REACTIONS OF WILDLIFE TO HUMAN ACTIVITY ALONG MOUNT MCKINLEY NATIONAL PARK ROAD

A MASTER OF SCIENCE THESIS

BY DIANE MARIE TRACY

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Biology and Resource Management Program
Alaska Cooperative Park Studies Unit
University of Alaska
Fairbanks, Alaska 99701

Cover design: Wolverine tracks, Igloo Creek, Mount McKinley National Park. Posterized from Kodachrome photo by F. Dean.

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RECOMMENDED:

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Frederick C. Dean
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George Calvert
Acting Director, Division of Life Sciences

APPROVED:

Vernon Alaback
Acting Dean, College of Environmental Sciences

April 27, 1977
Date

Vice-Chancellor for Research and Advanced Study

Date

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A

THESIS

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for the Degree of

MASTER OF SCIENCE

By

Diane Marie Tracy, B.S.

Fairbanks, Alaska

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Abstract

To evaluate the impact of human activities on wildlife along McKinley Park road, reactions of caribou, moose, Dall sheep, brown bears and red foxes were quantified during 100 trips along the road and 300 hr of intensive observations in 1973-1974. Backcountry and near-road mammal densities were determined in seven plots. Avoidance was found only for some bears and foxes and, possibly, large bands of caribou. Disturbances thwarted some road crossings by migrating sheep. Disturbances decreased feeding and increased movements by caribou within 200 m of the road. For ungulates, females with young were most easily disturbed; injuries to young may occur. Many individual animals appeared habituated to human activities. All species exhibited 50% "no visible response" between 50-100 m from the road. Few visible responses were given by animals beyond 400 m. Loud noises or people out of vehicles increased response strength for most species. Many animals were attracted to the road.

Acknowledgments

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INTRODUCTION

Mount McKinley National Park provides a refuge for a spectacular array of wildlife native to interior Alaska. The animals are one of the park's major attractions and most visitors wish to view a variety of species. The park road traverses much of the prime wildlife habitat in the park. Park managers hope to optimize visitor use along the road while minimizing disturbance to the wildlife, thus maintaining the animals' traditional use of the region and providing visitors the opportunity to observe wildlife from the road.

Recent dramatic increases in the annual number of visitors to the park have magnified the potential for disturbance of the wildlife. In 1974, 161,000 recreational visitors entered the park (Daniel R. Kuehn, pers. comm., 1975). Administrators have already taken several regulatory measures to minimize human impact on the natural features of the park. In the early 1950's, the Sable Pass Restricted Wildlife Area was established. Visitors are required to remain on the road in this area. In 1972, the National Park Service (NPS) closed the road to unrestricted use by private vehicles beyond Savage River (Km 23) and initiated a free shuttle bus system. In 1973, the first temporary closed areas were established around areas of critical wildlife habitat. No visitors are permitted in these areas. In 1974, a quota system was established to limit and distribute backcountry use.

In the past, very little quantitative information has been available on the effects of various types and levels of human disturbance

on wildlife. Recently, with the advent of oil development in the far North, several studies were conducted on the responses of wildlife to various types of human disturbance, particularly responses to aircraft disturbance (Calef and Lortie 1973, Klein 1974, Lenarz 1974, McCourt and Horstman 1974), noise disturbance (Espmark 1972, McCourt *et al.* 1974, Memphis State University 1971, P. C. Reynolds 1974), and man-made structures and seismic line clearings (Banfield 1974, Child 1973, Child and Lent 1973, Klein 1971, McCourt *et al.* 1974, Miller *et al.* 1972). Only a small body of literature exists on the responses of large mammals to roads and vehicles (Carbaugh *et al.* 1975, Dorrance *et al.* 1975, Klein 1971, McCullough 1969, Pienaar 1968, Reed *et al.* 1975, Ward *et al.* 1973), and most available papers are not quantitative. Notes on the behavioral responses of wild animals to human presence are scattered throughout hundreds of papers on individual species, but there are only a few comprehensive papers (Altmann 1958a, Bergerud 1974, Thomson 1972). The effects of human disturbance on the physiology, energy balance, reproduction, and mortality of mammals are least known. Geist (1971a, 1971b, 1975) has reviewed the literature on the effects of human disturbance on large mammals. He concludes that disturbance may produce changes in the behavior, distribution, population dynamics, energy balance, ecology, and physiology of a species. However, he suggests that large mammals can adapt to the presence of man if certain aspects of their biology are understood and human activities controlled accordingly to minimize disturbance.

The study reported here was initiated to provide background data

for use by park managers on human-wildlife interactions along Mount McKinley National Park road. The study was conducted during the summers of 1973 and 1974, and focused chiefly on large mammals. The objectives of the study were five-fold: 1) to describe quantitatively the types and levels of vehicular and visitor activities along the road, 2) to describe quantitatively the behavioral responses of the large mammals to various human activities, 3) to determine the effects of human activities on the distribution of large mammals near the park road, 4) to provide quantitative baseline data on the present distribution, relative abundance and population composition of large mammals along the park road, so that future changes in these parameters and the effects of future management policies may be assessed, and 5) to suggest ways to minimize human disturbance to wildlife along the park road.

STUDY AREA

Mount McKinley National Park covers 7,845 km^2 of interior Alaska, including parts of the Alaska Range and lands immediately north of the range (Fig. 1). The area is known for its cool, wet summer weather. Summer precipitation generally comes as frequent, light drizzles. A general snow cover usually remains into late May or early June, and drifts may last well into the summer. The average annual precipitation is only about 38 cm (A. Murie 1944, U.S. Dept. of Commerce 1970). May to September temperature maxima average 10-18° C (U.S. Dept. of Commerce 1970). Freezing temperatures may be experienced during any month. Summer wind speeds vary from 2-9 m/sec (5-20 mph)(U.S. Dept. of Commerce 1970). From mid-May til August there is no complete darkness. Permafrost occurs through much of the park.

The park road, completed in 1938, extends for 140 km east to west through the park (Fig. 1). It terminates at Kantishna, just outside the park boundary. All traffic must enter the park, and return, along the same road. The road lies north of, and roughly parallel to, the Alaska Range. It traverses a low region between the Alaska Range and the Outer Range. In some areas it reaches high on the south side of the Outer Range. The elevation along the road varies from 488 m near Riley Creek Campground at the entrance to the park, to 1,220 m at Highway Pass (Washburn 1971). The road crosses several major north-flowing rivers, characterized by broad gravel bars and many changing channels. Only the first 23 km of the road are paved. It is narrow, with frequent

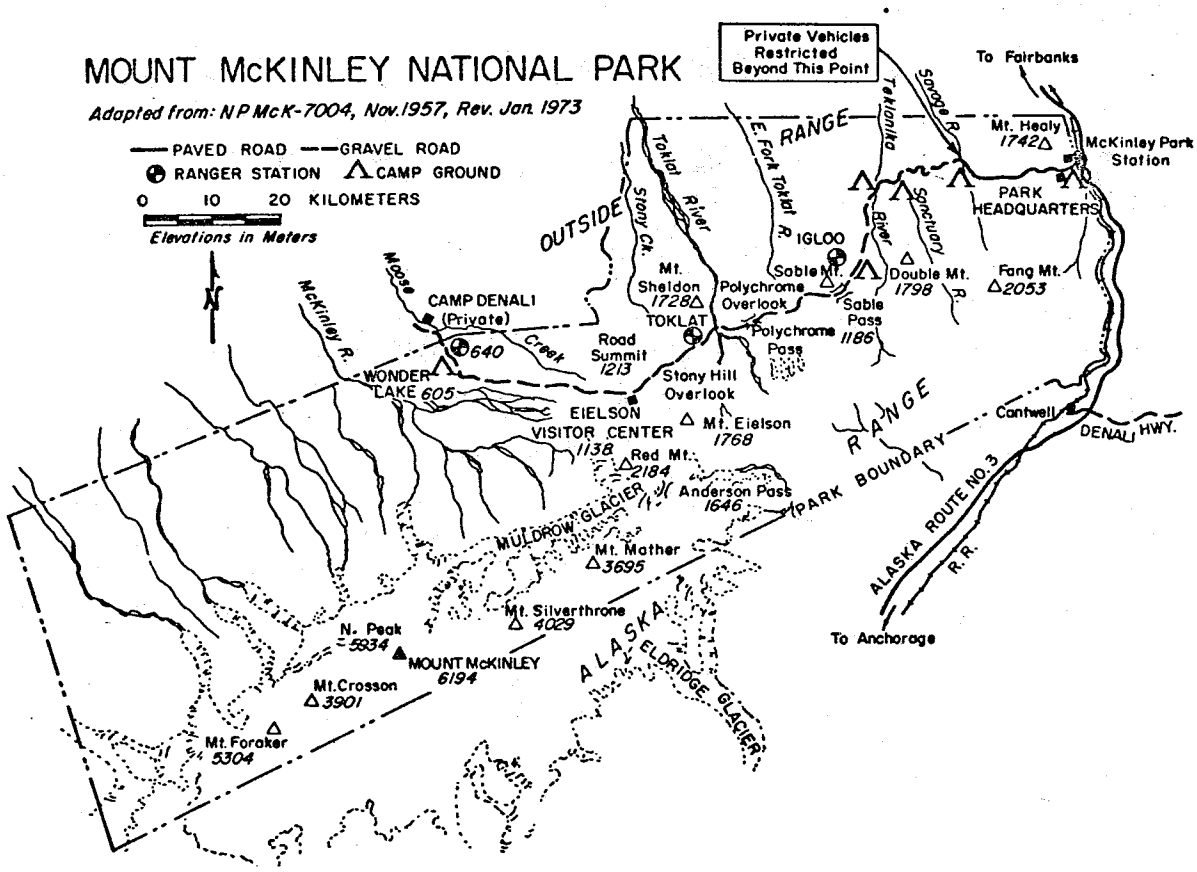

Figure 1. Mount McKinley National Park and features of the road, 1973-1974.

sharp curves, and is designed for slow driving. The road is generally passable for vehicles at least as far as Eielson Visitor Center (Km 107) from late May to mid-September. It is not kept clear of snow or open to traffic the rest of the year. In most areas the natural vegetation is low and one can see for long distances. Most of the work in the present study was conducted between Riley Creek Campground (Km 0.2) and Eielson Visitor Center (Km 107).

The east end of the park, through which the road passes, contains three main vegetation types (A. Murie 1944, Viereck and Little 1972). Boreal forest occurs to elevations of 762-914 m and somewhat higher along rivers (A. Murie 1944). Forests are found along the first 13 km of the road and in several areas where the road descends into major drainages. White spruce (*Picea glauca*) dominates. Aspen (*Populus tremuloides*) is common in the park headquarters area. The forest floors are open. Viereck and Little's (1972) "moist tundra" covers much of the area along the road. In the park, this type is dominated by low shrubs, including dwarf birch (*Betula nana*), small willows (*Salix* spp.), and blueberries (*Vaccinium uliginosum*). Taller willows occur along stream and river beds. Grasses predominate in some areas and wet regions may contain many sedges. Alpine tundra is found at higher elevations. *Dryas* spp. are characteristic of this type. Heather (*Cassiope tetragona*), dwarf willow (*Salix reticulata*), and other low-lying alpine and arctic plants are common. Alpine tundra occurs along the park road in the Polychrome Mountain, Highway Pass and Thorofare Pass areas. Many mountains near the road are topped by talus

slopes and rocky crags that have very sparse vegetation.

A strip of roadside vegetation, differing from the vegetation communities through which the road passes, occurs along each side of the road. The vegetation along the first 2 km of the road includes a variety of introduced species from a roadside stabilization program during which a mixture of seeds of exotic plants, including several grass species, was used. A few of these species have dispersed further along the road. The vegetation along the rest of the road is generally composed of native, early successional species. Willows, grasses, fireweed (*Epilobium* spp.), horsetail (*Equisetum* spp.), and *Artemesia* spp. occur frequently along the entire length of the road. Many other species occur where conditions are favorable. Many of these plant species are important food or cover species for various animals. The strip of roadside vegetation varies in width from 0 to over 30 m on both sides of the road; a width of 2-5 m is most common.

Reports from the park list 37 species of mammals (A. Murie 1962) and 132 species of birds (A. Murie 1963) occurring in the region. The larger mammals include moose (*Alces alces*), caribou (*Rangifer tarandus*), Dall sheep (*Ovis dalli*), brown bear (*Ursus arctos*), wolf (*Canis lupus*), red fox (*Vulpes vulpes*), wolverine (*Gulo gulo*), and lynx (*Lynx canadensis*).

METHODS

I have used several complementary methods to gather data on the distribution and behavioral responses to human activities of wildlife along the Mount McKinley National Park road. The study concentrated on moose, caribou, Dall sheep, brown bears and red fox. Many notes were also taken on wolves, snowshoe hares (*Lepus americanus*), porcupines (*Erethizon dorsatum*), willow ptarmigan (*Lagopus lagopus*), long-tailed jaegers (*Stercorarius longicaudus*), and the birds of prey. Because of the rarity of sightings or limits on time, few data were gathered on other species.

For one technique, seven study plots, varying in area from 9.8 to 20.7 km^2 (Fig. 2), were used. Six of the plots were paired (three pairs), with similar habitat within each pair. One plot of each pair was placed along the road and the other in the backcountry. The Igloo Road Plot (15.3 km^2) and Igloo Off-Road Plot (19.2 km^2) both cover narrow valleys with low but steep, rugged mountains on either side. Extensive tall willow and some small patches of spruce occur near the stream beds. At successively higher elevations on the mountains are found moist (low shrub) tundra, alpine tundra, and talus and rocky crags. Both plots include large areas of good sheep habitat. The road passes through the Igloo Road Plot on or near the streambed. The Highway Road Plot (17.9 km^2) and the Highway Off-Road Plot (12.9 km^2) cover broader valleys with small amounts of moist tundra just above spruce zones and with large areas of alpine tundra. The Stony Road Plot

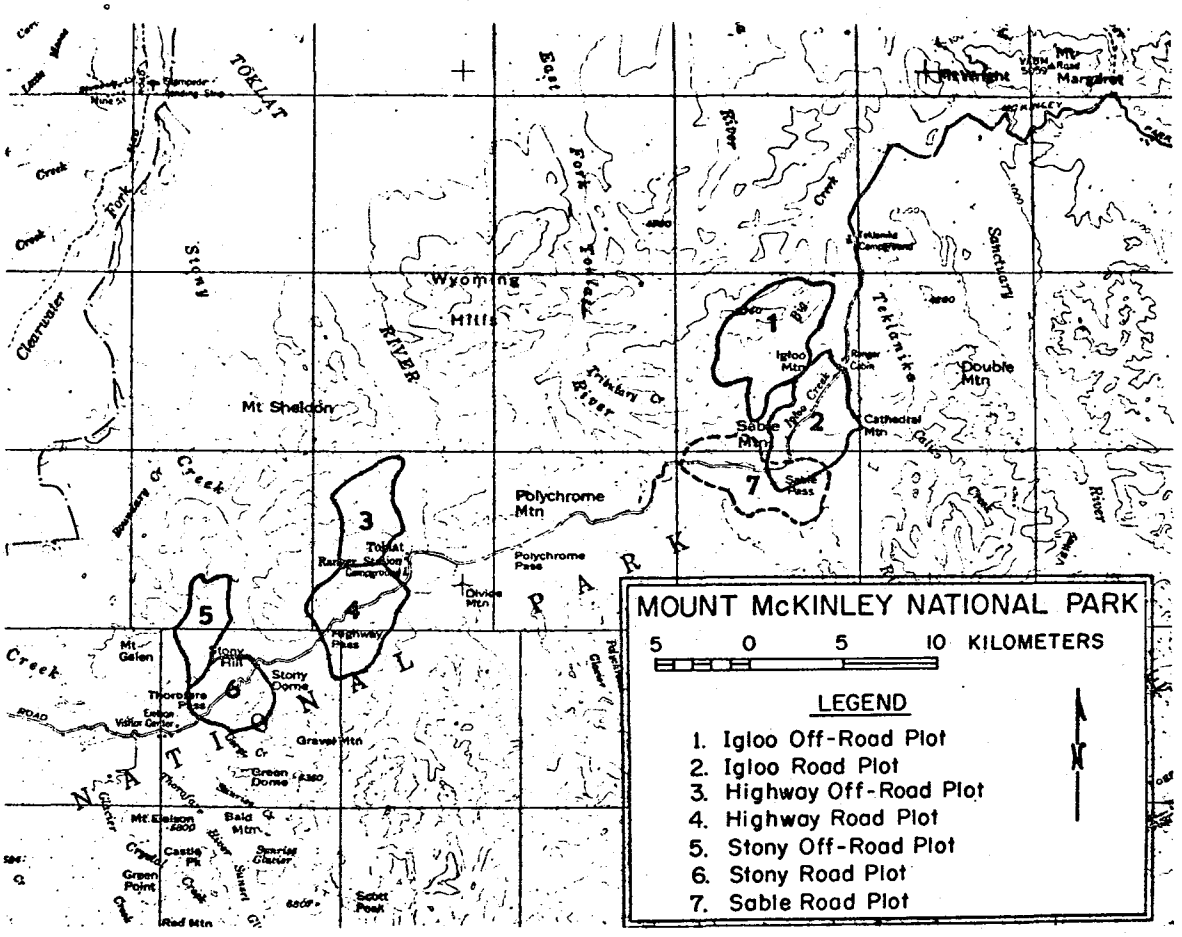

Figure 2. Location of study plots, 1973-1974.

(12.4 km^2) and Stony Off-Road Plot (9.8 km^2) include mainly areas of alpine tundra and wet tundra. Caribou migrate frequently along the road through the Highway Road Plot and Stony Road Plot. The Sable Road Plot (20.7 km^2) is in a unique area because of the presence of large amounts of grasses.

During the summer of 1973, I spent five observation periods in each plot. In 1974, the Igloo Road Plot and Igloo Off-Road Plot were visited an additional five times each. The observation periods for each plot were distributed through the summer, with a similar seasonal distribution of dates for the members of a pair. Each observation period began between 0500 and 0800 hours, depending on fog conditions, and lasted for several hours. The length of observation periods varied with plot size, topography, vegetation type, weather conditions and visibility. The dates of each observation period appear in Appendix Table A1. I walked the same predetermined route during each period and searched the land within the plot thoroughly with binoculars and spotting scope, noting the location and behavior of each large mammal observed. All human activity in the area was recorded. The observations were divided into "first search observations", i.e., all observations made during the first trip of the day through a plot, and "daily observations", which include "first search observations" and observations of new individuals made on the return trip through the plot. Return trips were less consistent than the first search because afternoon rains often hampered observations. The numbers of each species of large mammal observed per square kilometer in the plots are

used as minimum densities.

A second technique involved the use of the park's shuttle bus system and the hotel's wildlife tour buses. The wildlife tour buses differed from the shuttles by having a driver and hostess trained as tour guides. An observer rode a total of 70 eight-hour round-trips between Riley Campground (Km 0.2) and Eielson Visitor Center (Km 107) on these buses; 41 trips were taken in 1973 and 29 trips in 1974. Bowdy Train and Harold Downing were the chief observers on the buses, although Pat Valkenburg and I rode as observers on a number of trips. In 1973, three trips were made each week, one each beginning at 0400 hours, 0700 hours, and 1500 hours. In 1974, only two trips were made each week, one beginning at 0400 hours and one at 1500 hours. The day of the week for each trip was selected randomly. Twenty-five of the trips were made on the 0400 hours hotel wildlife tour bus, 16 on the 0700 hours shuttle, and 29 on the 1500 hours shuttle. The times given to identify the buses are for the beginning of the eight-hour trip. The trips were taken between May 26 and September 3 both summers (see Appendix Table A12). Appendix Table A12 shows the type of bus and date of each trip. During each trip the observer recorded the following information: 1) observer's name, 2) date, 3) the type and starting time of the bus, 4) the number of people riding the bus, 5) the number of buses leaving at the same time, 6) the observer's seat location. For each animal sighted the following was recorded: 1) species, 2) individual identification if known, 3) weather and visibility, 4) actions of the bus and people, 5) number and actions of other vehicles and people in the

area, 6) location, 7) time, 8) distance of animal from the road, 9) habitat, 10) number of animals in a group, 11) sex, 12) age, 13) color, and 14) behavior. When analyzing the data, each sighting was considered a "group" even if only one animal was involved. Also, when the percentage of groups exhibiting some behavior was calculated, if any animal in a group exhibited the behavior concerned the group was counted. Some groups were counted more than once if the individuals in the group reacted differently. Thus, percentages for groups may total more than 100%.

During analysis, each sighting from an entire round-trip of the bus was considered. Some individual animals could be counted twice on one trip if they were observed while the bus was traveling out into the park and resighted during the return.

The reactions of large mammals to the actions of the bus and people were divided into the following four classes: 1) unknown -- either the reaction was not observed or the behavior of the animal could not unambiguously be interpreted as a response to the disturbance, 2) no reaction -- the animal exhibited no visible reaction to the disturbance, 3) mild reaction -- the animal reacted by simply watching the disturbance or by moving at a walk less than 10 m, and 4) strong reaction -- the animal reacted by moving at a gait faster than a walk or for a distance greater than 10 m. It must be stressed that this technique reveals only the instantaneous, visible behavioral reactions shown by the animals. Nothing is revealed about physiological stress or subtle behavioral adjustments. Also, nothing is known about the animals that

react but which are not sighted at all.

A third method involved the use of a three-quarter-ton pickup truck to observe the numbers and distribution of animals near the road. An "observation trip" consisted of driving the vehicle at approximately 16 km/hr one-way between Riley Campground (Km 0.2) and the Toklat River (Km 86). The same types of data were recorded as during the shuttle-tour observation trips. These trips differed from the shuttle-tour trips in that the speed was slower, and I could stop at any time. Most trips began at 0600 hours, and lasted 8-10 hours, depending on the number and types of sightings. A total of 30 trips was taken in 1973 and 1974 combined. Twelve of the trips were made in late May and early June, just before and after the road was opened to public traffic of any type. Eighteen of the trips were made in late August and September, just before and after the road was opened to all private vehicles without limits. These trips provided data on the numbers and distribution of animals along the road during the two periods when visitor activities were unique by being absent or by having most visitors driving in private vehicles rather than riding in public buses. The dates of each trip and the condition of the road access appear in Appendix Table A29.

Long-term observations of individuals and groups were used as a fourth technique. Between late July and mid-August 1974, I made intensive observations of caribou between the Toklat River and Eielson Visitor Center. Several individuals were identified on repeated sightings by using antler form, body color, size, sex, age and other

characteristics for identification. During five days, the groups visible from the road were located five times each day, with time, location, distance from the road, individual identification, human activities, and caribou behavior being recorded. In addition, individual groups of caribou were observed continuously for periods up to 7 hours and for a total observation time of 41 hours. During these periods records were kept on the frequency and types of human and vehicular activities, the activities and movements of each individual animal, and the responses of each animal to vehicles and human activities.

Also in 1974, long-term observations were conducted on denning red foxes. Four fox families, three inhabiting dens in view of the road and one family at a den out of view of the road, were observed a total of 276 hours. Data were recorded on the activities and behavior of the animals, the frequency and types of human and vehicular activities, and the reactions of the foxes to these activities.

In addition, many useful observations were made of wildlife and visitor activities during the time spent traveling through and living in the park in conjunction with this study.

Some data were collected on traffic quantity and quality along the road. During all work on plots near the road and long-term wildlife observations, the time, type, and direction of each vehicle was recorded. Also, records were kept by NPS of all vehicles passing through the Savage River Guard Station for the entire summer of 1974.

Most mileage markers along the road are now missing or incorrect, and distances cited in visitor manuals vary. During this study a personal mileage map was developed using the odometer of a three-quarter-ton pickup truck.

RESULTS AND DISCUSSION

Visitation and Traffic Levels

Mount McKinley National Park recreational visitation levels have increased dramatically in recent years (Fig. 3). Sharp visitation increases followed developments improving access. In late 1958, the completion of the Denali Highway connected the park road with the road system of the state. Before this time access was chiefly via railroad. In 1972, the new Anchorage-Fairbanks highway (Alaska Route No. 3) opened; by 1973, most of the paving and construction was completed, making the park an easy day's drive from either Fairbanks or Anchorage. Recreational visits increased from 18,000 in 1964 to 161,000 in 1974. This visitation is concentrated into the summer months, when the park road is open for vehicle travel. In 1973, 98% of all visits occurred during May through September, with 6% in May, 13% in June, 39% in July, 27% in August, and 13% in September (U. S. Dept. of Interior 1974). Winter visitors to the park must travel by skis, snowshoes, or dogsled if they wish to go further into the park than park headquarters (Km 5). No snowmobiles are allowed in the park.

During most of the period of this study, 1973-1974, private vehicles were not allowed on the park road beyond the Savage River Guard Station (Km 23) unless the drivers possessed a permit to drive to a reserved campsite west of the guard station. Only a limited number of auto-campsites exists. A few special permits were issued to professional photographers and researchers. There was some through-traffic

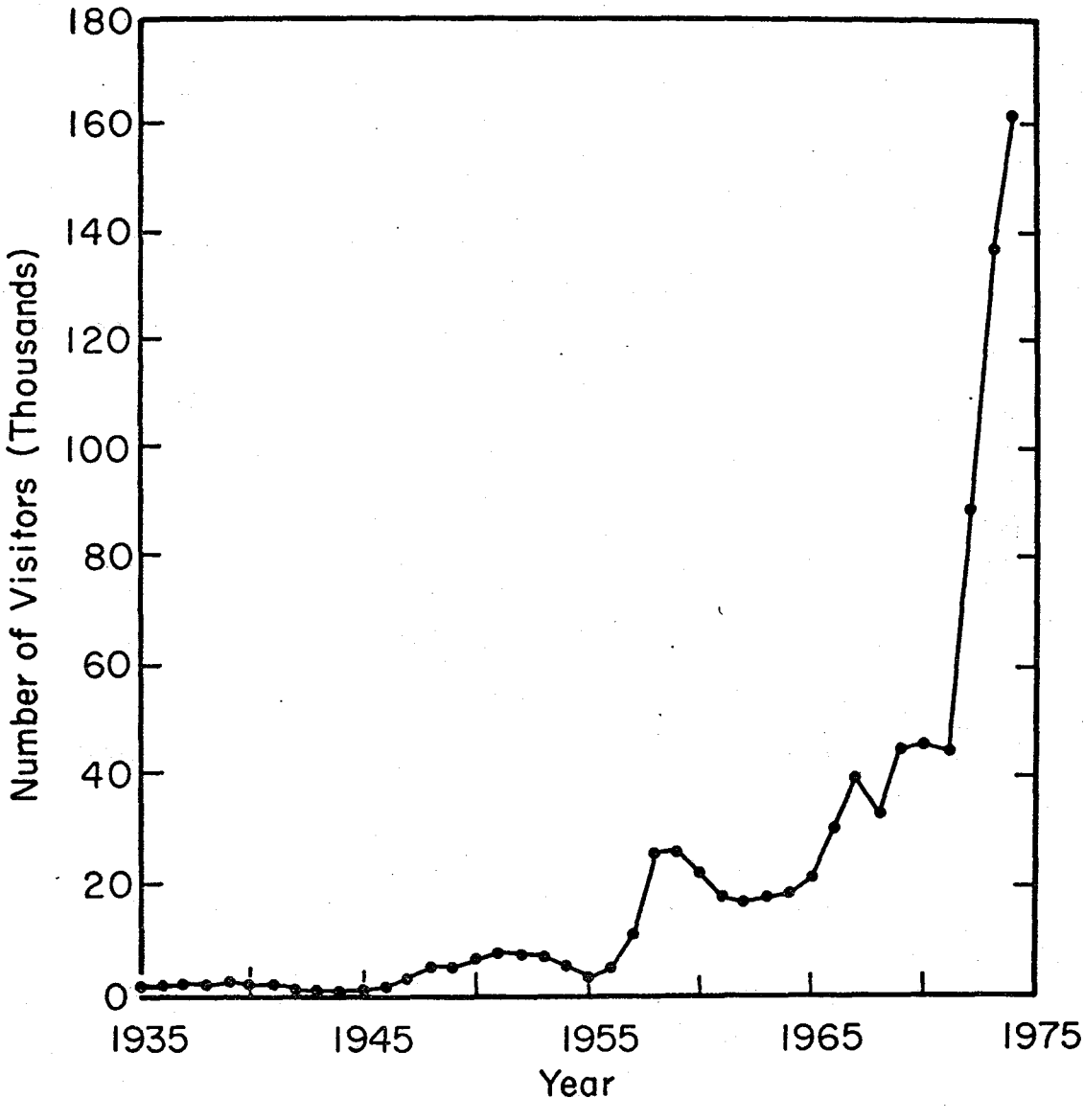

Figure 3. Mount McKinley National Park annual visitation levels, based on U.S. Department of Interior (1974) report.

to the Kantishna area west of the park. Most visitors using the road west of the guard station rode on public buses, either on the free shuttle bus system or on the hotel's wildlife tour buses. NPS maintenance and ranger vehicles also travel the road.

The data collected on traffic moving through the Savage River Guard Station in 1974 are summarized in Figure 4 (see also Appendix Table A30). The daily vehicle flow through this station, computed on a weekly average, increased until the end of June and then remained between 156 and 176 vehicles until mid-August. This leveling-off of the traffic flow results from the fact that only a limited number of private vehicles are allowed, determined by the number of auto-campsites, and that a fairly constant number of public buses travel the road each day, even though the number of people they carry may vary. A sharp increase in the number of private vehicles, and thus in the total number of vehicles, occurred in early September, because the restriction on private vehicles was removed and a permit was no longer necessary. This increase occurred despite the fact that the main tourist season is over by September. The shuttle buses stopped running in early September.

Figure 5 depicts the hourly traffic pattern during July 1974 at the Igloo Canyon-Sable Pass (Km 55 - Km 69) section of the park road. The graph results from an average of three to seven separate traffic counts for each hour of the day. Traffic levels ranged from 5 to 12 vehicles/hr from 0700 to 1900 hours, while fewer than 1 vehicle/hr passed from 2300 to 0600 hours.

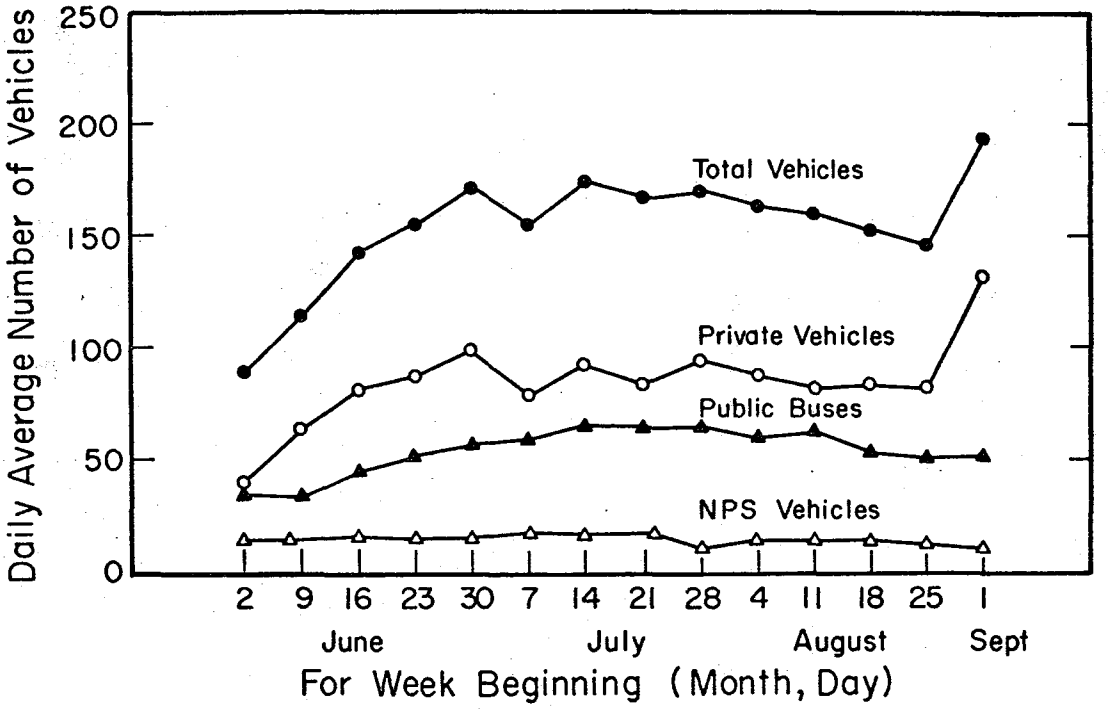

Figure 4. Average daily number of vehicles passing east plus west through the Savage River Guard Station in 1974, Mount McKinley National Park, Alaska.

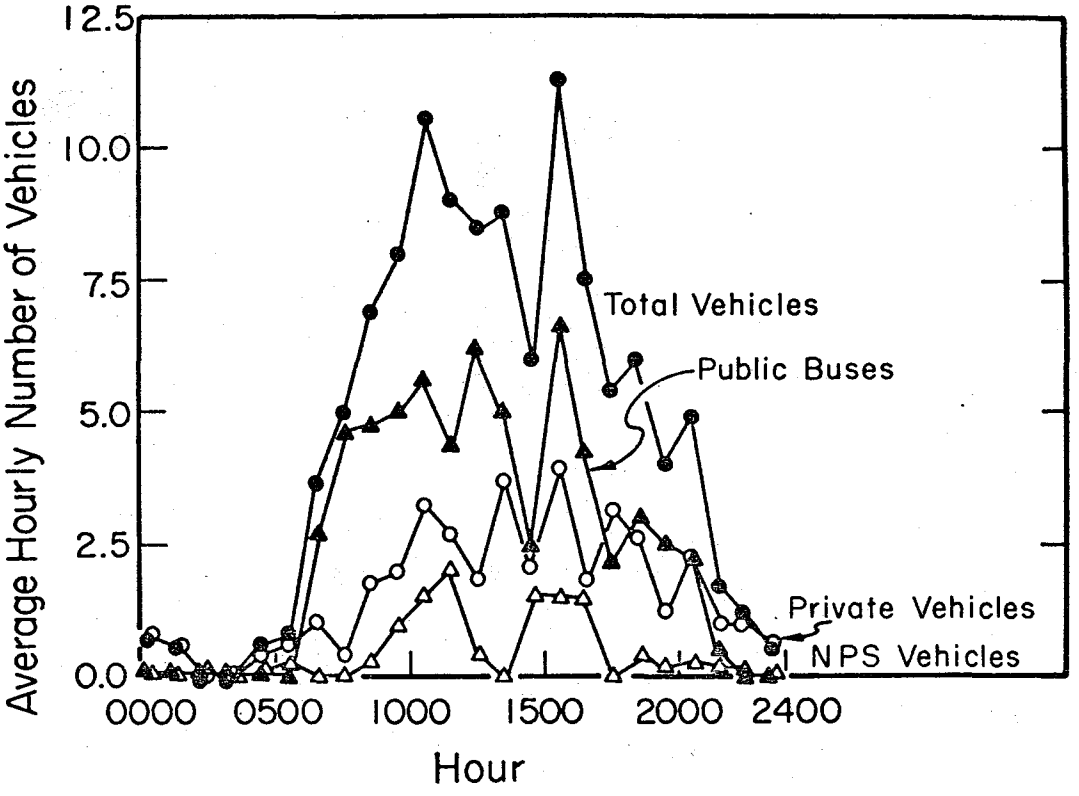

Figure 5. Hourly traffic pattern during July 1974 along the Igloo Canyon - Sable Pass section of the road, Mount McKinley National Park, Alaska.

The percentage of various types of vehicles in the traffic flow varies with the section of road. East of the Savage River Guard Station any private vehicle is permitted and, although precise counts were not conducted, this type of vehicle predominates. Traffic passing through the guard station in July 1974 consisted of 10% NPS vehicles, 38% public buses, and 52% private vehicles. At the Igloo Canyon-Sable Pass section of the road during the same period, the composition was 10% NPS vehicles, 56% public buses, and 34% private vehicles. The reduction in private vehicles reflects the fact that only one campground exists west of the Igloo-Sable area.

The quantity, quality and diel pattern of the traffic flow along the park road are all important factors in determining the effects of traffic and visitors on the wildlife near the road. Relationships between responses to disturbances and these factors are discussed under the separate species results which follow.

Caribou (*Rangifer tarandus*)

Population History, Numbers, Composition, Distribution

Very little information is available on the population dynamics, ecology, or movements of the McKinley caribou herd. Skoog (1968) summarized the existing information, demonstrating a herd history since 1835 of numerous fluctuations in numbers and distribution. Recently, the herd has decreased dramatically in numbers, with population estimates of 20,000 - 30,000 in 1944 (A. Murie 1944), 12,000 excluding calves in 1963 (Skoog 1963), 3,000 in 1971 (Haber 1972a), and less than 1,000 in 1975 (Willard A. Troyer, pers. comm. 1975). The reasons for the decline are largely unknown, although some evidence exists suggesting emigration (Haber 1972a, Skoog 1968) and possible changes in range vegetation (Frederick C. Dean, pers. comm. 1975). In the last decade, hunting outside the park and human disturbance inside the park may have affected the already declining herd, but documentation of these factors is lacking. The herd's annual movements presently include wintering to the west and to the north of the park, calving in the foothills of the Alaska Range in the eastern section of the park, a movement to the south of the Alaska Range in June, and a migration, especially of cows and calves, back north and then west, parallel to the park road, in late June and early July (Hemming 1971).

Caribou were sighted on 90% of the 70 shuttle-tour observation trips. Table 1 presents the total and average numbers of caribou observed. These figures exclude large bands with more than 50 animals.

Table 1. Numbers of caribou observed during shuttle-tour trips, excluding migrating bands of over 50 animals[a], Mount McKinley National Park, Alaska.

YEAR	TOTAL NUMBER OF CARIBOU OBSERVED		AVERAGE NUMBER OF CARIBOU OBSERVED EACH TRIP		AVERAGE NUMBER OF "DIFFERENT" CARIBOU OBSERVED EACH TRIP	
	Animals	Groups	Animals	Groups	Animals	Groups
1973	808	208	19.7	5.1	17.5	4.3
1974	371	134	12.8	4.6	10.7	3.9
TOTAL	1179	342	16.8	4.9	14.7	4.1

[a]Reasons for exclusion discussed in text.

(Note: Bands of over 50 animals occurred along the road for only a few days during the mass migration each summer. The characteristics and responses of these large migrating bands were different from, and are discussed separately from, the small bands that occurred along the road throughout the summer.) An average of 16.8 caribou in 4.9 groups was observed each trip. An attempt was made to identify animals that were sighted twice during one round-trip. If all recognized resightings are excluded, an average of 14.7 "different" caribou in 4.1 groups was observed each trip. The decrease of the average number of "different" caribou from 17.5 animals per trip in 1973 to 10.7 animals per trip in 1974 is the result of a peak in caribou numbers during the first two weeks of June 1973 which did not occur in 1974 (Appendix Table A12).

The numbers of caribou observed from the various types of buses, i.e. 0400 tour, 0700 shuttle, and 1500 shuttle, were compared by pairing trips on the various buses that were separated by no more than two days. A Wilcoxon Rank Sum test (Wilcoxon and Wilcox 1964) was then used. For 1973, no significant differences in the numbers of caribou sighted from the various bus types occurred although the average number of caribou sighted was higher on the 1500 shuttle than on the 0400 tour. For 1974, the Wilcoxon Rank Sum test showed significantly ($0.005<P<0.01$) more caribou observed each trip on the 0400 tour than on the 1500 shuttle. Three factors may be acting to produce these results: 1) weather, 2) time of day, and 3) trained guides. My records of the weather and visibility during the bus trips in 1973 show

that the visibility on the 0400 tour was unlimited or good only 61% of the time, while this value was 91% for the 1500 shuttle. In 1974, these values were 73% and 76%, respectively. Given similar weather, more caribou may be observed from the 0400 tour than the 1500 shuttle because of increased caribou activity during the morning hours. Also, the tour buses have trained guides who may spot more animals; however, we found that our trained observers seldom spotted animals not also observed by someone else on the bus, simply due to the large number of people intently watching for wildlife. In some years people on the 0400 tour may observe fewer animals than people on later buses because of frequent fog and poor weather in the early mornings.

Large bands of 50-800 animals migrating to the west were observed in view of the road from July 7 through July 12 in 1973 and from June 29 through July 6 in 1974 (Table 2). Large bands were probably in the vicinity of the road for a somewhat longer period each year. Small bands of fewer than 50 caribou occur along the road throughout the summer. A peak in numbers of caribou in small bands occurred in June 1973, with as many as 146 animals sighted on one shuttle-tour trip. The number of caribou decreased from mid-August to September to almost zero both years (Appendix Table A12).

Caribou are distributed in varying frequencies along the length of the park road because of varying habitat, and, perhaps, because of traditional use patterns. During the shuttle-tour trips no caribou were sighted between Km 0 and Savage River (Km 23). Only 5% of the caribou occurred between Savage River and Tattler Creek (Km 60), while

Table 2. Sightings of migrating bands of over 50 caribou from the road, Mount McKinley National Park, Alaska.

