GRIZZLY BEAR PREDATION ON ELK CALVES AND OTHER FAUNA OF YELLOWSTONE NATIONAL PARK

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Abstract: Success rate, frequency, chronology, and techniques of grizzly bear (*Ursus arctos horribilis*) predation on elk calves (*Cervus elaphus*) were determined from visual observations in the Pelican Valley area of Yellowstone National Park, 1984-88. Seventy hunts directed toward elk groups containing calves were recorded, 26 of which were successful. Twenty-one, 13, and 4 percent of all grizzly bear sightings in May, June, and July, respectively, involved hunts toward cow/calf groups. Success was significantly correlated with the number of attempts and the time of year. Grizzly bears were successful in killing calves in 71%, 42%, and 7% of the observed hunts in May, June, and July, respectively. Grizzly bears used 3 different techniques to hunt elk calves. Attempted predation on adult elk and other fauna was also observed.

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Several studies have documented grizzly bear use of elk carrion in Yellowstone National Park (YNP) (Craighead and Craighead 1972, Houston 1978, Knight et al. 1984). However, records of predation on live elk were limited to occasional observations or extrapolations from evidence at carcass sites. Cole (1972) reported that most predation on elk in YNP involved winter-weakened animals from March through May but suspected that observations did not adequately sample spring predation on newborn calves or fall predation on adult male elk during the breeding season. Fall predation on an adult bull was later documented by Mealey (1975). Craighead and Sumner (1982) noted grizzly bear predation on newborn calves in spring and suggested that some bears returned annually to calving areas. Schleyer (1983) reported predation on adult elk throughout the spring, summer, and fall and thought that predation on elk in YNP was underestimated. Harting (1985) suggested that in areas of YNP depauperate of vegetal foods, grizzlies became more adept at killing large mammals than did bears in areas with an abundance of high quality vegetal foods.

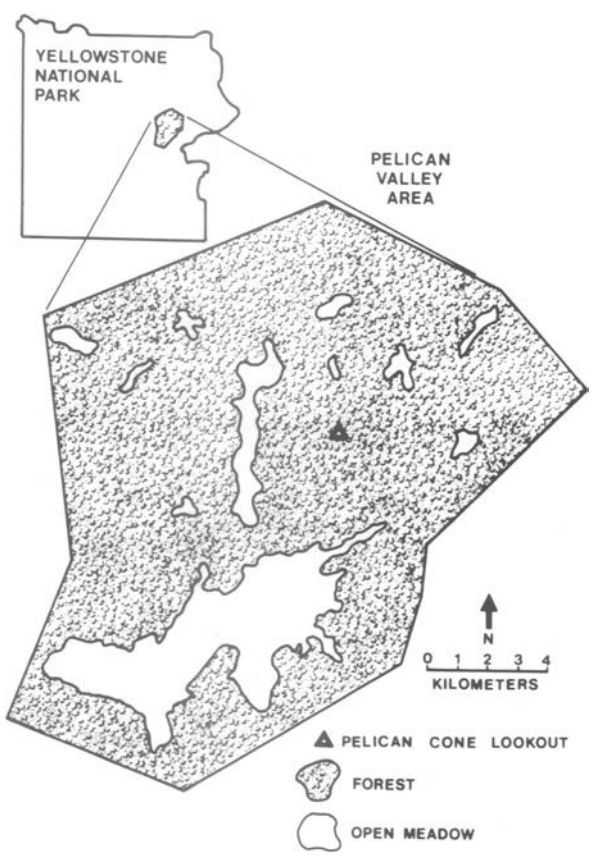

Fig. 1. Open meadow areas in Pelican Valley visible from Pelican Cone Lookout, Yellowstone National Park.

The data presented here address the techniques, frequency, chronology, and success rate of grizzly bear predation on elk calves in the Pelican Valley area of YNP from mid-May through mid-September, 1984-88. Predatory attempts on adult elk and other fauna are also noted.

