Effects of different baits, commercial dog food and commercial scent lure, on attracting carnivores to remote camera trap

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An increasing number of studies are attempting to assess ecological questions using noninvasive survey techniques such as remote camera trapping. However, camera trapping studies require intense human effort and are costly to maintain, pushing researchers to optimize detection of target species. We used 12 infrared cameras, six baited with commercial dog food and six with commercial scent lure. Food-baited cameras attracted more wildlife overall compared to control cameras, but not compared to scent-baited cameras. However, the composition of species that visited baited cameras changed. Raccoons were sighted more at both food-baited and scent-baited cameras, suggesting a preference for baited cameras. Domestic cats were sighted less at food and scent-baited cameras compared to control cameras. Other species surveyed (red fox, opossums, and striped skunk) did not significantly alter their behavior towards any bait. Food-baited cameras may be useful for ensuring all species that can be detected in an area are seen.

INTRODUCTION

Mammalian carnivores receive a great deal of conservation attention, often due to their charismatic and conflict-ridden image that draws attention from diverse segments of society.[1, 2, 3] Carnivores are integral members of a wildlife community and often drive key ecological processes (e.g., top-down trophic regulation).[4, 5] Carnivores are also particularly sensitive to the effects habitat fragmentation,[3,6] a leading cause of species decline worldwide.[7, 8] As a result, an increasing number of studies are attempting to assess presence or absence, relative abundance, distribution, and interactions of carnivore species in an increasingly fragmented world.

Many carnivores are rare or elusive and have large home ranges, making them difficult to study. Techniques to study carnivore ecology are typically invasive, requiring the capture and handling of individual animals. This intensive work is usually impractical for studies addressing questions over larger geographic scales and may also be inappropriate because of local regulations, costs and logistics, and risks to the animals and humans involved. Yet, because carnivores range over large areas and frequently interact with one another,[9] biologists and wildlife managers are increasingly recognizing the need for large-scale studies of entire carnivore communities. Thus, there has been a push to develop noninvasive survey techniques that can be deployed over large areas and detect multiple species.

Infrared-triggered remote camera traps have been used in many studies surveying carnivores.[10, 11, 12] Although camera traps require significant time and monetary investments to set up and require many nights of effort to accurately census a wildlife community, they appear to be the best compromise for studying carnivore ecology over large areas. One way to reduce effort needed is to bait cameras to attract wildlife. The most commonly used baits are scent lures (e.g. anal sac secretions or urine) and food lures. However, purchasing baits adds to the startup cost of the experiment, and thus selecting the most attractive bait is imperative. With this study, I aim to assess the effectiveness of two different baits, commercial dog food and commercial scent lure, in attracting carnivores to camera traps.

Expected Results:

1. I expect that cameras with bait will attract more wildlife overall than cameras that are not baited.
2. I expect that opossums (*Didelphis virginiana*), red foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), and domestic cat (*Felis catus*) will be more attracted to the commercial dog food. Opossums and raccoons are frequently reported to raid garbage bins[13], and would be familiar with commercial food scents. Saunders and Harris[14] found foxes to be attracted to and consume baits enhanced with artificial beef flavor. Many unowned domestic cats are fed by humans,[15] and will be familiar with the smell of commercial pet food. .
3. I expect striped skunks (*Mephitis mephitis*) to be more attracted to the commercial scent lure. The lure has a distinct skunky smell, which the skunks will find attractive.

METHODS

Study area

My study was conducted during Spring 2015 (9 Mar 2015 to 20 Apr 2015) at the Brookhaven National Laboratory, a 2,100 hectare facility located in Upton, New York, United States. The laboratory is in the Atlantic Coastal pine barrens ecoregion, dominated by pine (*Pinus* spp.) and oak (*Quercus* spp.) with patches of maple-blackgum forest alliance (*Acer rubrum* and *Nyssa sylvatica*, respectively). The understory consists of shrubs, including hillside blueberry (*Vaccinium pallidum*) and black huckleberry (*Gaylussacia baccata*). A section of the Peconic river runs through the northern and eastern areas of the laboratory. It is bound on the southern edge by the Long Island Expressway and on the western edge by William Floyd Parkway. The property is not fenced, allowing wildlife to freely move onto and off of the laboratory. Red fox, gray fox (*Urocyon cinereoargenteus*), raccoon, opossum, and striped skunk are known to occur in the study area. The area also hosts a population of feral cats (J. Higbie, pers. comm.).

