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WILDLIFE RESEARCH UNIT STUDIES

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Annual Project Segment Report
Federal Aid in Wildlife Restoration
Projects W-13-R-1, Job C-5 and W-15-R-1,
Jobs K-8, L-7, M-7, P-8, and P-9

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-13-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: C TITLE: Waterfowl

JOB NO. 5 TITLE: Ecology of the Emperor Goose

PERIOD COVERED: July 1, 1965 to June 30, 1966

ABSTRACT:

Brood size of emperor geese during July and August averaged 3.91 from ground observations in contrast to 3.43 from a Fish and Wildlife Service aerial survey on July 28. Emperor geese were found to share the same habitat types with cackler and white-fronted geese; this being in areas inland from the coast where vegetation is profuse. Emperor goose goslings reached class IIb in plumage development by late July, IIc in early August and class III by August 20. On the wintering grounds, bald eagles appeared to account for some predation on emperor geese. Eelgrass was the dominant food being used by geese in the Izembek Bay area. Ratios of young to adults could be obtained on the wintering grounds in February and young averaged 3.08 per adult pair in six samples in which counts could be made.

OBJECTIVES:

To investigate the nesting and winter ecology of the emperor goose (Philacte canagica).

TECHNIQUES:

The period from July 1 to August 25, 1965 was spent on the Yukon-Kuskokwim Delta in the vicinity of Old Chevak gathering data on the emperor goose broods. With the aid of a 12 foot skiff, the rivers and major sloughs were checked frequently to record brood frequencies. Also, a Cessna 180 flown by Dr. Calvin Lensink, manager of the Clarence Rhode National Wildlife Refuge, was utilized at times to compare population densities of geese among the several drainage systems in the area as well as for an emperor brood survey in the Baird Inlet area conducted on July 28.

In order to study the geese in their winter environment, approximately six weeks were spent in the Cold Bay-Izembek Bay area on the Alaska Peninsula from December 21 to January 4 and from February 9 to March 8.

With prevailing ice conditions in December, a 20-30x spotting scope was used to observe daily activities of the birds. However, by February, the ice was gone and the emperors were easily observed in the nearby coves without the aid of a scope.

FINDINGS:

During July and August, brood size frequencies were recorded. The following was obtained in the Old Chevak area:

	Brood Size Frequency								Average Young per Brood
	1	2	3	4	5	6	7	8	
July		9	13	12	13	1	1	1	3.82
August		1	2	4	4				4.00
									3.91

The annual emperor brood survey flown by the Fish and Wildlife Service was conducted again this year in the Baird Inlet and Hazen Bay areas on July 28. The results were as follows:

	Brood Size Frequency								Total Broods	Number Young	Average Brood Size
	1	2	3	4	5	6	7	8			
Single Broods		1	4	4		1			10	36	3.60
Double Broods					1			1	4	13	3.25
									14	49	3.43

Upon making a flight along the Kokechik River, over 200 emperors were observed. The average brood size per adult pair was 3.33.

With regard to nesting habitat, it was found that the emperors, cacklers and white-fronts shared the same general type of terrain. That is, all three species were located inland from the coast where the vegetation was profuse.

Plumage development in young was followed during July and August. By the latter portion of July, the goslings were in class IIb. After the first few days in August, they changed to IIc followed by class III when the last observations were made on the 20th.

Although there were no direct observations of mortality on emperors, glaucous gulls were frequently seen to take young brant and cacklers, especially when they became separated from their parents. Undoubtedly this large predatory bird accounts for a reduction among emperor broods throughout the critical period during their first few weeks of development.

While on the wintering grounds, avian predation was much in evidence. The flocks of geese were constantly harassed by bald eagles, but in only one instance was a goose observed to have been killed. Although the red fox was commonly observed along the beaches, no mortality from this source was recorded. Consequently, it appears that there are no serious detrimental pressures placed on the emperor population, at least in this area, from predation.

The principal food of the emperors in Izembek Bay is eelgrass (Zostera marina). Stomachs were obtained from five birds, four of which are from Adak, the remaining one being from Izembek Bay. Although no analyses have been made on them to date, they will be compared with those collected by field workers in the 1920's.

Behavioral changes were noticeable in February. At this time, the adults were becoming quite pugnacious and resented the intrusion of individuals outside the family group.

Since the immatures were readily distinguishable from the adults by their dark heads and yellow legs, family group counts could be made when an individual group was separated from the rest of the flock. For six groups, the number of young per adult pair was 3.08.

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-15-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: K TITLE: Moose

JOB NO. 8 (revised) TITLE: Moose Calf Survival

PERIOD COVERED: July 1, 1965 - June 30, 1966

ABSTRACT:

Behavior and calf survival were studied in a population of moose near Palmer, Alaska, from May through November, 1965. The study utilized ground and aerial observations and counts, and was aided by the tagging of 59 calves to allow their recognition as individuals. Calf mortality during the first two weeks after parturition was between 22% and 26%. Mortality during the first five months was at least 55% of the initial calf crop. Mortality of twin calves was significantly higher than that of single calves. Drowning, entrapment by vegetation, abandonment, injury inflicted by the dam, and predation by brown bears were observed and suspected causes of mortality of calves.

A majority of moose in all age-sex classes were seen most often in bog-meadow, black spruce habitat. Group size increased from the May-August period to October 31, with the greatest tendency toward aggregation occurring in bulls and in cows unaccompanied by calves. Females with calves remained predominantly unassociated with other moose throughout the period of study. Moose migrated from valley lowlands to higher ground beginning in mid-July, with greatest numbers observed in alpine habitat in October and November. Extent of movements of cows with calves was significantly less than that of all cows. Summer post partum home range was probably little more than 1 km^2 for most cows leading calves. All moose feeding on aquatic vegetation, when considered as a group, exhibited one activity peak per day. This peak occurred shortly after dawn. Cows with calves displayed three major peaks of activity daily. Bulls fed uninterruptedly for the longest periods. Length of feeding periods decreased progressively in cows with calves, cows without calves, calves, and yearlings. Females leading calves behaved most shyly when confronted with human beings. Some calves participated in alert toward disturbance. Moose reacted strongly to brown bears, but seldom reacted to black bears when they were in close proximity. Aggressive interactions between females leading calves and other moose were observed. Effective concealment of calves by calf behavior and by maternal "ignoring" of the calf was observed. Nursing was initiated mutually by dam and calf. Two cases of maternal confusion of possession of calves were observed.

OBJECTIVES:

To investigate the extent and nature of mortality of calves in the Jim-Swan Lakes area moose population near Palmer. Natural history of this species and tagging methods will also be investigated.

TECHNIQUES:

On May 28 and May 31, 1966, 59 moose calves were marked with colored ear flags to allow their recognition as individuals. Marking was done using helicopters to separate the calves from their dams and to run the calves down. Concurrently, nine cows with calves were marked by paint applied by throwing Christmas tree ornaments filled with paint. Calf mortality was studied both through aerial counts and through visual and physical recovery of tagged calves during ground observations. Behavior was observed both during aerial counts and from the ground. Aerial counts were flown in PA-18 aircraft shortly after dawn, with the pilot and observer both watching for moose and attempting to make a total count of all moose in the area. When there was any doubt of the sex of a moose, whether or not a cow was accompanied by a calf, or the presence or color of flags, the animal was circled at a very low altitude until the necessary information was obtained.

Ground observations were made from seven observation posts situated within the area on elevated ground, 50-350 m above the valley floor, with the aid of a tripod-mounted 15-60x variable spotting telescope and 6x30 binoculars.

FINDINGS:

Extent of mortality:

Aerial counts: Table 1 shows moose observed during aerial counts and Table 2 shows the decrease in number of calves:100 cows between May 27 and October 31, 1965, as estimated from these counts. Yearlings present from May 27 through June 25, 1965 are listed following the final fall count of calves in 1965, and are assumed to approximate the calf population as it will be present in May 1966.

The cumulative peak of parturition, at which time the ratio of calves:100 cows was at its maximum, occurred about June 1. Results of counts made on May 31 and June 1, combined, indicate that 84.3 calves:100 cows were present on these dates. On the basis of these data and the .375 ratio of tagged calves:untagged calves observed in May and June, supplemented by that sample of 140 cows and yearling females counted in October, a minimal estimate of 150 mature females present on the area throughout the summer was made. Using this estimate, the numbers of calves present on the day of each count were calculated from calf: cow ratios, and are listed in Table 2.

