Spatial avoidance tendencies between size classes of mammalian carnivores at the University of Notre Dame Environmental Research Center (UNDERC)

BIOS 35502: Practicum in Field Biology

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Abstract

In comparison to their population sizes, mammalian carnivores disproportionately impact the ecosystems they are part of, mainly by impacting trophic cascades. Top-down effects are commonly a result of alterations in population sizes or habitat use frequencies because of the presence and activity of top predators. Small predators tend to avoid areas frequented by larger predators in order to avoid intraguild predation and interference competition. Using a noninvasive survey method (scent stations), I calculated the relative habitat use frequencies of wild predators in a Great Lakes forest and determined the presence or absence of spatial avoidance between various predatory groups. Keeping in line with the mesopredator release hypothesis and previous studies, I hypothesized that areas more frequently used by mid-level predators would be less frequently used by small carnivores. Because raccoon (*Procyon lotor*) tracks comprised a large portion of my dataset and raccoons exhibit more omnivorous diets, I analyzed them separately from other small carnivores and expected them to lack spatial avoidance tendencies. The observed small predator data appeared to support the idea of body size being a factor in spatial avoidance behavior, though neither the raccoons nor the other small predators exhibited statistically significant preferences for high coyote or low coyote locations.

Introduction

Despite their relatively low populations, mammalian carnivores play major roles in a variety of ecosystems and frequently drive ecological processes (Gompper *et al.* 2006). Differences in habitat use frequencies of predators can significantly alter ecosystems through various cascading impacts. One way they can trigger such effects is by first affecting each other. The mesopredator release hypothesis predicts that top predators reduce the number of mesopredators in an area either directly through intraguild predation or indirectly through interference competition (Prugh *et al.* 2009), and in turn influence smaller predators, herbivores, granivores and plant communities (*Figure 1*).

Since intraguild predation is frequently characterized by differences in body size, the mesopredator release hypothesis states that small predators may spatially avoid areas frequented by mid-sized predators (mesopredators) and mesopredators avoid areas dominated by large predators (Gehrt and Prange 2006). For example, past studies have shown that red foxes (*Vulpes vulpes*) tend to spatially avoid core areas in coyote (*Canis latrans*) territory in order to reduce predation risk and competition (Harrison *et al.* 1989). As coyotes avoid wolf (*Canis lupus*) territories, it would be expected that small carnivores would be more prevalent in top predator territories due to reduced mesopredator populations (Smith *et al.* 2003).

In this study, I estimated the strength and degree of spatial avoidance behavior occurring between the different size classes of mammalian predators in a Great Lakes forest. Though carnivores are particularly difficult to survey due to their mobility and cautious behavior (Linhart and Knowlton 1975), I calculated relative habitat use frequencies of wild predators through noninvasive approaches (i.e. scent stations and scat surveying) and use the relative frequencies as indicators of spatial avoidance. I hypothesized areas more frequently used by mesopredators (i.e. coyotes) would be less frequently used by small carnivores.

Methods

Study site

This study was conducted in the mesic forests owned by the University Notre Dame Environmental Research Center (UNDERC), located on the border of Vilas County, Wisconsin and Gogebic County, Michigan (Curtis 1959). Forests consist of both deciduous and mixed coniferous stands and are interspersed with numerous water bodies including bogs, streams, lakes and ponds. Predator species located on-site include coyotes, gray wolves, gray foxes (*Urocyon cinereoargenteus*), red foxes, bobcats (*Lynx rufus*), striped skunks (*Mephitis mephitis*), raccoons, black bears (*Ursus americanus*), martens (*Martes americana*), fishers (*Martes pennanti*), minks (*Neovison vison*) and three species of weasels (*Mustela sp*.).

Scent Stations

Mammalian predators were determined to either be present or absent at 22 locations via the use of scent stations. Stations were placed at 1 km intervals in forests along UNDERC roads where possible (Henke and Knowlton 1995). Avoiding bogs, swamps, lakes and other inaccessible areas when necessary, I randomly selected on which side of the road to place each individual station (*Figure 2*).

Stations were established by first placing a circle of sifted and moistened sand (~1 m in diameter) 25 m perpendicular to the roadside (Gompper *et al.* 2006). Using Petri dishes as molds, I made plaster tablets and soaked them in fish oil as an attractant (Thompson and Gese 2007). The center of each sand circle was baited with a tablet (*Figure 3)*. I remoistened and smoothed the sand prior to each study night and replaced tablets or refreshed the scent when necessary. The data was obtained over 8 nights which were largely dictated by weather conditions, specifically no overnight precipitation. Visits were quantified based on the presence or absence of tracks in the sand the following mornings. Only the presence or absence of a species could be determined from tracks, not the number of individuals that visited (Linhart and Knowlton 1975).

