WORK PLAN SEGMENT REPORT
FEDERAL AID IN WILDLIFE RESTORATION

STATE:	Alaska		
PROJECT NOS.:	W-6-R-5 and 6	TITLE:	Alaska Wildlife Investigations
and	W-15-R-1	TITLE:	Big Game Investigations
WORK PLANS:	J(W-6-R-5 and 6)	TITLE:	Furbearer Studies
and	O(W-15-R-1)	TITLE:	Wolf and Wolverine
JOBS:	2(W-6-R-5 and 6		
and	1(W-15-R-1)	TITLE:	Wolf Studies

PERIOD COVERED: January 1, 1964 to June 30, 1966

ABSTRACT

Information on Alaskan wolf populations was obtained from examination of bounty records, 4,150 wolf radii and ulnae, 1,262 wolf carcasses, and from observations of wolves inhabiting a 20,000 square mile area where wolves were protected.

Pregnant adult female wolves averaged 6.5 fetuses; two-year-old females averaged 5.3 fetuses; female pups are not sexually mature.

In Alaska wolves conceive from late February through early April, but most females breed in March. Multiparous females breed earlier than first breeders. Multiparous females produce an average of 7.3 ova and 6.5 fetuses implant. The loss of ova from ovulation to implantation is significant. Multiparous females produce more ova than first breeders; the difference is highly significant.

Mortality of pups rather than the lack of initial production of pups is believed to be the reason for the observed variations in the proportion of pups in wolf populations. Wolf packs include members of all sex and age categories during the breeding season. Pack size is an indicator of abundance.

Wolves in an area where they were protected increased at an average rate of 20-30 percent per year during an 11 year period.

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OBJECTIVES

To determine productivity, population composition, and population identity of wolf populations in Alaska. To determine wolf population levels and factors affecting them. To evaluate the relationships of wolves and ungulates.

TECHNIQUES

Wolf carcasses were obtained from bounty hunters, trappers and sport hunters. Standard measurements, weight, stomach contents, skeletal parts potentially useful in perfecting age determination techniques and reproductive organs are collected from each carcass. The radius and ulna of all wolves presented for bounty are collected as the degree of ossification of the epiphysis to the diaphysis provides a separation of pups-of-the-year from adults.

An aerial census of approximately one-half of Game Management Unit 13 was conducted during the annual aerial moose sex and age composition counts in October and November, 1965.

Information on the size of wolf packs was obtained from aerial data forms completed by Department observers and from a bounty information sheet completed when wolves are presented for bounty. Data on ungulates killed by wolves were obtained by landing at kill sites and attempting to reconstruct the action leading to the kill and to salvage skeletal parts and organs potentially useful in establishing the age, sex and physiological condition of the prey. One wolf held through the cooperation of the Aero-Medical Laboratories, Fort Wainwright, Alaska, was injected with alizarin red, a vital stain that deposits in bone, in an effort to measure the periodicity of cementum deposits on teeth.

A summary of wolf specimen and bounty data is presented in Table 1.

Table 1. Wolf specimens and data collected, represented as percentages of the annual harvest.

Year	Annual Harvest[1]	Bounty Information Sheets: No. Wolves Info. Obtained on	Bounty Information Sheets: % Annual Harvest	Radii & Ulnae: Number Obtained	Radii & Ulnae: % of Annual Harvest	Carcasses: Number Obtained	Carcasses: % of Annual Harvest
1959-60	520	201	(39)	311	(60)	---	---
1960-61	725	257	(35)	392	(54)	---	---
1961-62	869	605	(70)	511	(52)	185	(21)
1962-63	757	602	(80)	614	(81)	166	(21.9)
1963-64	818	713	(87)	530	(65)	244	(29.8)
1964-65	800[3]	800	(-)	589	(74)	198	(24.7)
1965-66	1300[3]	1292	(-)	1213	(93)	469	(36)
TOTALS	5789	4470	(-)	4150	(72)	1262	(28)[2]

1 Harvests determined from bounty affidavits

2 Computed only on data from 1961-62 through 1965-66

3 Bounty affidavit records not complete at this time

FINDINGS

Introduction

Since the first conservation group was organized in Alaska, the wolf, Canis lupus, has been subjected to the same misguided efforts at "control" or "elimination" as it has suffered elsewhere. The persecution was patterned after programs established throughout North America and included the use of bounties, poison, and unrestricted hunting. The history of these operations in Alaska has been summarized by Lensink (1959) and Rausch (1961, 1964). Additional documentation concerning this sort of "management" of the wolf in North America is provided by Pimlott (1961).

Throughout most of the temperate zone in North America large carnivores interfered with agriculture by turning to domestic stock as native ungulates were reduced. The predictable reaction consisted of attempts to eliminate the offending predators. In Alaska the production of domestic livestock is a very minor industry, and conflicts between wolves and agricultural practices are few, except for the reindeer industry in Northwestern Alaska. Consequently, control of most wolf populations has been justified solely on the premise that wolves represent an undesirable hazard to indigenous ungulates and furbearers.

Organized control activities continued until 1960 when the new State obtained control of all natural resources. Formal predator control has now been eliminated except on the active reindeer ranges, but for various reasons (Rausch, op. cit.) the legislature has perpetuated the bounty system.

Although control efforts were intensive for a long period of time, wolves still inhabit most of the suitable range in Alaska. The only major exception is the Kenai Peninsula where the wolf disappeared 60 years ago. Persistent recent reports of sightings have not been verified by a subsequent population increase on this important recreation area where suitable prey species are abundant. Interestingly, the wolf disappeared from the Kenai at about the same time that the caribou, Rangifer tarandus, population was eliminated.

Wolves can live in association with man when afforded some degree of protection. This is typified by a situation in Interior Alaska where wolves still travel on the outskirts of Fairbanks, and several active wolf dens are within ten miles of this residential and military complex of some 30,000 people. The protection of wolves in this case is in the form of seasons and bag limits, and restrictions on the methods and means of taking.

This segment report presents some of the results of a study started in 1959 to obtain information on wolf population dynamics, life history, and relationships to ungulate prey species. The ultimate goal is to obtain sufficient information to place management of this unique carnivore in proper perspective (Rausch, op. cit.).

Description of the Study Areas:

Figure 1 shows the twenty-six Game Management Units used in administering Alaska's wildlife resources. The units generally represent drainages, or distinct physiographic areas somewhat different from adjoining units. For the purpose of this study I have grouped the units into four regions that represent areas differing in terrain, vegetation, climate, and prey species available to wolves. The wolves of Alaska are currently considered to represent three sub-species. These are: C. l. ligoni, in Southeast Alaska; C. l. pambasilius, in Southcentral and Interior Alaska; and C l. tundrarum in Arctic Alaska. The validity of this classification is presently under study.

The four regions mentioned above can be generally described as follows:

Southeastern Alaska - This region includes the coastal mainland from Prince William Sound south to Ketchikan, and the islands of the Alexander Archipelago. This is an area of high rainfall, up to 200 inches annually, and temperate climate with much of the area in climax rain forest. The dominant forest trees are Sitka spruce, Picea sitchensis, and Western hemlock, Tsuga heterophyla. Sitka deer, Odocoileus hemionus sitkensis, beaver, Castor canadensis, and goat, Oreamnos americanus, are the principal prey species. In some local areas moose, Alces alces gigas, are an important component of the wolf's diet.

Southcentral Alaska - This region includes coastal Alaska adjoining Prince William Sound and the adjacent mountains and plateaus to the crest of the Alaska Mountain Range. It constitutes one of the finest extensive big game ranges in Alaska. Caribou, moose, Dall sheep, Ovis dalli, and goat form the basic diet for wolves along with beaver, ground squirrel, Citellus spp., marmot, Marmota caligata, and snowshoe hare, Lepus americanus.

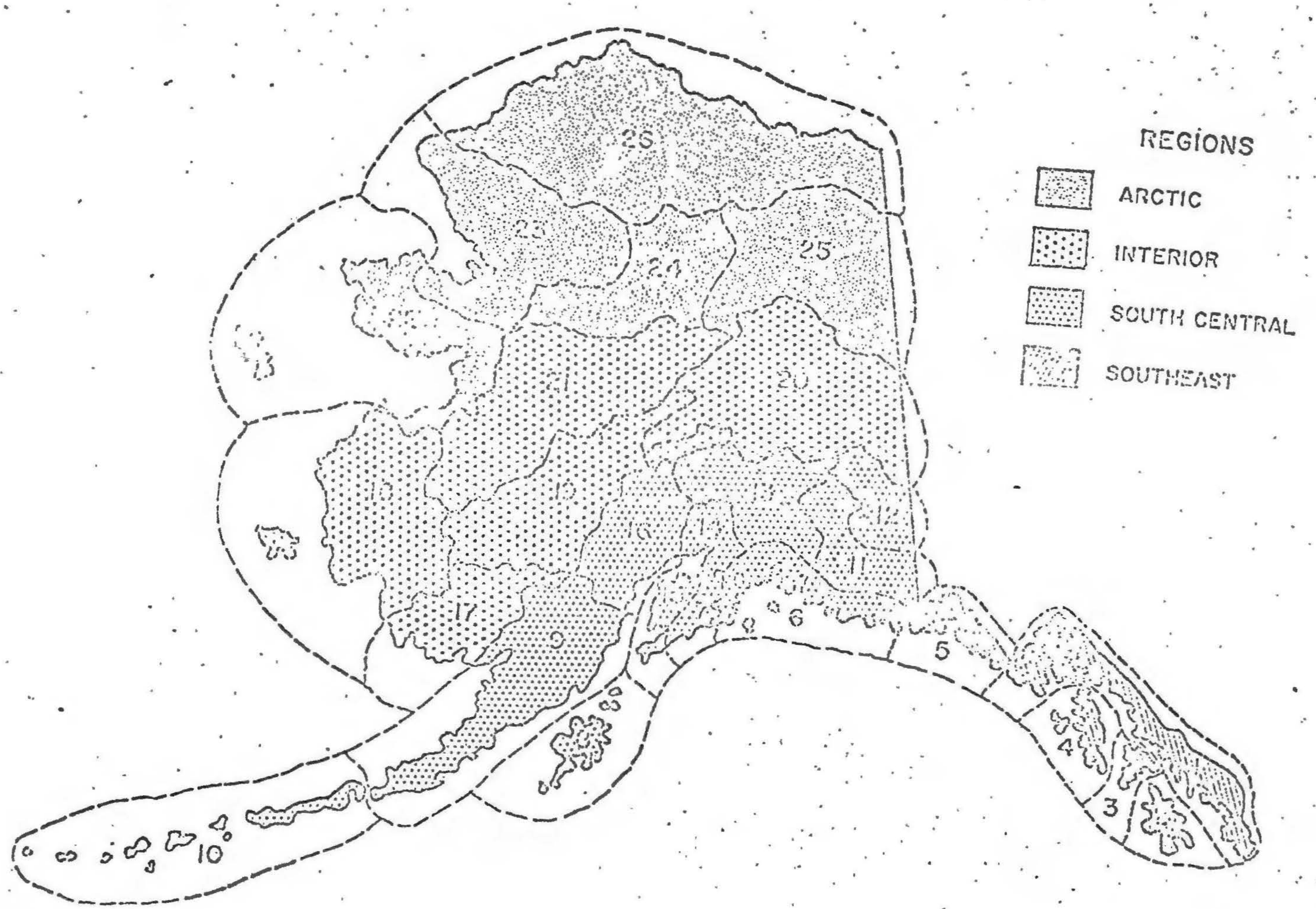
Interior Alaska - This area includes the drainages of the Yukon and Kuskokwim Rivers: typified by broad timbered valleys with old mountains in the central and eastern portions of the area. This region is bordered by the Alaska Mountain Range on the south and the foothills of the Brooks Range on the north. Moose, caribou, sheep, beaver, and snowshoe hare are prime components of the wolf's diet in this area.

