

Path Forward Committee Meeting June 4, 2019



Agenda

- Opening comments
- Modeling and regulatory support status
- Monitoring program status
- Ongoing DEQ discussion/issues
- Coordination with the UNC Collaboratory
- Status of the optional implementation approach
- Status of contract development for FY2020

Modeling and Regulatory Support Status

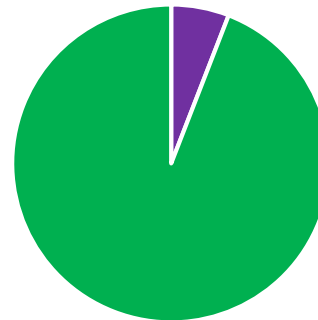
Draft Scope of Work for Fiscal Year 2020

FY2020 Anticipated Budget for the Re-examination

- Combine the transitional monitoring program, modeling, and regulatory support in a single contract
- Anticipated budget is \$740K to \$750K



- Environment 1
- Dynamic Solutions
- Systech Water Resources
- BC and Independent Consultants



- Monitoring
- MRS

Proposed Draft FY2020 Scope of Work for the Re-examination

- Continue the transitional monitoring program to collect data for future needs (adaptive management)
- Calibrate and validate mechanistic models for stream flows and lake levels
 - WARMF watershed
 - EFDC lake
- Continue with statistical analyses to support the mechanistic models and explore relationships for the empirical modeling
- Continue stakeholder engagement and support communications
- Work with the UNC Collaboratory on prioritizing studies in future years

Task 320: Transition Monitoring and Reporting

Proposes monthly sampling at 12 stations and relies on other organizations to sample other locations:

FLR-25(JB)	Flat River
DPC-23(JB)	Deep River
NLR-27(JB)	North Fork Little River
SLR-22(JB)	South Fork Little River
ENR-49(JB)	Eno River
ENR-23(JB)	Eno River
LGE-5.1(LL)	Ledge Creek
ROB-2.8(LL)	Robertson Creek
BDC-2.0(LL)	Beaverdam Creek
NLC-2.3(LL)	New Light Creek
LBC-2.1 (LL)	Lower Barton Creek
HSE-1.7(LL)	Horse Creek

Task 320: Transition Monitoring and Reporting

- Each sample would be analyzed by the laboratory for
 - Total phosphorus
 - Total Kjeldahl nitrogen
 - Total ammonia
 - Total nitrate plus nitrite
- Samples from the six lake loading stations [designated by “(LL)”] would also be analyzed for total organic carbon.
- Field duplicates and blanks would be analyzed at a rate of approximately 10 percent of the sample count for QA/QC purposes.

Task 320: Transition Monitoring and Reporting

- Following QAQC, data would be posted to the UNRBA website via the data portal quarterly
- Contractor would acquire monitoring data from other entities including DWR, City of Durham, City of Raleigh, and the Center for Applied Aquatic Ecology.
- Compiled data would be summarized in a brief technical memorandum for the UNRBA
- No Special Studies or evaluations of Special Studies are included in Transition Monitoring

Task 321: Setup, Linkage, and Testing of Watershed and Lake Models

- Setup watershed and lake models for
 - Calibration (2015 to 2016)
 - Validation (2017 to 2018)
 - Baseline comparison (2005 to 2007)
- Model linkages for each period will be established and tested

Task 322: Hydrologic and Hydrodynamic Calibration and Validation of WARMF Watershed and EFDC Lake Models

- Consistent with the performance criteria specified in the DWR-approved Modeling Quality Assurance Project Plan
 - Calibrate and validate the WARMF model
 - Observed streams flows using data from USGS
 - Calibrate and validate the EFDC lake model
 - Observed lake water levels (from USGS and USACE)
 - Observed temperature data (from DWR)

Task 323: Continued Data Collection, Processing, and Analysis to Support Future Water Quality Calibration

- Land use data released by USGS in May 2019 will be processed to determine amounts of existing and new development
- Water quality calibration in the watershed and lake will occur in FY2021
- Data collection and processing in FY2020 will occur in preparation
 - Air quality and air deposition estimates
 - Nutrient application rates by land use
 - Major and minor wastewater treatment plant effluent
 - Onsite wastewater treatment systems

Task 324: Statistical Analyses and Configuration of Model Inputs for Water Quality Calibration

- Evaluate the calibration and validation of the lake and watershed models relative to the performance criteria listed in the QAPP
- Coordinate with subject matter experts on the empirical modeling
- Configure model inputs associated water quality calibration that will occur in FY 2021

Task 325: Iterative Reporting

- Support development of meeting materials for the UNRBA Water Summit in the fall
- Provide presentation materials for the Annual Technical Stakeholder Workshop in the spring
- Provide presentation materials for the Water Resources Research Institute Annual Conference (spring)
- Develop draft technical memorandum for review by the MRSW and PFC
 - Times series and meteorology inputs
 - Land use, soils, and onsite wastewater treatment system data
 - Hydrologic/hydrodynamic calibration and validation of the WARMF watershed model

Task 326: Update Work Plan and Scope

- Update the work plan for future work under MRS Phases 3, 4, and 5 if updates relative to the QAPP are required
- Consider the latest information on legislative changes affecting either the UNRBA reexamination process and/or the UNC Nutrient Study of Falls Lake
- Develop the FY 2021 scope of work

Task 327: Regulatory Support as Needed and Coordination with Communications Team

- Support the UNRBA in their preparation and planning for meetings regarding discussions that may affect the reexamination
 - Agency staff
 - Watershed stakeholders
 - Interested parties
- Coordination with the communications team that the UNRBA has engaged to generate materials about the MRS project that are appropriate for a wide range of audiences
- Review and provide input on the materials generated by the communications team

Task 328: Client Communications, Stakeholder Workshops, and Project Management

- Provide status updates to the UNRBA through the MRSW and during their routine PFC and BOD meetings
- Status calls with the Executive Director on a regular basis and calls (or meetings if needed) with the MRSW
- Planning for and participation associated with the three stakeholder meetings
 - Water Summit
 - Technical Stakeholder Workshop
 - WRI Annual Conference
- Provide invoices and supporting documentation

Modeling Updates

Source Data Updates

- USGS released the land use data needed for the modelers to set up the baseline period model and the UNRBA monitoring period model
- Agriculture has provided acreages by county for crop types and pasture
- The State Climate Office will soon provide the radar precipitation data

Model Updates

- WARMF modeling catchments have been finalized
- Impoundments have been coded into the model
- Preliminary times series inputs have been input to the model for the baseline modeling period
 - Discharges from major and minor WWTPs
 - Releases from impoundments
 - Water withdrawals from impoundments
- Extended EFDC model grid based on flooding that occurred during the monitoring period
- Processed sediment quality data to set initial conditions for the EFDC sediment diagenesis module

Monitoring Program Status

Final UNRBA Monitoring Report for Supporting Re-Examination of the Falls Lake Nutrient Strategy

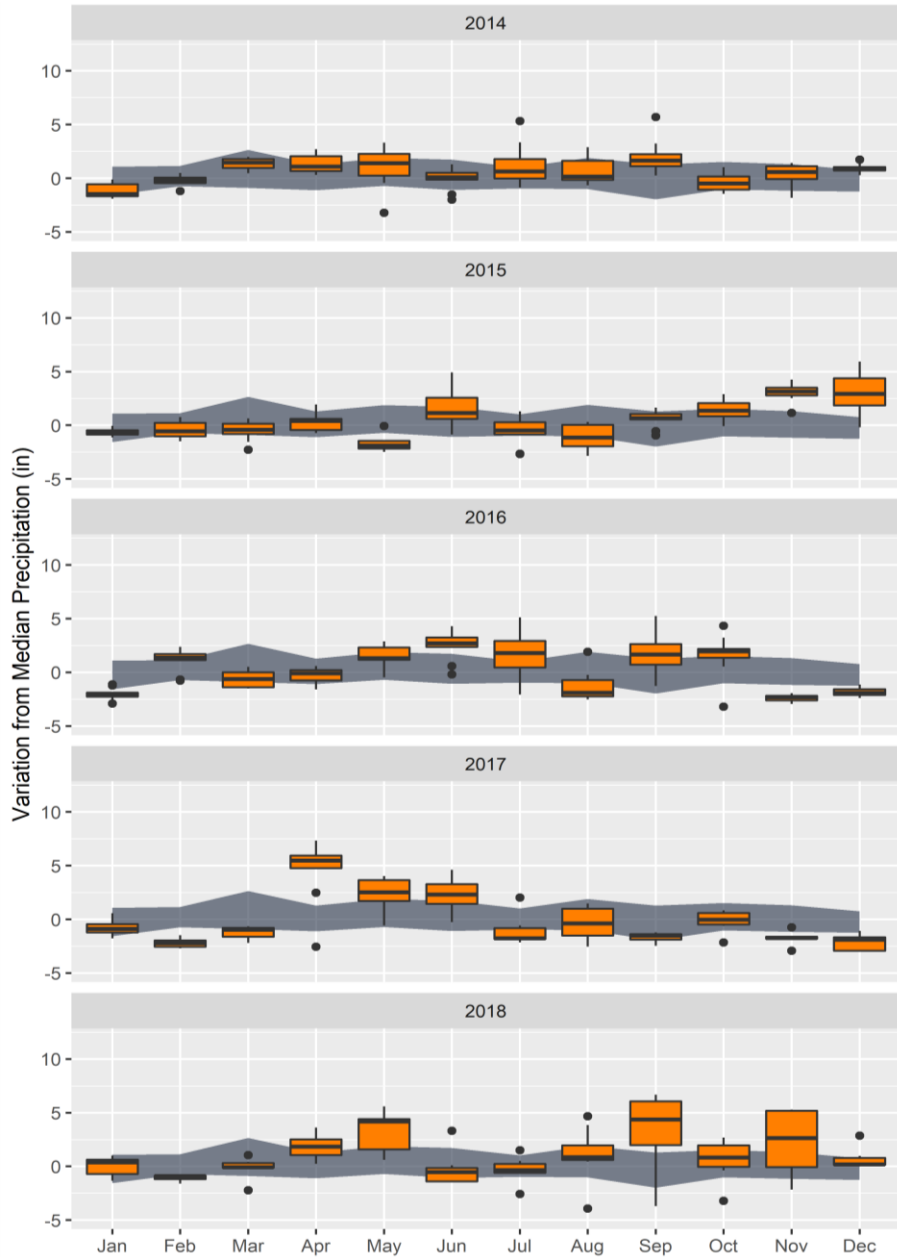
- Draft was delivered to the PFC for review on May 24th
- Two files were provided
 - Main report with Executive Summary and smaller figures
 - Figures document for Section 3 figures and some Section 5 figures
- Overview of results will be provided today following by discussion with the PFC

Something old, something new...

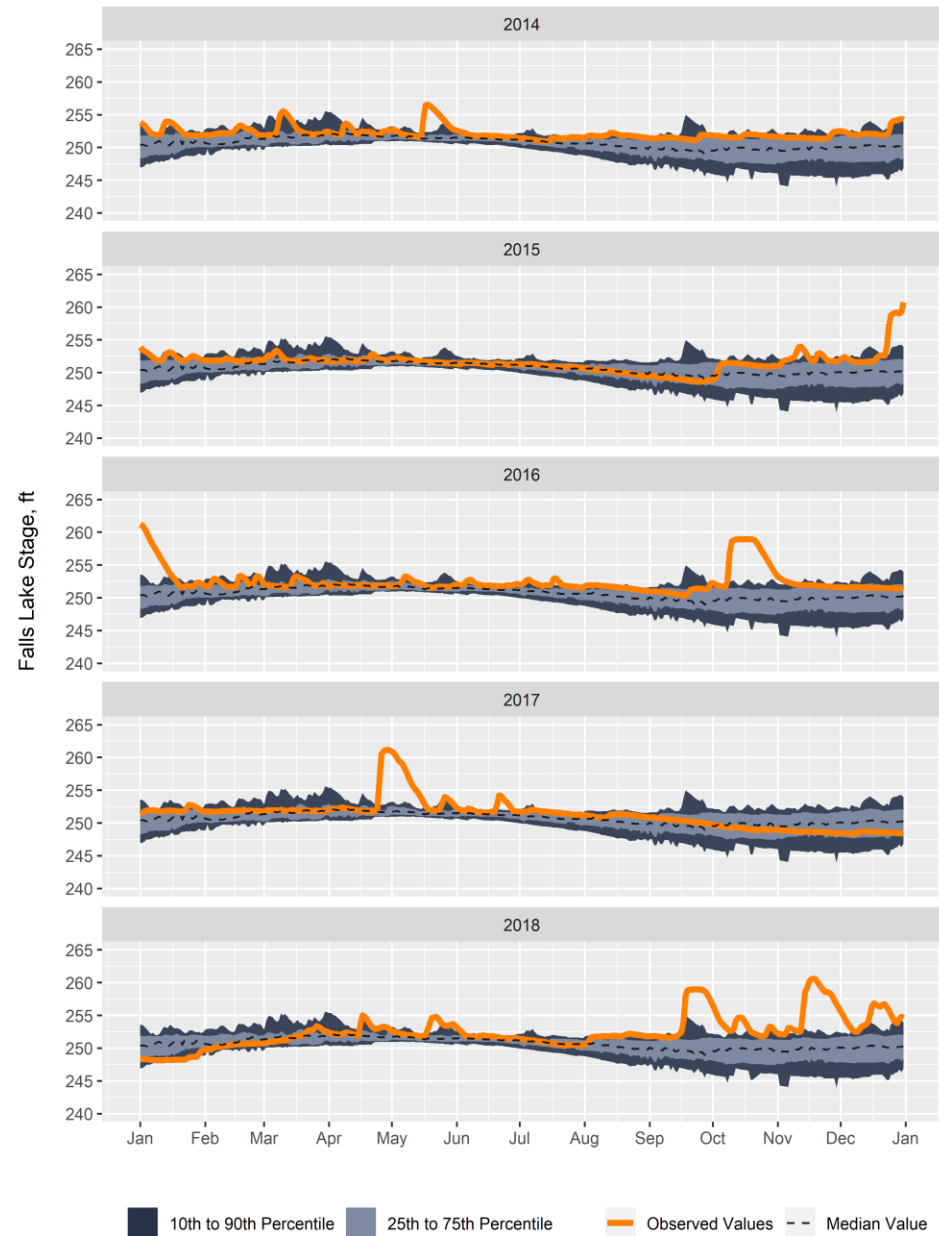
- Sections 1, 2, and 3, and Section 6 (QA/QC) of this Final Report are largely the same presentation of information as in prior Annual Reports
- Section 4 offers a summary of pre-impoundment studies of Falls Lake and an overview of characteristics of reservoir impoundments to be considered in modeling efforts and refinement of a nutrient management strategy
- Section 5 expands upon some topics from prior reports, but also includes new analyses and interpretation to more fully frame the conditions in Falls Lake

