GUIDELINES: A SAMPLE MANUSCRIPT

*Title includes key variables, study organism, and ecosystem examined.**

Effects of Food Availability and Stem Density on Population Sizes of Small Mammals in Successional Fields in Central Illinois

Senior author's name, then names of group members in alphabetical order.

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Clearly label sections of paper.

ABSTRACT (4-5 paragraphs)

Context of study

Background information

Extrinsic factors interact with intrinsic factors to determine population sizes of small mammals. A previous study of successional fields in central Illinois found more shrews in 5-yr fields and more voles in one-yr fields; mice number didn't differ between fields.

Question/focus

In this study I examined whether food availability of plants and arthropods, as well as plant stem density, explain population sizes of small mammals that differ in diet and body shape.

Hypothesis/Prediction 1

If food availability explains relative population sizes of carnivorous shrews and herbivorous voles, then 1) arthropod abundance will be greater in 5- than 1-yr fields and 2) plant biomass will be greater in 1- than 5-yr fields.

Hypothesis/Prediction 2

If ease of escape from predators does not determine the density of the stocky, non-agile shrews and moles, then the number of high and low density vegetation plots will be equal in 1- and 5-yr fields.

Methods (short)

Plant biomass and stem density were measured in 0.25 m^2 quadrats and arthropod abundance in 20 sweeps of the vegetation.

Results (short)

Mean arthropod number per 20 sweeps was greater in 5-yr than 1-yr fields, while mean plant biomass per quadrat was greater in 1-yr than 5-yr fields. Fields did not differ in the distribution of high- to low-stem density plots.

Conclusions

Food availability for small mammals determines, in part, the population sizes of these small mammals in these early successional fields. It remains unclear whether stem density plays

a complementary role because the lack of contrast in stem density precluded a test of this variable.

250 words maximum

Use "invented triangle" to organize introduction. First, give big picture/context.

INTRODUCTION (4-5 paragraphs)

Topic sentence of paragraph; all sentences in paragraph relate to this topic.

Background information.

Key references included.

No direct quotations – only paraphrases with sources. Proper literature format used.

Both extrinsic and intrinsic factors affect the relative population size of species of small mammals in local habitats. Extrinsic factors may include the amount of food availability (Bell 1989), presence of competing species (Holt et al. 1995), and the presence of predators (Batzli and Lin 2001). Intrinsic factors may relate to their diet and food preferences (Heskie 2004), competitive ability (Holt et al. 1995), and body shape (Hoffmeister 1989) that affects their speed and agility in escaping predators. Differences in these factors are expected to result in varying population sizes of species of small mammals among local habitats. Understanding the factors that affect a species' population size is important because it allows us to predict how changes in the environment will affect its population dynamics and the community structure.

Importance of study highlighted (Why should reader care?)

Prior studies/observations (data) relevant to specific study.

Augspurger et al. (2007) found that the relative population sizes of small mammals differed in successional old fields of contrasting age. Specifically, their four years of live trapping showed that voles have a large population in a field abandoned one year ago, while shrews have a larger population size in a field abandoned five years ago. Mice were approximately equal in both ages of field.

Background on factors that may contribute to explanation.

These small mammals differ in both their diet and body shape (Hoffmeister 1989). Shrews are carnivorous and eat invertebrates associated with the soil surface. The herbivorous voles eat green leaves, green stems, and seeds of grasses and forbs. Mice are omnivorous and eat mostly seeds, insects, and spiders (Hoffmeister 1989). Mice appear to have more flexibility in their diet and potentially in their habitat choice. Voles and shrews are more stocky and slower, and use dense vegetation to hide. Mice are more nimble and fast, and don't need dense vegetation to hide as they can run to escape predators (Hoffmeister 1989). Thus, voles and shrews appear to have more stringent requirements for their habitat than mice, based on both their diet and mobility. It is unknown whether diet, body shape, or both affect their population size.

Specific ideas of what factors may explain observation (introduction of independent and dependent variables).

Both food availability affecting mammal diet and vegetation complexity affecting mammal mobility change during old field succession. The species composition, growth habit, and density of plants of old fields change (Bazzaz 1976). Likewise, abundance of insects and spiders is expected to follow any changes in vegetation during succession (Richardson et al. 2005). It is unknown to what extent changes in these extrinsic factors impact the distribution and habitat choice of small mammals.

