

Who takes the bait? Nontarget species use of bear hunter bait sites

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Abstract: Hunting bears (*Ursus* spp.) over baits is legal in many countries, states, and provinces, but the practice remains a controversial topic among wildlife managers, hunting groups, and the general public. The baits used to attract bears may also provide a pulsed resource on the landscape that can be used by other wildlife species, particularly carnivores. To determine what other species might use bear bait sites, we constructed and monitored 21 bear bait sites with camera traps from August to October 2016 in the western Upper Peninsula of Michigan, USA. The sites mimicked typical American black bear (*U. americanus*) hunter bait sites. We tested recorded changes in carnivore visitation before and during hunting season using paired *t*-test and analyzed carnivore temporal shifts between the 2 periods using a nonparametric kernel density estimation procedure. We analyzed 7,915 images, of which 81.9% were nontarget species. Bear daily visitation at the bait sites was reduced by 49.3% during hunting season while nontarget carnivore visitation increased by 33.0%. Bears also increased their nocturnal activity by 22.4% during the legal hunting season while other carnivore species maintained their diel patterns. Because of the high rates of nontarget species use of the bear hunter bait sites, there is a potential for disease spread and conflict with hunters. Managers should evaluate the potential impacts on target and nontarget species when establishing hunter bait regulations.

Key words: bait sites, camera trap, carnivore, human–wildlife conflict, Michigan, mustelid, nontarget species, resource pulse, *Ursus americanus*

RESOURCE PULSES, such as seed mast events (e.g., *Quercus* spp.) and postspawning salmon (Salmonidae) carcass concentrations, are infrequent, large, and ephemeral events of increased food availability for generalist consumers (Yang et al. 2010). These pulses are ubiquitous across the globe, bridge ecosystem boundaries, and have the potential to impact communities for years after depletion (Holt 2008, Yang et al. 2008). Many species have likely evolved with the ability to take advantage and even anticipate naturally occurring resource pulses (Boutin et al. 2006, Gamelon et al. 2017). Anthropogenic resource pulses represent a special case that are similarly universal and may have comparable impacts on communities as naturally occurring resource pulses (Oro et al. 2013). However, human-provided resource pulses may differ temporally, spatially, and compositionally from naturally occurring resource pulses, which in turn may cause various effects on consumers and communities (Wilmers et al. 2003, Newsome et al. 2015).

Discerning how natural and anthropogenic resource pulses diverge is necessary to understand the ecological effects of human activities. Natural resource pulses likely have positive and negative impacts on consumer vital rates, such as fecundity and survival (Ostfeld and Keesing 2000, Newsome et al. 2015, Gamelon et al. 2017). Similarly, human-provided food has been linked to earlier reproductive age and higher litter sizes for consumer species (Rogers 1987, Beckmann and Lackey 2008, Kavčič et al. 2015). Pulses of human-provided food are likely to have similar effects as natural pulses (Holt 2008, Yang et al. 2008, 2010).

Alternatively, human presence and composition of anthropogenic pulses may cause a different impact on consumer species than natural pulses. For example, if consumer species detect higher risk associated with anthropogenic pulses, they may temporally shift their feeding behavior (Baruch-Mordo et al. 2014). Coyotes (*Canis latrans*) showed such a response to risk