Hydrologic Conditions

Rainfall

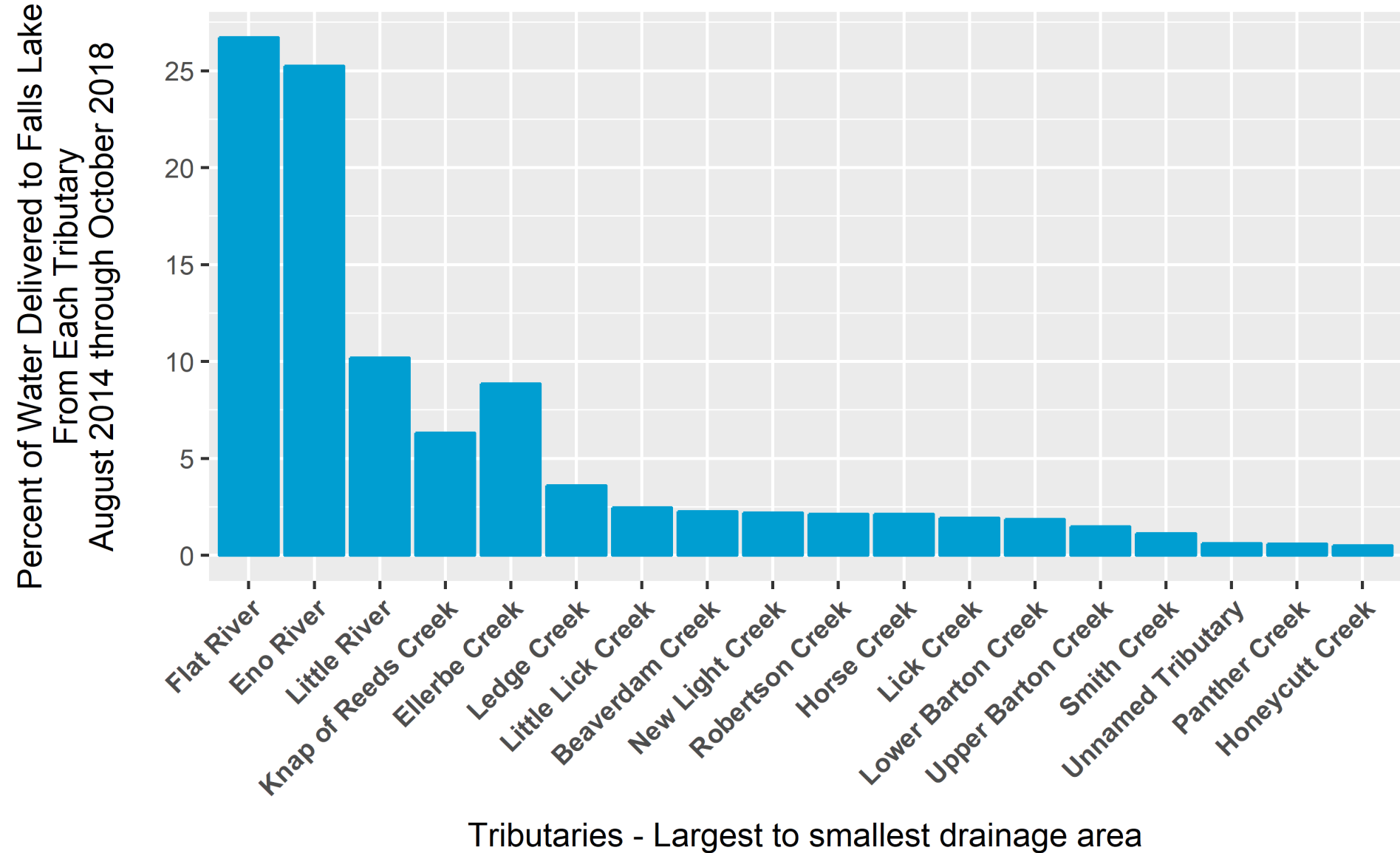


Lake Level

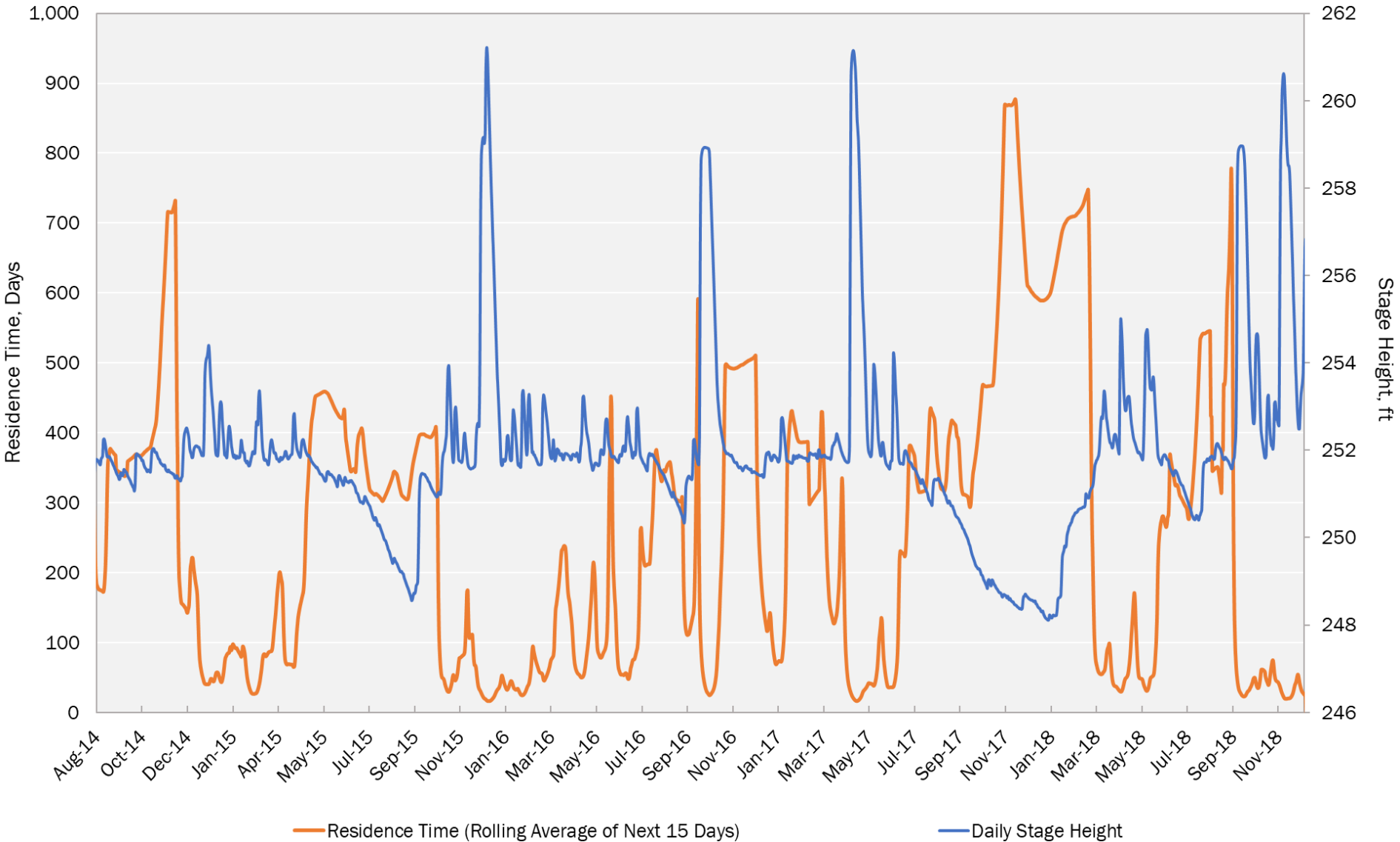


10th to 90th Percentile
 25th to 75th Percentile
 Observed Values
 Median Value

Hydraulic Loading from Tributaries



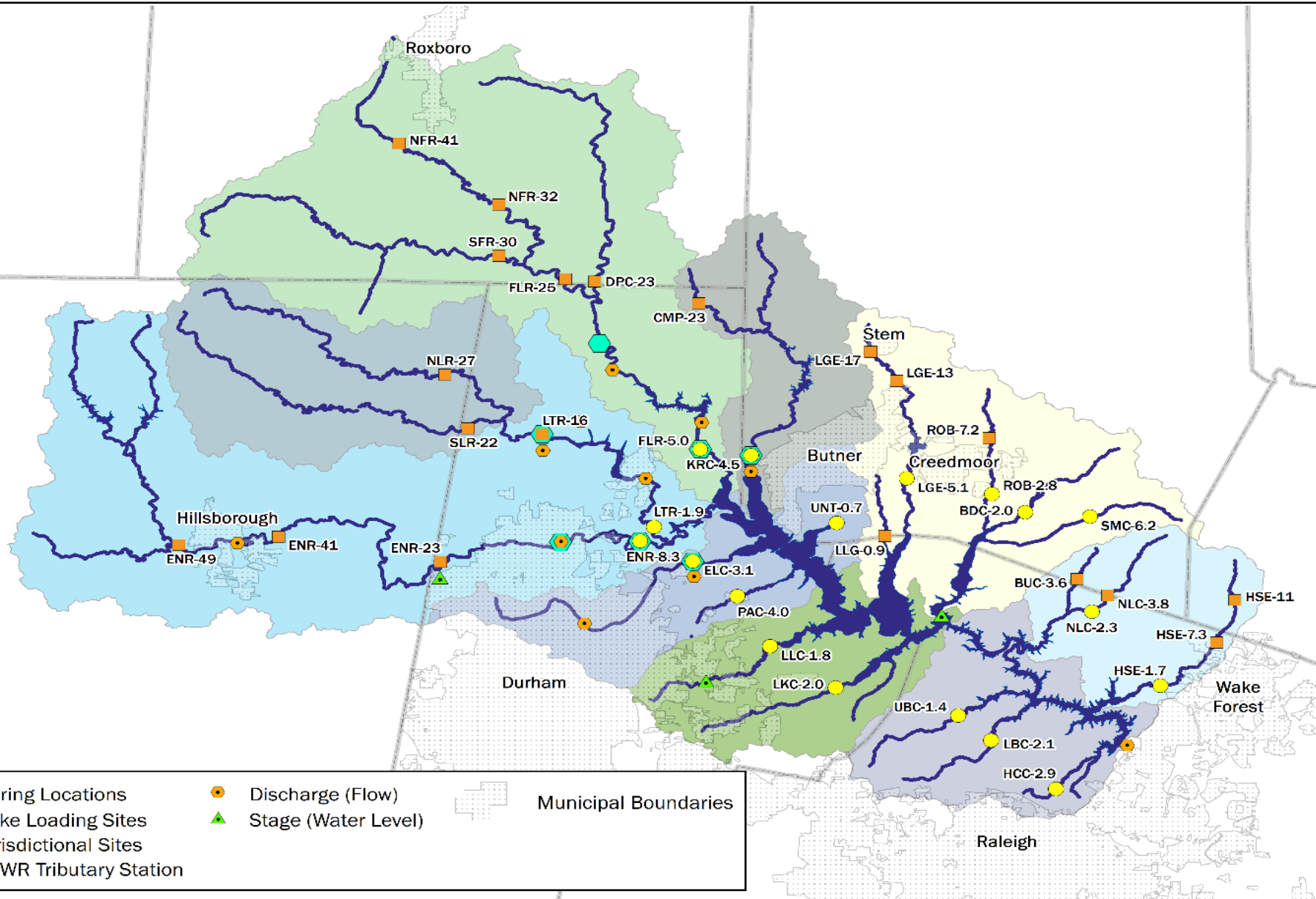
Reservoir Residence Time



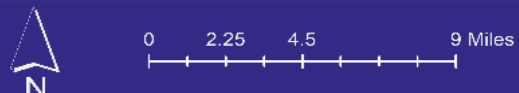
Routine Monitoring

Status of Data Collection Efforts

- The UNRBA Routine Monitoring effort was suspended after October 2018.
 - 51 months of continuous sampling at 38 tributary stations draining to Falls Lake
- “Transition Monitoring” has been under way by the UNRBA since November 2018 to provide ongoing sampling at 12 selected tributary stations
- DWR, the City of Durham, and the Center for Applied Aquatic Ecology are each continuing their monitoring of stations on Falls Lake and selected tributaries

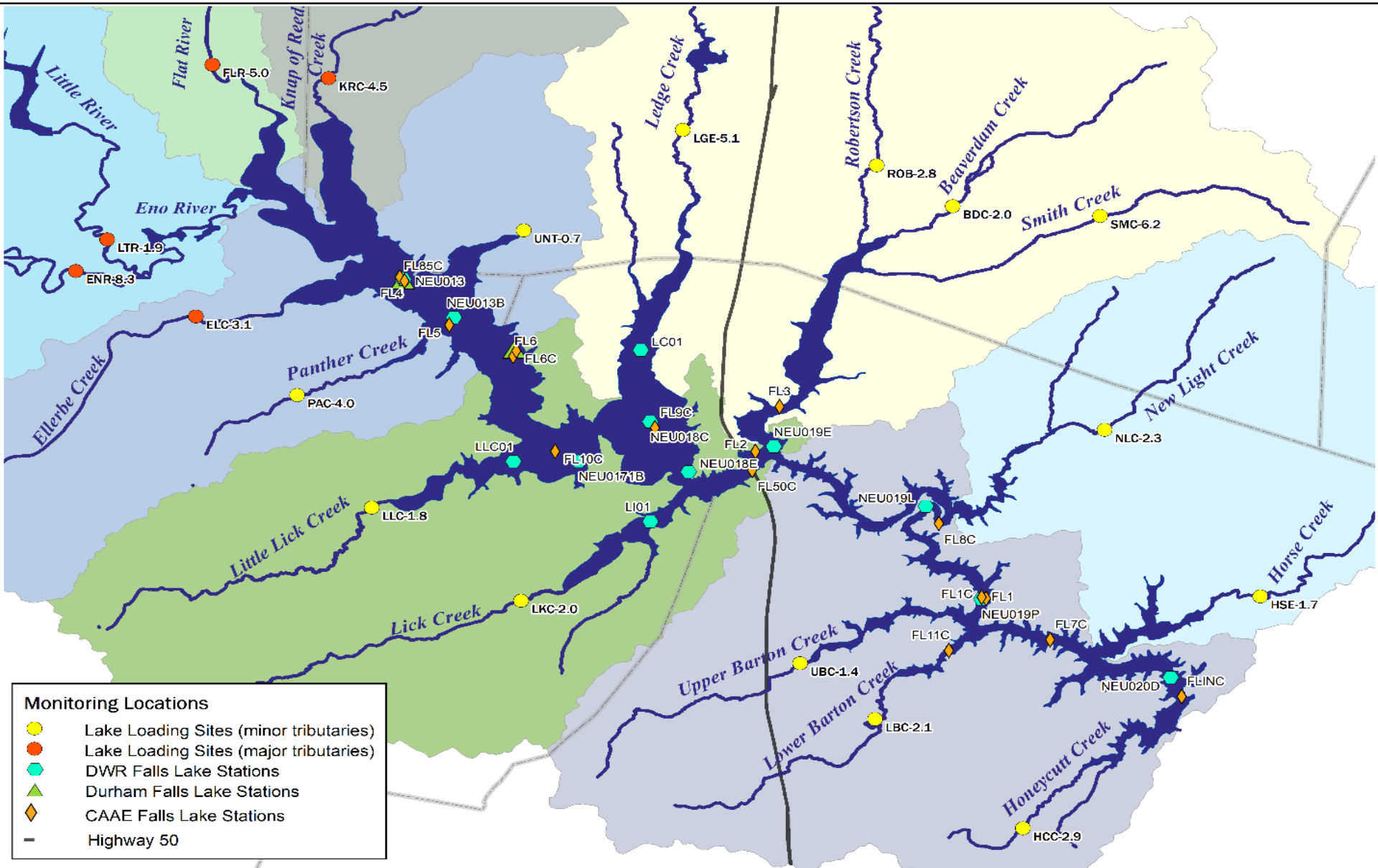


- Monitoring Locations
- Lake Loading Sites
- Jurisdictional Sites
- ⬡ DWR Tributary Station
- Discharge (Flow)
- ▲ Stage (Water Level)
- Municipal Boundaries

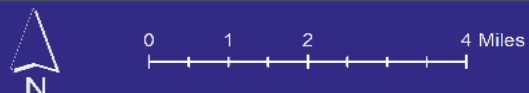


Tributary Monitoring Locations
 Upper Neuse River Basin Association
 North Carolina





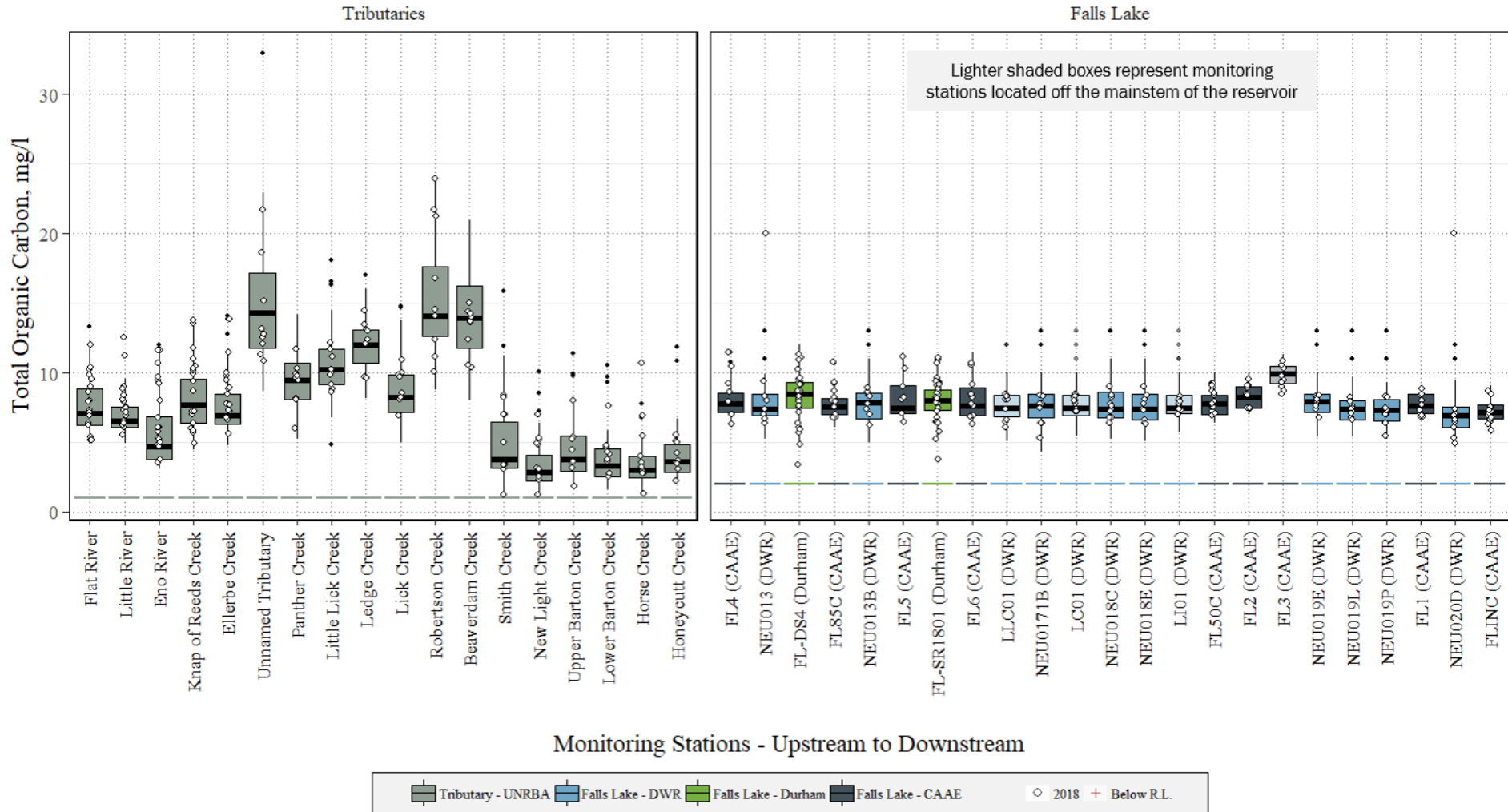
- Monitoring Locations**
- Lake Loading Sites (minor tributaries)
 - Lake Loading Sites (major tributaries)
 - DWR Falls Lake Stations
 - ▲ Durham Falls Lake Stations
 - ◆ CAAE Falls Lake Stations
 - Highway 50



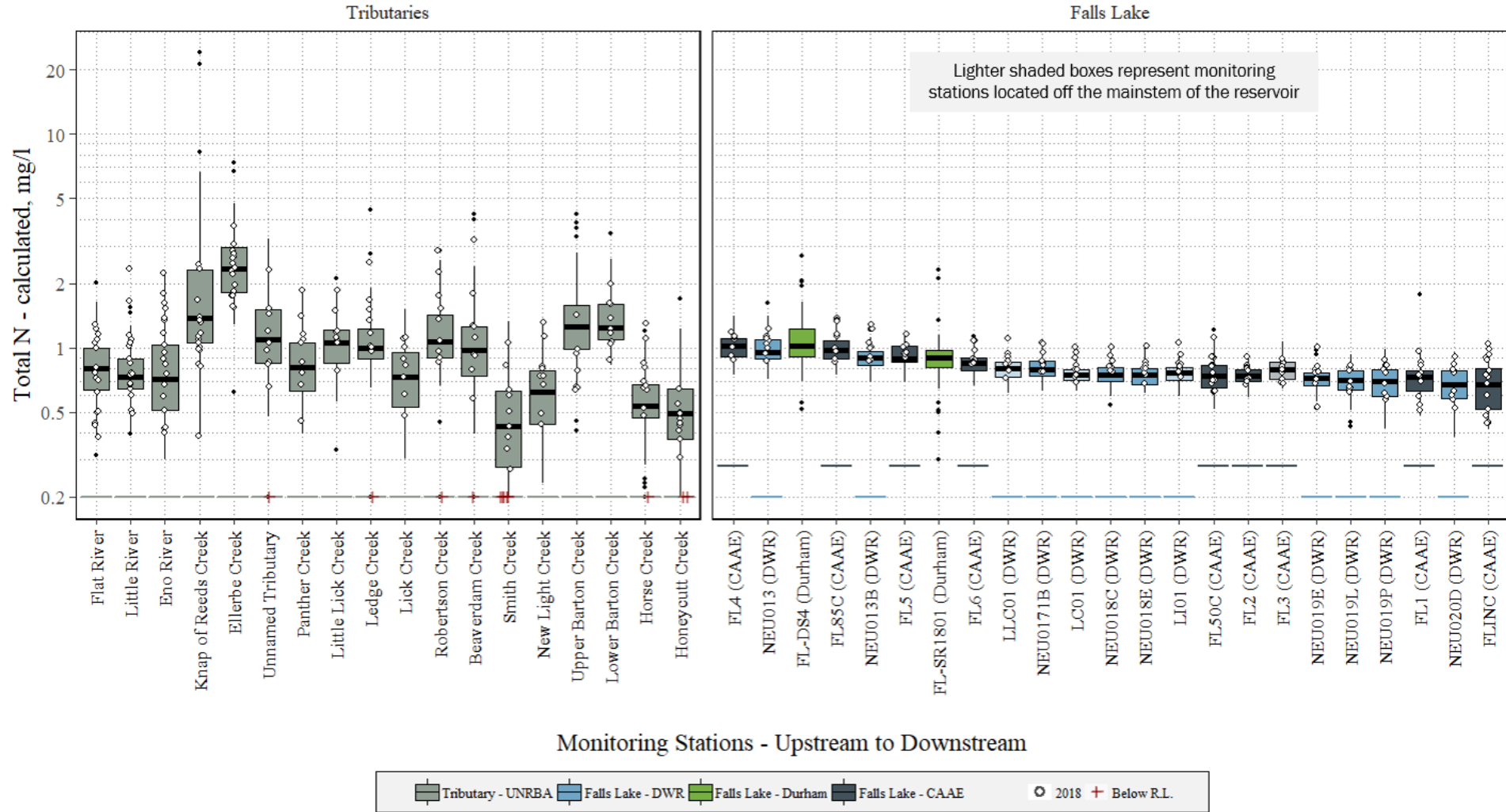
Monitoring Locations
 Upper Neuse River Basin Association
 North Carolina



Total Organic Carbon (2014 - 2018)



Total Nitrogen (2014 - 2018)



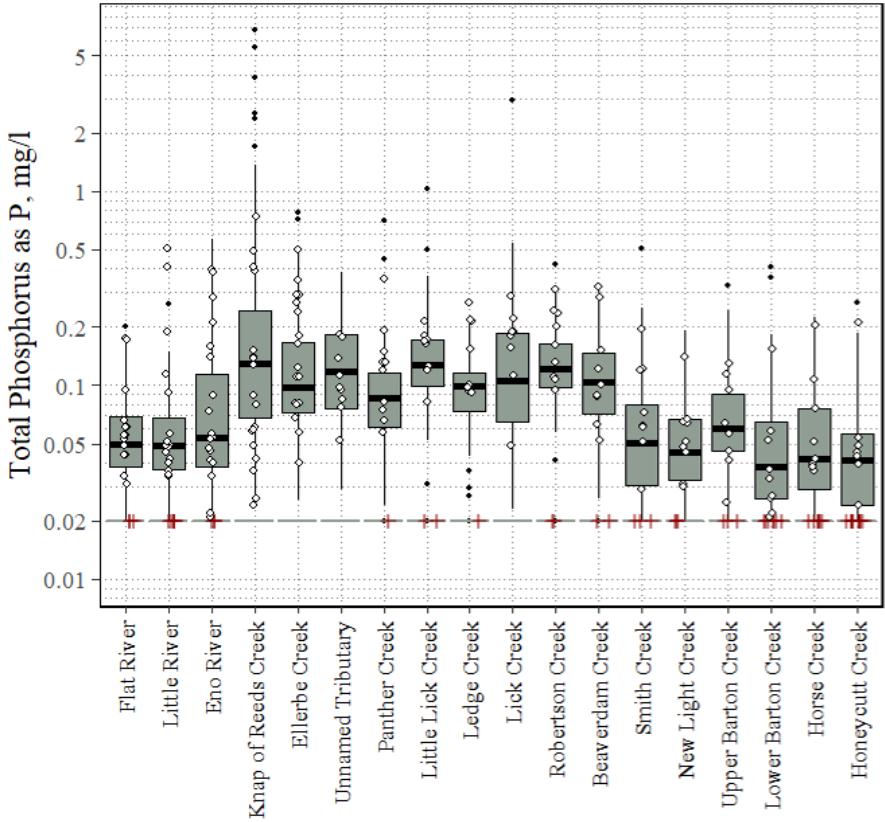
Most of Total Nitrogen is Organic Nitrogen.

