

Supplemental Material

CBE—Life Sciences Education

Ward *et al.*

APPENDIX I
Scientific Paper Writing Format and Scoring Rubric
*to be used with **Physiology and Community Ecology Papers***

Since BIOL 211 is a writing-intensive course, much emphasis is placed on producing polished, journal-style scientific papers. In the laboratory portion of this course, you will produce two journal-style scientific papers: one for the Transpiration Lab, and one for the multi-week Ecology Lab. Instructions are provided below, and you should discuss any further questions with your lab instructor.

Note that you are expected to **do all data analysis and writing independently**, without your lab partners or other persons. Ask your lab instructor if you have questions about this. Please be sure to paraphrase sources, including the lab manual and primary literature. ***Non-independent work or plagiarism of published work violates the UNCA Honor Code; such violation will result in you failing this assignment and/or the entire course.***

Use your McMillan *Writing in the Biological Sciences* (5th edition) book to help you as you complete this writing assignment. You might also find this website helpful: <http://classweb.gmu.edu/WAC/Biology/>

Each of your two paper assignments will be written using a format typically found in peer-reviewed scientific journals (often called “primary literature”). Your paper must include the following standard sections:

Title and Author (please read McMillan pp. 61 – 65 for detailed directions)

- Please save paper; do not use a separate title page!
- Use a title that is specific, descriptive, and succinct. Mention focal species by name. For example, include both the Latin and common name of the plant used in transpiration experiments within that paper’s title.

Abstract (please read McMillan pp. 65 – 68 for detailed directions)

- Abstracts should be only a single paragraph in length and should ***be less than 250 words***. DO NOT indent the Abstract.
- The paragraph should consist of 1 – 2 sentences from each section of the paper.
- ***Do not include citations, P values, or references to specific figures in this section.***
- Mention any species by both Latin AND common names the first time they appear in this section.

Introduction (please read McMillan pp. 69 – 70 for detailed directions)

- Mention any species by both Latin AND common names the first time they appear in this section.
- Be sure to explain why the study is important. What was the study’s impetus?
- Include background information, citing primary literature (journal articles) and your lab manual when appropriate. What is already known about this topic?
- Include your hypotheses.

Methods (please read McMillan pp. 71 – 76 for detailed directions)

- Do not write in list or bulleted form; use paragraphs.
- Do not list materials used. Instead, mention important materials or equipment within your experimental descriptions.
- Include site descriptions for field experiments (those done outdoors, like the Community Ecology lab).
- Use explicit descriptions and/or references so that a reader could replicate your experiment.
- Include explanations of statistical analyses (statistical programs used AND specific tests conducted). Assume that the reader knows that $P = 0.05$ is a standard statistical cut-off point, so do not mention this explicitly.

Results (please read McMillan pp. 76 – 81 for detailed directions)

- Summarize what you found. Do not interpret your findings (speculate about what they mean, explain how they are related to other data, etc.) in this section.
- Describe each table or figure in your writing, then refer to it by number. Tables and figures should be numbered in the order in which they appear within the *text* of your Results section. Use figures whenever possible.
- Statistical results do not need to be presented in tabular form. Instead, you can refer to P values within the text of your Results.

Discussion (please read McMillan pp. 81 – 85 for detailed directions)

- Interpret your results. What do they mean? Why are they important? What are the broader implications of this study?
- Do not refer to specific P values or figures in this section. Instead, just discuss trends in the data.
- Put your results in the context of other literature, using citations. Does this support or refute previous studies? The majority of your discussion should be devoted to discussing this and the previous bullet point.
- Discuss any weaknesses in the study. What errors were made? How else could the original study have been improved?
- What are the next steps in the study? What else should be explored?

