

SCIENCE IN TOTAL MAXIMUM DAILY LOAD STUDIES FOR LAKES: MYTH OR REALITY?

Alena Bartosova
Amy Russell
James Slowikowski

April 10, 2014

ACKNOWLEDGMENTS

- Illinois Environmental Protection Agency
 - Trevor Sample
- ISWS Field Crew & Data Crew
 - Kip Stevenson
 - Jennifer Hill
 - Mark Brazones
 - Ryan Whittaker
 - Mike Machesky
 - Will Hurley
 - Kris Kite
 - and others ...



WHAT IS TMDL

■ TMDL

- A numerical value: a maximum amount of a pollutant that can be received by a water body without violating water quality standards and designated uses
- The process of establishing the value
- The program that drives the process

■ Section 303(d) of Clean Water Act

- State develops a prioritized list of impaired waters

Table C-38. Statewide Individual Use-Support Summary for Freshwater Lakes, 2014

Designated Use	Statewide Acres Designated ⁽¹⁾	Acres Assessed	Acres Fully Supporting (Good)	Acres Not Supporting (Fair)	Acres Not Supporting (Poor)	Acres Not Assessed	Acres as Insufficient Information
Aesthetic Quality	316,877	144,226	15,309	118,802	10,115	165,902	6,749
Aquatic Life	316,877	144,244	132,956	11,270	18	165,884	6,749
Fish Consumption	318,477	93,102	6,840	85,668	594	225,375	0
Indigenous Aquatic Life	1,600	1,600	1,600	0	0	0	0
Primary Contact	316,877	1,814	1,092	722	0	315,063	0
Public and Food Processing Water Supply	75,402	74,869	45,802	29,067	0	173	0
Secondary Contact	318,477	1,092	1,092	0	0	317,385	0
Designated Use	Acres Assessed	Percent of Statewide Acres Assessed	Percent of Assessed Acres as Fully Supporting (Good)	Percent of Assessed Acres as Not Supporting (Fair)	Percent of Assessed Acres as Not Supporting (Poor)	Percent of Statewide Acres Not Assessed	Percent of Statewide Acres as Insufficient Information
Aesthetic Quality	144,226	45.5	10.6	82.4	7.0	52.4	2.1
Aquatic Life	144,205	45.5	92.2	7.8	0.0	52.4	2.1
Fish Consumption	92,898	29.2	7.4	92.0	0.6	70.8	0.0
Indigenous Aquatic Life	1,600	100	100	0.0	0.0	0.0	0.0
Primary Contact	1,814	0.6	60.2	39.8	0.0	99.4	0.0
Public and Food Processing Water Supply	74,869	99.8	61.2	38.8	0.0	0.2	0.0
Secondary Contact	1,092	0.3	100	0.0	0.0	99.7	0.0

Table C-39. Statewide Summary of Potential Causes of All Use Impairments in Freshwater Lakes, 2014

Potential Cause of Impairment	Acres Impaired
Total Suspended Solids (TSS)	113,330
Phosphorus (Total)	107,648
Mercury	78,337
Aquatic Algae	75,111
Aquatic Plants (Macrophytes)	31,134
Manganese	27,776
Polychlorinated biphenyls	25,859
Cause Unknown	9,669
Oxygen, Dissolved	6,575

IEPA'S 2014 INTEGRATED WATER QUALITY REPORT AND SECTION 303D LIST

<http://www.epa.state.il.us/water/tmdl/303-appendix/2014/iwq-report-surface-water.pdf>

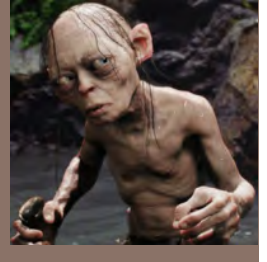
TMDL STAGES

- Stage 1: Watershed characterization
 - Collect existing data
 - Data analyses
 - Develop methodology
- Stage 2: Additional monitoring
 - As needed
- Stage 3: TMDL determination
 - Develop simulation models
 - Determine maximum loads for individual sources

