Falls Lake Nutrient Management Study Research Symposium

The UNRBA Pathway to a Re-Examination of the Falls Lake Nutrient Management Strategy

April 19, 2023

Upper Neuse River Basin (UNRBA)

- Members
  - Six counties
  - Seven municipalities
  - One water utility
  - Soil and water conservation districts
- Active External Stakeholders
  - Agriculture
  - Environmental groups
  - Land conservation organizations
  - NC DEQ/DWR
  - NC DOT
  - NC DA&CS

Falls Lake Designated Uses

- Provides drinking water for over 500,000 customers
- No taste, odor, or disinfection byproduct concerns
- Minimizes downstream flooding
- Protects water quality downstream
- Sustains minimum flows
- Provides habitat (aquatic and terrestrial)
- No bloom-related fish kills since filling
- Provides regional recreational facility

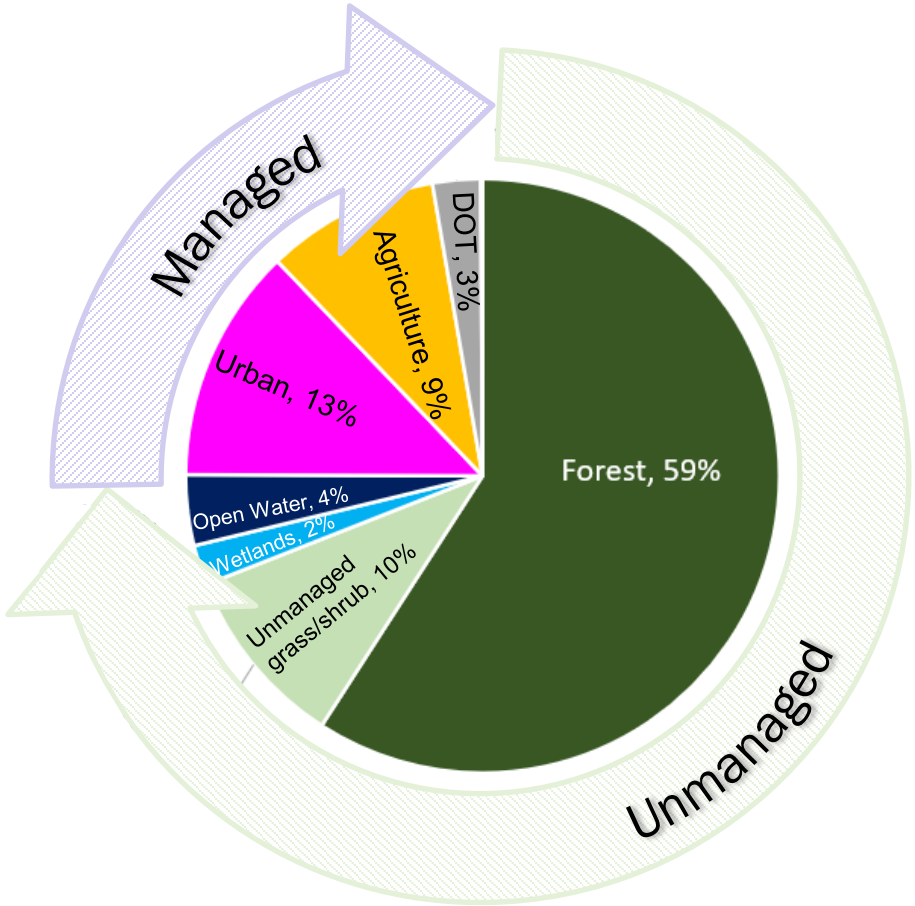
Current Falls Lake Regulatory Framework

- Falls Lake Nutrient Management Strategy passed by the State in 2011
- Two stages of nutrient reductions (relative to baseline year, 2006)
  - Stage I (20% TN, 40% TP)
  - Stage II (40% TN, 77% TP)
- Reductions are assigned by sector
- Estimated to cost over $1.5 billion
- Stage II requirements are beyond technological limits
- Adaptive management provision that allows for the re-examination of Stage II following
  - Collection of water quality data
  - Development of lake and watershed models

Key Findings from Watershed Data and UNRBA Watershed Model

Land Use Composition of the Falls Lake Watershed

- 75% is unmanaged land
- 13% is urban
  - 68% developed open space and non-DOT road rights of way
  - 20% low intensity existing development
  - 12% medium and high intensity development (1.5% of the total watershed area)
  - Over 350 existing development retrofits installed by Dec. 2015
- 9% is agriculture
  - Mostly small family farms
    - ~26,000 acres of pasture
    - ~20,000 acres of crops
  - Acreage has decreased by 44% since 2006 (baseline)
  - NC Department of Agriculture indicates that further reductions of loading from agriculture are not feasible

