

A COLLECTION OF GRAMMATICAL POINTS

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Most of these points boil down to common sense. Very few of them are inviolable: your goals should be clarity and ease of expression. Read aloud what you have written, and make sure that it says what you mean to say. Be succinct.

1. Data: This word is plural. The singular is *datum*, a *piece* of information. Information is, but data are, data are, data are.
2. Less/few: Use *less* for quantities that aren't composed of identifiable units, as in "less water," "less light." Use *few* and *fewer* for quantities with identifiable units, as in "few animals," "fewer references."
3. Comprise/compose: Many people misuse the first of these words, which means "include." The whole *comprises* the parts. The parts *compose* the whole. "The study comprises five experiments." "The study is composed of five experiments." What does "is comprised of" mean?
4. Avoid noun phrases. Would you want to look something up in a Forest Rodent Age Distribution Survey Volume Index?
5. This/these/that/those: The "this" to which you're referring is probably clearer to you than it is to your readers. Say explicitly what you mean: "This conclusion," "These measurements," "Those species."
6. Only comes directly before the word that's "only." "He only died last week" means "That's all he did, he didn't do anything else, he only died." (Courtesy J. Thurber)
7. To split is an infinitive; in spite of being two words it is a single unit and should not be split. (You thought I was going to carelessly split it, didn't you?)
8. Which/that: This distinction is sometimes tricky; *which* is often wrongly used in writing that adopts a formal tone. Use *which* for a phrase that is set off by commas and simply gives further information about a group that is already fully specified. Use *that* for a phrase that restricts or defines the group in question. A *which* phrase may be optional, but a *that* phrase is usually essential for the meaning of the sentence. Say "The blue car, which is on the driveway, has blown a gasket" if there is only one blue car around, and you want to tell someone where to head with the tools; say "The blue car that is on the driveway has blown a gasket" if you don't want this person to waste time messing around with the perfectly intact blue car that is sitting on the street.
9. Passive: Avoid using the passive voice. Don't be bashful. Instead of saying, "The plants were measured weekly," say, "I measured the plants weekly," or, better, "I measured the plants daily."
10. Subjunctive: If I *were* to use the subjunctive incorrectly, then I would say, "If I *was* to use the subjunctive...."
11. A preposition is not a word to end a sentence with.
12. "Chocolate and/or salsa" means that at least one of chocolate and salsa is included and that both of them might be—which is exactly what the shorter and less awkward "chocolate or salsa" also means. In contrast, the exclusive or, "chocolate or salsa but not both," must be specified explicitly.
13. One can predate a check, but a predator must prey on its prey.
14. Affect/effect: In their common meanings, the first is a verb ("to change something in some way") and the second is a noun ("the change itself"). However, effect can also be used as a verb: "This

grammar handout effected change in student's writing.”

15. The abbreviations i.e./e.g.: The first means “that is” (Latin *id est*) and is followed by an explanation. The second means “for example” (Latin *exempli gratia*) and is followed by an example. Consider using the English equivalents instead, since everyone already knows what they mean.
16. If you begin a list with *for example* or *such as*, then you needn't end it with *and so on* or *etc.*
17. Get is often clunky. It might be gotten rid of.
18. Hopefully: Don't use this word unless you are describing something as “full of hope.” It does not mean ‘I hope that . . .’ It does not even mean “It is to be hoped that...”
19. Enormity refers to a monstrous, evil outrage; use something else when you mean bigness.
20. Negatives: telling what something *isn't* is less direct than telling what it is, and often requires the reader to stop and decipher your meaning. If “This lake is not unlike the lakes in Minnesota,” what is it like?
21. Use thus and therefore only when you deserve them.
22. Apostrophe: *Its* main use is in contractions; *it's* not used in possessive pronouns (*his, her, hers*). If *you're* careful, then *your* writing will be a model of wonderfulness.
23. Dangling modifiers: A descriptive phrase without an explicit subject generally applies to the subject that is nearest to it—which may not have been its intended target. “Waving its tentacles, the student saw a rotifer devour two paramecia.” “Reanalyzing Van Valen's data, the trilobites quickly went extinct.” “Though a bit simplistic and vague, I hope it helps.” “Beat batter until lumpy.”
24. Alot: many folks use this term a lot, but it ain't a real word.
25. Putting words in “quotation marks” can “make” them look “silly.”
26. Parenthetical comments can liven up your prose by making it more conversational, but in scientific writing they can distract as well as inform. If something is important, then come out and say it directly.
27. The Royal We: As Mark Twain says, “The only people who should use the Royal We are editors and people with tapeworms.”
28. Punctuate clearly. A full stop is often a good start.
29. Use commas to show the structure of sentences, rather than to suggest vocal nuances in their delivery. Inserted phrases should get punctuation at both ends or neither. “Yet [pause] he never forgot her” gets no comma, although we are hanging on every word.
30. Consistently using a comma as well as an and before the last member of a list may seem redundant, but its extra clarity lets your readers keep track of any subgroupings with a glance. Otherwise, when you write about “the theatre of Godot, Cleopatra and Groucho, Harpo and Chico,” your readers will wonder why Groucho is on stage with Cleopatra instead of with his brothers. For the price of two commas you get “Godot, Cleopatra, and Groucho, Harpo, and Chico,” and your readers will be slightly less puzzled by the mysteries of human affinity.
31. When you use a comparative, tell explicitly what you are comparing (unless you are writing advertisements, in which case “More!” and “Whiter!” are great by themselves).
32. Whether or not rarely means anything more than *whether*. Ditto for *irregardless* and *regardless*;

prior to and *before*; *subsequent to* and *after*; *is indicative of* and *indicates*; *is helpful* and *helps*; *in order to* and *to*.

