

Water Quality BMP's

The Key to Good Fish Husbandry

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Aquaculture Realism

- “A Severely or Chronically Stressed Fish is a Dead Fish”
 - Severe stress is typically caused by a sudden event, causing death within minutes or up to a day.
 - Chronic stress is longer term exposure to poor living conditions, causing impairment to the immune system.
 - “A chronically stressed fish is a diseased fish and then eventually a dead fish”

An Interesting Insight

- “A Successful Fish Culturist is not successful because he or she is a successful biologist, physiologist etc”;
- “No, he or she is successful in large part because he or she is a successful water quality and aquatic waste management specialist”.
- “If you successfully degrade generated fish wastes and uneaten food safely and therefore maintain excellent water quality, the fish will take care of themselves”.

Water Quality BMP I

- **Set Realistic Production Goals!**
 - In aerated Midwest ponds, a realistic production goal is 3000 pounds of fish per acre. Above that requires increasing the pond's ability to digest additional wastes.
 - In RAS systems, production is based on gallons of water (living space) and the size of the filtration systems. ½ lb. per gallon of water.
 - In flow-through systems, production is essentially based on gallons of water and exchange rate. Flushing of wastes.



Water Quality BMP II

- Monitor the Right Parameters & Know Why!

- Water temperature
- Dissolved oxygen
- pH
- Nitrogen compounds
 - Nitrite
 - Ammonia
 - Un-ionized ammonia
- Alkalinity
- Carbon dioxide



SRAC has fantastic factsheets on water quality!

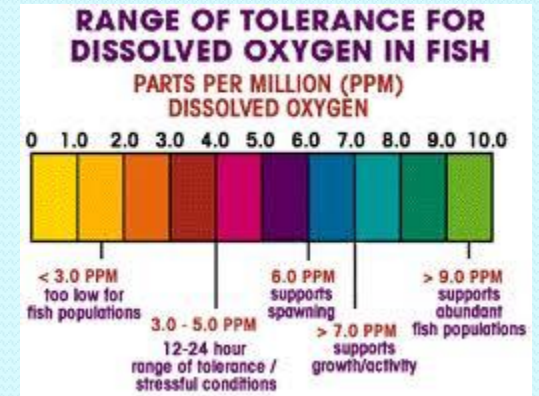
Water Temperature

- Each fish species has upper lethal thermal limits. Ex. Rainbow trout will start dying once water temps exceed 68 F.
- Elevated water temps can cause stress, leading to health issues.
- High water temps also negatively impact biological degradation of wastes. Bacteria less efficient!
- **Needed to calculate un-ionized ammonia levels!**



Dissolved Oxygen

- Less than 4 ppm can lead to chronic fish stress, less than 3 ppm can lead to fish deaths.
- Dissolved oxygen utilized by fish, plants, and bacteria.
- Bacteria most efficient in degrading wastes need oxygen! **Aerobic bacteria.**
- Strong pattern of daily and seasonal variation.



