HOW TO WRITE GOOD

Technical Writing Tips by Al Zale
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Technical writing is just as important **a tool in your professional repertoire** as a comprehensive understanding of fisheries science, as proficiency in experimental design and statistical techniques, and as expertise in laboratory and field techniques. Accept the fact that you're going to have to get good at it and work as hard to achieve that goal as you do on other components of your graduate education.

Most of us are poor writers when we start grad school. Moreover, virtually *all* of us are poor *technical* writers at that juncture, simply because we are inexperienced in that form. I certainly was. Despite my getting all As in composition K through 12 and as an undergrad, my major professor wrote more in red ink on the first draft of my MS proposal than I had written originally in black. We get better with experience–both experience in writing *and reading* technical literature. A common error by grad students, doubtless exacerbated by a lack of time, is to read technical articles only for their content and to ignore writing style, technique, and organization. Avoid this pitfall, especially when preparing to write. **Study and emulate the writing style of successful (i.e., published) authors**; use their work as a template when writing about similar studies or experiments you have conducted. How do they structure sentences, paragraphs, and sections? Emulate their Introductions and Methods sections when writing your proposal. Analyze how they got complex points across to you simply and tersely and use those same tactics in your writing. Emulating writing *style* is not plagiarism.

Having **a unique personal writing style guarantees poor technical writing**. Good technical writing reads as if you wrote it yourself, and therefore comes across as being perfectly understandable to all readers. In other words, a good technical writer strives to write just like everybody else who publishes in the scientific literature. Such homogeneity is precisely what you want to achieve. Save your unique and creative personal writing style for your next novel!

Note especially how authors **organize** their prose, and think about how that sequence got the points across to you. Was it sequenced temporally, or in increasing order of complexity, or spatially? Why did the author choose this order? What order would best get across what you did to your intended audience? A number of possibilities exist–some good, some bad. Consider as many as possible before starting to write; develop an outline and try different arrangements. Simply starting to write without devising an organization strategy first is a pointless waste of your time (and that of anyone trying to read your writing). It would be like trying to drive to Chicago by getting in your car and driving randomly without

consulting a map or set of directions. It is doubtful that you would ever get to Chicago and even if you did, it would not be expediently. Avoid wasting your valuable time by starting with an outline.

Avoid writing as you might speak. In conversation, or when speaking before a group, we tend to speak in rather convoluted and complex sentences, much like this one, that are sequenced and qualified, with various adorning phrases, to conform with the way the mind *listens*, much of the time anyway–and they're often grammatically incorrect. Plus, tone, voice quality, emphases, and facial expressions infer the speaker's true intent. However, the mind *reads* differently. It expects simple, declarative, and straightforward written sentences. Use this difference between hearing and reading to your advantage, both when writing and speaking. Do not simply write down your thoughts as you might express them verbally. Also, writing affords some efficiency tools that speaking does not. For example, we might *tell* a colleague that "The evidence suggests that high concentrations of Windex limit reproduction by brook trout," but when writing that concept we can simply state "High concentrations of Windex limit reproduction by brook trout (Dow 1954)." Including "The evidence suggests that" in writing would just take up space; the citation infers that evidence exists to back up the statement.

Strive for terseness and brevity. Every extra word or letter costs money and time – to write it, to print it, to read it, etc. Cut words and simplify sentences whenever possible. **Simple, direct sentences** (subject verb object period) convey thoughts efficiently and reduce the chances of making a grammatical error. Grammatical errors are to be avoided; they infer that you are illiterate. Conversely, use of simple, direct sentence structure will help make you appear literate! As you compose each sentence, ask yourself if it can be made shorter or more direct without a loss of understanding. Try different variations and pick the best. Also ask yourself if your meaning could possibly be misconstrued by a naive reader because of **ambiguity** or lack of clarity or specificity. **Find the perfect balance between brevity and completeness** in each sentence you write.