33. Whence means “from where.” What does “from whence” mean?
34. The word species is the same in both singular and plural. Table I shows some common patterns ‘for forming plurals of words derived from Greek and Latin.

Singular	Plural
Alga	Algae
Ascus	Asci
Criterion	Criteria
Datum	Data
Fish	Fish (all same species)
Fish	Fishes (at least two species present)
Fungus	Fungi
Genus	Genera
Larva	Larvae
Locus	Loci
Medium	Media
Octopus	Octopuses or octopi
Phenomenon	Phenomena
Phylum	Phyla
Pupa	Pupae
Species	Species
Taxon	Taxa

35. The fact that one can begin a sentence this way does not mean that one should. It goes without saying that the phrase that begins this sentence should be omitted. It is evident that beginning a sentence with an abstract “It” can be ponderous and indirect. What is wrong with the beginning of this sentence is that it is awkward. What it is, is redundant.
36. The reason why is redundant, and the reason is because *reasons* are already *why*.
37. Green colored: What do you expect something to be—green shaped? (Weed your verbiage!)
38. Beware of run-on sentences and be sure to use a short word when a polysyllabic one is unnecessary (*use* vs. *utilize*, *turkey* vs. *autoproctophragmotist*).
39. It may seem obvious that two or more subjects, even when conceptually linked, take a plural verb, yet phrases like “The abundance and distribution of animals constitutes the principal subject matter of ecology,” crop up in embarrassingly conspicuous places. “There’s my mom and dad.” “Where’s your shoes?”
40. Be consistent in your use of tense. The past tense is usually appropriate for descriptions of what you did or observed, the present tense for general statements about nature.
41. Capitalize all Latin taxonomic names except the species part of a binomial. Either italicize or underline all Latin names for genera and species, but treat adjectives made from taxonomic names as normal English words: “*Homo*,” but “hominid” “*Rosaceae*,” but “rosaceous.”
42. Is, are, and other forms of to be provide only vague information about the relationship between the words on either side of them: this verb may, for instance, define, describe, equate, or identify members of a set. Any time you write one of these words (or forms of the only slightly less vague to have), ask yourself whether a more specific verb might convey your meaning more clearly.

43. Position and emphasis: Words at the beginning or the end of a phrase automatically receive extra emphasis, and placing important words there can help reinforce your point. In contrast, the wording of, “This is an exciting result” emphasizes not that what you have found is exciting, but that it is a result. “This result is exciting” is somewhat better; recasting this sentence as part of a more informative one, such as, “This exciting result shows that . . . improves it even further.
44. Don’t be afraid to repeat a word in parallel constructions. Although varying your choice of words can often make your writing more lively, using synonyms simply for the sake of variety can distract the reader by suggesting misleading distinctions. For example, “First we counted the papaw trees and then we tallied the hedgehogs,” can leave the reader pondering the difference between *counting* and *tallying* rather than your exciting discovery about hedgehogs and papaw trees.

writing with precision, clarity, and economy

*To be good is noble; but to show others
how to be good is nobler and no trouble.*

Mark Twain (1899)

The Instructions to Authors for *Ecology and Ecological Monographs* include the statement: "Write with precision, clarity, and economy." This wonderfully self-illustrative sentence contains some of the most important instructions given to prospective authors, yet it is probably the most overlooked. Based on my experience as a subject editor for the past three years, I contend that verbiage, obscurity, and imprecision in manuscripts slow the editorial process and ultimately hamper communication. Many of my comments and solutions will sound familiar. They should. Our familiarity with them does not, however, make them less important.

Writing with economy.—Inclusion of extraneous material and redundancy between

sections of a manuscript are two big enemies of economical writing. Whole paragraphs often appear in Introductions and Discussions that are only tangentially related to Results. An Introduction should clearly state the manuscript's subject and place it in broad context (the "Big Picture"), then **swiftly focus on the specific question(s)** that the manuscript addresses. Because of the current emphasis on testing hypotheses in ecology, editors now commonly see each alternative hypothesis erected and discussed at length in a manuscript's Introduction, Discussion, or both. Taken to an extreme, such treatment wastes a lot of print.

