NEONATAL MORTALITY OF ELK IN AREAS WITH AND WITHOUT GRIZZLY BEARS

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✦ INTRODUCTION

The Greater Yellowstone Ecosystem (GYE) may support the densest populations of elk in North America, and a diverse community of large carnivores that prey on elk. From 1984 to 1996, the Jackson elk herd doubled in size exceeding its winter population objective of 11,000 elk by nearly 7,000 animals (Smith and Anderson 1998). In and adjacent to Grand Teton National Park (GTNP), mortality of neonatal elk averaged 15% annually during 1990-1992 (Smith and Anderson 1996). Predation by black bears and coyotes, when calves were less than 4 weeks of age, caused 68% of neonatal mortality. Calves killed by mountain lions were more than 4 months old. Except for hunting, predation was the largest source of mortality of radio-collared elk from birth through adulthood.

After 1992, grizzly bear activity on federal cattle grazing allotments in eastern GTNP and the adjacent Spread Creek drainage of the Bridger-Teton National Forest (the East Study Area or East SA) markedly increased as did cattle losses to bears. Personnel of the Wyoming Game and Fish Department attributed 26 cattle losses (25 calves, 1 cow) in the East SA in 1993 to grizzly bear predation (Wyoming Game and Fish Department 1995). The Wyoming Game and Fish Commission, which compensates cattle producers for losses due to grizzly predation, initiated a study in 1994 to quantify the proportion of cattle losses in the East SA due to grizzly predation. One grizzly bear documented killing cattle each year, was captured and euthanized in GTNP in 1996.

Grizzly bears are opportunistic omnivores that consume both plant and animal foods (Blanchard et al. 1992). Grizzly bear predation on elk calves less than 4 weeks of age was the primary cause of mortality of calves and a major factor regulating the size of Yellowstone National Park's northern elk herd (Singer et al. 1997). Smith and Anderson (1996) found no evidence of grizzly predation on Jackson elk during 1990-1992. However, mid-summer calf:cow ratios of elk in the Spread Creek area of eastern GTNP declined after 1993. We initiated this study in 1997 to compare causes of elk calf mortality in the grizzly-occupied East SA and the relatively grizzly-free area of GTNP west of the Snake River (West SA). The objectives were to: determine: 1) if grizzly bears were preying on elk calves, 2) whether such mortality was compensatory or additive to other sources of mortality, 3) if changes in neonatal mortality altered the harvestable surplus of elk

from the Jackson elk herd for hunters, and 4) any influence of environmental factors, and physiological status on survival of elk neonates.

✦ STUDY AREA

The study was conducted in elk calving areas of the Jackson elk herd unit of northwest Wyoming described by Smith and Robbins (1994). The study occurred in portions of GTNP and the Bridger-Teton National Forest. Elevations range from 1,950 to 2,450m. Vegetation included sagebrush (*Artemesia* spp.) grasslands, and aspen (*Populus tremuloides*) woodlands, interspersed with willow (*Salix* spp.) riparian zones, and coniferous forests of lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), and Engelman spruce (*Picea engelmannii*). The climate is characterized by long cold winters and warm short summers. The mean annual temperature is 1.7 C and ranges from monthly means of -11.0 C in January to 14.7 C in July (National Oceanic and Atmospheric Administration 1992).

✦ METHODS

Calf Capture and Marking

Calves were captured from a Hiller 12-E helicopter contracted by Hawkins and Powers Aviation of Greybull, Wyoming. Although capture of calves by investigators on foot and horseback has been used in some studies, newborn elk calves are most efficiently located and captured from helicopter (M. Schlegel, Idaho Department of Fish and Game, pers. comm., Singer et al. 1997, Smith and Anderson 1996). We searched known calving locations within the two study areas and located parturient female elk and their newborn calves. When we spotted a bedded calf, we landed the helicopter as close as was safely possible, then stalked, captured, blindfolded, and hobbled the calf. We weighed, sexed, aged (Johnson 1951), and examined each calf for general physical condition. Blood was drawn from a sample of calves to compare physiological indices of calves that survived and died. Total handling time was 5-10 minutes.

