Guidelines for REN R 690 Course Projects

Draft submission: **Feb 27, 6pm** - Final submission: **April 14, 6pm**

Scope and nature of the course project

The course project is a central, problem-based learning component of this class. Normally, this will be based on a dataset that you collected as part of your own thesis research. In terms of scope, your project should correspond to one chapter of your thesis or to a standard peer-reviewed journal article. Many students use this class as an opportunity to complete an advanced analysis for a thesis chapter or a manuscript.

If you only have incomplete data from your thesis research, then for the purpose of this class, you can use simulated data to add missing replications, sites or measurements (see details below). If you have no data at all, you can ask your supervisor for a related dataset or work with publicly available data (see details below).

The class project should be original work carried out during this course. You are welcome to build on previous work. Students who have taken my REN R 480 or RENR 580 classes are allowed to build on their previous class projects, and may continue to work on the same websites. Similarly, you may build on other previous work. However, ***you need to register this previous work with me*** when we first discuss your class project plans. You also need to submit a copy of your previous analysis and narrative (if other than REN R 480/580, which I have on record) and I will evaluate added value that you generated as part of this class.

An important milestone and grading criterion for your course project is to formulate valid and valuable research questions, objectives or hypotheses. You don't need to develop a scientific hypothesis, but if you use the word "hypothesis", be sure that you know what it means: http://tinyurl.com/rr480/video/hypothesisdev. Good hypotheses, research questions and objectives tend to emerge during exploratory data analysis. Sometimes, you have to first become familiar with your data, in order to find out what questions you can feasibly answer.

For inspiration, and to get a good idea of the scope of the class projects, you can view previous student's projects here: http://tinyurl.com/mv690/projects.

Data simulation and data sources for your class project (if need be)

(1) First, if you don't have any thesis data at all because you just started your degree at UofA, consider dropping this class for now and taking it later. The class really is designed for students who want to wrap up a thesis chapter with advanced quantitative analysis.

(2) For those who have partial thesis data but missing measurements or replications, here is a tutorial to create an empty data table and fill it with simulated data that represents your expected or desired effects and correlations: http://tinyurl.com/rr480/video/simulation. You can then later plug in the real data for your analysis.

(3) You may also use public datasets from open-access data repositories for the purpose of your course project. You can search for datasets in the area of your interest with these search engines by keyword, topic area or location: https://datacite.org, https://datasetsearch.research.google.com, https://explore.openaire.eu, https://www.frdr-dfdr.ca/, or https://geo.frdr-dfdr.ca. There are also journals that specialize in publishing high quality datasets. Browse their papers for inspiration, e.g.: https://www.nature.com/sdata. Another effective way to find datasets is to use Google with the search words: "download", "data", plus a file format such as "csv", "shapefile", "excel", "xls", "xlsx" (one at a time) plus some general topic words like "forest fire canada". Try various combinations (without quotes), like this.

I also note that one specialty of my own lab is to make climate data easily accessible for analysis. Many students in the past have taken advantage of this resource for their theses and projects if they deal with historical climate trends and projected climate change. Here is how: http://tinyurl.com/rr480/video/climate.

Draft project submission for peer review

For the draft project, I expect ***a complete research project report*** covering (1) study background and rationale, (2) project objectives, (3) experimental or sampling design, (3) data visualization and exploration, (4) presentation of results, (5) interpretation of graphs, and (6) conclusions. This ***must be complete***, in order to collect feedback from your peers and from me on all aspects of your project.

That said, the draft submission ***does not require*** a complete statistical analysis. Instead, focus on working out an objective or question that can be answered with your data, based on multivariate data visualization with graphics, ordinations, and dendrograms, which are cover in Labs 2 to 5 (minus MANOVA). In fact, ***I discourage you from including any inferential statistics*** in your draft submission. Techniques that produce predictions and p-values will be covered properly in the second half of the course. Save their use the final project submission. At the draft stage, you can just say what you are planning to do with regards to statistical testing and predictions.

