Giving up density as an indicator of black bear food preference in the Ouachita National Forest, SE Oklahoma

Abstract

Living in close proximity to humans can present costs to wildlife species but can also present benefits in the form of reliable, human-generated, food subsidies. Black bears are opportunistic omnivores that have adapted anthropogenic food sources into their diet. In the Oklahoma Ozarks, black bears consume corn from wildlife feeders on privately owned land, destroying them in the process. An important question in understanding this source of human-bear conflict is that, given an equal availability of anthropogenic and native food, do bears prefer one over the other? One way to address food preferences in wildlife populations is to measure giving up density (GUD), which involves simultaneously presenting two types of food in equal amounts that require equal effort to obtain. The animal will "give up" even though there may be food left over because it is no longer advantageous to search for it. The amount of food remaining after the foraging bout is the GUD. A lower GUD indicates preference. This method was used to gauge black bear food preference in the Ouachita National Forest (ONF). We deployed 4-5 pairs of horse toys with holes drilled in the bottom (feeders) to dispense food along 2 bear trapping lines and monitored interactions with game cameras. In the Trial Period 1, black bears exhibited a lower GUD for feeders with corn than for feeders with acorns ($Z= 1.74$, $df= 13$, $p= 0.041$). Median number of food capsules remaining with blueberries did not differ from the number of capsules remaining of corn ($Z=0.052$, $df= 19$, $p= 0.48$). Black bears spent, on average, more time at corn feeders than natural food feeders in both seasons, but neither comparison was statistically significant (Trial Period 1: $Z= -1.4$, $p= 0.92$; Trial Period 2: $Z= -0.57$, $p=0.72$). Given that both anthropogenic food and acorns were presented with equal difficulty to obtain and equal caloric value, black bears preferred corn to acorns. Understanding the relationships between black bear

behavior and both anthropogenic and natural foods will help design effective policy and outreach programs in mitigating human-black bear conflict.

Intro

Living in close proximity to humans can present costs to wildlife species but can also present benefits in the form of reliable, human-generated, food subsidies (Baruch-Mordo 2008). Such proximity to humans causes trade-offs and impacts wildlife behavior, especially large carnivores such as the American black bear (*Ursus americanus*). Black bears are recolonizing parts of their historic range throughout North America, including eastern Oklahoma near human populations (Bales *et al.* 2005). Black bears are opportunistic omnivores that have adapted anthropogenic food sources into their diet. In urban areas, black bears have changed their behavior in response to abundance of anthropogenic food, poor natural food years, and climate change (Beckman and Berger 2003; Baruch-Mordo *et al.* 2014; Laufenberg *et al.* 2018). Black bear scat in the Oklahoma Ozark Plateau (Ozarks) during the summer contains mostly anthropogenic food (corn) by volume as well as blackberries, black cherries, insects, grasses, (Connor *et al.* 2018) and in the fall, acorns.

In the Ozarks, black bears consume corn from wildlife feeders on privately owned land, destroying them in the process and causing conflicts with humans. It is unclear whether the bears forage at these feeders because they are a source of easily obtainable calories, prefer corn to their native food sources, or are compensating for a lack of food in the area. An important question in understanding this source of human-bear conflict is that, given an equal availability of anthropogenic and native food, do bears prefer one over the other? The answer would increase our understanding of black bear motivations to eat anthropogenic foods and may suggest ways to minimize human-bear conflict.

One way to address food preferences in wildlife populations is to measure giving up density (GUD) (Abu Baker & Brown 2014). This method involves simultaneously presenting two types of food in equal amounts that require equal effort to obtain. As the animal forages at the source, the food will be depleted over time, resulting in a diminishing rate of return. The animal will "give up" even though there may be food left over because it is no longer advantageous to search for it. The amount of food remaining after the foraging bout is the GUD. The lower the GUD, the more time and effort a bear expended, that is the more preferred that food type.

GUD was used to assess preference of black bears for corn versus native foods in east central Oklahoma (Artz 2016). Food was presented in modified horse toys that the bears had to shake or hit to obtain gelatin capsules containing food. Two feeders were hung on nearby trees, one containing capsules of corn and the other containing capsules of the same caloric content of acorns or blueberries (native foods).

