Student Project Guide

ESF - The Global Environment

Name:
Acknowledgements

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# Appendices

A. Research Project Proposal Rubric  
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Overview of the Research Project

The goal of this project is to teach you how to apply a scientific approach to thinking about the world around you. This project is an opportunity for you to immerse yourself in a topic that you are passionate about. You will conduct independent research to try to answer the questions that come to mind when you think about that topic and then present your findings in a paper and oral presentation. This will involve creativity, critical thinking, a lot of reading, and a lot of bouncing ideas back and forth amongst you, your peers, and your teacher.

Here is a general overview of the research process:

1. Choose an environmental topic and identify the major issues, problems, or questions surrounding the topic. This will require that you do background research on the topic. Be creative! A broad range of topics have been researched in the past. See the list of previous research projects to get some ideas.

2. Formulate a research question and a hypothesis about your topic. The goal of your research will be to test this hypothesis.

3. If you will be using secondary data sources (e.g., from databases), conduct a preliminary data search to determine what data are readily available for your research.

4. Develop the research methods that you will use to test your hypothesis. Your methods could include some combination field measurements, surveys, questionnaires, online database analysis, and a review of primary literature publications. You will also need to select your ‘study area.’ Depending on your research topic, your study area could range in size and location, from the size of your school district, to New York State, or to the entire U.S.

5. Gather the data to test your hypothesis.

6. Conduct an analysis to determine whether or not your data support or reject your initial hypothesis.

Your final research project report will be written in the format of a scientific journal article. It will include the following sections: abstract, introduction, methods, results (with tables/figures), discussion, conclusion, acknowledgements, and literature cited.
Your global issue:

Team Contact Information:

Name:  
Phone:  
Email:

1.

2.

3.
Research Project Timeline

Throughout the semester, in addition to other class activities and assignments, you will be required to complete the following assignments. All assignments are held to the same requirements as other coursework. All but one assignment is to be completed as a group.

1. Hypothesis
   Your group will turn in a scientific hypothesis that you will be investigating for your project. The Hypothesis must be related to your group’s “issue” and be testable within the time restraints of the semester.
   Date Due: ______________

2. Background Report*
   You will prepare a 2 page research paper (double spaced). Providing all of the necessary background information on your topic using primary literature and written in a scientific format.
   Date Due: ______________

3. Project Proposal
   Your group will write a preliminary research proposal. The objective is to present a plan of action that describes how you will investigate your research question.
   Date Due: ______________

4. Final Paper
   Your final research project report will be written in the format of a scientific journal article. It will include the following sections: abstract, introduction, methods, results (with tables/figures), discussion, conclusion, acknowledgements, and literature cited.
   Rough Draft Due: ______________
   Final Date Due: ______________

5. Presentation
   Your group will be required to give a 10 min power point presentation at the end of the semester that will be presented at the end of the year symposium.
   Date Due: ______________

* Individual assignment (must be completed by every member of the group)
How to read a scientific paper

Adapted from Review of a scientific article in the field of plant science by Robin Kimmerer

"Primary literature" refers to scientific articles which report research results and are written by the scientists who conducted the research. Primary literature is always "peer-reviewed", meaning that other scientists reviewed, edited, and approved of the quality of the article before it was published. Such articles are published in scientific journals, rather than in magazines or books. Primary literature forms the foundation of a scientific discipline, and serves to keep scientists and students up to date in the new developments in their field. Reading this technical literature is also an excellent way to learn how to write scientific reports of your own, and re-reading is always necessary, as scientific articles are dense with information.

In primary literature, the same general format is used so that readers know where to go to quickly get the information they need. The format includes the following sections in the following order: Title, Abstract, Introduction, Methods, Results, Discussion, Acknowledgements, and Literature Cited. Each section always includes the same type of information, but, depending on the journal, the sections might be organized slightly differently.

Here are some questions to guide your reading:

1. **Who wrote the article? With which institution(s) are the authors affiliated?** In addition to simply identifying the authors by name, it is useful to note the names of their departments and their home institutions. This allows you to differentiate between research at independent universities and research affiliated with government or industry. This information can give you clues as to the perspectives of the authors. If possible, look up other papers published by the same author. This can provide insight into the background and experience of the authors.

2. **What is the publication date?** In rapidly changing fields of science, it is important to know how this paper fits into the development of ideas over time.

3. **In what scientific journal is the paper published?** Is this paper a peer-reviewed scientific journal? Proceedings from a conference? A government research report? Does the journal have a general focus (e.g. *Science*) or a specific focus (e.g. *Plant Ecology*)?

4. **What is the goal of the paper?** Scientific papers are written with a variety of goals, most often to report the findings of a particular investigation and therefore advance our knowledge of the natural world. Papers may also have the goal of summarizing our current knowledge and formulating new generalizations, and such papers are termed "review papers." Alternatively, a paper may have the stated goal of resolving a controversy, proposing a new theory, or drawing attention to a phenomenon which requires the attention of scientists. The goal of a scientific paper is frequently found in the Introduction section; however, it may not be explicitly stated, leaving the reader to determine the authors' intent.

5. **What are the specific objectives of the paper?** The research objectives are usually stated in the Introduction, and they may be listed as hypotheses or predictions.
How to read a scientific paper

6. What is the conceptual framework into which this research fits? The authors should describe the current level of understanding of the research topic and explain how his/her study fits into this topic. This is accomplished by reviewing the past works of other scientists and then identifying the need for the current study. You will find this information in the Introduction and Discussion sections.

7. What methods are used to meet the stated objectives? A scientific paper must report the methods and materials used in sufficient detail to permit replication of the experiments. This level of details often makes for very difficult reading unless the reader is familiar with the field. These details are essential for critical evaluation of the work by other scientists, because the validity of the conclusions depends on the exact nature of the experiments performed. When you are reading a paper, it is often sufficient to understand the methods in a more general way, rather than the procedural details.

8. What are the major findings of the investigation? The results of the study are explicitly stated in the Results section and are usually accompanied by figures and tables. The highlights of each figure and table will also be presented in the narrative portion of the text. Each of the objectives presented in the Introduction should be addressed in the Results section. Are the hypotheses which were stated in the Introduction supported or disproved?

9. Are the stated conclusions supported by the data? Carefully check the results and evaluate for yourself whether or not the conclusions are justified. Note possible sources of error in the methods, the data analysis, or interpretation.

