

Wolves on the Katmai coast hunt sea otters and harbor seals

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Although considered to be primarily ungulate predators, gray wolves (*Canis lupus*) display a high degree of dietary plasticity and consume a variety of alternate prey including marine life (Newsome et al., 2016). Wolf consumption of marine mammals including seals (*Phoca* spp.), Steller sea lions (*Eumetopias jubatus*), humpback whales (*Megaptera novaeangliae*), walrus (*Odobenus rosmarus divergens*), and sea otters (*Enhydra lutris*) has been documented in diet studies using stable isotope ratios or by identification of prey remains within dried scats (Collins et al., 2019; Lewis & Lafferty, 2014; Watts et al., 2010). In some areas, marine mammals constitute a large proportion of wolf diets (Collins et al., 2019; Meiklejohn, 1994; Roffler et al., 2023). Wolves have been observed consuming sea otter carcasses, but the method by which wolves obtain these and the frequency of scavenging versus hunting marine prey is largely unknown. On the Alaska Peninsula, evidence suggests that coastal wolves may rely more heavily on nearshore species such as sea otters, harbor seals (*Phoca vitulina*), and seasonal

salmon (*Oncorhynchus* spp.) runs, particularly when ungulate prey (i.e., moose [*Alces alces*] and caribou [*Rangifer tarandus*]) are scarce or absent (Stanek et al., 2017; Watts & Newsome, 2017). Because so few investigations have been conducted in these systems, the predator–prey dynamics between wolves and marine mammals are not well characterized.

Harbor seals are common along the Katmai coast and can be seen hauling out on rocky islands and sandbars or swimming near shore and in-stream outlets to hunt salmon and other fish. On 22 July 2016, while conducting fieldwork in Hallo Bay in Katmai National Park, we witnessed a male wolf hunt and kill a harbor seal (Figure 1a,b; Video S1; Video S1 Legend). The wolf was positioned near the mouth of an intertidal creek and at ~10:30 he charged into the water, grabbing the tail of a harbor seal that was swimming out of the creek toward the bay with an outgoing tide. The wolf tore a wound in the seal's tail with its teeth and maintained a hold on the seal dragging it into shallower water while the seal

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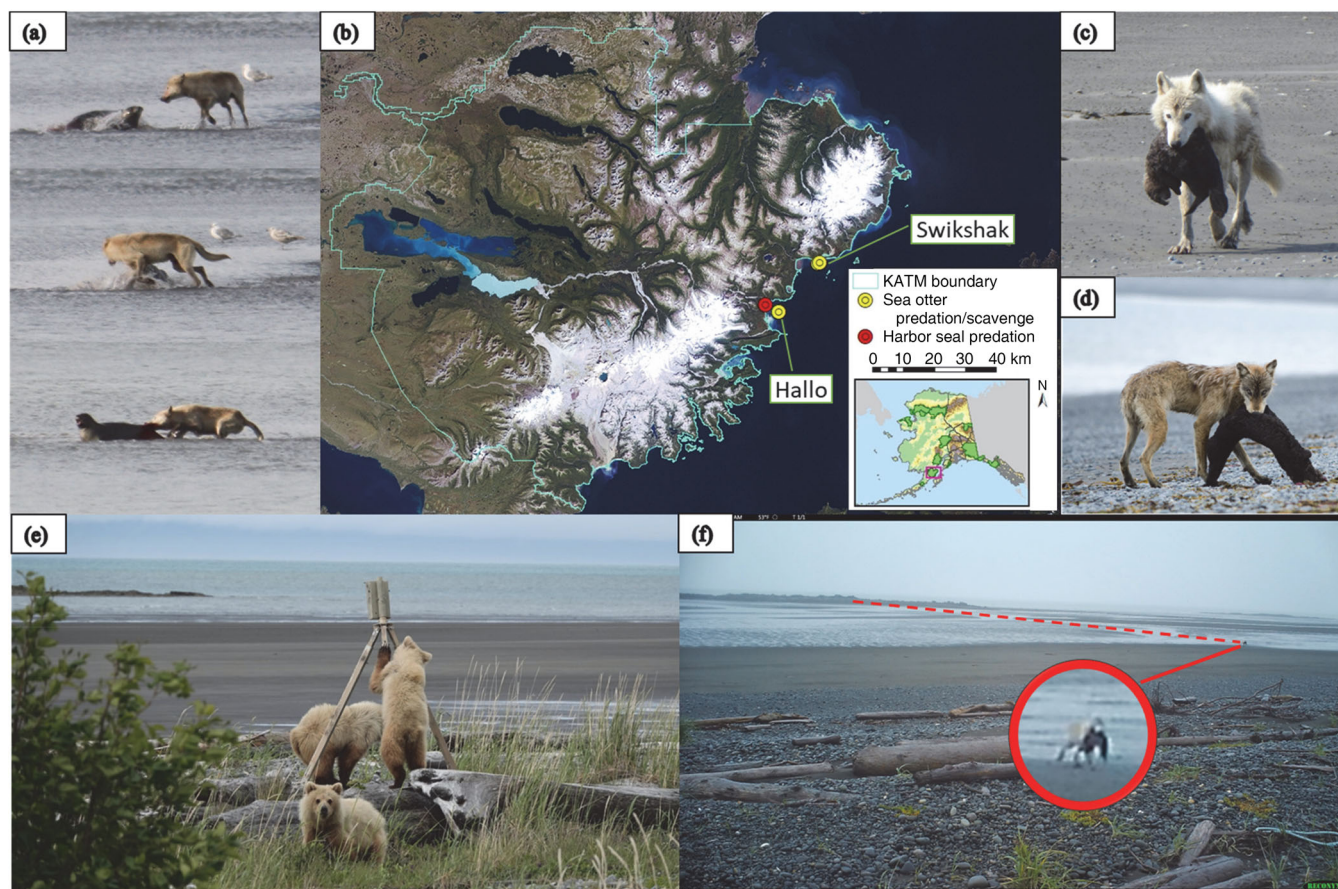


