

## Details



**Completion Time:** Less than a week

**Permission:** Download, Share, and Remix

## Salty or Not: A Taste of the Bering Sea

### Overview

What happens to the salinity in the Bering Sea during ice and no ice conditions? Does it change throughout the year and at different depths during different seasons? Create a model of the Bering Sea in ice conditions. Change the conditions based on seasonal changes to explore the effects of runoff on salinity.

### Objectives

The students will understand:

- How is Arctic polar water like water in your school or home? How is it different?
- How does polar water interact with polar ice?
- How would changes in the amount of polar ice change polar water?
- How does runoff from streams and rivers alter the polar water?

### Lesson Preparation

1. Mix 200 grams of salt in 4 liters of water and pour into 3 containers. Freeze 2 containers for at least 24 hours until there is a 2-3 centimeter ice layer.
2. Prepare a 300 ml solution of 28-30 ppt salt water.
3. For each student, pour a small amount of fresh water in one cup and 28 ppt salt water in the other cup.

### Background information:

Sea ice includes frozen sea water, such as that in the Arctic Ocean and the oceans surrounding Antarctica, and frozen lake and river water, which occur mainly in the polar regions.

Sea ice is formed by the direct freezing of the water on which it floats. If the water is salty, as it is in the ocean and in seas, during the freezing process the salt is left in the water, making the water more salty and denser and the sea ice less salty. Lake and river ice is frozen from fresh water generally and is therefore, not salty.

## Materials

- Water
- Table Salt
- Hydrometer
- 4 Containers (clean) such as milk containers or cartons
- Samples of water from your community or sink
- Small cups or stirring straws for tasting
- Eyedroppers (clean)
- Venn diagram for each student
- Copies of salinity data by depth and season for each group



Sea ice floats on the surface of bodies of water and ranges from 0 to about 10 m thick with average thicknesses of 3 m in the Arctic and 1.5m around Antarctica. Under the stress of wind and ocean currents, sea ice cracks and moves around. The cracks expose areas of relatively warm ocean water to the cold atmosphere during winter that sets up a large exchange of energy from the ocean to the atmosphere. Sea ice has a large seasonal cycle and changes on time scales of a few weeks to a few months. However, the magnitude of the seasonal changes is very sensitive to changes in the climate conditions in the atmosphere and oceans, extending the time scales associated with sea ice from months to thousands of years (i.e. ice age time scales). Sea Ice Information from <http://earth.rice.edu/mtpe/cryo/cryosphere.html>

Salinity is a measure of the concentration of dissolved salts in water. Until recently, a common way to define salinity values has been parts per thousand (ppt), or kilograms of salt in 1,000 kilograms of water. Today, salinity is usually described in practical salinity units (psu), a more accurate but more complex definition. Nonetheless, values of salinity in ppt and psu are nearly equivalent. The average salinity of the ocean typically varies from 32 to 37 psu, but in polar regions, it may be less than 30 psu. Sodium chloride (table salt) is the most abundant of the many salts found in the ocean.

Fresh water freezes at 0 degrees Celsius (32 degrees Fahrenheit), but the freezing point of sea water varies. For every 5 ppt increase in salinity, the freezing point decreases by 0.28 degrees Celsius (0.5 degrees Fahrenheit); thus, in polar regions with an ocean salinity of 35 ppt, the water begins to freeze at -1.8 degrees Celsius (28.8 degrees Fahrenheit).

When frazil ice crystals form, salt accumulates into droplets called brine, which are typically expelled back into the ocean. This raises the salinity of the near-surface water. Some brine droplets become trapped in pockets between the ice crystals. These droplets are saline, whereas the ice around them is not. The brine remains in a liquid state because much cooler temperatures would be required for it to freeze. At this stage, the sea ice has a high salt content. Over time, the brine drains out, leaving air pockets, and the salinity of the sea ice decreases. Brine can move out of sea ice in different ways:

1. Aided by gravity, the brine migrates downward through holes and channels in the ice, eventually emptying back into the ocean.
2. The ice surrounding the brine compresses and breaks the brine pockets, allowing the brine to escape to the ocean.
3. When the sea ice begins to melt during the summer, small freshwater ponds (called melt ponds) form on the top layer of the ice. This freshwater travels through the cracks and holes in the ice, washing out remaining brine.
4. When the sea ice surface cools, brine increases in salinity to the point at which it can melt ice at its underside. This leads to a downward migration of brine droplets, ultimately allowing the brine to escape into the ocean below the ice sheet. <http://nsidc.org/seaice/characteris->



tics/brine\_salinity.html

Sea ice regulates exchanges of heat, moisture and salinity in the polar oceans. It insulates the relatively warm ocean water from the cold polar atmosphere except where cracks, or leads, in the ice allow exchange of heat and water vapor from ocean to atmosphere in winter. The number of leads determines where and how much heat and water are lost to the atmosphere, which may affect local cloud cover and precipitation.