10. How do the results relate to the published findings of other authors? The authors should explain whether their findings agree or disagree with similar research in the field. Does this study resolve a conflict, or create a difference of opinion?

11. What future research directions are suggested as a result of this investigation?

12. Evaluate the clarity of writing. The dense, concise style of technical writing is very different from other forms of composition. It is a highly efficient means of conveying complex information, but is often difficult to read.

13. How was the research funded? The Acknowledgements section will list all sources of funding for the research.

14. Have the authors drawn upon all the appropriate references? The Literature Cited section, which concludes the paper, lists the details of the sources which were consulted (and cited) for this investigation.
How to Find Primary Scientific Literature Online

Locating primary, peer-reviewed literature is a critical step in the research process; however, searching for useful articles can take some practice. Here are several ways you can locate and download primary literature:

**Google Scholar (http://scholar.google.com)**
- Enter key words related to your topic, and the search engine will find relevant primary literature references.
- **IMPORTANT**: Google Scholar will usually provide you with only a link to the reference and **NOT** a link to the actual article. This is because many professional journals require a subscription in order to view and download their articles.

**Open Source Journals**
- Open source journals do not charge readers to access its content. You may search, view, print and save articles for no cost or subscription.
- Examples include: Applied Ecology and Environmental Research, Boreal Environment Research, Ecology and Society, Urban Habitats, Atmospheric Chemistry and Physics, American Journal of Environmental Sciences, Hydrology and Earth System Sciences, Natural Hazards and Earth System Sciences, and many more (over 2000 peer-reviewed journals available).
- Beware, some journals may not be peer-reviewed.

**Websites to Locate Open Source Journals:**
- Open J-Gate: http://www.openj-gate.com
- Directory of Open Access Journals: http://www.doaj.org
- BioMed Central: http://www.biomedcentral.com
- Scitopia: http://www.scitopia.org/scitopia
- Scirus: http://scirus.com

**Search Tips:**
- Try searching for the article directly in Google. Click on advanced search – select file format PDF. You might find that the PDF article is available directly from the author or other sources.
- If you can’t find any articles immediately, try different combinations of key words.
- Skim the abstract of an article first to decide whether it is relevant to your research.
- Find one really good paper and then look for more articles in the works cited page – these papers are more likely to be well written and well reviewed. You can also search for other papers published by the same authors since they will likely be writing on related topics.

Check with your local library to see if they have access to the content of some journals. They may also have archived and/or current print copies of popular journals.
Types of Research Projects

As you begin the challenging process of developing your research project, you will have to decide the type of research you would like to conduct. Would you prefer sampling invertebrates in a stream, conducting interviews in a shopping mall, or studying plant growth in a laboratory? The type of research that you select will depend on your research question; however, it is possible that you will use a combination of different types of research in your investigation.

I. Primary research
Investigate your research question by collecting new data from the field or the laboratory.

Local Field Research: Collect primary data to answer your research question by conducting fieldwork outside of the classroom. This type of research requires that you go to the location you are researching and collect data by recording observations, collecting samples, distributing surveys, or conducting interviews.

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observational</strong></td>
</tr>
<tr>
<td>* What species of soil invertebrates do you find in different types of soil?</td>
</tr>
<tr>
<td>* How does the water chemistry of a stream vary along a rural to urban gradient?</td>
</tr>
<tr>
<td>* What birds over-winter in this area and what types of food do these birds prefer?</td>
</tr>
<tr>
<td><strong>Survey/Interview</strong></td>
</tr>
<tr>
<td>* Examine local farm land use practices. Work closely with a farmer to analyze his/her practices and devise a plan to implement more sustainable practices.</td>
</tr>
<tr>
<td>* Survey 100 people in town/city of various age ranges. Calculate an average “ecological footprint” for a certain group of people (<a href="http://www.myfootprint.org">www.myfootprint.org</a>).</td>
</tr>
<tr>
<td><strong>Resource analysis</strong></td>
</tr>
<tr>
<td>* Do an energy audit of your school/home and identify ways to reduce energy consumption.</td>
</tr>
<tr>
<td>* Analyze the composition and quantity of the high school waste stream. Identify ways to reduce the quantity of garbage.</td>
</tr>
</tbody>
</table>

Laboratory Research: Collect primary data to answer your research question by conducting experimental research in the classroom laboratory. This type of research is considered a true experiment if subjects are randomly assigned to treatment and control groups to investigate a cause and effect relationship.

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observational (behavior)</strong></td>
</tr>
<tr>
<td>* Record the preferences of a species toward different environmental conditions.</td>
</tr>
<tr>
<td><strong>Experimental</strong></td>
</tr>
<tr>
<td>* Assess the effect of environmental factors (temperature, pH, moisture, light, direction, etc.) on above and belowground grass growth over time by sub-sampling plant biomass from grass samples grown indoors.</td>
</tr>
<tr>
<td>* Identify the impact of allelopathic plants on the growth of other plants.</td>
</tr>
</tbody>
</table>
II. Secondary research
Investigate your research question using data that was previously collected by an outside source. For this type of research, also known as data mining, you gather secondary data from online databases, publications, or experts. This allows you to examine changes in space and time over a larger scale than if you were to collect the data yourself. You can also download digital maps (e.g., soil types or demographic data) to use in geographical information systems (GIS).

**Examples**

**Database Research**
- Identify whether there is a relation between sea surface temperatures in the Gulf of Mexico and hurricane frequency and intensity.
- Examine trends over time and correlations between economic development indicators and deforestation in Indonesia.
- Determine if there is a relation between cereal production and fertilizer consumption over time in the U.S.

**GIS Research**
- Conduct a spatial analysis of a town to identify the areas suitable for wind mills.
- Use soil maps to identify areas suitable for a specific plant species.
- Examine the changes in different land uses in a watershed over time.

III. Environmental Action Plans
Analyze a previously developed environmental action plan or develop a new plan. Collect data on the outcomes of the current program, or similar programs, on potential financial/material limitations, on stakeholder concerns, and on other factors that limit the implementation of an environmental action plan.

**Examples**

**Assess and improve upon a previously developed plan**
- Assess a recycling initiative in the High School or throughout the district. Measuring the success of the plan by the amount of materials recycled.
- Examine the types of chemicals/cleaning supplies used by the school district, and work with school employees to research the availability and use of “cleaner” chemicals. Analyze the cost efficiency of the newer products.

