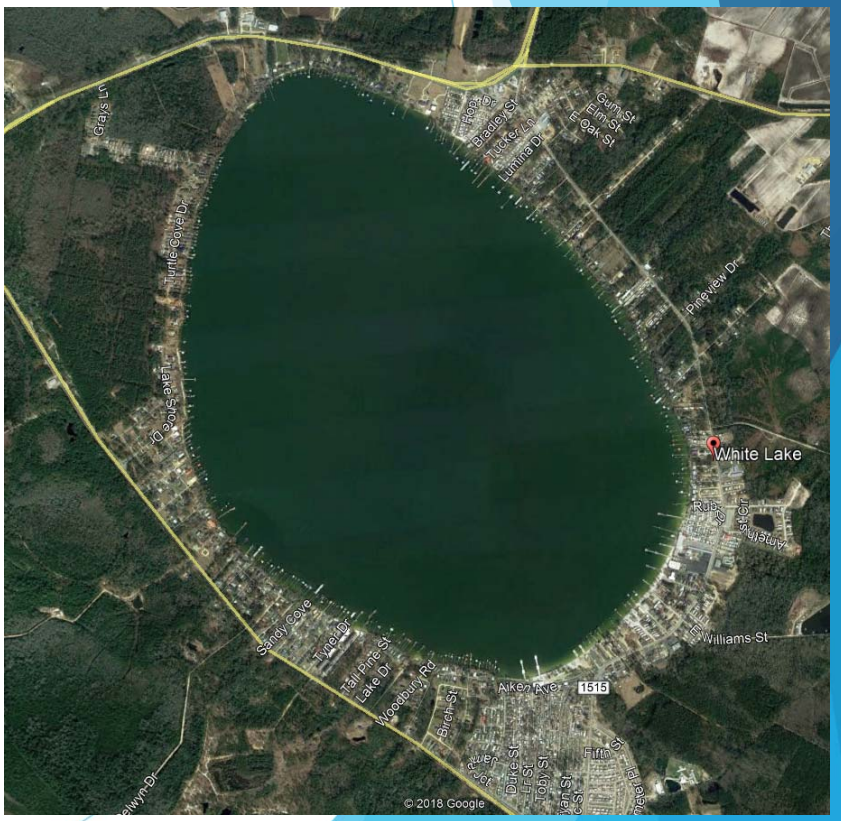
White Lake Fish Kill

NCDP SAC Meeting

May 31, 2018

White Lake

- Approximately 1,100 acres Carolina Bay lake in Bladen Co.
- Lake is a State Park, but land around lake is private and municipal.
- Groundwater fed (artesian aquifer) with no significant drainage area.
- Shallow, well-mixed with historic secchi depth of >2.0 m and pH <5.0

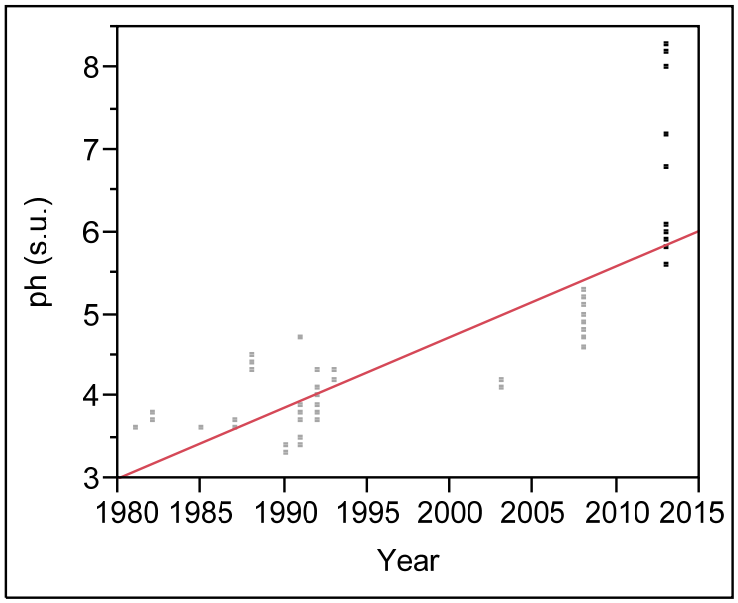


White Lake WQ Indicators

pH

Historic = 3.3 t 5.3 s.u.

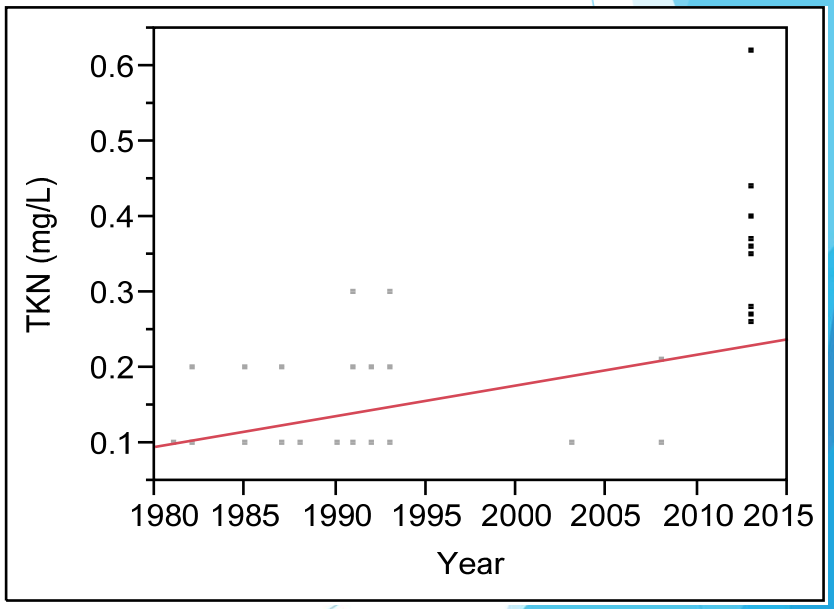
2013 = 5.6 to 8.3 s.u.