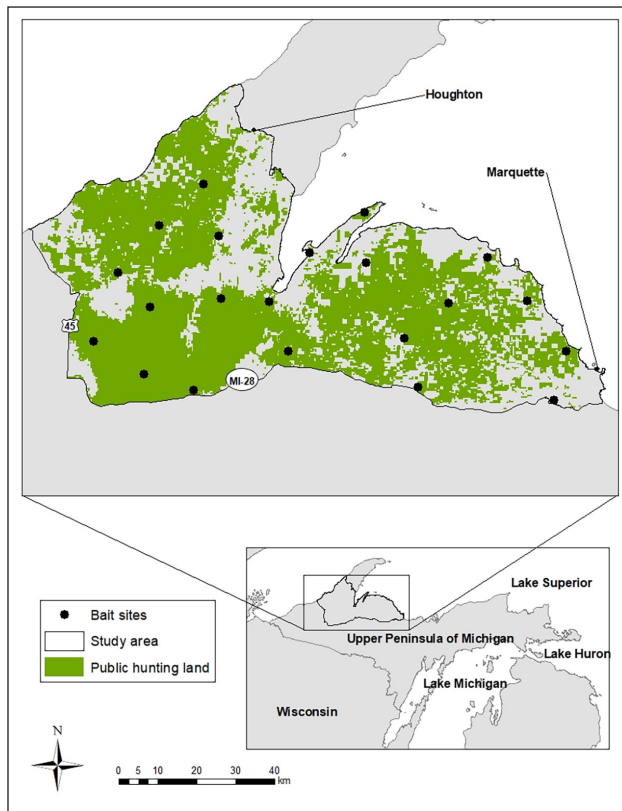


Figure 1. Locations of 21 black bear (*Ursus americanus*) bait sites with camera traps August to October 2016 in the western Upper Peninsula of Michigan, USA. The Baraga hunting unit includes land east of U.S. Hwy 45 and north of Michigan State Hwy 28.

in suburban environments, where they shifted to nocturnal prey, forcing common gray foxes (*Urocyon cinereoargenteus*) to consume more diurnal prey species (Smith et al. 2018). This result is consistent with the risk allocation hypothesis that predicts that species will respond to temporal variation in risk by changing their behavior (Lima and Bednekoff 1999).

Hunter bait sites are an example of an understudied anthropogenic resource pulse. Although hunting over baits is legal in many countries, states, and provinces, the practice remains a controversial topic among wildlife managers, hunting groups, and the general public (Peyton 1989, Dunkley and Cattet 2003). The baits are used to increase hunter success and are provided on the landscape for a regulated time before and during a hunting season (Bowman et al. 2015). Baits are typically placed in predictable locations aimed to attract target species.

In Michigan, USA, white-tailed deer (*Odocoileus virginianus*) and American black bear (*Ursus americanus*; bear) are both commonly baited and hunted species. It is permitted to bait both species with corn (*Zea mays*), fruit, and vegetables, but bears can also be attracted using meat, fish products, and baked goods (Michigan Department of Natural Resources [MI DNR] 2017). Though bait intended for bears is effective at attracting bears, unintended use by nontarget species is unknown.

The goal of this study was to investigate nontarget species use of black bear bait sites across a typical hunting season. We initiated this study because bait sites have been implicated in exacerbating human-wildlife conflicts (Bump et al. 2013). We assessed species visitation and diel patterns at bait sites across the “baiting only” period before hunting (~August 10 to September 9) and through the “baiting and hunting” period that follows (~September 10–24; MI DNR 2017). We expected visitation by nontarget carnivores would be higher while baiting only occurred than while baiting and hunting occurred because of increased human presence. Because bears generally experience hyperphagia during the hunting season (late summer to early autumn), we expected bears would maintain high visitation rates to bait sites (Hristienko and McDonald 2007). Similar to research on hunted black bears, brown bears (*U. arctos*), white-tailed deer, and coyotes, we expected that visitation at bait sites would shift to a more nocturnal pattern in response to more diurnal human presence on the landscape during hunting (Kilgo et al. 1998, Kitchen et al. 2000, Ordiz et al. 2012).

Study area

We conducted this study in the western Upper Peninsula (UP) of Michigan, USA (Figure 1). Our study area was within the Baraga bear hunting unit where ~1,166 bear hunting permits were purchased annually from 2013–2016 (4-year mean; Frawley 2017). Nearly 65.5% (419,178 ha)

of the total study area (640,271 ha) was publicly available hunting land. Further hunting likely occurred on private lands. Additionally, when hunting in the Baraga hunting unit, ~94% of individual hunters and 99% of hunting guides used bait to attract bears (Frawley 2017). We established bait sites across the Baraga hunting unit at locations where nontarget species densities were similar (e.g., gray wolf [*C. lupus*] abundance; O'Neil et al. 2017).

Land cover consisted of deciduous forests (53%), wetlands (1%), mixed forest (17%), conifer forest (17%), open water (2%), grassland and herbaceous (6%), and developed areas (4%; Homer et al. 2015). From August 1, 2016 to October 26, 2016, 11 weather stations throughout the study area recorded a mean daily precipitation of 0.43 cm (National Oceanic and Atmospheric Administration [NOAA] 2018). Temperatures ranged from -3.89°C to 32.22°C with a mean temperature of 12.59°C (NOAA 2018).

Methods

We used camera-trap surveys to monitor bear and non-target species use of hunter bait sites from August 1, 2016 to October 26, 2016. No baiting occurred for 9 days preceding the legal bear baiting (August 10 to October 26) and hunting (September 10 to October 26) season. We established an adjusted systematic design that allowed for full coverage of the study area and scaled placement of the sampling units to avoid detection overlap (O'Connell et al. 2010, Sun et al. 2014, Niedballa et al. 2015).

