Data on Dead Zones Instructor Guide

Product of the Scientist Spotlights and Data Nuggets Faculty Mentoring Network

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Course Information

Designed for a 50-min class period with online synchronous or in-person delivery. Target student level is introductory biology for majors or non-majors.

Learning Outcomes

- *(Data literacy)* Apply the concepts and terminology from biology to visualize and interpret data from experiments in biology
- *(Content)* Predict the environmental impacts of human activities on changing evolutionary and ecological processes
- *(Social justice)* Apply a social justice lens to promote both equity and innovation in the discipline of biology by reflecting on our own biases in how we perceive biological research and researchers

List of Materials and Preparation

1. Instructor Guide: 1_IG_Data_on_dead_zones.pdf; this document!
2. In-Class Presentation: 2_P_Data_on_dead_zones.gslides
3. Student Worksheet: 3_SW_Data_on_dead_zones.gslides
4. Link for Common Online Data Analysis Platform (CODAP) to distribute (e.g., paste into the chat) for second group activity:
    a. https://codap.concord.org/app/static/dg/en/cert/index.html
5. Data files in CSV form to distribute ahead of class or during class via LMS, chat, etc.
    a. Data Set A.csv
    b. Data Set B.csv
6. You may also want to prepare for using CODAP:
    a. https://codap.concord.org/app/static/dg/en/cert/index.html#shared=18324

Prerequisite skills or knowledge

- Little to no quantitative skill pre-requisites is expected
- The topics that could be referred to but are not necessary: homeostasis/regulatory feedback, neuromuscular system, population ecology, interactions between species, circulatory system, gas exchange, animal diversity, ecosystem ecology, climate change

Part 1: Interpreting graphs (15-20 min)

(slides 6-8) Explain how to read a graph, and introduce a new way to interpret them. This method breaks down the parts to focus first on the pattern of the data, then inspect the axes for meaning. This method separates the cognitive load of graph interpretation, especially for graphs of data where the axes may be difficult concepts to comprehend or are jargon-heavy.

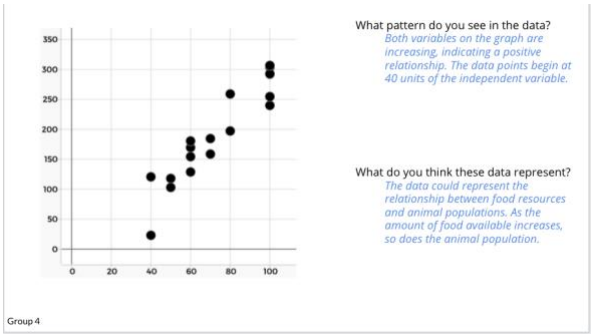

Figure 1. Example of student interpretation of graph without axis labels

(slides 9-11) Breakout or in-person group activity to interpret a graph with this method. Ask a few groups to volunteer their ideas for what the graph is about (Figure 1).

(slides 12-13) What the graph is actually about: define the axes. These are the answer slides, so don't show beforehand (Figure 2).

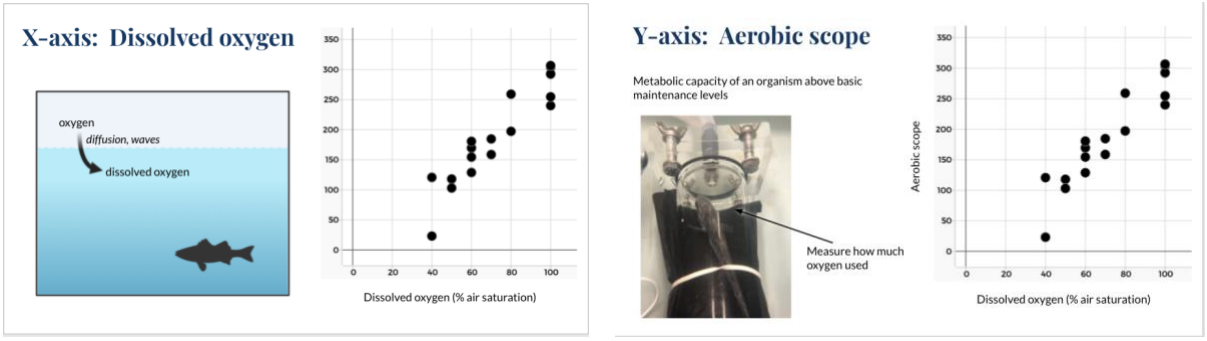

Figure 2. Reveal of the axis labels

(slides 14-15) Poll questions to interpret the graph now that the axes are defined (Figure 3).

