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# K-12 Partnership Lesson Plan

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# *Comparison of Historical Lake Ice Cover Data*

# *from Three Lakes in Michigan and Wisconsin*

## Overview

What evidence do scientists really have to support global climate change? Students will explore long term datasets on the duration of ice cover for three different lakes (Gull Lake, Fair Lake, and Lake Mendota). They will examine patterns of variation at different time scales to see the importance of long-term data as well as the importance of having multiple sources of support for scientific hypotheses (in this case, global climate change). (Made as an extension of the TIEE activity: <http://www.esa.org/tiee/vol/v3/issues/data_sets/lake_ice/abstract.html>)

**Objectives**

At the conclusion of the lesson, students will be able to:

* Interpret data
* Make interferences from trends or patterns in data
* Make spatial and temporal comparisons of ecological systems
* Explain how lake ice cover has changed due to global climate change on three lakes

**Length of Lesson**

1-2 days

**Grade Levels**

6-12

**Standards covered (NGSS)**

Disciplinary Core Ideas:

* **MS-ESS3-5**: ask questions to clarify evidence of factors that have caused the rise in global temperatures over the past century
* **MS-ESS3-4**: construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems

Cross Cutting Concepts:

* Patterns
* Scale, proportion, and quantity
* Stability and change of systems

Science and Engineering Practices

* Analyzing and interpreting data
* Using mathematics and computational thinking
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **E1.1D:** identify patterns in data and relate them to theoretical models
* **E1.1E:** describe a reason for given conclusion using evidence from an investigation
* **E1.1g:**  based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation
* **E1.1i:** distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate
* **E5.4A:** explain the natural mechanism of the greenhouse effect, including comparisons of major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone)
* **B1.1B:** evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions
* **B1.1E**: describe a reason for a given conclusion using evidence from an investigation
* **B1.2C**: develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
* **L3.p4A**: recognize that, and describe how, human beings are part of Earth’s ecosystems. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems.

**Materials**

* Handouts
* Student data file with KBS and LTER datasets (available on the “Comparison of Historical Lake Ice Cover” lesson page on the KBS GK-12 website)
* Access to computers with Microsoft Excel

**Background**

### *Strategy:* *inquiry cycles*: finding and explaining patterns in data (arguments from evidence); *inductive or field inquiry*: techniques-observations-patterns-explanations (TOPE)

### *Observations, patterns, and explanations*

|  |  |  |
| --- | --- | --- |
| Observations or experiences (examples, phenomena, data) | Patterns (laws, generalizations, graphs, tables, categories) | Explanations (models, theories) |
| Data = duration of ice cover on lakes | Graphs of ice duration over time | Global climate change |
| Application: Model-based Reasoning | | |
| Inquiry: Finding and Explaining Patterns in Experience | | |

### Activities of the session

1. Oral introduction to global warming and LTER data (see introductory powerpoint and “Introduction” written by Bohanan in the student handout)
2. Walk students through the data file (e.g., project the Excel file on a projector and explain each column to the students)
3. Break students into groups of 3-5 students. Assign students to one of the four datasets--Gull Lake (1924-2005), Fair Lake (1955-2004), earlier years of Lake Mendota (1885-1925), and later years (1926-1998) of Lake Mendota.
4. (optional) Have students discuss the three types of data (freeze day, thaw day, ice duration) from the data sets and brainstorm what evidence each of these may provide related to global change. Also, make sure they understand the spreadsheet.
5. Discuss these measures as a class, and suggest that everyone use ice duration data for their graphs.
6. Discuss (perhaps in their groups for two minutes and then as a class) what they expect their graphs to look like if their hypothesis (global climate change) is true--have students draw graphs on the board! Make sure they both understand what goes on the axes and think about predicting trends they expect to see.
7. Excel tutorial (if needed, do a graph as a class--could also assign a web tutorial as homework beforehand)
8. Students work with Excel to create three graphs: full ~80 years of ice duration over time for their lake, the same graph for just the first ~40 years of their data, and the same graph for just the last ~40 years of their data. Insert trendlines to see linear regression. (We recommend 1-2 students per computer if possible, and encourage them to split tasks so everyone gets practice.)
9. Students interpret graphs in their groups and evaluate support for their hypothesis.
10. If multiple groups in the class graphed one dataset (e.g., two groups graphed Gull Lake data), have them talk together and reach a consensus about the trends they see in their graphs.
11. Have each group present their results to the class and discuss similarities/differences in the four datasets.
12. Discuss support for hypothesis and value of long-term data.

**Resources**

* The original activity has many books and links to websites to check out for more info about global warming, limnology, LTER, etc. Check out the website: <http://www.esa.org/tiee/vol/v3/issues/data_sets/lake_ice/abstract.html>
* Also, their Excel tutorials (which could be assigned to students in advance of the class):
  + <http://www.usd.edu/ctl/self-paced-tutorials/microsoft-office-excel-2013>
  + <http://homepage.cs.uri.edu/tutorials/csc101/pc/excel97/excel.html>
  + <http://www.fgcu.edu/support/office2000/excel/>
  + <http://www.baycongroup.com/el0.htm>
* An addition Excel resource:
  + http://www.internet4classrooms.com/excel\_create\_chart.htm

**Extensions and Modifications**

* For younger students, can remove the ice on and ice off dates from the data file so that they have fewer columns to get confused (see alternative version of data file)
* Providing a check-list for students who have trouble staying on task
* There is an [Extra Data Set](http://www.tiee.ecoed.net/vol/v3/issues/data_sets/lake_ice/data/lake_ice%5bExtra_Data%5d.xls) in the Excel file that has data for two more lakes in Wisconsin along with Lake Mendota. This data set lets students to try to make sense of incomplete data, and students identify how differences in the physical characteristics of the three lakes might affect trends in ice cover.

**Assessment**

1. Ask students to answer questions or write a paragraph interpreting the trend or patterns that they see in their three graphs, and support for the global climate change hypothesis.
2. Ask students to answer questions or write a [minute paper](http://www.tiee.ecoed.net/teach/teach_glossary.html#minute) on the limitations of interpreting short-term versus longer-term trends in data.
3. Submit graphs created.
4. Have students answer written questions about the exercise.
5. Ask the students to design an experiment to test a hypothesis that emerged from their analysis of the ice data.
6. Ask students to predict the trend in ice cover for a very different lake (describe the physical characteristics) and to discuss the reasoning for their predictions.
7. Ask students to predict the trends beyond 2001 (can get current data via LTER website).