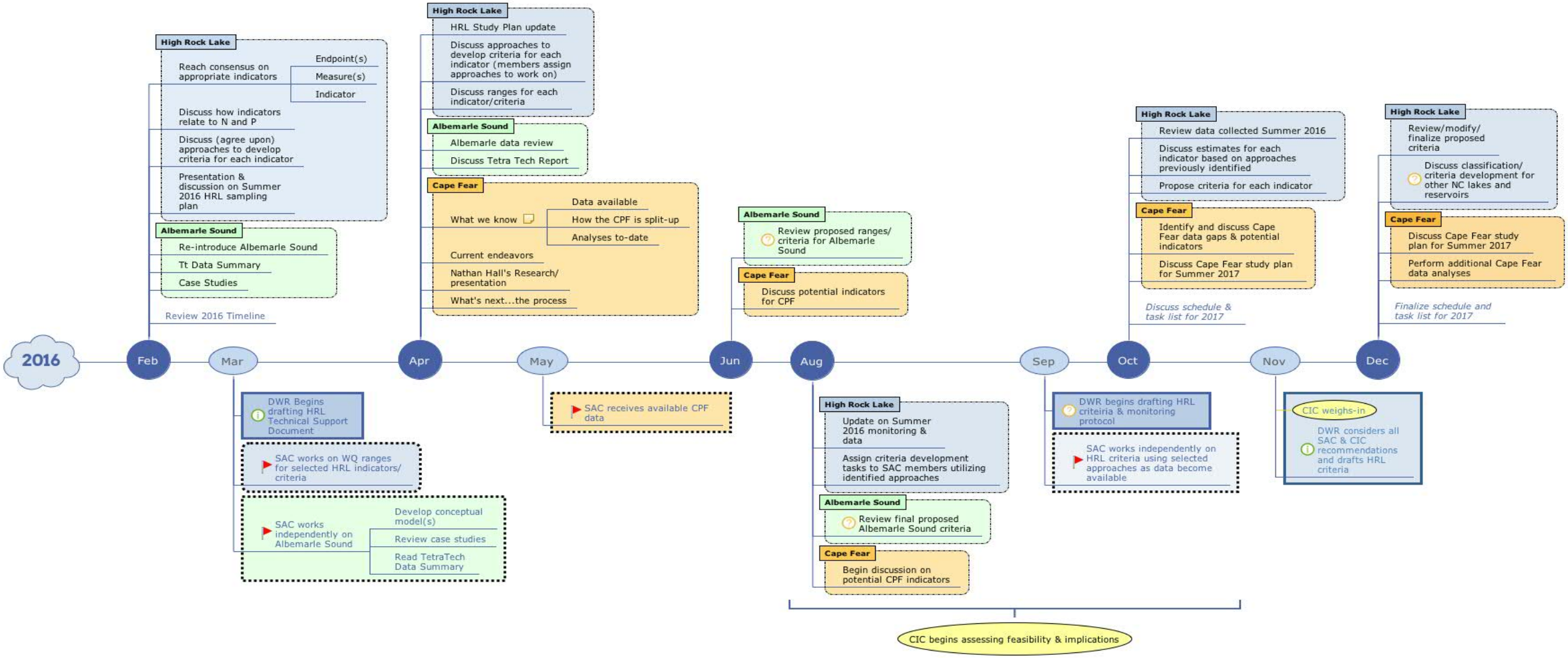


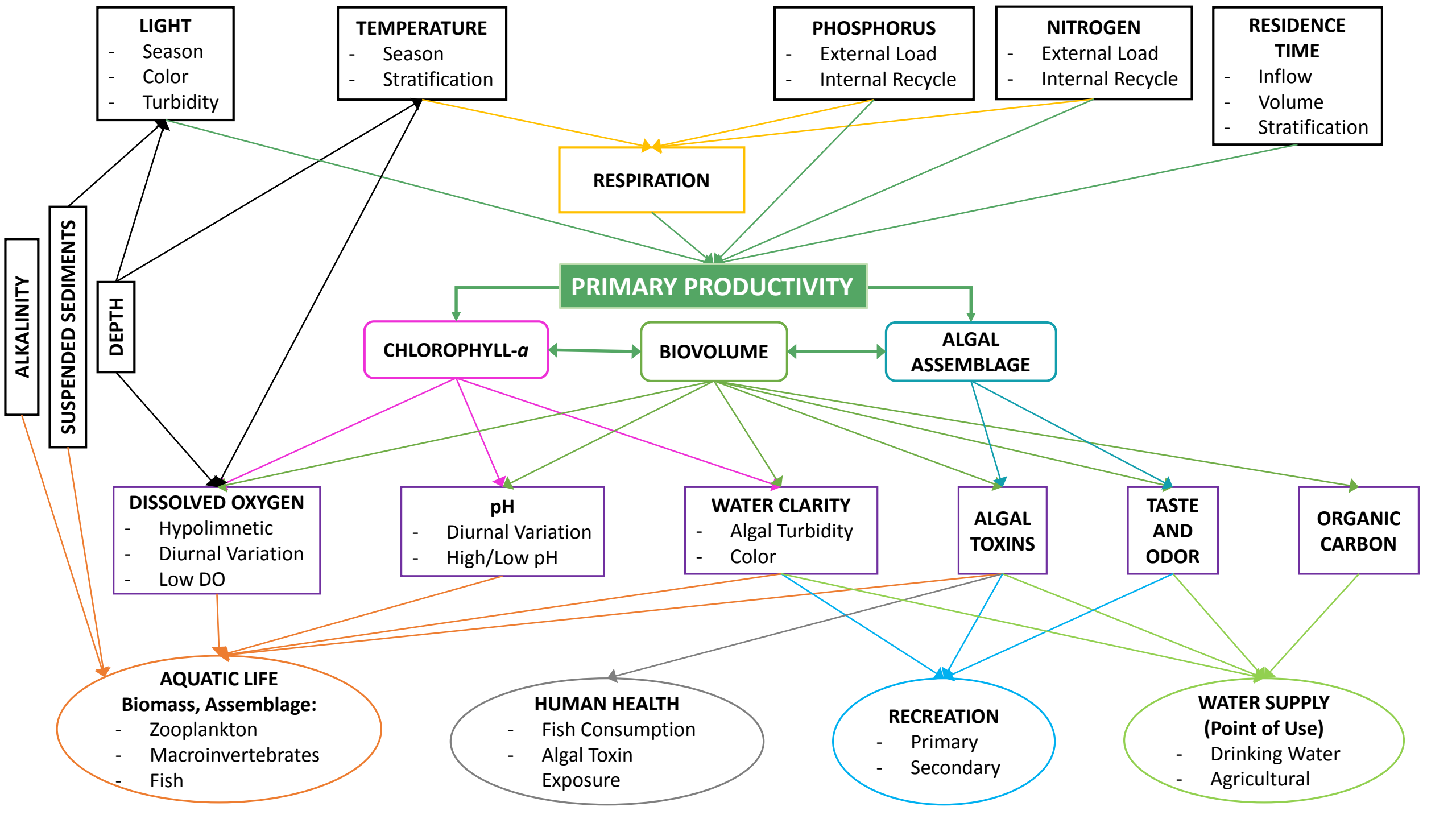
Tentative 2016 Nutrient Criteria Development Timeline

