

# Blackstone River HSPF Water Quality Model



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*A Day on the Upper Bay: Current  
Monitoring, Research, Source  
Reduction Progress and Future  
Challenges*

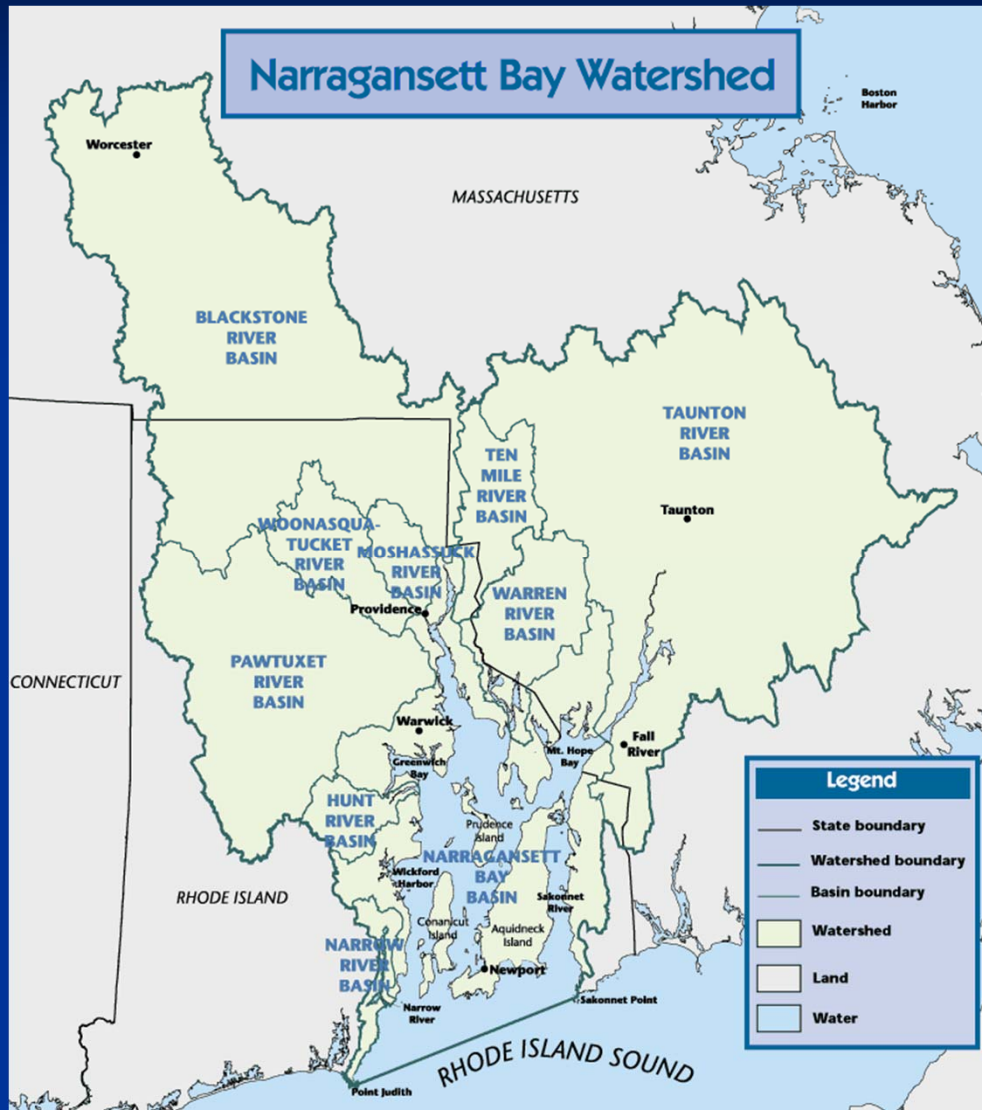


# Blackstone River Study Overview

- Study Objective: Characterize Watershed and Develop Tool to Study River Water Quality
- Data Compilation & Field Program
- HSPF Model
  - Dynamic – 10-year hourly
  - Accounts for time of travel
  - HSPF - EPA supported, broad range of application (quality & quantity)
- Evaluation of River Management Options



