Cascading interactions among wolves, coyotes and sciurids along the Upper Peninsula of Michigan and Wisconsin border

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Abstract

The wolf-coyote interaction has had powerful effects on various smaller mammalian consumers. Wolves suppress coyote populations and are hypothesized to subsequently increase the amounts of intermediate-sized coyote prey, such as hares. However, impacts on sciurids remain untested. I examined whether wolves indirectly benefit sciurids by surveying populations of chipmunks and squirrels with camera use frequencies in high wolf use and low wolf use areas in a Great Lakes forest. There were no differences in chipmunk or squirrel habitat use intensity, suggesting previously reported shifts in coyote predation pressure were not important to these prey species. We suggest that the lack of support for this hypothesis is due to a low amount of sciruids in the coyote diet, compared to other intermediate-sized prey. Future studies should consider varying predation diets, in order to better understand subsequent small mammal impacts.

Introduction

Cascades are a type of indirect effect in which the removal of a top apex predator initiates a series of population changes in the lower trophic levels (Rodriguez-Castaneda, 2012). In general, carnivores can reduce the numbers of herbivores and thus indirectly benefit plant populations (Hairston et al., 1960). Cascades have been demonstrated in both marine and terrestrial ecosystems, in a variety of different species (Rodriguez-Castaneda, 2012). Large carnivores can also directly affect smaller competing predators, which in turn can indirectly affect the populations of smaller prey (Berger et al., 2008; Carpenter et al., 2001). We refer to these cascades generated by interactions within the predator guild as intraguild cascades.

The wolf-coyote system represents an important example of these effects. Wolves suppress coyotes due to a niche overlap that is expected to lead to higher interference

competition, direct killing and spatiotemporal avoidance (Berger and Gese, 2007). This in turn can increase coyote prey populations like pronghorn fawns (*Antilocapra Americana)* and microtine voles (*Microtus montanus*) (Berger et al., 2008). The widespread removal of wolves from US habitats is thought to have increased the abundance of coyotes, which in turn is thought to have decreased the numbers of intermediate-sized prey such as snowshoe hares (*Lepus americanus*) (Flagel et al., in review) and smaller carnivores such as black-footed ferrets (*Mustela nigripes*) (Biggins, 2000) and foxes (Levi and Wilmers, 2012; Newsome and Ripple, 2014). Levi and Wilmers (2012) predict these increases in coyotes will also lead to a decrease of coyote prey items of intermediate size, which in general includes sciurids.

However, although previous studies have investigated the impacts of wolf-coyote interactions on smaller rodents (Miller et al., 2012; Flagel et al., in review), no studies have yet to look at the impact on chipmunk and squirrel populations. I examined chipmunk and squirrel use frequencies between high and low wolf use areas in a Great Lakes forest to investigate the following question: Does an intraguild cascade exist among wolf-coyote-chipmunk/squirrel populations?

Methods

Study site

This study was performed at the University of Notre Dame Environmental Research Center (UNDERC) near Land-o-lakes, Wisconsin and the Upper Peninsula of Michigan. The vegetation type consists of maple (*Acer* spp.) dominated northern mesic forests (Curtis, 1959). The main sciurid species in this region are the eastern chipmunk (*Tamias striatus*), Least chipmunk (*Tamias minimus*) and Red Squirrel (*Tamiasciurus hudsonicus*). Coyotes expanded their range into this area following European settlement (Gompper, 2002). In addition, wolves

recolonized this area around 2002, dividing the property into areas of high and low wolf use. (MI DNR, unpublished data).