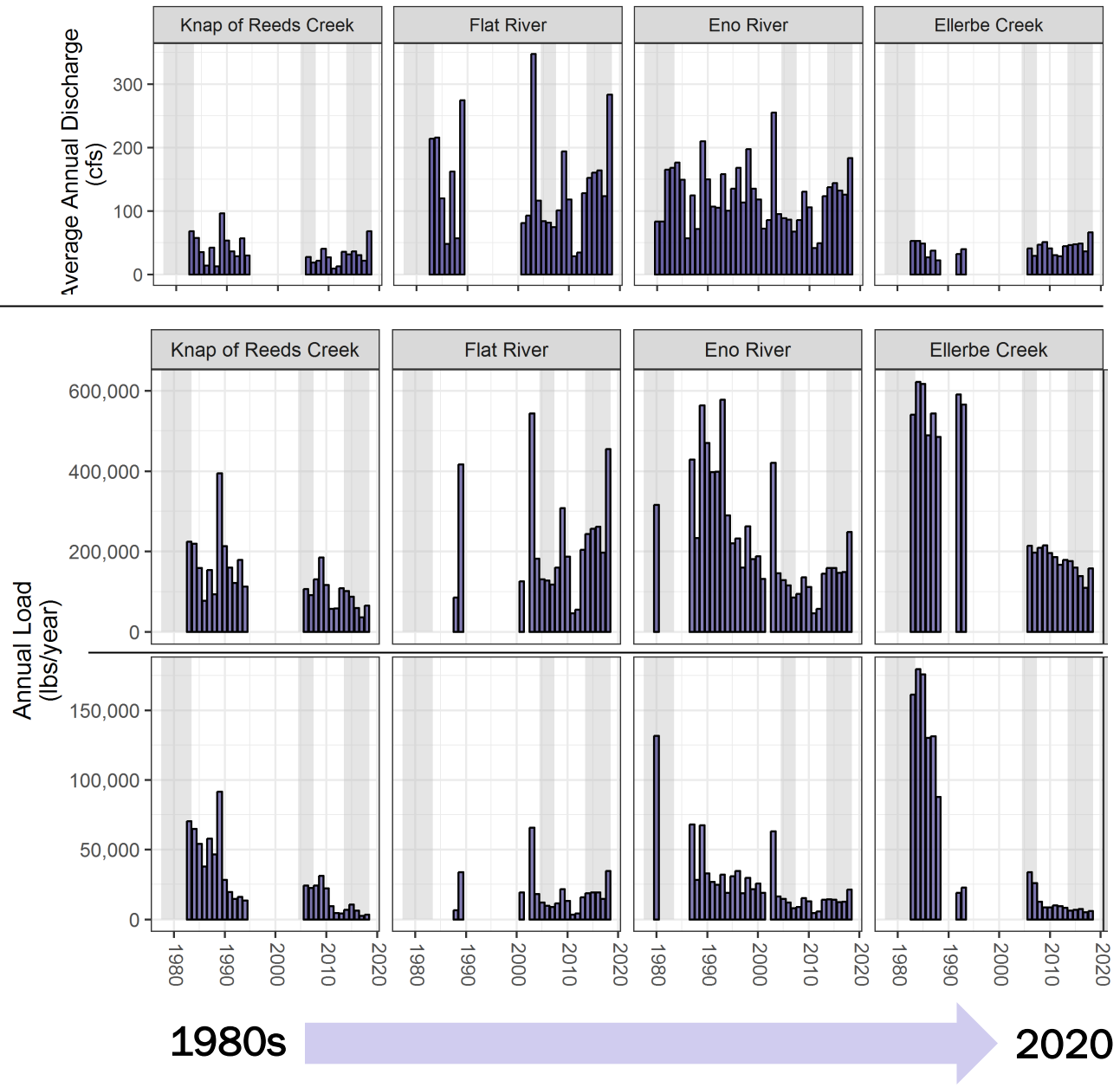


Nutrient Loads to Falls Lake have Declined

Flow (cfs)

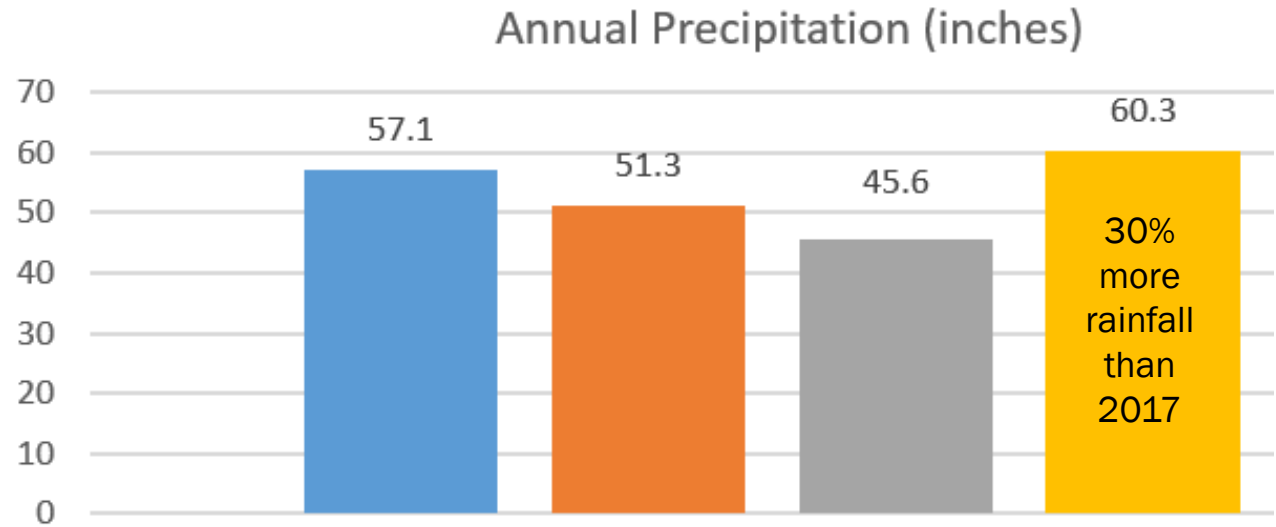
Nitrogen (lb/yr)

