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## PROBABLE GRIZZLY BEAR PREDATION ON AN AMERICAN BLACK BEAR IN YELLOWSTONE NATIONAL PARK

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Both grizzly bears (*Ursus arctos*) and American black bears (*U. americanus*) live in Yellowstone National Park (YNP), which is located primarily in Wyoming, USA. In areas where grizzly bears and black bears are sympatric, temporal isolation and behavioral differences likely reduce direct competition between the species (Aune 1994). In the Greater Yellowstone Ecosystem (GYE), grizzly bears are generally most active during nocturnal and crepuscular times (Schleyer 1983, Holm et al. 1999), whereas black bears are mostly diurnal (Barnes and Bray 1967, Holm et al. 1999). Grizzly bears evolved to exploit non-forested habitats, whereas black bears are primarily forest adapted (Herrero 1978). Grizzlies are also generally larger than black bears and much more aggressive in defending themselves and their offspring from conspecifics and other predators (Herrero 1978), whereas black bears typically escape predators by running into forest cover or

climbing trees (Herrero 1985).

Due to their larger body size, grizzly bears have a competitive advantage over black bears in large non-forested areas (Herrero 1977). Although displacement of black bears by grizzly bears from high quality habitat has been documented (Shaffer 1971, Kendall 1984, Aune 1994), interspecific killing of black bears by grizzly bears has only occasionally been reported (Arnold 1930, Jonkel and Cowan 1971, Murie 1981, Ross et al. 1988, Mattson et al. 1992).

We documented probable grizzly bear predation on an adult male black bear in Hayden Valley, in central YNP. Hayden Valley is a large (>8,500 ha) non-forested valley surrounded by the forested Central Plateau. Flora in the valley is dominated by sagebrush (*Artemisia* spp.) and a variety of forbs, grasses, and sedges (Meagher 1973). Numerous graminoid-dominated wetlands are present in the valley. Lodgepole pine (*Pinus contorta*) forest types that occur on infertile rhyolite soils dominate the forested plateau surrounding Hayden Valley (Despain 1990). Spruce (*Picea engelmannii*)–fir (*Abies lasiocarpa*) stands are interspersed throughout the lodgepole pine zone in areas of more favorable moisture regimes such as pond margins, north slopes, and drainages (Graham 1978). Grizzly bears are active in both the forested and non-forested areas of Hayden Valley throughout the non-denning season (Gunther et al. 1995). Black bears are mostly observed within and near the edges of the forested portions of the valley and rarely far from forest cover in the non-forested areas (Gunther et al. 1995).

On 2 August 1998 we received a report of a dead black bear on the northeast side of the Yellowstone River in Hayden Valley, across from the Grizzly Overlook interpretive sign along the Grand Loop road. We investigated

the report and found a dead adult male black bear in tall sedges on the bank of the river, 174 meters from the road. Field inspection of the carcass revealed that the dead black bear had canine puncture wounds to the head and nose as well as a crushed skull and left eye orbital. The penis, baculum bone, and testicles were bitten off and found next to the carcass. There were canine marks on the scrotum, and the left hind quarter was partially consumed. The carcass had not been buried. Two fresh scats containing vegetation were observed next to the carcass and near (<3 meters) the partially consumed hind quarter. The predator that scavenged and likely killed the black bear probably defecated these scats while feeding on the carcass. We collected the black bear carcass for necropsy to determine cause of death and to obtain evidence as to the species of predator that killed it. We collected the scats found next to the dead black bear for DNA analysis to confirm the species of the predator.

Laboratory necropsy indicated the dead black bear had been in fair to good physiologic condition given the time of year (kidney fat index measured 24%), and no evidence of disease was observed. The carcass (minus the eaten tissue) weighed 77.6 kg. Based on body size and condition, we estimated that the black bear probably weighed approximately 91 kg prior to being partially consumed. The hide and musculature of the left side of the head were torn away, exposing a portion of the skull. The left zygomatic arch was shattered and bone fragments were missing. A puncture wound had penetrated the skull ventral and posterior to the orbital process. Numerous puncture wounds were observed in the hide surrounding the head, but no damage was noted to the neck. Although several ribs on the left side of the thoracic cavity were broken, the lack of hematoma and tissue damage to that region indicated that the damage occurred post-mortem. Much of the tissue surrounding the left hind quarter and a portion of the large intestine had been eaten. The cause of death was determined to be trauma to the head.