Study's objective in general terms.

This study's objective was to determine whether food availability, ease of escape from predators, or both explain the relative population sizes of small mammals found in our earlier studies in successional old fields of contrasting age (Augspurger et al. 2007*)*.

Formal hypotheses/predictions.

If food availability explains relative population sizes of mice, voles, and shrews, then 1) arthropod abundance will be greater in the five- than one-year successional field and 2) plant biomass, including seeds, will be greater in the one- than five-year old succesional field. If ease of escape from predators is not a determinant of their population size, then the number of high density and low density vegetation plots will be equal in one- and five-year old successional fields.

Assumptions

It was assumed that plant density is a good indicator of vegetation cover and complexity needed for non-agile voles and shrews to hide from their predators.

Further rationale for logic of hypotheses.

When combined, the two hypotheses argue that food availability, rather than ease of escape from predators, explains the relative population sizes of these small mammals because the two types of mammals with similar non-agility occurred in greater abundance in different aged fields (shrews in 5-yr and voles in 1-yr).

Write in past tense and passive voice.

Describe location, habitats, size of study site, relevant ecological background.

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METHODS

Study Site

This study was conducted in Phillips Tract, an abandoned farm located 5 km northeast of Urbana in Champaign County, Illinois, USA (40°09’, 88°10’W). Two old fields were compared in the study. Corn was planted and harvested in Field 1 in 2007 and left to undergo natural succession through the growing season in 2008. Soybeans were planted and harvested in Field 2 in 2003 and left to undergo natural succession in all years through 2008. The two fields are each 30m x 250 m in size and are referred hereafter to as the 1-year and 5-year successional fields.

Clearly identify:

Dependent variables.

Independent variable.

Unit of measurement.

Sampling unit.

Number of replicates (sample size).

Sufficient detail of methods to allow others to repeat study.

Experimental Design

Measurements of arthropod abundance and plant biomass and density were made in both 1-year and 5-year successional plots. Sweep nets were used to determine the number of arthropods. Each sample was collected by making 20 consecutive sweeps while moving through the 30 m width of the field. A total of 20 samples were collected at regular intervals throughout the 250 m length of the field. After transferring each sample of arthropods to a sealed jar with ethyl acetate to immobilize them, the arthropods were spread on top of a series of three stacked trays with screens in them. The vegetation was removed. The trays were shaken to move the smallest arthropods through all three screens, including the bottom screen with a mesh size of 2 X 2 mm. These very small arthropods were discarded. The insects in the top and middle screens were transferred to the tray and counted. They represent the number of arthropods with a body size greater than 2 X 2 mm.

Unit of measurement.
Dependent variable.
Number of replicates.
Sampling unit.

Plant biomass per quadrat was determined in a total of fifty 0.5 m X 0.5 m quadrats. All stems rooted in the quadrat were clipped at ground level and weighed. To determine the location of plant collection, a stick was thrown haphazardly through the vegetation. The fifty quadrats were haphazardly located at approximately 5 m intervals throughout the 250 m length of the field.

Dependent variable.
Number of replicates.
Unit of measurement.

Plant density was determined in the same 50 quadrats. Prior to clipping the vegetation, the number of stems in the quadrat was counted. The density values were ranked. Each value above the modal value was considered a high density quadrat, while each below the modal value was a low density quadrat. The number of high and low density quadrats was tallied.

Statistical tests performed on each dependent variables.

Statistical Tests

The differences between the two fields in the mean number of arthropods per sweep sample and the mean plant biomass per quadrat were tested by two *t*-tests. The difference in distribution of high vs. low density plots in the two fields was tested by a 2 x 2 X^2 contingency test for independence.

Present each table and figure in numerical order. Organize by predictions. No interpretation of results; only facts.

RESULTS (1-2 paragraphs)

Present major pattern/trend.

Prediction 1- statistical details

Number of arthropods and plant biomass were inversely related in the two fields (Fig. 1, 2). Mean number of arthropods per 20 sweeps was significantly greater in the 5-year field than the 1-year field (*t*-test $P<0.01$) (Fig. 1).