DATE	OBSERVER	NUMBER OF CARIBOU	LOCATION
7/7/73	G. Haber[a]	800	Polychrome Pass, 2000 m S. of road
7/10/73 7/11/73	D. Tracy	320	Highway Pass to Eielson, 200-2000 m S. of road
7/12/73	B. Train	300[b]	Eielson, 500-900 m S. of road
6/30/74	D. Tracy	251	Km 80.0, near Toklat, 300-2000 m S. of road
6/30/74	D. Tracy	140	Km 78.0, near Toklat, 800 m S. of road
7/6/74	C. Downing	132[b]	Km 79.5, near Toklat, 300-400 m S. of road
7/6/74	D. Tracy	181	Toklat River-Highway Pass, 200-500 m S. of road

[a]Personal communication.

[b]Observed during the shuttle-tour trips.

95% occurred between Tattler Creek and Eielson Visitor Center (Km 107). The same pattern prevailed both summers. Bands tended to move west during late summer, but caribou were still sighted on Sable Pass (Km 63) in September.

Caribou group sizes, excluding the migrating herds, tended to be small. Table 3 presents the group size data. Solitary caribou comprised 41% of all caribou "groups", and 12% of all caribou observed. Groups of more than five animals accounted for only 15% of all groups, but 48% of all animals. The average group size, excluding migrating herds, was 3.9 animals in 1973. This value declined to 2.8 in 1974. Group sizes of five or less were observed throughout both summers. In 1973, most groups larger than five were sighted the first two weeks in June, but in 1974 the few sightings of groups larger than five were scattered through the summer. Groups larger than 10 occurred chiefly west of Polychrome Mountain (Km 74), while smaller groups were sighted in all areas utilized by caribou along the road.

Table 4 contains the data on the age and sex distributions of the caribou observed on the shuttle-tour trips. Distance and time available made it impossible to determine the sex and age of many of the animals. The relative lack of calves outside the large migrating herds should be noted. General observations indicate that the migrating herds contain chiefly cows, calves, yearlings, and, perhaps, young bulls, which are not easily distinguishable from cows. Two herds that were carefully counted in 1974 contained a total of 432 animals, including 73 calves, 15 yearlings, 26 large bulls, and 318 cows or young bulls. Caribou

Table 3. Sizes of caribou groups observed during shuttle-tour trips, excluding the migrating bands of over 50 animals[a], Mount McKinley National Park, Alaska.

CARIBOU GROUP SIZE	GROUPS						ANIMALS					
	1973		1974		Total 1973-1974		1973		1974		Total 1973-1974	
	No.	(% of Total)	No.	(% of Total)	No.	(% of Grand Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Grand Total)
1	77	(37)	63	(47)	140	(41)	77	(10)	63	(17)	140	(12)
2	33	(16)	22	(16)	55	(16)	66	(8)	44	(12)	110	(9)
3	30	(14)	18	(13)	48	(14)	90	(11)	54	(15)	144	(12)
4	20	(10)	3	(2)	23	(7)	80	(10)	12	(3)	92	(8)
5	12	(6)	13	(10)	25	(7)	60	(7)	65	(18)	125	(11)
6-10	22	(11)	11	(8)	33	(10)	163	(20)	75	(20)	238	(20)
10-50	14	(7)	4	(3)	18	(5)	272	(34)	58	(16)	330	(28)
TOTAL	208		134		342		808		371		1179	

[a]Reasons for exclusion discussed in text.

Table 4. Sex and age distributions of caribou observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

	1973		1974		TOTAL	
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)
SEX						
Male	216	(27)	147	(40)	363	(31)
Female	154	(19)	113	(30)	267	(23)
Unknown	438	(54)	111	(30)	549	(46)
Total	808		371		1179	
AGE						
Calf	15	(2)	8	(2)	23	(2)
Yearling	9	(1)	13	(4)	22	(2)
Adult	459	(57)	259	(70)	718	(61)
Unknown	325	(40)	91	(24)	416	(35)
Total	808		371		1179	

that remain east of Eielson after the main migration west are predominately bulls, particularly late in the summer.

During the shuttle-tour observation trips, caribou were observed in a variety of habitats. Of all caribou sighted outside the migrating herds, 38% occurred in dwarf shrub habitat, 24% in alpine tundra areas, 21% on gravel bars and moraines, 6% in wet meadows, 5% in tall willows and alder, 4% in tussock tundra, 2% on talus slopes, and 1% on snowbeds. These figures do not necessarily represent the distribution of habitat use by caribou in the park. The figures are given to show what habitats caribou along the road were in.

Human Disturbance

General Avoidance

Using paired plots along the road and in the backcountry, I attempted to determine if caribou avoided the vicinity of the road. Table 5 summarizes these data. The density data show no evidence that caribou, in large numbers, avoid watersheds through which the road passes. In addition, a comparison of the research vehicle observation trips with the shuttle-tour observation trips showed no changes in numbers of caribou along the road which could be attributed to the opening of the road to bus traffic in the spring or to all vehicles in the fall. At the time that the road was opened in the fall to unlimited vehicular use few caribou remained near the road, as they had already moved toward fall and winter ranges.

Table 5. Average number of caribou observed in study plots, Mount McKinley National Park, Alaska.

PLOT		AVERAGE DAILY TOTAL OBSERVATIONS				AVERAGE DAILY FIRST SEARCH OBSERVATIONS				NO. OF DAYS ANIMALS OBSERVED OUT OF FIVE POSSIBLE
		Actual Number		Density (per km^2)		Actual Number		Density (per km^2)		
		Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	
Igloo Road	1973	0.40	0.40	0.03	0.03	0.40	0.40	0.03	0.03	1
Igloo Road	1974	1.40	1.20	0.09	0.08	1.20	1.00	0.08	0.06	5
Igloo Off-Road	1973	0.40	0.20	0.02	0.01	0.40	0.20	0.02	0.01	1
Igloo Off-Road	1974	0.20	0.20	0.01	0.01	0.20	0.20	0.01	0.01	1
Highway Road	1973	2.20	1.40	0.12	0.08	1.60	1.20	0.09	0.07	4
Highway Off-Road	1973	0	0	0	0	0	0	0	0	0
Stony Road	1973	2.00	0.80	0.16	0.06	1.80	0.60	0.14	0.05	2
Stony Off-Road	1973	2.20	1.40	0.22	0.14	1.60	1.20	0.16	0.12	1
Sable Road	1973	8.40	4.00	0.41	0.19	6.80	3.20	0.33	0.16	5

The plot data do indicate that, during the summer, caribou may use areas near the road more intensively than watersheds with similar habitat north of the road. Pairing all first-search observation periods for each set of paired plots (Appendix Table A2) and applying a matched-pair t-test (Sokal and Rohlf 1969) reveals a significantly larger number of caribou observed per km^2 in the Igloo Road Plot 1974 (t=4.16, 0.01<P<0.02) and in the Highway Road Plot 1973 (t=2.78, 0.02<P<0.05) than in the corresponding backcountry plots. Other pairs showed no significant differences. The unpaired Sable Road Plot 1973 had densities of caribou at least twice as great as any of the other plots and appears to be a favored habitat. These data are consistent with the fact that the road was built in the same east-west fault valley utilized as the traditional major caribou migration route. This distribution pattern increases the potential importance of human disturbance along the park road to the caribou population. No plots were placed in the higher valleys south of the road; this area may also be heavily used by caribou.

Baskin (1974) felt that reindeer in eastern USSR prefer to maintain a distance of at least one kilometer from man. Klein (1971) reported that a herd of wild reindeer in Norway abandoned a section of their range cut off by a highway and a railroad, after several years of crossing. He emphasized the possible importance of the cumulative effects of more than one obstruction. In the present study, road crossings by single and small bands of caribou were frequently observed, but the large migrating bands moved west parallel to and south

of the road without crossing.

Although the study indicates that caribou are not, in general, avoiding the area of the park road, the nature of the study provides little insight on what individual differences may occur. Dorrance *et al.* (1975), during a telemetric study of white-tailed deer (*Odocoileus virginianus*), found that one doe with a fawn moved her home range over a mile from a new source of human disturbance, while other deer in the area did not change their home ranges. During the intensive caribou observations in late July and August 1974, I learned to identify certain individual caribou using characteristics of antler form, size, coat condition and color, scars, etc. I sighted certain individuals repeatedly in view of the road, including a young bull sighted over a period of 12 days, an adult bull for a period of 5 days, and four single cows for 6 days, 6 days, 8 days and 10 days. These are minimum periods, as the intensive observations covered only a short section of the road over only a three week period, and it required time to learn to recognize individuals. These observations show that at least some individual caribou remain in the vicinity or return to the vicinity of the road over a period of days or weeks and do not simply move quickly through the area. Bergerud (1974) reported that several individually recognizable caribou bulls in Newfoundland exhibited restricted home ranges during the fly season in July and August.

Reaction Distances

The shuttle-tour data relating the disturbance reactions of caribou to their distance from the disturbance appears in Table 6 and Figure 6. The percentage of caribou showing visible reactions to buses and visitors, and the ratio of strong to mild reactions, decrease with distance from the road. A *G*-test (Sokal and Rohlf 1969) performed on the number of caribou in each known reaction class at 100 m intervals from the road up to 500 m shows that the pattern is significant (G=197.2, P<0.005), i.e. there is a relationship between distance from road and reaction. The behavior of 9% of the animals was classified in the "unknown" class because of difficulties in interpreting the cause of some behavior patterns. Animals classified with unknown reactions were excluded when calculating reaction percentages. Sixty-one percent of the caribou within 100 m of the road exhibited some visible reaction to bus-related human activities, 41% exhibited strong reactions. Beyond 400 m from the road, less than 10% of the caribou gave visible reactions to road-related disturbances.

Mild reactions were underestimated by the shuttle-tour technique. Table 7 and Figure 7 compare the distance-reaction data generated from the shuttle-tour trips and from the intensive observations. Calves were excluded in this comparison. Their reactions differed from older animals and the percentage of calf observations was greater during the intensive observations than during the shuttle-tour observations. Chi-squared tests show significant differences in the distribution of reaction strengths (none:mild:strong) for the two techniques for the

Table 6. Reactions of caribou, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	KNOWN REACTIONS OF CARIBOU TO BUS AND VISITORS						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	11	16	32	26	57	58	38	19	42	21	4	6
0-100	39	42	19	25	41	34	217	97	243	104	21	30
0	0	0	46	36	54	64	24	11	26	11	2	3
1-25	28	33	7	11	64	56	14	9	16	11	1	3
26-50	32	44	25	24	43	32	56	25	60	26	5	8
51-75	52	39	39	50	10	11	31	18	33	18	3	5
76-100	50	56	4	11	46	33	92	36	108	40	9	12
101-200	67	77	21	13	12	11	226	71	235	78	20	23
201-300	85	80	10	13	5	7	165	45	168	47	14	14
301-400	83	86	11	7	6	7	105	28	137	32	12	9
401-500	93	90	7	10	0	0	121	21	124	23	11	7
501-750	100	100	0	0	0	0	119	23	125	25	11	7
751-1000	97	92	0	0	3	8	31	12	55	17	5	5
>1000	100	100	0	0	0	0	92	16	92	16	8	5
TOTAL	76	72	12	14	12	15	1076	313	1179	342		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A13.

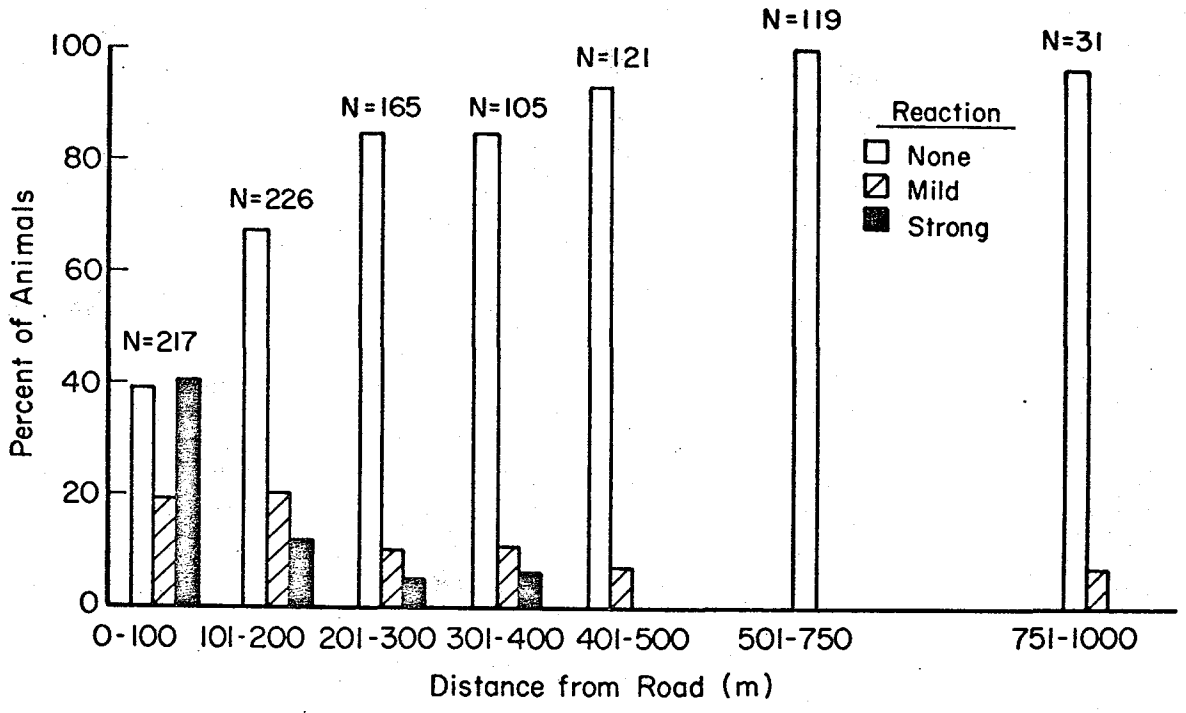

Figure 6. Reactions of caribou, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

Table 7. Reactions of caribou, at varying distances from the road, to traffic and visitors, as observed during shuttle-tour trips and during intensive observations, calves excluded, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF CARIBOU TO TRAFFIC AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
SHUTTLE-TOUR OBSERVATIONS							
0-100	83	(39)	42	(20)	89	(42)	214
101-200	151	(67)	47	(21)	26	(12)	224
201-400	222	(86)	23	(9)	13	(5)	258
>401	348	(97)	8	(2)	1	(<1)	357
TOTAL	804		120		129		1053
INTENSIVE OBSERVATIONS							
0-100	7	(8)	30	(35)	48	(56)	85
101-200	77	(44)	85	(48)	15	(8)	177
201-400	347	(73)	115	(24)	14	(3)	476
>401	216	(95)	12	(5)	0	(0)	228
TOTAL	647		242		77		966

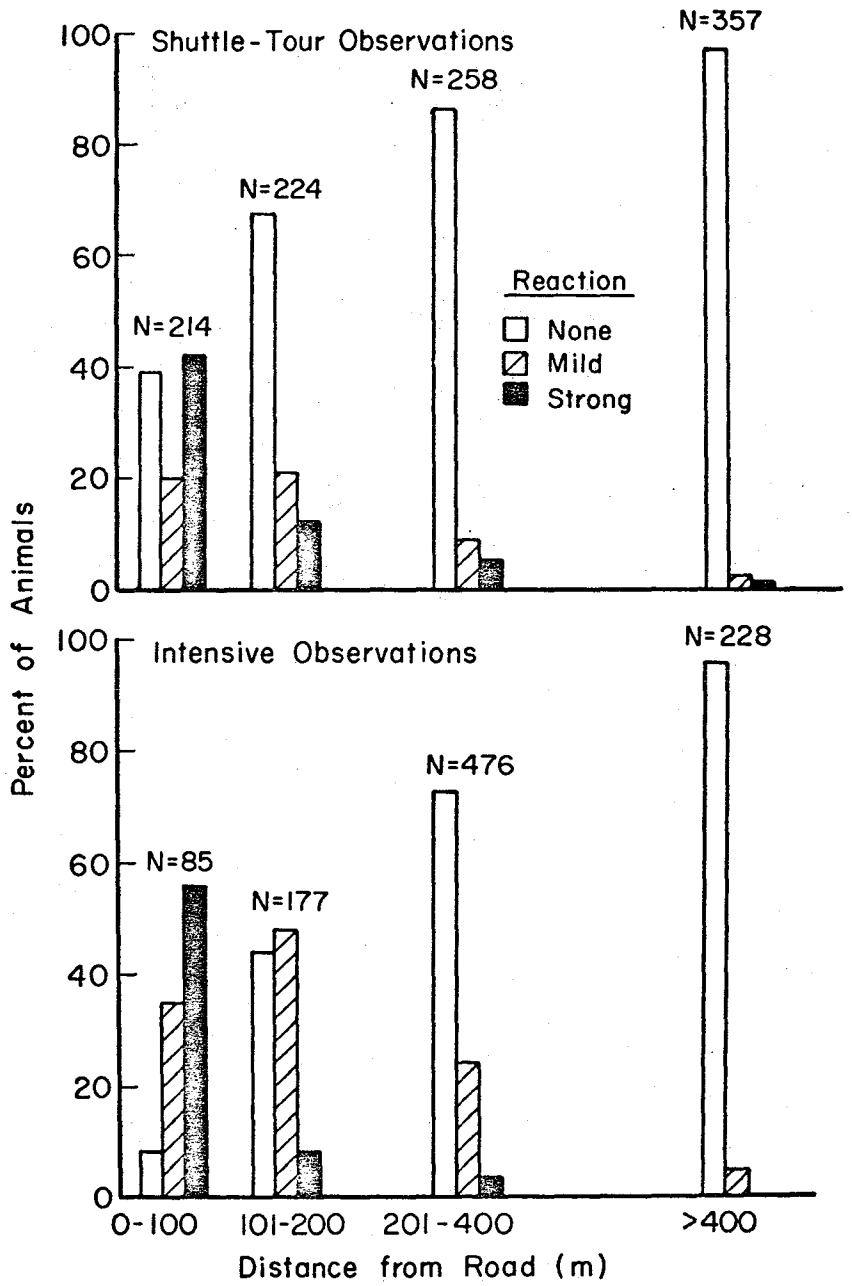

Figure 7. Reactions of caribou, excluding calves, to traffic and visitors; comparison of shuttle-tour observations and intensive observations, 1973-1974, Mount McKinley National Park, Alaska.

distance classes 0-100 m (X^2=28.00, P<0.005), 101-200 m (X^2=32.86, P<0.005), and 201-400 m (X^2=26.41, P<0.005). No significant difference at the P=0.05 level was found beyond 400 m. The difference results chiefly from a greater percentage of mild reactions observed during the intensive observations than during shuttle-tour observations. During intensive observations, I frequently observed caribou become alert to a vehicle when it first came into view at a great distance, then return to their former activities and give no other visible reaction when the vehicle reached the closest point to the animals. Such a reaction often would not be seen by an observer on a bus. During the intensive observations, no caribou were observed to note a vehicle in the distance and then purposely move out of view before the vehicle approached close enough for the animal to be observed from it. Strong reactions were probably not greatly underestimated. Differences in the percentages of strong reactions determined from the two techniques may relate to the fact that the intensive observations include reactions to private and NPS vehicles as well as to the public buses. A discussion of possible reaction differences to various types of vehicles appears later.

Quantification of caribou disturbance behavior has been attempted in other studies, chiefly in relation to caribou reactions to aircraft. Klein (1974) reported percentages of mild and strong reactions shown by caribou in response to small airplane overflights that are very similar, at comparable distances, to the intensive observation data from my study. He defined a strong reaction as a fast trot, run, or

panic reaction. Overflights below 200 ft (60 m) caused 60% strong reactions and 33% mild reactions. These percentages were 13% and 49%, respectively, for overflights above 500 ft (150 m). Calef and Lortie (1973) found caribou responding to aircraft by locomotion only for overflights at 400 ft (122 m) or below and exhibiting panic reactions only for overflights at 200 ft (60 m) or lower. However, McCourt *et al.* (1974) and McCourt and Horstman (1974) recorded some caribou movement responses to small aircraft even for overflights above 1000 ft (300 m). They reported thresholds for 50% mild responses (significant interruption of activity or trotting) and 50% strong responses (running flight) for airplane overflights at 500 ft (150 m) and 200 ft (60 m), respectively, and for helicopter overflights at 500 ft (150 m) and 300 ft (90 m), respectively. Geist (1975) provides a critique of the methods and results of these aircraft disturbance studies.

Kelsall (1957) has suggested 100 yd (90 m) as a "typical" flushing distance for caribou in response to the presence of a man, although he, de Vos (1960), and Lent (1964) all recognize great variability in flushing distances, citing instances of a few meters to 1 mi (1.5 km). In a more detailed analysis, Bergerud (1974) calculated distances during the spring of 107 ± 12 m to alert and 81 ± 11 m to flush for cows without calves, and 181 ± 54 m to alert and 164 ± 11 m to flush for bands of cows and calves.

Disturbance Frequencies

A high percentage of caribou within 200 m of the road reacted to

road-related human activities (Table 7). This fact combined with the frequency of traffic (Figs. 4-5) indicates a high degree of interaction of these caribou with the traffic. During the intensive observations, caribou within 200 m of the road averaged 4.5 mild reactions, and 2.5 strong reactions per hour from 0800 through 1700 hours, with a decrease during night hours. (Note: The diel traffic pattern differs somewhat in the Toklat River to Eielson Visitor Center section of the road, where the intensive observations were made, from the Igloo-Sable Pass section, where the data for Fig. 5 were collected.) Thomson (1973) determined that wild reindeer activity in Norway was interrupted once every four hours by disturbing stimuli, half of which were human disturbances. Non-human disturbances occurred once every eight hours and involved eagles, ravens, gulls and foxes. Wolves and bears were notably absent from his study area. In the Tanana Hills, Alaska, Curatolo (1975) noted a June to October average of one disturbance to caribou from wolves or bears each 20 hours, and a total non-human disturbance rate of one disturbance per 11 hours from wolves, bears, eagles, and ravens. Most of his observations were made during the day-time hours. These studies indicate that the interruptions of caribou activity caused by traffic on the park road are much more frequent than natural interruptions, in the absence of human activities.

Relationship of Reaction to Type of Disturbance

During the shuttle-tour observation trips the bus stopped for 80% of the caribou sighted, people got out of the bus for 16% of the animals,

and visitors walked off the road toward 4% of the caribou. For caribou within 200 m of the road these percentages were 88%, 15%, and 3%, respectively (Table 8). A chi-squared test on the differences in the frequency pattern of passing-stopping-people getting out for the various types of buses revealed no significant difference between the 0700 shuttle and the 1500 shuttle, but did show a significant difference (χ^2=45.76, P<0.005) between the shuttles and the 0400 tour. The tour stopped for 93% of the caribou sighted while the shuttles stopped for only 75%. There was no difference between shuttles and tours in the frequency that people got off the bus.

Table 8 and Figure 8 present the shuttle-tour data relating the reactions of caribou within 200 m of the road to the type of action of the bus and visitors (see also Appendix Table A23). Chi-squared analyses of the reactions of animals within 200 m of the road showed no significant differences in the reaction frequency patterns (none:mild:strong) for buses passing without stopping and buses stopping, without people getting out. Significantly different reaction patterns (χ^2=8.97, 0.01<P<0.025) did occur between buses stopping, without people getting out and with people getting out. The latter action caused an increase from 26% to 41% in animals exhibiting strong reactions. The sample size of situations when people got out of the bus and moved off the road toward caribou within 200 m was too small to warrant statistical analysis, but this action usually precipitated a strong response from the caribou (Table 8).

There is some evidence that loud noises increased the percentage

Table 8. Reactions of caribou, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park.

ACTION OF BUS AND VISITORS	KNOWN REACTIONS OF CARIBOU						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	61	71	21	24	18	6	33	17	36	19	8	10
Pass <15 mph	71	50	24	33	6	17	17	6	19	6	4	3
Stop, people remain on bus, quiet	54	59	22	18	24	24	290	111	314	122	66	67
Stop,people remain on bus, noisy	35	36	24	21	41	43	37	14	39	14	8	8
Stop, people off bus on road, quiet	62	57	7	21	31	28	45	14	49	15	10	8
Stop, people off bus on road, noisy	83	67	0	0	17	33	6	3	6	3	1	2
Stop, people walk off road, quiet	0	0	25	50	75	50	12	2	12	2	2	1
Stop, people walk off road, noisy	0	0	0	0	100	100	3	1	3	1	<1	<1
TOTAL	53	57	20	20	27	25	443	168	478	182		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A16.

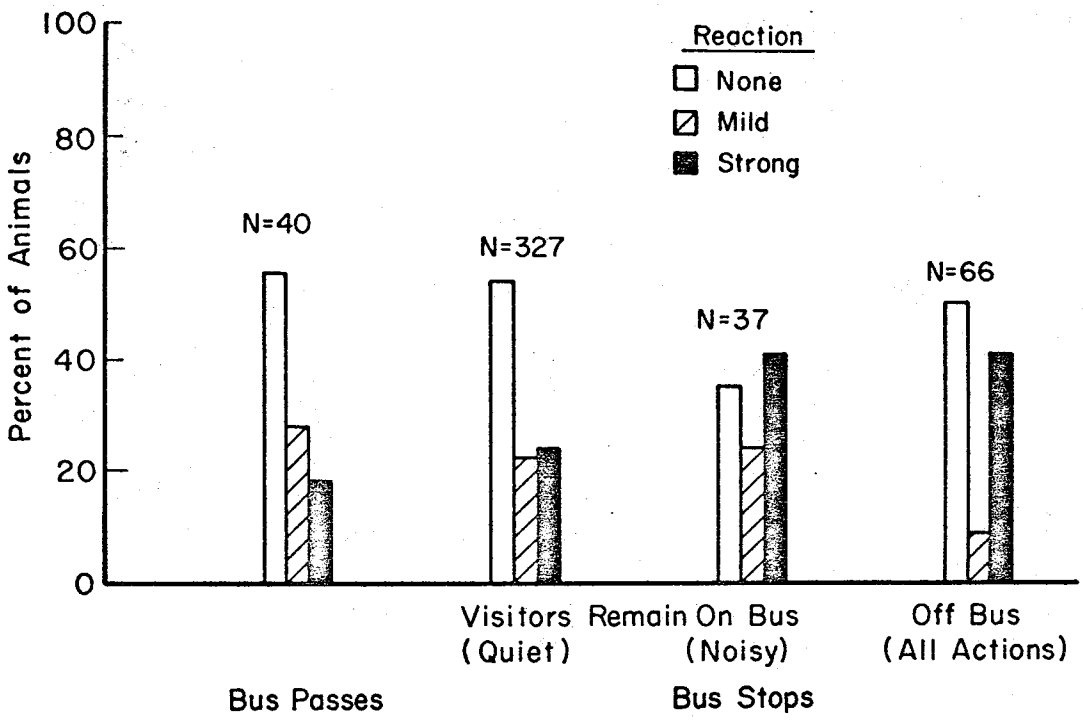

Figure 8. Reactions of caribou, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

and strength of reactions (Table 8). A chi-squared analysis of the reactions of caribou within 200 m of the road exposed to a bus stopping, with the people remaining in the bus and quiet, compared with those exposed to a bus stopping, with people remaining in the bus but making loud noises, showed significant differences (X^2=6.43, 0.025<P<0.05), although the latter action occurred during only 8% of the sightings, involving 8% of the animals. On 14 occasions the bus stopped and loud noises were generated by whistling, shouting, honking, banging the side of the bus, or screeching air brakes, while the people remained on the bus. These actions increased strong reactions from 24% to 43%. Occasionally, loud noises were accidental, but most often they were purposely generated to attract the animal's attention for photographic purposes.

During the 41 hours of intensive observations, I observed visitors getting out of their vehicles and remaining on the road four times from 196 buses, and four times from 117 private vehicles. People moved off the road toward caribou twice from the buses and twice from the private vehicles. In all cases when visitors moved off the road they approached the animals until they reacted strongly. The sample sizes are too small to be conclusive, but if one considers the numbers of visitors carried by each private vehicle and by each bus, on a per visitor basis, disturbances are greater from private vehicles. The actions of visitors riding public buses may be inhibited by the presence of other visitors and the bus driver. Some drivers actively attempt to control the actions of their passengers to minimize disturbances to animals.

The response of an animal to various types of disturbance depends

partly on the evolutionary development of its senses. Smell is the most discerning sense in caribou (Bergerud 1974, Kelsall 1968), and they often depend on smell to warn them of danger (O. J. Murie 1935). Moving objects are often investigated to receive their scent (Bergerud 1974). This behavior was frequently observed when visitors got out of their vehicles, especially when they walked off the road. Sight in caribou has evolved to perceive movement well, but they seem to have poor sensitivity to color, form, and recognition of motionless objects (Bergerud 1974, Harper 1955, Kelsall 1968). The alert response of caribou to vehicles at a great distance probably results from the perception of an unidentified movement. After a vehicle was recognized some caribou no longer responded to it. Hearing is reported to have little effect as a danger signal, except when combined with visual stimuli (Bergerud 1974, Ericson 1972, O. J. Murie 1935). Caribou in large groups are surrounded by the noises generated by other caribou (Lent 1964, O. J. Murie 1935), and Lent (1964) considered single caribou to be more responsive to noise than those in large groups. McCourt *et al.* (1974) reported that caribou avoid the intense noise of a simulated gas compressor station by only a distance of 300 m, and show little behavioral response to the sound beyond this distance. Ericson (1972) found a semi-domestic reindeer herd habituated to the common sounds of shouts, motors, and trains, but the animals exhibited a learned avoidance response to the sound of a snowmachine used by men capturing calves. On a few occasions during the intensive observations, I observed caribou that were out of view of the road noting traffic sounds and moving to a ridge crest to view the road.

A similar response to noise is reported by de Vos (1960).

Relationship of Reaction to Group Size

The shuttle-tour data indicate a relationship between responsiveness and group size for caribou within 200 m of the road (Table 9). Chi-squared tests revealed no significant differences in reactions between groups of one and two, or between groups of two and three to five. A comparison of animals in groups of one to five with groups of six to ten reveals a significant difference (X^2=15.80, P<0.005) in reaction patterns. The frequency of strong reactions was greater in the larger groups. Groups larger than ten were too few to analyze. Both Klein (1974) and McCourt and Horstman (1974) found increases in the frequency and intensity of reactions of caribou to aircraft overflights with increased group size. These results may relate to social facilitation of reactions. The more sensitive individuals in a group could stimulate responses in the other members of the group.

The relationship seems to reverse in large herds. Banfield (1954), de Vos (1960), Harper (1955), Jakimchak *et al.* (1974), Kelsall (1957), Lent (1964), O. J. Murie (1935), Symington (1965) and Thomson (1973) all reported decreased responsiveness of large herds to disturbances. Many disturbing stimuli may not be perceived by the majority of animals in a large herd, and disturbed individuals may be calmed by the lack of response by other herd members (Lent 1964). Child (1973) found caribou crossing success of a simlulated pipeline to decrease with increased group size and felt that animals in small groups were more investigative.

Table 9. Reactions of caribou, observed during shuttle-tour trips within 200 m of the road, in various size groups to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

GROUP SIZE	REACTION OF CARIBOU TO BUS AND VISITORS												TOTAL	
	NONE				MILD				STRONG					
	Number Animals	(Percent Animals)	Number Groups	(Percent Groups)	Number Animals	(Percent Animals)	Number Groups	(Percent Groups)	Number Animals	(Percent Animals)	Number Groups	(Percent Groups)	Number Animals	Number Groups
1	45	(56)	45	(56)	17	(21)	17	(21)	19	(23)	19	(23)	81	81
2	40	(64)	20	(64)	6	(10)	3	(10)	16	(26)	8	(26)	62	31
3-5	85	(62)	23	(62)	26	(19)	10	(27)	26	(19)	8	(22)	137	37
6-10	52	(48)	7	(47)	12	(11)	2	(13)	45	(41)	6	(40)	109	15
TOTAL	222		95		61		32		106		41		389	164

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given and percents for groups may total over 100%.

Relationship of Reaction to Age and Sex

Both the shuttle-tour and intensive observations show increased frequencies and strengths of reactions for calves compared with adults. All animals older than calves are considered "adults" because of the inconsistent identification of yearlings. Too few calves were observed during shuttle-tour trips to provide a statistically useful sample. Table 10 contains the relevant data from the intensive observations, which involved many observations of only a few individual calves. The reaction pattern (none:mild:strong) for calves is significantly different from those for adults in all distance classes with an adequate number of calf observations, *i.e.* 101-200 m (X^2=12.29, P<0.005) and 201-400 m (X^2=28.72, P<0.005). The calves observed were already six to twelve weeks old and often acted independently of the cows. It was often impossible to determine which cow was the dam of a calf, a problem also noted by Pruitt (1960). The calves often watched vehicles or people, even at relatively great distances (400-600 m), and followed moving objects with their eyes. On occasion, calves noted vehicles or visitors and trotted or ran closer to a cow or cows, even when the cows gave no visible response. This type of behavior in calves has also been noted by Calef and Lortie (1973), Espmark (1972), and Klein (1974). Lent (1964) describes cow-calf disturbance behavior in detail.

The data from this study did not show any differences in reaction patterns related to sex. In almost half the observations sex was not determined. Also, observations of cows with young calves were limited. Several authors give evidence that females, especially those with young

Table 10. Reactions of adult and calf caribou, observed during intensive observations, to vehicles and visitors, 1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF CARIBOU TO VEHICLES AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
ADULT							
0-100	7	(8)	30	(35)	48	(56)	85
101-200	77	(44)	85	(48)	15	(8)	177
201-400	347	(73)	115	(24)	14	(3)	476
>400	216	(95)	12	(5)	0	(0)	228
Total	647		242		77		966
CALF							
0-100	0	(-)	1	(-)	0	(-)	1
101-200	0	(0)	11	(65)	6	(35)	17
201-400	10	(29)	23	(68)	1	(3)	34
>400	35	(80)	9	(20)	0	(0)	44
Total	45		44		7		96

calves, are more wary than males (Bergerud 1974, de Vos 1960, Dixon 1938, Ericson 1972, Espmark 1972, Lent 1964, Thomson 1972). Ericson (1972), working with semi-domestic reindeer, found that cows with calves were the first to respond to disturbances. They initiated movement away from disturbances, traveled furtherest, and stayed away longest. Child (1973) reports that nursery bands and bands with female leaders are the most investigative and most successful at crossing a simulated pipeline, perhaps because of greater directional motivation.

Along the Mount McKinley National Park road, I observed a few individual caribou that were particularly unresponsive to human activities. All these animals were large bulls in the latter half of the summer. They allowed people to approach them to within 15-25 m without showing a visible response or giving only a mild response. Dixon (1938) and O. J. Murie (1935) considered old bulls the least wary of caribou. Thomson (1973) found rutting wild reindeer bulls least easily disturbed.

Relationship of Reaction to Behavior Before Disturbance

Both shuttle-tour and intensive observations show a relationship between the reactions of caribou within 200 m of the road to vehicles and visitors and the animals' behavior before the disturbance (Table 11). There are no significant differences between the reactions of feeding and lying caribou. However, both techniques indicate a significant increase in reactiveness in traveling caribou over both feeding (for shuttle-tour observations, X^2=123.83, P<0.005; for intensive observations, X^2=28.62, P<0.005) and lying caribou (shuttle-tour, X^2=5.24,

Table 11. Reactions of caribou, observed within 200 m of the road during shuttle-tour trips and during intensive observations, as related to behavior before disturbance, 1973-1974, Mount McKinley National Park, Alaska.

BEHAVIOR BEFORE DISTURBANCE	REACTION OF CARIBOU TO VEHICLES AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
SHUTTLE-TOUR OBSERVATIONS							
Feed	145	(82)	14	(8)	18	(10)	177
Feed-walk[a]	14	(52)	5	(19)	8	(30)	27
Lie	53	(72)	13	(18)	8	(11)	74
Stand	16	(64)	2	(8)	7	(28)	25
Travel[b]	0	(0)	36	(84)	7	(16)	43
Total	228		70		48		346
INTENSIVE OBSERVATIONS							
Feed	43	(38)	47	(41)	24	(21)	114
Feed-walk[a]	2	(6)	26	(74)	7	(20)	35
Lie	34	(43)	36	(46)	9	(11)	79
Stand	2	(29)	3	(43)	2	(29)	7
Travel[b]	3	(11)	4	(15)	20	(74)	27
Total	84		116		62		262

[a] Feeding while traveling at a walk.

[b] Movement at a walk, trot, or run.

$0.05<P<0.1$; intensive, $X^2=39.81$, $P<0.005$). The "behavior before disturbance" was determined during shuttle-tour trips only when the animals were sighted before reacting to the bus, thus the behavior before disturbance was often unknown for the more sensitive animals. This fact may explain differences between the results of the two techniques. During the intensive observations the behavior before disturbance was usually known. During these observations I felt that caribou moving and milling around (classified under "traveling") within 200 m of the road were often exhibiting this behavior as a prolonged reaction to recent prior disturbances, which may explain the increased reactiveness of these animals. More discussion of this factor appears in the following section on activity patterns. Many of the animals lying for long periods within 200 m of the road may have been habituated individuals. McCourt *et al.* (1974) reported that feeding and lying caribou bands were most reactive to aircraft, with lying animals showing the strongest reactions. Unlike my study, most of the traveling animals encountered during the study by McCourt *et al.* (1974) were in large migrating herds and had not been subjected to frequently repeated disturbances. Klein (1974) also found the reactions of caribou to aircraft to be dependent on the behavior before disturbance; lying groups were slightly more reactive than feeding groups and traveling groups showed fewer total reactions but more strong reactions.

Relationship of Reaction to Time and Season

Data from this study did not reveal any reaction differences related

to time of day. The literature also gives little insight into this factor. However, road crossings by caribou may be more frequent during times of low traffic frequency. During five days of caribou census trips between the Toklat River and Eielson Visitor Center, repeated at 0600, 1000, 1400, 1800 and 2100 hours each day, 74% (20 animals, in 4 groups) of all caribou observed crossing the road were sighted during the 0600 hour trips and 22% (6 animals, in 2 groups) during the 2100 hour trips. Bergerud (1974) states that caribou usually cross the trans-Canada highway early in the morning when traffic is light. These observations could be related either to a preference for crossing when traffic is light or to a greater amount of traveling during the night or early morning.

My study included only a short part of the yearly cycle, excluding late fall, the entire winter and early spring. The shuttle-tour data for caribou within 200 m of the road do show some changes in reactive patterns through the summer (Table 12). The data from the summer were divided into four four-week periods from May 26 to September 15. For the 1973 shuttle-tour data chi-squared tests showed no significant differences in reaction patterns for the three four-week periods from June 23 to September 15. There is a significant difference (X^2=15.22, P<0.005) between the caribou reaction patterns exhibited from May 26 to June 22 as compared to June 23 to September 15; a greater percentage of the caribou reacted to road-related disturbances the first four weeks of the tourist season. A similar decline in reactiveness occurred in 1974, but too few caribou were observed early in the season to provide

Table 12. Seasonal changes in reactions of caribou, observed within 200 m of the road during shuttle-tour trips, to the bus and visitors, Mount McKinley National Park, Alaska.

DATE PERIOD	REACTION OF CARIBOU TO TRAFFIC AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
1973							
May 26-June 22	42	(31)	45	(33)	50	(36)	137
June 23-Sept. 15	55	(54)	25	(25)	21	(21)	101
Total	97		70		71		238
1974							
May 26-June 22	9	(47)	2	(10)	8	(42)	19
June 23-Sept 15	129	(69)	17	(9)	40	(22)	186
Total	138		19		48		205

a statistically meaningful sample. A decrease in reactiveness through the tourist season may be caused by increased habituation in the caribou, an increasing percentage of old bulls among the caribou near the road, and the onset of the fly season. Kelsall (1957), Klein (1974), and Lent (1964) reported a reduced sensitivity to disturbance in caribou in mid-summer when fly harassment was great. At this time the animals are often in poor condition (Zhigunov 1961), and disturbances are a further drain on their already stressed condition. Other seasonal changes in responsiveness reported in the literature include increased responsiveness to disturbance during winter and during calving (Lent 1964, Thomson 1972).

Relationship of Reaction to Weather and Habitat

Lent (1964) found differences in disturbance behavior related to weather conditions, with caribou showing the most sensitivity in wind and storms. Freuchen and Salomonsen (1958) observed the same relationship in reindeer. McCullough (1969) reported increased responses of elk to vehicles in windy weather, but found no relationship to humidity. Darling (1937), however, attributed changes in irritability of red deer (*Cervus elaphus*) to changes in humidity and barometric pressure, and suggested that this resulted from the fact that a warm, moist atmosphere is a better conductor of scent.

Habitat may affect disturbance behavior. Calef and Lortie (1973) found caribou in timber to be more reactive than those in the open. Henshaw (1970) states that caribou show alarm, and hesitate when passing

through thick vegetation. De Bock and Surrendi (1974, cited in Geist 1975) found that caribou approach the Dempster Highway in the Yukon more readily on the open tundra than in the taiga. The increased wariness in closed vegetation may result from the decreased visibility and resultant reduced possibilities for the perception of predators.

