Un-ionized Ammonia

an Insidious Troublemaker in Culture Ponds

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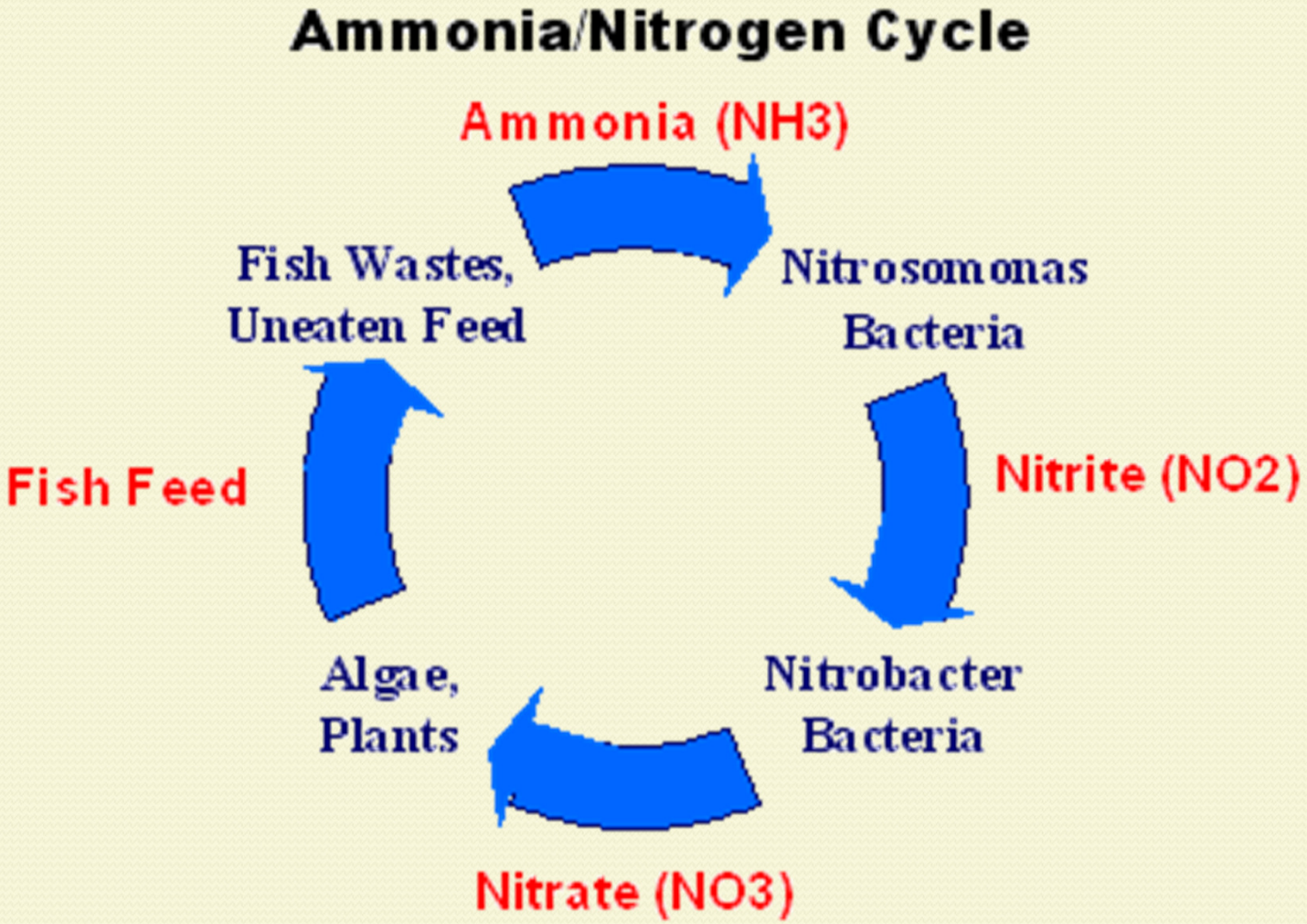
An Interesting Insight

- 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 nitrogenous fish wastes and uneaten food safely and therefore maintain excellent water quality, the fish will take care of themselves”.