The large number of puncture wounds inflicted to the bear's head made it difficult to locate a matching pair of canine puncture marks. However, one set of marks believed to be caused by the lower canines was observed near the right mandible. The center-to-center distance of these canine puncture marks was 59 mm, typical of average size, adult male grizzly bears in the GYE. In grizzly bears, lower canine widths range from 35 to 66 mm ( $\bar{x}$  = 53 mm, SD = 6 mm,  $n$  = 35). Based on measurements taken from reference skulls, a lower canine width of 59 mm is too large to have been inflicted by even a large black bear, wolf (*Canis lupus*), or mountain lion (*Felis concolor*) from the GYE. The distance between lower canines range from 37 to 55 mm ( $\bar{x}$  = 45 mm, SD = 4 mm,  $n$  = 31) in black bears, 35 to 48 mm ( $\bar{x}$  = 40 mm, SD = 3

mm,  $n$  = 33) in wolves, and 29 to 41 mm ( $\bar{x}$  = 35 mm, SD = 4 mm,  $n$  = 56) in mountain lions. Predation by wolves can be further ruled out because in 1998, wolves had only recently been reintroduced to YNP and no wolves had yet established territories in Hayden Valley (Smith et al. 1999). Predation by a mountain lion is not likely either. In YNP, mountain lions typically inhabit Douglas-fir (*Pseudotsuga menziesii*) and spruce-fir forest types containing numerous rocky canyons and outcrops (T. Ruth, Hornocker Wildlife Institute, Gardiner, Montana, USA, personal communication, 2001). The kill site was located in a large, non-forested valley bottom without these features, not typical of mountain lion habitat in YNP. Based on canine widths alone, we cannot completely rule out predation by a black bear because it is possible that an exceptionally large, old adult male black bear in YNP might have a 59-mm lower canine width. However, the identification of the predatory bear as a grizzly based on canine widths was also supported through laboratory analysis of DNA extracted from the bear scats collected at the kill site. DNA extraction and species identification using mitochondrial DNA fragment analyses (Murphy et al. 2000) unambiguously identified the scats collected next to the dead black bear as being from a grizzly bear.

The availability of trees as a means of escape through climbing or hiding was an important selective force in the evolution of black bears (Herrero 1977, 1978, 1985). In this incident, no tracks were left in the lush grass to enable us to determine the events that led to the black bear being killed. Therefore, we do not know if the black bear was stalked, ambushed, or chased to the kill site. There were no ungulate carcasses nearby that would have attracted multiple large carnivores to the area. To reach the potential security of a climbable tree to escape from the kill site, the black bear had 3 options. The nearest climbable tree was a dead snag 72 meters west of the kill site, on a small island (0.21 ha) in the Yellowstone River. The black bear would have had to swim and run through the river for 68 meters and run 4 meters on land to reach the snag. The nearest climbable, live trees were in a small (1.2 ha) stand, 129 meters to the southwest, and on the shore opposite from where the black bear was killed. To reach these trees the black bear would have had to swim and run through the river for approximately 118 meters and run 11 meters on land. The nearest climbable trees that could be reached without swimming were approximately 900 meters northeast and uphill from the kill site. These trees were also the nearest contiguous forest large enough to potentially have provided escape or hiding cover.

In areas where grizzly bears and black bears are sympatric, differences in morphology, behavior, food preferences, and habitat selection (Herrero 1978) generally allow

each species to exploit different subniches and coexist within common geographic areas (Aune 1994). Holm et al. (1999) reported overlap in home ranges of black and grizzly bears in the GYE. In that study, black bears included more forested habitats within their home ranges, whereas grizzly bears selected more nonforested habitats (Holm et al. 1999). Gunther et al. (1995) reported overlap in areas of activity of grizzly and black bears throughout most of YNP, but reported that black bears were seldom observed far from forest cover in large non-forested areas such as Pelican (Gunther 1991) and Hayden Valleys. Black bears may underutilize large non-forested areas due to habitat and food preferences (Aune 1994) or to avoid potentially aggressive interactions with grizzly bears, wolves, and coyotes (*C. latrans*; Herrero 1985). Our observation of interspecific killing gives insight into (1) potential selective pressures that may influence the distribution of black bears, and (2) subniche separation between black bears and grizzly bears in YNP.

