Improve your scientific writing:
To be read & remembered, convincing & influential.

Richard S. McBride, Ph.D.
Richard.McBride@noaa.gov
Northeast Fisheries Science Center,
Woods Hole Laboratory

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Dr. Richard S. McBride
Supervisory Research Fishery Biologist
National Marine Fisheries Service
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543 USA

Voice: 508-495-2000 (main desk)
Voice: 508-495-2244 (my office)
Fax: 508-495-2115

e-mail: Richard.McBride@noaa.gov
You will see this at the end of the talk, too,

So here, I will introduce this as an outline of this talk

Illustration: forums/science-in-africa/scientific-writing-complex-51396804
Here I thought it would be useful to point out the difference between scientific writing and science communication.

This website’s info graphic offers what I thought was a good distinction between these two forms of communication,

and this is certainly a topic that will be explored throughout today’s workshop.
There is one main difference between speaking and writing: You cannot track your audience as they read.

Who will read the document?
What do they know about the subject?
Why – and how – will they read the document?

These questions may or may not be obvious to you, the writer, but at the very least, recognize that: “Readers do not simply read; they interpret”

That means that your words will not magically enter the reader’s brain with the same message that you meant to convey. Misunderstandings are likely to occur because of ambiguity of not only the words used but the general style of the writing. Clear communication happens only after hard work on the writer’s part.

Gopen, G., and J. Swan. 1990. The Science of Scientific Writing. American Scientist 78(6):550-558. “we demonstrate a number of rhetorical principles that can produce clarity in communication without oversimplifying scientific issues. The results are substantive, not merely cosmetic: Improving the quality of writing actually improves the quality of thought.”
Elements of Scientific Writing

- Scavenge your proposal
- Establish structure with an outline
- How writers write
- How readers read

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The Craft of interpreting Psychological Assessments | Niche Consulting ...
380 x 251 | 48.8KB
www.nicheconsulting.co.nz
Writing is an integral part of science. Not something you simply tack on at the end of a science project. Your proposal is evidence of that.

How did you get the funding or the motivation to spend so much of your life on your project? You, or someone you work with, had an idea and make a pitch to someone else with deep pockets. Then you got a grant or a contract to support the project.

Or perhaps your advisor has funding, but he asked you to write up a proposal, and you thought it was some administrative hoop to jump through. If you did not put much effort into the proposal, or if you never went back to it, then it was an just a silly hoop, but that is on you isn’t it?

Either way, when you begin to start writing, don’t reinvent the wheel. Go back to the proposal.

Title (still good?)
Thesis (needs ‘thickening’?)
Methods (were/how were these revised?)
Literature reviewed (needs some updating but a good start, right?)
Didn’t write a proposal?

Well can you at least answer these three questions before you start building a manuscript…?

Doing so will set the stage.

Presumably you can answer these questions from your literature review, but even so,

If you are working with co-authors, this is a good moment to regroup, perhaps exactly as depicted here.

A three paragraph Introduction?
Perhaps that will follow the three questions posed on the previous slide.

Before you slog through with putting words on paper, look before you leap.

An outline may be essential to divvying up responsibility among co-authors.

There are lots of links out there to help you, as an individual. A sampling:
http://proeurasiamedwriter.com/Outline/Outline.html
http://www.studentgroups.ucla.edu/USJ/guide.pdf
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3178846/
https://www.elsevier.com/connect/six-things-to-do-before-writing-your-manuscript
https://www.elsevier.com/connect/11-steps-to-structuring-a-science-paper-editors-will-take-seriously
http://www.slideshare.net/AmericanJournalExperts/writing-a-cover-letter-for-your-scientific-manuscript
https://conbio.org/images/content_groups/Africa/Guidelines_ScientificWriting.pdf
https://medschool.vanderbilt.edu/meharry-vanderbilt/files/meharry-vanderbilt/public_files/MVA%20session%202%20and%203_final%202007.10.15.pdf
Provide “Enough information …so that the experiments could be reproduced by a competent colleague.” Day and Gastell (2006).

