WATER: MORE THAN MEETS THE EYE

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IF YOU DO NOT REGULARLY TEST YOUR WATER, *YOUR FISH ARE GOING TO DIE*. IT IS NOT A MATTER OF "IF" BUT ONLY A MATTER OF "WHEN"!

This article addresses two of the most important tests that you can and need to do to keep your fish alive and healthy.They are pH, and kH.

I cannot tell you how many times people have told me their fish were sick or dying in large numbers, but they didn't know why. When I start asking if they have tested any water parameters, they seem to dismiss my question and tell me that their water is fine because it is crystal clear, and that they have never had any problems over "X" number of years. This is an extremely incorrect assumption on their part!

The average pond will take up to three years to fully mature and or show signs of poor design and maintenance. In this time, the water is constantly changing due to many chemical and biological factors, as well as fish growth, weather, amount of feed given, type of feed and protein content, the addition of non-quarantined fish and plants etc. Basically, these individuals have been LUCKY, and for a multitude of reasons, and in a poorly designed and maintained system, the bad things could start to happen at this point.

Even if your water is crystal clear, it can be as deadly as the battery acid in your car's battery(that's clear too!). Most toxins or sudden chemical changes in your pond which hurt your fish, will almost never affect your water clarity. Also think of this: How many natural bodies of water, other than some small streams, are clear? As a matter of fact, most natural lakes or ponds that are clear are somewhat sterile, and usually have low numbers of aquatic life in them.

In natural bodies of water, plankton (microscopic plants) are the beginning of the food chain and play an important role in the overall fish-carrying capability of that body of water. This plankton is eaten by small invertebrates which, in turn, are eaten by small fish, which in turn, are eaten by larger fish, and so on. In intensive aquaculture, such as fish farms utilized to grow food fish, the water is actually fertilized to promote planktonic growth.

This plankton is a form of microscopic algae and give the water its greenish color as found in most natural lakes or ponds. This greenish tint is referred to as an "algae bloom." These blooms are maintained on a constant basis and measured with a special underwater instrument called a ?secchi disk. In general, the preferred secchi depth is usually 12" to 18". As you might guess, the visibility in these bodies of water is very limited due to the algae bloom. For those of you who are interested, this is the beginning of farm/mud pond management, and this is something to be encouraged and nurtured.

But for now, we will be discussing our man-made ornamental ponds.

In understanding the above and how it works in nature, you should understand that in the average ornamental pond housing Koi/goldfish, the green water would inhibit our ability to see our fish. We need our ponds to be crystal clear, but, as you can see, we are already going against nature by doing so. Also, the small size of our ponds leaves them susceptible to quick and drastic changes both chemically and thermally.

In nature, a fish's environment is fairly stable, and it usually has an inflow of fresh water of some sort, as well as an outflow of older water. Therefore they would be considered flow-through systems, and require much less work and monitoring. Our ornamental ponds are lacking these important factors, as they are closed/recirculation systems, and these require much more attention. We also tend to greatly overstock our manmade ponds well above what nature would allow. All of these are reasons we must keep a constant watch on the water.

It is vital to understand that fish are mainly comprised of fluid, housed in a thin layer of skin, living in a fluid environment. Therefore, any change in their environment has an immediate impact on them. This is the reason we must keep our ponds as stable as possible, both chemically and thermally. Fish are designed by nature to be "one" with their watery world, and nature's waters are designed to be stable. Our ponds are not.

Many things, such as rain, sunlight, runoff, pollution, etc., as well the many biological and chemical actions that occur in it, influence water. Nitrification (see The Nitrogen Cycle), respiration of the fish, and photosynthesis are just some of the biological/chemical factors, which will affect a pond's overall make-up and stability.

Below, I will attempt to give you a very basic understanding of how to maintain and control some of these processes, with the main focus being the Koi/goldfish pond. I hope it doesn't frighten you away from ponding, as it really isn't that difficult to do or understand. It is important, though, that you have read and understand "The Nitrogen Cycle" before moving on to these slightly more advanced topics.

pH

pH (potential of hydrogen) is something most of you have heard of, but I find that most people really do not understand its role in fish keeping, or its great effect on the fish. pH is basically a measurement of how acidic, alkaline, or neutral your water is, and is measured on a scale of 0-14.

