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MOOSE CALF MORTALITY STUDY, KENAI PENINSULA

By:

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Volume I
Project Progress Report
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Albert W. Franzmann, Charles C. Schwartz and Rolf O. Peterson.

Project No.: W-17-10 Project Title: Big Game Investigations

Job No.: 1.24R Job Title: Kenai Peninsula Moose Calf Mortality Study

Period Covered: July 1, 1977 through June 30, 1978.

SUMMARY

Forty-two calf moose were radio-collared with mortality sensor transmitters set for one hour. Abandonment of calves was high when we immobilized the cow (55.5%--5 of 9) but decreased when only the calf was handled (6.4%--2 of 31). After abandonment and one radio transmitter failure, 34 post-capture bonded calves remained. Through 30 June 1978 predation by black bears accounted for 29.4 percent mortality (10 calves), brown bear 5.9 percent (2 calves) and wolves 2.9 percent (1 calf). Total predation was 38.2 percent. There was no other mortality to the bonded calves. Differences between 1977 and 1978 calf mortality studies were compared and problems associated with the studies were discussed. The impact of predation and other mortality factors on an old age, low density moose population were discussed.

BACKGROUND

Background and justification for this study were outlined previously (Franzmann and Bailey 1977). Appendix I is a paper presented at the 14th North American Moose Workshop and Conference which outlines the moose (*Alces alces*) calf mortality study done last year (Franzmann and Peterson 1978).

OBJECTIVES

To determine the extent and causes of moose calf mortality on the Moose River Flats, Kenai Peninsula.

PROCEDURES

Specific procedures for this study were outlined in earlier reports (Franzmann and Bailey 1977, and Franzmann and Peterson 1978) (Appendix I). Variations from these procedures were as follows: (1) Radio transmitters were set to double their pulse rates when movement ceased for approximately one hour, rather than after four hours; (2) Most of the radio transmitters were produced by Telonics, Mesa, AZ and the expandable collars were made by Mrs. Mike Schlegel, Kamiah, ID.; (3) The dosage of xylazine hydrochloride (Rompun, Haver-Lockhart Laboratories, Shawnee, Kansas) was reduced from 300 mg per adult cow to 100 mg and the amount of etorphine (M-99, D-M Pharmaceuticals, Inc., Rockville, Maryland) was increased from 7 to 9 mg. Hyaluronidase (Wydase, Wyeth Laboratories, Inc., Philadelphia PA) was not used with the immobilizing drugs this year; (4) If calves were abandoned as a result of capture procedure, we recovered the calves and brought them to the MRC for raising and subsequent use in other studies; (5) If initial abandonment rates were excessive, we would cease immobilizing the cow and minimize handling and processing the calf; (6) The study area was expanded to include moose calves from the Willow Lake rehabilitated area (this was done because cows and calves were scarce in the Moose River Flats area and because we added omni-directional antenna capabilities); (7) Seven of 10 cows processed were also radio-collared to facilitate tracking and to assist Wayne Regelin (U.S. Fish and Wildlife Service) in a moose food habits study.

From 24 May through 13 June 1978, nine cows were immobilized and processed and 10 associated calves (1 cow had twins) were radio-collared and processed. On 24 May a cow was immobilized and processed and her calf was processed and radio-collared; however, the calf's radio immediately ceased to function so they were not included in the count data (Table 1). From 24 May through 1 June 1978, 31 calves were radio-collared without immobilizing the cow (Table 1). A total of 42 calves were radio-collared and 9 cows immobilized.

FINDINGS

Capture Method

Mean drug induction time for nine adult female moose was 10.9

Table 1. Capture and post-capture status of moose cows and calves for calf mortality study, 1978.

Date 1978	Cows Immobilized	Calves Processed with Cow		Calves Processed without Cow	
		Bonded	Separated	Bonded	Separated
May 24	7*	3	5	2	
May 25				3	
May 26	1	1		8	
May 29				13	2
May 30				2	
June 1				1	
June 13	1	1			
Total	9	5	5	29	2

* One immobilized cow and her calf are not included due to unknown disposition of the pair as a result of radio-transmitter failure.

minutes (range 4-19 min.). Mean induction time for the 1977 field season was 7.3 minutes (range 3-15 min.) for cows at the same seasonal physiologic and reproductive status. Gasaway et al. (1978) reported mean induction time of 16 minutes (range 5-50 min.) for adult moose immobilized during August and April in previous years. Last year, 250 units of hyaluronidase were added to the immobilizing drug mixture; this probably reduced induction time below that reported by Gasaway et al. (1978). This year no hyaluronidase was added and the mean induction time was greater (10.9 min. versus 7.3 min.). This lends support to the premise that hyaluronidase will reduce induction time with the xylazine hydrochloride and etorphine mixture. Franzmann and Arneson (1974) reported reduced induction times when hyaluronidase was used in conjunction with succinylcholine hydrochloride to immobilize moose.

Cow/Calf Separation

Seven cows with their calves were initially immobilized (8 single calves, one set of twins) (Table 1). Subsequent monitoring of these individuals indicated a 62.5 percent abandonment rate (5 of 8 calves) (Table 1). This was much too high, and subsequently only calves were handled except for two cows that were immobilized and fitted with radio-transmitters. These two cows did not abandon their calves. Calves were not moved by helicopter this year as they were last year. Reducing the dosage of xylazine hydrochloride from that used last year did not reduce abandonment rate. A cow that wandered off after administration of the antagonist (M 50-50) generally separated from her calf. Apparently, a young calf cannot keep up with the cow and, for unknown reasons, some of the cows do not come back searching for the calves.

Because of this higher probability of cow/calf separation, immobilization of and processing the cows were discontinued. Calves were handled only long enough to permit application of the mortality transmitter. Abandonment rate was only 6.4 percent (2 of 31) with this procedure (Table 1).

Six abandoned calves (those individuals not sighted with the cow after 24 hours) were brought to the MRC to be reared for additional studies (Franzmann and Swartz 1978).

Mean time associated with immobilizing the cow and processing the cow and calf was 49.6 minutes. Helicopter time associated with immobilizing the cow, once the cow and calf were sighted, was 16.5 minutes. When only the calf was radio-collared the mean helicopter time after the calf was sighted was 5.5 minutes.

Physiologic and Morphometric Measurements

Ages of immobilized cows ranged from 3 to 11 years and the mean age was 7.8 years (n = 10). Last year the cows' ages ranged from 4 to 14 years and the mean age was 9.3 years (n = 13). Last year's cows were primarily done in the Moose River Flats area, and most of this year's were done outside of that area.

Preliminary blood data from adult female moose were indicative of poor physical condition (Franzmann and LeResche 1978). No packed cell volumes (PCV) exceeded 47 percent ($\bar{x}$ = 40.5%) and hemoglobin (Hb) values did not exceed 18.5 percent ($\bar{x}$ = 15.2%). These values were slightly higher than those obtained from the moose handled last year (PCV $\bar{x}$ = 39% and Hb $\bar{x}$ 14.0%). Other blood chemistries have not yet been compiled and analyzed. Likewise, compilation of hair element analyses is not complete.

Franzmann and Bailey (1977) reported the possible relationship of moose calf weights and age based upon birth weights of MRC moose and subsequent daily weight gains. After handling more calves, and particularly twins, it has become apparent that the weight-age relationship can only be used in a general way. This would also hold true for morphometric measurements.

Calf weights from nine individuals processed this spring averaged 17.0 kg (37.5 pounds) with a range of 14.1 to 20.9 kg. Mean total length, chest girth, hind foot length and neck girth were 103.3, 63.4, 44.4, and 30.2 cm, respectively (n = 10). Most of the calves comprising this group were 3 days old or less.

Bonded Calf Mortality

Only calves that had reformed the cow/calf bond after capture were monitored to establish natural mortality. Thirty-four calves remained bonded with their cows for 48 hours or more after capture (Table 2). Up to 1 July 1978, total predation upon these calves was 38.2 percent (13 of 34) (Table 2). Black bear (*Ursus americanus*) predation comprised 29.4 percent of these losses (10 of 34); brown bear (*Ursus arctos*) predation 5.9 percent (2 of 34); and wolf (*Canis lupus*) predation 2.9 percent (1 of 34). No other type of mortality was recorded.

