

## SCIENTIFIC WRITING

### DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ECOLOGY

The purpose of a scientific paper is to describe and document an observational or experimental study. A scientific paper is typically divided into seven sections: Title Page, Abstract, Introduction, Methods, Results, Discussion, and Literature Cited. The **Abstract** is a short summary of the paper. The **Introduction** explains the background and significance of the problem being investigated and states any hypotheses being tested. The **Methods** describes study sites, equipment/materials and field, lab, and statistical procedures used in the study. The **Results** clearly and succinctly presents data, observations, and the outcome of any statistical tests. The **Discussion** elaborates on the significance of your findings, including supporting or not supporting hypotheses, and how your findings relate with previous studies. Literature referenced in the Introduction, Methods, and Discussion is listed in the **Literature Cited**. **Tables** and **Figures** are used to illustrate important results and are placed after the literature cited. Tables and Figures must be properly captioned and complement, not duplicate, the text. Both the text and Tables/Figures should stand alone as independent and complete stories. More detailed descriptions of each section of the scientific paper are given below. Set off the Abstract, Introduction, Methods, Results, Discussion, Literature Cited, and Tables and Figures sections with the appropriate heading centered on the sheet. Title pages do not need a section heading.

The general format described below will serve as a guideline for students preparing scientific research reports for classes in Environmental Science and Ecology (ENVE). Instructors may choose to modify their writing assignments based upon learning objectives. *However, please*

*note that the format described below should be used for all scientific research reports prepared by students in Environmental Science and Ecology classes, unless otherwise instructed. An example of a good scientific report, and a checklist that can be used as you are writing your paper are found at the Department of Environmental Science and Ecology website:*

<http://www.brockport.edu/envsci/writing.html>.

### **Title**

Include title, author(s), course number, and date centered at the top of the first page. Titles should be written sentence style. Some instructors may ask that your name not be included on the title page, but instead be written on the back of the last page.

### **Abstract**

The Abstract is placed on the first page, immediately after the title. The Abstract briefly summarizes the purpose of the study, methods, major results, and conclusions. The Abstract is written after the rest of the paper, and should be in the past tense. A good Abstract should be specific enough to give the reader a sense of how and why the study was done, the major results, and what the “take home” message was. Abstracts generally should be no more than 250 words long. For some assignments, an Abstract may not be required.

### **Introduction**

The Introduction provides the justification and purpose of the study, and states all questions and hypotheses examined. The Introduction should begin with a short review of background information necessary to understand the significance of the problem being investigated. Relevant scientific literature often will be cited in this part of the Introduction. All literature should be cited using the format of the journal *Ecology*; examples are in the Literature Cited section below. The last paragraph of the Introduction should describe the major objectives and state the hypotheses of the study, if any. A one sentence description of the general methods may help clarify the nature of the study. Objectives are the goals of the study, and should be as clear and precise as possible, while hypotheses are testable statements that can be falsified.

### **Methods**

The Methods section should briefly describe the procedures employed in the study, and should have enough detail so that a similarly trained scientist could duplicate and verify your work. Information from this section may come from a combination of your own experience and information from the lab handout, but make sure that it is written in your own words. Methods should be written in paragraph form at a similar level of detail that you found in the scientific articles cited in your report.

The Methods section should begin with a brief (one sentence) description of where and when the study was conducted. Location should include specific locality, county and state, such as: The College at Brockport woodlot, Monroe County, New York. Date should be given in the following format: 24 September 2015. For field studies, include a brief description of the habitat

and weather conditions. Be sure to identify important equipment and materials used in the study and how they were used. However, do not include a list of all materials and equipment used in the project. The final section of the Methods should include a brief description of how you analyzed the data (for example, calculating means and standard deviations) and any statistical tests you performed on the data.

## Results

The Results section usually includes: (1) one or more paragraphs of text and (2) a narrative that highlights the significance of one or more figures (graphs or illustrations) and/or tables that present important data or observations. Tables and figures should follow the Literature Cited section and are not integrated into the text of the results – see the description of this section below. Number tables and figures sequentially, and refer to them within the paragraph describing your results by using the following format: (Figure 1) or (Table 1). Tables and figures are referenced in the narrative text by stating a fact about the data shown [e.g., The mass of ENVE students increases daily (Table 1; Figure 1)]. Any data or observations you plan to discuss must be included in the Results section. State all findings in a concise and complete way, but *do not* include raw data, or attempt to interpret your findings.

If you have performed a statistical analysis, include this in the Results section paired with descriptions of the data you tested. Report all statistics in the following format: (symbol for test statistic = value, degrees of freedom, probability). For example: The *Rosa multiflora* bushes on

the edge of the forest were significantly taller than those in the forest interior ( $t = 3.451$ ,  $P = 0.0023$ ).

