

Nutrient Loads to Lake Lillinonah

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Overview

- **Background and Objectives**
- **Concentration and Discharge Data**
- **Load Model Results**
- **Load Model Limitations**
- **In-Lake Monitoring**
- **Active Monitoring**
- **Questions and Follow-up**

Background

- **Lake Lillinonah is an impoundment of Housatonic River**
- **Three primary drainages are Housatonic, Still and Shepaug Rivers**
- **Observed nutrient enrichment in Lake Lillinonah**

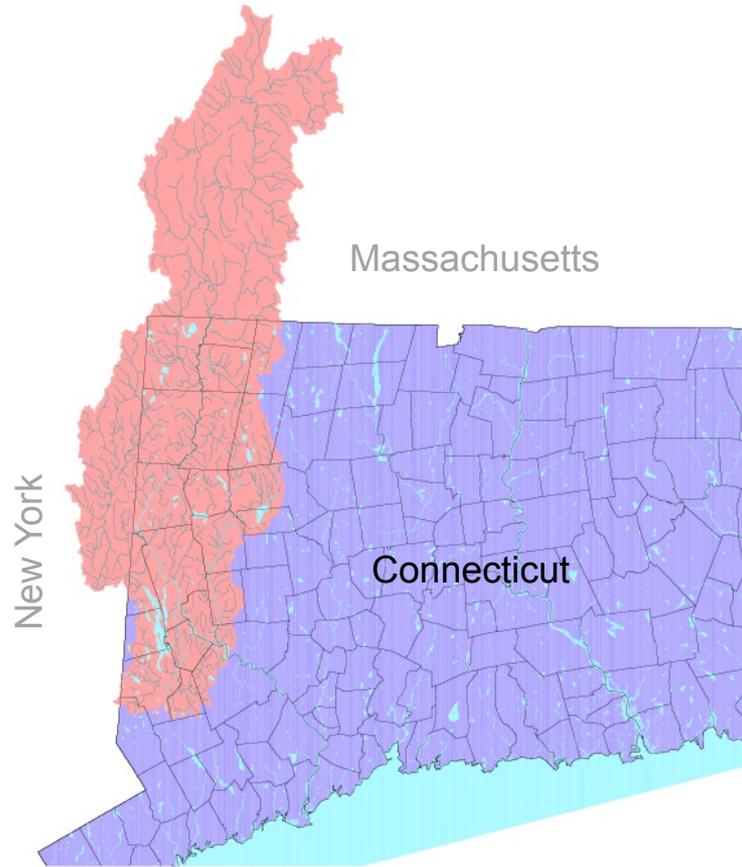
Environmental Setting

- Housatonic River at the Shepaug Dam drains 1,390 mi² of western Connecticut and southwestern Massachusetts
- Lake Lillinonah has an area of 1,900 acres
- The maximum depth is approximately 100 feet with a mean depth of 25 feet

Environmental Setting

- Housatonic River flows are affected by several impoundments for hydroelectric facilities upstream and downstream of Lake Lillinonah
- Average hydraulic residence time of the lake has been reported as 24 days

Lake Lillinonah Watershed



Objectives

- Calculate loads and yields of total nitrogen and phosphorus from the three primary contributing drainages to the lake
- Calculate velocity and direction of flow within the lake
- Discuss how monitoring activities improved load and yield calculation

Drainage Area and Period of Record for USGS/CTDEP Data Collection Locations

USGS station name	Drainage area, in square mi.	Period of published record Streamflow	Period of published record water quality
Housatonic R. at Gaylordsville, CT	996	1940 – present	No data available
Housatonic R. nr New Milford, CT	1022	No data available (Continuous discharge based on drainage area correction applied to Gaylordsville streamflow record)	1974 – 1991; 1995 – present
Still R at Brookfield Center, CT	62.3	2001 – present	1983 – present
Shepaug R. nr Roxbury, CT	132	1930 – 1971 2006 – 2007	1974 – present

Housatonic River near New Milford, CT Nutrient Concentration 1996-2007

	Total N (mg/L) (as N)	Total P (mg/L) (as P)
■ Minimum:	0.24	0.010
■ Mean:	0.68	0.043
■ Median:	0.67	0.030
■ Maximum:	1.1	0.294
■ Number of Samples:	53	53
■ Std Dev.:	0.18	0.045

Still River at Brookfield Center, CT

Nutrient Concentration 1996-2007

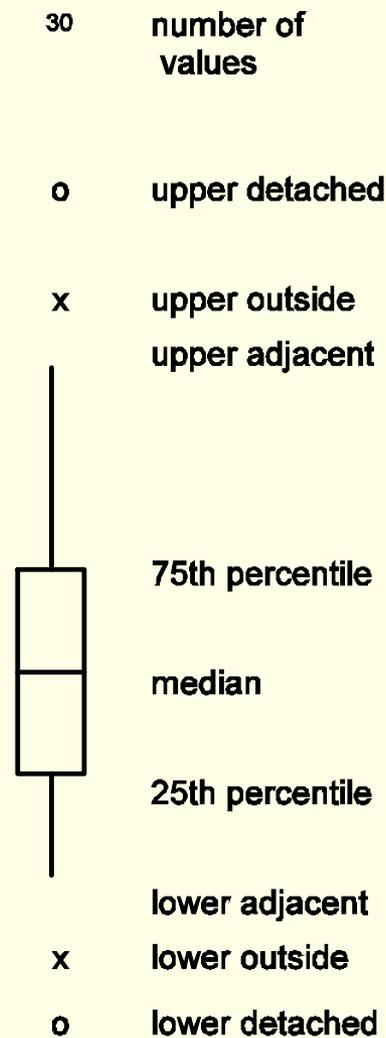
	Total N (mg/L) (as N)	Total P (mg/L) (as P)	Dissolved P (mg/L)
■ Minimum:	0.97	0.050	0.026
■ Mean:	5.6	0.258	0.210
■ Median:	4.3	0.196	0.140
■ Maximum:	15	1.15	1.04
■ Number of Samples:	112	112	112
■ Std Dev.:	3.77	0.199	0.205