Literature Cited (see McMillan Ch. 6, pp. 124 – 143 for information about documenting your sources in your paper and in the literature cited section)

- Use the style in McMillan (CSE style, name-year system, p. 139). Examples of correct references format:

(book)

Hemminga, M. and C. Duarte. 2008. *Seagrass Ecology*. Cambridge University Press: New York, NY. 298 pp.

in-text citation: Hemminga and Duarte 2008

(lab manual)

Horton, J. L., J. R. Ward, and H. D. Clarke. 2013. *Principles of Botany Laboratory Manual*. UNCA Press: Asheville, NC. 79 pp.

in-text citation: Horton et al. 2013 **note: this is not a primary resource**

(journal article)

Nicholas, J., D. Larson, and S. Huerd. 2011. Evidence of qualitative differences between soil-occupancy effects of invasive vs. native grassland plant species. *Invasive Plant Science & Management* 4(1) 11-21.

in-text citation: Nicholas et al. 2011

- Note that references must be both cited within the paper **and** be listed in the references section of at the paper's end. If you do not cite a paper, do not list it at the end.
- To receive full credit, you must include **at least** 4 primary literature (peer-reviewed journal) articles. At least one of these must be cited within the Discussion, to put your results into a broader scientific context. ***THESE CANNOT include papers cited within the lab manual.***

Tables and Figures (see McMillan Ch.3, pp. 39 – 60, and rubric, for examples of good figures, tables, and legends)

- Give each table or figure a number and a descriptive legend. The legend should be written BELOW each figure and ABOVE each table.
- ***Do not include titles within graphs.***
- These tables and figures should be included at the end of your paper after the literature cited.

Tips for Success (based on work done by previous years' students)

- Do *not* use quotes as you might in a paper for your literature course. Instead, you should paraphrase.
- Italicize all proper Latin names. Remember, the *Genus* (first word) of a scientific name is uppercase, while the *specific epithet* (second word) is lowercase. Ex: oriental bittersweet (*Celastrus orbiculatus*)
- Use the recommended citation format rather than the footnotes or numerical citations used in MLA style.
- Use first person voice. Active voice is appropriate to use in the primary biological literature.
- Be sure figures and tables have descriptive legends. Number these figures and tables *consecutively*, so that Figure 1 is the first referred to within the text. Figure captions go below figures, while table captions go above tables.
- Use spaces between numbers and their units.
- Be sure that each figure or table is referenced (parenthetically or otherwise) within the text. Be sure to capitalize “Figure” and “Table” when referring to specific figures and tables.
- Be sure that each reference listed at the end is referred to within the text.
- Watch for common grammatical errors, including:
 - using “data” as a singular word. this term is plural! ex: “These data showed that light had a stronger effect on transpiration than wind.”
 - confusing “affect” (a verb) and “effect” (a noun)
 - confusing “between” (comparing just 2 items) and “among” (comparing more than 2 items)
 - confusing “its” (possessive; belonging to it) and “it’s” (a contraction of “it is”. avoid using contractions in formal scientific writing!)
 - using inconsistent tense; most of the paper should be written in past tense, since it is already done. An exception is at the end of the Discussion, when you talk about next steps in the project.
- Use the checklist (McMillan, pp. 85 – 87) before submitting.

Scoring Rubric

The form below will be used to grade your scientific paper. Scores (percentage points) are listed in the top row of each graded item, and examples (or additional pieces of information) are listed in the second row below each graded item. Missing components will receive a score of “0” for that category.

Title and Abstract (5%)

1) Title is formal, specific to the questions addressed, and indicative of paper’s contents.

0	0.25	0.5	0.75	1
Plant Ecology Lab		Environment Influences Transpiration in Sunflower (<i>Helianthus</i>)		Effects of Light and Wind on Transpiration Rate in Sunflower (<i>Helianthus tuberosus</i>)

2) Abstract reviews main points from all sections (introduction, methods, results, discussion) of the paper.