The seasonal sea ice cycle affects both human activities and biological habitats. For example, companies shipping raw materials such as oil or coal out of the Arctic must work quickly during periods of low ice concentration, navigating their ships towards openings in the ice and away from treacherous multiyear ice that has accumulated over several years. Many arctic mammals, such as polar bears, seals, and walruses, depend on the sea ice for their habitat. These species hunt, feed, and breed on the ice. Studies of polar bear populations indicate that declining sea ice is likely to decrease polar bear numbers, perhaps substantially (Stirling, I. and C. L. Parkinson. 2006. Possible effects of climate warming on selected populations of polar bears (*Ursus maritimus*) in the Canadian Arctic. *Arctic* 59:261–275).

Ice thickness, its spatial extent, and the fraction of open water within the ice pack can vary rapidly and profoundly in response to weather and climate. Sea ice typically covers about 14 to 16 million square kilometers in late winter in the Arctic and 17 to 20 million square kilometers in the Antarctic Southern Ocean. On average, the seasonal decrease is much larger in the Antarctic, with only about three to four million square kilometers remaining at summer's end, compared to approximately seven million square kilometers in the Arctic. Over the past several years, Arctic minima have been only four to six million square kilometers. These maps provide examples of late winter and late summer ice cover in the two hemispheres. [http://nsidc.org/sotc/sea\\_ice.html](http://nsidc.org/sotc/sea_ice.html)

## Procedure

Engage:

1. Each student will receive 2 unlabeled cups. Pour a small amount of fresh water in one cup and 28 ppt salt water in the other cup.
2. Students describe the contents of their cups using physical properties (color, texture, smell...) Use a Venn diagram to record observations.
3. Students taste the contents of each cup to complete their observations.
4. Read the poem below, taken from the following website: [http://essea.strategies.org/module.php?module\\_id=104](http://essea.strategies.org/module.php?module_id=104)

### *Earth's Polar Places*

The Arctic and Antarctic are cold, polar places.  
With air, land, living things and water, too.  
On a globe, two circles outline their spaces.

Antarctica is a continent. The Arctic, it is not.  
North and South poles are magnetic.  
On a globe each pole is just a dot.

Earth's poles have polar ice caps.  
No, not some kind of polar hats.  
If you look you can see them on polar maps.

Now take your time.  
And read this rhyme.  
About Earth's polar water.

### *Polar Water*

Polar water moves around.  
In the sea, air and on the ground.  
Fluffy clouds up in the sky.  
How did water get up so high?

Polar water changes states.  
It freezes, melts and evaporates.  
From solid to liquid to gas and back.  
This cycle has a name. Is it Jack?

Arctic rivers freeze or run.  
Polar bears on ice packs sun.  
Polar oceans, ice and snow.  
Is drifting ice a berg or floe?

On polar land, the water's fresh.  
The seas are salty, what fish like best.  
The Arctic sun warms the frozen ground.  
But does permafrost stay around?

Down in the Antarctic, seals on a rocky beach.  
Penguins in icy water, swimming out of reach.  
Out in the polar oceans, whales come and go.  
Sprays of water in the air. Was that a whale hole blow?

### *A Polar Problem?*

Polar ice is changing fast.



Some wonder if it will it last.

Antarctic ice sheets break.  
Floating icebergs the pieces make.

In the Arctic sea ice floes.  
Melt in summer, in winter grow.

All of us having to think once or twice.  
Will polar water be changed by changing polar ice?

5. Connect information from the Venn diagram to the poem. Use the students' responses to informally assess prior knowledge of fresh and salt water.

6. Through discussion of the similarities and differences of the 2 samples, introduce the term salinity. (Salinity is the measure or amount of salt in water. The more salt there is, the higher the salinity. Saline solutions are often used to rinse eyes and contact lenses, clean wounds and ease sore throats).