**Develop a new environmental action plan**
- Initiate a town-wide campaign to promote/stop the use of/ make people aware of some environmental issue.
- Implement a “Green Schools” plan for your school with the goal of reducing energy consumption (www.greenschools.org).
- Research and implement a community garden by working with community members to determine the best location, researching the types of plants required, applying for necessary permits, and then begin planting the garden.
- Develop an interpretative nature trail for the school and surrounding areas, including posters and pamphlets for your trail.
Writing Scientific Hypotheses

What is a hypothesis?
A testable statement that proposes a possible explanation to some phenomenon or event.
A testable statement of a specific relationship between or among variables.

Testable means that you can perform a test (e.g., experiment) to show how the variables might be related. The results of the test will determine whether you “reject” or “fail to reject” your hypothesis.

The null hypothesis states that there is no relationship between the variables being tested.
The alternative hypothesis is the opposite of the null hypothesis; it states that there is a significant relationship between the variables being tested.

How to write a formalized hypothesis

1. Identify the independent and dependent variables that you are testing. The independent variable is the variable that you, the "scientist" control and the dependent variable is the one that you observe and/or measure the results. The dependent variable will change in response to changes in the independent variable.

   For example, if I’m interested in the effect of energy consumption on economic growth, then energy consumption is the independent variable and economic growth is the dependent variable.

2. Hypothesize how the two variables are related.

   For example, you might hypothesize that as energy consumption increases economic growth will increase. This is a positive relationship. If, on the other hand, you hypothesize that increases in energy consumption will lead to decreases in economic growth, this is a negative relationship.

3. Write your hypothesis using an IF/THEN statement.

   IF <insert dependent variable> IS <describe relation> RELATED TO <insert independent variable>
   THEN <insert the hypothesized relation between the variables>

   Using the example of the positive relation between energy consumption and economic growth, you would hypothesize the following:
   IF economic growth IS positively RELATED TO energy consumption, THEN as energy consumption increases, economic growth will increase

Caution! An IF/THEN statement is only a testable hypothesis if you describe the relation between the variables

Source: http://www.accessexcellence.org/LC/TL/filson/writhypo.php
Common Mistakes

- DO NOT make a statement you cannot back up
  - “people refuse to change…”
  - “thousands upon thousands..”
  - “The most important..”
- NOT a summary of the articles that you found
  - You are to sound like the expert, state the facts, then cite
- Cite any statements
  - (Smith 2004)
  - (1)
- Do NOT say:
  - “In a Journal I found…..”
  - “You can see....”
  - “Scientists say…”
  - “each and every one of us…”
- Affect (v) vs. effect (n)
- Do not ask questions to the audience
- Know your audience
  - You are writing to an educated, national scientific audience
- PROOFREAD
- Never use a: !
- Do not use words like:
  - thing
  - something
  - we or I
  - Maybe
- Write out your fractions
  - Do not use ¼
  - Use a decimal if you have to: 0.25
  - Or use a percent 25%
- Do not use unnecessary adjectives
  - Precious
  - Amazing
  - Perfect
  - Awesome
You will prepare a 2 page research paper (double spaced). Providing all of the necessary background information on your hypothesis using primary literature and written in a scientific format. The paper must reference at least 3 works of primary literature and include a works cited section (See "Citations and References"). The works cited section is in addition to the three pages and any diagrams, charts, tables, will not be included within your 3 page requirement. The objective of the paper is the following:

1. **Identify the subject area.** Describe the “thing” of situation you are studying. Provide all of the necessary background information that your audience would need in order to become more informed on your subject area. This is the section where you will be relying heavily on your researched articles.

2. **Justify why this is important.** You want the reader to read this and know that this issue or area of study is significant. Here you will justify why you are examining this topic.

3. **Set the scene for your study.** End your paper with a few statements on the purpose of your hypothesis and how it relates to the background research you have done on it.
After you have identified your research topic, your next step is to write a preliminary research proposal. The objective of your proposal is to present a plan of action that describes how you will investigate your research question. Remember to ask yourself, "Is this research plan feasible?"

**Answer the following questions:**

1. **Title:** Use keywords to clearly and concisely describe the content of your proposal.

2. **Hypothesis:** State the variables that you are testing and describe the expected relationship between the variables. Make sure your hypothesis testable.

3. **Introduction/Background:** Why is this research question important? *Think big picture.* What work has previously been done on this topic? Use facts, statistics, and primary literature references to back up your statements.

4. **Methods:** What steps will you take to investigate your research question and test your hypothesis? What type of data are you looking for? Who do you need to contact?

5. List at least 3 primary literature references on the back of this page.
Research Project Outline

Title
Authors

Introduction

- Organize your introduction in a logical order
- Start with the big picture, then narrow down to your topic
- Use the background information (previous studies) from your proposal as a starting point
- Include many references to convince the reader why this study is important
- State the objective of your study and your hypothesis at the end of the introduction

Methods

- Use subsections with headings
- State your assumptions (e.g., “Population will continue to grow at the same rate as in 2007.”)
- State the secondary sources of information (e.g., articles, databases)
- Provide the steps of your research procedure.
- Describe any statistics you use (e.g., averages, standard deviation, regression)

Results

- Use subheadings and for each section state the major result you found.
- Refer to your figures and tables.
- References are not necessary in this section

Discussion

- Interpret what your results mean. Why did you find what you found?
- Include many references to explain why you found what you found
- Use similar subheadings as in your results and methods
- Explain the implications of your findings
- If appropriate, include policy recommendations. You must include references with any policy recommendations.

Conclusions

- Restate the major findings and implications of your research.
- What future research needs to be done to more fully answer your question?

Acknowledgements

- Who has helped to guide your research? Who has provided you with materials and funding?

References

- List all references that you cite.
How to Write a Journal-Style Scientific Paper

Writing a scientific paper that effectively conveys complex information is an art that requires practice and expertise. However, most scientific papers follow a standard format that can be easily adopted. The following pages will provide you with information about how to write the different sections of a scientific paper.

This handout was adopted from *How to write a paper in scientific journal style and format* (2002) from the Department of Biology, Bates College.

