. The readings are given in Table 61. Lichens were evenly dispersed with a moderate density and production of fruticose forms. Of the areas sampled in Unit 13 in 1953 and 1954, the production of lichens was the highest at Tyone Lake.

In 1955 it was noted that 84 percent of the lichens were in a disturbed condition in Plot B and 86 percent were disturbed in Plot A.

Hanson described the vegetation in his rough draft as:

"This fairly dense black spruce-Heath stand, burned over many years ago, showed a pronounced polygonal pattern. The spruce trees averaged about 8-10 feet tall, some up to 25 feet, and were spaced from 2 to 20 feet apart. A few dead snags were scattered. The living trees were more common on old *Sphagnum* hummocks and in polygon centers than in the depressions.

The broad, firm, mound-like centers of the polygons varied considerably in area, from 3 x 5 to 10 x 20 feet. The border depressions, 10-15 feet wide and 1-3 feet deep, were usually wet in the bottom. The mounds had an excellent cover of lichens, and scattered plants of *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum decumbens*, *Betula glandulosa*, and *Carex bigelowii*. Small moss clumps were usually shattered and dead moss tufts scattered. The moss cover was 2.5. The packed and somewhat shattered lichens formed a crust 0.5 to 1 inch thick, cover 3.7, a few plants of *Cladonia spp.* showing short upright growth. Lichens under trees and shrubs, 2-4 inches high, were usually sparse. Depressions were occupied by mosses, *Sphagnum spp.*, *Carex bigelowii*, *Eriophorum vaginatum*, *Rubus chamaemorus*, *Ledum decumbens*, and *Oxycoccus microcarpus*. *Salix alaxensis*, 3-8 feet tall, and *Betula glandulosa*, 1-2 feet, were scattered. The total number of vascular species was 22.

In the soil profile the organic layer, 1 inch thick, was underlaid by silt loam at 1-2 inches, and a very wet sandy silt loam, showing pronounced flow tendency, at 2-35 inches. Stones were scattered throughout below the top inch. Seepage began at 9 inches. The pH was 6.0 at 1-2 inches; 7.1 at 2-35 inches. Roots were numerous to depths of 2 inches and the working depth was at 14 inches.

The range condition was rated as Poor to Fair, chiefly because of the short growth of the lichens on the polygon centers. Recovery from earlier heavy use was taking place."

Table 61. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1953.

Species	Tyone Lake o	Tyone Lake d	lbs/acre
Date	8/10-15/53		
Total Quadrats	32		7
Lichens:			
Foliose	100	12	225.71
Fruticose	100	34	3190.5
Woody:			
Andromeda sp.	-	-	0.89
Arctostaphylos alpina	19	0.5	-
Betula glandulosa	63	3	28.55
Empetrum nigrum	38	2	-
Ledum sp.	97	6	203.42
Oxycoccus microcarpus	13	0.1	5.35
Potentilla fruticosa	3	t	0.89
Rosa acicularis	16	0.1	2.67
Salix sp.	69	6	158.81
Vaccinium uliginosum	94	6	146.32
V. vitis-idaea	97	5	118.66
Sedge-Grass	97	5	41.04
Herbs	72	3	38.36
Moss	100	33	1572.94
Other:			
Equisetum spp.	31	0.3	3.56
Lycopodium sp.	-	-	1.78

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

Hanson stated that Quadrat 7 inside the exclosure contained a lichen mat one inch thick, mostly decumbent and with much dead moss and numerous dead parts of *Carex*. Two *Sphagnum* hummocks, one in the east center, and one in the south center, each raised about 3 inches, apparently were dying. There were depressions along the north side, 6 to 8 inches below much of the rest of the surface which contained small hummocks. The condition of the quadrat appears to have been the result of trampling and drying. Chief lichens included *Cladonia spp.*, and *Stereocaulon* with only scattered *Cetraria*. In Quadrat 8, outside in Plot B, he stated the lichens were similar to Quadrat 7 but somewhat more scattered. *Stereocaulon* was by far the most abundant genus, but there were also scattered upright growths of *Cladonia*, about 1/4 to 1 inch high. *Cetraria spp.* were scattered. There were many small, dead tufts of moss on the north side of the quadrat. Two low, small hummocks had *Ledum*, blueberry and shrub birch growing on them. The quadrat appeared trampled and packed. In 1966 McGowan stated that Plot B had a trail through the center of the plot, probably caribou, possibly moose. There were several moose tracks in the area. The plot had been trampled and most of the lichens were scattered and short, about 1/2 to 1 inch high. There was a very great difference between Plot A and Plot B at Station 4.

In 1970 it was noted that the lichen growth in Quadrat 7, inside of the exclosure, appeared to be starting good recovery, as most lichens were in an upright condition and at least 1 inch in length. Total cover was down in 1966 to 85 percent because of dead *Carex* and moss, but by 1970, the cover was 100 percent. Lichen cover remained the same since 1956 (Table 62) although Hanson's descriptions of the quadrats and comparisons of the photos indicate that, in fact, the lichens were in a much more luxuriant condition in 1970 and were well on their way to recovery. The secondary lichens were still the principal forms, primarily *Stereocaulon*, *Cladonia uncialis*, *C. gracilis* and the funnel-form *Cladonias*. However, the principal forage types, *C. rangiferina* and *C. arbuscula*, were also rather abundant. There is still some evidence of the dead moss hummocks referred to by Hanson, but most of these are covered with lichen growth so that total cover has changed only to a small extent. Meter square quadrats at the opposite end of Plot A and Plot B were also established in 1970 and these have been classified as Quadrat 7b inside in Plot A and Quadrat 8b outside in Plot B. Quadrat 7b was somewhat typical of a major portion of the vegetation inside the exclosure. Recovery still has not proceeded as much as in Quadrat 7 since 15 percent of the ground is still bare and the center portion of the quadrat is primarily moss and scattered fragments of lichens, primarily small *Stereocaulon*. The edge of the quadrat happens to be in an area that has recovered fairly well, but the large central portion evidently was on an old game trail that had severely deteriorated and recovery has not progressed by an appreciable amount on the trail.

The best recovery by far is on organic material usually near sedge and moss tussocks. On the trail, neither vascular plants nor moss have become established to any extent and lichens only occur as scattered individuals. Apparently an organic substrate must develop, which tends to hold moisture, before the fruticose lichens, especially those of Group

Table 62. Station 4: West side of Tyone Lake, spruce type.

Year	1955	1957	1966	1970		1955	1957	1966	1970	
Method	Line pt. 1000 pt.	Modified H-S scale	Modified H-S scale	Modified H-S scale		Modified 500 pts.		Modified H-S scale	Modified H-S scale	
Quadrat[a]	Plot A	7	7	7	7b	Plot B		8	8	8b
Total Cover	92.9	100	85	100	85	91	No Readings Available	75	90	85
Moss	11.8	2[b]	1	1	1	6.5		1	1	1
Betula glandulosa	0.4	-	-	1	-	t		1	-	-
Picea mariana	2.9	2	3	3	-	t		-	-	-
Arctostaphylos alpina	-	-	-	-	-	0.9		-	-	-
Ledum decumbens	1.3	1	1	2	1	0.6		2	2	2
Salix spp. (prostrate type)	-	-	-	-	-	2.1		-	1	2
Vaccinium uliginosum	1.2	-	-	-	1	4.2		3	4	4
V. vitis-idaea	1.8	1	1	1	1	1.1		2	1	1
Rosa acicularis	-	-	-	-	1	-		-	-	-
Calamagrostis inexpansa	-	-	-	-	-	-		t	1	-
Carex bigelowii	5.0	2	-	3	3	0.9		1	1	2
Rubus chamaemorus	0.2	1	t	-	1	-		1	1	1
Equisetum arvense	-	-	-	-	-	t		-	-	-
Lichens	68.1	6	6	6	4	73.8		4	4	4
Cladonia alpestris		-	-	-	1			-	-	-
C. rangiferina		-	-	2	-			-	1	1
C. arbuscula	44.5	-	-	3	1	41.1		-	1	1
C. amaurocraea		-	-	-	1			-	1	1
C. uncialis		-	-	2	1			-	1	1
C. gracilis	-	-	-	2	1	-		-	1	-
C. crispata	-	-	-	1	1	-		-	-	-
C. cornuta	-	-	-	1	1	-		-	-	-
C. spp. (coccifera-like)	-	-	-	2	-	-		-	-	1
Cetraria islandica	0.4	-	-	-	-	t		-	1	-
C. nivalis	t	-	-	-	-	1.3		-	1	1
Stereocaulon paschale	21.3	-	-	3	3	29.0		-	3	2

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

I, are able to reestablish themselves. It becomes apparent then that the continued sporadic use of the same magnitude that has occurred in the last 15 years is sufficient to disrupt the organic mat and that the principal lichen species, *Cladonia arbuscula*, *C. alpestris*, and *C. rangiferina*, will not recover.

The vegetation was much better inside than in Plot B outside of the exclosure. In Quadrat 8 outside, a comparison of the photographs taken in 1967 and in 1970 indicates that the quadrat possibly has deteriorated. However, the readings in Table 62 do not indicate a reduction in cover but, in fact, an increase primarily in blueberry cover. *Stereocaulon spp.* are by far the most predominant lichens outside.

The new Quadrat 8b is very similar to Quadrat 8 and similar to the outside vegetation in general, where *Stereocaulon* and other secondary lichens were the principal species. Seldom were any of the lichens over a quarter of an inch to a half an inch tall and all were scattered and fragmented. Apparently, with 15 years total protection, the lichen cover is starting to recover somewhat. However, the recovery apparently involves similar species that were present at the time the plots were established. There has been little change in the vascular plants. The outside area, although it does not continue to receive the heavy use that it had prior to 1955, still is deteriorating. The lichens show little sign of recovery outside of the exclosure. The station is located on a couple of good lichen stands in this characteristically open spruce type. These open areas have been heavily utilized in the past and lichen growth has deteriorated. However, recovery has occurred with total protection. The caribou concentrate in these areas, both because of the available forage and because the timber and tall shrubs restrict their movements.

Range Station 5: Northwest End of Tyone Lake, Spruce Type

This station was established and the vegetation was read in 1955. It is located at an elevation of about 2,500 feet. In 1957 Hanson described in his notes the vegetation at this site as:

> "This black spruce stand was burned over probably in 1924, charred fragments were found in the soil to a depth of 4 inches. The black spruce in 1957 were 5-15 feet high and widely scattered. This stand differs considerably in density of cover, in the variety of species, succession on frost boils, in frost action, and sparseness of lichens from the Spruce stands so far discussed. As shown in Table 63, *Salix pulchra* and *Betula glandulosa*, both 3-6 feet tall, were more numerous than in most stands. *Vaccinium uliginosum* was very dense and 6-15 inches tall, *Ledum groenlandicum*, 6-15 inches, and *L. decumbens*, 4-8 inches, were moderately abundant. *Vaccinium vitis-idaea* was also abundant. Other moderately abundant species were *Carex bigelowii* and *Rubus chamaemorus*. *Calamagrostis canadensis* was also more abundant than in many of the Spruce stands. The total number of vascular species was 25.

Table 63. Stand 52, east side of Tyone Lake, Salix-Betula-dwarf heath stand. August 13, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Ground Cover	100	100	100	100	100	100	100	100	100	100	100	
Arctostaphylos alpina	–	–	–	–	1	–	–	–	–	–	0.1	10
Betula glandulosa	2	1	2	3	1	2	1	2	1	2	1.7	100
Chamaedaphne calyculata	1	–	–	–	–	–	–	–	–	–	0.1	10
Empetrum nigrum	–	–	–	–	–	1	–	–	1	–	0.2	20
Ledum decumbens	1	2	1	–	2	1	1	1	1	–	1.0	80
L. groenlandicum	2	1	1	2	–	1	2	1	1	1	1.2	90
Oxycoccus microcarpus	–	–	–	–	–	–	–	–	2	1	0.3	20
Picea mariana	–	–	–	–	–	–	–	–	–	–	x	–
Rubus chamaemorus	1	1	1	1	1	–	1	1	2	1	1.0	90
Salix alaxensis	–	–	–	–	–	–	–	–	–	–	x	–
S. myrtillifolia	–	–	–	–	–	–	–	–	–	–	x	–
S. pulchra	3	–	3	3	1	1	4	1	4	1	2.1	90
S. reticulata	–	–	–	–	1	–	–	–	–	–	0.1	10
Vaccinium uliginosum	4	3	4	3	3	4	3	3	4	4	3.5	100
V. vitis-idaea	2	2	1	1	2	4	3	2	1	1	1.9	100
Calamagrostis canadensis	–	1	1	1	1	1	1	1	1	1	0.9	90
Carex bigelowii	2	3	2	1	1	1	1	1	1	–	1.3	90
C. capillaris elongata	–	–	–	–	–	–	–	–	–	–	x	–
Juncus castaneus	–	–	–	–	–	–	–	–	–	–	x	–
Eriophorum vaginatum	–	–	–	–	–	–	–	–	–	2	0.2	10
Epilobium angustifolium	–	1	–	–	1	–	–	–	–	1	0.3	30
Equisetum scirpoides	–	1	–	1	1	1	1	1	1	1	0.8	80
Pedicularis labradorica	–	1	–	–	–	–	–	–	–	–	0.1	10
Petasites frigidus	–	1	–	1	1	1	–	1	1	1	0.7	70
Pyrola sp.	–	–	–	–	–	1	–	–	–	–	0.1	10
Sphagnum	–	1	2	6	–	–	–	–	6	–	1.5	30
Mosses	2	3	3	–	1	4	2	3	2	5	2.5	90
Lichens	1	2	1	1	5	1	1	1	1	1	1.5	100

The polygonal ground was characterized by depressed frost boils in the centers. These were rectangular in outline, 9 x 12 to 12 x 15 feet in area. The depressed frost boils had very wet soil and appeared to be active. The few raised centers were dry and covered with a poor growth of lichens and some heath shrubs. Hummocks of moss appear on wet frost boils, following earlier invasion by other mosses. Cover of mosses was 2.5 and they invade dry frost boils also. As growth continues these hummocks coalesce. Lichen growth is fair on the sides of the hummocks, but usually the vegetation is too dense for good growth. The borders, about 20 feet wide, were dense with moss and *Sphagnum* hummocks which were covered with heath shrubs, *Carex bigelowii*, and occasionally *Eriophorum vaginatum*.

The organic layer in the soil profile, taken in an old frost boil covered with vegetation, extended to 4 inches. At 4-12 inches was a moist to wet silt loam flow earth; at 12-14 inches a sticky loam former surface horizon; and at 14-26 inches silt loam similar to that at 4-12 inches. The pH was 6.3 at 1.5-4 inches, 6.4 at 4-12 inches, 6.3 at 12-14 inches; and 6.9 at 14-26 inches. Roots were extremely numerous to about 4 inches and the working depth was at 15 inches.

The range condition was Poor, the average cover of lichens being only 1.5. The dense vegetation and frost action were both detrimental to lichen growth."

Table 63 is the analysis of the stand by Hanson as it appeared in his rough draft. He described the vegetation in permanent Quadrat 9, which is in Plot A, as being extremely dense. Moss and *Sphagnum* hummocks were up to 7 inches thick and he wondered if this type of vegetation was invading the large frost boils in the center of the plot. The edge of the quadrat was 25 to 29 inches from the depressed frost boil. In Quadrat 10, outside in Plot B, he stated that the moss hummocks in the southwest corner were 9 inches high, 4 to 5 inches on top. Split moss hummocks occurred in the south center, 11 inches by 6 inches by 7 inches high. The vegetation was very dense, interwoven and spongy to treading. In 1966 McGowan indicated that two of the large *Salix pulchra* plants were dead and that one of the *Salix alaxensis* plants was dying in Quadrat 9. In 1970 the *Salix pulchra* had decreased; however, *S. alaxensis* increased from a 1 to a 2 (Table 64). Cover remained similar and lichens remained relatively unchanged. Essentially there is only a trace of lichens in either plot. By 1970 there was little evidence of the frost boil in the center of the plot. Evidently the shrubs and especially the sedge, *Cartex bigelowii*, have covered the boil. *Carex bigelowii* has increased from a 1 to a 4 reading from 1966 to 1970. The vegetation is still tall and dense and there is not much of a noticeable difference inside or outside the exclosure. The stand is characteristic of large areas where the vascular plants are dominant and there are only very small and scattered clumps of lichens. There was a large amount of bare ground in the center and on both ends in the exclosure. There was a very heavy *Sphagnum* mat

Table 64. Station 5: North shore of Tyone Lake, spruce type.

