Nothing Compares
NORTH CAROLINA

NC Division of Water Resources
Nutrient Criteria Development

Nutrient Criteria Development Plan

Nutrient = nitrogen and phosphorus

Criteria = a **numeric** water quality standard protecting surface waters from deleterious effects of nutrients.

Development = to establish

Plan = schedule with milestones

Focus of today's talk

Development of a numeric water quality standard to protect the uses of surface waters from the deleterious effects of nitrogen and phosphorus

What does all of this mean for you?

Jargon

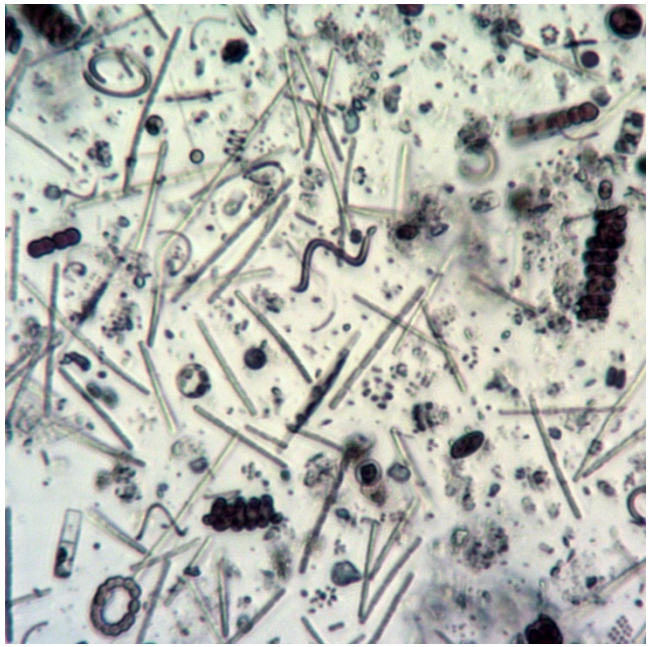
- NCDP = Nutrient Criteria Development Plan
- Water quality criteria = water quality standard = administrative rule → rulemaking → fiscal note
- Phytoplankton = algae
- Chlorophyll-a =
  - a plant pigment responsible for photosynthesis
  - an established/acceptable measure of algae
- Cyanobacteria = bluegreen algae
  - Certain species of cyanobacteria can be toxic
- Microcystis = a potentially toxic cyanobacteria species
- Microcystin = an algal toxin
- Cylindrospermopsin = an algal toxin

Overall View

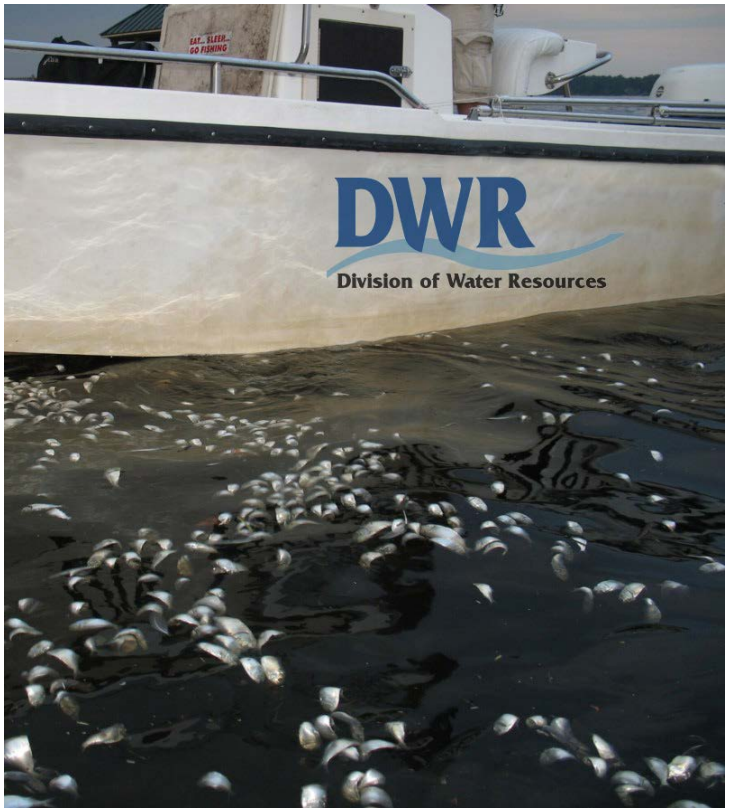
- N and P →
- Excessive algal growth →
  - ✓high DO,
  - ✓low DO,
  - ✓high pH,
  - ✓decreased water clarity,
  - ✓taste and odor,
  - ✓algal toxins

Nutrient Criteria

- The primary focus is on algae



Nutrients Affect Uses



A Plan Protects Uses

Environmental Protection Agency

1998 – "National Strategy for the Development of Regional Nutrient Criteria"

2001 – Federal Register Notice

- ✓ **States develop nutrient plans**
- ✓ **Expectation States adopt nutrient criteria into standards by 2004**

2001 – "Grubbs Memo"

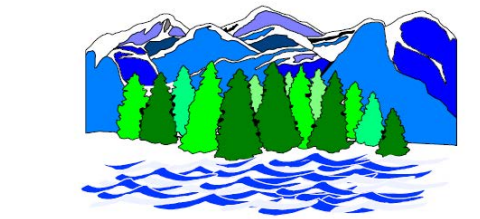
2000-2002 – Technical Guidance Documents

2000-2003 – Ecoregional Nutrient Criteria

2007 – "Grumbles Memo"

2009 – "EPA Needs to Accelerate Adoption of NNC"

2011 – "Stoner Memo"


EPA National Strategy for the Development of Regional Nutrient Criteria

June 1998

Late 2016 – Revised numeric nutrient criteria for lakes and reservoirs.

North Carolina

2004 – First Nutrient Criteria Implementation Plan

2004 – EPA agrees to NCIP

2005 – now: Legislation and DENR budget reductions

2011 – EPA rescinds NCIP

2012-2014 – DWR develops new plan (NCDP)

2014 – EPA agrees to the NCDP

2015 - now – 9 SAC and 2 CIC meetings

EPA Region 4 Comments

- NC's approach currently focuses mostly on one criterion – i.e. chlorophyll-*a* "Response only approach"
- Encourage criteria based on: TP, TN, Chl-*a*, and clarity
- Criteria must be:
  - ✓ Effective
  - ✓ Enforceable
  - ✓ Protective (not just reactive)
  - ✓ Measurable (i.e. numeric)

What is a Nutrient Criteria Development Plan?

