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Abstract

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In 1963 a joint University of Alaska-Smithsonian Institution crew worked at five locations in the Baird and Schwatka mountains in northwestern Alaska, conducting an ecological reconnaissance and faunal and floral inventory. Standard methods of observation and collection were used. Camps in the Kobuk drainage were located in the Redstone River valley and at Walker Lake, both on the margin of the taiga. The Noatak valley was represented by one camp each in the lower, middle, and upper reaches of the river, all in tundra. A summary of pre-1963 ornithological work in the region is presented. Significant records of distribution and/or breeding were obtained for the following birds: *Podiceps grisegena, Anas platyrhynchos, Aythya valisineria, Histrionicus histrionicus, Melanitta perspicillata, Mergus merganser, Aphrizia virgata, Bartramia longicauda, Actitis macularia, Tringa flavipes, Phalaropus fulicarius, Lobipes lobatus, Larus hyperboreus, Xema sabini, Sayornis saya, Nuttalornis borealis, Eremophilia alpestris, Tachycineta thalassina, Riparia riparia, Petrochelidon pyrrhonota, Phylloscopus borealis, Dendroica petechia, Leucosticte tephrocotis, Zonotrichia atricapilla, Calcarius pictus;* and the mammal, *Spermophilus undulatus.*

Good series of *Clethrionomys rutilius* (350) and *Microtus miurus* (147) have been deposited in the University of Alaska Museum. Severe doubt has been raised regarding the validity of the standard three-night trap grid for population estimation under wet conditions in arctic areas.

Author's Preface

The Baird and Schwatka Mountain Survey field work, completed in 1963, was described in Dean (1964) and Shetler (1964). These mimeographed reports have been used by many individuals during the past 10 years. We both have intended to publish our material long before now; however, we each became deeply involved with other responsibilities and consequently delinquent in this endeavor. Shetler was attempting to synthesize several collections from the south side of the entire Brooks Range; I hope that the current though unfortunate lack of funds for the Flora of North America project will permit him to complete this study.

Since 1970 there has been a surge of interest in the western Brooks Range and the Noatak Valley in particular. This has been accentuated by the inclusion of this valley in the Department of the Interior's selection of lands to be studied with reference to the forest, refuge, park, and wild river systems. The resultant increase of priority of information on the region has forced me to restrict the present paper to the aspects concerning birds and mammals. Hopefully, Shetler will be able to complete his work in time for it to be of use to the current group of workers. I have retained the plant names used in Shetler (1964) which, in general, followed Hultén (1941-1950). Since several significant range extensions were recorded for plants, interested workers are urged to contact Shetler at the Smithsonian Institution, Washington, D. C., or to examine his 1964 report.

Frederick C. Dean

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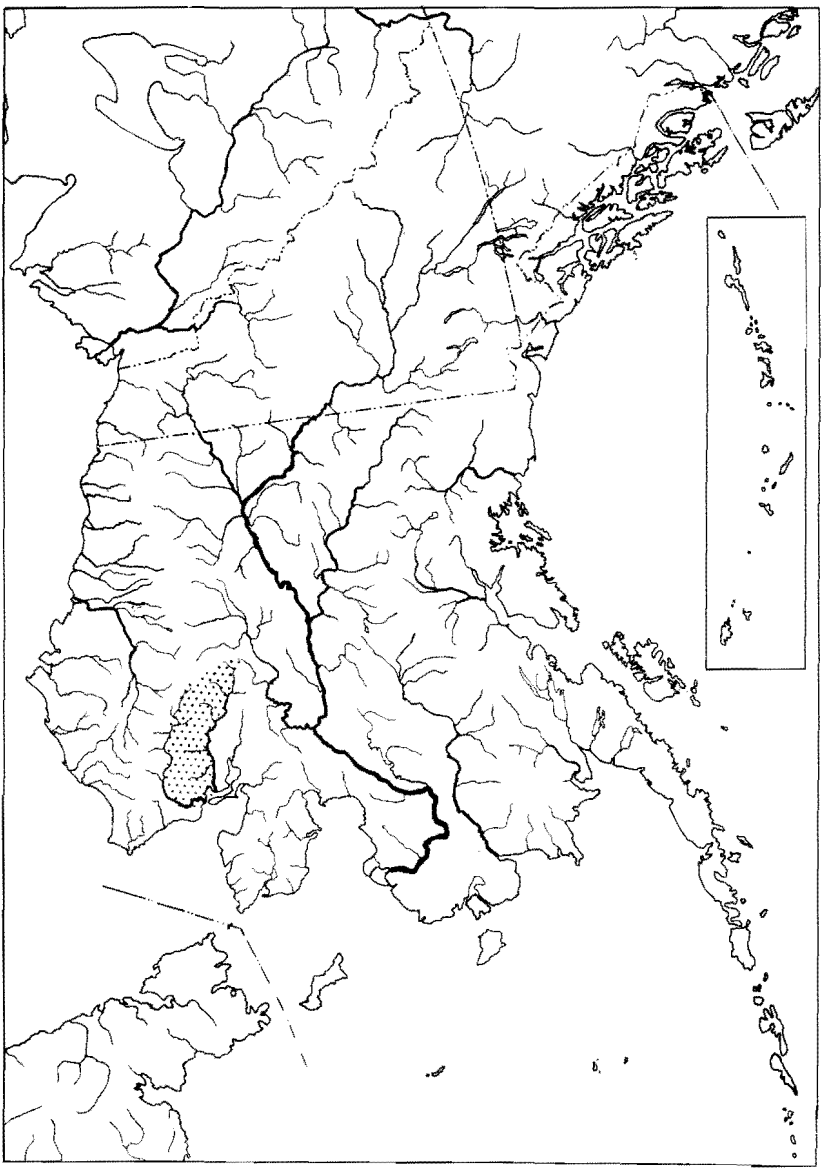
Photograph Credits and Notes

Figs. 15, 16, and 17 were made from Kodachrome slides taken by David L. Chesemore. Figs. 2, 9, 14, 18, and 24 were copied from prints furnished by the U. S. Geological Survey; note that some are from obliques and that none are distortion-free. All other photographs were taken by Frederick C. Dean.



Frontispiece: General location of Baird and Schwatka mountains in northwestern Alaska (stippled area).

Studies of Birds and Mammals in the Baird and Schwatka Mountains, Alaska

Introduction

The Baird and Schwatka mountains lie at the southwestern end of the Brooks Range in northern Alaska (see Frontispiece). The north side of these two ranges forms the southern portion of the Noatak River Valley, and on the south the two ranges slope into the Kobuk River. The area occupied by these two contiguous ranges and their foothills is approximately 14,500 sq miles (37,555 km^2). Their combined east-west length is about 240 miles (384 km).

Ecologically, the Baird and Schwatka mountains lie in an extremely interesting region where the northern edge of the taiga interdigitates with the southern portion of the tundra. The tree line of the sub-arctic forest is on the southern slopes of both ranges, and conditions vary widely from the comparatively low valley floors along the main rivers to the bare, rocky peaks of the alpine zone. The close geographical relationship with the eastern end of the Bering Sea land bridge suggests biogeographic and taxonomic boundaries, intergradation, and change.

It is difficult to realize that an area nearly twice as large as the State of Massachusetts, in such a strategic location, was almost totally neglected by biologists as recently as the early sixties, but the history of biological investigations in these mountains was nearly bare until then. Although various ships had worked through Kotzebue Sound and along the coast to the north in previous years, the first Caucasian explorations of the Kobuk and Noatak valleys began with Stoney's trip up the Kobuk River in 1883. The following year he made another trip up the Kobuk, reaching roughly 156° W. J. C. Cantwell also reached approximately the same point earlier the same year. Cantwell repeated his explorations in 1885 and continued to the head of the Kobuk region and Walker Lake. S. B. McLenegan, also of the U. S. Revenue Cutter Service, accompanied Cantwell on the 1884 trip; both men reported information of biological interest. In 1885 Cantwell made records of natural history observations throughout his whole trip to Walker Lake. C. H. Townsend, a trained ornithologist and a member of Cantwell's expedition, made valuable collections and observations through the summer of 1885 on the lower half of the Kobuk River. While Cantwell and Townsend were on the Kobuk River in 1885, McLenegan, with one assistant, made a trip up the Noatak River, reaching a point a short distance east of the mouth of the Aniuk River, which comes in from the north at about 158° W. McLenegan reported his observations, and these furnished the first record of the birds and mammals in the Noatak Valley. During the winter of 1885-1886, Stoney remained near Shungnak, on the upper portion of the Kobuk. He and members of his party made several extensive trips, including trips to the Alatna River and Chandler Lake and Ensign Howard's trip north across the Noatak Valley to the headwaters of the Colville River and then eventually to Pt. Barrow. The biological value of the record left by Stoney and Howard is not as great as those of Cantwell, Townsend, and McLenegan, partly because of the loss of original data and partly because of the season of the year.

These explorers concentrated their efforts along the main rivers. The mountains remained almost unknown to white men. The rush for gold which took place

at the end of the 19th Century brought some biological dividends in the Kobuk region as Joseph Grinnell, the ornithologist, joined a group of miners who wintered on the Kobuk River near the mouth of the Hunt River. Grinnell left a valuable record of his observations on birds and mammals; he worked not only along the main Kobuk but also in the vicinity of the Jade Mountains and up the Hunt River Valley. Following Grinnell's work, over half a century elapsed before the region began to receive much attention from biologists. Geologists, on the other hand, worked in the area in the early 1900's.

During the summer of 1901, W. C. Mendenhall and his Geological Survey party went from Ft. Hamlin, on the Yukon River, to the Helpmejack Creek divide and thence down the Kobuk to its mouth. In 1910, Philip S. Smith, also with the Survey, led a party that went from the Koyukuk River to the upper part of the Kobuk basin and then to the mouth of the latter river. In 1911, Smith and his party worked up the Alatna River and crossed to the Noatak through the Portage Creek pass. They then descended the Noatak, reaching Kotzebue in late August. The regions north and east of the Baird and Schwatka mountains received considerable geological attention through the 1920's, but no other significant work was done in these mountains during that decade or in the 1930's.

In 1940, L. J. Giddings began work on archaelogical sites along the Kobuk. In the late 1940's, Laurence Irving began a sequence of several years' work at Anaktuvuk Pass, which lies 90 miles (144 km) to the east of the Noatak region, and also began to collect information on the birds around Kobuk for comparison with that from Anaktuvuk Pass. In 1956, George E. Hudson spent part of the summer at Kotzebue and Selawik, making ornithological observations. During the 1950's, many individuals working out of the Arctic Research Laboratory at Barrow explored the north slope of the Brooks Range, concentrating principally, however, on the central and eastern portions of the region. The U. S. Atomic Energy Commission's Project Chariot, 1959 through 1963, produced a great deal of knowledge about conditions on the northwest coast of Alaska, including much information about plants, birds and mammals (Wilimovsky and Wolfe, 1966). Henry E. Childs, Jr., (1969) studied the birds and mammals of the Pitmegea River during the period 1957 through 1960.

Consequently, the Baird and Schwatka mountains constitute a large region, drained by two major rivers, that is ringed by a number of widely scattered points about which quite a bit is known. Within the region itself, our knowledge is fragmentary and for the most part old. Until the sixties, geologic mapping had been conducted only along the main river valleys, and the reader of Smith and Mertie (1930) will find frustrating expanses of white blanks where the Baird and Schwatka mountains should be. In addition, with the exception of the coastal region, the west end of the Brooks Range is still very lightly worked in a biological sense. Our 1963 survey was aimed particularly at (1) determining in some detail the flora and vertebrate fauna of the Baird and Schwatka mountain ranges, (2) relating the flora and fauna to an ecological framework, (3) obtaining sufficient numbers of specimens to permit taxonomic analysis wherever possible, and (4) making preliminary comparisons of the ecology of grizzly bears in this region with previous studies conducted in the Alaska Range.

The study was financed by the University of Alaska, the Smithsonian Institution, and The Conservation Foundation. The two former institutions contributed largely through the salaries of the senior investigators, travel, and support during

the period of analysis. The Conservation Foundation provided a grant which covered most of the field expenses and some of the analytic work.

The personnel involved in the field investigations were as follows: Stanwyn G. Shetler, botanist with the Smithsonian Institution; his wife, Elaine Shetler; David L. Chesemore, then a graduate assistant with the Alaska Cooperative Wildlife Research Unit; his wife Janice Chesemore; and the senior author, Frederick C. Dean, Professor of Wildlife Management at the University of Alaska. Shetler, assisted by his wife, had primary responsibility for the botanical aspects of the work and did almost all of the collecting. Chesemore did almost all of the field work with the small mammals and in addition performed much of the preliminary analysis of the mammal data. In addition to her duties as chief cook, Mrs. Chesemore performed admirably as his assistant. Dean had primary responsibility for work on birds, bears, and the general ecological aspects, as well as the overall supervision of the operation. Mrs. Dean assisted in general observations and plant collecting after the Shetlers' departure.

The itinerary below shows the dates and crew members for each of the camps.

Camp I, Lower Noatak, 11-26 June, D. and J. Chesemore;

Camp II, Middle Noatak, 26 June-7 July, D. and J. Chesemore, S. and E. Shetler, F. Dean;

Camp III, Redstone River Valley, 7-22 July, D. and J. Chesemore, S. and E. Shetler, F. Dean;

Camp IV, Walker Lake, 22 July-5 August, D. and J. Chesemore, S. and E. Shetler, F. Dean;

Camp V, Upper Noatak, 5-9 August, D. and J. Chesemore, S. and E. Shetler, F. Dean; 9-17 August, D. and J. Chesemore, F. and S. Dean; 17-29 August, D. and J. Chesemore, F. Dean.

Heinrich Springer and Clayton White, at that time research assistants in the University of Alaska's Department of Biological Sciences, spent 10 days during late June and early July 1963 near the mouth of the Kugururok River, which enters the Noatak River west of BSMS (Baird and Schwatka Mountain Survey) Camp II. They have kindly permitted the free use of their bird notes, and we wish to acknowledge our appreciation of their generosity. Both are experienced field ornithologists, and their information is of considerable value.

James Helmericks, who has spent many years living at Walker Lake and on the Colville River Delta, generously contributed information regarding some of his bird observations at Walker Lake. Keith and Anore Jones, residents of the Ambler and Onion Portage areas and trained biologists, and Kenneth T. Alt, at the time a graduate student in fisheries biology at the Univerisyt of Alaska, made available their ornithological notes from Ambler, Selawik, and Walker Lake. Their willingness to record and contribute this information is greatly appreciated.

General Description of the Region

GEOGRAPHIC LOCATION

The region under study is located at the southwestern end of the Brooks Range, northern Alaska. The center of the area is roughly 375 miles (600 km) northwest of Fairbanks. Generalized reference boundaries for the area are the lines 67° and 68° N and 154° and 163° W. The Baird Mountains occupy approximately the western half of the region that lies between the Kobuk and Noatak rivers; the Schwatka Mountains occupy the eastern half of this region.

REGIONAL PHYSIOGRAPHY

An examination of Fig. 1 will show the Baird Mountains to be a rather broad range of comparatively low mountains. Particularly in the western half of this range, the tendency is toward broad rounded tops, and valleys that are cut only moderately. The general level of most of the taller peaks is between 3,000 and 4,000 ft (ca. 900 to 1,200 m) above sea level; many peaks, however, are below 3,000 ft (900 m). The largest rivers draining the Baird Mountains flow to the south and empty into the Kobuk River. There is a zone averaging about 10 to 15 miles (16 to 24 km) wide between the foothills and the Kobuk River itself. Toward the west, nearer the mouth of the Kobuk, this distance increases considerably, forming part of a broad, flat valley. On the west and north, the Baird Mountain drainage flows into the Noatak River. With the exception of the lower portions of the major rivers, all of the streams draining the Baird Mountains are shallow and braided. Smith and Mertie (1930, Fig. 16) showed former glaciation as having covered all of the Baird Mountains except the very western and northwestern portions.

In contrast to the Baird Mountains, the Schwatka Mountains are higher and more rugged. Within the Schwatka Range there are many peaks over 5,000 ft (1,524 m), quite a number over 6,000 ft (1,829 m), and one that surpasses 8,500 ft (2,590 m). On the north, the Schwatka Mountains drop quickly into the comparatively narrow Noatak Valley. The tributary valleys are largely north-south oriented and show characteristics typical of glaciated regions, including steep walls, parallel sides, and divides with sharp ridges. The southern slope of the Schwatka Mountains drops more gradually into the Ambler lowland, which can be seen in Fig. 1 arching to the southeast from Camp III. Farther to the east the Schwatka Mountains drop off into the upper Kobuk Valley. Walker Lake is by far the largest lake within the region under consideration, stretching for some 14 miles (22 km) in a northwest-southeast direction near the east end of these mountains. In Fig. 1, the lake can be located by the Camp IV marker at the lake's north end.

To the south of the mountains are flat country, the Kobuk River, and the northern extension of the taiga or subarctic spruce forest. The Kobuk Valley is broad and is not as obviously subdivided as is the valley of the Noatak. The hills to the south of the Kobuk gradually rise to the divide between the Kobuk and the Koyukuk. In contrast, on the north of the Baird and Schwatka mountains, the Noatak winds through a valley with a width which ranges from only a mile or so at the headwaters to several tens of miles in the Aniuk lowlands. Smith (1913) named the several regions through which the Noatak flowed as follows: the headwater mountains, the Aniuk lowlands, the second highland (in the vicinity of our Camp II), the Mission lowland (in which our Camp I was situated), the Igichuk Hills, and a narrow coastal lowland. In each case, as the river flows through one of the highland areas, the valley constricts upon the water; in some places sizable canyons have been formed.

REGIONAL GEOLOGY

Smith and Mertie (1930) gave a summary of the regional geologic history for the northwestern part of Alaska. According to these workers, although many of the rocks originated from Paleozoic and Silurian deposits, the upheaval which had the major influence in determining the present mountain structures came during the Triassic time, though the record is not complete. Another major mountain-building period took place during the Late Cretaceous or Early Tertiary time. Near

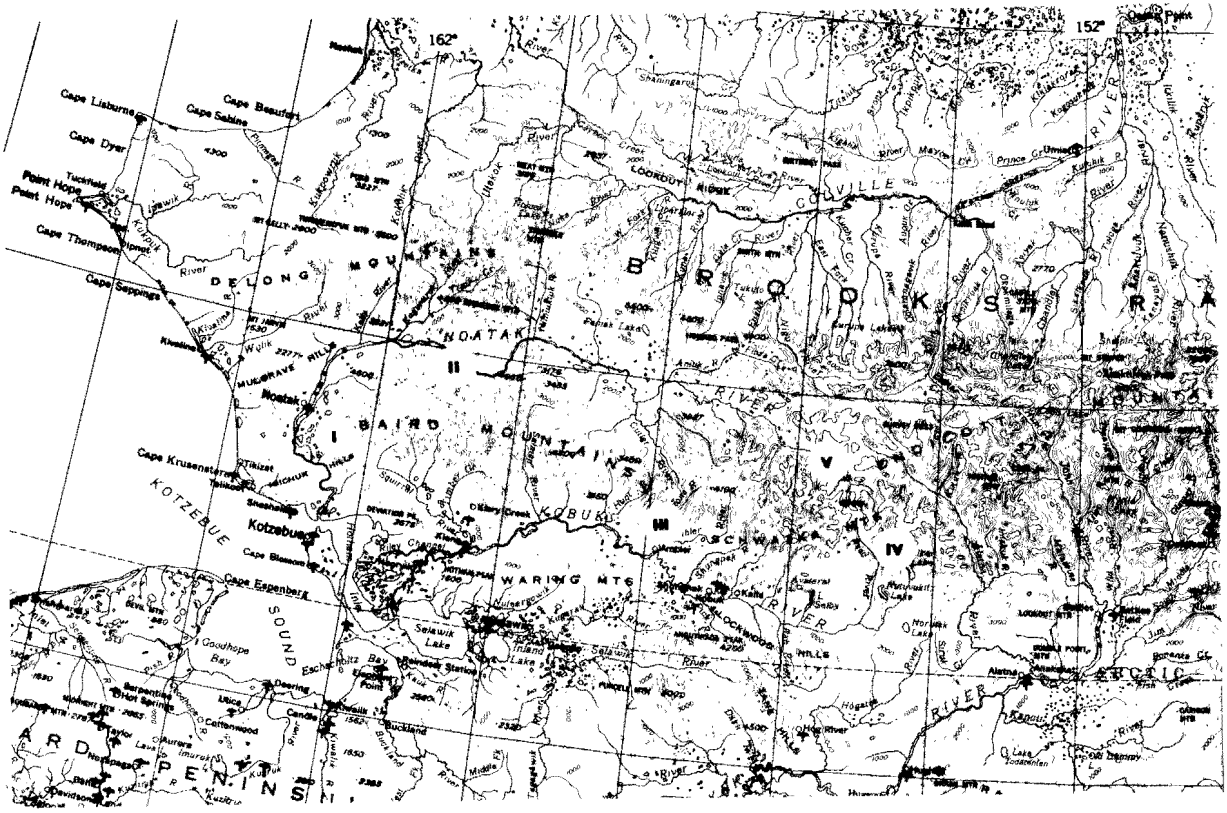


Fig. 1. Northwestern Alaska, showing the Baird and Schwatka mountains in relationship to the Kobuk and Noatak drainages. (From U. S. Geological Survey Alaska Map B. Scale is approximately 1:1,660,000.) The 1963 Baird and Schwatka Mountain Survey camp sites are shown by Roman numerals.

the center of the Brooks Range, where the effects were most severe, there are signs of extreme folding and profound faulting. The Tertiary uplift probably pushed many of the mountains above the snow line, giving rise to a period of glaciation. It is probable that the glaciated period was essentially contemporaneous with the maximum period of ice coverage in the southern states, but certainly not all of the Baird and Schwatka mountains were covered by ice; neither was the entire Noatak Valley. Smith and Mertie (1930) showed the approximate extent of glaciation in their Fig. 16.

The valley bottoms of both the Noatak and Kobuk rivers and many of the tributaries are covered with Quaternary sedimentary deposits of sand, gravel, and mud of variable origin. North of the Kobuk River, on the southern slopes of the Baird and Schwatka mountains, there are extensive deposits of highly metamorphosed rocks that Smith considered of early Paleozoic or older age. He described these as being dominantly sedimentary in origin but also including some that were probably igneous. At scattered points on the very edge of the valley floor there are deposits of Tertiary sediments. Also along the south slope of the Baird Mountains there is highly metamorphosed limestone. The hills around Lake Selby (south of the Ambler lowland) and to the east, on the south side of the Schwatka Mountains, are made of sandstone, shale, and conglomerate. Around Walker Lake there are also areas of Skajit limestone, but the mapping there is very incomplete. Fernald (1964) has mapped the surficial deposits in the Central Kobuk Valley.

Working from the mouth of the Noatak upstream, the major formations that are encountered include the Skajit limestone of which the Igichuk Hills are composed, an area of basic effusive and intrusive rocks in the neighborhood of the canyon south of the mouth of the Kugururok River, a large expanse of Noatak sandstone through the second mountain area, and finally, in the headwater mountains, large areas of undifferentiated Silurian (?) limestone and schist. Both the Mission lowland and the Aniuk lowland are broad expanses of Quaternary sediments. Small patches of Lisburne limestone are found in the second highland area. These are probably extensions from the large area of Lisburne limestone that forms much of the De Long Mountain range to the northwest of the Mission lowland. Information gained during the 1963 field season, both while in camp and during flights between camps, suggests that the major portion of the Baird and Schwatka mountains is composed of sandstone, schist, and highly metamorphosed rocks of various sorts. There are also extensive areas of limestone. However, the whole structure is extremely heterogeneous, and it will take considerable effort to get accurate geologic maps of the region. Gryc (1958) and Martin (1970) provided very general and quite detailed descriptions of the regional geological structure.

CLIMATE

The climate of the Kobuk-Noatak region and the Baird and Schwatka mountains is basically a subarctic continental one. Temperatures in the winter can frequently go below -60°F (-76°C). During the summer, daily maxima at lower elevations could be expected in the 60° and 70° F range (15° to 20° C) for two or three months. However, shade temperatures might not reach 70° F for more than one month of the year, particularly in the Noatak Valley. Temperature fluctuations are severe; for instance at Camp III on the Redstone River the high for July 8-9 was 83°F (28° C), and the low for the same period was 36° F or 2° C, both measured in the shade at ground level. Freezing weather and even snow can be expected at almost any time of year in the Noatak drainage. The lake at Camp I

was one-third covered with ice when the Chesemores arrived on 11 June. It did not clear completely until the 15th. The larger lakes in the region do not become ice-free until the last half of June. Several small lakes, at elevations of about 2,500+ ft (762 m) above sea level, and somewhat shaded from the south, were still frozen on 7 July 1963. Freeze-up in the Noatak headwaters is expected anytime after the first of September. These are indications of a short growing season. In addition, the weather can be cloudy for long periods of time, and there can be considerable precipitation. During 1963 it rained nearly five-sixths of the days we spent in the field. Weather records for the region are inadequate, and 1963 may well have been atypical. However, ground underlain by permafrost is normally moist; and frozen ground is both widely distributed and near the surface throughout the region.

