

# Descriptions of Wolf Attacks on Bison Calves in Wood Buffalo National Park

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**ABSTRACT.** Wolf predation on bison in Wood Buffalo Park and adjacent areas in late spring/early summer season was observed to be directed toward cow/calf herds. While hunting, wolf packs in early summer developed a strong preference for herds with calves. Packs of four to six individuals were observed. Of 14 interactions recorded, 12 were made from ground observations and 2 were made from the air. Five apparent defense strategies to protect calves were noted. These were: 1) to run to the cow, 2) to run to a herd, 3) to run to the nearest bull, 4) to get out in front and center of a stampeding herd and 5) to run through water bodies. When fleeing from wolves in open areas, cows with young calves took the lead, while bulls often were seen at the rear of the herds. When under attack from wolves, cows and particularly bulls were sometimes seen to defend the calves. Killing attempts observed in this study lasted from a few minutes to 11 hours.

**Key words:** wolf predation, bison, wolves, antipredator defense, Wood Buffalo National Park

**RÉSUMÉ.** On a observé qu'à la fin du printemps et au début de l'été, la prédation des loups envers les bisons du parc national Wood Buffalo et des régions adjacentes, était dirigée vers les troupeaux de femelles et de veaux. Quand elles chassaient au début de l'été, les meutes de loups développaient une forte préférence pour les troupeaux comprenant des veaux. On a observé des meutes de quatre à six individus. Sur les 14 interactions enregistrées, 12 l'ont été à partir d'observations faites du sol, et deux à partir d'observations aériennes. On a relevé cinq stratégies apparentes de défense pour protéger les veaux, qui consistaient à: 1) courir vers la femelle, 2) courir vers un troupeau, 3) courir vers le mâle le plus proche, 4) se mettre en avant et au centre d'un troupeau qui fuit précipitamment et 5) traverser des étendues d'eau en courant. En fuyant les loups en terrain libre, les femelles avec de jeunes veaux se plaçaient en tête du troupeau, tandis que les mâles étaient souvent observés à la queue du troupeau. Quand les bisons étaient attaqués par les loups, on a parfois vu les femelles et surtout les mâles, en train de défendre les veaux. Dans cette étude, on a observé des tentatives de mise à mort dont la durée allait de quelques minutes à 11 heures.

**Mots clés:** prédation des loups, bisons, loups, défense contre les prédateurs, parc national Wood Buffalo

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## INTRODUCTION

Wood Buffalo National Park and adjacent Slave River Lowlands (Fig. 1) are one of a few areas where wolves are preying on free-roaming bison (Van Camp, 1987). This historical association of wolves (*Canis lupus*) and bison (*Bison bison*) was first documented at the turn of the century by Seton (1886, 1911). Soper (1942) was next to comment on wolf numbers and their distribution in Wood Buffalo National Park. He believed that numbers during the 1920s were fewer than in previous years and that increases took place between 1932 and 1945 (Soper, 1945). Since 1932, residents of Fort Chipewyan and Fort Smith have urged governments to carry out predator control programs. Local programs were carried out in the late 1940s and early 1950s and resulted in wolf declines (Oldham, 1947; Fuller and Novakowski, 1955). During the late 1960s, wolves in the park again appeared to be increasing (Carbyn *et al.*, 1987) but because of changed park policies, no official control programs were carried out. However, opportunistic trapping and shooting by trappers occurred during that time (Van Camp, 1987).

Historically, Wood bison (*Bison bison athabasca*) ranged throughout much of western and northern Canada (Fuller, 1960), but by the late 1800s their numbers were greatly reduced (Fuller, 1962). Only about 500 bison were estimated to be present in the area now contained within the northern two-thirds of Wood Buffalo National Park at the time that legislation for the protection of remnant herds was passed in 1893 by the Canadian Parliament. Bison numbers slowly increased, particularly after police protection was available and the first six wardens were appointed in the beginning of the twentieth century (Carbyn *et al.*, 1987). Wood Buffalo National Park was set aside in 1922 to protect the remaining herds of wood bison (Graham, 1923). During 1925-28 attempts were made to transport approximately