The draft project will include are **two items** to submit:

The first is a ***5-minute narrated presentation*** that provides an overview of your project. This really must be short and simple. Think no more than 10 slides. Submit this as link to a video (e.g. YouTube or Vimeo), which you can create by recording a Zoom session where you share a screen with your slides (to an audience of nobody). For a more sophisticated video recording, use the PowerPoint narration function, e.g.: https://youtu.be/jHeH05PKvHg After recording, save your .pptx file also as .mp4, which you can upload to video sharing sites.

Secondly, present more detail and narrative in the form of **a simple 5-page website**. To generate a website, you can use any free on-line editor. I recommend Google Sites (tutorial here: https://youtu.be/5BhCVvFWEtE) or Weebly for fancier designs: http://tinyurl.com/mv690/videos/weebly.

For your draft project submission, email the following to ahamann@ualberta.ca:

- A link to your final course-project website. This can be un-listed (i.e. not searchable), but it must be set to public access (please double-check this by logging out of your account (or using another browser where you are not logged in). Then try to access the link you plan to share with me. There should be no log-in required.
- A link to the final 5-minute presentation on YouTube or Vimeo. This can be un-listed (i.e. not searchable), but it must be set to public access (please test this as explained above).
- [For your **final project submission**, add the following three annotated attachments as well: (1) Andreas' comments.docx, (2) Review1.docx, (3) Review2.docx, which briefly describe how you have addressed comments and suggestions from the peer review]

You can work on your draft and final project submissions throughout the course, and there will be opportunities during any of the scheduled in-person and on-line lab sessions to ask questions and get help about any aspect of your course project. If the lab sessions are not enough, the TA and myself will offer individual appointments as needed. Just let us know.

Suggestions for your research project and website (5 web pages)

Scientific research can be defined as the collection, analysis, and interpretation of data with the purpose of (potentially) changing your mind on something that's important to get right. The primary communication tool of scientific research results are brief, peer-reviewed papers, and in this course I would like you to develop a similar but even more concise report in the form of a peer-reviewed project website. The research scope and analysis should be comparable to a scientific paper, but the writing should be much shorter, boiled down to the essence using plain language that is clear to anyone in this class, ***without using jargon or abbreviations of any kind***. Use five pages, titled: Home, Intro, Methods, Data, Results, (optional: References, About) allowing for simple one-click navigation and everything being in plain sight (no further subpages, links to images or image carousels):

1. Home (~200 words)

Title – Aim for a short, descriptive and catchy title. Good titles and abstracts drive citations, and citations will drive your scientific career. If you spend two years working on a research project, it's well worth to invest two days to think up a great title and write a great abstract to make sure your paper will get recognized.

Regarding titles, avoid formulations like "*The effect of this on that*" and other uninformative variations, such as: "*Is this related to that*?" or "*This influences that!*" Instead, step back from your statistical analysis and think about your broader goal. Generally, questions are good, as are concise 2-part titles following the general pattern of "*Result: implications*", e.g.: "*High inbreeding found in xyz: implications for captive breeding programs*". You can also show off strengths/unique aspects of your data: "*A 56-year analysis reveals …*", or follow the format "*Topic/result: a comprehensive evaluation of 143 provincial parks reveal major gaps for…*". Clever wording and word-plays are effective: "*Some phenomenon: proximate and ultimate causes*", "*Some topic: dealing with uncertainty*" or "*Predicting something in the future: learning from the past*", etc. There are no real recipes - be genuinely creative.

Abstract – The abstract is different from the conclusions, in that it summarizes the entire paper in plain language, without any abbreviations or jargon. It contains: (1) two or three sentences why your research is timely and important; (2) a general objective statement communicating the overarching goal, not the work itself; (3) two or three sentences about your research approach: summarize your sampling procedure/experimental design/analysis; (4)Two or three sentences about your key results (express them quantitatively if you can); (5) end with your main conclusions, applications or implications.

