Polar Bears and Energy
6th and 7th grade unit

Created by Dr. Jody Reimer and Linda Zhao, University of Utah, Department of Mathematics

Math Core Curriculum:

Gr. 6 – The Number System
CCSS.MATH.CONTENT.6.NS.B.2: Fluently divide multi-digit numbers using the standard algorithm.

Gr. 7 – Ratios and Proportional Relationships
CCSS.MATH.CONTENT.7.RP.A.2: Recognize and represent proportional relationships between quantities.

Learning Objectives:

To understand conversions between calories and MJ (the standard scientific units of energy), in the context of polar bear energy use.

Students will need to be familiar with the following techniques to solve real life problems:

- Standard operations including addition, subtraction, multiplication, division.
- Unit conversions.

Additional Reading Materials:

Polar Bears Diet & Prey

https://polarbearsinternational.org/polar-bears-changing-arctic/polar-bear-facts/diet-prey/

A demanding lifestyle

https://www.science.org/doi/full/10.1126/science.aan8677

Academic Sources

Johnson, A. C., Pongracz, J. D., & Derocher, A. E. (2017). Long-distance movement of a female polar bear from Canada to Russia. Arctic, 121-128.

Pagano, A. M., & Williams, T. M. (2019). Estimating the energy expenditure of free-ranging polar bears using tri-axial accelerometers: A validation with doubly labeled water. Ecology and evolution, 9(7), 4210-4219.

Unit Conversion

Most of us measure our weight in pounds (lb), but scientists prefer to measure mass in kilograms (kg) instead. To go between the two measurements, we just need to know that **1 kg = 2.205 lb**.

1. Using this information, can you convert your weight from pounds (lb) to kilograms (kg)?

2. Now that you know your weight in kgs, we can compare you to a polar bear! If an average polar bear weighs 450 kg, how many of you would make up a polar bear?

Nutrition Facts

Serv. size 1 bar (68g)

Calories per serving 240

Amount/serving	% DV	Amount/serving	% DV	Amount/serving	% DV
Total Fat 3.5g	**5%**	**Cholesterol** 0mg	**0%**	Total Sugars 23g	
Sat. Fat 0.5g	**3%**	**Sodium** 115mg	**5%**	Incl. 19g Added Sugars	**38%**
Trans Fat 0g		**Total Carb.** 46g	**17%**	**Protein** 9g	**17%**
Polyunsat. Fat 1g		Dietary Fiber 4g	**14%**		
Monounsat. Fat 1.5g		Insoluble Fiber 3g			

Vit. D 2mcg 8% • Calcium 201mg 15% • Iron 2mg 10% • Potas. 233mg 4% • Vit. A 2% • Vit. C 6% • Vit. E 10% • Thiamin (Vit. B_1) 15% • Riboflavin (Vit. B_2) 15% • Niacin 25% • Vit. B_6 10% • Vit. B_{12} 25% • Phosphorus 20% • Magnesium 20%

Polar bears really like to eat seals – they are full of yummy fat! One bearded seal provides approximately 3700 MJ (megajoules) of energy. It's easier to understand just how much energy that is if we change the units to something more familiar. In fact, 1 MJ = 239 calories (the unit that is used to measure energy on food packaging), roughly the number of calories in one Clif Bar.

3. Approximately how many Clif Bars are equivalent to one bearded seal?

Ringed seals are smaller, and each ringed seal provides approximately 600 MJ.

4. How much energy will a polar bear gain if it hunts and eats 10 ringed seals? Do you have a guess for how long it might take a polar bear to catch 10 ringed seals?

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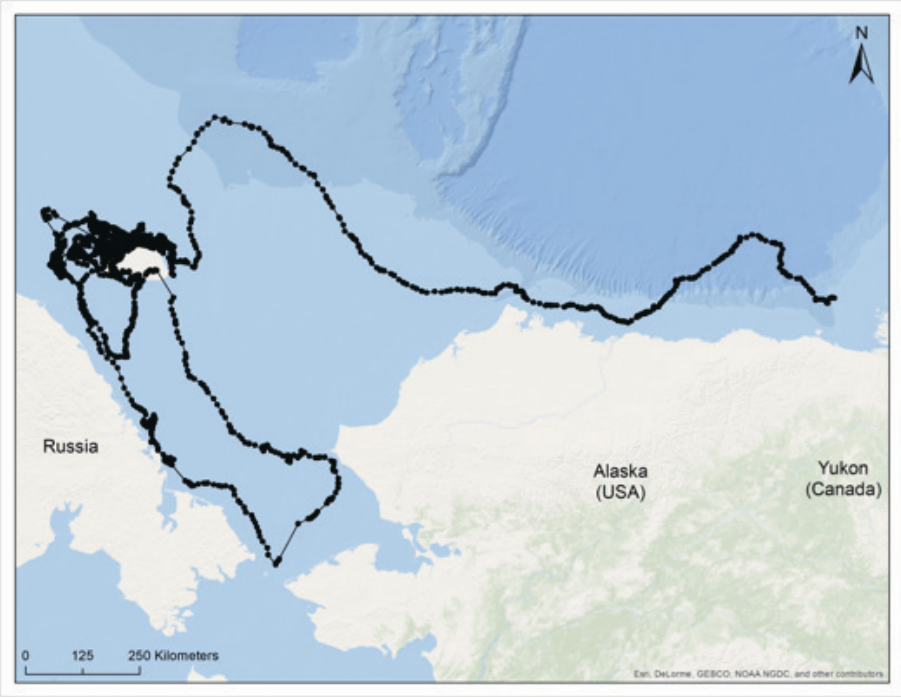
Bearded Seal on ice, Svalbard, Hornsund, 2001. Photo by Michael Haferkamp

Polar bears can travel really long distances. A female polar bear travelled a total of 11,686 km from Canada to Russia. The bear began traveling in the spring of 2009 and her recorded journey lasted 798 days, more than 2 years! Her path can be seen in the map on the right.