Total Kjeldahl Nitrogen

Historic = 0.05 to 0.30 mg/L

2013 = 0.26 to 0.62 mg/L

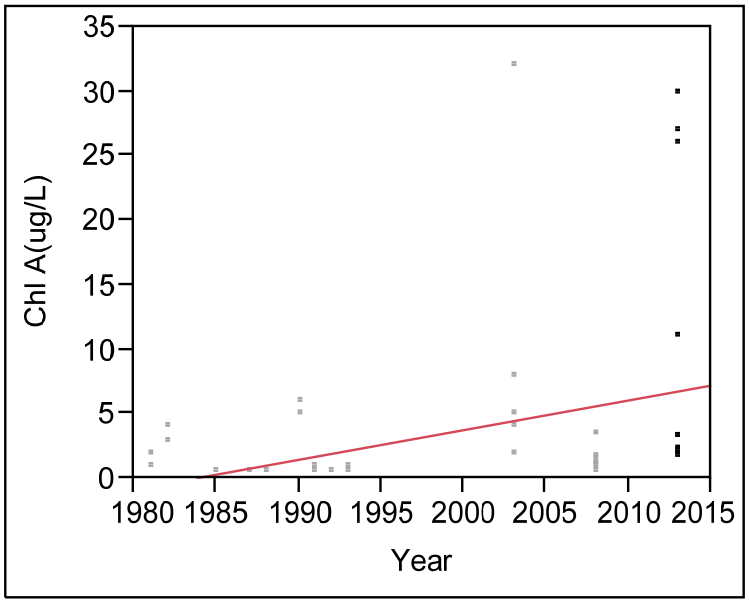


White Lake WQ Indicators

Chlorophyll-a

Historic = 1.6 to 6.0 µg/L

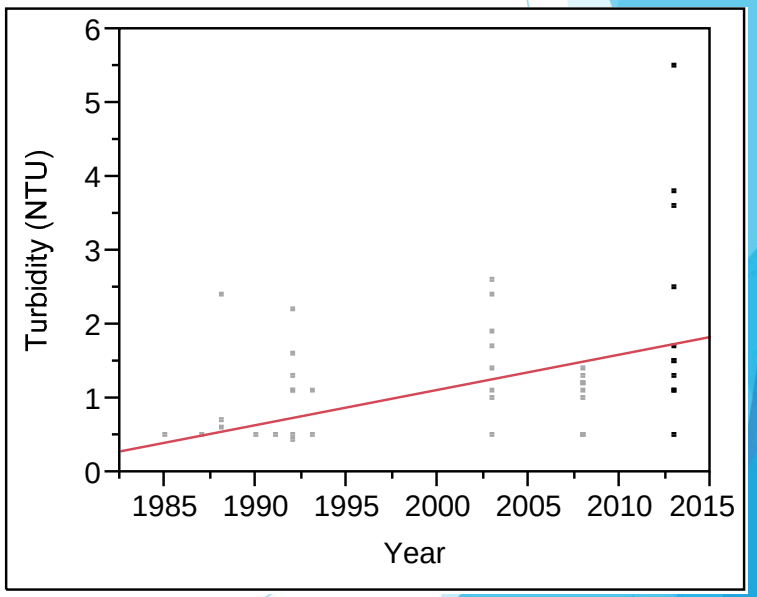
2013 = 6.0 to 30.0 µg/L



Turbidity

Historic = 0.4 to 2.6 NTU

2013 = 1.0 to 5.5 NTU



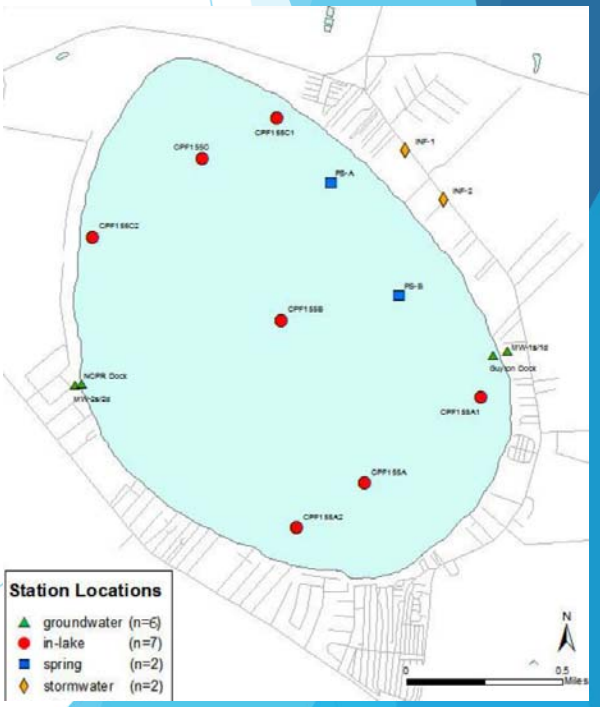
White Lake Recent History

- Lake eutrophication index began to shift in 2014-2015.
- pH has ranged from 6.5-7.5.
- Secchi depth decreased to <1 m.
- Algal community has exploded.

2017 White Lake Study

- Intensive Survey Branch conducted special study at White Lake in 2017.
- Physical and chemical parameters monitored in surface and groundwater, phytoplankton in surface water.
- Study showed that artesian flows have decreased allowing shallow groundwater more influence on the hydrology.
- Shallow groundwater has high nutrient concentrations.
- Phytoplankton assemblage shifted from desmids, cryptophytes, chrysophytes, and diatoms to blue-green (*Planktolyngbya*) dominated System
- Bloom continued through the winter.

