

# How Much Water is in this Snow?

## Vocabulary

Snow survey, snow sample, density, mass, volume, percent, snow water equivalent (SWE), watershed

## Methods

Students collect snow samples and calculate how much water there is in the snow. (percent density). They discuss how snow density is used to calculate “snow water equivalent (SWE)” to forecast our annual water supply.

## Objectives

- Students will be able to calculate snow density and understand how that is used to find the snow water equivalent (SWE) for water supply forecasts.
- Students will be able to explain why mountain snowpack is important to our water supply.
- Students will be able to relate how the mountain snowpack in Glacier is a resource for everyone in the United States.

## Background

Glacier National Park works with the Natural Resource Conservation Service (NRCS) to collect data on mountain snowpack. The NRCS is a federal agency within the U.S. Department of Agriculture that provides products and services that enable people to be good stewards of the nation’s soil, water, and related natural resources on non-federal lands. The NRCS continuously monitors mountain snowpack and climate. They use data gathered from manual surveys conducted by park rangers and other trained personnel along with automated information from the SNOTEL (SNOWpack TELemetry) network to forecast water supplies.

Major sectors of the economy — agriculture, industry, recreation, and government — base their water management plans on NRCS water supply forecasts, climate products, and drought risk assessments. NRCS snow surveyors measure mountain snowpack and forecast seasonal runoff in streams and rivers. This information is used to make sound water management decisions. Glacier National Park contains the head waters for three major watersheds in North America that meet at Triple Divide Peak. The Columbia River Drainage, the Missouri River Drainage, and the Hudson Bay Drainage. (See the information and background section about snow at the beginning of this guide). The NRCS website has excellent and extensive information about conducting snow surveys as well as the current water supply forecasts at <http://www.nrcs.usda.gov/feature/highlights/SnoServ.html>. In addition, the NRCS Agricultural Information Site Bulletin 536 has a clear explanation of the importance of mountain snow to water forecasting and the steps for conducting snow surveys. View the site bulletin at <http://www.wcc.nrcs.usda.gov/factpub/aib536.html>.

## Materials:

- \* “Locating Glacier National Park” map
- \* “How Much Water is in this Snow?” student worksheet
- \* Snow
- \* Snow sample containers for each pair of students - 1000 cc size or empty cans/ baby food jars that you know the volume of, or that students can calculate the volume for

### Procedure

1. Tell your group that they are going to follow similar procedures and calculations that rangers and NRCS personnel use to measure how much water is in the snow. But first, you want to discuss why it's important to know this and who it affects. (It's not just important to skiers and winter recreationists?)
2. Show students the map, "Locating Glacier National Park in Northwest Montana". Work together to label: their hometown, the rivers, the lakes, and the three watersheds. Make sure students understand the significance of having the headwaters of these three large watersheds for North America fall within Glacier National Park. Why would a community, or a nation, decide to keep the watershed headwaters undeveloped and in a protected area? Once students understand the significance of the watersheds, challenge them to think about how mountain snowpack in Glacier National Park contributes to those watersheds. You may even want to visit the SNOtel website at this point to see how much snow there is in Glacier right now. Go to the National Weather Surface Forecast Office website <http://www.wrh.noaa.gov/mso/newlcl.php>. Then scroll over the map surface observation map in the area of Glacier and find the yellow, SNOtel symbols for Flattop Mountain or Many Glacier. Those links will take you to the automated data about the most recent weather observations, including snow depth, for that site. Compare the snow depths and weather observations with where you live. Students may be amazed at the difference!
3. So now that students understand the importance of mountain snowpack as a water resource, it's time to calculate how much water is in the snow.
4. For younger students, a simple way to do this is to just collect the snow samples as described below and then bring the samples inside and add energy (heat) to change the snow from a solid to a liquid. Students can record observations of their sample container full of snow, and predict by writing it down, or by moving a rubber band on the outside of the container, what the water level will be when all the snow melts. How was their prediction? Can they imagine how deep the water would be outside if all the snow turned from a solid to a liquid right now?
5. For older students, the first step to find out how much water is in the snow is to understand what density represents, and to be able to calculate the density of the snow. Students will need to use a container of known volume to get a snow sample, and then find out the mass of the snow. A 1000 cc container makes the calculations really simple but if none are available, making students calculate the volume of a cylinder like a baby food jar or empty tomato paste can adds an additional math challenge.
6. Use the "How Much Water is in this Snow?" worksheet at the end of this lesson to help students walk through the steps of calculating snow density and percent density.
7. The density of new snow ranges from about 5% when the air temperature is 14° F, to about 20% when the temperature is 32° F. After the snow falls its density increases due to gravitational settling, wind packing, melting and recrystallization. Depending on the location, typical snowpack values can range from 10-20% in the winter to 20-40% in the spring.
8. To accurately calculate snow water equivalent (SWE) you need to know not only the density of the



