Biology 205 Lab Manual

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2022-09-15

Contents

Welcome

To your Biology 205 Labs!

First, a few important and relevant links…

- Canvas course shell
- Syllabus

Copyright

Please use the following for citing this document

Hay, T (2021). *Biology 205 Comparative Invertebrate Zoology Lab Manual.*. https://ubco-biology.github.io/BIOL-205-Lab-Manual/.

Some content provided by the University of British Columbia, Okanagan Biology Graduate Program students handbook and the National Center for Case Study Teaching in Science.

All source files are available https://github.com/ubco-biology/BIOL-205-Lab-Manual.

UBCO Biology open materials

This resource is part of a larger project to host UBCO Biology lab materials in an open, accessible format.

All BIOL open materials can be found at https://ubco-biology.github.io/

Conventions

Information relevant to lab logistics and grading.

Further insights or notes on presented materials.

Highlights and key take aways.

Optional material that dives deeper into a presented concept.

Labs 1 & 2 - BIOL 205

Last updated 2022-09-15

Planning Your Experiment

There is a lot to consider when developing an experiment to answer the problem you have outlined in front of you.

The link below will help you sort out best practices in experimental design. It is highly recommended that before you come to the lab to start designing your experiment that you take the time to review the material from BIOL 116 in the link below starting with the "statement of hypothesis" through to "conducting the research".

Experimental Methodology - What you need to know to design your experiment

Assignment 1: Primary Source Papers

Overview

Ensure you submit each summary to the specific submission locations on Canvas.

Submitting all in one location will result in a mark of zero.

See Canvas for assignment due dates.

Your TA will assign you one of the following topics for this assignment:

- Fish Population
- Macroinvertebrates, or
- Invasive Mussels.

Details about each of these projects can be found in the following pages of this lab manual.

Please read the Types of Sources section of the Procedures and Guidelines Document to review the differences between primary, secondary, and review sources, and to see examples of each type.

For each primary paper, you will need to select one figure you feel provides the most relevant information for your topic. You can work with your partner on selecting the 5 papers but this is an independent assignment. Be aware of plagiarism when working together. You will need to include the following information:

- The figure and its caption
- The URL for the paper itself
- A clear and concise description of the information provided by this figure (a couple of sentences)
- An explanation for how this information is relevant for your study

Here is an example submission with grading rubric: BIOL205_Assign-1_primary-source-paper-example-submission.docx

Primary Source Paper Rubric

Total /9

Figure Selected

/3

Criteria

- Figure and its caption is provided
- URL for paper is provided
- Figure is from the URL provided

Points	Criteria
Full Marks1.5 pts	All 3 criteria are met
Satisfactory1 pts	2 of the 3 criteria are met
Unsatisfactory0.5 pts	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Description of Figure

/3

Criteria

- Description provided is clear and easy to follow
- Description provided accurately describes the figure provided
- Description indicates that the student has a clear understanding of the information being conveyed by the figure

Points	Criteria
Full Marks1.5 pts	All 3 criteria are met
Satisfactory1 pts	2 of the 3 criteria are met
Unsatisfactory0.5 pts	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Relevance to Study

/3

Criteria

- Explanation is clear and the rationale
- Student has provided a convincing explanation of the relevancy of this figure
- Student shows a clear understanding of the significance of this figure to their study

Points	Criteria
Full Marks1.5 pts	All 3 criteria are met
Satisfactory1 pts	2 of the 3 criteria are met
Unsatisfactory0.5 pts	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Fish Population Project

Fish population declines: Mitigation recommendations needed

Phytoplankton, microscopic single-celled algae, are natural components of aquatic ecosystems and are natural components of aquatic ecosystems and are responsible for half of the carbon and oxygen produced by plants in the world. Some phytoplankton species, however, produce toxins. These toxin producing algae are becoming more common and showing up in more places worldwide. Some of these toxins will produce neurotoxins that prevent nerve transmission signals, resulting in negative effects in animals that consume it. Toxins from phytoplankton can be transferred through the food web and accumulate in higher trophic levels, causing mortality in shellfish, fish, sea birds, and humans. Humans that eat contaminated shellfish can become sick and die. A major challenge for aquatic scientists and environmental managers is to predict the response of animal populations to the proliferation of toxic phytoplankton. A great deal of scientific effort is spent trying to understand the population dynamics of toxic algal blooms and their effects on the food web.

A vital link between phytoplankton and higher trophic levels is provided by copepods, a type of zooplankton. Zooplankton are animal-like plankton that need to ingest other organisms to survive. Copepods are estimated to be the most abundant animals on the planet and are the main food source for many larval fish species. This leads to the refrain: no copepods no fish.

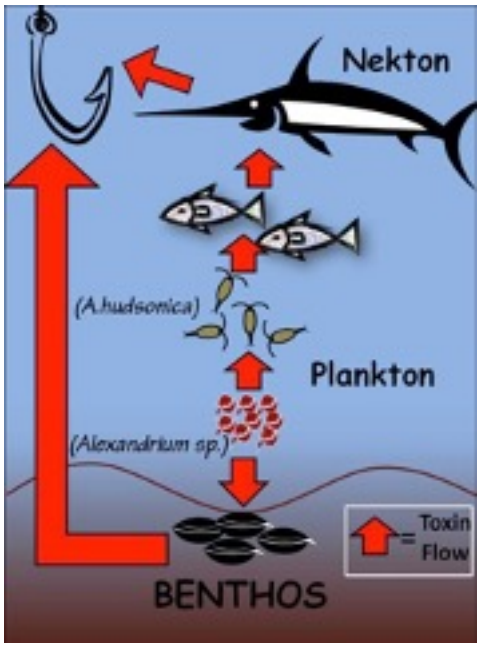


Figure 1: **Figure 1**. Simplified marine food web, including toxic phytoplankton

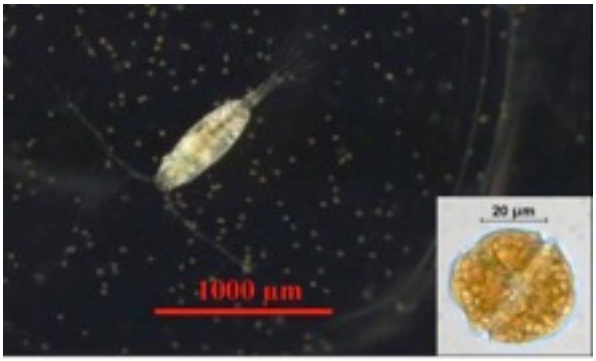


Figure 2: **Figure 2**. The copepod *Acartia hudsonicaand* a toxic phytoplankton cell, *Alexandrium fundysense*.

The toxic dinoflagellate genus *Alexandrium* spp. Often blooms from Long Island Sound in the United Sates, to the Bay of Fundy, Canada (Figure 3). This bloom results in negative effects in animals (grazers) that consume it and these toxins can accumulate in the higher trophic levels, causing mortality in fish, sea birds and humans. In order to better predict the response of animal populations to the proliferation of toxic phytoplankton, *Alexandrium fundysense*, scientist studied the populations of the copepod *Acartia hudsonica* found in two different regions of the distribution from the Bay of Fundy, Canada, to about Long Island sound, New York and Connecticut. There are frequent and high toxicity levels in the norther region of this range (e.g., Maine) and no toxic blooms recorded in the southern regions (e.g., New Jersey).

Figure 3: **Figure 3**. Geographical distribution of toxic *Alexandrium* spp. The frequency and toxicity of *Alexandrium* decreases from north to south. The copepod *Acartia hudsonica*, a main grazer of toxic *Alexandrium*, is found throughout the entire range shown. Stars correspond to population origins from experiments described here. Northern star indicates Maine, southern star indicates New Jersey sampling sites.

Scientist discovered that at maximum ingestion rates the Maine population had higher egg production compared to the New Jersey population (Figure 4) however when copepods were ingesting non-toxic phytoplankton there were no differences in egg production between these populations (Figure 5).

There is still much to learn about the fecundity, mortality and growth of copepods in response to toxic algae. Scientist need to better understand the inter-

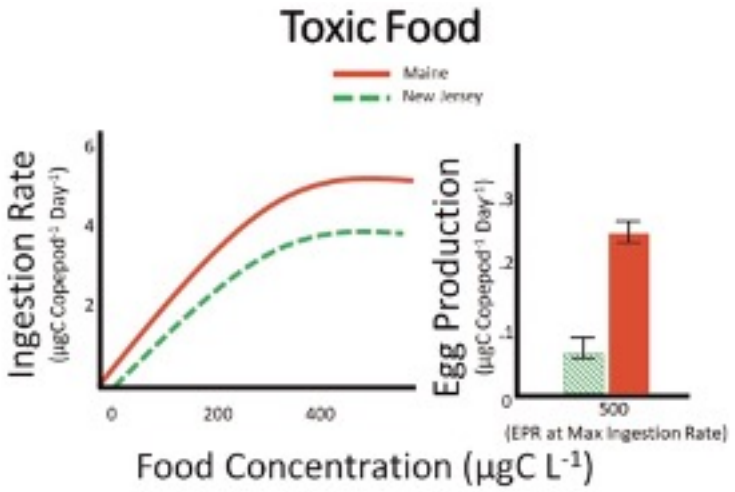


Figure 4: **Figure 4**. Ingestion rate (feeding; left) and egg production rate (reproduction; right) for copepods feeding on a diet containing toxic *Alexandrium* spp. Ingestion rates were measured over a range of food concentrations while egg production rates correspond to a single concentration. Food saturation occurs around 500 µgCL-1; this means that this concentration represents maximum ingestion and egg production. Scientist chose this concentration for egg production because this is where the greatest difference, if any, in ingestion rate occurred. The Maine population (red) had statistically higher ingestion and egg production rate compared to copepods from New Jersey (green). Units for the dependent variable are in micrograms of carbon (µgC; food) and per copepod per day (ingestion and egg production). Error bars represent standard deviation among replicates in egg production; they are omitted for clarity from ingestion rates. Data adapted from Colin and Dam (2007, 2004).

