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# WOLF REPORT



by

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Job No.: 14.6R Job Title: Characteristics of Wolf Den Sites

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SUMMARY

Wolf food habits, den site physiography and vegetation, den occupancy, litter size, population trends and immobilization of wolves were studied in the northcentral Brooks Range and in the Nelchina Basin of Southcentral Alaska.

Analysis of scats collected at wolf dens in the northcentral Brooks Range indicates that these wolves depend primarily on ungulates for food during the summer months but consume a variety of other items including sciurids, microtines, birds, fish and insects. Caribou and sheep appear to be the most frequently utilized ungulate prey. Ground squirrels appear to be the most frequently utilized small mammal. The summer diet of wolves on the North Slope varies with geographical, seasonal and annual differences in prey availability.

During this study locations of 78 wolf dens on the North Slope were determined. Physiographic data gathered at 28 of these dens show that wolf den excavations are usually situated on at least a moderately steep, southerly slope in relatively well-drained soil, usually sand, near a source of water. A variety of land forms are used and include cutbanks, blowouts, dunes, kames and various types of moraines. The dens and associated land forms that were inspected were variable in details and dimensions and physical relationships but showed uniformity in aspect, slope and depth of the active frost later, all of which critically influence drainage.

Information on litter size and partial histories of den occupancy are presented.

An immobilization technique is described and data from three immobilized animals are presented. Data gathered in the Arctic from 19 carcasses of ungulate prey and information obtained from 20 wolf-killed moose in Southcentral Alaska are presented.

Wolf populations on the North Slope were low in 1970 but appeared to be increasing in the summer of 1971. Data are presented which indicate that the wolf population in Game Management Unit 13 (Southcentral) is relatively high at present.

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## BACKGROUND

Management of the wolf (*Canis lupus*) has been interwined with conflicting emotional viewpoints since wildlife management was first recognized as a viable science. To a considerable extent, the confused and often conflicting viewpoints resulted from a lack of information on the role the wolf plays in manipulating ungulate populations. Important studies conducted primarily during the past 20 years have dispelled much of the fantasy about the life history of wolves (Mech, 1970), but these same studies have raised equally complex questions about the social behavior of wolves and its relationship to their population dynamics (Woolpy, 1968).

In the State of Alaska the issue is further complicated by the long history of federal predator control activities prior to statehood, public attitudes and political interference in game management. Nevertheless, progressive management has resulted in removal of the bounty from all except three game management units. Closed seasons are imposed where and when necessary, methods and means for taking wolves are prescribed and bag limits are imposed.

A reasonably comprehensive research effort has been directed in the past at developing techniques for assessing wolf population status (Merriam, 1964; Rausch, 1967) and for assessing, in a general way, the relationship of wolves, ungulates and sportsmen (Rausch, 1969b). Nevertheless, a number of unanswered questions remain. Of principal importance is the effect that wolves have upon selected stocks of big game, primarily moose (*Alces alces*), caribou (*Rangifer tarandus*), sheep (*Ovis dalli*) and Sitka black-tailed deer (*Odocoileus hemionus sitkensis*). Studies of relevance from other areas include those of Pimlott, et al (1970), Mech (1966) and

Stenlund (1955). None of these studies conclusively determined the impact of wolves upon hunted populations of ungulates. Nor did these studies satisfactorily clarify the questions concerning prey selection by wolves; especially as it applies to summer food habits.

Evaluation of summer food habits, prey selection, characteristics of prey and the impact upon selected prey populations are major goals of current research in Alaska. Answers to these questions are of utmost urgency for the survival of rational management.

## OBJECTIVES

To assess wolf population levels and determine the characteristics of exploited wolf populations in Arctic and Southcentral Alaska.

To determine the food habits of wolves during the spring and summer in Arctic and Southcentral Alaska.

To determine the physical condition and characteristics of ungulate prey taken by wolves in Arctic and Southcentral Alaska.

To characterize the ecology of wolf den sites in Arctic and Southcentral Alaska.

## PROCEDURES

In the Southcentral Alaska study wolf populations were measured indirectly through observations of wolves by Alaska Department of Fish and Game personnel engaged in field activities. Additional specific attempts were made to obtain wolf observations as outlined under Job 14.5. These consisted of aerial observations on the hunting activities of wolves in the Gulkana River area.

Additional observations were obtained from cooperators and from the reports required from holders of aerial wolf permits. To correspond with past years' intensive studies, these observations are for Game Management Unit 13 only unless otherwise specified.

Scat collections were made where possible while examining den sites. Many of the sites visited did not appear to have been used as natal dens for several years. Because the majority of the sites are located in places where there is considerable soil movement, signs of the wolves' presence are often quickly obliterated. The entrances to many of the older dens reported by the Nunamiut Eskimos of Anaktuvuk Pass were collapsed or otherwise obliterated. These sites yielded little in the way of food habits information. Since it is desirable not to disclose the precise locations of these dens, only the principal drainage is given. Each scat was collected in a separate plastic bag and later analyzed in the laboratory. The characteristics of food remains were usually assessed and recorded in the field. Hair slides representing

all of the large and small mammals in the region aided in the analyses of scats. In addition, a reference collection of microtine skeletons was prepared and used in conjunction with the enamel patterns of the occlusal surfaces of teeth (Bee and Hall, 1956) to identify small mammal species.

Scats were comprised primarily of indigestible matter, including hair, claws, hooves, bone, teeth, feathers, vegetation and soil. The scats were pulled apart and their contents examined with the aid of a dissecting microscope.

The scats of pups were, in most cases, clearly separable from those of adults on the basis of their smaller diameter (less than 1 in.). The approximate date that scats were deposited (i.e., summer of 1968, 1969 or 1970) was estimated from the general degree of weathering which the scats had undergone, including the amount of bile pigment still present.

From a study in which captive red foxes (*Vulpes vulpes*) were fed known quantities of prey and their fecal emissions studied, Scott (1941) concluded that frequency of occurrence provided the best estimate of the relative importance of prey species. He found that, in general, fecal passages are produced in direct proportion to the quantity of food consumed. From a similar study Lockie (1959) concluded that percentage weight is the most accurate way of interpreting the results of fecal analysis. For the purposes of the present study the frequency of occurrence method was employed since the volume of material precluded weighing all the material.

Due to their small size, a wide variety of small mammals can be ingested in a short period of time by a wolf. For this reason, and because the number of small mammal prey species is greater than the number of ungulate prey species in the area, small mammals are likely to score a greater number of occurrences in a scat than ungulates. Because of this Stephenson also presented the data in the "grouped" form suggested by Scott (1941). By this method, each group can score no more than one occurrence in a scat. These computations avoid overemphasizing the importance of small mammals and underemphasizing the importance of large prey in the wolves' summer diet.

The work of Kuyt (1970) in the Northwest Territories indicates that wolf pups are weaned when 4 to 6 weeks old. The "milk scats" deposited by the pups prior to this time are thought to be eaten by the bitch since no accumulation of them was noted by Kuyt in his work with both captive and wild animals. Limited observations in the present study support this conclusion. Therefore, the pup scats probably represent the diet of pups from mid to late June until the time they leave the den site, which can be any time in July or August.

The data are not sufficient to present a complete picture of the summer food habits of arctic wolves, and represent the food habits of wolves denning only in the northern Brooks Range. Collection of summer scats is being continued and should include scats from two dens located in the northern foothills of the Brooks Range in the spring of 1971 and will include data collected in the Nelchina Basin.

Bob Ahgook and Zaccharias Hugo, from Anaktuvuk Pass, identified prey remains on the basis of their intimate knowledge of prey anatomy and natural history. They also helped ascertain the probable time when scats were deposited.

In the Arctic study, between July 3 and July 8, 1971, 21 dens were visited by helicopter, including Nos. 3, 5, 6, 13, 14, 17, 18, 19, 20, 22, 23, 24, 30, 31, 32, 38, 39, 42, 44, 53 and 55. Dens 9, 25, 33 and 65 were visited in August and September using Department fixed-wing aircraft. A Den Data Form (Fig. 1) was filled out for each den. The completed forms are on file in the Fairbanks office along with a series of black and white photographs of each den. A 48-inch soil coring apparatus was used to measure depth to frost and to obtain soil profiles. Plant specimens were identified with the help of Dr. David R. Murray, University of Alaska. The degree of slope and the micro- and macro-relief were estimated.

In the Arctic data on the characteristics and conditions of ungulate prey taken by wolves were gathered as opportunities arose. In South-central, however, wolf packs were observed from a PA-18-150 (Supercub) in order to monitor their hunting activities, to locate kill sites, and to collect skeletal remains from prey killed by wolves. Aerial surveys were begun in February 1971 on the upper West Fork of the Gulkana River. Flights were made on alternate days when possible, terminating on March 26, 1971, when funds were exhausted. Wolves were located by searching for their tracks in the snow. When tracks were located they were followed, whenever possible, until the pack was found. On subsequent flights the observer returned to where the wolves were last seen, and an attempt was made to relocate the pack by following their trail. If the wolves could not be found readily, new areas, principally river beds, were searched for wolf trails. If a wolf trail became impossible to follow due to blown snow or confusion with other animal tracks, widening circles were flown until the tracks were relocated.

When a kill was located, efforts were made to land nearby to collect the desired specimens. This usually meant landing some distance from the kill and snowshoeing to the kill site. Kill sites were visited whenever their locations became known.

When possible in both studies, a femur and mandible were collected to determine nutritional status and age, respectively. Nutritional status, or condition, was assessed by examining the marrow (Neiland, 1970). Age was determined from tooth eruption and wear, cementum layers in the teeth or horn growth annuli. Information on the circumstances surrounding each kill was gathered from tracks and sign.

Carcasses of wolves taken by Anaktuvuk hunters during the winter of 1970-71 were autopsied to determine their sex and age and obtain food habits information.

In April and May an attempt was made in the Arctic to develop a technique for immobilizing free-roaming wolves using Cap-Chur equipment.

Fig. 1. Wolf den data form.

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Den No.:_____ Date:_____ Species:_____ Unit:_____

Drainage:_____ Elevation:_____ Lat.:_____ Long.:_____

Specific area:_____

_____

Activity status:_____

Scats: No. Pup:_____ No. Adult:_____

Apparent age:_____

Food remains:_____

_____

Macrorelief:_____

Microrelief:_____

Percent slope:_____ Aspect:_____ Wind exposure:_____

Entrances: No:_____ Ht.:_____ Wdth.:_____
Apparent depth:_____ (Sketch construction on back)

Distance to water:_____

View from den:_____

Trails:_____

Soil: Texture:_____ Friability:_____ Parent material:_____
Root penet.:_____ Moisture:_____ Color:_____
Slumping:_____

Vegetation: Growth form:_____
Plant cover (%):_____
Comm. association:_____
Species:_____

Prey populations:_____

_____

Comments:_____

_____

Gene Ludlow, wildlife biologist with the BLM Pipeline Division, was extremely cooperative in arranging logistics on two occasions for this purpose. The technique will be described in the Results Section. Blood samples and weights taken were from immobilized animals and colored nylon ear tags were applied. Serum samples are being screened for brucellosis and will be subjected to an electrophoretic analysis of proteins when a sufficient number of samples has been gathered. The possibility of using protein analysis to determine the degree of genetic isolation of populations in various parts of the state will then be assessed.

In addition to the previously described methods of collecting data, Stephenson relied heavily on the Nunamiut Eskimo as a source of authoritative information on virtually every aspect of wolf ecology. Their knowledge derived from almost daily observation of and association with wolves in the arctic environment, is surely unparalleled in depth and extent. They have generously aided in every aspect of the present study, freely offering the information that has taken decades of observation to gather.