# Narragansett Bay Watershed



- Located in MA/RI
- 1850 mi<sup>2</sup>
- 2 million residents
- Blackstone River contributes on average 25% of freshwater per day [Ely, 2002]

Source: NBEP Web Page

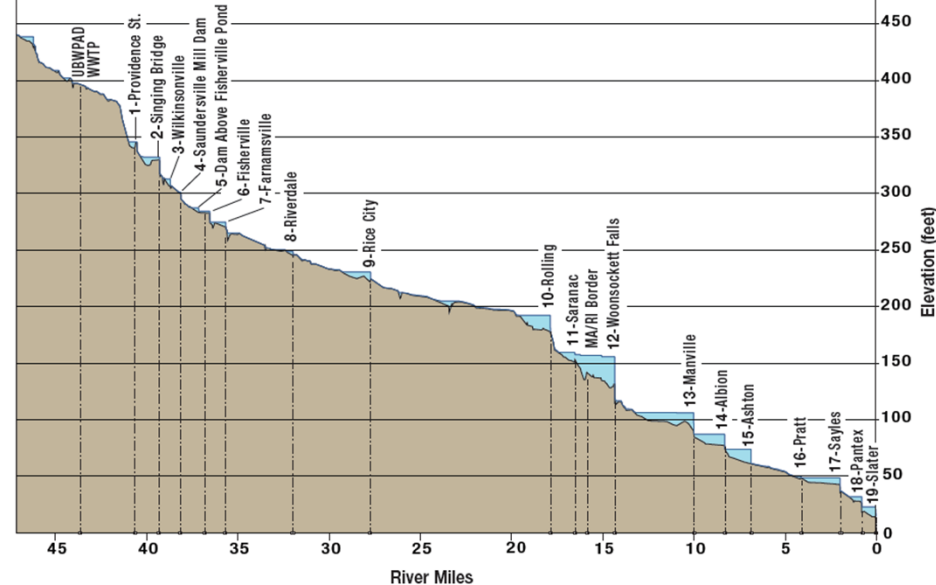
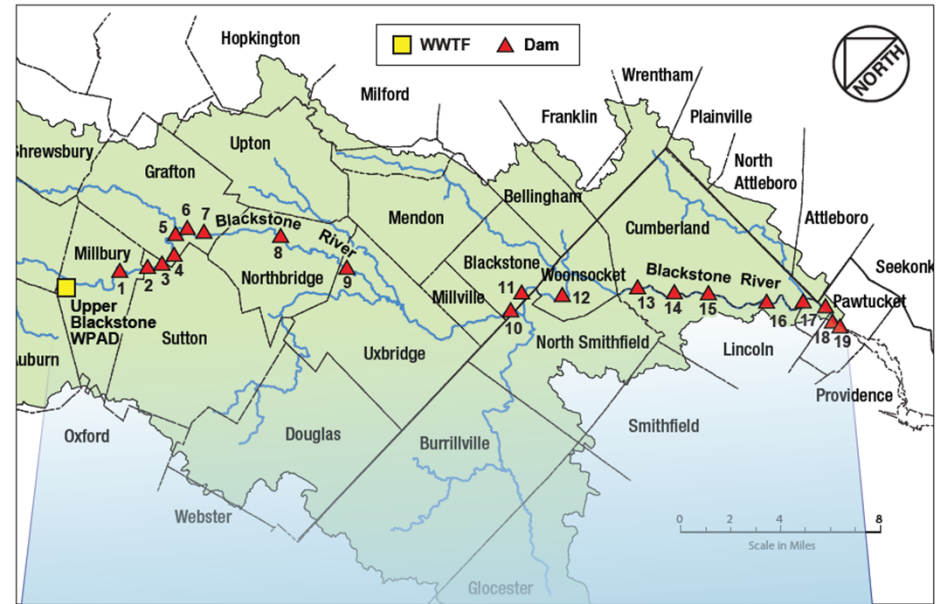
# Blackstone River Basin

