Chlorophyll-a Criteria Considerations for High Rock Lake

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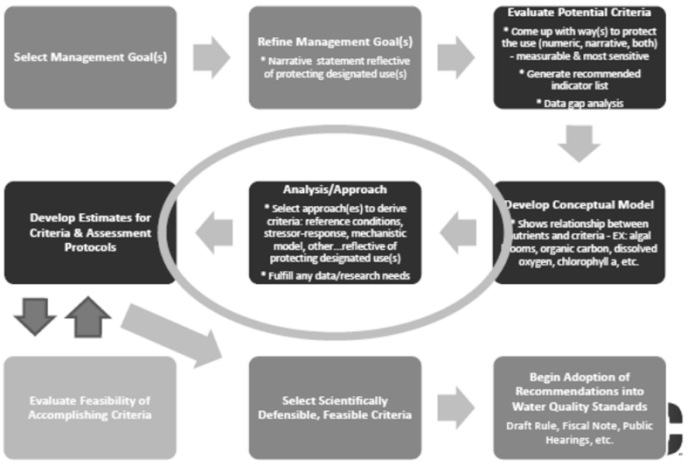
Nutrient Criteria Development (October 19, 2016)

Nutrient Criteria Development – Where are we now?



WHAT ARE CRITERIA?
NATIONAL GUIDELINES PRINCIPLES

- **Established at Level "Necessary to Protect Uses"**
  - Ensure Use Protection with Small Probability of Considerable Over/Under-Protection
  - Must Be Consistent With Sound Scientific Evidence - Demonstrated Dose/Response
  - Must Account for Major Factors Influencing Pollutant Impact
  - Confounded Studies Should Not Be Used for Criteria Derivation (or confounding factors need to be addressed)

High Rock Lake Designated Uses (August 18, 2015)

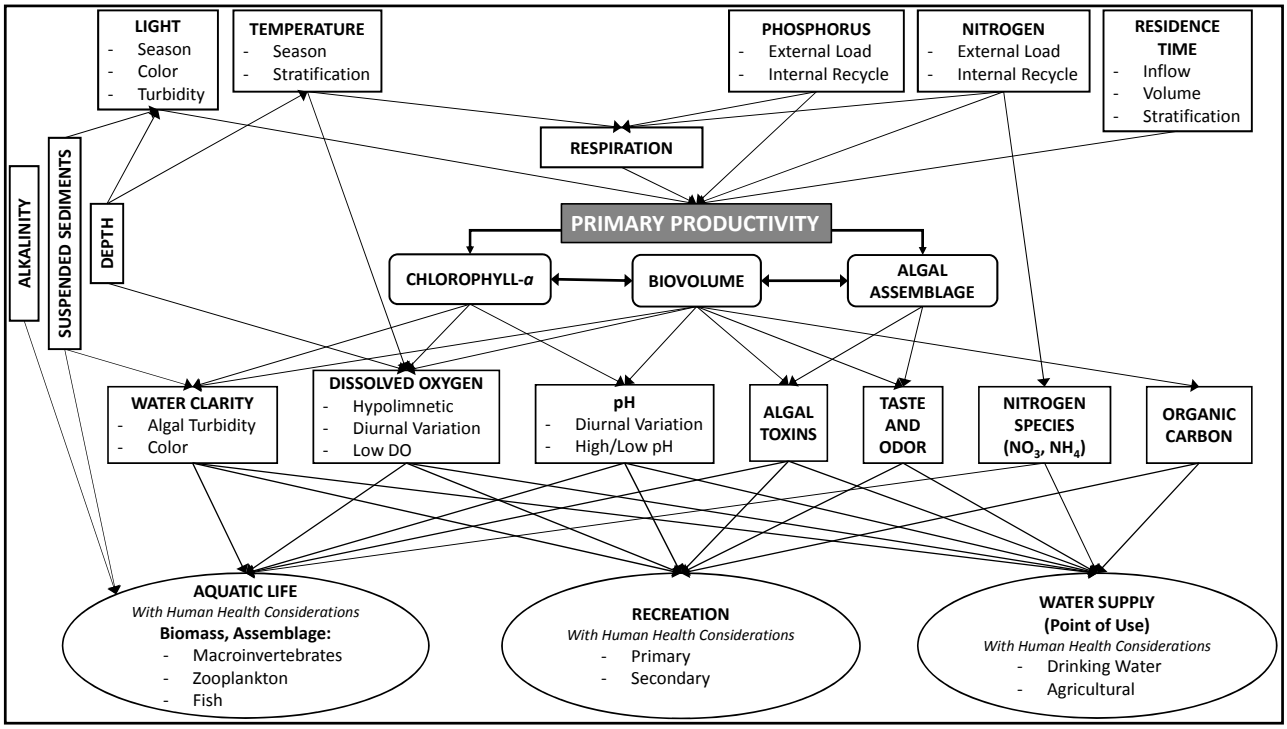
- Aquatic Life
- Fishing
- Fish consumption
- Wildlife
- Secondary Recreation (e.g. wading, boating)
- Agricultural uses (e.g. irrigation)
- Water Supply
- Lower lake: Primary Recreation – full human body contact (e.g. swimming, water skiing)