On 27 May 1978, twin calves 1872 and 1863 were monitored on fast mode via Supercub flight. When located on the ground, both calves were approximately 75 percent consumed. Radio-collared black bear B-5 was about 1.6 km from the kill site. No predator sign was near the area; however, when autopsied 1872 had 4 skull puncture wounds, two on each side of the skull with one posterior and one anterior to the eye. The wounds were 6 and 7 cm apart. Calf 1863 had puncture wounds over the loin area and the pelvis was crushed. The cow was standing approximately 50 m from the dead calves. The calves were in the same area as they were the day before. Both were very small calves weighing less than 14 kg.

On 29 May 1978, calf 251 was monitored on fast mode from the MRC tower. We went to the site via helicopter and found both calf 251 and its twin 253 dead. Calf 251 was 85 percent consumed and all that remained was the hide, head, and lower legs. Calf 253 was 65 percent consumed. The hide, head and most of the red meat were not eaten. The tongue was removed. Four black bear scats and three beds were in the immediate vicinity of the kill. One hour after we found the calves, black bear B-8 was radio-tracked and located 1.6 km from kill site. Both calves were observed near the kill site the previous day with the cow (28 May 1978). On 27 May the cow and twins were located about 1 km north of the 28 May sighting.

Table 2. Status of radio-collared bonded moose calves until June 30, 1978.

	Predator, Calf Number and Date			Other Mortality and Date	Live Calves
	Black Bear	Brown Bear	Wolf		
	1872 (5/27/78)	255 (6/15/78)	1870 (6/11/78)		12-1865 7-241
	1863 (5/27/78)	1860 (6/19/78)			10-235 1871
	251 (5/29/78)				1877 1867
	253 (5/29/78)				11-257 1873
	1854 (5/31/78)				1852 1855
	1865 (5/31/78)				1858 1863
	5-239 (6/4/78)				1872A 9693
	9708 (6/13/78)				9696 9704
	1866 (6/16/78)				1857A 9907A
	1875 (6/18/78)				249 2-233
Total	10	2	1		21
% of Total	29.4	5.9	2.9		61.8

Calf 1854 was monitored from the Supercub on 1 June 1978, on fast mode. The calf was located 2 km from its original capture site. It had been 90 percent consumed. All that remained was the hide and lower limbs. The skull had been opened and brains removed. There were six black bear scats near the carcass.

Calf 1865 was also monitored from the Supercub on fast mode on 1 June 1978. The 90 percent consumed carcass was found 100 m from capture site; everything had been eaten except the head, hide and lower legs. One black bear scat was located near the carcass. Both calf 1854 and 1865 had been killed within 24 hours of our locating them.

Calf 5-239 was monitored by Supercub on fast mode on 4 June 1978. The calf had been only 30 percent consumed. Radio-collared black bear B-13 was only 100 m from kill site and we believe that the bear was frightened away from the carcass at our approach. Only the viscera, loin and part of the hind legs were eaten. Black bear hair was found 2 m from the kill site between the kill site and the carcass. Both cow and calf were sighted the previous day from the ground by Larry Aumiller.

Calf 1870's signal was monitored on fast mode from the MRC on 12 June 1978. It had been 90 percent consumed but instead of having its viscera consumed and red meat partially eaten, the viscera were lying at the site. The hind legs had been dragged away 20 m from kill site. The ends of the bone and joint surfaces had been chewed and the hide was inverted on the limbs. A wolf track was imprinted on the spilled rumen content. About 3 m from the site another wolf track was impressed in the muskeg.

On 14 June 1978, a fast signal was detected from calf 9708 from the MRC tower. The calf had been regularly located near the old drilling pad on the road to the MRC. We drove to the pad and picked up the signal and walked to the calf. The calf was nearly 100 percent consumed. All that remained were bone fragments, the jaw and teeth. One bear scat was 5 m from the feeding site and another about 10 m away. The scats appeared to be black bear based on size, and consisted primarily of cranberries and vegetation, however, it could have been a brown bear.

On 15 June 1978, calf 255 was tracked to an area adjacent to Rabbit Foot Lake. The signal came from a clump of trees near the lake, but no cow or calf could be seen. After we circled the area, a female brown bear and two 2 1/2 year old cubs came from the wooded area. The signal continued on the slow mode, but we suspected that the signal would be on fast mode within a short period of time. Attempts to monitor the signal from the MRC failed. The next day we attempted to monitor the signal from the Supercub, but even over the area, we could not pick up the signal. On 18 June 1978, we took a helicopter to the area and after ground searching found the calf and radio. The calf had been nearly completely consumed and the radio-transmitter was damaged. The antenna was torn from the radio-collar and the transmitter itself was not functioning. We concluded that the brown bears had killed the calf, perhaps just before our initial flight over the area, and had also destroyed the radio-transmitter. We were fortunate to have found the calf. This instance supports one of the main reasons for relocating the animals regularly.

On 17 June 1978, calf 1866 was monitored on fast mode from the MRC. At the site we found the calf 90 percent consumed. Only the hide and lower limbs were remaining. There were two black bear scats at the area and black bear hair was discovered at the kill site. This was one calf of a set of twins; the other twin and the cow were about 500 m from the kill unharmed. On 16 June 1978, the cow and both calves had been located about 3 km east of the kill site.

On 17 June 1978, a fast mode signal was heard from calf 1860 via Supercub, but we could not see the calf in the spruce forest near Bear Lake. On 18 June 1978, we landed on Bear Lake, tracked the calf, and found it 95 percent consumed. All that remained was the hide and hoof, bone and teeth fragments; the skull top was removed and brains eaten. Subcutaneous hemorrhage and puncture marks were located on hide in the rump area. A large scat was found in the area which contained many bone and hair fragments and brown bear hair was found adjacent to the kill on bushes.

On 18 June 1978, black bear B-8 was radio-tracked and located approximately 200 m south of Red Poll Lake. This adult male bear was observed traveling north and feeding on vegetation. Approximately 30 minutes later, calf 1875 was located on the south shore of Red Poll Lake. Initally, only the cow was observed. She appeared to be very agitated and paced back and forth in a small (50 m^2) area with her head down and ears back. After considerable searching, the calf was located 30 m from the cow. Black bear B-8 was lying about 3 m from the carcass. It appeared that B-8 had just killed this calf. We returned to this area in a helicopter within 1 hour. The calf had been partially eaten (viscera, loin, and ribs) and its carcass was still warm. Black bear B-8 was sighted 100 m from the carcass. There was also one black bear scat 2 m from the kill site, plus an obvious bed.

In addition to recording predation with calf mortality transmitters, we were able to witness additional calf predation by monitoring radio-collared bears. On 25 May 1978, radio-collared female black bears B-13 and B-14 were on a recent moose calf kill. On 2 June 1978, radio-collared black bear B-8 was resting on a ridge above a calf kill. He was chased away by an uncollared black bear which went to the kill and fed. The latter was later (1 hour) immobilized and radio-collared. On 16 June 1978, radio-collared male black bear B-19 was feeding on a recently killed calf. On 20 June 1978, radio-collared female brown bear A-2 was observed feeding on a moose calf.

Overall, we were able to associate five of our 16 radio-collared black bears with moose calf predation. Brown bears A-1 and A-2 were seen feeding on a recently killed adult female moose, and A-2 was seen feeding on a moose calf. An uncollared brown bear female with cubs was seen on dead calf 255. Radio-collared wolves 15026 and 134 were observed killing a moose calf and harassing the cow on 29 May 1978. These were the only kills which could be attributed to a specific animal or animals.

Up through 30 June 1978, on 15 different flights over the study area, 30 uncollared black bears and three uncollared brown bears (sow and two cubs) were seen. The study area appears to support a very high density of black bears.

Movements (Bonded Calves)

Last year we reported (Franzmann and Bailey 1977) that there appeared to be characteristic calf movements associated with black bear predation. The calves generally moved 1.6 km or more a day or two prior to being killed. We assumed the movements were a result of tactics used by black bears in stalking and killing calves. This contention was supported somewhat by actually observing a black bear using this tactic on a cow and calf (Franzmann and Bailey 1977).

When possible, we recorded the movements of calves again this year. Seven of 13 calves experienced significant movements prior to being killed; however, one was a wolf kill and one other was a brown bear kill. When calves reach about 3 weeks of age, movement of the cow and calf appears generally to be on their own initiative. Up to this time it may be very advantageous for a predator to force the cow with her calf from the calving home range.

