ALASKA DEPARTMENT OF FISH AND GAME
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REPORT ON 1972 BROWN BEAR STUDIES

by
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Volume XIV
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-4, Jobs 4.2R and 4.4R (2nd half) and
Project W-17-5, Jobs 4.2R, 4.4R and 4.6R (1st half)

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Leland P. Glenn and James B. Faro

Project Nos.: W-17-4 & W-17-5 Project Title: Big Game Investigations

Job No.: 4.2R Job Title: Brown Bear Life History

Period Covered: January 1, 1972 through December 31, 1972

SUMMARY

The Alaska Department of Fish and Game captured, marked and released 112 brown bears on the Black Lake Study area in 1972. Tagging began on June 6 and continued for 31 consecutive days. Thirty-seven percent of these bears had been tagged in either 1970 or 1971. Excluding known mortality, an estimated 191 marked bears remained on the study area. During the summer of 1972, 16 bears were captured, marked and released at McNeil River. Six of these bears had been tagged in previous years. An estimated 47 tagged bears remained in the population. Life history information has been collected from all tagged bears.

Some Alaska Peninsula brown bears are successful breeders at 3.5 years of age. Three females bred successfully at this age and 12 of 31 3.5 year-old females captured were in estrus. Evidence is presented to show that many female bears do not conceive successfully until they are 4.5 or 5.5 years old, however. About one-half of the sows with young captured at Black Lake were less than 7 years of age when they conceived. The fact that a high percentage of sows are breeding at a young age may contribute significantly to the productivity of the population.

At Black Lake, cub mortality under parental care between the ages of 6 months and 1.5 to 3.5 years combined is less than 10 percent.

Evidence is presented to show that some sows care for their young for 3.5 years but most keep them only 2.5 years.

Information on 91 captured adult females indicates the mean interval between breedings is three years. Some individuals are known to have bred after two years and some had still not bred after four or five years. It appears that most sows are with young for three consecutive winters; the following spring, sows separate from their 2-year-old young and breed. As a result of this about one-third of the adult females are without young in the fall and are legal to hunt.

On the Black Lake Study area the sex ratio of 242 captured bears was 70 males:100 females. The sex ratio of bears 5 years of age or

older (sample size 80) was 29 males:100 females or one adult male for every 3.4 adult females.

Spring weights were taken on 261 bears. The largest female weighed 560 pounds and the largest male weighed 975 pounds. Unlike females, adult males increased in weight annually after sexual maturity had been reached.

CONTENTS

BACKGROUND

The Alaska Department of Fish and Game initiated a brown/grizzly bear (*Ursus arctos*) life history study in 1963 because knowledge of bear reproduction and survival was insufficient for management purposes. Contributions to the study were made by various investigators including Erickson et al. (1968) who found that male brown bears are sexually mature by 4 years of age. They also found that the male brown bear has a potential breeding season slightly exceeding one-half of the year and encompassing the greater portion of the den-free period. Erickson (1963 and 1964) documented cub adoption and mixed-age litters of young. Lentfer et al. (1972) presented information on denning habits with emphasis on description of dens. During their investigation no evidence of mortality associated with denning or parturition was discovered.

Two study areas, both on the Alaska Peninsula, were chosen for intensive brown bear life history investigations. These study areas are: 1) McNeil River, located on the west side of lower Cook Inlet; and 2) Black Lake, located on the Alaska Peninsula approximately 475 miles southwest of Anchorage between the villages of Port Heiden and Port Moller. Investigations started in 1963 at McNeil River and in 1970 at Black Lake.

The McNeil River area was chosen for one of the same reasons that makes it popular with photographers, i.e., concentrations of bears can be easily observed from the ground. It is common to see 30 or more different bears at McNeil River in one day. McNeil River was established in 1967 as a state game sanctuary and is closed to bear hunting. The life history study (Job 4.2) will terminate at McNeil River in 1973 and a Final Report will be submitted in 1974. Early results of the study have been reported by Lentfer et al. (1969), Glenn and Miller (1970),

Glenn (1971) and Glenn (1972). The primary reasons for terminating the McNeil River study are: 1) conflicts between research activities and public use of the sanctuary, i.e., tagging effort has been reduced in recent years because some members of the public dislike photographing or observing marked bears; and 2) the McNeil River investigation does not provide the opportunity to study a large population of bears or to relate the influence of hunting on population productivity. The life history investigation will continue at Black Lake in conjunction with distribution and movement studies (see Job. 4.4, this report).

OBJECTIVES

To investigate the time of family "break-up" and the survival of young from birth to family "break-up" and to breeding age.

To quantify the rate of cub production, growth and mean life expectancy.

To determine age, reproductive status and chemical composition of blood and milk from captured and hunter harvested bears.

PROCEDURES

Specimen Collecting Procedures

During the summer of 1972, 128 brown bears were captured at Black Lake and McNeil River using procedures reported by Glenn (1972). Field work started at Black Lake on June 6 and continued for 31 consecutive days. At McNeil River capture activities were limited to 2 weeks, July 24 through August 6.

Blood samples were taken from the femoral artery using donor tubes and 150 ml heparinized vacuum bottles. Blood smears, both thick and thin, were also taken for studies of parasites and for differential white blood cell counts. Whole blood samples were centrifuged at the field station and the red blood cells and serum separated and frozen. Analysis will determine multiphasic profiles which may allow interpretation of the populations' seasonal physical status. Urine, stool and hair samples were also collected for chemical, vegetational and parasite analysis.

Milk samples were obtained from lactating females by injecting a mammary gland with 2 cc of oxytocin (Wyeth Laboratories, Inc., Philadelphia, Pennsylvania) in concentrations of 10 u.s.p. units/cc. Samples were collected in 20 ml plastic containers and frozen.

Vaginal smears were collected from most estrous females to determine if sperm were present. A clear plastic vaginal extender was used to open the vaginal orifice. A cotton swab was then inserted through the opening to collect a sample. The swab was rolled across the surface of a glass slide and the specimen was then protected by spraying with a

water soluble fixative (Adams Spray-Cyte, Parsippany, New Jersey). These specimens were microscopically examined to detect presence of sperm.

The dentition of cub and yearling bears was examined to determine the stage of deciduous and permanent tooth eruption. Two teeth, a lower and upper first premolar, were pulled for cementum age determination. Tooth specimens were stored in 20 percent ethyl alcohol prior to processing. The technique used to section, stain and mount teeth has been previously described (Glenn, 1972).

Describing the Animal

The following body measurements were taken: chest girth, hind foot length, height at shoulder, neck girth, total length (standard), body length (standard), length of upper and lower left canine as measured from the gum line, and head length and width (measured between the most anterior surface of the upper first incisors and the posterior protuberance of the parietal crest and between the widest portion of the zygomatic arches).

Bears captured at McNeil River were not weighed. At Black Lake cubs-of-the-year and small yearling bears were weighed with a hand-held, 200-pound capacity spring scale. Heavier bears were weighed by slinging them beneath the helicopter in a cargo net. Weights were recorded by the pilot reading an electronic direct digital readout of the cargo hook load as he hovered with the bear. The electronic weighing system (Chadwick Inc., Beaverton, Oregon) has a test calibration switch in its display face and a zero knob to allow tare weight without internal adjustment. Resolution is in 10 pound increments.

Color photographs were taken of all bears to document pelt coloration, body size and other physical characteristics of interest.

Field information obtained from captured or observed tagged bears was recorded on a field data form (Fig. 1). This form provided a standard and efficient method of systematically recording captured bear information and served as a check list of work to be performed.

Productivity

Information on breeding biology was obtained by: 1) recording data on the size, coloration and lactating condition of mammae, condition of the vulva, baculum size and position of testes; 2) observing the frequency of adult male-female pairing; 3) recording litter size of all family groups; and 4) recording the frequency between litters of captured or observed tagged bears.

Population Structure

The age and sex composition of brown bears captured at Black Lake was determined by reading the cementum age of sectioned premolar teeth and by examination of genitalia. Aerial bear classification surveys were flown during June and early July in conjunction with spring bear

Fig. 1 BLACK-CHIGNIK LAKE TAGGED BROWN BEAR RECORD DATA

Bear No._____ Date_____ Sex_____ Est'd. Age_____ Cem. Age_____.

Collector_____Recorder_____ Recapture___ New___.

	Temp.	Pulse Rate	Resp. Rate	Convulsion	Tremor	Other
Time						
Time						

MEASUREMENTS: Measured Wt._____ T.L._____ Ht.Sh._____ H.F._____ Neck_____.

Girth_____ B.L._____ Head: Width_____ Length_____.

Length of Upper Left Canine_____ Lower Left Canine_____.

PHOTOGRAPHS: Dentition ( ), Collar ( ), Mammae ( ), Whole Bear ( ), Vulva ( )

SPECIMENS COLLECTED: Tooth(Be specific)_____ Blood: Vol._____.

Blood Smear: Yes____ No____ Vag Smear: Yes____ No____ Feces: Yes____ No____.

Urine: Yes____ No____ Milk: (No less than 10 ml prefer 100-200 ml) Vol._____.

PRODUCTIVITY: Female: No. of .5 yr. Olds_____1.5 yr._____2.5 yr._____.

Mammae: Length_____ Color_____ Vulva:_____ Male: Testes Descended: Yes___ No___.

Other Bears Present (Describe)_____

RECAPTURE DATA: Tattoo: No._____ Condition_____ Ear Tags(Number, Type, Condition)

Left_____ Right_____.

Collar (Number, Type, Condition)_____.

NEW TAG DATA: Left Ear: Large Roto No._____ Color_____ Small Roto No._____.

Color_____ Right Ear: Large Roto No._____ Color_____ Small Roto No._____.

Color_____ Collar: Type_____ Collar Color Code:_____.

_____ Collar Plate Ident.: Figure_____.

Temporary Markings:_____.

Time Departed_____ Completeness of Recovery_____.

Comments:_____

_____

Punch Tattoo No. Here

Fig. 1 (cont'd.)

Specific Location_____

Grid No._____ Map Coordinates_____

DRUG DATA: Est'd. Wt._____ Circle Each Used: 1. Sernalyn 2. Sparine

3. M-99 4. M 50-50 5. Other_____

	Dosage	Time Darted	Time Down	Dart Location
1st Hit				
2nd Hit				
3rd Hit				
Total				

REMARKS:

RESIGHTINGS:

tagging activities. Effort was made to survey mountainous areas where tagging crews seldom visited. A Piper PA 18-150 aircraft was used to conduct these surveys.

FINDINGS

Breeding Activity

Several investigators have documented the low reproductive capacity of brown/grizzly bears in comparison to other North American big game animals. Craighead et al. (1969) reported that grizzly bears in Yellowstone National Park do not attain sexual maturity until 4.5 years of age. Pearson (1972a) stated that female grizzlies in the Yukon Territory do not reach sexual maturity until at least their seventh year. Hensel et al. (1969) examined female reproductive tracts from Kodiak Island brown bears and indicated sexual maturity was attained at 3 to 6 years of age. At Black Lake some 3.5-year-old females are successful breeders. Three females, Nos. 747, 764B and 781, conceived at this age (Table 1). Examination of vulvas revealed that 12 of 31 captured females 3.5 years of age were in estrus. Fifteen of 26 captured females 4.5 to 6.5 years of age were with young. Three of these females conceived at 3.5 years of age, six conceived at 4.5 years of age, and six conceived at 5.5 years of age. The fact that a high percentage of females are breeding at a young age may significantly increase total productivity of this bear population.

Information on maximum breeding age is difficult to obtain at Black Lake since the rate of population turnover is high. The oldest producing female (No. 722) was 18.5 years old when first captured with her two yearling cubs. Conception would have occurred at 16.5 years of age. This sow was recaptured the following spring with one 2.5-year-old cub and was killed by a hunter during the fall bear hunting season. A 16-year-old sow (No. 22) was captured in 1966 at McNeil River. From 1966 through 1972 the sow was without young. Although it could be concluded that this sow had attained the maximum breeding age since she was never observed with young, it is possible that reproductive abnormalities rather than advanced age prevented successful breeding.

Length of the female breeding season has not been determined. At Black Lake estrous females were captured from early June through early July when capture work terminated. At McNeil River an estrous female was captured as late as August 1. This animal was observed the following summer without cubs.

Observations suggest that some males breed at 3.5 years of age though the success of these breedings is unknown. Three 3.5-year-old males were captured while they were accompanying estrous females; male No. 746 was with No. 745, a 15-year-old sow; male No. 715 was with No. 717, a 7-year-old sow and male No. 786 was with No. 823, a 5.5-year-old sow. Vaginal smears were obtained from these females but failed to show presence of sperm.

Table 1. The minimum breeding age of some female brown bears captured on the Black Lake study area.

