Final Paper Rubric and Instructions

Directed Studies and Applied Data Analyses 2021

Purpose

Writing effectively and communicating your results and ideas is a critical skill set in ecology and marine biology. Scientific writing follows a specific structure and this logical flow allows the reader to quickly understand and assess the qualities of the research being presented. The following instructions are your road map to for writing an effective scientific paper about your own research.

TIP: Write the entire document so that a scientist who is not a specialist in your field could understand it. Make sure to avoid jargon and define terms where necessary.

Formatting

- Double spaced for body of paper, single spaced for abstract, references, and figure captions
- Numbers on upper right corner of each page, no number on title page
- 12 pt. Calibri or Times New Roman font
- 2.54 cm margins
- Indent the first sentence in each paragraph, except in the abstract
- *Please refer to UP_Style_Guide on the BMSC website for more specific information about final report formatting and style.*

Citations and References

- All citations follow current APA (7^{th} edition)
- Plagiarism is a serious form of academic misconduct. Insure you are citing all information that is appropriate (see syllabus for home institution guidelines on plagiarism).
- Make sure all citations in text are also listed in full in the literature cited section
- When you include more than one citation in a set of parentheses, place citations in chronological order, e.g., (Smith 1987; Larsen and Doe 2000), not alphabetical order.
- Note: using a reference manager will save you a lot of time, but it is your responsibility to ensure the information being produced by the reference manager is correct.

Include the Following Sections in your Paper:

1) Title page

Include a title page (a.k.a. cover page) with the title of your paper, your names, the name of the class, your home university, your instructors, teaching assistant, and finally, the date. All information should be center aligned. Try to develop a concise title that summarizes the main result(s) of your research in a way that optimizes appeal to your readership.

2) Abstract (Less than 400 words)

An abstract is a detailed summary of your study. It should include a broad overview of your introduction, your research question, the methods of your research, the findings of your paper, and the significance of your study. Below is a basic framework for an abstract to give you an idea (note: do not include citations in the abstract).

Background and Justification (~2 sentences)
- Introduce the topic
- Identify what is not known: what is the problem or research question/hypothesis.

Objective(s) or hypothesis and predictions (~2 sentences)
- What is your big new idea or approach? What is your overarching aim, novel hypothesis, or approach that will answer the research question. What are your predictions?

Methodology (~2 sentences)
- How did you tackle your work? This includes a short summary of your methods and analysis.

Discussion/Conclusion (~2 sentences)
- What are the key results or findings from your research?
- What is the significance of your research to science and/or society?

3) Introduction

The introduction should include a concise summary of relevant background information, as well as and your objectives, research question, and hypotheses. The introduction gives the essential context, justification, or rationale for your research. Make sure to identify the gap in knowledge that you will address in your research and your overall objective or research question. Your hypothesis(/hypotheses) and predictions should also be included.

- Does the paper start relatively broadly?
- Does the beginning of your introduction "hook" the reader by setting the stage for the question(s) your paper answers?
- Does the paper include previous literature that is relevant to the current research question?
- Do you briefly summarize previous work that informs your current question(s)?
- Is the research question clearly stated?
- Are the hypothesis and predictions clearly stated and justified?
- Do you explain and justify your questions(s) instead of just extolling the virtues of your study organism?

4) Methods

Divide the methods section into **subsections with headings** that are appropriate for your topic. Subsections help you and readers stay focused. For example, you will all likely have "Study organism and husbandry" and "Data analysis" sections. Make sure to include citations if you plan to use methodologies that have been reported by other researchers (including statistical approaches). Write this section so that a biologist who is not a specialist in your field will be able to understand the rationale for the experimental approach and the specific methods.

Tip: A highly effective approach to writing a methods section is to explain how a certain method will enable you to test a particular prediction (or address a particular objective).

- Do you briefly explain the relevant natural history of your organisms or study system, if you haven't already included it in your introduction?
- Do you describe your methods thoroughly enough that another ecologist could repeat your experiment, but briefly enough that space-pressured journals won't send your manuscript back?
- Do you start the description of each experimental method with a phrase justifying why it was done?
- Do you include a brief explanation of each statistical procedure you used?
- Do you include only the methods relevant to your overall story?

