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Killing of a Muskox, *Ovibos moschatus*, by Two Wolves, *Canis lupus*, and Subsequent Caching

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The killing of a cow Muskox (*Ovibos moschatus*) by two Wolves (*Canis lupus*) in 5 minutes during summer on Ellesmere Island is described. After two of the four feedings observed, one Wolf cached a leg and regurgitated food as far as 2.3 km away and probably farther. The implications of this behavior for deriving food-consumption estimates are discussed.

Key Words: Wolf, *Canis lupus*, Muskox, *Ovibos moschatus*, predation, caching, food consumption, feeding, Northwest Territories, Canada.

"Encounters between wolves and muskoxen are rarely observed and seldom described in detail" (Gray 1987: 127–128). The only complete description of Wolves (*Canis lupus*) killing an adult Muskox (*Ovibos moschatus*) involved a single Wolf (Gray 1970, 1987); in addition, there are two partial accounts of two Wolves killing an adult (Gray 1983), and descriptions of several Wolves killing calves (Mech 1988). Here we describe two Wolves killing an adult, and we provide new information about caching of the kill remains.

The kill we observed took place on Ellesmere Island, Northwest Territories, Canada (80° N, 86°W) on 8 July 1998 when there is continuous daylight. The terrain is barren soil, gravel, rock outcrops and open tundra with no vegetation except widely scattered ground cover. The two Wolves involved were an adult male of unknown origin and a six-year-old female ("Explorer"), which the senior author had habituated to his close presence as a pup around a den in 1992 and studied in 1993 and 1994 (Mech 1995). In 1998, this animal lacked pups, as evidenced by her inconspicuous nipples and nomadic travels.

During the present observations, we used 4-wheeled All Terrain Vehicles to accompany this pair as they traveled and hunted (Mech 1994). We allowed the male to lead, and we paralleled him at distances of 50–100 m, while Explorer remained within a few metres of us; we continually watched ahead for any prey.

At about 0200 on 8 July 1998, the Wolves headed up some foothills along the side of a high escarpment and passed through a valley alongside the ridge. We spotted three Muskoxen about 500 m ahead in a valley at 0224 and immediately stopped and watched through 15X stabilized binoculars. The Wolves continued on toward the Muskoxen, and when about 100 m away, ran straight at them. The Muskoxen fled some 30 m and headed in a tight group up a steep slope, with the two largest animals (one a bull and the other presumably a bull) about half a body length ahead of the smallest, a cow.

As the Muskoxen were running about a third of the way up the slope at 0226, the male Wolf grabbed the last one (a cow) by the rump and hung on, and the female lunged toward the head. The cow wheeled around, and the male lost his grip. Both Wolves focused their attacks on the head and neck of the Muskox, biting at her nose and neck, sometimes hanging on and sometimes losing grip. The Muskox kept pushing up with her lowered head and horns but did not use her hooves. After about 30 seconds of the focused attack, one Wolf gained a solid grip on the cow's nose and the other immediately attacked the side of her neck, repeatedly grabbing a new purchase. The cow appeared to struggle little once the wolves had gained solid grips on her.

The two bulls had stopped about 15 m farther up the hill, and one of them suddenly charged down at the Wolves that were attacking the cow, sending one of the Wolves tumbling about 10 m down the hill. (We could not see whether contact was made, for the bull charged on the opposite side of the cow from us.) The bull hooked repeatedly at the remaining Wolf which eventually released its grip on the cow's nose. By now, the third Muskox had joined the other two, and they headed back up the hill with the cow tightly wedged between the 2 bulls. The Wolves quickly dashed back after the Muskox. Again one of the Wolves grabbed the rump of the cow, which wheeled to meet the wolf head on. The female then grabbed the cow by the nose, and the male by the side of the neck. The wolves kept their grips on the cow for about 30 seconds, and at 0231 the cow fell on a flat area of the hillside about 2/3 toward the top and stopped struggling. The Wolves

continued to tear at her head and neck, but the Muskox did not move.

Explorer fed on the Muskox, but the male climbed to the top of the ridge, possibly still wary of us even though we remained about 0.5 km away, and at 0243 he lay down about 20 m above the carcass. Explorer fed on the kill until 0324. She then immediately headed downhill intently searching around as if to begin caching, and went out of sight. At 0340, she passed by us, and we began accompanying her. At 0345, when about 1.5 km from the kill, Explorer dug a hole, regurgitated into it, and covered it. About 50 m away she repeated the behavior. She continued on out of sight at 0349, but the terrain prevented us from following.

At 0413, we saw Explorer about 0.8 km beyond the two caches, returning toward the kill, which she reached at 0441. She then slept near the carcass. Thus she was gone from the carcass for 77 minutes and had traveled at least as far as 2.3 km away from the carcass. From where and when we saw her disappear and reappear, we estimated that she had probably traveled as far as 5 km from the carcass, presumably continuing to cache throughout her trip.

We dug up the two caches and found that their contents of well-chewed, walnut-sized chunks of muscle meat weighed 0.65 and 0.66 kg. A Wolf's stomach can hold 10 kg of meat (Mech unpublished), so if Explorer ate and cached maximally, she could have made about 16 caches of the size we found. Her time and behavior away from the carcass suggests that she did make many caches, but her sleeping and lack of feeding immediately after returning to the carcass suggests that she may have retained at least some of what she had eaten.