To minimize photographing the same individual among sites, we scaled our sampling units based on the mammal species with the largest home range we expected to observe (i.e., gray wolf; Sun et al. 2014, Niedballa et al. 2015). Because our study area included public land (national and state forests), commercial forest land, and Michigan Technological University-owned land, we determined the available lands where bear hunting was legal within the hunting unit (MI DNR 2017).

To mimic bear hunters, we selected sites within 500 m of water. Once in the field, we adjusted placement at some locations based on characteristics bear hunters use to increase chances of bears encountering bait, such as along linear features (trails or roads) and under

moderate cover. We also created a circular buffer with a radius of 6.1 km, resulting in an area of 11,654 ha around each point to mimic the average size of a wolf's home range regionally (Beyer et al. 2006).

At each site, we deployed 1 camera (Reconyx Hyperfire series, Holmen, Wisconsin, USA) 0.5–0.8 m above ground directed toward the bait site (Burton et al. 2012, Bowman et al. 2015, Lesmeister et al. 2015, Stirnemann et al. 2015). We programmed the cameras to take 2 consecutive motion-activated pictures with a 5-minute delay. With each image, the date, time, and temperature were recorded (Bowman et al. 2015). We further classified each photo as obtained during daylight or nighttime hours. During August 1–9, the site remained un-baited while the camera recorded images to establish baseline conditions.

On August 10, we constructed a bait site 2–3 m from cameras to provide a maximum field of view focal length to obtain readable images of each site. To reduce images without animal subjects (e.g., false triggers), we removed vegetation likely to activate the camera. Twice a week from August 10 to August 26, the sites were re-baited with a mixture of food that replicated a typical Michigan bear hunter's bait (a combination of meat products such as dog and cat food, cafeteria leftovers, imitation maple syrup, fryer grease, pie filling, pastries, and Bruin Buster predator lure [James Valley Scents, Mellette, South Dakota, USA]). Bait was consistent across sites but varied with each baiting occasion depending on bait availability, similar to hunter baiting efforts.

From September 2–24, we re-baited each site weekly, similar to bear hunter behavior (Frawley 2017). Based on long-term bear hunter survey data, we concluded baiting September 24, the historical date when most UP bear hunters harvested bears and subsequently ceased baiting (Frawley 2017). Cameras remained at sites through the end of hunting season (October 26) to assess species visitation post-baiting.

Data analysis

We eliminated images containing no animals or blurred/unidentifiable images. Because each detection typically recorded 2 images, we only analyzed 1 image from the pair. For

Table 1. Camera-trap detections of all species at black bear (*Ursus americanus*) hunter bait sites, western Upper Peninsula, Michigan, USA, August to October 2016. Total number of detections are the number of animals in photographs (many images had multiple individuals) taken throughout the study with duplicate photos removed. Percent is the percent of total detections attributed to each species or taxonomic group.

Species and taxonomic groups	Total number of detections	Percent
Northern raccoon (<i>Procyon lotor</i>)*	8,427	69.82
American black bear (<i>Ursus americanus</i>)*	2,185	18.10
Mustelids (Mustelidae)*	768	6.36
Striped skunk (<i>Mephitis mephitis</i>)*	215	1.78
Unidentified small mammals	129	1.07
Snowshoe hare (<i>Lepus americanus</i>)	114	0.94
Red fox (<i>Vulpes vulpes</i>)*	92	0.76
White-tailed deer (<i>Odocoileus virginianus</i>)	45	0.37
Squirrel (<i>Sciurus</i> spp.)	29	0.24
Coyote (<i>Canis latrans</i>)*	22	0.18
Chipmunk (<i>Tamias</i> spp.)	11	0.09
Gray wolf (<i>Canis lupus</i>)*	9	0.07
Unidentified anuran	6	0.05
Moose (<i>Alces alces</i>)	6	0.05
Flying squirrel (<i>Glaucomys</i> spp.)	5	0.04
Bobcat (<i>Lynx rufus</i>)*	3	0.02
Common raven (<i>Corvus corax</i>)	2	0.0
Wild turkey (<i>Meleagris gallopavo</i>)	1	0.01
Turkey vulture (<i>Cathartes aura</i>)	1	0.01
Total	12,070	

* Carnivore species

each image, we recorded species present and number to calculate total number of detections (e.g., an image with 1 raccoon [*Procyon lotor*] counts as single detection and an image with 2 raccoons as 2 detections). These data indicate use of hunter bait sites rather than estimations of abundance of individuals.

