



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 close aquaculture friend recently told me “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!

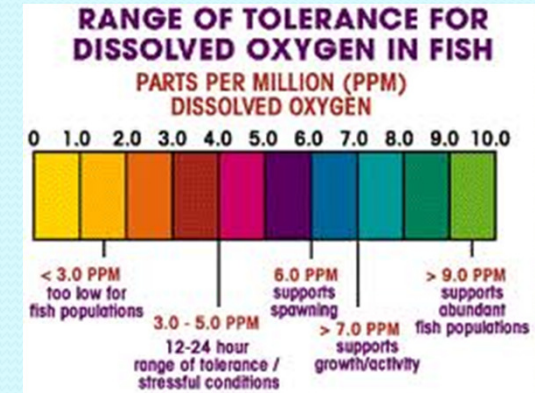
Water Temperature

- 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

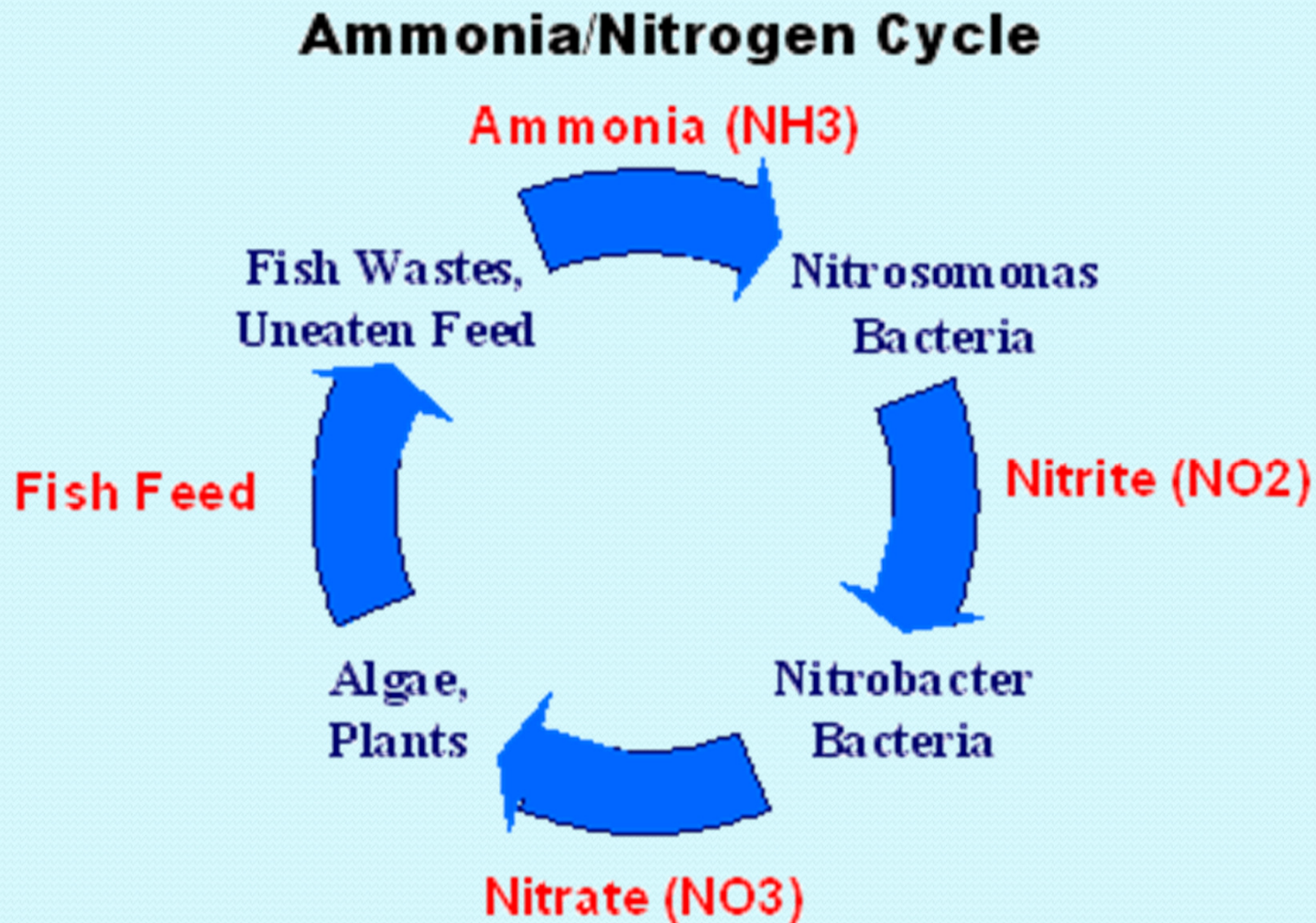
- Less than 4 ppm can lead to chronic fish stress, less than 3 ppm can lead to fish deaths.
- Dissolved oxygen utilized by fish, plants, and bacteria.
- Bacteria most efficient in degrading wastes need oxygen! **Aerobic bacteria.**
- Strong pattern of daily and seasonal variation.