Bear No.	Observed or Captured	Age	Age Conceived	No. of Cubs	No. of Yearlings	No. of 2.5 yr. old	Breeding Conditions
No. 747							
6/24/70	Captured	5.5	3.5	0	1	0	Normal
6/18/71	Recaptured			0	0	1	Normal
6/20/72	Recaptured			0	0	0	In estrus
No. 764B							
6/28/70	Captured	5.5	3.5	0	2	0	Normal
11/18/70	Observed			0	-	0	
7/3/72	Recaptured	7.5	6.5	1	0	0	Normal
No. 781							
7/2/70	Captured	3.5	3.5	0	0	0	In estrus
10/10/71	Hunter kill			3[1/]	0	0	
No. 3							
7/3/71	Captured	6.5	4.5	0	2	0	Lactating
6/6/72	Recaptured			0	0	0	In estrus
No. 19							
7/6/71	Captured	5.5	4.5	2	0	0	Lactating
6/21/72	Recaptured			0	0	0	Lactating
No. 707							
6/19/70	Captured	6.5	4.5	0	1	0	
10/12/70	Observed			0	1	0	
6/22/71	Recaptured			0	0	0	In estrus
10/1/71	Hunter kill						
No. 734							
6/22/70	Captured	6.5	4.5	0	1	0	
No. 785							
7/4/70	Captured	6.5	4.5	0	2	0	Normal
11/18/70	Observed			0	2	0	
6/14/72	Recaptured			0	0	0	In estrus

1/ Reported to have had three cubs. Hide examined and mammae very large and black in color.

On several occasions an adult male has been captured with two estrous females. In one instance a male was observed in the copulatory act just before he was captured with two estrous females. Maintenance of this bond is probably dependent on the length of estrus and on the ability of a male to defend females against other boars.

Observation suggests that the peak period of breeding activity is from June 20 through July 5. While breeding activity increased during this time, accurate determination of the length of breeding season awaits further study.

Litter Size and Mortality of Young

The average litter size of bears observed at Black Lake was 2.3 cubs-of-the-year and of older young still in family group status, it was 2.1 (sample size 749 young). Litters ranged from one to five young. Pearson (1972b) found that interior grizzlies in northern British Columbia produced smaller litters (1.6 cubs-of-the-year average) while Troyer and Hensel (1964) found litters on Kodiak National Wildlife Refuge averaged 2.36 cubs-of-the-year. The mean litter size of cubs-of-the-year observed at McNeil River during the years 1963 through 1972 was 2.1 (sample size 35 young).

At Black Lake, cub mortality under parental care was less than 10 percent (Table 2). This was the observed decrease in the mean litter size between age class 6 months and the combined age classes from 1.5 to 3.5 years (sample size 749 young). The sample size of young bears captured was small (99) limiting conclusions regarding the rate of natural mortality by age class. Sample size was also small at McNeil River, although comments may be of interest. The observed decrease in mean litter size of 6-month-old cubs and older young accompanied by sows (for a 10-year period) was 2.1 to 1.8, indicating a 12 percent mortality rate. Den studies and trend counts conducted by the Department on the Alaska Peninsula also indicate a low mortality rate under parental care in that area. Craighead and Craighead (1970) stated that 27 percent of the grizzly bear cubs in Yellowstone Park did not survive the first year and a half of life.

Interval Between Litters

At Black Lake some sows care for their young at least 3.5 years. I previously reported the observation of a sow with five young observed on the same stream during July and August for three consecutive years (Glenn, 1971). A more positive example is sow No. 731. She conceived in the spring of 1968 and was captured with the same young in the Junes of 1970, 1971 and 1972. The tendency for some sows to keep their young for 3.5 years is an important factor that could significantly lengthen the breeding interval.

Available data suggest the normal interval between breeding for adult sows is three years. Couturier (1954) and others contended that females usually breed every two years but sometimes three years pass between matings. Reproductive information gathered on the Alaska

Table 2. Mean litter size by age class of brown bears observed and captured at Black Lake showing the extent of natural mortality under parental care.

	Female w/young	No. of young	Average young/sow	Percent mortality
Litter Size by age class of bears observed during August 1965 through 1970 and 1972[1]				
Sows w/6 mo. old cubs	200	454	2.3	
Sows w/1.5 to 3.5 yr. old young[2]	142	295	2.1	9.0
Total	342	749		
Litter size by age class of bears captured during June 1970, 1971 and 1972				
Sows w/6 mo. old cubs	9	18	2.0	
Sows w/1.5 yr. old cubs	26	53[4]	2.0	0.0
Sows w/2.5 yr. old young	12	24[3]	2.0	0.0
Sows w/3.5 yr. old young	2	4	2.0	0.0
Total	50[5]	99	2.0	

[1] Bears observed during the June-July 1972 tagging season.
[2] Age classes are combined since they cannot be determined without capture.
[3] Includes sow of four 2.5 year-olds, one of two 2.5 two-year-olds, and one of two 2.5 year-olds that escaped during the capture attempt.
[4] Includes one of two 1.5 year-old young that escaped in the capture attempt.
[5] Sow No. 829 not included because the age of her three young are unknown.

Peninsula indicates that the number of sows breeding at two-year intervals is low and that this may only occur when young are lost or separated from sows prior to the breeding season. Only two incidents of sows breeding in alternate years were recorded (sample size of 91 marked adult sows). Sow No. 5 was observed in 1965 and 1967 with 6-month-old cubs. Sow No. 9 was captured with a cub-of-the-year on July 4, 1971. During October, 1972 a hunter killed the yearling. On June 21, 1972, the sow was observed mating with an adult male just before she was captured. Of seven adult females observed at McNeil River for three or more consecutive years, one gave birth at a two-year interval, four at a three-year interval, one at least a four-year and one at least a five-year interval.

Reproductive data collected at Black Lake support findings at McNeil River and show the normal interval between breeding is three years. Information is limited by the short period of time the study has been in progress, however, and only two complete years of data (Table 3) are available. The following data show the family group status of 158 young 1.5, 2.5 and 3.5 years of age: 1) 58 of 61 young 1.5 years old were with sows during the active breeding season. None of the 29 sows with these 58 young were in estrus and 12 were still lactating. If lactation inhibits ovulation, it is unlikely that these sows would have bred that year. Since none of the adult females were in estrus, mating would not have occurred that year. In that event the minimum interval between breeding is three years when cubs remain with sows for at least 1.5 years; 2) 24 of 54 young 2.5 years old were with a sow during the active breeding season. Five of the 12 sows with these 24 young were in estrus, two were nonturgid and five were still lactating and not in estrus. Again it is doubtful that the lactating sows would have gone into estrus. If they did not, the minimum interval between breeding for these lactating sows would have been four years. The probability that the five estrus sows would have bred that year seems high. If mating occurred, the minimum interval between breeding would have been three years; and 3) three of 43 young 3.5 years of age were with sows during the active breeding season. The two sows with these three young were in estrus. If these females had bred, the minimum interval between matings would have been four years. A review of reproductive data indicates that most sows remain with their young for three consecutive winters, the following spring sows separate from their 2-year-old young and breed. At this time the normal interval between adult female matings appears to be three years. This is substantiated by data presented in Table 4 which show that two-thirds of the adult female population are with young during the breeding season. Of particular interest to game managers is the fact that about one-third of the adult females are concurrently available to breed and available for fall hunters to harvest.

Sex and Age Structure

The sex and age structure of 242 bears captured on the Black Lake study areas is presented in Table 5. The sex ratio of all age classes was 70 males:100 females. More important to game managers is the sex ratio of the adult segment of the population. The ratio of 80 bears 5 years old and older was 29 males:100 females or 1 male for every 3.4 adult females.

Table 3. Number and percentage of captured young 1.5 and 2.5 years old with and without sows on the Black-Chignik Lakes study area.

	Number of young 1.5 and 2.5 years old with or without sows					
Year	Young w/sows 1.5 yrs.	Young without sows 1.5 yrs.	Young w/sows 2.5 yrs.	Young without sows 2.5 yrs.	Total Young With Sows	Total Young Without Sows
1970	26	1	9[2/]	10	35	11
1971	9[1/]	0	12	9	21	9
1972	23	2	3	11	26	13
Total	58	3	24	30	82	33

1/ Includes one of two 1.5 year-old young that escaped during capture.
2/ Includes two of four 2.5 year-olds, one of two 2.5 year-olds and one of two 2.5 year-olds that escaped during the capture attempt.

Table 4. Number and percentages of marked females 5.5 years old or older with or without young on the Black-Chignik Lakes study area. Sample taken between June 6 and July 7.

	Adult Females		
Year	Total No. Captured	Number w/young	Percentage w/young
1970	31	20	65
1971	24[1/]	17	71
1972	23	14	61
Total	78	51	65

1/ Includes sow No. 829, her three young not captured.

Table 5. Age and sex structure of brown bears captured on the Black Lake study area.

	Year Captured			Total	Percent of Bears in Each Age Class
	1970	1971	1972		
Cubs					
M	1	6	2	9	7
F	1	6	1	8	
1.5 Yrs.					
M	9	0	14	23	22
F	15	7	8	30	
2.5 Yrs.					
M	12	6	7	25	16
F	7	4	2	13	
3.5 Yrs.					
M	6	6	8	20	17
F	9	6	7	22	
4.5 Yrs.					
M	2	2	1	5	5
F	1	5	2	8	
5.5 Yrs.					
M	2	2	1	5	7
F	7	3	1	11	
6.5 Yrs.					
M	3	1	2	6	5
F	3	2	2	7	
7.5 Yrs.					
M	0	0	0	0	3
F	3	2	3	8	
8.5 Yrs.					
M	0	1	0	1	2
F	2	0	3	5	
9.5 Yrs.					
M	0	0	0	0	1
F	2	1	0	3	
10.5 Yrs.					
M	2	0	0	2	3
F	4	1	1	6	
11+ Yrs.					
M	1	1	2	4	10
F	8	6	7	21	
Total	100	68	74	242	

Comparing these ratios with those found in other brown/grizzly bear studies is impractical since other investigators have been unable to obtain a comparable sample size in a reasonable period of time. Major difficulties are encountered when attempting to determine bear population composition. This species does not lend itself to ground counting and sex cannot be determined by aerial observers. Severe bias in harvest data rule out their use. The only alternative is to capture a representative sample of bears. At Black Lake brown bears are captured only in areas where the helicopter can be maneuvered safely. It is difficult to determine the biases in a sample collected in this manner, though some are suspected. For example, it is known that some large boars and sows with cubs-of-the-year remain in the mountains until about the first of July. The low number of cubs-of-the-year captured (Table 5) indicates that this segment is not being sampled adequately. Mountainous terrain prevents random sampling and thick vegetative cover reduces the efficiency of bear capturing activities during the summer and early fall months. Knowledge of seasonal and daily movements eventually is expected to provide information on population density and segregation. This information will be used to determine the extent of biases in the spring sample.

Hunters start influencing the sex ratio in favor of females at age class 4. This change may reflect the reproductive status of the 4-year-old females, which, when they have litters, are protected from hunting. As the females go into production, less hunting pressure is applied to them than to males of the same age. About two-thirds of the adult females have cubs during the fall hunting season and even more have cubs during the spring season, making them illegal game for hunters. Capture data obtained at Black Lake reflect the high mortality rate among adult males. Table 6 shows that only 18 of 80 captured adults were males. At McNeil River, where bear hunting is not allowed, it was determined that of 179 adult bears observed (1967-1972), 87 were females, 51 were males and 41 were of unknown sex. Further discussion of sex ratios in relation to hunting and bear management is found under Job 4.4 of this report.

Growth Rates

Spring weights were measured on 261 brown bears captured at Black Lake. The largest female weighed 560 pounds and the largest male weighed 975 pounds. Weights of individual adult female bears remained about the same from year to year. Subadult bears showed the greatest weight gain between years. For example, on June 18, 1970, yearling male No. 704 weighed 140 pounds; on June 23, 1971 he weighed 215 pounds and on June 17, 1972 he weighed 230 pounds. The summer weight gain of this bear is of interest. On August 15, 1971, the male weighed 275 pounds for a net gain of 60 pounds in 53 days. The mean spring weights by age class of all captured bears are shown in Fig. 2. Unlike the females, adult males increased in weight annually for some years after reaching sexual maturity. Further information on growth will be presented in a subsequent report.