Nitrogen Compounds

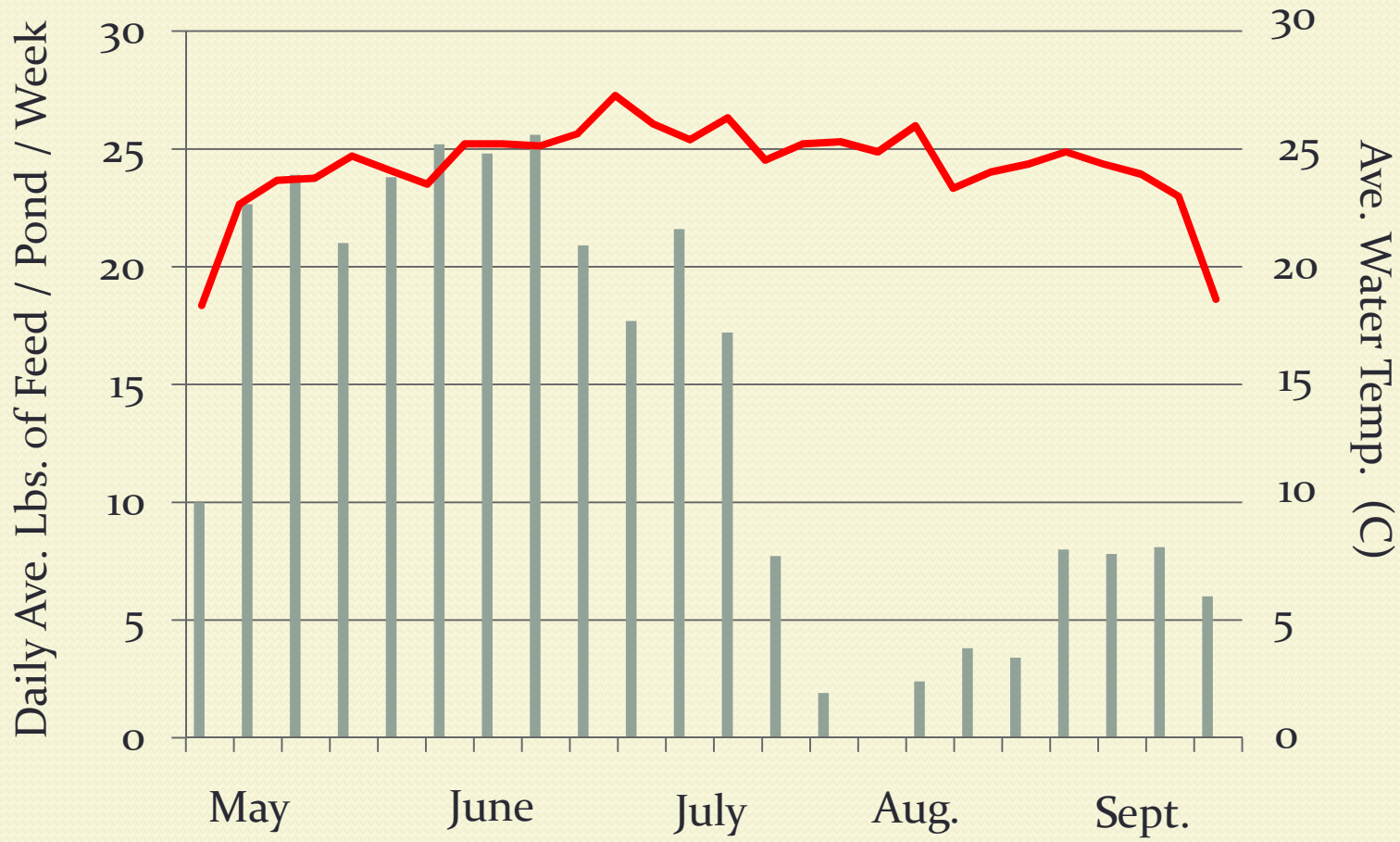


Nitrogen Compounds

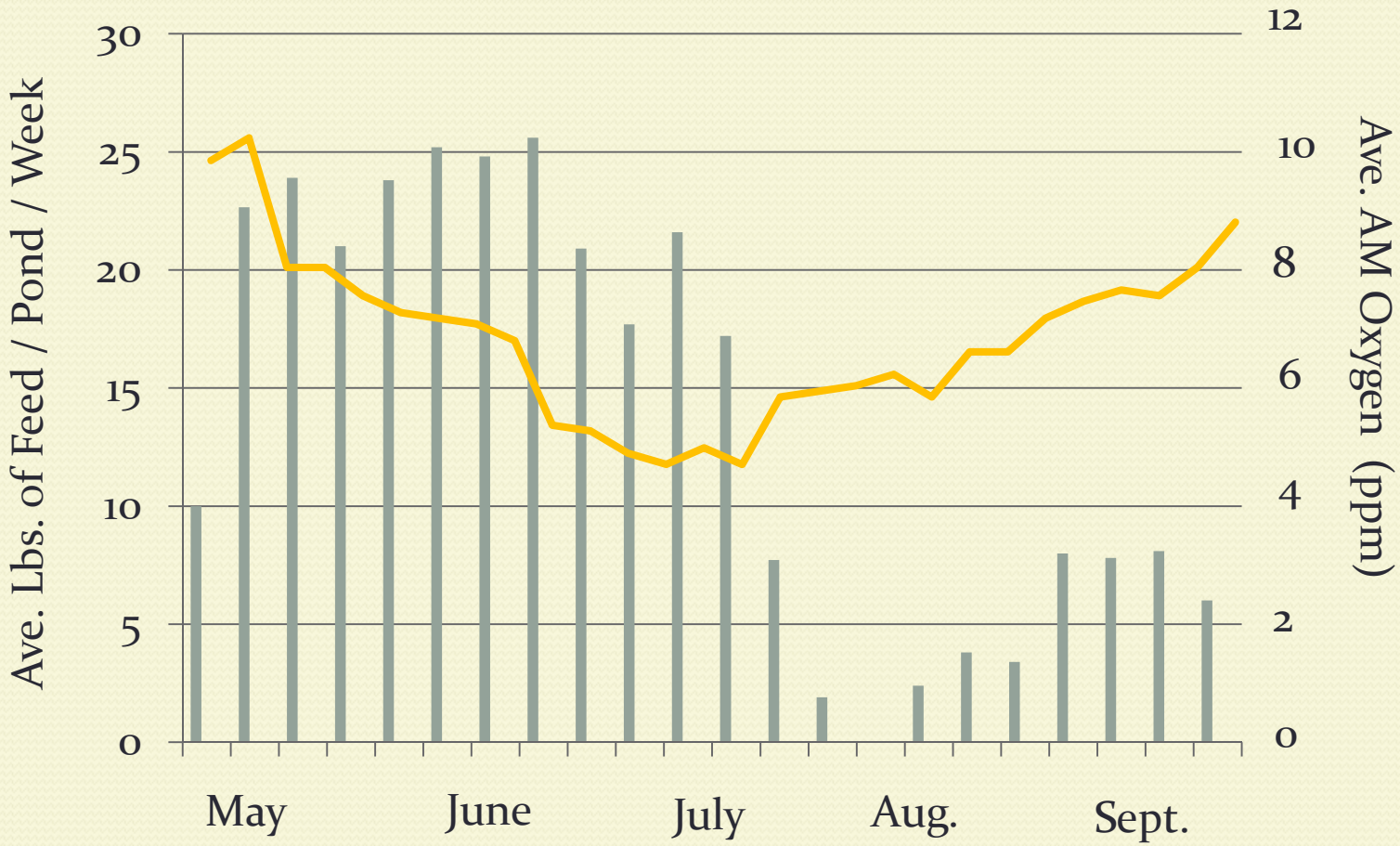
- Nitrate (NO_3)
  - Non-toxic up 200 ppm. Aquatic plants / algae quickly uptake nitrates.
- Nitrite (NO_2)
  - Very toxic to fish at very low levels, causes brown blood disease.
  - Fortunately, quickly converted to nitrates by bacteria.
- Total Ammonia (TAN)
  - Ionized ammonia (NH_4^+)
    - Not toxic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

A Real World Example (2012)

Water Temperature?



Low AM Oxygen?



