EFFECTS OF TREE CRUSHING ON BLACK BEAR PREDATION ON MOOSE CALVES[1]

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Abstract: Mortality of young moose calves (*Alces alces gigas*) was evaluated on the Kenai Peninsula, Alaska, during spring and early summer 1977 and 1978. Studies were conducted both inside and outside of a 461-ha browse-rehabilitated area (Willow Lake) where standing vegetation had been crushed with LeTourneau tree crushers in winter 1974–75. Uncrushed areas (control) were regrowth of vegetation that was burned by forest fire in 1947. Moose calves were radio-collared with mortality-sensor transmitters soon after birth. Black bear (*Ursus americanus*) predation accounted for 40–42% of the calf mortality in control areas (6 of 15 calves collared in 1977 and 10 of 24 in 1978); no calves (of 8 collared in 1978) were killed by black bears within the rehabilitated areas. Movements of 23 radio-collared black bears were also monitored during 1978 and 1979. Radio-collared bears, including 15 whose home ranges bordered or included rehabilitated areas, either did not utilize or avoided crushed sections. Results of our studies indicated that neonatal mortality of moose calves was significantly reduced within browse-rehabilitated areas.

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Efforts to enhance moose habitat commonly stress increased abundance, production, and diversity of large woody shrubs. These factors are emphasized because browse is the only food available to moose in winter over much of their range, and winter range is classically considered a limiting factor for moose populations.

Various types of browse rehabilitation programs to increase moose foods have been initiated on the Kenai National Moose Range (KNMR) since the 1950's. Starting in 1975, LeTourneau tree crushers (Oldemeyer 1977) have been used to enhance moose habitat, by mechanically crushing existing vegetation and stimulating browse regeneration. Although increased browse production was the primary objective of this program, it also resulted in reduced black bear predation of moose calves.

Neonatal mortality of moose calves has been identified as an important factor affecting population dynamics of moose on the Kenai Peninsula, Alaska (Chatelain 1950, Franzmann et al. 1980). Although 3 major species, timber wolves (*Canis lupis*), brown bear (*Ursus arctos*), and black bear, prey on moose, black bear predation accounted for 34% of total calf mortality (58%) during 2 summers of study (Franzmann et al. 1980).

This paper compares rates of predation by black bears on moose calves in an area crushed by LeTourneau tree crushers and in adjacent uncrushed areas. Movements of 14 radio-collared black bears whose home ranges were adjacent to or included 3 rehabilitation areas are discussed in relation to the results of the moose calf mortality study.

This study was a cooperative effort between the Kenai Moose Research Center of the Alaska Department of Fish and Game, and the KNMR, U.S. Fish and Wildlife Service. V. Lofsted, L. Aumiller, and D. Johnson provided field assistance, and K. Schneider and D. McKnight reviewed the manuscript.

STUDY AREAS

The Moose Research Center (MRC) study area is located on the KNMR in the northwestern Kenai Peninsula lowlands (Fig. 1). Detailed descriptions of the study area were presented by LeResche and Davis (1973) and Oldemeyer et al. (1977). Three areas enhanced for moose with LeTourneau tree crushers were: (1) Willow Lake rehabilitated area, (2) South MRC area, and (3) Mystery Creek rehabilited area (Fig. 1). Control and crushed areas were located within the extensive 1947 Kenai, Alaska, burn. A detailed description of the vegetation in the burn 25 years after the fire was given by LeResche et al. (unpubl. rep., Alaska Fed. Aid Proj. W-17-4, 1973).

Vegetation in the Willow Lake area prior to crushing was mixed stands of white spruce (*Picea glauca*), aspen (*Populus tremuloides*), and paper