Except for the possibility of a few late births, parturition was probably concluded by June 12. A count made on that date showed only 62.2 calves:100 mature females, or 93 calves present on the area compared to 127 at the peak of parturition. This drop of 26.8% in calves present during the 12 days immediately succeeding peak parturition does not consider the calves born after the peak date, but is nevertheless significant at the 94% confidence level. The decline in estimated calves of 22.1:100 cows is also significant at that level. Counts conducted on June 24 and 25 showed no significant difference in calf:100 cow ratio or in number of calves present from the count of June 12.

Brief and slight flooding of the study area on June 11 caused differential migration of moose from the valley lowlands where counts were made, and inflated the apparent calf:100 cows ratios observed in July and August. Because of this factor and because of the small samples of females counted during this period, the counts flown during these two months are of little use as indicators of calf mortality.

Counts flown on October 30 and 31 showed that countable moose were concentrated above timber line, and that almost all moose had left the valley floor. Although it was impossible to census the timbered area between the valley and the open slopes above, a count approaching a complete census was possible above timber line. It is possible, however, that this count underrepresented females with calves, which may have occupied the timbered areas disproportionately. The count above timber line revealed 42 calves and 140 females -- a ratio of 30.0 calves:100 cows, and an estimated calf population (assuming the estimated population of 150 mature females) of 45. These figures underestimate the number of calves present above timber line, for yearling females were indistinguishable from mature females at this time and were included among the 140 females observed.

An absolute maximum estimate of calves:100 cows and calves present may be made by estimating that 30 yearlings were present among the 140 females counted on October 31, leaving only 110 mature females observed with the 42 calves. This estimate of yearlings present in the sample exceeds a similar estimate of 25, which was derived from yearling:adult female ratios observed during May and June. It could be expected to over-ride any sampling error made in May and June and any bias toward yearling females which may have occurred during the October 31 count. The revised estimate of calves:100 cows present on October 31, allowing for the presence in the sample of 30 yearlings, is 38.2, and the similarly derived estimate of calves present per 150 adult females is 57. Both these estimates are still significantly lower than the June 24-25 estimates at the 99% level of confidence.

As shown in Table 1, the counts conducted in May and June indicated a yearling population of 42.7 yearlings:100 females, or 64 yearlings in the population. This estimate is not significantly lower than either the original or revised estimate for calves present at the end of October. The evidence indicates, then, that in 1965 in the Jim-Swan Lakes area the greatest mortality of calf moose occurred during the first five months after birth, when more than 55% of the calf crop was lost. Within the first five months, the greatest mortality occurred within two weeks after parturition, when approximately 26% of the newborn calves were lost.

Observations and recovery of tagged calves: Forty-three visual and physical recaptures of 28 tagged calves were made between June 1 and October 31. Whereas mortality of nine calves was confirmed between May 31 and June 25, no mortalities were confirmed after June 25. A summary of observed mortalities is given in Table 3.

The nine confirmed mortalities occurring before June 25 represent 15.3% of the 59 calves tagged in May. They comprise only little more than half of the 22-26%

mortality indicated by the aerial counts of June 12 and June 24-25. Even though the area was examined carefully during this period, some carcasses probably escaped detection. The estimate of mortality from recoveries is a minimum estimate of mortality, therefore, and the estimates derived from aerial counts are probably more accurate.

Nature of mortality:

Causes: Causes of confirmed mortality were accidents, predation, and desertion. Of nine confirmed mortalities, two were attributed to accidents. Accidents observed included drowning, entrapment by vegetation, and being kicked or stepped upon by other moose. Two confirmed deaths were the result of predation. Predation by brown bear was observed, and predation by black bears was suggested by evidence gathered. Two mortalities were attributed to desertion of calf by cow. Three confirmed mortalities were from unknown causes.

Accidents: Drowning was the probable cause of death in two instances, although no drowned calf was actually recovered. During the tagging operation, a cow with twin calves was driven across a swollen creek by the helicopter, and one of her calves was swept away and apparently drowned. The female was subsequently observed with her surviving (tagged) calf only, so mortality of the first calf was assumed. Later, on July 1, a similar incident was observed near the study area on the Matanuska River. A large calf was discovered stranded on a small gravel bar in the middle of the river, high due to recent rains. The cow could not be located and, unaided, the calf would in all liklihood have drowned, starved on the bar, or succumbed to other factors without maternal care.

During the tagging operation in 1965, Rausch (verbal communication) observed two calves held by scrub trees. In traveling, whether or not fleeing a helicopter, young calves encounter alders, birches and willows with numerous trunk branchings at heights which may entangle their long legs. The resilience and denseness of these shrubs makes them effective traps, from which a calf might not escape before its desertion or death by starvation or predation.

On May 31, the fresh carcass of a calf tagged on May 28 was recovered near the site of tagging. Uncoagulated blood in the nostrils and the fact that the body was warm indicated that the calf had died very recently. No external wounds were present. The calf was still protected by an aggressive cow. An autopsy conducted on the frozen carcass in November by Kenneth Neiland, Parasitologist of the Alaska Department of Fish and Game, revealed a fractured skull and indicated that this was the cause of death. Probably the fracture was incurred as a result of the calf's being kicked by its dam. Cows often were observed stumbling over calves, especially when agitated. In all other cases observed, the flexibility of the calf's body and the usually soft ground obviated any apparent injury; however, a direct blow to the head could easily crush a calf's skull.

Accidents seem a major cause of mortality in very young moose calves. Drownings are probably of import only during the first month of life. Calves observed in the latter half of July were accomplished swimmers and could negotiate large bodies of water in the face of large waves and high winds. Broken limbs,

entrapment by branches and injuries sustained through the clumsiness of cows also were probably important only during the first few weeks after parturition. By the first of July, calves appeared large enough and robust enough to avoid such injuries. Calves observed in July showed agility and balance comparable to that of adults. With its inexperience being compensated for by the presence of a cow, a calf over a month old is probably no more susceptible to accidents of this type than is an adult moose.

Predation: One instance of brown bear predation resulting in the death of two calves and a cow was observed. Rausch (verbal communication) observed one instance of successful predation by a brown bear and one instance in which attempted predation was unsuccessful.

On June 1, a large brown bear was observed from the air taking a tagged calf close to the carcass of the calf's dam, which the bear had apparently already killed. Subsequent examination of the site revealed that the bear had killed both of a tagged set of twin calves and their dam. Probably, the bear surprised the group of moose, grazing near the edge of a birch-aspen thicket, and killed the cow when she attempted to defend the calves.

On June 2, Rausch (verbal communication) observed a brown bear feeding on a tagged calf in the Willow-Kashwitna area. A cow moose circled the bear nervously 200 m away. On June 7, Rausch observed a calf (probably two to three weeks old) and a cow outrun a brown bear sow with two cubs in a wet hummocky area. On August 28, I observed an adult cow moose, surprised on land near the shore of a large lake, easily outswim a mature brown bear and reach the far shore of the lake, 1.2 km distant, a full five minutes before the bear.

These few instances indicate that a) brown bear predation is a factor in very early mortality of moose calves, and b) this predation occurs for only a short time and moose are capable of escaping from brown bears in most situations, perhaps even when as young as three weeks of age.

Evidence of predation by black bears was all indirect. Black bears were numerous on the study area, and were observed on a majority of days I was in the field. Thrity-five bear scats were examined in the field, and only two (5.7%), probably from the same bear, contained a small bit of moose calf hair. These two scats, examined on June 13, were the earliest found, and the hair they contained could well have been the result of scavenging. This apparent lack of black bear predation on moose calves is in contrast to the situation probably existing on the Kenai Peninsula, which was described by Chatelain (1950). During the spring of 1965, Laurence Ellison (correspondence), a biologist working on the Kenai National Moose Range, discovered two moose calf carcasses, both dead since about June 12 and both fed upon by large animals, probably black bears.

Predation, like accidents, is probably an important mortality factor only in very young calves. Calves more than a month old seem capable of escaping bears under ordinary circumstances and probably fall prey only in unusual situations of surprise or harsh environmental conditions. The little evidence present suggests that predation affects the survival of young calves to about the same extent as does the accident factor.

The demonstrated ability of a brown bear to take a young calf even though it is closely protected, as well as the much greater fear shown by moose at the presence of a brown bear, suggests that the larger bear is the more important predator. Moose were seen in association with black bears on five occasions and with brown bears three times, in addition to the instance of confirmed mortality. Only once did moose respond to the presence within less than 100 m of a black bear, and this response was only a nervous, not precipitous, retreat. On all three occasions when brown bears were encountered at such close range, moose fled precipitously with great agitation. Such fear suggests that dangerous contacts with brown bears are more common than are those involving black bears.

