

# Does Tree Type Affect the Type of Caterpillars That are Found In the Presence of Birds?

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## Introduction

Caterpillars are preyed upon by birds and in turn prey upon plants. Because of their trophic level they can be used to study several different relationships between different members of a biological community. One environmental aspect that can be studied using caterpillars are the effects of invasive plant species on herbivores and the predators that feed on them as in the paper by Narrago et al. in 2017. Caterpillars can also be part of complex, sometimes mutualistic, relationships with other insects such as ants (Clark et al., 2016). Birds also play an important role in mitigating damage to plants by grazing done by caterpillars (Berezcki et al., 2014).

- The effects of bird predation can be seen by measuring aspects of the tree including the amount of water and the trees surrounded the one being studied (Singer et. al., 2012).
- The amount of water is correlated to how the caterpillars diet affects their appeal to birds. Bird predation is linked to caterpillar population density (Berezcki et al., 2014)(Castagneyrol et. al., 2017).
- Insectivore populations are higher and more diverse with more native plants and more mixed forests (Berezcki et al., 2014).

**Research Question:** Do certain species of caterpillar get eaten by birds more often than others based on tree species?

## Hypotheses:

**H<sub>a</sub>:** The number of individuals of the caterpillar species *Melanolophia Canadaria* is dependent on the tree species and the presence of birds.

**H<sub>o</sub>:** The number of individuals of the caterpillar species *Melanolophia canadaria* is not dependent on the tree species and the presence of birds.

## Methods

### Data:

- Our data is from the forest caterpillar experiment, a manipulative field study conducted by the Michael Singer lab.
- Data collection occurred from 2008 to 2011 in three locations in Connecticut; Cockaponset State Forest, Hurd State Park, and Miller's Pond State Park (Singer).
- 2948 Caterpillars greater than ~1 cm were collected from 1167 trees containing experimental branches that were bagged and unbagged by nylon netting (Singer).