Year	1955	1957	1966	1970		1955	1957	1966	1970	
Method	Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	9	9	9	9b	Plot B	10	10	10	10b
Total Cover	86.4%	100	100	100	100	96.8%	100	95	100	100
Moss	23.1	5[b]	5	6	-	21.4	5	4	5	-
Betula glandulosa	3.0	2/12[c]	1/18	1/14	-	3.6	1/25	2/36	2/46	-
Empetrum nigrum	2.1	1	2	1	-	1.0	-	-	-	-
Ledum decumbens	2.0	2/6	2/8	4/12	2/12	1.6	1	1	3	3
L. groenlandicum	2.8	2/11	2/12	1/6	2/15	2.7	1/12	2/12	2/12	1/8
Oxycoccus microcarpus	2.7	1	2	-	-	-	-	-	-	-
Salix alaxensis	-	1/43	1/20	2/39	2/38	-	-	-	-	-
S. pulchra	5.9	2/36	2/30	1/32	4/36	1.2	2/23	1/34	1/15	-
Vaccinium uliginosum	21.1	3/10	2/7	3/9	4/16	25.9	6/13	5/12	6/12	5/15
V. vitis-idaea	5.0	3	2	3	-	13.1	4	4	5	2
Calamagrostis inexpansa	-	1	1	-	-	-	1	1	2	1
Carex bigelowii	11.3	2	1	4	5	3.3	1	1	2	3
Equisetum scirpoides	-	1	-	-	-	-	1	-	-	-
Petasites frigidus	t[d]	1	-	-	1	1.1	1	1	-	1
Rubus chamaemorus	t	1	1	2	1	t	-	-	-	-
Lichens	5.4	1	1	-	-	21.6	1	1	2	3
Cladonia arbuscula	-	-	-	-	-	-	-	-	-	1
C. rangiferina	-	-	-	-	-	-	-	-	-	1
C. gracilis	-	-	-	-	-	-	-	-	1	1
Cetraria islandica	-	-	-	-	-	-	-	-	-	1
C. cucullata	-	-	-	-	-	-	-	-	-	1
Peltigera aphthosa	-	-	-	-	-	-	-	-	1	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

and its conditions inside and outside the exclosure were quite similar. The moss mat and shrub cover were very dense and the only lichens that occurred were in protected sites underneath shrubs. There was very little use made of the area except of the vascular plants and there was no indication of any change due to use over the 15-year period.

Range Station 6: East Shore of Corky Lake, Spruce Type

Station 6 lies about 350 yards from the shore of the lake at an elevation of 2,700 feet. In 1955, when the station was established, the lichen cover was high in both Plot A and B; 75 and 78 percent, respectively. However, 33 percent of the lichens in Plot A were disturbed and 49 percent had been disturbed in Plot B.

In 1957 Hanson described the vegetation at this station in his rough draft as:

> "The black spruce trees were spaced from 3 to 40 feet apart, often in clumps, and from 3 to 15 feet high. The polygonal pattern was pronounced, spruce and shrubs mostly in the depressed borders, lichens and some dwarf shrubs on the raised centers. Some depressions contained water. *Carex* was abundant, but the species was *C. rotundata* compared to *C. podocarpa* in Stand 39. There was also much *Rubus chamaemorus* and *Petasites*, as in Stand 39. *Eriophorum vaginatum*, *Oxycoccus microcarpus*, and *Sphagnum* occurred in both stands, and the chief shrubs in both were *Vaccinium uliginosum*, *V. vitis-idaea*, and *Ledum decumbens*. The total number of vascular species was 18.
>
> In Stand 47 the flow earth was more pronounced, beginning in the 2-18 inch layer, which had covered a former surface horizon at 18-23 inches. Another flow layer below this had covered a second surface horizon at 29-33 inches. The flow was beneath the surface of the raised centers into the depressions. The range in pH was from 5.4 near the surface to 7.2 at 29-33 inches. Roots were very numerous to a depth of 2 inches, the working depth was at about 15 inches. Five inches of water accumulated in the bottom of the profile pit in 5 minutes.
>
> The range condition was Poor because lichens were short, packed and shattered in the centers and the taller lichens in the borders appeared to be unavailable to the caribou in the winter. The chief species was *Stereocaulon sp.*, *Cladonia arbuscula* and *C. rangiferina* were moderately numerous, *C. alpestris* and *Cetraria nivalis* were sparse. The lichen cover was 5.0, moss cover 2.9. Tussocks of moss on the centers were more or less broken down.
>
> It seems that this community may have developed from an *Eriophorum-Carex* marsh, similar to Stand 41, by the formation of *Sphagnum*-heath-*Rubus chamaemorus* hummocks, enlargement and coalescence of these hummocks and invasion of black spruce;

accompanied by frost action to form the low mound-like centers of the polygons."

Hanson described Quadrat 11 in Plot A as having a frost scar in the middle of the south edge, 7 inches by 7 inches containing no living vegetation. The southwest corner had several small stones, two within the quadrat and 2 just outside on the surface. There were four hummocks 5 to 7 inches high, one 8 x 10 inches, one 5 x 7 inches, one 4 x 4 inches, and one 4 x 6 inches. Mosses on these were quite dry and showed evidence of dying. The hummocks supported most of the blueberry, cranberry, and narrow-leaved Labrador tea. Lichens were upright 1/2 to 2 inches, unshattered, mostly *Stereocaulon* and *Cladonia arbuscula* with scattered *C. alpestris* and *Cetraria nivalis*. Lichens appeared to be in better condition than those in permanent Quadrat 12 in Plot B. Quadrat 12 was described as having two hummocks in the quadrat, one in the center, 10 x 12 inches by 4 to 8 inches high. The second one is in the northwest quarter, 9 by 16 inches by 3 to 5 inches high. Clumps of moss fragments were scattered about in the northeast corner. Lichens in the southern half were compacted and shattered, but the remainder of the quadrat was in fair to good condition. *Stereocaulon* predominated, followed by *Cladonia arbuscula* and *C. rangiferina*. Portions of the moss had dried out and were in rather poor condition. No *C. alpestris* was noticed. The quadrat had a disturbed appearance (frost or caribou (?)). In 1966 McGowan indicated that there was almost no change in the vegetation or coverage from the reading of 1957. By 1970 lichens were recovering inside the exclosure, yet they were still quite small, mostly less than one inch but they were very compact and upright, primarily secondary lichens such as *Stereocaulon* and *Cladonia uncialis*. On the dry area in the center of the hummock, the lichens are still very small. *Carex rotundata* has increased both inside and outside the exclosure. Outside has continued to receive extensive use and the condition of lichens has deteriorated considerably. This is particularly noticeable in the photograph that was taken in 1955 of Plot B compared to photos in 1970. The condition of lichens at that time was much more luxuriant than at present. The frost boil described by Hanson in 1957 in Plot A is now almost entirely covered by lichen growth and there is little evidence of the moss cover dying out. It should be noted that in 1957 Hanson remarked that the condition of the lichens was somewhat better inside of the exclosure.

In 1970 the lichens were entirely shattered and disrupted and moss hummocks were broken and even shrubs showed indication of the heavy use in Quadrat 12 (Table 65). Lichens outside appeared to be mostly decadent portions of old podetia, and were in very poor condition. With total protection in 15 years' time, those species that were originally present are showing good signs of recovery, especially *Stereocaulon* and *Cladonia uncialis*. However, seldom is any of this growth over an inch or inch-and-a-half in height. Outside, the continued sporadic use of the area has caused the lichens to deteriorate to a very poor condition.

Range Station 7: Southwest Shore of Corky Lake, Spruce Type

The station lies about 300 yards southwest of the lake marker at 2,700 feet. In 1955, when the exclosure was established, the total cover

Table 65. Station 6: East side of Corky Lake, spruce type.

Year	1955	1957	1966	1970		1955	1957	1966	1970	
Method	Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	11	11	11	11b	Plot B	12	12	12	12b
Total Cover	97.2%	100	90	100	100	97.2%	96	90	90	90
Moss	7.0[b]	2	2	2	5	10.7	4	5	5	4
Betula glandulosa	-	-	-	-	-	0.9	-	-	-	-
Ledum decumbens	0.9	1/6[c]	1/6	2/6	3/7	1.5	2/5	2/7	4/7	4/6
Picea mariana	1.0	-	-	-	-	-	-	-	-	-
Salix pulchra	-	-	-	-	-	-	1	-	-	-
Vaccinium uliginosum	6.6	2/6	2/6	2/4	2/3	2.6	1/4	1/4	3/4	4/4
V. vitis-idaea	2.4	1	1	1	2	1.5	1	1	1	2
Calamagrostis inexpansa	-	-	-	-	-	-	1	1	2	2
Carex rotundata	5.2	2	2	3	4	2.0	1	2	3	3
Eriophorum vaginatum	-	-	-	-	-	-	-	1	1	-
Equisetum scirpoides	-	-	-	-	-	-	1	-	1	-
Petasites frigidus	-	-	-	-	-	-	1	-	-	-
Rubus chamaemorus	0.2	1	1	-	-	0.5	1	1	2	2
Lichens	74.8	6	6	6	5	77.5	5	5	4	3
Cladonia alpestris		-	-	-	1		-	-	-	-
C. arbuscula		-	-	2	1		-	-	1	1
C. rangiferina	28.9	-	-	1	1	35.6	-	-	1	1
C. amaurocraea		-	-	1	-		-	-	-	1
C. uncialis		-	-	2	2		-	-	2	-
C. gracilis		-	-	1	2		-	-	1	-
C. crispata	2.6	-	-	1	-	4.3	-	-	-	-
C. cornuta		-	-	-	1		-	-	-	-
C. spp. (funnel-form)	-	-	-	1	2	-	-	-	2	-
Cetraria nivalis	2.8	-	-	1	-	0.7	-	-	-	-
C. islandica	1.7	-	-	1	1	2.3	-	-	1	1
C. cucullata		-	-	-	-	-	-	-	1	-
Stereocaulon spp.	38.8	-	-	4	4	33.4	-	-	-	2
Peltigera aphthosa	-	-	-	-	-	1.2	-	-	-	1

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

was near 95 percent with lichens comprising 75 and 71 percent in Plots A and B, yet 56 percent of the lichen cover in Plot A was disturbed and 64 percent in Plot B showed evidence of disturbance. Moss and blueberry were the other principal plants.

This was Hanson's Stand 39 which was presented in the rough draft of 1957 and Table 66 is his analysis for the stand as described below:

> "It is on a gentle east-facing slope of not more than 5° and in places nearly flat. This is an open stand of black spruce with fairly dense undergrowth of dwarf heath shrubs. The spruce trees were from about 5 to 15 feet high and 3 to 18 feet apart. The ground showed a polygonal pattern, particularly from a plane, lichen openings forming the centers and trees and shrubs the borders. This stand represents a kind of vegetation that is very widespread in the southeastern quarter of the Nelchina Caribou Range. Lichens formed a mat 0.5 to 1 inch thick on the firm, moundlike centers of the polygons. They were shattered in many places. The depressions were wet and many of them contained water. Small moss hummocks were scattered on the mounds. Many of them were broken down and contained much dead moss, others were pedestalled and were being undercut, apparently by trampling of caribou. Broken-off branches and exposed lower branches and roots of shrubs were scattered over the surface of the mounds. Frost action and exposure during drought periods may play a part in this deterioration, but the primary role is very likely played by the caribou.
>
> The chief shrubs were *Ledum decumbens*, *Vaccinium uliginosum*, and *V. vitis-idaea*. *Betula glandulosa* was fairly abundant in spots, lacking in others. *Salix* spp. were scattered. *Carex podocarpa* and *Rubus chamaemorus* were unusually abundant for this Spruce type. Lichens and mosses were both abundant. The lichens were 2-4 inches high on moss hummocks in depressions, but only 0.5-1.0 inch on the polygon centers. The chief kinds of lichens were *Cladonia rangiferina*, abundant under shrubs but scarce and shattered on mounds; *C. arbuscula*, frequent under shrubs, short and scattered on mounds; *C. gracilis*, infrequent; *C. alpestris*, infrequent to scarce; *Cetraria cucullata* and *C. nivalis*, frequent; *Stereocaulon paschale*, frequent on mounds; and *Nephroma arcticum*, freq. under spruces and shrubs. The most common mosses were *Pleurozium schreberi*, *Aulocomnium turgidum*, *Dicranum fuscescens*, and *D. elongatum*. This stand was richer in *Sphagnum* mosses than most of the spruce stands. *Sphagnum capillaceum* var. *tenellum* formed hummocks as high as 15 inches and 3.5 feet across. The most common kinds in depressions were *S. lindbergii*, *S. girgensohnii*, *S. recurvum* var. *tenue*, and *S. riparium*.
>
> The 0-6 inch horizon in the soil profile consisted of dark reddish brown organic matter in various stages of

Table 66. Stand 39, west shore of Corky Lake, black spruce-dwarf heath. August 6, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover	97	100	99	98	100	98	100	98	98	100	99	
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-	x	-
Betula glandulosa	-	3	2	1	1	2	-	-	-	1	1.0	60
Empetrum nigrum	-	-	-	-	1	-	-	3	2	-	0.6	30
Ledum decumbens	3	3	3	2	3	3	3	3	2	3	2.8	100
Picea mariana	2	2	3	-	1	-	2	-	2	-	1.2	60
Oxycoccus microcarpus	-	-	-	-	-	1	2	1	1	-	0.5	40
Rubus chamaemorus	1	2	1	1	2	3	2	1	1	1	1.5	100
Salix alaxensis	-	-	-	-	-	-	-	-	-	-	x	-
S. pulchra	1	-	1	-	-	-	-	3	1	-	0.6	40
Vaccinium caespitosum	-	-	1	-	-	-	-	-	-	-	0.1	10
V. uliginosum	1	1	2	3	2	3	2	3	2	2	2.1	100
V. vitis-idaea	1	3	2	2	2	2	2	3	1	2	2.0	100
Calamagrostis canadensis	1	1	1	1	1	-	-	-	-	-	0.5	50
Carex podocarpa	2	3	3	2	3	3	2	3	1	4	2.6	100
Eriophorum vaginatum	-	-	-	-	-	-	3	-	-	-	0.3	10
Equisetum scirpoides	-	-	-	-	-	-	1	1	1	-	0.3	30
Petasites frigidus	1	-	3	2	2	-	2	2	-	1	1.3	70
Pyrola minor	-	-	-	-	1	-	-	1	-	-	0.2	20
Sphagnum	-	-	2	-	1	-	-	2	1	-	0.6	40
Mosses	3	5	4	3	5	5	6	3	3	5	4.2	100
Mushrooms	-	-	-	1	-	-	-	-	-	1	0.2	20
Lichens	6	4	4	5	5	4	4	5	6	4	4.7	100

decomposition. The 6-8 inch layer was loam, very rich in organic matter, dark reddish brown, and saturated with water. The silt-loam layer at 8-19 inches was gravelly, gray brown, and showed a pronounced tendency to flow. Water seepage began at the top of this layer. The 19-28 inch horizon was compact silt loam, dark gray, with scattered stones and moderate amount of gravel, saturated with water and showed a tendency to flow, particularly immediately above the permafrost at 28 inches. The pH varied from 5.2 at 6-8 inches to 6.7 at 8-19 inches, and 6.4 below. No reaction occurred when 20% HCl was applied. The working depth of the roots was 12 inches. The roots were very numerous in the organic layer at 0-6 inches, and numerous at 6-8 inches. The range condition for caribou grazing during the winter rated as fair. It appears that the range has recovered somewhat from a worse condition."

Hanson wrote that in Quadrat 13, which he established in Plot A in 1957, cranberry apparently was becoming dominant and *Calamagrostis inexpansa* was increasing. Lichens formed a layer one-half to one inch thick and were more erect than those in Plot B, the composition was similar but *Cladonia alpestris* and *C. rangiferina* were in better condition. Some cracks were scattered throughout the quadrat. Apparently these were frost cracks, 1/2 to 1 inch wide, which were noted to form small polygonal areas. The hummocks in northwest and northeast corners are covered with moss, lichens, and blueberry, etc. in fair to good condition. In Quadrat 14, located in Plot B, there were some bare spots covered with very fine lichen squamules. Two prominent hummocks were in the quadrat, one in the southeast corner, 6 inches high by 3 inches across the top, covered with moss, blueberry, *Carex* and lichens. It was partly broken down on the east side. Lower stems of blueberry were partly exposed. The other hummock was in the northeast corner, and was very loose, undercut, 4 inches high by 3 inches across. It was covered with blueberry, moss and some lichens. The sides slant inward looking down on it. Another very small hummock was northwest of the latter one, and it appears that earlier it had been a part of the larger hummock. The lower stems of blueberry not in the hummock were exposed. There are scattered broken-off stems of blueberry and several dead tufts of *Carex* in the quadrat. Lichens form a loose layer about 1/2 inch thick, consisting largely of *Stereocaulon*, but also including a mixture of *Cladonia* spp. and *Cetraria nivalis*.

In 1966 McGowan stated that in permanent Quadrat 13, there were several one-inch cracks in the soil but the plants nevertheless appeared vigorous. About 1/8 of the lichens were dying or drying out, otherwise there was very little change from previous descriptions by Hanson. In Quadrat 14, in Plot B, he states that there were four moose tracks in the quadrat; that the lichens appeared dry, possibly dying out. Table 67 shows the readings over the last 15 years. There has been only small changes occurring in Quadrat 13, although lichens appear to possibly be drying out and dying. The quadrat is now covered largely with very small and decadent appearing forms of lichens. In the photograph they appear very numerous and gray; however, these apparently are morbid portions of

Table 67. Station 7: West shore Corky Lake, spruce type.