Statistics

Using SYSTAT software, I ran three Mann-Whitney U tests to analyze the effect of coyote habitat use levels (high or low) on the average frequencies that small predators visited scent stations. Coyote habitat use levels were based on the wolf territory boundary, under the assumption that coyotes use wolf territory less frequently due to interference competition and the risk of intraguild predation (Prugh *et al*. 2009). The UNDERC wolf territory boundaries were previously estimated by Flagel (unpublished data) using a combination of scats, observations and telemetry, and the scats I observed affirmed that wolves and coyotes were present throughout the course of my study. This allowed us to divide scent stations among locations of high and low coyote use. I determined the frequency of visits by the number of nights sampled that stations were visited by selected predator species.

As raccoons were by far the most common small carnivores detected and they exhibit potentially different behavioral patterns (Gehrt and Clark 2003), I analyzed small carnivore data both with and without including raccoons. Though according to the mesopredator release hypothesis I would have predicted raccoons would spatially avoid areas frequented by coyotes, data collected from previous studies led me to instead predict that raccoons would not show spatial avoidance due to having limited dietary overlaps with coyotes.

Results

From this study I found evidence of eight predator species on property, including black bears, canids, mustelids and raccoons (*Figure 4; Table 1*).

I used three separate Mann-Whitney U tests to analyze the frequencies of small predator visits (U=74.000; df=1; p=0.365; *Figure 5*), raccoon visits (U=86.000; df=1; p=0.081; *Figure 6*) and non-raccoon small predator visits (U=44.000; df=1; p=0.188; *Figure 7*) in high-coyote and low-coyote locations but none of the U tests showed statistical significance.

Despite the lack of significance, the data does indicate that small predators more frequently visited scent stations in low coyote areas, a trend that would be predicted by the mesopredator release hypothesis. For example, the only red fox prints I collected came from stations in wolf territory where relative coyote habitat use was low.

Discussion

My initial hypothesis that small predators would show significant spatial avoidance toward coyotes was not statistically supported by the results of the Mann-Whitney U tests. Small carnivores overall, however, did visit stations in low coyote-use areas more frequently so the observed trend was in line with the mesopredator release hypothesis. This trend is also consistent with previous ecological studies. For example, in Yellowstone National Park, the reintroduction of wolves decreased the coyote population by about 50% and as a result helped to increase populations of smaller predators (Smith *et al.* 2003). In another study, red foxes were found to spatially avoid potentially suitable habitats if they were in coyote territories (Harrison *et al.* 1989).

Raccoons, on the other hand, did not show any evidence of spatial avoidance. Since the mesopredator release hypothesis only takes body size into account, not diet, it is not always adequate for predicting spatial distributions of predators (Prange and Gehrt 2007). As omnivores and opportunistic scavengers, raccoons do not often actively hunt the way that other small predators do, meaning they only have a limited dietary overlap with coyotes (Gehrt and Clark 2003). One study actually found that raccoon populations have relatively low death rates in relation to predation, even when they are located within coyote territory (Gehrt and Prange 2006). The lack of spatial avoidance may therefore be based on a combination of the lack of predation risk and competition with the mesopredator in question.

Another key factor that could impact small predator spatial distribution is habitat type and location. The distribution of wolves and other top-predators is usually based, not on avoidance behavior, but on resource availability (Thompson and Gese 2007). Wolves do however tend to select territories away from areas frequented by people, thus exhibiting a human-avoidance behavior. The proximities of my survey sites to "human territory" could have impacted the distribution of mammalian predators I observed. Large predators are particularly cautious near areas of high human activity (Woodroffe 2000). Some species are especially acclimated human activity and are therefore more likely to cluster in areas frequently used by humans due to lack of competition with non-acclimated species. Raccoon tracks seemed to be found most frequently at stations near buildings and the most frequently used gate.

Though in general my study reflected similar results as previous research, I only was able to obtain a limited amount of data due to a variety of confounding factors. One particularly significant issue was the lack of the ideal weather I needed to implement my field techniques throughout the summer. In the future, it would be useful to cover stations to protect prints from precipitation.

