

BIOL 823 DEMOGRAPHIC METHODS - FORMAT OF RESEARCH PAPER

Preparing research in the format of a scientific paper can be a challenging skill to learn for many young scientists. The format of scientific writing is fairly rigid but the informal rules are not always clear. This checklist gives guidelines for a template that students should follow in preparation of their research paper. Read it before you start writing and again after you have completed a first draft of your research paper.

General considerations:

- **General format.** Research papers must be 8 to 10 pages in length, not including a cover page, literature cited or tables and figures. All pages must have margins that are at least 2.5 cm wide, and all text must be double-spaced and typed in a 12 pt font (preferably a serif font such as Times New Roman). Research papers may be printed on recycled or scrap paper but text should only be on one side of the page.

- **Hourglass format.** An effective research paper is often written from a hierarchical outline that can be thought of as taking the shape of an 'hourglass'. The Introduction starts at a broad level to provide background and context for the research. The Methods and Results are narrower in scope and are limited to consideration of the specific study system. The Discussion starts with a narrow focus of the present project but should conclude with the broader implications of the research.

- **Order of writing.** When preparing a research paper, it is not necessary to write the sections in the order that they appear. It is often useful to write the Methods first, while you remember everything you did. Summarize and analyse the data and prepare the tables and figures before writing the Results section. Next, prepare an outline for topics to be developed in the Introduction and Discussion before you write these sections. The Abstract and Literature Cited should be assembled last. Before you hand your paper in, proofread for spelling and grammatical errors.

- **Avoid plagiarism,** it will be treated as a serious academic offence.

Abstract - ½ page

The Abstract is a summary of all the sections below and should include important conclusions. It should be concise and informative rather than descriptive. It should be able to stand alone if removed from the rest of the paper.

- The research paper must have an Abstract.
- The Abstract usually contains no citations.

Introduction - 1 page

The Introduction should provide the aims and significance of the research and place it within the framework of existing work. It includes enough of a review of background information to give a rationale for why the study was conducted. Every major topic in the Results and Discussion should be foreshadowed in the Introduction. A good format is to use three paragraphs.

- **Paragraph 1.** Introduce the general area of theory that the study addresses. Does the topic best fit under a heading of ecomorphology? Or life-history theory? Ideally, the topic has greater relevance to understanding the biology of a broader range of birds, vertebrates or plants and animals.

- Paragraph 2. Discuss the theory as relevant to the local study system. Here, one can point out failings of previous work, identify research needs that have not been considered before, and discuss hypotheses that are relevant to the study system.

- Paragraph 3. Introduce the taxa or specific problem considered in this study. Give a brief sketch of the relevant aspects of the biology of the study species. Sell the study by emphasizing what is unique about this project. Is it the first test of a hypothesis? The first time that a particular species or area has been examined? Conclude this paragraph and the Introduction by stating the goals or objectives of the study. These can be framed as tests of predictions from relevant hypotheses. Sometimes the main findings of the paper are stated here as well.

Methods - 2 pages

The Methods section describes the techniques that were used in enough detail that the study could be replicated or critically evaluated by another scientist.

- Scale of study. Start with a description of the spatial, temporal and taxonomic scale of the project. Where was the study conducted? If at one site, pertinent details might include the geographic location (including lat/long co-ordinates) and a description of the habitat. What time of day, month or years were the information collected? How many person-hours of observations were collected? Last, describe the study taxa that you considered. Provide details of their biology that are relevant to the study. For example, it might not be necessary to discuss nesting habits if you are studying winter foraging.

- Species names. The first time that a common name of an animal appears, it should be followed by the Latin name (*Genus species*). The standardized common names of birds have initial capitals, at least in ornithology journals (e.g., Tree Swallow).

- Field and lab procedures. This is where one might present aspects of how observations were conducted, how specimens were measured, what experimental design was used. If specialized software or equipment is used, provide the name of the manufacturer.

- Statistical analyses. Conclude the Methods by describing the statistical analyses used. If analyses were restricted to a subset of the data, give the criteria that were used in selecting subsets of information. What computer programs were used to conduct the analyses? Were the assumptions of the statistical tests tested or met? For example, if parametric tests are used, it is good to confirm that the data were tested for normality. Indicate whether the tests were 1- or 2-tailed, and whether a conventional significance level of was used (i.e, $P < 0.05$). Confidence limits should be reported for all means and medians; mention here whether they are SD, SE, 95%CL or interquartile ranges.

