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WOLF REPORT

by
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and
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Volume XI
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-4, Jobs 14.3R, 14.4R, 14.5R, 14.6R and 14.7R
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JOB PROGRESS REPORT (RESEARCH)

State:	Alaska		
Cooperators:	Robert O. Stephenson (Arctic) and Loyal Johnson (South-central)		
Project Nos.:	W-17-4 & W-17-5	Project Title:	Big Game Investigations
Job No.:	14.3R	Job Title:	Characteristics of Exploited Wolf Populations
Job No.:	14.4R	Job Title:	The Spring and Summer Food Habits of Alaskan Wolves
Job No.:	14.5R	Job Title:	The Condition and Characteristics of Ungulate Prey Taken by Wolves
Job No.:	14.6R	Job Title:	Characteristics of Wolf Den Sites
Job No.:	14.7R	Job Title:	Radio Telemetry of Wolves in Northern Alaska
Period Covered:	July 1, 1971 to December 31, 1972		

SUMMARY

Estimates of wolf population density were made in the northcentral Brooks Range in the spring and fall of 1971 and in the fall of 1972. Our data suggest that density increased from 1 wolf/124 miles^2 in the spring of 1971 to 1 wolf/80 miles^2 in the fall of 1971. In the fall of 1972 density was estimated at 1 wolf/65 miles^2. This density falls in the mid-range of wolf densities reported elsewhere in North America (Mech, 1970).

Data obtained during a helicopter reconnaissance in the spring and fall of 1972 suggested that a minimum of 15 active dens were located in an area of 30,000 miles^2. Assuming that the average spacing of known dens (25 miles apart) held for the entire area, a maximum of 35 active dens (1 active den per 857 miles^2) could have been present in the area.

Observations in Southcentral Alaska indicate that the wolf population in the Nelchina Basin has undergone a significant reduction from its 1971 numbers.

The average weight of six 5-month-old pups taken in the fall of 1971 (from two litters) was 51.2 pounds compared to 61.4 pounds for nine pups taken in the fall of 1972 (from four litters). The pups from the 1972

litters were taken from two weeks to one month earlier than those in 1971, yet showed markedly greater deposits of subcutaneous and visceral fat. This suggests that there was a greater availability of prey during the summer and fall of 1972 than there was the previous year.

Resightings of tagged wolves, the 1971-72 hunter take of wolves around Anaktuvuk Pass, summer wolf observations, behavioral and morphological characteristics of wolves used by the Nanamuit Eskimo in ascertaining the sex and age of free-roaming wolves, and studies of wolf blood serum are discussed.

Results of studies on the ungulate prey of wolves in Southcentral Alaska during this period indicate that, at least during a severe winter, prey species are taken in proportion to the sex and age composition of that population, with the exception of young of the year. There appeared to be no difference between the nutritional well-being of adult moose killed by wolves and those killed by accident or illegally.

Criteria are provided by which it is usually possible to determine whether or not a prey animal was killed by wolves. Miscellaneous observations of wolf feeding habits are also presented.

CONTENTS

BACKGROUND

The background for wolf (*Canis lupus*) studies in Alaska has been discussed extensively in previous reports (cf: Rausch, 1966, 1967, 1969; Stephenson and Johnson, 1972) and will not be repeated here. The wolf is, by virtue of its intelligence, mobility, and low population density, one of the most difficult large mammals to study using classical methods. Quantitative data reflecting the long-term interrelationships between wolves and their ungulate prey, and the precise mechanisms through which wolf populations adjust to prey availability are only now being gathered, and it likely will be some time before we can understand the natural mechanisms through which wolf populations are controlled, and the effects that hunting by man have on wolf population dynamics.

Indications of a very low population of wolves on the North Slope in 1970 prompted the initiation of population monitoring and other studies of wolves in this area. Since that time the population has increased to a moderate level (about 1 wolf per 90 square miles) and in the next year emphasis in population studies will be shifted to the Interior.

The knowledge of the wolf possessed by the Nunamiut Eskimo comprises an unparalleled wealth of detailed information on this species, and efforts to recover more of this information and to incorporate Nunamiut as aides in future field investigations will be continued.

Primary emphasis of wolf studies in Southcentral Alaska has been directed toward wolf-prey relationships.

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

The objectives of work in the Arctic have been modified somewhat during the past year. The specific effort to characterize wolf den sites has been discontinued (as an isolated objective) due to the large number of dens visited in 1970 (Stephenson and Johnson, 1972). These dens, as related in the 1972 report, were located by Nunamiut Eskimos now living in Anaktuvuk Pass.

In the course of that work, and during subsequent visits to Anaktuvuk, it became apparent that the Nunamiut, due to some special circumstances, had developed a specific and accurate knowledge of the wolf. This led to a concerted effort to spend time with the Nunamiut studying wolves in order to learn their working knowledge of the wolf. This undertaking was the major objective during 1972. This work primarily involved on-the-ground travel and observation. Aircraft were used only briefly in the spring to locate active dens. Only a small number of wolf kills were examined and little further progress has been made in that aspect of the study.

Population estimates, based on both ground and aerial enumeration of wolves in the large area around Anaktuvuk Pass were made in spring and fall and are included in this report. Carcasses of wolves trapped by Nunamiut were collected and autopsied to obtain insight into the sex and age composition of the wolf population, food habits information, measurements for studies of sexual dimorphism, and measurements of nutritional status.

Seasonal estimates of the wolf population in the vicinity of Anaktuvuk Pass were made using track and wolf sightings made by Stephenson and about 15 Nunamiut hunters during travels with snowmachines. Wolf sightings made by reliable pilots were also used.

In the spring of 1972 known den sites were checked by helicopter for activity and attempts were made to locate newly occupied sites. This was done between 9 and 12 May, a period about one week earlier than desired since parturition usually occurs after 15 May at this latitude. However, wolves, and especially pregnant females, often visit prospective dens by late April and tend to remain progressively closer to the chosen den as parturition nears. Thus it is possible to obtain some idea of whether the den will be used by observing tracks, fresh diggings, and/or wolves.

Following the effort to locate natal dens, ground-based observations near Anaktuvuk were begun. The objectives of this work were to 1) obtain on-the-ground observations of undisturbed wolves during the summer denning period, and 2) provide a common basis of observed wolf behavioral phenomena, viewed both by an experienced Nunamiut hunter and by a trained biologist, and thus further our understanding of the behavioral and environmental parameters used by the Nunamiut hunter to evaluate and predict the activities of wolves. The approach consisted simply of attempting to find a wolf den with the method used by the Nunamiut during the wolf bounty years, observing the activities of wolves at the den, and recording the commentary of the Nunamiut regarding the behavioral events observed. One Nunamiut, Bob Ahgook, worked full time in this effort and another, Justis Mekiana, helped for a period of one week. For most of this work, a base camp was transported with a Coot ATV and established at an elevation a few hundred feet above valley floors at places providing the best possible field of view. Spotting scopes and binoculars were used to locate and observe wolves. Observations were recorded with a cassette recorder and later transcribed. This aspect of work began on 22 May and continued until 13 July.

In the latter part of the summer Stephenson participated in an experimental release of laboratory-reared wolves at Umiat. The wolves were released on 11 August after being transported from Barrow in a DC-3 aircraft. The release site was on the south bank of the Colville River opposite Umiat Mountain, which was used as a vantage point for observations during the ten days following the release. The results of this study are being published.

The months of September, October and the first half of November, 1972 were spent in the village of Anaktuvuk autopsying the carcasses of wolves trapped by the Nunamiut, obtaining wolf blood samples, accompanying trappers on their traplines to study trapping techniques and obtaining further data on the occupancy of wolf dens and anecdotal information concerning diverse aspects of wolf ecology based on Nunamiut experience. An estimate of wolf population density for this period is included in this report.

Certain Nunamiut hunters have shown a remarkable ability to ascertain the sex and to estimate the age of wolves observed at considerable distance, using correlated behavioral and morphological characteristics as indicators. Knowledge of this sort can aid greatly in future studies of wolves.

Other aspects of the Nunamiut hunters' sexing and aging criteria are treated in this report. Most of these are difficult to describe in exact terms and are set down here as tentative conclusions.

One aspect of sexual dimorphism, that of skull size, has been partly elucidated by Jolicoeur (1959), who found in a sample of 392 skulls that the skulls of male wolves averaged 4 percent larger in linear dimension than the skulls of females. To more completely describe this apparent difference in skull morphology a study of wolf skulls collected by R. A. Rausch, Alaska Department of Fish and Game, during wolf studies in the late 1960's was initiated. Mr. Sverre Pedersen, a student in wildlife management at the University of Alaska, is in the process of sorting the roughly 4000 skulls, of which 1861 have complete accompanying data including age as determined by cementum layers in canine teeth (Klevezal and Kleinenberg, 1969). Initially the skulls of 200 adults (equal numbers of each sex and age class) and 50 pups will be measured. Measurements of total length, condylobasal length, width at first molar, zygomatic width, interorbital width and rostrum height were chosed to reflect the size of each as a basis for examining sexual dimorphism of skulls.

The procedure used to locate wolf kills in Southcentral Alaska was the same as was used during 1971 (Stephenson and Johnson, 1972). Basically this consisted of flying the major river systems at low level in fixed-wing aircraft and either looking for kills directly or striking a fresh wolf trail and following it until a kill site was located. Kill sites were then visited if it were possible to land nearby. If fixed-wing aircraft could not land nearby, the kills were visited as soon as possible with snowmachine or helicopter. The latter method proved to be extremely useful.

Long bones, preferably femurs, were collected from skeletal remains to measure nutritional well-being of the animal, using the technique described by Neiland (1970). Age determinations of prey were based on examination of dentition.

Whenever possible kill sites were carefully examined in an attempt to determine the cause of death. Tracks at the scene of the kill were noted and the remains of the prey were examined. If only hair remained, moose (*Alces alces*) calves could be differentiated from adults on the basis of their short, fuzzy, grey hair.

FINDINGS (ARCTIC STUDIES)

Estimate of Population Density, Spring 1971

The wolf population on the North Slope reached an apparent low in

1969-70, caused by substantial aerial hunting, both legal and illegal. Thus data gathered during the spring of 1971 are meager. Nonduplicated sightings of wolves are summarized in Table 1, and the following constitutes a brief review of observations and pertinent commentary. Observations are numbered as in Table 1.

1. A pack of three wolves was seen in early March southwest of Anaktuvuk Pass in the Ekiakpuk River valley. One, a dark gray female weighing 90 pounds, was trapped on 8 March and appeared to be in excellent condition. Her left upper canine was broken; only 1/2 inch protruded from the gum. The uterus indicated she was in oestrus and exhibited five placental scars. The remaining two wolves of this pack were observed on 13 March sleeping at the 4000 foot level on a mountain north of Masu Creek. They remained at this spot, resting, from 1:00 p.m. until 4:30 p.m. at which time they rose and left. On 29 March they were observed ascending a 5000 foot peak north of Ekiakpuk. One animal was black and the other very dark gray. The second animal limped noticeably and examination of tracks revealed that its left hind foot had been lost, presumably in a trap.

2. Two wolves, a white male and a gray female, were sighted 20 miles northwest of Anaktuvuk at the headwaters of Tiglupuk Creek at 7:00 p.m. on 20 March. The female was shot by a local hunter the following day; 21 hours later and 20 air miles north of the first observation. This white male has frequented the area northwest of Anaktuvuk Pass since the spring of 1968 according to the Nunamiut, who have been able to identify him because of his distinctive pelage and evasive behavior. He was first observed in April, 1968 with an adult female and five pups of the previous year, near Natvakruak Lake. Four and possibly all of these pups were taken by Nunamiut that winter. In September, 1968 three pups were observed in the company of the white male and two of these, one gray and one almost white, were killed later that year. An adult female, thought to be the mate of the white male, was also taken in the fall of 1968. During the winter of 1968-69 and summer and fall of 1969 the white male was seen alone on several occasions. In the spring of 1970 he was seen with a gray female which was killed by a hunter who stated that it contained six fetuses. Then in March, 1971 another female was killed as related above. I examined this animal and found her to be pregnant (indicated by the color and tightness of her uterus) although the embryos were not as yet macroscopic. Her uterus also showed 10 placental scars from the previous year, indicating that she had bred. The apparent fact that a different gray female had mated with the white male in 1970 suggests that the female killed in 1971 associated with a wolf or wolves other than the white male in the previous year.

