

# POLAR PROBLEMS

Through mathematical investigations in the classroom, students make connections between melting Arctic ice and the difficulties that polar bears face in their habitat.

**Grade Level**  
6-12

**Theme:**  
Biodiversity  
Ecosystems  
Conservation

**Curriculum Connections:**  
S, M, T

**Materials:**

- \* Polar Bear Models (can be made by students using Crayola Magic)
- \* 60" x 90" Vinyl Table Cloth - Blue
- \* 12" Standard Ruler - 1 per group
- \* Foam Core Board - 90" x 30" or 2700 square inches
- \* Fine black permanent marker
- \* Paper and pencil
- \* 1" Grid Paper on transparencies

Did you know that math, polar bears and the Arctic all have something in common?  
**PROBLEMS!**

Through mathematical concepts, learn about the difficulties that polar bears face as their arctic habitat warms. Apply measurement, data analysis and graphing skills to get a snapshot of the "hot water" these cool critters are getting into.

**Background**

The Arctic Ocean is the smallest of the world's five ocean basins, with an approximate area of 5.4 million square miles, or 1.5 times the area of the United States of America. In winter, the ocean freezes, and the ice stretches from Canada to Russia. In summer, when the temperatures rise above freezing, it melts around the southern edges. Sea ice is basically frozen sea water floating on top of the Arctic Ocean.

Scientists started collecting data on the extent of sea ice in 1978, using satellites. The extent of sea ice in the Arctic Ocean is measured twice each year: in September, to measure the low at the end of the melting season; and in March, to measure how well it recovered during winter growth. Overall, the data collected has shown a decline in the coverage of sea ice in the Arctic Ocean at an estimated rate of 9% per decade. Summer ice is 21% less than it was in 1978. Many scientists predict that if the decline continues at the same rate, we could have an ice free Arctic Ocean by the year 2030.

Why is sea ice so important?

Polar bears rely on sea ice as a platform for catching seals and a method of transportation - a highway when it is solid or a raft when it breaks and floats. Although polar bears are very strong swimmers, they are adapted for swimming close to shore. They can swim distances of 40 - 60 miles at a time, but the more energy they use to swim, the less they have to hunt for their food.

As the ice floes continue to melt and drift farther apart, polar bears will be forced to swim greater distances, leaving them vulnerable to exhaustion, hypothermia, and possibly drowning.



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## Lesson Procedure...

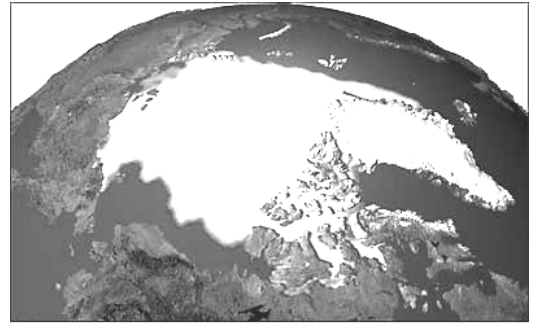
1. What do we know about the Arctic Ocean?  
Using Google Earth, locate the Arctic Ocean and discuss its features, including location, size, comparison and composition weather. Discuss current events that students are aware of that relate to the Arctic Ocean.
2. Explain to students that scientists have been observing the Arctic Ocean from satellites since 1978 and collecting data to learn about the Arctic and changes that are occurring there. Share visuals.
3. Provide students with Arctic Sea Ice Coverage handouts and instruct them to create a graph to organize this data. Discuss with students some of the different ways to graph information and which method would be best for the data they are working with. You may select to have all students create the same kind/s of graph or different groups to create different graphs.
4. Students work in groups to organize the data into the assigned type of graph. Once graphs are completed, discuss the trends that students can see from the data. What is happening to the ice coverage in the Arctic? What do you think we would see if this graph showed the next 10 years?
5. As a class, use the information from the data in the graph to predict the future trends of decrease of sea ice. Scientists predict that if current trends continue, sea ice in the Arctic will have completely disappeared by 2030, just 22 years from now. Continue the graph to find out how long sea ice will last, if loss continues at the same rate. To follow up this activity, students can calculate answers to questions about the data in the graph.
6. A Shrinking Habitat: What Melting Ice Means for Polar Bears (Measurement Activity).  
Students set up a model of the Arctic Ocean and use measurement to calculate the ratio of survival for polar bears in the Arctic. See activity write up.
7. As a closing activity for this lesson, use the following discussion question, "Is it okay for polar bears to become extinct?"  
Discuss the problems of the Arctic and discuss the cause and effect of different issues. What are some ways to solve these problems?



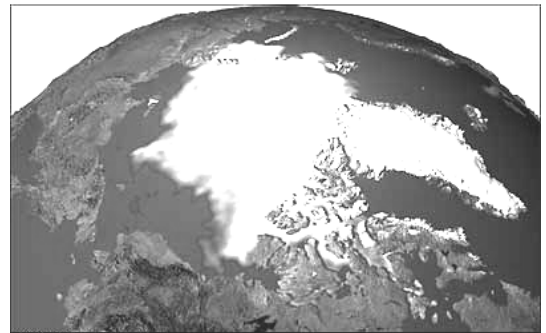
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## ARCTIC OCEAN SEA ICE: Summer Coverage - Yearly Minimum

