

HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?

UNIT 7: Your Environment
Lesson 13 — Grade 6
INSTRUCTIONS



Overview

In this lesson students will find the surface area of the footprints of a snowshoe hare and the surface area of their own feet. Next they will calculate the weight load per cm^2 for both the snowshoe hare and for themselves.

Objectives

On successful completion of this lesson, students will be able to:

- find the total surface area of the feet of a snowshoe hare and their own feet;
- find the amount of weight a snowshoe hare and a student applies per cm^2 ; and
- describe how weight and surface area relates to travel on snow.

Alaska Standards

Alaska Science Standards / Grade Level Expectations

[6] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.

[6] SC1.2 The student demonstrates an understanding of how science explains changes in life forms over time, including genetics, heredity, the process of natural selection, and biological evolution by recognizing that species survive by adapting to changes in their environment.

Alaska Math Standards

6.NS.3 Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. Express the remainder as a terminating decimal, or a repeating decimal, or rounded to a designated place value.

Alaska Cultural Standards

[E] Culturally knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:

[E2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope & Sequence

M.S. Sequence 6.6: Biological Evolution and Natural Selection

M.S. Sequence 6.9: Ecosystems

M.S. Sequence 8.6: Forces and Motion



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UNIT 7: Your Environment Lesson 13 — Grade 6 INSTRUCTIONS



Materials

- STUDENT WORKSHEET: Weight Distribution
- Centimeter graph paper (template included with worksheet)
- Tape

Additional Resources

Glencoe Life Science Ch 6, 21-22

Glencoe Physical Science Ch 2

Activity Preparation

1. Make copies of the Student Worksheet. Make additional copies of centimeter graph paper so multiple copies can be taped together.

Whole Picture

Adaptations enable plants and animals to survive in their environments. From deserts to tundra, organisms have adaptations for surviving in their particular environments. Adaptations that make an organism more successful will survive to pass the new characteristics on to its offspring. Changes in the structures of an entire species take place gradually, over many generations.

Animals in the Arctic have adaptations for surviving in the cold and for traveling on snow. For example, ptarmigan have feathers on their feet to keep them warm and increase the surface area of their feet. Snowshoe hares have large feet to help movement on snow; having large feet to carry the weight prevents them from sinking so deep into the snow. In addition both the ptarmigan and snowshoe hares change colors from winter to spring. In the winter they are white and in the summer the hares are brown and ptarmigan are mottled grey-brown.

Taking clues from nature, humans developed snowshoes to increase flotation on snow. It is estimated that snowshoes were invented between 4000 to 6000 years ago. Snowshoes were used mainly by men, for hunting and checking traps. Indigenous people of North America had diverse styles of snowshoes ranging from circular styles to ones that are long and narrow. Even amongst the tundra environment of the Bering Strait region, there were differences in design. In the northern Iñupiaq communities, people made snowshoe frames from spruce or tamarack, bending the wood into shape while it was still green, and interlacing fine sinew thread to fill in the frame. They made long snowshoes, or tagluk, for walking in the soft snow of the brushy areas of the tundra where deep drifts accumulate. They had a shorter version, called puyyugiak, with tough leather lacing for walking on the rough sea ice. The shorter, oval version also worked well for traveling inland, in “willow country”. In the Central Yup’ik areas, snowshoes, called tangluk, were made out of wood that was softened with hot water so it could be bent into shape. They formed an upturned toe to assist walking on soft, deep snow. The mesh was made from leather spiral-cut from a piece of caribou or other hide. (Smithsonian 2015.)



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UNIT 7: Your Environment Lesson 13 — Grade 6 INSTRUCTIONS



Traditional wooden snowshoes are still used today, as well as modern snowshoes made of aluminum and plastic. The newer materials are lighter weight and do not require annual varnishing for maintenance. However, the wooden snowshoes are quieter to walk in and also withstand extreme cold temperatures better.

Vocabulary

adaptation a feature that enables an organism to survive in its surroundings.