Camera trapping

I placed 12 passive infrared cameras 500 m apart in a 16 hectare area on a trapping grid (Figure 1). I grouped the 12 cameras into 6 paired locations based on similarities in vegetation community and deployment area. I used nine Bushnell® Trophy Cam™ (Bushnell Corporation, Overland Park, KS, U.S.A.; http://www.bushnell.com) and three Reconyx™ HC 600 Hyperfire (RECONYX, Inc., Holmen, WI, U.S.A.; http://www.reconyx.com). To maximize detection probability, I selected camera trap sites along hiking trails or roads, as carnivores are known to use trails as movement corridors.[16] I deployed cameras either by attaching them to a tree along the edge of the trail or to a post embedded in a cement block that was placed in between trees at the edge of the trail. All cameras were deployed at a height of 60 - 80 cm. I set the cameras to take 3 photographs every time the motion detector is triggered, with a delay of 10 seconds between each cluster of photographs. The cameras were set for 24-hour operation to catch both nocturnal and diurnal movement. I used high sensitivity and included a time and date stamp on all photographs for all cameras.

One camera from each pair was baited with commercial dog food (Foodhold U.S.A., LLC.; Landover, MD, U.S.A.) and the other camera with commercial scent lure (Caven's "GUSTO", Minnesota Trapline Products, Pennock, MN, U.S.A.; http://www.minntrapprod.com/). I chose these lures because they have performed well as baits or lures in other carnivore studies.[12, 17, 18] Lures were placed approximately 2 - 6 m from the camera trap in the center of the road or trail. Dog food was spooned onto the ground and any large chunks were broken up. Scent lure was spread on any low-growing vegetation with a stick and the stick was left on the ground. The food lure was consumed, so I replaced it every Monday and Thursday to ensure its effect was consistent throughout sampling. However, it was unnecessary to renew the scent lure every day as the smell was detectable for several days. I renewed the scent lure once a week except after heavy rain, when I refreshed the lure the following day. I treated each camera for two weeks, after which the cameras were moved a new random pair site, for a total of 18 sites.

Data analysis

I sorted photographs taken by the cameras into five categories: Carnivores, Other Animals, Animal Not Seen, Environmental Triggers, and Corrupt Files. The "Carnivores" category included photos of opossum, red fox, raccoon, striped skunk, and domestic cat. "Other Animals" included other species of wildlife caught on film, including American robins (*Turdus migratorius*), gray squirrels (*Sciurus carolinensis*), ground hogs (*Marmota monax*), killdeer

(*Charadrius vociferus*), white-footed mice (*Peromyscus leucopus*), white-tailed deer (*Odocoileus virginiana*), and wild turkey (*Meleagris gallopavo*). "Animal Not Seen" refers to photos in which the motion detector is triggered, but no animal can be seen in the frame. I used clues such as absence of moving vegetation or shadows to determine whether an animal triggered the motion detector. "Environmental Triggers" included photos of waving vegetation, the movement of the sun, and falling snow that did not include wildlife. Corrupt files were subtracted from the total number of photos and removed from analysis.

I calculated the number of animals captured per trap night per camera as:

Animals per Trap Night = A/T

where A = the total number of Carnivore and Other Animal photographs and T = the number of trap nights the camera was operational. The results were averaged across all cameras to give a value for the whole treatment. Success for each bait type per two-week sampling period was calculated as:

Success (%) = $(C_i/A) * 100$

where C = the number of individuals of carnivore species *i*. The results were averaged across each two-week sampling period to give a value for the whole treatment. I also used a chi-squared analysis at the 95% confidence level to test if the proportion of carnivores captured varied significantly between any of the treatments.

