OSU Oregon State University
Sea Grant Oregon

Lesson 5

Timeframe

One to two 50-minute class periods. This lesson may take longer if students have not previously learned about graphing. To provide an overall introduction to graphs and graphing skills, use the "Intro to Graphing" lesson.

Materials

- Graph paper
- Colored pencils
- Computers (and Excel, if using)
- Data collected and recorded on StreamWebs datasheets
- "Graphing Overview" and "5 Key Components of Any Graph" handouts

Objectives

- Construct graphs illustrating relationships within their data
- Analyze data to determine the health of the stream
- Discuss how this data and the possible relationships may or may not help answer students' investigative questions
- Identify areas where they might need to follow up and gather more data to better answer their investigative question

Analyze, Interpret, and Graph Field Data

Teacher Background

Understanding the meaning of the word *data* and how to graph, interpret, and use data can be very overwhelming to students. Helping students understand that data are simply information, that they can be many things depending upon what we are studying, or how we are using data is an important first step. Data change per project and are based upon the objective of your own goals. Data are evidence of a certain thing, change, idea, preference, or quantity and are often measured over time, especially for accumulated data. By helping our students feel more comfortable using data and learning about graphs and how to make them, we are setting students up to be successful in the future by giving them transferable skills.

In this lesson, students will consider *independent* and *dependent* variables. Independent is the variable, or part of the data, that changes and can be controlled or manipulated by the scientist, or any other user of data. This variable should be placed on the horizontal or x-axis, or represent the outside circle, or slices of the pie chart. This variable stands alone and cannot be affected by the other variable being measured. For example, someone's age or the time will not be affected by the dependent variable, such as how much time one spends on Facebook, watching television, or playing guitar. However, someone's age may affect how much time they spend on Facebook, watching television, or playing guitar. We are often trying to see if there is a relationship between variables, and if the independent variable possibly changes or affects the dependent variable.

Dependent is the variable directly affected by the independent variable. It is the result of what happens because of the independent variable; in other words, it depends on the other variables or factors. This variable is placed on the vertical or y-axis, or represents how big the sizes of the pieces are (usually percentages) of a pie chart. The pieces should be drawn out using radial lines from the center to the outside of the circle (much like the spokes on a bicycle wheel). This variable can change based upon the independent variable. For example, a test score may depend upon other factors, such as how much you slept or studied beforehand, making it a dependent variable.

Description

In this lesson, students will work on their data interpretation and visualization skills, and make their own graphs of their data. They will attempt to use their data to answer their question and/or discuss what additional data they would need to answer their question. If students did not develop an investigative question, you can pose one to them such as, "Is x creek healthy for the organisms that live there?" Students will create materials for their final presentation products that explain their findings and begin thinking about an audience to share their findings with.

Preparation

If your class needs an introduction to graphing or a refresher, prepare to teach the lesson "Intro to Graphing." Students will need to access their data (off their datasheets or in the StreamWebs database) and have access to laptops or tablets and Excel if they will make graphs with it. Students will reassemble to work together in their field teams with all their data and findings.

Next Generation Science Standards

DISCIPLINARY CORE IDEAS:

LS2.A: Interdependent Relationships in Ecosystems

PERFORMANCE EXPECTATIONS:

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

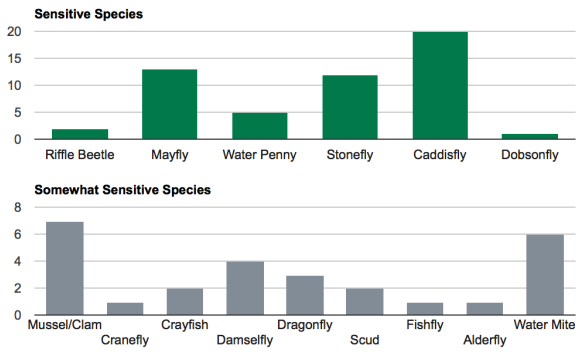
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

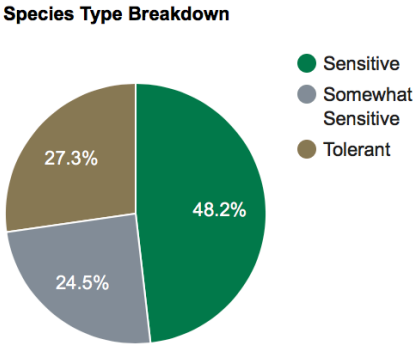
PRACTICES:

