Guidelines for Independent Project Proposal

A proposal is a document that describes research that you hope to do. For a professional scientist, the goal is usually to persuade a funding agency (such as the National Science Foundation) to provide money to fund the proposed research. The scientist must persuade reviewers and the program officers that 1) the work is important and interesting, 2) the work is feasible, and 3) the scientist will publish the findings, train students, and engage in outreach to the public. In short, the scientist must persuade the agency that funding the proposed research is a good investment. About half of the operating revenues of UAF come from indirect cost recovery from research grants (the "overhead" that the university charges on grants), so writing proposals is big business at UAF!

For this class, you do not have to persuade us to give you money. (Indeed, we don't have any to give). But, you do need to persuade us that your proposed research is interesting and feasible. Accordingly, we want you to follow a similar format to what you would use in a grant proposal to a funding agency. However, your proposal will be on a smaller scale. You shouldn't need more than about 5 pages to provide the information that we want to see. Your proposal should be typed, not hand-written. The sections that you should include are listed below.

1.) **Abstract**. This is a 1-paragraph summary of your proposed research. It should describe your question and why it is important, your objective, your hypothesis, and your methods (in brief). Do not cite any references in the abstract.

2.) **Introduction and background**. This section should describe the question that you hope to answer, and what is already known about it. You need to cite relevant work (by others) that provides context and background for your study. References should be cited in the format (Author Year), e.g. (Smith 1980). In this section, you need to convince the readers of the proposal that your question is interesting, and that what you are proposing to do will contribute to answering this question.

3.) **Proposed research**. This is the heart of the proposal. Here you need to describe what you are planning to do, how you plan to do it, and what you expect to find. Near the beginning of this section, state your **objective** in doing the research. Soon after that, you should present your **hypothesis**, and your **predictions**. Your hypothesis should be falsifiable, meaning that you should be able to reject it. Hence, it needs to be specific. The predictions describe in more detail what you expect to see from your experimental or observational treatments. The predictions should specify which outcomes would support your hypothesis, and which outcomes would suggest that the hypothesis be rejected. After the predictions, you should present the **experimental design, methods** and **analysis** that you plan to use to carry out your research (as described below).

4.) **Experimental design**. This is where you describe what treatments you are going to set up to answer your questions. What factors are you planning to alter? You should also be explicit here about the number of replicate plants (or samples) that you will include in each treatment.

5.) **Methods**. This is where you describe what you will actually measure. What techniques will you use? How many samples will you take? What is the timing of your measurements? You don't need to be extremely lengthy, but you need to provide enough information that a reviewer can judge whether your plan is feasible.

6.) **Analysis**. This brief section should describe how you plan to analyze your data, once you've collected them. What things will you compare? How will you assess whether the results are significant?

7.) **Summary**. At the end of the proposal, provide a concluding paragraph that briefly explains how the data that you collect will answer your question. Note that this should not be the same as your abstract.

8.) **References**. In this section, list the references that you have cited in the introduction and background. List the references in alphabetical order by the last name of the first author. Include all authors' names, the year of publication, the title, and relevant citation information. For citations of a journal article, provide the journal name, volume, and first and last page numbers. For citations from a text book, provide the publisher's name and city, and the page number(s) on which the cited information was found. See examples below.

Journal article example for format:
Oechel, WC, Vourlitis, GL, Hastings, SJ, Zulueta, RC, Hinzman, L and D. Kane. 2000. Acclimation of ecosystem CO2 exchange in the Alaskan Arctic in response to decadal climate warming. *Nature* 406: 978-981

Textbook example for format:
Taiz, L and E. Zeiger, eds. 2010. *Plant Physiology*, 5th edition. Sinauer Press, Sunderland, Massachusetts. p. 105-108

Guidelines for Introduction and Materials and Methods

Here are some brief guidelines for the draft of Introduction and Materials and Methods sections of your independent project. For further information, look back at the two handouts on Scientific Writing that I gave you earlier in the course.