- 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



Nitrogen Compounds

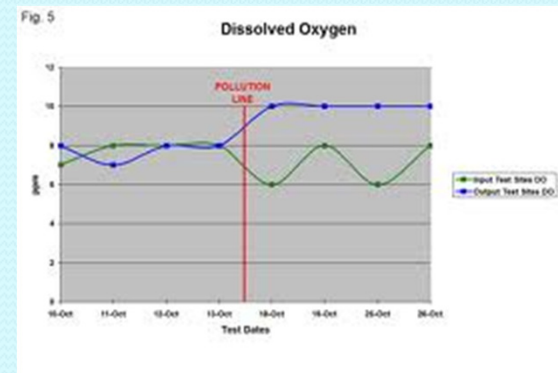
- Nitrate (NO_3)
 - Non-toxic up 200 ppm. Aquatic plants / algae quickly uptake nitrates.
- Nitrite (NO_2)
 - **Very toxic to fish at very low levels, causes brown blood disease.**
 - Fortunately, quickly converted to nitrates by bacteria.
 - Rare in ponds, a real concern in tank culture.
- Total Ammonia (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)

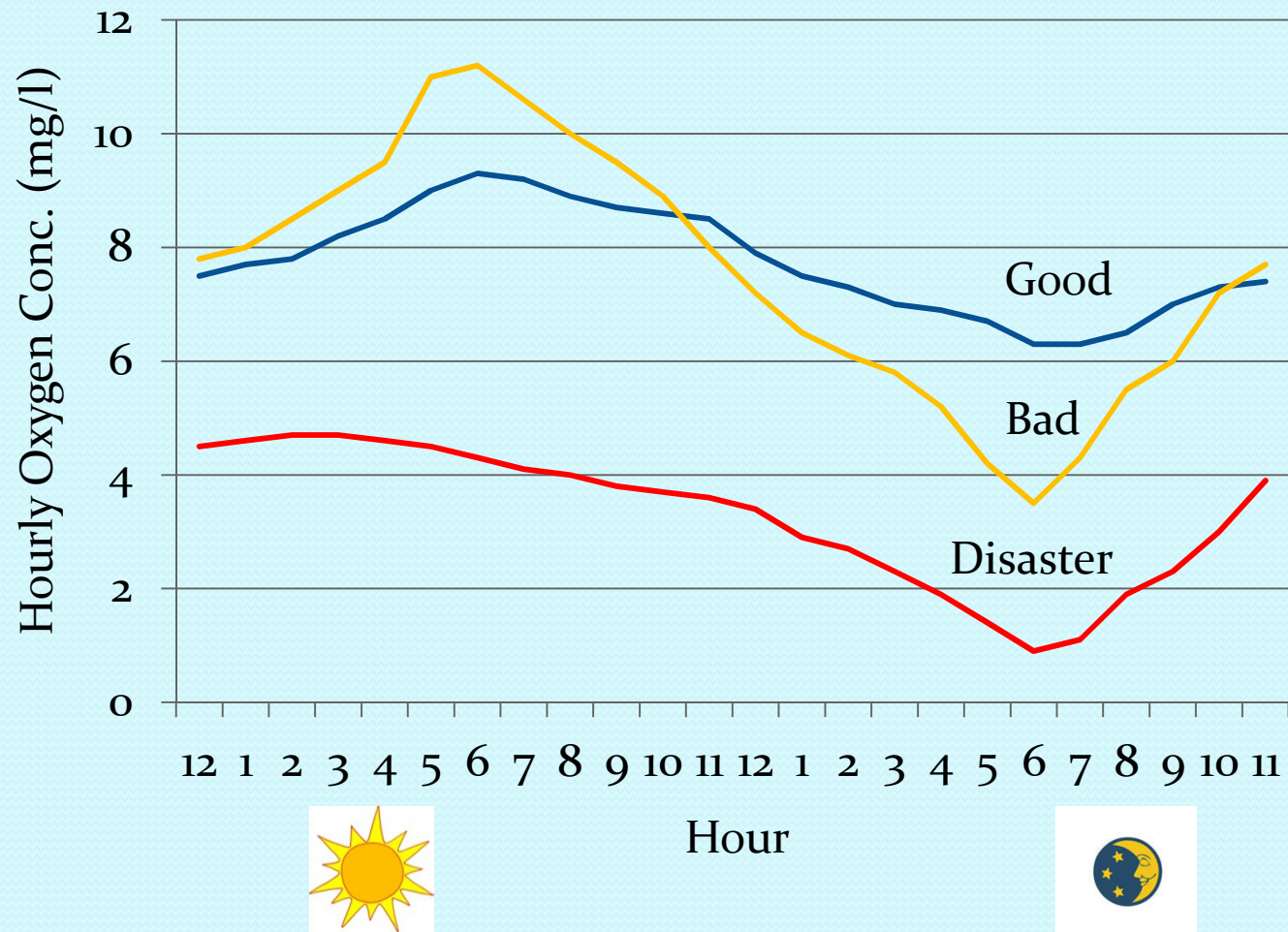
- Typical Published
 - AM Oxygen > 4 ppm
 - pH 6.5 -9.0
 - Hardness > 20 ppm
 - Alkalinity > 90 ppm
 - Nitrites < 0.05 ppm
 - Carbon dioxide < 20 ppm
 - Ammonia < 1 ppm
 - Un-ionized ammonia < 0.06 ppm
- Millcreek Perch Farm's
 - AM Oxygen > 5 ppm
 - pH 7.5 – 8.5
 - Hardness > 80 ppm
 - Alkalinity >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