High Rock Lake Designated Uses May 6, 2015

- Maintenance of biological integrity

Biological integrity means the ability of an aquatic ecosystem to support and maintain a balanced and indigenous community of organisms having species composition, diversity, population densities and functional organization similar to that of reference conditions.

Conceptual Model (Feb. 17, 2016)



HIGH ROCK LAKE, NORTH CAROLINA NUTRIENT-RELATED CONCEPTUAL MODEL

Model Description and Legend

The Scientific Advisory Council (SAC) for North Carolina's Nutrient Criteria Development Plan has developed a conceptual model to visually depict ecological linkages of nutrient-related variables (documented as "indicators") in High Rock Lake.

Causal indicators include nitrogen and phosphorus inputs and environmental factors, such as light penetration and in-lake water residence time. The model includes multiple levels of response indicators which may influence one another in a step-wise manner. For example, variations in causal indicator nutrient levels will impact response indicators that are primary productivity components (i.e. chlorophyll *a*, biovolume and algal assemblage), which in turn lead to changes in other response indicators, such as dissolved oxygen and/or algal toxin concentrations.

These relationships provide a scientific basis for discussions and development of criteria to support the designated uses of High Rock Lake, including Aquatic Life, Drinking Water Supply and Recreation. All causal and response indicators will be considered toward the goal of developing the most effective criteria for maintaining an ecological condition within the lake that supports the uses.

BLACK BOX
Causal indicator

YELLOW BOX & ARROWS
Respiration
& related causal indicators

PINK BOX & ARROWS
Chlorophyll *a*
& related response indicators

BLUE BOX & ARROWS
Algal biovolume
& related response indicators

RED BOX & ARROWS
Algal assemblage
& related response indicators

GREEN BOX & ARROWS
Primary productivity
& related causal indicators

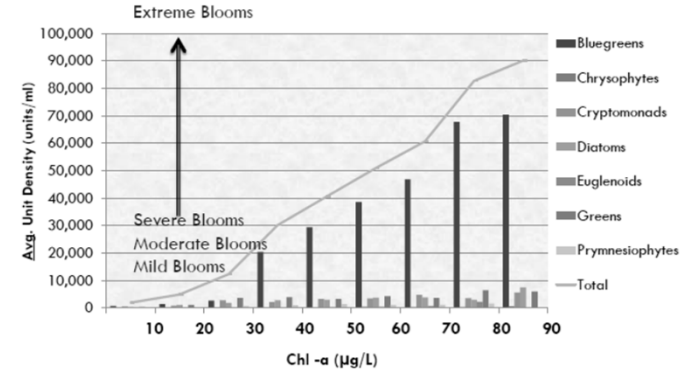
Components of productivity
(measured in different ways):
- **Chlorophyll *a***
- **Biovolume**
- **Algal Assemblage**

PURPLE BOX
Response indicator

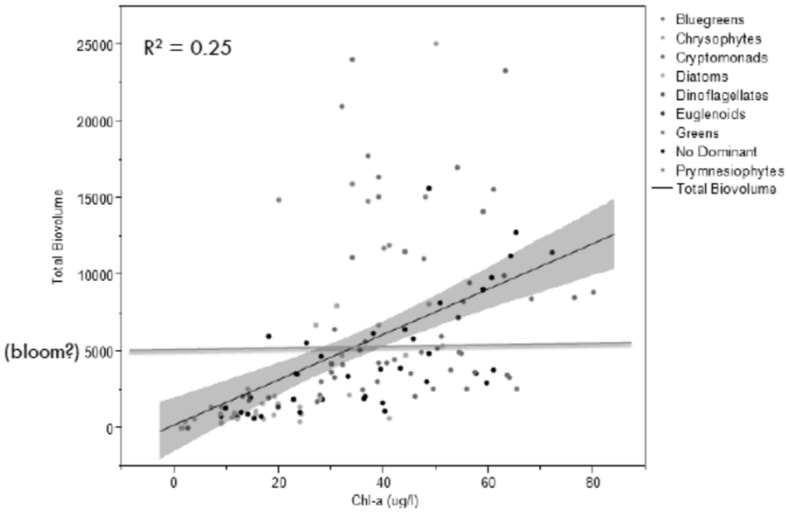
OVAL
(COLOR VARIES BY USE)
Designated uses & related indicators
- **Aquatic Life**
- **Recreation**
- **Water Supply**