Nitrate+Nitrite at lake stations is generally less than 0.1 mg/L (higher at some stream stations)

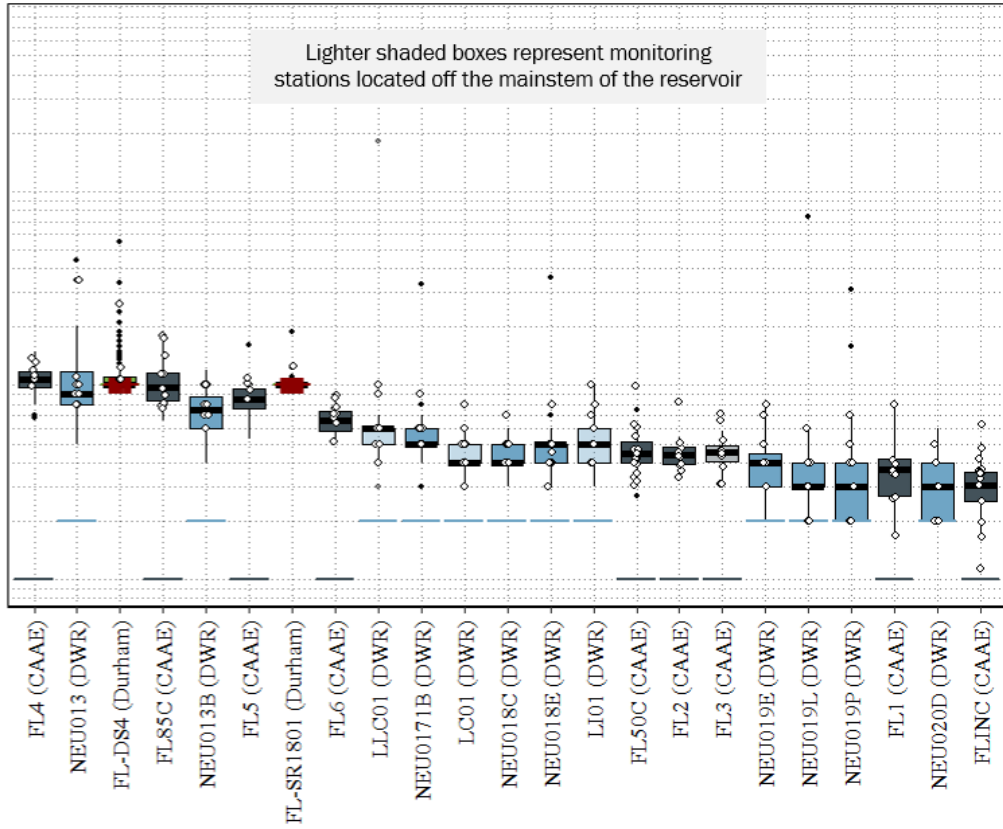
Ammonia Nitrogen is generally less than 0.2 at all stations, and often undetected at lake stations

Total Phosphorus (2014 - 2018)

Tributaries



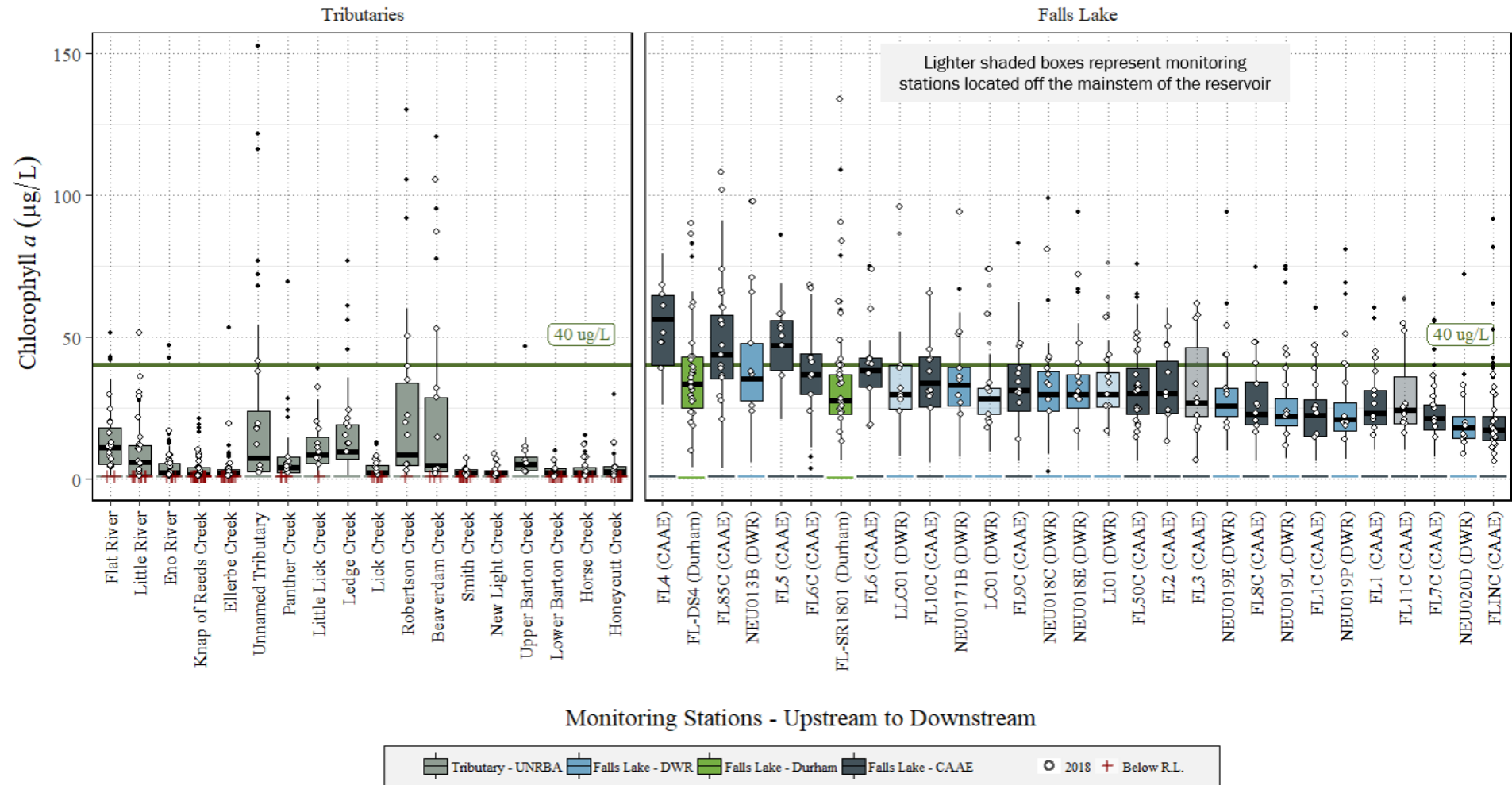
Falls Lake



Monitoring Stations - Upstream to Downstream



Chlorophyll *a* (2014-2018)



Additional Studies and Information on Falls Lake and Other Reservoirs

Pre-Impoundment Studies

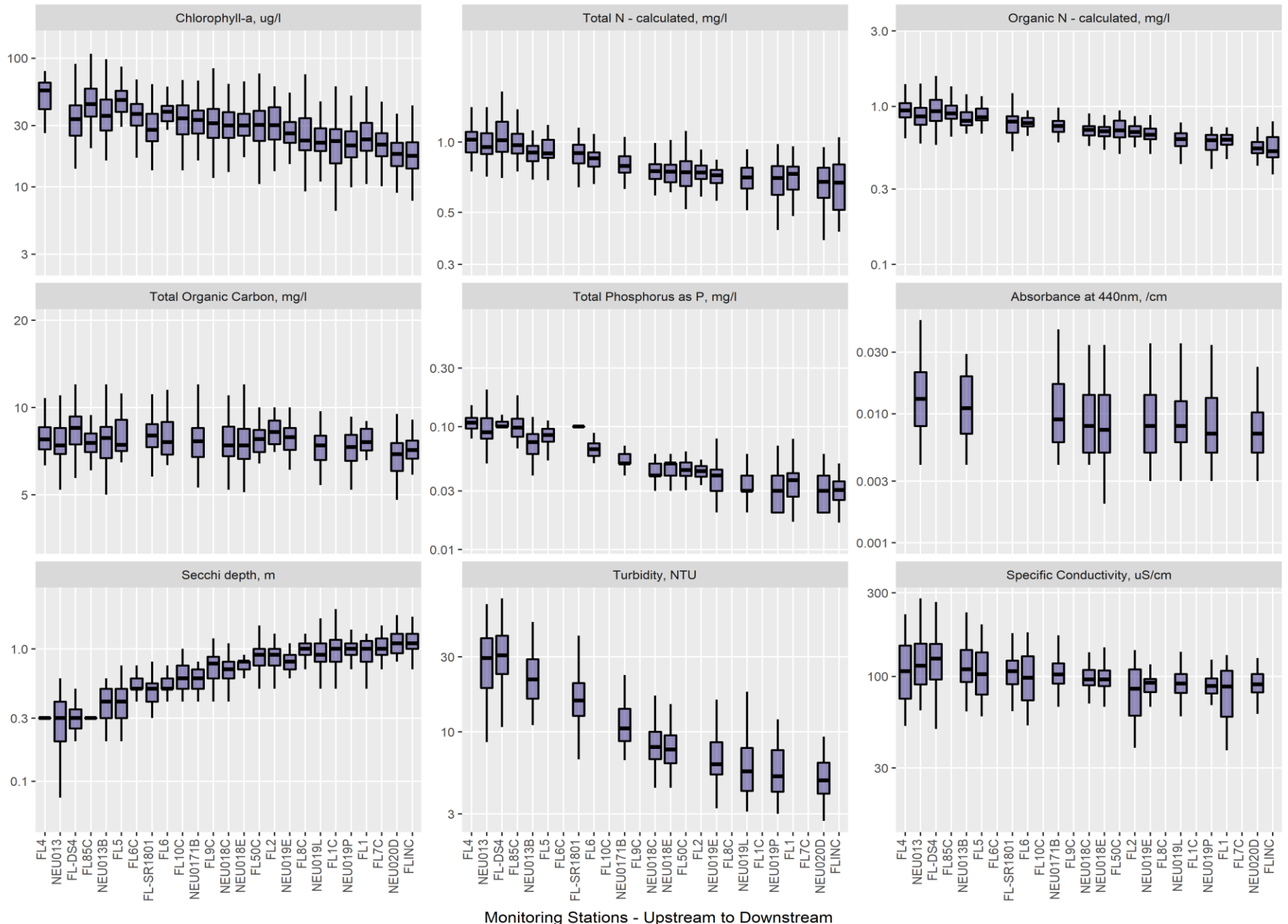
- NC DNER Study (1973)
- USACE Environmental Statement (1974)
- NC DEM (1983)
- Each study predicted a nutrient-rich system with abundant phytoplankton

Characteristics of Reservoir Systems

- Different from natural lakes in many ways
- Dominant hydrologic patterns driven by river/stream inputs and management of outflows from dam
- Nutrient and sediment transport driven by hydrology
- Algae dynamics affected by hydrology (residence time, stage, advection)

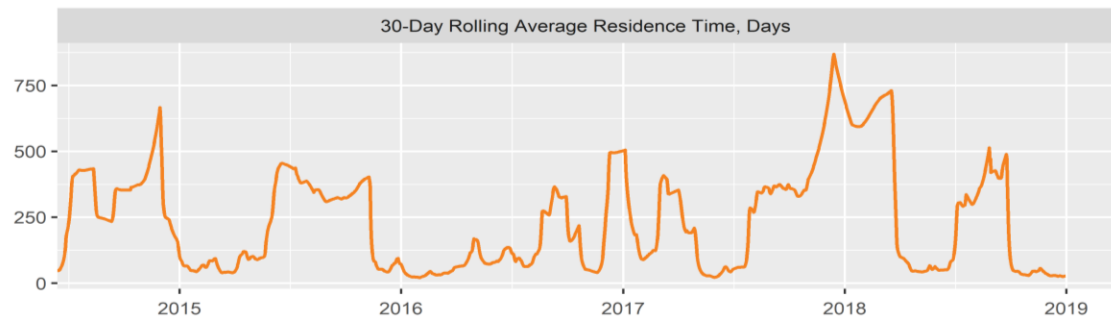
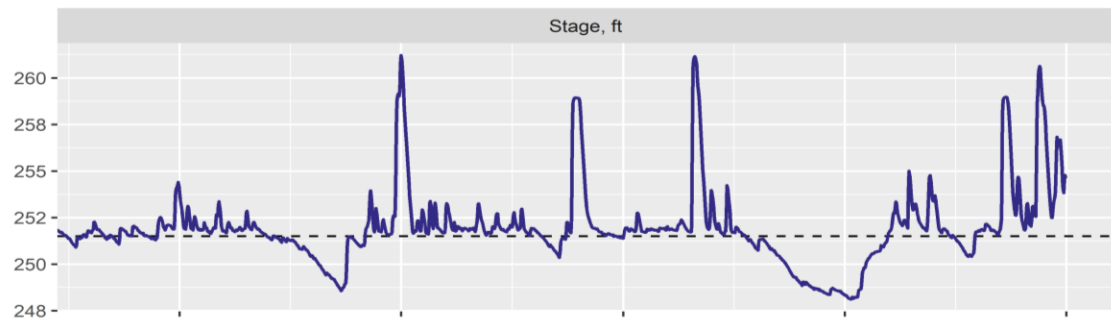
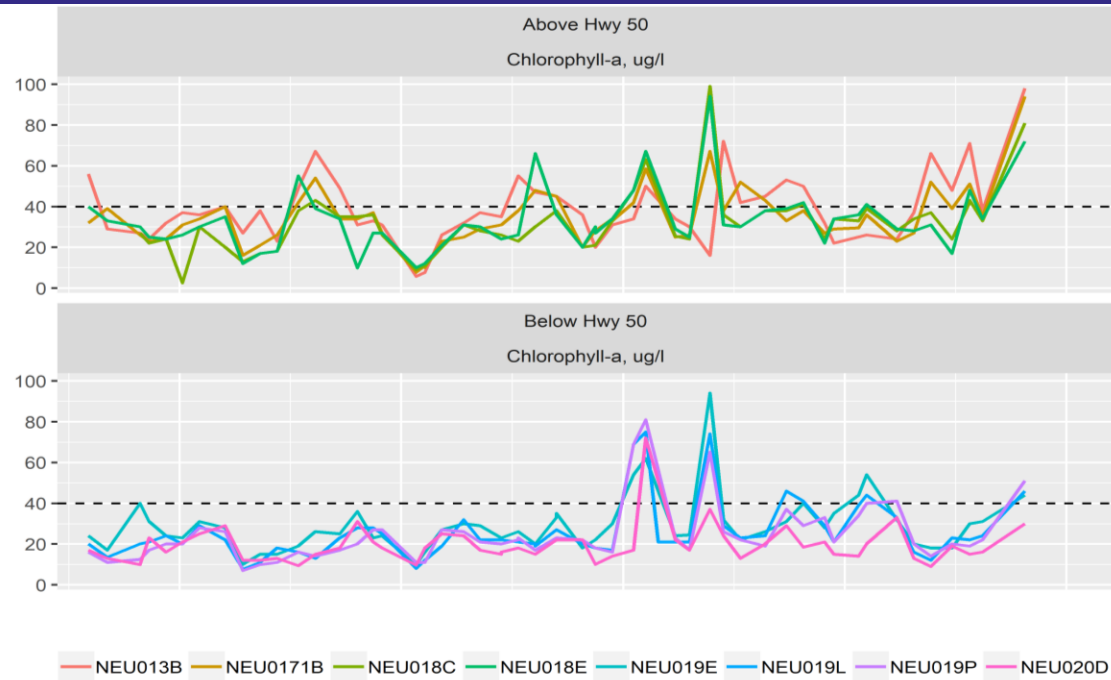
Extended Analysis and Discussion

Upstream to Downstream Lake Water Quality Patterns

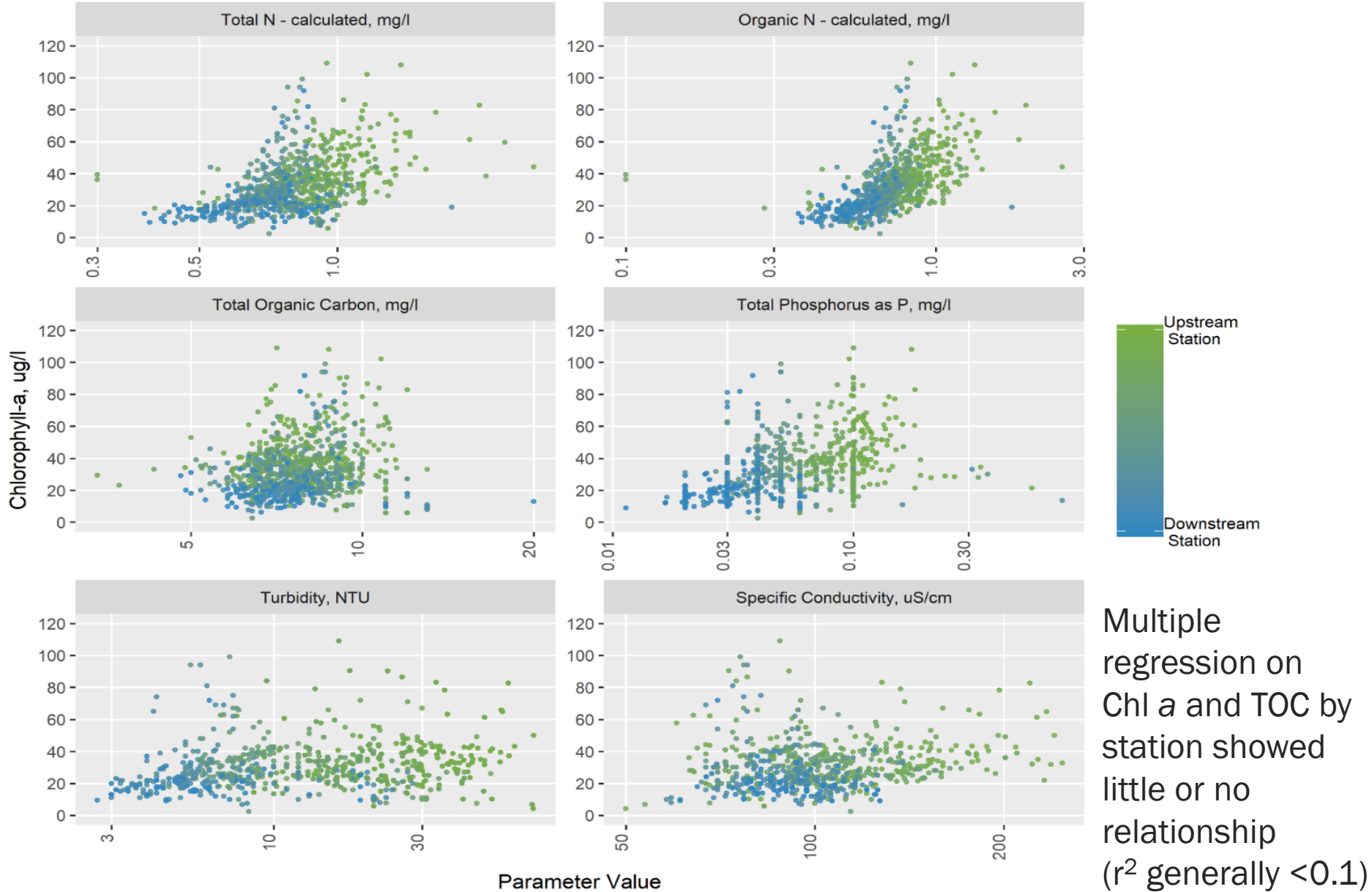


Time series of Chlorophyll-a, Stage, and Residence Time in Falls Lake

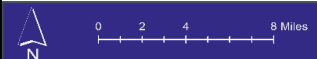
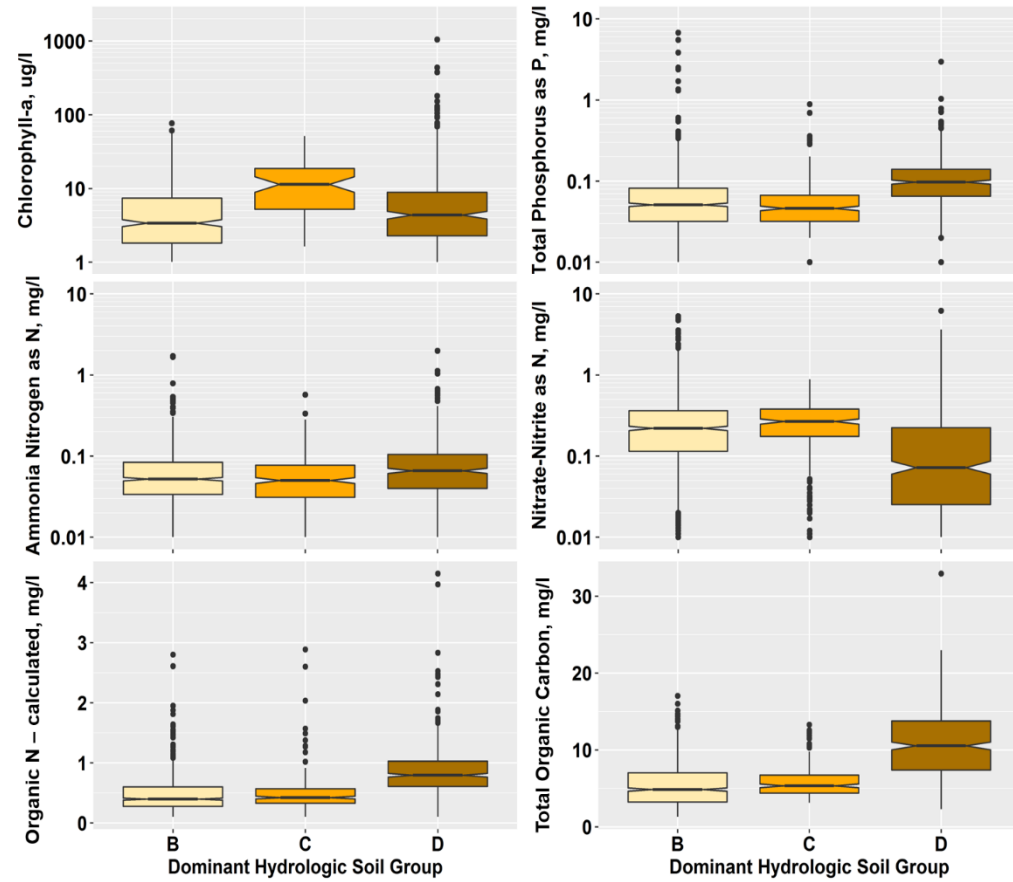
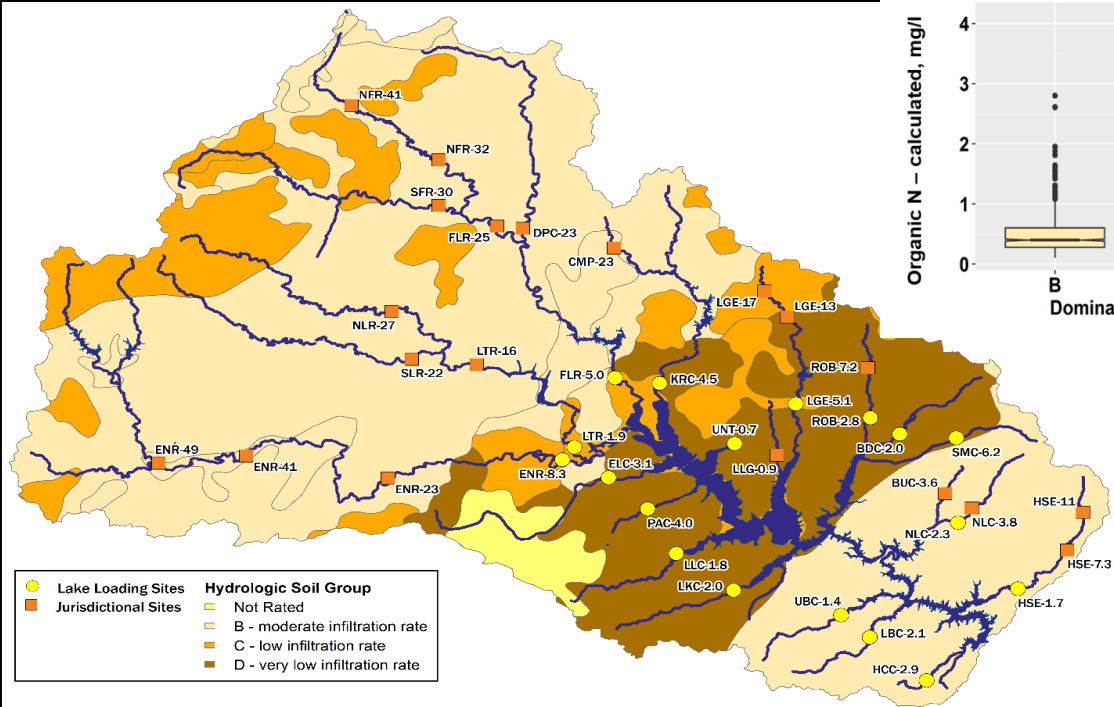
2014-2018