3. A pack of five wolves was observed at Chandler Lake on 23 March, 1971 and tracks observed at a later date indicated that as many as eight animals may have comprised this pack, which also frequented the Okokmilaga drainage to the west of Chandler Lake.

4. Also on 23 March the fresh tracks of two wolves were seen immediately north of Anaktuvuk Pass.

Table 1. Summary of nonduplicated sightings of wolves in spring, 1971, within 3600 square mile area around Anaktuvuk Pass. Observation numbers coincide with description of observations in text.

Obs. No.	Date	Location	Total Number	Black	Gray	White	Pups	Adults	Remarks
1.	9 March	Ekiakpuk R.	3	2	1		0	3	
2.	20 March	Tiglupuk Ck.	2		1	1	0	2	
3.	23 March	Chandler L.	8	2	3				Only five observed.
4.	23 March	Anaktuvuk Pass	2						Tracks only.
5.	23 March	Inukpasugruk Creek	1	1					
6.	23 March	Publituk Cr.	7						Tracks only.
7.	25 March	North Fork Koyukuk R.	6						Tracks only.
8.	25 March	Sagwon	4		4	0			
9.	25 March	Chandler R.	3	0	3	0			
10.	25 March	Chandler R.	3	0	3	0			
		Totals	39	5	15	1	-		Density 1 wolf per 124 square miles average pack size of 4.
	Average Pack Size for Anaktuvuk Pass area only (excluding obs. #8, 9 and 10)		3.9 29 4.0	5	5	1			

5. A single black wolf was seen on three occasions; on 21 March south of the Anaktuvuk River, on 23 March at the mouth of Inukpasugruk Creek, and on 18 May near Anivik Creek.

6. The tracks of a pack of seven wolves were observed at Publituk Creek on 23 March.

7. The tracks of a pack of six wolves were observed on 25 March along Ernie Creek at the head of the North Fork of the Koyukuk River.

8. On 25 March, 1971 during aerial reconnaissance of the Sagavanirktok and Chandler river areas, 10 wolves were seen. Four of these, all gray, were observed at 8:00 a.m. 1 mile south of Sagwon. When first sighted the four wolves were scattered around a cow and calf moose. Judging from the large area of trampled snow around the moose they had been under siege for one-half hour or more, but neither moose showed any sign of being injured. Ten minutes later we returned to find that the wolves had left and the moose had moved off a short distance.

9. & 10. Two groups of three wolves each were sighted on the lower Chandler River on 25 March. All were gray.

The data gathered during spring ground reconnaissance in the 3600 square mile area around Anaktuvuk Pass indicate that about 29 wolves (excludes observation numbers 8, 9 and 10) inhabited the area with an average pack size of four. The gray:black ratio from these limited data was approximately 100:30. The density suggested by these figures is 1 wolf per 124 square miles.

Estimate of Population Density, Fall 1971

Nonduplicated sightings of wolves in the northcentral Brooks Range during the fall of 1971 are summarized in Table 2. To avoid confusion the numbering of observations has been continued from Table 1. These data suggested an increase in wolf numbers since the spring of 1971, probably the result of normal production of young. A brief review of observations with pertinent commentary follows.

11. On 17 October, eight wolves were seen by a Nunamiut hunter as they rested at the base of a mountain between the Ekiakpuk and John rivers. The hunter, Jack Ahgook, howled three times from a distance of 2 miles and the wolves got up and headed toward him in single file, coming to within 1 mile before the hunt was spoiled by a low-flying aircraft. Mr. Ahgook stated two of the wolves were adults; one being a large black and the other a dark gray animal. He felt the remaining six were pups (3 gray, 3 black). On 18 October I saw this same pack of wolves 12 miles west on the Ekiakpuk River but only seven were observed, one black animal being missing. This same pack was seen on 1 November near the headwaters of Kollutarak Creek, 10 air miles north of the previous sightings. The Nunamiut who made this sighting stalked to within about 300 yards of the wolves, which were resting, before being discovered by what he said was the adult female in the group, a dark gray wolf exhibiting a pronounced limp, favoring her left hind leg. He stated that the other adult in

Table 2. Summary of nonduplicated sightings of wolves in fall, 1971, northcentral Brooks Range. Observation numbers coincide with descriptions of observations in text.

Obs. No.	Date	Location	Total Number	Black	Gray	White	Pups	Adults	Remarks
11.	17 October	Ekiakpuk R.	8	4	4	0	6	2	
12.	12 September	Anaktuvuk R.	7	1	2	4	4	3	
13.	20 October	Gunsight Mt. John R.	11	5	6	0			
14.	20 October	Hunt Fork	10						Tracks only.
15.	18 October	Ernie Ck. North Fork	3	0	3	0	3	0	
16.	25 October	Graylime Ck. Anaktuvuk R.	6	0	6	0			
17.	25 October	Galbraith L.	9						
18.	25 October	30 Mi. S. of Sagwon	5	0	5	0			
19.	25 October	5 Mi. E. of Sagwon	14						
20.	9 October	Kanayut R. Anaktuvuk R.	3	0	3	0			
21.	14 October	Okokmilaga R.	7	4	3	0			
22.	14 October	Colville R.	8	0	8	0			
23.	6 November	Suluak Ck.	6	0	6	0			

Table 2. (cont'd.)

Obs. No.	Date	Location	Total Number	Black	Gray	White	Pups	Adults	Remarks
24.	6 November	Okokmilaga R.	5	5	0	0	5?		
25.	6 November	Inukpasugruk River	2	2	0	0			
26.	31 October	Anaktuvuk R.	6						Tracks only.
		Totals	104	21	46	4			
	Average Pack Size		6.5						

this pack was a large black male. His description fits perfectly the two wolves observed in the Ekiakpuk valley on 29 March, 1971 (see above). It appears that this "three-legged" female bred and successfully raised six pups in 1971. She bred in 1972 as well but I was not able to determine how many pups she had, other than one which was seen in early June. The Nunamiut know of only one other instance in which a "three-legged" female had successfully reared pups.

A den that had been cleaned out, apparently in readiness for parturition, was discovered on 17 May, 1971 in the Kollutarak valley and tracks of two wolves were seen in the vicinity. A few days prior to the discovery of the den two Nunamiut hunters reported that two wolves had howled and barked at them for more than an hour as they traveled on the river ice nearby. The wolves were high on a mountain 1 mile north of the den site and the Nunamiut stated that the presence of humans in the vicinity of the prospective den had been the cause of the howling and barking. The den was not used, perhaps because of human interference. In view of the observations noted above another den was probably used.

12. Also in 1971, an active den was probably present somewhere near the headwaters of the Anaktuvuk River, since two adults and at least five pups were seen on three occasions in August and September at a rendezvous site in the Anaktuvuk River valley north of Rumbling Mountain. This group consisted of at least seven wolves, including four nearly white animals (one of which was an adult male), at least one black wolf, and two gray wolves (one of which was an adult female). This pack was seen during October in both the Anaktuvuk and Inukpuk drainages. The probable area of the den lies from 20 to 30 miles east of Kollutarak Creek, where the previously mentioned pack was thought to have denned.

13. A pack of 11 wolves (5 black, 6 gray) was seen on 20 October at a caribou (*Rangifer tarandus*) kill on the John River at Gunsight Mountain, 70 miles south of Anaktuvuk.

14. Tracks observed during the same period of time showed that a pack numbering about ten frequented the Hunt Fork area midway between the Ekiakpuk River and Gunsight Mountain.

15. On 18 October, three gray wolves, all pups, were seen west of Ernie Creek on the North Fork of the Koyukuk River.

16. A week later a pack of six gray wolves was seen 20 miles north of the above location, on the Anaktuvuk River. These two sightings were very likely of wolves belonging to the same pack.

17. On 25 October nine wolves were seen 1 mile north of Galbraith Lake, feeding on a caribou carcass. The observer, a pilot, noticed only that the majority were gray.

18. On the same day five gray wolves were seen 30 miles south of Sagwon.

19. Also on the same day 14 wolves were seen 5 miles east of Sagwon.

20. On the northern and western portion of the study area three gray wolves were seen on 9 October at the confluence of the Anaktuvuk and Kanayut rivers.

21. On 14 October seven wolves (4 black, 3 gray) were seen at the mouth of the Okomilaga River.

22. On the same day, one-half hour later, eight gray wolves were seen at a moose kill on the Colville River about 25 miles from the group of seven.

23. On 6 November six gray wolves were seen on Suluak Creek in the Killik drainage, near the remains of a caribou.

24. Five black wolves were sighted on the Okokmilaga River 12 miles northeast of the six grays. The black wolves were judged to be pups.

25. On 6 November two black wolves were seen in the Inukpusugruk River valley about three miles southeast of Anaktuvuk Pass.

26. The tracks of six wolves were seen on 31 October, 5 miles north of Anaktuvuk and indicating that these wolves had come from the north. Three of them, all pups, were trapped by a Nunamiut within two days.

The area north of the mountains and west of the Anaktuvuk River was not covered by aerial or ground reconnaissance during the fall of 1971. It is probable that the large white male wolf that has frequented this area since at least 1968 was still there since he was seen during the summer of 1971 and in 1972 on several occasions. Also, the Chandler Lake area was not covered. For the purpose of population estimation I have assumed that six wolves were present in this area.

The nonduplicate sightings of wolves within the 3600 square mile area total 39 animals (includes observation numbers 11, 12, 14, 16 and 26 of 8, 7, 10, 6, 6 and 2 wolves, respectively). The six wolves assumed to be in the area not covered brings the total to 45, suggesting a density of 1 wolf per 80 square miles.

The average pack size for the 16 sightings listed in Table 2 is 6.5 (104 wolves total; duplicate sightings excluded). These data suggest a gray:black ratio of 100:40 (white wolves included with grays).

The density of 1 wolf per 80 square miles is roughly 50 percent greater than the density of 1 wolf per 124 square miles estimated for the spring of 1971. Average pack size showed a slightly greater relative increase over the same period. Certain variables, however, make the strict comparison of average pack size from spring data with that of fall data difficult. Pack cohesiveness is likely to be less in spring due to breeding activity and because pups are older and probably have a greater tendency to spend time away from adults in the pack. Another factor tending to decrease average "pack" size during spring is natural

winter mortality to both pups and adults. In the vicinity of Anaktuvuk Pass trapping and hunting increase the disparity likely in a comparison of spring and fall average pack sizes. Seasonal movements discussed below could also have an important affect on both population estimates and average pack sizes.

A 50 percent increase in numbers from spring to fall is within the annual reproductive capability of wolves (Mech, 1970; Rausch, 1967). Data from the 1971-72 harvest of wolves (discussed below) in the area suggest that at least 50 percent of the fall 1971 population was pups, again indicating a spring to fall increase approximating 50 percent.

Harvest of Wolves, Anaktuvuk Pass, 1971-72

During the winter of 1971-72 residents of Anaktuvuk Pass trapped 36 wolves, including 19 pups, six adults and eight for which the age was not recorded. Of the known-age animals, 21 percent were older than one year and 79 percent younger than one year. Young wolves are much more liable to be trapped than are older animals, thus biasing the sample of trapped animals in favor of pups. Data from pack observations in the fall do, however, support the apparent preponderance of pups in the sample, and it seems safe to assume that at least 50 percent of the wolves in the vicinity of Anaktuvuk during the winter of 1971-72 were less than one year of age. A relatively high proportion of pups is characteristic of an exploited and/or growing population (Rausch, 1967; Mech, 1970).

The 1971-72 harvest included seven females (all pups) 19 males (all trapped adults (n=6) were males) and 10 for which the sex was not recorded.

Estimate of Population Density, Fall 1972

Nonduplicate sightings of wolves in the northcentral Brooks Range during the fall of 1972 are summarized in Table 3. The numbering of observations has been continued from Table 2.

27. On 7 August four gray pups were sighted north of the Anaktuvuk River.

28. On 2 September six pups, five white and one gray, were seen 2 miles south of this location. At least one of these groups, and perhaps both, were likely offspring of the adult wolves we observed in the area for several days in late June and July.

29. A group of Nunamiut saw a group of pups numbering at least six 25 miles northwest of Anaktuvuk on Tiglupuk Creek in early September. At least three were black. At least two adult wolves (1 black and 1 gray) were seen in the area as well.

