Grade Level/Course: Grades 3, 4, and 5

Lesson/Unit Plan Name: Mathematical Analysis of Animal Data

Rationale/Lesson Abstract: Students can observe dimensions and weights of mammals. Then they can graph, analyze, and interpret data.

Timeframe:
2 class periods

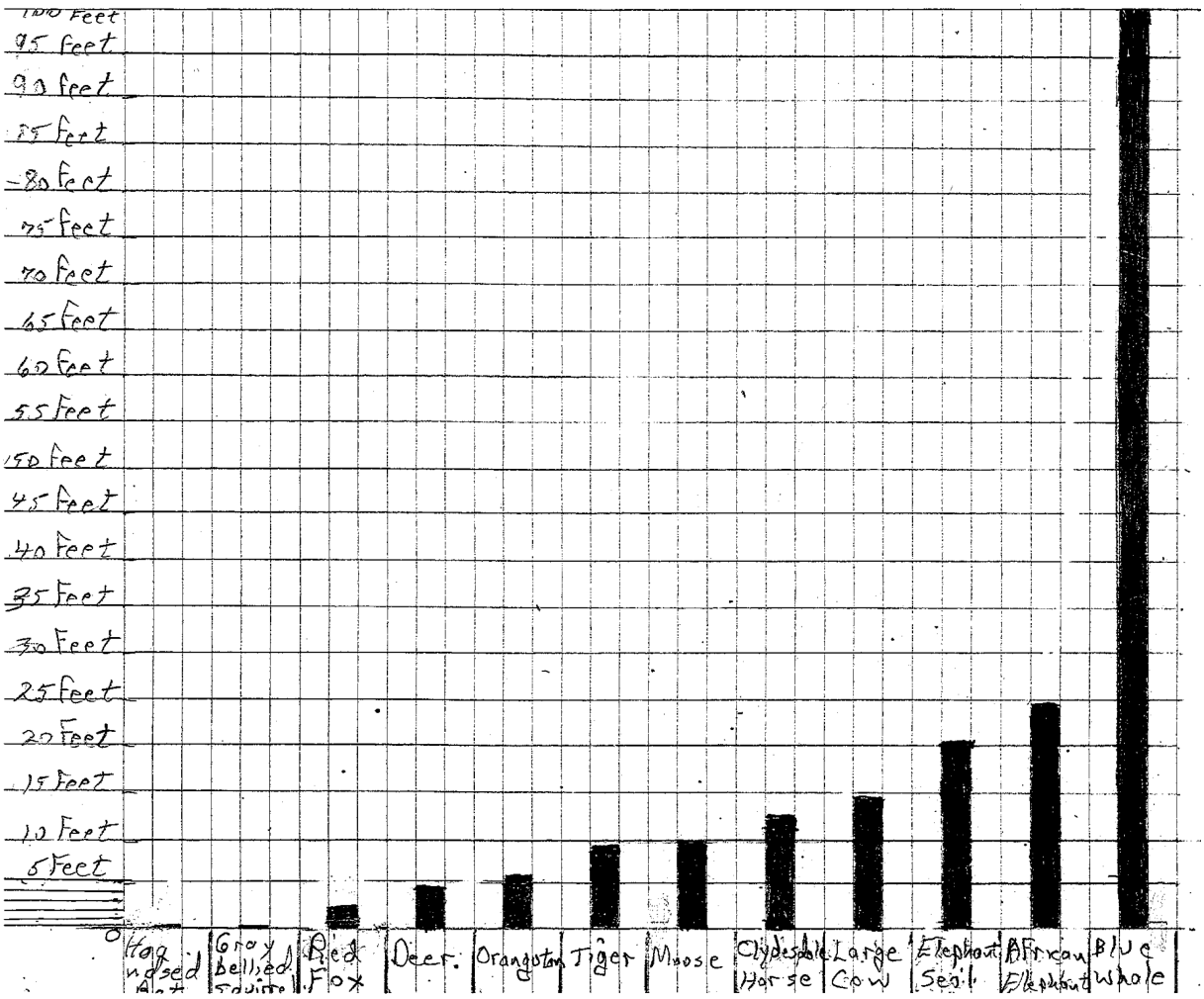
Standards
Grade 3 MD.3 Draw a scaled picture graph and scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.

Grade 4 MD.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.

Grade 5 G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Instructional Resources/Materials:
Animal sheets or cards printed by teacher from lesson (see page 7) onto card stock or regular copy paper depending on teacher preference; and pencils, graph paper, and scissors to cut out animal cards. Teachers can keep animal cards for future lessons.