Physical Parameters	Chemical Parameters
Temperature (°C)	Chlorophyll *a* (ug/L)
Dissolved Oxygen (mg/L)	Turbidity (NTU)
Dissolved Oxygen (% Sat.)	Total Solids (mg/L)
pH (s.u.)	Total Suspended Solids (mg/L)
Conductivity (µS/cm)	Nutrients
Secchi Depth (m)	-Total Phosphorus (mg/L)
	-Total Kjeldahl Nitrogen (mg/L)
	-Nitrate & Nitrite (mg/L)
	-Ammonia (mg/L)
	Phytoplankton



White Lake TAC

- Established to look at short-term and long-term water quality solutions and hydrilla abatement.
- Alum treatment was identified as a short-term solution.
- Aluminum sulfate and sodium aluminate (buffer) slurry applied to strip phosphorus and flocculate algae out of water column.

White Lake Fish Kill

- Alum application began in the afternoon of May 3, 2018.
- A fish kill was reported that same day.
- Multiple species (yellow perch, lake chubsucker, redear sunfish, large mouth bass, chain pickerel) and sizes.
- NC WRC estimated multiple thousands of dead fish.

Pre-Treatment Monitoring

Station	pH (SU)	DO (% Saturation)	Specific Conductivity (µS/cm)	Temperature (°C)	Secchi Depth (m)
A	9.6	123	33.6	22.4	0.5
A1	9.6	124	33.3	22.8	0.4
A2	9.7	123	33.6	22.6	0.5
B	9.6	122	33.1	22.2	0.5
C	9.4	122	33.2	22.1	0.5
C1	9.1	121	32.7	22.5	0.5
C2	9.6	123	33.7	21.9	0.6

Alum Application Treatment Area

Fish Kill Cause

- "Combined with the stresses caused by probable wide fluctuations in dissolved oxygen due to the algae bloom, it is possible that acute exposure to Alum in this case was a cause of this multi-species fish kill in White Lake, NC." – Dr. Mac Law, DVM, Ph.D., NC State University
- High pH and fluctuating DO concentrations from algal bloom likely caused the fish kill. – personal communication with Dr. Jim Rice, Ph.D., Extension Fisheries Specialist, NC State University
- DWR determined that multiple stressors (high pH, DO swings, and alum treatment) caused the fish kill.

Questions?

APNEP Indicators and Assessment for the Comprehensive Conservation and Management Plan (CCMP) 2012-2022.

CCMP Goal	CCMP Ecosystem Outcome	Indicator	Metric*
1-Human communities sustained by functioning ecosystem	A-Waters safe for personal contact	Harmful algal blooms	**Toxins**, **Chla**, **composition**, **DO**, **pH**, water column transparency
		Water column fecal coliform	**Fecal**, **enterococcus**, **water column transparency**
	B-Water supplies safe for consumption	Salinity	**GW salinity**
		Water column fecal coliform	**Total coliform**, **E. coli**
		Inorganic nutrients	**NOx**
		Emerging contaminants	
		Algae	**Cyanotoxins**
	C-Hydrologic regimes sustain uses	Natural hydrology and flow	**Discharge rates, point source discharge, GW levels**
		Salinity	**GW salinity**
	D-Fish and game safe for consumption		
2-Habitats support native species	A-Populations of aquatic and upland species protected		
	B-Upland and Aquatic habitats support ecosystem function	Algae	**Extent and frequency of blooms, toxins, Chla, composition, DO, pH**
3-Water quantity and quality maintain ecological integrity	A-Hydrologic regimes support ecological integrity	Water column alkalinity	ANC, pH
		Dissolved oxygen	DO
		Salinity	Estuarine salinity, FW conductivity
		Natural hydrology and flow	Stream flow
	B-Nutrients and pathogens do not harm water-dependent species	Dissolved nutrients	**Inorganic/organic N, Inorganic/organic P**
		Total nutrients	**TN/TP**
		Microbiota	**Chla, phytoplankton**
		Organic Carbon	**DOC, POC**
	C-Toxics do not harm water-dependent species	Dissolved metals	Dissolved metals
		Sediment condition	Toxicity, contaminant chemistry, benthic community
		Harmful algal blooms	Density, toxins
	D-Sediments do not harm water-dependent species	Water column transparency	Light penetration/attenuation, secchi disk depth, turbidity
		Sediment condition	Suspended sediment, grain size, % moisture, organic content
	Ecosystem Stressors	Water column temperature	Temperature
		Emerging contaminants	Pharmaceutical and personal care products
		Sea level rise	Relative sea rise
		Atmospheric nutrients	TIN deposition

*Bolded metrics are Tier I metrics and have a higher priority/importance.

2018 303(d) and Integrated Report Methodology

May 31, 2018 – NCDP SAC

Pam Behm, DWR Modeling and Assessment Branch

Department of Environmental Quality

Scope of Changes to 2018 303(d) Methodology

Scope of Changes: VERY NARROW

Address EPA concerns where possible, maintain integrity of listing method – balance listing and delisting decisions