To determine if there was a difference in visitation between the period before hunting (August 10 to September 9) and during hunting (September 10–24; baiting occurred during both periods), we determined the mean daily detection rate for different species or taxa (e.g., Mustelidae; *Martes pennanti*, *M. americana*, and *Mustela* spp.) from 100 bootstrapped samples in each period. We compared bootstrap samples

using a paired *t*-test, testing for difference in means and accepting statistical significance at $P < 0.05$. We also calculated a 95% confidence interval for each species or species group to better understand the effect size of the change.

We analyzed temporal activity of species based on detections before and during bear hunting season. We used a nonparametric kernel density estimation procedure to examine whether species altered activity patterns between these 2 periods (Wang et al. 2015). First, we converted times to radians, then used a kernel density estimator to create a probability density distribution for each species between periods (Ridout and Linkie 2009). We then calculated an overlap term ($\hat{\Delta}$) that

Table 2. Mean difference in daily number of detections before hunting season vs. during hunting season for taxa in the western Upper Peninsula, Michigan, USA, August to October 2016 observed at black bear (*Ursus americanus*) hunter bait sites. Differences between the period before hunting and the period during hunting were significant if the 95% confidence interval did not include 0.

Taxon	Mean difference	95% confidence interval
All species	-0.08	-0.17 to 0.01
Carnivores	-0.40	-0.52 to -0.29
Black bears	-1.33	-1.44 to -1.23
Mustelids	0.33	0.29 to 0.37
Raccoon	1.91	1.61 to 2.21
Skunk	0.38	0.36 to 0.40
Red fox	0.07	0.04 to 0.09
Coyote	0.04	0.03 to 0.04

ranged from 0–1 and indicated the proportion of temporal overlap shared between periods (Wang et al. 2015). We would expect that if $\hat{\Delta}$ were high, there would be no temporal shift from before hunting to during hunting. Ridout and Linkie (2009) compared 3 methods for estimating $\hat{\Delta}$ and suggested using $\hat{\Delta}_4$ with a smoothing parameter of 1 for sample sizes >50 and $\hat{\Delta}_1$ with a smoothing parameter of 1.25 for sample sizes <50 . We used $\hat{\Delta}_4$ to estimate overlap for bears, mustelids, raccoons, and the combined Carnivora because our sample sizes were >50 (Meredith and Ridout 2018). For red foxes (*Vulpes vulpes*), striped skunks (*Mephitis mephitis*), and coyotes, we used $\hat{\Delta}_1$ to estimate overlap because 1 species count from each period comparison was >50 (Meredith and Ridout 2018). Statistical analysis was conducted using the overlap package (Wang et al. 2015, Meredith and Ridout 2018) in R (R Development Core Team 2013). To calculate how bears changed their nocturnal activity between the 2 periods, we quantified the difference between the areas under the activity curves for the nocturnal time before hunting and the nocturnal time during hunting.

To test for significance of temporal change for each species, we applied Watson's U2 statistic employed in the CircStats package (Lund and Agostinelli 2012, Lashley et al. 2018). This test

calculates the probability that the 2 samples are homogeneous (i.e., that the 2 time periods have the same distribution). It tests the null hypothesis that there is no difference in the distribution of times of detection before hunting and during hunting (Lund and Agostinelli 2012). If a species significantly changed its diel pattern, we expected a Watson's U2 statistic greater than the critical value (0.19 for an α value of 0.05) and $P < 0.05$.

Results

We obtained 8,642 images; 727 images were of domestic species or humans and not included in analyses. Of the remaining 7,915 images, we calculated 12,070 individual animal detections (Table 1). Most of the images were raccoons (69.8%), followed by bears (18.1%) and mustelids (6.4%). More of the detections at sites (81.9%; Table 1) were nontarget species (~21). We also assumed some degree of consumption by carnivores because all were photographed in at least some images eating bait.