Effects of Disturbance on Activity Pattern

Table 13 presents a summary of the activities of caribou observed from the road. The shuttle-tour data are complicated by the fact that the observer could not always determine the behavior before disturbance. If traveling animals are more sensitive and less often observed before reacting, as discussed earlier, this fact may reduce the number of animals recorded as traveling before disturbance within 200 m of the road. The shuttle-tour data also include observations from throughout the summer, including frequent sightings of small migrating bands during June and July. These migrating bands were usually over 200 m from the road and thus increased the percentage of animals recorded as traveling in this distance class. The intensive observations were made on temporary residents and did not include groups migrating at the time observations were being made. The intensive observations were also continuous rather than point observations like the shuttle-tour data. The nature of the intensive observation data make them more suitable for comparing the activities of animals at varying distances from the road. A chi-squared test on these data reveal a significant difference (X^2>500.0, P<0.005) between the activities of caribou within 200 m of the road and those

Table 13. Behavior of caribou observed during shuttle-tour trips and intensive observations, number of animals exhibiting given "initial" behavior when first sighted during shuttle-tour trips and caribou-minutes of given behavior during intensive observations, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	BEHAVIOR OF CARIBOU												TOTAL
	FEED		FEED-WALK[a]		LIE		STAND		TRAVEL[b]		OTHER		
SHUTTLE-TOUR OBSERVATIONS	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals
0-200	187	(50)	39	(10)	74	(20)	25	(7)	48	(13)	0	(0)	373
>200	271	(45)	18	(3)	177	(29)	20	(3)	122	(20)	1	(<1)	609
Total	458		57		251		45		170		1		981
INTENSIVE OBSERVATIONS	Number[c] Minutes	(Percent Minutes)	Number Minutes	(Percent Minutes)	Number Minutes	(Percent Minutes)	Number Minutes	(Percent Minutes)	Number Minutes	(Percent Minutes)	Number Minutes	(Percent Minutes)	Number Minutes
0-200	1099	(39)	241	(8)	761	(27)	37	(1)	686	(24)	3	(<1)	2827
>200	3969	(56)	421	(6)	1532	(22)	496	(7)	605	(8)	24	(<1)	7047
Total	5068		662		2293		533		1291		27		9874

[a] Feeding while traveling at a walk.

[b] Movement at a walk, trot, or run.

[c] One caribou exhibiting given behavior for one minute.

beyond this distance. Within 200 m of the road, there is an increase in traveling at the expense of feeding. This increase seemed to be due to the frequent disturbances from vehicles and visitors. Thomson (1973) discovered a severe alteration of the activity pattern of wild reindeer during a period of intensive hunting; lying and grazing decreased and traveling increased compared to the same season without hunting.

The general activity patterns indicated by this study (Table 13) are similar to those reported by other workers. Curatolo (1975) determined the general activity pattern for caribou in interior Alaska during post-calving as approximately 53% feeding, 27% lying, 4% standing, and 17% traveling, and during August dispersal, 42%, 17%, 23%, and 19%, respectively. (Note: These figures were estimated from a graph in Curatolo 1975).

Behavior Patterns Related to Disturbance

Several distinct behavior patterns are associated with disturbance reactions in caribou. Detailed descriptions and discussions of some of these behaviors appear in Lent (1964) and Pruitt (1960). The maximum behavioral reactions of caribou observed in my study are summarized in Table 14. The behavior of caribou "watching" vehicles or people varied from a casual glance through an alert stance to an alarm pose. Caribou that were lying and chewing cuds were often observed temporarily ceasing cud chewing while watching traffic and visitors on the road. Caribou showing any response to a vehicle or person usually oriented their ears toward the disturbance, even if they did not look in the direction of

Table 14. Maximum behavioral reactions of caribou, observed during shuttle-tour and intensive observations, to vehicles and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	MAXIMUM REACTION OF CARIBOU TO VEHICLES AND VISITORS										TOTAL NUMBER ANIMALS
	NONE		WATCH		WALK		TROT		RUN		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
SHUTTLE-TOUR OBSERVATIONS											
0-200	235	(53)	73	(16)	29	(7)	57	(13)	49	(11)	443
>200	581	(92)	35	(6)	6	(1)	1	(<1)	10	(2)	633
Total	816		108		35		58		59		1076
INTENSIVE OBSERVATIONS											
0-200	84	(30)	120	(43)	8	(3)	47	(17)	21	(8)	280
>200	888	(84)	147	(14)	3	(<1)	13	(1)	11	(1)	1062
Total	972		267		11		60		32		1342

the disturbance. The alert stance is a "posture in which the animal stares fixedly with its tail raised and head up" (Lent 1964). The alarm pose includes the features of the alert stance, plus the extension of "one hind leg out to the side in an exaggeration of the urination pose" (Lent 1964). Urination was at times observed in conjunction with the alarm pose during my study. During the intensive observations, the alarm pose preceded 45% of all strong reactions, and occurred during 1% of the mild reactions. This posture was generally followed by movement at either a trot or a run. However, trotting or running from a disturbance was not always preceded by the alarm pose. Pruitt (1960) considers the alarm pose to be a ritualized behavior and it apparently serves as a social releaser, causing other caribou to become alert, but not to flee without further stimulus (Lent 1964).

The excitation jump is another disturbance-related social releaser. An animal exhibiting this behavior "raises on its hind legs suddenly, turns while on its hind legs and usually flees, bounding once or twice before settling into a trot" (Pruitt 1960). Dugmore (1913), Lent (1964) and Pruitt (1960) all concluded that this action leaves a scent from the interdigital gland on the ground at the point of occurrence and proposed that the scent serves as an olfactory danger signal. Lent (1964) found that caribou encountering such scent on a trail became more alert or even avoided the location. Pruitt (1960) and O. J. Murie (1935) felt that adult bulls gave excitation jumps more frequently than other groups, but any caribou may show the behavior. During the 41 hours of intensive observations in my study, excitation jumps were observed on

eight occasions. A total of 14 animals exhibited this behavior, including two cows and three calves. On five of the occasions, vehicles or people were within 50 m of the animals; on all occasions the disturbing object was within 300 m. The disturbances causing excitation jumps included: 1) vehicles passing without stopping on three occasions, 2) vehicles stopping without people getting out on three occasions, 3) people out on the road on one occasion, and 4) people off the road approaching the animals on one occasion. Modified, incomplete jumps were exhibited by an additional 14 individuals.

Locomotion in caribou, including the walk, trot, and run, is discussed by Skoog (1968). A walk or trot is generally used during migrations, and a fast trot is used for fleeing over long distances. Because of their heavy pelage, caribou tire and overheat quickly when running. O. J. Murie (1935) describes an instance in which a cow and a young bull died of overheating when caused to run in fright during a capture attempt. Table 14 shows that 11% of the caribou within 200 m of the road ran in response to disturbances during shuttle-tour trips, while 13% trotted. Such running and trotting, especially if repeated, affect the energy budgeting of these animals (Geist 1975). Extended running could affect their immediate health. Most caribou were observed to run less than 100 m. Extended running was observed on a few occasions when caribou, surprised on the road, chose to run down the road for up to 1.5 km in front of approaching vehicles.

Caribou exhibited investigative behavior during some disturbances. The animals became very alert and approached or circled the disturbing

object, using a loose, high stepping trot. The animal may have been attempting to receive a scent from an unidentified object that had been sighted. During the intensive observations this behavior was observed on two occasions when caribou approached and circled buses at 3 to 50 m, and on one occasion when two caribou approached to within 40 m of people who were off the road.

Sometimes caribou reacting to a disturbance bunch together. This behavior was observed on six occasions during the intensive observations. Bunching has been reported for reindeer and caribou in response to disturbances from aircraft, man, snowmobiles, and wolves (Child and Lent 1973, Chrisler 1956, Curatolo 1975, de Vos 1960, Ericson 1972, Thomson 1973). On two occasions during the intensive observations calves were observed to run up to cows.

Temporary leadership may occur during disturbing situations. This was especially noticeable when bunched groups traveled away from a disturbance or when a group crossed the road. During some road crossings one animal approached and crossed the road first, followed by the other members of the group, often in single file. Thomson (1973) noted temporary leadership during 25% of disturbance reactions of wild reindeer.

Displacement activities, resulting from disturbance-related stress, have seldom been reported for caribou, perhaps because of the difficulty of recognizing such behavior. Klein (1974) felt that on a few occasions "agonistic behavior was stimulated by aircraft disturbances."

Caribou appear to cross the road fairly readily, but show caution. During 41 hours of intensive observations, road crossings were observed

on 16 occasions, involving 63 animals. I observed the details of the crossings for 53 animals. For all but nine of these animals a vehicle, often mine, was in view at the time of the crossing. The animals seemed aware of the road as a discontinuity in their environment. Caution in crossing was observed even when no vehicles were in view. On four occasions crossings began as a deliberate approach movement 150-250 m from the road, and, after the crossing, continued as a deliberate movement away until the animals were 50-200 m from the road. The other crossings involved shorter movements. Most animals moved at least 40 m away from the road after crossing if vehicles were present. Of the 53 caribou, the fastest gait used while crossing the road was a walk for 26% of the animals, a trot for 64%, and a run for 10%. At times the animals turned and moved along the road once they were on it. This occurred on three of the 16 above occasions. On two other occasions caribou exhibiting running behavior stimulated by fly harassment turned when they came on the road and trotted or ran 20-30 m along the road before leaving on the same side, without crossing. On another three occasions, caribou, faced with approaching vehicles while they were on the road, trotted or ran along the road up to 1.5 km, with the vehicle following, then ran off to the side from which they had come. These instances were disrupted crossing attempts. Thus, the road at times diverted the direction of movement of animals that came upon it, so that they moved along the road rather than directly across it. Caribou harassed by flies, or frightened by approaching vehicles, may perceive the road as a favorable running surface, smooth and unvegetated. However,

extensive use of the road as a travel route by undisturbed caribou was not observed. Banfield (1974) and McCourt *et al.* (1974) have found that caribou in winter often divert their direction of travel to follow seismic line clearings, perhaps because of favorable snow conditions. De Bock and Surrendi (1974, cited in Geist 1975) found that caribou avoided crossing raised sections of the Dempster Highway, Yukon, preferring to cross where they could see across the road. Child (1973) found a similar visual factor important in successful caribou crossings of a simulated pipeline.

Summary and General Discussion

The park's caribou herd has declined markedly in numbers over the last decade or more. By 1975, only about 1,000 animals remained (Willard Troyer, pers. comm. 1975). However, small bands of 1-10 caribou were frequently sighted from the road during my study. Caribou were observed during 90% of the shuttle-tour trips. Large migrating bands of 50-800 animals were observed along the road for only about a week in late June or early July each summer. Calves were rarely sighted from the road except in the large migrating bands.

The park road follows the same east-west fault valley that has been traditionally used as a travel route by caribou during the major post-calving migration. Also, the plot data showed that significantly more caribou use this valley as a summer range than valleys north of the road. Thus, the road passes through an area that is of importance to the caribou during the summer and for this reason human disturbance

along the road could adversely affect the herd.

The plot data indicate that caribou, in general, did not avoid the vicinity of the park road. Certain individuals may avoid the road, although my data provide little evidence for or against this possibility. Occasionally, caribou responded to repeated human disturbances by moving out of view of the road. However, at least during August, some individuals remained near the road, often in view of it, over a period of at least two weeks. If such temporary restricted home ranges include the park road and result in repeated contact with traffic and tourists, the restricted home ranges could result in habituation to human activities by individual caribou or, alternatively, in a build-up of stress in these individuals. Individuals with temperaments favoring habituation would be most likely to remain for extended periods in the vicinity of the road. These individuals would be more frequently sighted by tourists than exceedingly wary individuals. White *et al.* (1975) noted that resident caribou at Prudhoe Bay, Alaska appeared to habituate to traffic in the area, while migratory animals did not. In McKinley Park avoidance of the road may be most prevalent in the large migrating bands. They were observed to approach the road within 200 m only at night when traffic levels were very low and were never observed to cross the road.

The responses of caribou to human disturbances are influenced by many variables, including distance from the disturbance, group size, sex and age of the caribou, past experiences, time, season, and weather. Although these and other variables have been analyzed separately, they all interact to determine the response of an individual to a given

situation at a given time.

Both this study and the literature indicate that caribou generally react to disturbances only at relatively short distances during the summer. My results show few strong responses beyond 200 m, and few visible responses at all beyond 400 m (Table 6). Reported "typical" flushing distances from a man on foot range from 100 yd (90 m) to 160 m (Bergerud 1974, Kelsall 1957). Several authors (Harper 1955, O. J. Murie 1935, Tyrrell 1898) have commented on the "tameness" of caribou. Bergerud (1974) proposed that caribou disturbance behavior evolved under the major influences of open habitat, gregariousness, and predation by wolves. He suggested that flight distances are related to the relative speeds of caribou and wolves, and that caribou can afford to allow wolves to approach in the open until predation intention movements are recognized. A number of authors (Banfield 1954, Jakimchuk *et al.* 1974, A. Murie 1944) commented on caribou showing little response to wolves moving 100 m away. Such behavior may result from a balance of the danger and the advantages of not expending large amounts of energy unnecessarily. Bergerud (1974) reported that one caribou herd that was reduced by human hunting to less than 100 animals after wolves were exterminated from its range has since developed flushing distances much greater than usual, possibly an adaptation to human hunting in the absence of wolves.

In Mount McKinley National Park, where wolves occur and hunting is not permitted, short flushing distances could benefit both caribou and visitors. If visitors learn not to exhibit "predation intention movements,"

such as quick movements or direct approaches, they can observe caribou at relatively close range without forcing the animals to abandon areas with easy visitor access, such as along the park road.

The shuttle-tour buses stopped for 88% of the caribou sighted within 200 m of the road and people got off the bus for 15% of the animals. Stopping, without people getting out did not significantly increase the frequency or strengths of responses over passing without stopping. Producing loud noises or getting out of the bus did significantly increase the frequency and strength of responses. The increased response when loud noises were produced by the bus and visitors may have resulted from the unexpectedness of the noises, rather than to a particular sensitivity to noises. Such noises occurred during only 8% of the bus disturbances. Thomson (1972) reported that sudden, strange sounds were particularly disturbing to wild reindeer. Both Lent (1964) and de Vos (1960) noted caribou responding to gunshots 0.5 mi (1 km) away. Geist (1971a) pointed out that animals strive to live in a predictable environment and that unexpected stimuli are disturbing.

The ability of animals to habituate to various stimuli may depend on the evolutionary significance of those stimuli. Animals may exhibit a fixed response to stimuli of great importance in their predator-prey relationships (Bergerud 1974). Thomson (1972) found that the response of wild reindeer to various disturbances waned with repetition, but such habituation did not occur in the case of human scent. Strong responses to the direct approach of humans may persist because of its similarity to stimuli from attacking wolves.

Responsiveness of caribou to disturbances increased with increasing group size for the small bands of 1-10 animals most frequently sighted along the road. The literature indicates that responsiveness is decreased in very large herds (de Vos 1960, Kelsall 1957, Lent 1964, Thomson 1973).

My data revealed that 6-12 week old calves were more sensitive to human disturbances than adults. Some old bulls were found to be least wary. Many authors have found cows with calves most sensitive (Bergerud 1974, de Vos 1960, Lent 1964) and old bulls least sensitive (O. J. Murie 1935, Thomson 1973) to disturbances. Bergerud (1974) suggested that the evolutionary fitness of the female relates to the safety and survival of her calf and thus to increased wariness, while the fitness of the male relates to his size, condition, and attentiveness to females during rut. The male especially must conserve and store energy to be successful during the rut and to survive the following winter.

The responsiveness of the caribou decreased through the summer. This decrease may have been associated with habituation and/or the onset of the fly season. Lent (1964) and Thomson (1972) found increased responsiveness of caribou and reindeer to disturbances during winter and during calving. It is to the advantage of the McKinley caribou herd that no road-related human disturbances occur during these two annual critical periods. During winter the McKinley Park road is closed. Most calving occurs in areas away from the road. However, non-motorized winter recreation is increasing in the park, along with motorized (snowmobiles, etc.) recreation outside the park.

Excitation jumps, a response to disturbance which leaves a scent on the ground that serves as an olfactory danger signal, occurred frequently. This behavior could cause additional stress, through olfactory stimuli, in caribou using areas near the road.

The activity pattern of caribou within 200 m of the road was significantly altered, as compared with caribou at greater distances from the road. Human disturbances increased the amount of time spent moving about and decreased the time spent feeding. The frequency of activity interruption caused by human disturbances for caribou within 200 m of the road, an average of 4.5 mild reactions and 2.5 strong reactions per hour from 0800 through 1700 hours, is many times greater than the one interruption every 8-11 hours from non-human disturbances noted by Curatolo (1975) and Thomson (1973). What physiological stress this frequency of disturbance may cause in the caribou is not known. The alteration of the activity pattern, with less feeding, and the frequent activity interruptions may adversely affect the energy balance of the caribou within 200 m of the road. These effects may remove the strip of caribou range near the road from the amount of range available for effective utilization. The possible importance of these effects are magnified by the data of White *et al.* (1975) which suggest that adult caribou are able to obtain net energy for growth and fattening during only a very short period each year. This period occurs during the summer.

Geist (1971a, 1971b, 1975) reviewed the effects of disturbance on caribou and reindeer and presented equations for calculating the energy

demands of various levels of response to disturbance. Most of the actual data come from experiences with reindeer reported in Zhigunov (1961). Disturbances from herding, snowmobiles, and aircraft at times resulted in loss in body weight, weakened animals with increased susceptibility to disease, emphysema, absorption of embryos, and desertion or trampling of calves.

Moose (*Alces alces*)

Population History, Numbers, Composition, Distribution

No intensive studies have been conducted on McKinley Park's moose population. Most of the available information has been collected in conjunction with studies on wolves (Haber 1972a, 1972b, A. Murie 1944). Haber (1972a) estimated the 1970 population of moose in the area north of the Alaska Range and inside the park, between park headquarters and the Teklanika-Shushana drainages, at 300 animals. He believes that the numbers have remained relatively stable for the last decade or more. In an intensive aerial survey covering the entire park in October and November 1974, Troyer (1974) counted 624 moose.

Moose were sighted on 91% of the shuttle-tour trips. Table 15 presents the total and average numbers sighted each year. For all 70 trips an average of 5.9 moose in 3.8 groups were observed. The maximum number observed on one trip was 25 animals. There appears to be a difference in the number of moose sighted depending on the type of bus, which is probably related to the time of day. Trips on different bus types were paired with no more than two days between trips of a pair and matched-pair t-tests were run. The results showed significantly more moose sighted on the 0400 tour than on the 1500 shuttle in 1974 (t=2.11, $0.01<P<0.05$). The average number of moose seen on each trip on the 0400 tour in 1974 was 7.9 animals, while on the 1500 shuttle the average was 3.7 animals. In 1973, too few trips separated by no more than two days were taken for statistical comparisons. Time of

Table 15. Number of moose observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

YEAR	TOTAL NUMBER OF MOOSE OBSERVED		AVERAGE NUMBER OF MOOSE OBSERVED EACH TRIP		AVERAGE NUMBER OF "DIFFERENT" MOOSE OBSERVED EACH TRIP	
	Animals	Groups	Animals	Groups	Animals	Groups
1973	238	153	5.8	3.7	5.5	3.5
1974	174	114	6.0	3.9	5.8	3.8
TOTAL	412	267	5.9	3.8	5.6	3.7

day seems to influence the number of moose sighted, with the early morning being the best time. This may be related to the fact that the moose frequent areas with dense vegetation and are most visible when active. Weather-related visibility seems less important to the numbers of moose sighted than to the numbers of caribou sighted, also probably because they inhabit dense vegetation and can only be sighted at relatively short distances, regardless of weather conditions. The only seasonal trend in the numbers of moose observed was the aggregating of moose for the rut in the Savage River area in September.

The sex and age distributions of the moose observed appear in Table 16. The sex of 83% of the moose older than calves was determined, giving a bull:cow ratio of 41♂:100♀. The low numbers of bulls sighted could be related to one or more of three factors: 1) an actual skew in the sex ratio, 2) differential distribution and habitat use by the two sexes, or 3) more wariness in bulls than cows. During his 1974 aerial moose survey Troyer (1974) divided the park into a number of survey areas. For the area of the park north of the Alaska Range between the eastern boundary and Sable Pass he found a bull:cow ratio of 41♂:100♀ (n=284). This area includes the section of the road where most of the shuttle-tour moose observations were made. The identical ratios for the two studies suggest an actual skew in this area. The number of bulls is extremely low for an unhunted population, although R. L. Peterson (1955) found that all reports he received from Alaska showed sex ratios favoring females. Rausch (1959) reported a bull:cow ratio

Table 16. Sex and age distributions of moose observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

	1973		1974		TOTAL	
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)
SEX						
Males	40	(17)	40	(23)	80	(19)
Females	108	(45)	85	(49)	193	(47)
Unknown	90	(38)	49	(28)	139	(34)
Total	238		174		412	
AGE						
Single Calves	27	(11)	2	(13)	49	(12)
Twin Calves	24	(10)	8	(5)	32	(8)
Total Calves	51	(21)	30	(17)	81	(20)
Yearlings	11	(5)	12	(7)	23	(6)
Two-Year Olds	3	(1)	2	(1)	5	(1)
Adults	154	(65)	124	(71)	278	(67)
Unknown	19	(8)	6	(3)	25	(6)
Total	238		174		412	

of 83♂:100♀ in a lightly hunted Alaskan population, and ratios of 21-38♂:100♀ where more intensive hunting occurred. Reports from Katmai National Monument, Alaska, for 1969-1972 give ratios of 79-94♂:100♀ (McKnight 1975). The skewed sex ratio in the eastern part of Mount McKinley National Park may have been caused partly by the severe winter of 1970-1971. Haber (1972a) felt that bull mortality was particularly high during that winter because of the poor post-rut condition in which bulls begin the winter. His counts showed bull:cow ratios in the eastern part of the park of 62♂:100♀ in October 1970 and 36♂:100♀ in October 1971. It is also possible that the moose in the eastern section of the park are subjected to some hunting. Winter ranges extend outside the park (Haber 1972b) in areas easily accessible to hunters. Troyer's (1974) counts in the park west of the East Fork River-Sable Pass area, where the moose are infrequently exposed to hunters, revealed a sex ratio of 124♂:100♀ (n=161). Bulls and cows seem to be unevenly distributed through the park, at least in late October and November when Troyer made his surveys. LeResche (1966) found segregation of the sexes by habitat in a moose population near Palmer, Alaska; adult males occupied the hillsides more and valley floors less than the cows. The park road is generally low where it passes through moose habitat, and this factor could affect the sex ratio of the animals observed from the road.

An age class was determined for 95% of the moose sighted, giving 21% calves, 6% yearlings, and 73% two-year olds and older (Table 16). These figures are probably not suitable for determining a calf:cow

ratio, because cows were often not observed for a sufficient amount of time to determine the number of calves present. Calves are born in late May and early June (A. Murie 1944). Twinning is relatively frequent in this area (my observations, A. Murie 1944). Moose are relatively long-lived. Bulls reach their prime from 6-10 years of age (Peterson 1955). Maximum ages are near 18-22 years (Houston 1968, R. L. Peterson 1955).

Table 17 shows the group sizes for moose observed during the shuttle-tour trips. Group sizes ranged from 1-8 individuals; 77% of the animals were solitary or in pairs. Except for cow-calf and rutting associations, moose are a relatively solitary ungulate. Even animals that appear to be in "groups" may be acting independently, being in close association only because of the presence of a favored resource (Denniston 1956, de Vos 1958, Geist 1963, Houston 1974, R. L. Peterson 1955).

Of the moose observed, 94% were sighted along the first 60 km of the road, between Riley Campground and Tattler Creek. Moose occurred all along this section of road. Further along the road, as far as Eielson Visitor Center, there are few patches of suitable habitat. Of the moose sighted, 48% were in open spruce-dwarf shrub habitat, 16% in spruce or mixed spruce and *Populus* woods, 18% in dwarf shrub habitat, 14% in tall willow stands, 2% on gravel bars, and 1% out on alpine tundra.

I learned to individually identify only three moose, one bull with a deformed antler and one cow with a calf. These animals were observed

Table 17. Sizes of moose groups observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

MOOSE GROUP SIZE	GROUPS						ANIMALS					
	1973		1974		Total 1973-1974		1973		1974		Total 1973-1974	
	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)
1	90	(59)	70	(61)	160	(60)	90	(38)	70	(40)	160	(39)
2	43	(28)	34	(30)	77	(29)	86	(36)	68	(39)	154	(38)
3	18	(12)	8	(7)	26	(10)	54	(23)	24	(14)	78	(19)
4	2	(1)	1	(1)	3	(1)	8	(3)	4	(2)	12	(3)
8	0	(0)	1	(1)	1	(<1)	0	(0)	8	(4)	8	(2)
TOTAL	153		114		267		238		174		412	

throughout the summer of 1973, all remaining in restricted areas of a few kilometers along the road. A. Murie (1944) noted a cow with two calves in the park that remained one entire summer along one 10 km section of the road. A. Murie (1961) reported on three bulls that remained together through the summer in an area 3 km across. LeResche (1974) reviewed the literature on movements and home range size for North American moose, including Alaska, and concluded that seasonal home ranges are seldom larger than 5-10 km^2, that cows with calves have the smallest seasonal home ranges, and that yearlings and rutting bulls wander most widely. Individuals often return to the same seasonal ranges in successive years (Houston 1974, LeResche 1974).

Human Disturbance

General Avoidance

Table 18 summarizes the data on moose observations in the plots. Moose occurred occasionally in all plots, except the Stony Road Plot. Moose were observed frequently only in the Igloo Road Plot. Individuals appeared to be residing in this plot through the entire summer each year; a cow and calf were sighted several times in 1973, and a cow and calf, a yearling cow, and an adult bull were frequently sighted in 1974. Moose apparently were not summer residents in the Igloo Off-Road Plot. They first appeared in this plot in late August and September. A quantity of shed antlers indicated that wintering moose use this area. The data do not indicate any large-scale avoidance by moose of watersheds containing the road. In the Igloo Road Plot, moose were

Table 18. Average number of moose observed in study plots, Mount McKinley National Park, Alaska.

PLOT		AVERAGE DAILY TOTAL OBSERVATIONS				AVERAGE DAILY FIRST SEARCH OBSERVATIONS				NO. OF DAYS ANIMALS OBSERVED OUT OF FIVE POSSIBLE
		Actual Number		Density (per km^2)		Actual Number		Density (per km^2)		
		Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	
Igloo Road	1973	1.80	1.20	0.12	0.08	1.40	1.00	0.09	0.06	5
Igloo Road	1974	2.80	2.20	0.18	0.14	2.80	2.20	0.18	0.14	5
Igloo Off-Road	1973	0.60	0.60	0.03	0.03	0.60	0.60	0.03	0.03	2
Igloo Off-Road	1974	0.20	0.20	0.01	0.01	0.20	0.20	0.01	0.01	1
Highway Road	1973	0.20	0.20	0.01	0.01	0.20	0.20	0.01	0.01	1
Highway Off-Road	1973	0.40	0.40	0.03	0.03	0.40	0.40	0.03	0.03	2
Stony Road	1973	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0.20	0.20	0.02	0.02	0.20	0.20	0.02	0.02	1
Sable Road	1973	0.20	0.20	0.01	0.01	0.20	0.20	0.01	0.01	1

often observed noticing passing traffic, but usually they did not move away long distances. Visitors seldom noticed the moose, which usually were in dense vegetation. The truck census data showed no reductions in moose numbers near the road associated with the opening of the road to public buses in the spring or to all vehicles in the fall.

Reaction Distances

The distances from the road of moose observed during the shuttle-tour trips appear in Table 19. Because moose usually occur in areas of dense vegetation, the moose sighted were distributed closer to the road than other species, such as caribou, which occur frequently in open country. Eighty percent of the moose observed were within 200 m of the road. Numbers observed decreased steadily with distance from the road.

The reaction of 15% of the moose was unknown or uninterpreted as to cause. Of all known reactions, 57% of the animals showed no visible response to the presence of the bus and visitors, 18% exhibited a mild reaction, and 24% exhibited a strong reaction. For animals within 200 m of the road these figures were 50%, 20%, and 29%, respectively. Mild responses may have been underestimated because of the habit of some moose of slowly drifting away from a source of mild disturbance, or slowly entering dense cover in response to disturbances. This type of response may be undetected by an observer on a bus restricted to a short observation period. This factor is discussed in more detail later.

Table 19. Reactions of moose, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	KNOWN REACTIONS OF MOOSE TO BUS AND VISITORS						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	20	22	9	12	71	70	69	50	77	53	19	20
0-100	46	47	19	19	35	35	216	154	255	172	62	64
0	0	0	5	8	95	92	19	13	19	13	5	5
1-25	28	30	10	14	62	61	50	36	58	39	14	15
26-50	30	38	40	38	30	27	53	37	70	45	17	17
51-75	54	53	21	24	25	24	24	17	26	18	6	7
76-100	80	78	13	12	7	10	70	50	82	56	20	21
101-200	66	68	25	21	8	12	59	34	72	44	18	16
201-300	70	76	22	18	9	6	23	17	25	19	6	7
301-400	92	92	0	0	8	8	26	12	31	14	8	5
401-500	100	100	0	0	0	0	10	6	11	7	3	3
501-750	57	75	43	25	0	0	7	4	9	5	2	2
751-1000	100	100	0	0	0	0	5	4	5	4	1	1
>1000	100	100	0	0	0	0	4	3	4	3	1	1
TOTAL	57	58	18	18	24	25	350	233	412	267		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A17.

Table 19 and Figure 9 show a steady decline in the percentage of moose reacting to vehicles and visitors, and in the ratio of strong to mild reactions, with increased distance between the animal and the human activities. A *G*-test reveals that the relationship between distance and response is significant (G=57.8, P<0.005). For the statistical test, 100 m intervals from 0-500 m were used. Only one group beyond 400 m from the road was observed to react to human activities on the road.

McCourt *et al.* (1974) studied the response of a few moose to overflights by a Cessna 185. For overflights within 600 ft (180 m) they recorded 55% nil reactions, 38% mild reactions ("significant" interruption of activity or trotting), and 8% strong reactions (running flight) (n=40). For six moose over 600 ft (180 m) from the aircraft, they recorded only nil reactions.

The flight distance of moose in response to a man on foot is variable and depends on a variety of factors. However, several "average" estimates have been reported by investigators who have become familiar with moose. For naive moose, reported flight distances include 90-140 yd (80-130 m) (Denniston 1956), 100 m (LeResche 1966), 150 yd (140 m) (McMillan 1954), and 100 m (Stringham 1974). Peterson (1955) found that some moose fled even at 0.25 mi (400 m) if downwind of a man. Moose appear to be rather easily habituated to the presence of man if they are not threatened. Flight distances reported for habituated moose include 20-50 yd (20-45 m) (Denniston 1956), 100 ft (30 m) (de Vos 1958), 25-50 yd (25-45 m) (McMillan 1954), and 30-50 m (Stringham

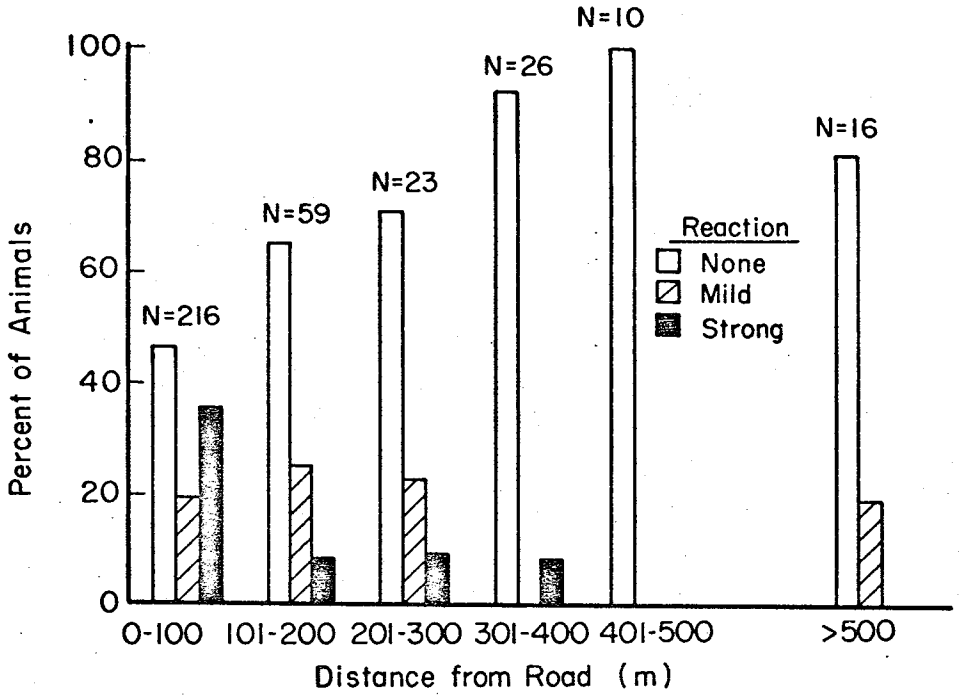

Figure 9. Reactions of moose, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

1974). Altmann's (1958a) work illustrates some of the factors affecting flight distances. After several years of work with moose, she reported the following flight distances: 30-70 ft (10-20 m) for cows with a newborn calf, 150-200 ft (45-60 m) for cows with a heeling calf, 100-120 ft (30-35 m) for bulls in velvet, 60-90 ft (20-30 m) for pre-rut bulls, 10-30 ft (5-10 m) for rutting adults, 20-60 ft (5-20 m) for groups in winter, 200-300 ft (60-90 m) for animals during a hunting season, and 15-35 ft (5-10 m) for animals exposed to the familiar actions of tourists, caretakers, or fishermen. Apparently many of the moose Altmann observed were habituated to man to some degree.

Relationship of Reaction to Type of Disturbance

Table 20 presents information on the actions of the bus and visitors when moose were sighted. The bus passed, without stopping, 14% of the animals sighted. The bus stopped, without people getting out, for 75% of the animals, while the bus stopped, with people getting out, for 11% of the moose sighted. For just the animals within 200 m of the road, these figures are 12%, 75%, and 13%, respectively. The shuttles tended to pass more animals (22%) than the tours (3%), and people got off shuttles for more of the animals (14%) than off tours (8%). The differences in the pattern of activities for tours and shuttles are significant (X^2=28.45, P<0.005). During the shuttle-tour trips people were not observed walking off the road toward moose, but this action was observed at other times.

Table 20. Reactions of moose, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	KNOWN REACTIONS OF MOOSE						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	70	71	9	13	22	19	23	21	30	26	9	12
Pass <15 mph	56	50	11	12	33	38	9	8	10	9	3	4
Stop, people remain on bus, quiet	56	56	21	20	23	26	186	121	221	140	68	69
Stop, people remain on bus, noisy	5	7	25	33	70	60	20	15	22	16	7	7
Stop, people off bus on road, quiet	31	35	23	20	46	45	35	20	41	22	12	10
Stop, people off bus on road, noisy	50	50	50	50	0	0	2	2	3	2	1	1
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50	51	20	20	29	30	275	187	327	215		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A20.

The reactions of moose are related to the type of disturbance in Table 20 and Figure 10. Chi-squared tests were used to compare the reaction patterns exhibited by moose within 200 m of the road in response to various actions of the bus and visitors. There are no significant differences in reactions to the bus passing, without stopping, compared to reactions to the bus stopping, with the people remaining quietly in the bus. There is a significant difference (X^2=9.08, P<0.025) in the reaction patterns of moose exposed to a bus stopping, with the people quietly remaining on the bus, compared with the bus stopping, with the people quietly getting off the bus. The latter action increased the strong reactions from 23% to 46%. There is also a significant difference (X^2=23.67, P<0.005) between the reactions of moose exposed to the bus stopping, with the people remaining quietly on the bus, and those exposed to the bus stopping, with the people remaining on the bus but making loud noises. Loud noises increased strong reactions from 23% to 70%.

Altmann (1958a), Denniston (1956), and McMillan (1954) all observed moose intensively in national parks, especially Yellowstone and Grand Teton. Both Altmann and Denniston comment that moose are less disturbed by the noisy, obvious activities of tourists than by the silent, stealthy approach of an investigator under cover. McMillan, however, stresses that a slow, quiet approach is less disturbing than a fast, noisy approach. The difference between the observations probably relates to a sneak approach, under cover, versus a slow, quiet approach, but in full view, and with the moose aware of the presence of

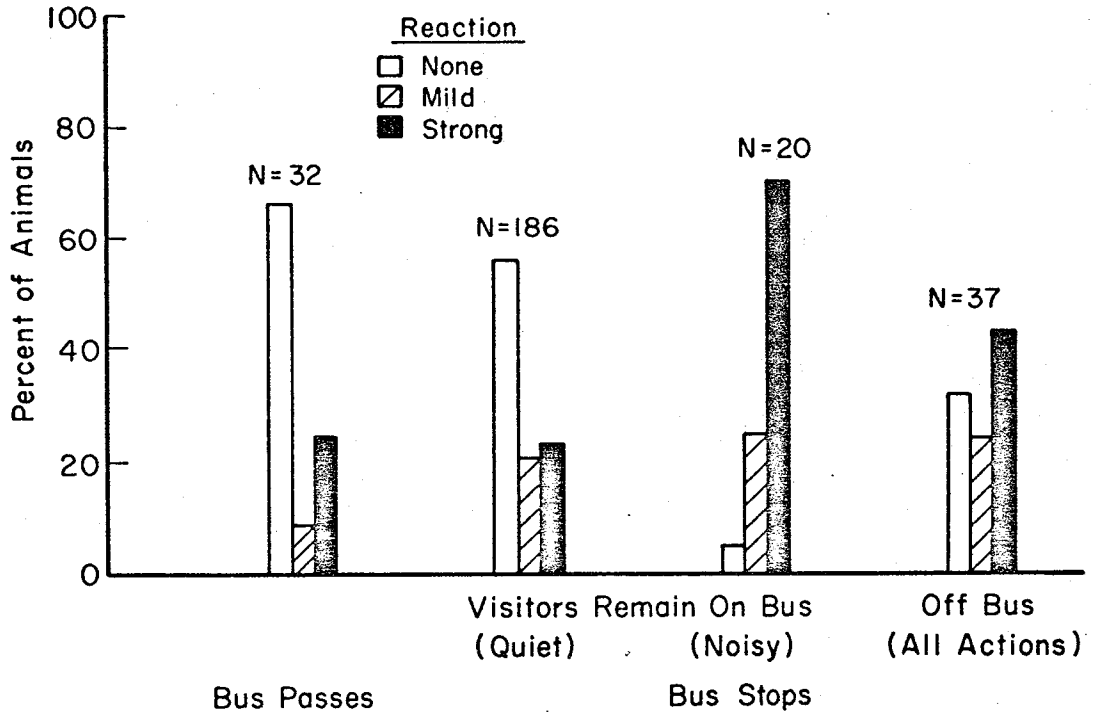

Figure 10. Reactions of moose, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

the observer. Moose seem to learn to recognize familiar, harmless human activities and often ignore them, while the unfamiliar, threatening, sneak approach remains disturbing. Moose also seem to recognize individual people they see frequently and exhibit fewer responses to them than to strange people (Altmann 1958a, McMillan 1954). As with many mammals, people on foot are more disturbing than vehicles, once a moose is habituated (Dixon 1938).

The sensitive hearing of moose is important in warning them of danger (A. Murie 1934, R. L. Peterson 1955, Van Wormer 1972). Moose are sensitive to the sounds of snapping twigs and rustling brush, often their first clue of danger in areas of dense cover (McMillan 1954, Van Wormer 1972). Van Wormer (1972) also reported that moose are sensitive to high-pitched metallic sounds. The sense of smell is reportedly sensitive in moose (A. Murie 1934, R. L. Peterson 1955). The sense of sight is poor with respect to the recognition of forms, but sensitive to movement (Altmann 1958a, A. Murie 1961, Van Wormer 1972). Sight is apparently least important in detecting danger.

Relationship of Reaction to Sex and Age

The relationship between sex and age and the reaction to human activities is given in Table 21. Statistical analyses for animals within 200 m of the road showed no significant differences between: 1) the reaction patterns of calves versus cows followed by a calf or 2) the reaction patterns of cows without calves versus bulls. However, there is a significant difference between the combined pattern of

Table 21. Reactions of various sex and age classes of moose, observed during shuttle-tour trips, to buses and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF MOOSE TO BUS AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
CALF							
0-100	14	(30)	13	(29)	19	(41)	46
101-200	2	(29)	5	(71)	0	(0)	7
201-400	5	(71)	1	(14)	1	(14)	7
>400	4	(67)	2	(33)	0	(0)	6
Total	25		21		20		66
COW WITH CALF							
0-100	12	(34)	8	(23)	15	(43)	35
101-200	2	(40)	3	(60)	0	(0)	5
201-400	4	(67)	1	(17)	1	(17)	6
>400	3	(75)	1	(25)	0	(0)	4
Total	21		13		16		50
COW WITHOUT CALF[a]							
0-100	37	(51)	14	(19)	21	(29)	72
101-200	18	(72)	4	(16)	3	(12)	25
201-400	15	(88)	2	(12)	0	(0)	17
>400	3	(100)	0	(0)	0	(0)	3
Total	73		20		24		117
BULL							
0-100	24	(52)	5	(11)	17	(37)	46
101-200	9	(64)	3	(21)	2	(14)	14
201-400	11	(85)	0	(0)	2	(15)	13
>400	1	(100)	0	(0)	0	(0)	1
Total	45		8		21		74

[a] Calf not seen, possible that a few of these cows actually had calves.

calves and their dams versus the combined patterns of cows without calves and bulls (X^2=14.28, P<0.005). The reactions of calves and their dams were interdependent. The calves and dams responded more frequently and strongly at a given distance, and responded at greater distances, than the cows without calves and bulls (Table 21). A number of authors have noted the increased wariness of cows with calves and their greater likelihood of fleeing (Altmann 1958a, Jakimchuk *et al.* 1974, Klein 1974, LeResche 1966).

