

Water Quality Projects at the Occoquan Watershed Monitoring Laboratory

Adil Godrej

28 February 2011

Background

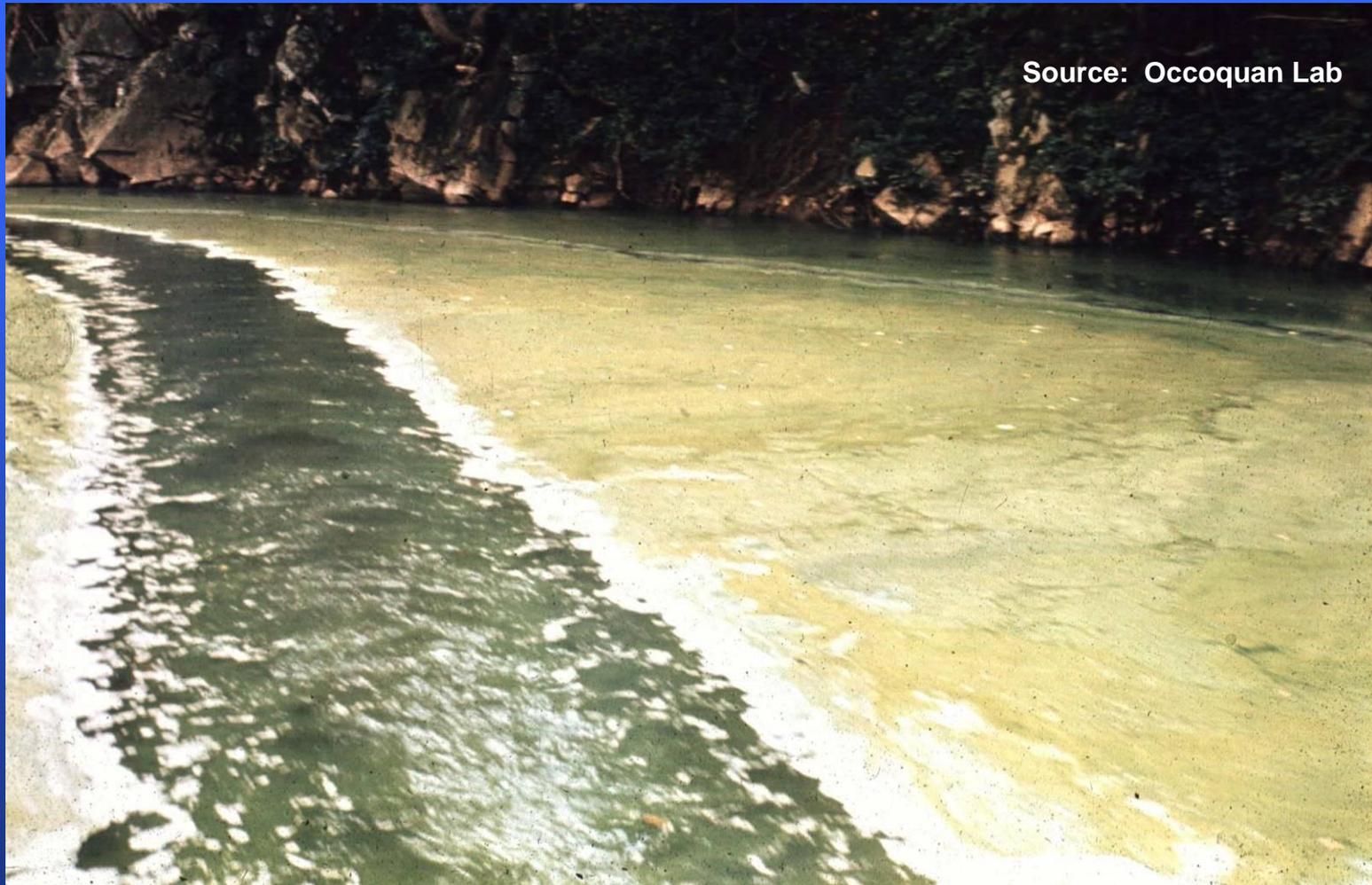
- Occoquan Watershed Monitoring Laboratory (OWML) is a functional unit of the Department of Civil and Environmental Engineering of the Virginia Tech College of Engineering
- Established in Manassas in 1972, and operated continuously since that time
- Organization has mandated work program requirements from Virginia DEQ in support of the State Water Control Law
- Laboratory Director and principal technical staff are all CEE faculty members

Establishment of the OWML

- Constructed in 1957, the Occoquan Reservoir is a principal component of the Virginia suburban water supply in National Capital Region
- Within 10 years, experienced severe water quality problems from nutrient enrichment (N&P) and organic matter loadings
- Virginia State Water Control Board (VSWCB) commissioned intensive studies in 1969 to determine causes of deteriorated water quality and to develop a long-term management plan



Example of Water Quality Conditions in 1973



The Occoquan Policy

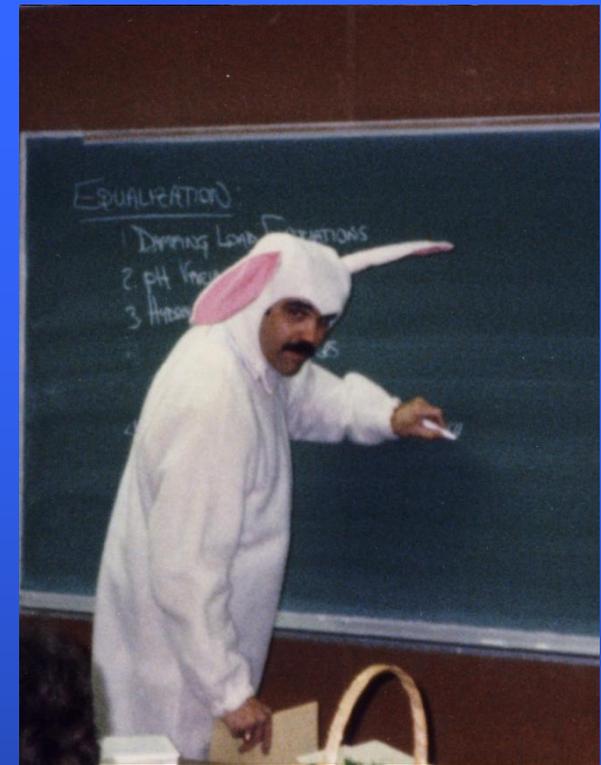
- 9VAC25-410: *A Policy for Wastewater Treatment and Water Quality Management in the Occoquan Watershed*
- Initially adopted by Virginia Water Control Board in 1970; latest revision in 1990
- Requirement for special water reclamation facilities in the Occoquan Watershed
- Additional requirement for ***independent monitoring*** of facility performance and effects of nonpoint sources (9VAC25-410-40)
- Similar requirement adopted for the Dulles Area Watershed (9 VAC25-401) tributary to the Potomac River above the fall line

People at the Occoquan Laboratory

- 4 Faculty Members
- 2 Research Associates
- 9 Classified Staff Members
- An assortment of full-time students
 - 6 PhD
 - 1 Masters

Tom Grizzard

- Professor and Director of the Occoquan Laboratory
 - Native Virginian and VT alumnus
 - Over 40 years of experience
 - 36 Years at Virginia Tech
 - All in exile to Northern Virginia
 - Research Interests
 - Nonpoint source and urban runoff: control and assessment
 - Effects of land use change on water quality
 - Water reclamation & effects on drinking water supplies
 - Water quality management in lakes and reservoirs
 - Sediment-water interactions in impounded waters



Adil Godrej

- Research Associate Professor and Associate Director of the Occoquan Laboratory
 - 21 Years at Virginia Tech
 - 30 years of experience
 - Research Interests
 - Water quality modeling
 - Watershed and impounded systems
 - Surface water quality management
 - Nonpoint pollution and urban runoff control



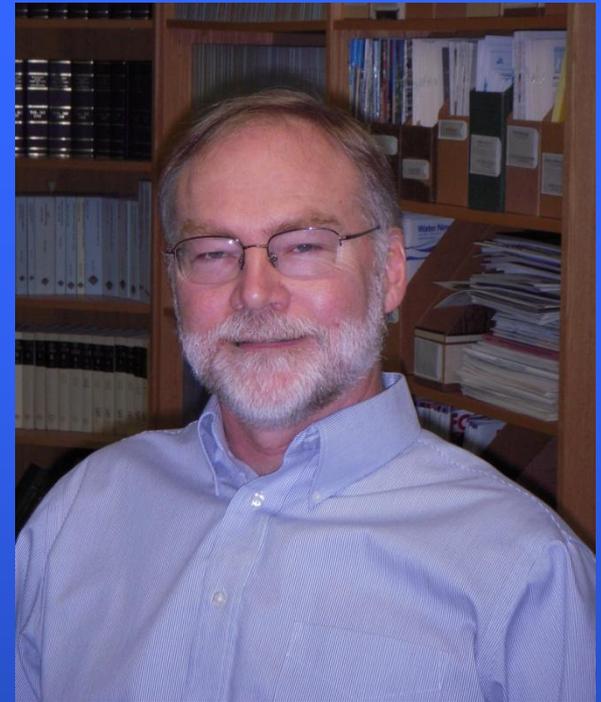
Glenn Moglen

- Professor of Civil and Environmental Engineering
 - New to Virginia Tech in Fall, 2008
 - Nearly 25 years experience in Environmental and Water Resources Engineering
 - Research Interests
 - Effects of land use change, especially urbanization, on floods, droughts, and water quality.
 - GIS-based hydrologic analysis and design
 - Land development policy, optimization, and smart growth