Redundancy between Results and Discussion is also common. One way to avoid this duplication is to compare drafts of the Results and Discussion line by line, **eliminating sentences in the Discussion that merely paraphrase results.** Although the reasons

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vary, the Discussion is certainly the section most likely to contain rambling prose. A Discussion longer than one-third of the manuscript should alert the author to check for over-interpretations of the data and irrelevant musings.

Consecutive paragraphs in a poorly written manuscript can often be collapsed into one by eliminating unnecessary sentences. Some authors seem to need a "running start" in each paragraph: they repeat statements made elsewhere, even statements in the preceding sentence. Others seem reluctant to eliminate any sentence once inserted into the text; for whatever reason, the result is a series of loose sentences, each of which says little. And still others try to salvage an awkward sentence instead of scrapping it and starting over (e.g., "Survivorship among later other cohorts that were studied followed similar patterns"). Sentences beginning with the hackneyed construction: "There is (are) . . ." are common in *Ecology*.

Bad syntax makes sentences long, convoluted, and incomprehensible. Compound sentences, used correctly, can link closely related ideas clearly and concisely. Take this run-on sentence, for example: "Evaluation of dating methods, including identification of historically documented cultural horizons in profiles of regional pollen, a 20th-century increase in sediment concentrations of grassland-produced opal phytoliths, ^{210}Pb , and ^{14}C prompted recommendations that ^{14}C dating be restricted to deposits older than 500 yr because confidence intervals approach the radiocarbon age in younger samples and because pollen and ^{210}Pb can provide precise chronologies for sediments deposited since human settlement." A semicolon (plus elimination of verbiage) clears the fog: "Deposits older than 500 yr were dated with ^{14}C ; younger deposits were dated with ^{210}Pb or by identifying cultural horizons with diagnostic pollen or opal phytoliths." A paragraph in which each sentence is followed by an excessively long string of citations frustrates comprehension, particularly when the sentences are the interconnecting pieces of an argument. (I once encountered a simple declarative sentence followed by 26 citations.) So-called freight train strings of adjectives (e.g., "the now actively growing, adult caespitose alien grasses") are a similar though more commonly recognized problem.

Superfluous words also slow down comprehension. We often write with the same verbosity permissible in conversational English. Consequently, I suspect that some manuscripts are transcripts from dictation. A conscientious author can easily eliminate these crutches from his manuscripts; Hart (1976), Day (1983), and Strunk and White (1979) in their excellent *The Elements of Style* all illustrate superfluous expressions. I have assembled expressions that are among those most annoying to me, along with more succinct alternatives, in Table 1. My list was compiled from just six manuscripts submitted to *Ecology*; the potential list of phrases and words to be avoided is, of course, much longer.

Although my intent is not to poke fun at any class of authors, manuscripts prepared from dissertations are the high-grade ore of the problems I discuss here. These are rarely in a form suitable for publication. Often the syntax is ponderous and stilted (i.e., passive voice, nondescriptive verbs, and excessive use of negative clauses). Furthermore, the conversion from dissertation to manuscript often seems to have been made in great haste. For example, the statement "(see Chapter III)" was inadvertently left in the text of one manuscript I edited. The marching orders for those preparing manuscripts from theses should be to prune words ruthlessly. All who supervise graduate students should ensure that their students gain a lot of experience in writing concisely and clearly. A primer such as *The Elements of Style* should be issued to each beginning graduate student, and the student should master its contents.

I am not advocating that our journals be reduced to collections of papers with staccato phrases, like the documentation for computer programs. I also do not favor changing our journals to the style of reports in *Science* or letters in *Nature*. But a recent comment by Leslie Real, another editor for *Ecology*, deserves careful assessment. He reports that some ecologists consider *Ecology* and *Ecological Monographs* to be "archival" compared to more "communicative" ecological journals. Perhaps they have gained this impression because some papers are unnecessarily long. If progress is directly related to communication, Real's observation bodes ill for the future of our journals.

Table 1. Common expressions with superfluous words (left column) and suggested substitutes (right column).

The purpose of this study was to test the hypothesis	I (or We) hypothesized
In this study we assessed	We assessed
We demonstrated that there was a direct	We demonstrated a direct
were responsible for	caused
played the role of	were
On the basis of evidence available to date	Consequently
In order to provide a basis for comparing	to compare
as a result of	through; by
for the following reasons	because
during the course of this experiment	during the experiment
during the process of	during
during periods when	when
for the duration of the study	during the study
the nature of	(eliminate by rearrangement)
a large (or small or limited) number of	many (or few)
conspicuous numbers of	many
substantial quantities	much
a majority	most
a single	one
an individual taxon	a taxon
seedlings, irrespective of species	all seedlings
all of the species	all species
various lines of evidence	evidence
they do not themselves possess	they lack
were still present	persisted; survived
the analysis presented in this paper	our analysis
indicating the presence of	indicating
despite the presence of	despite
checked for the presence of	checked for
In the absence of	without
a series of observations	observations
may be the mechanism responsible for	may have caused
It is reasonable to assume that where light is not limiting	With light not limiting
In a single period of a few hours	In a few hours
occur in areas of North America	are in North America
adjacent transects were separated by at least 20 m	adjacent transects were at least 20 m apart