30. The only positive sign of the other denning group observed in the Kollutarak River valley, 15 miles to the southwest, was the trail of four adult wolves observed on 10 October along the Kollutarak River, one being the three-legged female observed in June of 1972 at a den in the

Table 3. Summary of nonduplicated sightings of wolves in fall, 1972, northcentral Brooks Range. Observation numbers coincide with descriptions of observations in text.

Obs. No.	Date	Location	Total Number	Black	Gray	White	Pups	Adults	Remarks
27.	7 August	Anaktuvuk R.	4		4		4		
28.	2 September	Anaktuvuk R.	6		1	5			Two miles from obs. no. 27.
29.	c. 5 September	Tiglupuk Ck.	8	4	4		6	2	
30.	10 October	Kollutyak R.	4	1	1			4	
31.	11 September	Anaktuvuk Pass	8		8				
32.	17 September	Anivik Ck.	1	1				1	
33.	21 September	Inukpasugruk Creek	1		1			1	
34.	6 October	Makuktuk L.	8		8		6	2	
35.	17 October	Chandler L	6		6		6		
36.	30 October	Publituk Ck.	9	5	4		5	4	
37.	27 August	May Creek	6		6		5?	1?	
38.	1 November	Okokmilaga R.	8	4	4				
		Totals	69	15	47	5	32	15	

Table 3. (cont'd.)

Average pack size excluding observations 32 and 33 = 6.5
Gray:black ratio = 100:30
55 wolves obs. in 3600 square mile area
1/65 square miles

Kollutarak Valley.

31. A pack of eight gray wolves was seen on 11 September 2 miles northeast of the village. The Nunamiut who observed these wolves could not distinguish pups from older animals due to fog and poor light.

32. On 17 September two Nunamiut watched a black wolf "ambush" and pursue four caribou at Anivik, 6 miles north of Anaktuvuk. The caribou escaped after a chase of 1 1/2 miles through snow 2 to 3 feet deep.

33. An adult male gray wolf was shot on 21 September, 3 miles east of Anaktuvuk while it was chasing a cow caribou.

34. A pack of eight gray wolves was seen on 6 October at Makuktuk Lake 16 miles north of Anaktuvuk. A Nunamiut killed four of them, all of which were pups.

35. On 17 October six wolves were seen on the west side of Chandler Lake. Two Nunamiut killed four, all pups, and stated that the remaining two were pups as well and that the adults were probably away hunting.

36. On 30 October three Nunamiut, Stephenson and Richard Bishop (ADF&G) watched five black and four gray wolves at Publituk, on the east side of the John River 25 miles south of Anaktuvuk Pass. On the basis of size and behavior, five were judged to be pups of the year, the remaining four being juveniles and/or adults. Three pups were black and two were gray; of the adults, two were black and two were gray.

Sightings outside the 3600 square mile study area included the following:

37. On 27 August, at the headwaters of May Creek 60 miles northeast of Anaktuvuk, Bob LeResche (ADF&G) and Stephenson observed six light tawny-colored wolves. One, probably an adult, was seen 1 1/2 miles southwest of the others, within 300 yards of five bull caribou. When first seen the wolf was located in some willows along a small creek downwind from the caribou, perhaps indicating that it had been hunting the caribou when disturbed. The other five wolves were sighted near a small patch of willow growth surrounding some small pools of water on otherwise dry tussock tundra. All five were pups, judging by their size, pelage, and behavior. It seems probable that they had been left at a temporary rendezvous site while the adults were hunting.

38. On 1 November a pack of eight wolves, four black and four gray, were seen in the Okokmilaga Valley.

The nonduplicated sightings of wolves within the 3600 square mile area around Anaktuvuk Pass (excludes observation numbers 37 and 38) total 55, suggesting a minimum density of 1 wolf per 65 square miles. The average pack size for 10 sightings of wolves in groups of two or more (excludes observation numbers 32 and 33 of one wolf) was 6.5. The gray: black ratio for the 69 wolves observed was 100:30. Population estimates and other data are summarized in Table 4.

Table 4. Summary of wolf densities estimated for the northcentral Brooks Range, 1971 and 1972.

Season and Year	No. Wolves Enumerated	Area (sq. mi.)	Density in sq. mi. per wolf	Average Pack Size	Gray:black Ratio
Spring, 1971	29	3,600	1 wolf/124 sq. mi.	4.0	100:30
Fall, 1971	45	3,600	1 wolf/80 sq.-mi.	6.5	100:40
Fall, 1972	315	30,000	1 wolf/95 sq. mi.	Estimated from the occurrence of active dens.	
Fall, 1972	55	3,600	1 wolf/65 sq. mi.	6.5	100:30

Occurrence of Active Dens, 1972

Circumstances prevented making a spring 1972 population estimate comparable to those made in previous seasons. As mentioned earlier, however, a check of known dens was carried out with a helicopter in May. During this time seven dens that showed signs of impending use or were already being used were located. Of these seven dens, later checks of five indicated that they were used as natal dens. A visit to one of the remaining two in late Ausugt revealed that the den had been used at most only briefly prior to weaning, although an abundance of fresh tracks and diggings were observed from the air on 5 May. I was not able to determine the extent of activity at one of the seven dens.

In addition to the seven dens located, the probable locations of eight other potential active dens were deduced from the occurrence and behavior of adult wolves prior to and during the denning season, and from the occurrence of packs including pups in early fall, as reported by various reliable observers and from my own fieldwork during the summer and fall.

The area in which these dens occurred extends roughly from the headwaters of the Alatna River in the west to the headwaters of the Sagavanirktok River in the east, and from Gunsight Mountain (Chandler River) on the north to Wiseman in the south. There is very little information in the literature on wolves regarding the minimum and average distances between wolf dens. In the information gathered from the Nunamiut Eskimos on the occurrence of active dens over the past 30 years in the northcentral Brooks Range (Stephenson and Johnson, 1972) the shortest air mile distance between dens was 14 miles. There were a few instances of active dens being located 20 air miles apart and in the majority of cases distances were 25 more miles. These data suggest an average minimum distance of roughly 25 air miles between active dens, and observations during the past two years support this figure. Allowing 25 miles beyond the dens furthest north, south, east and west, a rectangle 30,000 square miles in area (150 x 200 miles) encompasses known dens. At a minimum there were 15 active dens in this area. Assuming that dens were evenly distributed at 25 mile intervals in the area there would have been a maximum of 35 active dens or roughly 1 den per 857 square miles.

The mean litter size for 43 litters observed in June and July, primarily by the Nunamiut, in the northcentral Brooks was 5.3 (Stephenson and Johnson, 1972). The fall observations summarized in Tables 2 and 3 include nine sightings of pups totaling 46 (groups of 6, 3, 5, 4, 6, 6, 6, 5 and 5) for an average of 5.0.

The number of adults observed at dens and with packs during winter varies widely in this area, with from one to eight being seen at any given time. For the purposes of this report, I will assume that four adults (includes yearlings) were associated with each den. Assuming that an average of five pups in each litter survived until early fall and that an average of four adults was associated with each of the 35 active dens, a total fall population of 315 wolves is indicated for the 30,000 square mile area. This is equivalent to 1 wolf per 95 square

miles, a lower density than that estimated from fall observations in the area around Anaktuvuk.

Discussion

The data summarized in Table 4 suggest that the number of wolves in the 3600 square mile area around Anaktuvuk Pass approximately doubled during a one and one-half year period, from spring 1971 to fall 1972. The initial population was very low for the area according to residents; the estimated density falls at the lower end of the range of densities reported elsewhere in North America while the density estimated for the fall of 1972 falls at mid-range.

The fact that the hypothetical density estimated from the occurrence of active dens is lower than that derived from sightings of wolves made in either 1971 or 1972 might suggest that the former estimate was too low and that there were actually more than 35 active dens in the 30,000 square mile area. Alternatively, it could mean that the estimates based on sightings around Anaktuvuk Pass are too high. Because the sightings were made over a period of about two months and because the boundaries of the 3600 square mile study area are arbitrary (that is, they do not conform to any natural boundaries to wolf movements or territories), I consider the latter possibility to be the most likely.

The gray:black ratios given in Table 4 support the prevailing notion that the proportion of gray animals generally is higher on the North Slope than in more southerly areas of Alaska. Johnson (Stephenson and Johnson, 1972) reported that the gray:black ratio in the Nelchina Basin in 1971 was 100:87 (n=232). Rausch and Winters (1964) reported gray: black ratios of 100:225, 100:100, and 100:61 in the years 1961, 1962 and 1963, respectively, in the Nelchina Basin and Rausch (1966) reported a gray:black ratio of 100:133 in 1965 in this same area.

For several reasons I doubt that the population estimates in Table 4 are representative of the North Slope in general but rather are higher than wolf densities further north. As a rule, the northern mountains and foothills of the Brooks Range offer substantially greater food resources in winter than does the coastal plain, and though wolves occur over the entire area, sightings are notably rare in the more northern areas. The winter distribution of wolves on the coastal plain is almost certainly governed by the occurrence of overwintering caribou which is sporadic, with large areas being devoid of ungulate prey for months at a time. Moose are rarely found on the coastal plain. During the winter of 1969-70 roughly 200 caribou wintered near Beechey Point (Gavin, pers. comm.) and on two occasions a pack of wolves was sighted in this area. On 12 November, 1969 Department biologist Jack Lentfer saw nine wolves (7 gray, 2 black) on Leavitt Island which lies 4 miles offshore near the Colville River Delta. On 2 May, 1970 British Petroleum employee Angus Gavin observed eight wolves (6 gray, 2 black) at Beechey Point, 13 miles east of Leavitt Island, feeding on a freshly-killed caribou. This was very likely the pack seen earlier by Lentfer and suggests that this pack wintered along the coast because of the availability of caribou.

Several Nunamiut hunters have stated that a southward movement of the wolf population occurs in winter. In former years these hunters ranged over much of the North Slope and have considerable basis for making this statement. Wolves den on the coastal plain but subjective information obtained from old, experienced Eskimos in both Barrow and Anaktuvuk indicates that dens are much rarer than in the more southerly, mountainous areas. It seems reasonable to expect that the generally lower availability of prey on the coastal plain during winter causes a southward movement of wolves, with a few packs lingering in the vicinity of wintering caribou. The Nunamiut state they notice wolf numbers are relatively greater in winter than during summer in the mountains, and since they are often familiar with local individuals they notice an influx of wolves with which they are not familiar. The data from the Anaktuvuk Pass area could probably be considered at least roughly representative of the northern Brooks Range but lower densities would be expected in the foothills and on the coastal plain. The Colville River area, however, probably also supports a relatively high wolf population because of its resident moose herd. According to Nunamiut who hunted there, prior to the 1940's, when moose apparently first became fairly numerous on the North Slope, wolves were rare in the Umiat area. In fact, the Nunamiut state that wolves were rare over most of the North Slope during the early 1900's, becoming relatively abundant only during the last two or three decades.

The fact that the 1971-72 harvest of wolves (36) by Anaktuvuk residents is nearly equal to the estimated total fall population (45) in the area where trapping occurred is an indication of the instability of winter home range among wolves in this area. The movement of wolves over the course of the winter is such that many wolves in addition to those present at the end of breeding season pass through the area. Despite the heavy trapping and hunting pressure exerted in the area by residents of Anaktuvuk the occurrence of active dens and the number of wolves frequenting the area are comparable to adjacent areas with similar habitat. This suggests that a breeding population of "trap smart" adult wolves, less vulnerable to human-caused mortality than pups or "transient" wolves, exists in the area. This is something the Nunamiut have long recognized and it probably constitutes a fairly important compensatory mechanism acting to maintain the reproductive capability of wolves in the area.

Fairly stable winter range boundaries are reported for wolves at more southerly latitudes (cf: Mech, 1970), however, a pack of 10 monitored for 45 days by Burkholder (1959) in Southcentral Alaska moved across an area measuring 100 by 50 miles and was still using new areas at the end of the study period. The fact that the wolf population was estimated to be 120 animals or roughly 1 wolf per 130 square miles (approximately one-fourth the density of 1 wolf per 35 square miles estimated for the same area seven years later (Rausch, 1969)) suggests that contact with other packs would have been at a minumum thus allowing the relatively extensive movement reported.

