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Do wolves ambush beavers? Video evidence for higher-order hunting strategies

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Citation: Gable, T. D., T. Stanger, S. K. Windels, and J. K. Bump. 2018. Do wolves ambush beavers? Video evidence for higher-order hunting strategies. Ecosphere 9(3):e02159. 10.1002/ecs2.2159

Abstract. Over the past decade, there has been much debating about whether wolves possess high-order cognitive abilities that facilitate deliberate or cooperative hunting strategies such as ambush to capture prey. Beavers can be important alternate or primary prey for wolves in North America and Europe, but no observations of wolves hunting and killing beavers exist. We describe the first documented observation of a gray wolf killing a beaver, an observation that has provided valuable insight into how beavers defend themselves when attacked by wolves, how wolves hunt beavers, and the predatory strategies and cognitive abilities of wolves. Our observation confirms that wolves do hunt and kill beavers by surprising and ambushing them, which demonstrates that wolves have a unique ability to switch between cursorial and ambush hunting strategies depending on the prey. We suggest that wolves learn how to hunt beavers using high-order mental abilities combined with information learned from prior interactions with beavers.

Key words: alternate prey; cognition; hunting behavior; kill site; predation behavior; predation risk; predator–prey; wolf predation.

Received 6 December 2017; revised 16 January 2018; accepted 23 January 2018. Corresponding Editor: Robert R. Parmenter.

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INTRODUCTION

Wolves (*Canis lupus*) are cursorial predators that rely predominantly on outrunning and outlasting ungulate prey to kill them (Peterson and Ciucci 2003). There are a few anecdotal accounts, though, of wolves attempting to, or successfully ambushing prey such as caribou (*Rangifer tarandus*), muskox (*Ovibos moschatus*), arctic hares (*Lepus arcticus*), and Canada geese (*Branta canadensis*; Mech et al. 2015, Nichols 2015). However, there is much skepticism about whether wolves use deliberate or cooperative hunting strategies such as ambush to capture prey (Peterson and Ciucci 2003, Muro et al. 2011, Escobedo et al. 2014, Mech et al. 2015).

Mech (2007:145) suggested that wolves use higher-order mental processes to hunt and kill prey (defined as "foresight [behaving appropriately for dealing with a future event], understanding [comprehending complex relationships], and planning [deciding to behave in a way that considers information relevant to perceived outcome]"). There has been much debate whether or not the perceived cooperation between wolf pack members while hunting is evidence of these higher-order mental processes or advanced cognitive abilities (Escobedo et al. 2014, Mech et al. 2015). Computer simulations suggested that wolf pack ambushing behavior, which might appear purposive or intentional, could be the result of wolves following simple

rules instead of using advanced cognitive abilities (Muro et al. 2011). Such simulations were likely oversimplifications of wolf hunting behavior (Bailey et al. 2013) and did not incorporate the temporal and spatial complexities associated with ambush predation.

For most of the year, wolves hunt large ungulate prey cooperatively in packs (Peterson and Ciucci 2003). During late spring–early fall, wolf pack cohesion is reduced, and wolves commonly forage as individuals or in small groups within the pack (Demma et al. 2007, Metz et al. 2011, Barber-Meyer and Mech 2015). The decrease in pack cohesion during hunting coincides with the period when wolves use homesites (i.e., den and rendezvous sites) to raise pups, and when wolves are largely relying on smaller prey such as ungulate neonates, beavers (*Castor* spp.), and hares (*Lepus* spp.; Gable et al. 2018). Our understanding of wolf predation during this period is relatively poor (Palacios and Mech 2010, Metz et al. 2012, Gable and Windels 2017) as most wolf predation studies have occurred during winter when conditions are more conducive to finding wolf-killed prey and observing wolf hunting behavior (Mech et al. 2015).

Beavers are important alternate and primary prey for wolves from spring to fall (i.e., when ice-cover is absent) in many systems in northern North America and to a lesser degree, parts of Europe and Asia (Gable et al., *in press*). In areas with mild winters (i.e., minimal ice-cover), wolves will hunt beavers all year (Milne et al. 1989), and as a result, beavers can be the primary annual prey of wolves in these areas (Sidorovich et al. 2017). Despite this, little is known about the interactions between wolves and beavers. In Voyageurs National Park, USA, wolves appeared, based on where wolves killed beavers and how wolves spent time in beaver habitat, to hunt beavers by waiting for, and then ambushing beavers once they came on or near land (Gable et al. 2016). This indirect approach to understand how wolves hunt beavers was necessary because no documented observations of wolves killing beavers exist, despite the thousands of hours of wolf observations that have occurred around the world (Gable et al. 2016). Herein, we describe the first observation of a gray wolf killing a beaver. Fortunately, this event was captured on video which allowed a detailed analysis of the behavior of both the wolf and the beaver during this encounter. Although this is only one observation, it provides valuable information about wolf–beaver interactions and the complex hunting strategies that wolves are capable of.