Calves were fitted with ear tag transmitters (Advanced Telemetry Systems, Inc., Insanti, MN). The transmitters remained silent while the calves were alive and active. When a transmitter remained immobile for >3 hours, a mortality switch initiated transmission of a continuous pulse signal. The transmitters donated to the study by Wyoming Game and Fish Department in 1997 were on just 4 frequencies. Consequently, 10-12 transmitters were deployed on each frequency in 1997. Additional transmitters on 6 frequencies were purchased in 1998 and 8 frequencies in 1999. Thus, transmitters were deployed on 10 frequencies in 1998 and 12 frequencies in 1999.

Radio Transmitter Monitoring and Mortality Investigation

The transmitters fitted to elk calves were monitored from 4 ground-based fixed towers mounted with twin 12 element yagi antennas. The calves were monitored at approximately 12-hour intervals from birth to 15 July and at 24 hour intervals thereafter through August. During fixed wing telemetry flights for radiotracking adult elk and grizzly bears, we monitored calf frequencies in areas beyond the reception range of our ground-based towers.

When a mortality signal was detected, investigators located and assessed the disposition of the calf as soon as possible (on average it took 2.3 days to locate each carcass in 1997, 0.5 days in 1998, and 1.0 days in 1999). At mortality sites, standard forensic procedures were followed to determine presence of predators or scavengers (Singer et al. 1997, Smith and Anderson 1996). A thorough search of the transmitter's location was conducted to find evidence of predator hair, feathers, tracks and scat, evidence of struggle and location of attack, and all remains of the carcass. Field necropsies were performed on partially consumed carcasses. Hair samples were identified to species based on color, texture, and scale patterns of the medulla and cuticle (Moore et al. 1974). Tissue samples were collected and sent to the Wyoming State Veterinary Lab for diagnostic tests to evaluate animal condition and disease status. Intact carcasses were frozen and sent to Wyoming State Veterinary Lab for necropsy and diagnostic tests.

Grizzly Bear Distribution

To document presence of bears in both the West SA and the East SA, we constructed 12 hair collection corrals (HCCs) in which cattle blood was used as a nonreward bait (Table 1). The HCCs consisted of a single strand of barbed wire encircling 4-6 trees with a center tree in the middle. The barbed wire was stapled 20-22 inches above the ground on the outside perimeter of the trees. Poles were wired horizontally above the barbed wire to prevent ungulates from entering the HCCs and insure that bears would enter beneath the barbed wire. A 1-gallon milk jug,

nearly filled with blood, was suspended by rope between 2 trees over the center of a HCC, beyond the reach of a tall bear. The Wyoming Game and Fish Department (1996) determined that cattle blood was the best attractant to lure bears into the HCCs. Jugs of cattle blood were replaced with fresh blood every 3 weeks.

Table 1. Locations and number of hair samples collected from hair collection corrals in the East and West study areas during 1999. Corrals were monitored for 16 weeks (Death, Granite, and Timbered Island) or 8 weeks (all others). Weekly frequency of visitation is shown for the 16-week sampling period (31 May – 20 September) of the Death, Granite, and Timbered Island corrals and for the 8-week period (31 May for all corrals.

Corral Name	Study Area	Species	Dates Hair Collected	Samples per Date	Frequency visitation 20 Sept.
Murie Ridge	West	Black bear	5-31, 6-7, 6-21 6-28, 7-5, 7-13 7-18,	7, 8, 3 7, 1, 5 2	
Murie Ridge	West	Lion	6-14	1	
Timbered Island	West	Black bear	6-21, 6-28, 7-13 7-18, 9-20	2, 2, 1 1, 1	0.31
Timbered Island	West	Coyote	7-5	1	0.06
Timbered Island	West	Grizzly bear	7-26	1	0.06
Burned Ridge	West				
RKO Road	West				
River Road	West	Black bear	5-31, 6-8, 6-21	3, 1, 1	
Death Canyon	West	Black bear	6-14, 7-6, 7-18, 7-26, 8-7, 8-16	7, 1, 1, 5, 1, 2	0.38
Death Canyon	West	Grizzly bear	7-26, 8-29	2, 1	0.13
Granite Creek	West	Black bear	5-31, 6-21, 6-28 7-18, 9-20	1, 15, 2 4, 2	0.31
Three Rivers	East	Black bear	6-28, 7-11	5, 5	
Three Rivers	East	Grizzly bear	7-11	1	
Wolf Ridge	East	Black bear	6-3, 6-21	10, 3	
Lava Creek	East	Black bear	6-29, 7-13, 7-20	1, 5, 1	
Wallace Draw	East	Black bear	6-1, 6-9, 7-20	5, 1, 3	
Mary's Lake	East				