By late October the region is usually under a blanket of snow. However, the depth of this varies considerably from place to place, as it continues to do throughout the winter. By late winter, on all except the most wind-blown ridges and knolls, there is a depth of a few inches to a few feet. While snow in some places accumulates sufficiently to form permanent snowbeds, in some areas on the unsheltered flats and raised ridges tussocks protrude from a skim of snow or some of the depressed alpine plants lie completely exposed to the dessicating influence of wind and cold, dry air. Even in midwinter there may be considerable areas of bare ground. Pruitt (1966) found between 30 and 40% of the ground bare of snow at Cape Thompson, which is swept by stronger winds than are the Baird and Schwatka mountains in most years. The snow in the lower levels of the Baird and Schwatka mountains is undoubtedly similar in many ways to that of the subarctic taiga with fine structure, low density, and low hardness through most of the winter. At higher elevations and to the north the character of the snow might be expected to change to a generally shallower, harder nature. Henshaw (1968) reported in detail on snow conditions in the Kobuk, Selawik, and Ambler lowland areas as observed over extended periods during the winters of 1961-1962 and 1962-1963. His are the only records of any significance for the area in question.

HABITAT LIFE FORMS

Because the conditions within a small unit of the environment, and consequently the animals that can tolerate them, are dictated to a great extent by the gross form of the vegetation present rather than by the particular taxonomic components of this vegetation, we have followed Pitelka (1941) in the use of "life forms" rather than habitat designations based on particular species; Kessel and Cade (1958), Williamson and Peyton (1962), and others working in Alaska have successfully used this "life form" concept. We have departed from a strictly morphological labeling of the form types where particular plants are so well-known and characteristic that their name will convey the best image to the reader. At this point, however, the intent is still to emphasize the form rather than the taxonomy of the plants. The reader can gain some feeling for each type from the notes in this general description, from the photographs which are cited as examples, and subsequently from comparisons of the descriptions of the specific study areas with their accompanying photographs. In order to clarify conditions at the several camps, all photographs have been grouped following the camp descriptions, even those used as general examples.

The system used by Hanson (1953) to classify vegetation types does not fill the need to emphasize form, and it does not recognize some vegetation we encoun-

tered. Essentially all of the types described by Johnson et al. (1966) will fit into three obvious categories in the system used here. These latter authors have provided a "table of equivalents" for comparing the major schemes for classifying subarctic vegetation.

Closed Spruce Forest (Figs. 8, 10, and 12) *

Dominants: White spruce (*Picea glauca*) and sometimes paper birch (*Betula papyrifera*) and/or balsam poplar (*Populus balsamifera*) in limited numbers.

Understory: Alder (*Alnus crispa*) and willows (*Salix* spp.) may be present, especially in larger openings. Spruce saplings infrequent.

Ground cover: Variable, ranging from little but spruce needles through dense growths of moss to small areas of herbaceous and shrubby plants. Few if any coniferous seedlings.

The dominant trees are usually from 30 to 50 ft (9 to 15 m) high and narrow-crowned, with the crowns occupying less than two-thirds of the crown space. This is scarcely a truly closed canopy form; however, from a slight angle the canopy appears closed. Trunks are usually less than 12 in (30 cm) dbh but sometimes reach 20 in (51 cm) or more dbh.

Closed Mixed Forest (Fig. 7)

The species composition of the dominants and understory is essentially the same as that of the "closed" spruce forest. However, the proportional representation of the several species is considerably changed; the hardwoods are either an important or dominating factor and frequently fill the crown gaps between most of the conifers. The understory may be more lush than is usually true of "closed" spruce stands.

Closed Hardwood Forest

Dominants: Paper birch or balsam poplar, sometimes with occasional spruce.

Understory: Saplings of dominants, willows, other shrubs.

Ground cover: Varies greatly in density and species composition.

The dominants are usually not over 50 ft (15 m) tall in the region under study. Trunk dbh is usually less than 12 in (30 cm), although the balsam poplar grows somewhat larger. The understory and ground cover may be quite dense. Stands of pole-sized trees are common. The character of this form obviously changes greatly with the season.

Open Spruce Forest (Figs. 6, 10, and 13)

Dominants: White spruce or black spruce (*Picea mariana*). Paper birch is frequently sub-dominant with the white spruce.

Understory: Spruce saplings. Alder and willow as tall shrubs, or these and/or dwarf birch (*Betula glandulosa*) as low shrubs.

Ground cover: Variable, from none of noticeable significance to tussock-heath tundra.

This type has several forms characterized by different degrees of stocking; the true muskeg bog condition has widely scattered spruce, as does some of the intergrade between spruce forest and tussock-heath tundra. On the other hand, extensive stands with a crown closure of 25% or more are typical of much of the northern limits of the taiga.

* Only the more obvious examples have been singled out, and in most cases not all of each photograph is to be considered as an example of one life form.

Tall Shrub (Figs. 3, 4, 10, 12, 19, 22, 26, and 27)

Dominants: Alder and/or willows. The alder often is in pure stands. Many of the willows likewise occur as single-species types, but frequently several species may be mixed.

Ground cover: None to fairly dense growths of grasses and forbs.

Within the region under study, this vegetation form is commonly encountered as a band along watercourses and beside lakes. These bands may vary from only a few feet in width to extensive stands up to half a mile or more wide. Tall shrubs often form extensive stands on the upper slopes of mountains just above the forest zone; such stands are frequently dense enough to make foot travel extremely slow.

Low Shrub (Figs. 7, 15, 16, 21, 25, 28, and 29)

Dominants: Alder, willows, dwarf birch, etc. less than 3 ft (1 m) high.

Ground cover: None to thick, ranging from tussock-heath tundra through tall grasses and forbs to short, dry tundra.

The general appearance of this vegetation form varies from solid stands of low shrubs to semi-open areas with scattered clumps of low shrubs. In either case the conditions may range from almost aquatic to quite xeric.

Tussock-Heath Tundra (Figs. 4, 5, 19, and 20)

Dominants: Sedges, especially "cotton-grass" (*Eriophorum vaginatum*), and grasses, with numerous ericaceous dwarf shrubs. The perennial sedges form tussocks separated by a few inches, and perhaps a foot in height. Microclimatic conditions between and under the tussocks are usually very cool and moist. There may even be standing water between the tussocks after prolonged rain. Patterning of the ground and vegetation in this form is common as an effect of ice- and frost-action; the result is an accentuation of the effects of micro-relief attributable to temperature and drainage.

Dry Tundra (Figs. 15, 25, and 30)

All of the vegetation in this form is low in height, perhaps not exceeding 6 in to 1 ft (15 to 30 cm) in most cases. Frequently the plant cover in general is not that tall. Dry tundra varies from pure short grass and sedge cover to a great mixture of grasses, sedges, forbs, lichens, and mosses. This form intergrades with habitats such as rock slides on the upper parts of the mountains.

Sedge-Grass Marsh (Figs. 7 and 28)

The sedge-grass marsh is an aquatic or semi-aquatic form which is monotonous in its species composition in this region. One or two species of *Carex* and *Calamagrostis* form the major part of the vegetation. A few forbs, such as *Potentilla palustris,* also are regularly found in these marshes. The vegetation is neither as tall nor as stout as that of a cat-tail marsh. Most sedge-grass marshes in this region are in the form of relatively narrow borders along sloughs, streams, and lakes, or else fill shallow ponds which are frequently of ox-bow origin.

Other Habitat Forms

Lake shores, standing and flowing waters, riparian cut-banks, alluvial deposits, and bluffs-slides-outcrops are familiar enough to obviate description.

Study Areas

In the descriptions of the study areas which follow, an attempt has been made to characterize the region within a 5-mile (8 km) radius of the camp site more specifically than the rest of the general area. In each case, ocular estimates were made with respect to local topography and the relative distribution of plant forms.

These estimates were based on information taken from the U. S. Geological Survey quadrangle maps, aerial photographs, photographs taken on the ground, and field notes. The purpose of these estimates is to provide a general idea of the character of the region rather than highly detailed information for comparative purposes. A treatment of the plants found at each of the study areas may be found in Shetler (1964).

The several areas are described in two groups, those in the Kobuk drainage in one and those in the Noatak drainage in the other. Place names found on the U. S. Geological Survey quadrangle sheets are used whenever possible. Where other names are used, they are indicated by quotation marks, and the source is identified. The latitude and longitude figures given for each camp have been scaled from the U. S. G. S. quadrangle sheets.

Two camps were located in the Kobuk River drainage; these were Camp III, in the Redstone River Valley, and Camp IV at Walker Lake. They will be described first since conditions there are intermediate between the more generally familiar spruce forest and the tundra.

CAMP III – REDSTONE RIVER VALLEY

(67° 14' 23" N, 157° 37' 4" W. Ambler River quadrangle. Figs. 2 through 8.)

The Redstone River Valley is approximately 100 miles (160 km) east of the mouth of the Kobuk River and empties into the broad lowland through which the Kobuk flows in its lower reaches. Our camp was located on the southeast side of the largest lake in the Redstone River Valley. The edge of the lake is approximately .5 mile (0.8 km) from the beginning of the slope of the mountain to the east. John Cross, our pilot and long-time resident of Kotzebue, knew of no name that was commonly applied to this lake; he called it "Redstone Lake."

The valley of the Redstone trends in a northeast-southwest direction through most of its length; the river turns to the southeast to join the Ambler River; but, by this point, it has entered what is more properly part of the broad Ambler Valley. The grade of the Redstone Valley is very low, and some 13 miles (21 km) of up-valley travel would be required to reach the point at which the 200-ft (60-m) contour crosses the river. The valley is approximately 3 miles (5 km) wide at its mouth.

The mountains bordering the valley are mostly less than 2,500 ft (762 m) high. However, in the general region, a few peaks exceed 3,000 ft (914 m), namely, the Jade Mountains and several of the peaks near the divide between the Redstone and the Cutler rivers. Near the mouth of the Redstone Valley, the mountains have relatively gentle slopes, with grades often less than 1,000 ft per mile (173 m per km). On the other hand, the sides of the mountains are considerably steeper at the head of the valley. Most of the mountains bordering the Redstone Valley are well anastomosed, and the connecting saddles show only relatively minor dips between the peaks. In addition, many of the ridge tops are long and of comparatively uniform altitude. The river, cut into the sedimentary valley floor, has banks ranging from a few feet to 20 or 30 ft (6 to 9 m) in height, the higher banks being found on the outside of bends. The inside bends of the river are characterized by rather wide and sandy bars. The river itself is clear and shallow under usual water conditions, but the level of the water fluctuates quite rapidly in response to precipitation in the headwaters. Another feature of the valley floor is an area of small ponds and lakes with some connecting streams. Some of these lakes are probably old meander lakes from the river, which has since changed its course. Others

have been formed in place without any influence of the river. "Redstone Lake" is approximately .8 mile long and .5 mile wide (1.3 km x 0.8 km). It is bordered on the south and east by banks that drop about 20 ft (6 m) fairly steeply into the water; on the west and north, where the banks are much more gentle, the shores are marshy.

Reference to Fig. 2 will demonstrate that one of the principal features of the valley floor is the interlaced drainage pattern. Many small streams come off the surrounding mountains, eventually join, and finally make their way to the Redstone River or some of the larger lakes. Unfortunately, this figure does not show much of the mountains to the east of camp or in the upper portion of the valley. However, those to the northwest of camp are reasonably typical. Scattered through the valley floor there are low knolls, usually of very small size. These afford some of the few spots having good drainage.

Smith and Mertie (1930) showed Quaternary sediments on the valley floor. They indicated that the bordering mountains are principally highly metamorphosed rocks of many kinds, dominantly sedimentary but some which are probably igneous. Fernald's (1964) map indicated that "Redstone Lake" is bordered by Recent alluvium except to the south where glacial drift abuts the lake. The lower slope of the mountain east of the lake is also drift. On the top of the mountain east of camp we found many outcrops of rock which had been greatly folded and which had weathered into striking shapes, a phenomenon characteristic of the region. In addition, much of the flat top surface of the ridge is composed of loose rock, often in a layer of considerable depth in terms of its biological significance. Because of the lack of soil which might hold water, this was one of the driest areas which Dean has seen in the north. However, in general the features of the Redstone Valley give the impression of considerable maturation since the time when the valley was occupied by glacial ice.

Within a 5-mile (8-km) radius of the campsite on "Redstone Lake," the topography is approximately 70% flat, 20% moderately steep, and 10% steep. Roughly 40% of the total area is occupied by forest. Nearly half of this forest could be classed as "closed" spruce forest. The rest is roughly divided between closed mixed forest and open spruce forest. Tall shrub, which is mostly riparian tall willow and alder, occupies about 10% of the total area; much of the tall shrub form here is in very narrow bands along the small streams draining the lateral slopes of the valley, but there is a great deal bordering the open coniferous forest. Tussock-heath tundra, covering about 30% of the total, is restricted almost entirely to the valley bottom. Dry tundra, found only on the mountaintops with the exception of minor patches capping bottomland knolls, covers about 10%. Sedge-grass marsh, standing waters, flowing waters, and bluffs-slides-outcrops each make up less than 5% of the total.

In general, the vegetation patterns can be traced from the banks of the river, where there is open spruce or closed hardwood forest, across fairly broad expanses of tussock-heath tundra (Figs. 4 and 5), which are interlaced with small shrub-bordered streams and pocked by small ponds, to the lower slopes of the mountains where open spruce forest (Fig. 6) begins to take over as the drainage improves. The forest becomes more dense, grading into "closed" spruce forest or closed mixed forest (Figs. 7 and 8) as one goes up the slopes of the mountains, until a tree line is reached at about 2,000 ft (600 m). Above the tree line there is a zone of tall shrubs, followed by a zone of dry tundra which is interspersed with rock outcrops.

A few snow patches persist in the shade of bluffs on the mountaintops, but these are widely scattered and are probably small or gone by the end of the summer. A more detailed description follows.

The forest along the river is predominantly open spruce which has a crown closure of about 25%. The trees are of relatively small diameter and are narrow-crowned. There is a dense layer of understory shrubs, and in many places a dense carpet of moss on the ground. At some points along the river, particularly on inside bends with sand and silt deposits, there are stands of hardwoods, mostly *Populus* sp.

The tussock-heath tundra is typical of that found over much of the north, being composed of tussocks formed by perennial sedges and containing many of the ericaceous shrubs. This type of vegetation provides a low ground cover which furnishes more than adequate concealment for mice as they move about between the tussocks, but it is not tall enough to furnish significant concealment for a bird such as the Whimbrel or a mammal the size of a fox. The flat, smooth appearance of this vegetation form is deceiving; in reality it is made up of rather flexible tussocks which will not support the weight of a man without bending and which are spaced just too close together to step between comfortably. Miles and miles of this type of vegetation stretch across the Redstone Valley.

The small marshes (Fig. 7) which dot the valley floor are limited with respect to the kinds of plants which grow in them. The sedge-grass marsh type is rather uniform in consequence. The emergent vegetation is almost entirely in the form of short, shallow-water species with thin, flexible above-water portions.

The tall shrub type is found principally as a border to the small streams. Here both willows and alder may reach a height of 10 or 12 ft (ca. 3 m) and form a zone perhaps 25 yards (ca. 23 m) or so in width. As was mentioned above, this type is also present on the lower slopes of the mountains just below the open spruce forest. Here the tall shrub form is primarily an extension of the forest understory outside the limits of the tree canopy. In such situations the shrubs may grow quite densely and actually close the canopy at their own level.

The forests on the mountain slopes are predominantly of a "closed" spruce or else a mixed form with some large spruce and many over-mature birch. The spruce, in particular, are widely spaced, so that the distance to the nearest neighbor of its own kind may be several tens of feet. However, the hardwoods tend to fill the gap, and there is a dense understory composed primarily of alder. The ground cover is quite rich and shows many indications of a more mesic type of vegetation than one would expect in this outpost of the interior forest.

The mountaintops are characterized by dry tundra which is dominated by plants only a few inches in height. There are many extensive stands of grasses and sedges as well as some large areas of mature lichen growth.

Although the mountains on the west side of the valley were not visited, they were inspected with a spotting scope; the forests on these mountainsides appeared to have a greater proportion of hardwoods than did those on the east side. The lower portion of the west side of the valley may have suffered a forest fire in the not-too-distant past. The slope to the east of our camp appeared to have been unburned for many years, although there were signs of considerable cutting activity which must have taken place many years ago, probably during the gold rush days. There were symetrical areas cut out of the forest, which had grown up for the most part to tussock-heath tundra. This sort of succession holds true even in scattered burns on the high mountain slopes near timber line.

"Redstone Lake" itself was definitely eutrophic. The bottom sloped rather gently to an unknown depth, but there were only a few areas of emergent vegetation. These were concentrated at the north and northwest portions of the shore line. Submersed aquatic plants grew in a zone around the perimeter of the lake.

In summary, the region around the mouth of the Redstone River Valley is typical of much of the northern coniferous forest zone, with the general exception that the various tree forms are reduced in size and density as well as in extent. There is a wide variety of habitats, and drainage or the lack of it seems to be one of the most important factors determining their distribution. The scattered nature and small size of the trees near the low timberline on the mountains indicate that the Redstone Valley is near the northern limit for the growth of trees under current climatic conditions. In addition, it should be pointed out that while patches of timber extend to the head of the valley, they appear to be more and more limited to south-facing slopes as the divide is approached, and no stands were seen on the north, or Noatak River, side of the divide.

CAMP IV — WALKER LAKE

(67° 12' 47" N, 54° 33' 43" W. Survey Pass quadrangle. Figs. 9 through 13.)

Walker Lake is nearly at the head of the Kobuk River and probably supplies a major part of the river's water. The lake shore is between 600 and 800 ft (ca. 200 m) above sea level. Many of the peaks surrounding the lake surpass 4,000 ft (1,200 m); some exceed 5,000 ft (1,500 m). The lake itself is nearly 14 miles (22 km) long, and even the narrower part is over a mile (1.6 km) wide in most places. The lake runs in a northwest to southeast direction and lies in a narrow valley between steep mountains having relatively great relief. The northern half of this narrow valley is filled with sediments through which Kaluluktok Creek has cut a channel which is relatively straight except in the lower one-quarter. There the creek begins to meander, forming broad curves with mud bars on the inside bends and having steep banks on the outside bends. Walker Lake itself occupies the lower half of the valley, spreading from wall to wall. The southern terminus of the lake is apparently blocked by a moraine.

In this region, in contrast to that around the Redstone Valley, almost all of the land is in the form of steep slopes, sharp ridge tops, and moderately high peaks. The upper ridges are relatively sharp-backed and the peaks are jagged. The lower ridges are rounded, weathered, and, on their lower slopes, composed of jumbled piles of large boulders. The lateral drainage in this region is characterized by narrow, cascading streams. The topography in the immediate vicinity of the camp at Walker Lake is really of only two types, flat and steep. The former, including the surface of the lake, covers roughly 20% of the zone within the 5-mile (8-km) radius of the camp site. Nearly all of the remainder of the area is steep.

The geologic map (Smith and Mertie, 1930) provides information only for the areas that are immediately adjacent to the lake. The southern terminus of the lake abuts an area of Quaternary sediments. The flanks of the lake are, for the most part, bounded by highly metamorphosed rocks of early Paleozoic or older age. There are apparently many kinds of rock involved. Smith and Mertie show some areas of Skajit limestone in the vicinity of the lake. While their map does not show any of this kind of rock in the immediate vicinity of the northwest corner of the lake, we found large expanses of limestone outcropping above our camp. The area to the west of our camp is characterized by sharp interfaces between the major forms of rock.

Kaluluktok Creek is forming a small delta which has changed its shape considerably as time has passed. The waters of the creek are normally clear, so that delta-building occurs principally after heavy rains and during the spring runoff. At such times, one may see the pattern made by the muddy water being injected into the crystal-clear waters of Walker Lake; probably a geologist would consider that the rate of delta accretion is comparatively rapid; but to biologists, considerable time has yet to elapse before the delta has closed across the north end of the lake.

The lake itself has strikingly parallel sides that make a gentle arc as the valley trends to the southeast. Although no soundings were made, it would be expected that at least the north end of the lake is quite deep. At several points along the shore we were able to stand on bluffs and look directly into water which was deep enough to prevent one from seeing the bottom, although the water itself was very clear.

Within 5 miles (8 km) of the camp site the dominant habitat forms are open spruce forest (25%), tall shrub (25%), dry tundra (30%), standing waters (5%), and bluffs-slides-outcrops (10%). Types which are present in small amounts include low shrub, tussock-heath tundra, sedge-grass marsh, and flowing waters. There are also such types as alluvial deposits and riparian cut banks; however, these make up a very small proportion of the total. Above the edge of the lake, the slopes are covered with open spruce forest which has a very sparse admixture of deciduous trees, principally birch. There is, throughout the greater part of the spruce forest, a dense understory of tall brush. The spruce forest extends up most of the mountain slopes to a height of between 2,000 and 3,000 ft (600 and 900 m) above sea level; beyond that point it is irregular and represented only by scattered small stands.

On the valley floor to the north of the lake there is a dense growth of tall shrub; spruce occurs there only in small stands. Much of the spruce which does grow in the Kaluluktok Valley is found along creek banks and in areas of old oxbows. Small, isolated stands of poplar grow along the creek. On the sides of the mountains, the open spruce forest gives way to tall shrub areas which are composed mostly of alder and tall willows. Above these tall shrubs there is a zone of scattered low shrubs intermingled with tall herbaceous growth, principally grasses. Finally, on the crests of the mountains and extending well down their sides, there is dry tundra, which is generally of a more lush nature than that which typifies the mountains of the Redstone River Valley.

At the head of Walker Lake extensive stands of luxuriant lichens and the abundant spruce growth which accumulates slowly testify to the long interval since the last burn. Walker Lake, like the Redstone River Valley, is a northern outpost of the interior spruce forest. However, in contrast to the latter area, the region around Walker Lake is generally well drained; the mountain slopes are much steeper and the altitude of the mountains is considerably greater than that of the low hills bordering the Redstone Valley. Many areas of rock outcrop occur, and there are numerous talus slopes which have, in general, become overgrown. Outside of the 5-mile (8-km) radius from the camp, many of the mountains appear to have large expanses of bare rock and talus, but within this radius the mountaintops are generally vegetated with dry tundra, except on the peaks.

Walker Lake, deep, clear, and cold, is comparatively sterile from the standpoint of vascular plants. There is a bed of *Chara* sp. over much of the bottom of the north end. Kaluluktok Creek is likewise clear; it flows through the study area without significant grade. Like many of the streams in the Brooks Range, Kalu-

luktok Creek responds very rapidly to heavy runoff, carrying large amounts of sediment as well as a greatly increased volume of water. On the deltas of Kalulluktok Creek and two smaller tributaries that enter the lake from the northwest there are stands of sedge-grass marsh of the usual uniform type.

CAMP I — NOATAK MISSION LOWLANDS

(67° 26' 9" N, 162° 42' 35" W. Noatak quadrangle. Figs. 14 through 17.)

Camp I was established at the outer edge of the foothills which lie to the west of the upper Agashashok River. The lake on which the camp was situated is one of the larger lakes on the eastern edge of Smith's (1913) "Mission lowland." This lake is roughly 5 miles (8 km) north of the Agashashok River and approximately 14 miles (22 km) southeast of the village of Noatak. The elevation is less than 500 ft (150 m), and the surrounding countryside is nearly flat in all directions but to the east, where the ground rises slowly through a series of benches to a low spur ridge at the west end of the Baird Mountains. The peaks on this end of the range are only 1,000 to 2,000 ft (300 to 600 m) above sea level and are well rounded.

Drainage is poor throughout, with the exception of minor areas of low relief in the immediate vicinity of the lake and along some of the old stream channels. Most of these ridges are less than 20 ft (6 m) above the surrounding terrain. The entire area is underlain by Quaternary sediments.

The lake on which the camp was established has a general northeast-southwest axis and is about 1.5 miles (2.4 km) long. All but the southern portion of the lake has steep banks. There are inlet and outlet streams, the latter joining others that eventually run into the Noatak. The whole Mission lowland is dotted with similar small, shallow lakes. Among them wind many streams which vary in depth from a few inches to several feet and which are as much as 50 ft (15 m) wide in places. Within 5 miles (8 km) of the campsite, probably 85% of the total area can be considered flat, and the remaining 15% is from gently to moderately sloping. The principal habitat type is tussock-heath tundra (50%). Roughly 25% of the total area is occupied by standing waters. Less than 10% is occupied by tall shrub; sedge-grass marsh and dry tundra occupy about 5% of the total. In this case, the microrelief, through its influence on drainage, is extemely important in determining the vegetation form. It is on the small knolls and the slopes to the east of the lake that one finds the dry tundra. Almost all of the remaining area is low, wet, and occupied by *Eriophorum* tussocks. The tall shrubs (alder, willow, and balsam poplar) are confined almost exclusively to stream banks and lake margins. Although the spruce forest extends up along the Noatak River into the Mission lowland and nearly to the mouth of the Kugururok River, the site of Camp I was several miles from the nearest spruce stand of any significance.

