

Response of *Erethizon Dorsatum* and *Lepus americanus* to specialized and generalized predators

BIOS 35502 Practicum in Field Biology
Daniel J. Osburn
Dr. Michael Cramer
2009

Abstract

The way that animals balance foraging needs with predation is a very interesting and widely studied subject in ecology. The purpose of this study is to determine whether the porcupine (*Erethizon dorsatum*) and snowshoe hare (*Lepus americanus*) have a response to the increased danger that a specialized predator, the fisher (*Martes pennanti*), poses over a general predator, the coyote (*Canis latrans*). Sticks soaked in brine were put out in different environments with three treatments of no scent, coyote urine, or fisher scent. The porcupine showed an overall reaction of preferring sticks with no scent ($p=0.016$) although they did not show a differential response to either predator ($p=0.72$). The hare showed no preference for sticks without scent ($p=0.074$) as well as no different reaction whether the scent was fisher or coyote ($p=0.69$). Environment also played no role in foraging choice ($p=0.16$). There was an issue with sample size that if solved could lead to the expected result that fisher scent has more of an effect than coyote urine.

Introduction

Natural selection predicts that all animals behave in a way that will maximize their potential fitness. Many experiments have shown that, in the presence of predators, prey balance their safety with the perceived benefits of other necessary functions to increase fitness, such as foraging for food and reproduction (Peckarsky et al 2008, Milinski and Heller 1978).

The behavioral response of prey species to potential predators is a widely studied and important topic in ecology. In the presence of a wolf (*Canis lupus*) population, elk (*Cervus canadensis*) drastically changed their foraging behavior, affecting the trophic cascade of their home forest (Fortin et al. 2005). Experiments have tested the feeding

habits of shoal fish in the presence of a predator. When no predator was present, the fish would eat foods of higher nutrition, but in the presence of a predator, the fish would stay away from the nutritious food and settle for the less nourishing food in the predator free environment (Pitcher et al. 1988). In the presence of coyote urine, porcupines forage in areas that provide more protection as a response to perceived danger of predation (Sweitzer and Berger 1992).

This project will investigate how the porcupine (*Erethizon dorsatum*) and the snowshoe hare (*Lepus americanus*) will alter their foraging behavior in the presence of a non-specialized predator, the coyote (*Canis latrans*), and a specialized predator, the fisher (*Martes pennanti*). The fisher's diet has been shown to consist mostly of porcupine and snowshoe hare (Zielinski et al. 1999). We are interested in seeing if these prey species can perceive the increased danger that the fisher presents, and if this increased danger results in different foraging decisions.

The porcupine is a model system for study as it is very large and slow but has an incredibly tough covering of quills that offer an extraordinary amount of protection from potential predators (Woods 1973). When the fisher is absent, porcupines can become a huge pest around camps because coyote and fox predation is insufficient for natural population control of porcupines (Cook and Hamilton 1957). The fisher however is a very specialized predator of the porcupine and has been widely and effectively used as a population control of the porcupine as it is strong, fast, and most importantly unbothered by the protective covering of quills (Cook and Hamilton 1957). It has developed a unique hunting and killing technique to take down porcupines (Powell 1977, 1978). The porcupine has an excellent sense of smell and the somatic sensory and motor areas of the

brain are very well developed (Lende and Woolsey 1956). The porcupine uses smell as a way to detect predators and danger rather than vision (Dodge 1982). This is important to this project, as predator olfactory cues will be used to assess porcupine response to the presence of predators.

Much work has shown that snowshoe hare populations cycle greatly with the presence of the genus *Martes*, indicating that the fisher is a specialized predator on the hare (Bulmer 1974, 1975). Although their auditory senses are incredibly well developed, the hare has also been shown to respond strongly to mustelid odors by several lifestyle changes including foraging behavior (Sullivan 1986).