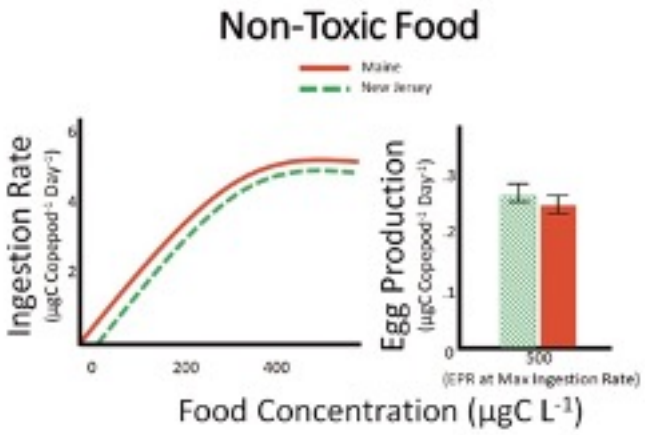


Figure 5: **Figure 5**. Ingestion rate (feeding; left) and egg production rate (reproduction; right) for copepods feeding on a n o-toxic diet. Ingestion rates were measured over a range of food concentrations while egg production rates correspond to a single concentration. Food saturation occurs around 500µgCL-1; this mean as that this concentration represents maximum ingestion and egg production. There were no differences between the Maine (red) and New Jersey (green) populations for both ingestion and egg production rate compared. That is, the two populations fed and reproduced at the same rate. Units and errors bars are the same as Figure 1. Data adapted from Colin and Dam (2007, 2004).

action between toxic algae and their grazers and the adaptability of copepods to toxic algae. Understanding these relationships is key to being able to predict and mitigate issues surrounding fish populations.

Your Role

You have been hired by National Freshwater Copepod Conservation and Fish Restoration agency (NFCCFR) to investigate the impacts of toxic algae on copepod populations. The NFCCFR is interested to know what negative effects, if any, can toxic algae produce in the copepod population in freshwater populations.

Due to budget constraints you and your partner will need to conduct this research in lab and provide the NFCCFR with a proposal for approval prior to initiating your research. (The NFCCFR is your TA in case you were wondering). Before you can begin developing your proposal you must first become immersed in your topic. You and your partner will need to source out **5 primary source papers** related to this topic.

Macroinvertebrates Project

Potential changes in macroinvertebrates: Mitigation recommendations needed

In Lannisport, a major town located in the city of Westeros, water sampling has been conducted by the Friends of the Turkey River Organization every three weeks from January to June in order to monitor the impacts of the Milford Farm on the Turkey River (Fig. 6).

There is growing concern that the levels in glyphosate and/or bacteria levels may impact the macroinvertebrate population found in the Turkey river. Data shown below on glyphosate levels (Fig. 2) and fecal bacterial levels (Fig. 3) have been collected every three weeks by a water quality sampling team.

There is serious concern about the impacts of the farm to the water quality of the creek. The growing concern is whether or not these changes in glyphosate or bacteria levels will result in changes to the macroinvertebrate population and thus the trout population. Both macroinvertebrates and fish populations are used to assess river health however as macroinvertebrate populations are a large source for many animals in this ecological system, the Friends of the Mission Creek (FMCO) and the National Wildlife Federation (NWF) are currently interested in looking at macroinvertebrates specifically.

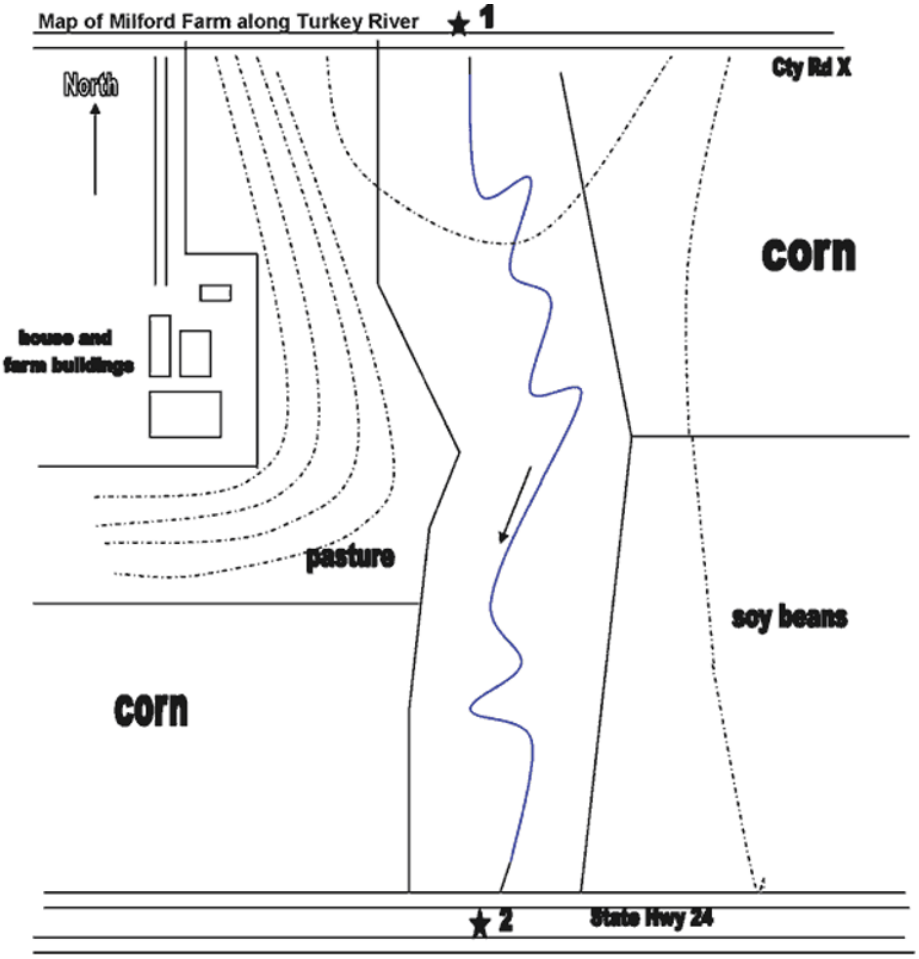


Figure 6: **Figure 6**. Map of Milford Farm along the Turkey River

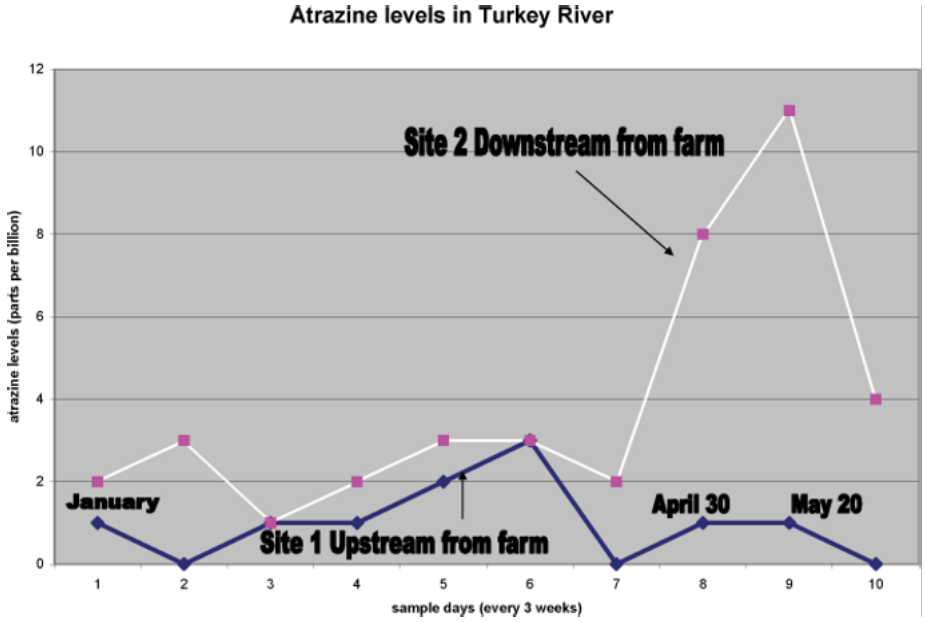


Figure 7: **Figure 7**. Glyphosate levels found both upstream and downstream from farm on the Milford property taken every three weeks.

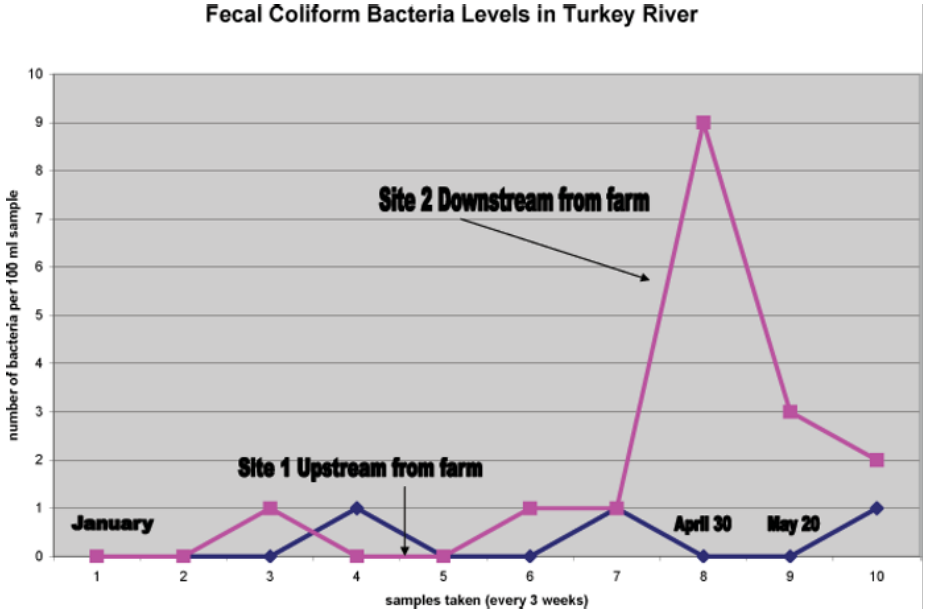


Figure 8: **Figure 8**. Number of fecal coliform bacterial levels per 100 ml sample upstream and downstream the farm on the Milford property taken every 3 weeks.