$TMDL = WLA + LA + MOS + RC$

 - Implementation plan

MY PRECIOUS DATA

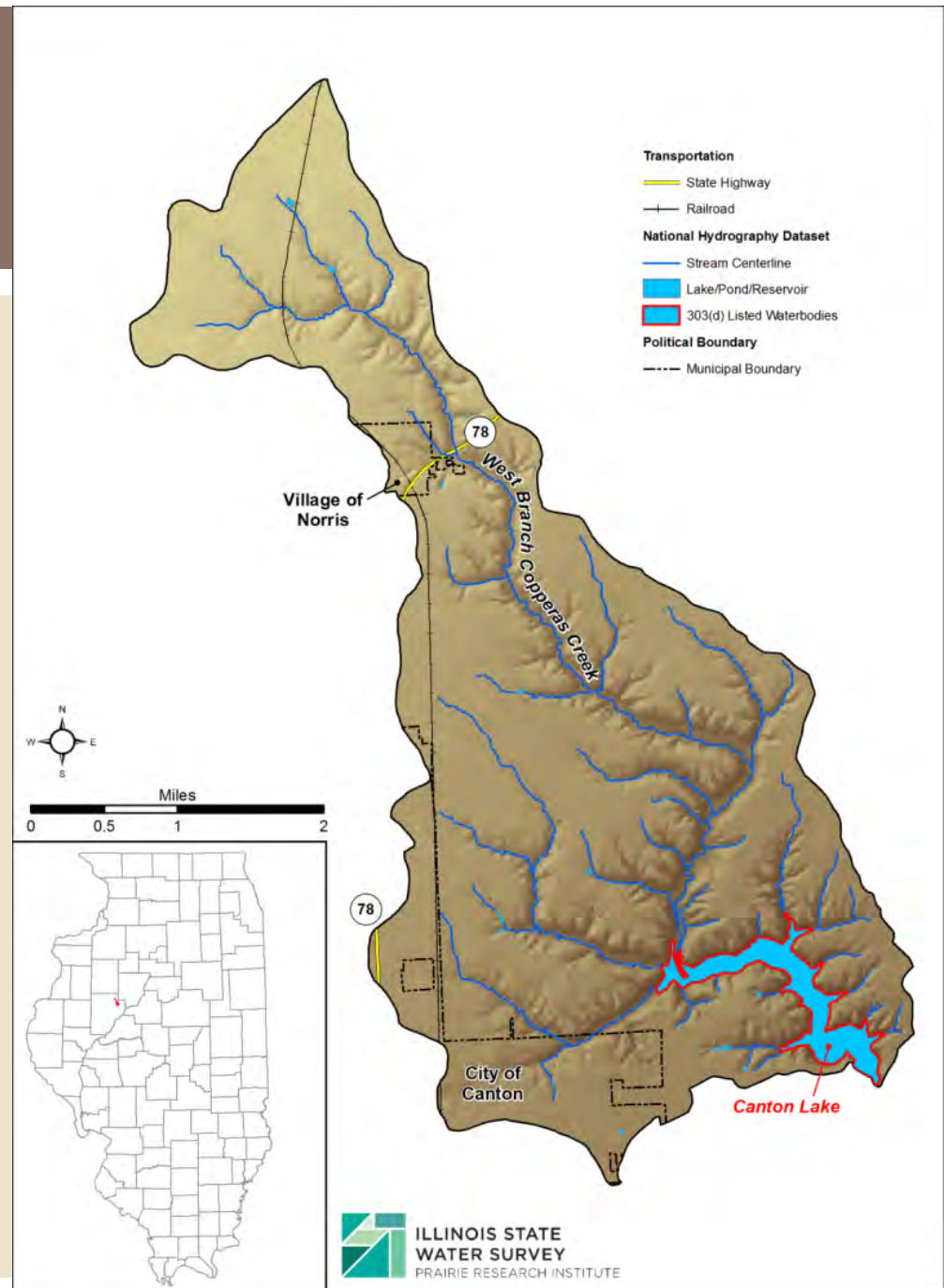


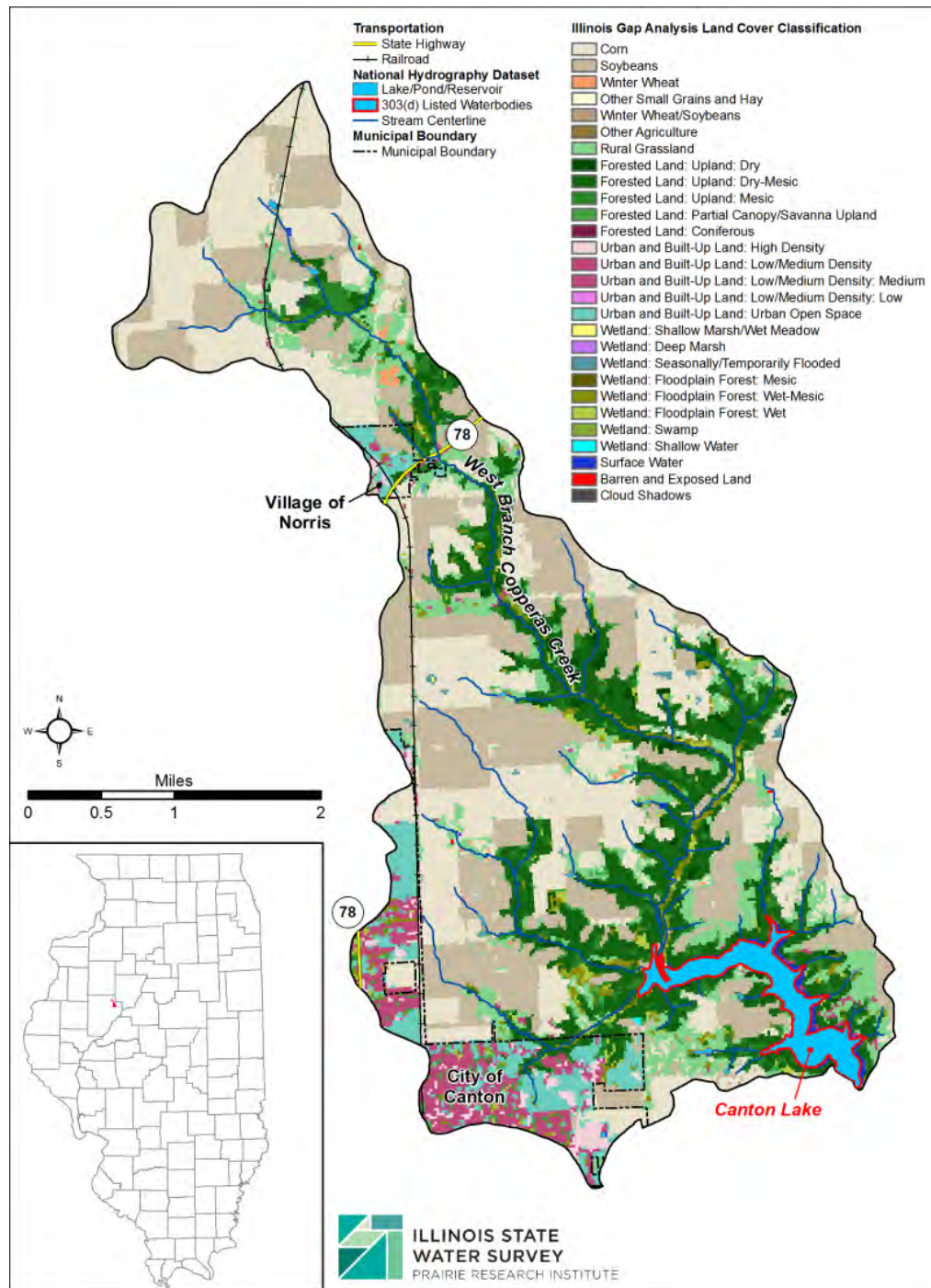
- Period of record
- Consistency/frequency
- Type of data
 - Assessed constituent vs. Supporting constituents
- Purpose
 - Assess lake impairment vs. Quantify loads from individual sources

IMPAIRED WATERBODY

- Canton Lake
 - Constructed in 1939
 - Drainage Area = 15 mi²
 - Surface Area = 230 acres

Water body	Impaired use	Causes of Impairment, 2008
Canton Lake	Public Water Supply	Manganese Total Dissolved Solids
	Aesthetic Quality	Total Phosphorus Total Suspended Solids
	Fish Consumption	Mercury