Year	1955	1957	1966	1970		1955	1957	1966	1970	
Method	Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	13	13	13	13b	Plot B	14	14	14	14b
Total Cover	94.6	99	95	100	95	98.0	98	85	40	95
Moss	8.4	2[b]	2	3	6	15.0	3	2	1	4
Arctostaphylos alpina	0.4	–	–	–	–	–	–	–	–	–
Betula glandulosa	–	–	–	–	–	0.3	–	–	–	–
Empetrum nigrum	1.2	–	–	–	–	–	–	–	–	1
Ledum decumbens	2.2	1	1	4/10	–	0.3	–	–	–	3/7
L. groenlandicum	0.1	–	–	–	–	–	–	–	–	–
Vaccinium uliginosum	3.9	3/5[c]	2/6	2/7	5/5	5.7	3/2	3/3	3/5	4/7
V. vitis-idaea	1.1	2	2	1	1	1.5	2	2	1	2
Calamagrostis inexpansa	–	1	1	–	1	–	–	–	–	–
Carex podocarpa	1.6	2	2	3	4	2.1	2	2	2	4
Equisetum scirpoides	–	–	–	–	–	1.3	1	1	1	–
Petasites frigidus	–	1	1	1	1	–	–	–	–	–
Pyrola minor	–	1	–	–	–	–	1	–	–	–
Rubus chamaemorus	0.1	1	1	1	1	0.3	1	–	–	2
Lichens	75.5	6	6	5	4	71.4	6	5	3	4
Cladonia alpestris	39.4	–	–	1	–	–	–	–	–	–
C. arbuscula		–	–	1	1	–	–	–	1	1
C. rangiferina		–	–	1	1	34.5	–	–	–	1
C. amaurocraea		–	–	1	2	–	–	–	–	1
C. uncialis		–	–	2	2	–	–	–	1	–
C. gracilis	2.6	–	–	2	1	3.4	–	–	1	1
C. crispata		–	–	–	1	–	–	–	–	1
C. gonecha	–	–	–	1	–	–	–	–	–	–
C. spp. (cup-type)	–	–	–	–	1	–	–	–	–	2
Cetraria nivalis	–	–	–	–	–	2.8	–	–	1	–
C. islandica	3.0	–	–	1	1	0.9	–	–	–	1
C. cucullata		–	–	–	1	–	–	–	1	–
Stereocaulon paschale	30.5	–	–	4	3	29.7	–	–	2	2

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

podetia. The lichens cover most of the area inside the exclosure, but are quite small, generally less than 1/2 inch tall. The exclosure itself was in somewhat poor condition and it is possible that caribou have gotten into it in the past; accounting for the apparent lack of vigor of the lichens inside the exclosure. The cranberry has not increased. In fact, it has decreased in Quadrat 13, possibly due to the rather dense lichen mat. The sedge (*Carex podocarpa*) has shown a moderate increase in the last 13 years. There was very little *Cladonia alpestris* present in 1970. However, in 1957 in his rough draft, Hanson indicated that *Cladonia alpestris* was one of the major lichens in the quadrat. There are still several frost scars giving the area a polygonal appearance as described by Hanson in 1957.

Outside the exclosure lichens are noticeably less dense than inside. There has been a large decrease since 1966 in Quadrat 14 in both total cover and in lichen cover. The cover has decreased from 85 percent to 40 percent since 1966 and lichens have gone from a 5 to a 3. Those lichens that still remain were very scattered and in poor condition. The entire plot was dry and very heavily used. Most of the lichens in Plot B were quite diminutive. The new Quadrat 14b contains lichens that are in somewhat better condition than most of Plot B. However, these were scattered and in relatively poor condition. Overall, at this station, the lichens are recovering somewhat inside, yet not nearly as well as would be suspected with 15 years of total protection. From an examination of the photograph that is available from 1955, it appears that there has been very little, if any, recovery. One possible reason is that caribou might have gotten inside of this exclosure and reduced the lichen vigor. Outside, dramatic decreases have occurred in both total cover and lichen condition which reflect the deterioration of the vegetation through continued use.

Range Station 8: South Shore of Harris Lake, Spruce Type

In 1953 the vegetation was sampled near Harris Lake (Table 68). Fruticose lichens were moderately abundant, as were moss, sedge-grass and the heaths.

Stations 8 through 14 were constructed and examined in 1956. Station 8 lies about 250 yards south of the lake on a low ridge. Both quadrats are on level, well-drained ground, about 25 yards apart. In 1956 lichens comprised about 1/3 of the total cover and in Plots A and B, 5 and 15 percent, respectively, of the lichens appeared damaged. Moss and heaths were the principal cover. Hanson in 1957 established the meter square quadrats and described the stand in his rough draft as:

> "The spruce in this moderately dense Black Spruce-Heath stand were 1-24 feet high, averaging 8-10 feet, and 3-10 feet apart. Dead snags were sparse. The polygonal pattern was conspicuous from an airplane. The centers were broadly convex, 7 x 10 to 20 x 30 feet in area, covered mostly with lichens and scattered heath shrubs. Borders were depressed (without standing water), 1-2 feet below the tops of the centers, usually about 10 feet wide, and filled with mosses,

Table 68. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1953.

Species	Harris Lake o	Harris Lake d	lbs/acre
Date	7/29-8/4/53		
Total Quadrats	64		16
Lichens:			
Foliose	44	3	59.77
Fruticose	91	33	2731.02
Woody:			
Arctostaphylos alpina	16	0.8	8.02
Betula glandulosa	77	5	25.87
Empetrum nigrum	61	5	184.68
Ledum sp.	84	5	142.75
Oxycoccus microcarpus	26	0.2	3.56
Rosa acicularis	14	0.4	0.89
Salix sp.	45	3	44.61
Spiraea beauverdiana	6	0.4	-
Vaccinium uliginosum	98	8	117.77
V. vitis-idaea	92	5	87.43
Sedge-Grass	91	9	94.57
Herbs	81	7	83.86
Moss	98	24	1958.37
Other:			
Equisetum spp.	13	0.4	-
Fungi	3	t	0.89
Bare:	2	0.2	-

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

Sphagnum in places and shrubs, chiefly *Vaccinium uliginosum*, *V. vitis-idaea*, *Ledum decumbens*, and *Rubus chamaemorus*. Spruce was rooted more often in the depressions than in the centers. The total number of vascular species was only 14.

The soil showed the usual kind of profile, with a one-inch organic layer underlaid by loam (1-1.5 inches), sandy silt (1.5-7.5 inches), and silt loam (7.5-32 inches). The tendency of the soil to flow increased below 15 inches. No seepage was present at this time. The reaction varied from pH 4.9 at 1-1.5 inches to 7.1 at 7.5-32 inches. Frost boils were seen frequently, about one per polygon center.

The range condition was rated as Poor to Fair because of the short (about 0.5 inch) and somewhat packed growth of the lichens, the scattered fragments of branches of shrubs, the exposed lower stems and roots, the dead tips of branches, and the pedestalled moss clumps. The lichen cover was 3.7, moss cover 3.5. *Stereocaulon* was the most abundant lichen, *Cladonia arbuscula* and *C. rangiferina* ranged next in abundance and were beginning to produce erect growth, *Cetraria cucullata* and *C. islandica* were scattered. Cracks in the lichen mat, one inch wide and as deep as 5 inches, were numerous. This stand has received heavy use by caribou in the past, such as in the spring of 1954 when a movement of very many caribou took place across it. Some recovery in lichen growth has occurred during the past 2 years or so."

Hanson stated that in permanent Quadrat 15 (Plot A), the lichens were usually 1/2 inch high, occasionally one inch. They were slightly taller than in Quadrat 16 in Plot B. They formed a loose mat on an attached partly decomposed organic matter up to 3 inches thick. Fairly numerous cracks up to one inch wide and 3-1/2 inches deep were scattered throughout with small moss hummocks on which a few lichens were growing. Frost apparently had exposed areas along the northwest side. Some roots were also exposed. Lichens under shrubs on the southwest side were up to about 2 inches tall mixed with moss. The chief lichens were *Cladonia rangiferina*, *C. arbuscula* and *Stereocaulon* (which was much less abundant than in Plot B). Scattered *Cetraria cucullata* and dark brown *Cladonia* were also abundant. Lichens appeared to be recovering more rapidly than in Plot B. Dead branches of shrubs and scattered broken branches were less numerous than in Plot B.

Hanson described Quadrat 16 in Plot B as having lichens that were mostly 1/2 inch high, with a few up to one inch. They formed a loose mat, 1 to 3 inches thick, which included partly decayed vegetation. There was a large variety of lichens, with *Stereocaulon* the most abundant. *Cladonia* spp., especially *C. arbuscula* and *C. rangiferina*, were next in abundance with *Cetraria cucullata* scattered and *C. islandica* very scarce. The surface was cracked and in numerous places formed polygonal patterns. The cracks were up to one inch wide with some as much as 5 inches deep.

A small hummock located near the center and in the southeast quarter was 2 to 4 inches high and 5 by 7 inches in extent. The moss was mostly dead and blueberry was in poor condition with several dead branches. Some dead moss clumps were scattered over the quadrat. Frost action had apparently been occurring and the death of the mosses probably was caused by exposure to drying and partly to trampling several years ago. Lichens appeared to be recovering from earlier heavy use. The bases of stems of some shrubs and some roots were exposed resulting in the death of one *Empetrum* plant in the center of the southeast corner.

In 1966 McGowan indicated that the average height of the lichens in Quadrat 15 in Plot A was about one inch. He stated that Quadrat 16 in Plot B showed heavy trampling effects by both moose and caribou. The lichens were mostly broken and scattered and the willows were very heavily browsed. Table 69 shows the readings that have been conducted at Station 8. It can be seen that the lichens have continued to deteriorate outside of the exclosure while there has been an increase of lichens, moss and shrubs inside of the exclosure. By 1970 lichen recovery inside of the exclosure was very good. Most lichens were luxuriant, mostly of about 2 inches in length, in contrast to what Hanson reported in 1957. It appears that in this period of time with total protection, the Group I and II lichens at this site have recovered quite well. Several secondary lichens still form a major portion of the lichen cover. Shrubs, especially narrow-leaved Labrador tea and moss, have increased as well, even within the last four years. The growth of lichens is most luxuriant at both ends of Plot A, which appear to be a little more moist than the center, which is principally a stand of *Stereocaulon paschale*. The lichens in Quadrat 15b are in exceptionally good condition. This appears to be due to the increased organic layer and moisture which, on the whole, is not typical of the stand. Towards the center the stand becomes drier and there is less moss-mat and *Stereocaulon paschale* becomes the predominant species. Outside, all lichens are scattered, fragmented and decadent in unprotected areas. Again, the total cover has been reduced dramatically in the last four years, going from 80 percent to 40 percent. It went from 90 percent in 1957 to 80 percent in 1966. The use by caribou and moose has continued to cause the deterioration of all vegetation in these quadrats, especially the lichens.

Range Station 9: East Shore of Betty Ann Lake, Spruce Type

The station lies about 150 yards from the lake on a level, well-drained site at 2,500 feet. In 1956 both plots had nearly 100 percent cover with lichens comprising over 40 percent of the cover. This was Stand 42 of Hanson's (1958) report. Table 70 gives the vegetative readings for Stand 42 and Hanson's description follows:

> "Stand 42. Spruce type - old burn: This stand was open, the black spruce trees averaging 10-12 feet tall, maximum about 25 feet (Table 70). The ground surface was hummocky and formed polygons. The rounded mound-like centers varied from 4 to 15 feet wide and up to 25 feet long. The borders varied from 3 to about 20 feet wide, 8 to 20 inches deep, and usually contained water. The

Table 69. Station 8: South side of Harris Lake, spruce type.

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	15	15	15	15b	Plot B	16	16	16	16b
Total Cover	100	97	95	98	100	100	97	80	40	100
Moss	23.1	3[b]	3	5	5	20.9	2	1	1	4
Picea mariana	3.9	-	-	-	-	4.4	-	-	-	-
Betula glandulosa	1.2	1/10[c]	1/10	2/8	1/5	3.1	-	-	1/5	4/16
Empetrum nigrum	1.5	2	2	3	-	3.0	1	-	-	5
Ledum decumbens	9.4	2/6	2/8	4/18	5/10	8.1	1/6	1/2	-	-
Oxycoccus microcarpus	0.6	1	1	-	-	3.1	-	-	-	-
Salix alaxensis	1.4	-	-	-	-	-	-	-	-	-
S. pulchra	0.1	-	-	-	-	2.0	-	-	-	-
Vaccinium uliginosum	5.1	2/5	2/6	3/7	-	4.1	2/4	2/6	3/7	3/12
V. vitis-idaea	6.1	2	1	1	2	6.8	1	2	2	3
Calamagrostis inexpansa	-	1	1	2	1.6	1	1	2	-	-
Carex bigelowii	5.0	1	1	3	-	-	-	-	-	-
Petasites frigidus	2.2	-	-	-	-	3.9	1	-	-	3
Rubus chamaemorus	2.4	2	1	2	4	2.1	1	1	1	2
Lichens	37.8	4	6	5	5	38.6	6	5	3	4
Cladonia arbuscula		-	-	3	2		-	-	1	2
C. rangiferina	26.5	-	-	3	2	28.0	-	-	1	-
C. amaurocraea		-	-	1	3		-	-	1	-
C. uncialis		-	-	2	-		-	-	1	1
C. gracilis		-	-	2	1		-	-	-	-
C. crispata	0.4	-	-	1	-	1.9	-	-	-	-
C. cornuta		-	-	1	-		-	-	-	-
C. gonecha	-	-	-	1	-	-	-	-	-	1
C. spp. (cup-type)	-	-	-	1	-	-	-	-	1	-
Cetraria cucullata	-	-	-	1	1	-	-	-	-	1
C. islandica	-	-	-	2	1	-	-	-	1	-
Stereocaulon paschale	6.3	-	-	3	-	5.0	-	-	2	1
Peltigera aphthosa		-	-	2	-		-	-	-	2
P. malacea	4.4	-	-	2	1	3.3	-	-	-	1
Nephroma arcticum		-	-	-	2	-	-	-	-	1

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

Table 70. Stand 42, Betty Ann Lake, black spruce-dwarf heath. August 8, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover, Percent	80	85	90	100	95	100	99	85	94	96	92.4	
Arctostaphylos alpina	-	1	-	-	-	-	-	-	-	-	0.1	10
Betula glandulosa	-	1	-	-	-	2	1	-	-	1	0.5	40
Empetrum nigrum	1	1	1	2	-	-	-	-	1	1	0.7	60
Ledum decumbens	2	2	1	2	2	3	3	2	2	1	2.0	100
Oxycoccus microcarpus	-	-	-	-	-	-	-	-	-	-	x	-
Picea mariana	1	2	-	3	1	2	3	4	2	1	1.9	90
Rosa acicularis	1	-	-	1	-	-	-	-	1	1	0.4	40
Vaccinium uliginosum	1	2	2	2	2	2	2	2	2	3	2.0	100
V. vitis-idaea	1	1	1	2	1	1	2	2	2	1	1.4	100
Rubus chamaemorus	1	1	1	1	-	1	2	1	-	1	0.9	80
Salix alaxensis	-	-	-	-	-	-	-	-	1	-	0.1	10
S. pulchra	-	1	-	2	-	-	-	2	-	-	0.5	30
Calamagrostis canadensis	1	1	1	1	1	1	1	1	1	1	1.0	100
Carex podocarpa	-	-	-	-	-	-	-	-	-	-	x	-
Eriophorum vaginatum	-	-	-	-	-	-	-	-	-	-	x	-
Equisetum sylvaticum	-	-	-	-	-	1	-	-	-	1	0.2	20
Petasites frigidus	1	1	1	2	-	3	2	1	1	-	1.2	80
Saussurea angustifolia	-	-	1	-	-	-	-	-	-	-	0.1	10
Sphagnum sp.	-	-	-	4	-	-	-	-	-	-	0.4	10
Mosses	1	3	2	3	2	6	3	4	4	2	3.0	100
Mushrooms	-	-	-	-	1	-	-	-	-	-	0.1	10
Lichens	4	4	5	3	6	3	6	3	5	6	4.5	100

mounds were usually covered with living and dead lichens, matted into a layer 0.5 inch thick or less. They were much shattered, with only a few upright plants, chiefly *Stereocaulon*. Small moss hummocks, 2-10 inches high, were scattered, resembling pedestals with vertical sides. They were more or less disintegrated and loose tufts were also scattered. A few dwarf shrubs such as *Vaccinium vitis-idaea*, *Ledum decumbens*, and *Betula glandulosa* usually occurred. Broken branches of shrubs, especially *Vaccinium uliginosum*, were frequently seen on the mounds. Lower parts of many branches of *V. uliginosum* and *B. glandulosa* were exposed, instead of being in the organic material. Spruce and shrubs were more numerous and taller in the borders of the polygons than in the centers. *Betula glandulosa* and *Salix* spp., the former 2-4 feet tall, the latter 3-10 feet tall, were scattered. *Vaccinium uliginosum*, 3-15 inches tall, and *Ledum decumbens*, 6-15 inches, were the most numerous shrubs. Under the spruce and the shrub lichens such as *Cladonia arbuscula*, *C. rangiferina*, an occasional *C. alpestris*, and *Peltigera aphthosa*, 2 to 4 inches tall were found. They were often abundant under the denser thicket-like clumps. These dense clumps evidently are not pawed by caribou in the winter as the polygon centers are. The depressions also contained much moss and some *Sphagnum* and much *Saussurea*. Their color is green in contrast to the gray, lichen-covered centers. The packed condition of the lichens on the mounds seems to be attributable chiefly to trampling by caribou during the winter. Contributing factors may be the weight of the snow and ice, for the snow may become as deep as four feet, and exposure of the lichen mat to drying and cracking during dry periods in the summers. The range condition for winter grazing by caribou may be classified as Fair; the lichens under the shrubs are apparently used very little, if at all.

The soil profile showed organic matter, well decayed below 0.5 inch to depth of 2 inches, and dusky red. The 2-6 inch horizon was silt loam, dark brown to brown, well developed crumb structure, and containing many stones. The 6.0-20.5 inch layer was a silt loam, dark gray brown, compact, with scattered stones. The 20.5-22.5 inch layer, apparently a former surface horizon, consisted of well decomposed organic matter with very little mineral material, reddish black, very loose structure and showed some evidence of fire. From 22.5 to 50 inches was sandy silt, very sticky, containing much gravel and small stones, and dark gray. This horizon was very wet, water seeped into the pit and the soil had a pronounced tendency to flow.

About ten inches of water collected in the bottom of the pit in half an hour. The pH varied from 4.3 in the top organic layer, to 5.4 immediately below, and 6.1, 6.4, and 6.2, respectively in the layers below. There was no effervescence with 20 percent HCl. No permafrost was encountered. The

working depth of the roots was only 7 inches, but the roots were very numerous in the uppermost 2 inches."