### Variables:

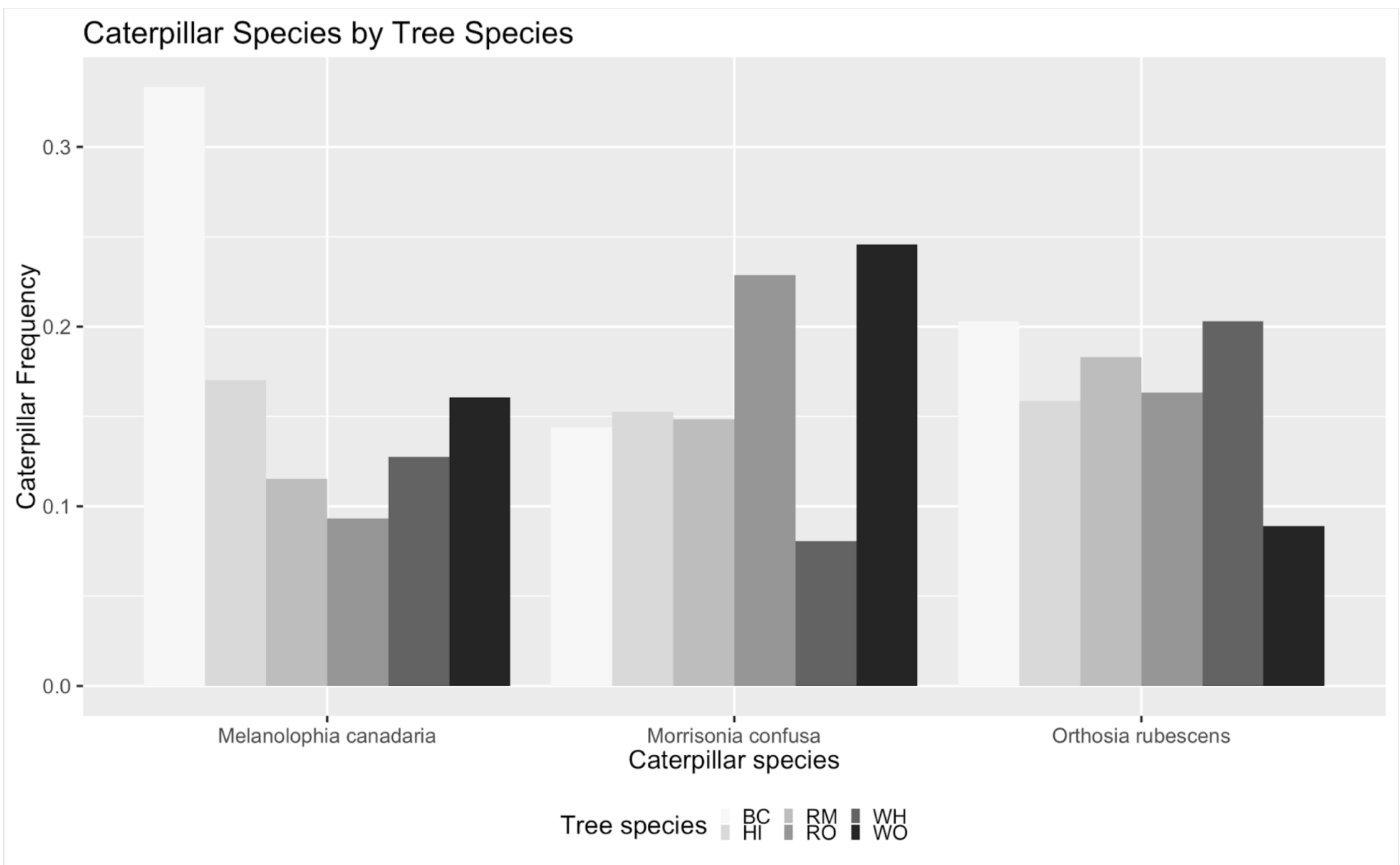
1. **Tree Species:** Of the original tree species the six which had the most caterpillars collected from them were used in the analysis. The tree species where caterpillars were found were Red Maple (*Acer rubrum*, RM), Witch Hazel (*Hamamelis virginiana*, WH), Black Cherry (*Prunus serotina*, BC), White Oak (*Quercus alba*, WO), Hickory (*Carya spp.*, HI), and Red Oak (*Quercus rubra*, RO).
2. **Caterpillar Species:** Of the forty one species that were recorded only the three most common caterpillar species were used in this project. The species which were used are *Melanolophia canadaria*(783 observations), *Morrisonia confusa*(282 observation), *Orthosia rubescens*(243 observations).
  - a. For the multivariate analysis these three species were narrowed down into two categories *Melanolophia canadaria* and not *Melanolophia canadaria* .
3. **Bird Treatment:** Birds were excluded from some branches using netting, preventing predation by birds. The covered branches were the control group of this experiment.

### Moderator:

Bird treatment shows the relationship between caterpillar species and tree species. This moderator tests if birds are consuming significant amounts more of caterpillars off of one tree species over another.

### Analysis Method:

A logistic regression was run to explain the odds ratio. A caterpillar belonging to the species *Melanolophia canadaria* if the caterpillar species was dependent on the tree species and bird treatment. This test was run both with and without an interaction term and the results were compared and the Akaike information criterion (AIC) was calculated for both. The model with the interaction term generated the higher AIC score so the model with the interaction term was discarded.



- Black cherry trees had the largest proportion of *Melanolophia canadaria* (0.333) while red oak trees had the smallest (0.093).
- White oak had the largest proportion of *Morrisonia confusa* (0.246) while witch hazel had the smallest proportion of that species (0.081).
- Black cherry and witch hazel had the largest proportions of *Orthosia rubescens* (Both 0.203) while white oak had the smallest proportion of *Orthosia rubescens* (0.089).

	<i>Melanolophia canadaria</i>	Confidence intervals for <i>Melanolophia canadaria</i>	<i>Morrisonia confusa</i>	Confidence intervals for <i>Morrisonia confusa</i>	<i>Orthosia rubescens</i>	Confidence intervals for <i>Orthosia rubescens</i>
Black Cherry (BC)	0.333	(0.305, 0.361)	0.144	(0.123, 0.165)	0.203	(0.179, 0.227)
Hickory (HI)	0.17	(0.148, 0.192)	0.153	(0.132, 0.174)	0.158	(0.137, 0.179)
Red Maple (RM)	0.115	(0.096, 0.134)	0.148	(0.127, 0.169)	0.183	(0.160, 0.206)
Red Oak (RO)	0.093	(0.076, 0.110)	0.229	(0.204, 0.254)	0.163	(0.141, 0.185)
Witch Hazel (WH)	0.128	(0.108, 0.149)	0.081	(0.065, 0.097)	0.203	(0.179, 0.227)
White Oak (WO)	0.16	(0.139, 0.181)	0.246	(0.221, 0.271)	0.089	(0.072, 0.106)