## **Discussion**

The Discussion section is where you evaluate the results of your study, based upon what is known or logically expected and speculate on the relevance and implications of your findings. Integrate your results with existing knowledge (i.e., cite relevant references). The discussion should include formal conclusions regarding your hypothesis. State your support or lack of support for each hypothesis. Never use the word 'prove' regarding a hypothesis. If your data differ from what might be expected given your hypotheses, provide some possible reasons.

The discussion is also where you point out assumptions and limitations associated with your study and, if appropriate, make suggestions for future work.

Note: The Discussion is a major section of your report and should be well thought out.

Analyzing the significance of data from figures and tables, and results of statistical tests, will be particularly important as you write the Discussion. In certain situations, such as short papers or simple studies, it may be desirable to combine the Results and Discussion into one section.

Dialogue with your partner, other teams, and the instructor will greatly facilitate development of a good discussion.

## Literature Cited

All literature cited in the laboratory report must be clearly and accurately referenced, in the format used by *Ecology*, unless instructed otherwise. List citations in alphabetical order, and include *only* those works cited in your paper. In the text of the paper, cite the references using the author's name and year. References with the same first author and date should be coded by letters, e.g. (Thompson *et al.* 1991 a, b). References should be listed in chronological order in the text and separated by a semi-colon, e.g. (Zimmerman *et al.* 1986; Able *et al.* 1997).

### One author:

"Male Harris's Sparrows actively defend their breeding territories (Jones 1985)." Or:

"Jones (1985) documented the territorial behavior of male Harris's Sparrows."

### Two authors:

"Male Harris's Sparrows actively defend their breeding territories (Jones and Smith 1985)."

### More than two authors:

"Male Harris's Sparrows actively defend their breeding territories (Jones *et al.* 1985)."

### Two or more separate works:

"Male Harris's Sparrows actively defend their breeding territories (Jones *et al.* 1985, Smith 1995)." Note that the more recent paper is given last.

Examples of the correct format (with special attention to capitalization, which is sentence style, punctuation, and spacing) for use in the Literature Cited section are as follows:

### Journal article

Author(s). year published. Title. Journal Name Volume:pages.

Buttner, J. K., J. C. Makarewicz, and T. W. Lewis. 1995. Concentration of selected priority organic contaminants in fish maintained on formulated diets in Lake Ontario waters. *Progressive Fish-Culturist* 57:141-146.

**Book**

Author(s). year published. Title. Edition (if applicable). Publisher, City, State, Country.

Merritt, R. W., and K. W. Cummins. 1996. An introduction to the aquatic insects of North America. Third Edition. Kendall/Hunt Publishing Company, Dubuque, Iowa, USA.

**Chapter in book**

Author(s). year published. Chapter title. Pages *in* Name of Editor(s), editor(s). Book title. Publisher, City, State, Country.

Nickum, J. G. 1993. Walleye. Pages 115-126 *in* R. R. Stickney, editor. Culture of non-salmonid freshwater fishes. CRC Press, Boca Raton, Florida, USA.

**Edited book**

Editor(s), editors. year published. Title. Publisher, City, State, Country.

Batzer, D. P., and R. R. Sharitz, editors. 2006. Ecology of freshwater and estuarine wetlands. University of California Press, Berkeley, California, USA.

**Thesis or Dissertation**

Author. year completed. Title. Institution, City, State, Country.

Meeker, J. E. 1993. The ecology of wild rice (*Zizania palustris* var. *palustris*) in the Kakagon Sloughs, a riverine wetland on Lake Superior. Ph.D. Dissertation. University of Wisconsin, Madison, Wisconsin, USA.

**Agency Report**

Author(s). year published. Title. Report series and number, Agency name, City, State, Country.

Wilcox, D. A., T. A. Thompson, R. K. Booth, and J. R. Nicholas. 2007. Lake-level variability and water availability in the Great Lakes. Circular 1311, U.S. Geological Survey, Reston, Virginia, USA.

**World Wide Web sources**

These should be used sparingly, and only with the Major Advisor's approval. Many web sites are scientifically suspect. In addition, use only those sites that are more or less permanent, although this may be difficult to determine.

Author(s). Year. Title, version. [Online.] Organization, City, State. Available at: web address. Access date.

Sauer, J. R., G. Gough, I. Thomas, and B. Peterjohn. 1997. The North American Breeding Bird Survey, version 96.1. [Online.] Pautuxent Wildlife Research Center, Laurel, Maryland. Available at <http://www.mbr.nbs.gov/bbs/bbs.html>. Accessed 17 August 1999.

Note: Information obtained by verbal correspondence or from unpublished material is not considered "literature," but may be referenced as (personal communication, individual, affiliation):

Aardvarks are not capable of insight learning (personal communication, Dr. Jane Doe, Department of Environmental Science and Biology, The College at Brockport – State University of New York.