In the northern Brooks Range, wolves apparently do not remain in a limited area and may move substantial distances. The situation on the

North Slope is, to a degree, similar to that described by Kelsall (1968) in the Northwest Territories, where wolves may move 100 to 200 miles south of their denning areas during winter in response to the southward movement of caribou. The effect of the prevailing scarcity of caribou on the North Slope in most winters is, however, lessened by the presence of moose, notably along the Colville and Chandler rivers, and Dall sheep (*Ovis dalli*) in the mountains.

Caribou were notably scarce in the northern Brooks Range during the winter of 1971-72, and this scarcity likely caused extensive movements by wolves. The general distribution of wolves in the fall of 1971 (described earlier) held until midwinter, when a southward movement of wolves evidently occurred. Some caribou wintered in the area south of Hunt Fork, and it is probable that wolves in the vicinity of Anaktuvuk moved south in response to prey scarcity. Nunamiut trappers reported that most wolves had moved out of the area around Anaktuvuk during February and March, returning in April as a few caribou moved northward into the area. Food scarcity is also suggested by the fact that five wolves and two wolverines (*Gulo gulo*) were killed in traps by wolves. Four of the wolves, all pups, were partly eaten, while one, an adult male, was killed but not eaten. One wolverine was eaten in the trap, the other was carried away.

In his review of the current knowledge of wolves, Mech (1970) discounts reports of the cannibalism of trapped wolves. There is, however, no doubt that Alaskan wolves may sometimes kill and eat a trapped member of their pack (Rausch, 1967). In at least two of the examples mentioned above there was no doubt that the wolf was killed and eaten by members of the pack with which it was traveling when trapped. In these instances tracks indicated that only one group of wolves, traveling together, had approached and then left the trap site. One likely explanation for trapped wolves being killed may be that, as in dogs, injured or frightened individuals acting strangely, emitting distress vocalizations, and perhaps snapping at other animals nearby are sometimes set upon and killed by other animals. This is not uncommon among sled dogs and probably occurs among wolves as well.

Evidence of fatal conflict among free-ranging wolves has also been seen by Nunamiut hunters, but its occurrence seems to be restricted to periods of relatively high population density. For instance, during the winter of 1942-43 wolf numbers were unusually high in the upper Killik River area. Two Nunamiut who trapped and hunted there during March and April caught a total of 43 wolves. One of these men reported that there was a great deal of fighting among wolves and that he found the remains of four wolves that had been killed and eaten by other wolves. He added that the tracks at these places indicated that the animals killed were either alone or in groups of two or three when they were confronted and pursued by a larger pack. Similar incidents have been observed by other Nunamiut in other years of high population and these will be reported elsewhere.

In March, 1972 an aerial hunter found a female gray wolf that had been severely injured by other wolves. She was found at the headwaters

of the Kobuk River, alive but unable to walk. Tracks indicated that approximately seven wolves had been involved and, according to the hunter, tracks indicated that the conflict occurred within the pack as they were traveling on a waterway. I was able to examine the skin of this animal a few weeks after the incident and found several puncture wounds around the neck and shoulders. The skin over much of this area was severely bruised. Positive determination of age was not possible but the size of the hide and development of claws suggested that the animals was at least 2 years old.

In February, 1972 another aerial hunter reported finding the remains of a large male wolf near Circle which had been eaten by wolves but I have not yet been able to obtain details of this incident.

The point here is to establish that fatal conflict and/or cannibalism is not uncommon among wolves during high populations, or when animals are trapped or snared.

Fall Condition of Pups

In the fall of 1971 and again in 1972 the carcasses of wolves trapped or shot by Nunamiut during October and November were examined and routine data and measurements were taken. This information included determination of sex; age; color; weight; body length; tail length; shoulder height; distance from sternum to bottom of heel pad; depth of subcutaneous fat on the midline of the rump, back, sternum and the flanks; and the distribution of visceral fat. Pertinent data from pups are given in Table 5.

The average weights of the pups examined in 1971 (n=6, from two litters) and 1972 (n=9, from four litters) were 51.3 and 61.4 pounds, respectively. None of the six pups from the two 1971 litters showed any subcutaneous fat and, compared to the 1972 pups, these animals had much smaller deposits of visceral fat. The fact that the pups examined in 1972 may have been from two weeks to one month younger and certainly were not any older than those examined in 1971 yet averaged 10 pounds heavier indicates that prey availability in the vicinity of Anaktuvuk was more limited in 1971 than in 1972. The Nunamiut hunters stated that the 1971 pups were unusually "skinny"; the 1972 pups were regarded by them as of average size, weight and condition for the area and season. They suggested that caribou may have been more scarce than usual during the summer of 1971 and accounted for the lean condition of the pups on this basis. Other factors that might account for these differences are variations in availability of migrating caribou in the fall and of small mammals through the summer. In the fall of 1971 only a few hundred caribou migrated through Anaktuvuk Pass but in 1972 in excess of 3,000 used this pass on their southward migration.

Microtine rodents were more abundant in 1972 than in either of the previous two summers, further suggesting generally greater prey availability in 1972.

Table 5. Weights and measurements of wolf pups trapped in the vicinity of Anaktuvuk Pass during October and November, 1971 and 1972. Sibling groups are separated by double spacing.

Accession Number	Date	Location	Age[1]	Original Number in Pack	Wt. lbs.	Color	Sex	Body[2] Length (in.)	Tail[3] Length (in.)	Sternum to Ground (in.)	Shoulder Height (in.)	Depth of Rump Fat (in.)
					1971							
61039	1 Nov.	Cache L.	5 mo.	C.8	50	gy	F	36.0 s.l.	14.0	15.0	22.0	0.00
61040	1 Nov.	Cache L.	5 mo.	C.8	44	gy	M	37.0 s.l.	15.0	17.0	24.0	0.00
61041	1 Nov.	Cache L.	5 mo.	C.8	50	gy	F	35.0 s.l.	13.5	15.5	23.0	0.00
61042	3 Nov.	Fan Mt.	5 mo.	C.8	53	gy	F	36.0 s.l.	16.5	15.0	24.0	0.00
61043	26 Oct.	Anaktuvuk River	5 mo.	C.7	55	wht	F		13.5	15.0	23.0	0.00
61044	28 Oct.	Inukpuk River	5 mo.	C.7	56	wht	M		15.5	17.0	26.0	0.00
				Averages	51.3			36.0 s.l.	14.6	15.7	23.6	0.00
					1972							
61066	6 Oct.	Makuktuk Lake	4 mo.	C.8	66	gy	M	42.0 c.		17.0	25.0	0.12
61067	6 Oct.	Makuktuk Lake	4 mo.	C.8	70	gy	M	42.0 c.		17.0	25.5	0.25
61068	6 Oct.	Makuktuk Lake	4 mo.	C.8	62	gy	M	42.0 c.		16.0	25.0	0.18
61069	6 Oct.	Makuktuk Lake	4 mo.	C.8	66	gy	M	42.0 c.		17.0	26.0	0.18

Table 5. (cont'd.)

Accession Number	Date	Location	Age[1]	Original Number in Pack	Wt. lbs.	Color	Sex	Body[2] Length (in.)	Tail[3] Length (in.)	Sternum to Ground (in.)	Shoulder Height (in.)	Depth of Rump Fat (in.)
61071	18 Oct.	Chandler Lake	4.5 mo.	C.6		gy	M	41.0 c.		16.0	23.5	0.05
61072	18 Oct.	Chandler Lake	4.5 mo.	C.6	65	gy	M	42.0 c.		16.5	24.5	0.12
61073	18 Oct.	Chandler Lake	4.5 mo.	C.6	59	gy	F	43.0 c.		16.0	23.0	0.18
61074	18 Oct.	Chandler Lake	4.5 mo.	C.6	60	gy	M	42.0 c.		16.0	23.0	0.05
61075	4 Nov.	Publituk	5 mo.	C.9	45	bk	F	38.5 c.	15	16.0	25.0	0.00
61078	9 Nov.	Anaktuvuk River	5 mo.	C.9	60	gy	F					0.25
				Averages	61.4			41.6 c.		16.4	24.5	0.14

[1]Assuming June 1 as birth date. Actual date could be one or two weeks earlier.
[2]Tip of nose to base of tail. c.=contour, s.l.=straight line.
[3]After skinning.

These data also suggest that pups in the 1972 litters were slightly taller and longer than pups in the 1971 litters. The difference of 10 pounds in average weight is probably due in large part, however, to the heavier fat deposits on the 1972 pups.

The left hind leg of one of the male pups (#61074) from Chandler Lake had been broken perhaps two months earlier. The fracture extended through the middle of both tibia and fibula and, although healed, this portion of the leg was twisted and slightly crooked. As a result of calcium deposition the healed area was roughly twice the diameter of the bone above and below it. The hunter who killed the wolf stated that it limped and was able to run at only about two-thirds the speed of the other three pups that were pursued. This pup was the only one of the four that retained both deciduous upper canines, suggesting that healing the broken leg had delayed the transition from deciduous to permanent dentition.

On the other hand pups from the 1971 litters had shed all of their deciduous teeth in spite of their relatively "poorer" nutritional status compared to pups in the 1972 litters which still possessed varying numbers of deciduous premolars. It appears that the lower nutritional status of the 1971 litters was not sufficient to slow the development of permanent dentition.

Resightings of Tagged Wolves

In an effort to assess the feasibility of using immobilization and tagging as a tool in studying wolf populations, two adult male wolves were immobilized and ear-tagged in April and May of 1971. One pregnant female was partially immobilized but not tagged.

A gray-brown male wolf, estimated to be 2 or 3 years old, was tagged on 16 April, 1971 on the John River at Gunsight Mountain. This animal was killed by an aerial hunter on 31 December, 1971, 8 1/2 months after being tagged, about 2 miles from Bettles and 44 air miles south of the place it was tagged.

The other male, also gray-brown and estimated to be 2 years old, was tagged on 10 May, 1971 near Galbraith Lake. He and the white female that was with him at the time of tagging were seen on several occasions in April and May, 1972 by core-sample drilling crews in the Atigun Valley south of Galbraith Lake, and from 4 to 12 miles from the site at which they were immobilized. Accompanying them were two other wolves, a black and a gray.

The occurrence of the gray-brown male 44 miles south of where it was tagged on the John River could indicate that it and others in its pack (it was traveling with five other wolves when taken) had moved south during the midwinter period to caribou overwintering areas. The Bettles area could, however, have been a routinely visited part of the pack's range.

Resighting the gray-brown male and white female very near the site

of tagging one year after they were tagged suggests that they either remained there during the winter or at least returned there for the summer denning period. The white female was pregnant when immobilized in 1971 and almost certainly reared a litter of pups in this area during that year. The fact that she was in the same area in April and May, 1972 strongly suggests that, if pregnant, she denned in the same area.

Summer Wolf Behavior Observations

Between 22 May and 13 July, 1972 we observed various wolves associated with two dens for a total of roughly 150 hours. During this period diverse behavioral phenomena, including one successful and one unsuccessful chase of caribou, were observed. In one sense the effort fell short of its goal since we were not able to observe the behavior of pups at a den. The effort was very successful, however, in providing an opportunity to witness two Nunamiut hunters using their knowledge of wolf behavior to explain and predict the behavior of free-roaming wolves, and in allowing me to obtain firsthand observations of wolves during summer.

The food procuring activities of juvenile and adult wolves associated with two dens were observed. Caribou were rare in the vicinity of these dens following the first week of June, and wolves spent a good share of their time in June and early July hunting small mammals and birds and their eggs, and scavenging on carcasses of ungulates killed by wolves earlier in the year or by Nunamiut hunters.

Detailed observations from the summer work will be reported in the future in combination with observations from subsequent summers.

Release of Pen-reared Wolves

During August, 1972 Stephenson cooperated in the release of five 2-year-old wolves raised at NARL, Barrow. This study was undertaken primarily to learn something about the role of learning in the development of prey killing, hunting and reproductive and social behavior of wolves. The five wolves consisted of two black females, a gray-tan female and two gray-tan males. Three litters were represented. The wolves has been placed together at the end of March 4 1/2 months prior to the release. Since birth all had been kept with various numbers of other wolves in outdoor cages measuring approximately 14 feet by 36 feet (4m x 12m).

