Utilization of Continuous Water Quality Monitoring for Assessing and Modeling Pollutant Export from Agricultural Catchments

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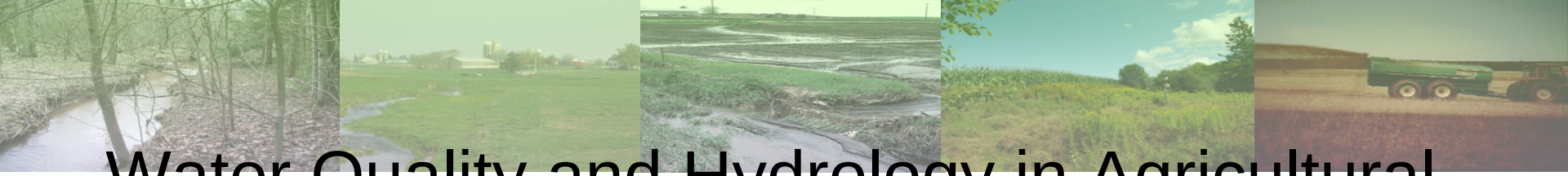
DALHOUSIE UNIVERSITY
Inspiring Minds



Water Quality and Hydrology in Agricultural Catchments

- Changes in hydrograph characteristics
  - Larger peak flows
    - Surface runoff
    - Drainage tiles
- Sediment Transport
- Nutrient Export
- Microbial Contaminants

Beneficial Management Practices (BMPs)

- “Agricultural management strategies that assure optimum plant growth while minimizing adverse environmental effects.”
  - Environmental aspects
    - Soil conservation
    - Water conservation

- Examples
  - Nutrient Management Planning
    - Time, method, type, and amount of fertilizer
  - Conservation Tillage
  - Buffer Zones
    - Filter strips
    - Riparian zones

Beneficial Management Practices (BMPs)

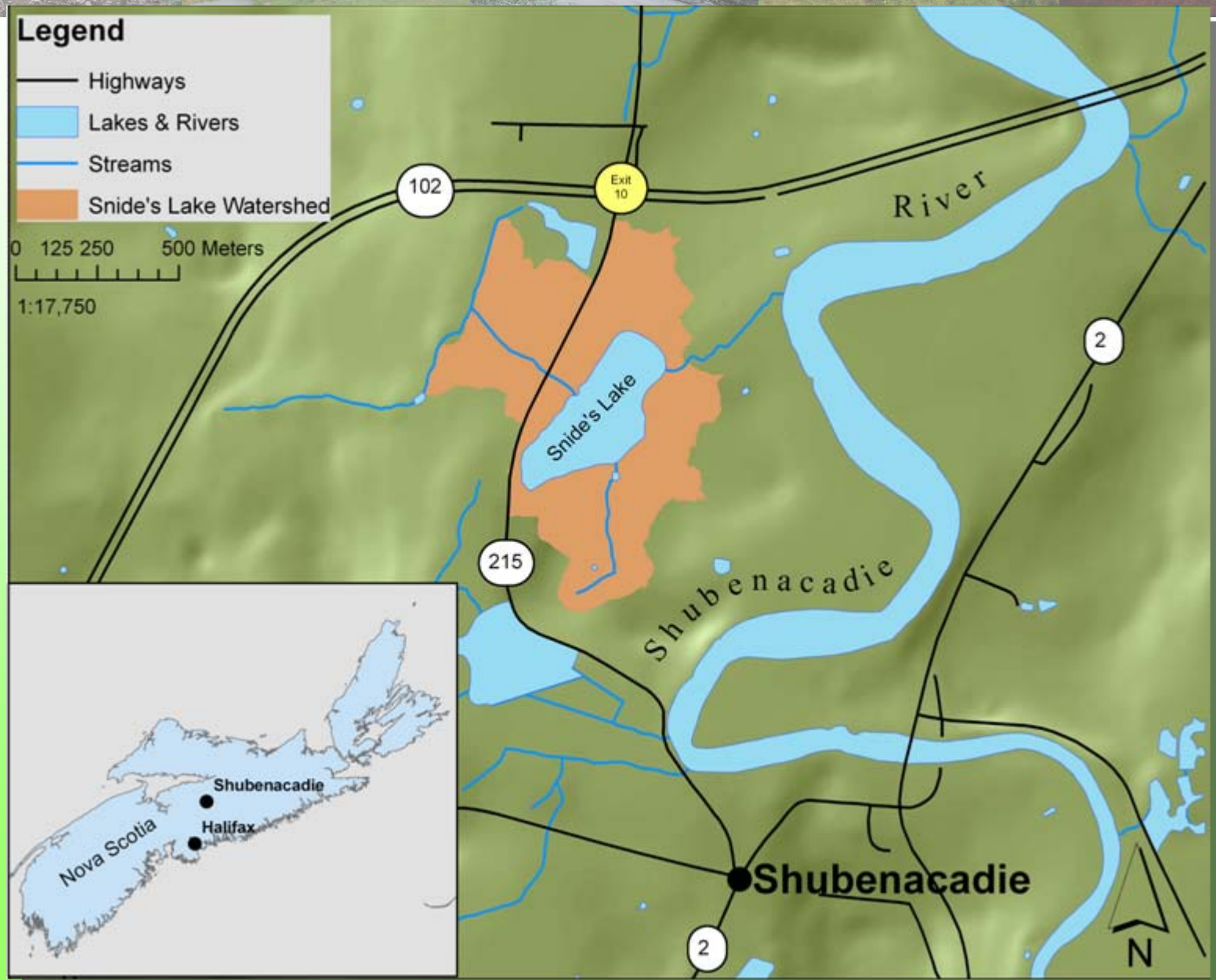
- BMP implementation is promoted by AAFC and provincial government agencies
- Significant investments in cost-sharing programs
- Key Questions:
  - Which BMPs should be applied?
  - Where should they be applied?
  - What is the benefit?