Your conclusions need to be valuable for at least some readers. Ask yourself: would people cite you for the take-away messages that arise from your research. Would somebody really say: "According to *insert your name* (2024), *insert your take-home message*"? For this to actually work, you can't conclude with technical or statistical statements, such as: "*This is different from that*". To make an impact, say what the statistical relationships or differences mean with regard to how the world really works, or with regard to practical management applications.

For the draft submission, your research and analysis should be at a stage where all the abstract elements can be written as described above, even if further analysis may change some of them later. Otherwise you will not be able to provide and receive useful and constructive feedback.

Visual Elements – Use a photo or another visual element that represents your research topic.

2. Intro (~500 words)

Background & Rational – Describe the context of your research (background), and explain why your research is important or interesting (rationale). Do include references here that can be added as a footnote or reference section, but note that *this is not a literature review*. Your goal here (as in a scientific publication) is to convince the reader that your research objective (next section) is timely and relevant. Use citations strictly as evidence for the points you make in explaining the value of your research. Keep this section as short as possible and aimed at your class-mates as peer-reviewers. Put yourself in their shoes: will they get it why your research has value?

Research Objectives – This is a key section that will take you some time to develop. Often, you will find that your initial objectives when you started the research sounded great, but you couldn't really accomplish any of that: Your experiment wasn't really suitable in hindsight, your study subjects didn't cooperate, a key measurement didn't work as expected, some of your results turned out too uncertain or uninterpretable, etc.

Nevertheless, you need to get this section right for a good grade in this class (and later to defend a thesis or publish). Rethink this section as your analysis progresses to arrive at feasible, valid research questions, applied objectives, or scientific hypotheses. Let this section be guided by the following: Are there practical applications of your research? Do you want to decide between two or more management options? Or do you have a true scientific hypothesis in a sense of two or more competing explanations that you want to investigate?

If you use the term "hypothesis" in this section (or in your corresponding thesis section), it should strictly be in a sense of a putative explanation for an observed phenomenon (https://en.wikipedia.org/wiki/Hypothesis and also explained here http://tinyurl.com/rr480/videos/hypothesisdev). You don't need to state a hypothesis. Stating an interesting research question or applied objective is just as good, but be sure you actually meet the objectives and answer those questions with your data in the end!

If you do state a scientific hypothesis, also state your expectations and reasons for those expectations. Further, expand on reasons for possible alternative outcomes. Alternatively, if you state applied objectives or research questions, then explain how different results would help you to decide between different management options.

Visual Elements – In this section, you may use simplified, conceptual graphs or diagrams to support your background narrative, or to illustrate what the possible outcomes of your study might be.

3. Methods (~200 words)

Data collection – Briefly describe your sampling procedure/experimental design/measurement protocols. Please only describe the data that you actually analyze as part of this course project, not other things you have done as part of your thesis!

Experimental or sampling design – Describe any sampling and statistical designs, replications, hierarchical or nested structures. Use diagrams or tables to show the number of replications, treatments, plots within treatments, etc. State what your predictor and response variable are.

Visual Elements – Probably most important in this section to keep your reader's, audience's, and my attention. Use maps of your study sites and diagrams of your experimental and sampling designs rather than trying to

describe that in a lengthy narrative. Ground or aerial photos of your field sites with diagrams drawn on top of them (e.g., https://tinyurl.com/mv690/v/graphics (minute 4:40) showing transects, plots, treatments, etc.) can be very effective. If you have experimental treatments or site types in sampling designs, use photos to illustrate your treatments or sample sites. Most of what you generate here will likely not make it into research papers, but some of it can be used in your thesis, and it is great material for conference talks and other presentations.

4. Data (~500 words)

This section is unique to this course project report, and would not normally be part of a paper, thesis, or conference presentation. Nevertheless, data exploration and quality control, as well as raw data visualization is essential to get your final results right, and to not miss anything interesting and important. Graphs you use here can be busy and messy, but they should allow you to see outliers, distributions, data volume and gaps. In the subsequent results section, you create simpler, cleaner graphs as higher-level summaries of raw data.