Review &
Next Steps for HRL

December Recap

- SAC described indicators
- SAC identified uses for HRL
- SAC linked indicators to uses

- DWR took all information and developed a summary for each indicator and a “complete” conceptual model for the lake


LIGHT
- Season
- Color
- Turbidity
TEMPERATURE
- Season
- Stratification
PHOSPHORUS
- External Load
- Internal Recycle
NITROGEN
- External Load
- Internal Recycle
RESIDENCE TIME
- Inflow
- Volume
- Stratification
RESPIRATION
ALKALINITY
SUSPENDED SEDIMENTS
DEPTH
PRIMARY PRODUCTIVITY
CHLOROPHYLL-a
BIOVOLUME
ALGAL ASSEMBLAGE
DISSOLVED OXYGEN
- Hypolimnetic
- Diurnal Variation
- Low DO
pH
- Diurnal Variation
- High/Low pH
WATER CLARITY
- Algal Turbidity
- Color
ALGAL TOXINS
TASTE AND ODOR
ORGANIC CARBON
AQUATIC LIFE
Biomass, Assemblage:
- Zooplankton
- Macroinvertebrates
- Fish
HUMAN HEALTH
- Fish Consumption
- Algal Toxin Exposure
RECREATION
- Primary
- Secondary
WATER SUPPLY (Point of Use)
- Drinking Water
- Agricultural

One Step Further

- **DWR developed WQ Goals (and then refined them) based on each use the SAC identified in December**
  - Aquatic Life
  - Water Supply
  - Recreation

Water Quality Goal(s) as Defined in Rule	Refined WQ Goal(s)
AQUATIC LIFE	
HRL should support a healthy and diverse population of fish, benthos, and wildlife.	HRL should support a Healthy and Diverse population of fish and benthos that are safe for Human Consumption **Diverse biological population that is safe for human consumption**
Protection of HRL to allow for the safe consumption of fish species	
HRL should maintain an aesthetic quality that does not interfere with any of the above uses.	
WATER SUPPLY	
HRL should be suitable for use as a water supply source	HRL should be free from cyanotoxins and excessive algal growth **Potentially harmful (toxic or excessive) algal bloom prevention**
HRL should not contain substances that cause taste and odor issues that are untreatable	
RECREATION	
Protection of HRL to allow for full-body contact recreation including swimming	HRL should provide water of adequate clarity that is free from excessive algae and algal toxins and is desirable for recreation **Waters desirable and safe for recreation**
Protection of HRL to allow for incidental or infrequent body contact recreation through boating, wading, or other activities	
HRL should maintain an aesthetic quality that does not interfere with any of the above uses	

What's Next?

Refined Conceptual Models for Each Goal

Refined WQ Goal(s)	Potential Assessment Endpoint(s)	Final Assessment Endpoint(s)	Measure	WQ Range(s) (Literature)	Potential Criteria	
					Response Indicator(s)	Causal Indicators(s)
AQUATIC LIFE						
Diverse biological population that is safe for human consumption	Algae Fish Macroinvertebrates Zooplankton		Water Clarity pH Algal Toxins DO Chlorophyll-a Algal Assemblage Algal Biovolume Suspended Sed. Alkalinity			

EXAMPLE

WQ Goal - Surface waters free from harmful algae

Refined WQ Goal(s)	Assessment Endpoint(s)	Measure	WQ Range(s) (Literature)	Potential Criteria	
				Response Indicator(s)	Causal Indicators(s)
AQUATIC LIFE					
★ **PHAB Prevention**	Algae Algal Toxins	Chlorophyll-a Microcystis Cylindrospermopsin	Piedmont Reservoirs Chl-a = 1 – 200 ug/L Micro = .1 – 50 ug/L Cylind = .5 – 25 ug/L	Chlorophyll-a Toxins (general)	Nitrogen Phosphorus Light Temperature Residence Time