Water Quality BMP V

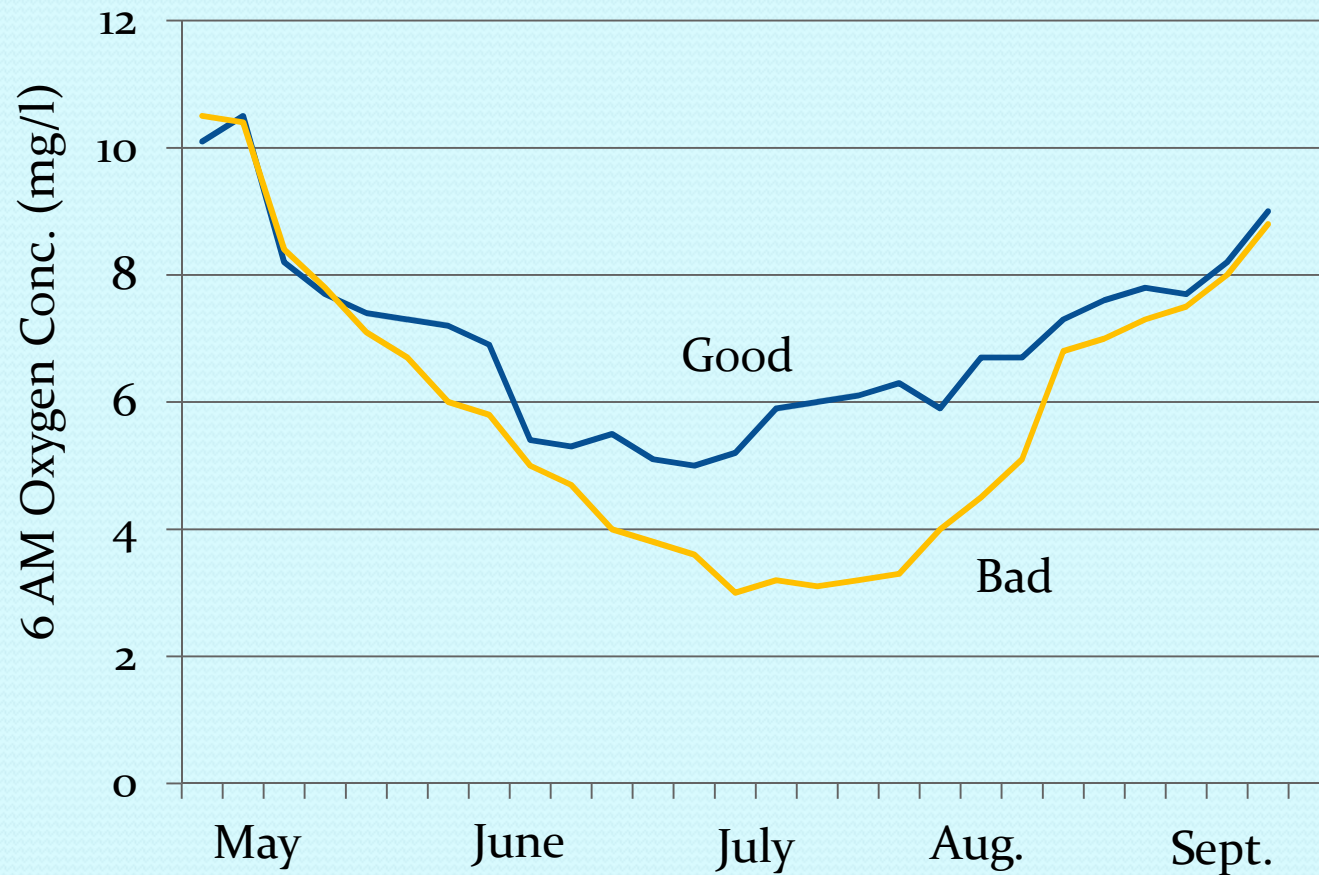
- **Monitor Water Quality Trends**
 - Trend monitoring allows assessment of how the production unit is functioning, whether it is a pond or a recirculating aquaculture system (RAS).
 - Allows assessing impacts of changes to the unit, such as increased feeding.
 - Can alert culturist to impending problems, 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)

