The following material was presented to the GEOL 701 class at the University of Nevada, Las Vegas on 11/5/07 by Dr. Matt Lachniet
How to write a Scientific Paper
or research proposal

Adapted from a presentation by Don Siegel at Syracuse, who came up with many of the ideas presented here
My qualifications to give this talk

• 16 peer-reviewed publications (13 as first author) since 1997.
• M.S. thesis = 2 publications
• Ph.D. = 3 publications
• Four successful NSF grants since 2003
• And most importantly:
  – Many harsh reviews of my manuscripts, and a few outright rejections!
  – Many rejected NSF Proposals
• Reviewer for Geology, Geomorphology, Hydrological Processes, NERC proposals, many more.
Outline

• Define the problem
• Provide the objective
• Determine if its significant (‘who cares?’)
• Formulate a hypothesis to be tested
• Design a test
• Collect or generate the data
• Present results
• In a different section, present the interpretation
• Outline the significance of the data
• Discuss your data to the “Big Picture”
• Identify remaining questions and suggest solutions to solving them
• Write the abstract
The title

- Make it interesting and active.
- Include the question
- A paleoclimate record of tropical rainfall from Costa Rica.
- Or, *Tropical response to high latitude glaciation?* *Speleothem isotopes indicate a weak monsoon during ice sheet meltwater discharge to the Atlantic Ocean*
- Which title is more interesting and active?
- My worst title ever: “Use of correlation and multiple stepwise regression to evaluate the climatic controls on the stable isotope values of Panamanian surface waters”
The Problem

- Without a problem there is no justification
- Identifies why previous studies have been insufficient
- A bad writer never identifies the problem. Their papers are tedious to read.
- Sometimes you will have to ‘spin’ your results – marketers have known this for decades
- Even if you don’t care what the problem is, and you just are happy someone will let you publish your M.S. for walking around in the mountains, convince the editor you only care about the science.
The Problem

• How is this study unique?
  – 1) a new technique to an old problem
  – 2) an old technique to a new problem
  – 3) a new technique to a new problem
    • Best – innovation!
The Problem

• *Flash flooding is costly in lives and dollars, yet the hydrologic response of Arizona streams to heavy rainfall is so bad that we can not predict flooding damages for a 100-year flood.*

• *Previous standard methods of determining flood discharge for large-magnitude events were not accurate.*
The Objective

• A quality paper has an objective that is…
  – Driven by the problem previously defined
  – Stated in one or two sentences
  – Emphasizes the PROBLEM, not the site location
Objective don’ts

- A poor quality paper rests on weak objectives
- For example:
  - To “characterize” is not sufficient
  - “No one has studied this before”
    - Maybe that’s because there isn’t a problem
  - emphasizes study area not the problem
The Objective

• The objective of this paper is to determine more accurately the flood risk for a 100-year flood in several Arizona stream basins, based on a new statistical technique with new gauge data.
The Hypothesis

- Absolutely essential to have a question in mind to help solve the “problem”, particularly in proposals
- What are the alternate hypotheses?
- The “null hypothesis” if you are using statistics
- For applied geology fields, a clear hypothesis might be absent, but is always implicit.
- Your job is to ‘spin’ a merely ‘fun and interesting’ project into the best thing to happen to society
The Hypothesis

• “We hypothesize that the 100-year flash flood risk for communities living in Arizona stream valleys is actually less than predicted by conventional methods.”
Hypothesis

• Does it matter if the hypothesis was correct?
• No. Only that we have learned something new to justify supporting the research.
The Test(s) and Methods

- How will you evaluate the hypothesis?
- What methods will be used?
- Are the methods appropriate?
- Did you explain the methods sufficiently?
Test and Methods

• To test our hypothesis, we analyzed flood hydrographs for 157 USGS gauging stations on 43 Arizona streams for flashiness, lag time with respect to rainfall, and downstream velocity of the flood wave.

• We analyzed the data using our new statistical technique using a program written in C++ and in Minitab for skewness, kurtosis, amplitude, and frequency.
Conclusions

• What are the conclusions?
  – Should fit in a few paragraphs
• How strongly supported are they?
• Are the conclusions reproducible?
Identify the Weaknesses

• What questions remain after this study?
• The weaknesses are the justification for another study
Provide the “nuts and bolts”

• All locations mentioned in the text must appear on a map figure
• Were the figures clear and concise or a waste of space?
• **References**: all appropriate and cited both in text and in bibliography?
  – Use EndNote! Don’t waste your time, buy it!
• Cite the “major players” always, nicely. They are likely to review your paper
• Written in active tense?
  – Passive tense sure way to lose reader’s interest
• Overuse of pronouns?
  – “This”, “That”, “Those” are not clear nor concise
Conclusions

• “The nugget”; “The take home message”
• “The Crux of the biscuit” (Zappa)
• Be able to summarize in one or two sentences:
  – We determined that the flood risk associated with a 100-yr flood event in Arizona is greater than previously expected based on a new modeling technique.
Reviews

• Editor makes the first cut for sending papers to be reviewed
  – Difficulty: very hard for *Science, Geology*; pretty easy for discipline journals and proceedings
• Usually reviewed by two to three external reviewers with expertise in your field
• Levels of reviews
  – Accept with minor revisions
    • Only editor looks it over again
  – Accept with major revisions
    • May go back to the reviewers
  – Reject
    • Start over or give up (I’ve given up once; for laziness)
  – And a new one that I like to call “Reject with major revisions” (‘revise and resubmit’ is the gentle way of saying that). This will go out for review again.
Revisions

• You must deal with every change suggested by the reviewer
• In some cases that means arguing why that criticism is unwarranted
• Provide a numbered point-by-point letter to the editor that
  – 1) summarizes the reviewer’s criticism in objective terms
  – 2) includes your response to show the editor you have considered it, and
  – 3) includes the location in your text where you have added this information
Publishing timeline

- Data generation: months to several years
- Writing: a few months to a few years
- Peer-review: 4 weeks (Geology) to 6 months or more
- Revision and resubmission: a few months
- Editor’s review: a few weeks to months
- Publishing details: Up to a year
  - Includes editing and reading “galley” proofs, preparation of electronic files for final publishing, etc.
- Waiting time after completion: up to six months
- Time to receive reprints: several months after publishing
- Total time: Fast = 6 months (GRL); slow = 4 years
Where to Publish

• Big Picture Science Journals

• Top tier geology journals
  – *Geology, GSA Bulletin, Journal of Geology*

• Discipline journals
  – *Quaternary Research, J. Structural Geology, J. of Hydrogeology*

• Conference proceedings
  – I don’t recommend, limited distribution, limited impact on your field

• University dissertations and theses
  – No longer considered a ‘real’ publication because of difficult access and lack of distribution. Peer review by committee may be biased or not totally appropriate

• Abstracts
  – Help to constrain your ideas, but time investment may outweigh benefits.
  – I keep to 2 or less per year
What to publish

• Organize your M.S. thesis in the format of a single journal paper for a disciplinary journal
• Organize your dissertation as three or four separate journal articles
• Will save you time in the long run
Why should you publish?

- Because taxpayers funded your research, TA, RA, etc.
- You are a writer and communicator before you are a scientist
- For the greater good
- You have an obligation to your advisor
  - Research is a group effort, unless you were completely self-funded and received no help from your advisor, you have a publishing obligation.
- But what if you just wanted to get a job?
  - A publication will get you a better job
  - You may give your advisor first-author status to see the paper published