WATERSHED LAND USE

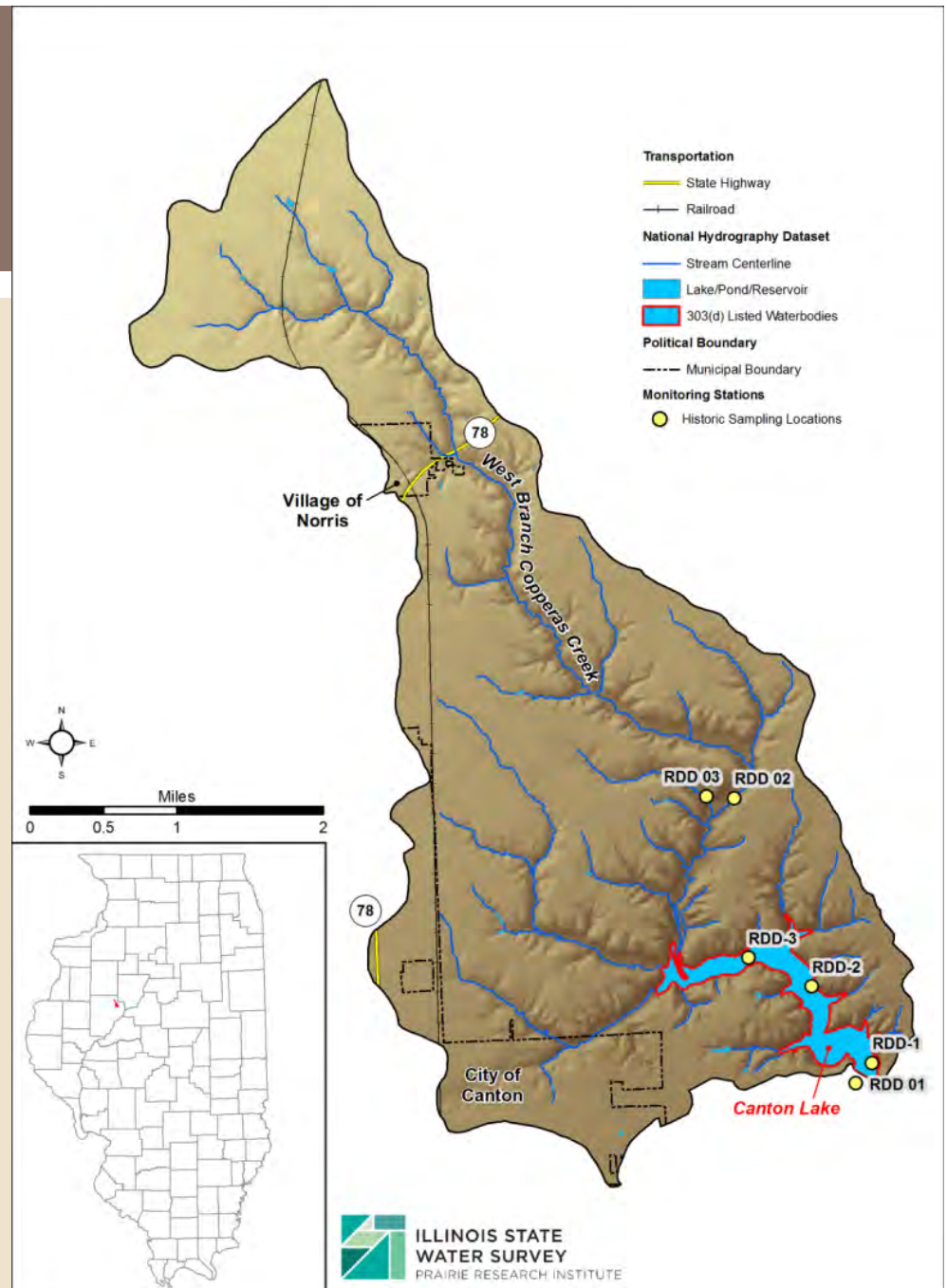
CANTON LAKE WATERSHED

- Agricultural Land 64%
- Forested Land 21%
- Urban 9%
- Wetland 3%
- Other 3%



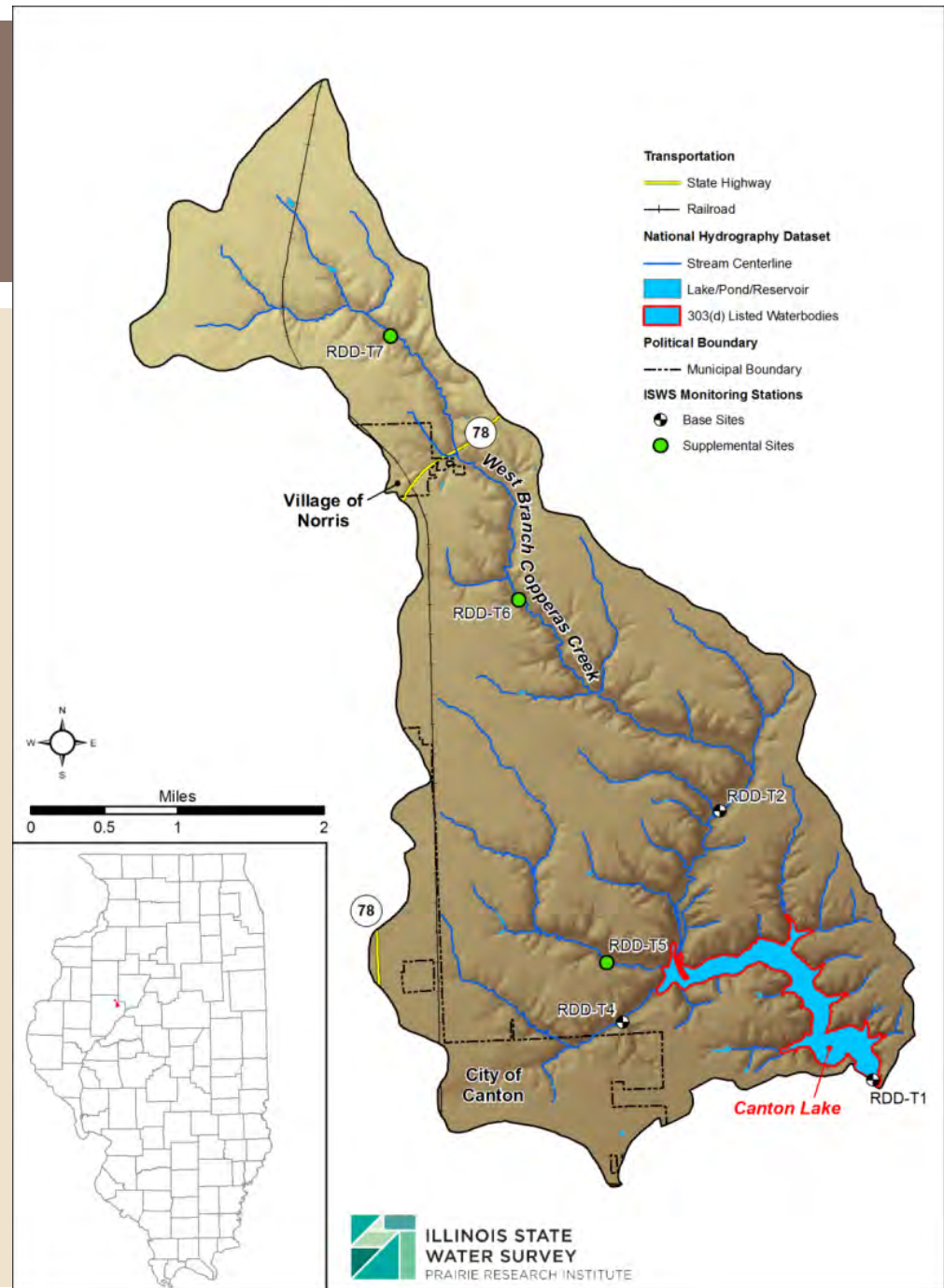
HISTORICAL WATER QUALITY

- 3 Canton Lake sites
 - TP, TSS, VSS, Mn, SpCond, TDS (spillway site only)
 - Selected years 1977-2011
 - IEPA monitoring efforts
 - ALMP
 - VLMP
 - Illinois Clean Lakes Program
 - ISWS study (Roseboom et al., 1979)
- 3 stream sites
 - TP, TSS, VSS, SpCond
 - Collected in 1992
 - Illinois Clean Lakes Program