CAMP II — NOATAK SECOND HIGHLAND

(67° 53' 38" N, 160° 48' 11" W. Baird Mountains quadrangle. Figs. 18 through 23.)

Smith (1913) called the region along the Noatak River between the Mission lowland and the Aniuk lowland the second highlands. This region is formed by the northern portion of the Baird Mountains. Our Camp II was located near the point at which the Noatak constricts into a narrow valley that winds among the hills, eventually passing through the canyon. The mile-wide gravel bars of the Noatak are at this point 900 ft (ca. 275 m) above sea level. Steep banks rise from the river course and flatten out about 100 ft (30m) above the bar to form gently

rolling benches on both sides of the river. These benches slope gradually, rising to the south into the foothills on the northern edge of the mountains. At approximately 2 miles (3 km) south of the river the elevation reaches 2,000 ft (600 m) above sea level, and the rise continues to the tops of rounded peaks that average about 2,600 ft (800 m). To the east of the camp, a braided stream flows north to join the Noatak. Its course has much exposed gravel bar and relatively little stabilized, vegetated bar. Directly south of the camp, at the foot of the bluff, low, marshy ground lies in what is apparently an old channel of this stream. The benches are topped with a few scattered lakes.

The rocks in this region are comparatively uniform. The lowland benches bordering the river are Quaternary sediments comprised to a great extent of gravels and sand brought down from the upper reaches of the Noatak. The mountains are almost entirely Noatak sandstone (Smith and Mertie, 1930). About 10 miles (16 km) to the south of the camp area there are large mountains apparently formed of little but limestone.

The topography is fairly uniform. Perhaps 10% of the total area in the immediate vicinity is in the flat category, and this is largely river bottom areas. About 5% is steep, mostly bluffs along the river and very little in the form of mountain peaks. The remaining area, and by far the largest proportion of the total, is moderately steep.

At this camp, about 10% of the total area is occupied by bare alluvial deposits, mostly in the bed of the Noatak River itself. Tussock-heath tundra is the dominant form of vegetation; it occupies approximately 75% of the total area. The remaining 15% can be divided among dry tundra on the mountaintops, low brush, some scattered stands of hardwood trees in the river bottoms, tall brush (mostly along the stream banks), and sedge-grass marsh. Lakes and ponds are uncommon in comparison to the Redstone River Valley or the Mission lowlands, and true forests are absent.

The general impression one gets from looking over the gently rolling country in this region is of vast expanses of *Eriophorum* spp. tussocks. At the time we occupied the camp, late June and early July, the distant hills were white with the "cotton" of these plants.

CAMP V — NOATAK HEADWATER MOUNTAINS

(67° 39' 25" N, 155° 32' 20" W. Survey Pass quadrangle. Figs. 24 through 31.)

Our camp in the Noatak headwater mountain area was located on the south side of Lake Omelaktavik. This lake is situated just east of the mouth of the Kugrak River and about 8 miles (13 km) east of the mouth of the Igning River. At this point, the Noatak River is a small, meandering stream, flowing through a rather gently sloping valley about 2 miles (3 km) wide. The mountains rise fairly sharply both to the north and south. The general direction of the Noatak Valley at this point is east-west.

The elevation of Lake Omelaktavik is just under 2,000 ft (600 m). Roughly 5 miles (8 km) to the south, Oyukak Mountain reaches a height of 7,310 ft (2,228 m); it is high enough to have a small glacier on its north face. Most of the mountains in the immediate vicinity of Lake Omelaktavik are between 5,000 and 6,000 ft (1,500 and 1,800 m) in height on the south side of the valley and between 4,000 and 5,000 ft (1,200 and 1,500 m) on the immediate north side of the valley; the latter rise to over 6,000 ft (1,800 m) at approximately 10 miles

(16 km) north of the valley. While the mountains to the north are relatively round-topped and smooth in the immediate vicinity of the Noatak River, those to the south, the northern edge of the Schwatka Range, are quite jagged, precipitous, and cut by long straight valleys characteristic of glaciated country.

Lake Omelaktavik itself is just over a mile (1.6 km) long, roughly half that wide, shallow, and low-banked. Between this lake and the narrow channel of the Noatak River, drainage is poor. In the mountains to the south, drainage is quick, and many small streams plunge into the main tributaries of the Noatak River. The Kugrak, normally clear and fordable, becomes silty and nearly impassable during prolonged periods of rain.

The bed of the Noatak Valley is covered with Quaternary sediments, and old benches are visible, forming steps up from the bottom of the present floor. Lakes, although not as abundant as in the Mission lowlands, are numerous. The mountains flanking the valley and forming the northern border of the Schwatka Range are composed of Silurian (?) limestone and metamorphic rocks; there is a great deal of schist (Smith and Mertie, 1930).

The topography at the upper Noatak study area is considerably more rugged than that at either of the other two Noatak camps. Probably 40% should be considered steep; 40% would fall in the flat category, and the remaining 20% in the moderate category. Here the landscape is characterized by two extremes of drainage.

Other than small scattered stands of poplar there are no trees. Tall shrubs occupy roughly 10% of the total area. This form is concentrated along the river banks. Tussock-heath tundra occupies 30% of the total, and most of the remainder is occupied by dry tundra and bare rock. Standing and flowing waters occupy less than 5% of the total. Low shrubs, growing particularly on the lower slopes and in the driest portions of the valley floor, probably do not exceed 5% to 10%. Sedge-grass marsh occupies a small percentage of the valley floor, mostly on pond margins but also in filled oxbows and other low spots.

Methods

In general, the objective of the methods employed was to become as familiar as possible with the area within one day's working radius of the camp. Even by limiting ourselves to a radius of a few kilometers, we were unable to cover completely the whole land surface within the immediate vicinity of any of the camps. This was particularly true for those at which we stayed only two weeks. A determined effort was made to visit all of the various habitat types which were represented in the vicinity, in order to get a good cross section of the environments and organisms that were present.

General observation was supplemented, when necessary and practical, by standard collecting techniques. A series of photographs was made at each of the camps. Birds were studied by direct observation, a limited amount of intentional collecting, and the utilization of specimens accidentally killed in small mammal traps.

The ornithological observations accumulated over the years in the Kobuk-Noatak region are summarized in tabular form later. Dean has made an attempt to place on a comparable basis the reports of different workers with different criteria for terms relating to abundance. Such an effort obviously involves considerable subjective interpretation of the information at hand, both in terms of the meaning read into the printed word and in terms of the compiler's own framework of know-

ledge and experience. While a certain amount of accuracy has undoubtedly been lost in the course of interpreting others' data, the end product should have gained considerably in utility and meaningfulness on a regional basis.

The reader should be aware of several things before progressing further. Abundance ratings (rare, uncommon, common, and abundant) were reached for the BSMS data in the following manner. A circle with a radius of 5 miles (8 km) was drawn around each camp, enclosing an area of about 79 sq miles (ca. 200 km^2). This area was large enough to be fairly representative of the general camp area and yet was small enough to permit reasonable extrapolation from the places we actually investigated to the rest of the 79 sq miles (200 km^2). The actual abundance of each species within the area was estimated on the basis of the frequency of our observations, the observed abundance, and our knowledge of the bird and the environment; the abundance was expressed as a power of 10 (i.e. 10^0, 10^1, 10^2 . . . representing 1-9, 10-99, 100-999 birds etc.) in the manner of Fay and Cade (1959). In converting from this to the terms mentioned above, 10^0 was considered uncommon (except for obvious rarities); and 10^1 and 10^2 were both considered common. No species was abundant enough to fall more than just within the 10^2 class. These ratings were not converted to birds per sq mile because the basic data do not warrant such apparent precision. Information presented by other workers could not be treated in the same manner and was simply equated as realistically as possible.

The only worker whose symbols have been preserved intact (and to which Dean's interpretation has been added) is Laurence Irving (1960). This was done because of the type of information provided by Irving on the status of the birds, as well as on their abundance. Although it would be desirable to have similar information for the other areas represented, the necessary assumptions regarding data of other workers and major portions of the year during which we were not in the given areas do not seem justifiable.

Small mammals were collected largely by systematic grid trapping, in which 100-trap grids were established on one-acre (0.4-hectare) plots, with the traps equally spaced and alternated between two kinds. Both Schuyler Animal Killers and Museum Special traps were used because of the selectivity that Pruitt and Lucier (1958) demonstrated. The traps were baited with peanut butter and rolled oats and were checked at least once a day. The quadrats were set for 3 days as a minimum, and they often remained set for longer periods. In the instances where the quadrat was functional for more than the standard 72-hr period, the data collected beyond this time were kept separate to permit comparison with population density figures gained through the standardized trapping procedure in other localities by other workers. An attempt was made to put the traps in juxtaposition with sign of small mammal activity, but all grid traps were set within 18 in (45 cm) of the grid intersection point. The traps in the six quadrats that were established during the summer accumulated 3,100 trap-nights. The quadrats were set as follows: middle Noatak-two, Redstone Valley-two, lower Noatak and upper Noatak-one each. None were put out at Walker Lake because the patchy interspersion of habitat types made it nearly impossible to find areas of large enough extent within a single type and because of the heavy rain. In addition to the quadrat trapping, 4,616 trap-nights were accumulated in spot- and line-trapping that was designed to provide qualitative sampling of the many types of habitats which were not sampled by the large quadrats. This type of trapping permitted the sampling of areas that were too small to hold a quadrat, a variety of places where sign of small

mammals indicated the presence of numerous animals, and also areas at some distance from the camp (see Table 1, p. 65).

The data on medium-sized and large mammals are largely based on visual observation and the analysis of sign. A total of 667 mammal specimens was obtained; the study skins and skeletal material have been added to the biological collections of the University of Alaska.

Birds of the Kobuk-Noatak Region

In order to assist in the interpretation of the available data, the localities represented in Table 2 have been arranged in separate series representing the Kobuk drainage and the Noatak drainage; within these a west-to-east order has been followed. In the table headings, the date or dates of field work have been given except where a long period of time has been included. All of the data included are either from the 1963 Baird and Schwatka Mountain Survey, Heinrich Springer and Clayton White (vicinity of the confluence of the Kugururok River and the Noatak River: 29 June to 6 July 1963), James Helmericks (Walker Lake: 1956-1957, full year; since then the months of May and June annually at least until 1964), Bee (1958), Grinnell (1900), Hines (1963), Hudson (1957), Irving (1960), Irving and Paneak (1954), McLenegan (1887, 1889), or Townsend (1887). Following the table some of the more significant records will be briefly annotated.

Irving's material from Anaktuvuk Pass and Bee's paper on the Brooks Range in general have been summarized in Table 2 because they provide a broad framework for the records from the Baird and Schwatka mountains. However, no detailed survey of the more recent ornithological observations in the central Brooks Range has been attempted here. John M. Campbell has published a number of papers on the birds of this region (1960, 1967, 1968a, b, 1969a, b, c) and will undoubtedly compile a summary paper at an appropriate point. Gilbert and Vivian Staender (Staender, 1964; Staender and Staender 1970) have reported some significant observations from Loon Lake and the upper part of the Hunt Fork of the John River; they confirmed breeding records for a surprising proportion of their total species list and are to be commended for their diligent work (see Table 2, p. 66).

The notes provided through personal communication by Keith and Anore Jones and Kenneth Alt have been summarized in Table 3. The Joneses made some phenological comments that are pertinent to an interpretation of their records: 1964-first open water, 23 May; first trip on bare tundra, 29 May; ice broke and moved on Kobuk River, 3 June. Alt was at the north end of Walker Lake from 1 to 10 August 1965. Table 4 lists the scientific and common names of all birds known to have been reported from the study area (see Table 3, p. 73 and Table 4, p. 75).

Red-necked Grebe — The Red-necked Grebes seen by Chesemore are the only ones reported north of the Kobuk drainage with the exception of a breeding occurrence at the mouth of the Itkillik River on the Colville River delta (Nelson, 1953). Chesemore saw one adult on a stream at the lower Noatak camp on 23 June 1963, and two on Lake Omelaktavik on 25 August 1963.

Horned Grebe — Grinnell (1900) and Irving (1960) have the only published records of Horned Grebe for the region. Irving reported it from the vicinity of Kobuk village and also the Alatna River. At Anaktuvuk, north of the forest, he considered this species "a rare visitor . . . ." We saw none. Horned Grebes were recorded at Onion Portage and Selawik (Table 3). The margin of the distributional range of the Horned Grebe must essentially coincide with the Kobuk Valley.

Whistling Swan — The Whistling Swan is apparently restricted to the coastal lowlands except as a migrant.

Mallard — Dean saw an adult female Mallard on 28 June 1963, in a sedge-grass marsh a short distance south of the Noatak River at Camp II. This was the only bird of this species seen by our party. The Joneses saw a pair near Onion Portage on 27 May 1964 and apparently saw birds of this species through the summer until 22 September 1964 (Table 3). There are no other reports north of the Kobuk River Valley or in the Brooks Range to the east, except at Anaktuvuk, where it was considered only a migrant by Irving (1960). Kessel and Cade (1958) listed scattered observations on the North Slope.

Pintail — Although Pintails are found throughout the region, there is a decided decrease in abundance with increasing altitude and latitude within the region.

Green-winged Teal — A question with regard to the BSMS Camp III record for Green-winged Teal arises, since Shetler, who saw two adults and two young on "Redstone Lake" on 18 July 1963, was not positive of the identification. However, his description left little doubt regarding the species concerned.

European Widgeon — The specimen from Selawik (Hudson, 1957) is one of the very few records for interior and northwestern Alaska. The species must be considered accidental in the area.

Canvasback — One adult female was seen by Springer and White (pers. comm.) on their camp-lake 1 mile (1.6 km) northeast of the mouth of the Kugururok River; the bird was present on 30 June and 1 July 1963, associating with Greater Scaup on the former date. The Canvasback has not been reported previously from northwest of central Alaska, but in recent years increasing numbers have spread into interior Alaska, and one might expect a few far-ranging stragglers. Canvasbacks were seen 23 May 1964 and 17 May 1965 at Onion Portage and Selawik respectively by the Joneses and Alt (Table 3).

Common Goldeneye and Bufflehead — McLenegan (1887) reported one pair of Common Goldeneyes on the lower Noatak; Hines (1963) saw one female goldeneye flying down the Noatak in the vicinity of the mouth of the Kelly River. Irving (1960) is the only worker to report the Bufflehead; he considered it to be regular in occurrence at Kobuk village. Since these are both hole-nesting species, their abundance must be linked to that of sizable trees, which are not common on the forest margin.

Harlequin Duck — The Harlequin Duck is probably more numerous than records indicate, since the fast-stream regions of the Baird and Schwatka mountains have not received adequate study. Helmericks (pers. comm.) reported that 15 or so are found regularly at the outlet of Walker Lake. Williamson et al. (1966) found these ducks breeding in the Ogoturuk Creek Valley at Cape Thompson.

White-winged Scoter — The White-winged Scoter may have become more numerous in the region since the initial group of observers made their trips. Recent workers have found this species fairly common and reported a number of definite breeding records.

Surf Scoter — Our record of a female Surf Scoter with eight downy young at "Redstone Lake" constitutes the first confirmed breeding record for the interior

of the Kobuk-Noatak region, although Grinnell (1900) and Irving (1960) both considered it a breeding bird in the Kobuk Valley. Skins of two of these young are now in the University of Alaska Museum. Springer and White (pers. comm.) saw three pairs on 29 June, five males and three females on 30 June, and collected one on 3 July 1963.

Common Scoter — Springer and White (pers. comm.) saw two pairs of Common Scoters 30 June 1963; they collected one adult male. One bird was seen, also on their camp-lake, on 3 July.

Common Merganser — The BSMS sight record at Camp I on the lower Noatake is a range extension for the Common Merganser and is also the only record for the region other than the birds seen on the Kobuk River by McLenegan (1889).

Goshawk and Sharp-shinned Hawk — The Goshawk and Sharp-shinned Hawk are both woodland birds that must reach their northwestern limit of fairly regular occurrence in the Kobuk Valley, even though they may not be common there. Irving (1960) reported that the Eskimos at Kobuk know the former, but he was uncertain as to the status of the latter. Grinnell's (1900) record for the Sharp-shinned Hawk still stands as the only reported observations and specimen from this area.

Rough-legged Hawk — The Rough-legged Hawk has been reported as a breeding bird from much of the Brooks Range; however, a pair with a flying immature, seen by Dean on top of the mountain east of "Redstone Lake," and a single dark bird that was seen by Springer and White (pers. comm.) at their camp-lake on 2 July 1963 were the only ones observed by our groups.

Marsh Hawk — The Marsh Hawk is either only a visitor to the tundra of the Brooks Range and North Slope or else breeds there in extremely low numbers. Irving (1960) considered it a visitor at Anaktuvuk; Hines (1963) saw one individual; only one was seen by Cade (Kessel and Cade, 1958); Williamson et al. (1966) listed it as probably breeding in the Cape Thompson area; and Dean saw one of unknown sex or age flying over tussock-heath tundra near Lake Omelaktavik on 21 August 1963. Irving (1960) listed it as nesting at Kobuk but gave no idea of the abundance of the species there. This is one of several species with respect to which McLenegan's (1887, 1889) estimates of abundance differ drastically from those made by subsequent ornithologists in the general region; the divergence may be attributable to population changes (some of which are suggested by consistency among the early workers), and some may be due to variation in criteria.

Osprey — Although Grinnell (1900) indicated that the Osprey was common in the Kobuk Valley, the only breeding record since is that for Kobuk (Irving, 1960). Hines (1963) saw four birds and one probable nest on the lower Noatak River. Springer and White (pers. comm.) saw one over their camp-lake on 2 July 1963. Dean saw one at "Redstone Lake" on 16 July 1963.

Peregrine Falcon — With the Peregrine Falcon a fairly common hawk along the Colville River (Kessel and Cade, 1958), and the Williamson et al. (1966) report of this species breeding in the Cape Thompson region where the Brooks Range meets the Chukchi Sea, it was surprising that none were seen during 1963 and that Irving (1960) recorded it only as a migrant through Anaktuvuk Pass. Kessel and Cade (1958) did not indicate a marked segregation between this species and the Gyrfalcon.

Sparrow Hawk — McLenegan (1887) said of the Sparrow Hawk, "More or less abundant throughout the region, but principally in the mountain districts. Nests about the middle of July." Grinnell (1900) questioned this identification, partly because of McLenegan's failure to report the Pigeon Hawk from the Noatak River region. One might question Grinnell's decision somewhat, since the year before, on his Kobuk River trip, McLenegan recorded and collected Pigeon Hawks but gave no report of Sparrow Hawks. Regardless of the accuracy of McLenegan's report of the Sparrow Hawk in the Noatak Valley, the species is currently considered that of a rare to casual visitor in the Brooks Range and to the north.

Ruffed Grouse — No published records of the Ruffed Grouse in the Kobuk region could be found except that of McLenegan (1889). Irving (1960) felt quite certain that this species was not present at Kobuk. No explanation is offered for a shift in the range of this species, if such has occurred, unless a maturation of the vegetation (following a reduction in the frequency of fire?) in the Kobuk Valley reduced the proportion of deciduous trees to too great an extent.

Willow Ptarmigan — Willow Ptarmigan were generally distributed, but not abundant at any of our camps. The scarcity of birds seen and heard, in comparison with the winter sign frequently encountered at Camp V, causes speculation as to whether this is simply a wintering area or whether there had been a sharp drop in the population level.

Sandhill Crane — The Sandhill Crane has been reported as a breeding bird within the region only from the broad flat valleys of the Kobuk and the lower Noatak rivers. Unfortunately, we were not on the ground in the Aniuk lowland along the middle part of the Noatak; perhaps they breed there as well. None were seen in the narrower highland valleys.

Surfbird (?) — Dean saw one Surfbird at about 4,300 ft (1,300 m) msl on the east side of the Kugrak River, Camp V, 6 August 1963. The bird was heard and seen for several minutes at moderate range before it disappeared behind a knoll. It was not seen again. Although the bird was not seen flying, he felt quite certain of the identification, as he has seen this species in Mount McKinley National Park on several occasions. Grinnell (1900) listed the only other record for interior northwestern Alaska and was able to substantiate his observation with specimens. He reported that the natives were familiar with this species, but that the bird was reported to nest in relatively inaccessible regions. Assuming that the species utilizes mountaintop habitat similar to that occupied in the Alaska Range and the Tanana Hills, and that its behavior is comparable in the two regions, it is not surprising that a succession of valley-bottom ornithologists has missed it in the Kobuk-Noatak region.

Common Snipe — An immature Common Snipe was collected in tussock-heath tundra at the edge of "Redstone Lake" on 13 July 1963. The bird could fly only weakly and was caught by hand. An adult was seen with it, and Dean saw a second immature in the same area on the following day. This constitutes formal confirmation of breeding by this species in the area. The species is fairly widely distributed through the marsh lowlands of the region as a whole.

Whimbrel — We found Whimbrels at Camp II on a low, level area of mixed vegetation about .5 mile (0.8 km) south of the Noatak River; sedge-grass marsh, tussock-heath tundra, and dry tundra (as narrow micro-ridges) were all present on the valley floor in the area occupied by the birds. The birds also flew widely, going

over and alighting on both tussock-heath tundra and low shrub areas. A maximum of six adults was seen at any one time, and one usually could locate all six simply by walking into the general area. They were extremely excitable, defensive (swooping close past human intruders repeatedly), and vocal. Such behavior was found to be area-related, but no nests or young were located. However, Dean feels quite certain that the birds were breeding in the immediate locality. They were constantly present and often heard, though we did not go close enough to the area to see them every day; Whimbrels were seen at Camp II on 26, 27, 28, and 29 June, and 1, 2, 3, and 5 July 1963. Dean had an opportunity to check carefully with a spotting scope the plumage details of several of the birds; they were all Whimbrels. Chesemore reported what he believed to be a Whimbrel from the upper Noatak Camp, but because of the possibility of his confusing it with Upland Plover and the scarcity of reports of Whimbrels from the Noatak River, we are forced to leave this report in a questionable status. We also saw a maximum of two Whimbrels at "Redstone Lake."

Bristle-thighed Curlew — No Bristle-thighed Curlews have been reported from this region since the bird Townsend (1887) collected.

Eskimo Curlew — McLenegan (1887, 1889) was the last worker to report Eskimo Curlews from the Kobuk-Noatak area.

Upland Plover — Townsend (1887) found the Upland Plover along the upper Kobuk River, but only two or three times. He collected one specimen. On the basis of Townsend's specimen and a single bird collected and three additional sight records at Anaktuvuk, Irving (1960) considered this species a visitor in both Kobuk and Anaktuvuk. Kessel and Springer (1966) reported the Upland Plovers that we found and which are described below. Campbell's (1967) summary of the status of the species in northern Alaska indicates scattered but regular breeding in a number of areas south of the crest of the Brooks Range. The Staenders (Staender and Staender, 1970) found them near the limit of spruce on the Hunt Fork. We found a group of Upland Plovers at Camp V on the slope above Lake Omelaktavik. The birds were seen and heard at close range over a period of several days (5, 6, 7, 10, and 19 August 1963). A maximum of five was seen at one time. Dean has had considerable contact with this species in the Alaska Range and in other parts of the breeding range. He feels that the group may well have been a pair with flying young; the birds were much more area-specific in a region with quite an extent of tussock-heath tundra and low shrub (which is the type they utilized) than would be expected of migrants. The birds that Edwin S. Hall reported nesting in 1962 (Campbell, 1967) were apparently about 2 miles (ca. 3 km) northeast of our Camp V. Hall also found this species along a 30-mile (48-km) section of the upper Noatak Valley.

Spotted Sandpiper — The adult and immature collected at Walker Lake on 28 July 1963 represent the first reported positive breeding record for the Spotted Sandpiper in the Kobuk-Noatak region although the species has been considered to breed in the Kobuk Valley by both Grinnell (1900) and Irving (1960). This species apparently is at the margin of its range here, judging by the reports of most workers. The only person considering it common in the region was Hines (1963), and Springer and White (pers. comm.) found none where they worked, less than 20 miles (32 km) farther up the Noatak River and still at the edge of the forest.

Wandering Tattler — The Wandering Tattler is another bird of the higher country that has escaped the notice of most ornithologists in the region. The re-

ports from the suitable habitat near Cape Thompson (Williamson et al., 1966), Kobuk and Anaktuvuk Pass, Howard Pass, (Irving, 1960; and Irving and Paneak, 1954), and Wahoo Lake in the eastern Brooks Range (Bee, 1958) suggest a wider distribution than is currently recognized. We saw none ourselves, although some suitable habitat was visited at Camp II and Camp V in particular.

