

## **Semester of Undergraduate Research in Forest Ecology and Restoration (SURFER)**

Independent Research in Restoration Ecology

F/NR 495

Spring 2019 Syllabus

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### **Course overview and goals**

This course is designed to give students hands-on experience conducting ecological research related to forest restoration ecology, collaborative restoration, and/or remote sensing techniques. SURFER is a one-semester program, but in some cases, projects may be continued to be expanded in a second semester. The course emphasizes reading primary scientific literature, data processing, analysis and written and oral presentation of research. In this course, students will

- (1) start and complete an independent research project related to forest restoration ecology,
- (2) gain experience with data collection, analysis, interpretation, and presentation,
- (3) gain experience and reading and critically reviewing peer-reviewed scientific literature,
- (4) present results through a short scientific paper and poster.

We aim to give students experience and practice applying the scientific method to ecological concepts, provide students with an introduction to methods for collecting and interpreting ecological data, and prepare students for future research endeavors in graduate professional school or career in natural resources.

### **Supervisory contact**

Drs. Jeffery Cannon and Tony Cheng will supervise this project. Jeffery Cannon will meet with students approximately weekly (Time TBA, Room TBA) to guide projects and to provide feedback, mentorship, and technical assistance. Additional meetings can be scheduled as needed. Tony Cheng will provide direction and review results and reports produced from the studies.

### **Hours, credit, and grading**

For a 3-credit course (F/NR 495), students will be expected to spend approximately 9 hours each week, totaling 135 total hours for each enrolled semester (15 weeks). For a 2-credit course, the expectation is approximately 6 hours per week, totaling 90 hours. These hours include time spent in individual or group meetings; conducting research, data collection, and analysis; guided reading and writing; and working on reports or presentations. Please keep track of your hours on the timekeeping chart. Hours are logged by students and checked periodically by the instructor to ensure goals and objectives can be met in the time available. Logging progress is helpful to ensure that projects are completed in an appropriate timeframe.

To receive credit for this course, students must satisfactorily (1) complete independent project (described below), research paper, and poster presentation, (2) complete and track all required hours as described above, and (3) adhere to the project timeline and assignment due dates outlined below. Given the variability in individual student projects, some portions of this timeline can be adjusted with permission from the instructor. The final grade in this course is calculated using a traditional A-F scale based on the number of points earned for assignments including an annotated bibliography, components of research article, in-class activities, and development and presentation of a research poster. Individual assignment details and rubrics can be found on the course Canvas page.

Assignment	Points	Points earned	Grade
Annotated bibliography	25	260 – 233	A
Developing an introduction	20	232 – 207	B
Lies, damned lies, and statistics (in-class)	5	206 – 181	C
Analyzing and presenting data	20	180 – 155	D
Developing a methods section	20	< 154	F
Developing a results section	20		
Developing a discussion	20		
Completing an original research paper	60		
Developing a research poster	50		
Poster presentation (in-class)	20		
Total points	260		

## Project descriptions

### Factors influencing large-scale interactions between wind damage and fire (Geon Ho Kim)

Forest disturbances from wind damage and fire often have predictable influences on forest structure, composition, and spatial patterns. When disturbances co-occur, they may interact in a synergistic way such that a forest disturbance may increase the probability, intensity, or severity of a second disturbance. In Fall 2018, Geon Ho Kim's independent research showed that wind damage and fire disturbances generally demonstrate buffering effects where wind damage decreased the severity of subsequent fires, and noted that this interaction attenuated for higher fire severity. Several factors such as time between disturbances, wildfire type, and climate and weather conditions may help predict when disturbance interactions are synergistic or antagonistic. This independent study will continue Geon Ho's earlier research and extend his examination of two publically available databases including the NOAA Storm Prediction Center's severe weather database cataloguing tornados since 1950, and the USGS Monitoring Trends in Burn Severity database tracking large fires since 1984. His expanded study will focus on incorporating climatological data, disturbance timing, and disturbance severity to better understand which factors drive changes in disturbance interactions. This project requires advanced experience in GIS and experience with R. Results, interpretation, and conclusions will be presented in a final report and in a research poster presentation. Participation in CURC research symposium or other venue is encouraged.

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### Discussion topics and assignment due dates

Week	Discussion topic	Date	Assignment (due 24-hours before class-time)
1	Course overview/ Assigned readings	1/22/2019	Review course materials (syllabus, assigned readings)
2	Reading feedback/ Research questions	1/29/2019	<b>Annotated bibliography</b> (half of readings)
3	Reading feedback/ Introductions	2/5/2019	<b>Annotated bibliography</b> (all readings)
4	Outline feedback/ Introductions	2/12/2019	Introduction outline
5	Introduction feedback/ Data analysis	2/19/2019	<b>Developing an Introduction</b>
6	Data preparation and analysis	2/26/2019	
7	Data preparation and analysis	3/5/2019	All project data collected and processed
8	Creating figures and tables	3/12/2019	<b>"Lies, damned lies, and statistics"</b> (in-class)
	---- HOLIDAY ----	3/19/2019	
9	Results feedback/ Methods	3/26/2019	<b>Analyzing and presenting data</b>
10	Methods feedback/ Results	4/2/2019	<b>Developing a methods section</b>
11	Results feedback/ Discussion	4/9/2019	<b>Developing a results section</b>
12	Discussion feedback	4/16/2019	<b>Developing a discussion section</b>
13	TBA or make-up	4/23/2019	
14	Draft feedback/ How to develop a poster	4/30/2019	<b>Completing an original research paper</b> (ungraded draft)
15	Presenting a poster	5/7/2019	<b>Developing a research poster</b>
	Poster presentation (final)	5/14/2019	<b>Poster presentation</b> (Present: 5/14/2019) <b>Completing an original research paper</b> (due 5/17/2019)

## Annotated bibliography

Fall 2018

### Learning goals

The goals of this assignment are to (1) develop contextual and technical knowledge for completing independent research through guided reading, (2) develop skills for critical reading and summarization of scientific literature, and (3) summarize scientific literature for use in final research report proposals and presentations.