Blood and Milk Analysis

Studies concerning blood and milk will be published on a coauthorship

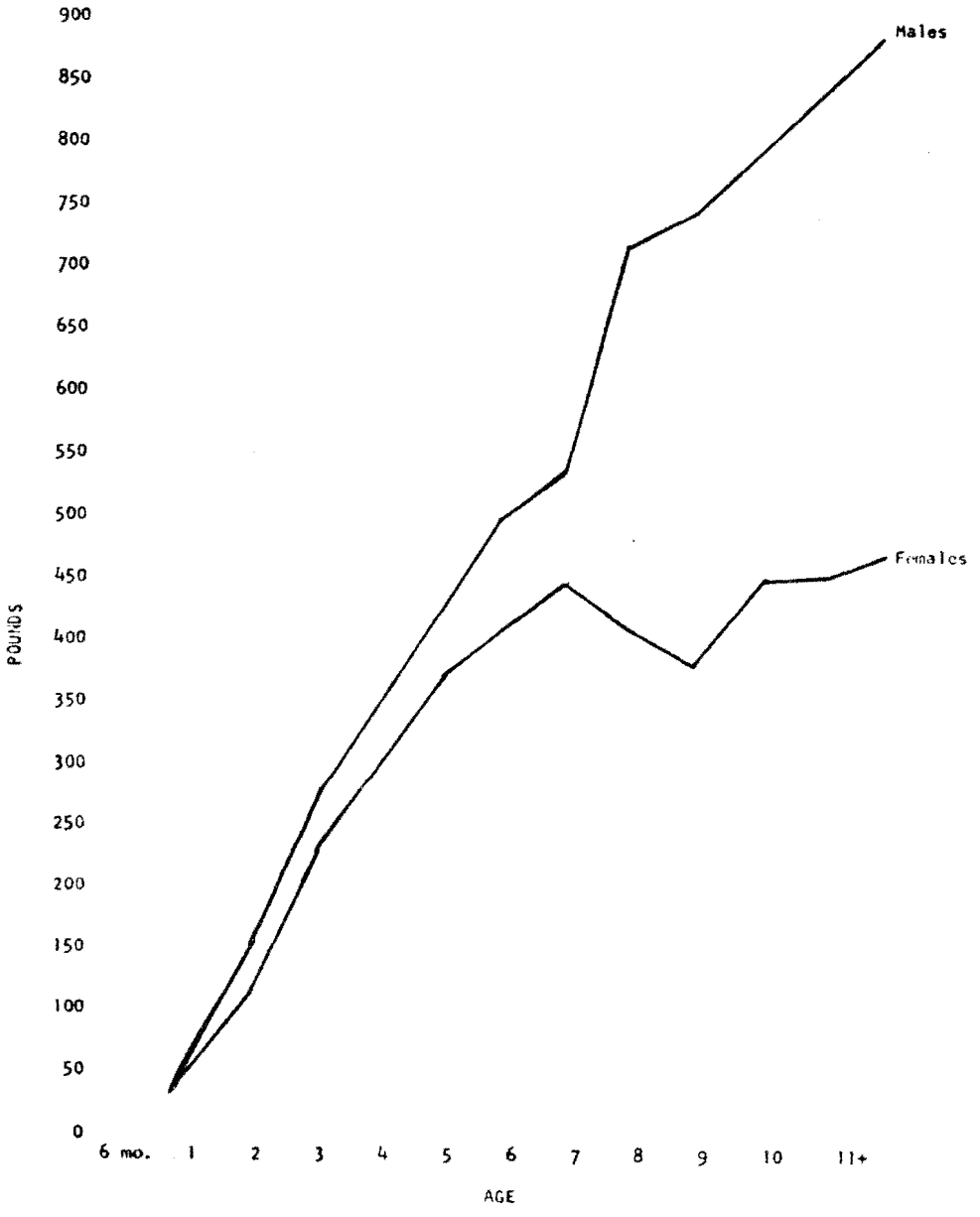
Table 6. Sexes of all bears captured on the Black-Chignik Lakes study area from 1968 and from 1970 through 1972.

Age	Sex		Total	Percentage Females
	Males	Females		
Cubs	9	8	17	47.1
1.5 & 2.5 year olds	48	43	91	47.3
*Subadults	25	30	55	54.5
Adults	18	62[1/]	80	77.5
Total	100	143	243	58.8

* Subadult bears defined as being 3.5 and 4.5 years of age.

[1/] Includes bear No. 725B.

Figure 2. Average Weights of Captured Brown Bears Taken At Black Lake in June and Early July 1970-1972.



basis with Dr. U. S. Seal, Research Biochemist, Veterans Administration Hospital, Minneapolis, Minnesota, and Dr. Robert Jennis, Professor, University of Minnesota.

RECOMMENDATIONS

It is recommended that those persons in the Department of Public Safety who seal brown/grizzly bears receive formal annual sealing instructions from qualified Game Division personnel. Persons not receiving these instructions should not be allowed to seal bears. Efforts by bear sealers to record accurate information on harvested tagged bears must be improved.

More detailed movement information is needed to supplement life history data. Emphasis should be placed on following large boars and sows with cubs-of-the-year. It is recommended that a limited number of these animals be radio-tracked from aircraft. To reduce cost, this should be done simultaneously with visual bear-monitoring activities.

Collecting, processing and reading of brown/grizzly bear teeth for cementum ages should continue, especially in game management units where a significant number of bears are taken. Persons sealing bears should be made aware of the importance of age composition data and be instructed on proper procedures for tooth selection and extraction. Most important when extracting a tooth, the bear sealer should not scratch the tooth root with his extracting tool as this damages the tooth cementum. If a tooth breaks during extraction, the bear sealer should pull another premolar. First choice should be the lower first premolars, and second choice the upper first premolars.

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By cooperative agreement, Utah State University graduate students under the direction of Dr. Allen W. Stokes provided assistance in conducting McNeil River bear studies. Students Allan Egbert, Mike Leque and Bill Fraiser participated in the field work.

Sincere thanks is given to all the above mentioned persons.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Leland P. Glenn

Project Nos.: W-17-4 & W-17-5 Project Title: Big Game Investigations

Job No.: 4.4R Job Title: Distribution and Movements of Alaska Peninsula Brown Bears

Period Covered: January 1, 1972 through December 31, 1972

SUMMARY

For the third consecutive year the Alaska Department of Fish and Game captured, marked and released brown bears on the Black Lake study area. One hundred-twelve bears were successfully marked between June 6 and July 7, 1972. Included were 41 bears which had been tagged in either 1970 or 1971. Excluding known mortality, it is estimated that 191 marked bears remain in the population.

Movement data collected on 124 different bears indicate the following: 1) adult females tend to return each spring to the same general area; 2) adult males remain in the mountains until early July and then move to salmon spawning streams when the salmon arrive; 3) adult and subadult females move about the same average distances; and 4) male bears have a larger home range than female bears. The longest movement by a male bear was 62 miles and the longest movement by a female was 36 miles.

Forty-five of 229 tagged bears have been killed by hunters. In four bear hunting seasons (two spring and two fall) hunters killed 26 of the 94 bears tagged in 1970; in two bear hunting seasons (one spring and one fall) hunters killed 13 of the 65 bears tagged in 1971 and in one fall hunting season hunters killed six of the 70 bears tagged in 1972. The mortality rate shown is minimal and represents only the known tagged bear harvest.

The size of the Black Lake bear population has not been determined. Recapture data are accumulating and when sufficient, will allow use of marked-unmarked ratios to estimate bear density. At the present time recapture success is less than 40 percent.

Harvest statistics and research studies suggest that the Alaska Peninsula brown bear population is as high today as it was 10 years ago. Mortality due to natural causes appears low. Hunting, however, influences the population by lowering the mean age of adults and by changing the adult sex ratio in favor of females. This change has been desirable since it has stimulated population productivity. Evidence now indicates

that the adult sex ratios of the 1970, 1971 and 1972 harvests were below the optimum level and that the 1972 harvest of 278 bears was excessive. A review of pertinent data to support these conclusions is presented.

The immobilizing drug Etorphine (M-99) was tested on 48 brown bears to determine a safe dosage, to determine induction time and to evaluate side effects. Based on the results of these tests, I recommend a dosage of 1.25 mg per 100 pounds of body weight. At this dosage, four minutes was the mean time required to immobilize. Symptoms noted in brown bears following M-99 injection included severe respiratory depression, muscle rigidity and excitement.

CONTENTS

BACKGROUND

There is nationwide interest and a wide range of views about brown/grizzly bear (*Ursus arctos*) management. These views range from total protection of bears and bear habitat to maximum utilization of the resouce. The Alaska Department of Fish and Game is responsible for management of the state's brown/grizzly bear resource. Much of the effort by the Department to develop a management program has been directed toward assessment of hunter harvest and the gathering of abundance and composition data. Other studies are designed to test and improve the accuracy of the cementum age determination technique, describe breeding biology and determine growth rates, survival rates and seasonal bear movements. Research studies in progress in southcentral Alaska are emphasizing these activities in order to provide information which can be used to improve bear management. In recent years the Department has designed studies to determine the effects of industrial activities which may conflict with the well-being of the species. These studies are being conducted in southeastern Alaska on areas subject to logging and in the interior of Alaska where intensive oil exploration may disrupt bear habitat. Information derived from these studies will be used to aid the development of progressive land classification programs vital to the welfare of the brown/grizzly bear resource.

This report addresses itself to brown bear studies which are in progress in southcentral Alaska. In 1969 the Alaska Department of Fish and Game chose the Black Lake area as the most suitable location to conduct brown bear research. The area is located on the Alaska Peninsula approximately 475 miles southwest of Anchorage. The background of this investigation has been reported previously (Glenn, 1971 and 1972). This study is designed to determine the seasonal distribution and movements of brown bears and to determine the effects of bear hunting on that population.

OBJECTIVES

1) To compile and summarize brown bear movement data, 2) to explore the application of population index methods to determine population size, 3) to summarize composition data which will be used as a basis for determining the rate of population turnover, 4) to conduct field experiments on brown bear identification collars, and 5) to test the capabilities of the immobilizing drug Etorphine (M-99) and its antagonist Diprenorphine (M50-50).

PROCEDURES

Monitoring Bear Movements

For the third consecutive year the Alaska Department of Fish and Game captured, marked and released brown bears on the Black Lake study area. One hundred-twelve bears were successfully marked between June 6 and July 7, 1972. Included were 41 bears which had been tagged in 1970 and 1971. Procedures used to capture, mark and monitor the movements of tagged bears have been previously described (Glenn, 1971 and 1972).

Population Size and Rate of Turnover

The brown/grizzly bear sealing program which has been in force since 1961 provided the means by which recovery data were collected from hunter harvested bears. By regulation, brown and grizzly bear hides and skulls must be presented to a member of the Department for examination and sealing within 30 days after the date of kill or upon demand. The sealing procedure involves attaching numbered metal tags to the bear hide and skull, extracting a premolar tooth for cementum aging purposes and completing the information requested on the bear sealing certificate (Fig. 1). Tagged bears were detected in the harvest by bear sealers while sealing the bear hides and skulls. Ear tags, or holes in the ears in the event ear tags had been lost, lip and groin tattooes and missing first premolar teeth informed the sealer that a bear had been tagged.

Evaluation of Marking Equipment and Drugs

Pelts of all recaptured and harvested marked bears were examined to determine the compatibility of marking equipment. Tagging equipment which caused hair rubbing or skin irritation was not used again or was modified to correct unfavorable characteristics. A description of brown bear identification collars tested during 1972 was included in the previous report (Glenn, 1972).

The synthetic morphine, Etorphine (M-99), and its antagonist, Diprenorphine (M50-50) (American Cyanamid Co., Princeton, New Jersey) were tested on free-roaming brown bears. Unlike those of the previous year, tests were conducted on a variety of age classes.

Figure 1.

State of Alaska
Department of Fish and Game

BEAR SEALING CERTIFICATE No. 6745

(For Department Use Only)

Skull_____

Hide_____ _____ _____
(Seal Numbers) (Place of Sealing) (Date of Sealing)

SPECIES	SEX	SEX IDENTIFIERS
Brown_____	Male_____	Penis Sheath_____
Grizzly_____	Female_____	Vaginal Orifice_____
Polar_____	Unknown_____	Teats: L____M____S____
		None_____

SKULL	HIDE	SPECIMENS COLLECTED
Length_____in.	Length____ft.____in.	Tooth_____
Width_____in.	Width____ft.____in.	Skull_____
Total_____in.	Total____ft.____in.	Repro._____
Condylobasal Length_____in.	Rubbed_____	Other_____
	Unrubbed_____	

TRANSPORTATION USED

Aircraft_____
Off-road Vehicle_____
Boat_____
Snow Machine_____
Dog Team_____
Other_____

Days Hunted_____ Date of Kill_____

Location of Kill: Unit_____

Mt. Range and Drainage_____

Specific Location_____

Name of Hunter_____

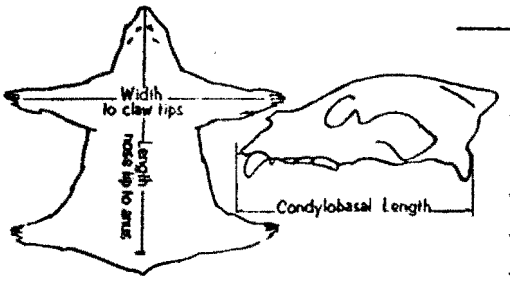
_____ / _____ / _____
(Address) (City) (State)

LICENSE NO.	TAG NO.	GUIDED HUNT
Resident_____		Yes_____ No_____
Non-Resident_____		Guide's Name_____

_____ _____
(Signature of Hunter) (Signature of Guide)

_____
(Sealed by)

Remarks:_____



11-78A (8/71)

FINDINGS

Bear Movements

The Alaska Peninsula is divided into two basic types of habitat: the Aleutian Mountains where individual bears may live year-round and the seasonally occupied, low lying coastal plain where spring use provides food for many bears. Observations made during June indicate a constant interchange of bears between the mountains and the coastal plain though part of the bear population seems to remain in or close to the mountains year-round. A change in bear activity is obvious in early July as salmon begin their annual migration into streams along the Pacific Ocean and Bering Sea coasts. By July 10 the bear population is concentrated on or near shallow salmon spawning beds which are usually located in the upper reaches of these waterways. Bears concentrate along spawning streams for about a month and then move to and from these streams feeding on a combination of fish and berries.