Note precise format of statistic and figure.
Prediction 2 –statistical details.

Mean plant biomass per quadrat was significantly greater in the 1-year field than the 5-year field (t-test $P<0.05$) (Fig. 2). The 1-year field had slightly more high- than low-stem density plots, while the 5-year field had slightly more low- than high-stem density plots (Fig. 3). However, the distribution of the two levels of density was independent of age of field (X^2 text, df = 1, $P>0.05$).

Prediction 3 – Reference made to next figure and important pattern described.

Prediction 3 – statistical details.

No figures/tables in text; put all at end of paper.
No repeat in text of numbers in figures.

DISCUSSION (6-7 paragraphs)

Clearly state whether hypothesis supported or not.

Give brief restatement of results.

Reference to direct observation hypothesis was trying to explain.

The results support the hypothesis that food availability explains relative densities of mice, voles, and shrews in these successional fields. As predicted, arthropod number was greater in 5-year than 1-year fields, while plant biomass was greater in 1-year than 5-year fields. These results for food availability correspond well with the previously measured densities of the small mammals (Augspurger et al. 2007). The carnivorous shrews had higher a larger population in the field with greater arthropod abundance. The herbivorous voles had a large population in the field with greater biomass. Population sizes of mice were equal in both ages of fields.

Hypothesis 2: Give brief restatement of results.

As predicted, the number of high density and low density vegetation plots was not different in one- vs. five-year old successional fields. Therefore, the small mammals had no choice between contrasting fields regarding escape from predators. The results do not directly support the second hypothesis because the lack of difference in stem density between fields did not provide an adequate test of the escape hypothesis.

Clearly state whether hypothesis supported or not.

Explanation of "negative" result. (Why Hypothesis 2 not supported).

If escape of predators determines habitat choice of small mammals, both shrews and voles should prefer the same density of field. In fact, the two mammals with the same body shape and agility were found in different aged fields. Because both fields had the same density and hence the animals had no choice, we cannot know whether they use stem density to make their choice. To rigorously test the role of escape of predators in habitat choice, it will be necessary to demonstrate that shrews and voles both choose high density fields instead of low density fields.

How to test better Hypothesis 2.

Compare your results to prior literature: Hypothesis 1

The study's findings that the 5-year field with more carnivorous shrews has more arthropods, while the 1-year field with more herbivorous voles has more plant biomass are consistent with studies in other old fields in several states (Brokaw 1983; Lin et al. 2004; McNicoll 2007). The abundance of arthropods in these fields in Illinois is greater than in the other states. Many extrinsic and intrinsic factors affecting arthropods may differ among these sites. Plant biomass differs less among the various study sites.

Compare your results to prior literature: Hypothesis 2.

This study did not adequately discriminate whether or not ease of escape by small mammals is a factor in explaining their habitat choice. In an earlier study of successional fields of more contrasting age, both voles and shrews were more abundant in the young field with higher density than the older field with lower density (Pickett et al. 1989). Therefore, ease of escape remains a viable explanation for habitat choice by small mammals.

Use primary literature. Avoid textbooks and internet.

Explain other ways to test Hypothesis 2.

The major limitation of the study was the lack of fields with both contrasting food and contrasting stem density. A future study would use many more sites with these contrasts. Alternatively, an experimental array of fields could be created with high density and high food, high density and low food, low density and high food, and low density and low food. This experimental design would test whether food availability and/or ease of predator escape determine their habitat choice and abundance.

The "take-home" message. What is important to remember?

As old fields undergo succession and alter food availability, the small mammal community changes as well. The study clearly showed that the change in food availability is one factor causing the shift from more voles to more shrews as the fields undergo succession. It remains unclear what role stem density plays as it interacts with body shape and agility to affect habitat choice. The lack of a contrast in stem densities between the two fields precluded a strong test of this escape hypothesis. Clearly extrinsic factors interact with intrinsic factors to determine the relative population sizes of these small mammals. The specific combination of factors may be more complex than this study was able to show.

LITERATURE CITED

Go to front of manual to find these instructions.