### Assignment

The instructor will develop a reading list for each student individually in order to (1) develop a broad background of the context and importance of your research question, (2) provide information on technical aspects of your project, and (3) provide examples of similar studies or approaches in other systems. You should spend approximately 1-1.5 hours reading and summarizing each reading.

As you read, you will create an annotated bibliography and write a separate entry summarizing each of the articles or book chapters assigned for your project. For each reading, provide a 200–400 word critical summary of each reading. For each entry, include the title, author(s), publication year, and journal or book title in the form of a proper bibliographic citation. See the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for formatting bibliographic citations. The guiding prompts below provide guidance to help you evaluate each article critically.

Depending on the focus of each individual reading, the emphasis of your summary will change

- Some readings are designed to provide project context, thus in your summary, focus on the importance or background of the problem or question and general findings (See *Evaluation questions focused on research context* below).
- Other readings are provided for technical guidance. For these, emphasize the study design, methods, or detailed summaries of results (See *Evaluation questions focused on technical guidance* below).

The summaries will form the basis for an introduction and discussion of your final research report. In your annotated bibliography include any diagrams, figures, or tables that you feel concisely demonstrate an important or relevant aspect of the reading. Screen captures can be useful for adding supporting material such as relevant figures or tables (Instructions for screen captures: [Mac](#)/[Win](#)).

### Writing prompts

Consider the following guiding questions while reading. The prompts guide critical reading and summary of each text. It is not necessary to respond to each prompt in every reading summary. However, please address the most relevant prompts in each summary.

#### Evaluation questions focused on research context

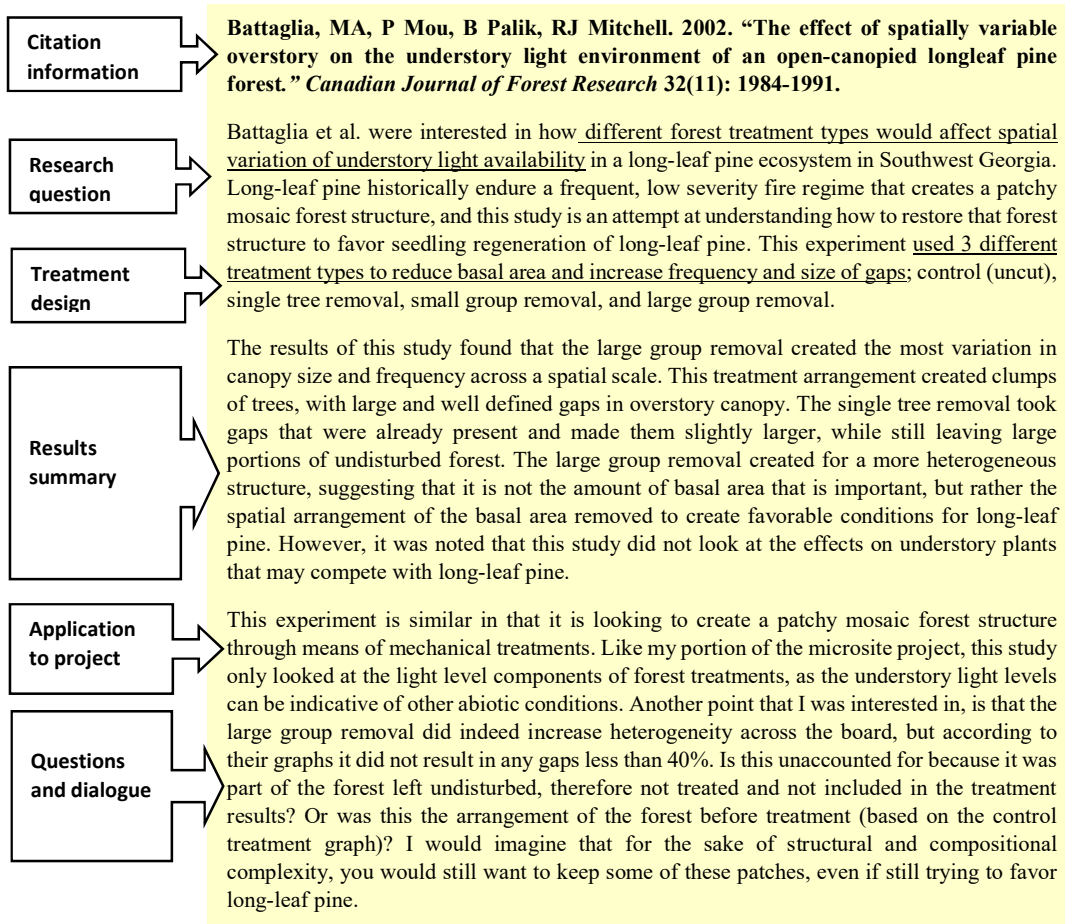
- Why did the authors conduct this study? What is the overall problem or question being addressed? What are the complexities of the issue? For whom is the topic important and why? What work has been done before to answer this question?
- Why is this reading included and how does it relate to your research question?
- How might this question be relevant for ponderosa pine forests of Colorado?
- What is already known about the topic under investigation, and what remains to be understood?
- What are the overall and specific findings of this study? Would you expect similar or different results applied to your study system, and why?
- What additional sources cited in this reading may you want to explore further?