Information on seasonal movements is insufficient for a detailed discussion at this time. However, several important points have already become evident and the amount and types of data collected so far demonstrate the potential value of the techniques being used. Limited movement data collected from 124 different bears indicate: 1) adult females tend to return each spring to the same general area; 2) adult males tend to remain in the mountains until the arrival of salmon in early July and then move to salmon spawning streams and 3) male bears have a larger home range than female bears. The maximum distance between recapture, hunter kill locations and observation points was measured for 71 bears on the Black Lake area. Data from 99 locations of 27 adult females; 18 locations of six adult males; 47 locations of 18 subadult females and 50 locations of 20 subadult males are shown in Table 1. Adult and subadult females moved about the same distances. Adult and subadult males moved twice the average distance of females, and a few males made long movements. Adult males Nos. 714 and 762 and subadult males Nos. 422, 702 and 870 are examples.

Movement data for some individual bears are presented in Figs. 2 through 7. These are limited and may show only parts of their home ranges or seasonal ranges. The extent to which age, sex, food supply and den sites influence the size of brown bears' home range has not been determined. Brief interpretations of Figs. 2 through 7 follow:

Figure 2. Subadult male No. 702 was captured on June 17, 1970 and observed at points A and B during 1970. On October 1, 1970 the male was killed by a hunter. The maximum distance traveled between location points was 51 miles. The male was 2.5 years old when first captured.

Figure 3. Adult male No. 714 was captured on June 19, 1970, observed at points A and B during 1970, recaptured on June 25, 1971, recaptured on June 11, 1972 and observed on June 25, 1972. The male was 6.5 years old when first captured and traveled 45 miles between the most widely separated location points.

Table 1. The Maximum Distance in Miles Between Points of Capture, Recapture, Observation of Kill for Bears on the Black Lake Study Area During 1968 and 1970 Through 1972.

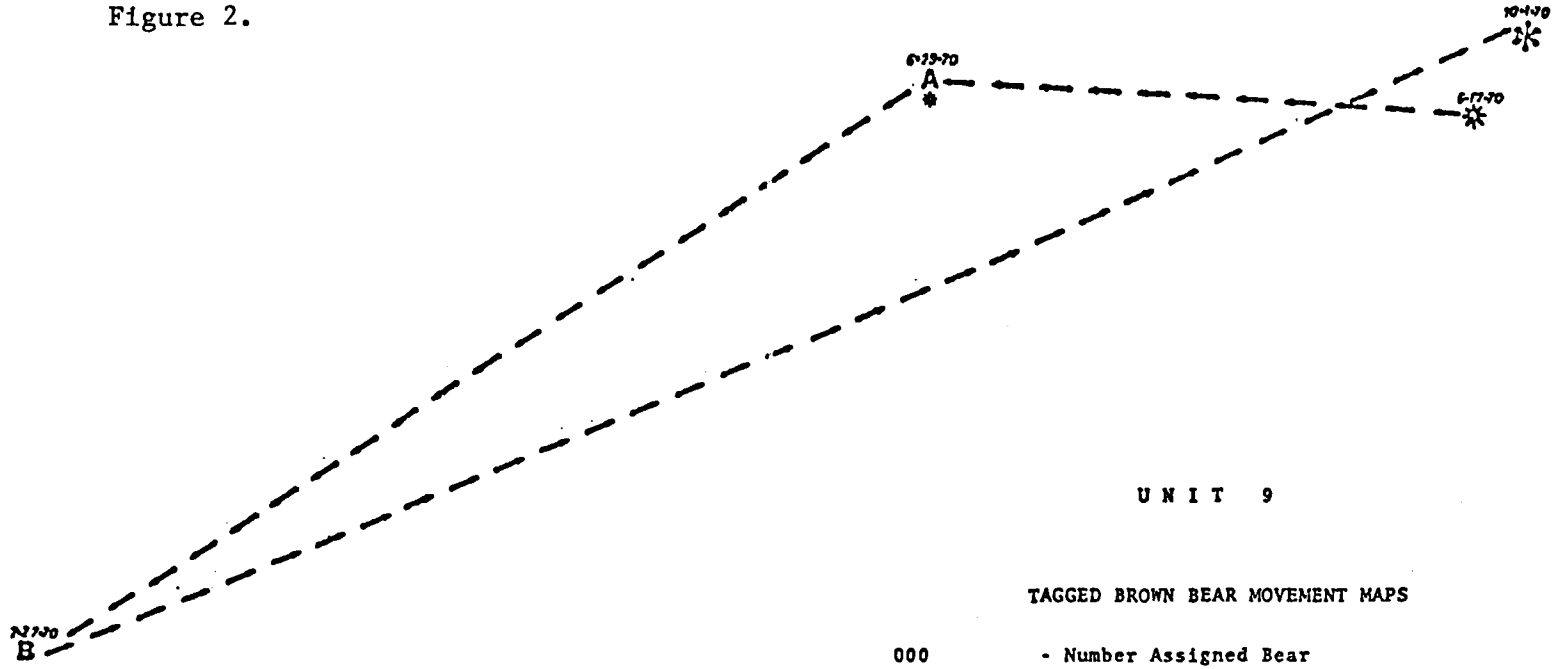
Bear No.	No. of Years Tagged	No. of Points	Distance in Miles
*Adult Females			
11	1	3	14.0
19	1	2	1.5
703	2	6	14.0
707	2	5	21.0
717	2	2	0.0
719	2	3	15.0
722	2	5	36.0
725A	2	4	11.0
728	2	5	17.0
731	2	8	17.0
734	2	4	12.0
736	2	2	4.0
738	2	2	4.0
747	2	4	24.0
753	2	3	4.0
757	2	3	14.0
761	2	4	20.0
769	2	3	27.0
770	2	3	5.0
779	2	3	25.0
785	2	5	21.0
794	2	2	3.0
825	2	4	17.0
839	1	3	25.0
851	4	4	11.0
867	1	4	24.0
900	2	3	6.0
Average			14.5
*Adult Males			
714	2	6	45.0
762	2	3	51.0
780	2	2	9.0
791	2	2	33.5
824	1	2	6.0
827	1	3	11.5
Average			26.0
**Subadult Females			
442	0.5	2	6.5
701	2	4	20.0
706	2	2	7.0
708	2	2	8.0
716	2	3	11.0

Table 1. (Cont'd.) The Maximum Distance in Miles Between Points of Capture, Recapture, Observation of Kill for Bears on the Black Lake Study Area During 1968 and 1970 Through 1972.

Bear No.	No. of Years Tagged	No. of Points	Distance in Miles
**Subadult Females (cont'd.)			
742	2	5	12.0
749	2	4	21.0
763	2	2	14.0
776	2	2	5.0
778	2	4	18.0
786	2	3	22.5
798	2	2	14.0
822	1	2	1.5
823	1	2	13.0
828	1	2	5.0
830	1	2	1.0
855	1	2	2.0
872	1	2	10.0
Average			10.6
**Subadult Males			
8	1	2	5.0
418	1	2	5.0
422	1	2	62.0
432	1	2	7.0
471	1	2	25.5
702	2	4	51.0
715	2	2	4.0
737	2	2	15.0
751	2	2	35.0
754	2	2	27.0
767	2	4	44.0
786	2	3	22.5
791	2	2	33.0
801	3	3	21.0
815	1	2	19.5
832	4	3	18.0
862	1	2	9.0
865	1	2	24.5
866	1	2	34.0
870	2	5	51.0
Average			25.6

* Adult defined as a bear 5.5 years of age of older.
** Subadult defined as a bear 3.5 and 4.5 years of age.

Figure 2.



UNIT 9

TAGGED BROWN BEAR MOVEMENT MAPS

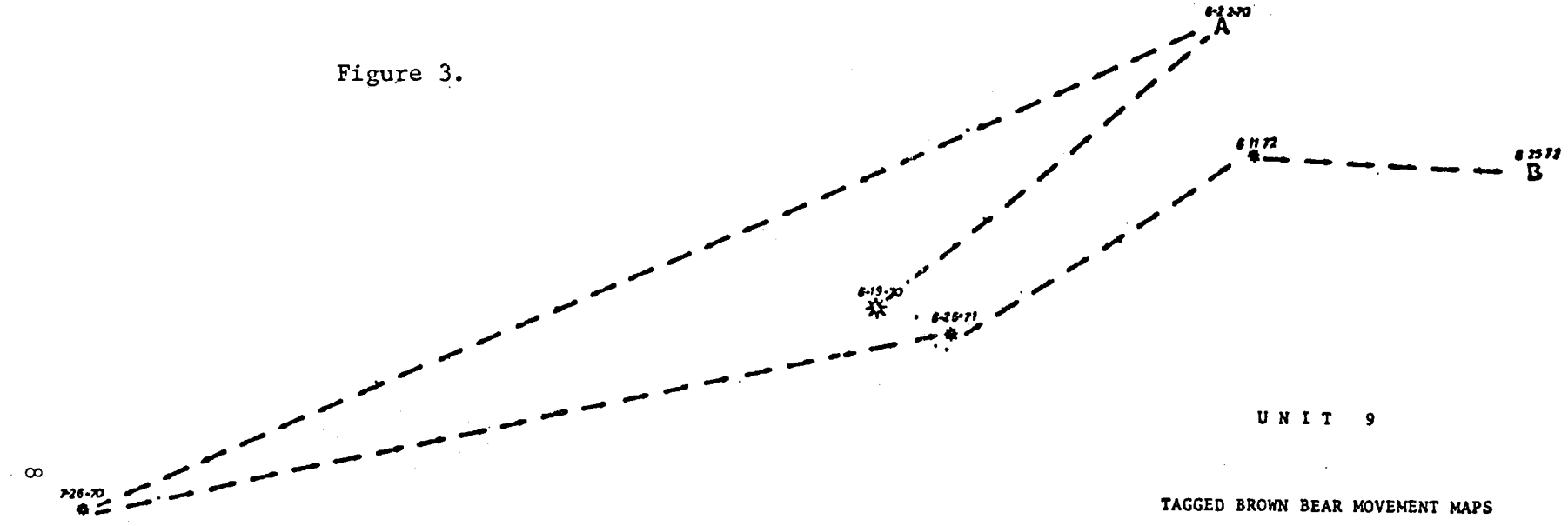
000	- Number Assigned Bear
M-F	- Sex
ooo,m-ooo,f	- Number and Sex of Young
✱	- Location and Date of First Capture
*	- Recapture
A-B-C-etc.	- Resightings
a-b-c-etc.	- Resightings of Young if Separated from Female
✱	- Bear Killed

702
M

SCALE 1:2 40000

5 0 5 10 15 20 25 MILES

Figure 3.



UNIT 9

TAGGED BROWN BEAR MOVEMENT MAPS

000	- Number Assigned Bear
M-F	- Sex
ooo,m-ooo,f	- Number and Sex of Young
✱	- Location and Date of First Capture
*	- Recapture
A-B-C-etc.	- Resightings
a-b-c-etc.	- Resightings of Young if Separated from Female
✱	- Bear Killed

714
M

SCALE 1:250000

Figure 4.