Specific Problems

A most disappointing problem mentioned earlier in this report was our inability to immobilize the cow and process the cow and calf to obtain critical physiologic data.

Because of the large number of animals radio-collared on the Kenai Peninsula on the 164.000 to 166.000 MHz frequencies, we had to assign frequencies to our calf transmitters which were only 5 KHz apart. Unfortunately, the receiver used was not crystal controlled (AVM LD-12) and because of drift we could not differentiate animals by their frequency. We had the opportunity to use a crystal controlled receiver and scanner (Telonics TR-2) for one day to sort out our signals. Although we thought perhaps the transmitters were drifting, each radio transmission was picked up on the crystal controlled receiver exactly on the frequency assigned. With the scanner on the receiver we could cut our flying time for locating animals by at least 60 percent.

This problem of distinguishing animals by frequency was compounded when our automated systems at the MRC (Franzmann and Bailey 1977) was not functional in time for the study. We could not rely on monitoring from the MRC as much as we had hoped.

Another problem encountered during this years field work, was a scarcity of moose in the original study area. We initially sampled the traditional calving area on the Moose River Flats to conduct this study. Because we had difficulty finding an adequate number of cows with calves, we sampled an additional subpopulation at the Willow Lake area. It appeared that this year the Moose River Flats did not contain a large number of productive females. This drop in moose density may be a result of a reduced population density or a shift from the traditional calving area.

Last year we placed visual collars on 14 cows in the Moose River Flats and this year we observed nine of these cows back in that area. Apparently tradition does play a role, but if we consider the age of those cows ($\bar{x}$ = 9.3 in 1977) and an apparent lack of moose in general in the area, the role of the Moose River Flats as a calving area does not appear to be as significant as in the past.

The severe winters in the early 1970's which resulted in over 90 percent calf mortality are beginning to be reflected in the reproductive segment of the population. Those individuals which otherwise would have been recruited into the population now would be at their reproductive peaks (5 to 8 years age).

In contrast to the Moose River Flats, we observed a high density of cows with calves in the Willow Lake Rehabilitated area. The vegetation in this area was rehabilitated with Le Tourneau tree crushers in the winter of 1974-75 (Oldemeyer 1977), and it has attracted large numbers of moose since then. We did not, however, see any of last year's visual-collared moose from the Moose River Flats in the area.

There appeared to be a high twinning rate in the populations of moose sampled this year. We randomly radio-collared calves as we found them on the Moose River Flats, the Willow Lake area, and the area between. Eight of 36 cow-calf units were twins (22.2%). With a high twinning rate one might speculate that this declining population is beginning to respond reproductively. The problem appears to be--can this low density, older age population maintain itself or expand in spite of the witnessed high bear predation on calves and the year round wolf predation in addition to other forms of mortality? Factors benefiting the population are: (1) availability and use of browse rehabilitated areas; (2) availability and use of 1969 burn area; (3) excellent overwinter calf survival resulting from the past three mild winters; (4) the presently high productive potential of the population as exemplified by the high twinning rate; and (5) the restricted hunting seasons.

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APPENDIX I

MOOSE CALF MORTALITY ASSESSMENT

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Abstract: The moose (*Alces alces*) calf mortality part of the Kenai Peninsula Predator-Prey study was initiated in spring 1977 to assess mortality transmitters, capture and immobilization techniques, an automated monitoring system, physiologic characteristics of both cows and calves, and ultimately, the cause of calf mortality. Fifteen radio-collared, postcapture bonded calves were monitored and mortality experienced by these calves was attributed to; black bear predation (6 calves, 40 percent), wolf predation (1 calf, 6.7 percent), brown bear predation (1 calf, 6.7 percent), unknown predation (1 calf, 6.7 percent) and unknown (1 calf, 6.7 percent). Total predation accounted for 60 percent of moose calf mortality. Total calf mortality was 66.7 percent.

A continual recurring gap of knowledge in moose (*Alces alces*) population dynamics relates to neonatal and summer calf mortality. LeResche (1968) reported a drop in calves per 100 cows from 84.3 to 36.2 from May to October near Palmer, Alaska. LeRoux (personnal communication) recognizes a significant drop in spring to fall cow/ calf ratios annually on the Kenai Peninsula. Chatelain (1950:231) suggested a high incidence of black bears (*Ursus americanus*) eating young moose calves on the Kenai Peninsula, Alaska. LeResche (1968) did not consider black bears an important predator of moose calves, but observed a brown bear (*Ursus arctos*) killing a cow and two calves. He also reported several accidental calf deaths and desertion of calves by cows in two instances.

In an Idaho study 16 of 27 radio-collared elk calves were killed during the 1974 calving season by predators, 8 by black bear, 4 by mountain lion (*Felis concolor*) and 4 by unknown predators. During the 1975 calving season 15 of 27 elk calves were killed by predators, 13 by black bear, one by mountain lion, and one by unknown predator (Schlegel 1976).

Other studies have reported significant predation by wolves (*Canis lupus*) on young ungulates (Rausch and Bratlie 1965, Mech 1966, Mech and Frenzel 1971, Kuyt 1972, and VanBallenberghe et al. 1975).

Wolves reappeared on the Kenai Peninsula, Alaska, during the 1960's and are presently at a density of approximately 1 wolf/78 km^2. With three major predators on the Kenai Peninsula (wolves, black bear, and brown bear) and four major ungulates (moose, caribou [*Rangifer tarandus*], Dall sheep [*Ovis dalli*], and mountain goat [*Oreamnos americanus*], it was necessary that we obtain a better understanding of predator-prey relationships. In 1976 a cooperative agreement between the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service was signed which outlined a predator-prey study consisting of three main parts; a wolf study, a moose calf mortality study, and a bear study. This paper presents our initial work on the moose calf mortality study. The objectives of this study were to assess the use of mortality transmitters, immobilization and capture techniques (immobilizing cows and capturing calves versus capturing calves alone), an automated monitoring system, physiologic characteristics of cows and calves, and the causes of mortality.

METHODS

The study area was in the northcentral Kenai Peninsula lowlands in the vicinity of the 1947 Kenai burn (Oldemeyer et al. 1977). The area is bounded on the north by Moose Lake, on the east by the Chickaloon River, on the south by Bear Lake and the Moose River Flats, and on the west by the Moose Research Center (MRC) (Fig. 1).

On May 29, 1977, eleven moose calves were processed and radio-collared following capture by means of a Bell Jet Ranger II helicopter (Kenai Air Service). The 10 associated cows (1 cow had twins) were also immobilized, visual-collared, and processed. On May 31, 1977, eight more moose calves were radio-collared. Three of the calves' dams (2 cows with twins) were immobilized, visual-collared, and processed; the remainder of the calves (4) were radio-collared and processed without immobilizing the associated cows. On June 7, 1977, another six calves were radio-collared and processed without immobilizing the associated cows.

Processing the cows and calves included blood-sampling the cows from the jugular vein (Franzmann et al. 1976); blood-sampling the calves from the radial vein using a 21 gauge needle on a 10 cc syringe; plucking and collecting at least 1 gram of hair from the hump (Franzmann et al. 1975); measuring total length, chest girth, and hind foot length (Franzmann et al. 1978); weighing the calves; extracting the first incisor from the cow for aging (Sergeant and Pimlott 1959); and assessing condition class of the cow (Franzmann et al. 1976). Roto-tags (Nasco Inc., Modesto, CA) were placed in each calf's ear and cows were visual-collared, ear-tagged and flagged (Franzmann et al. 1974). A small burlap bag was placed over each calf's head and all four legs were tied together to assist handling.

The cows were immobilized using a combination of 7 mg etorphine (M-99, D-M Pharmaceuticals Inc., Rockville, MD), 300 mg xylazine hydrochloride (Rompun, Chemagro, Kansas City, MO), and 250 units hyaluronidase (Wydase, Wyeth Laboratories, Inc., Philadelphia, PA). Upon completion of processing both cow and calf or calves, the antagonist diprenorphine (M 50-50, D-M Pharmaceuticals, Inc., Rockville, MD) was injected into the cow's jugular vein. The cow was generally up in 2 to 4 minutes following injection.

