# How big are the fish?

Rather than taking length and weight measurements of thousands of individual fish, we use a much quicker and easier method of weighing a group of fish together and then counting the number of fish in the group:

1. Put a bucket partially filled with water on a scale and reset the weight reading to zero.
2. Net some fish from the pond, allowing the water to drain.
3. Place some of the fish from the net into the bucket of water and weigh it (this is measuring just fish weight, and does not include water weight).
4. Count the fish from the bucket back into the pond.

Now we've collected the basic information we need, we can determine fish size. At the hatchery, we commonly talk about fish size in terms of ***fish per pound***. We already know how many fish we counted, and we already know how much they weighed together. Now we just divide the number of fish by the total weight to get fish per pound (the word ***per*** means you have to divide).

Before we begin calculating fish size, let's review some important rules about math and fractions:

1. Anything divided by itself gives an answer of 1. For example, 5 ÷ 5 = 1.
2. Anything multiplied by 1 equals itself. For example, 5 × 1 = 5.
3. A fraction is just another way of expressing a ***division***. The top part of a fraction is called the ***numerator***. The bottom part is called the ***denominator.*** So any fraction can be restated like this: $\frac{\text{numerator}}{\text{denominator}} = \text{numerator} \div \text{denominator}$
4. If you have something in the numerator that is also found in the denominator, that thing will cancel out: $\frac{3apples}{4apples} = \frac{3}{4}$ Here's another example: $\frac{A \times B}{B} = A$
5. When two fractions are multiplied with one another, you just multiply the two numerators to produce the new numerator, and you multiply the two denominators to produce the new denominator: $\frac{2}{5} \times \frac{3}{7} = \frac{(2 \times 3)}{(5 \times 7)} = \frac{6}{35}$
6. The ***inverse*** of a fraction means making the numerator the denominator. The inverse of $\frac{A}{B}$ is $\frac{B}{A}$.
7. Dividing a number by a fraction is the same as multiplying that number by the inverse of that fraction. $5 \div \frac{A}{B} = 5 \times \frac{B}{A}$ Follow these steps to see why:
   a. First, for ease of illustration, we'll change the way we write $5 \div \frac{A}{B}$:

      $5 \div \frac{A}{B} = \frac{5}{\left(\frac{A}{B}\right)}$ (***Remember that we said in Rule 3 that a fraction is a division***).

   b. Next, we'll multiply by a form of 1 (***Remember in Rule 2 we said that multiplying by 1 does not change our original number***). In this case, our form of 1 is $\frac{B}{B}$ (***in Rule 1 we***

***said that any number divided by itself is 1***).

So here we go: $$\frac{5}{\left(\frac{A}{B}\right)} \times \frac{B}{B} = \frac{5 \times B}{\left(\frac{A \times B}{B}\right)} = \frac{5 \times B}{A} = 5 \times \frac{B}{A}$$

Now that we've gotten through all that, we can finally begin to calculate fish size. For this example, let's say our sample included 335 fish and weighed 2,238 grams. Since we are going to use pounds instead of grams, we first need to convert the grams to pounds (there are roughly 454 grams in a pound):

$$2{,}238 grams \times \frac{1.0 pounds}{454 grams} = 4.93 pounds$$

Two important points about the above equation:

1. Because 454 grams equals one pound, if you divide one by the other, you get 1 (see ***Rule 1*** above).
2. Multiplying 2,238 grams by a form of 1 (in this example, the quantity 1.0 pounds / 454 grams) does nothing to change the weight, instead it just changes how we talk about the weight (instead of talking about grams, we are now talking about pounds – see ***Rule 2*** above).

Now to get fish per pound, we divide the fish count (335 fish) by the sample weight (4.93 pounds):

$$\frac{335 fish}{4.93 pounds} = 67.96 fish\ per\ pound$$

This means that for every pound of fish weight in a pond, there are almost 68 fish.

## How many fish are there?

Now that we know how many fish are in a pound, we can use that information to put whatever number of fish we want into a pond. We call this doing an ***inventory***.

Once we have prepared an empty pond to receive a population of fish (cleaned it, installed screens and shade covers), we weigh nets of fish and send the fish to the pond through pipes with water running through them.

Let's say we want to put 110,000 fish in a pond and the fish are 67.96 fish per pound. How many pounds of fish do we need to weigh into the pond to get 110,000 fish?

We have two numbers

1. the number of fish needed: 110,000 fish
2. the number of fish in a pound: $\frac{67.96\,fish}{pound}$ (remember ***per*** means divide)

Rather than memorizing a special formula for calculating the necessary fish weight, we will determine what to do with these numbers by examining their units (***fish*** and ***fish per pound***) and then considering what units we want our answer to have (***pounds***).

> If we arrange our known information (number of fish and fish per pound) in a fraction so that the ***fish*** term cancels out (see ***Rule 4***) and the ***pounds*** term is left in the numerator, we will have the answer we are looking for:
>
> $$110{,}000\,fish \times \frac{pound}{67.96\,fish} = 1{,}618.6\,pounds$$
>
> So to put 110,000 fish in our pond, we need to weigh almost 1,619 pounds of fish into it.