It would also be preferable to measure coyote habitat use directly, as using wolf territory use as a surrogate inherently makes an assumption based on the mesopredator release hypothesis. This is especially a concern for a few of the low-coyote sites because they are in areas that could be considered on the fringe of the territory and may not be used as frequently by wolves as some of the others. If coyote use did need to be determined indirectly in the future, it would be better to place all low coyote use sites deeper in wolf territory.

One other main issue with the scent station method is that predators respond to stations differently depending on species. Previous studies have shown that while some predators are more likely to visit stations 25 meters into forests, others (e.g. coyotes) are more likely to visit stations directly along roadsides (Linhart and Knowlton 1975). Another species difference is the species-selectiveness of the attractant. While species like raccoons are strongly attracted to fish oil, others which do not commonly consume fish may not be interested (Chalfoun *et al.* 2002).

Overall, however, my study was successful and I was able to estimate habitat use frequencies of the mammalian predator species on the UNDERC property. Contrary to my initial hypothesis, small predators did not show a significant preference for high-coyote or low-coyote habitats, though there was a slight trend toward higher frequencies of small predators in low-coyote areas. Similarly, raccoons did not show any significant preference, indicating the lack of spatial avoidance that was expected and reaffirming Gerht and Prange's finding that raccoons do not exhibit body size related spatial avoidance in the way members of the canid predator guild do (2006).

Due to their importance to ecosystems, predator data should continue to be collected in order to increase the amount of known, analyzable information. As the knowledge gained from previous research and my field study is limited, more studies will be necessary in the future in order to fully understand the distribution patterns and spatial avoidance behaviors of wild predators.

Tables

Table 1. A list of the species of predators observed on the UNDERC property during this study along with the number of scats, sighting and tracks found per species.

Species	**# of Tracks**	**# of Scats**
Black Bear	4	0
Coyote	1	6
Fisher	3	0
Mink	2	0
Raccoon	33	0
Red Fox	4	0
Weasel	2	0
Wolf	1	15
TOTAL	*50*	21

Figures

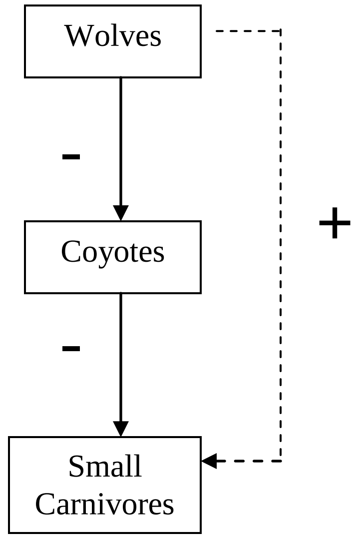

Figure 1. An diagram illustrating predator guild dynamics as they relate to the mesopredator release hypothesis. In this particular example, wolves are the top predators and coyotes are mesopredators.