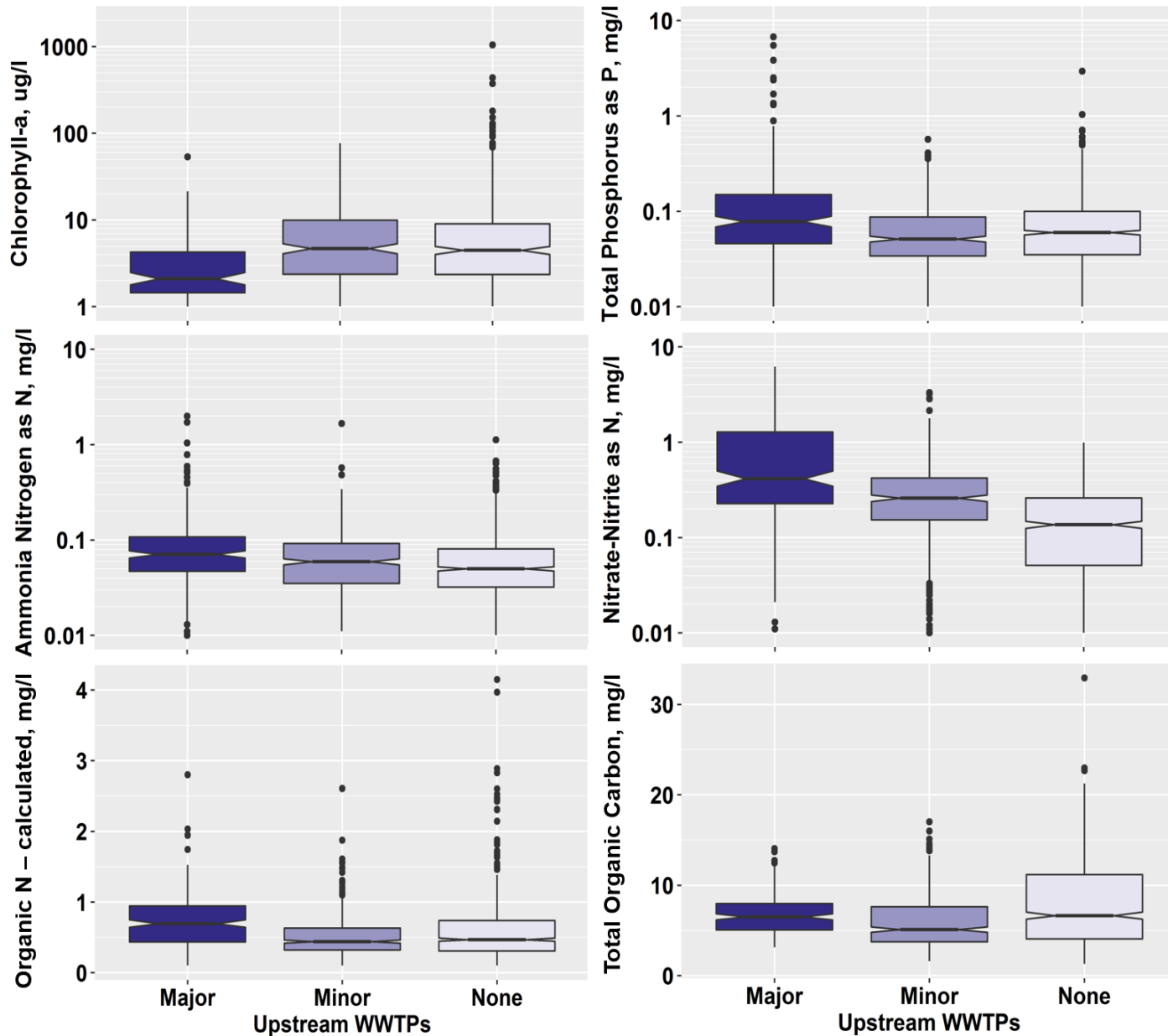
Relationships between Chl a and other parameters

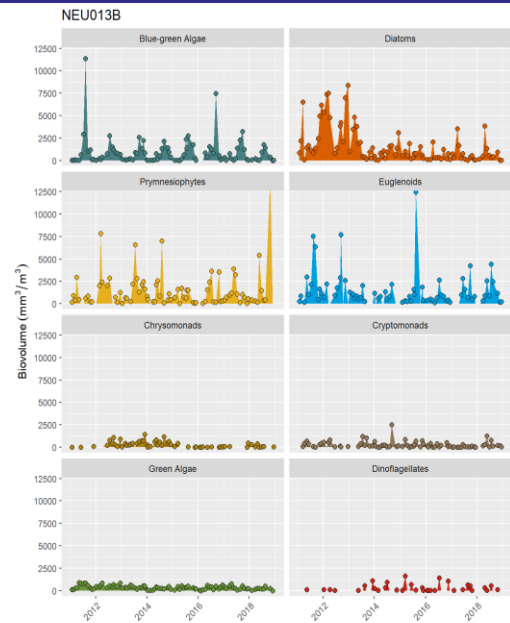


Soil Character and Water Quality

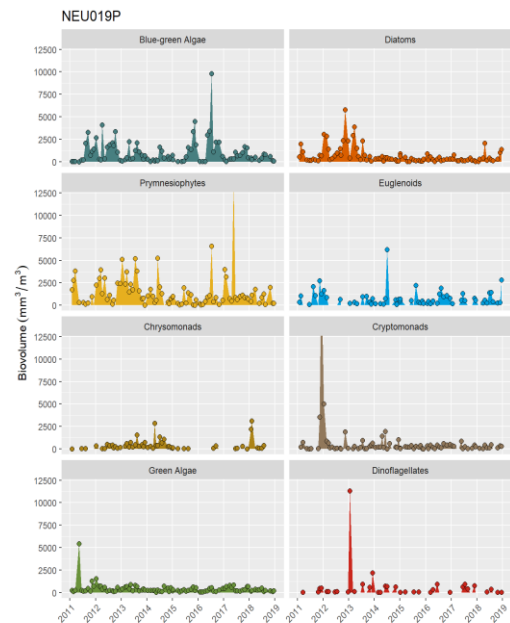


Wastewater Treatment Facilities and Water Quality

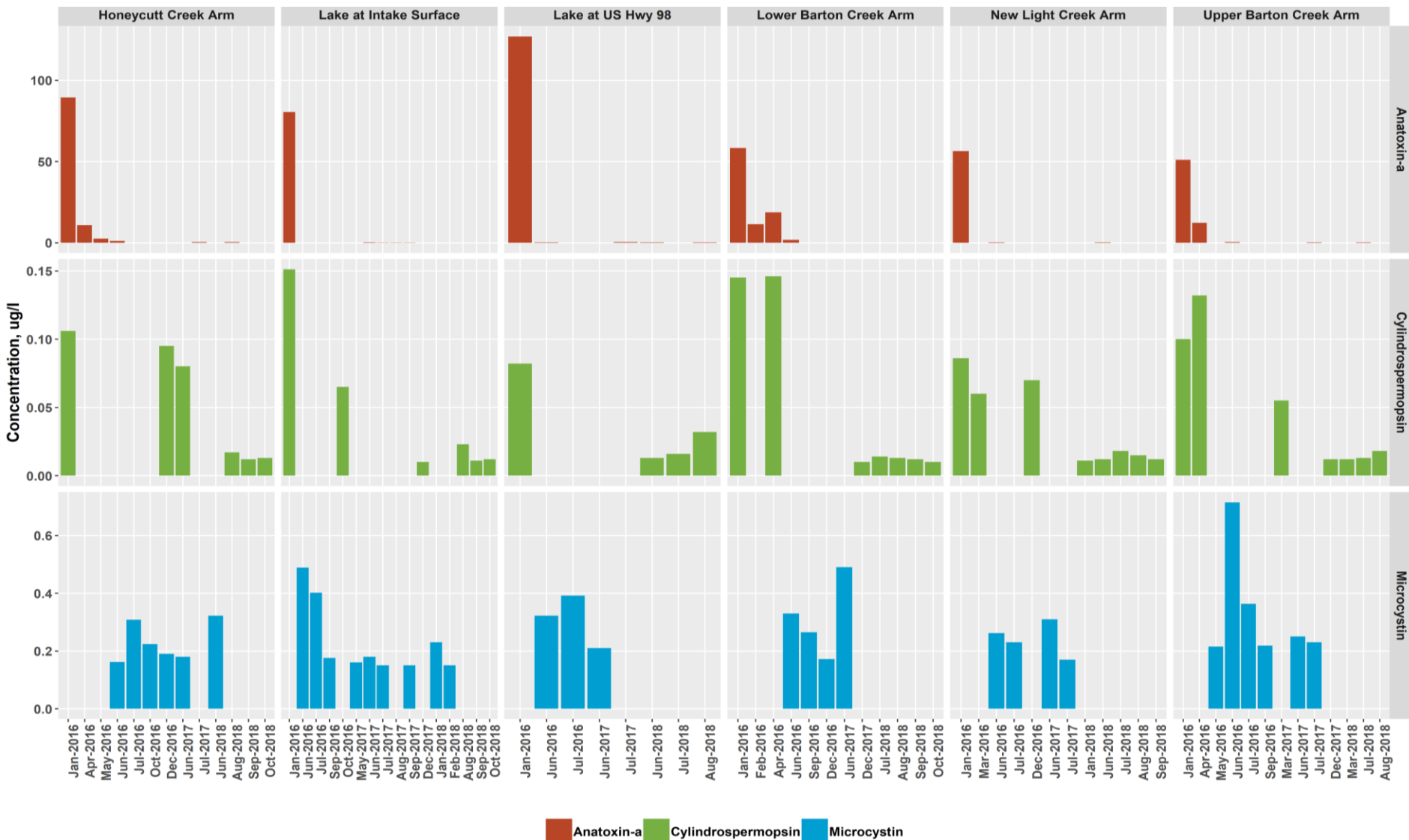




Algal Groups



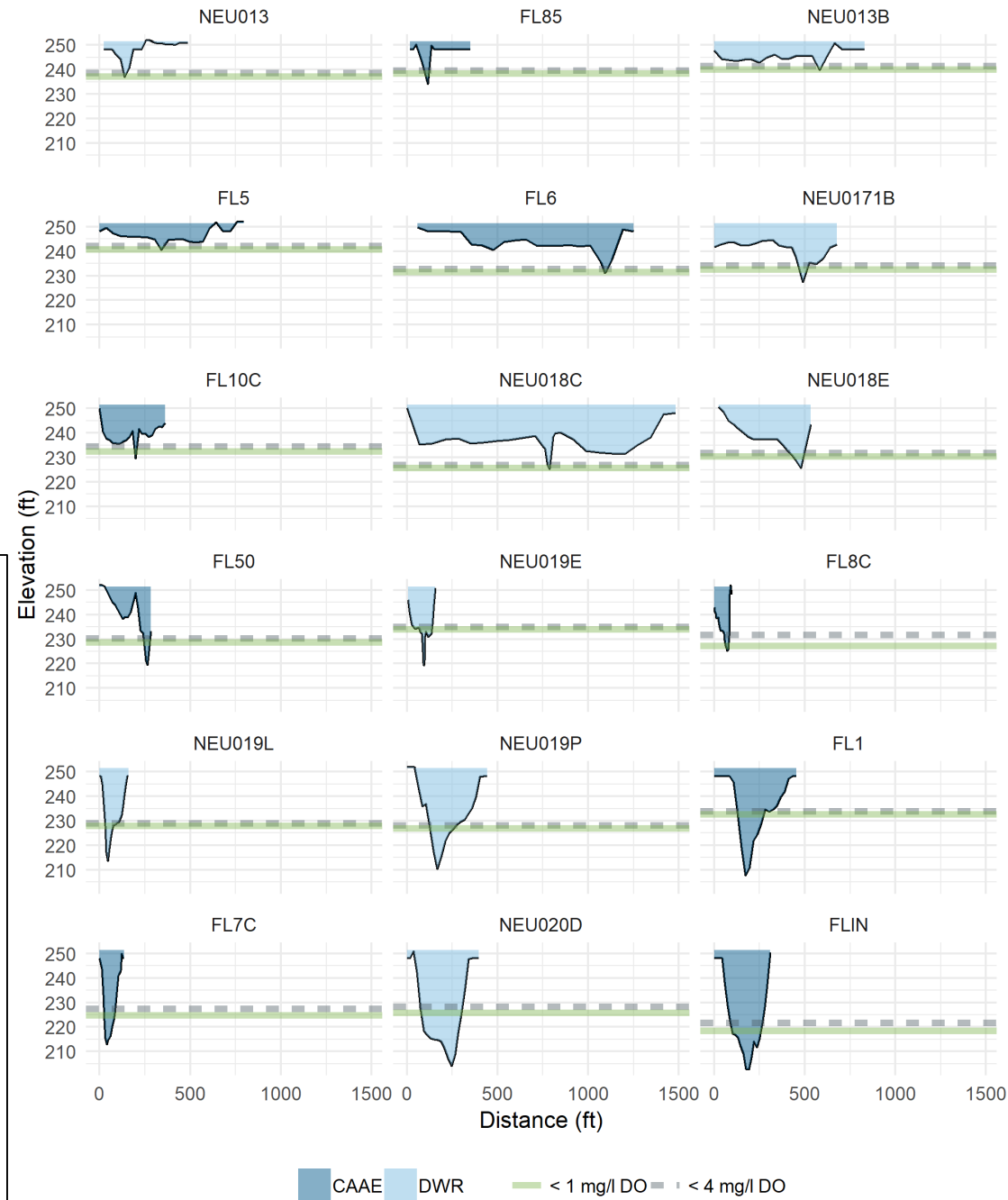
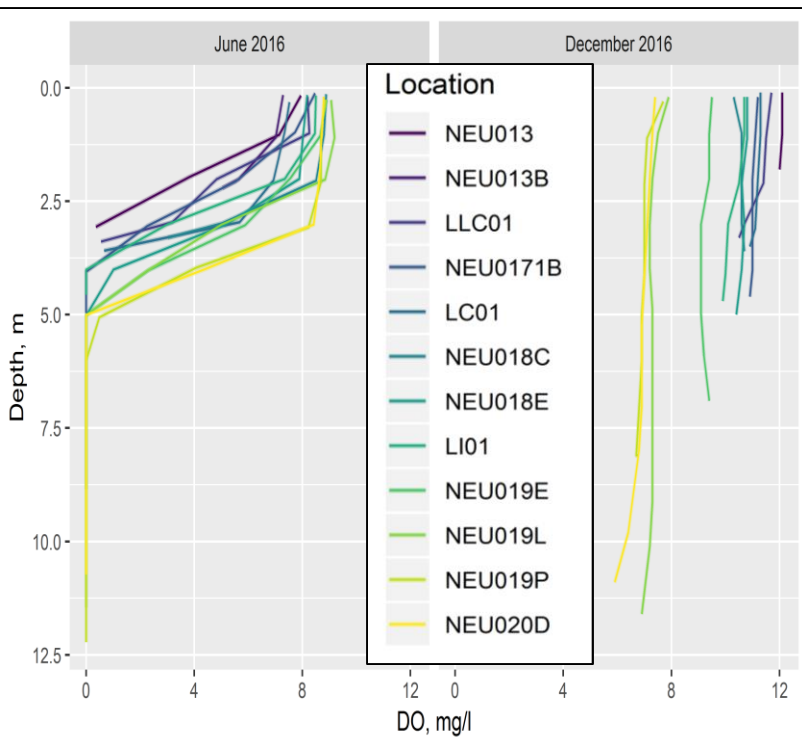
Algal Toxins



No NC criteria for these toxins. For microcystin, the WHO drinking water guideline is 1 ug/L and the EPA draft recreational guideline is 4 ug/L.

