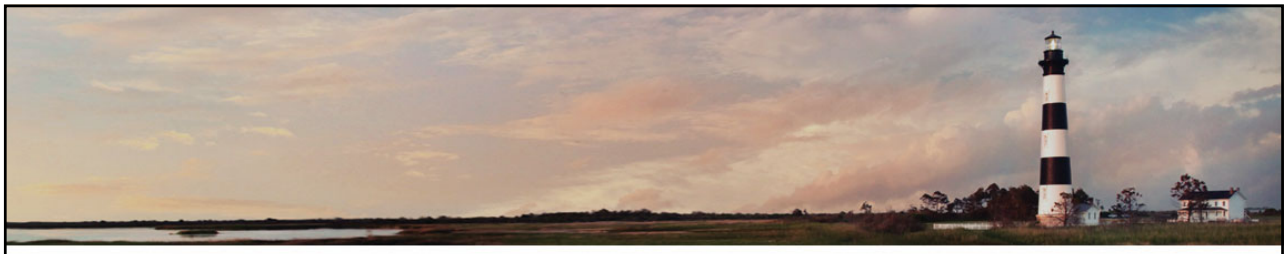
NCDP Scientific Advisory Council Agenda

10:00 am – 2:30 pm
October 30, 2019
Agronomic Division Building Conference Room
4300 Reedy Creek Road, Raleigh, NC 27607

Desired Outcomes:

- Shared understanding of the Nutrient Criteria Development Plan.
- Shared understanding and approval of the SAC Charter.
- Shared understanding of the APNEP Phase I report.
- Shared understanding of the existing conditions in the Chowan River/Albemarle Sound.

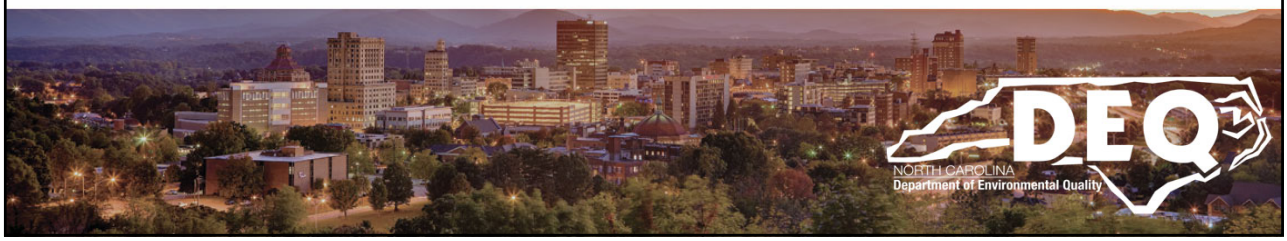
Time	Topic	Speaker(s)
10:00 am	Convene • *Welcome to new SAC members* • *Introductions* • *Approval/Comments on meeting minutes – June 2019* • *Administrative Business*	Lauren Daniel (facilitator)
10:15 am	Nutrient Criteria Development Plan v.2	Brian Wrenn
10:45 am	SAC Charter	Brian Wrenn
11:00 am	Break	
11:15 am	APNEP Phase I Report Review	Jim Hawhee
11:30 am	Criteria Development Schedule and Process	Brian Wrenn, Connie Brower, Chris Ventalaro
12:00 pm	Lunch (on your own)	
12:30 pm	Existing Condition of Chowan River and Albemarle Sound	Nora Deamer
1:15 pm	Break	
1:30 pm	Existing Condition cont'd	Leigh Stevenson, Astrid Schnetzer
2:15 pm	Wrap-up, closing remarks, and adjourn	Lauren Daniel (facilitator)
2:30 pm	Adjourn	



Nutrient Criteria Development in the Chowan River/Albemarle Sound

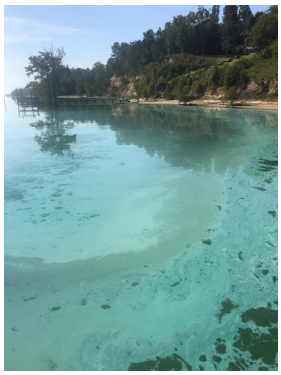
October 30, 2019

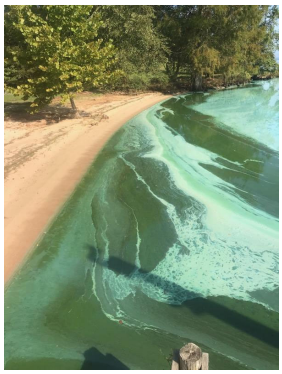
Brian Wrenn, Division of Water Resources



Talking Points

- Brief history and background of nutrient criteria development in NC
- Roles of the Scientific Advisory Council and Criteria Implementation Committee
- Chowan River/Albemarle Sound status
- Data Gaps





Photos:Charlton Godwin, NCDMF

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Nutrient Criteria Development in NC

- 2001 - Federal Register notice, states encouraged to develop nutrient management plans.
- 2004 - NC developed the Nutrient Criteria Implementation Plan (NCIP)
- 2011 - EPA memo to regions placing new emphasis on nutrient reductions
- 2012 - NC Forum on Nutrient Over Enrichment
- 2014 - Nutrient Criteria Development Plan (NCDP)
- 2019 – Revised NCDP

EPA

FEDERAL REGISTER
The Daily Journal of the United States Government

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Nutrient Criteria Development Plan

- Links nutrient criteria with protection of designated uses including downstream uses
  - "Fishable, swimmable, boatable"
  - Trout waters, public water supply, primary nursery areas, etc.
- Evaluate causal and response variables (nutrients, chlorophyll *a*, pH, dissolved oxygen, etc.)
- Express numerically or in narrative form with a numerical translator
  - Concentration
  - Mass quantities or loadings


Photo: Carolina Sportsman


Photo: Chuck Beckley, Sun Journal Staff

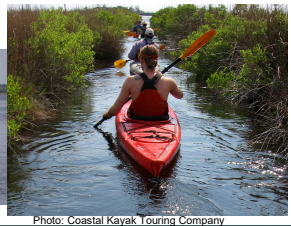
Photo: Coastal Kayak Touring Company

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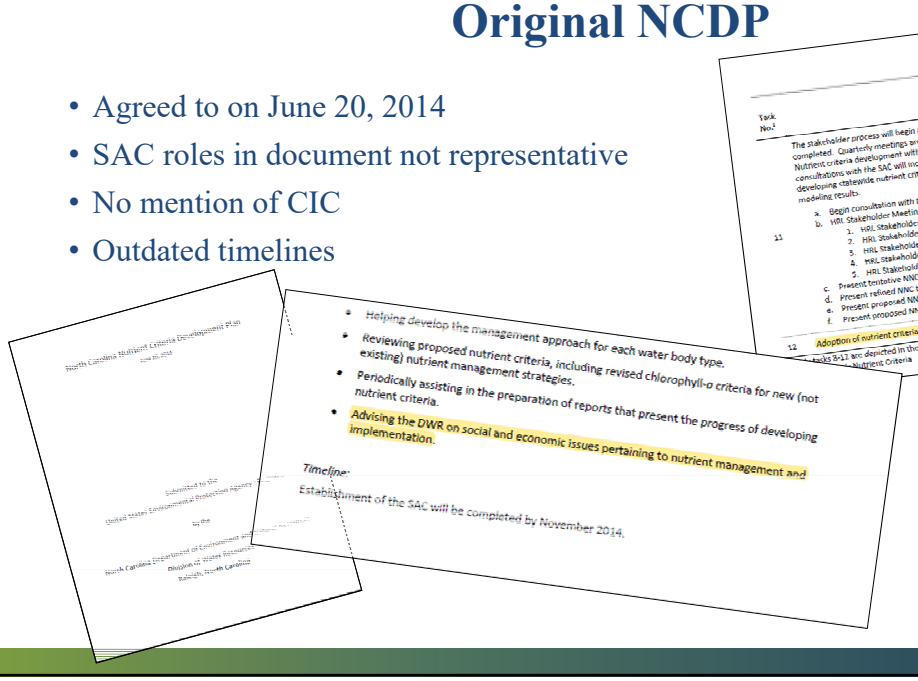
Original NCDP

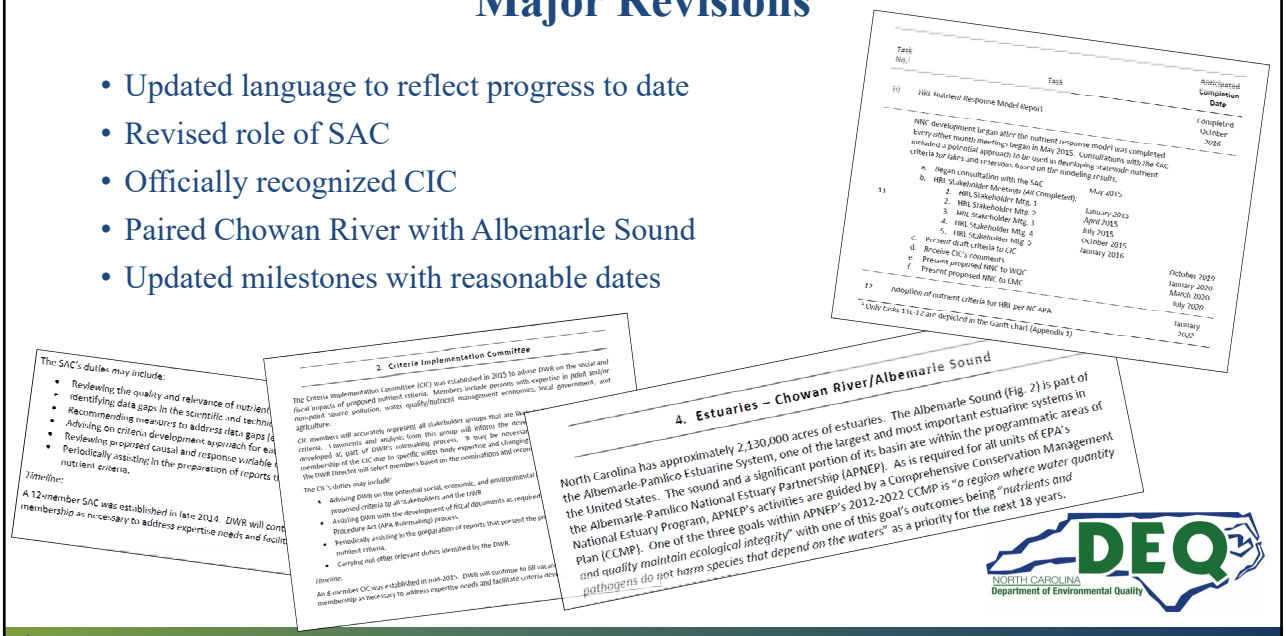
- Agreed to on June 20, 2014
- SAC roles in document not representative
- No mention of CIC
- Outdated timelines



Rule adoption 1 year ago!

Major Revisions

- Updated language to reflect progress to date
- Revised role of SAC
- Officially recognized CIC
- Paired Chowan River with Albemarle Sound
- Updated milestones with reasonable dates



SAC and CIC

- Scientific Advisory Council (SAC) created
  - Advise on the development of scientifically-defensible nutrient criteria
  - Made up of experts in water quality, nutrient management, nutrient abatement
- Criteria Implementation Committee (CIC) created
  - Comment on the social and fiscal impacts of draft nutrient criteria on stakeholders
  - Made up of economists, stakeholder representatives, and academics

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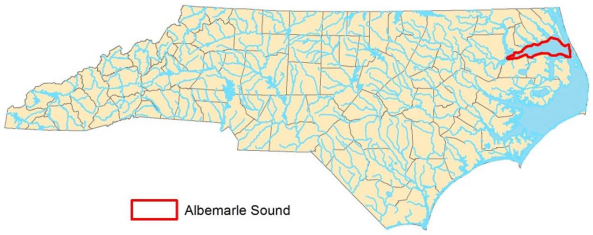
Nutrient Criteria Development Plan

- Develop criteria for three water body types
  - Landscape position, flow dynamics, sensitive species
  - Lakes/reservoirs, rivers and streams, estuaries
- Specific water bodies
  - High Rock Lake
  - Central Cape Fear River
  - **Chowan River/Albemarle Sound**



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NCDP and APNEP

- APNEP has done a significant amount of background research in support of the NCDP
- Two phase process:
  - Phase I - identify and prioritize potential criteria parameters, identify data gaps and research needs (bioassays, light attenuation modeling), Phase I report completed February 2018
  - Phase II – DWR and SAC will pick up evaluation efforts and develop final criteria proposal, beginning Fall 2019

Criteria Development for Estuaries

- EPA's Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters
- Many of the initial steps completed by APNEP in development of the Phase I report
  - Causal and response variables, data gaps, new data needs
- Physical Classification (salinity, hydrography), New Data Collection, Data Analysis, Establishing Reference Conditions

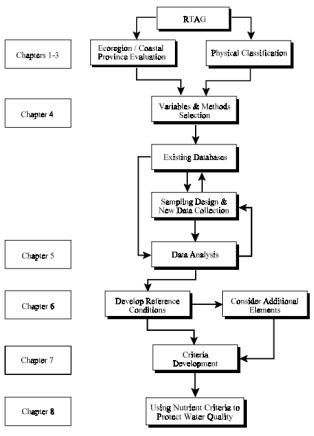

Figure 1-6. Flowchart of the nutrient criteria development process.

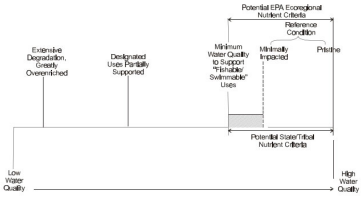

Figure 6-1. Environmental quality scale representing reference conditions and potential nutrient criteria relative to designated uses.

DWR Data Gaps

- Albemarle Sound water quality data
  - USGS, NARS-NCA
- Aquatic life – SAVs, DO sensitive fish
  - DMF, USGS, NARS-NCA
- Bioassays (N. Hall, UNC-IMS)
- Cyanotoxins (DWR, A. Schnetzer, NCSU)
- Clarity optical model?

Photo: Maryland DNR

Photo: NOAA

Questions?

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Charter
North Carolina Division of Water Resources
Scientific Advisory Council on Nutrient Criteria Development
October 28, 2019

Nutrient enrichment is one of the leading causes of negative environmental impacts to surface waters, such as algal blooms, low dissolved oxygen concentrations, fish kills, excessive growths of filamentous algae or bacteria, and generation of cyanotoxins. To better manage nutrients, the US Environmental Protection Agency (USEPA) has established a goal for states to develop and adopt nutrient criteria for all jurisdictional waters. The North Carolina Nutrient Criteria Development Plan (NCDP; May 16,2019), which was mutually agreed upon with the USEPA, details the Division of Water Resources' (DWR) strategy to accomplish this goal. The plan includes the development of a Scientific Advisory Council (SAC) to assist DWR with the incorporation of the best available data and science to establish defensible nutrient criteria that protect designated uses and are scientifically sound. Subsequent to criteria development, a separate group, the Criteria Implementation Committee (CIC), will work with the Division to determine fiscal implications of the proposed nutrient criteria.

Section I. Establishment

The NCDP SAC is established under the DWR. The SAC will be comprised of nine to twelve members appointed by DWR's Director.

The members appointed to the SAC shall be persons satisfying the qualifications as defined in Section II.A below. One USEPA representative will be asked to participate on the SAC. SAC members will serve two-year terms and may be reappointed at the discretion of the Director of the DWR.

Section II. Scientific Advisory Council

The objective of the SAC is to provide regional knowledge and technical guidance to the DWR during the process of developing site-specific nutrient criteria. These criteria shall be based solely on data and scientific judgments about causal and response variables and their indications of water quality. The recommendations of the SAC will be considered by the DWR as criteria are selected for proposal as water quality standards during the triennial review rulemaking process.

Section II.A SAC Member Qualifications

Each SAC member shall meet one or more of the following qualifications:

1. A scientist with expertise in the study of nutrients in freshwater, estuarine, and/or lake ecosystems.
2. A scientist with expertise in process-based and statistical water quality/nutrient response modeling.
3. A scientist with expertise in the study of aquatic life and food webs in freshwater and/or saltwater ecosystems.

4. A scientist with expertise in freshwater and/or saltwater hydrology and hydraulics, including the effects of dams on water movement.

Section II.B SAC Duties

The SAC shall have the following duties:

1. Provide regional knowledge and technical guidance to DWR to aid with development of numeric nutrient criteria.
2. Review and assess the quality of currently available nutrient data both nationally and regionally.
3. Identify data gaps in the scientific and technical information necessary for nutrient criteria development.
4. Recommend measures to address data gaps through additional monitoring or analysis.
5. Advise DWR on criteria development approach for each waterbody type.
6. Review and comment on proposed causal and response variable criteria developed by DWR.
7. Other duties as identified by DWR.

Section II.C Decision-Making Process

The SAC will strive for consensus. SAC advice and considerations will be made only with concurrence of all members represented at the meeting. A facilitator will be appointed by DWR to guide the discussions and assist the SAC in reaching consensus.

Consensus is the decision rule that allows collaborative problem solving to work. Consensus requires sharing of information, allows building of trust, which leads to mutual education and in turn provides the basis for crafting workable and acceptable alternatives. Consensus promotes joint thinking of a diverse group and leads to creative solutions. Also, because parties participate in the deliberation, they understand the reasoning behind the recommendations and are willing to support them. Consensus does not mean that everyone will be equally happy with the decision, but all do accept that the decision is the best that could be made at the time.

The SAC will reach consensus when it finally agrees upon a single alternative and each participant can honestly say:

- I believe that other participants sufficiently understand my point of view
- I believe I sufficiently understand other participants' points of view
- Whether or not I prefer this decision, I support it because it was arrived at openly and fairly.

If the SAC is unable to reach consensus regarding an issue, the lack of consensus will be noted in the meeting minutes and the SAC will summarize any points of disagreement in supporting documentation.

The SAC shall annually vote one member as Chairperson and another member as Vice-chairperson. The Chairperson will coordinate comment document development, delegate comment responsibilities to appropriate SAC members, and work to build consensus among members. The Vice-Chairperson will assist in these duties and act as Chairperson when the Chairperson is absent.

Section III. Administration

1. The DWR will assign a staff member(s) to provide support to the SAC. The support that will be provided includes but is not limited to the following: arranging meetings, ensuring notes are taken, distributed and made available to the public, collecting information requested by the members, ensuring requested analyses are performed and documented, maintain the web site, etc. This staff member may accept written comments from interested parties and disseminate appropriately.
2. Telephone or web conferencing may be conducted in lieu of meetings. Meetings may be streamed live if the technology is available.
3. Members of the SAC may be reimbursed for necessary in-state travel (mileage) to and from meetings.

Section IV. Implementation, Duration, and Frequency

1. This charter shall become effective October 30, 2019.
2. The SAC shall meet at intervals determined by the DWR-NCDP Program Manager in consultation with the members.
3. The SAC as an advising body shall continue for an indefinite period of time at the pleasure of the DWR Director.
4. All meetings will be open to the public.

Nutrient Criteria Development for Albemarle Sound: Phase I Proceedings

Jim Hawhee
N.C. Division of Water Resources
30 October 2019

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Phase I Proceedings Document

- Phase I proceedings summarized by DWR
- Accessible at: https://files.nc.gov/apnep/documents/files/past-committees/Albemarle-Sound-Report_combined.pdf
- Document includes:
  - Executive summary
  - Overview of meetings (topics discussed)
  - Overview of supporting materials
  - Prioritized research recommendations
  - Appendices include meeting minutes, reports, and research proposals

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Phase I Summary

- Open, APNEP-facilitated workgroup
- 9 meetings from 2014 to 2016
- Parameters considered: pH, DO, clarity, TSS, turbidity, phytoplankton and cyanotoxins, chlorophyll a, nitrogen, and phosphorus
- Original slate of supporting projects undertaken in 2015-2016

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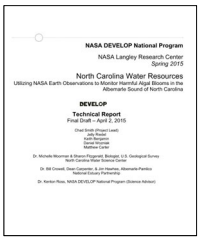
Phase I Supporting Projects

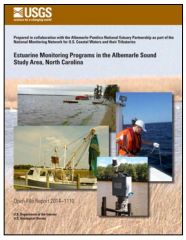
- Remote sensing evaluation (NASA)
- Data classification and analysis (Tetra Tech)
- National law and policy review (Sea Grant)


NASA DEVELOP National Program

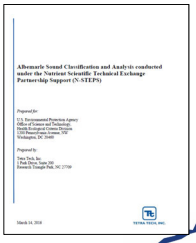
NASA Langley Research Center
Spring 2015

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


USGS

Estuarine Monitoring Programs in the Albemarle Sound Study Area, North Carolina


Albemarle Sound Classification and Analysis conducted under the Nutrient Scientific Technical Exchange Partnership Support (N-STEPS)

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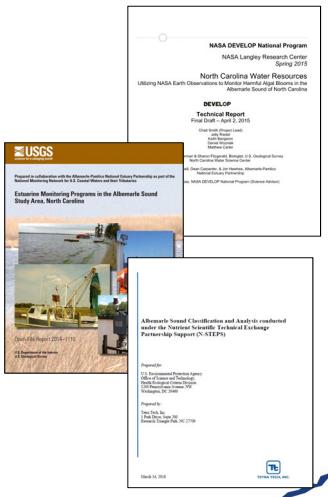
Phase I Supporting Projects

- Literature compilation (Tetra Tech)
- USGS Albemarle Sound initiatives
- DWR supplementary data analyses
- Criteria development case studies



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Phase I Summary, Continued

- Workgroup fact-finding in early 2016
- Member-generated criteria proposals evaluated by workgroup in late 2016
- Where limitations were evident, further research was proposed and ranked

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Prioritized Research for Phase II

- Additional algal toxin surveys
  - Status: some surveys underway
- Clarity optical model
  - Status: not underway, TSS data now being collected for calibration purposes
- Evaluate and summarize historical clarity data
  - Status: preliminary evaluation by DWR staff

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Prioritized Research for Phase II

- Nutrient bioassays
  - Status: grant proposal submitted
- Quantify historical SAV coverage
  - Status: APNEP mapping efforts largely complete, further evaluation of SAV habitat potential not underway
- Evaluate correlations between oxygen-sensitive fish species, habitat utility and seasonality.
  - Existing NOAA resources, but may require further evaluation

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What's next?

- Consideration of criteria by DWR, SAC and CIC in Phase II
- Potential areas for discussion:
  - Application and implications of a clarity standard?
  - Chlorophyll *a* as a seasonal average?
  - N & P criteria: whether and how to set?
  - Bioconfirmation approach?

9

Questions?

Jim Hawhee:
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October 30, 2019

Overview of Water Quality Standards for Surface Waters

Types of North Carolina Water Quality Standards

Surface Water Standards
Federal & State
(protects resource)

Se 5 ug/L

Drinking Water Standards
Federal
(treatment)

Se 50 ug/L

Groundwater Standards
State
(protects resource)

Se 20 ug/L

2

The Why & What of Surface Water Standards

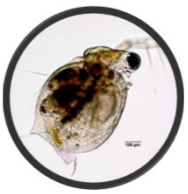
The Why:

The federal Clean Water Act of 1972 requires states to develop & routinely update WQS for surface waters, based upon recommended criteria

The What:

State regulations or rules that serve to protect the waters of the state from the detrimental effects of pollution

- Describe the desired conditions (goals) for waters & the requisites for attaining those conditions
- Established based on available scientific information
- Do not consider fiscal impacts



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Surface Water Classifications

Water body classifications (15A NCAC 02B .0200 rules)

- Define the desired conditions (as "best uses") and,
- Define the numeric & narrative criteria to attain the uses

Classifications include:

- ❖Freshwater: Class C, Class B, Class WS (I-V)
- ❖Saltwater: Class SC, Class SB, Class SA
- ❖Supplemental: HQW, NSW, ORW, Trout

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Designated Uses

Designated uses include:

- Class C/SC = aquatic life and wildlife, secondary recreation, fish tissue consumption
- Class B/SB = primary recreation
- Class SA = special requirements for shellfish areas
- Class WS = requirements for Water Supply waters, consumption of water and fish tissue, development limits
- Class HQW = special requirements for High Quality Waters

5

For a water body,

need to understand…..

Water body classification(s)

↘

Designated uses

↘

Numeric & narrative requirements

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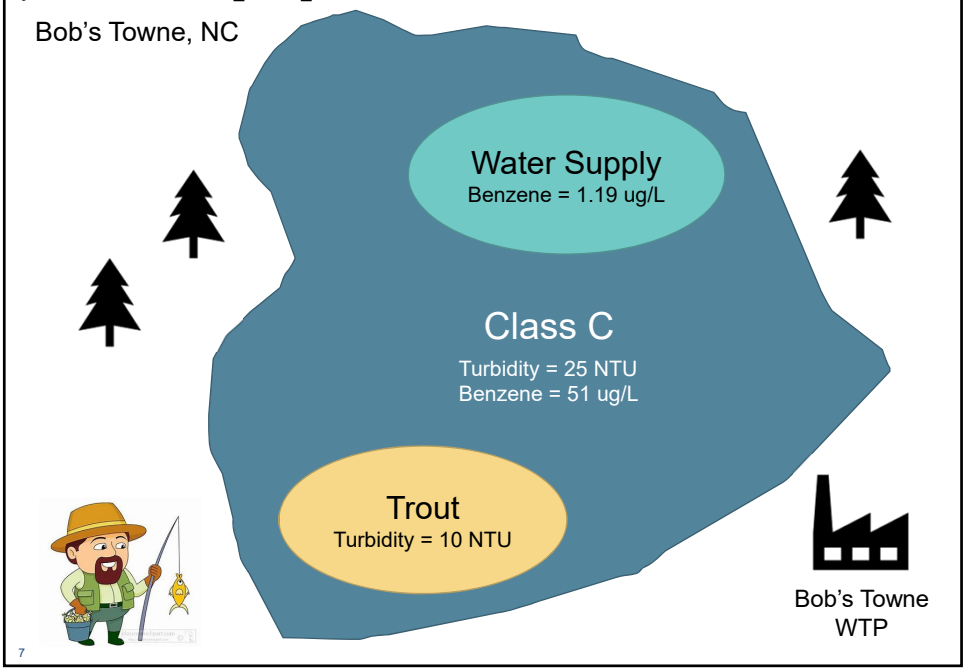

Surface Water Standard Development

- Can be a numeric value, a narrative statement or combination
- Considers protection of aquatic life, human health &recreation

Aquatic life standards protect biological integrity of indigenous species

Human health standards protect for consumption of fish tissue and use of surface waters as drinking water sources

Recreation standards protect for incidental exposure and aesthetic concerns

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Nutrient Standards

Nutrient-related standards can provide protection from physical, chemical and biological impacts resulting from high N and P concentrations….

However….development is challenging!

- N & P do not directly impact uses but may result in ecosystem changes that do → *ecosystems are complex!*

How can this be addressed?

- Establish relationships between causal and response variables
- Determine the most sensitive uses
- Develop numeric and/or narrative criteria based on these relationships to sensitive uses

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Considerations for Nutrient Standards

How do nutrients impact aquatic life?

- Altered phytoplankton composition
- Health effects from cyanotoxin exposure
- Altered habitat
- Altered physical chemistry (DO, pH)

What species are most sensitive to nutrient-related impacts in the Albemarle Sound?

- Submerged aquatic vegetation
- Threatened & endangered species
- Aquatic-dependent wildlife

What nutrient-related impacts could affect human health?

- Cyanotoxin exposure in recreators

How do nutrients impact aesthetics?

- Discolored water
- Odor
- Fish taste

Other considerations?

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Possible Nutrient-Specific Endpoints and Indicators

- Physical
  - DO, pH, turbidity, light penetration
- Chemical
  - Algal toxins
- Biological
  - Healthy seagrass (SAV)
    - High habitat value
    - Support aquatic life uses of estuaries
    - Sensitive to nutrient loads
  - Relate Chlorophyll-a targets to nutrient levels
  - Balanced Phytoplankton biomass production?
  - Balanced Aquatic Flora and Faunal Communities?

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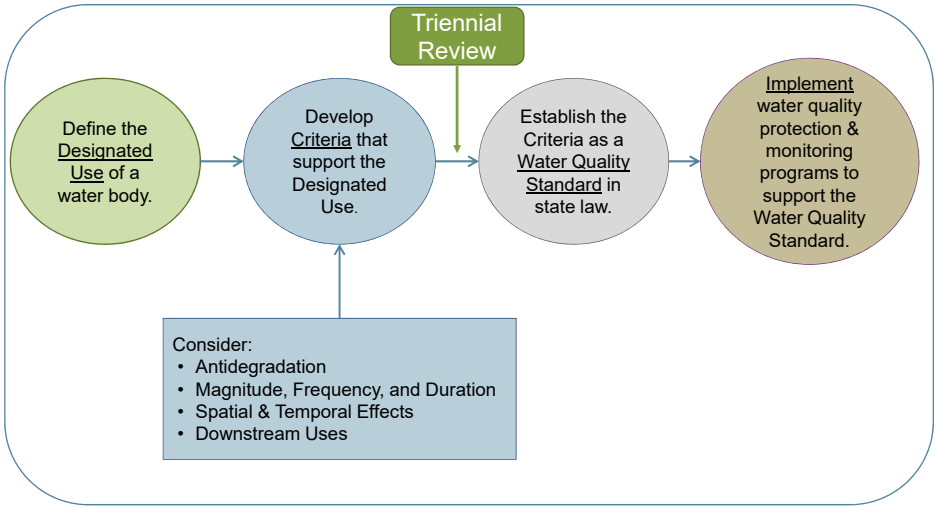
Overview of Development & Application



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Triennial Review Process

Development
- Staff review available guidance & literature and develop Triennial Review package
- Staff present TR to WQC for comment/modification
- Staff present TR for public notice/comment
- TR goes to EMC for review/comment/modification

State Approval
- EMC approves TR to become standards in rule
- EMC approved TR goes to RRC for language/intent/legality review
- RRC modifies/approves TR
- NC Attorney General signs off on TR
- Triennial Review codified in NC state law as Water Quality Standards

Federal Approval
- EPA reviews TR for compliance with Clean Water Act (40 CFR)
- USFW reviews TR for compliance with Endangered Species Act
- EPA informs NC of compliance assessment results
- Triennial Review approved/disapproved or modified based on federal requirements

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Water Quality Standards Team

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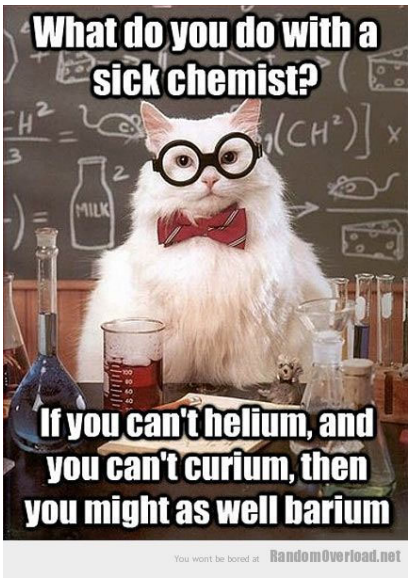

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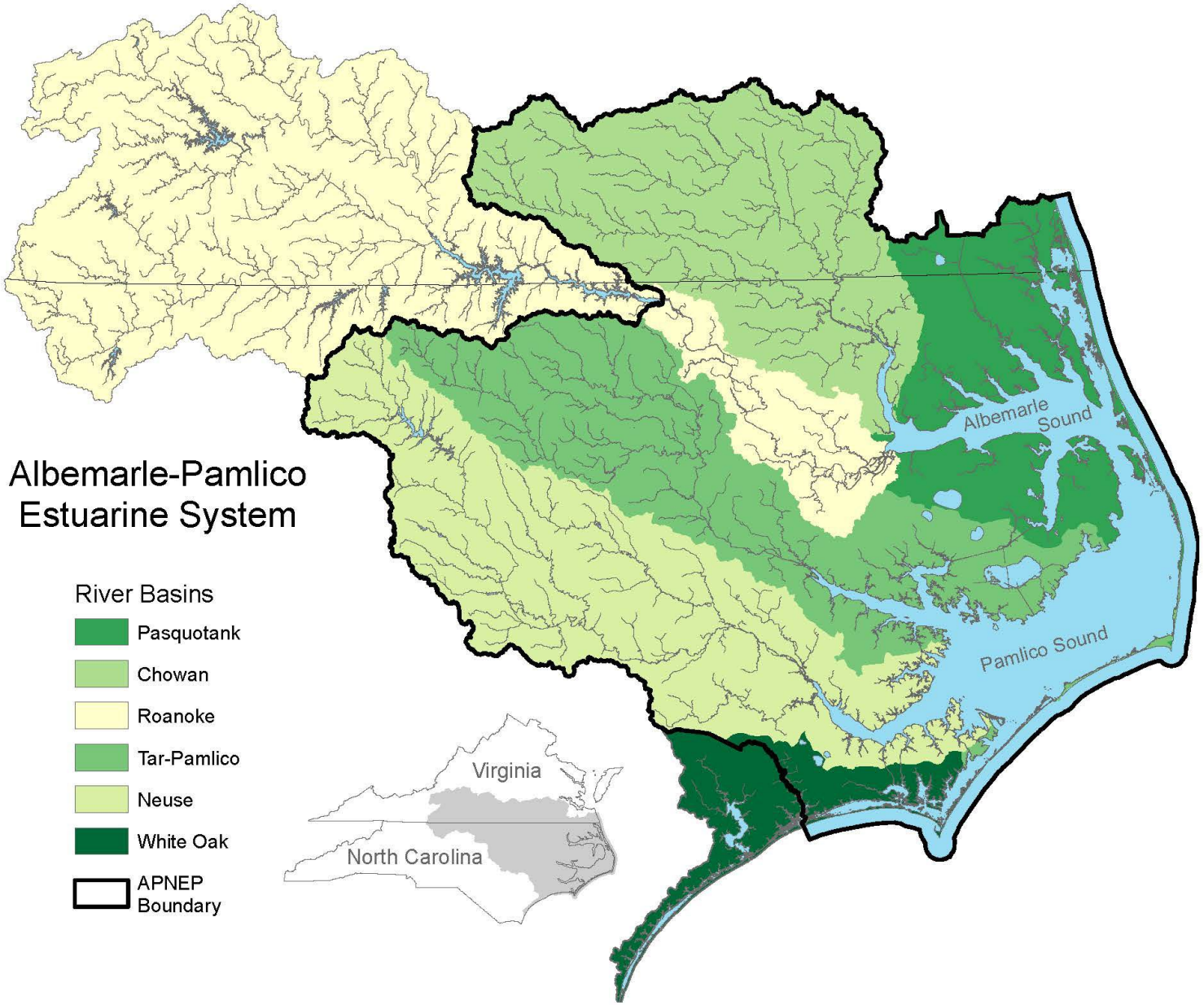
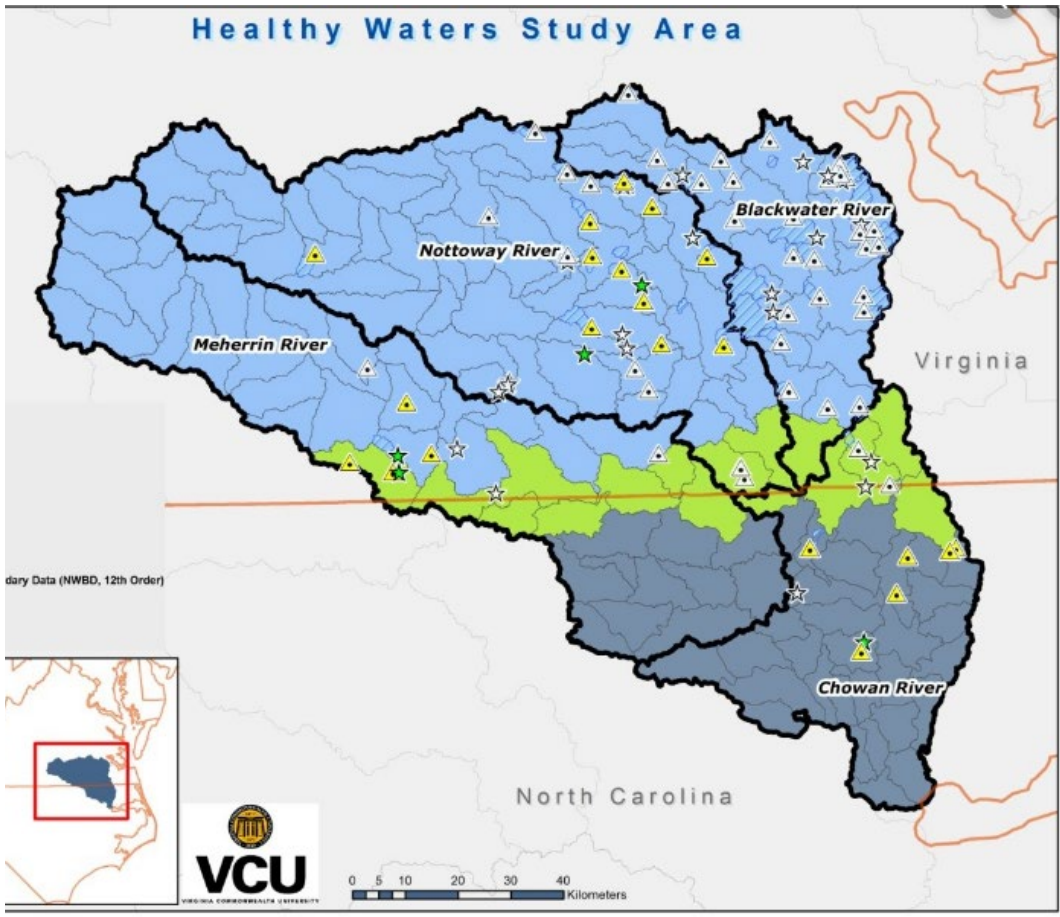
Nutrient Criteria Development Plan Meeting
Chowan River/Albemarle Sound

October 30, 2019

Nora Deamer – Basin Planner





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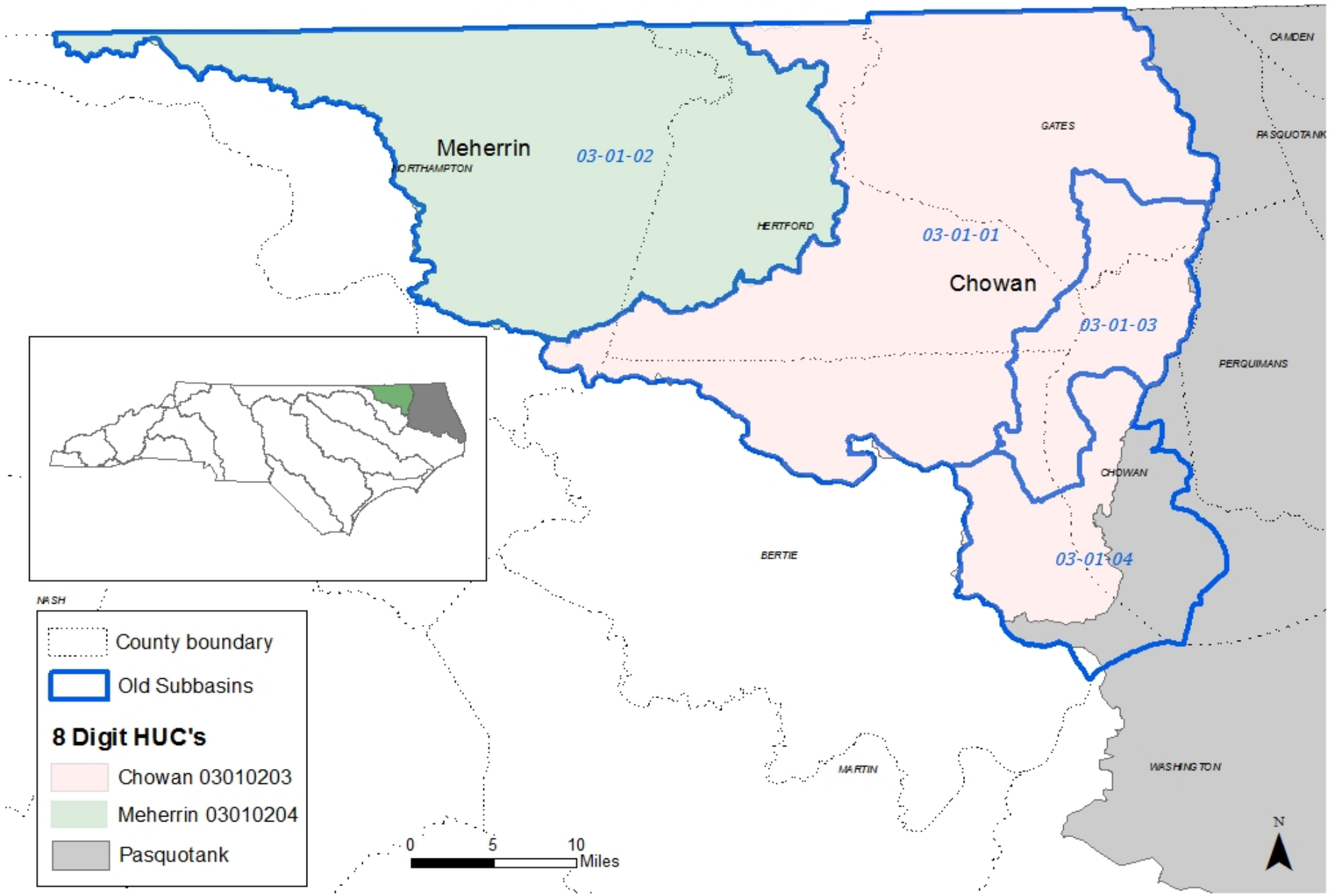
Chowan Basin
Conversion from Old DWQ Subbasins to 8-Digit HUC Subbasins



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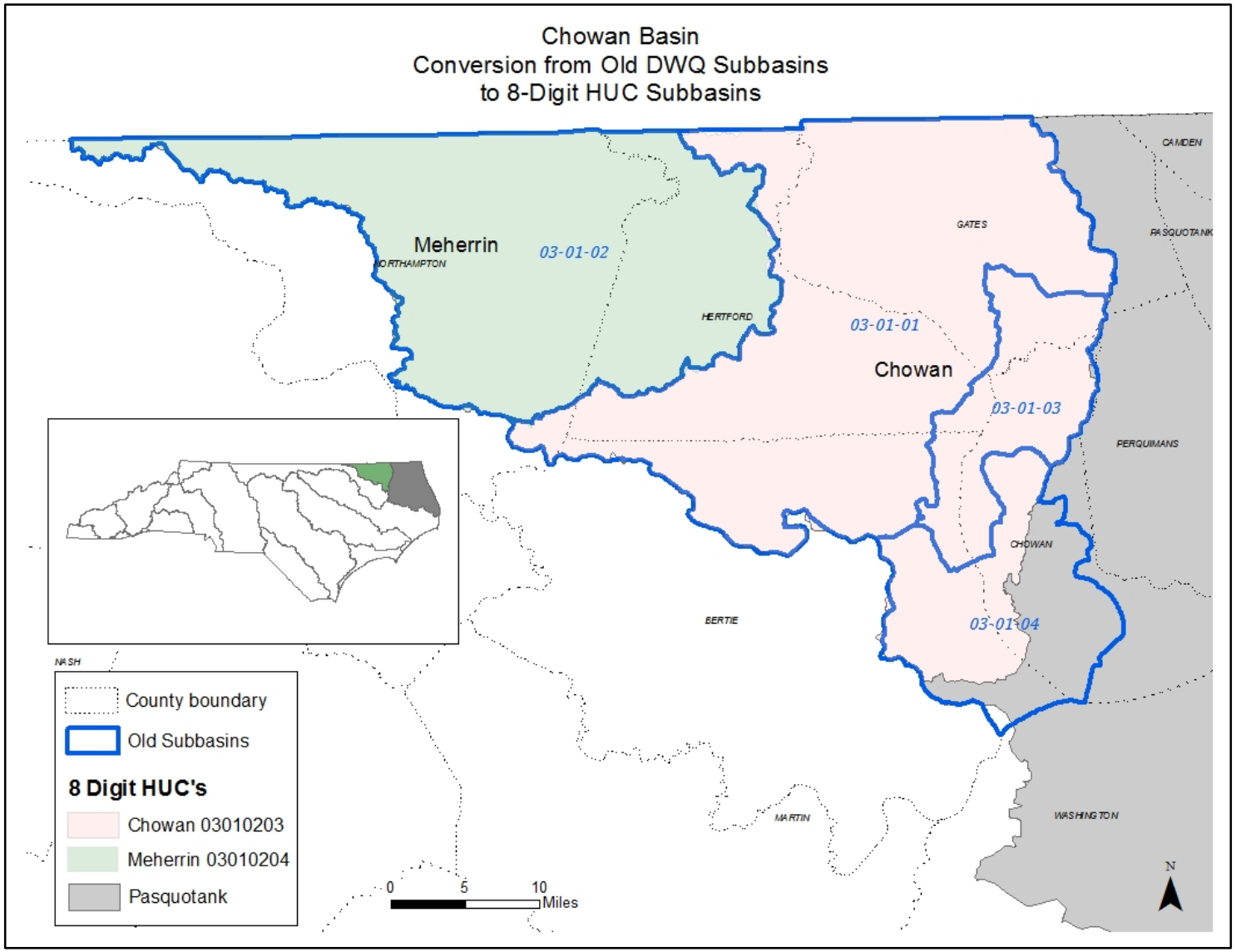
Chowan River Basin
Water Resources Management Plan Development

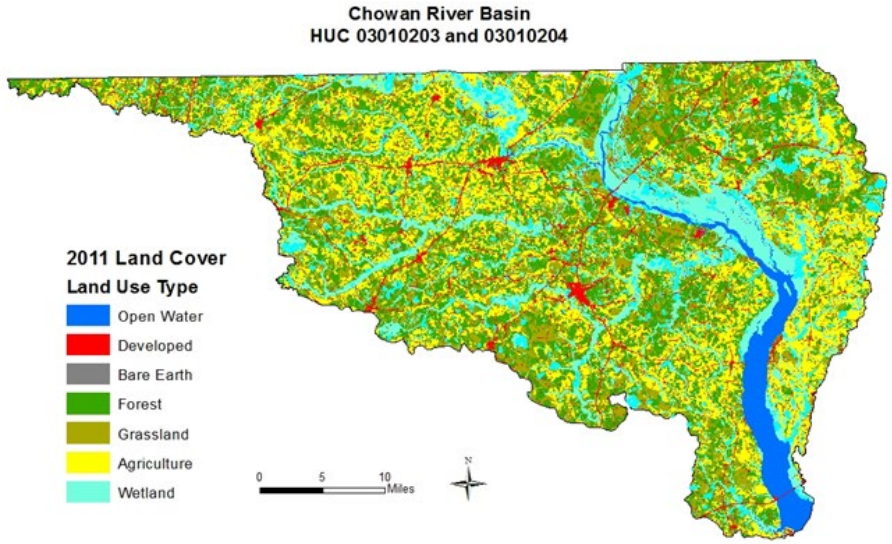


Basin Overview

- Water Quantity
  - Population and water needs
  - Water withdrawl and discharges
  - Stream flow
  - Groundwater availability and saltwater intrusion

- Water Quality
  - NSW Strategy
  - DWR Monitoring
    - Biological
    - Ambient
  - Agriculture and Water Quality
    - USDA Ag Census Data
  - Forestry and Water Quality
  - Drinking Water Protection Program
  - Groundwater quality

Name	SQMI	Aggregate Class	2001	2004	2006	2008	2011	2013	2016		Pecent change
Nottaway River											
D0000050	1720.943	Agriculture	17.00%	16.75%	16.82%	16.79%	16.67%	16.79%	16.82%		-1.06
D0000050	1720.943	Barren Land	0.18%	0.19%	0.20%	0.20%	0.20%	0.19%	0.18%		0.00
D0000050	1720.943	Developed	4.70%	4.70%	4.73%	4.73%	4.76%	4.76%	4.78%		1.70
D0000050	1720.943	Forest	55.25%	54.77%	55.05%	53.82%	53.99%	54.87%	52.75%		-4.52
D0000050	1720.943	Open Water	0.50%	0.53%	0.64%	0.59%	0.58%	0.56%	0.56%		12.00
D0000050	1720.943	Shrub/Grassland	10.22%	10.90%	10.51%	11.77%	11.68%	10.70%	12.77%		24.95
D0000050	1720.943	Wetlands	12.16%	12.16%	12.06%	12.10%	12.12%	12.13%	12.15%		-0.08
Blackwater River											
D0001800	739.6516	Agriculture	26.27%	26.27%	26.26%	26.25%	26.14%	26.40%	26.40%		0.49
D0001800	739.6516	Barren Land	0.07%	0.07%	0.07%	0.09%	0.08%	0.08%	0.08%		14.29
D0001800	739.6516	Developed	5.50%	5.50%	5.61%	5.61%	5.77%	5.77%	5.82%		5.82
D0001800	739.6516	Forest	41.04%	40.81%	40.47%	40.36%	40.43%	40.72%	40.28%		-1.85
D0001800	739.6516	Open Water	0.76%	0.71%	1.11%	0.84%	0.86%	0.81%	0.79%		3.95
D0001800	739.6516	Shrub/Grassland	6.64%	6.89%	7.03%	7.23%	7.12%	6.58%	6.97%		4.97
D0001800	739.6516	Wetlands	19.72%	19.74%	19.44%	19.61%	19.59%	19.64%	19.66%		-0.30
Potecasi Creek											
D4150000	224.0297	Agriculture	33.84%	33.79%	33.60%	33.39%	33.20%	33.20%	33.18%		-1.95
D4150000	224.0297	Barren Land	0.02%	0.02%	0.01%	0.01%	0.02%	0.02%	0.02%		0.00
D4150000	224.0297	Developed	4.33%	4.33%	4.34%	4.34%	4.36%	4.36%	4.40%		1.62
D4150000	224.0297	Forest	38.26%	37.50%	37.69%	38.13%	39.11%	39.56%	38.15%		-0.29
D4150000	224.0297	Open Water	0.14%	0.15%	0.14%	0.15%	0.20%	0.15%	0.15%		7.14
D4150000	224.0297	Shrub/Grassland	5.80%	6.61%	6.60%	6.37%	5.54%	5.10%	6.48%		11.72
D4150000	224.0297	Wetlands	17.61%	17.60%	17.62%	17.61%	17.58%	17.62%	17.62%		0.06
Chowan River @ US 17											
D9490000	4921.527	Agriculture	21.99%	21.81%	21.78%	21.70%	21.56%	21.65%	21.65%		-1.55
D9490000	4921.527	Barren Land	0.16%	0.17%	0.16%	0.17%	0.15%	0.14%	0.15%		-6.25
D9490000	4921.527	Developed	4.73%	4.73%	4.77%	4.77%	4.82%	4.82%	4.86%		2.75
D9490000	4921.527	Forest	48.34%	47.28%	46.97%	46.33%	47.29%	48.05%	46.70%		-3.39
D9490000	4921.527	Open Water	1.31%	1.35%	1.42%	1.36%	1.37%	1.34%	1.34%		2.29
D9490000	4921.527	Shrub/Grassland	8.54%	9.76%	10.05%	10.77%	9.93%	9.08%	10.38%		21.55
D9490000	4921.527	Wetlands	14.93%	14.90%	14.84%	14.89%	14.89%	14.91%	14.91%		-0.13



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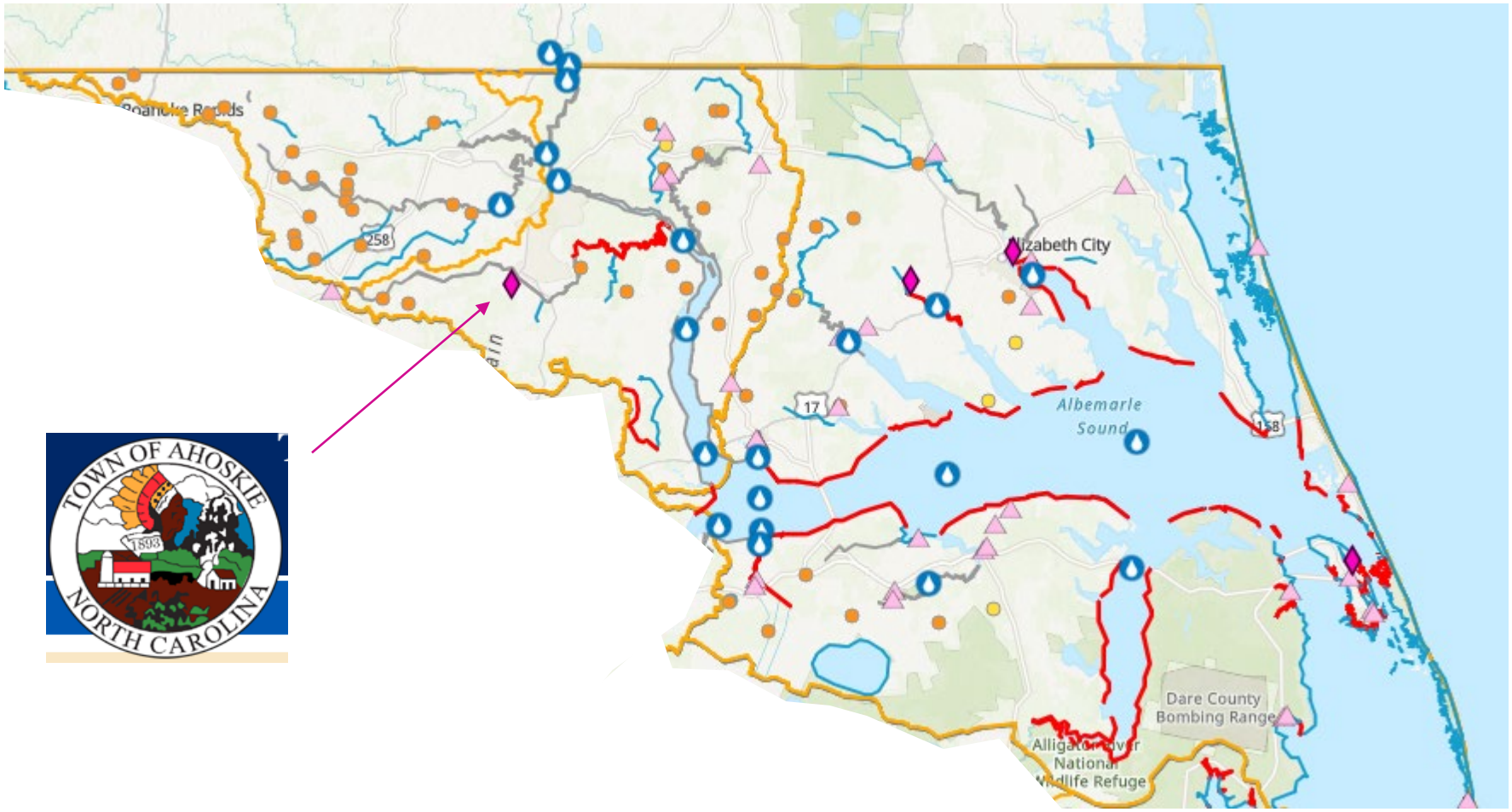
Animal Permits and NPDES Point Source Permits



- Animal Operation Permits
  - Swine State COC
  - Swine NPDES COC
  - Cattle State COC
  - Cattle NPDES COC
  - Wet Poultry State COC
  - Wet Poultry NPDES COC
  - Animal Individual State
  - Animal Individual NPDES
- NPDES WWTP Facilities
  - Major
  - Minor

TOWN OF AHOSKIE NORTH CAROLINA 1893

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NPDES WWTP in Chowan River Basin

Permit Number	Facility Name	Owner Type	County	Permit Type	Class	Permit Flow GPD	Receiving Stream
NC0033782	Gatesville Elementary School WWTP	Government - County	Gates	Discharging 100% Domestic < 1MGD	Minor	5,000 GPD	Bennetts Creek (Merchants Millpond)
NC0033804	T.S. Cooper Elementary School WWTP	Government - County	Gates	Discharging 100% Domestic < 1MGD	Minor	4,000 GPD	Raynor Swamp (Hunters Millpond)
NC0043974	Buckland Elementary School	Government - County	Gates	Discharging 100% Domestic < 1MGD	Minor	6,000 GPD	Cole Creek (Lilleys Millpond)
NC0088561	Ahoskie WWTP	Government - Municipal	Hertford	Municipal Wastewater Discharge, Large	Major	1,300,000 GPD	Ahoskie Creek (Ahoskie Swamp, Bear Swamp)
NC0032719	Valhalla WWTP	Non-Government	Chowan	Water Plants and Water Conditioning Discharge	Minor	Not limited	Rockyhock Creek (Bennett Millpond)
NC0089541	Ashton Lewis Lumber Co.	Non-Government	Gates	Industrial Process & Commercial WW Discharge	Minor	Null	Bennetts Creek (Merchants Millpond)

1 Major
&
5 Minor
WWTPs

Figure 1

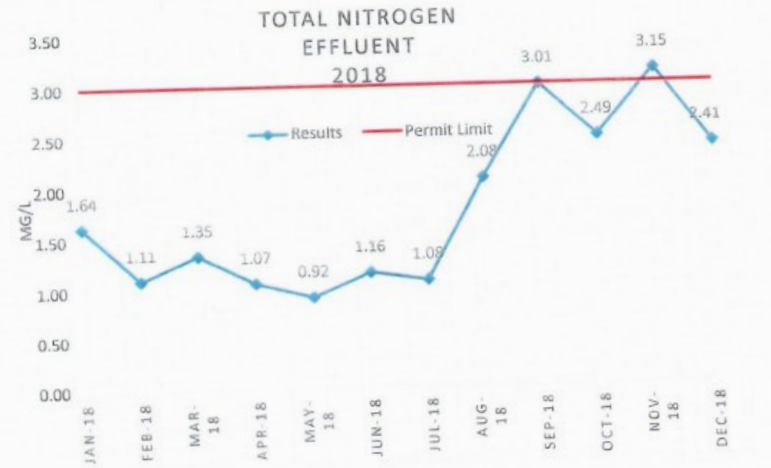
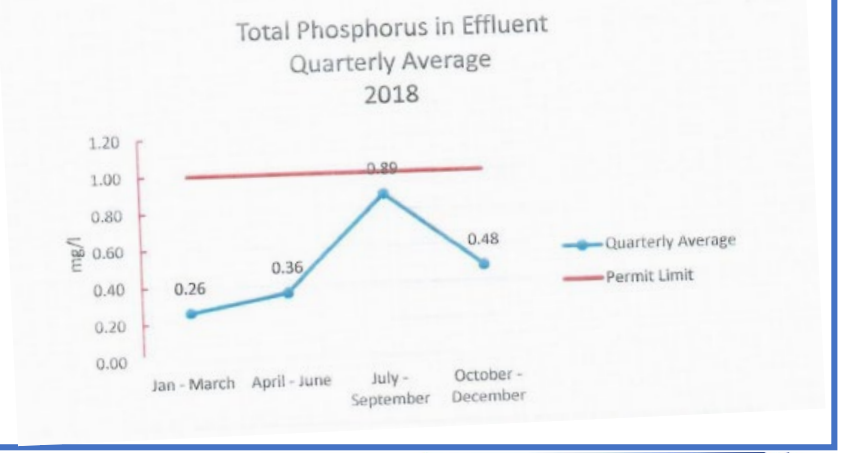


Figure 2

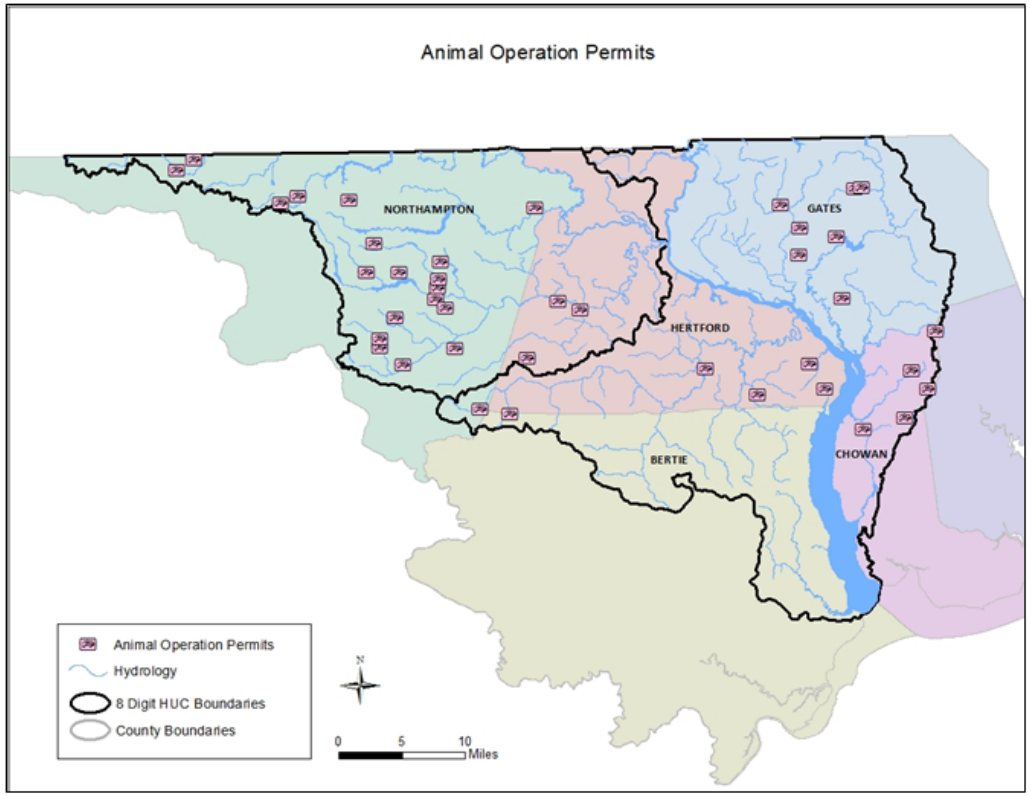


Agriculture - Chowan River Basin

	2002	2007	2012	2002	2007	2012
	Number of Farms			Number of Acres		
Number of Farms & Land Area	1,096	1,153	1,129	354,993	454,149	513,991
Land Use	**Number of Farms**			**Number of Acres**		
Total Cropland	1,255	849	870	340,481	354,632	351,288
Harvested Cropland	774	704	710	317,852	341,186	338,520
Irrigated Land	144	145	115	19,032	26,361	21,688
Livestock Inventory	**Number of Farms**			**Number of Animals**		
Cattle and Calf	153	115	96	5,692	4,100	4,142
Hogs and Pigs	110	46	52	274,092	292,637**	130,480**
Chickens*	183	114	131	10,117,979	9,496,888	11,396,089
Crops	**Number of Farms**			**Number of Acres**		
Corn for Grain	329	366	263	39,558	94,247	35,961
Soybeans	465	495	525	47,555	100,189	119,854
Cotton	409	317	289	164,720	117,573	116,848
Tobacco	171	59	44	4,013	4,442	5,997**
Peanuts	510	242	171	34,280	31,557	29,101
Forage (Land used for hay, haylage, grass silage and greenchop)	66	61	48	5,389	4,855	2,520

*Broilers and other meat-type chickens

**(D) Information withheld from counties to avoid disclosing data for individual farms (USDA, 2012).



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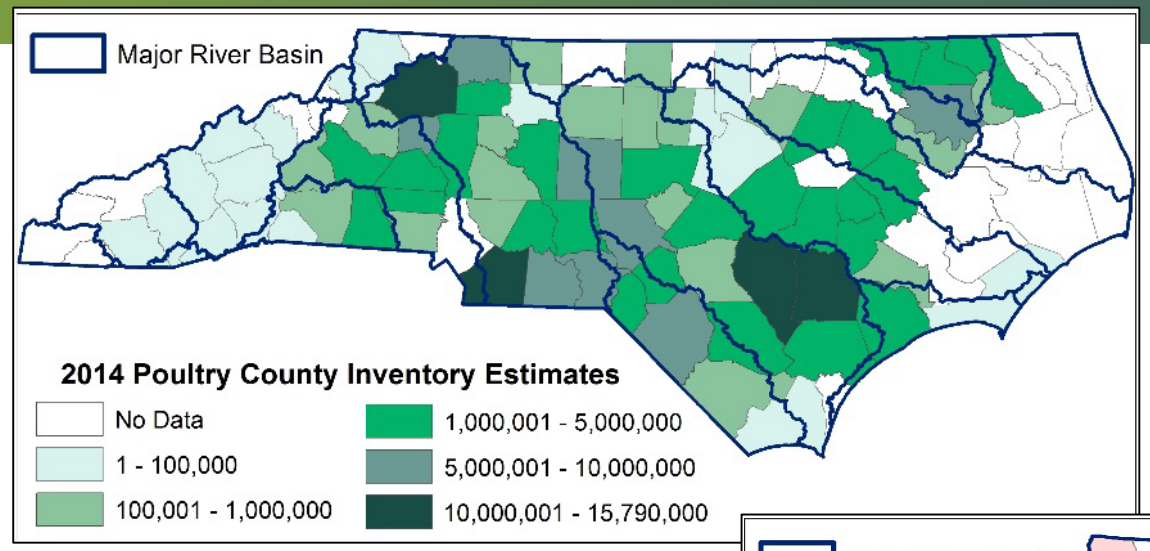
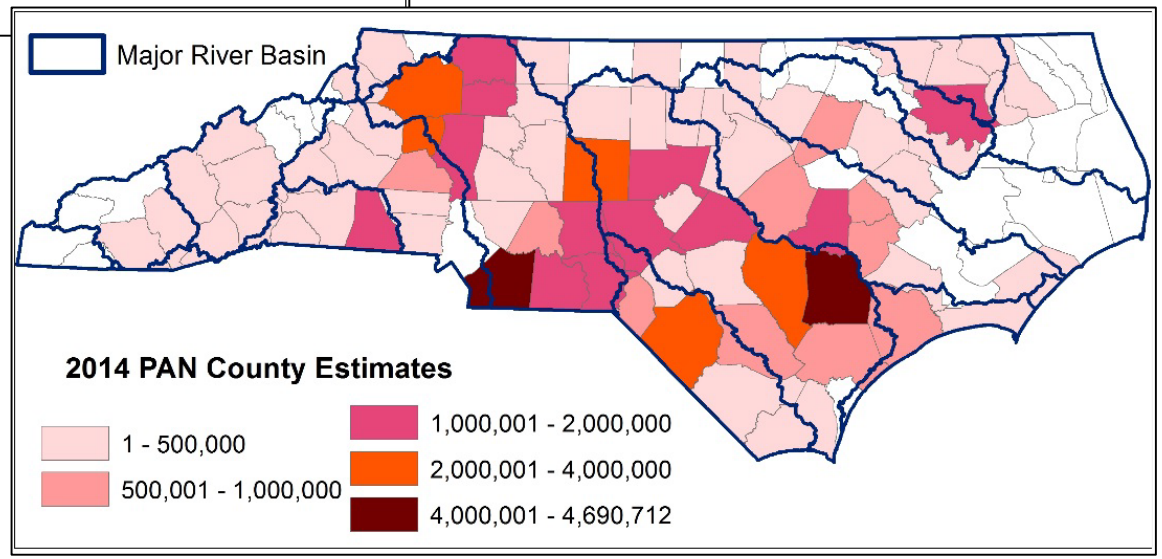
2014 Poultry Estimates





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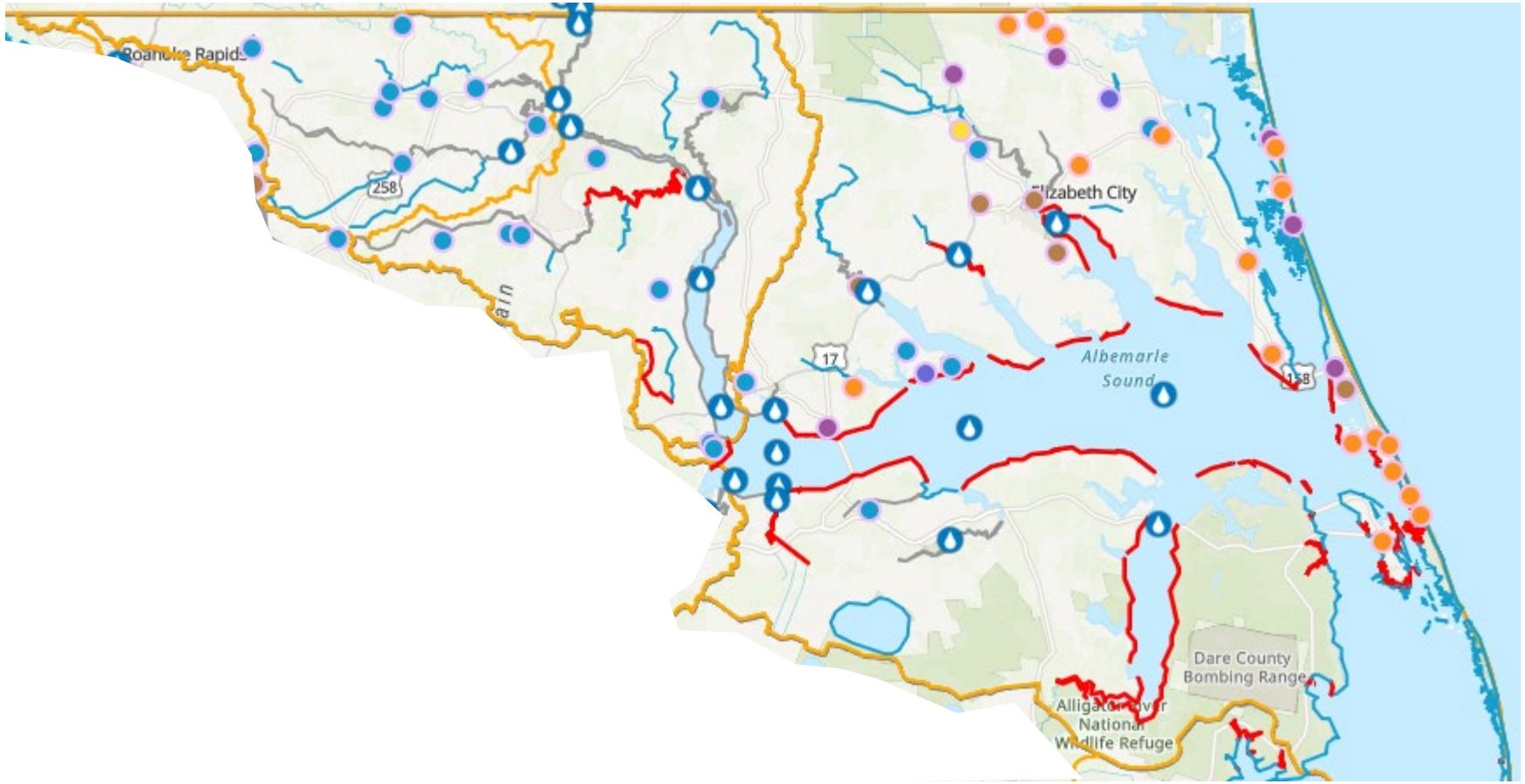
Non-Discharge Permits



- Non-Discharge Permits
  - Single-Family Residence Wastewater Irrigation
  - Wastewater Irrigation
  - Reclaimed Water
  - High Rate Infiltration
  - Closed-Loop Recycle
  - Other Non-Discharge Wastewater
  - Reclaimed Water Distribution
  - Distribution of Residual Solids (503)
  - Distribution of Residual Solids (503 Exempt)
  - Land Application of Residual Solids (503 Exempt)
  - Land Application of Residual Solids (503)
  - Surface Disposal of Residual Solids(503 Exempt)
  - Surface Disposal of Residual Solids (503)

