



Great Lakes! Great Graphing!



Cristi Cryderman Smith
with contributions from
Rebekah Meyers

LESSON FIVE



Subject/Grade:

Grade 4, Math, and Social Studies

Duration:

1 -2 class periods

Materials needed:

Per class:

- CD Player (optional)
- "The Great Lakes Song" from *Lake Rhymes* CD by Lee Murdock
- Overhead projector
- Overhead transparency of Constructing and Analyzing a Bar Graph (graph paper)
- Map of Waterborne Commerce on Great Lakes <http://www.epa.gov/glnpo/atlas/index.html>
- Map of US and Canadian ports <http://www.lcaships.com/GL-Map.pdf>
- Map of the Great Lakes

Per student:

- Constructing and Analyzing a Bar Graph
- Constructing a Bar Graph Checklist
- Great Lakes Facts – data tables

cristic@eup.k12.mi.us

Lesson Overview

Students use data about the surface area, depth, shoreline, population, cargo shipments, and ice coverage of the Great Lakes to construct tables and bar graphs, and then analyze the data.

Learning Objectives

After this lesson, students will be able to

1. Use Great Lakes data presented in table format to construct a bar graph.
2. Analyze the data displayed in their bar graph to make comparisons.
3. Answer questions using data from the table and bar graphs.

STANDARDS



Michigan Grade Level Content Expectations (GLCEs) Addressed

Grade 4 Math

RD.RE.04.01

Construct tables and bar graphs from given data

D.RE.04.03

Solve problems using data presented in tables and bar graphs

Grade 4 Social Studies

4-G2.0.2

Compare human and physical characteristics of a region to which Michigan belongs (e.g. Great Lakes, Midwest) with those of another region in the United States.

Background

The Great Lakes are comprised of five lakes: Lake Huron, Lake Ontario, Lake Michigan, Lake Erie, and Lake Superior. In this order, the first letter of their names spells HOMES (an easy way to remember!). Together, the Great Lakes contain the largest supply of available surface freshwater on the Earth. They are bordered by eight states: Minnesota, Wisconsin, Illinois, Indiana, Michigan Ohio, Pennsylvania, and New York, and two countries (United States along their southern shore, and Canada along their northern shore which includes two provinces: Ontario and Quebec). Only Lake Michigan is entirely within the United States borders.

A 3,700-kilometer (2,400 mile) marine highway stretches from the Atlantic Ocean through the St. Lawrence River, and Lakes Ontario, Erie, Huron, Michigan, and Superior directly into the U.S.-Canadian commercial, industrial and agricultural heartland, home to some 100 million people, roughly one quarter of the Canada/U.S. combined population. Some of the port cities handling the largest volumes of cargo on the Great Lakes are: Duluth, Minnesota; Thunder Bay, Ontario; Chicago and Indiana Harbor, Illinois; Marquette and Detroit, Michigan; Toledo, Cleveland, and Ashtabula, Ohio; and Hamilton, Ontario.

The Welland Canal connects Lake Ontario and Lake Erie through a series of eight locks, allowing ships to avoid the 51 meter (325 foot) high Niagara Falls. Large ocean-going ships from across the Atlantic are now able to travel beyond Lake Ontario to the upper Great Lakes, transporting a variety of commodities (cargoes) including: iron ore; grain; limestone; semi-finished steel; and various chemicals. Some 41 ports serve as on/off ramps connecting to a vast network of roadways and rail lines. Water transportation provides greater fuel efficiency as ships use only 10-20% of the energy required by trucks. A ship can move a ton of freight up to 800 kms (500 miles) on 4 litres of fuel (1 gallon). A single laker can carry as much cargo as three 100-unit trains or 870 truckloads, guaranteeing highly competitive unit costs.



By incorporating factual data into the constructions of bar graphs it brings meaning to the work students do. It is important to remind the students that the data they are using is factual. Even if your class has not spent anytime learning about the Great Lakes, this lesson brings purpose and relevance to learning the skills needed to construct and analyze bar graphs.

Bar Graph Vocabulary

Bar graph: a bar graph uses thick lines or bars to represent values. The longer the bar, the larger the number/value that is being represented.

Data: information collected about people or things.

Table: An organized way to present numerical data so that its easy to read.

Scale: A series of numbers placed at fixed distances on a graph to label the graph.