### Tables and Figures

All tables and figures must have captions clearly describing their content. Table captions are presented above the table while Figure captions are presented below the figure. Tables and figures also must include units [e.g., mass (g)], while figures must have clearly labeled axes. Figures should be grey-scale and not made with colors so that the reader can tell differences between categories when printed on a black-and-white printer. See the examples below for details. Do not forget, each table and figure must have accompanying text explaining its significance in the results section

Table 1. Nest site and nest patch characteristics (mean  $\pm$  1 SD) for Australian Pipits, Kosciuszko National Park, NSW, 2000-2001. Sample sizes for unsuccessful and successful nests are given in parentheses.

Variable	Successful	Unsuccessful	Test statistic	P
Shrub height (cm)	20.7 $\pm$ 4.8 (20)	18.8 $\pm$ 5.8 (17)	$t_{31} = 1.09$	0.283
Distance to edge of shrub (cm)	152 $\pm$ 165 (20)	79.5 $\pm$ 91.6 (17)	$t_{30} = 1.69$	0.101
% shrub cover, 1 m	91.4 $\pm$ 4.3 (18)	74.2 $\pm$ 15.5 (16)	$t_{21} = 2.09$	0.048
% shrub cover, 10 m	74.8 $\pm$ 4.2 (18)	57.6 $\pm$ 9.9 (16)	$t_{25} = 1.96$	0.062
Orientation ( $^{\circ}$ )	37.5 $\pm$ 30.8 (18)	84.2 $\pm$ 52.8 (16)	$F_{1, 32} = 4.429$	0.045



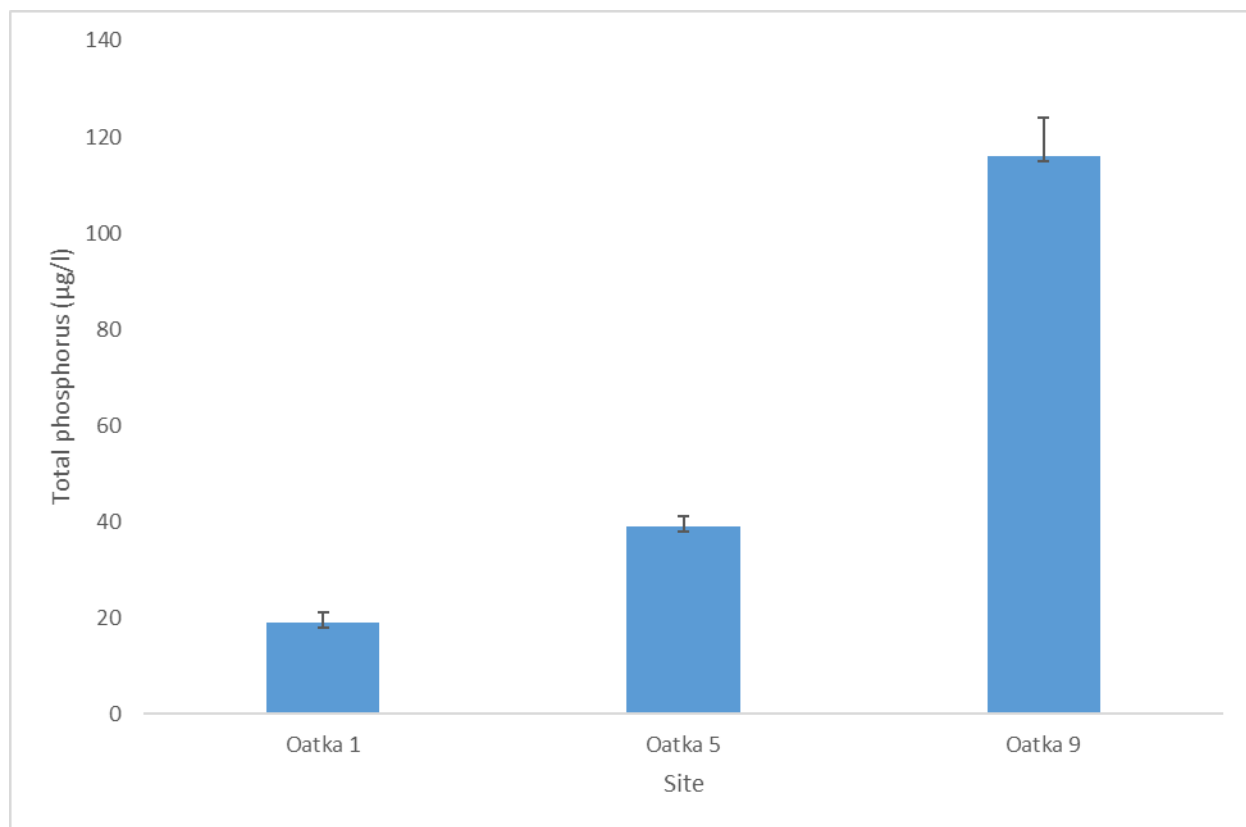


Figure 1. Mean total phosphorus concentrations ( $\mu\text{g/l}$ ) from three sites on Oatka Creek, Wyoming and Genesee Counties, NY on 23 September 2003. Error bars indicate standard deviation.

