

# Un-ionized Ammonia

## an Insidious Troublemaker in Culture Ponds

William E. Lynch Jr.

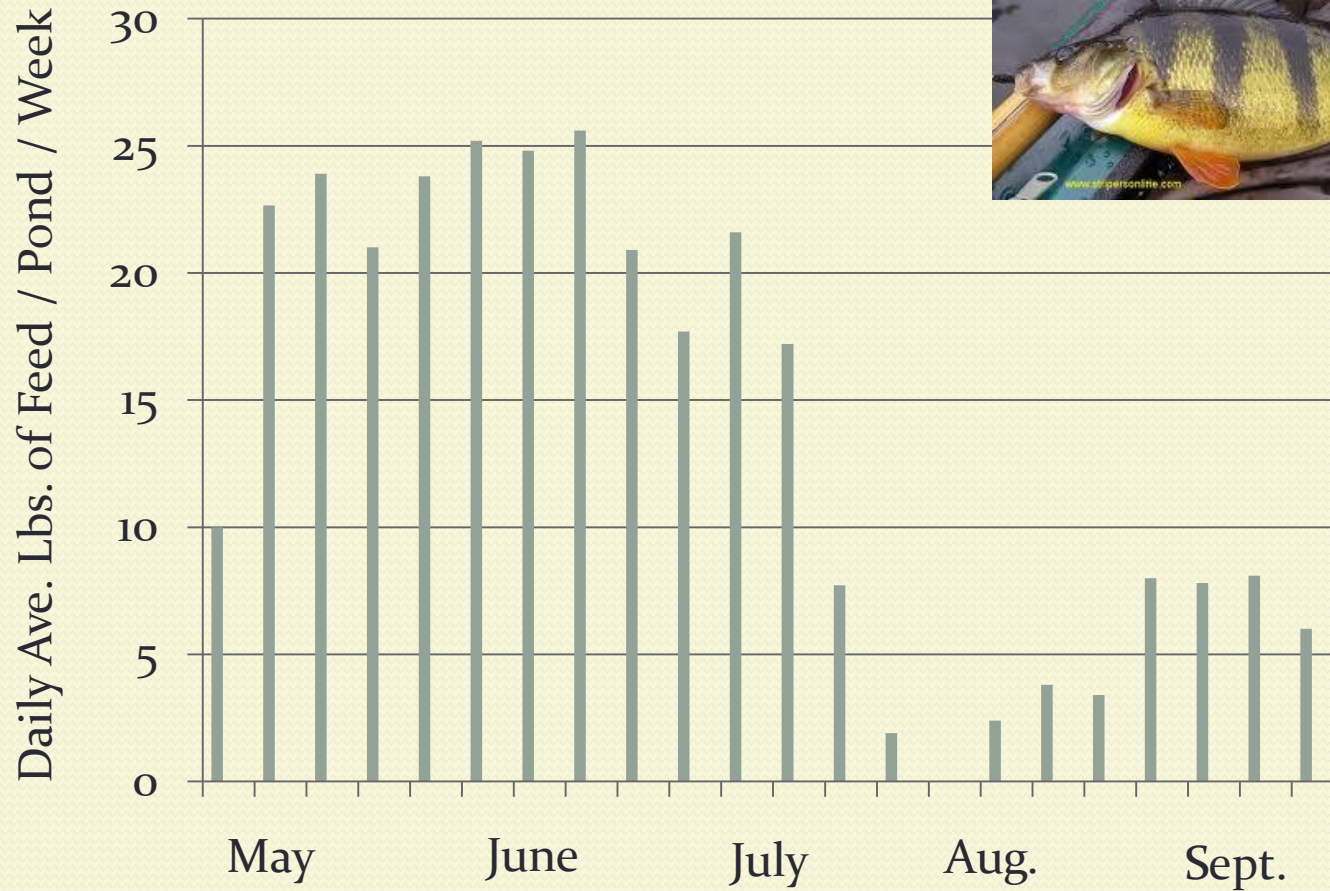
Co-Owner, Manager  
Millcreek Perch Farm  
Marysville, OH