Your Role

You have been hired by the Friends of the Mission Creek Organization (FMCO) and the National Wildlife Federation (NWF) to investigate how this happened, what the possible effects are on the aquatic life and what can be done to prevent it from happening again.

Due to budget constraints you and your partner will need to conduct this research in lab and provide the FMCO and the NWF with a proposal for approval prior to initiating your research. (The FMCO and NWF will be represented by your TA in case you were wondering). Before you can begin developing your proposal you must first become immersed in your topic. You and your partner will need to source out **5 primary source papers** related to this topic.

Invasive Mussles Project

Invasive Mussel Project – Mitigation Recommendations Needed

Both the zebra and quagga mussels have been shown to be extremely destructive in the Great Lakes (NOAA, 2008). Originally from Eastern Europe they were introduced here in Canada through ballast water discharge from ships, first the zebra mussels in the 80's and then the quaggas in the 90's. As of late it appears the quagga mussels can outcompete the zebra mussels due to their ability to tolerate colder temperatures, live I soft sediment and have a much longer siphon for feeding. The NOAA's Great Lakes Environmental Research Laboratory (GLERL) have been monitoring the issue since the arrival of the quaggas. The map below (Fig. 1) illustrate how quickly the quaggas have dominated the area.

Food production for native species have been declining since the introduction of these invasive mussels and in particular the shrimp-like organisms called *Diporeia* as shown in the Figure 1.

Along with increased mussels and decreased *Diporeia* researchers have seen an increase in the size and number of harmful bottom-dwelling alga in the Great Lakes. One such algal is called *Cladophora*, which makes its way on to beaches in clumps rendering the beaches unpleasant due to their unsightly and smelly nature and also impact nutrient levels in the water (NOAA, 2008).

The decline in *Diporiea* has resulted in some fish changing diet to a less nutrient rich diet in order to survive. As recreational fishing has a huge presence in the Great Lakes the presence of these invasive mussels has taken its toll on the economy (NOAA, 2008). Alongside this, the tourism industry has been impacted due to the less enticing beach quality that has resulted from the *Cladophoral* blooms (NOAA, 2008). Consequently, the GLERL has hired you to further

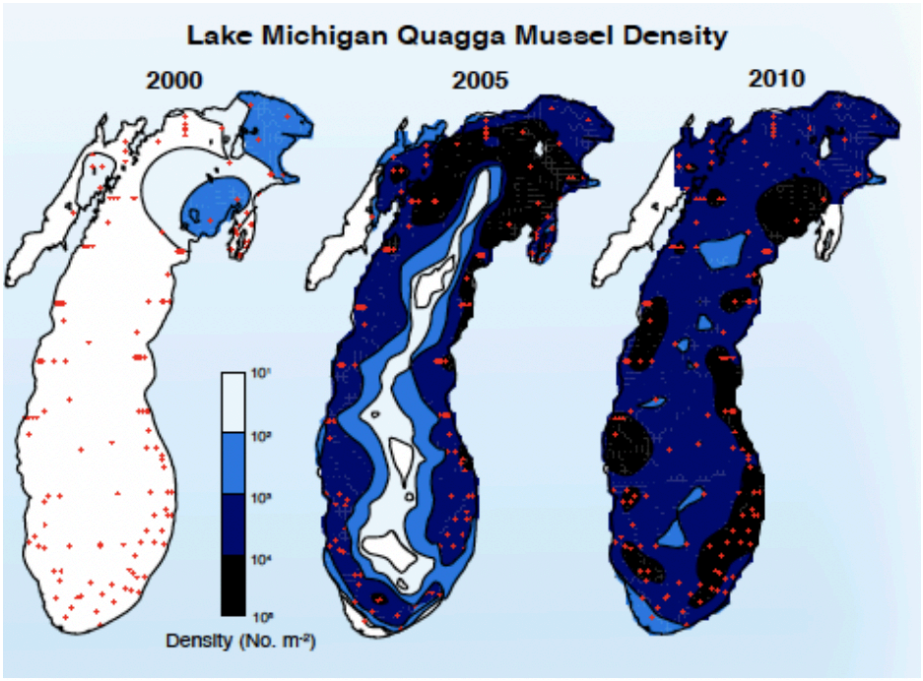


Figure 9: **Figure 9**. Density of Quagga Mussels in Lake Michigan determined in the year 2000, 2005 and 2010 (NOAA, 2008)

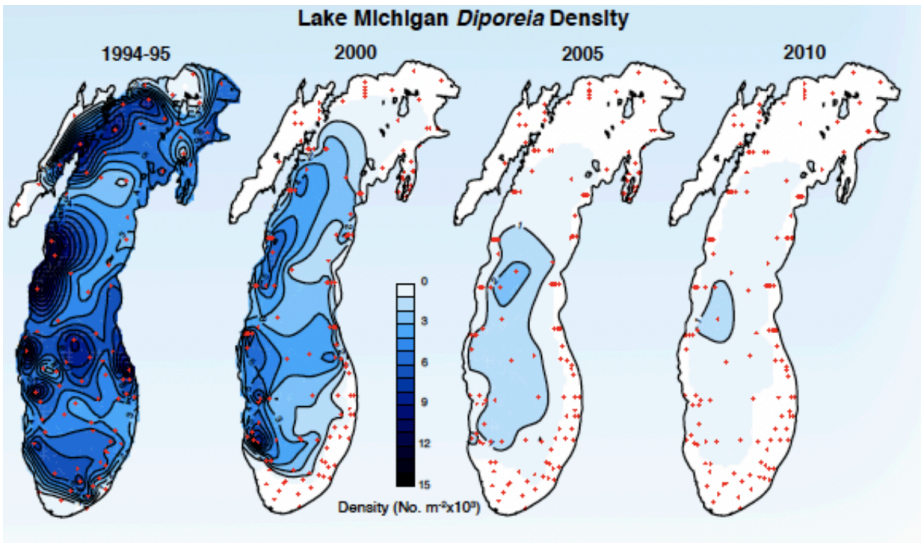


Figure 10: **Figure 10**. Density of *Diporeia* in Lake Michigan in 1994/1995, 2000, 2005 and 2010 (NOAA, 2008)

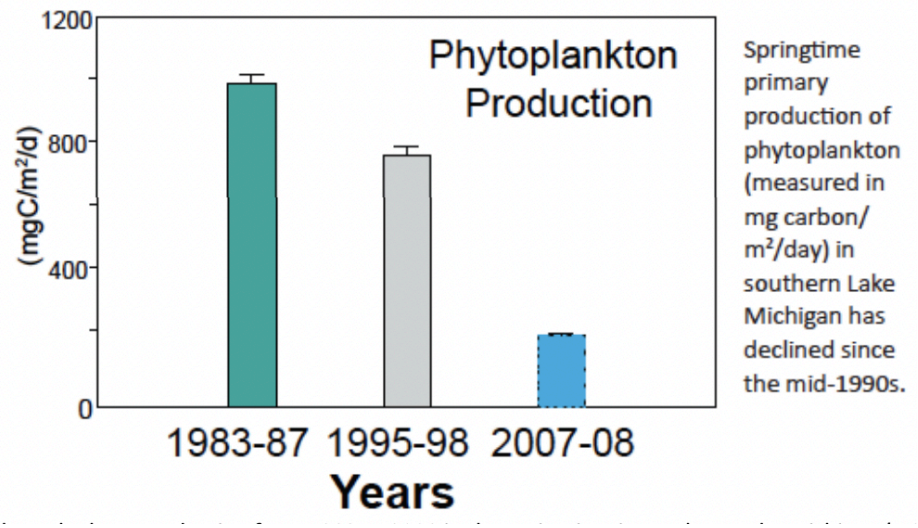


Figure 11: **Figure 11**. Phytoplankton production from 1983 to 2008 in the springtime in southern Lake Michigan (NOAA, 2008).)

investigate why and how this relationship is taking place in order to determine what mitigation strategies may be implemented.

Your Role

You have been hired by the Great Lakes Environmental Research Laboratory (GLERL) to investigate the relationship seen between invasive mussels and the harmful algal blooms. The GLERL is interested to know how these two populations are connected and what mitigation strategies can be implemented to help. Due to budget constraints you and your partner will need to conduct this research in lab and provide the GLERL with a proposal for approval prior to initiating your research. (The GLERL is your TA in case you were wondering). Before you can begin developing your proposal you must first become immersed in your topic. You and your partner will need to source out **5 primary source papers** related to this topic.

Lab 3 - BIOL 205

Last updated 2022-09-15

Getting Acquainted with Your Organism

As you will be working with this organism for the duration of the term it makes most sense to get to know your organism well. Thus far you have done some reading already and have likely learned a lot, however, there is nothing better than first-hand experience. This will help you in the design part of your experiment.

Based on your textbook and your previous knowledge from your primary papers research **please complete Getting Acquainted Assignment 2** on the next page.

Assignment 2: Getting Acquainted

Download a copy of the assignment here. BIOL205_Assign-2_getting-acquainted.docx

As part of this assignment you are expected to draw a diagram of your organism. For more information on the guidelines for drawing organisms, and for some examples of poorly and properly formated sketches see Sketches & Drawings in the UBCO Biology Procedures and Guidelines Document.