Methods and Results

In late October 2015, co-author Trent Stanger (TS) observed and recorded a video of a wolf hunting and killing a beaver while he was driving logging roads moose hunting in a remote, forested area outside of Remigny, Quebec (47°46′ N, 79°12′ W). In total, his observation lasted about 15 min, and he recorded the last four minutes of the observation when the wolf attacked and killed the beaver (Video S1). On the day of the observation, the temperature was below freezing (<0°C), a light dusting of snow was on the ground, and there was no wind (Video S1). We have provided a detailed description of his account and put the corresponding time (min:s) from the video in parentheses. Trent Stanger did not record the specific location or the direction he was driving when the observation occurred but a detailed map of the site where the encounter occurred is documented in Fig. 1. For simplicity, we considered north to be the direction the wolf was facing when the video starts (Fig. 1; Video S1). We edited out one minute of the video (starting at 0:52) when the wolf moved into the forest and TS exited the car to observe on foot because the video was unstable and of poor quality.

Trent Stanger was driving down a logging road around 10:00 a.m. in a pickup truck when he noticed a wolf standing in the middle of the road facing away from him staring into the forest. Trent Stanger stopped the truck about 50 m from the wolf and watched as the wolf stood for 6–7 min staring into the forest and down the road. The wolf then started trotting down the road for about 300–400 m before slowing down and starting to walk cautiously for a few meters. Trent Stanger followed slowly in his truck about 50 m behind the wolf. The wolf then stopped—its head below its shoulders, tail somewhat lowered, and body still—and stared intently into the forest to the east of the road for 1–2 min (Fig. 2A). There was an active beaver pond about 15 m north/northwest of the wolf, and water from the pond had flooded the road about 15 m ahead of the wolf (Fig. 1). A small stream ran along about 1–2 m off the east

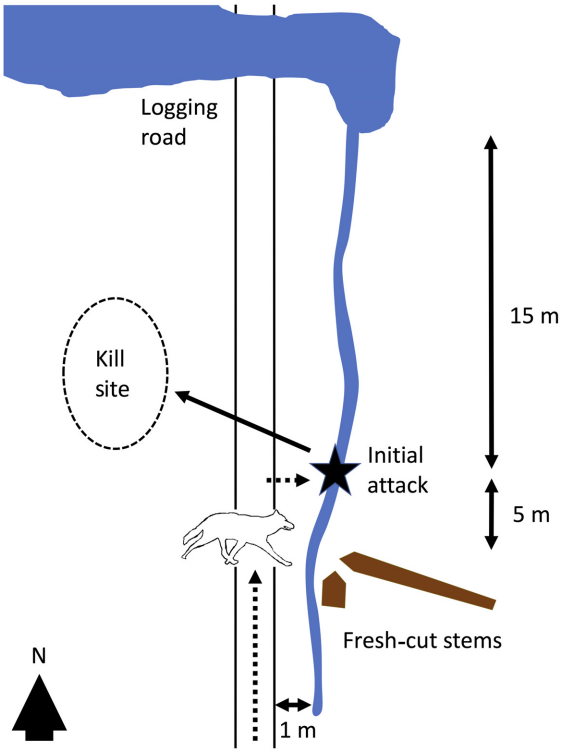

Fig. 1. A map detailing how a wolf encountered, attacked, and killed a beaver that was upstream of an active beaver pond in a small creek. The dashed lines show the wolf's movement prior to the attack, and the solid line shows the general movement of the wolf and beaver from the attack site to the kill site.

side of the logging road and fed into the southeast corner of the beaver pond.

After the wolf stood still for 1–2 min, TS slowly approached the wolf from behind in the truck but the wolf appeared unconcerned and continued staring into the forest (0:00–0:05). As TS got within 15–20 m of the wolf, the wolf took a few steps forward, briefly looked back at the truck, and then ran into the forest on the east side of the road (0:06–0:07). Two seconds later, the wolf reappeared on the road dragging a struggling, medium-sized beaver out of the forest (0:08, Fig. 2B). Once on the road, the beaver escaped the wolf briefly (0:10) and started running across the road toward the forest on the west side of the road (Fig. 2C). The wolf quickly grabbed the beaver by the tail and dragged it back out into the road (0:12–0:14) where the wolf continued attacking the beaver. Throughout the attack, the beaver repeatedly tried to bite the wolf around the face. At one point (0:15–0:16), the beaver appeared to have successfully bitten the wolf on the shoulder, causing the wolf to briefly jump back and release the beaver (Fig. 2D). Over the first 30 s of the attack, the wolf was primarily biting and dragging the beaver by the base of the tail (Fig. 2E, F). When possible, though, the wolf tried to get ahold of the beaver by the abdomen in an apparent attempt to pin the beaver (Fig. 2F, 0:17–0:25; 0:42–0:46).