Industry Advisory Council  
North Central Regional Aquaculture Center

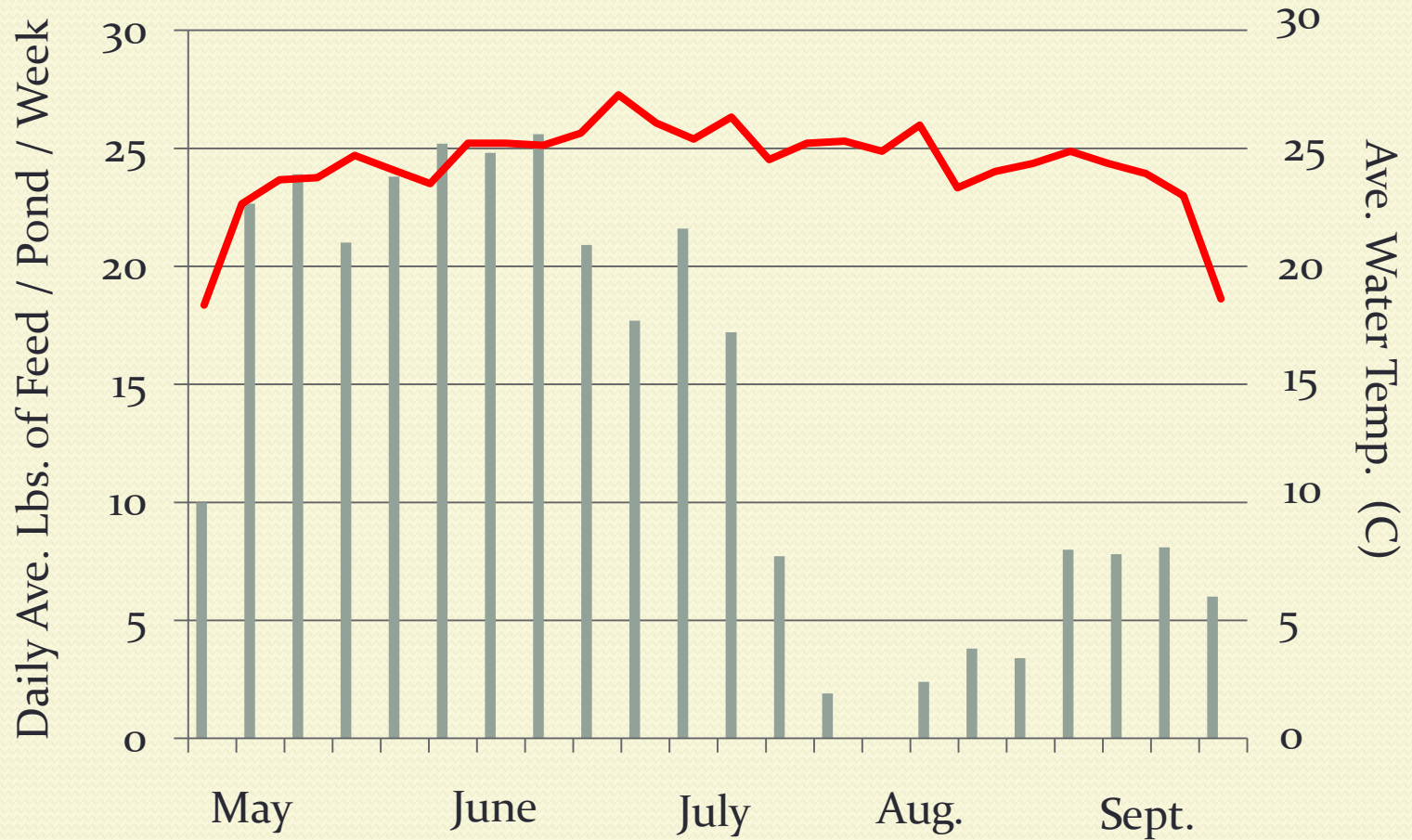
# Ammonia Compounds

- Total Ammonia (TAN)
  - Ionized ammonia ( $\text{NH}_4^+$ )
    - Not toxic at typical pond levels, can be at high levels.
  - Un-ionized ammonia ( $\text{NH}_3$ )
