Data Overload *Lesson Plan*

Students collect, organize and interpret real world water quality data.

Lesson Summary: In this lesson, students will learn to collect, organize (via tables and graphs), and interpret real world data world data. Well-organized data can be read quickly and easily, even when there is a lot of it, and potential errors and outliers can be more easily recognized. Students will also learn how to use spreadsheet/graphing software like Microsoft Excel.

Grade Level: 9^{th} – 12^{th}

Time Allotted: 2 class periods (approximately 50 minutes each)

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.
SC.912.L.17.20	Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

Math

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 Microsoft Excel is not required but is helpful.

Topic Overview

The students will learn how to collect and organize data, both in tables and in graphs, for ease of interpretation 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 rainfall that enters the waters of Orange County and the students will organize this data in both graph and table form, interpret the data, and then make predictions concerning future rainfall and its effect on the waters of Orange County.

Key Vocabulary

Data table
: A device for organizing and displaying data so that it is more easily read and interpreted. Typically arranged in a matrix-like format with rows and columns, each cell of the matrix contains a data value and the rows and columns are labeled so that the reader knows what the data in each cell represents.

Graph
: A visual representation of data. Typically containing a X and a Y axis, a graph will represent data as points, lines, bars, or other easily distinguished character along some kind of continuum in relation to other pieces of data. Graphs can represent data collected during a certain time period, over a certain distance, or during any other interval where the observer might wish to observe. The highly visual nature of graphs allows for easy recognition of changes or similarities in the data patterns.

Parameter
: One of the independent variables in a parametric equation.

Time-history graph
: A type of graph that shows how a variable changes over a period of time.

Spatial-trend graph
: A type of graph that shows how a variable changes due to location.

Materials

- Computer with internet access
- Microsoft Word and Excel, or equivalent programs.

References

The Climate Change Clearinghouse.

Climate Change and Water: Perspectives from the Forest Service. 2008. U.S. Department of Agriculture, Forest Service.

Procedure – Day 1

Engage/Elicit

Present students with the following problem: if global temperatures keep increasing, the rising temperatures will alter the weather patterns around the world, including here in Florida. We can't say for certain if it will cause more or less rainfall (those certain indicators do lean towards less), but either change can have a profound impact on the ecology of Orange County and its waters. But how can we know the amount of rain really does change? How much rain falls and enters Orange County's waters? And does the amount constantly change from season to season or has the amount of rainfall remained steady over time?

Use this problem set up as a hook to introduce the concept of collection, organizing, and interpreting data. Run through a description of basic data organization techniques, examples below, and ask the students to interpret some of these examples. Then allow the students to investigate rainfall levels in water sources in Orange County using the data download tool at www.orange.wateratlas.org.

Here is an example of using data tables to organize and interpret data for dissolved oxygen (DO) in water. Feel free to use other/additional examples you feel are appropriate:

"A Data Table is simply an organized way to display all of your related data, and you will frequently need to include data tables when creating reports or conducting investigations. There are many ways to create a data table (including plain old paper and pencil), but some kind of spreadsheet program (such as Excel) is most useful as they allow you to create your tables, easily change and manipulate your data if the current organization method is not useful or incorrect, perform many times of calculations and basic statistical analysis, create graphs and figures based on the data, and easily print the material.

"A common way to create a table is to display and compare several different parameters or variables. For example, in the table below, the columns represent various sampling locations, and the rows would be the results for each sampling date so we can easily compare the amount of DO in each location at each time point.

"This kind of table helps you look at trends in your data, such as how a parameter changes over time at one location, or how it changes as you move downriver on a given sampling date.

"Please note that the table has been titled and each column and row is clearly labeled to make sure that the information contained in the table is easily identified and interpreted. As you create your own tables, you should similarly title and label your efforts and also carefully check against your original laboratory and field notes to identify any errors."