GUD for corn in Early and Late summer was significantly lower than that of natural foods, suggesting the black bears preferred the corn over native foods. Black bears may prefer corn because of its high caloric and protein content, or because black bears in this area were more willing to forage for corn in this way than for natural food. The native diet items were abundantly available in the habitat during the time of the study. However, they did suspend foraging of native foods to extract corn from the experimental feeders.

My objective was to repeat the study in an area where black bears were most likely unfamiliar with manipulating wildlife feeders or anthropogenic food, in the Oklahoma Ouachita National Forest (ONF). In the state of Oklahoma, it is illegal to bait on public land, so the probability of a black bear encountering a wildlife feeder should be low. If black bears in this area show preference for corn over natural foods, we can predict that black bears prefer anthropogenic

foods to natural food regardless of experience. I hypothesized that black bears would exhibit a lower GUD, that is greater preference, for corn over natural foods.

Methods

The study area was located in southeastern Le Flore County, the core of the black bear population in the Oklahoma ONF. The northern unit of the ONF consists of about 722,100 ha of the Ouachita Mountains (hereafter Ouachitas). The Ouachitas are part of the Interior Highlands and are comprised of east-west ridges at elevations of 91.4 – 817 m. Mean annual temperature is 15° C (Oklahoma Climatological Survey). Mean annual precipitation is 127 cm, and perennial streams are common. Rolley and Warde (1985) identified 3 major land cover types in this area: pine forest, deciduous forest, mixed pine-deciduous forest. Pine forest was dominated by shortleaf pine (*Pinus echinata*), but Blackjack oak (*Quercus marilandiaca*) and post oak (*Q. stellate*) were also present. Understory in pine forest included low blueberry (*Vaccinium vacillans*), Farkleberry (*V. arboreum*) and poison ivy (*Toxicodendron radicans*). The herbaceous layer included panicum (*Panicum* spp.), little bluestem (*Andropogon scorparius)* and butterflypea (*Centrosema* spp.). Deciduous forest overstory was dominated by white oak (*Q. alba*) and northern red oak, mockernut (*Carya tomentosa)*, and black hickory (*C. texana*). Understory included flowering dogwood (*Cornus florida)*, eastern redbud (*Cercis canadensis)* and red maple (*Acer rubrum)*. Herbaceous material included panicum, wildrye (*Elymas* spp.), and sparglegrass (*Chasmanthium* spp.).

The population of black bears in the Oklahoma ONF is the result of the successful black bear reintroduction efforts to the Arkansas ONF between 1958 and 1968 (Smith and Clark 1994). This population has been under long term study since 2000 by the Oklahoma Department of

93 Wildlife Conservation and the Oklahoma Cooperative Fish and Wildlife Unit. Ongoing black
94 bear trapping provided an opportunity to conduct this study of black bear food preference.

95 We deployed 5 pairs of Amazing Graze™ PVC horse toys (Horseman's Pride, Millsburg, OH)
96 with holes drilled in the bottom (feeders) to dispense food along bear trapping lines on Lynn and
97 Walnut Mountain for two weeks each. The closest private inholding was 70 m from the trap and
98 the average distance from a private inholding to a trap was 700 m. These feeders contained 30
99 gelatin pill capsules (Torpac, Fairfield, NJ) filled with an equal caloric value of anthropogenic
100 (corn) or native foods and 15 larger, empty gelatin capsules that would not fit through the drilled
101 holes to make food capsules more difficult to remove. The gelatin capsules are water soluble, so
102 for the previous study (Artz 2016), feeders were removed when rain was likely. To make the
103 feeders water resistant, we covered the large hole in the side of the toys by screwing on square
104 pieces of PVC on the inside face then sealed it with Gorilla Glue. I placed feeders in areas that
105 bear presence was likely, at least 10 m away from the traps. If a trap and the feeders had no
106 evidence of bear interaction, the feeders were moved to another trap. As part of the larger study,
107 bucket cable traps were baited with pastries, sardines, and frosting (Pfander and Fairbanks 2018).