Hanson described Quadrat 17 in Plot A in 1957 as containing scattered small hummocks 2 to 6 inches high, mostly disintegrated, apparently recovering because of growth of moss and heath shrubs. The hummocks were about 2 to 5 inches across the top. Lichens formed a one-inch thick layer and were mostly decumbent. *Stereocaulon* spp. was very abundant with scattered small *Cladonia alpestris* podetia. There were a few small scattered cracks through the more level parts of the quadrat.

He stated that in Plot B the moss hummocks had been broken down and parts scattered. There were many broken, dead branches of blueberry on the surface, and the basal parts of blueberry stems and some roots were exposed. The lichens were larger, about 1/2 inch thick and were mostly scattered with scarcely any upright. *Stereocaulon* predominated and no *Cladonia alpestris* was seen.

In 1966 McGowan stated that in Quadrat 17, there was practically no change from the description by Hanson; even the cracks were the same, and growth apparently had been nil. Unfortunately by 1970 the exclosure had been completely destroyed, apparently by caribou, since there were caribou hair and droppings throughout Plot A. The entire area was in such a disrupted condition that there was no chance to reexamine the vegetation and get any meaningful information. It appeared that some recovery was commencing inside the exclosure. Table 71 shows the readings through 1966.

Range Station 10: East Shore of Betty Ann Lake, Recent Burned Spruce Type

The station lies about 200 yards north of the lake in a severely burned area at an altitude of 2,500 feet. The burn appeared to have occurred in about 1951 or 1952. The quadrats are well drained on a nearly level ground. Total cover was 86 percent in Plot A and 97 percent in Plot B in 1956, with moss comprising 1/3. The rest was mainly lichens, forbs, heaths and grass. This is Stand 43 of Hanson's which appears in his report of 1958. It is also quoted in its entirety here and the data are presented to provide an insight to the entire stand (Table 72).

"Stand 43. Spruce type - recent burn. This stand was burned over 5 or 6 years ago. Before the burn it was similar to adjoining Stand 42. Dead snags of black spruce, up to about 25 feet high were scattered over the area. The fire must have been fairly light as most of the spruce were still standing and sprouts have appeared from the bases of the willows. The stand was conspicuous because of the occasional green clumps of willow, 4-5 feet high, in the matrix of the yellow-green *Equisetum sylvaticum*, 6-10 inches high, and *Calamagrostis canadensis*. The polygonal ground structure was not as conspicuous as in Stand 42. The mound-like centers were somewhat firmer and the moss had been mostly burned or was very much disintegrated. The surface of the mounds was covered with a dry crust of organic material, too dry to determine

Table 71. Station 9: East side Betty Ann Lake, spruce type.

Year	1956	1957	1966	1956	1957	1966
Method	Line-pt. 800 pts.	Modified H-S Scale	Modified H-S Scale	Line-pt. 700 pts.	Modified H-S Scale	Modified H-S Scale
Quadrat[a]	Plot A	17	17	Plot B	18	18
Total Cover	98.2	98	95	100	83	80
Moss	18.2	3[b]	3	19.2	2	1
Picea mariana	6.5	-	-	6.4	1	-
Betula glandulosa	1.8	2/8[c]	2/10	0.4	-	-
Empetrum nigrum	-	-	-	0.3	-	-
Ledum decumbens	6.4	1/4	1/6	7.0	-	3/8
Rosa acicularis	1.2	-	-	0.7	1/7	-
Salix alaxensis	1.4	-	-	3.4	-	-
Vaccinium uliginosum	9.4	3/5	2/4	16.9	3/6	3/6
V. vitis-idaea	8.1	1	1	6.1	1	1
Calamagrostis inexpansa	3.4	1	1	5.7	1	1
Petasites frigidus	1.1	1	1	2.3	1	1
Rubus chamaemorus	0.1	-	-	-	1	1
Lichens	41.9	6	6	40.6	5	5

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.

Table 72. Stand 43, Betty Ann Lake, burned-over black spruce-dwarf heath stand. August 8, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover, Percent	50	75	85	70	60	55	80	95	75	92	73.7	-
Arctostaphylos alpina	-	-	-	-	-	-	-	-	-	-	x	-
Betula glandulosa	1	-	-	-	-	3	-	-	1	-	0.5	30
Ledum decumbens	1	-	1	2	1	3	3	1	1	-	1.3	80
Oxycoccus microcarpus	-	-	-	-	1	-	-	-	-	-	0.1	10
Rosa acicularis	1	1	-	1	2	1	1	-	1	-	0.8	70
Rubus chamaemorus	-	-	1	1	1	1	1	1	1	1	0.8	80
Salix alaxensis	-	-	-	2	-	-	-	-	-	-	0.2	10
S. pulchra	-	1	1	-	-	-	-	-	-	-	0.2	20
Spiraea beauverdiana	-	-	-	-	-	1	1	-	-	-	0.2	20
Vaccinium uliginosum	3	3	1	4	1	1	4	3	3	-	2.3	90
V. vitis-idaea	-	1	1	-	-	1	1	3	1	1	0.9	70
Calamagrostis canadensis	1	1	2	1	1	1	1	1	1	1	1.1	100
Epilobium angustifolium	2	1	1	1	1	-	-	1	-	1	0.8	70
E. palustre	-	-	-	-	-	-	-	-	-	-	x	-
Equisetum scirpoides	1	1	-	-	-	-	-	-	-	2	0.4	30
E. sylvaticum	-	-	-	1	2	1	1	2	1	1	0.9	70
Petasites frigidus	1	1	2	-	1	1	1	1	1	1	1.0	90
Pyrola secunda	-	-	-	-	-	-	-	-	-	-	x	-
Marchantia polymorpha	-	-	-	-	1	-	-	-	-	-	0.1	10
Mosses	2	2	4	4	4	1	1	3	3	6	3.0	100
Lichens	1	x	x	x	x	x	x	x	x	-	0.1	90

if the lichen fragments in it were alive or not. The numerous cracks in this crust were as much as one inch wide. Except for this crust, and *Equisetum* and *Calamagrostis*, the mounds were mostly bare. No frost scars were seen.

In the border depressions, as much as 12 inches below the centers, mosses were building up. The chief kinds were *Polytrichum strictum*, *P. juniperinum*, *Paludella squarrosa*, *Ceratodon purpureus*, *Aulocomnium palustre* in wet spots, and *Drepanocladus uncinatus*. The chief shrubs, mostly in the depressions, were *Vaccinium uliginosum*, 2-6 inches high, and *Ledum decumbens*, 2-8 inches high. Spruce seedlings, 2-3 inches high, were scarce. Table 72 shows the analysis of this stand.

The winter range condition for caribou rated Poor. For moose, however, it appeared to be good because of the abundance of young willow shoots. The lichen succession has a long ways to go, but the presence of organic matter to a depth of 3 inches on the surface was favorable for as rapid recovery rate as possible.

The 0-3 inch horizon of the soil profile consisted of organic material, dusky red with very little mineral matter. The silt loam horizon between 3 and 13 inches varies from dark gray brown to very dark gray brown with stones scattered below 4 inches. The very dark gray material resembled the old surface horizon seen in Stand 42. The horizon from 13 to 33 inches was a somewhat mottled silt, rocks increasing with depth. The colors varied from dark gray to strong brown; pH varied from 4.6 in the top horizon; 6.8 to 6.9 at 4-13 inches; 7.8 at 21 inches; and 8.2 at 28 inches. Slight effervescence upon application of 20 percent HCl was noted in soil from a depth of 24 inches. At 31 inches the effervescence was strong. No permafrost was encountered. The working depth of the roots was at 13 inches. Roots were very numerous in the 0.3 inch organic layer, and numerous in 4 inches and in the very dark gray brown material below this.

This recently burned stand differs from Stand 42 in having less prominent border depressions in the polygonal structure, firmer centers, pH above 7.0 below 20 inches, presence of lime at 24 inches and below, more abundant mosses, fewer lichens, only seedlings of *Picea mariana*, and a much more open cover of shrubs. The herbage cover was much less, 73.7% compared to 92.4% in Stand 42."

Quadrat 19 in Plot A had some debris, comprised predominantly of sticks, grass stems and grass leaves scattered in places over the surface. In 1957 there was a small hummock in the northwest corner with *Calamagrostis* on it and a small moss hummock in the southwest corner. In Plot B there were depressions in the northeast and southeast corners, 7 inches below

the rest of the surface of the quadrat. McGowan indicated in 1966 that possibly some animals might have gotten into the exclosure, although no damage of the plant cover was noted. As can be seen from Table 73, the total cover has increased from 1957 through 1970 in Quadrats 19 and 20, both inside and outside of the exclosure. This is due mainly to the recovery of moss and some of the shrubs, especially blueberry and felt-leaf willow, following the fire. There is very little lichen growth in any of these plots. However, there has been a gradual increase inside and outside of the exclosure. The exclosure was in very poor condition in 1970. It has been nearly destroyed, evidently by moose. There were numerous caribou droppings inside of the exclosure indicating that they have been inside. This must have occurred recently, because the plants, including lichens, inside are in much better condition.

The fire destroyed most of the organic mat and lichen development has been severely retarded. Recovery is proceeding mainly from shoots from the bases of felt-leaf willow. Mosses, *Equisetum silvaticum* and *Calamagrostis canadensis* are also expected to increase. As the litter accumulates, other forbs and shrubs, particularly blueberry and narrow-leaved Labrador tea, will probably expand. The first lichens, primarily *Cladonia gracilis*, funnel-form *Cladonias* (*C. coccifera*, *C. gonecha* and *C. pleurota*) and foliose forms in moist sites, become established between 6 and 15 years after the fire. With protection from grazing and trampling for nearly 20 years the shrubs, mosses and the same lichens increase. There was no sign of recovery by the preferred species. However, the moss mat is now almost complete and the Group I lichens should become established soon. Outside of the exclosure, the effects of continued grazing and movement of large animals are apparent as total cover in 1970 is much less than the 97 percent reported in 1956. This station should be repaired as it can provide an insight to recovery following a fire.

Stations 9 and 10 point up a very real problem that exists with the construction and maintenance of exclosures on ranges where there are moose. Moose and frost action have been the biggest sources of trouble in maintaining exclosures in Alaska. Moose seemingly go out of their way to destroy exclosures. Maybe a moose repellant program should be considered at range stations?

Range Station 11: Georgia Lake, Spruce Type, Old Burn

A general reconnaissance of the vegetation was made in 1954 at Georgia Lake (Table 74). Foliose lichens were more abundant than the fruticose forms and total production was low. Moss was by far the most abundant type of plant with blueberry ranking second.

The station lies about 50 yards southeast of the lake marker at 2,500 feet. Both quadrats are on level well-drained ground. The exclosure was built and the vegetation first examined in 1956. At that time total cover was 100 percent. Lichens comprised about 10 percent of the cover, about equal amounts of foliose and fruticose types. In 1957 Hanson described the site in his rough draft as:

Table 73. Station 10: East shore Betty Ann Lake, spruce type.

Year	1956	1957	1966	1970	1956	1957	1966	1970	
Method	Line pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	Line pt. 1000 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	19	19	19	Plot B	20	20	16	16b
Total Cover	86.2	50	75	95	97.2	50	85	100	50
Moss	32.9	-	5[b]	5	41.0	3	5	6	3
Betula glandulosa	3.3	-	-	1/6	2.5	-	-	1/4	3/31
Ledum decumbens	3.7	1/6[c]	2/6	3/6	1.6	1	1	1/6	4/12
Rosa acicularis	5.3	-	1	-	-	-	-	-	-
Salix alaxensis	-	2	2/48	3/68	3.8	3	5/35	4/44	-
S. pulchra	2.6	-	-	-	3.1	-	-	-	-
Spiraea beauverdiana	-	-	-	-	-	-	-	1	-
Vaccinium uliginosum	7.3	2/5	2/8	2/8	8.4	3/5	4/8	5/7	4/8
V. vitis-idaea	2.2	-	-	3	0.9	1	1	3	2
Calamagrostis canadensis	6.3	1	1	-	12.2	1	1	1	1
Festuca altaica	-	-	-	-	-	-	-	1	-
Equisetum sylvaticum	7.3	2	2	2	5.6	1	1	1	2
Epilobium angustifolium	0.2	1	1	1	0.2	-	-	1	1
Petasites frigidus	1.6	-	-	-	5.9	1	1	-	1
Pyrola secunda	-	-	-	-	1.0	-	-	-	-
Rubus chamaemorus	1.3	1	-	-	1.9	-	-	-	-
Lichens	11.8	-	1	3	8.5	-	1	2	2
Cladonia gracilis	-	-	-	2	-	-	-	1	1
C. cornuta	-	-	-	1	-	-	-	-	1
C. spp. (cup-type)	-	-	-	2	-	-	-	-	1
Peltigera aphthosa	-	-	-	-	-	-	-	2	-
P. canina	-	-	-	1	-	-	-	1	1

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.

Table 74. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1954.

Species	Georgia Lake o	Georgia Lake d	lbs/acre
Date	7/18-24/54		
Total Quadrats	64		2
Lichens:			
Foliose	91	12	446.1
Fruticose	97	16	329.2
Woody:			
Andromeda sp.	8	t	-
Arctostaphylos alpina	2	t	-
Betula glandulosa	69	0.4	18.7
Empetrum nigrum	38	2	-
Ledum sp.	92	2	397.9
Oxycoccus microcarpus	30	t	-
Rosa acicularis	8	t	-
Salix sp.	41	0.3	239.1
Spiraea beauverdiana	9	t	-
Vaccinium uliginosum	91	2	1005.5
V. vitis-idaea	97	4	236.4
Sedge-Grass	98	5	840.5
Herbs	91	0.3	21.4
Moss	100	48	3422.5
Other:			
Equisetum	33	t	120.4
Lycopodium sp.	2	t	-

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

"This area burned over, probably in 1924, and possibly by a later ground fire, judging by the rather small, dead, upright stems of willow and spruce and by the charred wood to a depth of 6.5 inches in the soil. Black spruce were widely scattered and up to 20 feet tall. Willows, 5-10 feet tall, were sparse. *Betula glandulosa*, 3-6 feet, and *Betula* hybrids, up to 12 feet, were scattered irregularly and were dense in places. The lower layer of shrubs consisted chiefly of *Ledum decumbens* 6-13 inches high, *Vaccinium vitis-idaea* 1-3 inches, and less frequently, *Rubus chamaemorus* and *Spiraea beauverdiana*. *Vaccinium uliginosum* was surprisingly scarce. The presence of *Equisetum sylvaticum* in moderate abundance supports the idea of a recent ground fire. The total number of vascular species was 15. Large *Sphagnum* hummocks with dwarf shrubs on them, up to 18 inches high, were numerous (the moss cover was 3.1). On the whole the vegetation was dense.

The organic layer, 5.5 inches thick, was underlaid by loam at 5.5-6.5 inches; sandy loam at 6.5-9.5 inches; silt loam at 9.5-15.5 inches; and mottled sand at 15.5-32 inches. Permafrost was present at 32 inches. The pH varied from 5.1 in the 5.5-6.5 inch layer to 6.1 below 15.5 inches. Roots were very numerous to 6.5 inches and numerous at 6.5-9.5 inches. The working depth was at 9.5 inches.

The range condition was Poor. The cover of lichens was fair, averaging 2.1, but the height was only about one inch. *Cladonia arbuscula* and *C. rangiferina* were both sparse, but the less useful as caribou feed, *C. gracilis* and *C. amaurocraea* were both frequent. Other lichens were *Cetraria cucullata* inf., *C. islandica* inf., *Stereocaulon tomentosum* inf., *Nephroma arcticum* inf., and *Peltigera aphthosa* abundant. The range appeared to be improving, judging by the erect growth of *Cladonia arbuscula* and *C. rangiferina*."

In 1957 when Hanson established Quadrats 21 and 22, he noted that Quadrat 21 in Plot A included a large *Sphagnum* hummock in the southwest corner. This was 18 inches above the depression in the west, while the remainder of the quadrat was only 10 inches above the general level of Plot A. The vegetation formed a mat on the ground 4 to 6 inches thick.

A large *Sphagnum* hummock, 12 inches high, was located in the eastern half of Quadrat 22 and was covered with narrow-leaved Labrador tea and cranberry. In 1966 McGowan noted caribou droppings in the quadrat and that 10 percent of the vegetation was disturbed. Also he was not certain that the exact location for Quadrat 22 was examined in 1957 and 1966, even though the vegetative readings were similar. In 1970 there was a difference in the growth of lichens inside compared to outside the exclosure. As can be seen from Table 75, lichens, predominantly Group I, have increased on the inside. They are very robust (2 to 3") and luxuriant inside, although of spotty distribution as is typical on a heavy *Sphagnum* mat. Outside only moderate use was indicated as there were scattered good

Table 75. Station 11: South shore of Georgia Lake, spruce type.