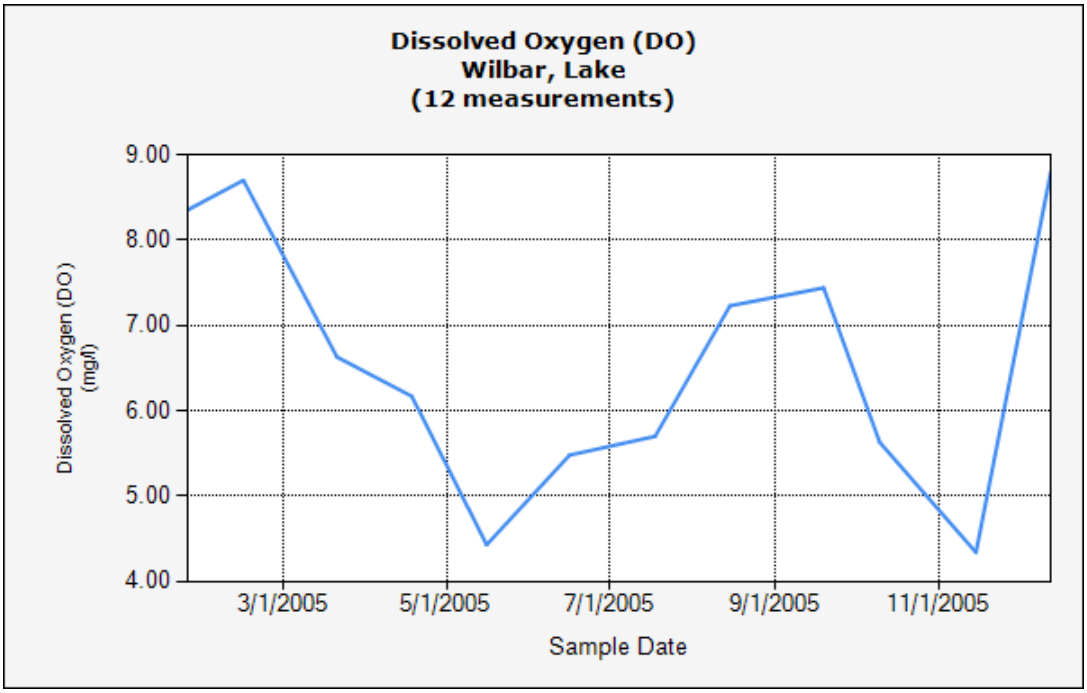
Figure 1. Dissolved Oxygen (mg/l) for the St. Johns River

Date	***Dissolved Oxygen in mg/l***					
	River Mile 8	**River Mile 9**	**River Mile 10**	**River Mile 11**	**River Mile 12**	**River Mile 13**
04/01/98	10.1	10.1	10.5	10.3	9.5	9.7
05/01/98	9.2	8.2	9.2	9.1	10.2	10.0
06/01/98	9.3	9.1	8.5	9.2	9.2	8.9
07/01/98	7.4	6.5	6.1	7.3	8.1	9.1
08/01/98	7.1	5.4	4.3	5.9	7.9	8.3
09/01/98	8.1	6.8	6.4	6.8	8.1	9.4

Next, use this example to discuss graphing data in the data tables:

"Graphing is an excellent way to display your data, and is very helpful when you are analyzing trends and correlations. There are many kinds of graphs, and you are encouraged to be creative in finding different ways of looking at data. For example, time-history graphs are graphs that show how a physical or chemical parameter changes with time at a sampling location. Here is a time-history graph for DO at a lake.

"This graphical representation of data allows a reader to easily see changes in the data and to more easily identify changes within the data set."



Explore

Using these examples (or another you have selected) ask the students to first study the table and then ask them to discuss the table in small groups. The groups should identify exactly what the table is trying to describe and also identify/interpret any major trends within the data. For example, they should be able to say that over time, the levels of DO in the water decreased, reaching its lowest values at the second to last time point and, in the final time point, appearing to rise again. They might further infer, based on this data, that the DO levels would then continue to rise to a peak at some point, before it begins dropping again in a cyclical patter (this is indeed what happens: As the water warms during the summer months, the amount of DO drops. As the water cools in the winter months, the DO levels rise). They should also be able to observe that the DO levels between the various sampling points on the river do not seem to follow a specific pattern and this is fine (sometimes there are no patterns to be found).

Next have the students study and discuss the graph. As with the table, the groups should be able to identify what the graph is trying to describe and also identify any major trends within the data. For example, there are peaks at the beginning and end of the year with a noticeable dip in the middle of the year. This could indicate a cyclic nature to the DO levels, with rising and falling levels of DO depending on the time of year. However there is a second large dip near the end of the graph; this could be due either to data collection error or this could be an interesting time point that would require further investigation to determine its cause.

After the students have had time to explore and discuss the examples, you will inform your students that they will be using tables and graphs to investigate the amount rainfall amounts in Orange County. They will use the Water Atlas to obtain this data but they will be responsible for the creation of any needed tables or graphs and for interpreting the data.

Organize the students into groups of 4 or 5, and have them visit the Orange County Water Atlas. They should use the Data Download Tool to collect data by following these steps:

1. When prompted to Select Data Type, click **Meteorological**
2. When prompted to Select Filters, check **Water Body Name** and **Date Range**
3. Have the students type in one of the following names:
   Lake Apopka, **Lake Beauclair**, **Boggy Creek, Lake Conway, Corner Lake, East Reedy Creek, Lake Hart, Lake Orlando, Lake Sheen, Shingle Creek,** or **Spring Lake**
   Each member of the group should pick a different water resource, they will need to repeat the remaining steps for each member of the group.
4. Pick a date range. Check the “The previous…” option and then select “years” in the pull down menu. Go back at least one year, but no more than 5 years.
5. Click **Give me all station data**.
6. Make sure “Excel” is marked next to File Type and then click the large **Generate File to Download** button. Save the file in a location where you can easily find it later.

Once they have downloaded the data, students can open their files in Excel and begin to construct a data table similar to the example. Tell them to choose what date(s) or date ranges they wish to include. They may want to include just high and low data points, or calculate an average or total rainfall for each month, for all or specific months, for quarters or seasons, or for the whole year. If they do not know, show them how to use the AVERAGE() and SUM() functions to calculate these.