To get even more technical, it measures the number of hydrogen ions on the acid end, in comparison to the number of hydroxyl ions on the alkaline end, with a pH of 7 being neutral. A neutral pH of 7 simply means that there are an equal number of hydrogen ions as hydroxyl ions. A pH of 8 means your water is alkaline compared to neutral, and has more hydroxyl ions than hydrogen ions and so on.

It is also very important to understand that each single digit increase or decrease above or below neutral is ten times more alkaline or acidic than the neutral reading of 7. Therefore, for every single digit change above or below neutral there is a tenfold difference. So, as

you can see, any sudden change of pH of one digit or more is a drastic chemical change and could be detrimental to your fish.

Koi and goldfish do best in a pH of between 7.0 and 8.6, **but even more important is how stable it is diurnally (in the process of a day).**

The proper way to check pH, is to take two readings. One should be taken in the early morning and the other should be taken in the late evening on the same day and preferably the same weather conditions. In doing so, you should not have more than a .3 (three tenths) difference between the two readings. If your local pond store is any good, you will notice they usually carry different ranges of pH test kits.

There are "wide range" kits which, as the name implies, measure the total scale of pH from 0-14 in one, or half-digit increments Then there are the "high range" kits which, as their name implies, measure a small range of pH above the neutral pH of 7, say 7.4-8.6 only. The "wide range" kits are used to get you an initial reading and to let you know in general what your pH is, but they are not capable of showing you any difference in pH in less than one half-point increments.

In other words, you can only read from 0-14 in one half-point increments. The "high range" kits will narrow the reading down to a smaller scale (once you know the general range your pH runs from the "wide range kit" and give you more accuracy in smaller increments. These smaller increments are important for you to be able to measure changes of less than one half point. Remember, you do not want your pH to fluctuate more than .3 (three tenths), so you will need to use the "high range" kit to verify this.

pH of the water is vital to the fish, in that the fish need to maintain a given (the same as the water) pH level in their blood to stay healthy. Remember how closely linked a fish is to its environment? It IS its environment! As mentioned above, for Koi to be healthy, they need a pH in the range of 7.0-8.6, and more importantly they need the pH to stay ***stable*** somewhere in that range. Internally, they are capable of counteracting pH swings, but only to a degree of a three tenths change per day. Ultimately,the change should be zero.

If the water becomes too acid or alkaline, and swings in one direction or the other, the fish have a means of adding acids or bases to their blood to counteract the changes, but they cannot do this very quickly, and they cannot easily counteract a change of more than three tenths. If the water becomes too acid or too alkaline too quickly, or if the pH goes outside that species' healthy range for too long, the fish are in danger of getting conditions such as Acidosis or Alkalosis. Both of these conditions can be detrimental to them and kill them.

Let's talk now, in detail, about what things have an impact on the stability of the water's pH. Many things, which get introduced into our ponds either naturally or by us, will eventually break down into either acid or alkaline ions and alter the pond's pH. Also, certain chemical and biological processes that occur naturally in the pond can add acids or cause a change in the pH.

Carbon dioxide from the air, for example, will get into the pond and create carbonic acid, and lower the pH of the pond by adding acids. Also, when fish breathe through their gills, or when any life form in the pond respires, they create carbon dioxide gas. When this gas comes into contact with water it to turns into **carbonic acid.** Note the word "acid"....so, when this acid is created in the water it will lower the pH . Plant life, on the other hand, during the day and through the process of photosynthesis, uses up carbon dioxide/ (therefore no carbonic acid is formed) and will therefore allow the pH to raise. At night, the reverse occurs. Algae blooms (green water) string algae, carpet algae, and any form of algae will also raise the pH value, because as a plant, the algae also removes carbon dioxide/carbonic acid, and therefore raises the pH.

The "Nitrogen Cycle" in your filter will also affect your pH. During this process, the nitrifying bacteria will release nitric and amino acids as a byproduct in their conversion of ammonia and nitrite, therefore lowering your pH as well. So as you can see, the more activity in your biofilters, the more likely the kH is to deplete more rapidly. Feed protein rates also affect the biofilter activity, and the higher the protein, the harder the nitrification process must work. The same holds true for periods of lots of plant growth, or an extreme amount of water plants being held in the pond. The more plant life there is (including any form of algae) the more likely the kH will be depleted rapidly. This is why the depletion of kH greatly varies from one pond to another, as each pond comes with varying degrees of the above discussed issues that affect the kH depletion.

