Pond Volumes by Salinity and Back Calculation

Duncan Griffiths

All medication/treatment applications in garden ponds that are already full of fish are fraught with dangers from the miss-dosing of medications/treatments. At best if you get it wrong, you end up with the same problem you started out with (under dosing) and at worse you end up with a pond full of dead or traumatized fish (overdose). All this is dependant on both accurate measures and accurate pond volumes.

Most people measure the volume of the pond as it fills for the very first time with a water meter; for others it is possible to determine the volume by taking measurements and applying mathematics to determine the volume. Measuring the length x breadth x depth x 6.25 = UK gallons or length x breadth x depth x 7.48 = US gallons, only really works with geometric shapes. With anything oddly shaped or benched ponds, this method starts to get less accurate or even fails.

A lot of hobbyists when building their ponds; never think about the fish becoming ill and needing treatments. Based on this, it's a reasonable assumption that it also never occurs to them to accurately measure the volume of the pond. In any event, for many it's a specification of the pond that only occurs after the fish are added but by this time it's a lot harder to find this measurement out and of course by this time it's an important fact that needs knowing.

Fortunately there is another mathematical method using two separate salinity measurements and back calculating the difference between the two after adding a *known* measure of salt to the pond. It works on the assumption if we know any three out of four variables accurately, we can calculate the fourth pretty accurately. This measurement will include all the water in the pond and the filters also which is very important as we need to know total volume including all filters and pipe work not just the actual pond.

This calculation is not hard and you do not even need to know why it works just commit the simple formula and method to memory or print it off and use it with the satisfaction that it can and does work and can be a lot more accurate than meters that are out of calibration and that you have no idea how accurate they are. So let's see how it works.

First we need to *accurately* measure the pond current salinity this can be done with either a electronic salinity/conductivity meter of the stick type or probe and meter type. You can also use a chemical titration kit of which there are a few available, take three stable measurements to be sure.

Do not use a hydrometer as they are useless for this purpose being not at all accurate

On measuring Bob's pond's salinity, this is found to be 0.11% or 1.1ppt (Parts per Thousand) salinity. So obviously Bob has added some salt at some point. Bob has no idea what the volume of his pond is, but medicates his pond based on what he believes his pond to be 2000 UK/imp Gallons.

Important at this point we don't add or take away any water, if you run a trickle in and out or RO system, turn this off till the final calculation has been made.

Second, once we are happy with this base line reading we can now add some more salt and raise the salinity of the pond. The amount of salt we put in must be significant to make a noticeable change without distressing the fish and most important this amount must be weighed and recorded accurately, there is not set amount we just need to know accurately how much salt was used.

In this case we add 70 lb of salt and left it for 24 hours to circulate and fully spread out over the pond and equalize out

Third, after the 24 hours period we then took another salinity reading from different parts of the pond

The new salinity reading is 0.65% or 6.5 PPT (parts per thousand)

This is all we need to know now to calculate the volume. We know what the original salinity was: 1.1PPT; we know it is now 6.5 PPT and we used 70lb of salt and it went from 1.1PPT to 6.5 PPT.

If we measure in percentages we must convert to PPT for the calculations to work

The equation we will now employ therefore looks like this

$$\textbf{Pond volume in UK Gallons} = \frac{(100 \times Z)}{(C2 - C1)}$$

Important the 100 in the equation stay the same in every calculation

C1 is the starting salinity and C2 is the newly raised salinity after the added salt.
Z is the number of lb's used to raise the salinity from C1 to C2 in our example 10lb

The 100 is arrived at like this, 1PPT (parts per thousand) is 1 lb of salt added to 1000lbs of water more precisely 999lb's of water 1000lb's of water is 100 UK gallons give or take

The same equation, with a minor adjustment, works for US gallons. Everything stays the same but we substitute 120 for 100 to give the answer in US gallons (20% different).

$$\textbf{Pond volume for US Gallons} = \frac{(120 \times Z)}{(C1 - C2)}$$

Our UK example looks like this

$$\textbf{Bob's Pond volume} = \frac{(100 \times 70)}{(6.5 - 1.1)} = \frac{7000}{5.4} = 7000 \div 5.4 = 1296 \text{ UK gallons}$$

So as you can see Bob's assumption was 704 gallons under, he was overdosing by significant amount.