During the 9-day pre-baiting period, we detected bears, raccoons, deer, 1 moose, 1 mustelid, and 1 snowshoe hare (*Lepus americanus*), totaling 40 detections resulting in a mean daily (24-hour) number of detections (+ standard deviation [SD]) of $0.09 + 0.06$ and accounting for only 0.33% of all detections throughout the entire study. For the entire study period, the mean daily number of detections (+SD) for raccoons was greater than any other species ($5.02 + 5.48$), followed by bears ($1.60 + 1.95$), and mustelids ($0.52 + 0.55$). Mean daily detections for all species remained constant before hunting and during hunting (Table 2). However, carnivore daily mean detections declined by $0.40 (\pm 0.11)$ due to reduced visitation by bears.

Black bear mean daily number of detections was reduced by 1.33 (± 0.11) between the 2 periods (Table 2). In contrast, all other carnivore species that were recorded >20 times, which excluded gray wolf and bobcat (*Lynx rufus*), increased visitation during the hunting period (Figure 2; Table 2). Though detections were low between the 2 periods, 7 and 1 for wolves and bobcats respectively, wolves were not recorded once hunting started while bobcats were not recorded until after hunting started. Though there was a significant overall increase

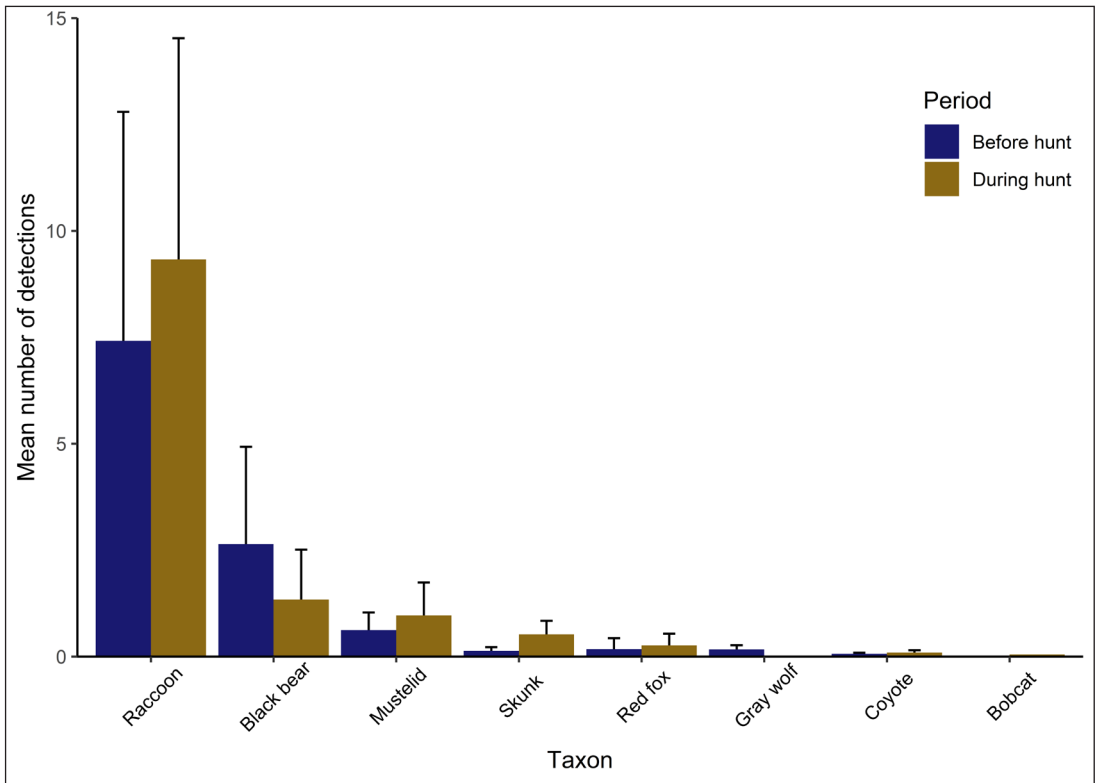


Figure 2. Mean (+ SD) daily number of camera-trap detections of taxa at black bear (*Ursus americanus*) hunter bait sites, western Upper Peninsula of Michigan, USA, August to October 2016.

regionally, this increase was not uniform across all bait sites. For example, at 1 site we detected 3 mustelids both before and during hunting, at another we detected 3 mustelids before hunting and 14 mustelids during, and yet at another detection was 5 mustelids before hunting and 1 mustelid during.