Table 1. Continued.

in the vicinity	nearby
separated by a maximum distance of 10 m and a minimum distance of 3 m	3–10 m apart
the present day population	the current population; the population
their subsequent fate	their fate
whether or not	whether
summer months	summer
are not uncommon	may be
due to the fact that	(eliminate by rearrangement)
showed a tendency toward higher survival	had higher survival
devastated with drought-induced desiccation	killed by drought

Journals avoid becoming merely archives in part by stressing that all *accepted* manuscripts convey justification, results, and tightly reasoned arguments in crisp, clear sentences and a logical sequence of coherent paragraphs. As William Strunk said, "Vigorous writing is concise." Through careful editing, the purpose of each paragraph, each sentence, and each word in a manuscript should be apparent and defensible. That position may strike many authors as extreme, but I think it is nevertheless a useful goal. The excuses for not taking such care have largely evaporated with the widespread availability of word processors, which make successive revisions convenient and quick.

Editing sometimes yields unexpected results. Most societal journals are budgeted for a maximum number of pages that may be printed each year; the current budget for *Ecology* and *Ecological Monographs* allows 2725 pages. The advice from reviewers and editors may help an author trim so many unnecessary pages that in effect another author's *whole manuscript* can be published. The obvious benefits of that effort are shared by all prospective authors.

A deluge of publications is a permanent part of our professional lives. To an increasing degree, manuscripts not written with economy of expression will receive the Churchillian judgment: "This paper, by its very length, defends itself against the risk of being read." (as cited in Manchester 1983).

Writing with clarity and precision.—Dictionary definitions of *clarity* are: "clearness or lucidity as to perception or understanding; freedom from indistinctness or ambiguity" (*Random House Dictionary of the English Language* 1971). In practice, clarity may simply mean *comprehensibility upon first reading* (J. R. King, *personal communication*). Despite the obligation to be clear in reporting our methods and results and the results and interpretations of others, problems commonly arise in manuscripts. Yet solutions sometimes appear from unexpected sources. For example, conversational English is often verbose, but it is usually clear. And some of its clarity can be effectively incorporated into manuscripts. Use of the first person avoids ambiguity in the description of experiments ("I divided the population into three equal groups.") and the presentation of opposing positions ("We believe Smith's (1983) contention is supported by his results, although Jones (1985) disagrees.").

Hurlbert (1984) urges editors to insist that the experimental design be described in sufficient detail to permit repetition by the reader. This straightforward practice can reveal ambiguities or missing pieces in the description of a design, and should always be employed by the author before submitting the manuscript. The practice might also reduce cases in which an editor inadvertently changes the meaning of a sentence (a common complaint of authors) because he or she guessed incorrectly about the sentence's murky meaning. Much misinterpretation also arises through reference to an indefinite antecedent, as in: "The radiocarbon dates define isochrones along the transect that establish a series of stratigraphic profiles. These provided the geomorphic basis for all subsequent analyses." Does "These" refer to the radiocarbon dates, the isochrones, or the profiles?

Improper word choice also creates ambiguities. The incorrect use of "which" and "that" continues to plague manuscripts. As the *CBE Style Manual* (1983) points out, "which" should only be used for nondefining, nonrestrictive clauses or phrases; i.e., those beginning with "which" add some nonessential information about the subject of the sentence. "That" introduces restrictive clauses or phrases in which the information answers the question "which one?—that one." Use

"while" to mean "during the time of" and not as a substitute for "although," "whereas," "as," "but," or "and" (Hart 1976). Neologisms will always be necessary in science, but jargon obscures clarity (e.g., "die-off," "root-wad," "feedforward"). An author using a phrase with no single, fixed meaning, such as "spatial and temporal pattern" should define it clearly.

By definition *precision* is intertwined with *clarity*. *Precise* means "definitely or strictly stated; being exactly that and neither more nor less; being just that and no other; carefully distinct" (*Random House Dictionary of the English Language* 1971). Nonetheless many common pitfalls occur through imprecise language alone. Instead of stating that "many" (or "few") organisms live in the area, state the number (even if in parentheses). Do the same for distances. Were the plants "in the vicinity of" each other (a phrase I consider verbose), "near" each other, or were they "adjacent to" each other, i.e., "juxtaposed"? The prepositions "to" and "with" are often used imprecisely. One compares something "to" something that is dissimilar ("of a different order," Strunk and White 1979), but compares something "with" something that is related (or at least not of a different order). As the editors for the British Ecological Society point out: "Your reputation will not be enhanced by a permanent record of woolly thinking." (British Ecological Society 1978).

Precision can also be foiled by a word with multiple definitions. For example, a factor may "decimate" or "devastate" a population. "Decimate" can mean to reduce by one-tenth (as well as to reduce by a great number or proportion), although "devastate" always means lay waste, i.e., cause great destruction (*Webster's Third New International Dictionary* 1963). Frequent use of an unabridged dictionary is the obvious and probably the unavoidable solution.