Desired Outcome: EPA approves 2018 303(d) list in a timely manner

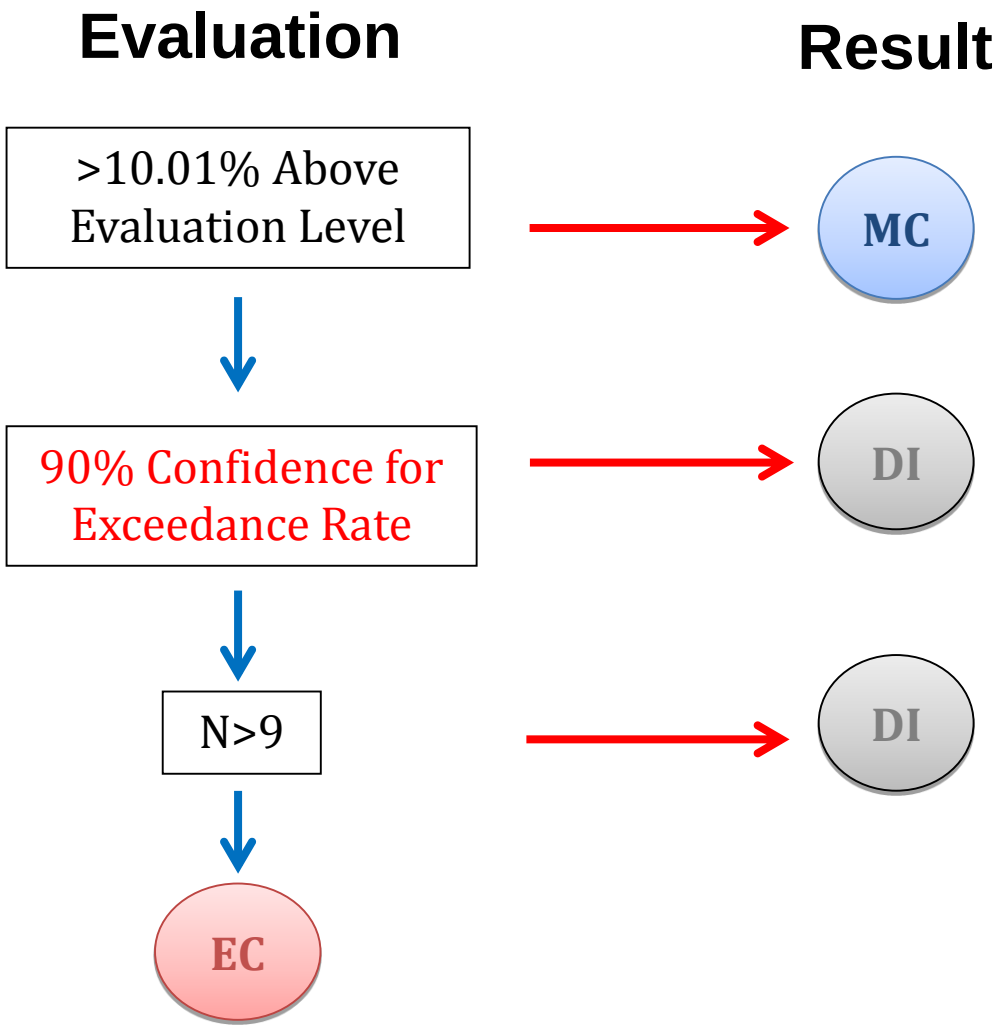
History

- 2014 303(d) list:
  - Added statistical confidence to impairment determination, did not apply any confidence criteria for delisting decisions
- 2016 303(d) list – same methodology as 2014
  - Received partial approval (1,231 Assessments) from EPA in Dec 2016
  - 3 areas of disapproval:
    - Removing waters (aka delisting) from 303(d) list for non-toxic pollutants when there is low confidence that waters are meeting criteria (17)
    - 303(d) assessment of small datasets (11)
    - Metals (44)

Delisting

- Must show “Good Cause” to remove water from 303(d) list
- NC methodology did not explicitly address delisting
- 2016 303(d) NC submittal included delisting waters where there was very low statistical confidence waters were meeting criteria (~8%)
- EPA did approve 38 delistings where NC showed “good cause”
- Action: DWR reviewed delisting strategy for several states that use binomial statistics in assessment, developed a process

Current Assessment Methods for Numeric Standards 2016



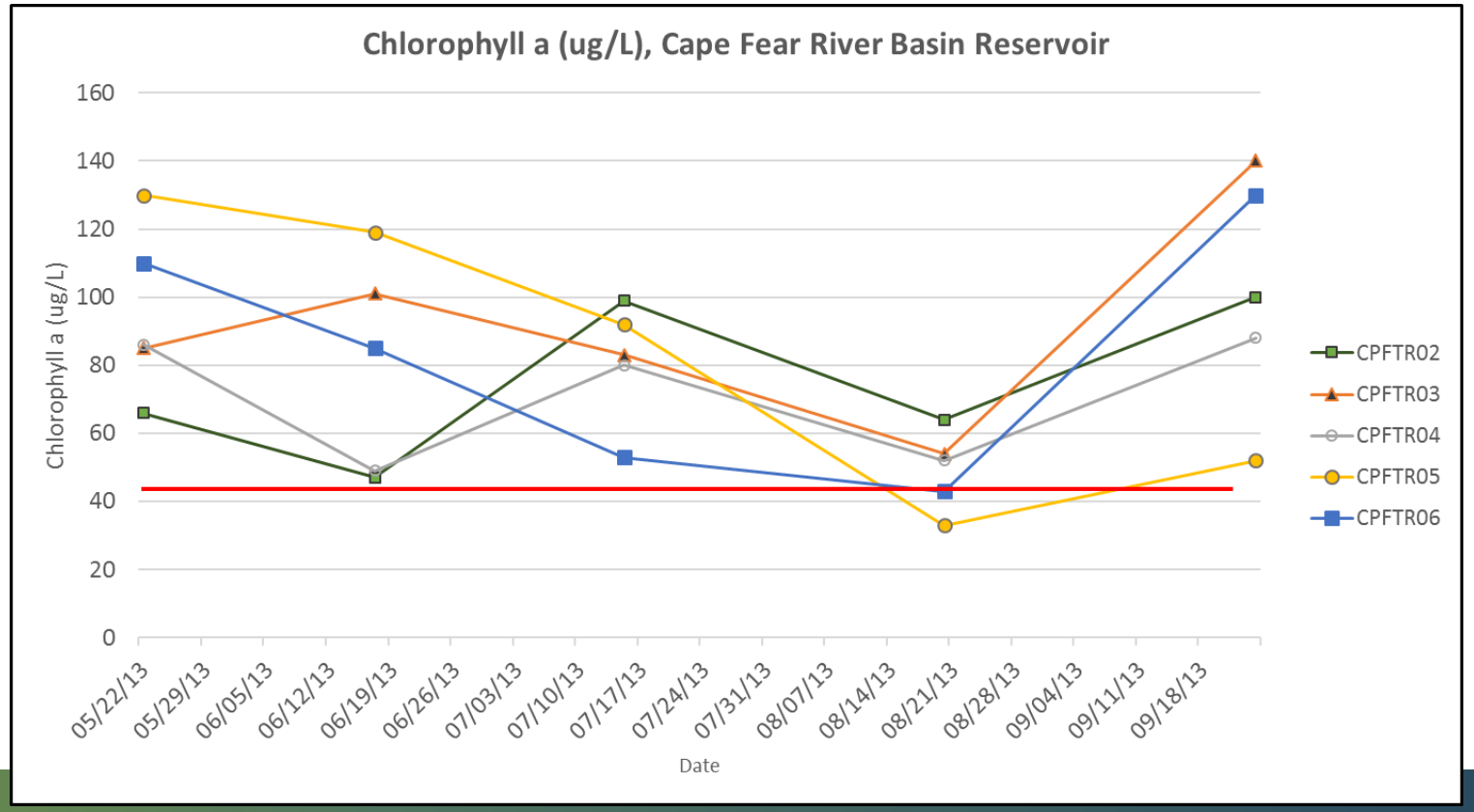
nmc	nexc	n	%ex	%mc	ec conf-1	mc conf
60	0	60	0.000	1.000		0.998
59	1	60	0.017	0.983	0.002	0.987
58	2	60	0.033	0.967	0.014	0.949
57	3	60	0.050	0.950	0.053	0.868
56	4	60	0.067	0.933	0.137	0.737
55	5	60	0.083	0.917	0.270	0.573
54	6	60	0.100	0.900	0.436	0.404
53	7	60	0.117	0.883	0.605	0.257
52	8	60	0.133	0.867	0.751	0.148
51	9	60	0.150	0.850	0.858	0.077
50	10	60	0.167	0.833	0.927	0.036