Shepaug River near Roxbury, CT

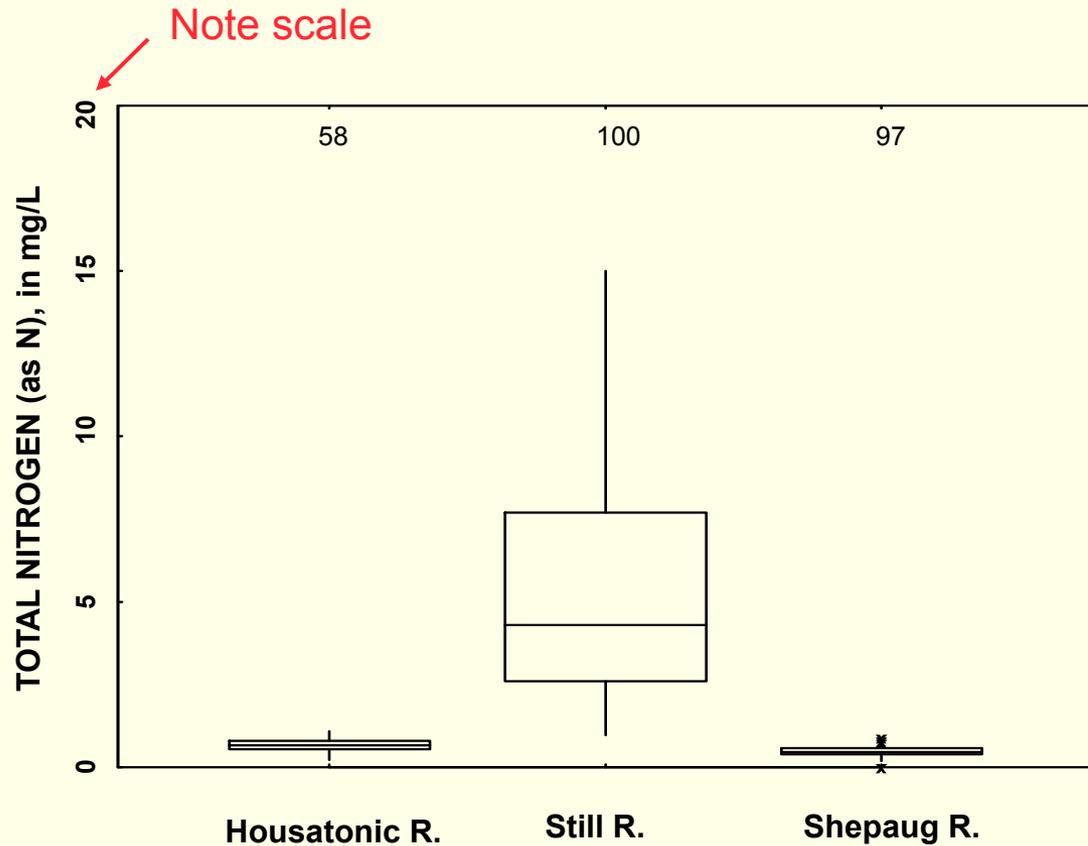
Nutrient Concentration 1996-2007

	Total N (mg/L) (as N)	Total P (mg/L) (as P)
■ Minimum:	0.11	0.007
■ Mean:	0.49	0.034
■ Median:	0.46	0.030
■ Maximum:	1.0	0.179
■ Number of Samples:	97	97
■ Std Dev.:	0.16	0.027

