Data Analysis *Lesson Plan*
Students learn to evaluate and interpret data measurements.

Lesson Summary: Students will learn to analyze real world data using averages and graphing techniques. This will include learning about outliers within data and what effects outliers can have on data analysis. Students will also learn how to use graphing software like MS Excel.

Grade Level: 9th – 12th

Time Allotted: 1 class period (approximately 40 minutes)

Performance Objectives

References are to the Next Generation Sunshine State Standards (2007).

Science

SC.912.L.17.4	Describe changes in ecosystems resulting from seasonal variations, climate change and succession.
SC.912.L.17.7	Characterize the biotic and abiotic components that define freshwater systems, marine systems and terrestrial systems.
SC.912.L.17.13	Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
SC.912.L.17.15	Discuss the effects of technology on environmental quality.
SC.912.L.17.16	Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.
SC.912.L.17.18	Describe how human population size and resource use relate to environmental quality.

Math

SC.912.L.17.20	Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.
MA.912.S.3.3	Calculate and interpret measures of the center of a set of data, including mean, median, and weighted mean, and use these measures to make comparisons among sets of data.
MA.912.S.3.9	Identify outliers in a set of data based on an appropriate graphical presentation of the data, and describe the effect of outliers on the mean, median, and range of the data.

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Prior Knowledge

Students must know how to perform addition, multiplication, and division. An understanding of basic algebra is recommended. Prior experience with spreadsheet/graphing software such as Microsoft Excel is not required but is helpful.

Topic Overview

The students will learn about simple data analysis (determining averages, identifying outliers, using Excel to graph, etc) by downloading data from the Water Atlas and manipulating the data to simulate climate change. In this module, the data will be focused on the amount of dissolved oxygen (DO) found in the waters of Seminole County and the students will learn to interpret this data in both graph and table form.

Key Vocabulary

Average
   A measure of central tendency obtained by adding several quantities together and dividing the sum by the number of quantities.

Dissolved oxygen
   The oxygen freely available in water that is vital to the existence of fish and other aquatic life.

Fecal coliforms
   Bacteria found in the intestinal tracts or feces of humans and other warm-blooded animals.

Mean
   Another word for average.

Outlier
   Data point whose value is widely separated from other data points

Parameter
   An independent variable in an equation that defines relationships between measured values.

Trend line
   A line on a two-dimensional graph that indicates the general tendency of the data.

Materials

- Computer with internet access
- Microsoft Word and Excel or equivalent programs (Free open-source software can be downloaded at http://www.libreoffice.org/)

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References

These references are available on the Seminole County Water Atlas:

A Beginner's Guide to Water Management: Oxygen and Temperature. 2004. Florida LAKEWATCH, University of Florida Institute of Food and Agricultural Sciences.

Learn More: Dissolved Oxygen. Seminole County Water Atlas.

Other references:

Climate Change Impacts: Changes in Temperature. 2009. Climate Change Clearinghouse.

Climate Institute Topics/Core Issues: Water. 2007. The Climate Institute.

Demo: Create charts in Excel 2007. Accessed July 2011. Microsoft, Inc.

Intergovernmental Panel on Climate Change. Website. Accessed June 2011.

A Student's Guide to Climate Change. Website. Environmental Protection Agency. Accessed June 2011.

Video: Create a chart (or graph). Accessed July 2011. Microsoft, Inc. *(Applies to Microsoft Office Excel 2003).*

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Procedure

Engage/Elicit

Present students with the following problem: If global temperatures keep increasing, the rising temperatures will have a negative impact on water quality in our area. One area of concern is that warmer water will not hold as much dissolved oxygen (DO) as cooler water; fish and aquatic plants depend on dissolved oxygen for aerobic respiration and lower levels of DO could cause a massive loss of suitable habitats. But how can we know if the DO levels really change? Is there any way to see just how bad it might be?

Use this problem setup as a hook to introduce basic data analysis. Run through a description of averages and how to calculate them and how to identify outliers (see examples below). Then allow the students to investigate current DO levels in water sources in Seminole County using the data download tool at http://www.seminole.wateratlas.org/.

Here is an example of calculating averages using fecal coliform measurements in water. Feel free to use other/additional examples you feel are appropriate:

In order to analyze data in large data sets it is often useful to calculate a number that summarizes the data. The most well-known and useful example is the average or mean value.