Writing well is difficult and time-consuming, even for those who do it all the time. Spending ten minutes on a sentence expressing a complicated thought is par for the course. Spending another ten minutes re-writing it the next day is common. Often, an entire day's work consists of several well-crafted paragraphs of several hundred words. If you're writing several thousand words a day, they're mostly crap. Write slowly and carefully, selecting each word and molding each phrase deliberately, re-reading and editing and revising over and over again. Do not get frustrated by the slow pace–that's just how it goes. Schedule plenty of time for writing.

Avoid redundancies. If you repeat the same phrase or concept in consecutive sentences, either 1) combine the sentences, or 2) delete the redundancy from one

and improve the transition between the sentences to make the redundancy unnecessary. If you repeat the same phrase or concept at different places in a paragraph or section, unite those two parts such that the phrase only has to be used once (or the concept only has to be covered once). If you bring up a topic once and then have to remind the reader of it again later, that typically means that you drifted away from the topic in between. Whenever this happens, excise and move the intervening material and coalesce the separated topic.

When you receive an **edited text** back from me, go through my edits one-by-one, making sure that you understand each edit; ask me about any you do not understand. Do not simply make the changes and forget about them. Keep a list of the things you have trouble with (*this* set of tips grew out of my list). Learn from the edits and avoid making those mistakes again in the future. Few things frustrate an editor as much as having to make the same type of correction over and over again on successive drafts of a text. Few students would dare repeat making the same mistake again in their gill-netting technique, statistical analyses, fish-culture protocol, or boat-docking technique after being corrected, but seem to think nothing of making a similarly egregious grammatical mistake over and over again.

After completing what you believe to be the perfect, final draft, put it away for at least 48 hours. Then give it a final read. You'll be amazed at the improvements you can make with a fresh perspective, plus you'll likely find a few typos that you read past a dozen times before!

Unless really, really good reasons exist not to, please use **AFS format** for anything you write for me. That applies especially to **references**. Moreover, be careful to cite a reference accurately; few things are as frustrating as looking up a citation only to find that it does not exist where cited. Inaccurate, missing, and ill-formatted references are the product of their position in a manuscript – at the end. Most writers wait until all other manuscript components are completed before typing in the references, often when the submission deadline is looming, time is tight, and some of the papers have already been misplaced. A better strategy is to type in the references as you cite them. Think of it as a deserved mini-break from wordsmithing. You can take the time to insure that the reference is accurate and formatted correctly, and you will entirely avoid the boring chore of typing in a long list of refences.

Never, ever cite a paper that you yourself have not read. Occasionally, a writer will misconstrue the facts in a paper he or she has cited. If you cite the original article based on that incorrect interpretation, you are compounding the error. If the original work (e.g., Parr 1664) is truly unavailable, cite it as "(Parr 1664 in Rowe 1803)" and provide both references.

It's always a good idea to **review the "manuscript components" section** of the AFS

"guide for authors" (at the back of the first issue each year or at the AFS web site http://www.fisheries.org/afs/publications/journals/tafs.pdf) to remind yourself what belongs in each section. For example, "An introduction should set the context for the work to be reported and establish the purpose and importance of that work."

Just because the Introduction section comes first does not mean that you have to write it first. I typically write it and the Discussion section second-to-last (just before the Abstract). These are both difficult sections to write that contain similar material and their content depends on the findings of the study. Therefore, they should be written after the Results section. Everyone seems to have their own preference for how to **order** their writing, but mine is to clearly write out the objective of the study first; the title is normally the objective re-arranged. I then develop a set of tables and figures that attains this objective explicitly, keeping notes on what important results each conveys. Often, re-analyses are necessary while working on the tables and figures to better address the objective. After I am satisfied with the tables and figures, I write the results section that explains them, using the important results notes as an outline. Next, I write the Methods section to describe how the results were determined.