Activity Procedure

1. Ask students to name some of the animals found around their community, then ask what adaptations they have for surviving in that area. Lead the discussion to walking around on snow during the winter. Ask why is it difficult, what can be done to make it easier, what animals seem to be better adapted to traveling in deep snow, etc.
2. Introduce the activity by asking how they could find the area of the feet of a snowshoe hare. Demonstrate how to use the STUDENT WORKSHEET graph paper to estimate the surface area of the track. Ask what direction the hare is traveling, from top to bottom, or from bottom to the top of the graph paper (answer: top to bottom). For this activity students will need to find only the left or right set of tracks, then multiply by 2 to get the total for all four feet. The class could be divided so that some students find the left set of tracks and some the right.
3. In part 2 students will need to convert their weight in pounds to grams. If necessary, do some examples with them, i.e. $75 \text{ lbs} \times 454 = 34050 \text{ grams}$, $100 \text{ lbs} \times 454 = 45400 \text{ grams}$.
4. For consistency, discuss with students if they should have shoes on, or off, when finding the surface area of their own feet.
5. Finish the activity with a class discussion. Prompt questions could include; besides a snowshoe hare, what are some other animals that have large feet relative to their size? Did everyone have the same answer for the surface area of the snowshoe hare? If there were differences, why did they occur? Would there be situations when large feet would be a disadvantage? When would you want to wear a snowshoe that is long and narrow? When would you want a snowshoe that is short and wide?

Note: In this lesson students find the weight load per surface area. The term pressure is also sometimes used. In the U.S. pressure is measured in pounds per square inch, or psi. In the SI (Système International) system pressure is measured in Newtons per square meter. The SI unit for pressure is the Pascal, or Pa. When traveling in countries where the SI system is used, it is common for people to give their weight in kilograms. It would be a rare for someone to give their weight in Newtons. Rather than having students convert their weight to Newtons this lesson uses grams for ease of understanding. If using Newtons is desired, pounds can be converted to Newtons by multiplying weight in pounds by 4.45.



HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?



Extension Activity

Bring in a pair of snowshoes, or trace the outline of a snowshoe on poster paper. Have students calculate, or estimate the surface area of a pair of snowshoes. Have students calculate the pressure they would have on the snow if they wore the snowshoes.

If a snowshoe is not available the surface area of different sizes of snowshoes are available from the manufacturers web site, such as Atlas, Tubbs, MSR and others. The table below has some examples of Atlas snowshoes.

Snowshoe Length (cm)	Surface Area (cm ²)
63	1135
76	1432
89	1742

References

"Below Zero – Snow Floats" (2003) Canadian Wildlife Federation

Smithsonian Institution, "Alaska Native Collections". Accessed March 2015. Accessed from: http://alaska.si.edu/search_results.asp?keywords=snowshoes&page=1



HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?



Answers

Part 1

Snowshoe Hare Data Table. Answers may vary. (Note: L is for the tracks on the left side of the paper. It would be the hare's right foot and vice versa.)

	1. Total interior squares (cm²)	2. Total perimeter	3. ½ perimeter	4. Area = interior + ½
Small foot	L = 21 R = 24	L = 18 R = 18	L = 9 R = 9	L = 30 R = 33
Large foot	L = 4 R = 3	L = 11 R = 11	L = 5.5 R = 5.5	L = 9.5 R = 8.5
			5. Area of large + small foot =	L = 39.5 R = 41.5
			6. X2 for the total of two large and small feet =	Total Surface Area L = 79 R = 83

7. Answer will vary.

$$L = 1100 \text{ gr} / 79 \text{ cm}^2 = 13.92 \text{ gr} / \text{cm}^2$$

$$R = 1100 \text{ gr} / 83 \text{ cm}^2 = 13.25 \text{ gr} / \text{cm}^2$$

Part 2

Answers will vary.

Part 3

1. Humans will sink deeper in snow because they apply more pressure on the snow than a snowshoe hare.
2. A lynx has much larger feet relative to its size.
3. To increase the surface area of their feet so they won't sink so far in the snow.



HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?