The reactions of cows with calves change with the age of the calf. For the first 3 days of life, a calf's locomotor abilities are poor (Altmann 1958b) and the cow often remains in thick cover, flushing only if approached very closely (Altmann 1958a). The locomotor abilities of calves have some importance in determining the effects of disturbance. I have observed very young calves stumble and, on one occasion, roll down a bank, when cows with young calves were surprised on or near the road by vehicles or off the road by hikers. The potential for occasional injuries to calves exists. Altmann (1958b) also reported that young calves occasionally follow humans that have approached closely and that this behavior may result in an attack on the person by the cow. When the calf is old enough to follow the cow easily, the flushing distance becomes very long (Altmann 1958a). The moose calf depends on the cow for protection, and Geist (1963) argued that calves are usually not alert to danger. However, we occasionally observed calves responding to buses and visitors by moving closer to the cow, or hiding behind her, while the cow gave no visible reaction to the

human activities. Yearlings, only recently deprived of maternal protection, have been reported as quite unresponsive (Geist 1963, R. L. Peterson 1955).

Relationship of Reaction to Season, Time, Weather, Habitat

The reaction patterns of moose appeared to change through the summer season (Table 22). For moose within 200 m of the road in 1973, there were significant differences between the reaction patterns from May 26-July 6 as compared to July 7-August 17 (X^2=13.14, P<0.005), and from July 7-August 17 as compared to August 17-September 15 (X^2=23.42, P<0.005). Trends were similar in 1974, but could not be analyzed statistically because of the small number of moose observed during the mid-summer period. The percentage of strong reactions showed little seasonal change, but mild reactions decreased through the summer. In 1973, but not in 1974, mild reactions increased again near the end of the summer. The decreases probably resulted from the habituation of some individuals through the summer. Animals that only reacted mildly to human activities early in the summer probably habituated sooner than those that reacted strongly. It is also probable that less habituation occurred to the types of stimuli that generated strong reactions. McMillan (1954), working in Yellowstone, reported that moose were most sensitive early in the tourist season and habituated as the season progressed. My study did not include the winter season, although the park is receiving increasing recreational use in the winter. Altmann (1958a) reports very short flushing distances for moose in the winter

Table 22. Seasonal changes in reactions of moose, observed on the shuttle-tour trips, to the bus and visitors, Mount McKinley National Park, Alaska.

DATE: DISTANCE FROM ROAD (m)	REACTION OF MOOSE TO BUS AND VISITORS						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
1973							
May 26-July 6							
0-200	40	(42)	25	(26)	30	(32)	95
>200	21	(75)	5	(18)	2	(7)	28
July 7-August 17							
0-200	30	(65)	1	(2)	15	(33)	46
>200	11	(100)	0	(0)	0	(0)	11
August 17-Sept. 15							
0-200	10	(31)	15	(47)	7	(22)	32
>200	1	(33)	0	(0)	2	(67)	3
1974							
May 26-July 6							
0-200	21	(49)	12	(29)	10	(23)	43
>200	5	(62)	3	(38)	0	(0)	8
July 7-August 17							
0-200	12	(67)	0	(0)	6	(33)	18
>200	23	(100)	0	(0)	0	(0)	23
August 17-Sept. 15							
0-200	25	(61)	3	(7)	13	(32)	41
>200	2	(100)	0	(0)	0	(0)	2

and relates the fact to reduced vigor and the difficulties of traveling through deep snow. Altmann also comments on the factor of time in relation to disturbance. She found moose less sensitive at dusk and dawn than at other times of the day.

Knowlton (1960) and R. L. Peterson (1955) reported that moose retreat to areas of dense cover and are less active during windy weather and storms, when possible warnings of danger, through sounds and smell, are more difficult to detect. However, de Vos (1958) was unable to find similar relationships in his study area. Altmann (1958a) and McMillan (1954) found moose more wary in open areas than in areas of good cover. LeResche (1966) felt that moose are more likely to flee precipitously if surprised in heavy cover than if approached in the open.

Behavior Before Disturbance

The behavior before disturbance for the moose observed on the shuttle-tour trips appears in Table 23. Increased traveling and decreased lying and standing, at least in the open where they are visible, within 200 m of the road is suggested by the data.

No comparisons could be made between various behaviors before disturbance and subsequent reactions to disturbances because few non-feeding moose were observed. McMillan (1954) reported that, in Yellowstone, lying moose were less easily frightened than feeding animals, especially after they had been bedded down for an hour or more.

Table 23. Behavior before disturbance of moose observed during shuttle-tour trips, 1973-1974, Mount McKinley Park, Alaska.

DISTANCE FROM ROAD (m)	BEHAVIOR OF MOOSE BEFORE DISTURBANCE												TOTAL NUMBER ANIMALS
	FEED		FEED-WALK[a]		LIE		STAND		TRAVEL[b]		OTHER[c]		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	188	(87)	1	(<1)	1	(<1)	5	(2)	12	(6)	10	(5)	217
>200	49	(73)	6	(9)	3	(4)	6	(9)	3	(4)	0	(0)	67
TOTAL	237	(83)	7	(2)	4	(1)	11	(4)	15	(5)	10	(4)	284

[a] Feeding while traveling at a walk.

[b] Movement at a walk, trot, or run.

[c] Alert, drink, interactions, rut activities.

Behavior Patterns Related to Disturbance

The maximum behavioral responses given by the moose observed during the shuttle-tour trips appear in Table 24. Fifty percent of the animals within 200 m of the road were recorded as showing no visible response to the bus and visitors. However, this figure probably overestimates the true percentage of animals that did not respond. Only during the second year of the study did I begin to realize the subtleness of some of the responses given by moose. I frequently noted moose standing completely still; and others browsing slowly along until they disappeared into cover, not to reappear. Although many of these moose never looked directly at the bus, they were probably responding to the presence of the vehicle. A delayed response and freezing stance appear to be characteristic of the reactions of moose to disturbances (Altmann 1958a, de Vos 1958, Geist 1963, Stringham 1974).

Only 11% of the moose within 200 m of the road were observed to watch the bus and visitors without then moving away. Denniston (1956) and McMillan (1954) describe the alert posture of moose, which includes raising the head, holding the ears erect and directed toward the source of disturbance, and staring intently for several seconds or minutes. If the animal becomes alarmed it may "freeze" (my observations, Altmann 1958a, Stringham 1974), bring its hind legs together and urinate on them (Geist 1963, McMillan 1954, A. Murie 1934, R. L. Peterson 1955), and give a short, harsh bark (de Vos 1958, McMillan 1954). Also, in a detailed behavior study, Stringham (1971) found that his presence near moose that appeared habituated but were actually still disturbed

Table 24. Maximum behavioral reactions of moose observed during shuttle-tour trips to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	MAXIMUM REACTION OF MOOSE TO BUS AND VISITORS										TOTAL
	NONE		WATCH		WALK <10 m		WALK >10 m		TROT OR RUN		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	138	(50)	30	(11)	26	(9)	26	(9)	55	(20)	275
>200	63	(84)	6	(8)	2	(3)	0	(0)	4	(5)	75
TOTAL	201		36		28		26		59		350

increased comfort movements from 2-5 per hr to 20-50 per hr, increased eliminations from 1-2 per hr to 4-8 per hr, and increased the rate of respiration from 1 every 2-6 sec to 2 per sec. He also noted a decrease in the length of feeding and rumination bouts.

For moose within 200 m of the road, 18% moved away from the bus and visitors at a walk, and 20% moved away at a trot or run. Flight is usually delayed for several seconds or minutes after a disturbance has been detected (my observations, Altmann 1958a, de Vos 1958, Geist 1963), and fleeing animals usually stop frequently to look back (my observations, Geist 1963, LeResche 1966, R. L. Peterson 1955). Flight is usually towards cover (my observations, de Vos 1958, McMillan 1954, R. L. Peterson 1955). Moose observed from the shuttle-tour buses often moved slowly away or into cover, while continuing to feed. It was often difficult to determine if the movement was in response to the bus and visitors or simply normal movement while feeding. However, after some experience, the observers learned to recognize purposeful, directional movements by some moose that continued to feed after the bus arrived. Stringham (1974) noted that undisturbed moose moved aimlessly over an area several body lengths in radius for an hour or more while feeding, while disturbed moose, although appearing to feed "aimlessly", drifted away from the source of disturbance. He found that if the disturbance continued movement increased and feeding decreased until finally the animal stopped feeding and walked or trotted away. Intense displacement feeding has been reported as common in disturbed moose, before, during, and after flight (Geist 1963, LeResche

1966). A moose that moves slowly into cover may begin trotting rapidly away after it has entered cover (my observations, de Vos 1958, R. L. Peterson 1955). Alternatively, a moose that moves either slowly or quickly into cover, may stop and stand silently, after it believes it is hidden (my observations, R. L. Peterson 1955). This type of behavior was often observed in response to the shuttle-tour buses and visitors on the road. McMillan (1954) noted that habituated moose in Yellowstone Park usually moved slowly away from a disturbance, while naive moose usually trotted or ran away. R. L. Peterson (1955) felt that moose seldom ran unless suddenly frightened. It was difficult for us to determine how far retreating moose moved away from the road, since they were usually quickly out of view in dense vegetation. Geist (1963) reported that moose usually do not flee very far.

McMillan (1954) noted that moose usually rested in cover and preferred resting areas that provided cover between themselves and the highway. LeResche (1966) found that moose made good use of islands and peninsulas of cover when moving out into open areas to feed.

Occasionally, moose, especially cows with calves, have been known to attack humans (Altmann 1958a, Denniston 1956). Before attacking, moose move with a stiff warning gait, raise the hair on their neck and back, flatten their ears, retract their lips, and often make a chewing motion with their mouth (Altmann 1958a, Denniston 1956, Geist 1963). These are warning actions. If the individual disturbing the moose leaves, attacks seldom occur (Denniston 1956). We observed no attacks on vehicles or people using the park road, although threat signals were

observed on rare occasions.

Moose were frequently observed crossing the road. They occasionally ran on the road for up to 1 km in front of approaching vehicles. One moose was hit and killed by a vehicle during the period of my study.

Influence of Roadside Vegetation

In many areas along the road willows grow in a strip along the side of the road where the drainage water runs off the road. On a few occasions moose were observed feeding on these roadside willows. The willows may occasionally attract or hold moose near the road. However, willow is abundant in many areas of the park and feeding on the roadside willows did not seem to occur frequently.

Summary and General Discussion

In 1970, the moose population in the park east of the Teklanika River, where the road passes through the most moose habitat, was estimated at 300 animals (Haber 1972a). During my study, moose were sighted on 91% of the shuttle-tour trips. The sex ratio of the moose observed that were older than calves was highly skewed toward females with 41♂:100♀, probably because of an actual skewed sex ratio in this area of the park (Troyer 1974). Of the moose observed during shuttle-tour trips 21% were calves. Seventy-seven percent of the animals were solitary or in pairs. My observations and the literature (Houston 1974, LeResche 1974, A. Murie 1944, 1961) indicate that many individuals have restricted seasonal home ranges to which they may return in

successive years. They are also relatively long-lived, reaching maximum ages of 18-22 years (Houston 1968, R. L. Peterson 1955). These characteristics undoubtedly result in many of the same individual animals being observed from the road repeatedly throughout a summer and in successive years. Repeated contacts with human activities would allow moose to habituate if the activities were of a type that did not reinforce the initial alarm response. If habituation did not occur individuals could be adversely affected by the frequent disturbances.

In the park, moose were observed congregating near Savage River during the rut. After a literature review, LeResche (1974) concluded that the moose population from a large area may concentrate seasonally in small areas of critical habitat and that the misuse by humans of a small critical area could seriously affect a large number of moose.

The plot data and the research vehicle road census data did not reveal any evidence that moose were avoiding the general vicinity of the road. Denniston (1956) felt that moose avoided a formerly heavily used area in Wyoming when road construction began there. Responses of moose to road construction activities are probably quite different than their responses to an existing road. In Yellowstone National Park, McMillan (1954) found that naive moose, frightened from a feeding area by human visitors, did not return that same day. Habituated moose often did return the same day.

As in other species, a variety of interacting variables affect the responses of moose to human activities. Flight distances for moose are relatively short. For moose sighted during shuttle-tour trips

within 200 m of the road, 50% gave no visible response to the bus and visitors, 20% gave mild responses, and 29% gave strong responses. Mild responses may have been underestimated due to the subtleness of some responses. The 50% threshold for strong responses was between 25 and 50 m from the road. Reported "average" flight distances from man range from 80-140 m for naive moose and from 5-50 m for habituated moose (Altmann 1958a, Denniston 1956, de Vos 1958, LeResche 1966, McMillan 1954, Stringham 1974). The evolutionary factors affecting flight distance in moose are not completely clear. Like most large mammals, they learn quickly and habituate to man in areas where they are not hunted. They may also often depend on cover to remain undetected, rather than on flight to escape. Their major predators are wolves, man, and perhaps bears. Mech (1970) found that moose often successfully protected themselves from wolves by standing and fighting rather than by fleeing. He also found that if a fleeing moose maintained a distance of only 100 yd (90 m) between itself and pursuing wolves the wolves usually gave up after 10-15 sec. Moose seem to depend on their abilities to stand and fight, or escape easily, more than on detecting wolves at a distance. Mech reported that during 120 of 131 wolf attacks on moose that he observed, the moose did not detect the wolves until they had already begun their stalk or charge.

The shuttle-tour buses stopped for 88% of the moose sighted within 200 m of the road, and people got off the bus for 13% of the animals. Stopping, without people getting out did not significantly change the frequency or strengths of responses over passing without stopping. The

frequency and strength of reactions were significantly increased when loud noises were produced or people got off the bus. The increase in strong reactions when loud noises occurred was probably related to the fact that these noises were unfamiliar or unexpected. Loud noises occurred during only 10% of the sightings, involving 12% of the animals. Moose are particularly sensitive to sound, because in the dense vegetation they inhabit sounds are often the first warning of danger (A. Murie 1934, R. L. Peterson 1955). However, McMillan found that moose in Yellowstone habituated to car horns, backfires and other highway sounds. Geist (1963) observed one bull moose feeding calmly within 100 yd (90 m) of a trail crew using a power saw but noted another bull jump at the sound of an axe 500-600 yd (460-550 m) away. The difference was probably related to surprise and habituation.

Cows with calves were found to be significantly more sensitive to disturbances than cows without calves, or bulls. Calves were common along the park road and very young calves with poor locomotor abilities may be injured if forced to flee during a disturbance.

Some habituation apparently occurred each year as the summer progressed. Although mild reactions decreased through the summer, strong reactions did not.

Moose disturbance behavior is characterized by standing without fleeing, short flights, and the use of cover. Many of the key factors in the disturbance behavior of moose are probably derived from the moose-wolf relationship as discussed earlier (Mech 1970). Mild responses were probably underestimated during my study because of the

subtle disturbance behavior of moose. Altmann (1958a) comments that "The popular belief that moose do not 'pay much attention' is erroneous. Even when eagerly browsing, grazing or standing still, the moose will closely observe the disturbance and select the most suitable moment for slipping away." After becoming more familiar with moose, I began to realize the truth of this statement. Because many disturbance studies depend on interpreting the instantaneous visible responses to a disturbance, the level of sensitivity in moose is probably often underestimated.

Dall Sheep (*Ovis dalli*)

Population History, Numbers, Composition, Distribution

Several biologists have studied the distribution, population dynamics, habitat utilization, and predator relationships of Mount McKinley National Park's Dall sheep population (Haber 1972a, A. Murie 1944, Murphy 1973, Sheldon 1930, Whitten 1975). Estimates based on actual counts have shown the population fluctuating between 500-3,000 animals since 1945 (Murphy 1973). During 1973, the population's size was estimated at 1,600 animals (Whitten 1975). At this population level, sheep were sighted during 100% of the 70 shuttle-tour trips. An average of 34.7 animals in 4.6 groups were observed each trip (Table 25). The maximum number sighted during one trip was 86 sheep. No seasonal trends in numbers were evident. There were no significant differences in the numbers sighted from the various types of buses.

The group sizes of sheep sighted varied from 1-45 animals (Table 26). The larger groups were generally ewe-lamb bands.

Very few of the sheep sighted during the shuttle-tour trips were sexed or aged, as most of the animals were more than 400 m from the road and the buses did not stop long enough for the observer to gather this data. In general, ewe-lamb bands were very common, while bands of old rams were observed only occasionally. Many rams move up to the higher valleys of the Alaska Range for the summer. Bands of sheep are often segregated by sex and age (Geist 1971, A. Murie 1944). Using ground counts, Whitten (1975) determined the population composition in McKinley Park for the summer of 1973 to be 44% adult ewes, 30% adult

Table 25. Number of Dall sheep observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

YEAR	TOTAL NUMBER OF DALL SHEEP OBSERVED		AVERAGE NUMBER OF DALL SHEEP OBSERVED EACH TRIP		AVERAGE NUMBER OF "DIFFERENT" DALL SHEEP OBSERVED EACH TRIP
	Animals	Groups	Animals	Groups	Animals
1973	1407	201	34.3	5.0	31.0
1974	1020	123	35.2	4.2	31.8
TOTAL	2427	324	34.7	4.6	31.5

Table 26. Sizes of Dall sheep groups observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

DALL SHEEP GROUP SIZE	GROUPS						ANIMALS					
	1973		1974		Total 1973-1974		1973		1974		Total 1973-1974	
	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)	No.	(% of Total)
1	20	(10)	11	(9)	31	(10)	20	(1)	11	(1)	31	(1)
2-5	83	(41)	50	(41)	133	(41)	274	(19)	166	(16)	440	(18)
1-10	157	(78)	94	(76)	251	(77)	696	(49)	430	(42)	1126	(46)
11-20	39	(19)	17	(14)	56	(17)	574	(41)	255	(25)	829	(34)
21-30	3	(1)	8	(6)	11	(4)	71	(5)	194	(19)	265	(11)
31-40	2	(1)	3	(2)	5	(2)	67	(5)	100	(10)	167	(7)
41-50	0	(0)	1	(1)	1	(<1)	0	(0)	41	(4)	41	(2)
TOTAL	201		123		324		1407		1020		2427	

rams, 6% yearlings, and 20% lambs. The life expectancy of sheep varies with the vigor and growth rate of individuals in a population (Geist 1971c), but animals over 10 years of age are generally considered old. The oldest sheep found by A. Murie (1944) in McKinley Park were 14 years of age.

Most of the sheep range in the park is east of Eielson Visitor Center (A. Murie 1944, Murphy 1973). The sheep winter in the Outer Range and, in mild winters, in a few favorable spots in the Alaska Range. During the summer some of the sheep remain on the winter range, while others cross the east-west valley through which the road passes and summer in the Alaska Range. Movements between winter and summer ranges generally occur in June, although there is great variability in timing (A. Murie 1944). While working with Stone's sheep (*Ovis dalli stonei*) in Canada, Geist (1971c) concluded that individual sheep show high fidelity to their seasonal home ranges, that home ranges and migration routes are transmitted by tradition from old to young animals, and that the social system minimizes dispersal of young. Geist stressed the patchiness of suitable sheep habitat, with patches connected by traditional migration routes. Murphy (1973) pointed out that the range in McKinley is more continuous than in the area where Geist worked. However, there is evidence of range fidelity for individual sheep in, and just outside, the park (my observations, Heimer *et al.* 1972, Whitten 1975).

Although sheep range is visible in the distance along most of the road from Riley Campground to Eielson Visitor Center, the road passes

within a few hundred meters of suitable sheep habitat in only a few places. During the shuttle-tour trips, 4% of the sheep sighted were between Riley Campground (Km 0.2) and Km 51, just before Igloo Canyon, 65% were sighted on Igloo, Cathedral and Sable mountains (Km 51-70), and 30% were sighted between the East Fork River and Eielson Visitor Center (Km 70-107). Both A. Murie (1944) and Murphy (1973) found some of the highest summer densities of sheep in the park in the Igloo-Cathedral-Sable mountains area. Most of the sheep sighted during the shuttle-tour trips were high on mountainsides, near escape terrain, unless they were crossing from one mountain to another. Of the sheep sighted, 47% were on talus slopes, 23% were in alpine tundra, 20% were in mixed alpine tundra and talus, 5% were in cliffs, 10% were in dwarf shrub-open spruce areas, and 1% or less were in each habitat type of spruce woods, *Populus* stands, tall willow, dwarf shrub, and gravel bars.

The timing of lambing in the park varies yearly, but late May and early June is the most common time (Dixon 1938, A. Murie 1944). Rutting usually peaks in November (A. Murie 1944, Sheldon 1930).

Human Disturbance

General Avoidance

Sheep were observed in all the study plots except the Stony pair (Table 27). The Igloo pair of plots contained the highest densities. The average minimum density of sheep in the Igloo Off-Road Plot was considerably higher than in the Igloo Road Plot each summer, but a

Table 27. Average number of Dall sheep observed in study plots, Mount McKinley National Park, Alaska.

PLOT		AVERAGE DAILY TOTAL OBSERVATIONS				AVERAGE DAILY FIRST SEARCH OBSERVATIONS				NO. OF DAYS ANIMALS OBSERVED OUT OF FIVE POSSIBLE
		Actual Number		Density (per km^2)		Actual Number		Density (per km^2)		
		Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	
Igloo Road	1973	32.80	4.40	2.14	0.29	28.20	3.40	1.84	0.22	5
Igloo Road	1974	17.40	3.20	1.14	0.21	15.69	1.05	1.02	0.21	5
Igloo Off-Road	1973	92.00	6.40	4.79	0.33	56.80	4.80	2.95	0.25	5
Igloo Off-Road	1974	45.00	4.80	2.38	0.25	45.20	4.60	2.35	0.24	5
Highway Road	1973	4.00	0.80	0.22	0.04	4.00	0.80	0.22	0.04	3
Highway Off-Road	1973	3.60	0.60	0.28	0.05	3.60	0.60	0.28	0.05	2
Stony Road	1973	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0	0	0	0	0	0	0	0	0
Sable Road	1973	6.60	1.00	0.32	0.05	6.20	0.80	0.30	0.04	3

matched-pair t-test on all the first search observation periods (Appendix A6) showed no significant difference at the P=0.05 level. The Igloo Road Plot receives frequent off-road visitor use. On five occasions during my 10 plot observation periods I observed visitors climbing the mountainside to approach bands of sheep. However, the sheep appeared quite habituated to this activity, often allowing humans to approach closer than 100 m, and did not move long distances away unless a photographer insisted on approaching closer and closer until the sheep moved a long distance away or moved onto the cliffs.

Most of the road runs below the areas of prime sheep habitat, so that close contact between sheep and human activities along the road is infrequent. However, on Polychrome Mountain the road cuts through the sheep range. Despite the presence of the road, some sheep still use this area, as discussed below. In the past there has been more use of this area by sheep (A. Murie 1944), but the level of use may be related to overall population size, density and range factors, as well as to the presence of the road.

Reaction Distances

Table 28 and Figure 11 show the distances from the road of sheep sighted during shuttle-tour trips and the reaction patterns of sheep at varying distances from the road. Only 6% of the animals sighted were within 200 m of the road. Most of the prime sheep habitat visible from the road is over 400 m away. Only under two situations were sheep generally within 200 m of the road: 1) when crossing the road during

Table 28. Reactions of Dall sheep, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF DALL SHEEP TO BUS AND VISITORS						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	20	38	18	25	63	50	51	16	51	16	2	5
0-100	44	45	21	27	34	33	116	33	120	34	5	10
0	0	0	12	25	88	75	24	4	24	4	1	1
1-25	37	50	22	25	41	42	27	12	27	12	1	4
26-50	31	43	25	29	44	29	16	7	16	7	1	2
51-75	92	75	8	25	0	0	26	4	29	5	1	2
76-100	52	50	39	33	9	17	23	6	24	7	1	2
101-200	93	80	0	0	7	20	15	5	34	9	1	3
201-300	91	90	2	5	7	5	115	21	123	23	5	7
301-400	98	91	2	13	1	4	189	23	197	25	8	8
401-500.	91	92	9	8	0	0	311	39	349	43	14	13
501-750	99	97	1	3	0	0	236	39	243	42	10	13
751-1000	100	100	0	0	0	0	888	88	910	92	37	28
>1000	100	100	0	0	0	0	446	54	451	55	18	17
TOTAL	95	91	3	5	2	5	2316	302	2427	324		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A21.

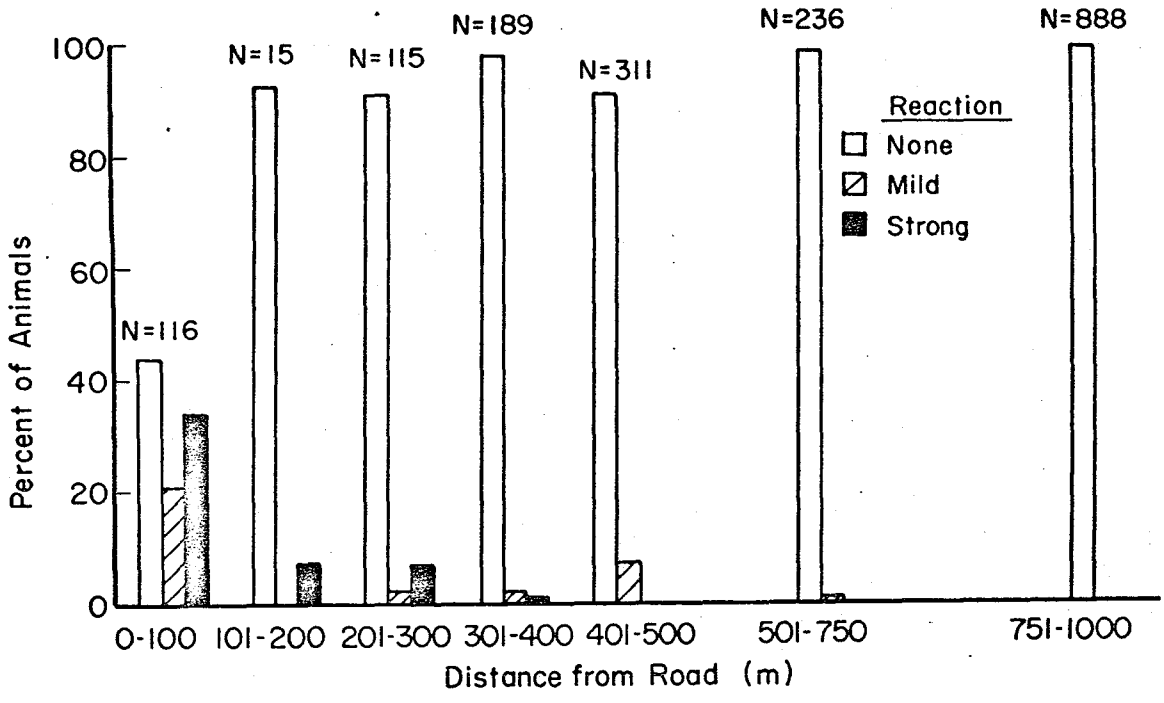

Figure 11. Reactions of Dall sheep, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

movements from summer range to winter range, and 2) when using the range on Polychrome Mountain through which the road passes.

Sheep crossing lowland areas between patches of mountainous habitat are very wary, probably because of their increased susceptibility to predators in the lowland areas (A. Murie 1944). Thus, sheep in this category are alert and cautious, even before they detect human activities along the road, and may be expected to be highly sensitive. Eight crossing attempts were observed during my study. The dates, times, locations, and numbers of animals involved appear in Table 29. Most crossings that occurred when the road is open to traffic take place in late May and June. There were several points along the road where crossings occurred. Of these eight groups, two groups crossed the road when no vehicles or people were in view on the road, two groups had crossed the road and continued across the valley before any vehicles arrived, one and part of another group crossed cautiously even though vehicles and people were nearby, and two and part of another group turned back and did not cross when vehicles approached during attempted crossings. The two groups that turned back both ran over 1 km back up the mountainside from which they had come before stopping. Thus, the road does inhibit the movements of some sheep and would affect range utilization if repeated crossing attempts were thwarted. However, other individuals exhibited a degree of habituation to crossing in the presence of vehicles and people.

Both years of my study, sheep used the Polychrome area, where the road climbs up into sheep habitat, from the time the road was opened

Table 29. Dall sheep observed attempting to cross the road while moving from winter to summer range, Mount McKinley National Park, Alaska.

DATE	TIME	LOCATION ALONG ROAD (km)	NUMBER OF SHEEP	CROSSING SUCCESSFUL
May 24, 1973	2220	27.4	7	No
June 3, 1973	0800	74.3	4	Yes
June 16, 1973	1245	86.9	2	Yes
June 23, 1973	0455	27.4	1	No
June 27, 1973	1345	57.1	3	2 Yes, 1 No
July 17, 1973	1205	14.5	17	Yes
June 20, 1974	1000	57.1	2	Yes
July 30, 1974	0710	61.2	3	Yes

until mid-June. In 1974, three full-curl rams remained in the area into July. It is not known how long in the winter and spring, before the road opens, this area is used. Both years at least 15 different sheep were sighted in this area, including rams of all ages, ewes, and yearlings, but no lambs. These sheep frequently rested and fed within 50 m of the road, often exhibiting only mild responses to vehicles and to people taking photographs from 20-50 m away.

The strength of reactions and the percentage of sheep showing visible responses to buses and visitors on the road decrease with increasing distances between the sheep and the road (Table 28 and Fig. 11). A G-test shows a significant (G=201.6, P<0.005) relationship between response and distance for 100 m distance classes from 0-500 m. Of all the sheep sighted from the buses, only 5% exhibited visible responses, but for sheep within 200 m of the road, 50% of the animals showed some visible response and 32% gave a strong response. No strong responses were noted at distance beyond 400 m.

Lenarz (1974) subjected 154 groups of Dall sheep in the Brooks Range to helicopter flights at diagonal distances of 300-500 ft (90-150 m) and reported that 15% of the groups did not move, 49% moved at a walk, and 36% ran away. Dall sheep are apparently capable of detecting, and may run from, aircraft up to 0.5-2 mi (1-3 km) away (Andersen 1971, Jakimchuk *et al.* 1974, Linderman 1972). However, under favorable circumstances, especially after a few days of habituation, a man on foot in plain view can often approach sheep closely without causing them to flee. Dixon (1938) and Jones *et al.* (1963)

found that they could observe some bands of Dall sheep from only 150 ft (50 m). Andersen (1971) reports that he was able to observe Dall rams from only 50 ft (15 m), and ewes with older lambs from 200 ft (60 m). Welles and Welles (1961) often watched bighorns (*Ovis canadensis*) from 100 ft (30 m) and some habituated individuals could be approached to within 6 ft (2 m) on foot or in a vehicle. Several factors discussed below affect flight distances for sheep.

Relationship of Reaction to Type of Disturbance

For 25% of the sheep sighted the bus passed without stopping; for 49% of the sheep the bus stopped, with the people remaining on the bus; and for 21% of the sheep the bus stopped and people got out. For animals within 200 m of the road, these figures were 14%, 72%, and 14%, respectively.

For sheep within 200 m of the road, the percentage of strong reactions increased between passing and stopping and between stopping and people getting out (Table 30 and Fig. 12). However, the sample sizes are insufficient for statistical analysis. There was a significant difference (X^2=45.59, P<0.001) between the reactions to the bus stopping, with the people remaining quietly on the bus, and the bus stopping, with the people remaining on the bus but making loud noises. All the sheep within 200 m of the road reacted strongly to sudden loud noises. McCourt *et al.* (1974) found that Dall sheep avoided the vicinity of a noise simulator producing the sounds of a gas compressor station. However, P. C. Reynolds (1974) observed little response by

Table 30. Reactions of Dall sheep, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	KNOWN REACTIONS OF DALL SHEEP						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	71	67	29	33	0	0	7	3	16	5	10	12
Pass <15 mph	28	25	72	75	0	0	7	4	7	4	4	9
Stop, people remain on bus, quiet	61	50	20	20	19	35	75	20	89	23	58	53
Stop, people remain on bus, noisy	0	0	0	0	100	100	20	2	20	2	13	5
Stop, people off bus on road, quiet	47	62	10	12	42	38	19	8	19	8	12	19
Stop, people off bus on road, noisy	100	100	0	0	0	0	3	1	3	1	2	2
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50	50	18	24	32	31	131	38	154	43		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A24.

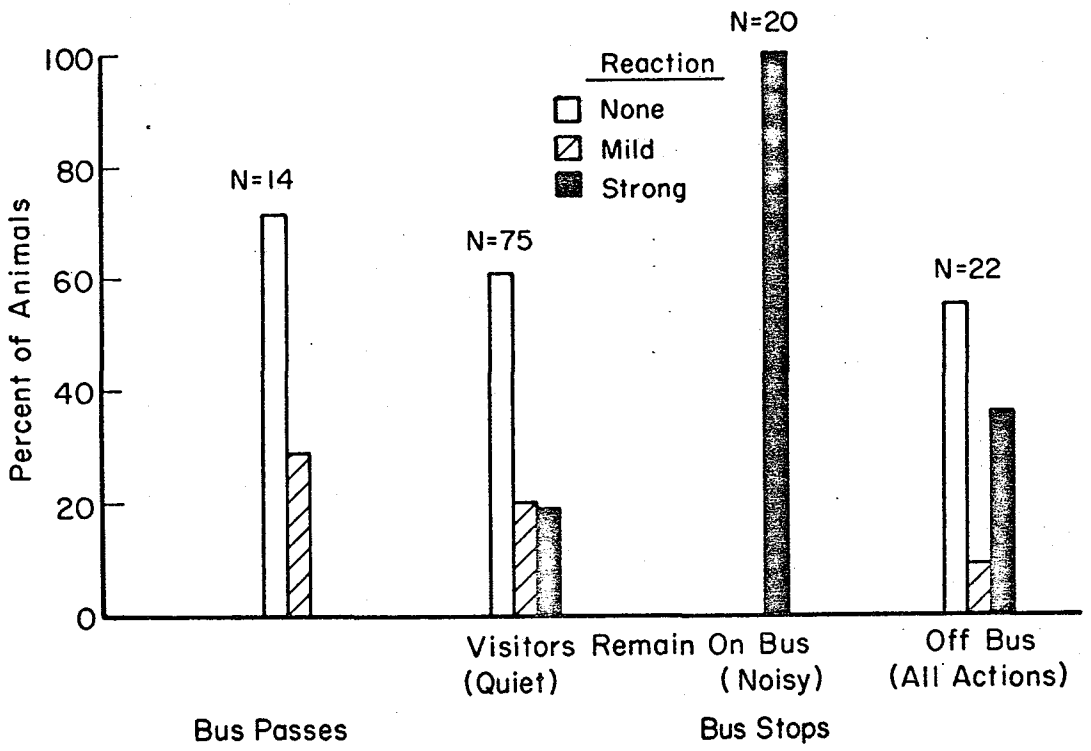

Figure 12. Reactions of Dall sheep, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

sheep at a lick to the same noise simulator 0.25 mi (0.40 km) away. She felt that the sheep were habituated to noises because of a high level of aircraft activity in the area in the past.

Many researchers working with wild sheep have found that the best way for a man on foot to approach the animals is to remain in full view, move slowly, stop often, and not approach directly (Andersen 1971, Couey 1950, Dixon 1938, Geist 1971c, Jones *et al.* 1963, Welles and Welles 1950). Sheep flee quickly from a person trying to stalk close under cover. In their relationships to predators, sheep apparently feel secure if they are near escape terrain and can see the movements of a potential predator. A. Murie (1944) found that wolves were usually successful in catching sheep in mountainous terrain only if they could surprise them at close range. He observed that once sheep sighted a wolf in the distance, they would sometimes move around to keep the predator in view, or flee if they lost sight of it. He also observed sheep showing little concern towards wolves resting in full view only 200 ft (60 m) away.

The direction of approach may also be important. A man approaching from above often causes sheep to flee at a relatively long distance (Couey 1950, A. Murie 1944). The sheep may pass close to a man in their attempt to flee upward (Smith 1954). However, Geist (1971c) preferred approaching sheep from above so that the wind was favorable. During my study, sheep were occasionally sighted on slopes below the road. Often these sheep ran up to the road, across it, and on upwards, when a vehicle approached. Some habituated individuals were not

frightened by vehicles or photographers above them. A. Murie (1944) noted that one successful hunting technique for wolves is to get above a band of sheep and drive them down towards the lowlands. This danger may explain the wariness of sheep towards humans or other animals above them.

Sight seems to be the major sense used by sheep to warn them of danger (Geist 1971c, A. Murie 1961, Welles and Welles 1961). Welles and Welles (1961) reported that bighorns can spot a moving person up to 1.5 mi (2.4 km) away. Geist (1971c) found that Stone's sheep could detect moving objects in obscure terrain much better than he could, but felt that their power to resolve lines and objects is not good. He noted sheep staring at animals over 400 yd (370 m) away for 10-20 sec even if it was only another sheep. The importance of smell to sheep is unclear. A. Murie (1944) concluded that scent is little used as a danger signal, perhaps because of the ever changing and complex air currents in sheep habitat. Geist (1971c) reported that under favorable conditions sheep can smell a man at 350 yd (321 m). Little is known about hearing in sheep but their abilities appear to equal man's (Geist 1971c, Welles and Welles 1961).

Relationship of Reaction to Sex and Age

Because so few of the sheep in my study were sexed and aged the effects of these factors cannot be isolated. Other workers have found that in unhunted or lightly hunted populations old rams are the least wary and easiest to approach (Andersen 1971, Dixon 1938, Lenarz 1974,

Smith 1954). This characteristic may be reversed in hunted populations, where rams may be most wary (Jones *et al.* 1963, McCann 1956). Ewes with lambs are particularly sensitive to disturbances (Jones *et al.* 1963, A. Murie 1944, Smith 1954). Welles and Welles (1961) found that a bighorn ewe, that was so habituated she ignored human observers only 6 ft (2 m) away, fled from the same observers at 200 yd (180 m) after she gave birth to a lamb. When the lamb was two and a half months old, the ewe was still more wary than before the lamb was born. It should be noted that during my study, lambs were almost never observed within 200 m of the road.

Relationship of Reaction to Season, Weather, Habitat and Experience

Smith (1954) reported that the bighorns he worked with were more wary during the summer than during the winter. Jones *et al.* (1963) found Dall sheep to be more wary and difficult to approach during periods of rain, fog, or snow that caused low visiblity. Since sheep depend on sight to detect and follow the movements of predators, reduced visibility may cause increased wariness.

A. Murie (1944) found sheep to be very wary when crossing valleys or feeding far from cliffs. Several authors (Andersen 1971, Price 1972, Welles and Welles 1961) reported increased wariness at springs and mineral licks, which are often located low on the slopes, away from escape terrain. As already discussed, sheep observed during my study within 200 m of the road were often attempting to cross the valley through which the road runs and were particularly cautious, alert and

ready to flee. Dixon (1938), Geist (1971c), Jones *et al.* (1963), and A. Murie (1944) all comment on the exteme wariness of wild sheep crossing low country, where the risk of predation is greater. They may spend several hours or days surveying the valley from an overlooking ridge before crossing (Geist 1971c, A. Murie 1944). During the actual crossing they often move in compact bands and do much trotting and running (Dixon 1938, Jones *et al.* 1963, A. Murie 1944).

Welles and Welles (1961) found that the responses to humans of bighorns in Death Valley depended on the past experiences of individuals and on the leadership of the band. A confident leader appeared to calm other individuals in a group. One band they observed became much more wary after the loss of its old, habituated leader.

Behavior Before Disturbance

Table 31 contains the data on the behavior before disturbance of the sheep observed during the shuttle-tour trips. The pattern of behaviors for sheep within 200 m of the road is significantly different (χ^2=5.52, P<0.005) from the pattern for sheep more than 200 m from the road. The major difference is the greater percentage of traveling animals within 200 m of the road, which reflects the animals attempting to cross the valley.

No analysis could be made on the relationship of behavior before disturbance to reaction because of the small number of sheep observed within 200 m of the road.

Table 31. Behavior before disturbance of Dall sheep observed during shuttle-tour trips, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	BEHAVIOR OF DALL SHEEP BEFORE DISTURBANCE								TOTAL NUMBER ANIMALS
	FEED		LIE		STAND		TRAVEL[a]		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	58	(51)	32	(28)	0	(0)	23	(20)	113
>200	1639	(77)	299	(14)	76	(4)	105	(5)	2119
TOTAL	1697	(76)	331	(15)	76	(3)	128	(6)	2232

[a] Movement at a walk, trot, run.

Behavior Patterns Related to Disturbance

Table 32 shows the maximum behavioral reactions exhibited by sheep toward the buses and visitors. Of the sheep within 200 m of the road, 50% showed no visible reaction, 14% watched the bus and visitors, 14% walked away, 2% trotted away, and 20% ran away.

Geist (1971c) described the "attention" and "alarm" postures of wild sheep. These postures may act to draw the attention of others in a group. Stamping and blowing may accompany the alarm posture (Geist 1971c, Jones *et al.* 1963, Welles and Welles 1961). Flight is usually uphill and often towards escape terrain (my observations, Andersen 1971, Geist 1971c, Jones *et al.* 1963, A. Murie 1944, Smith 1954, Welles and Welles 1961). Such uphill flight occasionally causes sheep in the park to dash across the road close to approaching vehicles. During flight, bunching and temporary leadership often occur (my observations, Dixon 1938, Geist 1971c, A. Murie 1944, Welles and Welles 1961).