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## GRIZZLY BEAR PREDATION ON A BULL BISON IN YELLOWSTONE NATIONAL PARK

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Grizzly bears (*Ursus arctos horribilis*) will eat meat whenever it is available to them (Mattson 1997). Ungulate meat is more prominent in the diet of grizzly bears from the Yellowstone area than other interior brown bear populations in North America (Craighead and Mitchell 1982, Mattson et al. 1991, Mattson 1997). Nitrogen ( $N_{15}$ ) isotope analysis of hair collected from grizzly bears in the Greater Yellowstone Area suggests that meat comprises almost half of the annual energy intake of adult females and over half for adult males (Jacoby et al. 1999). Grizzly bears obtain ungulate meat primarily through scavenging winter-killed (Green et al. 1997) and wolf-killed (*Canis lupus*; D. Smith, Yellowstone National Park [YNP], Wyoming, USA, personal communication, 2001) elk (*Cervus elaphus*) and bison (*Bison bison*) carcasses, and by predation on elk calves (Gunther and Renkin 1990). Grizzly bear predation on adult elk and moose (*Alces alces*) has also been reported (Schleyer 1983). However, reports of predation on adult bison are rare.

In an extensive review of the historical literature on bison, Roe (1951, 1970) found only one reference documenting grizzly bear predation on bison. Review of more recent bison literature adds no additional evidence that grizzly bears prey on adult bison (Meagher 1973, 1978; Reynolds et al. 1982; Shaw and Meagher 1998). Studies of grizzly bear behavior and food habits in YNP have not documented grizzly bear predation on adult bison (Mealey 1975, Schleyer 1983, Gunther and Renkin 1990, Mattson et al. 1991, Schullery 1992, Mattson 1997, Knight et al. 1999), except for the occasional killing of severely malnourished bison in spring (Craighead et al. 1995).

I observed a predatory attack by an adult female grizzly bear on a young adult bull bison near the Yellowstone River outlet in east-central YNP, Wyoming. The Yellowstone River outlet is surrounded by spruce–fir (*Picea* spp.–*Abies* spp.) and lodgepole pine (*Pinus contorta*) forest types (Despain 1990). The area is used extensively by grizzly bears (National Park Service 1984). Bison, mostly bulls, are active in the area from late April through December, with small groups of bison sometimes over-wintering in the area.

I observed the incident from the road on the west side of the Yellowstone River near the outlet of Yellowstone Lake (elevation 2,371 m) on the morning of 23 September 2000. I was observing a grizzly bear with 2 cubs-of-the-year that were digging for pocket gophers (*Thomomys talpoides*) in a meadow 300–400 m from the Lake Lodge. This family group had been frequenting the area throughout the summer. At approximately 1200 hours, the bears began walking northeast along the shore of Yellowstone Lake toward the Yellowstone River outlet at Fishing Bridge. At approximately 1300, the bears emerged onto the road at Fishing Bridge Junction and crossed to the north side. The bears continued walking north in a direction that would have taken them past a young adult bull bison lying under a tree 15 meters from the road. The bison stood up abruptly when the bears were approximately 5 meters away. When the bison stood up, the bears appeared startled. The adult female, then the cubs, stood up on their hind legs and looked at the bison. The bison stood in an alert posture with his tail raised and head down. After a few seconds, the adult bear lunged toward the bison. The bison immediately turned away and began trotting east, up slope along a bench directly above the road heading toward Fishing Bridge. The adult bear loped after the bison at less than full speed.