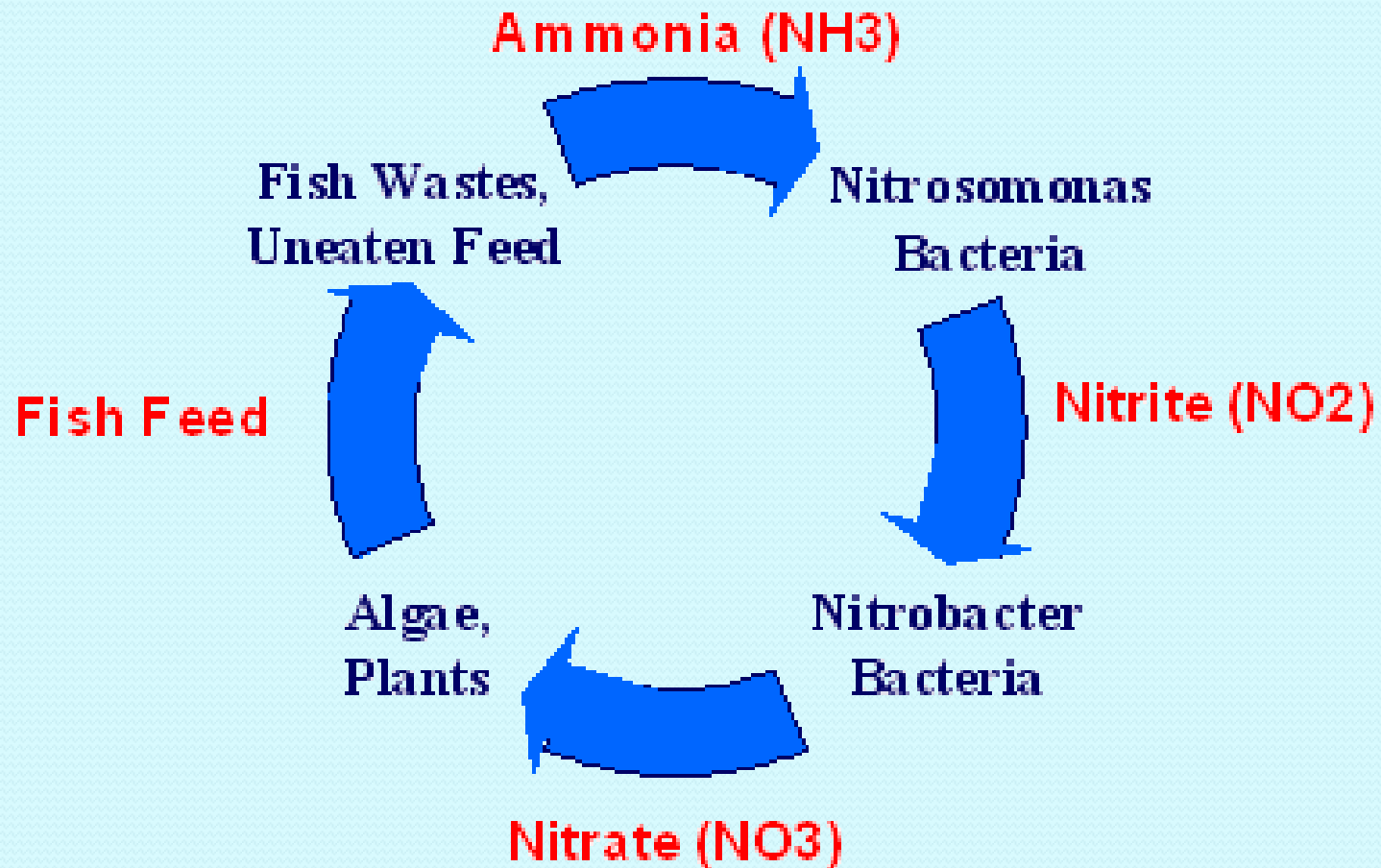
pH

- Most fish species tolerate 6.5 – 9.0 well, chronic exposure to lower & higher can become problematic. Avoid sudden changes!
- Bacteria critical to waste degradation function best at levels between 7.0 and 8.5.
- **Needed to calculate un-ionized ammonia levels!**
- Can be done with a meter! Easy!
- Higher pH in glaciated Ohio, 7.5 -9.0 common. 7.0 – 8.0 in Eastern Ohio.
- Strong daily variation due to carbon dioxide levels, which is related to plant & algae density.



Nitrogen Compounds

Ammonia/Nitrogen Cycle



Nitrogen Compounds

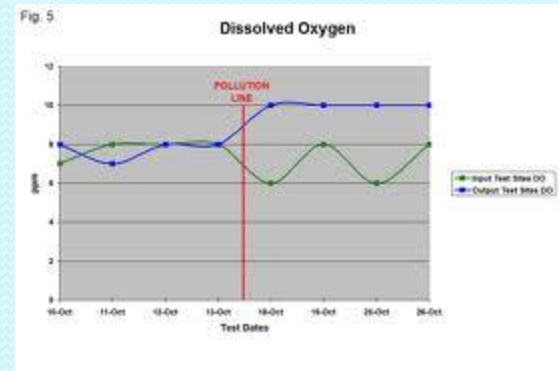
- Nitrate (NO_3)
 - Non-toxic up 200 ppm. Aquatic plants / algae quickly uptake nitrates.
- Nitrite (NO_2)
 - **Very toxic to fish at very low levels, causes brown blood disease.**
 - Fortunately, quickly converted to nitrates by bacteria.
 - Rare in ponds, a real concern in tank culture.
- Total Ammonia (TAN)
 - Ionized ammonia (NH_4^+)
 - Not toxic at typical pond levels, be careful in RAS!
 - Un-ionized ammonia (NH_3)
 - **Reduced feeding at 0.06 ppm, mortality above 0.6 ppm.**
 - Levels increase with higher pH and water temperatures.