- Commitment from States to address nutrient enrichment in surface waters
- Formalizes a strategy to adopt numeric nutrient criteria
  - ✓*Timelines, milestones, deadlines*
- Prioritization of water bodies
- Ongoing, collaborative process

Public Comments

1. Establish a scientific advisory council
2. Allow for significant stakeholder involvement
3. Existing nutrient management rules and TMDLs proceed as written
4. Consider site/water body specific criteria
5. Balance between best science and cost-effectiveness
6. No “one-size fits all”

Numeric Nutrient Criteria (NNC)

- *Causal and response variables expressed as numerical concentrations and/or mass quantities or loadings*
- *Causal and response variables expressed as narrative statements with a scientifically defensible translator mechanism to derive or calculate numerical concentrations and/or mass quantities or loadings*

Response Variables	Causal Variables
Chlorophyll-a	Nitrogen
Phytoplankton	Phosphorus
Periphyton	
Macrophytes	
Diurnal DO range	
Minimum DO	
Diurnal pH range	

Other variables may be considered

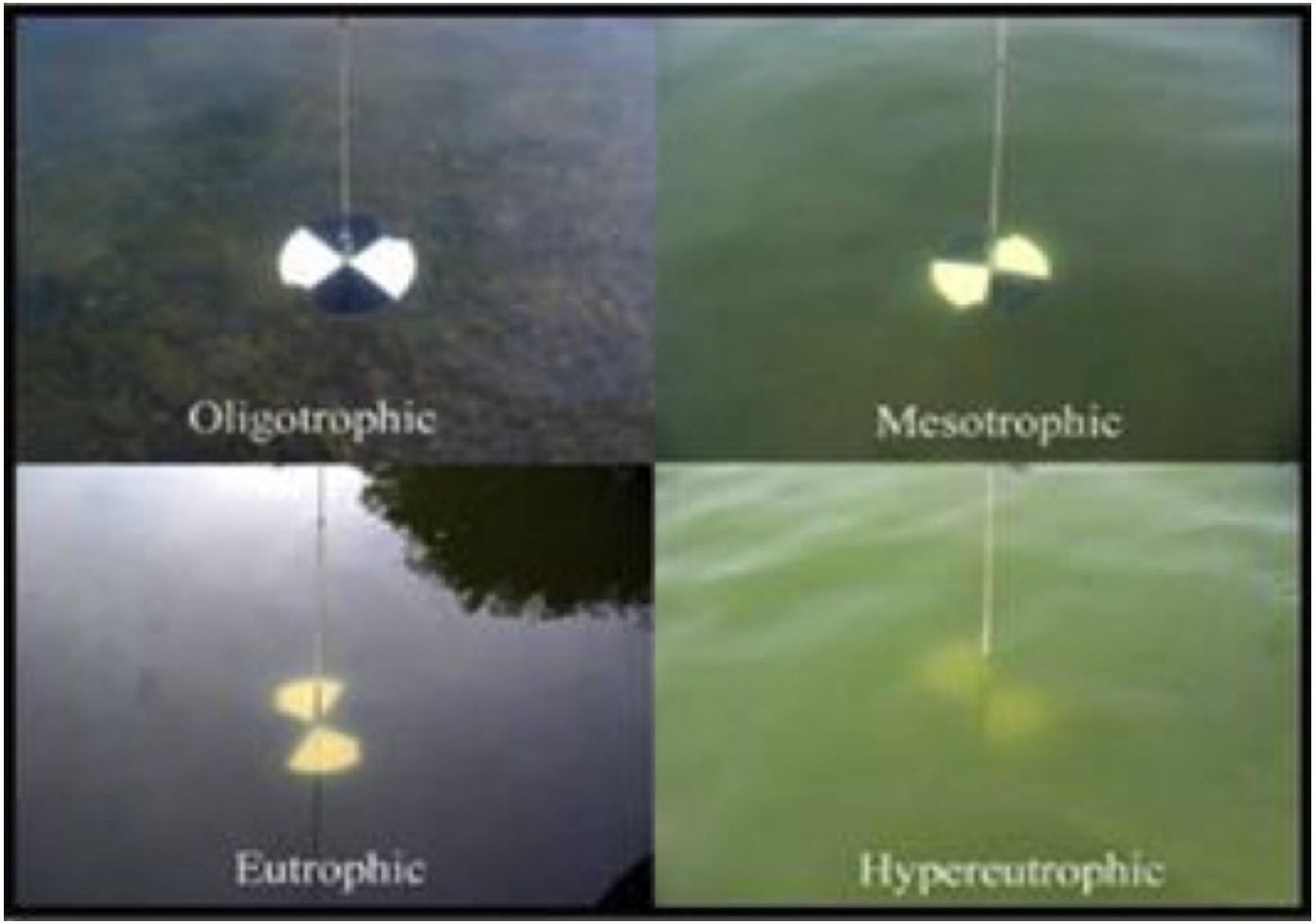
Approach to Adopt NNC

Site-Specific	Anticipated Completion Date
1. High Rock Lake	July 2018
2. Albemarle Sound	December 2020
3. Central Cape Fear River Basin	December 2021

Water body-Specific	Anticipated Completion Date
4. Estuaries	June 2023
5. Reservoirs/Lakes	June 2024
6. Rivers/Streams	June 2025

Timelines are subject to change based upon resources, research needs, sufficient funding, personnel and other unforeseen events

What is too much algae?