Measures of Central Tendency are statistics you calculate if you want to represent a group of data by a single value. This value may also be referred to as the expected or the most-likely value. The most common measure of central tendency is the mean, or average value. To calculate the mean, add up all of your values divided by the number of values:

Mean = (X1 + X2 + X3 + ... Xn)/ n

Where
- Xi = the value of your chemical parameter
- n = the total number of values

The **mean** is a useful measure of central tendency, but is very sensitive to unusually large or small values (called outliers). For example, the following is a typical data set for fecal coliform, a type of bacteria, at a sampling station, measured in coliform forming units per 100 milliliters of water:

Sample Date	Fecal Coliform (cfu/100ml)
1/2/1998	50
1/9/1998	40
1/16/1998	90
1/23/1998	500
1/30/1998	80

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The mean of these values is (50 + 40 + 90 + 500 + 80) / 5 or 152 cfu/100ml. This would be a clear violation of the Class A water quality standard of 100 cfu/100ml. However, if you remove the largest value (500) the mean becomes (50 + 40 + 90 + 80)/4, or 65 cfu/100ml. This mean value would pass Class A standards.

Given all of the possibilities for measurement error, sampling handling error, and natural variability, you don't want your conclusions to be heavily influenced by a single odd sample; the value of 500 cfu/100ml might be the result of sample contamination or just an unusually polluted parcel of water.

Explore

Inform your students that they will begin by exploring the waters of Seminole County on the Water Atlas to determine the levels of DO from the last few years.

Have the students go to http://www.seminole.wateratlas.org/ > Data & Mapping > Data Download and then follow these steps. The students should work individually or in pairs; the more sets of data, the better.

1. When prompted to Select Data Type, click **Surface Water Quality**
2. When prompted to Select Filters, click **Water Body Name**, **Date Range**, and **Parameter**
3. Type in a name of a lake (for example, Lake Apopka).
4. After selecting a body of water, select a date range of the past **2 years** using the drop down menu and then select **Dissolved Oxygen** (DO) as the parameter
5. Select a **station** or stations that have **recent data**. If none of the stations have recent data, return to Step 3 and select a different body of water.
6. Graph the data. Make sure the **Display Trendline** and **Median** boxes are checked, and refresh the graph.

    Once their data has been graphed, students can cut and paste the graph into a MS Word document (have them label it appropriately).

7. Have the students return to Step 5, choosing the same station(s) as before. This time, they should download the data into a table. On a new worksheet, have them paste just the **SampleDate** and **Result_Value** columns, so that the result looks similar to the Fecal Coliform table in the example. Have them copy this table and paste it into their MS Word document under the graph, and save the file.

Once the students have their graph and data table, they may explore new bodies of water or download data for a new parameter (perhaps look at Nitrogen levels or Fecal Coliform). Depending on the time you have available, you may wish to allow them to explore further during another class period after they have completed the rest of this module.

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Explain

Ask your students to interpret the data in the graph and table they have produced. What is the average value of DO across the 2 years? Are the DO levels increasing, decreasing, or staying about the same during this time period? Are there any outliers that are potentially skewing the average? If so, can the students identify them and recalculate a new average?

Have the students then share their data and compare averages. Many environmental factors (beyond just temperature) can influence DO levels, but they should all be fairly similar (most likely between 8 and 10 mg/L). If they are not, see the extend phase for possible ways to use these different data.

Extend

Depending on your time and resources, there are many different ways this lesson can be further extended. Either of these ideas will take at least another class period beyond what was scheduled in this module.

1. Have the students generate a corresponding temperature graph from the same time period using the Seminole County Water Atlas Data Download tool. Examine the trend lines for temperature and dissolved oxygen concentration. Is there any correlation between them?
2. You can have them practice more simple data analysis by selecting other parameters (such as levels of nitrogen in the water). This could be particularly useful if the students are not familiar with Excel; repeated exercises with known data points and a Water Atlas generated graph as a point of comparison will allow you to and the students to determine if they are using the program correctly. They may also wish to use Excel's graphing capability to make their own graphs to compare different parameters.

Exchange/Evaluate

To evaluate the data analysis, have the students print their graphs (properly labeled) and then write a brief summary on the back of the graph. This summary should explain what the graph illustrates, how they analyzed the data, what the data means, and what the effects of increase temperature had on the data.

If students need help describing the effects of increased temperature, refer them to the Digital Library and the Climate Change & Florida education page of the Seminole County Water Atlas for additional resources. For example, http://www.theclimatechangeclearinghouse.org/ > Climate Change Impacts > Changes In Temperature is particularly helpful.