BLACK BEAR PREDATION ON MOOSE CALVES IN HIGHLY PRODUCTIVE VERSUS MARGINAL MOOSE HABITATS ON THE KENAI PENINSULA, ALASKA.

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Abstract: High rates of predation on moose (Alces alces) calves by black bears (Ursus americanus) in the 1947 burn on the Kenai Peninsula, Alaska, generated the hypothesis that since black bear density was related to the food resource they would be more abundant in older forests and predation rates on moose calves would therefore be higher. This hypothesis was tested by conducting a moose calf mortality study in the "recent" 1969 burn to compare with mortality rates previously obtained in the "older" 1947 burn, also on the Kenai Peninsula. Predation rates by black bears on moose calves in the 1969 burn (35%) were essentially the same as those in the 1947 burn (34%) and we thereby rejected the hypothesis. Factors causing the rejection of the hypothesis are discussed. We detected no predation bias on sex of calves or for twins versus single calves. We concluded that under these circumstances predation rates were independent of moose calf density in this study. Natural abandonment of 3 calves was witnessed.

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Studies of the causes of moose (Alces alces) calf mortality on the Kenai Peninsula, Alaska were conducted during springs of 1977 and 1978 in a 310,000 ha area that was burned in 1947. In this study, 47 radio-collared calves were monitored and causes of mortality were: black bear (Ursus americanus) predation (16 calves, 34%), brown bear (Ursus arctos) predation (3 calves, 6.4%), wolf (Canis lupus) predation (3 calves, 6.4%), unknown predation (2 calves, 4.3%), and unknown mortality (2 calves, 4.3%) (Franzmann et al. 1980). Total predation rate was 48.9% and total mortality was 57.4%. Nearly all mortality occurred during the first 6 weeks of the calf's life (from late May birth to mid July) (Franzmann et al. 1980).

These high predation rates resulted in a reassessment of moose/black bear relationships. Since the study results were from a relatively "old" burn (1947) we decided to repeat the study in a "new" burn (1969) also on the Kenai Peninsula. A hypothesis was developed that stated since black bear density was keyed to the food resources (primarily berries) and because this resource was more abundant in older successional stages of forests (Smith 1984), bear density and predation rates would be lower in recently burned forests. Black bear density would also be less in the recent burns, because bears generally avoided nontimbered areas (Schwartz and Franzmann 1983, 1985). Density estimates of black bears were not available for the 1969 burn during design of this study. The study was designed to test the hypothesis and provide information on both black bear and moose ecology that would assist managers regarding decisions on management and habitat manipulation programs that may favor either species.

MATERIAL AND METHODS

This study was conducted during the springs and summers of 1982 and 1983 in the 33,500 ha 1969 burn located in the central lowlands of the Kenai Peninsula, Alaska. Physical aspects, vegetation, soils, and specific habitats have been described by Spencer and Hakala (1964), LeResche and Davis (1973), LeResche et al. (1974), and Oldemeyer et al. (1977).

Calves were located from aircraft when calving peaked during late May and early June and captured by helicopter borne crews, generally within 24 hours of birth. Each calf was sexed and fitted with an expandable neck collar (Schwartz et al. 1983) and mortality transmitter (Model S2B5, Telonics Inc., Mesa AZ). We then departed, usually within 1 minute, because previous studies indicated that the time involved to collect additional data contributed to calf abandonment (Ballard et al. 1979, Franzmann and Schwartz 1979). From a distance, we checked the cow and and calf to ensure that they reunited.

The transmitter pulsed at approximately 35 beats/min (slow mode) while the calf moved but doubled if movement ceased for 4 hours. To monitor the telemetry signals flights using fixed wing aircraft were made daily until mid June, every other day until early July, then twice per week until early August, and weekly flights until early October. When we detected a mortality mode signal, we located the calf from the air and marked its location on a map. We went by helicopter to the site and determined the cause of death using criteria outlined in Franzmann and Peterson (1978), Ballard et al.(1979), Franzmann and Schwartz (1978, 1979), and Franzmann et al. (1984).

RESULTS

Mortality mode radio transmitters were placed on 37 calves from 26 May through 1 June 1982 and on 42 calves from 23 to 27 May, 1983. Three calves (8.1%) were abandoned by their cows within 24 hours of capture in 1982, 1 calf (2.4%) was abandoned in 1983, and 1 transmitter ceased functioning on 5 June 1983. Thus, 74 calves were available for monitoring. The 3 calves (2 males and 1 female) abandoned in 1982 were each from a set of twins, and the calf abandoned in 1983 was a single male. All died in 3-4 days. The dead calves were undisturbed (scavengers) for several days as was reported in other studies (Ballard et al. 1979, Franzmann and Schwartz 1979, Franzmann et al. 1980).