David Sample

- Assistant Professor of Biological Systems Engineering (BSE)
 - Assigned to Occoquan Lab by agreement with BSE
 - Adjunct in CEE
 - New to Virginia Tech in Fall, 2008
 - Over 25 years experience in Environmental and Water Resources Engineering
 - Research Interests
 - Stormwater management, including BMP and LID design
 - Simulation of SWM practices and extension to watershed-scale models
 - Using GIS tools in modeling and analysis



Physical Facility Improvements

- New office addition construction started in spring, 2009
- Mostly complete in early 2010
- Old lab demolition started in late 2009
- Complete in spring, 2010



Lab Demolition and Operating Inconvenience



Lab Renovations



Completed Addition and Renovated Lab Space



Laboratory Certification

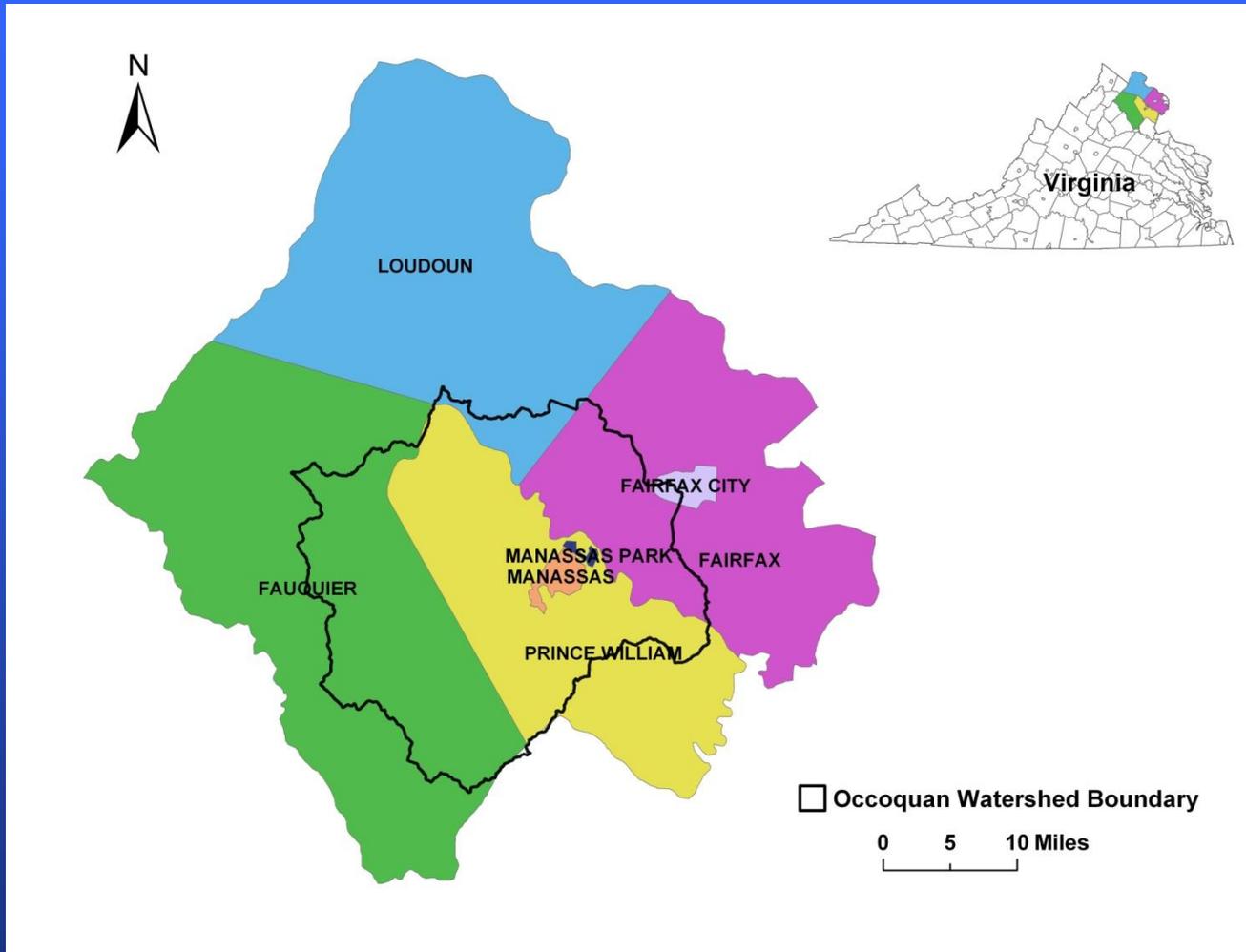
- Recently became the first university lab in Virginia to get interim accreditation under NELAP (National Environmental Laboratory Accreditation Program) from the Virginia Division of Consolidated Laboratory Services.
- Expect to get full certification within the next 2-3 months.

The Occoquan Program

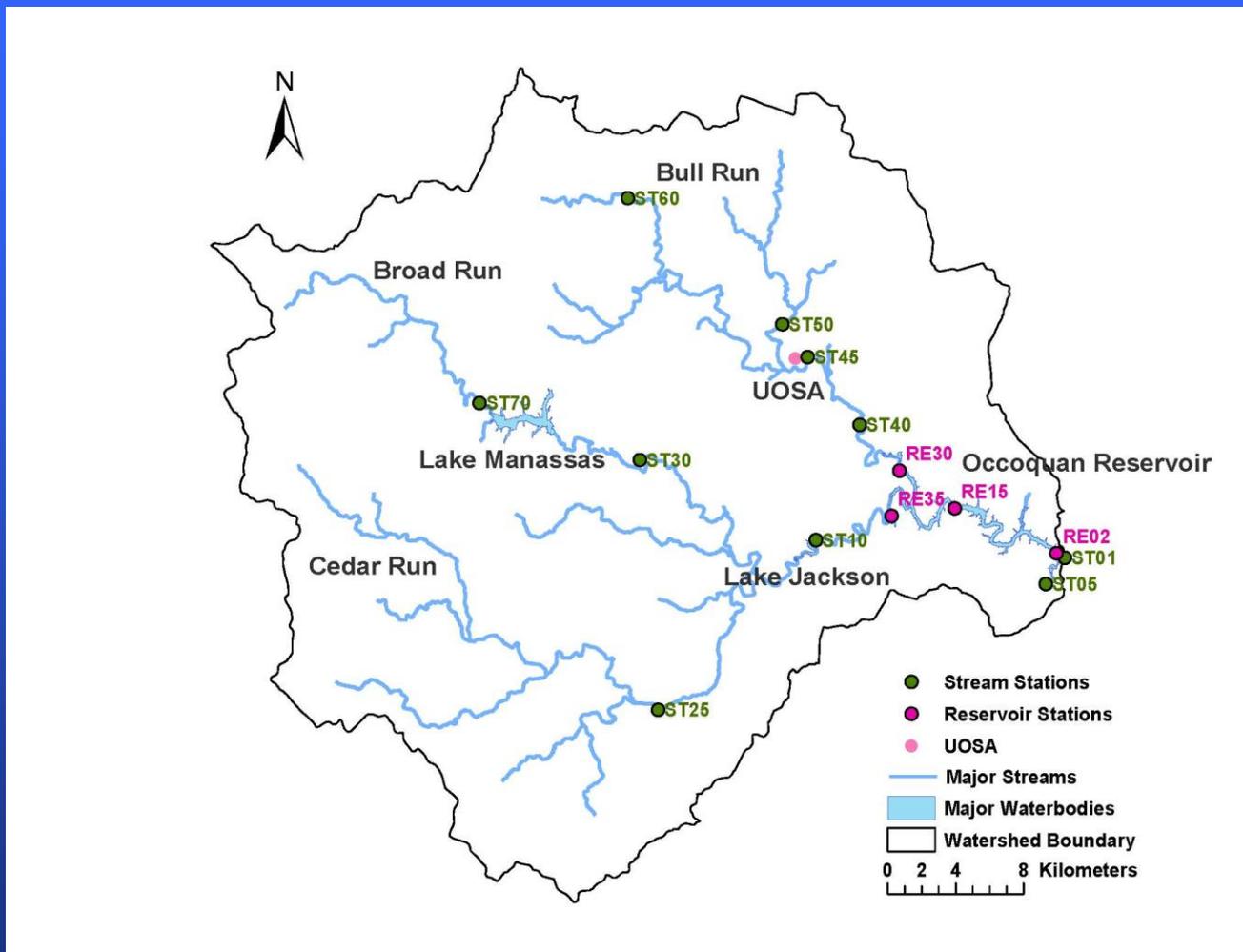
- Established under the Occoquan Policy in 1972
- Operates 10 stream stations
 - Flow measurement
 - Automated flow-weighted compositing and collection of stormflow samples



Occoquan Watershed



Stream and Principal Reservoir Stations



Sediment-Water Interactions Research

- Nitrified discharges from UOSA WRF into Bull Run provide a benefit during summer stratification
 - Nitrate serves as an alternate electron acceptor in the absence of dissolved oxygen in the deep waters (hypolimnion) and disallows the release of soluble phosphorus, iron, manganese and ammonia
 - Nitrate is denitrified in the process
 - Research by Francisco Cubas (PhD student)



Bathymetric Surveys



Potomac River Fall Line Monitoring at Chain Bridge

- Automated sampling station at Chain Bridge has been operated since 1982.
- Flow is measured at Little Falls and is used to pace the automated sampler at Chain Bridge.