The cow and calf or calves were together when the cow was given the antagonist, except for twin calves 39-171 and 39-173, which were 200 m from their cow when processed. We left the calves on a bog island when the cow left them during immobilization. We classified the remaining capture events as follows: (A) the calf was caught or caught and processed and placed in the helicopter; the cow was immobilized; and the calf was kept with the cow during processing (5 calves); (B) the cow was immobilized; the calf was caught and carried to the downed cow; and the cow and calf were processed together (4 calves); and (C) the cow was immobilized; the calf or calves stayed with the cow; and the cow and calf or calves were processed together (5 calves, including 2 sets of twins). Location of calves captured was recorded (Fig. 1).

The radio transmitters (AVM Instrument Co., Champaign, IL) placed on the calves ranged in frequency from 164.025 to 164.919 and while in motion pulsed at approximately 60 beats/minute. When movement ceased for approximately four hours the pulse tripled (188 to 217 beats/min). The radio-collar was designed to expand with calf growth to 66 cm circumference and then fall off. The beginning circumference was 33 cm (13 in.). The collar was fashioned after the design for expanding goose neck bands and was constructed of vinyl plastic (4 cm wide x 2 mm thick). The transmitter was encased in acrylic and fastened to the collar by vinyl plastic rings through which the collar could freely expand. A 25 cm insulated wire antenna protruded from the encased transmitter and extended along the side of the collar.

From May 30 to June 15, 1977, the calves were monitored and located by daily flights (at 0700 hrs) in a Super Cub equipped with two yagi antennas clamped to each wing strut. Locations and movements were plotted using Kenai National Moose Range (KNMR) aerial color photographs. During this period daily flights in a Super Cub (1900 hrs) were made by circling up over Kenai airport to an altitude necessary to obtain a signal from each calf.

By June 15, 1977, a 30 m tower equipped with two yagi antennas had been erected at the MRC. A Falcon Five receiver (Wildlife Materials Inc., Carbondale, IL) and a memory unit (W. W. Cochran design) were used to monitor the calves. The original intent was to utilize the system which would activate a signal to the Kenai National Moose Range (KNMR) repeater station when the fast mode was detected and broadcast it through the KNMR communications system. The signal consisted of a siren burst, followed by the pulse beat and then by binary coded tones which indicated which transmitter had been activated. The system was operational for fast mode signals at close range; however, it could not always detect the fast mode signal from the study area (up to 9.7 km from tower) when the collar was on the ground. Standing calves were easily monitored on slow mode. These circumstances provided another option to monitor the calves, that of regularly (every hour or two) monitoring the calves with the receiver at the MRC. If a calf's signal was not heard for several hours, we would be alerted to monitor more intensively, and if no signal was heard for 4 to 6 hours we would check the calf by Super Cub. When a fast signal was monitored we would similarly respond. If a calf's fate could not be determined from the Super Cub, a helicopter or Super Cub on floats was employed to go to the area and proceed to the calf on ground. A thorough investigation of the calf and area was made at that time. If predation was suspected, a form designed by Mike Schlegel, Idaho Fish and Game Department, was used to record area, carcass, and predator data. A necropsy was performed on calves which were sufficiently intact. Appropriate samples were collected. A photograph was taken of each calf prior to handling or movement.

RESULTS AND DISCUSSION

Capture Method

The mean induction time for adult female moose was 7.3 minutes (range 3-15 min.). Gasaway et al. (1978) reported mean induction times of 16 minutes (range 5-50 min.) for adult moose immobilized in August and April. The addition of 250 units of hyaluronidase may have been responsible for the decrease in induction time; however, moose immobilized in this study were in very poor condition (most were class 5 or 6 - see Franzmann et al. 1976). The poorer condition, in addition to stress of recent calving and lactation, may have been primarily responsible for decreased induction time. The post-immobilization tranquilizing effects of xylazine hydrochloride may have partially influenced cow-calf separation. No data suggests this, but separation occurred in some instances and anything which may have been a contributing factor should be investigated. The partially tranquil cow may not respond to stimuli that maintain or reinstate the cow-calf bond. Conversely, the partially tranquil cow may not be affected by post-capture activity (helicopter in area) and may rebond more readily. To assess cow response, future immobilization attempts should be made with reduced dosages of xylazine hydrochloride.

We immobilized the cow of each calf or calves for the first 14 cows (17 calves). Subsequent monitoring of these individuals indicated potential cow-calf separation. Additionally, one cow died from unknown causes at capture prior to receiving the antagonist and female #47 bogged down after capture. In spite of slinging her to high ground with the helicopter, she continued to weaken and was sacrificed. She was in extremely poor condition at capture (she fell down on initial pursuit). She was 14 years old, yet she had twin calves. Her packed cell volume (PCV) was 31 percent and hemoglobin was 10.5 gm/100ml. These were the lowest we ever recorded for an adult female moose (Franzmann et al. 1976).

The remainder of the calves radio-collared were processed without immobilizing the cow.

Cow/Calf Separation

Three of five cows immobilized by method A (the calf was caught or caught and processed, placed in helicopter; the cow was immobilized, and cow and calf were kept together during processing) experienced permanent separation. By method B (the cow was immobilized, the calf caught and carried to cow, and the calf and cow were processed together) no permanent separation was experienced (n=4). Using method C (the cow was immobilized, the calf or calves stayed with the cow, and the cow and calf or calves were processed together) one of three experienced permanent separation; however, that calf was apparently adopted by another unmarked cow and they bonded permanently. When one cow (#39) was processed separately from her calves, absolute separation occurred. When calves alone were captured 2 of 8 cow-calf groups were permanently separated, and one outcome unknown. Of the 22 total cow-calf groups, 15 bonded post-capture, 6 separated post-capture, and one outcome was unknown.

It is apparent that permanent cow-calf separation may occur during this type of study. Methods which lessen this possibility should be adopted whenever feasible. If the objectives include obtaining data from the cow, it seems beneficial to immobilize the cow prior to handling the calf. It may be necessary to refrain from immobilizing the cow if upon initial pursuit the cow/calf bond appears weak, with separation occurring at the first sign of the cow's disinterest in her calf. If study objectives do not include obtaining data from the cow, immobilizing the calf alone would be proper. Separation occurred with this method also; however, each case involved processing the calf for physiologic and morphometric data. If such data are not part of the objectives and simply radio-collaring the calf will suffice, separation would likely be lessened by capturing the calf, installing the radio-collar, and leaving as soon as possible. It should be noted that calves alone were captured later during this study and thus were older, a factor which may have increased their ability to maintain a post-capture bond.

The lack of physiologic and morphometric data from the cows and calves or from calves collared alone may be a substantial loss in terms of interpreting events taking place at this critical period in the life history of moose.

We found that considerable time was saved during observational monitoring of cows and calves when the cow wore a visual collar. The visual collar was a definite aid in obtaining data about cow-calf separation and recording post-predation movement of the cow. The adoption of calf #40-148 by an unmarked cow would not have been detected had this calf's mother also been unmarked. In addition, radio-collaring at least some of the cows for purposes of monitoring predator-prey activities during calving is warranted by the presence of three major predator species in the area.

The helicopter costs of radio-collaring and processing a calf alone were \$197.00; capturing and processing a cow cost \$201.00. Drug cost per cow processed was \$54.50. Costs for doing calves alone were somewhat biased in that these calves were larger and harder to find. Unfortunately, we do not have same-day cost comparisons, but the costs/ unit do not appear to be a limiting factor.

Physiologic and Morphometric Measurements

Preliminary blood data from adult female moose reflected poor condition (Franzmann et al. 1976). No packed cell volumes (PCV) exceeded 45 percent ($\bar{x}$ = 39%) and hemoglobin (Hb) values did not exceed 16.5 gm/100ml ($\bar{x}$ = 14.0 gm/100ml). Calf PCV values did not exceed 39 percent ($\bar{x}$ = 29.9%) and Hb vlaues did not exceed 13.5 gm/100ml). Other blood chemistries have not yet been assessed but should provide more information regarding physiologic status of cows and calves (Franzmann et al. 1976). The 13 cow ages (cementum annuli) ranged from 4 to 14 years ($\bar{x}$ = 9.3 years). Comparative physiologic data from cows with calves experiencing predation and/or separation may provide clues as to the possiblility of a physiologic basis for vulnerability to predation or bond breakdown. These possibilities will be investigated when analyses are complete and additional data is obtained.