6600 plains bison some 1200 km from Wainwright Buffalo Park in central Alberta to Wood Buffalo National Park. Heavy mor-

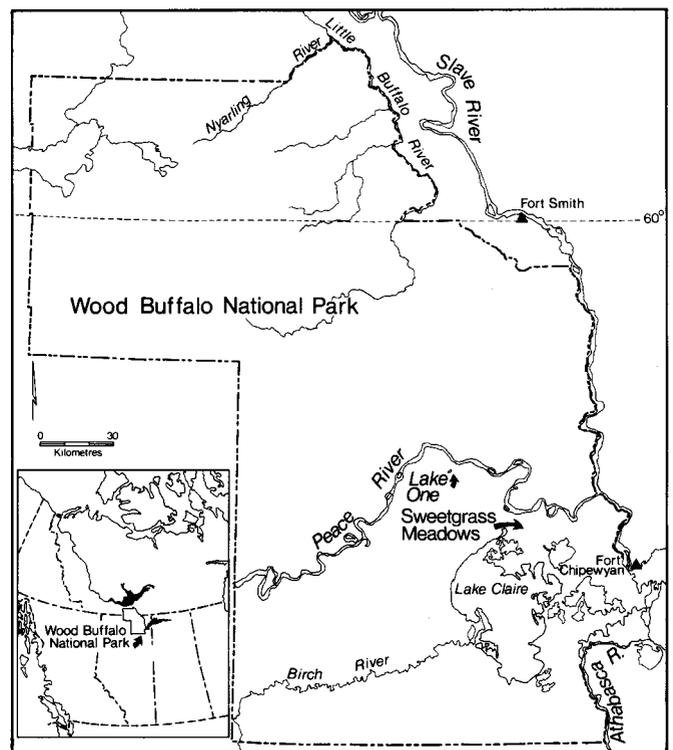


FIG. 1. Map of Wood Buffalo National Park, indicating locations of Lake One and Sweetgrass. Wolf/bison observations were carried out in these two areas of the park.

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tality occurred during the transport and the number of survivors was significantly less than 6600 (W.A. Fuller, pers. comm.).

The introduced plains bison interbred with the residual wood buffalo, and the bison observed in this study were the descendants of the original wood bison and introduced plains bison. Although the plains bison outnumbered the wood bison nearly ten to one, characteristics of the wood bison persisted perhaps more strongly than might be expected because the wood buffalo were, of course, well established in the region, while the introduced plains animals were stressed by the move and the new environment. Thus, many of the animals in the evolving population showed remarkably strong resemblance to wood bison (Carbyn *et al.*, 1987). The population of bison in the Wood Buffalo Park area peaked in the 1960s and declined to about 5000 animals in the mid-1980s (Carbyn *et al.*, 1987).

Wolves are natural predators of wood buffalo (Fig. 2), and a program of the Canadian Wildlife Service to reintroduce wood bison in northern areas of Canada beginning in 1975 (Reynolds *et al.*, 1982) resulted in an increase in the number of sites where wolf predation on bison could occur. Thus, the wood bison rehabilitation program generated increased interest in the dynamics of wolf-prey interactions.



FIG. 2. A pack of wolves in association with a herd of bison at Lake One. Bison not under attack by wolves appear to pay very little attention to the presence of wolves.

Studies on wolf/bison interactions were previously carried out from 1978 to 1981 (Oosenbrug and Carbyn, 1982) in Wood Buffalo National Park. During the three-year study, 43 wolves were captured and radio-collared and predation in winter was observed from fixed-wing aircraft (Oosenbrug and Carbyn, 1982). The present paper presents summer observations on wolf predation on bison when calves are small, from May to June 1980 and June 1986 and 1987.

## METHODS

Wolf predation on bison was observed using  $7 \times 56$  binoculars from a 2.5 m high tower located on the Lake One prairies, a mix of upland and marshy areas located approximately 7 km south of Peace Point. These observations on antipredator behaviour were supplemented by aerial and ground observations elsewhere in the Peace/Athabasca Delta in June 1986 and 1987. The observation tower in 1980 was manned from 0600 until 2200 h. Detailed sequences of wolf attacks were observed on several occasions and notes were recorded directly on tape. Distances were estimated in paces and converted here to metres.