Assessment of BMP Effectiveness

- Most BMPs have only been assessed at the plot or field scale
- Integrated assessments of BMP impacts at the watershed scale are lacking
- Measuring BMP impacts at the watershed scale presents several challenges:
  - Pollutant export is episodic and driven by event hydrology
  - How do we transfer results from monitored systems to other watersheds?

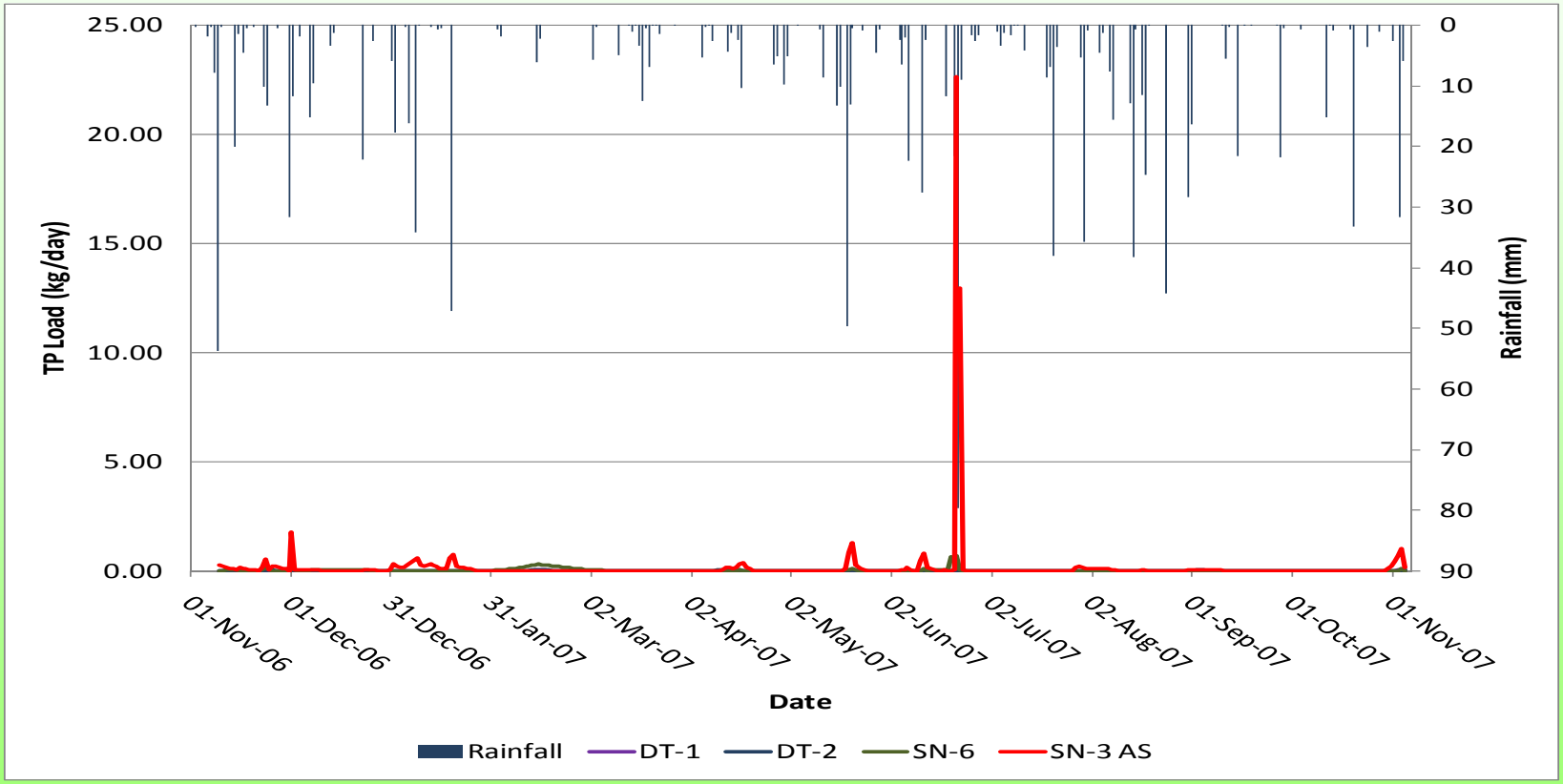
Dynamic Landscapes

Snide’s Lake


Legend
Highways
Lakes & Rivers
Streams
Snide's Lake Watershed
0 125 250 500 Meters
1:17,750
102
Exit 10
River
Snide's Lake
215
Shubenacadie
2
Shubenacadie
Nova Scotia
Shubenacadie
Halifax
2
N


ake
-1
Fisherbrand
SN

Continuous Monitoring at Snide's Lake



Daily inflow TP loading , based on results of manual sampling program, out of Snide's Lake with precipitation data