## FINDINGS

### Summer Food Habits (Arctic)

Data suggest that wolves denning in the northcentral Brooks Range depend primarily on ungulates (in terms of volume) for their summer food supply, but consume a variety of other items including microtines, sciurids, birds, fish, insects and, occasionally, vegetation and soil or rocks (Tables 1-8).

The Arctic study area lies roughly equidistant between and south of the major calving areas for the Arctic and Porcupine caribou herds and thus is generally devoid of caribou during June and July. For example, in the first week of July 1970 about 16 hours of low-level helicopter flying were done to points as far as 80 miles east and west of Anaktuvuk. Not a single caribou was seen. Observations obtained during more than 100 hours of fixed-wing flying by Department personnel over this area in 1970 suggested that the great majority of caribou (especially cows) were far to the north and west of the mountains and foothills by the end of May. Only small, widely scattered bands of bulls and yearlings were observed during June and even these were almost entirely absent (especially from the mountains) in late June and during July. Eskimo informants stated that on rare occasions caribou cows with newborn calves are seen in the northcentral mountains in early summer and occasionally a few bulls may summer here on high alpine areas. They agree that caribou are found only rarely in the area during June and July.

In the mountains moose (*Alces alces*) occur primarily in the larger valleys such as that of the Killik River. In more sparsely vegetated areas they are rare. The data indicate that moose are not utilized extensively by wolves denning in the northern Brooks Range.

Table 1. Incidence of prey in wolf pup scats collected September 1, 1970 at Den 9, Atigun River.

| Item | 18 Pup Scats | |
|---|---|---|
| | No. | Percent |
| *Rangifer tarandus* | 1 | 5.6 |
| *Spermophilus undulatus* | 8 | 44.5 |
| *Microtus miurus* | 3 | 16.7 |
| *Microtus oeconomus* | 2 | 11.1 |
| *Microtus* spp. | 4 | 22.1 |
| *Dicrostonyx groenlandicus* | 2 | 11.1 |
| Avian | 1 | 5.6 |
| Shoe Leather | 1 | 5.6 |
| Grouped Data | | |
| Ungulate | 1 | 5.6 |
| Small mammal | 18 | 100.0 |

The appearance of these scats suggested that Den 9 was a natal den in 1968 or 1969. Two adult wolves had visited the den a few days prior to my visit. The only food remains noted were the frontal bones and a few ribs from a bull caribou.

Table 2. Incidence of prey in wolf scats collected September 1, 1970 at Den 65, Itkillik River.

| Item | 30 Pup Scats | | 17 Adult Scats | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| *Rangifer tarandus* | 2 | 6.7 | - | - |
| *Ovis dalli* | 21 | 70.0 | 10 | 59.0 |
| *Marmota caligata* | 2 | 6.6 | - | - |
| *Spermophilus undulatus* | 3 | 10.0 | 2 | 11.8 |
| *Dicrostonyx groenlandicus* | 1 | 3.3 | - | - |
| Unid. Microtine | 2 | 6.6 | 2 | 11.8 |
| *Thymallus arcticus* | 12 | 40.0 | 6 | 35.3 |
| Snails | 1 | 3.3 | - | - |
| Avian | 3 | 10.0 | 2 | 11.8 |
| Egg shells | - | - | 1 | 5.9 |
| Vegetation | 2 | 6.7 | 2 | 11.8 |
| Soil | 1 | 3.3 | - | - |
| Grouped Data | | | | |
| Ungulate | 23 | 76.6 | 10 | 58.8 |
| Small mammal | 7 | 23.3 | 3 | 17.6 |

It appeared that Den 65 had not been used as a natal den since 1968. The snail remains consisted of 4, one-eighth inch diameter shells. The sheep remains in two of the pup scats were judged to be from lambs. Only a few widely scattered prey remains were found. These included a few vertebrae and long bones of a bull caribou, the antlers and frontal bones of a cow caribou killed in the spring (as evidenced by pelage) and the ribs from a calf caribou. All remains appeared to have undergone at least two years of weathering.

Table 3. Incidence of prey in wolf scats collected July 4, 1970 at Den 13, Okokmilaga River.

| Item | 62 Pup Scats | | 45 Adult Scats | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| *Rangifer tarandus* | 6 | 9.7 | 2 | 4.5 |
| *Alces alces* | 2 | 3.2 | - | - |
| *Ovis dalli* | 50 | 80.6 | 45 | 100.0 |
| *Spermophilus undulatus* | 6 | 9.7 | 1 | 2.2 |
| *Marmota caligata* | 4 | 6.5 | 2 | 4.5 |
| *Lemmus trimucronatus* | 5 | 8.1 | - | - |
| *Microtus miurus* | 2 | 3.2 | - | - |
| *Microtus oeconomus* | 4 | 6.5 | - | - |
| Unid. *Microtus* spp. | 5 | 8.1 | - | - |
| Unid. Microtine | 3 | 4.9 | 1 | - |
| Insecta | 15 | 24.2 | - | - |
| Vegetation | 7 | 11.3 | 3 | 6.0 |
| Rocks | 1 | 1.6 | 1 | 2.2 |
| Avian | 1 | 1.6 | 2 | 4.5 |
| Anatidae | - | - | 1 | 2.2 |
| Passerinae | 1 | 1.6 | - | - |
| Unknown | - | - | 1 | 2.2 |
| Maggots | - | - | 2 | 4.5 |
| Grouped Data | | | | |
| Ungulate | 50 | 80.6 | 45 | 100.0 |
| Small mammal | 25 | 40.3 | 2 | 4.4 |

Den 13 was undoubtedly a natal den in 1969. The moose hair in one of the pup scats was that of a calf. The Dall sheep remains in two of the adult scats were judged to be from a lamb. Sheep remains in two of the adult and five of the pup scats included large (1 to 2 in. diameter) pieces of hoof. The remains of *Bombus* were identified in two of the scats containing insect remains.

Food remains included the horns, frontal bones, and a few long bones of a 6-year-old ewe sheep; a few long bones from a calf caribou less than 6 months of age and the tibia of a moose killed several years earlier. The sheep had been in spring pelage when killed and was almost certainly killed in the spring of 1969, perhaps about the time the wolves first occupied the den in May.

Table 4. Incidence of prey in wolf pup scats collected July 6, 1970 at Den 20, Killik River.

| Item | 20 Pup Scats | |
|---|---|---|
| | No. | Percent |
| *Rangifer tarandus* | 12 | 60.0 |
| *Ovis dalli* | 7 | 35.0 |
| *Spermophilus undulatus* | 4 | 20.0 |
| *Microtus* spp. | 2 | 10.0 |
| Unid. Microtine | 2 | 10.0 |
| *Canis lupus* (pup) | 2 | 10.0 |
| Avian | 4 | 20.0 |
| Rock (1 in. in diameter) | 1 | 5.0 |
| Grouped Data | | |
| Ungulate | 16 | 80.0 |
| Small mammal | 6 | 30.0 |

Den 20 did not appear to have been used as a natal den since 1968. Food remains included the following (red foxes also den in this vicinity): the mandible from a marmot, a ground squirrel skull, the wing bones from a ptarmigan, long bones of an adult caribou, the rib and femur of a calf caribou, and a moose scapula. All remains were at least 2 years old. Both of the scats containing wolf pup hair were composed of at least 50 percent of this material, probably too large an amount to be ingested accidentally.

Table 5. Incidence of prey in wolf scats collected July 5, 1970 at Den 42, Killik River.

| Item | 16 Pup Scats | | 6 Adult Scats | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| *Rangifer tarandus* | 6 | 37.4 | 5 | 83.4 |
| *Ovis dalli* | 2 | 12.5 | 1 | - |
| *Microtus oeconomus* | 4 | 25.0 | - | - |
| *Microtus* spp. | 2 | 12.5 | - | - |
| Unid. Microtine | 2 | 12.5 | 1 | 16.7 |
| Avian | 5 | 31.2 | - | - |
| Grouped Data | | | | |
| Ungulate | 6 | 37.5 | 6 | 100.0 |
| Small mammal | 9 | 56.6 | 1 | 16.7 |

Den 42 appeared to have been a natal den in 1968. Prey remains included the skull of a bull caribou and a few ribs from a calf caribou.

Table 6. Incidence of prey in wolf scats collected September 3, 1970 at Den 25, Kurupa Lake.

| Item | 15 Pup Scats | | 4 Adult Scats | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| *Rangifer tarandus* | 3 | 20.0 | 1 | 25.0 |
| *Ovis dalli* | 11 | 73.2 | 3 | 75.0 |
| Unid. Microtine | 1 | 6.7 | - | - |
| Avian | 2 | 13.3 | - | - |
| Ptarmigan | 1 | 6.7 | - | - |
| Plastic bag | 1 | 6.7 | - | - |
| Grouped Data | | | | |
| Ungulate | 13 | 86.7 | 4 | 100.0 |
| Small mammal | 1 | 6.7 | 0 | 0.0 |

Den 25 was probably a natal den in 1969 or possibly the previous year. The only prey remains found here were the horns, frontal bones, and a few long bones of an ewe sheep. As determined by horn annuli, this animal was nearly 11 years old when it died.

Table 7. Incidence of prey in wolf pup scats collected July 6, 1971 at Dens 30 and 31, Anaktuvuk River.

| Item | Den 30 1 Pup Scat No. | Den 30 1 Pup Scat Percent | Den 31 5 Pup Scats No. | Den 31 5 Pup Scats Percent |
|---|---|---|---|---|
| *Rangifer tarandus* | - | - | 2 | 40.0 |
| *Spermophilus undulatus* | 1 | 100.0 | 1 | 20.0 |
| *Microtus oeconomus* | 1 | 100.0 | 1 | 20.0 |
| *Dicrostonyx torquatus* | - | - | 1 | 20.0 |
| Unid. Microtine | - | - | 1 | 20.0 |
| Avian | 1 | 100.0 | 3 | 60.0 |
| Grouped Data | | | | |
| Ungulate | 0 | 0.0 | 2 | 40.0 |
| Small mammal | 1 | 100.0 | 3 | 60.0 |

Den 30 was possibly inhabited by a litter of wolf pups for a short period in 1969 or earlier, but probably was not a natal den. No prey remains were found. Den 31 was used for a short time in 1969 according to Bob Ahgook who observed the litter of pups near the den in early fall. The only food remains noted were a few ribs from an adult caribou and the skull of a ground squirrel.

Table 8. Incidence of prey in wolf pup scats collected August 19, 1970 at Den 33, Colville River near Ocean Point.

| Item | 12 Pup Scats | |
|---|---|---|
| | No. | Percent |
| *Canis lupus* (pup-trace amount) | 1 | 8.3 |
| *Spermophilus undulatus* | 5 | 41.6 |
| *Microtus miurus* | 4 | 33.3 |
| *Lemmus trimucronatus* | 2 | 16.6 |
| Unid. Microtine | 2 | 16.6 |
| Avian | 7 | 5.8 |
| *Lagopus* spp. | 3 | 25.0 |
| Cotton string | 1 | 8.3 |
| Grouped Data | | |
| Ungulate | 0 | 0.0 |
| Small mammal | 11 | 91.7 |

Den 33 appeared to have been a natal den in 1969 or earlier. No food remains were found.

Sheep are present throughout the mountains but often they demonstrate marked seasonal and geographical variations in abundance. At Dens 65, 14 and 25, sheep were the predominant food item in scats and it appears that they were the primary ungulate prey taken by wolves associated with these dens. The presence of pieces of sheep hooves in many of the scats may be some indication of the degree to which ungulate prey are utilized during the summer.

It appears that all of the small mammals commonly found on the North Slope, with the exception of the red-backed vole (*Clethrionomys rutilus*) and shrews (*Sorex* sp.), are utilized by wolves to some degree during the summer months. In terms of volume consumed, the Arctic ground squirrel (*Spermophilus undulatus*) is probably the most important.

