Science Methods & Practice BES 301

January 18, 2011

Science Writing & Primary Research Papers

Science Writing Style:
Overall Goals of a Primary Research Paper

Science Writing Style:
The Structure of a Primary Research Paper

1. Abstract
2. Introduction
3. Site Description (optional)
4. Materials & Methods
5. Results
6. Discussion
7. Acknowledgments
8. Literature Cited
9. Illustrations

Science Writing Style:
The Goals of Primary Research Paper Sections

1. Abstract

- Brief summary of paper (< 150 words*)
- What is project & objectives (hypotheses)
- Most important results & conclusions / implications
- Usually the last thing to be written
- This section is very important

* Length is usually specified by the journal

Limits to the distributions of alpine tundra plants - herbivores and the alpine skypilot, *Polemonium viscosum*

Abstract

Plants of the alpine skypilot, *Polemonium viscosum*, occur from timberline to the highest ridgetops and summits of the Rocky Mountains, USA. To investigate the importance of herbivory in determining the lowermost boundary of the species' elevational range, I compared rates of inflorescence predation in high tundra versus lower krummholz habitats. Phloem-feeding by aphids and grazing by mammalian ungulates were both significantly more frequent in krummholz than tundra sub-populations. Grazed plants suffered complete loss of annual seed production in the current year and up to 80% loss of net seed production over a three-year interval. Plants showed no capacity to compensate for losses in reproductive capacity due to grazing. Alpine plants may be particularly vulnerable to risks of herbivory at and below timberline, because of their inability to allocate new meristems to flowering in a compensatory manner.

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Context

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Project & Objectives

Limits to the distributions of alpine tundra plants - herbivores and the alpine skypilot, *Polemonium viscosum*

Important Results (with specific information)

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Conclusions / Implications

Science Writing Style:
The Goals of Research Paper Sections

2. Introduction

Questions a reader will ask

- Why should I bother to read this?
- How does this fit into the larger body of knowledge in this area?
- Are you able to describe the context of your work with clarity?

- Nature of question(s) to be addressed
- Context, background & relevance: relationship to general field / theory (literature review)
- Justification for study
- Objectives & Hypotheses

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- Context, background & relevance: relationship to general field / theory (lit review)
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Introduction

One of the central objectives of population ecology is to explain the boundaries of species distributions. Perhaps nowhere has this task prompted more interest than at timberline, the boundary between subalpine forest and alpine tundra. Over the past two centuries, hundreds of studies have addressed why tundra, recognizable in large part by the absence of trees, exists (eg., Daubenmire 1954, Tranquellini 1979, Bliss 1985). In contrast, much less attention has been directed at the converse situation, the absence of many important tundra species from the surrounding subalpine vegetation. In the Rocky Mountains of western North America, biogeographic patterns suggest that for most tundra residents, subalpine vegetation represents an uninhabitable "ocean" (Hadley 1987). Moreover, for those species that do occur across the timberline transition, differentiation in phenology, growth form, reproductive capacity, and physiological traits between subalpine and alpine populations is the norm (e.g., Clausen et al. 1940, Grant and Hunter 1962, Rochow 1970, Pearcy and Ward 1972). These patterns imply that no all-purpose genotype can persist under the relatively warm, sheltered and crowded environments below timberline, and the physically more severe, exposed habitat of the alpine tundra. The few studies that have commented on factors impeding the lower extension of alpine plants agree that biotic risks such as predation, disease, and competition are probably of paramount importance (Dahl 1951, Griggs 1956, Rochow 1970). Yet the experiments and observations necessary to assess the operation of such factors at timberline are lacking. We need to determine whether negative effects of biotic interactions on plant survival and reproduction increase in importance as one approaches the lower boundaries of alpine species distributions. In this study I address one aspect of this question, herbivory, for the widespread alpine plant, *Polemonium viscosum*. By comparing incidence of herbivory between elevational sub-populations of one taxon, I can reduce the degree to which elevational differences in herbivore intensity are con-

- Question(s) & Hypotheses

founded with variation due to the palatability of more restricted timberline versus tundra plant species.

Polemonium viscosum is a common member of the Rocky Mountain flora. The species range extends from krummholz at the upper reaches of timberline to tundra on the highest ridges and peaks. Plants are long-lived herbaceous perennials which form compact clumps of shoots by rhizomatous growth. Seed production in *P. viscosum* requires animal-mediated outcross pollination (Galen and Kevan 1980). Individuals have 8–15 flowers per inflorescence and each flower typically sets 1–4 seeds (Galen 1985). Seed production in some seasons is significantly reduced due to ovary damage by nectar-thieving ants, and incidence of such damage increases near timberline (Galen 1983). Here, I extend studies of predation to include two forms of herbivory seen commonly in *P. viscosum*: aphid-mediated phloem feeding and infructescence grazing by mammalian ungulates. I address the following questions. (1) Does risk of aphid or ungulate attack increase near timberline? (2) What cost does grazing exact in long-term seed production? (3) Do individuals compensate for losses in reproductive capacity due to grazing?

Using related literature to provide context

- Studies do not have to be an exact replica of what you are interested in, to be relevant
- Be explicit about HOW a study relates to your question

Functional Influences of Cryptobiotic Surface Crusts in an Alpine Tundra Basin of the Olympic Mountains, Washington, U.S.A.

Abstract

Introduction

Citing Sources in the Text

Ideas, information, and examples must be attributed to sources they are taken from. We do this through citations in the text.

Attribution of specific information:

Adaptations to enhance the thermal microenvironment of reproductive parts have been documented in a few high arctic species (Kevan, 1972; 1975; Molgaard, 1989).

Attribution of general ideas / theory:

Successful reproduction and colonization is highly periodic in such a severe, variable environment (Bell and Bliss, 1980; Chapin, 1985).