Arctic Alaska - This region includes the drainages of the Arctic Ocean and the areas used as winter ranges by the Arctic caribou herds on the south and west slopes of the Brooks Range. Caribou are the dominant big game species, although moose and sheep are locally abundant. Ground squirrels are also abundant locally, and snowshoe hares are periodically numerous in the Noatak and Kobuk River drainages.

Results

Observations on the productivity of wolves suggest considerable variation in the components of productivity: litter size, breeding age, breeding period, breeding frequency and survival (Pulliainen, 1965; Mech, 1966; Murie, 1944; Young and Goldman, 1944; Merriam, 1964; Kelly, 1954). Most studies suggest that wolves have a high fecundity which is seldom translated into net productivity.

Figure 1.



ALASKA GAME MANAGEMENT UNITS AND WOLF MANAGEMENT REGIONS

My studies provide a quantitative estimate of the reproductive performance of Alaskan wolves.

Indicators of initial productivity include corpora albicantia of corpora lutea of pregnancy, placental scars, corpora lutea of pregnancy and fetus counts. All of these suggest that initial production averages between six and seven pups per adult female (Tables 2 and 3). Counts of corpora albicantia are not considered to be exact indicators of the number of ovulations associated with immediate past pregnancies, except in a general way. This is because groups of corpora albicantia may persist for a considerable time, possibly for the life of the animal. Also, scars similar in appearance to corpora albicantia may originate from ovarian functions not directly associated with ovulation. Still, I have found corpora albicantia counts in close agreement with the reproductive history of individual moose and with the productivity of populations of moose (Rausch, in litt.). In wolves there was a good correlation between the numbers of corpora albicantia and the number of placental scars found in the corresponding uterus. If the ovaries contained a large number of corpora albicantia the uteri frequently contained placental scars of two types. One was distinct with definite borders whereas the other type was faint with indistinct boundaries. Only the first class was considered representative of the immediate past pregnancy. I believe the second class of scars represents implantation sites of earlier pregnancies.

The fetus counts showed an average of 6.5 fetuses per adult female with an observed range of 3 to 11. Two-year-old females averaged 5.3 fetuses per pregnancy and apparently have a lower potential productivity than females that have bred previously.

Several references show that captive female wolves first breed at approximately 22 months, (Murie, op. cit.; Young and Goldman, op. cit.; Garceau, 1961; Pulliainen, op. cit.). My data supports the previous findings. Examination of 246 pups less than a year old revealed only two pups had follicles larger than 3 mm. Most follicles are 6-9 mm at greatest diameter just prior to ovulation. The pups with 3 mm follicles were collected in April after the period when most wolves breed. This plus the extremely small size of the uteri suggested that they would not have bred during this breeding period. Examination of the ovaries from 170 two-year-old wolves revealed no scars from ovulation or other ovarian functions. Ovulation by pups, if it occurs, is rare.

The period during which wolves breed has been reported to occur from January through April (Young and Goldman, op. cit.; Murie, op. cit.; Kelly, 1954; Fuller and Novokowski, 1955; Pulliainen, 1965; Makridin, 1962).

Pulliainen (op. cit.) reviewed wolf breeding records and concluded that copulation took place at the end of February and in March, but that the onset of breeding might be delayed in northern areas. Makridin (1962) reports that in the Yamal North of Russia, wolves pair in late March and early April. He cites one instance of a young female wolf being pregnant on the 15th of June. This indicated conception took place in mid - to late April.

Table 2. Indicators of productivity in adult wolves, 1957-1966, Alaska

Area	Corpora albicantia			Placental scars			Corpora lutea			Fetuses		
	No.	No. Animals	Ave.	No.	No. Animals	Ave.	No.	No. Animals	Ave.	No.	No. Animals	Ave.
Southeast	97	12	8.1	70	13	5.4	--	--	---			
Southcentral	98	16	6.1	74	11	6.7	25	4	6.2	8	1	--
Interior	967	128	7.6	321	45	7.1	381	56	6.8	119	18	6.6
Arctic	133	21	6.3	69	10	6.9	100	15	6.7	48	8	6.0
TOTALS	1292	177	7.3	534	79	6.7	506	75	6.7	175	27	6.5

Table 3. Indicators of productivity in two-year-old wolves, 1957-1966, Alaska

Area	Nonbreeders*	Corpora lutea			Fetuses		
	Number	No.	No. Animals	Ave.	No.	No. Animals	Ave.
Southeast	15	11	2	5.5	0	0	0
Southcentral	14	12	3	4.0	10	2	5.0
Interior	71	238	42	5.7	45	8	5.6
Arctic	12	62	11	5.6	14	3	4.7
TOTALS	112	323	58	5.6	69	13	5.3

Records of breeding dates in northern North America are scarce. Kelly (op. cit.) doubted that wolves in Alaska bred prior to March 15. Fuller and Novakowski (1955) working in Wood Buffalo National Park reported three of four adult females examined in March contained corpora lutea. Six implantation sites were counted in the uterus of a wolf taken on March 21. They estimated that proestrus might occur between March 5 and March 21.

Data from 84 adults and 58 two-year-olds collected throughout Alaska shows that a very few adults conceive in late February, but that most wolves breed in March. The exact kill dates were obtained for 84 adult wolves and 57 two-year-old wolves. These observations were grouped by 10 day intervals from February 1 through May 10 (Figure 2), and show that most adult female wolves breed during the first two weeks of March. Two-year-olds tend to breed somewhat later.

The failure of wolf populations to realize their potential rate of increase and the lack of, or low number of pups in some populations that have been studied (Merriam, 1964; Mech, 1966; Stenlund, 1955; Cowan, 1947) leads to speculation that failure of females to breed could be an important population control. The information obtained during this study shows that a high proportion of all females two-years-old and older did ovulate, conceive, and probably gave birth to pups annually (Tables 2 and 3 and Fig. 2).

The reproductive tracts of 89 adult and two-year-old females collected from March 13 through April 30 showed that 89 percent were gravid. The ovaries and uteri from two adult and two two-year-old females appeared to be inactive as they contained only follicles of less than 2 mm in greatest diameter. The uteri of these four exhibited none of the vascularization normally associated with proestrus.

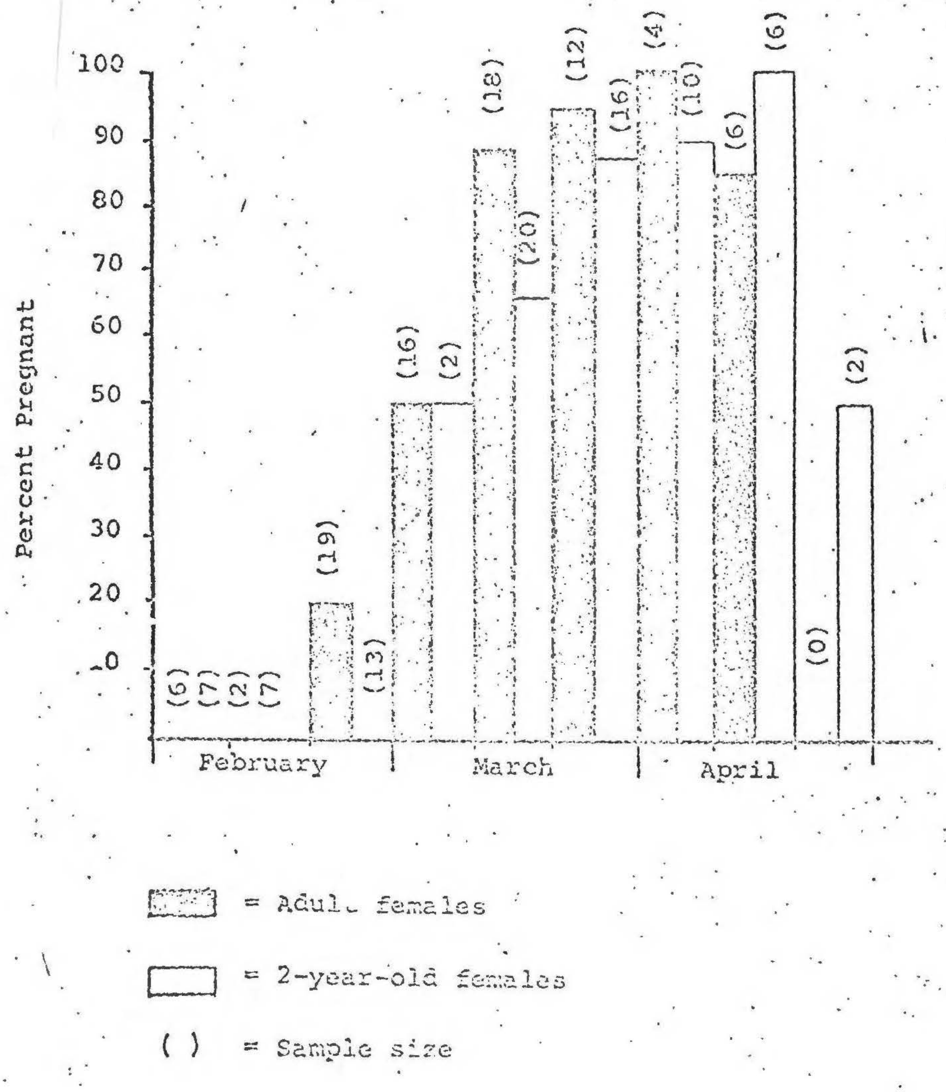
From these limited data I conclude that in Alaska at the existing level of exploitation, wolves breed from late February through early April. Most wolves conceive in March. Wolves breed annually and the observed variation in the abundance of young-of-the-year is a function of <u>in utero</u> and post-natal mortality.