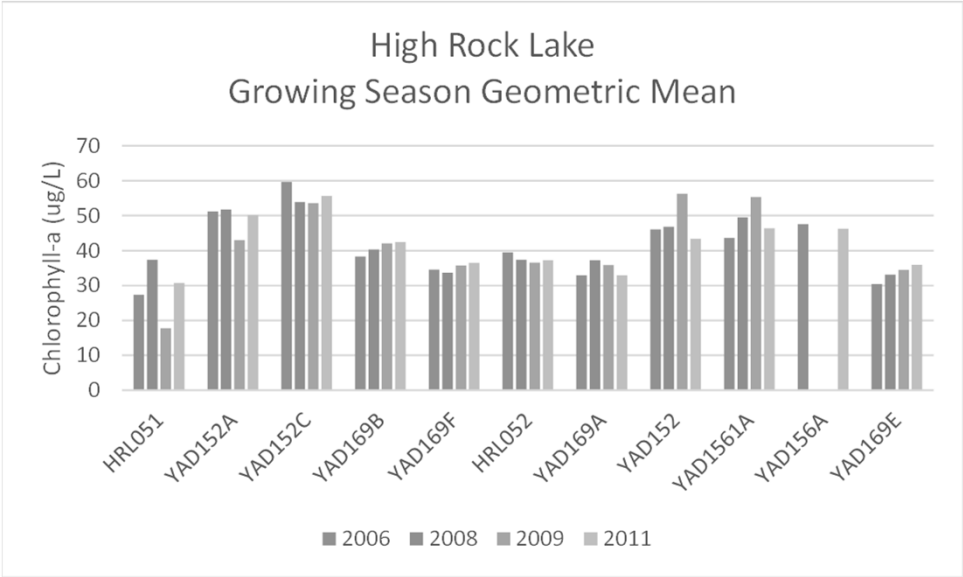
Algal Composition (August 18, 2015)

Algal Unit Density vs. Chl-a *(08-10)*



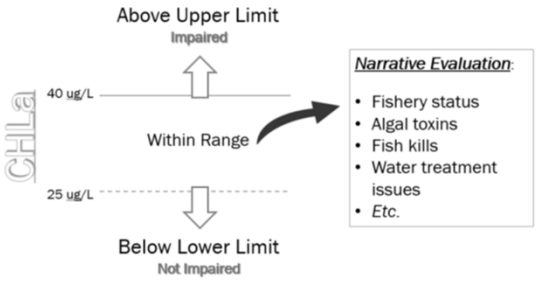
Algal Biovolume vs. Chl-a(05-10)





Chlorophyll-a Proposals

1. Clifton



2. Lauren

- **Risk Level Evaluation**

Category	Basis	Conc.
Low	9.3% blue greens Low DW concerns < 10 µg/L microcystin	16.5 µg/L
Medium	46.3% blue greens DW use impairments 10-20 µg/L microcystin	30.6 µg/L
High	61.5% blue greens DW use severely impaired >20 µg/L microcystin	47.5 µg/L

What Do We Know?

- HRL Chl-a Concentrations exceed 50 µg/L in mid-lake and arms, close to 40 µg/L near dam
- Aquatic Life Use Impairments have not been identified
- Recreational Use Impairments have not been identified
- Potable Water Use Impairments below the lake have not been identified
- Although blue green algae proliferate in the summer months, elevated levels of cyanotoxins have not been observed

Conclusion

The available data for High Rock Lake are insufficient to develop numeric nutrient criteria for chlorophyll-a.

What Do We Do Now?

- Retain existing 40 µg/L standard (Do Nothing Alternative).
- Clarify that existing standard is an average.
  - ✓(growing season or annual)
  - ✓(arithmetic or geometric)
- Provide Off-Ramp where there is no evidence of use impairment for lakes that already exceed 40 µg/L.
- Use anti-degradation requirements to prevent deteriorating conditions.

Other Considerations

- If possible, establish Aquatic Life WQC for "Balanced Indigenous Population of Organisms"
  - ➢Need to define for various types of lakes
  - ➢Determine defensible relationship between Chl-a and BIP
- If possible, establish WQC for recreation based on water clarity
  - ➢Determine defensible relationship between Chl-a and clarity (easy)
- For non-stratified lakes, relate primary productivity to DO (may be lake-specific)
- Establish WQC for cyanotoxins
  - ➢For lakes that support toxin forming blue-greens, that produce toxins in excess of WQC, determine defensible relationship between Chl-a and toxin threshold.