Water Quality BMP III

- **Regularly monitor water quality parameters!**
 - Oxygen / Temperature (AM)
 - Daily in ponds during warm weather and periods of heavy feeding. Once every 2-3 days otherwise.
 - Twice a day (12 hrs. apart) in RAS systems.
 - pH, nitrites, ammonia
 - Once every 2-3 days in ponds during warm weather and periods of heavy feeding. Weekly otherwise.
 - Twice a day in RAS systems.
 - Carbon Dioxide, Alkalinity
 - Weekly in ponds.
 - Daily in RAS systems.
- Conditions can degrade very quickly in RAS systems, requires daily monitoring & attention.**

Water Quality BMP IV

- Religiously record water quality data and set parameter goals!
 - Allows one to monitor trends, can be proactive in preventing a potential problem.
 - Provides a written historical record to look back over when similar concerns arise.
 - A fish health specialist / veterinarian will always ask to look at recent water quality data when problems arise.



Water Quality Goals (0.5 m)

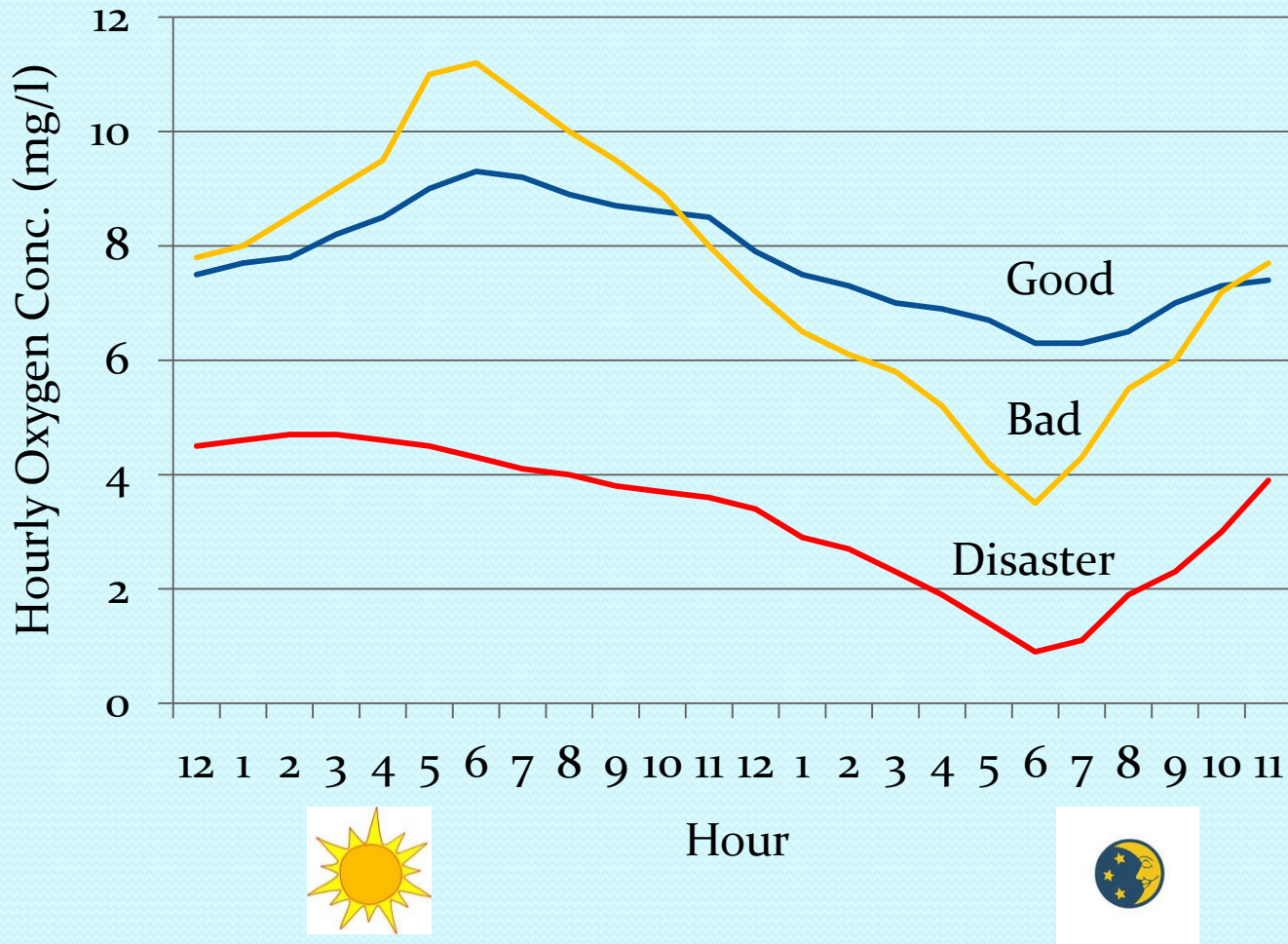
- Typical Published
 - AM Oxygen > 4 ppm
 - pH 6.5 -9.0
 - Hardness > 20 ppm
 - Alkalinity > 90 ppm
 - Nitrites < 0.05 ppm
 - Carbon dioxide < 20 ppm
 - Ammonia < 1 ppm
 - Un-ionized ammonia < 0.06 ppm
- Millcreek Perch Farm's
 - AM Oxygen > 5 ppm
 - pH 7.5 – 8.5
 - Hardness > 80 ppm
 - Alkalinity > 150 ppm
 - Nitrites < 0.02 ppm
 - Carbon dioxide < 5 ppm
 - Ammonia < 0.5 ppm
 - Un-ionized ammonia = 0.02 ppm