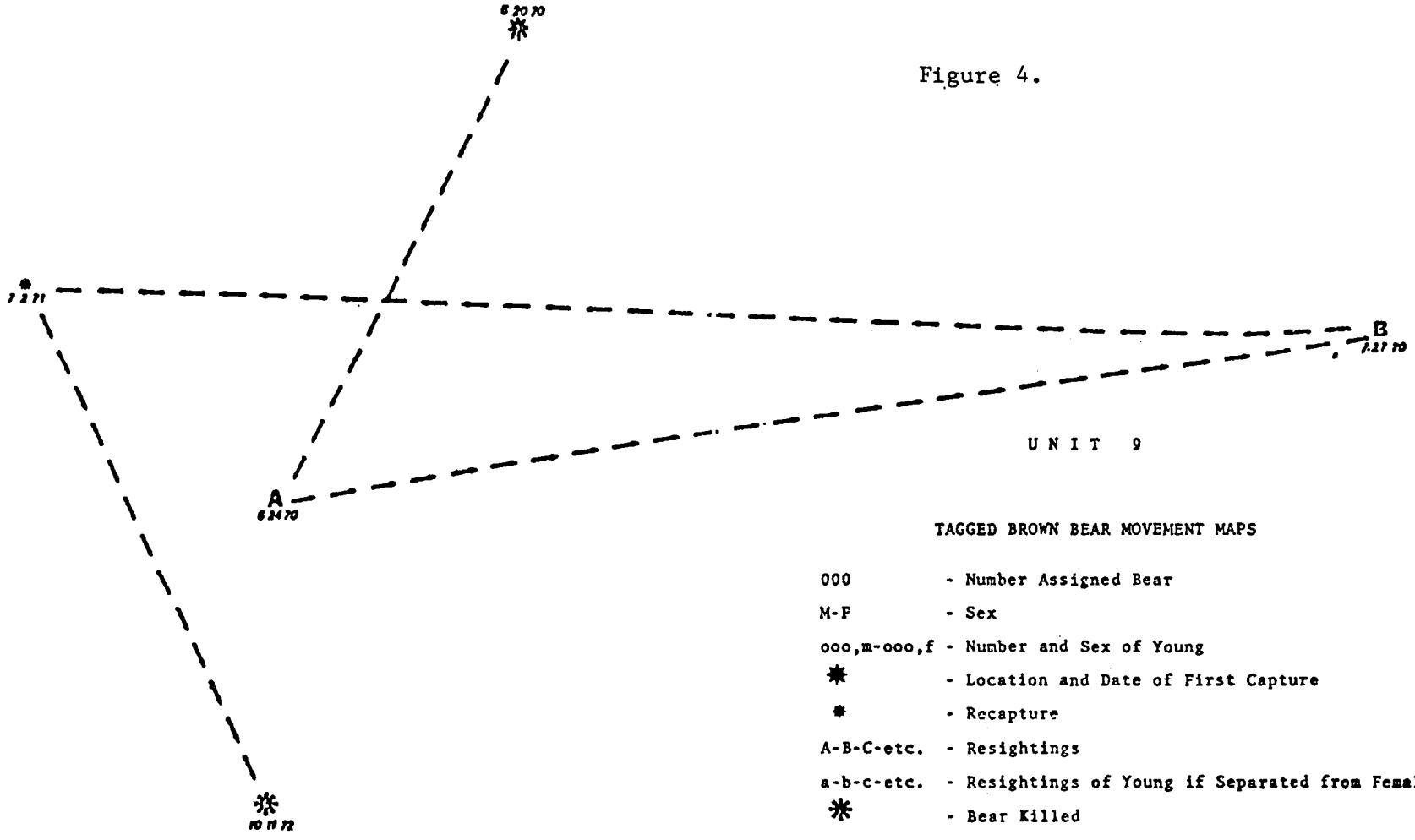
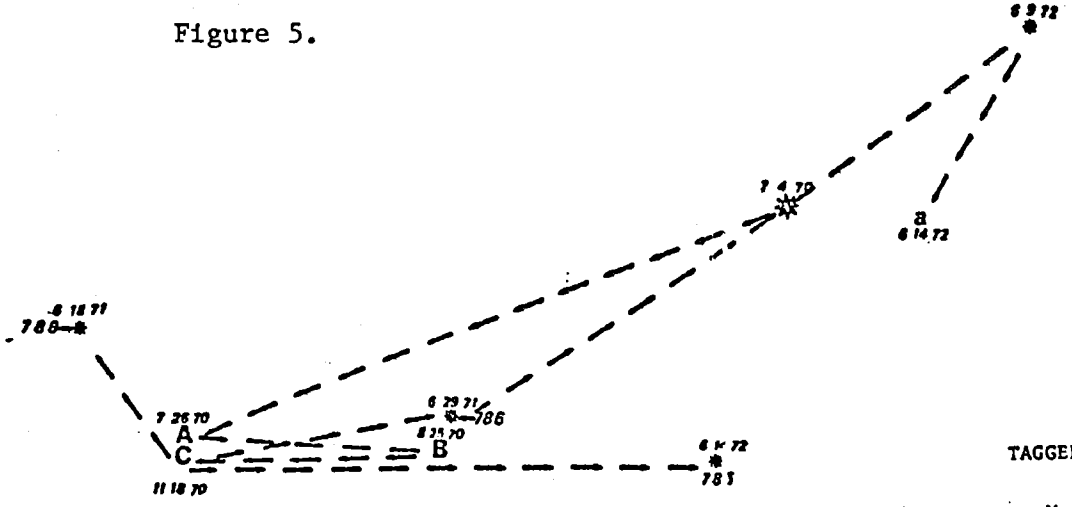

6 20 70
7 2 71
B
7 27 70
A
6 24 70
10 11 72
UNIT 9
TAGGED BROWN BEAR MOVEMENT MAPS
000 - Number Assigned Bear
M-F - Sex
ooo,m-ooo,f - Number and Sex of Young
- Location and Date of First Capture
- Recapture
A-B-C-etc. - Resightings
a-b-c-etc. - Resightings of Young if Separated from Female
- Bear Killed
870
M
SCALE 1:250000'
0
5
10
15
20
25 MILES

Figure 5.



UNIT 9

TAGGED BROWN BEAR MOVEMENT MAPS

000	- Number Assigned Bear
M-F	- Sex
ooo,m-ooo,f	- Number and Sex of Young
✱	- Location and Date of First Capture
*	- Recapture
A-B-C-etc.	- Resightings
a-b-c-etc.	- Resightings of Young if Separated from Female
✱	- Bear Killed

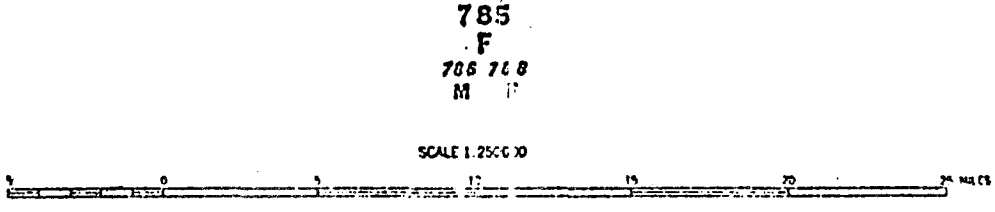
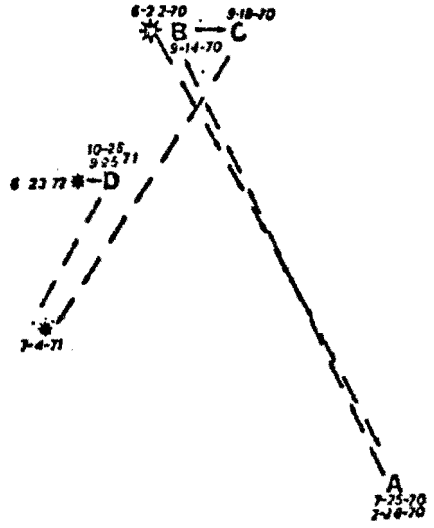


Figure 6.

U N I T 9

TAGGED BROWN BEAR MOVEMENT MAPS

000	- Number Assigned Bear
M-F	- Sex
ooo,m-ooo,f	- Number and Sex of Young
✲	- Location and Date of First Capture
✸	- Recapture
A-B-C-etc.	- Resightings
a-b-c-etc.	- Resightings of Young if Separated from Female
✲	- Bear Killed



F-731
732 • 733
M F

SCALE 1:250000

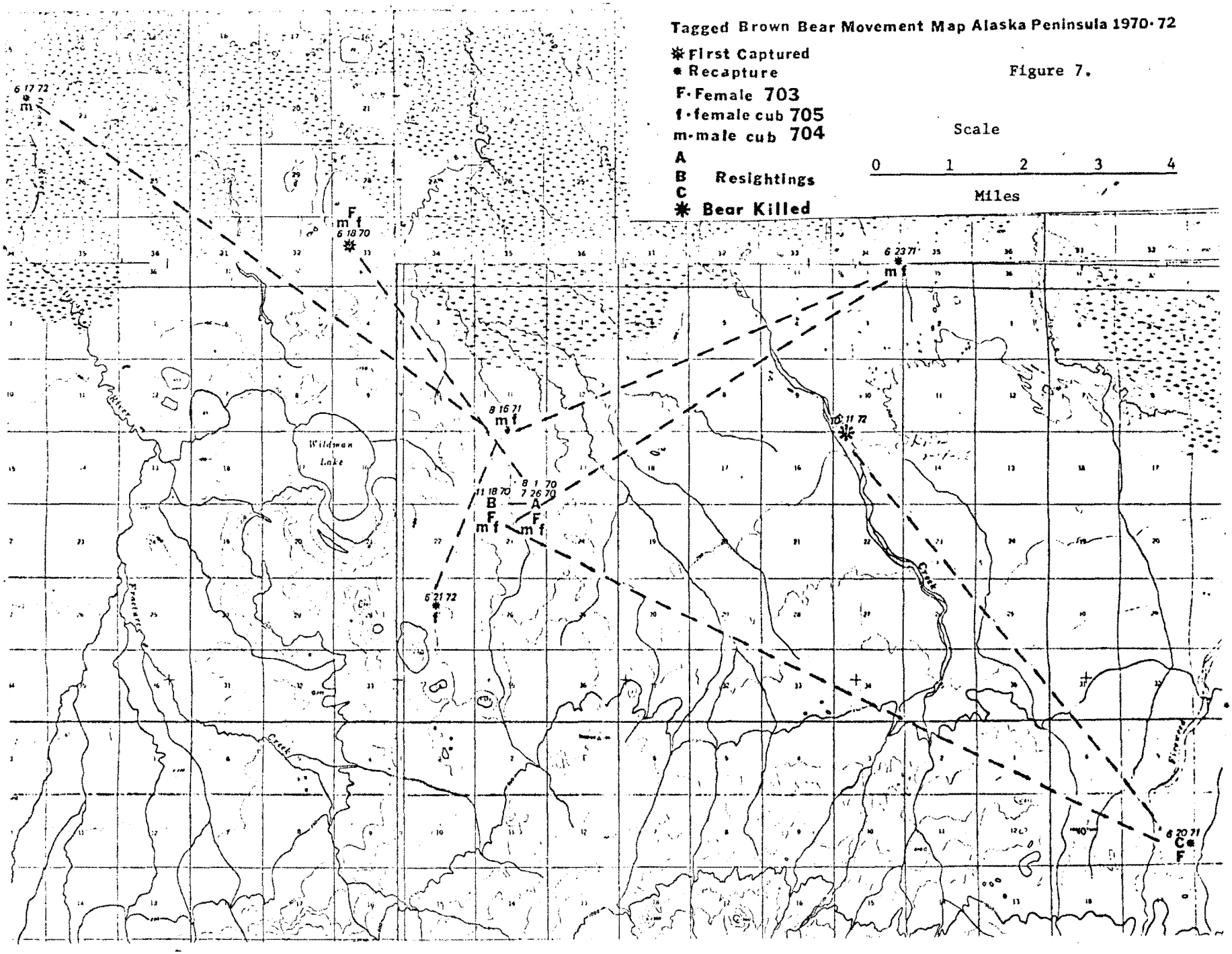

Tagged Brown Bear Movement Map Alaska Peninsula 1970-72
✲ First Captured
* Recapture
F-Female 703
f-female cub 705
m-male cub 704
A
B Resightings
C
✱ Bear Killed
Scale
0 1 2 3 4
Miles
6 17 72
m
F
m f
6 18 70
6 23 71
m f
8 16 71
m f
Wildman Lake
11 18 70
B
F
m f
8 1 70
7 26 70
A
F
m f
6 21 72
f
10 11 72
6 20 71
C
F

Figure 7.

Figure 4. Subadult male No. 870 was captured on June 20, 1970, observed at points A and B during 1970, recaptured July 2, 1971 and was killed by a hunter on October 11, 1972. The male was 3.5 years old when first captured and traveled 51 miles between the most widely separated location points.

Figure 5. Adult female No. 785 and her two yearling cubs Nos. 786 and 788 were captured on July 4, 1970. The family group was observed at points A, B and C during 1970. The sow was not seen again until June 14, 1972 when she was recaptured alone. Female cub No. 788 was recaptured on June 18, 1971. Male cub No. 786 was recaptured on June 29, 1971, recaptured again on June 9, 1972 and observed on June 14, 1972. The maximum distance traveled by the sow between location points was 21 miles. Male cub No. 786 traveled 22.5 miles and female cub No. 788 traveled 23 miles.

Figure 6. Adult female No. 731 and her two yearling cubs Nos. 732 and 733 were captured on June 22, 1970. All were recaptured together on July 4, 1971 and observed at the same location on September 25 and October 26, 1971. The family group was recaptured on June 23, 1972. The two young which were then 3.5 years old, were still with the sow at the time of recapture. In two years, the family group traveled 17 miles between the most widely separated location points.

Figure 7. Adult female No. 703 and her two yearling cubs Nos. 704 and 705 were captured on June 18, 1970. The family group was observed at points A and B on July 26, August 1 and November 18, 1970. The sow was recaptured alone at point C on June 23, 1971 and was killed by a hunter October 18, 1972. The two young were recaptured together on June 23 and August 15, 1971. The young were separated by seven miles when recaptured on June 17 and 21, 1972. The maximum distance between location points traveled by the sow was 14 miles. Male cub No. 704 traveled 12 miles and female cub No. 705 traveled eight miles between the farthest location points.