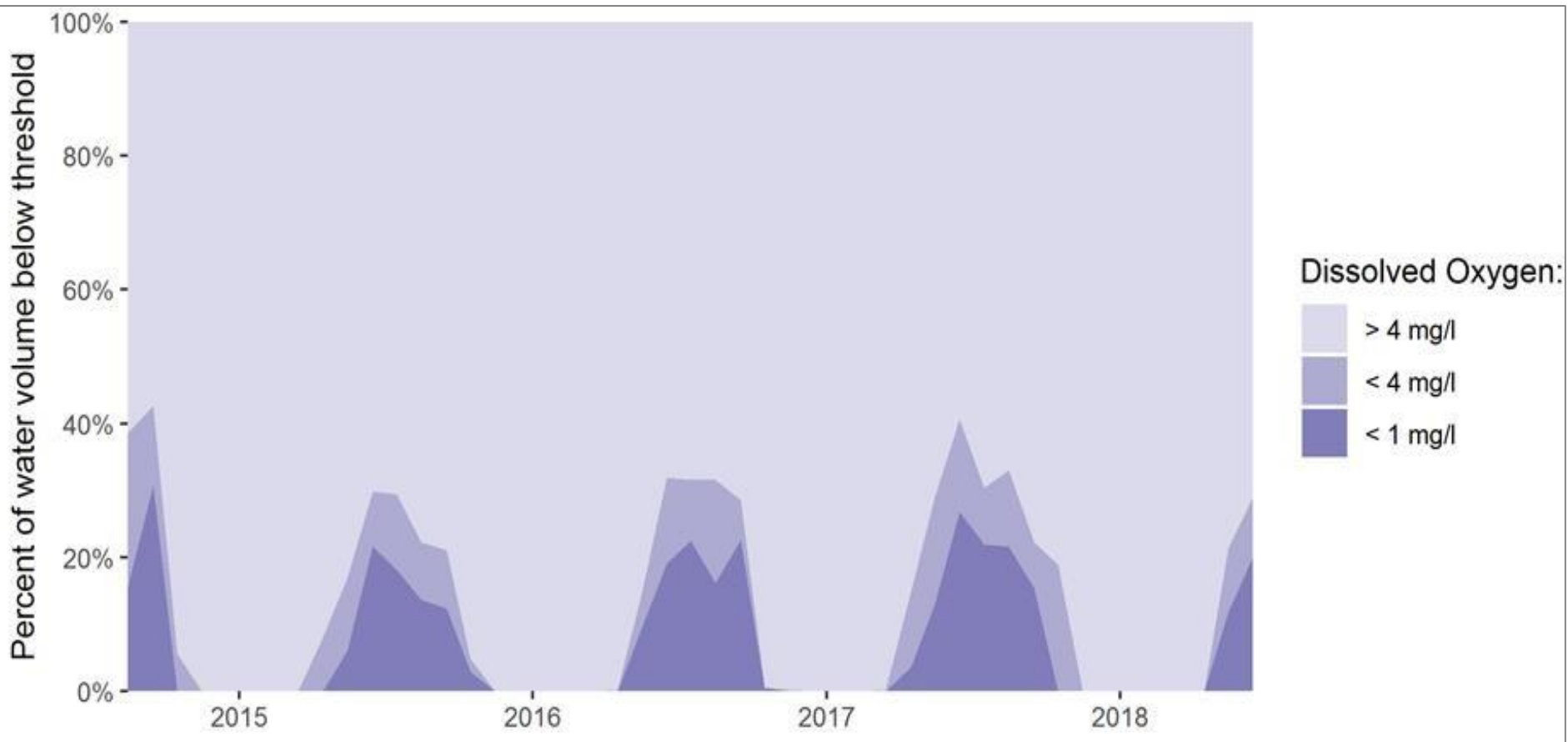
Hypoxia in Falls Lake

Median elevation of low dissolved oxygen conditions, April-September



Hypoxia in Falls Lake

Volume of reservoir experiencing hypoxia



Comparison of Results from Different Monitoring Entities

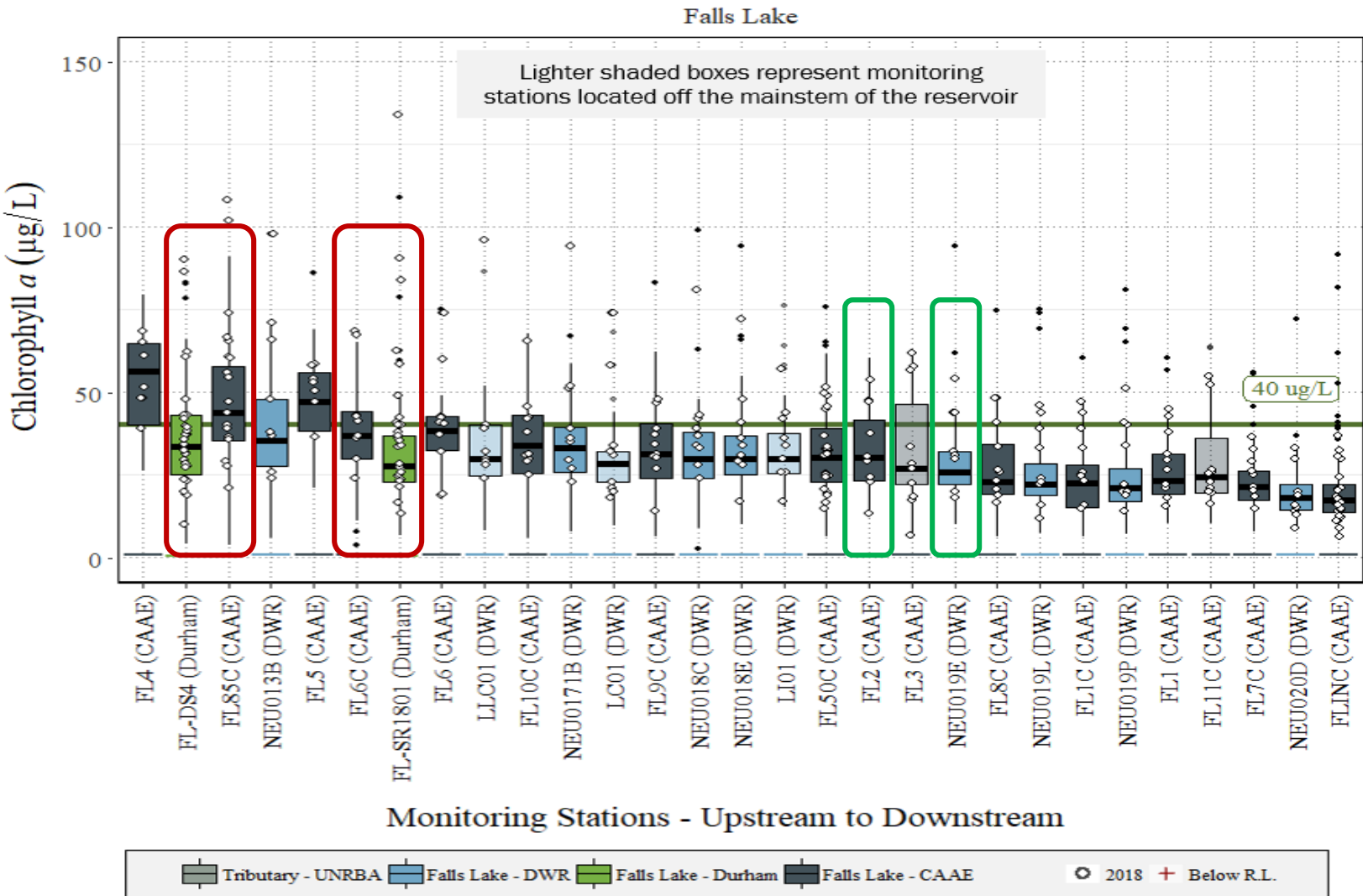
DWR vs. UNRBA Tributary Data



Comparison of Results from Different Monitoring Entities

CAAE vs. DWR and City of Durham Lake Data

Chlorophyll *a* (2014-2018)

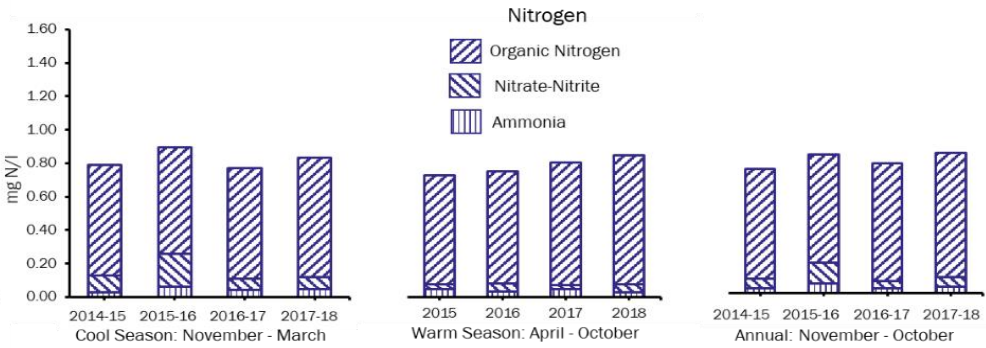
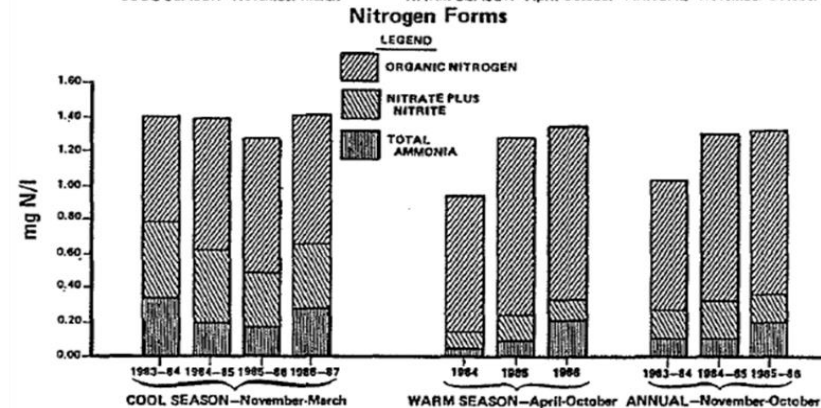
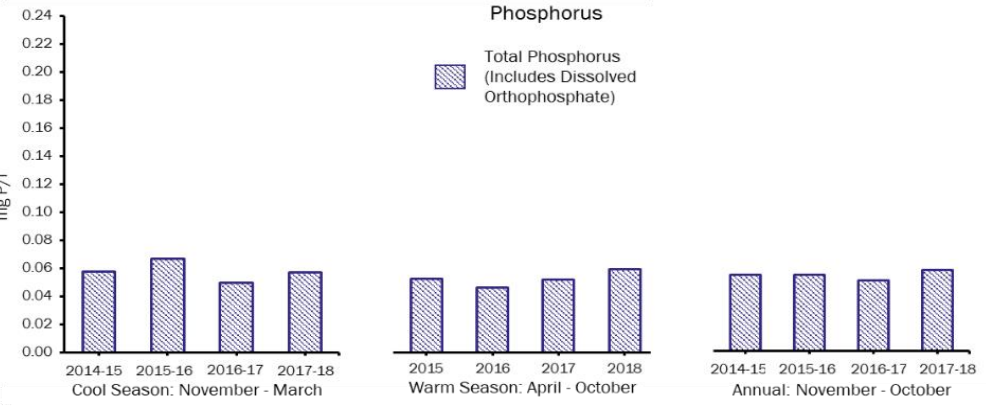
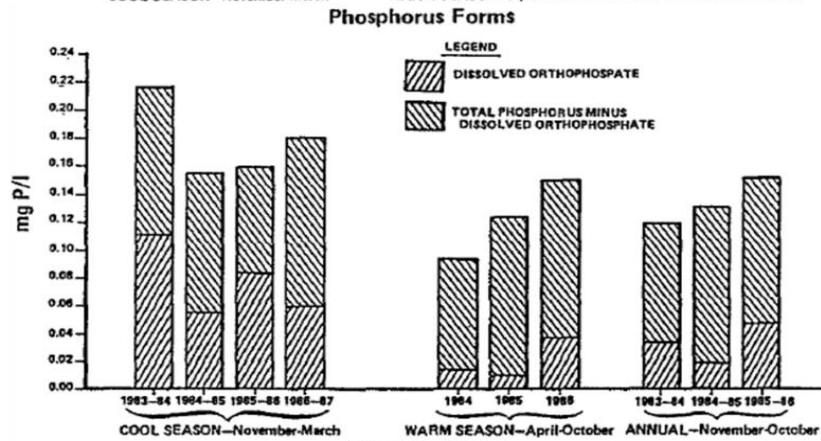
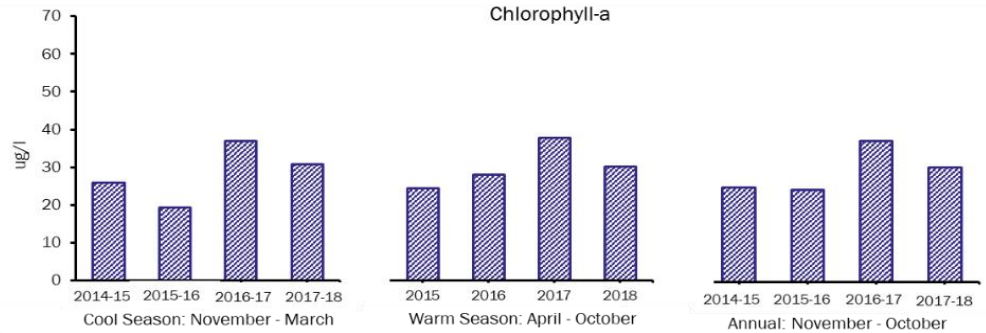
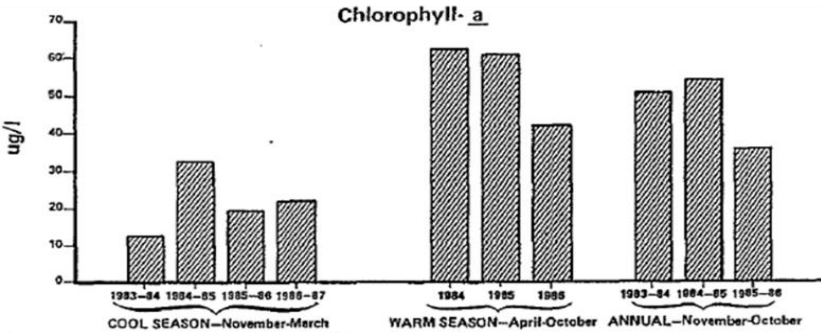


Comparison of DWR Baseline and Re-Examination Period



Comparison of Historic and Recent Water Quality

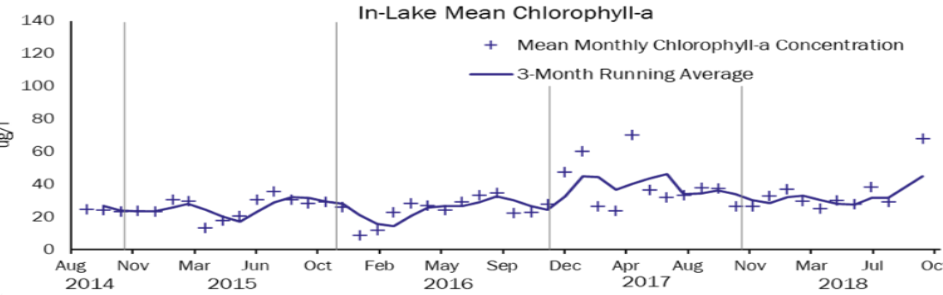
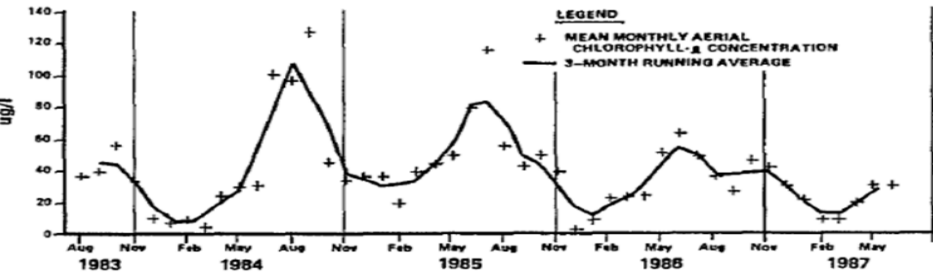
USACE Post-Impoundment Study vs. UNRBA Monitoring Period



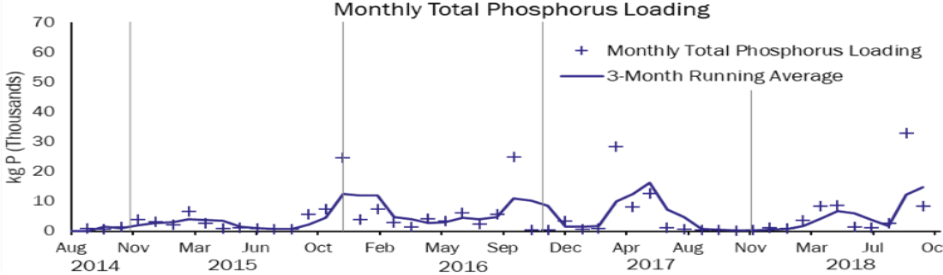
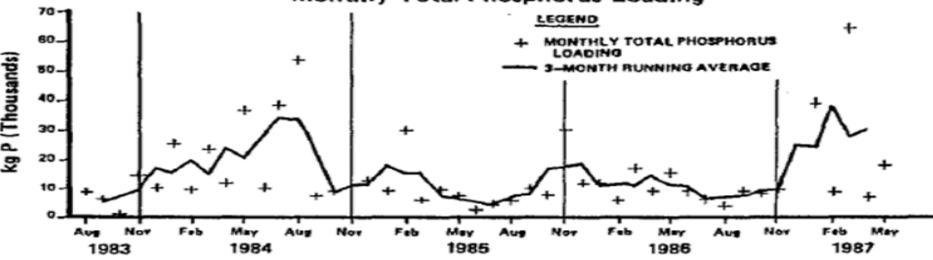
Comparison of Historic and Recent Water Quality

USACE Post-Impoundment Study vs. UNRBA Monitoring Period

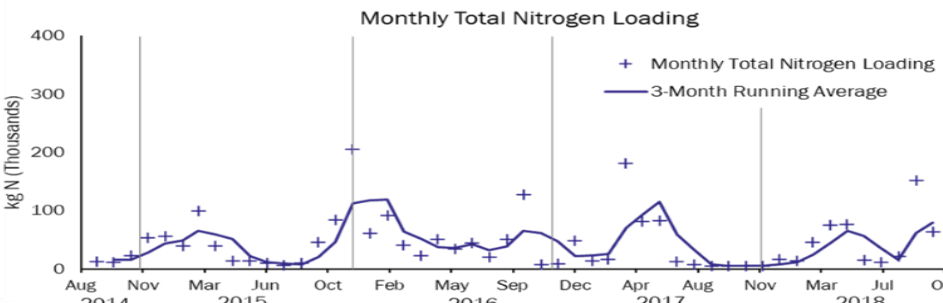
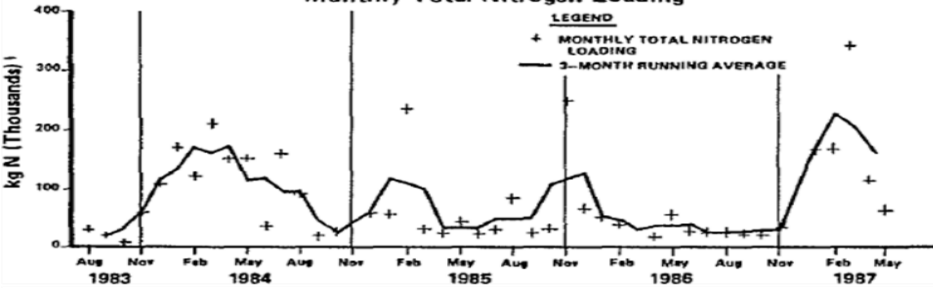
In-Lake Mean Chlorophyll-*a*



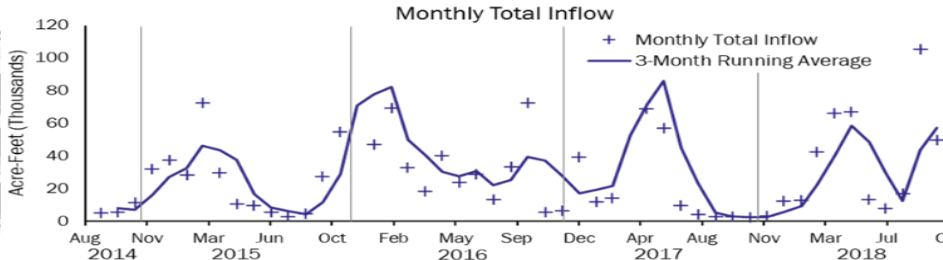
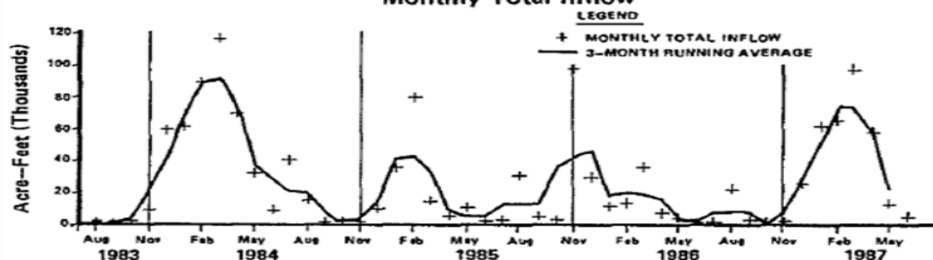
Monthly Total Phosphorus Loading