The efficiency of the female reproductive system and the effect of experience are factors that have not been evaluated in the wolf. Adult female wolves shed an average of 7.3 ova and implant 6.5 fetuses. This comparison is based on 23 wolves where both ovaries and intact uteri were present. This is slightly different from the data presented in Table 2 which presents "pooled" data and includes observations on animals from which only ovaries or uteri were present. The difference between the number of ova shed and the number of fetuses observed is significant at the .95 level but it is not significant at the .99 level ($t = 2.21$, $t_{.05} = 2.075$, $t_{.01} = 2.819$ at 22 d.f.) (Simpson, Roe, Lewontin, 1960).

In two-year-olds where only 12 observations were available, the difference between corpora lutea, average 6.08, and fetuses, average 5.41, was not significant at the .95 level.

The pooled observations on the production of ova by adults and by first breeders revealed adults produced more ova, (Table 2). These observations which were based on 75 adults and 58 two-year-olds showed an average of 6.7 and 5.6

Figure 2. Progression of pregnancy of Alaskan wolves



ova respectively. The difference is highly significant ($t = 4.547$, $t_{.01} = 2.576$ at 132 d. f.). The production of ova by multiparous females is greater than that of first breeders. The loss of ova between ovulation and implantation is significant in adults and is probably a biological reality in first breeders.

The early sexual maturity and large average litter size of wolves indicate a high potential rate of productivity; a rate much higher than that of their ungulate prey. Natural controls on wolf numbers in the form of direct mortality or social activities which inhibit the production of progeny must operate to prevent the wolf from rapidly outstripping its food supply. There is good evidence that such factors, mortality or social behavior, do operate (Mech, op. cit.; Merriam, op. cit.).

My data shows that mortality starts in utero. First there is a demonstrated loss of ova or blastocysts which was mentioned earlier. Resorption may be an important control, but I have observed only two instances of resorption and in each instance only one of the litter was affected. Of course, the progress of the pregnancy could not be predicted but the outward appearance of the remaining fetuses was normal. Information on growth and survival of fetuses during periods of stress induced by adverse weather conditions or food shortages is needed.

Mortality at birth and during the period spent in and at the den could be critical. In domestic dogs the greatest mortality is at or shortly after birth (Anderson and Wooten, 1959). They indicate that one-third of the pups whelped of one breed die before they are weaned. The hazards wolf pups encounter at the den are not known. Murie (op. cit.) relates several instances of grizzly bears Ursus arctos robbing food from near the entrance of a wolf den. No doubt, grizzly and black bears Ursus americanus would also eat wolf pups if the opportunity arose.

Mortality after leaving the den, aside from that inflicted by man, takes many forms including accidents while gathering food, diseases and parasites, and intra-specific strife.

Accidents associated with food gathering operations, particularly where moose are an important food item, may be important. Examination of approximately 4,000 left radii and ulnae and 1,250 skulls and skeletons, revealed numerous fractures that had healed or were healing. Compression fractures of the skull, involving the nasal and the frontal bones suggested heavy blows with a blunt object, presumably the hoof of a moose. Blows sufficient to cause compression fractures of the skull probably kill if delivered a few centimeters higher on the skull. Because of the probability of direct mortality, there is no way of determining the relative frequency with which wolves are killed or succumb to injuries inflicted while gathering food. I believe survival of severely injured individuals is facilitated by the social nature of wolves, as the injured animals clearly must depend upon associates for food. That feeding by wolves is on occasion a group activity without apparent hostility is substantiated in part by Burkholder (1959) and by my own observations.

However, the tendency for wolves to practice cannibalism during times of stress places another consideration upon the observed injuries. Some probably were inflicted by other wolves. A pierced premaxillary bone on a specimen from southeast Alaska could very well have been inflicted by another wolf and fractures to the radius and ulna may also be inflicted by members of the pack or strangers. Once a wolf is injured or handicapped, fellow pack members may consume him. I have recorded six occasions where a wolf caught in a snare or trap was devoured, except for the skull and a few bits of hair and viscera, by remnants of the pack. Aerial hunters who leave unskinned wolf carcasses in the field have returned the following day and found the carcasses being devoured by the remaining members of the pack. Merriam (op. cit.) reports considerable amounts of wolf hair in wolf scats collected on Coronation Island in southeast Alaska after the deer population had been greatly reduced by the wolves, and Kelly (op. cit.) lists six instances where wolves contained measurable quantities of wolf flesh in their digestive tract. The tendency of a pack to utilize its own disadvantaged or dead members for food partially offsets any benefits that accrue from their providing food for an injured member.

The diseases and parasites of Alaskan wolves have been reported on extensively by Rausch and Williamson (1959), and Rausch (1958). The importance of disease or parasites as a population control is not established. Certainly rabies could be an important control.

Although little quantitative information is available on specific mortality factors, other than man's bounty hunting, insight into annual survival of pups was obtained from the age composition of the animals presented for bounty (Table 4).

The survival of pups to the period of harvest varies considerably with time and among the four regions. An estimate of pup survival was obtained based on the overall age composition of female wolf carcasses examined. A sample of 593 female carcasses consisted of 177 adults, 170 two-year-olds, and 246 pups. Application of this age composition data to the material presented in Table 4 by assuming a 1:1 sex ratio reveals pup survival of 40 to 100 percent. With the exception of the high estimates for the Arctic areas, which may have been biased by hunting practices of several villages, the estimates fall within the ranges of survival estimates prepared for other big game species including moose (Rausch and Bratlie, 1965), caribou (Skoog, 1962), and bear (Klein, Troyer, and Rausch, 1958).

The indication that pup survival is similar to certain other large mammals does not help explain the scarcity of wolves as compared to their ungulate prey. Mortality may be constant, affecting all age classes equally at a rate of 40 to 50 percent per year. Application of these rates fits the present age composition data fairly well. Further insight into age composition of the population will be possible when age determination techniques now being perfected are applied to the data.

Wolf Pack Composition

Wolves are considered gregarious animals exhibiting highly developed social structures with strong family ties at least until the pups are sexually mature at about 21 to 22 months (Murie, op. cit.; Pulliainen, op. cit.; Burkholder,

Table 4. Age composition of 4,150 wolves; based on the fusion of epiphyses to diaphyis of radius and ulna, 1959-1966.

Year	Adults		Pups		Totals
	Number	Per Cent	Number	Per Cent	
1959-60	195	(63)	116	(37)	311
1960-61	209	(53)	183	(47)	392
1961-62	311	(61)	200	(39)	511
1962-63	351	(57)	263	(43)	614
1963-64	289	(55)	241	(45)	530
1964-65	305	(52)	284	(48)	589
1965-66	671	(55)	542	(45)	1213
TOTALS	2331	(56)	1829	(44)	4150

Arctic region wolf age composition, 1959-66.

Year	Adults		Pups		Totals
	Number	Per Cent	Number	Per Cent	
1959-60	78	(45)	93	(55)	171
1960-61	114	(59)	78	(41)	192
1961-62	111	(60)	73	(40)	184
1962-63	71	(49)	75	(51)	146
1963-64	44	(35)	82	(65)	126
1964-65	58	(42)	80	(58)	138
1965-66	147	(62)	92	(38)	239
TOTALS	623	(52)	573	(48)	1196

Table 4 co. Age composition of 4,150 wolves; based on the fusion of epiphyses to diaphyis of radius and ulna, 1959-1966.

Southeast region wolf age composition, 1962-66.

Year	Adults		Pups		
	Number	Per Cent	Number	Per Cent	Totals
1962-63					
1963-64	28	(48)	20	(42)	48
1964-65					
1965-66	22	(39)	18	(61)	40

Southcentral region wolf age composition, 1962-66.

Year	Adults		Pups		
	Number	Per Cent	Number	Per Cent	Totals
1962-63	5	( )	2	( )	7
1963-64	3	(40)	6	(60)	10
1964-65	16	(48)	17	(52)	33
1965-66	85	(39)	133	(61)	218

Table 4 co. Age composition of 4,150 wolves; based on the fusion of epiphyses to diaphyis of radius and ulna, 1959-1966.

Interior region wolf age composition, 1959-66.

Year	Adults		Pups		Totals
	Number	Per Cent	Number	Per Cent	
1959-60	15	(40)	22	(60)	37
1960-61	80	(47)	91	(53)	171
1961-62	200	(61)	127	(39)	327
1962-63	280	(60)	188	(40)	468
1963-64	245	(61)	159	(39)	404
1964-65	210	(50)	208	(50)	418
1965-66	417	(58)	299	(42)	716
TOTALS	1447	(57)	1094	(43)	2541

op. cit.; Mech, op. cit). Presumably wolves pair during the breeding season and the pack may be temporarily or permanently scattered by the strife created by males competing for females of breeding age. Intraspecific strife, associated with breeding, increased populations, food shortage or injuries, is one potential population control that has not been evaluated. During this study I had the opportunity to examine a number of wolf packs killed by aerial hunters during winter and early spring. The material is presented in tabular form in Tables 5&6.