The beaver then appeared to escape the wolf for a few seconds (0:50) and run into the brush on the west side of the road where the wolf quickly caught it again. When the wolf and beaver disappeared into the brush (0:50), TS slowly approached in his truck, stepped out of the truck, and observed the wolf still attacking the beaver ~10 m off the road (0:55–3:00). The wolf appeared oblivious of TS observing the encounter only meters away. The beaver continued to fight the wolf, but appeared to quickly become more lethargic likely due to exhaustion and injury (1:00–2:00). Every time the beaver tried to move forward the wolf would grab the beaver by the tail and jerk it back. The wolf had largely subdued the beaver, as the beaver was making minimal movements (1:58–2:36), until the beaver slowly turned over in an apparent attempt to defend itself or escape (2:37–2:38). The wolf, likely observing the beaver's lethargy, immediately grabbed the beaver by the head and neck (2:38–2:41), which likely killed the beaver as the beaver was not observed moving again. Interestingly, this was the first time during the attack that the wolf attempted to bite the beaver's head. A few seconds after the beaver appeared dead, the wolf, with its muzzle covered in blood, noticed TS observing from the road (3:51) but appeared hesitant to leave the kill. Trent Stanger then returned to his truck and left the area so as not to further disturb the wolf. We presume the wolf consumed the beaver but TS did not return to the kill after his observation.

In total, it took the wolf 3 min and 31 s to kill the beaver. The beaver was about 15 m upstream from the pond in the small creek when the wolf attacked it (Fig. 1). The beaver was likely traveling up this stream to access forage when it was attacked as there were no fresh cuttings or other terrestrial beaver sign where the attacked occurred but further upstream (~5 m) there were a few fresh-cut branches (Fig. 1).

Fig. 2. Progression of a wolf hunting a beaver: (A) the wolf waiting for, and then ambushing the beaver, (B) dragging the beaver out of a small stream and into the road, (C) chasing the escaping beaver, (D) briefly releasing the beaver after being bitten, (E) attacking the beaver again shortly after releasing it, (F) continuing to attack and subsequently kill the beaver.

Discussion

To our knowledge, this is the first recorded observation of a wolf hunting and killing a beaver (Mech et al. 2015; Gable et al., *in press*). Our rare observation provides valuable insight into how beavers defend themselves when attacked by wolves, how wolves hunt beavers, and the predatory strategies and cognitive abilities of wolves. Until now, observing wolves hunting beavers has been nearly impossible largely due to the dense riparian vegetation around most beaver habitats. In northern Manitoba, wolves were observed stalking beavers near feeding trails but unfortunately no other information about the observations is available (Nash 1951).

Beavers have been thought to be easily subdued once caught on land by large predators like wolves (Basey and Jenkins 1995, Mech et al. 2015), but our video suggests that beavers can be aggressive prey once attacked. Indeed, throughout the encounter the beaver continuously tried to bite the wolf. Beavers have incredible bite strength combined with long, sharp incisors that could seriously injure or kill a wolf. In Calgary, British Columbia, beavers mortally wounded a husky (*Canis familiaris*) and caused serious injury to six other dogs in 2010 (CBC News 2010). At

one point, the beaver successfully bit the wolf, which caused the wolf to briefly jump back and release the beaver (Fig. 2D). Ultimately, releasing the beaver was inconsequential in this encounter because the beaver was not close to water. When close to deep water, though, this defense could make the difference between the wolf killing the beaver and the beaver escaping into the water. In Voyageurs National Park, live-captured beavers have had healed puncture tail wounds presumably from wolves (the main predators of beavers in that system), indicating beavers do escape wolves even after being attacked on land (Gable et al. 2018). It is worth noting that the beaver (presumably a sub-adult) from our observation was not large (~10 kg). We can only surmise that large, adult beavers (~20–30 kg; Novak 1987, Baker and Hill 2003) could present a challenge for wolves, especially in areas such as Minnesota, Quebec, and Ontario, where wolves generally average <35 kg (see Table 5 in Theberge and Theberge 2004, Chenaux-Ibrahim 2015; S. Windels, *unpublished data*).

