BIOD59 / EEB1420 – Research paper instructions

Fall 2019

Deadline: Tuesday, November 26, 2019, 11:59am

Objectives

The BIOD59 / EEB1420 research project aims to introduce you to the process of conducting ecological research using models. As such, your course paper will be modelled after research papers submitted to ecological journals for publication (but of course be substantially shorter), addressing a specific biological question using a modelling approach. Your paper will therefore not just include the model and its analyses, but also discuss the biological background and biological implications of your findings:

In the Introduction, you will summarize the biological background of the question you are addressing and the modelling tools you will be using; in the Methods and Results sections, you will develop, implement and analyze your models; in the Discussion section, you will elaborate on how your modelling results have shed light on the question, discuss potential shortcomings and uncertainties of your model, outline future research directions, and discuss potential implications of your findings for management if applicable. As such, you will be evaluated on the soundness of your model and model analyses, **as well as** on your ability to clearly link a model to the underlying biology and relate model outputs back to the biological question.

Paper Sections

For examples of how modelling papers may be structured, see:

Molnár PK, Derocher AE, Lewis MA, Taylor MK (2008) Modelling the mating system of polar bears: a mechanistic approach to the Allee effect. *Proc. R. Soc. B* 275, 217–226.

Wonham MJ, Bailey SA, MacIsaac HJ, Lewis MA (2005) Modelling the invasion risk of diapausing organisms transported in ballast sediments. *Can. J. Fish. Aquat. Sci.* 62, 2386-2398.

Abstract (<180 words)

The primary purpose of an abstract is to allow readers to determine quickly and easily the content and results of a paper, understand why the research was done, as well as the significance of the results. As such, the abstract should be able to stand alone – the reader should not have to get any information from the rest of the text in order to understand the abstract. The abstract should provide a brief summary of the biological background and questions (~2-3 sentences), objectives of the study (~1-2 sentences), an outline of the approach taken (~1-2 sentences) and the main results (~2-3 sentences), plus a brief summary of the conclusions that are presented in the Discussion section (~1-3 sentences). The number of sentences allocated to each of these parts may vary from the guidelines I suggested, but

your **abstract must not exceed 180 words.** Each journal has strict word limits, and going over them would prevent submission to the journal; as such, you may lose marks for an abstract that surpasses the 180 word limit. Do not include literature citations in the abstract.

Keep in mind that your paper is interdisciplinary work, using mathematical models to address ecological, epidemiological, and/or conservation questions. Your work may thus be interesting to researchers and practitioners from a variety of fields (modelling, ecology, conservation, health management), but many of them may not be experts in one or more of the fields you combine. For example, a conservation manager may know little about modelling, while a modeller may not be familiar with the underlying biology. Good modelling papers keep this in mind, avoiding technical language wherever possible, and especially in the abstract.

Keywords

List 6 keywords. Keyword should be chosen such that a researcher who is looking for research on your topic would be directed to your paper by search engines. As your research is interdisciplinary, it is wise to include keywords representing different aspects of your study. For example, in a population viability analysis of polar bears that uses matrix models, my keywords may include "polar bear" "matrix model" and "population viability analysis". This would increase the chances that my paper is found both by bear biologists and by modellers. Note that journals typically refer to 'keywords' but often mean 'key phrases': "population viability analysis" would be one keyword.

Introduction (approx. 600-800 words)

As in non-modelling research papers, the Introduction is the place to summarize the biological background, outline the research question / conservation problem that is to be addressed, and provide a brief summary of the approach taken and possibly the key result to follow. For this paper, I would recommend beginning the introduction with 1-2 short paragraphs that outline the biological background and the research questions (in your own words) but without any modelling details yet. Following this (these) paragraphs, you should then outline briefly (1-2 paragraphs) why you think a modelling approach will shed light on these questions and what other studies have attempted in this context. This should be followed by a brief summary of what follows in the Methods and Results section (i.e. your approach and your key result). For example, you may say "to determine a sustainable harvest of anchovies in Peru, we used classical spawner-recruitment models to quantify the population dynamics of anchovies. We considered both Beverton-Holt and Ricker dynamics, and modified these classical models to account for local harvesting strategies. We found that… [1 sentence with key results]" Such summaries can be very helpful in modelling papers, as this way the reader is prepared for what the models aim to do when trying to read through some, potentially complicated, analyses. In other words, provide enough detail on the modelling in the introduction so the reader knows where you are going, but don't overwhelm them with technical detail here.