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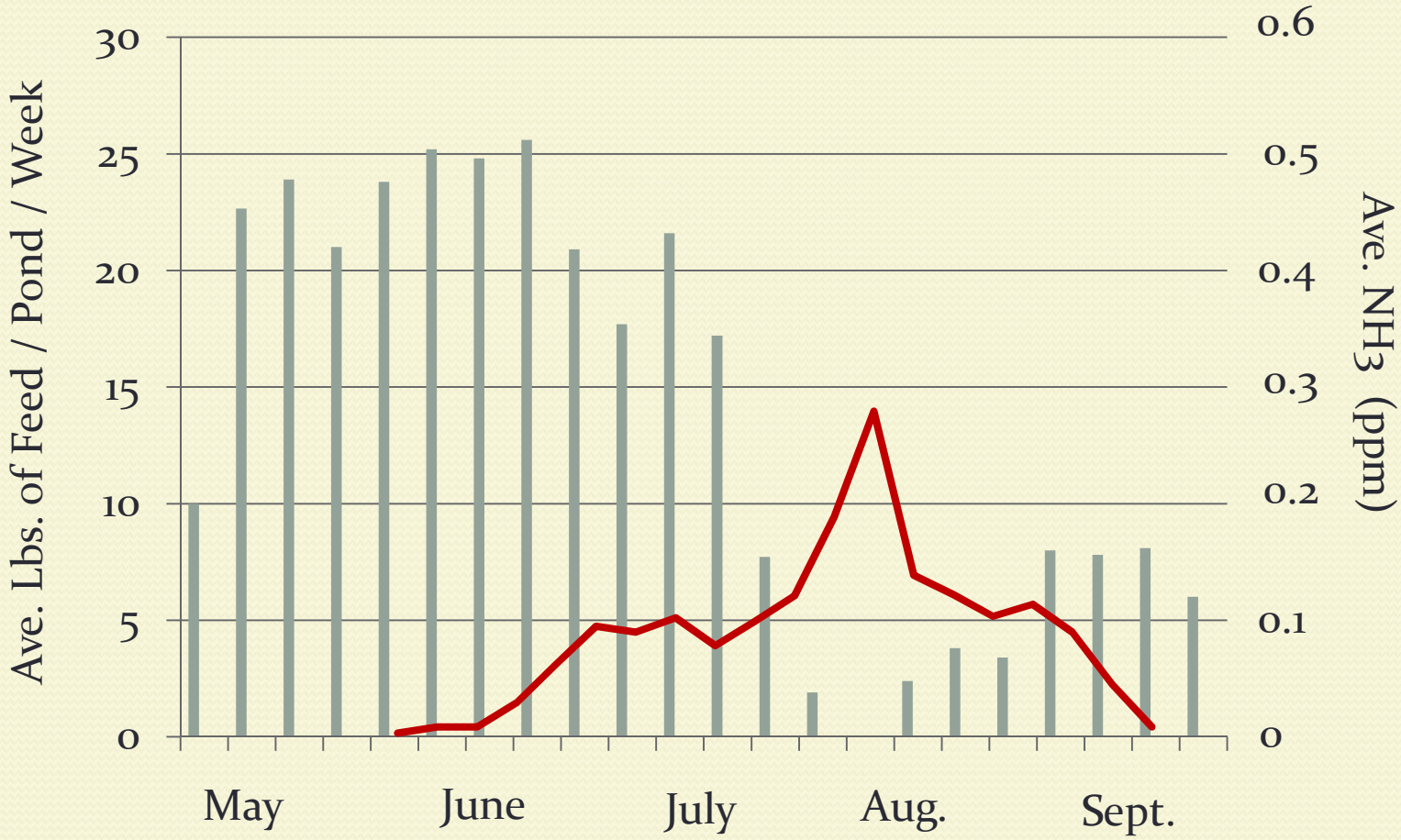
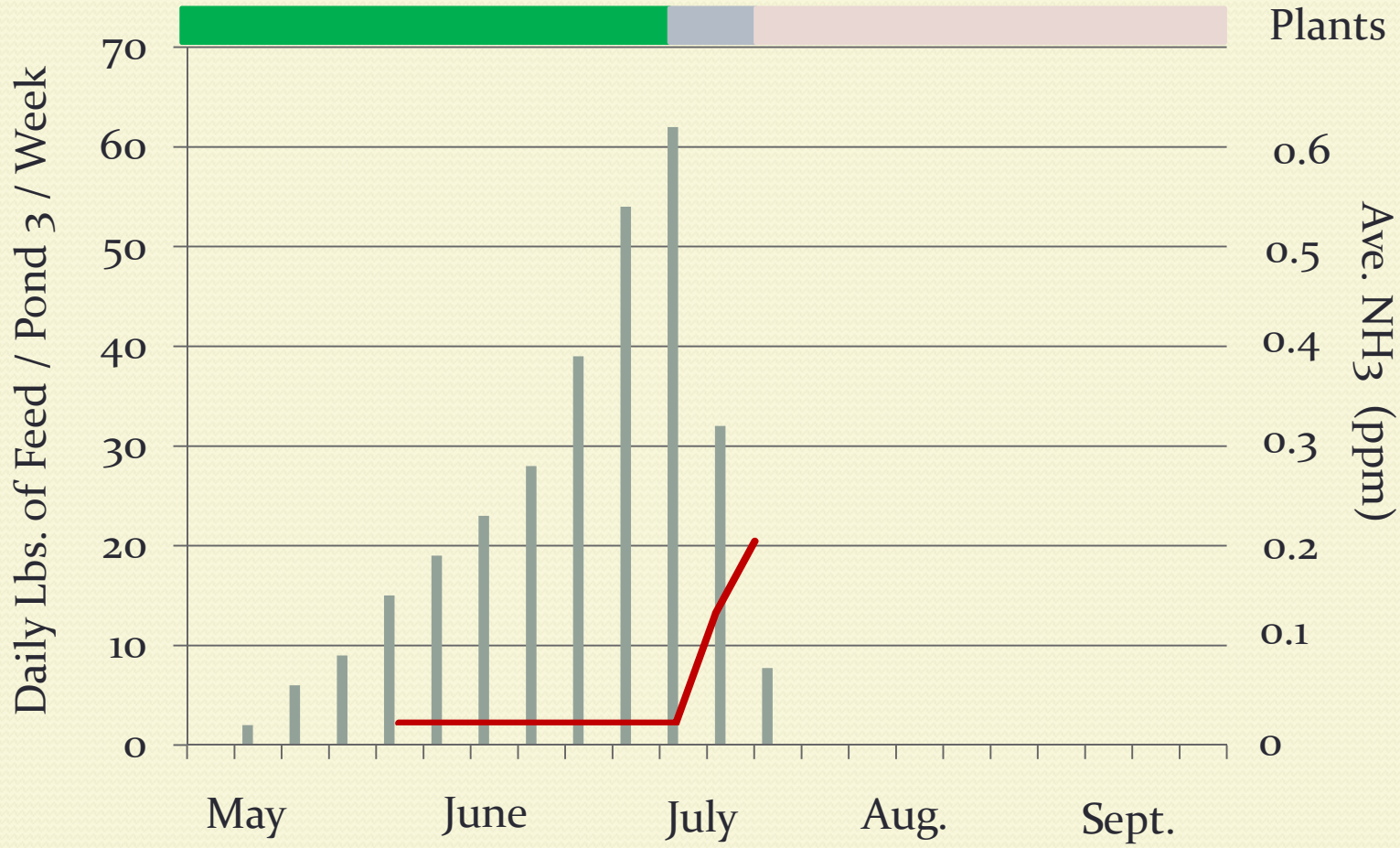