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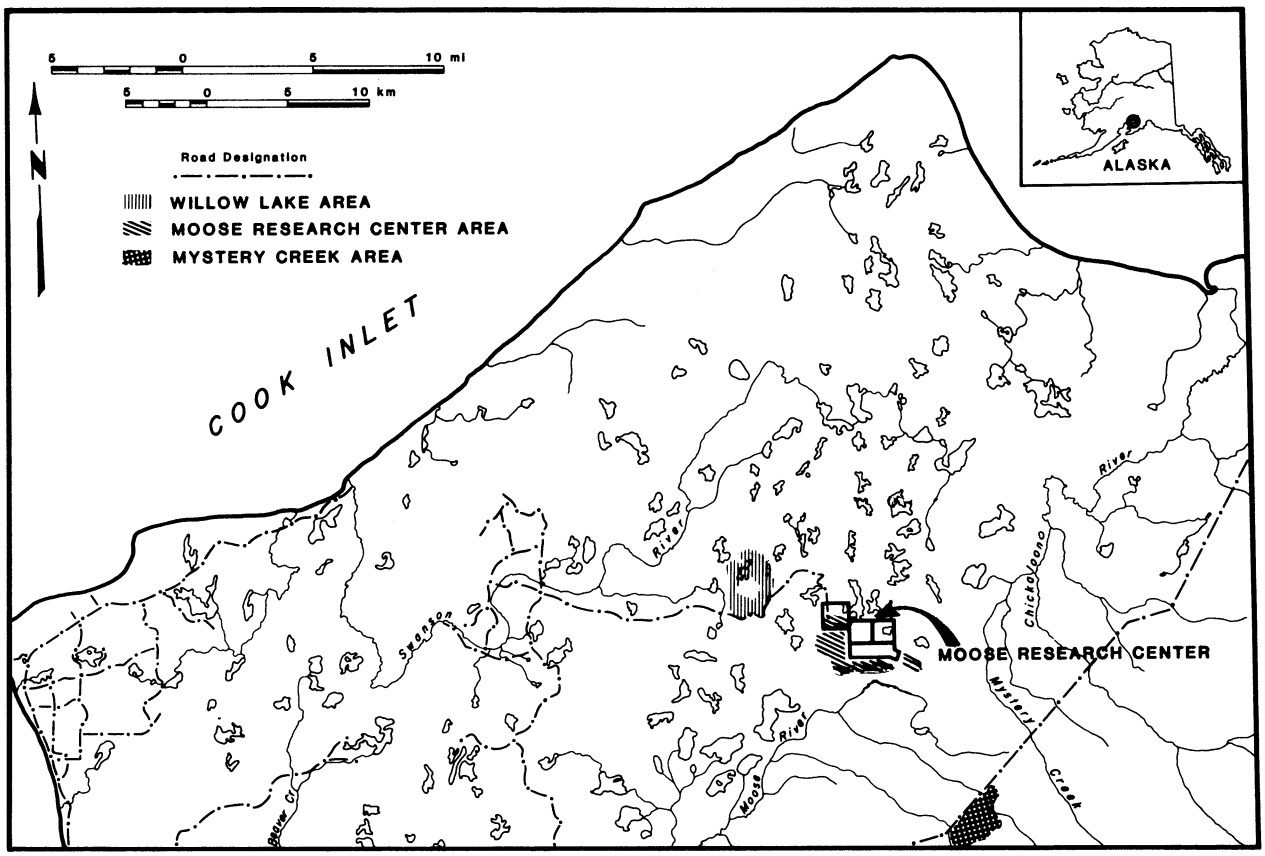

Fig. 1. Moose Research Center Study Area and location of the 3 LeTourneau tree-crushed areas.

birch (*Betula papyrifera*). Topography of the area was gently rolling to undulating with several small to medium sized (0.1–2.0 ha) lakes and bogs. During winter of 1974–75, 461 ha were crushed in the form of a "doughnut." The "doughnut-hole," which was not crushed, was approximately 182 ha in size and consisted of regrowth from the 1947 burn (112 ha) and mature birch-aspen forest (70 ha).

Prior to crushing, vegetation in the South MRC area was predominately black spruce (*Picea mariana*) and aspen regrowth with small stands of mature birch-aspen forest. Topography of the area ranged from relatively level in the broad lowlands to gently rolling in the uplands. During winter of 1975–76 approximately 584 ha were rehabilitated. The pattern of crushing in this area consisted of alternating crushed and uncrushed strips of varying lengths and widths interspersed with uncrushed mature forests.

The Mystery Creek area was dominated by black spruce and aspen regrowth prior to crushing. It is a drier site than the other crushed areas and relatively level. During the winters of 1976–77 and 1977–78, 945 and 910 ha, respectively, were crushed. The pattern of crushing was in large blocks separated by narrow strips of uncrushed regrowth or mature forest.

METHODS

Procedures used to study moose calf mortality were those described by Franzmann and Schwartz (unpubl. rep., Alaska Fed. Aid Proj. W-17-10, 1979) and Franzmann et al. (1980). Ballard et al. (1980) described techniques utilized to determine causes of moose calf mortality. Briefly, calves were fitted with radio collars which transmitted a pulse of 60 beats per minute as long as the calf moved. When movement ceased for 1 hour or more, the pulse rate tripled (mortality mode).

Upon detecting a mortality mode, we located the calf and determined the cause of death. Calves were monitored daily from time of capture until mid-June, then bi-weekly until mid-July and weekly thereafter until October.

During 1977, 15 radio-collared calves remained bonded with their cows. These calves were captured in regrowth of the 1947 burn. In 1978, we expanded our study to include the Willow Lake crushed area. Of 32 calves which remained bonded with their cows in 1978, 8 were radio-collared within the crushed area and 24 outside of the crushed areas.