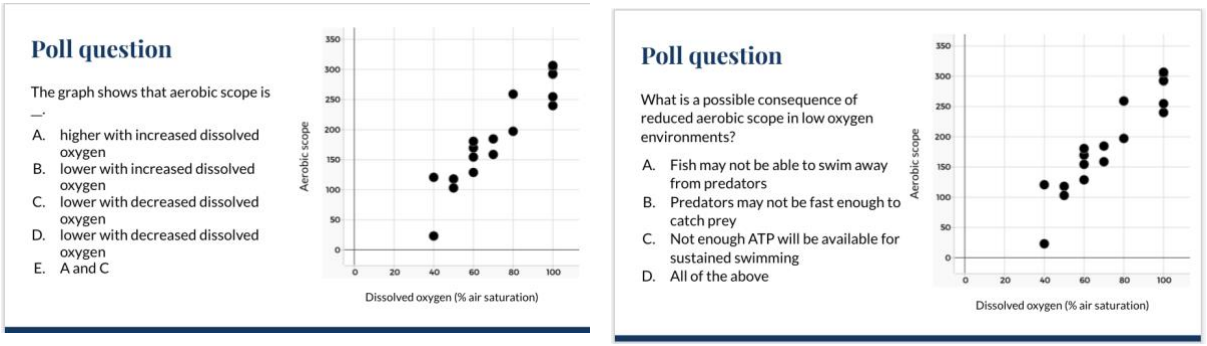

Figure 3. Poll questions (formative assessment)

(slides 16-20) Set some context for why we should care about the reduced aerobic scope of fish in diverse oxygen environments. Ask students to generate hypotheses on the influence of global warming on fish in hypoxic zones, and predict adaptations that would help fish to cope with warmer, hypoxic environments.

Suggested options and alternatives to Part 1

- You may want to make a set of multiple choice questions for an assignment on your learning management system (LMS).
- Instead of group work, you can have students complete the questions on their own. You will need to edit the worksheet for an individual assignment.
- Instead of digital documents, you could make physical worksheets.

Part 2: Constructing graphs (15-20 min)

Students will now follow up on the ideas and predictions proposed at the end of Part 1 by making graphs of data from experiments on fish in warmed and hypoxic environments.

(slide 22): An overview (animated) of the graphing tool CODAP that students will use in Part 2

(slide 23): Description of the variables the students will be graphing (Figure 4). In our implementation, we merely mentioned that there are two data sets, and asked students to go back to this slide once they started the breakout activity.

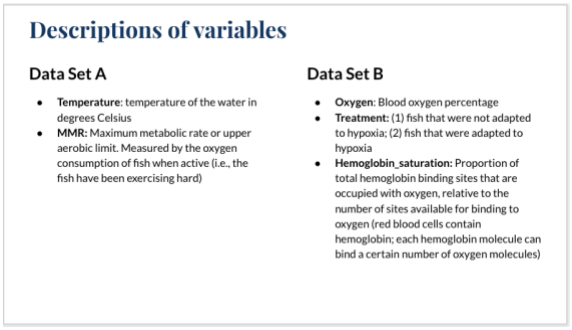

Figure 4. Data set descriptions for making graphs

(slides 24-26): Breakout or in-person group activity to construct graphs of one of two data sets. Half the class should graph one data set, and the other half graphs the second data set. Use the digital collaborative worksheet so that groups can see the graph that they didn't make after they are done making their graph (Figure 5).

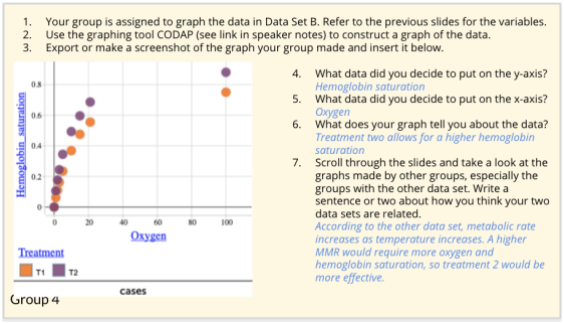

Figure 5. Example of student work for Part 2

(slide 27): Processing by the whole class to discuss their conclusions. Good points to try to target:

- If fish consume more oxygen when water is warmer (Data Set A), then they could be in big trouble in warm, hypoxic conditions (recall graph from Part 1)
- Some fish can adapt to hypoxic conditions by having hemoglobin that's better at binding to oxygen. In a warmer, more hypoxic world, this is good. This is important research that needs to be done.