Introduction:

The introduction **sets up the question and hypotheses** that you are addressing in your study, and **places your study in the context of work that has already been done**. It identifies **the scientific gap that your work will fill**. In the introduction, you need to make the case that your problem is interesting, so that folks will want to read further! You should start the process of writing the introduction by defining your **question and hypotheses**. Of course, many of you have already done that in your proposal. But now would be a good time to see whether they need adjusting, and get them into their final form.

Once your hypotheses and questions are defined, you need to do some background research to put your questions into a broader context. What is the larger question into which your work fits?

Putting your research into context is accomplished by discussing the relevant **primary research literature** (with citations) and summarizing the current understanding of the problem you are investigating. You should organize your introduction going from the **broad** to the **specifics** of your problem, and ending with your **hypothesis** and a **rationale** for the experimental design or method that you used in your study. Start by clearly identifying your topic of interest, and present the more general aspects of the topic early in the Introduction. Then narrow down toward the more specific topical information that provides context for your problem, and present your statement of purpose, hypothesis, and rationale for your experimental design near the end of the introduction. For the introduction, you should read and cite **at least 5 primary literature sources** (i.e., not textbooks or web sites). Your introduction should be approximately 3-5 pages long (double-spaced).

Materials and Methods:

The goal of this section is to explain clearly what you did in your study, providing enough detail so that someone else could repeat your study. Topics you should cover include the **organism**s that you studied, a description of **field sites** (if your study has a field component), your **experimental and sampling design**, your **protocol** for collecting data (i.e. how the experimental details were carried out), and how your data were **analyzed**. In general, you need to provide enough quantitative detail (how much, how long, when, etc.) that other scientists could reproduce your experiments. However, avoid the temptation to include too much detail. Use the past tense (because the work has been completed at this point), and use **subheading**s for each of the major topics that you describe. Your Materials and Methods section should be long enough to describe what you did; for most of you, it will probably be approximately 2-3 pages long.

Guidelines for Results and Discussion

Here are some brief guidelines for the draft of Results and Discussion sections of your independent project. For further information, look back at the two handouts on Scientific Writing that I gave you earlier in the course.

Results:

The Results section is the heart of your paper. Start by producing your **figures** and **tables**, and your **statistical analyses**. Organize your figures and tables around your hypotheses. What data do you need to present to support or disprove your hypotheses? You may need to plot your data in different ways, and do a variety of statistical tests, before you feel that you fully understand them. Your figures and tables (with their legends) should be as clear and illustrative as possible, and **completely self-contained**, with all the relevant information included in the legends or footnotes to the tables. Many readers of scientific articles just skim the abstract and look at the figures and tables.

The results of your **statistical analysis** should generally be presented in a **table**. For ANOVA results, you need to present the degrees of freedom for the numerator and denominator, the *F* values, and the *P* values (or their significance levels) for each of the main effects and interaction effects. This information will be given to you in the ANOVA table that comes from the statistical output, but you will need to condense those tables for your paper. On the last page of this handout is an example of a statistical table for a two-way ANOVA with a block effect and post-hoc tests. (You can ignore those two columns). Note that each variable tested gets its own line. The information needed for *t*-tests is similar, except that you will present *t*-values instead of *F* values. See the handout provided for lab 12 for information on *t*-tests.

Other data that often go into tables include environmental data (such as temperature, humidity, etc.) or data that isn't convenient to visualize in a graph. You should *not* present the same data in both graphical and tabular form. Tables and figures are assigned numbers (separately) in the order to which you refer to them. Legends to tables should go at the top of the table, while legends to figures should go at the bottom. Axes of figures should be labeled (with units), and you should generally present means plus or minus one standard error, unless you are presenting a regression relationship, when all individual data should be graphed in a scatterplot.