We can confirm that wolves do hunt and kill beavers by surprising and ambushing them (Fig. 2A). Wolves are not generally ambush predators (although see Mech 2007), instead relying on outrunning and outlasting ungulate prey to kill them (Mech et al. 2015). Because of this, most successful hunts of ungulate prey are simple and straightforward (Peterson and Ciucci 2003). However, our results suggest that wolves have a unique ability to switch between cursorial and ambush hunting strategies depending on the prey. Several authors (see Gable et al. 2016) have suggested that wolves hunt beavers this way, but their inferences were based on indirect evidence (e.g., where wolves bed down in active beaver habitats, or kill sites). When actively hunting beavers, wolves appear to wait concealed near areas of high beaver activity and ambush beavers once they come nearby (Gable et al. 2016). In Wisconsin, a wolf was observed successfully killing a beaver using this strategy (R. Schultz, *personal communication*). Although our recorded observation was of a wolf opportunistically encountering a beaver, there are similarities between this encounter and how wolves are thought to actively hunt beavers: (1) The wolf waited, albeit only a few minutes, after detecting the beaver for the beaver to get close, and (2) the wolf appeared to use vegetation along the roadside for concealment, which ultimately allowed the wolf to wait undetected until the beaver was within a few meters of the wolf (Fig. 2A).

Using vegetation for cover is an uncommon hunting strategy for cursorial canids (Bailey et al. 2013) but is likely necessary to successfully ambush beavers. Beavers have well-developed olfactory and auditory abilities that they use to detect and avoid predators (Novak 1987, Severud et al. 2011). Further, although beavers have poorly developed eyesight, their vision is likely sufficient to detect predators at close distances (Novak 1987). Because beavers generally forage in close proximity to water and can detect predators over 15 m away, wolves only have a short window to catch beavers once they have been detected (Basey and Jenkins 1995). Thus to ambush a beaver, a wolf must get close enough to the beaver so that the beaver does not have adequate time to return to water after hearing, seeing, or smelling the wolf.

Our observation provides further evidence that wolves do have higher-order mental abilities that facilitate complex hunting strategies. Wolves are able to understand causal relationships and adapt their cognitive abilities to their social environments (Lampe et al. 2017), and we think it is logical that these cognitive abilities extend to hunting strategy. The wolf's behavior suggests the wolf had detected the beaver 3–4 min prior to attacking (i.e., when the wolf went from a trot to a slow walk). However, instead of immediately attacking the beaver, the wolf slowly approached and waited for a few minutes. While the wolf was waiting on the road, we suspect the beaver was traveling upstream in the creek toward the wolf as it would be counterintuitive for the wolf to wait while the beaver traveled further downstream toward the safety of the pond. Indeed, the presence of fresh-cut branches further upstream from the attack site indicates that the beaver was likely moving up stream to access forage. The progression of this hunt suggests the wolf gathered information about its physical environment and the behavior of the beaver, processed this information (understanding), and then determined that its probability of success would increase by waiting instead of immediately attacking (foresight, planning). If the wolf had attempted to attack the beaver immediately after detecting the beaver,

instead of waiting, it is possible the attempt would have been unsuccessful given how close the beaver was to the pond (<15 m; Basey and Jenkins 1995). The fact that the wolf waited for the beaver to move closer suggests that the wolf correctly interpreted and anticipated the beaver's behavior. In the end, this hunting strategy allowed the wolf to get within a few meters of the beaver, which was presumably unaware of the wolf. But how did the wolf know that the beaver would continue traveling up the small creek?

We think that hunting beavers is a learned behavior whereby wolves use higher-order mental abilities along with information learned from prior interactions with beavers. Beavers are central place foragers that use feeding trails to access forage close (generally <50 m) to a central body of water (Baker and Hill 2003). Thus, beavers are unique prey for wolves given the short periods beavers spend on land in predictable areas (i.e., feeding trails, below dams) close to water. If wolves are to exploit beavers as a resource, having knowledge of terrestrial beaver behavior is advantageous, and arguably, necessary (Mech et al. 2015). We suspect that wolves are able to learn how beavers behave on land, can interpret beaver behavior, and employ hunting strategies to maximize success. Indeed, the fact that wolves will wait near areas of high beaver activity for hours to hunt beavers implies this is the case (Gable et al. 2016). Such a strategy requires prior knowledge of beaver behavior which is either learned from observing other wolves hunting beavers or through individual encounters with beavers. At what point, or how quickly, wolves learn how to hunt beavers is unknown. Learning different hunting strategies would be advantageous because it would allow wolves to exploit temporarily abundant alternate prey, or to persist during periods when primary ungulate prey are unavailable. Flexibility in hunting strategies has implications for predicting the functional role and conservation of wolves because carnivore hunting mode, specifically cursorial vs. ambush, is important to trophic control in ecosystems (Romero and Koricheva 2011).

Acknowledgments

We thank Voyageurs National Park, University of Minnesota, Minnesota Environment and Natural Resources Trust Fund and Van Sloun Foundation for providing support for this work. Additional funding was provided by National Science Foundation grants to JKB (NSF ID#1545611, NSF ID#1556676). We thank L. D. Mech for a helpful review of an earlier draft of this manuscript.

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Supporting Information

Additional Supporting Information may be found online at: http://onlinelibrary.wiley.com/doi/10.1002/ecs2.2159/full