RESULTS

Control Cameras

The control dataset included 39,581 photographs from 453 trap nights, including 206 carnivore photographs, 405 other animal photographs, 115 unseen animal photographs, and 38,855 environmental triggers (Table 1). Raccoons were the most numerous carnivore photographed (n = 145 photographs), followed by domestic cats (n = 56), opossums (n = 14), striped skunks (n = 3), and red fox (n = 2). Control cameras averaged 1.44 animals per trap night (95% CI = 0.89 to 2.00; Figure 2). Carnivores represented an average of 34.25% of animals photographed (CI = 29.54 to 38.96%). Raccoons represented an average of 22.54% (CI = 16.34 to 28.74%; Figure 3) of animals, domestic cats represented an average of 9.33% (CI = 8.32 to 10.34%), opossums represented an average of 2.06% (CI = 0.10 to 4.02%), striped skunks represented an average of 0.70% (CI = -0.68 to 2.08%), and red fox represented an average of 0.26% (-0.16 to 0.68%). The proportion of photographs that were of each carnivore species was significantly different between control cameras and food-baited cameras ($\chi^2 = 439.03$, df =4, $p < 0.05$) and between control and scent-baited cameras ($\chi^2 = 23.80$, df = 4, $p < 0.05$).

Baited Cameras

The cameras baited with food captured a total of 2,938 photographs during 238 trap nights, including 685 carnivore photographs, 349 other animal photographs, 268 unseen animal photographs, and 1,636 environmental triggers (Table 1). Raccoons were the most numerous carnivore photographed (n = 487), followed by red foxes (n = 116), domestic cats (n = 55), striped skunks (n = 15), and opossums (n = 12). Food-baited cameras averaged 4.13 animals per trap night (95% CI = 2.37 to 5.89; Figure 2). Carnivores represented an average of 66.18% of animals photographed (95% CI = 54.89 to 77.48%). Raccoons represented an average of 47.68%

(CI = 34.39 to 60.98%; Figure 3) of individuals, red fox represented an average of 10.57% (CI = -3.23 to 24.37%), domestic cat represented an average of 5.35% (CI = 4.14 to 6.55%), striped skunks represented an average of 1.52% (CI = -0.04 to 3.08%), and opossums represented an average of 1.06% (-1.01 to 3.12%). The difference in the proportion of individuals of each carnivore species was not significant between food-baited cameras and scent-baited cameras ($\chi^2 = 9.19$, df = 4, $p = 0.23$).

The cameras baited with scent lure captured a total of 4,684 photographs during 213 trap nights, including 227 carnivore photographs, 240 other animal photographs, 118 unseen animal photographs, and 4.099 environmental triggers (Table 1). Raccoons were the most numerous carnivore photographed (n = 192), followed by domestic cats (n = 23), striped skunks (n = 7), and red fox (n = 5). No photographs of opossums were recorded. Scent-baited cameras averaged 2.18 animals per trap night (95% CI = 0.88 to 3.48; Figure 2). Carnivores represented an average of 47.87% of individuals captured (95% CI = 40.18 to 55.56%). Raccoons represented an average of 41.15% (CI = 38.58 to 43.71%; Figure 3) of individuals, domestic cats represented an average of 3.94% (CI = -0.40 to 8.28%), striped skunk represented an average of 1.62% (95% CI = -1.56 to 4.80%), and red fox represented an average of 1.16% (CI = -1.11 to 3.43%).

DISCUSSION

Overall, food-baited cameras attracted more wildlife than control cameras. The scent-baited cameras did not show a significant difference between the control or food-baited cameras. However, the composition of wildlife species also changed when the cameras were baited. Carnivores constituted a significantly larger proportion of individuals captured at food-baited.

While the results were not significant for red fox and striped skunk, the results for raccoons, domestic cats, and opossums showed significant differences in their reactions to food-baited and scent-baited cameras.

Raccoons were seen significantly more often at food and scent-baited cameras than at control cameras. However, no difference was seen between food-baited and scent-baited cameras. These results suggest raccoons are more attracted to cameras with bait, but do not exhibit a preference for a particular bait. Domestic cats are significantly less likely to visit a camera baited with food or scent lure compared to control cameras. However, domestic cats may be overrepresented in our control samples. The control cameras were located on a solar facility nearby a residential property with a barn. It is likely this residential property augments the density of domestic cats around the solar facility as compared the rest of the Laboratory. Opossums were seen less often at scent-baited cameras than at control or food-baited cameras, although the results are not strongly significant. Opossums, striped skunks, and have low densities in urban and suburban systems,[19] which would account for our small sample sizes and lack of statistically significant results. The inability to distinguish individuals is the most likely source of the inflated average red fox sightings for the food-baited cameras. It is likely that a single fox visited the camera multiple times per night with enough temporal difference to be considered a separate capture.