I. Sections of the Paper

The sections of a journal style paper appear in the following order:

<table>
<thead>
<tr>
<th>Experimental process</th>
<th>Section of Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary of your research</td>
<td>Abstract</td>
</tr>
<tr>
<td>What is the problem?</td>
<td>Introduction</td>
</tr>
<tr>
<td>How did I solve the problem?</td>
<td>Materials and Methods</td>
</tr>
<tr>
<td>What did I find out?</td>
<td>Results</td>
</tr>
<tr>
<td>What does it mean?</td>
<td>Discussion</td>
</tr>
<tr>
<td>Who helped me?</td>
<td>Acknowledgments (optional)</td>
</tr>
<tr>
<td>Whose work did I refer to?</td>
<td>Literature Cited</td>
</tr>
<tr>
<td>Extra Information</td>
<td>Appendices (optional)</td>
</tr>
</tbody>
</table>

Main Section Headings: Each main section of the paper begins with a heading which should be capitalized, centered at the beginning of the section, and double spaced from the lines above and below. Example of a main section heading:

INTRODUCTION

Subheadings: When your paper reports on more than one experiment, use subheadings. Subheadings should be capitalized (first letter in each word), left justified, and either bold italics OR underlined. Example of a subheading:

*Effects of Light Intensity on the Rate of Electron Transport*
II. Title, Authors' Names, and Institutional Affiliations

Objective: Your paper should begin with a Title that concisely describes the contents of the paper. Use key words that you would associate strongly with the content of your paper (e.g., the molecule studied, the organism used or studied, the treatment, the location of a field site, the response measured).

Format: The title should be centered at the top of page 1. The authors' names (primary author first) and institutional affiliation are double-spaced from and centered below the title. When there are more than two authors, the names are separated by commas, except for the last which is separated from the previous name by "and". For example:

Ducks Over-Winter in Colorado Barley Fields in Response to Increased Daily Mean Temperature

Ima Mallard, Ura Drake, and Woodruff Ducque
East Syracuse-Minoa High School

III. Abstract

Objective: An abstract summarizes in one paragraph the major aspects of the entire paper. The abstract helps readers decide whether they want to read the rest of the paper.

Structure: The length of your abstract should be kept to a 200-300 words maximum. Limit your statements concerning each segment of the paper (e.g., purpose, methods, results, etc.) to two or three sentences, if possible. Use the following outline to write your abstract:

1. The question(s) you investigated (or purpose) (from Introduction).
   a. State the purpose very clearly in the first or second sentence.

2. The experimental design and methods used (from Methods).
   a. Clearly express the basic design of the study.
   b. Name or briefly describe the basic methodology used without going into excessive detail.
   c. Indicate the key techniques used.

3. The major findings including key quantitative results, or trends (from Results).
   a. Report those results which answer the questions you were asking.
   b. Identify trends, relative change or differences, etc.

4. A brief summary of your interpretations and conclusions (from Discussion).
   a. Clearly state the implications of the answers your results gave you.

Although it is the first section of your paper, the Abstract, by definition, must be written last since it will summarize the paper.
How to Write an Abstract: Use one or two concise sentences to summarize the most important aspects of your process for each section listed below.

Project Title (the same as the title of our scientific paper)

Introduction (what is this project about? Why is this project interesting or important)

Hypothesis (What did you think you would find? Why?)

Methods (Briefly explain your procedure)

Results (What did you find when you performed your experiment?)

Discussion (Are your results consistent with your initial hypothesis? Why or why not?)
Conclusion (What is your interpretation of what these results mean? Why should anyone become excited about or interested in your findings?)

IV. Introduction

Objective:
- Establish the context of the work being reported. This is accomplished by discussing the relevant primary research literature (with citations) and summarizing our current understanding of the problem you are investigating.
- State the purpose of the work in the form of the hypothesis, question, or problem you investigated.
- Very briefly explain the rationale for your methodological approach and anticipated results.

Structure: The Introduction structure can be thought of as an inverted triangle with the broadest, most general information at the top of the triangle and the specific problem you researched at the bottom. Organize the information to present the more general aspects of the topic at the beginning, then narrow toward the more specific topical information that provides context, finally arriving at your statement of purpose and rationale.

Use these steps to write your introduction:

4. **Identify the subject area.** Use key words from your Title in the first few sentences of the Introduction to get it focused directly on topic. This insures that you get to the primary subject matter quickly without losing focus, or discussing information that is too general.

5. **Establish the context.** Provide a brief and balanced review of the published literature that is available on the subject. The key is to summarize what we knew about the specific problem before you did your experiments or studies. This is accomplished with a general review of the primary research literature (with citations) but should not include very specific, lengthy explanations that you will discuss in greater detail later in the Discussion. Lead the reader to your statement of purpose/hypothesis by focusing your literature review from the more general context to the more specific topic of interest to you.
6. **Provide a brief, clear statement of the rationale for your approach to the problem studied.** Why did you choose this kind of experiment or experimental design? What are the scientific merits of this particular model system? What advantages does it confer in answering the particular question(s) you are posing? *Do not discuss the actual techniques or protocols used in your study – this will be done in the Materials and Methods.*

7. **State the purpose and or hypothesis of your investigation.** When you are first learning to write in this format it is okay, and actually preferable, to use a statement like, "The purpose of this study was to...." or "We investigated three possible mechanisms to explain...

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**V. Materials and Methods**

**Objective:** Provide enough information so that other researchers can replicate your experiment.

"The methods section of a research paper provides the information by which a study's validity is judged. Therefore, it requires a clear and precise description of how an experiment was done, and the rationale for why specific experimental procedures were chosen. The methods section should describe what was done to answer the research question, describe how it was done, justify the experimental design, and explain how the results were analyzed. Scientific writing is direct and orderly. Therefore, the methods section should: describe the materials used in the study, explain how the materials were prepared for the study, describe the research protocol, explain how measurements were made and what calculations were performed, and state which statistical tests were done to analyze the data (Kallet 2004)."

**Structure:**

1. Define the scope of the study and describe study area (*e.g.*, national analysis, central NY, ESM). Including the physical and biological features of the site and precise location.

2. Describe the subject (*e.g.*, bees in California, homes in NY, students at ESM) and when and where the study was carried out.

3. Describe your experimental OR sampling design. How was the experiment or study structured? For example, controls, treatments, the variable(s) measured, how many samples were collected, and replication.

4. If you are using secondary sources of data, describe the datasets. Who collected the data? What years are you looking at? Include citations!!

5. Provide a rationale for the specific procedure or data you chose to use.
   a. If using a particular methodology, cite the source of your methods.
   b. State your assumptions and provide justification.

6. Describe calculations - How was the data summarized and analyzed?
   a. For example, report averages standard deviation, t-tests, regression, slope, etc.
   b. Describe sources of error in your calculations.
Style & Organization:
- Write your methods in a paragraph form – not a list!
- Logical progression of ideas.
- Use subheadings.
- Use the past tense.
- Generally avoid the passive voice.
- Use only appropriate level of detail.