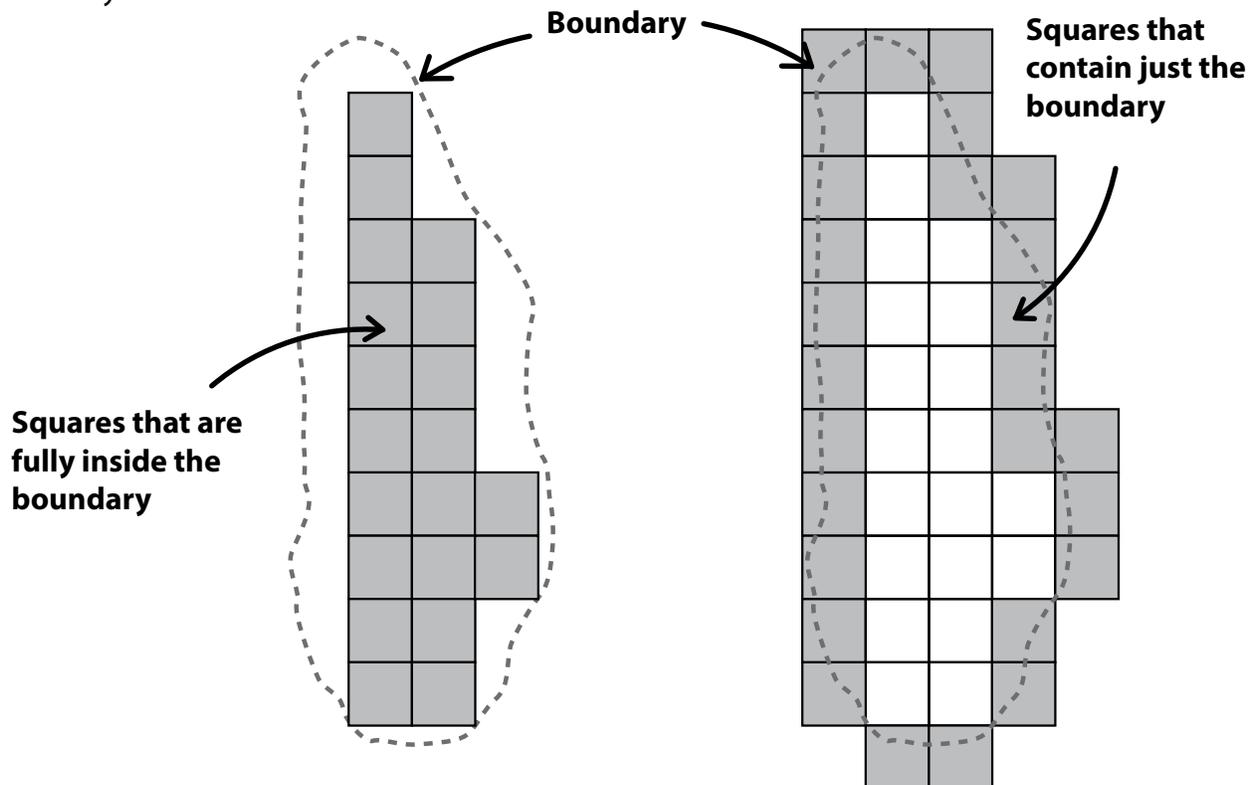
Student Worksheet: Weight Distribution

Name _____

Animals in the Arctic have adaptations for surviving in the cold and snow. For example, ptarmigan have feathers on their feet to keep them warm and increase the surface area of their feet. Caribou have large feet for their size and they grow extra hair inside their hooves for winter travel. Snowshoe hares have large feet to help them move around on snow in the winter. In this activity you will determine the amount of pressure a snowshoe hare puts on its feet, then compare it to the pressure on your feet. A low pressure helps keep an animal from sinking in snow.

Part 1 Snowshoe Hare Track

1. Use the snowshoe hare track on the cm grid graph paper. To find the total surface area of the hare's feet, you can measure either the left or right side of the track, and later multiply by 2 to get the total for all four feet. Locate all the squares that are fully within the boundaries of the large rear foot and all the squares that are fully within the smaller front foot. Write your answer in the data table below.
2. Count each perimeter square that contains a portion of the boundary of the foot. Write your answer in the data table below.



HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?



- In order to find the area of the irregular perimeter pieces, mathematicians assume that some grid units are almost full, some half full, and some mostly empty – the average being half. To find the area of the perimeter multiply the total number of perimeter squares by $\frac{1}{2}$ (or .5). Write your answer in the third column.
- Calculate the surface area of the large foot and small foot by adding the total number of interior squares and $\frac{1}{2}$ the number of perimeter squares.
- Add the surface area of the large foot and the small foot to get the total of one side of the track.
- Multiply the area of one side of the snowshoe track by 2 to find the total surface area of all four feet of the snowshoe hare.

Snowshoe Hare Data Table

	1. Total interior squares (cm ²)	2. Total perimeter	3. $\frac{1}{2}$ perimeter	4. Area = interior + $\frac{1}{2}$
Small foot				
Large foot				
			5. Area of large + small foot =	
			6. X2 for the total of two large and small feet =	

- Find the weight load, or amount of pressure this snowshoe hare is applying per cm². The weight of the hare is divided by the total surface area of its track. Assume this hare weighed 1100 grams. To find the pressure, use the formula:

$$\frac{\text{Hare's Weight (gr)}}{\text{Total surface area (cm}^2\text{)}} = \text{_____ gr/cm}^2$$

HOW HAVE PLANTS AND ANIMALS ADAPTED IN YOUR AREA?



Student Worksheet: Weight Distribution

Name _____

Part 2 Surface Area of Your Feet

How does your weight / per cm² compare to a snowshoe hare?

Hypothesis:

I think a snowshoe hare will have a greater, less, or the same (circle your answer) pressure than/as I do.

In order to answer your hypothesis, follow the same procedure as for the snowshoe hare.