This may be simple to write by revising material from your proposal with updates from your field or laboratory notes.

Illustration from: http://people.cornellcollege.edu/bnowakthompson/sciwrite.html
Assemble your illustrations (tables, figures, photos, video) to help you write the results.

The results are probably next, but before you write them, assemble your illustrations so you know what you will write.
Graphic display ‘revolutionized’ data science

Feynman diagrams

Feynman diagram of two electrons interacting electromagnetically by the exchange of a photon.

Drawing Feynman Diagrams

- Initial state particles are on the left
- Final state particles are on the right
- Critical particles are exchanged in the middle

Warning: do not interpret diagrams literally as time (x) and space (y) coordinates.

- Fermions
- Antifermions
- Photons
- Gluons
- W, Z, H bosons
In fisheries, we are often interested in predicting the abundance of fish from one stage to another. This is graphically represented here, and can be modeled with a series of functional equations, as proposed by Gerald J. Paulik.

Figure 194. A multi-stage spawner-recruit relationship for an exploited salmonid stock with three life stages. The ordinate of one life stage becomes the abscissa of the next. A detailed explanation of this figure is given in the text. It may help to rotate the page 90’ to the right with reading one life stage to the next. It is assumed the exploitation rate and biological relationships do not change.

“the Discussion and Introduction sections function in an opposite mirrored manner”


The introduction should introduce the reader to the general topic and why it is important. I should define jargon or concepts that are necessary to follow the paper, and out map out the outline of the paper. As described by Booth et al., it should finish with a strong claim or thesis statement.

Unless the journal is know for long introductions, or a special section (e.g., study area, historical review) is appropriate, three-four paragraphs are usually sufficient:

1) **general nature of the problem and some context (e.g., long-standing, topical, rapidly developing),**

2) **specific problem examined in this manuscript**

3) **develop the thesis statement (or include as part of the previous paragraph),**

4) **how the document is structured.**
The discussion is where the key results can be put in perspective (but not simply repeated, which would be redundant), with some level of speculation is offered along with a hint at what the future.
Very, very few people will read the entire paper.

“In conjunction with the master narrative, the modern scientific article has also evolved a master finding system. This system compartmentalizes the essential features in articles through the use of headings and subheadings, tables and figures integrated into the text with numbered captions describing their contents, and citations that supply additional context for statements at any point in the text. It also permits scientists to read articles selectively rather than sequentially, opportunistically scavenging the various components in search of useful bits of method, theory, and fact. With headings in place, for example, scientists not interested in methodological details do not need to read the Methods section. Alternatively, with the swarm of data segregated into tables and figures, scientists are able more easily to focus on them or on their commentary in the text or to alternate freely between the two.” (my bold)

Most people will read only the title of your paper. Make it count.

Fewer will also read the abstract. The abstract should stand alone in providing the context, the specific goal, the major results, and the importance or application of the work. A particularly hurried reader may only focus on the last 1-2 lines, so if your last line only says ‘The results will be discussed,’ then they will probably stop there and your work will go uncited as a result.

Image from http://people.eku.edu/ritchisong/801syl.htm
Some readers will skim your tables and figures, results or methods… Make sure the legends can stand alone, as the reader may give up if they realize they have to read too much of the text to follow along.

Very few people will read the methods: Perhaps only the journal reviewers, but also people that take your work so seriously that they will try to replicate it.

If they get to the Discussion, and this section doesn’t lead with a powerful summary of the importance of your work, or worse gets off to a slow and uninteresting recapitulation of the results, then there will be fewer people that will read the entire paper.
Don’t get me wrong, I read plenty of papers from beginning to end, and it is a joy to do so with a well written paper that is or has the appearance of a foundational study.

Still, what I just went through is how most papers are treated.