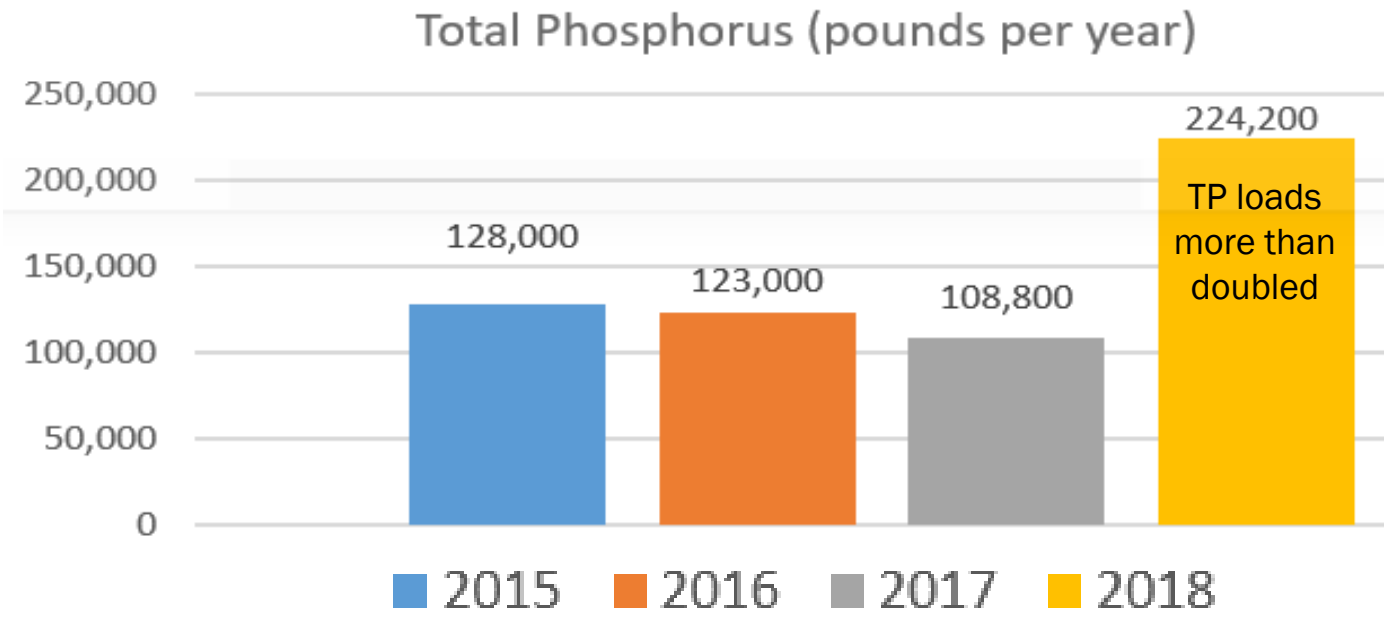
Phosphorus (lb/yr)



Importance of Precipitation on Delivered Loading

- Load is a function of stream flow and concentration
- Nutrient loads are highly variable from year to year based on precipitation
  - Loads to Falls Lake more than doubled in 2018 compared to 2017
  - Precipitation increased by 30%