Herbivores such as porcupines have a diet low in salt, so this project will use pieces of wood soaked in brine to attract porcupines (Cook and Hamilton 1957). Snowshoe hares have a very similar herbivorous diet that is also very low in certain minerals so hares also will also be strongly attracted to the salt-soaked wood (Faber et al. 1993). The amount of gnawing on the wood should give an accurate estimate of how safe prey feel in that particular environment.

If the porcupine and hare alter their foraging behavior in response to the presence of predators, we predict that the food resources in the environment where the least danger is perceived by the prey should be used the most. Resources in the control environment with no additional danger scents added should get the most attention from the porcupines. Because the coyote is not a specialized predator, the resources in that environment should get more attention than the resources in the fisher scent environment as the fisher is more dangerous to the prey than the coyote.

Another question that this experiment will help to answer is where the porcupine and hare forage the most. The data will be collected across many different types of habitats within the UNDERC property to assess which types of habitats experience the most foraging. It has been found that porcupine predation is high in more open areas (Sweitzer 1996), so we expect that the porcupines will take more resources from thicker, more overgrown habitats than forest habitats that tend to have little undergrowth. Snowshoe hares also avoid open habitats, and show preference for overgrown areas with vegetation cover (Pietz 1983). As a result of these studies, we predict that the sticks in the overgrown wetland environments will be much more likely to be eaten than sticks in the more open forest areas.

Methods

Sticks of pine wood (1.5cm x 3.5cm x 60cm) were soaked in a 90% saline solution for 24 hours then dried in a drying oven for at least 96 hours. ARCGIS was then used to select 50 random sites across the UNDERC property. At these sites a control stick and a stick with either coyote urine or fisher scent applied were anchored to the ground 15 meters apart. 2 ml of coyote urine was sprayed onto the stick at the site with a pipette, while the fisher scent was applied with Q-tips on site. Predator treatment (coyote vs. fisher) was determined randomly. The sticks were checked after five days then every three days after that for a foraging event. If a foraging event occurred then both sticks at the site were taken out of the field and the volume missing was recorded. The sticks were then examined to see which animal had been foraging on them by measurement of incisor

tooth marks left on the sticks. Hare incisors were accepted as 1.73-2.46 mm whereas porcupine incisors were accepted as 3.63-4.69 mm (Elbroch 2006).

All statistical analyses were done using SYSTAT. A univariate repeated measures analysis was done on both the sticks eaten by porcupines and hares using predator scent as the independent variable and the volume of control stick eaten and volume of experimental stick eaten as the dependent variables. A Pearson chi-square test was run on the two different environments, forest or wetland, using the criteria of whether sticks in the environment were foraged upon.

Results

The repeated measures analysis on the sticks eaten by porcupines was done with the null hypothesis that the presence of predator scent would have no effect on stick choice. This was rejected as a statistically significant preference for sticks without urine was found ($F_{1,9}=8.77$, $p=0.016$; Fig. 1). There was no significant difference found between the effect that coyote or fisher urine had on stick choice ($F_{1,9}=0.136$, $p=0.72$; Fig. 1).

Hares showed no statistically significant preference for sticks with or without the presence of predator scent ($F_{1,11}=3.86$, $p=0.074$; Fig. 2). Hares also demonstrated no preference whether the scent was coyote urine or fisher scent ($F_{1,11}=0.165$, $p=0.69$; Fig. 2).

A Pearson chi-square analysis was performed on whether sticks in certain habitats were eaten or not with the null hypothesis that habitat would have no effect. This was found to be the case that forest and wetland habitats had no statistically significant difference ($X^2=0.159$, $df=1$, $p=0.16$; Table 1).

Discussion

The main question that this study was asking was if the porcupine and the snowshoe hare could sense the increased danger that the specialized predator, the fisher, presents. The porcupine showed a very definitive response by foraging more on the sticks that contained no predator scent. This was expected as this is a well-documented response that prey have to predator scent (Nolte et al. 1994). Surprisingly the porcupine did not have a stronger response to the fisher urine than they did to the coyote urine. This was unexpected as fishers pose one of the only real dangers to the porcupine as they have evolved one of the only effective hunting techniques for killing porcupines.