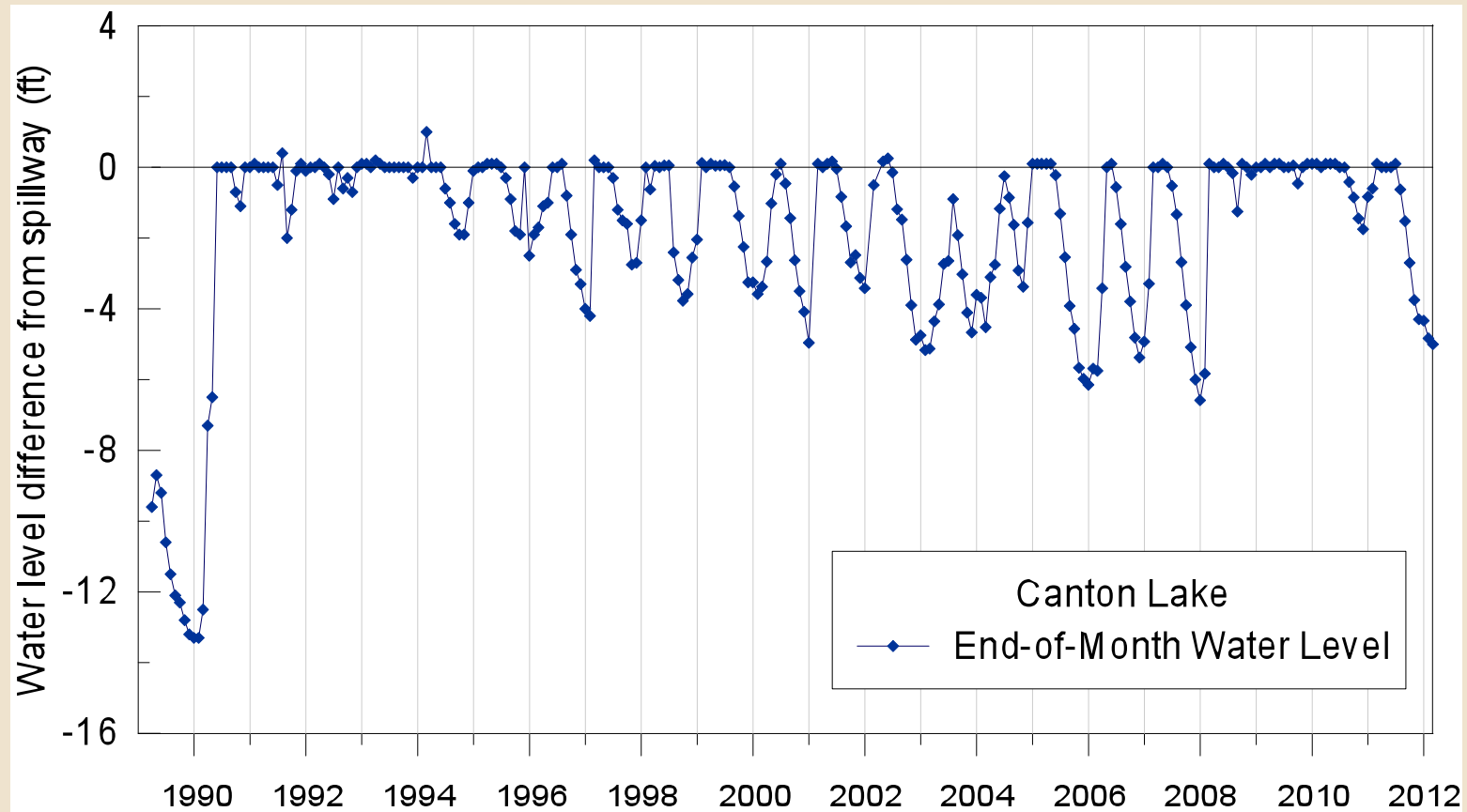


PROJECT MONITORING

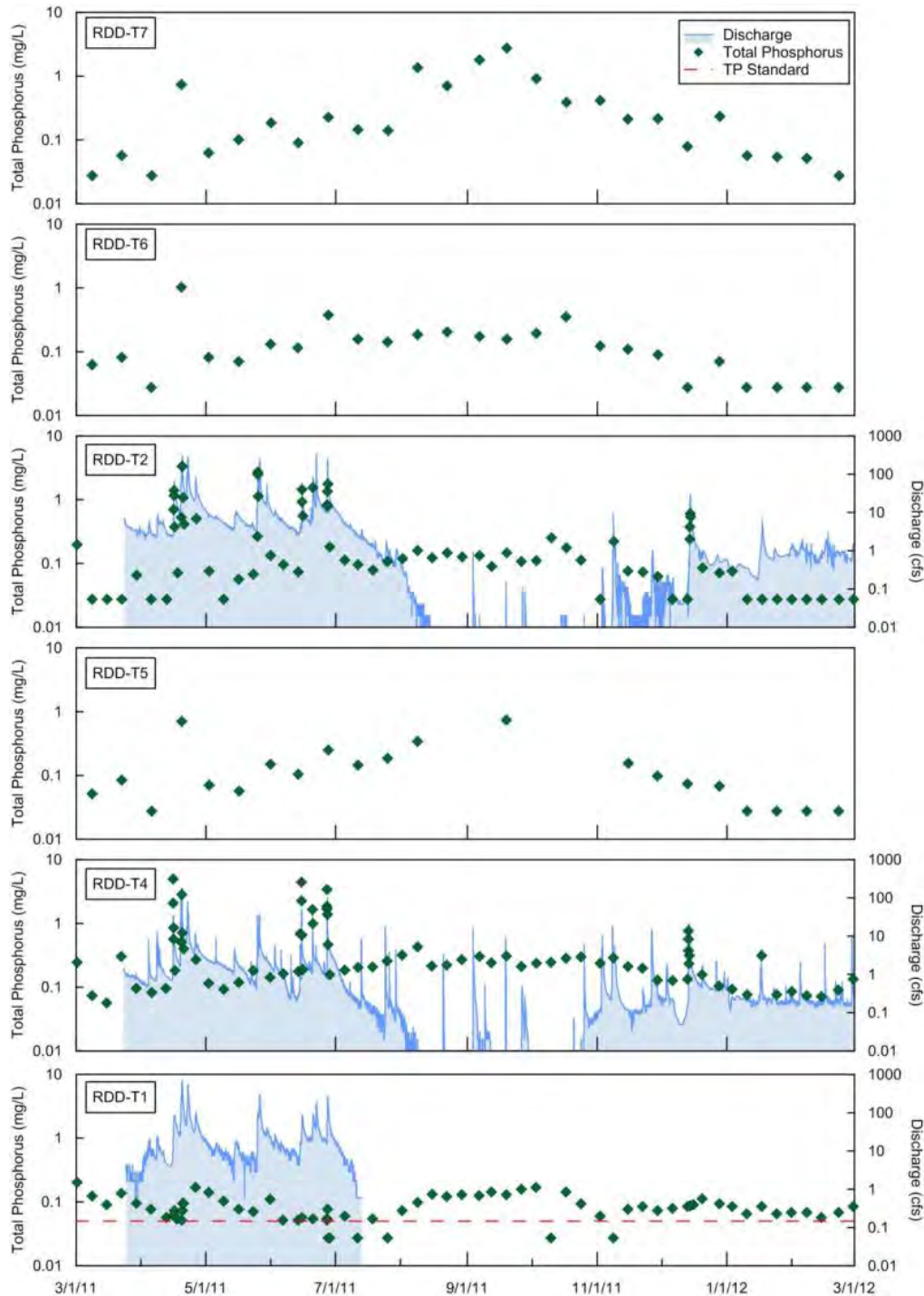
- Streamflow Monitoring
 - Three gaged (base) sites
 - Three supplemental sites
- Water Quality Monitoring
 - Six monitoring sites
 - Five tributary sites
 - One lake site
 - TP, TSS, VSS, Mn, TDS
 - March 2011 – October 2012