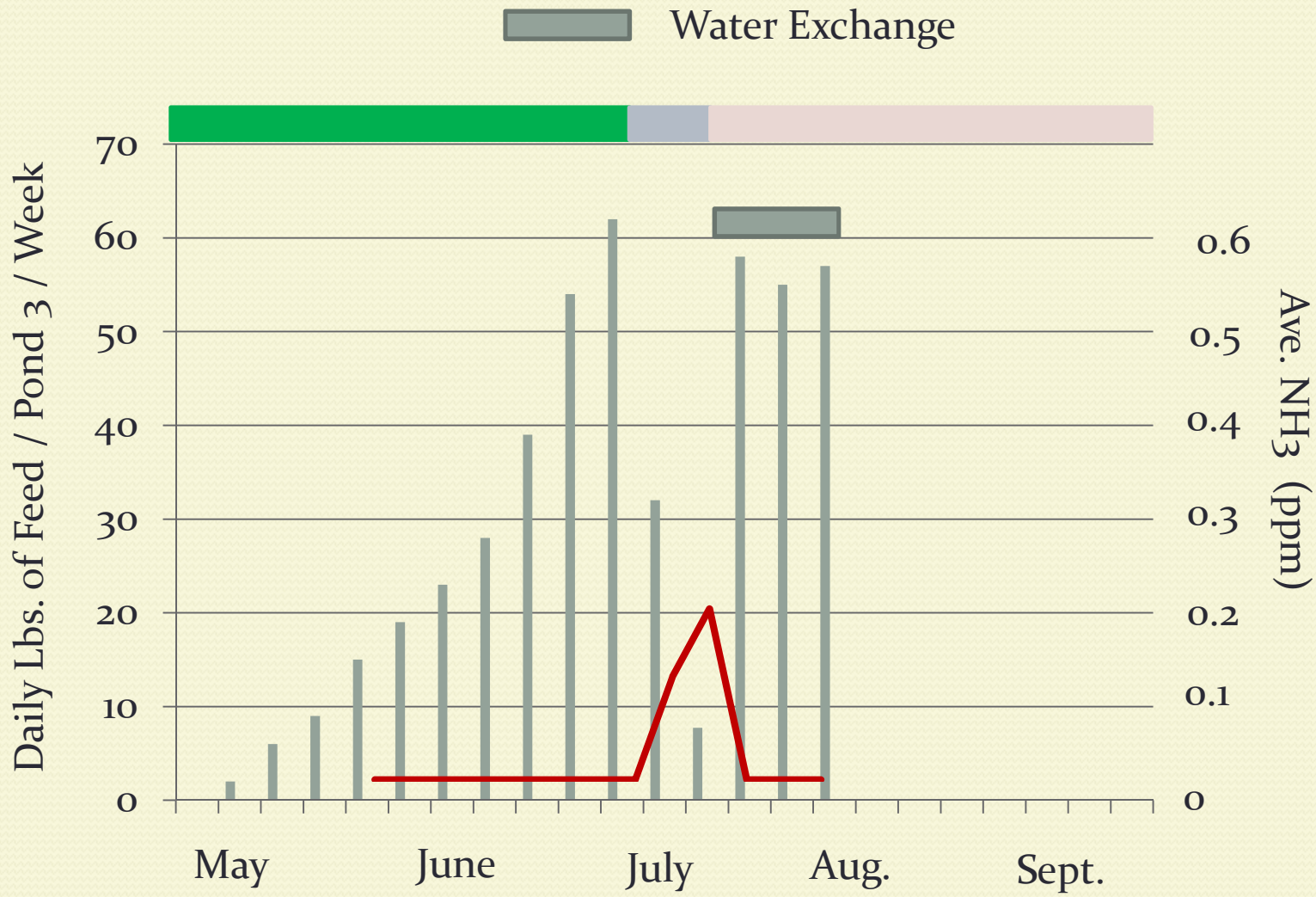
2013 Example - Fingerlings



Remedial Action

- Cut back feed to nearly zero. They had stopped eating anyway.
- Began exchanging water between the 1 acre production pond and an adjacent 1 acre fish-free pond choked with submerged plants. 70 gallons per minute.
- Ran paddlewheel at night.
- Production pond became de-stratified because exchange water originated at bottom in deep end.