Lesser Yellowlegs — Although the Lesser Yellowlegs has been reported frequently from the Kobuk Valley and was considered common at Anaktuvuk by Irving (1960), it was not found at Howard Pass just north of the headwater region of the Noatak River (Irving and Paneak, 1954). Hines (1963) had a questionable record at the mouth of the Kelly River. Springer and White (pers. comm.) saw at least three pairs at their camp-lake near the mouth of the Kugururok River (29 June and 3 July 1963) and three pairs south of Lake Narvakrak on 5 July 1963. On 7 and 10 August 1963, Dean saw Lesser Yellowlegs at Lake Omelaktavik; a maximum of two was seen simultaneously. It appears that the Lesser Yellowlegs is probably present, though in low numbers, throughout the main valley of the Noatak River; it probably also occurs in suitable habitat at slightly higher elevations such as Howard Pass, but perhaps not with any regularity.

Baird's Sandpiper — The Baird's Sandpiper is another species which Irving has found fairly common at Anaktuvuk but did not find at Howard Pass (Irving and Paneak, 1954; Irving, 1960). It must not be common in the Noatak Valley, as Dean found only one individual (28 June 1963 at Camp II), and neither Hines (1963) nor Springer and White (pers. comm.) reported any. These birds are uncommon to common on the North Slope (Bee, 1958; Kessel and Cade, 1958); at present no reason for their scarcity in the Noatak Valley can be offered.

Least Sandpiper — Springer and White (pers. comm.) collected a male Least Sandpiper on 29 June 1963, a pair (reproductive tracts in breeding condition) on 1 July 1963, and saw two more adults on 3 July 1963; all were near the camp-lake at the confluence of the Kugururok River with the Noatak. The only other report of this species from the Noatak Valley is that of McLenegan (1887). Irving and Paneak (1954) failed to find it at Howard Pass, although it is fairly common at Anaktuvuk (Irving, 1960).

Semipalmated Sandpiper — Although commonly reported from the lower Kobuk Valley, the Semipalmated Sandpiper has been reported from the Noatak Valley only by McLenegan (1887). Irving (1960) reported this species as common and definitely breeding at Anaktuvuk; however, he was unable to find it at Howard Pass (Irving and Paneak, 1954).

Red Phalarope — James Helmericks, who is well acquainted with the Red Phalarope on the Arctic Coast, reported having seen migrants at least once at Walker Lake, but he did not specify the date more closely than "summer" (pers. comm.). This is one of the few inland records for the species. Irving (1960) listed the bird as a migrant at Anaktuvuk Pass and indicated that it was uncommon there. Perhaps it occasionally moves through a number of the passes, including those at the head of the Noatak River.

Northern Phalarope — The Northern Phalarope has been reported from the Noatak Valley infrequently enough so that the following records are of interest. Springer and White (pers. comm.) saw one adult at their camp-lake on 29 June 1963 and two birds on the next day. The latter had the appearance of breeding birds. At Camp II on 28 June 1963, Dean saw three or fewer and, on the following

day, one. Although this species has been reported with some regularity from the lower Kobuk Valley, Helmericks (pers. comm.) has never seen it at Walker Lake.

Glaucous Gull — Springer and White (pers. comm.) saw Glaucous Gulls regularly; the birds flew along the Noatak River, and one pair had a nest just south of Lake Narvakrak on 5 July 1963. This is the first direct evidence of breeding for this species in the Noatak Valley.

Glaucous-winged Gull — Kenneth Alt (pers. comm.) recorded this species at the north end of Walker Lake.

Sabine's Gull — James Helmericks (pers. comm.) has seen Sabine's Gulls at Walker Lake three times during the 8 years covered in his discussion with Dean; he is well acquainted with this distinctive species from repeated observations of it on the Colville River Delta. This gull is uncommon to rare as far inland as Walker Lake.

Hawk-Owl — Springer and White (pers. comm.) saw one adult near their camp on 3 July 1963. This is the only record for the Noatak Valley, but it is not unpredictable that the species would occasionally reach the edge of timber there.

Short-eared Owl — Springer and White (pers. comm.) reported seeing one Short-eared Owl on the evening of 5 July 1963; the bird was flying over a wide marsh southeast of their camp.

Yellow-shafted Flicker — The Yellow-shafted Flicker reaches the edge of the forest on occasion, but obviously is not abundant there. We recorded only one, which was heard on 24 July 1963 by the whole party at Walker Lake. Helmericks (pers. comm.) has never observed this species there. Hines (1963) reported one bird from the lower Noatak Valley.

Black-backed and Northern Three-toed Woodpeckers — These birds are obviously resident, at least in low numbers, in the timbered areas of the region. However, we found only sign of bark-scaling and could not determine specific identity (Redstone River). Kenneth Alt saw the Northern Three-toed Woodpecker at the north end of Walker Lake (pers. comm.).

Say's Phoebe — At the time that Irving published his bird data from Kobuk, the Say's Phoebe had "not been reported in arctic Alaska west of the Killik Valley" (Irving, 1960). Since then, Helmericks (pers. comm.) has seen this species nesting at Walker Lake, and Dean collected one immature bird of undetermined sex just east of Lake Omelaktavik on 7 August 1963; he saw another that day, three on 8 August, and one on 23 August 1963. Helmericks' is the only record for the Kobuk Valley, although we are sure that they are more abundant in the mountains than this would indicate. Williamson et al. (1966) listed them as breeding in the Cape Thompson region.

Traill's Flycatcher — Hudson (1957) has reported a breeding record for Traill's Flycatcher at Selawik. This is the only record for the whole region, which is rather surprising considering the extent of stream-side alder habitat throughout the Kobuk drainage.

Western Wood Pewee — Hines (1963) has the only record for the Western Wood Pewee from the region; he heard one bird.

Olive-sided Flycatcher — The Olive-sided Flycatcher has been observed in the region only by Hines (1963), who saw one bird near the mouth of the Kelly River, and by Dean, who heard one calling from open spruce forest at the north

end of Walker Lake on 23 and 24 July 1963. The latter bird was not seen, but the call is unmistakable.

Horned Lark — The Horned Lark is another bird which breeds in the high, dry tundra above the paths of most ornithologists. Irving (1960) reported it as a common breeder in the Anaktuvuk Pass area and based his inclusion of the species in the Kobuk list on the local residents' knowledge of it. Irving and Paneak (1954) found it breeding at Howard Pass. On 9 July 1963, Dean saw two birds, probably a pair, on top of the mountain just east of "Redstone Lake." Williamson et al. (1966) included the Horned Lark as a breeding bird for the Cape Thompson area. The species must be less abundant in the region than it is in the Alaska Range; none were seen at our other high country camps.

Violet-green Swallow — The Violet-green Swallow has not been reported previously from the Kobuk Valley except for Hudson's observations at Selawik; he found them uncommon (Hudson, 1957). Bee (1958) reported the only other western Brooks Range record, one transient bird at Chandler Lake. In July 1963, we found a colony at the north end of Walker Lake; the birds were seen flying over the marshy area at the mouth of a small stream which enters the lake from the west at the extreme northern end of the lake. They also fed over the lake itstelf. Immatures were flying with the adults, but up on the mountainside west of our camp, on the boulder talus below a cliff, and on the stubs of spruce in that area, they were performing the usual fluttering and begging common to young birds. The activity of the whole colony appeared to be centered on two points, the marshy area and the cliff mentioned above. We gained the impression that the birds had probably nested in crevices in the face of the cliff, since it does not seem likely that there were enough holes in trees to accommodate all of them with nesting sites. It was impossible to make an accurate count, even with observations repeated on several days over the period that we were at Walker Lake (22 July to 5 August 1963); our best estimate was that the colony consisted of a total of 12 to 15 birds, with at least several immatures included. One adult was collected. Alt (pers. comm.) also saw this species at the north end of the lake in 1965.

Bank Swallow — Bank Swallows remained unrecorded in the Noatak Valley between McLenegan's (1887) report and 1963. Springer and White (pers. comm.) found a colony of about 20 pairs nesting in the bank of the Noatak River near the mouth of the Kugururok River on 1 July 1963. In addition, they saw small numbers (up to six) flying over their camp-lake on a daily basis. At BSMS Camp II we saw two flying over the river on 4 July 1963. At Camp V, Lake Omelaktavik, 20 were counted over the pond east of the lake on 7 August 1963; although a few others had been seen there between 4 and 7 August, none were seen after this date until three swallows (either Tree or Bank) were seen on 17 August.

Cliff Swallow — Irving (1960), in his Table 4, showed the Cliff Swallow as a breeding bird at Kobuk, but on page 145 he stated,

> Cliff Swallows are not now familiar near the village, where the houses seem to be too low to be attractive for nesting. Cliff Swallows at Bettles nest under the eaves of buildings with a second story. Eskimos at Kobuk know about their nests on cliffs and name them "mud swallows."

As Irving mentioned, Cantwell (1887) referred to Cliff Swallows nesting in large numbers in the upper canyon near the head of the Kobuk River. Helmericks, at Walker Lake, has noted these swallows nesting 5 to 12 ft (1.5 to 3.6 m) from the ground under cabin eaves. He has seen from 30 to 60 pairs there (pers. comm.).

Although Cliff Swallows may not nest near Kobuk village, they do breed in the valley; the location of colonies may shift from time to time, or else there may have been major population changes. Certainly there have been drastic shifts in the species composition of the swallow population of the Kobuk-Noatak region since the latter part of the last century.

Black-billed Magpie — McLenegan (1889) reported collecting one Black-billed Magpie on the Kobuk River, but Gabrielson and Lincoln (1959) were unable to locate the specimen in the U. S. National Museum. No other reports have been received for the region.

Dipper — Helmericks (pers. comm.) confirmed Grinnell's (1900) hearsay report of Dippers in the outlet of Walker Lake.

Varied Thrush — The Varied Thrush was reported from the north end of Walker Lake by Kenneth Alt (pers. comm.).

Hermit Thrush and Swainson's Thrush — Neither the Hermit Thrush nor the Swainson's Thrush have been recorded previously in the Kobuk Valley. This is surprising in view of the frequency with which Dean heard call notes of one or the other in the spruce forest on the mountain east of camp in the Redstone River Valley. Unfortunately, none of the birds was seen because of the dense undergrowth, and we were too late in reaching the area to hear the birds in song. At Walker Lake, birds identified as Swainson's Thrushes were frequently taken in mouse traps; these birds were mostly fledged immatures. Alt (pers. comm.) reported Swainson's Thrushes from the north end of Walker Lake.

Wheatear — Two Wheatears, one a fledged young bird, were seen on the mountain south of Lake Omelaktavik, on 6 August 1963. A third one was seen near the lake on 16 August 1963. Williamson et al. (1966) found them breeding in the Cape Thompson region, and they probably are scattered thinly throughout the high country of the entire western Brooks Range.

Bluethroat — The Bluethroat is spottily recorded over a wide range of habitat in northern Alaska, including a few sites in the mountains. Future workers should give special attention to learning more of the actual geographical and ecological distribution of this Old World species. We found none.

Arctic Warbler — Arctic Warblers were found commonly in the low shrub zone of the upper slopes on the mountains at the north end of Walker Lake. A few were also seen in the low shrub area around the small inlets at the north end. A minimum of 11 was seen and/or heard over quite an area between 23 July 1963 and 3 August 1963. Alt (pers. comm.) also found this species at the north end of Walker Lake in 1965. Siivonen (1949) speculated, on the basis of census evidence from Finland, that the closely related Willow Warbler (*Phylloscopus trochilus*) may undergo large fluctuations in abundance. Perhaps the Arctic Warbler does the same; it has certainly been reported erratically, and in Mount McKinley National Park Dean has been impressed by marked fluctuations in abundance from year to year. However, this is offered as a thought-provoker rather than a statement of fact.

Ruby-crowned Kinglet — The Ruby-crowned Kinglet is to be expected throughout the taiga, and it is apparently regular if not abundant in proper habitat in the Kobuk drainage. We were almost certainly too late to hear it in the Redstone Valley, but it was probably present there. On the other hand, one of the striking differences between Hines' (1963) and Springer and White's (pers.

comm.) records is the complete lack of this species from the latter's list. Perhaps, following the usual ecological pattern at the very margin of the spruce forest, the kinglet is less regular in its distribution and/or abundance than it is farther inside its range of suitable habitat.

Yellow Wagtail — Springer and White (pers. comm.) found four pairs south of Lake Narvakrak in a "dry marsh"; the birds showed behavior typical of breeding birds. Dean found only one pair (in open, low shrub and tussock-heath tundra) at BSMS Camp II in the second highlands of the Noatak River. This pair also showed breeding behavior, but considerable and repeated searching failed to uncover an active nest or young. A nest was found in the top of a *Carex* tussock in a small swale to which the birds were attached, but it was not conclusively from the 1963 season. Dean felt it was probably a wagtail nest, and after several searches, that the birds might well have had fledged young in the area. At Camp V in the headwaters of the Noatak River, flocks of pre-migrant or migrant Yellow Wagtails were conspicuous on 19, 20, and 21 August 1963; up to eight birds were seen in one flock.

Bohemian Waxwing — Hines (1963) found Bohemian Waxwings common and definitely breeding at the mouth of the Kelly River. These birds were present, but apparently less common, at the Kugururok-Noatak confluence area, as Springer and White (pers. comm.) saw them frequently and collected one adult male; they considered this species as probably breeding in the area. Bohemian Waxwings are not really common in the parts of the Kobuk drainage that have been worked by ornithologists, but these birds are probably present from time to time and in small flocks throughout most of the valley. Its habit of flocking lowers the probability of contact in a region where it is not abundant to begin with.

Yellow Warbler — Springer and White (pers. comm.) collected two Yellow Warblers and banded three others at the Kugururok-Noatak confluence area. One of the collected birds was an adult female with a brood patch; the other was an adult male in breeding condition. These are the first confirmed records for the Noatak drainage; Hines (1963) believed he heard some at the mouth of the Kelly, but did not observe any. Irving (1960) considered them only visitors at Anaktuvuk Pass, and we saw none in the tall shrub zones along the river at Camps II and V.

Gray-crowned Rosy Finch — Irving's inclusion of the Gray-crowned Rosy Finch in the Kobuk avifauna was based on Eskimo knowledge of the species from contact in the high country in the mountains north of the village. He listed rosy finches as regularly nesting but uncommon at Anaktuvuk Pass (Irving, 1960). He was unable to find the birds at Howard Pass (Irving and Paneak, 1954). Dean saw one immature (?) on 19 August 1963 on the high slope on the east side of the Kugrak River south of Lake Omelaktavik; this is the first record reported for the Noatak Valley, but the species probably occurs thinly scattered throughout the Baird and Schwatka mountains to the south and the DeLong Mountains to the north. Williamson et al. (1966) considered Gray-crowned Rosy Finches to be of casual occurrence in the Cape Thompson region.

Redpolls — Full discussion of the Redpoll situation has been reserved for Springer, who is studying the problems of the taxonomy, distribution, and ecology of these birds.

Golden-crowned Sparrow — The only Noatak Valley reports of Golden-crowned Sparrows are those of McLenegan (1887) and ours. We saw one adult male in low shrubs on the side of the mountain south of Camp II.

Fox Sparrow — Hines (1963) found Fox Sparrows common and observed fledglings. Springer and White banded and collected Fox Sparrows, but only in the spruce (pers. comm.). Irving and Paneak (1954) found this species at Howard Pass and presumed it was breeding there. It is a common nesting bird at Anaktuvuk (Irving, 1960). In view of these surrounding records, we were surprised not to find the birds at Camps II and V; perhaps we were too late to hear their song, and if they are not abundant north of the taiga, quiet birds could easily go unnoticed.

Lincoln's Sparrow — The only previous report of the Lincoln's Sparrow from the Kobuk-Noatak region was that of Townsend (1887), who collected one specimen. Dean is nearly positive that he saw one bird of this species on 18 July 1963 in low shrubs bordering a small pond just south of "Redstone Lake." Unfortunately, the observation was short and he was unable to collect the bird; however, he is quite familiar with the species, having banded the birds and seen many in the northeastern United States and some in the interior of Alaska.

Smith's Longspur — Smith's Longspurs were caught in mouse traps at Camp V, Lake Omelaktavik. Two specimens, one a male and the other of undetermined sex, were taken on 9 August 1963. This extends the known range westward from Anaktuvuk (Irving, 1960). It is of interest to note that this was one of the species that Irving and Paneak (1954) were unable to locate at Howard Pass. The birds we collected and the other longspurs seen were either locals grouping or actual migrants. Perhaps the Smith's Longspurs get this far west only in some years, or perhaps only in the fall migration, although such a pattern of movement is not consistent with their generally eastward distribution.

Snow Bunting — Surprisingly, no Snow Buntings were seen by BSMS personnel, although special watch was kept for them while in the high country.

Mammals of the Kobuk-Noatak Region

The mammalian fauna of the Brooks Range has been studied as a whole by relatively few workers. On the other hand, there is a limited number of species present, and numerous persons have conducted investigations on particular species, thus contributing significantly to our knowledge of the total fauna. Rausch has worked for many years in the Anaktuvuk Pass region in the central Brooks Range; his 1951 and 1953 papers are particularly helpful. Bee and Hall (1956) reported on a fairly extensive coverage of the mammals of the North Slope of the Brooks Range. Buckley and Libby (1957) included the eastern portion of the South Slope in their study area and found several species reaching their northern and northwestern limits in that region. Pruitt (1966) conducted intensive studies of the small mammals in the Cape Thompson region, and he has considerable data in unpublished form from several points on the South Slope. Pruitt's work on habitat ecology at Cape Thompson was continued by Mayo (1963). The considerably larger number of investigators who have dealt with restricted aspects of mammalian biology in northern Alaska will not be listed; some will be mentioned below as appropriate.

The discussion which follows will emphasize the geographic and ecologic aspects of the distributional records obtained during the summer of 1963. The ecological information will be based on a general study of our trapping data and observations. A more detailed and quantitative appraisal of the data is not justified, since the trapping effort was not intended to be related in an unbiased manner to the presence and extent of various habitat types. With the exception of the large

grids, all of the trapping was intended to be selective; consequently, the data are not eligible for comparisons intended to show abundance or even absence from a particular type (not all types were trapped). An effort of considerably more than two weeks per camp would be required to produce data that would yield valid comparative statistics on relative abundance and habitat preferences. Unfortunately, even the data from our quadrat trapping can not be considered more than suggestive of population levels; the influence of precipitation was marked, and necessitates a thorough reevaluation of snap-trapping as a means of obtaining data that will yield precise and reproducible population estimates in the types of environments that were under study.

There is an enormous mass of data which must remain unworked for the present. Data from specimens collected have considerable potential with respect to studies of taxonomic problems at the subspecies and race level, growth, reproduction, and, in some cases, population structure. There is enough work in connection with this material to occupy a senior mammalogist for several months or a year. The specimens are in the collections of the University of Alaska Museum, and undoubtedly some of this potential will be realized in the future.

The Brooks Range mammalian fauna is, as was noted earlier, limited in variety. The terrestrial and truly fresh-water species represent five orders and 12 families; in addition, it is likely that bats will be found in the region either regularly in very low numbers, as widely scattered colonies, or as visitors (see Banfield, 196lb). Nearly one-third of the total fauna is composed of taiga species which irregularly reach to or slightly beyond the northern limit of spruce. In addition, several of the small mammals can be expected to occur, even as irregulars, only on the southern slope of the eastern end of the Brooks Range; this group (see Table 5 for scientific names) includes the meadow vole, long-tailed vole, yellow-cheeked vole, and northern bog lemming (see Buckley and Libby, 1957; Banfield, 196la). Excluding the bats, the fauna for the range as a whole includes about 37 species; omitting the four microtines mentioned above, the list is reduced to 33. The 1963 survey recorded a total of 23 species; Table 5, p. 79, summarizes the distributional occurrence records. The individual species encountered are discussed below.

Masked shrew — The masked shrew was trapped at all five camps and about 14 times as frequently as was the arctic shrew. The masked shrew was taken in both tall shrub and low shrub and also in tussock-heath tundra in the Redstone River Valley; although some trapping was done there in the spruce forest, none of these shrews were caught in wooded habitats at Camp III. At Camp IV on Walker Lake, 13 were trapped in open spruce forest near the lake; and 4 were taken in a tall shrub area on one of the small inlet deltas. In the Noatak drainage, fewer of these shrews were caught, and they were found only in low shrub and tussock-heath tundra sites. We found masked shrews in valley-bottom locations but perhaps would have obtained them on mountainsides if more extensive trapping had been done there. Bee and Hall (1956) found the masked shrew in a wide range of physiographic and vegetational situations and considered it to be more strongly associated with wet and aquatic areas than the arctic shrew. Mayo (1963) also was unable to define a strict habitat preference for the masked shrew, since it occurred over a wide range of types; however, she found it associated with dry rather than wet tussock areas. Most of our catches also came from drier spots.

Bee and Hall (1956) mentioned that no visibly pregnant masked shrews had been taken during their work; they assumed that the main breeding season was in the summer. Four of the 44 specimens obtained from the Baird and Schwatka

mountains in 1963 contained macroscopic embryos (BSMS-61 Camp II, 29 June 1963, 3 embryos, largest =5.4 x 2.9 mm; BSMS-96 Camp II, 1 July 1963, 3 embryos, largest diam. = 3.4 mm; BSMS-131 Camp II, 5 or 6 July 1963, 8 embryos, largest crown-rump = 6.5 mm; BSMS-529 Camp IV, 29 July 1963, 1 embryo, crown-rump = 5.1 mm). Figs. 4, 5, 11, and 20 show, in the foreground, habitat from which masked shrews were taken fairly commonly.

Arctic shrew — Arctic shrews were caught only at the middle Noatak and Redstone Valley camps, and only three individuals were taken in total. One caught at the middle Noatak camp was taken in a low shrub area. The two from "Redstone Lake" were both obtained in dry tussock-heath tundra (Figs. 4 and 5). Obviously, no habitat preference statement can be based on such scanty data.

Snowshoe hare — The droppings, feeding sign, and fresh scrapes of snowshoe hares were commonly encountered in the tall shrub and hardwood forest types along the Noatak River at Camp II (See Fig. 22.). In fact, the willows in the tall shrub zone had been so heavily fed upon during the winter of 1962-1963 that we expected to see hares quite frequently; however, the animals were notably scarce and were presumed to have suffered a population crash. The only one seen was collected, and the remains of a second were recovered from an owl pellet found on the ridge just west of Camp II.

At Walker Lake (Camp IV), one snowshoe hare was seen at the edge of the open spruce forest at the north end of the lake at 2330 hrs on 22 July 1963. No other hares were seen there, and their sign was not particularly noticeable. The tall shrub zone along the Noatak River (Fig. 27) in the vicinity of Lake Omelaktavik contained rather plentiful evidence of these animals, although none were seen. The snowshoe hare must be on the margin of its habitable range in the Noatak Valley, living largely in the willow thickets along the watercourses. Occasional extensions farther north may occur, but again these would be limited to river bottoms containing willow stands. The Kobuk Valley is apparently good hare range, and dense populations have been reported from that region (Henshaw, 1966). The quality of the environment and consequently the abundance of the animals decreases as timber reaches its limit either at the northern end of the valleys tributary to the Kobuk Valley or on the sides of the mountains.

Arctic marmot — A den on top of the mountain immediately south of Camp II in the second highlands along the Noatak River had been used recently by marmots and perhaps was still in active use. Marmot droppings were found at this den on 5 July 1963; the den was under a rock outcrop at about 2,600 ft (790 m) above sea level. A special watch was kept for this species throughout the season, and although considerable time was spent in what appeared to be good habitat for the animals, none were seen or heard.

Arctic ground squirrel — At most of our camps, the habitat offered at least some possibility for occupation by ground squirrels. In several cases, though, the suitable habitat was a very small proportion of the total and was restricted to small knolls, ridges, and cut-banks; this was true at the "Redstone Lake" camp and the lower and middle Noatak River camps. At the "Redstone Lake" area several old holes were found at the top of the steep bank of the river west of camp; several traps set near them yielded only red-backed voles, but the holes were almost certainly originally made by ground squirrels. Low knolls north of "Redstone Lake" had old ground squirrel burrows. A mandible of a ground squirrel was recovered from a fox dropping picked up just north of the lake. The absence of ground

squirrels and their sign from the mountain east of "Redstone Lake" puzzled us, as did the absence of these animals from the higher country around Camp IV at Walker Lake.

The lower Noatak camp was similar to the one in the Redstone River Valley in that the only indication of the presence of this species was a series of old, disused dens on a gravel bench east of the camp-lake. At the middle Noatak River camp (Camp II), old burrows were found on stabilized portions of the gravel bar of the stream east of camp; fresh tracks were seen several times on this bar. Abundant fresh squirrel sign and actively used burrows were located along one branch of this stream in the cut-bank; one immature ground squirrel was shot at this colony. Several active colonies were noted on the mountain south of Camp II; an additional specimen was obtained from one of these. On the low hill west of Camp II, there were old, inactive burrows.