CANTON LAKE – HISTORICAL LEVELS

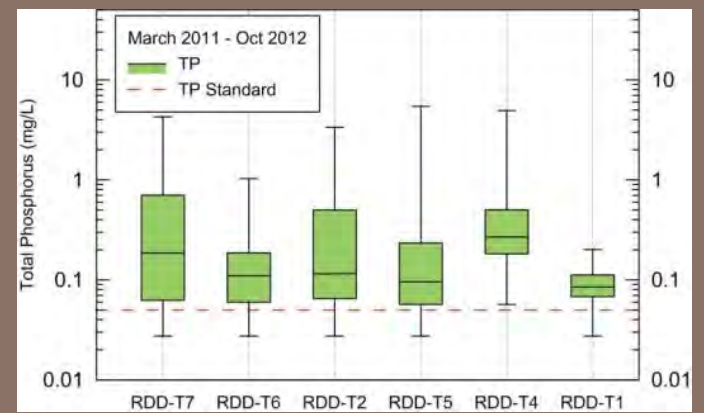


- The lake stopped spilling on July 13, 2011
- Lake Evaporation accounted for ~30% of Summer Outflows



TOTAL PHOSPHORUS – YEAR 1 PROJECT RESULTS

High Total Phosphorus (TP) concentrations increased with flows at tributary sites.



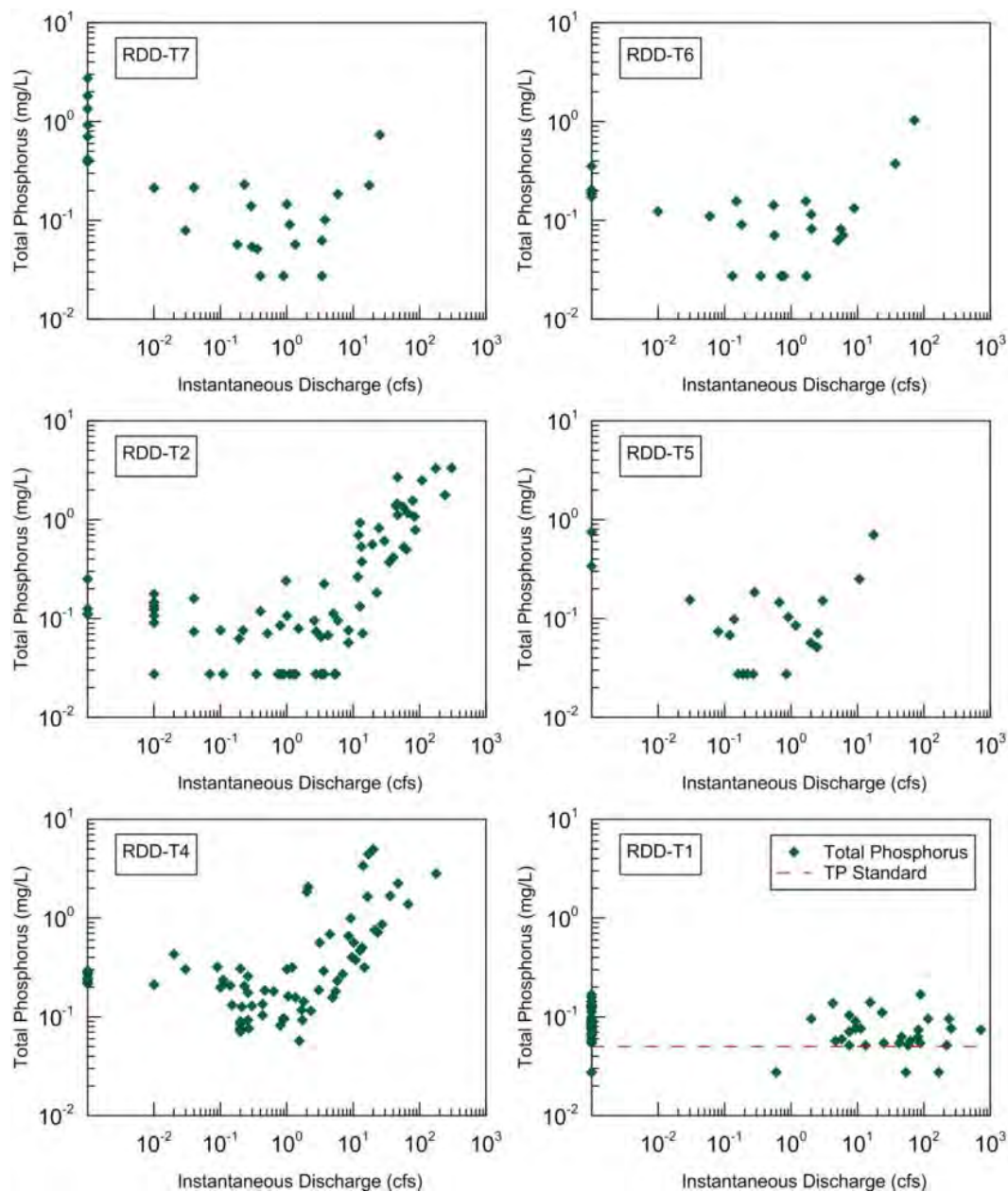
CANTON LAKE WATERSHED FLOW CONDITIONS – YEAR 1



