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SAMPLE LAB REPORT

The Optimal Foraging Theory:

Food Selection in Beavers Based on Tree Species, Size, and Distance

Laboratory 1, Ecology 201

Abstract. The theory of optimal foraging and its relation to central foraging was examined by using the beaver as a model. Beaver food choice was examined by noting the species of woody vegetation, status (chewed vs. not-chewed), distance from the water, and circumference of trees near a beaver pond in North Carolina. Beavers avoided certain species of trees and preferred trees that were close to the water. No preference for tree circumference was noted. These data suggest that beaver food choice concurs with the optimal foraging theory.

Introduction

In this lab, we explore the theory of optimal foraging and the theory of central place foraging using beavers as the model animal. Foraging refers to the mammalian behavior associated with searching for food. The optimal foraging theory assumes that animals feed in a way that maximizes their net rate of energy intake per unit time. An animal may either maximize its daily energy intake (energy maximizer) or minimize the time spent feeding (time minimizer) in order to meet minimum requirements. Herbivores commonly behave as energy maximizers and accomplish this maximizing behavior by choosing food that is of high quality and has low-search and low-handling time.

The central place theory is used to describe animals that collect food and store it in a fixed location in their home range, the central place. The factors associated with the optimal foraging theory also apply to the central place theory. The central place theory predicts that retrieval costs increase linearly with distance of the resource from the central place. Central place feeders are very selective when choosing food that is far from the central place since they have to spend time and energy hauling it back to the storage site.

We hypothesized that the beavers in this study will choose trees that are small in circumference and closest to the water. Since the energy yield of tree species may vary significantly, we also hypothesized that beavers will show a preference for some species of trees over others regardless of circumference size or distance from the central area. The optimal foraging theory and central place theory lead us to predict that beavers, like most herbivores, will maximize their net rate of energy intake per unit time. In order to maximize energy, beavers will choose trees that are closest to their central place (the water) and require the least retrieval cost. Since beavers are trying to maximize energy, we hypothesized that they will tend to select some species of trees over others on the basis of nutritional value.

Methods

This study was conducted at Yates Mill Pond, a research area owned by the North Carolina State University, on October 25th, 1996. Our research area was located along the edge of the pond and was approximately 100 m in length and 28 m in width. There was no beaver activity observed beyond this width. The circumference, the species, status (chewed or not-chewed), and distance from the water were recorded for each tree in the study area. Due to the large number of trees sampled, the work was evenly divided among four groups of students working in quadrants. Each group contributed to the overall data collected.

We conducted a chi-squared test to analyze the data with respect to beaver selection of certain tree species. We conducted t-tests to determine (1) if avoided trees were significantly farther from the water than selected trees, and (2) if chewed trees were significantly larger or smaller than not chewed trees. Mean tree distance from the water and mean tree circumference were also recorded.

Results

Measurements taken at the study site show that beavers avoided oaks and musclewood (Fig. 1) and show a significant food preference (x^2=447.26, d.f.=9, P<.05). No avoidance or particular preference was observed for the other tree species. The mean distance of 8.42 m away from the water for not-chewed trees was significantly greater than the mean distance of 6.13 m for chewed trees (t=3.49, d.f.=268, P<.05) (Fig. 2). The tree species that were avoided were not significantly farther from the water (t=.4277, d.f.=268, P>.05) than selected trees. For the selected tree species, no significant difference in circumference was found between trees that were not chewed (mean=16.03 cm) and chewed (mean=12.80 cm) (t=1.52, d.f.=268, P>.05) (Fig. 3).

Discussion

Although beavers are described as generalized herbivores, the finding in this study related to species selection suggests that beavers are selective in their food choice. This finding proves our hypothesis that beavers are likely to show a preference for certain tree species. Although beaver selection of certain species of trees may be related to the nutritional value, additional information is needed to determine why beavers select some tree species over others. Other studies suggested that beavers avoid trees that have chemical defenses that make the tree unpalatable to beavers. These studies also suggested that beavers prefer trees with soft wood, which could possibly explain the observed avoidance of musclewood and oak in our study.

The result that chewed trees were closer to the water accounts for the time and energy spent gathering and hauling. This is in accordance with the optimal foraging theory and proves our hypothesis that beavers will choose trees that are close to the water. As distance from the water increases, a tree's net energy yield decreases because food that is farther away is more likely to increase search and retrieval time. This finding is similar to Belovsky's finding of an inverse relationship between distance from the water and percentage of plants cut.

The lack of any observed difference in mean circumference between chewed and not chewed trees disproves our hypothesis that beavers will prefer smaller trees to larger ones. Our hypothesis was based on the idea that branches from smaller trees will require less energy to cut and haul than those from larger trees. Our finding is in accordance with other studies (Schoener 1979), which have suggested that the value of all trees should decrease with distance from the water but that beavers would benefit from choosing large branches from large trees at all distances. This would explain why there was no significant difference in circumference between chewed and not-chewed trees.