This is by no means a rigorous inventorying survey. Baits violate assumption of equal detectability (due to competition between bait and highly preferred natural food resources,[20] a lack of interest by target species, and individual personality differences towards novel objects), complicating using photography in capture-recapture studies. An inability to accurately distinguish individuals also skews the true number of individuals caught per night (e.g. an animal that walks one direction at 20:00 and returns at 2:00 is counted as two individuals). Unfortunately, individuals can only be accurately distinguished if the pictures are of a high enough quality, the species has identifying characteristics (e.g. stripped or spotted patterns in the fur), and the individual is photographed in a position where the characteristics can be clearly seen. Therefore, camera studies are not useful as a metric of occupancy unless individuals can somehow be ‘tagged’. Baited cameras may cause individuals to linger in front of the camera, potentially allowing for a decent picture of their identifying characteristics.

We show here that baiting camera traps helps to draw in more wildlife to the trap. Baits, especially food-scented baits, may make the tradeoff of approaching camera more beneficial to animal. For short term inventorying studies, bait may be useful to ensure all species that can be detected are. Caution must be used in urban and suburban systems, however, to prevent animal habituation to commercial pet foods. Seeking food at or near dwellings may bring wildlife into conflict with humans.

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Table 1. The number of photographs taken and individuals captured by all cameras, categorized by treatment. The first column in each category gives the total number of pictures taken, and the second column gives the number of individuals captured. Within each category N = total number of photographs taken and A = the total number of individuals captured.

	Control	Food Lure	Scent Lure
	N=39,581	N=2,938	N=4,684
Carnivores	247	685	227
Raccoons	145	487	192
Domestic Cats	56	55	23
Opossum	14	12	0
Striped Skunk	3	15	7
Foxes	2	116	5
Other Animals[a]	405	349	240
Unseen Animals[b]	115	268	118
Environmental Triggers[c]	38,855	1,636	4,684

a. "Other animals" includes American robins, gray squirrels, ground hogs, killdeer, white-footed mice, white-tailed deer, and wild turkey.
b. "Unseen animals" includes pictures that were triggered by wildlife, but the individual is not present in the frame.
c. "Environmental Triggers" includes photographs that were triggered by wind, sunlight, or snow that do not include wildlife.

Figure 1. Location of 36 camera traps on Brookhaven National Laboratory during Spring 2015. The colors designate paired sites. Within each pair, one location was randomly selected for treatment with scent lure and the other food lure.