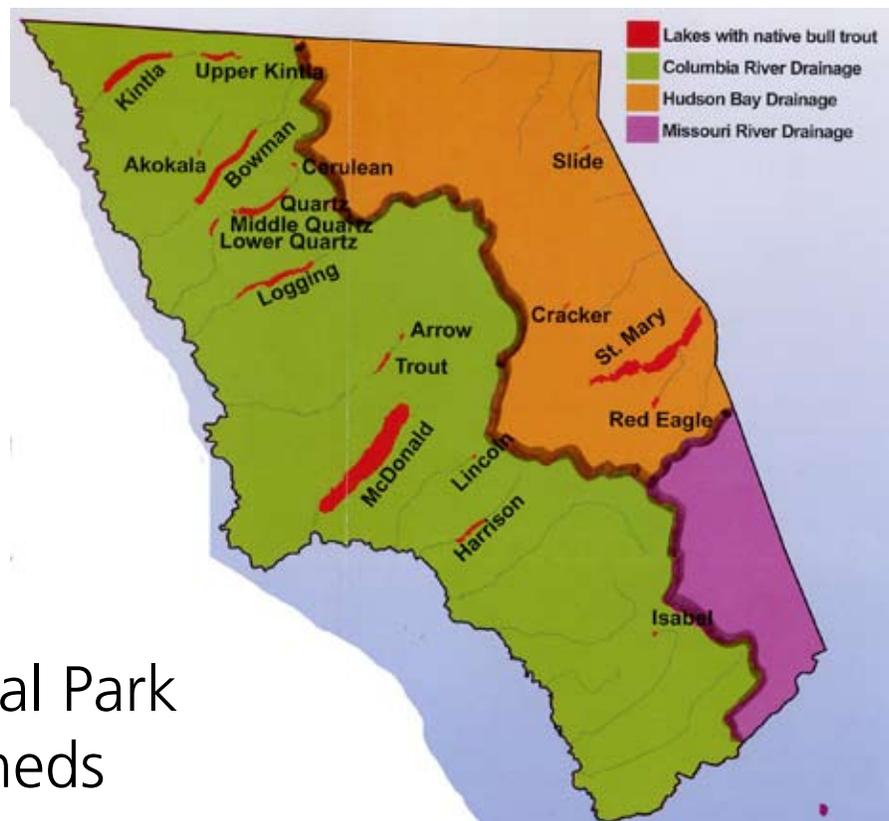
snow, but how deep the snow OF THAT SAME DENSITY is. This can be tricky since once snow hits the ground, its density is constantly changing. NRCS staff have a special snow tube they use for getting snow samples which collects snow from the entire snow column from the surface all the way to the ground, see website at <http://www.wcc.nrcs.usda.gov/factpub/aib536.html> . They also get multiple samples along a snow survey course and they return to that same course multiple times on a regular schedule throughout the winter.