Benefits of Continuous Monitoring

"The continuous monitoring program at SN-3 (Dec 2006 – June 2007) had a TP load of 49 kg compared to 29 kg for the manual program for the same time period." (Sinclair, 2009)

Watershed Evaluation of Beneficial Management Practices (WEBS) Program

- Partnership of Agriculture and Agri-Food Canada with Ducks Unlimited
  - Launched in 2004
  - 7 sites Canada wide

- Components
  - Measurement
    - Measure impacts of BMPs on water quality at a watershed scale
  - Modeling
    - Develop and validate watershed simulation models

- Outcome
  - Improved decision-support tools in agri-environmental science for BMP implementation

WEBs Sites


British Columbia
Alberta
Manitoba
Ontario
Quebec
New Brunswick
Nova Scotia

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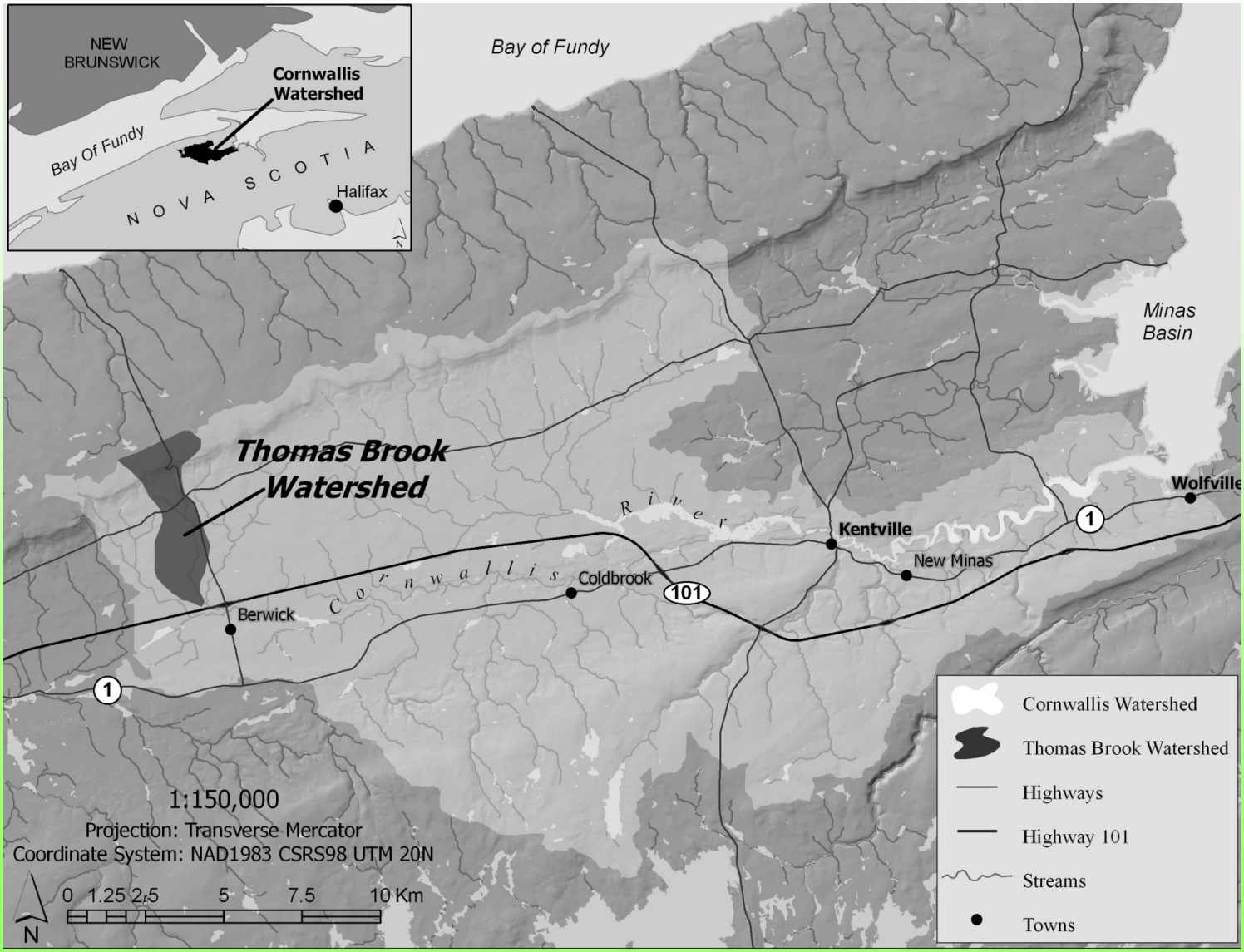