The **text of the Results** section should follow directly from the data presented, and should *not* include finer points of interpretation. The function of the results section is to **objectively present your key results and address your hypothesis**, in an orderly and logical sequence, referring to your tables and figures as appropriate. The text should guide the reader through your results stressing the **key results** that provide the answers to the question(s) investigated. A major function of the text is to provide clarifying information. Do not reiterate each value from a table or figure, just the key results or trends, referring to the figure or table from which they came. Do not report raw data values when they can be summarized as means, percents, etc. If you have negative results (insignificant statistical tests), you may omit the figure and just state the results in the text (with degrees of freedom, *F* (or *t*) values and *P* values in parentheses), unless the negative result provides the basis for a major conclusion in the paper, in which case you need to include the figure and all of the information relevant to the statistical analysis. Organize your results section in terms of presenting the data that will logically address your hypothesis or research questions as you presented it in the introduction. The text of the results section should

be written in the past tense, and you should avoid repetitive paragraph structures. The length of the Results section will vary depending on how many figures and tables you are presenting, and how much you need to say about them.

Discussion:

The function of the discussion section is to **interpret** your results in light of what was already known about the subject of the investigation, and to explain our new understanding of the problem after taking your results into consideration. You should return to your original objectives and hypotheses, to explain how your study addressed them. Rather than repeating results (or material from the introduction), the discussion should **interpret** your results and **place them into a broader context by citing and discussing related studies**. The discussion section also provides an opportunity to present some of the implications of your work, and develop new hypotheses. However, the discussion should not include extensive speculation unsupported by evidence. For these reasons, the Discussion usually starts narrowly with a statement of your most important result, then broadens to address scientific issues for which your results are relevant, citing appropriate literature to help you make your points. The Discussion is, in many ways, the most creative part of the paper, and thus it is the section that is least prescribed in terms of format. However, at the end of the Discussion, you need to clearly state **how your results change our understanding of the problem that you presented in the introduction (the resolution**). For the Discussion, you should read and cite **at least 5 more primary literature sources** (i.e., not textbooks or web sites, and **not the same** as the ones you used for your Introduction). The length of the Discussion will vary depending on what you say, but as a rough guideline, you can aim for approximately 3-5 pages long (double-spaced).

References

In this section, list the references that you have cited in the Introduction and Discussion. List the references in alphabetical order by the last name of the first author. Include all authors' names, the year of publication, the title, and relevant citation information. For citations of a journal article, provide the journal name, volume, and first and last page numbers. For citations from a text book, provide the publisher's name and city, and the page number(s) on which the cited information was found. See examples below.

Journal article example for format:
Oechel, WC, Vourlitis, GL, Hastings, SJ, Zulueta, RC, Hinzman, L and D. Kane. 2000. Acclimation of ecosystem CO_2 exchange in the Alaskan Arctic in response to decadal climate warming. *Nature* 406: 978-981

Textbook example for format:
Taiz, L and E. Zeiger, eds. 2010. *Plant Physiology*, 5th edition. Sinauer Press, Sunderland, Massachusetts. p. 105-108

Table 2. Results of analysis of variance on aboveground net primary production of vascular plants, all treatments included in the analysis. *** P < 0.001, ** P < 0.01, * P < 0.05, † P < 0.1, ns non-significant (P > 0.1)

	Factor												
	Block			Removal (R)				Fertilization (Ft)			R X Ft		
Growth form	Ndf	Ddf	*F*	Ndf	Ddf	*F*	Post-hoc	Ndf	Ddf	*F*	Ndf	Ddf	*F*
Deciduous shrubs‡	5	140	2.152 †	4	140	32.331 ***	MBL,B< C,L,M	1	140	20.752 *** (↑; F > C)	4	140	3.390 *
Evergreen shrubs*	5	140	1.136 ns	4	140	21.505 ***	MBL,L < B,L,M	1	140	57.631 *** (↓; F < C)	4	140	6.377 ***
Graminoids‡	5	140	0.684 ns	4	140	2.352 †	C < MBL	1	140	13.494***↑	4	140	0.916 ns
Forbs*	5	140	0.391 ns	4	140	0.472 ns		1	140	0.278 ns	4	140	0.467 ns
*Total production**	5	140	0.870 ns	4	140	2.481 ns		1	140	33.189***↑	4	140	1.291 ns

