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UNDERSTANDING WATER QUALITY REPORTS FOR YOUR POND

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Water quality tests are a very useful tool for pond owners who wish to manage their ponds to support the best possible fish population, and in some cases, water chemistry amendments are necessary in order to improve or support viable fish populations. There are tests that pond owners can use to determine the type and quantity of chemical compounds present in the water, which in turn provide insight into biological and chemical processes that are occurring.

However, as impressive as these capabilities are, they are of no practical use if the pond owner cannot interpret them or determine the necessary amendments to best improve their pond. This article will explain how to understand a water quality report from the point of view of a fisheries manager. In addition, it will explain the best water quality amendments to typical problems that are encountered and provide criteria to have a viable pond (acceptable range) or a more productive pond (desired range) for fish populations.

Depending on where water quality reports come from, be it Texas A&M or another university, agency, or private lab, the units may differ; just remember that parts per million (ppm) are equivalent to milligrams per liter (mg/L).

CALCIUM (CA)

Desired Range:

Greater than 20 ppm (mg/L)

Acceptable Range:

Greater than 5 ppm (mg/L)

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Calcium in some aquifers, especially in Texas, which was once an inland sea that left behind substantial calcium deposits, can be extremely high. Calcium in excess of 400 ppm can be detrimental to some species of fish but is generally not a problem for most common sportfish species in Texas.

Importance:

The eggs and fry of some fish species are sensitive to unstable pH. Therefore, stabilizing pH is of utmost importance and can be achieved by ensuring that total hardness derived from calcium is proportional to total alkalinity. Elevated concentrations of calcium also improve the survival of larval and juvenile fish in waters with low pH. Calcium is an essential element for fish osmoregulation and metabolism and is also critical for egg and larval development. Low concentrations of calcium can impede proper development of offspring, ultimately resulting in poor recruitment of the fishery.

Amendments:

If calcium concentrations exceed 400 ppm, amendment is often not possible except for in the smallest bodies of water, such as ornamental ponds and water gardens. In these cases, water softeners or reverse osmosis water can be employed to lower calcium concentrations, but care must be taken not to increase total salt concentrations to the point that they become detrimental to fish.

If calcium is below the desired concentration, but the total alkalinity concentration is also low and in proportion (approximately 1:1 ratio) to total hardness, then the addition of crushed calcitic agricultural limestone (ag lime; calcium carbonate) can be added to raise calcium concentrations while improving alkalinity and hardness. If calcium and total hardness are below the desired concentrations, but alkalinity concentrations are as desired, gypsum (calcium sulfate) or calcium chloride can be added to increase the calcium and hardness concentrations without increasing the alkalinity concentrations.

TOTAL DISSOLVED SALTS (TDS)

Desired Range:

Less than 3,000 ppm (mg/L); 3 ppt (g/L)

Acceptable Range:

Less than 10,000 ppm (mg/L): 10 ppt (g/L)

Importance:

Some salt ions (salinity) are required, as fish cannot survive in pure water due to problems with osmoregulation and removal of waste products at the gills. In general, freshwater pond species survive best in pond water that contains less than 3,000 ppm salinity, but many common pond species can survive in up to 10,000 ppm salinity; otherwise, the environment becomes too marine for their survival. For instance, channel catfish survival may become extremely reduced at salinities above 7,000 ppm salinity, and while adult largemouth bass will survive, bass reproduction becomes severely reduced at salinities above 8,000 ppm.

Amendments:

If the total dissolved salts are too low, non-iodized livestock salt (sodium chloride), or stock salt, may be added to increase total salinity to above 500 ppm. Total dissolved salts greater than desired concentrations can be amended by diluting with low-salinity well water or by draining the pond and allowing it to refill with rainwater. If the salinity is consistently too high, it may be best to consider stocking with marine (brackish) tolerant species such as blue catfish, hybrid striped bass, Atlantic croaker, or red drum with gizzard shad as a forage species.