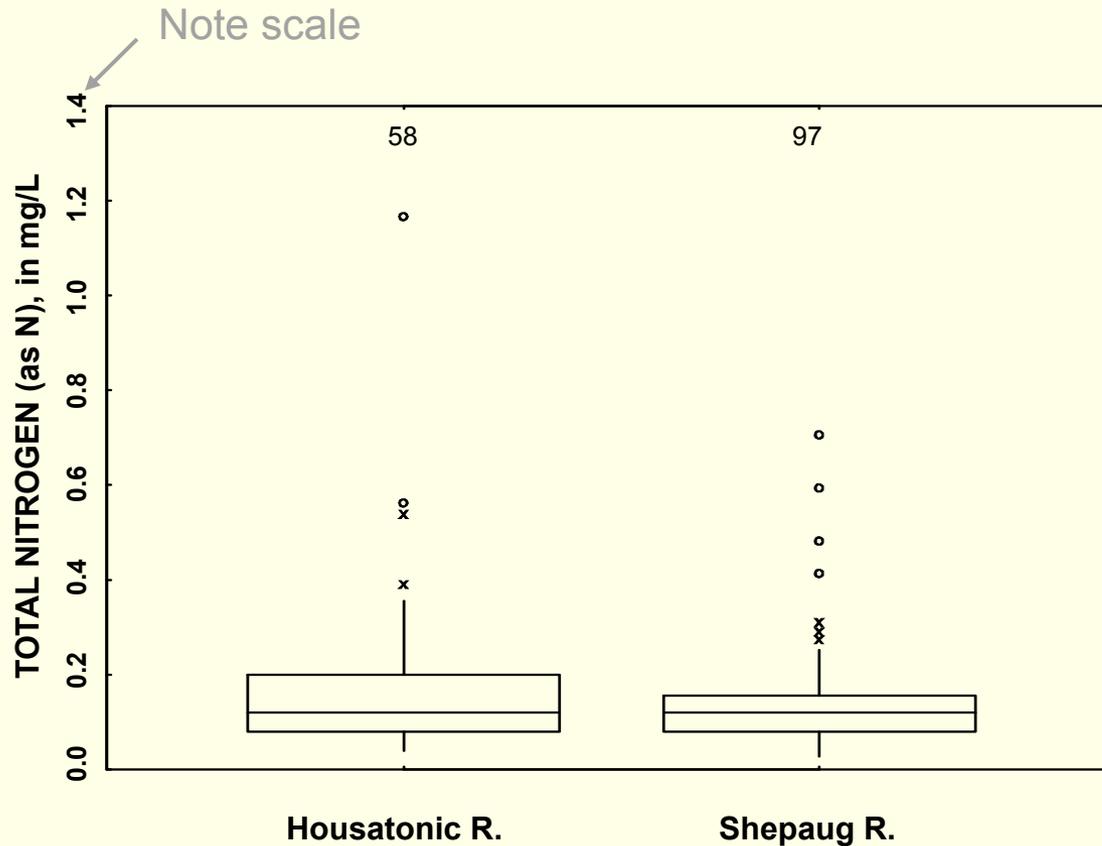
USGS Box Plots Explanation



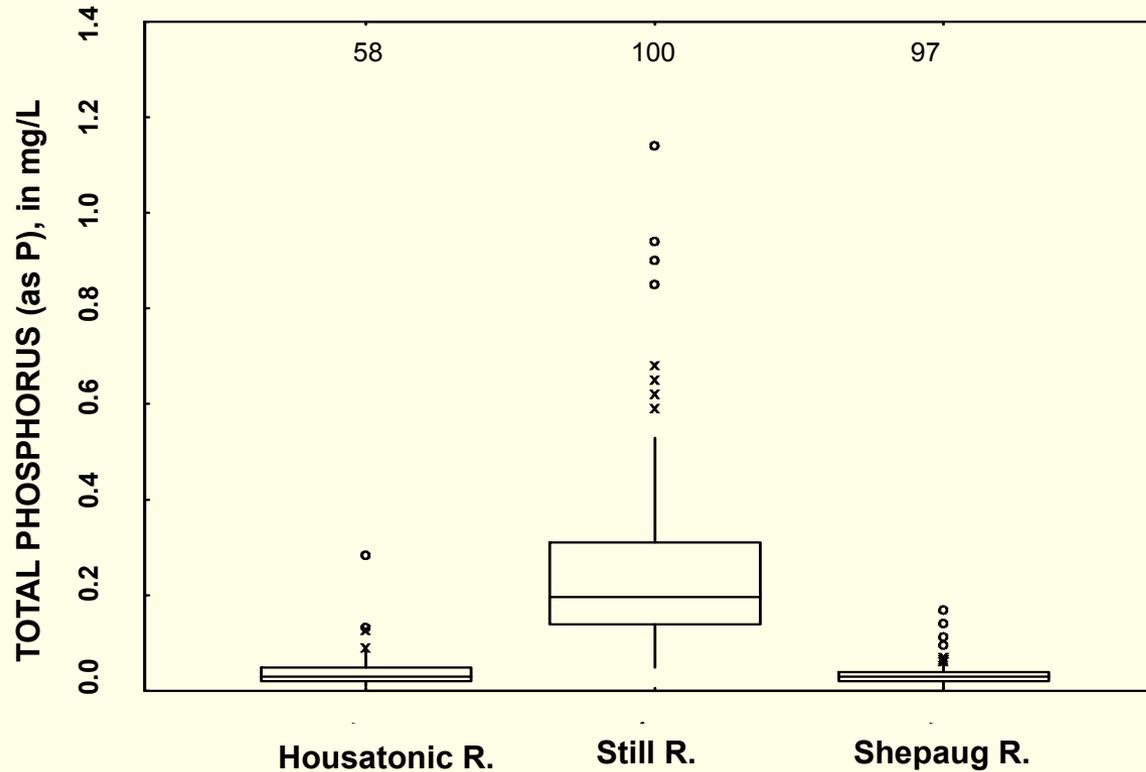
Total Nitrogen Concentration 1996-2007



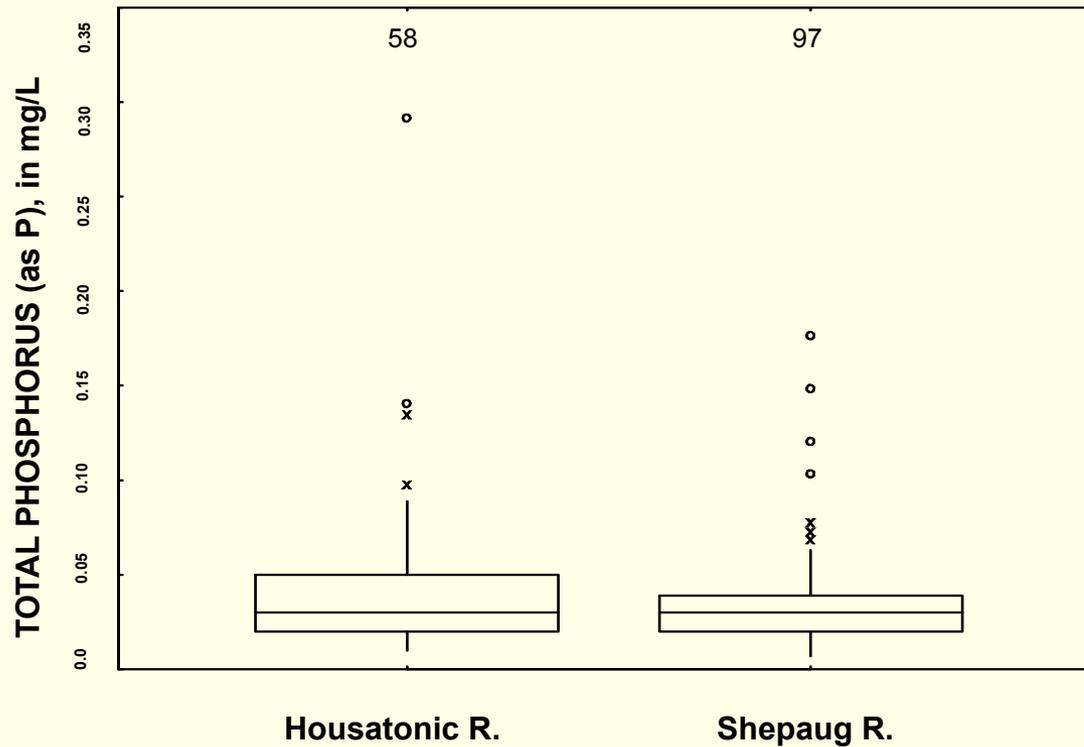