Collaborators included Robert E. Henshaw, Pennsylvania State University; Richard Shideler, Washington University; and Randall Lockwood, Washington University. All of these people were involved in ongoing research with wolves at the NARL colony.

On 11 August the wolves were immobilized with Sernylan, tranquilized with Promazine, and flown to Umiat in a NARL DC-3. Upon arrival they were transported 2 miles down the Colville River in a riverboat and placed in a holding pen on the south side of the river where they were held until they had recovered from drugs used in transit. A frozen bull caribou was placed 30 yards from the cage to serve as food for a few

days while the wolves became oriented.

For two weeks observations were made from a camp on 900-foot Umiat Mountain north of the Colville River and about one-half mile from the release site. Three wolves had been fitted with Davidson Co. radio collars, and a receiving station on Umiat Mountain as well as a C-180 aircraft were utilized for radio tracking purposes. However, one collar broke and fell off and the remaining two apparently malfunctioned during the first week. Thus efforts to maintain contact with the animals following their movement from the release area were thwarted.

A brief account of major events follows:

Days 1 and 2. The wolves were released on 12 August at 0730. Within one minute of release four of the wolves ran out of sight to the west after briefly sniffing the caribou carcass. They returned to the carcass one hour after release. The black female that remained in the cage wandered out after the others and disappeared, probably due to lingering effects of the drugs. She was seen about 2 miles west of the release site on the second day and rejoined the others on the morning of the third day. Four of the wolves remained within one-half mile of the release site for most of the first two days. The caribou was 80 percent consumed by the end of the second day. Besides feeding, activities included exploration of the area, romping in a small slough adjacent to the release site and pursuing of ravens (*Corvus corax*) and glaucous-winged gulls (*Larus glaucescens*) attracted by the caribou carcass, group social interaction and play and resting.

Days 3 - 5. The caribou was reduced to hide and bones by late in the third day. On day 4 two caribou passed within 25 yards of one of the black females who sat quietly as they entered the Colville River and swam across, unaware of her presence. The other wolves were sleeping one-half mile away at the time. During this time period, play behavior lessened and the wolves moved as far as 2 miles from the pen, often independently. Behavior became more food oriented.

Days 6 - 7. Food oriented behavior increased and virtually no play soliciting was observed. Scattered bands of caribou were within 1 to 5 miles of the release site but were not visible to the wolves and were situated downwind from them. On one occasion, however, five caribou swam across the Colville from the north and walked downwind to within 40 yards of the sleeping wolves. The alpha male awoke first, crept to within 30 yards of the nearest caribou, a bull, and appeared to use a small clump of willows for concealment. A few seconds later one of the black females awoke and dashed toward the caribou putting them to flight and awakening the other three wolves. Four of the wolves, led by the alpha male, pursued four of the caribou for 200 yards but were outdistanced by the caribou which swam across a nearby slough. The wolves did not follow. One wolf, a male, pursued a bull caribou that had approached from the south and had gone unnoticed by the other wolves. This wolf made a more determined attempt than the others and pursued the caribou for about one-half mile but was also outdistanced. Shortly after the chase, the gray-tan female swam north across the Colville at the place

the caribou had crossed. Her location remained unknown until five days later when she was seen at an oil well drilling site on the Ivishak River, 100 miles east of Umiat. She remained in that vicinity for at least 30 days, after which the oil camp moved. No further reports of her location have been obtained.

Days 8 - 11. During this time period the four remaining wolves usually ranged beyond visual contact and little is known of their activities except that the alpha male and a black female swam across the Colville and attempted to forage in the dump at Umiat.

Days 11 - 40. The alpha male and black female were seen at Umiat in early September and on 11 October the alpha male was shot there by a native hunter who stated that the wolf was in very poor condition (no subcutaneous fat, ribs protruding) and that it appeared that the male and the black female that accompanied him had remained at Umiat and tried to subsist on scraps in the dump.

On 2 October the other black female was shot by a native hunter on the Chipp River, 105 miles northwest of Umiat. Her carcass was examined at NARL and showed subcutaneous fat deposits comparable to those of adult wild wolves at this season (Stephenson, unpublished data). Apparently, she had been faring better than the two wolves that remained at Umiat. Caribou frequented the area where she was killed but it is not known whether she or any of the other wolves in the release pack made any kills.

No further information on the location of the remaining three wolves was obtained until 9 December when the black female that was last seen in Umiat on 11 October turned up back at NARL, Barrow, 175 miles northwest of Umiat, where she was again caged. This wolf was judged to be "healthy" by NARL personnel; it cached pieces of meat that were used to entice it into a cage. Apparently it had been successful in finding food of some sort.

It is difficult to say what factors accounted for the black female's return to Barrow. However, an explanation offered by Pete Sovalik of NARL seems tenable. He thought that the wolves could have oriented their direction of travel toward Barrow in response to noise from large aircraft on Fairbanks to Barrow and on the coastal Dewline routes. Small aircraft noise in the Barrow area and human activity along the coast and inland at fish camps on the Chipp River could also have played a part. From August through December, 1972 the wind at Barrow blew predominantly from the northwest, possibly being another cause for the movement of the two black wolves in that direction, assuming the wolves moved primarily upwind in search of food. As of February, 1973 two members of the release pack (a black female and the gray-tan alpha male) are dead. The location of two others (a gray-tan female and male) is unknown, and one (a black female) has returned to Barrow.

The results of the study suggest the following as tentative conclusions:

1. Captive wolves released in the wild maintain their affinity for men and can locate places of human activity over long distances. Once located they show a tendency to remain at these places, probably associating them with food.

2. When under free-ranging conditions pack cohesiveness may be lost, perhaps due to hunger.

3. A propensity to pursue prey species appears to be inherent in wolves. The determination and expertise necessary to successfully hunt and kill is not inherent.

4. Contrasting the results of this release study with those of Merriam's, begun in 1960, suggests that a greater availability of food than that found in the Umiat area is necessary to sustain inexperienced wolves until they can reliably capture large prey. In Merriam's study four 19-month-old, pen-reared wolves were released on the 30-square-mile Coronation Island in Southeast Alaska. They survived and multiplied, eventually becoming capable of capturing Sitka black-tailed deer (*Odocoileus hemionus*). In addition to deer, however, they were able to rely on an abundance of marine resources including mussels, harbor seals (*Phoca vitulina*) and various types of carrion (Merriam, 1964). Food resources in the Umiat region were limited largely to live terrestrial prey including microtines, ground squirrels (*Spermophilus undulatus*), moose and caribou. Following freeze-up in early September small mammals were probably relatively unavailable. Thus there was no easily obtainable food resource to sustain the wolves and foster their interest while they acquired expertise in killing large prey.

Sex and Age - Specific Characters of Wolves

In the past two and one half years, the Nunamiut pointed out various characters that they use in differentiating, in the field, between male and female, and young and old wolves. I have been able to test the validity of most of these characters, to varying degrees, during the summer field work and while examining and autopsying wolves shot or trapped in winter. Most sex and age specific characteristics cannot be described in exact terms but are only diagnostic relative to their opposites. To one unaccustomed to observing wolves, the many differences would not be detectable or would sometimes appear negligible. To the skilled observer with an intimate knowledge of the biology and behavior of wolves such as many Nunamiut possess, these characteristics are real and useful. In using these criteria, the Nunamiut always allow for the variability they know is inherent in wolf behavior and morphology and always consider the various parameters in combindation, synthesizing them as observations of an individual wolf accrue. Determination of sex is usually tentative until the wolf is within a few hundred yards or has urinated in a characteristic manner.

It is important to keep in mind that rarely is any single characteristic considered unequivocal evidence that the animal in question is either a male or female. They are always integrated with the entire array of clues available and each characteristic carries its own

predictive weight. Hunters differ somewhat in the weight they place on certain clues, probably because each relies, to a great extent, on his own experience in developing criteria of predictive value. The discussion of sexing and aging criteria is included here primarily because the techniques may be useful to other field investigators and may be tested by them. Quite probably, some of these characteristics are peculiar to Brooks Range wolves.

The literature on wolves contains virtually no mention of sex and age specific pelage characteristics. Young and Goldman (1944) devote two paragraphs to pelage and molt in wolves, however, and mention that wolves seem to become grayer with age.

Summer Characteristics used in Diagnosing Sex

In summer, lactating female wolves are distinguishable mainly by their retention of the long, dull colored winter fur until the end of lactation and by the dark appearance of the abdomen caused by the loss of hair around the mammae and a red-brown stain that colors the hair remaining on the abdomen and on the posterior thorax. The exact nature of this stain is not known but it may be caused by the oxidation of milk and/or saliva from nursing pups. Retention of winter fur by lactating females occurs among caribou (Kelsall, 1968), sled dogs (Shepherd, pers. comm.), and possibly moose (LeResche, pers. comm.). Male wolves and young females shed their winter pelage in May and June. One-year-old wolves complete their molt and possess short summer hair by late June. At this time, most adults exhibit complete summer pelage only on their legs, face and lower sides, where winter fur is first shed, thus providing a contrast with juvenile animals. As mentioned earlier, lactating females are the last to shed; evidently their germinal hair cells remain dormant longer than those in males and young females due to the high energy demand of lactation.

The abdomen of lactating females is darkest during lactation, prior to the regrowth of abdominal hair. The red-brown stain on surrounding hair, however, lingers through the winter and is a useful criteria during most of the year. With good binoculars and in favorable light, the darkly hued abdomen of lactating gray or white wolves is often visible at a distance of 500 m or more, and a 20x spotting scope renders it visible at perhaps 1000 m. On black wolves the color is more difficult to detect.

The Nunamiut also rely to some extent on morphological differences in sexing wolves. These criteria are the most difficult to express in exact terms and the judgment of sex is made on the basis of a complicated synthesis of many years of observation, and on the simultaneous evaluation of several characters, including relative size and robustness of head and neck, relative size of chest and abdomen and length of legs.

Compared to most male wolves, females generally have a narrower muzzle and forehead, thinner neck, slightly shorter legs, and less massive appearing shoulders, making the abdomen seem less slim than in males. There also seems to be an additional clue in the conformation of the abdomen and flanks, but I have not yet been able to understand the

precise difference.

The pitch and structure of the howl gives another clue to sex and age. In general, adult males howl at a lower pitch, i.e. have a deeper voice, than females and juveniles. Pups are easily distinguishable by their high pitched, quavering howls.

In addition to the sex and age specific characters useful in the field, the Nunamiut have pointed out other sex and age related differences that become evident upon close examination. These characteristics, like those described above, do not hold true in all individuals but are in most cases general trends that the Nunamiut have noticed over a period of years, while handling several hundred wolves.

The hair on the legs of female wolves is noticeably smoother appearing than that of males which usually shows a slightly tufted appearance caused by irregular patches of somewhat longer hair.

Many gray wolves have a reddish coloration on the lateral surface of the front and/or hind legs. Sometimes this coloration is continuous with a general red-brown cast of the fur on the body of the animal, but often it exists as the only red-brown coloration. The Nunamiut have noticed, and my observations corroborate, that female gray wolves have more red-brown coloration than do male gray wolves. In November, 1971 I examined three 5-month-old pups from the same litter, trapped on 1 November 5 miles north of Anaktuvuk. Two of these pups were females and both showed noticeably more of the red-brown coloration on the legs than the male pup.

Two pups from another litter, a male and a female, were examined during this same period of time. Both were predominantly white but also had a sprinkling of red-tipped hairs along the back, shoulders and on the lateral surface of the front legs. Here, also the female showed more extensive and denser occurrence of the red-tipped hairs than did the male.

In April, 1972 I examined a pack of six gray wolves taken by an aerial hunter on the Little Delta River, 68 miles south of Fairbanks. The pack contained two adult males, one slightly larger than the other, an adult female (pregnant), a male pup, and two female pups (pups almost 1 year old). All six of these wolves had remarkably similar coloration, being of the "typical" gray hue and lacking any brown undertone. However, each had an elongated chevron-shaped patch of red-brown coloration about six inches long at the distal end of the humerus, which is the common shape and position for red-brown coloration in Alaskan wolves. The color was very faint on the three males, but vivid on the three females.

Thus, there does seem to be a tendency for females to have larger amounts of red coloration than males. There are, of course, many exceptions to this general rule, but it is another parameter that the Nunamiut consider in diagnosing sex.