Water Quality BMP V

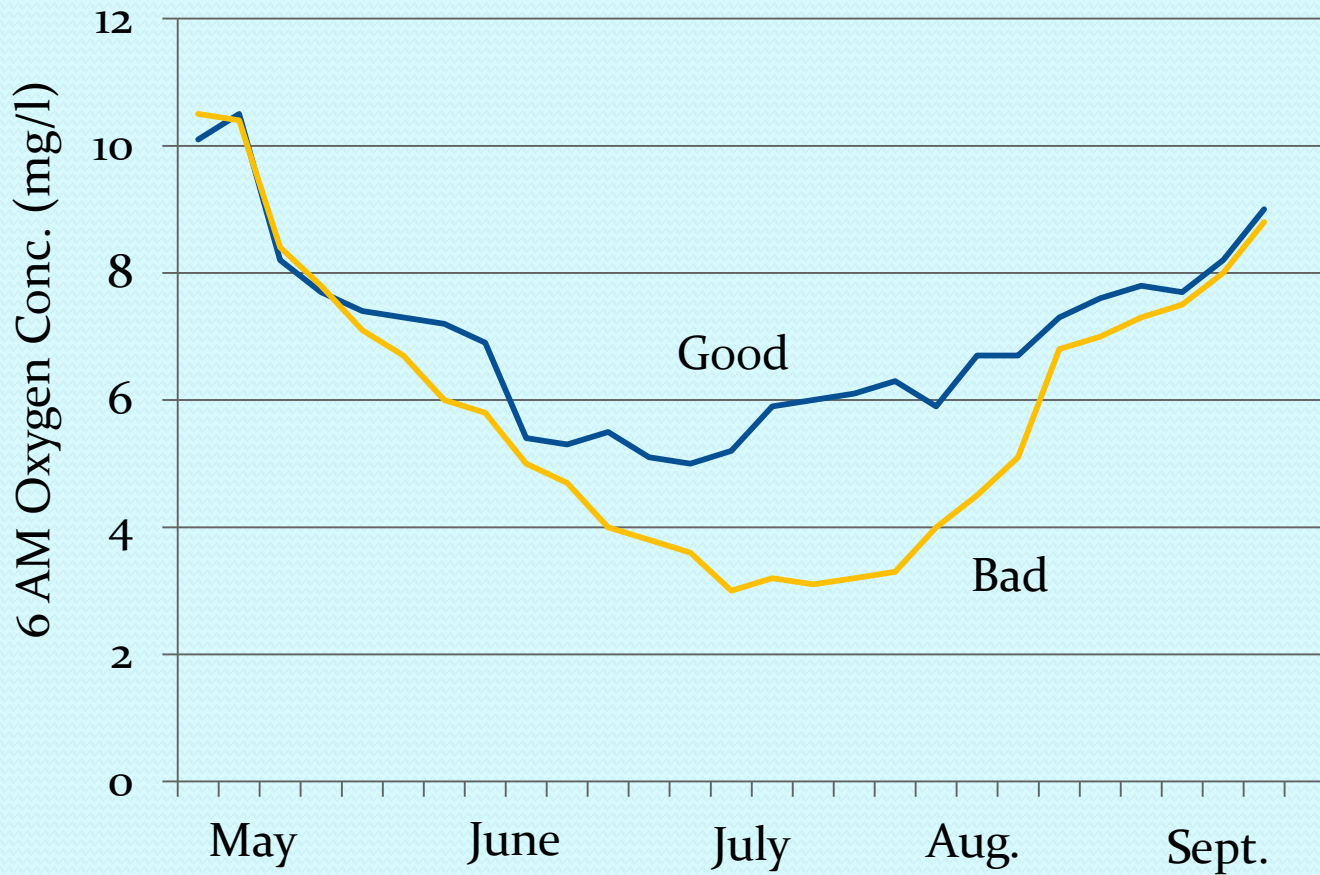
- **Monitor Water Quality Trends**
 - Trend monitoring allows assessment of how the production unit is functioning, whether it is a pond or a recirculating aquaculture system (RAS).
 - Allows assessing impacts of changes to the unit, such as increased feeding.
 - Can alert culturist to impending problems, thereby allowing a corrective action(s) to be instituted early.
 - **Water quality must be monitored regularly to allow development and evaluation of trends.**