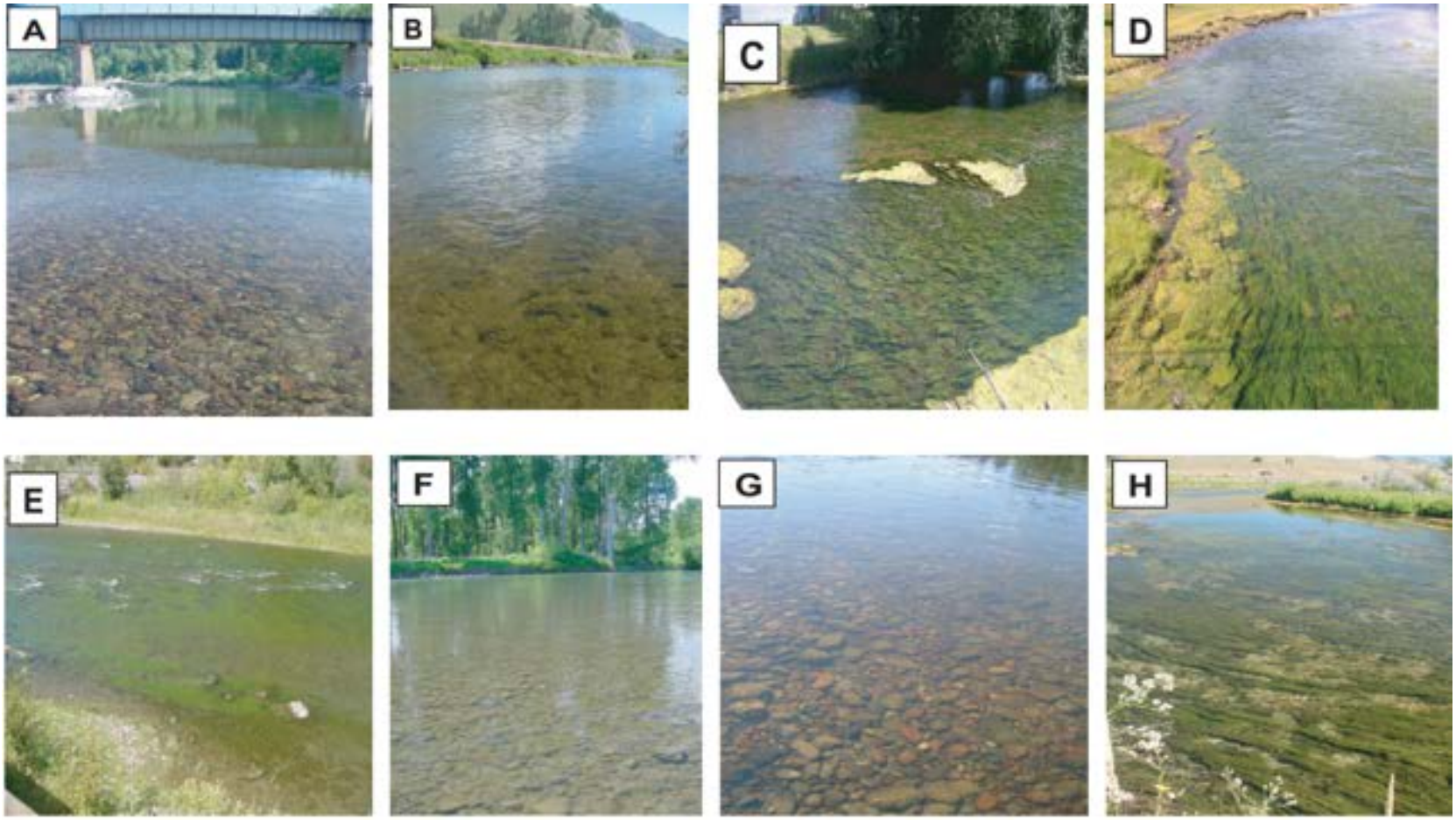


Environmental Review Commission
February 10, 2016

Tom Reeder

Assistant Secretary for the Environment

How Green is too Green?



What is too much algae?- China, 2008

To Save Olympic Sailing Races, China Fights Algae

By JIM YARDLEY JULY 1, 2008

What is too much algae?- China, 2008

Volunteers clear algae along the coastline of Qingdao, Shandong province, July 3, 2008 - more than 10,000 people and 1,200 vessels are involved in the clean-up

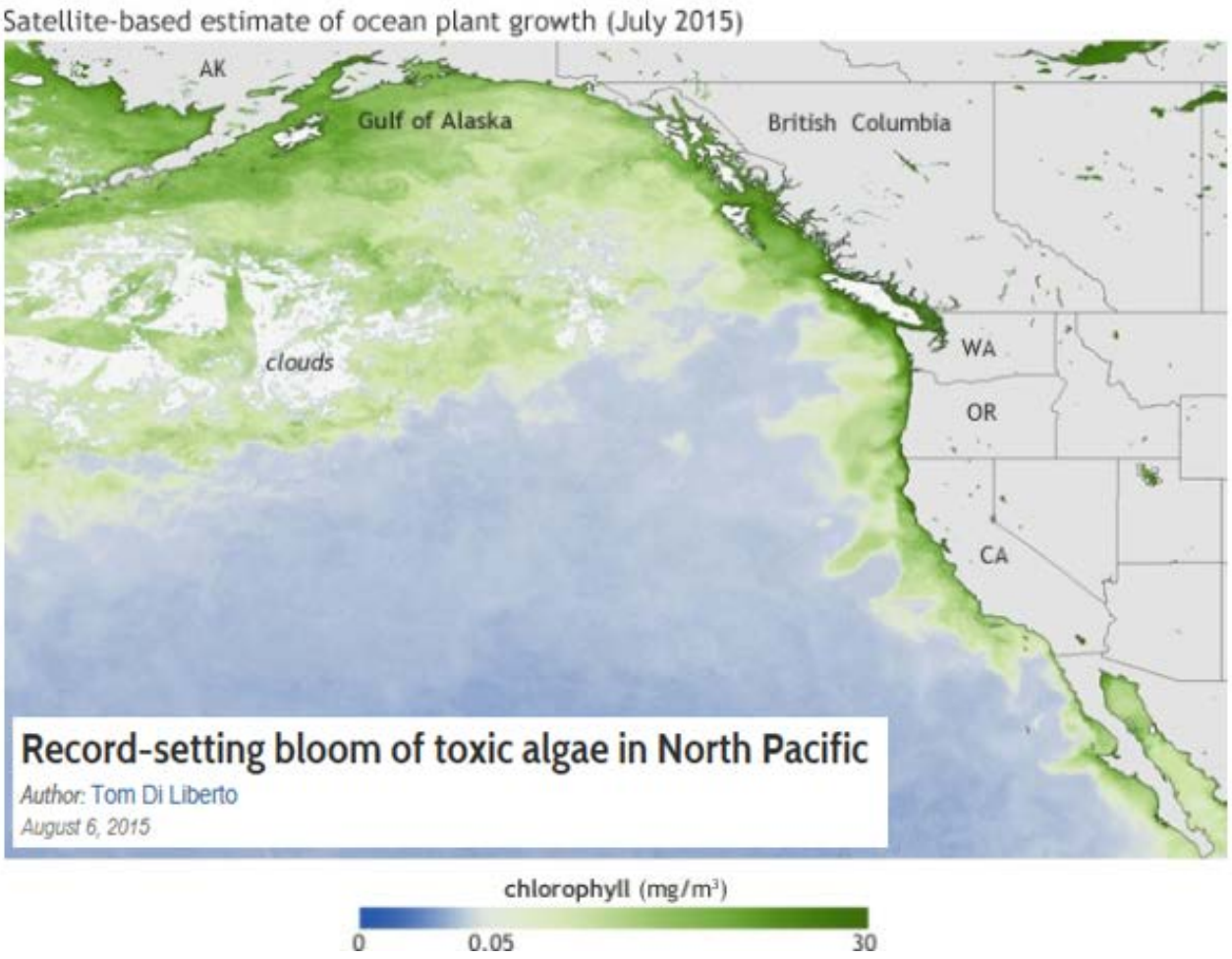
What is too much algae? - Toledo Ohio, 2014

Toledo bearing full brunt of Lake Erie algae bloom

What is too much algae? - Toledo Ohio, 2014

A man holds a glass filled with water from Lake Erie on August 3, 2014. Toledo's water supply intake sits in the background. Photo copyright Dave Zapotosky.