One other aspect of coloration that has been pointed out in this connection is the characteristic rufous color on the back of the ears of pups, which is most intense when the pups are about 2 months old, diminishing in intensity with age.

The pelage of female and, to a lesser extent, male wolves changes in texture as the animals become older. The fur of "old" females (animals older than about five years) has a much smoother texture than does the fur of young females and males. I have not been able to determine the precise nature of the change, but it seems that guard hairs are more dense and of more uniform length. It may also be that the fur becomes more posteriorly oriented, thus giving a smoother, less bristly appearance.

Two of the oldest Nunamiut thought that the number of white hairs on the tip of the tail was correlated with age, but other hunters pointed out that pups often have white hairs at this place and that, therefore, this was a poor index to age. In the wolves I have examined, I have noticed a tendency for old animals to show generally more white and gray hairs on the tip of the tail, as well as in other areas such as the muzzle and forehead. It appears that individuals do become grayer with age, as Young and Goldman (1944) suggested, but that each wolf is endowed, initially, with a particular amount of gray coloration, which varies widely, and that graying proceeds from that point.

I have also noted that the claws of wolves less than 1 year old are shorter in length than those of adults. The claws of animals older than 1 year protrude about three-fourths inch from the fur while claws of younger animals protrude about three-eights inch.

Serology Studies

Neiland (1972) discussed bacteriological and virological studies of northern mammals being carried out by the Department of Fish and Game and reported on the results of efforts to detect rangiferine brucellosis in serum taken from wolves in the Anaktuvuk Pass area. Sera from 15 wolves yielded seven reactors by the complement fixation method and five reactors by the agglutination method. The occurrence of *Brucella abortus*, *B. melitensis* and *B. suis* in various carnivores, particularly dogs, has been recognized for some time. Pathological effects, including generalized lymphadenopathy and invasion of the speen, liver, mammary glands, ovaries, uterus, testes, kidneys, prostrate glands, lungs, placenta, fetus, epididymis, and blood have been noted. An effect of posssible importance in the ecology of wild canines subsisting on caribou on infected ranges (such as the Arctic caribou herd) is the occurrence of abortions, which take place regularly in infected dogs such as beagles.

In addition to bacteriological and virological studies of blood, 12 sera were submitted to Dr. U. S. Seal, Veterans Administration Hospital, Minneapolis, Minnesota, for electrophoretic studies of transferrins to give an indication of the genetic isolation of wolf populations. The results of initial work on this aspect have not been received.

RECOMMENDATIONS (ARCTIC STUDIES)

An estimate of wolf population density should be made at least once annually for the 3600 mile^2 area around Anaktuvuk Pass and the collection of wolf carcasses taken by Nunamiut hunters should continue. This will provide continuity in population level and age ratio data for this apparently increasing population. At the same time more of the Nunamiut Eskimos' knowledge of wolves can be recorded. This aspect of the work has proven to be very productive.

A concerted attempt should be made to gather scats and food remains from recently used dens in both the Arctic and Interior regions.

The collection of wolf-kill remains should continue as opportunities arise in the course of work in the northcentral Brooks Range.

Wolf populations should be monitored in Interior Alaska by means of aerial surveys carried out annually on selected areas representative of habitat-faunal associations in the region.

To provide data on the movements and rate of prey consumption by wolves in the Interior region one or two packs should be followed for several periods of one or more weeks each during the fall, winter and spring. Coupling this information with wolf population estimates mentioned above and with data on moose, caribou and sheep densities derived from Departmental research and management projects on these species could provide the basis on which to assess, at least roughly, the annual impact of wolves on Interior Alaska big game populations.

FINDINGS (SOUTHCENTRAL STUDIES)

Physical Condition of Ungulate Prey

The most successful method of locating moose carcasses during the winter of 1971-1972 was simply to follow the larger rivers searching directly for carcasses. For reasons not fully understood it did not prove especially worthwhile to track wolves to kill sites.

During the winter of 1971-1972 deep snow concentrated moose along the major river bottoms where presumably travel was easier and food more plentiful. These rivers included the Copper, Gulkana, Klutina, Tazlina, Gakona, Chistochina, Susitna and Maclaren. This study was concentrated along these rivers because of their close proximity to the Gulkana airfield and because of the high moose concentrations and heavy wolf predation occurring in this area.

Caribou are known to be a favored prey species for wolves (Murie, 1944; Burkholder, 1959). During this study, the Nelchina and Mentasta caribou herds wintered in the eastern Wrangell Mountains - Nabesna area. That area is timbered and quite hilly so kills were difficult to locate and approach. The area is also a considerable distance from Gulkana airfield so round-trip flights are difficult to make in a single day.

Therefore, observations of wolf predation on caribou were not emphasized. During caribou population studies, however, numerous instances of caribou kills were observed. Only five of these kills were visited.

It is also recognized that wolves may at times actively hunt Dall sheep (Sheldon, 1930; Murie, 1944; Young and Goldman, 1944; Nichols and Heimer, 1972). In August, 1972 I found the remains of six sheep (including one very small lamb) in the Nabesna area which had been fed upon and largely consumed by large predators, probably wolves. However, because of the difficulty in finding and visiting a meaningful sample of sheep kills, no attempts were made to examine Dall sheep-wolf relationships.

Table 6 summarizes data from all large mammal carcasses examined during the course of this field activity. Included are a number of animals which died from causes other than wolf predation and are included for comparative purposes.

During the study period, 85 moose, five caribou and four bison (*Bison bison*) carcasses were examined on the ground. Fifty-seven of the moose and all five caribou were considered to have been killed by wolves. The remaining 28 moose were known to have met death through other causes, including winter kills, road kills and illegal kills. The bison were all winter kills.

Age and sex determinations were made on all animals known to have been killed by wolves whenever possible. Among the moose killed by wolves, excluding calves, the sex ratio was 19 bulls per 100 cows. The mean age of moose killed, again excluding calves, was 3.0 years and 8.6 years for bulls and cows, respectively. During the 1971 fall sex and age moose compositions in this area, there were 24 bulls per 100 cows (Annual S & I Report, 1973). Age analysis of moose killed by hunters during the 1971 season showed the mean ages of bull moose (excluding calves) to be 3.2 years and females 1 year plus to be 6.7 years (Annual S & I Report, 1973). Calves of the year accounted for 56.1 percent of the wolf kill sample. During 1971 moose composition counts, calves represented only 15.8 percent of the moose population sampled.

Analysis of fat reserves in marrow of the long bones has long been used as a measure of an animal's nutritional well-being (Cheatum, 1949). In Alaskan moose, it appears that adult animals with 20 percent or less and calves with less than 10 percent fat in their long bone marrow are approaching death through starvation/malnutrition (John Coady and Charles Lucier, pers. comm.). Marrow samples of eight wolf-killed adult moose averaged 75.8 percent fat. One adult known to have died through malnutrition showed 7.1 percent fat. An adult moose in extremely poor condition killed by Alaska Department of Fish and Game personnel as a public nuisance showed 17.0 percent marrow fat. Marrow samples from an illegally killed adult cow showed 88.2 percent fat. An 11-year-old bull killed at the same time as the cow showed 56.8 percent marrow fat. Marrow samples from 14 moose calves killed by wolves averaged 21.8 percent fat while samples of 11 calves known to have died from malnutrition averaged 6.8 percent fat.

Table 6. Summary of observed wolf kills - Southcentral Alaska - 1972.

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-1	67103	*Alces alces*	1/XX/72	Unk.	C	27.5	Wolf kill	Total	Gulkana River 3 mi. above Gulkana	Kill revisited until total utilization.
M-72-2	67104	*Alces alces*	1/XX/72	Unk.	C	39.1	Wolf kill	Total	Gulkana River 3 mi. above Gulkana	Kill revisited until total utilization.
M-72-3	67105	*Alces alces*	1/XX/72	Unk.	C	19.3	Wolf kill	Total	Gulkana River 3 mi. above Gulkana	Kill revisited until total utilization.
M-72-4	67106	*Alces alces*	2/3/72	Unk.	C	6.7	Winter kill	Total	Copper River at mouth of Gulkana R.	Kill revisited mostly by fox and coyotes.
M-72-5	67107	*Alces alces*	2/4/72	M	C	6.8	Winter kill	None	Mi. 11 Tok Cut-off	Collected whole.
M-72-6										
M-72-9	67108	*Alces alces*	1/25/72	M	C	6.9	Road kill	None	Glennallen	
M-72-10	67109	*Alces alces*	2/10/72	Unk.	C	69.0	Wolf kill	Total	Gulkana River 1 mi. above Sourdough	Old kill site when collected.
M-72-11	67110	*Alces alces*	2/10/72	Unk.	C	9.8	Wolf kill	Total	Gulkana River at Pipeline crossing	Old kill site when collected.
M-72-12	67111	*Alces alces*	2/10/72	Unk.	C	10.0	Wolf kill	Total	Gulkana River 5 mi. below Sourdough	Old kill site when collected.
M-72-13	67112	*Alces alces*	2/10/72	F	C	7.5	Wolf kill	Total	Gulkana River 5 mi. below falls	Carcass still warm. Revisited until total utilization.
M-72-14	67113	*Alces alces*	2/10/72	M	C	8.3	Wolf kill	Total	Gulkana River below Sourdough	Kill revisited until total utilization.
M-72-15		*Alces alces*	2/10/72	Unk.	C		Wolf kill	Total	Gulkana River 10 mi. below pipeline cross.	Total utilization when visited.[1/]
M-72-16	67114	*Alces alces*	2/21/72	F	C	7.4	Wolf kill	Total	Copper River at mouth Bear Cr.	Kill revisited until total utilization.
M-72-17	67115	*Alces alces*	2/21/72	Unk.	C	6.6	Winter kill	90%	Klutina River at Wilson Ranch	Kill site indicated winter kill.

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-18	67116	*Alces alces*	2/21/72	M	3	45.0	Wolf kill	Total	Klutina River at Earthquake slide	Extensive wolf activity at kill.
M-72-19	67117	*Alces alces*	2/21/72	Unk.	C	17.8	Wolf kill	Total	Klutina River at bluffs	Total utilization when visited.1/
M-72-20		*Alces alces*	2/21/72	Unk.	C		Wolf kill	Total	Tazlina River 5 mi. below Tazlina Lake	Total utilization when visited.1/
M-72-21	67118	*Alces alces*	2/21/72	F	C	25.0	Wolf kill	90%	Tazlina River 2 mi. above Moose Creek	Old kill when visited.
M-72-22	67119	*Alces alces*	2/21/72	Unk.	Ad.	34.8	Wolf kill	Total	Tazlina River at Moose Creek	Old when visited.1/ 2/
M-72-23	67120	*Alces alces*	2/22/72	Unk.	C	13.7	Wolf kill	90%	Copper River 3 mi. below Gulkana R.	2/
M-72-24	67121	*Alces alces*	2/22/72	F	12	81.8	Wolf kill	Total	Gulkana River 2 mi. above W. Fk.	Extensive wolf activity at kill.2/
M-72-25		*Alces alces*	2/22/72	F	2		Wolf kill	Total	Gulkana River 2 mi. above W. Fk.	Skull only found.
M-72-26		*Alces alces*	2/22/72	Unk.	C		Wolf kill	Total	Gulkana River Falls	Total utilization when visited.1/
M-72-27	67122	*Alces alces*	2/22/72	F	12	89.2	Wolf kill	Total	Gakona River E. Round Top Mt.	Total utilization when visited.
M-72-28	67123	*Alces alces*	2/22/72	F	16	75.9	Wolf kill	Total	Gakona River S.E. Round Top Mt.	Total utilization when visited.2/
M-72-29	67124	*Alces alces*	2/22/72	Unk.	C	44.5	Wolf kill	Total	Gakona River 20 mi. above Gakona	Total utilization when visited.2/
M-72-30		*Alces alces*	2/22/72	Unk.	C		Wolf kill	Total	Gulkana River Falls	Total utilization when visited.1/
M-72-31	67125	*Alces alces*	2/25/72	F	3	88.2	Illegal kill	Total (see remarks)	Mile 24 Tok Road	Total utilization by scavengers including wolves.
M-72-32	67126	*Alces alces*	2/25/72	M	11	56.8	Illegal kill	Total (see remarks)	Mile 24 Tok Road	Total utilization by scavengers including wolves.