At Lake Omelaktavik, we encountered a moderately dense population of these animals. They were seen on the cut-bank of the Noatak River, on the slope just above the valley floor, and on the mountainsides up as high as 3,500 and 4,000 ft (1,000 and 1,200 m) above sea level. The greatest density of both burrows and squirrels was on the slope between the valley floor and the mountains proper. There the squirrels have utilized the cover afforded by low clumps of willow as focal points for their den systems. The activity patterns of the squirrels were not studied in detail, but casual observation suggested that the periodicity reported by Carl (1962) for these animals in the Cape Thompson region was not strictly adhered to at Lake Omelaktavik during August 1963. Perhaps the prolonged precipitation disrupted the normal activity pattern. Many of the burrow systems were judged to be in active use, because of the strong skunk-like odor emanating from them; many had been partially excavated by grizzly bears. The number of actual observations of arctic ground squirrels was small in comparison to what was expected, considering the number of holes. We collected nine squirrels from the Lake Omelaktavik area; all were taken on comparatively dry tundra interspersed with low shrubs, or else on rock outcrops. Figs. 28 (lower slopes), 29 (on knobs), and 30 show ground squirrel habitat.

Red squirrel — In the Baird and Schwatka mountains, red squirrels are closely associated with, if not absolutely restricted to, areas of spruce forest. In the open spruce forest along the Redstone River, the only sign of red squirrel activity was a small pile of spruce cone scales on a stump; there the trees are relativly small and thinly stocked, although apparently present in sufficient numbers to support a low squirrel population during good cone years. The "closed" spruce forest on the mountain east of camp was composed of larger trees that were more densely stocked; in addition, cones were in good supply. Two moderately large cone caches and a tree nest were located in this forest, but no red squirrels were seen, heard, or trapped. The population on the outer fringe of the taiga must be quite sparse, judging against the number of cone caches found during good cone years in interior Alaska.

At Walker Lake, where the spruce forest is more extensive and continuous, although more open than on the sides of the Redstone Valley, red squirrels were fairly common. They not only inhabited the more densely stocked portions of the forest, where they behaved similarly to those of interior Alaska, but they also lived on the forest fringe, in areas where the inter-tree distance is a matter of tens of feet and the ground is covered with dwarf birch (*Betula glandulosa*) and lichens. In the latter situation, the squirrels appeared to live in ground burrows throughout

Fig. 2. Aerial view of lower Redstone River and "Redstone Lake," the site of Camp III. Note the rounded mountains and complex drainage pattern. North is at the top of the picture; the scale is approximately 1:149,000. (From Tri-metrogon oblique.)

Fig. 3. View to the northwest across "Redstone Lake" from Camp III. Note the flatness of the valley floor. Both low and tall shrub types are visible in the foreground. Tree line on the mountain is about 2,000 ft (600 m).

Fig. 4. View to the north from Camp III in the Redstone Valley. Tussock-heath tundra covers most of the valley floor. Tall shrubs fringe the small streams.

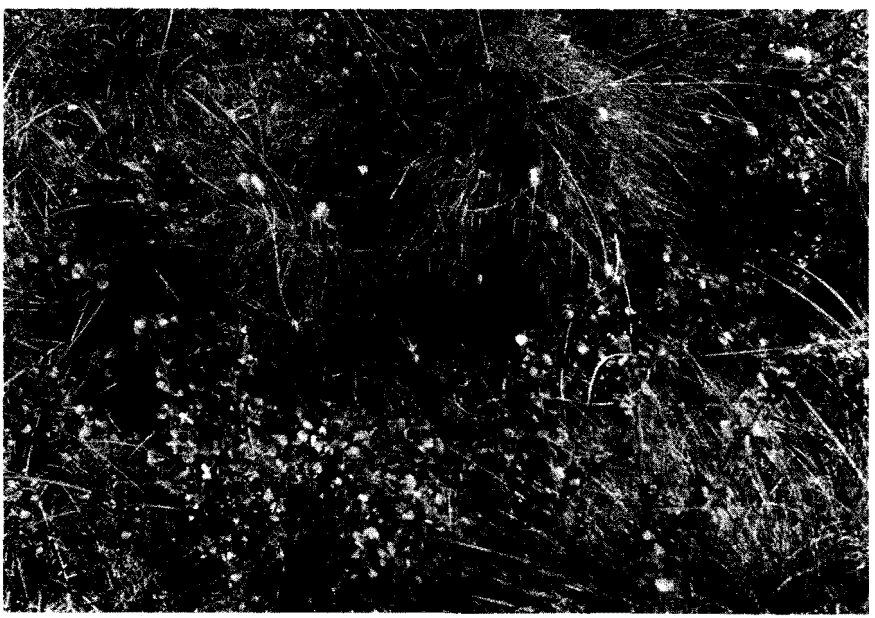


Fig. 5. Close-up vertical view of tussock-heath tundra, Redstone Valley.

Fig. 6. View to the west across "Redstone Lake" from the edge of the open spruce type at the transition point between valley floor and mountainside. The spruce at this point is predominantly black spruce.

Fig. 7. A small pond south of "Redstone Lake." Low shrub in the foreground, a narrow fringe of sedge-grass marsh, and tussock-heath tundra, borders this typical pond. On the mountainside "closed" mixed forest covers most of the west-facing slope. Some clearings, apparently old cuttings or burns, can be seen just below the crest of the ridge. Dry tundra caps the mountain in the distance.

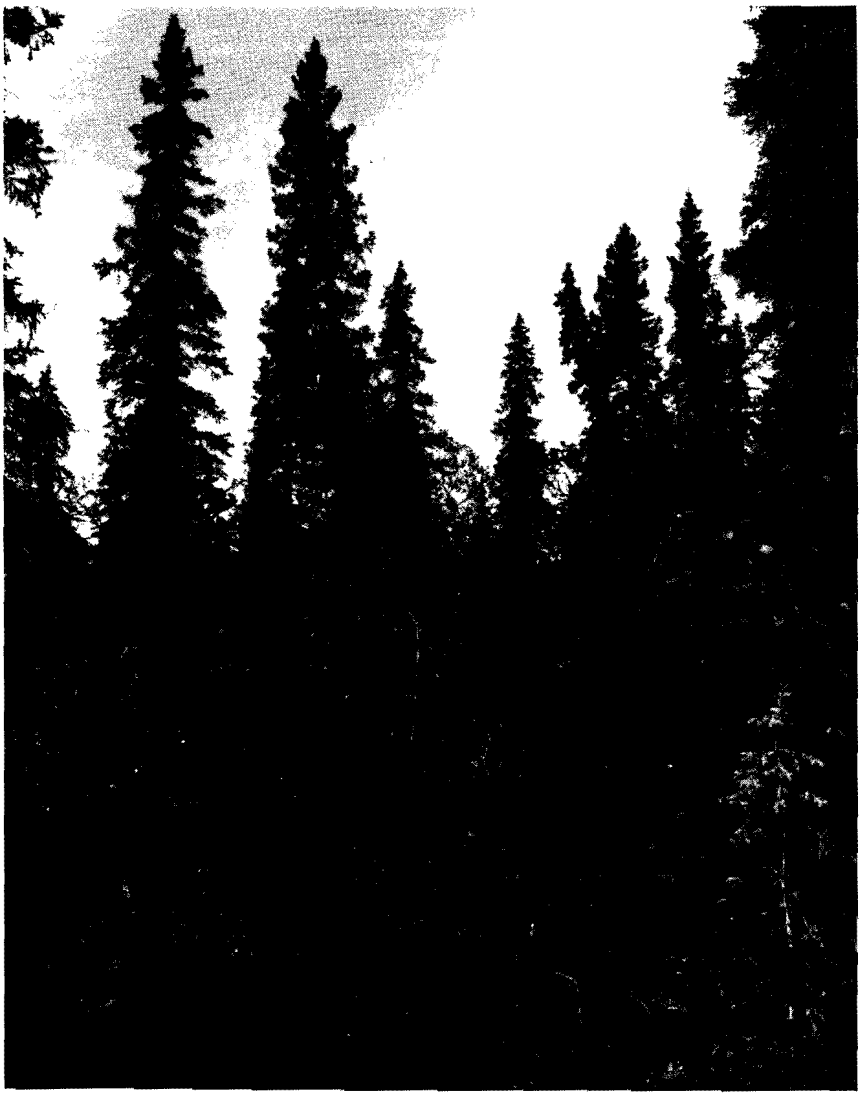


Fig. 8. "Closed" white spruce forest on the lower slope east of "Redstone Lake." The taller spruces are 50 to 60 ft (15 to 18 m) high and 12 to 18 in (30 to 46 cm) dbh. The understory is mostly alder.

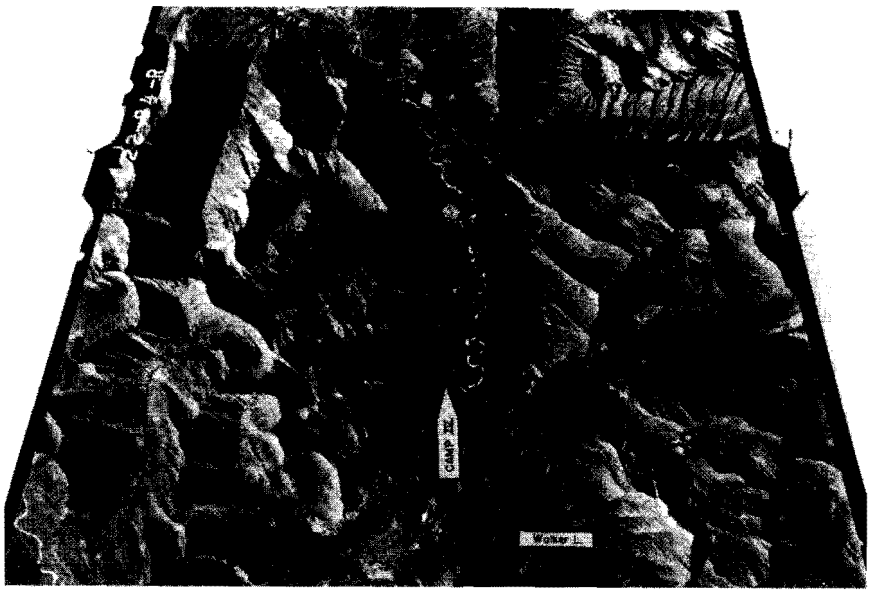


Fig. 9. Aerial view of the lower part of Kaluluktok Creek and the north end of Walker Lake. Note the steepness of the surrounding terrain and the narrowness of the valley bottoms. The difference in elevation between the lake and the adjacent peaks is over 3,000 ft (900 m). North is at the top of the photograph; the scale is approximately 1:160,000. (From Tri-metrogon oblique.)

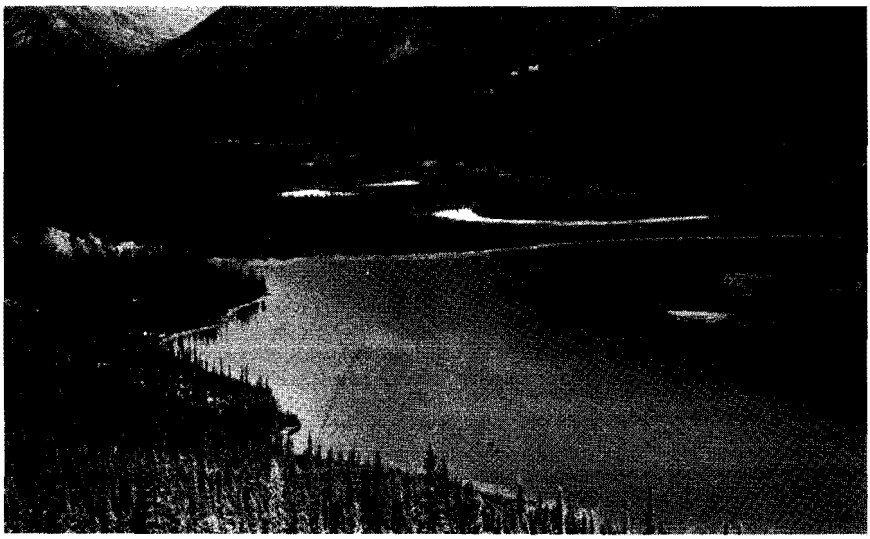


Fig. 10. View looking northeast across the north end of Walker Lake and Kaluluktok Creek. Spruce forest types are clearly visible. The marshy delta of the creek and mud bars along the creek can also be seen.

Fig. 11. Looking southeast down Walker Lake from a point just above Camp IV. Note the open nature of the spruce, the low shrub understory, and the dense ground cover of fruticose lichens.

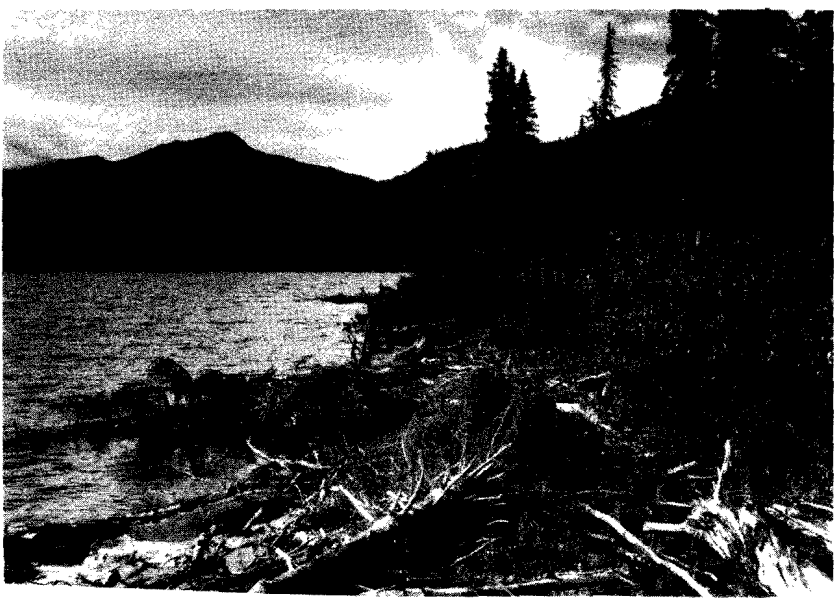


Fig. 12. The shore of Walker Lake showing the driftwood-cluttered beach, tall shrub, and spruce forest types.

Fig. 13. Ridges west of the north end of Walker Lake. The principal rock is schist, but a large limestone outcrop is visible in the middle-ground. The peak in the background is about 3,500 ft (1,066 m) high. The open spruce grades into shrub zones with increasing elevation.

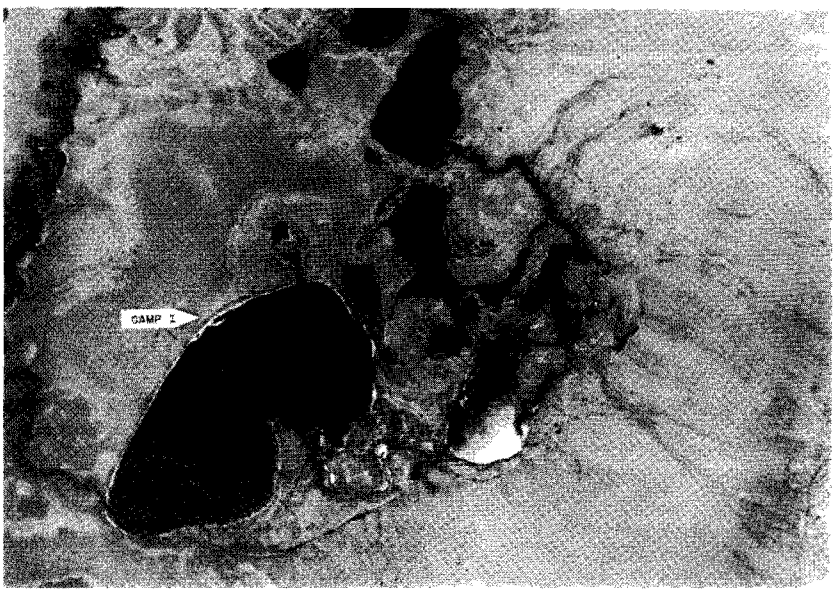


Fig. 14. Aerial view of the lake in the Noatak Mission lowland on which Camp I was located. The lake is about 6 miles (9.6 km) north of the Agashashok River in flat, wet country. The land rises slightly to the right or east side. The scale is approximately 1:32,000.

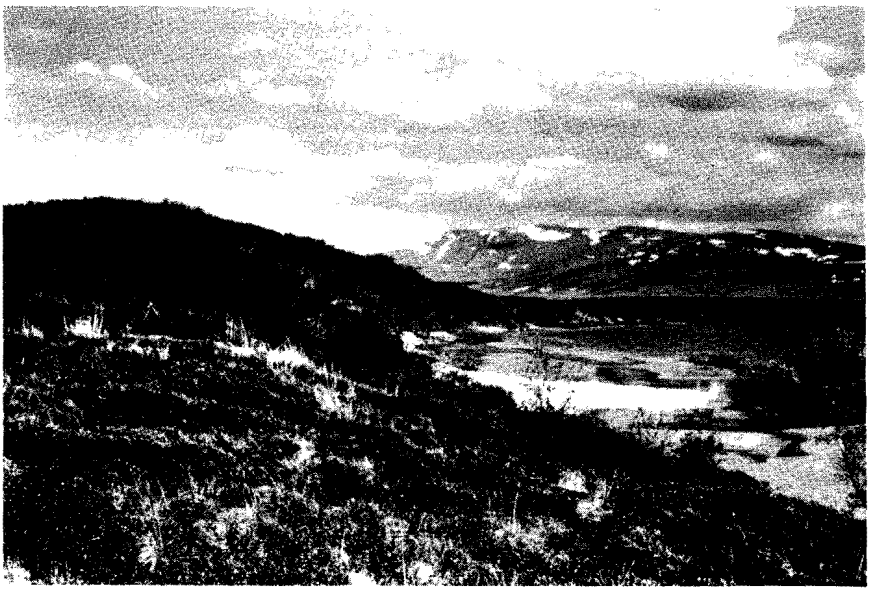


Fig. 15. Camp I lake in the Noatak Mission lowland. Note the dry tundra on the low ridge bordering the lake. The mountain to the northeast is on the west edge of the Baird Mountains and is about 2,000 ft (600 m) above sea level.

Fig. 16. The low flat country typical of the region around Camp I in the Noatak Mission lowland. Tussock-heath tundra occupies the low ground; low shrub grows on the small knolls with a ground cover of dry tundra. In the background there are tall shrubs growing along a stream channel.

Fig. 17. A micro-ridge with dry tundra and low shrub vegetation in the Camp I area. The west end of the Baird Mountains is visible in the background.

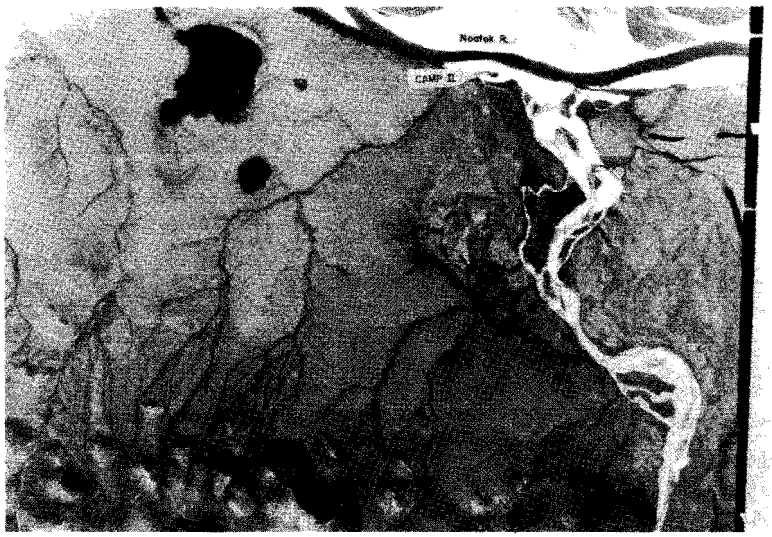


Fig. 18. Aerial view of the country around Camp II in the second highland on the Noatak River. The mountain southwest of the campsite is approximately 2,600 ft (800 m) above sea level. The two principal habitat types in this area are tussock-heath tundra and the alluvial deposits along the rivers. Directly south of the camp, a marshy area with small ponds can be seen. There are few steep slopes except on the mountains and on the bluffs by the Noatak River. The scale is approximately 1:177,000. (From Tri-metrogon oblique.)

Fig. 19. View northeast past the site of Camp II from the mountain southwest of camp. The Noatak River was in flood stage when this picture was taken; compare the degree of exposure of gravel bars with that in Fig. 18. Note the extensive areas of tussock-heath tundra (whitish areas) and the shrub-bordered drainage pattern.

Fig. 20. Tussock-heath tundra in the foreground and low shrub on the hillside just west of Camp II. The white spots are the "cotton" heads of *Eriophorum vaginatum*, the dominant sedge in the area. Mammal plot number two at this camp was located in this tussock-heath area; the area was characterized by the red-backed vole.

Fig. 21. Dry tundra with low shrubs just west of Camp II on the south bank of the Noatak River. Mammal plot one at this camp was located here; the area was characterized by singing voles (*Microtus miurus*).

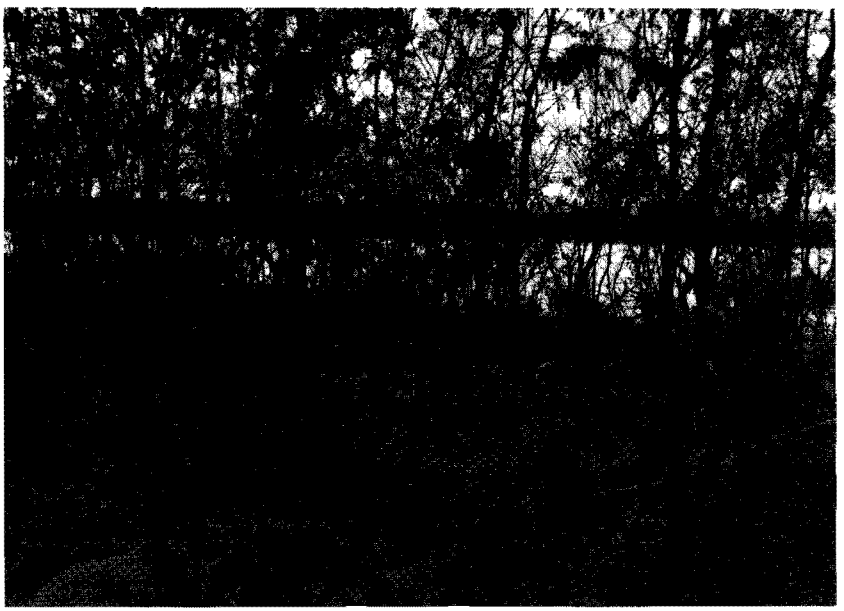


Fig. 22. A stand of tall shrub willow on the bank of the Noatak River at Camp II. Note the piles of driftwood, the bareness of the ground, and other indications of frequent flooding.

Fig. 23. Bare gravel bar beside the stream that enters the Noatak River just east of the site of Camp II. The stream is normally clear. The general view is southeast into the Baird Mountains.

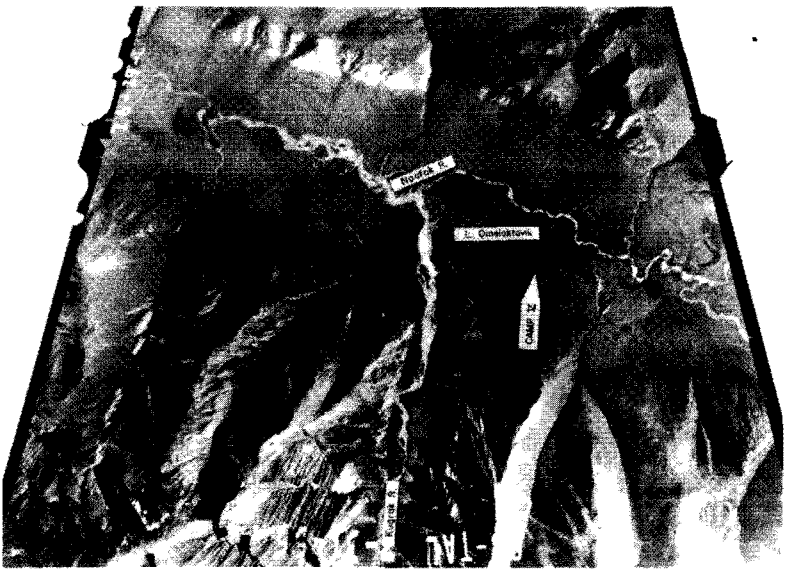


Fig. 24. Aerial view of the Lake Omelaktavik region at the headwaters of the Noatak River. The Kugrak River flows north into the Noatak. The mountains bordering the Kugrak rise more than 3,000 ft (900 m) above the level of the Noatak River at this point. Note the contrast between the well-defined drainage in the mountains and the lack of it in the Noatak Valley. The scale is approximately 1:138,000. (From Tri-metrogen oblique.)

Fig. 25. View from a mountainside southwest of Lake Omelaktavik across the Kugrak River and the Noatak Valley. Tussock-heath tundra and low shrub types are visible in the foreground. Tall shrubs grow along the rivers.