The pack sizes were generally smaller than those observed in the overall population because aerial hunters rarely kill all of a large pack. Therefore, the pack composition information presented may not be representative of that portion of the population comprised of large packs.

Some wolves continue to function as a pack even during the breeding season and as many as four gravid or potentially gravid adult and two-year-old females were found in one pack; which also included two adult males, two pup males and one pup female. Just about every possible combination of adults and pups was found in association during the February, March, and April period. Pups and adult males were under-represented when compared to the population averages in Table 7. In instances where three or more wolves were killed from one pack during the period February, March, and April, the composition was similar to that established from the harvest of entire packs.

The size of wolf packs has been reported for several areas, (Stenlund, op. cit.; Pulliainen, op. cit.; Kelly, op. cit.). Pack size, if packs represent adults with their young-of-the-year or if they merely represent temporary associations of a gregarious species, is a measure of abundance. Because, if the animals stay together even briefly after meeting, observations of pack size would reflect the frequency of such associations which are a result of chance.

A frequency distribution of pack size observed during different years, in the four Alaskan regions, is presented in Table 8. In the Southcentral region and Interior region the occurrence of large packs has increased with time, and probably represents an increasing population. In the Arctic region the pack sizes have remained constant or decreased slightly. The wolf population in this region is believed to be static or decreasing. The data from southeast Alaska suggest that no measurable changes have taken place.

The validity of the apparent pack size differences between areas in 1965-1966 was tested by Mr. Frank J. Ossiander, Biometrician, Alaska Department of Fish and Game, using a modified Kolmogorov-Smirnov test (Nickerson, Ossiander, and Powell, 1966). The results presented in Table 9 show that pack size composition is similar in Southcentral and Interior Alaska. Southeastern and Arctic Alaska are similar, but pack sizes in the Interior and Southcentral regions are larger than in the Arctic and Southeast regions. The results support the hypothesis that the frequency of larger packs is higher in populations of higher density.

An opportunity to observe the expansion of a protected wolf population in a large area with an abundant supply of prey species occurred when Game Management Unit 13 and the northern portion of Unit 14, comprising about 20,000

Sex and Age Composition of Entire Wolf Packs, Alaska

Table 5.

Date	Pack Size	Pup Male	Pup Female	Adult Male	Adult & two-yr old Females Preg.	C.A.	Non-preg	Remarks
Oct. 23	3		1			1		1 unknown
Dec. 22	6		2	1		1	1	1 unknown sex
Feb.	2	1				1		Follicles developing
Feb. 10	2			1		1		
March 5	9	2	1	2	1	2	1	Non preg.females all have developing follicles
March 14	5	1		2	2	(2)*		
March 20	4		1	2			1	Large follicles
March 28	2		1	1				
March 28	2		1	1	(1)			
March 29	6	4		1	1	(1)		
March 30	3		1	1	1			
April 4	6	3	1		2	(2)		
April 13	3	1			1			1 female status unknown
April 13	3	2			1			
April 17	4	1	1		2	(1)		
April 21	2			1	1			
		15	8		14	6	3	
Totals	63	23		13	23			

*( ) corpora albicantia in addition to current pregnancy

Sex and age composition and reproductive status of females in entire wolf packs.

Table 6. Per cent composition by pack size of entire wolf packs killed by aerial bounty hunters, Alaska.

Month	Pack Size	No. of Packs	% Pup ♂	% Pup ♀	% Adult ♂	% Adult ♀	% Unk Age ♂	% Unk Age ♀
Feb	2	7	7	0	42	50	0	0
	6	1	33	0	50	17	0	0
Mar	2	8	25	19	25	31	0	0
	3	2	0	17	50	33	0	0
	4	4	44	13	19	19	0	0
	5	2	10	10	50	30	0	6
	6	1	67	0	17	17	0	0
	9	1	22	11	22	44	0	0
Apr	2	2	0	0	50	50	0	0
	3	1	33	0	0	67	0	0
	5	1	20	0	20	40	0	20
	6	1	33	33	0	33	0	0

Table 7. Sex and age composition of Alaskan wolves taken from 1961 to 1964 as determined by carcass examinations

Year	Pups ♂	%	♀	%	Adults ♂	%	♀	%	Totals
1961-62	34	57	26	43	63	50	62	50	185
1962-63	39	57	28	43	45	45	54	55	166
1963-64	55	50	54	50	67	50	68	50	244
1964-65	51	50	52	50	46	48	49	52	198
1965-66	118	56	93	44	132	51	126	49	469
Totals	297	53	253	47	353	49.5	359	50.5	1262
TOTALS all years	550		43.5		712		56.5		

Table 8. Wolf pack frequency distributions.

Year	Region	Total Observations	Total Packs Observed*	Range of Pack Size	% Wolves In Packs of 8 or more
1961-62	Southeast	5	4	2-3	0
1962-63	"	11	7	2-8	23
1963-64	"	43	24	2-9	13
1964-65	"	23	14	2-12	57
1965-66	"	42	23	2-8	20
1961-62	Southcentral	4	4	4-15	72
1962-63	"	21	11	2-13	22
1963-64	"	41	29	2-14	28
1964-65	"	70	36	2-14	27
1965-66	"	139	85	2-21	44
1960-61	Interior	14	12	2-11	35
1961-62	"	85	69	2-13	25

Table 8 co. Wolf pack frequency distributions

Year	Region	Total Observations	Total Packs Observed*	Range of Pack Size	% Wolves in Packs of 8 or more
1962-63	Interior	77	44	2-15	39
1963-64	"	102	59	2-13	22
1964-65	"	146	100	2-20	31
1965-66	"	180	121	2-20	58
1960-61	Arctic	32	24	2-10	10
1961-62	"	47	45	2-20	18
1962-63	"	39	33	2-9	26
1963-64	"	39	26	2-10	25
1964-65	"	44	24	2-9	15
1965-66	"	59	42	2-8	22

* packs=two or more wolves

Table 9. Comparison of pack size composition among regions for 1965-66.

Area tested	Maximum Difference	Probability of a Difference Equal to or greater	Conclusion
Southeast vs. Southcentral	.184	.421*	Pack size composition different
Southeast vs. Interior	.177	.436*	Pack size composition different
Southeast vs. Arctic	.175	.697	Pack size composition the same
Southcentral vs. Interior	.069	.978	Pack size composition the same
Southcentral vs. Arctic	.140	.483*	Pack size composition different
Interior vs. Arctic	.148	.483*	Pack size composition different

* the null hypothesis tested was that pack composition was the same, this low a probability was considered grounds for rejecting the null hypothesis.

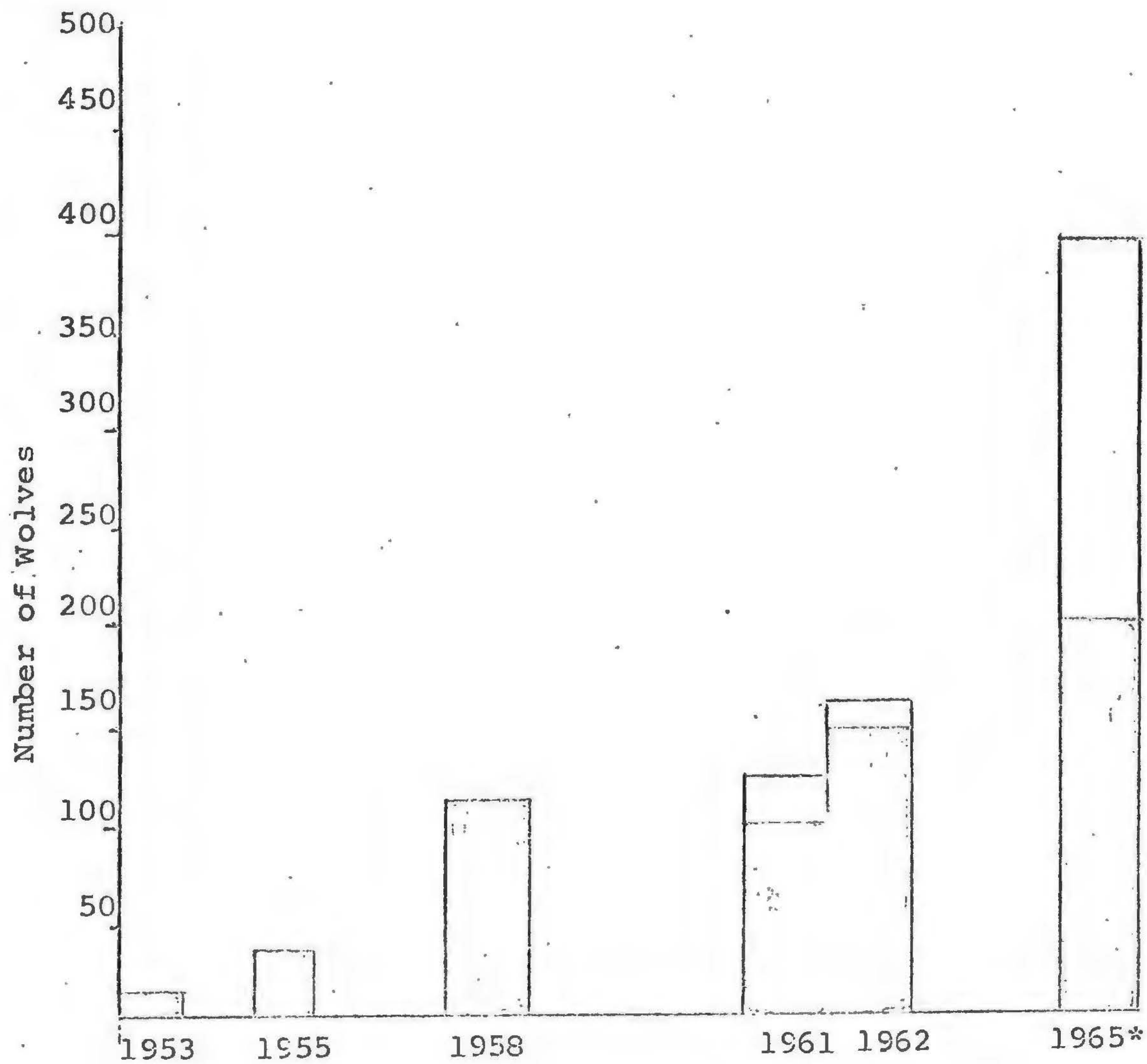
square miles, was closed to the taking of wolves in 1957. Prior to the closure the U.S. Fish and Wildlife Service had conducted intensive control resulting in the removal of over 200 wolves from 1948 through 1954. Bounty hunting concurrent to the control operation removed an additional but unknown number of wolves (Atwell, 1963). In 1953 the wolf population was estimated at not more than 12 animals. By 1955 game authorities recognized that moose, caribou, and sheep were very abundant and that moose and caribou were dangerously so from the standpoint of management. Most of the large predators, wolves and grizzly bears, had been removed through control activities and aerial bounty hunting and sports hunting. Access to the area was limited to one highway, the Glenn-Richardson, and the rudiments of the Denali Highway (the route to McKinley National Park which formally opened in 1958). Restrictive bag limits and seasons, poor access and removal of the only effective predator, at a time when the ungulate population was rapidly increasing following a low in numbers in the late 1940's, set the stage for an interesting and for Alaska a unique experiment. In 1957 wolves became a protected species in Unit 13 and the northern portion of Unit 14, with no provisions for harvesting them except as needed to conduct the study. The study area has an abundance of big and small game, and is perhaps the most important recreation area in Alaska. Some 5,000 to 8,000 caribou, 1,500 to 1,750 moose and approximately 100 Dall sheep are harvested annually by sports hunters from Anchorage and Fairbanks. The major ungulate prey species are estimated as follows: caribou 70,000 (Siniff & Skoog, 1962); moose 25,000-30,000 (Rausch, 1965); and several thousand sheep.