FIGURE 1 (a) Wolf attacking and ultimately killing a harbor seal at Hallo Bay on the coast of Katmai National Park on July 22, 2016 at ~10:30 (photographs: Kelsey R. Griffin). (b) Sites on the Katmai Coast where wolves preyed or scavenged marine mammals. (c) Wolves seen carrying sea otters at Swikshak Bay on May 23, 2016 at ~12:00 (photograph: Kelsey R. Griffin) and (d) on June 23, 2018 (photograph: Landon Bazeley). (e) Timelapse camera tripod setup at Swikshak Bay (photograph: Kelsey R. Griffin). (f) Photograph of a wolf with a sea otter captured by timelapse camera on September 29, 2019 at ~10:00 (photograph: Kelsey R. Griffin). Dotted line indicates the wolf's approximate path seen from photographs with a zoomed in insert of the wolf. Note tidal exposure of rock island where wolf came from as well as smaller island to the far right.

resisted by continuously arching its back and attempting to bite the wolf. During this struggle, the wolf occasionally released its hold and circled the seal. Briefly, the seal moved a short distance into deeper water; however, the wolf was able to regain hold of its tail. The wolf continued to tear into the flesh of the seal's tail and after a ~30-min struggle, the seal appeared to tire, straining to lift its head above water. The wolf dragged the seal onto the exposed sandbar and began to tear into the existing wound and consume the tail. The wolf then noticed our presence and after a few minutes left the carcass and crossed into the meadow. We began walking slowly down the beach away from the harbor seal, and after several minutes we observed the male wolf and a second wolf travel across the beach berm to the carcass and begin feeding.

On 23 May 2016, we observed a wolf carrying a young sea otter carcass at Swikshak Bay (Figure 1b,c) followed

by additional observations of wolves carrying sea otter carcasses on 23 June 2018 (Figure 1d) and on an offshore island at Hallo Bay on 8 July 2019. The sea otter population on the Katmai coast was decimated during the industrial fur trade. Although sea otters were protected from the fur harvest in 1911, their population slowly increased through most of the century. However, by 2012, sea otters on the Katmai coast had made a robust recovery with numbers reaching suspected carrying capacity (~8600 animals) and population growth limited by food availability (Coletti et al., 2016). Now, sea otters are seen frequently along the Katmai coast including on nearshore haul-outs. With more numerous sea otters and their need to haul out to thermoregulate and conserve energy (Bodkin, 2001), it is not known if wolves feeding on them is a rare event or a more frequent occurrence.