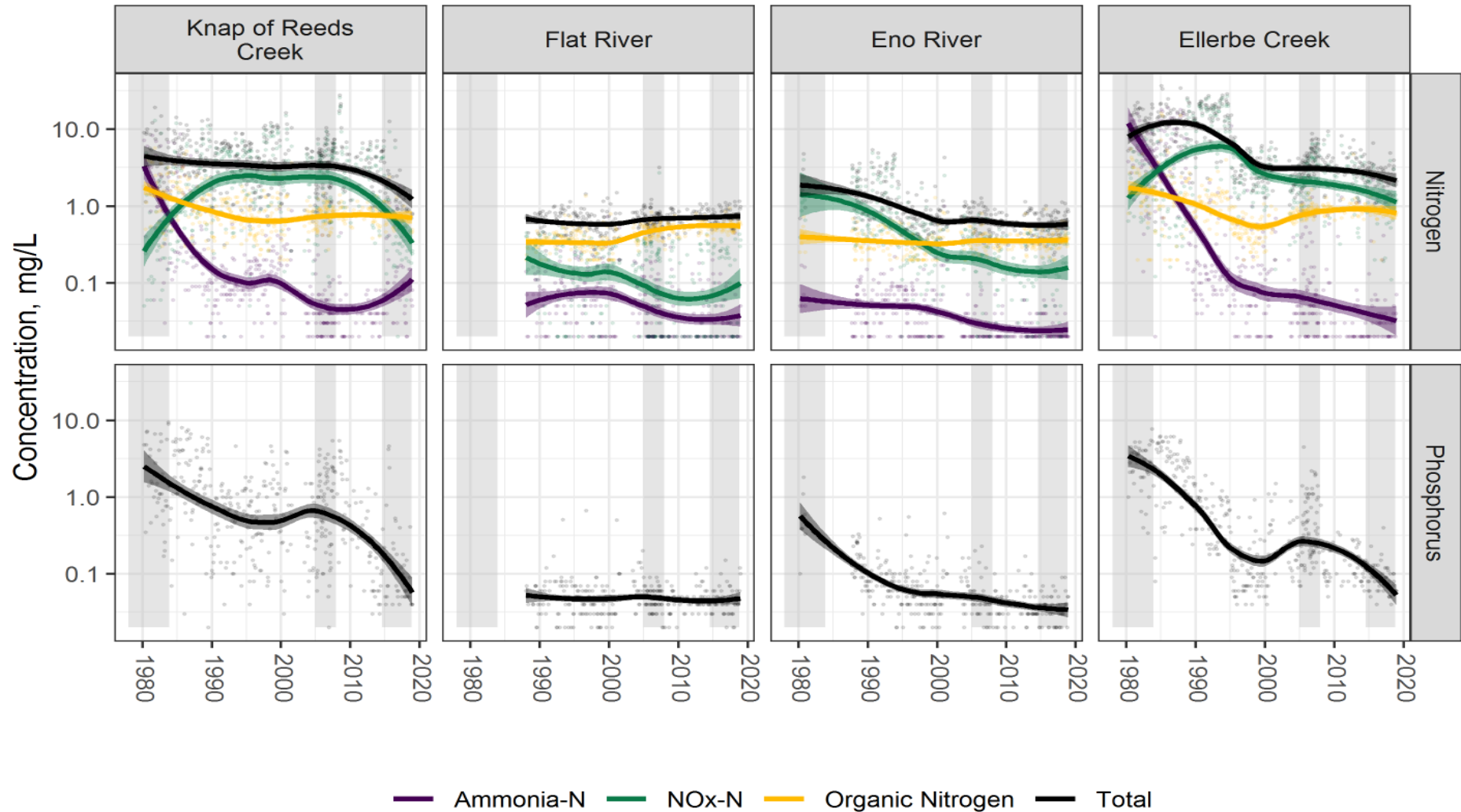
Monthly Total Nitrogen Loading



Monthly Total Inflow



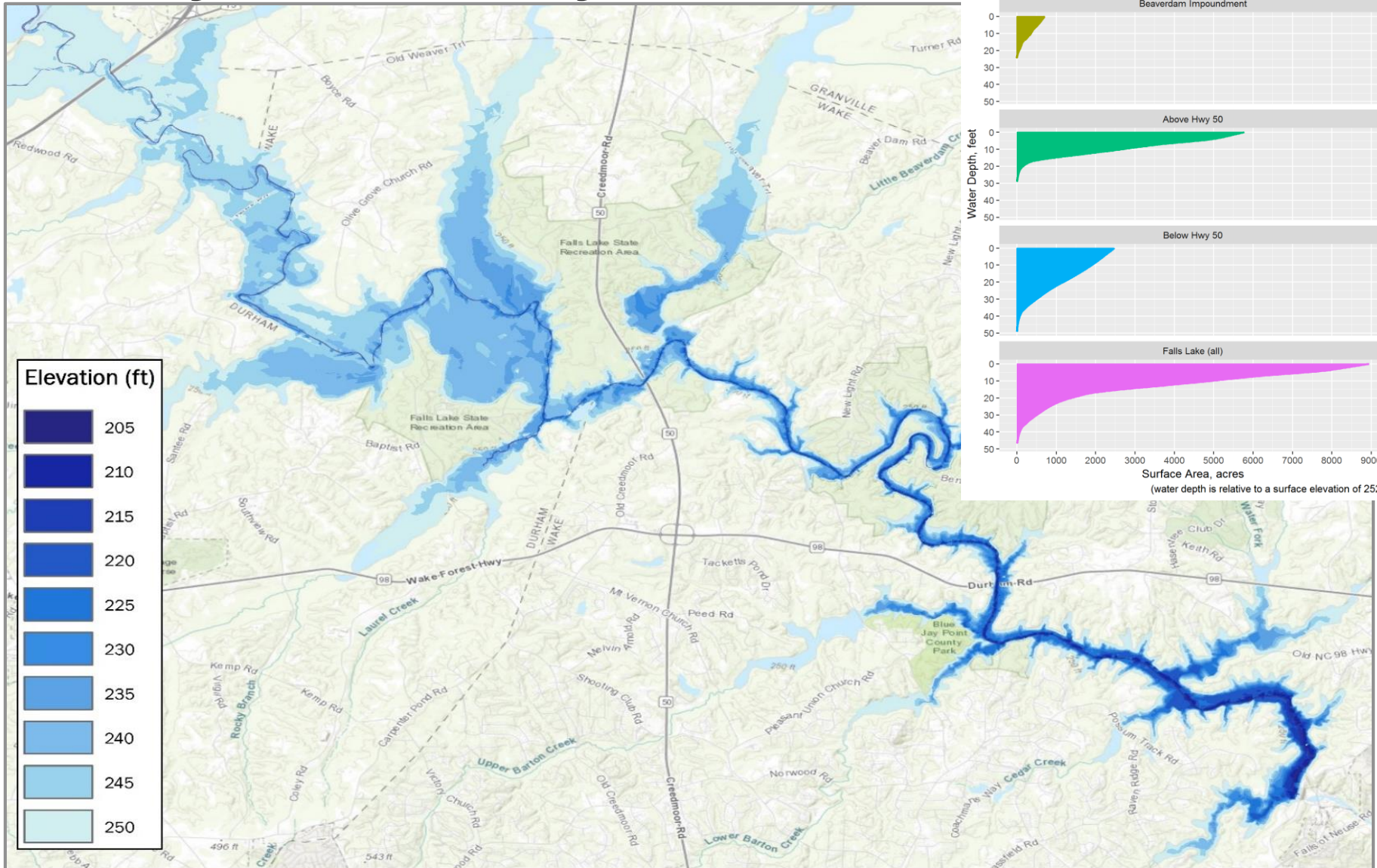
DENR Tributary N and P Data - 1980-2018



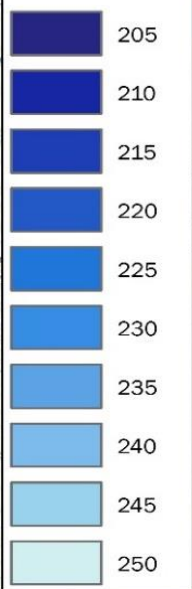
Shading shows the periods of reservoir construction and filling (1978 – 1983), Falls Lake Rules baseline period (2005 – 2007), and UNBA monitoring period (2014 – 2018).

Data: NC-DENR

Bathymetric Survey



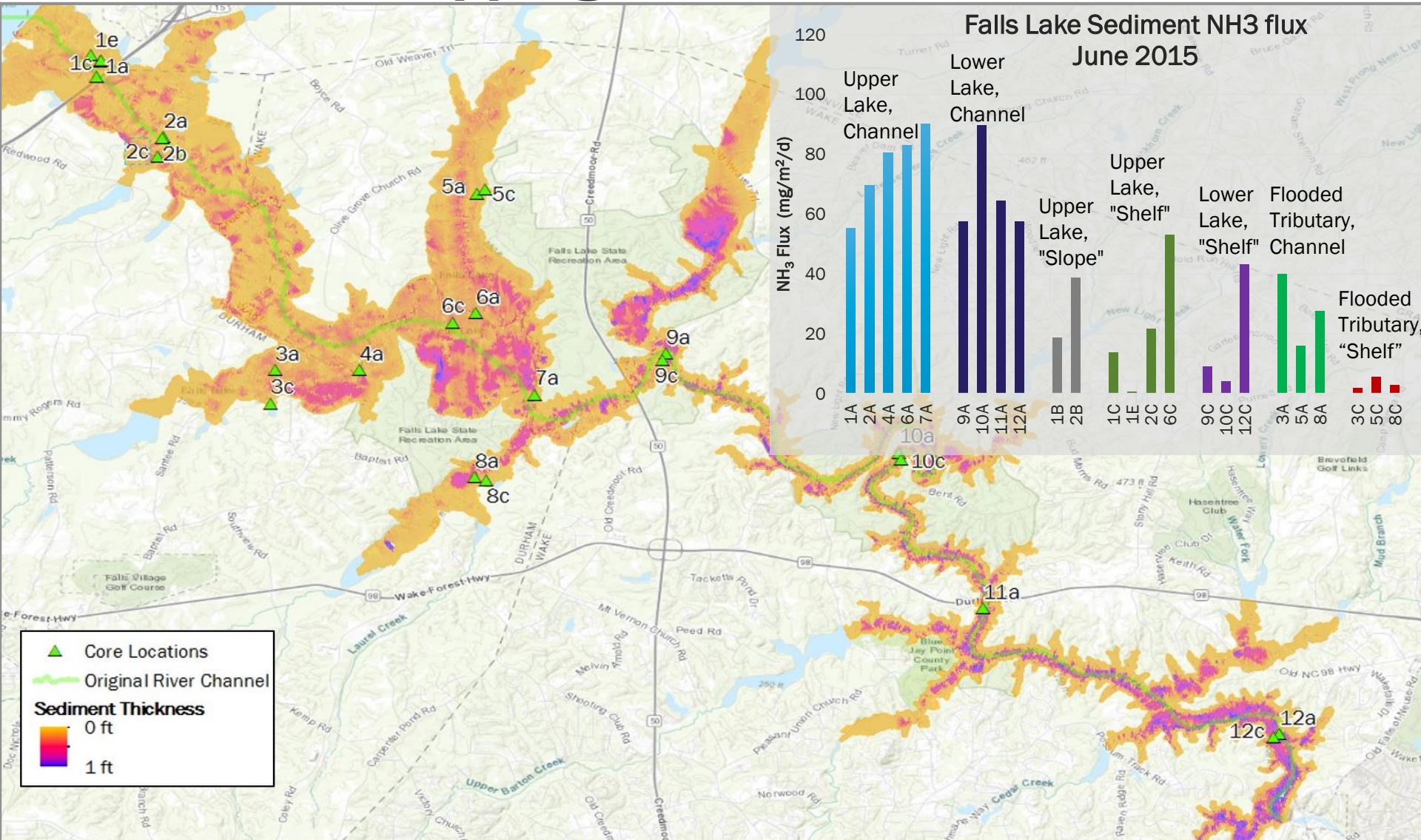
Elevation (ft)



Falls Lake Bathymetry
Upper Neuse River Basin Association
North Carolina

Brown AND Caldwell

Sediment Mapping



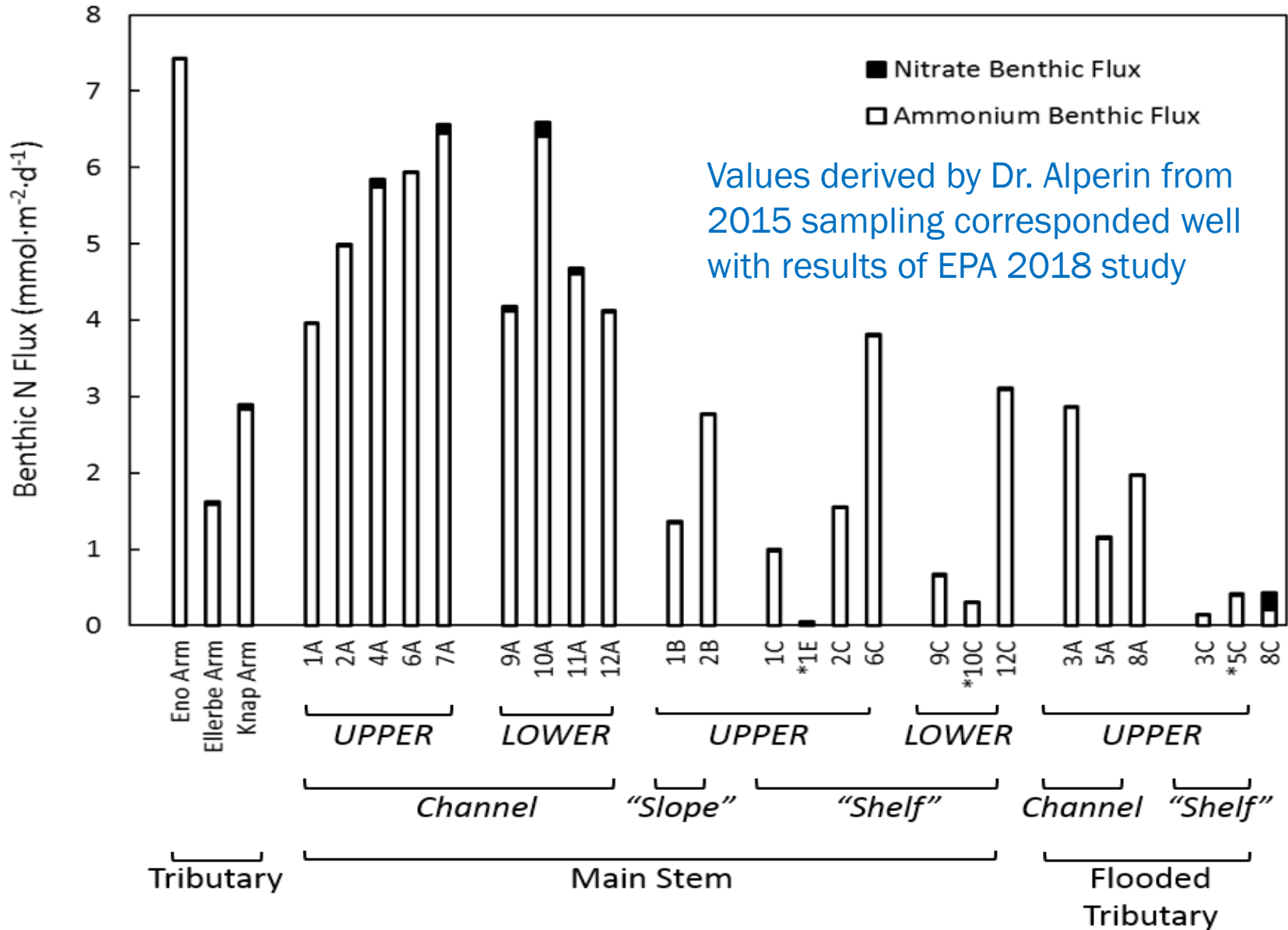
Falls Lake Sediment Thickness

Upper Neuse River Basin Association
North Carolina

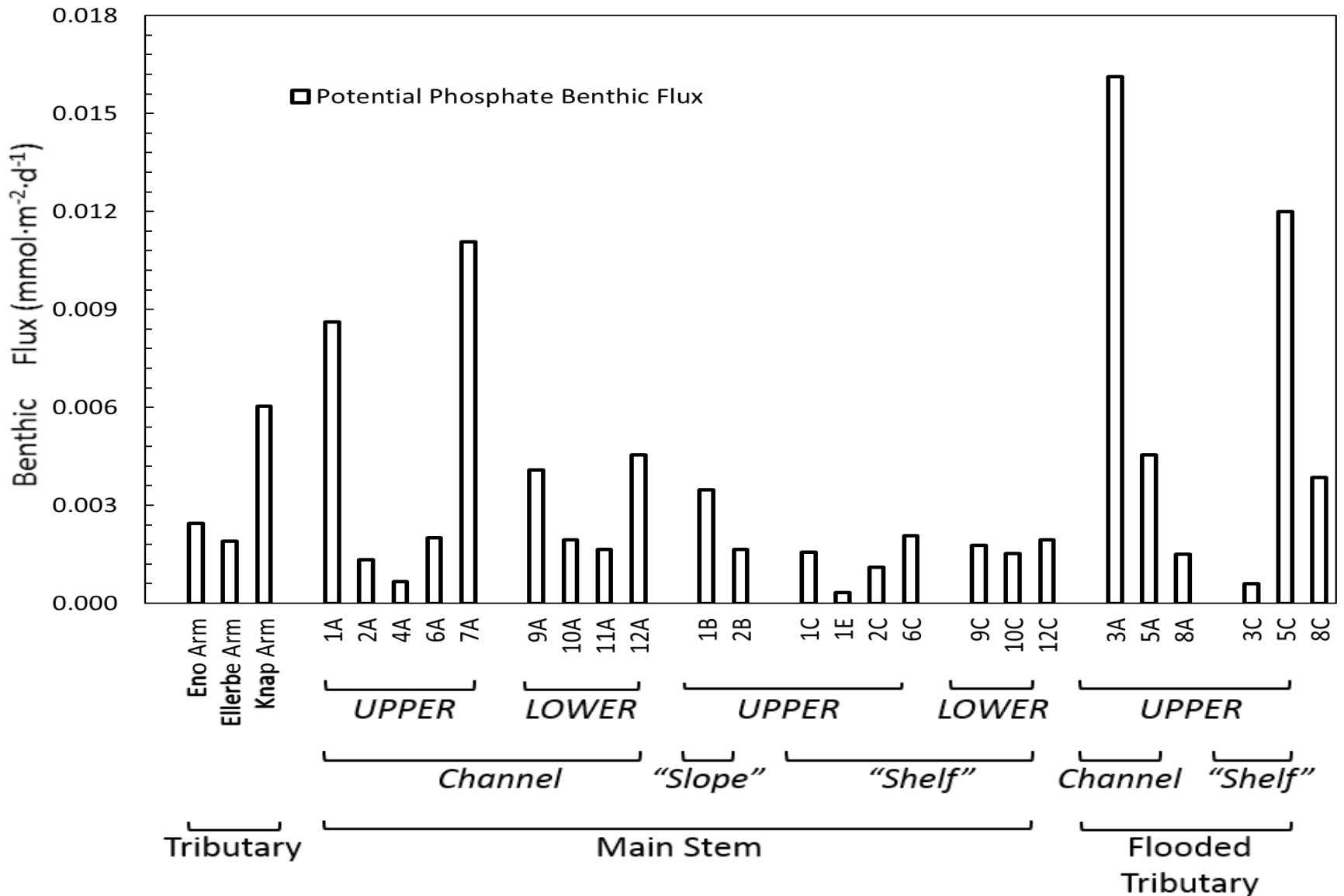
Brown AND Caldwell



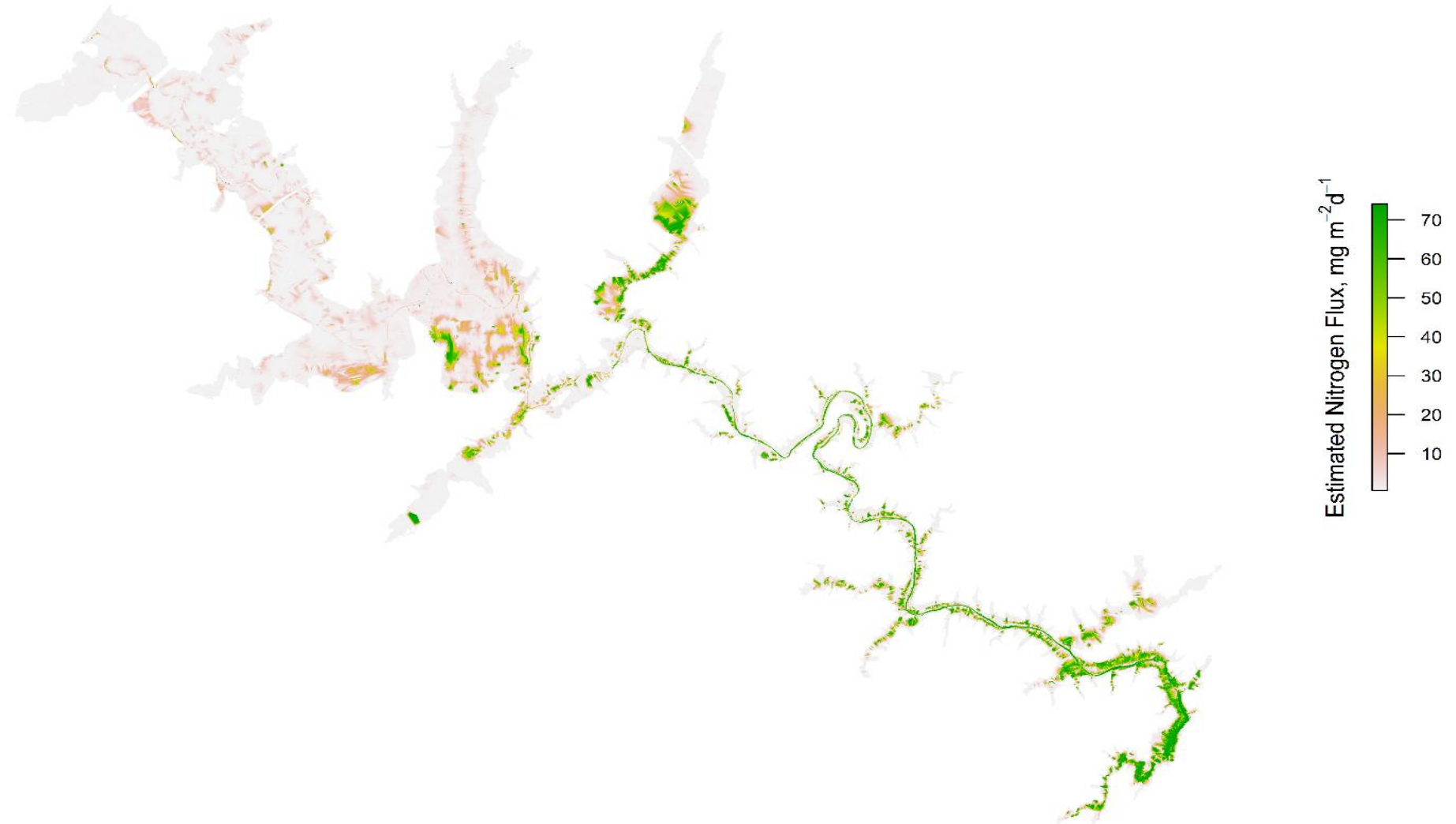
Sediment Analysis – Ammonia and NOx Flux