The increase of the wolf population is presented in Fig. 3. The source of estimates are indicated in Table 10. Limited poaching during the first several years no doubt influenced the rate of increase. The extent of the poaching is unknown. Legal hunting on the periphery of the closed area may also have slowed the rate of increase as wolves do travel considerable distances and some of the river boundaries and mountain passes that form the border of the closed area are known as "wolf trails". However, egress may have been compensated for by immigrant wolves from adjoining areas.

Starting with 12 wolves in 1953 and assuming three were adult females, the maximum potential population in 1966 would be something like 15,000. Of course the present population does not approach the biotic potential. The high estimate of 350-400 wolves, Fig. 3, represents an annual increase of 25 to 30 percent per year over the 13 years. If 1955 is used as a starting point, the estimated net increase to 1966 is 20 percent per year, similar to annual net increases for ungulate prey species such as caribou (Skoog, 1962), and moose (Pimlott, 1959). Unfortunately the influence of immigration, emigration and poaching cannot be measured.

Comparisons of the Unit 13 wolf population with populations in areas having similar prey species but where wolves have been subjected to intensive bounty hunting indicates that wolves in Unit 13 are not more productive than the exploited populations. If pack size is a measure of abundance then the 1966 data for Unit 13 suggests a more dense population than exists in the Interior region, Tables 8, 9, and 11.

Figure 3. Wolf population estimates, 1953-1966, Unit 13, Alaska



= Upper limit of population estimate

* In 1965 only one-half of the area was surveyed; the estimate for the total area was extrapolated from this survey.

TABLE 10. Estimated wolf population Unit 13 1958-1965.

Source	Year	Number	Method of Determination
Atwell, (1962)	1953	12	Knowledge of area from predation control activities.
Atwell, (1962)	1955	35	Knowledge of area from predation control activities.
Atwell, (1962)	1958	120	Active study of wolves.
Atwell, (1962)	1961	100-125 (79 accounted for)	Census
Atwell, (1962)	1962	145-160 (135 accounted for) (33 seen)	Census
Winters, (1964)	1963	Increasing 79 separate observations	Year around observations no census
	1963	No estimate	Project inactive
R. A. Rausch	1965	(91 accounted for) (81-110 tracks) (17s-201 on 1/2 of the area)	Based on combination of non-duplicated tracks and observations

TABLE 11. Wolf pack frequency distributions, Unit 13, Alaska

Year	Total Observations	Total Packs	Range of Pack Sizes	% Wolves in Packs of 8 or more
1960-61	5	4	2-7	0
1961-62	12	--	1-15	-
1962-63	48	--	2-15	-
1963-64	--	--	---	-
1964-65	--	--	---	-
1965-66	28	22	2-36	56

In 1965-66 a harvest of 218 wolves from the Unit 13 population consisted of 63 known illegal kills, substantiated by interviews and location of wolf carcasses within the study area. One hundred and fifty three wolves were harvested from the adjoining units; 11, 14 and 16. Most, 117, were from Unit 11. In October and November of 1965 a large portion of the Unit 13 caribou herd moved into this unit. Extensive aerial observation in October and November failed to reveal many wolves in association with the caribou. At that time they were concentrated near the center of Unit 13 feeding on moose and scattered bands of caribou. Apparently, a large portion of the wolves subsequently moved into Unit 11 where the caribou were wintering and became legal quarry for aerial-bounty hunters.

Discussion

The pooling of the reproductive material for all years and for the entire state may have masked local differences. One regional difference that appears upon examining Table 2, 3, 8, and 9 is that wolves in the Arctic region tend to shed fewer ova, implant fewer fetuses and are found in smaller packs. The observations of Kelly (1954) which showed an average of 5.7 fetuses in a sample of 31 uteri tends to support the suggestion that wolves in the Arctic have a lower potential productivity. Although most indicators suggest a lower productivity in the Arctic, the adult:pup ratio for the period 1959-1966 indicates slightly better survival of pups in the region. Interpretation of the status of the Arctic populations is further complicated by the continued exploitation of wolves by native hunters, aerial-bounty hunters, non-resident sportsmen, and federal wolf control activities on reindeer grazing leases. The slow response of the wolf population even when the limit for aerial-bounty hunters and sportsmen was reduced to two wolves per year may reflect the capability of the wolf population under conditions existing in the Arctic where caribou undoubtedly are a major source of food. The Unit 13 populations in the Southcentral region failed to increase at a rate much greater than the potential of their ungulate prey even when provided complete protection and provided with abundant food supply.

Although variables over which we had little control may have slowed the rate of increase of wolves in Unit 13, the increase until 1965 seems to have been gradual.

There is some indication that mortality of pups is the main factor preventing explosive irruption of wolves. However, mortality to all age classes appears high in the material examined, including the sample from the previously unhunted area, Unit 13.

The peak of breeding, mid-March, when coupled with a 60-day gestation period indicates that most wolf pups are born in mid-May. This is about two weeks later than the observations of wolves copulating (Mech, 1966) indicated the wolves on Isle Royale would whelp. I believe the timing of parturition is significant to the survival of wolf pups in that the most abundant ungulates, caribou, moose and sheep, all give birth in late May and early June. In Alaska those ungulates that have been studied, caribou and moose, exhibit a sharp peak of calving; most calves are born in a three-week period (the last two weeks of May and the first week of June). The Arctic caribou herds are an exception in that they apparently calve 10 to 14 days later than the southern herds. If wolves depend upon the young of ungulates, particularly during the summer, then the benefits of whelping at approximately the same time as the ungulate prey species give birth are obvious. At present, distributional data of wolf den locations is not sufficient to show a correlation between wolf den locations and caribou, moose or sheep natal areas. The few observations of dens that have been made recently suggest such a correlation, but active dens have been found that obviously were not well situated if ungulates are the major food source during the denning period. Survival of pups at the various types of den sites would be another measure of dependence of wolves upon young ungulates. Murie (1944) suggested that sufficient caribou prey may be present in some instances even after the main migration has passed. He considered most of the animals that remained "stragglers". Caribou, however, may disperse rather widely during the summer and may also exhibit some degree of sexual segregation, adult males separating from the bands of cows and calves. Consequently, determination of "stragglers", whatever it means, could be rather difficult.

The ecology of wolf denning areas and the factors affecting the relative success of the various sites are important and fascinating unknowns. I do have records of wolf dens from alpine areas to swamps; most, but not all, are well situated to take advantage of the abundance of moose, sheep or caribou in the particular area. Some, however, appear better suited to take advantage of the abundance of salmon runs, beaver or snowshoe hare. The loss of an entire year class could spell disaster to wolf population if, as I suggested earlier, mortality of all age classes is high.

The impact of predation upon ungulate populations has been debated extensively and intensively during the past without much clarification. Recently Mech (1966) and Jordan (in press) under Dr. Allen have sought to clarify this point, using Isle Royale as a laboratory. Here moose is the only ungulate prey. In Alaska, Merriam (1964) reported on a similar study involving black-tailed deer and wolves. Again this study is on an island which probably restricts the range of wolves as does Isle Royale. Another study was started in Alaska in 1957 when the Nelchina Basin, Game Management Unit 13, Fig. 1, was closed to the taking of wolves. Prior to this period, as mentioned earlier, wolves had been severely depressed through organized control efforts; poison (strychnine and cyanid), aerial shooting, and bounty hunting. This study has provided an opportunity to observe the general effect of wolves upon moose, caribou and sheep in an area of 20,000 square miles. While the wolves have been protected, the prey species have been the object of increasing sports hunting pressures.

No clear effect of wolves upon prey can be demonstrated at this time, but several inferences can be drawn.

The wolf population increased slowly; perhaps there were 10-15 times as many wolves present in 1965 as were present ten years earlier. During the same period the caribou population nearly doubled, from 40,000 plus (Watson and Scott, 1956) to 80,000 (Skoog, 1964). While increasing, the caribou were subject to increasing pressures by wolves and hunters. The annual harvest by hunters ranged from 5,000 to 8,000 animals; the magnitude of the harvest by sports hunters seemingly was dependent upon the availability of the herd to the access highways.