Summary and General Discussion

During 1973, the park's Dall sheep population was estimated at 1,600 animals. Sheep were sighted during 100% of the shuttle-tour trips. Groups sizes varied from 1-45 animals. Ewe-lamb bands were most common. Sixty-five percent of the sheep observed were sighted along the 10 km stretch of road near Igloo, Cathedral and Sable mountains.

The road runs below most of the area of prime sheep habitat, so the sheep are not in close contact with traffic. However, on Igloo

Table 32. Maximum behavioral reactions of Dall sheep, observed during shuttle-tour trips, to bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	MAXIMUM REACTIONS OF DALL SHEEP TO BUS AND VISITORS												TOTAL NUMBER ANIMALS
	NONE		WATCH		WALK <10 m		WALK >10 m		TROT		RUN		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	65	(50)	18	(14)	6	(5)	11	(9)	3	(2)	26	(20)	129
>200	2140	(98)	35	(2)	1	(<1)	1	(<1)	1	(<1)	9	(<1)	2188
TOTAL	2205		53		7		12		5		35		2317

and Cathedral mountains many people get out of vehicles and climb toward the sheep, which appear quite habituated. The plot data did not reveal any large-scale range abandonment stimulated by road-related activities. A few sheep still use the range by the road on Polychrome Mountain where the road runs up into sheep habitat. Use of this area by sheep has been much greater in the past (A. Murie 1944). Geist (1971) noted short and long-term abandonment of seasonal home ranges by Stone's sheep caused by hunting. Geist pointed out that hikers in an area where fear of man is reinforced by hunting may increase the frequency and seasonal duration of disturbances to sheep and help stimulate range abandonment. Linderman (1972) felt that Dall sheep on Table Mountain in the Brooks Range may have abandoned part of their summer range because of frequent aircraft disturbances. McCourt *et al.* (1974) found that Dall sheep temporarily abandoned the range within 1 mi (1.5 km) of their study area when helicopter activities became frequent and when a sound simulator, reproducing the sounds of a gas compressor station, was operating. Welles and Welles (1961) concluded that bighorns will not continue to use a desert spring once human dwellings are established there.

Only 6% of the sheep sighted during shuttle-tour trips were within 200 m of the road. Most of these animals were either attempting to cross the road while crossing between ranges, or were on Polychrome Mountain where the road runs through sheep habitat. Of eight crossing attempts observed, two groups and part of another turned back and did not cross because of disturbances from vehicles and people. During

spring movements from winter to summer range many sheep attempt to cross the road after it is opened to traffic. Disturbances of the sheep attempting to cross the road may be detrimental.

The buses stopped for 86% of the sheep within 200 m of the road, and people got out of the buses for 14% of the animals. The frequency and strengths of reactions increased as the bus stopped and as people got out, but the sample was too small for statistical analysis. There was a statistically significant increase in the strengths of reactions when sudden loud noises were produced by the bus or visitors. The loud noises may have been frightening because they were unexpected. Loud noises also have an evolutionary importance to sheep as a danger signal because of the prevalence of falling rocks, rockslides, and avalanches in sheep habitat. Dixon (1938), Geist (1971c), and Jones *et al.* (1963) all noted that wild sheep become alert to the sounds of falling rocks and snow, but respond by moving only if in danger of being hit. Welles and Welles (1961) found that bighorns in Death Valley learned to ignore horns, gunshots, shouts, motors, and car noises.

The nature of the road-related human activities may facilitate the habituation of the sheep to people on foot. People getting out of buses and standing on the road are generally in full view of the sheep and usually do not have enough time before the bus leaves to approach the sheep close enough to frighten them. Many investigators have found sheep least disturbed by a man in full view below them and moving slowly without approaching directly (Dixon 1938, Jones *et al.* 1963, Welles and Welles 1950). Wolves are generally successful in capturing sheep

only if they surprise the sheep from above, at close range, and away from escape terrain (A. Murie 1944).

The literature reveals that ewes with lambs are more sensitive to disturbances than other classes of sheep (Jones *et al.* 1963, A. Murie 1944, Smith 1954). The experiences and temperament of the leader of a group may also affect responses (Welles and Welles 1961).

Brown Bear (*Ursus arctos*)

Population History, Numbers, Composition, Distribution

The brown bears of Mount McKinley National Park have attracted the attention of several naturalists and biologists in past years. Major contributions to the knowledge of this population appear in Dean (in press), Dixon (1938), A. Murie (1944, 1961), and Sheldon (1930). The bears of this region generally hibernate from October to April and the young are born in the dens during mid-winter (A. Murie 1944, 1961). The breeding season extends from mid-May through mid-July (Dean, in press, A. Murie 1961).

Dean (in press), using data from his earlier studies and from my study, calculated minimum density estimates for the eastern half of the park of 0.026, 0.033, 0.041, and 0.038 brown bears per km^2, for the years 1957, 1958, 1959, and 1973, respectively. Although Sheldon (1930) and A. Murie (1944) did not make careful population estimates for brown bears, their records on the frequency of sighting these bears suggest that the population density probably was not greater than at present. Thus, the numbers of brown bears in the eastern half of the park in 1973-1974 probably equaled or exceeded the numbers present in 1906-1908 (Sheldon 1930), 1939-41 (A. Murie 1944), and 1957-1959 (Dean, in press). Pearson (1975), studying the "northern interior grizzly [brown bear] ecotype" at the Kluane Game Sanctuary in the Yukon, estimated a population density of 0.037-0.043 brown bears per km^2, very similar to the estimates for Mount McKinley National Park. Other estimates of densities of interior brown bear populations from areas of varying habitat quality include 0.045 bears per km^2 in Glacier National

Park, Montana (Martinka 1974a), 0.017 bears per km^2 in Yellowstone National Park, Wyoming (Cowan *et al.* 1974), and 0.007-0.008 bears per km^2 in the Brooks Range, Alaska (Curatolo and Moore 1975, Quimby 1974).

Brown bears were commonly sighted from the shuttle-tour buses during my study (Table 33). An average of 5.9 bears in 2.6 groups were observed during each of the 70 round-trips. The average number of "different" individuals was 4.9. The maximum number of different bears sighted on one trip was 14. Bears were sighted on 87% of all trips. Matched-pair *t*-tests comparing numbers of bears observed from the various types of buses, i.e. 0400 tour, 0700 shuttle, 1500 shuttle, on trips within two days of each other revealed no significant differences at $P=0.05$ in the numbers of bears observed from each type of bus. The only seasonal trend in the numbers of bears sighted was a decrease in numbers in August 1974 (Appendix A12).

Bears frequent, in varying concentrations, all areas along the road. The Sable Pass area, between Tattler Creek and East Fork River, produced the greatest concentration of sightings. Of all shuttle-tour bear sightings, 5% occurred between Riley Campground (Km 0.2) and Tattler Creek (Km 60), 34% between Tattler Creek and the East Fork River (Km 70), and 61% between the East Fork River and Eielson Visitor Center (Km 107). Table 34 gives an indication of the seasonal variations in use of different areas along the road. These variations are probably related to the availability of various foods. A. Murie (1944) outlines four major phases in the food habits of the park's bears, suggesting that the bears feed on roots in the spring and early June, green

Table 33. Number of brown bears observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

YEAR	TOTAL NUMBER OF BEARS OBSERVED		AVERAGE NUMBER OF BEARS OBSERVED EACH TRIP		AVERAGE NUMBER OF "DIFFERENT" BEARS OBSERVED EACH TRIP	
	Animals	Groups	Animals	Groups	Animals	Groups
1973	279	122	6.8	3.0	5.7	2.5
1974	136	58	4.7	2.0	3.6	1.6
TOTAL	415	180	5.9	2.6	4.9	2.1

Table 34. Distribution of brown bear observations during shuttle-tour trips by season and distance along road, Mount McKinley National Park, Alaska.

AREA	YEAR	SEASON					
		LATE MAY-JUNE		JULY		AUGUST-EARLY SEPTEMBER	
		% of Trips Bears Observed	Average Groups/Trip	% of Trips Bears Observed	Average Groups/Trip	% of Trips Bears Observed	Average Groups/Trip
Riley Campground (km 0)	1973	14	0.14	0	0	7	0.07
-Tattler Creek (km 60)	1974	9	0.27	0	0	17	0.17
Tattler Creek (km 60)	1973	33	0.80	83	1.83	29	0.28
-East Fork River (km 70)	1974	55	1.00	83	2.00	8	0.08
East Fork River (km 70)	1973	67	1.33	25	0.33	64	1.14
-km 88	1974	54	0.64	17	0.33	17	0.17
km 88	1973	60	1.07	42	0.92	57	1.00
-Eielson (km 107)	1974	36	0.73	50	0.83	25	0.42
TOTAL NUMBER TRIPS	1973	15		12		14	
	1974	11		6		12	

vegetation, especially *Equisetum* and grasses, in June and July, berries in late July through October, and roots again in late fall. All the shuttle-tour bear sightings between Riley Campground and Tattler Creek occurred in late May and August. Bears were observed on Sable Pass, between Tattler Creek and East Fork River, all through June, but heavy use of this area began in late June, peaked in July, then decreased to a low level in August. Since green vegetation, especially grass, is the main food source for bears on Sable Pass, this use pattern conforms with A. Murie's (1944) data on the seasonal use of green vegetation. Bear sightings between the East Fork River and Km 88 occurred chiefly in June, with considerably fewer sightings in July, and an increase again in August. Much river bar is visible from the road in this area and during June brown bears often feed on the roots of *Hedysarum* growing on bars and flood plains (A. Murie 1944). Berries may also attract bears to this area in August. Sightings on the alpine tundra from Km 88 to Eielson were more variable, showing no distinct seasonal trends. Of all the brown bears observed during the shuttle-tour trips, 43% occurred in dwarf shrub habitat, 24% in alpine tundra, 18% on gravel bars and moraines, 7% in tall willow and alder, 3% in tussock-heath wet tundra, 2% in mixed talus and alpine tundra, 1% on talus slopes, and 1% in open spruce.

Data on the sex and age distribution of the bears observed during the shuttle-tour trips appear in Table 35. These data include repeated observations of certain individuals, as discussed below. Females with young accounted for 64% of the groups sighted. Of all animals observed

Table 35. Sex and age distributions of brown bears observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

SEX-AGE	NUMBER OF BEAR OBSERVATIONS					
	1973		1974		TOTAL	
	Animals	Groups	Animals	Groups	Animals	Groups
# of Singles	42	42	19	19	61	61
# of Pairs (Mating?)	8	4	0	0	8	4
# of Females w/young	76	76	39	39	115	115
# of Cubs	57	28	3	2	60	30
# of Yearlings	90	45	25	12	115	57
# of Two-Year Olds	6	3	50	25	56	28

28% were females with young, 56% were young bears accompanying a female, 15% were single bears, and 2% were in pairs, probably mating associations. An attempt was made to identify individual bears observed in Mount McKinley National Park, both from the road and in the backcountry, during the years 1957-1959 and 1973 (Dean, in press). The methods are described in Dean (in press). This effort resulted in estimates for 1957-1959 of a population composition of 22% females with young, 39% young accompanying females, and 39% single bears. For 1973 these figures were 225%, 45%, and 30%, respectively. Thus, the single bears seem to be under-represented in the shuttle-tour observations.

Excluding the young bears following a female, a minimum of 71% of the sightings were of females. This figure includes only females with young and the sightings of one single bear known to be female. F. C. Craighead and J. J. Craighead (1966) reported sex ratios for tagged brown bears in Yellowstone National Park favoring males 2:1 in cubs, but favoring females in adult bears over 4 years old. Pearson (1975) found a sex ratio for all his captured bears with home ranges within his Kluane Game Sanctuary study area that favored males 56:44, but he does not discuss any relationship to age.

In all shuttle-tour observations of families, 26% included spring cubs, 50% included yearlings and 24% included two-year olds. A skew towards one age group of young occurred each year. In 1973, 37% of the young observed were spring cubs, 59% were yearlings and 4% were two-year olds (n=153) while, in 1974, these figures were 5%, 31%, and 64%, respectively (n=78). Dean's (in press) data from the park, in

1957-1959, also showed a skew towards one age group of young each year.

The average number of young per family for all shuttle-tour observations was 2.0 (n=115). A total of 64 different families were identified in the park during the years 1957-1959 and 1973. The average litter size for these four years combined was 1.81 for cubs, 1.83 for yearlings, and 1.67 for two-year olds (Dean, in press). Average litter sizes for various brown bear populations reported in the literature range from 1.60 to 2.36, with the coastal brown bears producing the higher averages (Lentfer *et al.* 1966, Martinka 1974a, Mundy and Flook 1973, Pearson 1975, Quimby 1974, Troyer and Hensel 1964). Group sizes for all sightings of bears from the shuttle-tour buses appear in Table 36. Except for four observations of pairs which may have been mating associations, all groups larger than one consisted of a female with young.

An additional factor of importance is the long life potential of the brown bear. Of all the brown bears legally killed in the game management unit north of McKinley Park from 1970-1975, 13% were 13.4 years old or over (Valkenburg 1976). Curatolo and Moore (1975) reported a mean age of 11.2 years for a population in the Brooks Range. Several authors found wild brown bears that were 20-25 years of age (Curatolo and Moore 1975, Mundy and Flook 1973, H. V. Reynolds 1974). The significance of the age and sex data as related to possible human disturbances will be discussed below.

In 1973, we placed some emphasis on observing bears and learned to individually recognize several families and a few single bears. Family

Table 36. Sizes of brown bear groups observed during shuttle-tour trips, 1973 and 1974, Mount McKinley National Park, Alaska.

GROUP SIZE	BEAR OBSERVATIONS			
	Animals		Groups	
	Number	(Percent)	Number	(Percent)
1	61	(15)	61	(34)
2	10	(2)	5	(3)
3	336	(81)	112	(62)
4	8	(2)	2	(1)
TOTAL	415		180	

composition, color, size, facial characteristics, location, and any distinctive physical features were used for identification purposes. Single bears were much more difficult to identify than families. Table 37 gives the number of sightings and the range of dates of the sightings of individually identified groups. These are minimum sighting records, since many other observations could have been of these same bears, but positive identification was not possible so the observations were not included. These data indicate that a few families occupy home ranges adjacent to, or including, the road, and that these families are sighted many times throughout the summer. Seven individually recognized families accounted for a minimum of 75% of the 1973 shuttle-tour observations of families, 46% of all groups and 62% of all animals sighted. Four of these families were observed on dates from June through August. One identifiable single bear, observed from May through August 1973, accounted for at least 28% of the 1973 shuttle-tour observations of single bears. Another 33% of the 1973 single bear observations were made on Sable Pass, and I believe these observations involved chiefly two individuals. Thus, seven families and three single bears accounted for at least 68% of the groups and 71% of the animals observed, in 1973, on the shuttle-tour trips. At least three of the families and one single bear were observed in both 1973 and 1974. Most observations of each given individual were confined to a section of the road 15 km or less in length. A. Murie (1961) noted that individual brown bears in the park possess definite, but overlapping, home ranges, that may be used in successive years. He reports

Table 37. Observations of individually recognized brown bears, Mount McKinley National Park, Alaska.

BEAR	YEAR	NUMBER OF SHUTTLE-TOUR OBSERVATIONS	NUMBER OF DAYS OBSERVED ON SHUTTLE-TOUR	RANGE OF DATES (MONTH/DAY)	NUMBER OF OTHER OBSERVATIONS	NUMBER OF OTHER DAYS OBSERVED	TOTAL NUMBER OF OBSERVATIONS	TOTAL NUMBER DIFFERENT DAYS OBSERVED	TOTAL RANGE OF DATES (MONTH/DAY)
Family #1 in 1973, female with two yearlings	1973	13	12	5/26-8/17	23	22	36	32	5/24-9/25
	1974	4	3	6/28-8/31	5	5	9	8	6/28-8/31
Family #2 in 1973, female with two cubs	1973	9	8	6/24-8/24	12	12	21	17	6/24-9/1
Family #3 in 1973, female with three cubs	1973	2	2	6/29-7/1	6	6	8	8	5/30-8/30
	1974	1	1	6/14	6	6	7	6	5/28-8/22
Family #4 in 1973, female with two yearlings	1973	15	10	5/27-8/18	12	10	27	18	5/22-8/18
Family #5 in 1973, female with two cubs	1973	4	2	8/24-8/31	7	7	11	8	8/24-9/23
	1974	0	0	--	10	10	10	10	5/26-9/2
Family #6 in 1973, female with two yearlings	1973	14	11	6/23-8/25	4	4	18	14	6/23-8/25
Family #7 in 1973, female with three cubs	1973	0	0	--	3	3	3	3	8/7-9/9
Family #8 in 1974, female with two cubs	1974	2	2	7/18-7/31	3	3	5	5	6/20-7/31
Single #1	1973	12	8	6/12-8/17	9	9	21	17	5/29-9/3
	1974	3	2	6/8-6/14	3	3	6	5	6/8-8/27
Sable Pass Single Bears (most observations of two bears)	1973	14	9	6/3-7/10					
	1974	8	6	5/26-7/23					

that a sow with cubs often limits its movements to an area less than 19 km in diameter. Four families observed frequently by Dean (in press) in the park in 1957 possessed minimum home ranges of 15-26 km^2. Seasonal home ranges are sometimes much smaller. Radio-tracking studies conducted on brown bears in other areas have shown that single males use larger home ranges than females (Curatolo and Moore 1975, Pearson 1975), that individuals may use the same home range in successive years (F. C. Craighead and J. J. Craighead 1972a, Curatolo and Moore 1975), and that long distance movements are sometimes made, especially by bears homing after a transplant attempt (Steve Buskirk, pers. comm. 1974, F. C. Craighead and J. J. Craighead 1972a, Mundy and Flook 1973).

Human Disturbance

General Avoidance

Brown bears were observed in all the study plots, illustrating that this species finds suitable habitat over much of the park. Minimum density estimates for the plots range from 0.01 to 0.41 bears per km^2 (Table 38). These estimates are generally higher than the minimum density estimates of 0.026-0.041 bears per km^2 for a much more extensive section of the eastern part of the park made by Dean (in press) for the years 1957-1959 and 1973. This difference may result from the greater difficulties of identifying all the bears in a larger area and from the fact that the larger area may include more unsuitable habitat. Dean's study, like mine, concentrated on the area near the park road,

Table 38. Average number of brown bears observed in study plots, Mount McKinley National Park, Alaska.

PLOT		AVERAGE DAILY TOTAL OBSERVATIONS				AVERAGE DAILY FIRST SEARCH OBSERVATIONS				NO. OF DAYS ANIMALS OBSERVED OUT OF FIVE
		Actual Number		Density (per km^2)		Actual Number		Density (per km^2)		
		Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	
Igloo Road	1973	0.40	0.40	0.03	0.03	0.40	0.40	0.03	0.03	2
Igloo Road	1974	0.80	0.20	0.05	0.01	0	0	0	0	1
Igloo Off-Road	1973	2.20	1.40	0.12	0.07	1.20	1.00	0.06	0.05	4
Igloo Off-Road	1974	2.20	1.20	0.12	0.06	2.20	1.20	0.12	0.06	3
Highway Road	1973	0.20	0.20	0.01	0.01	0.20	0.20	0.01	0.01	1
Highway Off-Road	1973	0.60	0.60	0.05	0.05	0.60	0.60	0.05	0.05	3
Stony Road	1973	0.80	0.40	0.06	0.03	0.80	0.40	0.06	0.03	2
Stony Off-Road	1973	1.20	0.40	0.12	0.04	1.20	0.40	0.12	0.04	1
Sable Road	1973	8.40	3.60	0.41	0.17	5.00	1.40	0.24	0.07	5

and comparisons of several population parameters already discussed earlier reveal no dramatic changes in the population between the years 1957-1959 and 1973, despite the great increase in visitation and traffic levels.

The data from the paired plots (Table 38) show consistently higher bear densities in the off-road plots compared to the road plots. A matched-pair t-test comparing all first search densities of bears for all observation periods in the backcountry plots with the respective densities for the paired road plots (Appendix A8) shows significantly more bears were observed in the backcountry plots (t=10.7, P<0.005). It seems that some bears may be avoiding the vicinity of the road, despite the fact that many bears are sighted from the road. Some single bears, in particular, may be avoiding the road. As already mentioned, single bears appeared to be under-represented in the bus sightings, compared to their representation in the population in general. I observed single bears in the backcountry more frequently than near the road. Excluding one habituated individual, single bears were sighted within 100 m of the road on only three occasions during the shuttle-tour trips.

However, the highest density of bears occurred in the unpaired Sable Road Plot, an area of unique, high quality bear habitat and a special managment unit where visitors are not permitted to move off the road. The special restrictions were initiated in the early 1950's because park personnel felt that over-persistent photographers were causing bears to move away from the vicinity of the road. In this

plot now, with the restrictions, bears even within 200 m of the road seldom reacted visibly to human activities on the road. However, in the nearby Igloo Road Plot, where much human activity occurs off the road, two of four groups of bears sighted during plot observation periods moved around a mountain and out of view of the road in response to human activities. One group was responding to hikers and the other to a passing shuttle bus.

Reaction Distances

The distribution of bears sighted during the shuttle-tour trips in relation to distances from the road appear in Table 39. Numbers observed generally decreased with distance from the road, and thus, with visibility. Individual bears varied in their tolerance to proximity to the road. Ten of the thirteen observations of single bears within 100 m of the road are accounted for by one recognizable individual, which frequently fed on vegetation within a few meters of the road and showed no concern as buses and cars passed and stopped.

Table 39 and Figure 13 show the reaction patterns of bears at varying distances from the road. A *G*-test (Sokal and Rohlf 1969) run on the reaction patterns of bears at 100 m intervals from the road up to 500 m shows that there is a significant (G=75.7, P<0.005) change in the reaction pattern that is related to distance from the road. For all the shuttle-tour bear observations for which reactions could be classified, 78% of the animals exhibited no visible reaction to the presence of the bus and people, 7% gave mild reactions, and 15% gave

Table 39. Reactions of brown bears, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	KNOWN REACTIONS OF BROWN BEARS TO BUS AND VISITORS						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	0	0	24	45	76	55	21	11	24	12	6	7
0-100	47	47	15	26	38	33	102	43	111	46	27	25
0	0	0	13	29	87	71	15	7	15	7	4	4
1-25	0	0	50	75	50	25	6	4	9	5	2	3
26-50	47	43	33	43	20	14	15	7	15	7	4	4
51-75	74	82	6	18	19	18	31	11	31	11	7	6
76-100	51	57	9	7	40	36	35	14	41	16	10	9
101-200	77	74	6	7	17	19	65	27	73	32	18	18
201-300	92	81	8	19	0	0	61	27	71	31	17	17
301-400	84	88	8	6	8	6	37	17	37	17	9	9
401-500	100	100	0	0	0	0	25	13	31	15	7	8
501-750	100	100	0	0	0	0	33	15	33	15	8	8
751-1000	91	92	0	0	9	8	34	12	37	13	9	7
>1000	100	100	0	0	0	0	19	11	22	12	5	7
TOTAL	78	72	7	9	15	12	376	165	415	180		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A25.

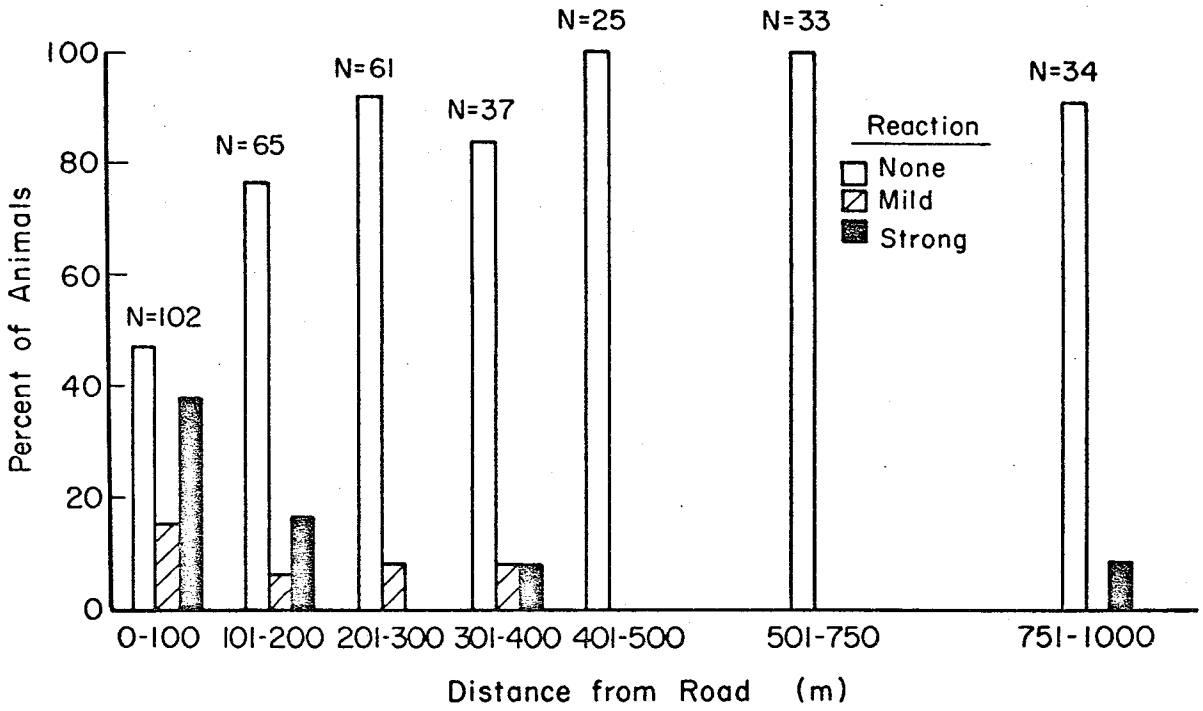

Figure 13. Reactions of brown bears, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

strong reactions. For brown bears within 200 m of the road, these percentages were 56%, 12%, and 32%, respectively. Eighty-three percent of the bears that reacted to the bus and visitors were within 200 m of the road, and 96% were within 400 m.

Very little information is available in the literature on the flight distances of brown bears. Both Klein (1974) and McCourt *et al.* (1974) found brown bears more sensitive to aircraft overflights than caribou or moose, although the reactions of the bears were quite variable. McCourt *et al.* (1974) reported that 8 of 10 bears subjected to overflights above 1000 ft (300 m) still exhibited "significant" reactions to the aircraft. Quimby (1974) determined that 32% of the bears sighted within 1 mi (1.6 km) of his aircraft were already running away when sighted. Most of the bears with which Quimby was working had already been subjected to drugging and tagging operations utilizing aircraft.

The distance at which a grizzly bear may detect and react to a man on foot is poorly documented. F. C. Craighead and J. J. Craighead (1966), after years of experience around brown bears, felt that the bears often could not discern the form of a motionless man beyond 100 yd (90 m). Pearson (1975) concluded that brown bears usually exhibit little alertness and are easily approached closely by a man, if no scent reaches them. In areas where human hunting is prohibited adult brown bears have few enemies except other bears and constant alertness may not be necessary.

Disturbance Frequencies

The frequency of road-related disturbances to bears may be calculated by combining the frequency data for vehicles passing through the Igloo Canyon-Sable Pass section of the road (Fig. 5) with the reaction pattern of bears within 200 m of the road (Table 39). This calculation predicts that an "average" bear within 200 m of the road exhibits 0.8 mild responses and 2.2 strong responses to vehicles and visitors each hour from 0600-2100 hours. Since no intensive observations were made on bears, the exact disturbance frequencies for individual bears cannot be given. The calculation above is meaningful only if a bear remains within 200 m of the road for an extended period. This situation may actually occur quite often. Bears were frequently resighted during the shuttle-tour trips, indicating that they commonly remain in view of the road for hours at a time. Forty-five percent of the bears sighted from the bus while the bus was traveling east were resighted on the return trip west the same day. Fifty-six percent of the resighted bears were within 200 m of the road during the first sighting. Fifty-three percent of the resightings occurred 2-5 hr after the first sighting; the rest occurred within 2 hr of the first sighting.

No data are available on the usual frequency of activity interruptions caused by non-human disturbances. The fact that the brown bear is a top level carnivore and its lack of alertness suggest that non-human disturbances are probably infrequent. Females with young were occasionally observed running from other bears.

Relationship of Reaction to Type of Disturbance

Table 40 and Figure 14 present the data from the shuttle-tour trips on the actions of the buses and visitors and the responses of brown bears within 200 m of the road to various types of human activities. The buses stopped for almost all bears sighted, passing only 5% of the animals. The buses stopped, with the people remaining on the bus, for 70% of the bears and stopped, with people getting out of the bus, for 25% of the bears. These figures for bears within 200 m of the road were 2%, 66%, and 32%, respectively. People were not observed to move off the road towards bears during these trips, although photographers were seen to do so at other times. The people accidently or purposely produced particularly loud noises while observing 10% of all animals, and while observing 16% of the animals within 200 m of the road. A comparison of shuttles and tours shows that visitors on the shuttles got out to observe 33% of the bears sighted, but visitors on the tours got out to observe only 8% of the bears sighted.

Chi-squared tests were used to compare the reactions bears within 200 m of the road exhibited towards the various actions of the bus and visitors. No significant relationships at the P=0.05 level were found. The response patterns (none:mild:strong) varied little, regardless of whether the bus simply stopped with the people remaining on the bus or if people got out of the bus and stood on the road. Loud noises caused an increase in the perentage of animals reacting strongly, but sample sizes were small. A. Murie (1961) commented that producing loud noises is a good way to drive away brown bears. It is possible that bears more

Table 40. Reactions of brown bears, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	KNOWN REACTIONS OF GRIZZLY BEARS						TOTAL KNOWN REACTIONS		TOTAL OBSERVATIONS KNOWN AND UNKNOWN REACTIONS			
	NONE		MILD		STRONG							
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	100	100	0	0	0	0	1	1	4	2	2	3
Pass <15 mph	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people remain on bus, quiet	59	54	12	18	29	28	90	39	100	43	54	56
Stop, people remain on bus, noisy	45	38	10	25	45	38	20	8	21	9	11	12
Stop, people off bus on road, quiet	64	67	12	19	24	19	50	21	50	20	27	26
Stop, people off bus on road, noisy	50	50	0	0	50	50	6	2	9	3	5	4
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	59	56	11	18	30	27	167	71	184	77		

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently. Raw numbers for animals and groups are presented in Appendix Table A28.

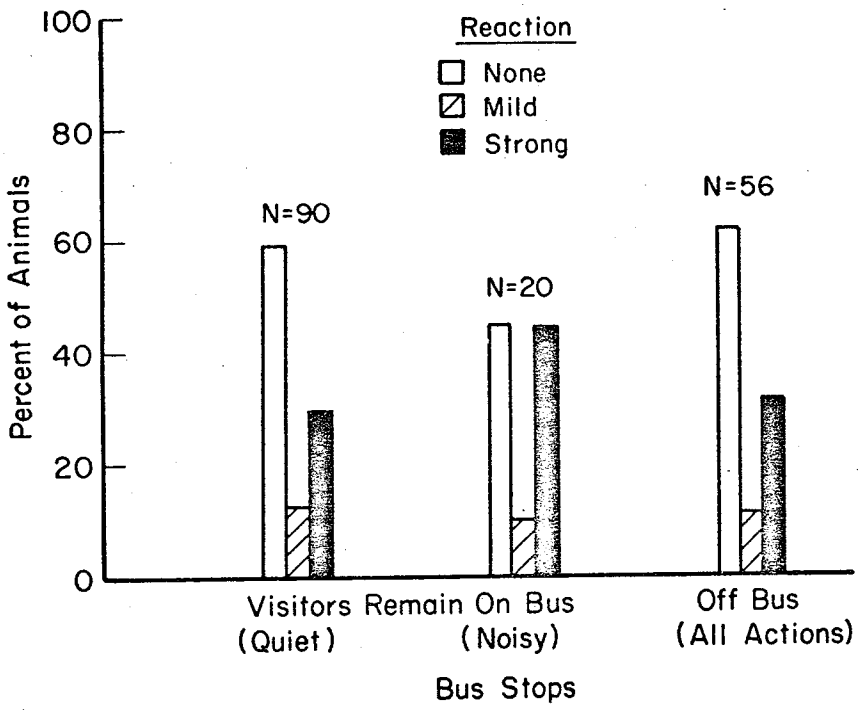

Figure 14. Reactions of brown bears, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

than 100-200 m from the road do not detect the details of the activities of buses and visitors. The brown bear's eyes are relatively small and their eyesight is apparently poor, although very little discerning information is available on the senses of bears. Russell (1967) felt that bears can see little beyond 300 yd (275 m), and F. C. Craighead and J. J. Craighead (1966) felt that brown bears cannot identify a motionless man by sight beyond 100 yd (90 m). However, MacPherson (1965) proposed that vision in bears is similar to man's, but with less ability to perceive movements at a distance. Sight seems to play a supporting role to the other senses and the sighting of objects or movements, alone, does not stimulate flight in bears (Johnson 1972, Pearson 1975). The ears of brown bears are small and quite rigid, unlike the large, mobile ears of most ungulates and many carnivores. F. C. Craighead and J. J. Craighead (1966) and Krott and Krott (1963) concluded that hearing in brown bears is keen and important, although MacPherson (1965) and Johnson (1972) felt it plays only a secondary role. There are few published comments on distances at which bears can detect sounds. Linderman (1974) noted a brown bear responding, apparently to the sounds of an aircraft, before Linderman himself could hear it. He also noted that bears, especially those that had been tagged previously, sometimes began fleeing when aircraft could be heard but not seen. Pearson (1975) also observed this type of learned response to aircraft sounds. Most authors agree that the bear's sense of smell is acute and the most important sense in warning it of danger (F. C. Craighead and J. J. Craighead 1966, Dixon 1938, Johnson 1972,

Krott and Krott 1963, MacPherson 1965). Johnson (1972) often observed brown bears scenting a man at distances of 150 yd (130 m). Human smell alone may cause precipitous flight in bears. F. C. Craighead and J. J. Craighead (1972a, 1972b) related an instance where tracks in snow revealed that a grizzly coming upon a human trail had urinated, and then had run for at least 200 yd (180 m). During my study, I watched from a ridgetop as a grazing brown bear came upon my trail in the valley. The bear responded to the scent by running at least 4 km across a valley, through a stream, over a steep talus ridge, and out of view. Hasselborg (reported in Schoonmaker 1968) observed a bear responding to human scent on a trail 14 hours after the man had passed.

Brown bears seem to learn easily and modify their responses to similar stimuli in varying situations. J. J. Craighead and F. C. Craighead (1972) found that their tagged bears apparently ignored human scent while feeding in garbage dumps but that the same individuals would flee after receiving a human scent in an area away from the dumps. I noted a similar dichotomy in Mount McKinley National Park. Certain families I had learned to recognize and had observed showing apparent habituation towards people and traffic on the road fled from me when I met them in the backcountry.

Relationship of Reaction to Sex and Age

Separate analyses of the distribution in relation to distance from road and the reaction patterns for single bears, females with cubs, and females with yearlings or two-year olds revealed only one difference

between these groups; single bears exhibited fewer strong reactions (Table 41). This result may be misleading. As mentioned earlier, 10 of the 13 observations of single bears within 100 m of the road were all of one individual. Thus, single bears other than this individual were seldom observed within 100 m of the road.

Many authors (Herrero 1970, Mundy and Flook 1973, Riegelhuth 1966) have concluded that female brown bears with young are more likely to attack during disturbing situations than single bears. This behavior may change with the age of the young (Pearson 1975). However, attack behavior was seldom observed by us in road-related visitor-bear interactions and this difference was not apparent. Barnes and Bray (1967) noted an interesting sex-related difference in black bears in Yellowstone National Park; the campgrounds were frequented mostly by adult males and the roadsides mostly by females and yearlings.

Relationship of Reaction to Behavior Before Disturbance

The behavior before disturbance, when known, for bears sighted on the shuttle-tour buses appears in Table 42. The apparent behavioral differences between bears within 200 m of the road and those further away probably results simply from visibility problems. Traveling bears are easier to sight at a distance than bears engaging in other activities, while lying bears are particularly difficult to sight at a distance.

Table 43 presents the data on the relationship between reaction and behavior before disturbance for bears within 200 m of the road.

Table 41. Reactions of single brown bears and families, observed during the shuttle-tour trips, to the bus and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF BROWN BEARS TO BUS AND VISITORS						TOTAL KNOWN REACTIONS	
	NONE		MILD		STRONG			
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups
SINGLE BEARS								
0-100	46	46	54	54	0	0	13	13
101-200	62	62	12	12	25	25	8	8
201-400	100	100	0	0	0	0	17	17
>400	100	100	0	0	0	0	19	19
Total							57	57
FAMILIES								
0-100	49	47	10	17	42	43	88	30
101-200	79	79	5	5	16	16	57	19
201-400	86	85	10	12	4	4	79	26
>400	97	96	0	0	3	4	87	29
Total							311	104

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently.

Table 42. Behavior before disturbance of brown bears observed during shuttle-tour trips, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	BEHAVIOR OF BROWN BEARS BEFORE DISTURBANCE														TOTAL NUMBER ANIMALS
	FEED		FEED-WALK[a]		LIE		STAND		TRAVEL[b]		PLAY		HUNT		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	76	(52)	24	(16)	22	(15)	0	(0)	13	(9)	8	(6)	2	(1)	145
>200	95	(48)	24	(12)	11	(6)	3	(2)	53	(27)	4	(2)	7	(4)	197
TOTAL	171	(50)	48	(14)	33	(10)	3	(1)	66	(19)	12	(4)	9	(3)	342

[a] Feeding while traveling at a walk.

[b] Movement at a walk, trot, or run.

Table 43. Reactions of brown bears, observed within 200 m of the road during shuttle-tour trips, to the bus and visitors as related to behavior before the disturbance, 1973-1974, Mount McKinley National Park, Alaska.

BEHAVIOR BEFORE DISTURBANCE	REACTION OF BROWN BEARS TO BUS AND VEHICLES						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
FEED OR HUNT	55	(71)	8	(10)	15	(19)	78
FEED-WALK[a]	20	(83)	3	(12)	1	(4)	24
LIE	17	(81)	4	(19)	0	(0)	21
TRAVEL[b]	4	(40)	0	(0)	6	(60)	10
PLAY	8	(100)	0	(0)	0	(0)	8
TOTAL	104		15		22		141

[a] Feeding while traveling at a walk.

[b] Movement at a walk, trot, or run.

This table includes only animals for which the behavior before disturbance was determined. Sample sizes are insufficient for statistical analysis, so the data are only useful as a preliminary indicator. Lying bears seem less responsive than feeding or hunting animals, while traveling individuals appear most sensitive. Possibly, as with the caribou, some of the traveling bears were still responding to previous disturbances and were particularly sensitive for this reason.

Behavior Patterns Related to Disturbance

The maximum behavioral reactions of brown bears in response to buses and visitors appear in Table 44. Of those bears sighted within 200 m of the road 58% gave no visible reaction and did not interrupt their normal activities in response to the human activities. This figure indicates a high degree of habituation in the individual bears involved. Bears within 200 m of the road were frequently observed engaging in such activities as nursing, playing, and sleeping, which suggest security and relaxation. Only 8% of the animals within 200 m of the road lifted or turned their heads and looked at the human activities on the road without subsequently moving away; 10% moved away at a walk and 23% at a run. Such movements were seldom over 100 m, but occasionally bears moved 200 m or more and out of view of the road. These short movements differ from my experiences with bears in the backcountry, where bears that had become aware of my presence usually ran out of view and sometimes ran 2 km or more. Bears fleeing from aircraft have often been observed to hide, when patches of dense vegetation were

Table 44. Maximum behavioral reactions of brown bears, observed during shuttle-tour trips, to buses and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	MAXIMUM REACTION OF BROWN BEARS TO BUS AND VISITORS								TOTAL NUMBER ANIMALS
	NONE		WATCH		WALK		TROT-RUN		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
0-200	98	(58)	14	(8)	(17)	(10)	38	(23)	167
>200	195	(93)	5	(2)	0	(0)	9	(4)	209
TOTAL	293		19		17		47		376

available (Erickson 1965, Klein 1974, Pearson 1975, Quimby 1974).

The "typical" response of a brown bear that has detected a strange or alarming object is to stand upright on its hind legs, sway its head, inhale deeply, and perhaps circle, to try to get a scent (Johnson 1972, Pearson 1975). If a human scent is detected the animal often retreats hastily (A. Murie 1961, Pearson 1975). These scent-detection behavior patterns were seldom observed in response to human activities on the road in the park. We observed bears standing upright on only five occasions; once by a female with young trying to cross the road in the midst of several vehicles, once by a female with young watching a camper-truck containing a loudly barking dog, once by a yearling when a bus driver honked a horn, and once each by a cub and a yearling just watching toward vehicles on the road.