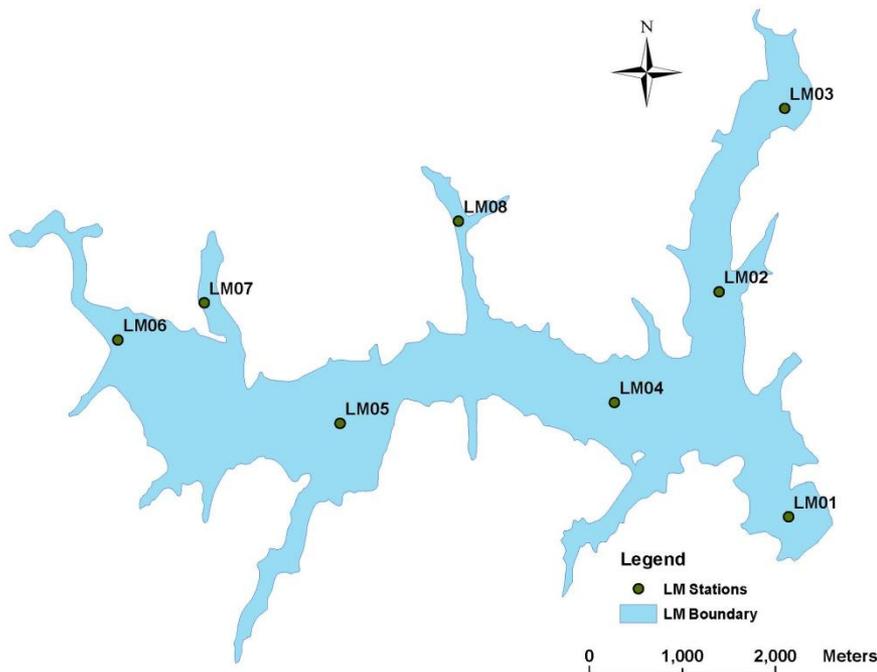
Sampling at Chain Bridge

- Pump to constant-head tank
- Sample from constant head tank
- Both, flow composited and discrete, samples



Lake Manassas Watershed Monitoring Program

- In operation since 1984, with 8 stream stations and 8 lake stations.



SOC Measurements

- All stream and reservoir sites in the Occoquan watershed
- Synthetic organic compound (SOC) measurements in water, sediment and fish
- Of which, fish is the most interesting.....



Broad Run (Loudoun) Monitoring

- Since 1990, monitoring at sites on Broad Run in Loudoun County
- In support of the construction of the Broad Run WRF

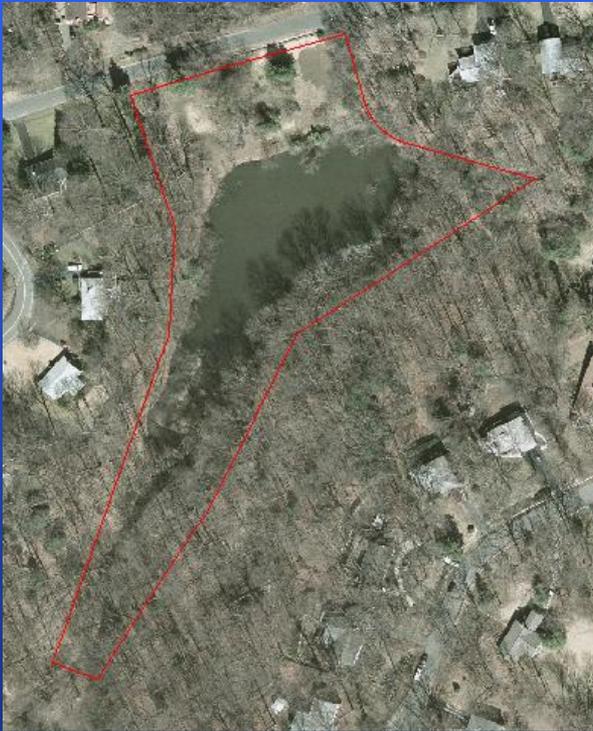


Operation of Prince William NPDES Stations

- Operation of stations and collection of samples since 1994 to meet NPDES monitoring requirements.
- Various sites over the years, including:
 - Powell's Creek at Spriggs Road
 - Neabsco Creek at Delaney Road
 - Cow Branch at Telegraph Road
 - Rocky Run at Worthington Drive
 - Little Bull Run at Catharpin Road

Floating Treatment Wetland in Fairfax

- Location: Ashby Pond, Fairfax City, VA.
- Funded by: National Fish and Wildlife Foundation



Floating Treatment Wetland in Fairfax

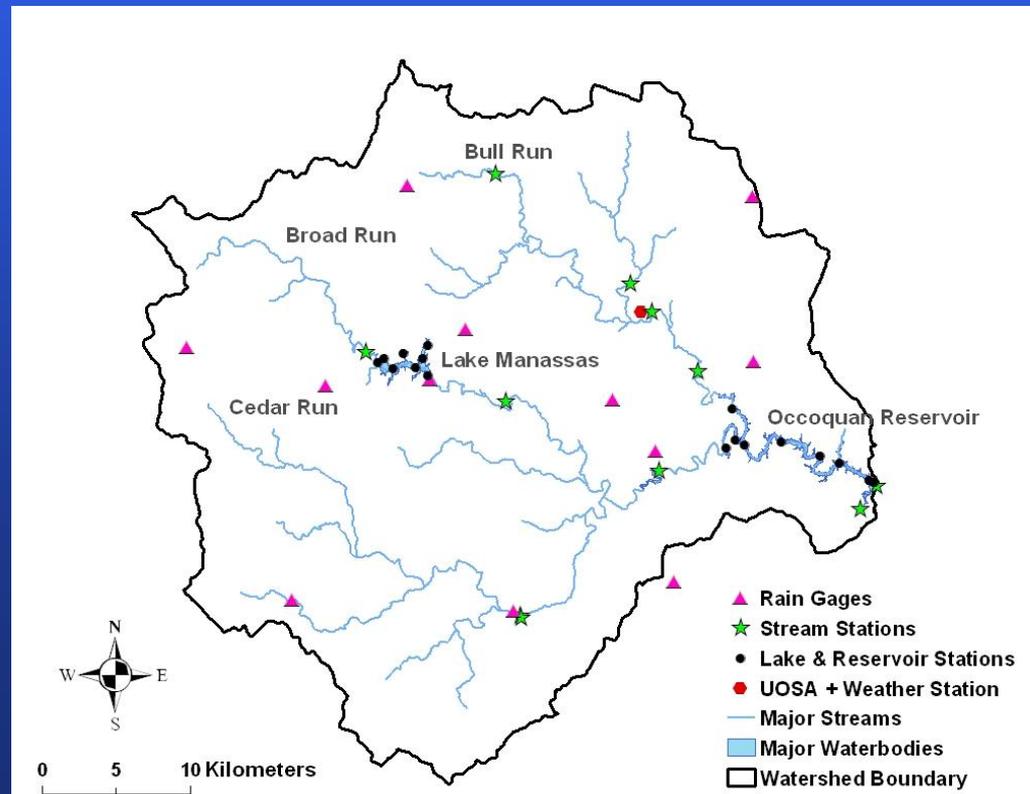
- Project Purpose:
 - Retrofit of a Wet Pond with Floating Treatment Wetlands