To further investigate how wolves were preying on or scavenging sea otters, we bolted a timelapse camera

tripod into beach cast logs at Swikshak in August 2019 (Figure 1e). The camera pointed at a large rocky island, ~530 m offshore, where wolves were suspected of obtaining the sea otters. Photographs were taken with a Reconyx Ultrafire XP9 every 2 min with varying photograph periods to exclude nighttime photographs and maximize capturing an animal transiting from the island. Both this island and a nearby smaller island (730 m from shore) are exposed during negative tide

cycles and entirely submerged by very high tides. On 29 September 2019, we captured photographs of a wolf carrying a sea otter carcass from the larger island at 10:00 during a low tide (Figure 1f, Table 1, Griffin, 2023). We did not obtain any additional photographs of sea otter consumption, but wolves and bears were recorded frequenting the islands. All wolf observations from photographs were of single wolves except for one photograph event of two wolves. Almost all wolves in photographs on

TABLE 1 Wolf and brown bear observations from timelapse camera photographs at Swikshak Bay in Katmai National Park from September 2019 through June 2021.

Date	Time	Species	No.	Corresponding tide	Activity
9/29/2019 ^a	09:36–10:02	Wolf	1	Low (−3.3' at 09:25)	On island
9/29/2019	10:54; 11:52–13:40	Bear	1	Low (−3.3' at 09:25) High (22.4' at 15:41)	On island/beach
10/4/2019	08:40	Wolf	1	High (16.0' at 07:26)	On beach
10/8/2019	09:32–10:06	Bear	1	High (15.1' at 12:36)	On island/beach
10/12/2019	09:27–10:18	Wolf	1	Low (0.9' at 08:27)	On beach/island
10/17/2019	10:08–10:28	Wolf	1	Low (3.1' at 11:00)	On island
10/18/2019	08:48–09:46; 11:16–11:36	Bear	3	Low (4.4' at 11:37)	On island/swimming
10/25/2019	16:56–17:00	Wolf	1	Low (0.4' at 19:20)	On island
10/27/2019	18:04–18:58	Bear	1	Low (−3.5' at 20:49)	On island/beach
10/30/2019	09:28–10:34	Wolf	1	Low (0.7' at 10:23)	On island
3/20/2020	08:44	Wolf	2	Low (5.0' at 07:18)	On beach
4/6/2020	06:28–08:34	Wolf	1	Low (−0.3' at 08:02)	On island
4/14/2020	07:12	Wolf	1	High (15.7' at 07:37)	On beach
5/4/2020	20:40	Wolf	1	Low (−0.4' at 19:07)	On beach
5/29/2020	13:08	Wolf	1	Low (1.0' at 14:20)	Near island
6/4/2020	06:12	Wolf	1	Low (−3.7' at 08:09)	On beach
6/5/2020	10:56–11:00	Bear	1	Low (−4.7' at 08:54)	On island/beach
6/25/2020	11:04–13:38	Bear	3	Low (−2.1' at 12:13)	On island/beach/swimming
7/6/2020	08:30–09:30	Bear	3	Low (−3.1' at 10:50)	On island/beach
7/15/2020	10:56	Wolf	1	High (12.2' at 11:45)	On beach
10/5/2020	07:58–08:34	Bear	1	Low (2.6' at 10:56)	On island/beach/swimming
10/11/2020	17:58–18:14	Bear	1	Low (7.9' at 16:52)	On island/beach/swimming
5/2/2021	12:18–14:58	Bear	1	Low (−0.3' at 13:31)	On island/beach
5/5/2021	14:12	Wolf	1	Low (2.4' at 17:25)	On beach
5/10/2021	19:40–19:42	Wolf	1	Low (2.0' at 20:45)	Near island
6/8/2021	08:36–11:26	Wolf	1	Low (−0.7' at 08:17)	On island
6/9/2021	09:14–09:56	Bear	1	Low (−1.4' at 08:50)	On island/beach
6/13/2021	09:18–09:22	Wolf	1	Low (−1.5' at 11:11)	On beach

Note: Time column represents timeframe of each observation; however, it does not indicate that an animal was seen in every photograph taken within that period. Animals within photographs were highly pixelated and difficult to detect. No wolves were captured on camera while transiting to and from the island, so time spent on island is likely underestimated. Only brown bear observations that included activity on the island are included. No wolves were detected from 5 August to 9 October (from 06:00 to 21:58) or 9 October to 19 November (from 08:30 to 19:44) in 2020. Tide predictions from National Oceanic and Atmospheric Administration, Seldovia, AK.