Techniques

Wolf use was previously determined through scat surveys and telemetry of local wolves (Flagel et al., in review). I surveyed each of the low wolf use and high wolf use areas for 9 trap days using twelve 8 MP Trophy Cam camera traps (Bushnell, Overland Park, KS), with six in low wolf use forest patches and six in the high wolf use forest patches. I placed the cameras on a tree about 4 inches from the ground, at least 65 feet from the road. This was done to avoid road impacts. I habituated wildlife to the cameras by placing peanuts every night at each of the cameras about one month before collecting any data. During each of the 9 trap days, I placed 100-peanut bait piles about 3 feet from the camera starting at 6am. I chose this 6am bait time to give the diurnal chipmunks and squirrels the most peanuts available before any competing consumption by nocturnally foraging raccoons (*Procyon loto*r) and black bears (*Ursus americanus*). I determined this satiation number based on the different peanut numbers remaining at 7pm during the habituation period. I continued to count peanuts removed at 7pm on trap days in order to generate data on peanuts removed per site.

Every 3 days, I removed and replaced camera memory cards to view the images. I recorded the date, time and classification of sciurids visiting the bait piles. Characteristics used to differentiate individuals included tail length, stripe length and overall body size. If unable to tell, the last viewing of a genus/species had to have at least a 10-minute separation from the next viewing in the camera, in order to be recorded as a new use frequency by that genus/species.

Statistical Analyses

I standardized total visit numbers of chipmunks and squirrels at each of the 12 plots to average visit numbers per day. I then conducted a series of Student's t-tests to see if average chipmunk and squirrel use frequencies per day were significantly different based on wolf use. In cases of non-normality, a Wilcoxon 2-Sample test was used instead. I looked at chipmunk and squirrel use frequencies both separately and combined (sciurids). Finally, I looked at average peanut removal per day in high wolf use and low wolf use areas, to see if seed removal was significantly different based on wolf use.

Results

Individual species and combined sciurid visits were similar. There was no significant difference in average chipmunk use frequencies (Mean +/- SE) per day at cameras within low (6.16 +/- 1.79) versus high (3.60 +/- 1.92) wolf use areas (t = -0.978, df = 10, p-value = 0.3511, Fig. 1). Similarly, there was no significant difference in average squirrel use frequencies per day at cameras within low (1.4 +/- 1.19) versus high (1.94 +/- 1.39) wolf use areas (W = 22.5, p-value = 0.5182, Fig 2). Unsurprisingly, there was also no significant difference in average chipmunk and squirrel use frequencies per day at cameras within low (7.71 +/- 2.57) versus high (5.53 +/- 1.79) wolf use areas (T = -0.692, df = 10, p-value = .05047, Fig 3). Finally, there was no significant difference in average peanut removal per day at cameras within low (76.9 +/- 11.06) versus high (68.9 +/- 12.65) wolf use areas (t = -0.4804, df = 10, p-value = 0.6413, Fig. 4)

Discussion

Wolf-coyote interactions do not appear to be having a significant effect on chipmunk and squirrel populations as previously predicted (Levi and Wilmers, 2012). These results are further supported by lack of a significant difference in peanut removals between high and low wolf use areas. It is important to note that some sites (both in high and low) did experience 100% removal

on some days, which may have reduced our average. However, this did not stop animals from visiting the sites.

One possible explanation for the lack of significantly different use frequencies may lie in the actual dietary preferences of the coyote. If coyotes do not preferentially consume chipmunks and squirrels, a higher abundance of coyotes may not have a substantial impact on their numbers. In a study on the frequency of major food items found within coyote scats in neighboring Minnesota, the red squirrel encompassed a negligible 0.7% of major food items in coyote scats, and chipmunks were absent (Berg and Chesness, 1978). In fact, studies on the ecology of red-tailed hawk predation suggest that avian predators are one of the most influential sources of predation on ground squirrels (Luttich et al., 1970). Given these diets and this information, it seems unlikely Great Lakes forest coyotes would affect sciurid populations. We also question whether coyotes will affect these species in other parts of the US. In a study on the stomach contents of 50,000 coyotes collected from across the United States, chipmunks made up less than half a percent of food items. In contrast, rabbits (which have been shown to increase in our high wolf use areas) (Flagel et al., in review) made up over 20% (Young and Jackson, 1978).