- 475 mi<sup>2</sup> watershed
- 45 miles long
- 19 dams
- Historical Significance
- Mixed Land Use
- Water Quality Impairments
  - Algae
  - Dissolved Oxygen



# Impact of Dams

- Worcester County, MA has the largest number of dams (425) of all U.S. counties
- At one point ~1 dam for every mile, legacy of the region's long history of mill dams
- Dams significantly impact travel time
- Travel time impacts algal growth





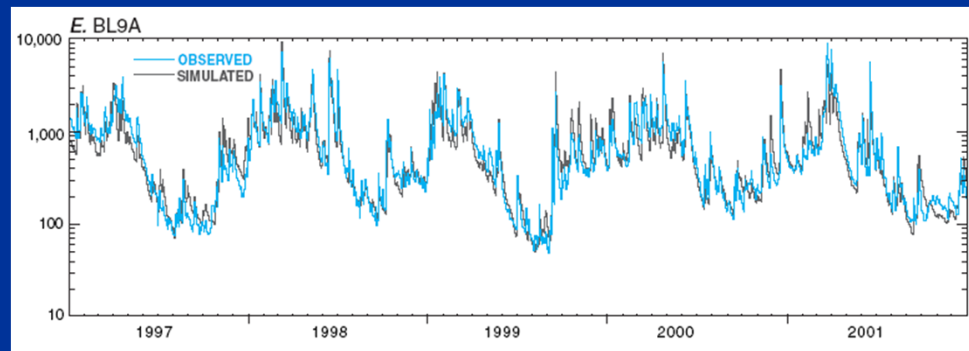
# Data Compilation & Field Program

- Compiled WQ Database from Multiple Sources
- UMass Water Quality Sampling Program