There is some indication (Tables 3, 5 and 6) that microtine mammals and insects are more frequently consumed by pups than by adults. This might be due to the fact that the pups spend considerable time play-hunting in the vicinity of the den while adults spend the majority of their time either resting at the den or hunting larger prey elsewhere.

The remains of Arctic grayling (*Thymallus arcticus*) were found in 12 pup and six adult scats collected at Den 65. Several of these scats were comprised entirely of scales and bones and most were at least 50 percent grayling remains. It is very likely that these fish were taken from a shallow (6 in. to 1 ft.) tributary of the Itkillik River one mile south of the den that is a spawning area for grayling. On September 1 about 50 grayling were still congregated in the lower reaches of this creek and around its mouth.

Birds and their eggs appear to be a minor item in the summer diet. Ptarmigan (*Lagopus* sp.) were most commonly taken.

Soil and vegetation were recorded as constituents of scats only when present in other than trace amounts, i.e., when it appeared that they were eaten intentionally. In a few cases scats were composed almost entirely of vegetation, primarily sedge (*Carex* spp.). It has been pointed out by several authors that canids may routinely ingest vegetation, possibly as a scour against helminths (Kuyt, 1970; Murie, 1944).

Work conducted by Kuyt (1970) in the Thelon Game Sanctuary, Northwest Territories, provides the only spring and summer food habits information strictly comparable to that in the present study. The major differences in prey species between Kuyt's study area and the North Slope were the lack of Dall sheep, the very low number of moose, and the presence of muskoxen in the former area. In Kuyt's study, 595 wolf scats (168 from pups) were collected at dens and analyzed using methods similar to those in the present study. The frequencies of occurrence of ungulates, small mammals, birds and vegetation were in general similar to those in the present study. Kuyt found that ".... during the spring and summer the diet of wolves is much more varied than in winter and

small rodents, passerine birds, eggs and fish are then resorted to, particularly in areas temporarily devoid of caribou."

The results of the present study are generally in agreement with this statement. The summer diet of wolves on the North Slope shows great variety, depending on geographical, seasonal, and annual differences in prey availability.

Den 12, near the Toolik River, was discovered on May 15, 1971. At this time 5 pups, approximately 1 day old (4 male, 1 female), were found lying in the bottom of a small pit 1 foot deep and 3 feet in diameter. Two adult wolves, one undoubtedly a female, were seen at the site at that time. The only remnant of food noted was the head of a freshly killed ground squirrel which lay a few inches from the pups. No scats were noted during the brief visit.

Den 77, on the Chandler River, was found on June 6, 1971. One adult wolf was observed and at least four pups inhabited the den. Food remains included the long bones and skull of a calf moose, the long bones of an adult moose, the wings and scattered feathers of a ptarmigan, and in two places regurgitated berries, red in color. No scats were found.

In addition to scats collected at den sites, the following scats were collected at other locations during the course of field work. Thirty-eight adult wolf scats were found near the scattered remains of a 3-year-old ram in the Okokmilaga River valley on June 21, 1970. The ram had been in winter pelage when killed. All of these scats were composed entirely of sheep remains including varying amounts of hair, bone, undigested meat, and pieces of hoof. On the same day 18 adult wolf scats, composed entirely of sheep remains, were found near the scattered remains of a 6-year-old ewe, also in winter pelage. On a small knoll a few hundred yards from these remains 20 adult wolf scats, composed entirely of sheep remains, were located. All of the above presumed wolf kills were found within a distance of approximately one mile on gently sloping alpine tundra at the base of the mountains on the east side of the Okokmilaga River, just south of Takuak Creek. The adjacent mountains support sizable sheep populations and small bands of sheep were observed a few hundred yards above the location at which the kills were found. Both of the above kills appeared to have been made in the spring of 1970, as evidenced by the still oily bones and the firmness with which the horns remained attached to the horn cores.

A fresh adult wolf scat collected along the Killik River near the mouth of Togoyuk Creek on August 20 contained grizzly bear (*Ursus arctos*) hair, ground squirrel remains and some unidentifiable microtine remains.

## Den Use, Litter Size and Number of Adults Observed at Dens (Arctic)

Table 9 presents data on histories of den use, litter size, and number of adults associated with dens found during the Arctic study.

Table 9. History of wolf den use, litter size and number of adults associated with dens, Anaktuvuk Pass area, Alaska.

| Drainage | No. | Status in 1970 | Known Previous Use | No. Pups | No. Adults Observed |
|---|---|---|---|---|---|
| Anaktuvuk* | 3 | UN | 1963 | 4 | 1 |
| | | | 1965 | 5 | |
| | | | 1967 | 7 | |
| Anaktuvuk* | 30 | DF | 1966 | | |
| Anaktuvuk* | 31 | UN | 1968 | | |
| Anaktuvuk | 64 | DF | | | |
| Okokmilaga* | 13 | UN | 1950 | | |
| | | | 1952 | 8 | 2 |
| | | | 1963 | 9 | 2 |
| Okokmilaga* | 14 | UN | 1943 | 6 | |
| | | | 1965 | 6 | |
| | | | 1969 - Signs of use | | |
| Okokmilaga* | 16 | DF | 1967 | 5 | 1 |
| Okokmilaga* | 17 | UN | Found in 1949 | | |
| | | | 1965 | 5 | 1 |
| Okokmilaga* | 18 | DF | Used once | | |
| Okokmilaga* | 32 | DF | 1967 | 6 | 1 |
| Okokmilaga | 26 | Unk | 1950 | 4 to 6 | 3 |
| Okokmilaga | 43 | Unk | ? | 5 or 6 | 2 |
| Okokmilaga | 45 | 1956 | | | |
| Okokmilaga | 46 | Found in 1946 or 47 | | | |
| Okokmilaga | 48 | 1946 | | | |
| Killik* | 19 | Unk | 1965 | 4 | 3 |
| Killik* | 20 | UN | 1942 or 43 | 4 | |
| | | | 1968 or 69 | | |
| Killik | 21 | Unk | 1945 | 4 | |

Table 9 (Continued).

| Drainage | No. | Status in 1970 | Known Previous Use | No. Pups | As Observed |
|---|---|---|---|---|---|
| Killik* | 22 | DF | | | |
| Killik* | 23 | DF | | | |
| Killik* | 24 | DF | | | |
| Killik | 28 | Unk | 1962 | 6 | |
| Killik | 41 | Unk | 1959 | | |
| Killik* | 42 | Unk | 1955 to 59<br>1969 | | |
| Killik | 51 | Unk | Found 1957 | | |
| Killik* | 44 | DF | 1940 | 3 | 2 |
| Killik | 50 | Unk | 1940's | | |
| Killik | 60 | Unk | 1959 | 5 | 1 |
| Killik | 61 | Unk | 1940 | Had left den | 1 |
| Killik | 62 | Unk | 1954 | Had left den | 1 |
| Killik | 63 | Unk | 1965 | 4 | |
| Nigu | 54 | Unk | 1958 or 59 | 4 or 5 | |
| Kurupa* | 25 | DF | 1940<br>1968 | 4 | |
| John | 1 | Unk | 1968 | 4 | 1 |
| John* | 5 | UN | Visited and cleaned out by wolves in spring of 1970 and 71 | | |
| John* | 6 | UN | 1966<br>1968 | 5<br>4 or 5 | 4<br>1 |
| John* | 55 | ND | 1952-55<br>1970 | 1 | |

Table 9 (Continued).

| Drainage | No. | Status in 1970 | Known Previous Use | No. Pups | No. Adults Observed |
|---|---|---|---|---|---|
| Itkillik | 10 | 1958 | 6 | | |
| Itkillik | 11 | Unk | Pups never found here | | |
| Itkillik | 40 | Unk | | | |
| Itkillik* | 65 | UN | 1960 | 7 | |
| Itkillik | 66 | Unk | 1951<br>1960 | <br>6 | |
| North Fork of Koyukuk* | 38 | UN | 1963-64 | | |
| North Fork of Koyukuk* | 39 | UN | 1951<br>1952<br>1959 - Vacant<br>1966 | <br><br><br>4 | |
| North Fork of Koyukuk | 34 | Unk | 1958<br>1967<br>Poss. 1970 | 9 | |
| Tingayuk | 35 | DF | 1967 | | |
| Atigun* | 9 | UN | 1957-58<br>1960 | <br>5 | 2<br>3 |
| Toolik* | 12 | ND<br>ND | 1970<br>1971 | 5-7<br>5 | 4<br>2 |
| Toolik | 27 | ND | 1970 | 4 | 1 |
| Colville* | 33 | UN | C. 1968 | | |
| Inaru | 67 | Unk | 1948 | 2 | 1 |
| Meade | 68 | Unk | Tracks seen in 1968 - no pups | | |
| Okokmilaga | 71 | Unk | C. 1945 | 8 | 2 |
| Okokmilaga | 72 | Unk | C. 1940 | 3 | 1 |

Table 9 (Continued)

| Drainage | No. | Status in 1970 | Known Previous Use | No. Pups | No. Adults Observed |
|---|---|---|---|---|---|
| Okokmilaga | 73 | Unk | C. 1940 | 5 | 1 |
| North Fork | 74 | Unk | C. 1959 | 4 | |
| Chandler | 75 | Unk | 1963<br>1964 | 3 | 2 |
| Chandler | 76 | Unk | 1965 | 5 | |
| Chandler | 77 | ND | 1971 | 4 | 2 |
| Lupine | 78 | Possibly ND | 1971 | | 2 |

* Indicates the den has been visited by Stephenson.

The status of the den in 1970 is indicated by the symbols UN (unused), DF (defunct), ND (natal den), or Unk. (unknown). For several dens (Nos. 2, 4, 7, 8, 15, 29, 35, 36, 37, 47, 49, 52, 56, 57, 58, 59, 60, 61, 62, 63, 69 and 74) I have been so far able to learn little except the location and have not included these dens in Table 9. Many of these are very old dens which were used before the Nunamiut were actively engaged in bounty hunting. The locations have in many cases been passed on from previous generations.

With few exceptions, the wolf den locations recorded were obtained from the Nunamiut Eskimos now living in Anaktuvuk Pass. The majority of these dens were located between 1940 and 1967. During this period small groups of hunters searched for new dens and checked previously discovered dens to obtain wolf pups and adults to bounty.

In most years hunters looking for wolf dens ranged east to the Itkillik River, north to the edge of the mountains proper and occasionally 10 miles into the northern foothills, west to the Killik River, and south as far as Ekiakpuk Creek and the upper part of the North Fork of the Koyukuk River. Most of the hunting activity occurred between late May and the first week of July. A rectangle about 150 miles long (E-W) and 50 miles wide (N-S), with the present village of Anaktuvuk lying at the center, circumscribes the area in which nearly all of these dens are located. The locations of the dens and, in most cases at least, a partial history of their use were obtained from the Nunamiut during the summer and winter of 1970 and in the course of other field work. The "interviews" were conducted as opportunities arose. Hunters were carefully and patiently questioned; in a few cases with aid by a translator. There are, of course, some den locations and other useful information that have been forgotten or have not yet been recorded. Efforts to compile more of this information are continuing. There is reason to believe, and the Nunamiut themselves say that the data presented below represent the majority of the dens known to them. The numbers under "litter size" and "number of adults" are, unless otherwise indicated, the number that were taken for bounty. Rarely did any young escape, but all adults associated with the den were only rarely taken. The number of litters recorded (as indicated in Table 9) does not represent the total number taken but does comprise the majority of them.