CHLORIDE (CL)

Desired Range:

50 to 100 ppm (mg/L)

Acceptable Range:

Greater than 5 ppm (mg/L)

Importance:

Chlorides play important roles in osmoregulation, recovery from stress, and the prevention of brown blood disease, which can become an issue for fish populations during the winter.

Amendment:

If chloride concentrations are low, the recommended amendment is to add common stock salt (sodium chloride), a non-iodized salt sold for livestock purposes.

BICARBONATE AND CARBONATE

Bicarbonate and carbonate are major constituents of alkalinity. The total alkalinity of water is made up of these compounds along with carbon dioxide. While important due to their contributions to total alkalinity, which is extremely important to managing water chemistry, these components are not managed individually. Therefore, any necessary amendments are based on total alkalinity and pH.

TOTAL ALKALINITY

Desired Range:

50 to 150 ppm (mg/L)

Acceptable Range:

Greater than 20 ppm (mg/L)

Concentrations greater than 400 ppm (mg/L) may become detrimental.

Importance:

Alkalinity is the capacity of an aqueous solution (pond water) to neutralize acid. This is important in order to maintain a stable pH, as rapid or large shifts in pH can stress fish and even lead to death in extreme circumstances. Total alkalinity is the concentration of bases, primarily carbonate and bicarbonate, in the pond water. Alkalinity, if present at sufficient concentrations, can reduce rapid changes in pH. Additionally, primary productivity, which is a measure of planktonic algae production that forms the basis of a pond's food chain, becomes limited when the total alkalinity falls below 30 ppm. Algae sequester carbon from carbon dioxide, carbonate, and bicarbonate during photosynthesis.

Amendment:

The addition of crushed agricultural limestone (ag lime; calcium carbonate) can be used to raise alkalinity to desired concentrations. The alkalinity in most ponds naturally decreases over time, and many ponds benefit from (if not require) the addition of lime every 5 to 7 years in order to maximize a pond's fishery, although some ponds may need to be limed more frequently. For more information, see *Liming Your Pond to Improve the Fishery* at *https://aquaplant.tamu.edu/files/2022/02/liming-your-pond-to-improve-the-fishery.pdf*. If the alkalinity concentration is too high, but the hardness is acceptable or low, gypsum (calcium sulfate) can be added to precipitate excess bicarbonate as calcium carbonate (limestone) and thus lower alkalinity.

pH

Desired Range:

6.5 to 9

Acceptable Range:

5.5 to 10

Importance:

Alkalinity and pH are strongly associated, but pH is not a measure of alkalinity, and alkalinity is not an indication of pH. A pond's pH may be within the desired range but have low alkalinity, leaving the fish vulnerable to large or rapid changes in pH. pH is not stable or constant within a pond, changing during the course of a day as photosynthesis occurs and carbon dioxide concentrations vary. It is important for pH to remain within acceptable ranges, as outside these ranges fish become stressed, leaving them more susceptible to disease, and the environment becomes detrimental to both fish growth and larval survival.

Amendment:

As the primary cause for extremes in or rapidly varying pH is low alkalinity, the recommended amendment is again the addition of agricultural lime (calcium carbonate), which increases the bicarbonate concentration in the water.

TOTAL HARDNESS

Desired Range:

50 to 150 ppm (mg/L)

Acceptable Range:

Greater than 20 ppm (mg/L)

Importance:

Total hardness is a measure of divalent ions in water, primarily calcium, magnesium, and in some cases, iron. Elevated concentrations of calcium improve the survival of larval and juvenile fish in waters with low pH. Calcium is necessary for bone and scale formation, blood clotting, and other metabolic reactions in fish. Fish absorb calcium directly from the water or from food. Sufficient free calcium helps reduce the loss of other salts, such as sodium and potassium, from the fish. If calcium is insufficient, fish must use energy supplied by food to re-absorb lost salts. This limits the energy available for growth. Additionally, the hardness concentration in a pond affects what concentration of phosphorus should be during fertilization programs. Higher concentrations of calcium require greater rates of phosphorous fertilization.