1	1.5	2	2.5	3
Some sections of the paper are described briefly, but important information is missing. <i>ex:</i> The transpiration rate of a sunflower under low light/low wind (baseline), low light/high wind, high light/low wind, and high light/high wind was examined. Potometers were used to determine the volume of water transpired in a given time. Light affects transpiration rate more than wind.		Some sections are described briefly in clear, grammatical language, but one section of the paper is missing from the description. <i>ex:</i> In an investigation of environmental influence on plant transpiration, we subjected specimens of <i>Helianthus tuberosus</i> to four treatments involving wind and light. Data were used to calculate transpiration rates under the treatments, and the Statistical Analysis Program (SAS) was used to analyze data for trends and significance. ANOVA and Tukey-Kramer tests showed both wind and light exposure to significantly increase rates of transpiration, and these findings are useful in understanding plant population trends under the influences of climate change and degradation.		All sections of the paper are included and described with detail in clear, grammatical language. <i>ex:</i> Transpiration is the process by which plants lose water to the atmosphere; it is affected by light, wind, temperature, and relative humidity. This is a stress on a plant, yet it is also necessary for the plant’s survival. This study measured the rate of transpiration in <i>Helianthus tuberosus</i> shoots under four treatments: high light/high wind, high light/low wind, low light/high wind, and low light/low wind. Data were analyzed using SAS, ANOVA, and a Tukey post-hoc test. <i>H. tuberosus</i> had the highest transpiration rate under high light and high wind and the lowest mean transpiration rate under low light and low wind. Light and wind both affected transpiration, but when considered independently, light had a stronger effect on transpiration than wind. The results of this study may help understand the ways in which plants react to light and wind, which is useful in efficient crop management.

3) Abstract is succinct in both word count and sentence number.

1	1.5	2	2.5	3
Superfluous wording and more than 2 sentences from each section of the paper.		Either superfluous wording or >2 sentences per section of the paper.		Succinct wording, with ~2 sentences per section of the paper. See example above.

Introduction (20%)

4) Need for and purpose of the study (thesis) is stated clearly and is justified. (*Note: examples below are excerpts!*)

1	2	3	4	5
The study’s purpose is stated, but the need for the study is not described. <i>ex:</i> In this experiment, we looked at light and air currents (wind) to evaluate their effects on transpiration rates in <i>Helianthus tuberosus</i> shoots.		The need for and purpose of the study are described, but vague or general terms are used. <i>ex:</i> This research is significant because it will demonstrate how environmental factors can affect the net photosynthesis of plants, and because our planet’s climate is changing, we need to know how influential these environmental factors might be.		The need for and purpose of the study are clearly stated and described specifically. <i>ex:</i> Understanding how factors like wind and light affect transpiration may allow us to understand how change in climate – due to warming, deforestation, flooding, or desertification - will affect plant populations.

5) Adequate background information about theory and other, related studies is provided. (*Note: examples below are excerpts!*)

2	4	6	8	10
<p>Summary of background and related work lacks important theoretical discussion or reference to important studies.</p> <p><i>ex:</i> Light influences positive stomatal opening in many plants, while increased wind portends potentially increased access to carbon dioxide, a necessity for plant carbohydrate synthesis.</p>		<p>Background information about theory and other, related studies describes, <i>in part</i>, the scientific context of the research to be conducted.</p> <p><i>ex:</i> Wind speed helps increase the rate of transpiration by removing the boundary layer of moist air around the stomata (Eichhorn, Evert, and Raven 671). Light intensity can increase or decrease photosynthetic activity, which causes more stomata to open in order to meet CO₂ demands.</p>		<p>Background information about theory and other, related studies describes thoroughly the scientific context of research being conducted.</p> <p><i>ex:</i> Plants open their stomata in the light to allow for maximum CO₂ diffusion into the leaf for photosynthesis, while at the same time controlling water loss (Jones 1998). Wind speed affects the transpiration of single leaves (Bange 1953) due to the fact that wind blows moist air that collects on the surfaces of leaves, called the boundary layer, off of the leaves and keeps the air dry.</p>

6) Hypothesis is creative and is supported by introductory information. It is not stated merely as a null hypothesis.