Note that you should ***not interpret or explain the results here***. Save your interpretation of the biological or applied meaning of what you see in your graphs for the next section. Here, you want to talk about your data quality, quantity, problems, imbalances, missing values, errors, gaps, outliers, and how you deal with it with regards to data cleaning or describing the limitations of the dataset to draw scientific conclusions.

Data table – Show and describe your simplified data table (i.e. include an abbreviated table displaying your variables in columns and a few sample rows of data. Describe the following: What are your sampling units or experimental units? What are the predictor variables? What are the response variables? Is the predictor variable manipulated in an experiment or simply observed? Is the predictor variable categorical or continuous? Again, strictly limit the description to what you analyze as part of this project.

Exploratory graphics – Before applying advanced multivariate statistics, you should thoroughly understand the nature of your data. Explore your dataset with the basic techniques and graphical tools that we covered in class so far. For a limited number of response variables, univariate diagnostic plots (histograms, boxplots, or scatterplots) can be used. Also, basic ordinations (PCA, NMDS, PCoA) can be used here. Use colors, symbols, sizes and/or labels to be able to identify plots/sites/treatments/etc. or important response variables. However, save the interpretation for the results and discussion section. As such you likely don't need to display vectors on ordinations here. Instead, talk about any potential problems with your data. If you made corrections or removed outliers, justify your choices. If you find gaps that may limit your inferences and interpretation later, say it here. Also, don't forget to number your figures (so that they can be referred to by your peer-reviewers) and add figure captions and legends, so that the graphs are completely understandable by themselves.

5. Results & Discussion (~500 words)

Take-home messages: I recommend that you structure this section with sub-titles that represent the main take-home messages (e.g. "No evidence for long-term drought impacts"). Start with your most important finding and refer to the figures and tables as evidence for what you state is actually true. Figures and tables need to be designed to specifically serve this function. Elaborate with additional interpretation (i.e. discussion). Be selective and only show a reasonable number of take-home messages supported by quality graphs. Move any extra graphs that don't serve this purpose to the data page. On the other hand, if a graph on the data page serves as evidence for a take-home message, feel free to create a polished duplicate version of it for the results page.

Take the reader by the hand: In any results section, never say something like: "Correlations between climate and species growth are shown in Table 1". Instead, your job is to take the reader by the hand and point out what's interesting, referring to figures or tables as evidence. Instead of the above, you can say: "We could not find evidence for drought to affect the growth in any of the species (Table1)." When correctly formulated, references to figures and tables should always be in parentheses, and not outside parentheses like in the first example. With regards for what is shown in the figure or table, that should be covered by the figure or table caption!

Visual elements, figure and tables: Consecutively number all visual elements across your web pages: maps, diagrams, photos like this: Fig.1, Fig. 2,…and tables like this: Table 1, Table 2 … (*This is especially important for the draft submission, so that your peers and I can give you feedback on specific graphs and tables !!!*) Further, use stand-alone and fully descriptive figure and table captions. The reader should be able fully understand the Figure or Table based on the caption and legend, without having to read any text. Table captions must be above the table, figure captions below. Start your figure and table caption with a short descriptive sentence that would read like a title for the Figure or Table, e.g. "Table 1. Pearson correlations between climate variable and species growth." This can then be extended with further detail, such as "Significant correlations at α=0.05 are indicated in bold". Avoid abbreviations not only in text but also in Figures and Tables. If you absolutely must use them due to

space constraints, and there is no way you can change the design of your table or figure to accommodate longer labels, explain all abbreviations in the legend or caption of every figure and every table. All the above applies to any scientific report, publication, or thesis document as well, so you might as well practice it here!

6. References / 7. About – You may add these as an additional pages to list your references or to acknowledge collaborators and sponsors of your research, and/or to say something about yourself.