Table 9 indicates that there is considerable variation in the number of years a given den might be occupied and in periodicity of use. Since most of the pups, and sometimes the adults, indicated in Table 9 were destroyed the chances for repeated use of dens, especially in successive years, would be greatly lessened. Successive use of dens has been recorded elsewhere and there is reason to believe that some propensity for the repeated use of dens, and especially in the case of the most durable sites, exists. The age of the female wolf and other aspects of the specific social entity in question undoubtedly also have an influence. Some Nunamiut indicated that a den is not often used in two successive years because of the lingering odor.

It is interesting to note that at Den 39, a den located at the base of a limestone escarpment, the same female wolf whose litter was taken in 1951 had another litter in the same den in 1952.

Many of the dens listed in Table 9 were used only once. This is due in part to the destruction of the inhabitants and probably also to the fact that some of these were constructed at what could be considered marginal sites which subsequently became less suitable.

The dens on the Meade and Inaru rivers were reported by Pete Sovalik of Barrow and, together with Den 33 on the lower Colville River, indicate that wolves may den on the coastal plain and possibly as far north as the coast of the Arctic Ocean, though to what extent is not yet known.

Litter Size (Arctic)

A few of the litter size entries are derived from observations made by Stephenson and personnel involved in oil related activities on the North Slope. The total number of litter sizes recorded is 43 totaling 225 pups. All but six of these litter sizes, totaling 22 pups, were reported by the Nunamiut. With few exceptions litter size data derive from observations made in late May and during June, when pups were from 1 to 7 weeks old. The mean litter size (225 ÷ 43) is 5.23. Prenatal reproductive data presented by Rausch (1969a) for wolves taken in the Arctic Region are included below (Table 10) for comparison.

The reproductive tracts of two adult females taken by the Nunamiut in March, 1971 and examined by Stephenson showed five and 10 placental scars, respectively.

A Chi-square test was used to assess the statistical significance of the difference between the mean litter size (5.23) and the mean number of placental scars (6.3; data from two specimens examined by Stephenson plus Rausch's 1969 data). The test revealed that mean litter size is significantly lower ($P = .10$, d.f. = 1, $X^2 = 3.36$) than the mean number of placental scars. Further, the differences between numbers of corpora albicantia, corpora lutea, fetuses (as recorded by Rausch) and mean litter size are of equal or greater statistical significance.

These data may provide some measure of the degree of postnatal mortality among young pups in the wild. Accidents, disease, predation, and cannibalism are all possible decimating factors operating on wolf litters. Of these the Nunamiut stated that predation, primarily by the golden eagle (*Aquila chrysaetos*), may be the most important. Instances of predation on wolf pups by this species have been witnessed by at least one Nunamiut and it was the opinion of most that this type of predation could be a relatively common occurrence. Bob Ahgook reported finding the carcass of a 1-month-old pup along the Hunt Fork River that appeared to have been killed and partly eaten by an eagle. Other large raptors might also take an occasional wolf pup, especially the very young ones. Two other Nunamiut reported that in 1964 they found the carcasses of an adult female and several pups that had been killed when a rock formation above a den collapsed. This occurred along the North Fork of the Koyukuk.

Table 10. Indicators of productivity in adult and 2-year-old wolves in Arctic Alaska. Data from Rausch (1969).

| Years | Corpora Albicantia | | | Placental Scars | | | Corporea Lutea | | | Fetuses | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | No. Animals | Ave. | No. | No. Animals | Ave. | No. | No. Animals | Ave. | No. | No. Animals | Ave. |
| Adults | | | | | | | | | | | | |
| 1957-68 | 331 | 44 | 7.5 | 127 | 20 | 6.4 | 225 | 32 | 7.0 | 106 | 16 | 6.6 |
| 1967-68 | 102 | 12 | 8.5 | 34 | 6 | 5.6 | 66 | 10 | 6.6 | 20 | 3 | 6.6 |
| Total | 433 | 56 | 7.7 | 161 | 26 | 6.2 | 291 | 42 | 6.9 | 126 | 19 | 6.6 |
| 2-year-olds | | | | | | | | | | | | |
| 1957-68 | | N/A | | | N/A | | 117 | 21 | 5.6 | 33 | 6 | 5.5 |
| | | 23 non-breeders | | | | | | | | | | |
| 1967-68 | | N/A | | | N/A | | 42 | 8 | 5.25 | 7 | 1 | - |
| | | 6 non-breeders | | | | | | | | | | |
| Total | | 29 non-breeders | | | - | | 159 | 29 | 5.5 | 40 | 7 | 5.7 |
| Total Adult and 2-year-old | 433 | 56 | 7.7 | 161 | 26 | 6.2 | 450 | 71 | 6.3 | 166 | 26 | 6.4 |

The Nunamiut stress the belief that in most cases wolves, especially the females, show great concern for their young, to the extent that pup mortality is a "rare" occurrence. The above mentioned instances are the only concrete examples of mortality among very young pups from any natural cause that I have been able to record, even after much specific inquiry on this subject. Only rarely have pups handled by the Nunamiut been in poor physical condition; they are reported to be "fat and healthy" almost without exception, even in years of relatively poor food supply.

In the experience of the Nunamiut, litter size is strongly dependent on the age of the female, the very young and very old females usually having from one to four pups and the "middle-aged" females (approximately four to six years old) have the largest litters, sometimes totaling eight or nine.

As indicated in Table 9, usually two, three, or four adults are associated with each natal den. The largest number of adults observed at a den by the Nunamiut is eight.

The data in Table 9 are representative of from roughly one-half to two-thirds of the total number of wolf pups taken by the Nunamiut in the last 30 years (by their estimation). They state that, on the average, roughly 20 pups and about half that many adults were taken each summer. Two cases were recorded in which a natal den had already been vacated when visited and in four instances the number of pups taken had been forgotten.

Physiographic Characteristics of Den Sites (Arctic)

Table 11 includes data on those quantifiable physiographic parameters that appear to most succinctly characterize dens. Physiographic and other data were recorded on the Den Data Form. Most categories of information are included in Table 9. Others, including macro- and microrelief, vegetation, dimensions of entrances, wind exposure, trails, and the view available from dens and certain aspects of den use will be discussed below. Sites visited by Stephenson are indicated by an asterisk(*). For several dens, including Nos. 2, 4, 7, 8, 15, 29, 35, 36, 37, 47, 49, 52, 56, 57, 58, 59, 60, 61, 62, 63, 69 and 74, little but the location has been recorded. In a few cases an indication of the soil, aspect, and status of a den has been obtained from the Nunamiut.

Soil moisture was rated subjectively as dry, moist, or wet (free water present). A 48-inch soil coring apparatus was used to obtain soil profiles and to measure the depth of the active frost zone. If any type of mass soil movement was involved in the full or partial destruction of excavations this is indicated.

A brief discussion of the recent geologic history of the Brooks Range is necessary for an interpretation of the data. The pre-Pleistocene history of the Brooks Range and North Slope is still unsettled. For a discussion of the relevant information on this topic the reader is referred to Porter (1966).

On the north slope of the Brooks Range streams flow generally northward through deep U-shaped glacially sculptured valleys. Six Pleistocene glaciations are recognized; each successive glaciation being of lesser magnitude and thus terminating further south than the preceding one (Detterman, et. al., 1958). Signs of these glaciers, including kames and ground, lateral and terminal moraines, are prominent features of valley floors and, because of their elevated nature, often support well-drained soils. In addition to material deposited by glaciers per se, these elevations are often covered with eolian deposits in the form of stabilized and semi-stabilized dunes. Other dunes, primarily of a poorly developed longitudinal type occur in discontinuous and isolated forms along most of the rivers and larger streams (Black, 1951). The source of this eolian material is glacial debris and water-sorted fines resulting from the extensive glaciation the valleys have undergone. Each year a very slow eolian reworking of the uppermost soil layers in the drier places occurs and is aided by the exposure of additional material by frost action. These soils are invariably at least moderately well-drained; "free" water is rarely present.

Dunes are often mantled with vegetation and appear inactive, but linear unvegetated blowouts, oriented in the direction of prevailing winds that blow parallel with the valleys, are found on many dunes, depending on location (Porter, 1966).

Soils forming under these conditions of free drainage and deriving from parent mineral material have been classified as Arctic brown soils by Tedrow and Cantlon (1958). In their words, "Their areal extent is small and is confined primarily to escarpment areas, ridges, terrace edges, and stabilized dunes. The upper mineral horizon approximates a dark brown color and is acid in reaction. Colors grade through various yellow-browns and grey-browns with depth. The active layer is usually deep. Arctic brown soil has been reported in Alaska north of the 71st parallel." As Tedrow and Cantlon point out, mature, zonal soils are of only local occurrence in the arctic tundra region due to the rarity of well-drained soils and low rate at which podzolization processes occur.

The Brooks Range lies in the zone of continuous permafrost in Arctic Alaska (Hopkins, Karlstrom and others, 1955). The ground thaws during spring and summer to a variable depth that depends on the character of the surface material, topography, exposure, vegetation cover, and overall drainage conditions. According to Porter (1966), "....at the end of the thaw period the active layer on till extends as much as 16 inches below the surface, whereas in more permeable kame-terrace gravels the depth of thaw may reach several feet. Where a thick mat of vegetation is present the ground thaws to a depth of only a few inches. Mudflow scars up to four feet deep indicate the depth of thaw on some favourably exposed slopes with limited vegetation cover. The average thaw depth by late summer, however, probably is of the order of about 12 inches."

The physiographic data presented in Table 11 show that characteristically wolf den excavations (as opposed to dens in naturally occurring

Table 11. Physiographic characteristics of wolf den sites in Arctic Alaska.

| Drainage | No. | Substrate or Soil | Land Form | Root Penetration (inches) | Soil Moisture | Soil Color | Active Frost Zone (Ft) | Mass Soil Movement | Aspect | °Slope | Distance to Water (Ft) | No. Usuable Excavations | No. Defunct Excavations | Depth (Ft) | Elevation (Ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ank* | 3 | Bedded Limestone | Bedrock Escarpment | - | - | - | - | - | S | 50° | 10 | 1 | 0 | 25 | 3200 |
| Ank* | 30 | Fine Sand | Cutbank/ Blowout | 5-8 | Moist | Brown | 4 | Yes | WSW | 50° | 15 | 0 | 1 | - | 1900 |
| Ank* | 31 | Fine Sand | Cutbank/ Moraine | 36 | Moist | Brown | 4 | Yes | S | 70° | 75 | 2 | 0 | 4,6 | 1900 |
| Ank | 64 | Bedded Limestone | Bedrock Escarpment | Very old den, collapsed due to water erosion of limestone, 1966. Reported to have been a larger cave than Den 3. | | | | | S | | | 0 | 1 | 25 | 2300 |
| Okm* | 13 | Fine Sand | Blowout/ Moraine | 30 | Moist | Brown | 4 | Yes | SW | 10° | 150 | 2 | 1 | 12 | 2100 |
| Okm* | 14 | Fine Sand | Moraine | 6-20 | Moist | Brown | 4 | No | S | 20° | 100 | 3 | 0 | 7,4,3 | 2300 |
| Okm* | 16 | Fine Sand | Blowout/ Moraine | 4-8 | Moist | Brown | 4 | No | S | 10° | 20 | 0 | 2 | - | 2500 |
| Okm* | 17 | Fine Sand | Kame Terrace | 10-12 | Moist | Brown | 4 | Yes | SE | 5-30° | 20 | 0 | 2 | C.7 | 2500 |
| Okm* | 18 | Clay-Gravel | Lateral Moraine | 8-10 | Moist | Tan | 4 | Yes | S | 70° | 30 | 0 | 1 | C.5 | 2950 |
| Okm* | 32 | Fine Sand | Ground Moraine | 4-8 | Moist | Brown | 4 | Yes | S | 10° | 20 | 0 | 2 | - | 2450 |
| Okm | 26 | | Ground Moraine | | | | | | | | | | | | |
| Okm | 43 | Shallow pit - no excavations - pups found exposed. | | | | | | | | | | | | | |
| Okm | 45 | Sand | Cutbank | | | | | | | | | | | | |
| Okm | 46 | | End Moraine | | | | | | | | | | | | |
| Okm | 48 | | Dune | | | | | | | | | | | | |
| Okm | 71 | Sand | Dune | | | | | | | | | | | | |
| Okm | 72 | Sand | Cutbank | | | | | | | | | | | | |
| Okm | 73 | Rocks | Cutbank | | | | | | | | | | | | |
| Klk* | 19 | Shallow pit - no excavations - pups found exposed. | | | | | | | | | | | | | |
| Klk* | 20 | Clay | Lateral Moraine | 3-4 | Dry | Tan | 4 | Yes | SSE | 60° | 75 | 3 | 5 | 9,5,4 | 2000 |
| Klk | 21 | Rock | Escarpment | | | | | | | | | | | | 3000 |
| Klk* | 22 | Sand | Dune | | | | | | | | | | | | 1900 |
| Klk* | 23 | Sand | Cutbank | | | | | | | | | | | | 1800 |
| Klk* | 24 | Fine Sand | Dune/Kame | 8-20 | Moist | Brown | 4 | Yes | S | 30° | 50 | - | - | - | 1750 |
| Klk | 28 | Clay | Lateral Moraine | | | | | S | | | | | | | 3600 |
| Klk | 41 | | Gravel Cutbank | | | | | | | | | | | | 2200 |
| Klk* | 42 | Fine Sand | Ground Moraine | 8-10 | Moist | Brown | 4 | Yes | S | 40° | 100 | 3 | 1 | 6,8 | 1890 |
| Klk | 51 | Sand | Dune | | | | | | | | | 2? | | | 1870 |
| Klk* | 44 | Sand | Blowout | | | | | | | | | | | | 1700 |