1	2	3	4	5
<p>A null hypothesis is stated without reference to the information and logic that has led up to the hypothesis. Not creative.</p> <p><i>ex:</i> Light and wind will have no significant effect on sunflower transpiration.</p>		<p>The hypothesis is clearly stated in positive terms, but it is not logically supported or introduced. Somewhat creative.</p> <p><i>ex:</i> I recorded the transpiration rate under four different conditions, and I expected to find that light and wind would positively affect transpiration rates.</p>		<p>The hypothesis is logically introduced and clearly stated in positive (not null) terms. Very creative.</p> <p><i>ex:</i> Because previous studies have shown that transpiration increases under high light or windy conditions due to boundary layer changes, I expected that transpiration would increase under these conditions relative to the control. I hypothesized that maximum transpiration rates would be observed under the high wind treatments, since wind has more of an effect on transpiration.</p>

Materials/Methods (15%)

7) Methods, including any statistical analyses, could be replicated based on amount and quality of information given. Specific equipment and statistical programs are mentioned by name. Extraneous details are avoided. For instance, papers about shrubs do not include information about tree sampling.

2	4	6	8	10
<p>Methodological explanations are cursory, omitting significant pieces of information or steps in the data collection and analysis processes. Methods might be in list or bullet form, rather than written as paragraphs.</p>		<p>Most methods are explained well. Statistical analyses might be missing, or explanations might be inadequate to replicate all portions of the experiment with precision. Alternatively, extraneous details (brand names of glassware, times of day at which experiments were conducted) might be included.</p>		<p>Methods are detailed, accurate, and avoid extraneous detail.</p>

8) Appropriate statistical analyses are used. Variables are defined, and the specific statistical program used is mentioned.

0	0.5	1	1.5	2
<p>No statistics are presented.</p>	<p>Only summary statistics (mean, standard deviation, etc.) are presented.</p>	<p>Statistical test does not match data (ex: regression used to compare only 2 time points).</p>	<p>Test is not most appropriate for data (ex: t-test used to compare more than 2 categories of independent variable).</p>	<p>Statistical test is appropriate for data (ex: ANOVA used to compare 3 categories of independent variable).</p>

Results (25%)

9) Tables and figures can be examined individually and understood. Choice of tables vs. figures is appropriate, and there are no redundancies. Style of figures (graph type, variables graphed, etc.), is appropriate. Axes are labeled with both titles and units, when appropriate. Error bars are shown, if applicable. (Example of 15-point graph below).

3	6	8	10	12
Most tables or figures are not clear, or not appropriate, or not complete.		Some of the tables or figures are not clear, or not appropriate, or not complete. However, most are well-designed.		All criteria listed above are met or exceeded for all tables and figures.

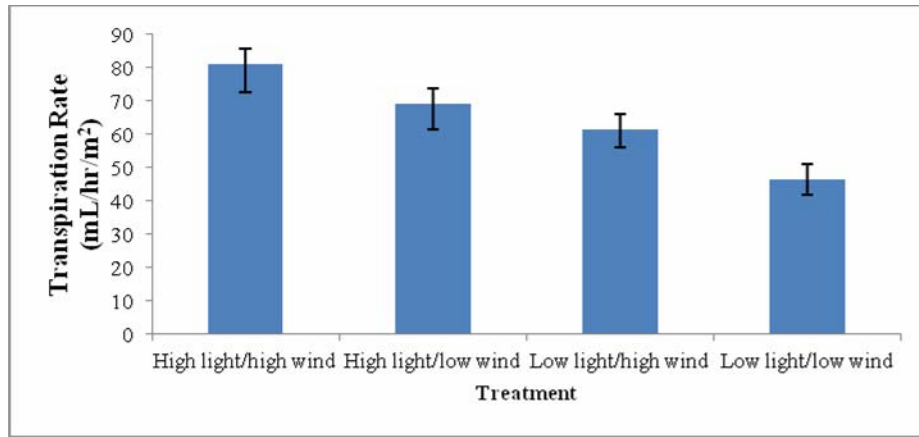


Figure 1. Mean (+/- 1 S.E.) transpiration rate for *H. tuberosus* under four environmental treatments.