    - Gill damage at 0.06 ppm.
    - Reduced feeding at 0.11 ppm.
    - Mortality above 0.6 ppm.
    - Some species variation.
    - Levels increase with higher pH and water temperatures.

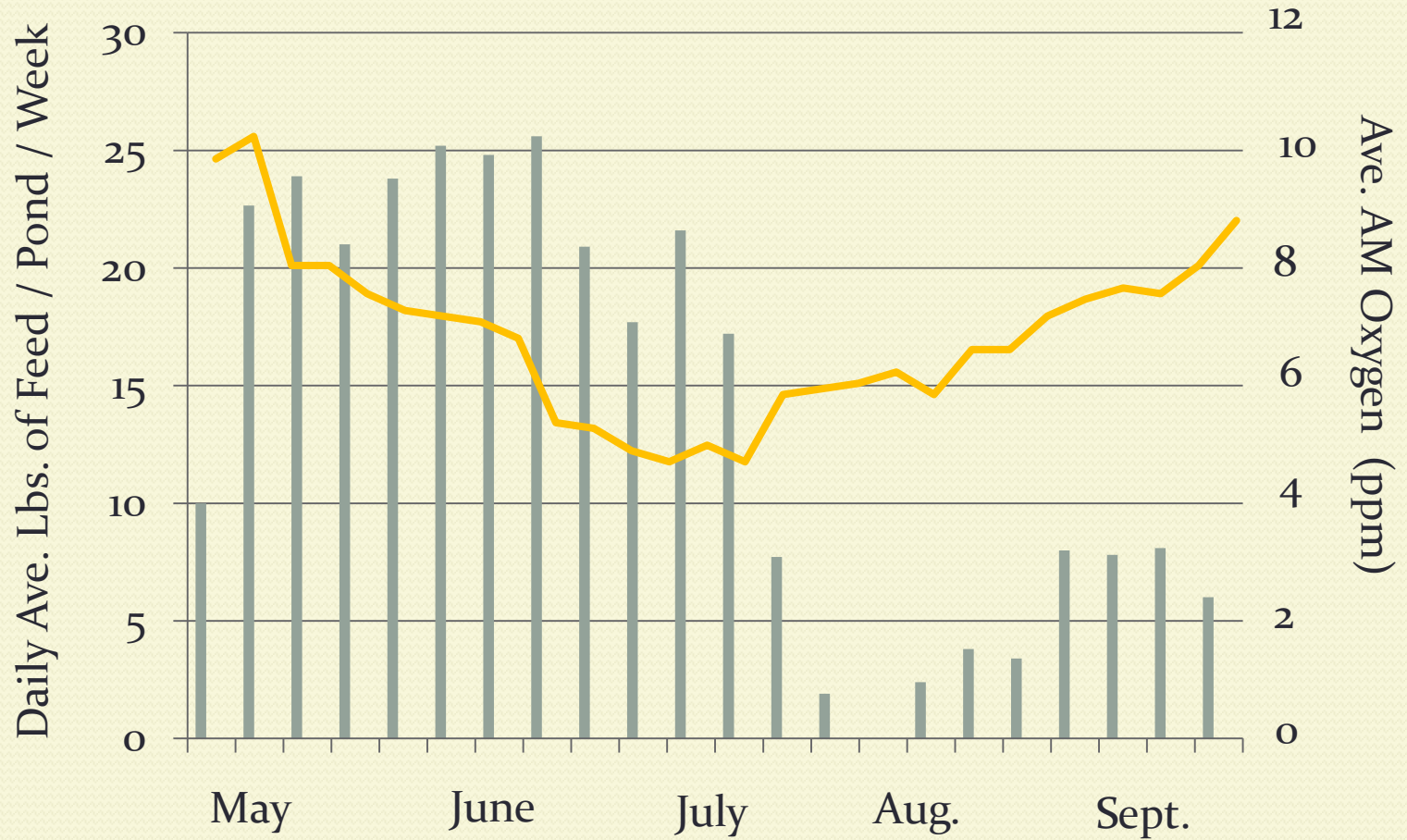
# A Real World Example (2012)