## GROUND OBSERVATIONS

*28 May 1980.* Observations made on this day accounted for 11 attacks. Wolves had been testing several small bison herds for three days prior to major interactions that occurred on 28 May. One small herd (15 bulls, 1 cow, and a calf about 5-20 days old) was seen resting on 28 May at 0620 h. Four wolves were spotted lying approximately 200 m from the bison. The wolves made no effort to conceal themselves. At 0720 h, the bison stood up and started to graze. Bulls began to disperse and the cow and calf moved away from the wolves. When the cow and calf began to run, the wolves followed, circling the bulls. A group of five bulls separated from the main herd, and the cow led her calf to that group. The four wolves, once widely separated, converged, pressing the attack. One wolf lunged at the calf as the cow wheeled around and charged with head low and tail raised. The other three wolves passed the cow and continued to chase the calf. In the meantime, the five bulls surrounded the calf while attacking the wolves. Wolves constantly avoided the charges of the bulls.

This interaction lasted only seconds, with the wolves finally retreating, while the cow and calf, surrounded by bulls, walked in a closed group to higher ground. As it moved on, the herd spread out, with bulls butting one another (displacement activity?). A lone bull charged two wolves, which subsequently retreated. Bulls bunched up around the cow and calf and watched the wolves, which by then had moved away about 200 m. All four wolves lay down in a lowland sedge area, still watching the bison. At 0830 h, one wolf arose and trotted toward the grazing bison. The second attack began when the cow and calf trotted away from the group, which ignored the cow until the four wolves ran by in pursuit of the calf. The leading wolf was turned aside by the charging cow, while the calf ran away on its own. Several wolves grabbed the calf and pulled it down. The calf struggled free and ran off in a semi-circle. The cow met it coming back, along with several bulls that charged the circling wolves. The cow stood with head turned aside and the calf pressed against her flank.

Two wolves trotted 150 m east of the tight group. The other two wolves "patrolled" the opposite side of the herd. Shortly the cow raised her tail and trotted off, leading the calf and the bulls south. Two of the wolves were quickly forced back when the bulls charged. All four wolves persisted in their pursuit of the cow and her calf. The cow turned to meet them as her calf once again fled, this time seeking protection from the advancing bulls. The bulls charged the wolves.

Fifteen minutes after this attempt three bulls, the cow, and calf were standing 100 m south of the main herd. The bulls were grazing or lying down, ruminating. The wolves rested 100 m

north of the herd. That situation remained until 0910 h, at which point about 3 hours had elapsed since the first attacks. The alpha wolf then rose and moved past the group of bulls. Two other wolves followed. When all three were among the bulls, the cow and calf began walking away. The wolves followed, then retreated when the bulls turned on them. Seven other bulls were approaching from the north, and they successfully chased the wolves aside and thwarted their efforts.

At 0915 h, the cow, calf, and five bulls had reached an area closer to forest cover. The remaining bulls lagged behind, grazing in widely scattered groups. One wolf rose and first trotted south, then east, until well past the cow-calf group. Two other wolves walked among the trailing bulls. At first it seemed that the wolves wanted to prevent the cow and calf from entering the forest, but later it appeared more likely that the wolves were trying to stampede the small herd and cause them to scatter. When the cow and calf ran for cover, three wolves swung around and ran parallel to the forest, effectively cutting off their quarry. The cow and calf turned back to return to the slower bulls. When the group containing the cow and calf bolted a second time, several bulls entered the forest and disappeared. The cow, however, veered southeast before turning abruptly along the side of a sand ridge, where she and 7 to 11 bulls kept the wolves at bay for 2 hours.