What is too much algae? – North Pacific Ocean, July 2015



What is too much algae?- Florida, June 2016

SUN-SLIME STATE: Florida beaches coated in 'guacamole-like' sludge

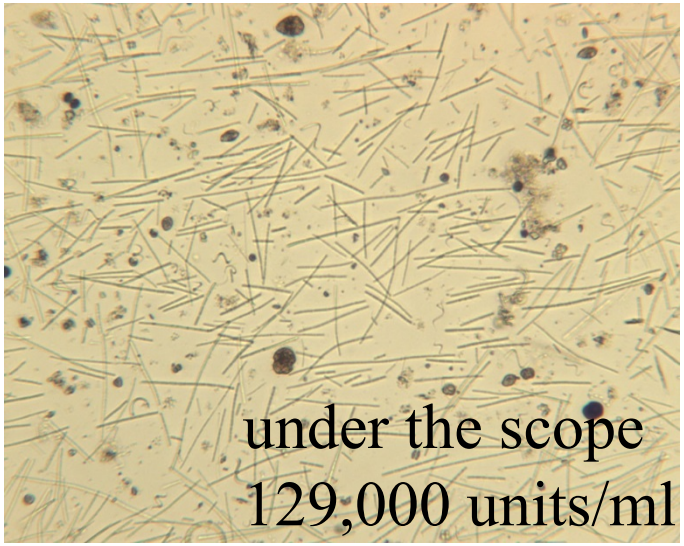
What is too much algae? – Florida, June 2016

Too much algae?
Senator Marco Rubio

Edenton - July 2016

Is this too much algae?

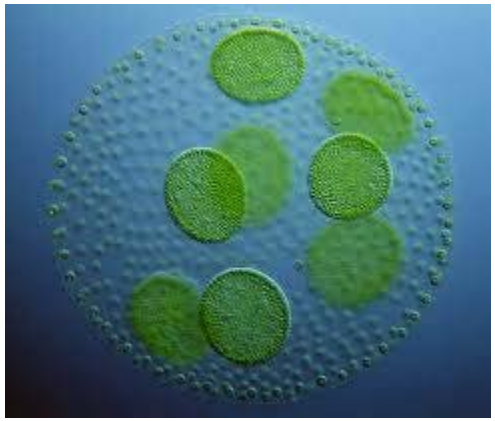
Too much algae? Jordan Lake

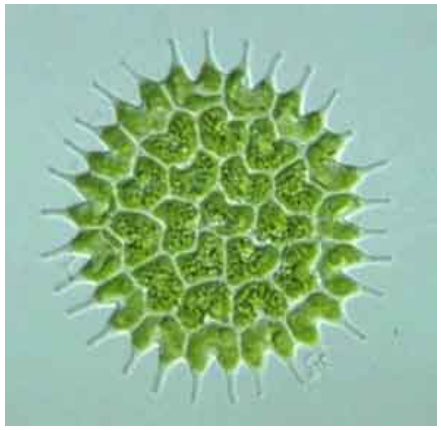


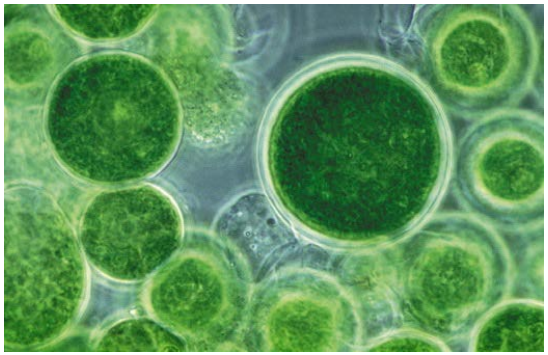
Haw River Arm

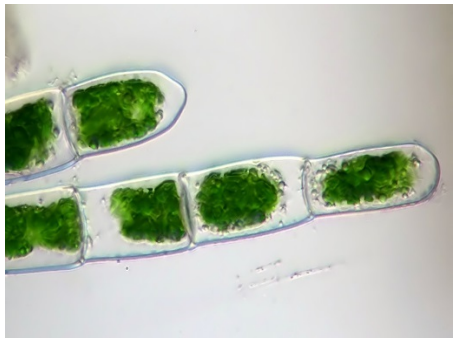
10 ml = $\frac{1}{2}$ ounce

The NC Chlorophyll-a Standard









NC Chlorophyll-a Standard

Early 1970s

- excessive algal growth noted in NC's estuaries and Chowan River

February 1975

- Public hearings on water quality standards including a narrative standard for nutrient and algae control

NC Chlorophyll-a Narrative Standard (1975)

"*In impounded or slow moving waters which are subjected to nutrient enrichment and in which excessive algae activity results in or is expected to result in interference with established water uses, the Department of Natural and Economic Resources is authorized to establish a stream nutrient standard appropriate to the body of water affected.”*

NC Chlorophyll-a Standard

1975 – 1977

- Realization that a numeric standard would be more effective than a narrative standard

1977

- State requested assistance of the Water Resources Research Institute to develop, if possible, numeric standards for controlling algae. Advisory group established

NC Chlorophyll-a Draft Numeric Standard (1977)

"Chlorophyll a shall not exceed 50 µg/L in fresh water lakes and reservoirs, 20 µg/L in lakes and reservoirs designated as trout waters, and 100 µg/L in all sounds, estuaries, and other slow moving waters. The chlorophyll a concentration shall be that concentration determined at any one time and at a depth equal to one-half the secchi depth."