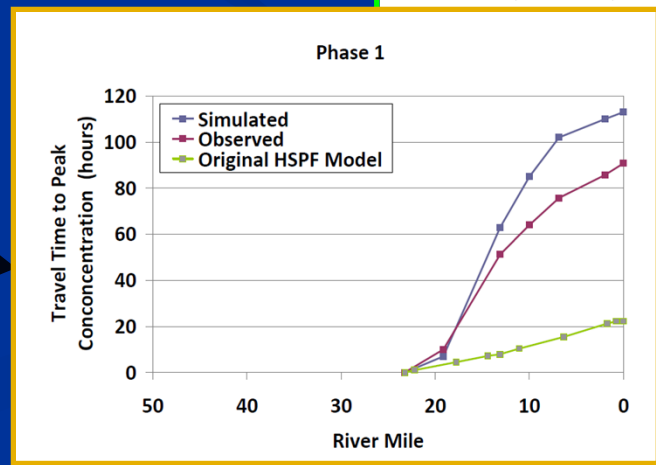
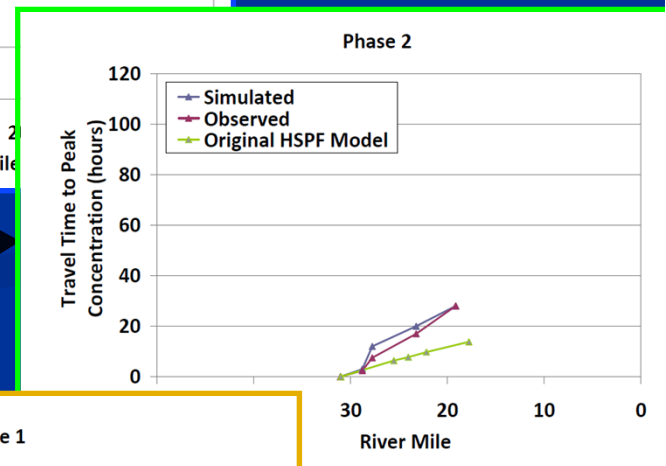
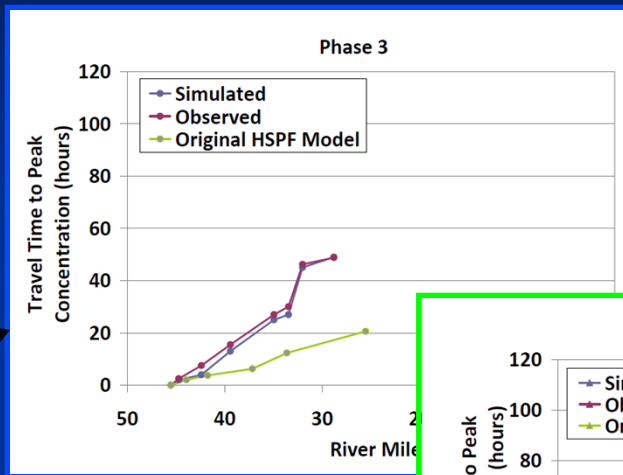
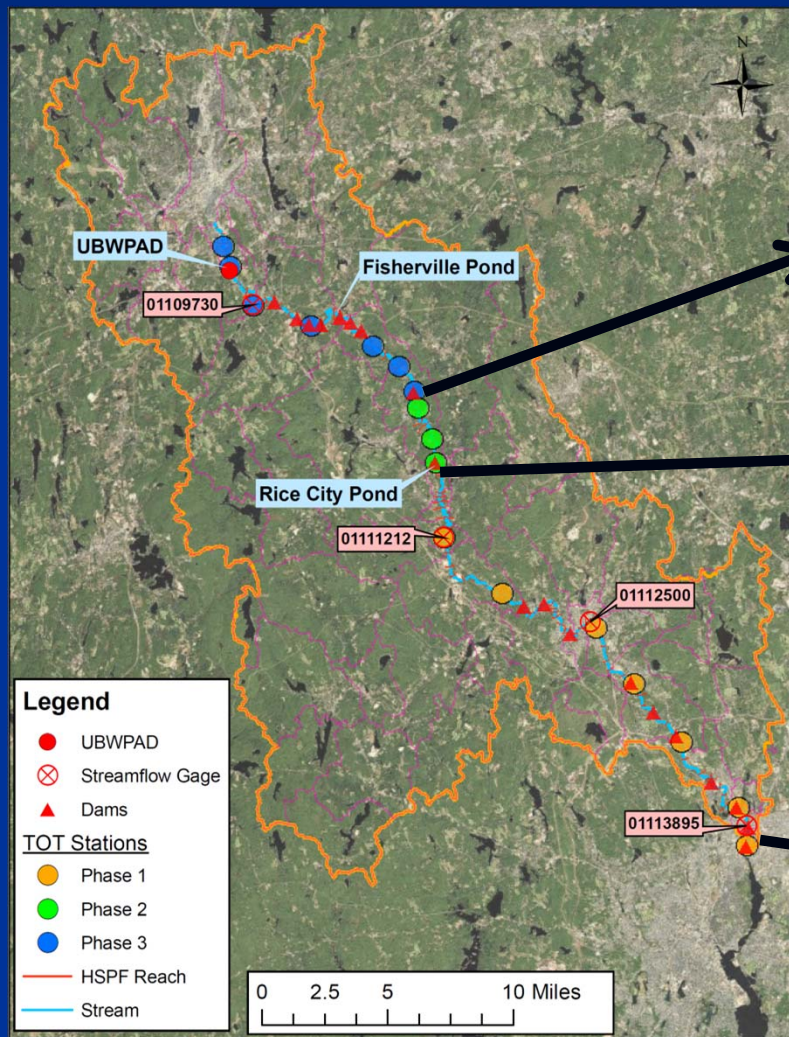


# USGS Hydrologic Model

- Hydrologic Simulation Program FORTRAN (HSPF)
- U.S. Geological Survey (2006)
- Evaluate water management impacts on in-stream flows
- Calibrated to daily stream flow