4/1/2011



4/19/2011



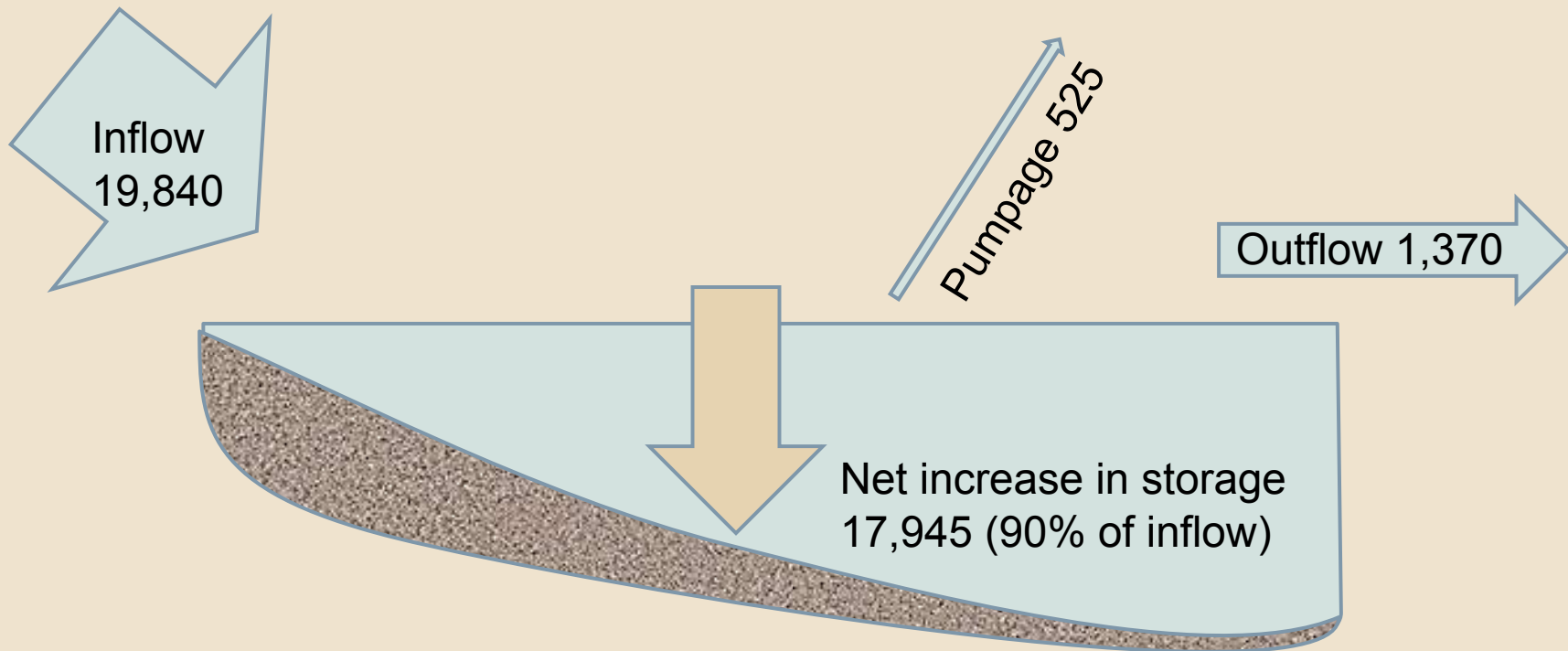
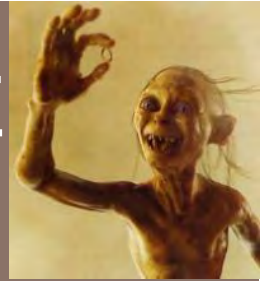
TOTAL PHOSPHORUS – CHANGES WITH FLOW

TP increases with flow for tributaries

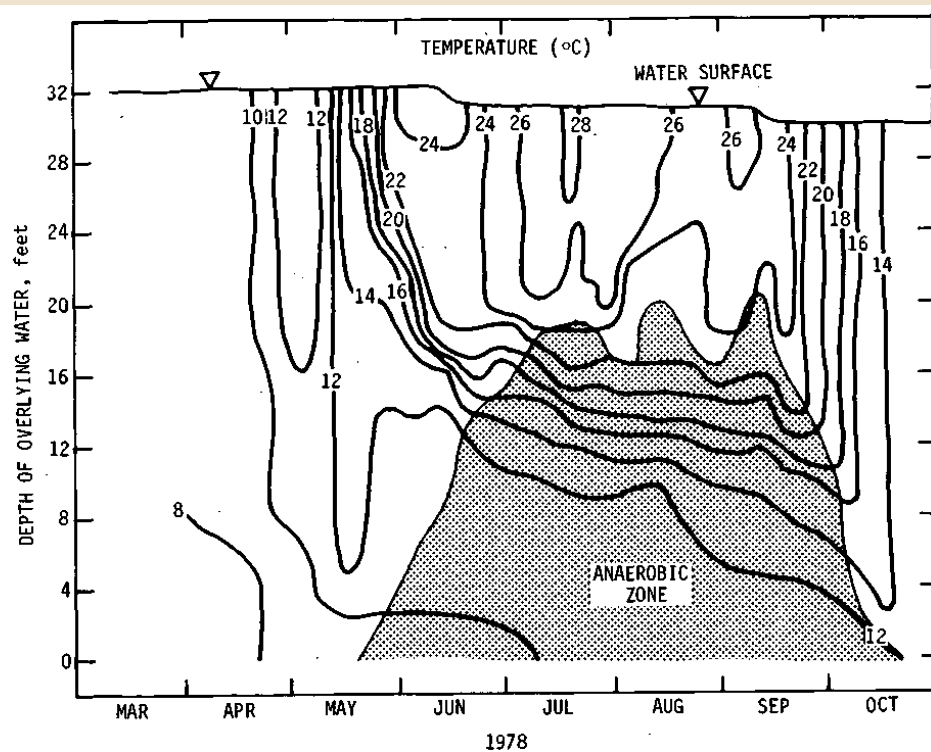
TP concentrations do not appear to be correlated to flow at the spillway site.

STORM MONITORING IS ESSENTIAL

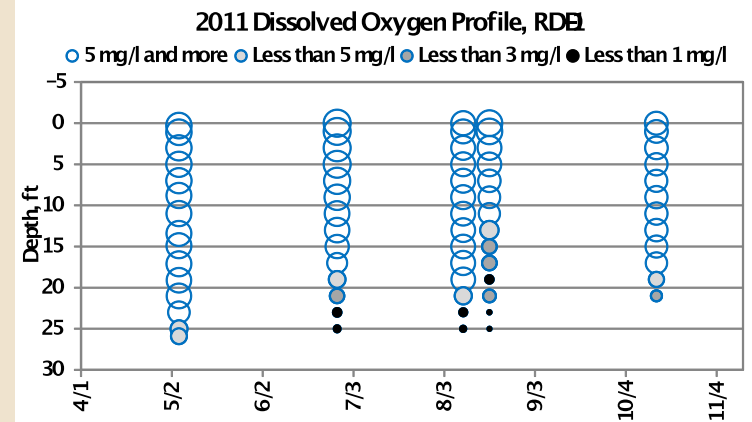
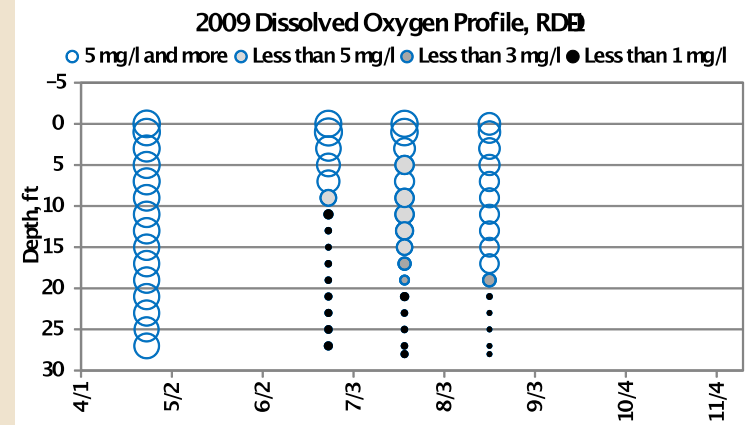
YEAR 1 PHOSPHORUS BALANCE (LBS/YR)



ANAEROBIC CONDITIONS IN SUMMER



Isothermal plots for Canton Lake (Roseboom et al., 1979)