Suggestions for the project presentation (5 minutes)

Format – Use a narrated PowerPoint slide show that summarizes you study concisely. Please with threes (rule of threes), using three main components: an opening, a body, and a closing. You may also aim for three questions and three take-home messages. Do not use bullets, or written paragraphs on slides. Remember, you are talking, so this is not necessary. Many studies have conclusively shown that transmission is blocked if your audience simultaneously tries to read and listen to you. Also, speak freely. This may take a little longer but it's worth it. If you find you waste much time by searching for words, practice a little, but don't over-practice (i.e. don't memorize the exact wording), and don't read from notes. It sometimes helps to write down what you want to say concisely, but then DON'T use this as an aid when you speak. The words will just come fluently once you have clearly formulated it for yourself. If you forget something, it doesn't matter. Nobody will know.

1. Opening: Hook, Backgound & Problem Statement – (2-4 slides / 1-2 minutes).

A "hook" is an opening technique to focus people's attention so that they don't miss the title and your opening statement, and hence the entire point of your talk. This is very effective at busy conferences where people already suffer from information overload. You can deliver your hook in 30 seconds or less, for example, while your title slide is up and people are still not quite focused on you. There are many options for an effective hook, but few work for a recorded presentation. Omit them or maybe consider:

- Something about yourself or something that connects you personally to the research
- Something you just "read in the news" (fine to fake it by elevating older news)

For in-person presentations, you have additional options, but they don't work well in video recordings:

- Perhaps you can ask the audience an interesting question based on a photo or a prop that you bring
- A good joke or cartoon that is related to the talk. If you can't stop giggling while thinking about it, it's good. If it does not pass that bar, leave it.
- The most powerful hook is to relate *ad hoc* to a previous presenter in some way. This way you truly connect to an audience and make this a conversation.

After your hook, briefly say what this presentation is about and state your research question/objective. You may say a few words about your species, your study site, and the context of your research: why is it important or exciting? State your questions, objectives or hypotheses. You can also take your conclusions to the front: "I will show you that…". You don't need an outline or overview slide for a presentation that's less than 20 minutes. It's better to have a good story than excessive structure and outlines.

2. Body: Methods, Results and Discussion – (4-8 slides / 2-3 minutes).

Briefly describe your data and experimental or sampling design using diagrams. Diagrams overlayed on photos are perfect for this. Limit the method description to what you actually analyze.

Use your results from either exploratory analysis of raw data, of from grapsh and tables of descriptive statistics Explain all graphs you show: What are the x and y axes? What do the points/lines/bars represent? Tell your audience what relationship or effect they see in the graph and explain how the findings can be biologically interpreted and/or what the practical applications are. Tell a complete story around a graph, if you can, including the interpretation and implication of the results. For the final presentation, add information from inferential statistical analysis.

3. Closing: Conclusion and take-home messages – (1-2 slides / 30 seconds to 1 minute).

Aim for a nice conclusion, e.g. going full circle back to your opening statement or linking back to your original hook is very effective, giving the audience a natural sense of closure. Alternatively or additionally, you can add some personal opinion, interesting speculation, or any kind of personal or scientific highlight of your study. For a short talk you don't need to explicitly repeat and summarize your results at the end. You may want to drive your

main points home again in a different way (aim for three messages) – but avoid a "word for word" repetition of the exact same thing that you just said a minute earlier.

For the final presentation, simply update this talk with the results from your multivariate statistical analysis. Treat this presentation as if the class has never heard what you did before (and most was either never absorbed or has been forgotten since your first presentation). So, feel free to repeat anything from your first talk.

Draft Project Evaluation Criteria (Assuming Completeness)

The analysis and writing of your draft and final course project submissions MUST BE ORIGINAL (i.e., they must generated by yourself during this course). You may build on prior work by yourself and others, but THIS MUST BE REGISTERED and cleared with me before you submit your draft project. My evaluation in some of the rubrics below will then be based on added value generated during this class.

Website Layout (20%): High marks are given for effective use of headings, paragraphs, diagrams, photos, and graphs in your website. Everything should look polished with consistent fonts, font-sizes, colors, and symbols. Font sizes in your graphs and tables should be easily readable and about the same size in your figures (titles, labels, tickmarks) as in your website text (about 2mm height on a normal computer screen, like those in the lab). Resize anything significantly larger or smaller. Make use of white spaces between paragraphs. Use short paragraphs and group your graphs, tables, or diagrams with the paragraphs that refer to these visual elements. However, always start with your narrative and place the visual elements subsequently.