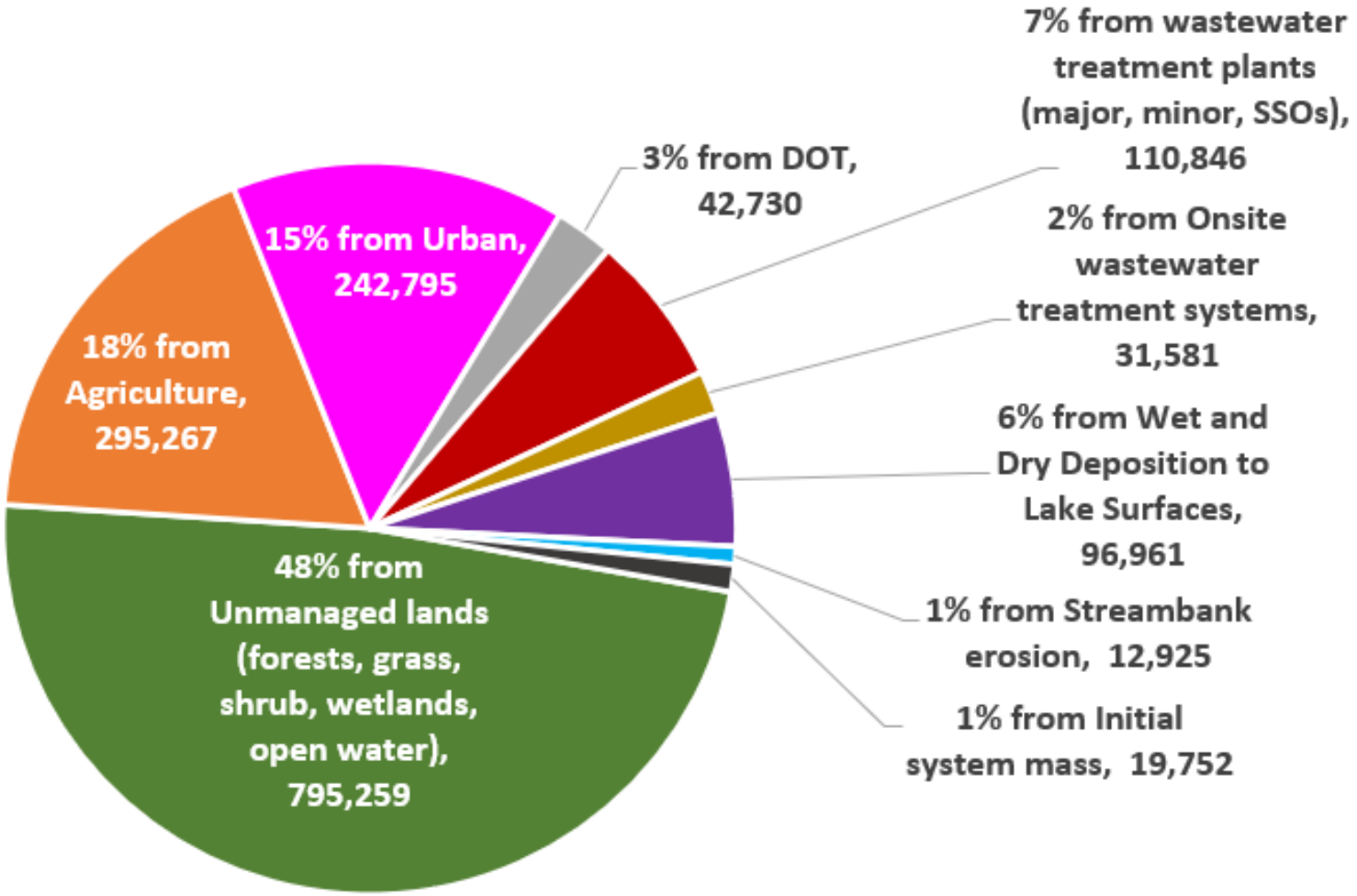




Sources of Total Nitrogen (TN) Delivered to Falls Lake

Annual average loading for 2015 to 2018:

- 8.6 million pounds of TN applied, deposited, or discharged to the watershed each year
- ~20% reaches Falls Lake (1.65 million lb/yr)
- Unmanaged lands contribute the most (48%) because they comprise 75% of the drainage