Attacks on humans by brown bears are uncommon. Herrero (1970) summarized records for all North American national parks containing brown bears and found an injury rate from brown bears of five persons per year or one person per 1.5 million visitors. He reported only five brown bear-caused deaths in the parks in 97 years. In the 14 years from August 1961-August 1975 in Mount McKinley National Park, six attacks occurred, none of them fatal (Buskirk 1975, Cauble 1975). At least two of these attacks were provoked by the close approach of photographers, and at least five of them involved females with young. After an intensive literature review Riegelhuth (1966) concluded that the brown bear's temperament is chiefly defensive, not aggressive, and that attacks generally occur under one of three circumstances: 1) a

close approach to a female with young, 2) a close approach to a bear at a favored food supply, or 3) surprising a bear at close range. Even under these circumstances a bear usually runs. Herrero (1972) attributes the defensiveness of brown bear females with young to the fact that young rarely climb trees, are often in open country, and depend on the female for protection. Feeding on garbage or human foods may also make a bear dangerous (Johnson 1972, Martinka 1974b). The defensive behavior of bears seems similar in bear-bear and bear-man interactions (Barnes and Bray 1967). Bluff charges are much more common than actual attacks (Barnes and Bray 1967, F. C. Craighead and J. J. Craighead 1972a, Russell 1967). No attacks were recorded during interactions of bears and vehicles or persons near vehicles along the park road during my study, even though vehicles and visitors were often within 50-100 m of females with young. Apparently these females did not consider the situation threatening, since the people did not move off the road toward them. Also, the bears have not become accustomed to receiving food from people, a situation which often leads to injuries. On one occasion I witnessed a short bluff charge by a two-year-old towards a person standing by the open door of a car.

We frequently observed bears crossing the road, even when vehicles were nearby. They occasionally traveled along the road. I observed one family travel at least 2 km on the road, once making a detour around several parked cars and then returning to the road.

Influence of Roadside Vegetation

As described previously, for most of its length the road influences both the species composition and phenology of a narrow strip of vegetation on either side. This roadside vegetation includes several species of grasses, herbs, and *Equisetum* which are utilized as food by brown bears. On 11 occasions I observed bears feeding on this narrow band of vegetation, apparently drawn to the road or remaining by the road because of its presence. All such observations occurred between June 10 and June 20 each year. From gross examination it appeared that the roadside vegetation began growing and "greening-up" somewhat earlier than the other vegetation, probably because of snow removal, quickened melt because of dust, and drainage patterns related to the road. Apparently, the bears at times take advantage of this early growth. Three different families and one single bear were involved in these observations. The one single bear, a particularly habituated individual, accounted for seven of these observations and, unlike the other bears, she frequently continued feeding on the roadside vegetation as vehicles stopped or passed.

Influence of Garbage

Mount McKinley National Park has only one garbage dump presently in use within its borders. In conjunction with this study, Chip Downing monitored wildlife activity at this dump and has reported the results in a manuscript to NPS (Downing 1975). During the summer of 1974, brown bears frequented the dump throughout the summer; 17

different individuals were identified and a few more probably used the area. Garbage feeding adversely affects the distribution and activities of a wild population of bears and is a lamentable situation. The problem is still small in Mount McKinley National Park compared to such areas as Yellowstone National Park where visitation levels are much higher (Cole 1972, J. J. Craighead and F. C. Craighead 1972b, Martinka 1974b). Since my study was completed, NPS has already implemented plans to eliminate garbage, in the dump and at the campgrounds, as a source of food for bears (Steve Buskirk, pers. comm. 1976).

Summary and General Discussion

The minimum density of brown bears in the eastern half of the park in 1973 was estimated at 0.038 bears per km^2 (Dean, in press). The population level appeared to be as high or higher in 1973 as in past years when visitor numbers were much lower (Dean, in press, A. Murie 1944, Sheldon 1930). Bears were sighted on 87% of the shuttle-tour trips. The sex and age data for the bears observed from the buses indicate: 1) a predominance of family groups, 2) a predominance of females for those bears sighted that are over two years of age, and 3) a skew towards one age class of young each year. A few individual families and single bears were sighted repeatedly from the road. Seven families and three single bears accounted for a minimum of 68% of the groups and 71% of the animals observed during the 1973 shuttle-tour trips. Individuals may live up to 20-25 years (Curatolo and Moore 1975, Mundy and Flook 1973, H. V. Reynolds 1974) and home ranges may be

used in successive years (F. C. Craighead and J. J. Craighead 1972a, Curatolo and Moore 1975). Thus, certain individuals are frequently in contact with human activities along the road and may habituate or become stressed, largely depending on the behavior of the humans. Important factors in the biology of brown bears to consider when evaluating the potential effects of disturbance include low population densities, low reproductive potential, restricted home ranges, and long life.

The plot data and shuttle-tour data suggest that some bears, particularly single bears, may be avoiding the vicinity of the park road. Single bears, particularly males, usually use larger home ranges than families (Curatolo and Moore 1975, Pearson 1975). A single bear with a larger home range may come in contact with the road less frequently and have less opportunity to habituate than families with small home ranges. A larger home range would also allow more areas for a bear to use in preference to the vicinity of the road. Individual bears whose home ranges extend outside the park, especially during hunting season, may exhibit more wariness towards man under all circumstances. Past experiences in the park, which led to the establishment of the Sable Pass Wildlife Restricted area, also indicate that bears may avoid the vicinity of the road under some circumstances. Faro and Eide (1974) reported that increasing numbers of photographers at McNeil River Falls, Alaska, caused brown bears to modify the time and location of their fishing activities to reduce contact with humans. They also felt that some bears may have abandoned the falls completely.

However, several families and a few single bears have become habituated to the road and traffic in McKinley Park, and these bears were the ones most commonly sighted from the shuttle-tour buses. The threshold distance where 50% of the animals exhibited strong responses occurred between 50 and 75 m from the road. The threshold distance for 50% visible response occurred between 100 and 200 m from the road (Table 39).

The buses stopped for 98% of the bears sighted within 200 m of the road, while people got out onto the road to observe 32% of these bears. During these trips people did not move off the road towards the bears. No significant differences in the reactions of the bears were found that were related to the type of activity of the bus and visitors. There were large individual variations in responses, and these variations, combined with small sample sizes, may have obscured any general patterns. Adult brown bears are usually not susceptible to predation except by man and, occasionally, other bears. The danger from man to North American bears was probably minimal until development of dependable rifles. Johnson (1972), after reviewing the accounts of explorers in North America, concluded that bears had to learn to fear man and the first explorers found them very unafraid and unwary. It is possible that the brown bears must learn responses to various types of environmental stimuli and possess few innate fear responses, as compared to species that have evolved under the selective pressures of effective predators. Perhaps, for this reason bears may show large individual variations in responses to various types of stimuli, i.e. the

components of approach, stopping, and visitors unloading from a bus. Information from the literature discussed earlier also indicates that the bear's senses may not detect the detail of visitors' activities beyond 100-200 m (F. C. Craighead and J. J. Craighead 1966, Russell 1967).

Bears occasionally seem to be attracted to the road to feed on the roadside vegetation during June. During this period the roadside vegetation is often green and growing although the vegetation in the surrounding area may not have begun to green.

Red Fox (*Vulpes vulpes*)

Population History, Numbers, Composition, Distribution

A. Murie (1944) made numerous general observations on the red fox population in Mount McKinley National Park. He studied food habits, movements, and den sites. He described this species as "abundant" during the period of his studies. The only other study focusing on the red fox in the park was conducted by Allison (1971) during 1968-1969. She described den characteristics, activity patterns and behavior.

The number of red foxes observed from the shuttle-tour buses during my study appears in Table 45. The average number of animals observed each trip was much lower in 1974 (0.4 animals/trip) than in 1973 (2.1 animals/trip). In 1974, foxes were observed on 34% of the trips, while in 1973, they were observed on 63% of the trips. The difference between the two years is accounted for by the large number of sightings, 74% of all animals, that occurred at or within 1 km of known active den sites in 1973. Although there were active dens within view of the road in 1974, they were much less well known by the bus drivers. All 1974 sightings during the shuttle-tour trips were of adults more than 1 km from known den sites. The number of foxes using the area may have actually decreased to a low level in 1974. The number of active fox dens seemed to decrease, as discussed below. During both summers, sightings were made more frequently during the first half of the summer than during the second half. In 1973, the average number of animals sighted each shuttle-tour trip before July 15 was 3.38, while after July 15 this number dropped to 0.80. For 1974,

Table 45. Number of red fox observed during shuttle-tour trips, Mount McKinley National Park, Alaska.

YEAR	TOTAL NUMBER OF RED FOX OBSERVED		AVERAGE NUMBER OF RED FOX OBSERVED EACH TRIP	
	Animals	Group	Animals	Group
1973	87	46	2.1	1.1
1974	13	13	0.4	0.4
TOTAL	100	59	1.4	0.8

these figures were 0.83 and 0.18, respectively. This decrease may be related to decreased activity around den sites, movement of families to new, unknown dens, and decreased daylight activity of adults, associated with the increasing independence of the young. Foxes were observed all along the park road and in all major types of habitat.

During my study, 26 fox den sites were located within 1 km of the road. The distances from the road and use of these dens during 1973-1974 are shown in Table 46. In 1973, 9 active dens were known within 400 m of the road. In 1974, 5 active dens were known within 400 m of the road. Some families used more than one known den site during a summer; the number of different families known to use one or more dens within 400 m of the road was nine in 1973 and four in 1974. A. Murie (1944) reported that in 1940 he located 5 active dens along a 32 mi (51 km) stretch of the park road, and knew the approximate location of 4 other dens in the same area. Allison (1971) was able to locate 20 dens known to be used sometime during 1967-1969, although she does not report the distances between the dens and the road.

Pups, as well as adults, were frequently sighted from the road. In 1973, 59% of the fox sightings from the shuttle-tour buses were of pups. In 1974, all the shuttle-tour sightings were adults, but I observed many pups from the road in 1974 during my intensive fox observations. The average litter size for eight families was 4.8 pups.

Ables (1975) reviewed the literature on home ranges and movements of red foxes in North America. He concluded that the normal activities of individuals and families in temperate habitats are generally

Table 46. Use of known red fox dens near the Mount McKinley National Park road, 1973-1974.

DISTANCE FROM ROAD (m)	NUMBER AND USE OF KNOWN RED FOX DENS						TOTAL KNOWN DENS
	ACTIVE		INACTIVE		ACTIVITY UNKNOWN		
	1973	1974	1973	1974	1973	1974	
0-100	3	3	5	5	0	0	8
101-200	3	1	-	5	3	0	6
201-400	3	1	-	3	1	0	4
401-1000	2	4	2	3	4	1	8
TOTAL	11	9	7	16	8	1	26

conducted in an area less than 8 km^2 and that individuals may use the same home range or seasonal home range for several years. A. Murie (1944) was able to recognize several individuals in McKinley Park, each of which used a restricted home range over 2-4 years. A. Murie (1961) also noted foxes in the park hunting 3-4 mi (4-6 km) from their dens. Allison (1971) regularly observed adults hunting over a mile (1.6 km) from their dens within the park.

Human Disturbance

General Avoidance

The plot data for foxes are presented in Table 47. A comparison, using a matched-pair t-test, of all first search observation periods in the backcountry plots with the observations in the paired road plots reveals a weak significant difference (t=1.7, P<0.05), with the density of foxes in the road plots being higher (Appendix A10). Fourteen of the 16 foxes observed during first searches were in the road plots. These sightings were generally associated with active dens. In 1973, the Igloo, Highway, and Sable Road Plots each contained a known active den. No active dens were discovered in the off-road plots. Some individual foxes may be attracted to the road, as discussed below. There is no evidence that a large percentage of foxes avoid the road as an activity area or as a denning area, although individual differences do occur. As discussed earlier, many active dens were in view of the road, including one only 5 m from the road. Most pups are born before the park road is open to traffic in the spring, so no vehicular

Table 47. Average number of red foxes observed in study plots, Mount McKinley National Park, Alaska.

PLOT		AVERAGE DAILY TOTAL OBSERVATIONS				AVERAGE DAILY FIRST SEARCH OBSERVATIONS				NUMBER OF DAYS ANIMALS OBSERVED OUT OF 5 POSSIBLE
		Number		Density (Per km^2)		Number		Density (Per km^2)		
		Animals	Groups	Animals	Groups	Animals	Groups	Animals	Groups	
Igloo Road	1973	1.00	0.60	0.06	0.04	1.00	0.60	0.06	0.04	2
Igloo Road	1974	1.20	0.60	0.08	0.04	1.20	0.60	0.08	0.04	2
Igloo Off-Road	1973	0.20	0.20	0.01	0.01	0	0	0	0	0
Igloo Off-Road	1974	0	0	0	0	0	0	0	0	0
Highway Road	1973	0.80	0.60	0.04	0.03	0.60	0.40	0.03	0.02	2
Highway Off-Road	1973	0.20	0.20	0.02	0.02	0.20	0.20	0.02	0.02	1
Stony Road	1973	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0.20	0.20	0.02	0.02	0.20	0.20	0.02	0.02	1
Sable Road	1973	0.20	0.20	0.01	0.01	0	0	0	0	0

disturbance occurs during the selection of whelping dens. However, no abandonment of dens near the road was noted when the road opened or when the volume of traffic increased. Allison (1971) noted that two families moved from whelping dens to summer dens that were closer to and more visible from the road. The red fox is well known for its adaptability to environments modified by man (Ables 1975, Lloyd 1975, Storm 1972).

Reaction Distances

The responses of foxes at various distances from the road to vehicles and visitors are presented in Table 48. In addition to my general definition of a "strong" response given under "Methods," if a fox entered a den in response to a disturbance it was considered a strong response. During my intensive observations of foxes at dens, animals within 100 m of the road responded to vehicle and visitor activities mildly 51% of the time and strongly 15% of the time. For animals 101-200 m from the road, these figures decreased to 27% and 1%, respectively. However, the shuttle-tour data indicate greater responsiveness in foxes within 100 m of the road but away from den sites. These animals gave 45% mild responses and 36% strong responses. Probably more of these animals were unhabituated than those observed at dens near the road. Occasionally, foxes traveling or resting on the road showed no visible response to vehicles or visitors also on the road, and they often gave only mild responses. However, foxes 600 m from the road were occasionally observed responding to passing vehicles. Few

Table 48. Reactions of red foxes at various distances from the road to vehicles and visitors, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTIONS OF RED FOXES						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
SHUTTLE-TOUR OBSERVATIONS (Animals <25 m from Den)							
0	1	(4)	16	(64)	8	(32)	25
1-100	7	(41)	3	(18)	7	(41)	17
101-200	0	(0)	0	(0)	2	(100)	2
201-400	1	(50)	0	(0)	1	(50)	2
>400	0	(-)	0	(-)	0	(-)	0
Total	9		19		18		46
SHUTTLE-TOUR OBSERVATIONS (Animals >25 m from Den)							
0	0	(-)	0	(-)	0	(-)	0
1-100	4	(80)	0	(0)	1	(20)	5
101-200	27	(73)	9	(24)	1	(3)	37
201-400	0	(-)	0	(-)	0	(-)	0
>400	0	(0)	5	(100)	0	(0)	5
Total	31		14		2		47
SHUTTLE-TOUR OBSERVATIONS (Total Animals)							
0	1	(4)	16	(64)	8	(32)	25
1-100	11	(50)	3	(14)	8	(36)	22
101-200	27	(69)	9	(23)	3	(8)	39
201-400	1	(50)	0	(0)	1	(50)	2
>400	0	(0)	5	(100)	0	(0)	5
Total	40		33		20		93
INTENSIVE OBSERVATIONS AT DEN							
0-100	47	(34)	70	(51)	20	(15)	137
101-200	67	(73)	25	(27)	1	(1)	93
400-600	48	(87)	6	(11)	1	(2)	55
Total	162		101		22		285

comments are made in the literature on flight distances for foxes. Those reported generally describe animals that had apparently habituated to man. Several authors reported foxes ignoring the presence of people 2-50 m away (Dixon 1938, A. Murie 1944, Rue 1969).

Relationship of Reaction to Type of Disturbance

Table 49 presents the actions of vehicles and visitors at active fox dens near the road when foxes were visible. These data were collected during the intensive observations at fox dens. At the Sable Den, only about 50 m from the road, the public buses stopped more frequently (68%) than private vehicles (54%), so that visitors could observe the foxes. Persons in private vehicles probably failed to sight the animals as often as those on public buses, where more pairs of eyes and a trained and experienced driver make sighting animals easier. Also, visibility of the den was better from the higher elevation of the bus seats. Once the animals were sighted, however, and a vehicle stopped, persons in private cars tended to get out of their vehicles more often (36%) than persons in public buses (9%). For foxes at dens over 100 m from the road, few persons spotted the animals and stopped their vehicles. During the shuttle-tour observations, the bus passed 10% of the foxes sighted without stopping; stopped, without people getting out for 76% of the sightings; and stopped, with people getting out for 14% of the sightings.

The reactions of fox adults and pups within 200 m of the road to various actions of vehicles and visitors, as I observed them during the

Table 49. Actions of vehicles and visitors at red fox dens, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF VEHICLES AND VISITORS	TYPE OF VEHICLE						TOTAL	
	NPS VEHICLE		PUBLIC BUS		PRIVATE VEHICLE			
	Number Vehicles	(Percent Vehicles)	Number Vehicles	(Percent Vehicles)	Number Vehicles	(Percent Vehicles)	Number Vehicles	(Percent Vehicles)
DENS WITHIN 50 m OF ROAD								
Pass >15 mph	8	(80)	14	(30)	11	(42)	33	(40)
Pass <15 mph	0	(0)	1	(2)	1	(4)	2	(2)
Stop, people remain in vehicle, quiet	1	(10)	29	(62)	8	(31)	38	(46)
Stop, people remain in vehicle, noisy	1	(10)	0	(0)	1	(4)	2	(2)
Stop, people out of vehicle on road, quiet	0	(0)	0	(0)	4	(15)	4	(5)
Stop, people out of vehicle on road, noisy	0	(0)	1	(2)	0	(0)	1	(1)
Stop, people off road, quiet	0	(0)	2	(4)	1	(4)	3	(4)
Stop, people off road, noisy	0	(0)	0	(0)	0	(0)	0	(0)
Total	10		47		26		83	
DENS 50-200 m FROM ROAD								
Pass >15 mph	4	(100)	23	(85)	22	(92)	49	(89)
Pass <15 mph	0	(0)	0	(0)	0	(0)	0	(0)
Stop, people remain in vehicle, quiet	0	(0)	4	(15)	1	(4)	5	(9)
Stop, people remain in vehicle, noisy	0	(0)	0	(0)	0	(0)	0	(0)
Stop, people off vehicle, on road, quiet	0	(0)	0	(0)	1	(4)	1	(2)
Stop, people off vehicle, on road, noisy	0	(0)	0	(0)	0	(0)	0	(0)
Total	4		27		24		55	

intensive den observations, appear in Table 50. A chi-squared analysis of the reaction patterns exhibited toward the various actions of the vehicles and visitors reveals a significant difference (X^2=9.8, P<0.01) between the responses to a vehicle passing as compared to a vehicle stopping, with the people remaining in the vehicle. The percentage of mild and strong responses increased when a vehicle stopped. No significant difference in responses was found between responses to a vehicle stopping, with the people remaining in the vehicle, as compared to a vehicle stopping, with people getting out. The sample size for this comparison was small.

Relationship of Reaction to Age and Sex

During 140 hours of intensive observations at one fox den within 50 m of the road, 108 responses of pups and 28 responses of the adult female to vehicles and visitors were observed. A chi-squared test showed no significant difference in the reaction patterns (none:mild: strong) of the pups compared to the adult female, although some behavior patterns differed as described below. The adult female at this den appeared thoroughly habituated to vehicles and visitors and exhibited no, or only mild, responses to vehicles and persons on the road. The adult male from this den was observed at the den on only four occasions, all at night. He appeared much more wary than the female and pups. The adult male was the only member of the family that frequently watched the parked vehicle from which I made observations and circled well around the vehicle when passing by it. On only one of the male's

Table 50. Reactions of red foxes, adults and pups at dens within 200 m of the road, to vehicles and visitors, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF VEHICLE AND VISITORS	REACTION OF RED FOXES						TOTAL NUMBER ANIMALS
	NONE		MILD		STRONG		
	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	Number Animals	(Percent Animals)	
Pass >15 mph	69	(60)	43	(37)	4	(3)	116
Pass <15 mph	0	(0)	3	(75)	1	(25)	4
Stop, people remain in vehicle, quiet	34	(40)	38	(45)	12	(15)	84
Stop, people remain in vehicle, noisy	0	(0)	2	(100)	0	(0)	2
Stop, people out of vehicle on road, quiet	4	(40)	5	(50)	1	(10)	10
Stop, people out of vehicle on road, noisy	0	(0)	1	(100)	0	(0)	1
Stop, people walk off road, quiet	6	(50)	3	(25)	3	(25)	12
Stop, people walk off road, noisy	0	(-)	0	(-)	0	(-)	0

visits did a vehicle drive up and stop near the den. The male responded by leaving the area immediately.

I observed another den over 800 m from, and out of view of, the road. The den was observed from a distance of 75 m, which was as far away as an observer could get and still see it. Again, the adult male was the most disturbed by my presence. He usually barked for several minutes, then left the denning area, when I was present.

At the other dens observed, not enough responses of the two adults were observed to distinguish differences. However, one male regularly rested during the day at a den 500 m from, and in view of, the road. At this distance, the male occasionally raised his head to watch passing vehicles.

Allison (1971), A. Murie (1961), and Rue (1969) commented that male foxes often appear more wary than females. However, Rue (1969) observed a den in McKinley National Park for several days and noted that the male was much more tolerant of human presence than the female.

Use of Road as Travel Route

On many occasions foxes were observed traveling along the road. They may be attracted to the road as an easy travel route. Usually the distances traveled on the road were not known, but distances of up to 2 km were recorded. During 23 visits to a den within 50 m of the road by the adult female, she came to the den along the road on 10 visits and left along the road on 9 visits. When the pups from this den began venturing away from the den, they often left and returned along the

road. Pups from three dens were known to occasionally use the road as a play area. Adults were also observed hunting in ditches and on roadsides as they traveled along the road. On one occasion an adult fox captured a ground squirrel which had been temporarily distracted by a passing vehicle. A. Murie (1944) and Rue (1969) described foxes hunting along the road in the park.

Behavior Patterns Related to Disturbance

Allison (1971) described many of the behavior patterns foxes exhibit when disturbed. Table 51 summarizes the disturbance behavior patterns I observed during intensive observations at one den within 50 m of the road. At this den the animals showed no visible response to 50% of the vehicular and visitor activities along the road, and only watched during 37% of the disturbances. During 2% of the distubances, pups ran up to a den hole and then stood or sat and observed the human activities. During 8% of the disturbances, pups entered the den and, thus, were no longer in view from the road. The adult male tended to leave the den site during disturbances. The adult female often ignored human activities. She barked, causing the pups to enter the den, on only one occasion, when a bus stopped with people remaining on the bus. At a den 800 m from the road, that I visited several times on foot, the male often barked persistently at me, while the female did not bark except when the male was present and barking. Both adults investigated me by circling and approaching to within 3 m. In August the pups sometimes barked when disturbed.

Table 51. Maximum behavioral reaction of red foxes at dens within 200 m of the road to vehicles and visitors, as observed during intensive observations, 1973-1974, Mount McKinley National Park, Alaska.

RESPONSE TO VEHICLES AND VISITORS	NUMBER ANIMALS	(PERCENT ANIMALS)
No Visible Response	113	50
Watch	85	37
Walk Away from Road	0	0
Trot Away from Road	1	<1
Run Away from Road	2	1
Run to Den Hole	5	2
Enter Den	17	8
Leave Den Area	3	1
TOTAL	226	

Barking by the adult serves as a warning of danger to the pups. Allison (1971) found that pups under 6 weeks of age immediately entered the den when an adult barked. Older pups often responded to a bark by running to the nearest den entrance and waiting for the danger to pass. Allison also described a "hacking cough" which was apparently a more emphatic danger signal, causing even older pups to react immediately.

Foxes encountered away from den sites during shuttle-tour trips showed a greater tendency to run from the road than is indicated by the intensive observations at dens. Thirty-nine percent of these foxes ran. Probably many of the foxes encountered away from dens are individuals that have less contact with, and are less habituated to, road-related human activities than those individuals denning near the road.

Feeding of Foxes by Visitors

During my study I was aware of only one fox, an adult, that regularly begged for food along the park road. This fox was often seen along the road east of Savage River, where the road was open to unrestrained use by private vehicles. The fox was observed traveling along the road and trotting up to vehicles that slowed or stopped, often being rewarded with food from the visitors. The adults and pups at the den within 50 m of the road, where I made many of my intensive observations, were never observed begging or being fed. This den is located along the section of road where private vehicle use has been restricted since 1972. However, a long-time resident, Charlie Ott (pers. comm. 1974), remembers past years when pups using this same den had become beggars,

running to the road when vehicles passed. Perhaps restricting private vehicle use has reduced the amount of feeding of foxes by visitors.

Summary and General Discussion

Red foxes were observed on 63% of the shuttle-tour trips in 1973 and on 34% of the trips in 1974. Nine families in 1973 and four families in 1974 were known to use dens within 400 m of the road.

No evidence was found that foxes, in general, avoid the vicinity of the road during daily activities or during denning. Some individuals may have been attracted to the road. The road was frequently used as a travel route by foxes. One fox was frequently fed by visitors and purposefully approached vehicles.

Many of the foxes denning along the road were habituated to human activities. Adult males seemed more wary than females. They often left the denning area in response to human activities. Because of small sample sizes, these response differences may have been related to individual, rather than sexual, differences. In either case, if differences cause one adult of a pair to make fewer visits to the den with food, the survival of the pups, or energy demands on the other adult could be adversely affected.

Stopping a vehicle increased the frequency and strength of responses significantly compared to those elicited when vehicles just passed.

Other Mammals

Wolf (*Canis lupus*)

The wolves of Mount McKinley National Park, as elsewhere, have attracted the interest of researchers (A. Murie 1944, Haber 1968, 1972a) and visitors alike. The number of wolves in the park, east of Wonder Lake, has been about 40-50 in recent years (Haber 1972a, 1972b). They are distributed throughout the park. Chapman (in prep.) is currently preparing a detailed thesis on the effects of human disturbance on wolves in McKinley Park and elsewhere. Because this work will soon be available and because my own observations are limited, my comments here are brief.

Wolves are observed much less frequently than the other large mammals already discussed. During the 70 shuttle-tour trips, wolves were observed on 5 occasions (7% of the trips). Each sighting was of a single animal. Two of the animals ran across the road in front of the approaching bus. The other three were each 300-400 m from the road when sighted. All the wolves sighted on these trips exhibited strong reactions to the buses, running away from the road and out of view. However, wolves near the road did not always react strongly to vehicles, as discussed below. During my plot surveys I observed wolves on three occasions, once in the Sable Road Plot and twice in the Highway Off-Road Plot, which was within 2 km of an active wolf den.

Besides the sightings mentioned above, during my general activities in the park I sighted wolves near the road on 10 occasions. During four of these sightings the animals did not, at least immediately, react strongly to the presence of one or more vehicles. All the animals

involved were more than one year old. One wolf was observed for 7 min as it traveled and hunted, covering about 1.5 km, at distances of 100-300 m from the road. My vehicle and a tour bus stopped to observe the animal. The wolf glanced in the direction of the road, but not directly at the vehicles, several times. It successfully captured an arctic ground squirrel and lay down to eat before continuing on. It was finally lost from view behind a hill. On another occasion, two wolves were observed resting 500 m from the road without showing visible reactions to passing vehicles. On a third occasion, a wolf was approaching the road at 20 m when I rounded a corner in my truck, sighted it, and stopped. The wolf whirled, ran 3 m, then stopped and began sniffing at the ground and investigating holes, as if hunting. It proceeded in this manner, never again looking at the truck, until it was lost from view 10 min later 300 m from the road. On the fourth occasion, I rounded a bend in the road and observed a black wolf standing in the road 20 m ahead. I stopped my truck. The wolf continued standing, looked at the truck for about 10 sec, then slowly approached the truck, moving off the road about 2 m. At this time a shuttle bus approached and stopped immediately behind my truck. A man with a camera got out of the bus and quickly approached the wolf to within 10 m. The wolf watched the man and walk-trotted out of view into a small ravine 30 m from the road. It reappeared 40 m from the road, stopped, stared at the man, sniffed at the ground three times, and then walk-trotted another 20 m away and disappeared into another ravine. It was rumored among seasonal rangers that a wolf in the area

of this sighting had been fed on one or more occasions by visitors, but I did not talk to anyone who had actually seen this happen. It is interesting that the animal approached my vehicle after I stopped. No wolves in McKinley have been known to become real beggars. However, experiences along the trans-Alaskan pipeline route have shown that wolves can become habitual beggars where feeding by humans is not controlled (Dan Roby, pers. comm. 1976).

Wolves, like the red fox and other species, sometimes use the park road as a travel route. On one occasion I observed a wolf travel 4.5 km along the park road in 40 min. A. Murie (1944) observed tracks indicating that wolves at times use the road in winter as a route for easy access to Dall sheep on Polychrome Pass, and were even able to kill sheep that used the road as a place to rest. Many authors have provided evidence of the use of roads, human hiking trails, and snowmachine or snowshoe trails as travel routes by wolves (Mech 1970, Peters 1974, Peterson and Allen 1974). Peters (1974), in an extensive study of travel patterns of wolves in Minnesota, concluded that although wolves used human roads and trails, especially in the winter, these did not cause great alterations in their natural travel patterns. R. O. Peterson and Allen (1974) reported a 90% decrease in wolf scats found along hiking trails in Isle Royale National Park two weeks after human visitation began in the spring.

During the period of my study, wolves were observed scavenging one moose that had been killed by a vehicle. Wolves returned repeatedly to the carcass despite the fact that it was lying in the road

ditch. I observed single wolves on the carcass on two occasions; each time they ran into cover when vehicles approached. Large mammals are only rarely killed by vehicles on the park road and the scavenging of road-kill carcasses could not be an important food source for wolves. Carbyn (1974a, 1974b) commented on road-kill scavenging by wolves in Jasper National Park, Alberta.

Wolf kills of large mammals are not frequently observed from the park road. During the period of my study persons in a tour bus observed wolves chasing and killing a caribou 150 m from the nearest point on the road, but 500 m from the point of observation. This carcass was completely utilized, first by wolves, especially at night, and later by grizzly bears, over a period of several days. Richard Chapman (pers. comm. 1976) observed one wolf feeding at the carcass at night as a vehicle with its lights on crossed a bridge 500 m away. The wolf stopped, watched the vehicle momentarily, and then continued feeding. On another night a different wolf, attempting to approach the carcass, ran towards cover when a vehicle crossed the bridge. On another occasion, wolves attacked a caribou on a river bar within 75 m of the park road, but were apparently frightened off by a private vehicle that arrived during the attack (Earl Sinns, pers. comm. 1973). The badly wounded caribou remained at the same spot and was killed by a brown bear later the same day. Road-related disturbances to wolves at carcasses or during attacks appear to be infrequent.

The effects of the road on the denning of wolves are not well documented. Since 1973 active wolf dens have been protected by special

closed area status, which prohibits people from approaching the dens closely. As with foxes, the wolves choose their whelping dens and bear their pups before the road opens to vehicular traffic in the spring. In 1973, wolves used a den only 100 m from the road for at least two weeks after the road was opened to traffic. They then moved the pups to a den about 500 m from the road, and mostly hidden from view, where they remained until the end of the denning period. In 1974, a wolf family occupied a den 2 km from, and in view of, the road during June and part of July. From this den a long stretch of road on Polychrome Mountain is visible. Richard Chapman (pers. comm. 1976) observed this den for 335 hours and found that the wolves generally ignored vehicles passing on the road, although he once observed two adults watching a particularly noisy bus ascending the road up Polychrome Mountain. These observations illustrate that wolves may successfully den in close proximity to the road, at least if persons are kept from approaching the den. Individual wolves undoubtedly differ in their tolerance to the road (Chapman, in prep.). Carbyn (1974a, 1974b) discussed the abandonment of wolf dens in areas of heavy human use in Jasper National Park. A. Murie (1944) described an extreme case of disturbance, during which he entered the den and took a pup, after which the adults and remaining pups continued to use the den.

Lynx (*Lynx canadensis*)

Lynx were not frequently sighted in the park in 1973 or 1974. During the 70 shuttle-tour trips lynx were sighted on two occasions, one single and one pair. During my plot surveys I observed lynx once, an adult female and three kittens, in the Igloo Road Plot. The single lynx sighted from a bus sat 3 m from the road for 5 min while visitors observed it from the bus. It then walked parallel to the road and out of view. The pair sighted from a bus was seen only briefly walking in a ravine 100 m from the road before they were out of view. I sighted the female and three kittens while I was walking 200 m off the road. Although the female was aware of my presence, she allowed me to sit in full view and observe the family from less than 100 m away for 20 min. The female roamed over a small clearing, then lay down while the kittens played and explored. Finally, the family wandered into the shrubs and out of view. During this time several vehicles passed on the road 200 m away. The female occasionally glanced towards them.

Wolverine (*Gulo gulo*)

Wolverines were not sighted during any of the shuttle-tour trips or plot surveys. During 1973 and 1974, I observed one wolverine traveling 350 m from the road. It immediately ran out of view as my vehicle approached.

Porcupine (*Erethizon dorsatum*)

Forty-six porcupines were sighted during the 70 shuttle-tour trips. They were observed on 27% of the trips. Fifty percent of the porcupines sighted were on the road, especially the vegetated edges of the road. Table 52 shows the distances from the road for all porcupines observed. All observations were of single animals along the first 55 km of the road. Thirty-three percent of the porcupines observed were in spruce woods, 28% in dwarf shrub tundra, 24% in mixed open spruce and dwarf shrubs, 13% on gravel bars and 2% in tall willows. Buses often did not stop to observe a porcupine, if one had already been sighted earlier during the same trip. The buses passed, without stopping, 54% of the porcupines; they stopped, without people getting out, to observe 45% of the animals; and they stopped, with people getting out, for 4% of the animals. Nearly all the porcupines that were on the ground within 20 m of the road hurried away when the bus passed oor stopped.

The road appears to have an influence on the distribution of porcupines in the early summer. During both the shuttle-tour trips and my road census trips in the research vehicle, porcupines were sighted frequently before June 15 and rarely after this date (Table 53). This trend was apparent in both 1973 and 1974 although these animals were more numerous in 1973. Porcupines appear to be attracted to feed on the young green vegetation on the roadsides in late May and early June. As discussed earlier under "Brown Bears", the first new green vegetation of the year in a given area usually appears on the roadsides. After

Table 52. Observations of porcupines during shuttle-tour trips, 1973-1974, Mount McKinley National Park, Alaska.

	DISTANCE FROM ROAD (m)					
	0	1-5	6-10	11-50	51-100	TOTAL
Number of Porcupines Observed	23	9	6	6	2	46

Table 53. Numbers of porcupines and snowshoe hares observed along the road before and after June 15, 1973-1974, Mount McKinley National Park, Alaska.

DATE	TYPE OF OBSERVATION TRIP	NUMBER OF TRIPS	AVERAGE NUMBER OF PORCUPINES PER TRIP	AVERAGE NUMBER OF SNOWSHOE HARES PER TRIP
1973				
Before June 15	Shuttle-Tour	9	3.22	-
After June 15	Shuttle-Tour	32	0.22	-
Before June 15	Research Vehicle Road Census	7	6.43	24.86
After June 15	Research Vehicle Road Census	10	0.30	2.20
1974				
Before June 15	Shuttle-Tour	6	0.83	2.83
After June 15	Shuttle-Tour	23	0.22	0.65
Before June 15	Research Vehicle Road Census	5	1.40	8.20
After June 15	Research Vehicle Road Census	8	0.12	0

new vegetation is widely available, porcupines are rarely seen feeding on the roadside.

Snowshoe Hare (*Lepus americanus*)

Snowshoe hares were abundant during the early summer of 1973, but declined in numbers from that time through 1974 (Table 53). In 1973, hares were not recorded during the shuttle-tour trips because keeping records on the large number of hares interfered with observing large mammals. During the 1974 shuttle-tour trips and my research vehicle road census trips both years, records were kept on the hares. The average number observed per trip appears in Table 53. This table shows that hares, like porcupines, were observed on the roadsides much more frequently in the early summer, when the first green vegetation appeared, than later in the summer. They were apparently attracted to the roadside vegetation. Nearly all the hares were observed along the first 56 km of the road, in spruce woods, deciduous woods, and dwarf shrub habitats. Buses seldom stopped to allow visitors to observe snowshoe hares, and the hares almost always ran to cover when vehicles passed.

Hares are killed on the park road with some regularity by vehicles. During 17 road censuses in 1973, eight road-kill hares were counted. During 13 similar trips in 1974, when hares were scarce, no road-kills were seen.

Besides being attracted to the greening vegetation on the roadsides in early summer, hares were also attracted to two short sections of the road throughout the summer. Along the first 2.4 km of the road, a wide

section of disturbed ground at the side of the road has been stabilized with a rich mixture of grasses and herbs. Snowshoe hares were frequently observed feeding in concentrations on this vegetation, especially at night. During the research vehicle road censuses, 15% of the hares sighted were seen along this stretch of road. Hares were also frequently observed on the road along a 1.5 km stretch just west of Savage River. Eighteen percent of the hares sighted during research vehicle road censuses were observed along this short stretch of road, while 44% of the hares sighted from the shuttle-tour buses in 1974 were observed here. These animals frequently appeared to be licking dirt from the road along this stretch. It is possible that special minerals are available here. Dale Guthrie (pers. comm. 1976) has found gravel in hare pellets in this area. Short-eared owls were also observed concentrating along this stretch of road and may have been attracted by the hares.

Marmots (*Marmota caligata*)

An average of 1.3 marmots per trip were observed on the shuttle-tour trips. Marmots were sighted on 44% of these bus trips. All the observations, except one, were made on Polychrome Mountain. Sixty-six percent of the animals sighted were within 20 m of the road. The buses stopped for the visitors to observe the marmots 85% of the time.

Arctic Ground Squirrel (*Spermophilus undulatus*)

Arctic ground squirrels are abundant in the park. They are occasionally killed by vehicles on the road. Four road-killed squirrels were counted during the 30 research vehicle road census trips. Several species of wildlife, especially common ravens, magpies, mew gulls and long-tailed jaegers, were seen feeding on road-killed squirrels. Ground squirrels are frequently fed by visitors, despite regulations prohibiting feeding. Beggar squirrels occurred at several points along the road, including the hotel, campgrounds, visitor's center, and major scenic viewpoints.

Collared Pika (*Ochotona collaris*)

Pikas are found where suitable habitat occurs along the road. The building of the road has created some new habitat. Pikas live in roadside scree slopes in Igloo Canyon and on Polychrome Mountain.

Birds

Golden Eagle (*Aquila chrysaetos*)

An average of 1.4 golden eagles were observed during each of the shuttle-tour trips. These birds were sighted on 69% of the trips. Sixty-five percent of the eagles sighted were within 200 m of the road. The bus stopped, so visitors could observe eagles, during 61% of the sightings. Eagles seen from the road were usually flying, although some were observed perched and feeding near the road. One one occasion I observed a golden eagle stoop and successfully capture an arctic ground squirrel running across the road 60 m in front of a moving bus. On two other occasions I observed eagles stooping at prey near the road; once 5 m from my parked vehicle and once 70 m from my moving vehicle. During 1973 and 1974, I knew of no active eagle nests in close proximity to the road. In the 1950's two nests within 200 m of the road were frequently used, but since then both have been abandoned, possibly because of increased visitor activities (Frederick C. Dean, pers. comm. 1976).

Short-eared Owl (*Asio flammeus*)

In 1973, when microtines were relatively abundant, an average of 2.4 short-eared owls per trip were sighted on the shuttle-tour trips. They were seen on 71% of the trips. In 1974, with microtines reduced in numbers, only 0.14 owls per trip were sighted, with the birds being observed on only 14% of the trips. The buses stopped so that the visitors could observe the owls during only 31% of the sightings. Short-eared owls appeared to be attracted to the road as a hunting area.

Microtines, arctic ground squirrels, and snowshoe hares crossing or wandering on the road may be particularly easy prey. In 1973, during periods of twilight and darkness, I flushed as many as 30 short-eared owls from the road or roadside, while driving the first 50 km of the road. Owls were particularly concentrated on the road, with as many as eight observed at one time, along a 1.5 km stretch just west of Savage River. Snowshoe hares, perhaps seeking special minerals, were often seen on this section of road and their presence may have attracted the owls.

Long-tailed Jaegers (*Stercorarius longicaudus*)

An average of 0.9 long-tailed jaegers were sighted during each of the shuttle-tour trips. Jaegers were observed on 44% of the trips. These birds attracted the attention of visitors more than most other bird species. The buses stopped during 74% of the sightings. I was aware of three jaeger nests within 100 m of the road each summer. One of these nests was known to have hatched, although the fate of the others is not known. Just after fledging, a young jaeger from the successful nest was observed on several occasions feeding on road-killed ground squirrels near the nest site. One parent was also seen feeding on road-killed squirrels. These birds allowed vehicles to approach within 5 m while they were on the road feeding.

Willow Ptarmigan (*Lagopus lagopus*)

Records were not kept on ptarmigan during the shuttle-tour trips. Notes were made on ptarmigan observed during the research vehicle census trips. The numbers of ptarmigan observed during these trips appear in Table 54. Ptarmigan were more abundant in 1973 than in 1974. In early spring, males often used the raised roadbed as a vantage point from which to survey their territories (Table 54). They also used roadside willows as vantage points. Many willows grow along the road, because of drainage patterns from the road, while being absent from nearby areas. Later in the summer I observed families feeding on the roadside, especially where *Eriophorum* was localized in wet roadside ditches. Ptarmigan were also observed taking gravel from the road. Thus, these birds are attracted to the road for a variety of reasons.