All four wolves wandered back and forth along the ridge, eventually lying down at 20-50 m from the shielded calf. Later, the cow descended the ridge, heading north at a fast walk; however, the calf lingered behind with a group of bulls until its mother was about 150 m away. It then descended the ridge and was detected by one wolf lying 100 m from the scene. The cow ran back and escorted her calf up the ridge, as the four wolves came from the opposite side of the ridge. The wolves were charged by several young bulls at the top of the ridge. Then for the third time, the cow headed north off the ridge and across the prairie, apparently leading her calf away from the wolves. After about 200 m she stopped to look back and waited as her calf slowly descended the ridge to follow. When the calf was 50 m out, the alpha wolf came around the ridge, initiating a series of pursuits that resulted in the fourth all-out attack.

From a halting gait, the wolf broke out into a fast lope, while the calf quickly reached its mother, fleeing at a quick pace. After about 600 m the cow was forced to turn and defend her calf. The calf swung around and was knocked down by the charging wolf. After scrambling to its feet, the calf fled with a burst of speed toward the ridge, leaving the wolf behind to face the cow. The wolf gave chase but was cut off by a young bull. The cow appeared to strike the wolf with her forefeet. The wolf rolled over, came to its feet and ran quickly past the young bull, almost catching the calf as it descended the ridge. At the same time, three other wolves came over the ridge, as three bulls on top surrounded the calf. Within seconds the cow and young bull returned to help drive off the wolves.

The wolves then reunited into a pack. The bulls resumed feeding, but the cow and calf remained alert. At 1030 h, the cow headed east while the calf lagged behind with three young bulls. The wolves, which were standing at the edge of the forest, then proceeded to move out into the open prairie. Both the calf and a young bull trailed the cow. When the calf drew ahead of the bull, the wolves closed to within about 300 m of the calf, at which point the cow and bull turned around to defend it. The wolves skirted them, avoiding the charges. The cow then ran northeast, followed by her calf as three more bulls approached.

The wolves passed them and overtook the calf. The alpha wolf then grabbed the calf (fifth time) at the back of its left flank, only to be chased off by two bulls and the cow. A skirmish occurred, with bulls charging and wolves dodging. The calf, with the cow at its side, was repeatedly rushed by the wolves. Two wolves downed the calf (sixth time), but it squirmed out and took off running. Three wolves pulled the calf down again (seventh time), but again the adult bison chased them off. Four very excited wolves circled and darted in, looking for an opening as bulls and cows shielded the calf. The alpha wolf persisted, finally grabbing the calf again (eighth time), before being chased off by the cow. The downed calf rose slowly this time and stood weakly. The calf appeared to be wounded in several places.

The wolves persisted in their attacks as the cow and calf trotted northeast, four young and two mature bulls following. One young bull escorted the cow. The wolves were apparently tiring, cantering along behind with the alpha wolf leading. When the herd gathered and stopped near an aspen bluff, the wolves moved into tall grass and rested. The cow moved off again, with the calf and two bulls following behind. The wolves sprang up and gave chase. When they overtook the foursome, two bulls wheeled to charge, but the wolves by-passed them and soon overtook the cow and calf. The cow turned on them, but they veered around her and caught the still-running calf. Two wolves grabbed it (ninth time) by the hind legs, but the calf kicked itself free while continuing to run. Three bulls then rushed in to protect it. The alpha wolf, with tail swinging in an arc over its back, charged the group. The pack circled the bison, looking for an opening, the alpha wolf being the most persistent. When the remainder of the bulls caught up, the cow left with them in a very tight formation walking in a northeasterly direction.

At 1105 h, the cow and calf ran off to the east once more, bulls trotting about 20 m behind. The wolves persisted in the attack, at which point the cow turned and ran back to the bulls, which then shielded the calf. The cow bolted from the herd, heading northwest with her calf. The wolves rushed in, but not soon enough, as four young bulls closed around the twosome. Again the cow ran off, this time her calf and one bull trailing. The wolves appeared to be tiring (panting hard), but some gave chase. A stand-off resulted, with the cow and one bull protecting the calf until other bulls charged, driving the wolves off. The calf wheeled around the cow, who charged the wolves while the calf ran in a circle and returned to the other three bulls. Meanwhile, two wolves grabbed the calf (tenth time), taking it down. The cow and bulls chased them off, the calf scrambling to its feet and running back to the sand ridge, followed by two young bulls and the cow. Once more the pack nearly caught up to the calf, but the bulls were surprisingly fast and quick in their defense.