Interval: the distance between two numbers on the scale of the graph.

X-axis: the horizontal line on a coordinate grid such as a bar graph.

Y-axis: the vertical line on a coordinate grid such as a bar graph.

Advance Preparation

Create an overhead transparency of the graph paper from *Constructing & Analyzing a Bar Graph* and *Great Lakes Facts*.

Make copies of student handouts:

Constructing and Analyzing a Bar Graph

Constructing a Bar Graph Checklist

Great Lakes Facts

Map of the Great Lakes

Procedure

Focus Questions

- *What are some characteristics of the Great Lakes that make them really “great”?*
- *How can we visually compare data about the Great Lakes?*

Activities

1. As students enter the room, have “The Great Lakes Song” playing in the background to peak their interest. At the conclusion of the song, ask the students to discuss what they may already know about the Great Lakes. Encourage students to not only talk about their location but some statistics or facts that compare and contrast the 5 Great Lakes. (Distribute *The Great Lakes Map* at this time to use as a discussion starter.)
2. Display a table of Great Lakes data, e.g. *Maximum Depths of the Great Lakes*. Remind students that tables are boxes that contain information. Ask students to refer to the table to tell you which Great Lake has the greatest depth? Which is shallowest? Explain that tables are an excellent way to record numerical data, but that there is another way to display data that allows the reader to quickly compare information. Remember the saying, “A picture is worth a thousand words?” Show students the bar graph titled Maximum Depths of the Great Lakes. Ask students which method of displaying data, table or bar graph, is easier for interpreting or comparing the data?



3. Distribute the student pages *Great Lakes Facts*, *Constructing and Analyzing a Bar Graph*, and *Constructing a Bar Graph Checklist*.
4. Look over the Great Lakes Facts student page and Great Lakes Shipping Facts student page. Discuss the variety of data presented (in table format).
5. As a class, select one of the data tables for the teacher to model the construction and analysis of a bar graph.
6. Use the overhead transparency and *Constructing a Bar Graph Checklist* to model the construction of a bar graph.
7. After the completion of the graph, as a class, discuss the *Analyzing Bar Graphs* questions.
8. Assign students the construction of one bar graph using one of the data tables from *Great Lakes Facts* or and *Great Lakes Shipping Facts*.
9. After students have completed the construction of their bar graph, group them with other students that used the same data table to discuss how they created their graphs and compare their responses to the *Analyzing Bar Graphs* questions. Teachers may want to allow time for students to adjust/adapt their own graphs and/ or answers after their group discussion, but before turning them in to be graded, as a means of self-monitoring.

Assessment of Student Learning

Grade students' bar graphs for accuracy of construction based upon the steps listed in the *Constructing a Bar Graph Checklist*. Written responses for *Analyzing Bar Graphs* should be evaluated based upon the completeness of the answer.

Extensions

Create a Graph – This site gives students the opportunity to make a bar graph the easy way! Students select a bar graph design, enter data and labels, then preview and print their computer-generated bar graph. <http://nces.ed.gov/nceskids/createagraph/default.aspx>

Use *Constructing and Analyzing Bar Graphs* and *Constructing a Bar Graph Checklist* can be used to create bar graphs with data from other sources.

Use the list of questions to stimulate student thinking about the Great Lakes.