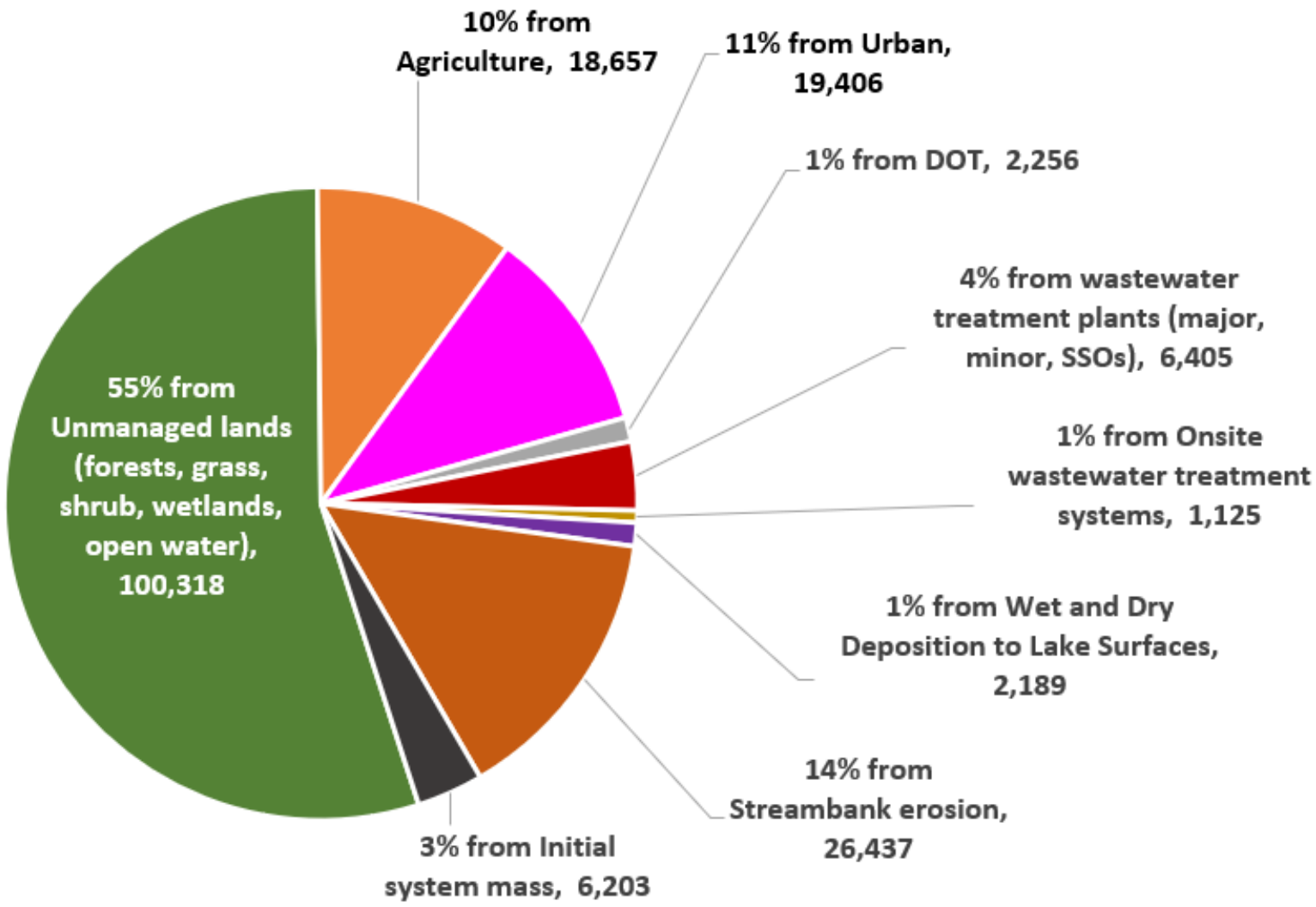


9

Sources of Total Phosphorus (TP) Delivered to Falls Lake

Annual average loading for 2015 to 2018:

- 1.1 million pounds of TP are applied, deposited, or discharged to the watershed each year
- ~20% reaches Falls Lake (183,000 lb/yr)
- Unmanaged lands contribute the most (55%) because they comprise 75% of the drainage
- Streambank erosion contributes ~14%