Oxygen: Daily Variation

(do monthly in ponds / weekly in RAS)

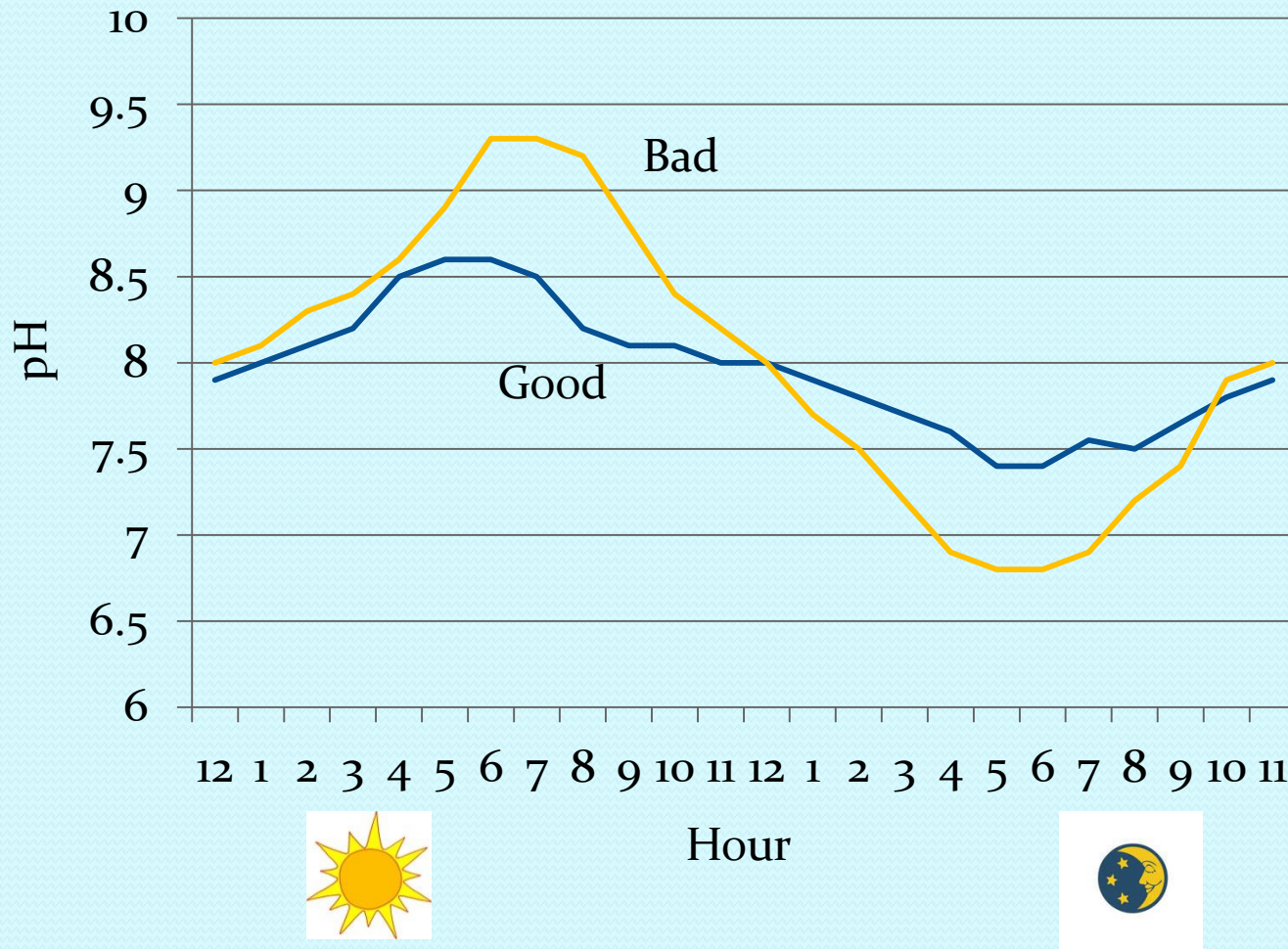


Oxygen: Growing Season Variation



pH: Daily Variation

(do monthly in ponds / weekly in RAS)



Water Quality BMP VI

- Understand Factors that Influence Water Quality Parameters

- Sunlight / Photosynthesis
- Seasonal
- Water temperature
- Amount of aquatic plants / algae / planktonic algae
- Bacteria
- Interactions between monitored water quality parameters as well as above factors.

The image displays two fact sheets from the Southern Regional Aquaculture Center (SRAC). The top sheet is titled "Managing Ammonia in Fish Ponds" and discusses ammonia levels, their effects on fish, and management strategies. The bottom sheet is titled "Interactions of pH, Carbon Dioxide, Alkalinity and Hardness in Fish Ponds" and explains the chemical relationships between these parameters. Both sheets include a map of the Southern United States and the SRAC logo.

Managing Ammonia in Fish Ponds

Ammonia is toxic to fish at elevated levels. It is produced by fish excretion, uneaten feed, and decomposition of organic matter. Ammonia levels should be monitored regularly. Management strategies include: increasing water volume, increasing aeration, and using biofilters. Ammonia levels should be kept below 0.5 mg/L.

Interactions of pH, Carbon Dioxide, Alkalinity and Hardness in Fish Ponds

Water quality is affected by the interaction of several chemical components. Carbon dioxide, pH, alkalinity, and hardness are interrelated and can have significant effects on fish health. pH and carbon dioxide are particularly important. pH is a measure of the acidity or basicity of water. Carbon dioxide is a gas that dissolves in water and forms carbonic