Proposed Criteria: Chlorophyll-a with a toxin component and nitrogen threshold

EXAMPLE

WQ Goal – Safe, clear water desirable for swimming

Refined WQ Goal(s)	Assessment Endpoint(s)	Measure	WQ Range(s) (Literature)	Potential Criteria	
				Response Indicator(s)	Causal Indicators(s)
AQUATIC LIFE					
★ **Good Recreational Quality Water**	Water Clarity	Suspended Sediment Depth	Southeastern Lakes & Reservoirs Turb = 5 – 120 NTU Depth = 7 – 15 M	Secchi Depth	Land Use Soil Composition Residence Time

Proposed Criteria: Depth threshold and narrative criteria

Next: Approaches to Develop Criteria

- Reference Condition (Regional approach)
- Stressor-Response
- Mechanistic Model (Site-specific)
- Weight-of-Evidence
- Best Professional Judgement
- Other

Potential Criteria	
Response Indicator(s)	**Causal Indicators(s)**
AQUATIC LIFE	
Chlorophyll-a Toxins	Nitrogen Phosphorus Light Temperature Residence Time

Refined WQ Goal(s)	Potential Assessment Endpoint(s)	Final Assessment Endpoint(s)	Measure	WQ Range(s) (Literature)	Potential Criteria	
					Response Indicator(s)	Causal Indicators(s)
AQUATIC LIFE						
Diverse biological population that is safe for human consumption	Algae Fish Macroinvertebrates Zooplankton		Water Clarity pH Algal Toxins DO Chlorophyll-a Algal Assemblage Algal Biovolume Suspended Sed. Alkalinity			
WATER SUPPLY						
Potentially harmful (toxic or excessive) algal bloom prevention	Algae		Org. Carbon Taste & Odor Algal Toxins Water Clarity Algal Biovolume Algal Assemblage Chlorophyll-a			
RECREATION						
Waters desirable and safe for recreation	Algae		Water Clarity Algal Toxins Taste & Odor			

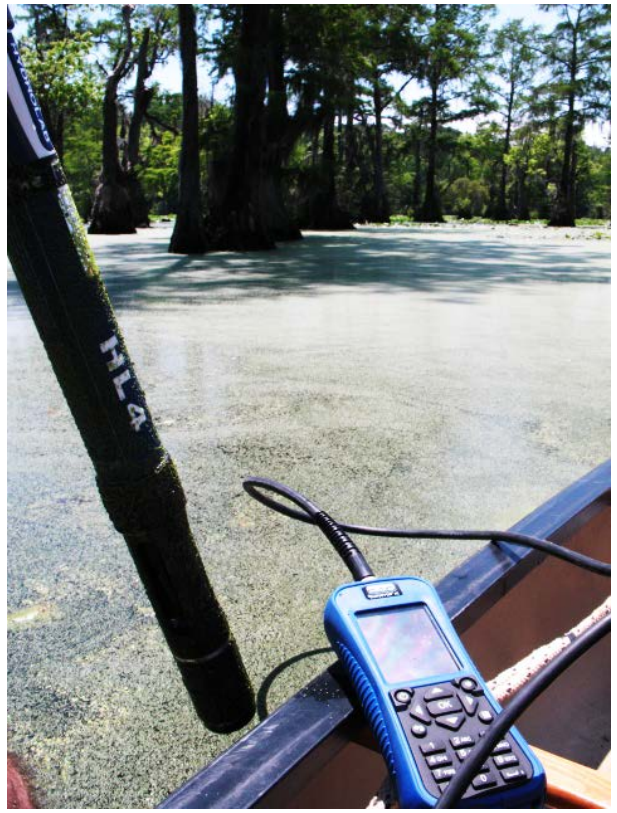
Ambient Lakes Monitoring

What Is Collected?

Chemical samples are collected from the photic zone using an integrated sampler.

-Nutrients (NH3,NOX,TKN,TP)
-Turbidity
-Chlorophyll *a*
-Total Solids
-Total Suspended Solids
-Total Metals and Chloride (Water Supply Lakes)

Ambient Lakes Monitoring



What Is Collected?

Physical Conditions are measured with multi-probe meters.

-Temperature (°C)
-Dissolved Oxygen (mg/L)
-pH
-Conductivity (µmhos/cm)
-Secchi Depth (m)

Photic Zone is determined using a Secchi disk.
(Photic Zone = 2x secchi depth)

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North Carolina Trophic State Index
NCTSI