108 Feeders were paired, one with anthropogenic food and one with natural food, and suspended by
109 13 mm steel cable from trees to hang 1-1.5 m off the ground and 5-10 m apart. To correspond
110 with changes in natural food available to bears, the field season was split up into 2 periods: Trial
111 Period 1 (1-14 June 2018) and Trial Period 2 (15-30 June 2018). In the Trial Period 1, red oak
112 acorns (Curious Country Creations LLC, West Jordan, UT) were used as the natural food and in
113 the Trial Period 2, commercial no-sugar-added, organic, dried blueberries (Bella Viva Orchards,
114 Hughson, CA) were used as the natural food. These foods were selected to correspond with the
115 food naturally available at the time of the trials. To ensure that bears would be able to smell the

food, a small portion of the food was hung up inside the feeder in a nylon bag out of reach of the openings at the bottom of the feeder.

We set up nine motion activated Stealth Cam model STC-G42NG (Stealth Cam, Grand Prairie, TX) singly to capture both feeders or paired to capture one feeder each with a 3 shot burst or a 30 second video setting. We checked cameras daily to ascertain black bear interaction with one or more feeders. If a black bear interacted with a feeder, we took it down and recorded the number of food capsules remaining in the feeder as the GUD. Capsules were replenished and the feeder was hung back up in the tree for the next trap night. Photos and videos were downloaded to a PC for further analysis.

The game camera footage of interactions at the feeders were categorized as one or multiple individuals, single or paired, manipulation or observation, and successful or unsuccessful manipulation. If a black bear only manipulated one feeder, the interaction was classified as a single interaction; if a black bear manipulated both, we considered it a paired interaction. We assumed that if a bear interacted with only one feeder they knew of the presence of the other feeder, but chose not to interact, resulting in a GUD of 100% for the ignored food type. Interactions wherein more than one bear extracted food from a feeder within a 24-hour period were not included in the analysis, because a GUD could not be determined for multiple individuals. Identification of individuals was facilitated by the large proportion of tagged and collared bears and natural markings. Manipulation interactions were described as those that involved moving, shaking, or hitting the feeder; observation interactions were defined as those that were investigative in nature such as sniffing or visually inspecting the feeder.

The GUDs for both seasons were strongly right-skewed and non-normally distributed. Therefore, we used a non-parametric Wilcoxon Rank Sum test to determine the difference between the

median GUDs of the two food types. Duration of interaction was determined with game cameras and also examined as an indicator of preference. We used a Wilcoxon Rank Sum to test the difference between the median time spent manipulating feeders of the two food types. To determine if there was a relationship between time and capsules obtained we also analyzed the relationship between length of interaction and number of capsules obtained using a Spearman Rank Correlation test. For all statistical analysis, $\alpha < 0.05$.

Results

In Trial Period 1, I deployed 4-5 feeders for 14 days resulting in 49 trap nights (26 nights on Lynn and 23 on Walnut trap lines) and in Trial Period 2, 4-5 feeders were deployed for 14 days, resulting in 55 trap nights (on Walnut). For Trial Period 1, 22 manipulations were recorded with 7 of them being successful. We removed 3 manipulation interactions from the analysis, because in the photographs of one interaction it was unclear which feeder the bear manipulated and the other 2 because multiple bears interacted with the feeder in the same night. We estimate that 16-20 individual bears interacted with the feeders in Trial Period 1.

In Trial Period 2, 24 manipulation interactions were recorded, 6 of which were successful. One manipulation interaction was excluded from the analysis as the feeder was stolen by the bear and could not be recovered. We estimate that 14-15 individual bears manipulated the feeders in Trial Period 2.

In the Trial Period 1, black bears left fewer food capsules in feeders with corn (lower GUD) than in feeders with acorns ($Z= 1.74$, $df= 13$, $p= 0.041$) (Figure 1). Median number of food capsules remaining with blueberries did not differ from the number of capsules remaining of corn ($Z=0.052$, $df= 19$, $p= 0.48$).