References

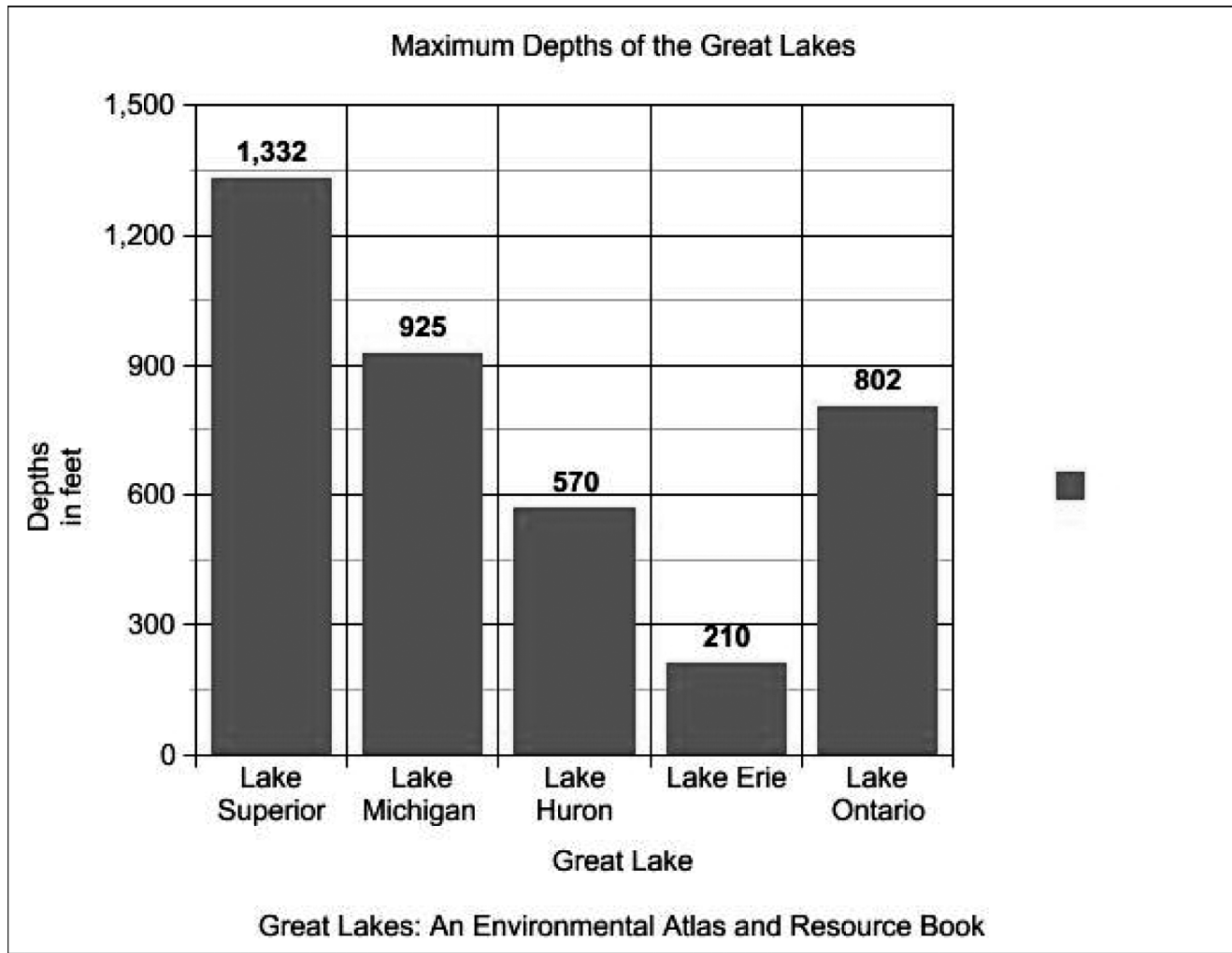
The Great Lakes: An Environmental Atlas and Resource Book. (1995). Retrieved October 26, 2007 from <http://www.epa.gov/glnpo/atlas/index.html>

Murdock, Lee and Joann. *Lake Rhymes Folk Songs of the Great Lakes Region songbook, study guide, and 18-song CD*. (2004). Depot Recordings Publications. Kaneshville, IL.



Sample Bar Graph

(from <http://nces.ed.gov/nceskids/createagraph/default.aspx>)