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	21	21	21	21b	Plot B	22	22	22	22b
Total Cover	100	100	100	100	100	100	100	95	90	100
Moss	32.4	6[b]	6	6	6	30.8	6	5	5	6
Betula glandulosa	-	1/16[c]	2/18	2/24	-	-	-	-	-	-
Ledum decumbens	18.5	4/9	5/8	5/7	3/7	20.5	3/10	3/10	4/10	5/12
L. groenlandicum	-	-	-	-	-	-	1	-	-	-
Salix pulchra	0.5	-	-	-	-	-	-	-	-	-
Spiraea beauverdiana	2.2	-	-	-	-	2.1	1	1	-	1
Vaccinium uliginosum	5.4	1/4	1/6	-	3/11	0.4	-	-	2/7	-
V. vitis-idaea	14.3	4	4	4	2	18.6	4	4	4	4
Calamagrostis inexpansa	7.0	1	1	2	2	9.0	1	1	2	2
Eriophorum vaginatum	2.1	-	-	-	-	0.6	-	-	-	-
Equisetum silvaticum	3.0	1	1	1	3	2.0	1	1	3	2
Epilobium angustifolium	-	-	-	-	-	0.3	1	1	1	-
Oxycoccus microcarpus	1.1	-	-	-	-	-	-	-	-	-
Petasites frigidus	0.7	-	-	-	2	1.5	1	1	1	1
Rubus chamaemorus	2.2	2	2	3	1	0.7	2	1	1	-
Lichens	10.4	3	2	4	5	13.5	1	1	2	4
Cladonia arbuscula		-	-	2	2		-	-	1	2
C. rangiferina	6.5	-	-	1	2	5.7	-	-	-	1
C. amaurocraea		-	-	2	-		-	-	1	1
C. gracilis	0.4	-	-	1	2	-	-	-	-	-
C. bellidiflora	-	-	-	-	-	-	-	-	1	-
Cetraria cucullata	-	-	-	1	1	-	-	-	-	-
Stereocaulon paschale	-	-	-	-	2	-	-	-	-	-
Peltigera aphthosa		-	-	1	1		-	-	1	1
P. malacea	3.3	-	-	1	1	7.6	-	-	-	1
Nephroma arcticum		-	-	-	1		-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.

stands of lichens in protected sites. In open areas the lichens were small and scattered. Hanson indicated in 1957 that recovery was improving at that time as indicated by the erect growth of *Cladonia arbuscula* and *C. rangiferina*. It has proceeded noticeably well under total protection until 1970. There has been only moderate grazing outside and there are good stands of lichens in protected areas. Those areas that are fully exposed to grazing and trampling are still in poor condition, however. Total cover of the vascular plants has changed to a minor extent since 1956. By 1970, with total protection, the vegetation appears to have recovered fully from the fire 46 years ago. Grazing and trampling have retarded recovery in open areas.

Range Station 12: Gross Lake, Spruce Old Burn

The vegetation was sampled in 1954 at Gross Lake. Fruticose lichens, moss, sedge-grass and *Ledum spp.* were the principal forage producers (Table 76). Lichen cover was nearly 40 percent at that time.

The exclosure is about 50 yards from the north end of the lake at 2,500 feet. It was contructed and read in 1956 at which time lichen cover was nearly 30 percent. Moss and blueberry were the other major constituents of the flora. The photographs show that there was little damage to the lichen flora at that time. Evidently recovery from the fire was almost complete.

Stand 48 of Hanson's was located at Station 12 and he described it in 1957 in his rough draft as follows:

> "This area burned over in 1924, or earlier. The polygonal structure differed from that in most of the stand by having smaller centers and larger borders. The firm, mound-like centers were 1 x 2 to 10 x 12 feet in area, covered with lichens, mosses, some birch and heath shrubs, chiefly blueberry up to one foot high, cranberry, and *Ledum spp.* from 6-15 inches high. The depressions were filled with *Salix spp.* 6-10 feet high, shrub birch 2-5 feet, heath shrubs, mosses and some *Sphagnum spp.* *Carex bigelowii* and *Calamagrostis canadensis* were scattered throughout. The total number of vascular species was 20.
>
> The organic layer in the soil, one inch thick, was underlaid by fine sandy loam to 8 inches, silt loam between 8 and 32 inches, and very wet sandy loam at 32-38 inches. The last horizon showed slight effervescence with 20% HCl. The pH varied from 6.5 at 1-8 inches to 7.9 below 32 inches. Roots were extremely numerous in the top inch, numerous to sparse below this to 8 inches, and the working depth was at 18 inches.
>
> The range condition was Poor. The lichens, 2.8 in cover, consisting mostly of *Stereocaulon*, and moss, 3.7 in cover, formed a packed layer, 0.5 to 1.0 inch thick on top of the mounds. They were shattered somewhat. *Cladonia rangiferina* and *C. arbuscula* were short but abundant in spots. Shattered moss hummocks were widespread. The most common lichen under

Table 76. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1954.

Species	Gross Lake o	Gross Lake d	lbs/acre
Date	8/8-14/54		
Total Quadrats	32		3
Lichens:			
Foliose	91	5	191.8
Fruticose	97	36	1804.92
Woody:			
Andromeda sp.	3	t	-
Betula glandulosa	69	0.3	13.4
Empetrum nigrum	31	0.3	-
Ledum sp.	78	0.5	532.6
Oxycoccus microcarpus	25	t	29.4
Picea sp.	34	t	-
Salix spp.	-	-	16.9
Vaccinium uliginosum	69	0.4	79.4
V. vitis-idaea	100	1	161.5
Sedge-Grass	94	5	878.8
Herbs	91	t	21.4
Moss	94	35	1051.0
Other:			
Equisetum spp.	25	t	11.6
Fungi	3	t	8.0

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

the shrubs was *Peltigera aphthosa*. The rate of succession of both the spruce and the lichens has been slow in this stand."

In 1957, when Hanson established Quadrat 23 in Plot A, he stated there were hummocks near the northwestern and southwestern corners, 8 inches and 6 inches, respectively, above frost boils. There was a frost boil in the southeast corner covered with a dark crustose lichen and scattered *Stereocaulon* and *Cladonia* spp. were invading on one side and *Salix myrtillifolia* was invading the frost boil. There was a *Sphagnum* hummock in the northeast corner, 12 inches high, in Quadrat 24. The rest of the surface was comprised of low hummocks, 2 to 4 inches high. In 1966 McGowan reported that 20 percent of the area in Quadrat 23 was bare. This area was in the southeast corner and was the same area in which Hanson reported a frost boil covered with crustose lichen. In 1966 frost action had disrupted the vegetative growth which appeared to be increasing in size as compared with 1957. In 1970 this area was still about 20 percent bare, but *Carex bigelowii* had started to grow in the boil and some of the *Salix myrtillifolia* was starting to cover the frost scar. Lichen growth was scattered and it seems possible that sedges will eventually cover it.

Lichens appeared to be recovering well inside the exclosure in 1970. However, there has not been much increase in the lichen cover over the 13-year period since Hanson's reading (Table 77). The active frost boil has not been covered sufficiently to enable lichen growth to increase, but in those portions of Plot A that are more stable, lichen growth appears fairly good. But from a comparison with the original photo in 1962, lichens appeared to be in relatively good condition so that total protection has led to little difference. Outside the lichens have not been severely abused as there is considerable shrub cover and the lichens are relatively protected. Of interest at this station is the fact that lichens had recovered from the fire 28 years or more before and since then, with total protection, there has been little change in lichen cover or composition. The principal change has been an increase in shrubs both inside and outside the exclosure.

Range Station 13: Janet Lake, Spruce, Old Burn

This station lies about 150 yards west of the lake marker at 2,500 feet. Both quadrats are well-drained, lying about 60 yards apart. The exclosure was built and the vegetation examined in 1956. Total cover was 100 percent, with lichens comprising 1/4 and the rest were mainly mosses and shrubs, principally blueberry.

In 1957 Hanson described the stand at this station as:

"This former Spruce stand, dominated now by Heath, seems to have been burned over after 1924, later than Stand 45, judging by the lack of regeneration of spruce and by the large number of dead, standing spruce stems, 1-4 inches in diameter. *Betula glandulosa* and *Salix* spp. were usually widely scattered, 3-8 and 3-10 feet

Table 77. Station 12: North end of Gross Lake, spruce type.

Year	1956	1957	1966	1970		1956	1956	1957	1970	
Method	Line pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. 700 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	23	23	23	23b	Plot B	24	24	24	24b
Total Cover	100	100	80	80	100	100	100	100	100	100
Moss	25.2	4[b]	4	4	5	22.4	4	4	6	6
Picea mariana	-	-	-	-	-	-	-	-	1	-
Betula glandulosa	5.8	1/18[c]	1/20	2/22	4/26	3.3	2/10	2/16	2/22	2/26
Ledum decumbens	2.4	-	-	-	3/7	3.9	2/6	2/5	4/6	2/7
L. groenlandicum	2.4	1/6	1/6	2/7	2/8	6.4	1/8	1/10	-	2/12
Rosa acicularis	t[d]	1/8	1	-	-	0.4	-	-	-	-
Salix alaxensis	5.1	-	-	-	5/44	6.0	-	-	-	2/36
S. pulchra	0.9	-	-	-	-	-	-	-	-	-
S. myrtillifolia	t	3	3	4	-	-	-	-	-	-
Vaccinium uliginosum	12.9	3/6	3/8	3/6	-	12.0	3/6	4/6	4/5	3/12
V. vitis-idaea	6.5	1	1	1	2	6.1	2	3	2	1
Calamagrostis inexpansa	-	1	1	1	-	5.3	1	1	2	1
Hierochloe alpina	-	-	-	-	-	-	-	-	1	-
Carex bigelowii	7.0	2	3	4	3	4.5	-	-	-	4
Equisetum scirpoides	0.7	1	1	-	-	1.6	1	1	1	-
Pedicularis labradorica	-	-	-	-	-	-	1	-	-	-
Petasites frigidus	0.4	1	-	-	1	0.7	1	1	2	4
Rubus chamaemorus	-	-	-	-	-	t	-	1	1	-
Lichens	30.2	4	3	4	3	27.0	4	4	4	2
Cladonia alpestris		-	-	-	-		-	-	1	-
C. arbuscula		-	-	2	-		-	-	2	-
C. rangiferina	16.4	-	-	1	-	14.2	-	-	1	-
C. amaurocraea		-	-	-	-	-	-	-	1	-
C. uncialis	-	-	-	-	-	-	-	-	1	-
C. gracilis	t	-	-	1	-	t	-	-	-	-
C. crispata	-	-	-	1	-	-	-	-	-	-
C. spp. (cup-type)	-	-	-	-	-	-	-	-	1	-
Cetraria cucullata	-	-	-	-	-	-	-	-	1	-
Stereocaulon paschale	8.4	-	-	1	-	5.0	-	-	-	-
Peltigera aphthosa	5.1	-	-	-	2	7.7	-	-	1	1
P. malacea		-	-	2	2		-	-	1	2

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

tall, respectively. The most abundant heath shrubs were *Vaccinium uliginosum* and *Ledum* spp., forming a layer up to 6-12 inches high. *Vaccinium vitis-idaea*, 0.5-2 inches, was also abundant. The total number of vascular species was 20.

Mosses and lichens were abundant, averaging 3.0 and 2.8 in cover, respectively. Polygonal structure of the ground was evident. The small, mound-like centers, 2 x 2 to 8 x 15 feet in area, were firm, dry, and covered with a thin, 0.5-1 inch, lichen-moss layer with many cracks. Lichens were taller under the shrubs. Lichens similar to *Cladonia pleurota* covered much of the polygon centers between the shrubs, the latter were mostly in the depressed borders. *Stereocaulon* sp. was scattered, *Cladonia rangiferina* and *C. arbuscula* were scarce. *Peltigera aphthosa* and *Nephroma arcticum* were fairly abundant, under or close to shrubs.

The range condition was Poor. Lichens appear to have been greatly shattered in the past, but there was much upright growth in 1957. Caribou droppings and trails indicated heavy use in earlier years, but not during the past 2 winters.

Successionally, this stand seems to be near the middle of the sere following fire. The soil profile was not described."

In 1957 Hanson stated Quadrat 25 in Plot A had a slightly irregular surface but no well developed hummocks. The northeast corner was largely covered with crustose lichens and was cracked in several places. His reading of 99 percent ground cover included a large portion that was covered with crustose lichens.

He stated that Quadrat 26 sloped to the west and that the western half contained many cracks and appeared bare but was covered generally with crustose and other lichens in poor condition. There was a low hummock of *Sphagnum* near the northeastern corner. The 99 percent cover also included considerable amount of crustose lichen. In 1966 a few of the forbs were no longer present. In 1970 ground cover was almost complete and it was composed primarily of shrubs and lichens. The lichen cover had increased in Plot A since it was originally established. There was only one small portion in one corner that still only had squamules, but throughout the rest of the plot, it was covered principally by secondary lichens (*Cladonia gracilis*, as well as *C. uncialis*) with some *C. arbuscula* and with a few foliose lichens. The growth was robust but not very dense because of the heavy shrub overstory. It seemed doubtful that they would ever become very dense in that type of habitat because of the dense shrub cover. As can be seen from Table 78, the shrub cover had increased fairly dramatically outside of the exclosure but only to a small extent inside. Outside, the lichen cover had continued to deteriorate. The lichens present were scattered and in poor condition, seldom did they

Table 78. Station 13: West shore Janet Lake, spruce type.

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line pt. 500 pts.	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale		Line pt. H-S Scale	Modified H-S Scale	Modified H-S Scale	Modified H-S Scale	
Quadrat[a]	Plot A	25	25	25	25b	Plot B	26	26	26	26b
Total Cover	100	99	95	98	100	100	99	95	100	90
Moss	24.0	4[b]	4	4	5	19.6	3	3	5	4
Betula glandulosa	5.9	1	1	1/26	-	9.6	-	-	5/72	-
Ledum decumbens	8.7	3/6[c]	4/6	4/10	4/11	4.6	1/6	1/5	3/13	4/13
L. groenlandicum	3.0	-	-	1/11	2/15	3.0	-	-	-	-
Rosa acicularis	t	1	-	-	-	t	-	-	-	-
Salix alaxensis	5.7	-	-	-	3/10	5.4	-	-	4/88	-
Vaccinium uliginosum	15.2	3/5	4/7	4/10	3/16	17.3	3/5	3/7	5/13	4/11
V. vitis-idaea	9.7	2	2	2	3	8.3	1	1	5	1
Calamagrostis inexpansa	t	1	-	-	-	0.7	1	1	-	-
Equisetum silvaticum	0.6	1	-	-	-	-	-	-	1	1
E. scirpoides	-	-	-	-	-	3.0	1	-	-	-
Oxycoccus microcarpus	1.3	-	-	-	-	-	-	-	-	-
Epilobium angustifolium	-	-	-	-	-	-	1	1	-	1
Petasites frigidus	-	-	-	-	-	1.1	-	-	2	-
Rubus chamaemorus	t	1	-	-	-	-	-	-	-	-
Lichens	24.3	5	5	6	4	27.1	3	3	2	3
Cladonia arbuscula	5.1	-	-	3	1	3.1	-	-	1	1
C. uncialis		-	-	2	-		-	-	-	1
C. gracilis		-	-	4	2	-	-	-	-	1
C. crispata	7.2	-	-	1	-	7.3	-	-	-	-
C. cornuta		-	-	-	-		-	-	-	1
C. coccifera	4.8	-	-	-	-	8.4	-	-	-	1
C. macrophylla	-	-	-	1	-	-	-	-	-	-
Cetraria islandica	0.6	-	-	1	1	0.5	-	-	-	1
Stereocaulon tomentosum	1.2	-	-	1	1	0.7	-	-	1	-
Peltigera aphthosa		-	-	2	2		-	-	2	-
P. pulverulenta	5.3	-	-	1	2	7.3	-	-	-	2
Nephroma arcticum		-	-	2	-		-	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Average height in inches.
d Trace.

exceed 1/4 inch in length. Caribou and moose have used this area extensively. Quadrat 26 was under a large shrub so that lichen growth was naturally inhibited and consisted primarily of *Peltigera aphthosa*.

Range Station 14: Springer Lake, Spruce, Old Burn

In 1954 a general reconnaissance of the area revealed a diversity of species but a low density of most, except for lichens, moss, blueberry and cranberry (Table 79).

In 1956 the station was established on the northwest end of the lake at an altitude of about 2,300 feet on nearly level ground. The vegetation at that time covered 100 percent of the area, with lichens making up 1/4 of the cover and the rest being primarily moss, blueberry, cranberry and narrow-leaved Labrador tea.

In 1957 Hanson described the stand as:

> "This stand burned over in 1924 or earlier. Black spruce was regenerating very well. Trees varied from 2 to 14 feet in height, and up to 3 inches in diameter. They were scattered as single trees 10 to 20 feet apart, or in small clumps. *Betula glandulosa* and *Salix* spp. were scattered, the former 3-6 feet tall, the latter 4-10 feet. The chief heath shrubs were *Vaccinium uliginosum*, 3-6 inches tall between the trees and 10-12 inches under the taller shrubs; *V. vitis-idaea*, 0.5-1.0 inch, and *Ledum* spp., 6-12 inches. The total number of vascular species was 21. Mosses were abundant (cover 3.2), hummocks, about 6 inches high and showing some disintegration, were scattered in open areas. Occasional depressions, 1-2 feet deep, were present in this area.
>
> The organic layer to depth of 1.5 inches was underlain by an organic-silt layer to 3 inches; at 3-11 inches sand with much gravel; at 14-30 inches loam becoming more sandy with depth. The pH was 6.0 at 1.5-3 inches and 7.2 at 14-30 inches. The roots were very numerous to 3 inches; numerous at 3-11 inches; and working depth was at 12 inches.
>
> The range condition was rated Poor to Fair. Lichens, cover 3.0, formed a packed layer 0.5-1.0 inch deep. There were some shattered lichens, but the growth generally was erect. The lichen layer was much cracked, probably because of dry weather. Lichen succession has apparently been delayed by dry conditions, especially during drought periods. Because of so much sand and gravel in the soil, this stand has probably suffered more during drought than many other stands which have more silt or clay in the soil."