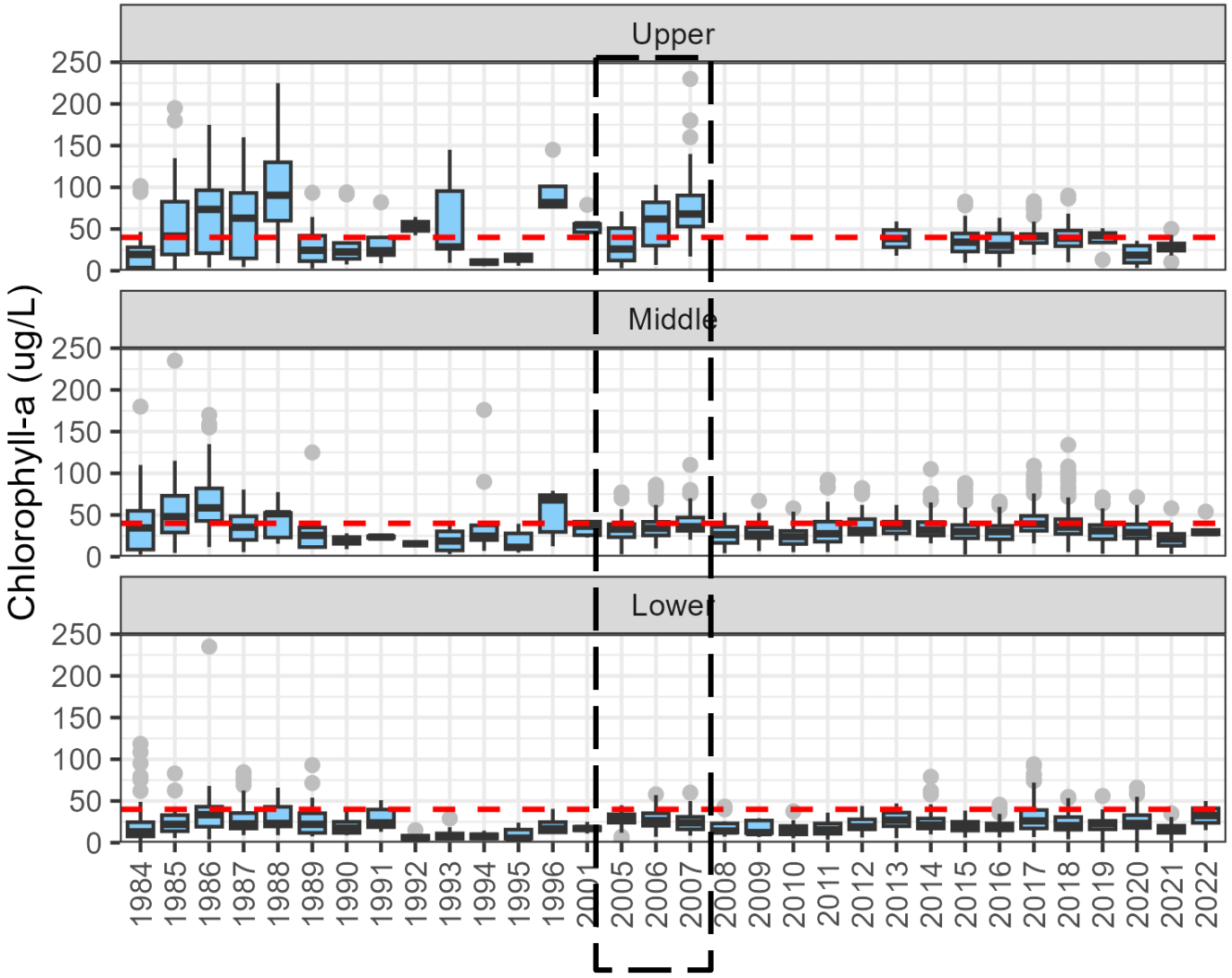


10

Key Findings from Lake Data and UNRBA Models

Chlorophyll-a (µg/L)

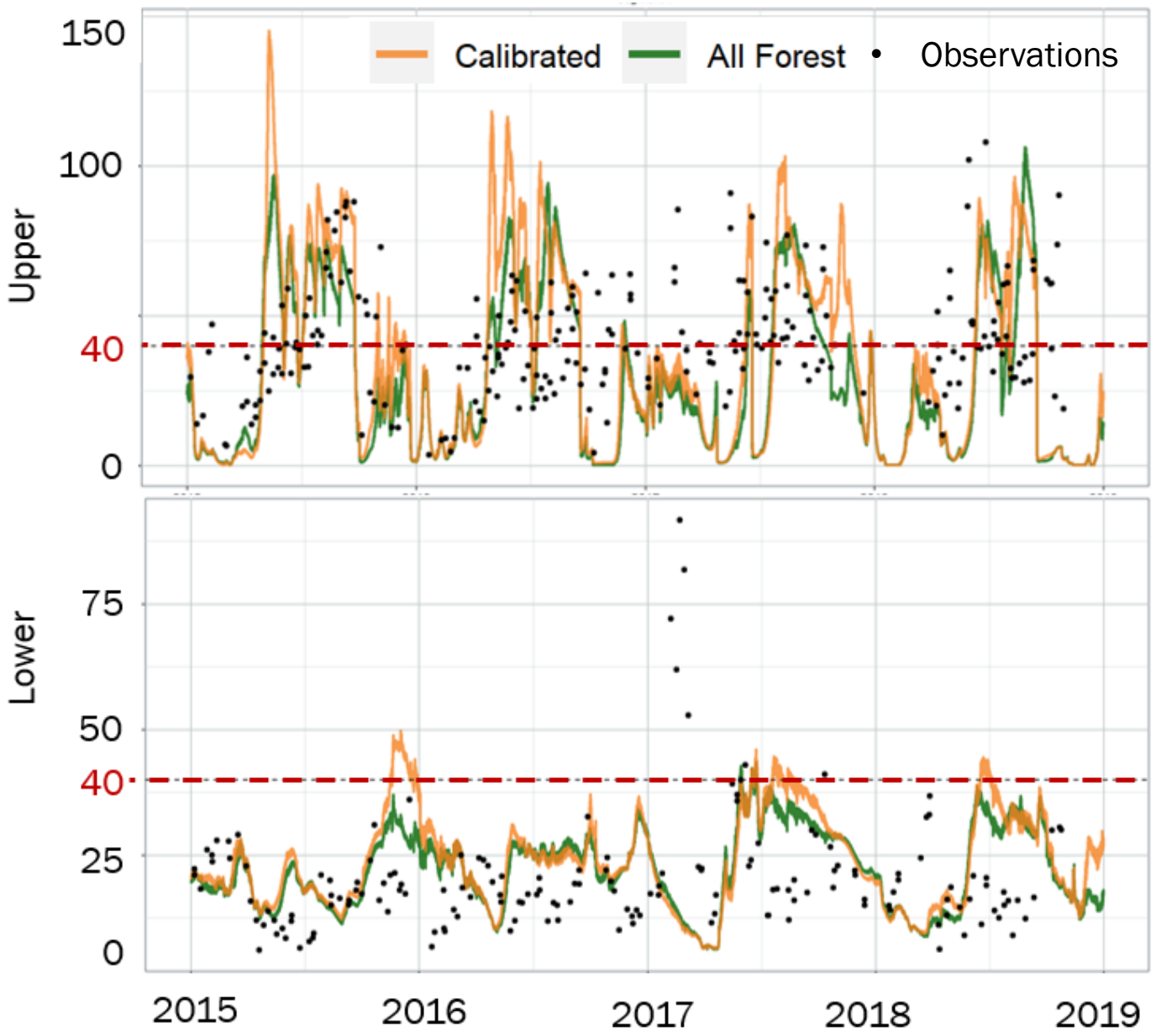
- Historic levels above 40 µg/L, especially in upper and middle sections
- Improvement and stability since 2008
- Decrease from upstream to downstream
- Lower segment has always seen fewest excursions above 40 µg/L
- Reservoir improves water quality