Abandonment: Two apparently deserted calves were recovered on the study area, and one was captured elsewhere in the Matanuska Valley. A fourth calf was observed without a cow present, but desertion was not substantiated.

The first of the apparently abandoned calves was recovered alive within the same square mile in which it had been tagged three days before. A thorough aerial search did not locate a cow near the calf on the day of its recovery, although cow and calf had been photographed running off together immediately after the calf had been tagged. The second "abandoned" calf was recovered on June 16, sixteen days after its tagging. The calf had been dead for about a week, and was unmarked except for wounds in the pelvic and anal regions, almost certainly inflicted by small scavengers. A field examination of the viscera revealed no abnormalities. The rumen was full, and the animal had browsed on willow, spruce, and a small amount of Ledum; however, the plant material in the digestive tract was undigested.

A deserted calf removed from the Matanuska River was described earlier in the discussion of drowning. No cow was observed accompanying one calf during its tagging on May 31. The calf was not subsequently observed, but no further evidence of abandonment was present.

No one explanation can account for all instances of desertion. The tagging process, maternal confusion, physical obstacles, and predation attempts are possible precipitating causes.

Although both deserted calves recovered on the area had been tagged, neither desertion could be positively attributed to tagging. The first calf described was reaccepted by its dam immediately after tagging. Any rejection caused by this disturbance did not occur immediately, and it is difficult to imagine a delayed desertion response. Further, it is doubtful that the calf recovered dead survived for over a week without maternal care, as must have been the case if it was deserted upon tagging.

Immediate reacceptance of tagged calves by females was observed in almost every instance, so it is unlikely that the normal tagging operation caused desertion in a great number of cases. Thirty-four cows were chased more vigorously than others in attempts to mark them with paint. Eighteen of the calves of these cows (53%) were observed with a cow one or more days after tagging. Of all 59 calves tagged, only 28, or 47%, were later observed with cows. Thus, no correlation between degree of harassment of cows and calf mortality was detected, although such a correlation might well have existed.

Maternal confusion and contestation of the ownership of calves was observed twice, and is a possible cause of desertion. It is possible that a calf trapped by a natural barrier, such as a swollen river or a tree limb, might subsequently be unable to rediscover its cow.

Twin differential: Of the nine confirmed mortalities, five involved twin calves. Within 30 days, the original population of 16 recoverable twins decreased by five (31%). In the same period, 45 tagged single calves were depleted by four (9%). These mortality rates are significantly different at the 90% confidence level.

As shown in Table 3, the visual confirmation of three mortalities depended upon the presence of a second tagged twin. Thus, the possibilities of inferring mortality among twins were more numerous than among single calves, so the compared mortality rates may be misleading. However, the unknown probability of the death of the second calf in a set of twins and the difference in probability of recovering a carcass and sighting a painted cow make precise quantitative description of this factor impossible.

Behavioral characteristics observed during tagging substantiate the reality of the mortality differential between single calves and twins. Cows with twin calves seemed content if accompanied by only one calf, and did not actively defend the second calf. When both calves were captured simultaneously, the cow usually fled with the first one released. When only one twin was captured, the dam displayed much less intense agitation and antagonism toward the captors than did cows with single calves.

Tagging-induced mortality: It is unknown how much, if any, mortality was induced by the tagging operation. As mentioned previously, immediate reacceptance of tagged calves by cows was almost invariably the case. Subsequent desertion for reasons associated with tagging seems unlikely. It has been shown that degree of harassment of the cow showed no negative correlation with later observations of the calf with a cow. No obvious injuries to calves occurred during tagging, and most calves fled vigorously when released. One calf was tagged within moments after birth, and was observed in apparent robust health four times, last on October 31. The mortality attributed to injury inflicted by the cow could have been the result of tag-induced hostility in the cow. If this response occurred, however, it did not do so until three days after tagging, a possibility that seems highly unlikely.

The proportion of tagged calves observed during aerial counts decreased significantly from May 31-June 1 through October 31 (Table 1). The large part of this decrease, however, did not occur until after June 24-25, so any differential in early mortality between tagged and untagged calves is not evident from this data.

Behavior:

The accounts of moose behavior presented here result from both aerial counts and observations made from the ground. The former were most valuable in locating the animals and in establishing general patterns of behavior; whereas, the

latter were necessary in gathering detailed observations of individual behavior necessary for the accounts of such things as social, maternal, agonistic, and feeding behavior.

Habitat preferences:

The study area was divided into five habitat types, characterized by topography and dominant flora. Table 4 shows numbers and percent of total observed moose by age-sex class observed during aerial counts in specific habitat types.

No significant change in habitat preference was detected over the course of the summer. However, the count conducted on October 31 found 100% of the animals observed in a different habitat type -- alpine, in the mountains adjoining the study area -- than occupied before. This habitat, characterized by patches of birch and alder 3-4 m high, occurred at 0.9-1.1 km elevation above sea level, and the moose apparently migrated to it following the rut period.

Figure 4 shows that, in general during the study, moose preferred the wet sedge-dwarf birch bog-meadow habitat with "islands" of black spruce that covered most of the study area. Parturition was witnessed exclusively in this habitat, with most births and early hiding taking place on the drier spruce islands. During the months of June, July, and August, moose fed on the vegetation produced by this habitat, utilizing both the shallow lakes and the open meadows, and bedded down in bordering spruce and willow.

The habitat second in preference was the sparse forest of mature birch and aspen covering the dry northeast portion of the area. This habitat, preferred by approximately 15% of each age-sex class, provided food (the open understory allowed much birch and aspen regeneration) and better cover for adult animals than did the bordering meadows to the west and scrub forest to the south.

The one anomaly discovered in the otherwise consistent pattern of habitat preferences concerns the 13% of females with calves preferring the scrub birch, aspen habitat in the dry southeast sector of the area. The vegetation in this area was very dense, and provided secluded places for the bedding of calves. Food was abundant, but presumably less palatable than that in the bog-meadows. The unique behavior of parturient cows in occupying this habitat type is probably due to their selection for the added seclusion it affords.

Within the black spruce, bog-meadow habitat, moose made use of specific features of the vegetation. Most conspicuously, the edges of open bog-meadows and lakeshores were used for concealment by both resting and travelling moose. Calves and older animals almost invariably bedded within 1 m of the edge of willow or spruce islands. In this position, nestled among the hummocks and further obscured by scrubby willows, calves and adults were all but invisible. Examination of beds indicated that the animals sought out drier areas between hummocks, and tended to re-use established beds in these dry areas. Cows with calves moved almost exclusively along the edge of spruce and willow islands and fingers, either moving among the scrub at the edges or just within the periphery of the taller timber. Moose travelling to open areas made maximum use of timber

fingers as concealing factors. When about to enter a lake or bog-meadow, an animal would skirt the open area until it reached a projection of timber, and would then enter the area via this projection.

Open areas -- lakes and bog-meadows -- had use primarily as feeding areas and, as such, often contained groups of animals.

Sociability:

Group size: Group size increased significantly (92% confidence level) from the period of parturition and summer feeding, when 258 of 311 groups observed (83%) consisted of only one moose or a cow and her one or two calves, to the beginning of the post-rut period on October 31, when only 55 of 87 groups observed (63%) were single animals or cows with calves. During the pre-rut summer period, only three groups containing more than four moose each were seen, and no group larger than nine moose was observed. On October 31, ten groups exceeding four moose were seen, and three of these groups were composed of 12, 12, and 20 moose.

Cows without calves and bulls were the two classes contributing most to the seasonal change in group size. During the May-August summer period, 32% of 99 females unaccompanied by calves and 56% of 46 mature bulls seen were solitary. During this period, 36 additional females without calves were in groups of only two animals. On October 31, 65% of 100 cows without calves and 90% of 49 mature bulls seen were in groups of three or more moose. Both these changes are significant at the 99% confidence level.

During summer and autumn, females with calves were usually not associated with other moose. No significant change was noted in group size on October 31, but eight females with calves were observed to be associated with other moose on that date. Yearlings, which were indistinguishable from other moose on October 31, were most often solitary or in association with one other moose during the post parturition and summer season.