Total Nitrogen Concentration 1996-2007



Total Phosphorus Concentration 1996-2007



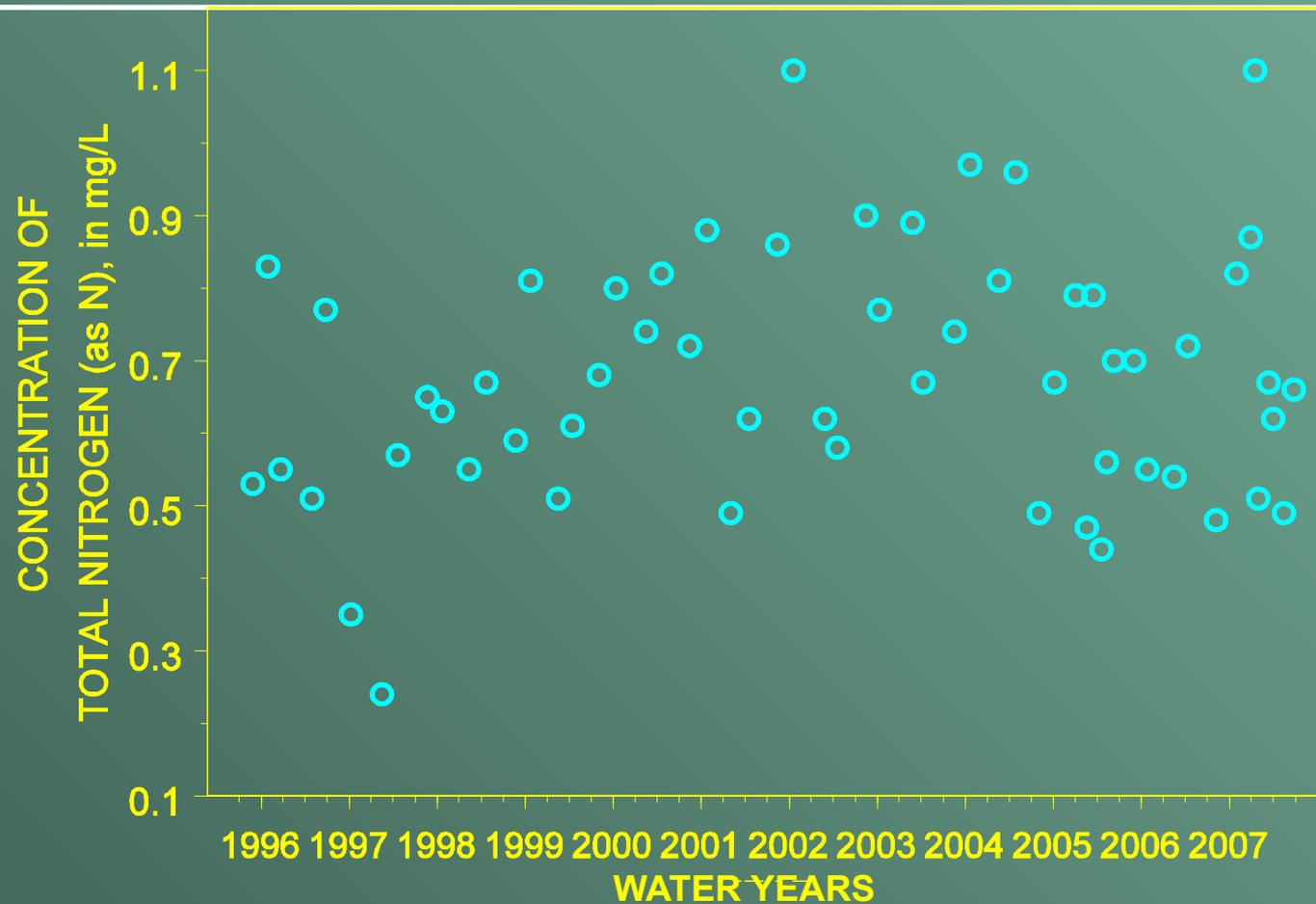
Total Phosphorus Concentration 1996-2007