The data on moose is not clear as no estimate of total population was prepared before 1965, at which time the population was estimated at 25,000-30,000 animals (Rausch, 1965). Insight to the well-being of the moose populations has been gained through making aerial sex and age composition counts of selected areas since 1952. The proportions of various age classes and sexes are believed to reflect herd well-being in a general way. The calf crop to early or mid-winter is shown in Fig. 4. Moose apparently were increasing rapidly during the mid-fifties and continued to increase until 1959-60 or 1960-61. By then they were incredibly abundant. During the caribou survey conducted in February, 1962, (Siniff and Skoog, 1964) it was apparent that many were starving. Starvation was enhanced by the unusual depths of the snow cover. Subsequent calf crops have not been good, except locally. At present the ranges appear fully stocked. Some 6,000 moose were tallied on a portion of the area in 1965, but in view of low survival of calves, the population cannot be increasing much. The failure of calf crops may be related to a succession of late cold springs combined with an over-stocked climax range. Much of the range is willow at, or just below tree line. The effects of prolonged overuse that occurred during the moose erruption of the fifties is not known, but visual inspection of a portion of the range indicates considerable deterioration. The recovery rate may be slow. Concurrent studies on other areas where wolves are absent or scarce shows that moose do not fare well on overstocked, decadent ranges. Of course, wolves undoubtedly are exercising some influence on the moose population, but I doubt that significant portions of the range can sustain a greatly increased moose population.

An examination of bounty information data compiled from 1921-1966 is presented in Figures 5 and 6, and Table 12. The precision of the harvest figures for the early years is unknown. Apparently the bounty funds frequently had to be enlarged by succeeding legislatures and the relationship of year-of-kill to year-of-bounty payment is unknown. Even in recent years there has been a considerable lag by hunters presenting wolves for bounty and in processing the bounty payments. Only the data from bounty information sheets is believed to reflect accurately the period of harvest. Bounty information data is not completed on all wolves, (Table 1), but is is reasonably complete for the last few years. The harvest by unit is presented in Table 12. No analysis is presented at this time.

Acknowledgements

A large number of sportsmen, bounty hunters and Department personnel assisted in obtaining, processing and compiling the data presented. Although it is not possible to list them individually, I wish to express my appreciation to each individual who contributed to this study.

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Fig. 4. Moose Calf Survival to Mid-Winter,

Nelchina Basin, 1952 - 1965

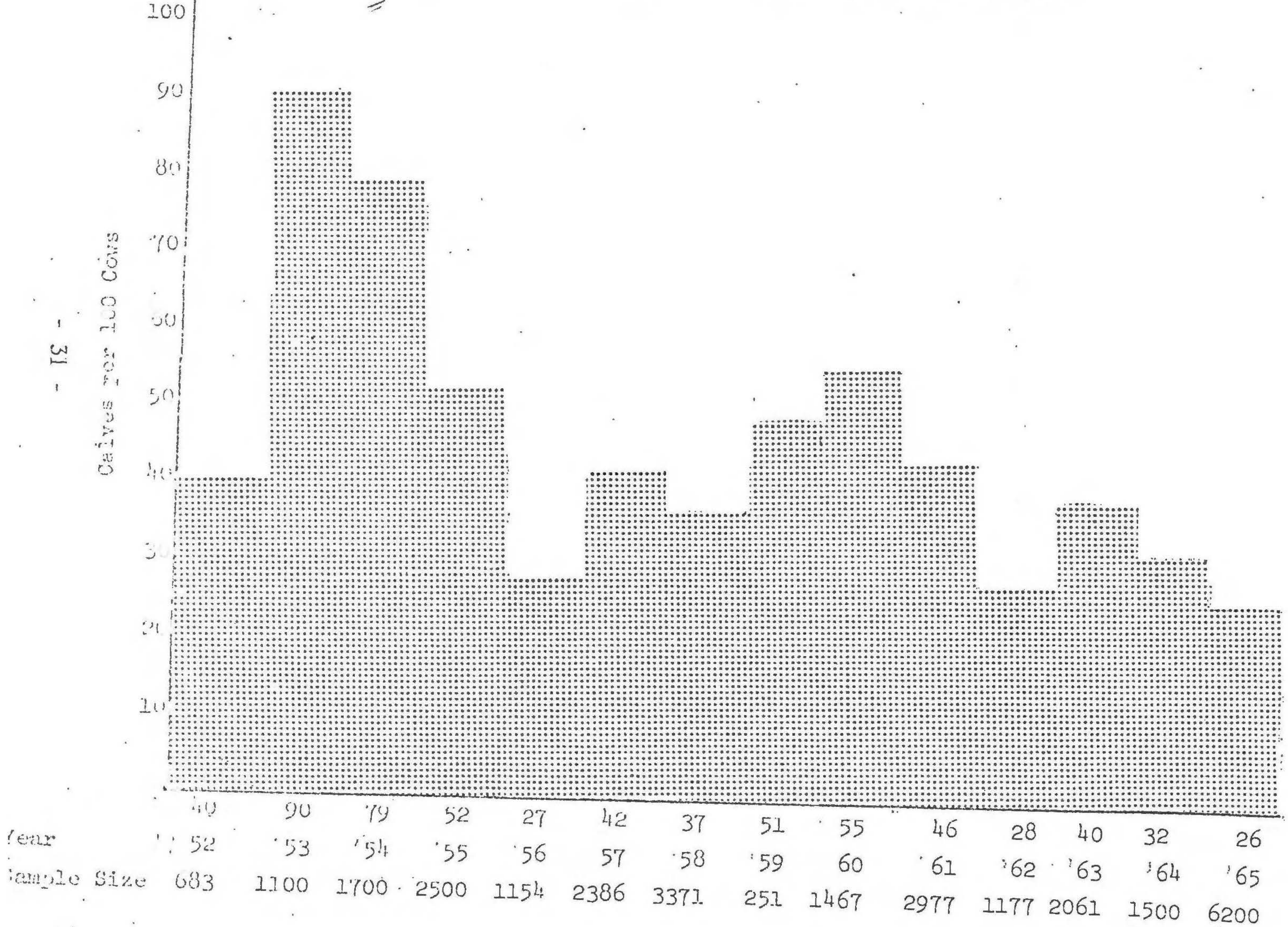

Figure 5. Wolves Bountied, 1921-1966, Alaska

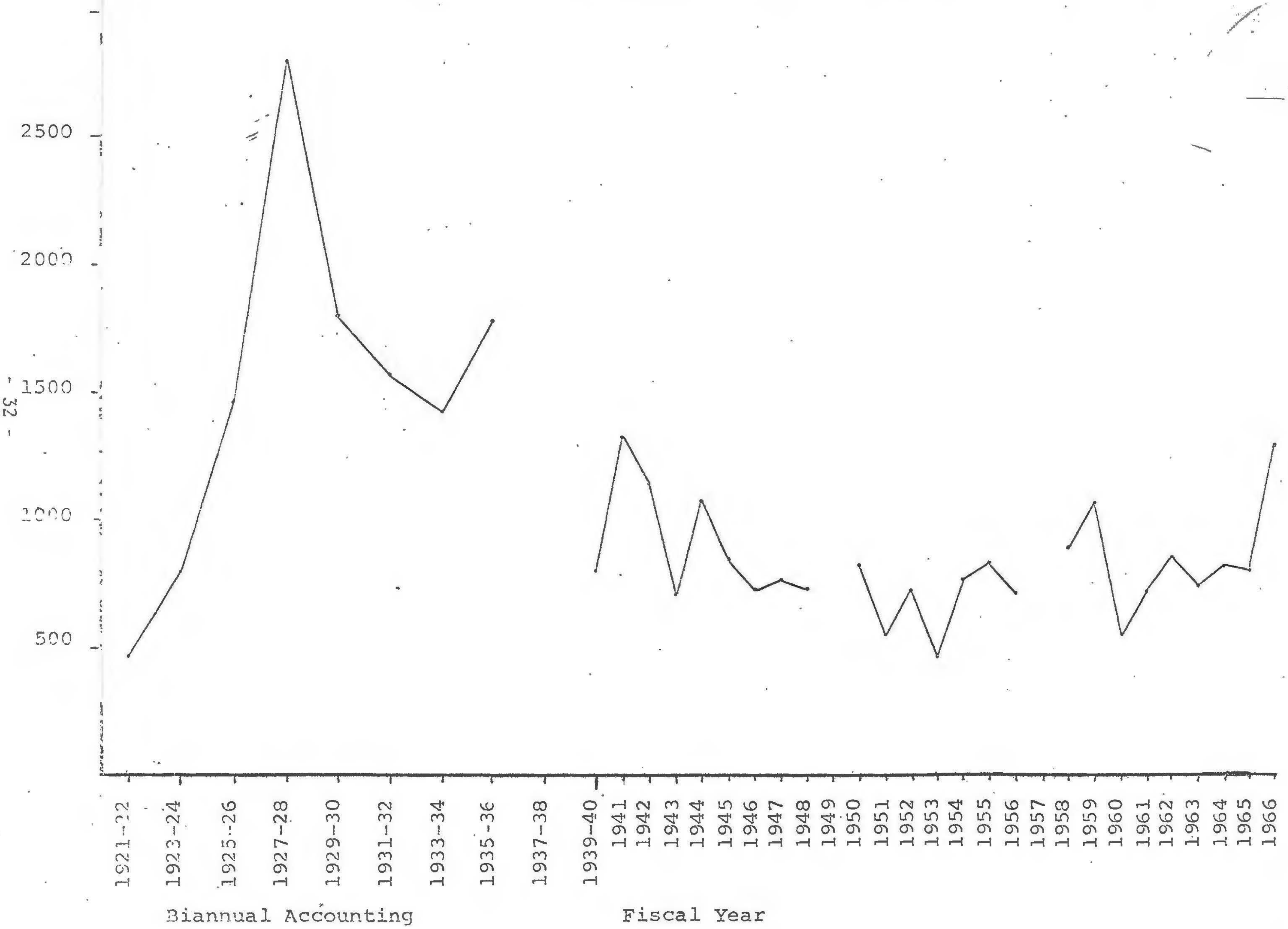

Fig. 6. Wolves Bountied, 1921 - 1966, Alaska

(Biannual Reporting)