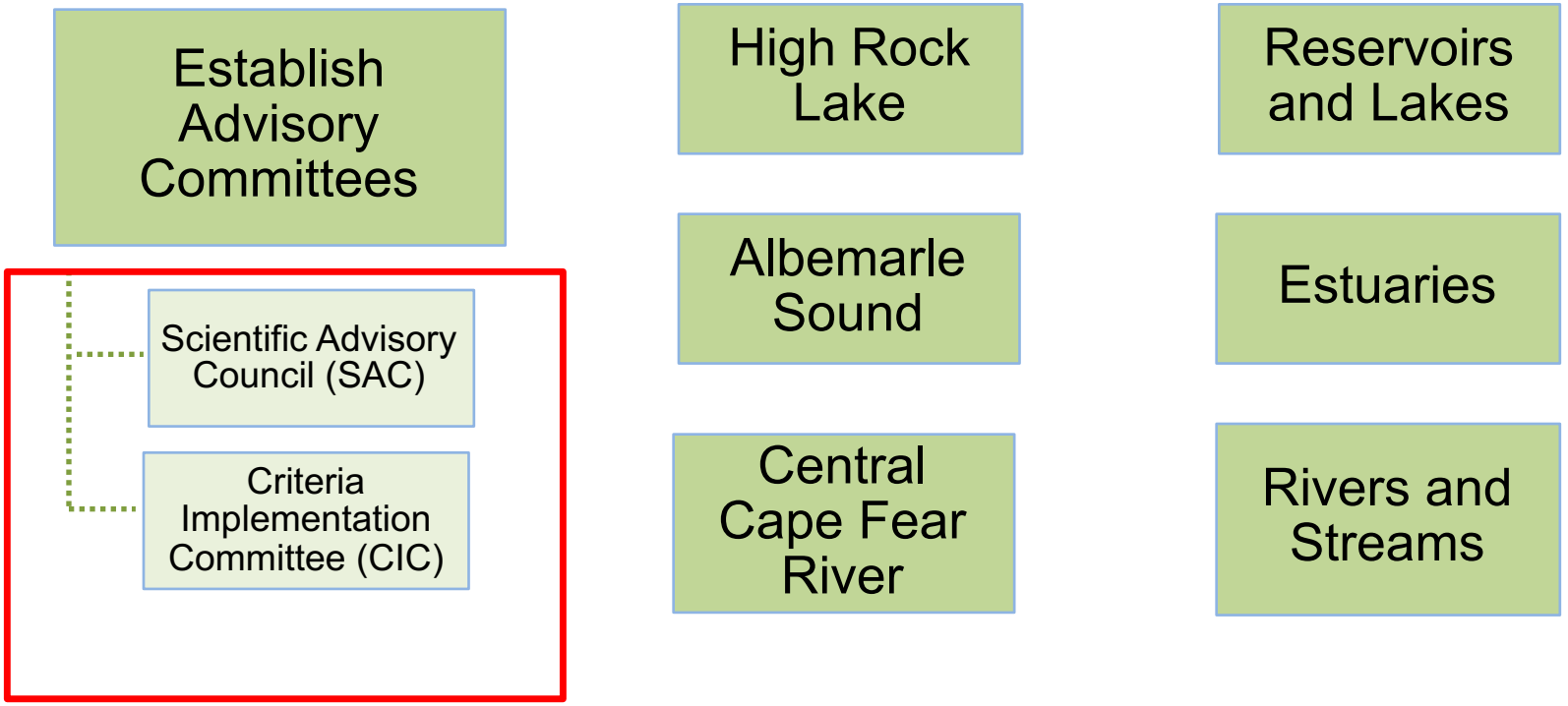
NC Chlorophyll-a Adopted Numeric Standard (1979)

"Chlorophyll a: not greater than 40 µg/L for lakes, sounds, estuaries, reservoirs, and other slow-moving waters not designated as trout waters, and not greater than 15 µg/L for lakes, reservoirs, and other slow-moving waters designated as trout waters (not applicable during the months of December trough March; not applicable to lakes and reservoirs less than 10 acres in surface area)."

NC Chlorophyll-a Standard (1986, 1989, 2001, 2015)

Chlorophyll a (corrected): not greater than 40 µg/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters, and not greater than 15 µg/l for lakes, reservoirs, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters (not applicable to lakes or reservoirs less than 10 acres in surface area). The Commission or its designee may prohibit or limit any discharge of waste into surface waters if the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;

Nutrient Criteria Development Plan Advisory Committees



Scientific Advisory Council (SAC)

focus on Science

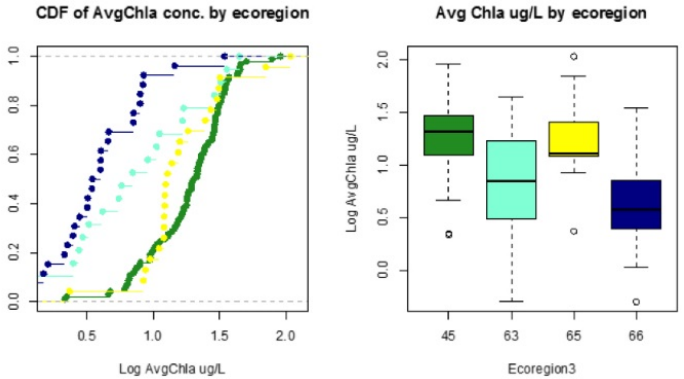
1. Marcelo Ardon
2. James Bowen
3. Michael O'Driscoll
4. ~~David Kimmel~~
5. Deanna Osmond
6. Hans Paerl
7. Astrid Schnetzer
8. Clifton Bell
9. Linda Ehrlich
10. Bill Hall
11. Martin Lebo
12. Lauren Petter

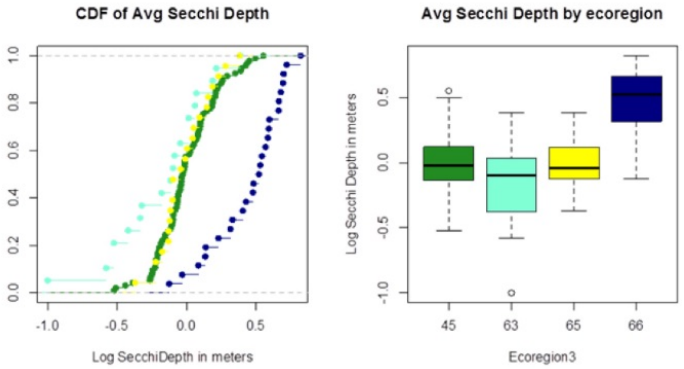
Criteria Implementation Committee (CIC)