The observed changes in group sizes correlated well with rutting activity and the concurrent change in habitat by the population. The open alpine environment occupied on October 31 seemed conducive to grouping. Further, rut had just finished at the time, and almost all of the groups observed were heterosexual in composition.

Social interactions: All social interactions observed, with the exception of those involving cows and their calves, were of a tenuous nature. Groups of three, four, and up to six moose associated loosely in feeding areas in the summer, and, although moose within the groups did not interact specifically with one another, the group as a whole had an amorphous consistency of movement. Though seldom less than 30 m from each other, all moose in a group moved about large feeding areas together, and most often, when one of a group left the area, all other moose in the group followed, one at a time, by the same route within 5-10 minutes. "Clubs" of yearlings (Altmann, 1960) behaved in much the same manner, although association within such groups seemed to be tighter than

within adult feeding groups. No dominance order was detectable in any such groups.

Many associations of yearlings with adult female moose were of a tenuous nature, and showed no discernable interactions. In three cases, however, yearlings were seen with cows in interactions of an offspring-maternal nature, in which the yearling followed the cow closely and "cued" on her movements in much the same way as a calf. One such instance involved a cow marked with red paint (indicating that she had had a calf during the tagging period) associating with a yearling almost 20 days after the peak of parturition. Apparently, the cow had "readopted" a yearling after the early loss of her calf, although it is not known whether the readopted yearling was actually the cow's offspring. This association lasted for at least two days.

Movements and home range:

Seasonal migration: Moose began leaving valley lowlands beginning in mid-June or early July. The flooding of the valley on July 11 may have hastened the emigration, which was detected by a steady decrease in the number of moose seen per hour of aerial counting, but normal activities preceding rut were probably its primary cause. As early as August 21, almost a month before full rut, apparent movements of the heaviest concentrations of moose toward the head of the valley was noted, and moose were first observed on bluffs adjoining the area on that date.

The rutting migration took the Jim-Swan Lakes moose population to altitudes of approximately 1000 m, almost precisely at tree line, and, in some cases, as far as 10 km from the area on the slopes of a nearby mountain. A heavy concentration (48 in 2.5 km^2) of moose was also seen in the alpine-like vegetation close to the Knik Glacier.

Seasonal migration seemed to have lateral as well as altitudinal limits. Whereas, on all other areas, moose were seen at tree line, on the broad, gently sloping bed of one creek, none were present more than 6.5 km from the valley floor, where the altitude was only 750 m and the vegetation was still more dense than at tree line.

Home range: Home range was estimated from hunter returns of tags from animals killed during 1963, 1964 and 1965 (Alaska Department of Fish and Game files) and from observations of specific moose over a period of time during the summer and fall of 1965. Cows leading calves maintained a smaller home range than other moose, and their home range was smaller during the first five months after birth of the calf than thereafter. Average distance from the tag site of 19 adult females recovered in the Matanuska Valley was 10.6 km. The same distance for 25 tagged calves visually recovered before October 31, 1965 was 2.9 km, and for 26 calves seen before and on October 31, was 4.0 km. It is unknown how many of the 19 adult females recovered were leading calves.

Ground observations suggested that many cows with calves maintain a home range even smaller than that indicated by the above figures, especially during the calf's very early life. Cows with calves were observed for as long as six

consecutive days within areas of less than 1.6 km^2. Two cows with calves first seen near a large lake were observed at the same spot 40 days later.

Feeding:

Feeding periods: Bulls spent the longest periods in uninterrupted feeding as a general rule, with most of them feeding for at least 60 minutes at a time. In contrast, yearlings fed intermittently for long periods, but the longest observed period of uninterrupted feeding by a yearling was 39 minutes. Cows without calves fed generally for a little less than 60 minutes (average for seven periods of seven different cows, 54 minutes). Twenty-four complete feeding periods of cows leading calves averaged 66 minutes each, and 26 complete feeding periods of calves averaged 37 minutes.

Geist (1960) found that in winter most calves and cows began feeding simultaneously and bedded down at the same time. During summer, calves on the Jim-Swan Lakes area most often left hiding after their dams had fed for 3-4 minutes, and bedded down while the females remained feeding. In about half the cases observed, the calf reappeared momentarily one or more times to approach the cow or feed while the cow continued feeding, and then returned to hiding on its own. In the other cases, the calf re-emerged only to greet the cow as she entered the brush, or was not seen again after bedding down. Feeding cows with calves hidden in the brush spent a greater proportion of time in alert and semi-alert posture than did other feeding moose, but seldom directed their alert behavior directly at the calf.

One peak in feeding activity was detected for all moose. This peak occurred from 0300 to approximately 0700, Alaska Standard Time, and roughly corresponded with the hour after dawn, the wide spread probably being a result of the change in the hour of sunrise from May through August. Cows with calves exhibited three major peaks of feeding activity during the summer. Their earliest peak occurred between 0600 and 0700, and was roughly analagous to the post-sunrise peak for all moose. A second peak was evident between 0900 and 1100, and a third occurred shortly before sunset, between 1700 and 1800.

Reaction to disturbance:

Cows leading calves behaved most "shyly" when confronted with disturbance from sources other than other moose. It was often possible for me to approach a feeding group of bulls, yearlings, and cows without calves without causing any manifestations of alarm other than a gradual drifting away of the group. Whenever an attempt was made to approach a cow with a calf, the animals left rapidly, not allowing nearly so close an approach as was possible with other moose. Often, stalking from a distance of as much as 300 m resulted in the silent disappearance of cow and calf. Truly precipitous flight from a human being was never observed in a cow with a calf. The common means of retreat was slow, with frequent pauses for broadside alert in the direction of disturbance. In about half the instances observed, the calf ran ahead, seemingly determining the path of retreat. On two occasions in August, calves were

observed to participate in alerts to disturbance, exhibiting the same head high, ears up, broadside posture seen in cows.

In reacting to other moose, cows with calves most often displayed the same shy behavior they exhibited toward human disturbance. When cows did defend their calves from close approach by other moose, they exhibited no evidence of the defense of a "sliding territory," as described by Altmann (1958). Rather, cows seemed to defend their calves as entities, often allowing close non-threatening approaches by other moose. In several cases, cows allowed other moose to move between themselves and their calves, and to approach the calves within 20-25 m without responding with more than a brief alert glance in the direction of the calf.

Protection of calves:

Concealment of the calf was at least as important a protective mechanism as aggressive defense of the young. Calves were the best concealed of all moose, as indicated by the fact that the ratio of calves:100 cows seen during aerial observations to the same parameter seen during ground observations was larger than the same ratio in any other age-sex class. Calves were hidden from observation by their own behavior and by the behavior of their dams. Calves characteristically bedded down in concealing brush while their dams fed in the open, and the dams almost universally maintained an "indifferent" manner that very effectively complemented the hiding behavior of the calf. Cows fed and bedded down, within 10-20 m of bedded calves, for periods as long as 90 minutes, without giving any indication of the presence of the calf. In one extreme case, a cow grazed almost 300 m from her bedded twin calves for more than an hour. The calves remained bedded until her subsequent approach.

Nursing:

Of seven instances of nursing behavior observed, only two were initiated by the calf. In all other cases, nursing appeared to be by mutual initiation, with the cow and calf meeting at a point half-way between their respective former positions. In all cases, nursing was terminated when the cow took one step away. Twin calves were observed nursing simultaneously on two occasions.