We did not observe the Wolves from 0605 to 2150 on 8 July. From 2325 on 8 July to 0003 on 9 July, Explorer again fed on the carcass. Afterwards she alternately slept near the carcass and chased off an Arctic Fox (*Alopex lagopus*).

From 0251 to 0336, 9 July 1998, Explorer fed once more from the carcass. She then pulled off a front leg and shoulder and carried it off while zigzagging and looking around as if searching for a place to cache it. She brought the leg to us, and paraded around us a bit. Her abdomen was noticeably distended. After a couple of minutes, she continued on another 600 m to a rocky stream wash and buried the leg in gravel at 0415; only the hoof and ankle were exposed. She continued on in the same direction as when on her previous caching trip, and we lost sight of her again. We did not see her until she arrived back at the carcass at 0541. Her sides were no longer bulging, so apparently she had continued to cache. When we returned to our lookout at 0445, the male was feeding and he continued to do so until 0537, alternately chasing the Fox. Explorer fed again from 0543 to 0559 and lay down about 30 m away from the carcass. We left at 0645.

When we returned at 2130, the Wolves were gone. We then determined that the Muskox was a cow with well-worn teeth and an estimated 25% fat in her femur marrow. This poor condition may explain why the Wolves so readily attacked the cow and killed her so quickly, for often Wolf attacks on Muskoxen are far more prolonged (Gray 1970, 1983, 1987; Mech 1988 and unpublished). We each independently estimated that the amount eaten and cached from the carcass was about 90 kg, which was about all the readily available flesh.

Most Wolf food consumption estimates (summarized by Mech 1970 and by Schmidt and Mech 1997) are made by calculating the weight of edible material taken from a carcass and dividing that by the number of Wolves and days. In this case, the estimate would have been about 22.5 kg/Wolf/day. However, after two of the four feedings we observed, the Wolf cached unknown amounts. If the amount cached were about equal to that digested, then the actual consumption rate would have been only about half the estimate.

How often Wolves cache after killing large animals is unknown, but such caching is not uncommon (Murie 1944, Cowan 1947, Mech 1988, Mech et al. 1998). However, because most observations of Wolf predation are made from aircraft circling around a kill site for short periods, detailed observations such as we relate here are not usually made. Therefore, we suggest that previous food consumption estimates derived as described above may have to be qualified to account for possible caching that went undetected. In particular, conclusions derived from observations over intervals of a few days could be greatly inflated. We also suggest that future research emphasize attempting to determine how commonly Wolves cache after killing large animals, and under what circumstances.

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Evaluation of Various Methods Used to Color Mark Ducklings

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Seven methods used to color mark ducklings for the purpose of individual identification were evaluated for retention on groups of domestic ducklings. Marker loss varied considerably among methods and only nasal discs gave satisfactory retention beyond five days. This method of marking ducklings is tentatively recommended for studies concentrating on duckling movement and behavior. Furthermore, it is recommended that before any technique is used, the rate of marker loss be considered in light of the potential to influence results.

Key Words: marker, marking, duckling, nape tag, patagial tag, nasal disc.

Color-marking newly hatched ducklings to monitor subsequent movement, behavior and survival has proven to be problematic. Marking ducklings by injecting vegetable dyes into the egg (Evans 1951) provided a practical method of distinguishing broods during the early stages of development. However, in addition to an increase in embryo mortality due to the treatment (Evans 1951; McAloney 1973), retention time of these dyes was limited as ducklings underwent down loss and feather growth (Guignion 1967). Also, dark coloration of ducklings of many species masks the dyes (McAloney 1973; Milne 1963), further limiting applicability of this technique. Hardware markers such as patagial streamers (Weeks 1972) and nape tags (Bedard and Munro 1977; Foley 1956; McAloney 1973) have been used on ducklings in field situations but we are aware of no study which determined the retention times of these devices in controlled situations before field use on ducklings. Due to their thin and growing skin, ducklings may be more prone to marker loss than are adults of the same species, marked with the same technique. Knowledge of rates of marker loss and length of retention are critical if mortality and survival estimates are objectives of a study.

Once hatched, individual, wild ducklings are difficult to find due to their high mobility, gregarious nature and propensity to seek cover. Relatively few studies have attempted to mark individual ducklings due to difficulties capturing them and in devising a practical means of identification that would not hamper their activities or disrupt brood integrity. During a study of creching behavior of White-winged Scoters (*Melanitta fusca deglandi*) (Kehoe 1986), distinctive marking of individual and brood specific ducklings was necessary. In that study, a marker that would last from hatching to fledging was desired. Several marking systems were tested and evaluated using domestic ducklings (*Anas platyrhynchos*), before attempting to mark young scoters in the field.

Methods

Seven types of markers were tested for retention times, and effects on duckling survival using groups of domestic ducklings in a controlled environment. This environment was considered to give a "best case scenario" with respect to conditions that may influence marker loss. The ducklings were two days old when markers were applied. The marked ducklings were divided into groups of five, based on marker type, and groups were isolated from one