^aObservation of wolf with sea otter.

or near the island ($n = 9$) during the camera deployment period were detected during a low tide (Table 1, Griffin, 2023). Six out of seven wolf visits to the island lasted from 20 to 170 min, suggesting that wolves were searching for prey (Table 1, Griffin, 2023). Bear activity on the island also coincided with low tide and was observed in photographs on 4 days in 2019, 5 days in 2020, and two in 2021 with a bear visiting the island ~1 h after the wolf in 2019 was seen leaving with a sea otter. Animals on or near the large island appeared very small and grainy in photographs due to the distance of the island, so it is likely that some animals went undetected.

On 25 June 2021 we watched wolves hunt and consume an adult sea otter on a rocky island at Swikshak Bay during a negative tide cycle (Figure 2). We arrived at the site on 21 June at low tide and immediately observed a single lactating female wolf walking along the island's intertidal zone, occasionally slowing her pace and crouching. The following day (22 June) we observed sea otters hauled out on shallow rocks near the larger island.

On 25 June, we saw the lactating female wolf visit the large island at 07:40. She seemed alert and focused, stopping frequently and appearing to “scan” the island before she moved to the small island where she eventually disappeared over the rocks out of sight. Two male wolves (including a large breeding male) walked across the intertidal zone toward the islands. Both male wolves headed to the large island while the single female wolf on the small island remained out of sight. The two male wolves soon approached the small island from different angles on either side of where the female disappeared. All wolves disappeared from view for ~1 min, then reappeared carrying a limp sea otter over the rocks to the top of the island. At 08:45 the wolves began working together to tear the sea otter apart, eventually ripping pieces off. The large male took a piece that appeared to be the head and lay down to eat while the other wolves continued to tear at the carcass. The three wolves fed on the carcass for ~60 min. The smaller male departed the island carrying a piece of sea otter pelt in his mouth