Table 1. Results of aerial counts

Date	Time	Total Time	Moose /hr	Calves (Tagged/Untagged) Cow /0	Cow /1	Cow /2	Cow /?	Yearlings W/0 Cows	Cow /1	Cow /2	Male	Total Cows	Total Cows-Cows/?	Total Calves	Total Moose
[a]27 May	0340-0507	1:27	66.2	9	26	2	1	10	4	1	7	43	42	30	96
[a]31 May	0100-0700	3:15	44.3	13	12/22	3/5	9	4/16	0	2	12	66	55	50	144
[b] 1 June	0310-0440	1:30	29.3	2	6/2	0	8	6	1/4	0	2	23	15	8	44
12 June	0325-0510	1:45	42.9	8	7/7	1/1	5	1/5	6	*	10	37	32	18	75
24 June	0325-0450	1:25	5.44	11	4/11	2	2	12	2/3	0	6	35	33	19	77
25 June	0335-0500	1:25	46.6	7	2/10	1	7	2/14	0	1**	4	30	23	14	66
12 July	0812-0850	0:32	36.8	0	4	0	0	2/1	0	0	2	4	4	4	14
20 July	0402-0541	1:39	20.0	6	2/6	0	0	2	2	0	5	16	16	8	33
5 Aug.	0419-0600	1:41	17.9	0	5	0	5	2	1	0	11	11	6	5	30
11 Aug.	1409-1523	1:14	19.5	0	1/6	0	4	3	0	0	3	11	7	7	24
21 Aug.	0536-0636	1:00	20.0	2	6	1	0	3	0	0	0	9	9	8	20
[c]30 Oct.	(Below timber line) 0837-1026	1:49	1.3	2	0	0	0	0	0	0	0	2	2	0	2
31 Oct.	(Above timber line) 0921-1151	2:30	97.2	102	3/31	1/3	0	1/0	0	0 (20 young 40 adult)	60	140	140 (115)***	42 (115)***	243

[a]Rausch observer

[b]Pilot did not participate in observations

[c]Yearlings no longer distinguishable with accuracy

*1 yearling/2 cows

**2 cows/3 yearlings

***revised estimates, discounting yearling females

Table 2. Estimates of calves:100 cows and total number of calves present, derived from aerial counts, showing estimated yearlings through June with a revised estimate of calves on October 31.

Date	Cows/?= Cows/1	± 2 Std.Dev.	Ignoring Cows/?	± 2 Std.Dev.	Cows/1= Cows/?	± 2 Std.Dev.	Ignoring Cows/?	± 2 Std.Dev.
27 May	67.4	53.1- 81.7	71.4	57.4- 85.4	101	79.7-122.5	107	86.2-128.0
31 May 1 June	84.3	76.7- 91.9	80.6	71.2- 90.0	127	114.9-138.1	121	106.9-134.9
12 June	62.2	46.2- 78.2	56.3	38.7- 73.9	93	69.4-117.2	85	58.1-110.9
24 June 25 June	65.6	54.5- 76.7	60.0	46.8- 73.2	98	80.6-116.2	90	70.2-109.8
12 July	100	50 -150	100	50 -150	150	0-300	15	0-300
20 July	50	25 - 75	50	25 - 75	75	37.4-112.6	75	37.4-112.6
5 Aug. 11 Aug.	95.5	86.7-104.3	92.3	77.6-107.0	143	130.1-156.5	138	115.8-160.2
21 Aug.	88.9	67.9-109.1	88.9	67.9-109.1	133	101.8-165.0	133	101.8-165.0
31 Oct.	30.0	22.3- 37.0	30	22.2- 37.8	45	33.4- 56.6	45	33.4- 56.6
Revised estimate for 31 Oct.	38.2	28.8- 47.6	38.2	28.8- 47.6	57.3	43.3- 71.3	57.3	43.3- 71.3
27 May- 25 June yearlings:100 cows	42.7	36.3- 49.1	50.0	43.0- 57.0	64	59.2- 69.0	75	64.4- 85.6

Table 3. Confirmed calf mortalities

Calf No.	Date	Method of Confirmation	Probable Cause of Death
10	31 May	Recovered live	Deserted by female
27	31 May	Fresh carcass recovered	Kicked in head by dam (?)
2*	1 June	Observed predation - carcass recovered	Killed by brown bear (Cow also killed)
3*	1 June	Observed predation - lower joint of leg and hoof, piece of scapula, and end of femur recovered	
34	Before 16 June	Carcass recovered	Desertion by female
41*	Between 6 June & 24 June	Cow and other twin observed (6/24 and 6/25) unaccompanied by this twin	Unknown
Unknown	Before 19 June	Cow with red paint unaccompanied by calf observed 18, 20, 24, and 25 June	Unknown
Twin of 1*	Before 25 June	Cow and other twin observed (6/25) unaccompanied by twin	Unknown (drowning?)
Twin of 53*	Before 25 June	Cow and other twin observed (6/25) unaccompanied by twin	Unknown

*one of set of twins

Table 4. Habitat preferences of age-sex classes of moose during spring and summer, as indicated by aerial observations, showing number and (%) of moose of each class observed in each type of habitat.

	Habitat Type					
	1	2	3	4	5	Total
Cows With Calves	16(.07)	38(.15)	8(.03)	0(.00)	185(.75)	247(1.00)
Cows Without Calves	14(.13)	16(.15)	2(.02)	0(.00)	74(.70)	106(1.00)
Mature Males	0(.00)	5(.18)	2(.07)	0(.00)	21(.75)	28(1.00)
Yearlings	0(.00)	8(.13)	3(.05)	0(.00)	48(.80)	60(1.00)

Habitat Types:

1. Dry, scrub Betula papyrifera and Populus tremuloides.
2. Dry, mature B. papyrifera and P. tremuloides.
3. Mature Picea glauca and Populus tricocarpa, with dense understory of Oplopanax horridus.
4. Disturbed (logged) mature P. tricocarpa and P. glauca.
5. Wet bog-meadows (sedges, B. nana, Salix spp.) with "islands" of Picea mariana and Alnus crispa lining stream banks.

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-15-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: L TITLE: Caribou

JOB NO.: 7 TITLE: The Caribou Warble Fly

PERIOD COVERED: July 1, 1965 to June 30, 1966

ABSTRACT:

Warble fly larvae emerged and dropped from two captive caribou during a 24 day period from May 25 through June 17, 1965. Larvae failed to form puparia at 5°C and 10°C, but at 20°C and 25°C puparia were formed within three days. A direct correlation was found to exist between temperature and adult emergence. At 25°C emergence occurred within 15 days, and at 20°C it occurred at 22 days. Longevity of adults ranged from two to eight days.

The degree of infestation of reindeer with warbles on Nunivak Island was found to average 114 for bulls, 64 for steers and 63 for females. Older bulls had a higher incidence of infestation than younger males.

OBJECTIVES:

To investigate aspects of the ecology of the caribou warble fly, Oedemagena tarandi, including the influence of weather conditions on the free living stage and the relationship of the warble fly to the physiological status of the host species.

TECHNIQUES:

For the pupal development study, the larvae were collected as they emerged and dropped to the ground from two female caribou that were held in captivity on the University of Alaska campus. The larvae were then placed in peat moss where they were allowed to pupate. Groups of these larvae were then placed in 5°C, 10°C, 20°C, and 25°C and the pupation periods determined. A control group was left in ambient temperature at the caribou pens. Daily maximum and minimum temperatures and moisture conditions were recorded. The percent survival to the adult form was recorded and adult longevity experiments were conducted.

The second part of the study was conducted on Nunivak Island in conjunction with the normal reindeer harvest. Each animal was weighed (both whole and carcass weights determined) and the carcass was graded to give a relative idea of physiological condition. The jawbones were collected for age determination and hind foot measurements were recorded. Each hide was tagged and the number of the present year's warble fly scars were counted after the hides were refleshed so that all of the scars were visible.

FINDINGS:

A total of 272 warble fly larvae were dropped from two female caribou. This figure includes dead skins and warbles that were destroyed by the caribou stepping on them; 163 viable larvae were placed in four control temperature chambers and a control group left in ambient temperature. The dropping of grubs took place over a period of 24 days beginning on May 25 and ending on June 17, 1965. Among the larvae placed in 5°C and 10°C, none formed a puparium, however, among larvae placed in 20°C and 25°C all formed puparium within three days. A direct correlation between temperature and adult emergence was observed. Adults first emerged within 22 days in 20°C and 15 days in 25°C. Among the larvae used in the pupal development studies, 56.09 percent emerged as adults in the control group, 53.57 percent in 25°C and 53.12 percent in 20°C. None formed a puparia or emerged as adults in 5°C and 10°C. Attempts to stimulate mating and egg deposition of the adult flies were not successful. Several adult warble flies were kept in room temperature and their longevity ranged from two to eight days.

Among the reindeer examined on Nunivak Island, all were infected with warble fly larvae. The degree of infestation is as follows: Bulls--average 114.33 scars per animal - range 7 to 417; steers--average 64.40 scars per animal - range 5 to 207; females--average 62.74 scars per animal - range 9 to 183. Grading of the carcass (1=low, 2=medium and 3=high) based on fat deposition and finish was: Bulls--2.68, steers--2.42 and females--2.20. The carcass weights represented 47.29 percent of the total weight for bulls, 44.60 percent for steers and 41.88 for females. The average live weight of the bulls was 250.75 pounds, steers 240.0 pounds and 197.7 pounds for females.