Evaluation questions focused on technical guidance:

- What approach do the authors use to answer the main question?
- Are there any methods or techniques utilized in this study that may help address your research question?
- How may the methods used in the study need to be adjusted for use in your research system?
- What measurements were made in this study and how may they be applied to your question?
- What are the overall and specific findings of this study? Would you expect similar or different results applied to your study system, and why?
- What are the overall conclusions of the study? Do you agree or disagree with them?
- What do you still not know or understand about the reading? What scientific questions remain following this study?
- What additional sources cited in this reading may you want to explore further?

**Annotated bibliography entry example**

In the short sample annotation entry below, the student includes three paragraphs: a summary of the research question, summary of the results, and a reflection on its applicability to his own research.



**Rubric: Annotated bibliography**

You will complete an annotated bibliography entry for a total of **ten peer-reviewed research articles or book chapters**. Using the assigned reading list below, complete bibliography entries (using the example above as a guide) for each of the eight assigned readings. Please also conduct a literature search using Google Scholar to identify and read and annotate an additional two relevant readings of your choice. You can receive up to 2.5 points for each of the 10 bibliography entry for a total of 25 points.

Annotated bibliography [2.5 pts x 10 = 25]

You will earn 2.5 points for each bibliographic entry that clearly meets the following criteria [0.5 pts each]

- (1) summarizes the main research question and its importance,
- (2) summarizes the overall main approach and methods of the study
- (3) clearly links the implications to your own project
- (4) includes dialogue or additional questions, and
- (5) Includes a proper bibliographic citation

## Criteria

Assigned reading	1	2	3	4	5	Comments

Points \_\_\_\_/25

Grading criteria, each "X"s above is worth 0.1 points for the following criteria

- (1) Summarizes the main research question and its importance.
- (2) Summarizes the overall main approach and methods of the study.
- (3) Clearly links the implications to your own project.
- (4) Includes dialogue or additional questions.
- (5) Includes a proper bibliographic citation.

## Assigned reading list

The articles below are ordered to guide you first through context, then through technical detail, but may be read and summarized in any order. Electronic copies of the readings can be found in the 'Readings' section of the course folder. If a reading is not available, please add it to the library.

### Geon Ho Kim

#### Essential background and theory

- Myers, R.K., Van Lear, D.H., 1998. Hurricane-fire interactions in coastal forests of the south: A review and hypothesis. *For. Ecol. Manage.* 103, 265–276. [https://doi.org/10.1016/S0378-1127\(97\)00223-5](https://doi.org/10.1016/S0378-1127(97)00223-5)
- Cannon, J.B., Peterson, C.J., O'Brien, J.J., Brewer, J.S., 2017. A review and classification of interactions between forest disturbance from wind and fire. *For. Ecol. Manage.* 406, 381–390.
- Finco, M., Quayle, B., Zhang, Y., Lecker, J., Megown, K. a., Brewer, C.K., 2012. Monitoring Trends and Burn Severity (MTBS): Monitoring wildfire activity for the past quarter century using LANDSAT data. *Mov. from Status to Trends For. Invent. Analysis Symp.* 222–228.
- Cannon, J.B., O'Brien, J.J., Loudermilk, E.L., Dickinson, M.B., Peterson, C.J., 2014. The influence of experimental wind disturbance on forest fuels and fire characteristics. *For. Ecol. Manage.* 330, 294–303.

#### Technical examples

- Harvey, B.J., Donato, D.C., Turner, M.G., 2016. Burn me twice, shame on who? Interactions between successive forest fires across a temperate mountain region. *Ecology* 97, 2272–2282.
- Buma, B., Wessman, C.A., 2012. Differential species responses to compounded perturbations and implications for landscape heterogeneity and resilience. *For. Ecol. Manage.* 266, 25–33.
- Cannon, J.B., Hepinstall-Cymerman, J., Godfrey, C.M., Peterson, C.J., 2016. Landscape-scale characteristics of forest tornado damage in mountainous terrain. *Landsc. Ecol.* 31, 2097–2114.
- Turner, M.G., Hargrove, W.W., Gardner, R.H., Romme, W.H., 1994. Effects of fire on landscape heterogeneity in Yellowstone National Park, Wyoming. *J. Veg. Sci.* 5, 731–742.
- Two (2) student selected readings

### Wesley Hartman

#### Technical examples

- Bitella, G., et al., 2014. A novel low-cost open-hardware platform for monitoring soil water content and multiple soil-air-vegetation parameters. *Sensors* 14: 19639-19659.
- Fisher D.K., and Gould, P.J., 2012. Open-source hardware is a low-cost alternative for scientific instrumentation and research. *Modern Instrumentation* 1: 8-20.
- Kizito, F., et al. 2008. Frequency, electrical conductivity and temperature analysis of a low-cost capacitance soil moisture sensor. *Journal of Hydrology* 352: 367-378.
- Ogbu, K.N., et al. 2016. Development and testing of a capacitive digital soil moisture metre. *Nigerian Journal of Technology* 35: 686-693.