As stated before, in terms of how a scientific paper is written, don’t be discouraged in any way that a scientific paper is not read in the way it was written. This stylized, even rigid, format make it easy for a busy professional to find just what they need because they will know were to look for it. Again, work with the readers’ expectations!
I like Jarita’s recommendation for how to strategically approach writing a manuscript:

This is a strategic approach to revision, revision, and revision:
Dump Draft – Just get started
Organizing – assemble and review what you have, section by section
Spackle draft – fill in gaps
Smoothing draft – paragraph level – at this point your refine what you have written, as more and more focused layers
Wordsmithing – sentence level
Copy edits – word level
Formatting – Follow instructions to authors

Here advice provided structure to this excellent advice by Mark Twain:
“The secret of getting ahead is getting started. The secret of getting started is breaking your complex, overwhelming tasks into small, manageable tasks, and then starting on that first one.”

Art retrospective example – the masterpieces of ‘fine art’ started with sketches, studies, mistakes, etc., before the painter sat before a giant canvass.
Too complex? Here is the advice stated without any structure at all (quote by Jodi Picoult)

____________________________________________________
Jarita Davis: http://www.nefsc.noaa.gov/publications/contacts.htm
By section: Lack of coherence between sections
Titles-thesis statement-abstract-text-Illustration
If not connected, it is a tangent

There are two sides to the 'it is in the text but not in the title, thesis or abstract.' If so, then it is probably a tangent and the text part should be deleted. However, sometimes writers, perhaps unconsciously, have created a 'surprise ending,' a conclusion that simply was not obvious in the abstract. Well, science writing is different than a novel. Remember, your reader has expectations, and 'being surprised or blindsided in the discussion' is not one of those expectations.

Room for some redundancy, but emphasize everything in its proper place
Put conclusions in the conclusions, summary in the summary, etc.
Use the correct verb tense in each section

By the illustrations
Don’t repeat the information in a table (or figure) in the text (or visa versa)
Good topic sentences improve your writing. They satisfy these criteria:

The readability and organization. They usually meet the following criteria:

1. Like the cup cake model (top, right), a topic sentence is the frosting, or more literally the first sentence of the paragraph. If you bury it in a subsequent sentence, or you never really write a topic sentence, then how is a reader to follow the outline of your argument?

2. Topic sentences use keywords or phrases from the thesis or from the outline you presented in the introduction to keep the reader on track.

3. As much as they may introduce the topic of the paragraph, they likely refer back to or transition from the previous paragraph (think of a hamburger [not a cup cake] model, where the buns are the first and last sentences that map out the outline and the meat is in the middle.

Pet peeves:

• Don’t start a sentence (or worse the whole paragraph) with ‘Table 1 shows the effect of x on y’
• The topic is the phenomenon, not the table (or figure)
• Don’t use headers for single paragraphs. That is the job of the topic sentence. Headers should be used to group more than one paragraph together under a common subject (as required by AFS publications).

One thing to try, with a fairly complete draft, is to read just the topic sentences.

Does your argument flow well?

http://public.wsu.edu/~campbelld/topic.htm
see also http://colelearning.net/who/module1/page35.html
See http://www.bartleby.com/141/strunk5.html

#9 Make the paragraph the unit of composition: one paragraph to each topic.
#10 As a rule, begin each paragraph with a topic sentence; end it in conformity with the beginning.
#16 Keep related words together.

By sentence: Lack of parallelism
Defined as ‘presenting similar information in a similar fashion’
Winter mortality due to harvesting and other causes was lower in winter than in summer. ([http://fisheries.org/docs/pub_stylefl.pdf](http://fisheries.org/docs/pub_stylefl.pdf))
This can also be the case between sentences...