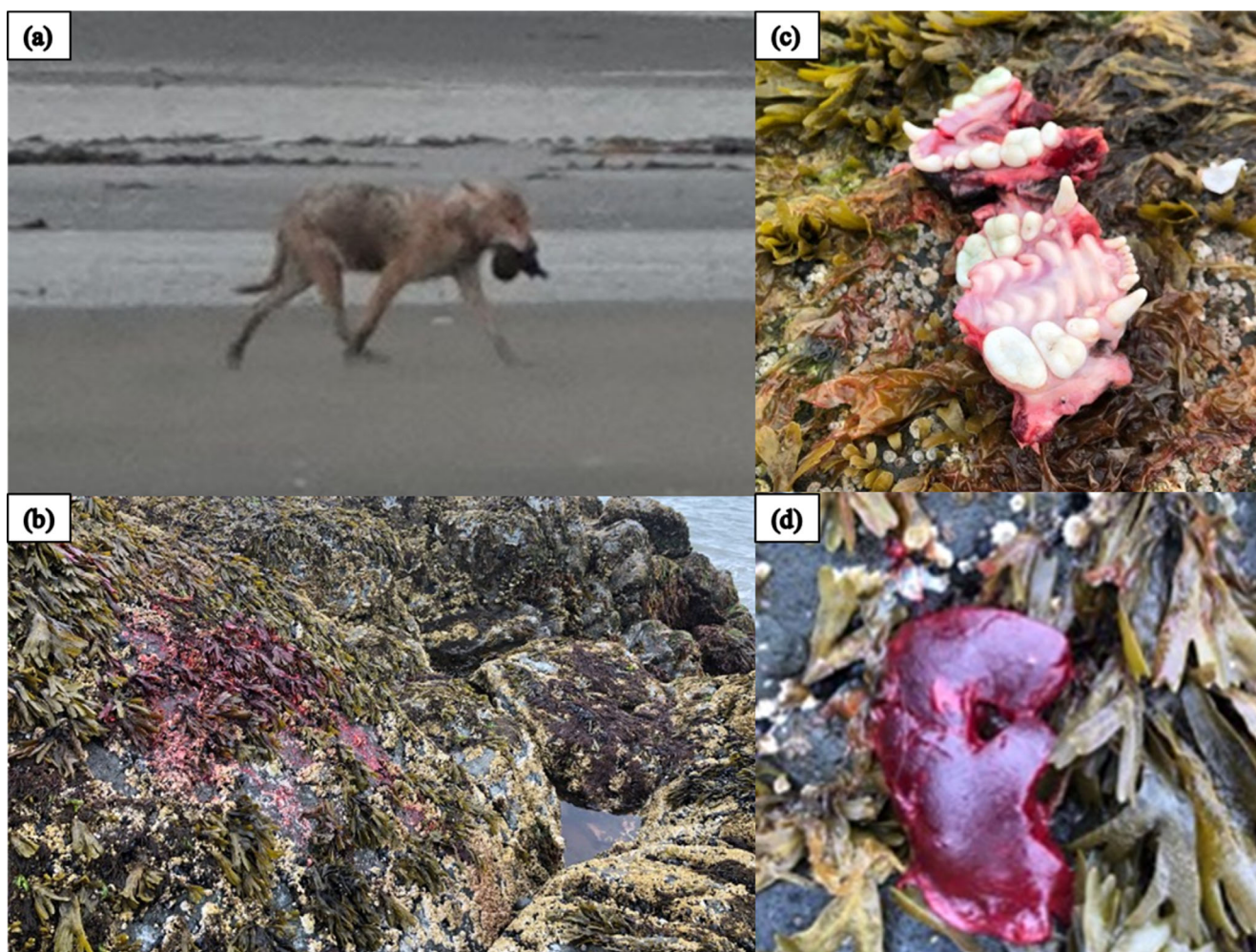


FIGURE 2 (a) Younger male with sea otter remains (photograph Kelsey R. Griffin). (b) Sea otter kill site closeup (photograph Ellen M. Dymit). (c) Sea otter mandible and (d) liver at kill site (photographs Ellen M. Dymit).

(Figure 2a) followed by the female's departure. The large male moved slowly away from the island down the beach, stopping briefly to drink sea water. We immediately examined the kill site and found an area of concentrated blood where the sea otter was likely killed while resting on a fairly steep rocky area within 3–4 m of the water (Figure 2b). The presence of blood indicates the sea otter had been alive when ambushed by the wolves, as opposed to a scavenged carcass that would not produce fresh blood pooling (Cristescu et al., 2022). A visible blood trail across the exposed rocks led from the blood pool to the location where we observed the wolves tearing apart and consuming the sea otter. Here the only sea otter parts remaining were scattered rib bones stripped of the muscle tissue, the mandible in two pieces, and the liver (Figure 2c,d). The size of the mandible and tooth wear indicated it was likely an adult female sea otter (J. L. Bodkin, personal communication, March 31, 2022). The liver tissue was tested at the University of Alaska Fairbanks for mercury and contained a concentration of 48.8 total Hg ppb wet weight (liver collected under United States Fish and Wildlife Service MMPA permit no. 067925). Although this level of mercury is not markedly high, the liver was tested at the Alaska State Environmental Health Laboratory for paralytic shellfish toxins and contained a high concentration (140 µg/100 g) compared with the Federal Drug Administration's regulatory health hazard safety limit of 80 µg/100 g. In addition, we discovered in further tests of trace element concentrations (performed at the University of Alaska Anchorage) high levels of rubidium (µg/kg = 4,000,000; SD = 710,000), which can indicate liver toxicity in rats at that level (Usuda et al., 2014). The elevated concentration of paralytic shellfish toxins and rubidium supports our suspicion that the wolves did not consume the liver as a conditioned response to avoid ingesting toxins.

Wolf hunting behavior has been comprehensively described through detailed observations of ungulate hunting, in groups or singly, that generally involve cursorial behavior to chase prey (Peterson & Ciucci, 2003). Although wolves are known to hunt seals, first-hand accounts of successful predation have not been well documented (Mech et al., 2015). Some observations of wolves hunting prey such as beavers indicate that wolves can incorporate intentional processes such as planning and foresight of future events to position themselves for a successful ambush (Gable et al., 2018; Mech et al., 2015). Our observations of wolves ambushing marine mammals on the Katmai coast suggest that they may focus their hunting efforts at sites where prey presence is most predictable; for example, tidal streams or rocky island haul-outs. We have also detected temporal patterns in wolf prey-searching activities in the nearshore coinciding

with low tide cycles indicating that they are aware of periods of greater access to haul-out sites. Solitary or partial pack hunting of marine mammals may be an efficient strategy to maximize prey intake. Our observations indicate that solitary wolves may successfully ambush seals and sea otters on the Katmai coast and may have developed unique hunting and foraging strategies compared with their interior counterparts. With the Katmai sea otter population peaking in 2012 at an estimated 8600 animals (Coletti et al., 2016), there may be more frequent opportunities for wolves to obtain sea otters than previously thought. Sea otters could be an important contribution to wolf diets, with implications for terrestrial predator–prey dynamics.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data (Griffin, 2023) are available from the National Park Service DataStore Integrated Resource Management Applications database at <https://doi.org/10.57830/2300632>.

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SUPPORTING INFORMATION

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