Ten HCCs were constructed in late May 1997 and monitored once a week for 7 weeks from the last week of May through the second week of July in 1997. Two additional corrals were constructed the second week of July and also monitored for 7 weeks. In 1998 and 1999, all 12 HCCs were monitored weekly during June and July. Additionally, 7 of the HCCS (Murie's Ridge, Timbered Island, Death Canyon, Granite Creek, Wolf Ridge, Wallace Draw, and Mary's Lake) were monitored through September or first week of October 1998 to gather additional information on bear occurrence during late summer. In 1999, 3 corrals (Death, Granite, and Timbered Island) were monitored 31 May through 20 September, and the remaining 12 corrals were monitored only through July.

The HCCs were visited weekly. Hair samples were removed from the barbed wire, individually bagged, and submitted to the Wyoming Game and Fish Department Lab for species identification as described above.

✦ RESULTS AND DISCUSSION

Hair Collection Corrals

During 1997-1999, a total of 558 hair samples were collected from bears at the 12 HCCs, including 550 from black bears and 8 from grizzly bears. Over the 3 years, black bear hair was sampled throughout both study areas (Table 1). No samples of grizzly bear hair were collected at HHCs in 1997, 3 samples in 1998, and 5 samples in 1999. These limited data suggested that grizzly bears occurred in both study areas, but to a far lesser extent than black bears (Table 2). However, the reliability of HHCs for measuring the presence or relative spatial abundance of bear species is uncertain. Radiocollared grizzlies were known to have frequented the East SA during our monitoring period all 3 years of this study. Calves were killed each year by grizzlies in the East SA, yet visits by grizzly bears to HCCs in the East SA numbered zero in 1997, just 1 in 1998, and 1 in 1999. Some grizzly bears likely avoid entering HCCs. There may also be error in identifying species of bear with microscopic techniques. Current efforts to estimate size of grizzly bear populations from hair samples at HCCs use DNA microsatellite technology (Woods 1994, Wyoming Game and Fish Department 1996). It is also uncertain if we have achieved an optimum density of HCCs to attract grizzly bears in the two study areas. However, some patterns emerged regarding relative occurrence of black bears, such as higher levels of black bear use of HCCs in the West SA (Table 2).

Table 2. Frequency of visitation (proportion of weeks visited during the sampling period) of black and grizzly bears at hair collection corrals in the East and West study areas during 1997-1999. We monitored all corrals weekly from approximately 1 June through 31 July 1998 and 1999 (8 weeks). In 1997, we monitored all hair collection corrals 1 June through the third week of July (7 weeks) except Granite Creek and Death Canyon, which we monitored only during July (4 weeks).

			Frequency of visitation		
Corral Name	Study Area	Species	1997	1998	1999
Murie Ridge	West	Black bear	0.71	0.75	0.88
Timbered Island	West	Black bear	0	0.13	0.50
Timbered Island	West	Grizzly bear	0	0	0.13
Burned Ridge	West	Black bear	0.29	0.50	0
RKO Road	West	Black bear	0.57	0.13	0
River Road	West	Black bear	0.29	0.13	0.38
River Road	West	Grizzly bear	0	0.13	0
Death Canyon	West	Black bear	1.00	0	0.50
Death Canyon	West	Grizzly bear	0	0	0.13
Granite Creek	West	Black bear	0.50	0.25	0.50
Three Rivers	East	Black bear	0	0.25	0.25
Three Rivers	East	Grizzly bear	0	0	0.13
Wolf Ridge	East	Black bear	0	0	0.25
Lava Creek	East	Black bear	0.57	0.63	0.38
Wallace Draw	East	Black bear	0	0	0.38
Mary's Lake	East	Black bear	0.14	0	0
Mary's Lake	East	Grizzly bear	0	0.13	0
All corrals	West	Black bear	0.48	0.27	0.39
All corrals	East	Black bear	0.14	0.18	0.25
All corrals	West	Grizzly bear	0	0.02	0.04
All corrals	East	Grizzly bear	0	0.03	0.03