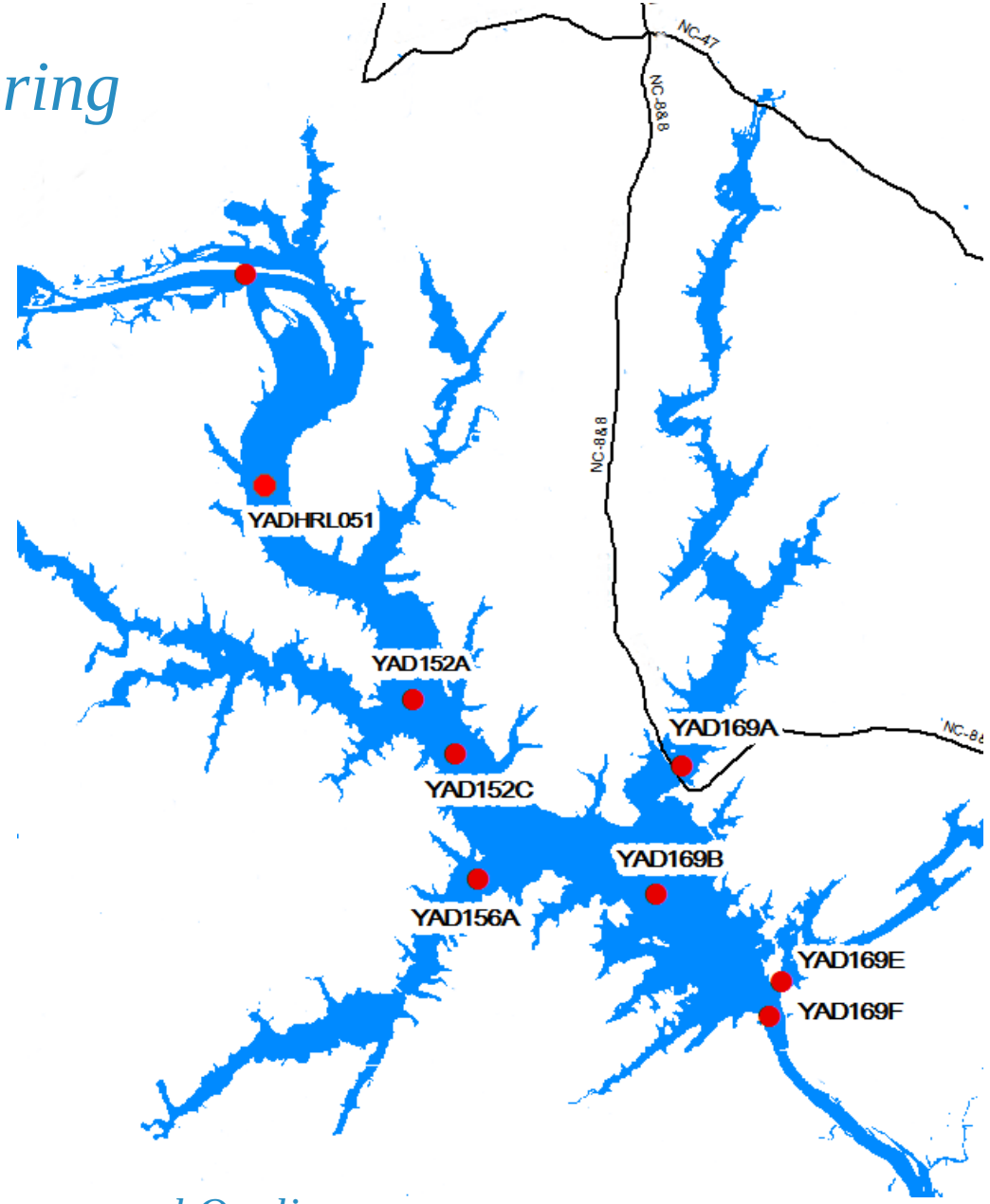
CHL = Chlorophyll a (g/L)
TON = Total Organic Nitrogen (mg/L)
TP = Total Phosphorous (mg/L)
SD = Secchi Depth (inches)

< -2.0	Oligotrophic
-2.0 - 0.0	Mesotrophic
0.0 - 5.0	Eutrophic
>5.0	Hypereutrophic

NC Trophic State Scale

< -2.0	Oligotrophic
-2.0 - 0.0	Mesotrophic
0.0 - 5.0	Eutrophic
>5.0	Hypereutrophic

Ambient Lakes Monitoring



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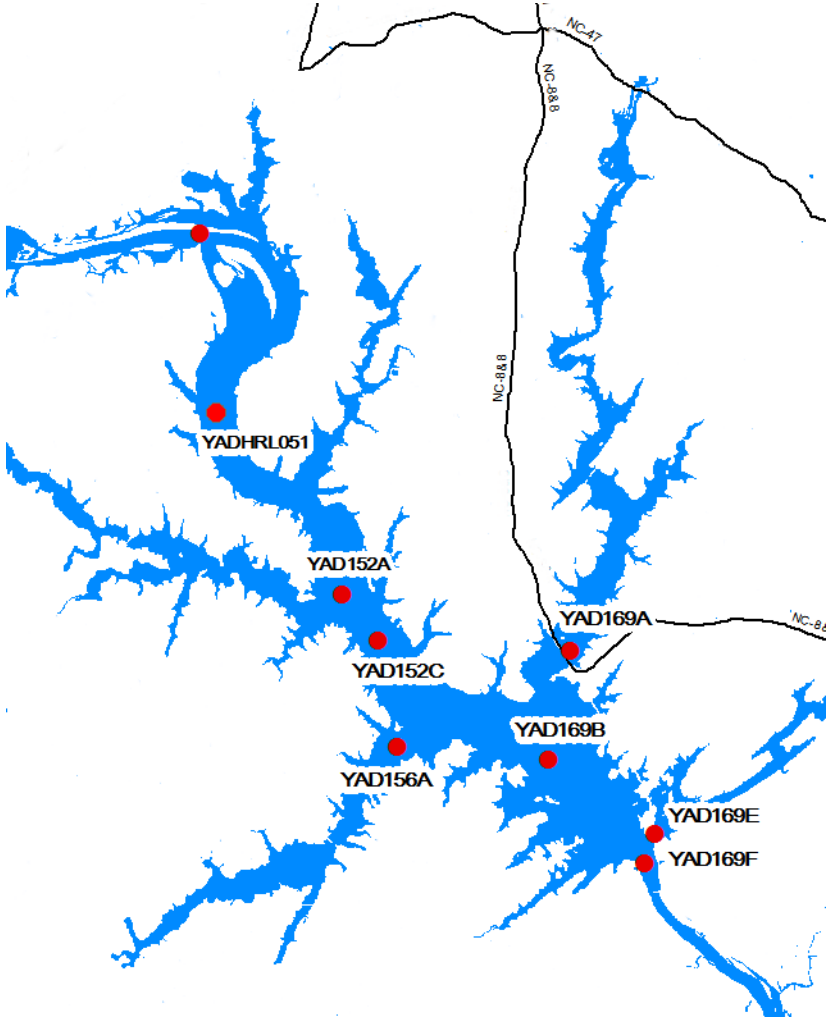
High Rock Diurnal Study



Site Name

YADHRL051
YAD152C
YAD169A
YAD169B

Physical WQ Parameters	Physical
	Hourly over 24 hour period
Temperature(°C) pH (s.u.) Dissolved Oxygen (mg/L) % Saturation Oxygen Conductivity (us/cm)	
Potential Chemical Parameters	Chemical??
	4 per site visit
Turbidity (NTU) TSS (mg/L) Chlorophyll a (µg/L) Nitrate+Nitrite (mg/L) TKN (mg/L) NH3 (mg/L) TP (mg/L)	Maximum photosynthetic activity (highest D.O., pH). Lowest photosynthetic activity (lowest D.O., pH). Intervals between maximum and minimum.