Scientific Drawing Rubric

Total /18

Criteria	Pts
Caption - No title present - Caption includes multiple sentences - Caption thoroughly described what the structure is	3
Drawing - Appropriate number of fine lines drawn - Dotted lines used to show depth - No shading on the drawing - Labels are organized in a column on one side of the drawing - Labels are found on the right side of the drawing - Label lines are straight - Label lines do not intersect with anything	7

Criteria	Pts
Organisms and Structures - Drawing is oriented such that the anterior or oral aspect of organism is at the top of the page - Any structures removed or displaced have been indicated on this drawing - Genus and species are Italicized - Genus is capitalized - Specific epithet should be all lower case	5
Microscope - No circle is drawn around the organism - The scale (or magnification) of the drawing is at the bottom right of the drawing - Scale/magnification determination is accurate	3

Quiz 1: Getting Acquainted

Complete Quiz 1: Getting Acquainted on Canvas

Lab 4 - BIOL 205

Last updated 2022-09-15

Open Science, R, & RMarkdown Tutorial

You were introduced to Open Science practices, RMarkdown, and RStudio when you completed a protocol and subsequent Recommendation Report in BIOL 125. We will be using a similar format and template for your 3rd and 4th assignments in BIOL 205.

Protocols are frequently not formally peer-reviewed. However, there is a specific publication type known as a Registered Report, in which peer-review of a protocol is an integral part. In a Registered Report, you submit a protocol with a detailed study design and plan, which is then reviewed by an editorial board, often suggestions for improvement are made, and if accepted on re-submission, the journal, within reason, commits to publishing your study irrespective of whether your findings are statistically significant.

Following on this model, Assignment 3 will be your detailed study design plan. Your TA will be your peer reviewer as they grade your submission. Assignment 4 will be your re-submission of your study design based on feedback from your TA. This will be followed by your final in class presentation of the results of proposed study!

We'll also be moving away from using an R Shiny App to create figures and compute analyses and instead use a few `R` scripts.

To prepare you for this, we'll start with a short review of materials related to Open Science, `R`, & RMarkdown from BIOL 125 and then we'll introduce the `R` scripts that you'll be using later when you do your final report. After reviewing this material, you will be prompted to complete a quiz in Canvas before the rest of the term's material is made available.

Overview

Open Science

Open Science is a movement that tries to combat the replication crisis, questionable research practices, and flashy research trumping quality research in two ways. First, by providing different incentives and rewards for research. That is, changing what we measure as a success in research, shifting from a culture that emphasizes novel findings to one that also rewards the many other aspects of practicing good science. Second, by making all parts of the scientific research process transparent and accessible, allowing for a critical review of how a study was conducted, and ultimately enabling that study to be independently replicated.

For an optional refresher of Open Science principles and core values, visit the Open Science 101 Module that was covered in BIOL 116.

Registered Reports

A Registered Report involves submitting–in the form of a protocol–your research question, hypotheses, and planned methods, for peer review prior to beginning data collection.

Using this format enhances research quality because it gives researchers a chance alter study design and methods before investing time into data collection. Just think of a time where you spent countless hours writing an essay thinking it was perfect, only to give it to a friend to read and receive a ton of editing comments. Often readers notice things the author doesn't! This approach also helps avoid questionable research practices like selective reporting of results and publication bias.

The protocol that you submit for peer review will include:

- Performing a literature review on your research topic and documenting a list of consulted studies, how they were found, and the strengths, limitations, and weaknesses of each.
- Submitting a a priori hypothesis, experimental design, and plan for presenting and analyzing your data. This will be marked before the experiment implementation phase and TA feedback incorporated into the project as needed. Creating a detailed, thorough plan for your research often takes as much time as running the experiment and collecting and analyzing your data. The more you plan, including anticipating potential problems, the easier the implementation!
- Implementing the study according to your plan, and noting any deviations from that plan (Note: deviations often happen, and that's OK! The key is to document them). These reflections will be submitted for marks.

- Submitting and presenting the details of your experiences implementing the research plan (including any changes recorded, justification for changes, analysis of the data, and your interpretation and conclusion).

It is expected throughout this process that you will be implementing best practices for research data management as articulate in the UBCO Procedures and Guidelines, including using appropriate version control on electronic documents and proper file and data management practices throughout your experiment. Need a refresher? Revisit the rules outlined in Chapters 1-5 File and Data Management in the Procedures & Guidelines.

Why Use `R` & RMarkdown?

While there are numerous programs that you can use to write lab reports, research manuscripts, and perform statistical analysis, there are so many benefits to using R & RMarkdown!

First, `R` is both free and open source! Moreover, using `R` allows for computational reproducibility of your work. Computational reproducibility is the ability to document data and analyses so that others can understand and replicate the computations that led to the results and conclusions.

While you could use `R` to perform statistical analyses and write your report separately using a program like Microsoft Word. By using RMarkdown to write your lab report, you can include data analyses directly within the report which allows for everything to be stored in a single document. This makes it simple for readers to understand the computations used to conduct analyses as they read through your paper. For your Registered Report in BIOL 205 you won't be expected to have the code for your analyses directly embedded within your RMarkdown document but you will use pre-made `R` scripts to perform these analyses.

Accessibility is a key aspect of Open Science. And while digital accessibility has many connotations, one of these relates to cost. `R` has no associated financial costs with it and RStudio supports free distribution of their software for educational use. The same can't be said for many alternative authoring and statistical programs, for example products from Microsoft.

Scientific Writing, Installation of `R` & RStudio

For a refresher on scientific writing, the different sections of a lab report, and setting up `R` & RStudio, see the BIOL 125 Lab Manual here https://ubco-biology.github.io/BIOL-125-Lab-Manual/recommendation-report.html. **Read all of the subsections under the Recommendation Report.**

Assignment Template

You will use the following template for your Registered Report:

20220824_Lab03_205_Assignment_V1.Rmd

Before starting your Registered Report, we'll spend some time going through the different parts of this template.

Using the Template

All the markdown syntax that you need for RMarkdown can be found in the Markdown section of the BIOL Procedures and Guidelines.

Directory Structure & File Naming

It is expected that you will have a root project folder for your work associated with this lab. And that at the minimum you will have a folder for your report, your data, your figures, and your scripts. And that you will download this template into your `report/` directory. And that lastly, you will rename the template in accordance with the file naming conventions in the Biology Procedures and Guidelines document.

Lastly, we'll be working with an RProject file this round to help ensure our project's working directory is properly set up in `R`.

It's important to load your project using the RProject file and not the RMarkdown file to ensure your working directory is properly set and that all the scripts and templates we'll be using work as intended!

Review the instruction here in the Procedures and Guidelines Document, for setting up a working directory and RProject file.

Your project directory structure should look something like this once you've created your RProject file and you've downloaded a copy of the RMarkdown file:

```
BIOL205_RP/
    BIOL205_report.RProj
    data/
    figures/
    report/
        20220101_Lab03_205_Assignment_V1.Rmd
    scripts/
```

YAML

The top of the template contains some front matter called YAML. YAML provides instructions to all the pieces of software involved in converting your RMarkdown document to it's outputs, in this case, `pdf`. YAML is very specific to spacing, so don't add any extra spaces!

What you need to do.

1. Provide a title within the quotations after `title`.
2. Provide your name within the quotations after `author`.
3. Provide your abstract within the quotations after `abstract`.

What might be nice to know.

1. r Sys.Date() pulls the date from your computer and auto populates this for you.
2. The `output` tag defines the output format. Other options include `html_document` and `word_document`.

What exactly is YAML?

> YAML™ (rhymes with "camel") is a human-friendly, cross language, Unicode based data serialization language designed around the common native data types of dynamic programming languages. It is broadly useful for programming needs ranging from configuration files to internet messaging to object persistence to data auditing and visualization.

Read more at the Official YAML Web Site

Document Body

The template is then pre-populated with first level headers for each section you're expected to include in your report. Each heading re-iterates the key elements the content of these headings should address. This is just place holder text, so replace it with your own.

Images & Graphs

There is one sample graph referenced in the template. If you'd like to download this image and place it in your `figures/` directory to test knitting your template, the file can be downloaded at this link. And your project should look like this:

```
BIOL205_RP/
    BIOL205_report.RProj
    data/
    figures/
        MVD_BIOL125-Lab5_Fig-1-Boxplot_V1.png
    report/
        20220101_Lab03_205_Assignment_V1.Rmd
    scripts/
```

You might note the following directly after the image path: `{width=50%}`. This reduces the image size by 50%.

As noted in the template, you do not need to write `Figure 1:` before your figures; this small piece of text is handled during the conversion from RMarkdown to pdf. Any other information that you would like to include in the caption should go in the `[]` before the `()` that contain the path to the image.

Figure placement

The engine behind the conversion from RMarkdown to pdf is a typesetting application, one with pretty strict rules about how content should be formatted - much more strict than something like Microsoft Word.

What this means is that if the placement of your images will disrupt your prose - by creating large amounts of empty white space for example - this typesetting application will *push* your figure to somewhere lower in your report where it won't create this white space.

Your figures should be adjacent to the relevant text in your RMarkdown file. How this manifests to your pdf might look a little different; that's ok.