Constructing and Analyzing a Bar Graph

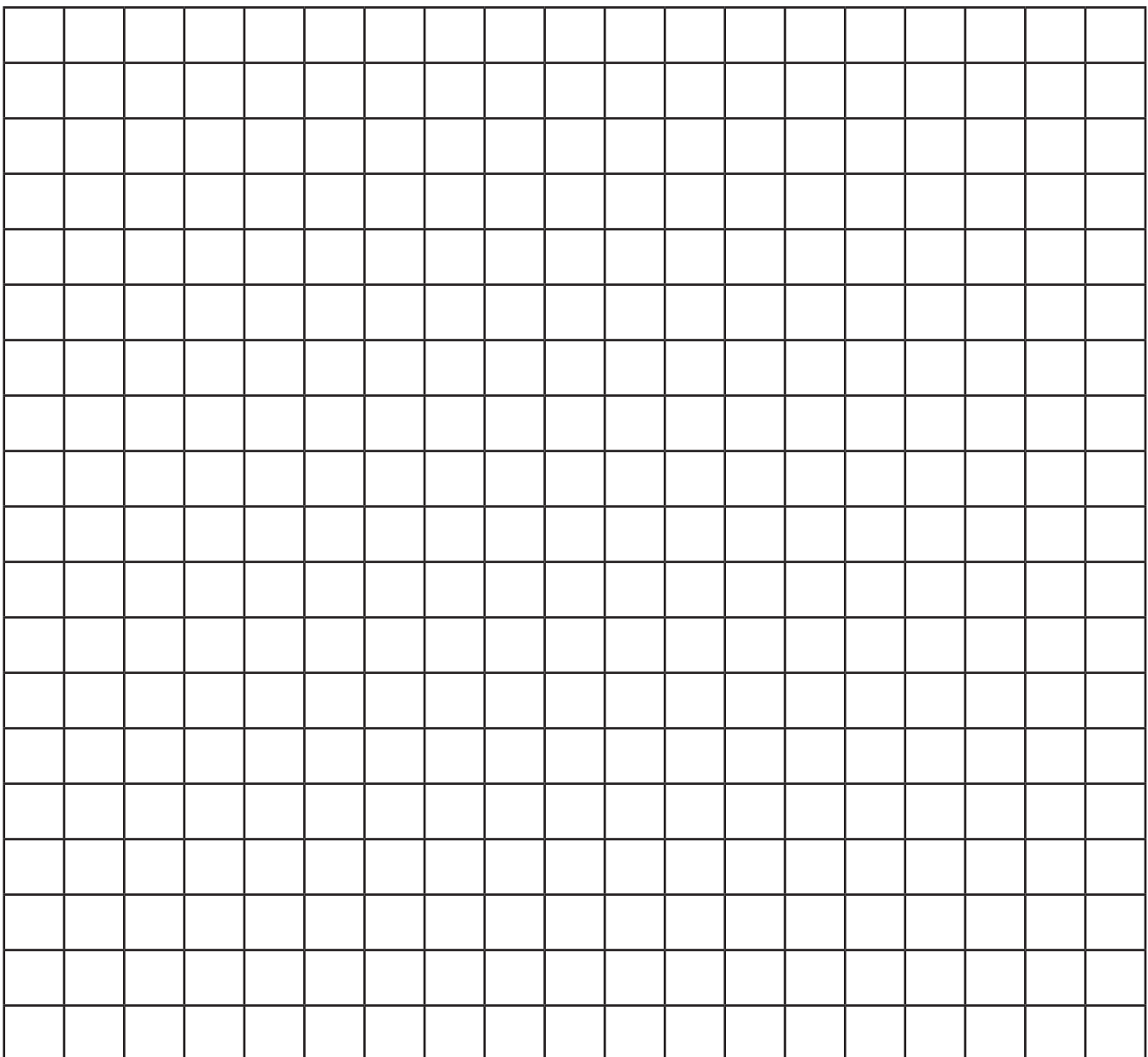


A bar graph uses thick lines or bars to represent values. The longer the bar, the larger the number/value that is being represented.

Select one set of data from the attached Great Lakes Facts sheet and use the Constructing a Bar Graph Checklist to make a bar graph in the box below.

When you are done, answer the questions on the Analyzing Bar Graphs page. on the next page.

Title: _____



Created by Cristi Cryderman Smith for Great Lakes! Great Graphing!





Analyzing Bar Graphs

1. The title of the bar graph tells us _____

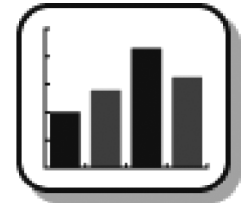
2. The Y-axis label is: _____ The X-axis label is: _____

3. The bar graph shows that _____

4. Who would be interested in using this information and why?



Constructing a Bar Graph Checklist



- _____ 1. Look at the data provided and decide on a title for your bar graph.
- _____ 2. Label your graph with your title.
- _____ 3. Draw the vertical and horizontal axis.
- _____ 4. Label the horizontal axis with an appropriate title.
- _____ 5. Label the vertical axis with an appropriate title.
- _____ 6. Decide on a scale and interval range for the horizontal axis. Label the horizontal axis with the appropriate scale and interval for the data being graphed.
- _____ 7. Label the vertical axis with your scale and interval.
- _____ 8. Label the horizontal axis with the appropriate labels for the bars being created.
- _____ 9. Draw a bar to represent the data shown for each item on the table.
- _____ 10. Analyze (compare) the data in the bar graph.