- Restarted feed slowly 3 days after beginning water exchange. Fish returned to aggressive feeding on day 5.
- Goal: Lower production pond ammonia levels by moving 1) high ammonia water from production pond into vegetated pond, and 2) ammonia free water back into production pond.

2013 Example - Fingerlings



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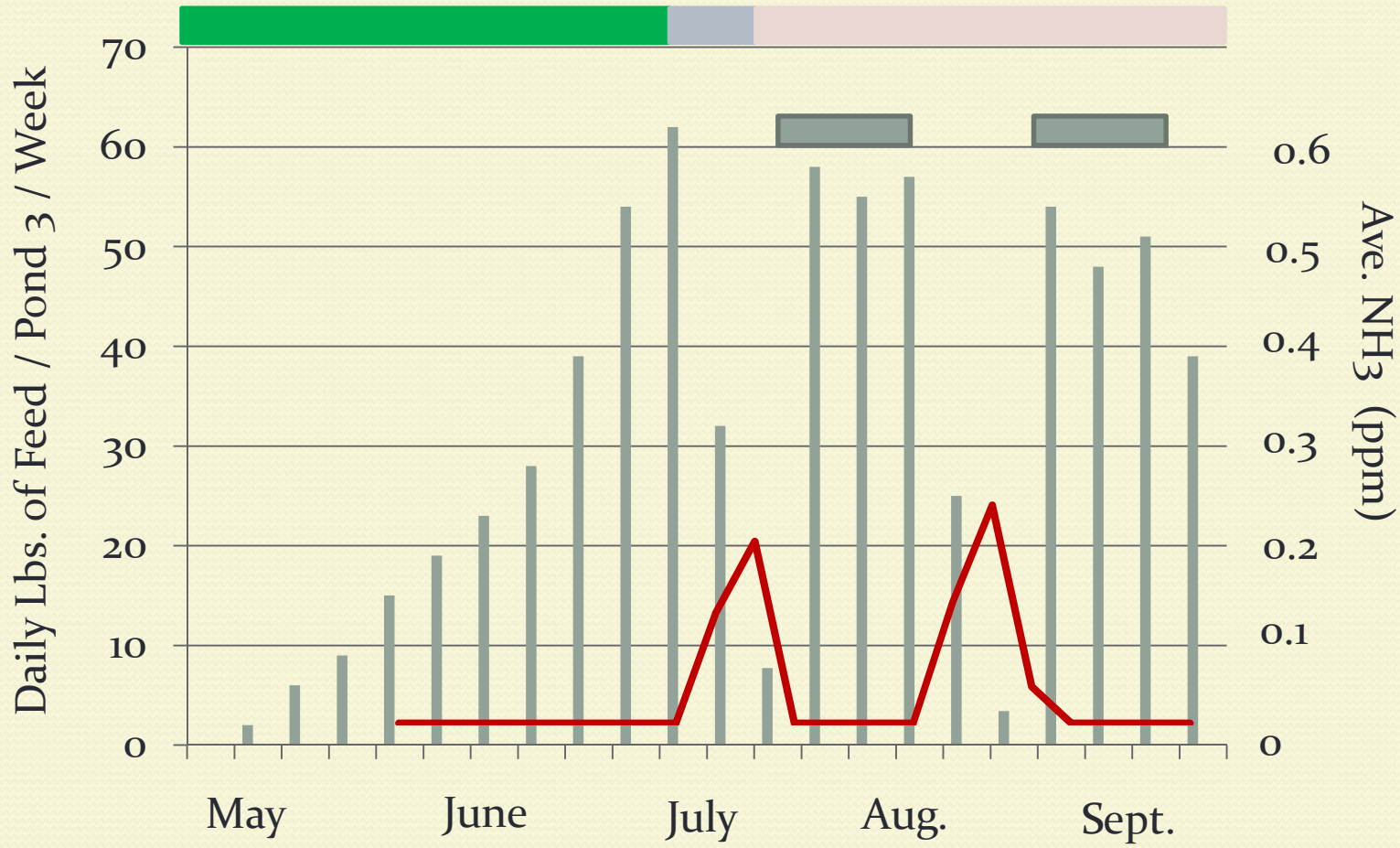