I drove east along the road, observing the movement of the bears and bison approximately 15 meters away. After trotting about 50 m, the bison broke into a full run. The adult bear then chased the bison at full speed. At the crest of the hill above the Yellowstone River, the bear swiped its paw across the hindquarters of the bison, knocking the bison's back legs out from under it. The bison began to slide down the steep embankment of the hill on its back. After striking a tree with considerable force on its front quarters, the inverted bison continued to slide toward a pedestrian boardwalk at the base of the hill. The grizzly leaped onto the stomach of the inverted bison and skidded down the hill on top of it while attempting to bite at the bison's neck. The bear and bison came to a stop at the base of the hill on the pedestrian boardwalk. The bear continued to bite and pull at the bison's neck while the bison tried to get to its feet. The bison managed to stand and struggled to remain standing, but the bear continued to pull the bison back down to the ground. When the bison did stand, its hind legs buckled under its own weight. The bear took advantage of this and jumped onto the back of the bison, biting and clawing at its back, inflicting a number of bite and claw wounds around the bison's hump and lower back. With a quick head motion, the bull managed to free itself from the bear and stand up a second

time. At this time, I observed that the bison's left front leg was broken. This injury may have occurred when the bison slammed into the tree while sliding down the steep hill. The bison continued attempts to stand and fought off the bear with its head and horns for several minutes. The bear stood up on its hind legs and swiped at the bull's head with its paws. The bison reacted by rearing up, which caused it to slide backward into a ditch adjacent to the Fishing Bridge boardwalk. Being in the ditch appeared to put the bison in a better position to fend off the bear with its head and horns.

At this time the 2 cubs, which had been observing their mother from on top of the hill, came down and reunited with her near the bison. The bison continued to struggle to keep up-right and bled profusely from its back and hind-quarters. The adult bear attacked the bison several more times, but the bison was able to use its head and horns to repel the attacks. The cubs did not participate in these attacks but remained nearby. On 5 occasions the bears left the area and were no longer visible to me, then came back and the adult attacked the bull again, but was unable to kill it. The interval between attacks increased from approximately 5 minutes to several hours between return visits.

At approximately 1800 the bears left and did not return, enabling me to investigate the bison in the ditch. The bison was startled upon my approach and attempted to climb out of the ditch. It fell down and was unable to pull itself out of the mud. Due to the proximity of the bison to the main road and concerns for the safety of visitors and a construction crew working on the road bridge adjacent to the attack site, park management decided to dispatch the bison and move the carcass. After shooting the bison, the carcass was moved 0.9 km away to a location remote from public use areas. Managers hoped that the bear family group would follow the scent trail to where the carcass was disposed and scavenge the remains.

The next morning (24 September), an adult female grizzly with 2 cubs returned to the area where the attack occurred. The 3 bears were identical in size and color to the bears that had encountered the bison the previous day, and I believe they were the same family group. The adult female grizzly paced, circled, and sniffed the ground as she searched the site where she had attacked the bison the day before. Several visitors saw the bears from the main road and approached them in an attempt to get pictures. As they approached, the adult bear bluff charged them and chased them back toward the road. Due to the danger that an adult female grizzly accompanied by 2 cubs posed to park visitors and bridge construction workers, the bears were hazed out of the area with cracker shells. I monitored the area where the bison carcass was moved to, but never observed the female with cubs or their tracks in the

snow at the new location. Three days later, I observed a large adult male grizzly scavenging on the carcass. I observed that bear at the carcass for 5 consecutive days and then did not see it again. In that time, the grizzly consumed most of the bison. After the grizzly stopped returning to the carcass, a large male black bear (*Ursus americanus*) began frequenting the carcass and scavenging the remains. The black bear returned to the carcass to scavenge for several days until the carcass was entirely consumed. I did not see the female and her 2 cubs in the area again for the remainder of the season.

Tooth eruption and wear from the bison's mandible indicated it was 3½ years old (M. Meagher, YNP, Wyoming, USA, personal communication, 2001). Femur bone marrow was grayish-pink in color, indicating that the bull may have been in the early stages of marrow fat depletion, although not yet severely malnourished (Cheatum 1949). Visually, the bison had looked slightly thin, but there was no other evidence of poor health or injury prior to the attack or when I observed it fleeing from the bear.

Based on the paucity of documentation in the literature, grizzly bear predation on adult bison is likely very rare. However, the incident I observed indicates that grizzly bears can opportunistically pursue and kill adult bison under conditions where the bear has an advantage. In this case, the bison was alone and lacked the group protection afforded by a herd; it was also young and likely lacking in experience. The bison attempted to flee rather than stand its ground. Large ungulates such as bison (Smith et al. 2000), moose (Mech 1966), and elk (D. Smith, YNP, personal communication, 2001), are often more successful at deterring predatory attacks by confronting predators rather than fleeing. Although human safety concerns required euthanizing the bison and moving its carcass, the extent of the injuries already inflicted on the bison lead me to conclude that given more time and less human interference, the grizzly would undoubtedly have killed the bull.