The older bulls had the greatest degree of infestation while the females had fewer scars. Since only a few white animals get through the slaughter process, it was not possible to determine if the warble flies are attracted by white areas as has been reported by several observers.

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-15-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: M TITLE: Bear

JOB NO.: 7 TITLE: Ecology of the Black Bear

PERIOD COVERED: July 1, 1965 to June 30, 1966

ABSTRACT:

Green vegetation dominated the spring diet of black bears in Interior Alaska. Equisetum was present in 86 percent of the sample units and appeared to be the main staple of the spring diet. Blueberries (Vaccinium uliginosum) are the most important item in the fall diet, although other berries, particularly low-bush cranberry (V. vitis-idea), also are used extensively. Most animal matter consumed by bears is in the form of carrion, although ants and wasps were found in several stomachs. Garbage was found more frequently in spring material than in specimen material collected in the fall.

Distribution of bears appears to be governed mainly by food availability with particular reference to the abundance and availability of berries in late summer and fall. Mean litter size for 1964 (10 litters) was 1.50 and for 1965 (20 litters) 1.85. Of 16 bears examined, 12 were found to be infested with intestinal parasites (cestodes and ascarids).

OBJECTIVES:

1. To establish population structure and welfare.
2. To determine basic food habits in relation to food abundance.

TECHNIQUES:

Much of the early field work involved contacting and alerting potential cooperators. Black bear observation forms and specimen forms were prepared and distributed in conjunction with this phase of the work. The former provided information on litter size, seasonal distribution within the various habitat types, and color phases. The latter provided general harvest data including place and date of kill, sex, approximate size, color, and condition.

Most specimen material was obtained from hunter-killed or nuisance bears, although three animals were collected by the investigator. Skulls, reproductive tracts, and complete digestive tracts were collected from each specimen. In addition, long bones, pelvis, liver, and diaphragm were collected from some bears and complete measurements and weights were taken whenever possible.

As this study ultimately emphasized food habits work, lab work involved analysis of stomach and intestinal contents, and scats almost exclusively. Stomach contents were sampled and segregated as completely as possible, and data were

recorded in terms of frequency of occurrence and percentage volume (measured). In most cases small items recognizable as individual (such as fruits) were enumerated. Contents of intestine and scats were recorded in terms of frequency of occurrence and estimated percentage volume. For the purpose of this study, the season of bear activity was divided into two seasons: 1) spring - emergence from winter dens through 15 July, 2) fall - 16 July through return to winter dens. The cut-off point, 15 July, corresponds approximately with the beginning of the ripening of many berries, an important event in the lives of Interior Alaskan black bears. Specimen material used in the food habits study includes the following: 23 stomachs (12 spring, 11 fall); 16 intestines (8 spring, 8 fall); and 44 scats (16 spring, 28 fall).

An attempt was made during the 1965 field season to evaluate berry production in each of three habitat types--deciduous forest, spruce forest, and tundra--in the Deadwood Creek drainage near Circle Hot Springs, Alaska. Plots were set up in berry patches prior to the appearance of berries, and were sampled after the ripening of blueberries in mid-August. Numbers and weights of blueberries (Vaccinium uliginosum), cranberries (V. vitis-idea) and crowberries (Empetrum nigrum) were recorded for five subplots (.25m^2) within the 11 plots (25 m^2) established in each habitat type.

FINDINGS:

Food Habits:

Table 1 lists the food items which seemed to be the most important to Interior Alaskan bears in 1964 and 1965 (from stomachs and scats only). For a complete list of all foods consumed during these two years, the reader is referred to the thesis.

Green vegetation: Green vegetation proved to be by far the most important component of the spring diet of Interior Alaskan black bears. Various unidentified grasses (Gramineae), the shoots and succulent stems of wild rhubarb (Polygonum alaskanum), and the young stems and leaves of northern bedstraw (Galium boreale) and lousewort (Pedicularis sp.) occurred occasionally, but Equisetum, present in 86 percent of the spring sample units, was the real staple during this season. The largest stomach examined contained nearly five liters of shoots and young stems from the swamp horsetail, E. limosum. The bear involved, a large male, was standing in two feet of water feeding on this emergent when shot. A number of reports of other bears standing belly-deep in swamp water "feeding like moose", indicates that this was not an exceptional case. E. limosum was identified in the stomachs and intestines of two bears, both collected in May, and composed 90 percent (or more) by volume, of each.

All other occurrences of Equisetum were from samples collected in non-marsh situations and involved the common horsetail (E. arvense) and/or the meadow horsetail (E. pratense). Distinction between these two species could not be made with certainty. However, on the basis of silica spicule characteristics as described in Gray's Manual of Botany, approximately 50 percent of these occurrences probably involved the former of these two species only, and the rest

involved either or both. This E. arvense-pratense complex then, comprised the most important spring food in upland habitats, and it continued to be important through the first two or three weeks of the fall season. With respect to fall, the leaves of arctic lupine (Lupinus arcticus) proved to be the only other green item of even minor importance.

A number of items such as the leaves of Labrador tea (Ledum decumbens), dwarf birch (Betula glandulosa), and willow (Salix spp.), and the needles of spruce (Picea sp.) had high frequencies of occurrence, particularly in the fall, but nearly always occurred at the trace level. These are believed to have been ingested incidentally to other foods, especially berries.

Fruit: Among the various fruits available in Interior Alaska, two species of Vaccinium, V. vitis-idea (lowbush cranberry) and V. uliginosum (blueberry) are the most important. The former overwinters well and contributes much to the spring diet in some areas. In addition, in the late fall cranberries become important after the first few frosts (which effectively reduce the availability of blueberries and increase the sugar content of the cranberries themselves). But blueberries, when they are available, are by far the most important fall food. Highbush cranberries (Viburnum edule), crowberries (Empetrum nigrum), and rose hips (Rosa acicularis) are occasionally taken in fairly substantial amounts, particularly in better-drained habitats in the fall.

Animal: Most vertebrate material reported here appeared to be carrion. Snowshoe hare (Lepus americanus), the most common item in this category, was found throughout both seasons but seemed to be slightly more important in the spring. Hind feet and pieces of hide are the most persistent remains of hare kills, and these were the Lepus parts involved in most occurrences. Moose (Alces alces) meat in one stomach contained hundreds of maggots, thus attesting to its carrion nature. Many other moose occurrences were suspected carrion because of proximity of specimen collection points to known moose kills. The wing of a female goldeneye (Bucephala sp.), both wings and feet of a varied thrush (Ixoreus naevius), and pieces of fish skin in one stomach suggested that the bear involved had been cleaning up after a smaller carnivore or perhaps a raptor. A fledgling white-crowned sparrow (Zonotrichia leucophrys) and two species of microtines found in my analyses were probably captured by the bears involved, but these were one-time occurrences.

Insects of the order Hymenoptera constituted an important proportion of the animal food consumed. Adults, eggs, and pupae of ants (Formicidae) and wasps (Vespidae) occurred frequently, the former family being more important in the spring season and the latter in the early fall.

Other: Garbage, material discarded by human beings, was taken more often in the spring than it was in the fall. Bears that ate garbage usually ate large amounts. Debris refers to naturally occurring items that were obviously accidental, or at least incidental. Pieces of rotten wood, which often occurred when ants were present, wasp nest material, and small stones were common debris items.

Seasonal distribution and activities:

In 1965, the first reported bear sighting of the year was on 1 May and the last occurred on 2 October, thus the 1965 bear season was at least 154 days long. No reports were received in the spring of 1964, but the last sighting during that year was 4 October. These data plus interviews with experienced outdoorsmen indicate that the season of activity for an Interior Alaskan black bear is usually five to five and one-half months in duration, beginning in early May and ending in early to mid-October. It follows that six and one-half to seven months of the year are spent in the winter den.

As would be expected, the distribution of bears in space seems to be governed largely by food availability. Throughout May and June and into July, bears are observed most often in river bottom, lakeshore, and other lowland situations where they are feeding largely on succulent green vegetation. In addition, Rausch (personal communication) says that in the early spring, bears are commonly seen in these same areas feeding on winter-killed moose. When they are not in the wetter areas, bears seem to spend much of their time in spring in deciduous forests where lowbush cranberries left over from the previous year seem to be the main attraction. Also, it is at this time of year that bears seem to be the most wide-ranging in search of food, and garbage dumps, campground trash cans, and human habitations are common objects of bear visits.