5) Results

The results section is meant to provide a comprehensive, understandable description of the results. These should be carefully illustrated with appropriate figures or tables that have clear captions and can be understood separately from the text (e.g., if you were presented with only the caption and the figure, can you understand what is presented?).

- Are your results presented in a logical order to help your reader follow your story (not in the order in which you did your experiments, if that is different)?
- Have each of your results been presented once, and only once (in the text, a figure, and/or a table)?
- Does your text inform your readers of your results as much as possible, instead of simply referring them to your figures or tables?
- Do you describe your results in trends without discussing the biological mechanisms?
- Do you present effect sizes for each of your results?
- Do you include the relevant statistical information (e.g., degrees of freedom, p-value)

Tables and Figures:

- Should be numbered in consecutive order as they are referenced in text
- A stand-alone caption should be included for every graph and figure. Stand-alone means that if the figure or graph was taken out of context from your paper, it would still be understandable.
- Captions should be presented above a table, and below a figure.

Some questions to ask yourself:

- Are your figures and tables as simple as possible?
- Do the titles and captions convey enough information that your reader can understand the meaning without referring to the text?
- Do your figures show error bars, if appropriate?
- Do your scatter plots include a line that describes the best fit, if appropriate?
- Do your figures have a legend identifying the treatments, if appropriate?
- Have you trimmed your figures and tables to the lowest number possible to tell your story clearly?

6) Discussion

The discussion section is for evaluating your results. This should be done in context with your own research questions, hypotheses, and predictions, as well as in the context of the published literature. Subheadings, where appropriate, can be helpful but are not necessary (e.g., you may choose to include a 'conclusions' subheading at the end of the discussion, but not have subheadings throughout).

- Do you restate your main results very briefly and interpret them?
- Do you generalize to larger ecological concepts where appropriate?
- Does the information in your discussion relate to your initial question(s)? Does your story seem cohesive?
- Are your main results restated in a synthetic and non-repetitive way?
- Is each main result interpreted more specifically using appropriate literature, comparing and contrasting that literature?
- Discussion of results should follow the presentation of results in the results section?
- Shortcomings of experimental design, if relevant, are identified or explained, and follow-up questions are identified (e.g., a 'limitations' subheading can be helpful)?
- Includes some consideration of alternative explanations for main findings, if appropriate?
- Concluding remarks restate the main results and place them in a broader context comparable to the opening paragraph of the introduction?
- No new information should be included in the concluding remarks?

Significance, Conclusions and Future Directions

Use approx. one paragraph to describe the significance of your project including the scientific significance and/or real-world applications.

- Do you hit your reader over the head one last time with your take-home message?

Title and Abstract
(10%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ Title concisely summarizes main result(s) that optimizes appeal to readership	□	□ Organism and main results are mostly described in the title. Could be more concise or is weak in appealing to a wide readership	□	□ Title does not describe the main findings or address study questions
□ Concisely identifies **gaps of knowledge** being addressed	□	□ Background is established, does not adequately justify the purpose of study or is not concise	□	□ Important background is not addressed
□ Concisely summarizes **important** methods	□	□ Methods are established. Most important methods are not exclusively highlighted, or are somewhat unclear	□	□ No methods are addressed
□ Concisely summarizes **main** findings	□	□ Results are established. Most important results are not exclusively highlighted, or are somewhat unclear	□	□ No findings in abstract
□ Effectively and concisely identifies the **relevance/impact** of main findings	□	□ Relevance of findings is established. May not effectively link the relevance of work or under/over states the impact of findings	□	□ Does not link relevance of work