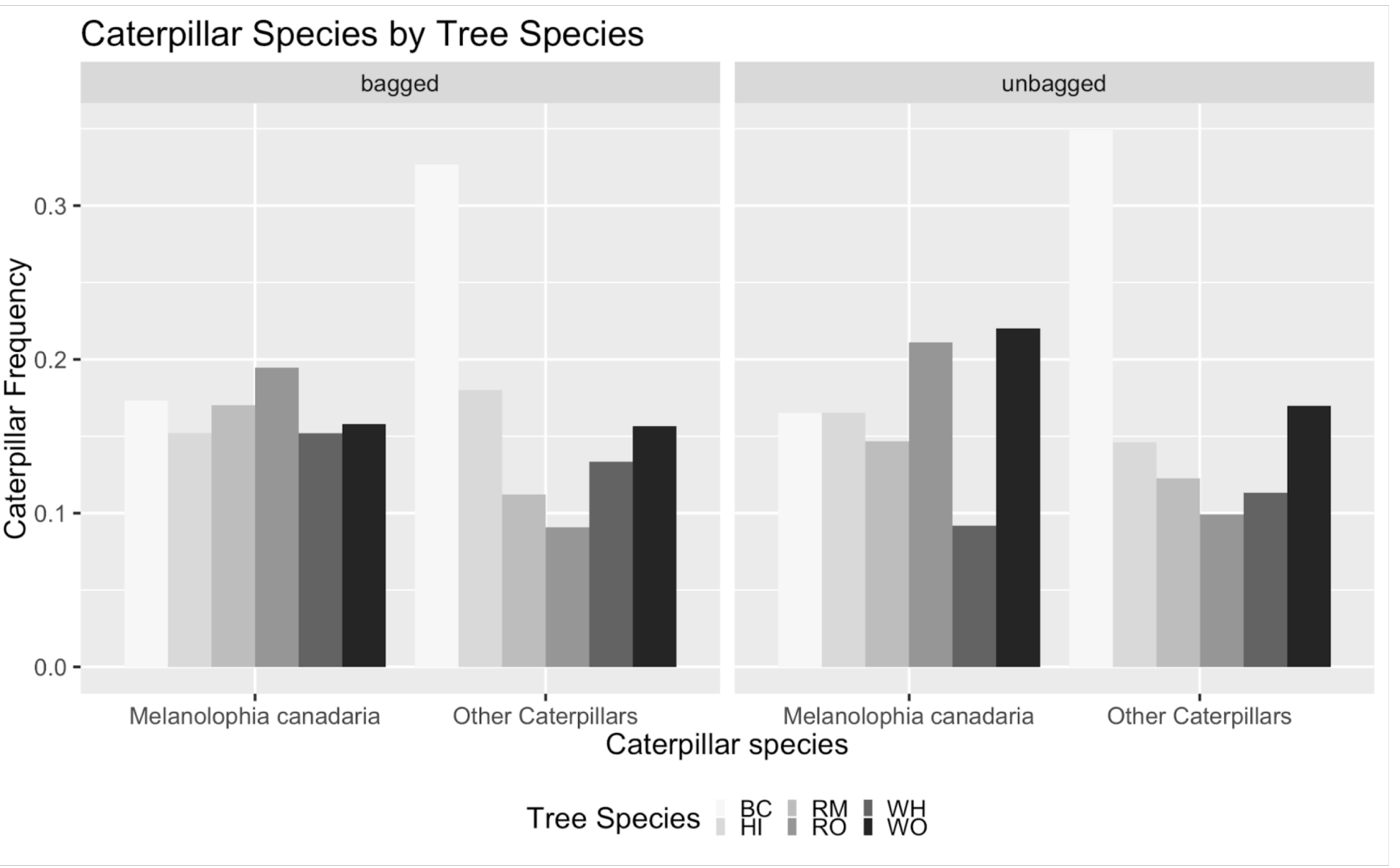
### Chi-square analysis

- The association between Tree Species and Caterpillar Species, with a P-value < 0.0001 (X<sup>2</sup>=89.5, df= 10), is significant.