Calf weights at time of capture were used in estimating age. A male calf born at the MRC weighed 14.5 kg (32 pounds) at birth and at age one week weighed 23.6 kg (52 pounds), a gain of 1.3 kg (2.9 pounds) per day (Franzmann and Arneson 1973). The range in moose calf weights for this study was 14.4 kg (30 pounds) to 36.3 kg (80 pounds) for calves age 1-16 days.

Morphometric measurements also reflected calf age. For calves age 1-16 days, total length measurements ranged from 88 to 115 cm; heart girth ranged from 55 to 75.5 cm; hind foot ranged from 31 to 41 cm (length to dewclaw was approximately 10 cm less on all age classes); and neck circumference ranged from 27 to 36 cm. Reported total length/weight correlation was 0.94; chest girth/weight correlation was 0.90; and hind foot/weight correlation was 0.87 (Franzmann et al. 1978). Measurement/weight relationships from calves age 1-16 days corresponded to these correlations. Neck circumference measurements were not available from older moose.

Bonded Calf Mortality

Only calves that had retained the cow/calf bond after capture were monitored to establish natural mortality. Fifteen calves remained bonded with their cows for 48 hours or more after capture (Table 1). An additional unradioed twin calf (#159, brother of calf #157) was available for observation until June 15, 1977, when two brown bears killed #157. The fate of calf #159 was unknown. Total predation of bonded calves was 60 percent (9 calves). Black bear predation was 40 percent (6 calves); wolf predation was 6.7 percent (one calf); brown bear predation was 6.7 percent (one calf); unknown predation was 6.7 percent (one calf), and unknown mortality was 6.7 percent (one calf). Total mortality was 66.7 percent (10 calves) (Table 1). Calves were monitored until August 1, 1977. By then the remaining transmitters had fallen off or gone dead.

Table 1. Mortality of moose calves with good post-capture cow/calf bond.

Calf Number	Predator and Predation Date: Black Bear	Brown Bear	Wolf	Unknown	Other Mortality and Date	
38-161						
38-163					7/5/77	
40-148	7/13/77					
41-145				6/2/77		
42-143	6/3/77					
43-141			6/2/77			
44-189	6/21/77					
46-185						
48-178	6/12/77					
50-126	6/12/77					
146						
155						
157		6/15/77				
167						
191	6/29/77					
						Total
Percent	40.0%	6.7%	6.7%	6.7%	6.7%	66.7%

Calf #41-145 was monitored on fast mode at 1600 hrs on June 2, 1977, and we arrived at the site at 1900 hrs. No predators were seen in the area. The cow was sighted 100 m from carcass (#41 collar). The birch (*Betula papyrifera*)-spruce (*Picea mariana*) canopy cover was approximately 10 percent. The uncovered carcass was 90 percent consumed, with only parts of skull, mandible and teeth, broken femurs, other bone pieces and the partially inverted hide remaining. No predator sign was located (scats, hair, or prints). The hide was ripped in several areas. The cause of mortality was recorded as unknown predator but was likely a black or brown bear.

Calf #43-141 was located by Super Cub on June 2, 1977, with a black wolf near the slow mode signal site at 0800. At 1930 we went to the area by helicopter. The black wolf was again sighted in the area, and the signal was still on slow mode. The calf's carcass was found buried in the duff layer at the base of a hill in a mature birch stand with 50 percent canopy cover. The calf was approximately 40 percent consumed (hind legs, entrails), with the hind legs lying 47 m from the remainder of the buried carcass (hide still intact). The radio-collar was on the carcass. The cow was not seen in the area. The cause of mortality was determined as wolf predation.

On June 3, 1977, a black bear was sighted at 0745 near the slow mode signal origin of calf #42-143, but neither cow nor calf was observed. On subsequent morning flights (June 4 and 5) neither cow nor calf was sighted, though the signal origin location remained the same. At 1900 on June 5 a fast mode signal was detected at 1900 m over Kenai Airport. On June 7 we went to the site via helicopter and found the calf carcass 84 percent consumed (by weight). All that remained were bone fragments and the partially inverted hide, which had 30-40 cm tears. The radio was 20 m from the feeding site. Four bear scats were located within a 30 m radius of the feeding site. The cause of mortality was determined as black bear predation.

On June 11, 1977, cow #48 and calf #48-148 had moved 17.6 km up Thurman Creek into the mountains. The signal location was identified but the calf was not seen in the heavy spruce. Two black bears were sighted in the area. On June 12 at 0830 the slow mode signal was located farther up Thurman Creek but neither cow nor calf was sighted. A black bear was sighted 1 km from the signal. On the morning of June 13 the signal was on fast mode. We went to the area via helicopter and located the uncovered calf carcass on a hillside near Thurman Creek in a 20 percent spruce canopy cover. The partially inverted hide and partially eaten head (ears, tongue, and nose) were at a site 12 m from the broken radio-collar, parts of broken femur, and scapula. No predator sign was found in the area. The cause of mortality was determined as black bear predation.

On June 12, 1977, at 0930 the carcass of calf #50-126 was sighted by Super Cub in a clump of spruce. A large black bear was feeding on a winter-kill calf 60 m from the calf carcass. Cow #50 was not in the area. The radio signal was on slow mode. On June 13 we went to the site via helicopter. The signal was still on slow mode and the cow was still not in sight. The uncovered carcass was 80 percent consumed (all flesh except one thigh) and was located in a spruce bog area with 30 percent canopy cover. The leg bones were not cracked and the head was eaten.

it was on fast mode. We inspected the site on afternoon of July 1 and determined it to be black bear predation. There were 10 black bear scat piles in the area. The carcass was 90 percent utilized under 20 percent canopy cover. The calf had moved nearly 20 km from June 27 to June 29. The kill site was 20 km from tower, and we received a good signal, perhaps, because the transmitter was lying under a very tall spruce tree.

On July 5, calf #38-163 was monitored by aircraft on fast mode. Nothing could be sighted in the area which was 25 km east of the tower near the Chickaloon River. The helicopter was used to go to the area and we found only the intact collar. An intensive search of the area provided no clues; however, the collar had small teeth marks imbedded in it and we assumed the collar was carried to the area by a small mammal. No cause of mortality could be determined for this calf.

On July 15, calf #40-148 was monitored by aircraft on fast mode. An on ground inspection at the site indicated black bear predation. Black bear scats, tracks and hair were found at the site. The calf was sighted in the area on July 12, and we assumed that no significant movement was associated with predation in this case.

As of July 15, only three calves remained with transmitting radioes, and by August 5, two of these had fallen off and one radio went dead.

The question arises as to whether or not the calves classified as predation mortalities may have died of other causes prior to predation. Separation and starvation of four calves (one set of twins) and capture-related deaths of two cows (one cow at capture, one scraficed after unsuccessful attempts to sling her from a bog) occurred during this study. Their carcasses remained on the study area. We were not able to check back on all the capture-related deaths, but those which we checked were virtually unutilized for days. Cow #47 was sacrificed on May 31, 1977, and no sign of disturbance was noted until June 12, 1977. Calf #39-171 died on June 6, 1977, and had not been disturbed as of June 14, 1977. Calf #169 was dead 36 hours prior to radio recovery, and it was undisturbed at that time. Calf #151 died June 8, 1977, was necropsied that same day, and, when visited on June 18, had not been utilized. Warren Ballard witnessed similar predator-scavenger non-use of dead moose calves in his study conducted in the Nelchina Basin, Alaska (pers. comm.). Using calf carcasses for baiting wolf traps during early June, we observed similar predator-scavenger non-use of dead calves. We concluded that in those instances when we did not see the predator at or near the kill site the predator signs at the area warranted a conclusion that predation was the cause of death.

During the flights over the study area, 13 adult or subadult black bears were seen in addition to a sow and three cubs, which were observed several times. Two subadult brown bears were seen on two occasions and two adult brown bears were seen on three occasions. A single gray and a single black wolf were also seen. With three major potential predators (black bear, brown bear and wolf) in the area, it was difficult to identify the specific predator without witnessing it at the kill site when sign (scats, tracks, etc.) at the site were absent.

Movements (Bonded Calves)

From capture dates (May 29 and 31 and June 7, 1977) movement of the cow and calf or calves was plotted by daily Super-Cub flights until June 15, 1977, when monitoring from the MRC was begun. Thereafter, moose calves were located on a schedule compatible with radioed wolf tracking and flights to assess calf mortality.