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Ungulate meat is one of the most concentrated sources of digestible energy and protein available to grizzly bears (*Ursus arctos horribilis*) in the Yellowstone ecosystem (Mealey 1975, Pritchard and Robbins 1990, Craighead et al. 1995). Grizzly bears obtain ungulate meat primarily through scavenging winter-killed elk (*Cervus elaphus*) and bison (*Bison bison*) carrion (Craighead et al. 1995, Mattson 1997), usurping wolves (*Canis lupus*) from their ungulate kills (D. Smith, Yellowstone National Park, Wyoming, USA, unpublished data), and by predation on elk

calves (Mattson 1997). Although predation on elk calves in Yellowstone National Park (YNP), by both grizzly bears and American black bears (*U. americanus*), has been well documented (e.g., Howell 1921, Johnson 1951, Cole 1972, Craighead and Mitchell 1982, Gunther and Renkin 1990), we found no records in the literature documenting bear predation on bison calves. Although Skinner (1927) reported that grizzly bears preyed on bison calves, he gave no description to document that he actually saw it occur.

We describe a successful predatory attack on a bison calf by a grizzly bear in YNP, Wyoming. The event was observed by the senior author and observed and photographed by both a professional cinematographer (Landis Wildlife Films, Gardiner, Montana, USA) and a still photographer (Chadwick and Sartore 2001). The film footage allowed repeated review by both authors, enabling us to clearly describe the event. We also had an experienced bison biologist review the videotaped film of the predation event.

The kill took place in Hayden Valley in central YNP. Hayden Valley is a large (>8,500 ha) nearly treeless valley surrounded by the forested Central Plateau. Flora in the valley consists of sagebrush (*Artemisia* spp.) and a variety of forbs, grasses, and sedges (*Carex* spp.) (Meagher 1973). Numerous graminoid-dominated wetlands are present in the valley. Lodgepole pine (*Pinus contorta*) forest types that occur on infertile rhyolite soils dominate the forested plateau surrounding Hayden Valley (Despain 1990). Spruce (*Picea engelmannii*)–fir (*Abies lasiocarpa*) stands are interspersed throughout the lodgepole pine zone in areas of more favorable moisture regimes such as pond margins, north slopes, and drainages (Graham 1978). Bison are active in Hayden Valley during all months of the year and breed and calve in the valley (Meagher 1973). Grizzly bears are active in the valley throughout the non-denning season from March through November.

The senior author observed the event from a vehicle pullout along the Grand Loop Road in Hayden Valley at approximately 730 hours on 26 June 2000. Observations were made with a 40x spotting scope and 8x binoculars. An adult female grizzly bear accompanied by 2 cubs-of-the-year was foraging approximately 2.5 km away, on a southwest facing slope on the northeast side of the Yellowstone River. The bear moved through the sagebrush in a searching pattern commonly observed when bears are hunting for newborn elk calves, as described by Gunther and Renkin (1990) and French and French (1990). Several cow elk were scattered along the tree-line 200–300 meters upslope from the bears. The 3 bears were working their way down slope toward the river as they apparently searched the sagebrush for elk calves. We observed a cow bison and her calf walking southeast along a bench on the northeast side of the river below the bears.