The other dangers brought about by all of these acids being produced, is a pH crash. Let's say your pH runs at or near neutral. Now, think about all of those acids being injected into the pond as discussed above. With the pH being near neutral, you could be in danger of these acid excretions dropping the pH quickly, and below 7. This is a pH crash, and will kill your fish. This is where we come to the buffering capacity of your water, and its' kH level.

kH (carbonate hardness or total alkalinity)

As you can see, there are many things that can cause your pH to fluctuate, and most of them will cause the pH to drop. For this reason, it is vital to constantly monitor the pond"s pH. Now you might be wondering what you can do about all of this if you do see diurnal fluctuations in your pH of more than .3 (three tenths).

That brings us to kH, also known as alkalinity, total alkalinity, and/or temporary hardness. Call it what you want, but in ponding circles it is usually referred to simply as kH, **and is in my opinion one of the most important parameters to monitor.** kH is the buffering capacity of your water, and is usually measured in dKH (degrees of harness) or PPM (parts per million). As acids are introduced by the varying methods described above, it is the kH (carbonates) which instantly neutralize them and keep them from making your water more acidic and causing pH changes or crashes. Without the proper kH levels to counteract these things, your pond is a ticking time bomb, and all of your fish are at risk.

These carbonates/kH are used up each time they neutralize these acids, and it is for this reason that we must monitor their levels. Think of it like this: Pretend the kH level of

your pond is a "Tums" antacid sitting there. When acids are excreted by whatever, the "Tums"/kH instantly neutralize them.Over time, the kH can get used up, just as a "tums" might. If you eat something spicy, and it gives you indigestion, you must take an antacid. If you eat something else spicy after that you will most likely have to take more antacid. This is exactly how the kH buffers your water, and you have to understand that there is a minimum level to accomplish this, and that it gets used up over time.Therefore the kH has to be monitored on a regular basis, and you will have to most likely replenish it.

Acceptable kH levels for our ponds would be between 80 and 200 PPM depending on many factors as discussed above. If you have lots of pond plants, algae growth, green water, heavy fishloads, and high feed rates, to name a few, than you should try to maintain the higher end numbers between 150 PPM to 200 PPM. In the average pond maintaining a kH of 150 ppm is usually more than sufficient. With this level of carbonate hardness, you should not see very much change in the daily pH values, and you will be protected from the dreaded "pH crash"!. It is possible however, that in times of extreme plant growth in your pond, that the pH can fluctuate more than the three tenths, but as long as you maintain the proper kH levels, the fish will be fine.

Now, let's say you get a kH test kit and it only gives you your kH readings in degrees of hardness. To convert degrees of hardness to PPM, simply multiply by 17.9. For example, if your kit tells you your kH is 5 in degrees of hardness, simply multiply 5 times 17.9 to get the equivalent in PPM. In this case the PPM would be 89.5 PPM, and would fall in the acceptable range we want.

Raising kH

If you test your kH and it falls below the minimum 80 PPM, then you need to raise it gradually. This is done by simply adding sodium bicarbonate (baking soda). But, remember the importance of keeping the fish's environment stable? Well, it is for this reason that you should never raise your kH more than 20 PPM per 24-hour period. For example, if your kH was 40 PPM, you will have to add the baking soda twice over a 48-hour period, with each addition being 24 hours apart, to get it to the minimum 80 PPM.

NOTE: You should recheck your kH reading 24 hours after each addition of baking soda to make sure it is not increasing more than desired due to some sort of miscalculation on your part, such as pond gallonage or baking soda measurement, etc. Also, you must be aware that baking soda has a consistent pH of 8.4, and will raise the pH of your pond to this figure if it is below that. Also, be sure to check your ammonia in your pond before the addition of baking soda. Ammonia becomes much more toxic as the pH rises above the neutral reading of 7,so if you have any ammonia in your pond I would not recommend the addition of the baking soda until you get the ammonia to 0 ppm.

The general rule of thumb for increasing your kH is by 20 PPM increments every 24 hours, by adding ½ cup of baking soda per every 1,000 gallons of pond water. For smaller volumes you would add about 1/4 TEASPOON for every 10 gallons of water to raise the

kH 20 PPM. Remember, however, to recheck your kH and pH 24 hours after each addition. It is also wise to keep an eye on your fish for any adverse reactions during this period, but if you have calculated correctly, there should be none. You would have to be off tenfold to really see a negative reaction from the fish.