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STUDY AREA

The study area encompassed approximately 4,850 ha of nonforested habitat in the Pelican Valley area of YNP (Fig. 1). The vegetation of Pelican Valley is a mosaic of community types dominated by silver sagebrush/Idaho fescue (*Artemisia cana/Festuca idahoensis*) with riparian habitats of tufted hairgrass (*Deschampsia cespitosa*) and sedges (*Carex* spp.) (Graham 1978). The forest types

surrounding the valley bottom range from seral lodgepole pine (*Pinus contorta*) to mature stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) (Despain 1973).

Grizzlies are active in the area from March through November (S.J. Fowler, Natl. Park Serv., pers. commun.). Elk that summer in Pelican Valley migrate to the area from the Park's northern winter range (Craighead et al. 1972, Houston 1982). These elk calve both in the valley and along migration routes (M.M. Meagher, Natl. Park Serv., pers. commun.). The calving period in YNP takes place from about mid-May through mid-June (Rush 1932, Johnson 1951). Newborn elk calves are very immobile until 3 to 4 days old; after about 5 days calves are proficient runners (Johnson 1951). Aerial surveys of the Pelican Valley elk herd were conducted in 1987, counts ranged from 702 to 1,292 elk (Harting and Singer 1988). The July calf:cow ratio was only 19 calves per 100 cows but was thought to represent less than one-half of the actual rate. In areas of YNP with less shrub cover to conceal calves, ratios of from 47 to 61 calves per 100 cows were recorded. Bison (*Bison bison*), moose (*Alces alces*), and mule deer (*Odocoileus hemionus*) also frequent and bear young in Pelican Valley, but no predatory attempts on these species were observed.

METHODS

Observations were made from the Pelican Cone fire lookout (elevation 2,939 m) from 18 June - 22 September 1984, 6 June - 18 August 1985, 10 June - 7 September 1986, 15 May - 7 September 1987, and 18 June - 22 July 1988. The lookout provided a stationary, nonintrusive vantage point from which prey species, chase distance, duration, and outcome of attempted predation were observed. Binoculars (11x80) were used for scanning. A 2,000-mm telescope with a usable magnification of 44 to 77 power allowed detailed observations. Data were collected incidentally during a study designed to determine the effects of backcountry recreational use on bear activity in the valley (Gunther 1990). Therefore, the types and quantity of data that could be collected on predation were limited.

Observations were made in open areas during daylight hours. Predation in forested areas or at night was not addressed. However, elk calves in YNP are most often found in nonforested vegetation types. Johnson (1951) reported that 77% of all calves in YNP were found in sagebrush vegetation types, 11% in forest types, and 5% in sagebrush/forest ecotone. Since grizzly bears in YNP are generally most active during nocturnal and crepuscular hours (Schleyer 1983, Harting 1985) the meadows and open areas were scanned once every half hour from 0500 - 1100 hr and from 1800 - 2145 hr. Between 1100 and 1800 hr the valley was scanned once every hour. Fog, low lying clouds, haze, heat waves, and heavy precipitation limited observations on some days. Although bears could only be observed during daylight hours, most bears using the area were probably included since bears exhibiting nocturnal activity patterns generally have crepuscular activity peaks (Schleyer 1983, Harting 1985).

Each bear or group of bears observed was recorded as 1 bear sighting. Bears observed together, such as females with young, breeding pairs, or pairs of subadults were recorded as 1 bear sighting. Recording data in this way eliminated bias toward the behavior of females with young or the behavior of the dominant bear of breeding pairs or pairs of subadults.

An attempt at predation, or "hunt", was defined as a bear sighting in which the bear(s) chased, stalked, or otherwise searched for various prey. During attempted predation on elk, a hunt was considered "in progress" until the bear(s) successfully killed or completely stopped chasing elk for the remainder of that bear sighting. Calves killed by bears were not examined, therefore the age structure of calf kills was unknown.