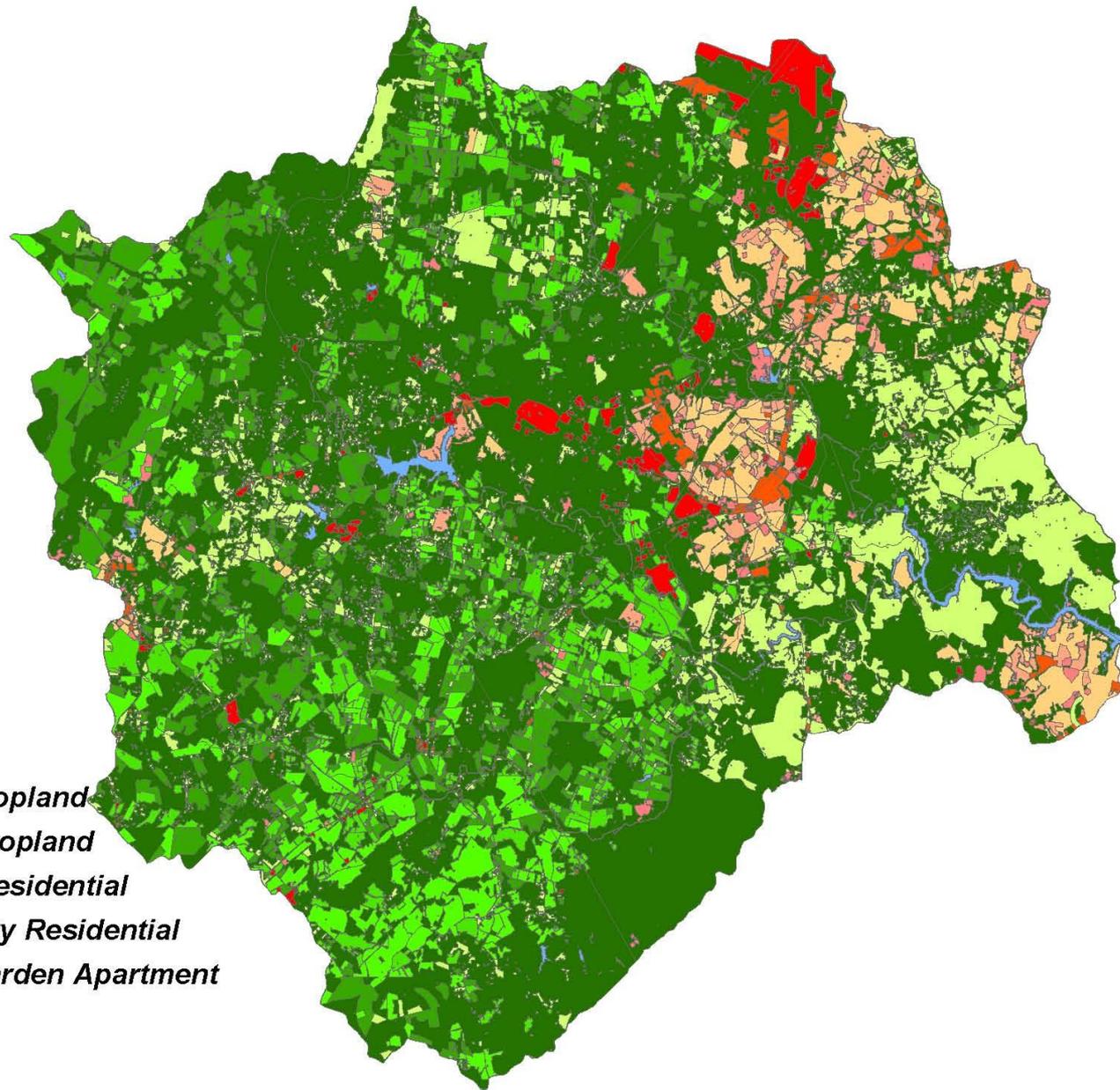


Pilot Experiment

Occoquan Model

- A linked hydrodynamic and water quality model for the Occoquan watershed, including Lake Manassas and the Occoquan Reservoir.
- Uses HSPF and CE-QUAL-W2 software.
- Yingmei Liu (PhD student)

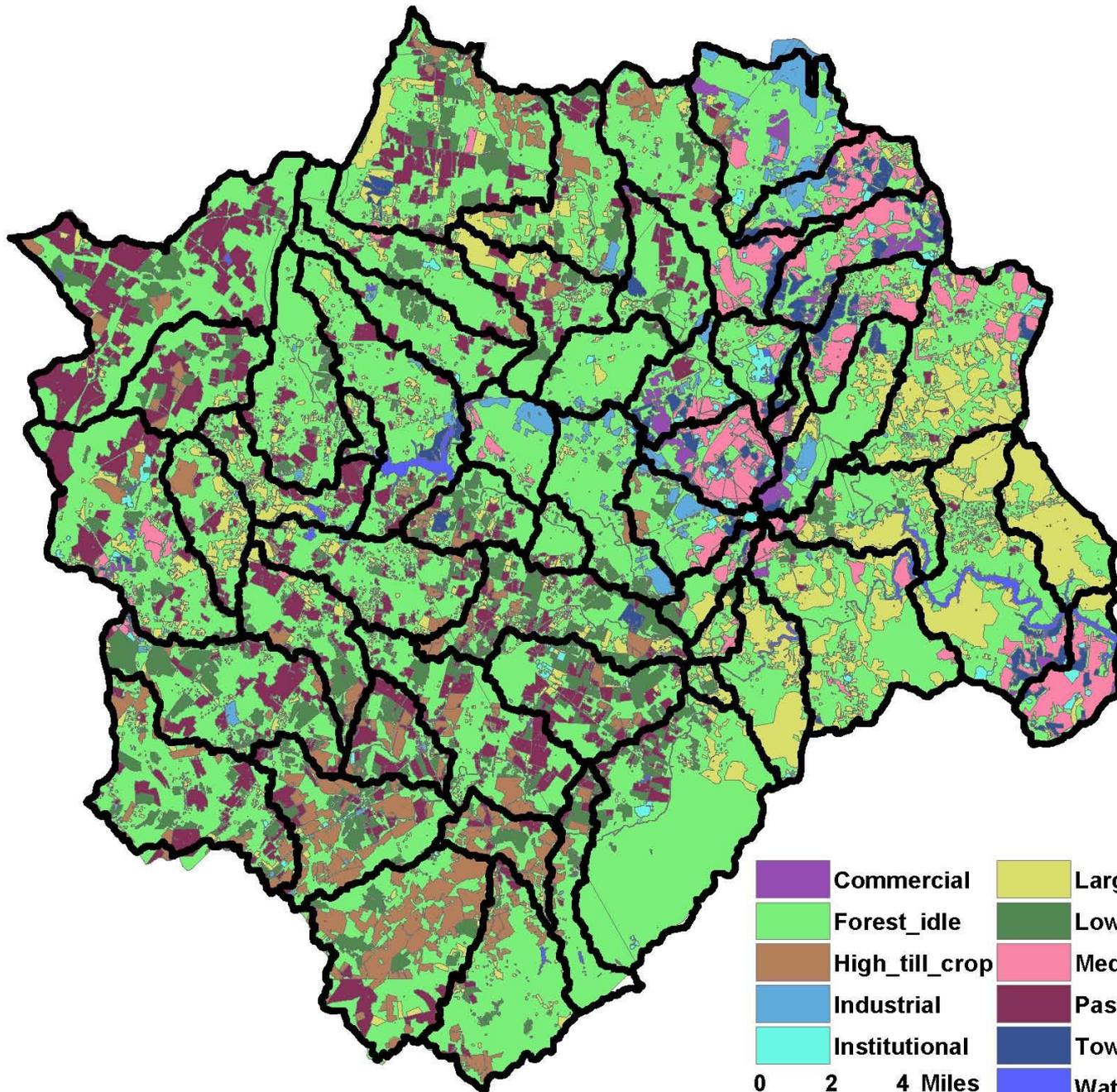




-  *Forest/Idle*
-  *Pasture*
-  *Low Tillage Cropland*
-  *High Tillage Cropland*
-  *Low Density Residential*
-  *Medium Density Residential*
-  *Townhouse/Garden Apartment*
-  *Institutional*
-  *Commercial*
-  *Industrial*
-  *Waterbodies*