Sediment Analysis - Potential Orthophosphate Flux

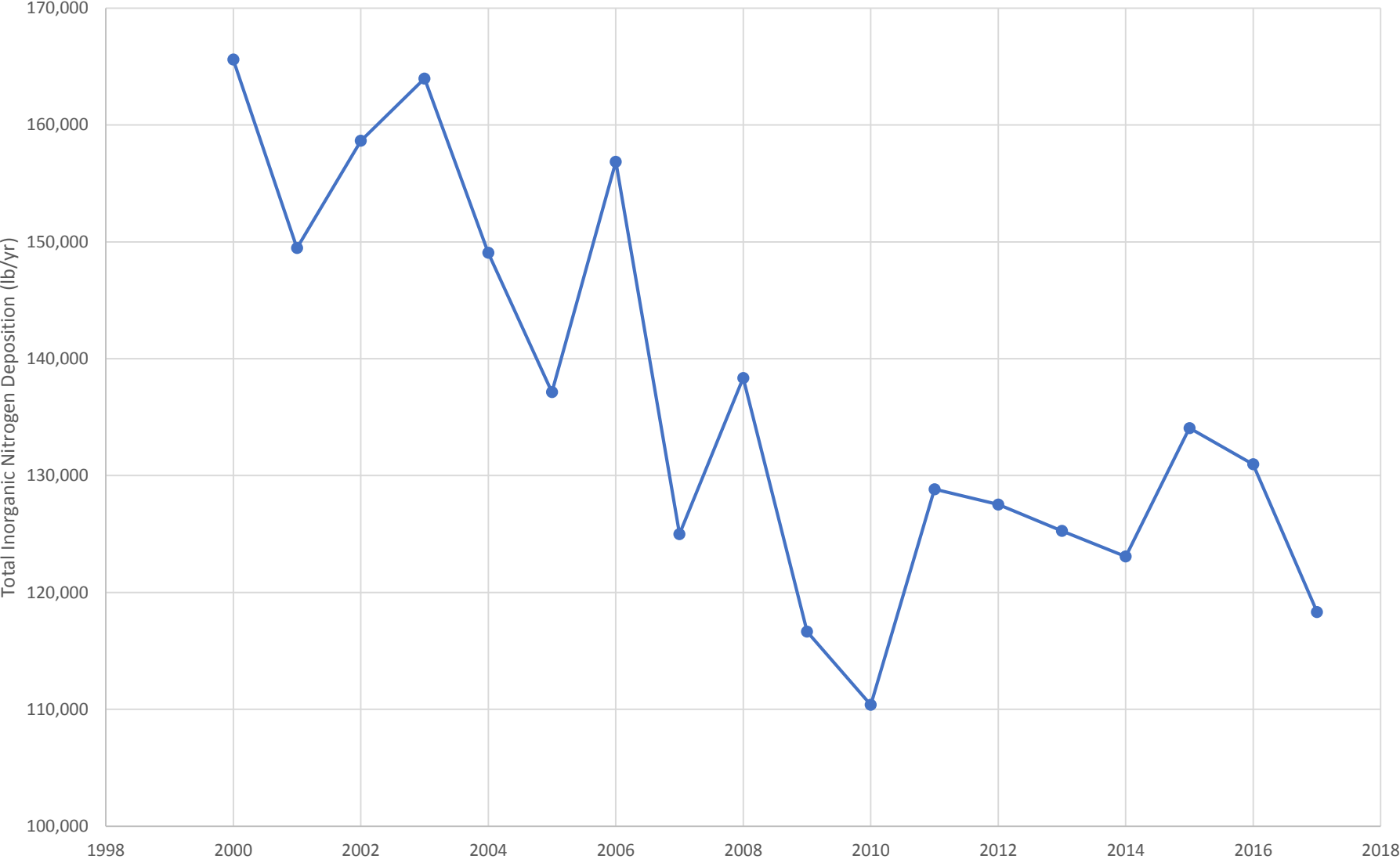


Estimated Internal Nitrogen Loading based on Sediment Quality and Sediment Mapping Efforts