Hanson described Quadrat 27 in Plot A as being slightly hummocked, most of the hummocks about 3 to 6 inches above the depression. In Quadrat 28 he indicated that the surface was slightly hummocky, the northeast

Table 79. Unit 13: Plant composition as determined by visual estimation of plant cover and forage production from clipped meter-square quadrats, 1954.

Species	Springer Lake o	Springer Lake d	lbs/acre
Date	8/4-8/54		
Total Quadrats	32		2
Lichens:			
Foliose	63	3	108.8
Fruticose	81	39	1156.6
Woody:			
Andromeda sp.	3	t	-
Arctostaphylos alpina	19	0.2	-
Betula glandulosa	38	0.2	-
Empetrum nigrum	38	0.7	12.5
Ledum spp.	100	2	33.9
Oxycoccus microcarpus	16	t	-
Picea spp.	41	t	-
Rosa acicularis	3	t	-
Salix spp.	63	0.1	-
Vaccinium uliginosum	91	3	531.8
V. vitis-idaea	97	2	233.8
Sedge-Grass	75	3	NA
Herbs	91	0.2	21.4
Moss	97	42	2091.3
Other:			
Equisetum spp.	44	0.1	1.8
Fungi	25	t	9.8

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

corner was 7 inches and the southwest corner was 5 inches below general surface level. In 1970 the lichen growth inside the exclosure was very good, 2 to 6 inches in length, upright and very luxuriant. Recovery was almost complete, particularly in the south half of the plot which was more open. Outside of the exclosure there was moderate use and the condition of lichens had remained relatively stable (Table 80). The lichens were scattered in localized areas, however, they were not normally as badly damaged as at several other stations in this range unit. Use evidently was only moderate and not for prolonged periods. There was sufficient shrub growth and a moss layer to provide protection for the lichens at this site. The moss evidently retained the moisture needed as Hanson's description of the stand showed it had mostly a sand and gravel soil, which would tend to dry rapidly. Moisture retention was provided by the moss layer and recovery with total protection had proceeded very well. The photographs taken in 1956 showed that the lichens appeared to have been in relatively good condition at that time.

Skoog (1968) described caribou use in Range Unit 13 accordingly:

> "During the early 1950s and possibly before, caribou wintered here in great numbers. Since 1955, however, only a small portion of the herd has spent the winter, although many thousands of Nelchina caribou usually swing across the Flat each year during the October - December period, before moving to other wintering areas."

This pattern of use has continued up to the present and, from the Range Station studies, it appears to be sufficient to suppress lichen recovery. However, there are large quantities of sedges remaining, particularly *Carex aquatilis*, which would be a valuable early winter forage.

In 1959 Skoog stated that Unit 13:

> "has been a favored wintering ground in the past and the heavy use has caused much deterioration of the lichen growth. Group I lichens are being replaced by those of Groups II and III and the lichen mat has become matted and cracked. At present the area could be classed as being in stage IIIb. It is difficult to state whether lichen succession has regressed from a more advanced stage or merely remained more or less static due to fire and caribou use."

Aerial surveys (Skoog, 1968) indicated that 56 percent of the spruce type in the Lake Louise Flat has burned and presently the lichen growth is primarily secondary types, such as *Stereocaulon* spp., *Cladonia gracilis*, *C. uncialis*, *Cetraria cucullata*, and *C. islandica*. Isolated patches of the preferred lichens occur (i.e. *Cladonia arbuscula* and *C. rangiferina*) usually in depressions of the polygons where they are unavailable during the winter and also in protected sites under the shrubs. Skoog noted in 1961 that a large group of caribou wintered in the Lake Louise Flat in the winter of 1960-61. They fed extensively on the sedges protruding through the ice of the numerous ponds and sloughs and on the vegetation

Table 80. Station 14: Spring Lake, spruce type.

Year	1956	1957	1966	1970		1956	1957	1966	1970	
Method	Line pt.	Modified	Modified	Modified		Line pt.	Modified	Modified	Modified	
Quadrat[a]	700 pts. Plot A	H-S Scale 27	H-S Scale 27	H-S Scale 27	27	700 pts. Plot B	H-S Scale 28	H-S Scale 28	H-S Scale 28	28b
Total Cover	100	100	100	100	100	100	100	100	100	100
Moss	20.0	3[b]	2	4	5	21.3	3	3	4	5
Picea mariana	6.8	3	2	Dead	1/8[c]	4.0	-	-	-	2/10
Betula glandulosa	7.0	-	-	-	4/42	3.7	2/33	2/36	2/46	-
Empetrum nigrum	0.3	-	-	-	-	-	-	-	-	-
Ledum decumbens	0.2	-	-	-	-	11.5	2/7	3	4/14	2/8
L. groenlandicum	9.5	1/8	1/8	1/10	5/22	0.7	-	-	-	-
Rosa acicularis	-	-	-	-	-	t[d]	1	1/6	-	-
Salix alaxensis	3.4	-	-	-	3/74	3.8	-	-	-	-
S. pulchra	-	-	-	-	-	2.4	1	1/18	1/21	2/38
Vaccinium uliginosum	15.9	4/8	4/10	4/19	2/5	16.4	3/5	5	5/12	4/14
V. vitis-idaea	7.7	2	2	2	5	7.0	1	1	-	1
Calamagrostis inexpansa	1.1	1	1	-	1	7.1	1	1	-	4
Carex bigelowii	-	-	-	-	-	-	-	-	1	-
Eriophorum vaginatum	-	-	-	-	-	t	-	-	-	-
Equisetum scirpoides	2.7	-	-	-	-	5.1	1	1	2	1
E. silvaticum	-	-	-	-	-	t	1	1	1	1
Oxycoccus microcarpus	-	-	-	-	-	1.1	-	-	-	-
Petasites frigidus	-	-	-	-	-	1.0	1	1	-	1
Rubus chamaemorus	-	-	-	-	-	0.6	1	1	1	-
Lichens	25.4	6	6	6	5	30.1	4	4	4	3
Cladonia arbuscula		-	-	4	3		-	-	2	1
C. rangiferina	13.6	-	-	1	1	18.5	-	-	-	1
C. amaurocraea		-	-	-	-		-	-	-	1
C. uncialis	3.3	-	-	-	-	1.6	-	-	2	-
C. gracilis	0.8	-	-	3	1	1.0	-	-	1	1
C. crispata	3.1	-	-	2	-	1.2	-	-	-	-
C. pseudorangiformis	-	-	-	1	-	-	-	-	-	-
Cetraria islandica	-	-	-	-	-	-	-	-	1	-
Stereocaulon paschale	0.7	-	-	1	1	t	-	-	-	1
Peltigera aphthosa		-	-	-	2		-	-	2	-
P. malacea	3.8	-	-	2	-	7.7	-	-	1	2

a A - inside exclosure, B - outside exclosure.

b Cover by modified Hult-Sernander scale.

c Average height in inches.

d Trace.

on muskrat pushups. This undoubtedly had a detrimental effect on the muskrat population on the Flat but was a source of vegetation that normally might be unavailable to caribou.

Throughout the Nelchina range from the earlier studies in 1953 to those in 1970, the Group I lichens were usually encountered only in isolated, scattered locations where they had protection from grazing, trampling or fire. The effects of fire have been spotty, and lichens occurring on a dense moss mat, which would be moist and resistant to burning, often were not burned. Frost polygons are characteristic of the Lake Louise Flat and lichen growth usually occurs on the top of the polygons which are slightly elevated; usually shrubs are less dense and the area is more exposed to grazing and trampling. These sites are usually the most severely damaged. Quite often, adjacent to an elevated mound, luxuriant stands of lichens can be found in the border depressions. This is probably because of the increased moisture content and moisture retention by the moss cover and protection by the shrubs. Overall, the shrubs, particularly blueberry, cranberry, narrow-leaved Labrador tea, shrub birch, and willows, were increasing at almost all stations that were examined. Several sites were underlain by permafrost. Sedges are usually a principal component of such a stand, although there has been very little indication of increase in the sedge cover at any of these stations. Observations indicate that the Nelchina herd has utilized sedges to a large extent but, unfortunately, only one or two of the stations are in representative stands and very little change in the sedge cover has occurred with either protection or left open to grazing. Apparently the sedges are quite able to withstand the current level of use.

All stations are showing signs of recovery of the lichen growth after 14 or 15 years of total protection. The recovery is by lichen species that occurred at the time of building the exclosure. These include *Stereocaulon* spp., *Cladonia uncialis*, *C. arbuscula* and *C. rangiferina*. There has been almost no recovery by *Cladonia alpestris*. Very likely *C. rangiferina* and *C. arbuscula* should be considered climax for the Flat due to the intense frost action and use by large animals, both moose and caribou. Most stations showed a continued deterioration of the lichens outside of the exclosure with the lower level of use that has been made since the mid 1950s. This is particularly true at Stations 6, 7 and 8, which are at Corky and Harris lakes, close to the calving grounds. The caribou move through in large numbers annually across these stations. Deterioration of the total range has continued, especially the lichens, but also numerous moss pedestals are apparent at several of the stations. Total cover has been severely reduced and large amounts of bare ground are now exposed. Several of the stations are located in advantageous stands for studying recovery from fires, especially Station 10 at Betty Ann Lake which experienced a rather recent fire. This station showed that 6 to 15 years with total protection were required for the first lichens to establish themselves. After 20 years, the primary species, such as *Cladonia gracilis* and several of the funnel-form *Cladonias* were still about the only lichens present. Some of the stations on an old burn that occurred in 1924 or before showed that the recovery by *Cladonia arbuscula* and *C. rangiferina* usually occurred within

30 to 40 years following the fire. Station 12 is a good example showing the relatively slow progress that has been made in 15 years of total protection on an old burn. It appeared that recovery by the lichens had occurred within 30 years and that since that time, there has been very little change in the lichen cover or composition. The condition of lichens in the Lake Louise Flat would have to be considered poor as they are still deteriorating. Lichen recovery will require a minimum of 15 years of total protection, which is unfeasible, since the caribou will likely be using the Flat in the future. Very likely moose will continue to be in the area and their movements will tend to retard improvement of the condition of lichens, as will frost action. The Flat contains an abundance of sedge-forage and caribou are evidently utilizing this source to a large extent. Effort should be made in the future to more accurately determine the role of sedges in the winter diet of caribou because it is obvious that the Flat cannot be considered a major wintering site based on the condition of lichens. The recovery by lichens within exclosures has shown marked changes in the last four years, and it appears that within the next 10 years, there will be very rapid changes in the condition and composition of lichens to a more nearly climax condition, with total protection. These range stations will provide very valuable insights into lichen recovery within the next 10 years. An effort should be made to maintain them and particularly to strengthen the exclosures to minimize damage by moose and large caribou movements.

Range Unit 14 - Sheep Creek

This unit lies on the southwest corner of the Nelchina Range. It is bounded on the west by the Alaska Railroad, on the south by the Kashwitna River, and on the east and north by the Sheep and Talkeetna rivers. There are 860 square miles in the unit, which is 4.9 percent of the total. About half, 54 percent, is below 3,000 feet and the altitude ranges from 800 feet to 8,000 feet. Table 80 shows that spruce and heath are the major vegetation types in the unit and approximately 20 percent is bare ground, either glacier or water. Snowfall, according to Skoog (1968), is relatively heavy and persists late in the spring.

Skoog (1968) stated that spruce, white birch, alder and bluejoint grass dominated the western half of the unit. Shrub birch, heath and meadow occurred in the higher elevations. There were some good stands of forage lichens in the heath type, but overall they were not abundant. Sedges and grasses were numerous, however. There had not been any on-the-ground examinations of the vegetation and very little information was available. The area was only used minimally by the Nelchina herd. Essentially there was very little caribou use and Unit 14 was not of major importance to the Nelchina herd.

Unit 15: Caribou Creek

This unit is the southern limit of the Nelchina range. It is bounded on the west by the divide separating Granite Creek from Kings River, on the south by the Matanuska and Nelchina rivers, on the east by the Little Nelchina River, and on the north by Units 11 and 12. It contains 1,250 square miles, which is 7.1 percent of the total Nelchina range. Sixty-

Table 80. Percent composition by vegetation types in Unit #14.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	5.0
2. Aspen-Poplar	-
3. Bog (Heath-Moss-Sedge)	3.1
4. Bluejoint Grass (*Calamagrostis*)	1.3
5. Shrub Birch	3.1
6. Fescue Grass (*Festuca*)	-
7. Heath	18.6
8. Meadow (Sedge-Grass-Forb)	6.8
9. Water Sedge (*Carex aquatilis*)	0.4
10. Spruce	32.5
11. White Birch	3.9
12. Willow	4.4
13. Glacier	6.5
14. Bare Ground	13.1
15. Water	1.3

five percent of Unit 15 is above 3,000 feet and 22 percent is above 5,000 feet and characterized by steep mountains. The altitude ranges from 600 to 8,500 feet.

Snow and winds are of moderate intensity. Table 81 shows that shrub birch, heath and spruce are the principal vegetation types; however, bare ground makes up 20 percent of the unit due to the ruggedness of the mountains. Skoog (1959) stated that the eastern one-third contained excellent stands of climax or near climax lichens, predominantly *Cladonia alpestris* and *C. rangiferina*.

In 1953 one group of quadrats was examined along the Glenn Highway in this unit. These data are presented in Table 82.

Hanson (1958) described two stands in this unit near Eureka and they are included here, as there is little vegetative information for this unit.

> "Stand 37 was located on the upper gentle slope, of not over 5 degrees, on top of a hill about a mile north of Eureka, at an altitude of about 3400 feet, Lat. 61°57', Long. 147°11'. Analysis was made on July 31, 1957. This stand appeared to be typical of many square miles in this part of the Caribou Range. This dense, medium tall *Betula glandulosa* stand is near the upper limit of the spruce. As indicated by well decomposed stumps and charcoal under considerable accumulation of organic material, this site burned over many years ago. Trees before the fire were as much as 14 d.b.h. Occasional living white spruce, as tall as about 30 feet, were widely scattered. *Betula glandulosa*, cover 3.4, was usually about 4 feet tall (2.5-5 feet). The shrubs were usually on hummocks, up to a foot high, consisting of lichens, mosses, and heath shrubs. These hummocks were separated by firm, apparently packed areas, 1 x 4 feet wide, which have a shorter cover of lichens and fewer heath shrubs than the hummocks.
>
> The organic horizon in the soil was 2.5 inches thick. The 2.5-4.0 inch layer consisted of organic material with considerable intermixed silt. The very dusky red color and pieces of charcoal indicated that it was the surface horizon at the time of the fire. The 4-10 inch layer was sand with very little silt and with scattered gravel and small stones. Below this to 25 inches were sand with stones and very much gravel. It was very wet at the bottom. The structure was loose throughout and the drainage was good to 22 inches. The pH increased from 4.2 at 2.5-4.0 inches to 5.5 at 10-25 inches. Roots were numerous at 0.0-2.5 inches and the working depth was at 14 inches.
>
> As seen in Table 83 the species composition was similar to that in Stand 17, *Vaccinium uliginosum*, up to 15 inches high, was much more abundant however. *Ledum decumbens* was

Table 81. Percent composition by vegetation types in Unit #15.

VEGETATION TYPES/TERRAIN CATEGORIES	PERCENT
1. Alder	1.9
2. Aspen-Poplar	2.0
3. Bog (Heath-Moss-Sedge)	0.3
4. Bluejoint Grass (*Calamagrostis*)	-
5. Shrub Birch	19.5
6. Fescue Grass (*Festuca*)	3.3
7. Heath	19.0
8. Meadow (Sedge-Grass-Forb)	4.5
9. Water Sedge (*Carex aquatilis*)	0.5
10. Spruce	16.2
11. White Birch	0.6
12. Willow	7.7
13. Glacier	2.5
14. Bare Ground	20.9
15. Water	1.1

Table 82. Unit 15: Plant composition as determined by visual estimation of plant cover in meter-square quadrats, 1953.

Species	Glenn Highway o	Glenn Highway d
Date	6/6-17/53	
Total Quadrats	60	
Lichens:		
Foliose	30	2
Fruticose	82	29
Woody:		
Arctostaphylos alpina	15	0.4
A. uva-ursi	5	2
Betula nana	55	0.1
Cassiope spp.	5	0.7
Dryas spp.	30	3
Empetrum nigrum	60	11
Ledum spp.	33	0.2
Picea spp.	2	t
Potentilla fruticosa	8	t
Rosa acicularis	5	t
Salix spp.	60	1
Spirea beauverdiana	3	t
Vaccinium uliginosum	38	2
V. vitis-idaea	60	3
Sedge-Grass	88	13
Herbs	82	2
Moss	83	26
Other:		
Equisetum spp.	8	1
Bare	3	1

o Occurrence - Percent of quadrats w/plant.
d Average plant coverage (%) - based on all quadrats.
t Trace.

Table 83. Stand 37, 1 mile north of Eureka, *Betula glandulosa* climax. July 31, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover	100	100	100	100	100	100	100	100	100	100	100	
Betula glandulosa	3	4	4	4	3	4	4	3	2	3	3.4	100
Empetrum nigrum	2	3	3	-	3	3	4	2	3	3	2.6	90
Ledum decumbens	3	-	-	-	-	-	2	3	2	1	1.1	50
Rubus chamaemorus	-	-	-	1	-	-	-	-	-	-	0.1	10
Salix glauca angustifolium	-	-	-	-	-	-	-	-	-	-	x	-
Spiraea beauverdiana	-	1	-	1	-	1	1	1	1	1	0.7	70
Vaccinium uliginosum	3	3	3	2	4	3	3	3	3	3	3.0	100
V. vitis-idaea	1	2	3	1	2	2	2	2	1	3	1.9	100
Calamagrostis canadensis	1	1	2	1	1	1	1	1	1	1	1.1	100
Carex brunnescens	-	-	-	-	-	-	-	-	-	-	x	-
Festuca altaica	-	1	-	-	1	-	-	-	1	-	0.3	30
Cornus canadensis	2	-	-	1	1	-	-	-	-	-	0.4	30
Mosses	3	2	3	2	1	3	2	1	2	2	2.1	100
Mushrooms	-	-	-	-	-	1	-	-	1	-	0.2	20
Lichens	6	6	6	6	6	6	6	6	6	6	6.0	100

up to 12 inches high. *Empetrum nigrum* and *Vaccinium vitis-idaea* were abundant. *Calamagrostis canadensis* and *Spiraea beauverdiana* were scattered, and *Festuca altaica* was scarce.