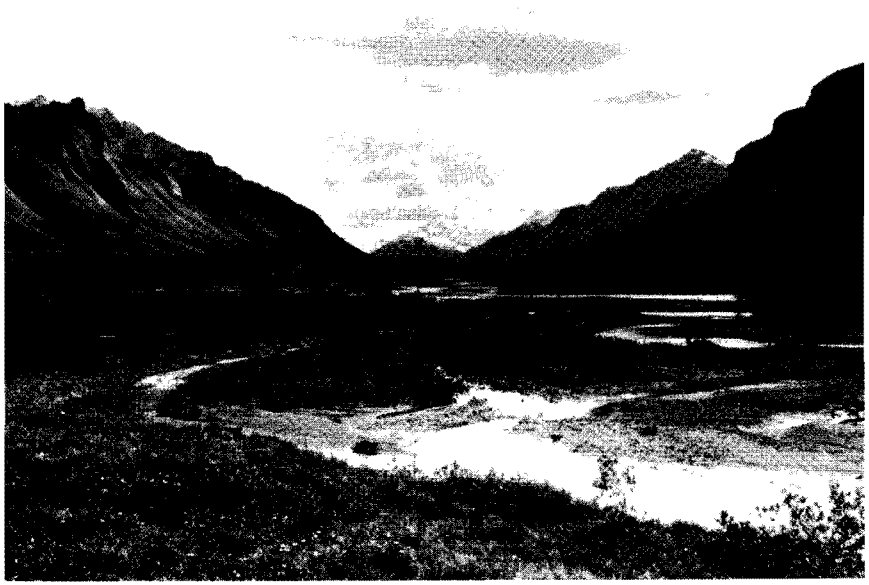


Fig. 26. View to the south in the Kugrak River Valley. Note the braided stream channels, tall shrubs, and tussock-heath tundra. The upper slopes of the mountains furnish good Dall sheep range.

Fig. 27. Tall shrubs growing along the Noatak River north of Lake Omelaktavik. Note the great amount of slumping which occurs along the bank on the outside bend. Such erosion contributes to the silt load of the Noatak and causes frequent changes in the location of the river's channel.

Fig. 28. The east end of Lake Omelaktavik. Low shrub, tussock-heath tundra, and sedge-grass marsh are visible.

Fig. 29. Mountain slope east of the Kugrak River. Tussock-heath tundra and low shrubs are in the foreground; dry tundra covers the slope. Note the snow line which was down to a level between 3,500 and 4,000 ft (1,066 and 1,220 m) on August 1963). The mid-slopes are heavily used by sheep.

Fig. 30. Boulder field overgrown with dry tundra on the mountain south of Camp V. Singing voles, Wheatears, and sheep inhabited this area. Bare rock talus slopes in the background.

Fig. 31. Dry tundra, talus, and schist outcrops. View to the north across the Noatak River near Lake Omelaktavik.

the year rather than use tree nests during the warmer months. Five red squirrels were collected at Walker Lake.

Beaver — Beaver were observed only at Walker Lake although the Redstone River Valley certainly could support some. Just north of the delta of Kaluluktok Creek there was a lodge and a number of related canals and runways. Two adult beaver were seen a number of times swimming and feeding in the vicinity of the lodge. On the west shore of the lake about 2 miles (3 km) south of our camp site, there was another bank lodge which gave the impression of disuse when observed through a spotting scope. Along the shore of the lake, alders have been cut over quite a long period of time, and the beaver were seen towing alder branches from points as far as .4 mile (.6 km).

Red-backed vole — More than 350 red-backed voles were trapped during the summer of 1963. This species was the commonest small mammal at both camps in the Kobuk drainage. At "Redstone Lake", 172 were taken, mostly from tussock-heath tundra. The first quadrat for this camp was located just east of the lake in a section of tussock-heath tundra that was mostly dry (Figs. 4 and 5); the second quadrat was in a tussock area which was wetter and showed indications of polygon formation. The narrow runs of tall shrub (willows and alder) that border the small streams which wind across the valley floor have a ground cover which includes a large proportion of blue-joint grass (*Calamagrostis* sp.); this vole finds such places suitable habitat. Red-backed voles were found commonly both in the open spruce forest along the Redstone River, where the moss carpet furnished cover for their burrows, and in the "closed" spruce forest on the mountainside. This species was also taken along the upper edge of the alders just below the dry tundra on top of the mountain. Smaller numbers of trapped voles of this species indicated their presence in low shrub and riverbank situations.

The catch of red-backed voles at Walker Lake was predominantly from open spruce forest, some of which was mature and perhaps almost of the "closed" sort. Although the following numbers reflect trap distribution to a great extent, they also serve to indicate the habitats supporting the most red-backed voles: open spruce forest — 84, overgrown talus — 17, tall shrub — 13, low shrub — 5, and rock outcrop — 4. The altitudinal range covered by catches of this species was about 1,500 ft (450 m), beginning at lake level.

In the Noatak drainage, while the species was present at all the camps, the red-backed vole was not dominant except in certain situations, and often was a minor component of the total biomass. At the lower Noatak camp, only nine small mammals were trapped in total; five of these, taken in low shrub habitat, were red-backed voles. The wet tussock-heath tundra plot at Camp II on the middle Noatak was dominated by animals of this species, and some were present in a dry tundra-low shrub area dominated by the singing vole. In the headwater region of the Noatak River, at Lake Omelaktavik, only eight red-backed voles were caught out of a total catch of over 150 small mammals; these were taken mostly in areas of tall shrubs and dry tundra. Bee and Hall (1956) and Mayo (1963) have stated the preferences of red-backed voles for tussock-heath tundra habitat and the associated overhead cover; our data do not indicate any change. During the course of the summer at the various camps, red-backed voles were found in the same habitat with all of the species of shrews and microtine rodents which we encountered; Bee and Hall (1956) and Pruitt (1966) have dealt with interspecific associations at some length. Red-backed voles were numerous in the habitats shown in Figs. 4, 5, 6, 8, 11, 12, 13, and 20.

Meadow vole — C. H. Townsend (1887) reported obtaining specimens of *Arvicola riparius,* an old synonym for *Microtus pennsylvanicus,* from the lower Kobuk River. Since the presently known range of the meadow vole does not come closer to the region in question than Bettles, there is some question as to the identification of his specimens. It seems probable that they were tundra voles, *Microtus oeconomus.* Animals of this kind were considered subspecific representatives of the meadow vole and were apparently not recognized in North America as a separate species until several years after Townsend's trip to the Kobuk River. On the other hand, many southern animals extend their range into the Kobuk Valley at least on a limited basis; with a collection from Bettles in the Koyukuk drainage, it is conceivable that future workers may find populations of meadow voles in the Kobuk drainage, which is just over the divide from the Koyukuk.

Tundra vole — The tundra vole was not common either in the Redstone Valley or at Walker Lake. At "Redstone Lake" three were taken in tussock-heath tundra and three in tall shrub situations along small stream swales or at the edge of a marsh. At Walker Lake seven were taken from open spruce forest where red-backed voles were dominant; one was caught on an overgrown talus slope, and five were trapped on the small delta at the extreme north end of the lake in a tall shrub (willow) situation.

Only nine small mammals were trapped at the lower Noatak camp; one was a tundra vole taken in tussock-heath tundra. Five of the nine voles of this species trapped at Camp II on the middle Noatak River were obtained in tussock-heath tundra (Fig. 20), again in association with red-backed voles. Three were from tall shrub types, principally the riparian willows shown in Fig. 22; here the voles lived under piles of driftwood and flood debris and were subjected to flooding. High ground was no more than 30 yards (10 m) away from most of this riverbank habitat. One tundra vole was obtained from a low shrub area at Camp II. In the headwater region, at Lake Omelaktavik, tundra voles were trapped in roughly equal numbers in low shrub, sedge-grass marsh, and dry tundra areas; 14 were taken there. Several authors (Rausch, 1951; Bee and Hall, 1956; Buckley and Libby, 1957; Mayo, 1963) have noted the association of this vole with wet habitats. Some have felt that the species was restricted to a variety of plant types characterized by wetness, while others found tundra voles over a wider range of conditions. From the descriptions provided by these authors, it seems likely that this species prefers moist situations but is capeable of surviving drier sites. Mayo (1963) encountered a high population level, with the mice occurring in a wide range of habitats; expansion into suitable but less preferable environments during times of high population density is a well known ecological phenomenon. Since tundra voles were not abundant at any of the study areas worked in 1963, they could be expected in the apparently preferred wetter areas, as seemed to be the case. We found them in association with both the red-backd voles and singing voles, although perhaps more commonly with the former.

Singing vole — In the parts of the Kobuk drainage visited, singing vole habitat appeared to be largely limited to the tops and upper slopes of the mountains. One individual of this species was seen on a rock outcrop at the north end of the mountain east of "Redstone Lake"; the only additional evidence pointing toward the presence of this species in the Redstone area was what may have been the remains of old hay piles at the base of some of the alders on the slope up from the water at the lake shore. However, the only mice caught in the immediate vicinity

were red-backed voles, and the identification of the singing vole as the maker of the piles must remain conjectural. Certainly, most of the wooded mountainsides and the comparatively wet valley floor do not appear to be good habitat for the latter species. The situation at Walker Lake is much the same, with the limited valley floor and the lower mountainsides being unsatisfactory or at least very questionable as singing vole habitat. At about 2,500 ft (760 m) on the mountain west of camp, there were abandoned holes in the *Dryas* mat which we attributed to this species. Farther up the ridge, as high as about 3,200 ft (975 m), many old holes and some remains of hay piles were seen. There was no fresh sign, and five traps set for three nights at the 2,500 ft (760 m) level failed to catch any mice. Since no other species had replaced the singing vole in this community, and since there did not appear to be a current or previous shortage of food, it is interesting to speculate on the cause of a complete or nearly complete elimination of the voles.

Singing voles were quite numerous in appropriate habitats at Camp II on the middle Noatak. More than 20 were taken from low shrub types, including Quadrat No. 1, which was laid out in an area of scattered low willows with a dry tundra type of ground cover (see Fig. 21); this area was relatively well drained in spite of its flat topography, as it was situated just back from the steep bank of the river. Also in the vicinity of Camp II, singing voles were taken from tussock-heath tundra and tall shrub. On the mountain south of camp, colonies of this species were encountered at about 2,000 ft and 2,400 ft (600 and 700 m); a few individuals were trapped there during the afternoon. The habitat was low willow and *Eriophorum* tussocks in one case and low willow in a gulley in the other.

At Lake Omelaktavik the singing vole dominated the areas trapped. A total of 119 was taken, mostly from the low shrub-dry tundra hillside immediately south of the lake. A few were taken from areas of fairly dense low willow and some from tall shrub situations, even those immediately adjacent to the Noatak River in the middle of the valley, where they were separated from other dry habitat by a large fraction of a mile (more than 1 km) in straight-line distance. Perhaps the populations in the river bank areas had invaded along the meanders, starting from some point at which the river was closer to the lateral hillsides or from the contact with the well-drained bank of some tributary stream such as the Kugrak River. Singing voles were living at least as high as 4,000 ft (1,200 m) on the mountain south of camp, where they occupied a talus slope overgrown with dry tundra. Only eight were taken in tussock-heath tundra. The most characteristic features of the greater part of the singing vole habitat in the headwater region were slope, relatively good drainage, widely scattered willows of several kinds (but especially *Salix glauca*), and short, tundra ground cover with a high proportion of deep moss (see the lower slopes shown in Fig. 28 and also Fig. 30).

Bee and Hall (1956) found singing voles building their hay piles by the end of the first week of August, apparently responding to low temperatures and snowfall. Although we were at Lake Omelaktavik from 5 August 1963 through 29 August 1963, and were in an area with a high population of these animals, only one or two new hay piles were seen, and very little additional cutting activity was noted. The hay pile starts were on an old talus slope at about 3,400 ft (1,036 m). The lack of more forage collecting was surprising, since the daily temperature minima were below 40°F (ca 5°C) most of the month and the temperature at camp reached freezing during the nights of 5-6, 9-10, and 23-24 August. In addition, snow was staying on the ground down as low as 3,500 ft (1,066 m) much of the time and must have fallen at levels below that. A brief but hard snowfall cov-

ered the ground at camp on 9 August, but it did not last. One hay pile collected on the old talus slope mentioned above contained roughly half and half dwarf willow and dwarf fireweed (*Salix reticulata* and *Epilobium latifolium* respectively); there was a slight admixture of *Carex* sp. The total volume of the material in the pile was about 1.3 quarts (1.4 liters) in a dry and uncrushed condition. The protection afforded by a small rock with a slight overhang had been taken advantage of in placing the pile so it could cure. This pile was collected on 6 August 1963; the spot was rechecked on 19 August, but no additional material had been cached at this same place. A second pile, found on 19 August and located under a similar slanting rock not far from the site of the first, contained about 66% *Salix reticulata* leaves, 10% *Dryas octopetala* leaves, 10% *Cassiope tetragona* stems with leaves, and 10% miscellaneous leaves and stems; the vegetation within 15 ft (4.6 m) of the pile was roughly 70% *Cassiope*, 15% *Dryas*, 10% *Vaccinium uliginosum*, and 5% *Salix reticulata*. Even allowing for a reduction in the standing plants because of the cutting, the mouse had obviously selected for the willow. The total volume in the pile was one pint (.7 liter).

Although the singing voles at Lake Omelaktavik had not really started their fall harvest of winter forage by the end of August, on 19 August there was a great deal of fresh burrowing sign in the *Dryas*-moss cover on the mountainside at about 3,000 ft (900 m). In some places, areas of several hundred square feet were spotted with burrow entrances separated by only a few feet. An increase in burrowing activity was also noted on the slope just above the lake.

Muskrat — Although muskrats are abundant in the flat, marshy region in the lower Kobuk Valley, their populations become sparse as one moves to the more restricted valleys and the higher country where, instead of vast, marshy areas with many deep channels and ponds, water is generally limited to small ponds and shallow lakes. Also, much of the water is so shallow that it will freeze to the bottom with a high degree of frequency. Such freezing is probably the most important limiting factor affecting the distribution of this adaptable species.

A muskrat was collected at "Redstone Lake" as it swam along the lakeshore on 17 July 1963. Sign of muskrat feeding was seen only once in the Redstone Valley; a bunch of *Carex* had been clipped in a sedge-grass marsh bordering a stream that was about 6 ft (2 m) deep. The main river fluctuates too much to be optimum or perhaps even satisfactory habitat. In the Noatak Valley, we found muskrats at Camps I and V. At least two individuals lived on the Camp I lake, and bank burrows, cuttings of *Equisetum* sp., and two live muskrats were found at Lake Omelaktavik. Bee and Hall (1956) had no records for muskrats on the North Slope, and none on the South Slope north of the timbered country. Rausch (1953) reported this species as common around Arctic Village on the South Slope of the eastern Brooks Range; this village is south of timberline and in a rather broad valley.

Brown lemming — The brown lemming was not seen or trapped during the 1963 field season. However, examination of owl pellets picked up at the middle and upper Noatak camps revealed one skull of this species taken at each place. At the upper camp, Lake Omelaktavik, the one brown lemming skull was found in a series of six pellets containing identifiable remains of five microtine rodents (the rest were singing voles). The population of brown lemmings must have been very low while we were there, since the valley floor habitats were trapped without catching any, even in the area where the skull was recovered.

Collared lemming — One immature collared lemming was trapped in tussock-heath tundra which was developing a weak polygonal pattern; this was at the northeast corner of "Redstone Lake." No other collared lemmings or sign of these animals were seen. Both lemmings are characterized by violent changes in abundance, and we apparently hit a very low period for the two species.

Porcupine — The only evidence of porcupine was a pile of old droppings collected by David Chesemore at the foot of a small white spruce on an isolated knoll near "Redstone Lake."

Wolf — Fresh tracks of one wolf were found in the mud beside a small stream just east of "Redstone Lake" on 8 July 1963. At Lake Omelaktavik, fresh wolf tracks indicating two large animals and one smaller one (the latter's track measured 5.5 in [13.75 cm] from the tip of the claw to rear of heel) were found along the bank of the Noatak River. A wolf den which was being actively used was located; a few ptarmigan feathers were picked up near the den. No wolves were seen or heard, but these animals normally range throughout the study region. They were hunted intensively during the winters of 1961-1962 and 1962-1963; the Alaska Department of Fish and Game has restricted the take from this region since that time.

Red fox — The red fox ranges rather generally throughout the region, wherever small mammals and birds can be found. The only camp at which positive evidence of this fox was not obtained was Walker Lake, and the lack of evidence is not significant in this case. At "Redstone Lake" there was an old fox den on a small knoll just north of the lake; this rise was the best-drained site for some distance and was surrounded by wet tussock-heath tundra. Pieces of caribou antler and ptarmigan feathers were found near the den entrances; the former may have been playthings. While the den was not in active use, it had been used within fairly recent time. The disturbance of the sod caused by the digging and other activity of the animals made the knoll subject to moderate wind erosion. The holes were too small to have been made by wolves. Red fox tracks were found on a bar of the Redstone River which had been flooded not long before.

At Camp I, in the Noatak Valley, the remains of a red fox were found on 11 June 1963. A fox den was located on a low mound of sandy, silt-loam covered with willows; this den was in use. Fresh tracks were seen on the lake shore once. At Camp II, in the second highland, we saw fox tracks quite frequently and observed red foxes on two occasions. Dean watched two adults on a streambank on 1 July 1963; they repeatedly uttered a low-pitched call best described as "ooh-oooh-oooh-oooh," a noise with which he was unfamiliar. The call was given both when the two animals were separated by only 50 ft (15 m) and also when the lead animal was out of sight of the other. Both gave the call. In the vicinity of Lake Omelaktavik, red foxes were seen several times, both down by the Noatak River and up near the 3,500-ft (1,066-m) contour on the mountain south of camp. One animal was collected.

Black bear — The black bear is a fairly common animal in the Kobuk drainage, at least within the timbered areas and on their fringes. At Camp III, old black bear tracks were seen on a bar of the Redstone River; a small black bear was seen on the bank of the river on 18 July 1963 by several members of the crew; and a large individual was watched on 19 July 1963 as it fed through an area of tussock-heath tundra and very open spruce northeast of our camp. At Walker Lake, this bear was common. Tracks were seen three times on the beach in front of camp.

Two black bears were seen in camp. Droppings were found commonly, mostly containing berries. On 30 July 1963, while watching from a spot on the mountain west of camp, Dean saw four different black bears between 1620 and 1655 hrs. On this date the bears were feeding on both herbaceous material and berries.

We saw no black bears in the Noatak drainage; and John Cross, at that time a Wien Alaska Airlines bush pilot who flew out of Kotzebue for many years, had never seen or heard of this species along the Noatak River.

Grizzly bear — Although the Noatak River Valley and the surrounding country having a reputation of being excellent grizzly bear range and of having an abundance of these animals, we saw very few during the summer of 1963. On the flight from Camp I to Camp II, David Chesemore saw bear tracks in snow patches on the mountains southwest of the latter camp. When we arrived at Camp II, Dean found tracks of a medium-sized grizzly along a path which led from the bar of the main river up through our camp site; however, the tracks were not fresh. Other old tracks of grizzlies were found on the bars of the river that enters the Noatak River just east of Camp II. A few grizzly droppings were found on the level bench just above the river and also at about 2,000 ft (600 m) on the mountain south of Camp II. Bears had dug up mouse nests in the low willow type south of the camp; there were also places where they had dug up the roots of *Hedysarum* sp. Dean's field notes for 5 July 1963 contain a summary impression about the quality of the environment:

> There does not seem to be a great deal of "good" grizzly range close at hand, judging by McKinley Park standards. The areas of lush grass are small and scattered; there is quite a bit of grass in some of the high draws that have alder and small streams, but not the broad expanses that one finds at Sable Pass [in Mount McKinley National Park]. There is also quite a bit of *Equisetum* that they may eat. The berries seem to be present as thinly scattered plants (blueberry and *Shepherdia*). *Arctous* and *Empetrum* are more abundant; in some areas, quite so.

At Walker Lake, there was little grizzly sign. A spruce tree by a trail around the northwest end of the lake had been used as a rubbing post by both black bears and grizzly bears; hair from both species was collected there. The Shetlers saw a small bear that they were sure was a grizzly on the east side of Kaluluktok Creek on 31 July 1963. The bear was just above the stream when first seen, and they watched it from a distance of only a few hundred feet for over 15 min. No other grizzlies were seen at this camp, despite considerable searching done with the spotting scope.

At Lake Omelaktavik, in the Noatak headwater region, grizzly sign was more abundant, and these bears were seen on several occasions. Droppings were fairly common on the low shrub-dry tundra slopes above the valley floor and along the trails which parallel the river. Places where the bears had dug up mouse nests (mostly singing voles), ground squirrel burrows, and *Hedysarum alpinum* roots were very common. In some instances, several square feet had been plowed up, and the cumulative effect of the sod-breaking action of the bears must be even more significant in such a northern region, where frost action is more severe and vegetative regrowth is slower than it is in the Alaska Range to the south. Grizzly bears were seen on nine occasions while we were at Camp V, and 15 hrs 25 min of intensive observation were accumulated. Data from these observations, measurements of digging activity, berry crop estimates, and other information gathered on grizzlies

at this camp do not furnish an adequate basis for generalizations. None of the observations made involved unusual behavior or events. The greatest divergence between the habits of the grizzlies in the Brooks Range and those in the Alaska Range may be found in the early part of the summer, due to the lower availability of grasses in the more northern area.

Least weasel — Only one weasel was caught during the entire summer, and none was seen alive. The trapped animal was a least weasel taken in tussock-heath tundra on Quadrat 2 at the middle Noatak camp. The scarcity of these animals, if trapping results can be considered reliable, is surprising, since populations of red-backed voles and/or singing voles were high at all camps but the first.

Mink — The only positive indication of mink seen all summer was a set of tracks Dean found on 12 July 1963 on an area of mud which had been deposited by recent flooding. There is little reason to doubt the existence of at least low populations of this furbearer along the larger streams and rivers on the south side of the Baird and Schwatka mountains. The animals require access to open water, even if under ice, and would be forced out of areas which regularly freeze solid. The mink is probably very limited in numbers (and perhaps is even restricted to the status of a visitor) in the middle and upper portions of the Noatak drainage.

Moose — Moose were seen at all five camps; of the five, the Redstone Valley is the best habitat for this species. Several different individuals were seen at each camp, but there were at least three mature bulls and two adult cows at "Redstone Lake." Calves or their tracks were seen at Camps II, III, and V. Rather extensive areas of the Redstone Valley furnish satisfactory winter range for the population there, and although some balsam poplar along the river was being maintained at a height of about 4 ft (1.2 m), no vegetation was seen which appeared to be severely overbrowsed. At Walker Lake, as at "Redstone Lake," the bulls spent quite a bit of time feeding on aquatic vegetation in the lake. The Kaluluktok Creek valley north of Walker Lake appears to be heavily used by moose during the winter. There the effects of browsing on the willows are easily seen. The spruce stands bordering the north end of Walker Lake also are utilized, probably as cover, by wintering moose.

The population of moose in the Noatak Valley is sparse, but the animals are distributed throughout the valley of the main river wherever stands of willows are extensive enough to provide browse for a few individuals. Smith (1913) did not mention this species; and according to bush pilot John Cross, the population is increasing. This seems to be true of most areas in and north of the Brooks Range.

Caribou — The investigations conducted by Lent (1966) and previous work by biologists working for the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game have shown that, while many caribou utilize or move through the Baird and Schwatka mountains and other parts of the Kobuk and Noatak drainages, these are largely migrating and wintering animals. Caribou are notorious for inconsistency and undoubtedly have moved through or wintered in the vicinity of each of the five BSMS camps at some time in the relatively recent past. However, there is no assurance of their presence in large numbers on an annual basis. Lent, in his paper cited above, reported wintering bands of several thousands in the vicinity of Camp I, migrating animals along the Redstone, and many wintering and migrating bands in the rest of the general region. Apparently he worked during a period when the Kobuk Valley was utilized more heavily by caribou than it had been for many years before.

The evidence we found does not conflict with Lent's more extensive information. The persistent trails left by migrating herds, shed antlers indicative of wintering animals, and (at Camps I and II) signs of fall hunting harvest, all bore witness to the rather regular presence of these animals at all of our camps except Walker Lake. There the only evidence of caribou was a single piece of shed antler; reports indicate that in some years a northward migration takes place through the Walker Lake valley, but most of the animals may move on the ice, thus leaving comparatively little sign. The Walker Lake-Kaluluktok Creek route is one of several that are probably used with fair regularity; the others include, but are not limited to, the Ambler River, the Redstone River-Cutler River, and the Salmon River. Tracks in mud deposited during the spring flood at Camp II indicated the presence of at least a few individuals there in the late spring. We also saw one lone animal keeping to the high country south of that camp.