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-34	67127	*Alces alces*	3/4/72	M	9	7.1	Winter kill	None	Head Dadina River	Carcass intact when found.
M-72-35	67128	*Alces alces*	3/3/72	Unk.	C	7.6	Winter kill	Total except spinal column	Copper-Chistochina confluence	Traps set around this kill.
M-72-36	67129	*Alces alces*	3/3/72	Unk.	C	7.1	Winter kill	Total except spinal column	Copper-Chistochina confluence	Scavenged - partially covered by overflow.
M-72-37	67130	*Alces alces*	3/3/72	M	3	23.6	Wolf kill	Slight	Copper River 3 mi. above Chistochina	Still warm - traps set around carcass.[2/]
M-72-38	67131	*Alces alces*	3/3/72	F	7	80.2	Wolf kill	85%	Sanford River 4 mi. above Copper River	Kill revisited until total utilization.
M-72-39	67132	*Alces alces*	3/8/72	M	C	7.4	Winter kill	None	In Copper Center	Collected intact for autopsy.
M-72-40	67133	*Alces alces*	3/9/72	F	C	6.5	Winter kill	None	Mile 126 Richardson Highway	Collected intact for autopsy.
M-72-41	67134	*Alces alces*	3/14/72	F	Ad.	65.4	Wolf kill	Total	E. Fk. Chistochina 6 mi. above main r.	Upper jaw only found.
M-72-42	67135	*Alces alces*	3/14/72	F	3	64.7	Wolf kill	Slight	Gakona River east of Paxson tower	Kill revisited until total utilization.
M-72-43	67136	*Alces alces*	3/14/72	Unk.	3	66.4	Wolf kill	Total	Chistochina River 5 mi. above hwy.	Four grey wolves at kill.
M-72-44	67137	*Alces alces*	3/21/72	F	16	89.7	Wolf kill	Total	Sanford River 5 mi. above Copper R.	
C-72-45	N54932	*Rangifer tarandus*	3/21/72	Unk.	8	36.6	Wolf kill	Total	S.E. of Chistochina - Unit 11	
C-72-46	N54933	*Rangifer tarandus*	3/21/72	Unk.	6	41.0	Wolf kill	Total	Pass Creek - Unit 11	
C-72-47	N54934	*Rangifer tarandus*	3/21/72	M	9	21.9	Wolf kill	Total	Goat Creek - Unit 11	
M-72-48	67138	*Alces alces*	3/3/72	Unk.	14	31.1	Wolf kill	Total	Sanford River opposite bluffs	

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-49	67139	*Alces alces*	3/22/72	F	C	6.0	Winter kill	None	Copper Center	Collected whole for autopsy.
M-72-50	67140	*Alces alces*	3/31/72	M	C	6.4	Winter kill	None	Mile 56 1/2 Tok Highway	Scavenged only.
M-72-51	67141	*Alces alces*	3/31/72	F	16	7.1	Winter kill	None	Mile 58 1/2 Tok Highway	Scavenged only.
M-72-52	67142	*Alces alces*	3/30/72	F	15	17.0	ADF&G collection	None	Mile 43 1/2 Tok Highway	
M-72-53	67143	*Alces alces*	4/1/72	F	C	6.7	Winter kill	None	W. Fk. Gulkana at Keg Creek	Ultimately complete utilization.
M-72-54	67144	*Alces alces*	4/1/72	Unk.	C	6.5	Wolf kill	Total	Gulkana 5 mi. above Sourdough	Total utilization when found.[1/]
M-72-55	67145[3/]	*Alces alces*	4/11/72	F	10	IV	Wolf kill	90%	Head Sanford R.	
M-72-56	67146	*Alces alces*	4/14/72	M	C	I	Winter kill	Slight	Copper R. 1 mi. above Sanford R.	Scavenged only.
M-72-57	67147	*Alces alces*	4/14/72	F	C	I	Winter kill	50%	Copper R. 5 mi. below Chistochina	Scavenged only.
M-72-58	67148	*Alces alces*	4/14/72	M	C	I	Wolf kill	Slight	Copper R. 4 mi. below Chistochina	Evidence indicated wolf.[2/]
M-72-59		*Alces alces*	4/17/72	F	11		Illegal kill	None	Copper R. 1 mi. above Gakona	Frozen solid - bird scavenged.
M-72-60	67149	*Alces alces*	4/17/72	Unk.	C	II	Wolf kill	Total	Copper R. 1 mi. above Gakona	Spinal column only remains.
M-72-61	67150	*Alces alces*	4/18/72	F	C	I	Winter kill	Total	Gulkana River at mi. 139 Rich. Hwy.	[1/]
M-72-62	67151	*Alces alces*	4/17/72	F	13	I	Winter kill	None	Mile 22 Tok Hwy.	Ultimately scavenged.
M-72-63	67152	*Alces alces*	4/24/72	Unk.	C	I	Winter kill	Total	Gulkana R. at Poplar Grove	Total utilization by wolves.

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-64		*Alces alces*	4/24/72	M	10		Illegal kill	Total by humans	Gulkana at Sourdough	
M-72-65	67153	*Alces alces*	4/24/72	Unk.	C	I	Wolf kill	Total	2 mi. up W. Fk. Gulkana	
M-72-66	67154	*Alces alces*	4/24/72	Unk.	C	I	Wolf kill	Total	2 mi. up W. Fk. Gulkana	2/
M-72-67	67155	*Alces alces*	4/24/72	Unk.	C	I	Wolf kill	Total	2 1/2 mi. up W. Fk. Gulkana	1/
M-72-68	67156	*Alces alces*	4/24/72	F	C	I	Winter kill	None	8 mi. up W. Fk. Gulkana	Carcass intact.
M-72-69	67157 & 67158	*Alces alces*	4/24/72	M	C	I	Winter kill	Total	10 mi. up W. Fk. Gulkana	No blood on calcaneus.
C-72-70		*Rangifer tarandus*	4/24/72	Unk.	Ad.		Wolf kill	Total	Monsoon Lake	No specimens available.
M-72-71	67159	*Alces alces*	4/24/72	M	C	I	Winter kill	Total	Middle Fk. Gulkana 5 mi. from Dickey Lk.	1/
M-72-72		*Alces alces*	4/24/72	Unk.	Ad.		Wolf kill	Total	Middle Fk. Gulkana 10 mi. from Dickey Lk.	1/
M-72-73	67160	*Alces alces*	4/24/72	F	12	III	Wolf kill	Total	Gulkana at 12-Mile Creek	Very old kill.
M-72-74		*Alces alces*	4/24/72	M	C		Wolf kill	Total	Gulkana at 12-Mile Creek	Very old kill - wolverine scavanged. 2/
M-72-75	67161	*Alces alces*	4/24/72	F	2	I	Wolf kill	50%	Gakona east of Paxson tower	Very fresh kill. 2/
M-72-76	67162	*Alces alces*	4/24/72	F	14	IV	Wolf kill	Total	Gakona east of Paxson tower	Very old kill.
M-72-77		*Alces alces*	4/24/72	Unk.	C		Wolf kill	Total	Gakona east of Round Top Mtn.	Very old kill. 1/
M-72-78	67163	*Alces alces*	4/24/72	F	6	IV	Wolf kill	Total	Gakona S.E. of Round Top Mtn.	Spinal column only.

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-79		*Alces alces*	4/24/72	Unk.	C		Wolf kill	Total	Gakona S.E. of Round Top Mtn.	1/
M-72-80	67164	*Alces alces*	4/25/72	F	3	III	Wolf kill	Total	Copper R. 2 mi. below Dry Creek	
M-72-81		*Alces alces*	4/25/72	Unk.	C		Wolf kill	Total	Copper River at Simpson Hill	No specimens available. 1/
M-72-82	67165	*Alces alces*	4/25/72	Unk.	C	I	Winter kill	None	Tazlina River at Glennallen	First observed 3/27/72 intact.
M-72-83	67166	*Alces alces*	4/25/72	Unk.	Ad.	IV	Wolf kill	Total	Tazlina River at Nickel Creek	No jaw available. 2/
M-72-84	67167	*Alces alces*	4/25/72	Unk.	C	I	Wolf kill	Total	Copper River 4 mi. below Copper Center	2/
M-72-85		*Alces alces*	4/25/72	Unk.	C		Wolf kill	Total	Copper River 4 1/2 mi. below Copper Center	
M-72-86		*Alces alces*	4/25/72	Unk.	C		Wolf kill	Total	Dadina River 4 mi. above Copper River	No specimens available. 1/
M-72-87	67168	*Alces alces*	4/25/72	Unk.	5	IV	Wolf kill	Total	Copper River 2 mi. so. Dadina River	Total utilization except skeleton.
M-72-88	67169	*Alces alces*	4/25/72	F	14	I	Wolf kill	Total	Copper River opposite Klawasi River	
M-72-89	67170	*Alces alces*	4/25/72	M	C	I	Wolf kill	Total	Copper River at Klawasi River	Probably calf of 67169.
M-72-90	67171	*Alces alces*	4/27/72	F	4	57.9	Wolf kill	Total	Gakona River S.E. Round Top Mtn.	
M-72-91	67172	*Alces alces*	4/27/72	F	5	67.2	Wolf kill	Total	Gakona River S.E. Round Top Mtn.	2/
M-72-92	67173	*Alces alces*	4/27/72	M	3	63.5	Wolf kill	Total	Gakona River S.E. Round Top Mtn.	2/

Table 6. (cont'd.)

Field No.	Perm. Accession No.	Species	Date of Collection	Sex	Age	Marrow Analysis % Fat	Cause of death	Degree of Utilization when first visited	Location of kill	Remarks
M-72-93	67174	*Alces alces*	4/27/72	F	C	7.6	Winter kill	Scavenged only	Copper River at Tulsona Creek	
C-72-94		*Rangifer tarandus*	4/28/72	F	9	8.2	Wolf kill	75%	Nabesna River at Totschadan Creek	

1/ Age of moose, i.e. calf or adult based on examination of hair, gray, fuzzy and short indicating calf.

2/ Bloody calcanei indicating wolf kill.

3/ Accession numbers M-72-55 - M-72-89 (67145-67170) represent animals on which marrow analysis data lost. Based on gross visual analysis, I represents <10% fat, III represents 11-59% fat, IV represents >60% fat.

4/ Kill revisited by wolves until utilization complete.

As would be expected during such a severe winter, there was a noticeable reduction of the fat content of bone marrow of adult moose as the winter progressed. Fat content of "healthy" adult cows was approximately 80-90 percent early in the winter but was down to 60-70 percent when the last samples were collected in April.

Unfortunately, marrow fat content data from 25 marrow specimens were lost during laboratory processing. The data from those specimens, listed by gross analysis only, are presented in Table 6. They are not included in averages of fat content given above.

Our data do not support the long-held theory that predators, especially wolves, prey only upon the disabled and inferior individuals of a prey species. Rather they suggest that prey species are taken in proportion to the sex and age composition of the population, except for young of the year. As indicated by fat content of bone marrow, there appeared to be no difference in the nutritional well-being of adult animals killed by wolves and adult animals killed by accident or illegally. In the calf segment of the moose population killed by wolves, apparently healthy animals appeared to predominate.

The winter of 1971-72 was the most severe ever recorded in terms of snowfall and snow accumulation in the Gulkana basin. A total of 88.6 inches of snow fell with a maximum depth of 55 inches on the ground on March 17, 1972. Normal seasonal snowfall is 46 inches. These records are provided by the U. S. Department of Commerce. A snow accumulation of that magnitude, especially for such a long duration, is known to exert a very dibilitating effect on moose populations. This was well illustrated during the course of this study and by other observations by Alaska Department of Fish and Game personnel, during which large scale die-offs, particularly among calves, were noted. Such severe snow depths probably reduce the efficiency of all moose to the point that they are relatively easy for wolves to kill. It is interesting to speculate from a genetic standpoint on the effects of the predator-prey relationship when an apparently healthy moose calf survives the effects of a very severe winter only to be preyed upon by wolves.

The degree of utilization of moose carcasses by wolves was very high, both for animals killed by wolves and for those dying from other causes. In most cases, wolves revisited kills until only rumen contents, some long bones, perhaps the skull, and some hair remained. Calf moose, with their softer bones, were usually totally utilized and even the bones were eaten. Complete utilization of a calf moose is shown in Fig. 1.