‡Data were rank-transformed to achieve homogeneity of variance

*Data were log-transformed to achieve homogeneity of variance

Independent project proposal
Student Name:

		Points Possible	Points Earned	Deductions
Report on time?	Yes/No			
Report typed on a computer?	Yes/No			
Report written using good grammar, complete sentences, and correct spelling				
Exciting and interesting ideas?				
All necessary elements included?	Yes/No			
Missing Elements:				
Abstract		3		
Appears first in report?				
Concise summary of problem and proposed work?				
Introduction		5		
Sufficient background material to understand problem?				
Citation of relevant literature?				
Proposed Research		3		
Research objective stated clearly?	Yes/No			
Hypothesis stated clearly?	Yes/No			
Predictions stated clearly?	Yes/No			
Experimental Design		5		
Sufficient detail to understand experimental treatments?				
Design is adequate to address hypothesis?				
Plant species specified?				
Replicates specified?				
Methods		5		
Sufficient detail to understand what will be measured?				
Methods are reasonable to answer the question?				
Timing of measurements specified?				
Analysis		2		
Description of what will be calculated and compared?				
Description of statistical tests to determine significance?				
Summary		1		
Concise summary of proposed work and how it will address research objective?				
References		1		
Appropriate to topic				
Cited in correct format				
Total		25		

Comments

Independent project Draft of Introduction and Methods
Student Name:

		Points Possible	Points Earned	Deductions
Report on time?	Yes/No			
Report typed on a computer?	Yes/No			
Report written using good grammar, complete sentences, and correct spelling				
Writing is clear and easy to follow				
Writing is awkward				
All necessary elements included?	Yes/No			
Missing Elements:				
Introduction		20		
Scientific problem stated clearly?				
Sufficient background material to understand problem?				
Citation of relevant literature?				
Citation of at least 3 primary sources?				
Discussion of background proceeds from general to specific?				
Importance of problem is justified?				
Research objective stated clearly?				
Hypothesis stated clearly?				
Materials and Methods		25		
Site and Experimental treatments:				
If a field component, information on site is adequate?				
Sufficient detail to understand experimental treatments?				
Design is adequate to address hypothesis?				
Writing contains too much (extraneous) detail?				
Plant species specified?				
Replicates specified?				
Measurements:				
Sufficient detail to understand what was measured?				
Methods are reasonable to answer the question?				
Timing of measurements specified?				
Analysis				
Description of what was calculated and compared?				
Description of statistical tests to determine significance?				
References		5		
Appropriate to topic				
Cited in an appropriate format				
Total		50		

Comments

Independent project Draft of Results and Discussion
Student Name:

		Points Possible	Points Earned	Deductions
Report on time?	Yes/No			
Report typed on a computer?	Yes/No			
Report written using good grammar, complete sentences, and correct spelling				
Writing is clear and easy to follow				
Writing is awkward				
All necessary elements included?	Yes/No			
Missing Elements:				
Results text		10		
Results are presented in a logical order?				
Results text describes important findings, but does not duplicate tables and figures?				
Use of statistical information is appropriate?				
Results presented address hypothesis?				
Results do not include interpretation/speculation?				
Discussion		20		
Discussion proceeds from narrow to broad?				
Statement of key result?				
Hypotheses are addressed?				
Interpretation of results?				
Presentation of issues for which key result is relevant?				
Resolution is clear?				
Appropriate literature citations?				
Speculations are supported?				
Figures and Tables		15		
All axes are labeled, with units				
Figures are appropriate for the data being presented				
Tables contain appropriate information				
Units are specified for variables where appropriate				
Tables and figures do not present duplicate information				
References		5		
Appropriate to topic				

Cited in an appropriate format	
Total	50

Comments