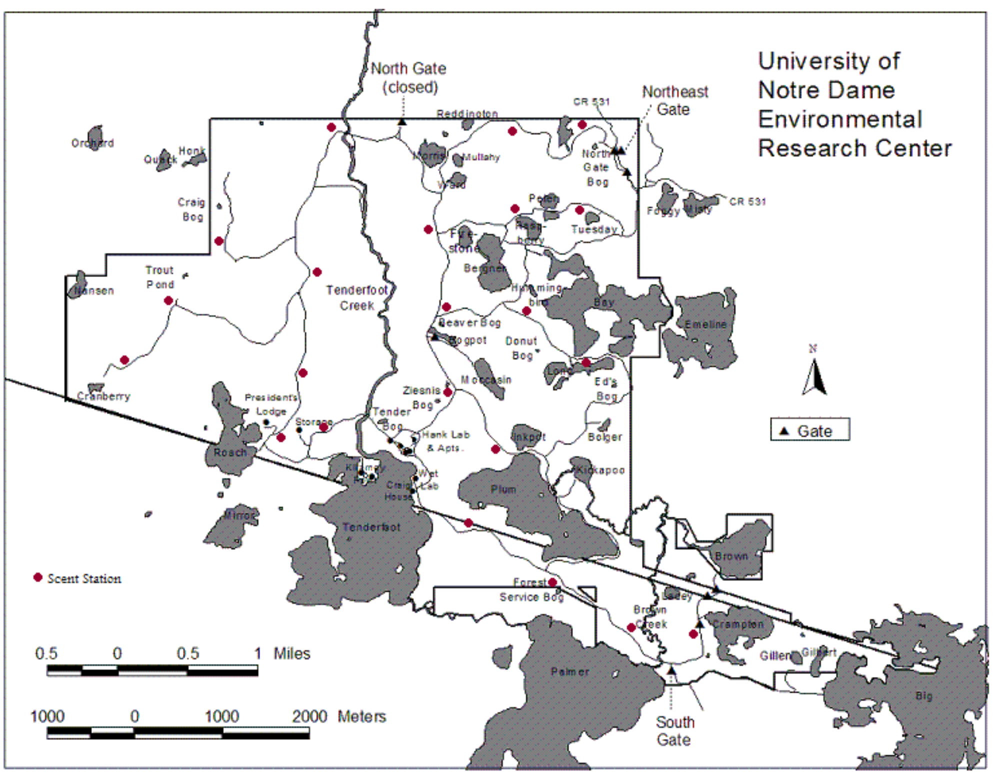

Figure 2. A map of the University of Notre Dame Environmental Research Center property and the scent station locations.

Figure 3. Scent station composed of a circle of sand baited with a fish oil-coated plaster disk in the center.

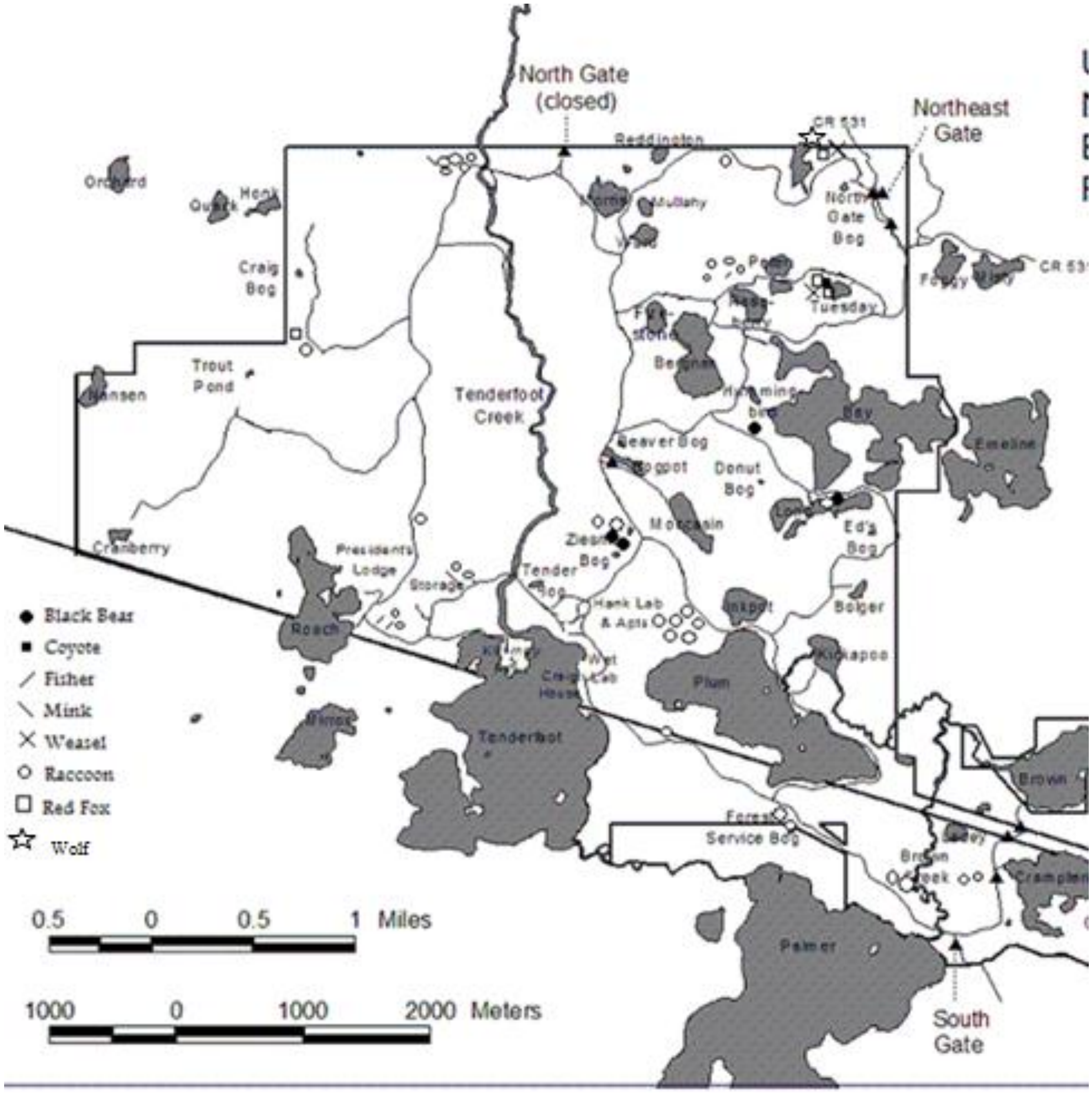

Figure 4. A map of predator track locations.