Conclusion.—Good writing will not make bad science good (the proverbial sow's ear into silk purse), but poor writing can prevent good science from receiving the recognition it deserves. We all can list examples of similar points made in contemporaneous papers: one paper is often cited, the other languishes in obscurity. Not only do manuscripts vie for journal space; they ultimately vie for recollection by readers. Memorable papers are clear, brief, and forceful. No one would willingly

consign his work to obscurity, but we do so with imprecise, ambiguous, and verbose manuscripts.

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Twenty-One Suggestions for Writing Good Scientific Papers:

Notes on Writing Papers and Theses

1. *Know your audience and write for that specific audience.*

Scientific and technical writing can almost never be 'general purpose'; it must be written for a specific audience. For the kinds of writing addressed here, that audience will generally be the community of ecologists who read a particular journal or study a particular subject. This community is represented by your professor for class papers. In all cases, you must adopt the style and level of writing that is appropriate for your audience. Stylistic conventions and acceptable jargon can vary tremendously from one field to another, and to some extent, from one journal to another. If you are unfamiliar with the conventions of a field, study them as they are manifested in a selection of highly regarded papers and in the "**Instructions for Authors**" for key journals.

2. *Your supervisor/professor is not here to teach you basic grammar and spelling.*

The more time and emotional energy she or he spends on correcting basic English usage, the less remains for issues of content or fine-tuning. You are responsible for mastering the basics of the language; save your supervisor's time for more substantive issues. A few glitches and non-parallel tenses will slip through your own careful editing, but there is no excuse for frequent ungrammatical sentences. Similarly, with word processors and spellcheckers having become standard writing tools, typos or other spelling errors should be very rare. Use a spelling checker before submitting anything for anyone else's reading.

If you find you are about to submit a paper that you know contains poor writing, consider why you are doing so. If there is a writing problem with which you are having a hard time (for instance, organizing the structure of an argument in its most effective form), it is legitimate to submit this for someone else's review with the problem highlighted as a focused request for assistance. Otherwise, submitting a piece of writing with known errors or problems means either: (1) you do not consider your writing worth improving, (2) you do not respect the reader enough to present writing that is as good as you can make it, or (3) you are incapable of improving the writing. Every piece of writing, at some point, is as good as its writer can make it without outside review. That is the time to give it to your supervisor.

3. *Do Not Turn in a First Draft!*

Ever! Most people's first drafts are terrible. I would not make anyone else suffer through mine. Don't make others suffer through yours. I have read early drafts of papers by eminent ecologists whose final products are jewels of English construction. Their first drafts are terrible too. "**Good writing is rewriting**," and you should make a serious effort at editing, rewriting, and fine-tuning before you give the manuscript to anyone else to

read. There are few things more frustrating to read than a paper in which you know there are pearls of wisdom, but where sloppy and ambiguous writing hides those pearls. The chapters of my Ph.D. thesis had been through 3-5 drafts before anyone on my advisory committee ever saw them. If you need to put a piece of writing away for a few days before you can approach it dispassionately enough to rework it, do so.

It takes much longer to read poor writing than good writing. **It** is a waste of an advisor's or editor's time to read material that is not yet ready to be presented - and it is disrespectful to expect them to do so. When an advisor receives a thesis in which -the writing is poorly developed, expect them to go through enough of it to demonstrate the kinds of changes required, and then return it with the rest unread.

Consider forming a mutual editing team with other students to review each other's work. Publication quality scientific writing is usually a product of the research community rather than the sole effort of the author(s): reviewers and editors make a big difference to the vast majority of published papers. You should become accustomed both to reviewing other people's work and to having your own reviewed.

4. *Get and use stylebooks.*

All aspiring ecologists should have a library of books that supports their technical communication. Distinguish between those that are primarily manuals of accepted rules, those that address how to create a draft (e.g., disconnecting the creative from the critical voice, etc.), and those that focus on rewriting. I recommend Williams (1990) as a manual for rewriting. Williams focuses on how to turn a draft into a finished product.

5. *Avoid abusing word forms.*

Use words in the form that conveys your meaning as clearly and simply as possible. A variety of writing problems arise from using verbs and adjectives as nouns. Such word forms are called nominalizations (Williams 1990). Consider the sentence, "The low rate of encounters **was** a reflection of population density reductions." The verbs, "to reflect" and "to reduce" are used as nouns, and the sentence is more turgid and less direct than when they are used as verbs: "The low rate of encounters reflects a reduced population density." Some nominalizations are both useful and effective, as in "taxation without representation." Williams (1990) has an excellent discussion of useless and useful nominalizations.

Creating **awkward** phrases where nouns and verbs are used as adjectives or adverbs is another common problem leading to awkward and wooden writing. In his delightful critique, Hildebrand (1981) called nouns used this way "adjectival nouns." Such constructions **are** almost invariably clumsy and unclear. For instance, unless specifically referring to a document, "the Chilko Lake park proposal" is not as good as "the proposal

for a park **at** Chilko Lake." The **first** form illustrates both a nominalization ("proposal" as noun **vs.** verb) and adjectival nouns ("Chilko Lake" and "park" as adjectives modifying "proposal" **rather** than nouns).