#14 Avoid a succession of loose sentences.
#15 Express co-ordinate ideas in similar form.
#18 Place the emphatic words of a sentence at the end.
By words: defining jargon
Overuse of or not defining acronyms or abbreviations
You may not even be aware you are using jargon, slang, or idioms (in an international context)

Abbreviations/acronyms: If not used > 2 times, why use it at all?
By words: Once you have defined the term, please stick with it!
Non-native English speakers don’t need to wade through your creative use of synonyms, which will only muddle you point.

The global English style guide: writing clear, translatable documentation for a global market

Unneccesary modifiers: Don’t tell me that it is ‘obvious’ in Table 1 or that the result is a ‘dramatic’ increase. Walk me though the highlights of the table so that it is obvious. Give me a measurable demonstration of the increase (e.g., 2-fold, 2 orders of magnitude?). Remember, show don’t tell.
Illustration:  
http://www.melissaclarkson.com/teaching/writing_seminar/archived_website/  
See http://www.bartleby.com/141/strunk5.html

**#13 Omit needless words.** Vigorous writing is concise. A sentence should contain no unnecessary words, a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts. This requires not that the writer make all his sentences short, or that he avoid all detail and treat his subjects only in outline, but that every word tell.
1. Abbreviations and Acronyms
2. Capitalization
3. Italics
4. Mathematics and Statistics
5. Numbers and Measurements
6. Punctuation
7. Quotations
8. References
9. Species Names
10. Spelling and Compound Words
11. Symbols
12. Tables and Figures
13. Vendors and Commercial Products
14. Word Usage

Appendices
A. Spelling List
B. Symbols, Abbreviations, and Acronyms
C. Plurals of Fish Names
D. Geographic and Geological Terms

http://fisheries.org/docs/pub_stylefl.pdf
Boring but important.
Endear yourself to the (copy) editor and follow these.

A more general example

Preface
Acknowledgments

Part 1: Publishing Fundamentals

Chapter 1 Elements of a Scientific Publication
Chapter 2 Publication Policies and Practices
Chapter 3 The Basics of Copyright

Part 2: General Style Conventions

Chapter 4 Alphabets, Symbols, and Signs
Chapter 5 Punctuation and Related Marks
Chapter 6 Spelling, Word Formation and Division, Plurals, and Possessives
Chapter 7 Prose Style and Word Choice
Chapter 8 Names and Personal Designations
Chapter 9 Capitalization
Chapter 10 Type Styles, Excerpts, Quotations, and Ellipses
Chapter 11 Abbreviations
Chapter 12 Numbers, Units, Mathematical Expressions, and Statistics
Chapter 13 Time, Dates, and Age Measurements
Chapter 14 Geographic Designations

Part 3: Special Scientific Conventions

Chapter 15 The Electromagnetic Spectrum
Chapter 16 Subatomic Particles, Chemical Elements, and Related Notations
Chapter 17 Chemical Formulas and Names
Chapter 18 Chemical Kinetics and Thermodynamics
Chapter 19 Analytical Chemistry
Chapter 20 Drugs and Pharmacokinetics
Chapter 21 Genes, Chromosomes, and Related Molecules
Chapter 22 Taxonomy and Nomenclature
Chapter 23 Structure and Function
Chapter 24 Disease Names
Chapter 25 The Earth
Chapter 26 Astronomical Objects and Time Systems
A couple-three parting shots


(which, of course, answers the question of how many Caltech PhDs does it take to write a sentence.)

Image: books to the ceiling, by Arnold Lobel
I learned during my graduate school experience that scientists write a lot, and I even had some very good mentors teach me how to write better. Mostly I learned that I liked to write but that I was not very good at it. Don’t get me wrong, I write better than average, but at the post-doctoral level I realized that if I was to reach my full potential, I needed to tackle this performance issue head on.

So I read books. Lots of them. Cover to cover.
Show the books you have brought with you.

Then I realized that others might want to do the same thing and that I could help them be selective about which book to read, so I wrote this article in ‘Fisheries’ in 2009.

My point is that there are some great resources out there, so use them.