0 5 10 Kilometers



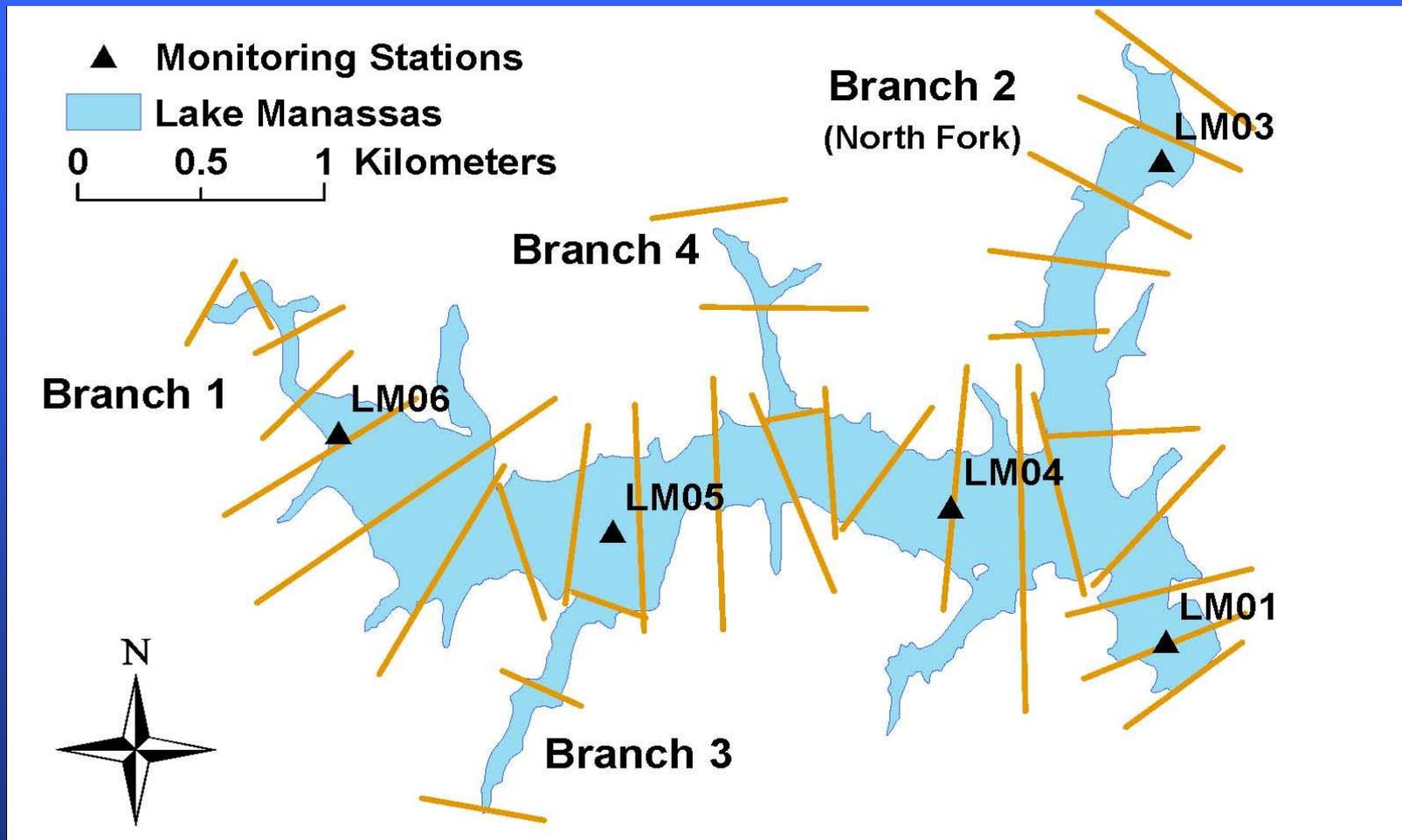


Lake Manassas, 1994



Source: USGS/MS Terraserver

Lake Manassas Segmentation



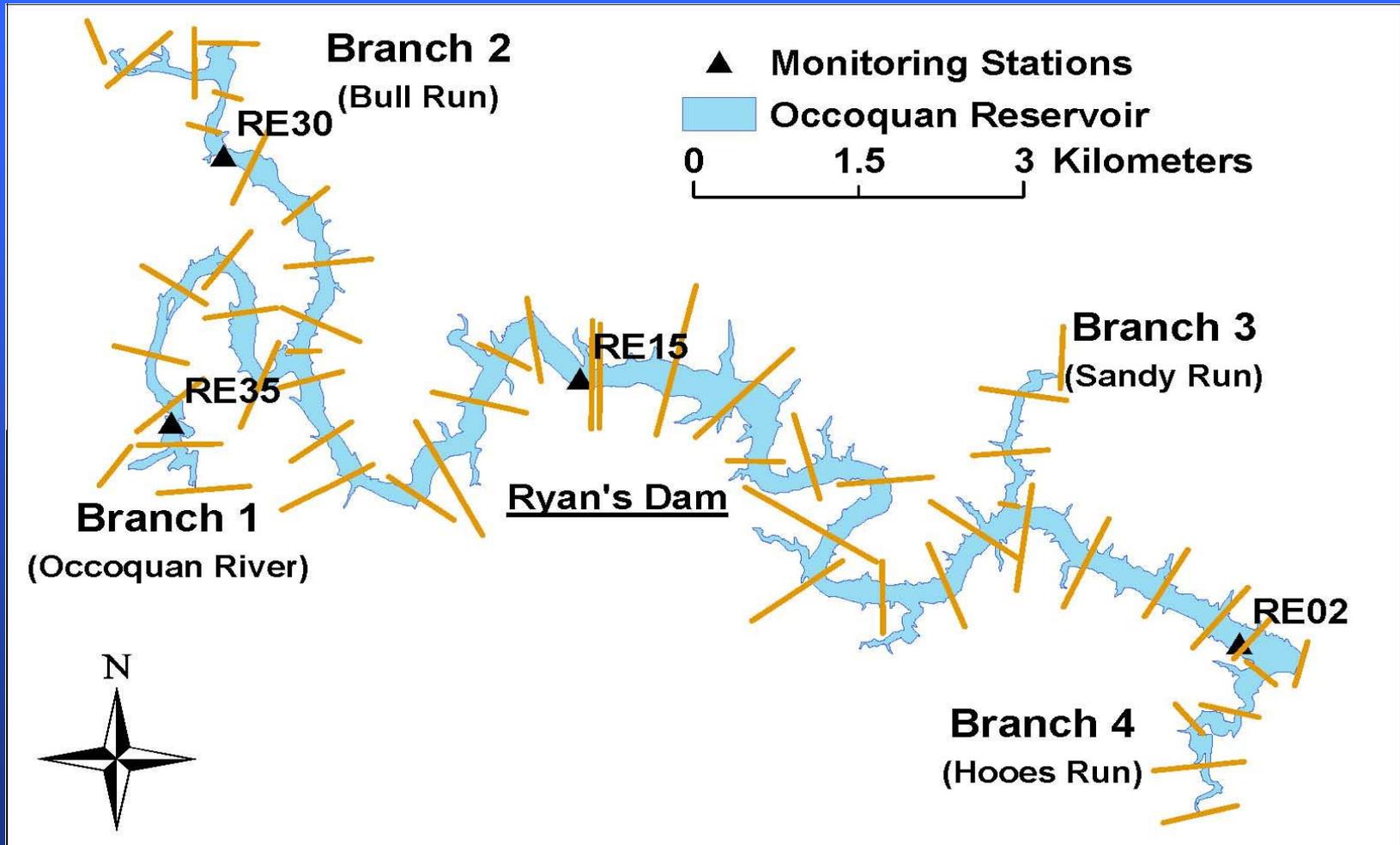
Number of segments: 29

Average Segment Length: 343 m

Occoquan Reservoir, 1994



Occoquan Reservoir Segmentation

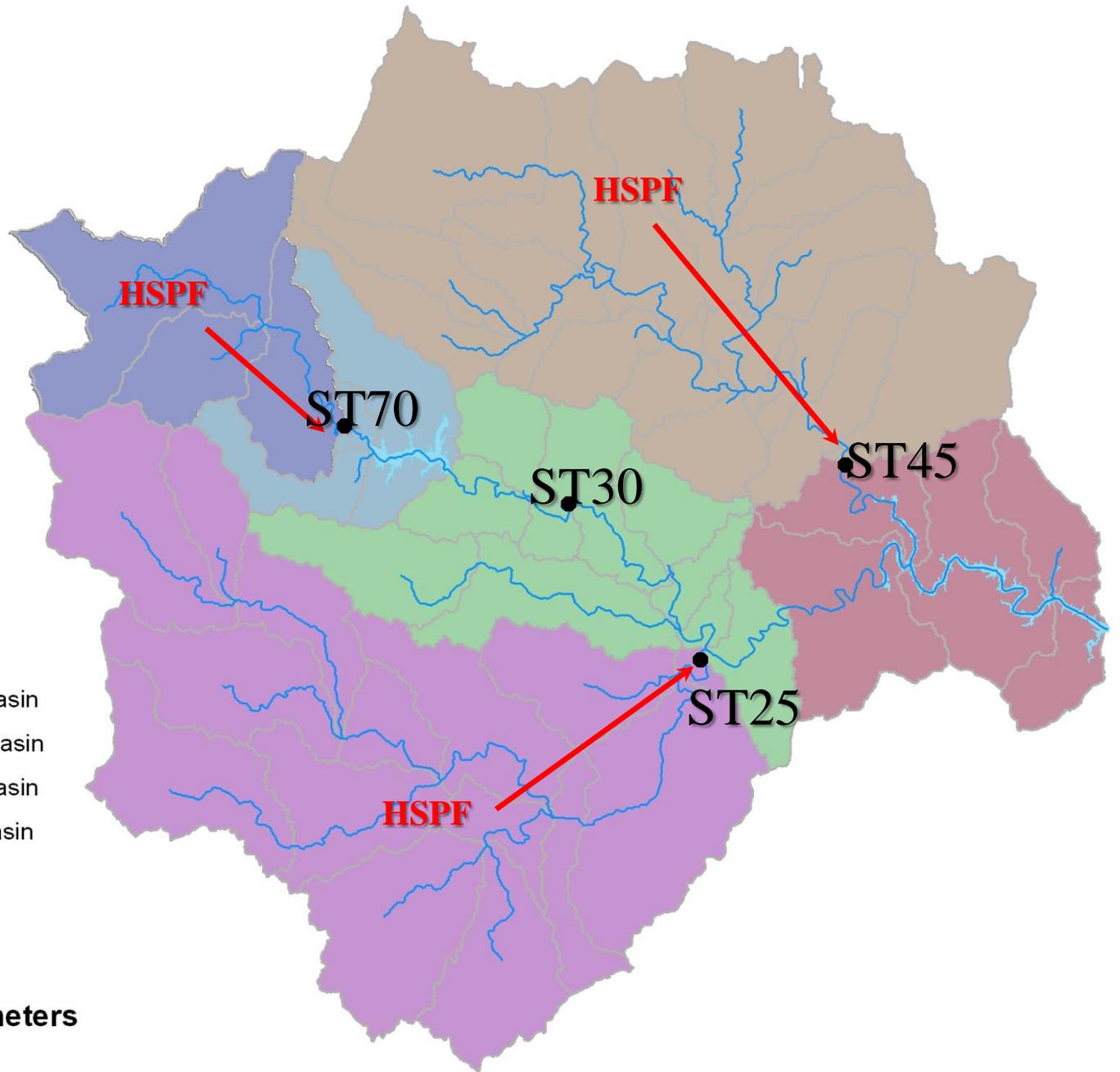