Time spent manipulating feeders was also analyzed as an indicator of black bear food preference. Trial Period 1 interactions included in the GUD analysis were used in the test, but one interaction was excluded due to some discrepancies with the time stamps on the photos. In Trial Period 2, 2 interactions were removed from the analysis for the same reason. Black bears spent, on average, more time at corn feeders than natural food feeders in both seasons, but neither comparison was statistically significant (Trial Period 1: $Z= -1.4$, $p= 0.92$; Trial Period 2: $Z= -0.57$, $p= 0.72$) (Figure 2). While we did find a significant relationship between capsules obtained and time spent manipulating the feeder, one variable may not necessarily account for the variation in the other variable ($\rho(60)= 0.34$, $P= 0.007$) (Figure 3).

Discussion

Black bears exhibited a lower GUD for anthropogenic food in Trial Period 1 which corroborates results from the Early Summer period of the study conducted in the Oklahoma Ozarks (Artz 2016). Given that both anthropogenic food and acorns were presented with equal difficulty to obtain and equal caloric value, black bears preferred corn to acorns. By repeating the experiment in the ONF where bears likely have much less exposure to wildlife feeders, we can rule out that black bears prefer corn to acorns because it is easier to obtain. In addition, the acorns used in this study should have been more attractive to bears than the acorns available after overwintering because they were not weathered or partially consumed by insects. In Trial Period 2, results are inconclusive but Artz indicated that black bears preferred anthropogenic food over blueberries in the Late Summer period. These results may be due to the low number of successful manipulation interactions during Trial Period 2.

While there were many more total black bear interactions in the ONF, black bears in the Ozarks (Artz 2016) had many more successful manipulations (This Study: Trial Period 1=7, Trial Period

2: 6; Ozarks study: Early Summer= 13 Late Summer= 21). The lower success rate supports our assumption that black bears in the area were not as experienced at manipulating feeders to extract corn. Alternatively, they may have been less willing to expend the effort due to differences in the placement of feeders in the study area. In the Ozarks, feeders were placed in areas that black bears were known to frequent based on GPS collar data and hair snare work. In the ONF, for logistic reasons, we placed feeders about 10 m from a bucket cable trap in our trap line. Additionally, bears may have been more interested in the bait (pastries, sardines, frosting etc.) in the bucket cable traps than the food in our experimental feeders. Nevertheless, a large number of manipulations by black bears was observed and black bears did exhibit a preference for corn over acorns in Trial Period 1. Additionally, black bears in the Ozarks appeared to spend, on average, more time manipulating the feeders than black bears in the ONF (Ozarks: Acorns=15.62 min, Corn= 20.37 min, Blueberries= 10.61 min, Corn= 14.15 min; ONF: Acorns = 1.76 min, Corn= 5.92 min, Blueberries= 1.17, Corn= 1.78). This may also be due to the difference in feeder placement between studies.

As black bears expand their range in the Oklahoma Ozarks and outside the ONF in southeastern Oklahoma, human-wildlife conflict regarding black bears' use of anthropogenic food may increase. In response to abundant natural food in their home ranges, black bears in other areas are entering dens later in the season (Beckman and Berger 2003; Johnson *et al.* 2018) Anthropogenic food has a similar effect on black bears, but with the added effect of shortening the duration of time in the den (Johnson *et al.* 2018). The problem can be especially exacerbated in times of natural food shortage, because black bears near urban areas are likely to supplement their diet with anthropogenic food and risk human-caused mortality (e.g. harvest, lethal removal, vehicle collisions, etc.). Laufenberg *et al.* (2018) report a 57% decline in the female black bear

population around Durango, Colorado during a time of natural food shortage, with harvest and vehicle collisions making up most of the human-caused mortalities that year. The results of Artz (2016) and our study suggest that anthropogenic food such as corn from deer feeders may contribute importantly to overall food availability regardless of a natural food shortage and thus contribute to changes in black bear behavior and interactions with humans. Deer feeding provides an attractive supplemental food on the landscape for black bears and in our study areas they were willing to forgo time searching for and consuming natural food sources to exploit this anthropogenic source. Feeders associated with deer hunting may also come with a lower likelihood of negative human interactions because they are less likely to be placed near areas of high human activity. Nevertheless, we suggest to Oklahoma hunters to remove deer feeders during the summer when bears are most likely to destroy them.