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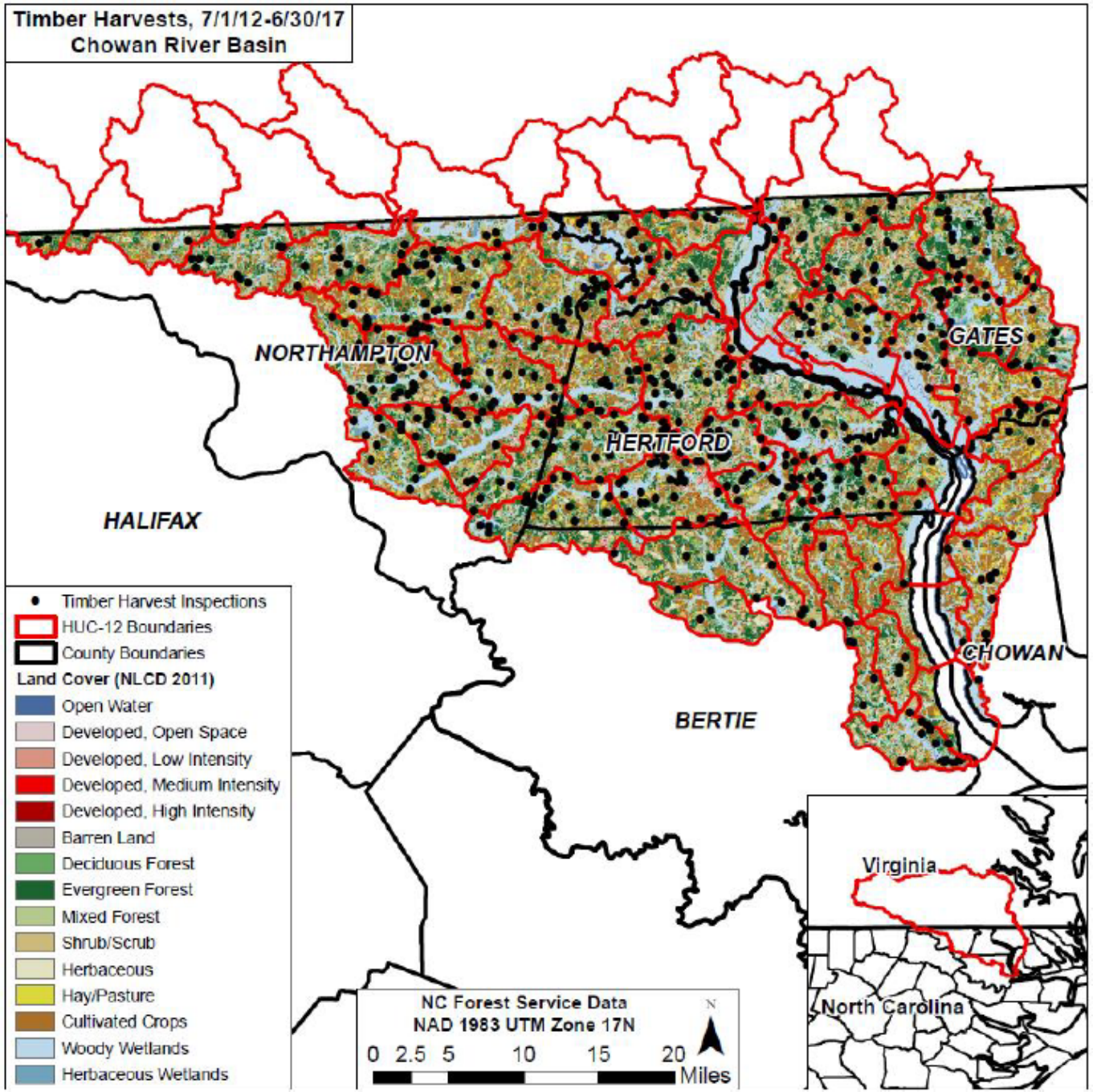
Permit #	Facility Name	Owner	County	Permit Type	Permit Flow GPD
WQ0005910	Avoca Farms - Merry Hill	Avoca Inc	Bertie	Wastewater Irrigation	50,000
WQ0012404	CF Nitrogen Site in Tunis, NC	C F Industries Inc	Hertford	Groundwater Remediation	54,795
WQ0000267	Gates Correctional Center #4130	County of Gates	Gates	Wastewater Irrigation	25,000
WQ0002012	Georgia-Pacific Chemicals LLC	Georgia-Pacific Chemicals LLC	Northampton	Wastewater Irrigation	-
WQ0002096	Pinewood Manor Rest Home	Jor Enterprises LLC	Hertford	Wastewater Irrigation	7,500
WQ0005192	Murfreesboro Hatchery #5	Perdue Foods LLC	Northampton	Wastewater Irrigation	10,909
WQ0001536	Perdue Grain and Oilseed LLC	Perdue Grain and Oilseed LLC	Hertford	Wastewater Irrigation	35,000
WQ0003885	Town of Ahoskie WWTP	Town of Ahoskie	Hertford	Wastewater Irrigation	406,000
WQ0000777	Aulander Town - WWTP/Spray Fac	Town of Aulander	Hertford	Wastewater Irrigation	333,510
WQ0011119	Colerain WWTP	Town of Colerain	Bertie	Wastewater Irrigation	75,000
WQ0001284	Town of Conway-WWTP	Town of Conway	Northampton	Wastewater Irrigation	150,000
WQ0006785	Murfreesboro WWTF	Town of Murfreesboro	Hertford	Wastewater Irrigation	649,610
WQ0003299	Seaboard Town WWTF/Spray	Town of Seaboard	Northampton	Wastewater Irrigation	134,000
WQ0001868	Severn Town - WWTP/Spray Sys	Town of Severn	Northampton	Wastewater Irrigation	62,000
WQ0001602	Town of Winton WWTP	Town of Winton	Hertford	Wastewater Irrigation	585,000
WQ0004910	Town of Woodland WWTF	Town of Woodland	Northampton	Wastewater Irrigation	185,000

Non-Discharge Permits Chowan River Basin

- Non-Discharge Disposal Methods
  - Spray/Drip Irrigation
  - High-Rate Spray/Drip Infiltration
  - High-Rate Basin Infiltration
  - High-Rate Rotary Infiltration
  - Closed-Loop Recycle
  - Reclaimed Water Reuse
  - Reclaimed Water Irrigation

Timber Harvest Inspections



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Chowan River Basin – 303(d) Impaired Waters List

2018 NC Category 5 Assessments "303(d) List" Final

Chowan River River Basin — **Chowan Subbasin** — **03010203**

25-24-2 **Cricket Swamp**

From source to Salmon Creek

Classification	C;NSW	Length or Area	8	Units	FW Miles	Previous AU Number	

Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	> 10% and >90 conf	pH (6 su, AL, FW)	5

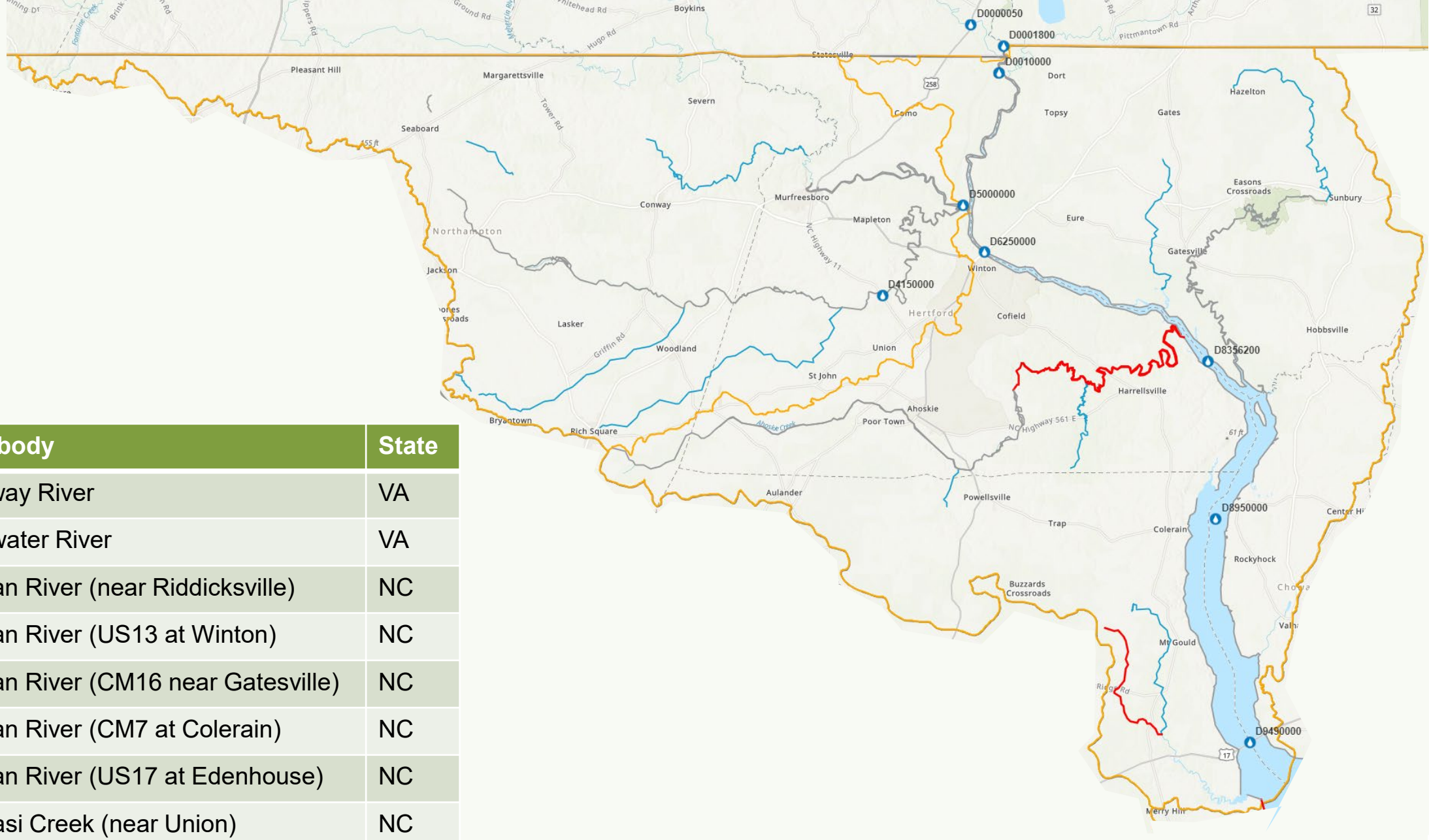
25-14 **Wiccacon River (Hoggard Swamp)**

From source to Chowan River

Classification	C;NSW	Length or Area	23	Units	FW Miles	Previous AU Number	

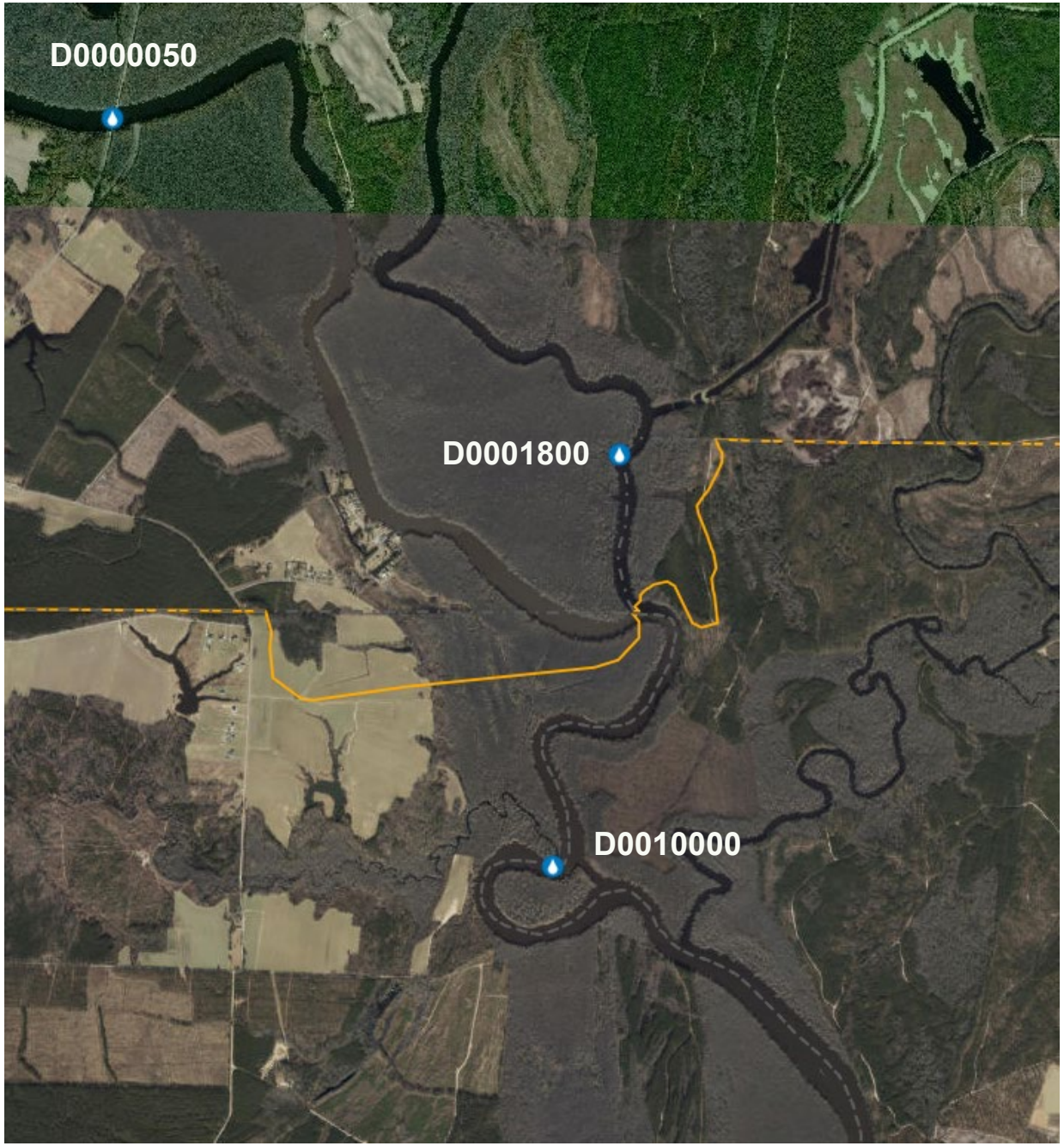
Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	Fair	Benthos (Nar, AL, FW)	5

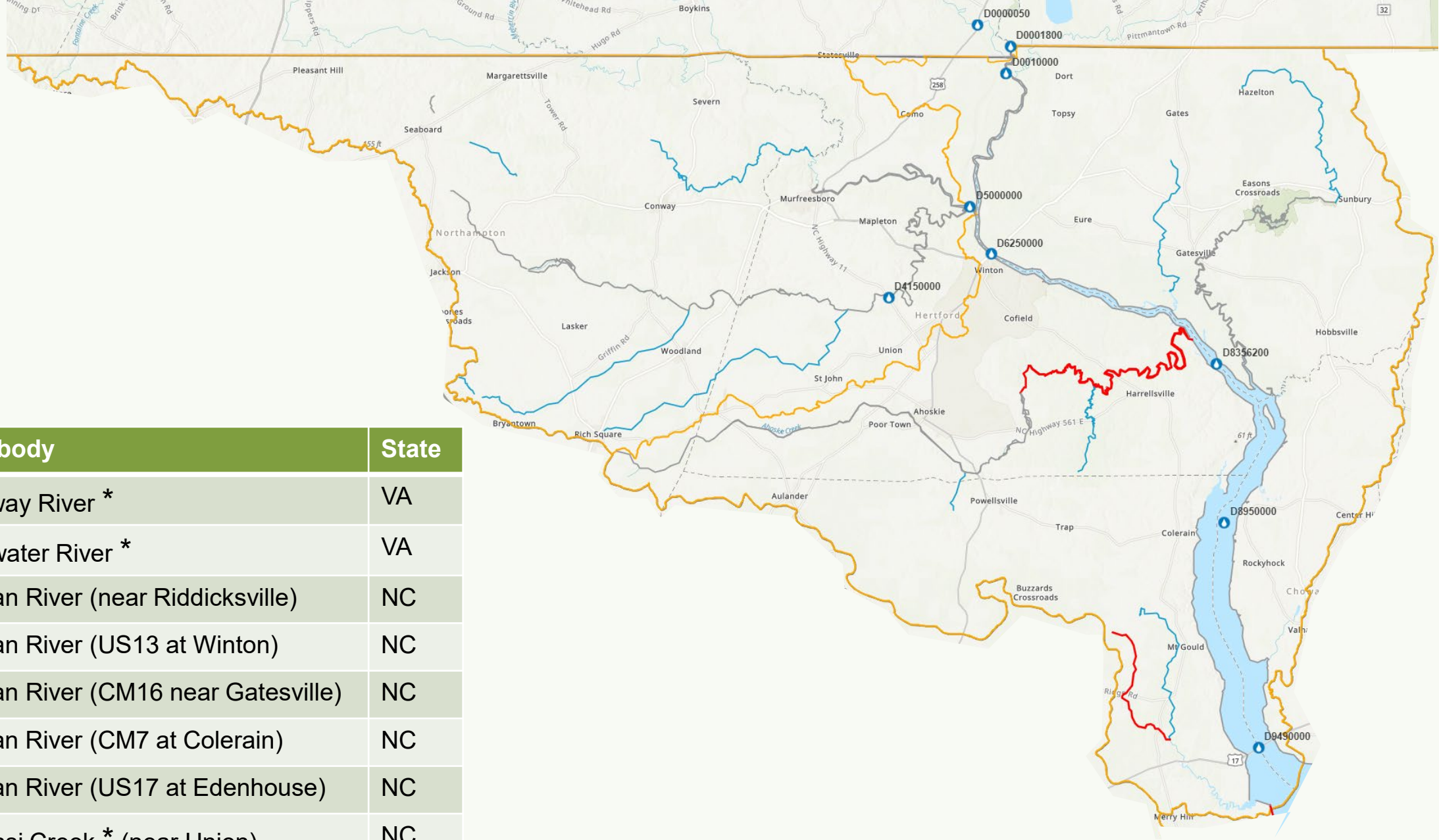
303(d) link - https://files.nc.gov/ncdeq/Water%20Quality/Planning/TMDL/303d/2018/2018-NC-303-d--List-Final.pdf
2018 IR link - https://files.nc.gov/ncdeq/Water%20Quality/Planning/TMDL/303d/2018/2018IR072519.pdf



Station	Waterbody	State
D0000050	Nottoway River	VA
D0001800	Blackwater River	VA
D0010000	Chowan River (near Riddicksville)	NC
D6250000	Chowan River (US13 at Winton)	NC
D8356200	Chowan River (CM16 near Gatesville)	NC
D8950000	Chowan River (CM7 at Colerain)	NC
D9490000	Chowan River (US17 at Edenhouse)	NC
D4150000	Potecasi Creek (near Union)	NC
D5000000	Meherrin River (near Como)	NC


D0000050
River Rd
258
34 ft
Cathole Landing
Blackwater River
D0001800
Riverdale Dr
34 ft
Battles Beach Rd
Chowan River
D0010000
Mill Neck Rd
32 ft


D0000050
D0001800
D0010000



Station	Waterbody	State
D0000050	Nottoway River *	VA
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D0010000	Chowan River (near Riddicksville)	NC
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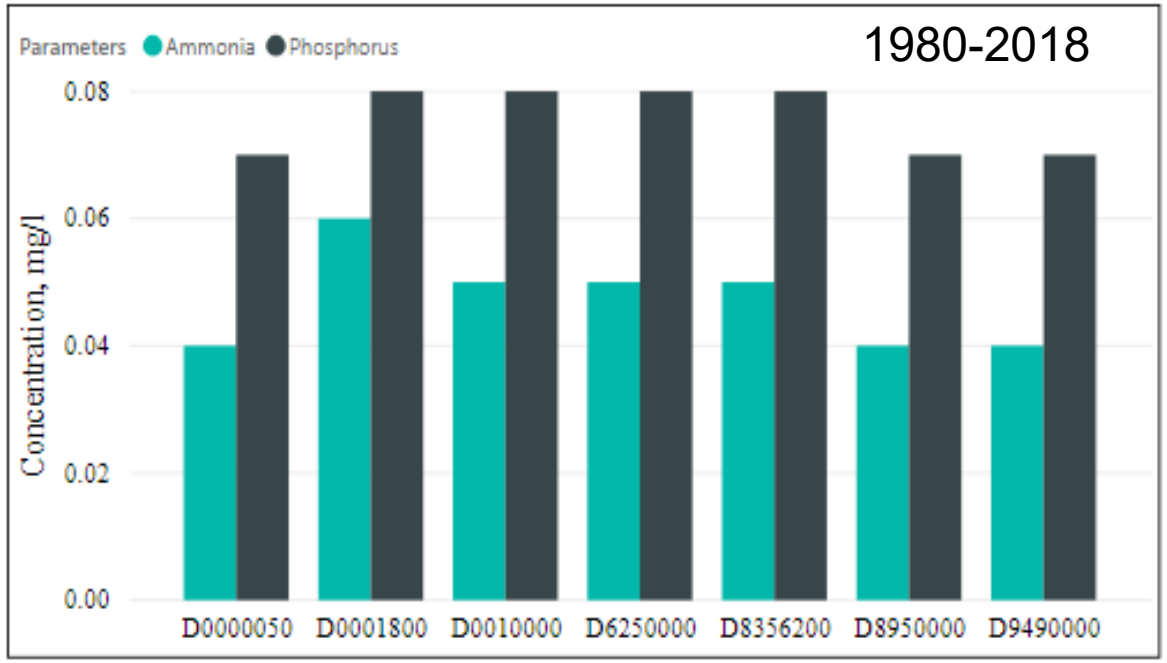
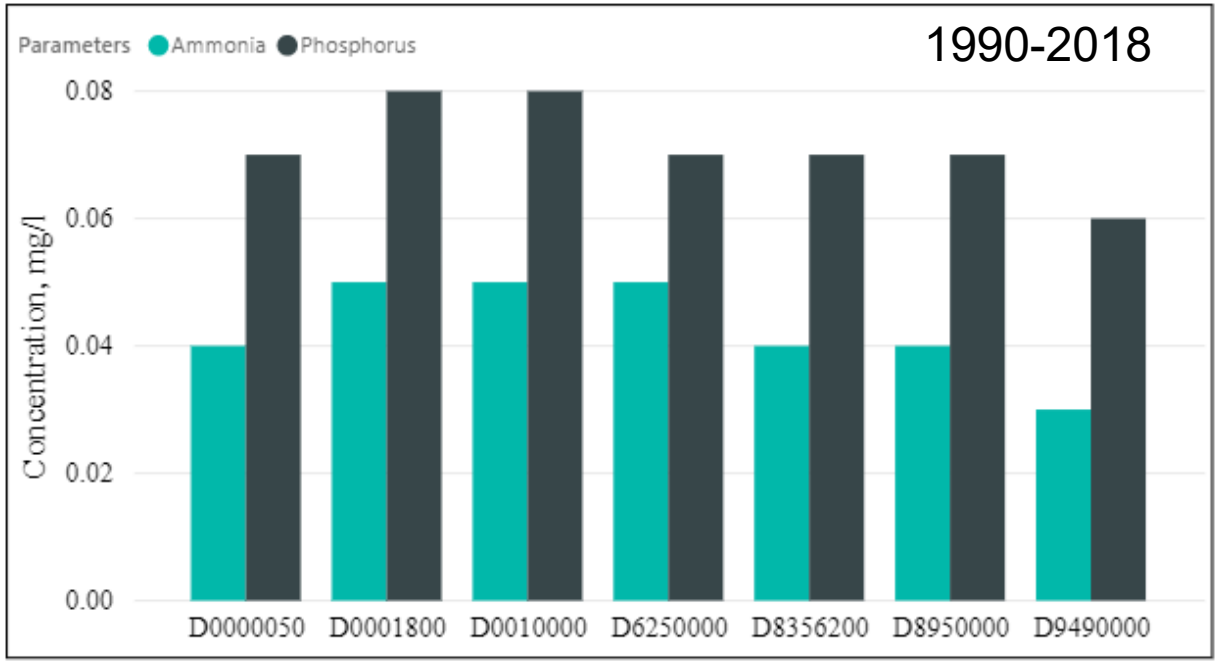
D8356200	Chowan River (CM16 near Gatesville)	NC
D8950000	Chowan River (CM7 at Colerain)	NC
D9490000	Chowan River (US17 at Edenhouse)	NC
D4150000	Potecasi Creek * (near Union)	NC
D5000000	Meherrin River (near Como)	NC

* Near USGS Flow Gage

Mean Concentration





Nottaway River

Blackwtr River

Chowan Riddicksv

Chowan Winton

Chowan Gatesv

Chowan Colerain

Chowan Edenhouse

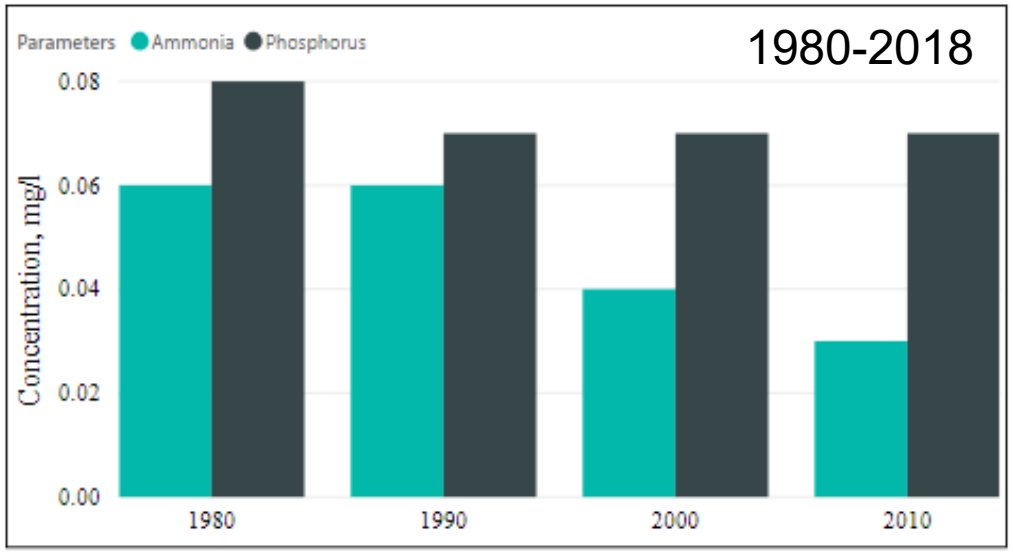
Meherrin River

Wiccacon River

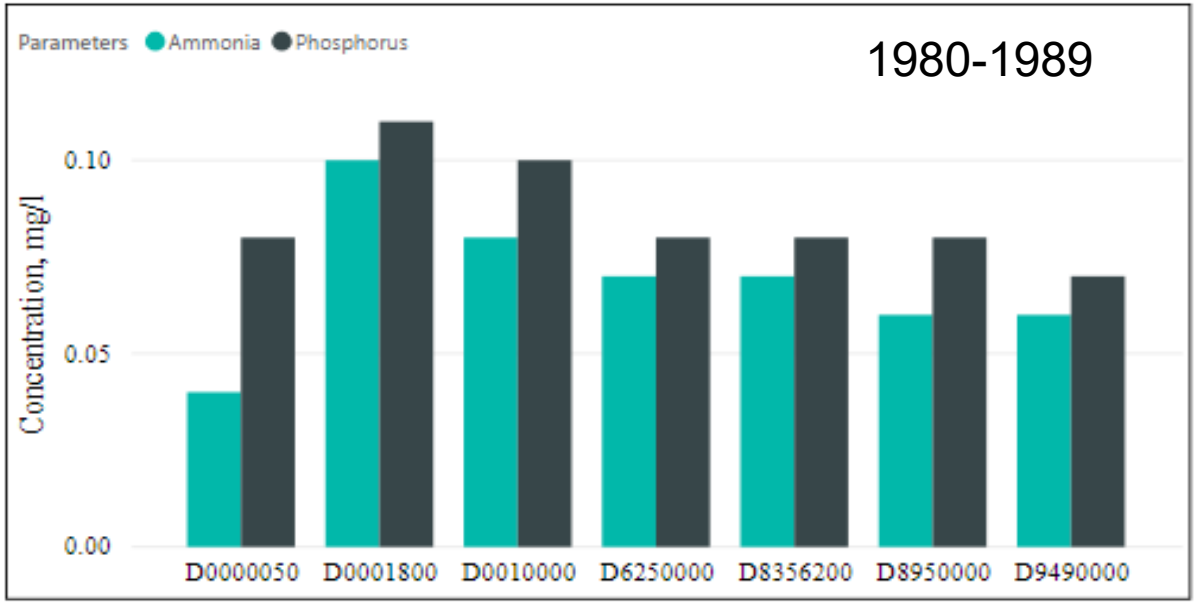
Bennetts Creek

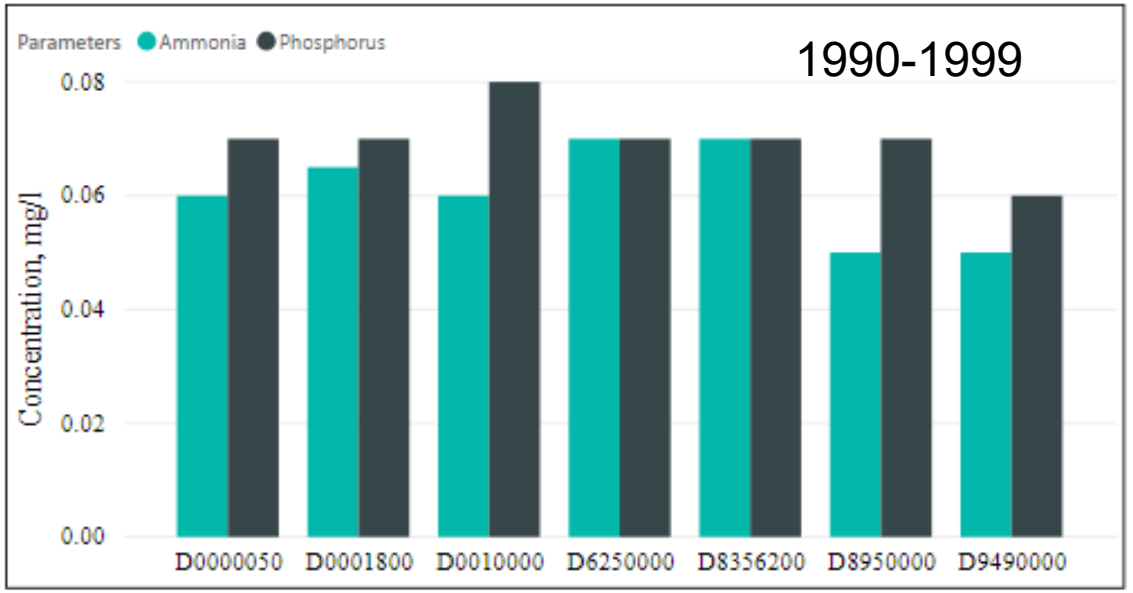
Downstream

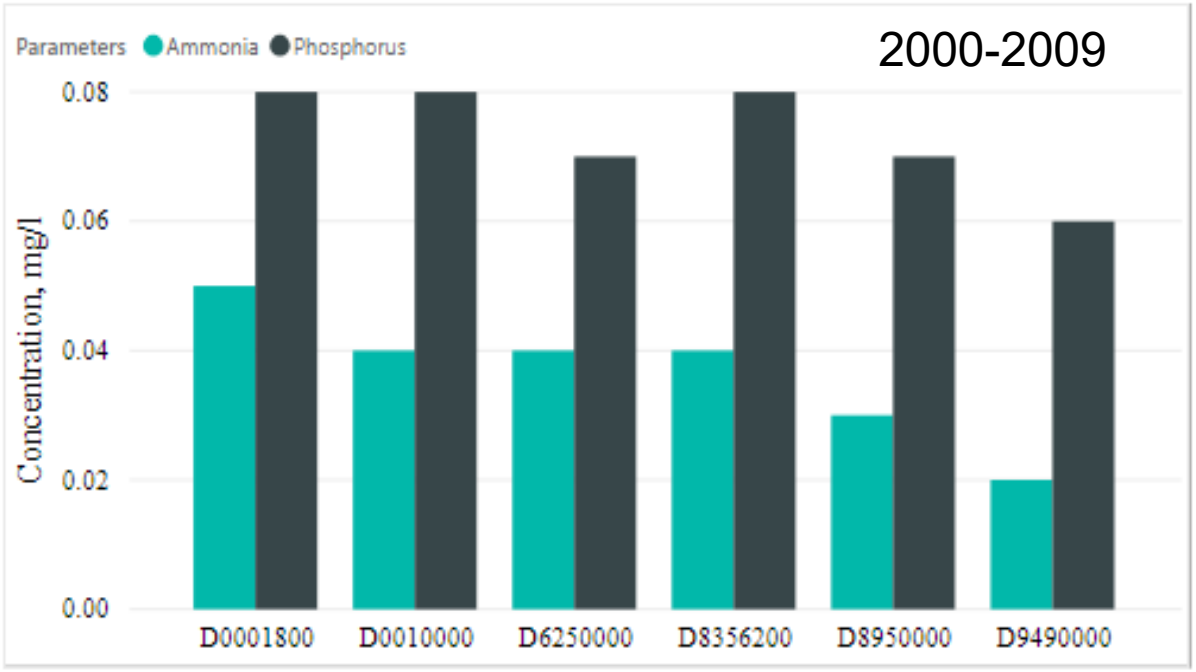
All Mainstem Stations

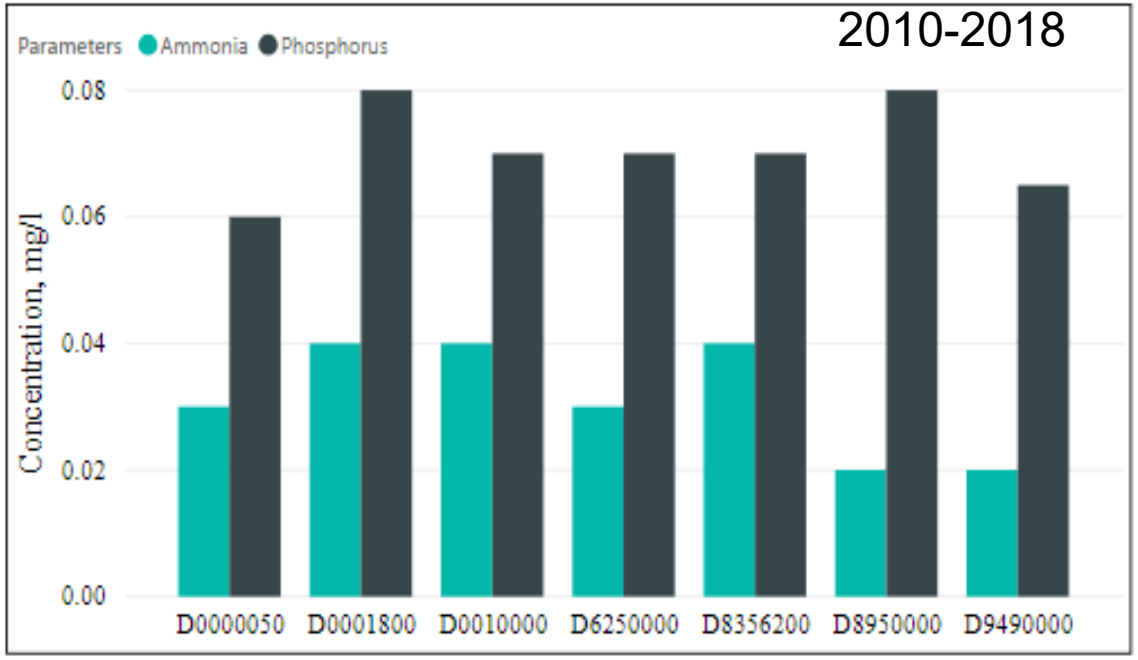


Mean Concentration









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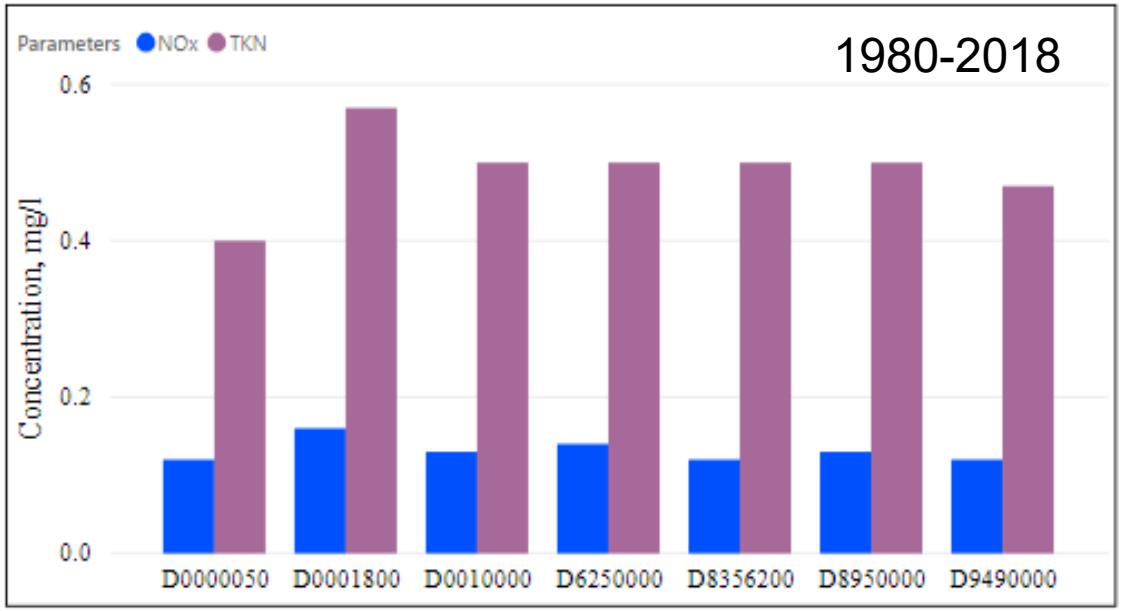
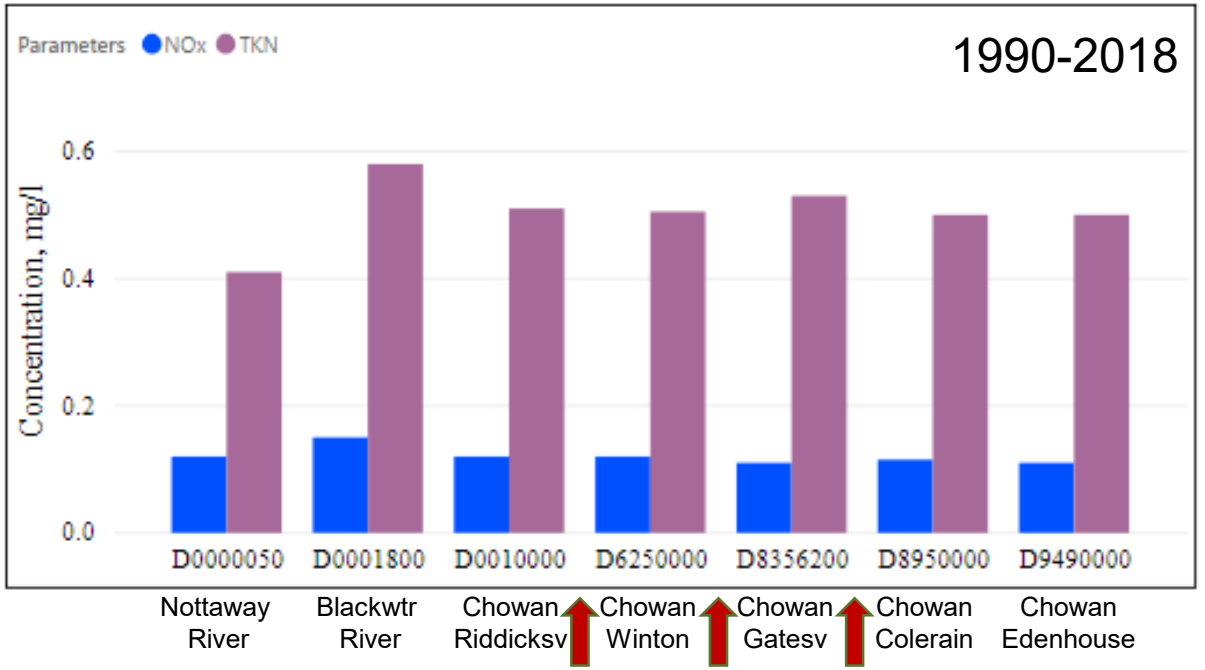
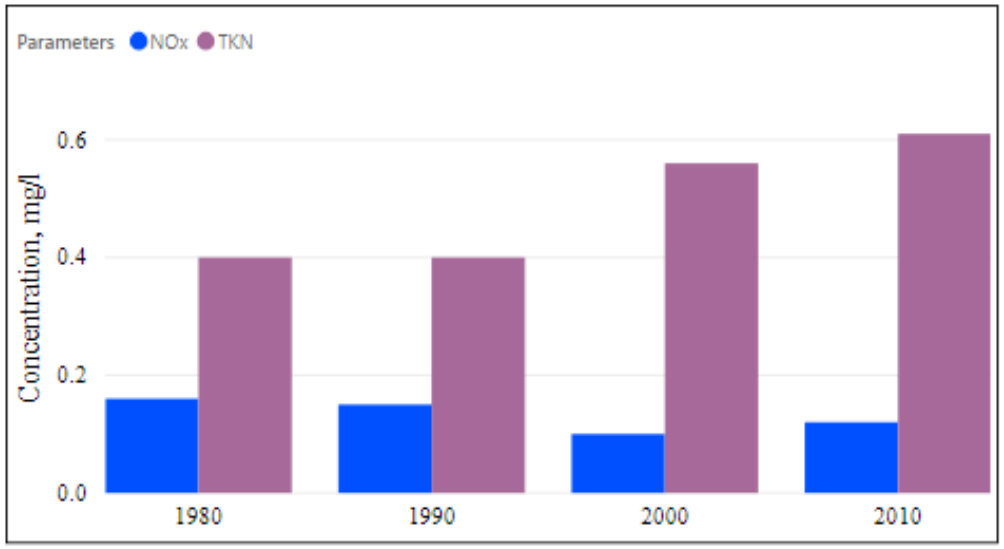
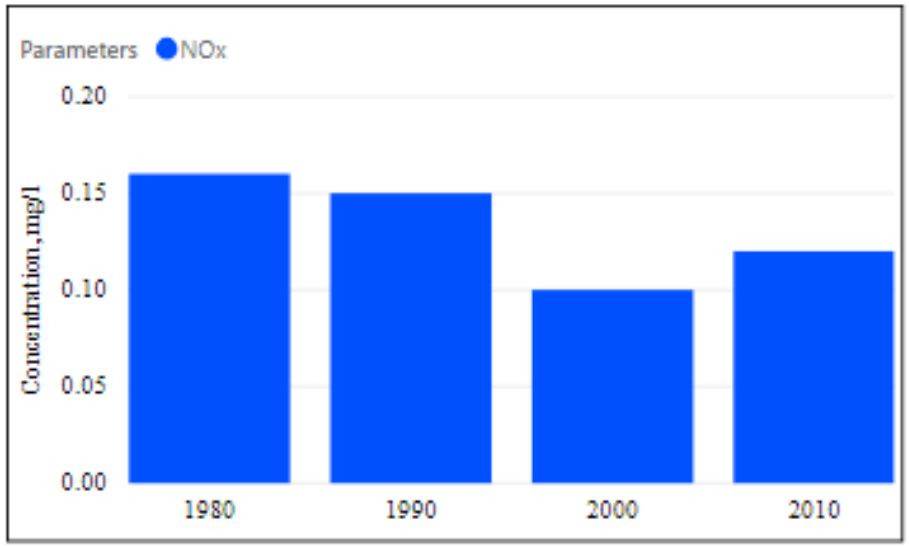


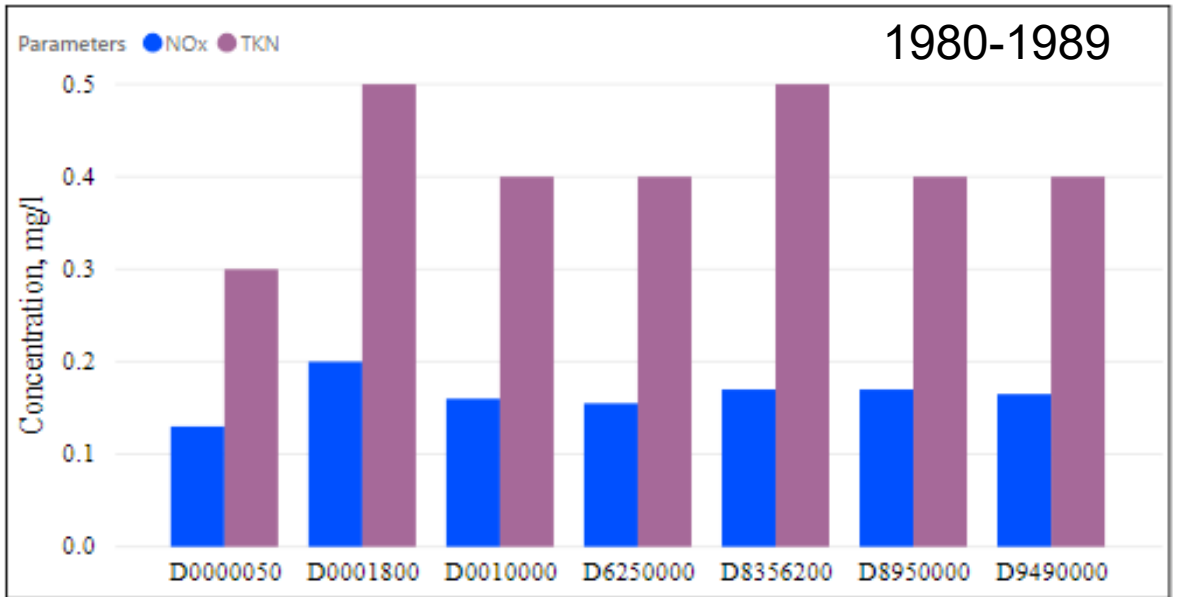


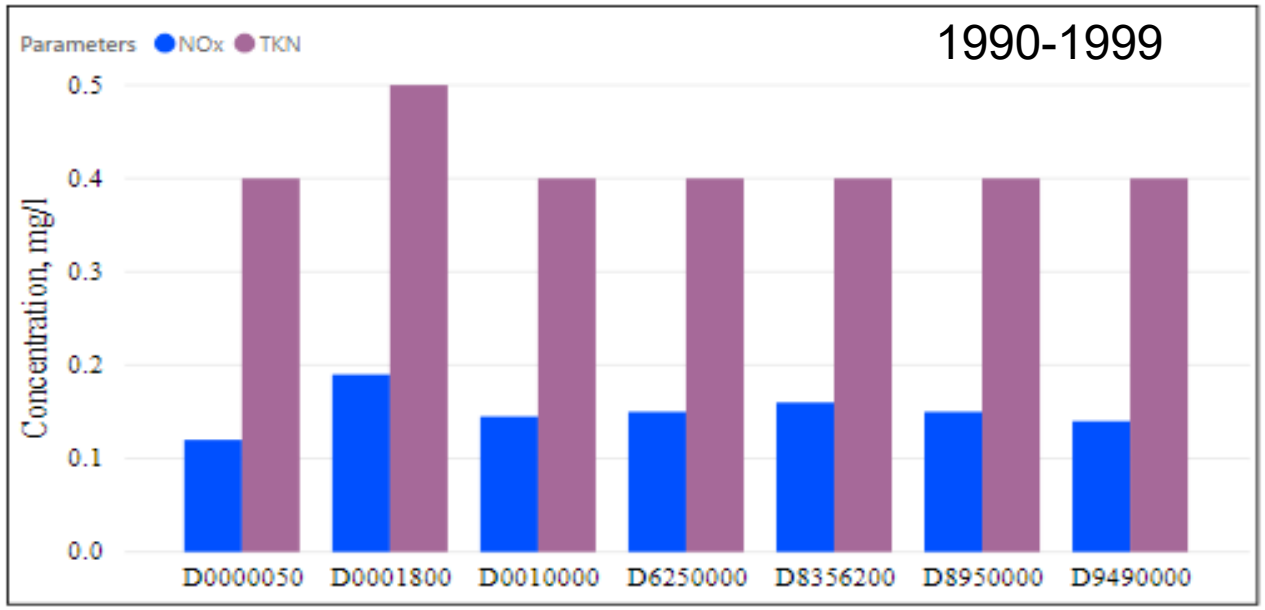
All Mainstem Stations

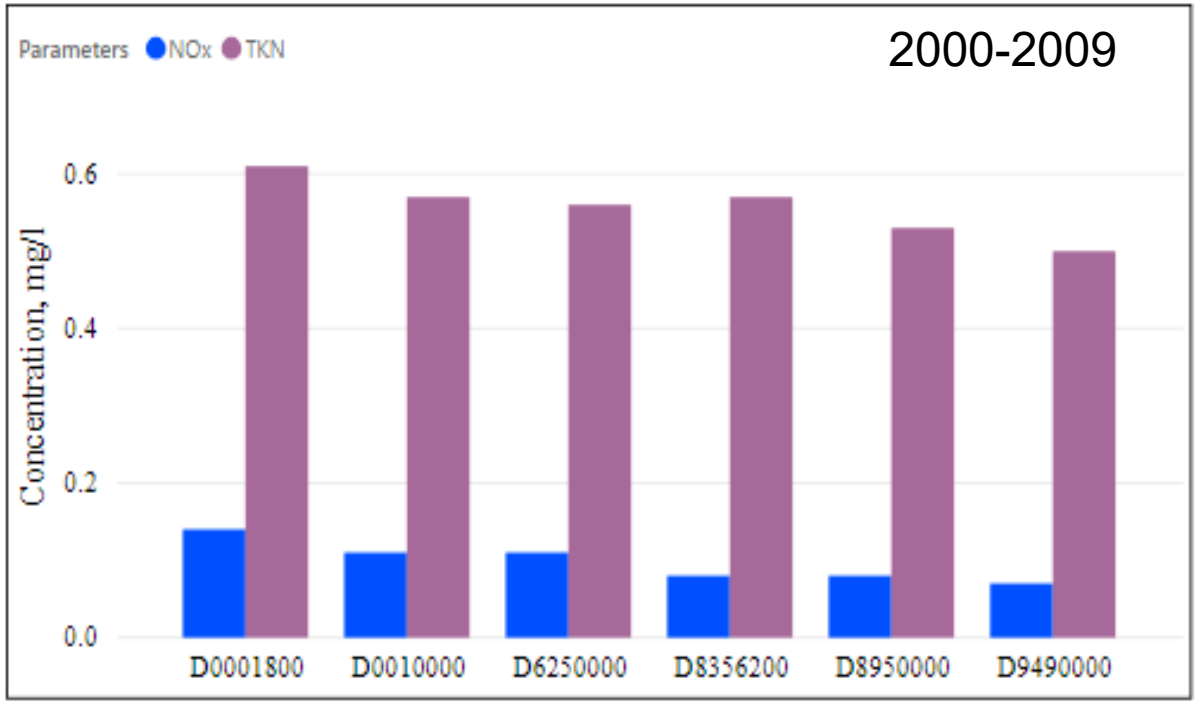


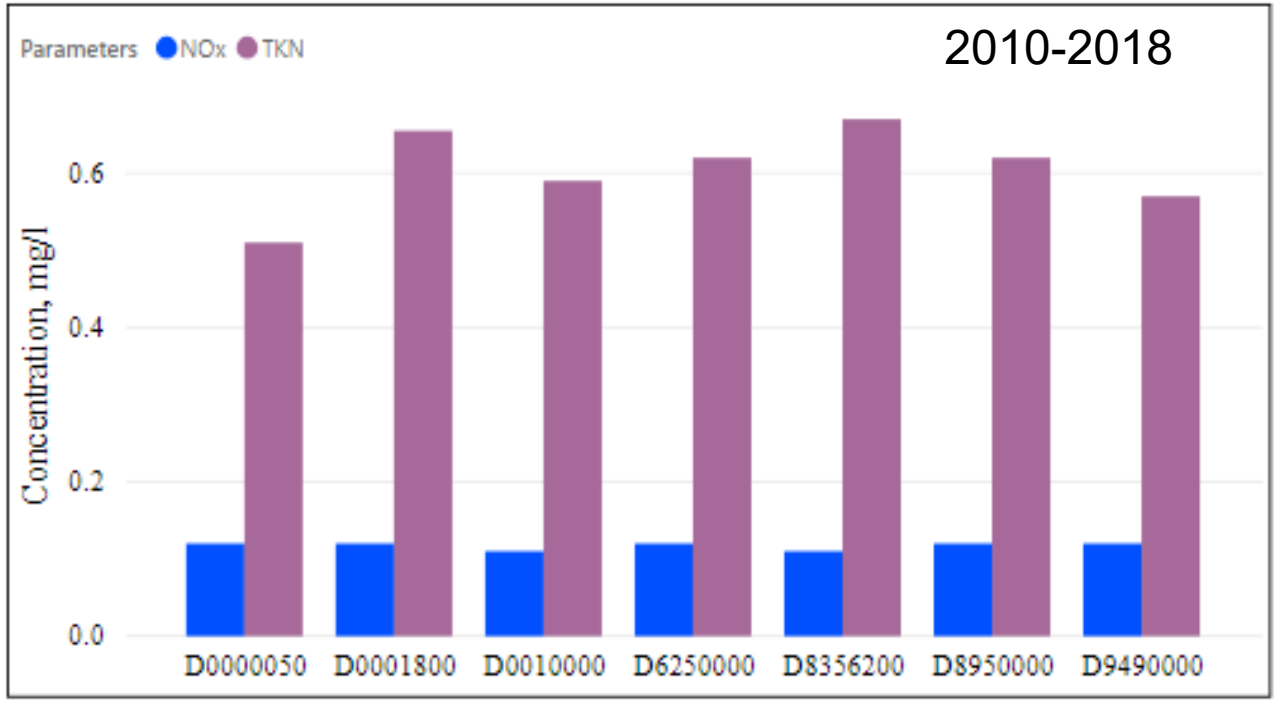


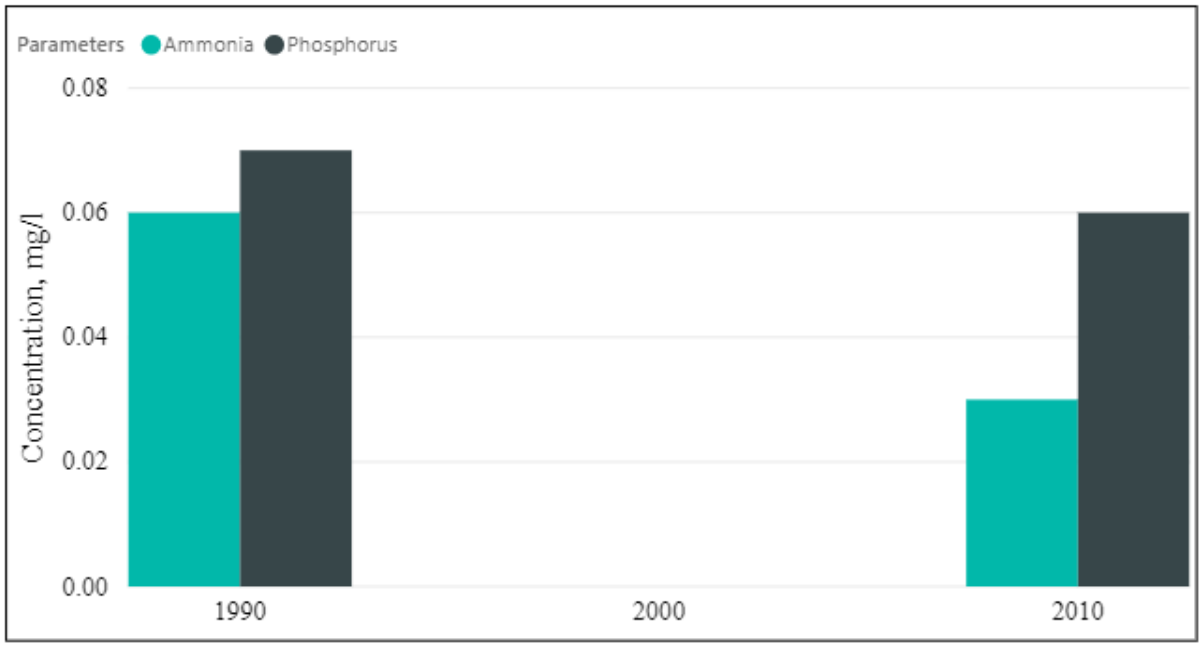
Mean Concentration







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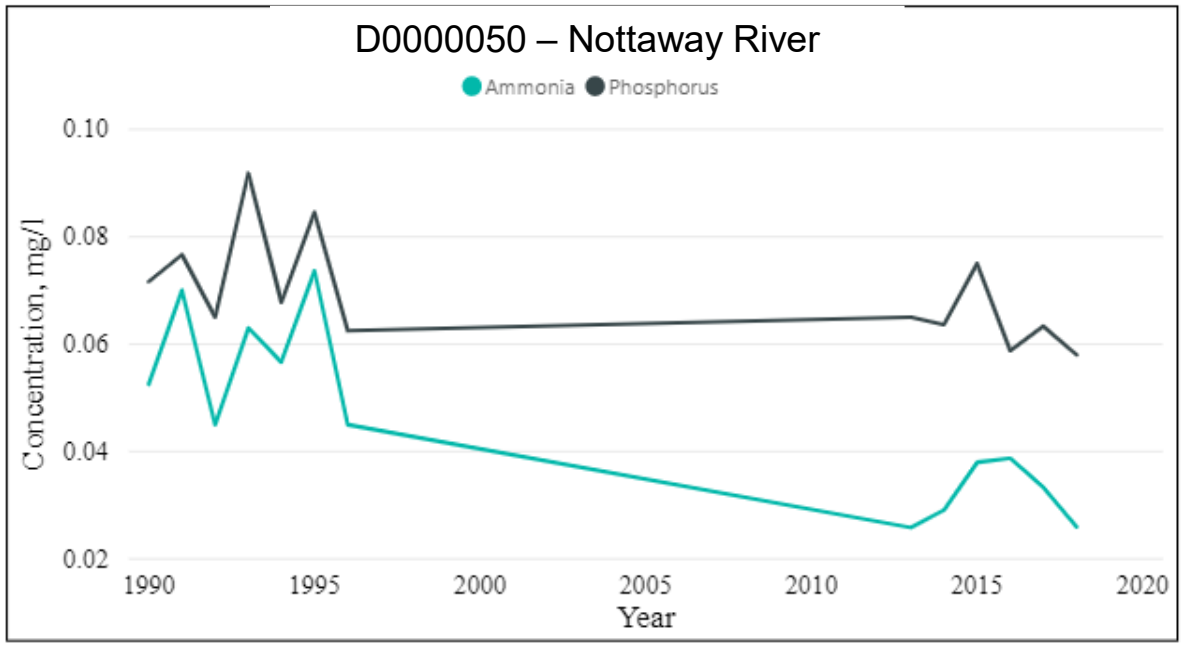
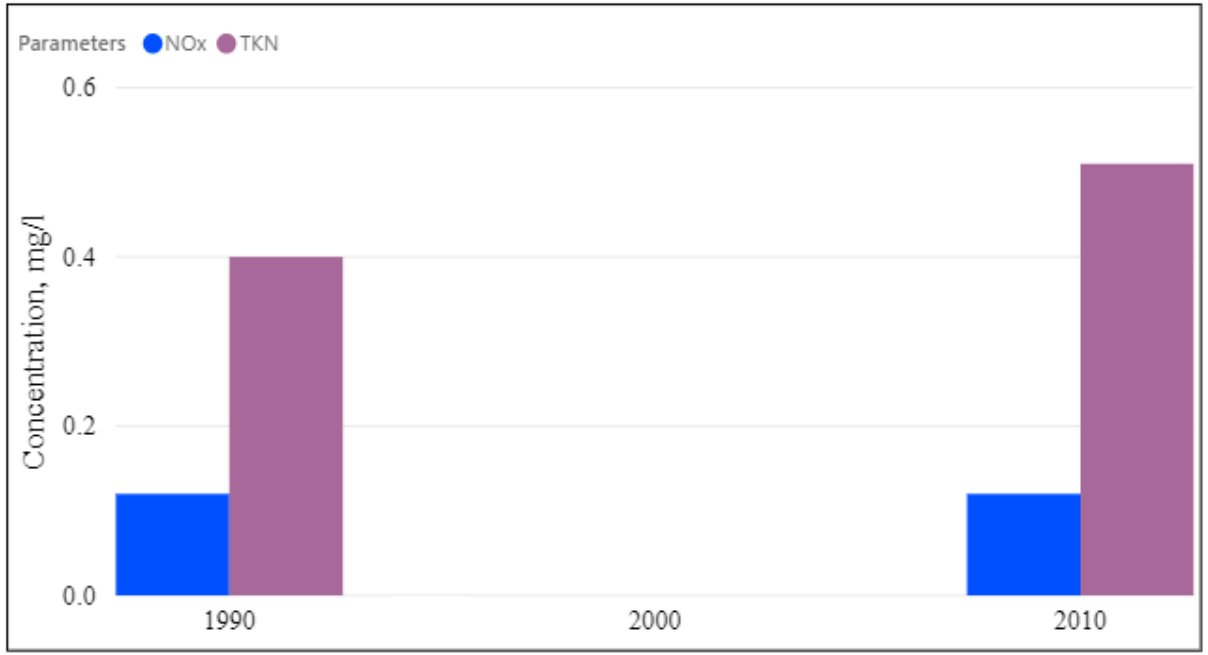
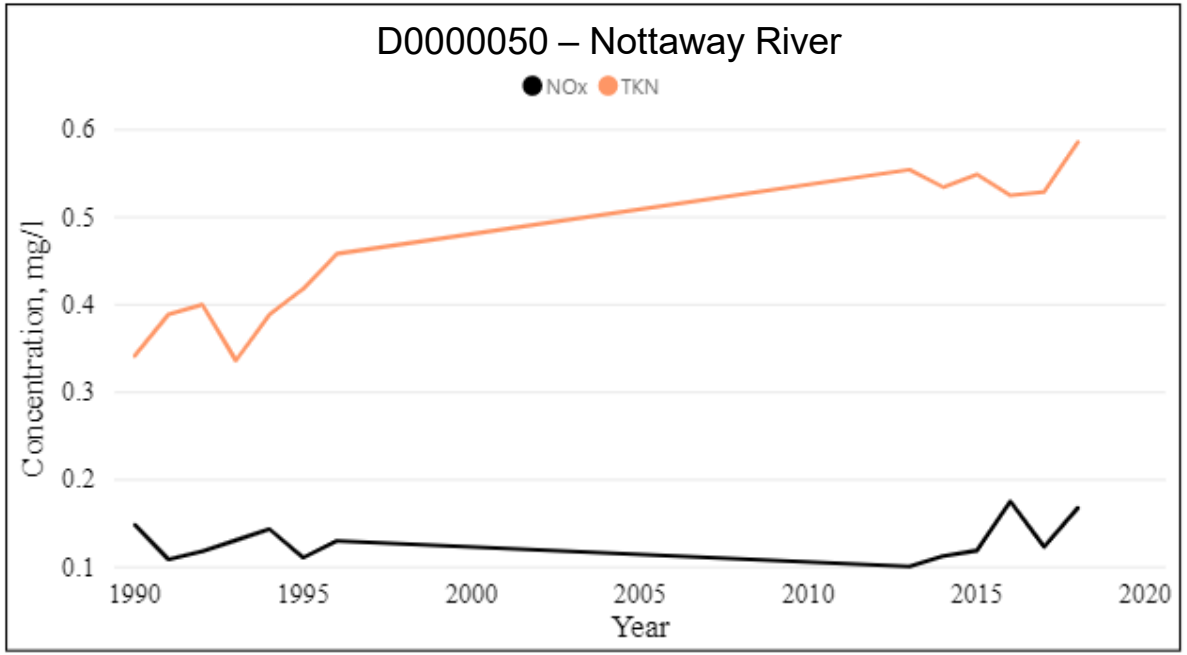
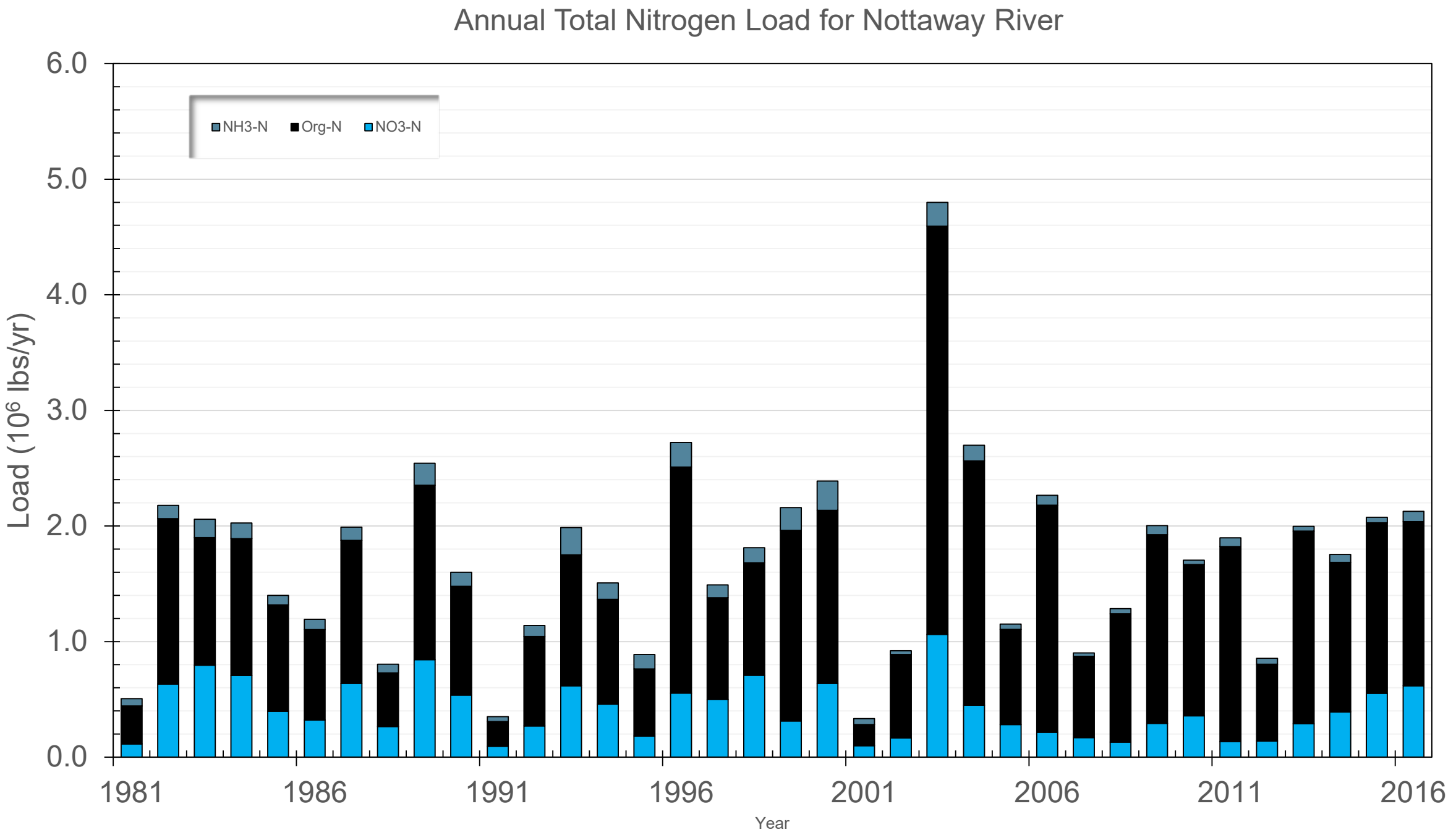
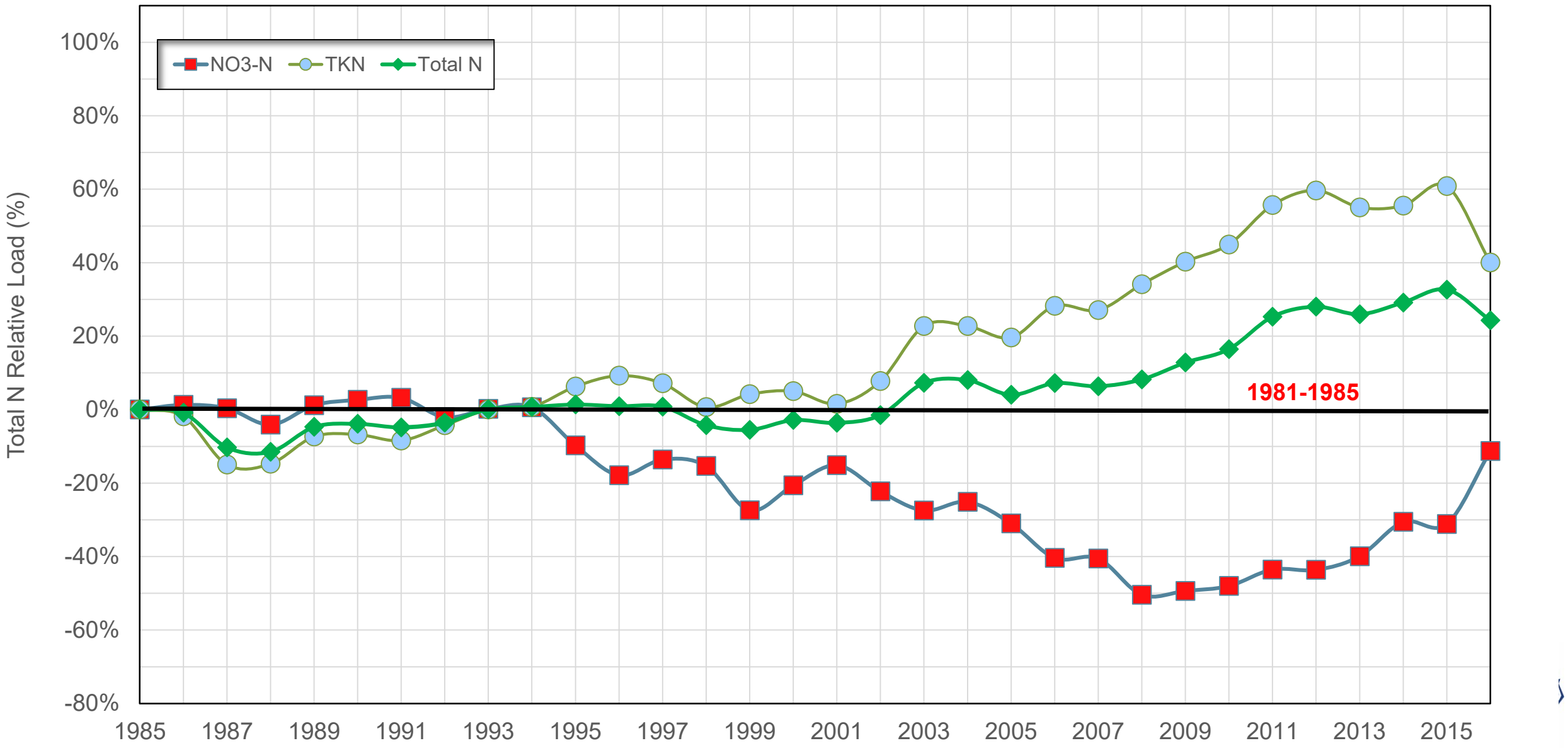
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