Predators killed 33 of the 74 (45%) calves. Black bears killed 26 (35%), brown bears killed 2 (3%), wolves killed 1 (1%), and unknown predators accounted for 2 (3%). Three calves died after natural abandonment (4%), 1 (1%) drowned, and 1 (1%) died from unknown causes. Total mortality was 38 (51%) (Table 1). Most deaths (34, 89.5%) occurred before the calves were 30 days old.

Natural abandonment (cow/calf separation after the cow and calf rebonded after capture) occurred with 3 calves. In 1982, 2 female calves were abandoned, one on 3 June, 7 days after capture and the other on 7 June, 11 days after capture. In 1983 we witnessed an additional abandonment of a bonded calf 7 days after capture. We found no evidence that the cows had died.

Table 1. Causes of moose calf mortality based upon monitoring 75 radio-collared calves during summers 1982-83 in the 1969 burn on the Kenai Peninsula, Alaska.

Causes of Mortality	1982 (n)	Percent (n=34)	1983 (n)	Percent (n=40)	1982 1983(n)	Percent (n=74)
Black bear	11	32.4	15	37.5	26	35.1
Brown bear	-	-	2	5.0	2	2.7
Black or brown bear	1	2.9	1	2.5	2	2.7
Wolf	1	2.9	-	-	1	1.4
Unknown predator	2	5.9	-	-	2	2.7
Total predator mortality	15	44.1	18	45.0	33	44.6
Natural abandonment	2	5.9	1	2.5	3	4.1
Drowned			1	2.5	1	1.4
Unknown	1	2.9			1	1.4
Total monthly	18	52.9	20	50.0	38	51.4

Visual coverage of the study area while monitoring these calves and while monitoring black bears for a concurrent study in the area provided observations of 7 nonradioed calves being eaten by black bears (4 in 1982, 3 in 1983).

During this study, radio signals from the 74 calves were checked 2180 times (1,049 in 1982, 1,131 in 1983). We arrived at mortality sites (n = 38) of 24 (63%) calves within 24 hours, of 6 (16%) within 48 hours, and 4 (11%) within 72 hours. We were on site of 4 (11%) calves while bears were still feeding on them. Getting to the sites quickly assured us of an accurate assessment of the causes of mortality.

Male calves comprised 64% of calves captured; 68% (47 of 74) in 1982 and 60% (24 of 40) in 1983. Of the calves killed by predators, 70% were males (23 of 33). In 1982, predators killed 67% males (10 of 15) and in 1983, 72% (13 of 18) (Table 2).

The twinning rate for cows observed with calves in the 1969 burn study area was 70% (71 of 102); 67% (35 of 52) in 1982 and 72% (36 of 50) in 1983 (Franzmann and Schwartz 1985). The twinning rate in the population captured was the same as the population from which the captures were made for the combined years of the study (70%). Combined years mortality for twins was 77% by black bears (20 of 26) and 73% by all predators (24 of 33) (Table 3).

Table 2. Sex ratios of moose calves captured for mortality studies in two habitats on the Kenai Peninsula, Alaska.

	1947 burn area			1969 burn area			Combined years and areas
	1977	1978	1977-78	1982	1983	1982-83	
Total calves	15	32	47	34	40	74	121
Male number	9	20	29	23	24	47	76
Male %	60	63	62	68	60	64	63
Female number	6	12	18	11	16	27	45
Female %	40	37	38	32	40	36	37
Calves killed by predator	9	14	23	15	18	33	56
Male number	5	9	14	10	13	23	37
Male %	56	64	61	67	72	70	66
Female number	4	5	9	5	5	10	19
Female %	44	36	39	33	28	30	34

Table 3. Predation and total mortality rates of twin versus single calves in the 1969 Kenai Peninsula burn.

Year	No. and % Single calves monitored	No. and % Twin calves monitored	No. and % Singles killed Black bear	No. and % Twins killed Black bear[b]	No. and % Singles killed by predation	No. and % Twins killed by predation	No. and % Singles Total Mortality	No. and % Twins Total Mortality
	Total = 34		Total = 11		Total = 15		Total = 18	
1982	10(29%)	24(71%)	3(27%)	8(73%)	5(33%)	10(67%)	5(28%)	13(72%)
	Total = 40		Total = 15		Total = 18		Total = 20	
1983	12(30%)	28(70%)	3(20%)	12(80%)	4(22%)	14(78%)	6(30%)	14(70%)
	Total = 74		Total = 26		Total = 33		Total = 38	
1982 1983	22(30%)	52(70%)	6(23%)	20(77%)	9(27%)	24(73%)	11(29%)	27(71%)

DISCUSSION

The hypothesis we developed in planning this study stated that since black bear density was keyed to the food resource and these food resources were more abundant in older successional stages of forest (1947 burn) then black bear numbers should be less in recently burned forests (1969 burn) and predation rates correspondingly less. We rejected our hypothesis as per the results of this study because the black bear predation rate (35%) in the recent 1969 burn was essentially the same as the rate (34%) in the previous study in the older 1947 Kenai Peninsula burn (Franzmann et al. 1980). Total mortality was also similar: 49% in the 1947 burn and 45% in the 1969 burn. We had no way to measure the possible effect that the time differences between these studies may have had, but we assumed none.