References

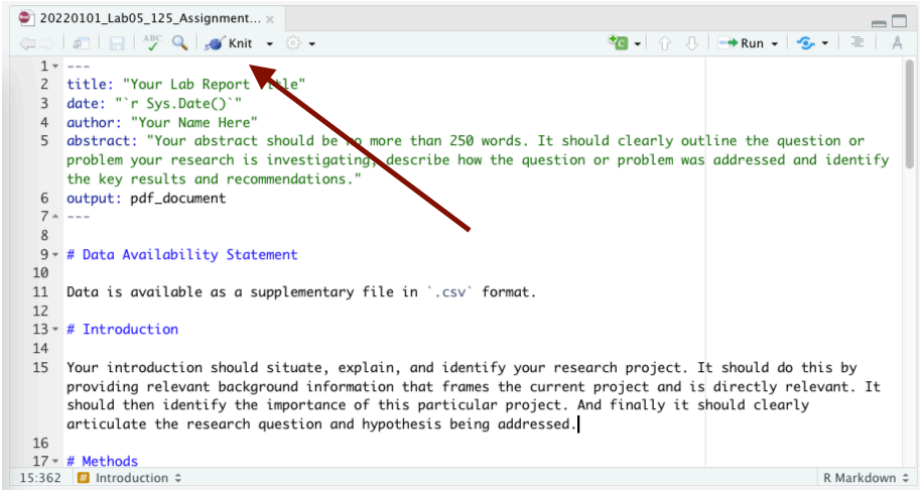
Just before the heading for references you'll see the following

```
\clearpage
```

This creates a page break between your references section and the rest of your report.

Building the `pdf`

If you've installed `R`, RStudio, and the `markdown` and `tinytex` packages succesfully, when you open the template `.Rmd` file you should see an option to `Knit`.



Click this button or select the drop down arrow and select `Knit to pdf`. This will generate a pdf in the same directory as your `.Rmd` file.

Using the RScripts

For the quiz associated with this lab we'll have you investigate and play around a bit with the scripts we've built for your analyses. And we'll have some sample data that you can use to explore the scripts.

The instructions below primarily relate to building an appropriate project structure for your final report and analyses. It would be good practice at this stage to set up a temporary project space on your computer, using the folder structure detailed below. In fact, when you get the section Practicing Using the `R` Scripts later in this lab, you'll be provided with direct links to a sample data set and an appropriate `R` script to use with that dataset within this directory structure, which will in turn allow you to get the screen shots required for the quiz.

`R` scripts are text files containing the commands (aka code) and comments used to perform computations. For BIOL 205, we've written the majority of the code for you. In BIOL 202, you'll be doing much more of this from scratch. Even though much of the code has been written for you, we encourage you to read through the scripts in detail and see if you can figure out with the help of the comments exactly what's going on!

There is a separate `R` script for each type of variable combination you might have for your research project. When it comes time for your final analyiss, download the `R` script that corresponds to the types of variables you have in your experiment. In the mean time, download all or any that you're interested in looking through.

- Both response and explanatory variables are categorical
  - BIOL205_Script_Categorical-Categorical.R
- Both response and explanatory variables are quantitative
  - BIOL205_Script_Quantitative-Quantitative.R
- Categorical explanatory variable and quantitative response variable
  - BIOL205_Script_Quantitative-Categorical.R

While there are instructions within the `R` scripts themselves, the following sections describe how to use the `R` scripts in more detail. Be sure to read **everything here and in the `R` scripts!**

Alongside each line of code in the script is a comment proceeded with a hash tag (#). The comments are either descriptions of what the code is doing or instructions describing things you need to do.

You must correctly set up your project and working directory using the instructions below for this to work. You must also not simply open your `R` script, but instead launch your RProject file and then from within RStudio load the script from the built in file manager.

The general workflow here is:

1. Launch RStudio using your RPoject file
2. Load your data
3. Provide the script with your variable names and the labels you'd like to use on your graphs
4. Generate a graph; the script will save these to your `figures/` directory
5. Run your descriptive stats; the script will save these to your `report/` directory where you can copy the relevant information to your RMarkdown file
6. Run you statistical analyses; the script will save these to your `report/` directory where you can copy the relevant information to your RMarkdown file

If you quite RStudio, you will need to re-run steps 1-3 to do any of steps 4-6 again.

Step 1: Set your working directory

If you haven't already, make sure your working directory is set according to the instructions here in the Procedures and Guidelines Document.

Your directory should look something like this when you're done, that is, after downloading at least one script, ensuring your data is in the project's data

folder, you've created an RMarkdown file, you've generated an RPoject file and put everything in its respective directory. Don't worry if you don't have all these things ready yet, just make sure that when you're ready to run your scripts with your data, this is the model you're working with.

```
BIOL205_RP/
    BIOL205_report.RProj
    data/
        20221023_sample-data.csv
    figures/
    report/
        20220101_Lab03_205_Assignment_V1.Rmd
    scripts/
        BIOL205_Script_Quantitative-Categorical.R
```

Step 2: Installing & Loading Required Packages

We'll be using a couple of features that are not part of the basic install of `R` in our scripts. We add additional features in `R` with packages.

Packages in `R` contain a set of functions, code, and data that you can use for your analysis. Before you can use the functions within a package, the package must be both installed in `R`, which we do once, and loaded into `R`, which we do each time we start the application.

While packages only need to be installed once, if you're on a lab computer, since the computers are re-set at the end of each day you may need to re-install packages at each log in.

To install packages noted in the `R` script, copy the installation lines of code without the preceding hashtag (#) ie. remove the `#` from

```
# install.packages("ggplot2")
```

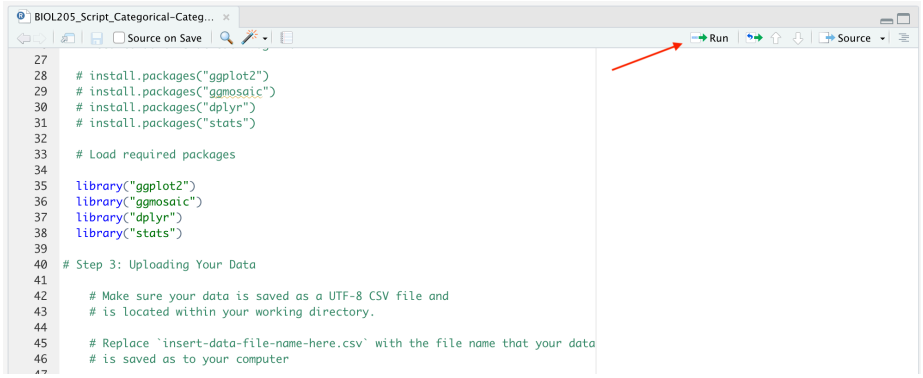
so it looks like this

```
install.packages("ggplot2")
```

and copy it into the `R` console (lower left pane of RStudio). When you hit enter on your keyboard the package will install. Be sure to do this for all of the required packages noted in the `R` script; these are in the first few lines of each script.

Once packages are installed, they must be loaded to your current session. You will have to do this each time you re-start `R`. To load packages use the `library()`

function by running the lines of code pre-written into your R script. For example, run `library(ggplot2)` by placing your cursor in that line of code and clicking the 'Run' button at the top right of the working document. To load all packages at the same time, use your cursor to highlight all of the sections of code you want to run (lines 35-38 in the screenshot below), and then click 'run'.



Running code can be done several ways in RStudio. You can go through line by line, putting you cursor in the line you wish to run, and executing each independently of the next. Or you can run a section of code by highlighting the 'chunk' you want to run.

The scripts are broken into 'steps'. It's probably best to highlight whole sections of each step and then running that chunk. But if you'd like to run line by line to get a better sense of what's happening, go for it!

To quickly run a line of code, place your cursor on the line and use `ctrl + Enter` or `Command + Enter` if you're on a Mac.

Step 3: Uploading your data

Replace the content within the quotes that read 'insert-data-file-name-here.csv' with the file name that your data is saved as to your computer. This will be in between lines 45 and 50 depending on the script you're using.

If my data file was called `20221023_sample-data.csv`, I'd change the following line

```
my_file <- paste0(dir,"insert-data-file-name-here.csv") # assign file name to a variabl
```

to

```
my_file <- paste0(dir,"20221023_sample-data.csv") # assign file name to a variable
```

If your data file contains a header row, be sure that the following line, which reads

```
my_data <- read.csv(file = my_file, header = TRUE)
```

shows `header = TRUE`. If you have no header row, simply change the code to `header = FALSE`.

Step 4: Visualizing your data

You'll need to tell `R` some information before you can create graphs or do analyses. Specifically, you need to assign the names of your variables and axis labels. You can do this by

- Replacing "X variable name" and "Y variable name" with the names of your x and y variables
- Replacing "X label name" and "Y label name" with your desired x and y axes labels

So, we update the following lines

```
x_var <- "X variable name" # Replace with the name of your x variable
x_label <- "X label name" # Replace with your desired x axis label
y_var <- "Y variable name" # Replace with the name of your x variable
y_label <- "Y label name" # Replace with your desired y axis label
```

with something like

```
x_var <- "ht" # Replace with the name of your x variable
x_label <- "Height (in cm)" # Replace with your desired x axis label
y_var <- "day" # Replace with the name of your x variable
y_label <- "Day" # Replace with your desired y axis label
```

`R` is case sensitive. When providing your variable names, make sure they match exactly the variables used in your csv file!

In the `R` script for a categorical explanatory and a categorical response variable, code for both a boxplot and a stripchart is included.

Recall that according to the Biology Procedures and Guidelines document, you should use a boxplot if the groups of your categorical variable have more than 20 data points. Alternatively, you should use a stripchart if each group contains less than 20 data points. Be sure to only produce one desired figure.

In some of the R scripts there are some additional pieces of code that you don't need to worry about for now; you'll learn more about these in BIOL 202!

For example, we have to factor the categorical variables before producing graphs. You will see this additional code if the script you are using includes categorical variables.

In the code for creating a boxplot or stripchart, we refer to a function that calculates confidence intervals. So we have to define that function prior to running the code to produce the figure. You will find this additional piece of code in your R script if your experiment has a categorical explanatory variable and quantitative response variable.

There are some regions in the R scripts where variables are re-named or manipulated. If your up for it, take some time to read through the script and see if you can figure out exactly what's happening!