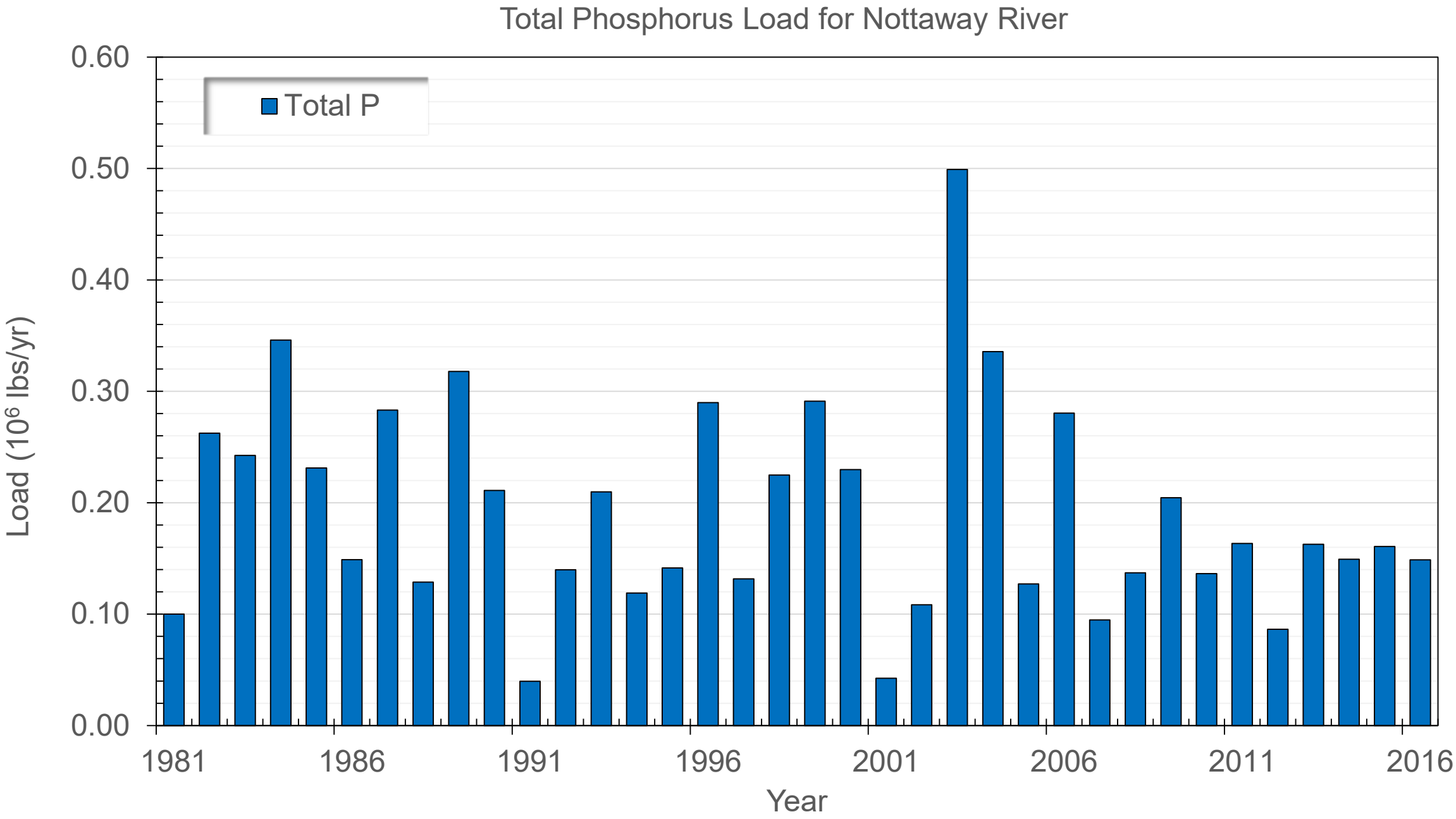

D0000050 – Nottaway River
Ammonia
Phosphorus
0.10
0.08
0.06
0.04
0.02
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

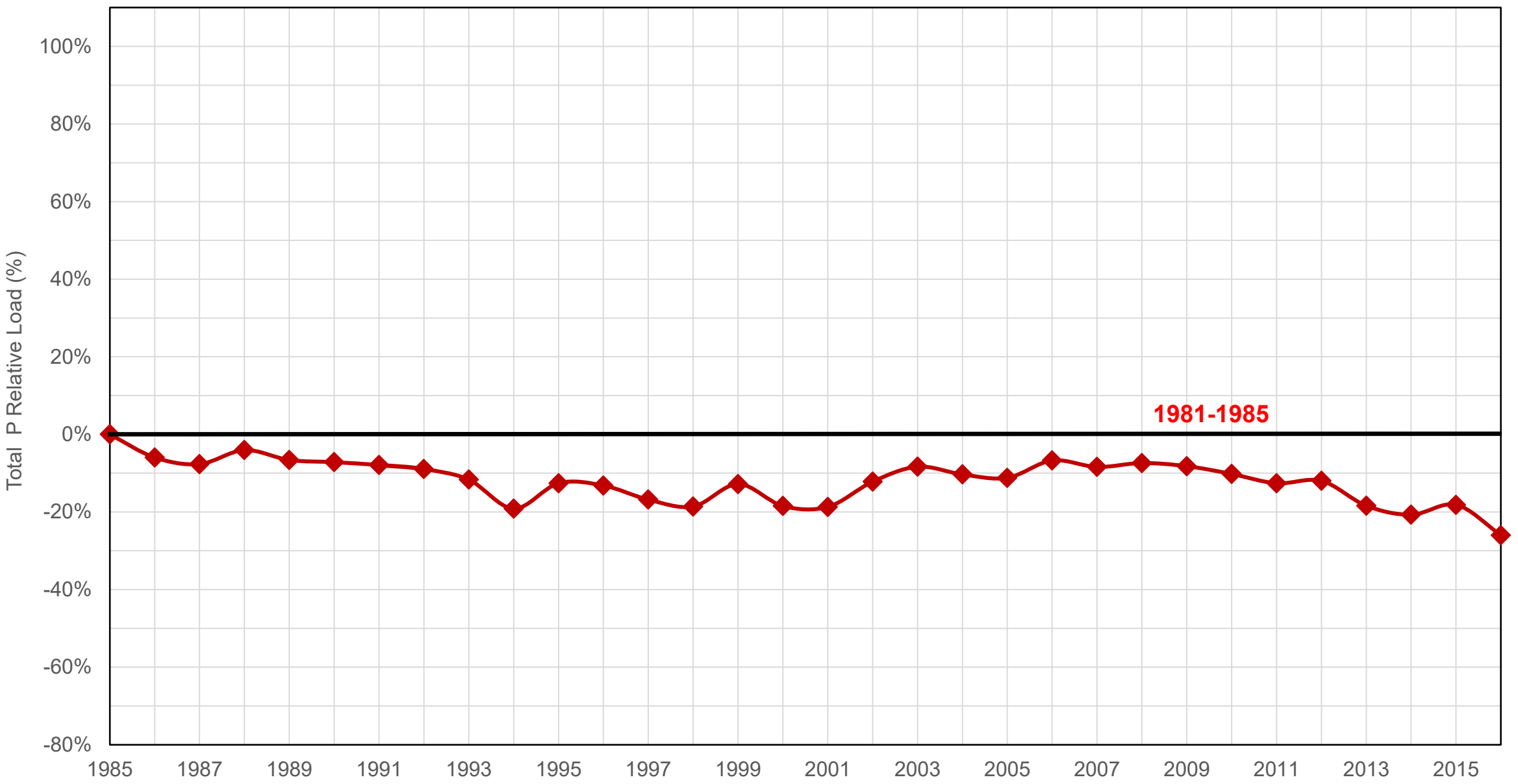

Parameters
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010

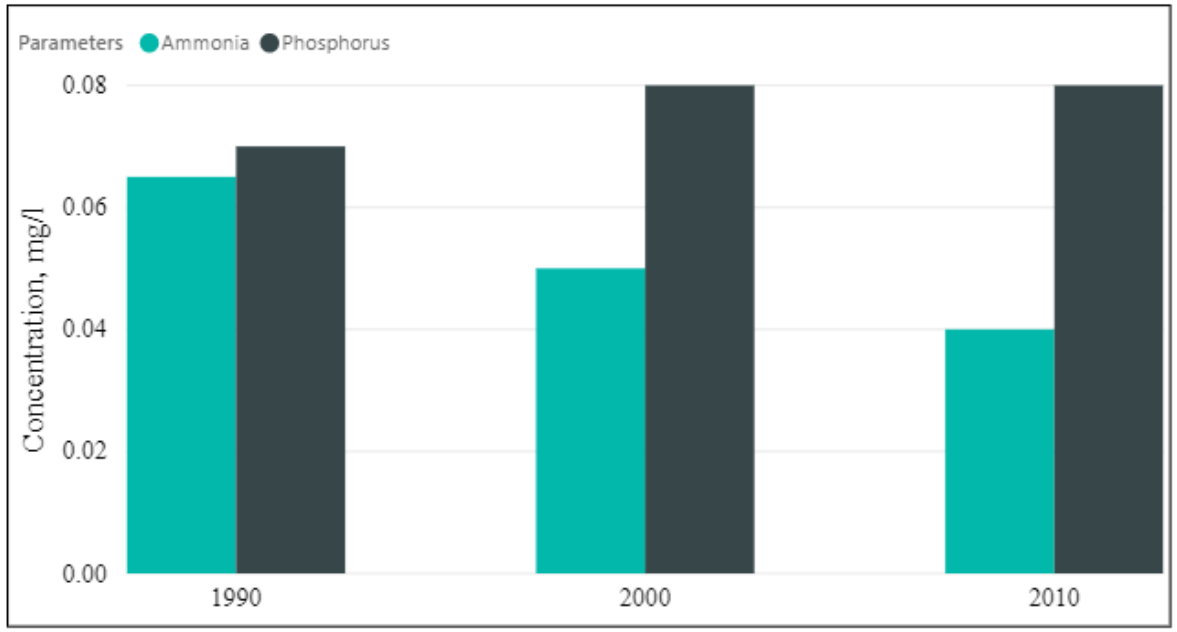

D0000050 – Nottaway River
NOx
TKN
0.6
0.5
0.4
0.3
0.2
0.1
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

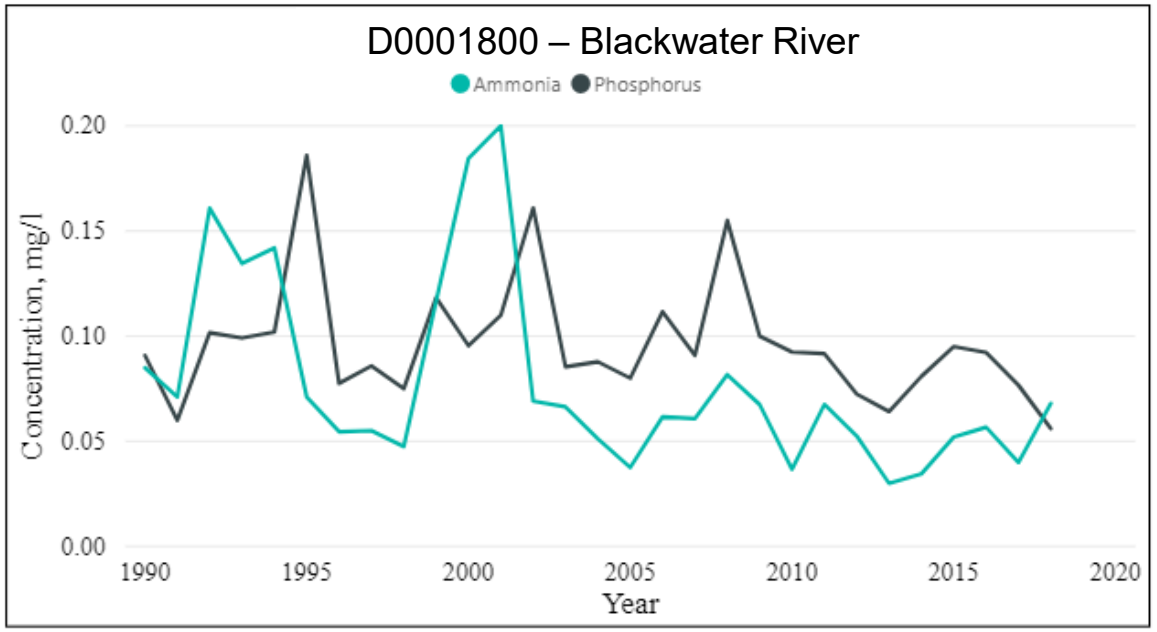

Annual Total Nitrogen Load for Nottaway River
NH3-N
Org-N
NO3-N
Load (10^6 lbs/yr)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1981
1986
1991
1996
2001
2006
2011
2016
Year

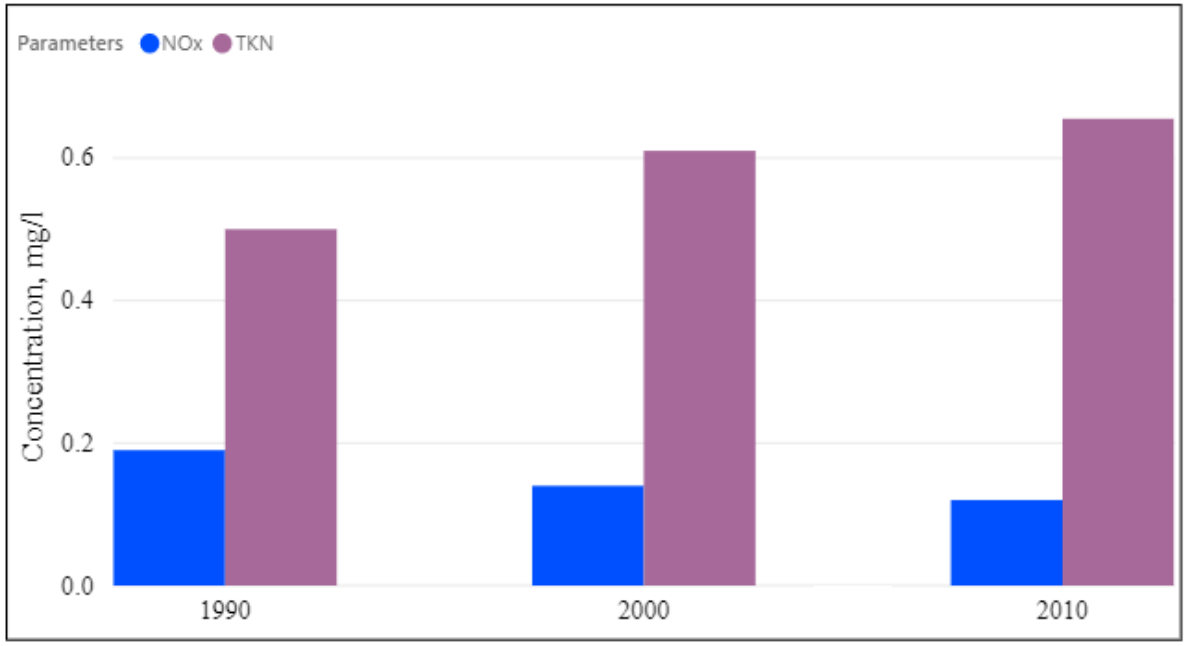

Nitrogen Reduction for Average Flow Condition for Nottoway River, VA - Relative to 1981-1985
NO3-N
TKN
Total N
Total N Relative Load (%)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
1981-1985

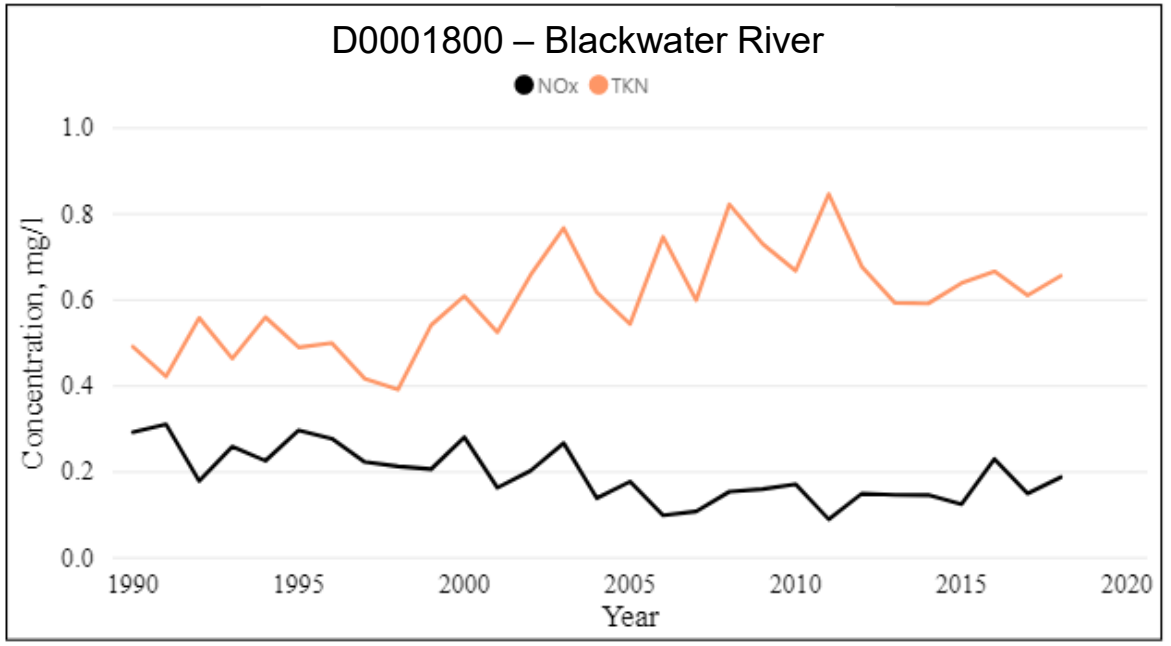

Total Phosphorus Load for Nottaway River
Total P
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Load (10^6 lbs/yr)
1981
1986
1991
1996
2001
2006
2011
2016
Year


Phosphorus Reduction for Average Flow Condition for Nottoway River, VA - relative to 1981-1985
Total P Relative Load (%)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
1981-1985
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

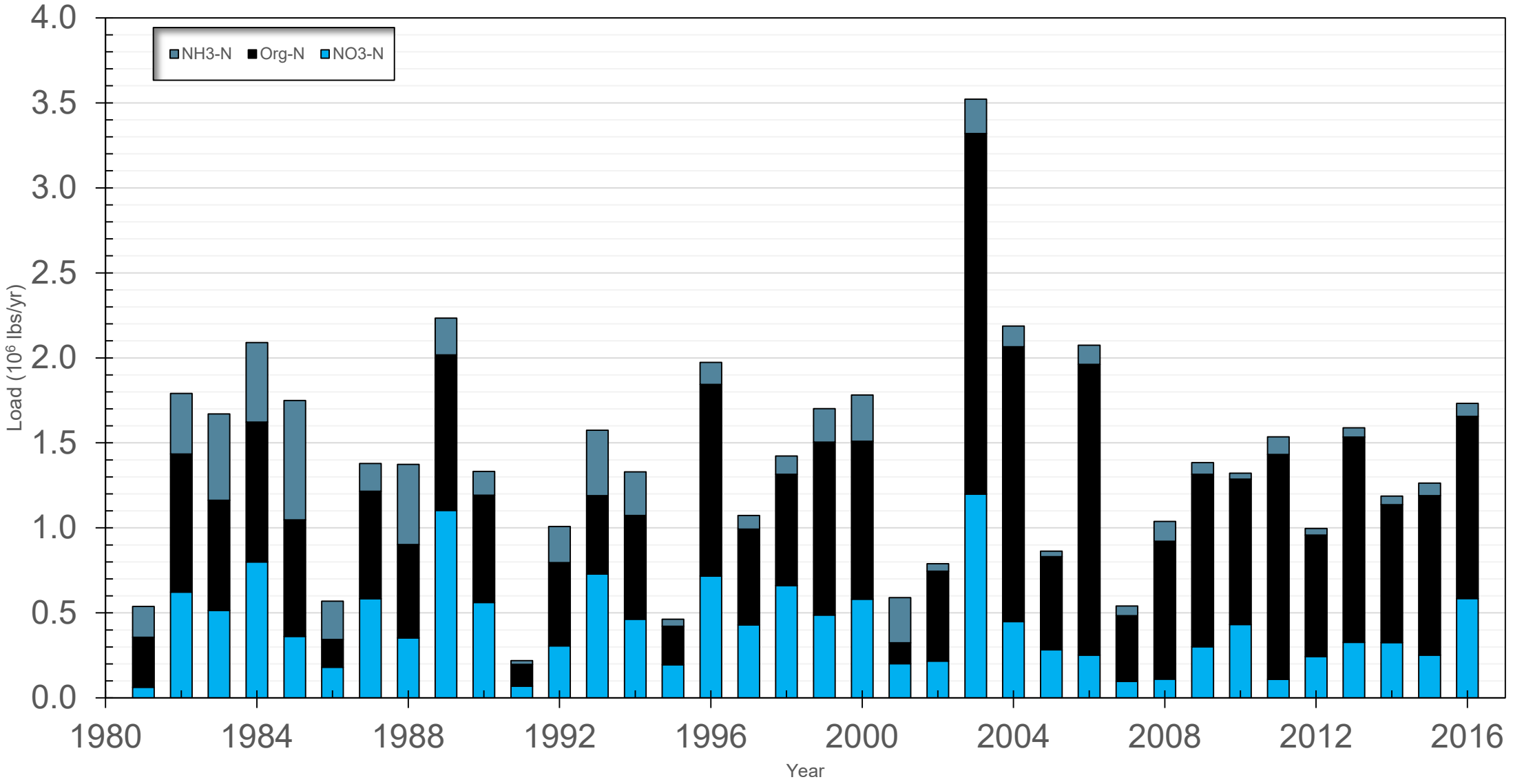

Parameters
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

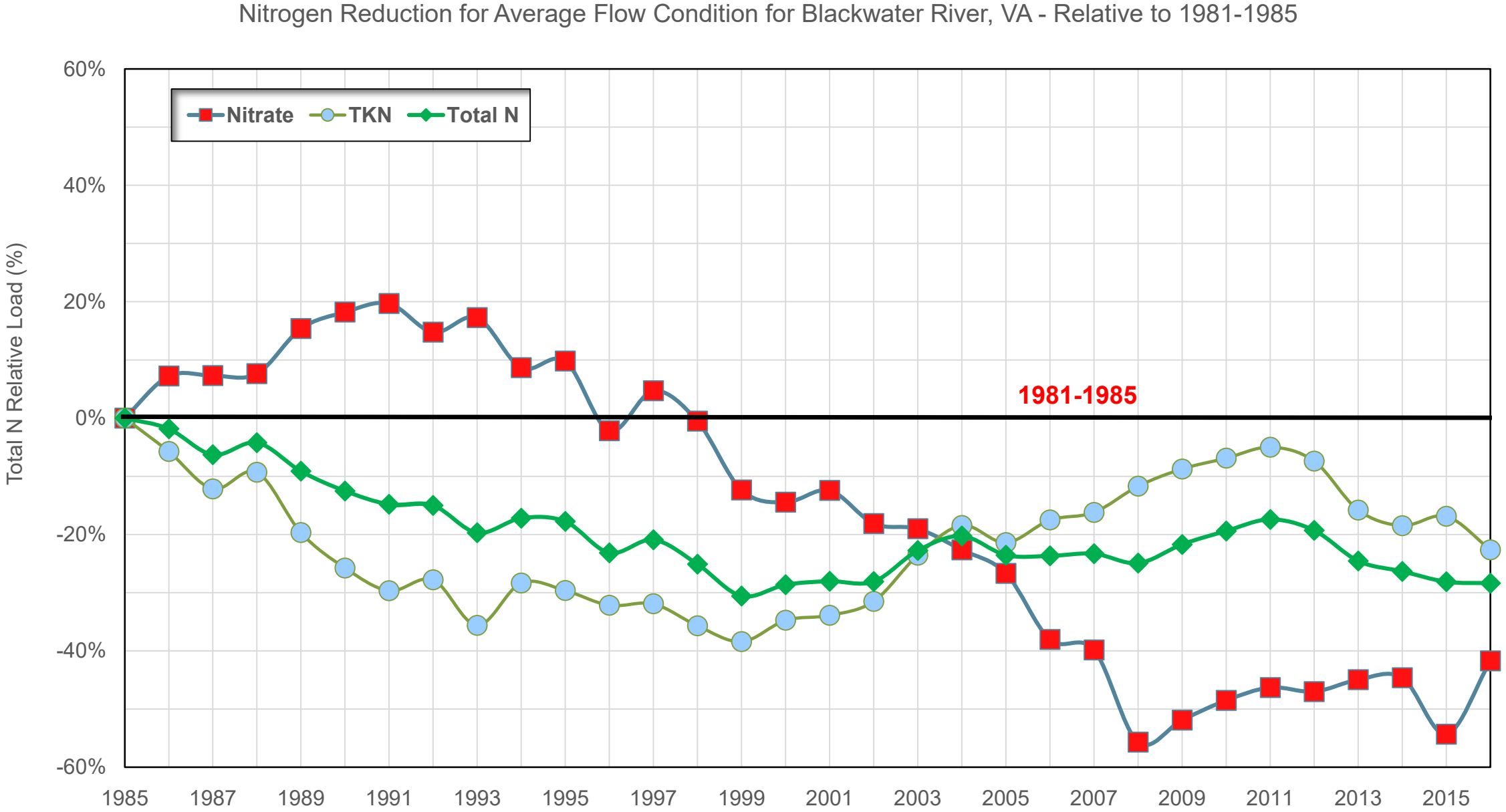

D0001800 – Blackwater River
Ammonia
Phosphorus
0.20
0.15
0.10
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

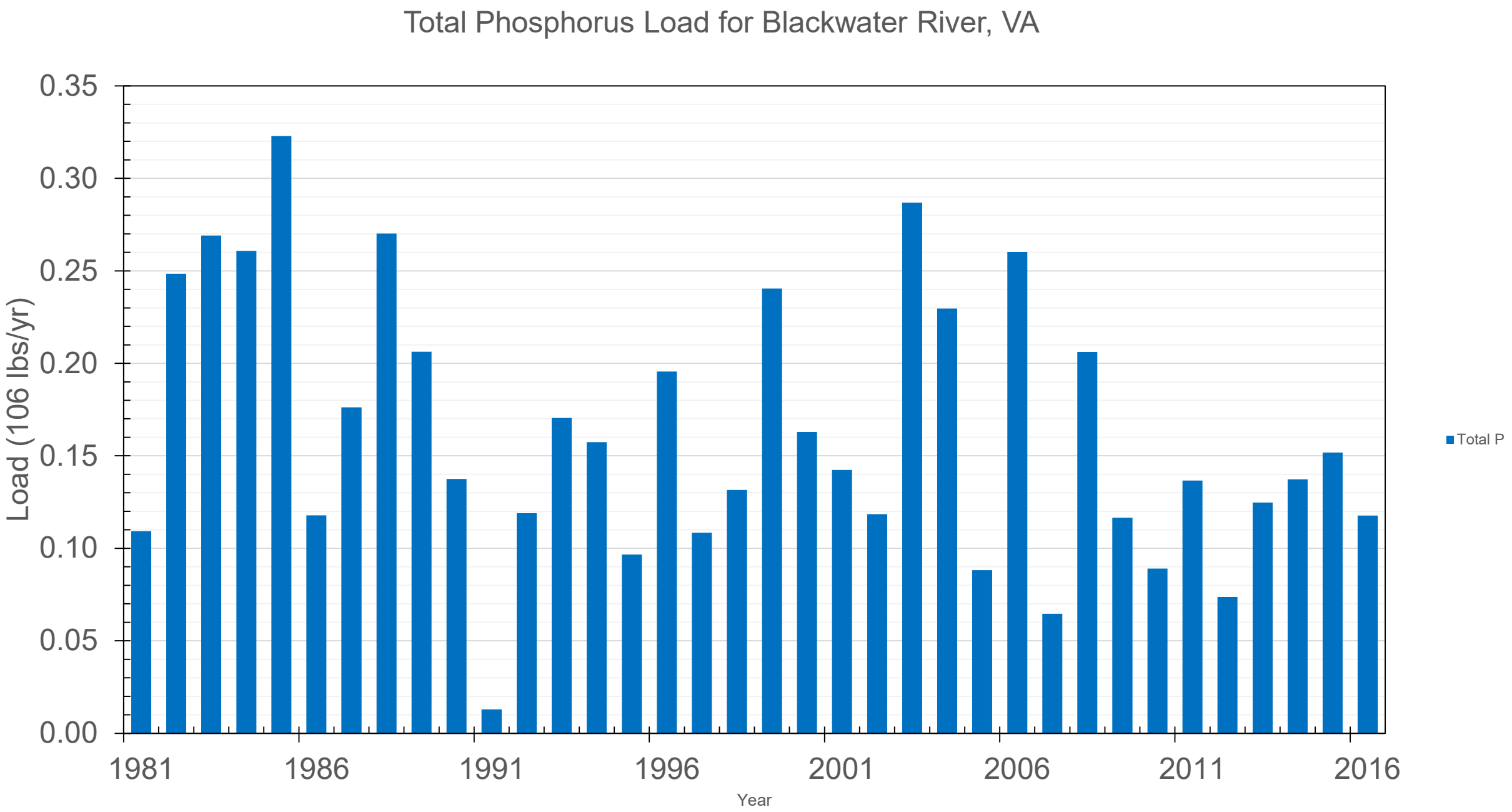

Parameters
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010

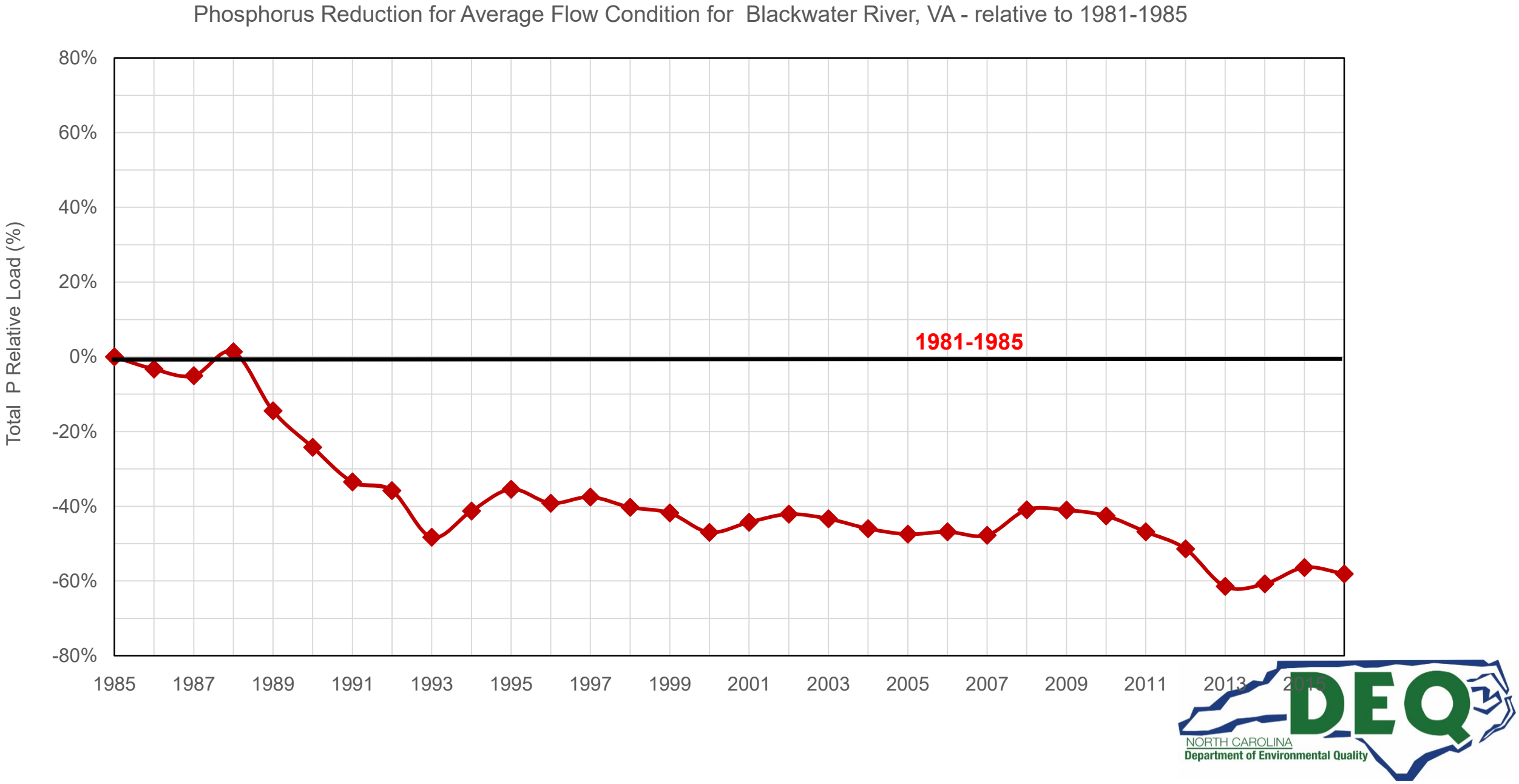

D0001800 – Blackwater River
NOx
TKN
1.0
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

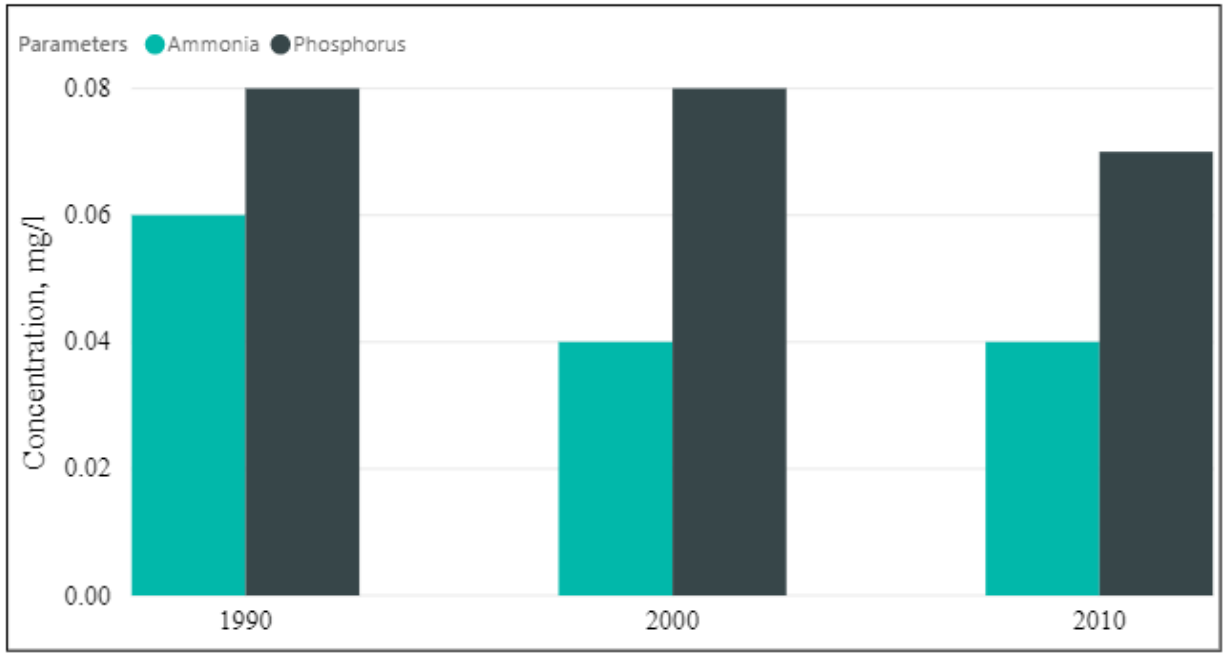
Annual Total Nitrogen Load for Blackwater River, VA

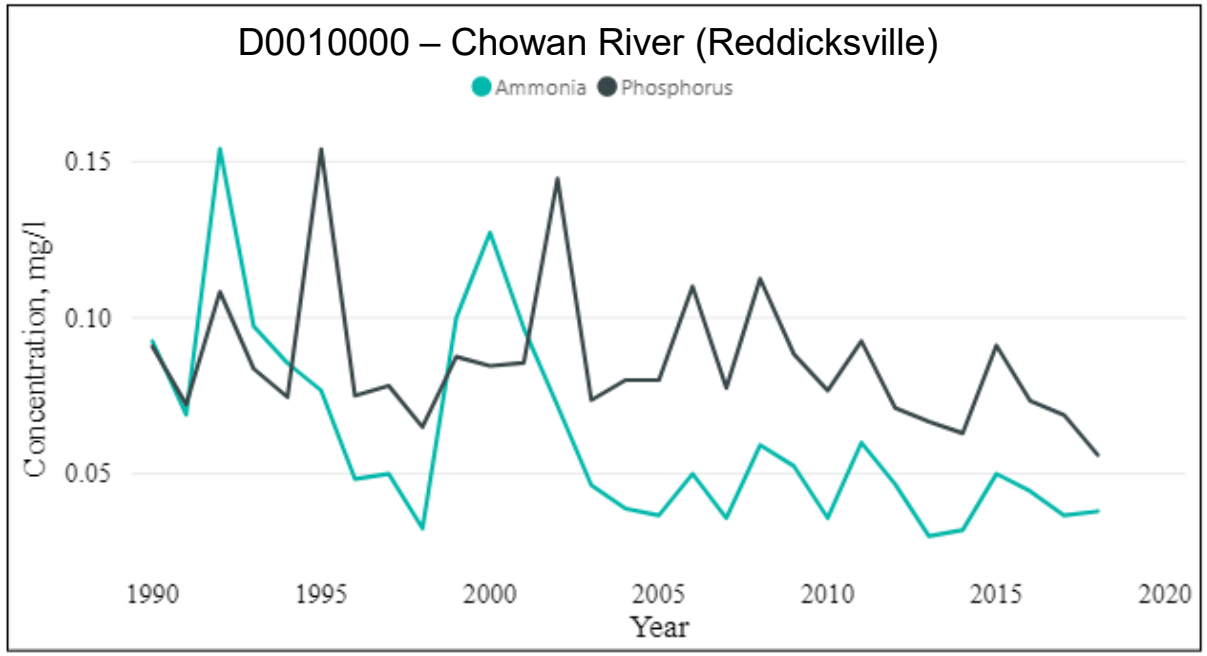


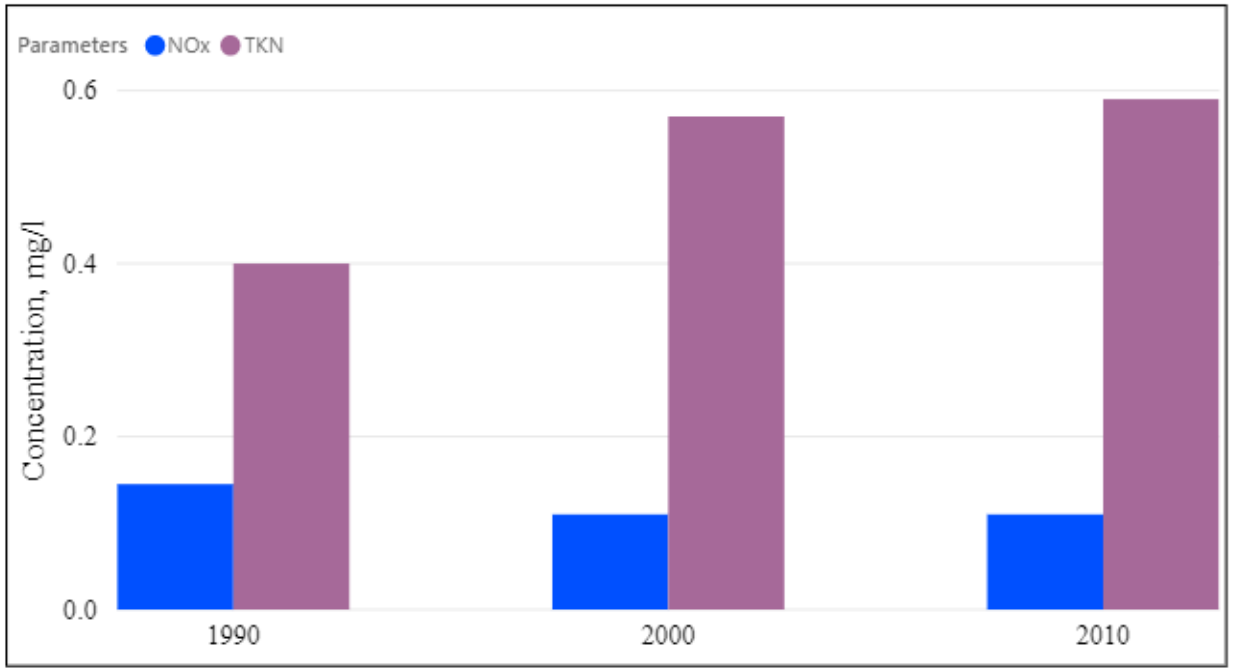

Nitrogen Reduction for Average Flow Condition for Blackwater River, VA - Relative to 1981-1985
Nitrate
TKN
Total N
1981-1985
Total N Relative Load (%)
60%
40%
20%
0%
-20%
-40%
-60%
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

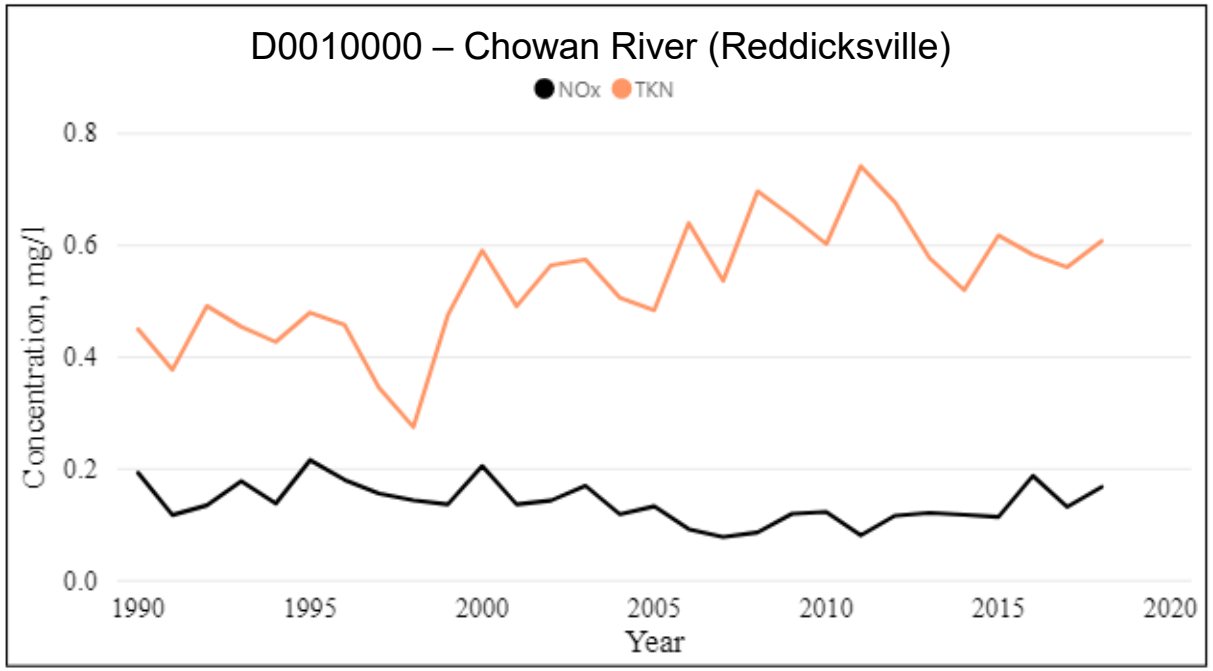

Total Phosphorus Load for Blackwater River, VA
Load (106 lbs/yr)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1981
1986
1991
1996
2001
2006
2011
2016
Year
Total P

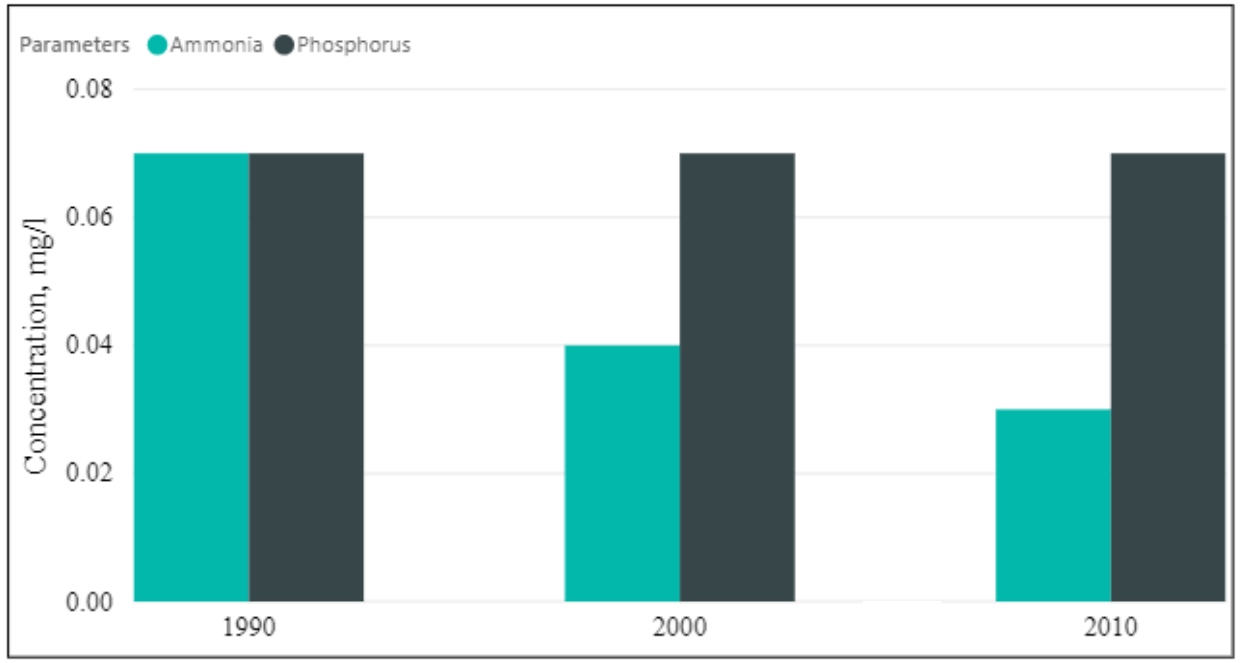

Phosphorus Reduction for Average Flow Condition for Blackwater River, VA - relative to 1981-1985
Total P Relative Load (%)
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
1981-1985
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

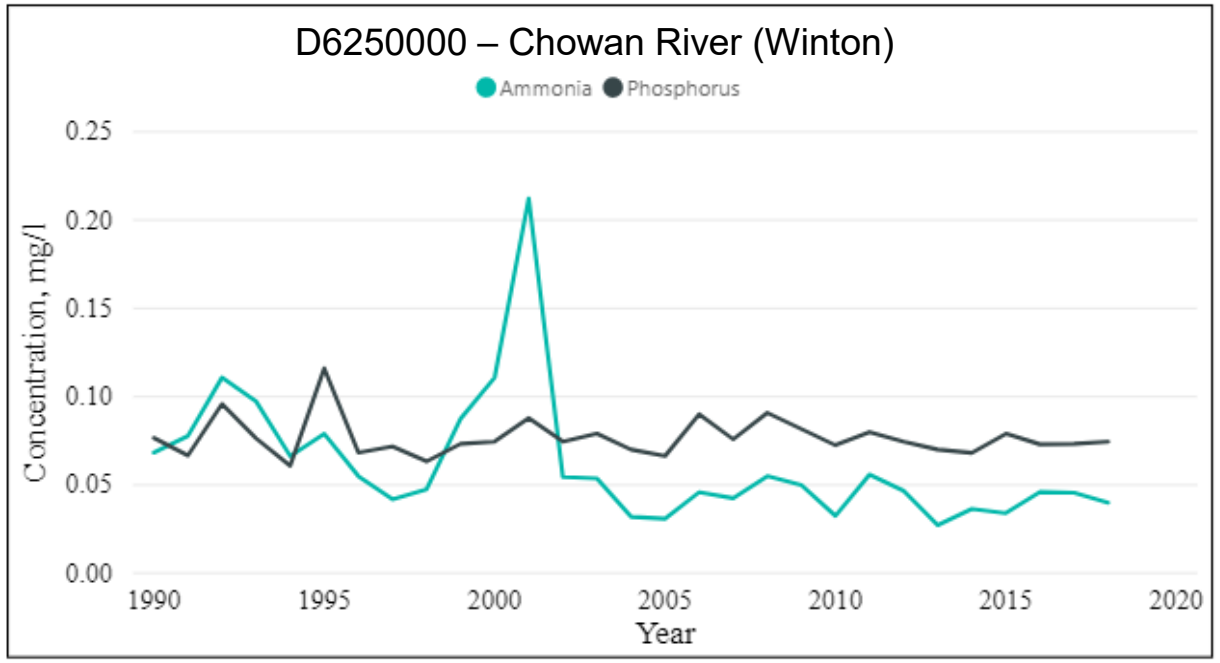

Parameters
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

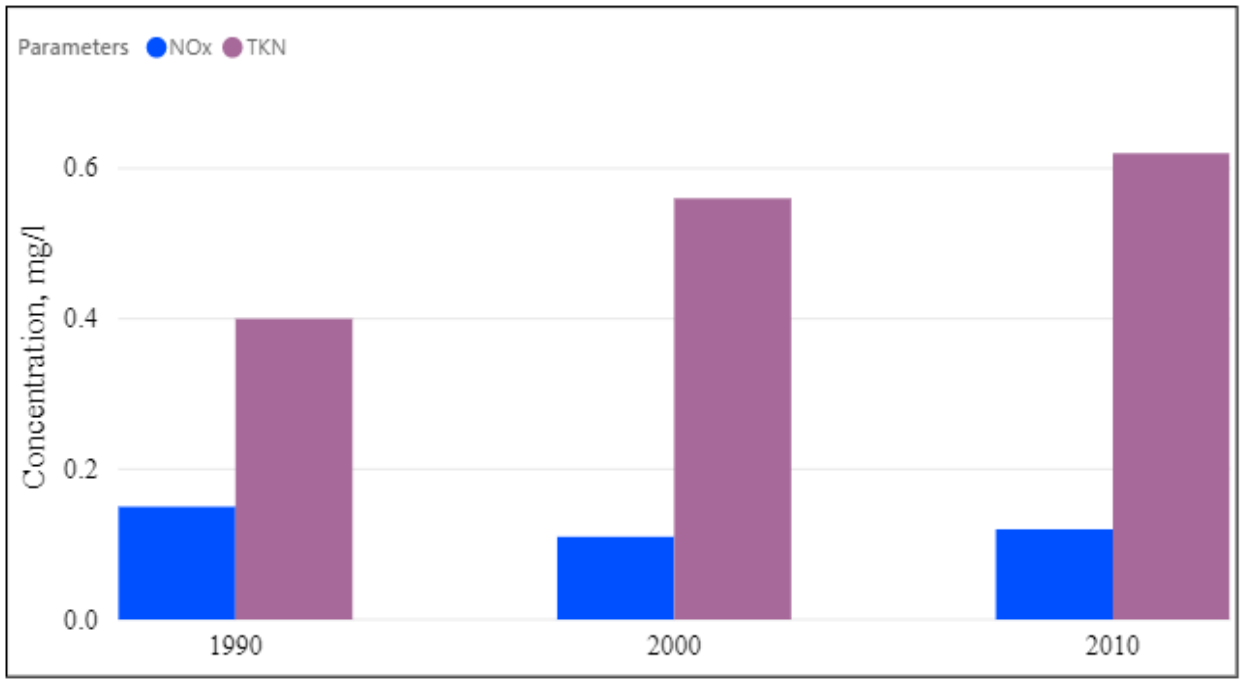

D0010000 – Chowan River (Reddicksville)
Ammonia
Phosphorus
0.15
0.10
0.05
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

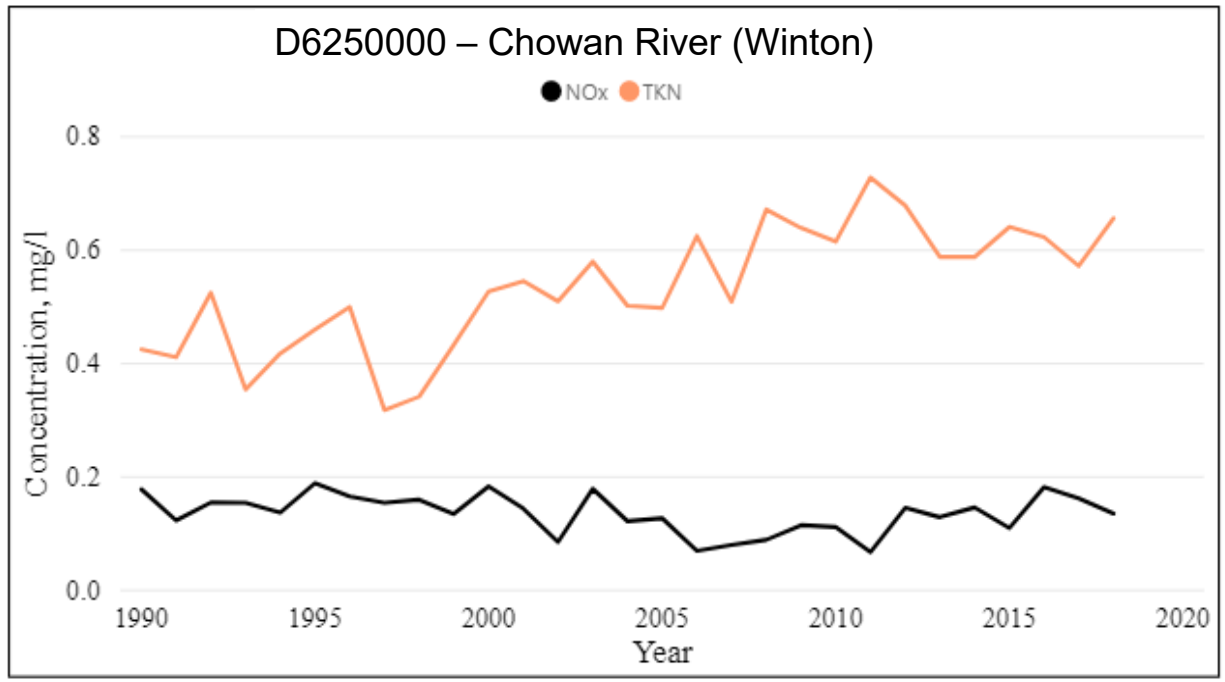

Parameters
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010

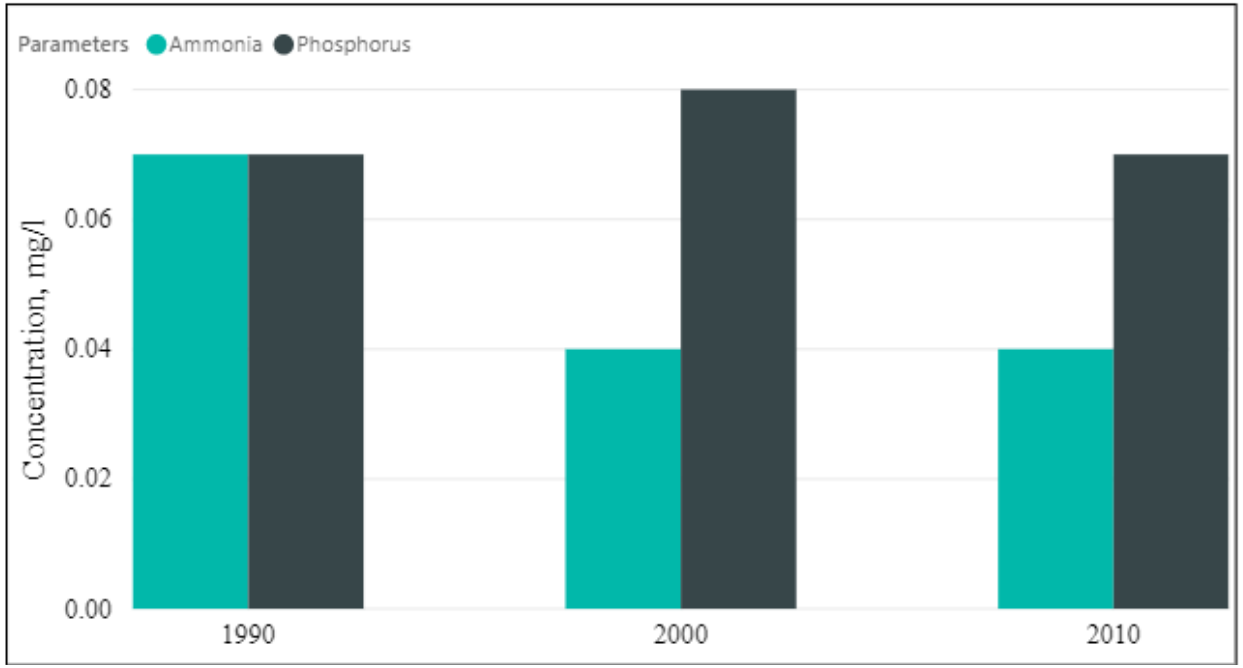

D0010000 – Chowan River (Reddicksville)
NOx
TKN
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

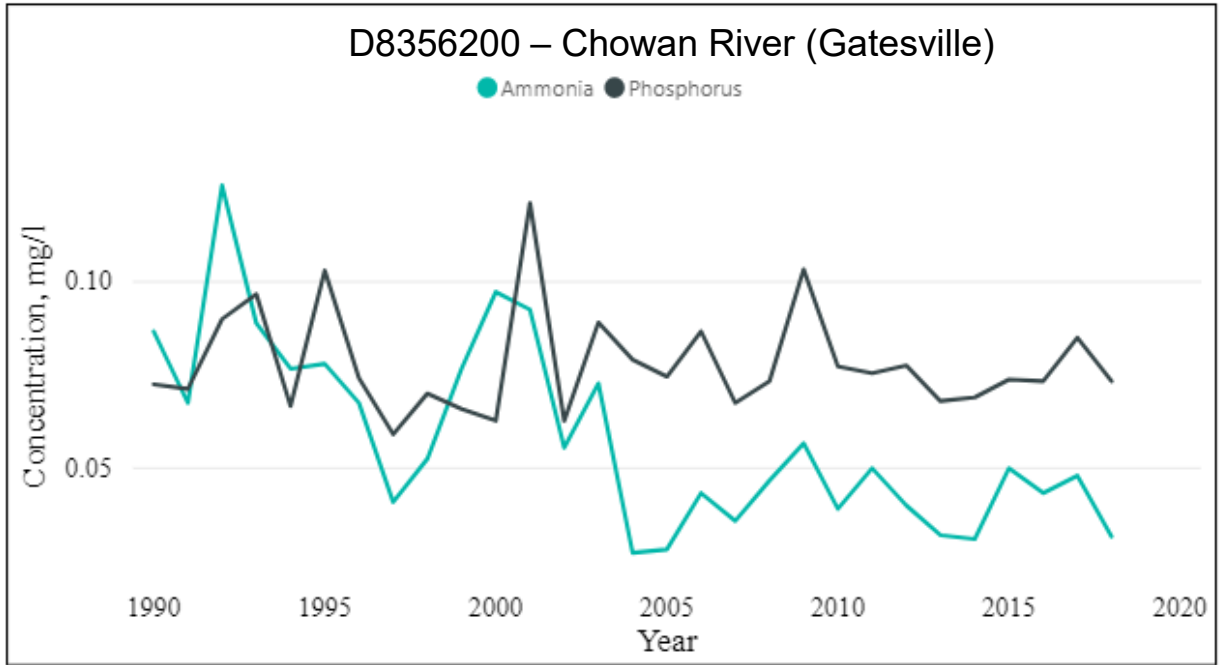

Parameters
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

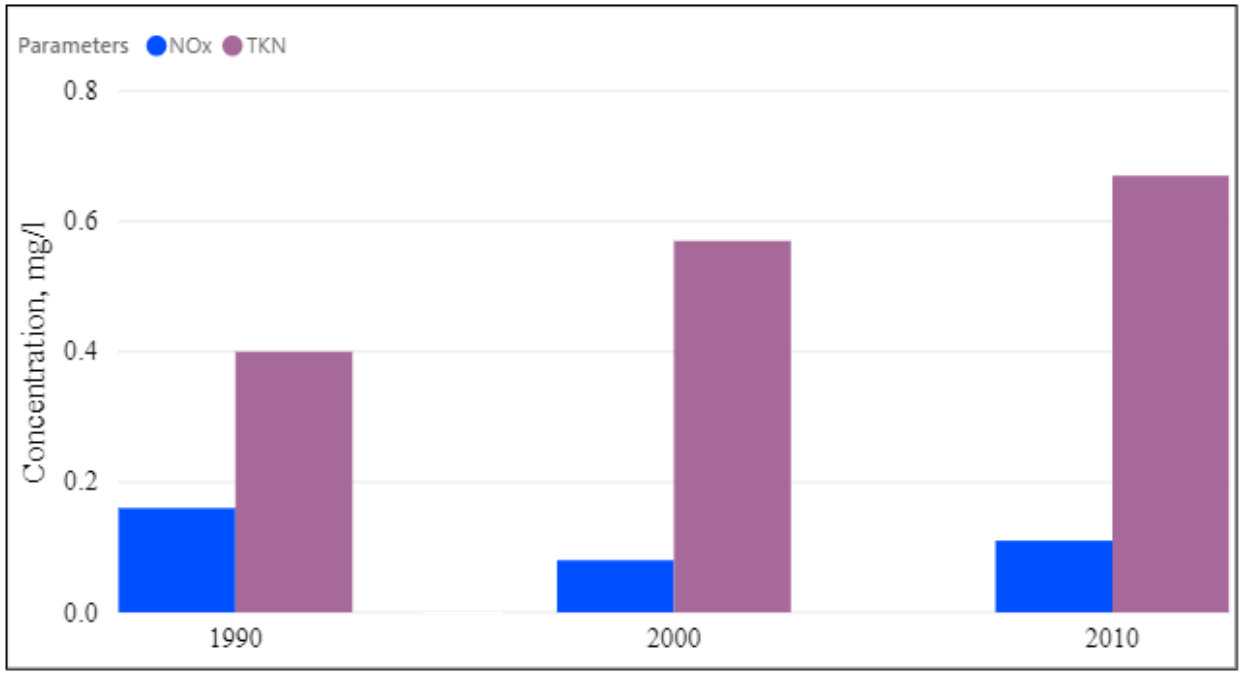

D6250000 – Chowan River (Winton)
Ammonia
Phosphorus
0.25
0.20
0.15
0.10
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

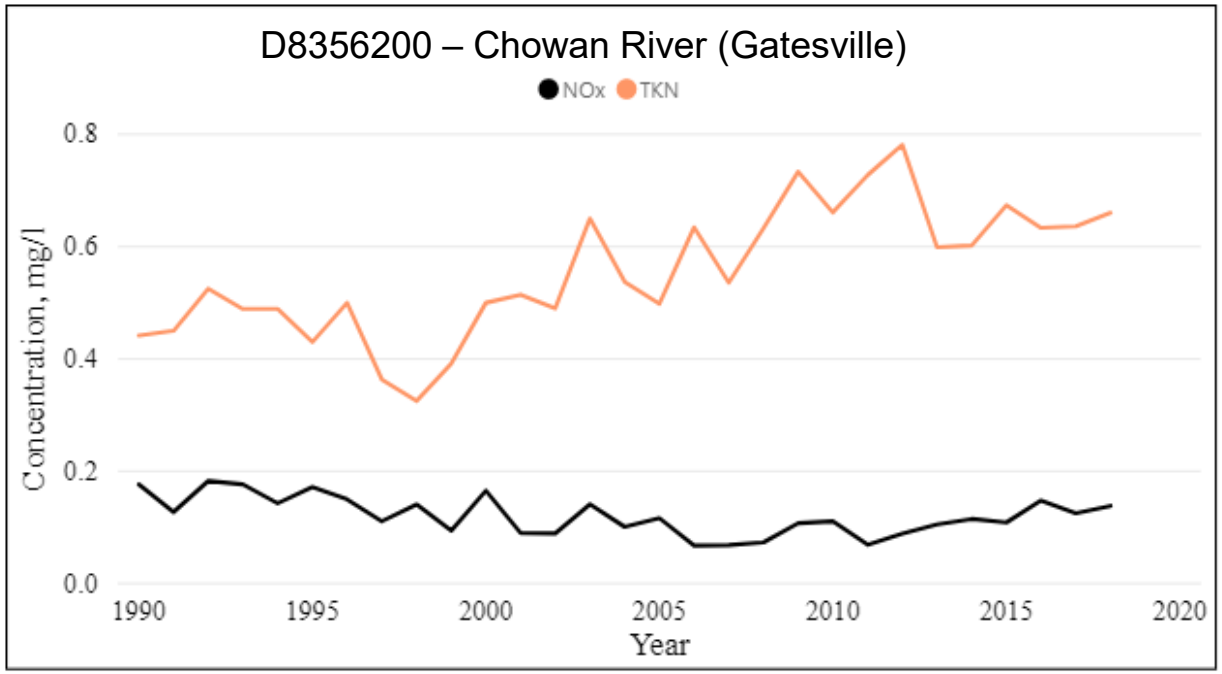

Parameters
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010

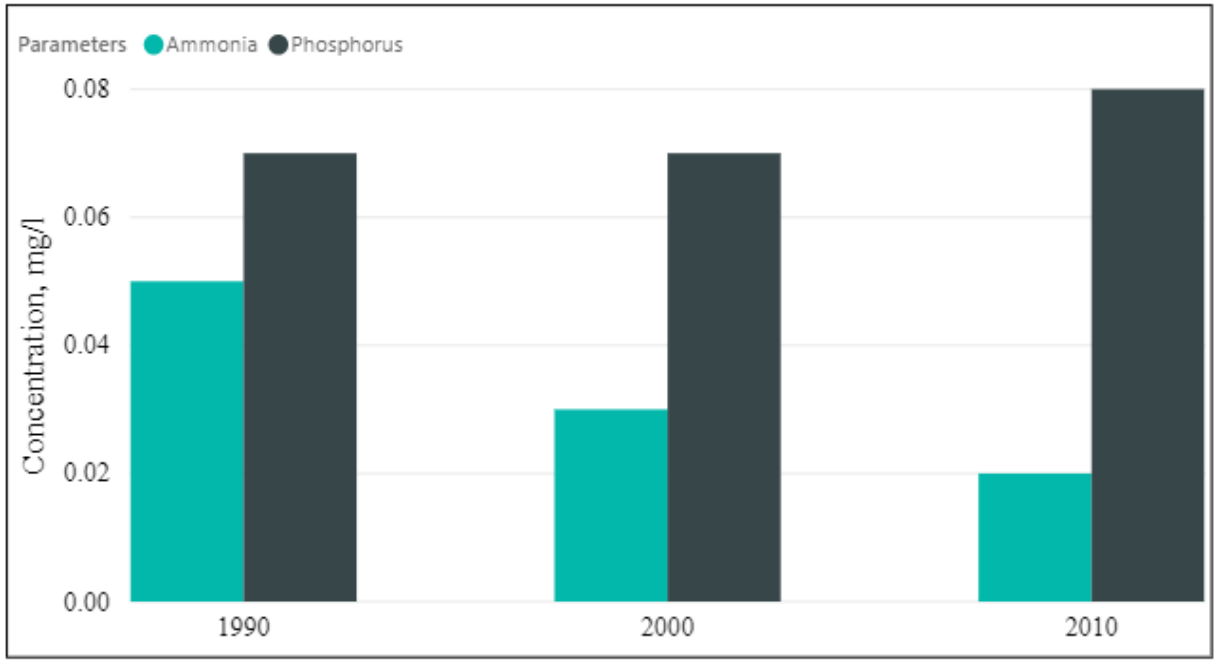

D6250000 – Chowan River (Winton)
NOx
TKN
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

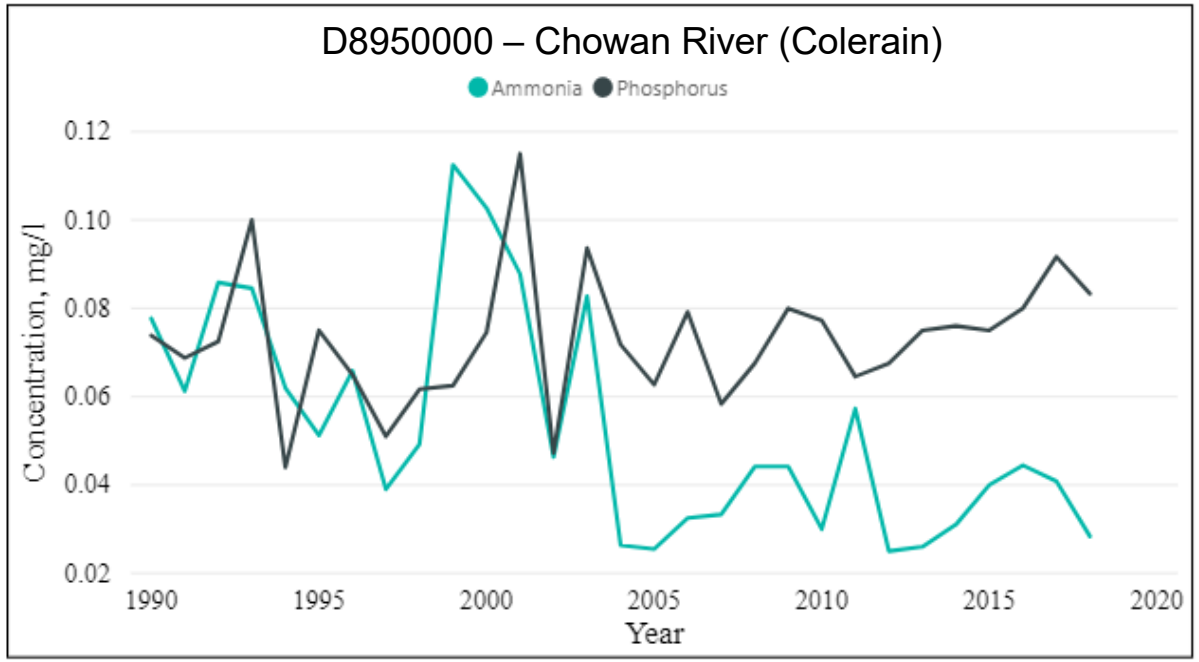

Parameters
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

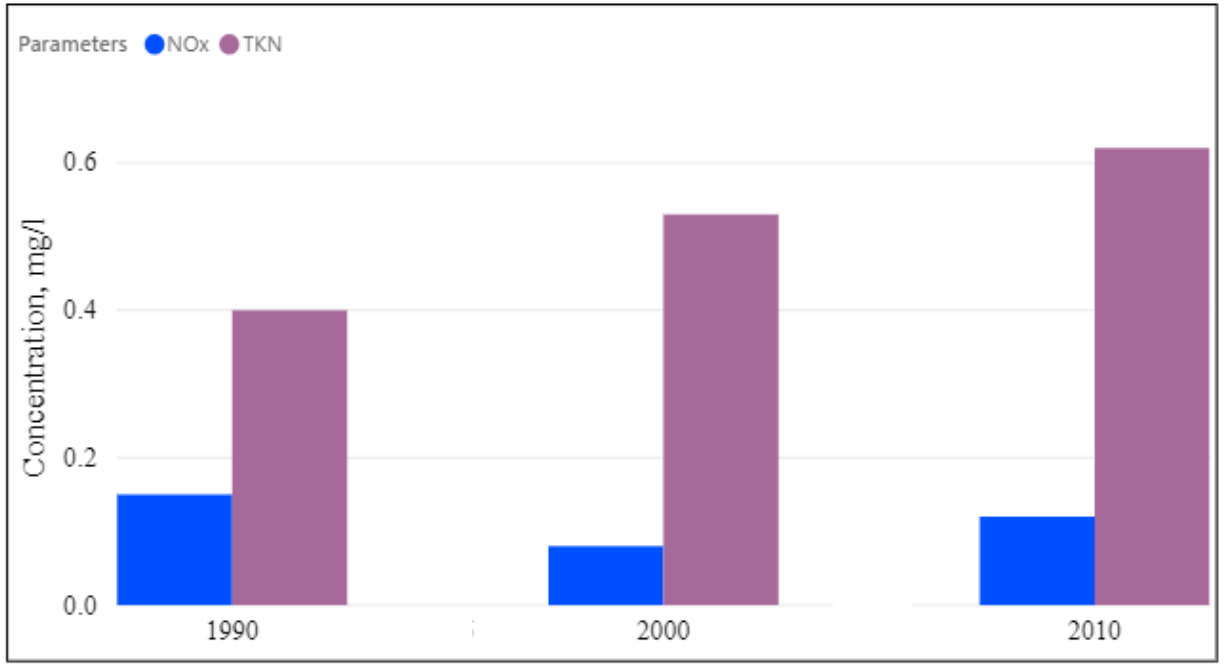

D8356200 – Chowan River (Gatesville)
Ammonia
Phosphorus
0.10
0.05
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