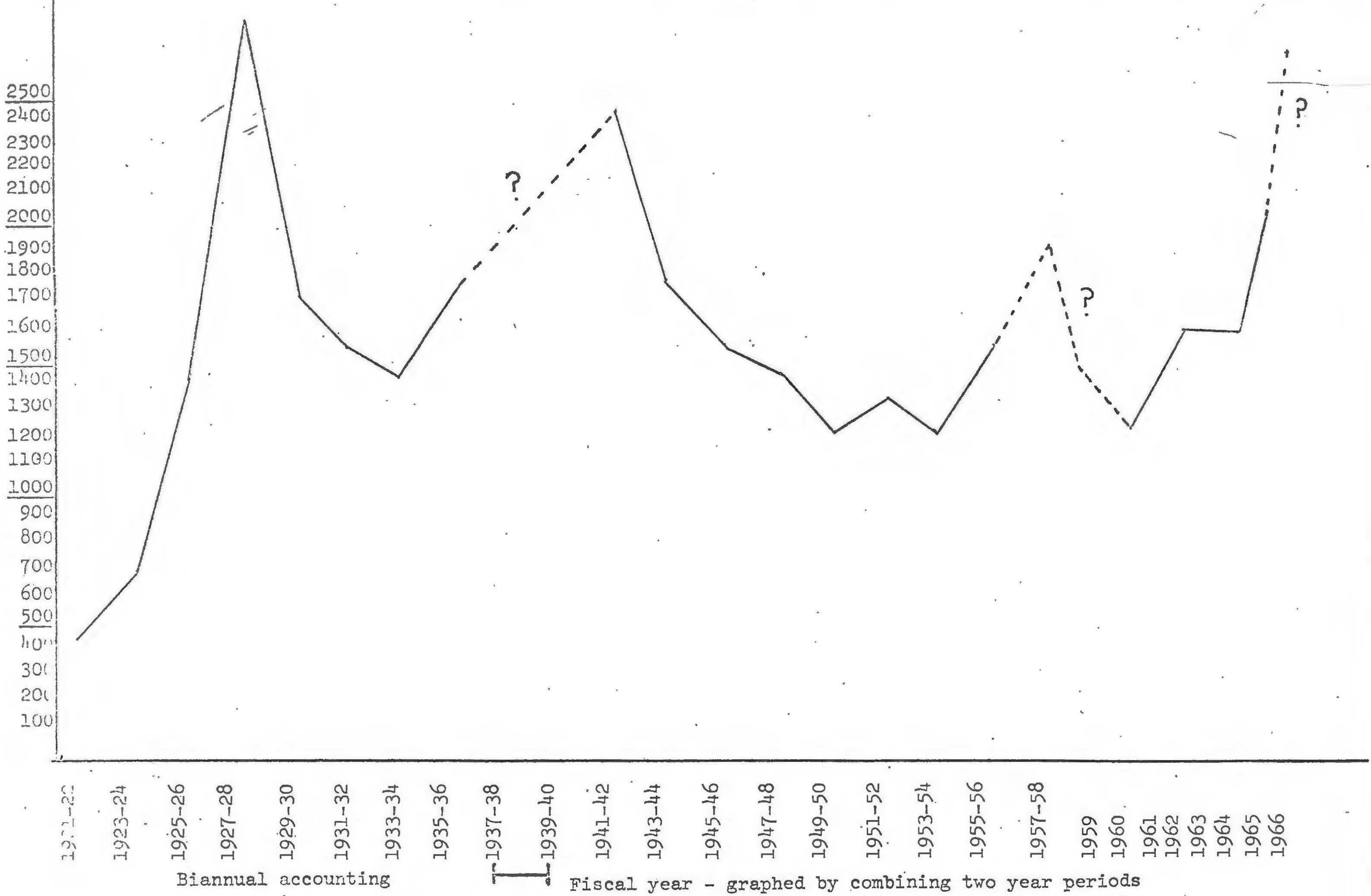

Table 12 - Statewide Wolf Bounty Analysis, 1959-1960.

Game Mgt. Unit	Class of Hunter 1. Professional 2. Incidental 3. Recreational 4. Unknown				Sex			Color					Method of Take 1. Ground Shooting 2. Trapping 3. Snaring 4. Digging Out 5. Aerial Shoot 6. Unknown							Total Wolves Taken
	(1)	(2)	(3)	(4)	♂	♀	Unk	BL	BR	GR	W	Unk	(1)	(2)	(3)	(4)	(5)	(6)	(1-2)	
Unk			3				3			3			3							3
19				1			1					1						1		1
20	9	3	12		2	9	13	5	2	9		8	9		5	2		8		24
21	4	5		2	5	4	2	5		2		4	2	4	1			4		11
23	18						18	5		12		1	18							18
24	4			1			5		1	2		2	1	1				3		5
25	26	4		2	8	5	19	5		10		17	4	4	1			23		32
26	63	14	35	5	12	17	88	21		80	2	14	20	7		7	67	16		117
TOTALS	124	26	50	11	27	35	149	41	3	118	2	47	57	16	7	9	67	55		211

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1960-1961.

Class of Hunter

1. Professional
2. Incidental
3. Recreational
4. Unknown

Method of Take

1. Ground Shooting
2. Trapping
3. Snaring
4. Digging Out
5. Aerial Shoot
6. Unknown

Game Mgt. Unit	Class of Hunter (1)	(2)	(3)	(4)	Sex ♂	♀	Unk	Color BL	BR	GR	W	Unk	Method of Take (1)	(2)	(3)	(4)	(5)	(6)	(1-2)	Total Wolves Taken
12		1				1		1					1							1
19		1				1				1			1							1
20	35	11	2	1	21	13	15	9	5	36		1	11	22	13		1	2		49
21	9	4		1	4	3	7	2	2	7		3	7	2				5		14
23	17	2		1	7	12	1	2		18			4				15	1		20
24	44	3			9	5	33	15	7	23		2	25	7	1		7	7		47
25	49	7	2	4	15	14	33	17	5	31	3	6	21	25			6	10		62
26	60	1		2	15	14	34	9	7	44		3	26	11			25	1		63
TOTALS	214	30	4	9	71	63	123	55	24	160	3	15	96	67	14		54	26		257

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1961-1962.

Class of Hunter
1. Professional
2. Incidental
3. Recreational
4. Unknown

Method of Take
1. Ground Shooting
2. Trapping
3. Snaring
4. Digging Out
5. Aerial Shoot
6. Unknown

Game Mgt. Unit	Class of Hunter				Sex			Color					Method of Take							Total Wolves Taken
	(1)	(2)	(3)	(4)	♂	♀	Unk	BL	BR	GR	W	Unk	(1)	(2)	(3)	(4)	(5)	(6)	(1-2)	
Unk	15				7	4	4	10		5							15			15
1	46	15	6		31	27	9	20	23	9		15	6	57			1	2	1	67
2	10	1	1		1	9	2	1	9			2	1	9				2		12
3	15	3			8	9	1	10	4	4			3	15						18
9		4			4			4					3	1						4
11	8				7	1		1		6	1			2			6			8
12	5	3			4	3	1	2		6					2	5			1	8
18	2				1	1				2			2							2
19	9	2	1		6	5	1	6	1	5			6		2		3	1		12
20	75	14		1	46	32	12	19	6	64		1	30	27	9	5	18	1		90
21	70	2		3	44	27	4	30	2	40	3		16	3	6		47	3		75
23	66	2	1	2	42	20	9	9	2	58		2	13	2	1		52	3		71
23 & 24	84						84					84					84			84
24	11	1			8	2	2	2		10			9				3			12
25	69	8	3	2	27	27	28	14	2	59		7	40	18	8	6		10		82
26	45				19	8	18	7	1	36	1		22	8	1	2	2	10		45
TOTALS	530	55	12	8	255	175	175	135	50	304	5	111	151	142	29	18	231	32	2	605

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1962-1963.

Class of Hunter: 1. Professional 2. Incidental 3. Recreational 4. Unknown

Method of Take: 1. Ground Shooting 2. Trapping 3. Snaring 4. Digging Out 5. Aerial Shoot 6. Unknown

Game Mgt. Unit	Class of Hunter				Sex			Color					Method of Take							Total Wolves Taken
	(1)	(2)	(3)	(4)	♂	♀	Unk	BL	BR	GR	W	Unk	(1)	(2)	(3)	(4)	(5)	(6)	(1-2)	
Unk	3	1			1	3		2		2			1	3						4
1	9	10		4	13	10		11	4	8			7	11				5		23
2	21	22			21	18	4	1	26	10		6	23	20						43
3	24	2			12	14		6	4	16			5	21						26
9	2	6	1		5	4		4	2	3			3	1			4	1		9
11	18		3		10	9	2	5		15		1	3	12			6			21
12	21	5			13	13		5		21			7	4	1		12	1	1	26
14		1	2		3				2	1				2				1		3
16	2	1	2		3	2		1		4			1				4			5
17	10	5			8	7		5			10						15			15
18	1	1			1	1		1		1			1				1			2
19	26		8		23	11		14	1	19			6	7	3		17	1		34
20	64	12	19		41	41	13	17	3	75			28	22	40		3	2		95
21	110	5	15	2	58	46	28	50	2	63		17	18	9	4		101			132
22	4	2			5	1		3		3			6							6
23	15	4	4		11	3	9	8	1	9		5	3	2	3	5	10			23
24	79	5	1		47	34	4	20	2	54	1	8	16	5			64			85
25	50	20	14	2	46	20	20	33	2	50		1	35	24	8	3	1	15		86
26	20	11	6		22	6	9	4		33			28				3	4	2	37
TOTALS	479	113	75	8	343	243	89	190	49	387	11	38	191	143	59	8	241	30	3	675

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1963-1964.

Game Mgt. Unit	Class of Hunter (1. Professional, 2. Incidental, 3. Recreational, 4. Unknown) (1)	(2)	(3)	(4)	Sex ♂	♀	Unk	Color BL	BR	GR	W	Unk	Method of Take (1. Ground Shooting, 2. Trapping, 3. Snaring, 4. Digging Out, 5. Aerial Shoot, 6. Unknown) (1)	(2)	(3)	(4)	(5)	(6)	(1-2)	Total Wolves Taken
1	20	16			12	24		9	8	17		2	11	24				1		36
2	31	22			29	21	3	4	28	15		6	16	24				6	7	53
3	25	12			15	21	1	5	2	30			15	20	1			1		37
5		1				1		1					1							1
6		1			1			1						1						1
9	9	6	1		11	5		3	2	11			10		1		4	1		16
11	15	9			13	11		8	1	13	1	1	1	11			9	3		24
12	15	1	1		14	3		4		13			6	9	1		1			17
14	5	2		1	4	4				7		1	3		5					8
16	16	2	2	1	15	6		6		11		4	3	3			14	1		21
17	14				9	5		6		8							14			14
19	47	6			27	24	2	9		44			9	4	1		37	1	1	53
20	168	33	28	8	124	101	12	70	3	160	1	3	49	82	94		9	3		237
21	23	11	1	8	23	15	5	16	2	23		2	11	9	2		20	1		43
23	26	13	1	1	27	13	1	13	1	27			14	12			13	2		41
24	8	4			7	3	2	3		8		1	3	3	2		2	2		12
25	43	1	2	4	23	14	13	13	1	35	1		11	17	7		7	8		50
26	43		5	1	36	9	4	15		34			21	11			17			49
TOTALS	508	140	41	24	390	280	43	186	48	456	3	20	184	230	114		147	30	8	713

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1964-1965.