At Lake Omelaktavik, small numbers of caribou were in sight almost every day from 5 August 1963 on. However, the animals kept very high on the mountains north of the Noatak River. On 27 August 1963, nearly 1,000 animals were counted on these mountains; they were moving toward Lake Omelaktavik and our camp. Most skirted the lake, but one band swam the lake and came ashore only a few hundred yards west of camp. The southward movement persisted through the next two days and had not really stopped by the morning of 29 August, when we left. A count of antlers visible on the ground of the mountain slope north of Lake Omelaktavik and on the valley floor was made with the aid of the variable power spotting scope. Six or seven pairs were still joined to the skull; three were separated from their opposites; and one was undetermined. Since most of these antlers were spotted at a distance in excess of 2 miles (3 km), the bias toward seeing antlers of large animals must be recognized. Undoubtedly some antlers of smaller size were present but unobserved. While some of the joined antlers may represent animals that died solely of disease or old age, probably most represent wolf or human kills. The period of time represented by this series of antlers could be quite long because of the persistence of bony material in that climate, and the animals which consume the antlers may have been absent, or present in low numbers, for a number of years.

Dall sheep – Dall sheep are reported to have a rather erratic distributional pattern in the Baird and Schwatka mountains. The pattern is not well enough known to us to speculate as to the specific influential factors. We found trails made by sheep or caribou (probably the former) in the talus slopes of mountains at the head of the Eli River in the northwestern part of the Baird Mountains. These were observed during a flight made between Camps I and II. In addition, David Chesemore saw five sheep during a flight between these two camps. Above 1,900 ft (580 m) on the mountain south of Camp II there were old sheep droppings; these were limited to areas that would be wind-blown and relatively free of snow during the winter. While no sheep were seen on this mountain or others in the vicinity, the area apparently serves as winter range for at least a few animals.

Janice Chesemore and John Cross saw seven or eight sheep on a mountain one drainage east of the Salmon River while flying from Camp II to Camp III on 7 July 1963. Cross stated that sheep are rare in the Baird Mountains east of the Salmon River.

On the mountains west of camp at Walker Lake, Dean found a few piles of sheep droppings and a small wad of sheep hair on 24 July 1963, and a few more piles of droppings along a lightly-used trail on the crest of the ridge of the next

mountain to the south on 27 July 1963. No other sign of sheep was seen in the immediate vicinity of Walker Lake.

A short distance to the north, in the Noatak headwater region, there are good populations of Dall sheep. In the pre-white period and perhaps into fairly recent times, Eskimos from the central Kobuk Valley traveled to the head of the Noatak River to hunt sheep. Giddings (1956) described the summer hunt in the high country in a general way. Smith (1913) found horns representing several years' accumulation from kills made along Twelvemile Creek, and he met some Kobuk River people hunting sheep in this headwater area in early August. We saw bands of 10 to 40 sheep in several places in the quadrant north of Lake Omelaktavik; these were mostly ewes, lambs, and young rams. In the higher mountains at the head of Portage Creek and in those to the south and southwest of our camp, there were several small bands of mature rams. The west-facing side of the mountain immediately south of our camp showed evidence of heavy use, apparently mostly as winter range.

The Brooks Range animals are not as large as those in the Alaska Range or the Wrangell Mountains, and they have less massive horns. Some data on sheep shot in the vicinity of Lake Omelaktavik are given in Table 6, p. 80.

General Ecological Notes

While the ecology of the Baird and Schwatka mountains is not well known specifically, there is a rapidly increasing understanding of the ecology of subarctic and arctic regions as a whole. The facts that these regions have rather limited numbers of species composing their faunas and floras and that, at least in a gross sense, the environmental conditions are reduced in variability as compared to those in temperate and tropical regions, make extrapolation slightly less hazardous than it might be otherwise. The reader interested in discussions of subarctic and arctic ecology in general is referred to the following sources as starting points: Bee and Hall (1956), Drury (1956), Hansen (1957, especially the papers by Britton, Buckley, Heusser, Pewe, and Pitelka), Hanson (1953), Lutz (1956), Porsild (1951), Sigafoos (1958), the many papers on soils of northern Alaska by Tedrow and his group (cited in Britton), and Wilimovsky and Wolfe (1966).

The work done in 1963 was not designed to uncover the complexities of the many ecological gradients encountered in the Baird and Schwatka mountains. However, some of the gradients and transitions are so abrupt that they can hardly escape notice. The principal one in the Kobuk drainage is the "tree-line" and the "limit of species" (both used in the sense employed by Hustich, 1953, with reference to the spruces and hardwood trees). There is a distinct impoverishment in the taiga with decreasing distance from the "tree line." Shetler (1964) discussed this with respect to the variety of plant species found in the margin of the taiga region at "Redstone Lake" and Walker Lake. His data are not indicative of the whole picture, however, since he was more concerned with presence or absence rather than abundance. As the boundary of the taiga zone is approached, the frequency with which a particular species is encountered may decrease greatly. As an example, clearings in and edges of white spruce stands in the Redstone Valley were characterized by very scattered rose bushes, whereas in the Tanana Valley of interior Alaska roses form dense patches in many areas. Many other plants could be cited to illustrate this gradient in abundance. Animals show it as well. The Yellow-shafted Flicker, other woodpeckers, Hawk Owls, many other birds, and such mammals as the red squirrel, were found in significantly decreased abundance in comparison

with their populations in portions of the taiga more distant from its margin.

The "tree line" and "limit of species" were seen from the air at the head of the Hunt River and the Akillik River. Spruce of tree size were restricted to the well-drained river gravels and south slopes. With increasing closeness to the divide between the Kobuk and Noatak drainages at the head of these rivers, both the stands of spruce and the individual trees become smaller and more widely separated, reflecting the greater marginality of most sites. Finally, near the crest of the divide, exceedingly sharp boundaries of such stands are caused by changes in exposure, soil conditions such as drainage, temperature, and probably snow cover characteristics. Because of the low elevation of many of the passes between the Kobuk drainage and the drainage of the Aniuk lowland, the differences between sites supporting spruce trees and those just beyond the "tree-line" and even the "limit of species" are minimized. Under such conditions, both observational and experimental work on the factors responsible for making a particular site untenable might be particularly productive. Under conditions observed on the upper Alatna River, which is immediately east of the headwaters of the Noatak River, Thomas D. Hamilton (pers. comm.) feels that winter winds and snow-blasting probably effect the "limit of species" there. The latitudinal "tree-line" north of Walker Lake was not observed.

Since there are few areas in the Baird and Schwatka mountains that are truly separated by topographic relief from the rest of the ranges, it seems likely that few barriers of a physiographic or topographic sort exist, considering the time which has been available and the continuity that can be found between areas of particular vegetation types. Also, there is a narrow coastal plain connection between the mouths of the Kobuk and Noatak valleys. The north-south passes through the mountains are, in many cases, less than 1,500 ft (450 m) above sea level and of low approach grade. Many have wide saddles with an accumulated soil bed; this in turn should make it possible for plants to germinate and survive given the right edaphic and microclimatic conditions. These same passes provide easy avenues of travel for mammals and any birds that are not so closely tied to tree growth that they ordinarily will not leave the timber; some of these forest species may even follow the winding threads of willow that drop from the saddles, twisting across the wide expanses of tussocks, and following streamlets as they spread over ever-widening gravel bars and become rivers.

Perhaps one of the greatest barriers in the region is the vastness of some of the tussock tundra. On and on for miles, without interruption other than the meandering streams with their flanking willows — the drainages of the Cutler River and the Aniuk lowlands are carpeted for tens of miles with sedge tussocks. These must certainly form formidable barriers to small mammals of some types; perhaps the singing vole would go around or at least stay with the line of willows. Red squirrels? Marmots? The snowshoe hare might follow the willows, but this would mean a low rate of spread. Probably such a barrier would affect some of the invertebrates and other relatively immobile animals the most. Other potentially significant barriers to the spread of animals are the extensive areas of rock without vegetation, particularly in the Schwatka Mountains.

Through the long course of time, the barriers mentioned above have been skirted by one route or another, and the several potential members of the fauna are probably occupying the major segments of suitable range, although presence and abundance may change drastically with time. The probable effect of the barriers in the degree in which they exist now is to reduce greatly the rate of gene flow

and prohibit it entirely in some directions. Subspeciation may be a consequence and is to be expected in inverse relationship to the mobility of the individuals of the species in question. Thus, the smallest mammals and non-flying insects should show relatively great response to these partial barriers.

There are myriad reminders of the thinness of the margin between habitable and uninhabitable environments in the region as a whole. A rise of 2 or 3 ft (ca. 1 m) results in adequate drainage; a tilt of only a few degrees cools a slope sufficiently to reduce the surficial thaw zone to a matter of only a foot or so. Many other examples could be given, but the point is made — the balance is extremely delicate. Under such conditions, the latitude of ecological tolerance seems to diminish, and survival is possible only under more and more restricted conditions. Such a situation results in an emphasized relationship of plants, birds, mammals, and other organisms with characteristic habitat types which may be quite narrow in several senses.

Suggestions for Further Research

Like most initial investigations and surveys, the Baird and Schwatka Mountain Survey of 1963 has raised more questions than it has answered. These are too numerous to receive individual treatment here, but a few examples will be cited both to illustrate the types of problems which exist and to point out certain specific cases that appear to have some priority. The research that will be needed before a good understanding of the region is achieved can be divided into several areas: (a) description and inventory with reference to the environments and the organisms inhabiting them, (b) taxonomy, (c) ecology and biogeography, (d) problems utilizing situations or organisms in or from the Baird and Schwatka mountains whose solution does not require that the subject be from this particular place.

Obviously, inference of the fine points of the distribution and temporal changes in abundance from one season's work in a region as large as the Baird and Schwatka mountains is not possible. A distributional picture of the components of the flora and fauna would, of necessity, be based on extreme extrapolation if it were put together now. A compiler would be forced to assume the presence of species in suitable plant types, and even the distribution of the components of the vegetation is not accurately known. A skilled photo-interpreter who was familiar with representative sections of the region could prepare a vegetation map from aerial photographs, and this would be a good first step for any detailed study. Since changes in the abundance of organisms occur both seasonally and from year to year, the temporal factor must be incorporated into plans for measuring such differences; simultaneous spatial differences also occur and should be known if a full understanding of the ecology of the region is to be had. This is especially true of the microtine rodents. The other aspect of a descriptive inventory which should eventually be made at enough points with the region to permit valid extrapolation is the quantitative measurement of the physical environment. This is a huge undertaking in such a large and diverse area; but by selecting samples representing the major combinations of environmental features, a reasonable degree of accuracy should be attained. More refined gradients and boundaries will have to be studied with specific attention. Do the meadow vole, long-tailed vole, and yellow-cheeked vole reach the southern portions of the Baird and Schwatka mountains as they do the South Slope in the eastern Brooks Range? This and other questions relating to geographic range fringe phenomena will be answered only by long-term, intensive inventory work.

Once a reasonably thorough inventory is achieved, and to some extent as a part of the inventory, specimens should be examined for taxonomic variation. There are several small mammals whose status is in need of clarification or in relation to which very arbitrary range lines have been drawn through or around the Baird and Schwatka mountains as the case may be. The masked shrew has been divided into several subspecies, with the crest of the Brooks Range being considered the point of demarcation between certain populations (Hall and Kelson, 1959). However, the distribution of specimen collections with reference to the postulated boundary is so sparse and of such a pattern that the boundary is obviously no more than conjecture, and perhaps even the validity of the subspecies is open to question. A similarly arbitrary range map was presented by the same authors in the case of the arctic ground squirrel; they separated two subspecies whose ranges are presumed to extend along the coast, meeting at a point northwest of the Mission lowland of the Noatak River Valley. The greater parts of the Kobuk and Noatak drainages are excluded from the range of the species. Since we found these animals at all of the Noatak Valley camps and at "Redstone Lake," the range map should obviously be revised, and the question of subspecific assignment arises, providing the distinctions are defensible. The tundra vole provides an interesting puzzle; Paradiso and Manville (1961) recognized several subspecies, including two whose ranges include portions of the Baird and Schwatka mountains. The most unusual aspect of this situation, however, is that the proposed line between the two is north-south and runs through our Camp II location. What potential barrier or gradient runs north-south through this portion of northwestern Alaska? There may be none, and the two subspecies may have become involved in a mutual swamping operation after having spread from two widely separated points. The collared lemming is another example of a subspecies distribution question.

One might question an ecologist's interest in subspeciation, but the process usually requires boundaries or gradients of ecological significance and thus can be used as a tool for locating such points of environmental change and also as a means of studying the degree of response produced in the organisms. Many interesting examples could be presented, drawing from plants, invertebrates, fishes, birds, and mammals. However, those that have been mentioned are among the more obvious and perhaps in some ways the more interesting; at any rate they will serve as illustrations of the type of potential which is latent in the area.

There are strictly ecological problems that need attention. What controls the distribution and abundance of Dall sheep? If it is the distribution of limestone and soils derived from this material, the relationship is not immediately obvious. However, as was indicated earlier, our knowledge of the geological structure of the Baird and Schwatka mountains needs expanding. A similar question arises with respect to marmot distribution; and, particularly with this last species, one can inject speculation regarding its relation to the Bering Land Bridge. A different sort of ecological investigation, but one which promises to be of interest, is that required to discover precisely what triggers hay-making activity in the singing vole. Temperature and snowfall have been suggested by Bee and Hall (1956), but they did not precisely define the releasing conditions. In addition, the situation we observed at Lake Omelaktavik did not seem to fit their criteria. This problem is one which may well require a blending of field work with some use of controlled environment chambers. An ecologist should seriously examine the constancy and validity of the plant-animal "associations" proposed by Bee and Hall (1956); some of the 1963 work appears to furnish a basis for questioning these as general concepts.

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Table 1. Baird and Schwatka Mountain Survey Small Mammal Trapping Effort, 11 June through 29 August, 1963, Measured in Trap-Nights (one trap set for 24 hrs. represents one trap-night).

Trap Type	Trap Nights					Totals
	Kobuk Drainage		Noatak Drainage			
	Camp Number					
	III	IV	I	II	V	
Museum Special	535	778	547	595	1,234	3,689
Schuyler	716	778	543	635	1,261	3,933
Pit-falls, live-traps, and size 1½ steel traps	42	9	5	5	33	94
Totals	**1,293**	**1,565**	**1,095**	**1,235**	**2,528**	**7,716**

Table 2. Birds of the Kobuk and Noatak Drainages and the Central and Western Brooks Range, Alaska.

[Legend: (U) uncommon, (C) common, (A) abundant, (+) presumably breeding, (#) indirect evidence of breeding, (*) definite breeding record, (R) resident, (RM) resident and migrating, (M) migrating but not remaining to nest, (MN) migrating to nest and also migrating, (N) migrating to nest there and not migrating farther, (V) visitor, (WV) winter visitor, (HF) Hunt Fork, (Neg) not found after conscious search.]

	Kobuk Drainage													Noatak Drainage and other Brooks Range Areas															
	McLenegan 1884 Lower Kobuk & Selawik		Grinnell 1898–1899 Lower Kobuk & Hotham I.		Hudson 1956 Kotzebue–Selawik		Townsend 1885 Kobuk R.		Grinnell 1898–1899 Kobuk R. near Hunt R.		BSMS III 1963 Redstone River		Irving Kobuk Village Region	Helmericks Walker Lake	BSMS IV 1963 Walker Lake		BSMS I 1963 Lower Noatak		Hines 1960–1961 Lower Noatak & Kelly R.		Springer & White 1963 Noatak R. – Kugururok R.		McLenegan 1885 Lower & Middle Noatak		BSMS II 1963 Middle Noatak R.	Irving 1952–1953 Howard Pass		BSMS V 1963 Upper Noatak R.		Irving Anaktuvuk Pass		Bee 1951–1952 Brooks Range	
Common Loon	U						C	#					MN		U	*										U	+	U		MN	U*		
Yellow-billed Loon	U	#					U	#					M				U		U		U					U	+			MN	U +	U	*
Arctic Loon	A	#	C	*	C	*	?		C	*	C	#	MN				U		U	#	C-A	*	C			C	+	C	*	MN	C +	U	+
Red-throated Loon	U	#	C		U	*	C		C		U		MN						U	#					U	C	+			MN	C +	U	+
Red-necked Grebe			C	*	C	*							N				U											U					
Horned Grebe													N																	V			
Whistling Swan	C	#					U		U				MN				C	#	U	#	U		U							M			
Canada Goose	C	#			C	*	C	*					MN	C +			C	#	C		U		A	#						M			
Black Brant													M																	M			
Emperor Goose			U										Rare																				
White-fronted Goose	C	#	C	*	C		A	+	C	+			MN	C +			C						A							M			
Snow Goose													M																	M			
Mallard			Rare		U				Rare				N												U					M			
Pintail	C	#	C	*	A	*	A		C	*			MN	*			U		U		C	*	C	#	U	C	+	U		MN	C *	U	
Green-winged Teal	C	#	U		C	*	C	*	U		?	*	MN	*	U						U	*	U		U	C	+			MN	U *		
European Widgeon					Rare																												
American Widgeon	U	#	C	+	A	*	C	*	C		C	#	MN				U				U		C	*						MN	U *		
Shoveler					U	*							MN																	M	Rare		

	Kobuk Drainage															Noatak Drainage and other Brooks Range Areas																	
	McLenegan 1884 Lower Kobuk & Selawik		Grinnell 1898–1899 Lower Kobuk & Hotham I.		Hudson 1956 Kotzebue–Selawik		Townsend 1885 Kobuk R.		Grinnell 1898–1899 Kobuk R. near Hunt R.		BSMS III 1963 Redstone River		Irving Kobuk Village Region	Helmericks Walker Lake		BSMS IV 1963 Walker Lake		BSMS I 1963 Lower Noatak		Hines 1960–1961 Lower Noatak & Kelly R.		Springer & White 1963 Noatak R.–Kugururok R.		McLenegan 1885 Lower & Middle Noatak	BSMS II 1963 Middle Noatak R.	Irving 1952–1953 Howard Pass		BSMS V 1963 Upper Noatak R.		Irving Anaktuvuk Pass	Bee 1951–1952 Brooks Range	
Canvasback																						Rare										
Greater Scaup	U	*	C	*	C	*			U	+	C	*	MN	*				C	*			C	*	C	*	}	*	C	*	MN C	*	U +
Lesser Scaup																														MN U	*	
Common Goldeneye																				? Rare				Rare								
Bufflehead													N																			
Oldsquaw	C	*	A	*	C				C	+	U	*	MN	C	*			C	*			U	*				U	*	C	*	MN C	+	U
Harlequin Duck									Rare				MN	C	*												U	+			MN		
King Eider			C	*																				Rare								
White-winged Scoter	U		U										MN	*								C				U		C	*	MN C	*	
Surf Scoter			C	+	U				C	+	U	*	MN					C				C						U		MN U	*	U
Common Scoter	U	*	C	+	U		U		U				V					C	*			U										
Common Merganser	C	*																Rare														
Red-breasted Merganser	C	*	C	*	U		C	*	U				MN	C	*	C	*	U	*	A	*			C	*		C	+			MN C	*	
Goshawk	Rare				C								R																	V		
Sharp-shinned Hawk									U				N																			
Rough-legged Hawk							C				U	*	M											Rare		U	*			M-Rare N		
Golden Eagle													MN	C	*	U				Rare						U		C	+	C	*	MN C	*	C +
Bald Eagle													V	V												C	+			V		
Marsh Hawk	C	+	U		U		C	*	C				N							U						C	+			V, Rare		
Osprey			U	*			C	*			U		N							U	*	Rare								V, Rare		
Gyrfalcon	C	+							U				R	WV												U	*	U		R	*	
Peregrine Falcon																														M		
Pigeon Hawk	C	+					C	*	C				MN							U	*					U				MN *		U
Sparrow Hawk																										C	+			V		
Spruce Grouse	U	*					U	*	C	*			R	R	*	C	*			U												
Ruffed Grouse	U	+																														

	Kobuk Drainage													Noatak Drainage and other Brooks Range Areas																			
	McLenegan 1884 Lower Kobuk & Selawik		Grinnell 1898–1899 Lower Kobuk & Hotham I.		Hudson 1956 Kotzebue–Selawik		Townsend 1885 Kobuk R.		Grinnell 1898–1899 Kobuk R. near Hunt R.		BSMS III 1963 Redstone River		Irving Kobuk Village Region	Helmericks Walker Lake		BSMS IV 1963 Walker Lake		BSMS I 1963 Lower Noatak		Hines 1960–1961 Lower Noatak & Kelly R.		Springer & White 1963 Noatak R.–Kugururok R.		McLenegan 1885 Lower & Middle Noatak		BSMS II 1963 Middle Noatak R.		Irving 1952–1953 Howard Pass		BSMS V 1963 Upper Noatak R.		Irving Anaktuvuk Pass		Bee 1951–1952 Brooks Range	
Willow Ptarmigan	C	+	C	*	A	*	U		C	*			RM	R	*		C	*			C	+	C	*	C	+	C	*	U	*	RM	*		
Rock Ptarmigan	U	*							U	+	U	*	R								U						C	*			R	*	C	+
Sandhill Crane	C	#	C	*	U		C		C	+			MN								C	#			U						M			
Semipalmated Plover	C	#	Rare		U		C		Rare				MN	U	*						C	*	U		C	+	C	#	C	+	MN	U	*	
Killdeer																															?	M		
American Golden Plover	C	#	U	+							U		MN						U						U	+	U	#	U	+	MN	A		
Black-bellied Plover	C	+											MN												C	+					M	U		
Surfbird									U				V																?	U			
Ruddy Turnstone	Rare		U	+									M																		M			
Black Turnstone	Rare						U														C													
Common Snipe	U	#	C	+	C				C	+	C	*	MN	U							C		C	#			C	#	C	+	MN	C	*	U	+
Whimbrel	U	#	C	*	?	U			C	+	U		MN												A		C	#			M			
Bristle-thighed Curlew							Rare																											
Eskimo Curlew	C	#																							A									
Upland Plover							U						V																C	#	V			
Spotted Sandpiper					C		Rare		U	+			MN			U	*				C	#									M	U	U	
Solitary Sandpiper	Rare		U						C	+			MN								U	#	U	#							M-Rare			
Wandering Tattler													MN														U	+			MN	C	Rare	
Lesser Yellowlegs	C	#	U				U	+	C	+	U		MN								?		U	#	C	#			U		MN	C		
Knot			M-Rare																															
Pectoral Sandpiper	C	#							Rare				MN																		MN	U	+	U
White-rumped Sandpiper																															V,	Rare		
Baird's Sandpiper			M	C					M	U			M	U													U	#	Rare		CN,	AM	U	
Least Sandpiper			U				C		U	+			MN			U							U	#	C	#					MN	C		
Dunlin	Rare		Rare		Rare								V																		V,	Rare		
Long-billed Dowitcher	A	#			A	#							M												A	#			U		M	C		

	Kobuk Drainage													Noatak Drainage and other Brooks Range Areas															
	McLenegan 1884 Lower Kobuk & Selawik		Grinnell 1898–1899 Lower Kobuk & Hotham I.		Hudson 1956 Kotzebue–Selawik		Townsend 1885 Kobuk R.		Grinnell 1898–1899 Kobuk R. near Hunt R.		BSMS III 1963 Redstone River		Irving Kobuk Village Region		Helmericks Walker Lake		BSMS IV 1963 Walker Lake		BSMS I 1963 Lower Noatak		Hines 1960–1961 Lower Noatak & Kelly R.		Springer & White 1963 Noatak R.–Kugururok R.		McLenegan 1885 Lower & Middle Noatak		BSMS II 1963 Middle Naotak R.		Irving 1952–1953 Howard Pass		BSMS V 1963 Upper Noatak R.		Irving Anaktuvuk Pass		Bee 1951–1952 Brooks Range
Stilt Sandpiper																													
Semipalmated Sandpiper	A	*	A	*																							M	U	
Western Sandpiper			U		A	*																							
Buff-breasted Sandpiper													M														M	U	
Bar-tailed Godwit	C	*	U	+									M														M	U	
Hudsonian Godwit	C	*																											
Sanderling	Rare		U	*									M	U													M		
Red Phalarope	U	*	U										M	U	Rare												M	U	
Northern Phalarope	C	*	C	+	C	*			U				MN		Neg						U	*			U	*			
Pomarine Jaeger			U		C								V		Rare												V, Rare		U
Parasitic Jaeger			U	*	C								MN								U		U				MN	U	U +
Long-tailed Jaeger	U	*	U	*	C				U	+	U		MN								C		U	*	U	*	MN	U	
Glaucous Gull	A	*	C	*	C	*	C		C	*			MN	C							U		A	*	U	*	C		U		U	+	MN	U	U
Glaucous-winged Gull	U						C		U																		C	*							
Herring Gull					?						U		N						U				U						V	U				
Mew Gull			C	*	U				C	+	C		MN						C	*	U		C	*	C				U		U	+	U	+	MN	U	+	U	+
Bonaparte's Gull	U	*	U	+			U		U	+			V												U										
Sabine's Gull			U						U				V		V																		V, Rare		
Arctic Tern	A	+	A	*	A		C		C	+	C		MN		+		U				C		C	*	C		A	*	U		U	+	U	MN	U	+	
Great Horned Owl					U								R	*									?										V, Rare		
Snowy Owl	U	+	U						U				WV														U	*				U	WV, Rare		Rare
Hawk-Owl	U								U	*			R		WV										U								HF		
Great Gray Owl	U	+											R																				HF		
Short-eared Owl			C	+	U		Rare		C	*			MN												U				U		U	+		MN	U	U	
Boreal Owl													R																				V, Rare		
Belted Kingfisher	C	*			U		C	*	U	*			N		U								U	*			Rare								