Practice 4: Analyzing and interpreting data

Practice 5: Using mathematics and computational thinking

Macroinvertebrates Data Graphing





Activity Introduction

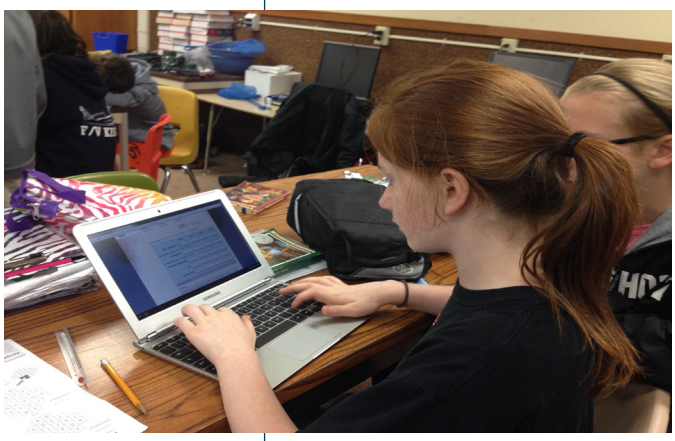
Let students know that they will be working in their field teams to construct graphs, tables, and written materials to interpret and share their data. Inform teams they are going to examine their data, decide how to best graph them, and then make two or three graphs to represent their data. Students will also create tables, paragraphs, maps, or even cartoons to best present their data. It is important that students understand it is okay if they do not have an answer to their investigative question, as long as they talk about what they did find, notice, and infer from their data.

Discuss the following guidelines for creating graphs with students:

- Choose correct colors for data visualization and representation. *E.g., colors that are easy to see and that align with what people may already perceive as related to certain colors, such as red for hot and blue for cold.*
- All graphs should be about a third to a half of a page, so that information and data points can be located on them clearly and accurately.
- The scales should be selected so the data points fill the graph space.
- The graph must have a title and the axes should be clearly labeled.
- The quantity and units must be shown for each axis.
- Consider independent and dependent variables. *E.g., an independent variable might be time, and a dependent variable might be water quality parameters such as temperature, dissolved oxygen, or types of macroinvertebrates.*
- Data points should be recorded with a clear dot or easy-to-see symbol; bars or pie wedges should be clearly drawn with separate colors.
- Appropriate and best graphs chosen for specific data: line graph, bar graph, pie chart (see Intro to Graphing lesson).

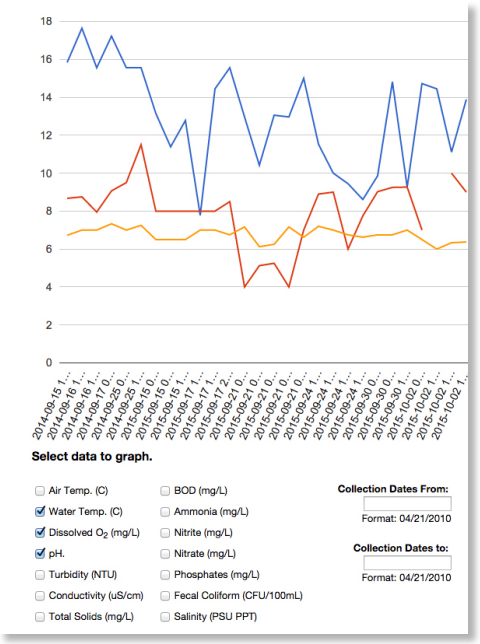
Guiding Questions

- **What might data tell us about our site?** *Watershed health; whether or not our stream can support macroinvertebrates, fish, and other aquatic organisms; provide clues to problems in our watershed such as pollution, too-small trees and plants for coverage; and problems with food sources, cooling, or other issues.*
- **How can graphs act as a tool to demonstrate these relationships?** *Consider our information, what we are trying to share or demonstrate with our graph, what the variables are, etc.*



Activity: Analyzing and Interpreting Data

1. Group students into their previous field teams. They will need access to their data in StreamWebs or their original datasheets.
2. Hand out or project the "Graphing Overview" and "5 Key Components of Any Graph" sheets for students to reference.
3. Instruct students to revisit their investigative question and discuss what they are trying to show or share in relation to their question. They will want to make some conclusions or correlations from their data to answer their investigative question(s). Have teams briefly discuss their data and brainstorm what type of graphs or tables they will use to demonstrate this information.
4. Ask each team to identify its independent and dependent variables for each data set they plan to graph to answer their investigative question, which axis each variable will go on, and their scale. Have each team share with the class or individually with the teacher to ensure students are using proper variables, and understand the relationship between them.
5. Hand out graph paper and colored pencils, and instruct students to make their graphs. When student teams are done, have them share their graphs.