6. *Do not use more words where fewer will do.*

Do not use long words where short ones will do. A good example is using "utilization" when "use" will do. Do not use jargon where regular language will do. Another example is the use of "in order to." Any time you write that phrase, delete it and replace it with "to." You will find that it does the job nicely. Do not use special words to make your writing seem more technical, scientific, or academic when the message is more clearly presented otherwise.

7. *Use an outline to organize your ideas and writing.*

When you first start a writing project, make an outline of the major headings. List the key ideas to be covered under each heading. Organize your thinking logic and the logic of your arguments at this level, not when you are trying to write complete, grammatical, and elegant sentences. Separate out the three tasks of: (1) figuring out what you want to say, (2) planning the *order* and *logic* of your arguments, and (3) crafting the exact language in which you will express your ideas.

It is very easy to write and expand outlines with word processors. When starting a writing project, I create a file in which I first develop an outline as described above. I save a copy of the outline separately and then commence the writing by expanding the outline section-by-section. I usually get ideas for later sections while writing earlier ones and can easily page down and write myself notes under later section headings. This is especially useful for filling out the structure of a Discussion while writing the Results. (for instance, "When discussing the removal experiment, don't forget to contrast Karamozov's 1982 paper - his Table 3- with the astonishing results in Figure 7.") By the time I get to writing the Discussion, the outline has usually been fleshed out substantially and most of the topic sentences are present in note form.

8. *Think about the structure of paragraphs.*

Poorly structured paragraphs are one of the most common problems found in student writing. Though most students can write reasonable sentences, a surprising number have difficulty organizing sentences into effective paragraphs. A paragraph should begin with a topic sentence that sets the stage clearly for what will follow. One of my most frequent comments on student papers is that the contents of a paragraph do not reflect the topic sentence. Make topic sentences short and direct. Build the paragraph from the ideas introduced in your topic sentence and make the flow of individual sentences follow a logical sequence.

Many writers try to finish each paragraph with a sentence that forms a bridge to the next paragraph. Paying attention to continuity between paragraphs is a good idea. However, such sentences are often better as a topic sentence for the following paragraph than a concluding sentence of the current one. It is nice to conclude a paragraph by recapitulating its main points and anticipating what follows, but you should avoid statements of conclusion or introduction that contain no new information or ideas.

Strive for parallelism in structure at all times. When you present a list of ideas that you will explore further ('Three hypotheses may account for these results: hypothesis 1, hypothesis 2, hypothesis 3.'), make sure that you address the ideas in the same sequence and format in which you have presented them initially. It is both confusing and frustrating to read a list presented as '1, 2, 3, 4,' and then find the topics dealt with '1,4,3,2.'

Think about how the structure of your paragraphs will appear to the reader who is reading them for the first time. The reader should not have to read the text more than once to understand it. Carefully lead the reader along so that the structure of your argument as a whole is clear, as well as where the current text fits in it.

Paragraphs containing only one or two sentences are rarely good paragraphs because they can't develop ideas adequately. Two-sentence paragraphs usually represent either misplaced pieces of other paragraphs or fragments of ideas that should be removed or expanded. Outlining helps pull topics together. They may initially appear that a separate paragraph is needed to define each when, in fact, the topics are quite related and can be included in the same paragraph.

Choppiness both within and among paragraphs often results from the ease with which we can cut and paste text on the computer. Ideas that were written separately but belong together can be moved easily. Unfortunately, they often still read as if they were written separately. This is a great way to structure a draft. However, you *must* read over such text for continuity before submitting it to others for review.

It is difficult to read for continuity on the computer screen because you can see so little text in front of you at any given moment. It is also more difficult to flip over several pages to scan for repetition, parallel structure, etc. To do a really good job of proofing a paper, most writers find it necessary to read hard copy at some point during the writing/rewriting process. Print all but final drafts on paper that has been used previously on one side.

9. □ Pay attention to tenses.

Problems of inappropriate or inconsistent tenses are common in student writing. What you, or others, did in the past should be stated in the past tense (e.g. data were collected...."). Events or objects that continue to happen or exist can be described in the

present tense (e.g., "in this paper, I *examine*..... The data reject the hypothesis that.....). Events that will take place in the future can be in the future tense. Whatever tense you choose, be consistent. Be careful in using "might," "may," and "would" (as in "this might indicate that..."). They are frequently used as ways of weaseling out of making a clear statement.

10. □ *Captions should not merely name a table or figure, they should explain how to read it.*

A caption (figure or table heading) should contain sufficient information so that a reader can understand a table or figure, in most cases, without reference to the text. While very simple tables and figures may require only a title for clarity, and exceptionally complex ones may require reference to the text for explanation, these circumstances are rare. Captions are often most effective when they briefly summarize the main result presented in the table or figure. Do not leave caption writing to the end of the project; write captions when you organize your Results section and it will help you write the text.