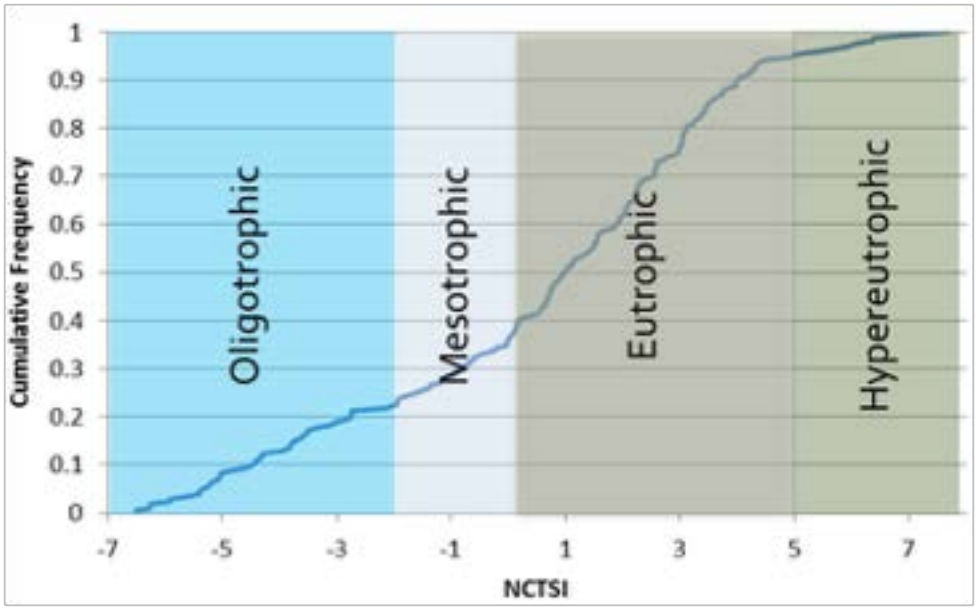
focus on implementation/costs

1. **Anne Coan** – *NC Farm Bureau*
2. **Doug Durbin** – *Cardno Entrix*
3. **John Fear** – *NC Water Resources Research Institute*
4. **Bill Kreutzberger** – *CH2M Hill*
5. **T.J. Lynch** – *City of Raleigh*
6. **Andy McDaniel** – NC Department of Transportation
7. **Carla Seiwert** – *EPA Region 4*
8. **Douglas Wakeman** – *Meredith College*

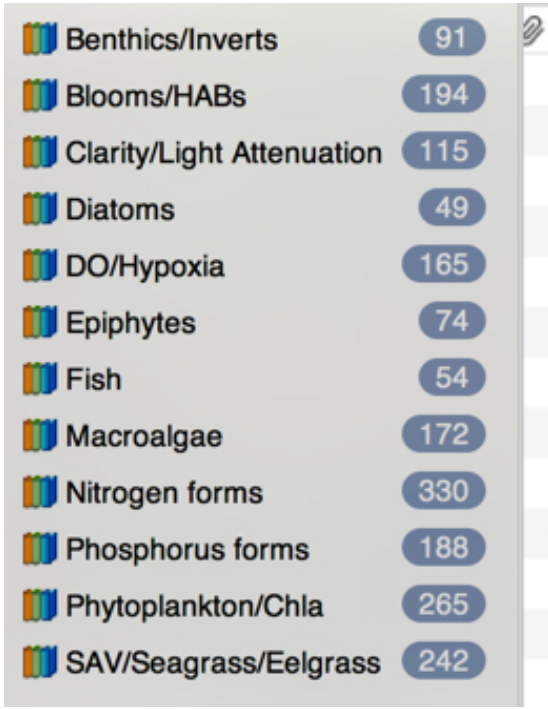
Reservoir and Lakes - Data Summary







Literature Review - Estuaries



Author	Year	Reference Type	Title
Chainho	2008	Journal Article	Use of multimetric indices to classify estu
Chalar	2011	Journal Article	Trophic assessment of streams in Urugu
Chamberl...	1996	Journal Article	Evaluation of water quality and monitorin
Chambers	2011	Journal Article	Application of nitrogen and phosphorus c
Chambers	2012	Journal Article	Development of Environmental Threshol
Chang	2011	Journal Article	Response of the plankton community to h
Chang	2010	Report	Southern Indian River Lagoon and St. Lu
Chang	2008	Web Page	IRL South Nutrient Targets Marine Nutrie
Chang	2014	Journal Article	Effective removal of Microcystis aerugino
Chanton	2002	Journal Article	Examination of coupling between primary
Chaplin	1995	Journal Article	The effect of residential and forested wat
Chapra	1997	Book	Surface Water-Quality Modeling
Chasar	2005	Journal Article	Evaluating the effect of environmental dis

High Rock Lake Water Quality Goal

To provide for the protection of designated uses in the HRL reservoir by defining and proposing the appropriate level of algal related indicators for each of the following uses:

- ✓ 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)

Potential Indicators

- **Aquatic Life**
  - ✓ pH
  - ✓ Dissolved oxygen (DO)
  - ✓ Algal toxins
  - ✓ Biovolume (better than unit density for aquatic Life)
- **Fishing**
  - ✓ Quality of fishery
- **Recreational**
  - ✓ Algal toxins
  - ✓ Cyanobacteria density
  - ✓ Reported incidents of adverse impacts
- **Water Supply**
  - ✓ Algal toxins
  - ✓ Taste & odor

Indicator Short List

Parameters for Numeric Ranges	No. of Votes
Chlorophyll-a	11
pH	10
Dissolved Oxygen	10
Clarity (Secchi depth or turbidity)	9
Algal toxins	8
Nitrogen and Phosphorus (needs discussion)	6

Parameters for Narrative Ranges	No. of Votes
Algal Community Structure	2
Fishery	2

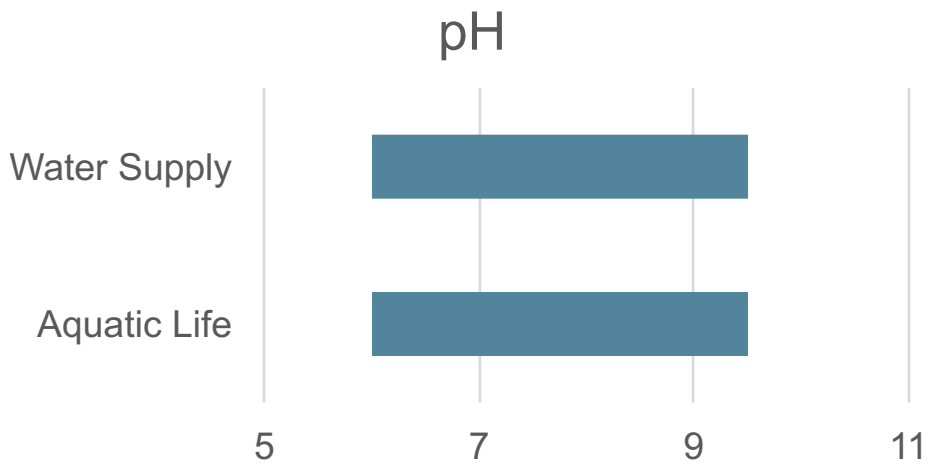
pH

Options for Frequency & Duration

- Use multi-year 10% exceedence with 90% confidence (current method)
- Express as an annual or seasonal 90th percentile