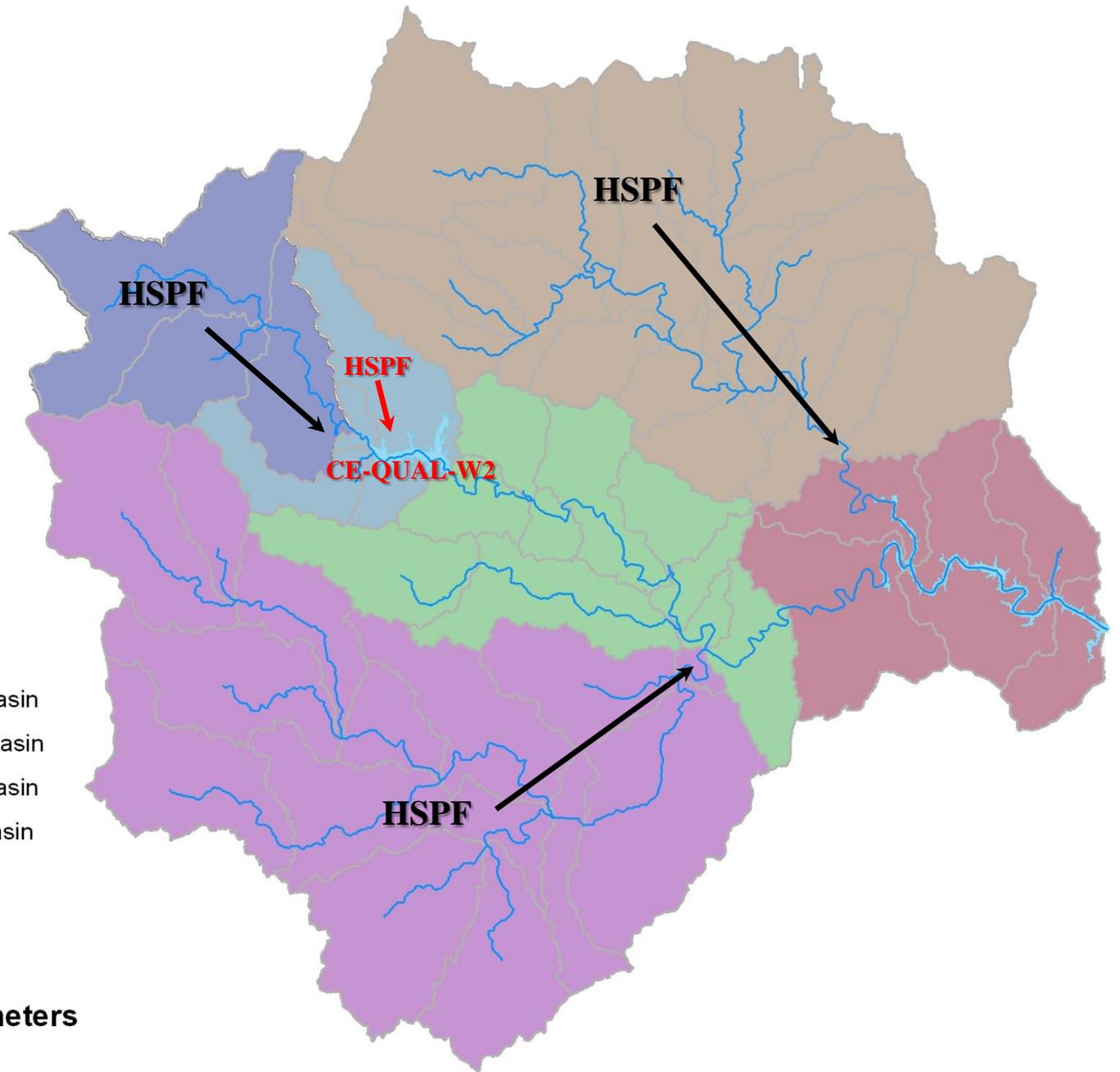
Number of segments: 69 Average Segment Length: 583 m

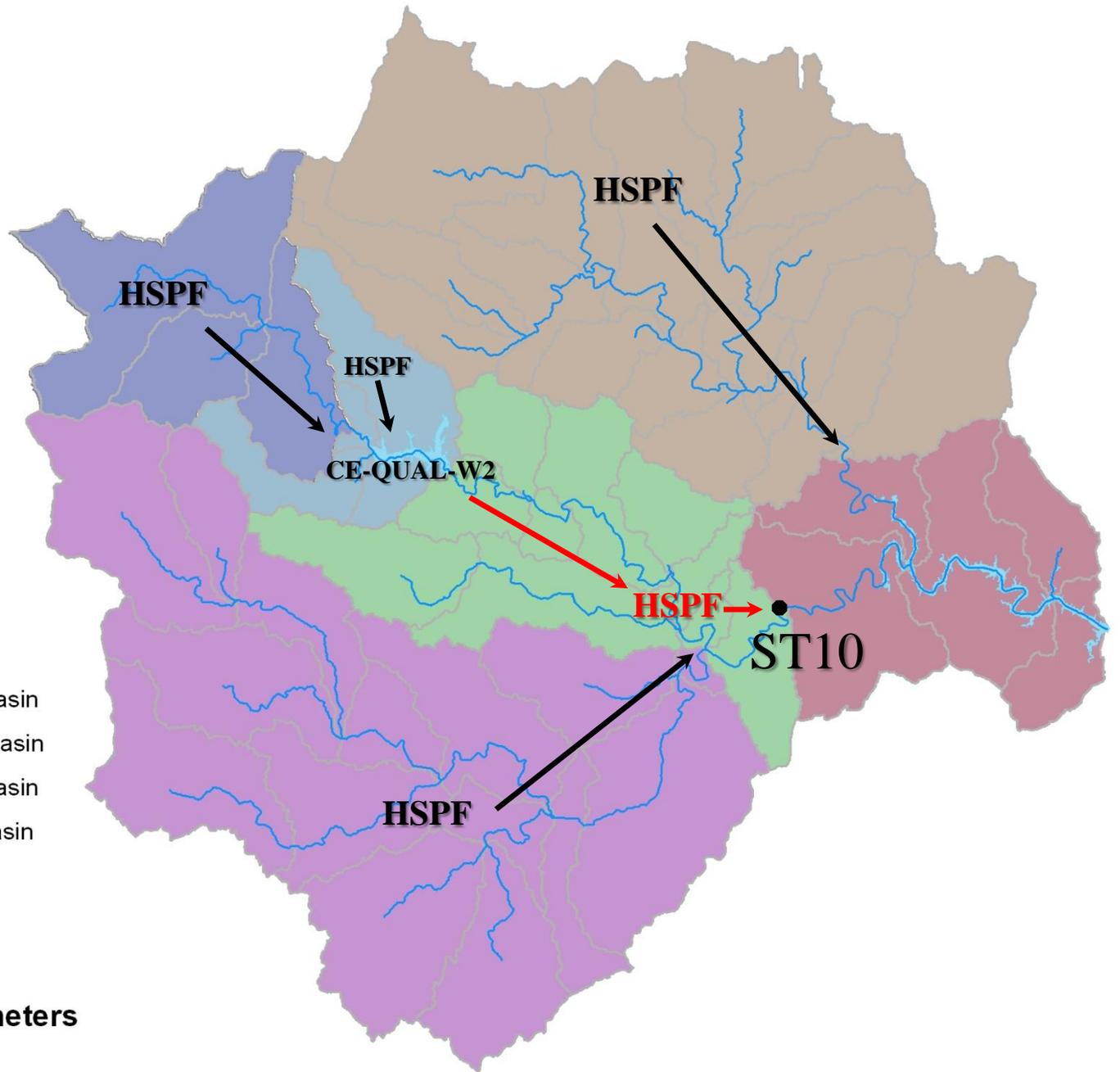


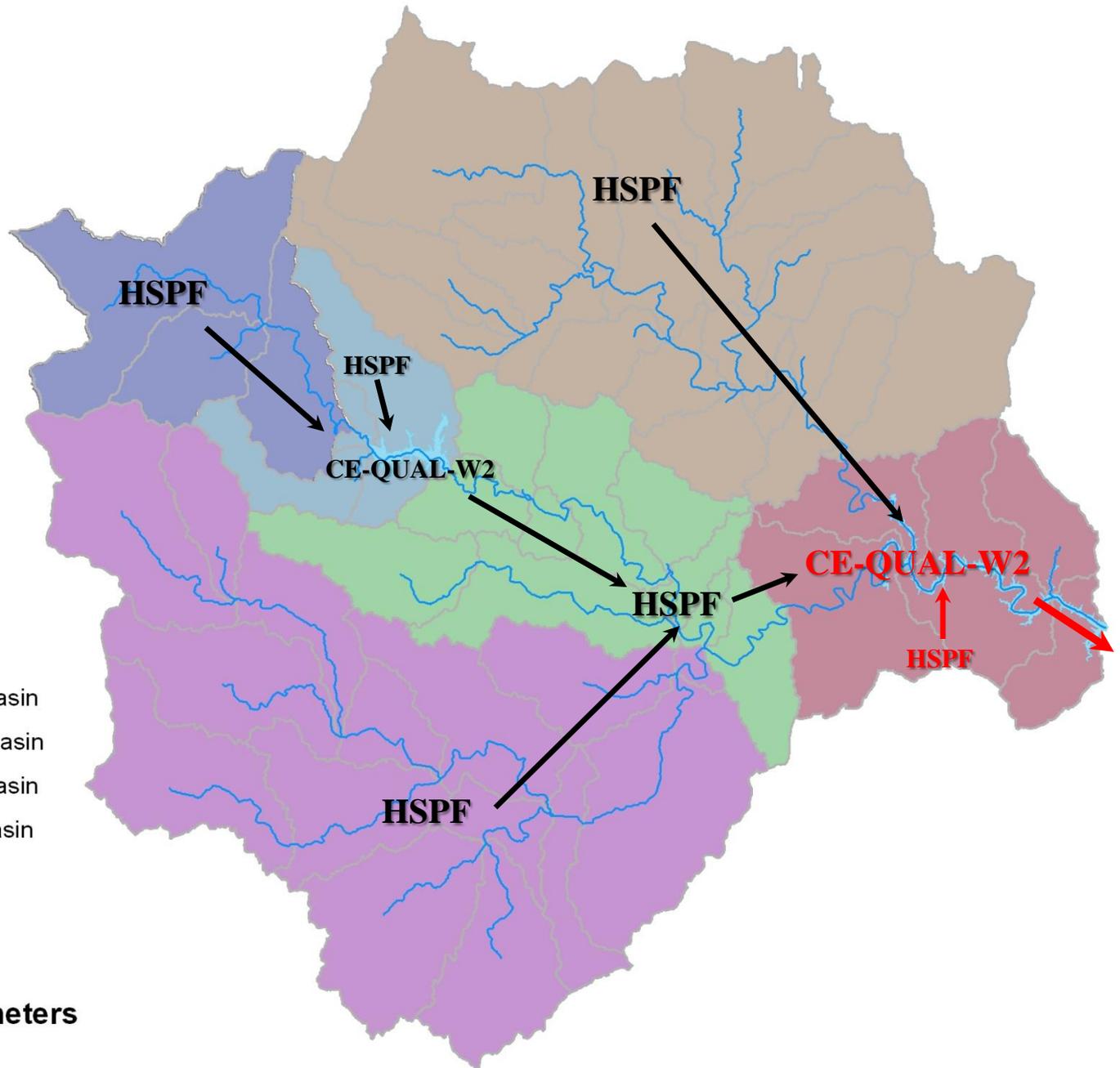
- Major Streams
- Major Waterbodies
- Watershed Segments
- Bull Run Subbasin
- Cedar Run Subbasin
- Lower Broad Run Subbasin
- Middle Broad Run Subbasin
- Upper Broad Run Subbasin
- Lower Occoquan Subbasin