As a group, carnivore species changed their diel activity to be slightly more nocturnal from before hunting to during hunting ($\hat{\Delta}_4 = 0.93$, $U_2 = 0.58$; Figure 3), though this is largely driven by shifts by bear. Bears altered their behavior more dramatically and tended to visit at nocturnal times during hunting ($\hat{\Delta}_4 = 0.73$, $U_2 = 2.74$; Figure 3). We observed a 22.4% increase in nocturnal activity for bears during hunting. Conversely, mustelids, red foxes, coyotes, and skunks maintained their diel pattern between both periods ($P < 0.001$; Figure 3). Wolves were only detected before hunting, but overall detections were low (i.e., 9 detections across 3 sites; Figure 2). Additionally, few bobcats were detected and only during and after hunting (i.e., 3 detections across 2 sites; Figures 2 and 4).

Discussion

Our results indicated that overall nontarget species use of bait stations was higher than bear use. Most of the nontarget species are opportunistic omnivores (e.g., raccoons, skunks, and coyotes) while some are predominantly herbivores (e.g., snowshoe hares and squirrels [Sciuridae]). The variety of consumers visiting bait sites was possibly a result of the variety of bait types used (Figure 4). Mean daily visitation and total number of detections during the pre-baiting period was very low, indicating that bear bait was an important attractant to consumers.

Although many hunters in the Northern Great Lakes region have reported wolves at bear bait sites (Ruid et al. 2009), we detected few and none once hunting started (Figure 2). Our bait was similar to a typical bear hunter’s bait, but ingredients used may not have been as desirable to wolves as other bait types commonly used by bear hunters (e.g., meat).

As expected, bear visitation shifted to a more nocturnal pattern during hunting season