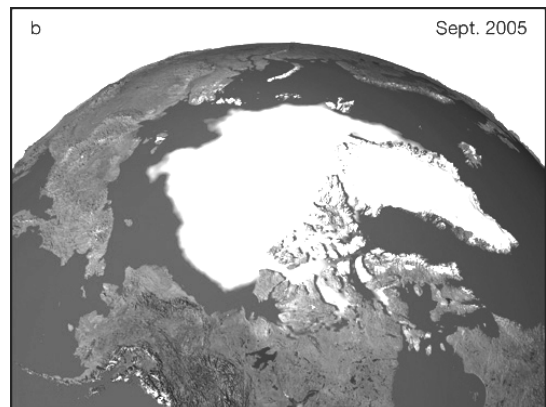
YEAR	Sea Ice Extent (approximate million square miles)
1979	2.74
1980	3.05
1981	2.78
1982	2.86
1983	2.90
1984	2.78
1985	2.66
1986	2.90
1987	2.74
1988	2.86
1989	2.70
1990	2.39
1991	2.55
1992	2.90
1993	2.51
1994	2.78
1995	2.36
1996	3.05
1997	2.63
1998	2.55
1999	2.39
2000	2.43
2001	2.63
2002	2.28
2003	2.39
2004	2.36
2005	2.05
2006	2.20
2007	1.60
2008	1.81
2009	1.97



1979 SSM/I Composite Data



2003 SSM/I Composite Data



# POLAR PROBLEMS

## A Shrinking Habitat: What Melting Ice Means for Polar Bears...

Materials: Polar Bear Models (can be made by students using Crayola Magic)  
60" x 90" Vinyl Table Cloth – Blue  
12" Standard Ruler – 1 per group  
Foam Core Board - 90" x 30" or 2700 square inches  
Fine black permanent marker  
Paper and pencil  
1" Grid Paper on transparencies

### Preparation:

1. Using a fine, black permanent marker, measure, draw and color a 1" square in the corner of the vinyl table cloth.
2. Next, cut the foam core into 30 to 40 pieces, some small and some large. The bigger pieces should form the center of the ice mass. Label each piece of foam core with a letter of the alphabet, using lower case and upper case letters to allow labeling of all pieces.
3. Make polar bear models, using photographs from magazines as a guide.

### Activity Procedure:

1. Lay the blue table cloth on the floor and explain to students that the table cloth represents the Arctic Ocean, which is approximately 5.4 million square miles in area. This table cloth measures 60" x 90". What is the area of the table cloth? What area of the Arctic Ocean is represented in one square inch which has been colored? Calculate the scale.
2. Next, bring out the foam core pieces. Tell students that this will represent the ice coverage in September of 1987, when there was approximately 2.7 million square miles of ice covering the Arctic Ocean. Divide students into groups and give each group a piece of the "ice" and a grid transparency. Tell them that they need to use the grid to calculate the approximate area of their piece of ice (some groups may need multiple transparencies to simplify calculations). Students should count squares as wholes or halves.
3. Once they have calculated the area of their ice, students need to calculate the percentage of the ice that they have. As a class, share the percentages that were calculated by students and adjust as needed, so that the percentages represent the entire area of ice. Students should write the percentage assigned to their piece of ice onto the foam. If you plan to reuse materials in this lesson, use a post-it note to label "ice" with percentages.
4. Lay the "ice" onto the top of the ocean, starting in the center with the larger pieces and building out. Each group should choose an ice floe onto which to place their polar bear onto. Explain that to ensure survival, polar bears need to travel across and swim between ice floes to hunt for their food. Polar bears are strong swimmers and can swim distances of 40 – 60 miles. However, the greater distances they travel between ice floes, the more energy they use, thus, limiting their hunting ability. Currents in the Arctic Ocean cause ice floes to move. Students should lightly blow to create currents and move some ice. Students will calculate the probability of polar bear survival based on the ice floe they selected.



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5. Students will work together in their groups to calculate the likelihood of their polar bear surviving if it had to swim to another ice floe. You can choose to have students calculate the probability of survival by measuring 4 directions (N, S, E, W) or 8 directions (N, NE, E, SE, S, SW, W, NW). Be sure to mark North on the table cloth, pointing to the center from all corners. Using a ruler, students will measure from the edge of the ice to the edge of a different ice floe, in each direction that you indicate. The scale for measurement in this part of the activity is 1 inch equals 30 miles. If a polar bear swims 60 miles or less, it is very likely it will survive. If a polar bear swims greater than 60 miles survival rate is greatly decreased. (Of course there are exceptions to every rule, but for this activity, a distance of 60 miles or less will represent survival.) Students will measure and record distances for each direction on the worksheet provided, and then calculate the probability of the polar bear's survival. Once all students have completed the first set of measuring, allow them to move to another ice floe and repeat the process. Students may repeat the process several times.
6. The class will discuss the results. In 1987, did polar bears have a good chance of survival when travelling on summer ice? What was the percentage of survival?
7. Students learned in the graphing activity that Arctic ice coverage is decreasing. From 1987 to 2007 it decreased by 40%, leaving approximately 1.6 million square miles of Arctic ice at the end of the summer melting season. Students should remove ice pieces from the ocean to represent 40% of the ice coverage.
8. Repeat step 4 & 5 of the activity for 2007 ice coverage and record results, using same table.
9. Discuss: With shrinking ice, is the polar bear's chance of survival maintained, increasing, or decreasing?



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## DATA SHEET: What Melting Ice Means for Polar Bears

Record the distance your polar bear swims to get from the beginning ice floe to the nearest ice in the given direction. Once you measure the distance in each direction, calculate the ratio of survival for the polar bear.

1987 – Arctic Ice Extent = 2.7 million square miles

Beginning Ice Floe	Travelling north, distance to closest ice	Travelling east, distance to closest ice	Travelling south, distance to closest ice	Travelling west, distance to closest ice	Ratio of Survival

2007 – Arctic Ice Extent = 1.6 million square miles

Beginning Ice Floe	Travelling north, distance to closest ice	Travelling east, distance to closest ice	Travelling south, distance to closest ice	Travelling west, distance to closest ice	Ratio of Survival