Wildlife managers should consider the affect anthropogenic food can have on the behavior, movements, and potential human conflict with black bears, especially in conjunction with climate change and its effect on food availability. Understanding the relationships between black bear behavior and both anthropogenic and natural foods will help design effective policy and outreach programs in mitigating human-black bear conflict.

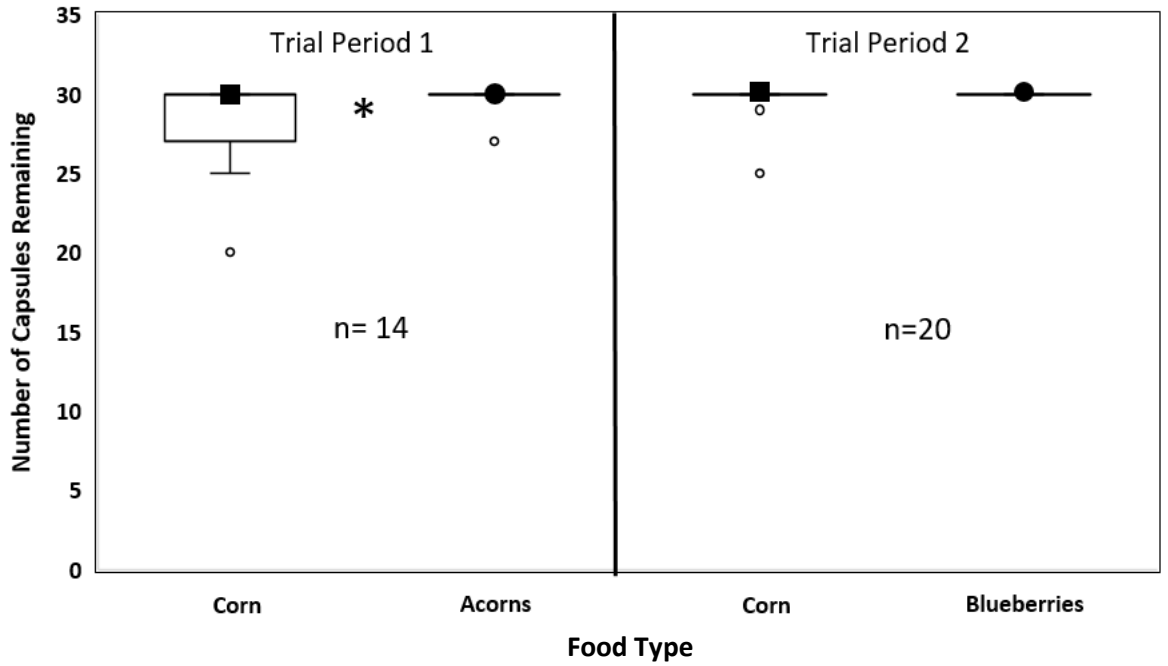
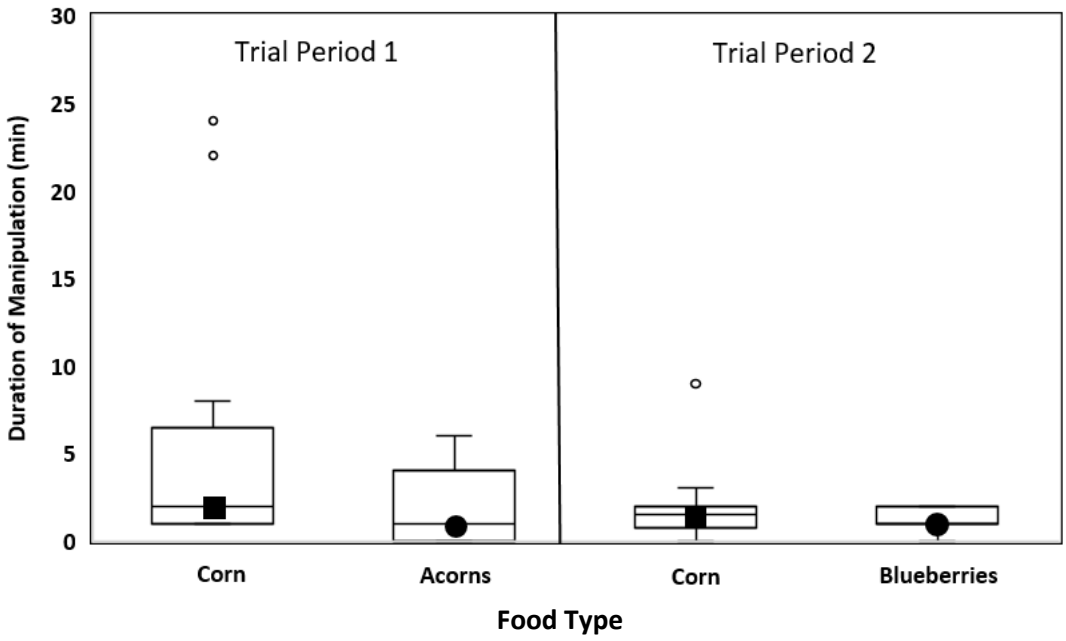