IN-LAKE DATA

■ In-Lake Sampling

■ August 2012

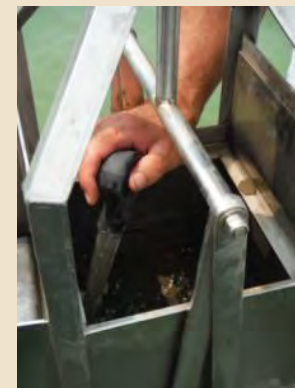
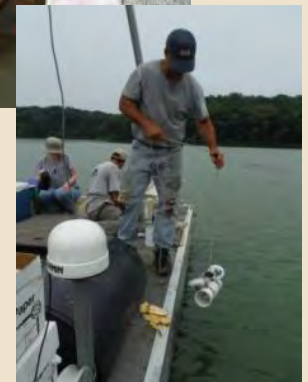
- Water quality samples at 3 depths
- Mn, TDS, TSS, VSS, TP

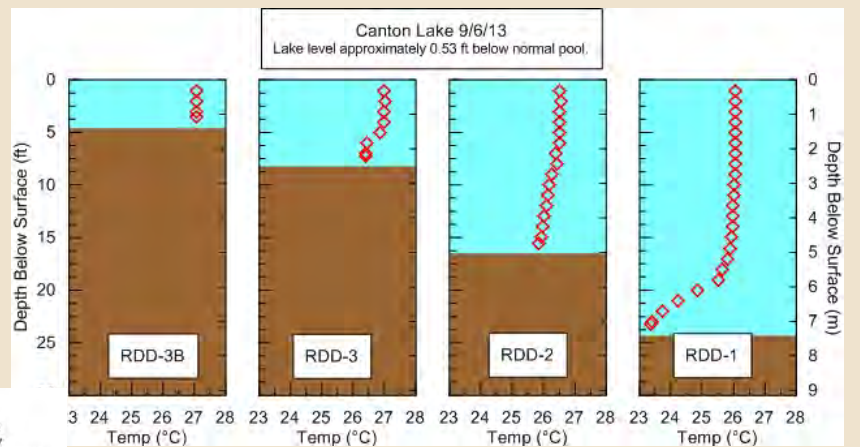
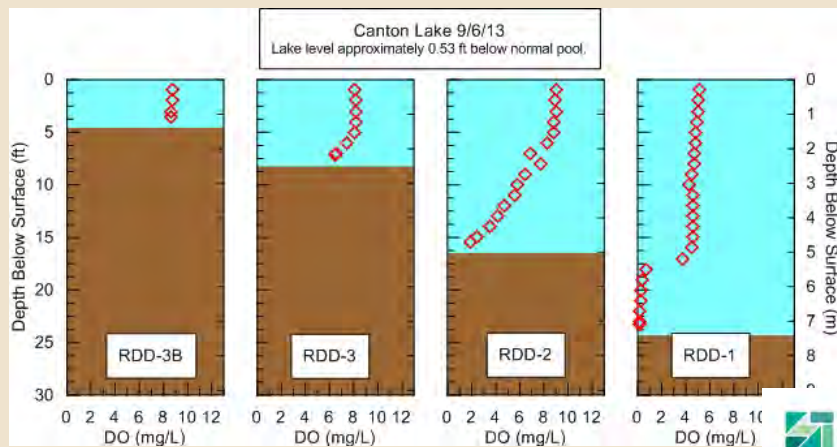
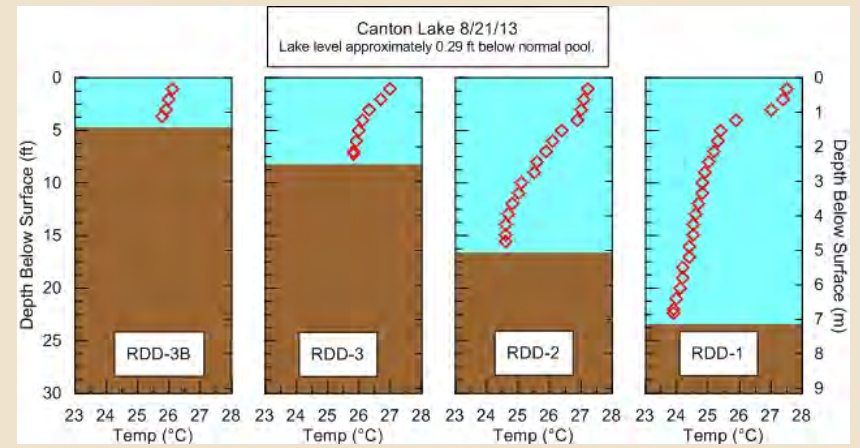
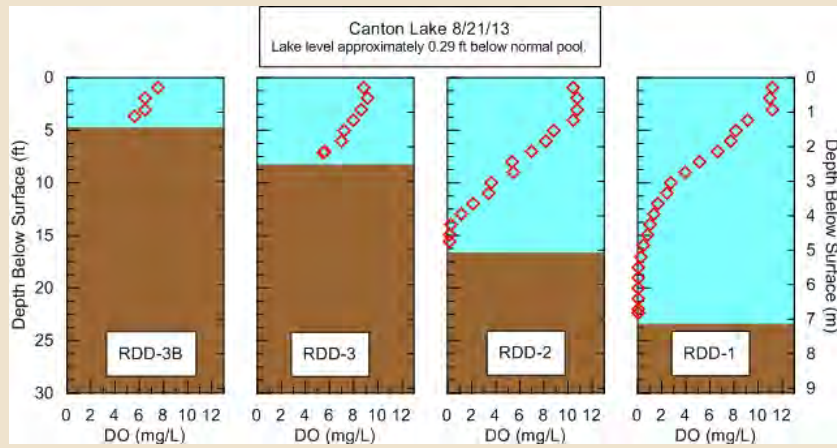
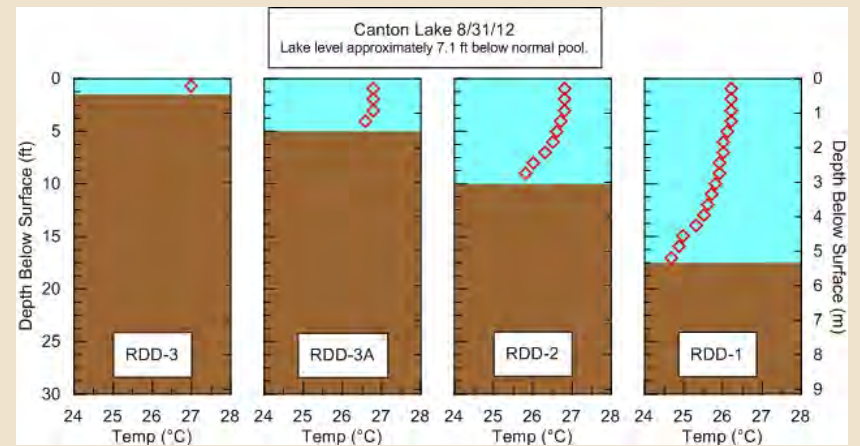
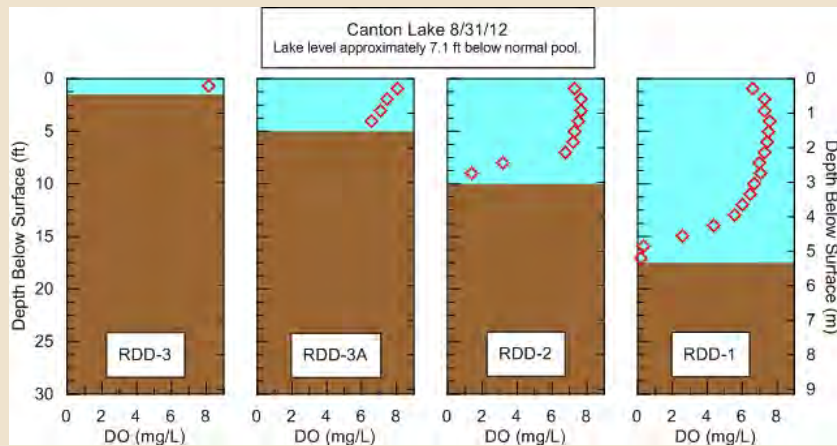
■ August 2013