### Format of the ENVE Scientific Paper:

1. Remember that this is a scientific report and not an extensive term paper, don't exceed page limitations, if given.
2. Because the laboratory report relates work previously done, it should be written totally in the past tense (e.g., we measured, temperature was recorded, collected data indicate).
3. Because we desire to read your original thoughts, avoid quotations.
4. Be concise and precise; use complete, grammatically correct sentences.
5. Footnotes are inappropriate and should be avoided.
6. Use a word processor and double-space the text. Text can be written on both sides of the paper. Staple together all pages in the upper left. Use a font size of 12, with 1" margins on the left and right. Number all pages in the upper right hand corner, or bottom center.
7. The scientific name (binomial) *must* be used the first time any organism is mentioned in the paper; common names can then be used by themselves. Because scientific names are in Latin, they should be either underlined or in italics, as in: We studied Harris's Sparrows (*Zonotrichia querula*) near Lawrence, Kansas.
8. Always use metric units and their abbreviations! Some of the more common ones are:
 

km = kilometers	s = seconds
m = meters	min = minutes
cm = centimeter	h = hours
ha = hectares	d = days
l = liters	kg = kilograms
ml = milliliters	g = grams
	mg = milligrams
9. Use the following rules when reporting numbers. When reporting counts (number of items), write out numbers < 11 (one aardvark, nine eggs, etc). Numbers > 10 should be in numerals (11 newts, 30 wombats, etc). When reporting measurements with units (days, meters, liters, seconds, kilograms, etc), always use numerals, as in 1.0 m, 5 ha, 3 s, etc. The only exception to the above rule is that you cannot use a numeral when starting a sentence.
10. Plagiarism is unacceptable, and grounds for failure. Plagiarism can be the blatant copying at length from another work or the failure to give credit for information obtained through reading an article. When in doubt, reference the source according to the following practices: Buttner *et al.* (1996) found... or yellow perch survived and grew (Buttner *et al.* 1996).
11. Try to write using the active, rather than the passive, voice. Examples are given below.
 

Passive voice: Numbats were studied near Perth, Western Australia.

Active voice (preferred): We studied numbats near Perth, Western Australia.
12. Grades will be based on following the guidelines above, quality of results and clarity of presentation, discussion, conclusions, organization, grammar, neatness, and spelling.

## SCIENTIFIC PAPER CHECKLIST, ENVIRONMENTAL SCIENCE AND ECOLOGY

The checklist below should help you write a good, complete, and properly formatted scientific paper for your Environmental Science and Ecology classes. Go through the checklist before you write, and after your first draft is complete!

### I. Abstract: Does the Abstract summarize the following points:

- Question being investigated?
- Methods?
- Major results?
- Conclusions?
- Is the Abstract concise?

### II. Introduction: Does the Introduction:

- Provide an adequate, broad background through reference to other studies?
- Introduce the topic in a straightforward way?
- Present the rationale for the experiment/project?
- Give major hypotheses?

### III. Methods: Does the Materials and Methods:

- Accurately describe the methods in a manner that could be repeated by someone not familiar with the project?
- Present the methods in a **concise** way?
- Give relevant information on date, location, and habitat (if necessary)?
- Briefly describe the experimental design, data analysis, and any statistical tests used?

### IV. Results: Does the Results section:

- Have an adequate text describing the results of the experiment/project?
- Present the results of all statistical analyses in a clear way and interpret them correctly?

### V. Discussion: Does the Discussion:

- Summarize in a **concise** way results of the experiment or project and relate them to other research?
- Provide sufficient citations for a context in which to evaluate results of the project?
- State support or lack of support for each hypothesis set out in the introduction
- Draw appropriate conclusions?

### VI. Literature Cited: Does the Literature Cited:

- Cite works in the format of *Ecology*?
- List all references cited in the text, in alphabetical order by last name of the first author?
- Are references cited properly in the body of the paper? (e.g., Smith *et al.* 2003)?

### VII. Tables and Figures: Does the Tables and Figures section:

- Present only necessary figures and/or tables in the proper format?
- Are the tables and figures in numerical order, as presented in the text?
- Are the tables and figures placed after the literature cited section?
- Do all figures and tables have clear captions, with necessary units and any abbreviations defined?

### VIII. Overall:

- Is the paper clearly and logically written, with good grammar and spelling?
- Are all sections included?
- Is the paper in the correct format?
- Are metric units used throughout?