For a proposal, I start with the objective and then write the Methods needed to achieve it. The Introduction comes last. It is primarily a justification for the objective based on what has been done before and what needs to be done now to solve an unsolved problem of critical importance to the funding entity.

A **Methods** section should include only those methods needed to get what is presented in the results section. For example, don't explain that you weighed fish weekly, but then only use their weights at the end of the experiment in your analyses. Order the methods in a logical arrangement that starts with the basics and builds thereon. Introduce a method only after precursors to it have been described. For example, describe how fish were collected and processed before describing how they were aged.

Methods sections of proposals should be in **future tense** ("Fish *will* be collected with a sharp stick.")

Report your results and those of other previous studies in the **past tense**. The only exception to this is when reporting on a universal truth ("Trout live in water"), in which case the present tense is generally more appropriate. In most cases, our work doesn't approach that level, and we can only report on what we found in our study in a particular place and time ("walleye ate crayfish" not "walleye eat crayfish").

Do not start a **Results** section, or a paragraph therein, with a reiteration of methods. If you did a good job organizing the Methods section, you won't have to;

the reader will know what to expect. The order of results should duplicate the order of the methods used to achieve those results. Often, we make the mistake of starting the Results section with the number of samples we collected or when and where they were collected. Such material belongs in the Methods section. Even worse is the practice of reporting the number of fish collected during the entire study in the first sentence of the Results section in an effort to impress the reader with your superhuman effort. Impress the reader with what you discovered instead.

Use **tables** when the actual numeric values are important to convey because someone will need to use them in the future (per diem rates for different cities that will be needed to calculate travel reimbursements) and **figures** when you're showing relationships (the relationship between per diem rates and city-specific cost-of-living rates). We tend to use too many tables and not enough figures.

Start each paragraph with a **topic sentence**. It tells the reader what a paragraph covers. All sentences in a paragraph are about a single topic. The topic sentence summarizes that one main idea. All other sentences in the paragraph must support that sentence.

Never waste an entire sentence merely **referring the reader to a table or figure**: "Back-calculated lengths at age of chocolate snook are shown in Table 2." Cite the table or figure in a sentence telling the reader about what is important in that table: "Back-calculated lengths at age of chocolate snook were highest from turbid estuaries (Table 2)." If you find that you have nothing important to say about the contents of a table or figure, delete it.

Fancy **punctuation** is a direct path to poor grammar in the hands of an inexperienced writer, which applies to most of us. Stick to periods and a minimum of commas to avoid embarrassment. Other punctuation marks are trouble, particularly colons, semi-colons, hyphens, and dashes. Virtually all uses thereof by beginning graduate students are incorrect and avoidable. Even question marks have limited use in technical writing.

Do not use **contractions** ("don't") in technical writing. Also, limit **possessives** ("angler's opinion") as much as possible ("opinion of the angler"). In other words, avoid using apostrophes. Apostrophes are also unnecessary in dates (1930s not 1930's).

Never start a sentence with "**There were** …" or "**It is** …" (or there are, was, is, it was, etc.). For example, "There were significant differences among the treatments" starts with and therefore places emphasis on the word "There," which is entirely inconsequential and makes the sentence longer than it needs to be. Instead, rewrite the sentence to read "Significant differences existed among the

treatments" or maybe even better "The treatments were significantly different" depending upon which is more important–the differences or the treatments. Do not use "there were" *within* a sentence either.

Make sure that **plural** subjects have plural verbs and **singular** subjects have the singular form of the verb. "Gill *nets were* used" not "Gill *nets was* used." The word "**data**" is plural; "datum" refers to a single data point. Be careful also with "**bacteria**," "**strata**," "**media**," and "**annuli**," all of which are plural.

