Do Small Mammals Prey Switch During the Winter? An Evaluation of Invertebrate Prey Availability in the Subfolium Level of the Forest Floor

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Introduction:

- Prey Switching falls under the Alternative Prey Hypothesis (APH). It is defined as a predator switching from one prey species to another due to fluctuating population densities.[1]
- Northern short- tailed shrews (*Blarina brevicauda*) are known to eat conspecifics and other small mammals as well as macroinvertebrates.[2]
- *Peromyscus* species, white- footed mouse and the deer mouse, are known to eat conspecifics as well as macroinvertebrates.[2]
- Leaf litter creates the subfolium space, which supports terrestrial macroinvertebrates[3] that serve as a staple food source for small mammals[4].
- Macroinvertebrates migrate vertically in the soil during periods of low temperatures[5,6], making them less available for small mammals.

Objectives:

Our objectives were to determine if there's a relationship between macroinvertebrate abundance and temperature and if this impacts small mammal capture rates based on olfactory cues for vertebrate prey.

Hypothesis:

As seasonal temperatures decline, macroinvertebrate density will also decline. Therefore, small mammals capture rates will increase in traps containing the scent of vertebrate prey.

Methodology:

- Trapping and macroinvertebrate analysis was conducted along two transect sites in the Millersville University Biological Preserve from August 2017 until May 2018.

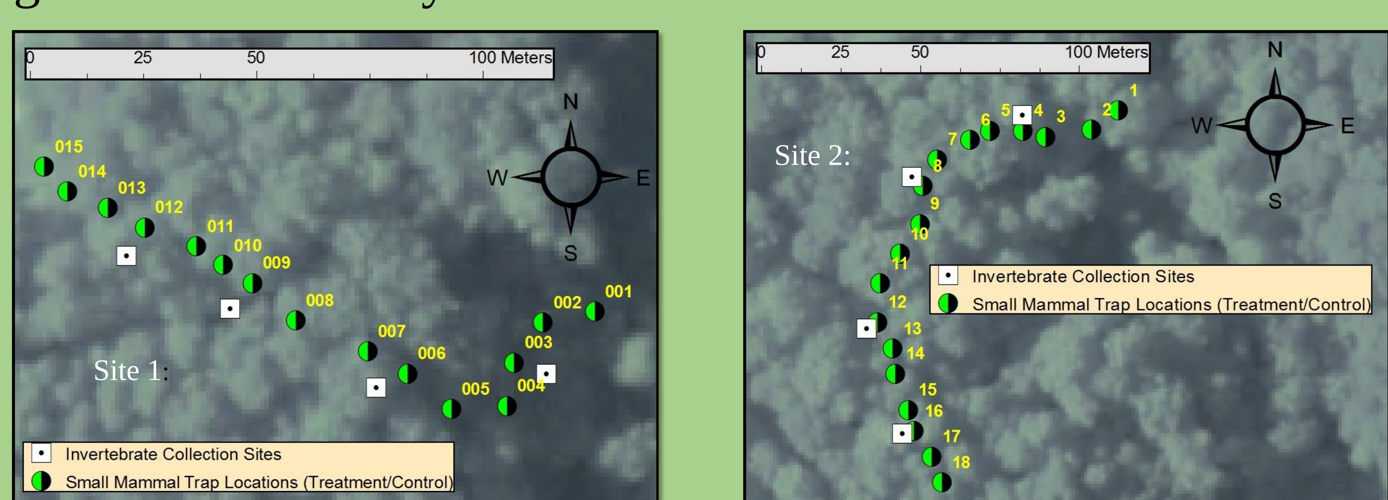

Figure 1. Trap sites were placed 10 m apart and paired traps were 1m apart. Macroinvertebrate analysis sites were moved 1 meter weekly.

- Paired Sherman live traps were used. Control traps were baited with plain woodchips and Treatment traps were baited with chips soaked in *Mus musculus*, common house mouse urine, to act as a potential source of vertebrate prey. Woodchips were received from the Millersville University Mouse Colony.
- Traps were set 5 pm every Thursday night and were placed in alternating directions so small mammal movements wouldn't be a compounding factor. Traps were checked 8:30pm and 11:30 pm on Thursday evenings.
- Traps were cleaned to maintain independence. Cleaning took place on Fridays with Lysol wipes since they were found not to impact small mammal capture rate[7].
- Weekly invertebrate sampling was conducted along both transects, at moving collection sites. A 25x25cm area of leaf litter and loose topsoil, and temperature measurements at soil, subfolium, and ambient locations, were obtained. Soil samples were processed using Berelese funnels to drive macroinvertebrates into ethanol for preservation and analysis[8].

Results:

- Data was analyzed using regression analysis to see which model (linear, quadratic, or logistic) best fit the small mammal capture rate to invertebrate abundance and the macroinvertebrate abundance to temperature data.