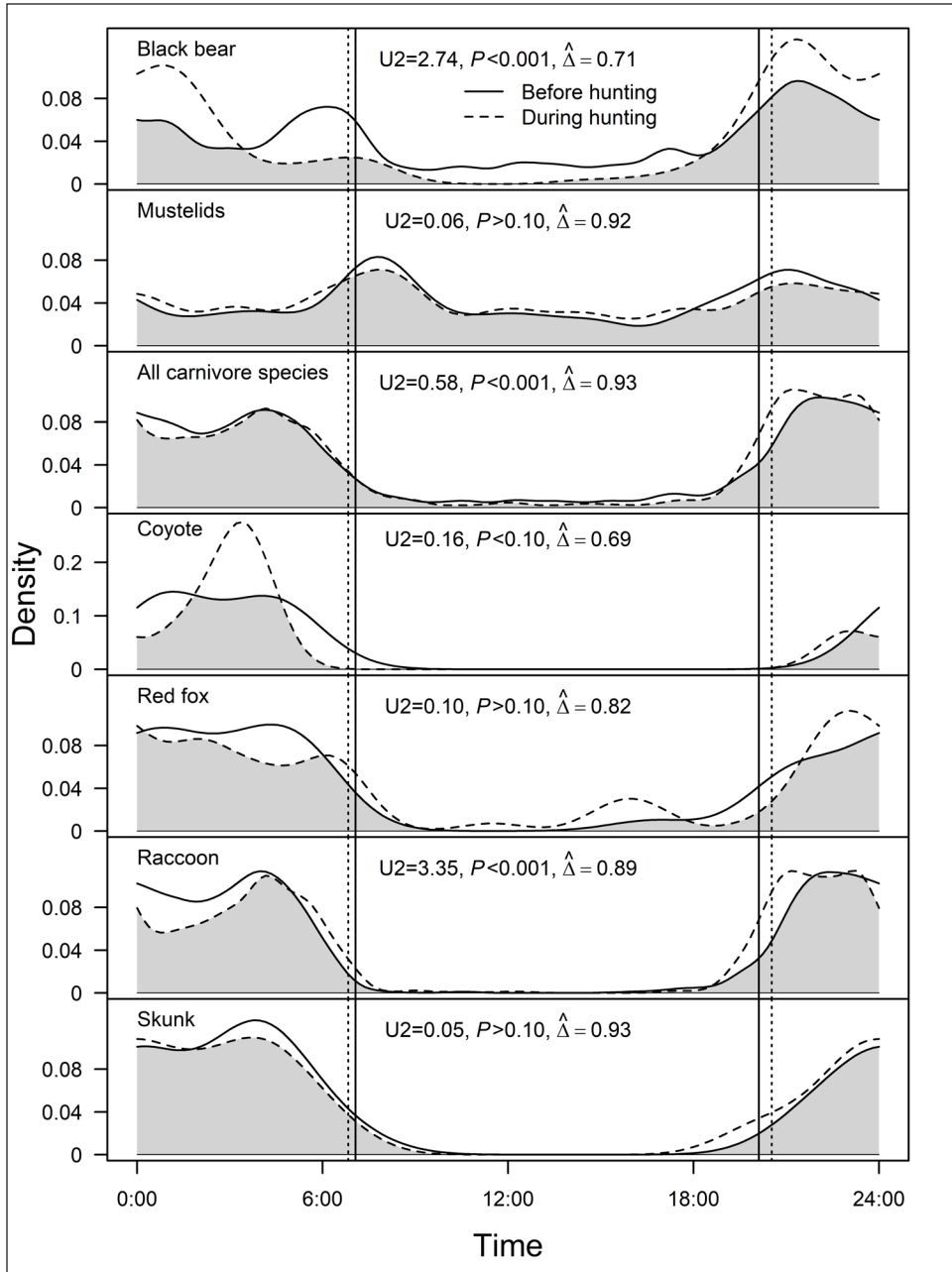


Figure 3. Temporal overlap for indicated species at black bear (*Ursus americanus*) hunter bait sites before hunting (solid line; August 10 to September 9) and during hunting (dashed line; September 10–24) in the western Upper Peninsula of Michigan, USA. Shaded area indicates the temporal overlap between the 2 time periods. Vertical lines indicate start (~06:50 and ~07:04) and end (~20:32 and ~20:07) of shooting hours for September 10, 2016 (dotted) and September 24, 2016 (solid), respectively. The reported U2 statistic is compared with the test statistic $U2 = 0.19$.

(Figure 3). An overall increase in nocturnal and diurnal activity has been observed in unhunted bear populations consistent with hyperphagia in autumn (Garshelis and Pelton 1980, Hwang and Garshelis 2007). However, we recorded a decrease in diurnal activity at bait sites with a

shift to nocturnal activity (Figure 3).

Hunted bears in Virginia, USA, and brown bears in Sweden demonstrated similar trends during hunting season (Bridges et al. 2004, Ordiz et al. 2012). This shift is also evident in populations that experience periodic high

human activity, such as increased hiking and angling, that may pose no direct threat to bears (Gunther 1990, MacHutchon et al. 1998, Olson et al. 1998, Kaczensky et al. 2006). However, human activity in our study area was high before hunting in the form of baiting and bear dog (*Canis familiaris*) training efforts (hunting bears with the assistance of dogs is also permitted in Michigan; MI DNR 2017), which has been suggested as a reason for temporal shifts in hunted Virginia black bear populations (Bridges et al. 2004). Therefore, the shift we observed may be a response to active hunting of bears (Erb et al. 2012). Consistent with risk allocation theory, bears are likely shifting their activity patterns to less risky nocturnal visitation to avoid human hunters (Lima and Bednekoff 1999). How black bears detect the difference between the baiting only period (August 10 to September 9) and the baiting and hunting period (September 10–24) remains unexplained.

Because bears experience hyperphagia before and during hunting season, we expected that detection rates at bait sites would remain high (Hristienko and McDonald 2007). We observed that bears not only shifted to nocturnal visitations, but also reduced their visitation overall by 49.28% (Figure 2). Though we did not actively hunt our bait sites, bears may have perceived a higher risk at bait. Previous research has reported the bears spatially shift away from unpaved roads used by hunters in the UP during hunting season (Stillfried et al. 2015). Bears may avoid bait sites during hunting season and instead target less risky, natural foods available during the fall (Gray et al. 2004, Kirby et al. 2017). The regional bear food index for 2016 was within normal conditions for the region (Garshelis and Tri 2017). In a low mast year, we may not observe a reduction in visitation as bears might compensate for lower natural food availability and continue to target bait sites (Oro et al. 2013).

Counter to our expectations, all other carnivore species that we detected >20 times increased their visitation to bait sites during hunting season (Figure 2). Though bears may not usually pose a threat, smaller carnivore species may yield bait sites to the much larger predator (Briffa and Sneddon 2007). However, nontarget carnivores, with the exception of

raccoons, did not alter their temporal patterns from before hunting to during hunting, indicating that they did not temporally avoid bears (Figure 3). The shift in activity patterns by raccoons from earlier to later in the morning might indicate that they are avoiding bears, who shifted from late morning to early morning hours (Figure 3).