2016 Ambient Lakes Monitoring

Yadkin River Basin Lakes
26 lakes

High Rock
Roberdel
Page
Falls
Tillery
Tuckertown
Badin
Blewett Falls
Reese
Back Creek
Coddle Cr.
Winston
Wadesboro City Pond
Tom-A-Lex
Lee
Monroe
Twitty
Rockingham
Hamlet
Kannapolis
Fisher
Kerr Scott
McCrary
Concord
Bunch
Salem

Lumber River Basin Lakes
3 lakes

Waccamaw
Tabor
Pages

ISB Studies

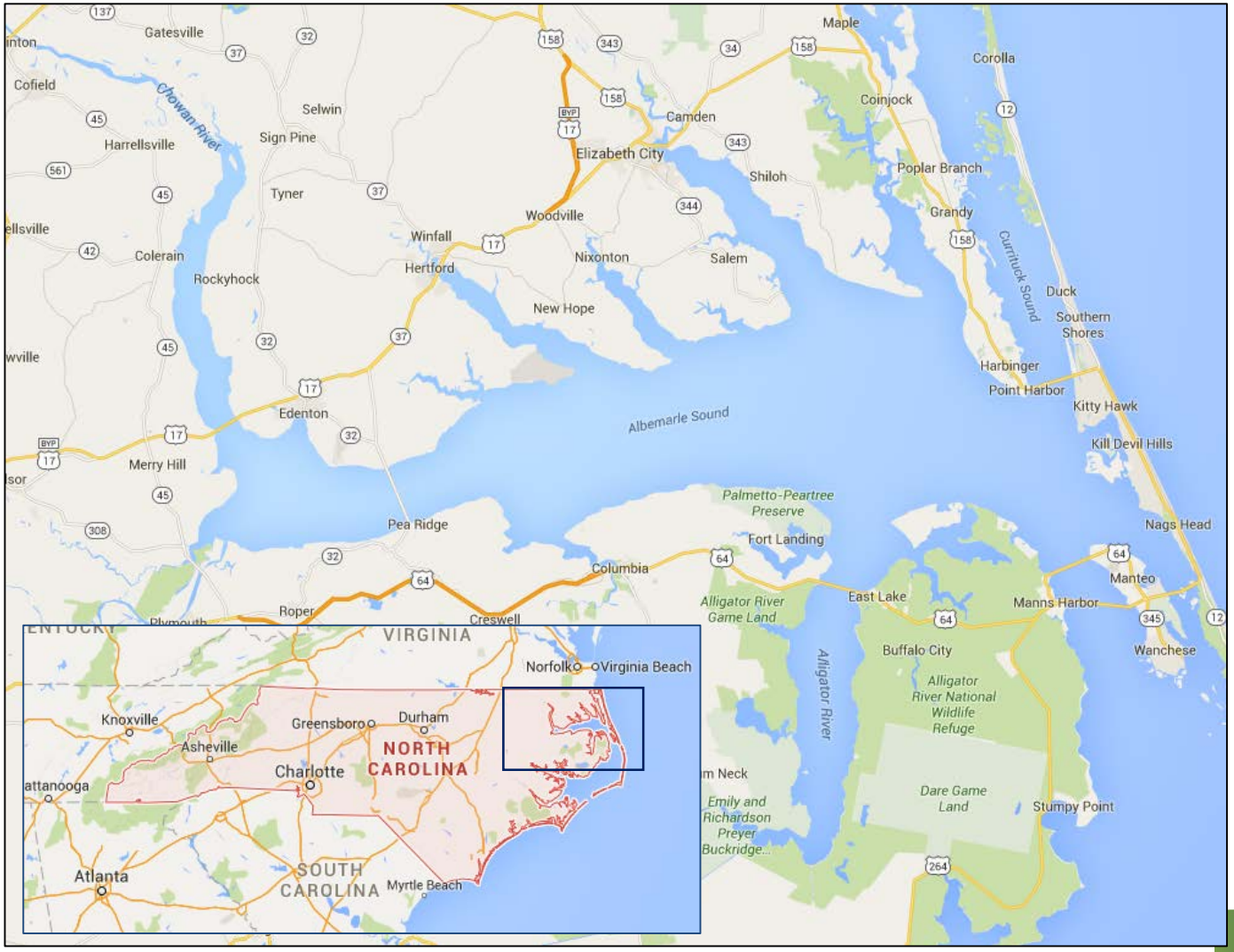
1:4 Dioxane
Jordan Lake Solar Bee
Rocky River Study
Hannah Creek
Falls Lake
Coal Ash Fish Tissue