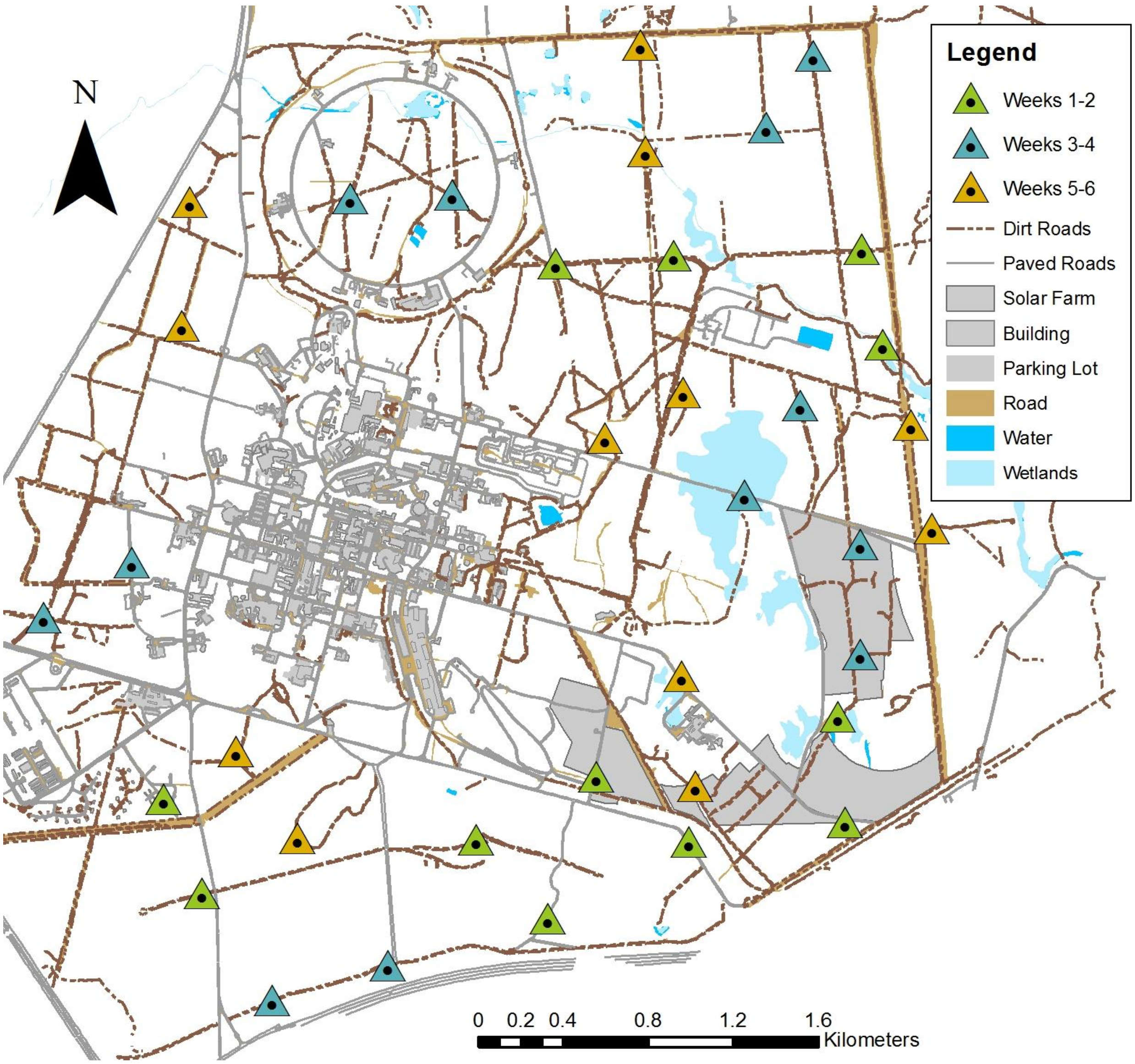


Figure 2. The average number of animals captured per trap night for each treatment. Error bars denote 95% confidence intervals.