Do not start sentences with "**To**" ("To sample the fish,") or "**In**" ("In the third experiment,") or "**On**" ("On several dates,"), "**In order to**, " "**During**," "**At**," or anything similar. These words almost always invert a sentence making it less direct. For example, "At each of the nine ages, fish were exposed to four levels of parasite dose" sounds good conversationally, but reads more directly as "Fish were exposed to four levels of parasite dose at each of the nine ages." I recently read "In the Missouri River mainstem, below Hauser Dam, where the spawning habitat is limited, relative to the large population of rainbow trout, the presence of multiple redds and superimposition was common (Spoon 1985)." Those four introductory clauses likely sound dramatic and persuasive in making a point orally, but "Multiple redds and superimposition were common in the Missouri River below Hauser Dam where spawning habitat was limited for abundant rainbow trout" is preferable in technical writing.

The words "**found**," "**observed**," "**determined**," and "**documented**" are red flags when used in citing supporting work. For example, "Jones and Smith (1692) *found* that trout live in water" can be shortened and made more direct as "Trout live in water (Jones and Smith 1692)" by getting rid of "found that" and inverting the sentence. The subject of the sentence is now the trout, which are likely what you're really interested in, and not a couple of long-dead and irrelevant authors. The only exception to this is when you're writing about the historical development of something and "what" is less important than "who" and "when."

Write out the **full common name** of a species or subspecies (as listed in the most recent "Names of Fishes") the first time you use it in each paragraph ("westslope cutthroat trout"). Thereafter within that paragraph only, you can use simply "trout" to refer to these fish, but only if there exists no possible way for the reader to confuse these fish with other trout.

When reporting **comparative results** (higher, greater, slower, etc.), always include what the finding is being compared to ("Fish biomass was greater in the effluent-enriched reach *than upstream from the sewage treatment facility*"). Don't leave a reader possibly questioning "greater than what?" Sometimes it isn't obvious.

Be anal. **Pay close attention to detail**. Spelling, proper names, grammar, citations,

format, proofreading, reference format, etc. Doing good science requires paying extremely close attention to detail; if your writing is not similarly meticulous, then the reader may question the quality and veracity of your science as well. It happens all the time; poorly-written manuscripts describing excellent research get rejected consistently. The opposite is also true. Questionable science and uninteresting findings manage to get published when the authors make a special effort to conform to the "guidelines for authors" perfectly and write clearly. I've done this a few times myself.

Be consistent. If you introduce an area as "Study Reach 1" (caps), don't shift to "study reach one" (lower case) the next time you mention it.

Use **hyphens** between numbers and units of measure when using the two in combination as an adjective: "Sample sites were located at intervals of 50 m; the 50-m spacing precluded disturbance of adjacent sites."

Numbers between 0 and 1 (e.g., 0.37) should always **include the zero before the decimal point** (i.e., *not* .37).

If you write that something happens "**between** July and September," the reader must conclude that it happens only during August, because that's the only thing *between* July and September. "From July through September" may more accurately describe your intent.

Do not **start a paragraph** with the word "Similarly" or anything similar (e.g., use of the word "also" in the first sentence). If you need that transition, you likely should not be starting a new paragraph.

Do not start a sentence with an abbreviation, not even the "*T.*" in "*T. tubifex*."

Is it to much too ask that writers distinguish between "**to**" and "**too**?"

Fish vs. fishes: "Fish" is the plural of "fish" (10 *fish* in a bucket; three carp and seven bluegill). "Fishes" is a plural for "species of fish;" i.e., that bucket has only two *fishes* in it.

Names of fishes can be used in two ways–as the species (singular) or as a number of individuals of that species (plural); i.e., "*the* westslope cutthroat trout has a limited distribution" vs. "westslope cutthroat trout are limited in distribution." Avoid going back and forth between the two, especially in the same sentence, as in "westslope cutthroat trout ***are*** sparsely dispersed throughout ***its*** historic range."