Differing numbers of rodents could further yield varying levels of seed predation and consequent tree growth (Schnurr et al., 2004). However, based on our seed removal rates, it seems levels of seed predation may be similar in both low wolf and high wolf use areas. It has also been suggested that the increase in coyote numbers and decrease in fox numbers may be linked to increases in the prevalence Lyme disease, as small rodent numbers (including chipmunks) increase (Levi et al., 2012). However, we found no evidence of chipmunk increases, though it should be noted previous work has found decreased deer mice (*Peromyscus*) (a primary source of fox prey, see Hatfield 1939) in high wolf use areas (Flagel et al., in review).

These results suggest that squirrel management should be unaffected by wolves and coyotes in this region. Squirrels have often been identified as a game species (Nixon et al., 1975), but since our results do not show any impact on their population, the management of their numbers should remain fairly similar. Overall, these findings provide insight regarding dietary preferences of the coyote, and more research should be done on carnivorous feeding patterns to clarify any proceeding interactions.

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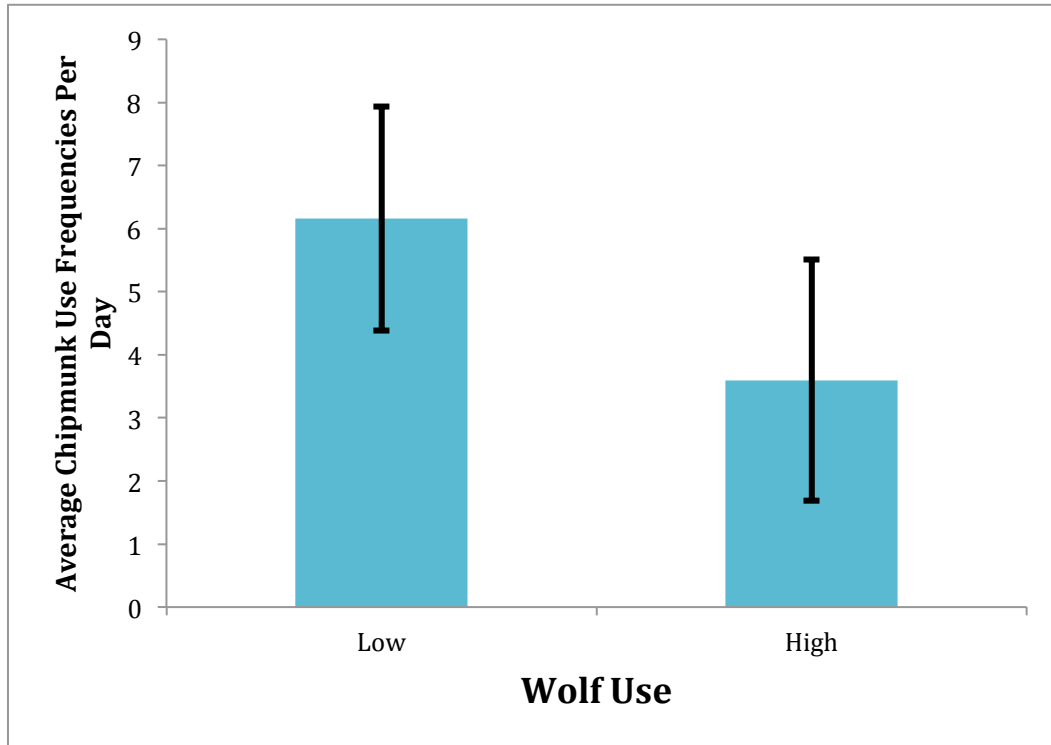
Figures