Writing (30%): High marks are given for concise and logical writing that makes plain sense. Write for an audience of your fellow students from various disciplines in the life and environmental sciences. Write as you would to a friend to explain your research project! They'd be interested in what you do, but they will not want to look up references, technical terms, and abbreviations.

Your content matters most for a high mark. As a summary of the above: • Your introduction should provide a rationale for your objectives, not a literature review. • Both general and specific objectives need to be ultimate goals, or you must clearly explain how they contribute to an ultimate goal. • Your results should be statements of important insights based on data (with tables and figures cited in parenthesis as evidence for what you say is true). • Your discussion should be an interpretation of your results, not a literature review. • Your conclusions (which can be part of the discussion), should clearly (not vaguely) meet your stated objectives (if they do not, state different objectives). • There has to be a straight forward, logical storyline from the first to the last page of your website (try to write science as you would write a story). • Do not use any abbreviations for example for treatments or locations. Only extremely common abbreviations like "GIS" may be used.

With artificial intelligence tools now available to draft, re-write, and polish your text, I expect near a perfect English grammar, spelling and writing style. Feel free to use ChatGPT, Quillbot, Grammarly and other AI-based tools. Note that generative AI tools can also easily create large amounts of original text that sounds great, but doesn't actually make scientific sense, or that serves a direct purpose in the context of your analysis. Nobody needs this. Points get deducted for not being concise or for not making sense.

Figures & Tables (30%): I do expect high quality scientific graphs based on what you learned in this class. • Efforts in creative use of symbols and colors, leading to salient figures, is rewarded (i.e. it should be easy for the reader to see that what you state in the results is true). • Customizations and touch-up are rewarded. • Also, make sure all graphical elements (labels, titles, etc.) are easy to read, non-overlapping, and consistently sized. They should be about the same size as your paragraph text, but sans-serif fonts are preferred. • Tables need to conform to standard scientific layout. Take screen prints of tables to upload as an image to your website. • Every Figure or Table should be consecutively numbered throughout the website (this is especially important for the ***draft submission***). • There must be a caption above Tables and below Figures that start with a short sentence that reads like a title, followed by additional detail for the reader to understand the figure and explain all abbreviations. Tip: whenever you are tempted to say: Figure 3 shows … in your results narrative, this should actually go into the figure caption. • Unless impossible to fit, labels and legends should NOT be abbreviated.

Presentation visuals (20%): Do not use bullets, or written paragraphs. Remember, you are talking, so this is not necessary. Many studies have conclusively shown that transmission is blocked if your audience simultaneously tries to read and listen to you. Never do this to your audience. Inexperienced presenters like bullets and text

because they serve as speaking notes, but the presentation is not for you, it should be designed for your audience. A good score here will require that you use photos, diagrams, maps, figures and tables to support your narrative. For a scientific audience always use plain, high-contrast themes, simple graphical elements, easy-to-read labels, and NO abbreviations. Also, avoid distractions such as clip-art, crowded slides, or funky animations.

- Note that you are neither evaluated on your presentation skills per se (although you will get feedback), nor on the value of your results for science. Rather, I want to see that you can communicate a reasonable rationale and objective, and explain what your results mean to an audience that consists of your peers. As such, you do not need to explain what senior undergraduate or junior graduate students in an environmental and life science disciplines generally understand. Neither do you need to explain the statistical methods covered in this class.

Final Project Evaluation Criteria (Assuming Completeness)

Website Layout (20%): as above.

Writing (30%): as above.

Figures & Tables (20%): as above.

Analysis (20%): A full mark for this section requires that you choose the right method, recognize the assumption and limitations of the analysis for your dataset, and interpret the results correctly. A high mark requires good judgment. Both, overstating your results or being overly cautious with conclusions when the results are clear would lead to deductions.

Presentation visuals (10%): as above.