Now you're ready to run the code to create your figures and statistical calculations! Remember, once the code has been run, your figures will show in the lower right panel of RStudio under 'Plots' as well as being exported as .png image to your `figures/` directory, and the results of your statistical analyses will be displayed in your R console, the lower left panel, as well as being saved as either .csv or .txt to your `reports/` directory.

Step 5: Calculate descriptive statistics

The code here should run smoothly if everything in the proceeding steps was done correctly. Once the code has been run, your descriptive statistics will be printed in the console of RStudio (lower left panel). The instructions below describe how to interpret this output depending on the types of variables in your experiment.

Two Categorical Variables

Here is an example of the descriptive statistics output produced by the R script for two categorical variables. The explanatory (independent) variable and its associated groups appear in the first column, while the response (dependent) variable appears at the top. In this case the explanatory variable was species and the response variable was sex. The numbers provided in the table describe the frequency for each category. For example, in this sample there was 1 female Adelie penguin and 0 male Chinstrap penguins.

```
##           sex
## species    female male
##   Adelie       73   73
##   Chinstrap    34   34
##   Gentoo       58   61
```

Two Quantitative Variables

Here is an example of the output produced by the `R` script for two quantitative variables. The explanatory (independent) variable appears in the first row, while the response (dependent) variable appears in the second row. `n` indicates the sample size, while the following columns represent the mean, standard deviation, median, and interquartile range, respectively.

```
##                   n mean   sd median  iqr
## bill_length_mm 344 43.9 5.46     NA 9.27
## bill_depth_mm  344 17.2 1.97     NA 3.10
```

One Categorical and One Quantitative Variable

Here is an example of the output produced by the `R` script for one categorical and one quantitative variable. This table is organized so that the descriptive statistics of the quantitative response variable are reported based on the groups of the explanatory variable. `n` indicates the sample size, while the following columns represent the mean, standard deviation, median, and interquartile range, respectively. For example, the mean mass (g) for Adelie penguins in this sample is 3775 g.

```
##     species   n   mean     sd median   iqr
## 1    Adelie 152 3700.7 458.57   3700 650.0
## 2 Chinstrap  68 3733.1 384.34   3700 462.5
## 3    Gentoo 124 5076.0 504.12   5000 800.0
```

Take a screenshot of these values or write them down for writing your lab report later.

Step 6: Performing statistical analyses

Similar to with the descriptive statistics, the code here should run smoothly if everything in the proceeding steps was done correctly. The type of statistical analyses you will perform depends on the types of variables in your experiment.

Code for all possible statistical tests is included within the `R` scripts. Only run the code that corresponds with the type of variables in your experiment. Use the guidelines below to help you choose the appropriate statistical test.

Both response (dependent) and explanatory (independent) variables are categorical

- Both your response and explanatory variables have exactly 2 groups -> Use Fisher's Exact Test

- At least one of your response or explanatory variables has more than 2 groups -> Use Chi-Square Contingency Analysis

Both response (dependent) and explanatory (independent) variables are quantitative

- Use Correlation Analysis

Response (dependent) variable is quantitative and explanatory (independent) variable is categorical

- Your categorical variable has exactly 2 groups -> Use Two Sample T-test
- Your categorical variable has more than 2 groups -> Use ANOVA

When interpreting the output from a statistical analysis for this project, focus on the p-value provided by `R`. You'll learn more about the other details shown by the output in BIOL 202! Below are some examples of output for each type of statistical test.

Fisher's Exact Test

`Penguins` data set with `sex` and `species` variables - the p-value is evident:

```
##
##  Fisher's Exact Test for Count Data
##
## data:  fisher.table
## p-value = 0.979
## alternative hypothesis: two.sided
```

Chi-Square Contingency Analysis

`Penguins` data set with `sex` and `species` variables - the p-value is evident:

```
##
##  Pearson's Chi-squared test
##
## data:  chi.table
## X-squared = 0.048607, df = 2, p-value = 0.976
```

Correlation Analysis

`Penguins` data set with `bill_length_mm` and `bill_depth_mm` variables - the p-value is fairly evident, labeled p.value:

```
## # A tibble: 1 x 8
##   estimate statistic   p.value parameter conf.low conf.high method       alter~1
##      <dbl>     <dbl>     <dbl>     <int>    <dbl>     <dbl> <chr>        <chr>
## 1   -0.235     -4.46 0.0000112       340   -0.333    -0.132 Pearson's p~ two.si~
## # ... with abbreviated variable name 1: alternative
```

Two-Sample T-test

`Penguins` data set with `species` - filtered to Chinstrap and Adelie - and `body_mass_g` variables - the p-value is evident:

```
##
##  Two Sample t-test
##
## data:  body_mass_g by species
## t = -0.50809, df = 217, p-value = 0.6119
## alternative hypothesis: true difference in means between group Adelie and group Chinstrap is n
## 95 percent confidence interval:
##  -158.21193   93.35996
## sample estimates:
##    mean in group Adelie mean in group Chinstrap
##                3700.662                3733.088
```