Fig 1. Average chipmunk use frequencies per day in low versus high wolf use areas. Error bars are included. Species of chipmunk include the Eastern chipmunk and Least chipmunk.
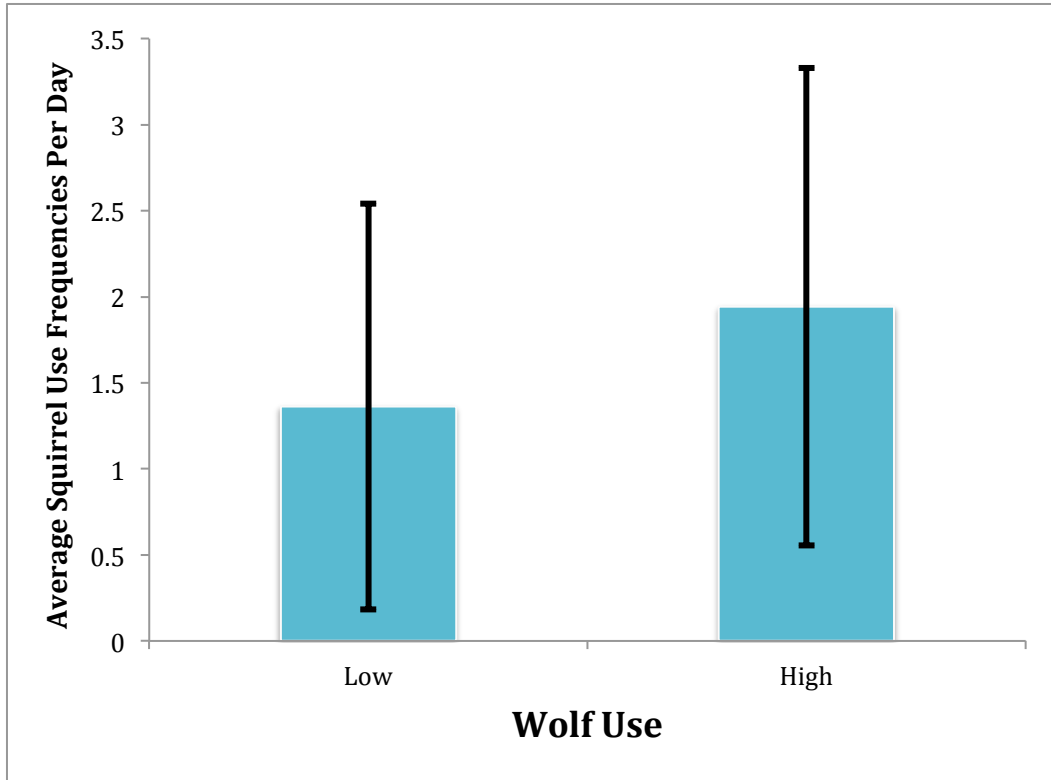
Fig. 2. Average squirrel use frequencies per day in low versus high wolf use areas. Error bars are included. Squirrel species include the Red squirrel and the Grey Squirrel. Nocturnal flying squirrels are excluded.