Figure 1: Boxplot of the number of capsules remaining according to food type. Small circles indicate outlier points. Whiskers indicate the lowest value. The bottom edge of the box indicates the first quartile. Squares indicate the median for corn and circles indicate the median for natural food. A * indicates a significant comparison of medians (α=0.05).



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230 Figure 2: Boxplot of time elapsed in a manipulation according to food type and trial period.
231 Squares indicate the median value of anthropogenic food. Circles indicate the median value of
232 natural food. Small circles indicate outlier points. Whiskers indicate the lowest value. The
233 bottom edge of the box indicates the first quartile.

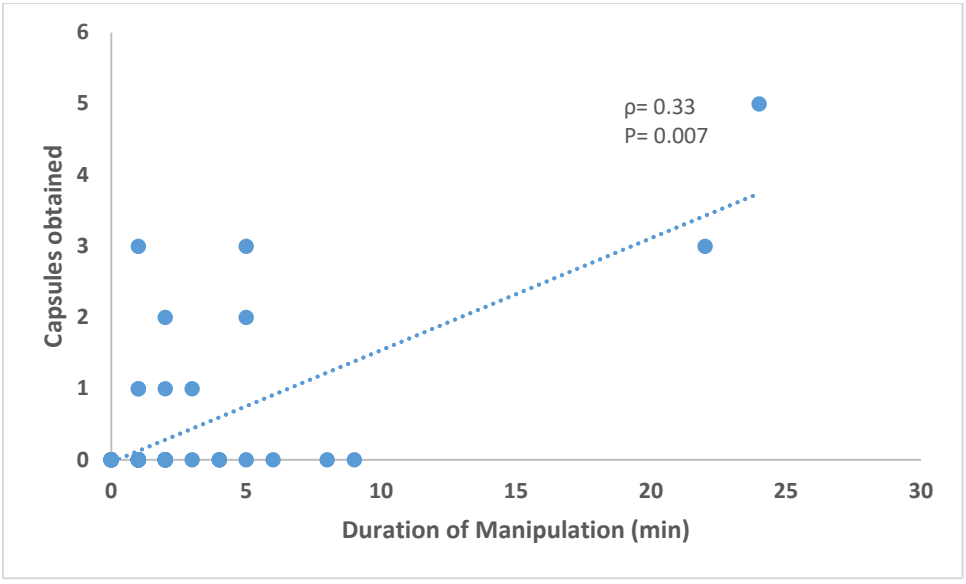

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Figure 3: Line graph of the relationship between capsules obtained and time spent in a manipulation interaction. Both Trial Period 1 and 2 included. ($\alpha = 0.05$)

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