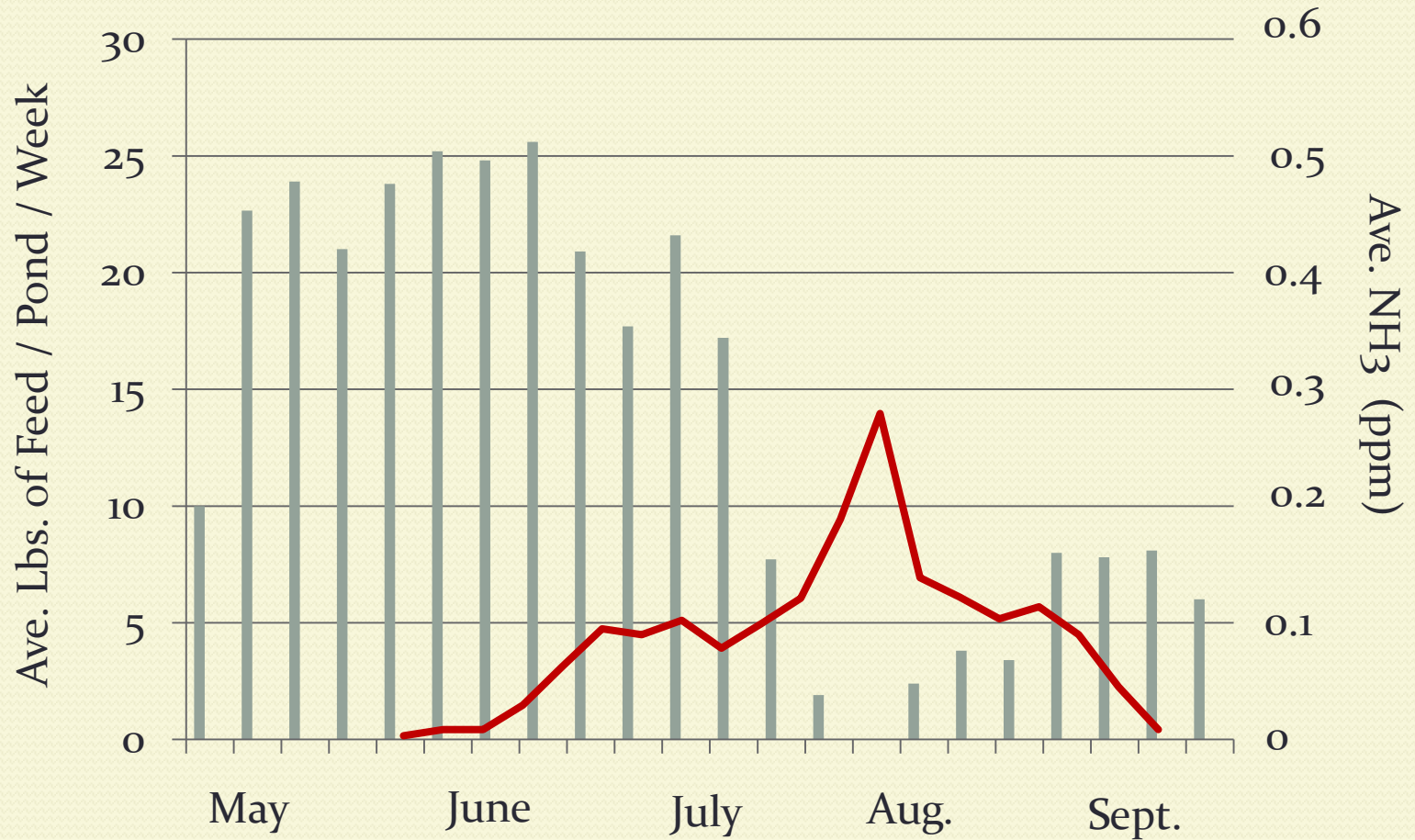
# Water Temperature?