### Post-Hoc Analysis (Fisher Test)-

- When comparing *Melanolophia canadaria* to *Morrisonia confusa* seven of the differences between caterpillar numbers in different trees were significant while eight were not.
- *Morrisonia canadaria* compared to *Orthosia rubescens* had six significant differences between tree species and nine insignificant ones.

**Moderator:** Bird treatment shows the relationship between caterpillar species and tree species. This moderator tests if birds are consuming significant amounts more of the caterpillar species *Melanolophia canadaria* off of one tree species over another. Since this is a significant association at the bivariate level , it can be expected that this relationship is significant for the whole population.



	OR	LCL	UCL
Hickory	0.57 (p-value = 0.005)	0.38	0.84
Red Maple	0.36 (p-value < 0.0001)	0.24	0.54
Red Oak	0.24 (p-value < 0.0001)	0.16	0.36
Witch Hazel	0.48 (p-value = 0.0006)	0.32	0.73
White Oak	0.47 (p-value = 0.0002)	0.32	0.70
Unbagged	1.24 (p-value = 0.123)	0.94	1.64

The reference group for the tree species is Black Cherry

### Multivariate Description:

- The graphs show that there is a correlation between the number of individuals of *Melanolophia canadaria* and other caterpillar species and the particular tree species along with the bird treatment. So the presence of birds affects the numbers of caterpillars found on each tree species.
- When bird treatment is constant, than the odds of finding *Melanolophia canadaria* caterpillars on any of the tree species is lower than the odds of finding the other two caterpillar species.
- When tree species is held constant the odds of finding *Melanolophia canadaria* caterpillars is higher on unbagged trees when compared to bagged trees.
- An interaction term was tested and was found to not be significant. A model with an interaction term had a larger AIC than the model without the interaction term.

## Conclusions

### -Bivariate

- Not all of the differences between caterpillar species found on different trees are significant.
- There are significant differences between the numbers of some caterpillar species found on some trees. These results support our hypothesis that tree species and presence of birds affects the number of caterpillars found on a branch.
- Overall there is a significant relationship between the number of individuals of a caterpillar species and the tree species.

### -Multivariate

- There is a significantly lower chance of *Melanolophia canadaria* being present based on tree species, but there was an increase in the odds of *Melanolophia canadaria* being present on trees that were unbagged. However, this relationship was not significant (p-value = 0.123) implying that the branch treatment might not have been very effective.
- According to the bivariate data there is a significant association (p<0.0001) between tree species and caterpillar species.
- When taking into account the moderator, bird treatment, there is an unlikely association (OR<1) between the caterpillars that potentially get eaten by birds from the unbagged branches versus the bagged branches, and what tree species the caterpillars were collected from.
- Previous research results disagree with this assessment, they state that the tree does affect the rate of bird predation according to the resources the tree provides to the caterpillar (Singer et. al., 2012).

## Implications

- The number of caterpillars is not associated with what type of tree a species of caterpillar is found on, but it is dependent on the type of bird treatment. This implies that the rate of predation on caterpillars is unlikely to be dependent on tree species.
- These findings could be used to better understand the implications of changing plant communities because if tree species does not affect whether a bird will eat a caterpillar, then for example if an invasive tree species enters an area, the caterpillar population, and therefore the bird population, will not be significantly affected.

## Limitations

- This study is limited to the caterpillars and tree species located in Connecticut; Cockaponset State Forest, Hurd State Park, Miller's Pond State Park.
- The univariate data has a varying range of how much data per species was collected, possibly affecting the associations.
- There were model assumptions that were not upheld. Since the number of caterpillars collected for each species had a very wide range of number of observations, we chose the species with the most data points, assuming this would give us the most accurate representation of the population.
- This was an observational study, with no manipulation of the associations studied, creating no biases
- Many factors can influence where a specific caterpillar species may be found, it may be advantageous to construct a study including more variables such as the average leaf size, total leaf size, location (site) of tree, and the number of leaves per branch, in order to gain more insight.

## Literature Cited

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