#### Essential background and theory

- Allen, C.D. et al., 2002. Ecological Restoration of Southwestern Ponderosa Pine Ecosystems: A Broad Perspective. *Ecological Applications*, 12(5), pp.1418–1433.
- Churchill, D.J. et al., 2013. Restoring forest resilience: From reference spatial patterns to silvicultural prescriptions and monitoring. *Forest Ecology and Management*, 291, pp.442–457.

- Ex et al. Does the spatial pattern of forest restoration treatments impact treatment longevity outcomes? A mechanistic approach to understanding the influence of restoration treatments on forest stand dynamics. MacIntire–Stennis proposal 2017.
- Grubb, P.J. 1977. The maintenance of species-richness in plant communities: The importance of the regeneration niche. *Biological Reviews*, 52(1), pp. 107-145.
- Two (2) student selected readings



## Developing an Introduction

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) organizing a persuasive research rationale, (2) formulating and describing a quantifiable research question and hypothesis, (3) and effectively use citations of scientific literature.

### Assignment

For this assignment, you will draft an introduction that will eventually be incorporated into an original research paper. Using the entries you wrote for the “Annotated bibliography” assignment, you will write an introduction section for your research paper. The content in the introduction should (1) convey adequate background material for readers to understand the importance of your research question(s) (2) review similar studies specifying known and unknown areas, and (3) explicitly state your hypothesis or hypotheses and predictions.

Overall, the introduction should follow an “inverted triangle” structure with broad background information of interest to most readers leading to a specific rationale of your hypothesis. Organize writing with each paragraph starting with a topic sentence supported by several details or examples before transitioning to the next paragraph. Supporting information should come from scientific literature and include appropriate citations. A minimum of three references is required, however, 5-6 references are likely needed to provide adequate background information and support for your hypothesis. The introduction should be approximately 500 – 1000 words, typed, and double-spaced using a 12 point serif font. Please include a tentative title that is descriptive and concise. Also include appropriate in-text and bibliographic citations for all scientific literature that is referenced. Check all spelling, grammar, and punctuation for accuracy.

For details on how to go about writing an introduction please refer to class notes and read the “Introduction” section (pages 5 – 7) of “The Structure, Format, Content, and Style of a Journal-Style Scientific Paper” reading located in the course Resources folder. You may also refer to the example research paper included in the Resources folder. See also the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for in-text and bibliographic citations.

### Rubric: Developing an Introduction

Topic	Criteria	Points possible
Scientific content	Adequate background information conveying relationship of research to important topic	2
	Background for objectives and hypotheses (reviewing knowns and unknowns from literature)	3
	Explicitly states hypothesis with expectations	3
	Adequate support of statements by peer-reviewed references	3
Writing cohesiveness	Writing clearly flows from "big picture" importance to hypothesis (hourglass structure)	2
	Paragraphs with clear topic sentences, details, and transitions	2
	Correct grammar, spelling, and punctuation	1
	Includes minimum of 3 peer-reviewed articles	3
	References incorporated smoothly with proper citations	1
Total		20

## "Lies, damned lies, and statistics"

Fall 2018

### Learning goals

The goal of this in-class assignment is to recognize and repair common errors that lead to misleading figures. A secondary goal is to develop skills necessary to critically interpret data from figures, especially misleading ones.

### Assignment

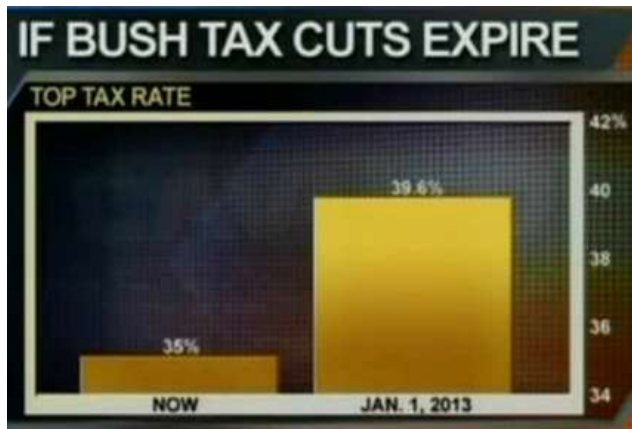
Mark Twain popularized the phrase, "there are three kinds of lies: lies, damned lies, and statistics." Raw data are difficult for readers to understand, so a key skill for all scientific communication is using figures to present data summaries for readers. Unfortunately, poor presentation of data in figures can be misleading, at best, or fraudulent, at worse.

For this exercise, you will read a claim and observe a figure that was used as evidence to support the claim. The figures are from a real cable television news network, although the claims that go along with them are changed for instructional purposes. For each claim, evaluate the figure to support the claim. In 2-3 sentences, identify why the graph is misleading and re-draw the graph to properly present the data. Be sure to include all necessary components of the figure including axis labels, units, and a descriptive caption.

### Rubric: "Lies, damned lies, and statistics"

Points	Criteria
4-5	Responses correctly identify main issues with reasonable correction and revision
2-4	Responses either do not identify main issues or do not offer reasonable correction and revision
0-2	Responses neither identify main issues nor offer reasonable correction and revision, or assignment is late or incomplete

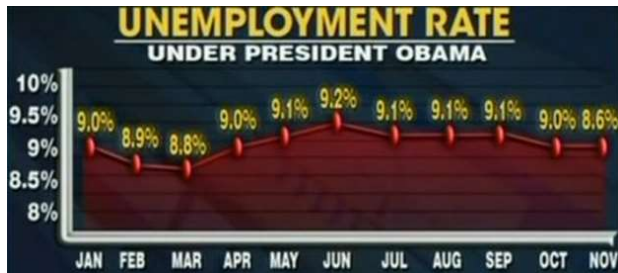
1. **Claim:** "Expiration of the Bush tax cuts will dramatically increase the top tax rate."