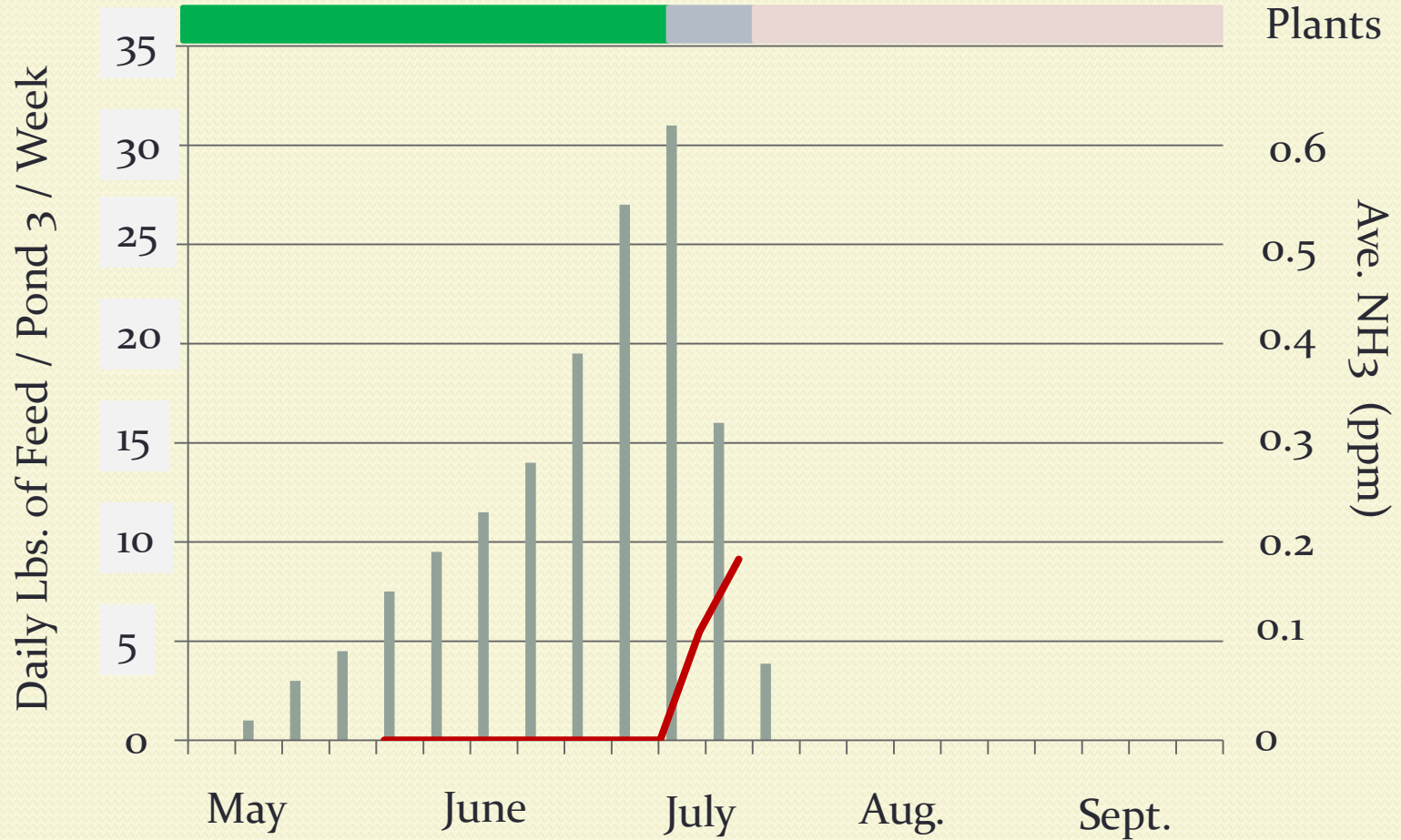
# Low AM Oxygen?