Five hours had elapsed since the chase began, and yet the wolves persisted in their attempt to kill the calf. The calf was injured and bled from various cuts. At 1110 h, the wolves again tried to bring it down. The herd turned back toward aspen cover, walking briskly, with a young bull out front trotting. The wolves appeared exhausted and were panting. The cow waited for the other bulls to join her, then continued on. The wolves dropped well back of the herd, as though tiring. Only the alpha wolf accelerated its movements when the cow and calf outran the herd, but at this stage even this wolf was unable to overtake the bison. Chases back and forth continued. The calf walked stiffly, limping; yet it could still run and seemed to have the stamina to resort to short bursts of speed when needed. The herd spent an

hour grazing, then gradually moved to a pond, where they drank water.

By 1330 h, all were down resting and remained so until 1630 h. Finally the cow and calf got up. She waited as her calf slowly "hobbled" up to her. Examination of the calf through binoculars revealed wounds on the upper left front leg near the chest. The forehead was bloody, and conspicuous wounds were present on the lower hind legs. The upper right hind leg was noticeably swollen. There was no sign of any profuse bleeding anywhere, as the rain-soaked prairie probably kept blood washed off the calf. Fifteen minutes after the bison got up, the alpha wolf appeared from the north. The wolf trotted almost in a straight line toward the bison and was followed by the rest of the pack.

The bison drew together and walked to higher ground. The herd stood huddled, some tails raised, watching the alpha wolf circle the herd and then return to the other three wolves. The wolves were about 600 m away when the cow bolted and led her calf away from the protection of the herd. The alpha wolf looked back, saw this, and quickly started back toward the bison, travelling in a straight line through hummocky water-soaked lowland as it responded to a sudden dash by the alert cow southwest of where several bulls were grazing. The wolf overtook and passed the cow, but the calf out front reached one bull, who swung around defiantly. The calf fled around to the protected side of the bull. The alpha wolf, unable to stop and perhaps intending to ambush the calf, appeared to leap over the bull's rump. Cow and bull, with backs arched and tails raised, shielded the calf from the prancing, excited wolf.

The wolves subsequently left and reappeared at 1730 h. At that time the cow, calf, and one mature bull grazed and stood only 50 m away from one of the wolves. A subordinate female wolf kept up a brisk, steady pace, as if ignoring the bison, then suddenly rushed the calf. One bull spotted her and charged. The cow reached its calf and the wolf was forced to retreat. At 1800 h, two wolves entered the prairie and trotted northwest. Despite its white coat, the wolf was very close to the calf before the bull appeared to notice. The cow rushed up to face the wolf. The calf ran in a tight circle, trying to shake the predator and return to safety, but was hit on the right shoulder (eleventh attack) before the cow and the bull chased the wolf away. The wolf circled the huddled trio, tail wagging as it watched briefly from 10 m away before continuing westward, abandoning the chase.

For the next two days these bison were seen frequently. The calf, very stiff at first, appeared to recover quickly from the ordeal, and was seen "frolicking" and nursing after a 24-hour period. Not known, of course, is whether subsequent gangrene set in the wounds, a condition recorded under similar circumstances by W.A. Fuller (1962).

The strategy of the wolves had been to lie in wait, then when the herd moved, to try to isolate the calf from the adults. The calf survived because of its speed, its very agile movements when downed, and the quick defense responses of the bulls. Particularly effective were the younger bulls. It appears that the main reason why the wolves could not kill the calf was the defense put up by the bulls. Had the herd been larger, with a lower calf/bull ratio, the outcome might have been different.