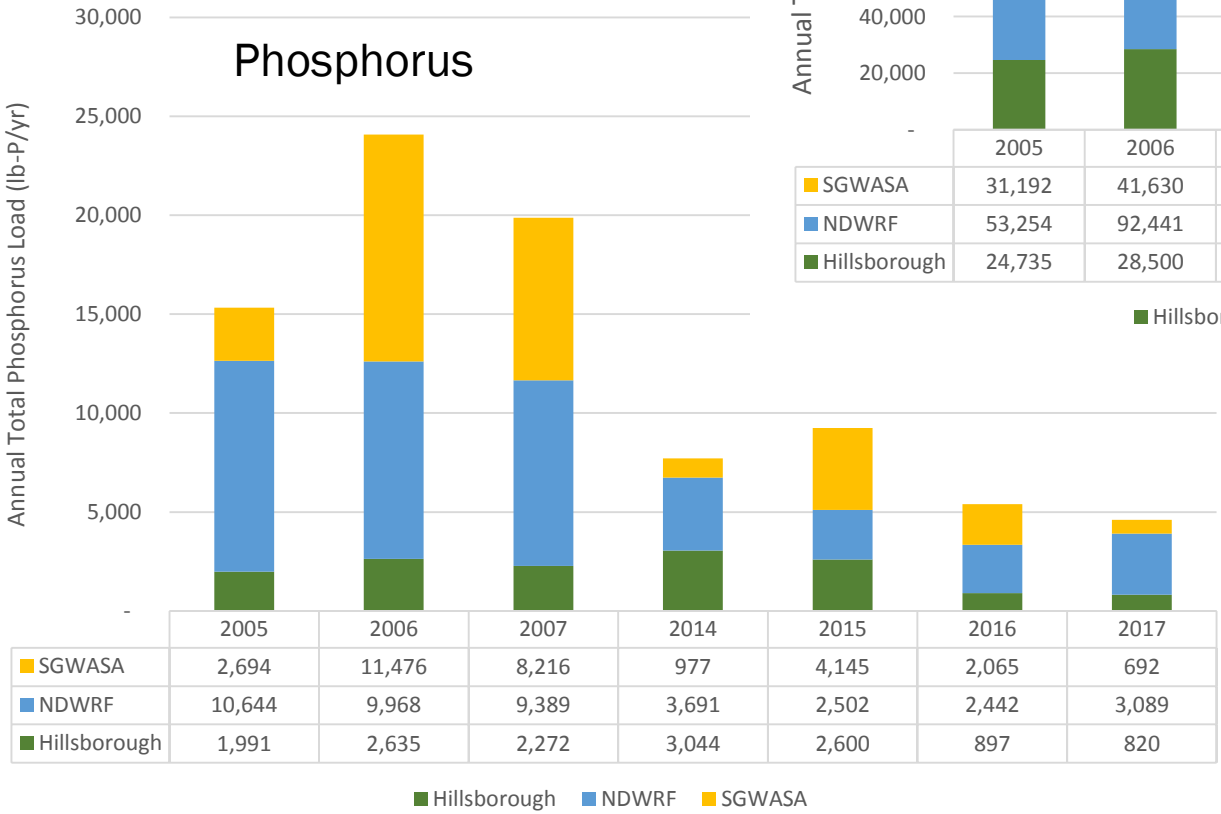
Loading Analysis

Atmospheric Deposition onto Falls Lake

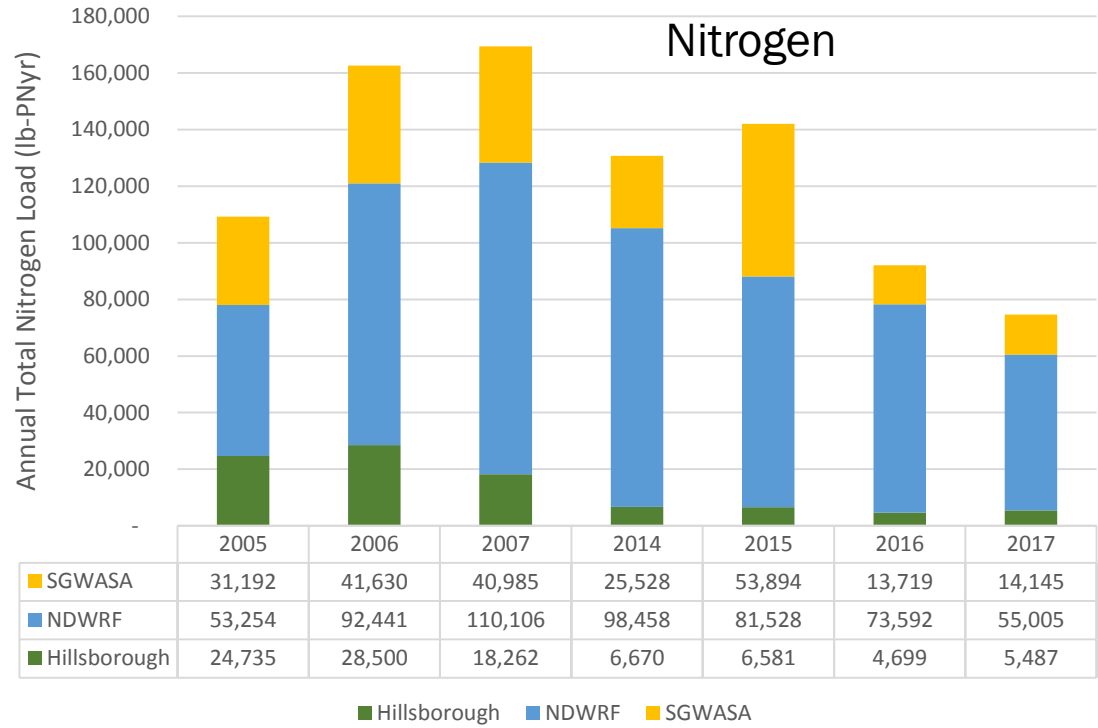


Nutrient Loading from Treatment Facilities

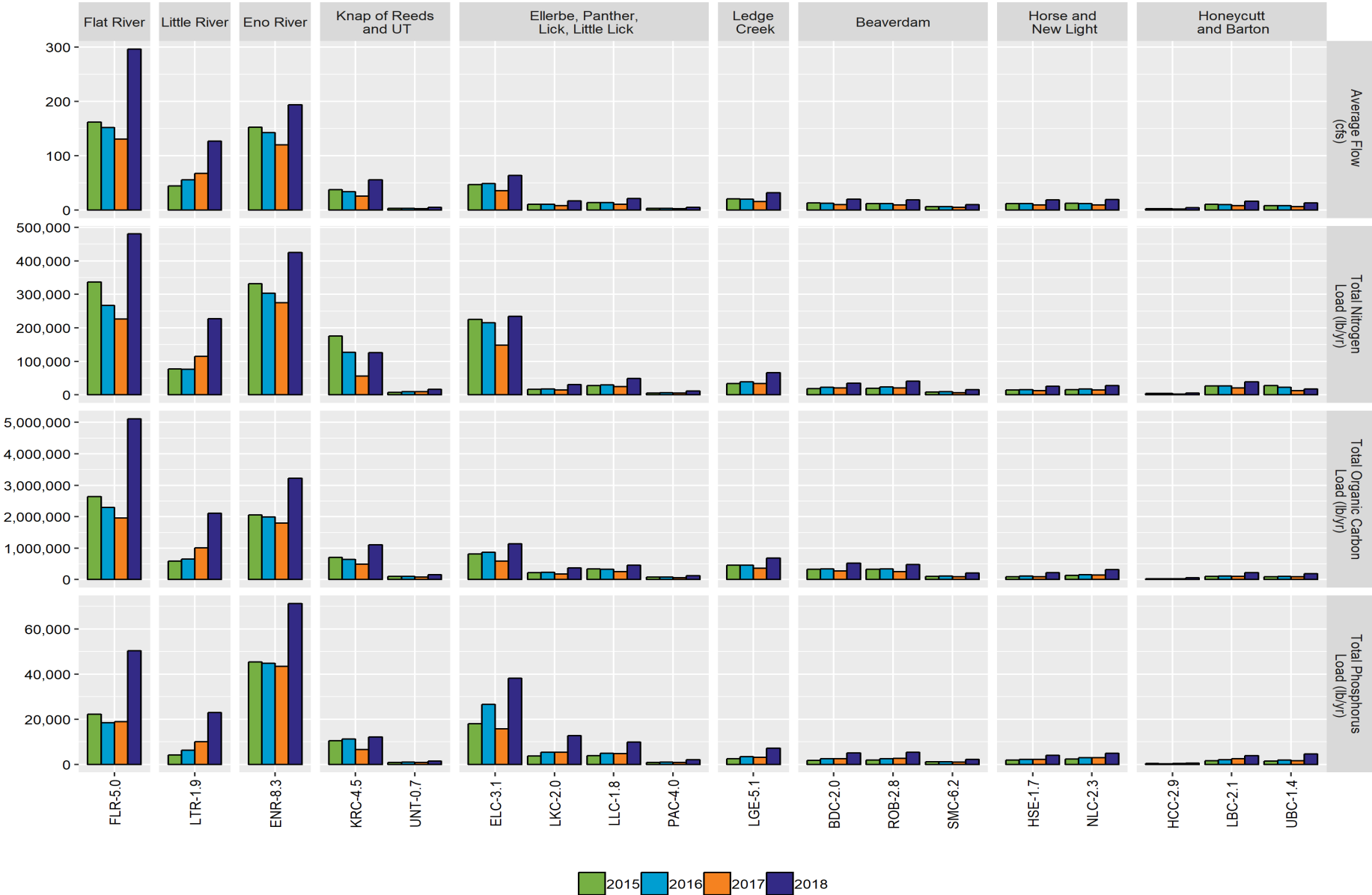
Phosphorus



Nitrogen

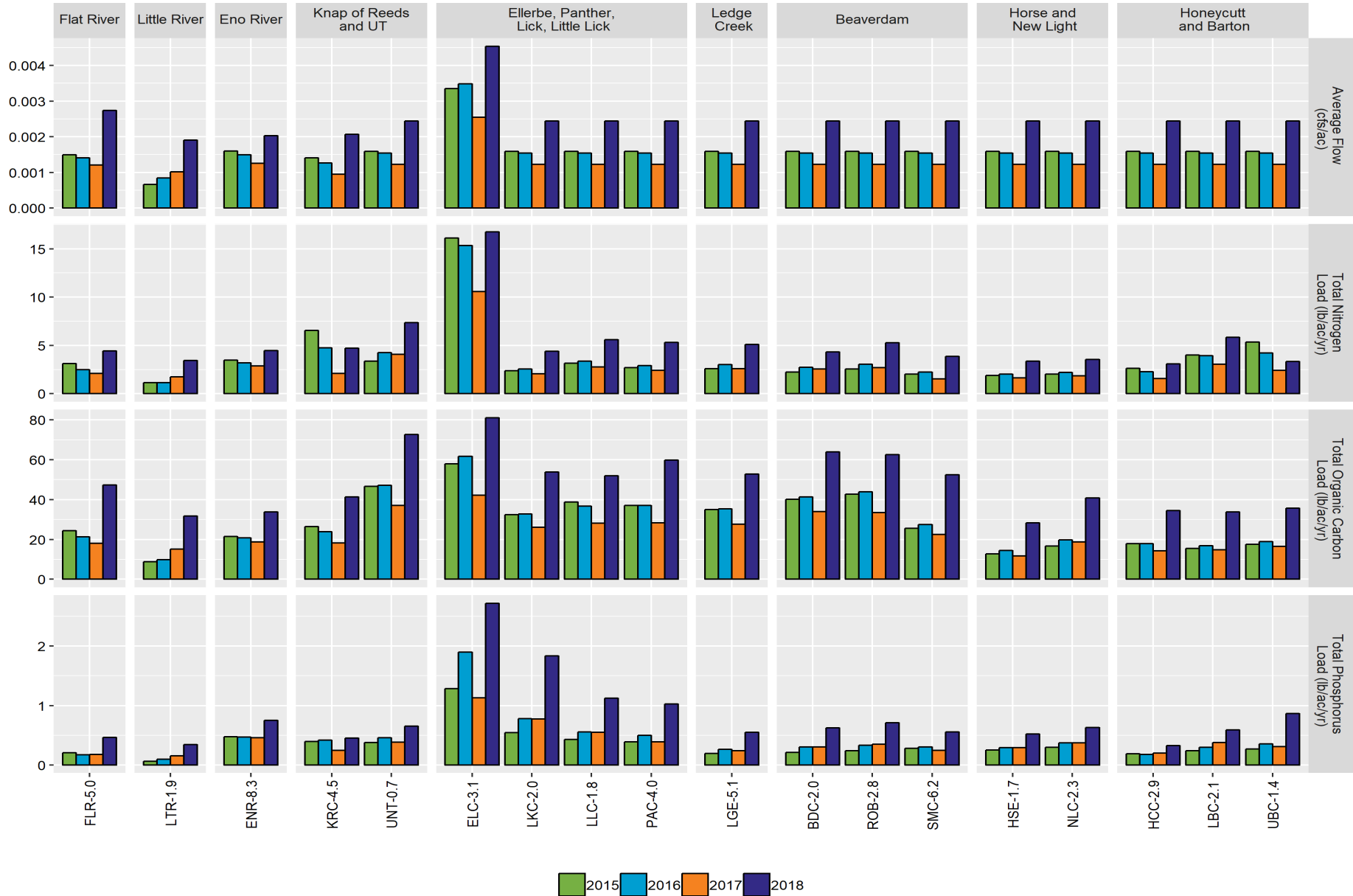


Nutrient Loading Analysis – Annual loading

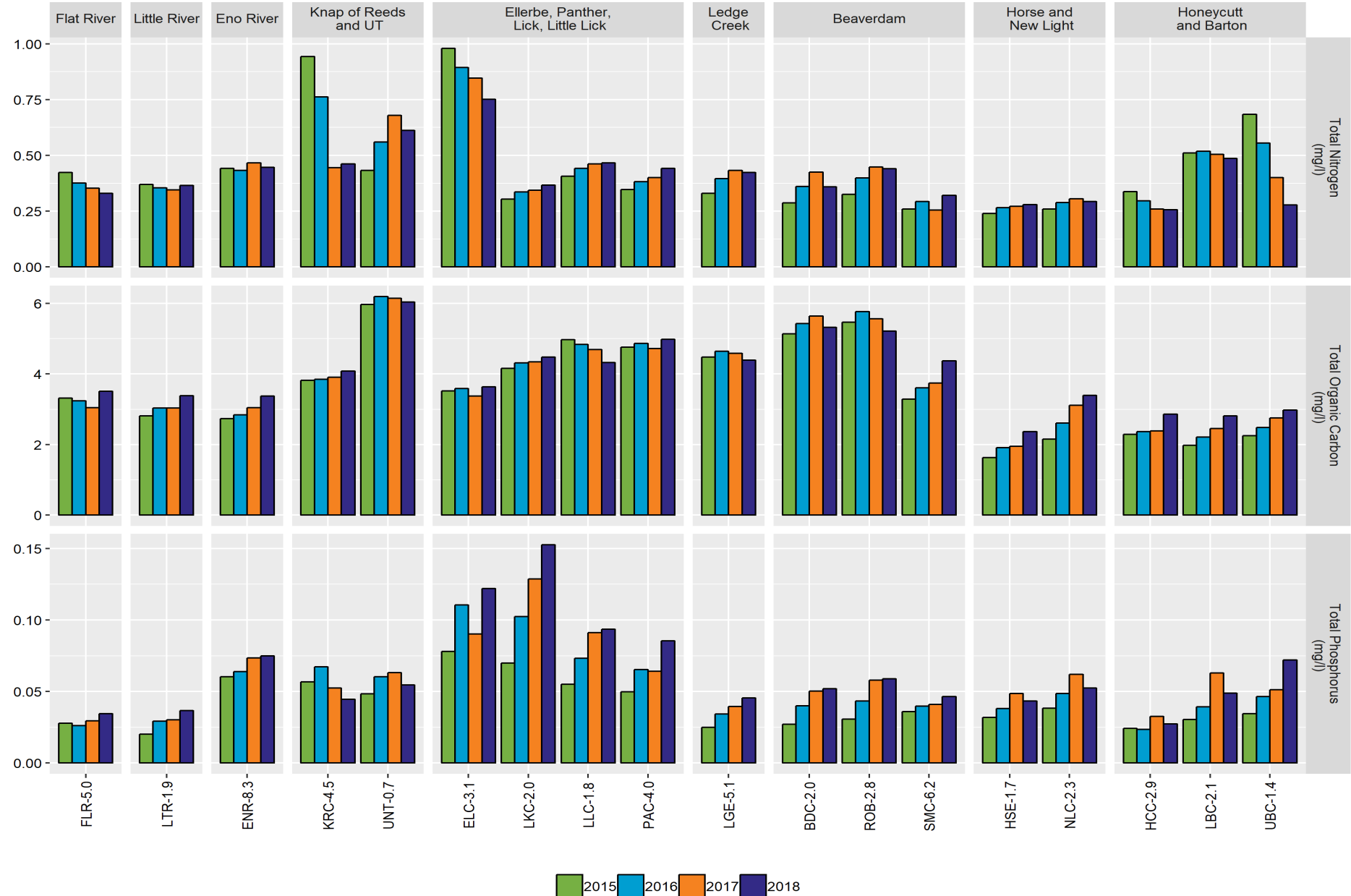


2015 2016 2017 2018

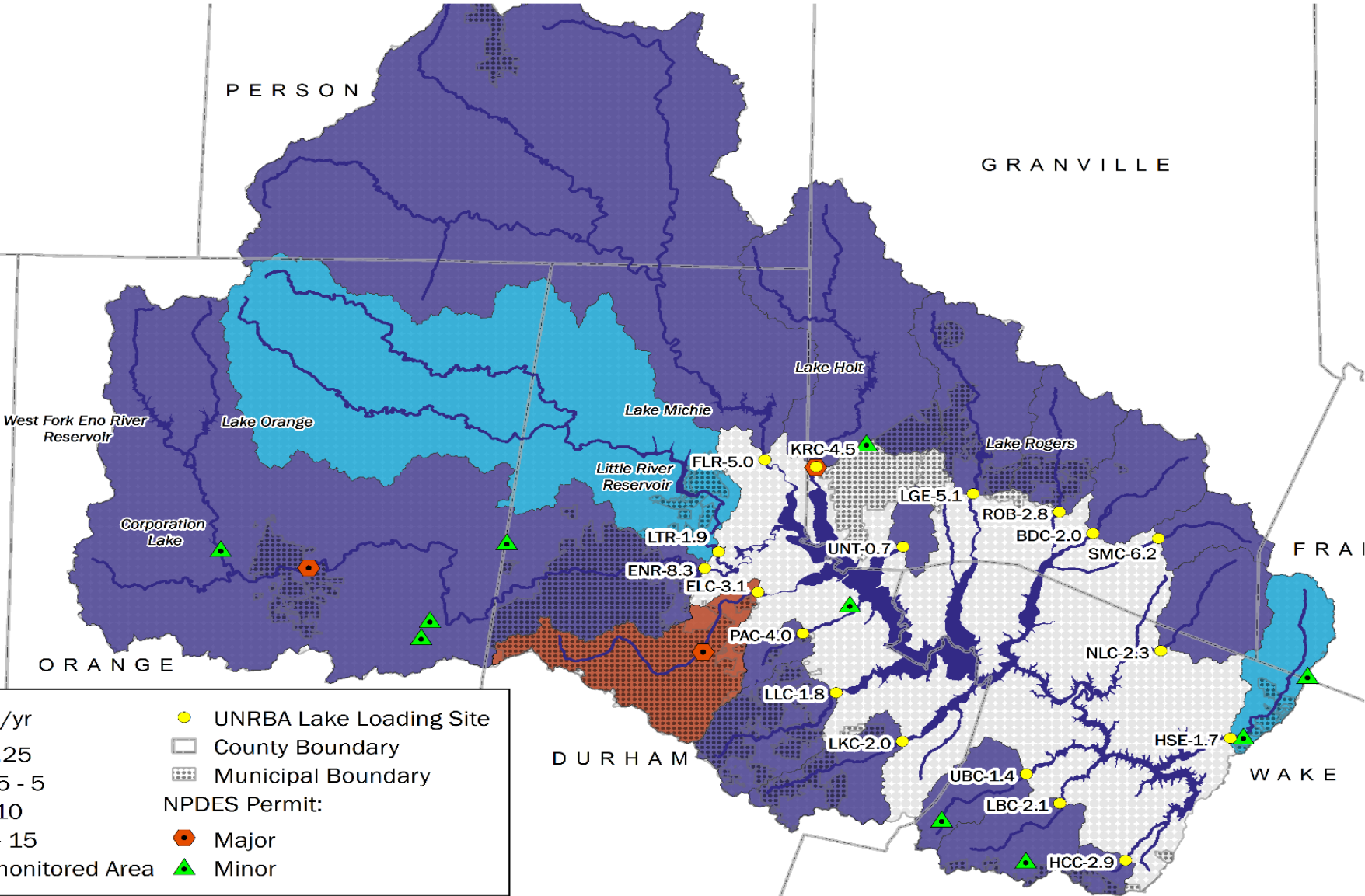
Nutrient Loading Analysis – Normalized to lbs/ac/yr



Nutrient Loading Analysis – Mean Annual Concentrations



Nutrient Loading Analysis - TN



lbs-N/ac/yr

- < 2.25
- 2.25 - 5
- 5 - 10
- 10 - 15
- Unmonitored Area

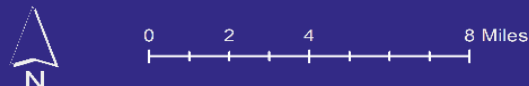
UNRBA Lake Loading Site

County Boundary

Municipal Boundary

NPDES Permit:

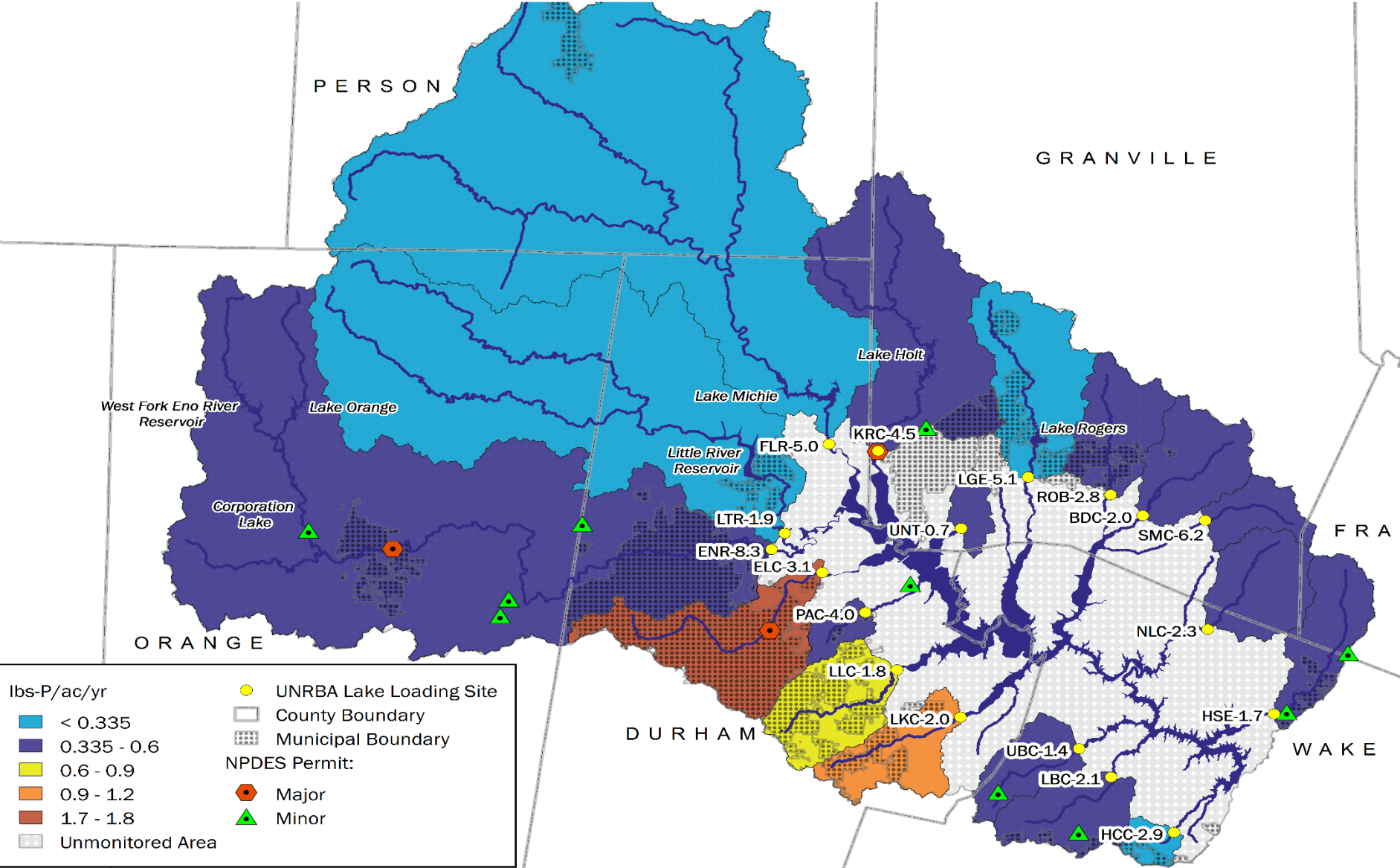
- Major
- Minor



Average Annual Loading Rates (2015-2018)
 Upper Neuse River Basin Association
 North Carolina



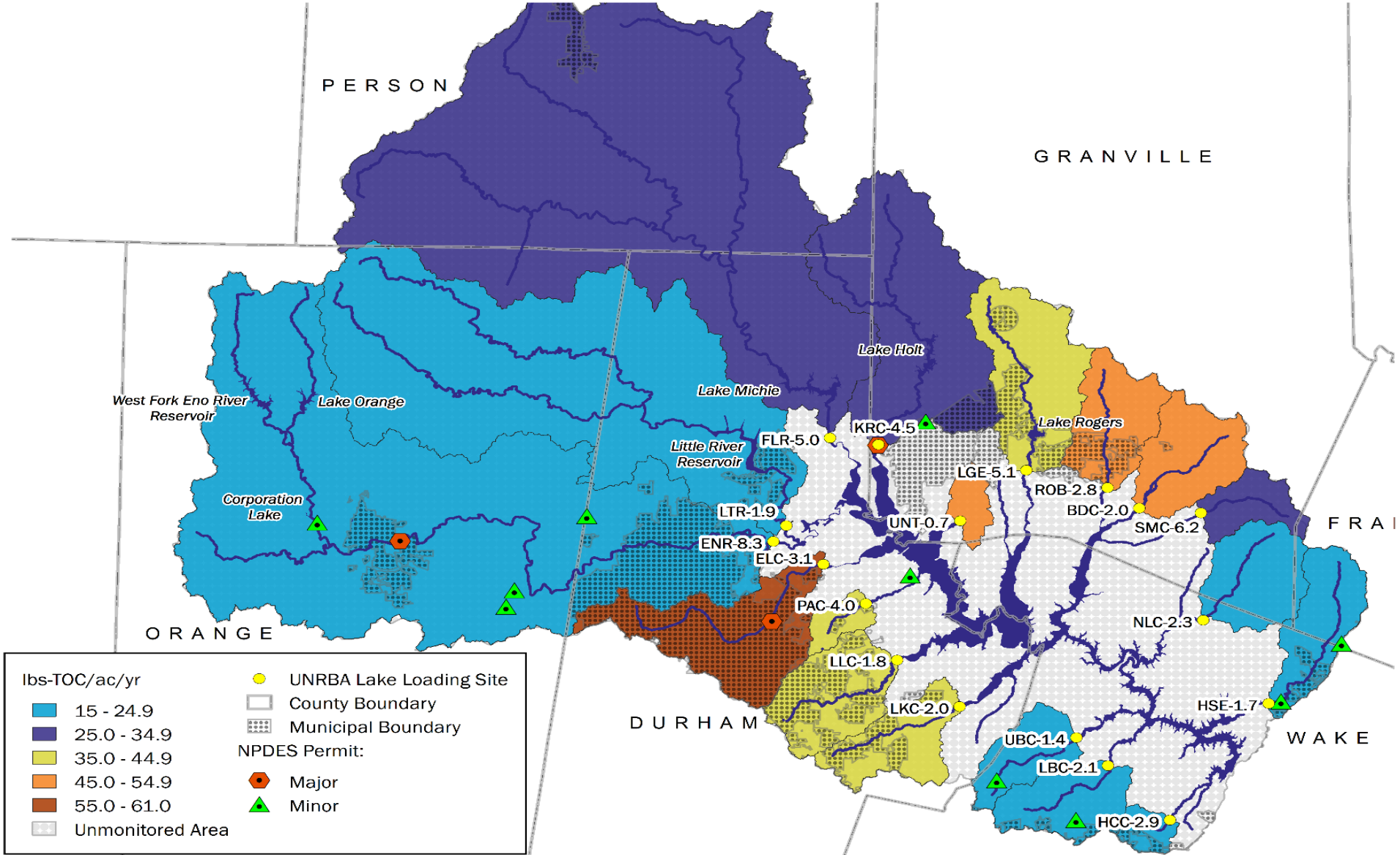
Nutrient Loading Analysis - TP



Average Annual Loading Rates (2015-2018)
 Upper Neuse River Basin Association
 North Carolina



Nutrient Loading Analysis - TOC



lbs-TOC/ac/yr

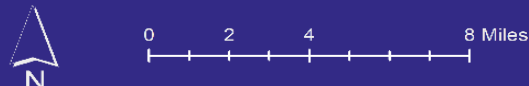
- 15 - 24.9
- 25.0 - 34.9
- 35.0 - 44.9
- 45.0 - 54.9
- 55.0 - 61.0
- Unmonitored Area

UNRBA Lake Loading Site

- County Boundary
- Municipal Boundary

NPDES Permit:

- Major
- Minor

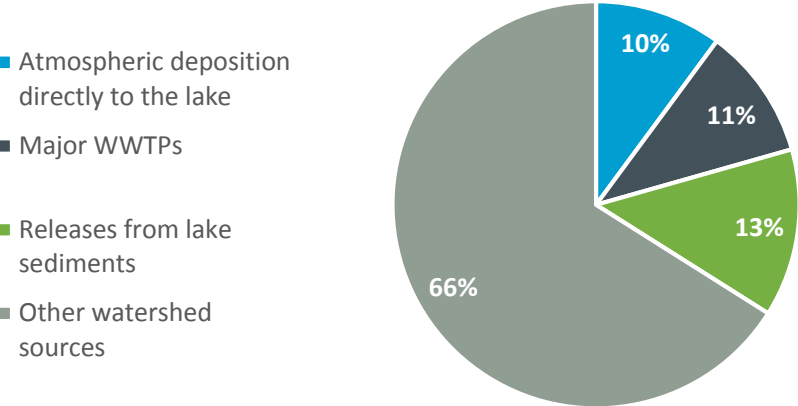


Average Annual Loading Rates (2015-2018)
 Upper Neuse River Basin Association
 North Carolina

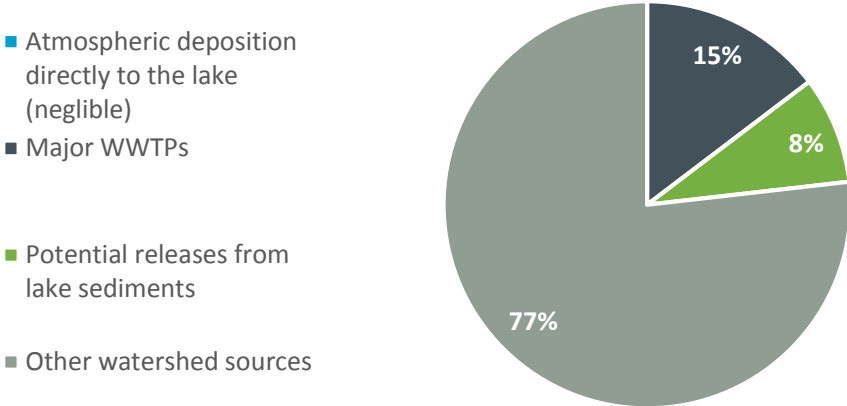


Nutrient Loading Analysis

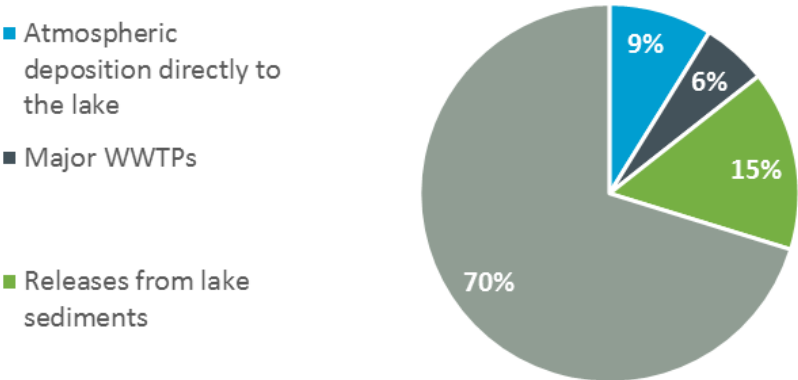
2006 Total Nitrogen Load (~1,550,000 pounds)



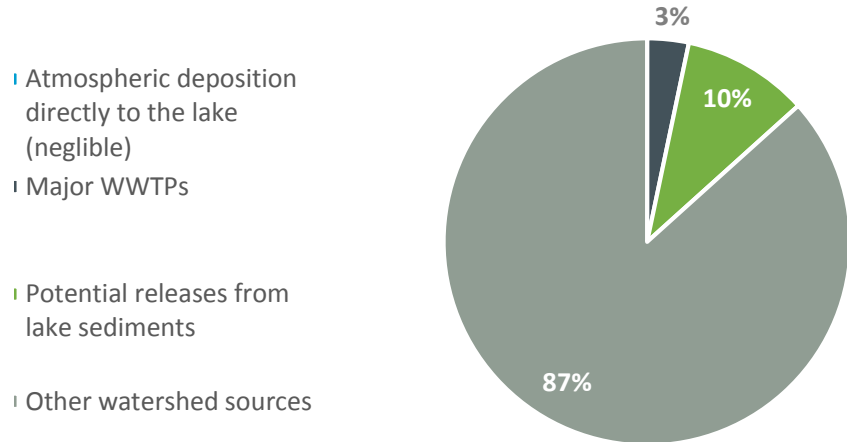
2006 Total Phosphorus Load (~164,200 pounds)



2017 Total Nitrogen Load (~1,340,000 pounds)



2017 Total Phosphorus Load (~139,500 pounds)



Recreational Use Support

A variety of social media and other online sources were reviewed for information relevant to Falls Lake

- TripAdvisor contains more than 230 individual reviews, with over 90% rating Falls Lake as “Very Good” or “Excellent”
- Various online fishing resources provide user experiences in the form of species and numbers caught, locations fished, and photos and videos of anglers
 - One mobile application reflects more than 700 individual catches, comprising over 20 species, including more than 400 largemouth bass, 60 channel catfish, nearly 100 crappie and numerous additional panfish and rough fish
 - Online videos of Falls Lake fishing have been visited by thousands of viewers, suggesting a broad interest in the fishery
- Numerous fishing tournaments are held on Falls Lake annually, including professional events paying tens of thousands of dollars to winners

QA/QC

Quality Assurance/Quality Control

- 98 percent of sampling events were completed as planned
 - Most missed events were due to dry conditions
 - Others were due to inaccessibility from flooding or snow
- The Final Report provides uncertainty statistics derived from laboratory QA data that allow users to estimate the margin of error in the monitoring results
- Minor issues were observed for some total phosphorus and ammonia records, but these comprised a small proportion of overall results and are likely linked to the low detection limits sought by the UNRBA
- Correspondence between tributary water quality values obtained by DWR and UNRBA is generally high, as is agreement between DWR data and CAAE data collected within the reservoir

Conclusions and Next Steps

Next Steps and Recommendations

- Continue the Transition Monitoring Program initiated in November 2018 in FY2020
- Continue to obtain and review results from DWR, City of Durham, and CAAE ongoing monitoring programs
- UNRBA Monitoring Team leaders will coordinate with the Modeling Team to ensure they have all raw data and other materials developed through the UNRBA Monitoring Program
- UNRBA Monitoring Team members will be available to respond to Modeling Team inquiries about this report, the underlying data, etc.
- The UNRBA is communicating with the UNC Collaboratory regarding potential opportunities for collecting additional data that will support the re-examination and modeling effort.
- The UNRBA will continue to work with North Carolina Department of Environmental Quality regarding appropriate assessment units for Falls Lake that are consistent with the functionality of the lake, the processing of nutrient loads that enter the upper part of the lake, and continued protection of designated uses

Path Forward Committee Discussion

- Questions or concerns regarding the report
- Points of clarification needed for the Board
- Submittal to the Board by June 12th
- Presentation to the Board on June 19th

Coordination with the UNC Collaboratory

Meeting with the UNC Collaboratory May 16th

- Previously discussed at PFC meeting on May 13, 2019
- Input provided by the PFC on May 13th
 - Develop cost benefit analysis tools to enhance the quality and confidence of any fiscal analysis.
 - UNC appreciative w/ possibilities including Dr. Gregory W. Characklis, Director, Center on Financial Risk in Environmental Systems.
- UNRBA provided list of potential research projects
- Collaboratory indicated they would take UNRBA input into consideration
- Focus their discussions by mid-June with potential funding in early August

Ongoing DEQ Discussion/Issues

Ongoing DEQ Discussion

- Clean Water Act 305(b) and 303(d) evaluation of Falls Lake
- Memorandum of Understanding / Agreement
- Land conservation credit
- Revision of the chlorophyll-a water quality standard
- Summary of the basic principles of the Optional Implementation Approach under review by the UNRBA

Closing Comments Additional Discussion