

Guidelines for Technical Writing

The IMRaD Style

Much of the technical writing you will do will be in the style of a journal article, characterized by its structured Introduction, Methods, Results and Discussion (IMRaD). Although you have been reading such papers for years, it is far too easy to overlook the standard formatting that characterizes them. A general overview of this format and some specific guidelines follow. Note that not all papers will include every section as itemized below. As a general rule, you should follow the formatting protocols of a key journal in your field. Journals vary in their idiosyncratic details; just choose a format and be consistent. As an environmental professional, you have tacitly agreed to adhere to your field's norms—so follow the rules.

Introduction

Introduce the topic and why we are interested in it. Specifically, what is the purpose and rationale for doing what you did? Include a clear statement of your objectives. In some cases, it might read better to phrase these as specific research questions. If you have several, it often works well to enumerate these as an inset list. Close the introduction by anticipating your main results somewhat—in effect enticing the reader to finish the paper! In this section, it is perfectly acceptable to write in the first person, active voice (but see Results, below). An Introduction typically will be front-loaded with a bunch of references that establish the legitimacy and importance of the issue (see References for details, below).

Background

You need not have a section titled “Background” but rather, this information might be tucked at the end of the Introduction or at the beginning of the Methods, as appropriate. Tell the reader what we already know, where the gaps or uncertainties are, and how what you have done will fit into this framework. This would normally include a concise and synthetic review of the relevant literature (“synthetic” means there is some interpretation and packaging provided by you). Cite key papers that have framed the current state of knowledge. This review and synthesis helps establish your credibility to the reader. This occurs in two ways: you must demonstrate that you know the literature and the key papers that define the intellectual arena in your area, and you need to tell the reader how your work fits into this larger context.

Methods

Present all of your methods, including the study area, data collection and processing, and analyses at a level of detail so that others could reproduce your study exactly. This is often the hardest section to write, as it demands precision and clarity without unnecessary detail. Subsections (Study Area, Model Development, Data Collection, Analyses, etc.) help keep this section organized, although the subsections will depend on the application. You may include references to authorities on well known techniques, or equations and explanation of techniques that are less familiar (i.e., you needn't include equations for t -tests or other tools that most readers will already know). If the equation is quite simple ($A=\pi r^2$) you can include it in-line in the text. If it is more complicated, isolate it on its own line, numbered, with the terms defined on the following line. For example:

Semivariance is computed (Legendre and Fortin 1989):

$$2\gamma(d) = \frac{1}{n_d} \sum_i \sum_j w_{ij} (y_i - y_j)^2 \quad (1)$$

where y_i and y_j are values measured at locations i and j , respectively, w_{ij} is an indicator function that takes on a value of 1 if the two samples are in the same distance class, else 0. Semivariance essentially describes how sample dissimilarity varies with separation distance.

Make sure you explain in words what the equation says, and cite an authoritative source for the equation for readers who might want to pursue more information. An “authoritative source” is someone who motivates and explains the idea or method—not someone who happens to have used this same method in another application.

The text of this section should clearly convey the intent of the analysis: *why* you did what you did. As a litmus test, a reader unacquainted with your methods should get the gist of it and trust you for the rest. Importantly, another researcher should be able to reproduce your results by following your methods as you describe them.

Results

A Results section should simply present the results as clearly and concisely as possible. In many cases, tables and figures will be appropriate; figures often provide the most effective summary. These should be called from a narrative that highlights the main points. There should be no personal interpretation of the results in this section, although it is appropriate to provide some explanation or guidance for particularly complicated figures or tables. It often is easiest to keep the Results impersonal by writing in the third person voice, though this doesn't mean the writing needs to be dry or passive. An example of a sentence that highlights a key result is:

The number of patches shows a nonlinear relationship with the proportion of landscape occupied by forest (p), reaching a peak at approximately $p=0.30$ (figure 1).

as compared to an unfocused and lazy sentence (don't do this!):

Results are in figures 1-7.

Also, make the narrative the focus of this section, down-playing the figures and tables. You do this by choosing phrasing such as the first example (above) instead of:

Figure 1 shows the relationship between the number of patches and the proportion of the landscape occupied by forest (p).

Figures and Tables. Figures should be clear and as simple as possible, and should be interpretable by themselves, with just a brief caption. The caption goes *beneath* the figure. Tables should also be able to stand alone, with a short title *above* the table. Figures and tables should be numbered sequentially, beginning with the first one you call from the text, and should appear *after* you call them (i.e., at the end of the paragraph from which they are called). It is OK to embed the figure in the text if it does not break up the flow too much. For example, centering a figure after the calling paragraph is fine; elaborate word-wrapping around embedded figures can be distracting. If you have a lot of figures, you might consider stacking them at the end of the Results section, or even at the end of the document. Make sure the figures are large enough that

they can be easily read. Note that if you are using Excel or some other low-level graphics package, the software might want to default to figures that do not match these specifications; please take the time to override the defaults (remove the title, scale the axes appropriately, choose useful tick intervals, change the line widths and styles, and so on).

Discussion

Recap the main results without simply repeating them (don't be redundant), and remind the reader why they are important: tie them back to the framework you developed in the Background, and to the larger issues you raised in the Introduction. The Discussion also is the place where you can speculate or rant, injecting your own personal spin on the results. If you switched to third person in the Results, you may revert to first person in the Discussion again.

Since your discussion might range far from your specific results, it might be appropriate to collect the main points and conclusions into a closing section or paragraph that "finishes" your report, bringing it back if possible to the objectives you itemized at the end of your Introduction. That is, we hope that once you've finished the paper you can answer the questions that motivated the effort in the first place.

References

Citation styles vary among journals and especially among disciplines. One thing most journals *do* agree on: do not use footnotes for references. In general, cite parenthetically in the text, by author's name and date (Urban 2002). Multi-authored papers are cited by lead author (O'Neill et al. 1988). If you cite several papers at the same time, arrange them chronologically and then alphabetically (Abbot 1993, Costello 2000, Zeta-Jones 2000).

Websites are citable *only* if they are archival; in the text, cite them by author and date (NCDC 2005). In the reference list, report the full name and URL:

National Climate Data Center (NCDC). <http://www.ncdc.noaa.gov/oa/ncdc.html>. (May 27, 2005).

Websites that are not archival should not be cited except as *public communications*. Material that is not peer reviewed should be treated accordingly.

A personal communication is cited only in the text and is not included in the list of references. Cite the communication by name and affiliation (J. Franklin, University of Washington, *pers. comm.*). Unpublished data provided to you by others are cited the same way (D. Graber, Sequoia-Kings Canyon National Park Research Office, *unpublished data*). Data provided via archived websites are often cited as public communications (Triangle Greenprint, *public comm.*).