Small Datasets

- “Readily available data”
- NC methodology limits assessment to 5-year window and minimum of 10 samples
- Primarily impacts small reservoirs, non-toxic parameters
- EPA proposed adding 11 waters to 303(d) list where there were at least 3 excursions
- EPA did not take final listing action
- Action: NC’s methodology does provide for augmenting small datasets, NC developed process for 2018

Small Datasets Example

1. Current methodology requires a minimum of 10 samples to make an impairment determination (equals 3 excursions)
2. Example of a Cape Fear Reservoir:

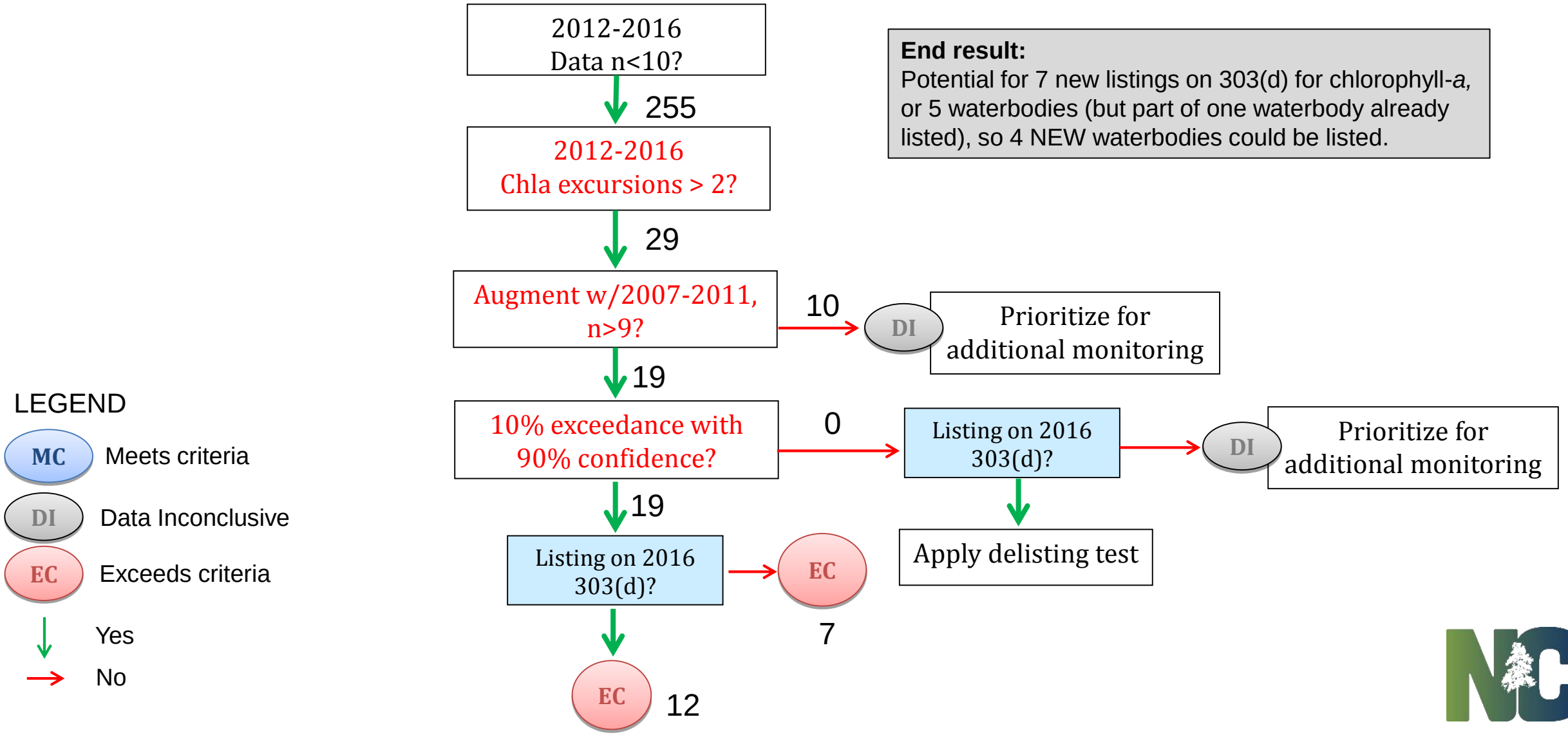


Augmenting Small Datasets n<10, 2012-2016

- If >2 excursions in data window (2012-2016), augment with previous 5 years data
  - If n < 10 after augmenting, prioritize for additional monitoring
  - If n ≥ 10 after augmenting, perform assessment, but require minimum of 3 excursions in the 2012-2016 data window