This lab gave us the opportunity to observe how a specific mammal selects foods that maximize energy gains in accordance with the optimal foraging theory. Although beavers adhere to the optimal foraging theory, without additional information on relative nutritional value of tree species and the time and energy costs of cutting certain tree species, no optimal diet predictions may be made. Other information is also needed about predatory risk and its role in food selection. Also, due to the large number of students taking samples in the field, there may have been errors which may have affected the accuracy and precision of our measurements. In order to corroborate our findings, we suggest that this study be repeated by others.

Conclusion

The purpose of this lab was to learn about the optimal foraging theory by measuring tree selection in beavers. We now know that the optimal foraging theory allows us to predict food-seeking behavior in beavers with respect to distance from their central place and, to a certain extent, to variations in tree species. We also learned that foraging behaviors and food selection is not always straightforward. For instance, beavers selected large branches at any distance from the water even though cutting large branches may increase energy requirements. There seems to be a fine line between energy intake and energy expenditure in beavers that is not so easily predicted by any given theory.

Literature Cited

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*Note: This document was modified from the work of NCSU graduate students Selena Bauer, Miriam Ferzli, and Vanessa Sorensen.

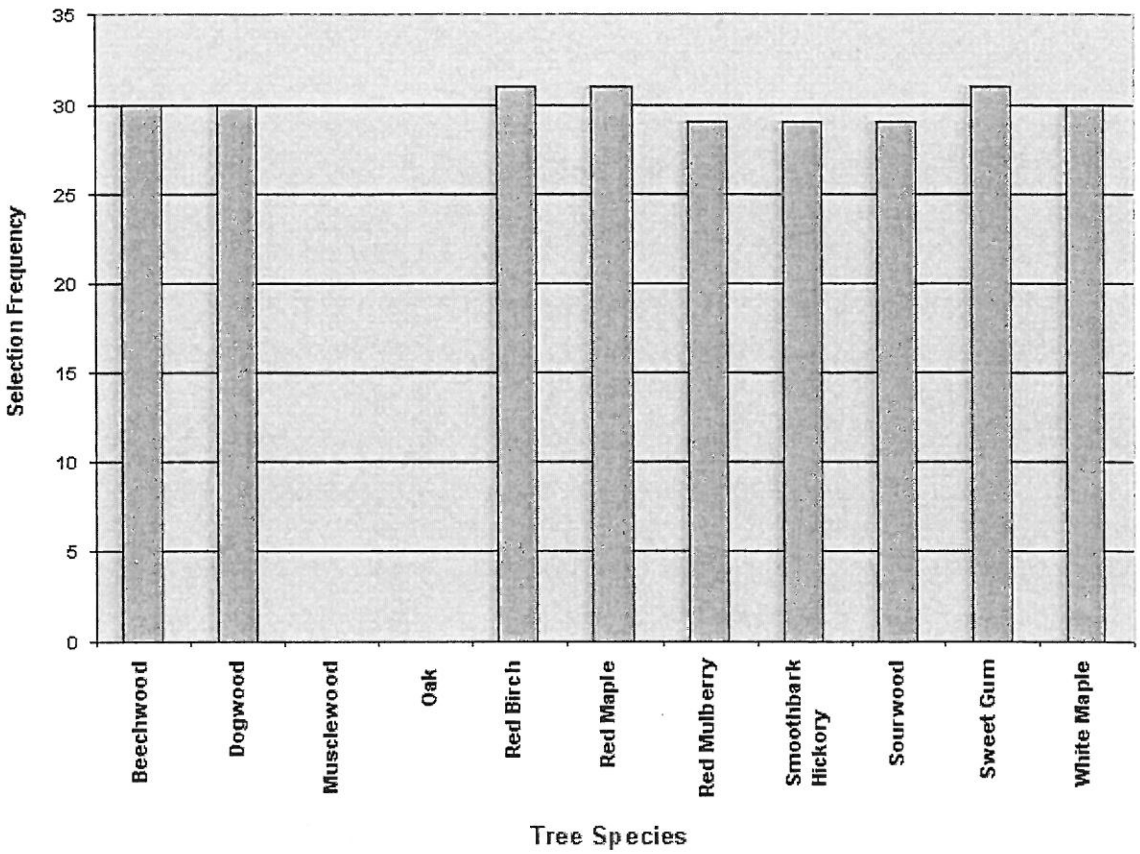
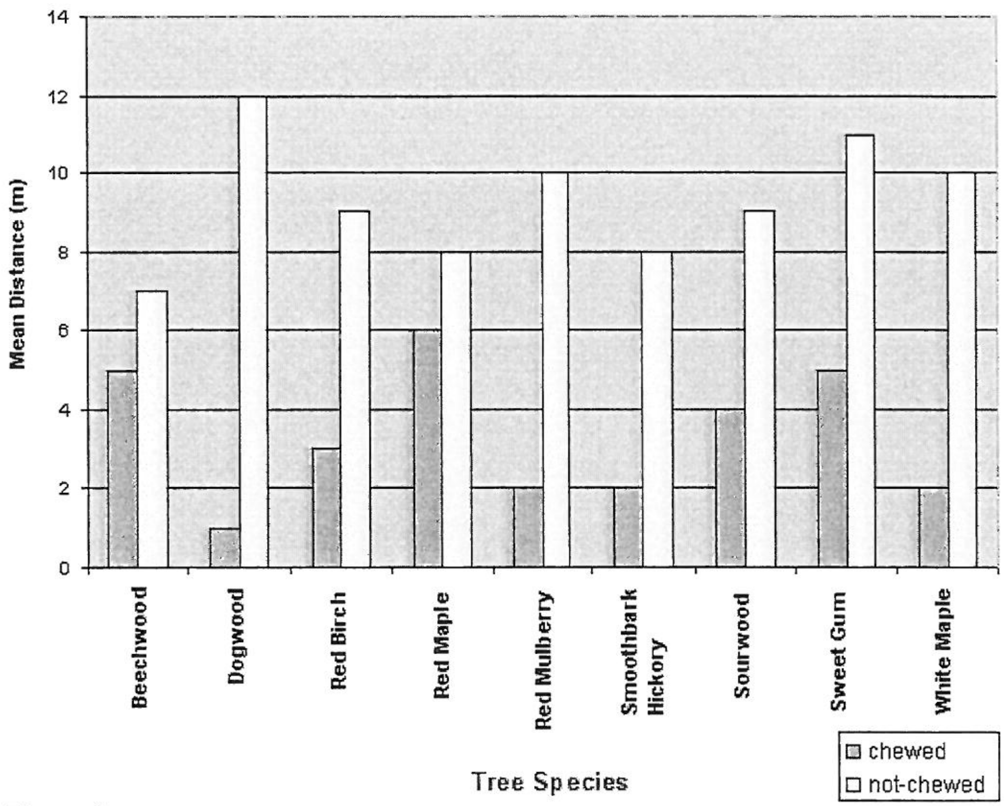
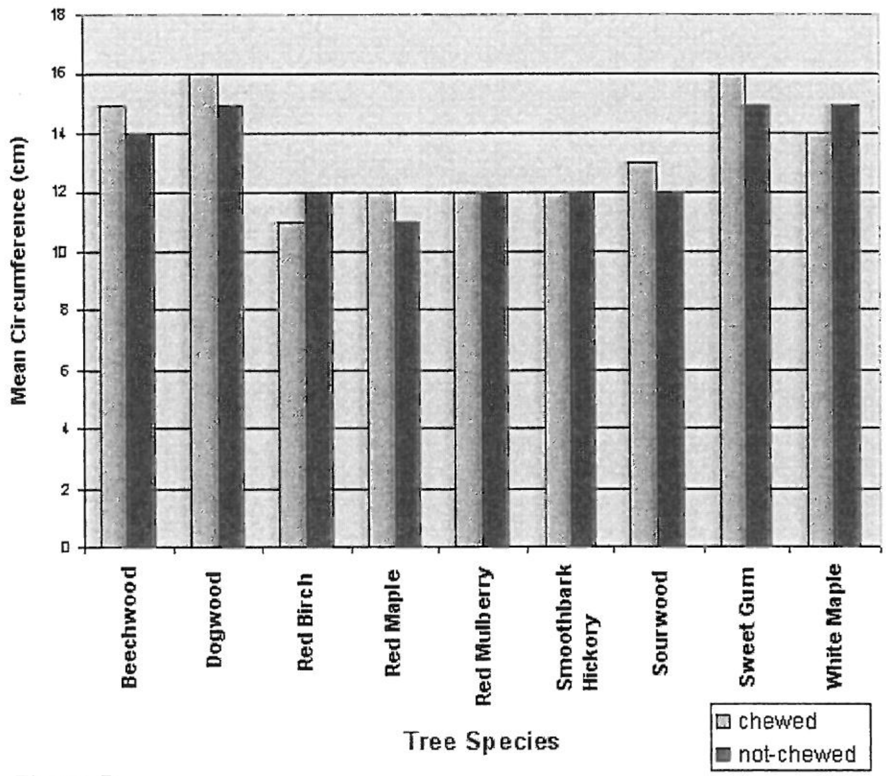

35
30
25
20
15
10
5
0
Selection Frequency
Beechwood
Dogwood
Musclewood
Oak
Red Birch
Red Maple
Red Mulberry
Smoothbark Hickory
Sourwood
Sweet Gum
White Maple
Tree Species

Figure 1.



Mean Distance (m)
14
12
10
8
6
4
2
0
Beechwood
Dogwood
Red Birch
Red Maple
Red Mulberry
Smoothbark Hickory
Sourwood
Sweet Gum
White Maple
Tree Species
chewed
not-chewed

Figure 2.



18
16
14
12
10
8
6
4
2
0
Mean Circumference (cm)
Beechwood
Dogwood
Red Birch
Red Maple
Red Mulberry
Smoothbark Hickory
Sourwood
Sweet Gum
White Maple
Tree Species
chewed
not-chewed

Figure 3.