ANOVA

`Penguins` data set with `species` and `body_mass_g` variables - the p-value is under the header Pr(>F):

```
## Analysis of Variance Table
##
## Response: body_mass_g
##            Df    Sum Sq  Mean Sq F value    Pr(>F)
## species     2 146864214 73432107  343.63 < 2.2e-16 ***
## Residuals 339  72443483   213698
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

If you would like to have the code directly embedded within your RMarkdown report. Feel free to use the template below that corresponds with the types of variables in your research project. All of the code within these templates is the same as those described above but there are no instructions embedded in these templates.

- Both response and explanatory variables are categorical
  - 20220824_Lab03_205_Assignment-Categorical-Categorical_V1.Rmd

- Both response and explanatory variables are quantitative
  - 20220824_Lab03_205_Assignment-Quantitative-Quantitative_V1.Rmd
- Categorical explanatory variable and quantitative response variable
  - 20220824_Lab03_205_Assignment-Quantitative-Categorical_V1.Rmd

Similar to the `R` scripts, code for all possible statistical tests is included within these templates. **Only include the code that corresponds with the type of variables in your experiment.** In other words, delete the `R` chunk that contains code for any statistical test you are **NOT** using.

Similarly, code for both a boxplot and a stripchart is included within the quantitative-categorical template. If you plan to include a boxplot and not a stripchart, be sure to delete the `R` chunk that contains the code for the stripchart.

Quiz 2: Open Science, R, & RMarkdown

Before starting this quiz, you must:

- practice knitting the assignment template RMarkdown file
- practice using the `R` script for a categorical explanatory variable and quantitative response variable

The next two pages provide you with sample files to do each of these. Refer to the previous sections on working with RMarkdown files and the `R` scripts if you run into any issues.

The quiz will ask you to upload screenshots and will have questions from the output of the knitting process and the `R` scripts.

Practicing Knitting

If you haven't already downloaded the assignment template, here it is again:

20220824_Lab03_205_Assignment_V1.Rmd

To test the template,

- ensure the template `.Rmd` file is in your `report/` directory
- download the following image into your `figures/` directory
  - MVD_BIOL205-Lab5_Fig-1-Boxplot_V1.png (4 KB)
- launch your project using your RProject file
- open the template `.Rmd` file from within RStudio
- insert your name as the author in the YAML header
- knit the document to a PDF

You should get something that looks like this after `Knitting` the `.Rmd` file:

- 20220824_Lab05_125_Assignment_V1.pdf (180 KB)

Your knitted document should show your name under the title! Take a screenshot of the first page of the knitted assignment template. You'll need to upload this screenshot to the quiz on Canvas.

Practicing Using the `R` Scripts

We'll practice using the `R` script for a categorical explanatory variable and quantitative response variable. Follow these steps:

- download this `R` script and save it in your `scripts/` folder
  - BIOL205_Script_Quantitative-Categorical.R
- download this sample data set and save it in your `data/` folder
  - BIOL205_sample-data.csv
- launch your project using your RProject file
- open the `R` 'script from within RStudio
- follow the instructions provided earlier for working with the script - setting up variable names etc - and run *ALL* code in the script
  - save the boxplot produced to your `figures/` folder. You will need to upload this to the quiz on Canvas
  - Keep the results of descriptive statistics and statistical analyses open while you complete the quiz. You will need some of these values to answer questions!

Complete the Quiz

Now you're ready to start the quiz. Complete the Quiz titled Open Science, R, & RMarkdown on Canvas.

Assignment 3: Protocol (first submission)

You will use the following template for your Registered Report:

20220824_Lab03_205_Assignment_V1.Rmd (3 KB)

See Canvas for assignment due dates.

For this assignment you will submit a protocol with an established a priori hypothesis, experimental design, and plan for presenting and analyzing your data. This will be marked before the experiment implementation phase and TA feedback incorporated into the project as needed. Creating a detailed, thorough plan for your research often takes as much time as running the experiment and collecting and analyzing your data. The more you plan, including anticipating potential problems, the easier the implementation!

Your protocol will be comprised of the following sections:

- Abstract
- Data availability
- Introduction
- Methods
- Discussion - describe the potential implications of your project
- References

Protocols don't often have an abstract. But being able to write a concise synopsis of what's to come is a critical skill in academic writing. So we're going to take advantage of the opportunity to practice by requiring one for this assignment!

Your data availability statement should be a proposed statement. Something like 'Data will be made available…'.

You will receive your marked protocol one week from the time it is submitted. If you have any questions regarding your mark and / or the comments from your TA please ensure you take the opportunity to chat with your TA to go over

these. This will ensure that you are in the best position to attain the highest marks possible for this assignment.

Tips for Preparing a Protocol

- Read a lot! It is important that you have a thorough understanding of the topic. At the very least you should have at least 3 primary source papers you are referring too throughout your report.
- Discuss your ideas with other students (not just your partner). Get a feel for what everyone else is doing and the depth they are working in.
- Start writing early! Students often make the mistake of starting the night before the report is due. This more than not results in poor submissions and thus lower grades. You should expect that you will have at least 3 rounds of revisions before you submit.
- Someone reading your report should be able to tell what question(s) you will address, why the topic is interesting and/or important, how you will approach the problem, the types of data you will collect, and how your research will advance the field.

Assignment 3: Detailed Outline

COPY FROM WORD DOC

You will need to submit 2 files for this assignment:

- Updated Protocol as `.Rmd`
- Updated Protocol as `.pdf`

Assignment 3: Rubric

PENDING

Lab 5 - BIOL 205

Last updated 2022-09-15

Data Collection Round 1

This week you will be working in the labs collecting data for your project.

Quiz 3: Who Am I?

Complete Quiz 2: Who Am I? on Canvas

Lab 6 - BIOL 205

Last updated 2022-09-15

Data Collection Round 2

This week you will be continuing data collection for your project.

Assignment 4: Protocol (final submission)

Overview

See Canvas for assignment due dates.

You will need to submit 3 files for this assignment:

- Updated Protocol as `.Rmd`
- Updated Protocol as `.pdf`
- Data dictionary as `.md`

Following a week after you submit your Registered Report Draft you will have received the edits from your TA. You can decide to resubmit the report without making any changes or you will have the opportunity to review the edits from your TA and make the needed changes in order to increase your mark. If you have any questions regarding your mark and/or the comments from your TA please ensure you take the opportunity to chat with your TA and go over these. This will ensure that you are in the best position to attain the highest marks possible for this assignment.

At this stage as well, you have started your data collection. Between your protocol and active data collecting, you should have what you need to be able write a data dictionary. Need a refresher on writing a data dictionary? Review chapter 4.6 of the Procedures and Guidelines.

Registered Report Rubric

NEEDS UPDATING AND NEEDS TO INCLUDE DATA DICTIONARY ASPECT

Total /41

Abstract

/3

Criteria

- Brief, no more than 500 words
- Clearly outlines the question/problem
- Clearly describes how the question/problem will be addressed

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
No Marks0 pts	None of the criteria are met

Introduction

Your Introduction & Background should:

- Provide a brief literature review to contextualize the proposed research **(1-2 pages)**
  - What do you know about the organisms involved
    - What does it need to survive?
    - What temperature is it typically found?
    - Remember you have to run this experiment in the lab and be able to control for all variables
  - What do you know about the issue surrounding toxic algal blooms
  - What differences are there between saltwater systems and freshwater systems if any that need to be considered when making inferences from one to another
- Clearly outline the problem and why this is so important. You will likely need to use the background information to justify the importance **(0.5-1 pages)**
- Provide clear hypotheses

/6

Grading Criteria

- Relevant background information provided

- Clearly articulates how the background information is connected to the current project idea
- Well written and easy to follow
- Flows from more general and broad background information and narrows towards the focus of this proposed project
- Hypothesis/question(s) posed are clearly stated towards the end of this section
- No factual errors are present

Points	Criteria
Full Marks6 pts	All 6 criteria are met
Excellent5 pts	5 of the 6 criteria are met
Proficient4 pts	4 of the 6 criteria are met
Satisfactory3 pts	3 of the 6 criteria are met
Unsatisfactory2 pt	2 of the 6 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Background

/4

Grading Criteria

- Information regarding the feeding and habitat needs of the organism being used provided
- The significance of using this particular organism to study the issue at hand has been provided
- Information regarding the specific problem being addressed, both current and historical, have been provided
- Student has shown a solid understanding of the organism, its habitat and its impact on other organisms within its range

Points	Criteria
Full Marks4 pts	All 4 criteria are met
Proficient3 pts	3 of the 4 criteria are met
Satisfactory2 pts	2 of the 4 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Significance of Project

/3

Grading Criteria

- Significance of the problem is clearly and convincingly stated
- Experimental design has been described in a way that elicits confidence in this study
- Background information was used well in order to show the importance of this project

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Experimental Design

Your Methods section should:

- Outline the major methods and data collection (including what statistical analyses to be used, when appropriate and a list of materials required). There should not be any bullet points here **(1 page)**

/6

Grading Criteria

- No bullet points
- The experimental design is specific and addresses the question/problem
- Enough information is provided that someone else may be able to run a similar experiment
- There is an appropriate control where applicable
- Both independent and dependent variables are clearly defined
- Statistical analysis to be used has been clearly outlined

Points	Criteria
Full Marks6 pts	All 6 criteria are met
Excellent5 pts	5 of the 6 criteria are met

Points	Criteria
Proficient4 pts	4 of the 6 criteria are met
Satisfactory3 pts	3 of the 6 criteria are met
Unsatisfactory2 pt	2 of the 6 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Spelling & Grammar

/3

Grading Criteria

- No spelling errors
- No grammar errors
- No awkward sentence structures

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

References & In-Text Citations

/4

Grading Criteria

- APA format used properly and consistently
- Minimum of 5 primary source papers used in the report
- In-text citations are used when required
- Citations and references match up

Points	Criteria
Full Marks4 pts	All 4 criteria are met
Proficient3 pts	3 of the 4 criteria are met
Satisfactory2 pts	2 of the 4 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met

Points	Criteria
Incomplete0 pts	None of the criteria are met

Plagiarism & Quotations

/3

Grading Criteria

- No plagiarism of any kind has been found
- No quotations present
- Information attained from outside resources are properly cited

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Format

/4

Grading Criteria

- 5 pages (not including references)
- Font 12
- Times New Roman
- Double spaced

Points	Criteria
Full Marks4 pts	All 4 criteria are met
Proficient3 pts	3 of the 4 criteria are met
Satisfactory2 pts	2 of the 4 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Timeline

You must:

- Provide a detailed projected week by week timeline of your research. The information in this table should include the following and be in chronological order:
  - Start date of experiment (include pilot round if relevant)
  - Data collection dates and how data will be collected
  - Non-data collection dates should be included with a detail of what you expect to be working on. E.g. you may need to complete a water change or feed your organisms
  - Additional notes may be added in the case where you anticipate there may need to be a change in timeline depending on previous weeks
  - End date of experiment
  - Below is an example format

Table 1: Projected weekly timeline

Date	Activity	Notes
September 13, 2021	Experimental set up - clean tank, fill with spring water and heat to appropriate temperature and add organisms	
September 20th, 2021	Count organisms using pods from a small sample and estimating total number to provide baseline population size	May need to readjust environment depending on organism survival
September 27th, 2021	Add variable - pesticides	May need to adjust amount of pesticides depending on survivability

/3

Grading Criteria