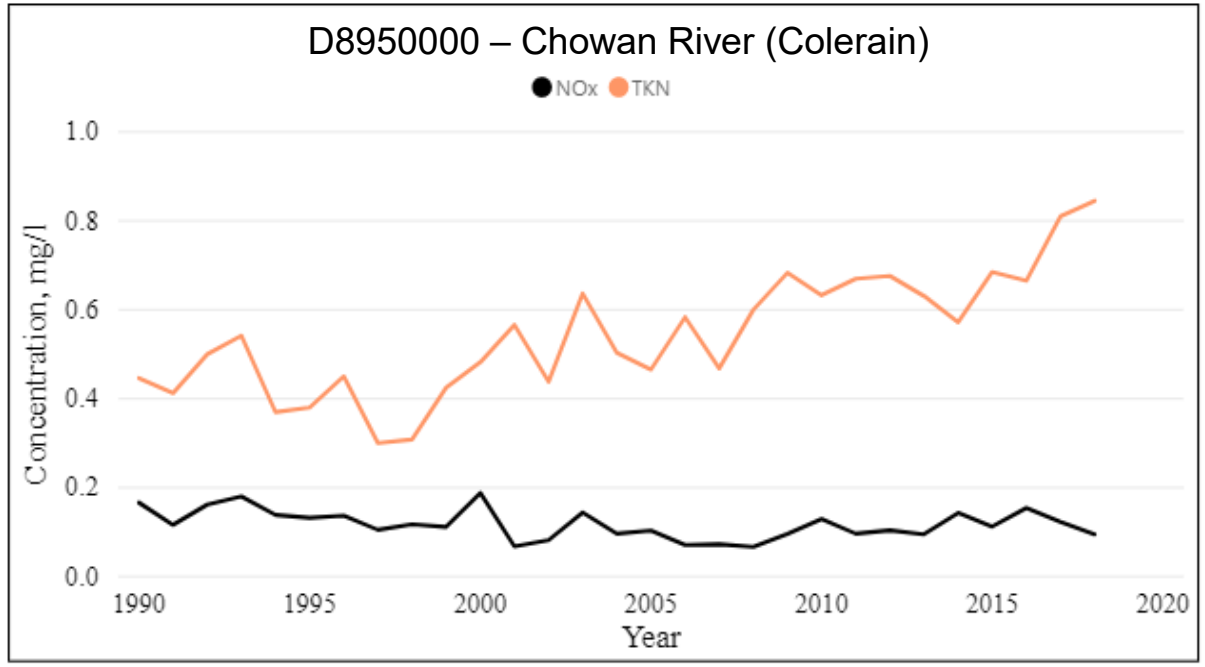

Parameters
NOx
TKN
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010

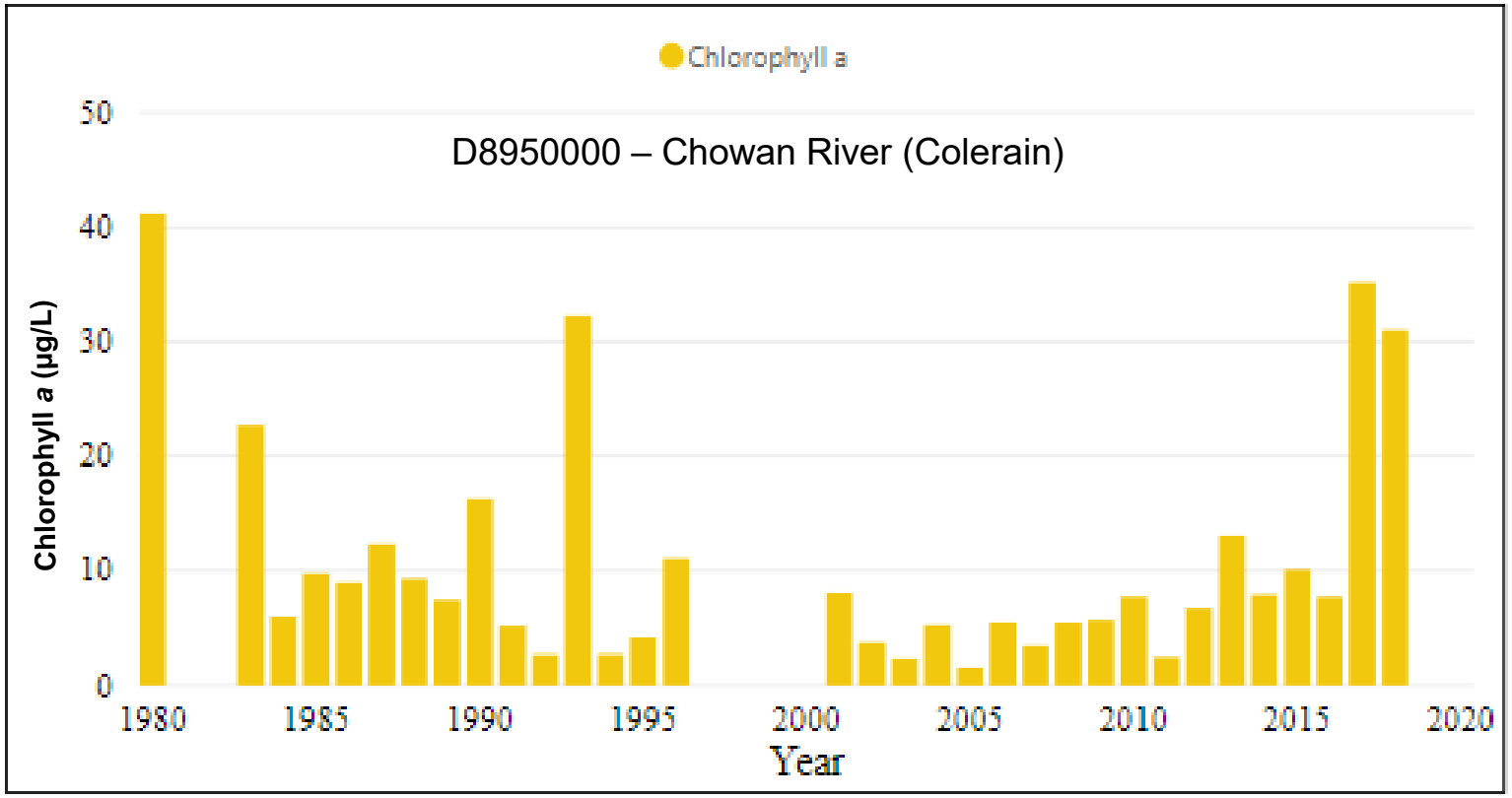

D8356200 – Chowan River (Gatesville)
NOx
TKN
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

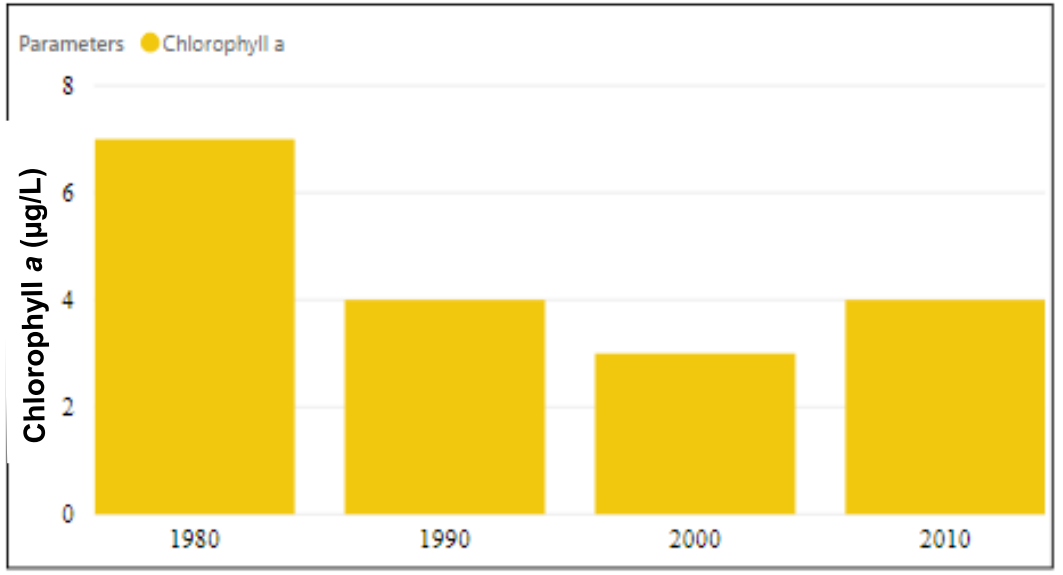

Parameters
Ammonia
Phosphorus
0.08
0.06
0.04
0.02
0.00
Concentration, mg/l
1990
2000
2010

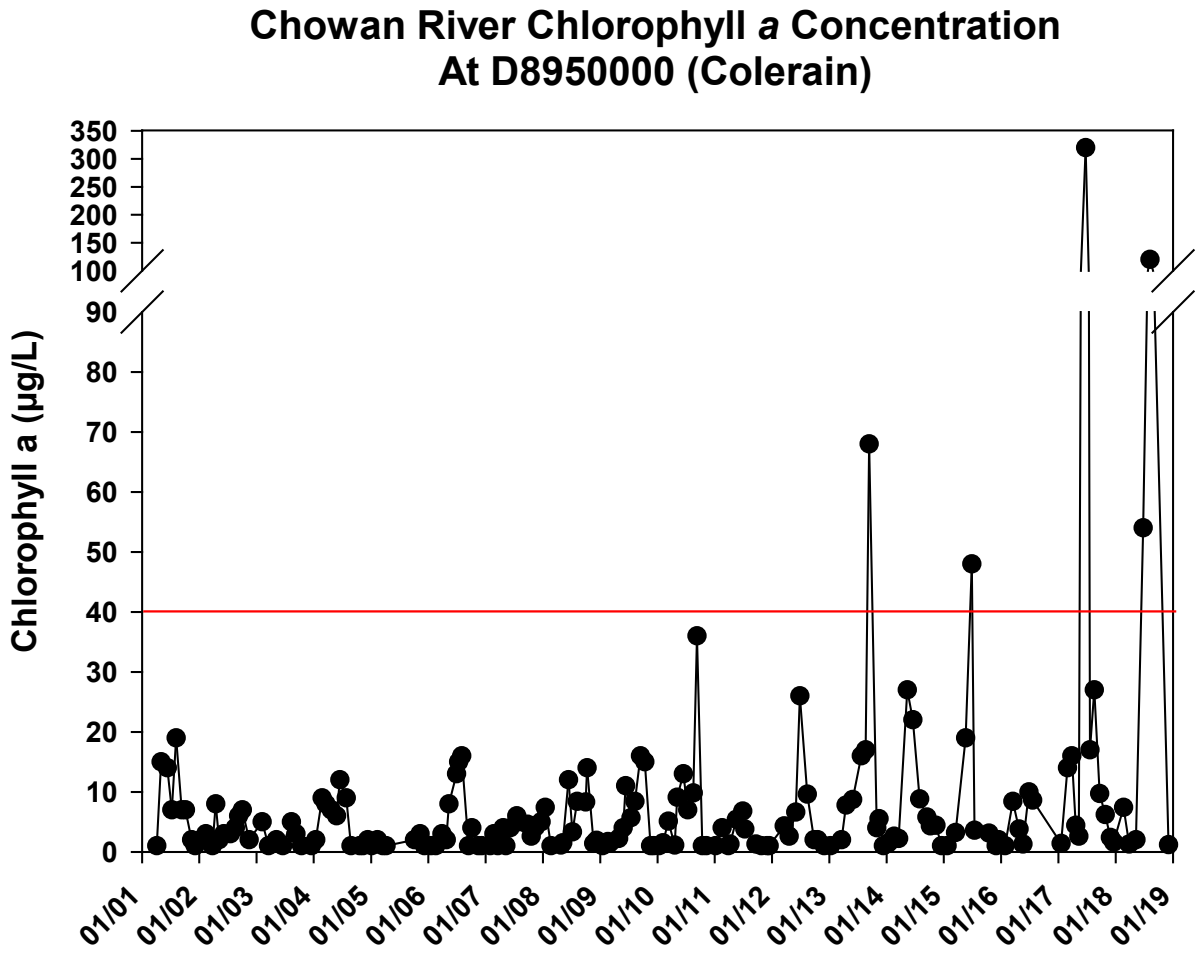

D8950000 – Chowan River (Colerain)
Ammonia
Phosphorus
0.12
0.10
0.08
0.06
0.04
0.02
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


Parameters
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
2000
2010


D8950000 – Chowan River (Colerain)
NOx
TKN
1.0
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


Chlorophyll a
D8950000 – Chowan River (Colerain)
Chlorophyll a (µg/L)
50
40
30
20
10
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year


Parameters
Chlorophyll a
Chlorophyll a (µg/L)
8
6
4
2
0
1980
1990
2000
2010



IR period	2016	2018	2020
Mean Chl *a* Conc. (µg/L)	7.6	9.0	16.5
Number of samples	50	42	42
n > 40 µg/L Chl *a*	1	2	5
% > 40 µg/L	2	4.8	11.9
Data Window	2010 - 2014	2012 - 2016	2014 - 2018

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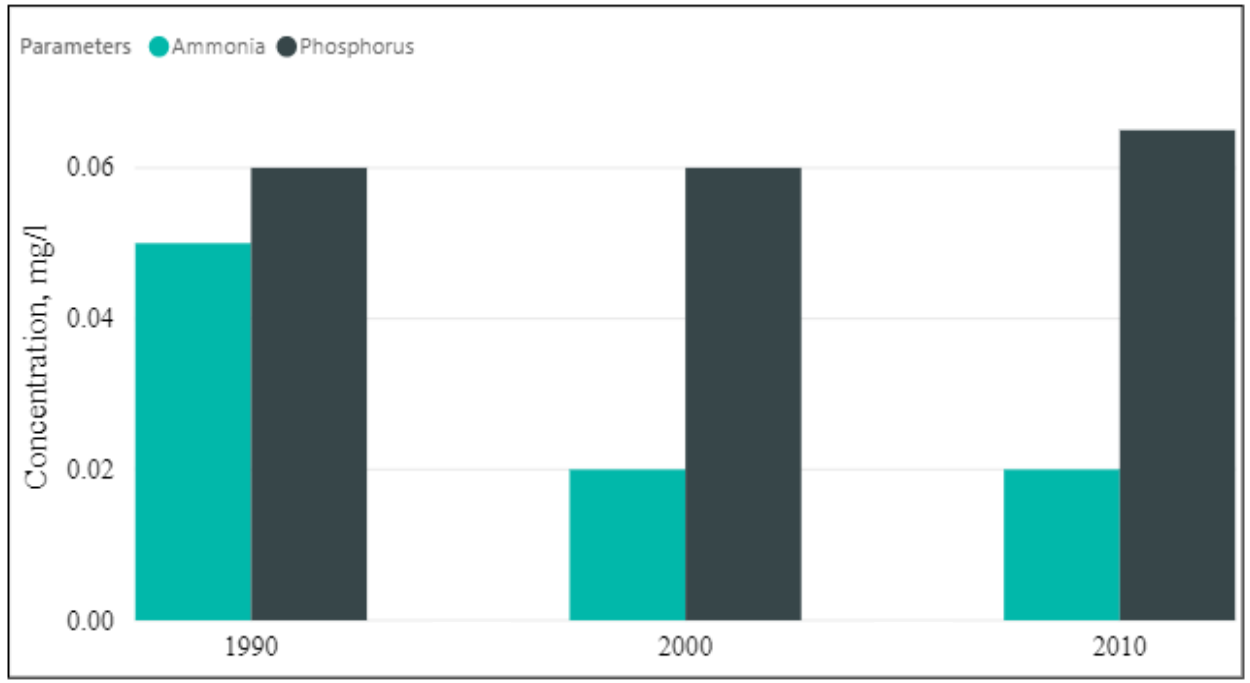
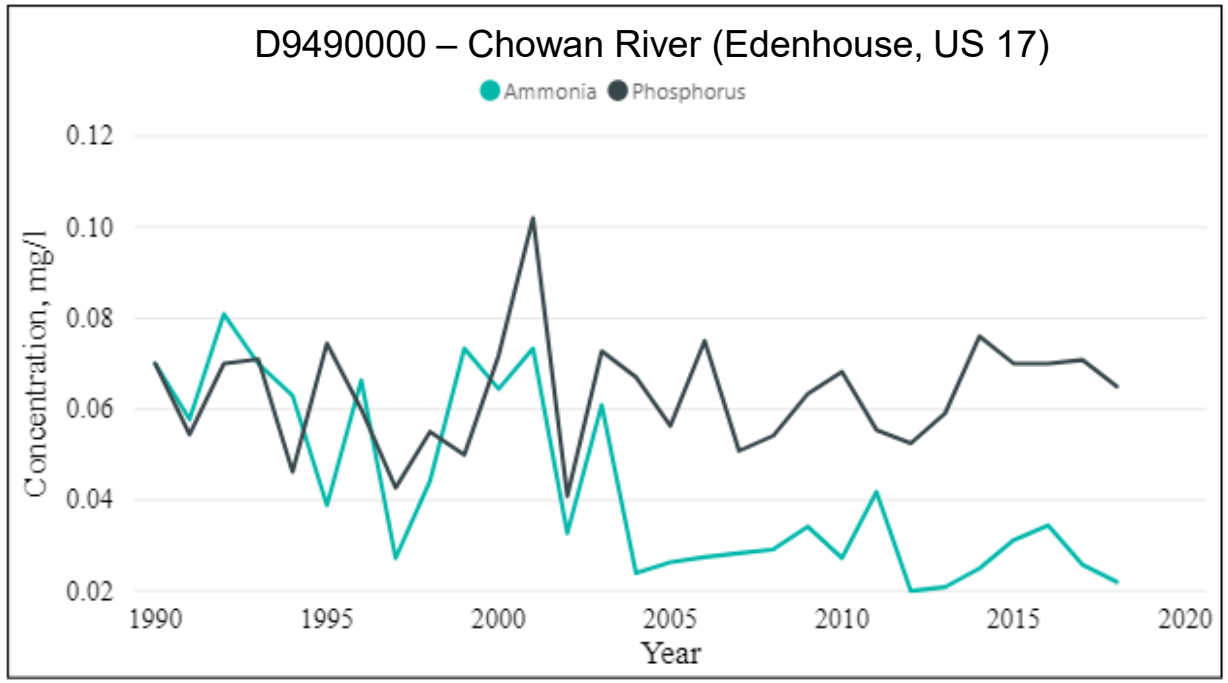
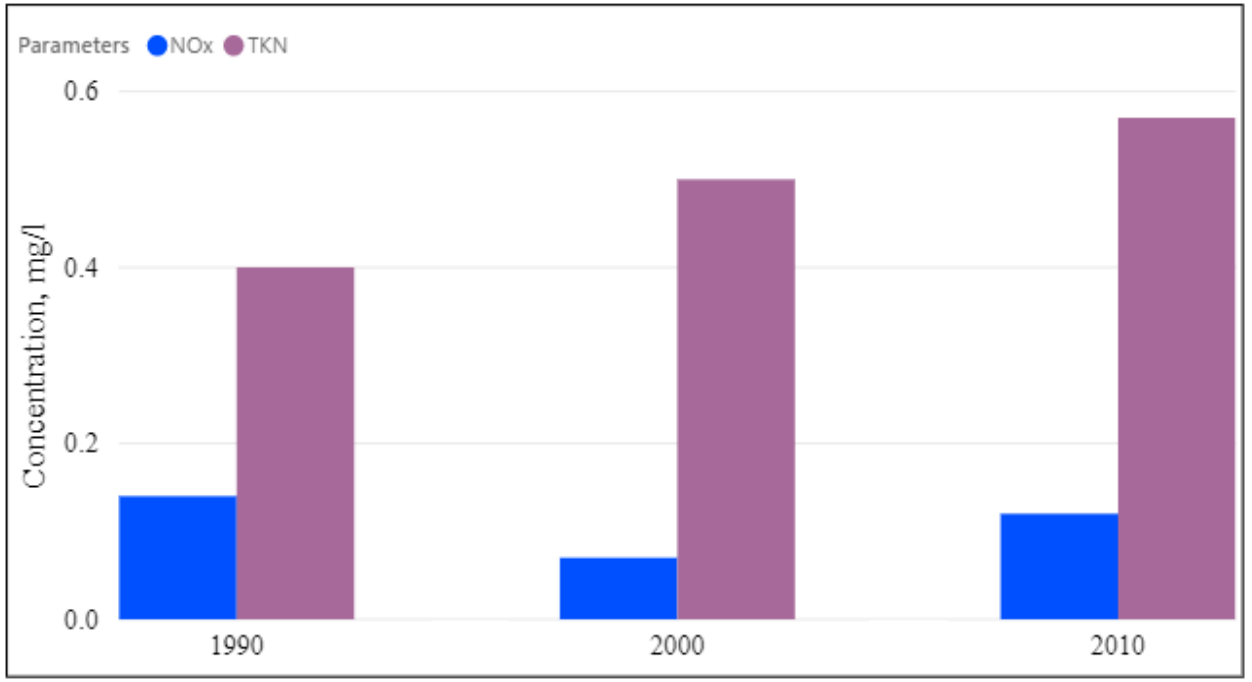
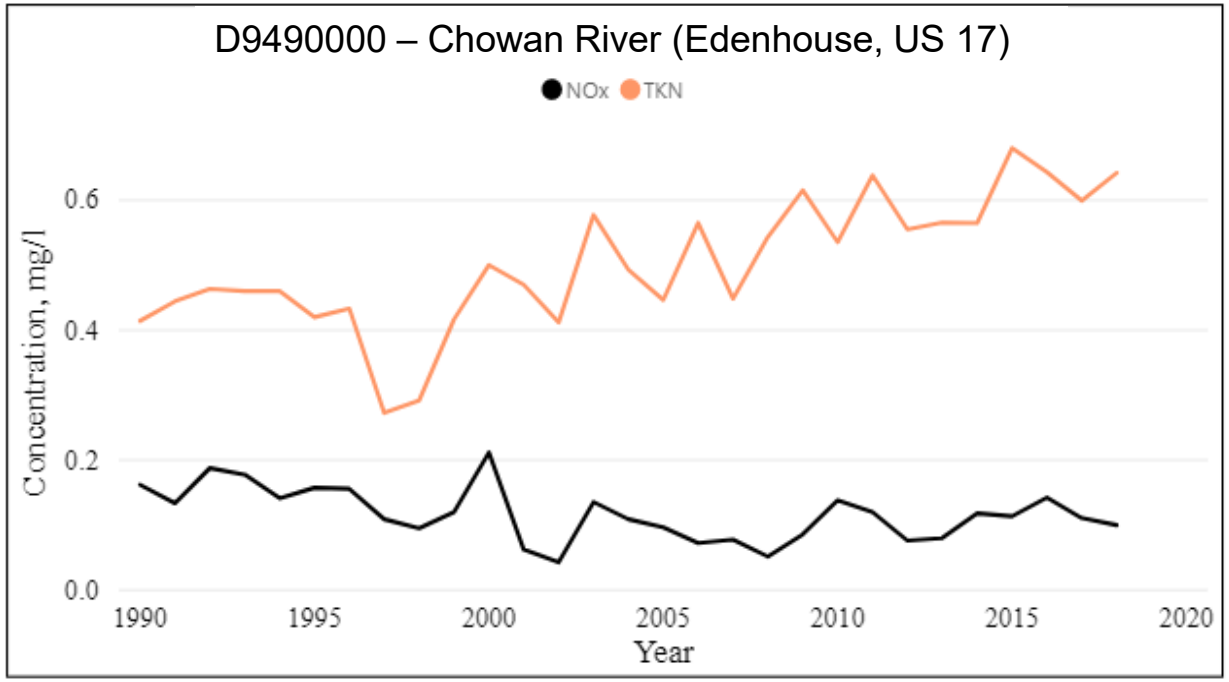
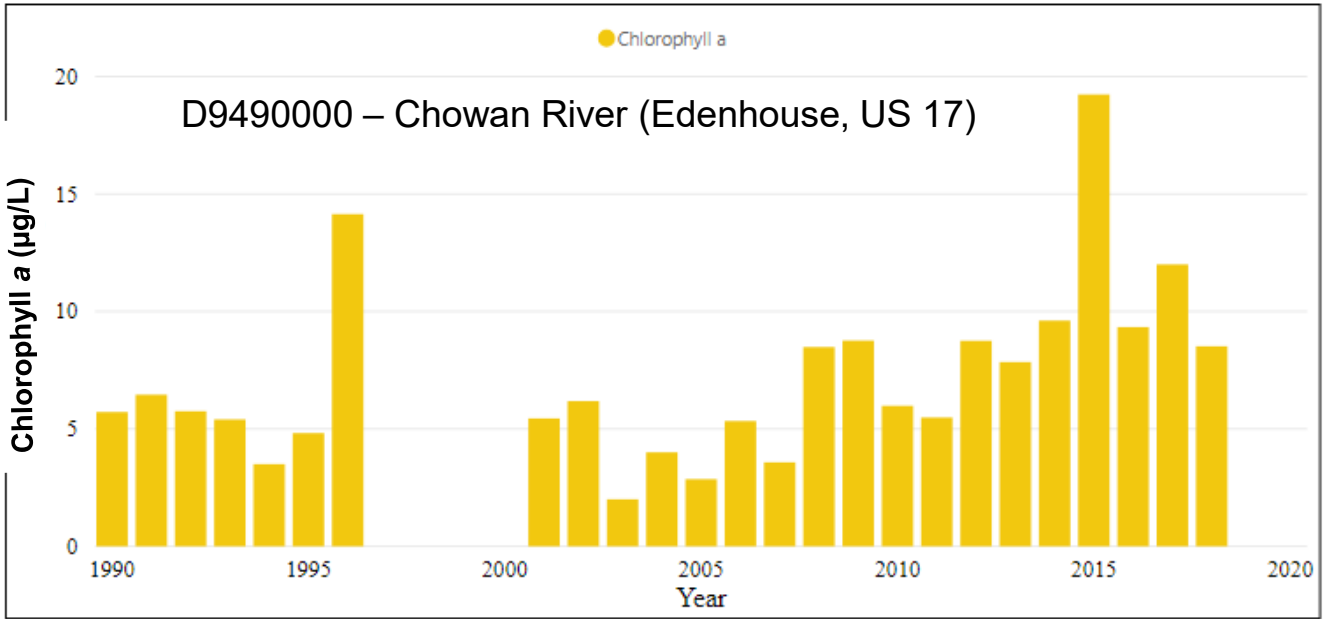
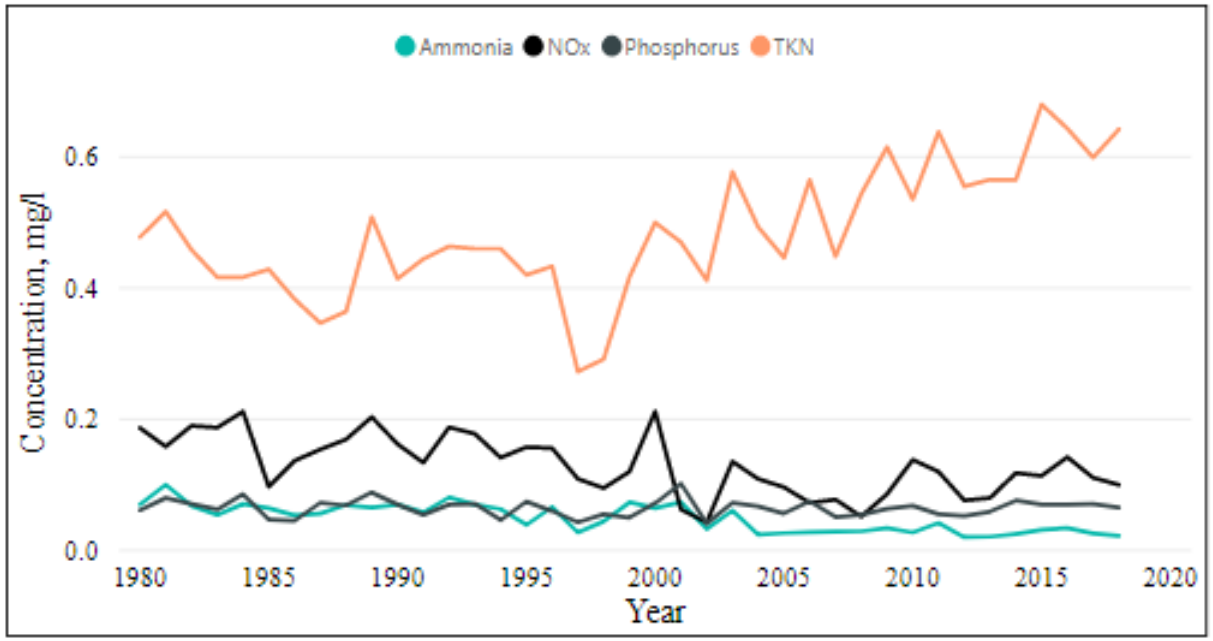

Parameters
Ammonia
Phosphorus
Concentration, mg/l
0.06
0.04
0.02
0.00
1990
2000
2010

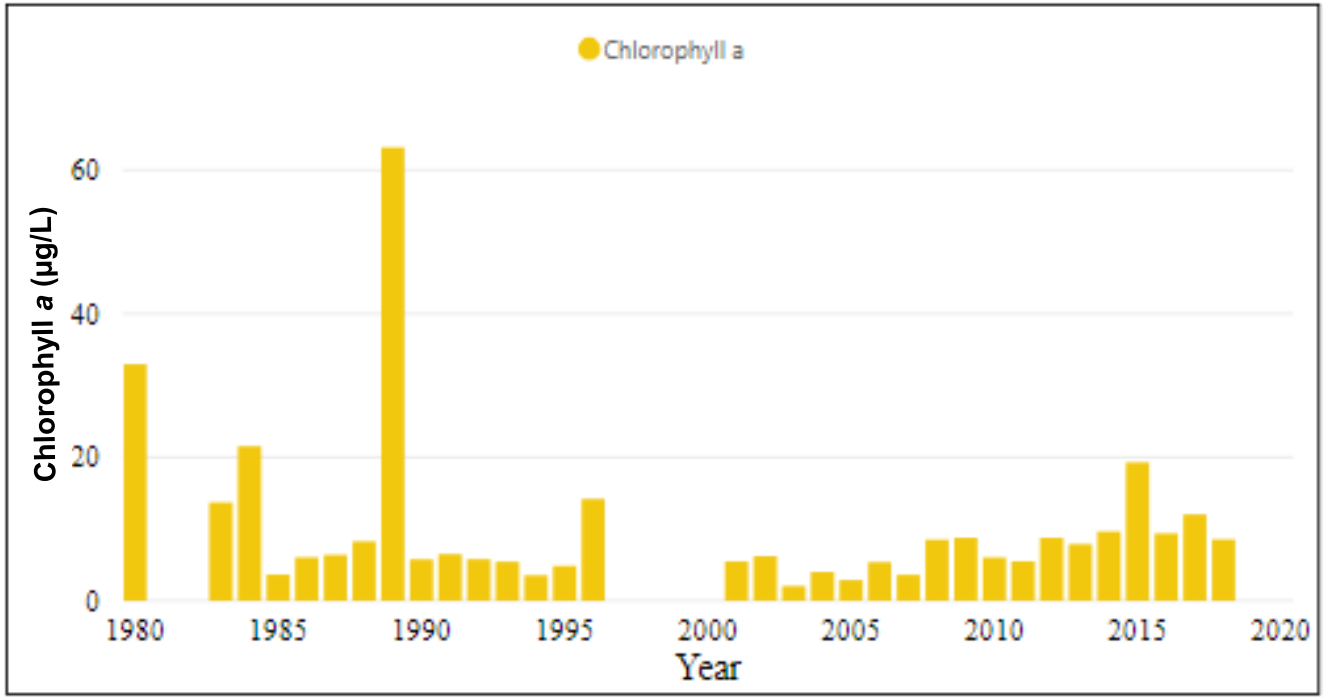

D9490000 – Chowan River (Edenhouse, US 17)
Ammonia
Phosphorus
Concentration, mg/l
0.12
0.10
0.08
0.06
0.04
0.02
1990
1995
2000
2005
2010
2015
2020
Year

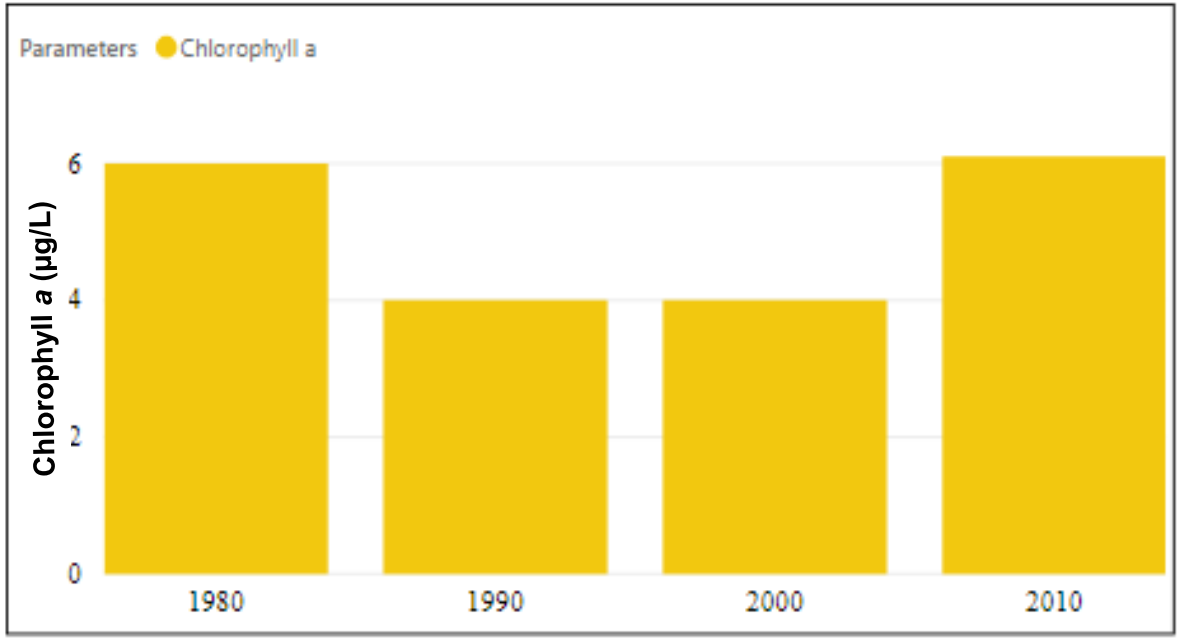

Parameters
NOx
TKN
Concentration, mg/l
0.6
0.4
0.2
0.0
1990
2000
2010

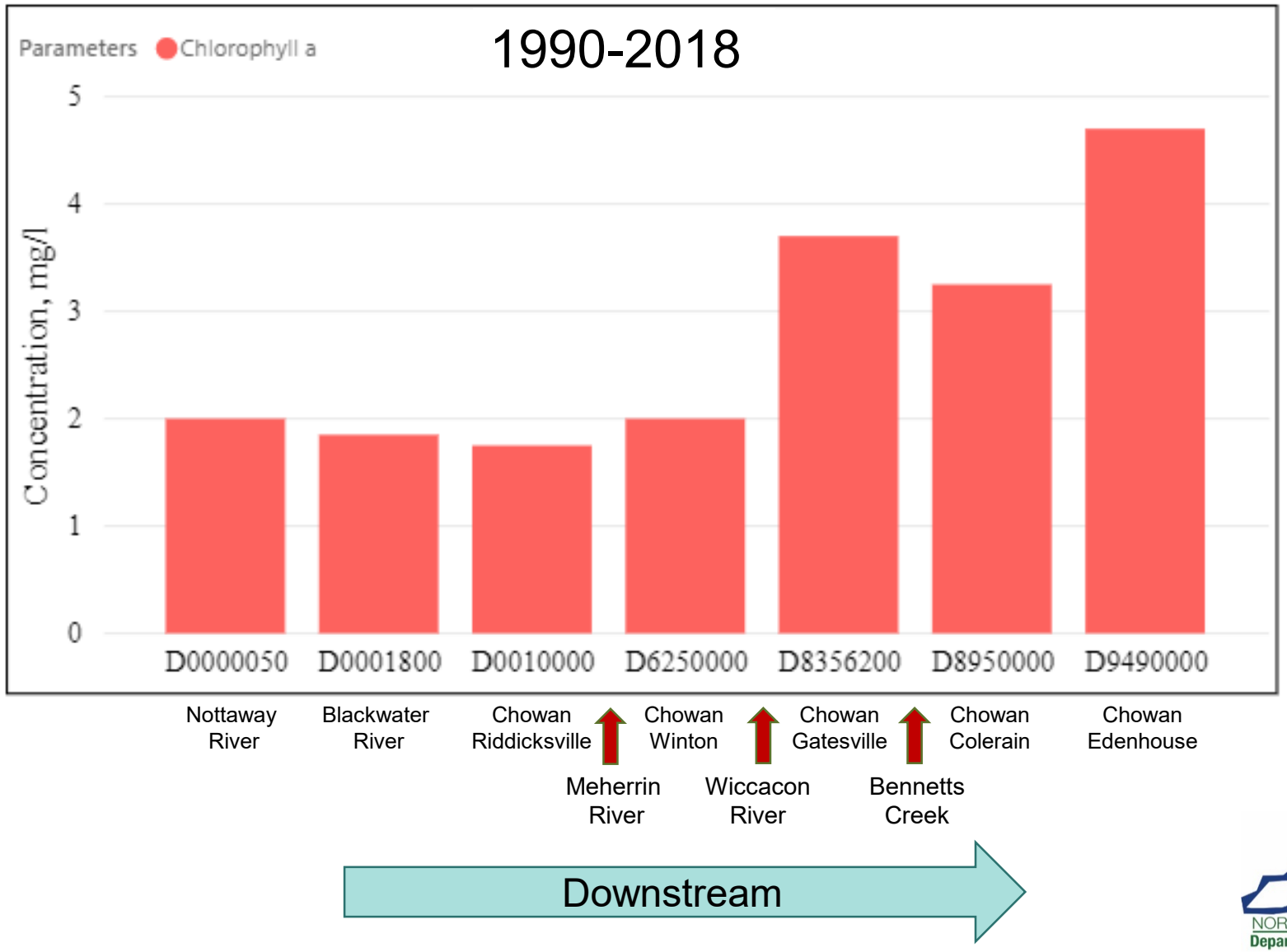

D9490000 – Chowan River (Edenhouse, US 17)
NOx
TKN
Concentration, mg/l
0.6
0.4
0.2
0.0
1990
1995
2000
2005
2010
2015
2020
Year

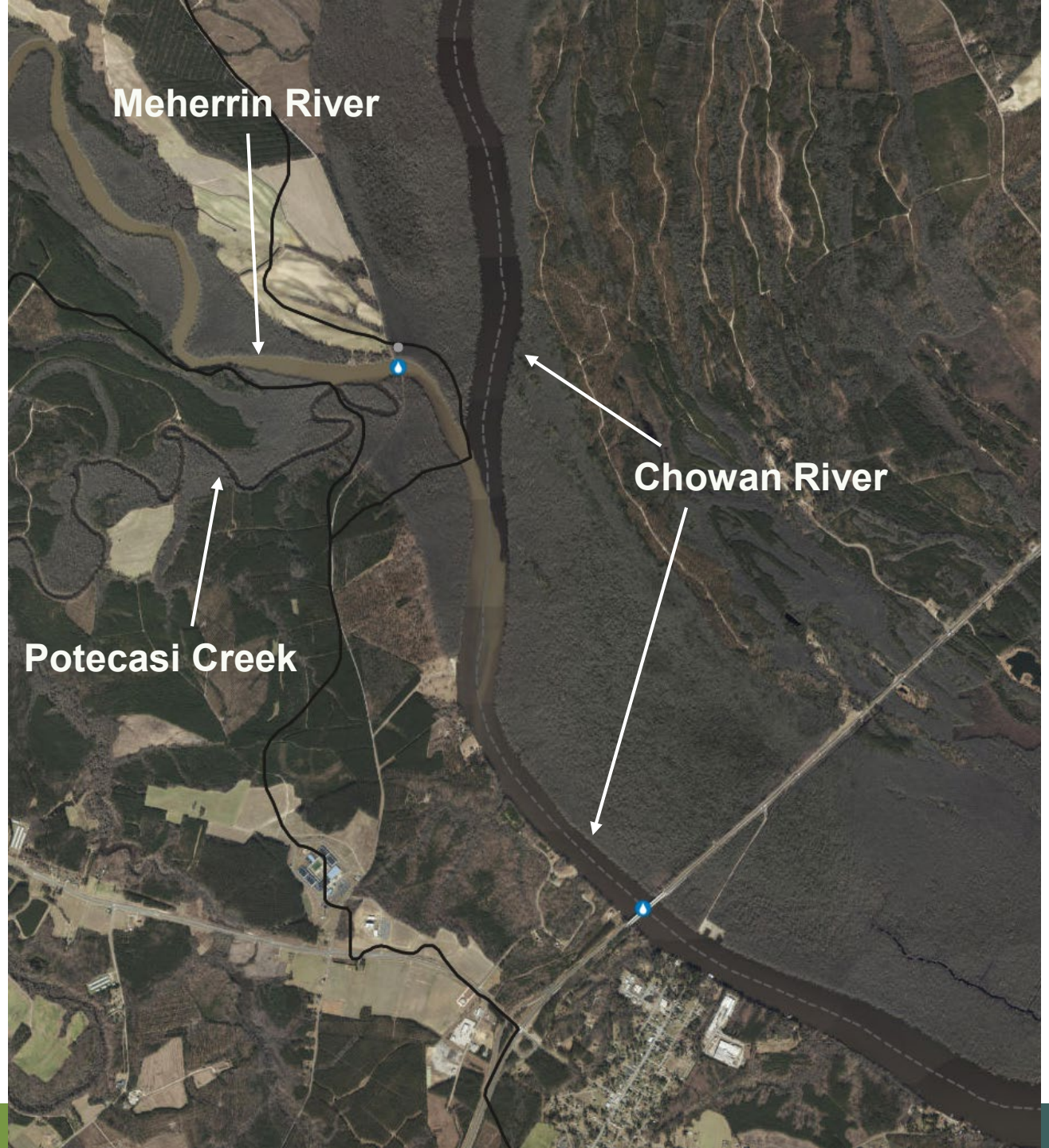

Chlorophyll a
D9490000 – Chowan River (Edenhouse, US 17)
Chlorophyll a (µg/L)
20
15
10
5
0
1990
1995
2000
2005
2010
2015
2020
Year


Ammonia
NOx
Phosphorus
TKN
Concentration, mg/l
0.6
0.4
0.2
0.0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

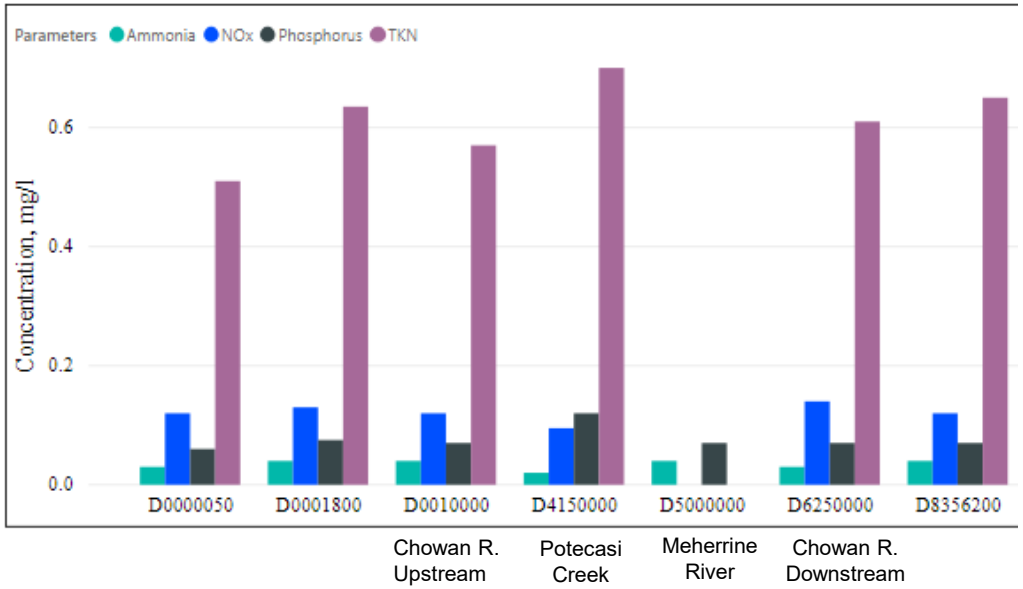

Chlorophyll a
Chlorophyll a (µg/L)
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year

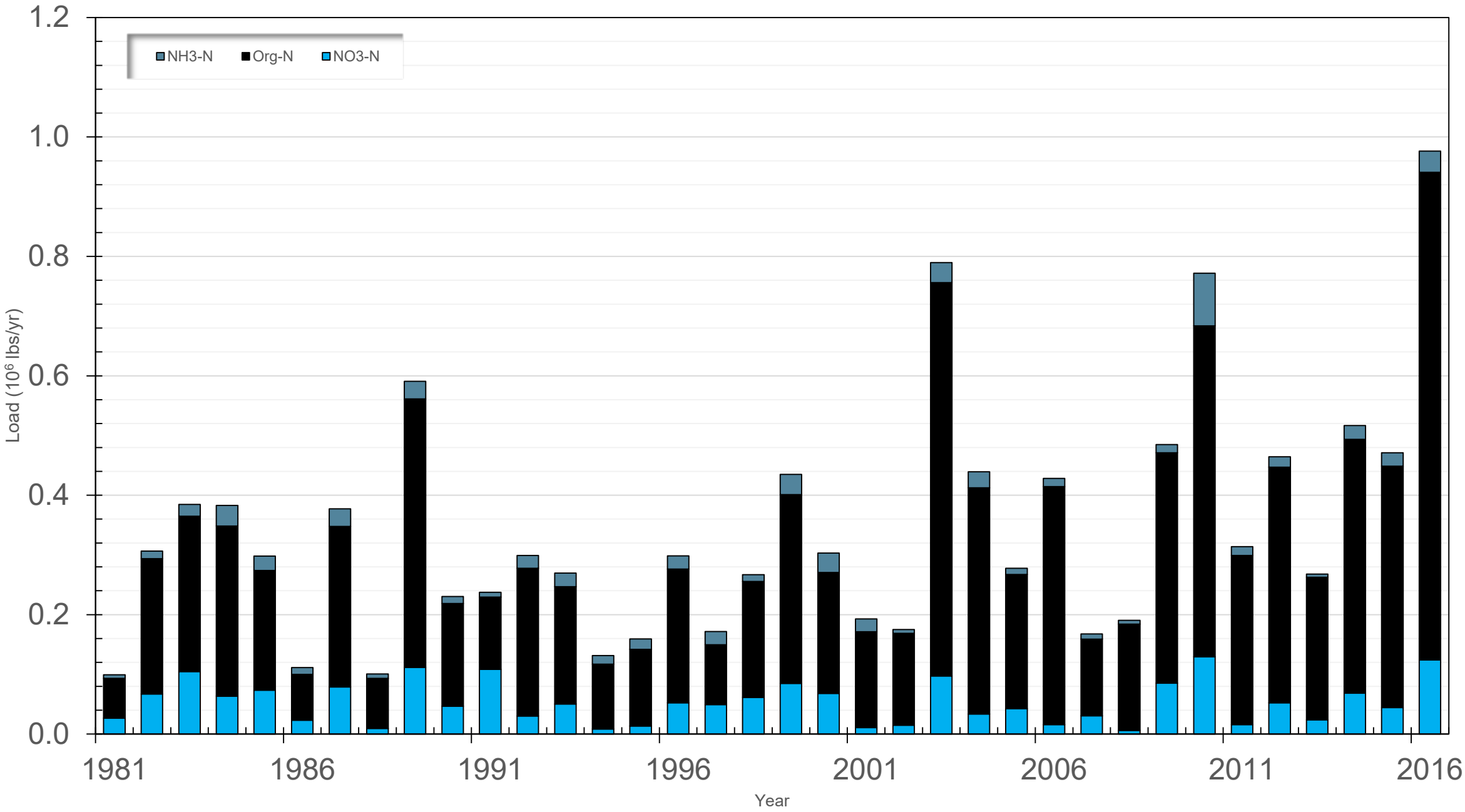

Parameters
Chlorophyll a
Chlorophyll a (µg/L)
6
4
2
0
1980
1990
2000
2010

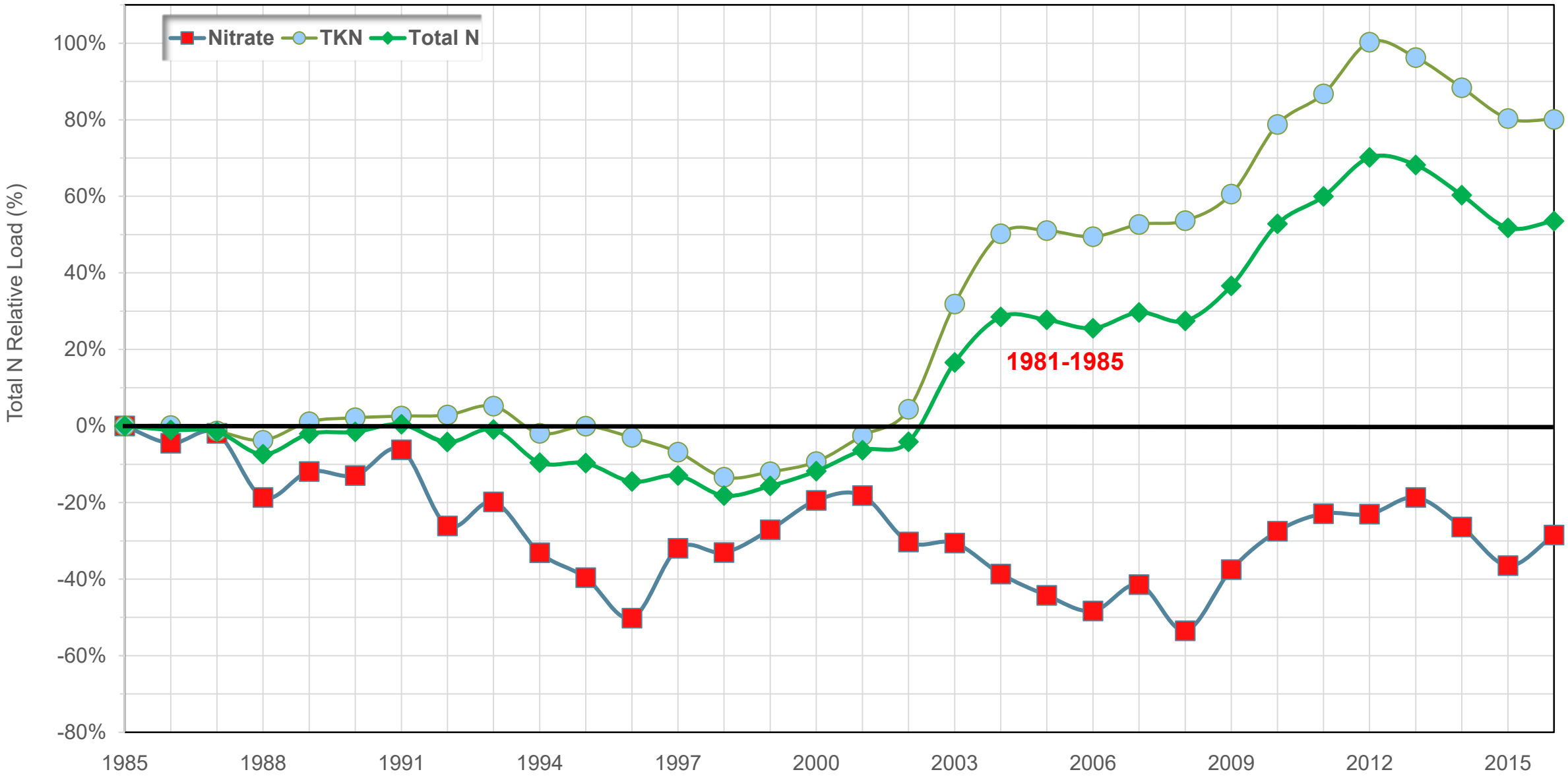

Parameters
Chlorophyll a
1990-2018
Concentration, mg/l
5
4
3
2
1
0
D0000050
D0001800
D0010000
D6250000
D8356200
D8950000
D9490000
Nottaway River
Blackwater River
Chowan Riddicksville
Chowan Winton
Chowan Gatesville
Chowan Colerain
Chowan Edenhouse
Meherrin River
Wiccacon River
Bennetts Creek
Downstream

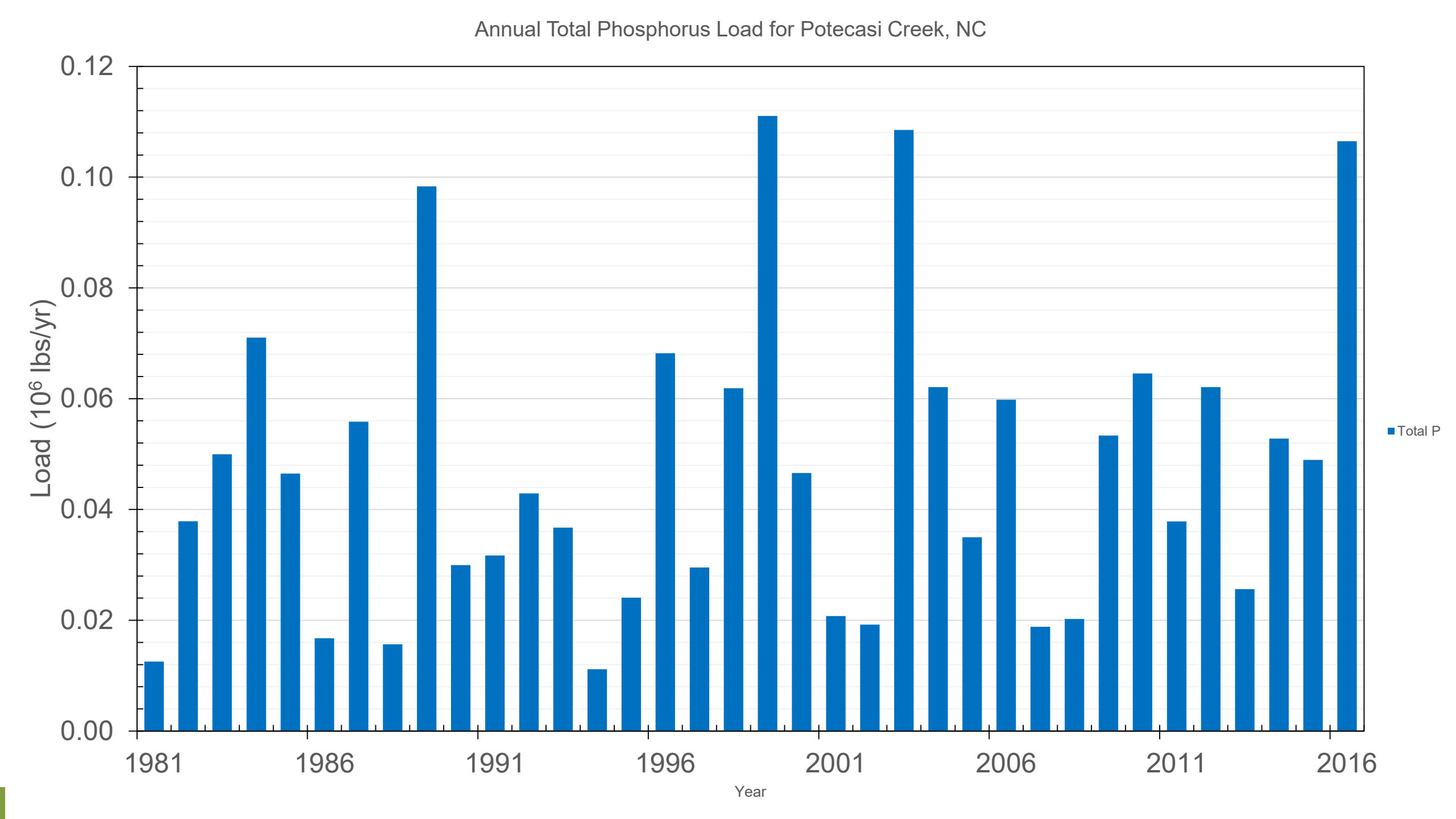


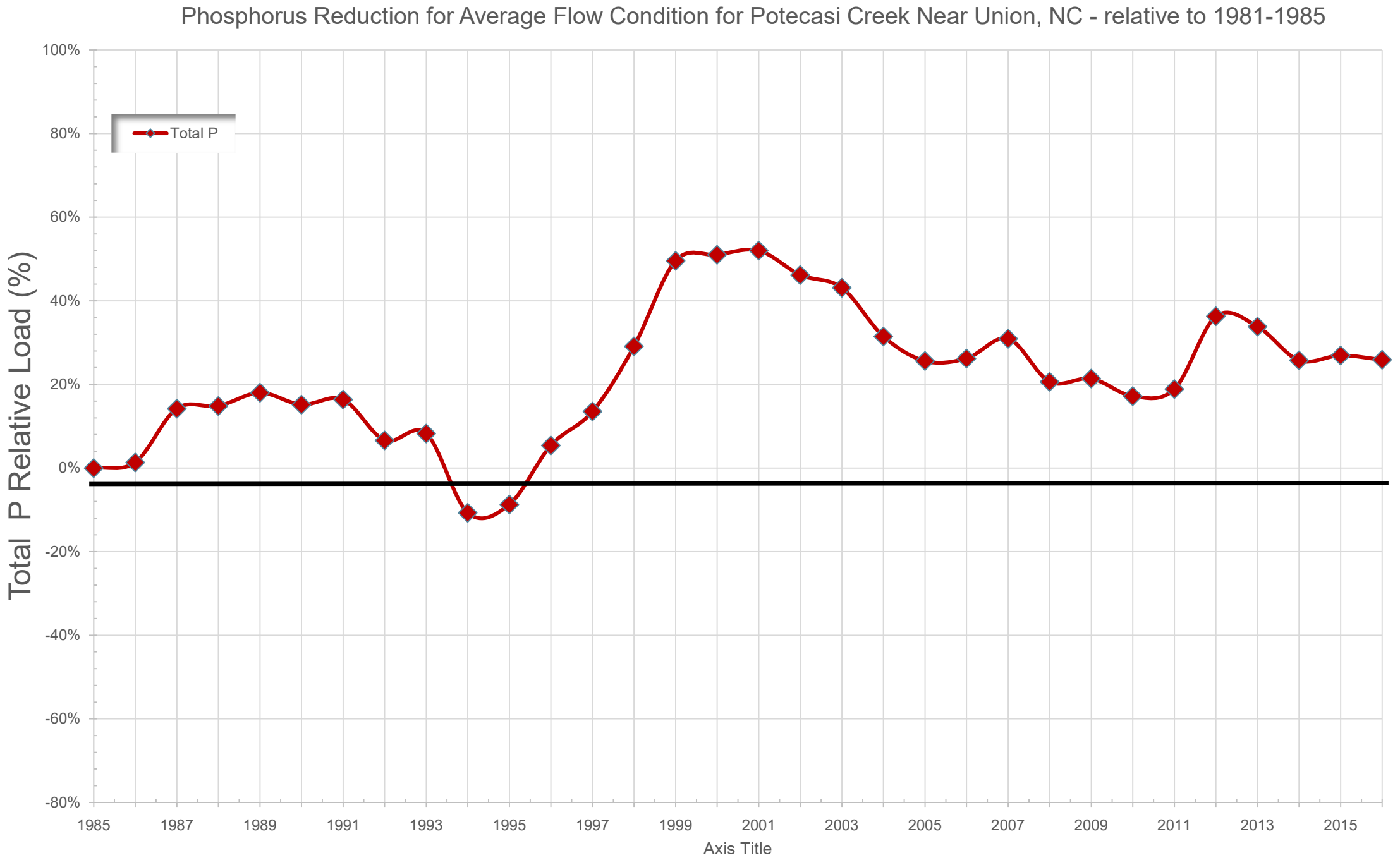
2012-2018 data window



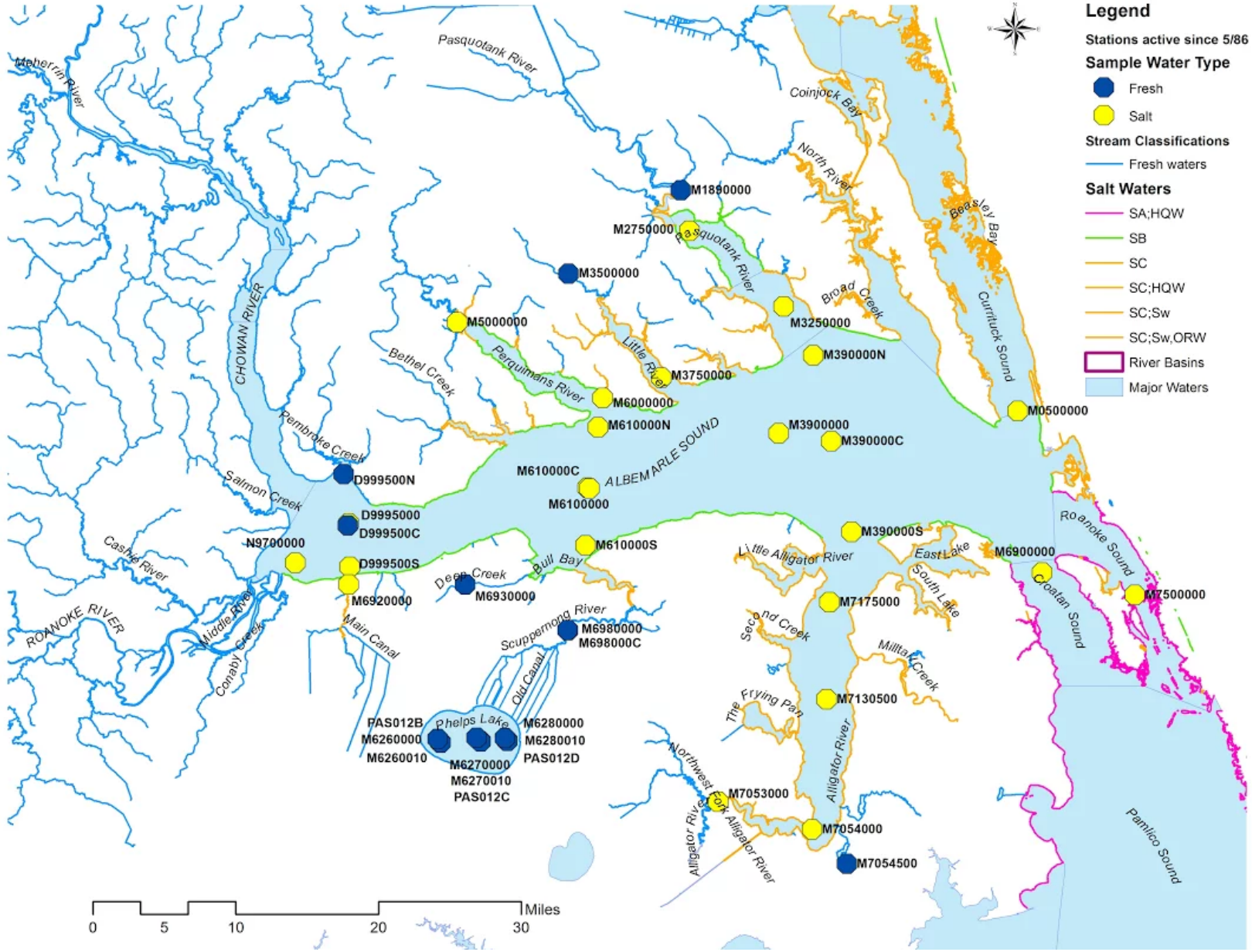

Annual Total Nitrogen Load for Potecasi Creek, NC
NH3-N
Org-N
NO3-N
Load (10^6 lbs/yr)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1981
1986
1991
1996
2001
2006
2011
2016
Year

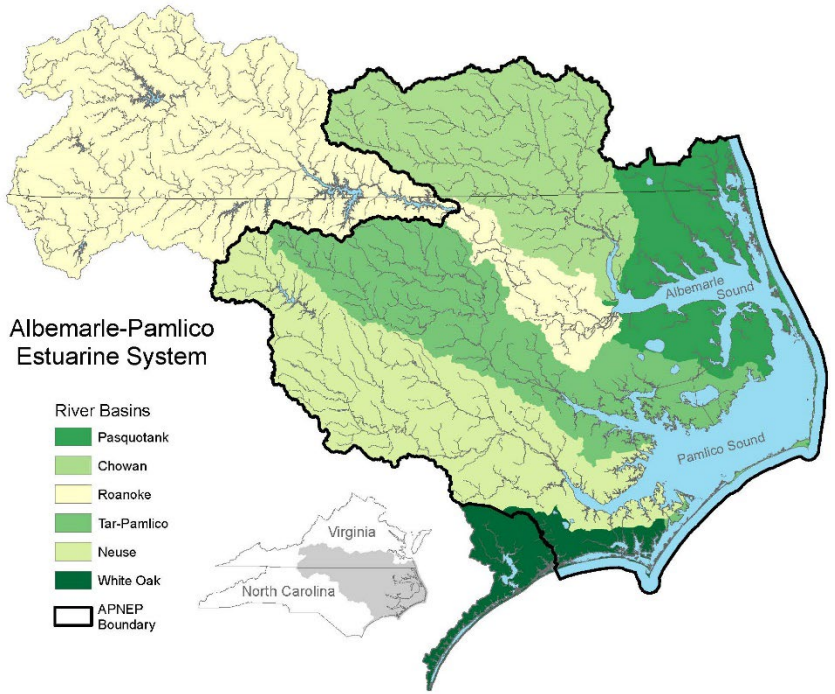

Nitrogen Reduction for Average Flow Condition for Potecasi Creek Near Union, NC - Relative to 1981-1985
Nitrate
TKN
Total N
Total N Relative Load (%)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
1981-1985


Annual Total Phosphorus Load for Potecasi Creek, NC
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Load (10^6 lbs/yr)
1981
1986
1991
1996
2001
2006
2011
2016
Year
Total P

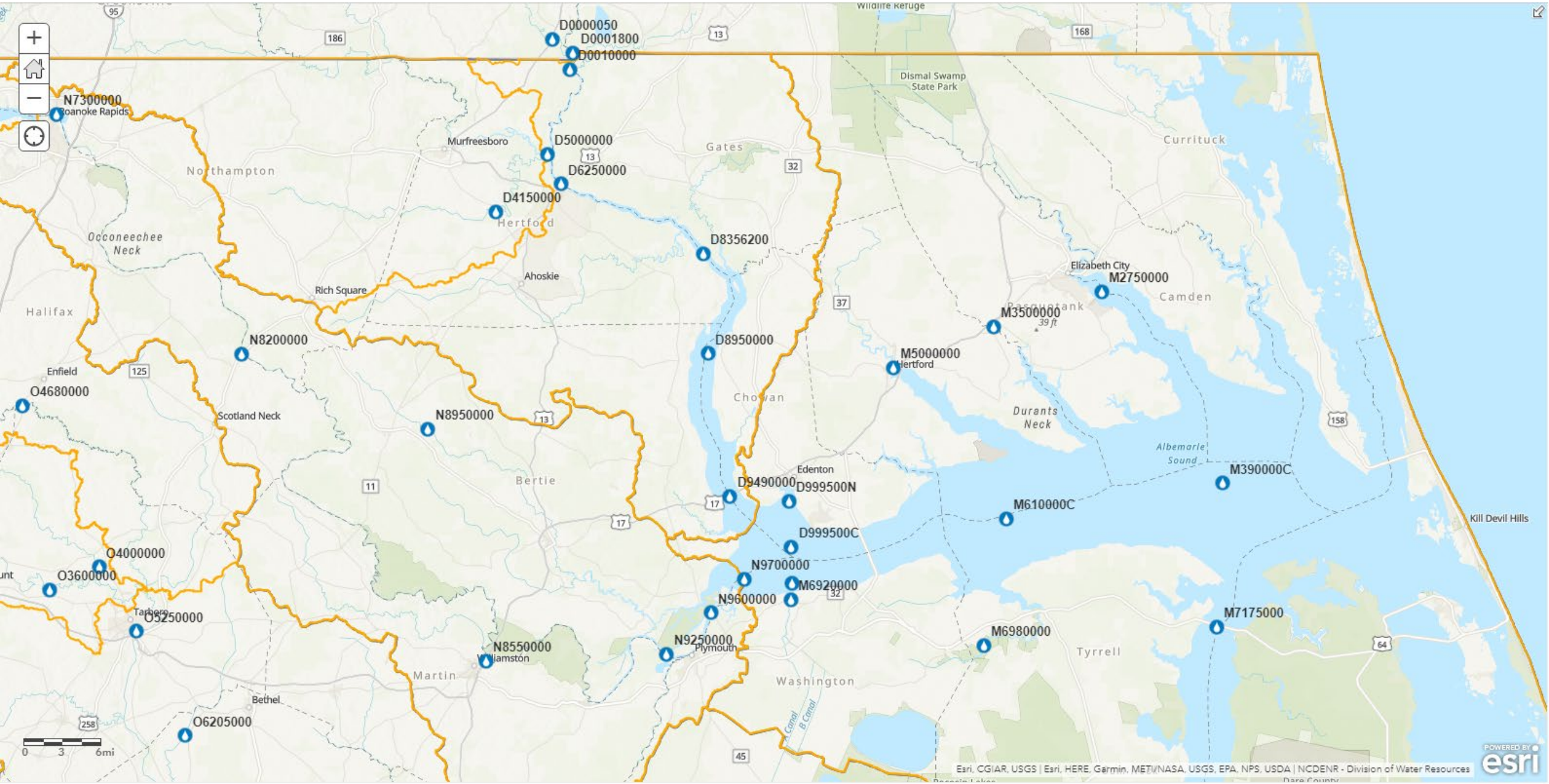

Phosphorus Reduction for Average Flow Condition for Potecasi Creek Near Union, NC - relative to 1981-1985
Total P
Total P Relative Load (%)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Axis Title