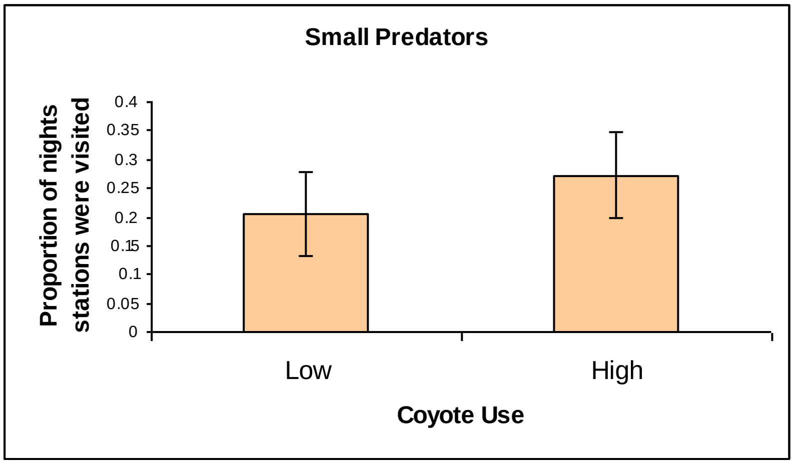

Figure 5. A bar graph showing the average frequencies at which stations were visited by small predators in areas of high and low coyote use (U=74.000; df=1; p=0.365).

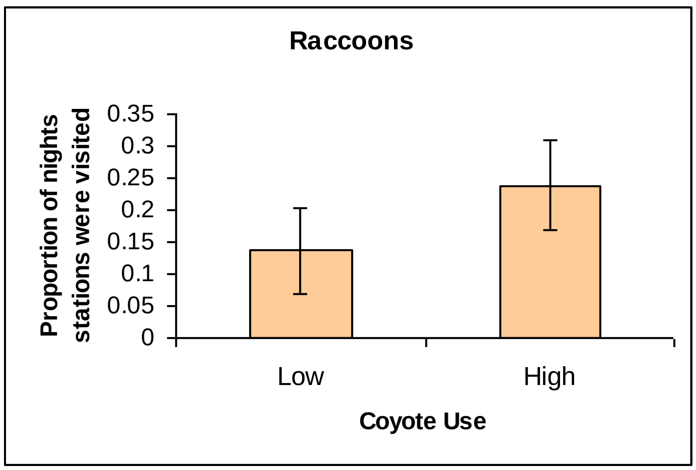

Figure 6. A bar graph showing the average frequencies at which stations were visited by raccoons in areas of high and low coyote use (U=86.000; df=1; p=0.081).

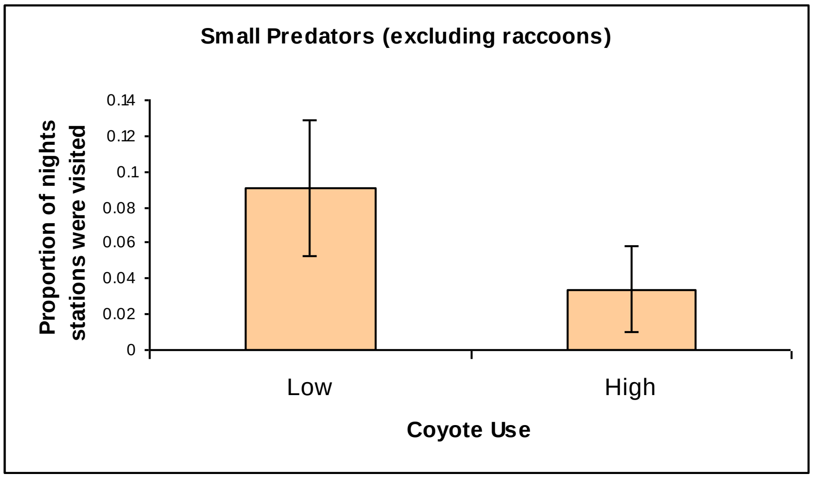

Figure 7. A bar graph showing the average frequencies at which stations were visited by small predators (excluding raccoons) in areas of high and low coyote use (U=44.000; df=1; p=0.188).

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