Page 2 of methodology:
augment small sets of current data (i.e. when n<10) with the previous five years of data (2007-2011) where available. NC will require a minimum of three exceedances in the current data set for inclusion on the 303(d) list.

Estimated Impact
Augmenting Small Datasets – Chlorophyll-a Example



End result:
Potential for 7 new listings on 303(d) for chlorophyll-*a*, or 5 waterbodies (but part of one waterbody already listed), so 4 NEW waterbodies could be listed.

Summary of Updates to 2018 303(d) Listing and Delisting Methodology

1. Updated data window: 2012-2016
   - Adds 2 years of new data from 2016 303(d)
2. Added delisting language
3. Added process for small datasets
4. Updated methods for numerical assessment (added process flowcharts as appendix)

Timeline

- EMC approves clarifications to methods and receive comment on methods during 303(d) public review: March
- Apply new methods: March - April
- Combined DEQ review and assessment: May - July
- Public comment on 303(d) list: July - August
- Report to EMC: November
- Submit to EPA: December 1
- Begin process for 2020: December 1

Thank You!

Contact Information:

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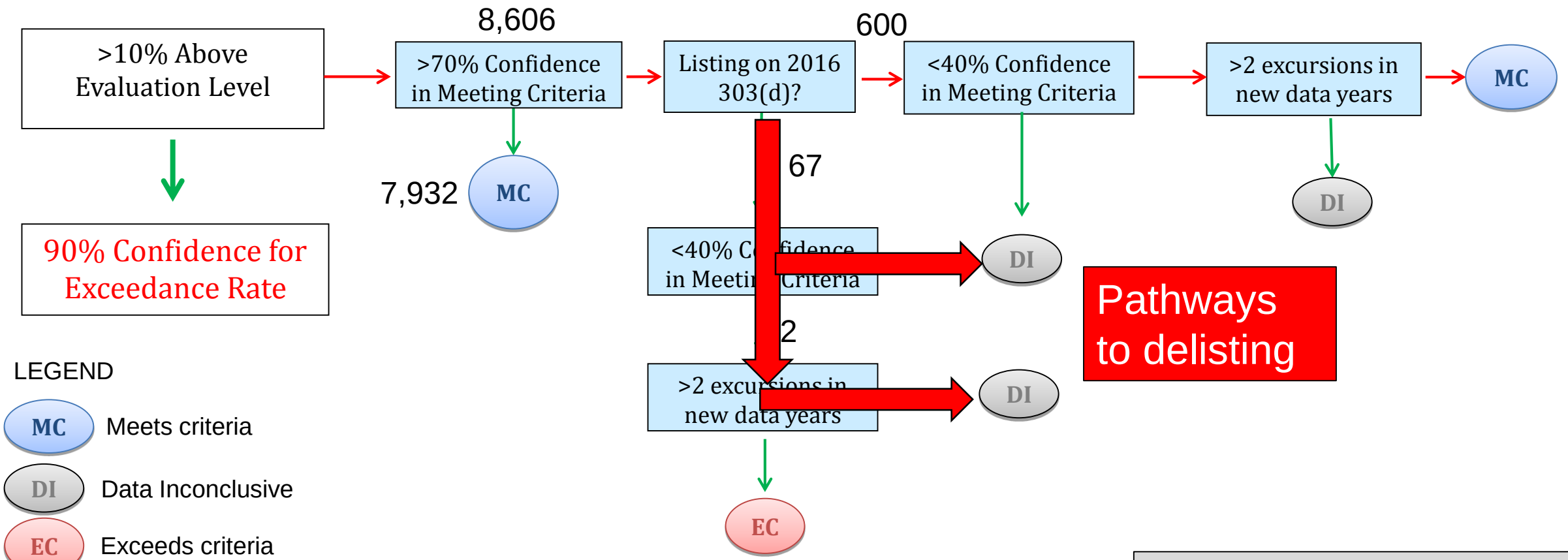
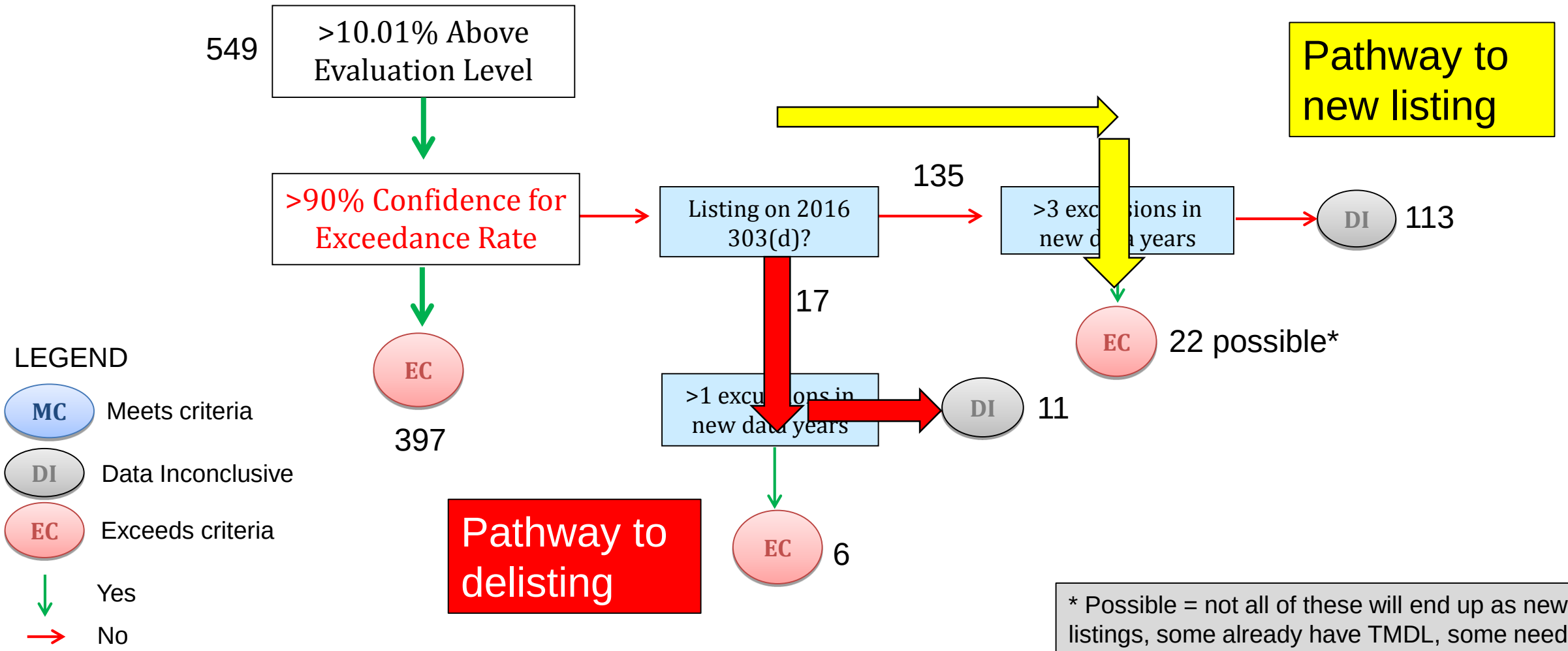
Estimated Impact
Less than 10% exceedance
Using 2016 303(d) data for analysis