Do not report any results in this section!

VI. Results

Objective: Present your key results, without interpretation, using both illustrative materials (Tables and Figures) and text.

Structure: Determine the sequence of Tables and/or Figures that will allow you to present your key findings in a logical order. The text of the Results section will be organized to follow this sequence.

Types of results you might report:
- Trends (X increases or decreases over time)
- Correlations (as Y increases, X also increases)
- Differences (Y is greater than X)

Style & Organization:
- You must refer to each Table and/or Figure in the text and clearly indicate for the reader the key results that each conveys.
- Report key trends, correlations, differences rather than specific numbers.
- Report means and percents when possible.
- Figures and Tables are numbered in the order in which you refer to them in the text.
- Figures and Tables are numbered independently of each other. For example, if you presents one figure and one table, they would be numbered Fig. 1 and Table 1.
- Always enter the appropriate units when reporting data or summary statistics.
- Use the past tense.
- Figure legends go below the figure, Table legends go above the Table.
- DO NOT provide any interpretation of the data (i.e. why population is increasing) – this belongs in the discussion section.
- Do not present the same data in both a Table and Figure.

Statistical test summaries are usually reported in parentheses with the test name and p-value after the results that they support. For example:

"Males (180.5 ± 5.1 cm) averaged 12.5 cm taller than females (168 ± 7.6 cm) (two-sample t-test, p < 0.001)."
In this example, the average height of males was 180.5 cm and the standard deviation was 5.1 cm. The researchers used a statistical test called a two-sample t-test to determine whether the height of males was statistically significantly different than the height of the females.

*For more information on statistics see Appendix A.*

Report negative results: They are important! If you did not get the anticipated results, it may mean your hypothesis was incorrect and needs to be reformulated, or perhaps you have stumbled onto something unexpected that warrants further study.

VII. Discussion

Objective: In this section you interpret your results based on previously published research and you explain how your new findings change our understanding of the problem. *Think big picture.* Why do you think that you got these results? Why are your results important? You must relate your work to the findings from previous studies conducted by yourself and other investigators. Do not introduce new results in the Discussion.

Structure: The topics of the discussion section should follow the same order as the Results section. Interpret/address the results of each of the experiments or studies presented in the Results. The Discussion will always connect to the Introduction by way of the question(s) or hypotheses you posed and the literature you cited. It does not simply repeat or rearrange the Introduction. Instead, it tells how your study has moved us forward from the place you left off at the end of the Introduction.

Questions to answer in your discussion:

- Do your results provide answers to your testable hypotheses? If so, how do you interpret your findings?
- Do your findings agree with what others have shown? If not, do they suggest an alternative explanation or perhaps an unforeseen design flaw in your experiment or theirs?
- Given your conclusions, what is our new understanding of the problem you investigated and outlined in the Introduction?
- If warranted, what would be the next step in your study, e.g., what experiments would you do next?

VIII. Acknowledgements

If, in your experiment, you received any significant help in designing, carrying out the work, or received donated materials from someone, you must acknowledge their assistance and the service or material provided. Authors always acknowledge outside reviewers of their drafts and any sources of funding that supported the research.
IX. Literature Cited

Provide an alphabetical listing (by the first author's last name) of the references that you actually cited in the body of your paper.

X. Figures and Tables

Objective: To represent data in a clear and organized way.

Each figure and table should stand on its own without having to refer back to the text. The title and footnotes should be detailed. The text referring to the tables and figures should not repeat what is found in the tables and figures, but should point out trends and inferences important to the conclusions of the study. Tables and Figures are assigned numbers separately and in the sequence that you will refer to them from the text.

- The first Table you refer to is Table 1, the next Table 2 and so forth.
- Similarly, the first Figure is Figure 1, the next Figure 2, etc.

Each Table or Figure must include a brief description of the results being presented and other necessary information in a legend.

- Table legends are positioned above the Table; tables are read from top to bottom.
- Figure legends are positioned below the figure; figures are usually viewed from bottom to top.

XI. Appendices

Objective: Contains information that is non-essential to understanding of the paper, but may present information that further clarifies a point without burdening the body of the presentation.

Some examples of material that might be put in an appendix (not an exhaustive list):

- Raw data
- Maps (foldout type especially)
- Extra photographs
- Explanation of formulas, either already known ones, or especially if you have "invented" some statistical or other mathematical procedures for data analysis.
- Specialized computer programs for a particular procedure
- Full generic names of chemicals or compounds that you have referred to in somewhat abbreviated fashion or by some common name in the text of your paper.
- Diagrams of specialized equipment
Citing is the process of giving credit to the sources you used to write your paper. Reference “citations” are located within the text and a “reference list,” usually called a “Literature Cited” section, is located at the end of the work. Sometimes it can be difficult to determine which sources need to be credited. For more information see Appendix C.

When to Cite Rule of Thumb
If you knew a piece of information before you started doing research, generally you do not need to credit it. You also do not need to cite well-known facts, such as dates, which can be found in many encyclopedias. All other information such as methods, statistics, and ideas should always be cited in your papers.

Scientific literature citations
Citations from scientific papers are typically not formatted as quotations. Instead, paraphrase main ideas or state specific information from the article. Also, avoid using words such as “one study found,” or “a recent study showed.” State the main point of the study and be concise.

Unpublished data and personal communications
Sometimes a researcher has data that has not yet been published or has a conversation with someone else with unpublished data. In this case, the information must be cited, but we report “unpublished data” or “personal communication” instead of a year (e.g., Smith, unpublished data).

Anatomy of a Citation
Citations in the text are typically found within the sentence or at the end of the sentence that refers to the article. Be aware that there are a number of formats to choose from (see the ‘Choosing a Format’ section below). In general, citations are formatted either as names and dates within parenthesis (e.g., Smith 2004) or as numbers within parenthesis that correspond to a numbered list at the end of the document (e.g., 1). If there are two authors, both names are reported (e.g., Smith and Jones 2004). If there are more than two authors the Latin abbreviation “et al.” (and others) is used after the name of first author (e.g., Smith et al. 2004). It is important that all citations are reported consistently throughout the document.

Here is an example that includes a number of elements discussed above.