Determining Nitrogen Compound Levels

- Nitrate (NO_3)
  - Colormetric test kit or dip stick strips
- Nitrite (NO_2)
  - Colormetric test kit or dip stick strips
- Total Ammonia (TAN)
  - Colormetric test kit, Colormetric meter, or dip stick strips
  - Un-ionized ammonia (NH_3)
    - Must be interpreted from a chart or calculated from a website.
    - To do so, need measurement of total ammonia, water temperature, and pH.

Total Ammonia Sources

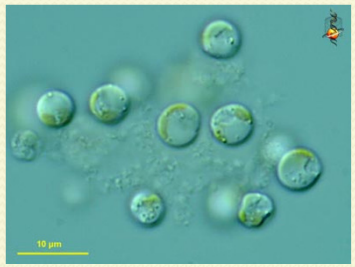
- Decaying Non-Feed Organic Matter
  - Dead plants, fish, invertebrates etc.
  - Algal crashes especially problematic. Quick ammonia spike.
- Feed Eaten
  - Metabolism of consumed feed results in the discharge of ammonia via the gills and;
  - Decomposition of solid feces also produces ammonia.
- Uneaten Feed
  - Decomposition of uneaten feed produces significant amounts of ammonia.

Factors Affecting Total Ammonia Levels

- Aerobic bacteria efficiency
  - Oxygen-loving aerobic bacteria within the nitrogen cycle are very efficient at converting total ammonia to eventually nitrates. Again, no total ammonia = no un-ionized ammonia.
  - Amount of oxygenated substrate for aerobic bacteria
    - Aquatic Plants – stems and leaves provide substrate
    - Pond bottom – aerobic bacteria form dense colonies on oxygenated pond bottom materials.
    - A lack of oxygen along the bottom can severely decrease the conversion of ammonia to nitrates, which could increase un-ionized ammonia levels under certain conditions.
    - Bottom oxygen needed 24/7.

Factors Affecting Total Ammonia Levels

- Uptake by Aquatic Plants
  - Submerged aquatic plants and algae use ammonia as a critical nutrient. Planktonic algae particularly effective at using ammonia. The denser the plants and algae the more ammonia removed.
  - Be careful! Excessive plants can be a double-edged sword!
    - Oxygen depletion – abundant plants & algae increase respiration at night, lowering oxygen levels. Could cause a fish kill.
    - Sudden plant or algae die-off – spikes ammonia, nitrite, and likely un-ionized ammonia levels. Not only from decay of plants, but also loss of substrate for aerobic bacteria.