Study sites

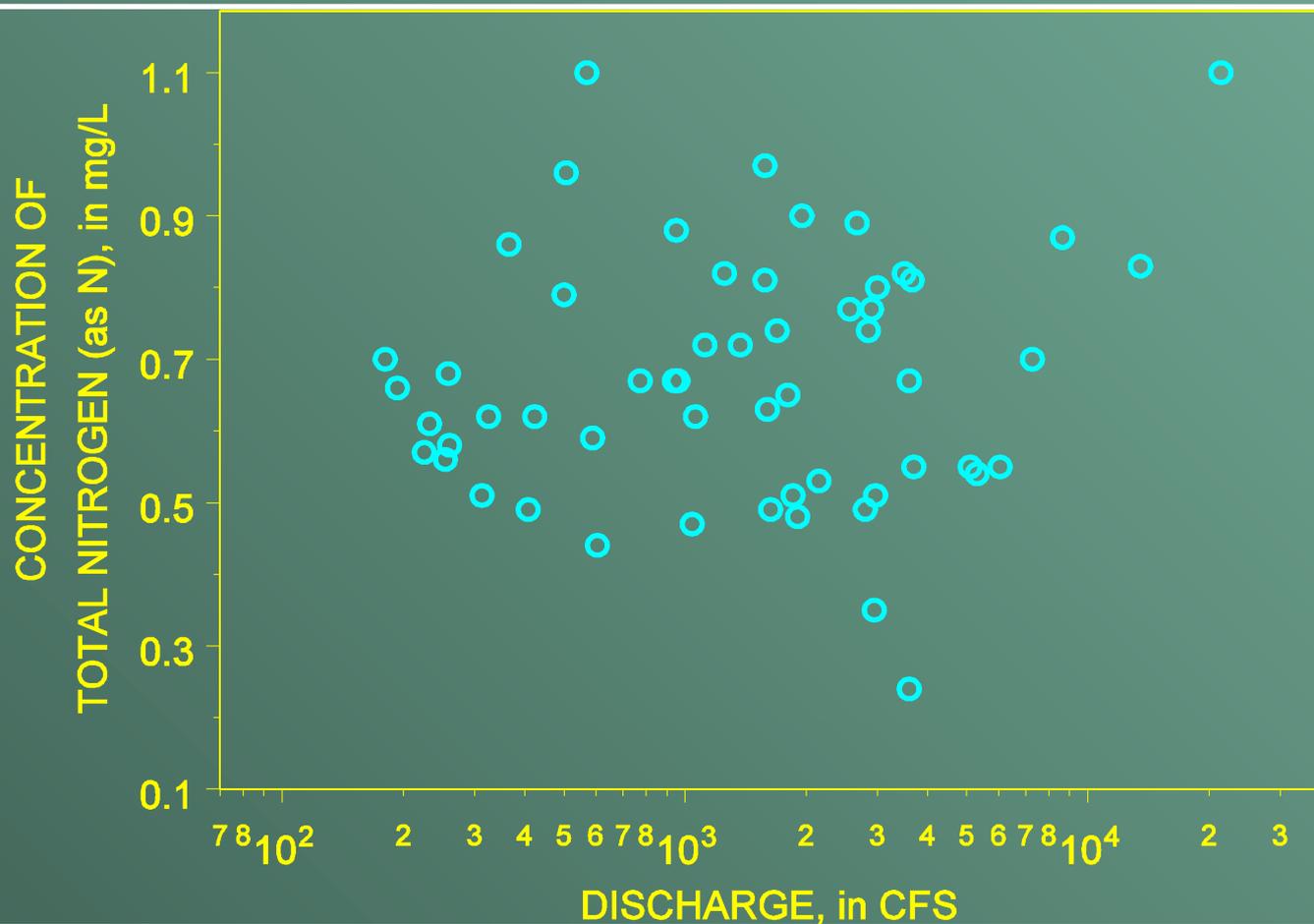
- **Housatonic River near New Milford**
- **Still River at Brookfield Center**
- **Shepaug River at Roxbury**