Dotted box is the historic drought that occurred in 2005 to 2007.

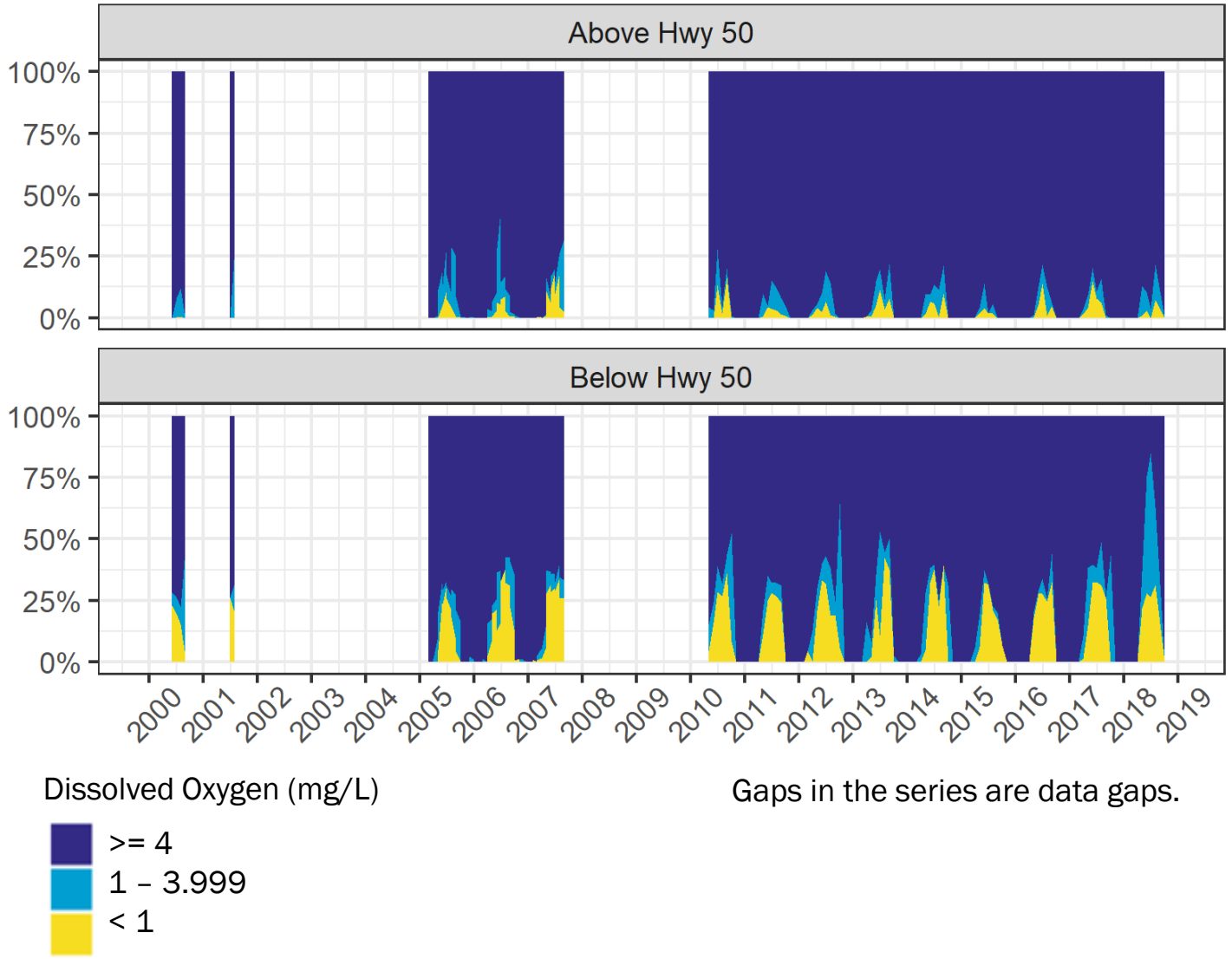
Simulated Chlorophyll-a (µg/L)