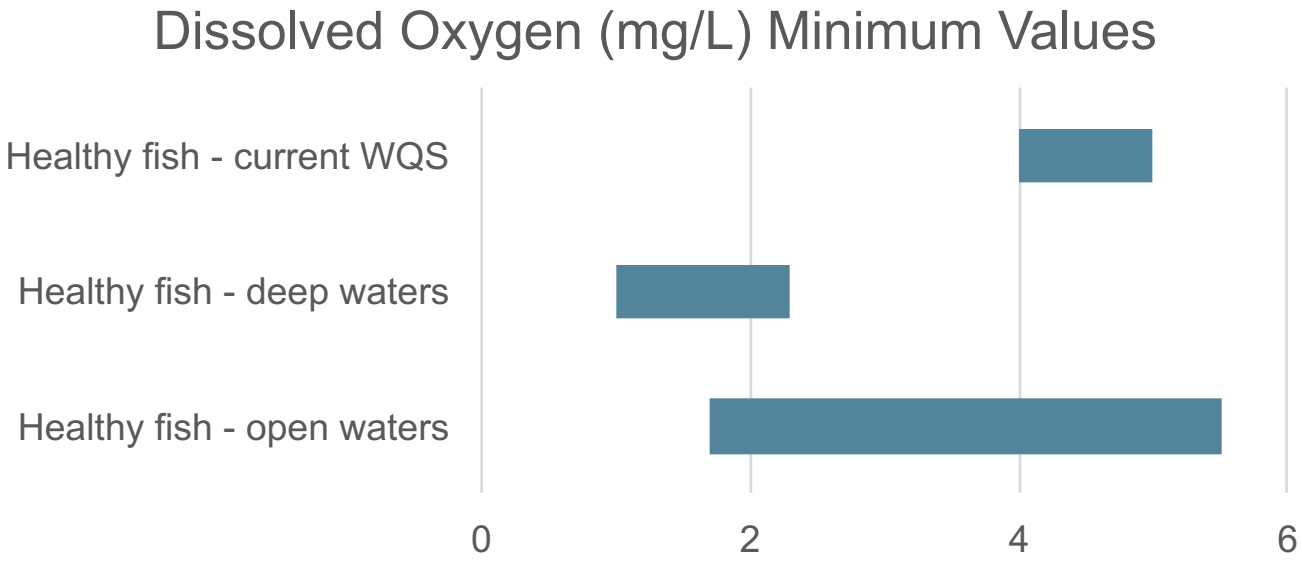
Spatial considerations

- Current method = surface only
- May want to aggregate data from mainstem



Dissolved Oxygen

WQ Goal: Aquatic Life	Instantaneous	Average	Range	Notes
Healthy fish - open waters	1.7	5.5	3.8	upper photic zone: instantaneous minimum; 30-day mean
Healthy fish - deep waters	1	2.3	1.3	below photic zone/thermocline: instantaneous minimum to protect benthic forage base; daily average to protect fish
Healthy fish - current WQS	4	5	1	minimum 4 mg/L; daily average 5 mg/L



Dissolved Oxygen Background

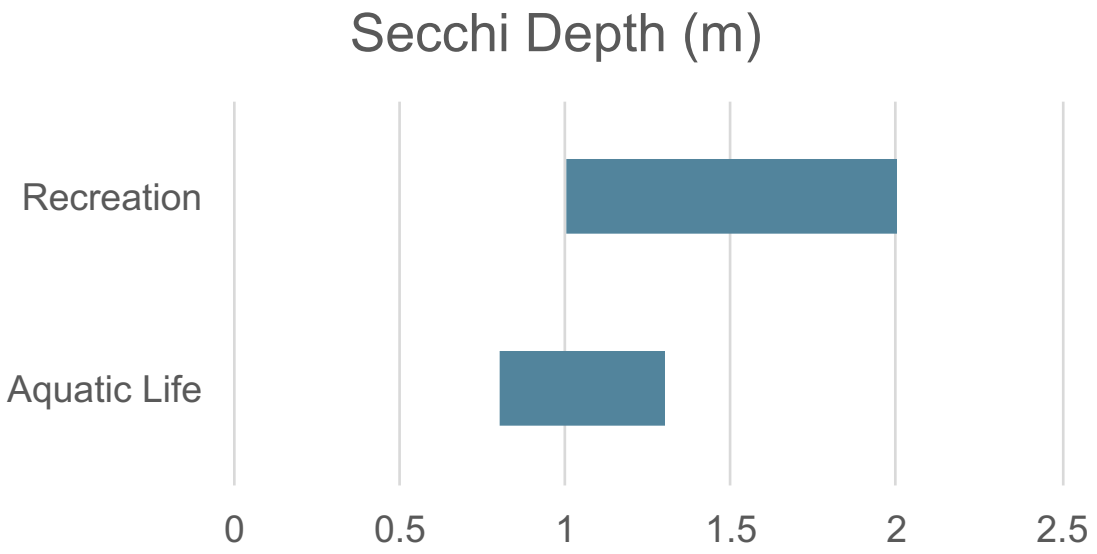
WQ Goal: Aquatic Life	Instantaneous	Average	Range	Duration	Special Considerations	Literature
Healthy fish - open waters	1.7	5.5	3.8	(1)	Open Waters (2) [M. Lebo]	See Lebo spreadsheet 4/2016
Healthy fish - deep waters	1	2.3	1.3	(3)	Deep Waters (4) [M. Lebo]	See Lebo spreadsheet 4/2016
Healthy fish - current WQS	4	5	1	(5)	Current WQS [M. Lebo]	NCDEQ WQS code viewed online

Notes: (1) low is instantaneous; high is for 30-day mean; (2) open waters is the upper photic zone; (3) low is instantaneous to protect benthic forage base; high is daily average of deep waters for protection of juvenile and adult fish; (4) deep waters below photic zone/thermocline; (5) minimum 4 mg/L and daily average of 5 mg/L. [M.Lebo]

Water Clarity

Criteria considerations:

- Determine duration & frequency protective of uses
- Is minimum the only criterion needed for Secchi (max not an issue)?
- Piedmont lakes reference condition Secchi depth = 1.66 m
- Current turbidity WQS = 25 NTU ≈ 0.5 m Secchi depth
- < 0.5 m = hypereutrophic, no recreation; > 1 m = clear, no blooms