Albemarle Sound: Nutrient Criteria Development Progress

Jim Hawhee
N.C. Division of Water Resources
17 February 2016

Department of Environmental Quality

Albemarle Sound



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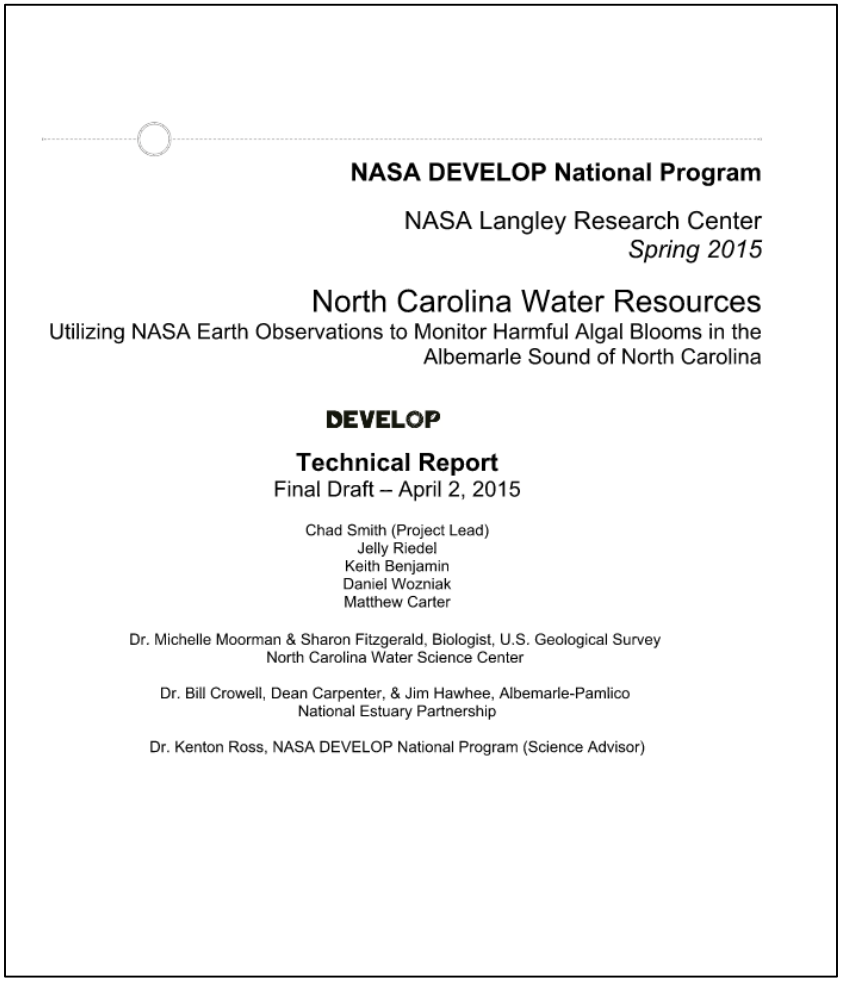
Albemarle Sound- Status

NASA DEVELOP Project

- Status: Complete
- Results inconclusive
- Summary: Project participants analyzed satellite color imagery to evaluate its accuracy for detecting chlorophyll a. Results showed poor correlation with previously collected water quality data.
- Full report on Google Drive



NASA DEVELOP National Program

NASA Langley Research Center
Spring 2015

North Carolina Water Resources
Utilizing NASA Earth Observations to Monitor Harmful Algal Blooms in the Albemarle Sound of North Carolina

DEVELOP

Technical Report
Final Draft – April 2, 2015

Chad Smith (Project Lead)
Jelly Riedel
Keith Benjamin
Daniel Wozniak
Matthew Carter

Dr. Michelle Moorman & Sharon Fitzgerald, Biologist, U.S. Geological Survey
North Carolina Water Science Center

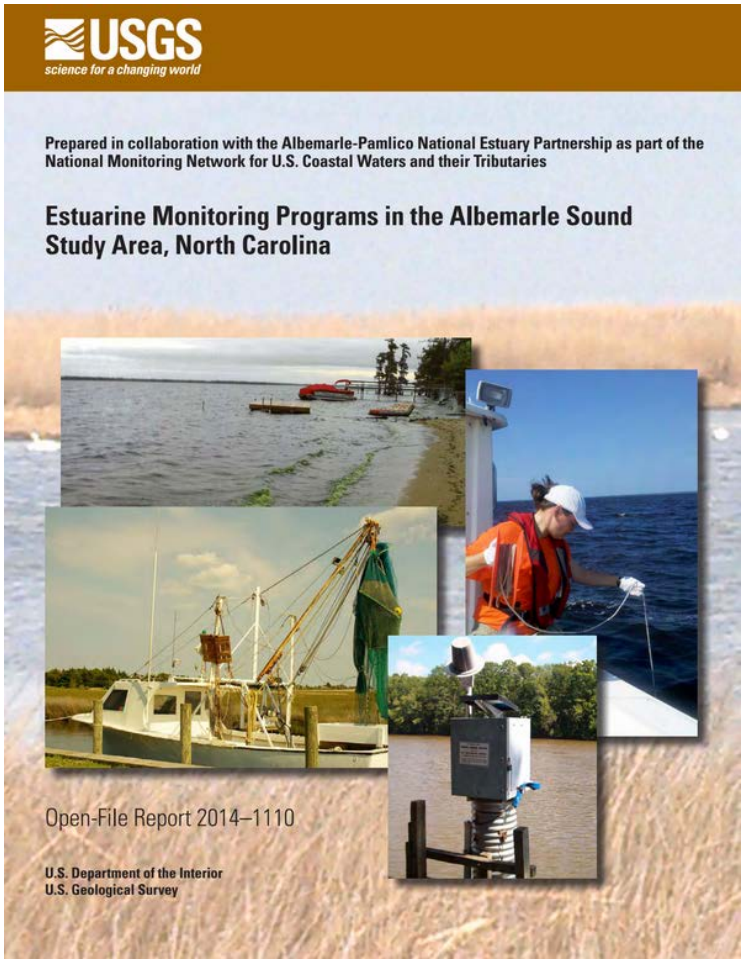
Dr. Bill Crowell, Dean Carpenter, & Jim Hawhee, Albemarle-Pamlico
National Estuary Partnership

Dr. Kenton Ross, NASA DEVELOP National Program (Science Advisor)

Albemarle Sound- Status

USGS Albemarle Sound Initiatives

- Status: Nearly complete
- An inventory of monitoring programs and available data in the Albemarle Sound watershed has been completed.
- Duke MEM project supervised by lead USGS PI offers trend analysis of variables including chl a, DO, turbidity, nitrogen and phosphorus.
- Both reports available on Google Drive
- USGS report analyzing results of field efforts ready soon.