Housatonic River near New Milford, CT Total Nitrogen Concentrations 1996-2007

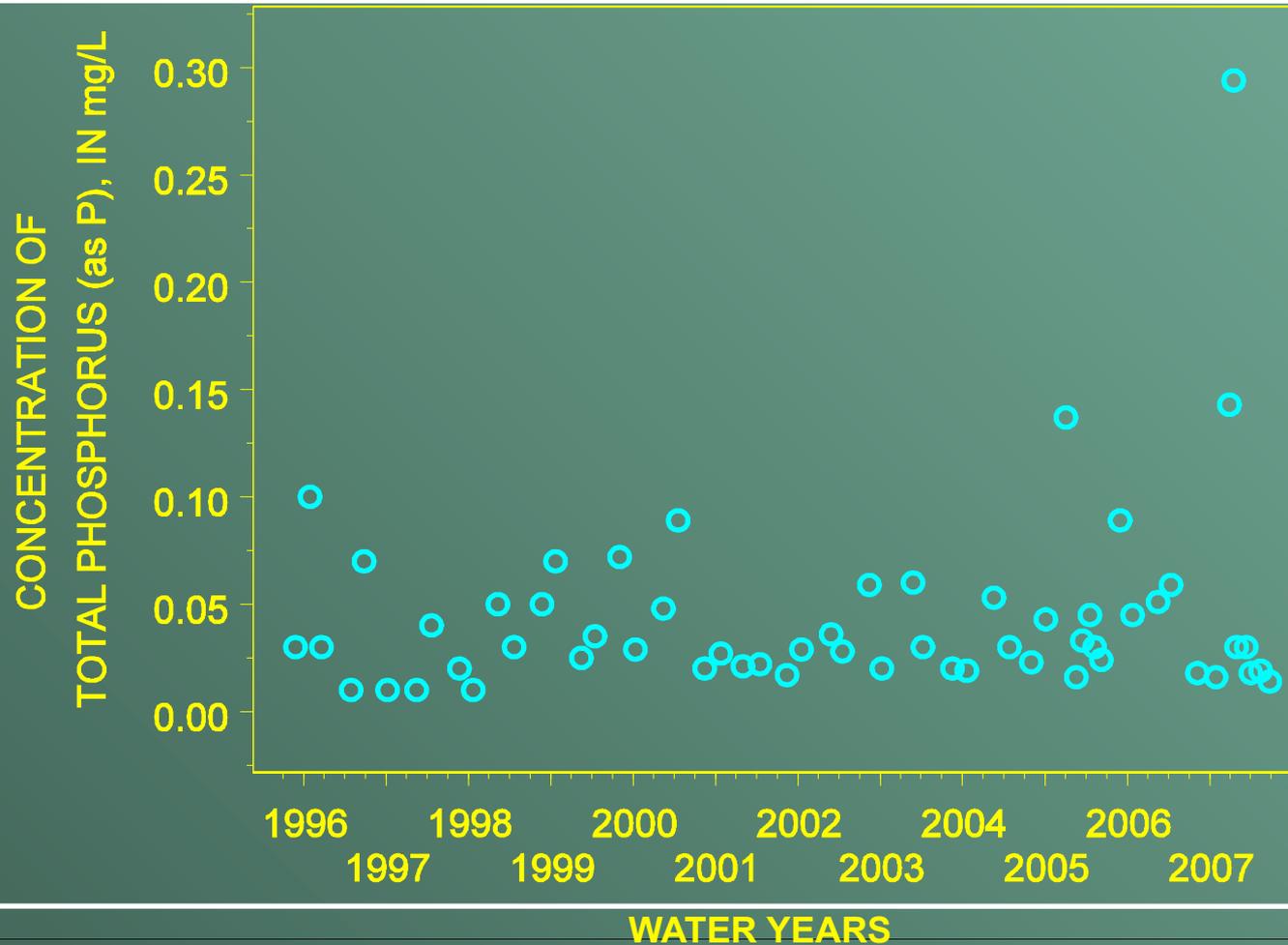


Housatonic River near New Milford, CT

Total Nitrogen Concentration Relative to Discharge