Males on the road in the spring were sometimes bold in their reactions towards vehicles. During my road surveys, I drove slowly past ptarmigan. They responded in the following manners: 12% flew away from the road, 22% walked or ran a short distance off the road, and 65% remained on the road, usually crouching low and watching my vehicle pass. A few males ran aggressively towards my vehicle or ran along in front of it, as if leading the vehicle out of their territories.

Mew Gull (*Larus canus*)

During my road census trips in the research vehicle, an average of 9.5 mew gulls per trip were observed on the 12 spring trips. None were observed on the fall trips. Mew gulls, like ground squirrels, are

Table 54. Numbers of willow ptarmigan observed during road census trips in research vehicle, 1973-1974, Mount McKinley National Park, Alaska.

DATE	NUMBER OF TRIPS	AVERAGE NUMBER OF PTARMIGAN PER TRIP	
		ON ROAD	TOTAL OBSERVED
1973			
May 21 - May 24	6	12.00	32.67
June 21	1	3.00	4.00
August 30 - September 30	10	5.10	11.80
1974			
May 25 - May 29	2	2.00	14.00
May 30 - June 1	3	0	1.00
August 28 - September 8	8	0	0

frequently fed by visitors and some have become beggars. During the shuttle-tour trips, up to 11 gulls were counted at the Eielson Visitor Center, feeding on visitor handouts. Mew gulls were frequently observed flying along the road, following buses and other vehicles, and twice landed on my vehicle to peer through the window. They also frequent campgrounds and the garbage dump (Downing 1975).

FINAL DISCUSSION

General Biological Concepts and the Responses of Wildlife to Human Activities

Many general concepts in the fields of animal behavior and ecology are directly useful in understanding the responses of wild animals to human activities. A key factor influencing the behavior of higher vertebrates, especially mammals, is their ability to learn. Mammals function best physiologically in a familiar, predictable environment (Geist 1971a, 1975). Maximum energy efficiency in the utilization of their environment only occurs when sources of fear and uncertainty are minimized (Baskin 1974, Cowan 1974, Geist 1975). Mammals often respond to strange new situations or stimuli with a combination of alarm and curiosity. Later, through learning, they modify their responses appropriately to reduce uncertainties and danger. Depending on the outcome of their first encounters with a new stimulus, they may learn to avoid, approach or ignore it. Thus, the response of mammals to human activities depends to a large degree on the actions of people during the animals' first encounters with them. If alarm and fear responses are not reinforced, habituation occurs. If the animals are rewarded during encounters with humans, they may become attracted to people. Responses learned during early experiences with a given stimulus may be generalized to other stimuli perceived as similar by the animal (Cowan 1974).

In national parks, the habituation of animals to common human activities and artifacts, such as vehicles and roads, should be

encouraged. Habituation allows wild animals to efficiently utilize habitat near centers of human activity (Geist 1971a). It also provides visitors with an excellent opportunity to observe wild animals in near-natural environments. Alternatively, if park animals are repeatedly frightened and learn to fear humans, they may avoid areas of human activity or expend critical amounts of energy in physiological stress and frequent fear responses. Both situations could adversely affect the health and population dynamics of the species involved.

In order to take advantage of and encourage the capacity of mammals to habituate to human activities, an understanding of the stimulus-response mechanisms of the species in question is necessary. Animals continuously filter the stimuli coming to them from their environment and selectively respond to key stimuli. The perception of a situation and its accompanying stimuli by one species may be quite different than the perception of the same situation by another species, including man (von Uexküll 1957). The perceptive abilities and relative importance of the various senses in the large mammal species found in McKinley Park have never been studied in detail. However, previous discussions in this report indicate that smell is of major importance as a danger signal to caribou and brown bears, while hearing is important to moose and sight is important to sheep.

The ability of an animal to habituate varies with the type of stimulus to which it is subjected. Bergerud (1974) suggests that the responses to certain stimuli have an ontogenetic origin and are not easily modified by learning. These stimuli are usually key factors

used by the species to identify dangers that have been present during its evolutionary history. Important evolutionary factors influencing disturbance responses include predator-prey relationships and natural environmental hazards. Stimuli of importance to an animal may seem subtle to humans. Pruitt (1965) discovered that caribou responded strongly to the outline of a man wearing a wolf-ruff hood around his head, but did not respond to the same man when the hood was down. He postulated that the tall, narrow outline, with a broadly rounded top, of a man with a hood was very similar to the outline of a hunting wolf approaching directly, with its head lowered and the broadly rounded ruff of its shoulders providing the top outline. Non-hunting wolves generally have their heads up and present a different outline. Klein (1971) noted that reindeer refuse to cross bridges and suggested that the hollow sound of a bridge produces the same stimuli to the reindeer as thin ice. A common stimulus situation that may produce ontogenetically-based fear responses in a variety of species is a direct, close approach, as this is often associated with predators. Thus, direct approaches by park visitors reinforces the alarm response of a naive animal and inhibits habituation to visitor activities.

Other types of stimuli, besides those releasing ontogenetically-based fear responses, may generate alarm. These include stimuli that are not a familiar or predictable part of the environment or stimuli that generate sharp contrasts in the environment, such as loud noises or sudden movements (Geist 1971a). To encourage habituation these types of stimuli should be avoided during encounters between humans and wild

animals.

Besides predator-prey relationships, many factors in the life strategy of a species are important in understanding the responses of animals to human activities along a road. Home range size affects the frequency of encounters between individuals and road-related activities, and the frequency of encounters affects the habituation process. Habituation occurs only if a harmless situation becomes familiar and predictable (Geist 1971a). Species with small home ranges which include the road would frequently encounter human activities, allowing habituation or the buildup of physiological stress, depending upon the nature of the encounters. Individuals with large home ranges may rarely encounter the road, resulting in less opportunity for habituation. The discussions in this report provide evidence that moose, Dall sheep and brown bears, especially females with young, all have restricted seasonal home ranges of only a few square kilometers that are often used in successive years. Caribou tend to be more nomadic than the other species. Male brown bears often utilize large home ranges. Naive caribou and naive male brown bears are probably more frequently sighted from the road than naive moose, sheep, or brown bear families, and may be expected to be less habituated to human activities. The large mammals in the park generally have relatively long life spans of 10-20 years (Mundy and Flook 1973, A. Murie 1941, R. L. Peterson 1955). For the species with restricted home ranges, the same individuals are often observed from the road throughout a summer and in successive years. These individuals may also have been raised near the

road. These individuals could easily become habituated to human activities if humans did not reinforce the animals' initial fear responses.

During certain critical periods in the annual cycle, the potential damaging effects of disturbances are magnified. Disturbances during periods of severe cold, deep crusted snow or food shortages in winter can cause abortions, injuries, additional stress and death (Geist 1971a, Zhigunov 1961). The park road is not open to vehicular traffic during the winter, so disturbances from human activities are greatly reduced at this time. However, winter use by skiiers and mushers is increasing rapidly. Calving time is also a critical period, since disturbances can cause desertion, trampling and injury to the young (Zhigunov 1961). Most of the caribou in the park calve away from the road, but very young moose calves are frequently sighted from the road. Disturbances during migration may delay or divert migrating animals, possibly affecting their range use. In the park, sheep sometimes failed in attempts to move from winter to summer ranges because they were disturbed while attempting to cross the road. The large migrating bands of caribou always remain south of the road, not attempting to cross.

Interacting Variables Affecting Responses

A large number of internal and external variables interact in determining the response of an animal to human activities. These factors include distance and frequency of disturbance, type of human activity, group size, sex, age, behavior before disturbance, motivation, social facilitation, past experiences, individual temperament, health, time,

season, weather and habitat. These factors have been discussed, by species, previously in this report. A few comparative or general comments appear here.

Reaction Distances

The response patterns (none:mild:strong) at given distances were remarkably similar for the four most frequently observed large mammals, i.e. caribou, moose, Dall sheep and brown bears (Figs. 6, 9, 11, 13). For caribou, moose and bears the distance at which 50% of the animals exhibited strong reactions occurred between 25 and 50 m from the road. For Dall sheep this point occurred between 10 and 25 m from the road. All four species passed the threshold of 50% "no visible reaction" between 50 and 100 m from the road. All the species exhibited less than 10% strong responses beyond 200 m. There were no strong responses, except for three bear families, at distances beyond 400 m. Strong responses, by definition, included all flight behavior except "walking less than 10 m." Flushing distances are highly variable between individuals and situations and may be over 1 km under certain conditions (de Vos 1960, Jakimchuk *et al.* 1974). However, the average flushing distances in response to man reported in the literature all fall within a small range. For naive caribou, reported average flushing distances range from 90-160 m (Bergerud 1974, Kelsall 1957), for naive moose 80-140 m (Denniston 1956, McMillan 1954, Stringham 1974), for habituated moose 5-50 m (Denniston 1956, McMillan 1954, Stringham 1974), for habituated sheep 15-60 m (Anderson 1971, Dixon

1938, Jones *et al.* 1963), and for naive bears about 100 m (F. C. Craighead and J. J. Craighead 1966). Thus, "typical flushing distances" for these species seem to be 90-160 m for naive animals and 5-60 m for habituated animals.

Some differences between species become apparent when one looks at the distance in the shuttle-tour data at which 90% of the animals exhibited no visible response to the human activities. This distance was between 100-200 m for Dall sheep, 200-300 m for brown bears, 300-400 m for moose and 400-500 m for caribou. Caribou showed the highest percentage (41% of the animals) and sheep the lowest percentage (34% of the animals) of strong responses within 100 m of the road. Caribou may be the most reactive species to road-related human activities because they range over a larger area than the other species and a higher percentage of naive individuals may be included in the encounters. They are also highly social; one naive animal in a group can stimulate responses by others. The results for Dall sheep showed them to be particularly unresponsive to human activities. Few sheep occurred within 200 m of the road because very little habitat for sheep was found within this distance of the road. Most observations of sheep close to the road involved a small, well-habituated band on Polychrome Pass. Brown bears were particularly unresponsive at distances beyond 200 m, although their responses were more variable than other species. Adult brown bears have few enemies except other bears and man. Even man has probably only been a serious predator since the development of dependable firearms. Brown bears seem to exhibit fewer innate fear

responses and less wariness than ungulates. The latter have evolved under the influence of effective predators. Many bears, especially sows with families, remained in small areas near the road for long periods and in successive years, thus having the opportunity to habituate. The great variability in responses by bears may result from the fact that fewer responses are innate and responses are highly modified by individual experience. Bears encountered by the road also include both highly habituated families and naive single animals which range long distances and only occasionally encounter the road.

Type of Disturbance

The actions of the shuttle-tour buses varied slightly depending on the species. The actions of the buses were as follows: 1) they passed, without stopping, 2-12% of the individuals of each species sighted, 2) they stopped, with the people remaining in the bus, for 62-75% of the animals, 3) they stopped, with the people getting out but remaining on the road, for 13-32% of the animals, and 4) they stopped, with people getting out and walking off the road, for 0-3% of the animals. Tour buses tended to stop more often than shuttles, but people tended to get out of shuttles more often than tour buses. People on the buses seemed very efficient at sighting animals, both because of the experienced drivers and because there were many pairs of eyes searching in all directions. Observations of private vehicles, although inconclusive, indicated that people got out of them slightly more often and walked off the road toward animals more often than people

in buses. People in private cars failed more often than the people in buses to sight foxes at dens. The frequency of spotting animals from private cars is not known for the other species.

For large mammals within 200 m of the road, only foxes showed a significant increase in responses when vehicles stopped, with people remaining in the vehicle, compared to passing without stopping. Since buses infrequently passed animals that were observed, useful sample sizes often were not available. People getting out of the buses increased strong reactions for caribou, moose and sheep but not for bears or foxes (Figs. 8, 10, 12, 14, Table 50). It appears that the ungulates, all of which have evolved under the influence of effective predators, are more sensitive to the appearance of people than the carnivores. The foxes involved were at dens near the road and highly habituated. People from buses infrequently moved off the road but this action generally resulted in strong responses by the animals. As discussed earlier, animals do not habituate quickly to the threatening stimuli of a direct approach. Loud noises produced by shouting, whistling, honking, banging on the side of the buses, screeching brakes and other means dramatically increased strong responses from caribou, moose, sheep, bears and foxes (Figs. 8, 10, 12, 14, Table 50). The increase was particularly great for sheep and moose. Loud noises were effective in eliciting responses probably because they provided sharp contrasts to the usual sound stimuli. They were also unexpected, since they occurred during only 10% of the encounters. Moose, which often inhabit dense vegetation, are particularly dependent on hearing to warn them of danger (R. L. Peterson 1955). Sheep,

living in mountainous habitat, are vulnerable to rock slides and avalanches and loud noises are of particular significance as a warning signal to them (Dixon 1938, Geist 1971c).

Sex and Age

My study and the literature reviewed in the previous species discussions show that, in unhunted populations of caribou, moose and sheep, females with young are generally the most sensitive to environmental disturbances and old males are least sensitive. Reproductive success for females depends on the protection of the young from predators. Fleeing from sources of potential danger is a protective strategy used by many ungulates, and females with young are often characterized by long flushing distances. However, young moose calves need several days to develop fully their locomotor abilities (Altmann 1958b). Female moose with very young calves may have very short flight distances and may attack a potential source of danger rather than flee (Altmann 1958b). The males of these ungulate species depend on their size and condition during the rut to become part of the reproducing population. By minimizing their responsiveness to environmental stimuli they would conserve energy. If an attack occurs, a healthy male in his prime may more easily escape predators than smaller, younger animals.

Effects of Disturbance

Geist (1971a, 1975) reviewed the possible effects of various levels of disturbance on large mammals. Minimally, escape behavior

and anxiety require the utilization of energy. This energy must either be replaced by increased food intake and thus increased pressure on the food source, drawn from fat reserves, or redirected away from other energy uses, such as growth, development, fat deposition, and reproduction. Energy costs depend on the intensity, duration and frequency of disturbances. Chronic excitation or stress can cause physiological disorders (Zhigunov 1961). The mere act of fleeing, especially panicky flight, may result in abortions, desertion or trampling of young (Zhigunov 1961). Repeated disturbances may cause abandonment of habitat (Geist 1971c). All these responses may, in turn, adversely affect reproduction and mortality. Unfortunately, field studies of the actual energetic and physiologic costs of various types and levels of disturbance have not been done.

My study did not reveal any large-scale adverse effects of human activities on the wildlife near the park road. Many of the animals were habituated to some degree to human activities, especially those confined to the area of the road. Animals usually fled less than 200 m in response to road-related human activities. Longer flights occurred in a few sensitive individuals, or when animals were persistently followed off the road by visitors or chased along the road by a vehicle. The intensive observations of caribou did show that during the day animals within 200 m of the road tended to mill around more and feed less than caribou further from the road. These animals encountered human activity along the road several times each hour and did not appear to completely return to normal activities between encounters. Thus, the balance of energy

intake versus energy expended was not as favorable for animals feeding within 200 m of the road as for those feeding further away. This type of relationship may have also been true for other species, but not enough intensive observations were made on them to document it.

There is no evidence that the vicinity of the road was avoided by a large number of individuals of any of the major species. A few sensitive individuals probably did avoid the road. Male bears seemed to be under-represented near the road. Fewer male bears may have been habituated to the road because their large home ranges resulted in each individual only infrequently encountering the road.

Ground squirrels and snowshoe hares, when abundant, were frequently hit and killed by vehicles. Road-kills of large mammals were very infrequent.

Attraction of Wildlife to the Road

A number of species were attracted to the road to feed on the roadside vegetation. In the spring, the vegetation along the roadside began its new growth before the vegetation in nearby areas, and porcupines, snowshoe hares and, to a lesser extent, brown bears were attracted to feed on this new growth. Throughout summer, the hares continued to feed on grasses and herbs seeded to stabilize the roadside near the entrance of the park. Hares were also attracted to one other short section of the road, possibly by special minerals. Road drainage patterns favored roadside sedges and willows in some areas. Moose occasionally fed on the willows. Willow ptarmigan sometimes fed on

the seeds of roadside sedges. They also obtained gravel from the road and took dust baths on its surface. Male ptarmigan sat on the raised road in the spring to survey their territories.

Mew gulls, long-tailed jaegers, ravens and magpies were observed feeding on squirrels and hares that had been killed by vehicles. Short-eared owls were apparently attracted by the hares which concentrated along parts of the road. Foxes frequently used the road as a travel route and sometimes hunted along its edge. Ground squirrels and mew gulls concentrated near centers of tourist activity, where they received handouts of food from visitors. Some foxes were also observed being fed by visitors.

Management Recommendations

Many of the animals in Mount McKinley National Park are habituated to various degrees to human activities along the park road. Habituation should be encouraged, as it allows wild animals to utilize the roadside habitat without expending large amounts of energy in fear responses and physiological stress caused by human activities. Habituation of animals also allows visitors to view the animals. At the same time, visitors must be educated to respect wildlife and not to treat habituated wild animals as domestic pets that can be approached closely, touched, teased or fed.

To encourage habituation, stimuli that generate fear in wild animals should be avoided or minimized during human-wildlife encounters. Such stimuli include direct approaches, "sneak" approaches, loud noises,

quick movements, getting out of vehicles under certain circumstances and other situations discussed previously. Animals habituate best to situations that are familiar and predictable. The more uniform the actions of vehicles and visitors, the less disturbing they will be to the wildlife. For instance, controlling the speed of vehicles helps minimize disturbance. If most vehicles pass slowly and the animals are accustomed to this action, then a vehicle speeding past usually stimulates a strong response. Some uniformity of visitor activities has already been introduced by the use of a public transportation system. This system makes many of the vehicles on the park road uniform in appearance and the activities of visitors on the public buses are more predictable than those of visitors in private cars. The presence of other visitors and the bus driver inhibits blatant harassment or quick approaches towards animals. The bus system also provides a plus for the park visitor since the many pairs of searching eyes in a bus are usually able to spot as much or more wildlife than a well-trained observer.

The drivers of the public buses are the park personnel with the most contact with both visitors and wildlife along the road. They could effectively moderate many visitor-wildlife encounters. Bus drivers should be made to feel like an important part of the park system. During training, bus drivers should be given a sound knowledge of and respect for the park's wild animals. They should be made aware of the visitor activities that are most disturbing to wild animals and which animals are most sensitive. This knowledge would enable them to moderate visitor activities. Communication of this information to passengers is equally important. This

same information should be available to park visitors driving private vehicles.

Animals in certain situations are particularly sensitive to disturbance and the intensity of human interactions with animals in these situations should be minimized, perhaps by having people observe quietly from their vehicles. Such situations include encounters with females with newborn or small young, Dall sheep attempting to cross the road while moving from one range to another, bears and wolves on carcasses, wolves at dens and foxes at dens, if one or both of the adult foxes appear sensitive to human activities.

Feeding of wildlife is already prohibited in national parks. However, beggar animals still occur with some frequency. An informative explanation of the reasons for the "no feeding" regulation should be made available to visitors and this regulation should be strictly inforced.

The frequency of vehicles on the road during the day seems already high enough to significantly affect the activity patterns of caribou, and perhaps other species, within about 200 m of the road. Some of these animals remain nervous for most or all of the time between encounters with vehicles and their feeding time is reduced. The frequency of disturbances per visitor is reduced by using public buses rather than private vehicles because more people can ride in each vehicle. The frequency could be further reduced by encouraging vehicles to travel together rather than spreading out along the road.

It would be useful to park managers to systematically monitor

wildlife abundance and behavior along the park road. This could be done using an observer on public buses, as in this study. Data from such monitoring would provide early indications of changes in wildlife abundance, distribution or behavior near the road. Such changes may be correlated with changes in numbers of visitors, changes in visitor use patterns, changes in management policies, or changes within the wildlife populations or habitats unrelated to human activities inside the park.

Much more research is needed on the physiological effects of various types of human disturbances on wild animals. Disturbances could have many serious, but not immediately visible, effects that cannot be detected by a study such as the one reported here. Park managers could benefit by encouraging and supporting species-specific research into these problems, even if the work is not conducted within the park.

APPENDIX A. SUPPLEMENTARY DATA TABLES

Table A1. Dates of plot observations, Mount McKinley National Park, Alaska.

PLOT		DATE OF OBSERVATION PERIOD				
		1	2	3	4	5
Igloo Road	1973	June 25	July 20	August 14	August 20	September 1
Igloo Road	1974	June 20	July 8	July 30	August 12	August 22
Igloo Off-Road	1973	July 1	July 9	August 10	August 18	August 26
Igloo Off-Road	1974	June 21	July 25	August 2	August 14	August 25
Highway Road	1973	July 4	July 23	July 30	August 15	August 23
Highway Off-Road	1973	July 21	July 28	August 9	August 17	August 24
Stony Road	1973	June 19	July 5	July 22	August 19	September 7
Stony Off-Road	1973	June 22	July 6	July 25	August 19	September 4
Sable Road	1973	June 30	July 22	July 27	August 15	August 25

Table A2. Actual numbers and minimum densities of caribou observed during each plot observation period, first-search, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (FIRST-SEARCH)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	2	0.131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Road	1974	1	0.065	1	0.065	1	0.065	1	0.065	2	0.131	1	0.065	1	0.065	1	0.065	1	0.065	1	0.065
Igloo Off-Road	1973	2	0.104	1	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Off-Road	1974	1	0.052	1	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Highway Road	1973	4	0.223	2	0.112	1	0.056	1	0.056	2	0.112	2	0.112	0	0	0	0	1	0.056	1	0.056
Highway Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Road	1973	1	0.081	1	0.081	0	0	0	0	8	0.642	2	0.161	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	8	0.816	6	0.612	0	0	0	0
Sable Road	1973	10	0.482	2	0.097	13	0.628	6	0.290	6	0.290	3	0.145	2	0.097	2	0.097	1	0.048	1	0.048

Table A3. Actual numbers and minimum densities of caribou observed during each plot observation period, total day, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (TOTAL DAY)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	2	0.131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Road	1974	1	0.065	1	0.065	1	0.065	1	0.065	2	0.131	1	0.065	2	0.131	2	0.131	1	0.065	1	0.065
Igloo Off-Road	1973	2	0.104	1	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Off-Road	1974	1	0.052	1	0.052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Highway Road	1973	4	0.223	2	0.112	1	0.056	1	0.056	5	0.279	3	0.168	0	0	0	0	1	0.056	1	0.056
Highway Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Road	1973	1	0.081	1	0.081	1	0.081	0	0	9	0.726	3	0.242	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	11	1.122	7	0.714	0	0	0	0
Sable Road	1973	10	0.483	2	0.097	15	0.725	8	0.386	11	0.531	4	0.193	2	0.097	2	0.097	2	0.097	2	0.097

Table A4. Actual numbers and minimum densities of moose observed during each plot observation period, first-search, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (FIRST-SEARCH)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	1	0.065	0	0	0	0	3	0.196	2	0.131	1	0.065	1	0.065	1	0.065	1	0.065
Igloo Road	1974	4	0.261	3	0.196	2	0.131	2	0.131	2	0.131	2	0.131	3	0.196	2	0.131	3	0.196	2	0.131
Igloo Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	1	0.052	1	0.052	2	0.104	2	0.104
Igloo Off-Road	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.052	1	0.052
Highway Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.056	1	0.056
Highway Off-Road	1973	1	0.078	1	0.078	0	0	0	0	0	0	0	0	0	0	0	0	1	0.078	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	1	0.102	1	0.102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	1	0.048	1	0.048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A5. Actual numbers and minimum densities of moose observed during each plot observation period, total day, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (TOTAL DAY)																	
		1				2				3				4				5	
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	1	0.065	2	0.131	1	0.065	3	0.196	2	0.131	1	0.065	1	0.065	1	0.065	1	0.065
Igloo Road	1974	4	0.261	3	0.196	2	0.131	2	0.131	2	0.131	2	0.131	3	0.196	2	0.131	3	0.196	2	0.131
Igloo Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	1	0.052	1	0.052	2	0.104	2	0.104
Igloo Off-Road	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.052	1	0.052
Highway Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.056	1	0.056
Highway Off-Road	1973	1	0.078	1	0.078	0	0	0	0	0	0	0	0	0	0	0	0	1	0.078	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	1	0.102	1	0.102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	1	0.048	1	0.048	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A6. Actual numbers and minimum densities of Dall sheep observed during each plot observation period, first-search, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (FIRST-SEARCH)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	62	4.052	9	0.588	7	0.458	2	0.131	26	1.699	2	0.131	32	2.092	3	0.196	14	0.915	1	0.065
Igloo Road	1974	9	0.588	5	0.327	27	1.765	4	0.261	15	0.980	2	0.131	17	1.111	2	0.131	15	0.980	2	0.131
Igloo Off-Road	1973	40	2.083	3	0.156	81	4.219	6	0.312	45	2.344	8	0.417	15	0.781	3	0.156	102	5.312	4	0.208
Igloo Off-Road	1974	30	1.562	7	0.365	3	0.156	1	0.520	62	3.229	6	0.312	48	2.500	6	0.312	83	4.323	3	0.156
Highway Road	1973	8	0.447	2	0.112	9	0.503	1	0.056	3	0.168	1	0.056	0	0	0	0	0	0	0	0
Highway Off-Road	1973	0	0	0	0	14	1.085	2	0.155	0	0	0	0	0	0	0	0	4	0.310	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	0	0	0	0	5	0.242	2	0.097	0	0	0	0	0	0	0	0	26	1.256	2	0.097

Table A7. Actual numbers and minimum densities of Dall sheep observed during each plot observation period, total day, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (TOTAL DAY)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	77	5.033	10	0.654	11	0.719	4	0.261	30	1.961	4	0.261	32	2.092	3	0.196	14	0.915	1	0.065
Igloo Road	1974	9	0.558	5	0.327	27	1.765	4	0.261	19	1.242	3	0.196	17	1.111	2	0.131	15	0.980	2	0.131
Igloo Off-Road	1973	80	4.167	4	0.208	112	5.833	10	0.521	94	4.896	11	0.573	72	3.750	5	0.260	102	5.312	4	0.208
Igloo Off-Road	1974	30	1.562	7	0.365	3	0.156	1	0.520	62	3.229	6	0.312	48	2.500	6	0.312	85	4.427	4	0.208
Highway Road	1973	8	0.447	2	0.112	9	0.503	1	0.056	3	0.168	1	0.056	0	0	0	0	0	0	0	0
Highway Off-Road	1973	0	0	0	0	14	1.082	2	0.155	0	0	0	0	0	0	0	0	4	0.310	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	2	0.338	1	0.145	5	0.242	2	0.097	0	0	0	0	0	0	0	0	26	1.256	2	0.097

Table A8. Actual numbers and minimum densities of brown bears observed during each plot observation period, first-search, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (FIRST-SEARCH)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	1	0.065	1	0.065	1	0.065	1	0.065	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Road	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Off-Road	1973	1	0.052	1	0.052	1	0.052	1	0.052	3	0.156	2	0.104	1	0.052	1	0.052	0	0	0	0
Igloo Off-Road	1974	4	0.208	2	0.104	0	0	0	0	0	0	0	0	1	0.052	1	0.052	6	0.312	3	0.156
Highway Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	1	0.056	1	0.056	0	0	0	0
Highway Off-Road	1973	0	0	0	0	0	0	0	0	1	0.078	1	0.078	1	0.078	1	0.078	1	0.078	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	3	0.242	1	0.081	0	0	0	0	1	0.081	1	0.081
Stony Off-Road	1973	6	0.612	2	0.204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	3	0.145	1	0.048	10	0.483	4	0.193	6	0.290	4	0.193	3	0.145	1	0.047	0	0	0	0

Table A9. Actual numbers and minimum densities of brown bears observed during each plot observation period, total day, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (TOTAL DAY)															
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	1	0.065	1	0.065	1	0.065	1	0.065	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Road	1974	0	0	0	0	0	0	0	0	4	0.261	1	0.065	0	0	0	0	0	0	0	0
Igloo Off-Road	1973	4	0.208	2	0.104	1	0.052	1	0.052	3	0.156	2	0.104	3	0.156	2	0.104	0	0	0	0
Igloo Off-Road	1974	4	0.208	2	0.104	0	0	0	0	0	0	0	0	1	0.052	1	0.052	6	0.312	3	0.156
Highway Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	1	0.056	1	0.056	0	0	0	0
Highway Off-Road	1973	0	0	0	0	0	0	0	0	1	0.078	1	0.078	1	0.078	1	0.078	1	0.078	1	0.078
Stony Road	1973	0	0	0	0	0	0	0	0	3	0.242	1	0.081	0	0	0	0	1	0.081	1	0.081
Stony Off-Road	1973	6	0.612	4	0.204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	7	0.338	3	0.145	11	0.531	5	0.242	6	0.290	4	0.193	6	0.290	2	0.097	6	0.290	2	0.097

Table A10. Actual numbers and minimum densities of red foxes observed during each plot observations period, first-search, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (FIRST-SEARCH)																	
		1				2				3				4				5			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	2	0.131	3	0.196	1	0.065	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Road	1974	0	0	0	0	5	0.327	2	0.131	0	0	0	0	1	0.065	1	0.065	0	0	0	0
Igloo Off-Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Off-Road	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Highway Road	1973	0	0	0	0	0	0	0	0	1	0.056	1	0.056	2	0.112	1	0.056	0	0	0	0
Highway Off-Road	1973	0	0	0	0	0	0	0	0	1	0.078	1	0.078	0	0	0	0	0	0	0	0
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	1	0.102	1	0.102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table All. Actual numbers and minimum densities of red foxes observed during each plot observation period, total day, Mount McKinley National Park, Alaska.

PLOT		OBSERVATION PERIOD (TOTAL DAY)															
		1				2				3				4			
		Animals		Groups		Animals		Groups		Animals		Groups		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	2	0.131	2	0.131	3	0.195	1	0.065	0	0	0	0	0	0	0	0
Igloo Road	1974	0	0	0	0	5	0.327	2	0.131	0	0	0	0	1	0.065	1	0.065
Igloo Off-Road	1973	1	0.052	1	0.052	0	0	0	0	0	0	0	0	0	0	0	0
Igloo Off-Road	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Highway Road	1973	1	0.056	1	0.056	0	0	0	0	1	0.056	1	0.056	2	0.112	1	0.056
Highway Off-Road	1973	0	0	0	0	0	0	0	0	1	0.078	1	0.078	0	0	0	0
Stony Road	1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stony Off-Road	1973	1	0.102	1	0.102	0	0	0	0	0	0	0	0	0	0	0	0
Sable Road	1973	0	0	0	0	0	0	0	0	1	0.048	1	0.048	0	0	0	0

PLOT		OBSERVATION PERIOD (TOTAL DAY)			
		5			
		Animals		Groups	
		No.	Density (Per km^2)	No.	Density (Per km^2)
Igloo Road	1973	0	0	0	0
Igloo Road	1974	0	0	0	0
Igloo Off-Road	1973	0	0	0	0
Igloo Off-Road	1974	0	0	0	0
Highway Road	1973	0	0	0	0
Highway Off-Road	1973	0	0	0	0
Stony Road	1973	0	0	0	0
Stony Off-Road	1973	0	0	0	0
Sable Road	1973	0	0	0	0

Table A12. Total number of each species of large mammal observed during each shuttle-tour round-trip from Riley Campground to Eielson Visitor Center, Mount McKinley National Park, Alaska.

DATE	TYPE BUS	CARIBOU		MOOSE		DALL SHEEP		BROWN BEAR		RED FOX		WOLF	
		Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups
1973													
May 26	0600 Shuttle	18	9	4	4	30	7	5	2	1	1	0	0
27	1500 Shuttle	18	3	12	10	53	13	7	3	0	0	0	0
28	1500 Shuttle	3	3	12	6	18	5	3	1	4	2	0	0
June 3	1500 Shuttle	47	7	10	8	16	6	4	2	8	1	0	0
8	1500 Shuttle	24	6	13	9	48	7	12	4	1	1	0	0
9	1500 Shuttle	47	7	13	8	54	10	2	2	12	5	1	1
10	0600 Shuttle	118	12	11	8	67	11	3	3	5	2	0	0
11	1500 Shuttle	85	13	5	4	87	10	14	6	5	3	1	1
12	1500 Shuttle	146	17	13	9	12	3	9	5	5	2	1	1
17	1500 Shuttle	25	11	12	7	16	5	11	5	2	2	0	0
19	0700 Shuttle	12	7	7	7	49	8	2	2	4	3	0	0
23	0400 Tour	3	2	9	6	32	6	12	4	0	0	0	0
24	0400 Tour	7	2	2	1	59	3	11	4	7	1	0	0
27	0400 Tour	2	2	4	2	43	6	13	5	4	2	0	0
29	1500 Shuttle	10	5	1	1	39	3	4	2	2	2	0	0
July 1	1500 Shuttle	16	8	2	1	19	2	4	1	0	0	0	0
3	0400 Tour	6	1	1	1	5	1	3	1	0	0	1	1
4	0700 Shuttle	12	3	6	2	32	3	1	1	1	1	0	0
10	1500 Shuttle	4	2	1	1	24	5	11	5	0	0	0	0
12	0600 Shuttle	10	4	1	1	60	4	11	5	6	2	0	0
13	0400 Tour	18	8	4	3	35	3	5	3	4	2	0	0
17	0400 Tour	14	5	12	5	34	2	5	3	2	2	0	0
19	0600 Shuttle	10	2	3	2	30	5	13	5	1	1	0	0
24	0700 Shuttle	15	10	0	0	24	6	6	4	0	0	0	0
26	0400 Tour	21	6	9	5	6	1	5	3	1	1	1	1
27	0700 Shuttle	26	5	2	1	11	1	8	4	1	1	0	0
31	0400 Tour	9	5	5	4	22	3	4	2	2	1	0	0
Aug. 1	0700 Shuttle	10	5	2	2	36	4	0	0	2	2	0	0
2	1500 Shuttle	13	5	0	0	20	2	5	3	0	0	0	0
5	1500 Shuttle	12	3	6	4	16	4	10	4	3	2	0	0
7	0700 Shuttle	11	5	0	0	75	8	9	3	0	0	0	0
8	0400 Tour	11	6	5	4	17	1	3	1	1	1	0	0

Table A12 (continued)

DATE	TYPE BUS	CARIBOU		MOOSE		DALL SHEEP		BROWN BEAR		RED FOX		WOLF	
		Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups
1973 (cont.)													
Aug. 16	1500 Shuttle	0	0	16	8	2	1	11	5	1	1	0	0
17	0700 Shuttle	3	3	0	0	36	3	13	5	0	0	0	0
18	0600 Shuttle	5	2	4	2	22	3	7	3	0	0	0	0
23	0400 Tour	7	5	9	4	70	11	9	3	2	2	0	0
24	1500 Shuttle	7	7	2	2	30	3	9	3	0	0	0	0
25	0700 Shuttle	3	2	5	3	62	6	6	2	0	0	0	0
31	0700 Shuttle	0	0	8	4	46	5	6	2	0	0	0	0
Sept. 2	0700 Shuttle	0	0	4	2	28	6	3	1	0	0	0	0
3	0700 Shuttle	0	0	3	2	18	3	0	0	0	0	0	0
1974													
May 26	0400 Tour	36	6	11	5	29	9	16	6	2	2	0	0
31	1500 Shuttle	9	6	10	6	8	3	1	1	0	0	0	0
June 5	0400 Tour	3	1	0	0	4	2	0	0	0	0	0	0
8	1500 Shuttle	0	0	4	3	26	4	7	3	0	0	0	0
9	0400 Tour	3	1	6	6	34	6	6	2	0	0	0	0
14	1500 Shuttle	4	2	4	2	36	8	10	5	1	1	0	0
19	0400 Tour	12	2	6	4	46	3	0	0	1	1	0	0
26	1500 Shuttle	10	10	8	6	45	3	9	5	1	1	0	0
28	0400 Tour	11	5	2	2	60	6	9	3	1	1	0	0
29	1500 Shuttle	12	6	2	1	77	6	5	3	2	2	0	0
30	1500 Shuttle	4	1	1	1	59	4	3	1	0	0	0	0
July 6	0400 Tour	32	6	10	7	34	4	8	4	2	2	0	0
18	1500 Shuttle	10	9	5	4	40	5	10	5	0	0	0	0
23	0400 Tour	20	6	11	3	23	3	4	2	0	0	0	0
27	1500 Shuttle	8	8	1	1	41	6	3	1	0	0	0	0
30	0400 Tour	23	5	5	4	4	2	12	4	0	0	0	0
31	0400 Tour	34	8	3	2	57	6	9	3	1	1	0	0
Aug. 3	1500 Shuttle	25	11	5	3	37	5	5	3	0	0	0	0
5	0400 Tour	11	8	8	4	51	5	0	0	0	0	0	0
9	1500 Shuttle	7	4	7	5	22	2	0	0	0	0	0	0
16	0400 Tour	25	7	8	6	19	2	3	1	0	0	0	0
17	1500 Shuttle	22	3	1	1	37	2	0	0	0	0	0	0
18	0400 Tour	16	4	25	16	33	4	0	0	0	0	0	0
19	1500 Shuttle	11	3	7	4	4	2	3	1	0	0	0	0
25	0400 Tour	4	2	8	6	30	2	3	1	0	0	0	0
30	0400 Tour	0	0	8	5	26	2	3	1	0	0	0	0
31	1500 Shuttle	0	0	1	1	69	5	3	1	1	1	0	0
Sept. 1	0400 Tour	17	8	7	6	57	10	0	0	1	1	0	0
2	1500 Shuttle	2	2	0	0	10	2	4	2	0	0	0	0

Table A13. Reactions of caribou, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF CARIBOU TO BUS AND VISITORS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	4	3	4	3	12	5	21	11	42	21	4	6
0-100	26	10	84	41	42	24	90	33	243	104	21	30
0	2	1	0	0	11	4	13	8	26	11	2	3
1-25	2	2	4	3	1	1	9	5	16	11	1	3
26-50	4	1	18	11	14	6	24	8	60	26	5	8
51-75	2	1	16	7	12	9	3	2	33	18	3	5
76-100	16	5	46	20	4	4	42	12	108	40	9	12
101-200	9	7	151	55	47	9	28	8	235	78	20	23
201-300	3	3	140	36	16	6	9	3	168	47	14	14
301-400	32	4	87	24	12	2	6	2	137	32	12	9
401-500	3	2	113	19	8	2	0	0	124	23	11	7
501-750	6	2	119	23	0	0	0	0	125	25	11	7
751-1000	24	5	30	11	0	0	1	1	55	17	5	5
>1000	0	0	92	16	0	0	0	0	92	16	8	5
TOTAL	103	33	816	225	125	43	135	48	1179	342		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 6.

Table A14. Reactions of caribou, observed during shuttle-tour trips, to various actions of the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF CARIBOU								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	14	6	148	44	12	6	6	1	180	57	15	17
Pass <15 mph	28	3	26	7	4	2	1	1	59	12	5	4
Stop, people remain on bus, quiet	42	21	513	146	79	26	77	29	711	219	60	64
Stop, people remain on bus, noisy	2	1	13	5	9	3	15	6	39	14	3	4
Stop, people off bus on road, quiet	4	1	93	17	18	5	23	7	138	30	12	9
Stop, people off bus on road, noisy	0	0	5	2	0	0	1	1	6	3	<1	1
Stop, people walk off road, quiet	13	1	13	3	3	1	9	1	38	6	3	2
Stop, people walk off road, noisy	0	0	5	1	0	0	3	1	8	2	<1	<1
TOTAL	103	33	816	225	125	43	135	48	1179	342		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given.

Table A15. Reactions of caribou, observed during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF CARIBOU						TOTAL KNOWN REACTIONS	
	NONE		MILD		STRONG			
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups
Pass >15 mph	89	86	7	12	4	2	166	51
Pass <15 mph	84	70	13	20	3	10	31	10
Stop, people remain on bus; quiet	77	73	12	13	12	14	669	200
Stop, people remain on bus, noisy	35	36	24	21	41	43	37	14
Stop, people off bus on road, quiet	69	59	13	17	17	24	134	29
Stop, people off bus on road, noisy	83	67	0	0	17	33	6	3
Stop, people walk off road, quiet	52	60	12	20	36	20	25	5
Stop, people walk off road, noisy	62	50	0	0	38	50	8	2
TOTAL	76	72	12	14	12	14	1076	313

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently.

Table A16. Reactions of caribou, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; number of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF CARIBOU								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	3	2	20	12	7	4	6	1	36	19	8	10
Pass <15 mph	2	1	12	3	4	2	1	1	19	6	4	3
Stop, people remain on bus, quiet	24	12	157	66	63	20	70	27	314	122	66	67
Stop, people remain on bus, noisy	2	1	13	5	9	3	15	6	39	14	8	8
Stop, people off bus on road, quiet	4	1	28	8	3	3	14	4	49	15	10	8
Stop, people off bus on road, noisy	0	0	5	2	0	0	1	1	6	3	1	2
Stop, people walk off road, quiet	0	0	0	0	3	1	9	1	12	2	2	1
Stop, people walk off road, noisy	0	0	0	0	0	0	3	1	3	1	<1	<1
TOTAL	35	17	235	96	89	33	119	42	478	182		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 8.

