

What does a walleye weigh?

by Clay Burkett



Picture from the Montana Department of Fish Wildlife and Parks

Fishing is one of the most popular leisure time activities in the United States. In Montana, fishing is a wildly popular pastime. The movie “*A River Runs Through It*” introduced fly-fishing for trout to many moviegoers around the country and increased the number of people who visited Montana in pursuit of piscatorial pleasure. Walleye fishing, though not as widely practiced as trout fishing, experienced a surge in participation in the ‘90’s and many anglers spend much time on the water hoping to catch a few of these delicious freshwater fish.

Some people take their fishing frenzy to a higher level and stalk the wily walleye in weekend fishing tournaments. To win the cash prize offered at most of these tournaments, a team (pair) of fishers submits their five largest fish of the day to tournament officials at a “weigh boat” to see who has the most pounds of walleye caught that day. The interesting thing is, no one on the weigh boat actually weighs the walleyes—someone measures the fish in inches to determine its weight. Now here is a question for a person who is pondering how the length of a fish is related to its weight: Is there some kind of mathematics at work here?

Recreational fishers often have stick-on rulers applied on their boats for easily measuring the length on the fish caught. Some of these rulers include a table that relates the length to the weight of a fish for a given species. One such ruler has the following table for walleye:

Walleye Length vs. Weight

Length (inches)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Weight (pounds)	1.2	1.5	1.8	2.2	2.5	3.0	3.4	3.9	4.5	5.1	5.7	6.5	7.2	8.1	9.0	9.9

1. Using a graphing calculator, create a scatterplot of the walleye data—use length as the control variable (x) and the weight as the dependent variable (y). What type of equation has a graph that resembles the pattern you see in the walleye data?
2. Using the statistical feature of your graphing calculator, determine a regression equation for your data. Use the type of regression that you think resembles the data.
3. Graph the regression equation on the same axis as your scatterplot. Do you think the equation models the data well? Why do you think so?
4. A good mathematical model not only graphically represents the data, but conceptually represents the data as well. In order to help determine what kind of equation to use to

model the walleye data, you should consider the relationship between the length of an object and its volume (weight is a function of volume for a given object). To help understand this relationship, begin with a cube that has a side of one unit. What is the volume of this cube? Remember to include the units. Now take a cube with a side of two units—what is the volume of this cube? What is the volume of cubes with sides three and four units long? Make a table that relates the side and volume of these cubes.

Cubes

Length	1	2	3	4
Volume				

5. How do the volumes relate to the lengths of these cubes? Is this unique to cubes or does this relationship apply to other figures as well? To help you decide, you must have an understanding of similar figures.
6. What does it mean for figures to be similar? What is a scale factor and how does that apply to similar figures?
7. Use your cubes to construct two similar rectangular prisms and compare the scale factor of the prisms to the volume of the prisms. Do you see the same type of relationship as you did with the cubes? What is that relationship? Verify this relationship by comparing two other similar rectangular prisms.
8. Perhaps the relationship between the scale factor of similar figures and the volumes of these figures applies only to rectangular prisms. To see if the same relationship applies to other similar figures, sketch two similar cylinders (make sure to include the dimensions of the cylinders). Calculate the scale factor and the volumes for your similar cylinders ($V = \pi r^2 h$ for a cylinder). Does your relationship between scale factor and volume still work for cylinders? Do you think this relationship holds for all similar figures?
9. Describe the relationship you see between the scale factors and volumes of similar figures:
10. Complete the following numerical example of this relationship: If the ratios of the scale factors of two similar figures is 1:4, then the ratio of the volumes is _____.

Now, back to the walleye. While one walleye may not be mathematically similar to another, biologically they are similar. The biological similarity between the walleye allows us to use mathematical similarity as a model to predict the weight of the fish based on its length. When the length of one walleye is compared to the length of another, we have a scale factor between the fish. The ratio of the scale factors cubed is the ratio of the volumes of similar figures. Therefore, it stands to reason that a mathematical model for a walleye's weight based on its length would involve a cubic function. Take another look at the table comparing the walleye lengths and weights.

11. Use your graphing calculator to determine a cubic regression equation to model this length/weight relationship in the walleye. Graph your equation on the same set of axis as

the scatter plot of the walleye data. How well does this equation model the data? Is this equation a better model than the first one you chose? Why or why not? Use this model to predict the weight of a 31" walleye.

Below is a table relating northern pike lengths to their weight:

Northern Pike

Length (inches)	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Weight (pounds)	4.4	5.0	5.6	6.2	7.0	7.7	8.5	9.3	10.2	11.2	12.2	13.3	14.5	15.7	16.9	18.3

12. Make a scatterplot of this data and determine a cubic regression equation to model this length/weight relationship in the northern pike. Graph your equation on the same set of axis as the scatterplot of the pike data. Use this equation to predict the weight of a 24" pike, and a 41" pike. How long would a northern pike be if it weighed 25 pounds?
13. Summarize the mathematical relationship (concept) that allows a prediction of a fish's weight based on its length.

You have just experienced some of the work that might be done by a wildlife biologist. If you want to explore this further, a good resource is the Montana Department of Fish Wildlife and Parks (<http://fwp.mt.gov>) !