The porcupine result is most likely a function of the small sample size making statistical significance very difficult to achieve. The general trend that was expected of very little consumption on the fisher-scented sticks is certainly evident (Fig. 1), even though this is not a statistically significant result.

The snowshoe hare had no statistically significant response to predator scent on the sticks, although hare response approaches statistical significance. This is also unexpected and can most likely be attributed to the small sample size making the statistics less powerful. It was also found that there was no more of a response to coyote urine than there was to fisher scent, although there appears to be a trend towards coyote urine having a larger effect.

Small sample size is certainly one aspect of the outcome with regard to snowshoe hare foraging. However, the hare, unlike the porcupine, primarily uses auditory cues to perceive danger. Although olfaction is important and has been shown to have an effect on the hare, auditory cues seem to be most important for detecting danger (Best 1996).

Because of this it is possible that the scent did not have as large of an effect on the snowshoe hare as it did on the porcupine, which exacerbates the problem of the small sample size, as smaller differences will be harder to detect.

When the trends are examined, the porcupine seems to have a stronger response to the fisher urine, while the hare appears to have a much stronger response to the coyote urine (Figures 1 and 2). This result would suggest that the coyote presents more of a danger to the hare than the fisher, even though the fisher has been known to prey successfully on hares. The snowshoe hare's best defense against predation is its great speed, unlike the porcupine's quill defense. This fact could make the coyote more dangerous to the hare when it is out foraging, as the coyote is a much faster predator.

The other part of the experiment was to see whether the habitat type had any influence on foraging choice. It was found that there was no relationship between habitat and whether a stick was eaten. The wetland environments were much overgrown with ground cover so it was expected that more foraging would occur in those environments as the prey would feel safer than in the more open forest habitat. Not all of the forest sites were completely open with little undergrowth, so the partitioning of sites is not completely indicative of the ability of prey to hide there. Another explanation for this result is the great discrepancy in number of forest sites compared with number of wetland sites, causing statistical difficulty. A more even habitat distribution of test sites would address this problem.

A higher sample size should give better results in the future. Another interesting study is to see if there is a correlation between the amount of ground cover and light around the stick site and whether that causes the porcupine or snowshoe hare to be more

comfortable in the presence of predator scent. It is expected that in an open environment these animals will be much more wary of predator scent than in thick overgrowth.

Acknowledgements

I would like to thank the Hank Family Endowment for the funding for this research. Thanks to Heidi Mahon and Dr. Andy Mahon for helpful advice. Special thanks to Dr. Michael Cramer for guidance and advice through all stages of this project.

Literature Cited

- Best, T. L. 1996. *Lepus californicus*. *Mammalian Species* 530: 1-10
- Bekoff, M. 1977. *Canis latrans*. *Mammalian Species* 79:1-9
- Bulmer, M. G. 1974. A statistical analysis of the ten-year cycle in Canada. *Journal of Animal Ecology* 43:701-18
- Bulmer, M. G. 1975. Phase relations in the ten-year cycle. *Journal of Animal Ecology* 44:609-22
- Cook, D. E. and W. J. Hamilton, Jr. 1957. The forest, the fisher, and the porcupine. *Journal of Forestry*, 55:719-722.
- Dodge, W. E. 1982. Porcupine (*Erethizon dorsatum*), p. 355–366. In: J. A. Chapman and G. A. Feldhamer (eds.). *Wild mammals of North America*. Johns Hopkins University Press, Baltimore, MD.
- Elbroch, Mark. 2006. *Animal skulls: a guide to North American species*. Stackpole Books
- Faber, W. E. Pehrson, A. Jordan, P. A. 1993. Seasonal use of salt blocks by mountain hares in Sweden. *The Journal of Wildlife Management* 57:842-846