10) Data are not interpreted in this section. Results are just stated, not explained.

0.5	1	1.5	2	3
Many results are interpreted.		Some results are interpreted.		No results are interpreted.

11) Figures and tables are described well within the text and in the legends.

1	2	3	4	5
Missing some legends or reference to figures/tables.		Most figures/tables have legends and are referred to (by number) within the text. Legends might include too much or not enough detail.		All figures/tables have descriptive legends and are referred to by number within the text. Detail within legend is appropriate.

12) Statistical results are interpreted correctly, focusing on significance / non-significance rather than just P values.

1	2	3	4	5
The P value of 0.042 showed that the effects of the independent variable were significant.		According to the 2-way ANOVA test, both light (P = 0.0128) and wind (P = 0.0176) had significant impacts on transpiration rates.		High light, high wind, and the combination of high light / high wind resulted in a significant increase in transpiration rates (ANOVA; P < 0.05 for all).

Discussion (20%)

13) Discussion focuses on meaning and broader implications of the data. It is *creative* in its interpretation of the results, making broad connections across disciplines and speculating about reasons for observed results (whether expected or not!). Sources of error are considered, and future experiments / next steps are outlined.

2	4	6	8	10
At least one of these components is missing, and some interpretations of data are inaccurate.		At least one of the above-listed components is missing.		None of the components listed above are missing.

14) Discussion is *well integrated* with the literature. It considers the main findings of the study and compares or contrasts them with other published studies. (*Note: examples below are excerpts!*)

2	4	6	8	10
References to primary literature are missing from the Discussion, or are cited incorrectly.		Discussion refers to the literature, but does not discuss the main findings of the study completely or does not refer to the most relevant published studies. <i>ex:</i> The statistical analyses of the data, showing that light and wind have an additive effect on the transpiration rate of <i>H. tuberosus</i> shoots, supported my initial hypothesis that transpiration rates would be the greatest with the high light and high wind treatment. This makes sense given that both light and air currents cause water loss under dry conditions (Raven 2005).		All criteria listed above are met. <i>ex:</i> The results of this experiment show that wind and light can both impact sunflower transpiration, but it is truly light that has the greatest impact. This conclusion is consistent with other studies (Oguntunde 2005, Chu 2009).

Citations and Style (15%)

15) Articles are relevant and appropriate selections from the primary scientific literature. At least 4 articles are cited at appropriate points and ways within the paper, putting the experimental choice or results into a broader context. Choices do NOT include articles cited in the manual, and all papers are ≤ 10 years old.

1	2	3	4	5
Fewer than 4 articles are cited, or articles are not from the primary scientific literature, or articles are too old.		4 primary literature articles are cited, within either the Introduction or the Discussion sections of the paper. However, the primary literature is not related closely to the paper's content, or it is cited in a way that does not support the paper, or it is too old.		More than 4 primary literature articles are cited, within either the Introduction or the Discussion sections of the paper. Primary literature is related closely to the paper's content and is cited in a way that supports the paper.

16) McMillan format is used throughout for style, citations, references list.

1	2	3	4	5
Many errors in in-text citations or reference lists.		A few errors in in-text citations or reference lists.		No errors in in-text citations or reference lists.

17) Grammar, spelling, syntax, and tone are correct, and are appropriate for a formal, journal-style scientific paper.

0	1	3	5	6
Many errors in grammar, spelling, syntax, and tone.		A few errors in grammar, spelling, syntax, and tone.		No errors in grammar, spelling, syntax, and tone.