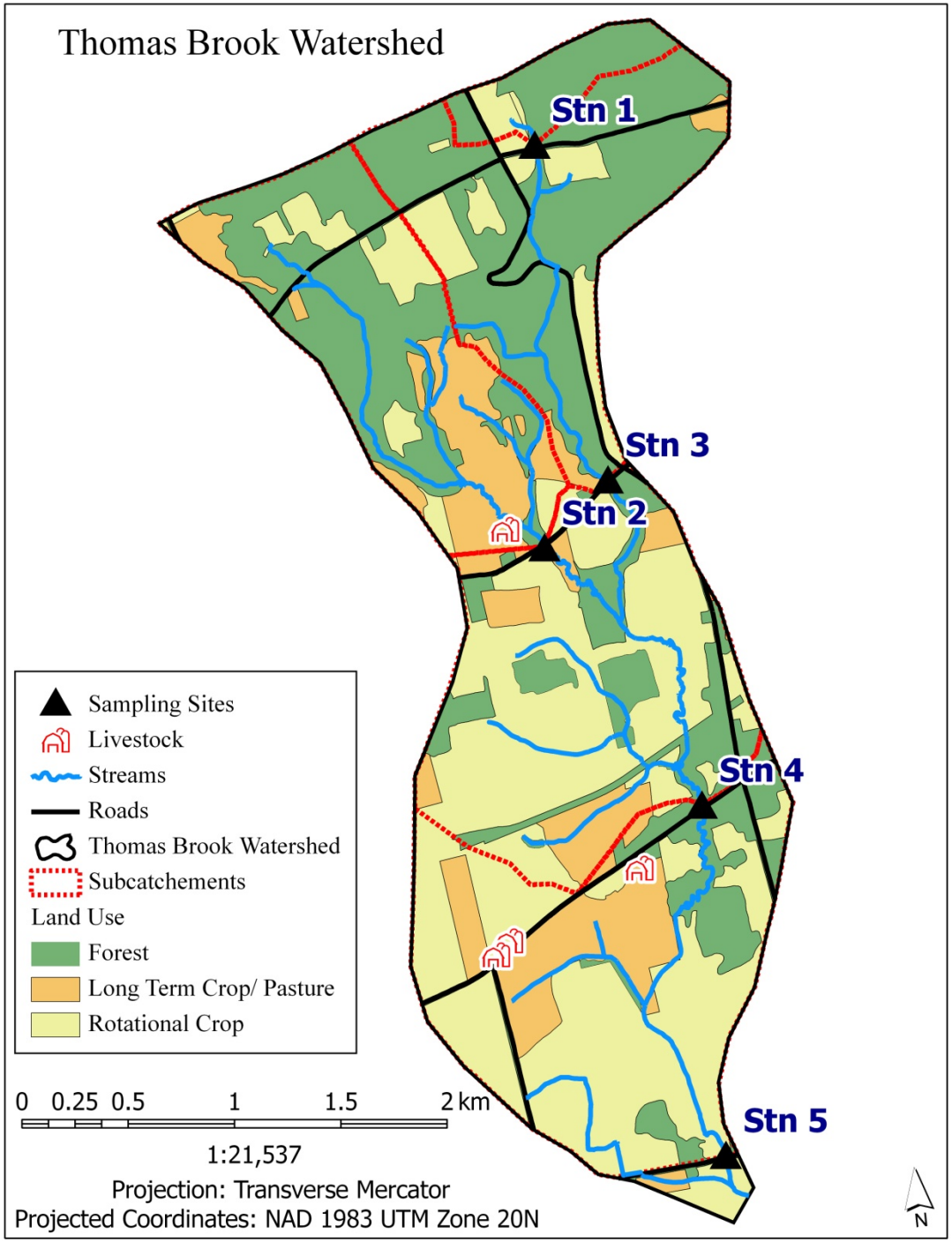
Thomas Brook Watershed

Monitoring Program

- BMPs
  - Restricted Cattle Access to Riparian Zones
  - Nutrient Management Planning
  - Farmyard Runoff Management