1. Use cm² graph paper to trace an outline of your foot. You may need to tape two pieces of graph paper together. Complete the #1 - #5 in the data table below.

	2. Total interior squares (cm ²)	3. Total perimeter squares (cm ²)	4. ½ perimeter squares (cm ²)	5. Area = interior + ½ perimeter (cm ²)
Your foot				
			6. X2 for the total of left and right foot =	

2. Find your weight load per cm².

Note: One pound is approximately 454 grams. To convert pounds to grams use the formula:

_____ pounds x 454 = _____ grams

Student's Weight (gr)

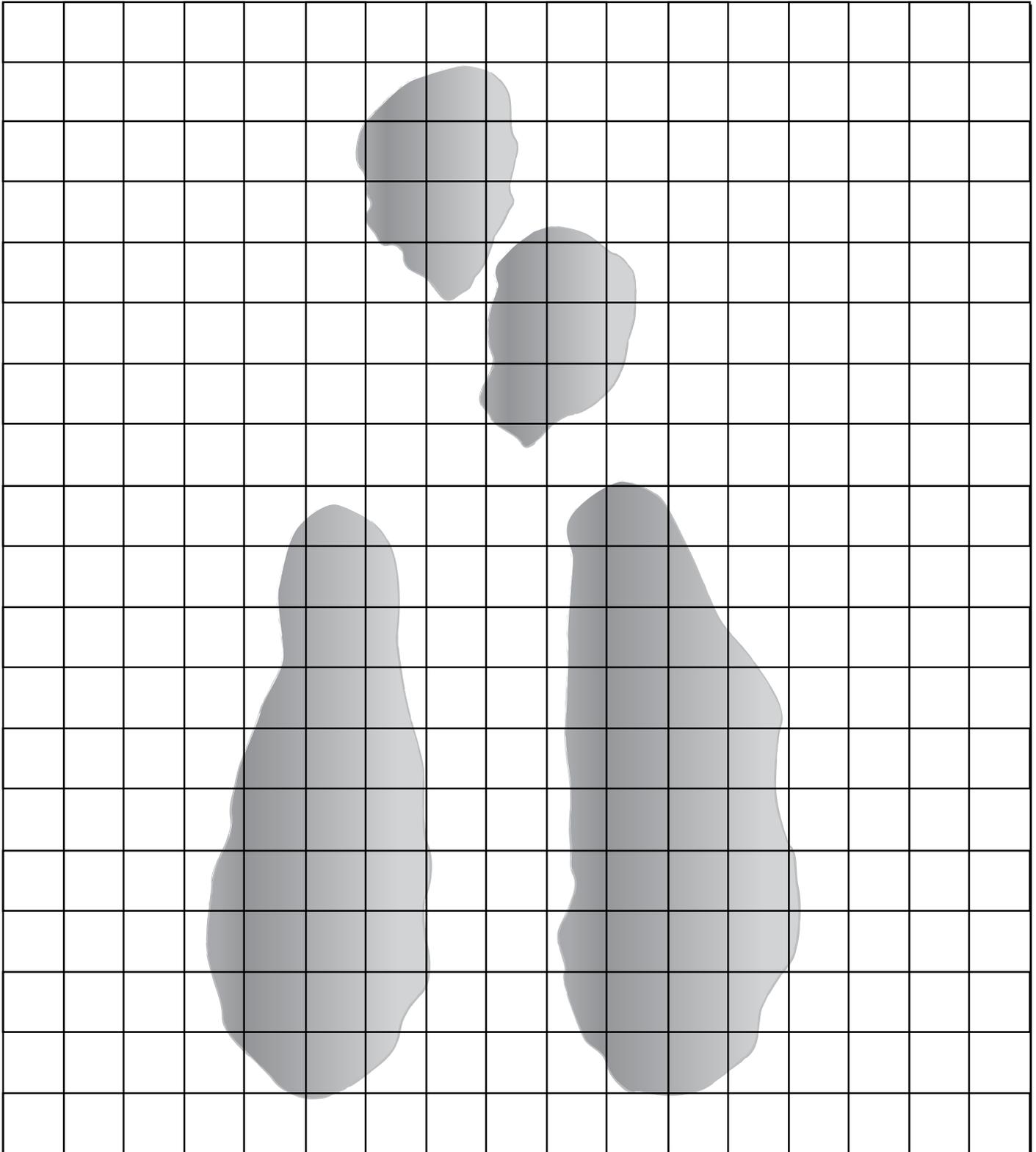
_____ = _____ gr/ cm²

Total surface area (cm²) = _____ cm



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STUDENT WORK



Centimeter Graph Paper