- All data collection dates included and a description of what data will be collected and how this will be done
- All non-data collection dates included with details of what will be done on those days

- Start and end of dates are provided

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

File Uploads

/2

Grading Criteria

- Registered Report has been submitted as pdf
- Registered Report has been submitted as RMarkdown

Points	Criteria
Full Marks2 pts	All 2 of the criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Quiz 4: Who Am I?

Complete Quiz 2: Who Am I? on Canvas

Lab 7 - BIOL 205

Last updated 2022-09-15

Data Collection Round 3

This week you will be continuing data collection for your project.

Quiz 5: Who Am I?

Complete Quiz 4: Who Am I? on Canvas

Lab 8 - BIOL 205

Last updated 2022-09-15

Data Collection Round 4 & Cleanup

This week you will be continuing data collection for your project.

Quiz 6: Who Am I?

Complete Quiz 5: Who Am I? on Canvas

Lab 9 - BIOL 205

Last updated 2022-09-15

Data Analysis

For the data analysis portion of your presentation, you are permitted to use any operating program you are comfortable with. R shiny is a very simple way to run some basic stats however you are more than welcome to use R, SPSS, or even Excel depending on your needs and comfort level. Biol 202 is going to be a great resource for you so take a look through your notes. There is no assignment due for this module however you should meet with your TA online to discuss the statistical options you plan to pursue your data set and be able to explain why. This will help give your TA an opportunity to guide you and ensure you are appropriately analyzing your data in order to have the best outcome for your presentation.

R is a great way to produce your graphs however students are permitted to use whichever program they feel most comfortable using.

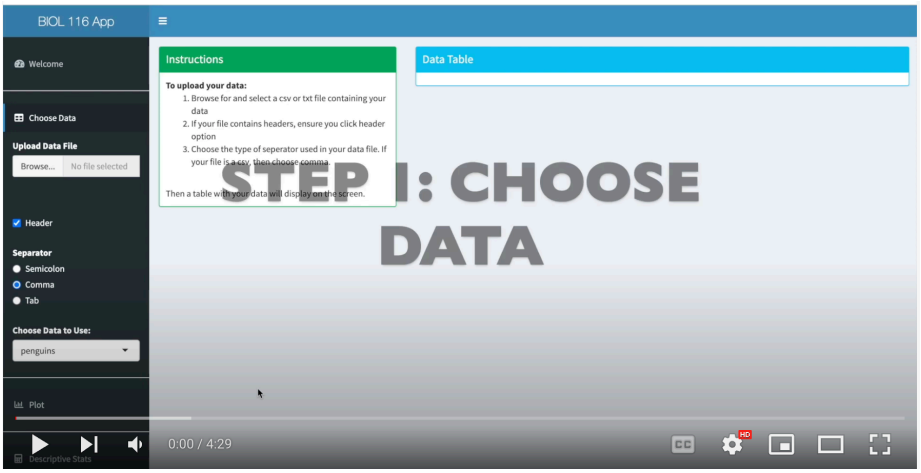
Analysis Using R Shiny

If you are a bit uncomfortable using R, the R Shiny App is a nice way to work through your data without requiring an understanding of R.

For more information on using R Shiny please visit the following link https://ubco-biology.github.io/BIOL-116-Lab-Manual/intro-to-r-shiny-apps.html

The Shiny app you can use to run your analysis can be found here at https://openscience.ok.ubc.ca/shiny/BIOL-116

The YouTube video here can be used to walk you through the steps of using the R Shiny App



You may wish to refer back to the section on Preparing your data from BIOL 116 and the chapter Tidy Data in the UBCO Biology Procedures and Guidelines document.

Analysis Using Excel

Below are a few videos which can help you get acquainted with running statistical analysis in Excel. There are much more available but this should help get you started.

- Basic Data Analysis in Excel - 1
- How to Perform Regression Analysis in Excel
- How to Perform A One-Way ANOVA in Excel
- How to Perform a Chi-Square Test of Independence in Excel

Lab 10 - BIOL 205

Last updated 2022-09-15

Assignment 5: PowerPoint Presentations

Overview

See Canvas for assignment due dates.

Now that you have developed a thorough understanding of the topic you will need to present your findings and provide some potential solutions to the original problem to your funders, which in this case are your peers.

All groups will give oral presentations in your regular lab period during the last week of term. Each group will have 10 minutes for their talk followed by a couple of minutes for questions. This is typically the time period allowed at a scientific conference. Each student in the group should participate equally in the presentation. Your presentation must be done using PowerPoint. A computer and projector will be available in the lab. Bring your presentation on a usb. You are also required to hand in a hard copy of your presentation at this time 24 hours prior to the start of your lab. Failure to do so will result in an instant 10% deduction. Your group will be given a grade for the quality of your oral presentation. It is important that you;

- Outline your talk as early as possible
- Get together to organize and practice the presentation so the timing is accurate and you do not repeat information
- Remember that your goal is to present material in a clear, succinct and interesting manner.

Suggestions for Content and Structure

- Plan a strong, clear beginning and ending.
- Provide a clear context for your work. Your introduction should include the objective and biological context of your study.

- Include your hypotheses and prediction.
- Present your materials and methods in a simple or streamlined manner. Keep it short and simple.
- Use the PowerPoint example here to help guide you

Helpful presentation pointers for your content

- Know your audience – think about who you are presenting too. In this case you are reporting your findings to the which every organization is funding your research
- Reiterate why this research was so important
- Show your passion for the topic. Every story has a beginning, middle and end. For example, you started with a problem, you sought to answer it and finally you found an "answer".
- Keep things simple! Don't make things so complicated that your audiences lose track of where you are. Keeping it simple will help everyone be able to follow along with you. When needed define abbreviated terms you plan on using. Never assume your audience will know what they mean.

Presentation pointers for you

- Practice over and over and over again until you can flow through the material without any hesitation. This will help ensure you have a handle on the material when you are nervous up at the front of the class. Take the opportunity to practice your presentation in the class
- Get ready to perform. This is a performance! Know your lines and your subject. Memorizing your lines can be problematic as you may start to sound too scripted. Use bullet points to help tell you what to talk about instead. Remember you are telling a story.
  - In order to help deal with nerves before a presentation work out slowing your breathing, visualize yourself giving a relaxed talk and even tell yourself you are confident. You may even want to "power pose" it! For those that don't watch Grey's Anatomy this is when you stand like superman or superwomen right before attempting something that makes you nervous. There are studies indicating this is very successful but at the very least it's not going to hurt right?
- Walk confidently to the front of the room to get you in the right frame of mind
- Stand tall when you are up there and keep your chest lifted. Remember you totally got this!
- Above all…smile! You will instantly appear more relaxed and research shows that smiling can actually reduce your stress level. Plus, there is the added benefit of people enjoying the interaction more as you don't look like you are totally miserable up there .

- Speak up. People want to hear what you have to say so make sure they can.
- Take your time. For you it's going to feel like its lasting forever but for your audience you may come across like you just had two coffees and a Redbull. Allow for those "awkward" pauses as for the audience it will actually sound more normal.
- Talk to the audience and not your screen or cue cards. You should know the information so well that all you need is a quick bullet point to get you talking.
- Keep to the time frame. This is where giving yourself lots of practice time will help out.

Present results clearly and simply. If you choose to present summary tables and graphs, make sure they illustrate only the points you want to make. Be sure to describe the axes before the trends in the data and ensure your figures/tables are large enough to be seen by the students at the back of the room.

Compare your results directly with the results of other similar research form the literature

Do not restrict yourselves to presenting only your best results. Mention problems you had and how you would avoid them next time as well as sources of variation and error and how these impacted your results.

Oral Presentation Rubric

You and your partner(s) will be assessed base on the below rubric. Please use this rubric when creating and presenting your PowerPoint presentation.

Total /54

Title Slide

/3

Criteria

- Title is clear and tells the audience what the presentation is about
- All names of researchers provided
- Affiliations are provided

Points	Criteria
Full Marks3 pts	All 3 criteria are met

Points	Criteria
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Outline

/2

Criteria

- Outline has been provided and is clear
- Outline goes over all relevant items which will be discussed

Points	Criteria
Full Marks2 pts	All criteria are met
Satisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Background

/6

Criteria

- 2 slides
- Only essential information has been provided
- Relevancy about the project has been described
- Student objectives/hypotheses have been well described
- Presenter displays a clear passion for the importance of the topic and is engaging
- 1-2 min was provided for this section

Points	Criteria
Full Marks6 pts	All 6 criteria are met
Excellent5 pts	5 of the 6 criteria are met
Proficient4 pts	4 of the 6 criteria are met
Satisfactory3 pts	3 of the 6 criteria are met
Unsatisfactory2 pt	2 of the 6 criteria are met
Poor1 pt	Only 1 of the criteria is met

Points	Criteria
Incomplete0 pts	None of the criteria are met

Experimental Design

/6

Criteria

- 1-2 slides with
- Photos/figures used help to explain the methods
- Description of the design was clear with enough information provided so others can replicate
- Study group is described and an explanation for why it was used is provided
- Variables being tested were described
- Control group described
- Information regarding sample size and trial numbers was provided
- Experimental design was appropriate to test the question/hypothesis

Points	Criteria
Full Marks6 pts	All 7 criteria are met
Excellent5 pts	5-6 of the 7 criteria are met
Proficient4 pts	4 of the 7 criteria are met
Satisfactory3 pts	3 of the 7 criteria are met
Unsatisfactory2 pt	2 of the 7 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Results

/5

Criteria

- At least 2 slides were provided which included graphs/charts etc
- No raw data was provided
- No figures/tables were provided and not explained
- Both quantifiable and qualitative results were provided
- A mixture of text, tables, figures, photos were used to convey results and those selected were the most appropriate for that type of data

Points	Criteria
Full Marks5 pts	All 5 criteria are met
Proficient4 pts	4 of the 5 criteria are met
Satisfactory3 pts	3 of the 5 criteria are met
Unsatisfactory2 pt	2 of the 5 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Discussion

/6

Criteria

- 2 slides provided
- Results not repeated
- Interpretation of the results was provided and was accurate
- Findings were clearly presented with the most relevant to the least relevant
- Results were clearly described and compared to other similar studies and their findings
- Limitations to the study were clearly provided

Points	Criteria
Full Marks6 pts	All 6 criteria are met
Excellent5 pts	5 of the 6 criteria are met
Good4 pts	4 of the 6 criteria are met
Proficient3 pts	3 of the 6 criteria are met
Satisfactory2 pt	2 of the 6 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Recommendations

/6

Criteria

- Recommendations were clearly outlined
- Recommendations were relevant to the problem at hand
- Recommendations were based on current research
- Recommendations were based on previous studies and their findings

x	Points
Full Marks6 pts	All 6 criteria are met
Excellent5 pts	5 of the 6 criteria are met
Good4 pts	4 of the 6 criteria are met
Satisfactory3 pt	3 of the 6 criteria are met
Unsatisfactory2 pt	2 of the 6 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Acknowledgements

/2

Criteria

- All those individuals involved were recognized for their efforts
- Funding acknowledgment was provided

Points	Criteria
Full Marks2 pts	All criteria are met
Satisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Slide Content

/5

Criteria

- Titles for each slide told the audience exactly what they were looking at
- Proper sans serif font was used
- Slides were presented in the order of the outline
- Slide was not wordy but rather all content is done in point form
- Any copyrighted materials were cited appropriately

Points	Criteria
Full Marks5 pts	All 5 criteria are met
Proficient4 pts	4 of the 5 criteria are met
Satisfactory3 pts	3 of the 5 criteria are met
Unsatisfactory2 pt	2 of the 5 criteria are met

Points	Criteria
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Oral Presentation Skills

/7

Criteria

- Presenters did not sound scripted
- Presenters did not read of computer and/or notes
- It was clear that the presenters understood the material they were presenting
- Presentation fell within the appropriate time span
- All charts/figures/graphs were explained thoroughly
- All associations were clearly described
- Questions were answered knowledgeably and professionally.

Points	Criteria
Full Marks7 pts	All 7 criteria are met
Excellent6 pts	6 of the 7 criteria are met
Proficient5 pts	5 of the 7 criteria are met
Satisfactory4 pts	4 of the 7 criteria are met
Unsatisfactory3 pt	3 of the 7 criteria are met
Insufficient2 pts	2 of the 7 criteria are met
Poor1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Additional

/3

Criteria

- Presentation was submitted 24 hours prior to the presentation
- Each presenter contributed equally to the project
- All in-text citations are references were provided

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met

Slide Appearance

/3

Criteria

- Slides were simple, high-contrast, and had a consistent colour scheme
- Slides were built to be “colour-blind friendly”
- Slides were uncluttered, clear, and visible from across the room

Points	Criteria
Full Marks3 pts	All 3 criteria are met
Satisfactory2 pts	2 of the 3 criteria are met
Unsatisfactory1 pt	Only 1 of the criteria is met
Incomplete0 pts	None of the criteria are met