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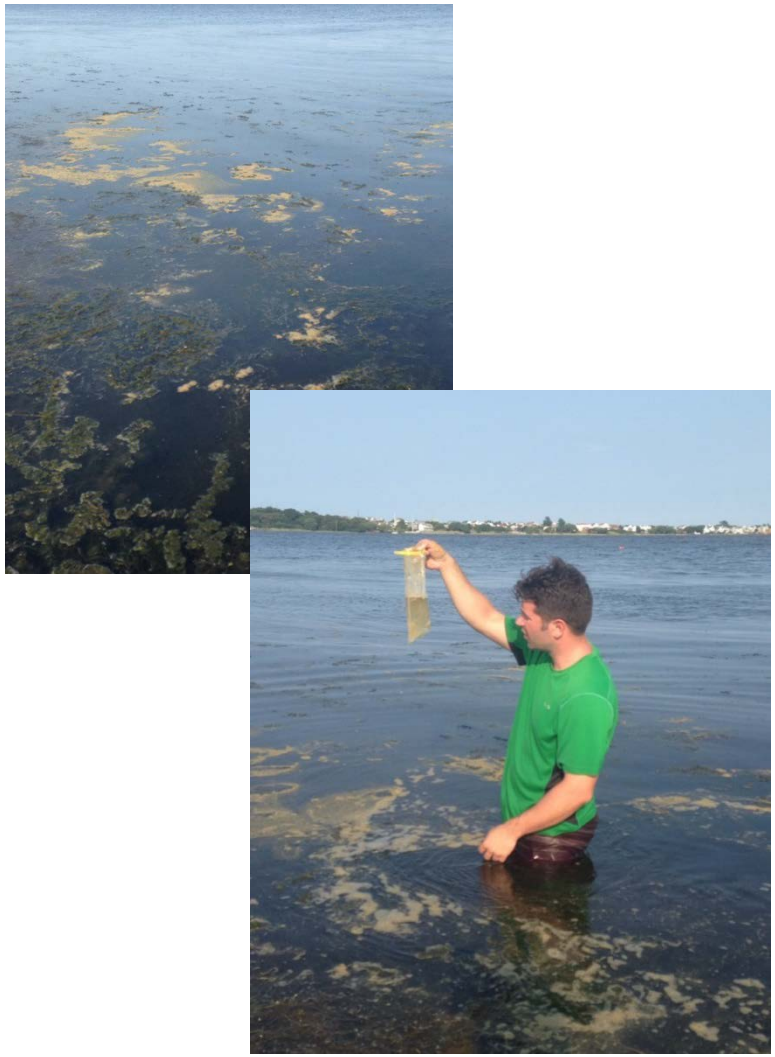
Albemarle Sound- Status

Literature Review

- Status: Complete
- NSTEPS proposal for literature review funded and conducted by Tetra Tech.
- Summary: ~4,000 estuarine literature citations organized and associated with keywords for further exploration. Abstracts provided for most sources. Tags include geographical sorting, environmental endpoints, and methods.
- EndNote database, Excel sheet and a series of text files associated with each keyword are available via Google Drive.



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Albemarle Sound- Status

Data Review and Analysis

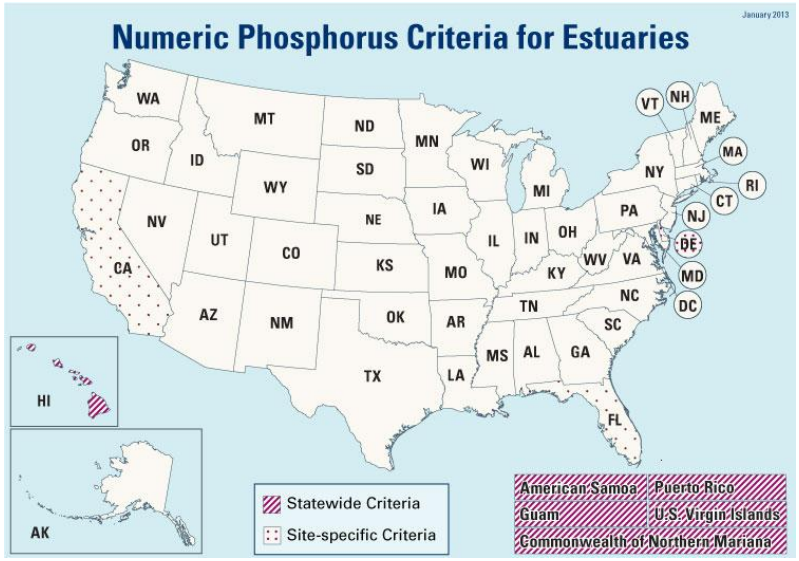
- Summary: Advanced statistical and spatial analyses of historical DWR monitoring data in and near Albemarle Sound to inform criteria development
- Status: Final draft submitted