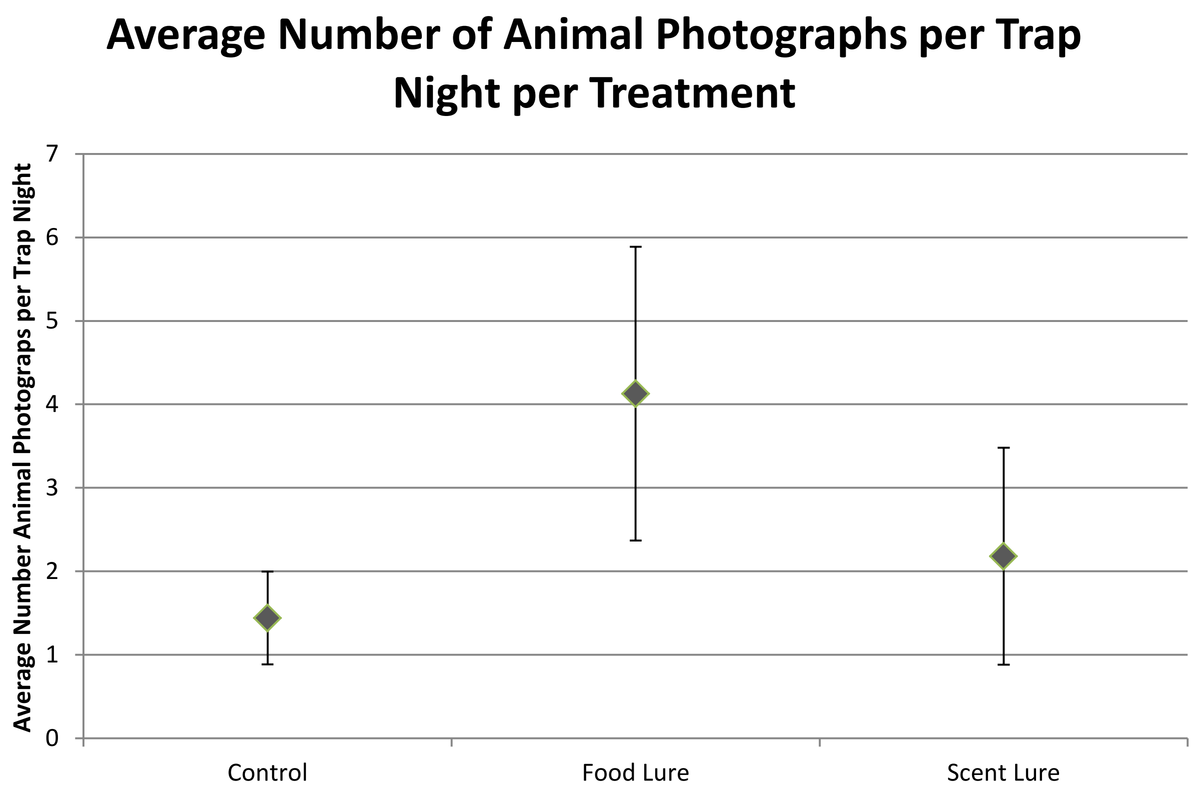
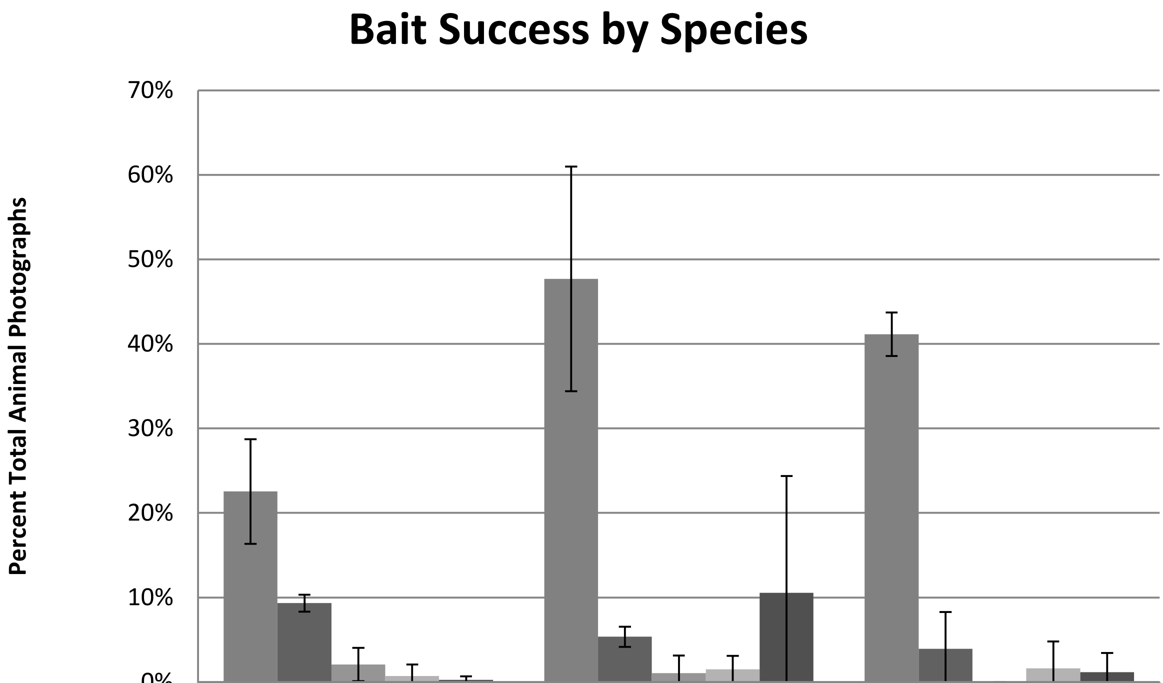


Figure 3. The composition of individuals captured, categorized by bait type. Error bars denote 95% confidence intervals.



	Control	Food Lure	Scent Lure
Raccoon	22.54%	47.68%	41.15%
Domestic Cat	9.33%	5.35%	3.94%
Opossum	2.06%	1.06%	0.00%
Striped Skunk	0.70%	1.52%	1.62%
Red Fox	0.26%	10.57%	1.16%