- Lake water quality profiles (1 ft increment)
- Sediment pore water quality
- Sediment quality
- Continuous sonde readings

■ Bathymetry

- June 4-5, 2013
- 13 miles of transects





PHOSPHORUS PROFILE

Dissolved P

Water column

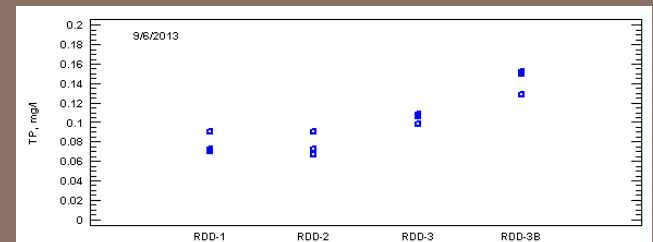
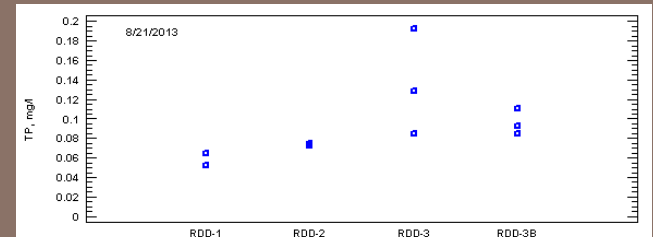
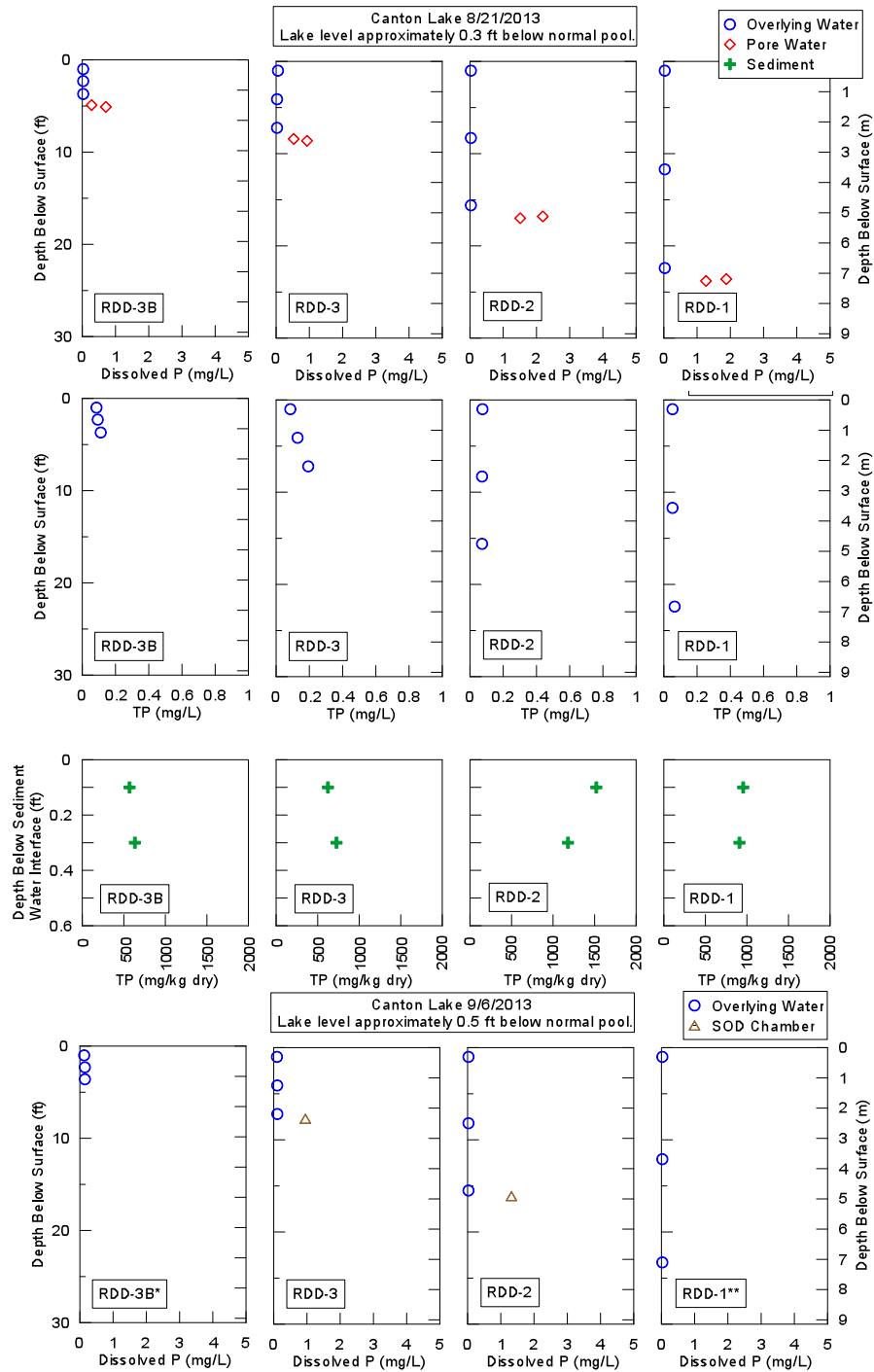
Sediment pore water

Total P

Water column

Sediment

SOD chamber



TOTAL PHOSPHORUS

- Summary

- High concentrations and loads entering the reservoir through tributaries during storms
- High concentrations in the reservoir sediment
- Low dissolved oxygen concentrations at the reservoir bottom can lead to release of phosphorus from the sediment
- ~ 90% incoming load remained in the reservoir during Year 1 of monitoring

- Stage III needs to address:

- Lake stratification and internal loading from sediment during low dissolved oxygen periods
- Contribution from runoff

STAGE III PLAN

■ Model Calibration

- Estimate loads from the watershed (GWLF)
 - Runoff from various land surfaces (TP, Mn)
 - Background concentrations (Mn)
 - Potential contribution from septic systems (TP)
- Determine fate of pollutants in streams and lakes (CE-QUAL-W2)
 - Storage in sediments and release (TP, Mn)
 - Lake stratification (TP, Mn)
 - Effect of anoxic conditions (TP, Mn)

■ Load Calculation

■ Implementation Plan



QUESTIONS?

Canton Lake Spillway – 7/3/12

Thank
You!

SEDIMENT OXYGEN DEMAND