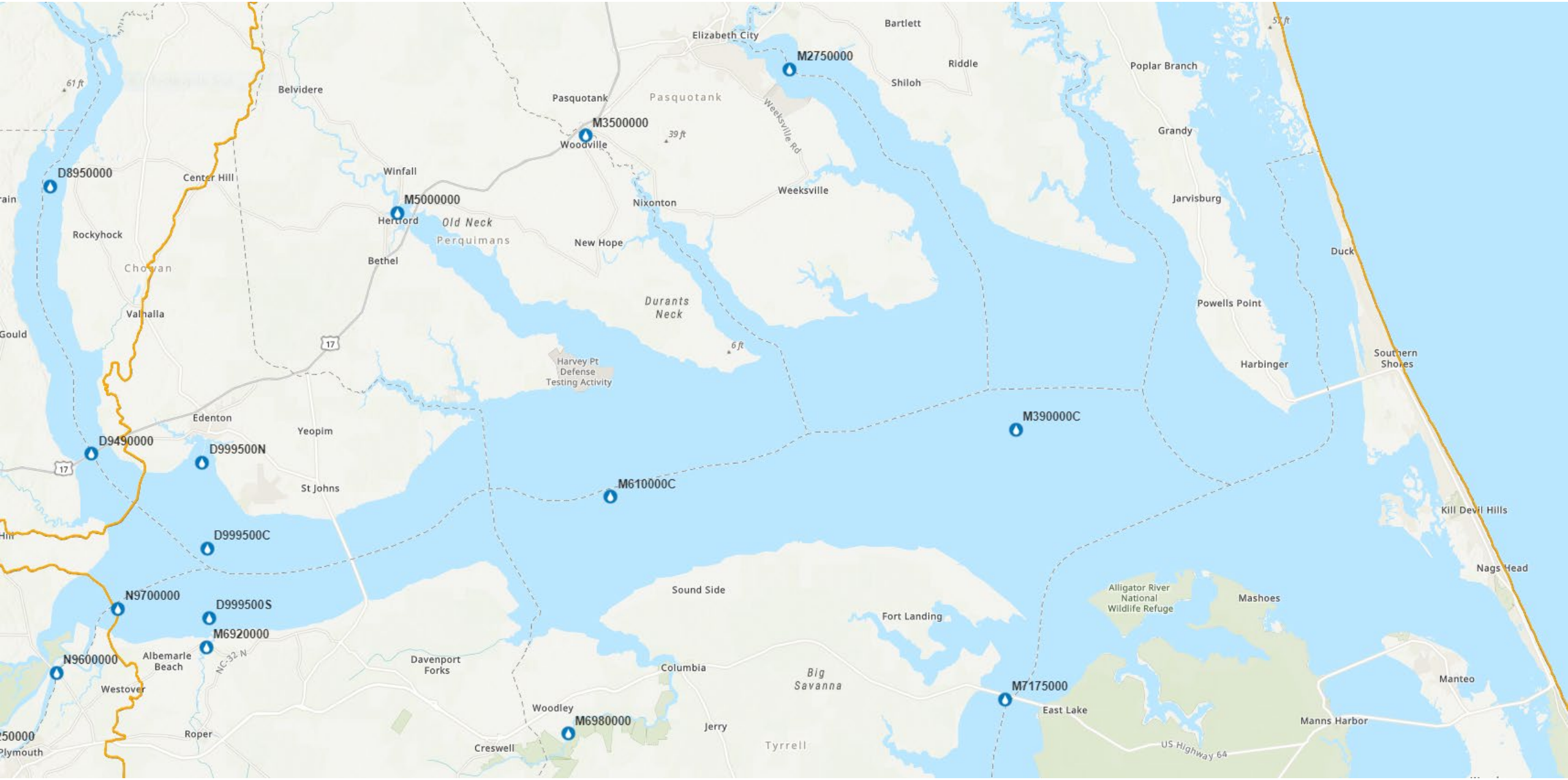
Albemarle Sound

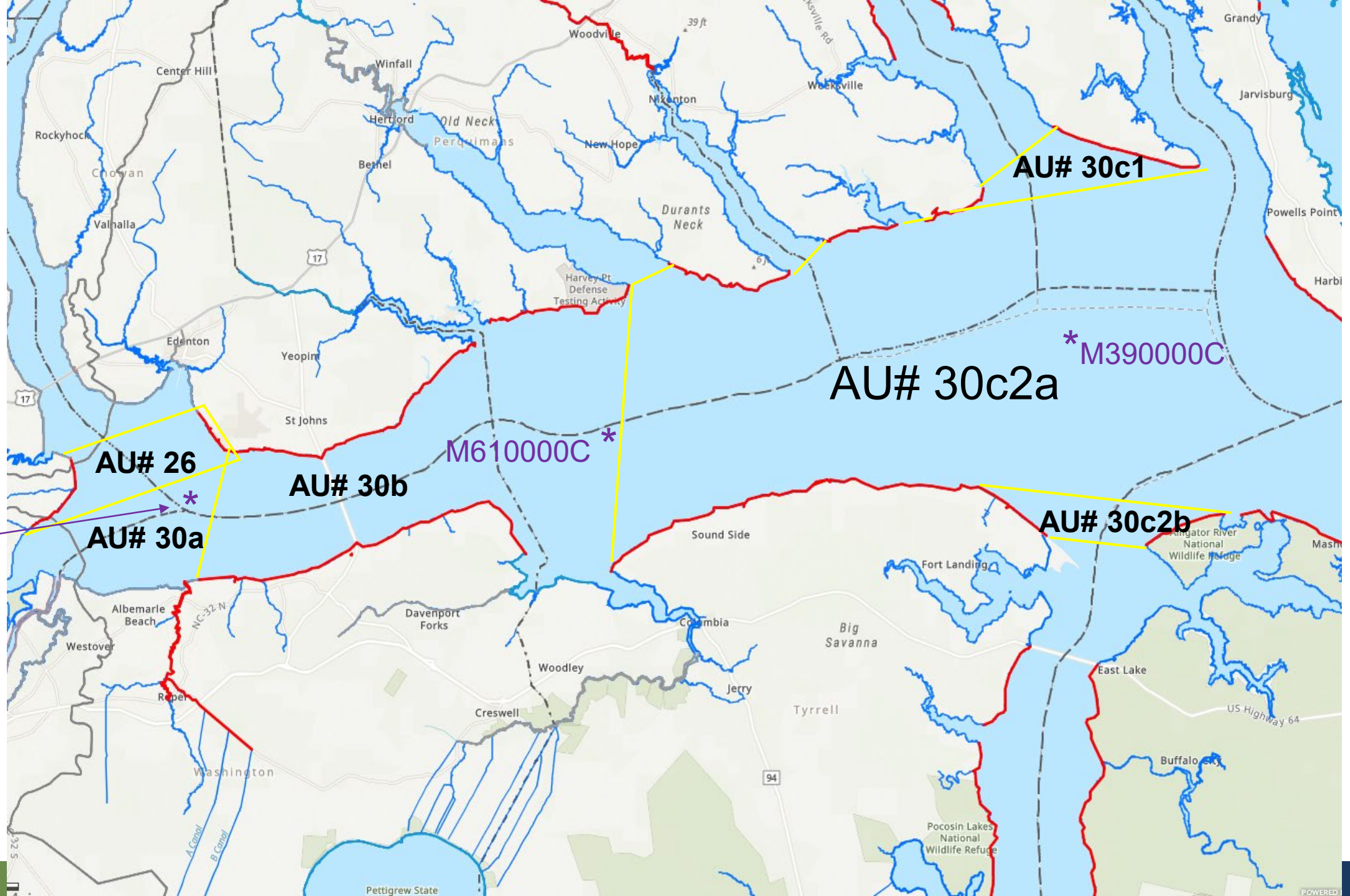




NORTH CAROLINA
Department of Environmental Quality


D0000050
D0001800
D0010000
N7300000
Roanoke Rapids
Murfreesboro
D5000000
D6250000
D4150000
Hertford
D8356200
Ahoskie
Rich Square
Halifax
N8200000
Enfield
O4680000
Scotland Neck
N8950000
D8950000
Chowan
Edenton
D9490000
D999500N
Bertie
M2750000
Elizabeth City
Camden
M3500000
M5000000
Durants Neck
Albemarle Sound
M390000C
M610000C
Kill Devil Hills
D999500C
N9700000
M6920000
N9600000
O4000000
O3600000
O3250000
Tarboro
N8550000
Williamston
N9250000
Plymouth
M6980000
M7175000
Tyrrell
Washington
Martin
Bethel
O6205000
Northampton
Occoneechee Neck
Gates
Currituck
Dismal Swamp State Park
Wildlife Refuge
0 3 6mi
Esri, CGIAR, USGS | Esri, HERE, Garmin, METI/NASA, USGS, EPA, NPS, USDA | NCDENR - Division of Water Resources


Elizabeth City
Bartlett
M2750000
Riddle
Shiloh
Poplar Branch
Belvidere
Pasquotank
Pasquotank
M3500000
Woodville
39 ft
Weeksville Rd
Grandy
D8950000
Center Hill
Winfall
M5000000
Hertford
Old Neck
Perquimans
Nixonton
Weeksville
Jarvisburg
Rockyhock
New Hope
Bethel
Duck
Durants
Neck
Powells Point
Valhalla
Gould
17
6 ft
Harvey Pt
Defense
Testing Activity
Harbinger
Southern
Shores
M390000C
Edenton
Yeopim
D9490000
D999500N
17
St Johns
M610000C
Kill Devil Hills
D999500C
Nags Head
N9700000
D999500S
Sound Side
Alligator River
National
Wildlife Refuge
Mashoes
Fort Landing
M6920000
N9600000
Albemarle
Beach
NC-32 N
Davenport
Forks
Columbia
Big
Savanna
M7175000
Manteo
Westover
East Lake
Manns Harbor
Woodley
M6980000
Jerry
Roper
Creswell
Tyrrell
US Highway 64


AU# 30c1
AU# 30c2a
*M390000C
AU# 26
AU# 30b
M610000C *
AU# 30a
*
D999500C
AU# 30c2b
Woodville
Winfall
Center Hill
Rockyhock
Hertford
Old Neck
Perquimans
Bethel
New Hope
Mixenton
Weeksville
Jarvisburg
Grandy
Durants Neck
Powells Point
Valhalla
Harvey Pt Defense Testing Activity
Edenton
Yeopim
St Johns
Sound Side
Fort Landing
Albemarle Beach
Westover
Davenport Forks
Columbia
Big Savanna
Woodley
Jerry
Tyrrell
East Lake
Creswell
Buffalo City
Washington
Pocosin Lakes National Wildlife Refuge
Pettigrew State
NC-32 N
A Canal
B Canal
US Highway 64
94
17

2018 303(d) Impaired Waters (Data window 2012-2016)

26 ALBEMARLE SOUND

From mouth of Chowan River, defined by a line extending in a southerly direction from Reedy Point on the north shore of Albemarle Sound to a point of land on the south side of Black Walnut Swamp to a line running across Albemarle Sound in a southerly dire

Classification	Length or Area	Units	Previous AU Number
B;NSW	15,600	FW Acres	

Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	Fish Consumption Advisory	Dioxin Fish Tissue Advisory (Advisory, FC, NC)	5

30b ALBEMARLE SOUND

Sound from 0.5 miles east of Kendricks Creek to the Harvey Point/ Bull Bay Crossing

Classification	Length or Area	Units	Previous AU Number
SB	61,750	S Acres	

Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	> 10% and >90 conf	Copper (3 µg/l, AL, SW)	5

30c1 ALBEMARLE SOUND

Portion at Mouth of Pasquotank River

Classification	Length or Area	Units	Previous AU Number
SB	203,119	S Acres	30c

Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	> 10% and >90 conf	Copper (3 µg/l, AL, SW)	5

30c2a ALBEMARLE SOUND

Sound from the Harvey Point/ Bull Bay Crossing to Roanoke and Croatan Sounds. Except for portion at Mouth of Pasquotank River excluding the mouth of the Alligator River

Classification	Length or Area	Units	Previous AU Number
SB	16,747	S Acres	30c2

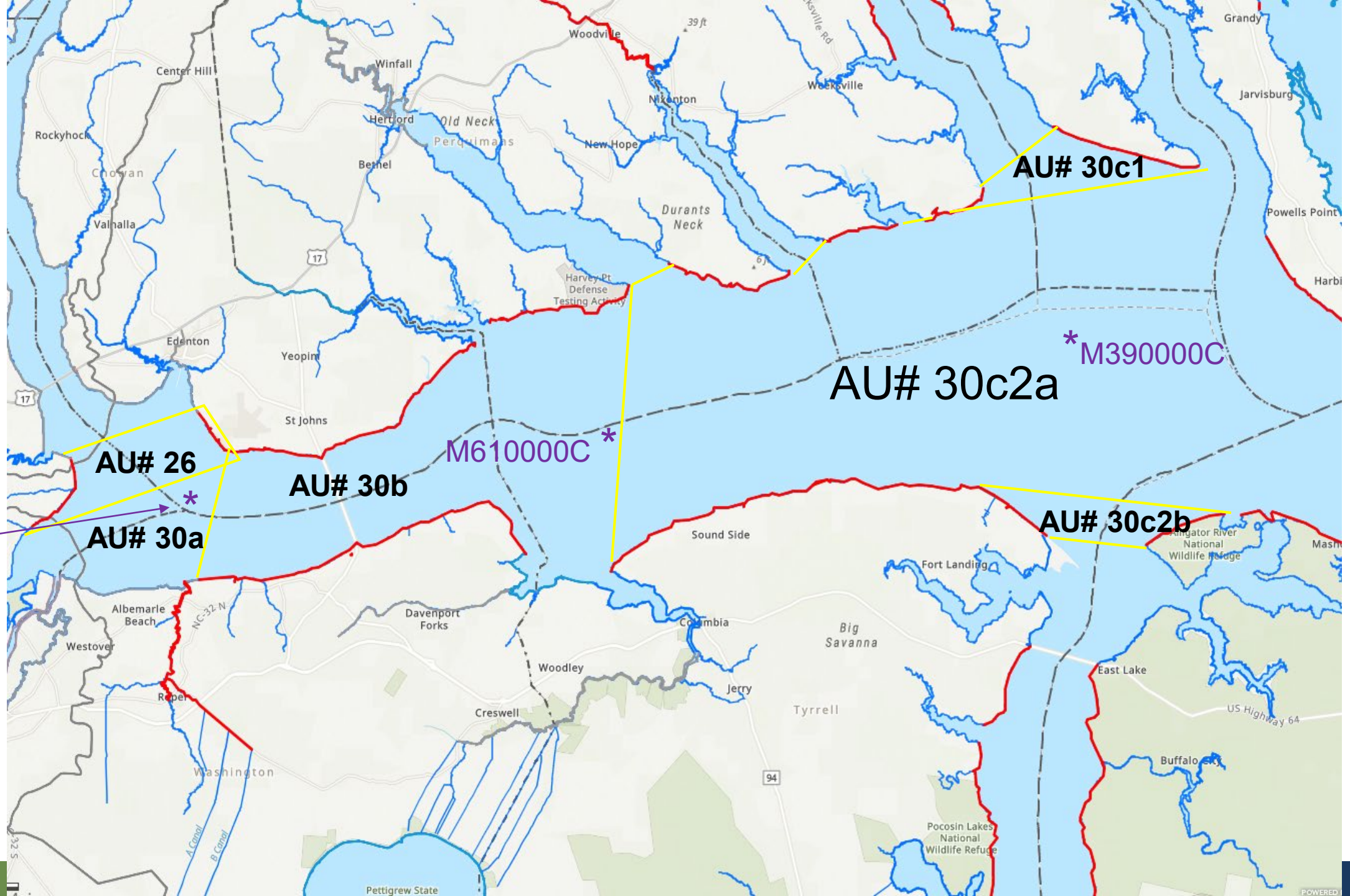
Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	> 10% and >90 conf	pH (8.5, AL, SW)	5
Exceeding Criteria	> 10% and >90 conf	Copper (3 µg/l, AL, SW)	5

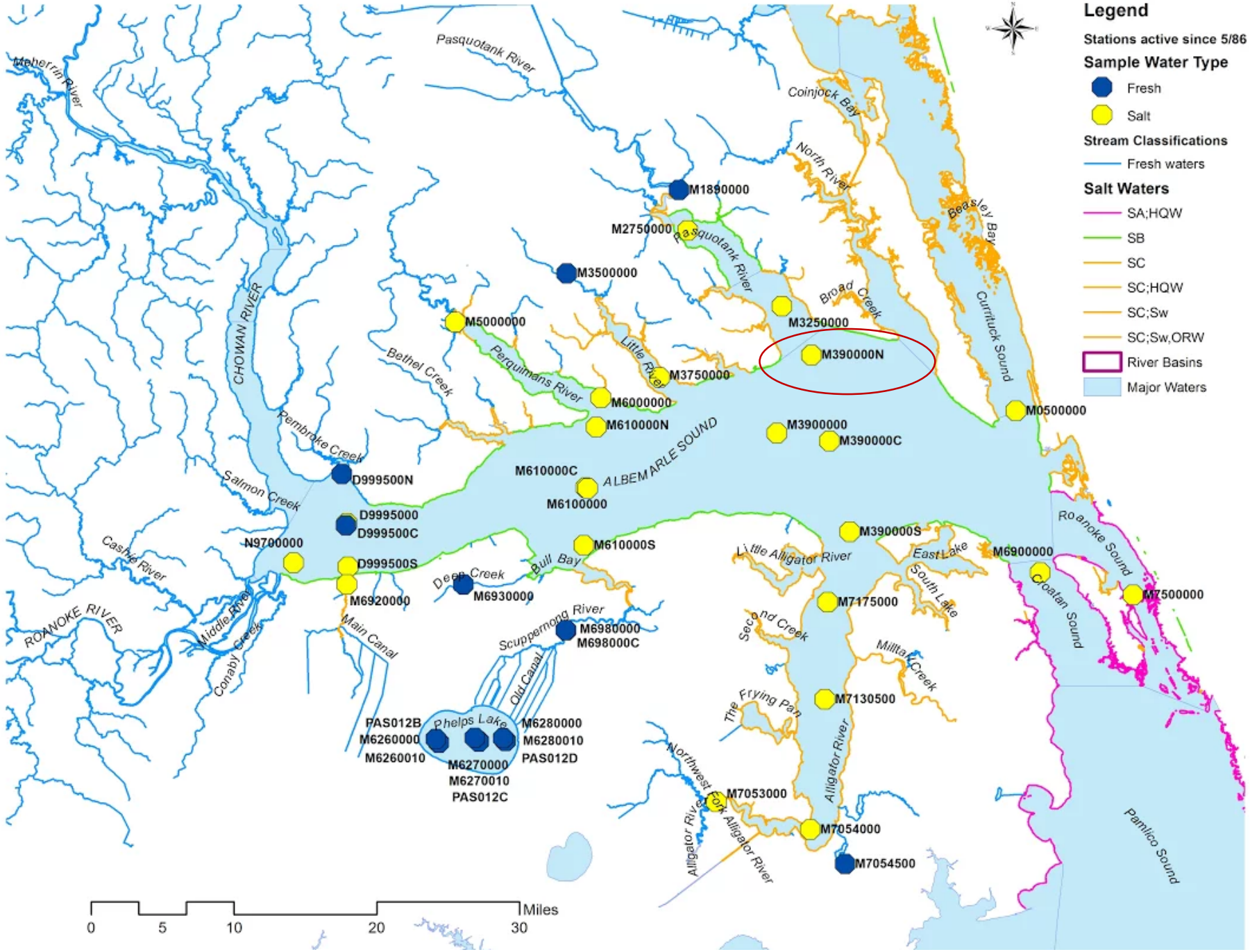
30c2b ALBEMARLE SOUND

Mouth of the Alligator River

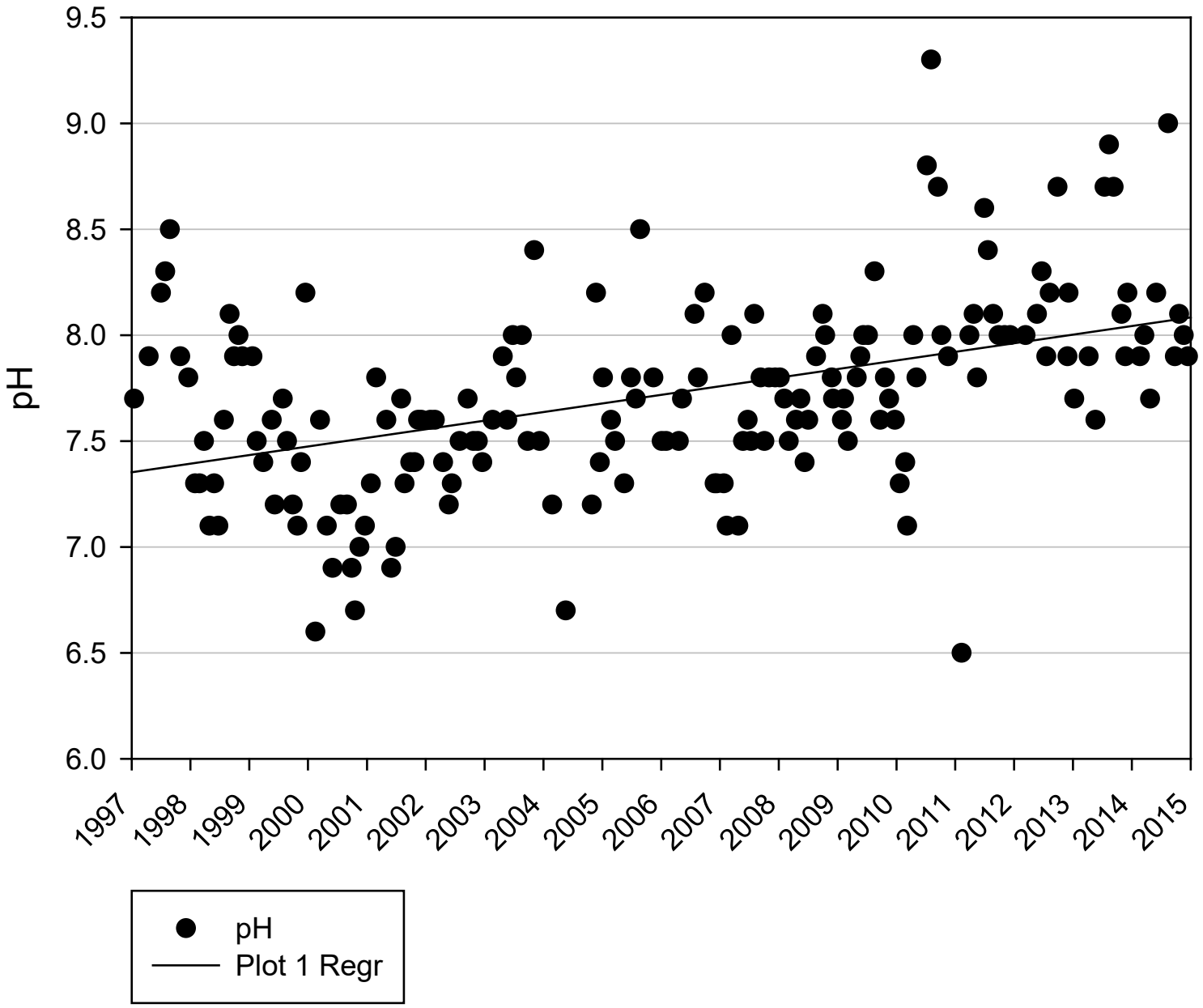
Classification	Length or Area	Units	Previous AU Number
SB	16,747	S Acres	30c2

Assessment Criteria Status	Reason for Rating	Parameter of Interest	Category
Exceeding Criteria	> 10% and >90 conf	Copper (3 µg/l, AL, SW)	5


AU# 30c1
AU# 30c2a
*M390000C
M610000C *
AU# 26
AU# 30b
AU# 30a
*
D999500C
AU# 30c2b
Woodville
Winfall
Center Hill
Mixenton
Weeksville
Grandy
Jarvisburg
Rockyhock
Hertford
Old Neck
Perquimans
New Hope
Bethel
Durants Neck
Powells Point
Valhalla
Harvey Pt Defense Testing Activity
Edenton
Yeopim
St Johns
Sound Side
Fort Landing
Albemarle Beach
Davenport Forks
Columbia
Big Savanna
Westover
Woodley
Jerry
Roper
Creswell
Tyrrell
East Lake
US Highway 64
Washington
Buffalo City
Pocosin Lakes National Wildlife Refuge
Pettigrew State
NC-32 N
A Canal
B Canal
17
94

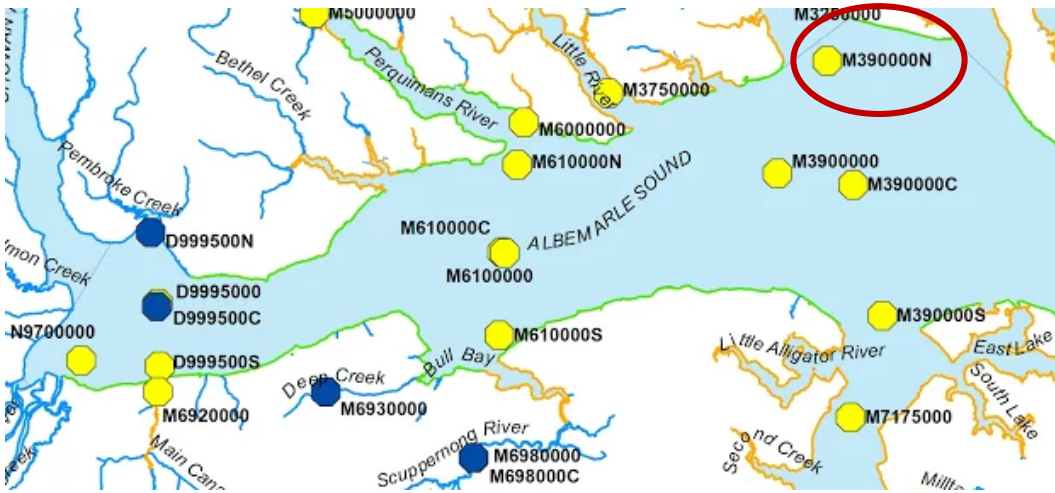

Legend
Stations active since 5/86
Sample Water Type
Fresh
Salt
Stream Classifications
Fresh waters
Salt Waters
SA;HQW
SB
SC
SC;HQW
SC;Sw
SC;Sw,ORW
River Basins
Major Waters
Pasquotank River
Coinjock Bay
North River
Beasley Bay
Currituck Sound
Broad Creek
Pasquotank River
Meherrin River
CHOWAN RIVER
Bethel Creek
Perquimans River
Little River
Pembroke Creek
Salmon Creek
ALBEMARLE SOUND
Cashie River
ROANOKE RIVER
Middle River
Conaby Creek
Main Canal
Deep Creek
Bull Bay
Scuppernong River
Old Canal
Phelps Lake
Little Alligator River
East Lake
South Lake
Second Creek
Milltail Creek
The Frying Pan
Alligator River
Northwest Fork Alligator River
Alligator River
Roanoke Sound
Croatan Sound
Pamlico Sound
M1890000
M2750000
M3500000
M5000000
M3750000
M6000000
M610000N
M3250000
M390000N
M0500000
M3900000
M390000C
M610000C
M6100000
D999500N
D9995000
D999500C
N9700000
D999500S
M6920000
M6930000
M610000S
M390000S
M6900000
M7500000
M7175000
M7130500
M6980000
M698000C
PAS012B
M6260000
M6260010
M6280000
M6280010
PAS012D
M6270000
M6270010
PAS012C
M7053000
M7054000
M7054500
0
5
10
20
30
Miles

M390000N
ALBEMARLE SOUND NR FROG ISLAND N SHORE



2016 IR (2010-2014 data window)

n	46
n>8.5	9
%>8.5	19.57
% Conf.	96.34



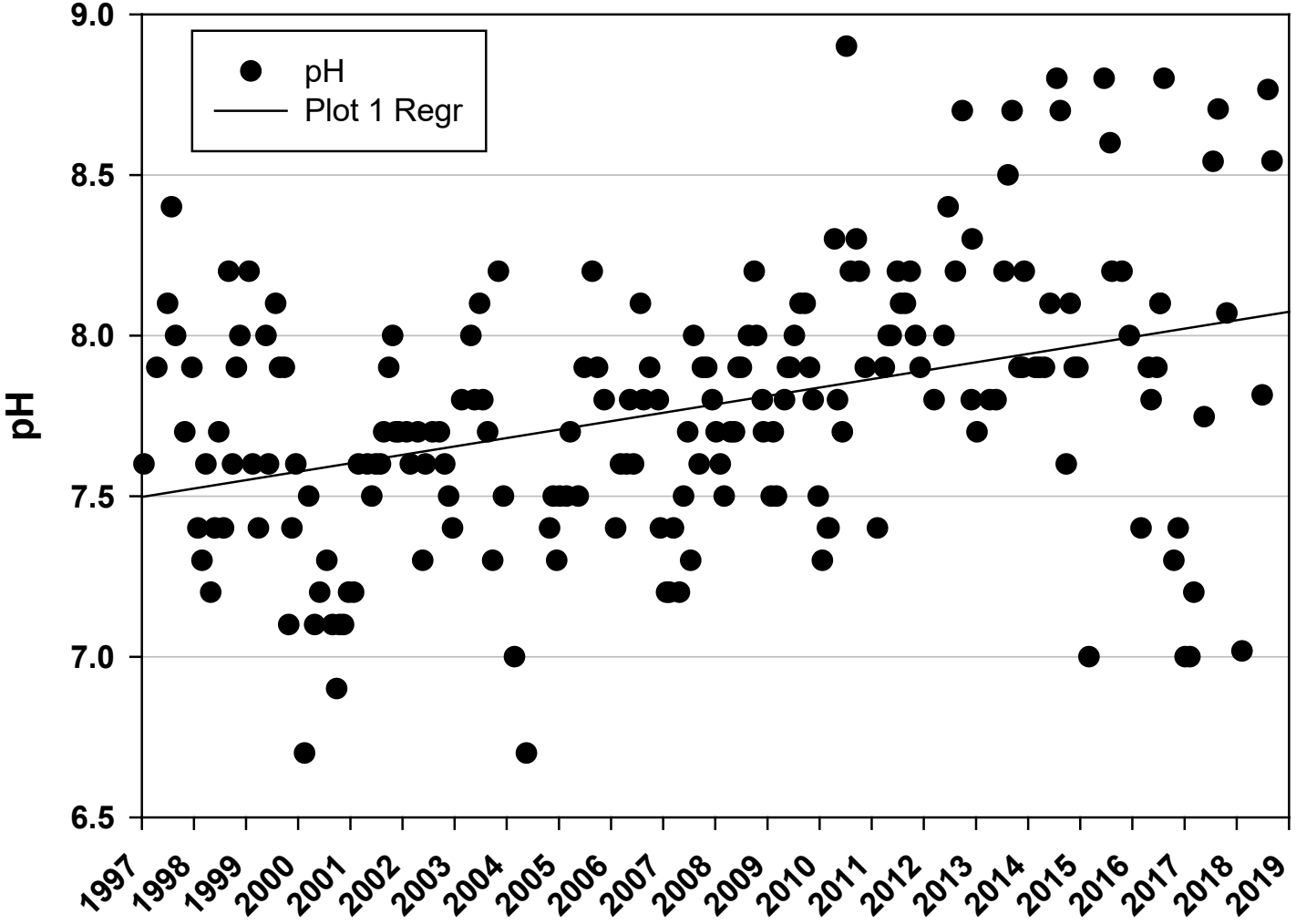
Last monitored on 12/16/14

Plot 1
Order 1

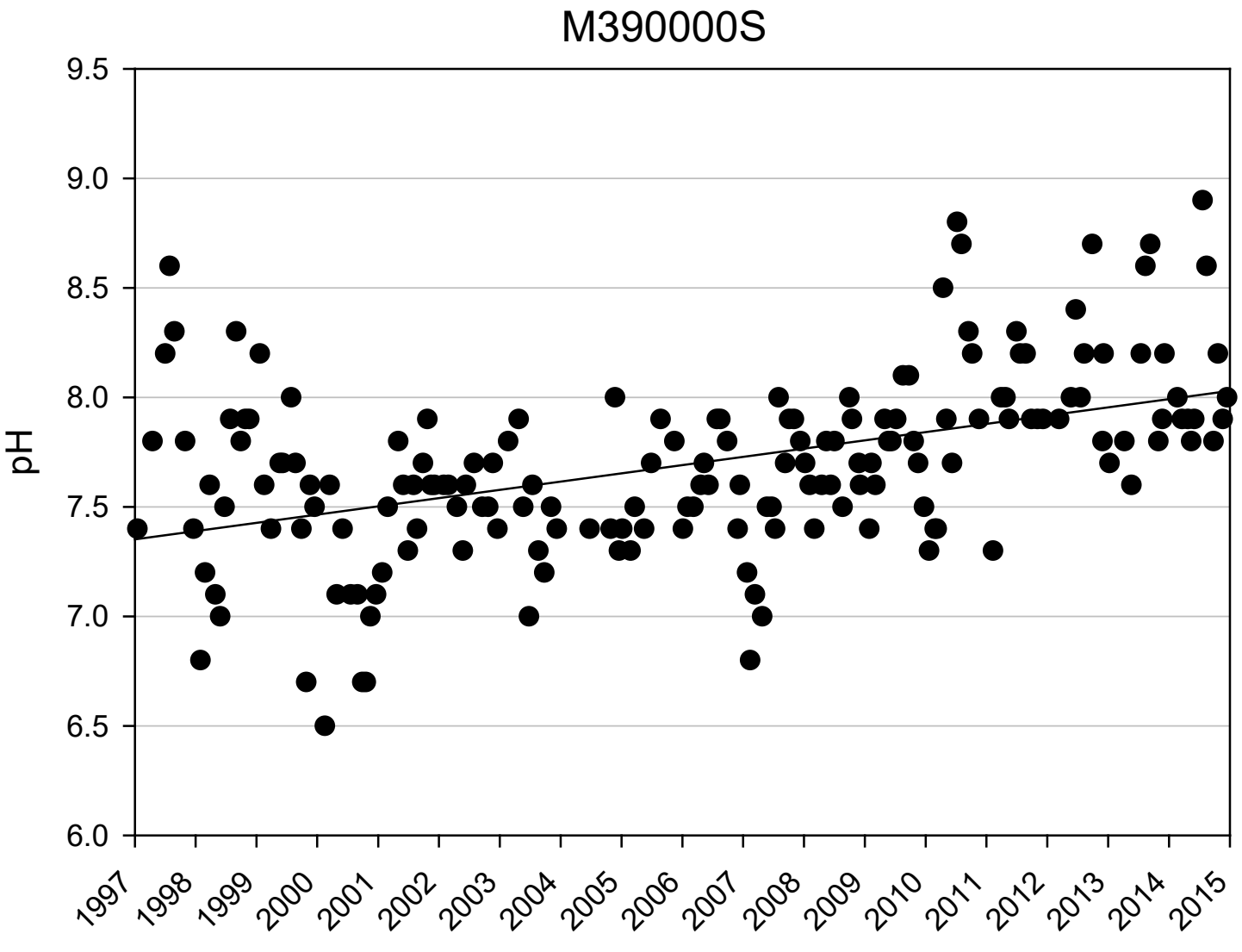
Curve 1:
pH value column 4:
Coefficients:
b[0] -264.8503991387
b[1] 1.1108293812e-4
r ² 0.2074648903

Albemarle Sound AU# 30c2a

M390000C

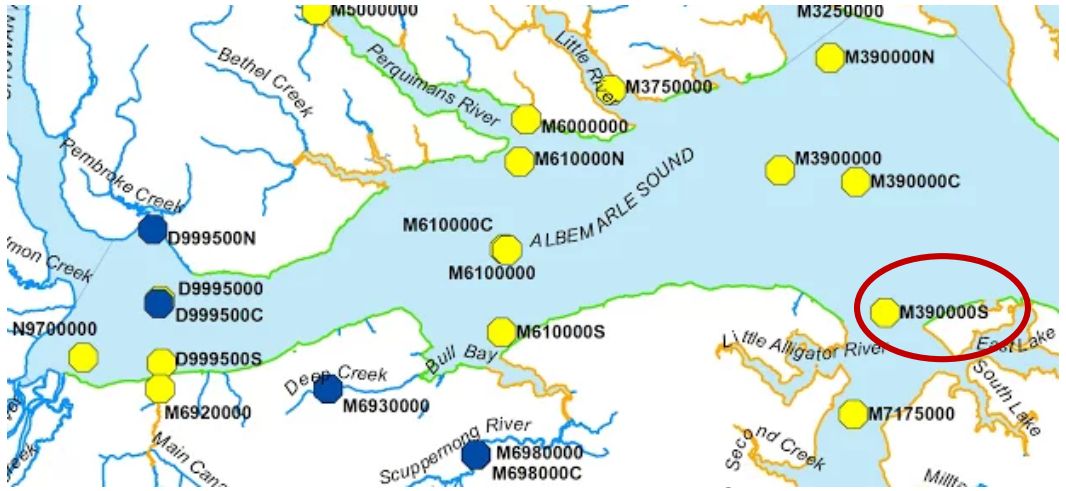


pH Assessment	2018 IR	2020 IR
n	40	35
Mean	8.1	8.0
Median	8.0	7.9
Min	7.0	7.0
Max	8.8	8.8
n>pH8.5	7	9
%>pH8.5	17.5	25.7
% confidence	90.0	99.4
Data Window	2012-2016	2014-2018



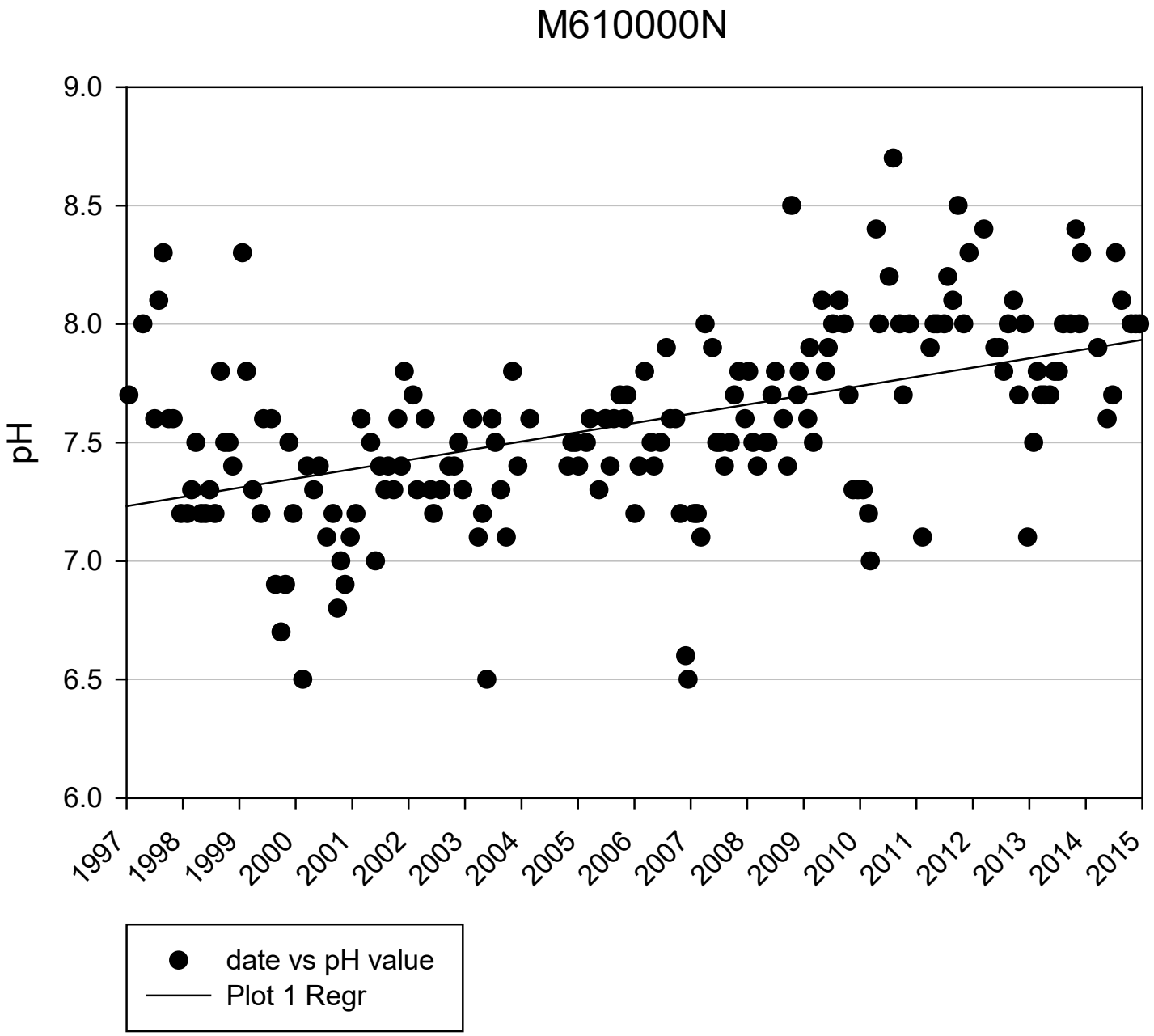
2016 IR (2010-2014 data window)

n	49
n>8.5	7
%>8.5	14.29
% Conf.	78.46



Curve 1:
pH value□column 5:
Coefficients:
b[0]□-245.4573979476
b[1]□1.0316825391e-4
r ²□0.2209342633

Last monitored on 12/16/14



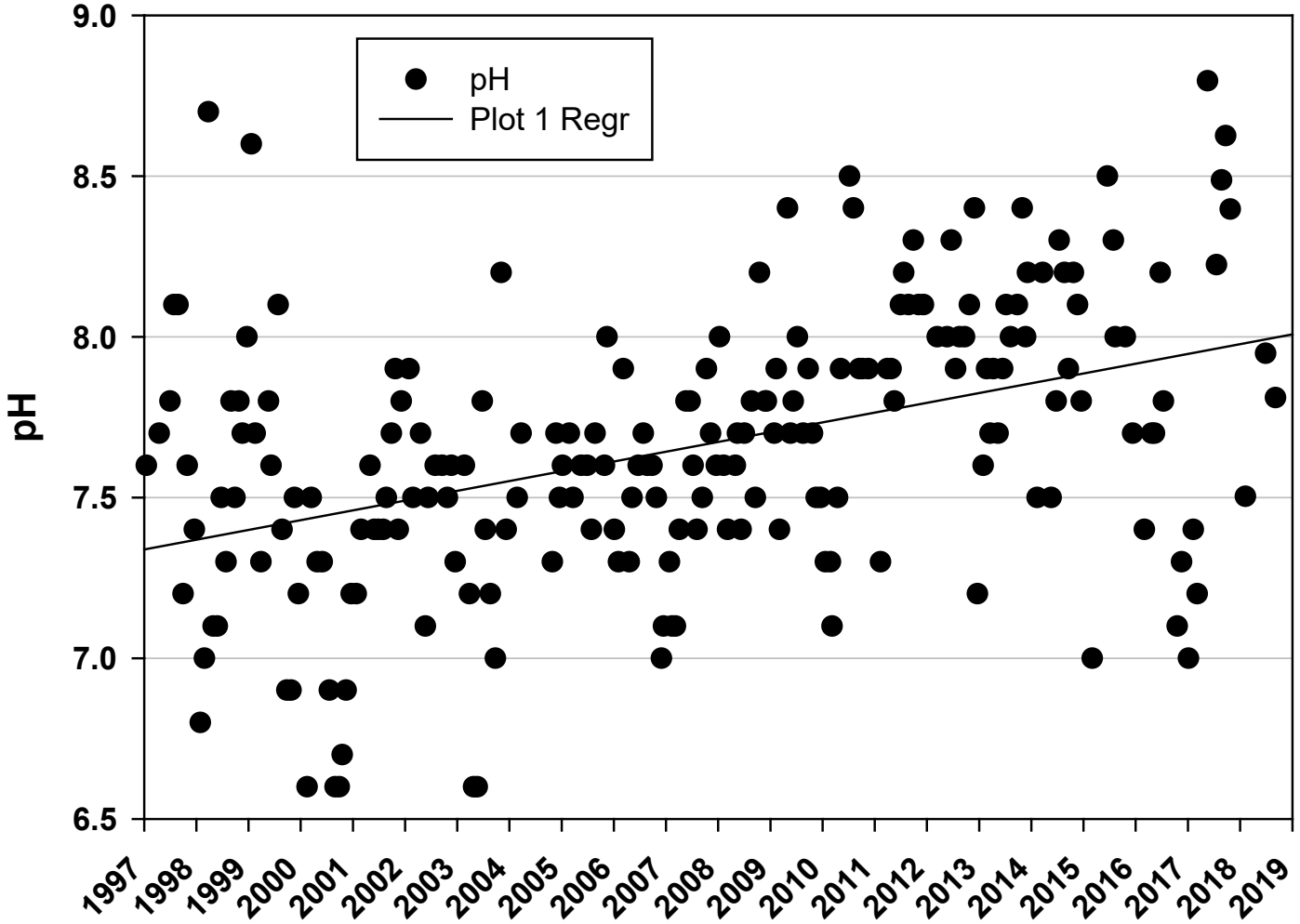
2016 IR (2010-2014 data window)

n	49
n>8.5	1
%>8.5	2.040816
Conf.	0.036738

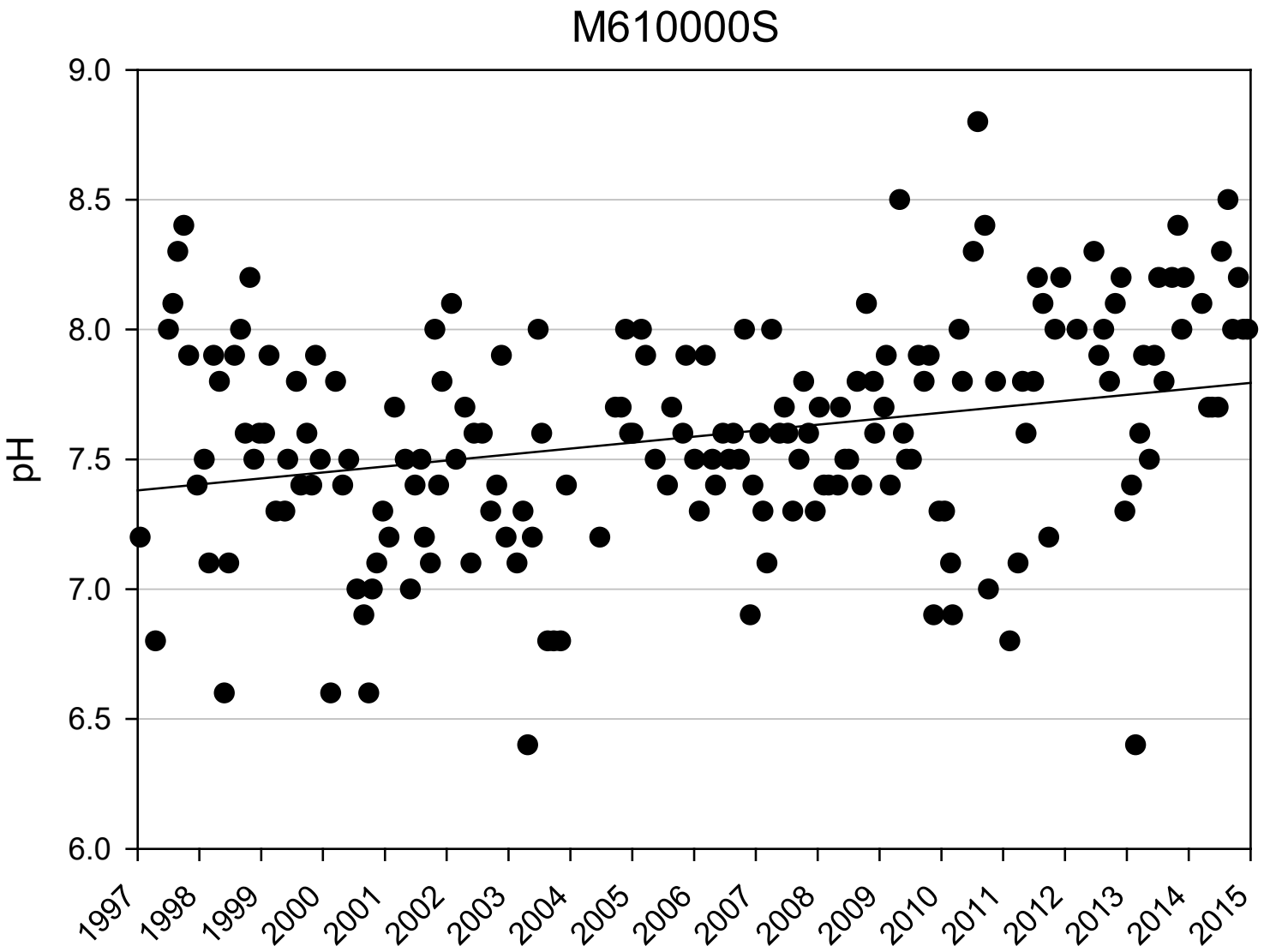
Last monitored on 12/16/14

Albemarle Sound AU# 30b

M610000C

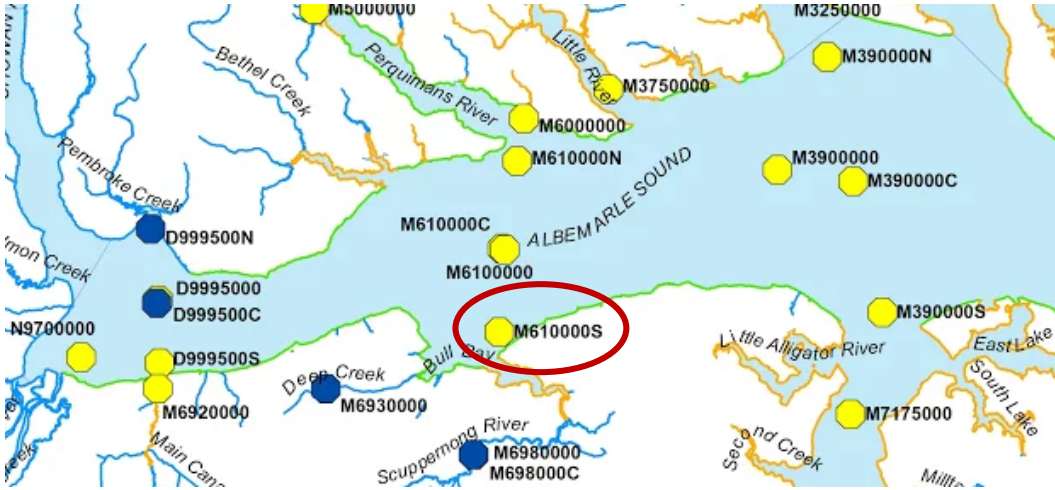


pH Assessment	2018 IR	2020 IR
n	44	35
Mean	7.9	7.9
Median	8.0	7.9
Min	7.0	7.0
Max	8.5	8.8
n>pH8.5	0	3
%>pH8.5	0	8.6
% confidence		30.6
Data Window	2012-2016	2014-2018



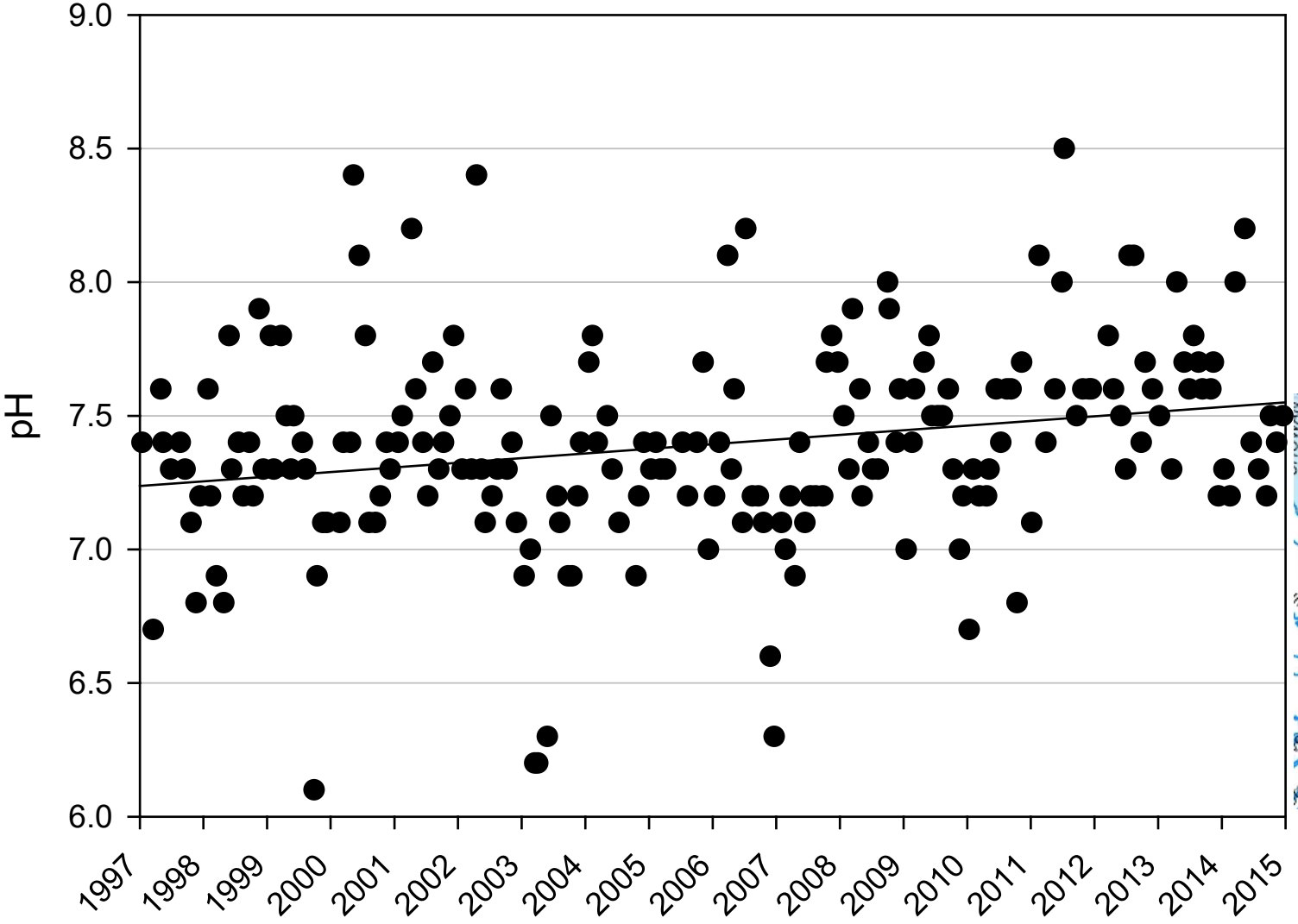
2016 IR (2010-2014 data window)

n	51
n>8.5	1
%>8.5	1.960784
% Conf.	0.4612



Last monitored on 12/16/14

D999500N



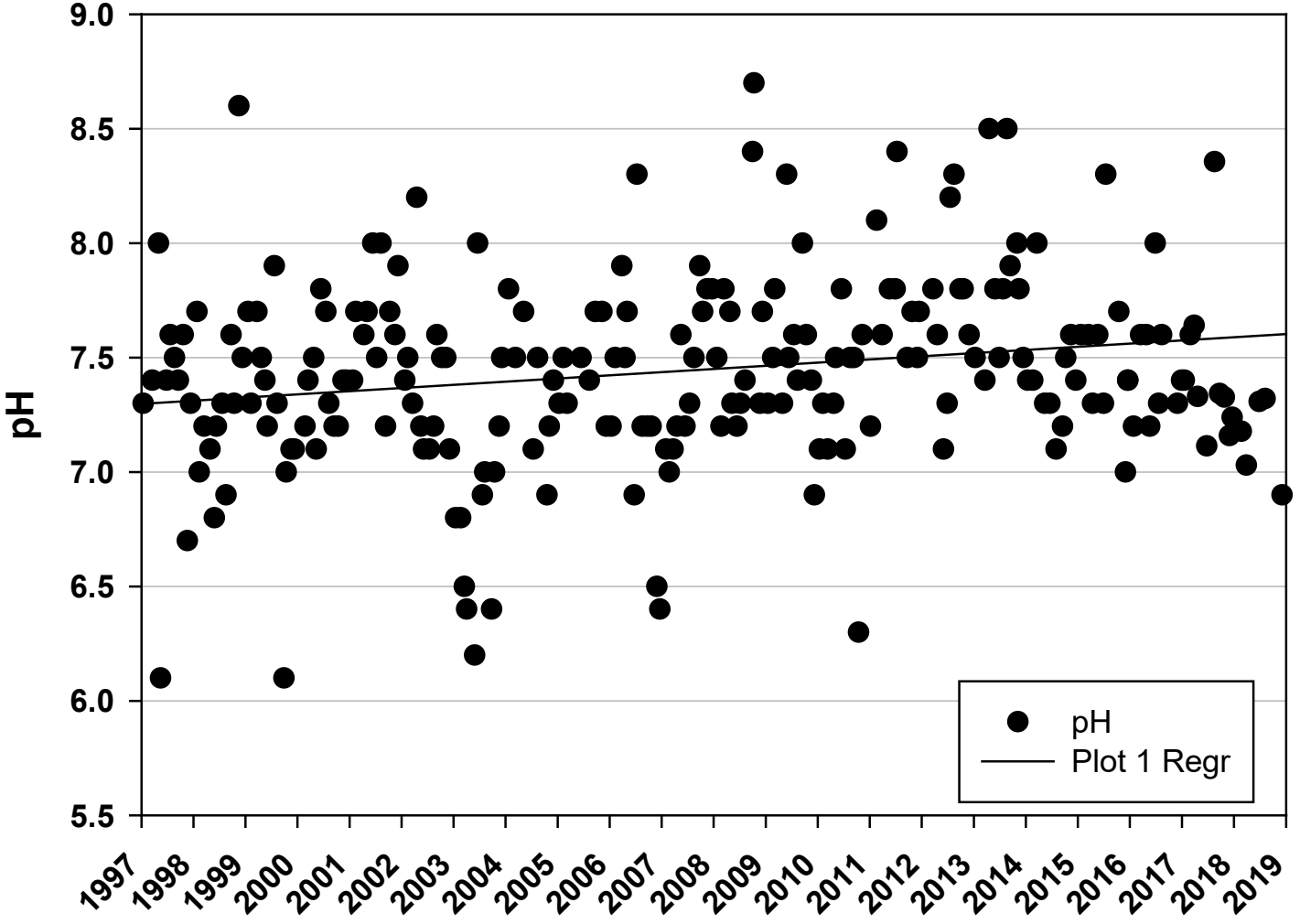
2016 IR (2010-2014 data window)

n	51
n>8.5	0
%>8.5	0
Conf.	

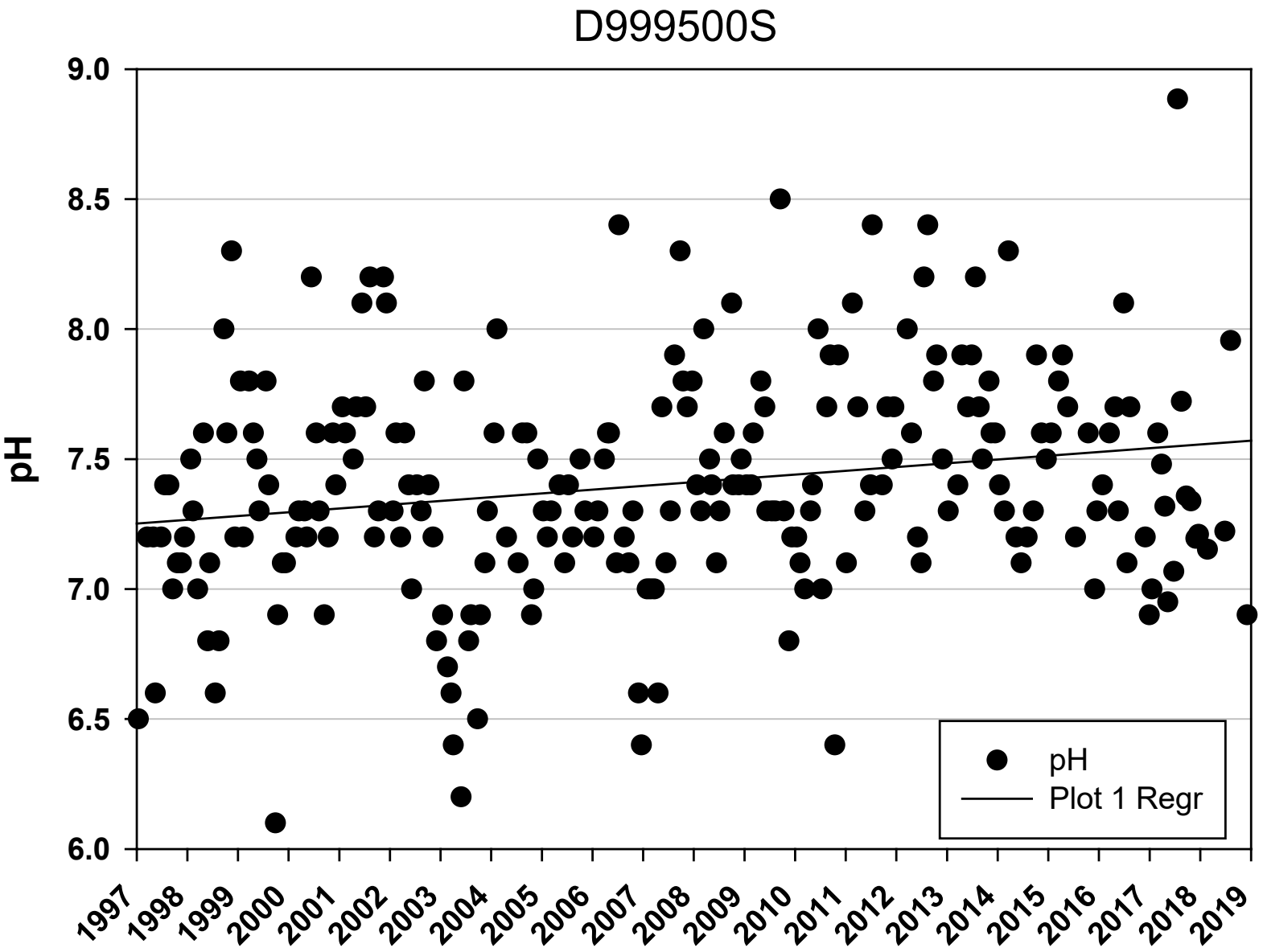
Last monitored on 12/17/14

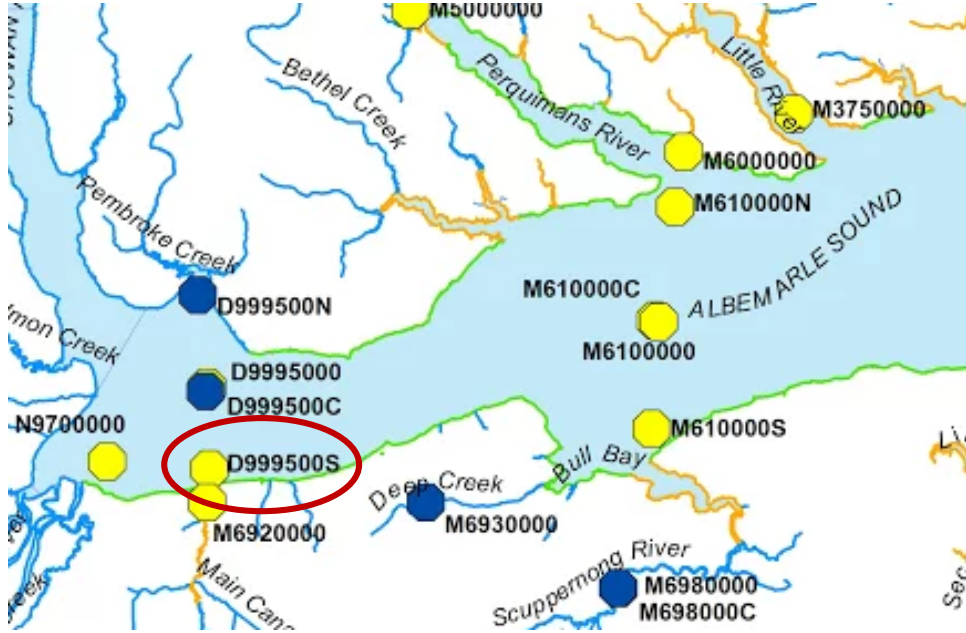
Albemarle Sound AU# 30a

D999500C



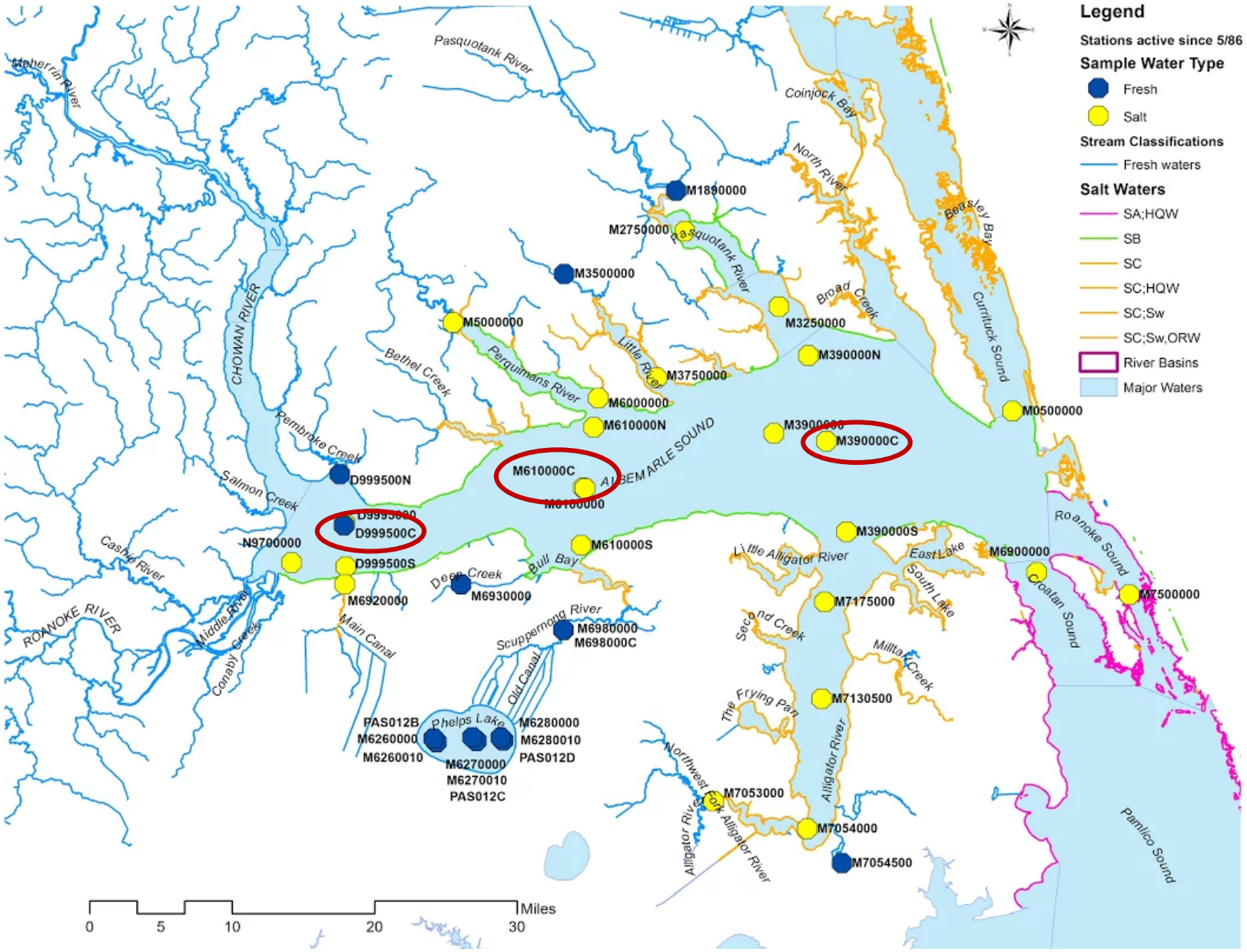
pH Assessment	2018 IR	2020 IR
n	49	45
Mean	7.6	7.5
Median	7.6	7.4
Min	7.0	6.9
Max	8.5	9.2
n>pH8.5	0	1
%>pH8.5	0	2.2
% confidence		0.87
Data Window	2012-2016	2014-2018


D999500S
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
pH
Plot 1 Regr

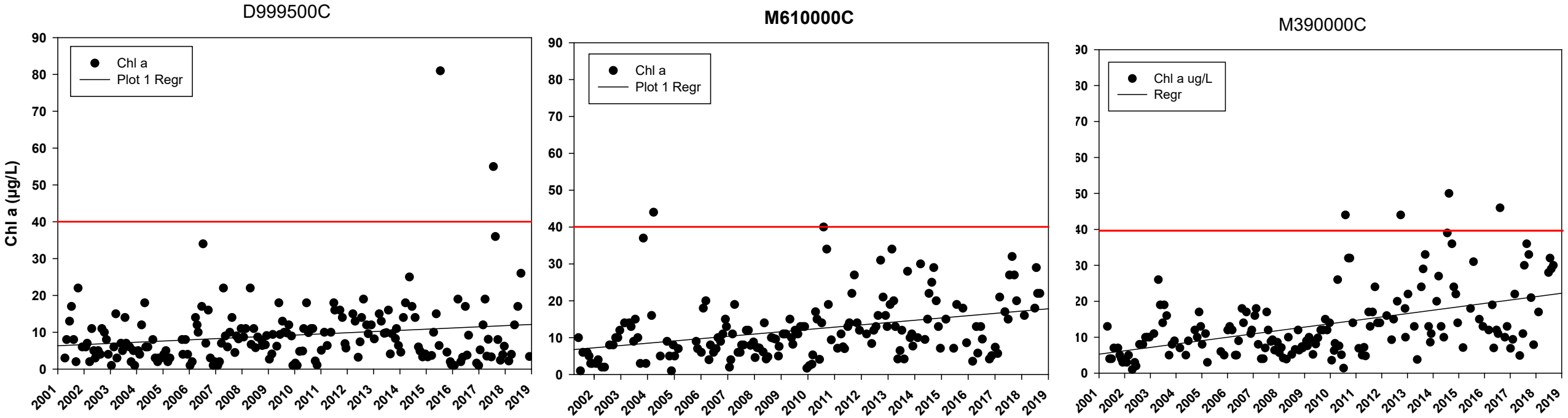

Bethel Creek
Perquimans River
Little River
M3750000
M6000000
M610000N
Pembroke Creek
ALBEMARLE SOUND
D999500N
M610000C
M6100000
D9995000
D999500C
N9700000
M610000S
D999500S
Deep Creek
Bull Bay
M6930000
M6920000
Main Canal
Scuppernong River
M6980000
M698000C

Chlorophyll *a* Data

- Data only available at the center channel stations.
  - ✓ M390000C
  - ✓ M610000C
  - ✓ D999500C
- Data starting in 2001 or 2002.
- Some data at M6100000 but only to 1996.