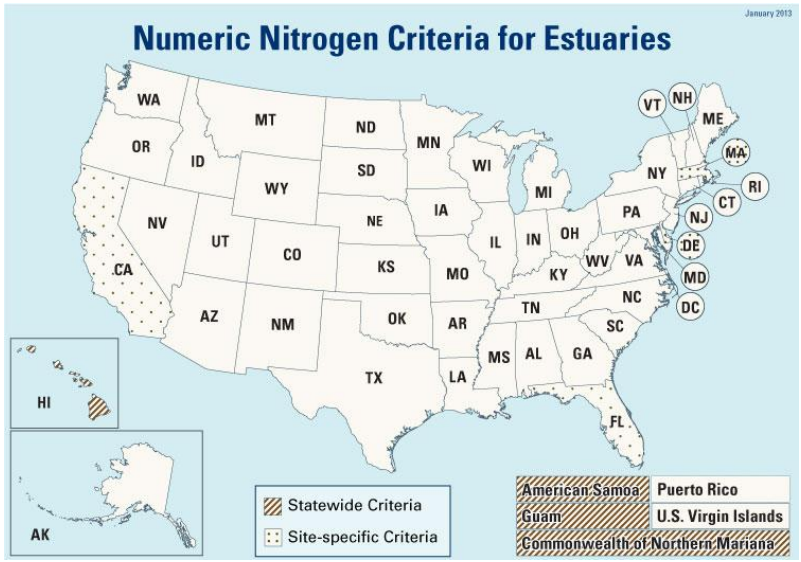
Albemarle Sound- Status

Law and Policy Review

- Status: Complete, report on Google Drive
- Summary: An evaluation of case law regarding numeric nutrient criteria development nationally and high-level policy case studies of other jurisdictions that have revisited nutrient criteria.
- Analysis conducted by a legal fellow associated with N.C. Sea Grant and the N.C. Coastal Resources Law, Planning and Policy Center.

February Meeting: Case Studies





Review of 11 estuarine nutrient criteria case studies

- Varying approaches, parameters, thresholds, and states of progress
- Case studies available on Google Drive

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Albemarle Sound- What's Next?

- Tentative March agenda includes:
  - Discussion of Tetra Tech data analyses
  - 303(d) listing methodologies
  - Overview of present monitoring efforts

- Conclusion of Phase I presently targeted for summer 2016:
  - Report summarizing proceedings and recommendations
  - Consultation with SAC

Albemarle Sound- SAC Homework

- Evaluate High Rock conceptual model for applicability to Albemarle Sound, recommend adjustments as necessary.
- Review case studies
- Review Tetra Tech report

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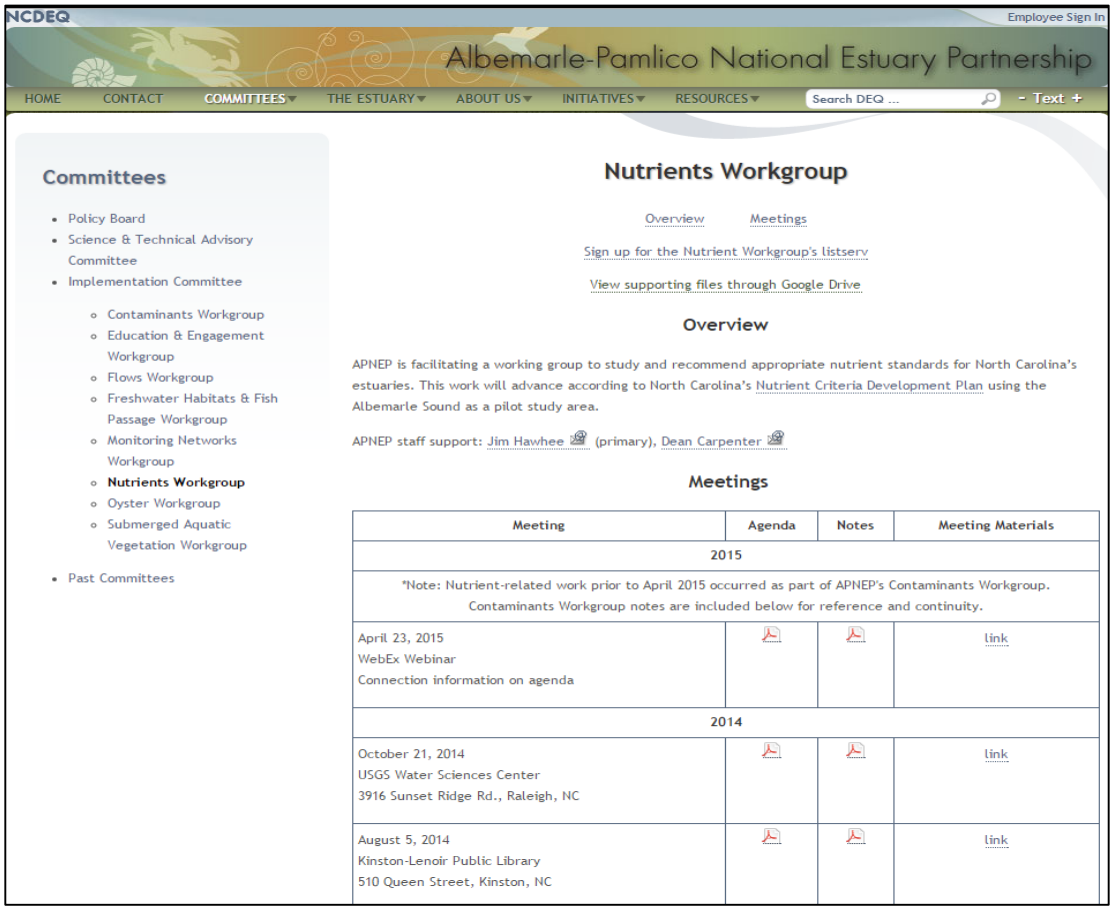
APNEP Nutrient Workgroup Website



http://apnep.org/web/apnep/nutrients

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Questions?

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