Introduction
(20%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ The intro **hooks** the reader by setting the stage for the question(s) of the paper	□	□ Background relevance is established, but does not connect to the larger impact or importance	□	□ There is little attempt at building a story for broad interest
□ The introduction provides in-depth and relevant **context** for the research, all topics to be addressed in the paper are well-covered	□	□ Background context is generally complete and relevant, but some topics lack detail/include irrelevant information, or some topics are missing	□	□ There is little to no background information, or background information has little to no relevance to the topic
□ Connections between the topic(s) of the paper and the **literature** are well-established, relevant, and insightful	□	□ Connections between the topic of the paper and literature are generally clear and well-established, but some are weak/vague/irrelevant/not well-connected	□	□ Generally the connections between topic(s) of paper and literature are weak/vague/irrelevant/not well-connected
□ The introduction clarifies the motivation for the work by clearly and actively stating all the **objectives** of the paper	□	□ Objectives are generally clear; however, some objectives require clarification or improved connection with the motivation for the study, or some objectives are missing	□	□ Objectives of the paper are inaccurate/vague/unconnected to the topic/many of the objectives are missing
□ All **hypotheses** are present and correct, and the biological mechanisms leading to the hypothesis are fully explained	□	□ Hypotheses are generally correct, but some hypotheses lack clarity/biological mechanisms are not stated, or some hypotheses are missing	□	□ Hypotheses are inaccurate, or many are missing, or are so unclear that the reader is unable to interpret them
□ All **predictions** are insightful and accurate and are explicitly linked to the hypotheses	□	□ Predictions are generally clear, but some require clarification, or are inconsistent with the hypotheses, or some predictions are missing	□	□ Predictions are unclear/incorrect/not linked to the hypotheses, or many predictions are missing

Methods
(20%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ Concise and effective description of the **study system** (i.e., study organism(s), site description), with no extraneous details	□	□ Description of the study system is generally clear and concise, but may contain some extraneous information, or not enough detail, or some information is missing. May cause minor difficulty in replicating the study	□	□ Description of the study system is unclear and rambling, contains extraneous information, or not enough detail, or much information is missing. May cause major difficulty in replicating study
□ Comprehensive description of the **experimental design**. Reader could easily replicate the experiment because all necessary information is included (replicates, sampling method, treatment levels, etc.)	□	□ The description of the experimental design is generally complete, but some of the details of the experimental design are missing. This may cause minor difficulty in replicating the study	□	□ The description of the experimental design has insufficient detail for the reader to replicate (no replicates, sampling method, treatment levels)
□ The description of the **data collection** (i.e., sampling, techniques, assays, sample processing) is detailed and comprehensive. Reader could easily replicate the methods used to collect data	□	□ The description of the data collection is generally clear and complete; however, some aspects of data collections are unclear or missing, which may cause minor difficulty in replicating study	□	□ The description of the data collection is generally unclear and incomplete; many aspects of data collection are missing, which may cause major difficulty in replicating study
□ Description of **data analysis** used (statistical test used, summary statistics, data transforms, etc.) is thorough, accurate, and appropriate to the experimental design	□	□ Description of data analysis is generally accurate and appropriate; some parts are unclear, or aspects are missing or inappropriate. This may cause minor difficulty in replicating the analyses	□	□ Description of data analysis is inaccurate and/or inappropriate: many parts are unclear, or aspects are missing. This may cause major difficulty in replicating the analyses

Results and figures
(20%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ Results are accurately and clearly described in terms of **trends and patterns** without discussion of biological mechanisms	□	□ Results are generally accurately and clearly described in terms of trends and patterns, but with some mistakes: trends described incorrectly, results are not summarized as trends or patterns, mechanisms are discussed, some results are missing	□	□ Results are partially or weakly described in general trends or patterns, biological mechanisms are discussed, many of the descriptions are inaccurate or results are not summarized as trends and patterns
□ All **statistical analyses** are performed correctly with no mistakes and all necessary tests are performed	□	□ Statistical analyses are generally correct with some mistakes: some of the tests are incorrect, missing, unjustified.	□	□ Statistical analyses are generally incorrect or missing
□ All **statistical conclusions** are correct	□	□ Statistical conclusions are generally correct, but some errors exist	□	□ Statistical conclusions are generally incorrect
□ All statistical results are correctly **reported** in the text with all the necessary information included (test performed, test statistic calculated, df, p-value, full model)	□	□ Statistical results are generally correctly reported in the text, but some errors exist (missing information, incorrect formatting)	□	□ Statistical results are generally incorrectly reported in the text
□ All figures and tables cited in text, correct format, with a stand-alone caption below figures and above tables	□	□ Figures general correct, missing some citations in text/some incorrect formatting/figure caption/not below figure	□	□ Some figures missing entirely/major mistakes in formatting/caption missing/not descriptive
□ Results are correctly and clearly presented in figures/tables that are appropriate to the research question	□	□ Results presented in figures/tables with some mistakes: some data plotted/tabulated incorrectly, some problems with axes (incorrect/missing units), may be unclear	□	□ Presentation of the results in figures/tables contains many errors: data plotted or tabulated incorrectly, axes not labelled or incorrect, unclear presentation of data