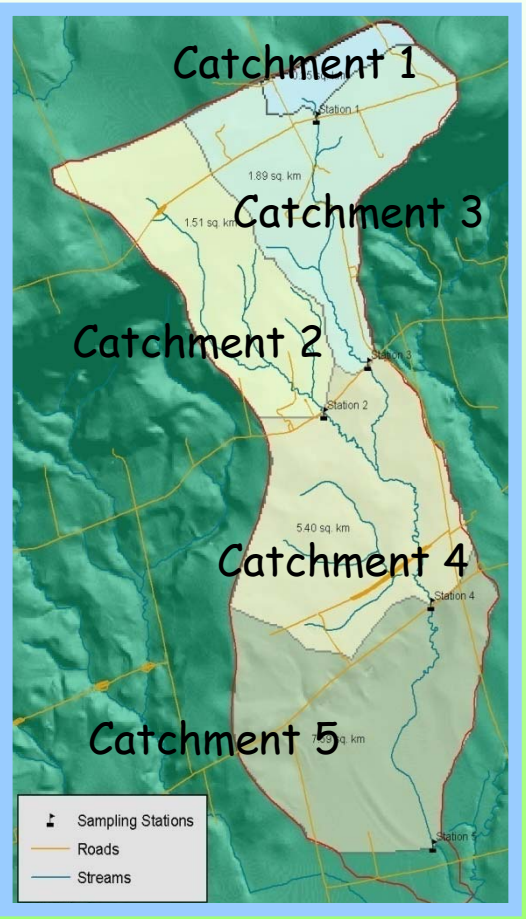
- Monitoring Approach
  - Pre (2001-2004) and Post BMP (2005-2008) implementation monitoring
  - Nested watershed approach with 5 primary sampling stations equipped with continuous flow and autosampling instruments
  - Continuous measurement of DO, pH, and temperature with YSI sondes