# Un-ionized Ammonia?



# 2013 Example - Fingerlings

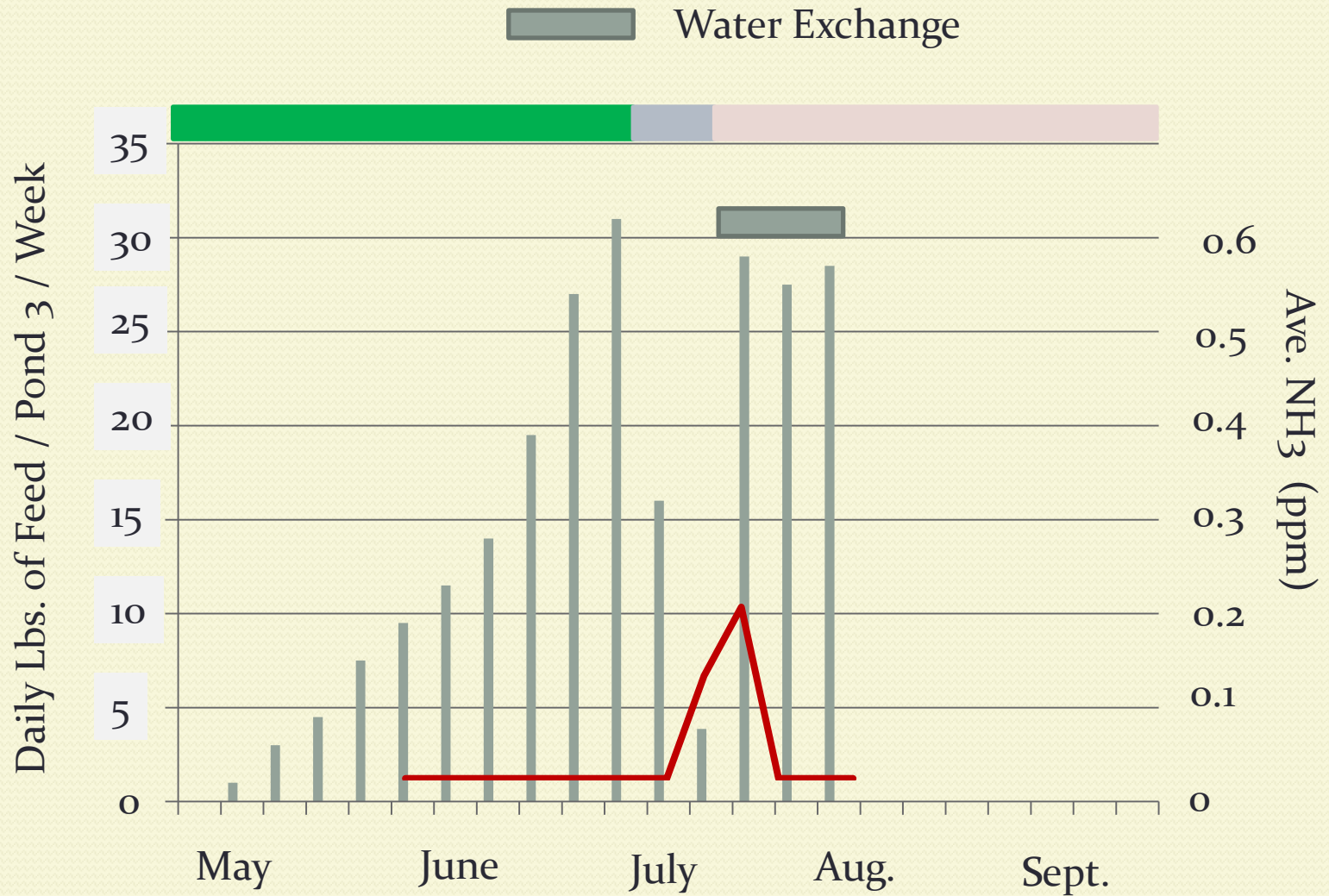


# Remedial Action

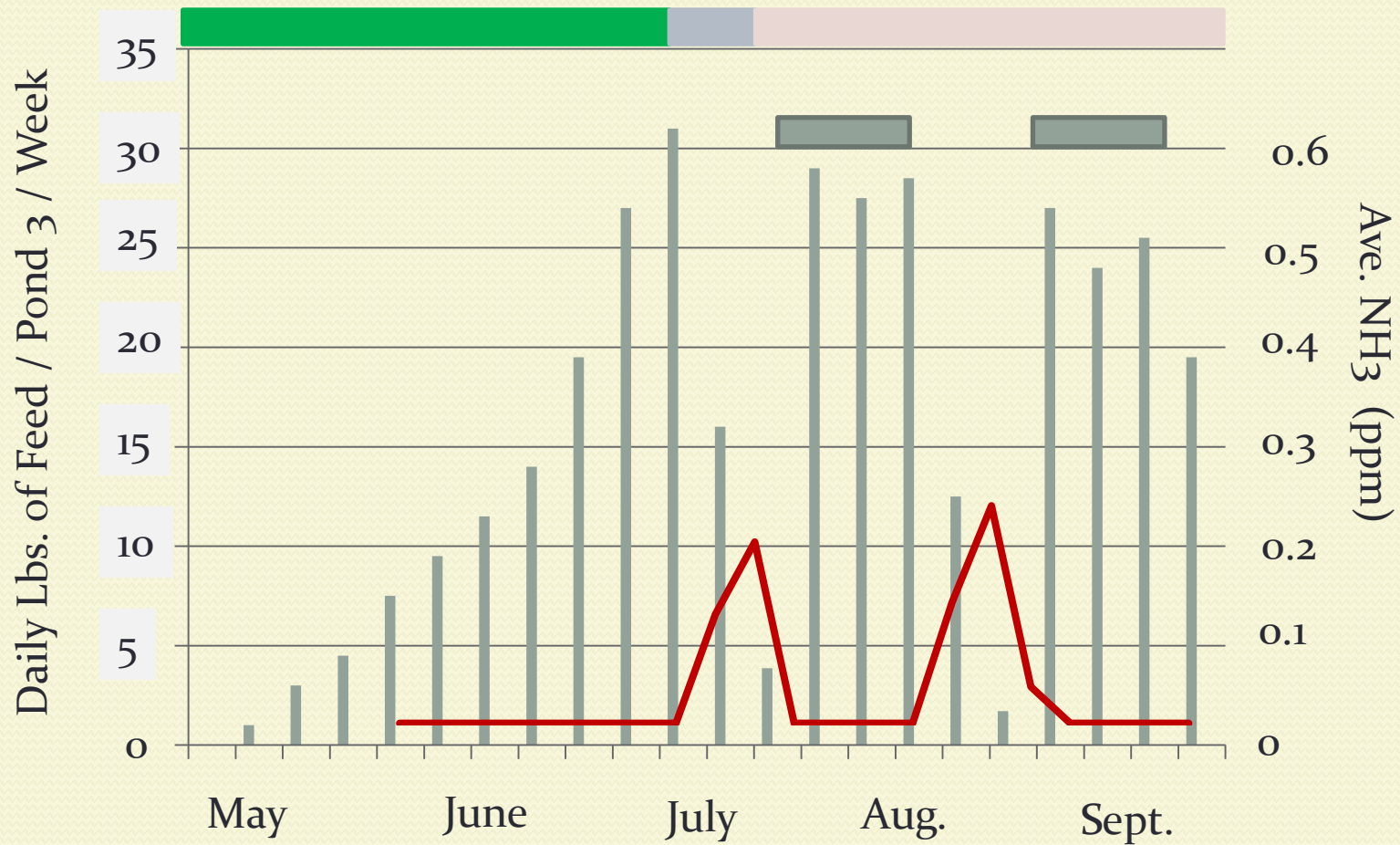
- Cut back feed to nearly zero. They had stopped eating anyway.
- Began exchanging water between the 1 acre production pond and an adjacent 1 acre fish-free pond choked with submerged plants. 70 gallons per minute.
- Ran paddlewheel at night.
- Pond with fish became de-stratified because exchange water 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