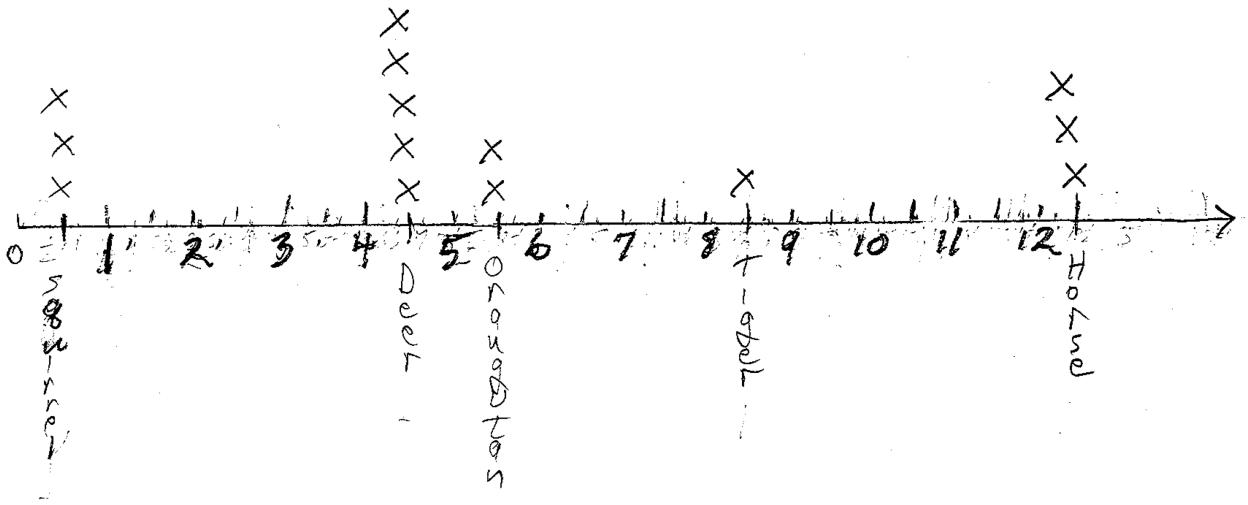
Activity/Lesson:
At the 3rd grade level, students can cut out animal cards and place in order. Then on the graph paper template, students can create a scaled picture graph and bar graph (see sample below). Teachers may want students to place names of 12 animals labeled horizontally, and lengths incremented by 5 up to 100 vertically. Teachers may make a pre-labeled graph or have the students create the graph from scratch. Students can then make bars for each animal's length. Once students can see the bars and look at the lengths, teachers, as an extension to the lesson, can discuss with students how weights of animals increase more rapidly than lengths increase. These are considerations meant to open up proportional reasoning but should not be assessed at this grade level.



At the 4th grade level, students will display the lengths of animals on a line plot. They can first put the animal cards in order by length to become familiar with the data. Then they can be given this problem:

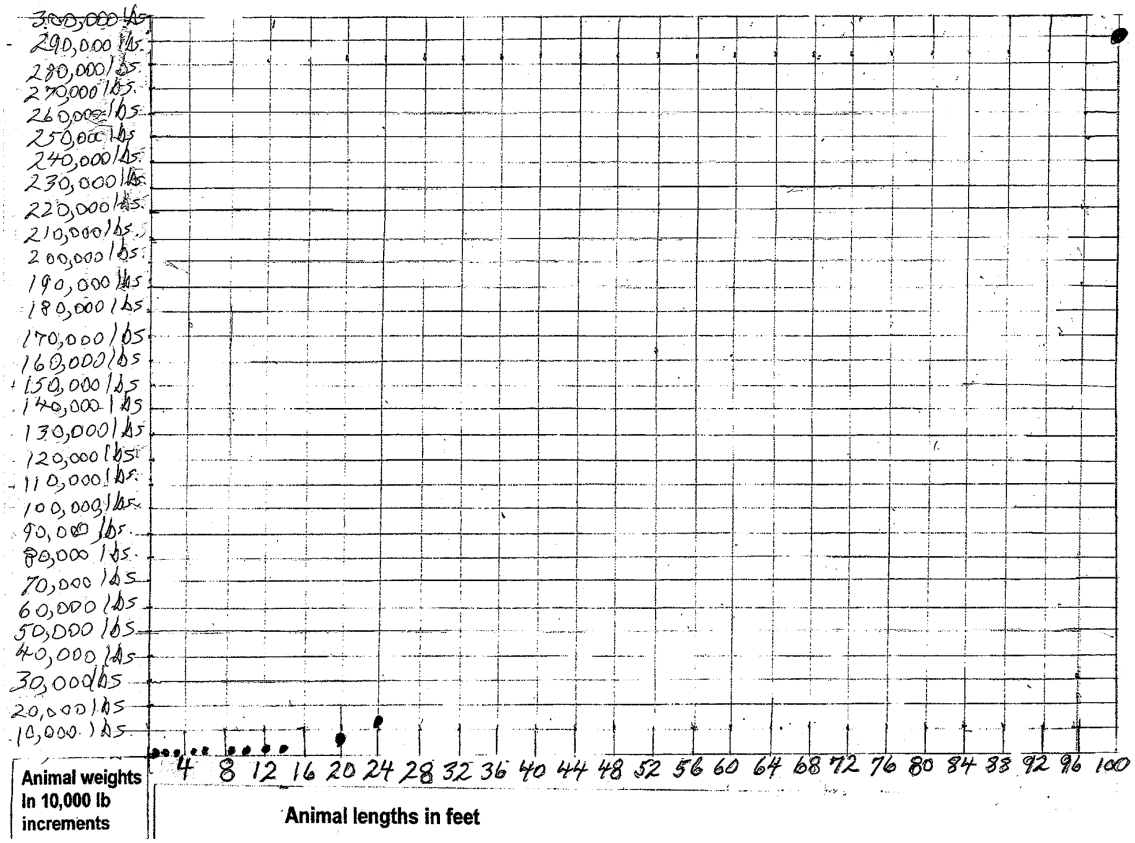
"A visitor to an animal park saw 3 squirrels, 5 deer, 2 orangutans, 1 tiger, and 3 horses. Plot the lengths and numbers of these animals on a line plot."

Sample of what a student's work might look like in response to this question:



Students can also make a table pairing animal lengths to animal weights for animals up to 1000 pounds. Then, with lengths incremented horizontally and weights vertically, students can answer questions about differences of lengths and differences of weights, e.g., how much heavier or longer is a moose than a deer? As an extension to the lesson, teachers can encourage students to compare the length to the weight for each animal by dividing the length into the weight and observe the rapid change rise in quotients showing that as the animal gets longer and of course wider, it gets heavier much faster. Teachers might choose to discuss how this phenomenon could cause size limits in nature. This proportional reasoning discussion is an extension and should not be assessed at this grade level.

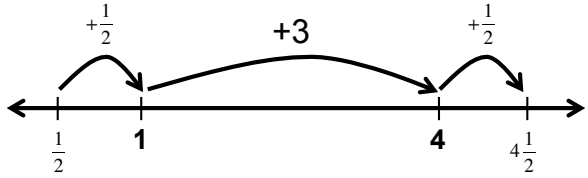
In the 5th grade, students can graph the information on a coordinate plane (positive quadrant only). The animal lengths will be incremented along the *x*-axis, and the weights incremented along the *y*-axis.



As an extension, teachers can help students see the science behind the information in the graph. Can students see that the volume/weight increases faster than the lengths increase? If the comparison of lengths to weight is set as rates, the denominators are getting bigger faster and the ratio is getting smaller. This suggests that there are maximum sizes in nature. If the small bat is 1 foot in length to 1 pound in weight, and the whale is 1 foot in length to 3000 pounds in weight, then as dimensions such as length increase, volumes increase much faster. This would suggest that sizes of things could get to a maximum. As with Grades 3 and 4, the proportional reasoning aspect is an extension and should not be assessed, but should be introduced to students to promote their excitement and interest in studying science and mathematics connections.

Assessment:
3rd graders can produce the pictograph and show different lengths of mammals. They may be able to answer addition and subtraction comparison questions, such as, "How much longer is the cow than the moose?" Also, students at this grade level can read the fractional lengths.

4th graders can show the differences of lengths between animals and also the differences of weights. Students can be asked comparison questions involving fractions and mixed numbers, e.g., "How much longer is a deer than a gray squirrel?" Students may use multiple methods to find the answer:



$$4\frac{1}{2}-\frac{1}{2}$$
$$=\frac{1}{2}+3+\frac{1}{2}$$
$$=\frac{2}{2}+3$$
$$=4$$

$$4\frac{1}{2}-\frac{1}{2}$$
$$=4+\frac{1}{2}-\frac{1}{2}$$
$$=4+\left(\frac{1}{2}-\frac{1}{2}\right)$$
$$=4+0$$
$$=4$$

5th graders can plot points on the coordinate plane. They can be assessed to see whether they can plot the lengths on the *x*-axis and the weights on the *y*-axis.