The primary influences on our hypothesis were (1) the presence of significant amounts of mature forest in island stands creating "edge" in the 1969 burn for bears, (2) a higher density of black bears in the 1969 burn than was evident when the study was designed, and (3) the predation rate of black bears was independent of moose calf density. Each factor will be discussed in light of our present information base. Factors that we cannot assess from this information are those related to differences in black bear predation strategy. The black bear is a very adaptable animal, and it is not inconceivable that predator strategy could vary in different habitats. How the bears use the available cover and to what extent their home ranges and activity centers correspond to available moose calves are factors requiring long term black bear ecology studies.

The greater intensity of the 1969 burn resulted in fewer "islands" of unburned forest than in the "cooler" 1947 burn (46% of area inside the 1947 burn was unburned compared to 7% in the 1969 burn) (Bangs et al. 1985). However, the remaining forest stands in the 1969 burn provided adequate edge, overstory, and cover to permit black bears to effectively utilize the entire area to prey on moose calves. All calf kills were within 0.8 km of mature forest (three in forest) except 1 which was 3 km from forest, but that calf was killed by a brown bear. Findings from black bear studies in the 1969 burn indicate that black bear movements and activities are closely associated with mature forest (Schwartz and Franzmann 1983, 1985). The distribution of black bear kills in or in close proximity to the mature stands of forest reflected this activity pattern.

Preliminary estimates of black bear density indicated there were fewer female bears (7.06/100km) in the 1969 burn than in the 1947 burn (11.23/km^2) (Schwartz et al. 1984). However, these studies indicated that total bear estimates were quite similar (18.9 vs. 19.0/100km^2). These data were not available when the calf mortality study was designed.

We concluded from the lack of differences in predation rates in the 2 study areas that these rates were independent of moose calf density because density in the 1969 burn was much greater than in the 1947 burn. This was evident from our experiences in capturing calves in the 2 areas. In the 1947 burn we had difficulty locating calves to collar and had to expand our study area (Franzmann and Schwartz 1979). No problems were experienced locating calves in the 1969 burn. We were able to capture 20 calves using

1 helicopter load of fuel in the 1969 burn and only 10 calves/load in the 1947 burn. Also, the higher twinning rate in the 1969 burn favored and reflected higher moose calf density (Franzmann and Schwartz 1985).

The 2 factors listed (islands of mature forest in the burn, and high black bear density) which provided the strongest basis for rejecting the hypothesis, were each of potentially great impact on a predator/prey relationship. In this study both factors were working to favor high predation rates of black bears on moose calves.

The period of intense predation by black bears on moose calves was during the first 4 weeks of the calf's life. This pattern was reported in other studies of causes of neonatal mortality implicating black bears (Franzmann et al. 1980) and brown bears (Ballard et al. 1981) as the primary predators on moose calves.

The 3 calves that we identified as naturally abandoned were visually sighted several times following capture and we do not believe that capture was a contributing factor because they were rebonded after capture for a minimum of 7 days. We can only speculate as to the cause, but believe the abandonments were associated with predation attempts that forced the movement of the cow and calf which subsequently separated them. We know from our capturing experiences that each cow varies as to the strength of the cow/calf bond. Some cows leave the calf as soon as the helicopter appears, while others will aggressively attack the helicopter and capture personnel. The strength of the cow/calf bond is certainly a factor to be considered in the cause of natural abandonment.

Calf mortality studies in the 1947 burn during 1977 and 1978 showed sex ratios in favor of male calves (62%, 29 of 47) (Franzmann et al. 1980). In this study we also had a sex ratio favoring males (64%, 47 of 74) in the calves captured (Table 2). The combined sex ratio of calves captured on the Kenai Peninsula studies was 63% males (76 of 121). The predation rate on sexes of calves was similar (66%, 37 of 56) to their component in the captured population. We can conclude that there did not appear to be a sex bias in predation of moose calves.

Findings relative to twinning rates and their implication between the 1947 and 1969 burns on the Kenai Peninsula were reported elsewhere (Franzmann and Schwartz 1985). The twinning rate of 70% from this study were the highest ever reported in North America. This was a relection of the quality of the habitat and was compared to the 22% rate observed in the 1947 burn which was considered poorer habitat (Oldemeyer et al. 1977, Franzmann and Schwartz 1985). Twin calves made up 70% of the population and of the captured calves we monitored. The proportion of black bear kills was 77% twin calves and of all predators 73%. We concluded that there was a slightly higher rate of predation on twins than singles, but the difference was not significant and there appeared to be no selectivity by predators for either twin or single calves.

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