Table 11 (Continued).

| Drainage | No. | Substrate or Soil | Land Form | Root Penetration (inches) | Soil Moisture | Soil Color | Active Frost Zone (Ft) | Mass Soil Movement | Aspect | °Slope | No. Distance to Water (Ft) | No. Usuable Excavations | Defunct Excavations | Depth (Ft) | Elevation (Ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Klk | 50 | Rock | Ground Moraine | | | | | | | | | | | | 3400 |
| Ngu | 54 | Sand | Cutbank | | | | | | | | | | | | |
| Kpa* | 25 | Limestone | Bedrock Escarpment | | | | | | E | 60° | 100 | 1 | 0 | 12 | 3200 |
| Jon | 1 | Sand | Cutbank | | | | | | SE | 60° | 10 | | | | 900 |
| Jon* | 5 | Sand, Rock | Gravel Cutbank | 8-30 | Moist | Brown | 4 | No | S | 20° | 10 | 1 | 0 | 8 | 2500 |
| Jon* | 6 | Kanayut Conglomerate | Escarpment | - | - | - | - | - | SSW | 50° | 300 | 2 | 0 | 12 | 2800 |
| Jon* | 55 | Boulders | | | | | | | S | | | | | | 3000 |
| Itk | 10 | Sand | Kame | | | | | | SW | 40° | 100 | | | | 2400 |
| Itk | 11 | Sand | Ground Moraine | | | | | | S | 15° | 50 | | | | 2200 |
| Itk | 40 | Sand-Rock | Alluvial Fan | | | | | | SW | | | | | | 3000 |
| Itk* | 65 | Fine Sand | Dune | 8-20 | Moist | Brown | 4 | No | S | 30° | 100 | 3 | 5 | 6-12 | 2300 |
| Itk* | 66 | Fine Sand | Blowout | 10-20 | Moist | Brown | 4 | No | S | 30° | 50 | 0 | 1 | 8 | 2400 |
| Nfk* | 38 | Sandy Loam | Wooded Kame | 48 | Moist | Brown | 4 | Yes | SSW | 4° | 10 | 0 | 1 | 4 | 1850 |
| Nfk* | 39 | Limestone | Escarpment | - | - | - | - | No | S | 30° | 500 | 2 | 0 | 10 | 2400 |
| Nfk | 34 | Sand | | | | | | | S | | 100 | | | | 2000 |
| Atg* | 9 | Fine Sand | Dune | 36 | Moist | Brown | 4 | No | S | 20° | 200 | 3 | 3 | 3-6 | 2600 |
| Tlk | 27 | | Pingo | | | | | | | | | | | | 700 |
| Tlk* | 12 | Sand-Gravel | Ground Moraine | Shallow pit - pups exposed. | | | - | - | S | 20° | 200 | | | | 2200 |
| Clv* | 33 | Med. Sand | Dune | 12-18 | Moist | Brown | 4 | Yes | SSW | 15° | 100 | 1 | 0 | 7 | 120 |
| Inr | 67 | Sand | Dune | | | | | | | | | | | | 55 |
| Mde | 68 | Sand | Dune | | | | | | | | | | | | 50 |
| Chr | 75 | | | | | | | | | | | | | | 2600 |
| Chr | 76 | Sand | | | | | | | | | | | | | 3200 |
| Chr* | 77 | Alluvial Sand | Cutbank | 36 | Moist | Brown | 4 | No | S | 40° | 150 | 1 | 0 | 7 | 700 |
| Lpn | 78 | | | | | | | | | | | | | | 1600 |

Abbreviations:

Ank - Anaktuvuk
Ngu - Nigu
Itk - Itkillik
Tlk - Toolik
Mde - Meade
Okm - Okokmilaga
Kpa - Kurupa
Nfk - North Fork of Koyukuk
Clv - Colville
Chr - Chandler
Klk - Killik
Jon - John
Atg - Atigun
Inr - Inaru
Lpn - Lupine

* Indicates those dens visited by author in 1970 or 1971.

rock formations) are situated on at least a moderately steep southerly slope in a relatively well-drained soil (usually sand) and near a source of water. Various land forms are used including cutbanks, blowouts, dunes (at various stages of stabilization), kames and various types of moraines. The dens and associated land forms that were inspected were variable in details of dimensions and physical relationships but showed uniformity in aspect, slope and depth of the active frost layer, all of which critically influence drainage.

Southerly slopes receive the greatest net radiation during the year and are the first to thaw in spring, often preceding northerly slopes by several days. Another factor probably equally important in determining the dry nature of den soils relative to surrounding areas is their elevated, exposed nature. These sites characteristically remain almost snow-free during the winter because the high winds typical of the region and especially common in the north-south valleys allow little or no snow accumulation.

The depth of the active layer at den sites, which in all cases was greater than four feet, is indicative of the special drainage conditions required for den soils when compared to the depth of the active layer over the great majority of the North Slope which rarely exceeds 20 inches.

Some of the dens examined were undoubtedly red fox dens at a former time and have been enlarged by wolves for their own use. Specific cases where this has happened are known to the Nunamiut and other cases where foxes have usurped ground squirrel burrows are also known. The latter phenomenon has been documented for Arctic foxes in other areas (Macpherson, 1969; Stephenson, 1970). Unoccupied wolf dens are commonly used by porcupines, perhaps more in winter than in summer; a few quills and numerous scats were found in several dens and the Nunamiut stated that on several occasions porcupine quills, supposedly picked up in dens, were found in wolf pups.

Truly zonal soils occurred only at the more stabilized sites. The greatest root penetration (three to four feet) and the highest percentage of plant cover occurred at these locations. Many dens were located in less stabilized locations that showed signs of considerable soil movement caused by high winds; soils at these sites might better be referred to as regosols since zonation was absent, the soil being comprised of parent material unaltered by soil forming processes. Some vegetational stabilization was noted, even at these sites; dens were usually constructed in one of the older dunes in a given complex. A den excavated in this sandy soil may last from one to several years, depending on the particular soil and moisture conditions involved. Sagging, slumping, and eolian soil movement act at varying rates and in combination to alter dens. As Table 9 indicates, the same site may be renewed and used repeatedly. Dens constructed in the more stable morainic deposits generally appear to be more durable because of greater root penetration and established nature of the vegetation. Three dens were located in clay soils. One of these, Den 18, was used once several years ago and is now collapsed.

This den lies at the base of a very steep 300-foot slope on which signs of mass soil movement were obvious, undoubtedly accounting for the destruction of the den. Den 20 showed signs of recent use and had three recently formed entrances and five other excavations that had collapsed or were destroyed by humans. The clay at this site was tan with a dark yellow horizon about six inches below the surface. Limestone cobbles ranging from two to five inches in diameter were scattered throughout the soil. In July the soil was dry and extremely hard. This soil becomes softer when wet, accounting for the collapsed excavations. It is the experience of the Nunamiut, and it is reasonable to expect that extreme dryness most often causes the collapse of dens formed in sandy soil while extreme wetness is responsible for collapse in clay soil.

Naturally occurring rock formations are the most stable substrate in which wolf dens occur and, in some cases, have provided essentially unchanging den sites for decades and perhaps even centuries. Even these, however, are subject to destruction through tectonic and gravitational forces and, in the case of limestone formations, by the dissolution of the substrate by water.

A description of each den would be beyond the scope of this report but a general characterization will be undertaken here to supplement data given in Table 11.

Entrances to dens excavated by wolves were usually 16 to 20 inches in height and width and rarely exceeded 24 inches in either dimension. Depths ranged from four to 12 feet and configuration of the excavations showed great variability. Many of the excavations, and especially the longer ones, did not extend their full length perpendicular to the substrate but instead curved, sometimes at a right angle and continued parallel to the surface of the ground. Both ascending and descending excavations were observed, the latter being more common. In the majority of cases a "nest chamber" was located at the end of the excavation. The size of "nest chambers" varied but generally they were four to five feet long, three to four feet wide and two to three feet high.

Without exception, den interiors were devoid of organic material such as hair, vegetation, bones, scats, etc. Several of the Nunamiut indicated that this was invariably the case; never have they found a den like that described by Haber (1968) in Mt. McKinley National Park in which the "nest chamber" was lined with fur.

At dens with two or more separate excavations of similar vintage the nest chamber was usually located in the deepest one, although other, smaller "chambers" might occur in the other excavations as well. In some cases, two or more excavations terminated in a single "nest chamber."

As used here, the term macrorelief refers to the local relief of the formation in which a den is excavated, relative to the nearest level terrain. Macrorelief ranged from six feet to several hundred. One den was excavated in a cutbank six feet above the maximum water level of the

Chandler River. Another den was found on the coastal plain in a series of dunes six to 15 feet above the surrounding level tundra near Ocean Point on the Colville River.

A few dens were in mountain sides 200 to 500 feet above the valley floor. Most dens, including those located in dunes, moraines, kame terraces and cutbanks, were from 10 to 100 feet above the level terrain (often above a floodplain or lake).

Haber (1968) suggested that wolves select elevated places for dens partly because of the good view of surrounding country and the resultant increased opportunity for sighting game. A few dens located during the present study were situated so as to provide only a limited view of the surroundings; sometimes only the area within 50 feet around the den was visible because of thick vegetation. Thus it would seem more accurate to view the location of dens on elevated terrain as primarily a result of drainage requirements rather than the preference by the wolf for dens from which he can see well. A "view" is apparently not a prerequisite for a successful den.

The microrelief at dens ranged from a few inches to a few feet, the greatest microrelief usually was found at dens adjacent to blowouts. The percent plant cover ranged from a few percent to nearly 100 percent. The lowest density of plants occurred on relatively unstabilized soils.