Table A17. Reactions of moose, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF MOOSE TO BUS AND VISITORS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	8	5	14	11	6	6	49	35	77	53	19	20
0-100	39	24	99	73	41	30	76	54	255	172	62	64
0	0	0	0	0	1	1	18	12	19	13	5	5
1-25	8	5	14	11	5	5	31	22	58	39	14	15
26-50	17	10	16	14	21	14	16	10	70	45	17	17
51-75	2	2	13	9	5	4	6	4	26	18	6	7
76-100	12	7	56	39	9	6	5	5	82	56	20	21
101-200	13	10	39	23	15	7	5	4	72	44	18	16
201-300	2	2	16	13	5	3	2	1	25	19	6	7
301-400	5	2	24	11	0	0	2	1	31	14	8	5
401-500	1	1	10	6	0	0	0	0	11	7	3	3
501-750	2	1	4	3	3	1	0	0	9	5	2	2
751-100	0	0	5	4	0	0	0	0	5	4	1	1
>1000	0	0	4	3	0	0	0	0	4	3	1	1
TOTAL	62	40	201	136	64	41	85	59	412	267		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 19.

Table A18. Reactions of moose, observed during shuttle-tour trips, to various actions of the bus and visitors; number of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF MOOSE								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	8	6	29	28	2	2	5	4	44	40	11	15
Pass <15 mph	1	1	9	6	1	1	3	3	14	11	3	4
Stop, people remain on bus, quiet	44	26	148	92	46	27	47	34	285	174	69	65
Stop, people remain on bus, noisy	2	1	3	2	6	6	14	9	25	18	6	7
Stop, people off bus on road, quiet	6	5	11	7	8	4	16	9	41	22	10	8
Stop, people off bus on road, noisy	1	1	1	1	1	1	0	0	3	2	1	1
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	62	40	201	136	64	41	85	59	412	267		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given.

Table A19. Reactions of moose, observed during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF MOOSE						TOTAL KNOWN REACTIONS	
	NONE		MILD		STRONG			
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups
Pass >15 mph	81	82	6	6	14	12	36	34
Pass <15 mph	69	60	8	10	23	30	13	10
Stop, people remain on bus, quiet	61	61	19	18	20	23	241	150
Stop, people remain on bus, noisy	13	12	26	35	61	53	23	17
Stop, people off bus on road, quiet	31	35	23	20	46	45	35	20
Stop, people off bus on road, noisy	50	50	50	50	0	0	2	2
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0
TOTAL	57	58	18	18	24	25	350	233

Note: "Groups" may total over 100% since some groups were counted under more than one reaction class when various animals in the group reacted differently.

Table A20. Reactions of moose, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; number of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF MOOSE								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	7	5	16	15	2	2	5	4	30	26	9	12
Pass <15 mph	1	1	5	4	1	1	3	3	10	9	3	4
Stop, people remain on bus, quiet	35	21	104	68	39	24	43	32	221	140	68	69
Stop, people remain on bus, noisy	2	1	1	1	5	5	14	9	22	16	7	7
Stop, people off bus on road, quiet	6	5	11	7	8	4	16	9	41	22	12	10
Stop, people off bus on road, noisy	1	1	1	1	1	1	0	0	3	2	1	1
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	52	34	138	96	56	37	81	57	327	215		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 20.

Table A21. Reactions of Dall sheep, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; number of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF DALL SHEEP TO BUS AND VISITORS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	0	0	10	6	9	4	32	8	51	16	2	5
0-100	4	2	51	15	24	9	40	11	120	34	5	10
0	0	0	0	0	3	1	21	3	24	4	1	1
1-25	0	0	10	6	6	3	11	5	27	12	1	4
26-50	0	0	5	3	4	2	7	2	16	7	1	2
51-75	3	1	24	3	2	1	0	0	29	5	1	2
76-100	1	1	12	3	9	2	2	1	24	7	1	2
101-200	19	4	14	4	0	0	1	1	34	9	1	3
201-300	8	2	105	18	2	1	8	2	123	23	5	7
301-400	8	2	185	21	3	2	1	1	197	25	8	8
401-500	38	4	283	36	28	3	0	0	349	43	14	13
501-750	7	3	233	38	3	1	0	0	243	42	10	13
751-100	22	4	888	88	0	0	0	0	910	92	37	28
>1000	5	1	446	54	0	0	0	0	451	55	18	17
TOTAL	111	22	2205	274	60	16	51	15	2427	324		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 28.

Table A22. Reactions of Dall sheep, observed during shuttle-tour trips, to various actions of the bus and visitors; number of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF DALL SHEEP								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	44	9	486	76	6	3	0	0	536	88	22	27
Pass <15 mph	0	0	71	8	5	3	0	0	76	11	3	3
Stop, people remain on bus, quiet	34	10	1174	140	41	7	20	8	1269	163	52	50
Stop, people remain on bus, noisy	0	0	1	1	0	0	20	2	21	3	1	1
Stop, people off bus on road, quiet	19	2	453	46	8	3	9	4	489	53	20	16
Stop, people off bus on road, noisy	14	1	16	3	0	0	0	0	30	4	1	1
Stop, people walk off road, quiet	0	0	4	1	0	0	2	1	6	2	<1	<1
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	111	22	2205	274	60	16	51	15	2427	324		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given.

Table A23. Reactions of Dall sheep, observed during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF DALL SHEEP						TOTAL KNOWN REACTIONS	
	NONE		MILD		STRONG			
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups
Pass >15 mph	99	86	1	14	0	0	492	79
Pass <15 mph	93	73	7	27	0	0	76	11
Stop, people remain on bus, quiet	95	91	3	5	2	5	1235	154
Stop, people remain on bus, noisy	5	33	0	0	95	67	21	3
Stop, people off bus on road, quiet	96	90	2	6	2	8	470	51
Stop, people off bus on road, noisy	100	100	0	0	0	0	16	3
Stop, people walk off road, quiet	67	50	0	0	33	50	6	2
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0
TOTAL	95	91	2	5	2	5	2316	303

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently.

Table A24. Reactions of Dall sheep, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF DALL SHEEP								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	9	2	5	2	2	1	0	0	16	5	10	12
Pass <15 mph	0	0	2	1	5	3	0	0	7	4	4	9
Stop, people remain on bus, quiet	14	4	46	10	15	4	14	7	89	23	58	53
Stop, people remain on bus, noisy	0	0	0	0	0	0	20	2	20	2	13	5
Stop, people off bus on road, quiet	0	0	9	5	2	1	8	3	19	8	12	19
Stop, people off bus on road, noisy	0	0	3	1	0	0	0	0	3	1	2	2
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	23	6	65	19	24	9	42	12	154	43		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 30.

Table A25. Reactions of brown bears, observed at varying distances from the road during shuttle-tour trips, to the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

DISTANCE FROM ROAD (m)	REACTION OF BROWN BEARS TO BUS AND VISITORS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
0-25	3	1	0	0	5	5	16	6	24	12	6	7
0-100	9	3	48	20	15	11	39	14	111	46	27	25
0	0	0	0	0	2	2	13	5	15	7	4	4
1-25	3	1	0	0	3	3	3	1	9	5	2	3
26-50	0	0	7	3	5	3	3	1	15	7	4	4
51-75	0	0	23	9	2	2	6	2	31	11	7	6
76-100	6	2	18	8	3	1	14	5	41	16	10	9
101-200	8	5	50	20	4	2	11	5	73	32	18	18
201-300	10	4	56	25	5	2	0	0	71	31	17	17
301-400	0	0	31	15	3	1	3	1	37	17	9	9
401-500	6	2	25	13	0	0	0	0	31	15	7	8
501-750	0	0	33	15	0	0	0	0	33	15	8	8
751-1000	3	1	31	11	0	0	3	1	37	13	9	7
>1000	3	1	19	11	0	0	0	0	22	12	5	7
TOTAL	39	16	293	130	27	16	56	21	415	180		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 39.

Table A26. Reactions of brown bears, observed during shuttle-tour trips, to various actions of the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF BROWN BEARS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	3	1	14	8	0	0	0	0	17	9	4	5
Pass <15 mph	0	0	2	2	0	0	0	0	2	2	<1	1
Stop, people remain on bus, quiet	29	12	180	80	16	9	32	13	257	113	62	63
Stop, people remain on bus, noisy	1	1	22	8	2	2	9	3	34	14	8	8
Stop, people off bus on road, quiet	3	1	72	31	9	5	12	4	96	39	23	22
Stop, people off bus on road, noisy	3	1	3	1	0	0	3	1	9	3	2	2
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	39	16	293	130	27	16	56	21	415	180		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given.

Table A27. Reactions of brown bears, observed during shuttle-tour trips, to various actions of the bus and visitors; percent of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF BROWN BEARS						TOTAL KNOWN REACTIONS	
	NONE		MILD		STRONG			
	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Percent Animals	Percent Groups	Number Animals	Number Groups
Pass >15 mph	100	100	0	0	0	0	14	8
Pass <15 mph	100	100	0	0	0	0	2	2
Stop, people remain on bus, quiet	79	78	7	9	14	13	228	102
Stop, people remain on bus, noisy	67	62	6	15	27	23	33	13
Stop, people off bus on road, quiet	81	89	10	14	13	11	89	35
Stop, people off bus on road, noisy	50	50	0	0	50	50	6	2
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0
TOTAL	79	80	7	10	15	13	372	162

Note: "Groups" may total over 100%, since some groups were counted under more than one reaction class when various animals in the group reacted differently.

Table A28. Reactions of brown bears, observed within 200 m of the road during shuttle-tour trips, to various actions of the bus and visitors; numbers of animals and groups, 1973-1974, Mount McKinley National Park, Alaska.

ACTION OF BUS AND VISITORS	REACTION OF BROWN BEARS								TOTAL			
	UNKNOWN		NONE		MILD		STRONG					
	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	Number Animals	Number Groups	% Grand Total Animals	% Grand Total Groups
Pass >15 mph	3	1	1	1	0	0	0	0	4	2	2	3
Pass <15 mph	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people remain on bus, quiet	10	4	53	21	11	7	26	11	100	43	54	56
Stop, people remain on bus, noisy	1	1	9	3	2	2	9	3	21	9	11	12
Stop, people off bus on road, quiet	0	0	32	14	6	4	12	4	50	20	27	26
Stop, people off bus on road, noisy	3	1	3	1	0	0	3	1	9	3	5	4
Stop, people walk off road, quiet	0	0	0	0	0	0	0	0	0	0	0	0
Stop, people walk off road, noisy	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	17	7	98	40	19	13	50	19	184	77		

Note: Some groups are counted under more than one reaction class if various animals in the group exhibited different types of reactions. Thus, the number of groups entered under the different reaction classes may total more than the actual total number of groups given. The percentages of animals and groups exhibiting each type of reaction appear in Table 40.

Table A29. Research truck road census trips, dates of trips and condition of road access, Mount McKinley National Park, Alaska.

CENSUS TRIPS 1973		CENSUS TRIPS 1974	
Date	Road Access	Date	Road Access
May 21	Road closed to public beyond Mile 30	May 25	Road closed to public beyond Mile 30
May 21	"	May 29	Road open to public and private vehicles with permits
May 22	"	May 30	"
May 23	"	May 30	"
May 24	"		
May 24	"		
June 21	Road open to public buses and private vehicles with permits	June 1	"
August 30	"	August 28	"
August 31	"	August 29	"
		August 31	Road open to all private vehicles without permits
Sept. 1	Road open to all private vehicles without permits	Sept. 1	"
Sept. 2	"	Sept. 3	"
Sept. 3	"	Sept. 4	"
Sept. 4	"	Sept. 7	"
Sept. 8	"	Sept. 8	"
Sept. 9	"		
Sept. 22	"		
Sept. 23	"		

Table A30 Average daily traffic, traveling east plus west combined, through Savage River Guard Station 1974, Mount McKinley National Park, Alaska.

Week beginning	Time of day (hour) 0000 -- 0600 NPS veh.	Public bus	Private veh.	Total	0600 -- 1200 NPS veh.	Public bus	Private veh.	Total	1200 -- 1800 NPS veh.	Public bus	Private veh.	Total	1800 -- 2400 NPS veh.	Public bus	Private veh.	Total	Total NPS veh.	Public bus	Private veh.	Total
June 2	0	2.0	1.5	3.5	6.5	20.5	11.0	37.0	5.0	10.6	17.4	33.0	2.3	3.0	9.0	14.3	14.8	36.1	38.9	89.8
June 9	0.6	3.4	3.4	7.4	4.7	14.3	19.4	38.4	6.0	11.0	23.6	40.6	4.0	6.4	18.0	28.4	15.3	34.4	64.4	114.1
June 16	0.4	2.7	2.7	5.8	6.6	19.3	24.8	50.7	5.2	16.9	32.5	54.6	3.8	6.9	20.7	31.4	16.0	45.8	80.7	142.5
June 23	0.3	4.0	3.7	8.0	5.5	20.6	27.6	53.7	5.5	20.0	35.4	60.9	4.3	7.7	21.7	33.7	15.6	52.3	88.4	156.3
June 30	0.9	5.0	4.0	9.9	5.4	22.5	27.7	55.6	6.0	19.6	37.3	62.9	2.4	10.2	20.4	33.0	15.0	57.3	99.4	171.7
July 7	0.7	5.4	1.9	8.0	5.5	22.0	23.5	51.0	7.1	22.1	32.0	61.2	4.6	9.5	21.5	35.6	17.9	59.0	78.9	155.8
July 14	0.7	5.8	4.2	10.7	6.3	25.1	25.7	57.1	6.3	22.1	36.7	65.1	3.5	13.0	26.2	42.7	16.8	66.0	92.8	175.6
July 21	0.6	5.8	2.7	9.1	6.2	25.1	22.8	54.1	7.2	22.0	37.7	66.9	4.1	12.2	21.3	37.6	18.1	65.1	84.5	167.7
July 28	0.4	5.3	2.3	8.0	3.1	26.4	30.3	59.8	4.3	21.8	35.7	61.8	3.3	11.7	26.0	41.0	11.1	65.2	94.3	170.6
August 4	0.3	5.6	1.2	7.1	4.7	24.6	24.1	53.4	5.4	22.6	39.6	67.6	4.9	7.6	23.7	36.2	15.3	60.4	88.6	164.3
August 11	0.7	6.0	2.4	9.1	3.8	26.9	26.9	57.4	4.8	20.4	33.6	58.8	5.3	10.1	19.6	35.0	14.6	63.4	82.5	160.5
August 18	0.4	5.1	3.2	8.7	4.9	20.4	35.2	50.6	4.7	19.3	37.9	61.9	4.6	9.7	18.1	32.4	14.6	54.5	84.5	153.6
August 25	0.3	3.8	2.1	6.2	3.3	20.6	21.8	45.7	4.4	18.8	36.0	59.2	4.2	8.6	22.0	34.8	12.2	51.8	82.9	146.9
Sept. 1*	0	4.0	1.5	5.5	2.0	19.5	38.5	60.0	5.0	16.0	45.5	66.5	3.5	12.5	27.0	43.0	10.5	52.0	132.5	195.0

*Data for only two days.

LITERATURE CITED

Ables, E. D. 1975. Ecology of the red fox in North America. Pages 216-236 *in* M. W. Fox, ed. The wild canids. Van Nostrand Reinhold Co., N. Y.

Allison, L. M. 1971. Activity and behavior of red foxes in Central Alaska. M.S. Thesis. Univ. of Toronto, Toronto, Ontario. 92 pp.

Altmann, M. 1958a. The flight distance in free-ranging big game. J. Wildl. Manage. 22(2):207-209.

_____. 1958b. Social integration of the moose calf. Anim. Behav. 4(3,4):155-159.

Andersen, R. 1971. Effects of human disturbance on Dall sheep. Alaska Coop. Wildl. Research Unit Quart. Rept. 22(3):23-27.

Banfield, A. W. F. 1954. Preliminary investigations of the barren-ground caribou, Part II: Life history, ecology, and utilization. Can. Wildl. Serv. Wildl. Manage. Bull. Ser. 1, No. 10B. 112 pp.

_____. 1974. The relationship of caribou migration behavior to pipeline construction. Pages 797-804 *in* V. Geist and F. Walther, eds. The behavior of ungulates and its relation to management. Vol. 2. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 24, Morges, Switzerland.

Barnes, V. G., Jr. and O. E. Bray. 1967. Final report: Population characteristics and activities of black bears in Yellowstone National Park. Submitted to the U.S. Nat. Park Serv. Colorado Coop. Wildl. Research Unit, Colorado State Univ., Fort Collins. 199 pp.

Baskin, L. M. 1974. Management of ungulate herds in relation to domestication. Pages 530-541 *in* V. Geist and F. Walther, eds. The behavior of ungulates and its relation to management. Vol. 2. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 24, Morges, Switzerland.

Bergerud, A. T. 1974. The role of environment in the aggregation, movement, and disturbance behavior of caribou. Pages 552-584 *in* V. Geist and F. Walther, eds. The behavior of ungulates and its relation to management. Vol. 2. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 24, Morges, Switzerland.

Buskirk, S. 1975. U.S. Dept. of the Interior, National Park Service, Case incident record No. 1514. Unpubl. Official Files, Mount McKinley National Park, U.S. Nat. Park Serv. 2 pp.

Calef, G. W. and G. M. Lortie. 1973. Observations on the Porcupine caribou herd. Pages 1-127 *in* Interim report no. 3 towards an environmental impact assessment of the portion of the MacKenzie gas pipeline from Alaska to Alberta. Environmental Protection Board, Winnipeg, Manitoba.

Carbaugh, B., J. P. Vaughan, E. D. Bellis, and H. B. Graves. 1975. Distribution and activity of white-tailed deer along an interstate highway. J. Wildl. Manage. 39(3):570-81.

Carbyn, L. N. 1974a. Wolf population fluctuations in Jasper National Park, Alberta, Canada. Biol. Conserv. 6(2):94-101.

_____. 1974b. Wolf predation and behavioral interactions with elk and other ungulates in an area of high prey density. Unpubl. Can. Wildl. Serv. Prepared for Parks Canada. Jasper National Park. 233 pp.

Cauble, E. C. 1975. Chronology of grizzly bear attacks on humans from Aug., 1961 through May, 1975, Mt. McKinley National Park. Unpubl. Official Files, Mount McKinley National Park, U.S. Nat. Park Serv. 3 pp.

Chapman, R. C. (in prep.). The effects of human disturbance on wolves (*Canis lupus* L.). M.S. Thesis. Univ. of Alaska, Fairbanks.

Child, K. N. 1973. The reactions of barren-ground caribou (*Rangifer tarandus granti*) to simulated pipeline and pipeline crossing structures at Prudhoe Bay, Alaska. A Completion Report to the Alaska Coop. Wildl. Research Unit, Univ. of Alaska, Fairbanks. 49 pp.

_____ and P. C. Lent. 1973. The reaction of reindeer to pipeline simulation at Penny River, Alaska. Interim Report, Alaska Coop. Wildl. Research Unit, Univ. of Alaska, Fairbanks. 30 pp.

Chrisler, L. 1956. Observations of wolves hunting caribou. J. Mammal. 37(3):337-346.

Cole, G. F. 1972. Preservation and management of grizzly bears in Yellowstone National Park. Pages 274-288 *in* S. Herrero, ed. Bears -- their biology and management. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 23, Morges, Switzerland.

Couey, F. M. 1950. Rocky Mountain bighorn sheep of Montana. Fed. Aid in Wildl. Rest. Proj. 1-R, Bull. 2, Montana Fish and Game Commission. 90 pp.

Cowan, I. M. 1974. Management implications of behavior in the large herbivorous mammals. Pages 921-934 *in* V. Geist and F. Walthers, eds. The behavior of ungulates and its relation to management. Vol. 2. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 24, Morges, Switzerland.

Cowan, I. M., D. G. Chapman, R. S. Hoffman, D. R. McCullough, G. A. Swanson, and R. B. Weeden. 1974. Report of the committee on the Yellowstone grizzlies. National Academy of Sciences, Division of Biological Sciences, Assembly of Life Sciences, National Research Council. 61 pp.

Craighead, F. C., Jr. and J. J. Craighead. 1966. Trailing Yellowstone's grizzlies by radio. Natl. Geogr. Mag. 134(8):252-267.

Craighead, F. C., Jr. and J. J. Craighead. 1972a. Data on grizzly bear denning activities and behavior obtained by using wildlife telemetry. Pages 84-106 *in* S. Herrero, ed. Bears -- their biology and management. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 23, Morges, Switzerland.

_____. 1972b. Grizzly bear prehibernation and denning activities as determined by radio tracking. Wildl. Mongr. No. 32. 35 pp.

Craighead, J. J. and F. C. Craighead, Jr. 1972. Grizzly bear-man relationships in Yellowstone National Park. Pages 304-332 *in* S. Herrero, ed. Bears -- their biology and management. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 23, Morges, Switzerland.

Curatolo, J. A. 1975. Factors influencing local movements and behavior of barren-ground caribou (*Rangifer tarandus granti*). M.S. Thesis. Univ. of Alaska, Fairbanks. 146 pp.

_____ and G. D. Moore. 1975. Home range and population dynamics of grizzly bears (*Ursus arctos* L.) in the Eastern Brooks Range, Alaska. Pages 1-79 *in* R. D. Jakimchuk, ed. Studies of large mammals along the proposed MacKenzie valley gas pipeline route from Alaska to British Columbia. Arctic Gas Biol. Rept. Ser. Vol. 32.

Darling, F. F. 1937. A herd of red deer. Oxford Univ. Press, London. 215 pp.

Dean, F. C. (in press). Aspects of grizzly bear ecology in Mount McKinley National Park. Paper given at the Third International Conference on Bear Research and Management held May 31-June 1, 1974 in Binghamton, New York.

De Bock, E. A. and D. Surrendi. 1974. Some aspects of the ecology of the Porcupine caribou herd. Preliminary report prepared for the Task Force on Northern Oil Development, Ottawa. n.p. (Cited in Geist 1975, original not seen.)

Denniston, R. H. 1956. Ecology, behavior and population dynamics of the Wyoming or Rocky Mountain moose. Zoologica 41:105-118.

de Vos, A. 1958. Summer observations on moose behavior in Ontario. J. Mammal. 39(1):128-139.

_____. 1960. Behavior of barren ground caribou on their calving grounds. J. Wildl. Manage. 24:250-258.

Dixon, J. S. 1938. Birds and mammals of Mount McKinley National Park, Alaska. Fauna of the National Parks of the U.S., Fauna Ser. No. 3. U.S. Govt. Printing Office, Wash., D. C. 236 pp.

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39(3):563-69.

Downing, C. 1975. Wildlife activity at the McKinley Park area garbage dumps. Unpubl. report submitted to the U.S. Nat. Park Serv. and Mount McKinley National Park from the Alaska Coop. Park Studies Unit, Univ. of Alaska, Fairbanks. 67 pp.

Dugmore, A. R. 1913. The romance of the Newfoundland caribou. J. B. Lipincott Co., Phil. 191 pp.

Erickson, A. W. 1965. The brown-grizzly bear in Alaska, its ecology and management. Fed. Aid in Wildl. Rest. Proj. Rept. 5. Alaska Dept. Fish and Game. 42 pp.

Ericson, C. A. 1972. Some preliminary observations on the acoustic behavior of semi-domestic reindeer (*Rangifer tarandus tarandus*) with emphasis on intraspecific communication and the mother-calf relationship. M.S. Thesis. Univ. of Alaska, Fairbanks. 121 pp.

Espmark, Y. 1972. Behavior reactions of reindeer exposed to sonic booms. Deer. Jour. Brit. Soc. 2(7):800-802.

Faro, J. and S. Eide. 1974. Management of McNeil River State Game Sanctuary for nonconsumptive use of Alaska brown bears. Pages 113-118 *in* Proc. Fifty-fourth Ann. Conf. Western Ass. State Game and Fish Comm., Albequerque, N. M., July 16-19, 1974.

Freuchen, P. and F. Salomonsen. 1958. The arctic year. G. P. Putnam's Sons, N. Y. 438 pp.

Geist, V. 1963. On the behavior of North American moose (*Alces alces andersoni* Peterson 1950) in British Columbia. Behav. 20(3-4):377-416.

_____. 1971a. A behavioral approach to the management of wild ungulates. Pages 413-424 *in* E. Duffey and A. S. Watt, eds. The scientific management of animal and plant communities for conservation. Brit. Ecol. Soc. Symp. No. 11. Blackwell Sci. Publ., Oxford.

_____. 1971b. Is big game harassment harmful? Oilweek 22(17):12-13.

_____. 1971c. Mountain sheep: a study in behavior and evolution. Univ. of Chicago Press, Chicago, Ill. 383 pp.

_____. 1975. Harassment of large mammals and birds -- with a critique of the research submitted by Arctic Gas Study Ltd. on the subject. Unpubl. report to the Berger Commission. 69 pp.

Haber, G. C. 1968. The social structure and behavior of an Alaskan wolf population. M.S. Thesis. Northern Michigan Univ., Marquette. 197 pp.

_____. 1972a. The McKinley Project: behavioral-ecological studies of wolves and prey in a subarctic biosystem. Unpubl. Univ. of British Columbia, Vancouver. 21 pp.

_____. 1972b. Mount McKinley Park and north boundary wildlife problems -- a proposal. Unpubl. Univ. of British Columbia, Vancouver. 21 pp.

Harper, F. 1955. The barren ground caribou of Keewatin. Univ. of Kansas Press, Lawrence. 163 pp.

Heimer, W., A. C. Smith, S. Linderman, and P. D. Shaughnessy. 1972. Dall sheep movements and mineral lick use. Proj. Rept. Fed. Aid Wild. Rest. Proj. W-17-3 and W-17-4. Pages 1-17 *in* L. Nichols and W. Heimer. Sheep Report. Vol. 13. Alaska Dept. Fish and Game, Juneau.

Hemming, J. E. 1971. The distribution and movement patterns of caribou in Alaska. Alaska Dept. Fish and Game Tech. Bull. No. 1. 60 pp.

Henshaw, J. 1970. Consequences of travel in the rutting of reindeer and caribou (*Rangifer tarandus*). Anim. Behav. 18(2):256-258.

Herrero, S. 1970. Human injury inflicted by grizzly bears. Science 170(3958):593-598.

_____. 1972. Aspects of evolution and adaptation in American black bears (*Ursus americanus* Pallus) and brown and grizzly bears (*U. arctos* Linné) of North America. Pages 221-231 *in* S. Herrero, ed. Bears -- their biology and management. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 23, Morges, Switzerland.

Houston, D. G. 1968. The Shiras moose in Jackson Hole, Wyoming. Tech. Bull. No. 1, Grand Teton Natural History Assoc. in coop. with the U.S. Nat. Park Serv. 110 pp.

_____. 1974. Aspects of social organization of moose. Pages 690-696 *in* V. Geist and F. Walther, eds. The behavior of ungulates and its relation to management. Vol. 2. Int. Union Conserv. Nat. Nat. Resourc. Publications New Series No. 24, Morges, Switzerland.

Jakimchuk, R. D., E. A. De Bock, H. H. Russell, and G. P. Semenchuk. 1974. A study of the Porcupine caribou herd, 1971. 115 pp. *in* R. D. Jakimchuk, ed. The Porcupine caribou herd -- Canada. Arctic Gas Biol. Rept. Ser. Vol. 4.

Johnson, A. S. 1972. Man, grizzly and national parks. Natl. Parks Conserv. Mag. 46(2):10-15.

Jones, F. F., R. F. Batchelor, H. R. Merriam, and L. A. Viereck. 1963. Sheep and goat investigations. Vol. III. Ann. Proj. Segment Rept. Fed. Aid in Wildl. Rest. Act. Proj. W-6-R-3, Work Plan E. Alaska Dept. Fish and Game, Juneau. 47 pp.

Kelsall, J. P. 1957. Continued barren-ground caribou studies. Wildl. Manage. Bull. Ser. 1, No. 12. Can. Dept. Northern Affairs and National Resources. 148 pp.

_____. 1968. The migratory barren-ground caribou of Canada. Can. Wildl. Serv. Monogr. No. 3. Queen's Printer, Ottawa. 340 pp.

Klein, D. R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173(3995):393-398.

Klein, D. R. 1974. The reaction of some northern mammals to aircraft disturbances. Pages 377-383 *in* Proc. XI Int. Congr. Game Biologists, Stockholm, Sweden, Sept. 3-7, 1973.

Knowlton, F. F. 1960. Food habitats, movements and populations of moose in the Gravelly Mountain, Montana. J. Wildl. Manage. 24(2):162-170.

Krott, P. and G. Krott. 1963. Zum verhalten des Braunbären (*Ursus arctos* L. 1758) in den Alpen [in German, English summary]. z.f. Tierpsychol. 20(2):160-206.

Lenarz, M. 1974. The reaction of Dall sheep to an FH-1100 helicopter. Ch. 3, 14 pp. *in* R. D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser. Vol. 23.

Lent, P. C. 1964. Calving and related social behavior in the barren ground caribou. Ph.D. Thesis. Univ. of Alberta, Edmonton. 220 pp.

Lentfer, J. W., J. R. Blum, S. H. Eide, and L. H. Miller. 1966. Bear studies. Fed. Aid in Wildl. Rest. Rept. Proj. W-6-R-6. Alaska Dept. Fish and Game, Juneau. 54 pp.

LeResche, R. E. 1966. Behavior and calf survival in Alaska moose. M.S. Thesis. Univ. of Alaska, Fairbanks. 85 pp.

_____. 1974. Moose migrations in North America. Naturaliste Can. 101:393-415.

Linderman, S. 1972. A report on the sheep study at the Dietrich River headquarters. Appendix 3. Proj. Rept. Fed. Aid Wildl. Rest. Proj. W-17-3, W-17-4. 13 pp. *in* L. Nichols and W. Heimer. Sheep Report, Vol. 13. Alaska Dept. Fish and Game, Juneau.

_____. 1974. Ground tracking of arctic grizzly bears. Final Rept., Fed. Aid in Wildl. Rest. Proj. W-17-6, Job 4.12 R. Alaska Dept. Fish and Game, Juneau. 24 pp.

Lloyd, H. G. 1975. The red fox in Britain. Pages 207-215 *in* M. W. Fox, ed. The wild canids. Van Nostrand Reinhold Co., N. Y.

MacPherson, A. H. 1965. The barren-ground grizzly and its survival in Canada. Can. Audobon 27(1):2-8.

Martinka, C. J. 1974a. Population characteristics of grizzly bears in Glacier National Park, Montana. J. Mammal. 55(1):21-29.

_____. 1974b. Preserving the natural status of grizzlies in Glacier National Park. Wildl. Society Bull. 2(1):13-17.

McCann, J. L. 1956. Ecology of the mountain sheep. Am. Midl. Nat. 56(2):297-325.

McCourt, K. H., J. D. Feist, D. Doll, and J. J. Russell. 1974. Disturbance studies of caribou and other mammals in the Yukon and Alaska, 1972. Arctic Gas Biol. Rept. Ser. Vol. 5. 246 pp.

McCourt, K. H. and L. P. Horstman. 1974. The reaction of barren-ground caribou to aircraft. Ch. 1, 36 pp. *in* R. D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser. Vol. 23.

McCullough, D. R. 1969. The Tule elk: its history, behavior, and ecology. Univ. of Cal. Press, Berkeley. 209 pp.

McKnight, D., ed. 1975. Annual report of survey-inventory activities, Part I: Moose, deer and elk. Vol. 5, 1970-1975. Fed. Aid in Wildl. Rest. Alaska Dept. Fish and Game, Juneau. n.p.

McMillan, J. F. 1954. Some observations on moose in Yellowstone Park. Am. Midl. Nat. 52(2):392-399.

Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. Nat. Hist. Press, Garden City, N. Y. 384 pp.

Memphis State University (for the Environmental Protection Agency). 1971. Effects of noise on wildlife and other animals. U.S. Govt. Printing Office, Wash., D. C. 74 pp.

Miller, F. L., C. J. Jonkel, and G. D. Tessier. 1972. Group cohesion and leadership response by barren-ground caribou to man-made barriers. Arctic 25(3):193-201.

Mundy, K. R. D. and D. R. Flook. 1973. Background for managing grizzly bears in the national parks of Canada. Can. Wildl. Serv. Rept. Ser. No. 22. Information Canada. Ottawa. 35 pp.

Murie, A. 1934. The moose of Isle Royale. Univ. Mich. Mus. Zool. Misc. Publ. 25. 44 pp.

Murie, A. 1944. The wolves of Mount McKinley. Fauna of the National Parks of the U.S., Fauna Ser. No. 5. U.S. Govt. Printing Office, Wash., D. C. 238 pp.

_____. 1961. A naturalist in Alaska. The Devin-Adair Co., N. Y. 302 pp.

_____. 1962. Mammals of Mount McKinley National Park, Alaska. Mount McKinley Natural History Ass. in coop. with the Pisani Printing Co., U.S. Nat. Park Serv., San Francisco. 56 pp.

_____. 1963. Birds of Mount McKinley, Alaska. Mount McKinley Natural History Ass. in coop. with the U.S. Nat. Park Serv. Pisani Printing Co., San Francisco. 86 pp.

Murie, O. J. 1935. Alaska-Yukon caribou. N. Amer. Fauna Ser. No. 54. U.S. Govt. Printing Office, Wash., D. C. 93 pp.

Murphy, E. C. 1973. An age structure and a reevaluation of the population dynamics of Dall sheep (*Ovis dalli dalli*). M.S. Thesis. Univ. of Alaska, Fairbanks. 113 pp.

Pearson, A. M. 1975. The northern interior grizzly bear *Ursus arctos* L. Can. Wildl. Serv. Rept. Ser. No. 34. Information Canada, Ottawa. 86 pp.

Peters, R. P. 1974. Wolf-sign: scents and space in a wide-ranging predator. Ph.D. Thesis. Univ. of Michigan, Ann Arbor. 228 pp.

Peterson, R. L. 1955. The North American moose. Univ. of Toronto Press, Toronto, Ontario. 280 pp.

Peterson, R. O. and D. L. Allen. 1974. Ecological studies of the wolf on Isle Royale. Unpubl. Fourth Ann. Rept., 1973-1974, to Nat. Park Serv. 14 pp.

Pienaar, U. De V. 1968. The ecological significance of roads in a national park. Koedoe 11:169-187.

Price, R. 1972. Effects of human disturbance on Dall sheep. Alaska Coop. Wildl. Research Unit. Quart. Rept. 22(3):23-28.

Pruitt, W. O., Jr. 1960. Behavior of the barren-ground caribou. Univ. of Alaska Biol. Pap. No. 3. 44 pp.

_____. 1965. A flight releaser in wolf-caribou relations. J. Mammal. 46(2):350-351.

Quimby, R. 1974. Grizzly bear. Ch. 2, 97 pp. *in* Mammal studies in northeastern Alaska with emphasis within the Canning River drainage. Can. Arctic Gas Biol. Rept. Ser. Vol. 24.

Rausch, R. A. 1959. Some aspects of population dynamics of the railbelt moose populations, Alaska. M.S. Thesis. Univ. of Alaska, Fairbanks. 81 pp.

Reed, D. F., T. N. Woodard, and T. M. Pojar. 1975. Behavioral response of mule deer to a highway underpass. J. Wildl. Manage. 39(2):361-367.

Reynolds, H. V. 1974. North Slope grizzly studies. Vol. I. Proj. Rept., Fed. Aid in Wildl. Rest. Proj. W-17-6, Jobs 4.8R, 4.9R, 4.10R, and 4.11R. Alaska Dept. Fish and Game. 27 pp.

Reynolds, P. C. 1974. The effects of simulated compressor station sounds on Dall sheep using mineral licks on the Brooks Range, Alaska. Ch. 2, 82 pp. *in* R. D. Jakimchuk, ed. The reaction of some mammals to aircraft and compressor station noise disturbance. Arctic Gas Biol. Rept. Ser. Vol. 23.

Riegelhuth, R. 1966. Grizzly bears and human visitation. M.S. Thesis. Colorado State Univ., Fort Collins. 80 pp.

Rue, L. L., III. 1969. The world of the red fox. J. B. Lippincott Co., N. Y. 204 pp.

Russell, A. 1967. Grizzly country. Knopf, N. Y. 302 pp.

Schoonmaker, W. J. 1968. The world of the grizzly bear. J. B. Lippincott Co., N. Y. 190 pp.

Sheldon, C. 1930. The wilderness of Denali. Scribner's, N.Y. 412 pp.

Skoog, R. O. 1963. Caribou report. Fed. Aid in Wildl. Rest. Proj. W-6-R-4. Alaska Dept. Fish and Game, Juneau. 31 pp.

_____. 1968. Ecology of the caribou (*Rangifer tarandus granti*) in Alaska. Ph.D. Thesis. Univ. of Cal., Berkeley. 699 pp.

Smith, D. R. 1954. The bighorn sheep in Idaho -- its status, life history, and management. Fed. Aid Wildl. Rest. Idaho Proj. 99-R. Idaho Dept. Fish and Game Wildl. Bull. No. 1. Boise, Idaho. 154 pp.

Sokal, R. R. and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Co., San Francisco. 776 pp.

Storm, G. L. 1972. Population dynamics of red foxes in North Central United States. Ph.D. Thesis. Univ. of Minnesota, Minneapolis-St. Paul. 227 pp.

Stringham, S. F. 1971. Calf behavior and the cow-calf bond in moose. Alaska Coop. Wildl. Research Unit Quart. Rept. 22(4):12-32.

_____. 1974. Mother-infant relations in semi-captive Alaskan moose (*Alces alces gigas*). M.S. Thesis. Univ. of Alaska, Fairbanks. 140 pp.

Symington, F. 1965. Tuktu -- the caribou of the northern mainland. Can. Wildl. Serv., Ottawa. 92 pp.

Thomson, B. R. 1972. Reindeer disturbance. Deer. Jour. Brit. Deer Soc. 2(8):882-883.

_____. 1973. Wild reindeer activity, Hardangervidda, 1971. Report from the grazing project of the Norwegian IBP committee. Statens viltundersøkelser, Direktoratet for Jakt, Viltstell og Ferskvannsfiske, Trondheim, Norway. 76 pp.

Troyer, W. A. 1974. Winter moose census, Mount McKinley National Park, 1974. Unpubl. Official Files, Nat. Park Serv., Anchorage, Alaska. 4 pp.

Troyer, W. A. and R. J. Hensel. 1964. Structure and distribution of a Kodiak bear population. J. Wildl. Manage. 28(4):769-772.

Tyrrell, J. W. 1898. Across the sub-Arctic of Canada, a journey of 3,200 miles by canoe and snowshoe through the barren lands. T. Fisher Unwin, London. 280 pp.

U.S. Dept. of Commerce. 1970. Climatic summaries of resort areas -- Mount McKinley Park, Alaska. U.S.D.C. Publication No. 21-49-1. 5 pp.

U.S. Dept. of Interior, Alaska Planning Group. 1974. Final impact statement: proposed Mt. McKinley National Park additions, Alaska. 687 pp.

Valkenburg, P. 1976. A study of the brown bear (*Ursus arctos*) in the proposed northeastern addition to Mount McKinley National Park. M.S. Thesis. Univ. of Alaska, Fairbanks. 88 pp.

Van Wormer, J. 1972. The world of the moose. J. B. Lippincott Co., N. Y. 160 pp.

Videsott, R. 1967. Impact écologique du tourisme et des loisirs dans les parcs nationaux italiens [in French, English summary]. Pages 118-120 *in* Towards a new relationship of man and nature in temperate lands. Part I. Ecological impact of recreation and tourism upon temperate environments. Int. Union Conserv. Nat. Nat. Resourc., Morges, Switzerland.

Viereck, L. A. and E. L. Little, Jr. 1972. Alaska trees and shrubs. Agriculture Handbook No. 410. Forest Service, U.S. Dept. of Agri. U.S. Govt. Printing Office, Wash., D. C. 265 pp.

von Uexküll, J. 1957. A stroll through the world of animals and men. Pages 5-80 *in* Schiller, C. H., ed. Instinctive behavior. International Universities Press, Inc., N. Y.

Ward, A. L., J. J. Cupal., A. L. Lea, C. A. Oakley, and R. W. Weeks. 1973. Elk behavior in relation to cattle grazing, forest recreation, and traffic. Pages 327-337 *in* J. B. Trefethen, ed. Trans. 38th N. Amer. Wildl. and Nat. Res. Conf., Wildl. Manage. Inst., Wash., D. C.

Washburn, B. 1971. A tourist guide to Mount McKinley. Alaska Northwest Publ. Co., Anchorage, Alaska. 79 pp.

Welles, R. E. and F. B. Welles. 1961. The bighorn of Death Valley. Fauna of the National Parks of the U.S., Fauna Ser. No. 6. U.S. Govt. Printing Office, Wash., D. C. 242 pp.

White, R. G., B. R. Thomson, T. Skogland, S. J. Person, D. E. Russell, D. F. Holleman, and J. R. Luick. 1975. Ecology of caribou at Prudhoe Bay, Alaska. Pages 151-201 *in* J. Brown, ed. Ecological investigations of the tundra biome in the Prudhoe Bay region, Alaska. Univ. of Alaska Biol. Pap., Spec. Rept. No. 2.

Whitten, K. R. 1975. Habitat relationships and population dynamics of Dall sheep (*Ovis dalli dalli*) in Mt. McKinley National Park, Alaska. M.S. Thesis. Univ. of Alaska, Fairbanks. 177 pp.

Wilcoxon, F. and R. Wilcox. 1964. Some rapid approximate statistical procedures. Lederle Laboratories, Pearl River, N. Y. 60 pp.

Zhigunov, P. S., ed. 1961. Reindeer husbandry. Transl. from Russian. Israel Program for Sci. Transl., Jerusalem, 1968. 348 pp.