Great Lakes Facts



Table 1: Widths of the Great Lakes (Width measured at its greatest point.)	
Lake Superior	160 miles
Lake Michigan	118 miles
Lake Erie	57 miles
Lake Huron	183 miles
Lake Ontario	53 miles

Table 2: Population of the Great Lakes Watershed			
Great Lake	Population		Combined Total Population in the Watershed
	Watershed in United States (1990)	Watershed in Canada (1990)	
Huron	1,502,687	1,191,467	
Ontario	2,704,284	5,446,611	
Michigan	10,057,026	-----	
Erie	10,017,530	1,664,639	
Superior	425,548	181,573	
GRAND TOTAL			

**Students should complete the "Combined Totals for the United States and Canada" column*

Table 3: Maximum Depths of the Great Lakes	
Lake Superior	1,332 feet
Lake Michigan	925 feet
Lake Erie	210 feet
Lake Huron	570 feet
Lake Ontario	802 feet

Table 4: Lengths of the Great Lakes (Length measured at its greatest point.)	
Lake Superior	350 miles
Lake Michigan	307 miles
Lake Erie	241 miles
Lake Huron	206 miles
Lake Ontario	193 miles

Table 5: Water Surface Area of the Great Lakes	
Lake Superior	31,700 sq. miles
Lake Michigan	22,300 sq. miles
Lake Erie	9,910 sq. miles
Lake Huron	23,000 sq. miles
Lake Ontario	7,340 sq. miles



Great Lakes Facts, continued



Table 6: Shoreline Lengths of the Great Lakes

Lake Superior	2,726 miles
Lake Michigan	1,638 miles
Lake Erie	871 miles
Lake Huron	3,827 miles
Lake Ontario	712 miles

Table 7: Volume of the Great Lakes

Lake	Volume (cubic miles)
Huron	850 cubic miles
Ontario	393 cubic miles
Michigan	1,180 cubic miles
Erie	116 cubic miles
Superior	2,900 cubic miles

Table 8: Percentage (%) of Lake Covered by Ice at Maximum

Lake	Mild Winter	Normal Winter	Severe Winter
Huron	40	60	80
Ontario	8	15	25
Michigan	10	40	80
Erie	50	95	100
Superior	40	60	95



Great Lakes Shipping Facts

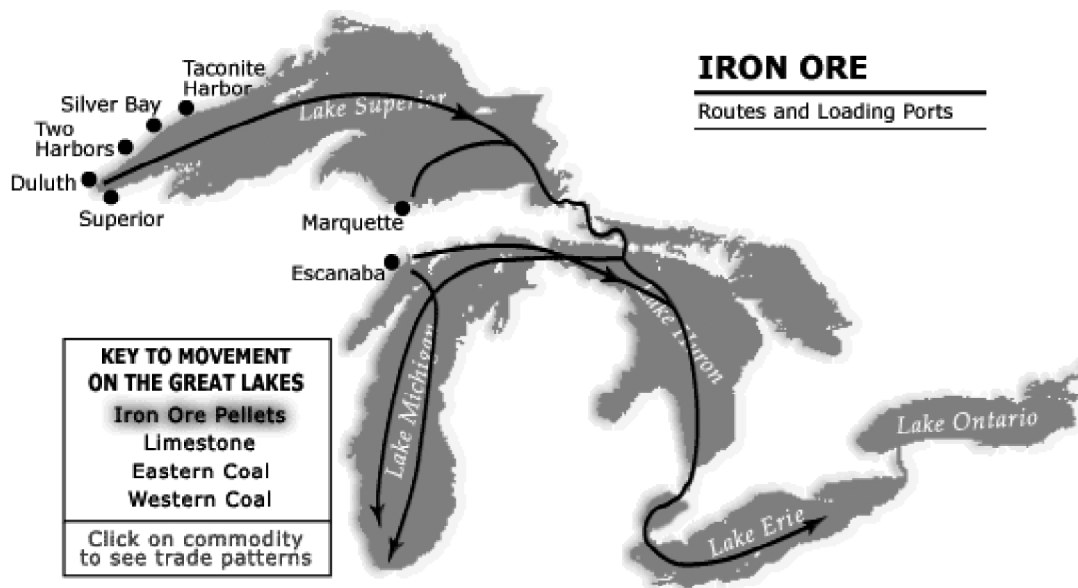


Table 9. Cargo Shipped on the Great Lakes: 2002-2005

(by volume)
(Source: Lake Carriers Association www.lcaships.com)