*6 June 1980.* A herd consisting of 21 cows, 4 yearlings, 3 animals of unknown age, and 6 calves was observed from 1440 to 1700 h. The herd was seen resting at the edge of forest cover and was under surveillance by four wolves. Bison intermittently stood up to graze briefly or nurse. There was no major move-

ment until 1600 h. The wolves did not relax their vigilance throughout. At 2130 h, this herd was seen again moving about restlessly. Calves, whether resting or moving, remained as a unit (described as pods; Carbyn and Trottier, 1987) and appeared to favour the mid-area of the herd. Wolves followed the moving herd in an uncoordinated fashion but did not attack.

*12 June 1980.* At 0635 h, the above herd moved along the edge of Lake One prairie, while one wolf trailed it at a distance 50-250 m. The wolf veered around the herd and entered forest cover while the bison began to graze. The cows and calves moved in the central portion of the herd. The bison moved into cover and were followed by two wolves. At 0730 h, the herd stampeded out of the cover and several adults in the rear turned as if facing wolves, which were not visible. Then the herd returned to the forest along a bison migration trail. At least two wolves followed and, although not witnessed because of dense vegetation, a calf was attacked and killed. The length of the chase in the bush was about 300 m. A cow was seen at 1330 h moving about quickly (suggesting stressed condition). Vocalization by the bison included grunting, interrupted by loud "snorts." The cow charged the alpha wolf while it was feeding on the calf. She also spotted the human observer nearby and, with tail raised slightly, advanced slowly. The observer quickly retreated. The cow returned to her calf two more times that day (1920 and 2200 h). The cow received gashes along the upper left flank and had lost her tail. Portions of the tail were found at the kill site. Virtually nothing remained of the calf carcass within 24 hours except small tufts of hair and small portions of both scapulae, pelvis, and lower jaw.

On 13 June a second calf within the same herd seemed to limp, to walk slowly, and to have trouble getting to its feet. On 14 June, only four calves were seen, none of them limping. The curious behaviour of one cow (identical to that observed in the cow that had lost her calf on 12 June) and the persistent movements of the alpha wolf to a specific area also frequented by the cow suggested that the limping calf had been killed and consumed by wolves.

*15 June 1980.* At 1020 h, two subordinate wolves were seen feeding on a bison calf while the alpha wolf rested nearby, but details of the attack were not obtained. Inspection of the kill an hour later revealed that flesh from the left femur was all that had been consumed. Because rigor mortis had not yet set in, it appeared that the calf had been chased and killed in an open prairie and that the wolves were not hungry enough to immediately consume the carcass. Wounds that exposed the lungs were noted on the right shoulder. Trampled grass for 20 m indicated the trail of attack. Examination of the site one day later revealed that the whole carcass was either eaten or dragged away, as the only remaining evidence of the kill was trampled and blood-stained grass.

#### AERIAL OBSERVATIONS

*18 June 1986.* About 75 bison running full out were seen fleeing from six wolves. The first observation was by chance encounter, so it was not possible to determine how long the chase had been in progress at the time the herd and wolves were first spotted. The chase was observed from 1840 to 1900 h. Calves with adults formed the front half of the herd. A number of mature bulls were seen at the rear. The position of subadults

was not clear, as their identity could not be ascertained from the air. The herd was in a tight formation and its flight path paralleled a creek. Advancing wolves were charged by the closest bulls. Upon reaching a bison trail, the herd quickly changed course by 90° and crossed a water body. Three wolves did not enter the water, and of the three that did, only one reached the other side. The bison immediately discontinued running, and at that point observations from the air were discontinued.

18 June 1986. The above herd was again tested by the same wolves from 1940 to 2000 h. When first seen, the wolves were watching the helicopter, while the bison appeared to be in a state of agitation. The six wolves attacked and the herd fled in the same manner as in the previous observation, that is, in a tight formation with cows and calves in the lead and bulls in the rear. A few bulls fell behind the wolves and the attacking wolves showed no interest in them. Calves that edged to the side of the fleeing herd were singled out for attacks by the closest wolf. Occasionally a wolf would increase its efforts by lunging out to reach calves that appeared to be in the open. Each time, a bull or the nearest cow would lower its head in defense. The chase ended when the wolves discontinued the attack, apparently exhausted. The herd then stopped and spread out, with straggling bulls attacking wolves as they passed by.