No specific movement activities were evident from this small sample; however, certain movement observations may be associated with predation or predation attempts. In general, all bonded calves tended to remain within 1.6 km (1 mile) of the capture site (usually within 100 m). Movements of 1.6 km or more (up to 14.4 km) were recorded for what seemed, at the time, no apparent reason. When movements were compared with predation a pattern seemed to develop. The moose calves killed by black bears had traveled 3.2, 4.8, 14.4, and 20 km one or two days prior to predation. Calves killed by the wolf and by brown bears and the unknown kill were within 1.6 km of capture site. Calves not killed by June 15 had on occasion made sporadic moves, but only one exceeded 3.2 km. Calf #44-189 moved 4.8 km 7 days after capture. It was later killed by a black bear on June 21, but no pre-kill movement data were available. Calf #40-148 moved nearly 12 km 11 days after capture, but did not move significantly prior to being killed by black bear as far as we could tell.

During the study a black bear was observed stalking a cow and calf. The bear made no direct moves toward the pair but continually moved in their general direction, forcing the nervous cow to move in bursts. She would stop, observe the bear, and then proceed at a rapid gait, gradually slowing and then stopping. She would then repeat the process. The calf stayed with her. The bear continued to stalk the pair until it sighted the observer (A. Franzmann) and bolted in the opposite direction. The cow and calf came right by the observer without concern.

Moose calf movements associated with black bear kills may be interpreted from this observation to be the result of tactics used by black bears in stalking and killing moose calves. The cow and calf may be forced into unfamiliar surroundings, thus increasing the predator's chances for success. The lack of movement of calves killed by the wolf and brown bears may be the result of a different predator strategy. Other major movements not actually followed by black bear predation may have occurred because of attempted predation.

Obviously, more observations and data are required, but these preliminary findings indicate that there are opportunities to obtain such data and that there is need for a more intensive approach to the study.

CONCLUSIONS

The use of mortality transmitters on moose calves provided important post natal life history information, particularly regarding predation. The four hour setting for activation of the fast mode was too long. In the future one hour setting will be employed. The plastic material used in the expandable collar design was susceptible to brea',ng and several collars were lost prior to providing information desired.

Immobilization of the cow and capture of the calf versus capture of the calf alone both resulted in cow/calf separation. If information from the cow is important in the study design she should be immobilized; however, it appears that cow/calf separation may occur at a higher rate when the cow is immobilized. Decreased amounts of xylazine hydrochloride in the immobilization dose may improve rate of cow/calf separation. Hyaluronidase was apparently a useful additive to the immobilizing dose.

The automated monitoring system was helpful and decreased the requirements for flights; however, we could not depend upon it alone since much valuable information was derived from daily flights over the area to locate radio collared calves. Improvement in tuning of radio transmitters should be pursued to obtain the strongest signal possible. The addition of an activity receiver system would be an important adjunct to the study.

Physiologic characteristics of the cows sampled indicated a relative poor physiologic state. Additional data would be desireable from both calves and cows to establish base-line data at this critical period of the life history of moose.

The high rate of predation experienced with the radio collared calves was alarming. Black bears appeared to be the major predators of these calves, although wolves and brown bear were present on the calving grounds. It would be desireable to radio collar some of the predators, particularly bears, in the calving area to obtain information regarding predation behavior. We need to determine if this calf predation is general for the black bears in the area or if just certain black bears with learned predation behavior are responsible. It would be helpful to have some cows radio collared as well as their calves for ascertaining the cow-calf bond characteristics in an area with such a high calf predation rate.

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Charles C. Schwartz and Albert W. Franzmann

Project No.: W-17-10 Project Title: Big Game Investigations

Job No.: 17.3R Job Title: Black Bear Predation on Moose

Period Covered: January 1. 1978 through June 30, 1978

SUMMARY

Nineteen black and four brown bears were captured and processed. Capture techniques, immobilization success, and morphometric measurements are presented and discussed. We are currently monitoring 16 black and four brown bears that were fitted with radio-transmitters. Radio-collared black bears were relocated 114 times, and the brown bears 21 times. During this period, radio-collared bears were observed feeding on three moose calves. In addition, 31 uncollared black and four uncollared brown bears were sighted in the study area.

BACKGROUND

Based upon population estimates from random stratified counts (Evans et al. 1966) the moose (*Alces alces*) populations on the Kenai Peninsula have steadily declined in the past five years. Factors contributing to this decline include long-term deterioration of vegetation (Oldemeyer et al. 1977), and increased adult mortality from wolf (*Canis lupus*) predation (R. Peterson pers. comm.), highway accidents, hunting, poaching and development encroachment on suitable habitat. In addition, there was little or no recruitment into the population during the early 1970's due to severe winters.

High calf mortality has been documented on the Kenai Peninsula (LeRoux 1975) and at the Moose Research Center (MRC) (Franzmann and Arneson 1973, 1974, 1975). Studies of moose calf mortality on the Kenai Peninsula (Franzmann and Bailey 1977) and the Moose Calf Mortality Study (this report) indicate that black (*Ursus americanus*) and brown (*U. arctos*) bears kill a substantial (32-38%) portion of the new calf crop. Bear predation on moose calves has been observed elsewhere on the Kenai Peninsula (Lucas 1932, Palmer 1939) and near Palmer (LeResche 1968). Prior to the moose calf mortality study, no effort had been made to document the extent of this mortality on moose on the Kenai Peninsula. As outlined in the Kenai Peninsula Predator Prey project (Franzmann and Bailey 1977), studies were initated to assess the impact of black and brown bear predation on moose calves in the Moose River Flats calving area and to ascertain density, movements, home range, and food habits of black and brown bears in and near the moose calving area.

OBJECTIVES

To determine densities of black bears on the Moose River Flats during May, June and July.

To determine movements and predation behavior of bears tagged on the Moose River Flats during May, June and July.

PROCEDURES

Bears either were captured with Aldrich foot snares (Jonkel and Cowan 1971) using techniques described by Flowers (1977) or darted from a helicopter (Bell Jet Ranger) with a projectile syringe fired from a Cap-Chur gun (Palmer Chemical and Equipment Co., Douglasville, GA). Snares were set in cubby-type trap-sites constructed of logs and covered with freshly cut spruce trees. Various baits and/or scents were tested to determine which type of lure would attract bears most effectively. Snares were set on existing roads around the perimeter of the MRC.

Snared and darted bears were immobilized with phencycline hydrochloride (Sernylan, Bio-Ceutic Laboratories, Inc., St. Joseph, MO). Bears in traps were administered the drug intramuscularly by means of a hypodermic syringe mounted on the end of 2 m aluminum tube. Dosages were calculated from the estimated weight of each bear and administered on the basis of

2.2 mg/kg of body weight.

Immobilized animals were measured for total body length (tip of nose to tip of tail), neck circumference at base of skull, heart girth (circumference of chest posterior to shoulders) and hindfoot width (at widest point across pad) and length (from tip of pad on the longest toe to the end of pad at the heel). In addition, the skull width (widest point on zygomatic arches) and length (junction of gums and upper incisors to the posterior end of the sagittal crest), and lengths of the left upper and lower canines were recorded.

All animals were marked with numbered yellow plastic ear tags, tattooed on both sides of the upper lip and fitted with a radio transmitter (Telonics Inc., Mesa, AR). Blood and hair samples were collected for physiologic assessment and the first upper premolar was extracted for age determination. Teeth were decalcified, sectioned, stained and read at the Alaska Department of Fish and Game Laboratory in Anchorage. All injured or stressed animals were given an intramuscular injection of penicillin G and some were given injections of B-vitamin complex. Whenever possible, bears were weighed with a spring scale.

Bear movements were monitored weekly via Supercub fitted with wing strut mounted antennas. When possible animals were visually located and the vegetation type, and activities noted (Fig. 1). Locations were plotted on a map to determine home range and usage of the moose calving areas. Unmarked bears were also noted and recorded in a similar manner.

FINDINGS

All bears were captured between 8 October 1977 and 30 June 1978 (Table 1). Of the 19 black bears captured, one was shot by a hunter before processing, two died of drug related complications and 16 were fitted with radio transmitters. All four brown bears were fitted with transmitters. Three of the 19 black bears were snared during fall 1977 (under S&I Job 17.0) and the remaining 16 black and four brown bears were captured in spring 1978. An additional three black bears were snared in the spring; all other bears were captured using a helicopter.