Do not use the word "**impact**" unless you're talking about whacking burbot with a baseball bat. Use "effect" (noun) or "affect" (verb) instead. "Effect" can be a verb

that means “bring about” (“Darwin’s theory effected a change in how we view life”), but it is used rarely and causes confusion. It’s better not to use it that way at all. And yes, "affect" can be a noun, but only in reference to signs of emotions or feelings ("Ralph exhibited no affect as his girlfriend's Subaru rolled down the boat ramp").

“**Between**” refers to 2 things, whereas “**among**” refers to 3 or more. “A significant difference existed between the two lizards but not among the three frogs.”

The words “**since**” and “**while**” should be used only in a temporal sense. Other uses are slang. “Since” means *in the time after*; e.g., “*since* her release from prison.” Do not use “since” in place of “because” (“dip netting was impossible *since* runoff made the water turbid”). “While” means *at the same time as*; e.g., “*while* doing time.” Do not use “while” in place of “whereas” (“rainbow trout spawn in spring *while* brook trout spawn in autumn,” which could only make sense if the referenced fish resided separately in the northern and southern hemispheres).

Use “**once**” when referring to a single event. Don’t use it in place of “after” (“*Once* we realized he was a whiner, …”).

Avoid using “**due to**.” It’s ok if used in place of “caused by” or “attributable to” but incorrect in place of “because of.” I find it simpler to just avoid the issue entirely. However, if you absolutely must use “due to,” at least please do not spell it “do to.”

Replace “**approximately**” with “about” and “**utilize**” and “**utilization**” with “use” (no exceptions). The verb “approximate” is OK.

Do not use “**and/or**.” Replace “electrofishing and/or snorkeling” with “electrofishing or snorkeling or both”

“**et al.**” has no period after the “et” but does have a period after the “al” (because “al.” is an abbreviation)

Do not use “**via**” to convey the meaning of “by *means* of.” Use it to convey “by *way* of.” “We traveled from Gardiner to Livingston via the Yellowstone River” is correct; “we traveled from Gardiner to Livingston via drift boat” is not.

“Autumn” is preferable to “**fall**” because “fall” has multiple meanings.

Never use “**very**” as a qualifier (very big, very fast, very high, very deep, etc.); it is superfluous in technical writing. Superlatives in general are unnecessary in technical writing.

I will not be discreet in stating that "**discrete**" and "**discreet**" have discrete meanings

"**Like**" is slang for "such as;" don't use it. "Fish like dolphin" means something entirely different from "fish such as dolphin."

No such thing as a "fish **community**" exists, at least not in the minds of people trained in ecology (and this *is* a Department of Ecology). "Fish assemblage" is the proper term. Similarly, there's no such thing as a "juvenile fish **population**" unless it's neotenous and reproduces by budding.

When using "**which**," be sure that it refers to the noun immediately preceding it; otherwise, things can get confusing, as in: "Gotham yuppies love their BMWs, crafted by meticulous German engineers, which fill the parking lots of trendy nightspots in the Hamptons each summer." [That reminds me of "The trout were caught using a backpack electrofisher." I guess they didn't have a collecting permit. Or "The warblers were observed using binoculars." The new featherweight type?]

A comma should always precede "**respectively**" and "**which**" and follow "**i.e.**" and "**e.g.**"

"**Predominate**" *can* be used as an adjective, but "predominant" is preferable and means exactly the same thing. Use "predominate" as a verb.

The word "**however**" is typically found at the beginning of a sentence or more rarely after a semicolon. It is followed by a comma. If you use the word in the middle of a sentence, you have more than likely used it improperly. For example, the following is not a sentence: "All 105 samples have been preliminarily aged, however final ages will not be estimated until all samples have been prepared." One fix is to insert a semicolon and comma: "All 105 samples have been preliminarily aged; however, final ages will not be estimated until all samples have been prepared." Another is to simply create two sentences: "All 105 samples have been preliminarily aged. However, final ages will not be estimated until all samples have been prepared." If maintaining a single sentence is critical, try: "Whereas all 105 samples have been preliminarily aged, final ages will not be estimated until all samples have been prepared."