Game Mgt. Unit	Class of Hunter (1)	(2)	(3)	(4)	Sex ♂	♀	Unk	Color BL	BR	GR	W	Unk	Method of Take (1)	(2)	(3)	(4)	(5)	(6)	(1-2)	Total Wolves Taken
Unk	1		2				3			1		2	1					2		3
1	25	8	3		25	10	1	9	4	23			17	19						36
2	37	20			31	18	8	6	18	16		17	26	31						57
3	15	9	2	1	15	12		4	4	18		1	14	12				1		27
5		4			3	1				4			4							4
6	1				1			1						1						1
9	16	17	11		19	19	6	1	3	37	3		25	5	6		8			44
11	19	4	6	1	13	17		11		19			7	14	1		8			30
12	13	6	5		19	4	1	10		14			8	4	5		6		1	24
14	5	2	4		6	5		2	1	8			9	2						11
16	14	9	14		22	15		14	5	17		1	13				24			37
17		1			1					1			1							1
19	19		37	1	12	8	37	22	1	33	1		39	4			14			57
20	167	24	74	2	158	98	11	81	4	180		2	66	58	76		60	7		267
21	20	2	10	1	12	9	12	12	1	16	1	3	22	7	1		1	2		33
22		1	2	1	1	2	1	2		2			1				2	1		4
23	16	8	6	5	26	8	1	8		27			10	15			7	3		35
24	34	10	1		28	12	5	17	1	25		2	39	4	1			1		45
25	24	1			5	6	14	15		10			6	2		8		9		25
26	47		10	2	29	18	12	10		46	3		12	9			19	19		59
TOTALS	473	126	187	14	426	262	112	225	42	497	8	28	320	187	90	8	149	45	1	800

Class of Hunter: 1. Professional 2. Incidental 3. Recreational 4. Unknown

Method of Take: 1. Ground Shooting 2. Trapping 3. Snaring 4. Digging Out 5. Aerial Shoot 6. Unknown

Table 12 (Cont.) - Statewide Wolf Bounty Analysis, 1965-1966 (through June 1, 1966).

Game Mgt. Unit	Class of Hunter: 1. Professional 2. Incidental 3. Recreational 4. Unknown				Sex			Color					Method of Take: 1. Ground Shooting 2. Trapping 3. Snaring 4. Digging Out 5. Aerial Shoot 6. Unknown							Total Wolves Taken
	(1)	(2)	(3)	(4)	♂	♀	Unk	BL	BR	GR	W	Unk	(1)	(2)	(3)	(4)	(5)	(6)	(1-2)	
Unk		1				1			1				1							1
1	9	5		3	10	7		4	6	6		1	13	3			1			17
2	23	26	1		30	19	1	8	28	14			28	21				1		50
3	33	17	1	1	27	25		15	5	32			21	29				2		52
5	5	1	1		4	3		2		5			2				5			7
6		4	1		4	1				5			1				4			5
9	23	2		2	20	7		3	6	18			6	12			7	2		27
11	70	4	42	1	64	53		50		67			9	10	5		92	1		117
12	17	23	5	2	25	22		17	4	25		1	21	13	4		6	3		47
13	56	6	2		43	20	1	32	2	26		4	62	2						64
14	7	6	6		9	6	4	7		12			5	2	2		10			19
15	61	3	20		47	37		28		46	1	9	6	4			74			84
17	15	3			10	8		6		12							18			18
19	105		5		58	50	2	21		26		63	10	2	1		93	4		110
20	98	33	125	6	143	109	10	65	4	169	1	23	44	121	18		71	8		262
21	184	2		1	106	73	8	34	1	77	1	74	8	12	2		155	10		187
22	7	2	2		9	2		5		6			11							11
23	24	13	10		31	11	5	8		38	1		9	2			35	1		47
24	64	1	2		33	22	12	12		47	1	7	23	2	1		38	3		67
25	54		5		29	18	12	18	4	34	1	2	14	10	5	10	9	11		59
26	39		2		17	9	15	6	1	31	1	2	9				6	26		41
TOTALS	894	152	230	16	719	530	70	341	62	696	8	185	303	245	38	10	624	72		1,292

compiled most of the bounty information data on wolves and wolverine; and Sam Snyder and Scott Grundy processed much of the specimen material.

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Literature Cited

Allen, D. L. and L. D. Mech. 1963. Wolves vs.moose on Isle Royale. Nat. Geogr. 123:200-219.

Anderson, A. C. and Eloise Wooten. 1959. The esterus cycle of the dog. pp. 359-397. In H. H. Cole and P. T. Cupps (eds.), Reproduction in domestic animals. Academic Press, New York and London.

Atwell, Gerry. 1963. An aerial census of wolves in the Nelchina wolf study area. Proc. Alaska Scien. Conf. 14:79-83.

Burkholder, Bob L. 1959. Movements and behavior of a wolf pack in Alaska. J. Wildl. Mgmt. 23 (1):1-11.

Cowan, Ian M. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res., 25 (5):139-174.

Fuller, W. A. and N. S. Novakowski, 1959. Wolf control operations, Wood Buffalo National Park, 1951-52. Can. Wildl. Ser. Mgmt. Bull. Seri. 1, 11. p. 20.

Garceau, Paul. 1963. Wolf predation on Sitka black-tailed deer. Alaska Dept. of Fish and Game, Fed. Aid Wildl. Restor. W-6-R-3, K:3-16.

Jordon, Peter. 1966. Paper presented at the 17th Annual A.I.B.S. meeting , U. of Maryland, College Park, Maryland (in press).

Kelly, Maurice W. 1954. Observations afield on Alaskan wolves. Proc. Scien. Conf: 35.

Klein, D. R., Willard Troyer, and Robert A. Rausch. 1958. The status of the brown bear in Alaska. Proc. 9th Alaska Scien. Conf.

Lensink, C. J. 1959. Predator control with the bounty system in Alaska. Div. Biol. Res. Alaska Dept. of Fish and Game, Juneau. p. 10 (Mimeo).

Makridin, V. P. 1962. The wolf in the Yamal North. Zoologicheckii Zhurnal XLI (9):1413-1417. (Translated from the Russian by Peter Lent.)

Mech, D. L. 1966. The wolves of the Isle Royale. U.S. Nat. Parks Fauna No. 7, p. 210.

Merriam, Harry, 1964. The wolves of Coronation Island. Proc. Alaska Scien. Conf. 15:27-32.

Nickerson, Richard B., Frank J. Ossiander and Guy C. Powell. 1966. Change in size class structure of populations of Kodiak Island commercial male king crab due to fishing. J. Fish Res. Bd. Canada 23 (5):729-736.

Pimlott, D. H. 1959. Reproduction and productivity of Newfoundland moose. J. Wildl. Mgmt. 23 (4): 381-401.

Pimlott, D. H. 1961. Wolf control in Canada. Reprinted from Can. Audubon Mag. Nov-Dec:145-152.

Pulliainen, Errki. 1965. Studies on the wolf (Canis lupus l.) in Finland. Ann. Zool. Fenn. 2:215-259.

Rausch, R. A. 1964. Progress in the management of the Alaskan wolf population. Proc. Alaska Scien. Conf. 15:43

Rausch, Robert A. 1965. Corpora albicantia as an indicator of age and past reproductive performance in moose. Unpublished ms. Alaska Dept. Fish and Game Files, Fairbanks.

Rausch, R. A. 1966. The status of moose in Alaska. unpubl. ms. Alaska Dept. Fish and Game, Fairbanks, p. 26.

Rausch, R. A. and Arthur Bratlie. 1965. Annual assessments of moose calf production and mortality in Southcentral Alaska. Proc. Western Assoc. Game and Fish Comm. 45.

Rausch, R. L. 1958. Rabies in Alaska. J. Wildl. Mgmt. 22(3):246-260.

Rausch, R. L. and Francis S. L. Williamson. 1959. Studies of the Heleminth fauna of Alaska XXXIV the parasites of wolves, Canis lupus l., J. Parasitol. 45(4):395-403.

Simpson, George Gaylord, Anne Roe and Richard C. Lewontin. 1960. Quantitative zoology (Revised ed.) p. 440. Harcourt, Brace and Co.

Siniff, Donald B. and R. O. Skoog. 1962. Aerial censusing of caribou using stratified random sampling. J. Wildl. Mgt. 28 (2):391-401.

Skoog, R. O. 1962. A gross method of estimating current size and status of caribou herds. Proc. Alaska Scien. Conf. 13:37-39.

Skoog, R. O. 1964, Incomplete Comprehensive Report on Caribou, Alaska Dept. of Fish and Game files, Juneau, Alaska.

Stenlund, Milton H. 1955. A field study of the timber wolf (Canis lupus) on the Superior National Forest, Minnesota. Tech. Bull. Minn. Dept. Cons. 55 pp.

Watson, Gordon and Rupert F. Scott. 1956. Aerial censusing of caribou. Trans. 21, N.A. Wildl. Conf.: 499-510.

Winters, Richard L. 1963. Wolf management investigations. Alaska Dept.

Fish and Game (unpubl.) Fed. Air in Wildl. Project, W-6-R-4, K-2:1-4.

Young, Stanley, P. and E. A. Goldman, 1964. The wolves of North America, their history, habits, economic status and control. Stanley P. Young. p. 385, Dover Publ. Inc., 180 Varick St. New York 14, N.Y.

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