Potential issues

Data set B has a third variable of treatment, which is graphed by putting treatment in the plot area, not either axis. There aren't instructions on the overview slide of CODAP for this, but students are often able to figure it out. Students may choose to put treatment on the x-axis. This

is OK, but then what will they do with the oxygen variable? We found that gentle nudges were needed.

Suggested options and alternatives to Part 2

- You may want to make a set of multiple choice questions for an assignment on your LMS.
- You could have students do this individually. You will need to make a digital worksheet for an individual assignment.
- (in-person only) You could have students graph the data on paper instead of using CODAP. This will take more time, so budget accordingly.

Scientist Spotlight (15 min)

(slides 29-37) We now want to ask "What are the roles of scientists and citizens in addressing these environmental impacts?" The remainder of this lesson is a feature on the scientist whose data the students graphed and interpreted, Benjamin Negrete, Jr! He is doing the important research that needs to be done mentioned in the notes for Part 2.

This interview is arranged on different slides as clips, one interview question per slide (Figure 6). Select as few or as many as you want to use, depending on time and what you think your students will be interested in. If you know there are some you want to omit, you use "Skip Slide" to do so ahead of time. Total video time is 11:17. https://youtu.be/RqbHNV2ChQE

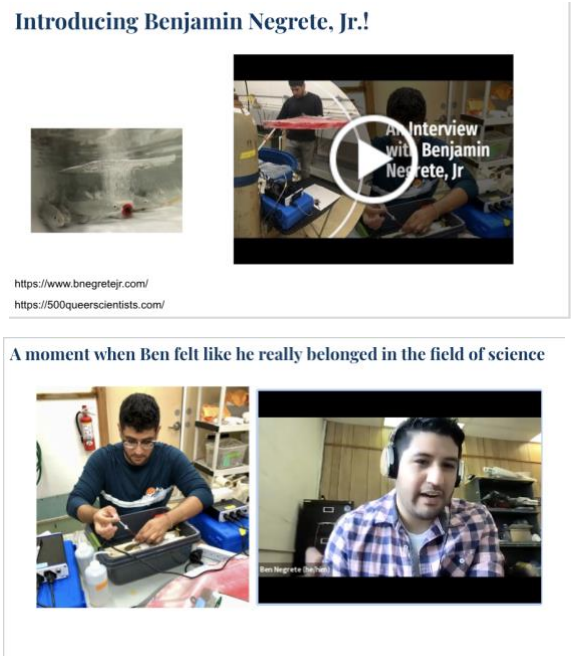

Figure 6. Example clips from video interview

Post-activity assignment

Reflection essay with prompts adapted from Schinske et al. 2016 after the activity, graded for completion.

After reviewing the background and scientific work of Benjamin Negrete, Jr, write a four to five sentence reflection on what you discovered. You might wish to address some of the following:

- What did you learn from today's activity about adaptation to hypoxia, interpreting graphs, environmental impacts of human activities, conservation?
- What new questions do you have after today's activity?
- What did today's activity tell you about the types of people that do science?

References/resources

1. Method for interpreting graphs without axes from Fleming-Davies, A., Wojdak, J. M. (2018). Figure of the Day. BIOMAAP: Biology Student Math Attitudes and Anxiety Program, QUBES Educational Resources. doi:10.25334/Q4M13D.
2. CODAP - Common Online Data Analysis Platform. https://codap.concord.org/
3. Schinske, J. N., Perkins, H., Snyder, A., & Wyer, M. (2016). Scientist spotlight homework assignments shift students' stereotypes of scientists and enhance science identity in a diverse introductory science class. CBE—Life Sciences Education, 15(3), ar47.
4. The Scientist Spotlights Initiative | San Francisco. https://scientistspotlights.org/.
5. Project Biodiversify Tools. https://projectbiodiversify.org/.