### Evaluation

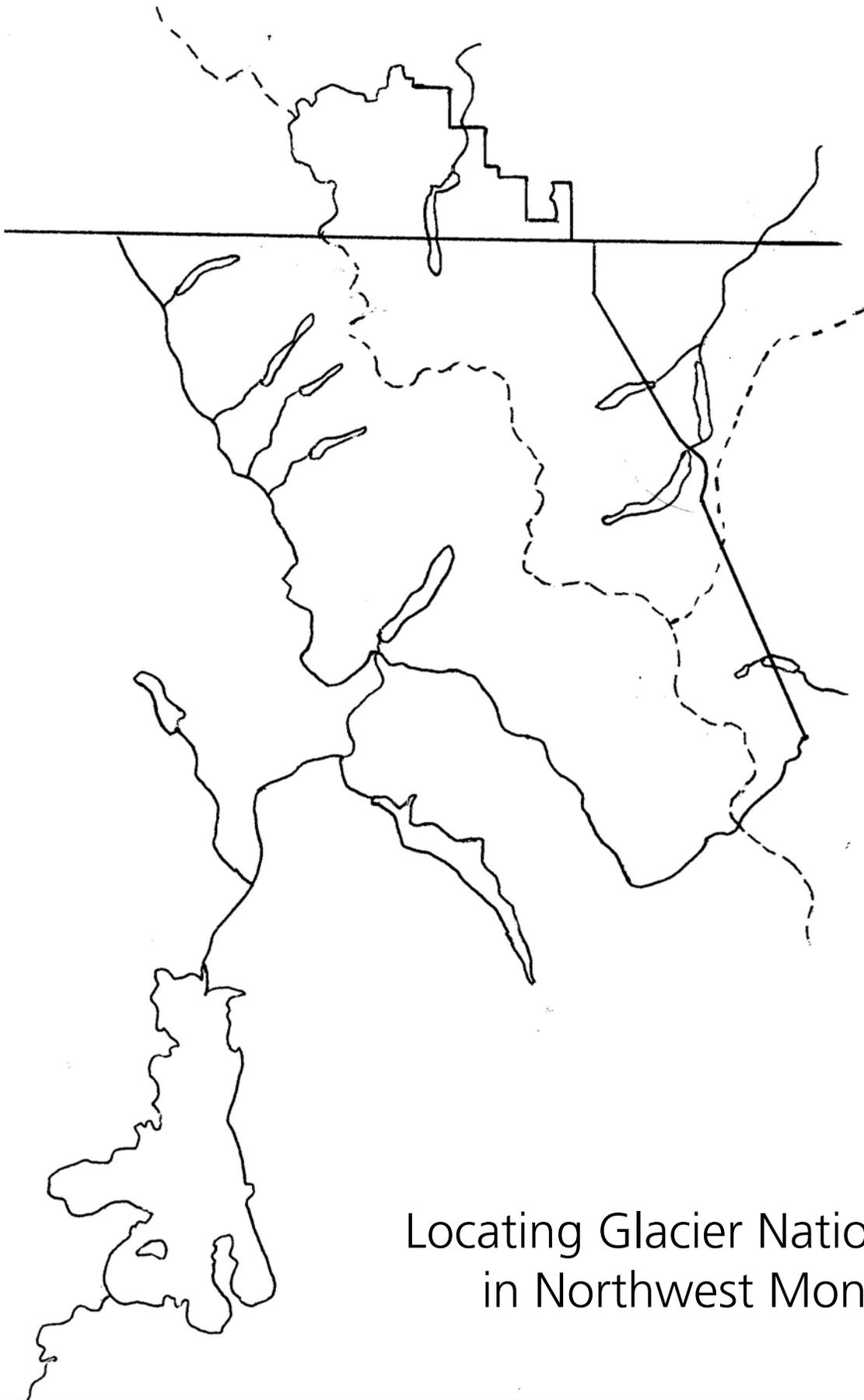
Compare the students' measurements and calculations for snow density. Were they all the same? Different? Why or why not? Can students correctly label the three watersheds that meet in Glacier National Park and give one reason mountain snowpack is important to people living within those watersheds? Challenge students to think about what would happen if the precipitation at Glacier National Park did not fall as snow, but as rain. How would that affect our water supply (even if it were the same amount of precipitation)?

### Extension

Have students calculate how much water they use per day and compare it with the average per capita use for United States residents. Then compare the average U.S. per capita water use with other countries. The snow that accumulates in Glacier National Park throughout the winter is an extremely valuable source of water for people and animals. When the snow melts, it flows down through the streams to the lakes and replenishes the water supplies that we all depend on. What are some things we can all do to help ensure that we have enough clean, fresh water?



Glacier National Park  
Major Watersheds



Locating Glacier National Park  
in Northwest Montana

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## How Much Water is in this Snow?

Name \_\_\_\_\_

1. Mass of snow sample container empty = \_\_\_\_\_

2. Mass of snow sample container with snow = \_\_\_\_\_

3. Subtract line 1 from line 2 to get the mass of just the snow = \_\_\_\_\_

4. Volume of your snow sample container (get the volume from your teacher or calculate it yourself with the formula your teacher provides) =

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5.  $\frac{\text{Snow Mass (\#3)}}{\text{Volume of Container (\#4)}} = \text{Snow Density}$

6.  $\text{Snow Density (\#5)} \times 100 = \text{Percent of water in your snow sample.}$

7. Compare your answer for snow density to other students' results. Did everyone get the same snow density? Why or why not? Where in the snowpack does the snow seem to be the most dense (top, middle, or bottom)? Do you think you would get the same results tomorrow?

8. Water supply forecasters use snow density to calculate what the depth of water would be if all the snow melted right now. They call this the **snow water equivalent** or **SWE**. To get SWE, the snow density (not the percent) must be multiplied by the depth of the snow. Can you calculate SWE for your snowpack? What would you have to do to make it accurate?