acid. Alkalinity is the water's ability to resist changes in pH. Hardness is the concentration of calcium and magnesium ions in water. The relationship between these parameters is complex and can be summarized by the following equation: $\text{pH} = \text{pK}_a + \log \left(\frac{[\text{Alkalinity}]}{[\text{CO}_2]} \right)$. This equation shows that pH is directly proportional to the logarithm of alkalinity and inversely proportional to the logarithm of carbon dioxide concentration.

pH and carbon dioxide

The relationship between pH and carbon dioxide is a key factor in water quality management. pH is a measure of the acidity or basicity of water. Carbon dioxide is a gas that dissolves in water and forms carbonic acid. The relationship between these two parameters is summarized by the following equation: $\text{pH} = \text{pK}_a + \log \left(\frac{[\text{Alkalinity}]}{[\text{CO}_2]} \right)$. This equation shows that pH is directly proportional to the logarithm of alkalinity and inversely proportional to the logarithm of carbon dioxide concentration.

Figure 1. pH scale showing recommended range.

The figure shows a pH scale from 0 to 14. The recommended range for most aquaculture systems is between 7.0 and 8.5. The scale is divided into three regions: Acidic (pH 0-7), Neutral (pH 7-8.5), and Alkaline (pH 8.5-14). The recommended range is highlighted in the neutral region.

Education! Education!

- Be a life-long learner!
- Use all sources of information on water quality, fish health, and fish husbandry.
 - State extension programs
 - Factsheets, bulletins, published articles, websites (SRAC)
 - Workshops
 - Other culturists!
- Create, review and re-work your own **Water Quality & Fish Husbandry BMP** – it is a living document.