Amendment:

If the total hardness *and* alkalinity of pond water are lower than recommended, a common amendment is to add agricultural lime. However, many times water contains sufficient alkalinity but low hardness. In these instances, gypsum (calcium sulfate) needs to be added to improve hardness without increasing the alkalinity.

One of the largest points of confusion on many reports is that hardness is reported twice. In one location, hardness may be listed as grains of calcium carbonate per gallon and elsewhere listed as ppm of calcium carbonate. These two units are essentially different measures of the same thing; each grain of calcium carbonate per gallon is roughly equivalent to 17 ppm of calcium carbonate. In terms of fishery management, the primary attention should be focused on the hardness concentration in ppm.

MAGNESIUM (MG)

Magnesium is generally not limiting in freshwater, although it may require supplements in some marine or brackish ponds supporting marine species.

SODIUM (NA)

Sodium is a major constituent of salt in water. In general, a relatively low sodium concentration is considered more desirable. In freshwater environments, sodium concentrations are not a concern for pond owners unless the concentration exceeds 1,000 ppm *and* the total dissolved salts exceed 3,000 ppm.

BORON (B)

Boron is often a topic of concern for pond owners in Texas, where the groundwater has exceptionally high boron concentrations when compared to other parts of the country. Boron is capable of concentrating in water and in the soils of the pond bottom but has no immediately known detrimental effects to fish populations. If pond water is used for any other purpose, such as livestock watering or irrigation, then excessive levels of boron will need to be evaluated.

SULFATE (SO_4)

In Texas groundwater and well water, sulfate, like boron, can have higher-than-normal concentrations compared to other areas of the country. Sulfate can range from 0 to greater than 1,000 ppm. It is generally not a concern for fish populations unless the water is being used for other purposes, such as watering livestock or irrigating crops.

NITRITE (NO_2^-)

Desired Range:

Less than 0.5 ppm (mg/L)

Acceptable Range:

Less than 1.0 ppm (mg/L)

Importance:

Nitrite is a toxic substance to fish, but the susceptibility varies from species to species, with lethal concentrations to kill most fish species being 2.0 ppm during a 96-hour or shorter exposure time. If an issue of excess nitrite is not appropriately addressed, it can result in brown blood disease becoming prevalent in the pond due to changes in the fish's hemoglobin to methemoglobin.

Amendment:

As mentioned previously (chloride), the best method for lowering nitrite toxicity in a pond is through the addition of chloride ions from stock salt (sodium chloride) and maintaining a chloride concentration 10 times that of the nitrite concentration.

NITRATE (NO_3^-)

Desired Range:

Less than 10 ppm (mg/L)

Acceptable Range:

Less than 50 ppm (mg/L)

Importance:

Nitrate, unlike nitrite and ammonia, is only mildly toxic to fish. Therefore, nitrate generally does not require any active management until the concentrations exceed 50 ppm.

Pond owners wanting to determine if their water will support a fishery or if they need a pond-clearing test can send their water samples to the Texas AgriLife Extension Service Aquatic Diagnostics Laboratory *(https://fisheries.tamu.edu/aquatic-diagnostics-lab/).* A base water chemistry analysis for freshwater ponds should be ordered to determine water chemistry and concentration, while a water-clearing treatment test and a base water chemistry analysis for freshwater ponds should be ordered for those interested in clearing a muddy or turbid pond. Reports provide detailed water chemistry concentrations as well as recommended amendments to correct any issues found. Please note that Aquatic Diagnostics Laboratory personnel cannot comment on reports from other labs or at-home readings.

If there are any questions or if any portion of the water quality report needs to be clarified, a Texas A&M AgriLife Extension Service Fisheries Specialist or other state fisheries manager can be consulted.

See also: Stone, N., Shelton, J. L., Haggard, B. E., & Thomforde, H. K. (2013). *Interpretation of Water Analysis Reports for Fish Culture* (SRAC Publication No. 4606). Southern Regional Aquaculture Center, United States Department of Agriculture.

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