Rate of Population Turnover

On the study area, 45 of 229 tagged bears have been killed by hunters. The mortality rate is higher than expected. Examination of Table 2 shows that: 1) in four bear hunting seasons (two spring and two fall) hunters killed 26 (28%) of 94 bears tagged in 1970; 2) in two bear hunting seasons (one spring and one fall) hunters killed 13 (20%) of 65 bears tagged for the first time in 1971; and 3) in one fall bear hunting season hunters killed six (9%) of 70 bears tagged for the first time in 1972. The mortality rate shown in Table 2 is minimal. Of 94 bears captured in 1970, 11 were sows with 25 young, leaving a minimum of 58 bears legal to hunt in the fall of 1970. Of 65 bears captured in 1971, eight were sows with 20 young, leaving a minimum of 37 bears legal to hunt in the fall of 1971. Of 70 bears captured in 1972, 10 were sows with 23 young, leaving a minimum of 37 bears legal to kill in the fall of 1972. It is impossible to determine the exact number of legal, tagged bears in the population after fall 1970 because the status of some is not known. However, from 7 to 16 percent of the legal bears were killed

Table 2. The number of tagged bears of all ages on the Black-Chignik Lakes study area at the end of each year and the known numbers harvested in following years. Bears killed during handling are not included. Natural loss from the population has not been quantified.

Year Tagged	Number Tagged	Number of Tagged Bears Killed					Hunter Harvest	Percent Mortality	Mortality Period
		1968	1969	1970	1971	1972			
1968	10	2	0	1	0	0	3		4.5 years
1969	0		0	0	0	0	0	-	-
1970	94			4	10	12[1/]	26	28	2.5 years
1971	65				4	9[1/]	13	20	1.5 years
1972	70					6[1/]	6[1/]	9	0.5 years

[1/] Three tagged bears were killed during the fall 1972 season and not identified to the year captured. The harvest is adjusted by entering one bear in each of the years 1970 through 1972.

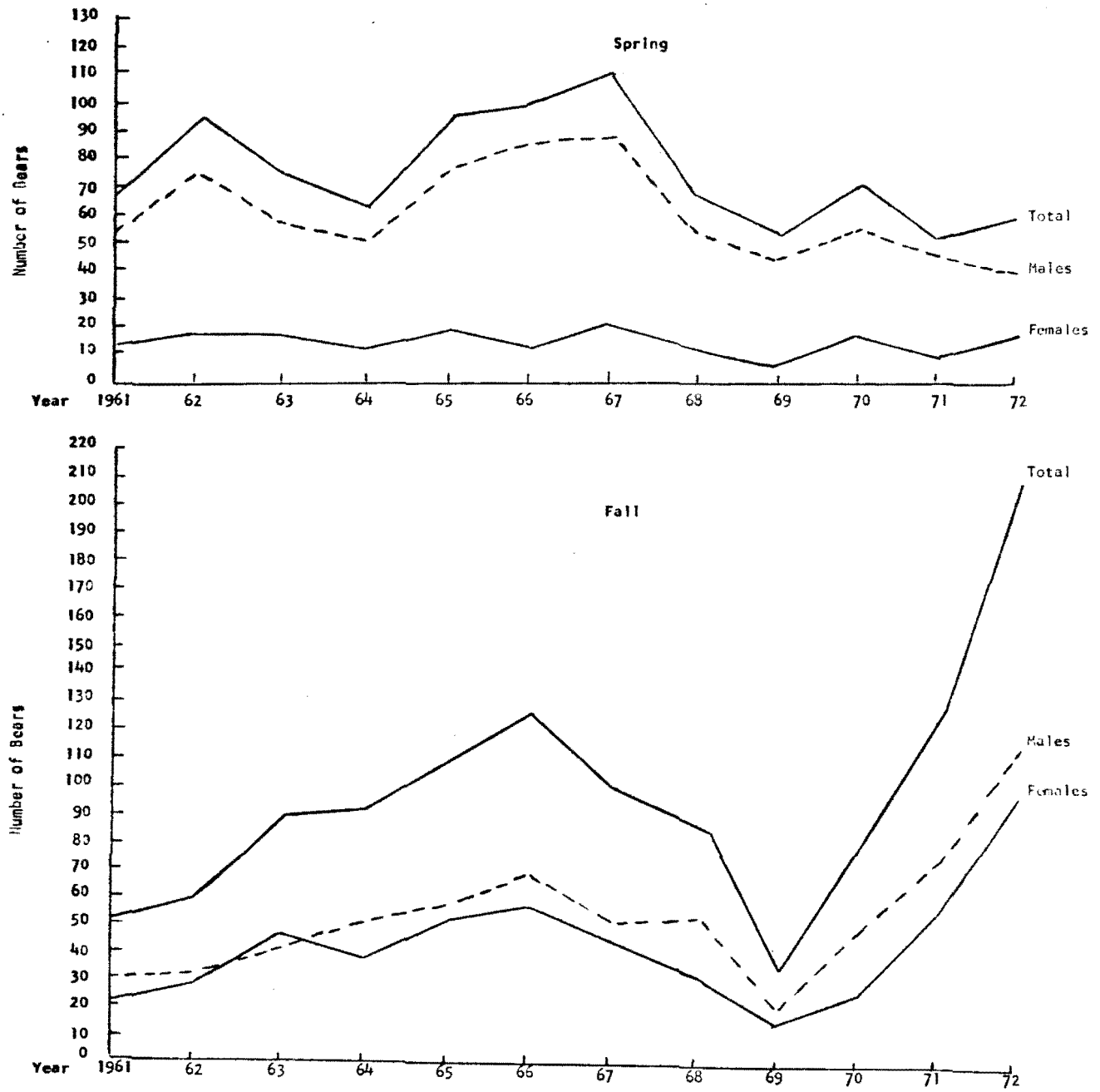
in the fall season following their capture. Consideration must also be given to the fact that kill figures may not represent the total tagged bear harvests. Instances of poor sealing procedures have been experienced. An example of this error came to my attention when a guide returned the ear tags from two tagged bears which had been sealed as untagged bears. Table 2 represents only the known minimum rate of tagged bear harvest.

Harvest statistics and research studies indicate that the Alaska Peninsula brown bear population is as high today as it was 10 years ago. Mortality due to weather, food shortages or other natural conditions does not appear to exert a significant limiting influence on the population. Troyer and Hensel (1964) found that the Kodiak bear population density changed from year to year and that numbers were highest whenever food was abundant. On the Alaska Peninsula, aerial bear surveys have not detected significant population fluctuations which can be attributed to natural conditions. Hunting, on the contrary, has affected the population by lowering the mean age of adults, changing the adult sex ratios and increasing population productivity. Years of bear hunting have reduced the adult male and increased the adult female percentages. These changes have been desirable since they have stimulated population productivity.

Spring bear seasons have had a greater influence on lowering the percentage of adult males than have fall bear hunting seasons. In the spring males emerge from dens earlier than females and are subject to greater hunting pressure. Additionally a larger percentage of males are taken in the spring because some hunters are more selective toward larger bears which are usually males and because more adult females are with young in the spring than at any other time of year. By increasing the length of the spring season, managers can lower the percentage of adult males to the desired level. Fall seasons have the opposite effect and tend to reduce the number of adult females in the population. Since season length largely determines the magnitude of kill, it is important to regulate season combinations that will achieve the appropriate size of harvest in the sex ratio desired. Fig. 8 clearly demonstrates the effects that spring and fall seasons have on changing harvest sex ratios. From 1961 through 1969, the Department maintained liberal bear seasons which opened in September and closed in May. During these years approximately one-half of the annual harvest was taken in the spring (58 percent) and approximately one-half in the fall (41 percent). Male bears comprised 83 percent (range 80 to 89 percent) of the spring kill and 57 percent (range 49 to 65 percent) of the fall kill. From 1970 through 1972, the Department maintained a two-week spring and a four-week fall season. This changed the chronology and sex composition of the annual harvest. During these years, 38 percent of the annual harvest was taken in the spring and 62 percent in the fall. Males comprised 76 percent (range 69 to 83 percent) of the spring kill and 56 percent (range 53 to 58 percent) of the fall kill. The effects of this change point out the value of season manipulation in regulating bear harvest sex ratios.

The adult sex ratio may be near or just past the optimum desirable level. Composition data compiled from 243 captured bears suggest that there is one adult male for every three adult females and that two out

Figure 8. Number of Brown Bears Harvested on the Alaska Peninsula



of every three adult females are with young during the fall bear hunting seasons. Assuming this sample is representative, adult bears are available to fall hunters on a 1:1 sex ratio. Harvest data for the fall 1972 bear hunting season tend to support research findings and show that at the present harvest level, one adult male was killed for every one adult female. Factors such as availability and hunter selectivity may influence the sex ratio of the harvest, however. Fig. 9 shows the sex composition of bears of all ages harvested on the Alaska Peninsula from 1961 through 1972. Interpretation of this figure is complicated by a number of factors, however it can be stated that prior to 1970 hunters took a high percentage (average of 68 percent) of male bears. Season changes were initiated in 1970 which changed the sex ratio of subsequent bear harvests. In 1972 the harvest was the highest on record (278 bears) and was 70 percent higher than the 10-year (1961-1970) mean of 166 animals. As a result of this harvest the sex ratio approached 1:1.

The mean age of the male harvest is lower than the mean age of the female harvest, though age differences are not great. During the 1972 Alaska Peninsula bear hunting season, only 67 of 154 (43 percent) harvested males and 66 of 118 (56 percent) harvested females were 6 years of age or older. The average age of these adults was 10.8 years for males and 11.4 for females. The average age for bears in all age classes was 7.1 years for males and 8.2 years for females.

Population Size

The size of the Black Lake brown bear population has not been determined. Data are accumulating which ultimately will allow use of marked-unmarked ratios to estimate bear density. Calculations will be based on tagged-untagged ratios of animals captured, observed or killed. Before estimates of population size can be made, seasonal bear movements must be understood. Without this information it will be difficult to adjust for sampling errors. Of importance are the movement patterns of bears in areas where rough terrain prevents adequate sampling. For example, it is known that some large boars and some sows with cubs-of-the-year remain in the mountains until about the first of July. Mountainous terrain prevents random sampling and seasonal development of thick vegetative cover prevents extension of bear capturing activity past that time. Knowledge of seasonal movements is expected to provide information on the extent of these biases.

Less than 40 percent of the tagged bears have been recaptured in subsequent years. During the spring 1972 field season, 53 (37 percent) of an estimated 145 live-tagged bears were recaptured. Recapture rate becomes more meaningful each year that capture work is continued; therefore, 1970 recapture data are superior to information obtained on bears tagged in 1971 and recaptured in 1972. For example, of 94 bears tagged in 1970, six were shot by hunters and 34 (39 percent) of the remaining 88 bears were recaptured in 1971. The following year 10 bears were shot by hunters and 20 (26 percent) of the remaining 78 bears were recaptured. During the fall of 1972, 10 bears were shot by hunters leaving a maximum of 68 of the original 94 bears. Recapture information for bears tagged in 1970 and 1971 is given in Table 3.

Figure 9. Number of brown bears harvested in Unit 9.

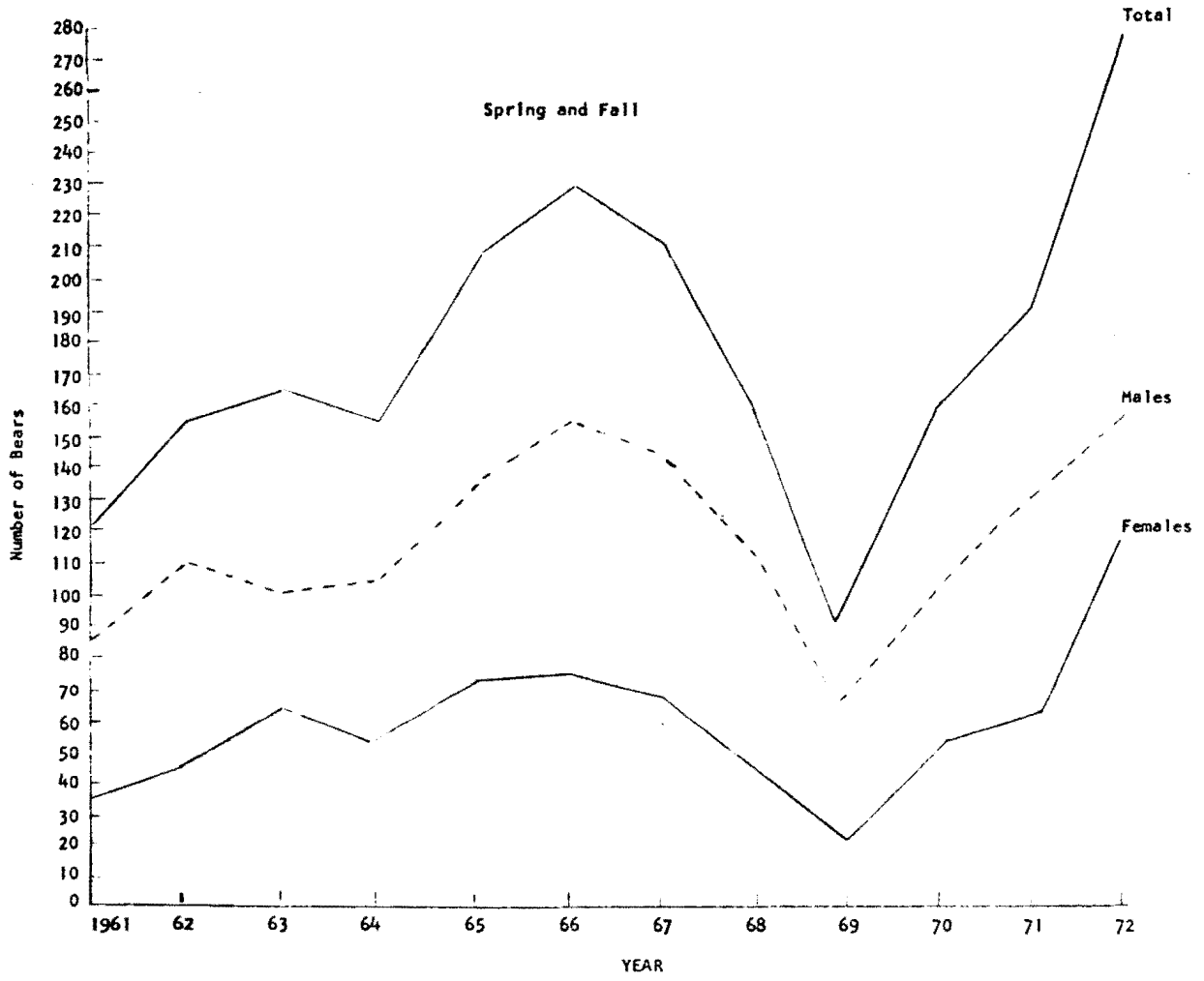


Table 3. The number of marked bears of all ages on the Black Lake study area at the end of each year and the numbers recaptured in following years. The number known to have been killed through hunting or handling is deducted from the total.

