Modeling the effects of precipitation events on nutrient loading in Munroe Brook, Shelburne, VT

VT EPSCoR Streams Project
April 2009
Nichole Bushey & Meredith Simard
Modeling vs. Monitoring

• Crucial to address issues of water quality from a watershed perspective

• Monitoring
  ▫ Provides information about the current state of the watershed
  ▫ Costly and time-consuming

• Modeling
  ▫ Predicts changes resulting from future conditions
  ▫ Tests future alternative scenarios
Watershed Details

- Drains into Shelburne Bay
- Watershed area: 1435.46 ha (3547.01 acres)
  - 85 ha high density urban
  - 121 ha low density urban
  - 281 ha agriculture
- Total stream length: 28.6 km (17.8 miles)

Sampling Details

- 12 sample sites named by tributary
  - T1
  - T2
  - M
- Focus at M1
AVGWLF & PRedICT

- **ArcView Generalized Watershed Loading Function**
  - Monthly outputs of sediment and nutrient loads based on daily discharge
  - Advantages:
    - “Mid-Level” model
    - Ease of use
    - Less complex input datasets

- **Pollution Reduction Impact Comparison Tool**
  - Evaluates implementation of urban and rural pollution reduction strategies at watershed level
Modeling Process

- Locate and create input data
- Simulate discharge and nutrient loads and compare with sample data from 2006 and 2007 sampling seasons
  - Calibration
- Scenarios
  - Current status
  - Future precipitation and temperature associated with climate change
  - Future land management
Calibrating the Model: Discharge

Changed 630 ha of Row Crops to Golf Course to better match watershed landuse.
Calibrating the Model: Nutrients

2007 Total Phosphorus: Modeled vs. Actual Data

2007 Total Nitrogen: Modeled vs. Actual Data
Climate Change Scenarios: Parameters

- Lower Emissions Scenario for 2069
  - Average annual temperature increase of 3.7°F
  - 11% increase in winter precipitation

- Higher Emissions Scenario for 2069
  - Average annual temperature increase of 5.8°F
  - 16% increase in winter precipitation

- Increase in frequency of droughts
- Increase in likelihood and severity of heavy rainfall events
- Increase in winter precipitation falling as rain and 25-50% decrease in snowfall by the end of the century
- Increasing period of low streamflow due to higher temperature and increased evapotranspiration.
Climate Change Scenarios: Hydrological Results

Effects of climate change on discharge

Evapotranspiration predictions for 2069
Climate Change Scenario: Nutrient Results

**Total Nitrogen Loading**

- **Low Emission Scenario**
- **High Emission Scenario**
- **Current Emissions**

**Total Phosphorus Loading**

- **Low Emission Scenario**
- **High Emission Scenario**
- **Current Emissions**

---

**Total Nitrogen Loading**

- **Low Emission Scenario**
- **High Emission Scenario**
- **Current Emissions**

**Total Phosphorus Loading**

- **Low Emission Scenario**
- **High Emission Scenario**
- **Current Emissions**
Watershed Improvements

Stream Bank Fencing

Rain Garden

Vegetated Buffers
Vegetated Buffers

940m of stream length

1190m of stream length
0.6 ha of rain gardens will drain just over 5 ha of impervious surface
Stream Bank Fencing

- Cows negatively impact:
  - water quality
  - streambank stability
- Goal: Protect 300m of stream bank from livestock
Improving our Study

• Improve accuracy of landuse layer
• Additional Input data
  ▫ Septic systems
• Compare tributaries to whole watershed
• Alternative and more comprehensive scenarios
  ▫ Climate change predictions based on multi-year averages
  ▫ Urban watershed management practices
  ▫ Further utilization of PRedICT software
Acknowledgements

- Maeve McBride
- KathiJo Jankowski
- Meredith Curling (UVM)
- Bill Hoadley (LaPlatte Watershed Partnership)