Factors Affecting Toxic Un-ionized Ammonia Levels

- pH has a large impact on portion of total ammonia that is in the un-ionized ammonia form – water temperature less so.
  - 0.25 ppm total ammonia (measured)

pH	20 C	25 C	30 C
7.5	0.003	0.004	0.006
7.8	0.006	0.008	0.012
8.1	0.012	0.017	0.023
8.4	0.023	0.031	0.042
8.7	0.041	0.055	0.072
9.0	0.071	0.090	0.131
9.3	0.110	0.133	0.154

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1.0 ppm total ammonia

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8.4	0.090	0.125	0.168
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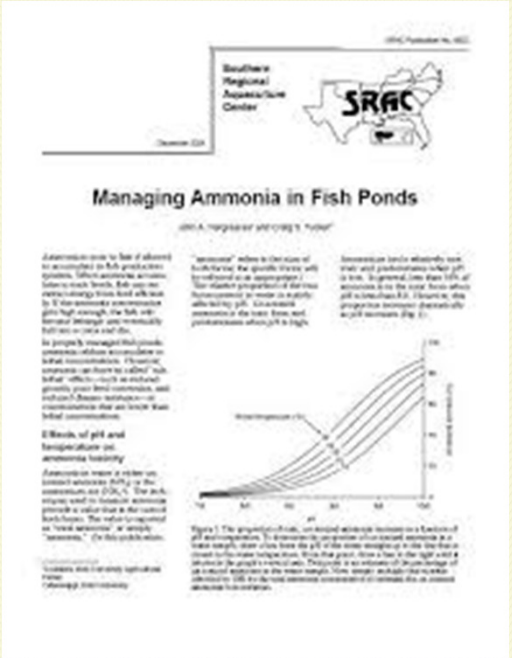
What To Do If My Un-ionized Ammonia Levels Start to Rise?

- Reduce / Stop Feeding
  - Will not reduce un-ionized ammonia levels quickly, but keeps you from worsening the problem.
- Exchange Water
  - Realistic only in smaller ponds. Per our example, helped us in a one acre pond. Expensive.
- Read SRAC's "*Managing Ammonia in Fish Ponds*"
  - Reviews other options, but explains why they are slow to work or don't work



Prevention is Key!

- Set Realistic Production Goals!
  - A NCR pond's waste management capability can support the feed required to grow about 3000 pounds of fish per acre.
  - This equals about 22-25 pounds of feed per day per acre. Exception: flow-thru ponds.
  - Avoid the temptation to feed more to boost production. Eventually the pond's bacteria & plant community will be unable to handle the wastes, water quality will degrade, fish will stop eating, and death could follow.

Prevention is Key!

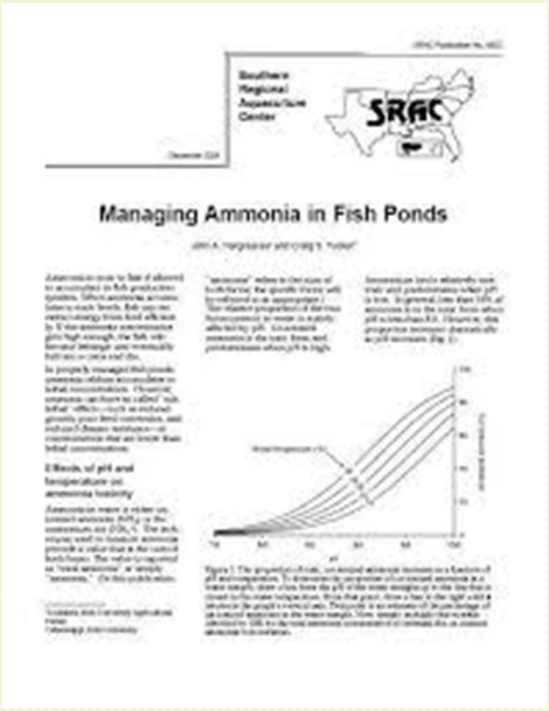
- Encourage / Tolerate a Diverse Aquatic Plant Community!
  - Combination of algae & submerged plants.
  - 15-20% Coverage.
  - Improves aerobic bacteria abundance & efficiency due to increased surface area on plant stems & leaves
  - Enhances conversion of ammonia into harmless nitrates.
  - Helps keep un-ionized ammonia levels at very low levels if not zero.

Prevention is Key!

- Use Bottom Bubble Aeration!
  - Prevents water column stratification.
  - Better oxygen profile, including oxygen along the pond bottom.
  - Improves aerobic bacteria abundance & efficiency. Slows muck build-up.
  - Enhances conversion of ammonia into harmless nitrates.
  - Helps keep 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?