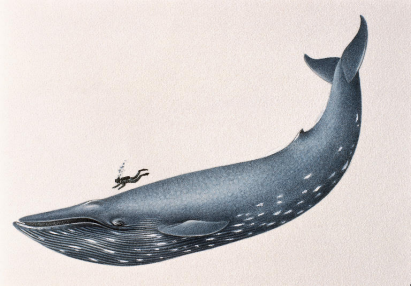
Additional extensions and background for the teacher to the lesson:

The parts of the lesson described above by grade level are aligned to Common Core standards. However, students can be encouraged to think beyond their grade level, to spur their curiosity and excitement about science.

This lesson is an introductory preparation for students to begin developing an understanding of the workings of Galileo's square cube law in biological applications. In this theory, as the surface area of objects/organisms/mammals grows, increases, and scales up, the volume/weight increases faster, since it is three dimensional. It will increase cubically while the surface area increases only by the square of the multiple. In other words, a one-unit cube would have a surface area of 6 faces times 1 unit squared and a volume of one unit cubed. If we double the length of the cube, it would now have a surface area of 2 units squared times 6 which would be 24 units squared (from 6 square units to 24 square units), which is 4 times larger. However, the 2 unit length must be cubed to get the volume which would be 2 times 2 times 2 or 8 cubic units which is 8 times larger. Since students at this grade level will not be working with surface area, this lesson's scope will only include one dimension, the length, as it compares to the rapidly increasing volume/weight of the creature. If we compare the length of a mammal to its volume/weight as a fraction with the length as the numerator, and the volume/weight as the denominator, we can help students see that the denominators get larger

than the numerators, much faster as the animal gets longer. As numerator size increases compared to denominator size, the ratio get smaller. For example, an animal at ten feet long, could have an approximate weight of one ton. At a length of 24 feet, the animal would be much heavier in comparison to its length. It would weigh 6 tons, which is a smaller ratio of 4 feet per ton. For this grade level we will use approximate quantities without decimals of very large mammals to compare. Students may be encouraged to see that because volume/weight increases quicker than length, such things as bones would need to be much bigger and stronger to support the much heavier animal. It can also be reasoned that there are size maximums in nature. Creatures, even humans, can only get so big before there are health issues. Even man made objects such as ships and buildings must follow this size limitation before structural fortifications would need to be implemented to accommodate the increased volume/weight.

Mammals Large and Small



Blue Whale: about 100 feet long and weighs about 300,000 pounds.

Elephant: about 24 feet long and weighs about 12,000 pounds.

Deer: about 4½ feet long and weighs about 90 pounds.

Cow: about 14 feet long and weighs about 2,800 pounds.

Moose: about 10 feet long and weighs about 1,000 pounds.

Tiger: about 8½ feet long and weighs about 320 pounds.

Horse: about 12½ feet long and weighs about 1,500 pounds.

Elephant Seal: about 20½ feet long and weighs about 6000 pounds.

Orangutan: about 5½ feet long and weighs about 125 pounds.

Hog Nosed Bat: about ¾ inch long and weighs about 1 ounce.
(1 foot per pound)

Red Fox: about 3 feet long and weighs about 30 pounds.

Gray Squirrel: about ½ foot long and weighs about 1 pound.
(1 foot for every 2 pounds)

Warm-Up

SBAC/Benchmark: Grade 3 MD.3

A teacher wants to buy ice cream for her class. Three students want chocolate, seven students want vanilla, and six students want strawberry.

Draw a scaled picture graph and bar graph to show the data.

- How many more students want vanilla than chocolate? Justify your answer.

Review: Grade 4 NBT.6

Divide:

$$320 \div 8$$

- Find the answer using three different approaches.

Current: Grade 4 NF.3c

A deer is $4\frac{1}{2}$ feet long.

A squirrel is $\frac{1}{2}$ foot long.

How much longer is the deer than the squirrel?

- Find the answer using three different approaches.

Other:

What do you think is the heaviest mammal to have ever lived on earth?

List three large mammals.

List three small mammals.

- Put your animals in order by size.

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