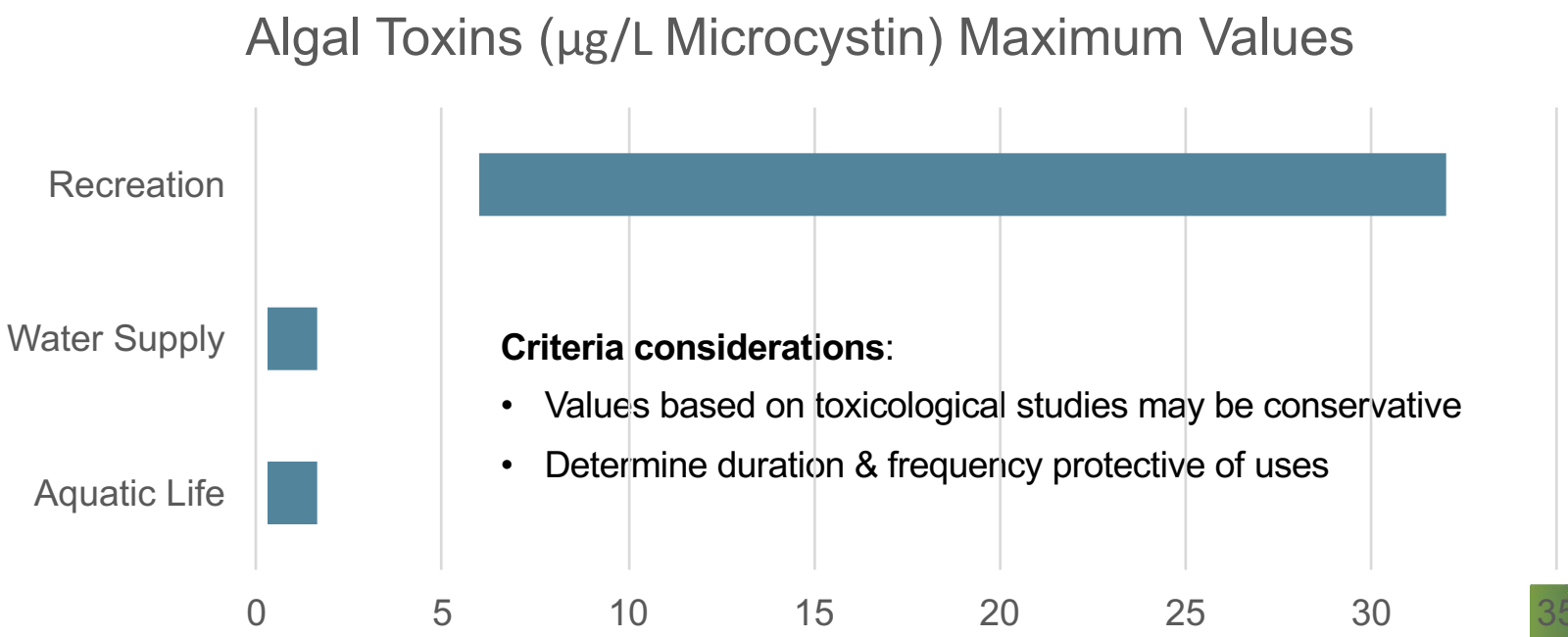
Water Clarity

Indicator: Clarity (Secchi Depth in m)					
WQ Goal: Aquatic Life	**Low**	**High**	**Range**	**Special Considerations**	**Literature**
Healthy fish population	0.8	1.3	0.5	excellent to good; good to acceptable range	Burden et al. 1985, Younos 2007

Indicator: Clarity (Secchi Depth in m)					
Water Quality Goal: Recreation	**Low**	**High**	**Range**	**Special Considerations**	**Literature**
Full-body contact	0.8	2	1.2		Smith et al. 1995, Younos 2007
Incidental/infrequent contact	0.5	2	1.5	0.5 hypereutrophic, no recreation	Lee et al. 1995, Younos 2007
Aesthetics	1	2	1	>1 clear, no blooms	Barica 1975, Younos 2007: Burkart et al. 2008

Algal Toxins

WQ Goal	Children	Adults	Range	Notes
Aquatic Life	0.3	1.6	1.3	Aquatic Life & Water Supply values based on drinking water for children (low) & adults (high)
Water Supply	0.3	1.6	1.3	Dissolved toxins = issue for drinking water; Cell-bound toxins removed in treatment process
Recreation	6	32	26	Recreation values based on accidental ingestion for children (low) and adults (high)



Criteria considerations:

- Values based on toxicological studies may be conservative
- Determine duration & frequency protective of uses

Fisheries (narrative criteria)

Large mouth bass

Indicator: Fish						
WQ Goal	**Low**	**High**	**Range**	**Duration**	**Frequency**	**Special Considerations**
Abundance (CUE/hour)	50	105	55			Based on samples every 3 years by NCWRC [M. Ardon]
Composition (length/weight) (length)	50	550	500			
Condition (safe for consumption)			0			There haven't been any advisories for Large mouth bass. There have been for catfish. [M. Ardon]

Crappie

Indicator: Fish						
WQ Goal	**Low**	**High**	**Range**	**Duration**	**Frequency**	**Special Considerations**
Abundance (CUE night)	4	31	27			Sampled every 3 years by NCWRC [M. Ardon]
Composition (length/weight)			0			
Condition (safe for consumption)			0			

2016

2016 EPA Nutrient Criteria?

Numeric Nutrient Criteria Webinar Series

Numeric Nutrient Criteria for Lakes and Reservoirs of the Conterminous United States

Tuesday, June 21, 2015

3:00 PM Eastern

Lester Yuan,
U.S. Environmental Protection Agency

EPA United States Environmental Protection Agency

2016 EPA Nutrient Criteria?

Summary

- Candidate assessment endpoints and exposure metrics were selected to link nutrient pollution to designated use protection in lakes and reservoirs.
- National Lakes Assessment data analyzed to estimate relationships between nutrient concentrations and different endpoints.
  - New classes of lakes defined by statistical analyses.
  - Stressor-response relationships estimated using Bayesian models
  - Approach developed for interpreting state data in the context of national models.

- EPA considering proposing new 304(a) nutrient criteria for lakes and reservoirs later in 2016.

2016 EPA Nutrient Criteria?

Candidate exposure metrics for drinking water source and recreational uses

- Drinking water source:
  - Microcystin concentration
  - Possible threshold: 0.3 µg/L (US EPA Health Advisory for children, 2015)
  - Based on a variety of health effects
- Recreation (related effort):
  - Cyanobacteria abundance
    - Exposure associated with skin rashes and gastrointestinal illness
  - Microcystin concentration
    - Incidental ingestion during recreation

2016 Appropriations Act

DEVELOPMENT OF NEW COMPREHENSIVE NUTRIENT MANAGEMENT REGULATORY FRAMEWORK

SECTION 14.13.(a) The General Assembly finds all of the following:

(1) It is necessary for the State to have a comprehensive management strategy to protect and improve water quality.

(2) Over the last 20 years, comprehensive watershed nutrient management strategies and buffer rules have been implemented in several river basins and watersheds in North Carolina where surface water quality has been impaired by excess nutrients.

(3) It is in the interest of the State to review the costs and benefits of existing nutrient management strategies and determine whether those nutrient management strategies should be modified in order to maintain and improve water quality in nutrient sensitive waters.

(4) The State should revise nutrient strategies to maintain proven measures already shown to be effective; incorporate new technological and management innovations; recognize investments in water quality already implemented by stakeholders; and share costs on an equitable basis.

Questions?

Steve Kroeger

(919) 743-8409

steve.kroeger@ncdenr.gov

www.ncwater.org