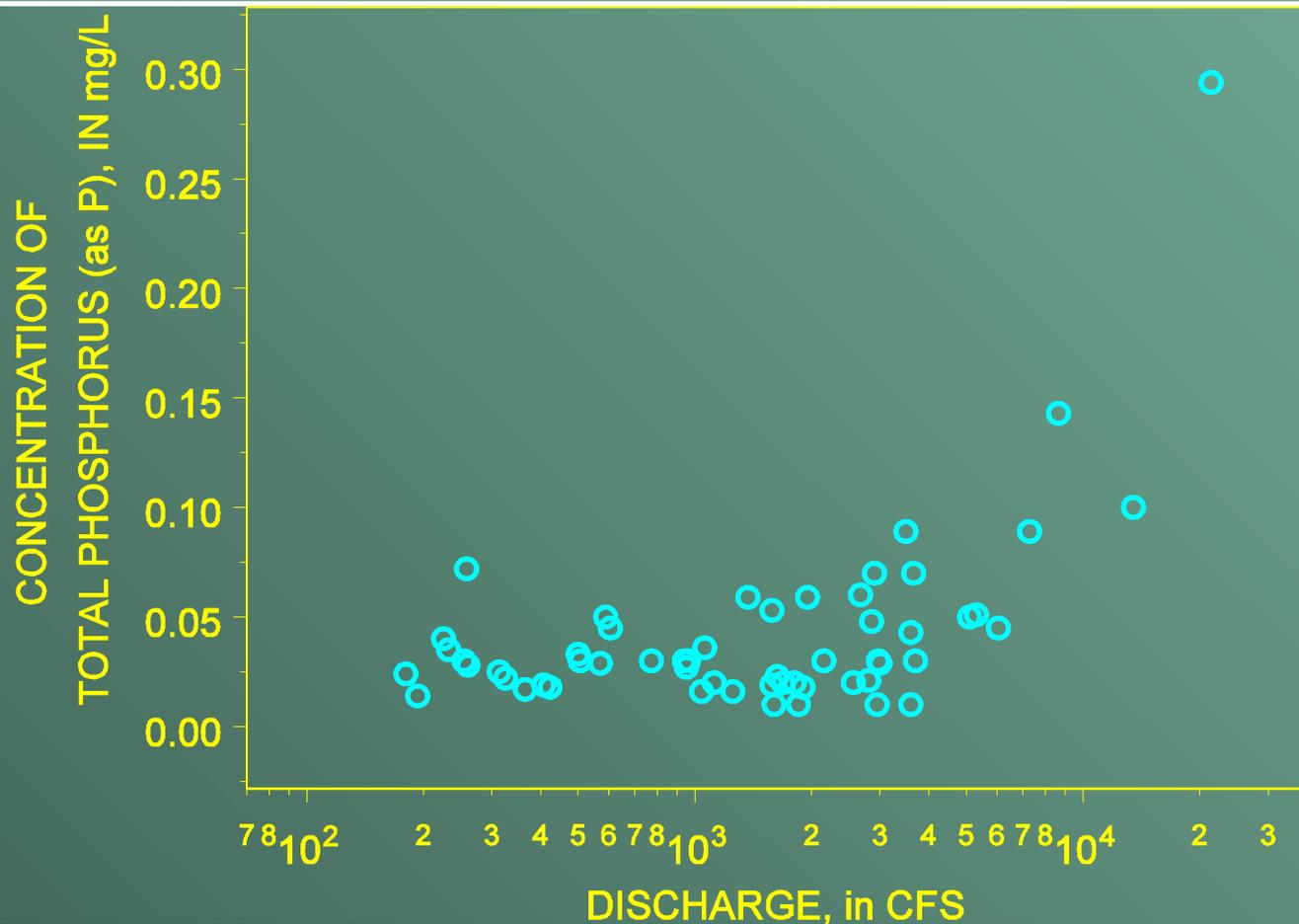


Housatonic River near New Milford, CT Total Phosphorus Concentration 1996-2007



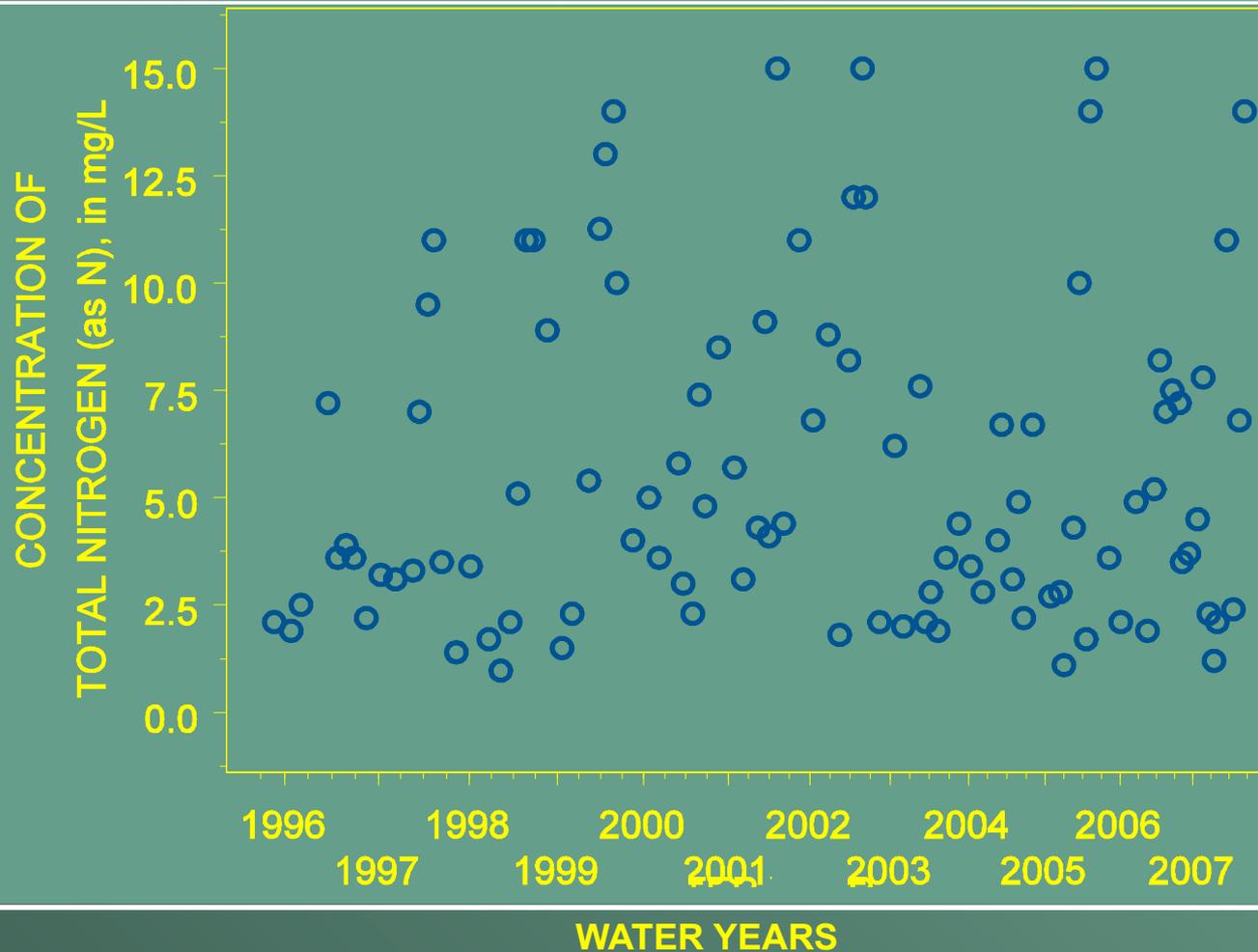