In summation, results of this study suggest that wolves can select and kill prey easily when climatic conditions (e.g. heavy snow accumulation) are severe, and that the prey so killed are a representative sampling of the adult segment of the prey population. Young of the year of the prey species are particularly handicapped by excessive snow and are the easiest prey. These young animals are preyed upon at a higher rate than they occur in the population.

Fig. 1. Total utilization of a moose calf by wolves. Klutina River February 21, 1972.

The effects of predation on a healthy population are probably not too severe to the adult segment except through direct reduction of those animals killed. The immediate effects of such a rate of predation in conjunction with extreme winter is a severe depletion of that year's age class. If such a rate of predation should continue, as it well might in view of the rather abundant wolf population, the effect would be a serious reduction of the annual calf crop resulting in low annual recruitment to that population. With the moose and caribou populations in this area now experiencing downward trends for a variety of reasons it is very possible that wolf predation can lessen recruitment to the point that these populations will continue to decline. This conceivably could continue until food becomes critical for the wolves, at which time their own population control factors would bring about a reduction in wolf numbers. The classic predator-prey hypothesis of predatory selection of poor quality animals probably holds true in a "normal" situation but probably does not in times of extreme conditions when all segments of the population are under stress.

Miscellaneous Observations

Cause of death of prey - During the course of this study, it was imperative to determine the cause of death of animals examined to gain a true picture of the condition of wolf-killed animals. Several criteria were developed during this study upon which it was usually possible to assign the actual cause of death to each dead game animal that was encountered.

Wolf-kill sites are quite characteristic. They are usually in an open area, such as a frozen lake or stream or a small opening in the woods. If the kill is only a day or so old, circumstances of the kill can generally be constructed from the tracks in the snow. There are usually considerable signs of struggle, with bits of hair, blood and often rumen contents strewn over a wide area. Bounding wolf tracks, indicating extreme excitement on the part of the wolves, are usually present. There will typically be several wolf trails radiating from the kill, often ending on a prominence where the wolves rest after feeding. After feeding on a fresh carcass, wolves "preen" themselves by wallowing in the snow near the kill site. After a few days scavenging birds, especially ravens and eagles, smaller carnivores (fox, coyotes and wolverines) and repeated visits of the wolf pack usually obliterate the tracks at a kill site.

Examination of very recent kills reveals that wolves kill large animals, especially moose, by attacking their rear quarters and flanks as the animals are standing or running (see also Mech, 1970 and Burkholder, 1959). The hair around the calcanei typically is saturated with blood on a large animal killed in this manner. The lower hind legs are usually the last portion of a carcass to be eaten or removed by wolves so skeletal remains which have a blood soaked calcaneus are good evidence of a wolf kill. Such a blood soaked leg is recognizable for several weeks after death of the animal. Skeletal remains with reasonable fat reserves in the long bone marrow indicate that the animal did not die of malnutrition.

The carcass of a wolf-killed animal is usually on its side with all four legs extended (Fig. 2). On the other hand, animals scavenged by wolves also show typical characteristics. Animals dying from malnutrition frequently seek solitude in dense brush just prior to death. They often freeze solid before scavengers, including wolves, find them. When such a carcass is scavenged, often only the uppermost portion is eaten. The calcanei do not show blood saturation. There are fewer indications of wolf excitement and preening signs are scarce. There is seldom any blood around the carcass. Winter-killed moose generally reflect total utilization of all fat reserves. An animal dying of malnutrition/starvation reclines in the position typical of large herbivores, its legs doubled up under its body and its body in an upright position (Fig. 3). If it freezes before it is scavenged, the folded-up position is recognizable until the skeleton is disarticulated (Fig. 4). Careful examination of skeletal remains of animals killed and not salvaged by humans but scavenged by wolves usually will reveal ax or saw marks, bullet wounds or other marks not made by wolves. Bone marrows of such kills usually show good fat reserves.

Wolf Abundance

As reported by Rausch (1967) pack size is a good indicator of wolf abundance. During the 1971-72 study, 58.5 hours were flown in fixed-wing aircraft and helicopter. Only three sightings of a total of seven wolves were made, with four animals being the largest pack sighted. This low incidence of observations was surprising in view of the rather high degree of wolf predation observed.

Average pack size, as reported by aerial permit holders in Game Management Unit 13 and based on 34 observations of 136 wolves, was 4.0. These packs ranged in size from 1 to 11 animals. During the 1971 moose sex and age composition counts in Unit 13 four packs of 33 wolves, for a mean pack size of 8.35, were observed. Sixteen of these wolves were in one pack.

Combining observations of aerial permittees and Alaska Department of Fish and Game personnel during this reporting period in Unit 13, 41 packs totaling 176 wolves, for a mean pack size of 4.3, were seen. Numerous wolf observations were made while doing caribou census work in the Nabesna area, Game Management Unit 11. It is possible that a considerable number of the wolves that normally inhabit the Nelchina Basin followed the caribou to the Nabesna area. Aerial permittees reported sighting 11 packs totaling 57 wolves for a mean pack size of 5.2 in Unit 11.

These data suggest that the wolf population in the Nelchina Basin appears to have undergone a significant reduction since 1971.

Food Habits

Food habits of wolves have been intensively studied throughout the range of the animal. They are well summarized by Mech (1970). The present study was not intended to provide significant data on year-round

Fig. 2. Adult moose killed by wolves. Note that animal is on side and that legs are stretched out straight. Klutina River.

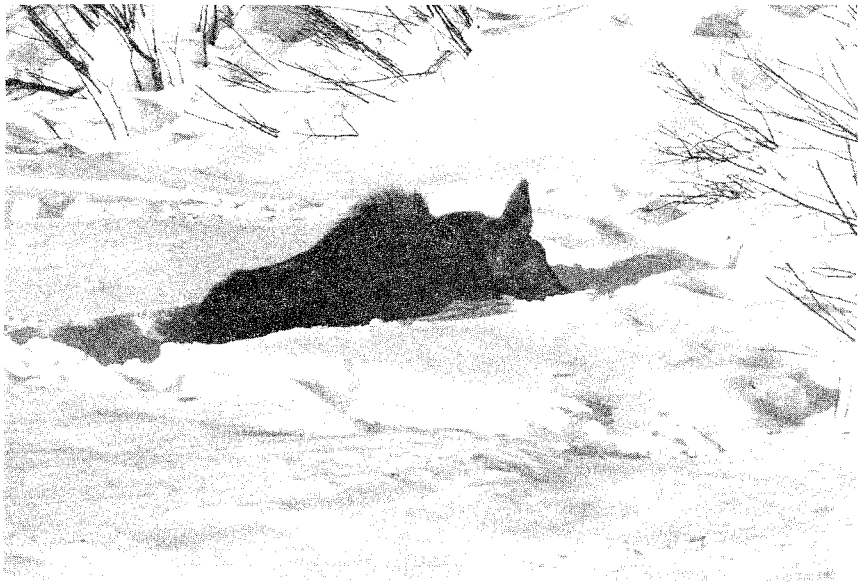

Fig. 3. Winter-killed moose calf in typical reclining position, Mile 126 Richardson Highway, March, 1972.

Fig. 4. Scavenged remains of calf moose dead from starvation showing folded rear legs, Tazlina River.

food habits, but during the time spent afield collecting data on wolves some interesting feeding observations were made.

In the spring of 1971, caribou hunters along the Nabesna road found the remains of a river otter (*Lutra canadenses*) which had been eaten by wolves. I examined the remains of the otter skull for positive identification. It is not known if the otter was killed by the wolves but, since it had not been skinned, it seems probable that the otter was not killed by humans.

Snowshoe hare (*Lepus americanus*) populations were moderate to dense during the study period. While tracking wolves on the Gulkana River, on April 1, 1972, I landed at the site of concentrated wolf activity centered in a dense stand of spruce, in which I assumed I would find a moose carcass. A careful search revealed only wolf and hare tracks, the remains (hind feet) of two hares and three deposits of wolf vomitus containing only *Lepus* hair. It appeared that this concentrated wolf activity was probably the result of intensive hare hunting. Several additional areas of concentrated wolf activity were later observed at which no large mammal kill was found. These were concluded to be areas where wolves had engaged in hunting for snowshoe hares.

On July 26, 1972, a recently vacated wolf rearing den was visited on Mt. Drum, in the Wrangell Mountains. Approximately 200 pup scats were collected. These have not been analyzed yet but the only fresh remains of prey species present at the den site were numerous remnants of snowshoe hares. Hind feet, which apparently are not eaten, were the most often encountered remains.

Cannibalism by wolves is often reported and I know of one instance of that happening. A female wolf was trapped in the spring of 1971 by Frank Zimbicki in the Crosswind Lake area. The animal was about half eaten by other wolves. It is not known if the animal was eaten by members of her own pack.

On April 27, 1972, while snowshoeing to a wolf-killed moose on the Gakona River, I found the frozen body of a gray wolf curled up under a cottonwood tree. When the carcass was thawed and skinned, it was noted that the wolf had been severely attacked at the throat and rear quarters (while alive, as evidenced by hematoma) by other wolves. There were about 40 puncture holes in the throat alone. Two 00-buckshot pellets, presumably fired by an aerial gunner, were located in the animal's body. There had been no apparent attempts at feeding on the carcass by wolves even though the crippled animal had obviously been killed by wolves.

In the spring of 1970, a female Labrador dog was killed and eaten by a pack of wolves while she was chained near a residence at Slana, Alaska. At a location where a trapper had shot one of his dogs, I found where a pack of wolves had fed upon the frozen blood of the dog but the carcass was not eaten.

During the severe winter of 1971-72, several bison in the Copper River herd succumbed to starvation/malnutrition. These bison carcasses

were intact when first observed, but on subsequent visits I watched as the carcasses were ultimately totally utilized, primarily by wolves.

On two occasions during early winter wolf tracks were examined on Klutina Lake where it was determined that the wolves had been digging up and feeding on the frozen carcasses of spawned-out red salmon (*Oncorhynchus nerka*). On April 7, 1971, wolves were observed feeding on frozen red salmon carcasses on Fish Lake at the headwaters of the Gulkana River by Kenneth Roberson, Commercial Fisheries biologist. I have also observed and photographed wolves digging at muskrat (*Ondatra zibethica*) houses or "pop-ups" on frozen lakes in the Gulkana River drainage.

These miscellaneous observations on feeding indicate that wolves are opportunistic in their feeding habits and apparently will eat just about any animal matter they encounter.

Utilization by Humans

Wolf pelts and wolf hunting continue to command a high degree of human interest. The requirement that all wolves killed in Alaska be presented to Alaska Department of Fish and Game personnel for sealing was inaugurated effective July 22, 1971. The information gathered through that program for Unit 13 is summarized in Table 7.

Wolf Coloration

As previously noted (Stephenson and Johnson, 1971), wolf coloration should be monitored because the ratio of dark to light colored individuals might be an indicator of the wolf population trend. Insufficient observations were made by Alaska Department of Fish and Game personnel to provide a reliable sample. Of the 111 wolves taken from Unit 13 and presented to Alaska Department of Fish and Game for examination and sealing the black:gray ratio was 25:100. The lower number of black animals in the harvest as compared to 1971 might support the suspected reduced wolf population (see page 44) but might also be a matter of hunter selectivity as the pelt of gray wolves commands a higher price on the fur market.

RECOMMENDATIONS (SOUTHCENTRAL STUDIES)

Investigations of summer food habits should be continued.

Studies of denning ecology should continue in Southcentral when more den locations become known.

Additional data on the characteristics and condition of ungulate prey should be gathered on a year-to-year basis. The status and productivity of the Southcentral wolf population should continue to be monitored. The relationship between wolves and prey should receive intensive investigation, particularly now that the populations of the major prey species, moose and caribou, are considerably below what they have been in recent years.

Table 7. Wolf harvest, Unit 13, 1971-72.

Males - 61 Females - 45 Unknown - 5 Total - 111

Chronology by Month

Month	Number	Percent	Month	Number	Percent
September	4	3.6	February	31	27.9
October	4	3.6	March	24	21.6
November	2	1.8	April	22	19.8
December	7	6.3	Unknown	0	0.0
January	17	15.3	TOTAL	111	99.9

Method of Take	Number	Percent
Ground shooting	22	19.8
Trapping	41	36.9
Snaring	2	1.8
Aerial shooting	46	41.4
TOTAL	111	99.9

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