Cargo	Average (Net Tons ^a)
Iron Ore	58,146,828
Coal	41,739,083
Limestone	37,514,466
Grain	12,155,137
Salt	8,392,088

^aIn United States: Ton = 2000 pounds

Table 10. U.S. Flag Lakers^b in Service on the Great Lakes from 1999-2006

(Source: Lake Carriers Association www.lcaships.com)

2006	69
2005	70
2003	73
2002	54
2001	54
2000	63
1999	64

^b U.S.-Flag Laker is a vessel that operates exclusively on the Great Lakes and is U.S.-owned, -built and -crewed.

Table 11. Transportation Mode & Amount of Cargo Transported

Source: U.S. Army Corps of Engineering-Detroit District Soo Locks Brochure

Transportation Mode	Amount of Cargo Transported (tons)
1000-foot ship	60,000 tons cargo
100-car Train ^c	10,000 tons cargo
Semi-truck & trailer	26 tons ^d

^c100 tons of cargo carried per train car

^d26 tons carried per large truck



Great Lakes Shipping Facts, continued



Table 12. Air Emissions Compared by Transportation Mode

1000-footer Laker	
Train Cars	4321 tons
Trucks	14,250 tons

(Source: Lake Carriers Association www.lcaships.com)

Table 13. Fuel Consumption by Freight Transportation Mode (1991)
(per 1000 BTU of energy per Ton Freight Carried per Mile)

Marine (ship)	411
Rail (trains)	371
Truck	4,359
Air (planes)	31,809

Source: Battles, Stephanie. (1999). Energy Efficiency Report Chapter 5: Transportation Sector.
http://www.eia.doe.gov/emeu/efficiency/eefig_ch5.htm Data Sources: U.S. Department of Energy, Oak Ridge National Laboratory (ORNL), *Transportation Energy Data Book*, Editions 11 and 14, Table 2.6 and unpublished 1985 data from ORNL.



Great Lakes...Great Numbers!

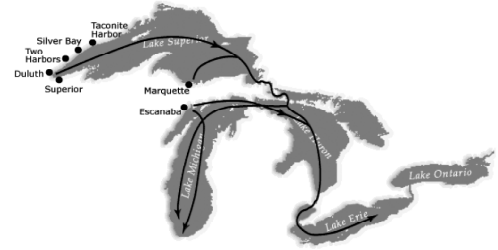


Table 1: Widths of the Great Lakes

1. Which Great Lake has the greatest width? _____

Table 2: Population of the Great Lakes Watershed

The population of the entire Great Lakes watershed (land area around the Great Lakes) is measured by counting the number of people living in each Great Lake’s watershed (land area around each Great Lake) on both the Canadian and United States side of each lake.

Population of the Great Lakes Watershed			
Great Lake	Population		Combined Total Population in the Watershed
	Watershed in United States (1990)	Watershed in Canada (1990)	
Huron	1,502,687	1,191,467	
Ontario	2,704,284	5,446,611	
Michigan	10,057,026	-----	
Erie	10,017,530	1,664,639	
Superior	425,548	181,573	
GRAND TOTAL			

2. Complete the “Combined Totals for the United States and Canada” and the Grand Totals on the table.

3. Why isn’t a Canadian population listed for Lake Michigan? (Hint: refer to the map of the Great Lakes system to help you answer the question.)

4. Name the 2 lakes that have the greatest US population and refer to your map to explain why their population is largest.



-
5. Name the lake with the least U.S. and Canadian population. _____
Why is its population so small? (Hint: refer to your map to explain.)