Methods (approx. 600-1000 words)

As models are used in a variety of situations, the structure of the Methods section of modelling papers often varies a bit from case to cases. However, most papers do share some general themes, which I also recommend for your papers. In general, as in other papers, the Methods section should provide sufficient information to allow a reader to repeat your work.

- A *Model Development* subsection is often used to define the model mathematically and justify modelling choices in terms of the biology. Begin with explaining what type of model you are choosing and why. To do this, outline the structure and biological assumptions of your model in words first; flow diagrams and other visual representations of your model can be very useful here, too. Then outline the model equations. Make sure to define every term. A table of state variables and parameters can be very helpful to allow the reader easy reference. Don't forget to include the units of your parameters and state variables in such tables.
- A *Model Parameterization* subsection is often used to describe how model parameters were estimated. In cases where such estimates are derived from data presented in the study, this would be the place to describe such data, and how parameters were obtained from the data (e.g. statistical analyses, such as regression or likelihood). If model parameters are derived from the literature, then this should also be outlined here. Describe each parameter and its source. A summary table of all parameters may again help with clarity.
- A *Model Analysis* subsection outlines how the model was analyzed. For example, did you evaluate equilibria? Were you analyzing transient dynamics? Were you attempting forecasts, and if so, how did you quantify uncertainty? What you describe here depends of course on the questions that your model aims to address, but in general, what you outline here is what you will report in Results.

Importantly, note that your model and analyses should aim to be as simple as possible but as complex as necessary. **That is, your paper will not be graded on how fancy or complicated your model is, but rather on how appropriate the model is, and how relevant the derived biological insights are, for the biological question that is asked.**

Results (approx. 400-1000)

As in other research papers, the Results section should succinctly and accurately summarize your findings, but generally defer interpretation of these findings to the Discussion section. For example, if your objective was to determine climate change impacts on an ecosystem by evaluating how system equilibria change under different environmental conditions, you should report the model results of how equilibria depend on environmental conditions in the Results section. However, discussion of what these results may mean for the preservation of that ecosystem under climate change should be deferred to the Discussion.

Support your results with figures that summarize your model analyses. There is no minimum or maximum number of figures for this paper. Figures should simply be chosen such that they support the story that your paper is telling. However, as we are mimicking the scientific publication process, and because all journals limit the number of figures that can be included in the article, **you should pick a**

maximum of 4 figures that are the most important for showing your main findings (this may include flow diagrams and other visuals introduced in other sections) to be included in the main text. If you have more than four figures, designate 'less important' figures as 'Supplementary Material' (cf. formatting guide below). This allows the reader to focus on your main message, rather than the many details that sometimes need to be addressed, as well.

Discussion (approx. 500-800)

As in non-modelling papers, the Discussion should explain the significance of your results. A structure that often works in modelling papers is as follows but variations are allowed: 1. First paragraph – restate your major findings concisely without restating excessive detail of the Results section. 2. Second paragraph – outline how these findings have shed light on the biological question you asked (what insights have you gained? how do your findings relate to what was previously known?). 3. Third paragraph – what are the limitations your model? how certain are you that your model captures reality? 4. Fourth paragraph – Conclusions. Again, this may vary from topic to topic, but for example, you may address questions in the conclusions, such as how your results may inform management, or how future biological research could lead to better parameter estimates and reduce uncertainties. Generally, provide an outlook here.

References

Your paper is interdisciplinary work, using mathematical models to address questions in ecology, epidemiology, and/or conservation biology. As such, it is critical to properly reference both the biological background and the modelling approaches you use. Your paper should contain about 12-18 references, covering both your biological and your mathematical bases.

Figures and Tables.

Figures and tables should support your methods (e.g. flow diagrams, tables of state variables) and findings (e.g. population time series). Ideally, a reader should be able to understand the gist of your paper just from the figures, tables, and their captions. As such, design your figure in a way that they tell the story of your paper. Use subplots to group logically related figures. Use a maximum of four figures and 2 tables that tell the main story in the main text, any additional figures and tables should be designated and referred to as Supplementary Material. Figure captions should be concise (<150 words per figure) but clearly explain all lines, dots, dashed lines etc in a figure. Label your axes properly!