11. □ *When citing a reference, focus on the ideas, not the authors.*

Unless the person who reported a result is an important point in a statement, literature citations should be parenthetical, rather than in the body of the sentence. For instance, in most cases, it is preferable to write a sentence of the form "Though mean growth rates in Idaho were < 10 cm per year, growth rates of > 80 cm are common in populations in Alberta (Marx 1982)." rather than "Though mean growth rates in Idaho were < 10 cm per year, Marx (1982) found growth rates of > 80 cm to be common in populations in Alberta." Sometimes the identity of the writer is important to the meaning of a statement, in which case emphasis on the citation is appropriate (e.g., "While Jones (1986) rejected this hypothesis, Meany's (1990) reanalysis of his data failed to do so.').

12. □ *Show us don't tell us.*

Rather than telling the reader that a result is interesting or significant, show them how it is interesting or significant. For instance, rather than "The large difference in mean size between population C and population D is particularly interesting," write "While the mean size generally varies among populations by only a few centimeters, the mean size in populations C and D differed by 25 cm. Two hypotheses could account for this...." Rather than describing a result, show the reader what they need to know to come to their own conclusion about it.

13. □ *Write about your results, not your tables, figures, and statistics.*

Confusing and disjointed Results sections often arise because the writer does not have a clear idea of the story she/he intends to tell. The frequent consequence of this is a Results section consisting of a long, seemingly unrelated sequence of tables and figures. We

often go through a lengthy and convoluted process in understanding the content of a data set; your paper need not document all the twists and turns of that process. Expect that you will produce many more figures and perform many more statistical tests than will be included in the final written product. When preparing to write your results, decide on the elements of the story you wish to tell, then choose the subset of text, figures, and tables that most effectively and concisely conveys your message. Organize this subset of tables and figures in a logical sequence; then write your story around them.

Novice writers of scientific papers frequently pay too little attention to discussing the content of tables and figures. They sometime merely present a list of references (e.g., "Table I shows this result, Table 2 shows that result, Figure 1 shows the other result."). When writing Results sections you should use the tables and figures to illustrate points in the text, rather than making them the subject of your text. Rather than writing, "Figure 4 shows the relationship between the numbers of species A and species B," write "The abundances of species A and B were inversely related (Figure 4)." Distinguish between your scientific results and the methodological tools used to support and present those results.

14. Focus on ecological hypotheses, not statistical hypotheses.

Most students have learned the importance of having and testing clear hypotheses. Unfortunately, many focus their writing on statistical hypotheses, not ecological hypotheses. Statistical hypotheses are generally a trivial consequence of standard approaches to statistical inference, such as the null hypothesis of no difference between two populations. They rarely have inherent ecological significance and are meaningful only in the context of the specific test being performed. Focus your writing on the ecological hypotheses underlying your research (e.g., that species A is influenced by processes X and Y in a specific way, resulting in different growth rates in habitats S and 1), not the statistical null hypotheses required to test specific predictions of those ecological hypotheses (e.g., there is no difference in growth rates among populations of species A in habitats S and 1).

15. Develop a strategy for your Discussion.

Many novice paper writers begin their Discussion section with a statement about problems with their methods or the items in their results about which they feel most insecure. Unless these really are the most important thing about your research (in which case you have problems), save them for later. Begin a Discussion with a short restatement of the most important points from your results. Start with what you can say clearly based on what you did, not what you cannot say or what you did not do. Use this statement to set up the ideas you want to focus on in interpreting your results and relating them to the literature. Use sub-headings that structure the discussion around these ideas.

16. Introductions and conclusions are the hardest parts - plan on spending a lot of time on them.

Many technical writers prefer to write their introductions last because it is too difficult to craft that balance of general context and specific focus required for a good introduction. Often it is easier to achieve this after you have already worked through writing the entire paper or thesis. If you need to write the introduction first to set the stage for your own thinking, resist the temptation to perfect it. The introduction will likely need substantial modification by the time you have finished the rest of the paper. The same concerns apply to conclusions, abstracts, and summaries. These components of the paper are all that many people will read, and you must get your message across in as direct, crisp, and enticing a manner as possible. Plan on taking your time and giving these components several more drafts than the rest of the paper.

17. *Break up large projects into small pieces and work on the pieces.*

Don't write a thesis; write chapters or papers. Many thesis writers have a hard time starting to write because they are intimidated by the huge project looming ahead of them. As a result, their first few months' efforts are often awkward and disjointed, as well as sparse. The thesis should be separated into small discrete sections, ideally distinct publishable papers. The overall organization of ideas should be done during the planning stage so that when you work on individual sections you can concentrate on them.

Don't wait until you think you have completed all your analyses to start writing. 'Parallel processing' of writing one chapter while you complete the analyses for others and make presentation quality figures is a good strategy for avoiding writer's burn-out. Writing and analysis for any given chapter or paper is often an iterative process. Writing the results section of a paper is often the best way to discover the analyses and figures that still need to be done.