The consumption of bait by opportunistic species may not only affect those consumer species, but may impact the broader mesopredator community (Figure 4). Similar to effects of natural resource pulses, consumption of bait may affect vital rates of consumers. For instance, bears that consume bait have increased fecundity and higher litter sizes (Gray et al. 2004, Kavčič et al. 2015, Kirby et al. 2017). These effects are likely to occur in nontarget consumers as well. Additionally, consumers may experience higher densities than would naturally occur (Oro et al. 2013). As opportunistic species are the primary consumers of bear bait, their populations might benefit the most. Individuals disproportionately affected as a result of a poor food year, particularly young, inexperienced, or individuals in poor condition, will be positively affected by consumption of bait (Oro et al. 2013).

Though bait may have positive impacts on populations of opportunistic species, bait might also create an ecological trap for species at lower trophic levels (Morris 2005, Cortés-Avizanda et al. 2009). We recorded several rodent species and snowshoe hares at bear bait sites, all of which are prey of mustelids, coyotes, and red foxes. Presence of both predators and their prey at bait sites may increase encounters and therefore predation risk for prey. Research in urban environments has shown that food subsidies to predators reduced their need to hunt, decoupling the predator–prey relationship (Rodewald et al. 2011). Additional research is needed to investigate if bear bait negatively impacts some nontarget prey species.

Encounter competition among consumer species might also be exacerbated at bait sites (Schoener 1983). Larger-bodied species are likely to win an encounter, therefore having a higher resource holding potential (Briffa and Sneddon 2007). Encounter competition may explain why non-target carnivore species limited their



Figure 4. Camera-trap detections of 4 black bears (*Ursus americanus*; A), 3 fishers (*Martes pennanti*; B), 3 raccoons (*Procyon lotor*; C), and 2 bobcats (*Lynx rufus*; D) at black bear hunter bait sites, western Upper Peninsula, Michigan, USA, August to October 2016.



Figure 5. Camera-trap detections of red fox (*Vulpes vulpes*) and raccoons (*Procyon lotor*) demonstrating aggressive behavior (A) and sharing food (B), striped skunk (*Mephitis mephitis*) and raccoon displaying defensive behavior (C), and American marten (*Martes americana*) and raccoon (D) at black bear (*Ursus americanus*) hunter bait sites western Upper Peninsula, Michigan, USA, August to October 2016.

mean daily visitation to bait sites, avoiding competition with bears and increasing their visitation when bear visitation was reduced. However, during hunting, species of similar sizes (i.e., red foxes and raccoons) increased their daily visitation to bait sites, making the outcome of an encounter less predictable (Allen et al. 2016). We regularly observed raccoons and red foxes as well as raccoons and skunks at bait sites together (Figure 5). Bear bait creates a foraging

arena, aggregating and possibly increasing encounter competition between non-target consumers (Ahrens et al. 2012, Allen et al. 2016).

Bear baiting is a common practice in North America, occurring in 11 of the 27 states in the United States and 10 of the 13 provinces and territories in Canada where black bear hunting is permitted (black bear hunting is not permitted in Mexico). Although bear baiting might have positive effects on nontarget species, some of these benefits may manifest as negative community-level impacts (Wilmers et al. 2003, Bump et al. 2013, Oro et al. 2013, Newsome et al. 2015, Kirby et al. 2017). In addition to inter- and intra-specific conflict at bait sites, human–wildlife conflict might be exacerbated. For example, hunting dog–wolf conflicts may be positively related with bear bait duration on the landscape (Bump et al. 2013). Chronic wasting disease (CWD) was recently documented in the UP (Michigan Department of Natural Resources 2018a) and, perhaps non-intuitively, we recorded deer visiting bear bait sites. This has management implications because, in areas with CWD, deer baiting is typically banned (Michigan Department of Natural Resources 2018b).

Research of white-tailed deer at hunter bait sites shows that concentrated deer are more likely to spread diseases such as CWD and bovine tuberculosis (Thompson et al. 2008). Aggregation of species at bear bait sites, such as raccoons and skunks, also provides opportunity for the spread of diseases (e.g., rabies) that are transmitted through contact (Houle et al. 2011).

Management implications

This research demonstrated that bear bait attracts several nontarget species whose resource need and feeding activity directly compete with the intention of hunters to use the bait to attract bears exclusively. Managers should consider that the amount, type, method, and duration of baiting is likely to affect what and how species use bait. Additionally, the aggregation of individuals and different species at bear bait sites increases the potential for disease spread.

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