Lichens were very abundant, cover rating of 6 and height of 4-6 inches under the *Betula*, 1-3 inches between the shrubs. The chief species were *Cladonia rangiferina* very common and very abundant, *C. arbuscula* abundant, *C. alpestris* abundant, *C. gracilis* frequent, *C. deformis* infrequent, *C. amaurocraea* infrequent, *C. coccifera* scarce, *Stereocaulon paschale* frequent between shrubs, *Cetraria islandica* infrequent, *Nephroma arcticum* infrequent, *Peltigera pulverulenta* and *P. aphthosa* infrequent. The range condition was rated Excellent. The density and height of *Betula* did not appear to be sufficiently great to prevent use by caribou during the winter. At present only a few caribou bulls frequent this vicinity occasionally. Successionally this stand appears to be climax or near climax. It does not seem likely that a spruce forest will develop here under present conditions, at least not for a very long time."

"Stand 9: Fescue-Willow Community: Stand 9, rich in forbs, is located on the nearly level top of a large hill about 3 miles north of Eureka: altitude 4250 feet, Lat. 61°58', Long. 147°14'. This stand is representative of extensive grassland areas in the southwestern part of the Nelchina Caribou Range. Shallow wet draws with an abundance of sedges occur occasionally. Clumps of *Salix pulchra*, 2-5 feet high, were scattered. The ten quadrats were located in the areas between the draws.

The chief herbs were *Festuca altaica*, *Artemisia arctica*, *Anemone narcissiflora interior*, and *Carex aquatilis*. The abundance of the last species seems to be related to the shallow water table. Heaths, mostly *Vaccinium vitis-idaea* and *Empetrum nigrum*, were sparse, and *Betula glandulosa* very sparse. The total number of vascular species was 26 (Table 84).

Lichens, mosses, and debris formed a layer about 2 inches thick over the surface. In the soil profile the 0-2 inch layer consisted of dark reddish brown organic material; 2-4 inches, dark reddish gray loam with scattered small stones; 4-19 inches, variable, dark gray brown to dark reddish brown gravelly loam. The profile was saturated throughout with water, seepage began at depth of 12 inches. The working depth of the roots was at 15 inches. The pH at 2-4 inches was 4.8, at 4-19 inches 5.6.

Mosses were moderately abundant; lichens very abundant, 2-4 inches high. The area has been used very little by caribou, as indicated by the very few trails and droppings, and the good condition of the lichens. Ground squirrels were absent, probably because of the shallow water table, but

Table 84. Stand 9, Fescue-willow stand, rich in forbs, 3 miles north of Eureka. July 10, 1957.

Species	1	2	3	4	5	6	7	8	9	10	Ave. C.	Frequ. %
Herbage Cover, Percent	95	98	100	100	100	100	100	100	96	99	99	
Betula glandulosa	-	-	-	-	-	-	-	-	-	-	x	-
Empetrum nigrum	-	-	-	-	-	1	-	-	-	3	0.4	20
Salix polaris selwynensis	-	-	-	-	-	-	-	-	-	1	0.1	10
S. pulchra	x	1	3	-	1	-	2	1	3	1	1.2	80
S. reticulata	-	-	-	-	-	1	-	3	1	-	0.5	30
Vaccinium vitis-idaea	1	1	1	2	2	1	1	1	1	1	1.2	100
Calamagrostis canadensis	-	-	-	-	-	-	1	-	-	-	0.1	10
Carex aquatilis	1	x	2	1	3	2	2	1	3	1	1.6	100
Festuca altaica	2	3	3	3	2	2	3	2	2	2	2.4	100
Aconitum delphinifolium	-	-	1	-	-	1	-	-	1	-	0.3	30
Anemone narcissiflora interior	1	2	2	3	3	3	1	2	2	2	2.1	100
Antennaria monocephala	1	1	1	1	1	1	x	2	-	1	0.9	90
Arnica lessingii	-	-	-	-	-	-	-	1	-	-	0.1	10
Artemisia arctica	1	1	3	2	3	2	3	2	3	2	2.2	100
Claytonia sarmentosa	-	-	-	-	x	-	-	-	-	-	0.1	10
Dodecatheon frigidum	-	-	1	1	-	-	-	2	-	1	0.5	50
Pedicularis capitata	-	-	-	-	-	-	-	-	-	-	x	x
P. Langsdorfii arctica	-	-	x	-	-	-	-	x	-	x	0.1	30
Petasites frigidus	1	-	-	-	1	1	1	-	1	-	0.5	50
Polemonium acutiflorum	1	-	-	-	-	1	x	x	1	1	0.4	60
Polygonum viviparum	1	-	-	-	-	-	-	1	-	-	0.2	20
Pyrola minor	-	-	-	1	1	1	-	1	-	-	0.4	40
Seedling	-	-	x	-	-	-	-	-	-	x	0.1	20
Stellaria laeta	x	x	1	-	-	1	x	-	1	-	0.3	60
Swertia perennis	1	-	1	x	-	-	-	-	-	-	0.2	30
Valeriana capitata	-	-	-	-	-	-	-	-	-	-	x	-
Mosses	1	2	4	2	2	4	4	4	4	2	2.0	100
Lichens	5	6	5	6	5	5	5	4	4	6	5.1	100

lemmings and meadow mice did occur. The range condition (winter, spring, or summer grazing) was Excellent."

In 1959 a general ground reconnaissance was conducted in the Eureka area where a large portion of the Nelchina herd, up to about 10,000, had wintered during November to March the previous winter. At that time it appeared that heavy use was being made of the area, yet in the following August, the vegetation appeared to have only received light to moderate use. Skoog (1959) stated that broken branches of blueberry and shrub birch were common, and that tufts of the lichens and the moss mat were lying loose in some places. Caribou droppings were common, yet most of the lichen mat appeared undisturbed and an excellent stand of forage lichens remained. He was impressed by the relatively light use of the vegetation after the large number of animals had wintered there. He stated that the vegetation at that site was primarily shrub birch and contained good growth of lichens about 3 inches high with a ground cover of 50 to 75 percent. The principal species included *Cladonia alpestris*, *C. rangiferina*, *C. uncialis* and *Stereocaulon* spp. Also a ground reconnaissance conducted along Hicks Creek drainage revealed that the major vegetation was shrub birch with large stands of meadow in the poorly drained areas. He stated that lichens were scarce for the most part, but occasional excellent growth of *Cladonia arbuscula* was found within the shrub birch stand. The area was primarily a summer range, but during the previous winter it had been used heavily.

Range Station 16: Mile 130.6 Glenn Highway, Spruce Type

Station 16 is the only exclosure located in Unit 15. It was constructed in 1960 and the first examination of the vegetation was in 1962.

It is at an elevation of 3,250 feet on a level slope. The vegetation was described in 1962 by Skoog as:

> "exclosure lies in a climax white spruce stand near timberline. Spruce are thinly scattered, 20-30 feet tall with a d.b.h. to 24 inches. Understory consist of medium 3-5 feet shrub birch, *Salix pulchra*, 3-4 feet common, as are heaths, blueberry, cranberry, narrow-leaved Labrador tea and crowberry. *Festuca altaica* is abundant as well. Lichen cover is good, consists mostly of *Cladonia alpestris*, *C. rangiferina* and *C. arbuscula* of 3-4 inches height. Group I lichens cover about 60-75% of the ground. *Stereocaulon* is common in some of the open areas as is *Cladonia uncialis*, usually located in scattered small clumps. *Peltigera* spp. are common with moss at the base of shrub birch. There is very little disturbance to the lichen cover evident. The stand lies adjacent to a Fescue strip of about 30 x 300 yards. Seems to be somewhat of a transition zone between the shrub birch and the Fescue. It appeared that the Fescue might be invading on the basis of lichen cover. Lichens more nearly approached climax stage in the Fescue, whereas the birch has more species with *Stereocaulon* being a common one."

This station was examined in 1971 and Table 85 shows the readings. There was no noticeable difference in the readings inside or outside of the exclosure. The exclosure is located in a dense shrub birch stand which restricts grazing use. However, the more open areas have apparently been heavily grazed in the past as *Stereocaulon* spp. predominate. This area has been used in the past during the winter, but evidently the use is sporadic and restricted to the more open areas since snow accumulation would be deep near the shrubs. Lichens, both inside and outside the exclosure, are robust, dense and over 2" long. Grazing use was not evident at any of the quadrats; however, the *Cladonia* species appear to be replacing *Stereocaulon* in the dense shrub areas. This exclosure does not reflect the true winter use of Range Unit 15 as it is located in a dense shrub stand and does not encompass the open areas. Several of the open areas outside show moderate effects of grazing use.

The use by caribou takes place primarily during summer by large numbers of bulls. Quite often large portions of the Nelchina herd move through the eastern half in the fall and early winter. There have been a couple of years when large groups have wintered in the unit, but it remains an excellent summer and winter range and Skoog (1968) considered it to have great potential in the Nelchina herd's ecology. From the limited vegetative studies conducted in this unit, apparently large quantities of good lichen forage remain, at least in the eastern portion of the unit. There has been only sporadic use, although it sometimes appears rather heavy and, as yet, only limited damage has been done to the lichen forage.

Table 85. Station 16: Mile 130.6 Glenn Highway, spruce type.

Year	1962	1971	1962	1971	1962	1971	1962	1971
Quadrat[a]	A1	A1	A2	A2	B1	B1	B2	B2
Total Cover	100	100	100	100	100	100	100	100
Moss	4[b]	2	6	4	6	4	3	2
Betula glandulosa	6	5	5	5	5	4	3	4
Empetrum nigrum	2	2	2	3	1	4	-	-
Vaccinium uliginosum	3	3	4	4	3	4	3	4
V. vitis-idaea	2	2	1	2	1	3	t	1
Festuca altaica	2	4	3	3	1	1	2	3
Cornus canadensis	1	1	1	-	-	-	-	-
Lichens	5	5	4	3	6	6	6	6
Cladonia alpestris	t[c]	-	t	-	1	4	4	-
C. arbuscula	t	-	-	1	2	2	2	4
C. rangiferina	5	5	2	2	4	4	3	2
C. gracilis	1	1	2	1	t	1	t	-
Cetraria cucullata	-	-	-	-	-	-	t	-
Stereocaulon	-	-	-	-	-	-	2	4
Peltigera aphthosa	-	-	-	-	3	3	1	2
P. spp.	1	-	1	1	1	-	-	-

a A - inside exclosure, B - outside exclosure.
b Cover by modified Hult-Sernander scale.
c Trace.

SUMMARY OF THE CARIBOU-RANGE RELATIONSHIPS OF THE NELCHINA RANGE

In Canada, Scotter (1964, 1968) demonstrated the importance of fire in the ecology of lichens on caribou ranges. Skoog (1968) reported that up to 56 percent of the Lake Louise Flat had burned over the past several years which indicated that between fires and caribou use, lichens have little chance of full recovery in that particular unit. However, most other units are not very susceptible to burning due to the rugged terrain which tends to contain most fires. Fires are of importance primarily in timbered regions (Units 7 and 13 principally).

Palmer and Rouse (1945) indicated that lichens on tundra ranges are quick to react to any disturbance and the length of time required for their recovery is directly proportional to the degree of the disturbance. They found that on moist sites vascular plants, primarily cotton grass (*Eriophorum* spp.), were the first to invade. However, on the drier sites shrubs recover the fastest. In the heath type recovery was rapid following light grazing, but slow with heavy grazing. They also found that a depleted lichen range under complete protection required from 20-40 years for restoration of the original density and height. Their work is substantiated by the fact that at Unalakleet in a heath type, total recovery of the original density of lichens has not occurred after 33 years, because the shrubs have become difficult to replace (Pegau, 1970b). Andreev (1954) also pointed out the slow recovery of lichens once they have been heavily utilized. Lichen growth is quite slow, usually a quarter inch or less a year, (Andreev, 1954; Scotter, 1963; and Pegau, 1968b). Skuncke (1969) remarked that *Stereocaulon paschale* was more resistant to grazing because it has solid podetia as opposed to the hollow ones of *Cladonia* and is slightly more attached to the ground, often directly on stones or coarse sand, and is less easily dislodged by movements or grazing of animals. The protein content of *Stereocaulons* is greater than most *Cladonias* (Skuncke, 1969; Scotter, 1965; Courtright, 1959; Tener, 1965). Although *Stereocaulon* spp. appear to be more resistant to trampling and possibly of better nutritional value, there has been very little information to indicate that they are grazed substantially by caribou. Further investigations should be conducted to determine the role of the *Stereocaulon* spp. in the diet of the Nelchina herd as they are one of the early successional stages and recovery usually is by *Stereocaulon* spp. on severely disturbed sites.

There are several exclosures on reindeer ranges in Sweden on both summer and winter ranges. These exclosures have only been in operation for approximately 15 years but some of the preliminary findings are that *Cladonia alpestris* will recover in 6 to 8 years if only the top inch is grazed (Skuncke, 1969). It was also noted that after fragmenting the lichens no recovery was evident within 8 years. Grazing of all the living material precluded any recovery within 14 years.

The nutritional biology of caribou is of importance and has been detailed extensively by Klein (1970a). Klein remarked that:

"while rapid rates of growth, with high dietary protein requirements, are characteristic of arctic ungulates during the brief polar summers, these animals enter a state of virtual physiological dormancy during the long winters. Even in captivity, when offered unlimited quantities of high quality food, caribou voluntarily reduce their food intake as winter approaches, growth rates level off and metabolic rates drop to a relatively low level (McEwan and Wood, 1966). Winter dietary requirements for protein are therefore greatly reduced over the summer, and energy requirements from carbohydrates become of paramount importance in the diet to meet the needs of basal metabolism, locomotion and maintenance of body heat. These changes in requirements coincide with the change in availability from summer vegetation of high protein content to lichens of low protein and high starch content which are consumed during the winter."

With a wide diversity of habitats, a considerable nutritional range of plants are available throughout a prolonged period during the brief summer at which time the rapid rate of growth and body maintenance takes place. The caribou's feeding behavior enables them to select the highest quality forage available on the range. However, low population density and the opportunity to range over wide areas, as pointed out by Klein (1970a), are essential to the well-being of caribou. Klein's (1968) studies of the St. Matthew Island reindeer herd indicated that the drastic population decline occurred after the population reached a level at which the animals were no longer able to select a high quality diet because of the high population density and consequent deterioration of the range.

The Nelchina range contains a wide variety of habitats due to its diversity of terrain features and vegetation types. Skoog (1968) reported that:

"Extensive alpine areas (55% of range lies above timberline) provide the Nelchina caribou with excellent calving areas and nutritious forage year-round; wind swept terrain furnishes relief from the harassment of flies during summer and easy access to forage during winter. The below-timberline areas contain adequate stands of Spruce, Bog, and Water Sedge vegetation for a continued high-plane of nutrition well into the winter.

Of the 12 vegetation types designated, Shrub Birch, Heath, Meadow and Willow are of most importance, based on observed caribou usage; together, these four comprised about 51% f the range vegetation (excluding the 18% of the range found to be glacier, rock, bare ground, and water). Spruce comprises about 37% of the vegetation, and is of secondary importance to caribou, mostly for early-winter use. Fescue grass, Bog, and Water Sedge are important forage types, but limited in distribution,

comprising only 7% of the total. The remaining four types are of insignificant value to caribou, and comprise only 5% of the vegetation."

Hanson (1958) reported that the northern portion of the Nelchina range was generally in good to excellent condition in regard to both lichens and vascular plants. There were a few areas in the vicinities of Tangle Lakes and 12-Mile Summit that the lichen range had deteriorated to fair condition. He felt at that time that the winter range was sufficiently large and in good enough condition for the population of caribou that was present on the Nelchina range in 1957.

Of the 15 range units, Unit 12 (Oshetna River) is the focal point of the Nelchina caribou herd. This is their principal calving and summering area. Unit 5 (Deadman Lake) is an important summering and occasional wintering range. These two units have received the most continuous use in recent years and the vegetation has continued to deteriorate in the last 10 years.

Units 1, 2 and 4 show the effects of increased winter use during the last 10 years. Originally they consisted primarily of climax stands of lichens, principally *Cladonia alpestris*, which started to deteriorate with 2 to 3 winters' use. The deterioration has been rapid and in some instances very dramatic over the 10-year period.

Units 6, 8 and 9 also contain isolated areas of regressing range condition, particularly in the heath type that is available to winter grazing where the shrub cover is not sufficiently dense to provide protection to the lichens from grazing or movements of large animals.

In Unit 13 (Lake Louise Flat) lichens continue to regress, although this unit has been used much less extensively than it was prior to the late 1950s. This sporadic use is evidently sufficient to suppress lichen recovery and, in fact, there are some instances of deterioration of the vascular species as well.

Skoog (1968) felt that in total, there was considerable winter forage, including sedges, available in almost all units, including the 3 most heavily utilized, Units 5, 12 and 13. Several other units contained excellent climax stands of lichens, and sedges were abundant in all alpine areas and as well as in several locations below timberline.