Year Tagged	No. Tagged	Year Recaptured	No. Killed	Total Adjusted	Recapture Success	
					No.	Percent
1970	94					
		1971	6*	88	34	39
		1972	10*	78	20	26
		1973	10**	68	-	
1971	65					
		1972	8*	52	19	37
		1973	5**	52	-	
1972	70					
		1973	6**	9	-	
Total	229		45	184		

* Represents the spring and fall bear season harvest of tagged bears.
**Represents only the fall 1972 tagged bear harvest.

Evaluation of Marking Equipment and Drugs

After two years of development and testing, a satisfactory brown bear identification collar has been constructed. The new collar may not be 100 percent successful, however. Some bears may not tolerate neck collars and may continue to manipulate attached equipment in a manner that will cause pelt damage. Similar problems have confronted other investigators who have attached radios, ear tags and other marking equipment to bears. The frequency of pelt damage which occurred as a result of collar testing follows:

1. During the spring of 1970, 39 four-inch-wide canvas collars were attached to captured brown bears. After two months of observation it was obvious that these collars were not withstanding the abuse they received. I decided to remove these collars the following spring. Prior to their removal, 10 hunters shot collared bears and two of these hunters reported pelt damage as a result of collar attachment. During the springs of 1971 and 1972, 17 collared bears were recaptured and their collars removed. Hair on the necks of five of these bears had rubbed as a result of collar attachment.

2. During the winter of 1971, a new collar was designed and built. Eight of these collars were constructed with single thickness nylon belting and four with double thickness nylon belting. These collars were placed on captured bears in the spring of 1971. During the fall 1971 and spring 1972 bear hunting seasons, hunters shot three collared bears. One hunter complained of hair rubbing and was allowed to take another bear. It was found that the double thickness nylon belting caused hair rubbing. Double belting made the collar stiff; as the bear turned its head the collar rubbed the bear's neck instead of collapsing. Three of the remaining nine collared bears were recaptured in the spring of 1972 and no evidence of pelt damage from the collars was found. These bears wore the single thickness nylon collar. Two additional collared bears were observed during the 1972 field season. Both of these bears appeared to be in excellent condition and no pelt damage was visible.

The immobilizing drug Etorphine (M-99) and its antagonist, Diprenorphine (M50-50) were tested on 48 brown bears to determine a safe effective dosage of M-99, to compare induction time and to evaluate side effects of the drug. Based on the bears' reaction to these drugs, I recommend a M-99 dosage of 1.25 mg. per 100 pounds body weight. Four minutes was the mean time required to immobilize at this dosage level. Symptoms noted in brown bears following M-99 injection included severe respiratory depression, muscle rigidity and excitement. Table 4 allows comparison of physiological response between the drugs M-99 and Sernylan. Diprenorphine was administered on a ratio of 1:2 (Etorphine to Diprenorphine) with excellent results. Bears appeared to be fully recovered 10-15 minutes after administering the antagonist.

Two bears died after receiving injections of M-99. The death of bear No. 9 was attributed to suffocation caused by the position in which she was lying and the death of bear No. 436 was attributed to the drug. In the latter case, the 5-year-old female lay down four minutes after

Table 4. A comparison of the physiological effects of the immobilizing drug M-99 (Etorphine) and Sernylan on brown bears.

	M-99 Cubs	M-99 One Year Plus	Sernylan One Year Plus
Sample Size	15	33	123
Mean Time to Immobilize	4 min.	4 min.	7 min.
Mean Temperature	101.2°	103.5°	103.7°
Temperature Range	98°to 105.5°	95° to 107.8°	99° to 107.0°
Mean Respiration	5/minute	6/minute	64/minute
Range in Respiration	2 to 6/minute	1 to 18*/minute	8 to 152/minute
Mean Pulse Rate	77	62/minute	98/minute
Range in Pulse	68 - 94	36 to 89/minute	60 to 136/minute

*Bear No. 22 which woke up during the tagging process.

receiving 0.6 mg. per 100 pounds of M-99. Two minutes later the bear was approached; she got up, walked 30 yards and lay down again. After a two-minute wait she was approached and was found dead. Field autopsy was performed and all organs appeared normal. The cause of death is unknown but may be attributed to a low M-99 dosage level which may have depressed respiration and maximized the excitement stage. The administration of M-99 is unique in that it is safer to give a maximum dose rather than minimum dose. According to drug manufacturer charts underdosing may cause alkalosis that may lead to death.

RECOMMENDATIONS

Population productivity may be lowered on the Alaska Peninsula if present bear seasons are allowed to continue. The effect during the past three years of a two-week spring and a four-week fall season has been a noticeable increase in the adult female kill. Harvest composition changes indicate that the 1972 harvest of 278 bears was excessive. Preliminary findings indicate that the annual harvest south of the Naknek River-Katmai National Monument should not exceed 150 to 200 bears and should include 65 to 70 percent male bears. To accomplish this objective I recommend spring and fall seasons of equal duration with the present four-week fall season shortened to reduce excessive bear kills.

The marking phase of the brown bear mark and recovery program should continue. A large percentage of the population must be marked in order to estimate population size and rate of turnover. Success of the movement study is dependent upon capturing a large number of adult bears and attaching neck collars which can be identified by observers flying in fixed-wing aircraft. The ability to capture an adequate sample of bears has been demonstrated and development of a satisfactory bear identification collar was achieved this year. Techniques are now available to capture, mark and monitor the seasonal movements of the Black Lake bear population.

It is recommended that a limited number of sows with cubs-of-the-year and large bears be radio-tracked from aircraft. This population segment is secretive in its habits and is difficult to observe.

It is recommended that members of the Game Division staff provide an annual brown/grizzly bear sealing course to Department of Public Safety personnel who may seal bears. Bear sealing kits would be assigned to persons completing the course with the stipulation that only they could seal bears during the following 12-month period. Annual course instruction should be given in Juneau, Anchorage and Fairbanks. Particular emphasis should be placed on how to identify and collect accurate information on marked bears.

Surveillance is recommended before, during and after bear seasons on the Alaska Peninsula to attempt control of illegal hunting with aircraft. Appropriate emergency closures should be taken if illegal use of aircraft for hunting is widespread and cannot be controlled. Only

with regulatory compliance will the Department be able to maintain liberal bear seasons.

ACKNOWLEDGMENTS

The following Alaska Department of Fish and Game personnel participated in scientific activities relevant to this report: Leo H. Miller, Charles A. Irvine, David B. Harkness, Harry V. Reynolds, III and James B. Faro.

Sincere thanks is given to all the above mentioned persons.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Leland P. Glenn

Project No.: W-17-5 Project Title: Big Game Investigations

Job No.: 4.6R Job Title: Comparison of Brown/ Grizzly Bear Skulls by Size, Age, Sex and Geographic Location

Period Covered: July 1, 1972 through December 31, 1972

SUMMARY

Results of the brown/grizzly bear skull study will not be available until next year. Within the past six months, 325 of approximately 500 skulls have been measured, weighed and photographed. Two premolar teeth from each of these skulls have been extracted and await sectioning and mounting. The skull collection is large and will require 8 to 10 months of laboratory work to complete processing.

CONTENTS

BACKGROUND

In 1967, the Alaska Department of Fish and Game began measuring the condylobasal length, total length and width of harvested brown/grizzly bear (*Ursus arctos*) skulls. Skull length and width measurements were used as a management tool to indicate trends in the male age composition by season and by game management unit. The condylobasal length measurement was never used. Investigators such as Mundy and Fuller (1964) have determined that age is positively correlated with zygomatic breadth in Canadian grizzlies. Rausch (1963) reported that grizzly bear skulls increased in width after they ceased to increase in length. By 1970, the Department had successfully completed four years of research work, developing a cementum aging technique. Cementum aging was proven reliable and replaces the need for skull measurements as an indicator of age. The question now arises as to the value skull measurements have as a bear management tool. Studies are therefore required to determine the relationship of skull size to age, sex and geographic location. Only then can we determine the possibilities of these data for management application.

Game Division personnel began collecting brown/grizzly bear skulls in 1960. The collection remained small until 1967 when a regulation was passed requiring all hunters to present their bear skulls for sealing. The skull collection grew rapidly after adoption of this regulation. Many hunters had no desire to keep their bear skulls and donated them to the Department. It wasn't until 1972, however, that the collection was of sufficient size to attempt the type of analysis described.

OBJECTIVES

1) To compare skull size by area, sex and age; 2) to establish the rate and duration of skull growth; 3) to investigate the latitude of deciduous and permanent tooth eruption; and 4) to discover any physical characteristics which are common to bears within a specific area.

PROCEDURES

Collecting and Cleaning Specimens

When a bear skull was collected, it was stored frozen until it could be cleaned. Cleaning was accomplished by boiling or steaming until all connecting tissue could be removed. The skull was then bleached for two hours in a solution of half water and half 35 percent hydrogen peroxide. Bleaching was done to reduce odor, whiten the skull and loosen remaining tissue. The skull was allowed to dry then coated with water soluble glue which seals the skull to reduce tooth cracking and bone separation. Finally the skull was stored in a sealed plastic bag.

Processing Technique

All skull measurements were taken to the nearest millimeter and recorded on a standardized data form (Fig. 1). A description and diagram of the method used to take each measurement follow:

1. Total Length - Measured from the most anterior portion of the skull (usually I^1) to the most posterior portion of the skull (terminus of sagital crest, Fig. 2).

2. Condylobasal Length - Measured from the most posterior portion of the left occipital condyle to the most anterior portion of the left basal bone (Fig. 2).

3. Zygomatic Width - Measured from the most lateral extension of the zygomatic process of the left temporal bone to the most lateral extension of the zygomtic process of the right temporal bone (Fig. 2).

4. Sagital Crest - Measured as the greatest height of the sagital crest with dial metric calipers from a point 9 millimeters out on a line perpendicular to the sagital crest itself (Fig. 3). The measurement is taken in this way to avoid the curvature where the parietal bone fuses with the sagital crest. To measure, rest the lower right hand corner of the calipers on the center of the sagital crest. With the thumb of the right hand, open the calipers until the movable bar touches the parietal bone. Read the measurement from the dial.

5. Total Height - With the lower mandible articulated and the whole skull resting on a table top, measured from the surface of the table to the highest part of the skull. A ring stand with the adjustable arm at right angle to the vertical post was used for this measurement. To make this measurement put the arm over the highest part of the skull, then lower it until it touches the skull. Remove the skull and measure the distance from the table top to the point of contact on the adjustable arm with a pair of large calipers. Move the calipers past the closed position for this measurement (Figs. 2 and 4).

6. Canine Measurements - Four measurements were taken on both the upper and lower left canines with the dial metric calipers.