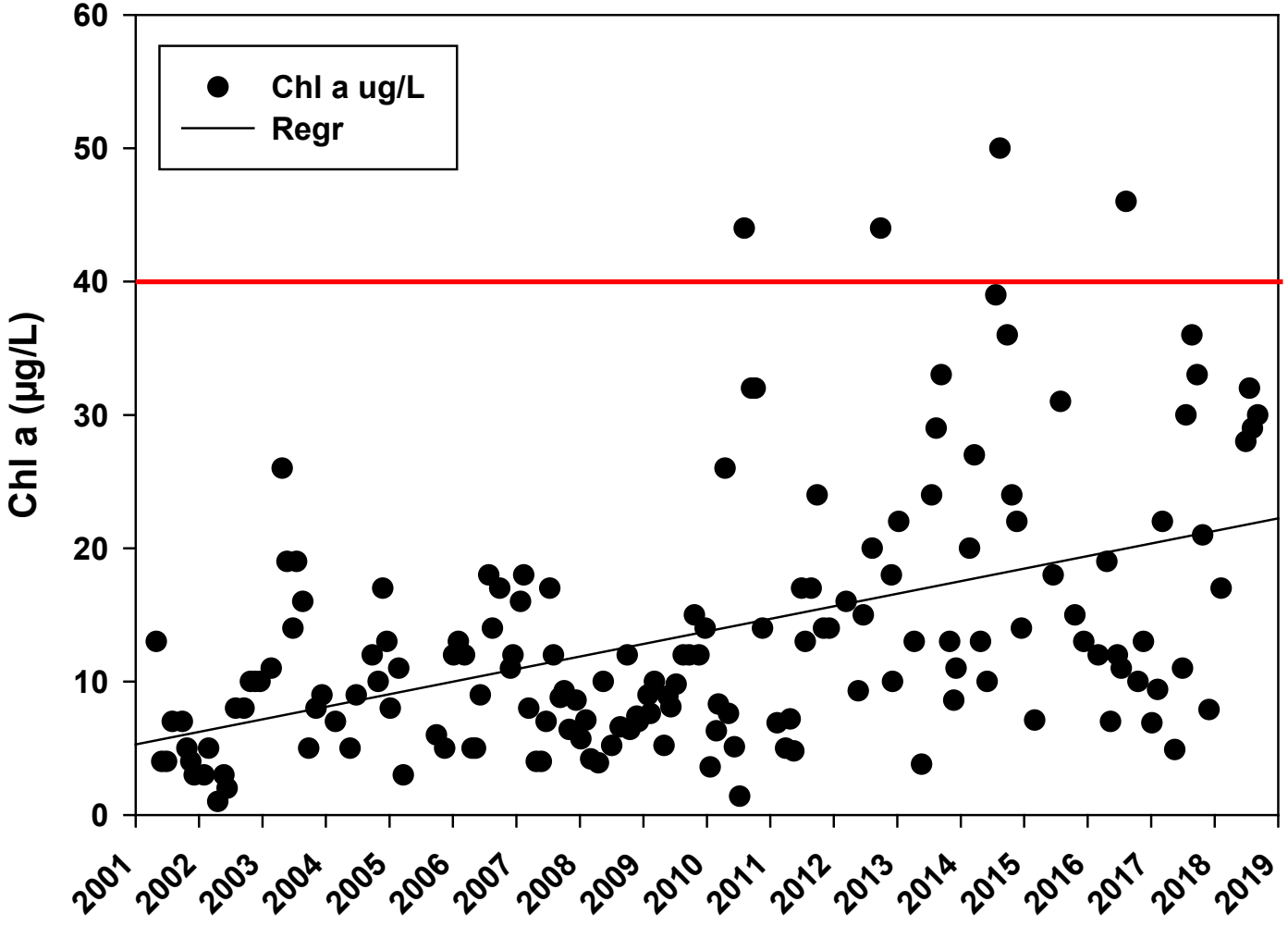


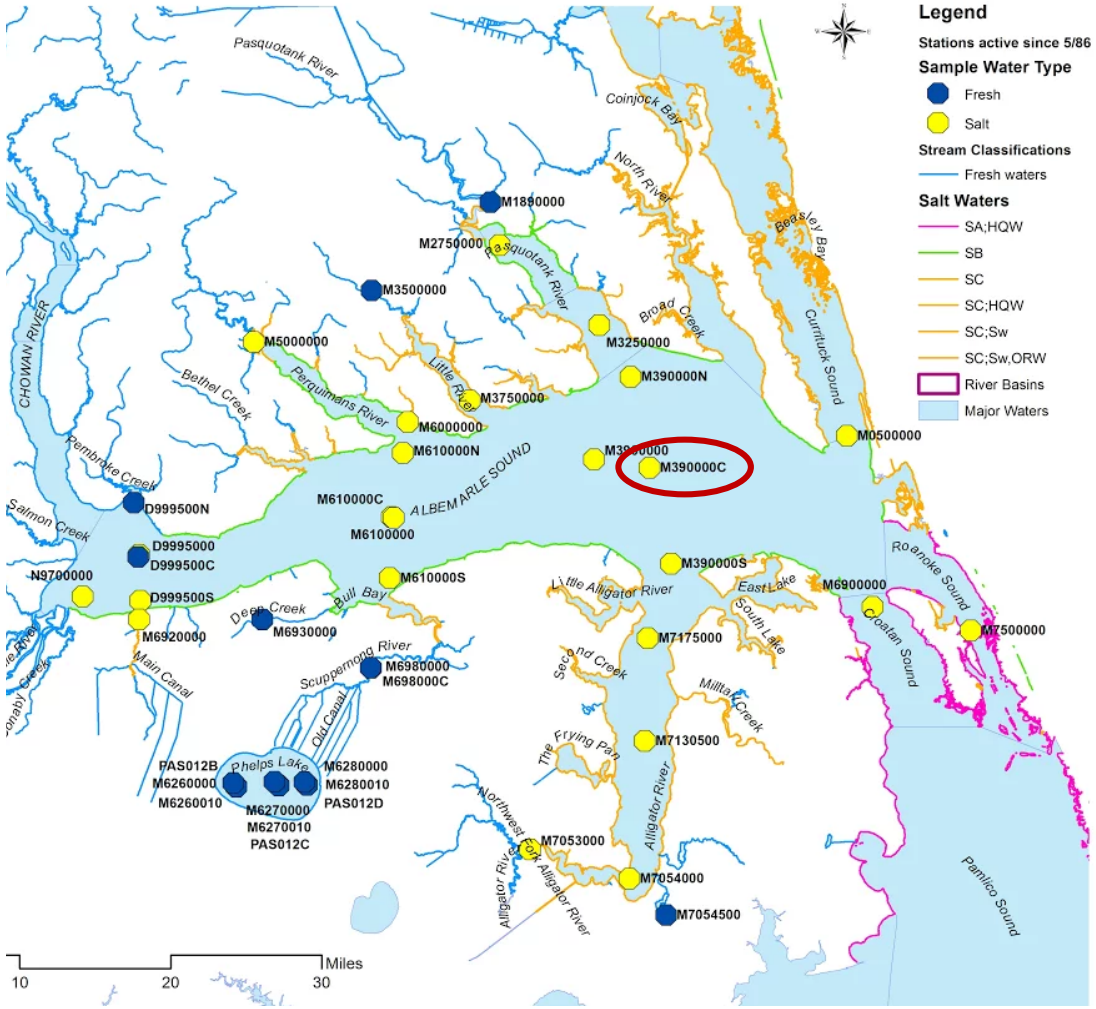
Chlorophyll *a*

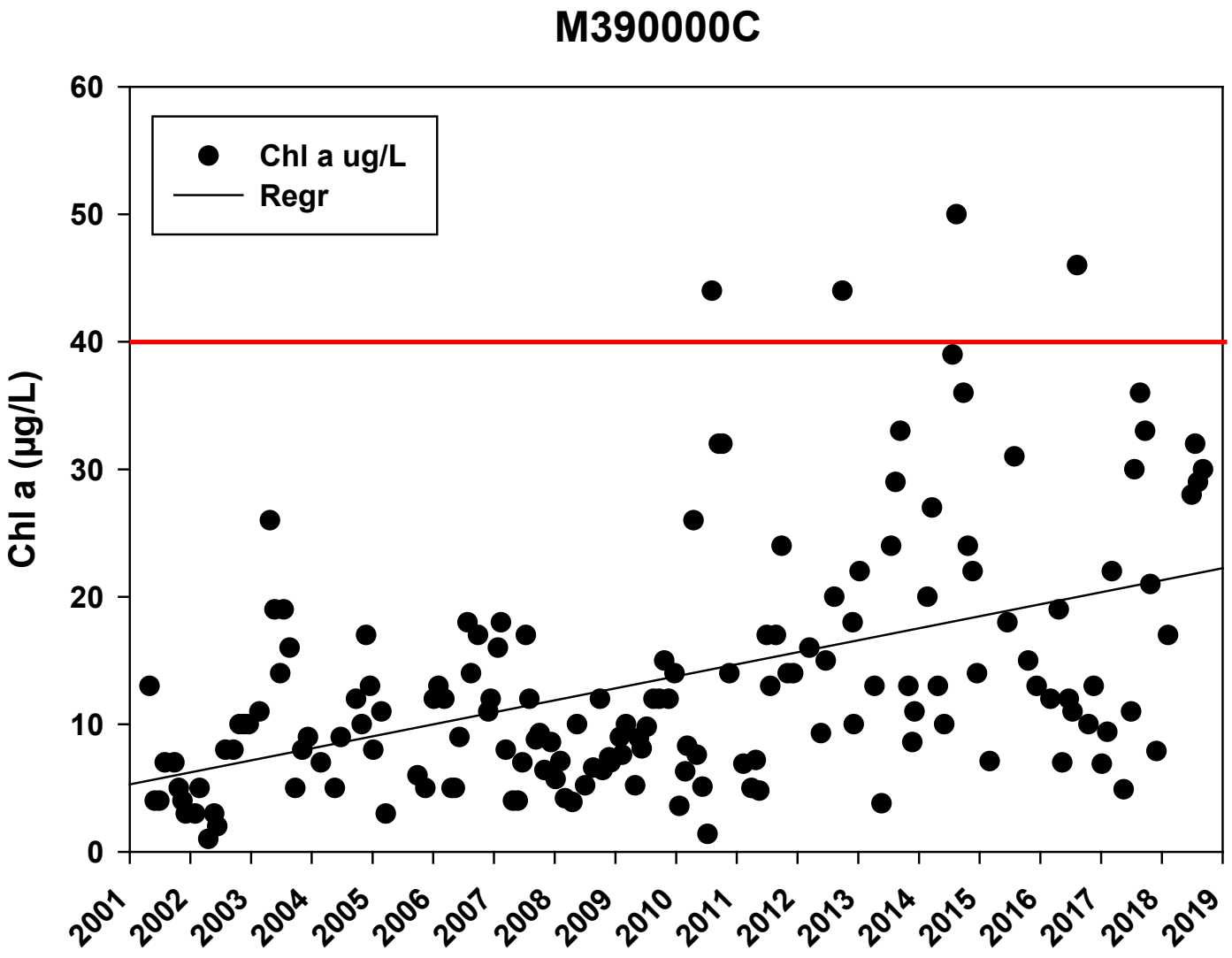


Albemarle Sound AU# 30c2a

M390000C





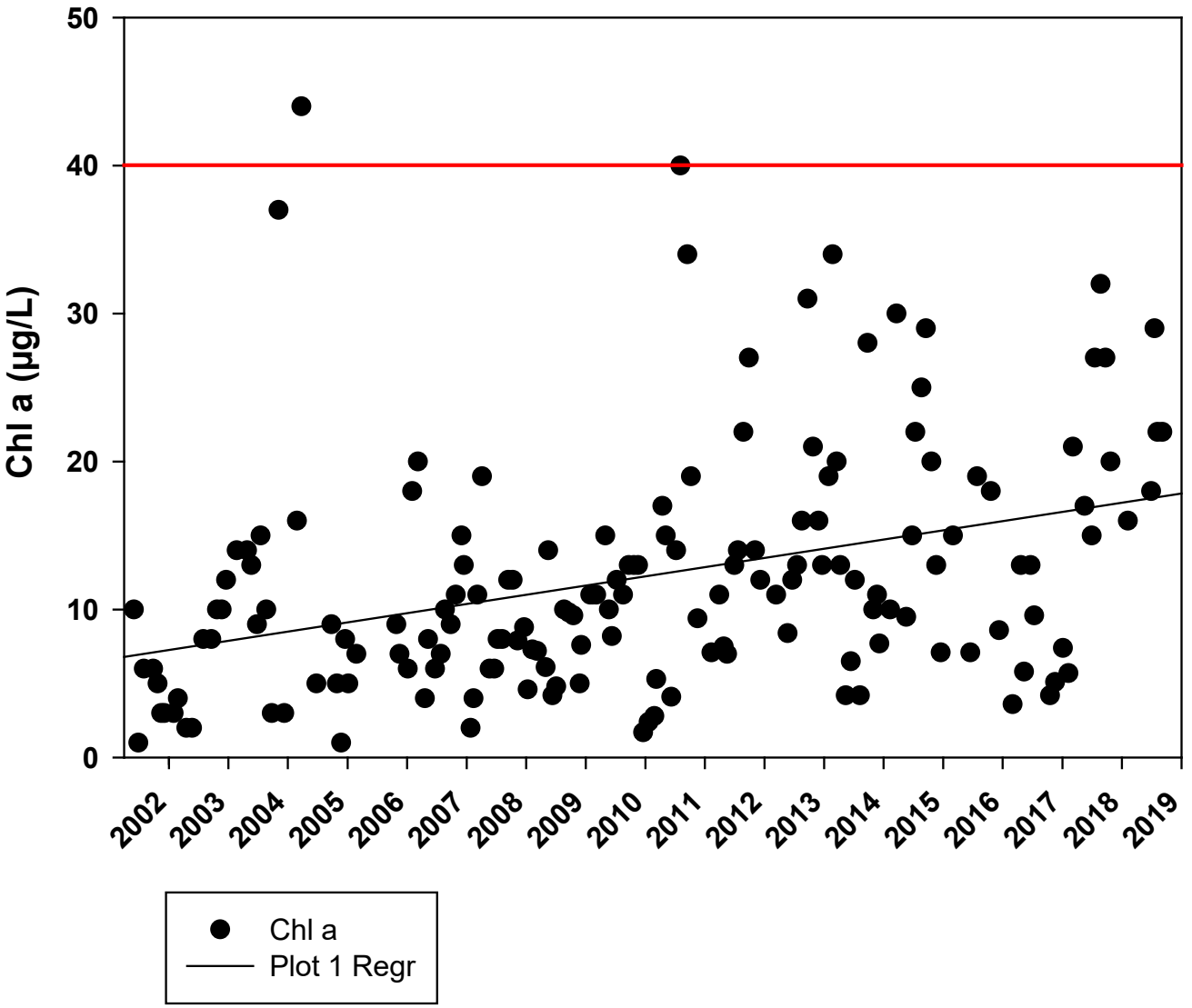


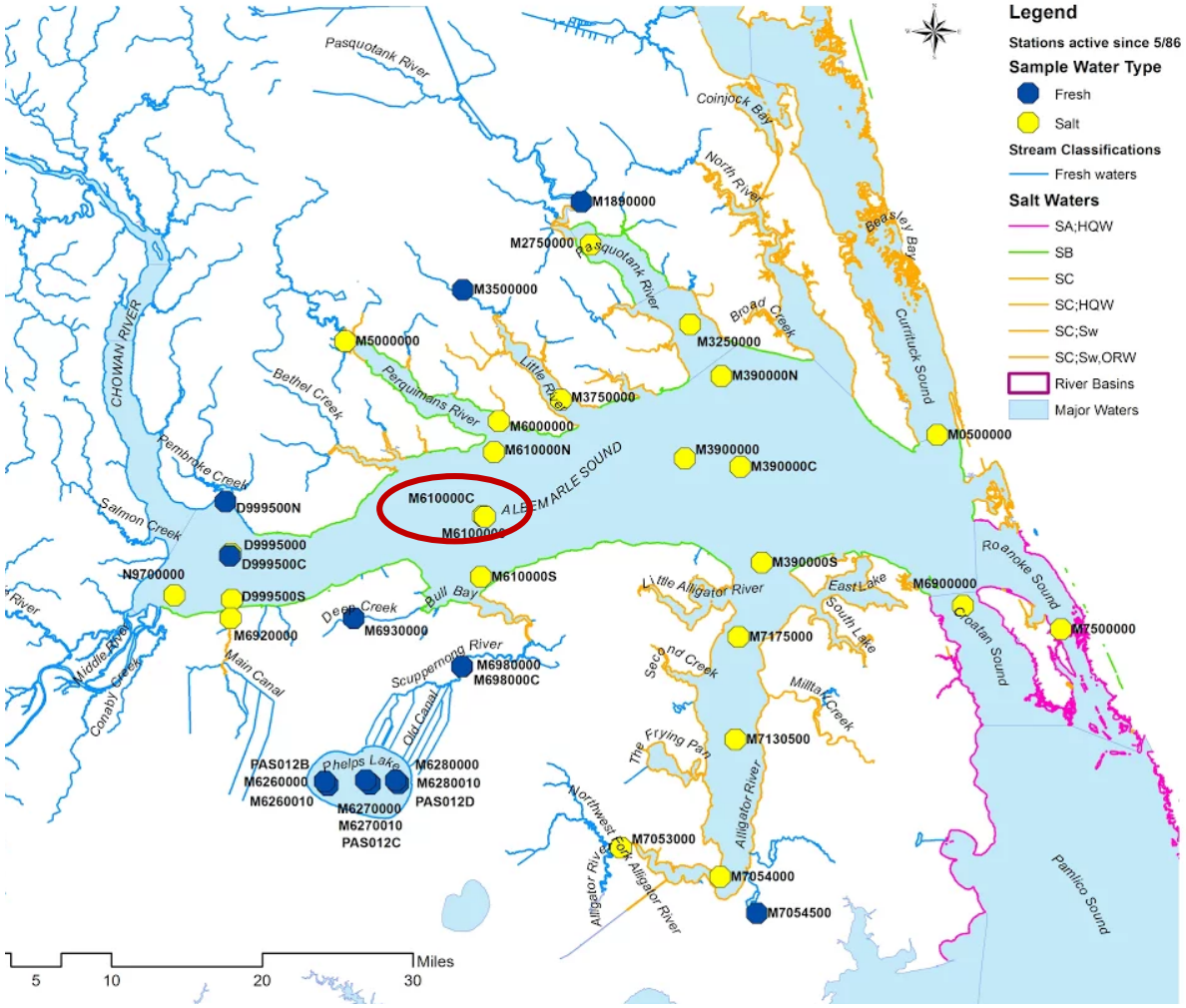
Albemarle Sound AU# 30c2a

pH Assessment	2018 IR	2020 IR
n	39	38
Mean	19.5	20.7
Median	15.0	18.5
Min	3.8	4.9
Max	50	50
n>Chl a 40µg/L	3	2
%>Chl a 40µg/L	7.7	5.3
% confidence	23.7	9.5
Data Window	2012-2016	2014-2018

Albemarle Sound AU# 30b

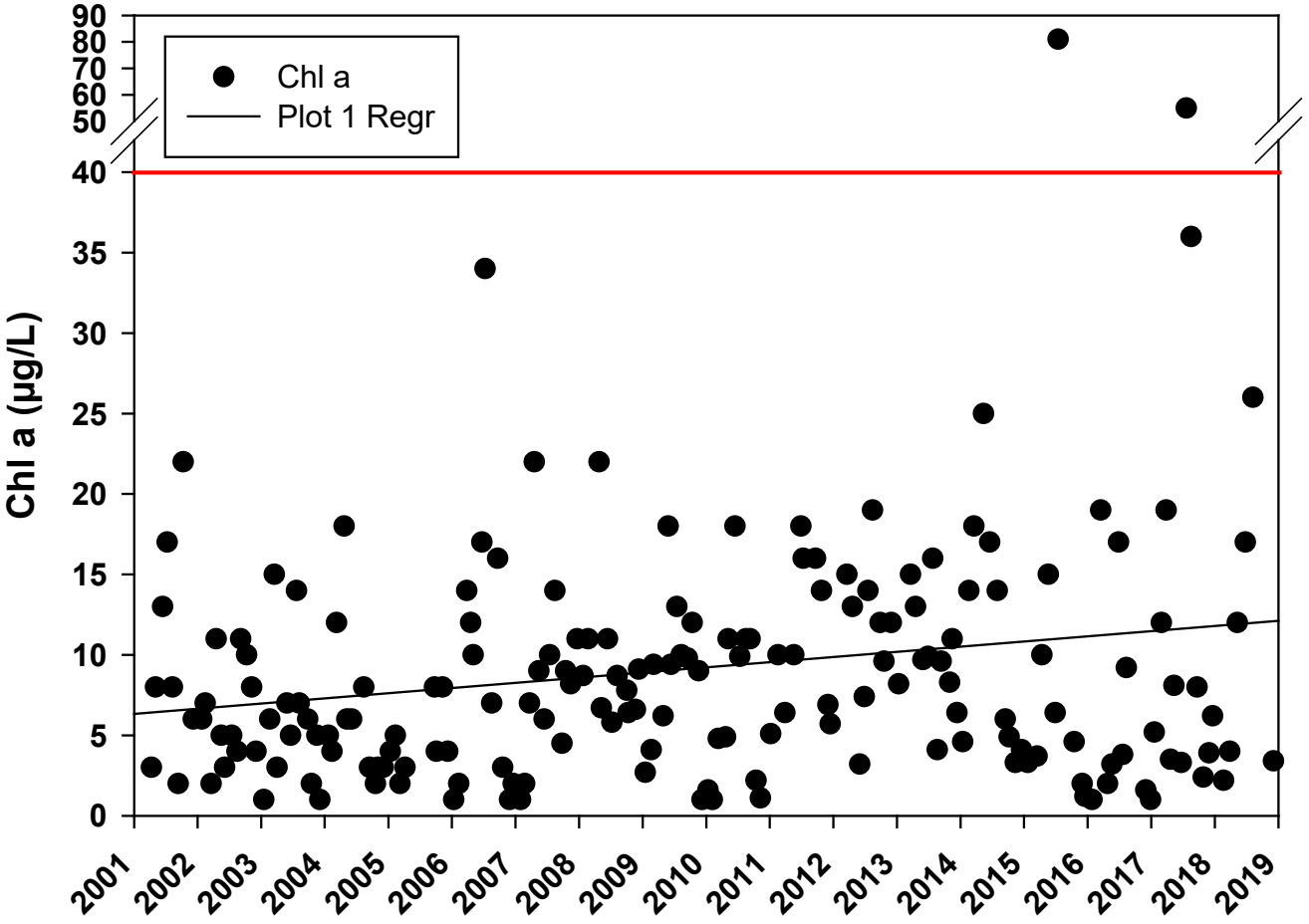
M610000C

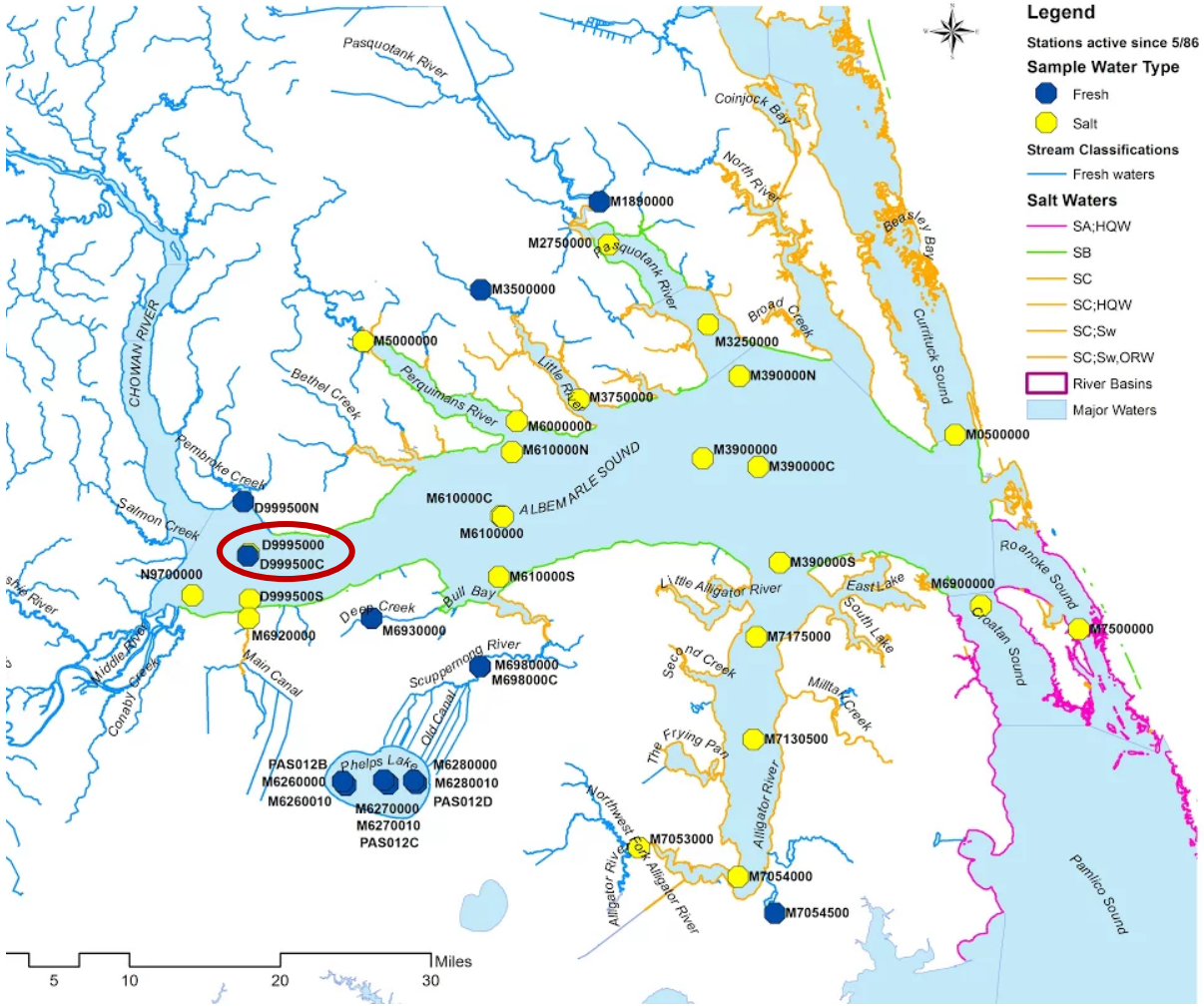




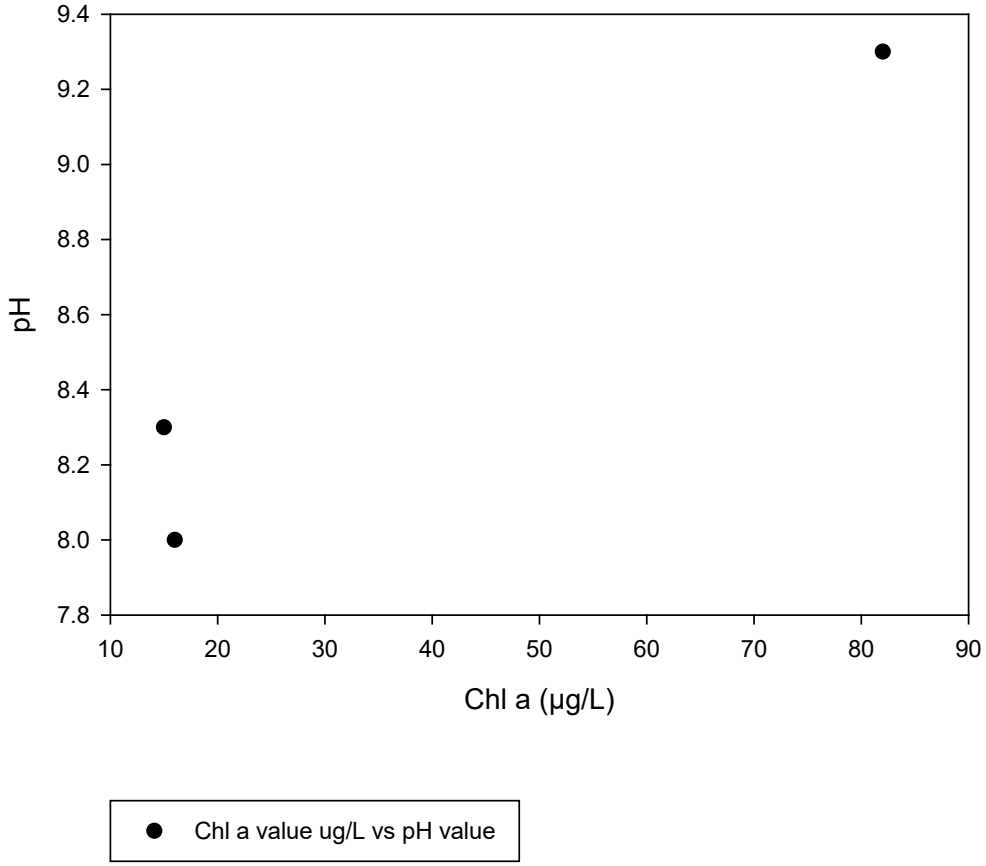
Albemarle Sound AU# 30a

D999500C

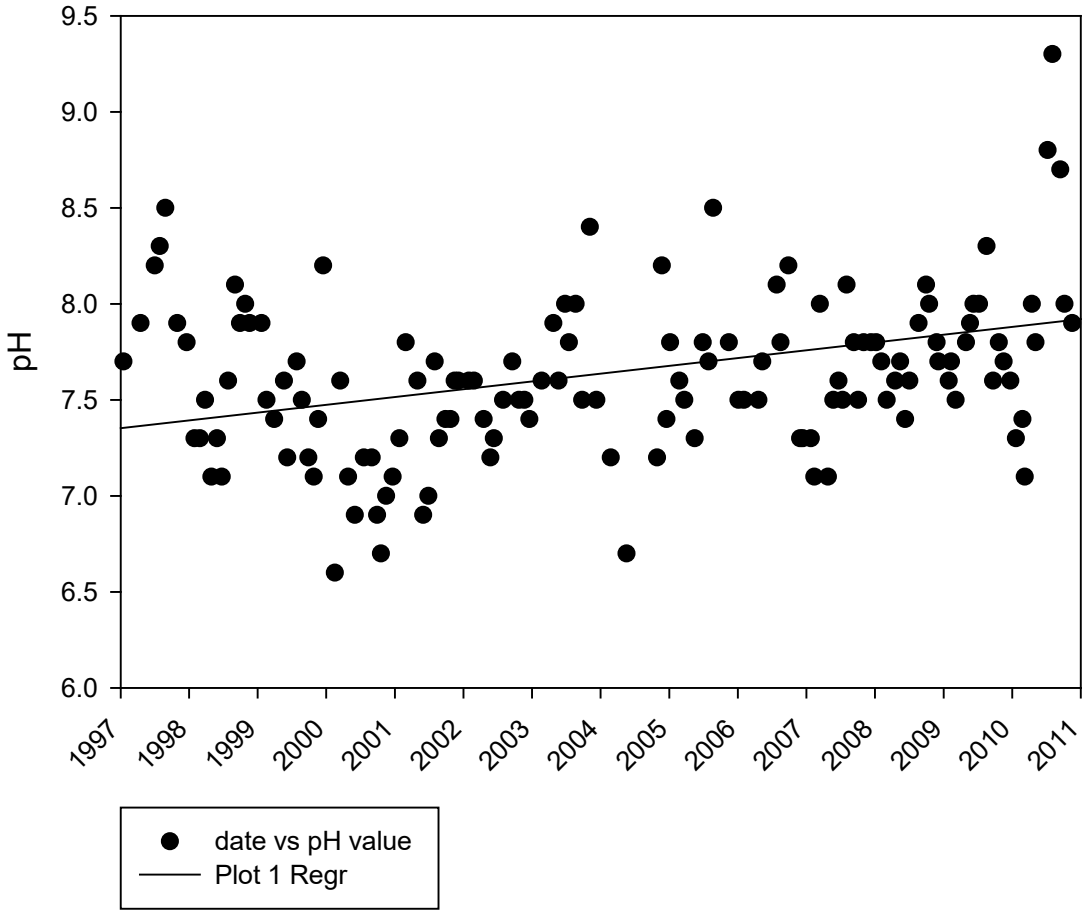


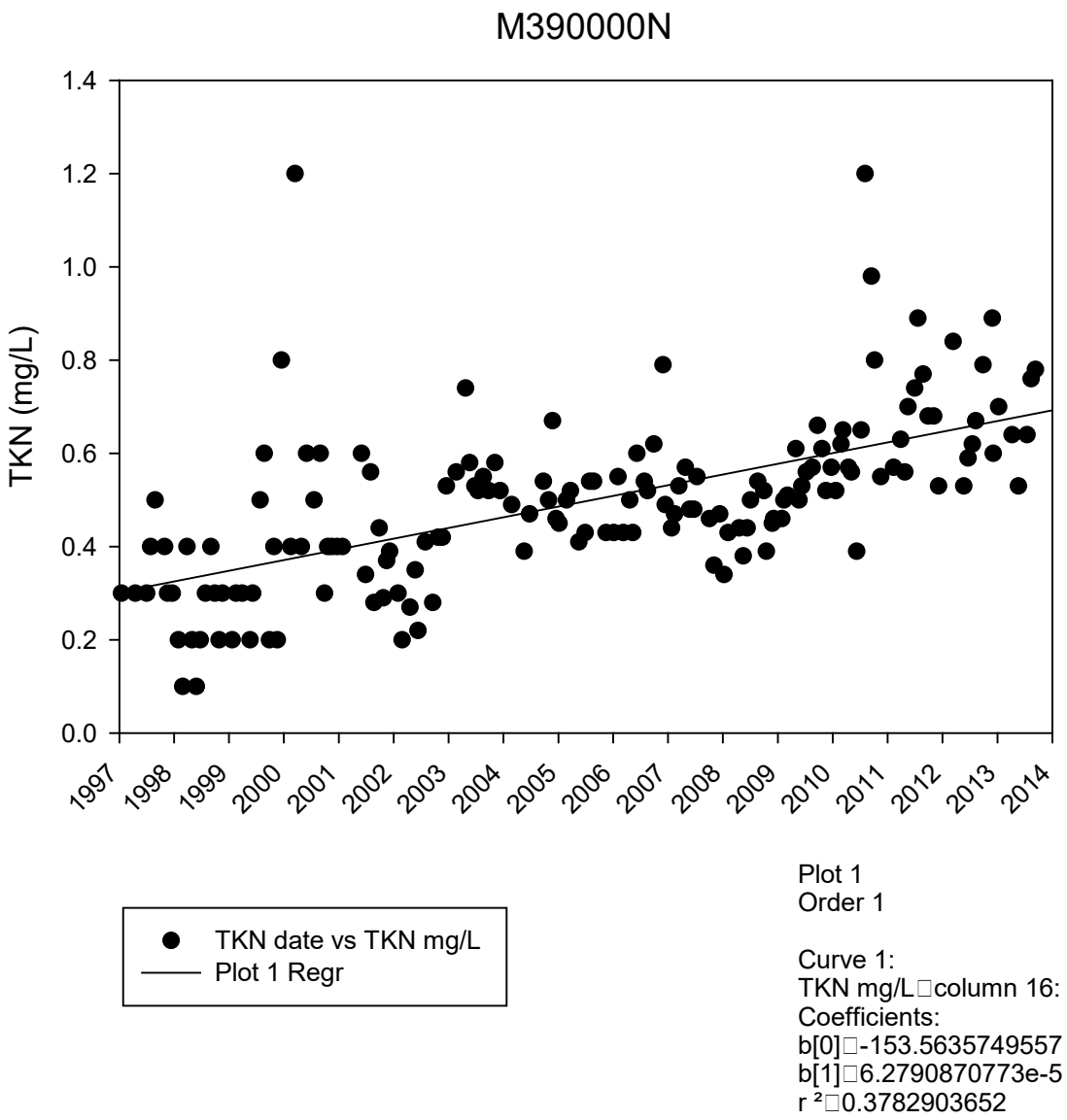


M390000N
ALBEMARLE SOUND NR FROG ISLAND N SHORE



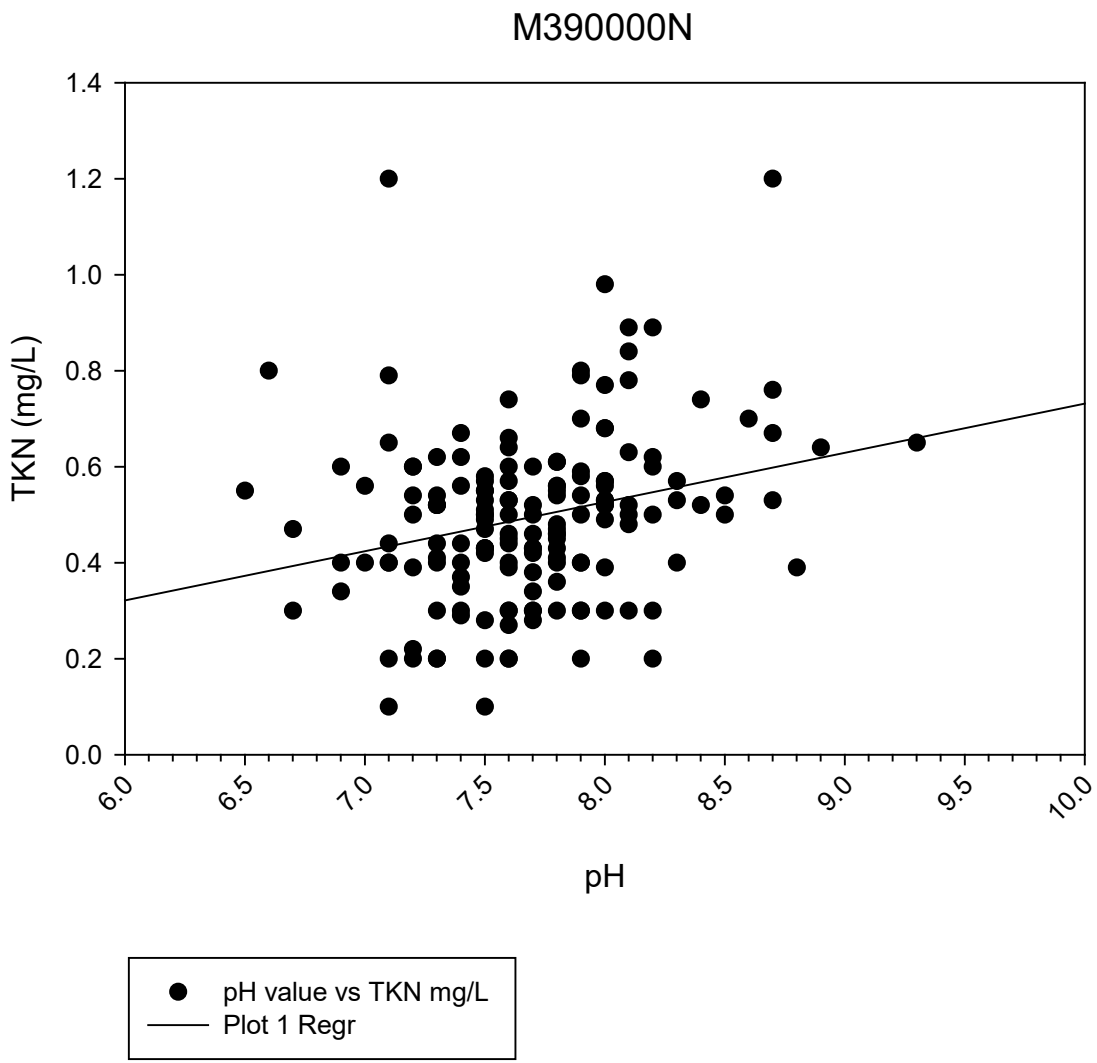
M390000N
ALBEMARLE SOUND NR FROG ISLAND N SHORE

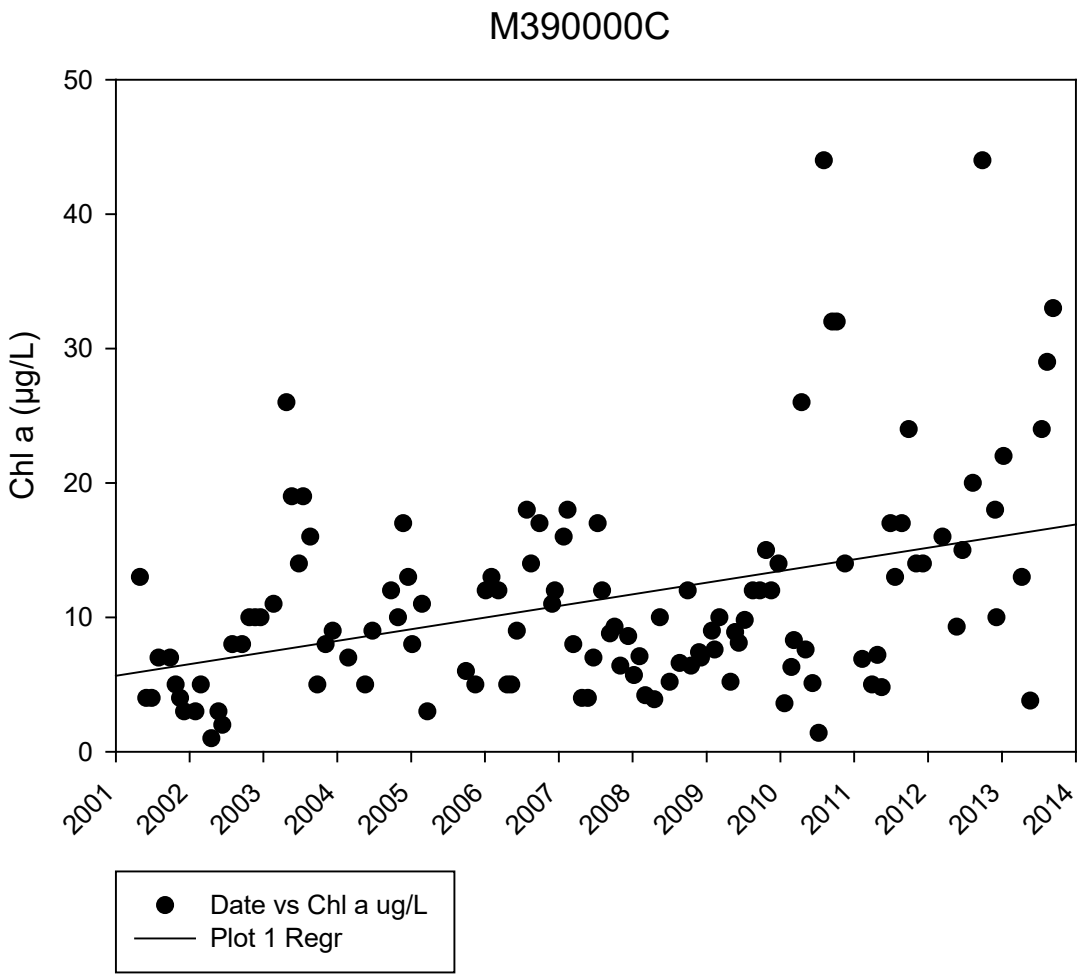


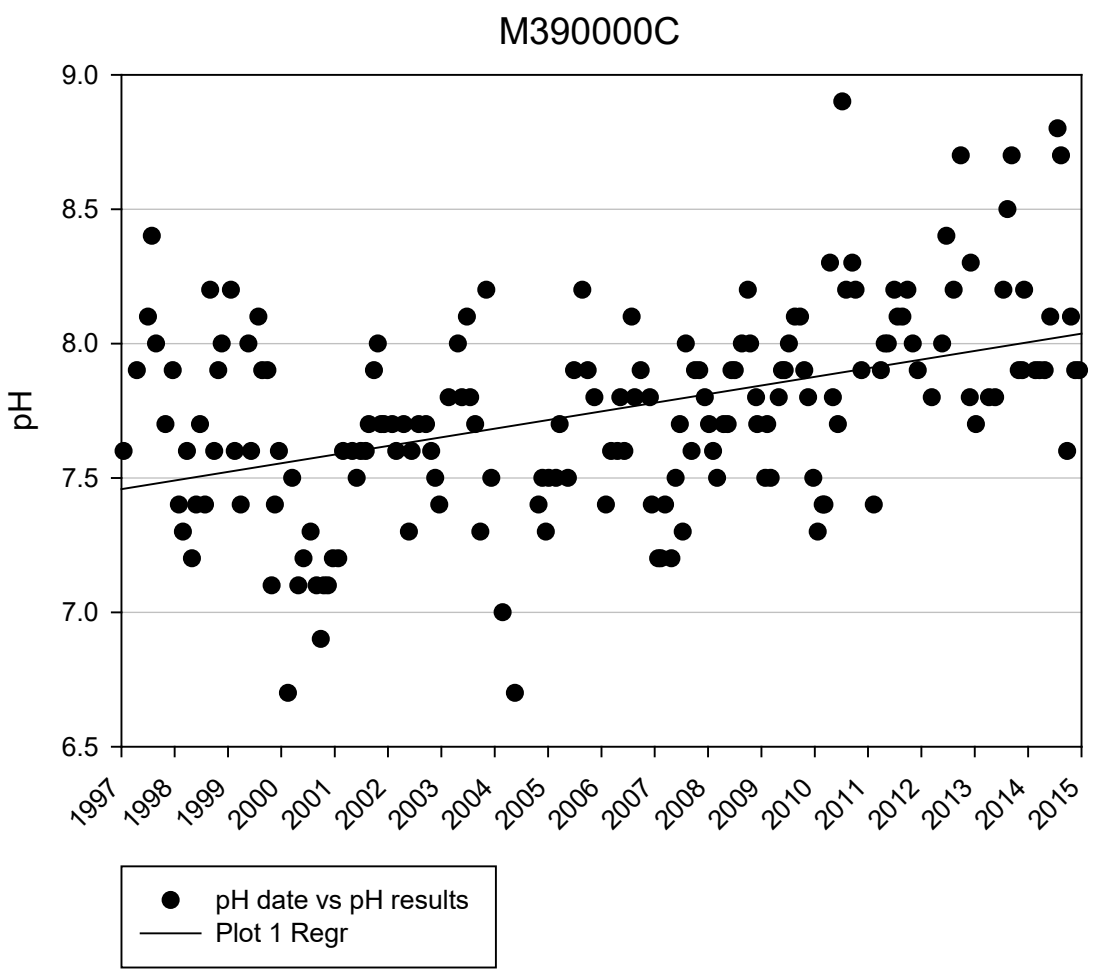


Plot 1
Order 1

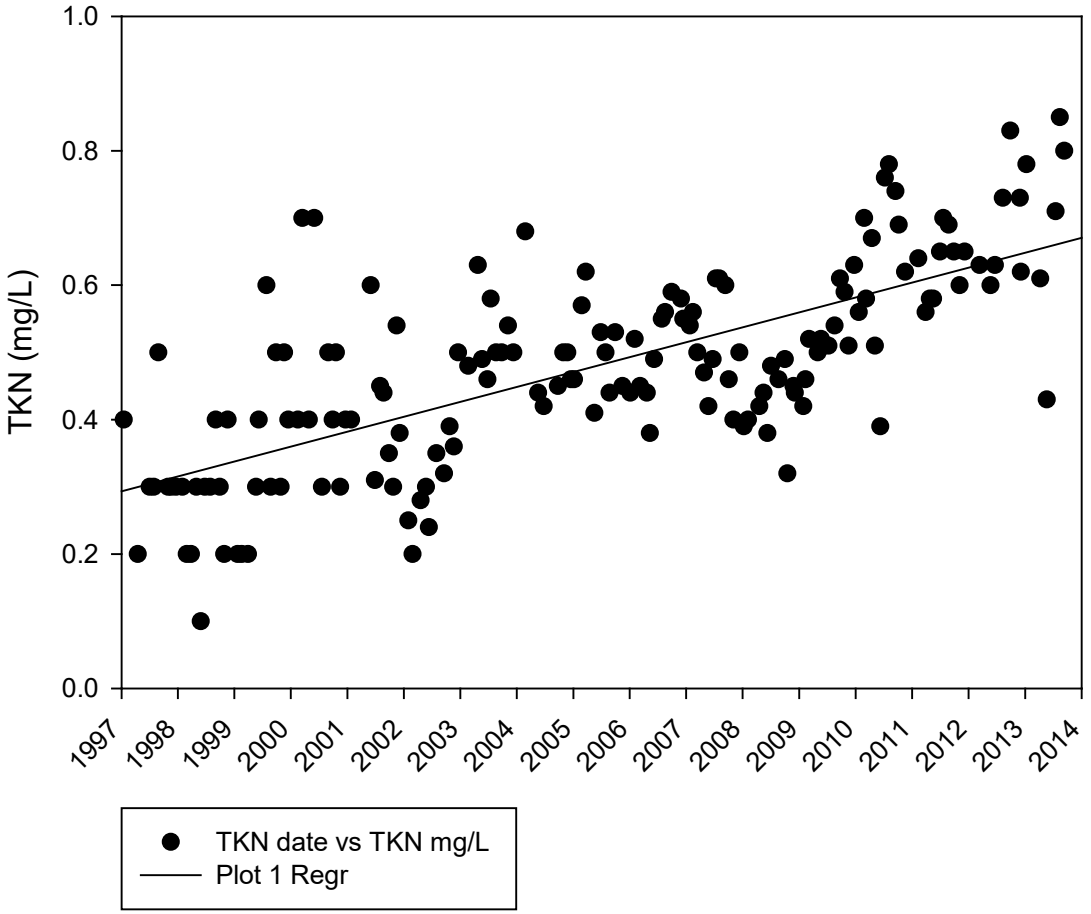
Curve 1:
TKN mg/L□column 16:
Coefficients:
b[0]□-153.5635749557
b[1]□6.2790870773e-5
r ²□0.3782903652



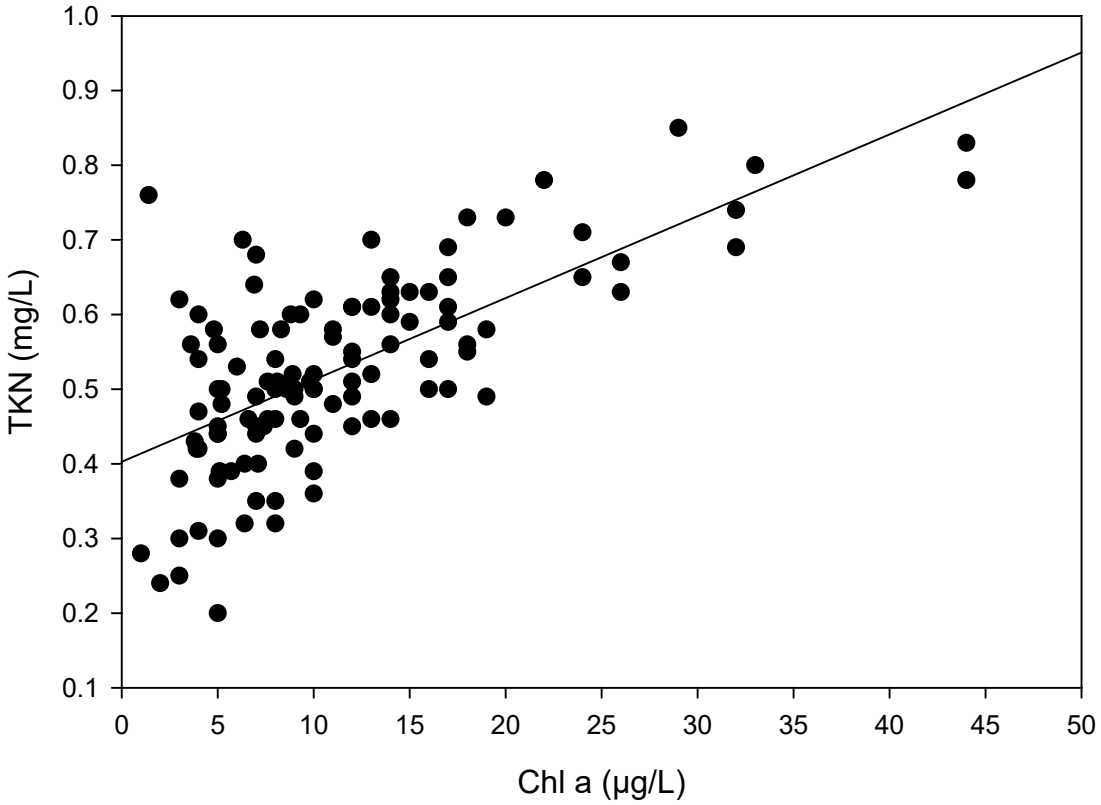

M390000C
Chl a (µg/L)
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Date vs Chl a ug/L
Plot 1 Regr


M390000C
pH
9.0
8.5
8.0
7.5
7.0
6.5
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
pH date vs pH results
Plot 1 Regr

M390000C

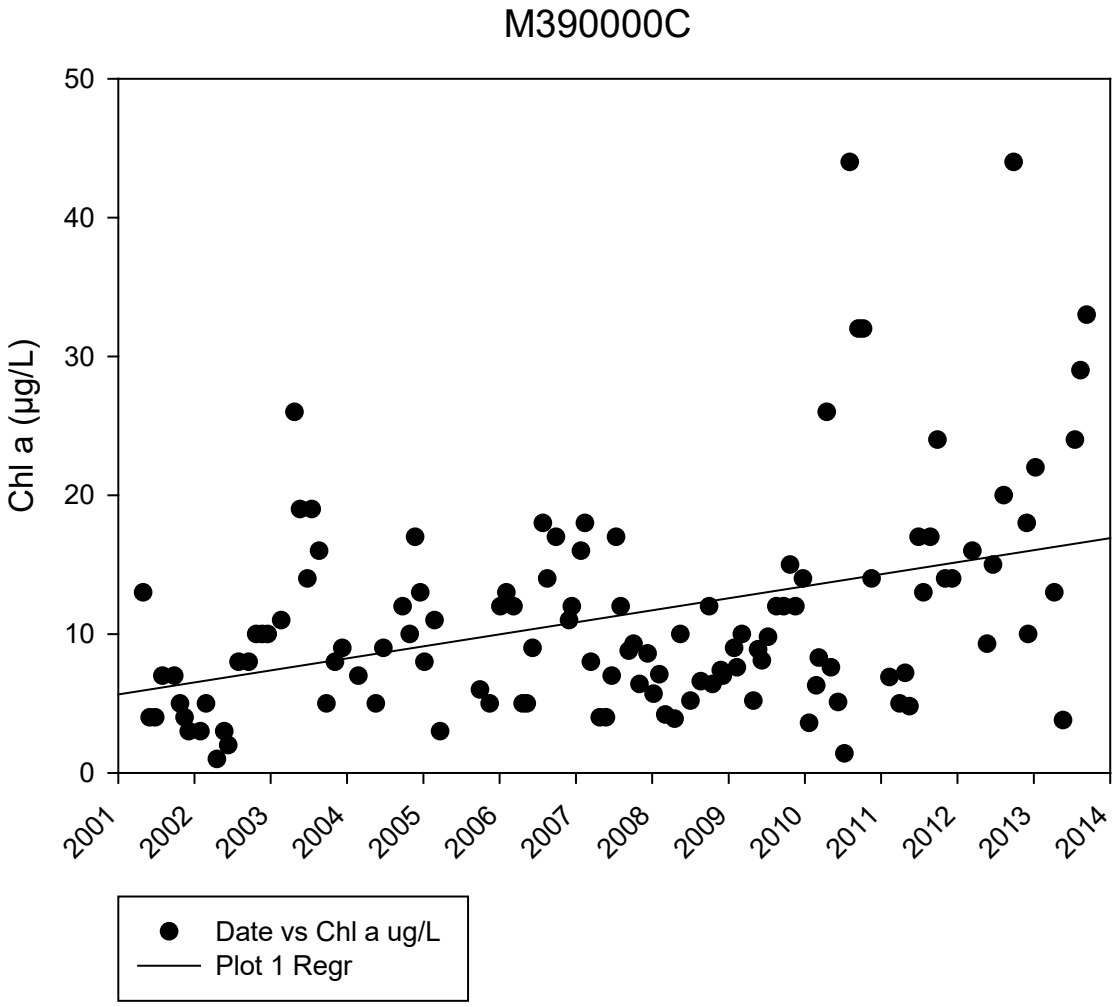


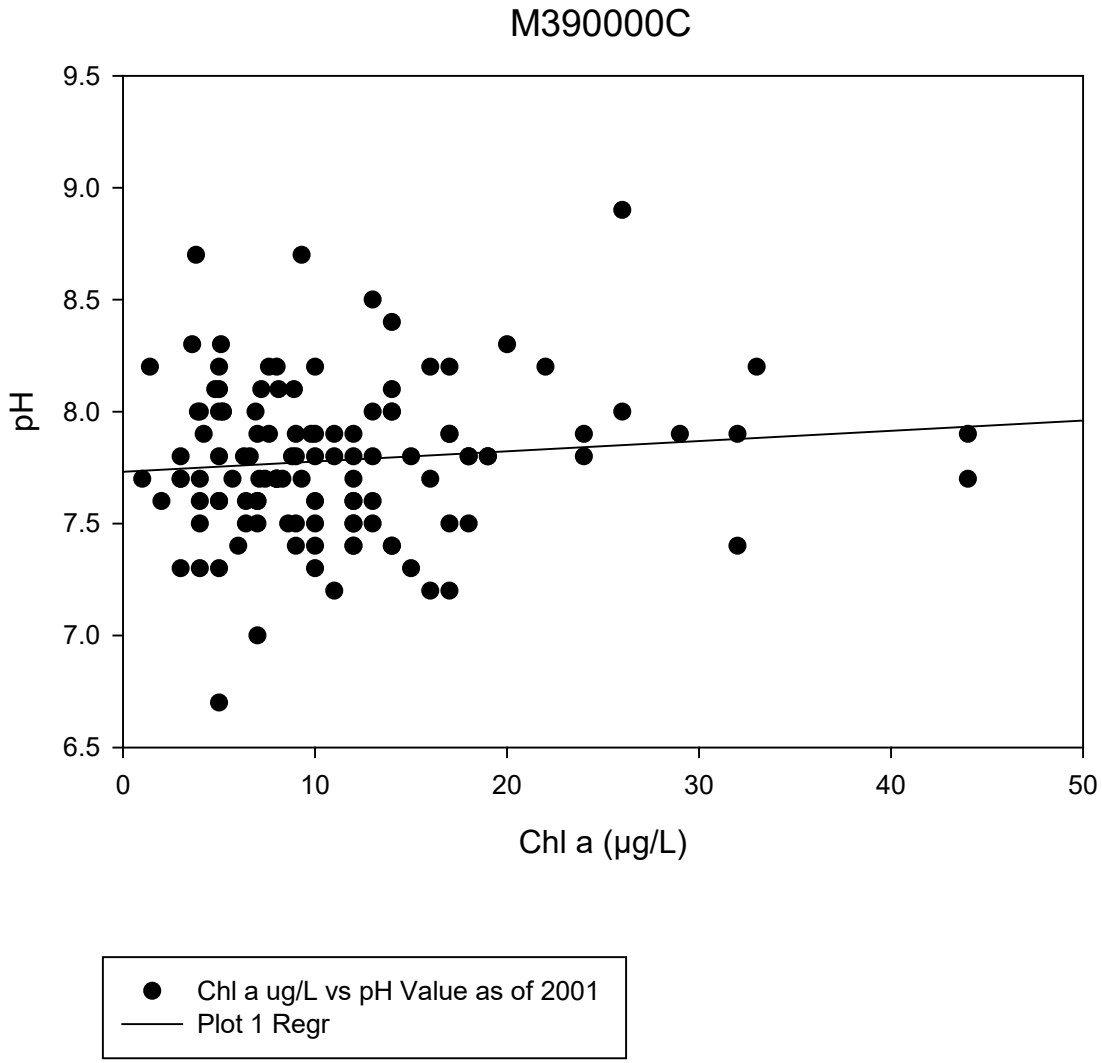
M390000C



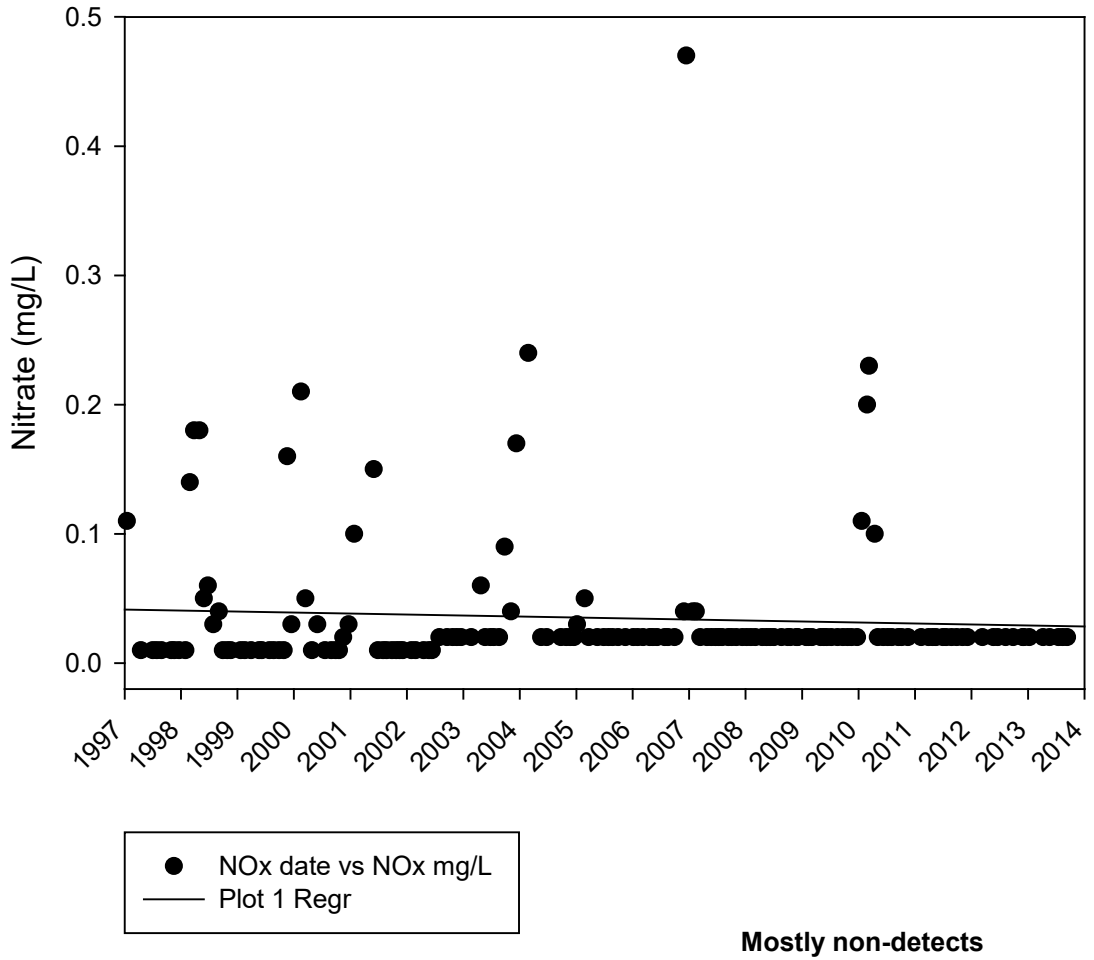
Plot 1
Order 1

Curve 1:
TKN mg/L□column 34:
Coefficients:
b[0]□0.4028701634
b[1]□0.0109641297
r ²□0.4564624997

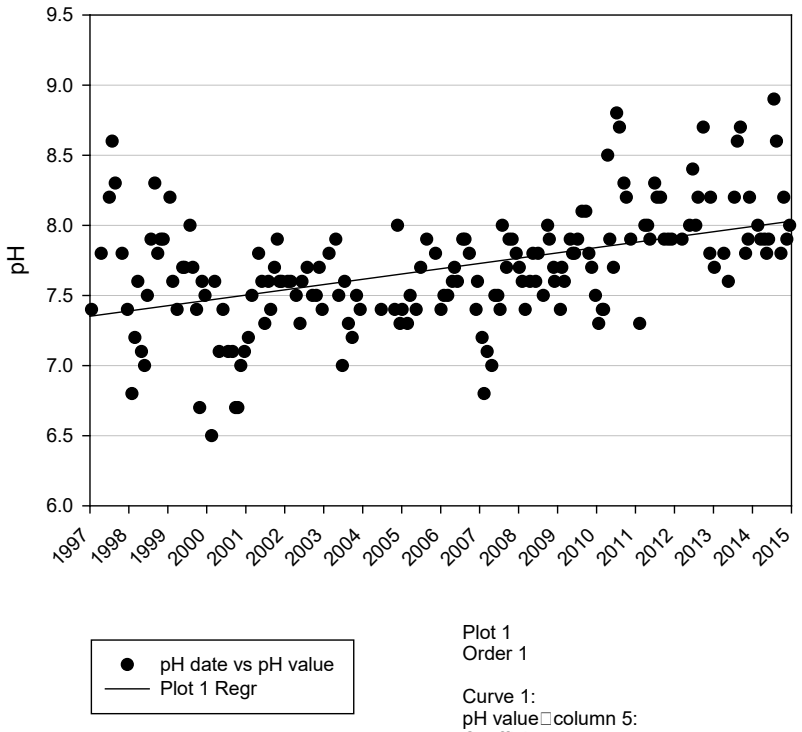

M390000C
Chl a (µg/L)
50
40
30
20
10
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Date vs Chl a ug/L
Plot 1 Regr


M390000C
pH
9.5
9.0
8.5
8.0
7.5
7.0
6.5
0
10
20
30
40
50
Chl a (µg/L)
Chl a ug/L vs pH Value as of 2001
Plot 1 Regr

M390000C

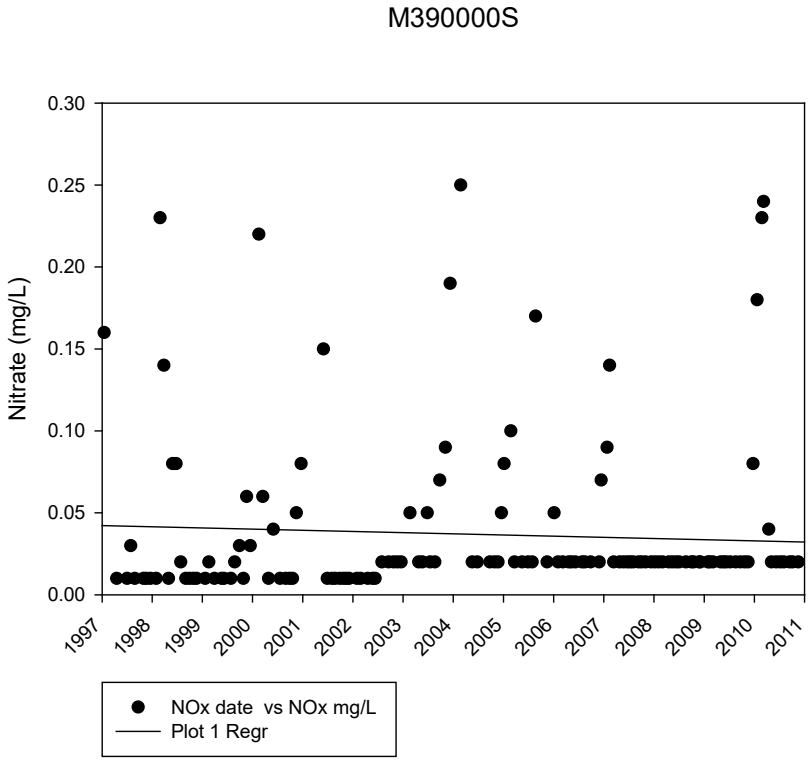


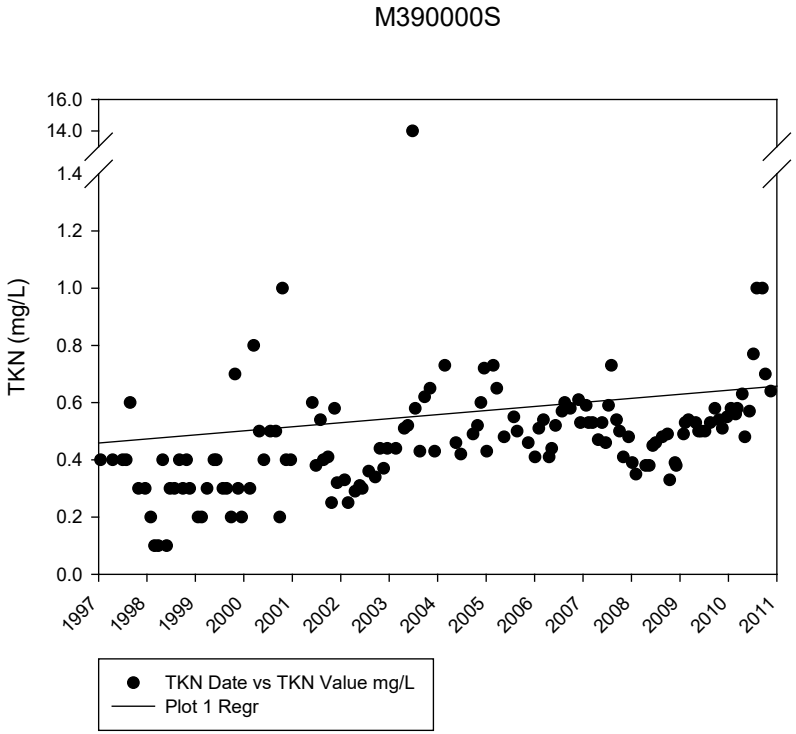
Mostly non-detects

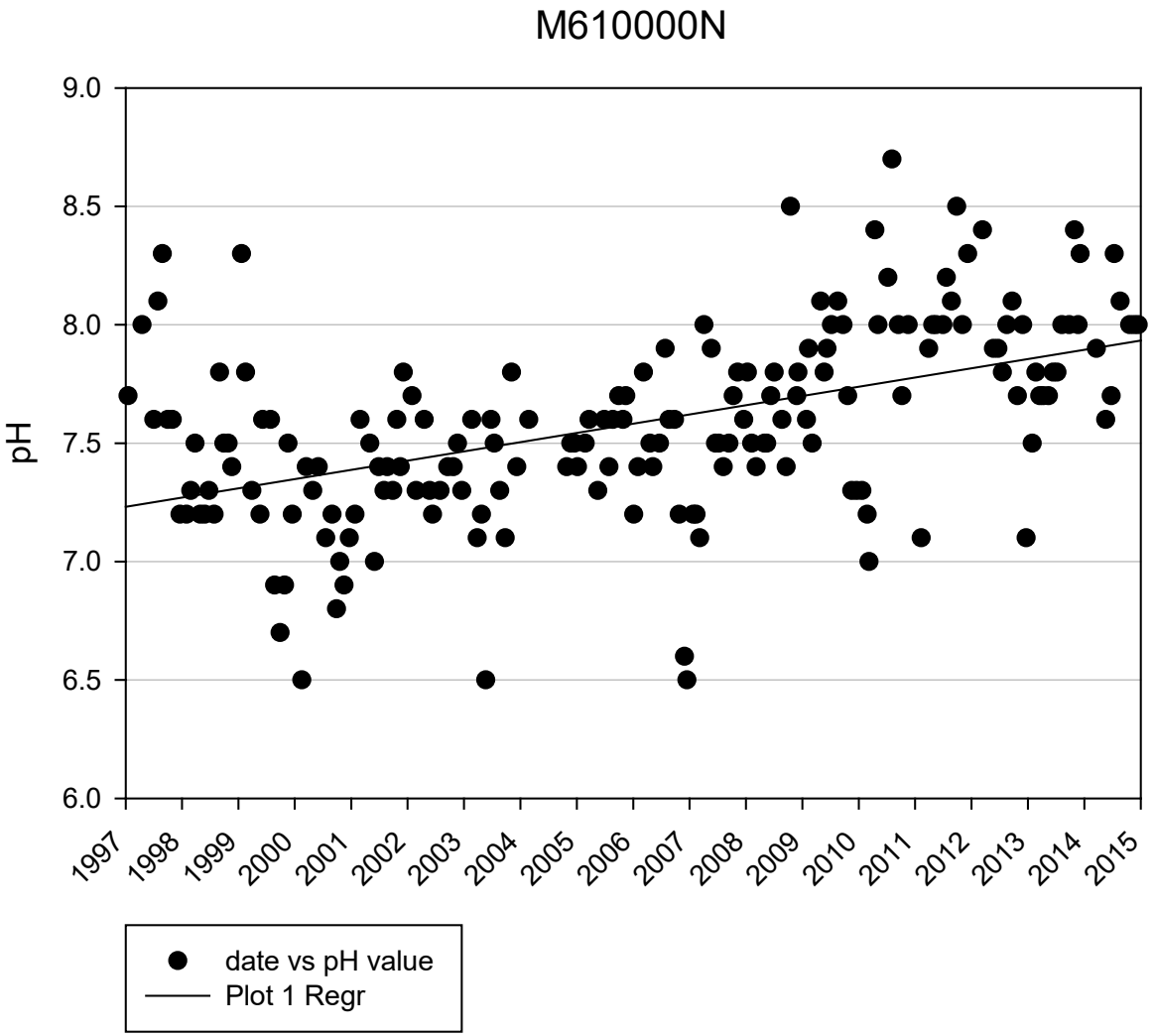


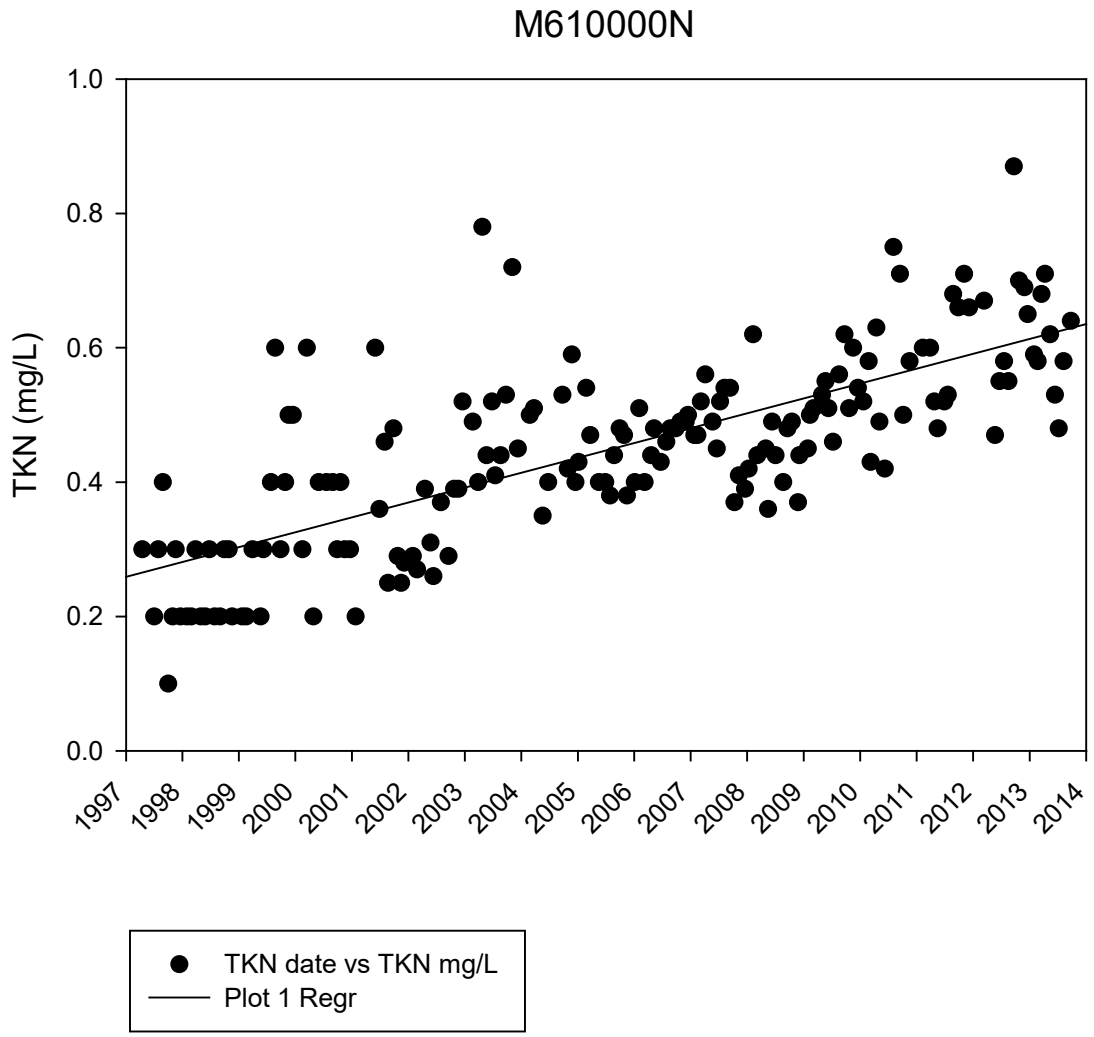
Plot 1
Order 1

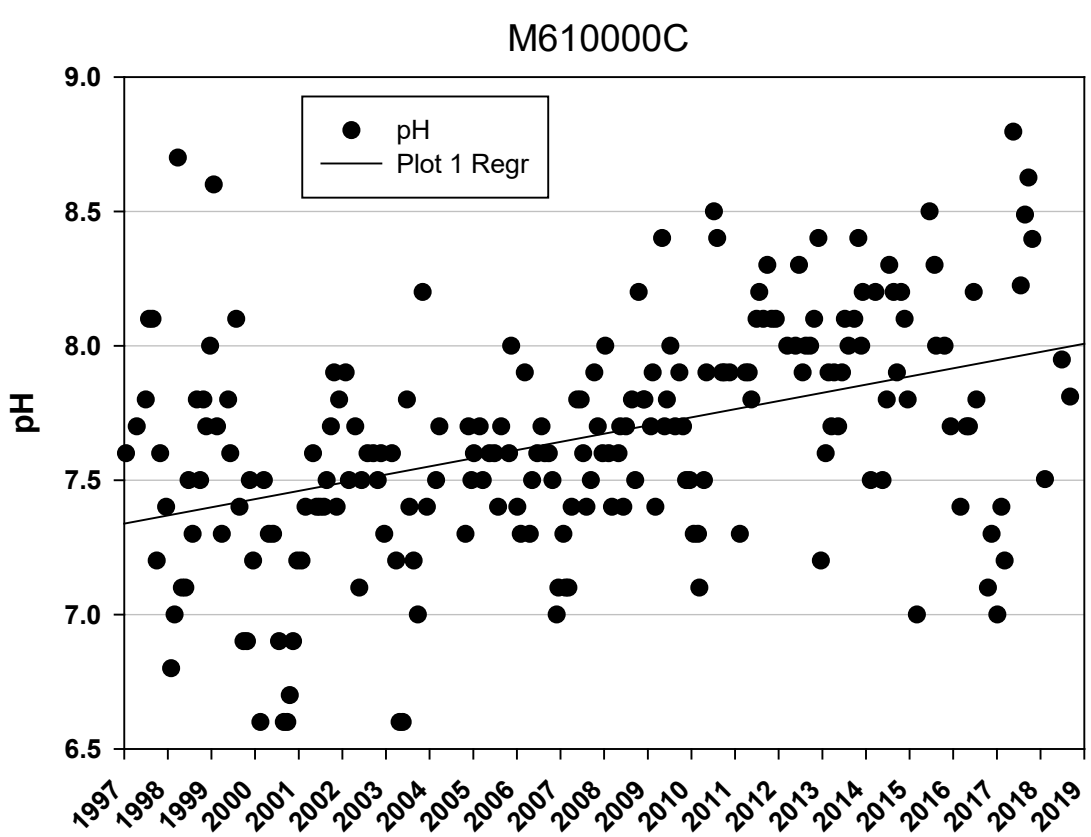
Curve 1:
pH value□column 5:
Coefficients:
b[0]□-245.4573979476
b[1]□1.0316825391e-4
r ²□0.2209342633