Activity Wrap Up

- Do you have the data you need to answer your investigative question?
- If not, what data do you still need to collect, or would you collect in the future?
- Were you able to illustrate your answer(s) in the form of a graph?
- Did you discover any new relationships or information while you were graphing your answers to your investigative question(s)?
- How strong is your scientific evidence? How do you know?

  Stress to students that even if they don't have the data they need to answer their question, they can still present what they do have and explain their findings, what they still need, and any changes to their investigation plan.

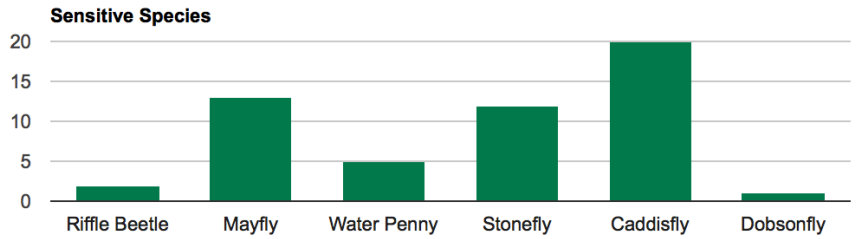
A Graphing Overview

Line Graphs:

- Are often used to show how something changes over time
- The x-axis (horizontal line) has the data for the time period (months, days, or time)
- The y-axis (vertical line) has the data for things being measured

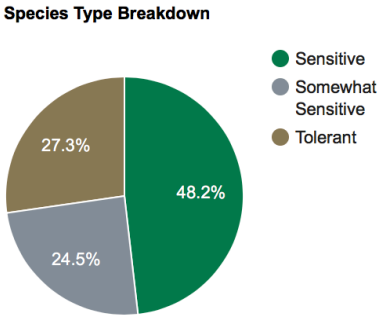
Bar Graphs:

- Are often used to represent categorical data
- The x-axis (horizontal line) represents the categories being measured
- The y-axis (vertical line) represents the amount of the information/ data being measured
- Sometimes they may display data that have nothing to do with time
- Macroinvertebrate data are easily shown in a bar graph, where each bar is a different macroinvertebrate and the height of the bar represents the number of each species that were found.



Pie Charts/Graphs:

- Useful for showing percentages, or portions of a whole
- Show data at a certain and set point in time, and are not used to show information over time



Advice on Creating Maps:

- All graphs should be big enough (for example, half of a piece of an 8.5x11 page) that information and data points can be located on them clearly and accurately.
- The quantity and units must be labeled for each axis, bar, or pie piece.
- Data points, bars, or pie pieces should be recorded, or drawn with a clear dot, bar, or easy-to-see symbol. Depending upon what the graph represents and who it is being prepared for, symbols may be used instead of simple plotting dots.

  For example, for our StreamWebs data we may use fish to represent our data, and draw them stacked upon each other to represent each bar.
- Choosing correct colors for data visualization and representation is another important step. Choose colors that are easy to see and are representative of categories in data (e.g., red symbolizing hot and blue symbolizing cold).

Five Key Components of any Graph

1. The Title
   - Explains concisely what the graph is about
   - Should give the reader an idea about what he/she will see or learn about in the graph
   - Placed above the graph
2. The Independent Variable
   - The data that change and can be controlled or manipulated by the scientist, or any other user of data
   - Represented along the horizontal or x-axis, or the outside circle, or slices of the pie chart
   - This variable stands alone and cannot be changed by the other variable being measured
   - Graphs are often used to observe whether the independent variable possibly changes or affects the dependent variable
3. The Dependent Variable
   - The variable directly affected by the independent variable
   - Represented along the vertical or y-axis, or by how big the pieces of a pie chart are (usually percentages)
   - This variable stands alone and cannot be changed by the other variable being measured
   - Graphs are often used to observe what defines how a dependent variable changes when we graph data
4. The Scales for Each Variable
   - Guides where we plot the points, or symbols, representing the data when we construct our graph
   - Designed to include all the data points and fill the graph space as much as possible
   - Each space or mark in the scale should have a consistent and standard increase in amount, or increment, on a particular axis
5. The Legend
   - Short description concerning the graph's data
   - Tells the reader what they are looking at, including symbology, color scheme, or lines on graph
   - Short, concise, and placed directly under or beside the graph

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Published by Oregon Sea Grant, 1600 SW Western Blvd., Suite 350, Corvallis, OR 97333. Phone: 541-737-2714. Web: seagrant.oregonstate.edu/

This report was prepared by Oregon Sea Grant under award number NA16NOS4290143 (grant ID NA295A) from the National Oceanic and Atmospheric Administration (NOAA) StreamWebs Student Stewardship, U.S. Department of Commerce, and by appropriations made by the Oregon State Legislature. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of these funders.

ORESU-E-17-002

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