18. *Make your writing flow and resonate.*

Probably the most frustrating and useful review I have received was from my master's advisor on a draft of a paper from my M.S. thesis. He said that all the key points were there and that the writing was clear, but it did not 'flow and resonate.' He sent me back to rework it, and, eventually, the published product did 'flow and resonate' (at least we thought so).

Once or twice a year I come across a paper that is written so well it is a joy to read. If the content is as good as the writing, the experience of reading it can shape my thinking

for some time thereafter. Papers written so well that they 'flow and resonate' are much more likely to influence your readers than the equivalent message presented in a form that is merely clear. When you find a paper that succeeds in this, study carefully how the authors constructed their arguments and used language; try to identify what makes the paper work so well.

19. □ Use word processors effectively and back up your work religiously.

Computers have improved tremendously the ease with which we can edit, shuffle, rewrite, and spell-check a paper. To do this efficiently requires investing time in learning about your tools. You need not learn how to use all the more exotic features of your word processor, but learn the options that are available and how to find out the details when you need them. Minimally, be familiar with basic requirements for document formatting (character and paragraph formatting, how to make lists with hanging indents, page organization, etc.) and basic operating system requirements (copying and saving files, doing directory searches). The same comments apply to the use of statistical packages, graphics programs, and spreadsheets. It is often possible to get the job done with little finesse in manipulating your software, but you will usually do a better job more efficiently after some investment in technical skills.

Almost everyone seems to require their own personal disaster to convince them of the need for backing up important files regularly. The frequency of 'lost file' based excuses for late papers is remarkable. I save files to my hard drive frequently during working sessions and at the end of each session I make a back-up copy of any file that I would mind losing. The working memory of your computer is transitory and easily purged of its contents. Individual hard and floppy disks are little better as permanent storage forms. Redundant copies dispersed in space and time are your main hope for avoiding disasters. When you have invested a lot in a writing project such as a thesis that is nearing completion, keep at least one at school at all times - in addition to your working copy on a hard drive. Keep sample hard copies of recent drafts until you complete the project.

20. □ Take editorial comments seriously.

It may be clear from an editor's comments that they did not understand the point you were making. If so, that is a clear indication that you need to improve your writing. □ Also, an editor, no matter who they might be, has invested their time to help improve the quality of your writing. □ Respect their investment.

21. □ One Last style suggestion: limit the use of prepositional phrases at the start of sentences and limit the use of 'the.'

It is very easy to start a sentence with a prepositional phrase, however, it often causes the main point of the sentence to be lost. Reread a sentence that starts with a prepositional phrase but place the phrase somewhere within the sentence, even at the end. You will often find that the sentence reads more clearly with the prepositional phrase buried within the sentence or that you do not need the phrase at all.

'The' is probably the most overused word in the English language. When rewriting your first draft, think about whether or not the placement of every "the" is necessary. For example: "The samples were taken using a Ponar dredge" reads Just as well when written

as 'Samples were taken using a Ponar Dredge.' The only difference is the latter sentence is neat, tidy, and to the point.

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FUNNY RESEARCH DEFINITIONS

The following phrases, frequently found in technical writings, are defined here for your edification and enlightenment. This list was plagiarized from some unknown genius who evidently read one too many scientific papers.

IT HAS LONG BEEN KNOWN: I haven't bothered to look up the original reference.

OF GREAT THEORETICAL AND PRACTICAL IMPORTANCE: Interesting to me.

WHILE IT HAS NOT BEEN POSSIBLE TO PROVIDE DEFINITE ANSWERS TO THESE QUESTIONS: The experiments didn't work out, but I figured I could get a publication out of it.

EXTREMELY HIGH PURITY: Composition unknown except for the exaggerated claims of the supplier.

THREE OF THE SAMPLES WERE CHOSEN FOR DETAILED STUDY: The results on the others didn't make sense and were ignored.

ACCIDENTLY STAINED DURING MOUNTING: Dropped on the floor.

HANDLED WITH EXTREME CARE DURING THE EXPERIMENT: Not dropped on the floor.

TYPICAL RESULTS ARE SHOWN: The best results are shown.

PRESUMABLY AT LONGER TIMES: I didn't take the time to find out.

THESE RESULTS WILL BE REPORTED AT A LATER TIME: I might get around to this sometime.

THE MOST RELIABLE VALUES ARE THOSE OF JONES: He was a student of mine.

IT IS BELIEVED THAT: I think.

IT IS GENERALLY BELIEVED THAT: A couple of other guys think so too.

IT MIGHT BE ARGUED THAT: I have such a good argument for this objection that I shall raise it.

WITHIN A MAGNITUDE OF: Wrong.

IT IS HOPED THAT THIS WORK WILL STIMULATE FURTHER WORK IN THE FIELD: This paper is not very good, but neither are any of the others on this miserable subject.

THANKS ARE DUE TO JOE GLOTZ FOR ASSISTANCE WITH THE EXPERIMENT AND TO JOHN DOE FOR VALUABLE DISCUSSIONS: Glotz did the work and Doe explained what it meant to me.