During attempted predation on elk, duration of chases <1 minute were estimated to the nearest 5-second interval. Chases of ≥1 minute were timed to the nearest minute. The length of chases ≤183 m was estimated. Travel routes of chases >183 m were drawn onto U.S. Geological Survey 15-minute series topographic quadrangle maps and measured. Attempts by grizzly bears to prey on other species were simply recorded as successful or unsuccessful.

For statistical analysis, multiple linear regression and Mann-Whitney *U* tests followed procedures described by Zar (1974). $P < 0.05$ was considered to be significant.

RESULTS

Availability of Elk

Adult elk had already arrived in Pelican Valley from the northern winter range when observations began each year. The earliest newborn calf sighting occurred 22 May 1987 and the latest 24 June 1988.

Predation on Elk Calves

In 944 bear sightings, 70 hunts, 26 of them successful, were observed on elk groups containing calves (Table 1). Twenty-one (6 of 28 sightings), 13 (43 of 323 sightings), and 4 (16 of 400 sightings) percent of all grizzly bear sightings in May, June, and July, respectively, involved

Table 1. Weekly summary of grizzly bear predation on elk calves in the Pelican Valley area of Yellowstone National Park, 1984-88.

Week (month/day)	Grizzly sightings	Total hunts	Successful hunts	Unsuccessful hunts	Outcome[a] unknown	Success rate (%)[b]
5/15 - 5/21[c]	8	0	0	0	0	0
5/22 - 5/30[c]	20	7	5	2	0	71
6/01 - 6/07[c]	16	3	2	1	0	67
6/08 - 6/14[d]	72	16	9	6	1	60
6/15 - 6/21	85	11	4	6	1	40
6/22 - 6/30	150	17	5	10	2	33
7/01 - 7/07	124	5	1	2	2	33
7/08 - 7/14	114	2	0	2	0	0
7/15 - 7/21	83	7	0	7	0	0
7/22 - 7/31	79	2	0	2	0	0
8/01 - 9/21	193	0	0	0	0	0

[a] Termination of hunt obscured by forest cover or topography.
[b] Calculated as successful hunts/(total hunts minus outcome unknown).
[c] Observations for 1987 only.
[d] Observations for 1985 - 1987 only.

hunts directed toward cow/calf groups. No hunts were observed in August or September. Hunts for elk calves ranged in time from 5 seconds to 71 minutes ($\bar{x}$ = 11.7 min ± 2.3 SE) and covered distances from 5 to 4,812 m ($\bar{x}$ = 812 m ± 128 SE). Bears tended to chase elk groups containing calves for longer time periods ($\bar{x}$ = 8.7 min with calves vs 0.2 min without calves; Mann-Whitney *U*-test, $U = 98, P = 0.001$) and for greater distances ($\bar{x}$ = 820 m with calves vs 120 m without calves; $U = 111, P = 0.002$) than elk groups without calves.

Excluding hunts of unknown outcome, grizzlies were successful in 41% (26 of 64) of the observed hunts on cow/calf groups. Success (SUC) was positively correlated with the number of attempted hunts (ATT) and negatively correlated with the time of year (WEEK) (SUC = -0.91 + (0.65 x ATT) - (0.18 x WEEK), df = 7, $R = 0.96, P < 0.01$). Grizzly bears were successful in killing calves in 71%, 42%, and 7% of the observed hunts in May, June and July, respectively. After the first week of July, grizzlies were apparently unable to catch elk calves.

The size of the elk group chased also influenced the success rate. Grizzly bears successfully took calves in 38% of the hunts that involved cow/calf groups of >25 elk and in only 14% of the hunts that involved groups of ≤25 (Table 2).

Single bears accounted for 80% of the observed predatory attempts on cow/calf groups (Table 3). Since bears were not marked for this study, single bears could not be classified by sex or age. Breeding pairs, subadult pairs, females with cubs, and females with yearlings were also observed chasing elk calves.