# Time of Travel

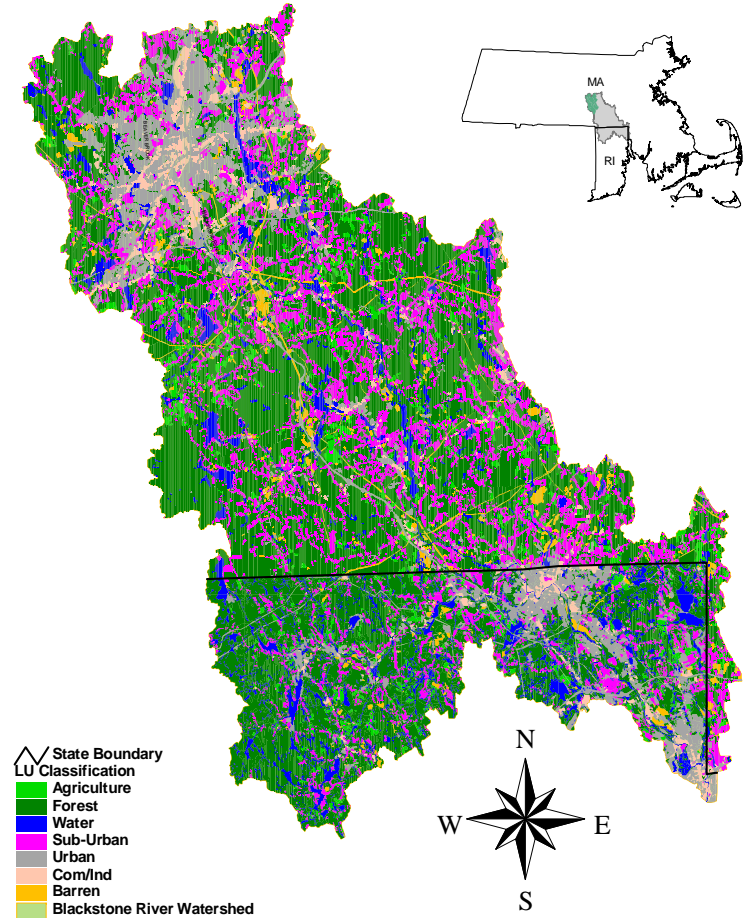




# HSPF Water Quality Model

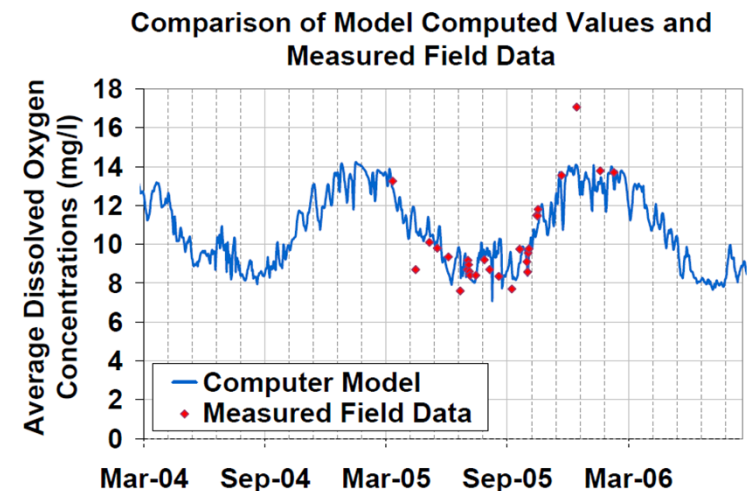
- Input
  - Nonpoint Sources
  - Point Sources
  - Benthic Sources
- Parameters
  - Nutrients, N and P
  - Dissolved Oxygen
  - Chlorophyll a (phytoplankton)
- Calibration Targets