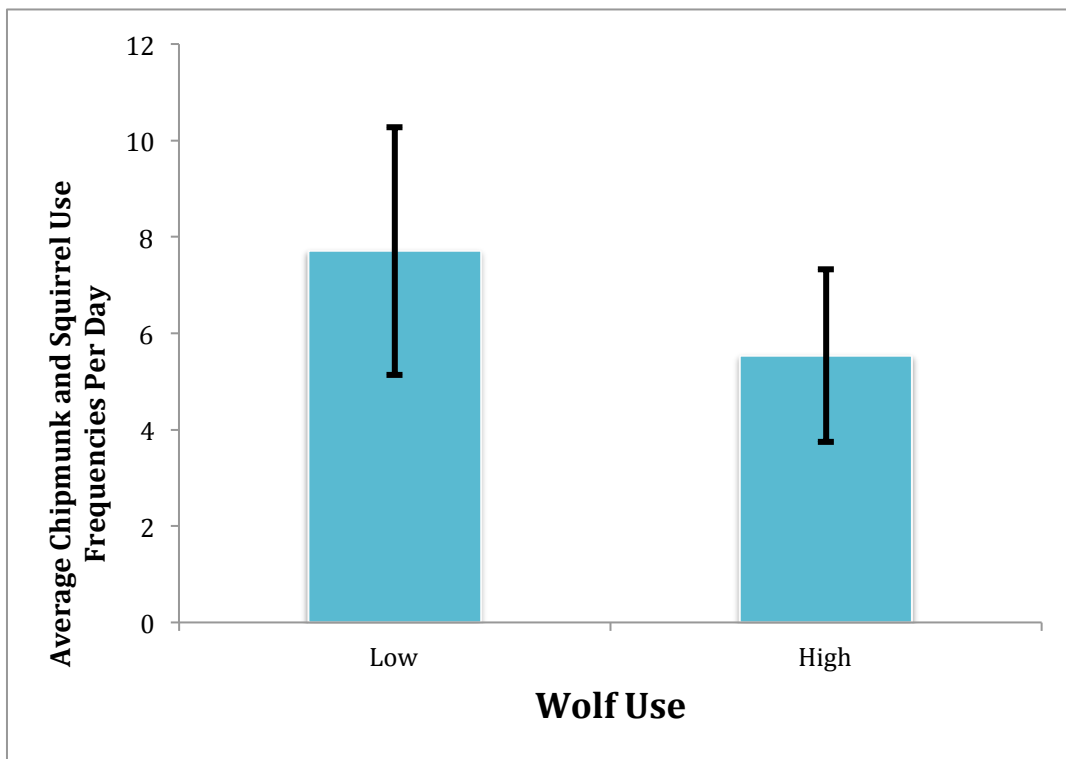
Fig 3. Average combined chipmunk and squirrel use frequencies per day in low versus high wolf use areas. Error bars are included.
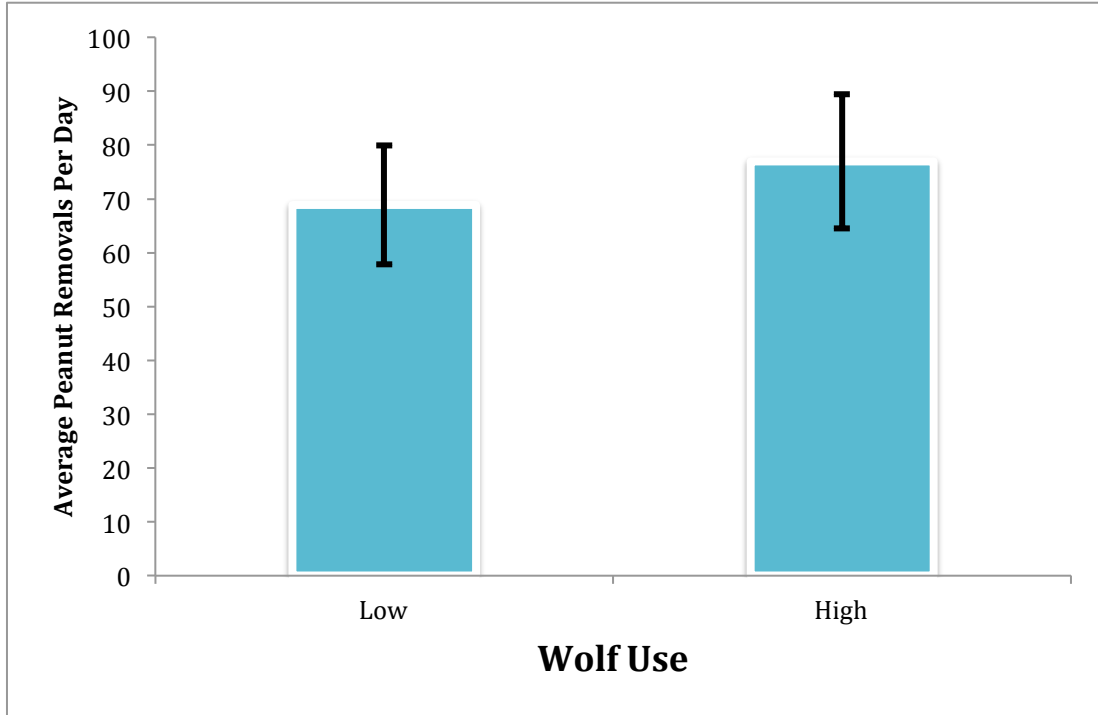

Fig 4. Average peanut removals per day in low versus high wolf use areas. Error bars are included. Peanut removals were counted at 7pm.