While radio-collaring calves in 1978 we radio-collared 16 black and 4 brown bears (*Ursus arctos*) found within the study area (Franzmann and Schwartz, unpubl. rep., Alaska Fed. Aid Proj. W-17-10, 1978). Seven additional black bears were radio-collared in 1979. Home ranges of individual bears were delineated, and movements and utilization of the 3 crushed areas noted. Details of methods were listed by Schwartz and Franzmann (unpubl. rep., Alaska Fed. Aid Proj. W-17-11, 1980).

RESULTS AND DISCUSSION

In 1977, 9 of 15 bonded calves (60%) were killed by predators prior to 13 July (Table 1). Of the 15, 6 (40%) were killed by black bears. During a similar period in 1978, 14 of 32 bonded calves (44%) were killed by predators by 30 July. Black bears killed 10 (31%) of these 32 calves.

When the 1978 data were partitioned according to whether the moose were in crushed or uncrushed areas, different trends in mortality were evident. Of 8 calves collared at the Willow Lake crushed area, none were killed by black bears. Moose calves collared in the Willow Lake area remained in the crushed area during the early summer when black bear predation was a threat (Franzmann et al. 1980). In contrast, 10 of 24 calves (42%) were killed by black bears outside the rehabilitation area. When the calves collared at Willow Lake were factored out, mortality rates in 1977 and 1978 were nearly identical (Table 1). Although our sample of calves collared at Willow Lake was not large ($N = 8$), we felt that the differences in mortality rates of moose calves reflected differences in predation rates between the two areas. These findings were further supported by observations of radio-collared black bears.

Table 1. Predation on radio-collared moose calves in an untreated area and an area where vegetation had been crushed for browse rehabilitation, Kenai Peninsula, Alaska.

	Uncrushed area				Crushed area	
	1977		1978		1978	
	No.	%	No.	%	No.	%
Total calves collared	15	100.0	24	100.0	8	100.0
Killed by predators:						
Black bear	6	40.0	10	41.7	0	0
Brown bear	1	6.7	2	8.3	0	0
Wolf	1	6.7	2	8.3	0	0
Unknown predator	1	6.7	0	0	0	0
Totals	9	60.0	14	58.0	0	0

Of the 23 black bears radio-collared in 1978 and 1979, 15 had home ranges which included or bordered 1 or more of the crushed areas. However, observations of these bears indicated lack of utilization and/or avoidance of crushed areas. During the 1978 and 1979 field seasons, these 15 bears were located a total of 574 times. During this period, collared bears were located in crushed areas only 8 times. In 6 of these 8 observations, the bears were in uncrushed stands of forest within rehabilitated areas. All 8 sightings were either of 1 female (B1) and her 2 cubs (B21, B23) or B21 as a yearling the following year. The area utilized by B1 was the uncrushed forest in the center of the Willow Lake area (doughnut-hole). She went to this area once each year when traveling from her traditional home range to her summer feeding area (Schwartz and Franzmann, unpubl. rep., Alaska Fed. Aid Proj. W-17-11, 1980). Her yearling, B21, also used the "doughnut-hole" when returning from her summer feeding area in 1979. Her movements, home range, and summer feeding area were included in the area used by her mother (B1). As a yearling, B21 utilized strips of uncrushed regrowth spruce in the MRC crushed area shortly after she separated from B1 in 1979. Yearling B21, in observations from a fixed-wing aircraft, exhibited different behavior in crushed areas versus uncrushed strips. When traveling in the crushed area and between the uncrushed strips, she usually ran. Once in the forest, she resumed walking and began searching for insects, tearing apart rotten logs, and feeding on available vegetation.

Another intensively studied female (B12) used areas both to the north and south of the MRC crushed area, but was not located in a crushed

area during 2 years of study. Her movements indicated that she probably used a strip of uncrushed spruce to travel though the crushed area. Similarly, the home ranges of females B2 and B13 bordered the MRC crushed areas. These bears were not located in or on the opposite side of the rehabilitated area, suggesting that the crushed vegetation may have delimited a boundary of their home range.

The home ranges of 5 adult males and 1 juvenile male bordered or encompassed the MRC and/or Willow Lake crushed areas; none of these individuals were located in a crushed area. The home ranges of 2 adult males and 1 adult female also bordered the Mystery Creek crushed area. These 3 radio-collared bears utilized the uncrushed forest around this area, but avoided the crushed areas.