Grizzlies used 3 techniques to hunt elk calves. In May and early June, when newborn calves are extremely immobile, bears were observed locating newborn calves, apparently by scent, in calving/bedding areas (9 of 70 hunts, 6 successes). Adult elk retreated as bears approached these areas. Bears then moved through the sagebrush in a zigzag pattern, occasionally rising onto their hind legs. Calves that had remained bedded and were detected by bears were killed. These hunts ranged in time from 5 seconds to 71 minutes ($\bar{x}$ = 32.2 min ± 9.6 SE) and covered distances from 5 to 1,625 m ($\bar{x}$ = 935 m ± 211 SE).

The most common hunting technique observed (59 of 70 hunts, 18 successes) was similar to that described by Cole (1972). Bear(s) approached cow/calf groups at a loping pace while in the open, apparently not using vegetation or topography for cover. Elk were aware of the bear's presence, and reacted by bunching into tight

Table 2. Number of chases, number of kills, and success rate of attempted grizzly bear predation on different size elk cow/calf groups in the Pelican Valley area of Yellowstone National Park, 1984-1988.

Elk group size	Number of chases[a]	Number of kills	Percent of total chases	Percent of total kills	Success rate (%)
1 - 25	7	1	13	5	14
26 - 50	18	7	33	37	39
> 50	30	11	54	58	37

[a] Does not include hunts of unknown outcome or hunts through calving/bedding areas that did not involve a chase.

Table 3. Characteristics of grizzly bears observed chasing elk in Pelican Valley, Yellowstone National Park, 1984-1988.

Category	Chases of elk calves			Chases of adult elk		
	No.	% of total	% success	No.	% of total	% success
Single bears	56	80	44	5	50	0
Breeding pairs	8	11	43	2	20	0
Subadult pairs	4	6	0	1	10	0
Females with cubs of the year	1	1	0	0	0	0
Females with yearlings	1	1	0	2	20	0
Females with 2-year-olds	0	0	0	0	0	0

groups while intently watching the bear. After the initial approach, the bear(s) made a series of charges that tended to separate confused calves from the group. The chase then concentrated on these calves. Elk calves could generally outdistance bears in a straight run, but were often caught when bears cut to the inside of calves changing direction in an effort to rejoin the herd. Once within reach, bears used their forelegs to grasp and pull down running calves by the rump. This type of hunt ranged in time from 5 seconds to 58 minutes ($\bar{x}$ = 8.7 min ± 2.0 SE) and covered distances from 27 to 4,812 m ($\bar{x}$ = 818 m ± 149 SE). Chasing elk calves over long distances was not always futile. Bears were successful in 27% (4 of 15) of the hunts that covered distances > 805 m. On 1 occasion a bear chased a group of elk for 14 minutes over a distance of approximately 2,346 m before killing a calf. The bear then spent 20 more minutes chasing the elk over a circuitous 1,372 m and killed 2 more calves. The bear was observed feeding on 2 of the 3 calves and may have returned at night to feed on the remaining calf.

Bears were observed killing more than one calf on 2 other occasions. In 1 instance a bear killed 2 calves in a bedding area and fed on both of them. On another occasion a bear chased and killed 3 calves. This bear fed on 2 of the calves; a second, larger bear then chased it off and fed on the third calf.

The third style of hunting observed (2 of 70 hunts, both successful) involved the use of cover. Bears used tree cover to approach elk grazing within 50 m of the forest edge. Each of these hunts lasted less than 20 seconds and covered less than 137 m. In each incident elk suddenly became alert and closely monitored the forest edge before a bear rushed from the trees and initiated chase. Due to the high efficiency (short chase, high success rate) of this type of hunt, it may occur more frequently than observed.

Bears spent from 9 to 76 minutes ($\bar{x}$ = 40 min ± 4 SE) feeding on calves immediately following the kill. Bears returned to 6 of 26 (23%) calf kills for a second feeding period. Second feeding episodes ranged from 4 to 10 minutes ($\bar{x}$ = 7 min ± 1 SE). Bears may have returned at night to feed on diurnal kills. Coyotes (*Canis latrans*), ravens (*Corvus corax*), and bald eagles (*Haliaeetus leucocephalus*) were commonly observed feeding on the remains of calves killed by bears.