Formatting Requirements.

Format your paper as if for submission to the *Proceedings of the Royal Society of London Series B: Biological Sciences*. Format all aspects of your paper (e.g. reference format, fonts, etc) following the journal's instructions (https://royalsociety.org/journals/authors/author-guidelines/) except in cases

where the instructions found in here are in conflict with *Proceedings B* instructions (e.g. word limits should adhere to those stated in this document, not those of *Proceedings B*).

Word Limits

- Abstract: less than 180 words
- Keywords: less than 6
- Main text: Approximate recommendations for each subsection are given above, but these should be viewed only as suggestions. The important part is that your paper addresses the biological question asked and tells a coherent story from the biological background to the modelling approaches and back to the biological implications. Overall, you should aim your paper to be in the range of 2000-3000 words, but keep in mind that quality, not length, determines your grade.
- References: 12-18
- Figures and Tables: up to four figures and two tables in main text. Additional figures and tables should be amended in the Supplementary Material as outlined above. Figure and Table captions should be less than 150 words each.

Marking:

As outlined above, your work will be evaluated on the soundness of your model and model analyses, **as well as** on your ability to clearly link a model to the underlying biology and relate model outputs back to the biological question.

Your mark will be distributed as follows:

7% - Abstract

13% - Introduction

30% – **Methods (model development, parameterization etc)**

25% – **Results (model analyses, use and presentation of figures etc)**

13% – **Discussion**

4% – **Formatting, spelling, grammar etc.**

8% - Clarity of writing: Modelling is interdisciplinary work, and as such is often read by researchers with widely differing backgrounds. As such, it is critical that your writing is as clear as possible, and that technical details are well explained. Where possible you should aim your writing to be understandable to researchers from different fields, and where things get technical, you should aim to explain such technicalities as intuitively as possible. The clarity of writing does impact the success of a paper – it is easy to dismiss what sounds too obscure.

Time management tips

It is essential that teams work together on all aspects of the project. Distribute work among group members wisely to reduce work load. For example, while all members should contribute to all aspects of the paper, different sections of the paper can be drafted first by different group members, and then worked back and forth between group members to achieve the best possible writing. **If any group member is consistently not pulling their weight, attempt resolution within the group, but see the Instructor if that is not possible.**

Suggested work timeline:

Weeks 1 & 2: Research the biological background of your question; establish key references from the literature. Begin researching and understanding the gist of previous modelling approaches that may have addressed a similar question (if there are any such studies). Begin developing your model, potentially with different versions if you cannot decide at this point which model may be the most appropriate; establish flow diagrams or other visual aids for your model. Begin thinking about how the diagrams may be translated into model equations. Begin planning the structure of your paper: what is the story you want to tell, and how will you tell it? What figures and tables would be useful for telling your story? Etc.

Weeks 3 & 4: Continue looking for relevant papers and background reading. Develop model equations, establish parameter estimates and implement first simulations. Do you think these initial results make sense? At this point, you will likely find one or several of the following: programming errors, a realization that your model structure omits key biology, a realization that your model may be too complicated, problems estimating parameters, and other issues. Begin addressing these issues.

Weeks 5 & 6: Address model issues, fix programming errors, try alternative models if necessary, refine parameter estimates. Keep running simulations and analyses to determine progress on an ongoing basis. Begin drafting sections that you can already write (e.g. biological background in the introduction, most parts of Methods)

Weeks 7: Finalize the model, simulations, figures and tables. At this point, your paper should approach its final format. Write parts of the paper that you haven't written yet.

Week 8: Give your paper a final polish. Try to read it with the eyes of someone who sees this for the first time. Clarify things that may not be clear yet. Polish the writing. Format the paper to journal standards. Run a final spell & grammar check. Submit. Relax!

How to get help

Time will be allocated in the tutorials after reading week for answering questions related to everyone's topic. In addition, if you require help at any point during the process of this project, you should contact the teaching assistant Juan Vargas who will make appointments on a request basis. Note that EEB1420 students should contact the instructor, not the teaching assistant for help.