2. **Claim:** "Gas prices have been stabilizing over the past year."



3. **Claim:** "The recent decrease in unemployment has actually been modest."



## Analyzing and presenting data

Fall 2018

### Learning goals

The goal of this assignment is to give you experience analyzing and presenting your original data using some of the statistical and graphing techniques we have discussed in class.

### Assignment

Look over your introduction, and select a research question for which you have preliminary or final data. Review your experimental design and select an appropriate analysis with which to answer your research question. Refer to the “Selecting an analysis for quantitative research” handout as a guide. First, analyze your data using an appropriate statistical analysis. Next, use the data and your analysis to answer the 3 questions listed below. Your responses should be typed (1-1.5 pages, double-spaced, 12 point serif font). You will find it helpful to consult the rubric below for more details (see below).

1. Which statistical test did you chose to analyze the data and why was it appropriate to answer the research question asked (2-3 sentences)? **[2 pts]**
2. Write a short (1-2 paragraph) results section. In your paragraph, address the following topics **[10 pts]**
  - Make a general statement describing the overall results. Where appropriate, use simple calculations (means, median, percentages, differences, etc.) to emphasize the differences in your response variable across experimental treatments or environmental gradient.
  - Report the statistics appropriate to the test you chose. The values to report include are specific test statistic you chose (e.g., *t*-value, *F*-value, slope, etc.), the *P*-value for your hypothesis test, and the appropriate degrees of freedom.
  - Write a short (1-2 sentences) interpretation of your results and how they relate to the research question asked.
3. Using R or Excel, create a graph that demonstrates the results of your analysis. Be sure to include axis labels with units, a legend, a descriptive caption, and error bars or best fit line, where appropriate. **[8 pts]**

### Rubric: Analyzing and presenting data

Topic	Criteria	Points possible
Justification	Justification of statistical test for research question	2
Results and statistics	Overview of findings	2
	Accurate description of significant factors and interactions in statistical test	1
	<b>Summary of individual findings with specific supporting calculations (e.g., differences, means, percentages, modes)</b>	4
	Statistics accurately reported (test statistic, degrees of freedom, p-value, etc.)	3
Figure	Figure clearly addresses research question	3
	Descriptive figure caption included	1
	Error bars and/or best fit line included in graph	2
	Axis labels, units, and legend included and accurate	2
<i>Total</i>		20

## Developing a Methods section

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) effective communication of manipulative experiments, (2) detailed understanding of study system, variables, and measurement techniques, and (3) understanding of the utility of data analysis techniques.

### Assignment

For this assignment, you will draft a Methods section that will be incorporated into an original research paper. Using notes from in-class discussion and any appropriate papers from your “Annotated bibliography” assignment, you will write a methods section for your research paper. The content of the Methods should (1) convey the overall approach used in your experiment, (2) convey detailed information to allow for repeatability, (3) justify the methods used, (4) explicitly link methods to your research questions, and (4) adequately describe analytical methods used.

Overall, the methods section should clearly link to the specific research questions addressed in your introduction. Importantly, the methods section should use a “parallel structure” where elements of your research question, methods, and results, are organized in a consistent order. As with the introduction, the methods section should begin with an overview of the experimental approach. As always, organize writing within each paragraph starting with a topic sentence followed by supporting details and a transition to the next paragraph. A minimum of one reference is required, however, more references may be needed to provide adequate justification for methods used. The methods section should be approximately 250 – 500 words, typed, and double-spaced using a 12 point serif font. Include appropriate in-text and bibliographic citations for all scientific literature that is referenced. Check all spelling, grammar, and punctuation for accuracy. Always use past tense to describe your methods (even if you are still working on them!) and use active voice as much as possible (“We measured basal area” rather than “Basal area was measured”). See this article for information about using active voice (<https://www.quickanddirtytips.com/education/grammar/active-voice-versus-passive-voice>).

For details on how to go about writing a methods section, refer to class notes. Please read the “Materials and Methods” section (pages 7 – 10) of “The Structure, Format, Content, and Style of a Journal-Style Scientific Paper” reading located in the course Resources folder. You may also refer to the example research paper included in the Resources folder. Refer to the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for in-text and bibliographic citations.

### Rubric: Developing a Methods section

Topic	Criteria	Points possible
Content	General statement of overall experimental approach	3
	Justifies methods used, clearly linked to research questions	3
	Written with enough detail to be repeated	3
	Figure(s) included to illustrate methods used (experimental design, study site, etc.)	3
	Explains how data was analyzed to answer research questions	3
Writing cohesiveness	Use of parallel structure to link questions, methods, and findings	2
	Includes at least 1 peer-reviewed article justifying methods with proper citations	1
	Correct grammar, spelling, and punctuation	1
	Use of past tense and active voice	1
Total		20

## Developing a Results section

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) communicating results of original research via visual aids such as tables and figures, (2) communicating results of original research via written description, and (3) convey results of statistical analyses.

### Assignment

For this assignment, you will draft a Results section using notes from in-class discussion and data, tables, and figures generated from previous assignments. The content in the results section should (1) summarize the overall trends in your data, (2) visualize important data using tables or figures (3) digest major trends and present summary supporting information, and (4) explicitly link results to the appropriate research questions and methods they relate to.