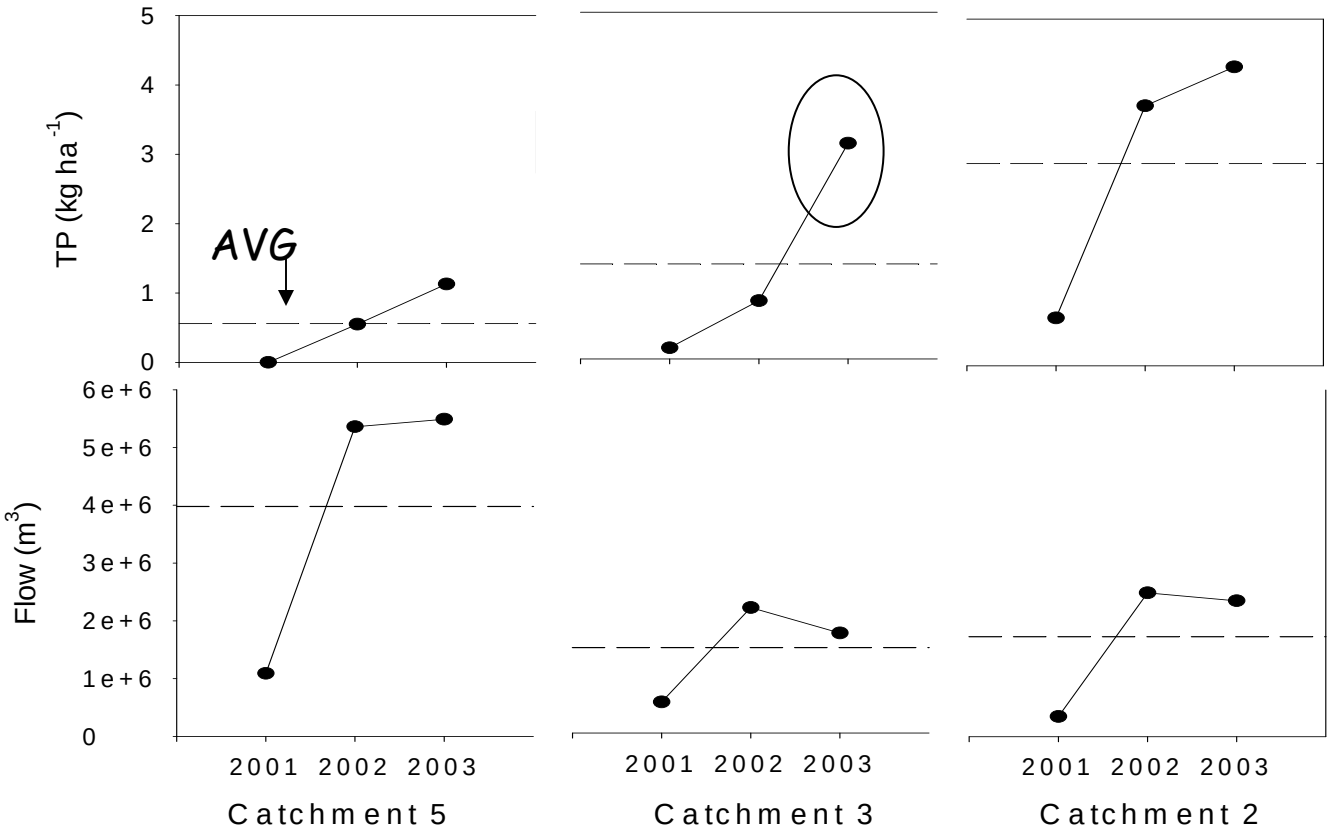
Thomas Brook Watershed



Catchment Phosphorus Loadings

Ilustration of Annual Variability





82%

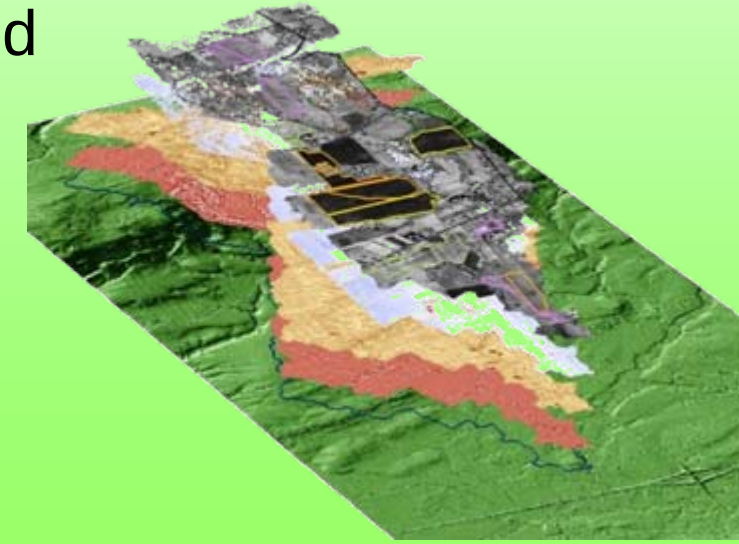
22%

35% + livestock

Model Development and Testing

- The Soil and Water Assessment Tool (SWAT) is undergoing validation in most WEBS watersheds

- Physically based computer simulation model developed by the USDA for predicting impacts of BMPs in mixed landuse watersheds



Overview of SWAT

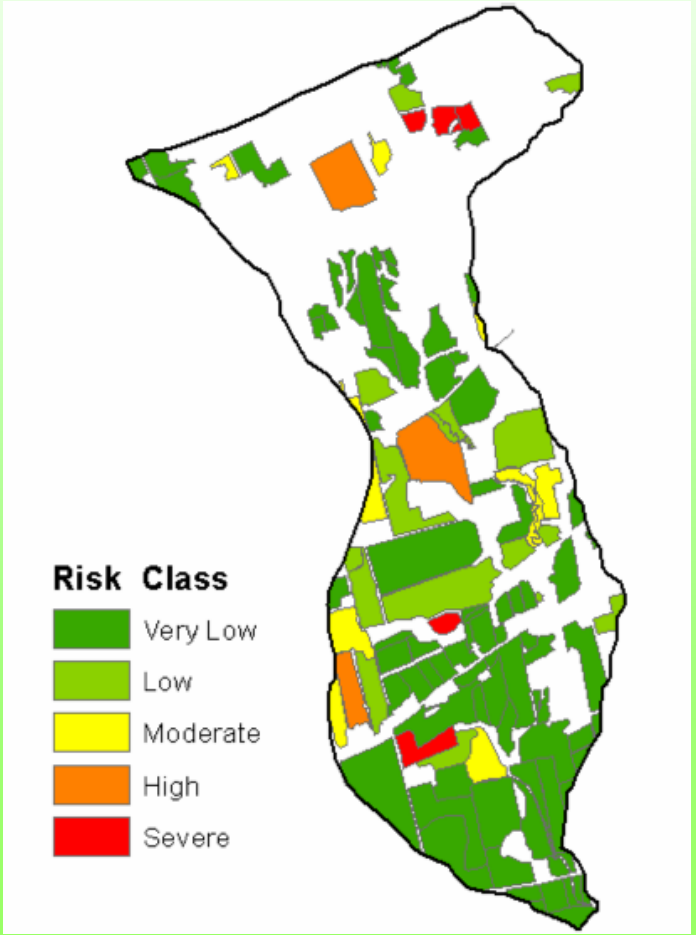
- Continuous simulation model
  - operates on a daily time step
- Most appropriate for long-term simulations
- Can predict impacts of land management practices on hydrology, sediment transport, nutrient export, and microbial water quality dynamics
- Computationally efficient and possesses user friendly GIS-based interface

SWAT Challenges

- Highly parameterized
  - 25 parameters directly affect nitrogen species
  - Not all parameters are measurable
- Integrated Watershed Model
  - Assumptions or requirements of one sub-models might be overlooked
- Accurate calibration is a necessity to have confidence in model performance

SWAT Calibration and Validation

- Data requirements for calibration are intensive
- Requirements include:
  - Year round monitoring
  - Captures storm events
  - Multiple years to account for annual variation
  - Spatially targeted monitoring is needed to validate specific model processes