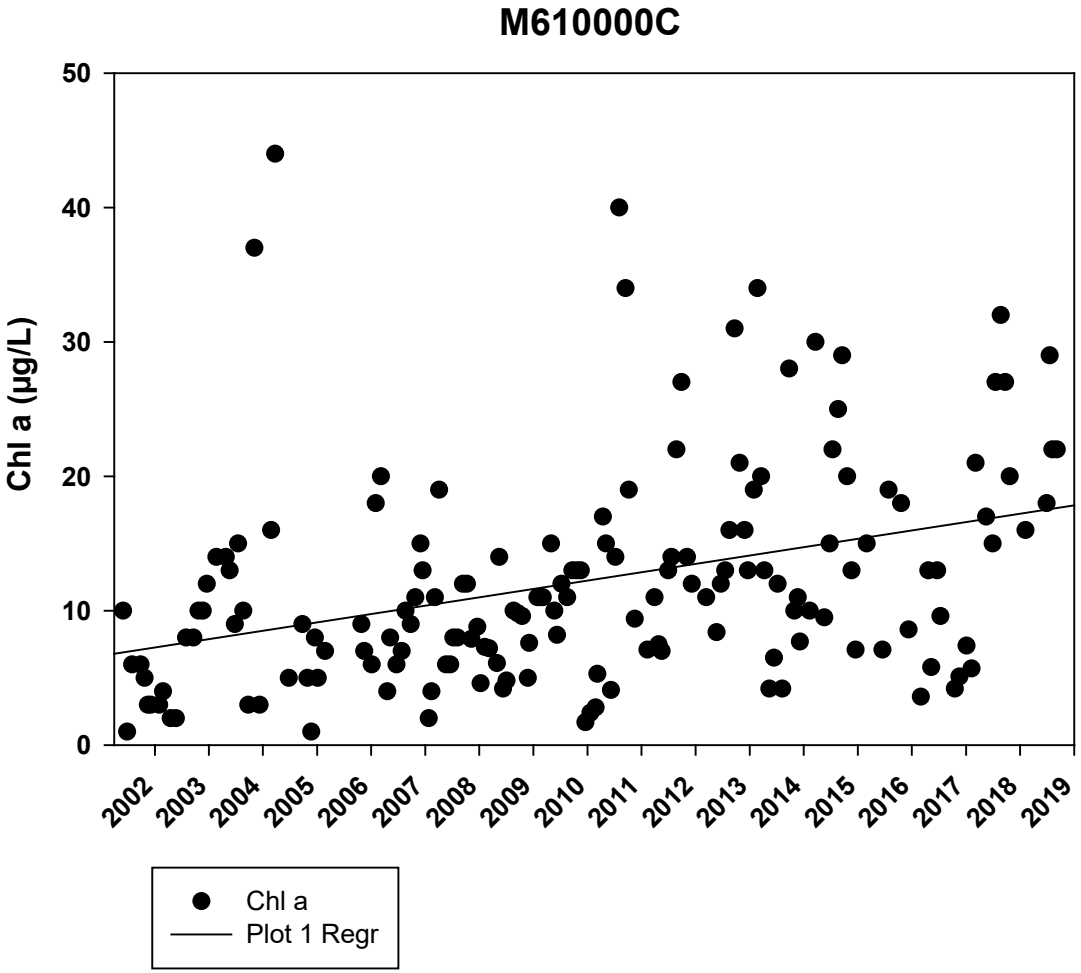


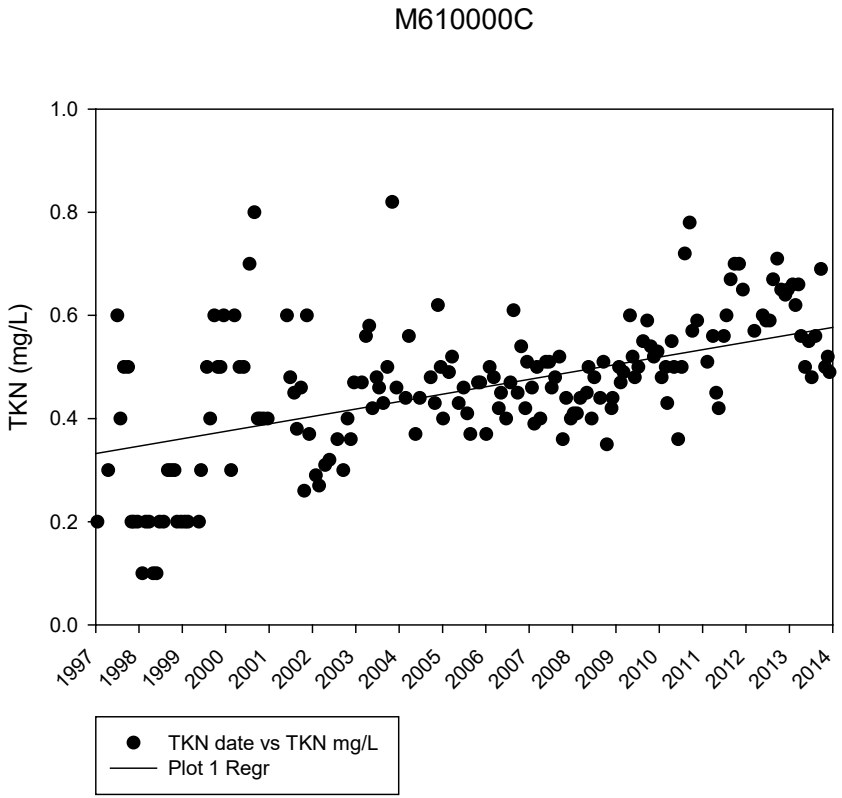


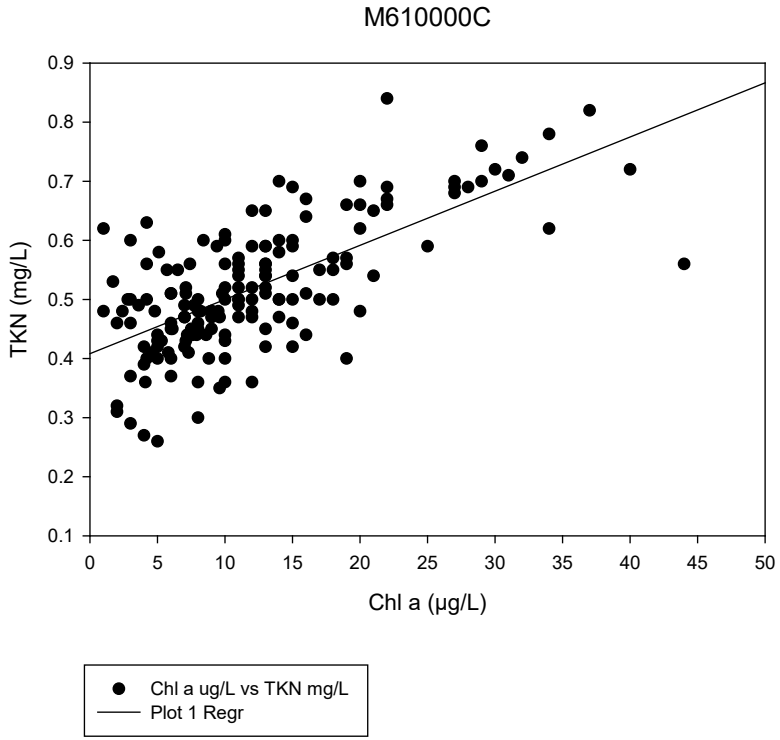

M610000N
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
date vs pH value
Plot 1 Regr

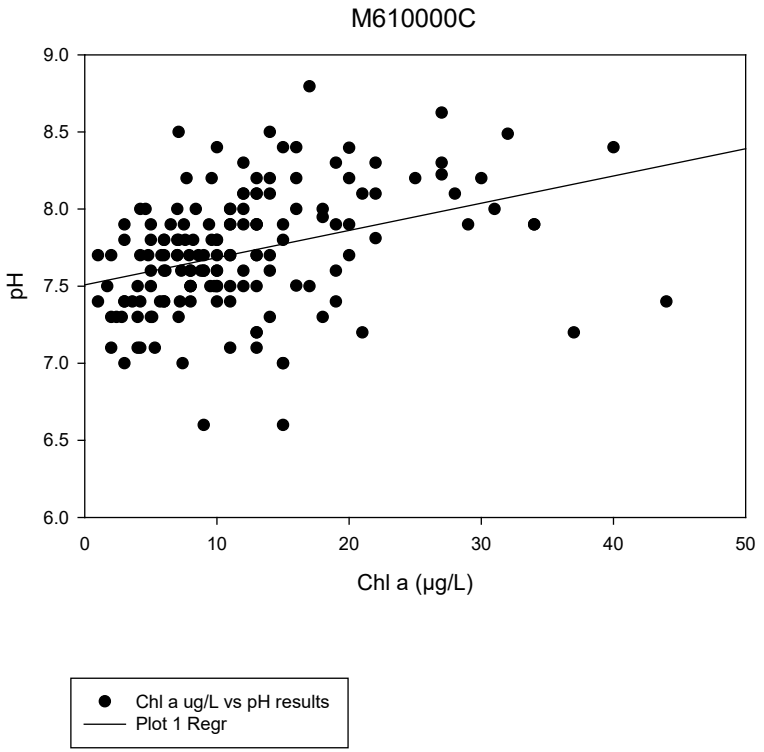

M610000N
TKN (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
TKN date vs TKN mg/L
Plot 1 Regr

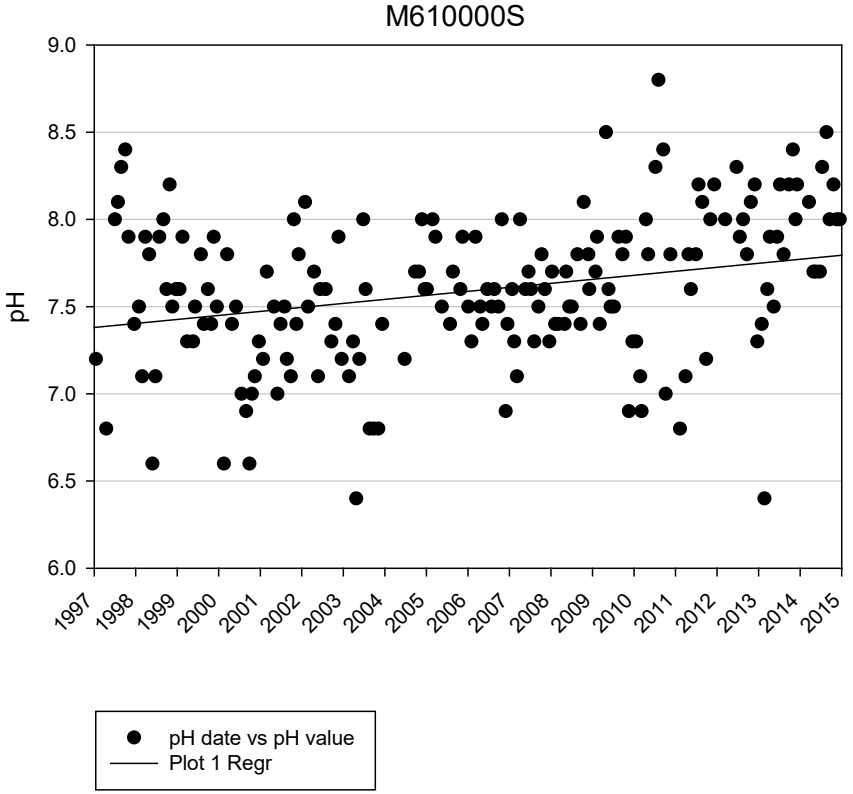

M610000C
pH
Plot 1 Regr
9.0
8.5
8.0
7.5
7.0
6.5
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

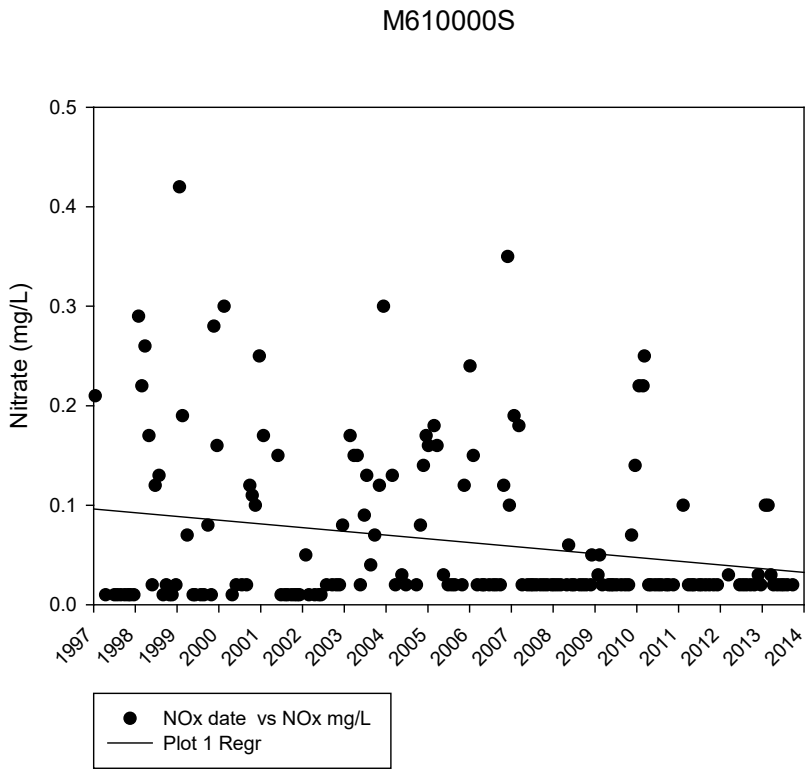

M610000C
Chl a (µg/L)
50
40
30
20
10
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Chl a
Plot 1 Regr

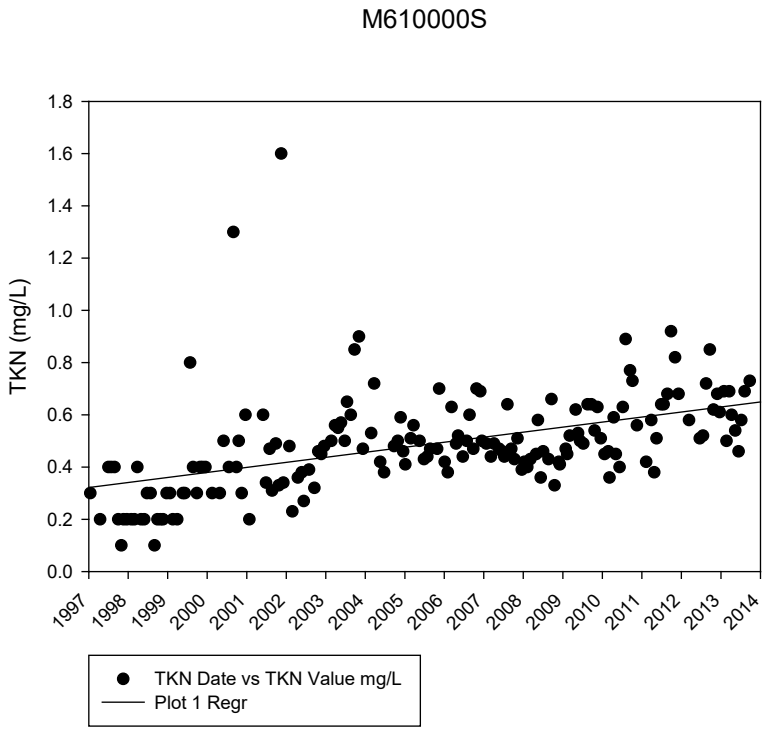

M610000C
TKN (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
TKN date vs TKN mg/L
Plot 1 Regr

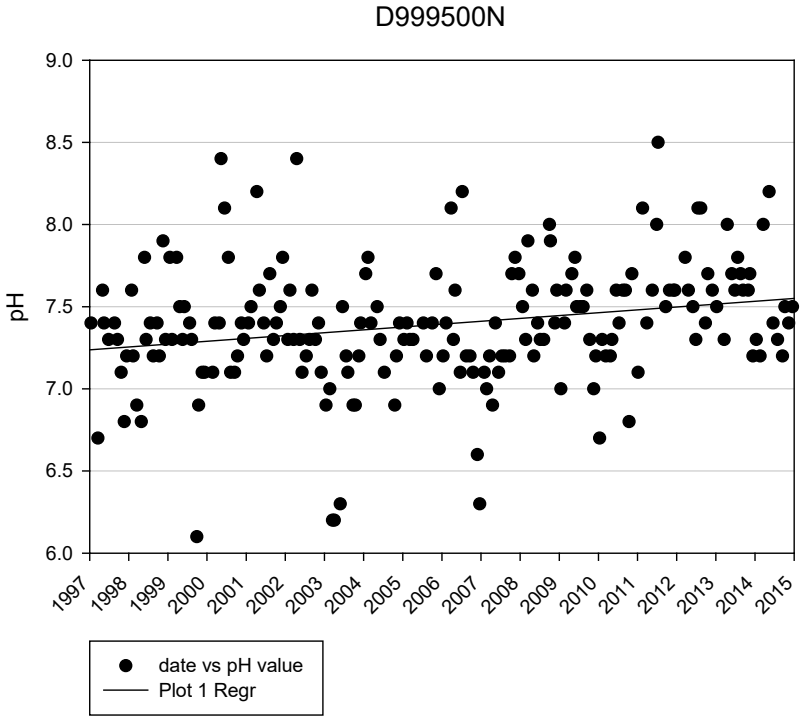

M610000C
TKN (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
10
15
20
25
30
35
40
45
50
Chl a (µg/L)
Chl a ug/L vs TKN mg/L
Plot 1 Regr

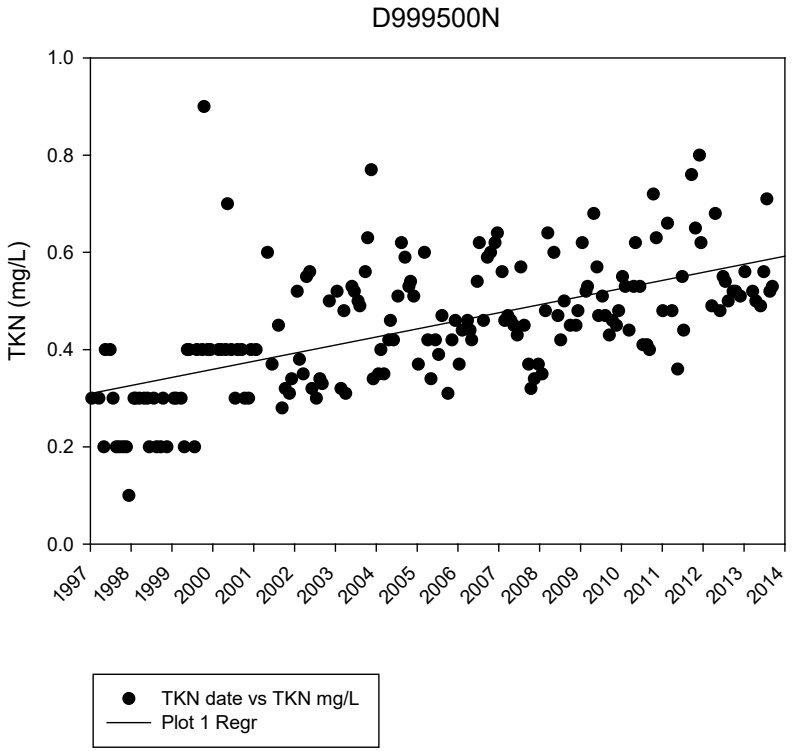

M610000C
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
0
10
20
30
40
50
Chl a (µg/L)
Chl a ug/L vs pH results
Plot 1 Regr

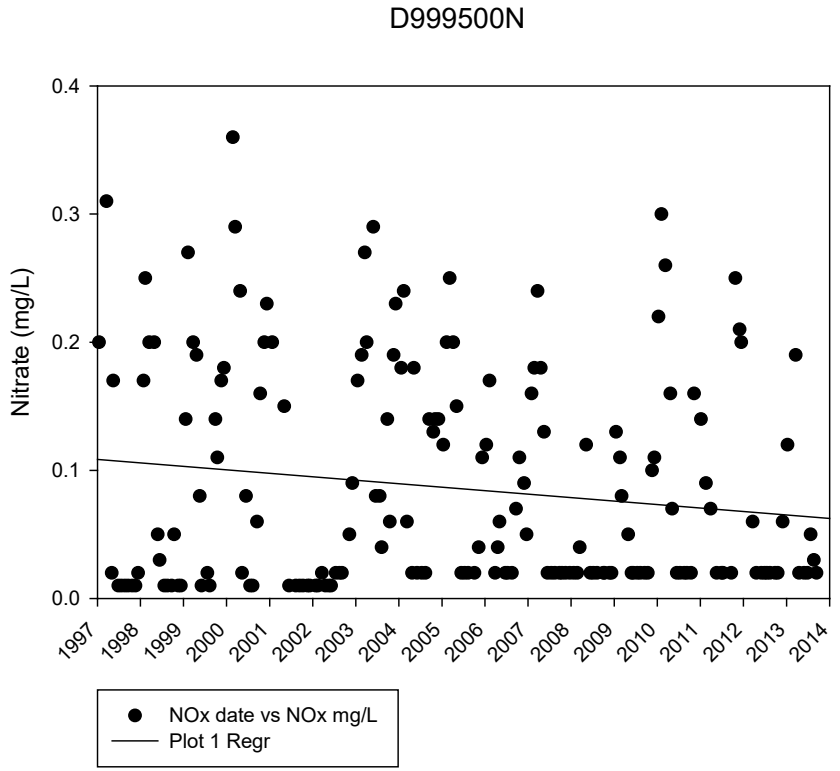

M610000S
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
pH date vs pH value
Plot 1 Regr

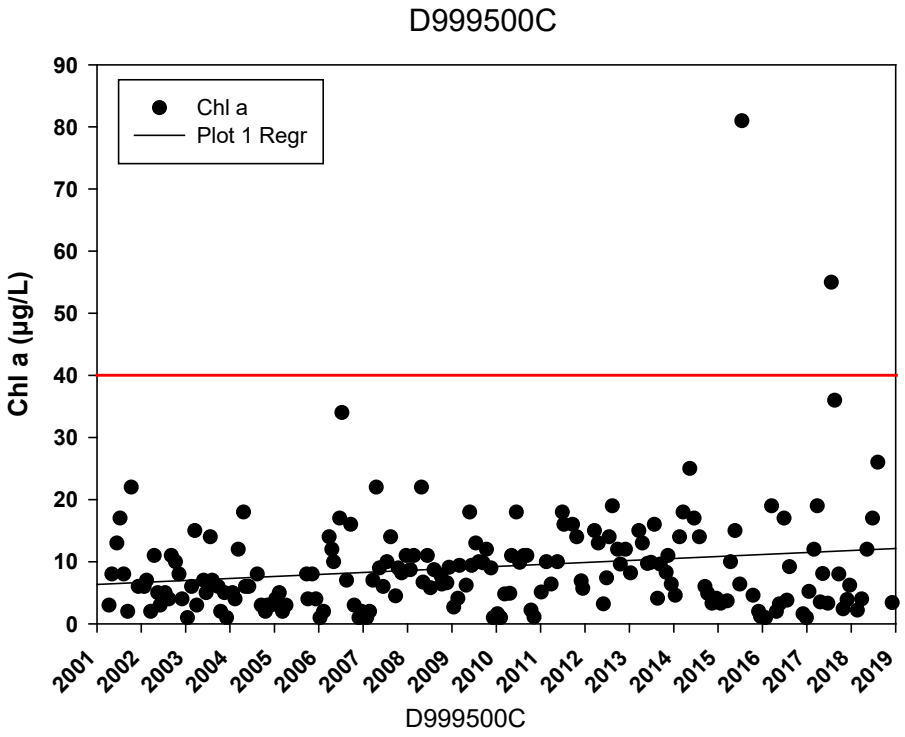

M610000S
Nitrate (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
NOx date vs NOx mg/L
Plot 1 Regr

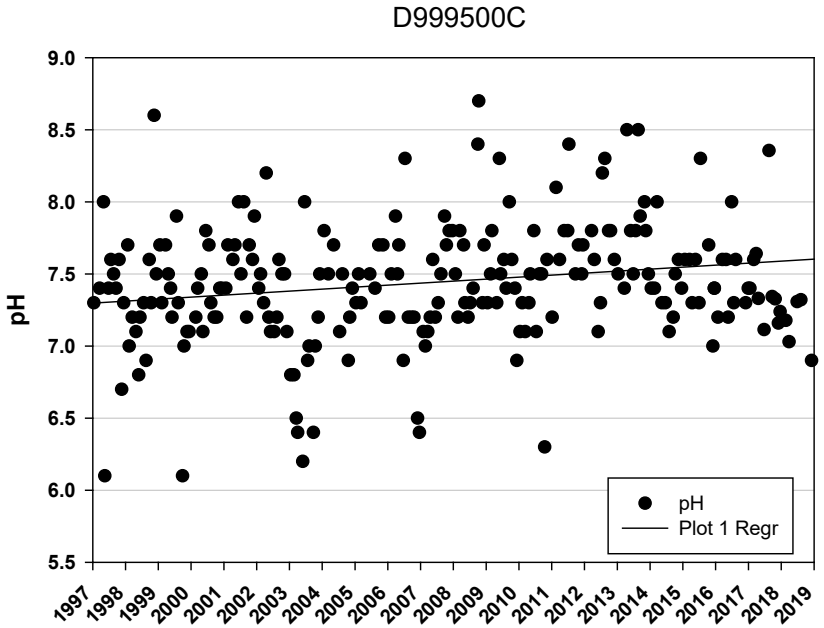

M610000S
TKN (mg/L)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
TKN Date vs TKN Value mg/L
Plot 1 Regr

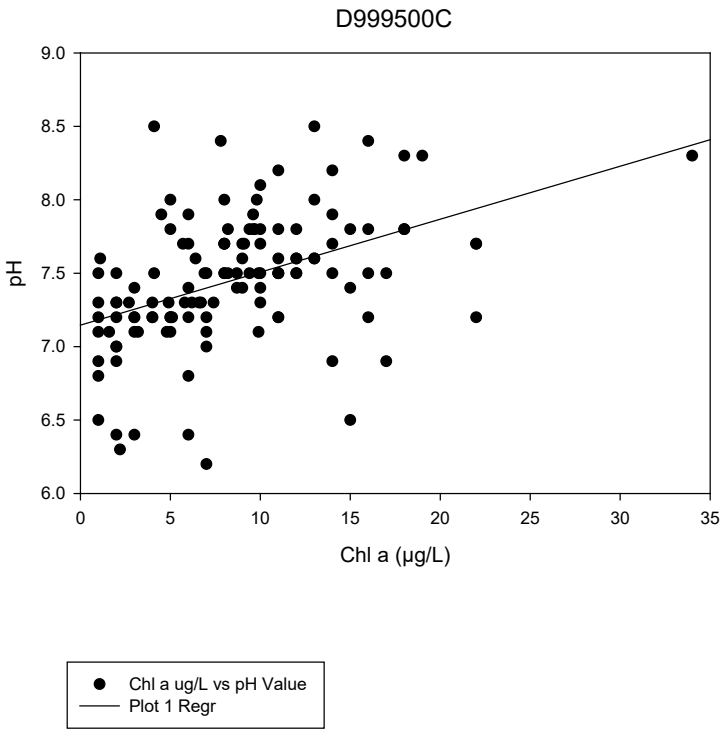

D999500N
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
date vs pH value
Plot 1 Regr

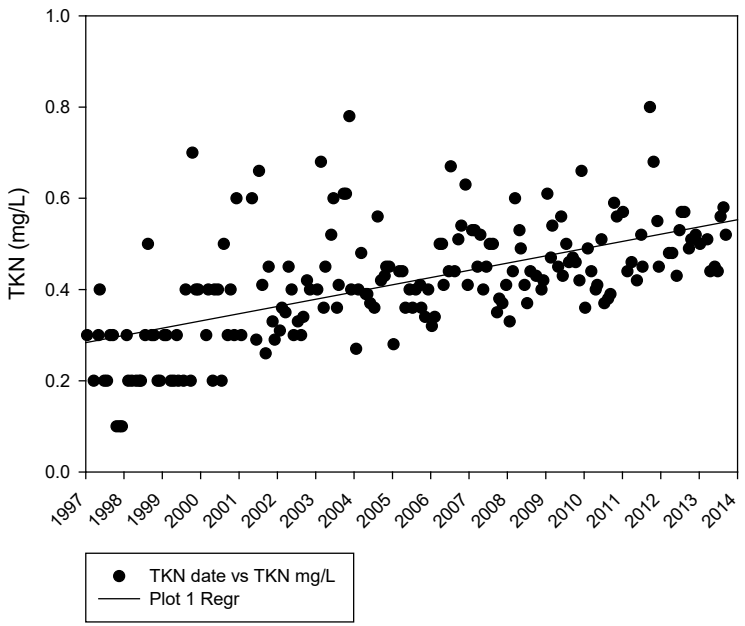

D999500N
TKN (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
TKN date vs TKN mg/L
Plot 1 Regr

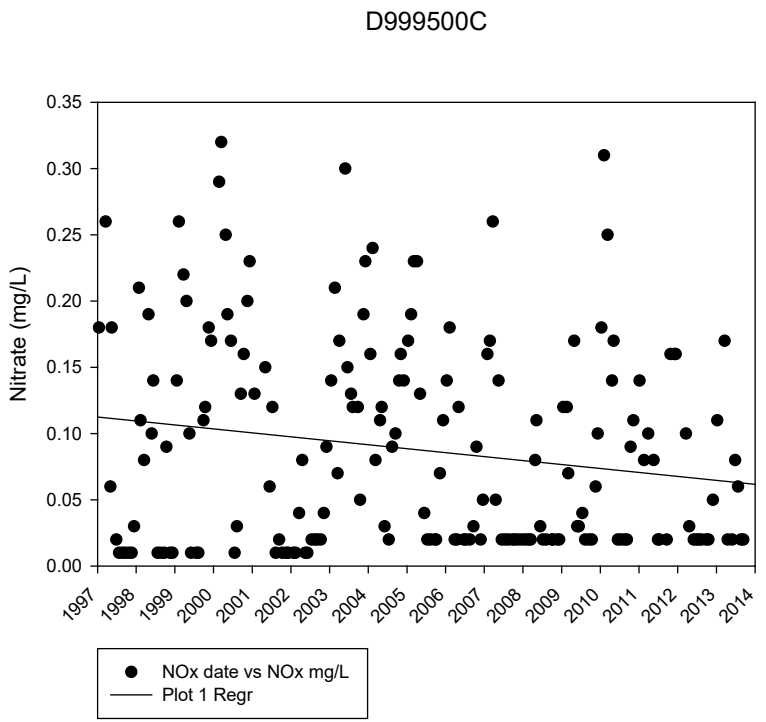

D999500N
Nitrate (mg/L)
0.4
0.3
0.2
0.1
0.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
NOx date vs NOx mg/L
Plot 1 Regr

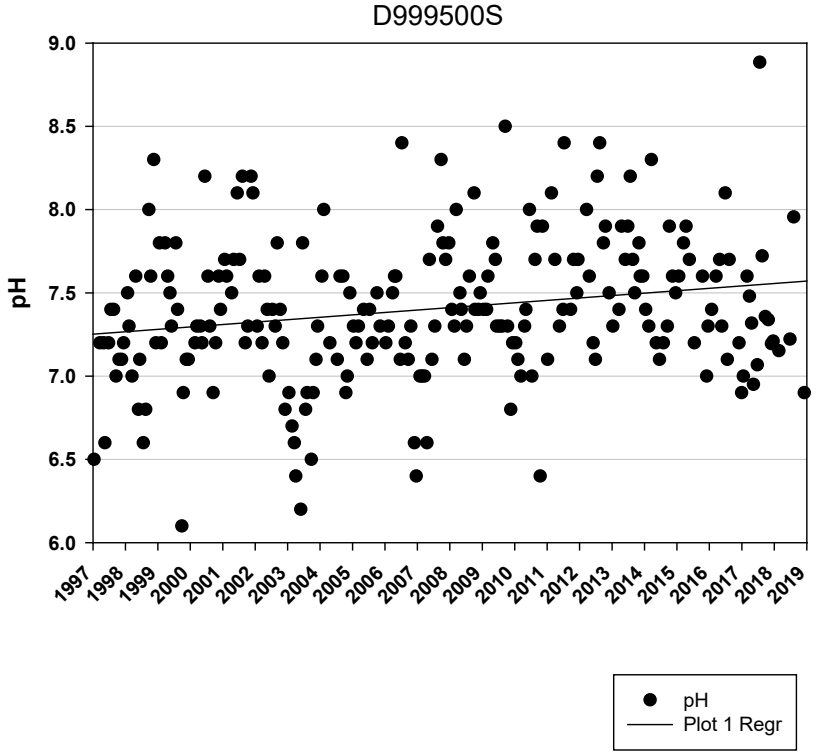

D999500C
Chl a
Plot 1 Regr
Chl a (µg/L)
D999500C

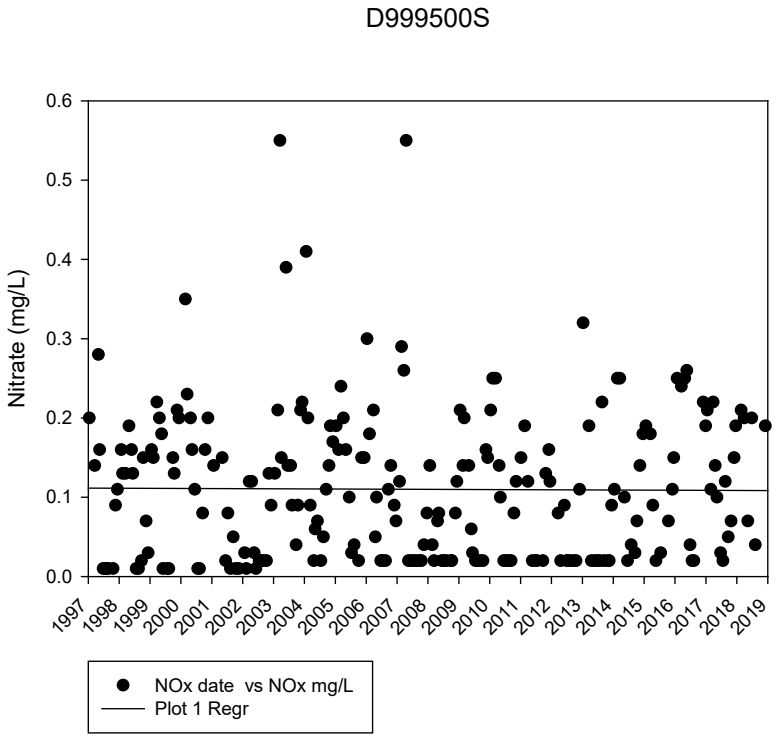

D999500C
pH
Plot 1 Regr

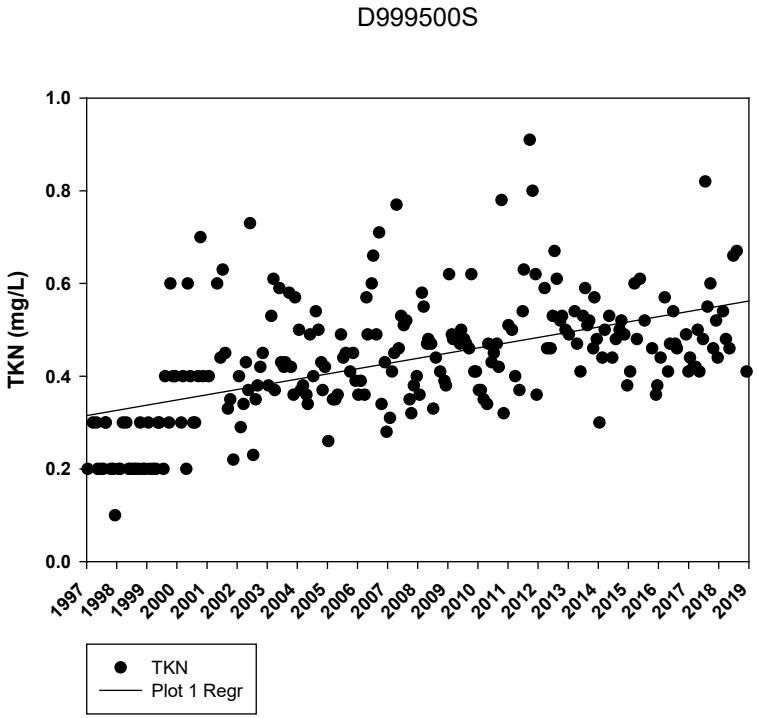

D999500C
pH
Chl a (µg/L)
Chl a ug/L vs pH Value
Plot 1 Regr


TKN (mg/L)
TKN date vs TKN mg/L
Plot 1 Regr


D999500C
Nitrate (mg/L)
NOx date vs NOx mg/L
Plot 1 Regr

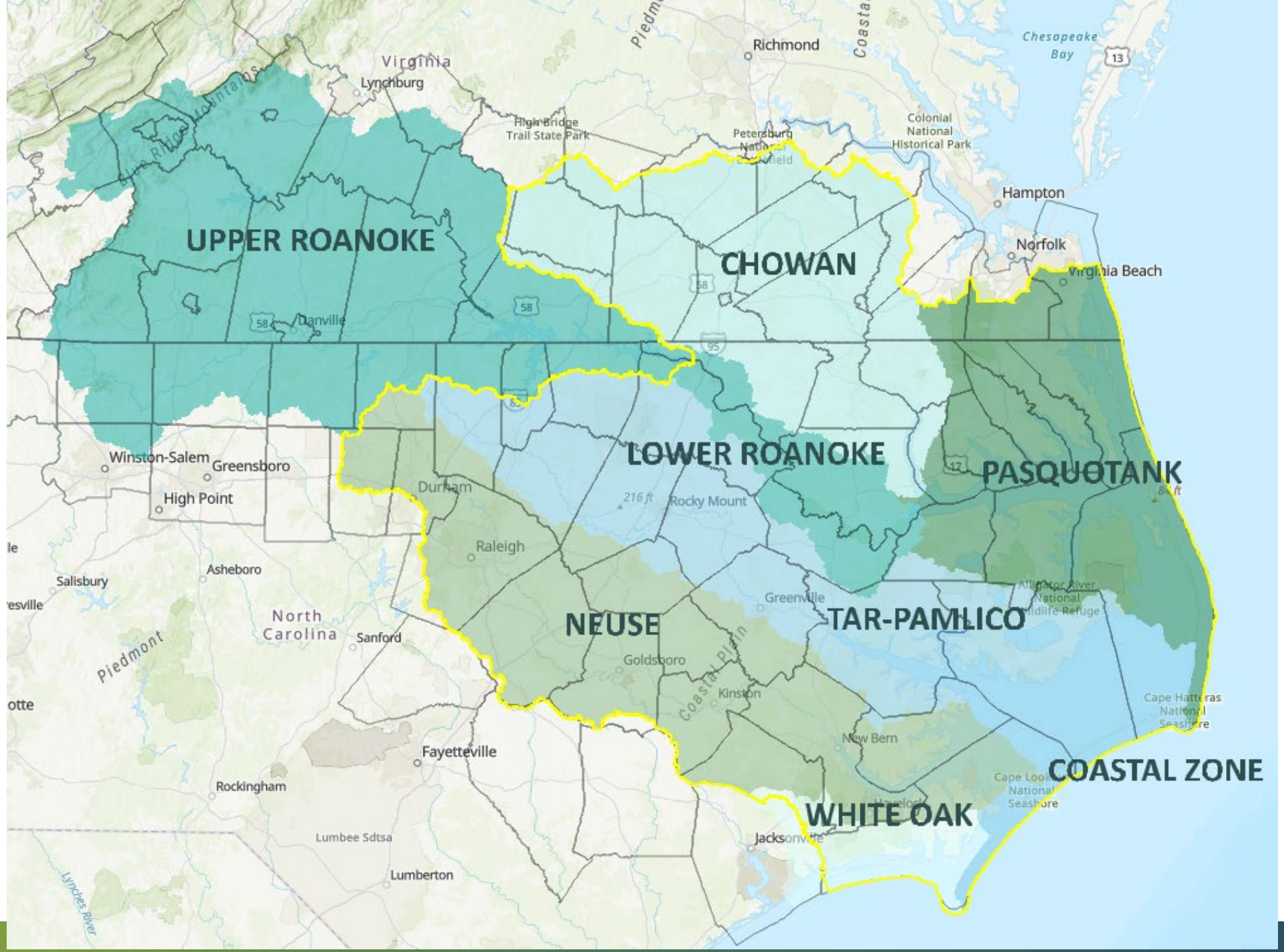

D999500S
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
pH
Plot 1 Regr


D999500S
Nitrate (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
NOx date vs NOx mg/L
Plot 1 Regr


D999500S
TKN (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
TKN
Plot 1 Regr

Questions

NORTH CAROLINA
Department of Environmental Quality



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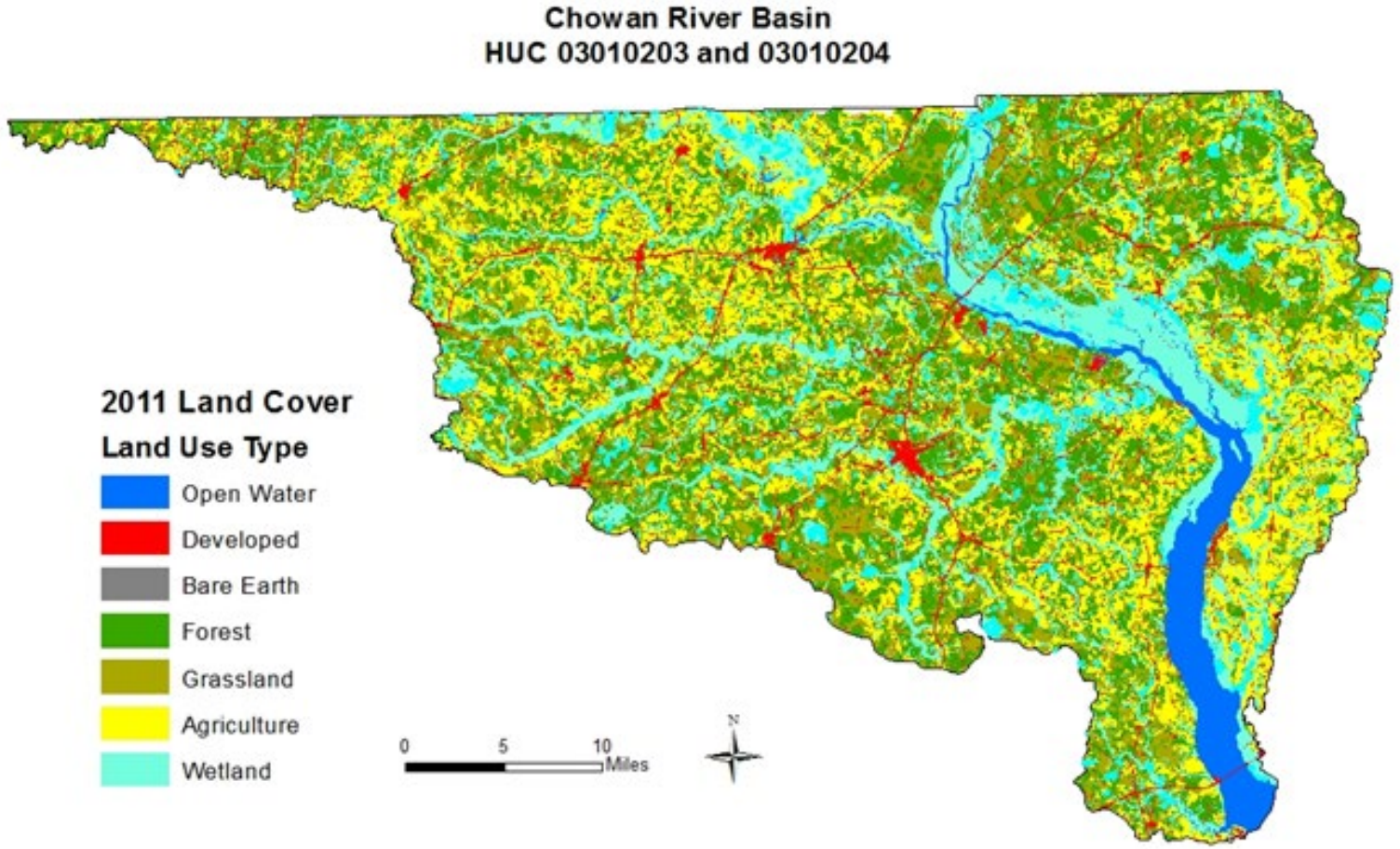
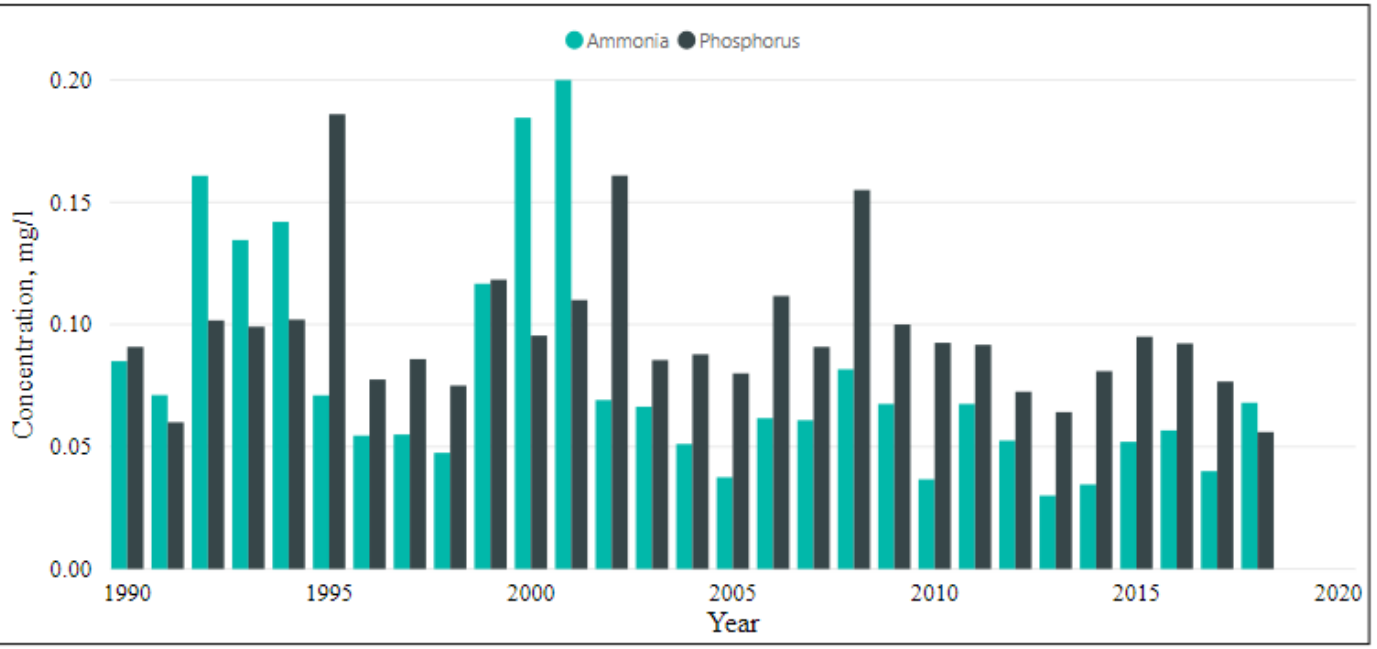
NORTH CAROLINA
Department of Environmental Quality



NORTH CAROLINA
Department of Environmental Quality


Ammonia
Phosphorus
0.20
0.15
0.10
0.05
0.00
Concentration, mg/l
1990
1995
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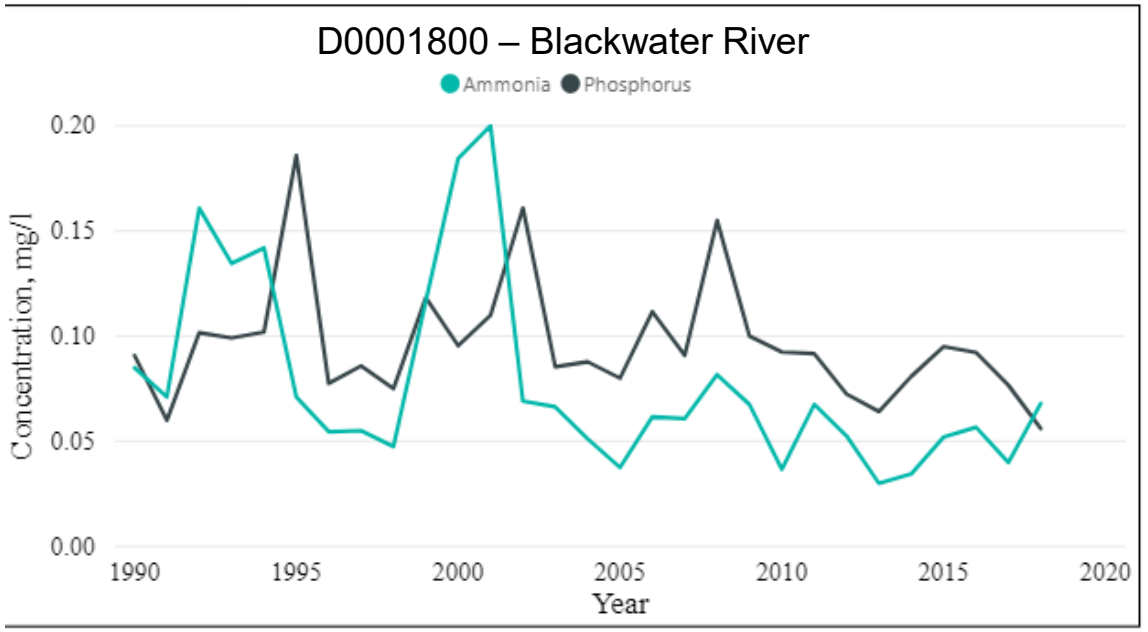
2015
2020
Year


D0001800 – Blackwater River
Ammonia
Phosphorus
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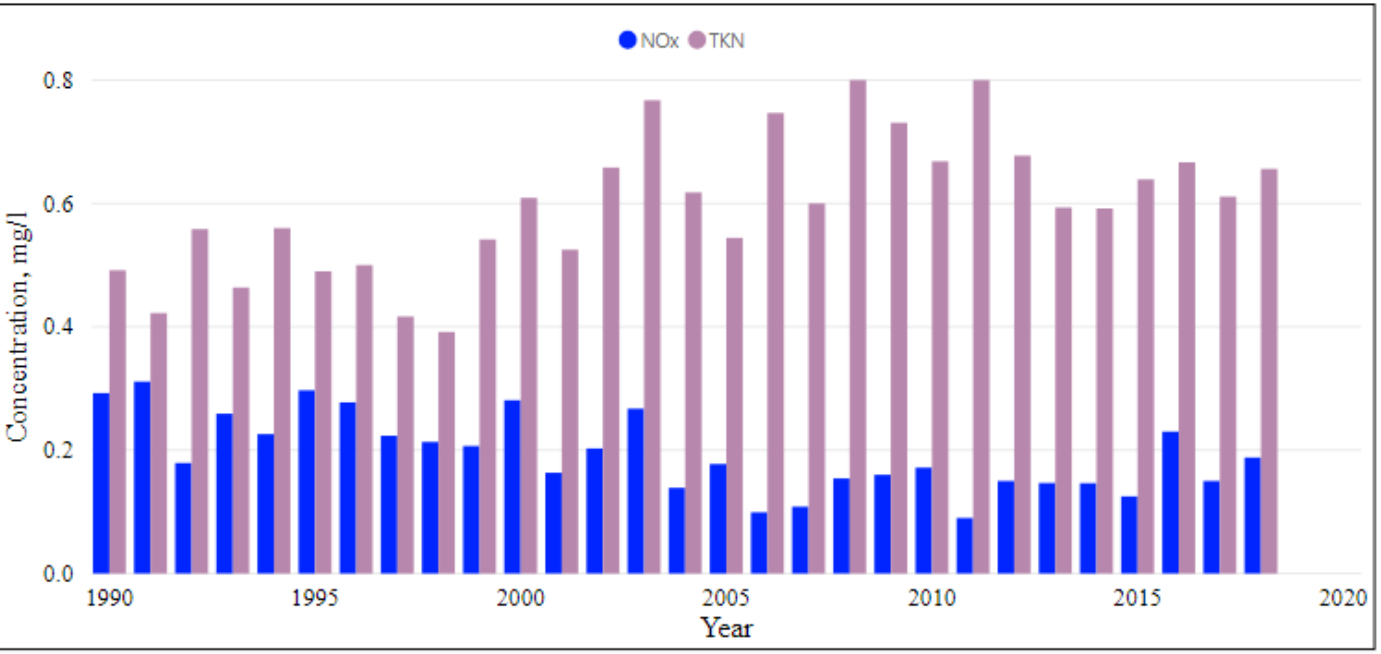
0.15
0.10
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year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Concentration, mg/l
1990
1995
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2005
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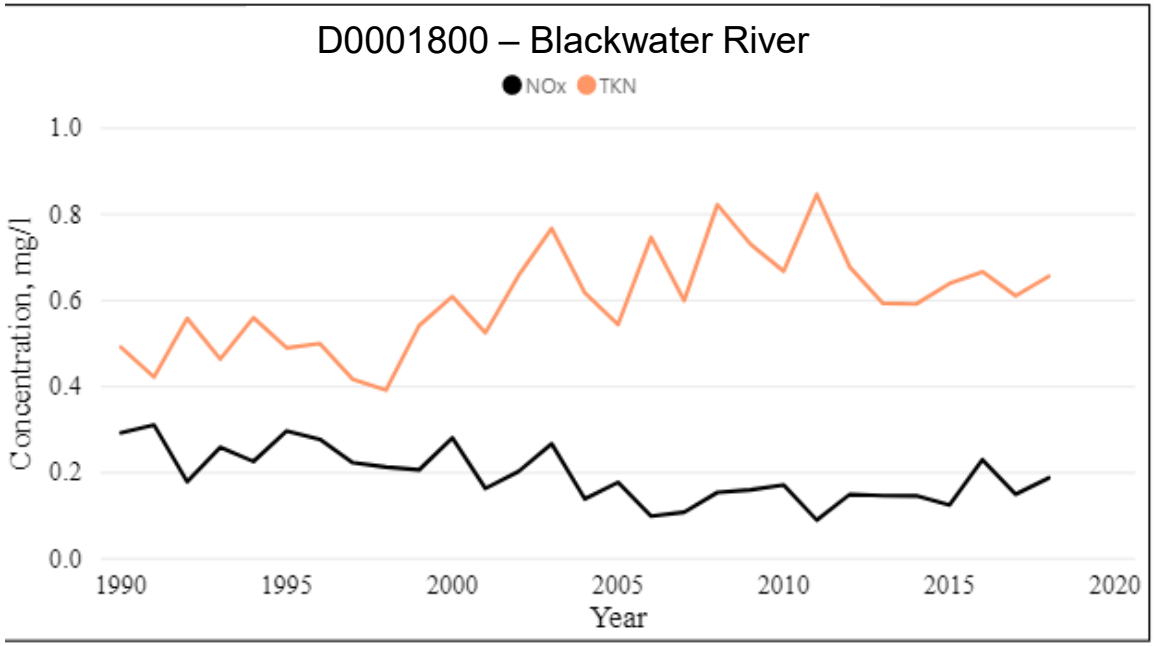
2015
2020
Year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TKN
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0.4
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Concentration, mg/l
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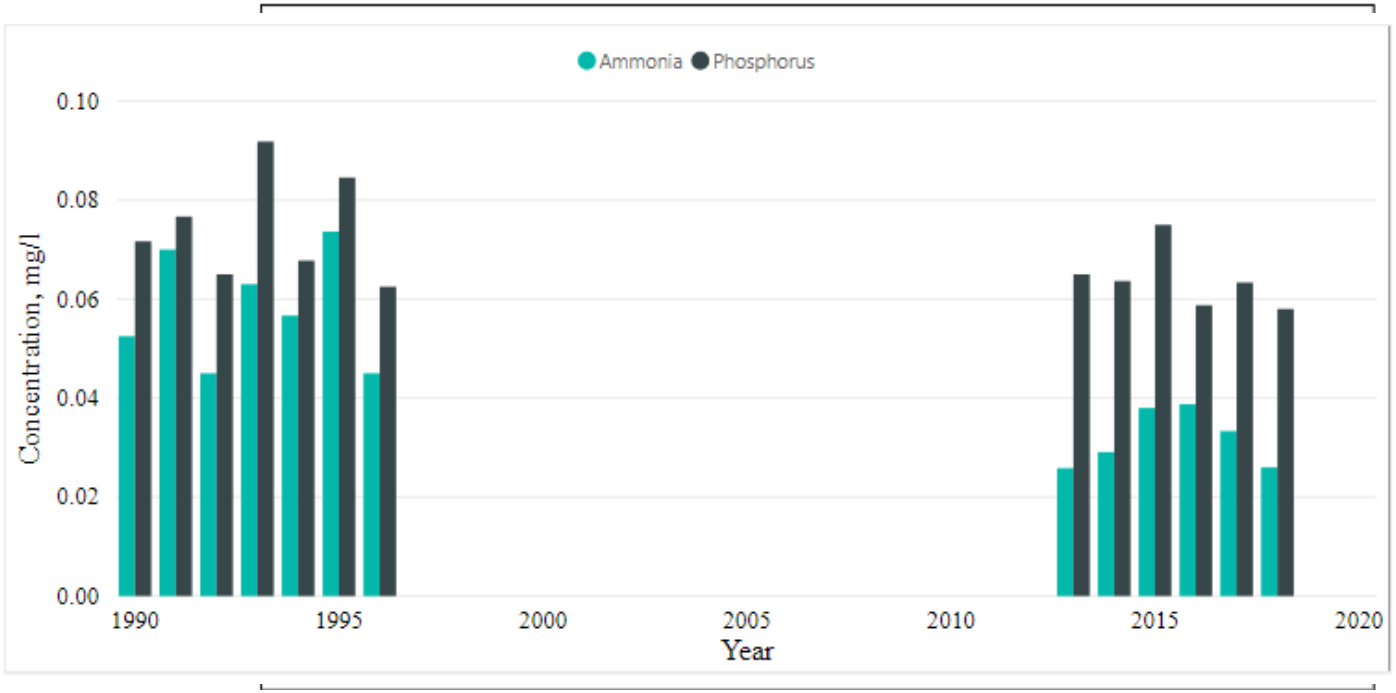
Year


Ammonia
Phosphorus
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0.04
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0.00
Concentration, mg/l
1990
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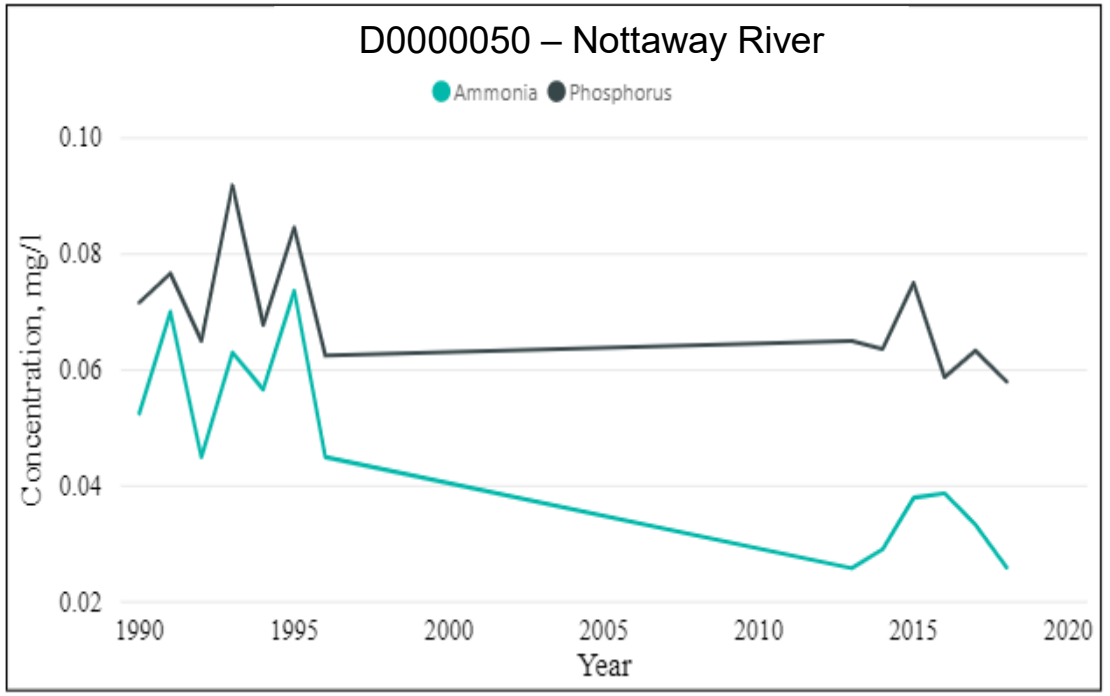
2015
2020
Year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0.06
0.04
0.02
Concentration, mg/l
1990
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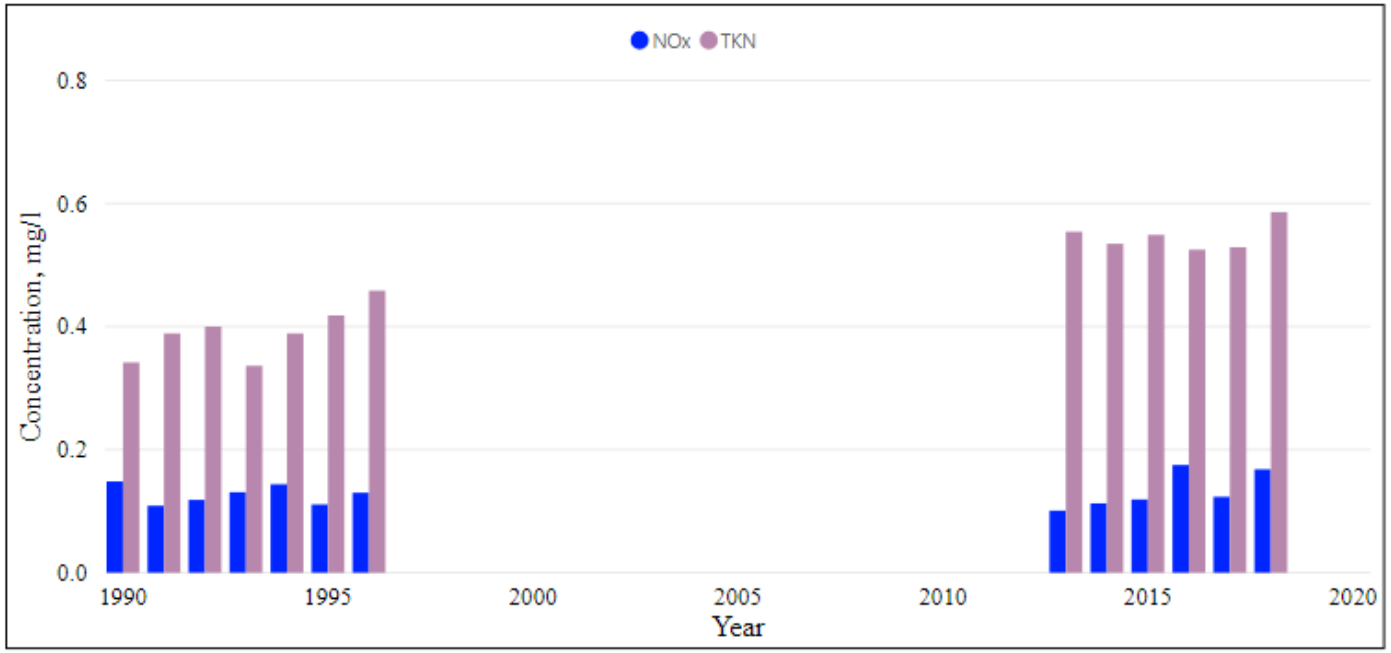
2000
2005
2010
2015
2020
Year


NOx
TKN
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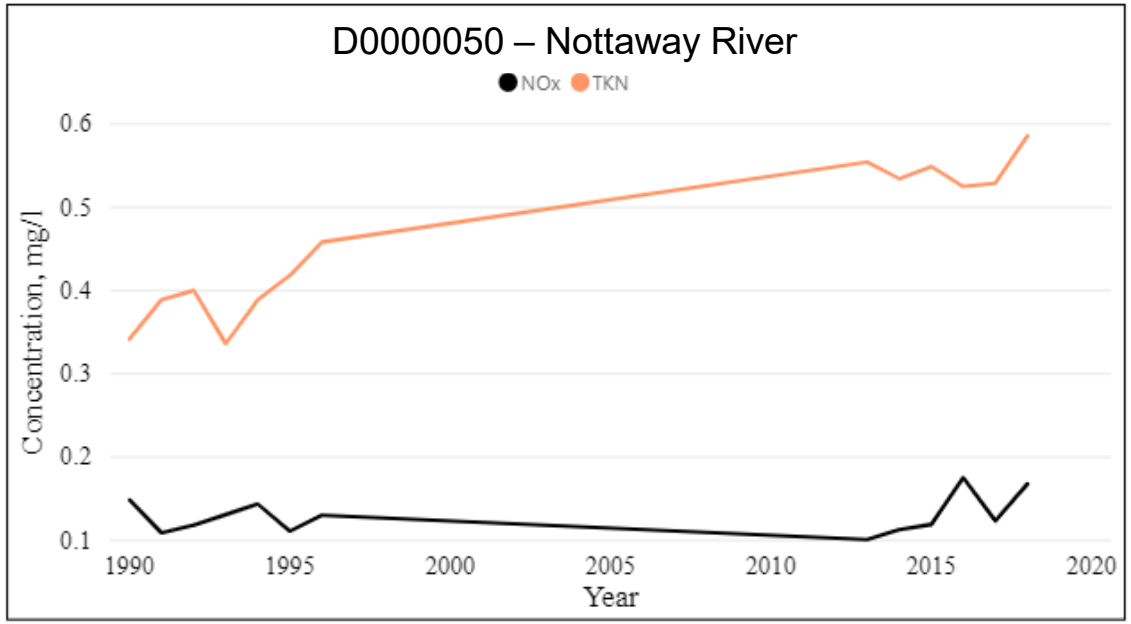
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D0000050 – Nottaway River
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TKN
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0.1
Concentration, mg/l
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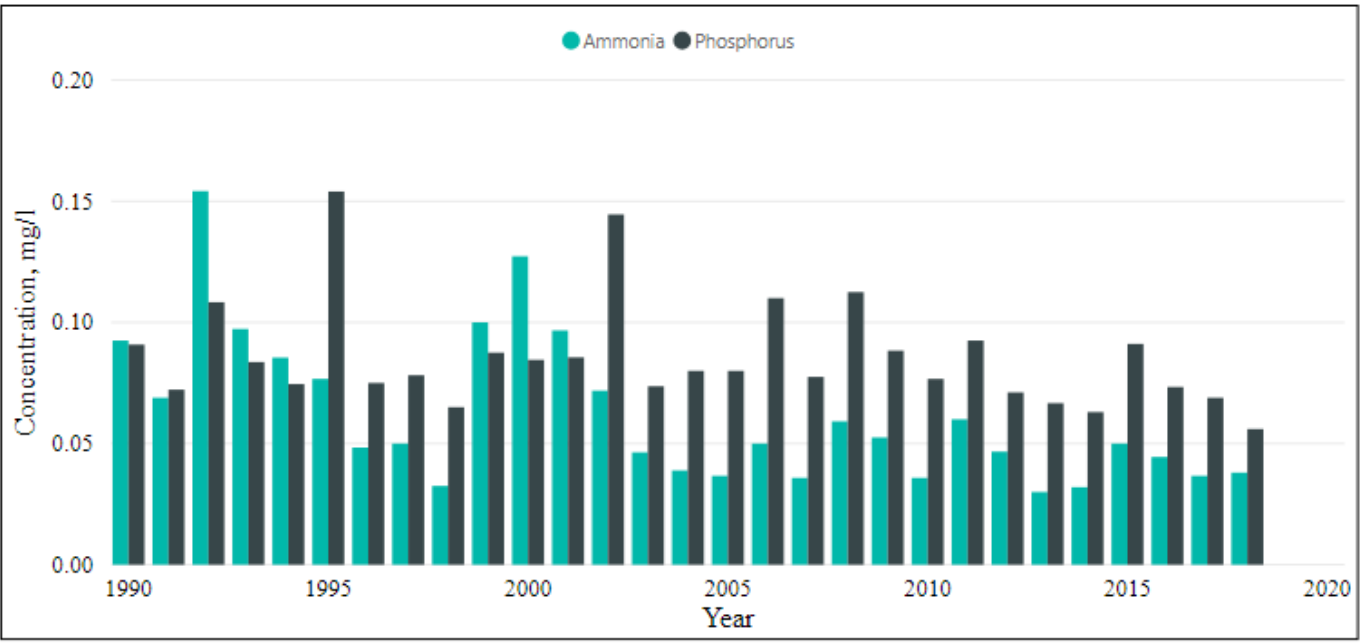
2000
2005
2010
2015
2020
Year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0.00
Concentration, mg/l
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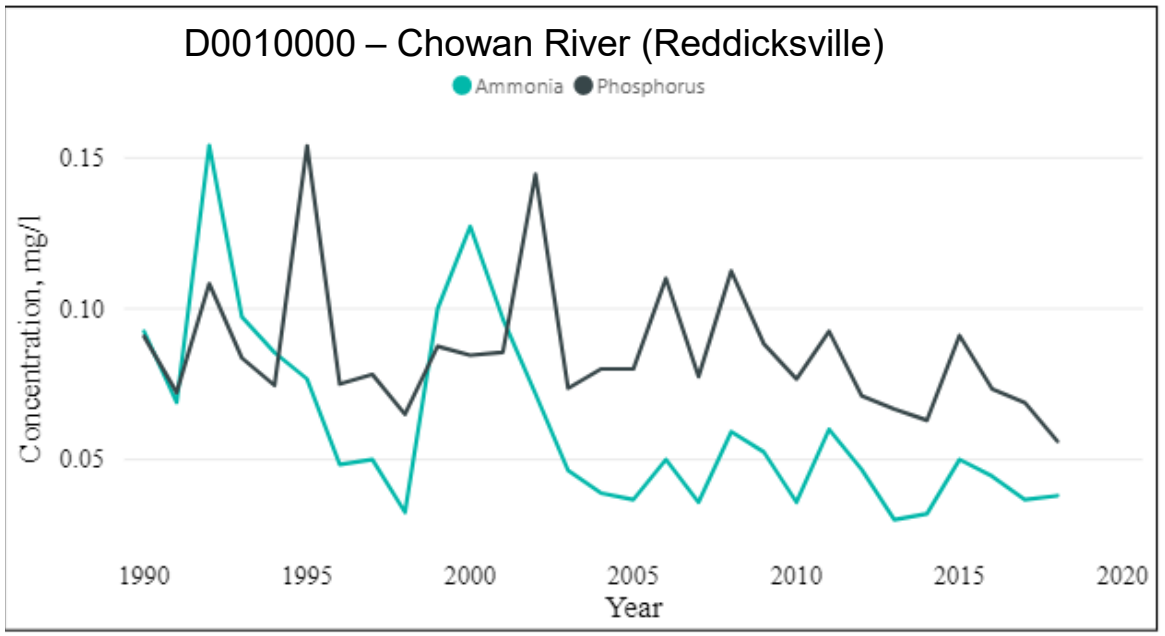
2020
Year


