Hubbard Brook Environmental Literacy Program
Data Inquiry Activities

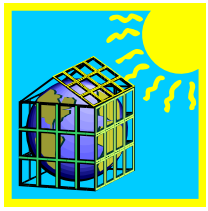
Climate Change- a hot topic!	
Summary	Students explore climate change by graphing and analyzing 40 years of ice cover data from Mirror Lake, NH.
Subject areas	Biology, ecology, environmental science; Assumes students have some prior knowledge of lake ecology.
Skill level	Average
Objectives	• Differentiate between *weather* and *climate*. • List types of data that can be collected to document climate change. • Represent data in graphical form. • Analyze and evaluate data. • Explain how change in duration of ice cover might affect lake ecology.
NH Science Framework Standards	• SPS1:11:1.1- Making observations and asking questions • SPS1:11:2.2- Designing scientific investigations • SPS1:11:4.1- Representing and understanding results of investigations
Time	Two hours, including teacher introduction and post activity discussion
Materials	• Excel file Mirror Lake Ice Data.xls • Student handout
Assessment	Student handout plus graph. Answer key included.

Note to teachers:

This exercise not only asks students to graph data in a scatter plot but also to analyze and evaluate the results. Part of the analysis has students use Excel to fit a trend line and calculate an R^2 value for the data. When data points are scattered over a graph, a trend line can be helpful in identifying whether any trend exists. An R^2 value tells how well the trend line describes the data. It is a descriptive value between 0 and 1; the closer an R^2 value is to 1, the better the trend line fits the data points. Please note that R^2 does not denote whether a relationship is *significant*. Significance is a statistical term that goes beyond the scope of this lesson.

To learn more about trend lines and R^2 values, we recommend the following resource:
http://www.ncsu.edu/labwrite/res/gh/gh-linegraph.html

Many thanks to teacher Sarah Thorne, who developed this lesson for her Prospect Mountain High School Ecology class.



Climate Change-- A Hot Topic!

Suppose you were charged with determining whether or not our climate is changing, right here in New Hampshire. How would you do it? Do this exercise with your group.

1. First of all, what are we talking about? What is climate? Use your textbook to help you define it.

2. How is climate different from weather? Give an example.

3. Make a list of what might change about the climate and what measurements would you take to document this change. Think of at least five physical characteristics **that you could measure** to better understand climate and change over time here in NH.

1.

2.

3.

4.

5.

Finish this assignment in the Computer Lab.

4. With your partner, open up Mirror Lake Ice Data.xls. On the spreadsheet you will find data from the Hubbard Brook Experimental Forest in Woodstock, New Hampshire. Mirror Lake is a 15 hectare lake next to this forest and is one of the most studied lakes in the world. The data shows the days of ice cover for Mirror Lake. The date of ice in is recorded as the date when more than 50% of the lake surface is covered with ice and remains covered. Ice out is the reverse.

- What was the maximum number of days of ice cover, and what year was it?

- What was the minimum number of days of ice cover and what year was it?

- Do you see any trends?

5. Using Excel, plot this data as a line graph with year on the x-axis and days of ice cover on the Y-axis.

- What do you observe about the results? Can you see any patterns that you couldn't see before?

- Do you think these patterns are more than random chance? Why or why not?

6. Using Excel, fit a trend line to your data points and calculate the R^2 value. To add the trendline, right click on a data point and choose *Add Trendline*. In the Trendline box, select *Linear* and Excel will fit a line to the data points. We can find out how well this line describes the data by asking the computer to calculate the R^2 value for the line. The highest an R^2 value can be is 1; and the higher the R^2 value, the closer the data points fall to the line. To do this, again right click on a data point, choose *Add Trendline,* and at the bottom of the Trendline box, click in the box next to *Display R-squared value on chart*.

- Now what do you observe? How can you interpret the data better than you could before? What is your R^2 value?

7 a. What do you think might change the number of days of ice cover from year to year?

b. What data would you want to gather to test your hypothesis? Over what time period?

8. Given what you have learned about lake ecology, how might the days of ice cover affect the lake? Write a paragraph with your group.

9. Print out and attach your graph.

The data used in this activity was provided by Dr. Gene E. Likens through funding from the National Science Foundation and the A.W. Mellon Foundation. We also wish to acknowledge Donald C. Buso for field assistance.