- Fortin, D. Beyer, H. L. et al. 2005. Wolves influence elk movements: behavior shapes a trophic cascade in Yellowstone National Park. *Ecology* 86:1320-1330.
- Lende, R. A.; Woolsey, C. N. Sensory and motor localization in cerebral cortex of porcupine (*Erethizon dorsatum*). *Journal of Neurophysiology*. 1956, 19, 544-563.
- Milinski, M.J. ; Heller, R. 1978. Influence of a predator on the optimal foraging behaviour of sticklebacks (*Gasterosteus aculeatus L.*). *Nature* 275: 642.
- Nolte, D. L. Mason, J. R. Epple, G. et al. 1994. Why are predator urines aversive to prey. *Journal of Chemical Ecology* 20: 1505
- Peckarsky, B.L., Abrams P.A., et al. Revisiting the classics: considering nonconsumptive effects in textbook examples of predator-prey interactions. *Ecology* 2008, 89, 2416-2425
- Pietz, P. J. 1983. Habitat selection by snowshoe hares in north central Minnesota. *The Journal of Wildlife Management* 47: 686-696
- Pitcher. T.J., S.H. Lang, and J.A. Turner. 1988. A risk balancing trade off between foraging rewards and predation hazard in shoaling fish. *Behavioral Ecology and Sociobiology* 22:225-228
- Powell, R. A. 1977 Hunting behavior, ecological energetics, and predator-prey community stability of the fisher (*Martes pennanti*). Ph. D. Dissertation, University of Chicago, Chicago.
- Powell, R. A. 1978. A comparison of fisher and weasel hunting behavior. *Carnivore* 1:28-34
- Sullivan, T. P. 1986. Influence of wolverine (*Gulo gulo*) odor on feeding behavior of snowshoe hares (*Lepus americanus*). *Journal of Mammalogy* 67: 385-388
- Sweitzer, R. A. Predation or starvation: consequences of foraging decisions by porcupines (*Erethizon dorsatum*). *Journal of Mammalogy*, 1996, 77, 1068-1077
- Sweitzer, R. A. and J. Berger. Size-related effects of predation on habitat use and behavior of porcupines (*Erethizon Dorsatum*). *Ecology* 1992, 73, 867-875.
- Woods, C. A. 1973. *Erethizon dorsatum*. *Mammalian Species* 29: 1-6
- Zielinski, W. J. Duncan, N. P. et al. 1999. Diet of fishers (*Martes pennanti*) at the southernmost extent of their range. *Journal of Mammalogy* 80: 961-971

Table

Table. Counts of habitat type (rows) by whether sticks were eaten (columns). There was no significant difference found showing no preference for habitat ($X^2=0.159$, $df=1$, $p=0.16$). Note the large discrepancy in number of habitats tested.