#### DISCUSSION

During early summer, wolves selectively seek out herds with calves over herds without calves (Carbyn and Trottier, 1987). From this it can be deduced that the predators must have developed a search image for calves. Therefore, as suggested by Mueller (1971) for other species, "oddity" of the prey (in this case a calf) and specific search image of the predator are probably more important in the predation equation than is conspicuousness of the herds. We therefore assume that wolves will seek out herds with calves. Calves are small and once captured are easier to kill than adult bison. It was a surprise to us that young calves were not as vulnerable to wolves as would have appeared on a superficial evaluation, although Fuller (1962) suggested that this might be the case. Ungulate populations must develop antipredator strategies that will protect calves (oddities), which are important to the survival of the herds. Defense of calves observed in this study included 1) running to the cow, 2) running to the herd, 3) running to the nearest bull, 4) getting out to front and center of fleeing herd, and 5) running through water bodies.

In another study (Oosenbrug and Carbyn, unpubl. data) it is pointed out that calf losses to predation in winter are high. It is logical to assume that the protective formation of keeping calves in the front third of fleeing herds breaks down when bison are chased from meadows into timbered areas. Heavy vegetation in the form of trees probably acts as a "filter." Large animals (bulls, cows) crash through the vegetation, while calves tend to fall behind and are then exposed to trailing wolves.

Among African mammals the most gregarious species inhabit open grassy plains rather than forests, and it is not uncommon for bovids (members of the family *Bovidae*) to show group defense against predators (Estes, 1974). Muskoxen (*Ovibos moschatus*) inhabiting tundra regions have also evolved group defenses against wolves (Gray, 1983). In this paper we have shown that bison in Wood Buffalo National Park have acquired group defenses that, unlike those of muskoxen, appear to be less

structured (i.e., lack defense formations) but involve both sexes. The participation of bulls can be crucial, as was clearly evident by the marathon encounter documented for 28 May 1980.

Observations discussed in this paper suggest that bison have several responses to wolf attacks. The group episode of the lone cow with calf and small bull described for 28 May 1980 was atypical, because at that time of year most cows and calves are found in larger herds with a number of cow/calf combinations. Calves then often form small groups or "pods" (Carbyn and Trottier, 1987) within the larger herds. Whether this has a social function (play?) or an antipredator function is not clear, but we suggest that an antipredator function cannot be ruled out. Bulls participate actively in the defense of calves against wolves. The cow-calf bond provides "cover" for the offspring, and the presence of bulls increases the amount of "cover." We were impressed by the agility of calves, even at an early age. A calf under attack could outrun adult bison and thereby sought new "cover" by going from one adult to another. When herds stampeded, the strategy for calf protection appeared to change. For maximum protection in fleeing herds, calves should be forward of the center of the herd and flanked by adults. Although sample sizes are small, this was observed in herds in open prairies. Once fleeing herds are chased into forests, or otherwise more heavily vegetated areas, the positioning of calves probably changes. It appears that when herds of cows with calves enter forests, vulnerability of calves increases, in that they are less agile in areas where their movements are obstructed. Vegetation is likely a greater obstacle to the movements of calves than it is to that of adults. This results in the separation of young from adults and increases the probability of death of the calves.

Gray (1983) suggested that wolves were more likely to be successful when muskox herd stampede than if they stand their ground. We believe this also to be the case for bison.

Aerial observations, brief as they were, and also some of the ground observations indicated that bison can avoid wolf predation by flight. We did not see evidence of bison using water bodies in the manner that has been observed for other ungulates such as moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), and elk (*Cervus elaphus canadensis*). These species are known to flee into lakes, ponds, and sometimes rivers and to stay in the water to escape predation. In the one case observed in this study, bison ran through a stream, which was sufficient to terminate the chase by the attacking wolves. It appeared that the bison herd changed direction deliberately to cross the water body, which suggests that escape is enhanced if water bodies are nearby.

In this study we observed that bison protect young calves by means of a combination of group defense and fleeing. Group defense is not as highly developed as described for muskoxen but, nevertheless, is effective under some circumstances.

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