In 1978 and 1979 we observed 128 uncollared black bears during routine radio-tracking flights over the study area. Although the sightability of black bears in a rehabilitated area was greater than in the forested areas, only 1 black bear was seen in a crushed area and was observed traveling across the area for over 30 minutes. The following excerpt from out field notes describes the event:

> 9 June 1978—medium size black bear (70 kg) was observed moving at a walk in an uncrushed strip southeast of Duckling Lake. Bear approached a radio-collared calf, No. 1855, which ran with cow out of uncrushed strip into crushed area. The black bear ran after them, but turned and fled when the cow charged the bear. The bear then ran several hundred m across the rehabilitated area and entered another uncrushed strip of regrowth spruce. The bear walked 50 m or so in this strip before it encountered another cow with a calf. The cow and calf ran at a run (calf in front of cow) from the uncrushed strip for 300 m before stopping. The bear pursued them for 10–15 m and then returned to the uncrushed strip and resumed its travel in an ENE direction until it came to the end of the uncrushed strip. The bear then ran for 100 m until it came to a patch of uncrushed forest where it slowed to a walk and began tearing apart a log. After feeding, the bear walked to the edge of the uncrushed forest and ran the remaining distance of 100 m to the edge of the crushed area. Once in the forest, it walked to a small lake where it took a long drink and then swam across the lake.

We lost sight of the bear shortly afterwards in dense vegetation. Throughout this extended observation, the bear appeared to be "uncomfortable" when not in the forested strips. We do not feel this was a result of our presence in the aircraft overhead because the bear displayed "expected" behavioral traits when it was in the uncrushed strips.

Mid-winter herd composition counts of moose conducted within the Willow Lake rehabilitated area revealed 28 calves/100 cows compared with 5 calves/100 cows in a nearby 1947 burn control count area (T. Bailey, U.S. Fish and Wildlife Service, KNMR, Kenai, Alaska, pers. commun.).

Our data suggest that moose calf predation is lower in crushed areas and that black bears avoid crushed areas. Herrero (1972), in a review of the aspects of evolution and adaption of black bears, indicated that black bears were very reluctant to venture far from trees. Erickson (unpubl. rep., Alaska Fed. Aid Proj. W-6-R-5, noted that garbage dumps in Alaska, if located in open areas, tended not to be visited by black bears, while those located close to or in forested areas were frequently utilized for feeding.

Throughout most of the area inhabited by black bears in Alaska, black and brown bears are sympatric. Relative densities of the 2 species vary, but on the Kenai Peninsula black bears are more abundant (Schwartz and Franzmann, unpubl. rep., Alaska Fed. Aid Proj. W-17-11, 1980). Interspecific encounters between black bears and brown bears were observed twice during this study. In both cases, the black bear fled from the area when it detected the presence of the brown bear. Cahalane (1947) reported observations of brown bears treeing black bears. Grizzly bears were observed to prey on black bears in Montana (Jonkel, unpubl. rep., Montana Fed. Aid Proj. W-98-R-2, 1962), although the converse situation was not documented. Black bears have been observed to leave dumps when grizzlies arrive (Finley and Finley 1940, Herrero 1972).

Reviews by Herrero (1972, 1978) suggested that the black bear evolved as a forest dwelling

species and were excellent tree climbers. Herrero felt that, in response to potentially dangerous situations, tree climbing placed black bears in a position of relative safety. These "safety" trees were absent in crushed areas. Black bears traveling in crushed areas would, therefore, be some distance from potential escape cover should a threatening situation occur. However, this does not explain why black bears frequently feed in alpine areas which are also devoid of trees.

Another major factor which probably contributed to reduced mortality rates of moose calves in the crushed areas was the forage supply. There was a greater quantity and diversity of woody species available to moose in the Willow Lake crushed area than in the 1947 burn (J. Oldemeyer, U.S. Fish and Wildlife Service, Kenai, Alaska, pers. commun.). Cow moose utilizing the Willow Lake area probably wintered in better condition and consequently produced more vigorous and healthy calves than those in the 1947 burn. Thorne et al. (1976) found that survival of elk calves (*Cervus elaphus*) was directly related to the nutritional plane of the cow during gestation. Although crushed areas were not utilized as extensively as the forest by black bears, they were not bear-free. As noted earlier, black bears occasionally entered or crossed crushed habitats. Consequently, moose calves in crushed areas were subjected to predation attempts. We therefore hypothesize that vigorous, healthy calves would be best able to outrun or elude a black bear. Moose on a higher plane of nutrition would be expected to have higher calf survival.

CONCLUSIONS

It is likely that no single factor was solely responsible for the observed increase in survival of moose calves within the crushed habitat. Changes induced by crushing the overstory vegetation improved the habitat for moose by increasing the quantity of desirable browse species available and by increasing the diversity of woody browse. An additional benefit derived was the reduction of moose calf predation in those crushed areas due to the general avoidance of the areas by black bears. We concluded that mechanical crushing of trees favored survival of moose calves. In future applications, managers should consider crushing trees in areas that may provide protective buffers to critical moose calving areas, as well as for general improvement of moose habitat.

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