Overall, the results section should clearly link to the specific research questions addressed in your introduction and methods. Like the methods, the results section should use a “parallel structure” where elements of your research question, methods, and results, are organized in a consistent order. The results section should begin with an overview of the major results. As always, organize writing within each paragraph starting with a topic sentence followed by supporting details and a transition to the next paragraph. In the results section, report all appropriate analyses, and statistical results (t-value, F-value, P-value,  $R^2$ , etc.) needed to address your research questions. In addition to directly answering research questions, provide appropriate calculations (percentages, differences, etc.) that help support overall trends. Be sure to merely report results, as it is not necessary to discuss or interpret them in this section. The results section should be approximately 250 – 500 words, typed, and double-spaced using a 12 point serif font. Include appropriate in-text and bibliographic citations for any scientific literature that is referenced. Check all spelling, grammar, and punctuation for accuracy. Always use past tense to describe your results (even if you are still working on them!) and use active voice as much as possible.

For details on how to go about writing a results section, refer to class notes, and read the “Results” section (pages 11 – 14) of “The Structure, Format, Content, and Style of a Journal-Style Scientific Paper” reading located in the course Resources folder. You may also refer to the example research paper included in the Resources folder. Refer to the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for in-text and bibliographic citations.

### Rubric: Developing a Results section

Topic	Criteria	Points possible
Content	Summarizes overall trends	2
	Individual results reported and digested	4
	Statistical results reported properly (include effect size, statistic, <i>P</i> -value, $R^2$ , etc.)	2
Figures and Tables	Tables and figures display important data	2
	Figures and tables with labeled axis, units, error bars (if necessary), and legend	4
	Figures and tables with captions that briefly explain the data shown	2
Writing cohesiveness	Written in past tense and active voice	2
	Use of parallel structures to link questions, methods, and findings	1
	Correct grammar, spelling, and punctuation	1
Total		20

## Developing a Discussion

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) evaluating evidence in support of a hypothesis, (2) linking original research to other studies and broader themes, and (3) effectively communicating caveats and unexpected findings of original research.

### Assignment

For this assignment, you will draft a Discussion section that will be incorporated into an original research paper. Using notes from in-class discussion and appropriate papers from your “Annotated bibliography” assignment, you will write a discussion section for your research paper. The content in the discussion should (1) evaluate the evidence presented in the results to support or refute your hypothesis and expectations, (2) effectively communicate any caveats, limitations, and generalizations about your work, (3) link your findings to broader themes in the literature using similar papers and big picture topics.

Overall, this section should evaluate evidence presented in the results to your specific hypothesis, and link these findings to broader themes in the scientific literature. The discussion should begin with an evaluation of support for your hypothesis, explain any unexpected findings and caveats, compare your findings with similar studies, and link your findings to broader research themes. As always, organize writing within each paragraph starting with a topic sentence followed by supporting details and a transition to the next paragraph. A minimum of three reference are required, however, more references are likely needed to provide adequate discussion of your results. The discussion should be approximately 500– 1000 words, typed, and double-spaced using a 12 point serif font. Include appropriate in-text and bibliographic citations for all scientific literature that is referenced. Check all spelling, grammar, and punctuation for accuracy.

For details on how to go about writing a discussion section, refer to class notes. Please read the “Discussion” section (pages 14 – 15) of “The Structure, Format, Content, and Style of a Journal-Style Scientific Paper” reading located in the course Resources folder. You may also refer to the example research paper included in the Resources folder. Refer to the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for in-text and bibliographic citations.

### Rubric: Developing a Discussion

Topic	Criteria	Points possible
Content	Clear conclusions drawn from data	2
	Discuss whether results support or refute hypothesis	1.5
	Explain unusual and unexpected findings	1.5
	Relate findings from your study to similar studies	3
	Discuss caveats, unknowns, and avenues for future research	2
	Concludes with "big picture" implications (link findings back to introductory material)	2
Writing cohesiveness	Writing organized around a central thesis, with clear topic sentences and transitions	2
	Caveats and unknowns discussed without undermining findings	0.5
	Smoothly expand narrow results to broader field of research (hourglass structure)	2
	Includes minimum of 3 peer-reviewed articles	1.5
	Correct grammar, spelling, and punctuation	1
	References incorporated smoothly	1
Total		20

## **Completing an original research paper**

Fall 2018

### **Learning goals**

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) communicating an original hypothesis using rationale from the scientific literature, (2) communicating experimental design, measurement, and analysis of original research, (3) communicating and illustrating data from original research, (4) evaluating evidence, limitations, and broader themes from original data, and (5) development of skills in technical scientific writing.

### **Assignment**

For this assignment, you will combine elements of all previous course assignments (annotated bibliography, research paper sections, and data analysis activities) and submit an original research paper. Using notes from in-class discussion, example papers, and research papers of your own choosing, you will compile a final original research paper. For each section (Abstract, Introduction, Methods, Results, Discussion, Literature cited), refer to notes and rubrics from all previous assignments. Please incorporate all revisions suggested in previous assignments as you compile the report. In addition to the previous assignments, please include an Abstract, a short summary that conveys the major points from each section of the report (6-10 sentences).

Be sure to follow the Writing Cohesiveness tips in the previous sections, including an overall “hourglass” structure to the report. Please use parallel structure in the research questions, methods, and results. As always, organize writing within each paragraph starting with a topic sentence followed by supporting details and a transition to the next paragraph. A minimum of ten total references are required, however, more references may be needed to provide adequate support for rationale, justification of methods, and discussion of results. The final report should be approximately 2500-4000 words, typed, and double-spaced using a 12 point serif font. Include appropriate in-text and bibliographic citations for all scientific literature referenced. Check spelling, grammar, and punctuation for accuracy. Use past tense to describe your methods and use active voice as much as possible.