Figure 1. BROWN/GRIZZLY BEAR SKULL AND DENTITION DATA FORM

(All Measurements are to be Taken From the Left Side Unless Noted)

Skull Seal No. _____ Hide Seal No. _____ Sealed By _____ Sex _____ PS__VO__T:L__M__S__ Age _____ PM_____

Date of Kill _____ Location of Kill: Unit _____ Drainage or Locale _____ Length M^2 _____

Skull Measurements, mm:

Total Length	Condylobasal Length	Zygomatic Width	Sagital Crest, Ht.	Total Height

Canine Measurements, Upper/Lower, mm:

Length Above Gumline	Length Above Alveolus	Lateral/Lingual-Libial Greatest Width at Alveolus
/	/	/ - /

Dentition:

		I_1	I_2	I_3	C_1	P_1	P_2	P_3	P_4	M_1	M_2	M_3
Lower:	Left											
	Right											
Upper:	Left											
	Right											

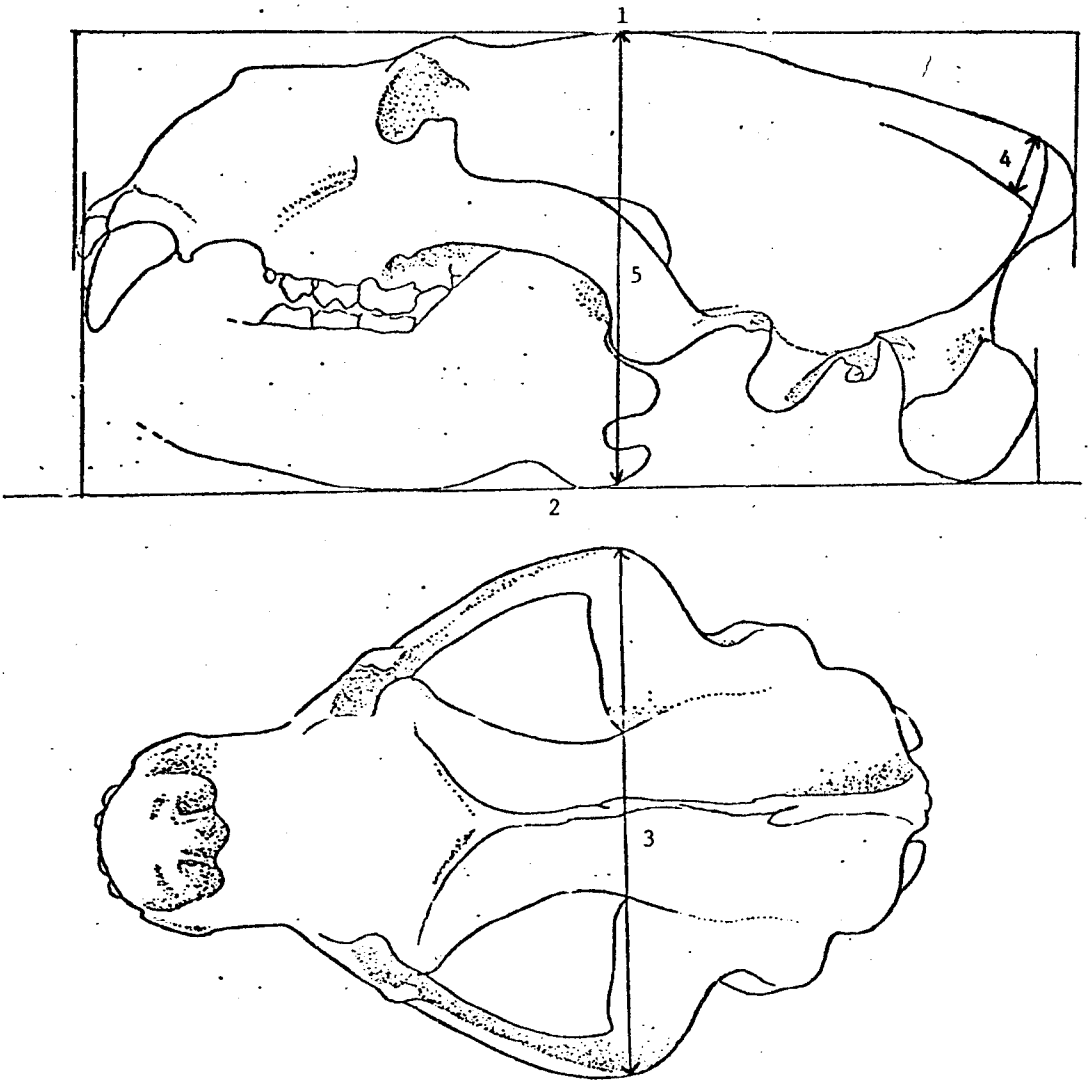
Legend: "---" indicates tooth is missing, "0" indicates bone is fused over tooth alveolus, or tooth never erupted, "(P)" indicates permanent tooth is erupting, "D" indicates deciduous tooth is present.

Photo: Include label; Sequence: Frontal, Lateral, Top, Palatal-Mandibular

Sealing Form Information: Skull: Length _____ Hide: Length _____
Width _____ Width _____
New Box No._____ Total _____ Total _____
Old Box No._____ Condyl _____

Remarks:

Figure 2. Diagram Showing Skull Measurements Taken



1. Total length
2. Condylobasal length
3. Zygomatic length
4. Sagital crest height
5. Total height

Figure 3. Method used to measure sagital crest

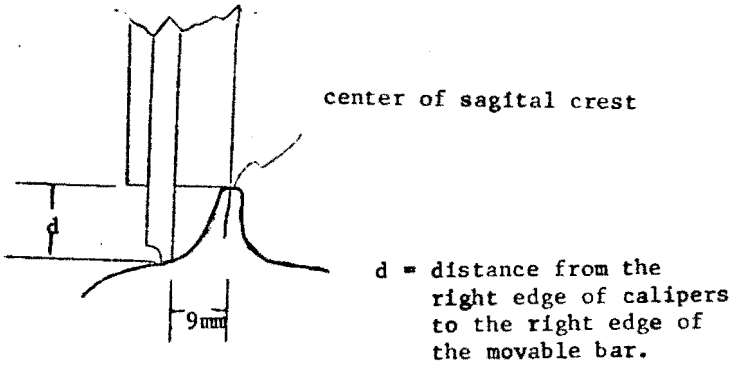
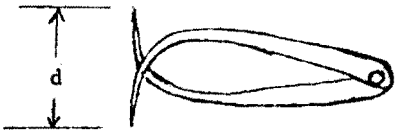


Figure 4. Position of calipers when measuring total height of skull



Length Above Gumline - Measured from the tip of the tooth to the point of intersection of the gum line and the median of the longitudinal surface of the tooth. Occasionally the gum line will not be uniformly crescent-shaped but will parallel the irregular structure of the alveolus. Measurement when this occurs is discussed under "Length Above Alveolus." When the tips of both canines are chipped (up to 3-4 mm), the length is measured from the break to the gum line and the length of the missing piece is estimated. When both teeth are chipped more than 3-4 mm, neither canine is measured. If only the left canine is chipped, the right canine is measured and noted on the data form.

Length Above Alveolus - Measured from the tip of the tooth to the point of intersection of the alveolus and the median of the transverse surface of the tooth. The alveolus may not be uniformly crescent-shaped, but irregular in structure. The three major irregularities and the manner in which they are measured are shown in Fig. 5.

Greatest Lateral Width at Alveolus - Measured from the intersection of the median of the anterior transverse surface and the alveolus of the canine to the intersection of the median of the posterior transverse surface and alveolus of the canine. The sum of the widths of external cracks in the tooth affecting the lateral width measurement are recorded in the "Remarks" section of the data form.

Greatest Lingual-Labial Width at Alveolus - Measured from the intersection of the median of the lingual surface and the alveolus of the canine to the intersection of the median of the labial surface and alveolus of the canine. Again, the sum of the widths of cracks affecting the lingual-labial measurement is noted under "Remarks."

7. Total Length of M^2 - The longest length of tooth crown (enameled portion of tooth) is measured with dial metric calipers at a right angle to the longitudinal center line of the tooth (Fig. 6).

The symbols used to describe dentition listed in the "Legend" (Fig. 1) are are self-explanatory. With missing teeth (-) it is impossible to tell whether the teeth were missing during life, or fell out after death or during storage. In the case of fusion of the alveolus, it often happens that the tooth is missing or has been broken off and the alveolus is only partially fused. If this were the case, it was noted under "Remarks."

Three photographs (Fig. 7) of each bear skull were taken in the following position and manner: 1) Frontal - Photographed so that an extended line formed by the occlusal surfaces of the upper and lower incisors when the jaw was closed bisected both mandibular condyles. 2) Lateral - Photographed from slightly above the horizontal to record the true external cranial outline. One-eighth to one-quarter of the lingual (internal) side of the right half of the mandible was visible in the viewfinder of the camera. The left side of the skull was photographed unless it had been crushed or one or both canines were missing. 3) Top and Palatal-Mandibular - Both the skull and mandible were stood in a vertical position and supported if necessary under the occipital

Figure 5. Showing three major irregularities of the alveolus

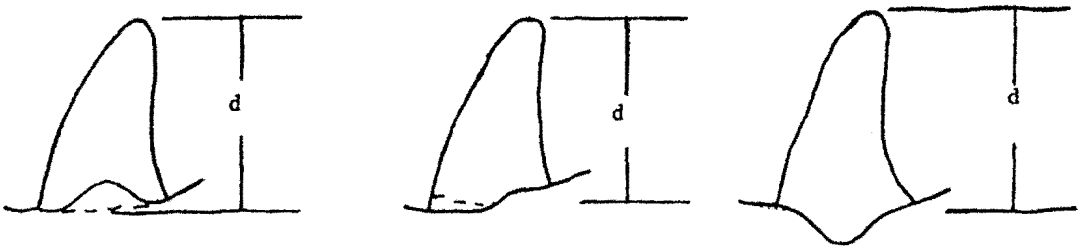
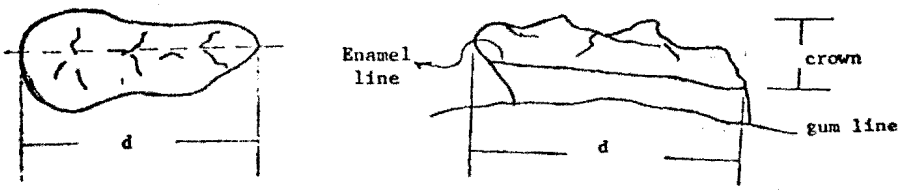


Figure 6. Method used to measure length of M^2



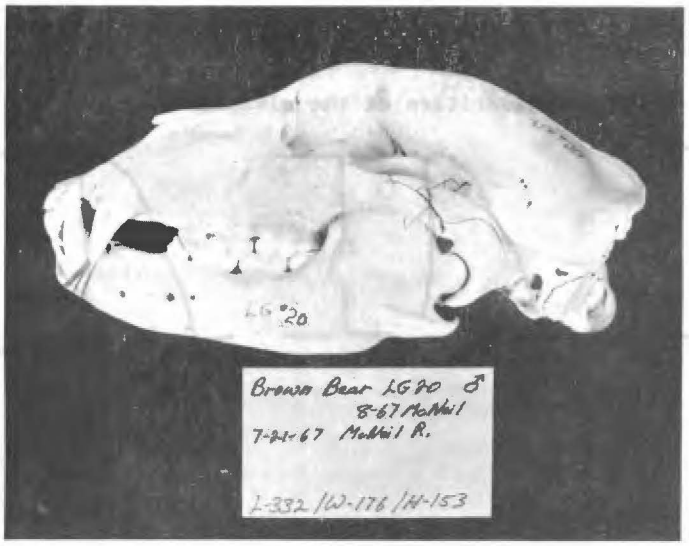
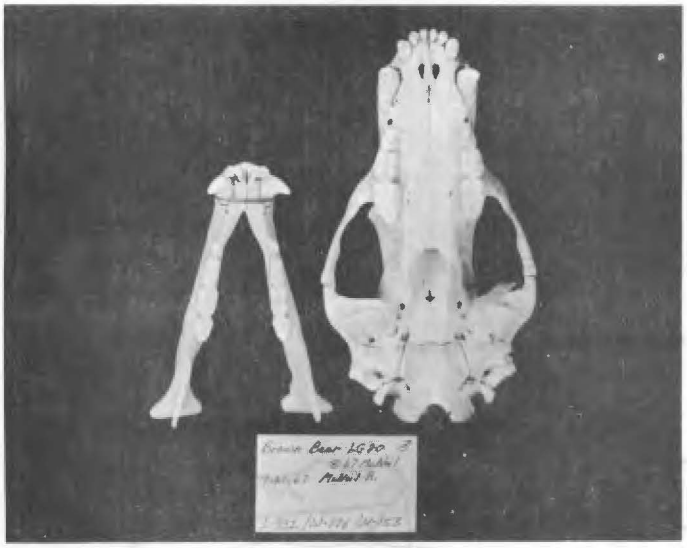


Figure 7. Position of bear skulls for photographs.

Lateral Photograph



Top and Palatal-Mandibular Photograph

Frontal Photograph

condyles and corotioid processes (ascending rami), respectively. The skull and mandible were oriented perpendicularly to the line of view of the camera. The camera was moved up or down until it was horizontal to the center of the opening of the eye socket. The top of the skull and bottom of the mandible were included in one photograph, and the dental aspects (palatal-mandibular) of the two were in the other photograph.

FINDINGS

Results of the brown/grizzly bear skull study will not be available until next year. The skull collection is large and will require eight to 10 months of laboratory work to complete processing. Within the past six months, 325 of approximately 500 skulls have been measured and photographed. Two premolar teeth from each of these skulls have been extracted and await sectioning. In addition, there are approximately 100 skulls which must be collected from various Fish and Game offices, these skulls are important to the study since many of them are from areas where a representative sample is lacking.

RECOMMENDATIONS

No recommendations are made at this time.

ACKNOWLEDGMENTS

Sincere thanks is given to Charles A. Irvine and Nathan Johnson for their time and effort in processing 350 brown/grizzly bear skulls.

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