See **GUIDELINES MANUSCRIPT ORGANIZATION/DETAILS**

Follow the precise format there to complete this section.

* Method of developing an annotated manuscript was adapted from:

Knisely, K. 2005 (2nd edition). A Student Handbook for Writing in Biology. Sinauer Associates, Inc. W.H. Freeman and Company.

Figures go on separate page(s) after Literature Cited.

All parts of Figure large enough to read easily.

Axes have proper spacing, clear labels and include unit of measurement (e.g. ℃ or mm).

Figure is "clean" with no gridlines or title.

Clear notation in legend of what values represented (e.g. mean +/-SD)

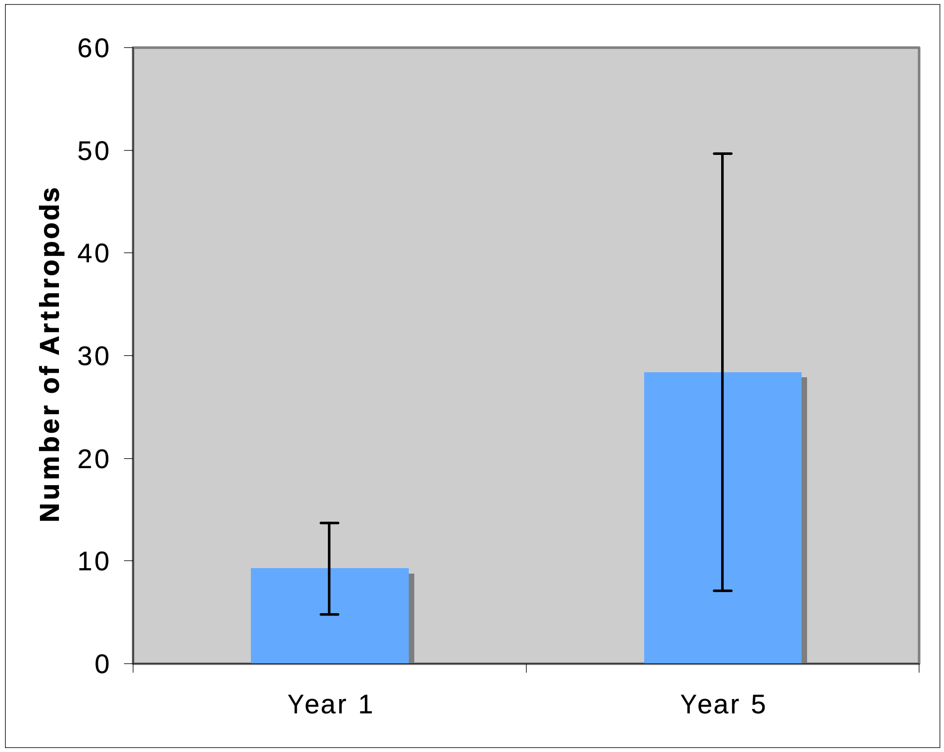

Figure 1. Comparison of number of arthropods collected in twenty sweeps (mean +/- SD) in fields abandoned for one-year vs. five-years.

Figure (not Fig.)
Legend (caption) is more than a repeat of x, y axes.
Figure legend (caption) is below figure.
(Table legend is above table).