As indicated in Table 11, wolf pups are occasionally found lying in shallow pits offering none of the shelter associated with the usual den structure. The Nunamiut ascribe the occurrence of "pit dens" to the fact that in these cases parturition took place "unexpectedly," when the female wolf was some distance from the prepared den.

Vegetation Chacteristics of Den Sites (Arctic)

Den site vegetation displayed high stand-to-stand diversity, and was rarely aggregated into types; each habitat was modified locally by frost action, permafrost, cryopedological processes, local relief, parent-material differences, drainage patterns, irregular snow accumulation, and animal activity. Thus immediately adjacent areas support widely different vegetational types, often with considerable intergradation. The climax concept is probably not applicable here due to exigencies of the northern environment which produce disorder, especially in the substratum (Johnson, et. al., 1966). As a result of these factors, analytical treatment of den site vegetation is very difficult.

A mosaic of habitats, supporting widely different plant associations, was characteristic of sites located at dunes and blowouts. The more stabilized soils, usually those on terraces above the den entrance, supported heath-shrub communities comprised of varying densities of willows (often dwarf type), dwarf birch, ericaceous shrubs and, occasionally, alder. Species include *Salix arctica* (prostrate only), *S. alaxensis*, *S. pulchra*, *S. glauca*, *S. richardsonii*, *Betula nana exilis*, *B. glandulosa*,

*Arctostaphylos, Empetrum nigrum, Vaccinium, Ledum, Chamaedaphne calyculata* and *Alnus crispa*. The less stable soils, usually in dune and blowout troughs below the den entrance, supported associations of perennial and annual herbs, grasses and sedges. Species commonly encountered here were *Trisetum spicatum, Calamagrostis purpurascens, Agropyron violaceum, A. boreale, Deschampsia caespitosa, Poa glauca, P. arctica, Arctagrostis latifolia, Hierochloe odorata* and *Lupinus arcticus*.

Cutbanks supported shrubs including most of those mentioned above. Herbaceous species such as *Equisetum, Parnassia, Aconitum delphinifolium, Lupinus arcticus, Rumex arctica, Papaver macounii, Saussurea angustifolia* and *Valeriana capitata* were common between patches of shrubs.

The large clay-rock lateral moraine in which Den 20 was located was vegetated only by the pioneer annual herb *Artemesia alaskana*, which formed an open cover on about 50 percent of the slope.

Vegetation at Den 25, an alpine site, included the species *Salix glauca glabrescens, Cassiope tetragona, Boykinia Richardsonii, Dryas integrifolia* and various mosses and lichens.

Those dens visited on the south slope of the Brooks Range, along the North Fork of the Koyukuk and the lower John River, were situated under varying densities of white spruce (*Picea glauca*), aspen (*Populus tremuloides*) and alder (*Alnus crispa*). Ground cover included the species *Rosa acicularis, Rubus chamaemorus* and *Equisetum arvense*.

Immobilization and Tagging (Arctic)

Immobilization was attempted using the same helicopter technique widely used for immobilizing larger animals. A FH-1100 turbine powered helicopter was used. Cap-Chur equipment included the "Extra Long-Range Projector" and 3 cc. projectile syringes fitted with a three-quarter inch barbed needle. The "Low" powered Cap-Chur charge was used in most instances. The pertinent data on immobilized animals are presented in Table 12. A combination of circumstances made the effort only marginally successful. The present relatively low population level of wolves in the area made it difficult to find them, even with favorable weather. As expected, the animals proved to be extremely evasive and rarely presented a reasonable target.

A red or yellow numbered nylon "Salascolor" ear tag was placed in each ear of the animal. From 5 to 10cc's of blood was drawn from the brachial vein and allowed to separate for 24 hours after which serum was decanted and frozen.

Each "dart" was loaded with 100 mg. (about 1 mg/lb) of Sernylan (Phencyclidine Hydrochloride, Bio-Ceutic Laboratories, St. Joseph, Missouri). The variation in "reaction" and "down" times can be attributed primarily to the different injection sites (and consequent varying rates of absorption) and probably also to a variation in the actual dosage injected due

Table 12. Immobilization and tagging data for three wolves immobilized in central Brooks Range, April - May, 1971.

| Date | Location | Sex | Wt. | Color | Ear Tag | Remarks |
|---|---|---|---|---|---|---|
| 16 April | Gunsight Mt. John River | Male | Est. 85 lb. | Gray-brown | Rt. - Yellow 250<br>Lt. - Red 275 | Drug injected in right masseter muscle. Reaction time 15 minutes. Down time approx. 3 hours. Appeared to be 2-3 years old. |
| 10 May | Galbraith Lake | Male | 76 lb. | Gray-brown | Rt. - Yellow 251<br>Lt. - Yellow 252 | Drug injected in upper right shoulder. Reaction time 8-10 minutes. Down time approx. 2 hours. Appeared to be a 2-year old and evidently the mate of the female listed below. |
| 10 May | Galbraith Lake | Female | Est. 90 lb. | White | - | Traveling with above male. Evidently received only a partial dose of Sernylan as she remained immobile only long enough for her pregnancy to be ascertained by palpation. Further immobilization was not attempted in view of the near term pregnancy. Effective dart struck left haunch but bounced out. Reaction time 10 minutes. Down time 1 hour (head never went down). Because above male was down at same time, 1 mile away, was not able to tag female before she was again mobile. Decided against giving second dose. Age estimated at 3-5 years. |

to the variability in dart performance and wound characteristics. It is interesting to note here that adult captive wolves in the N.A.R.L. colony at Barrow react uniformly and predictably to a dose of 50 mg. of Sernylan injected with a hand syringe while exhibiting varied responses to 100 mg. administered with a Cap-Chur syringe (Robert E. Henshaw, personal communication).

The immobilization technique used involves considerable risk of serious injury to the animals since, except under rare conditions (i.e., with the wolf essentially immobilized by deep snow and fatigue), the shooter has little real control over the place the dart will strike. Thus, in the case of lateral shots, the abdomen and thoracic cavity have almost as great a chance of being hit as do the more heavily muscled upper legs, back, or neck. A hit in either of the former areas could easily be fatal.

For a number of reasons, vertical shots are preferable to those from other angles; this lessens the effect of rotor turbulence on dart trajectory, shields the abdomen and lower chest and, in some cases, the noise and accompanying turbulence may confuse the animal momentarily, causing it to remain stationary.

Characteristics and Condition of Ungulate Prey (Arctic)

Table 13 presents wolf-kill information obtained in the Arctic study during 1970-71. The number in parenthesis is the class in which the sample was assigned on the basis of color and consistency of the marrow, Class 4 indicating the highest and Class 1 indicating the lowest fat content. The initials "R.S." indicate that the specimen was collected by Stephenson. Specimens and kill information from other sources is so indicated.

The samples are as yet too limited to allow any broad conclusions. Of interest, however, is the predominance of old animals among sheep taken by wolves and the great variation in marrow fat values among adult moose. The marrow fat values of 80, 85 and 92 percent among adult moose are indicative of high nutritional status, suggesting that wolves are not restricted to preying upon young and/or physically inferior moose.

Characteristics and Condition of Ungulate Prey (Southcentral)

The technique used for finding wolves in Southcentral Alaska was successful as wolves were encountered on each flight after the tracking technique and habits of the animals were learned. The wolves were observed until their activities were determined but they were not harassed.

Kill sites were usually located while tracking wolves. Information on the activities of the wolves, age and condition of the kills and other data collected on the spring 1971 flights are summarized in Table 14.

Table 13. Data from ungulate prey utilized by wolves, North Slope, 1970-71.

| Accession Number | Species | Probable Date of Kill | Place | Sex | Age | Marrow Analysis % Fat | Source of Specimen | Remarks |
|---|---|---|---|---|---|---|---|---|
| 61001 | *Ovis dalli* | Winter 1969-70 | Base of mtns. on east side of Okokmilaga River near Takuak Creek | F | 12 | Unk. | R.S. | Though possibly not taken by wolves, this animal was utilized by wolves as evidenced by 38 wolf scats containing sheep hair found within a 30-ft. radius of the remains. |
| 61002 | *Ovis dalli* | Winter 1969-70 | Base of mtns. on east side of Okokmilaga River near Takuak Creek | F | 6 | Unk. | R.S. | Similar to above. Six wolf scats at remains, all of which contained sheep hair. |
| 61003 | *Ovis dalli* | Winter 1969-70 | Base of mtns. on east side of Okokmilaga River near Takuak Creek | M | 3 | Unk. | R.S. | Similar to above. Five wolf scats containing sheep hair found at remains. |
| 61004 | *Ovis dalli* | Winter 1969-70 | North side of Suluak Creek | M | 8 | Unk. | R.S. | Head, vertebrae, and parts of long bones found on alpine meadow north of Suluak Creek. |
| 61007 | *Ovis dalli* | Winter 1968-69 | Okokmilaga River - east side | Unk. | 15-16 | Unk. | R.S. | Only mandible was found. First lower premolar on each side extended about 1/2 in. above other teeth indicating mal-occlusion. Teeth exhibited heavy wear. Aging by cementum |

Table 13 (Continued).

| Accession Number | Species | Probable Date of Kill | Place | Sex | Age | Marrow Analysis % Fat | Source of Specimen | Remarks |
|---|---|---|---|---|---|---|---|---|
| 61007 (continued) | | | | | | | | layers showed that the animal was 15-16 yrs. old at death and had died in summer or early fall. This may be the oldest sheep aged by this Dept. |
| 61009 | *Ovis dalli* | Winter 1969-70 | Okokmilaga River - east side | Unk. | Lamb 1st winter | Unk. | R.S. | Only a part of mandible found. Origin uncertain. |
| 61031 | *Ovis dalli* | February 1971 | Near pass between Kollutuk Creek and Chandler Lake | M | 10 | Unk. | David Mekiana, Anaktuvuk Pass | Found by informant in February shortly after wolves had killed it. Frontal bones and horns were all that remained by April. |
| 61023 | *Ovis dalli* | March 13, 1971 | Foothills east of John River. 1 mi. south of Kollutuk Creek | M | 13+ | 5.5% (1) | R.S. | Found 2-3 days after death. Two wolves had consumed about 40% of carcass. The throat area was untouched indicating that the animal may have died a natural death. The fat content of the marrow indicates animal was in very poor condition at death. Necropsy of lungs and heart revealed no gross abnormalities or parasites. |

Table 13 (Continued).

| Accession Number | Species | Probable Date of Kill | Place | Sex | Age | Marrow Analysis % Fat | Source of Specimen | Remarks |
|---|---|---|---|---|---|---|---|---|
| 61005 | *Rangifer tarandus* | Aug. 1, 1970 | Umiat Mtn. | F | 8 | Unk. | R.S. | Found about 12 hrs. after death. Part of throat area and viscera had been eaten. 24 hrs. later viscera, except for rumen, had been completely removed and one hindquarter had been removed at proximal end of femur and carried away. |
| 61006 | *Rangifer tarandus* | Aug. 1, 1970 | Umiat Mtn. | Unk. | 2 mos. | Unk. | R.S. | One foreleg and scapula were found 100 yds. away from above site. Apparently the leg had been carried away from kill site, which was not found. |
| 61008 | *Rangifer tarandus* | 1968 or 1969 | Okokmilaga River | M | 8+ ? | Unk | R.S. | Cause of death unknown. Included here because of severe necrosis of right mandible around first and second molars. Both teeth and bone tissue were necrotic. |
| 61028 | *Rangifer tarandus* | April 7, 1971 | Oksrukuyik Sagavanirktok River | Unk. | 10 mos. | 8.0% (1) | R.S. | Only scattered bones and hair remained on 20 April. Three wolves were observed at kill on 7 April. |

Table 13 (Continued).