No other bison were visible in the area. Although hills blocked the view in some areas, the landscape could be observed for >500 m in all directions, and for a km or more in most directions. When the cow and calf approached the base of the slope below where the bears were foraging, they began to trot past, the cow in the lead. The adult grizzly, approximately 200 meters upslope from the bison, stood on her hind legs and looked at the cow and calf as they trotted past. The bear then dropped down to all 4 legs and ran down the slope pursuing the bison, leaving her cubs behind. As soon as the bear began running downslope, the cow and calf began to run away. The cow changed position and ran behind her calf, keeping herself between the bear and her calf. Within seconds, the bear had closed the distance and was within a few meters of the fleeing cow and calf. The chase proceeded west toward the bank of the river and reached a swale approximately 1 km from the observers where sagebrush and the low swale partially obscured our view. As the bear started to pass the cow in pursuit of the calf, the cow whirled around and confronted the bear. However, the bear veered past the cow and continued chasing the calf. When the 3 animals emerged from the swale, the calf was running in front followed by the bear and then the cow. As the bear drew near the calf, the calf turned and ran in tighter and tighter circles. The chase moved back into the swale again, partially obscuring our view. While in the swale, the bear made contact with the calf and knocked it down. It made contact again and appeared to bite the calf before jumping out of the way of the charging cow, which lowered its head and tried to hook at the bear with its horns. The bear reappeared from the swale holding the calf in its mouth with the cow chasing it. The bear stopped, dropped the calf, and stood its ground over the calf while facing the cow. The cow momentarily stopped pursuing it, but remained 20–30 meters away, circling and occasionally rushing in and hooking its horns at the bear. However, the cow always retreated quickly when the bear did not run. After the cow stopped charging at the bear, the bear began to eat the calf. The cow stayed 20–30 meters away and occasionally nibbled grass. After the bear had been feeding on the calf for approximately 15 minutes, the cow abruptly ran north and did not return.

The bear fed on the calf for about 30 minutes, then spent approximately 10 minutes covering the carcass with dirt, grass, and sagebrush branches. By this time, the cubs had moved across the slope approximately 300 meters to the east and far uphill from the kill site. The cubs stood up often and looked around. The bear then moved directly east upslope to her cubs and led them up a long draw and into a forested area and out of sight. The bear and 2 cubs returned to the carcass at approximately 1945 hours that evening. The bear uncovered it and fed on it steadily un-

til 2130 hours, when it became too dark to make further observations. The cubs investigated and played around the carcass most of the time their mother was feeding on it.

Most bison calves in YNP are born in early May, and calving is generally over by the end of May, although a few calves are born as late as September (Meagher 1973). Based on horn size, body size, and coloration, the bison calf killed by the grizzly bear was 7–8 weeks old (M. Meagher, YNP, Wyoming, USA, personal communication, 2001). It is uncommon for bison cows with calves of that age to be away from mixed herds (females, other calves, juvenile males, and often one or more mature males). Bison cows, especially with calves, are rarely separate from a mixed herd even in winter (Fuller 1960, Meagher 1973, Shaw and Meagher 1999). However there are exceptions. In the harsh winter environment in Yellowstone's Pelican Valley, bison groups often disperse as snow deepens and scatter as individuals or a few animals together, moving into geothermal areas that provide the survival margin in the deep snows (Meagher 1970, 1973, 1986). An isolated cow with a calf is not rare in these conditions. Also, beginning in 1982, the Yellowstone bison population has been undergoing major changes in distribution and numbers (Taper et al. 2000). As part of this, group size and cohesiveness has changed, with mixed herds decreasing in size earlier in the breeding season and bison aggregations much more spread out. By the summer of 1996, there appeared to be a breaking of the more usual bison social bonds, even before the end of the growing season (M. Meagher, personal communication, 2001). These changes may have contributed to the presence of the apparently solitary bison cow with her calf and left them vulnerable to predation.

Injury, disease, or malnutrition could also have left the bison cow and calf vulnerable to predation. However, multiple reviews of the videotaped film did not suggest that the bison cow was impaired in any way. She did not limp or appear to be uneven in her gaits. Her agility appeared unimpaired as she changed directions and turned to face the bear. Her physical condition appeared to be prime, with none of the end-of-winter boniness of ribs and iliac crest often observed. The condition of her coat and timing of the molt were also consistent with those of a bison in good condition. Nutrition influences hair condition and timing of the molt in mammals (Robbins 1983). At the time of the observation, bison are often still shedding winter coats, which may cling in ragged lighter-colored patches on top of newly-growing pelage. But a bison in poor condition may have much of the winter coat still attached, and look generally unthrifty (M. Meagher, personal communication, 2001). Nothing in the appearance of the bison cow's coat indicated that it was malnourished.