0 5 10 Kilometers

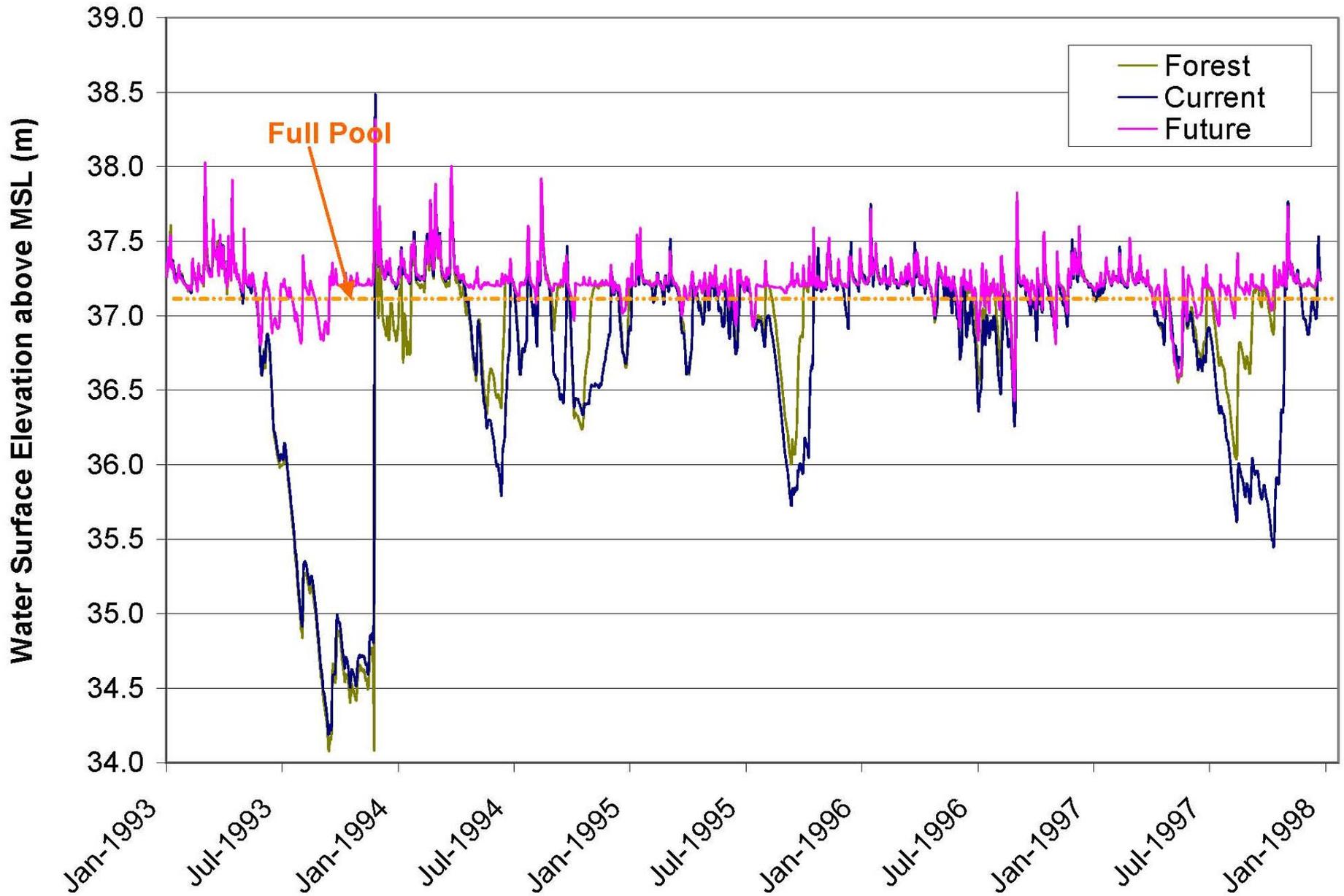




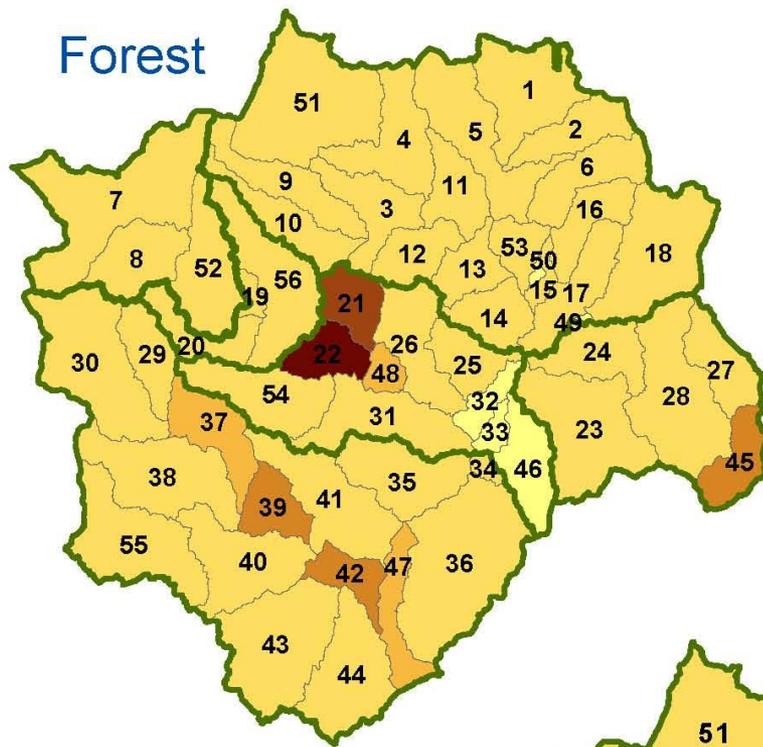




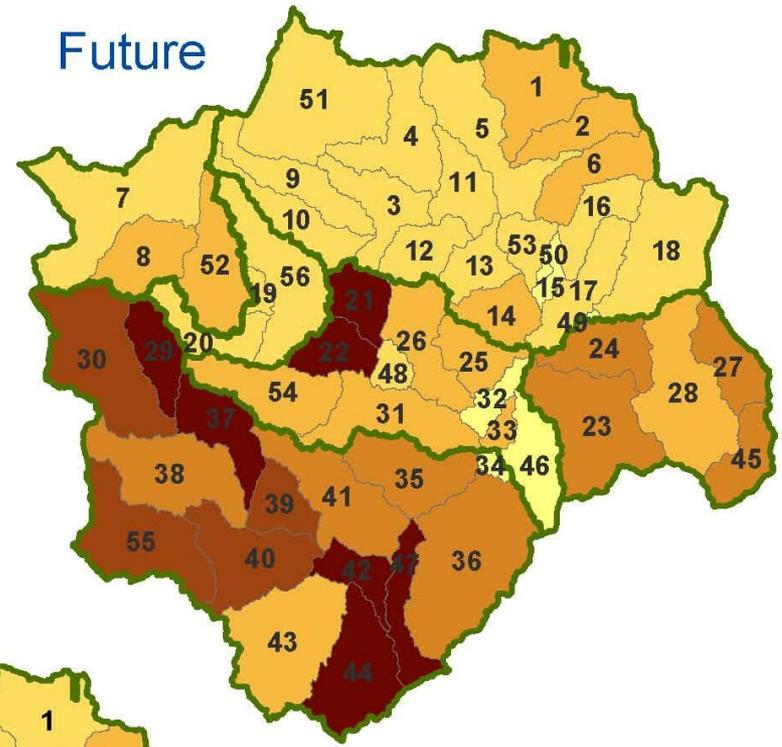
Water Surface Elevation at the Occoquan Reservoir Dam