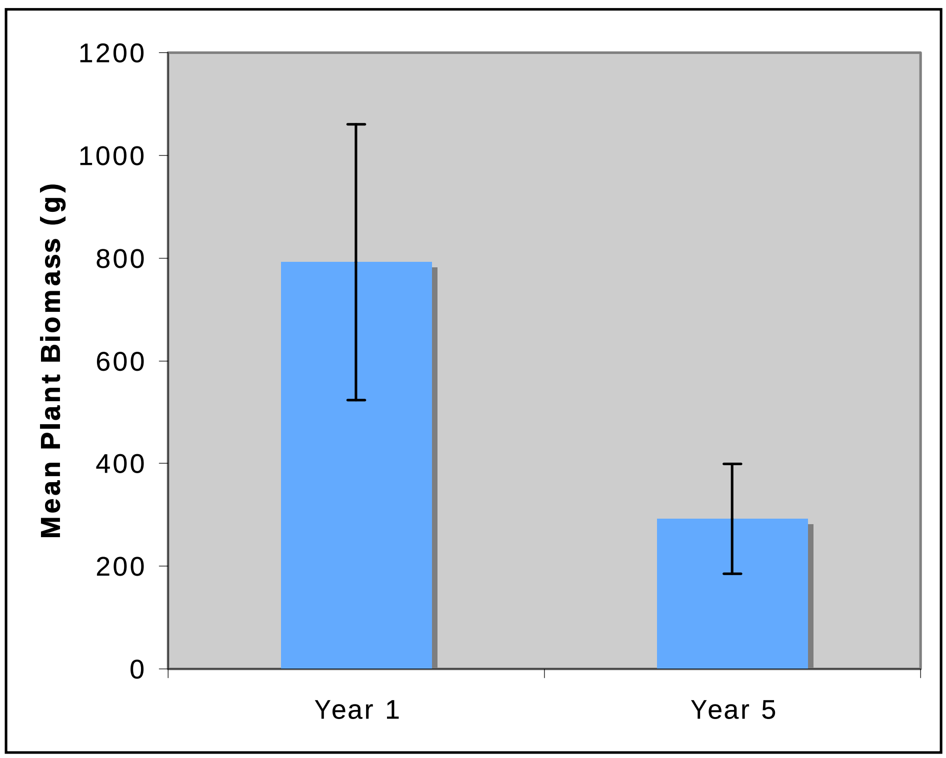

Figure 2. Comparison of plant biomass per 0.25 m^2 (mean +/- SD) in fields abandoned for one-year vs. five-years.

Number each figure sequentially.

Legends have enough information to understand figure without reading methods and results.

Clear notation of what different shading refers to.

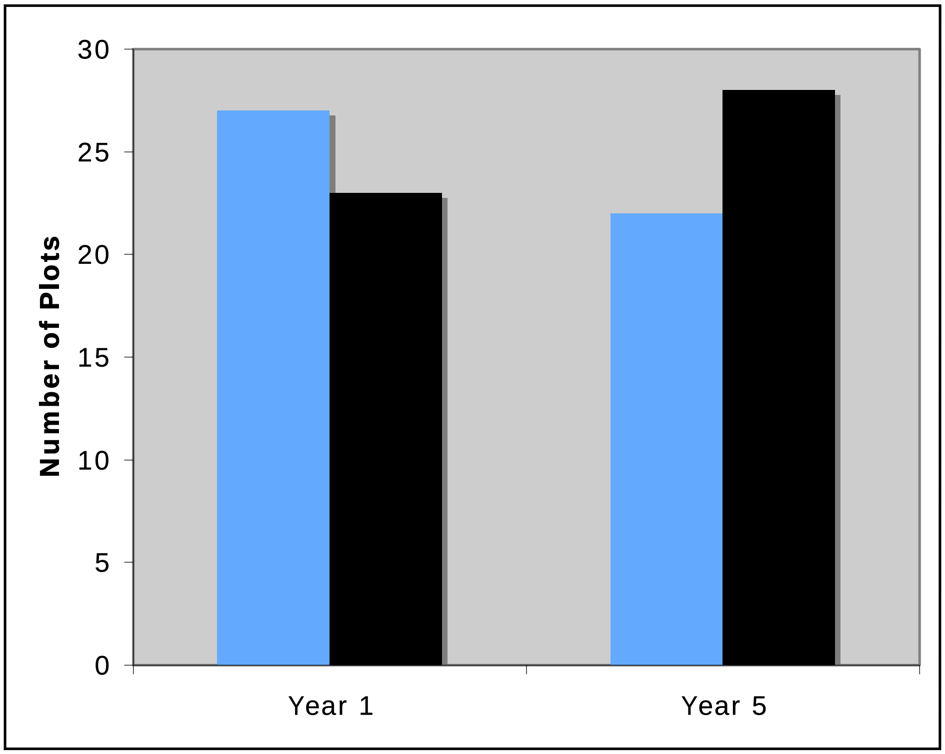

Figure 3. Number of plots (0.25 m^2) with high- (light bar) and low- (dark bar) stem density in fields abandoned for one year vs. five years.