5. How much energy would she have used on this long journey if she uses 55 MJ per day?

6. How many bearded seals would she need to eat to fuel her trip?

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Unit Conversion

Most of us measure our weight in pounds (lb), but scientists prefer to measure mass in kilograms (kg) instead. To go between the two measurements, we just need to know that **1 kg = 2.205 lb**.

1. Using this information, can you convert your weight from pounds (lb) to kilograms (kg)?

Solution: for example, if your weight is 100 lbs, then your weight in kgs can be calculated as 100/2.205 = 45.35 kg.

2. Now that you know your weight in kgs, we can compare you to a polar bear! If an average polar bear weighs 450 kg, how many of you would make up a polar bear?

Solution: For example, if your weight is 45.35 kg, then the solution is:

450 / 45.35 = 9.92, so the polar bear is nearly 10 times as big as you. Imagine 10 of your friends all standing together, combined into one polar bear!

Nutrition Facts

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Calories per serving 240

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3. Approximately how many Clif Bars are equivalent to one bearded seal?

Solution: if one bearded seal is 3700 MJ, and a Clif bar is roughly 1 mJ, then the bearded seal is equivalent to approximately 3700 Clif bars. That's a lot of Clif bars.

Ringed seals are smaller, and each ringed seal provides approximately 600 MJ.

4. How much energy will a polar bear gain if it hunts and eats 10 ringed seals? Do you have a guess for how long it might take a polar bear to catch 10 ringed seals?

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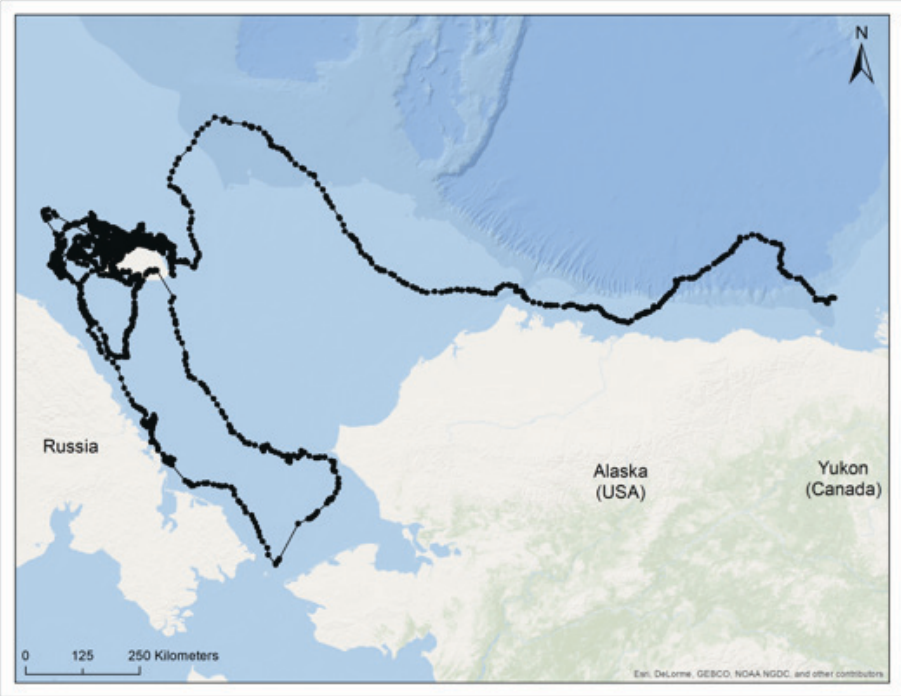
Solution: energy from 10 ringed seals = (10)(600) = 6000 MJ. How quickly a polar bear can catch 10 ringed seals depends on where the bear is hunting and how many seals are in the area, so the number can vary wildly. In the spring, when hunting is good, if a bear caught a ringed seal every 3 days, it would take them roughly a month to catch 10 ringed seals.

Bearded Seal on ice, Svalbard, Hornsund, 2001. Photo by Michael Haferkamp

Polar bears can travel really long distances. A female polar bear travelled a total of 11,686 km from Canada to Russia. The bear began traveling in the spring of 2009 and her recorded journey lasted 798 days, more than 2 years! Her path can be seen in the map on the right.



5. How much energy would she have used on this long journey if she uses 55 MJ per day?

Solution: If she was travelling for 798 days, and each day she used 55 MJ, then her total energy used was (798)(55) = 43,890 MJ.

6. How many bearded seals would she need to eat to fuel her trip?

Solution: Since a bearded seal provides 3,700 MJ of energy, she will need 43,890 MJ ÷ 3700 MJ per seal = 11.86 seals. Does that number seem reasonable to you, given how long she travelled? If she was eating smaller prey, such as ringed seals, do you think she would need to eat more or less?