For details on how to go about compiling the report, refer to comments on previous drafts, rubrics, and all class notes. Please review “The Structure, Format, Content, and Style of a Journal-Style Scientific Paper” reading located in the course Resources folder. You may also refer to the example research paper included in the Resources folder. Refer to the handout “Scientific Style and Format Citation Quick Guide” in the Resources folder for details on format for in-text and bibliographic citations.



**Rubric: Completing an original research paper**

Topic	Criteria	Points possible
Introduction	Adequate background information conveying relationship of research to important topic	3
	Background for objectives and hypotheses (reviewing knowns and unknowns from literature)	3
	Explicitly states hypothesis or hypotheses with expectations	2
	Adequate support of statements by peer-reviewed references	2
Methods	General statement of overall experimental approach	2
	Justifies methods used, clearly linked to research questions	2
	Written with enough detail to be repeated	4
	Figure(s) included to illustrate methods used (experimental design, study site, etc.)	2
	Explains how data was analyzed to answer research questions	2
Results	Summarizes overall trends	2
	Individual results reported and digested (means, differences, percentages, etc.)	3
	Statistical results reported properly (include effect size, statistic, <i>P</i> -value, <i>R</i> <sup>2</sup> , etc.)	2
Figures and Tables	Tables and figures display important data	1
	Figures and tables with labeled axis, units, error bars (if necessary), and legend	2
	Figures and tables with captions that briefly explain the data shown	2
Discussion	Clear conclusions drawn from data	1
	Discuss whether results support or refute hypothesis	3
	Explain unusual and unexpected findings	2
	Relate findings from your study to similar studies	3
	Discuss caveats, unknowns, and avenues for future research	2
	Concludes with “big picture” implications (link findings back to introductory material)	3
Writing cohesiveness	Writing organized around a central thesis	2
	Writing clearly flows hourglass structure	2
	Clear topic sentences and transitions between paragraphs	1
	Use of parallel structures to link questions, methods, and findings	1
	Includes minimum of 10 peer-reviewed articles	2
	Correct grammar, spelling, and punctuation	1
	Use of past tense and active voice	1
	References incorporated smoothly with proper citations	2
Total		60

## Developing a research poster

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate your knowledge in the following areas: (1) effective written communication of original research (2) understanding data analysis techniques, (3) effective organization and presentation of research in poster format.

### Assignment

For this assignment, you will develop and deliver a poster presentation on an experiment related to your area of research. The poster will be in the format of a poster presentation delivered at a scientific conference. For the poster you will use real data related to your independent research. For the poster, you should analyze the data set, create several figures to explain the results and present some material for a brief introduction and discussion. The experiment you write about must have a degree of complexity. That is, it must require a statistical analysis more advance than a *t*-test or single factor ANOVA. There are ample examples of research posters of varying quality in the course Resources folder and throughout the hallways of the campus buildings. We will discuss further in class the elements of a good poster. After finishing your poster, we will host a poster session during the final exam where each student will display their poster and present to the class and instructor.

### Audience

You will construct the poster for an audience of other scientists in your field attending a research conference. You can assume the audience has a general undergraduate education in natural resources, ecology, or biology, but you should define any terminology specific to your research.

### Detailed description and format

The poster should be 36" x 48", created in PowerPoint or other software, and include figures, tables, and at least 3 references. The poster should be in the format of a research poster at a scientific conference and should include the following sections.

**Title:** Your title should be descriptive yet as concise as possible

**Abstract:** Your abstract should summarize the important points from every other section of your paper and should be in approximately 200–300 words, and take up approximately 5% of the poster area.

**Introduction:** The introduction section of your poster should be concise, and should take up approximately 20% of the poster area. It should introduce relevant background information, explain the hypothesis you will be testing, and explain your predictions. Please include at least 3 citations to relevant literature in your introduction. I usually recommend using bullet points to organize the introduction and any relevant figures or photographs to describe the background information.

**Methods:** The methods section of the poster should up approximately 20% of the poster. Again I recommend bulleted points to organize the methods that touch on the following points.

- Describe the experimental design you used to test the hypothesis giving the details of your particular experimental design including treatment levels, replication, and any blocking or nesting, etc.
- Create a figure or diagram of your experimental setup to help concisely describe your experimental design.
- Explain how you manipulated treatment levels or gradients and measured the response variable.
- Describe what analyses you used use to test your hypothesis.

**Results:** This is the focus of most research posters, and it should take up approximately 30% of the poster space. Figures with captions and a few bulleted summaries are usually adequate for this section.

- Provide one or more figures that illustrate your data (e.g., bar graph or scatterplot) including all appropriate elements as discussed in class.
- Explain any trends in your data such as comparing treatment means or a description of the correlations you found (strong/weak, positive/negative, means, differences, etc.).
- For each statistical analysis you do, report statistical information (e.g., test statistic, degrees of freedom, *P*-value).

**Discussion:** The discussion section can also be bulleted and should take up approximately 20% of the poster area. In the discussion be sure to provide an interpretation of your results in the context of your original question. Do your results provide support for your hypothesis? Compare your results to other studies and discuss the implications of the findings.

**References:** In a small area in the corner of your poster (approximately 5% of the area), please use consistent literature citations according to the conventions of your discipline, or refer to the Annotated Bibliography assignment for examples. Include at least 4 appropriate peer-reviewed references.