Calf Mortality

During 3 field seasons, we captured and radio eartagged 154 elk calves during 26 May--13 June 1997-1999. We captured 64 calves (37 males, 27 females) in the East SA and 90 (39 males, 51 females) in the West SA. One female in the West SA cast its transmitter before 31 July 1998. Forty-two of the remaining 153 neonates (27.5%) died during the 3 years between birth and 31 July, compared to 22 of 145 (15.2 % during 1990-1992). Predation accounted for 32 of 42 (76%) mortalities during 1997-1999. Six calves were killed by grizzly bears, 5 in eastern GTNP in the East SA and 1 near the Snake River in the West SA. Black and grizzly bears killed 23 of 32 neonates taken by predators during 1997-1999. Two neonates were also killed by mountain lions during 1997-1999. Accidental deaths increased from 1 during 1990-1992 to 4 during 1997-1999. Six calves died from disease during each of the studies. No other calves died through September of each year except one calf that was killed in an automobile collision in August 1998. Analyses of serum samples are not yet completed to evaluate immunocompetence and physiological status of calves.

Through this research, we seek to promote informed decision making by wildlife managers and land managers regarding the conservation and management of expanding populations of large carnivores and their prey. A manuscript of this investigation is in preparation for publication in the Journal of Wildlife Management.

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✦ LITERATURE CITED

Blanchard, B. M., R. R. Knight, and D. J. Mattson. 1992. Distribution of Yellowstone grizzly bears during the 1980s. American Midland Naturalist 128:332-338.

Johnson, D. E. 1951. Biology of the elk calf, *Cervus canadensis* nelsoni. Journal of Wildlife Management 15:396-410.

Moore, T.D., Spence, L.E., and Dougnolle, C.E. 1974. Identification of dorsal guard hairs of some mammals of Wyoming. Wyoming Game and Fish Department, Bulletin 14. Cheyenne, Wyoming. 177pp.

National Oceanic and Atmospheric Administration. 1992. Monthly station normals of temperature, precipitation, and heating and cooling degree days, Wyoming, 1961-1990. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, N.C. 27pp.

Singer, F. J., A. T. Harting, and K. K. Symonds. 1997. Density-dependence, compensation, and environmental effects on elk calf mortality in Yellowstone National Park. Journal of Wildlife Management 61:12-25.

Smith, B.L., and S.H. Anderson. 1996. Patterns of neonatal mortality of elk in northwest Wyoming. Canadian Journal of Zoology 74:1229-1237.

Smith, B.L., and S.H. Anderson. 1998. Juvenile survival and population regulation of the Jackson elk herd. Journal of Wildlife Management 62:1036-1045.

Smith, B. L., and R. L. Robbins. 1994. Migrations and management of the Jackson elk herd. USDI National Biological Survey Research Publication 199. Washinton, D.C.

Woods, J.G., A. Fonatan, T. Hamilton, J. Krebs, B. McLellan, and D. Peterson. 1994. West Slopes bear research project working plan 1993-1999. 27pp.

Wyoming Game and Fish Department. 1995. Grizzly bear-cattle interactions on the Blackrock/Spread Creek cattle allotment, Bridger-Teton National Forest and the Elk Ranch East cattle allotment, Grand Teton National Park. Wyoming Game and Fish Department, Lander, WY.

Wyoming Game and Fish Department. 1996. Effectiveness of attractants to lure grizzly bears into hair collection sites for future DNA fingerprinting - the Blackrock/Spread Creek area study. Wyoming Game and Fish Department, Lander WY.