Results - 2-3 pages

The Results section is a summary of the relevant findings of the study. Only results pertinent to the hypotheses or questions raised in the Introduction and treated in the Discussion should be included. Attempts at interpretation should be deferred until the Discussion. The format of the Results is usually organized in 2-3 sections that build from simple descriptive statistics to more complex analyses. Guidelines to follow closely include:

- Text. The Results must have a text section and cannot consist solely of Tables and Figures. The latter are used if data are too complex to present as text. Use Tables to present actual numbers, and Figures to emphasize patterns or relative differences.

- Avoid redundancy. Data can be presented in either the text or in a Table/Figure but not both.

- Citing Tables and Figures. In the text, the relevant patterns in the tables and Figures must be described without repeating the data verbatim. All Tables and Figures must be cited in the text and must be numbered in the same order that they are cited. Table 1 appears before Table 2 and so forth. In the text, refer to Figures and Tables parenthetically. Instead of saying: "In Figure 3 you can see male ptarmigan have bigger combs...", make a statement and reference it: "Male ptarmigan have bigger combs (Fig. 3)...". This is more concise and reads better.

- Captions. All Tables and Figures must have a caption or title that is a complete sentence. The title includes the figure number and can contain information pertinent to the figure (e.g., Fig. 1: Comb size in male ptarmigan). Information that should be on every figure or in the title include: the sample size and labels of the measures of central tendency and variability (e.g., mean and 95% confidence interval).

- Figures must be legible. All lines and points on a figure should be large and of good contrast for legibility. Avoid using pencil or tiny points on your figures. Scale your axes so the data is spread across the entire page. For example, if the range of one of your variables is 15-30, start your axis at 14 not 0. Most journals publish in black and white and it is useful to get in the habit of using patterns (eg. dashed vs solid lines) instead of colours to mark different treatments.

- Amount of data per figure. A figure can include one or more plots. If you have multiple plots with a similar format, combine them onto a sheet and label it as one figure. Conversely, there is a limit to the amount of data that can be effectively put on one plot. Try not to clutter each plot with too much data.

- Data must be summarized. Raw data can only be included in an Appendix. If you are doing a literature review, you must summarize the tables and figures from your sources yourself.

- Descriptive statistics. When analyzing data a useful first step is to look at the raw distribution of the data before deciding which measure of central tendency and variability to use. If the distribution is bell-shaped or normally-distributed, use of means and SE is acceptable. Such data are best analysed with parametric tests. If the distribution is strongly skewed or nonnormal, medians and interquartile ranges may be more appropriate. Nonparametric or frequency tests may be best.

- Variability. Variability in the dependent variable may arise from methodological error or from biological processes. Variability due to methodological error can be investigated with repeated measures.

- Results of statistical tests. When presenting results of a statistical test include: the name of the test, the test value, the degrees of freedom and the probability value. E.g. "was significantly different (Chi-square test, $\chi^2 = 20.5$, $df=10$, $P = 0.025$)". Report sample size in either the text or the Table and Figure captions.

- Significant figures. Significant figures should reflect the precision of the measurements. If wing length is measured to 1 mm, then results should not be presented to 0.01 mm. *P*-values should usually be presented to only three decimal places ($P = 0.562$ or $P < 0.001$)

Discussion - 3-4 pages

The Discussion should review the data presented in the Results and compare it to the predictions made in the Introduction and to previous studies in the literature.

- **Summary of Results.** Start the Discussion with a statement or paragraph that summarizes the main results of the study. The last sentence of this section should be a topic sentence that outlines the major points that will be considered in the remainder of the Discussion.
- **Interpretation.** When interpreting the Results, try to be even-handed. Do not make conclusions that the data do not support or fail to address. Present alternative explanations if caveats are appropriate. Being self-critical takes this option away from a reviewer. Keep in mind that sample sizes and the size of the differences between your treatments may be small.
- **Quotes.** Avoid quoting large passages from the references. Quotes are used rarely and only to illustrate specific points that cannot be otherwise rewritten in your own words.
- **Broader perspective.** Conclude the Discussion by addressing the broader implications of the research. This can include: questions that remain unanswered, suggestions of areas where further research is necessary, implications of the results for problems in other taxa or areas of theory, development of new hypotheses, or implications for management and conservation.