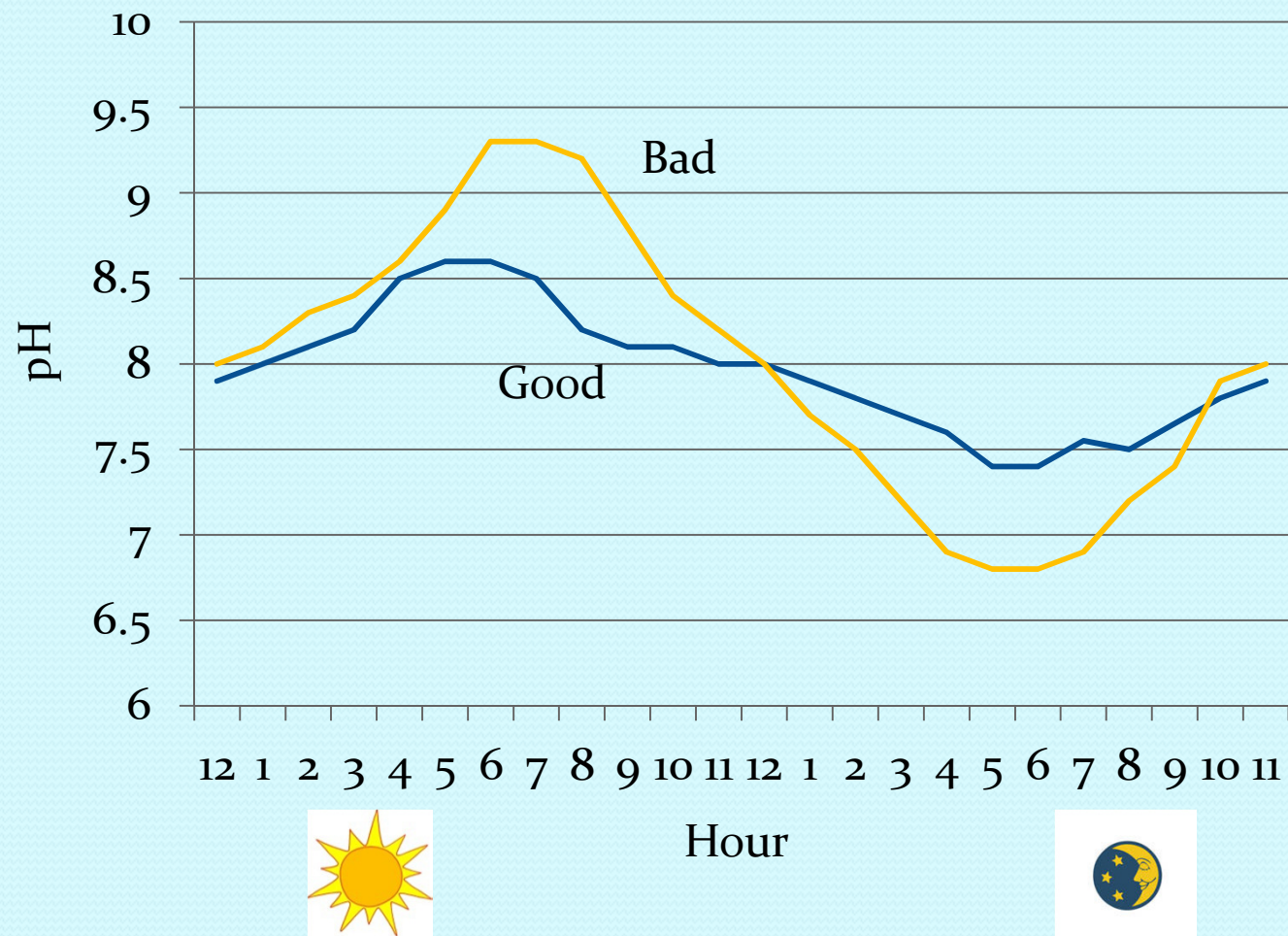


Oxygen: Growing Season Variation



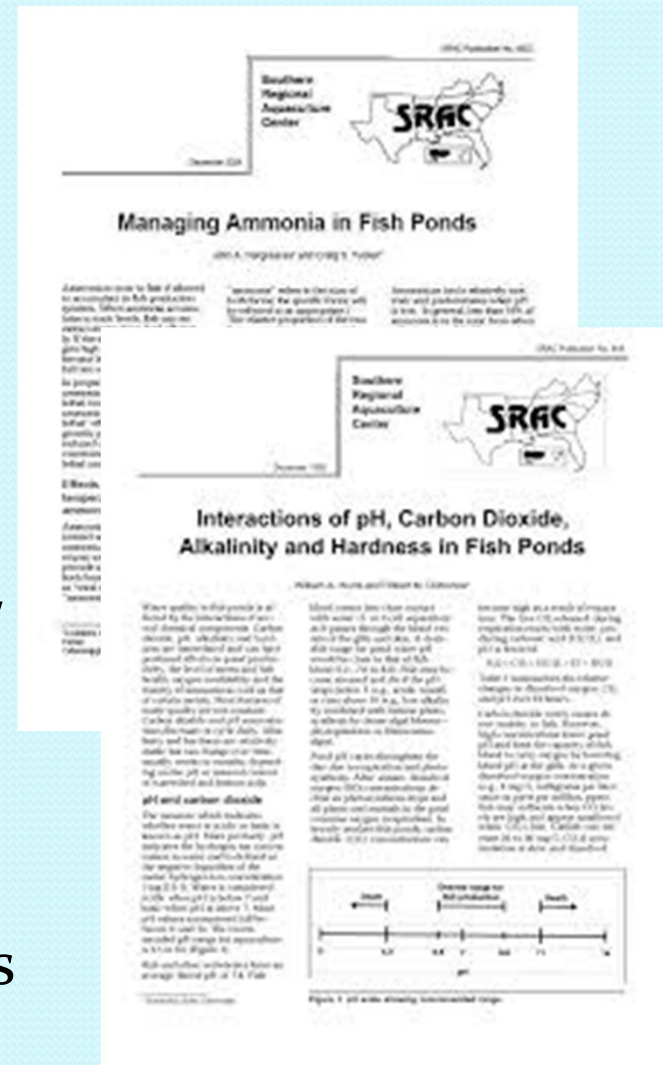
pH: Daily Variation

(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.



Factors Affecting Daily & Seasonal Oxygen Levels

- Sunlight
 - Sunlight produces oxygen, BOD uses oxygen at night.
 - Cloudy days lower daylight oxygen production, affecting night levels.
 - After June 21, losing daylight.
- Water temperature
 - Warm water holds less oxygen than cool water.
- Amount of aquatic plants / algae / planktonic algae
 - “Choked” greenery elevates daytime oxygen to very high levels but night levels are very low (Respiration).
 - Sudden die-off of planktonic algae major cause for concern.
 - Aquatic plants / filamentous algae do not die-off suddenly unless you do it!

More Factors Affecting Daily & Seasonal Oxygen Levels

- Feeding
 - Lower oxygen levels during periods of heavy feeding.
 - Begin to elevate a pond's BOD quickly once feeding exceeds 15 lbs per day per acre.
 - There is a feed / waste cumulative effect.
- Fish size
 - 2nd year growout equals higher feed amounts in June, July, & August as compared to 1st year fingerlings.
- Aeration
 - Nighttime oxygen levels can be raised with vigorous surface aeration.
- Volume of oxygen-less water
 - Increased volume of "hypolimnion" lacking oxygen lowers night levels.

Water Quality BMP VII

- **Aerate your bacterial community!**
 - Pure oxygen in high-density RAS; bottom diffusers, or direction surface aeration in ponds.
 - Prevents water column oxygen stratification in ponds.
 - Better oxygen profile, including oxygen along the pond bottom.
 - Improves aerobic bacteria abundance & efficiency.
 - Enhances conversion of ammonia into harmless nitrates.
 - Keeps un-ionized ammonia levels at very low levels if not zero.



Water Quality BMP VIII

- **Encourage / Tolerate a Diverse Aquatic Plant Community!**
 - Combination of algae & submerged plants.
 - Mitigates seasonal and daily “boom & bust” oxygen levels prevalent in ponds dominated by planktonic algae.
 - Improves aerobic bacteria abundance & efficiency due to increased surface area on plant stems & leaves
 - Enhances conversion of ammonia into harmless nitrates.
 - Keeps un-ionized ammonia levels at very low levels if not zero.



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.

Questions?