**Blackstone Watershed Land Use 1999/1995**



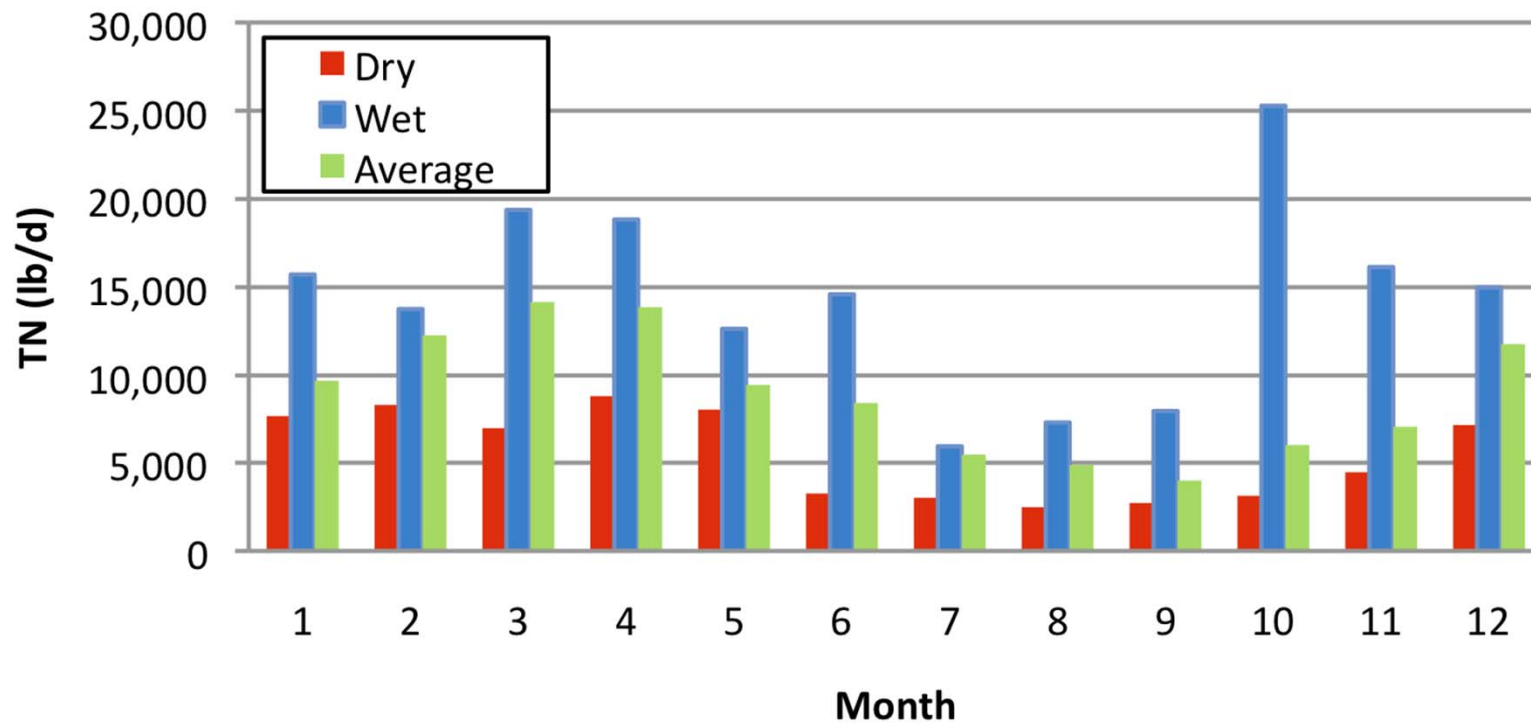
# Model Calibration Results

- Hydrologic model – captures daily variations in flow, time of travel consistent with field TOT results from 2009
- Nonpoint sources: model consistent with values from other studies
- In stream nutrients: model captures both temporal and spatial variations
- Reviewed by TAC



# Natural Variations in TN Load to the Bay

## Load to Narragansett Bay (Historic)



# Model Application

- Use model to evaluate alternative management strategies
  - Non-point Source Control
  - Impoundment Management
  - Point Source Control

Scenario	Parameter	% of Limit	Scenario Value, mg/L	Design, mg/L	Applicable Dates
<b>2001 NPDES (UP1)</b>	TP	80	0.6 or as is	0.75	Year Round
	TN	80	8 or as is	10	Year Round
<b>2008 NPDES (UP2)</b>	TP	90	0.09 or as is	0.1	4/1 to 10/31
	TP	80	0.6 or as is	0.75	11/1 to 3/31
	TN	90	4.5 or as is	5	4/1 to 10/31
	TN	80	8 or as is	10	11/1 to 3/31