	No	Yes	Total
Forest	20	14	34
Wetland	6	10	16
Total	26	24	50

Figures

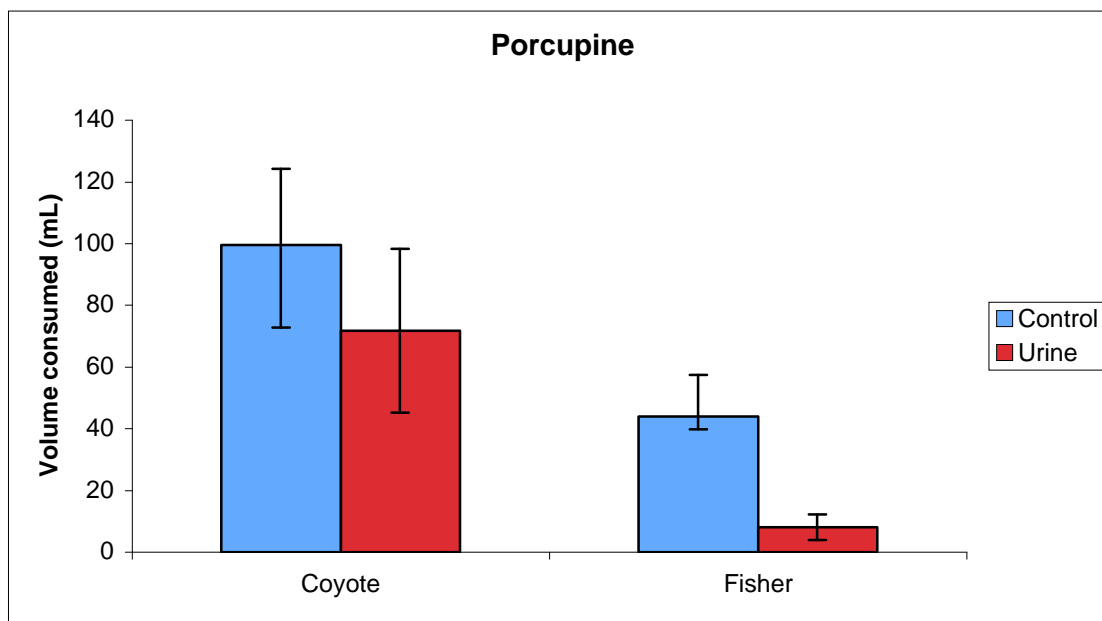


Figure 1. Comparison of average volume of wood consumed by porcupines on control sticks compared with the paired predator scented sticks. Porcupines demonstrated overall preference for sticks with no predator scent ($F_{1,9}=8.77$, $p=0.016$) but there was no difference dependent on type of predator scent (coyote or fisher; $F_{1,9}=0.136$, $p=0.72$).

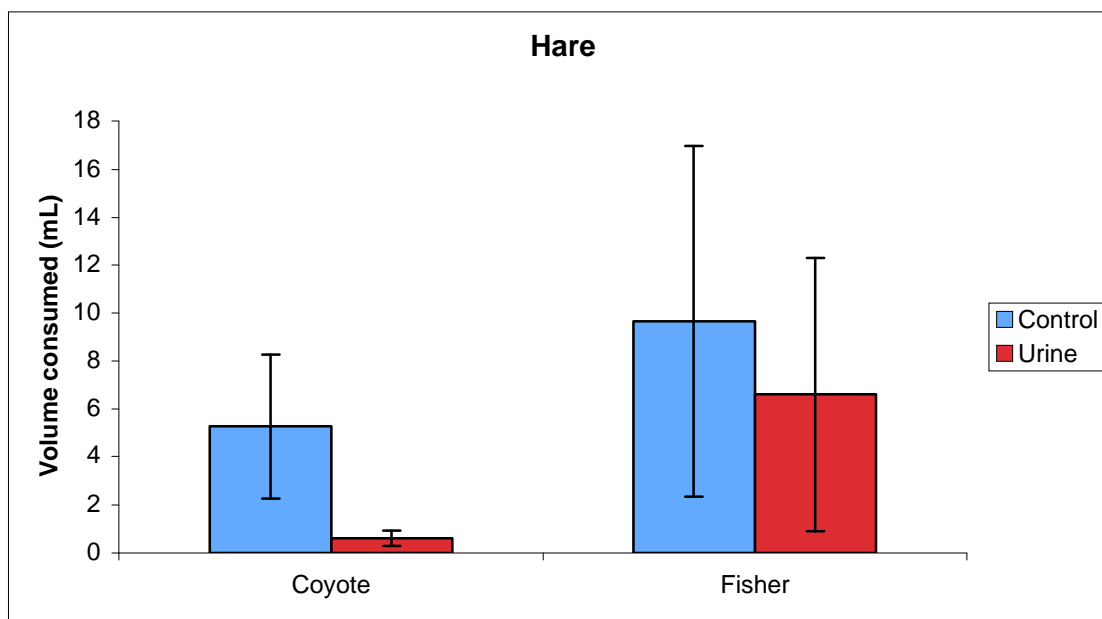


Figure 2. Comparison of average volume of wood consumed by hares on control sticks compared with the paired predator scented sticks. There was no preference overall for sticks with or without predator scent ($F_{1,11}=3.86$, $p=0.074$) as well as no difference whether the scent was fisher or coyote ($F_{1,11}=0.165$, $p=0.69$).