- UNRBA WARMF Lake model
- Linked to the watershed model
- Used to evaluate scenarios and compare to observations
  - Top: Upper Lake (near I-85)
  - Bottom: Lower Lake (near dam)
- **Hypothetical "Land Conversion to All Forest" scenario (i.e., no human inputs)** would not meet the chlorophyll-a standard in the upper segment
- Meeting the standard everywhere all the time is not feasible

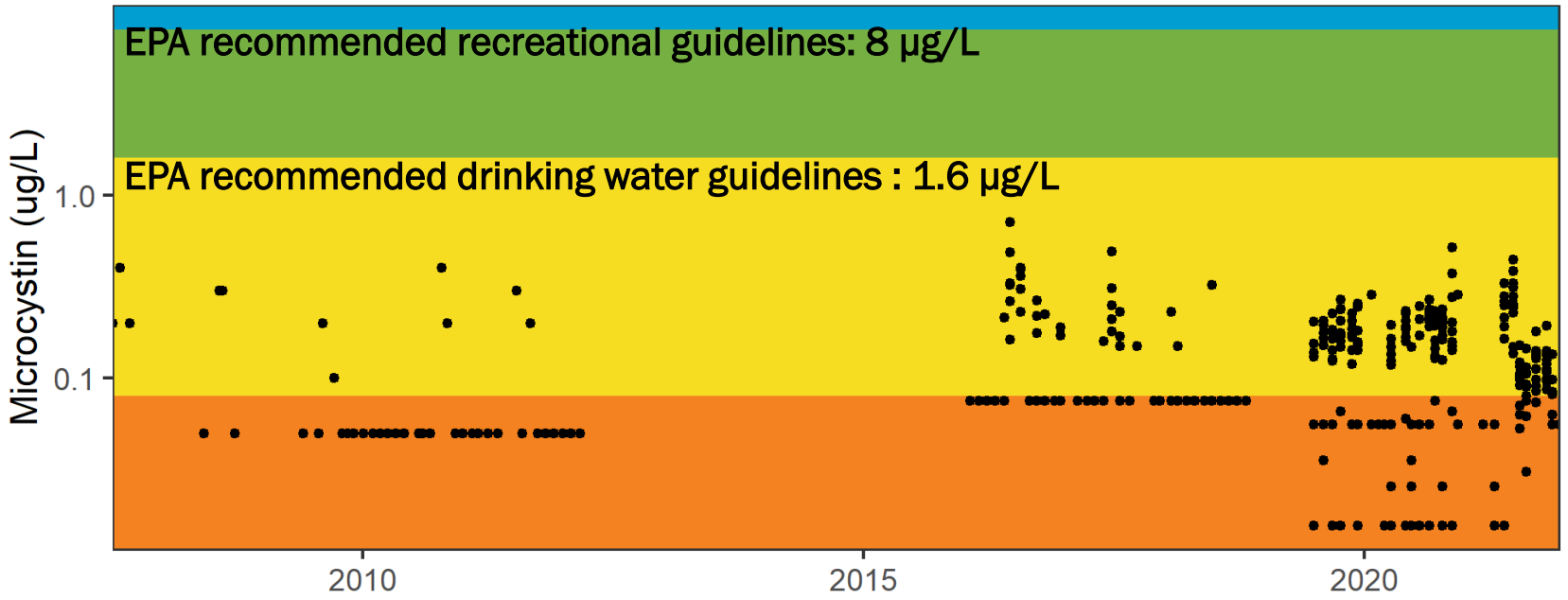


Volume of Lake Relative to Dissolved Oxygen (DO) Criterion

- Monthly mean DO volume as a percent of total lake volume
  - UNRBA bathymetric survey
  - USGS water level
  - DWR lake profile data
- Volume of lake above and below Highway 50 are similar
- Majority of the lake volume is always above 4 mg/L, with brief exception in summer 2018
  - 4 mg/L is the instantaneous minimum criterion
- **Well oxygenated waters are always present**



Algal Toxins: Microcystin (µg/L) Example



Microcystin (µg/L)[1]		
Low	ND to 1.6:	Below recommendations for drinking water and recreation
Moderate	1.6 to 8:	Below recommendations for recreation, but not drinking water
High	> 8:	Higher than both recommendations

- Collected by the City of Raleigh and Dr. Astrid Schnetzer, NCSU
- Microcystin concentrations are consistently below EPA drinking water and recreational guidelines
- Same for cylindrospermopsin
- EPA does not have anatoxin guidelines; the World Health Organization (WHO) does
  - January 2016 had exceedances of WHO recommendations for anatoxin

NC Collaboratory Research Studies on Falls Lake

- Falls Lake is the most studied reservoir in NC
- The UNRBA has been coordinating on research efforts with the NC Collaboratory since it was formed in 2016
- Researchers have been providing input on model development and third-party review
- **Coordination ensures models are based on the best science**

- Nutrient releases from lake sediments
- Cyanotoxin presence
- Nitrogen fixation and denitrification
- Water movement and temperature
- Zooplankton-phytoplankton relationships
- UNRBA third-party review