	Kobuk Drainage											Noatak Drainage and other Brooks Range Areas									
	McLenegan 1884 Lower Kobuk & Selawik	Grinnell 1898–1899 Lower Kobuk & Hotham I.	Hudson 1956 Kotzebue–Selawik	Townsend 1885 Kobuk R.	Grinnell 1898–1899 Kobuk R. near Hunt R.	BSMS III 1963 Redstone River	Irving Kobuk Village Region	Helmericks Walker Lake	BSMS IV 1963 Walker Lake	BSMS I 1963 Lower Noatak	Hines 1960–1961 Lower Noatak & Kelly R.	Springer & White 1963 Noatak R.–Kugururok R.	McLenegan 1885 Lower & Middle Noatak	BSMS II 1963 Middle Neotak R.	Irving 1952–1953 Howard Pass	BSMS V 1963 Upper Noatak R.	Irving Anaktuvuk Pass	Bee 1951–1952 Brooks Range
Yellow-shafted Flicker	Rare						N		U		U						V, Rare	
Downy Woodpecker	Rare						R				WV, Rare-U							
B. Three-toed Woodpecker							R											
N. Three-toed Woodpecker					U *	?	R	U			U *						HF	
Say's Phoebe								*								U	MN U *	
Traill's Flycatcher			U *															
Western Wood Pewee											Rare							
Olive-sided Flycatcher									Rare-U		Rare							
Horned Lark						U	MN								C *		MN C *	
Violet-green Swallow			U						C *									Rare
Tree Swallow	? A *	Rare	U		Rare *		MN *	U *			C *	U					V, Rare	
Bank Swallow		C *	U A *	C *	C *		MN					U *	U	U		C	V	
Barn Swallow	C *	U-C *		U			V						C +				V, Rare	
Cliff Swallow							N	C *										
Gray Jay	Rare			C	C *	C *	R	U	C *		A *	C *	C *	U *		U	R U	
Black-billed Magpie	Rare																	
Common Raven	C *		U *	C	C +	U	R	R U	U	U	U	U	C +	U	U +	U	R U	U
Black-capped Chickadee					Rare	U	R	? U									WV U	
Gray-headed Chickadee	C *				C *		R				C? *							
Boreal Chickadee	C *			Rare	C *	C	R		C		U *		C *				HF	
Dipper					U +		R	Rare									R Rare	
Robin	C *	C +	U	C *	C +	C *	MN	*	U	U	U-A *	U	C	U	C *	C *	MN U *	U +
Varied Thrush			U	U *	A *	C	N	? U			A *	C	Rare					
Hermit Thrush						? C												
Swainson's Thrush									C *									
Gray-cheeked Thrush	A +	C *	C *	C	C *	C *	MN *		C *		A *	A +	C-A *	C	C +	U	MN U +	U-C

	Kobuk Drainage																Noatak Drainage and other Brooks Range Areas																											
	McLenegan 1884 Lower Kobuk & Selawik			Grinnell 1898–1899 Lower Kobuk & Hotham I.			Hudson 1956 Kotzebue–Selawik			Townsend 1885 Kobuk R.			Grinnell 1898–1899 Kobuk R. near Hunt R.			BSMS III 1963 Redstone River			Irving Kobuk Village Region			Helmericks Walker Lake			BSMS IV 1963 Walker Lake			BSMS I 1963 Lower Noatak			Hines 1960–1961 Lower Noatak & Kelly R.			Springer & White 1963 Noatak R.–Kugururok R.			McLenegan 1885 Lower & Middle Noatak			BSMS II 1963 Middle Noatak R.			Irving 1952–1953 Howard Pass			BSMS V 1963 Upper Noatak R.			Irving Anaktuvuk Pass			Bee 1951–1952 Brooks Range		
Wheatear																				MN																		C	*		U	#		MN	C	+	C	+
Bluethroat				Rare-U																																				Rare	*								U	
Arctic Warbler				Rare			Rare			Rare			Rare							MN						C						U-A	#								C	*					MN	U	*		
Ruby-crowned Kinglet				U									U							MN												C														V				
Yellow Wagtail				A	*		A	*												MN			Neg									U									C	+		C			MN	C	*		
Water Pipit				Rare-U						C						U				MN						C						U						C		#	C	*		C	*		MN	C	*	C	+
Bohemian Waxwing													Rare							R	?	U				U						C	*		U		#									HF				
Northern Shrike	U	#		U	+		U	#		Rare			U	+						MN						U						U	*		U			C		#				U	+		U	#		MN	U	*	Rare	
Orange-crowned Warbler	C	+											Rare							N												U-A	*		C	*															
Yellow Warbler	A	#		C	+		C	*		U	*		C	+						N												?			U	#											V. Rare				
Myrtle Warbler	U			C	*					U-C	*		C							N		C	*		U							A	*		U											V. Rare				
Blackpoll Warbler	U	#		C	+		C	*		U-C	*		C	+						N												A	*		U		#													
Northern Waterthrush				C	+		C	#		U			C	+						N												U-C	*		U		#													
Wilson's Warbler	C-A	#		U			U			C			U			C				N					C				U		A	#		U						C	#		Rare	+		U			N	U			
Rusty Blackbird	C	+		U	+		U	#		U			U	+		U				MN					C				U		U	*		U			U											N	U	*		
Pine Grosbeak				C	+								C	*						R												A	+		U													WV	U			
Gray-crowned Rosy Finch																				MN																					Neg			U			N	U			
Hoary Redpoll	C	+		C	*		C						C	*		U				RM												A?			A	*					C	*		C	*			RM	A			
Common Redpoll	C	#		U	+		C	*		U			U	+		C	*			RM					C				C		A?			A	*					C	*		C	*		C		MN	C		U	
Pine Siskin																																																		Rare	
White-winged Crossbill													C	*						R						C																					HF				
Savannah Sparrow				C	*		C	*		A	*		Rare			C	#			MN												U			A	#		C	#		C	*		C			MN	U	+	C	+
Slate-colored Junco										C			U	+		U				MN			*			C	#																				V. Rare			
Tree Sparrow	C	#		C	*		C	#		C	*		C	+		C				MN			*			C			C			A	#		A	*					C	#		C	*		C	#	MN	C	*	C	+
White-crowned Sparrow	C	+		U	*		C	#		A	*		C	*		C				MN			*			C			C			A	*		A	*		U-C			C			C	*		C		MN	C	*	U	
Golden-crowned Sparrow	U	#											U							N																		U-C	#		U											Rare	

	Kobuk Drainage									Noatak Drainage and other Brooks Range Areas								
	McLenegan 1884 Lower Kobuk & Selawik	Grinnell 1898–1899 Lower Kobuk & Hotham I.	Hudson 1956 Kotzebue–Selawik	Townsend 1885 Kobuk R.	Grinnell 1898–1899 Kobuk R. near Hunt R.	BSMS III 1963 Redstone River	Irving Kobuk Village Region	Helmericks Walker Lake	BSMS IV 1963 Walker Lake	BSMS I 1963 Lower Noatak	Hines 1960–1961 Lower Noatak & Kelly R.	Springer & White 1963 Noatak R.–Kugururok R.	McLenegan 1885 Lower & Middle Noatak	BSMS II 1963 Middle Noatak R.	Irving 1952–1953 Howard Pass	BSMS V 1963 Upper Noatak R.	Irving Anaktuvuk Pass	Bee 1951–1952 Brooks Range
Fox Sparrow	C *	U +		Rare	C +		MN		U		C *	U			U +		MN C *	U
Lincoln's Sparrow				Rare		?												
Lapland Longspur	A +	C *	U A	A	U *		MN			C				C	A *		MN A *	C
Smith's Longspur															Neg	U	MN C *	U
Snow Bunting	U	U *			U	Neg									U *	Neg	U*,AM	Rare

Table 3. First Spring and Last Fall Dates for Birds Seen Near Onion Portage, Kobuk River, and at Selawik, Alaska.

	Onion Portage, Kobuk R. (67°07'N, 158°18'W) Keith and Anore Jones				Selawik (66°36'N, 160°00'W) Kenneth Alt
	Fall 1963	Spring 1964	Fall 1964	Spring 1965	Spring 1965
Arctic Loon		30 May		25 May	29 May
Red-throated Loon				28 May	22 May
Red-necked Grebe		31 May	3 Oct	23 May	
Horned Grebe		7 June			24 May
Whistling Swan		23 May			20 May
Canada Goose		< 26 May	24 Sept	16 May	3 May
Black Brant					29 May
White-fronted Goose		14 May		12 May	1 May
Snow Goose				28 May	27 May
Mallard		27 May	22 Sept		
Pintail		23 May		20 May	17 May
Green-winged Teal		31 May			17 May
American Widgeon		31 May		22 May	17 May
Shoveler					17 May
Canvasback		23 May			17 May
Lesser Scaup			19 Sept		18 May
Oldsquaw		31 May		22 May	20 May
White-winged Scoter					3 June
Surf Scoter					3 June
Common Scoter					3 June
Red-breasted Merganser					26 May
Goshawk		March	12 Nov	27 April (incub.)	
Rough-legged Hawk		4 May		29 April	
Golden Eagle					23 April
Marsh Hawk		6 May		19 May	16 May
Gyrfalcon			R		
Spruce Grouse			R	R	
Willow Ptarmigan		R			
Sandhill Crane		6 May		8 May	8 May
Semipalmated Plover		30 May		19 May	29 May
American Golden Plover		29 May		21 May	17 May
Common Snipe		< 29 May		18 May	27 May
Whimbrel		30 May		21 May	18 May
Spotted Sandpiper		3 June			
Pectoral Sandpiper					18 May
Least Sandpiper					17 May
Long-billed Dowitcher					17 May
Western Sandpiper					24 May
Northern Phalarope					24 May
Pomarine Jaeger				1 June	
Parasitic Jaeger					24 May
Long-tailed Jaeger		27 May		19 May	17 May
Glaucous Gull		11 May	12 Oct	15 May	20 May

	Onion Portage, Kobuk R. (67°07'N, 158°18'W) Keith and Anore Jones				Selawik (66°36'N, 160°00'W) Kenneth Alt
	Fall 1963	Spring 1964	Fall 1964	Spring 1965	Spring 1965
Glaucous-winged Gull					16 May
Herring Gull		25 May		22 May	17 May
Mew Gull				23 May	
Bonaparte's Gull				26 May	
Sabine's Gull					7 May
Arctic Tern		26 May		19 May	20 May
Great Horned Owl	R	R	R	R	
Snowy Owl			R		
Hawk Owl	Dec	17 May		2 April	18 May
Short-eared Owl					16 May
Boreal Owl	late Nov				
Belted Kingfisher				25 May	
Say's Phoebe				25 May	
Tree Swallow				25 May	22 May
Bank Swallow				30 May	
Gray Jay		R	R	R	
Common Raven		R	R	R	
Black-capped Chickadee			R	R	
Boreal Chickadee		R	R	R	
Robin		21 May		19 May	24 May
Varied Thrush		21 May		16 May	
Hermit Thrush					4 June
Gray-cheeked Thrush		29 May		26 May	7 June (4 eggs)
Wheatear		21 May			
Yellow Wagtail					4 June
Bohemian Waxwing				27 May	
Northern Shrike		24 May		4 May (dead)	
Yellow Warbler				28 May	7 June
Myrtle Warbler		25 May		22 May	
Wilson's Warbler		2 June		25 May	
Rusty Blackbird		24 May		16 May	17 May
Pine Grosbeak	R—absent few weeks only		R	R	
Common Redpoll	R—infrequent in winter			R	15 May
White-winged Crossbill		R?, 30 April			
Savannah Sparrow				26 May	24 May
Slate-colored Junco				19 May	
Tree Sparrow		27 May		26 May	27 May
White-crowned Sparrow		25 May		17 May	15 May
Golden-crowned Sparrow		25 May		23 May	
Fox Sparrow		25 May		20 May	
Lapland Longspur		21 May		19 May	17 May
Snow Bunting				3 April	17 April

Table 4. Scientific and Common Names of Bird Species in the Kobuk and Noatak Drainages and Adjacent Brooks Range Areas.*

* *Editor's Note*: These names follow the *Check-list of North American Birds* (American Ornithologists' Union, 1957), since the manuscript had been submitted for publication prior to the issuance of the Thirty-second Supplement (A.O.U., 1973).

F. *Gaviidae*: Loons
- *Gavia immer*, Common Loon
- *Gavia adamsii*, Yellow-billed Loon
- *Gavia arctica*, Arctic Loon
- *Gavia stellata*, Red-throated Loon

F. *Podicipedidae*: Grebes
- *Podiceps grisegena*, Red-necked Grebe
- *Podiceps auritus*, Horned Grebe

F. *Anatidae*: Swans, Geese, and Ducks
- *Olor columbianus*, Whistling Swan
- *Branta canadensis*, Canada Goose
- *Branta nigricans*, Black Brant
- *Philacte canagica*, Emporer Goose
- *Anser albifrons*, White-fronted Goose
- *Chen hyperborea*, Snow Goose
- *Anas platyrhynchos*, Mallard
- *Anas acuta*, Pintail
- *Anas carolinensis*, Green-winged Teal
- *Mareca penelope*, European Widgeon
- *Mareca americana*, American Widgeon
- *Spatula clypeata*, Shoveler
- *Aythya valisineria*, Canvasback
- *Aythya marila*, Greater Scaup
- *Aythya affinis*, Lesser Scaup
- *Bucephala clangula*, Common Goldeneye
- *Bucephala albeola*, Bufflehead
- *Clangula hyemalis*, Oldsquaw
- *Histrionicus histrionicus*, Harlequin Duck
- *Somateria molissima*, King Eider
- *Melanitta deglandi*, White-winged Scoter
- *Melanitta perspicillata*, Surf Scoter
- *Oidemia nigra*, Common Scoter
- *Mergus merganser*, Common Merganser
- *Mergus serrator*, Red-breasted Merganser

F. *Accipitridae*: Hawks, Old World Vultures, and Harriers
- *Accipiter gentilis*, Goshawk
- *Accipiter striatus*, Sharp-shinned Hawk
- *Buteo lagopus*, Rough-legged Hawk
- *Aquila chrysaetos*, Golden Eagle
- *Haliaeetus leucocephalus*, Bald Eagle
- *Circus cyaneus*, Marsh Hawk

F. *Pandionidae*: Ospreys
- *Pandion haliaetus*, Osprey

F. *Falconidae*: Caracaras and Falcons
Falco rusticolus, Gyrfalcon
Falco peregrinus, Peregrine Falcon
Falco columbarius, Pigeon Hawk
Falco sparverius, Sparrow Hawk
F. *Tetraonidae*: Grouse and Ptarmigan
Canachites canadensis, Spruce Grouse
Bonasa umbellus, Ruffed Grouse
Lagopus lagopus, Willow Ptarmigan
Lagopus mutus, Rock Ptarmigan
F. *Gruidae*: Cranes
Grus canadensis, Sandhill Crane
F. *Charadriidae*: Plovers ,Turnstones, and Surfbirds
Charadrius semipalmatus, Semipalmated Plover
Charadrius vociferus, Killdeer
Pluvialis dominica, American Golden Plover
Squatarola squatarola, Black-bellied plover
Aphriza virgata, Surfbird
Arenaria interpres, Ruddy Turnstone
Arenaria melanocephala, Black Turnstone
F. *Scolopacidae*: Woodcock, Snipe, and Sandpipers
Capella gallinago, Common Snipe
Numenius phaeopus, Whimbrel
Numenius tahitiensis, Bristle-thighed Curlew
Numenius borealis, Eskimo Curlew
Bartramia longicauda, Upland Plover
Actitis macularia, Spotted Sandpiper
Tringa solitaria, Solitary Sandpiper
Heteroscelus incanum, Wandering Tattler
Totanus flavipes, Lesser Yellowlegs
Calidris canutus, Knot
Erolia melanotus, Pectoral Sandpiper
Erolia fusicollis, White-rumped Sandpiper
Erolia bairdii, Baird's Sandpiper
Erolia minutilla, Least Sandpiper
Erolia alpina, Dunlin
Limnodromus scolopaceus, Long-billed Dowitcher
Micropalma himantopus, Stilt Sandpiper
Ereunetes pusillus, Semipalmated Sandpiper
Ereunetes mauri, Western Sandpiper
Tryngites subruficollis, Buff-breasted Sandpiper
Limosa lapponica, Bar-tailed Godwit
Limosa haemastica, Hudsonian Godwit
Crocethia alba, Sanderling
F. *Phalaropodidae*: Phalaropes
Phalaropus fulicarius, Red Phalarope
Lobipes lobatus, Northern Phalarope
F. *Stercorariidae*: Jaegers and Skuas
Stercorarius pomarinus, Pomarine Jaeger

Stercorarius parasiticus, Parasitic Jaeger
Stercorarius longicaudus, Long-tailed Jaeger
F. *Laridae*: Gulls and Terns
Larus hyperboreus, Glaucous Gull
Larus glaucescens, Glaucous-winged Gull
Larus argentatus, Herring Gull
Larus canus, Mew Gull
Larus philadelphia, Bonaparte's Gull
Xema sabini, Sabine's Gull
Sterna paradisaea, Arctic Tern
F. *Strigidae*: Typical Owls
Bubo virginianus, Great Horned Owl
Nyctea scandiaca, Snowy Owl
Surnia ulula, Hawk-Owl
Strix nebulosa, Great Gray Owl
Asio flammeus, Short-eared Owl
Aegolius funereus, Boreal Owl
F. *Alcedinidae*: Kingfishers
Megaceryle alcyon, Belted Kingfisher
F. *Picidae*: Woodpeckers and Wrynecks
Colaptes auratus, Yellow-shafted Flicker
Dendrocopos pubescens, Downy Woodpecker
Picoides arcticus, Black-backed Three-toed Woodpecker
Picoides tridactylus, Northern Three-toed Woodpecker
F. *Tyrannidae*: Tyrant Flycatchers
Sayornis saya, Say's Phoebe
Empidonax traillii, Traill's Flycatcher
Contopus sordidulus, Western Wood Pewee
Nuttallornis borealis, Olive-sided Flycatcher
F. *Alaudidae*: Larks
Eremophila alpestris, Horned Lark
F. *Hirundinidae*: Swallows
Tachycineta thalassina, Violet-green Swallow
Iridoprocne bicolor, Tree Swallow
Riparia riparia, Bank Swallow
Hirundo rustica, Barn Swallow
Petrochelidon pyrrhonota, Cliff Swallow
F. *Corvidae*: Jays, Magpies, and Crows
Perisoreus canadensis, Gray Jay
Pica pica, Black-billed Magpie
Corvus corax, Common Raven
F. *Paridae*: Titmice, Verdins, and Bushtits
Parus atricapillus, Black-capped Chickadee
Parus cinctus Gray-headed Chickadee
Parus hudsonicus, Boreal Chickadee
F. *Cinclidae*: Dippers
Cinclus mexicanus, Dipper
F. *Turdidae*: Thrushes, Solitaires, and Bluebirds
Turdus migratorius, Robin
Ixoreus naevius, Varied Thrush

Hylocichla guttata, Hermit Thrush
Hylocichla ustulata, Swainson's Thrush
Hylocichla minima, Gray-cheeked Thrush
Oenanthe oenanthe, Wheatear
Luscinia svecica, Bluethroat

F. *Sylviidae*: Old World Warblers, Gnatcatchers, and Kinglets
Phylloscopus borealis, Arctic Warbler
Regulus calendula, Ruby-crowned Kinglet

F. *Motacillidae*: Wagtails and Pipits
Motacilla flava, Yellow Wagtail
Anthus spinoletta, Water Pipit

F. *Bombycillidae*: Waxwings
Bombycilla garrula, Bohemian Waxwing

F. *Laniidae*: Shrikes
Lanius excubitor, Northern Shrike

F. *Parulidae*: Wood Warblers
Vermivora celata, Orange-crowned Warbler
Dendroica petechia, Yellow Warbler
Dendroica coronata, Myrtle Warbler
Dendroica striata, Blackpoll Warbler
Seiurus noveboracensis, Northern Waterthrush
Wilsonia pusilla, Wilson's Warbler

F. *Icteridae*: Meadowlarks, Blackbirds, and Troupials
Euphagus carolinus, Rusty Blackbird

F. *Fringillidae*: Grosbeaks, Finches, Sparrows, and Buntings
Pinicola enucleator, Pine Grosbeak
Leucosticte tephrocotis, Gray-crowned Rosy Finch
Acanthis hornemanni, Hoary Redpoll
Acanthis flammea, Common Redpoll
Spinus pinus, Pine Siskin
Loxia leucoptera, White-winged Crossbill
Passerculus sandwichensis, Savannah Sparrow
Junco hyemalis, Slate-colored Junco
Spizella arborea, Tree Sparrow
Zonotrichia leucophrys, White-crowned Sparrow
Zonotrichia atricapilla, Golden-crowned Sparrow
Passerella iliaca, Fox Sparrow
Melospiza lincolnii, Lincoln's Sparrow
Calcarius lapponicus, Lapland Longspur
Calcarius pictus, Smith's Longspur
Plectrophenax nivalis, Snow Bunting

Table 5. Mammals, Other than Man, Known to Occur or to be Expected in the Brooks Range, Alaska, as a Whole, and Those Recorded by the Baird and Schwatka Mountain Survey. Scientific names follow Hall and Kelson (1959) except those marked with an asterisk. The latter follow Rausch (1953).

	BSMS Camp Number				
	Kobuk Drainage		Noatak Drainage		
	III	IV	I	II	V
Family Soricidae					
Sorex cinerus, masked shrew	+	+	+	+	+
Sorex arcticus, arctic shrew	+			+	
Sorex vagrans, vagrant shrew					
Family Vespertilionidae					
(Probably *Myotis lucifugus* or *Lasiurus* spp. as accidentals)					
Family Leporidae					
Lepus americanus, snowshoe hare		+		+	+
Lepus othus, tundra hare					
Family Sciuridae					
Marmota marmota broweri, arctic marmot*				+	
Spermophilus undulatus, arctic ground squirrel	+		+	+	+
Tamiasciurus hudsonicus, red squirrel	+	+			
Family Castoridae					
Castor canadensis, beaver		+			
Family Cricetidae					
Clethrionomys rutilus, red-backed vole	+	+	+	+	+
Microtus pennsylvanicus, meadow vole					
Microtus oeconomus, tundra vole	+	+	+	+	+
Microtus longicaudus, long-tailed vole					
Microtus xanthognathus, yellow-cheeked vole					
Microtus miurus, singing vole	+	+		+	+
Ondatra zibethicus, muskrat	+		+		+
Lemmus trimucronatus, brown lemming				+	+
Synaptomys borealis, northern bog lemming					
Dicrostonyx groenlandicus, collared lemming	+				
Family Erethizontidae					
Erethizon dorsatum, porcupine	+				
Family Canidae					
Canis latrans, coyote					
Canis lupus, gray wolf	+				+
Alopex lagopus, arctic fox					
Vulpes fulva, red fox	+		+	+	+
Family Ursidae					
Ursus americanus, black bear	+	+			
Ursus arctos, grizzly bear*		+		+	+
Thalarctos maritimus, polar bear					
Family Mustelidae					
Martes americana, marten					

Mustela erminea, ermine					
Mustela rixosa, least weasel				+	
Mustela vison, mink	+		?		
Gulo luscus, wolverine					
Lutra canadensis, river otter					
Family Felidae					
Lynx canadensis, lynx					
Family Cervidae					
Alces alces, moose	+	+	+	+	+
Rangifer tarandus, caribou	+	+	+	+	+
Family Bovidae					
Ovis dalli, Dall sheep		+		+	+

Table 6. Measurements of Male Dall Sheep Taken Near Lake Omelaktavik, Noatak River Headwaters, Alaska.

	BSMS–797		BSMS-798		BSMS–799		BSMS–800		BSMS–801	
Age	9 Yr		10 or 11 Yr		5 or 6 Yr		7 or 8 Yr		12 Yr	
Curl	3/4		1–1/4		1/2–3/4		Full		≤ Full	
Body Measurements–mm:										
Shoulder height	820		960		890		850		Not Measured	
Hind foot length	395		435		405		400		"	
Girth behind shoulder	1,090		1,230		1,200		1,310		"	
Total length along back	1,500		1,530		1,490		1,410		"	
Horn Measurements–mm:										
	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.
Greatest spread	451		592		536		482		597	
Tip to tip spread	448		592		536		451		597	
Length	705	683	930	960	620	628	787	787	845	851
Basal circ.	286	279	320	320	302	305	295	295	305	305
First quarter circ.	235	232	285	293	242	238	267	267	279	286
Second quarter circ.	156	159	244	243	180	172	202	203	216	229
Third quarter circ.	86	101	150	147	114	111	121	127	114	130

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