Many of the columns in the file will be unnecessary and can be deleted, the students will only really need the columns containing the rainfall level itself and the column identifying the date the data was recorded. However, the students are meant to figure this out in their group as part of the table creation process; you can help them determine what is and is not necessary for their table, but do not tell them specifically what they need. Their final data table for the group should contain the date(s) in the first column and then each subsequent column should be the rainfall for a specific location on those dates. All parts of the table should be clearly labeled. Make sure they print and save the completed table.

Explain

If you have enough time left in the class period, ask your students to interpret the table they have produced. What are the chosen data meant to communicate? Are there any patterns to the level of rainfall across time? In the different locations? Did certain years or locations appear to be more or less dry than the others? Are the amounts of rainfall increasing, decreasing, or staying about the same during the time period? Were there any outliers or other anomalous data that stood out? If so, do the students have any idea what might be the cause of the anomaly? Have each group hand in a written interpretation of their table (they can write it on the back of their printed table for easy reference). If you do not have time this class period, begin the next day with this activity.

Extend

No extension for this lesson. Between covering the examples and the collection of the data, this day will be very full.

Exchange/Evaluate

Have the students hand in their table and written interpretations. Grade the table on completeness (paying particular attention to labels and titles) and whether their interpretations are reasonably based upon the data table and not just wild speculation.

Procedure – Day 2

Engage/Elicit

Begin the lesson by reminding the students of what they learned on Day 1. If you did not have time to have them interpret their tables on Day 1, do so at this time. Alternatively, have the groups print new tables to share with other groups, and give groups a few minutes to discuss and interpret these each others' tables.

Explore

After the students have had a few minutes to refresh themselves regarding data tables and interpretation, ask them to take their data table and create a graph based on the table. With multiple columns in the table, they can either make a separate graph for each location or they can plot all locations on a single graph (the choice is yours and, if your students are already familiar with Excel the single graph is probably the better option).

Explain

Once they have created their graphs, ask them to compare the graphs to the data table: even though they are both made using the same data, they look very different. Ask the groups to interpret the graphs and compare their interpretations to the interpretations from the table:

- Have they noticed any new patterns?
- Do they come to the same conclusions they did before?
- Do any of the data points on the graph seem to stand out more than they did in the data table?
- Why might you want to use a graph to present some types of data over a data table (and vice versa)?

As the students discuss their interpretations and observe these differences, have them create a list of their observations and differences in interpretations.

Extend

Now ask the students to consider what impact climate change and warming of the local environment might have on rainfall. Over the course of a year, did they notice any trends or patterns to the amount of rainfall in relation to temperature? Specifically, did the amount of rainfall vary between summer and winter months?

Many factors could influence the amount of rain that fell during these seasons, but average temperature is a significant contributor to the weather patterns. If the average global temperature rises by even a few degrees, massive changes in weather patterns can occur. For example, some models predict that Florida and other locations in the southern United States will likely receive much less precipitation on average, especially during winter months. If you have not discussed climate

change in detail with your class before, have them read ***Climate Change and Water: Perspectives from the Forest Service***, listed in References, to provide some context for this part of the lesson. (You may wish to assign this reading for homework after Day 1 to prepare them for the discussion, or have them visit The Climate Change Clearinghouse website as homework.

Ask the students to consider their data tables now within the context of climate change. While it is uncertain exactly what will happen to precipitation here in Florida if the climate continues to warm, can they predict what might happen to the rainfall based on their reading/past class discussion of climate change? What might their data tables and graphs look like 100 years in the future? Would they remain the same? Would they change? If they change, would they predict a uniform change (e.g. would the levels just decrease by a fixed amount across all time points and all locations?) or would certain locations and/or seasons be affected more dramatically than others?

Have the students record their predicted changes to the data tables and graphs. Add a new column to each location in the data table: they will now have the "current location" that they acquired the data for yesterday and a new "future location" that they will have to create some data for based on their predictions. The students will have to best decide how to predict this future data: maybe they have already noticed a small change over time in their current data sets and can use that change as a guide; maybe they want to assume that there will be a uniform increase/decrease in all precipitation; maybe their own understanding of climate change leads them to another set of assumptions. The actual predictions are not as important as their justification for making the prediction: as they create their new data table, they should also record their reason(s) for the predictions. Once the new table has been completed, have the students graph the new table with both the new data and the old data on the same graph so that the different lines can be easily compared (they can still create a separate graph for each different location, though). If your students are unfamiliar with Excel, you may have to help them put multiple lines of data on a single graph.

Exchange/Evaluate

Have the students print both the new table and the new graphs. If enough time remains in the lesson, have a spokesperson from each group briefly present to the rest of the class their predictions (along with justifications). The other students may ask questions if the justifications or predictions are not clear.

Collect the tables, graphs, and lists of justifications the students created. Grade the tables and graphs for completeness (paying particular attention to labels and titles) and compare their predicted values on the tables and graphs to their justifications. If their predictions are supported by their understanding of climate change or other reasonable evidence, they will get full credit for their predictions.

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