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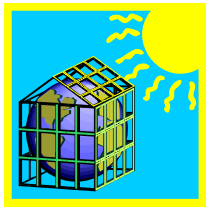


Climate Change-- A Hot Topic!

Suppose you were charged with determining whether or not our climate is changing, right here in New Hampshire. How would you do it? Do this exercise with your group.

1. First of all, what are we talking about? What is climate? Use your textbook to help you define it.
Answers will vary.

2. How is climate different from weather? Give an example.
Weather is variable- it changes from day to day, and season to season. Weather includes measurements like temperature, barometric pressure, humidity, precipitation, and wind. These measurements can also help describe an area's climate, but climate is a more long-term description, more of an average of the weather in an area over a period of time.

3. Make a list of what might change about the climate and what measurements would you take to document this change. Think of at least five physical characteristics **that you could measure** to better understand climate and change over time here in NH.
Answers will vary. Some possibilities:

1. *Temperature (can be measured with a thermometer)*
2. *Rainfall- amount (can be measured with a rain gauge)*
3. *Rainfall- patterns (can be measured by keeping track of timing of precipitation events)*
4. *Snowfall (can be measured in various ways)*
5. *Ice on lakes and ponds (date of ice on, date of ice going out)*
6. *Humidity (can be measured with psychrometer)*
7. *Extreme events, such as tornados*
8. *Phenological characteristics: timing of different life cycle events of plants and animals (i.e., when trees leaf out, when migrating birds return in spring).*

Finish this assignment in the Computer Lab.

4. With your partner, open up Mirror Lake Ice Data.xls. On the spreadsheet you will find data from the Hubbard Brook Experimental Forest in Woodstock, New Hampshire. Mirror Lake is a 15 hectare lake next to this forest and is one of the most studied lakes in the world. The data shows the days of ice cover for Mirror Lake. The date of ice in is

recorded as the date when more than 50% of the lake surface is covered with ice and remains covered. Ice out is the reverse.

- What was the maximum number of days of ice cover, and what year was it?
  149 days, in 1968
- What was the minimum number of days of ice cover and what year was it?
  108 days, in 1999
- Do you see any trends?
  It seems hard to see any trends, though the first data point (1968) is the year with the longest duration of ice cover. Students may notice this and say that it has decreased ever since then.

5. Using Excel, plot this data as a line graph with year on the x-axis and days of ice cover on the Y-axis.

- What do you observe about the results? Can you see any patterns that you couldn't see before?

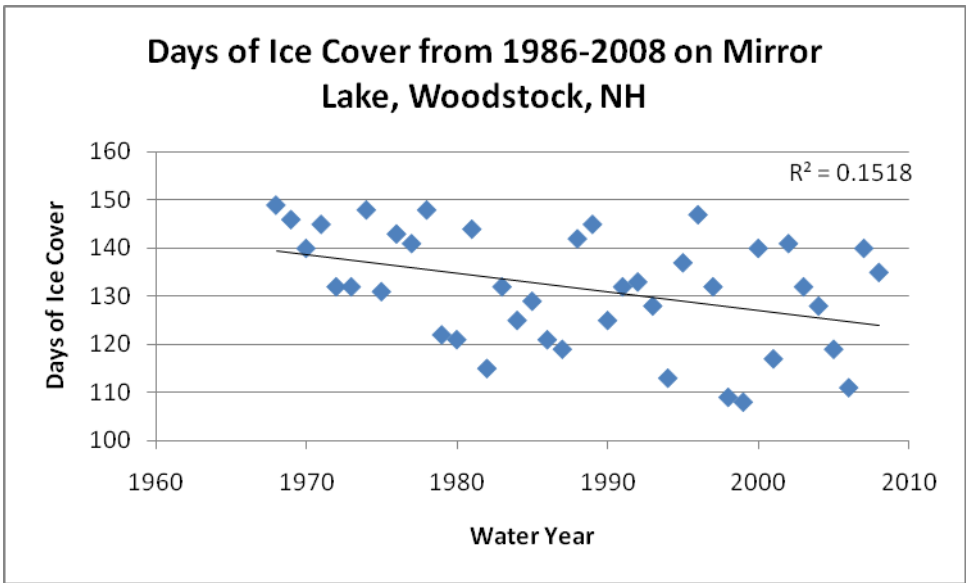
There is much variation. Depending on the scale of the Y-axis, students may or may not be able to see that it seems like the number of days of ice cover is decreasing over time. It is easier to look at this data graphically than in just 'raw' (numerical) form.