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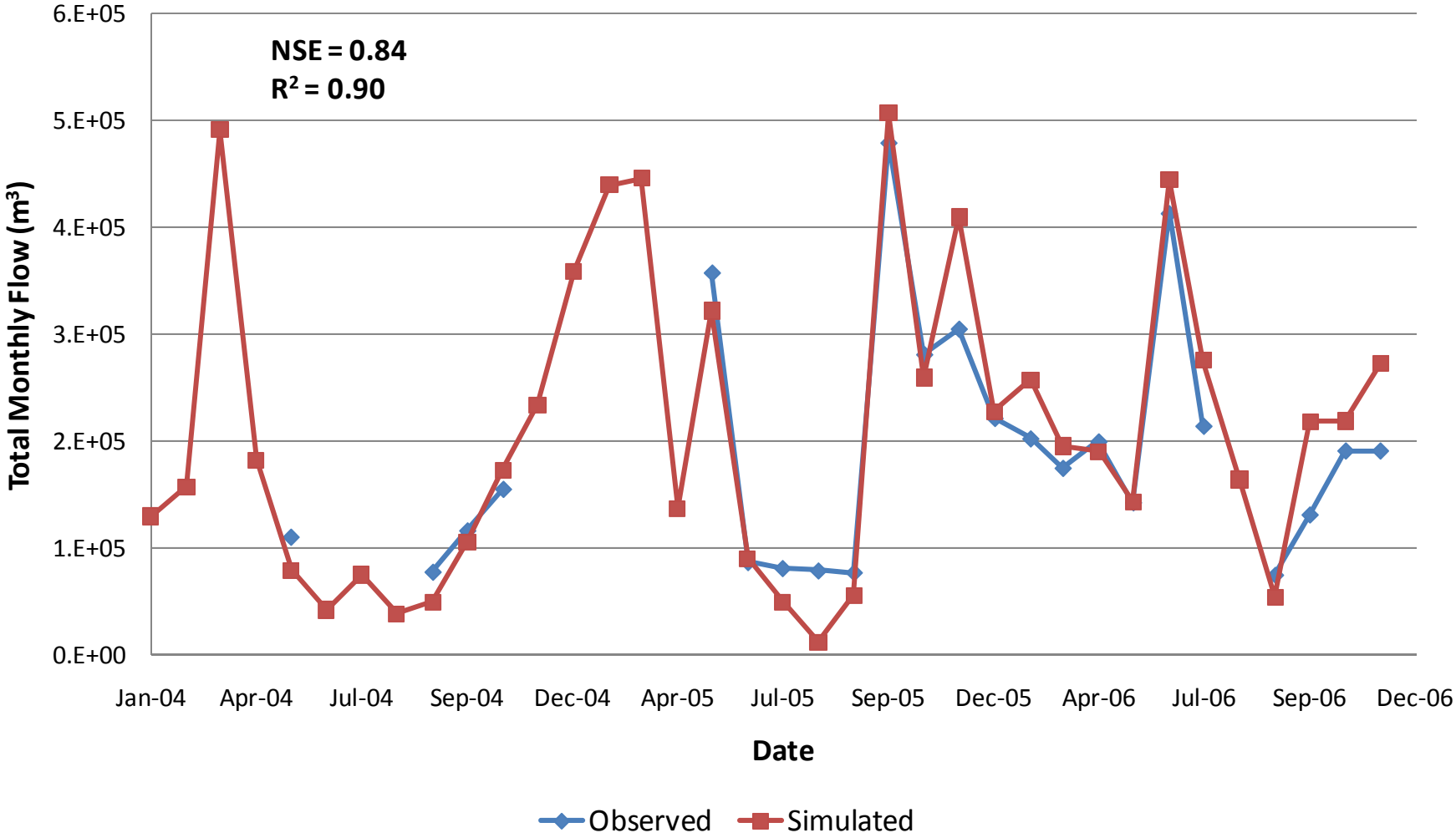