Citations should be placed in immediate conjunction with the information they refer to (same sentence).

Citing Sources in the Text

How often does one need to cite a source?

- Citation should occur with initial use of material.
- Citation of that source need not be repeated **IF IT IS CLEAR** that the material comes from that source in subsequent sentences.

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Example 1

" Similar to our conclusion, Chapin et al. (1988) suggested that the influence of soil water content on the vascular plants is mediated through alterations in nutrient availability. In their case, high soil water contents were associated with lateral subsurface water flow, enhancing nutrient fluxes to the surface of plant roots."

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Example 2

"The timing of growth also varies because the optimal conditions for growth of these organs occur at different times, with the highest air temperatures and light intensities in late June and July while most of the soil is frozen solid (Chapin and Shaver, 1985). After it finally thaws, the soil may not freeze again until late September or October. This is a month or more after air temperatures go below freezing and aboveground growth stops.

[2 more sentences, then Chapin and Shaver (1985) is cited again at end of paragraph]

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Rule of thumb:

Citing Sources in the Text

Citation style

Parenthetical citations are preferred for brevity

Rather than:

Burke and others (1997) did a study in lowland old growth forests that showed large woody debris is important in providing sustained levels inorganic nitrogen to streams throughout the summer and winter months.

Use this:

Large woody debris in lowland old growth forests provide sustained levels of inorganic nitrogen to streams throughout the summer and winter months (Burke et al., 1997).

Parenthetical citation style places focus on message rather than source

Citing Sources in the Text

CSE Name / Date Style

In text (last names only):

Arthropods are more common in lush herb meadows than fellfields (Jones and Smith, 1988).

In Literature Cited section:

Jones, M.A. and H.G. Smith. 1988. Arthropod density in alpine communities. Ecology 67: 233-238.

Citing Sources in the Text

CSE Name / Date Style

In text (last names only):

ONE AUTHOR:

Low temperatures were shown to limit reproduction in marmots in the Rocky Mountains (Allen, 1998).

TWO AUTHORS:

Log decomposition greatly accelerated soil development in a lowland old growth forest of southwestern Oregon (Barnes and Lask, 1995).

> 2 AUTHORS:

Human trampling is most evident in stressful ecosystems (Poldt et al., 1998).

In Literature Cited section (all names included):

Poldt, M.A., S.B. Martin, and H.G. Smith. 1998. Recreational trampling and ecosystem stress. Ecology 97: 133-138.

Science Writing Style: The Goals of Research Paper Sections

3. Site Description *

- **Necessary only if relevant**

  Details necessary to interpret study and its relationship to the larger body of scientific knowledge
- **Location**
- **Site Characteristics**
- **Why this site?**

** not applicable to all studies; sometimes included in methods*

Science Writing Style: The Goals of Research Paper Sections

4. Materials & Methods

- **Materials used and methods employed**
- **Enough detail so procedure can be duplicated**
- **Enough technical detail to allow independent interpretation of results**
- **Standard procedures omitted or referenced**
  - ✓ e.g., how a thermometer works
- **Experimental design & statistical methods often included**

Science Writing Style: The Goals of Research Paper Sections

5. Results (the "news" section) ***

* Sometimes combined with Discussion

Science Writing Style: The Goals of Research Paper Sections

6. Discussion (the "editorial" section)

- **Authors' interpretation & critical analysis of results**
  Why is this usually kept separate from the 'results"?
- **Comparison to other studies & theory**
  - ✓ Where does this fit in?
  - ✓ What are the larger implications (if any) and overall significance of the study?
- **Modeling applications used for further analysis**
- **Potential errors**
- **Directions for the future**

Science Writing Style: The Goals of Research Paper Sections

7. Acknowledgements

- **Individuals that contributed significantly in a direct way to research**
  - ✓ Intellectual contributions
  - ✓ Methodological / analysis contributions
  - ✓ Review contributions

  It is not always easy to determine who should be an author vs. being acknowledged
- **Supporting institutions**
  - ✓ Funding agencies
  - ✓ Agencies granting permission to use land / equipment

Science Writing Style: The Goals of Research Paper Sections

8. Literature Cited

- **List only sources cited in text** (not a general source list)
- **Exact format required**
  - ✓ This is a headache: no uniform style accepted – journal specific
  - ✓ CSE Name/Date Style format acceptable for class
- **Clarity and sufficiency for others to find source**
  - ✓ True for any citation
  - ✓ Time sensitive sources must have a date accessed (e.g., web sites)
- **Remember NOT to include web link information for what are truly print articles – even if you access them online!!!**

Science Writing Style: The Goals of Research Paper Sections

8. Literature Cited

Example of CSE name-date style citation of a journal article

One author:

Ayala, F. 1971. Competition between species: frequency dependence. Science 171: 820-824.

1. **Author: last name and initials**
2. **Year of publication**
3. **Title of article**
4. **Journal name (do NOT abbreviate)**
5. **Volume**
6. **Pages**

Use hanging paragraph format for ease of reading

Science Writing Style: The Goals of Research Paper Sections

9. Illustrations

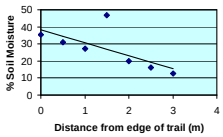
2 Primary Types of Illustrations

TABLES

	Gullies	Ridges
# Trees / m^2	0.06	0.90
# Avalanches / year	4.2	0.3

Site 1	Site 2
Phleum alpinum	*Potentilla fruticosa*
Draba corymbosa	*Salix arctica*
Tsuga mertensiana	*Abies lasiocarpa*

FIGURES (graphs, maps & photos)



Science Writing Style: The Goals of Research Paper Sections

9. Illustrations

- **Tables, Figures (graphs & photographs / drawings / maps)**