Between 22 September and 9 October 1977 a total of 19 cubby sets were constructed, baited and set. During this trapping session we successfully captured three female black bears and missed eight additional unidentified bears. We trapped a total of 477 trap days with a catch success of one bear per 159 days trapped. This success rate was very low for several reasons. Snares were originally set in cubbys and baited with bacon grease and/or a wolf lure which successfully attracted black bears in the past (Rolph Petersen pers. comm.). After 8 days (149 trap days) of trapping without any sign of bear activity near the sets, we rebaited all cubbys with salmon carcasses retreived from the Kenai River. Within two days after baiting we had two separate cubbys visited by bears but did not catch the animals. Following these two misses, we relocated our snares further from the bait. Several days later we caught two bears. One of these was shot and killed by a black bear hunter who had failed to read the warning signs that had been posted

Table 1. Capture and marking information for 18 individual black and 4 brown bears handled near the Moose Research Center, Kenai Peninsula, Alaska 1977-1978.

Bear and tattoo No.	Sex	Capture Date	Capture Location	Transmitter Frequency	Transmitter Color	Ear tag No. Right	Ear tag No. Left
A1[1]	M	9 May 1978	Bear Lake	165.010	Red/green	690	691
A2	F	17 May 1978		165.000	Blue	699	700
A3	M	13 June 1978	Grus Lake	165.020	Red	644	645
A4	F	13 June 1978	Grus Lake	165.005	Yellow	632	631
B0	F	8 Oct 1978	North Pen 1	------D E A D------			
B1	F	8 Oct 1977	West Side Pen 1	164.452	Red	677	676
B1A	F	31 May 1978	West Side Pen 1	164.370	Blue/yellow	677	676
B2	F	15 Oct 1977	East Side Pen 3		Yellow	679	678
B2A	F	9 June 1978	Vixon Lake	164.310	Yellow/white	679	678
B3	M	28 April 1978	West Side Pen 1	164.178	White	685	684
B4	M	2 May 1978	West Side Pen 1	------D E A D------			
B5	M	2 May 1978	Jay Lake	164.295	Yellow	680	681
B6	M	2 May 1978	Rifle Lake	164.190	Green/red	694	695
B6A	M	30 May 1978	Schwartz Lake	164.260	Blue/white	694	695
B7	F	9 May 1978	Buteo Lake	------D E A D------			
B8	M	16 May 1978	1/2 mile east Arrow Lake	164.230	Yellow/red	686	687
B9	M	17 May 1978	1/2 mile west Schwartz Lake	164.240	Green/white	697	698
B10	M	17 May 1978	Moose Lake	164.290	Red/green	688	689
B12	F	19 May 1978	Vixon Lake	164.180	Blue	626	627
B13	F	19 May 1978	Vixon Lake	164.210	Green	636	637
B14	F	25 May 1978	Buteo Lake	164.340	Yellow/Green	630	628
B15	F	30 May 1978	Rifle Lake	164.386	White	633	634
B16	M	2 June 1978	Chick Lake	164.350	Red/blue	647	646
B17	M	5 June 1978	Moose Lake	164.330	Red/white	649	650
B18	F	13 June 1978	Bear Lake	164.360	Blue/white	641	642
B19	M	13 June 1978	Esst Pen 4	165.015	Red	639	638

1/ Prefix A indicates brown bear, B indicates a black bear, an A following the number indicates a recapture.

near cubbys to alert the public of our trapping operations. The second individual (B1) was immobilized, and fitted with a radio transmitter. Several days later, we discovered that the radio collar slipped off the bear. The third black bear snared in fall 1977 was fitted with an AVM expandable collar on 15 October and denned in Pen 3 of the MRC on 26 October.

Snaring activities were reactivated 26 April 1978 and continued through 18 May. During this period we set eight cubby sets, trapped 158 trap days and captured three male black bears and missed an additional six unidentified bears. Trapping success was 52.7 trap days per individual captured. This improved success over that in the fall was probably due to several factors. First, our ability to construct cubbys and set snares had improved. Secondly, our best success (two captures, three misses) was at a cubby baited with a winter-killed moose. Bear activity at this cubby was continuous until the moose carcass was completely consummed. Other sets with bear activity were baited with rotten salmon carcasses collected the previous fall and/or fresh caught herring. We also baited several cubby sets with carcasses of lynx (*Lynx canadensis*) wolf, and wolverine (*Gulo gulo*). Bears were not attracted to this carrion and no set with these carcasses caught or missed bears. Finally, our higher success was probably related to food abundance in the spring versus the fall. During fall 1977, there was a bumper crop of lowbush cranberry (*Vaccinium vitis-ideae*), and because of this, bears were probably less interested in our baits.

Prior to major leaf development on the deciduous trees, black bears were easily sighted from a helicopter. Capture success during this period was high and we successfully darted 13 black and four brown bears. Black bears exhibited fear toward the helicopter and ran from it. As a result, the pilot was able to maneuver animals into openings where they were easily darted. On four occasions, the bear was herded into a lake, darted, and then herded to shore. This process worked well and also reduced the potential for overheating in the animal. The use of the helicopter to capture black and brown bears was an efficient, safe and practical method. No data were collected on the cost per bear darted since several animals were sighted and darted incidental to moose calf tagging operations (see Moose Calf Mortality Study this report). However, estimates from 10 bears indicated approximately 1.5 hours of helicopter time per animal. This includes search time which varied considerably between individuals and between days. We captured these 10 bears in five days.

Results from immobilization attempts on 21 black bears indicate that seven individuals received adequate dosage levels after one injection, 10 animals required additional drug and four animals were given excessive amounts (Table 2). Analysis of dosage levels showed that there was considerable variation in drug sensitivity between individuals. A dosage of 2.1 to 2.5 mg/kg appeared adequate in most cases; however, a dosage of 2.3 mg/kg was inadequate for one very large male and a dosage of 2.1 mg/kg was fatal for a small male. The latter individual was in extremely poor physical condition. Necropsy revealed no subcutaneous or mesenteric fat deposits. Failure to immobilize the large male was probably a consequence of incomplete administration of the drug due to an excessive fat layer. Inadequate dosages ranged from 0.73 to 1.7 mg/kg

Table 2. Method, time, dosage, and results from the immobilization of 21 black and 4 brown bears captured on the Kenai Peninsula, 1977-78. The drug used was phencycline hydrochloride (Sernylan).

Bear No.	Wt (kg)	Immobilization time (min.)	Dosage (mg/kg)	Method of take	Comments
B1[1/]	79.5	6	2.5	Snare	Dosage adequate, no convulsions.
B1A	52.2	16	1.5	Helicopter	No visable effect; incomplete injection.
		4	1.5	Helicopter	Second dosage adequate; no convulsions; total dosage unknown.
B2	64.4	13	2.3	Snare	Dosage adequate, no convulsions.
B2A	59.0	5	1.4	Helicopter	Dosage adequate, no convulsions.
B3	54.4	10	3.7	Snare	Slight convulsions.
B4	47.6	4	2.1	Snare	Several convulsions, animal died 84 hrs. later. Bear in extremely poor condition.
B5	106.6	7	2.1	Helicopter	Dosage adequate, no convulsions.
B6	90.7	17	1.7	Helicopter	Dosage minimal animal not completely down.
			0.55		Supplemental on ground.
B6A	106.6	12	1.7	Helicopter	Dosage minimal--animal reradioed only.
B7	52.2	3	2.9	Helicopter	Several convulsions, animal died; suspect overheating.
B8	95.3	7	1.4	Snare	Dosage adequate, no convulsions.
B9	99.8	12	1.5	Helicopter	No visable effect.
		17	1.5	Helicopter	Second dosage minimal; animal still taxic.
		3	1.0		Supplemental on ground--total dosage for bear appeared adequate. No convulsions.
B10	131.5	13	2.3	Helicopter	Minimal dosage, animal still taxic. Supplemental on ground--total dosage for bear appeared adequate. No convulsions.
B12	53.5	5	2.2	Helicopter	Slight convulsions; dosage adequate.
B13	49.9	4	2.6	Helicopter	Slight convulsions, animal cooled with water dosage may have been slightly high.
B14	47.6	5	2.1	Helicopter	Dosage adequate, no convulsions.
B15	47.6	12	1.6	Helicopter	Dosage minimal, animal still taxic.
			1.5		Supplemental on ground. Dosage appeared adequate, no convulsions.
B16	136.1	17	1.6	Helicopter	Dosage minimal; animal still taxic.
			0.37		Supplemental on ground; total dosage appeared adequate; no convulsions.