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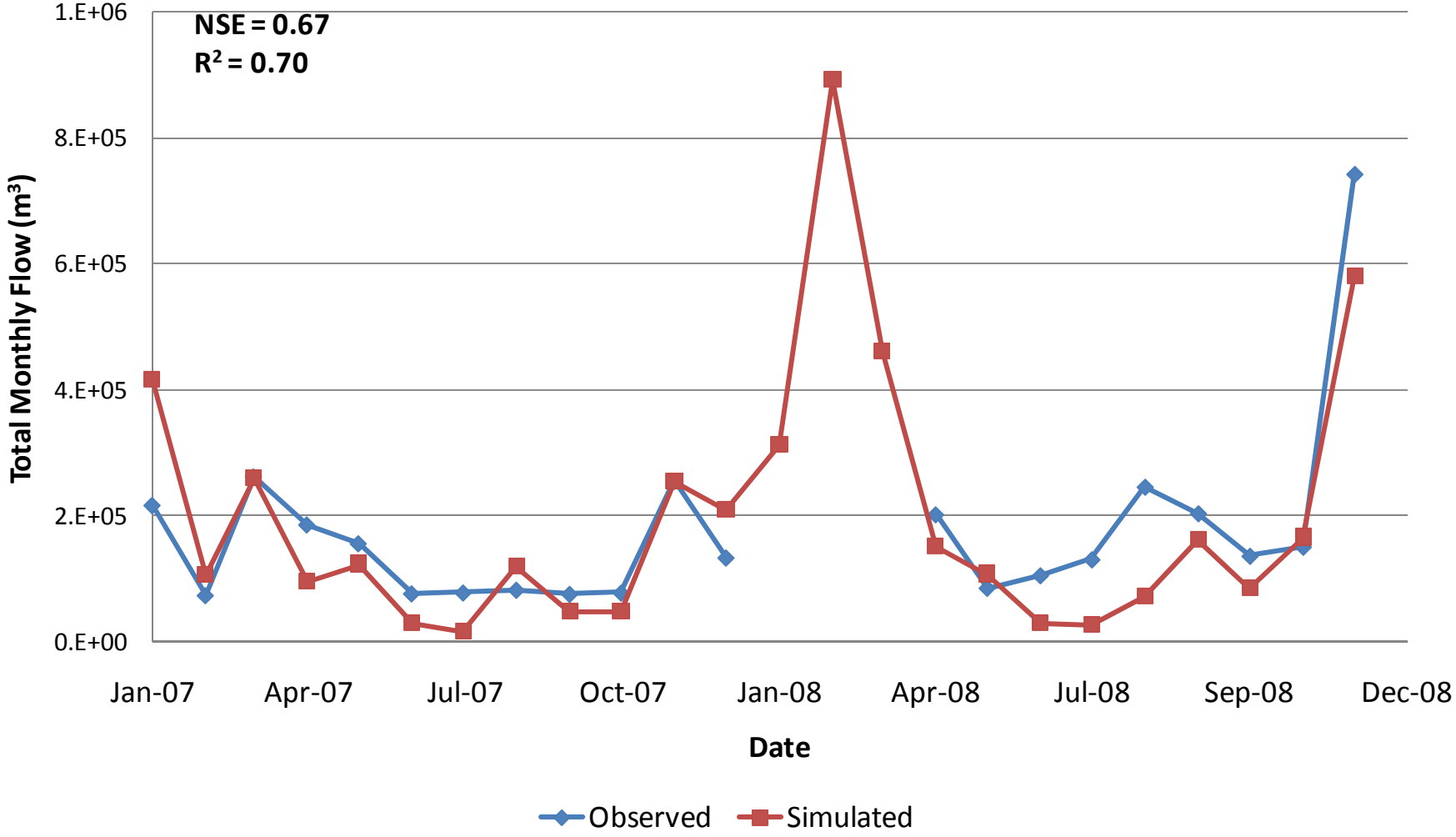
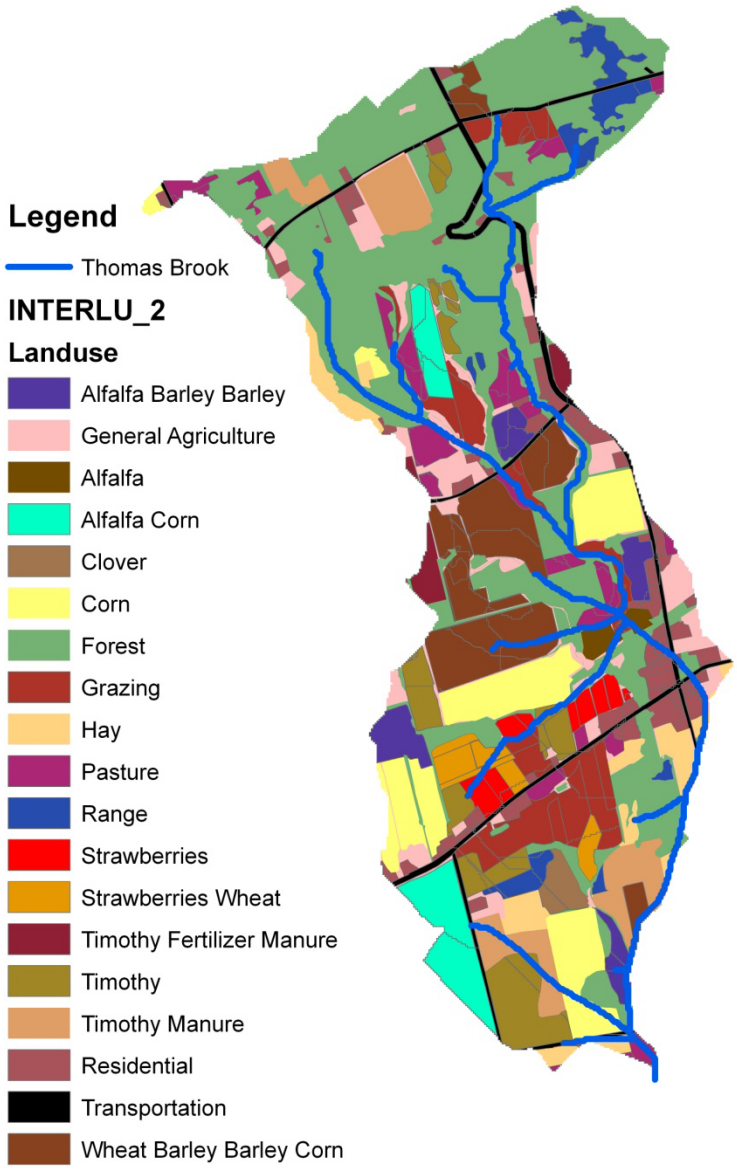


SWAT Next Steps

- Calibration and validation of nutrient processed requires accurate land management data
- Nutrient transport will be calibrated and validated
- Alternative BMP scenarios will be examined



Summary

- BMP policies/strategies must be backed up with good scientific evidence
- BMP planning should be conducted at the watershed scale to ensure that BMPs have a positive effect on receiving water systems
- Continuous monitoring systems are required to verify BMP effectiveness and validate predictive tools