I cannot talk about writing for science without tipping my hat to Fred Serchuck. Dr. Serchuck retired from NMFS last year, but he still communicates with many of us in near daily emails filled with writing tips.

I know that some of you here today attended his seminars on scientific writing, one of which was held in Woods Hole back in 2013 as an AIFRB/AFS-SNEC-sponsored workshop like what is occurring today.

As I recall, Fred could talk a couple-three hours on this topic along, so with a bit of irony, I have pulled these three words from his talk.

I don’t think you can find three more informative words to keep in mind if you are writing and revising your work.

https://www.linkedin.com/in/fred-serchuk-538615b
“Over the past three centuries, however, a master narrative has evolved. This narrative represents a tribute to the efficacy of the experimental method as a means of exploring nature. It opens with a title and abstract intended to minimize the time and effort needed to uncover the article's gist. That is followed by an introduction placing the reader in the scientific context in which the authors are working. Next comes the main body: a section on methods and materials that outlines the procedures and materials used to acquire new facts, a results section that displays the facts so generated and the intellectual context of their acquisition, and a discussion section that offers an explanation for the new facts. A conclusion section reiterates the central facts and explanations and, perhaps, also addresses future work that would confirm or extend the original investigation. This narrative is not a straitjacket, but a flexible prototype out of which authors fashion numerous variations.

An often-overlooked complement to this verbal narrative is the visual evidence presented in establishing facts and their explanations. Scientific visuals perform multiple tasks. They depict relationships visible in nature, such as those between insects and plants; relationships in nature not visible to the naked eye, such as crystalline structures and underground geological sections; relationships posited by a theory, such as the Feynman diagram; or tables and graphs organizing masses of data in support of lawlike relationships.
Because of their obvious communicative utility, visuals have greatly increased in number and proportion taken up within the text. As a result of this increased visual component, the scientific article has now become almost as much about interpreting information in figures and tables as reading straight text.”


http://istl.org/06-summer/review3.html
Interestingly, Alley never talks about the I-M-R-D format. Instead he write more generally. In terms of structure – beginning, middle, end with transitions.

In terms of language -- precision, clarity, forthrightness, familiarity, conciseness, and fluidity.

Does the word communicate the needed precision?
If precise, does the word avoid needless complexity?
If precise, does the word avoid being too abstract?

Writing examples are deconstructed to show how to hone this “craft” and to reveal the benefits of revising your own writing (see www.writing.engr.psu.edu/csw.html for a preview.)
e,g, https://www.softchalkcloud.com/lesson/serve/p0Jh74EBzuWYca/html
Most obvious in the process of science is to advance a ‘claim’ and support it with ‘evidence’. However, you need to ‘reason’ with reader that the evidence is relevant to claim. Booth et al. also discuss that you will likely need to establish a connection (called the warrant) between the claim and reason.

All of this can get confusing quickly, so as an example, let’s use the game of ‘Clue’

Finally, science is most robust when a ‘family’ of hypotheses are considered. This may occur up front, with multiple claims-warrants-reasons-evidence

Or perhaps at the back end, as part of a process of acknowledging and responding to various issues that could affect your logical argument.


Illustration from: Febby Ai: Summary Of "The Craft Of Research“ 543 x 307 | 47.7KB
See also: http://www.sciencemag.org/careers/2016/11/how-keep-scientific-literature
1) Whether you are speaking, making a poster, or writing a report, match your approach to the occasion

2) Writing a paper sequentially is not necessary nor may it be efficient, and readers are unlikely to read your paper sequentially, either.

3) Once you realize that, you are free to build a manuscript in a way that works best. I suggest a ‘layers of revision’ style.

4) Our hour together will hopefully jump start your success at writing your next manuscript, but in the long term, there are lots of resources out there, so take stock of what you think your particular weakness is and work on that in a strategic way.

Illustration: forums/science-in-africa/scientific-writing-complex-51396804