The above calculation is very, very accurate but is dependant on you being able to measure the salinity C1 & C2 accurately and weigh and record the amount of salt used Z accurately
And during the C1 and C2 stage not adding or taking any water away
If you can't or are not able to do any of these do not attempt this calculation

Let's do another one

First salinity test C1 = 0.05ppt we then add 55lb of salt and allow it to circulate for 24 hours

We do a test and find we have a salinity of or a C2 of 2.15

The equation looks like this

$$\textbf{Fred's Pond volume} = \frac{(100 \times 55)}{(2.15 - 0.05)} = \frac{5500}{2.1} = 5500 \div 2.1 = 2619 \text{ uk gallons}$$

Rules

If you measure salinity in % you must convert to PPT (part per thousand) for the calculation eg 1% = 10 PPT, 0.5% = 5ppt if your gauge measure in PPT no problem.

Do not use a hydrometer.

For the C1 and C2 measurements, measure each three times and allow 24 hours for the salt to disperse between C1 and C2

The more salt you use the more accurate this method gets, but do not add more salt than is good for your fish, don't overdose and put your fish into osmotic shock.

Do not add or take any water away during the whole procedure

Whatever amount of salt you use, you must accurately measure that amount of salt used accurately. Further remember damp or wet salt weighs heavier than dry salt so moisture must be taken into account or errors will occur (when you add wet salt the weight will be both water/moisture and salt so the actual salt will not be as great as the measured amount)

Use a new unopened bag of vacuum dried salt

Finally if you don't think you can accurately measure your salinity or accurately weigh out the salt, don't do the calculation it would be pointless! It would be a moot point! It will be wrong, there is no point getting into this level if accuracy if it fails on measures and calculations

Inaccuracies and failure mode analysis

To demonstrate the importance of measuring the salinity correctly and/or weighing the salt accurately lets look at how a simple but very small error can affect the outcome by taking the first example Bob's correct pond calculations

$$\text{Bob's Pond volume} = \frac{(100 \text{ X } 70)}{(6.5 - 1.1)} = \frac{7000}{5.4} = 7000 \div 5.4 = 1296 \quad \text{UK gallons}$$

In Bob's pond all things being equal and accurate we can see his pond worked out to 1296 gallons

But lets say due to moisture in the salt the actual weight of salt when taking that moisture into account or rather not taking it into account the salt added was just 5lb light and was 65 lb (which is not a lot when weighing salt but the scales were telling us it was actually 70lb the equation now looks like this

$$\text{Bob's Pond volume} = \frac{(100 \text{ X } 65)}{(6.5 - 1.1)} = \frac{6500}{5.4} = 6500 \div 5.4 = 1203 \quad \text{UK gallons}$$

That places us 93 gallons light or about a 7% inaccuracy

Similarly if we now say we weighed out 78lb when in fact we weighed just 70lb it looks like this

$$\text{Bob's Pond volume} = \frac{(100 \text{ X } 78)}{(6.5 - 1.1)} = \frac{7800}{5.4} = 7800 \div 5.4 = 1444 \quad \text{UK gallons}$$

148 gallons over about an 11.5% error

Ok lets take salinity errors again with the same example let make an error in salinity readings and instead of it being 6.5ppt and 1.1 ppt respectively we now have an error on both readings so we now have 5.5ppt and 1.5 the equation now looks like this

$$\text{Bob's Pond volume} = \frac{(100 \text{ X } 70)}{(6.1 - 1.5)} = \frac{7000}{4.6} = 7000 \div 4.6 = 1521 \quad \text{UK gallons}$$

225 gallons over or a 17.5% error

Now let's put the two errors together and say we totally screwed up

$$\text{Bob's Pond volume} = \frac{(100 \text{ X } 80)}{(6.1 - 1.5)} = \frac{8000}{4.6} = 8000 \div 4.6 = 1739 \quad \text{UK gallons}$$

A 443 gallon over 34% error

I think I have proved how fast and how far these errors can occur if you're not careful, but the exact thing same applies to all measuring systems on a pond to no lesser degree. Having said all that its still a very accurate measure if readings and measures are carefully and accurately done and as such it makes it potentially more accurate than certain other measures and certainly a lot better than guessing the pond volume and there is no reason for anyone now not to know their exact pond volume

Ref Norm Meck

My thanks to Norm Meck San Diego koi club