Craighead et al. (1995) studied grizzly bear behavior in YNP from 1959–70 and documented grizzly bears killing malnourished adult bison in spring but did not observe predation on bison calves. The Interagency Grizzly Bear Study Team (IGBST) has conducted research on grizzly bears in YNP since 1973 and has not documented predation on bison calves during that 29-year period (M. Haroldson, IGBST, Bozeman, Montana, USA, personal communication, 2001). Long-term (37 years) bison research and monitoring in YNP also has not documented bear predation on bison calves (Meagher 1973; M. Meagher, personal communication, 2001). Extensive reviews of recent bison literature (Meagher 1986, Reynolds et al. 1982, Shaw and Meagher 1999) found no evidence of grizzly bear predation on adult bison or calves (but see Wyman 2002). In an exhaustive review of historical sources, Roe (1970) found a credible account of one successful grizzly bear kill of a bison cow, but none on calves. Given the extensive documentation in the literature of grizzly bear predation on elk calves, we believe that predation on bison calves is an infrequent, opportunistic event or it would have been reported previously.

Bison behavior coupled with the risks associated with predation on bison calves may preclude more extensive use of this resource by bears. We hypothesize that the bison cow and calf were vulnerable to predation due to being isolated from a herd or mixed group. Most bison are highly gregarious (Meagher 1973, Shaw and Meagher 1999). Situations where cows with calves are isolated from herds or mixed groups as in the incident we described are uncommon except for a short period during and immediately after calving (Reynolds et al. 1982). In groups, adult bison are very formidable in protecting their calves. Gunther (1991) described an incident where an adult grizzly bear approached 19 bison including 5 calves. As the bear approached, the adult bison bunched together into a tight group and stood adjacent to each other facing the bear. The calves ran behind the adult bison for protection. The bear stopped its approach, sat down and looked at the bison, then turned and walked away.

Even when isolated from herds, the protective behavior of adult cow bison combined with their size (318–545 kg), sprinting ability (66 km/h, Meagher 1986), agility, and horns (Meagher 1973) make them quite formidable when protecting their calves, even if the defense is only a bluff. In addition, not all behavioral threats made by bison during interspecific interactions are bluffs. McHugh (1958) observed defensive behavior against humans, horses, ravens (*Corvus corax*), a pronghorn (*Antilocapra americana*), and a porcupine (*Erethizon dorsatum*). YNP files contain one account of a jogger injured by a cow bison with a new calf and multiple accounts of park visitors being injured by bull bison almost every year (M.



Meagher, personal communication, 2001). In addition, there have been several incidents of horses being gored by bison in the park. We hypothesize that the frequency of attempted grizzly bear predation on bison calves is likely limited by threats from the bison and the potential for injury to predatory bears.

A review of the literature describing wolf–bison interaction may provide some insight into anti-predator defense tactics bison use against large predators and explain why the bison cow turned to confront the bear rather than continue fleeing. Of 45 observed encounters between groups of YNP bison and wolves, the bison reacted by tightly grouping 38 times (Smith et al. 2000). In 32 of the 45 observed incidents, the bison stood and faced the wolves. Of 14 known successful predation events, 8 involved bison that were impaired. Videotape of wolf–bison interactions (D. Smith, personal communication, 2001) indicated that wolves attempted to take healthy bison when the bison were plunging in line in deep snow. As the bison reached solid open ground, the target individual would turn and face the wolves, which then backed off. In Canada's Wood Buffalo National Park, wolves often singled out individuals separated from herds (Haynes 1982, Carbyn et al. 1993). We can only infer that grizzly bears are capable of judging their opportunities and reacting accordingly to a separated cow with a calf, especially when the bison are at a disadvantage downslope from the bears. In spite of the speed at which bison can sprint, they typically react to large predators such as wolves by standing their ground (Smith et al. 2000). This tactic has also been observed to be successful for muskoxen (*Ovibos moschatus*; Gunn 1982), moose (*Alces alces*; Mech 1966) and elk (D. Smith, personal communication, 2001) in deterring predatory wolves and for bison mixed groups against grizzly bears (Gunther 1991). This type of reaction to a threat to her calf, even if a bluff, might explain the solitary cow's apparent effort to keep herself between her calf and the bear when initially fleeing and then to confront the bear when it caught up to her and her calf.

The incident we described involved a female grizzly bear with cubs, suggesting that some cubs have at least limited opportunity to learn this behavior from their mothers. Although we believe that bear predation on bison calves is rare, this incident indicates that grizzly bears are capable of taking advantage of favorable circumstances to kill and consume bison calves.

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