# 2013 Example - Fingerlings



# Determining Unionized Ammonia Levels

- Total Ammonia (TAN)
  - Colormetric test kit, Colormetric meter, or dip stick strips
- Un-ionized ammonia ( $\text{NH}_3$ )
  - 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.

# Effect of pH and Water Temperature

- Values are % of total ammonia nitrogen (TAN) in the toxic, unionized form.

pH	20 C	25 C	30 C
7.5	1.24%	1.77%	2.48%
7.8	2.44%	3.47%	4.84%
8.1	4.76%	6.69%	9.21%
8.4	9.07%	12.50%	16.80%
8.7	16.60%	22.20%	28.8%
9.0	28.40%	36.30%	44.6%
9.3	33.85%	42.34%	50.80%

# 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

# Factors Affecting Un-ionized Toxic Ammonia Levels

- pH has a large impact on un-ionized ammonia levels – water temperature less so.
- 0.25 ppm total ammonia
- 1.0 ppm total ammonia

pH	20 C	25 C	30 C
7.5	0.003	0.004	0.006
7.8	0.006	0.008	0.012
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9.3	0.110	0.133	0.154

pH	20 C	25 C	30 C
7.5	0.012	0.018	0.025
7.8	0.024	0.035	0.048
8.1	0.047	0.067	0.092
8.4	0.090	0.125	0.168
8.7	0.166	0.222	0.287
9.0	0.284	0.362	0.446
9.3	0.442	0.531	0.616



# Factors Affecting Un-ionized Toxic Ammonia Levels

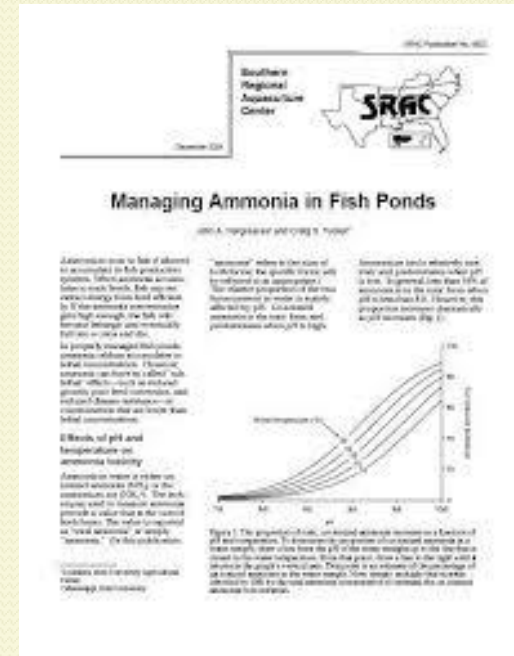
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# What To Do If My Un-ionized Ammonia Levels Start to Rise?

- 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.
- 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.



# However . . .

- Can management strategies be developed to allow more fish production per acre without raising ammonia / unionized ammonia levels?
- Enter stage right . . . The NCRAC Research Project!