| Accession Number | Species | Probable Date of Kill | Place | Sex | Age | Marrow Analysis % Fat | Source of Specimen | Remarks |
|---|---|---|---|---|---|---|---|---|
| 61036 | *Alces alces* | Dec. 15, 1970 | 20 mi. north of Anaktuvuk Pass | F | 1-1/2 | Unk. | Raymond Paneak, Anaktuvuk Pass | Tracks of 4 or more wolves observed at kill. Moose was brought down after 100 yd. chase originating in small patch of willows along Anaktuvuk River. |
| 61029 | *Alces alces* | March 1971 | Sagavanirktok River at mouth of Lupine River | F | 7 mos. | 9.7% (2) | R.S. | Found April 17, 1970. Parts of long bones, pelvis, skull and rumen remained. |
| 61030 | *Alces alces* | March 1971 | Sagavanirktok River 15 mi. S. of Sagwon | F | 8 | 80.0% (4) | R.S. | Found April 17, 1970. Skeleton largely intact, 90% of flesh removed. |
| 61032 | *Alces alces* | Late winter 1970-71 | Ribdon River | Unk. | Unk. Adult | 92.1% (4) | R.S. | Found May 15, 1970. Only hair and scattered bones remained. |
| 61033 | *Alces alces* | Late winter 1970-71 | Ribdon River | M | Unk. | 9.0% (1) | R.S. | Found May 15, 1970. Only hair and scattered bones remained. |
| 61034 | *Alces alces* | April 1971 | Kollutarak Creek | M | Unk. Adult | 12.3% (2) | R.S. | Found May, 17, 1971. One-third consumed. Six in. of antler growth present. |
| 61035 | *Alces alces* | Winter 1970-71 | Toolik River 20 mi. N. of Toolik Lake | Unk. | Unk. Adult | 85.1% (4) | R.S. | Found May 14, 1971. Only hair and scattered bones remained. |

Table 14. Summary of observed wolf kills in spring 1971 - Gulkana River.

| Accession Number | Species | Date of Collection | Location of Kill | Sex | Age | Marrow Analysis % Fat | Size of Wolf Pack | Degree of Utiliz. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | *Alces alces* | Feb. 17, 1971 | W. Fork Gulkana | Unk. | Unk. | Unk. | 23 | Total | Unable to land. |
| 54853 | *Rangifer tarandus* | Feb. 19, 1971 | Fish Lake | M | 2 | 8.3 | Unk. | Total | |
| | *Alces alces* | Feb. 22, 1971 | Minnesota Lakes | M | Unk. | | | | Killed by hunters - antlers only taken. Eaten by wolves, fox, etc. |
| | *Alces alces* | Feb. 26, 1971 | N.E. Susitna Lake | Unk. | Adult | Unk. | 5-8 | Total | Unable to land. |
| | *Alces alces* | March 1, 1971 | W. Fork Gulkana | Unk. | Unk. | Unk. | Unk. | Total | Unable to land. |
| | *Alces alces* | March 3, 1971 | Minnesota Lakes | M | Unk. | Unk. | 8 | | Killed by hunters, antlers only taken. Eaten by wolves, fox, etc. |
| 67033 | *Alces alces* | March 9, 1971 | Gulkana River | F | 8 | 86.4 | 8 | Total | Unable to land. |
| 67032 | *Alces alces* | March 9, 1971 | W. Fork Gulkana | F | 1 1/2 | 80.5 | 2 | Slight | Wolves frightened and never returned. |
| 67034 | *Alces alces* | March 12, 1971 | W. Fork Gulkana | Unk. | 2 | Unk. | 12 | Total | Jaw only found. |
| | *Alces alces* | March 12, 1971 | Twin Lakes | Unk. | Unk. | Unk. | 12 | Total | Unable to land. |

Table 14 (Continued).

| Accession Number | Species | Date of Collection | Location of Kill | Sex | Age | Marrow Analysis % Fat | Size of Wolf Pack | Degree of Utiliz. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | *Alces alces* | March 18, 1971 | Keg Creek | Unk. | Unk. | Unk. | Unk. | Total | Unable to land. |
| 67035 | *Alces alces* | March 18, 1971 | Deep Lake | F | ) | 83.9 | 10 | Total | |
| | *Alces alces* | March 18, 1971 | W. Fork Gulkana | Cow & calf | | Unk. | Unk. | Slight | Unable to land, not revisited. |
| 67037 | *Alces alces* | March 20, 1971 | Monsoon Lake | F | 3 | 84.8 | 23 | Total | Dam of 67036. |
| 67036 | *Alces alces* | March 20, 1971 | Monsoon Lake | Unk. | Calf | 11.6 | 23 | Total | |
| 67038 | *Alces alces* | March 22, 1971 | Monsoon Lake | F | 12 | 70.3 | 23 | Total | |
| 67039 | *Alces alces* | March 26, 1971 | Between W. Fk. and Gulkana | Unk. | Unk. | 89.4 | 6 (nearby) | Total | Could not locate jaw. |
| | *Alces alces* | March 26, 1971 | Between W. Fk. and Gulkana | Unk. | Unk. | Unk. | 6 (nearby) | Total | Unable to land. |
| | *Alces alces* | March 26, 1971 | Between W. Fk. and Gulkana | Unk. | Unk. | Unk. | 6 (nearby) | Total | Unable to land. |
| | *Alces alces* | March 26, 1971 | Between W. Fk. and Gulkana | Unk. | Unk. | Unk. | 6 (nearby) | Total | Unable to land. |
| 67040 | *Alces alces* | April 22, 1971 | 15 Mi. No. Christochina | M | 10 | 63.2 | 16 | Total | |

Survey and inventory data on the Unit 13 moose population show adult females to be the most abundant age class present. In the sample of nine wolf-killed moose examined, five were adult cows. The number of bone marrow fat samples is small but the animals examined did possess fat reserves that appear normal for the various sex and age categories.

Snowfall and the accumulation of snow on the ground were relatively great during the winter of 1970-71 and wolves apparently had little difficulty killing prey. Prey species present in the study area consisted of moose, a few caribou, hares (*Lepus americanus*) and ptarmigan. Hares and ptarmigan were very abundant. Dall sheep do not occur in the study area.

The remains of 20 moose killed by wolves were inspected and in 16 instances wolves killed only one moose; twice they killed cows accompanied by a calf.

Utilization of animals killed was high with the exception of a moose killed March 9, 1971 by two wolves (Table 14). These wolves were apparently disturbed by the airplane and did not return to the kill. In most other instances, the wolves returned several times even after being disturbed by aircraft. It was also noted that two moose illegally killed by "trophy" hunters who removed only the antlers were heavily utilized by wolves. These carcasses were visited several times by wolves.

Winter Food Habits (Arctic)

Due to unfavorable weather, a fuel shortage, and the low population of wolves relatively few animals were taken by Nunamiut hunters during the winter of 1970-71. Data from the few carcasses examined are presented in Table 15.

All of the older Nunamiut stated that the winter of 1970-71 was the most severe, in terms of temperature, wind, and snow accumulation, in the last 30 years. A few small bands of caribou were present in the northern Brooks Range during the early part of the winter, but from January until late April they were absent. Aerial and ground reconnaissance as far as 100 miles north and east and 50 miles south and west of Anaktuvuk revealed no sign of caribou. Throughout the previous winter caribou were fairly common in the foothills north of the Brooks Range. Moose are consistently available along all of the larger drainages in the northern foothills and also on the south slope of the Brooks Range. An unusually high number of moose (the highest in the memory of the older Nunamiut) overwintered in the mountains adjacent to Anaktuvuk Pass during 1970-71 and persisted through the summer of 1971. During this period moose of all sex and age classes have been frequently observed, even in the smallest willow thickets along intermittent streams at elevations up to 4,000 feet. The causes of this evident population shift are unknown, but be may be tentatively ascribed to range deterioration and/or excessive snow depth along the larger, more heavily vegetated drainages to the north and south.

Table 15. Data from wolves taken by residents of Anaktuvuk Pass, winter 1970-71.

| Acc. No. | Date Killed | Sex | Age Pup or Adult | Color | Stomach Contents | Wt. | Remarks |
|---|---|---|---|---|---|---|---|
| 61015 | 16 December | M | Adult | Black | *Rangifer tarandus* | | |
| 61016 | 15 October | M | Pup | - | *Rangifer tarandus* | | |
| 61017 | 10 November | F | Pup | - | *Lagopus* sp. | | |
| 61018 | 1 October | M | Adult | Gray-Brown | Empty | | |
| 61019 | October | M | Pup | Gray | - | | |
| 61021 | 9 March | F | Adult | Dark Gray | *Rangifer tarandus* | 90 | In oestrus. Five placental scars. Heavy back, visceral and mesenteric fat. |
| 61024 | 21 March | F | Adult | Gray | Empty except for a few minute bone chips and a small white feather. | 86 | Was accompanied by white male. Pregnant uterus. Ten placental scars. Unusually fat. |

It appears, from the data presented in Tables 12 and 13, and from observations made in the field during December, January, March and April, that all three ungulate species present in the mountains were utilized by wolves at roughly comparable rates during the winter of 1970-71, but with a lessened dependence on caribou during the latter half of the winter. During the late winter, concurrent with the disappearance of caribou, wolves in the vicinity of Anaktuvuk appeared to rely to a considerable degree on meat caches and remains of kills made by the residents of Anaktuvuk. In the fall of 1970 a certain research institution offered the sum of $5 for caribou blood samples and, by doing so, induced a few resident hunters to kill numbers of caribou in excess of their subsistence needs. Most of this activity occurred near the John River between Masu Creek and Ekiakpuk Creek, about 15 miles south of Anaktuvuk. The carcasses of at least 50 caribou left there were utilized by wolves during the winter. In late winter this was one of the few areas in which Stephenson consistently observed wolves or signs of their recent presence.

Population Status and Current Trends (Arctic)

At present only limited, subjective information is available that would indicate the trend in the Arctic wolf population. All indications are that during the 1960's the Arctic population of wolves, and particularly that segment inhabiting the area north of tree line (Unit 26), was overexploited, primarily through aerial hunting, both legal and illegal. A regulation promulgated in the fall of 1962 imposed a bag limit of two wolves from this area when aircraft were used. This regulation remained in effect until the closure of Unit 26 to aerial hunting in 1970 but did not sufficiently limit the harvest, largely because a few operators disregarded this difficult-to-enforce law and continued to take excessive numbers of wolves. The harvest from the Arctic reached successive highs in 1966-67 and 1967-68 then showed a significant decrease in 1968-69 (Rausch, 1969). A big game census conducted by the Department of Fish and Game in April 1970 indicated that the wolf population was indeed at a low level. The paucity of natal dens among those visited in July 1970 (Table 9) was further indicative of a low population. The Nunamiut that accompanied Stephenson on visits to the dens shown in Table 9, expressed surprise at finding so little evidence of use, even at dens they considered to be the most consistently productive. The hunters in Anaktuvuk agree that the wolf population is low, perhaps one-half to two-thirds that of five years ago and report a marked decrease in the proportion of old-age animals in the population concomitant with the decrease in numbers.

Observations made by Department personnel and others on the North Slope during the summer of 1971 suggest that there has been an increase in the number of natal dens over 1970 and that a general increase in the wolf population is occurring. The frequency of wolf sightings, especially of young of the year animals, has increased markedly.

## Population Status and Current Trends (Southcentral)

All wolf observations made in Southcentral Alaska are recorded on standard Wolf Observation Forms (Fig. 2). The sightings for the period, January 1970 to October 1971, are summarized in Tables 16, 17 and 18. Because these observations were made over a long period of time, they undoubtedly contain duplicate sightings and cannot be considered a population estimate. A series of flights made to obtain sex and age composition of moose in Game Management Unit 13 in November 1970 yielded 12 observations totaling 112 wolves (Table 17). Some of these were known to have been duplicate sightings. In covering about one-third of Unit 13, at least 72 different wolves were observed. The mean pack size for these sightings was 9.3.