“Additionally, facilitation between nonnative invaders and native species (Richardson et al. 2000) may occur in stressful (Smith et al. 2004; B. Von Holle, unpublished manuscript) or highly disturbed areas, whereas competition-based processes may occur more commonly in more benign areas, as has been found for native-native interactions across a range of ecosystems (Callaway and Walker 1997).”

Citations and References

Anatomy of a Citation
As you compile your list of cited sources, it is helpful to know what type of information you need to write down. Here is a mock citation with each of its important parts labeled and shown in a generic format. We will explore which format to choose in the next section.

<table>
<thead>
<tr>
<th>Authors:</th>
<th>D. W. Forrester and A. J. Aquaguy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Linking water quality with forest type.</td>
</tr>
<tr>
<td>Title of Periodical:</td>
<td>Natural World.</td>
</tr>
<tr>
<td>Volume:</td>
<td>32:</td>
</tr>
<tr>
<td>Page(s):</td>
<td>39-42.</td>
</tr>
<tr>
<td>Year:</td>
<td>2007.</td>
</tr>
</tbody>
</table>

Choosing a Format
Each journal has its own format for citing and listing references which can be found in the section titled "Instructions for Authors" for that publication. In the Appendix of this guide is an example from the journal Nature's "Instructions for Authors." You'll see that it is very detailed. Most of the formats journals choose are based on one of a few well known formats, some of which are listed here.

- American Medical Association Manual of Style, 9th ed.: medicine, health, and biological sciences.
- A Manual for Writers of Term Papers, Theses, and Dissertations, 6th edition (Turabian): designed for college students to use with all subjects.
- Chicago Manual of Style, 15th ed.: used with all subjects in the "real world" by books, magazines, newspapers, and other non-scholarly publications.

Useful websites:
- http://www.chicagomanualofstyle.org/home.html
- http://www.dianahacker.com/resdoc/
- http://www.liu.edu/cwis/cwp/library/workbook/evaluate.htm#citing
  http://owl.english.purdue.edu/owl/
PowerPoint Tips

Format:
1. Title slide – title of presentation, authors, school name
2. Hypothesis
3. Introduction
4. Methods
5. Results
6. Discussion/Conclusion
7. Acknowledgments/References

Design tips:
- Use the slide master feature in PowerPoint (View → Master → Slide Master) to create a consistent and simple design template.
- Be consistent with elements such as font, colors, and background through the presentation.
- Every slide should have a heading with the same format (text size, font and color)
- Use simple backgrounds – patterned backgrounds obscure the text
- Use contrasting colors. Font colors should be in the range of whites to yellow for dark backgrounds and black to dark blue for light backgrounds. Never use red and green.
- DO NOT use Serif fonts (Times, Times New Roman, Garamond, Palatino)
  Use Sans Serif fonts (Ariel, Helvetica, Comic Sans, Papyrus, Avant Garde, Verdana)
- Font size: Headings 48-32 point, Body 20-30 point, References 14-18pt
- Use grids and guides in the drawing tool bar for even spacing of text and images
- Use high quality images. Low resolution images will distort and look grainy when projected onto a large screen.
- If you have a bulleted list of text, it can effective to ‘unveil’ each bullet using the function: Slide show → custom animation → add effect → entrance → appear

Keep it simple:
- Avoid the use of flashy transitions such as text fly-ins. These features are distracting.
- Overuse of special effects, such as animation and sounds, may make your presentation seem "cutesy" and unprofessional.
- Limit the text to a maximum of 6 words per line and 6 lines of text per slide.
- Use key phrases (not sentences) and include only essential information.
- Limit punctuation and AVOID PUTTING WORDS IN ALL CAPITAL LETTERS.
PowerPoint Tips

- Use white space – DO NOT crowd each slide with too much text and too many images.
- Limit the use of numbers, because they will overwhelm your audience. Instead of presenting a data table, use visual aids such as graphs and use relative numbers such as percentages.
- Limit the total number of slides in the presentation. Less can be more. Presenters who constantly "flip" to the next slide are likely to lose the attention of their audience.

Presentation style:

- During the title slide introduce your study and hint at the take-home message.
- During each slide remember to state the major point or conclusion.
- Do not read from your slides. The content of your slides is for the audience, not for the presenter.
- Face your audience and talk to your audience. Do not face or talk to the screen.
- Make eye contact with your audience. Smile.
- Never overestimate your audience (or their attention span). Remember – you are the expert.
- Time your remarks on each slide. When you bring up a new slide give your audience a moment of silence to digest the content of the slide.
- Time your whole presentation – a rule of thumb is one to two slides per minute.
- Do not go over your time – it is unprofessional.
- If presenting with a partner, determine ahead of time who will present which slides.
- Save time for questions at the end.
- Anticipate questions from the audience by preparing extra slides that you can present during the Q&A.

Prepare for the worst:

- Have a Plan B in the event of technical difficulties, such as an extra flash drive with a copy of your presentation, a laptop, transparencies, or handouts.
- Arrive as early as possible to the room in which you will be presenting to check that the equipment and your presentation are working properly.
- Practice with someone who has never seen your presentation. Ask them for honest feedback about colors, content, and graphics you’ve included.

Practice, Practice, Practice!
Appendix A: Project Proposal Grading Rubric

Total Points Possible: 60

Title – 5 points:
- Does it exist? Is it interesting?
- Will it reflect the content of the paper?

Introduction – 15 points:
- Is background literature used to provide a context for the project?
- Is the source of the literature cited when facts from the source are used?
  For example:

  Teachers should consider providing academic service learning opportunities for their
  students. Academic service learning emphasizes applying classroom concepts and skills in
  the community. It is a type of experiential learning that actively engages students. Service
  learning can help students foster lifelong interest, develop greater civic responsibility, and
  prepare students to make effective life choices (Wood, 2003).

- Are the goals and the objectives of the project stated?
- If an opinion is stated, is evidence (literature, interviews, etc.) provided to affirm this
  belief?

Methods – 15 points:
- Do the methods directly reflect, or explain, the stated goals and objectives?
- Do the methods provide information on exactly how the project will proceed?
- Are the methods detailed enough that someone could replicate this study?