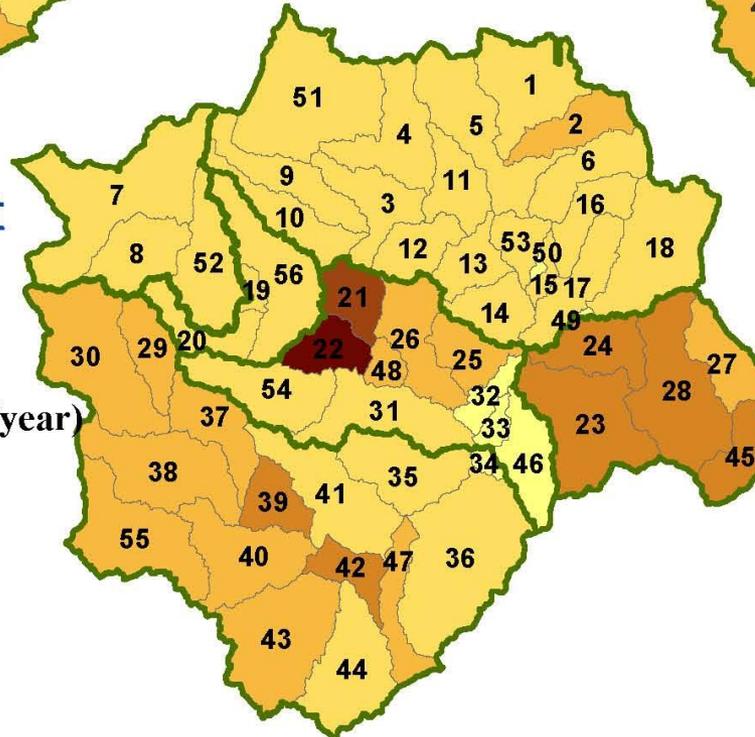
Forest



Future



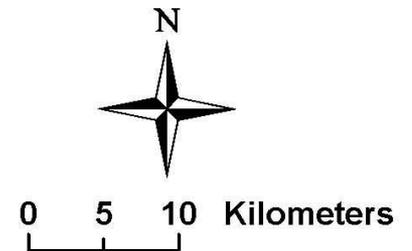
Current



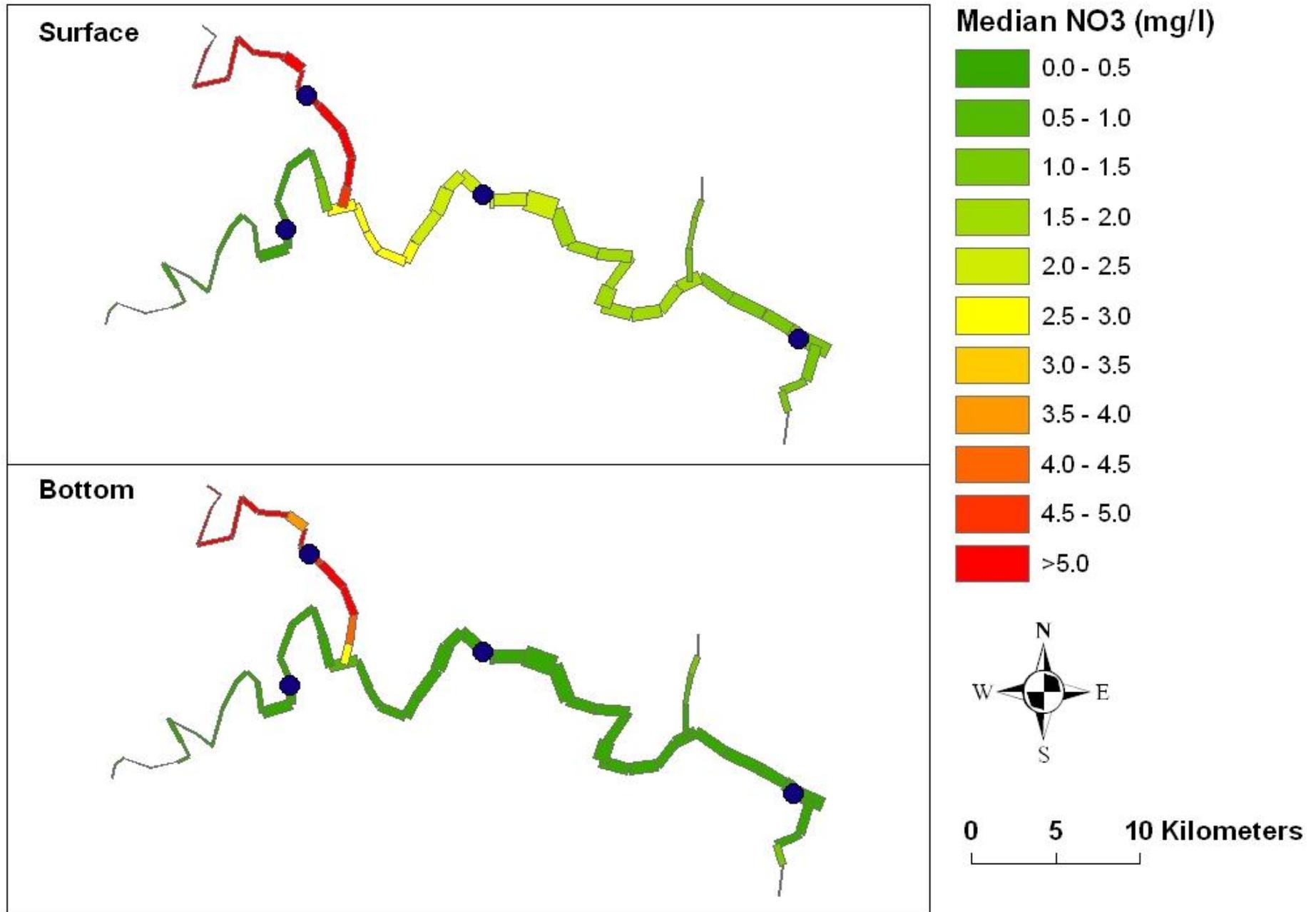
NH₄-N Yield (kg/square km/year)

-  < 0.0
-  0.0 - 20.0
-  20.0 - 40.0
-  40.0 - 60.0
-  60.0 - 80.0
-  > 80.0

 Subbasin Boundary

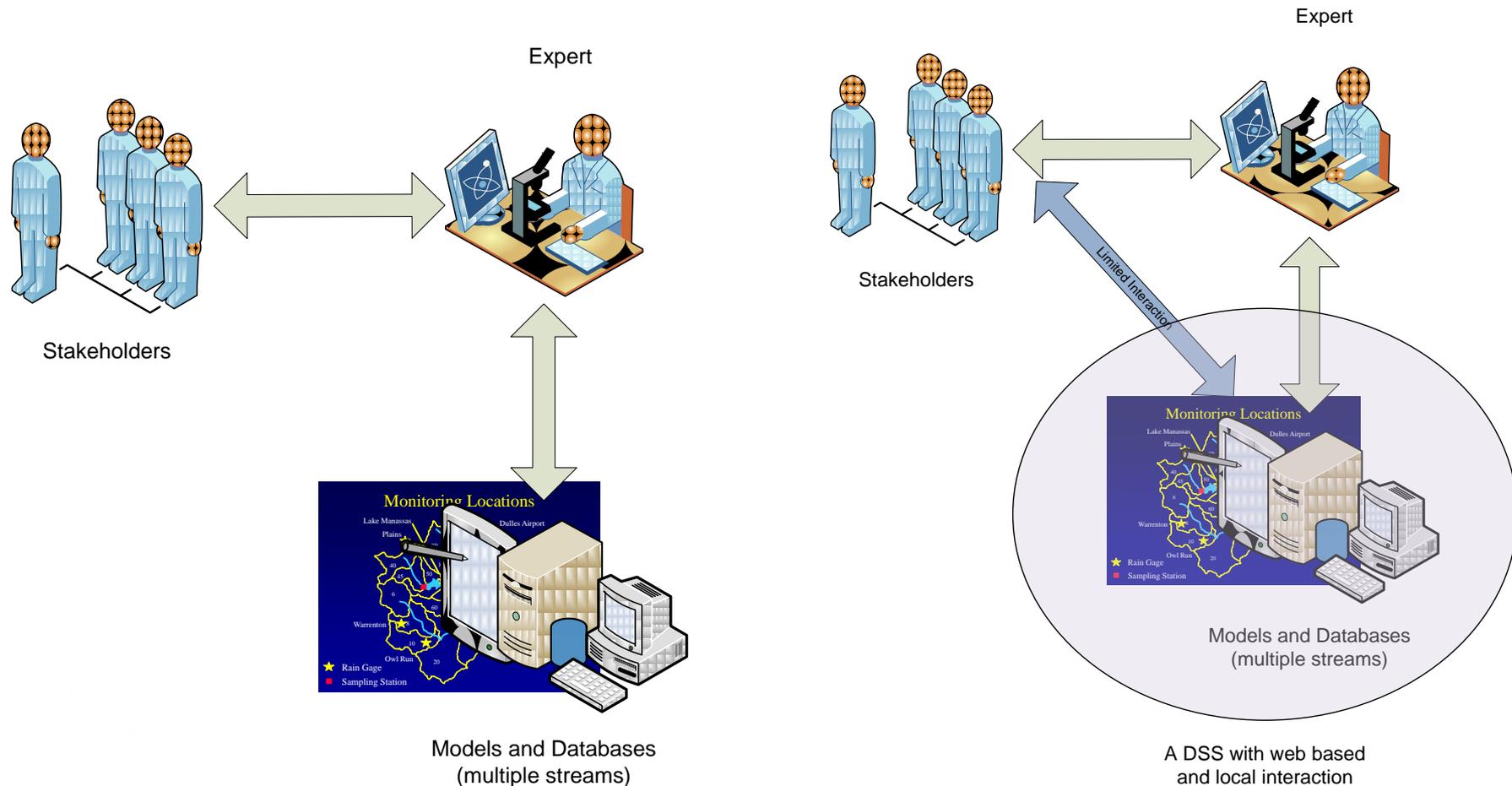


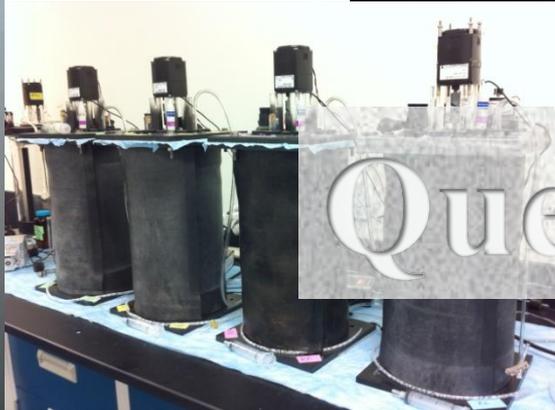
Nitrate-N Median in Occoquan Reservoir 1998-2001



Environmental Decision Support system

- Created by Saurav Kumar (PhD student)





Questions?