End result:
Potential for 2 waters staying on 303(d) list (i.e. not meeting criteria for delisting)

Estimated Impact
Greater than 10% exceedance, less than 90% confidence
Using 2016 303(d) data for analysis



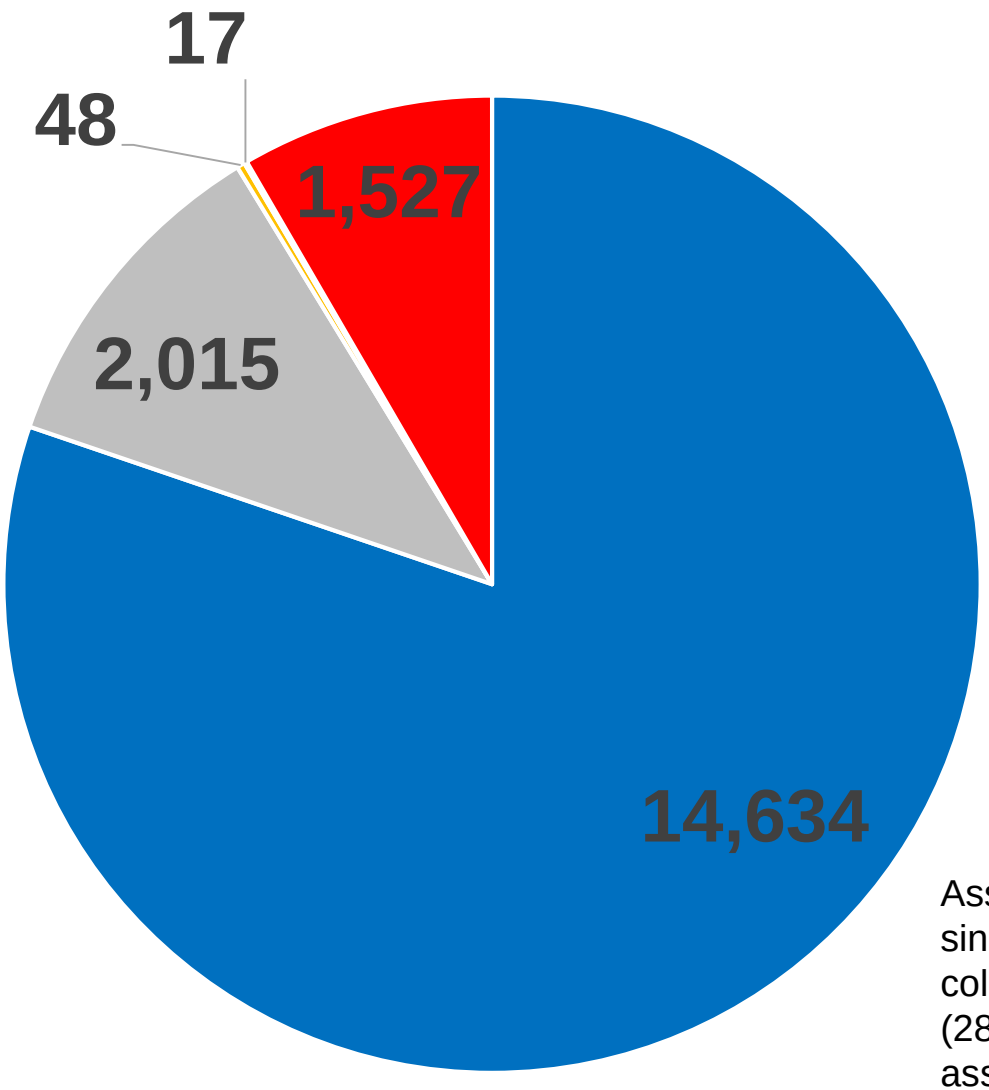
* Possible = not all of these will end up as new listings, some already have TMDL, some need follow-up for natural conditions analysis, etc

New Decision Points

- Balance statistical confidence for listing and delisting decisions
- Look at new data

Listed on 303(d)?	Consider current listing status.
>70% Confidence in Meeting Criteria?	Consider confidence that Water Quality standards are being met. This is lower than 90% confidence that assessments are exceeding criteria due to increased resources needed to determine meeting criteria.
Excursions in new data years?	Along with other criteria, consider newer data, evaluate if water quality issue ongoing or from a previous episodic event.
<40% Confidence in Meeting Criteria?	Along with other criteria, will address concern regarding delisting with very low confidence that water quality criteria are being met.