Discussion and Conclusion
(20%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ The discussion contains a concise, accurate, and clear **summary** of all the results	□	□ Main points of results are summarized with some mistakes: some results are incorrectly summarized, some results are not summarized, or summary is unclear	□	□ Many of the results are not summarized or are summarized inaccurately, or the summary is so unclear the reader is unsure of the findings
□ **Discusses** thoroughly and clearly the results with respect to the hypotheses, predictions, and objective outlined in the introduction	□	□ Most of the results are discussed with respect to the hypotheses, predictions, and objectives, but some of the discussion is missing, inaccurate, or is unclear	□	□ Many results are not discussed with respect to the hypotheses, predictions, and objectives, or the discussion is inaccurate or unclear
□ **Synthesizes** all the results in the context of the entire experiment, providing a clear overall message. The student clearly understands the overall concepts in the paper	□	□ Partially synthesize the results, but some of the results are not examined in the context of the entire experiment	□	□ Synthesis of the results is weak and does not provide an overall message of the experiment
□ The student provides detailed and relevant **context** for the results and relates results to the broader context and literature	□	□ Results are discussed within the context of the literature, but some of the context may be irrelevant, or inaccurate, or some may be missing	□	□ The student fails to relate the results to the context of the literature
□ Concluding statements include all main results and refer to the main purpose of the experiment (support or refute). Significance of the study is well thought out and applied to several groups (ie. non-scientists, scientists, policy makers etc.). Future-directions are well thought out and considerate. Includes strong summary and memorable take home message.	□	□ Concluding statements present with some mistakes: some main points missing/not well connected to hypotheses/some incorrect conclusions. A connection to significance of study and future-directions is made, but not well developed.	□	□ The concluding statement is weak and unclear. Missing significance of research and/or future-directions.

Effective Writing
(10%)

5 (Exceeds Expectations)	4	3 (Meets Expectations)	2	1 (Does Not Meet Expectations)
□ **Organization** is fluent and logical, allows the reader to easily understand the content of the paper. Format style was followed.	□	□ Organization of content (introduction/discussion) somewhat lacks structure, but does not interfere with the ability of the reader to understand the meaning. Format style mostly followed.	□	□ The organization is very poor and this causes confusion for the reader. Format style mostly not followed.
□ The content of the introduction flows from the **general to the specific** and the content of the discussion flows from **specific to general**	□	□ Content of the introduction flows somewhat general to specific but can be inconsistent in the flow	□	□ Content of the introduction shows no discernible flow
□ Writing shows sophistication in **language choice**, only minor errors in spelling and grammar are present and these errors do not interfere with the message of the paper	□	□ Writing skills are adequate; there is a moderate level of spelling and grammatical errors, but these do not interfere with the reader's ability to understand the paper	□	□ Language is inappropriate, may consistent spelling and grammatical errors; theses errors make it difficult for the reader to understand the paper
□ Paragraphs are **focused** (single topic) and coherent. First sentence conveys the topic of the paragraph	□	□ Paragraphs: some lack a focus/each paragraph not introduced appropriately	□	□ Paragraphs lack structure/lack focus/are incoherent
□ The student's writing is concise	□	□ Writing somewhat concise, but includes some extraneous details	□	□ Writing is not concise, uses run-on sentences, vague rambling sentences
□ Literature Cited correctly within text and full citations in literature cited section	□	□ Literature cited: generally correct, a few mistakes in formatting in text and/or in literature cited section	□	□ Literature cited: major formatting errors in text and in literature cited section