Citation of references in the Introduction and Discussion

Students should rely on previously published materials to provide a context for their research, and should attempt to cite journal articles of the highest possible quality.

- **Quality of references.** Three criteria can be used to assess the value of a research article: date, source and journal. 1. Work published recently is more likely to be current. 2. Material published in scientific journals has a higher premium than information in books or theses because it has been peer-reviewed before publication. 3. Articles can also be ranked by the journal source where they are published.
 - Top-tier journals include *Nature* and *Science*. Research articles in these journals tend to be short and succinct.
 - Next best are general journals that publish papers on a range of topics and taxa such as *Am. Nat.*, *Ecology*, *Proc. Nat. Acad. Sci.*, *Proc. Royal Soc. Lond. B.* or *TREE*.
 - A range of journals have good quality articles in specific fields including behavior: *Anim. Behav.*, *Beh. Ecol. Sociobiol.*, conservation and management: *Biol. Cons.*, *Cons. Biol.*, *Ecol. Appl.*, *J. Wildl. Mgmt.*, ecology: *Oikos*, *Oecologia*, or general zoology: *Can. J. Zoology*, *J. Zool.*
 - Taxa-specific journals can be good but have more limited readership. Of the ornithological journals, *Auk* is the best, *Condor* and *Ibis* are fairly good, and *Ardea*, *Bird Study*, *J. Field Ornith.* and *Wilson Bull.* are lower-tier.
 - The journals with the lowest value are ones aimed at a popular audience: *Natural History*, *National Geographic* or *Scientific American*.
- **Citing references in text.** When citing papers in the text, you can use the authors as either the subject or object of the sentence. For example, "Smith and Jones (1987) found that juvenile songbird mortality..." is as valid as "Juvenile songbirds mortality is... (Smith and Jones 1987)". With more than two authors, use the abbreviation "et al." as in "Smith et al. (1987) found that...". "et al." is an abbreviation for the Latin term "et aliae" which means "and others".

Literature Cited - 2-3 pages

The Literature Cited section contains the full citation for all of the references cited in the text of the research paper. Do not include articles that you have read but are not cited in the research paper.

- Final list. Every reference in the Literature Cited section must be cited within the text of the research paper and vice versa.

- Sorting. Within the Literature Cited section, the references are ordered alphabetically by surname with ties decided by initials of the author and then by date. Where the authors and date of two papers are identical, subletters are added to the date (eg. 1987b).

- Bibliography. The Literature Cited (or References) section is not a Bibliography. A Bibliography is a complete set of every reference published on a particular topic. A Literature Cited section is usually only a subset of the possible papers that could be cited.

- Format. Format the Literature Cited section following the conventions of the ornithological journal *The Auk*.

- Journal articles. For citations of journal articles, write out the full title of the journal:

Willis, E. O., and Y. Oniki. 1978. Birds and army ants. *Annual Review of Ecology and Systematics* 9:243-263.

- Book or Thesis:

Lack, D. 1954. *The natural regulation of animal numbers*. Oxford University Press, London.

Freeman, S. 1991. *Molecular systematics and morphological evolution in the blackbirds*. Ph.D. dissertation, University of Washington, Seattle.

- Book chapter or BNA Species Account: :

Walsberg, G. E. 1983. Avian ecological energetics. Pages 161-220 in *Avian biology*, vol. 7 (D. S. Farner, J. R. King, and K. C. Parkes, Eds.). Academic Press, New York.

Lowther, P. E. 1993. Brown-headed Cowbird (*Molothrus ater*). In *The birds of North America*, no. 47 (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, D.C.

- Website. Date in brackets indicates when information on the website was accessed:

White, G.C. 1999. Analysis of marked animal encounter data.

<http://www.cnr.colostate.edu/~gwhite/mark/mark.htm> (Jan. 2001).