**Style and Organization:** Please see example posters in the Resources folder for previous examples of research posters. There are also examples of research posters of varying quality throughout the hallways of the campus buildings. Be sure your poster does not include large blocks of text (besides the abstract), and that all important information is easy to find. The poster should balance the use of photos, figures, and text, and guide the reader with proper headings. Text should be readable when printed (recommended font size of approximately 40 for body text using for 36" x 48" posters). Colors, fonts, and design elements (boxes, etc.) are recommend to help organize information, but keep their use minimal and professional.

## **Rubric: Developing a research poster**

You will be graded based on the following criteria for a total of 50 points.

- Abstract [3 pts]
  - You will earn 2-3 points for an abstract that clearly and succinctly summarizes the important points from each section of your study, 1-2 points for an abstract that is unclear or does not adequately summarize your study, or 0-1 points if your abstract is absent or incomplete
- Introduction [8 pts]
  - Introduction provides adequate background information [2 pts]
  - Background information clearly leads to predictions [2 pts]
  - States the hypothesis or research questions being tested [3 pts]
  - State the predictions expected [1 pts]
- Methods [8 pts]
  - Description of experimental design: You can earn up to 4 points for an experimental design that is clearly described and is the most appropriate for the question asked.
  - Diagram of your experimental setup: You can earn up to 2 points for a diagram that is organized and clearly conveys the experimental design described in the text.
  - Statistical Analyses: You can earn up to 2 points for analyses that are appropriate for the hypothesis and experimental setup described.
- Results and Discussion [18 pts]
  - Figure or table: You can earn up to 6 points for a figure or table that includes all the necessary features (axis labels, legend, caption, error bars, etc.) and clearly conveys your findings.
  - Major findings and trends: You can earn up to 4 points for clearly describing the results from your analyses and pointing the reader to the main trends.
  - Appropriate statistics reported: You can earn up to 4 points for properly reporting all statistical details (test statistic, degrees of freedom, *P*-value, *R*<sup>2</sup>, etc.).
  - Discussion contains clear explanation of results in context of original question [1 pt]
  - Discusses areas of certainty and remaining uncertainty [1 pt]
  - Compares findings to other similar studies [1 pt]
  - Includes potential avenues for future research [1 pt]
- References [1 pts]
  - You will receive 0.25 points for each appropriately cited reference up to 1 point.
- Style and Organization [12 pts]
  - Clear logical flow with main points easy to find [6 pts]
  - Appropriate amount of white space and use of color [2 pts]
  - Avoids large blocks of text [3]
  - Consistent formatting throughout [1 pts]

## Presenting a research poster

Fall 2018

### Learning goals

This assignment is designed to allow you to demonstrate (1) effective communication of original research, and (2) understanding of research methods and results.

### Assignment

For this assignment, you will deliver a poster presentation of your original research. Using the poster of your original research you created in the previous assignment, you will deliver a 5-7 minute presentation of your research. Your presentation should convey the major points of your project and communicate the importance of the research and the questions you addressed. You should use the figures on your poster to guide your description of the methods and results. You should not read from your poster, but rather summarize the main points of your poster and present it conversationally. Lastly, you should be prepared to answer questions and defend decisions made at various points in your research project. You will be graded according to the attached rubric, and evaluation from your peers will also be included as part of your score.

### Audience

The intended audience for your poster presentation is an undergraduate research conference. You can assume that the audience has a general undergraduate education in natural resources, ecology, or biology, but you should define any terminology specific to your research. Note that after the course, you may present this research at an undergraduate or other research conference.

### Tips for poster presentation<sup>1</sup>

- Your poster presentation should include the necessary background to introduce your topic to a broad audience who may not know much about your topic and should lead directly to the research question you addressed.
- Be sure to read your audience for feedback to ensure that points are understood clearly before moving forward.
- Your presentation should explain why the methods you used and the results you obtained were ideal for answering your question.
- Your presentation should conclude with the overall findings and how they related to your initial question and background information.
- Practicing your presentation is crucial: You should know exactly what all your figures mean and be able to explain them, and you should know all the key points to your research without reading notes.
- Be prepared for questions about your methods or other relevant material. It's hard to predict what people may ask!
- Dress appropriately. For conferences in biology and ecology, a suit and tie is unnecessary. However, business casual dress is encouraged.

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<sup>1</sup> Information from NueroWire: Tips for presenting your scientific poster at a conference. *Scientifica UK*. Accessed Nov 2018: <https://www.scientifica.uk.com/neurowire/tips-for-presenting-your-scientific-poster-at-a-conference>

**Rubric: Presenting a research poster**

You will be graded based on the following criteria for a total of 20 points.

- Clear description of background information appropriate for audience [4 pts]
- Clear description of methods with justification for their use [4 pts]
- Clear description of research results and their implications [4 pts]
- Professional attitude and appropriate dress [1 pt]
- Fields questions related to research adequately [3 pts]
- Average score from peer-evaluations scaled to maximum of 4 points [4 pts]

**Student peer-evaluation rubric: Presenting a research poster**

Presenter Name or Title:			
Criteria	Possible	Earned	Comments
Introduction: Clear description of introduction appropriate for a general audience. Introduction should clearly lead from background to research questions	4		
Methods: Clear description of methods, including a justification for why they are appropriate	4		
Results and Discussion: Clear description of results which are related back to original research questions and implications	4		
Professional attitude and dress	1		
Fielded questions adequately	3		
Total	16		
Overall comments and suggestions:			