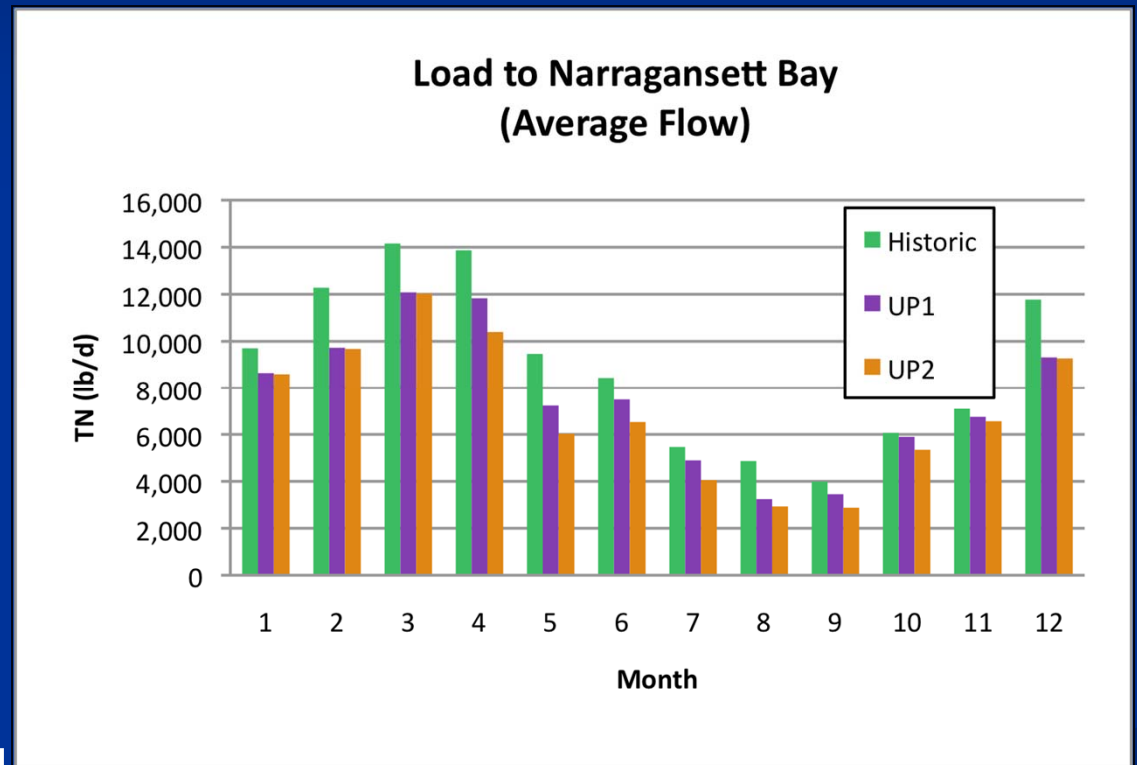


# Model Scenarios

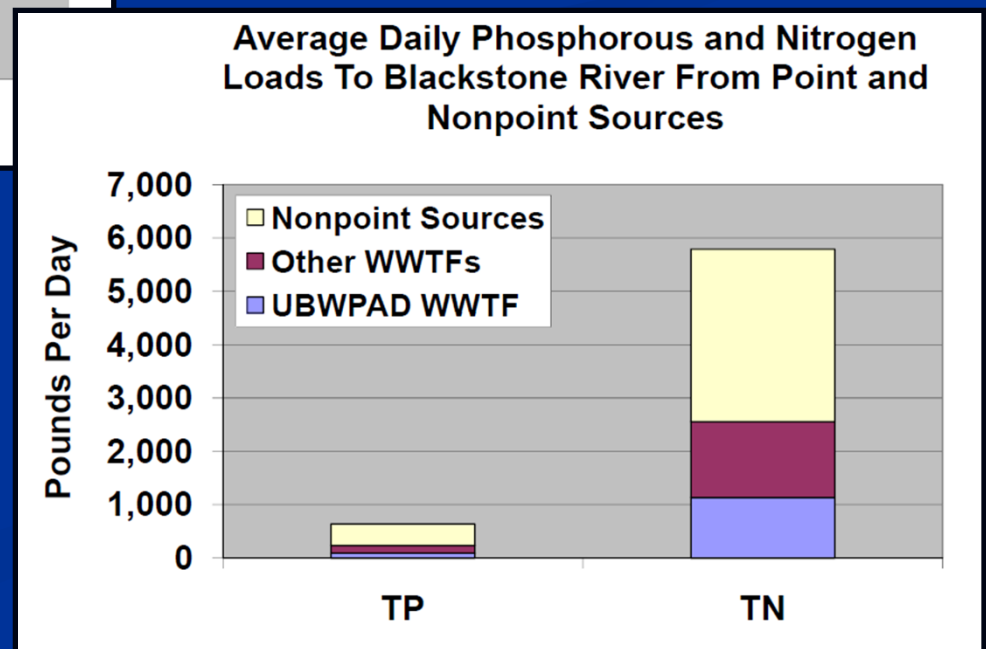
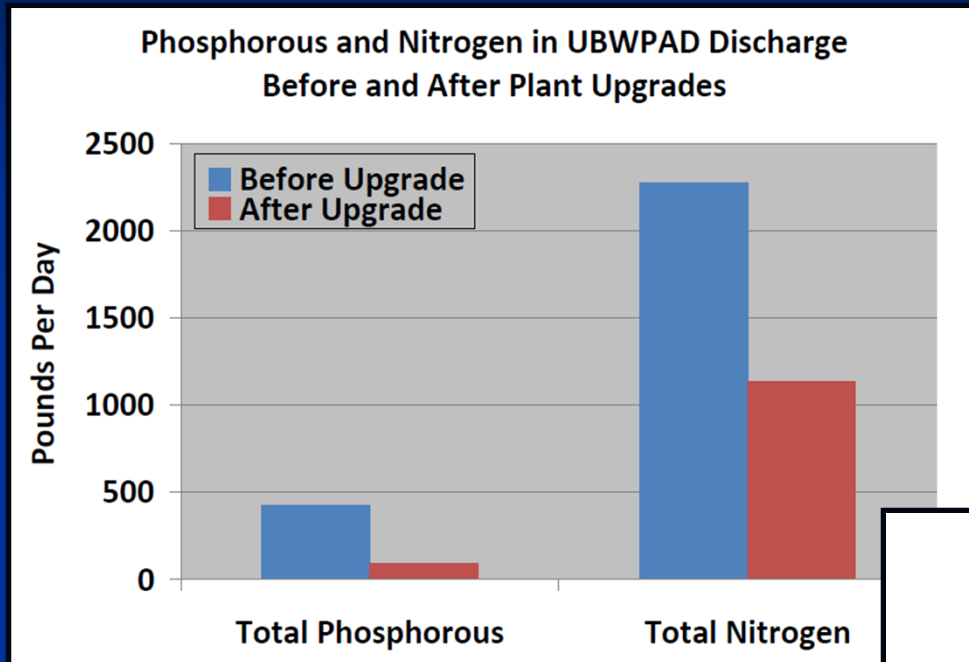
Scenario	UBWPAD	NPS Reduction	Dam Conditions
Historical	Historical	0	Existing
UP1	2001 Permit	0	Existing
UP2	2008 Permit	0	Existing
UP1_NPS60	2001 Permit	60%	Existing
UP1_FERC	2001 Permit	0	FERC Dams Only
UP1_NoDams	2001 Permit	0	No Dams
UP1_NPS60_FERC	2001 Permit	60%	FERC Dams Only
UP2_NPS60_FERC	2008 Permit	60%	FERC Dams Only

# Impact of Reductions on TN Load to Bay

- Reductions to the Bay are modest
- This is due to the impact of NPS throughout the watershed
- In UP2, algal growth is reduced (less TN uptake)



# Relative Sources of Nutrients



# Conclusions

- The dynamic water quality model has improved our understanding of the multiple factors dictating the health of the Blackstone River and NB estuary.
- Impoundment dynamics and management play a role in achieving water quality objectives for the river; there is a slight associated influence on delivery of nutrients to NB estuary
- There is significant monthly and annual variation in TN delivery to the Bay due to NPS
- NPS reduction will reduce loads to both river and bay



# Acknowledgements

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# Questions?