From the exclosure studies presented in this report and those of Hanson (1958) and Skoog (1968), it is apparent that the successional trend of the Nelchina range is towards a drier condition and subsequent increase in shrubs. The exclosure studies and the study of Palmer and Rouse (1945) show that use by caribou stimulates the growth of shrubs as the lichen cover is reduced. Shrubs have increased at almost all range stations on the Nelchina. Dwarf shrubs increase on tundra ranges and, once established, they are able to repress recovery of the fruticose lichens (Palmer and Rouse, 1945, and Pegau, 1970b). Crowberry and alpine bearberry are especially detrimental to lichens as they form mats through which lichens have a difficult time penetrating. They increase the value

of a summer range but may be concluded to reduce the winter range condition since, to date, there has been no indication that shrubs are important in the winter diet of caribou.

At Unalakleet full recovery of the lichens in a heath type that had been overused had not occurred within 33 years and the shrubs continued to suppress the recovery of the lichen flora (Pegau, 1970b). The browse species appeared to have been stimulated by moderate grazing. In an alpine Dryas area within the heath type, recovery in a severely disturbed quadrat had not occurred within 36 years. The only recovery that had occurred was from peripheral plants that were already in the area, particularly *Dryas octopetala*.

In the Nelchina range exclosures there was some change in lichen species composition, but normally the recovery has been primarily of those species already present at the time the areas were first protected.

Skoog (1968) presented considerable data on historical and recent population size of the Nelchina caribou herd. Evidently the herd has been characterized by large scale fluctuations since its earliest recorded history. They were at a high in the mid 1800s followed by a low in the late 1800s and a rising population during the early 1900s. He states: "a low-point in numbers probably was reached during the late 1930s or early 1940s." Since 1955 more detailed estimates of population size have been obtained showing an increase in total numbers of animals from about 40,000 in 1955 to nearly 70,000 in 1962. Hemming and Glenn (1968) reported that the minimum 1967 population was from 61 to 66,000 caribou. This indicates either a stabilization of the herd or previous counts were high or the 1967 count was low. Another census is scheduled for the summer of 1972 which should determine which counts are accurate. Regardless of which counts prove to be valid, it is apparent that the Nelchina herd has continued to increase during the 1950s and early 1960s with possibly a leveling off in the late 1960s. The increase in total numbers of the Nelchina herd has been accompanied with an expansion of the "normal" Nelchina range, especially during the winter. During the 1960s these caribou have traditionally utilized a major portion of the Wrangell Mountains area as part of their wintering range. Areas that had previously been used, such as the Lake Louise Flat, now only receive sporadic use. Also during the early 1960s, the caribou used the northwestern quarter of the Nelchina range extensively; an area which had been virtually untouched by caribou for at least 20 or 30 years.

Skoog's (1968) winter utilization studies show that the amount of area utilized during the winter is consistently low, seldom exceeding 9 percent of the total area. The fact that caribou or reindeer only utilize small portions of their range during any one winter is further substantiated by Makhaeva (1963) and Davydov (1958) in the Soviet Union. Yet, as previously mentioned, several parts of the Nelchina range have deteriorated. It becomes quite apparent from several of the exclosures and the relatively light use during the winter, that trampling plays a very important role in affecting the vegetation. This is particularly noticeable in Units 1, 2, 4 and 13.

Palmer and Rouse (1945) stated: "trampling has a greater damaging effect upon lichens than has grazing or even removal of the plant cover." This followed their extensive studies in several vegetation types of plant recovery following various degrees of simulated grazing. Some of the earliest investigations on the Nelchina range pointed out the fact that trampling constituted a major portion of the damage to lichens. Trampling becomes even more important as we realize that the Nelchina population is expanding, therefore, it will become of greater significance. Is it possible that the characteristic large population fluctuations of caribou have evolved with lichen suppression and recovery? Apparently, even though the animals move out and utilize new areas, the continued sporadic use of previously heavily used areas suppresses lichen growth and prevents restoration of the lichens. From the exclosure studies it appears that lichens on the Nelchina range need almost total protection for lengthy periods of time (over 25 years?) to recover fully, yet it only takes 5 to 8 years of use to destroy climax lichen stands.

The Nelchina caribou herd has been, and possibly still is, undergoing the classic population dynamics of building up, expanding into new areas and then crashing. The range is continuing to deteriorate and indications are that the present population levels of the Nelchina herd may very well be in excess of what the lichen flora can withstand. If such is the case, it is most important to determine the feasibility of other plants, particularly the sedges, being more heavily utilized during the winter. There are examples in Alaska of reindeer or caribou herds utilizing lichen poor ranges and remaining in good condition (the Alaska Peninsula, Nunivak Island, Stuart Island, and the Kakaruk reindeer herd). The St. Matthew Island reindeer herd had apparently essentially destroyed its lichen range several years before the population crash (Klein, 1968). On St. Matthew Island sedges and grasses increased with the increasing density of animals yet, at the time of the die-off, the animals appeared to be utilizing primarily crowberry.

Skoog (1968) stated that:

> "There is some indication of "overgrazing" in some of the Range Units as noted above. During the past 10 years, however, the Nelchina herd has been utilizing a number of wintering grounds, and even extending beyond the "normal" range boundaries. This shifting of range-use cannot help but benefit the vegetation and I can foresee no problem with food shortages now or in the future."

Skoog did not have the benefit of the most recent readings from the exclosures and was not aware of the deterioration of the range that had occurred in the last 5 years. I would agree with him that as long as there are new areas for the caribou herd to move into possibly there would be no food shortages. However, the Nelchina range is a finite area and, sooner or later, the caribou could utilize the entire range. Apparently, at the present population level, the lichens are not going to recover. Therefore, unless the animals do shift to other plants during the winter, the range apparently cannot withstand the present number of animals.

RECOMMENDATIONS

The history of caribou investigations on the Nelchina range points out that most range studies are going to be conducted by personnel who remain on the project for 3 to 5 years and often less. Considerable time has been spent at most exclosures, usually maintaining them, but there is a reluctance to do any examinations of the vegetation. Therefore, it is imperative that evaluation techniques be relatively simple so that a biologist with little range background can obtain valid vegetative data. It is recommended that photopoints be established for each quadrat at the exclosure stations and that color photographs, preferably stereo pairs, be taken. A reading of the meter square quadrat by the modified Hult-Sernander scale, which is quite simple, should be taken to supplement photographs. In the future anyone at a station could take the extra hour that would be required to take photographs of the permanent plots. The greatest expense involved is getting personnel to the station so an easy technique such as photographing the plots is recommended. These photographs can be compared with previous photos to ascertain what changes have occurred, and the behavior of individual plants can be followed.

Because the Nelchina herd is possibly overgrazing its range, it is imperative that an accurate determination of the diet of the animals be obtained. Micro-techniques are now available that apparently will enable the identification of the smallest fragments in the rumen and they should be tested on ranges of different conditions. The role of lichens should be determined. Are they necessary for the survival of caribou? It is apparent that there are animals living on very poor lichen ranges in Alaska and elsewhere that appear to be in good condition. However, will a large population, such as the Nelchina herd, voluntarily change their diet to other plants, particularly vascular species such as sedges? This question is especially important for the management of the Nelchina herd because the vascular plants are a seral stage, whereas the lichens are a climax stage which requires a much longer time to reach than a lower stage composed of vascular plants, which very likely have a higher average annual production. From the work of McEwan and Wood (1966) and, as reported by Klein (1970a), the winter diet is primarily a maintenance diet and the summer diet is most important for growth and preparation for the winter.

The dwarf shrubs are increasing and it should be determined to what extent caribou will utilize them during the winter. The exclosure stations should be maintained and examined to determine the successional stages of the vegetation on the Nelchina and its response to grazing. Most of the stations, particularly those establshed in 1960, are apparently at the stage where the greatest recovery is going to occur in the next few years within the exclosure. They will be very valuable in determining the status of the range and its response to caribou use. Recommendations are:

1. Delineate new range units to include areas now being used during the winter. Vegetation surveys should be conducted in these units to obtain basic vegetative data.

2. Collect rumen samples and body condition measurements from caribou on ranges of different quality. Analyze these samples for species composition of the diet and, if possible, basic nutritional quality.

3. Establish several permanent quadrats, such as #32 and #33, where no fences are erected but only a permanent location is marked. The vegetation in these permanent quadrats should be recorded by the use of photographs and with supplementary readings by the Hult-Sernander scale or preferably by estimating forage production. At similar sites, an examination of the vegetation by the caribou winter range condition and trend score card developed recently (Hemming and Pegau, 1970) should be conducted.

4. Maintain all exclosures and reexamine the vegetation by photographs and with supplementary reading of the Hult-Sernander scale. Fences should be strengthened to minimize damage by moose, caribou, and frost action. Reexamine all exclosures in 1975. At that time the entire Plot A and Plot B should be examined as presently the quadrats are located on the ends of each plot. Descriptions of the vegetation by 10 quadrat stands should be conducted, if at all possible, for Stations 1-39 to compare with Hanson's or Skoog's descriptions.

5. Establish photopoints at all quadrats and stations.

6. Construct about 4 more exclosures on typical winter ranges in alpine areas, primarily in the heath type. Select the sites during the winter when the exact sites that are being grazed can be observed, thereby insuring that the exclosures will be located in stands that are being utilized. The exclosures should be larger than at present; a minimum of 1/2 acre would be ideal.

7. Establish exclosures in Range Unit 12 in more representative stands than the present stations to follow the effects of heavy use on vascular plants.

8. A detailed file should be set up by range units and all vegetative data from the range stations be placed together including readings, photographs, and sightings of caribou near the exclosures, etc. Place all caribou distribution information on a range unit basis and file by range units. Attempt to be as specific as possible as to exact areas being utilized, number of animals and length of time.

9. Try to locate all missing photos, range data and herbarium specimens.

10. Conduct vegetative surveys at the same locations sampled in 1953 and 1954 and by Hanson to compare range condition over the past 15 years which will supplement those data available from the exclosures.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: James E. Hemming

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

Job No.: 3.4R Job Title: Refinement of Caribou Composition Counting Techniques

Period Covered: July 1, 1970 to December 31, 1970

SUMMARY

In 1970 a field test was conducted to measure the effects on composition count results of using genital and body size only versus more classical methods including body form, antler size and conformation, facial profile, and obvious genital characteristics. The results of this test emphasize the need to identify the sex of each animal according to genital characteristics.

BACKGROUND

In order to estimate population size, mortality, and recruitment it is necessary to obtain an accurate measure of the sex and age strata of the population. Banfield (1954), Banfield et al. (1955), Bergerud (1958), Kelsall (1968), and Skoog (1968) have contributed to the development of techniques for measuring herd composition. The identifying characteristics of both sexes and different age classes at different times of the year have been adequately described in the literature, but methods used for classifying the animals have been extremely variable and seasonal segregation and stratification of these groups have not been adequately studied. Inconsistencies which cannot be explained have shown up in recent composition counts in Alaska. In order to refine these techniques, it will be necessary to learn more about subtle seasonal changes in distribution of different sex and age classes.

OBJECTIVES

To improve caribou composition counting techniques.

PROCEDURES

Pre-count surveys must be flown to delineate the areas occupied by caribou. The relative abundance of animals in each area is noted for proper allocation of sampling effort. In order to reduce sampling bias each major area containing caribou is sampled plus an equivalent sampling of peripheral areas containing scattered bands.

The accepted criteria for identifying different sex and age classes in the field have included body form, antler size and conformation, facial profile and genital characteristics. To eliminate sex bias it has been necessary to restrict observers to classification of animals on the basis of genitalia only, except for males over three years of age in the fall that are conspicuous by their large antlers. A 20X spotting scope must be used and animals are not classified at ranges greater than 200 yards.

All counts are done from the ground. Unfortunately most counts prior to 1967 were conducted from fixed-wing aircraft resulting in questionable tallies. At the present time optimum ground locations are reached by helicopter.

In order to further reduce sampling bias, 10 percent of the population should be sampled. The possibility of using a smaller sample size will be determined by this study.

FINDINGS

No work was accomplished on Adak Island or in the Nelchina area to determine minimum sample sizes. However, a test of sex and age classification was conducted on the Alaska Peninsula. From 15-17 October, during

the peak of the rut, composition counts of 3116 animals were made. Group I was classified according to genital characteristics and body size only at close range. Group II animals were classified at close range using a combination of body form, antler size and conformation and obvious genital characteristics. The results of these counts are shown in Table 2.

Table 2. Sex and age structure of the Alaska Peninsula caribou herd by two different methods, 1970*.

Group	Sample Size	Bull:Cow Ratio	Yearling:Cow Ratio	Calf:Cow Ratio
I	1283	59:100	9:100	48:100
II	1833	42:100	6:100	45:100

* Group I animals classified by genital characteristics and body size. Group II animals classified by body form, antler size, and obvious genital characteristics.

Since each of these counts was done in the same area the relative composition of each group should have been the same. The sample sizes also exceed the 10 percent minimum (the Alaska Peninsula herd contained approximately 12,500 in 1968, excluding Unimak Island). Therefore, this first test indicates that composition counting errors result if observers do not classify all animals according to genital characteristics. Probably the greatest source of error is the problem of differentiating between young males and adult females. Undoubtedly many of the Group II males were classified as females.

RECOMMENDATIONS

This study must be continued to improve composition counting techniques.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: James E. Hemming and personnel of the U. S. Navy

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

Job No.: 3.5R Job Title: Optimum Sex Ratios for Maximum Sustained Yield Management

Period Covered: July 1, 1970 to December 31, 1970

SUMMARY

Valuable insight into population growth and structure can be obtained from studies of the caribou herd on Adak Island. However, due to an unanticipated problem of field access on Adak, a shortage of field staff and shifting of priorities, the Adak study must be temporarily discontinued.

BACKGROUND

Past studies of caribou and caribou hunters in Alaska suggest that some sport hunters are selective for caribou with large antlers, while others select a particular sex or age at different times of the year. If hunters are in fact selective in a measurable way, the sex and age structure of harvest from a given population of caribou could be controlled by manipulating the timing of the open season. The minimum sex ratio for maintenance of high production of calves has not been determined. However, Zhigunov (1961) reported that by selective breeding of reindeer, yearly production of 85-90 calves per 100 cows could be achieved from an adult sex ratio of 5 bulls per 100 cows. In order to develop a workable management plan, this ratio must also be determined for wild caribou.

OBJECTIVES

To determine the maximum ratio of breeding males to breeding females that will yield a maximum sustained yield of viable calves.

PROCEDURES

The percentage of breeding males in the Adak caribou herd were to be reduced each year until calf production was suppressed. Since recurrent estrus occurs in caribou, breeding males may have to be reduced to a very low level. The following procedures may be used to accomplish this goal:

1. Encourage trophy hunting.
2. Selective harvest of breeding males by staff biologists.
3. Restrict the open hunting season to the period from 10 August to 31 December. After that time adult males do not retain antlers.
4. Measure annually the ratio of breeding males to breeding females by direct count.
5. Measure calf production each year by direct count.
6. Measure the sex ratio of each cohort from birth to breeding age.
7. Gather data on reproductive viability in older age classes from collected specimens.

FINDINGS

Little field work was accomplished on Adak Island this year. However, negotiations with the U. S. Navy were productive. The Navy will offer helicopter support for field operation and specimen collection and will provide warehouse space and sleeping shelters on remote portions of the Island.

A census of the Adak herd was accomplished on 3 December 1970 shortly after the close of the hunting season. A total of 150 caribou was counted from two Navy helicopters. The remaining animals should produce about 50 calves in May. Calf production counts should be conducted about 1 June to check this estimate.

The caribou on Adak appear to be extremely sensitive to helicopter activity. Therefore, composition counts will have to be done on foot. The terrain on the Island is rugged with many hills, ravines and sheer mountains. The wet conditions that prevail there combined with a deep mat of ground vegetation make hiking difficult. A great deal of time will be required to conduct herd composition counts.

Hunters killed 56 caribou on Adak from 10 August to 28 November including 26 males and 27 females. Since foot travel is difficult, hunters usually took the first animals they saw. Little selectivity on the part of the hunter was observed this year.

It is intersting to note that adult male caribou on Adak Island retain their antlers much longer than their recent ancestors in the Nelchina herd. On the mainland most adult male caribou drop their antlers by mid-November, but on Adak essentially all of the males still retained antlers on 3 December.

RECOMMENDATIONS

In view of the fact that more field time than anticipated will be required due to access limitations on Adak Island, it is recommended that this project be scaled down unless additional manpower can be acquired. It has also become obvious that emphasis on caribou research must be shifted to the Nelchina herd because of manpower limitations. Therefore, I recommend that all phases of the Adak study be discontinued, except for specimen collection, measurement of hunter harvest, and calf production counts, until such time as additional support is approved.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: James E. Hemming

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

Job No.: 3.6 Job Title: Computerized Population Models for Use in Projected Caribou Management Plans

Period Covered: July 1, 1970 to December 31, 1970

SUMMARY

Preliminary work has begun to gather information from past studies and to develop a bibliography.

BACKGROUND

The computerized population models offer the best potential at this time for projecting optimum harvest levels, and composition of harvest for management. Previous studies plus ongoing projects will provide base data for developing population models which can eventually be applied to all caribou populations in Alaska.

OBJECTIVES

To develop a long-term caribou management plan with the use of computerized population models.

PROCEDURES

All applicable caribou population information from the literature and from previous studies in Alaska will be utilized to develop the initial population model. The initial model will be modified using data from all Alaskan caribou herds as they become available.

FINDINGS

This period was spent gathering and consolidating recorded information from past studies of sex and age composition, age structure, mortality and productivity for each of Alaska's caribou herds. A bibliography is also being prepared.

RECOMMENDATIONS

This study should be continued.

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