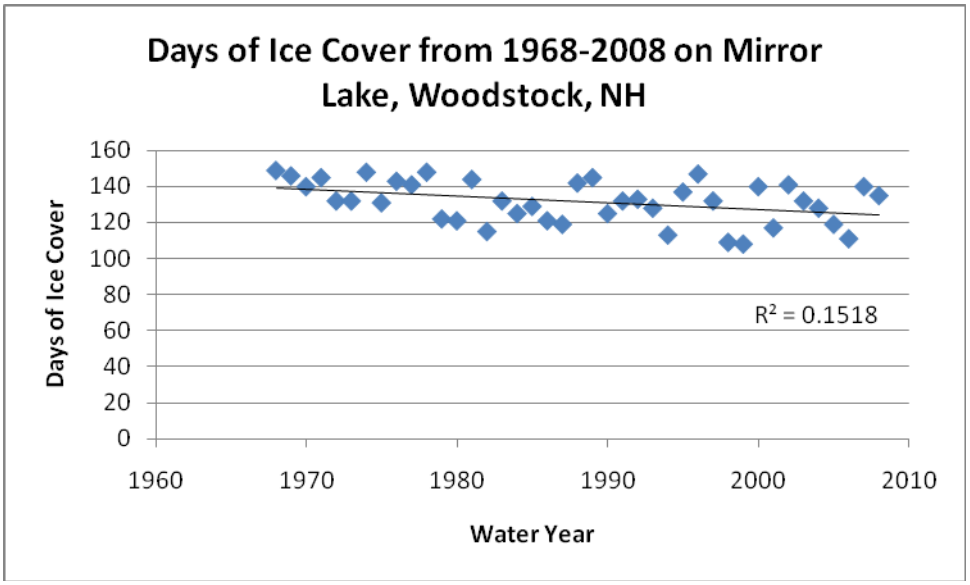
- Do you think these patterns are more than random chance? Why or why not?

Answers will vary.

6. Using Excel, fit a trend line to your data points and calculate the R^2 value. To add the trendline, right click on a data point and choose *Add Trendline*. In the Trendline box, select *Linear* and Excel will fit a line to the data points. We can find out how well this line describes the data by asking the computer to calculate the R^2 value for the line. The highest an R^2 value can be is 1; and the higher the R^2 value, the closer the data points fall to the line. To do this, again right click on a data point, choose *Add Trendline,* and at the bottom of the Trendline box, click in the box next to *Display R-squared value on chart*.

The following two versions of the graph show the same data, but the scale for the Y-axis is different. The Y-axis for the first graph ranges from 100 to 160 days of ice cover, while the Y-axis range for the second graph ranges from 0 to 160 days of ice cover. The wider range used in graph #2 might make it easier to see a trend before the trend line is added.





- Now what do you observe? How can you interpret the data better than you could before? What is your R^2 value?

Adding the trend line makes it easier to see that there is a decreasing trend in duration of ice cover. However, the R^2 value is relatively low. This indicates that there is a lot of

variation- that the line does not describe all the data well. Note: low R^2 values are common for long-term ecological data, in contrast to laboratory controlled experiments. Also note: the R^2 value does not indicate whether this data is significant (statistically speaking, data is significant if it is unlikely to have occurred by random chance). Other statistical functions, outside the scope of this lesson, are required to determine significance.

7 a. What do you think might change the number of days of ice cover from year to year?
Answers will vary.

b. What data would you want to gather to test your hypothesis? Over what time period?
Answers will vary, but students' suggestions for types of data to gather should be data that are measurable. Data collected over a longer time period will be more useful than data collected over a shorter time period.

8. Given what you have learned about lake ecology, how might the days of ice cover affect the lake? Write a paragraph with your group.
Students should have sufficient background information before this lesson to be aware of parameters, such as temperature and dissolved oxygen, which affect the biota of lakes. Ice cover affects a lake's ecosystem because it provides a barrier between the atmosphere and the lake. A lake without ice cover provides a less stable environment for organisms to overwinter in, as it is more susceptible to winds, which churn the water and affect temperature and dissolved oxygen.

Whitefish egg mortality in the bays in the Great Lakes has been studied to be greater during winters that lacked full ice cover, as the ice protects the eggs from wind and waves. If the teacher provides students with this background knowledge before the lesson, students should be able to make inferences as to how this might affect the food web of a lake.

9. Print out and attach your graph.

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