Number of Assessments



Legend
14,634 – # meeting criteria
2,015 – # inconclusive
1,527 – # impaired
17 – # of delistings with low confidence
48 – # of metals assessments not approved for delisting

Assessment Units (AU)= Waterbodies or Waterbody segment. A single AU can have multiple Assessments. Each parameter collected in an AU results in one assessment. 3,744 of 13,401 (28%) of NC AUs have assessments. Range per AU is 1 to 52 assessments.

Responses to pH Review and Confirmation Memo

Agree	Disagree	No Response
8	2	1

Presenter	CB1	CB2	LP	BH	Existing WQS
Basis	Balance between (1) mostly favorable site-specific indicators (excellent fishery, lack of nuisance scums, low algal toxins, etc.) despite CHLA up to 55 ug/L; and (2) literature-based concerns at lower CHLA levels.	Balance between (1) mostly favorable site-specific indicators (excellent fishery, lack of nuisance scums, low algal toxins, etc.) despite CHLA up to 55 ug/L; and (2) literature-based concerns at lower CHLA levels.	Multiple lines of evidence: literature, with consideration of site specific information, such as HRL modeling (natural conditions ~20-25 ug/L using arithmetic average but can change with re-do of DWR plot); medium level of toxin risk; targets use protection for all uses	Level "necessary to protect uses"; it is strongly recommended that DEQ approve other use metrics to define when a use is impaired (e.g., biological index for aquatic life use; cyanotoxin concentration for recreational use; water clarity value for recreational use; drinking water use impairments (applied at potable water intake)) so that relationship between chlorophyll-a and use can be evaluated.	No change
Magnitude	40 ug/L, derived from 25-40 ug/L range for warmwater reservoirs. Upper end of range selected due to mostly favorable use indicators.	40 ug/L, derived from 25-40 ug/L range for warmwater reservoirs. Upper end of range selected due to mostly favorable use indicators.	~30 ug/L (30.6 ug/L based on medium level of cyanotoxin risk) OR To address the interest in a geo mean that is "comparable" to the above recommended magnitude, a geo mean between 16-18 represents HRL specific data from years suspected as being less enriched during record (1982 and 1990), HOWEVER computing the geo mean would be required by DWR in order to develop a confirmed/more accurate geo mean based on the modeling so the 16-18 could change.	40 µg/L; If existing water quality exceeds target, use impairment must be documented before exceedance is confirmed as nutrient criterion exceedance. Similarly, if chlorophyll-a is below 40µg/L but nutrient-related use impairment is present, will require assessment to determine a lower chl-a target based on relationship between chl-a and impairment metric.	40 ug/L
Measure	Note: I interpreted this row as redundant with "Duration/Averaging Period", which had a more clear meaning, so did not enter anything for "Measure"	Note: I interpreted this row as redundant with "Duration/Averaging Period", which had a more clear meaning, so did not enter anything for "Measure"	Seasonal (May-Oct) arithmetic avg, but open to modifying to reflect April start and different averaging (once an updated source of information is completed by DWR)	see duration	instantaneous
Frequency	not to exceed > 1 in 3 years.	In leiu of an explicit frequency component, express as a multi-year geometric mean not be exceeded at a 90% confidence level.	not to be exceeded > once in 3 years	not to exceed once in 3 years, on average	not to be exceeded in 10% of samples with a 90% confidence
Duration	Geometric mean (Apr-Oct); individual years	Geometric mean (Apr-Oct); multiple years	See measure row for duration	Growing season (May-Oct) geomean	
Spatial	Combine all data in assessment unit	Combine all data in assessment unit	Existing protocol	Given the limited amount of sampling and data (once every 5 years), sampling stations should be combined (e.g., the centerline stations 152A, 152C, 169B, and 169F could be combined to yield a single assessment for the lake). For potable water use impairment, assessment needs to be made at point of potable water intake. If HRL is assessed for downstream potable water use impairment, assessment should only consider discharge from lake (Station 169F).	Each assessment unit is separate
# Samples	At least 3 years of data, data from at least five different months within growing season for each year	at least 10 needed for statistical analysis; data from at least 5 different months within growing season for each year; data from at least two years.	I would envision we suggest that not all months are required but some minimum monthly coverage should be suggested to prevent concerns with single grab sample in one year or missing a single month due to a hurricane for example	At least one sample in each month of the growing season. Prefer 2/month.	at least 10 needed for statistical analysis[1]
Monitoring	Photic zone composite over 2X Secchi depth	Photic zone composite over 2X Secchi depth	Existing protocol	Photic zone grab at 2X Secchi depth	Photic zone grab at 2X Secchi depth
Notes		Could assess spatially based on limnological category of lake sections (riverine, transitional, lacustrine)	This recommendation balances the literature available with HRL specific details and increased knowledge of risk from elevated chl a levels.	Deterioration from existing conditions to be addressed using antidegradation requirements for TP.	[1] Monitoring is during one growing season every 5 years resulting in approximately 5 samples. Where small sample sizes occur, data evaluations can go back one monitoring cycle to achieve 10 samples.