Table 1. Small mammal capture rates were not impacted by macroinvertebrate abundance.

Trapping Data	Model	P-Value	R-Squared
Treatment	Linear	0.42	0.02
Control	Linear	0.70	0.01
Treatment	Logistic	0.41	0.03
Control	Logistic	0.69	0.01
Treatment	Quadratic	NA	NA
Control	Quadratic	NA	NA

- There was no significant correlation between small mammal capture rates and macroinvertebrate abundance for any of the models.

Table 2. Regression analysis shows the linear model is the best fit for macroinvertebrate abundance vs. temperature.

Temperature Location	Model	P-Value	R-Squared
Ambient	Linear	**0.014**	0.17
Subfolium	Linear	**0.007**	0.21
Soil	Linear	**0.004**	0.23
Ambient	Logistic	0.545	0.18
Subfolium	Logistic	0.760	0.23
Soil	Logistic	0.162	0.26
Ambient	Quadratic	0.377	0.19
Subfolium	Quadratic	0.233	0.25
Soil	Quadratic	0.492	0.24

- The linear regression had a significant relationship between invertebrate abundance and temperature location (soil, subfolium, and ambient).

Table 3. Subfolium temperature was the best single predictor variable of macroinvertebrate abundance based on Akaike weight and evidence ratios.

Temperature Location	AICc	ΔAICc	w_i	ER
Subfolium	264.57	0.80	0.17	0.00
Subfolium & Ambient	264.60	0.83	0.16	1.02
Soil & Ambient	264.93	1.16	0.14	1.20
Soil	265.33	1.56	0.11	1.46
Subfolium & Soil	265.33	1.56	0.11	1.46
Subfolium, Soil & Ambient	265.77	2.00	0.09	1.82
Ambient	266.05	2.28	0.08	2.10

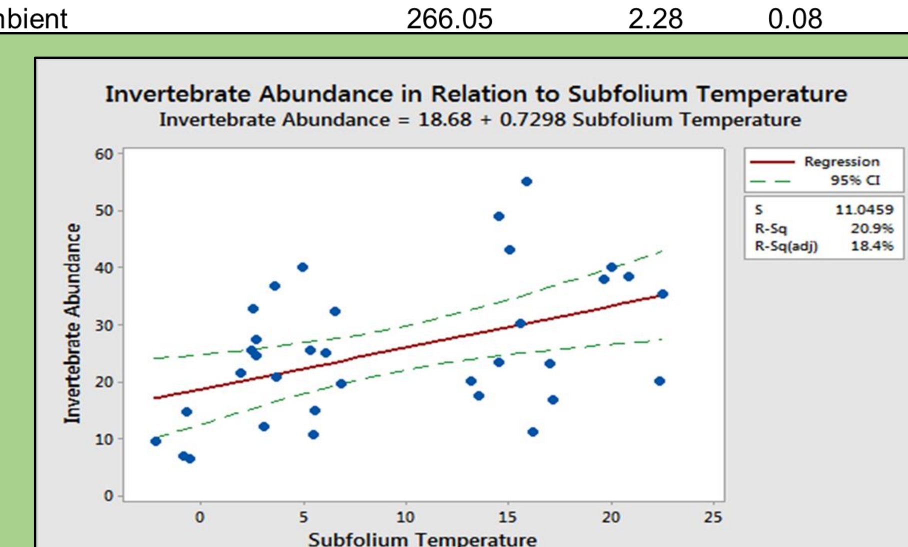

Figure 2. The linear regression model demonstrates a positive correlation between macroinvertebrate abundance and subfolium temperature.

- Subfolium temperature was the best single variable that predicted macroinvertebrate abundance.

Discussion:

- No correlation was found between macroinvertebrate numbers and small mammal capture success. This could have been the result of the following:

1. Non-native house mouse (*Mus musculus*) odor may not be an attractant.
   - White- footed mouse (*P. leucopus*) and deer mouse (*P. maniculatus*) odor may be more of an attractant.[9, 10]
2. Small mammals may be tactile hunters and not use olfaction.
3. Invertebrate numbers did not lower enough to cause small mammals to prey switch. Therefore, small mammals like shrews maintained winter activity by continuing to feed on macroinvertebrates.[4]
4. Besides temperature, macroinvertebrate abundance may also have been impacted by substrate cover, reproductive season, and soil moisture.[6, 11]

Further Research:

Year 2: Implement same methodology but compare mice scented traps to those that have traditional small mammal bait (sunflower seeds and dog food).

Year 3: Move research efforts to off campus field sites.

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Pictures: Joe Coelho, https://dkphoto.photoshelter.com, and https://calphotos.berkeley.edu

Figure 3: Examples of organisms captured and collected in our study: a) Order Hemiptera b) Order Lepidoptera and c) *Peromyscus leucopus*. All found in the leaf litter of the forest floor.