Table 2 (cont.) Method, time, dosage, and results from the immobilization of 21 black and 4 brown bears captured on the Kenai Peninsula, 1977-78. The drug used was phencycline hydrochloride (Sernylan).

Bear No.	Wt (kg)	Immobilization time (min.)	Dosage (mg/kg)	Method of take	Comments
B17	133.8	18	1.12	Helicopter	No visable effect.
		12	.56	Helicopter	Dosage adequate; no convulsions.
B18	68.9	10	1.16	Helicopter	No visable effect.
		10	.72	Helicopter	Dosage adequate; animal extracted from stream; no convulsions.
B19	68.0	5	.73	Helicopter	No visable effect.
			1.5	Helicopter	Minimal dosage; animal still taxic.
			.73		Supplemental on ground; dosage adequate; no convulsions.
A1	--	16	500[2/]	Helicopter	Dosage adequate.
A2	est 170	17	150[2/]	Helicopter	No visable effect; dart malfunction only 75 mg injection.
		7	200[2/]	Helicopter	No visable effect.
		13	100[2/]	Helicopter	Dosage adequate; no convulsions.
A3	--	27	400[2/]	Helicopter	No visable effect.
		3	200[2/]	Helicopter	Dosage adequate; animal cooled with water; no convulsions.
A4	est 160	14	300[2/]	Helicopter	No visable effect.
		6	200[2/]	Helicopter	Dosage adequate; animal became taxic 2 hrs. after down.

1/ Prefix B indicates black bear; A indicates brown bear; an A following the number indicates a recapture.

2/ Brown bear weights were not determined; dosage indicates total mg administered.

although two bears were adequately immobilized with 1.4 mg/kg of drug. Excessive amounts were administered in four cases and dosages ranged from 2.6 to 3.7 mg/kg. But, as mentioned above, one individual died with a dosage of 2.1 mg/kg, yet another individual of similar size survived a dosage of 3.7 mg/kg with only slight convulsions. In general, we overestimated the weights of small bears and underestimated body weight of large bears. Several small bears had extremely dense hair coats with long guard hairs. These bears, because of their thick coats, appeared to weigh 15-20 kg more than they actually weighed. Consequently most small bears received dosages adequate to induce immobilization upon first injection. Large individuals required supplemental dosages in most cases. This was a direct result of underestimating in weight and/or a thick subcutaneous fat layer which may have intercepted part of the drugs. Needless to say, we attempted to use the minimum amount of drug necessary to immobilize the animal and thereby reduce drug related casualities.

No attempt has been made to analyze morphometric data (Table 3) during this report period. Teeth extracted from individuals have been processed and ages are listed in Table 3. Blood samples have been analyzed for hemoglobin and packed cell volume but other analyses are incomplete. Hair samples have been dried and labeled and will be sent to Dr. Arthur Flynn, Cleveland Clinic Foundation, Cleveland, OH, for element analyses.

Currently, we are still monitoring 14 black bears and two brown bears (Table 4). Black bear B-6 has probably lost his transmitter. The radio signal has been located in the same place three times, and no visual sighting of the bear has been made. We attempted to retreive this transmitter on 29 June, but problems with our receiver prevented us from locating it. Black bear B-9 was fitted with a transmitter on 17 May 1978. He was relocated via Supercub on 23 May 1978 although visual contact was not made. Since that date, no signal has been received. We experienced a major problem with the radio frequency from the transmitter of B-8 overlapping the signal of B-9 and any attempt to locate B-9 invariably resulted in locating B-8. Therefore the status of B-9 is unknown. Both male brown bears, A-1 and A-3, have not been located recently (Table 4). Apparently, both animals have traveled out of the range of our receiver.

Through the 30 June report period, the 16 radio-collared black bears were relocated a total of 114 times while the brown bears were located 21 times. During this period an additional 30 uncollared black and four uncollared brown bears were also sighted.

Observations of bears feeding on moose calves and other bear activity associated with moose calves were summarized in the Kenai Peninsula Moose Calf Mortality section of this report (Job 1.24R).

Table 3. Age and morphometric data for 18 black and 4 brown bears captured near the Moose Research Center, Kenai Peninsula, Alaska, 1977-1978.

Bear No.	Weight (kg)	Age (years)	Total Length	Circumference		Hind Foot		Skull		Left Canine Length	
			Centimeters								
				Chest	Neck	Length	Width	Length	Width	Upper	Lower
A1[1/]	Est 317	12	228		109	26.5	17	46	30.5	4.9	3.5[2/]
A2	Est 170	7	194	128	77	22	15.5	35	22.0	3.2	2.9
A3	Est 295	6-9	222	150	97	30	18.5	39.5	26.0	3.8[3/]	3.5
A4	Est 160	3	176	114	72	23.5	14.5	35.5	19.5	3.0	2.9
B1	79.5	3	161	98	51	16.5	9	25	12.5	2.6	2.6
B1A	52.2		141	92	44	17	9	26	14.0	2.8	2.6
B2	64.4	2	156	85	48	16	9	24	14.5	2.5	2.4
B2A	59.0		136	84	46	17	9	27	14.5	2.7	2.5
B3	54.4	2-3	155	80	44	--	--	26	14.7	2.9	2.9
B4	47.6	2	150	78	44	--	--	25	15.0	2.7	2.6
B5	106.6	4	151	110	69	20	10	29.2	18.5	2.9	2.6
B6	90.7	4	161	98	65	23	11	28.6	16.8	2.8	2.4
B6A	106.6		--	--	--	--	--	--	--	--	--
B7	52.2	8	145	81	42	12	8.5	24.5	15.0	2.5	2[3/]
B8	95.3	10	165	110.5	62	20.5	12.5	32	19.25	3.0	2.8
B9	99.8	4	178	98	55	20	11.5	20.5	17.5	2.0	2.8
B10	131.5	9	189	112	70	21	12.5	32	19.5	3.0	2.7
B12	53.5	3	165	84	41	17	9.5	24.5	14.0	2.5	2.4
B13	49.9	3	137	79	39.5	15	8.5	23.5	13.5	2.2	2.1
B14	47.6	2	139	80.5	41	17.1	8.7	23.4	14.4	2.5	2.4
B15	47.6	2	145	72	41	17	8.5	24	13	2.5	2.4
B16	136.1	7	165	120	79	21	12	29	16.5	2.9	2.8
B17	133.2	9	167	112	75	22	12.5	32	21	3.2	2.9
B18	68.9	5	163	91	50	19	9.5	27.9	16	2.2	2.0
B19	68.0	1	142	89	51	19	9.5	26.5	16	2.8	2.4

1/ Prefix A indicates brown bear, B indicates black bear; an A following the number indicates a recapture.

2/ Left lower canine was badly damaged so right was measured.

3/ Tip of canine broken off.

Table 4. Aerial tracking data and current status of 16 black and 4 brown bears fitted with radio-transmitters on the Kenai Peninsula, October 1977--June 30, 1978.

Bear No.	Times Located	Last Observed	Current Status
B1	9	29 June 1978	Active
B2	11	30 June 1978	Active
B3	5	15 June 1978	Active
B5	8	24 June 1978	Active
B6	8	23 June 1978	Status unknown; collar located several times in same location animal not sighted.
B8	11	24 June 1978	Active
B9	1	23 May 1978	Status unknown; transmitter frequency overlapped with B8
B10	9	26 June 1978	Active
B12	9	24 June 1978	Active
B13	11	24 June 1978	Active
B14	11	26 June 1978	Active
B15	4	28 June 1978	Active
B16	3	24 June 1978	Active
B17	3	28 June 1978	Active
B18	2	24 June 1978	Active
B19	9	30 June 1978	Active
A1	6	22 June 1978	Status unknown; unable to locate, probably moved out of area.
A2	8	30 June 1978	Active
A3	3	18 June 1978	Status unknown; unable to locate; probably moved out of area.
A4	4	24 June 1978	Active

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