D0010000 – Chowan River (Reddicksville)
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Phosphorus
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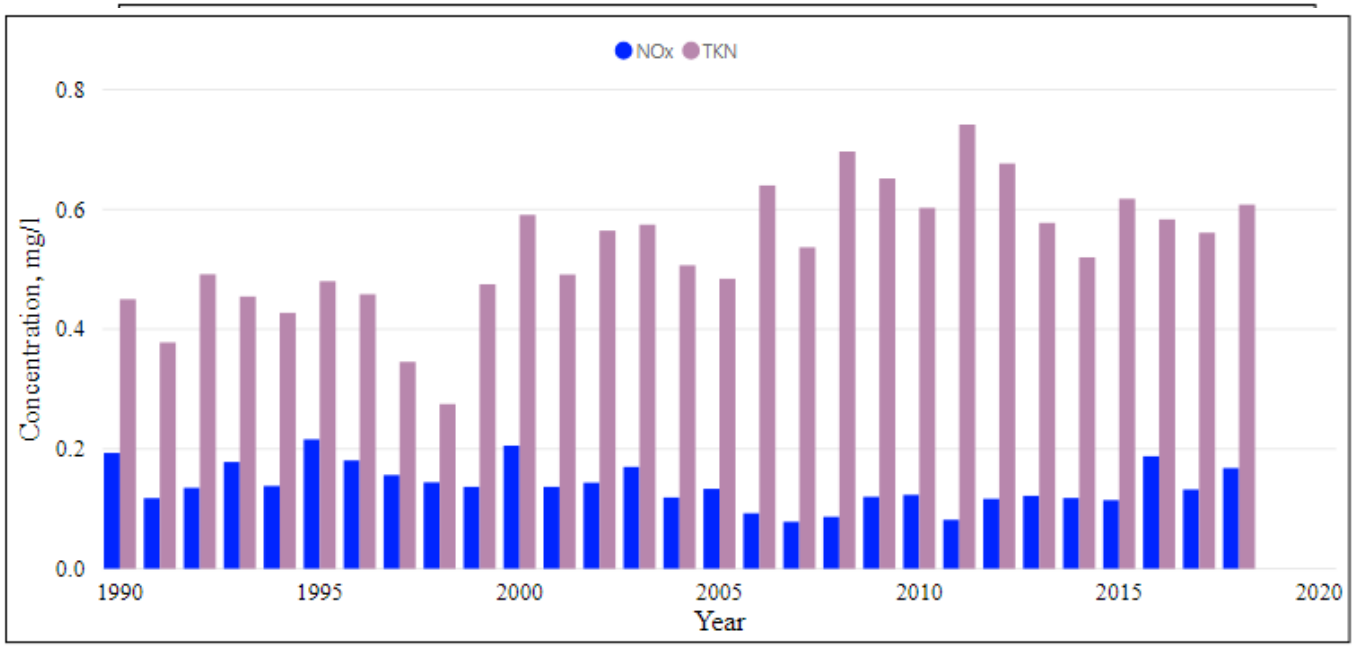
0.10
0.05
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


NOx
TKN
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0.4
0.2
0.0
Concentration, mg/l
1990
1995
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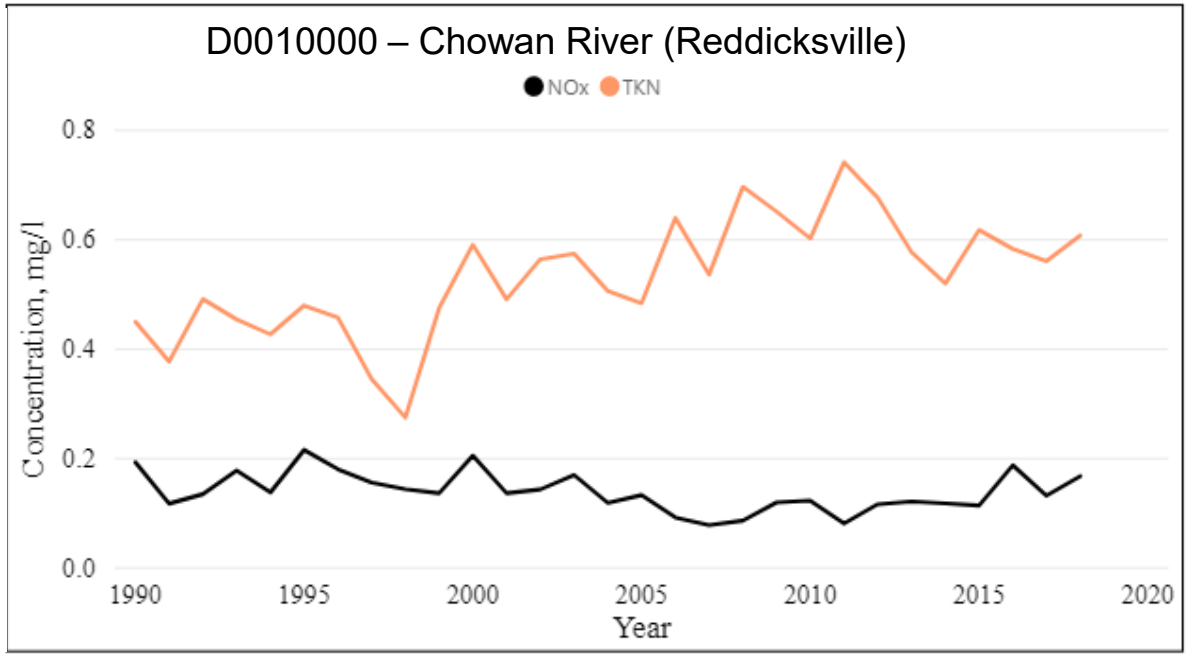
2005
2010
2015
2020
Year


D0010000 – Chowan River (Reddicksville)
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TKN
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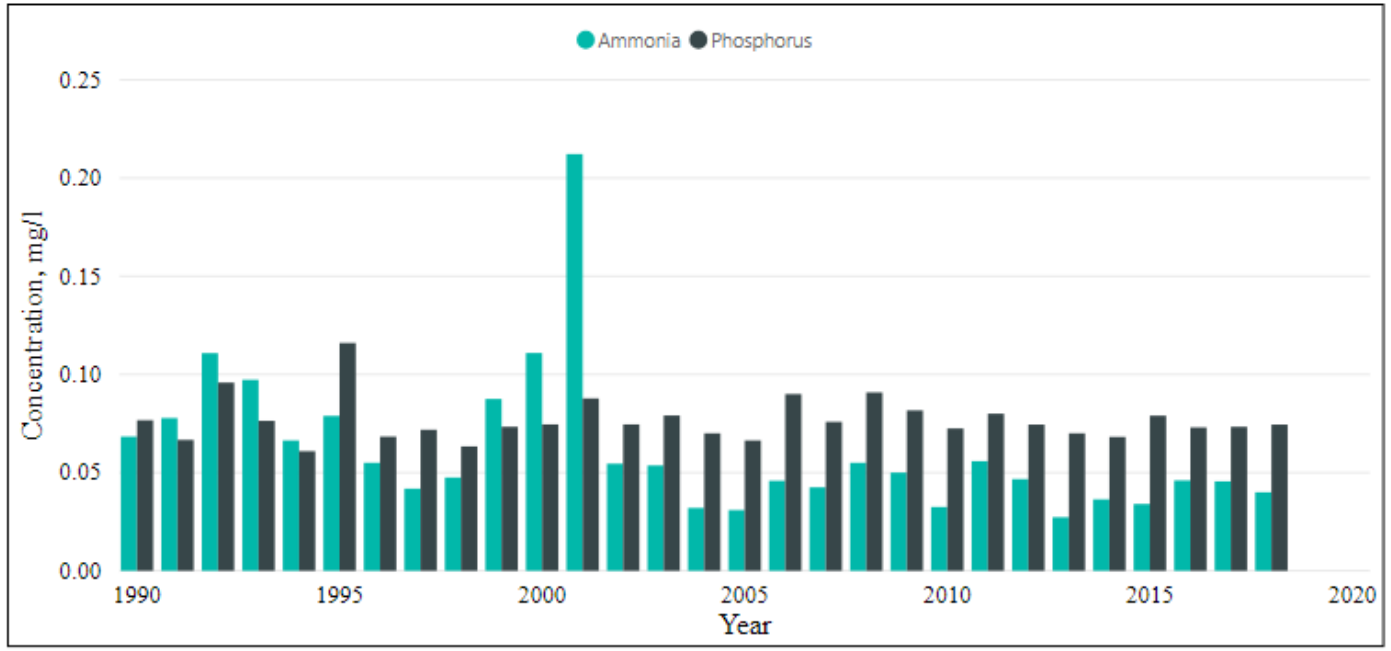
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year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Phosphorus
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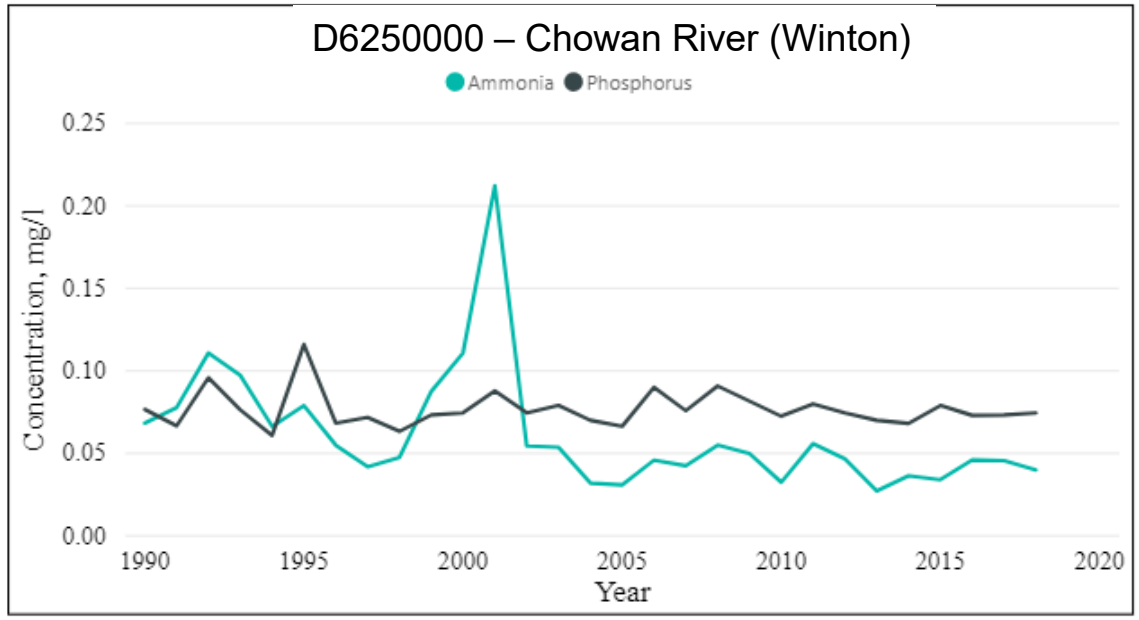
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D6250000 – Chowan River (Winton)
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Phosphorus
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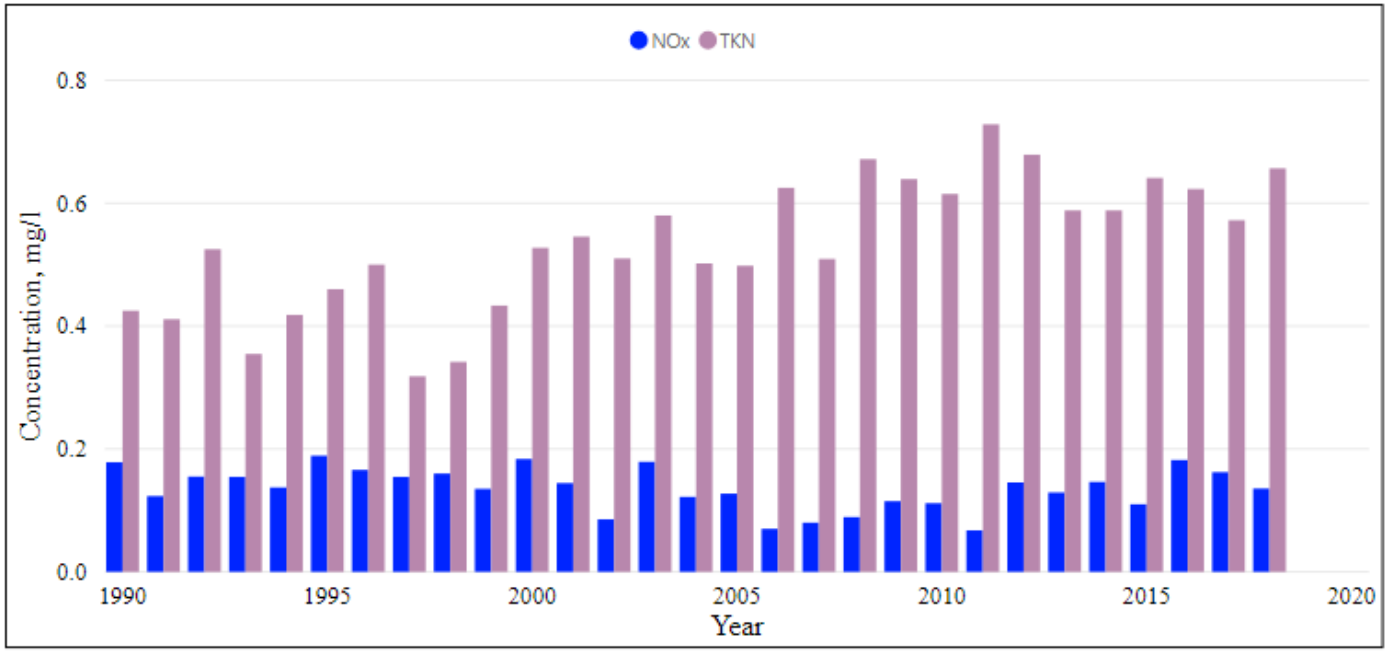
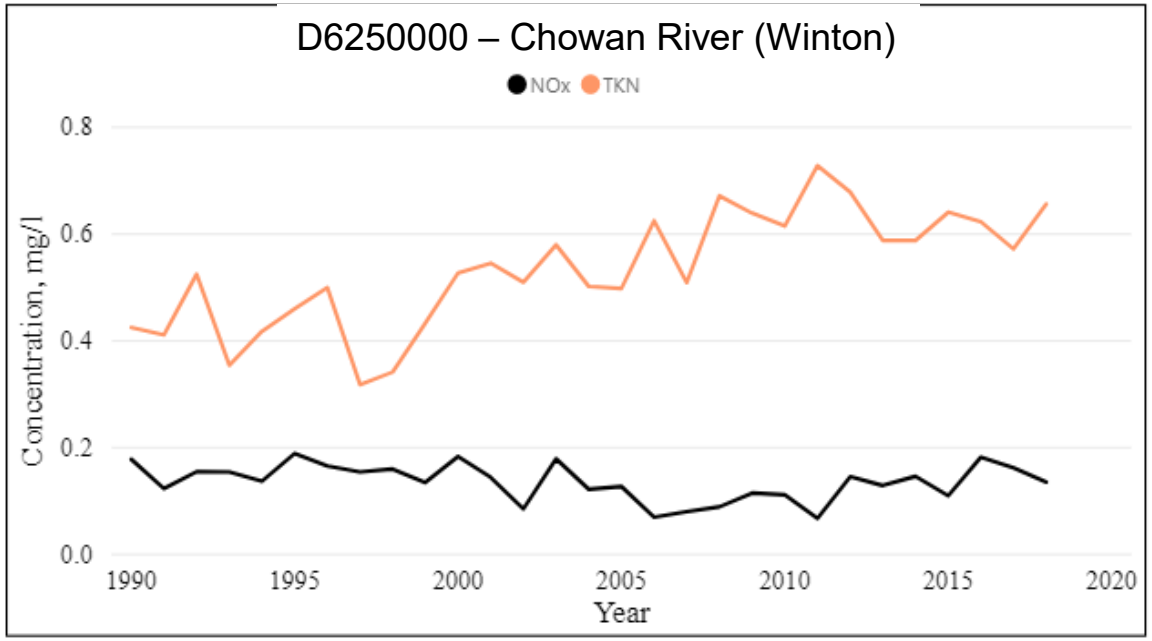
0.10
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


NOx
TKN
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D6250000 – Chowan River (Winton)
NOx
TKN
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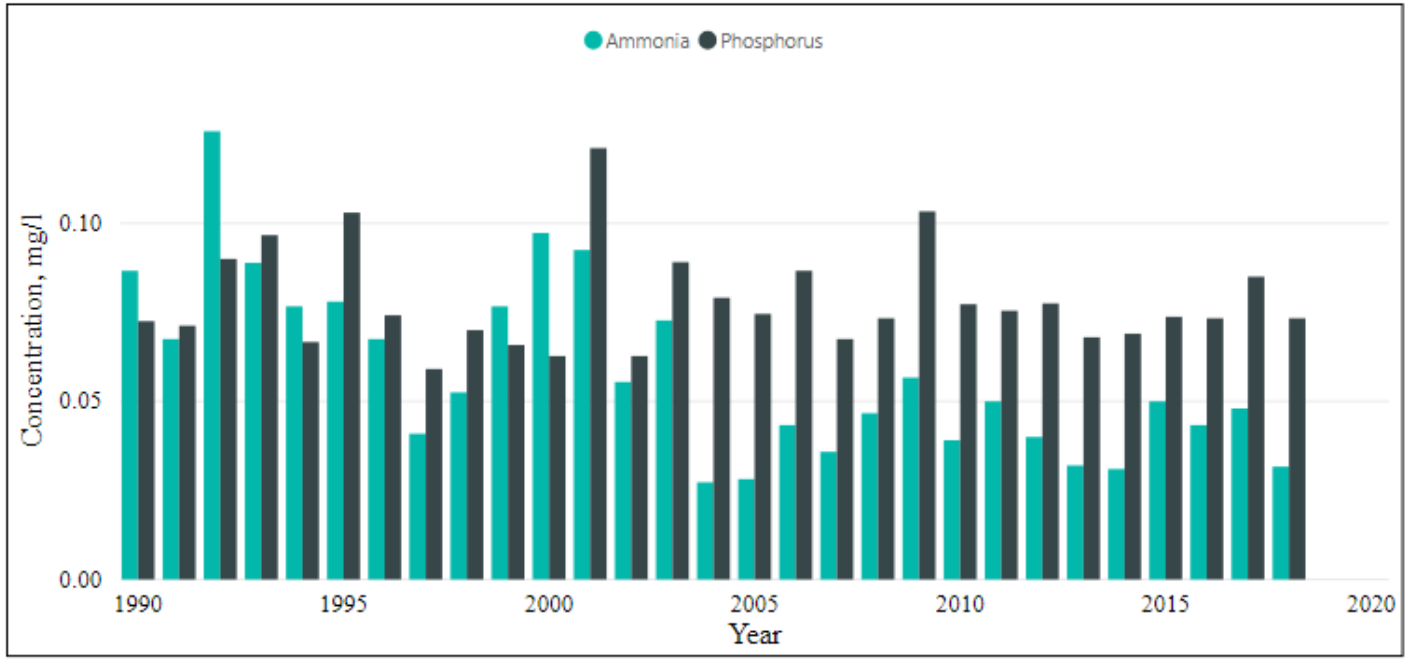
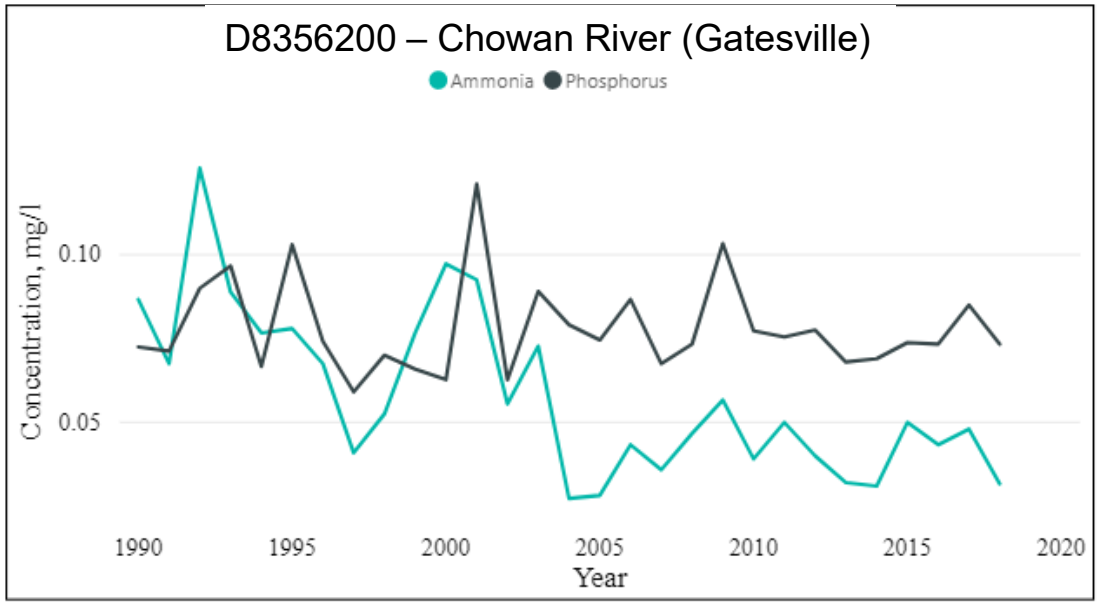
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


Ammonia
Phosphorus
Concentration, mg/l
0.00
0.05
0.10
1990
1995
2000
2005
2010
2015
2020
Year


D8356200 – Chowan River (Gatesville)
Ammonia
Phosphorus
Concentration, mg/l
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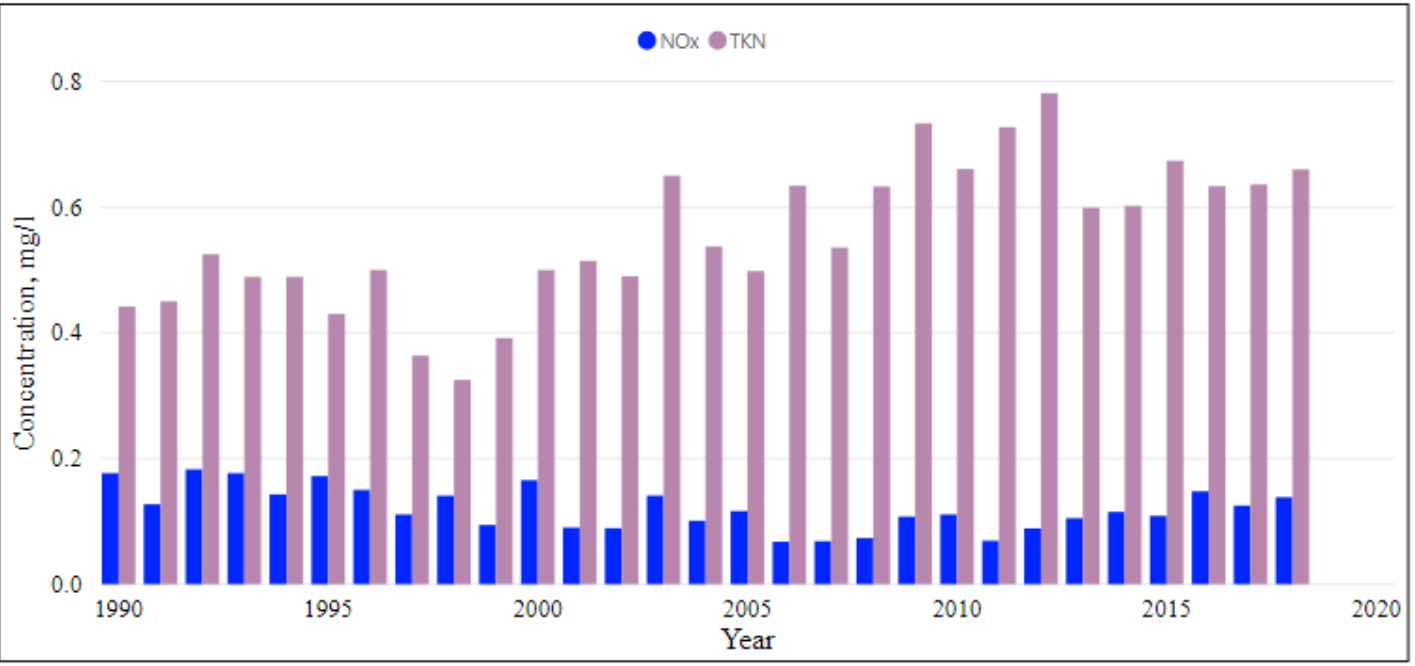
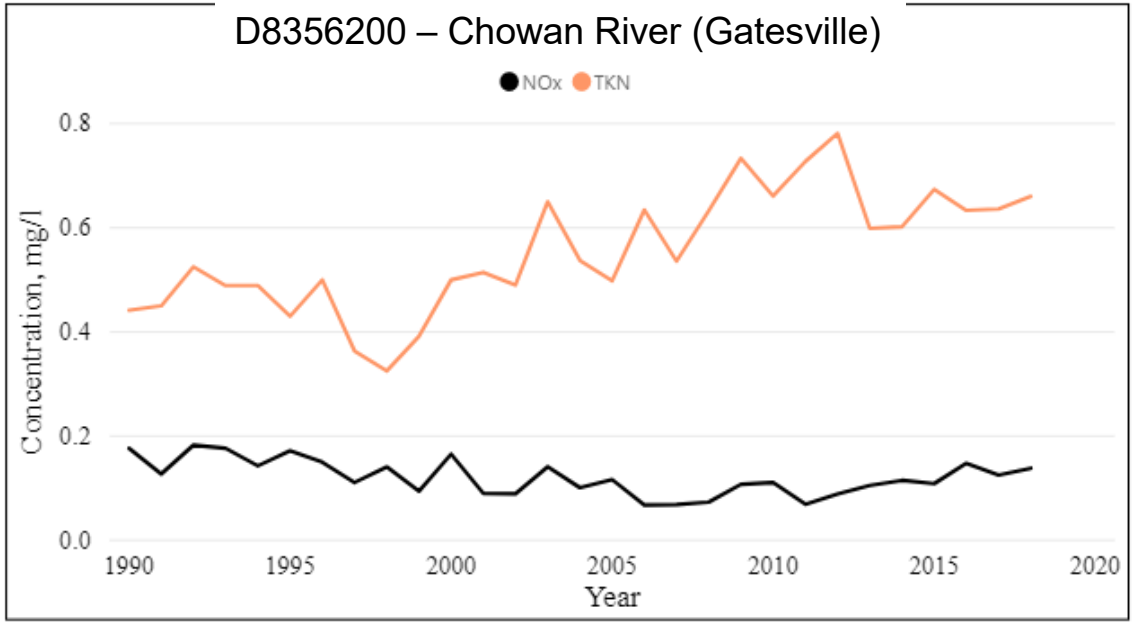
0.10
1990
1995
2000
2005
2010
2015
2020
Year


NOx
TKN
Concentration, mg/l
0.0
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
2020
Year


D8356200 – Chowan River (Gatesville)
NOx
TKN
Concentration, mg/l
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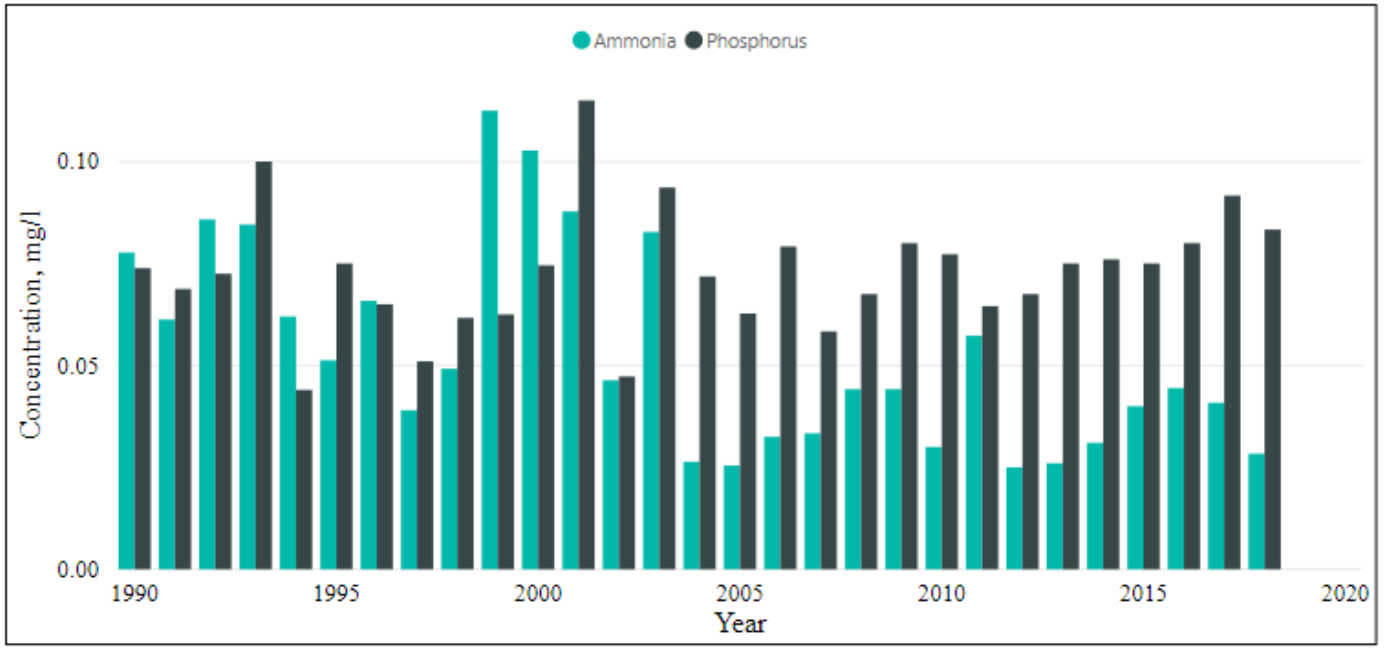
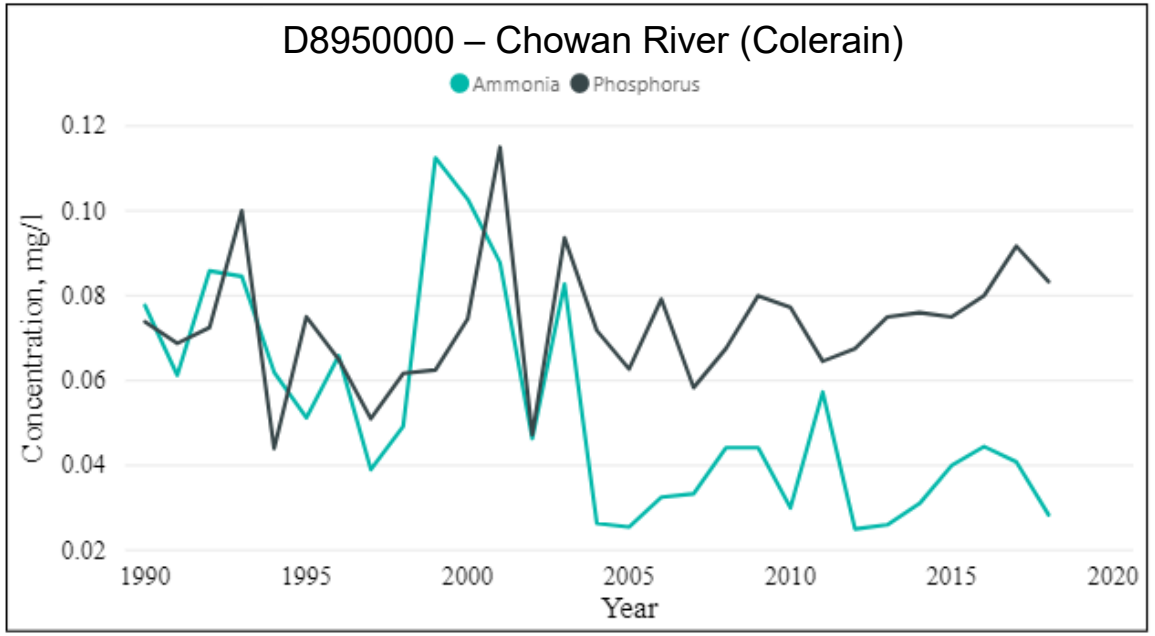
0.2
0.4
0.6
0.8
1990
1995
2000
2005
2010
2015
2020
Year


Ammonia
Phosphorus
0.10
0.05
0.00
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D8950000 – Chowan River (Colerain)
Ammonia
Phosphorus
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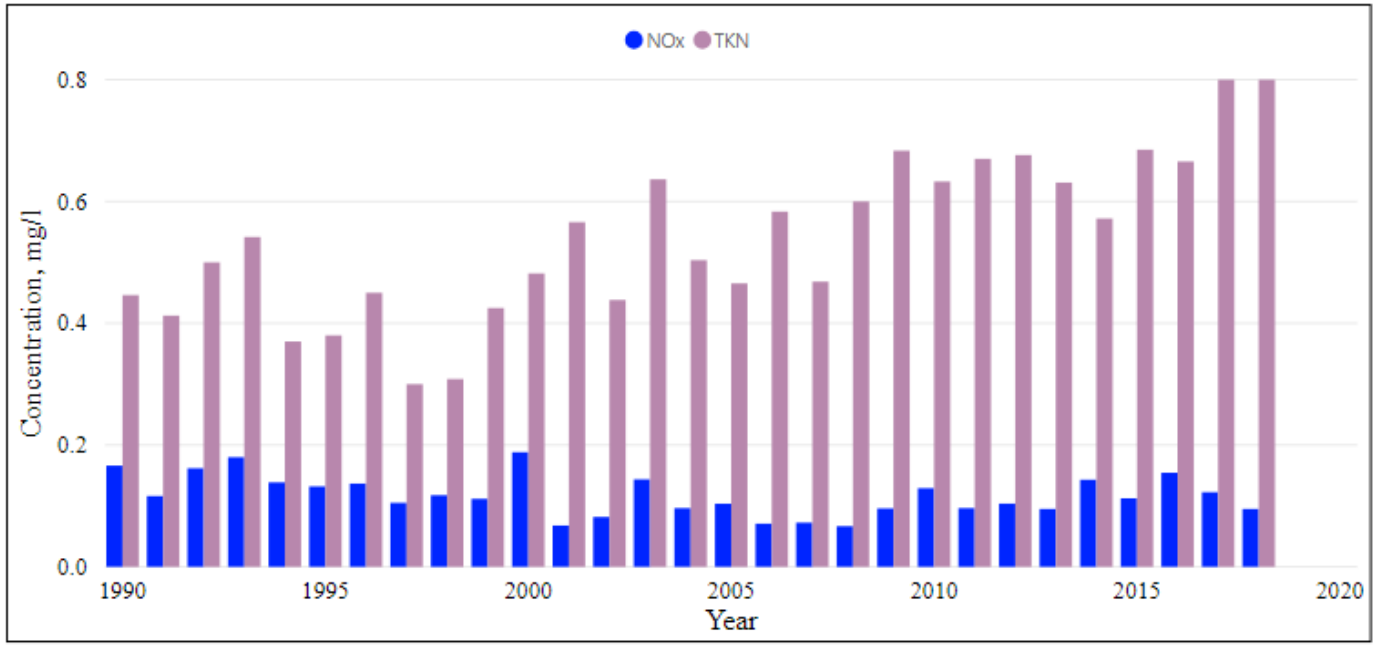
0.06
0.04
0.02
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


NOx
TKN
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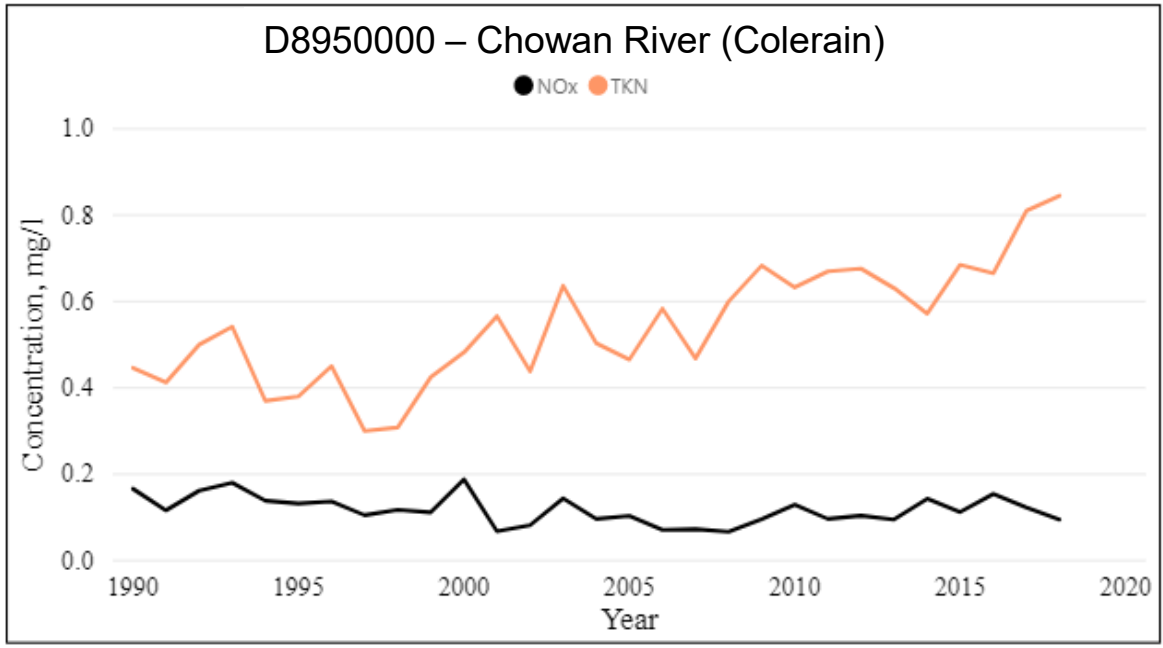
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D8950000 – Chowan River (Colerain)
NOx
TKN
1.0
0.8
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
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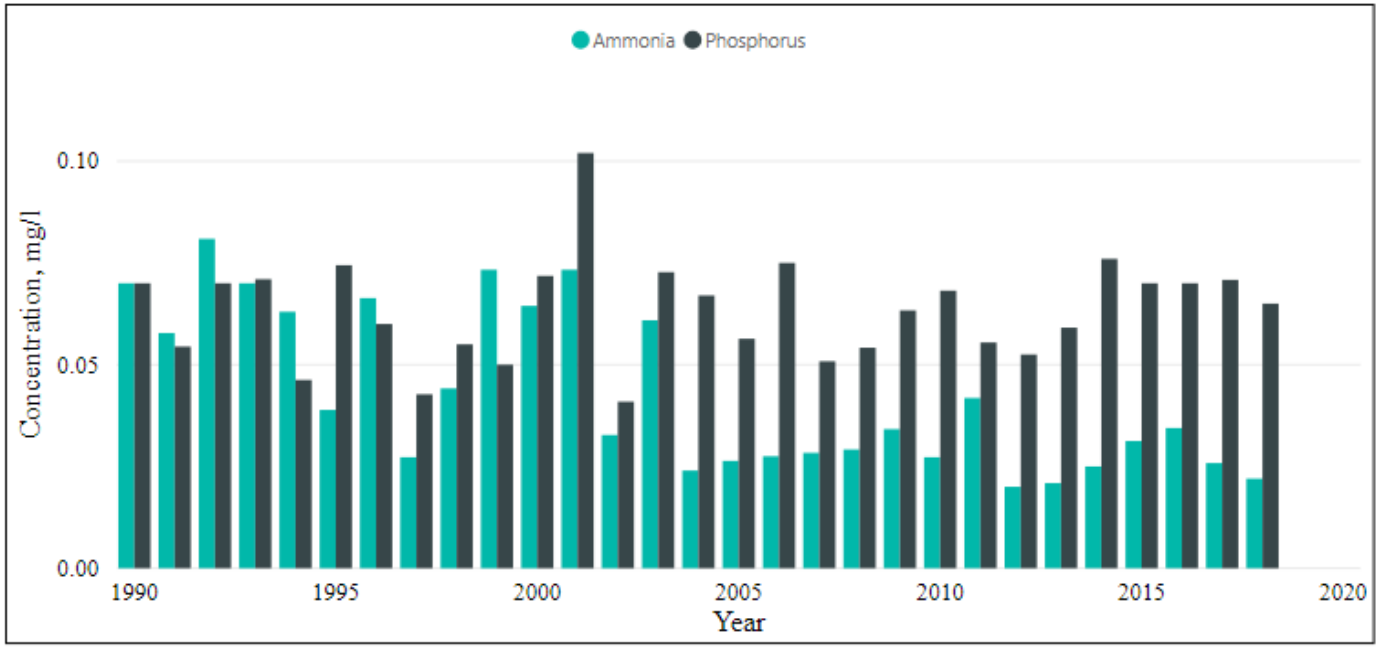
2010
2015
2020
Year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Phosphorus
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0.05
0.00
Concentration, mg/l
1990
1995
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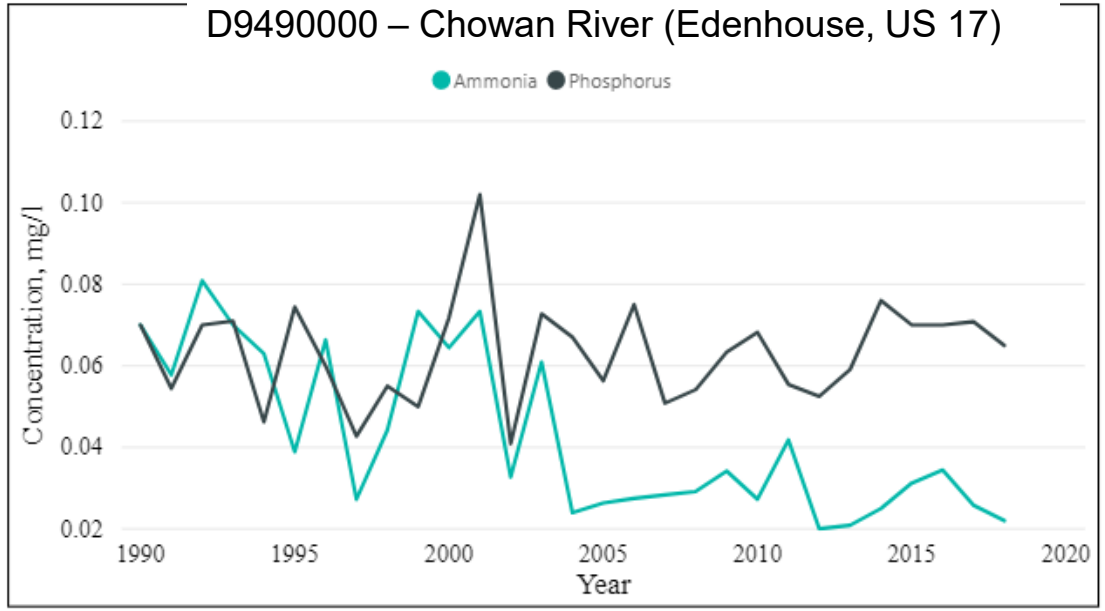
2005
2010
2015
2020
Year


D9490000 – Chowan River (Edenhouse, US 17)
Ammonia
Phosphorus
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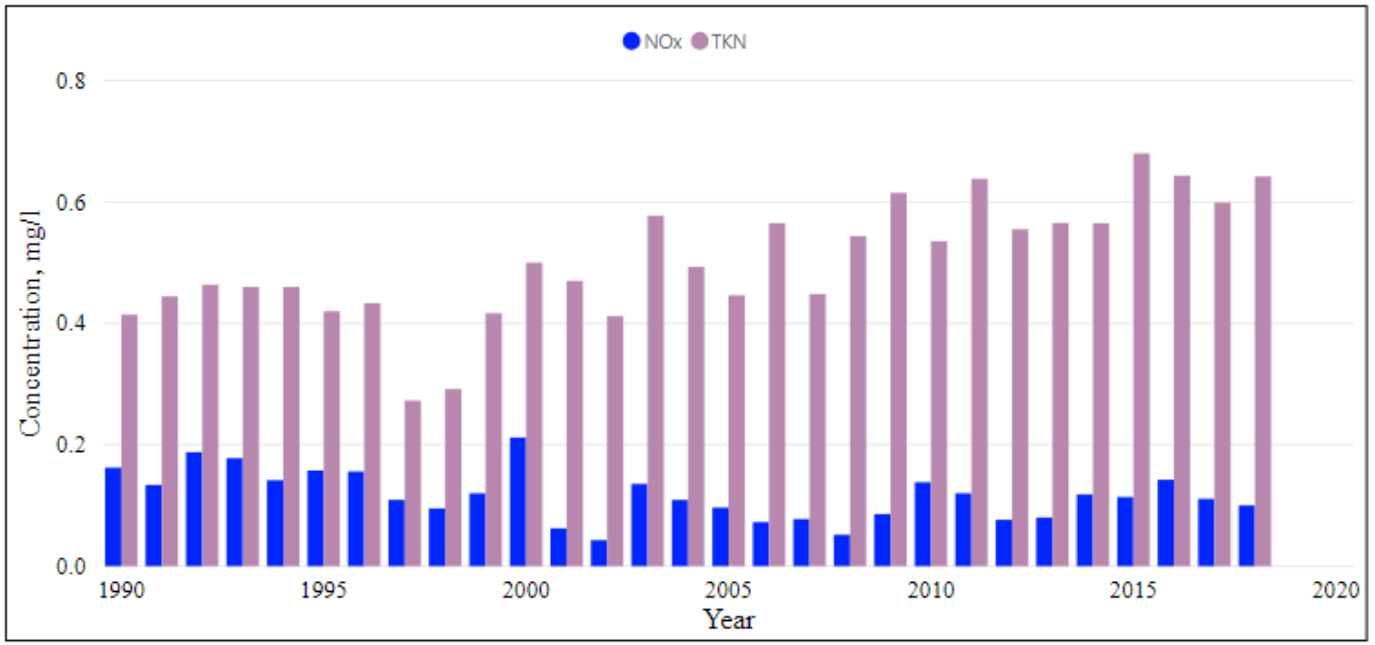
0.06
0.04
0.02
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


NOx
TKN
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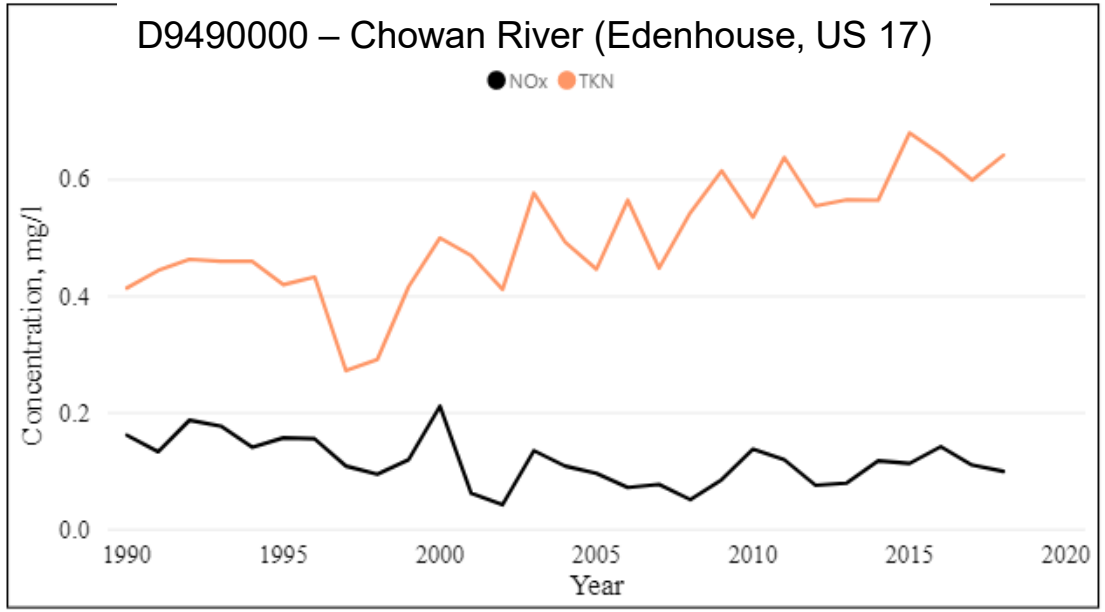
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year


D9490000 – Chowan River (Edenhouse, US 17)
NOx
TKN
0.6
0.4
0.2
0.0
Concentration, mg/l
1990
1995
2000
2005
2010
2015
2020
Year

October 30, 2019

Cyano HABs in the Chowan River and Albemarle Sound

Department of Environmental Quality

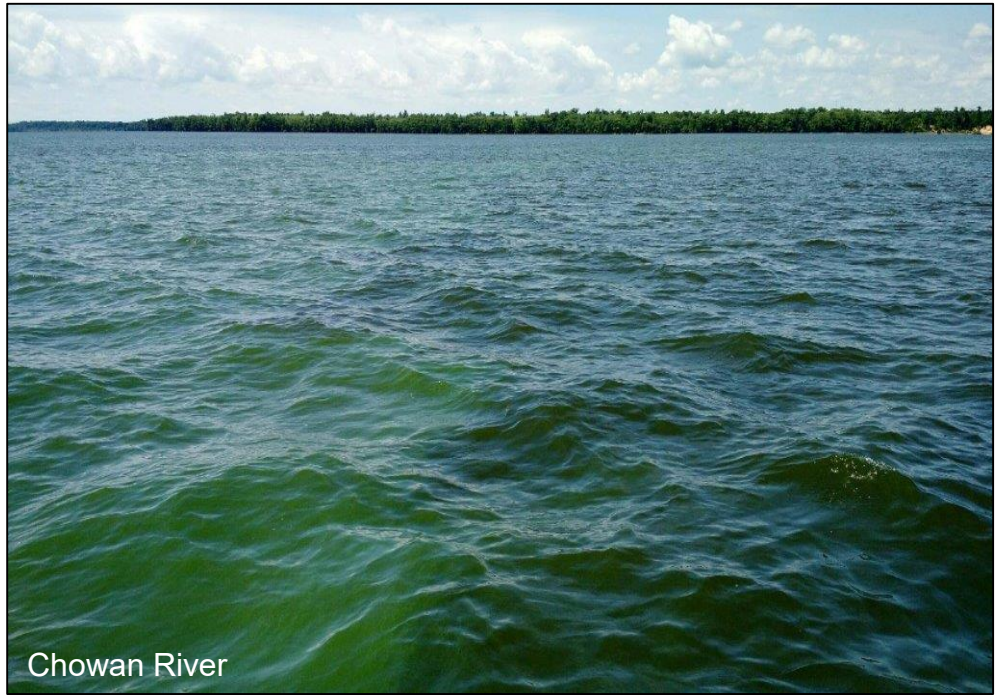
Division of Water Resources

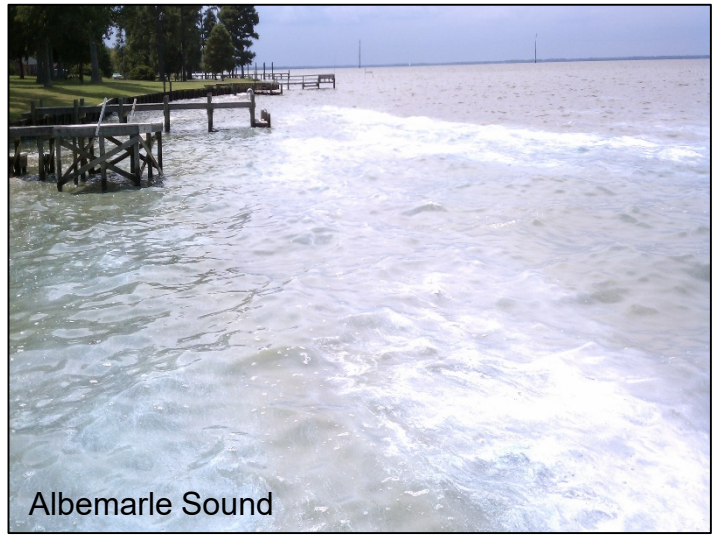
Overview

- Chronic cyanobacterial blooms reported annually since 2015
- Historically, bloom reports concentrated in Chowan River/Albemarle Sound
- 2019 blooms documented in all major Rivers draining to the Albemarle Sound
- Impacts are widespread
  - Human/animal health risks
  - Aquatic Life (shellfish and crabs)
  - Recreation
  - Local Economy

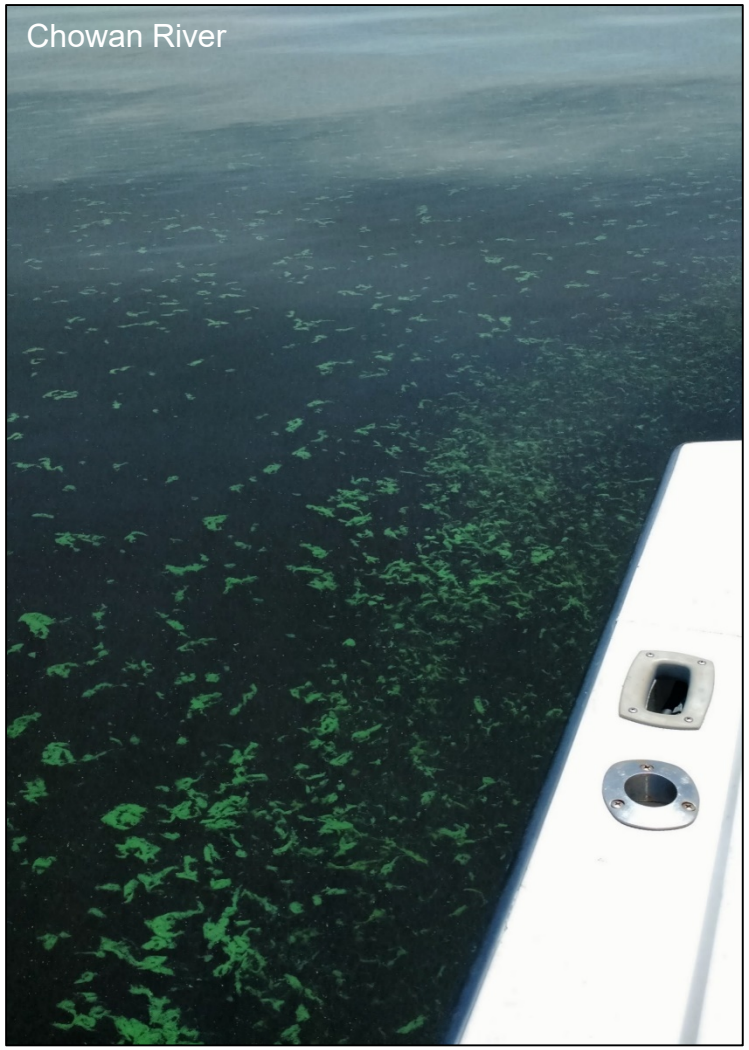
2015


Chowan River - Microcystin (54 ug/L)


Chowan River


Albemarle Sound

2016



2017


2018


2019

Bloom Characteristics

- Discolored water and/or thick surface scums
- Blooms tend to accumulate along shorelines and in canals
- Blooms are dynamic and mobile
- Microcystin production above recreational guidelines

Year	# Episodic Samples	First Sample Event
2013	1	August 19
2014	0	NA
2015	3	July 14
2016	4	July 19
2017	8	June 12
2018*	9	June 20
2019*	13	May 13

*Microcystins detected > 10 µg/L

Seasonal Bloom Taxa Progression

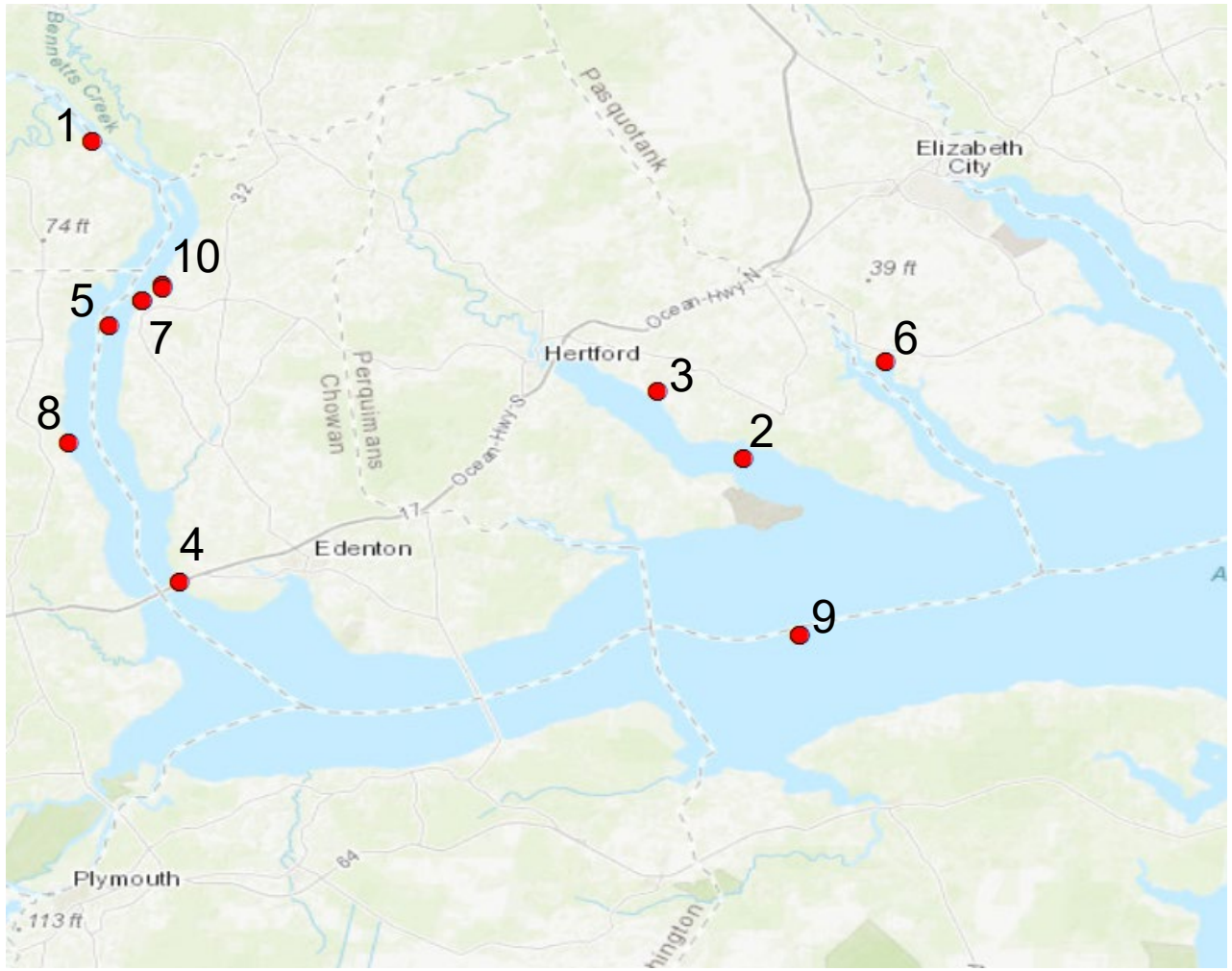
Bloom Analysis - 2018

Location	Date	Unit Density (units/mL)	Biovolume (mm^3/m^3)	Microcystin (ug/L)	Chl-a (ug/L)
1	6/25/18	9,900	7,400	BD	120
2	6/27/18	259,000	474,000	0.44	5,400
3	7/19/18	3,600	2,000	0.72	28
4	8/6/18	137,000	8,300	BD	29
5	8/6/18	79,000	5,300	0.4	22
6	8/7/18	25,000	61,000	**14.0**	NS
7	8/7/18	7,500	11,000	BD	NS
1	8/7/18	5,800	8,400	1.4	120
6	8/28/18	4,700	4,500	**6.4**	120

BD: Below Detection NS: Not Sampled

Cyanotoxin	World Health Organization	EPA Draft Human Health Recreational AWQC
Microcystins	10 ug/L	8 ug/L

Bloom Analysis - 2019



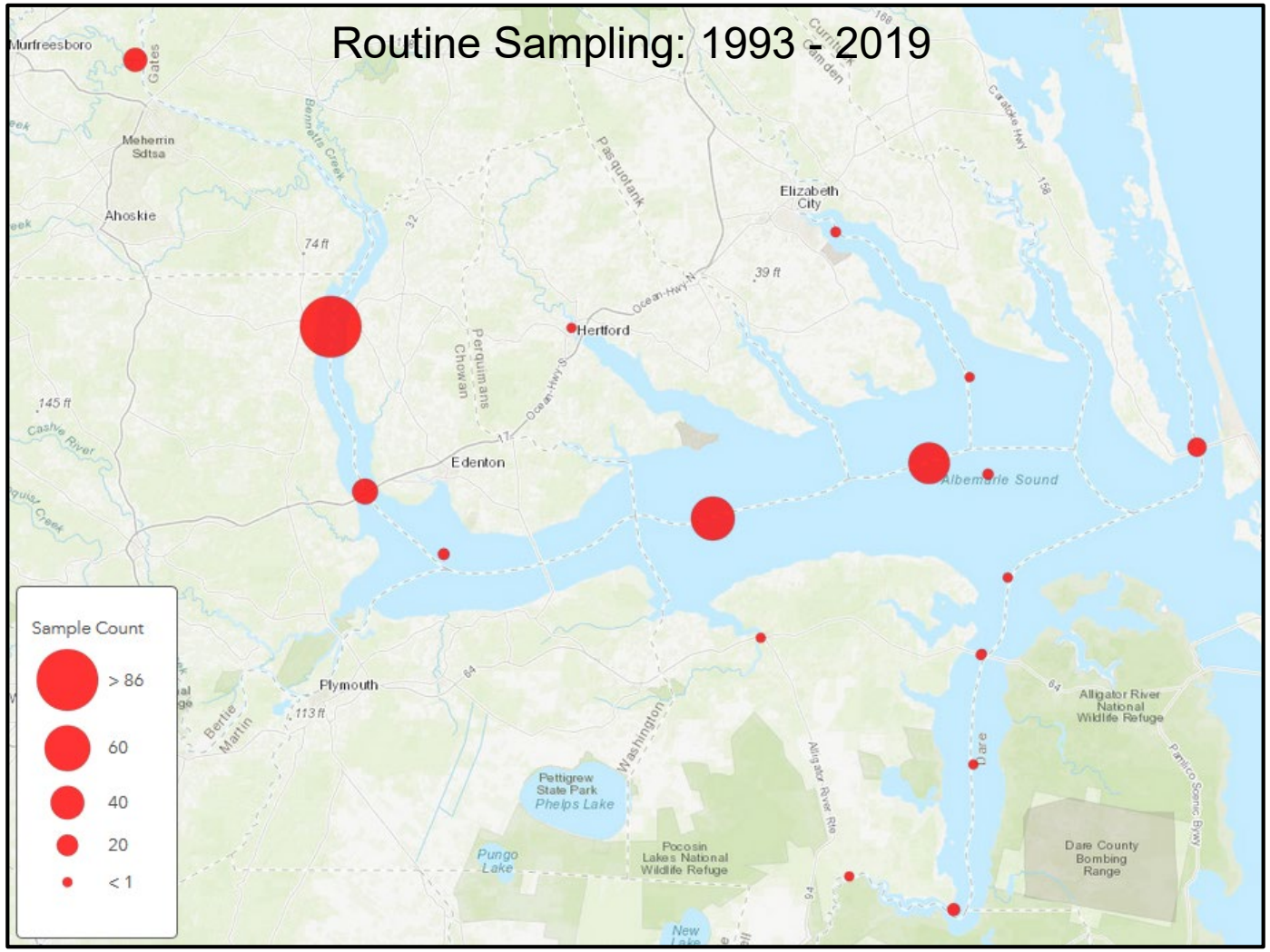
Location	Date	Unit Density (units/mL)	Biovolume (mm^3/m^3)	Microcystin (ug/L)	Chl-a (ug/L)
1	5/13/2019	19,000	9,800	NS	610
2	6/5/2019	14,000	15,000	NS	131
3	6/12/2019	140,000	19,000	0.4	86
4	6/18/2019	7,600	6,900	BD	94
5	6/27/2019	8,000	5,600	NS	57
6	7/2/2019	120,000	45,000	BD	NS
7	7/17/2019	7,900	32,000	**310.0**	984
7	7/23/2019	5,600	12,000	**21.0**	72
8	7/29/2019	9,600	280,000	**190.0**	630
9	7/31/2019	110,000	7,100	3.3	19
10	8/13/2019	13,000	560,000	**620.0**	NS
10	8/19/2019	2,600	7,900	9.3	32
9	9/11/2019	66,000	5,000	NS	33

BD: Below Detection NS: Not Sampled

Cyanotoxin	World Health Organization	EPA Draft Human Health Recreational AWQC
Microcystins	10 ug/L	8 ug/L

Algal Monitoring: Routine Sampling

- Phytoplankton collected at Ambient Monitoring Stations (AMS)
- Date range: 1993-present
- Collected as composite samples over depth of photic zone (2x secchi depth)
- Analyzed for algal community structure and density
- Mid-channel stations may not capture “bloom” conditions



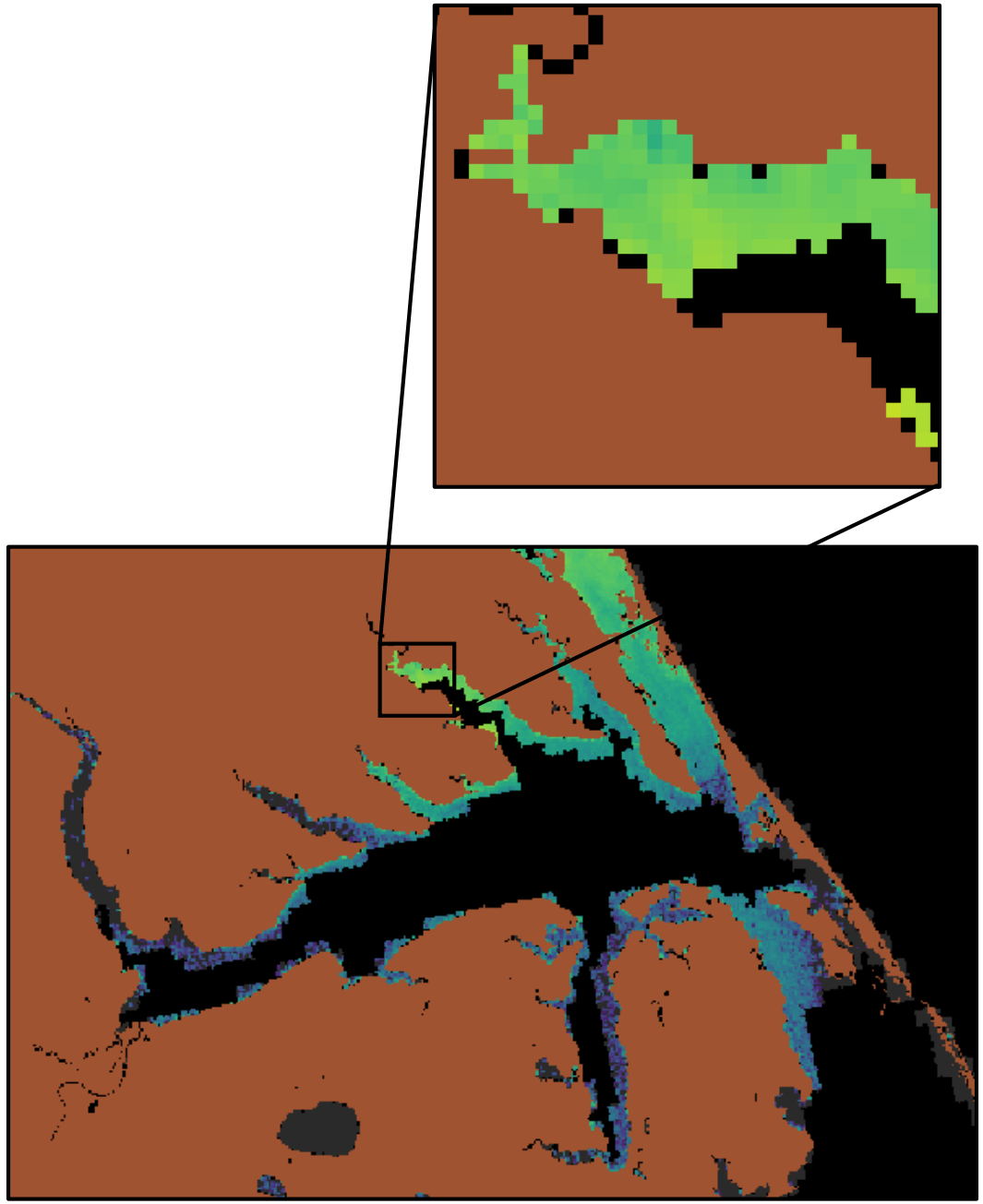
Algal Monitoring: Near-Shore Sampling

- Located at Wharf Landing near US 17 bridge
- Objectives:
  - Capture routine water quality data at “bloom prone” location
  - Compare bloom sampling methodologies (surface vs photic zone)
- Preliminary results indicate no significant bloom event captured by routine monitoring

Sample Type	Collection Method	Frequency
Phytoplankton	Surface Grab + Photic	Monthly (Jan-Dec)
Chlorophyll –a	Surface Grab + Photic	Monthly (Jan-Dec)
Microcystins	Surface Grab +Photic	Monthly (May-Sept)
Nutrients	Photic	Monthly (Jan-Dec)
Turbidity	Photic	Monthly (Jan-Dec)

Remote Sensing

- Satellite imagery available weekly from the Cyanobacteria Assessment Network (CYAN)
- Data range (2012 – present)
- Currently used as a screening tool for cyanobacterial bloom monitoring and response
- Pixels values can be converted to…
  - cyanobacterial cell density (cells/mL)
  - Chlorophyll-a (ug/L)
- Limitations
  - Land-shore interface
  - Resolution (300 x 300 m)
  - Algorithms developed from freshwater systems



Questions?

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leigh.stevenson@ncdenr.gov • (919) 743-8451