Defense of Calves by Cow Elk

A cow elk was observed attempting to protect her calf during a chase. The bear was overtaking a calf that had become separated from the cow during the chase. The cow ran at the bear, approaching it from an angle and succeeded in veering the bear away from the calf. The cow then attempted to lead the calf away from the area. The bear, however, quickly initiated a second chase, this time successfully taking the calf without further interference from the cow. In another instance, 3 bears (1 adult and a mating pair) had successfully taken 3 calves in a calving area. As the bears fed upon the calves, a cow elk cautiously moved back into the calving area and led her calf, still hidden in the sagebrush, away from the bears. On another occasion a group of elk left a calf bedding area as a grizzly bear approached. A lone cow remained and watched the bear catch and feed on a calf, presumably its own, from a distance of approximately 30 m. When the bear finished feeding 56 minutes later and moved away, the cow defended the carcass and chased off 2 coyotes that approached.

Attempted Predation on Adult Elk

Ten hunts (8 unsuccessful, 2 outcome unknown) on adult elk were observed. These hunts ranged in time from 5 seconds to 1 minute ($\bar{x}$ = 0.2 min ± 0.09 SE) and covered distances from 27 to 402 m ($\bar{x}$ = 107 m ± 35 SE). Grizzly bears were observed hunting adult elk from May through July. No attempts at predation on adult elk by grizzly bears were observed in August or September.

Predation on Other Fauna

Grizzly bears, generally considered opportunistic predators (Herrero 1985), were observed unsuccessfully chasing ducks (*Anatidae*) twice, Canada geese (*Branta canadensis*) twice, and sandhill cranes (*Grus canadensis*) 6 times. Bears were also observed fishing in Pelican Creek tributaries on 3 occasions with 1 known success of at least 3 fish (either cutthroat trout, *Salmo clarki*, or longnose suckers, *Catostomus catostomus*).

DISCUSSION

Elk calving on the northern winter range takes place from about mid-May through late-June, thus observed calves killed in Pelican Valley could have been from newborn to about 7 weeks old. Total body weights corresponding to these ages range from approximately 8.6 kg (Johnson 1951) to 58.9 kg (Murie 1951). At an estimated 4,600 kcal/kg, ungulates rank as the highest source of net digestible energy in the Yellowstone ecosystem (Mealey 1975).

Although elk calves are a good source of protein and high net digestible energy for bears (Mealey 1975), they are available for only a short period of the year (mid-May - early July). Elk calves in YNP were most vulnerable to predation during their first 30 days of life (Singer and Harting 1988). Grizzly bears in YNP feed extensively on winter-killed carrion from March through May (Knight et al. 1984). Peak successful grizzly bear predation on elk calves occurs about the time (late-May through mid-June) that winter-killed ungulates are no longer readily available and may act to extend the spring season of high protein consumption by 2 - 4 weeks for some bears.

The observed decrease in hunting effort and success over time probably reflected a decrease in the cost/benefit of expending energy chasing elk calves as they became more mobile with age and as the proportion of catchable age calves in the population declined over time. At that point, less nutritious but more readily available plant foods became more cost efficient diet items.

From 1935-67 the northern Yellowstone elk herd was reduced to an artificially low population of <5,000 elk (Houston 1982). Since 1967, elk numbers have increased to over 19,000 (Singer et al. 1988). Bear use of elk calves through predation could be expected to increase with this greater availabilty of elk. Documentation of grizzly bear predation on elk calves prior to termination of the elk herd reduction program (Cole 1972, Craighead and Mitchell 1982, Craighead and Sumner 1982) did not quantify to what extent bears made use of the elk resource through predation. Although rates of predatory attempts documented in this study cannot be compared to past levels, these results can be used for future comparison with predatory rates during any significant fluctuation in elk numbers as well as to evaluate the relative contribution of elk as carrion vs. prey in grizzly bear food habits.

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