Timeline – 5 points

Literature Cited (References) – 10 points
- Did you include 5 peer-reviewed sources using the APA format? (2pts/citation)

General Grading – 10 points:

Did you use the five main section headings (Title, Introduction, Methods, Timeline, Literature Cited)?
- Are references that are cited in the text included in your references section?
- Are there any spelling or grammatical errors?
- Is your document typewritten, double-spaced?
Appendix B: Rubric For Rough Draft and Final Paper

<table>
<thead>
<tr>
<th>Scoring for each section:</th>
<th>0 = didn't even try</th>
<th>1 = poorly done</th>
<th>2 = good effort, but incomplete</th>
<th>3 = everything is there, but not great</th>
<th>4 = Wow!</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>General (10 total points):</th>
<th></th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well written and easy to read</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Few errors in spelling, punctuation and grammar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logical flow and organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear and concise, uses fewest words possible to make point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses predominantly active voice (more exciting to read)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses headings and subheadings to visually organize the material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report handed in on time.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title (4 points):</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearly and concisely describes the study</td>
<td></td>
</tr>
<tr>
<td>Includes pertinent information</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abstract (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summarizes the research question</td>
<td></td>
</tr>
<tr>
<td>Summarizes the methods</td>
<td></td>
</tr>
<tr>
<td>States major findings</td>
<td></td>
</tr>
<tr>
<td>States the significance of the findings</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Introduction (12 points):</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrates solid understanding (4 points)</td>
<td></td>
</tr>
<tr>
<td>Tone is authoritative and confident</td>
<td></td>
</tr>
<tr>
<td>Uses relevant scientific or technical words, concepts, and theories</td>
<td></td>
</tr>
<tr>
<td>Demonstrates familiarity with work previously done on this topic</td>
<td></td>
</tr>
<tr>
<td>No major informational gaps in the argument presented</td>
<td></td>
</tr>
<tr>
<td>Need for research on this topic is clearly established (rationale)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>References (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 5 references from the scientific literature</td>
<td></td>
</tr>
<tr>
<td>References are appropriate and properly used</td>
<td></td>
</tr>
<tr>
<td>References are properly cited, e.g. (Haydn and Mozart 1932)</td>
<td></td>
</tr>
<tr>
<td>All important points are backed up with a cited reference</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research question (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives of the study are clearly stated</td>
<td></td>
</tr>
<tr>
<td>Hypothesis is clearly stated, specific, and testable</td>
<td></td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>

30
<table>
<thead>
<tr>
<th>Materials and Methods (20 points):</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Well designed (4 points)</strong></td>
<td></td>
</tr>
<tr>
<td>Research design is a well-constructed test of the stated hypothesis.</td>
<td></td>
</tr>
<tr>
<td>Data source or materials and equipment suit the research question</td>
<td></td>
</tr>
<tr>
<td>Use of data source or materials and equipment is justified</td>
<td></td>
</tr>
<tr>
<td>If appropriate, calibration procedures are identified and explained</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Well illustrated: EXPERIMENT PROJECT ONLY (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pertinent diagrams and/or photographs included</td>
<td></td>
</tr>
<tr>
<td>Diagrams are appropriate and informative</td>
<td></td>
</tr>
<tr>
<td>Photographs are appropriate and informative</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Well described: DATA SET PROJECTS ONLY (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data source (e.g., website or scientific paper) is cited and described</td>
<td></td>
</tr>
<tr>
<td>Optional: Raw data is included at the end of the paper and labeled as an Appendix.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables identified (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies experimentally- or mathematically-manipulated variables</td>
<td></td>
</tr>
<tr>
<td>All potentially confounding variables are identified</td>
<td></td>
</tr>
<tr>
<td>Expected effects of all variables are stated and justified</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Experimental methods (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes controls for confounding variables where appropriate</td>
<td></td>
</tr>
<tr>
<td>Alternative methods are explored, where applicable</td>
<td></td>
</tr>
<tr>
<td>Detailed enough to be repeatable, but not overly detailed</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Analytical methods (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant descriptive statistics (e.g., mean, std. dev.) are described</td>
<td></td>
</tr>
<tr>
<td>Statistical analysis procedures described</td>
<td></td>
</tr>
<tr>
<td>Proposed analysis is appropriate for addressing the hypothesis</td>
<td></td>
</tr>
<tr>
<td>Analyses chosen are justified</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Results (12 points):</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use of Figures (graphs) and Tables (4 points)</strong></td>
<td></td>
</tr>
<tr>
<td>Results correspond with the stated methods</td>
<td></td>
</tr>
<tr>
<td>Where appropriate, data are presented in Figures and Tables</td>
<td></td>
</tr>
<tr>
<td>Axes, titles and legends of tables and figures are properly labeled</td>
<td></td>
</tr>
<tr>
<td>Figures and Tables are professional-looking and easy to interpret</td>
<td></td>
</tr>
<tr>
<td>Appropriate types of Figures (line vs. bar) are used</td>
<td></td>
</tr>
<tr>
<td>Does not interpret (explain) the results</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Prose description (4 points)</th>
<th>Score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>All calculations not in Figs. and Tables are described in the text</td>
<td></td>
</tr>
<tr>
<td>Each Fig. or Table presented is described in the text.</td>
<td></td>
</tr>
<tr>
<td>Fig. and Tables are cited in the text that describe them</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Comments: |        |</p>
<table>
<thead>
<tr>
<th>Analytical methods (4 points)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant descriptive statistics (e.g., mean, std. dev) are presented</td>
<td></td>
</tr>
<tr>
<td>Relevant analytical statistics (t-test results) are presented</td>
<td></td>
</tr>
<tr>
<td>No important analyses are omitted</td>
<td></td>
</tr>
<tr>
<td>Data and data analysis are presented in a logical order</td>
<td>Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discussion and Conclusions (12 points):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explains the results (4 points)</strong></td>
<td></td>
</tr>
<tr>
<td>State whether the hypothesis was supported by the results</td>
<td></td>
</tr>
<tr>
<td>Presents a logical explanation/interpretation of results</td>
<td></td>
</tr>
<tr>
<td>Explains the significance of the all results</td>
<td></td>
</tr>
<tr>
<td>Provides evidence from other studies to support explanations</td>
<td>Score:</td>
</tr>
<tr>
<td>No extraneous information is presented</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discusses implications research (4 points)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe how these results fit into the “big picture”</td>
<td></td>
</tr>
<tr>
<td>Discuss how results change understanding of study subject</td>
<td></td>
</tr>
<tr>
<td>Discusses the practical applications of the results</td>
<td></td>
</tr>
<tr>
<td>Includes policy suggestions if relevant</td>
<td></td>
</tr>
<tr>
<td>Demonstrates creative thinking</td>
<td>Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demonstrates solid understanding (4 points)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tone is authoritative and confident</td>
<td></td>
</tr>
<tr>
<td>Words, concepts, and theories are used properly</td>
<td></td>
</tr>
<tr>
<td>Discusses possible reasons for unexpected results</td>
<td></td>
</tr>
<tr>
<td>Identifies and discusses all major potential sources of error</td>
<td></td>
</tr>
<tr>
<td>The writer anticipates the reader’s concerns, biases or arguments</td>
<td>Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conclusion (4 points)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concise summary of the paper</td>
<td></td>
</tr>
<tr>
<td>Restate major findings</td>
<td></td>
</tr>
<tr>
<td>Restate significance of the findings</td>
<td></td>
</tr>
<tr>
<td>Generates ideas and questions to guide future research</td>
<td>Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Literature Cited (4 points):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All citations in text are listed in this section</td>
<td></td>
</tr>
<tr>
<td>Correct citation format is used</td>
<td>Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comments:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Score:</td>
</tr>
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## Appendix C: Presentation Rubric