During the spring of 1971, attempts were made to locate wolf packs and to monitor their hunting activities under Job 14.5R. These sightings showed considerable variation from the published accounts of pack fidelity as evidenced by consistency in numbers (Murie, 1944; Mech, 1970; Burkholder, 1959). Ten sightings of wolf packs made in the same general area during a 65-day period showed no two packs with the same numbers or color combinations. These observations are summarized in Table 18. The mean pack size of these sightings was 8.9. Prior to and near the end of these surveys, these wolves were subjected to a rather intensive hunting effort. This disruptive activity may have influenced the sightings.

Analysis of aerial wolf hunter reports for Unit 13 for the period November 1970 to March 1971, shows an average pack size of 6.4 wolves. This figure was derived from 34 observations of packs containing a total of 220 wolves. All wolf observations for Unit 13 combined total 65 observations of packs containing 461 wolves. This indicates a mean pack size of 7.1 animals. Rausch (1967) reported that pack size is an indicator of wolf abundance. The mean of 7.1 wolves per pack may represent an increase over the mean pack size of 6.2 as reported for 1967 by Rausch (1969). Based on the total number of observations, mean pack size, limited areas covered, hunter kill and comparison with past years' data, it appears that the wolf population in Game Management Unit 13 is high. A knowledgeable and reliable pilot-guide-hunter, who has lived and hunted in this area since the mid 1940's, reports that he believes wolves are now more abundant than they have been since his arrival. This view is shared by others familiar with this area. Past population estimates, hunter kill, and other population data are shown in Table 19.

## Human Utilization

Wolf pelts now command a price which makes aerial hunting profitable and exploitation of the sizeable Unit 13 wolf population was expected. Removal of bounty payments in 1969 made it impossible to accurately assess the hunter kill. To remedy this, the Board of Fish and Game has instituted a mandatory sealing requirement for all wolves killed after July 22, 1971.

Fig. 2. Wolf Observation Form

Code_____ Game Management Unit_____

WOLF OBSERVATION FORM

Observer: Date: Time:

Type Aircraft: Snow Conditions:

Drainage: Weather:

Specific Area:

Wolves only sighted: Yes_____ No_____

Tracks only sighted: Yes_____ No_____

Tracks then wolves sighted: Yes_____ No_____

Number wolves sighted:_____

Number tracks sighted:_____

Color: Gray_____ Black_____ Brown_____

Activity: Traveling_____ Bedded down_____ Feeding_____

Direction moving:_____

Kill: Moose_____ Caribou_____ Unknown_____

Observed from: Air_____ Ground_____ Both_____

Indication kill was made by wolves:

Yes_____ No_____ Unknown_____

If yes, why?_____

_____

_____

Table 16. Miscellaneous wolf observations 1970-71, Game Management Unit 13. Track-only observations not included

| Date | Specific Location and Unit | Color | | | Total in Pack |
|---|---|---|---|---|---|
| | | Black | Gray | Other | |
| 4/14/70 | Lone Butte - 13(A) | | 2 | | 2 |
| 8/27/70 | Sinona Creek, Lone Butte - 13(A) | 1 | 2 | | 3 |
| 9/12/70 | 15 Miles North Lake Louise - 13(A) | 2 | 4 | 1 white | 7 |
| 4/6/71 | Upper Fish Lake - 13(B) | | 3 | | 3 |
| 7/7/71 | Fogg Creek - 13(D) North | | 1 | | 1 |
| 7/10/71 | Mile 51 Tok Highway - 13(C) | | 1 | | 1 |
| 9/15/71 | Hungry Hollow - 13(B) | 4 | 3 | | 7 |
| 9/17/71 | Round Top Mountain - 13(C) | | 5 | | 5 |
| 9/17/71 | Round Top Mountain - 13(C) | | 11 | | 11 |
| | TOTAL | 7 | 32 | 1 white | 40 |
| | | Mean Pack Size - 4.4 | | | |

Table 17. Wolf observations during 1970 moose surveys, Game Management Unit 13. Observations 10 and 12 known to be duplicates, at least in part, so were not utilized in population estimates.

| Date | Observation Number | Specific Location and Unit | Color | | | Total in Pack |
|---|---|---|---|---|---|---|
| | | | Black | Gray | Brown | |
| 10/30/70 | 1 | 4 Mi. W., Mouth E. Fk. Chistochina - 13(C) | | 5 | | 5 |
| 11/7/70 | 2 | Mid. Fk. Gulkana, 6 miles above main Gulkana - 13(B) | 4 | 8 | | 12 |
| 11/8/70 | 3 | Hungry Hollow - 13(B) | 4 | 2 | | 6 |
| 11/9/70 | 4 | Gulkana River between Keg and Moose creeks - 13(B) | 4 | 1 | | 5 |
| 11/10/70 | 5 | 6 Mi. So. Jct. Big and Little Oshetna River - 13(A) | 10 | 2 | | 12 |
| 11/11/70 | 6 | Oshetna B.M. - 13(A) | 1 | | 1 | 2 |
| 11/11/70 | 7 | 3 Mi. So. McClaren Lodge - 13(B) | | 9 | | 9 |
| 11/11/70 | 8 | 7 Mi. W. Crosswind Lake - 13(A) | 3 | 4 | | 7 |
| 11/11/70 | 9 | Dicky Lake - 13(B) | 9 | 4 | 1 | 14(1) |
| 11/12/70 | 10 | Dicky Lake - 13(B) | 9 | 4 | 1 | 14(1) |
| 11/12/70 | 11 | 2 Mi. So. McClaren Lodge - 13(B) | | 3 | | 3 |
| 11/30/70 | 12 | Island Lake - 13(A) | 21 | 2 | | 23(2) |
| | | TOTAL | 65 | 44 | 3 | 112 |
| | | | Mean Pack Size - 9.3 | | | |

Table 18. Wolf pack observations made in conjunction with Job 14.5R, spring 1971.

| Date | Observation Number | Specific Location and Unit | Color | | | Total in Pack |
|---|---|---|---|---|---|---|
| | | | Black | Gray | Brown | |
| 2/16/71 | 1 | W. Fk. Gulkana River, 20 Mi. W. Hogan Hill - 13(B) | 21 | 2 | | 23 |
| 3/1/71 | 2 | VABM, Bragg - 13(A) | 1 | 1 | 1 | 3 |
| 3/3/71 | 3 | 15 Miles N.E. Lake Louise - 13(A) | 1 | 6 | 1 | 8 |
| 3/9/71 | 4 | Gulkana River, 8 miles W. Hogan Hill - 13(A) | 1 | 7 | | 8 |
| 3/9/71 | 5 | W. Fk. Gulkana between Keg and Moose creeks - 13(A) | | 2 | | 2 |
| 3/12/71 | 6 | 10 miles W. Sourdough - 13(A) | 11 | 1 | | 12 |
| 3/18/71 | 7 | 3 miles north Deep Lake - 13(A) | | 10 | | 10 |
| 3/20/71 | 8 | 2 miles north Monsoon Lake - 13(B) | 1 | 1 | | 2 |
| 4/22/71 | 9 | 2 miles W. Sourdough - 13(C) | | 5 | | 5 |
| 4/23/71 | 10 | 15 miles north Chistochina - 13(C) | | 16 | | 16 |
| | | TOTAL | 36 | 51 | 2 | 89 |
| | | | Mean Pack Size - 8.9 | | | |

Table 19. Summary of reported wolf population data. Game Management Unit 13.

| Year | Estimated Population | Mean Pack Size | Hunter Kill | Source |
|---|---|---|---|---|
| 1953 | 12 | | | Burkholder |
| 1955 | 35 | | | ADF&G Segment Rausch |
| 1958 | 120 | | | Unit 13 Moose Survey - Johnson spring wolf |
| 1961 | 100-125 | 4.8 | | activity. Job 14.5R Johnson. Total of all |
| 1962 | 140-160 | 3.8 | | ADF&G plus aerial wolf hunters FY 70-71 |
| 1963 | No Estimate | | | |
| 1964 | No Estimate | | | |
| 1965 | 400-450 | 9.7 | | |
| 1966 | No Estimate | | 64* | |
| 1967 | 300 | 6.2 | 31* | |
| 1968 | | 5 | 120** | |
| 1969 | | | 13*** | |
| 1970 | | 9.3 | 40*** | |
| 1971 | | 8.9 | | |
| 1970-71 | | 7.2 | 90**** | |

* Illegal kill.
** First legal season, 95 legally taken.
*** Incomplete report of aerial permits only.
**** Aerial kill only and as reported by permittees. Known to be low.

Harvest figures for the 1970-71 regulatory year are based only on the reports from aerial wolf hunting. The number of wolves taken by trappers, recreational hunters and others are not known. Analysis of the aerial permits issued in Southcentral Alaska only showed that 90 wolves were reported taken from Unit 13. It is believed that actual kill of wolves in Game Management Units 11, 12 and 13 exceeded 250 although the reported kill was only 123. The discrepancy is believed to be caused by aerial hunters who violate terms of the aerial permits. The mandatory sealing requirement plus PL 72-159, which relates to aerial hunting, should aid in enforcing the wolf bag limit. Management efforts must be maintained and intensified if possible because locally the current high population of wolves is exceedingly controversial. Conversely, many preservationists are agitating to eliminate all killing of wolves and they are directing most of their attention at aerial hunting.

Wolf Coloration

Coloration in individuals of a species with nonuniform coloration may be an indication of differential survival through natural selection or it may be an indication of the trend of that population. Dr. Dale Guthrie of the University of Alaska is currently testing the hypothesis that a natural population reduction is eminent when there is a high incidence of darker colors in a red fox population. If true, perhaps a similar phenomenon occurs among wolves. The black/gray coloration of wolves in Game Management Unit 13 for the years 1961, 1962 and 1963, when intensive studies there were underway, was 225:100, 100:100 and 61:100, respectively (Rausch and Winters, 1964). During that period, the population was reportedly increasing. The population peak was reported as occurring in 1965 (Rausch, 1966), when the black/gray ratio was 133:100; that figure coming from bounty records of but 58 animals. Analysis of year-round wolf observations covered by this report indicates a black/gray ratio of 87:100 in a sample of 232 wolves. The ratio of black to gray animals should be monitored throughout the years as this ratio may be an indicator of abundance. It is known that certain colors predominate in certain areas. For instance, black wolves predominate in the upper Gulkana area and gray animals are more common to the east. These observations are substantiated in part by those reported in earlier Alaska wolf studies and perhaps suggest a family characteristic for coloration for specific areas. Hunter selectivity may influence the color ratios in some areas as the lighter colored pelts command the highest prices. On the other hand, the dark colored animals are more avidly sought by trophy hunters.

## RECOMMENDATIONS

Efforts to record the zoological knowledge of the Nunamiut Eskimo should continue.

Investigations of summer food habits should continue for another year.

Studies of denning ecology should emphasize the behavioral aspects of den use and the possible causes of juvenile mortality.

Sufficient data on the physiographic determinants of Arctic den sites have been gathered; this aspect of the study can be terminated.

Additional data on the characteristics and condition of ungulate prey should be gathered. The status and productivity of the Arctic and Southcentral populations of wolves should be monitored and eventually an effort should be made to quantify the relationships between wolves and their prey.

Game Management Unit 26 should remain closed to aerial hunting.

Aerial wolf hunting permits in Game Management Units 11, 12 and 13 should allow the taking of only two wolves per permit.

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