Explore:

1. What happens to water in each season at home and in a polar region? Watch the video and discuss what happens to polar water on the Bering Sea? [http://www.polartrec.com/files/journal/video/original/9336\\_dwheeler\\_icefromgreasetofloes.mov](http://www.polartrec.com/files/journal/video/original/9336_dwheeler_icefromgreasetofloes.mov)
2. Predict what happens to the salinity of the Bering Sea during the colder months? In the summer months? At different depths during colder and warmer months?
3. Pass out surface salinity data sheets (attached). Students compare their predictions to the data. (Differentiation: Cut the graphs apart and allow the students to pair the graphs together to make their own conclusions.)
4. What happens at the surface of the water during different seasons? At 10 m, at 25 m, 50 m, 100 m, 200 m, and 300 m? Is it the same from season the season at each depth? Chart the students' conclusions.
5. Predict how and why the salinity changes from spring and fall.
6. Bering Sea Water Model- Show the students 3 containers. Discuss how the model is like the Bering Sea and how it is different. (The salinity is higher in the model than the Bering Sea.)
  1. Measure the salinity of the salt water.
  2. Predict the salinity of the frozen Bering Sea model. Will the salinity be different in the ice layer as compared to the unfrozen layer below?
  3. Remove the ice layer. Place the ice into an empty container. Allow it to melt. (Students can suggest ways to speed the melting process)
  4. Measure the salinity of the unfrozen layer. Compare the measurement to the predictions. How will the measurement of the unfrozen layer affect the measurement of salinity in the ice layer?
  5. After the ice layer has melted, measure the salinity. Compare the results to the prediction.



6. Discuss any seasonal changes that might affect the salinity of the water. (Lead the students to the melting of ice and snow from the land, rivers and streams that will flow into the Bering Sea).
7. With the other frozen container, add at least 50 ml of water to the edges to represent the runoff. Allow it to melt. Measure the salinity.

Explain:

1. Discuss the results. As the ice layer increases, the salinity of the water lowers. As runoff increases into the Bering Sea, the salinity decreases.
2. Show the graphic of the ice layer over the Bering Sea. Have students interpret the graphic. As the ice thickens, salt leaves the ice layer through small pores in the ice layer.
3. View the movie <http://www.youtube.com/watch?v=bec3-hQYnQQ> to see a scientist measure salinity in the Bering Sea.

**Extension**

Salt water science lesson

[http://arcticclimatemodeling.org/subject\\_sea\\_ice\\_dynamics.html](http://arcticclimatemodeling.org/subject_sea_ice_dynamics.html)

Daily Sea Ice Images

[http://nsidc.org/data/seaice\\_index/](http://nsidc.org/data/seaice_index/)

Ice Map graphics

<http://pafc.arh.noaa.gov/icemap.php>

Sea Surface Temperature and Sea Ice analysis and forecast

<http://pafc.arh.noaa.gov/ice.php>

30 day animation of sea ice coverage in Bering Sea

<http://arctic.atmos.uiuc.edu/cryosphere/>

Salinity Movie

<http://svs.gsfc.nasa.gov/vis/a010000/a010500/a010504/index.html>

Numerous lessons on ice and our connections

<http://www.lpi.usra.edu/education/explore/ice/>

Can you drink melted sea ice?

New ice is usually very salty because it contains concentrated droplets called brine that are trapped in pockets between the ice crystals, and so it would not make good drinking water. As ice ages, the brine eventually drains through the ice, and by the time it becomes multiyear ice, nearly all of the brine is gone. Most multiyear ice is fresh enough that someone could drink its melted water. In fact, multiyear ice often supplies the fresh water needed for



polar expeditions. See Salinity and Brine in the Characteristics section of the following web site for more information. <http://nsidc.org/seaice/intro.html>

### **Resources**

Frequently Asked Questions about Sea Ice  
<http://nsidc.org/arcticseaicenews/faq.html>

Map

[http://www.lib.utexas.edu/maps/islands\\_oceans\\_poles/arctic\\_region\\_pol\\_2007.jpg](http://www.lib.utexas.edu/maps/islands_oceans_poles/arctic_region_pol_2007.jpg)

Google Earth

[http://essea.strategies.org/module.php?module\\_id=104](http://essea.strategies.org/module.php?module_id=104) Polar Water activity and poem

### **Assessment**

1. In the winter, Animal X lives in the Bering Sea near the mouth of a river. Describe why Animal X migrates to the middle of the Bering Sea in the summer and returns to the mouth of the river in the winter. Explain the environmental condition/s and their effects on Animal X.
2. How will the migration of Animal X be affected during a very dry, warm winter? Use what you have learned to describe the effects.

### **Credits**

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## **National Science Education Standards (NSES)**

### **Content Standards, Grades 5-8**

Content Standard A: Science As Inquiry

- a. Abilities necessary to do scientific inquiry
- b. Understandings about scientific inquiry

Content Standard B: Physical Science

- a. Properties and changes of properties in matter

Content Standard C: Life Science

- d. Populations and ecosystems
- e. Diversity and adaptations of organisms

### **Content Standards, Grades 9-12**

Content Standard A: Science As Inquiry

- a. Abilities necessary to do scientific inquiry
- b. Understandings about scientific inquiry

Content Standard B: Physical Science

- a. Structure and properties of matter

Content Standard C: Life Science

- e. Matter, energy, and organization in living systems