Observations show that between mid-July and early August a major shift of local bear populations occurs, with most bears moving from the lowland spring areas to higher country. The shift is almost certainly related to the ripening of berries, particularly blueberries, in the higher areas. From this time until mid-September, frosts reduce blueberry availability (if the blueberry crop has been adequate), bears remain mostly in alpine situations. After the blueberry season is over, it appears that many bears move back down into forested areas where scats and stomach contents show that other fruits which have been largely ignored until this time, especially cranberries and crowberries, are utilized. Denning follows; it is not known for sure where most Interior Alaskan bears den, but the three dens and den areas I have heard of were at low (valley bottom or near valley bottom) elevations.

Litter Size:

Table 2 lists Interior Alaskan black bear litter sizes for the two years studied. The mean litter sizes given compare with 1.96 for 23 Southcentral Alaskan litters and 2.15 for 20 Michigan litters as given by Erickson, et. al. (1964). These comparisons plus comparisons with literature from other areas indicate that Alaskan litters (speaking primarily in terms of the number of cubs which emerge from the winter den), are typically smaller than litters in areas farther south. As has been discussed in the thesis, the condition of the female at the beginning of the denning period and the duration of the denning period are probably the two most important factors governing the size of the litter which actually emerges from the den in Interior Alaska. It seems likely that condition is related to the abundance of blueberries in the fall. The relative "earliness" or "lateness" of the spring is the important aspect of denning duration.

Parasites:

Parasites encountered during this study were intestinal helminths discovered incidentally to the food habits work. Of 16 bears examined, 12 (75 percent) were infested with cestodes and/or nematodes. All cestodes examined proved to be cyclophillideans, probably Taenia spp. All nematodes appeared to be ascarids. Some heavy infestations were found as an examination of Table 3 will show.

Berries:

Results of the berry sampling done in 1965 are shown in Table 4. Much more work is needed to provide between year and between area comparisons before anything conclusive can be said about berry production in Alaska. At Deadwood Creek, deciduous forest proved to be the most productive habitat, due largely to its excellent lowbush cranberry production. Within the deciduous forest, mature, relatively open forest with little shrub understory provided the best crops.

Open spruce forest, including some muskeg situations, was the best blueberry-producing habitat in this area. However, the most productive patches occurred at the edge of a 20 year-old burn.

Tundra produced poorly in this area in 1965, and this was likely because two violent thunderstorms, which occurred on 27 and 28 June, knocked most of the flowers from the relatively unprotected alpine blueberry plants in this area.

Blueberries, shown by food habits studies and observation to be the most used food in the fall, provided the greatest weight of material per berry in all habitats.

Population density:

Aerial transects flown over the Minto Flats on 26 May 1965 revealed an exceedingly minimal figure of one bear for each 10-13 square miles of this lowland area. New foliage on deciduous trees in the area limited visibility which had been good on a reconnaissance flight a few days earlier.

Table 1.

Food Items	Season	23 Stomachs Freq.	% Trace	Mean % Vol.	44 Scats Freq.	% Trace	Mean % Vol.
GREEN VEGETATION:							
Equisetum spp.	Spring	0.92	9.1	61.8	0.94	0.0	51-75
	Fall	0.45	20.1	36.2	0.21	16.7	26-50
Polygonum spp.	Spring	0.17	50.0	2.4	0.00		
	Fall	0.00			0.00		
Lupinus arcticus	Spring	0.08	100.0	trace	0.00		
	Fall	0.36	50.0	12.0	0.18	80.0	1-5
Pedicularis spp.	Spring	0.17	0.0	16.0	0.00		
	Fall	0.09	100.0	trace	0.00		
Gramineae	Spring	0.33	0.0	12.0	0.44	42.9	1-5
	Fall	0.27	33.3	1.6	0.39	63.6	6-25
FRUITS:							
Vaccinium uliginosum	Spring	0.17	100.0	trace	0.13	50.0	76-100
	Fall	1.00	9.1	49.9	0.79	0.0	51-75
Vaccinium vitis-idea	Spring	0.58	14.3	22.5	0.75	8.3	6-25
	Fall	0.64	85.7	10.4	0.39	36.4	51-75
Rosa acicularis	Spring	0.17	100.0	trace	0.00		
	Fall	0.73	50.0	24.8	0.29	12.5	6-25
Empetrum nigrum	Spring	0.00			0.06	0.0	6-25
	Fall	0.36	25.0	8.0	0.25	50.0	6-25
Viburnum edule	Spring	0.08	100.0	trace	0.00		
	Fall	0.18	0.0	4.25	0.18	0.0	6-25
ANIMAL:							
Lepus americanus	Spring	0.33	0.0	13.4	0.38	0.0	6-25
	Fall	0.45	40.0	5.6	0.36	20.0	6-25
Alces alces	Spring	0.08	0.0	2.5	0.00		
	Fall	0.18	50.0	43.7	0.14	50.0	6-25
Formicidae	Spring	0.33	50.0	11.6	0.31	0.0	6-25
	Fall	0.27	66.7	1.4	0.11	33.3	6-25
Vespidae	Spring	0.08	100.0	trace	0.00		
	Fall	0.45	20.0	17.5	0.18	20.0	1-5
OTHER:							
Garbage	Spring	0.25	33.3	93.3	0.00		
	Fall	0.09	0.0	10.8	0.18	60.0	26-50
Debris	Spring	0.33	0.0	5.6	0.06	0.0	26-50
	Fall	0.64	14.3	16.0	0.18	0.0	6-25

Table 2. Black bear litter sizes, 1964 and 1965.

Year	Total Litters No.	%	One-cub Litters No.	%	Two-cub Litters No.	%	Three-cub Litters No.	%	Cubs per Litter Mean
1964	10	100	5	50	5	50	0	0	1.50
1965	20	100	6	30	11	55	3	15	1.85
	30	100	11	37	16	53	3	10	1.73

Table 3. Intestinal parasites from 16 Interior Alaskan black bears.

Specimen No.	Date Taken	Parasites Present	Number	Vol. (cc)	Wt. (g)
2-64	VI-28-64	nematodes	4	-	-
3-64	VII-8-64	none	0	-	-
105-65	V-26-65	none	0	-	-
109-65	V-31-65	none	0	-	-
110-65	V-31-65	cestodes	1-2	-	-
112-65	VI-5-65	none	0	-	-
114-65	VI-9-65	nematodes	1	-	-
		cestodes	-	19	13.9
118-65	VI-25-65	cestodes	-	78	40.4
126-65	VII-30-65	cestodes	-	125	72.0
7-64	VIII-24-64	nematodes	13	1	-
		cestodes	-	8	-
8-64	VIII-25-64	nematodes	18	11	11.3
		cestodes	-	62	63.0
9-64	VIII-27-64	nematodes	29	8	7.6
10-64	IX-4-64	nematodes	4	-	-
		cestodes	-	-	-
12-64	IX-12-64	nematodes	249	101	106.8
131-65	IX-17-65	nematodes	1	-	-

Table 4. Results of the berry sampling, 1965.

	Blueberry		Cranberry		Crowberry		Total Berries
	No.*	Wt./100	No.*	Wt./100	No.*	Wt./100	No.
DECIDUOUS FOREST							
Total (11 plots)	821		1726		529		3074
Mean per plot	74.6	29.6	156.9	15.8	48.1	20.7	279.5
SPRUCE FOREST							
Total (11 plots)	1060		517		575		2152
Mean per plot	96.4	28.4	47.0	15.8	52.3	20.2	195.6
TUNDRA							
Total (11 plots)	381		256		59		694
Mean per plot	34.6	25.6	23.3	14.2	5.4	14.8	63.1

*Number of berries per m^2.

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-15-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: P TITLE: Disease, Parasite and Data Collections

JOB NO.: 8 TITLE: Musk ox Surveys

PERIOD COVERED: July 1, 1965 to June 30, 1966

ABSTRACT:

A total of 4,640 toe-point and line-point vegetation samples were taken which yielded a breakdown into seven major range types for Nunivak Island. Herbage clippings indicate approximately 6,000 lbs./acre and 3,400 lbs./acre, respectively, available for animal use from the Dune Grass-Forb type and the Streamside Grass-Willow type. Five hundred and twelve musk ox were counted in an aerial census, of which 110 were calves.

OBJECTIVES:

To determine the basic population dynamics and range interrelationships of the Nunivak Island musk ox herd.

TECHNIQUES:

Field work was conducted on Nunivak Island in the Bering Sea during the summer of 1965 from July 1 to August 27, and during late winter from March 11 to 27, 1966.