Table 3: Maximum Depths of the Great Lakes

6. Which is the deepest Great Lake? _____ Explain why this lake is the coldest? (Hint: consider depth and location.) _____
7. Which lake is the shallowest of the Great Lakes? _____
Explain why this lake is also the warmest? _____

Table 4: Lengths of the Great Lakes

8. Which lake has the longest length? _____ miles
9. Which lake is the shortest? _____ miles
10. What is the combined length of all of the Great Lakes? _____ miles

Table 5: Water Surface Area of the Great Lakes

11. What is the total water surface area of all 5 of the Great Lakes? _____
(Note: This is larger than the states of New York, New Jersey, Connecticut, Rhode Island, Massachusetts, Vermont, and New Hampshire COMBINED!)
12. If you removed the water surface area of Lake Superior from the total of the five Great Lakes, what is the new water surface area of the remaining four Great Lakes?

13. Which two of the lakes are “twins” on the map and are almost the same in water surface area? _____

Table 6: Shoreline Lengths of the Great Lakes

14. Lake Huron has approximately 30,000 islands. How do the islands affect the length of its shoreline? _____
15. Which Great Lake lies entirely within the boundaries of the U.S.? _____

Tables 1-7 contain facts from <http://www.epa.gov/glnpo/atlas/gl-fact1.html>



Table 7: Volume of the Great Lakes

16. Which lake holds slightly more than 3 times the water in Lake Erie? _____
17. Which lake is 3rd largest by volume? (Note: this lake is the 6th largest lake in the world!) _____
18. Which lake has a volume so large it could contain all the other 4 Great Lakes and still have room left over? _____

Table 8: Percentage (%) of Lake Covered by Ice at Maximum

19. Which lake has the highest percentage of ice coverage during mild, normal, or severe winters? _____ (Hint: refer to your depth table to explain why this lake has the greatest ice coverage.)

Refer to Great Lakes Shipping Facts to answer these questions:

Table 9. Cargoes Shipped on the Great Lakes

20. What cargo is the largest shipped (by volume)? _____
21. How many net tons of limestone are shipped? _____

Table 10. U.S. Flag Lakers in Service on the Great Lakes (1999-2006)

22. Which year saw the most U.S. Flag Lakers in service? _____

Table 11. Transportation Mode & Amount of Cargo Transported

23. How many ships, trains, and trucks are needed to transport 180,000 tons of cargo, if they each carry the same number of tons?
- _____ Ships _____ Train cars _____ Trucks

Table 12. Air Emissions Compared by Transportation Mode

24. Which transportation mode has the highest air emissions? _____
- Lowest? _____

Table 13. Energy Consumption by Freight Transportation Mode

(1000 BTU of energy per ton freight carried per mile)

25. Which two modes of transportation use the least amount of energy per ton of freight carried? _____ and _____
26. Which mode of transportation is the most energy intensive? _____

Prepared by Joan Chadde jchadde@mtu.edu and Rebekah Meyers bmeyers@eup.k12.mi.us



Answer Key

1. Lake Huron (183 miles)
2. Combined population totals for each watershed:
Huron-2,694,154; Ontario-8,150,895; Michigan-10,057,026; Erie-11,682,169; Superior-607,121;
Grand totals: United States-24,707,075 and Canada-8,484,290;
Combined total population in the Great Lakes watershed-33,191,365
3. Lake Michigan does not have a border with Canada. It is entirely within the U.S.
4. Lakes Michigan and Erie. They have large cities located on each lake.
5. Lake Superior. There are only a few cities in the Lake Superior watershed.
6. Lake Superior. The deeper the body of water, the colder it is because sunlight does not reach very deep, and Lake Superior is furthest north of the Great Lakes and has a colder climate.
7. Lake Erie. It is the shallowest.
8. Lake Superior
9. Lake Ontario
10. 1,297 miles
11. 94,250 square miles
12. 62,550 square miles
13. Lakes Huron and Michigan.
14. They add to the length and make it the lake with the most shoreline.
15. Lake Michigan
16. Lake Ontario
17. Lake Huron
18. Lake Superior
19. Lake Erie has a small surface area and it is very shallow.
20. Iron ore
21. 37,514,466
22. 2005
23. one Ship; 600 Train cars; 2308 Trucks
24. Trucks; ships
25. Ships and trains
26. Airplanes



Map of the Great Lakes



Map image from Great Lakes Home Page for Kids
http://www.grc.nasa.gov/WWW/K-12/Summer_Training/LincolnParkES/START_PROJECT.html