Environmental Summit Presentation Evaluation

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<th>Project Name:</th>
<th>School:</th>
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<td>Student Names:</td>
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<tr>
<th>DESCRIPTION</th>
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### I. OBJECTIVES AND HYPOTHESES

- A. Research objectives are clearly stated
- B. Hypotheses are specific and testable
- C. Student explains relevance to environmental science

### II. METHODS

- A. Study design is described in detail
- B. All variables identified and properly measured
- C. Methods are rigorous and appropriate to the hypotheses

### III. RESULTS

- A. Correct use and understanding of data processing and statistics
- B. Clear presentation of results, including figures and tables

### IV. DISCUSSION AND CONCLUSIONS

- A. Conclusions supported by data and analysis
- B. Identifies limitations and scope of the study
- C. Discusses new research questions

### V. REFERENCES

- A. References are cited when appropriate
- B. Literature review is sufficient and credible

### VI. PRESENTATION

- A. Quality of visual aids/multimedia
- B. Quality of oral presentation
- C. Student demonstrates high degree of professionalism

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<tr>
<th>Comments</th>
<th>TOTAL SCORE</th>
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Appendix C: Presentation Rubric

GENERAL SCORING

4 = Exemplary. Student exceeds expectations and excels in the category and all of its elements.
3 = Accomplished. Student clearly includes all of the necessary elements and meets all of the expectations.
2 = Developing. Students meet some of the expectations, but some elements are missing or incomplete.
1 = Beginning. Students have made an attempt to include elements in this category, but most elements are missing or incomplete.
0 = Missing. The students made no attempt to include the elements required in this section.
N/A = Not applicable. The category and its elements are not applicable to this presentation. For example, if your are evaluating a poster and the student is not available to present the research and answer questions, score the "VI.B. Quality of oral presentation" as N/A.

I. OBJECTIVES AND HYPOTHESES

A. Research objectives are clearly stated in terms of a general research question that is relevant to an existing body of research. The students provide a context for the hypothesis and their research.

B. Hypothesis is specific and testable. Students clearly identify the independent and dependent variables and present the hypothesized relationship between those variables AND the presented hypothesis can be evaluated using the scientific method.

C. Student explains relevance to environmental science

II. METHODS

A. The study design is described with sufficient detail to be replicated by another scientist. Time and location of research is mentioned. If sampling was used, the population and the sampling technique (e.g. stratified random) are identified. Presentation of methods is clear, and avoids extraneous details (e.g. how a random number table was generated, the company from which materials were purchased).

B. All primary variables (i.e. manipulated variables, response variables, other variables central to the study) are clearly identified and defined. All important potential confounding factors are identified and discussed. Solid understanding of the focal system is demonstrated. Students describe measurement techniques for all variables, including specific equipment used. Calibration methods (e.g. the use of standards) are included where appropriate. Techniques are appropriate for advanced high school students.

C. Methods are rigorous and the experimental design clearly addresses the research goals. Controls for potentially confounding variables are included where appropriate. Sample size and replicates are appropriate for the research goals. Methods address the research goals in a reasonably simple and direct manner. Alternative methods are explored where applicable.
III. RESULTS

A. Analysis includes correct processing of data; AND adequate statistical analysis (descriptive statistics with a measure of variability and test statistics are reported); AND student exhibits an adequate understanding of the analysis.

B. Appropriate use AND explanation AND readability of figures/tables/graphs

IV. DISCUSSION AND CONCLUSIONS

A. Conclusions are realistic, accurate, and within the scope of the project.

B. Suggests realistic improvements, identifies limitations, and identify the scope of the study

V. REFERENCES

A. Four statements appropriately referenced within text of presentation, citations found in multiple sections of the presentation or 5 or more citations all in one section

B. References are sufficient and credible (references slide/section present). Four primary references provided with sufficient detail that audience could locate each article or 5 or more references without sufficient detail to locate

*If statements needing citations are not cited, -1 point.

VI. PRESENTATION

A. Visual aids are readable at appropriate distances, arranged in a logical order, and contain an appropriate amount of information

B. Oral Presentation: Language is almost always appropriate, grammar is correct, appropriate tone of voice and speed, some vocal fillers may be used, eye contact is present during most of the presentation, some movement and idiosyncrasies may be present but are not distracting

C. Professionalism: Dress is not casual, shows courtesy to questioners, acknowledges at least his/her teacher, answers questions, makes attempt to answer when student obviously does not know answer
## Appendix D: Reference Page

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Appendix E: Laboratory Notebook
A Checklist for Completeness and Consistency

- Is the title specific and informative?
- Does the Abstract and Table of Contents include all relevant parts of the paper?
- Have you included enough information in the Materials and Methods section to enable someone else to repeat your study?
- Have you explained in Materials and Methods the procedures for collecting all the data presented in the Results?
- Are figures and tables numbered consecutively in separate series?
- Is every figure and table cited correctly in the text?
- Do the data in each figure or table agree with your in-text discussion?
- Do any figures or tables present conflicting data?
- Are data in related figures or tables shown in a consistent manner?
- Is each table and figure understandable apart from the text?
- Are any important Results missing?
- Have you used enough headings and subheadings to guide the reader?
- Does the Discussion address the major implications of your findings?
- Have you considered problems, inconsistent results, and counter-evidence?
- Have you cited all necessary sources?
- Are all sources cited in the text listed in the Literature Cited section?
- Does the Literature Cited section include any sources not cited in the text?