Studies consisted primarily of vegetation sampling. Toe-point and line-point methods were used to determine stand composition preparatory to typing of the range on the island. Herbage was clipped from 9.6 sq. ft. plots in areas typifying preferred musk ox range to arrive at some idea of herbage yield in the Dune Grass-Forb type and Streamside Grass-Willow type.

During the latter part of August, 14 utilization cages were put out on the island in areas of known musk ox use. Six were placed in the vicinity of Dooksook Lagoon, six near Duchikthluk Bay and two on Twin Mountain. Cages were built of hogwire anchored on a tripod arrangement of three 2"x2"x7' poles driven into the ground. Check plots were established 30 ft. from the cages for comparison when the plots are inspected in the summer of 1966.

One hundred thirty-eight plant species were collected and identified.

Musk ox were observed whenever the opportunity arose. The annual musk ox census was flown from July 22 to 25 in a De Haviland Beaver (N-715) piloted by Refuge Supervisor Spencer with Refuge Manager Lensink and the writer as observers.

The visit to the island in March 1966 was concerned principally with musk ox winter range relationships. The island was surveyed for musk ox and reindeer distribution and observations of winter feeding were made.

Transportation consisted of native fishing boat and U.S.F.W.S. Cessna 180 during the summer and native snowplane during the winter.

FINDINGS:

During the summer, 4,640 toe-point and line-point readings were taken. A preliminary breakdown of range types is suggested as:

Range Type	Dominant Genera
Dune Grass-Forb	Elymus, Angelica
Streamside Grass-Willow	Calamagrostis, Salix
Wet Tundra Sedge-Willow	Carex, Salix
Dry Tundra Crowberry-Sedge	Empetrum, Carex
Grass Hummock	Festuca, Carex
Alpine Tundra Dryas-Crowberry	Dryas, Empetrum
Barren Rock	

Herbage clippings which were taken from the Dune Grass-Forb type and the Streamside Grass-Willow type indicate herbage available for animal use to be in the neighborhood of 6,000 lbs./acre and 3,400 lbs./acre, respectively. These figures are based on a very limited sample (8) and may not be representative for these types over the entire island. Values are based on air-dry weight. Production of willow leaves (Salix pulchra) alone is above 4,000 lbs./acre.

The results of the 1965 musk ox census are presented in Table 1. Five hundred and twelve musk ox were counted, of which 110 were calves. This compares favorably with 1964's figures of 467 and 102, respectively.

Table 1 - 1965 Musk Ox Survey Data

	No. of Observations	No. Seen	Ave./Observation
Calves	49	110	2.24
Yearlings	33	66	2.00
Subadults*	25	39	1.56
Cows	50	134	2.68
Bulls	88	99	1.13
Herds only**	59	461	7.81
Bulls only**	44	51	1.16
Herds & Bulls	103	512	4.97

*Subadults are difficult to classify to sex, although this group is presently thought to be predominantly males.

**Observations were always either of herds of mixed sex and age composition or of bulls only.

From the above data, the calf:cow ratio is found to be 82:100, while the calf: adult ratio is 47:100.

The accuracy of the overall composition data from the aerial census is best for calves and herd totals, and is less reliable for the other classes. However, several herds were believed to be accurately classified, and the data from such herds, in addition to data from ground counts made on several herds during the summer and data from aerial counts collected during the latter part of August from a Cessna 180 craft is thought to be considerably more accurate in indicating herd composition. Table II is a compilation of this data.

Table II - Musk Ox Herd Composition Counts - Summer 1965

Date of Observation	Calves	Yearlings	Subadults	Cows	Bulls	Totals
7/17/65	8	4	4	9	2	27
7/19/65	4	3	2	5		14
7/22-25/65	3	4		3	1	11
		1	2	2	1	6
	2		2	2	1	7
	2			3	1	6
	1			2	2	5
	3	1		3	1	8
		3	2			5
	2			2	1	5
	2	2	1	2	1	6
	2			2	1	7
	1		2	1	1	5
	1	3	1	1	1	7
	2			2	1	5
8/10/65	1	1		2		4
8/11/65	1	1		2	1	5
	1	2		1		4
	1		2	2	1	6
8/15/65	2	4		2	1	9
8/26/65	2		2	3	1	8
	3			3	1	7
	3	4	1	4	1	13
	2			2	1	5
	2		1	2	1	6
	1	2		2	1	6
	2		1	2	1	6
	3	1		3	1	8
	57	36	23	69	26	211

During the field studies in March 1966, 390 musk ox were observed. This is considerably below the 512 musk ox counted during the aerial census of July 1965. This discrepancy is due to inaccessibility of some sand dune areas to snowplane travel and to limited visibility during periods of blowing snow. Some musk ox possibly winter in the interior of the island. However, of the 390 musk ox seen, all but 14 were within one mile of the coast. The 14 exceptions were in one herd on Muskox Mt., approximately 10 miles south of the village of Mekoryuk. This herd is believed to be resident in this area year-round. Most musk ox were seen on the southern coast from Nash Harbor to Cape Corwin. This distribution is generally similar to the summer distribution except that those musk ox found in the interior of the island in summer have moved to the adjoining coast.

In general herd sizes ran much larger than those of summer (see Table III). The largest herd seen was 37 on Cape Mendenhall. Five herds had 20 or more individuals. The average herd size was 11.47. By comparison, the largest herd seen during the summer of 1965 was 27 with one herd over 20 and only two over 16. Average size of summer herds was 4.97 considering all musk ox, and 7.39 considering groups of two or greater. Only one lone bull was seen during this winter study period, all other bulls having joined herds. Several herds composed exclusively of bulls were seen, particularly in areas occupied by lone bulls in the summer.

Table III
Summer and Winter Musk Ox Herd Sizes

Summer		Winter	
Size of Herd	No. Seen	Size of Herd	No. Seen
27	1	37	1
19	1	35	1
15	1	26	1
14	3	20	2
13	1	18	1
12	1	14	2
11	4	13	1
10	2	12	2
9	3	11	1
8	9	10	3
7	7	9	4
6	4	8	1
5	15	7	1
4	4	6	6
3	2	5	4
2	5	4	1
1	39	3	4

Winter reindeer distribution on Nunivak Island did not coincide with that of the musk ox. The reindeer were generally found in the interior eastern two-thirds of the island. Reindeer herds were well scattered, with concentrations noted in the Kimit Hills area east of Nash Harbor, near Roberts Mt., and in the southeast

corner of the island. Few reindeer were seen close to the coast. In most such instances, musk ox were not present in the same area. One herd of five musk ox was found near some reindeer near Nash Harbor. No reindeer were seen west of Nash Harbor. Apparently there is very little interaction between reindeer and musk ox during the winter. Natives who were interviewed said the distributions as described above were typical, and that such distributions hold throughout the winter.

Musk ox feed much like reindeer in that they paw through the snow, forming feeding "craters". Plant species utilized by musk ox during the period were those that were available in the feeding crater. Species taken were related to the area where feeding was done. Musk ox in the sand dune areas fed primarily on beach rye (Elymus mollis), with some crowberry (Empetrum nigrum) and moss used also. Musk ox on the bluff areas near Dooksook Lagoon and on Muskox Mt. were feeding on crowberry, cranberry (Vaccinium vitis-idea), sedge (Carex), woodrush (Luzula), lichens, and moss. Musk ox on Cape Mohican used predominantly sedges, grasses, woodrush, and moss. Usually the area within the crater was closely cropped with all species evidencing use. Craters were individually distinct even in areas where large herds were feeding. They were generally several feet in diameter. Old craters indicated that the musk ox paw new craters regularly. Sign and feeding craters suggested that winter movements are not very extensive. Musk ox on Cape Mohican and Muskox Mt. appear to have been restricted to small areas less than 1/2 square miles. Utilization did not appear to be excessive. Herds were well scattered along the coast.

All musk ox seen appeared to be in good condition. Natives reported one dead musk ox near Twin Mt., but it was not located. How recently this mortality occurred was not ascertained.

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WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT: W-15-R-1 TITLE: Alaska Wildlife Investigations

WORK PLAN: P TITLE: Disease, Parasite and Data Collections

JOB NO.: 9 TITLE: Growth and Nutrition

PERIOD COVERED: July 1, 1965 to June 30, 1966

OBJECTIVES:

To determine the characteristics of growth and the physiological status of arctic and subarctic mammals under varying nutritional regimens and environmental conditions.

TECHNIQUES:

Inactive.

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