Housatonic River near New Milford, CT

Total Phosphorus Concentration Relative to Discharge



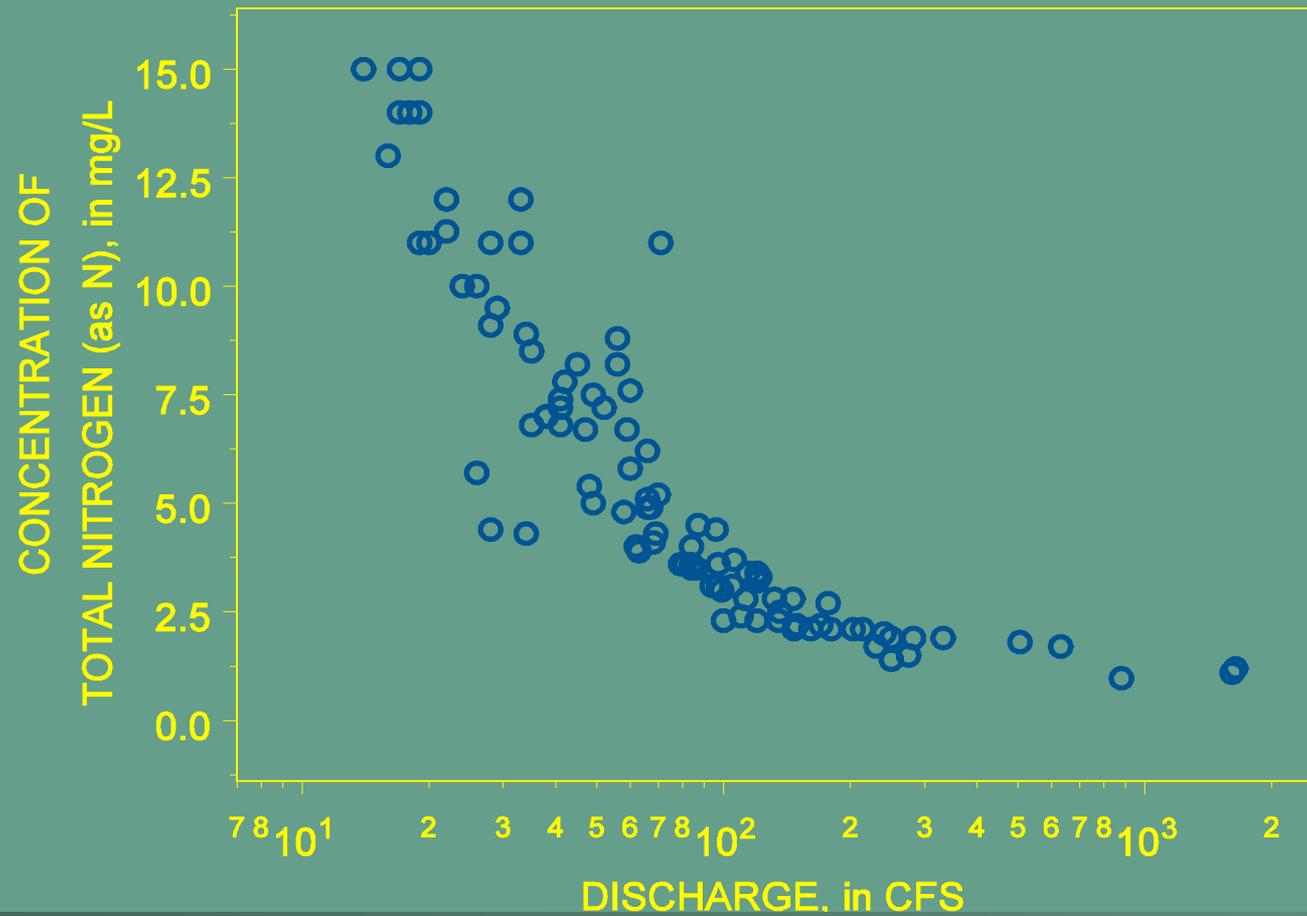
Still River at Brookfield Center, CT

Total Nitrogen Concentration 1996-2007



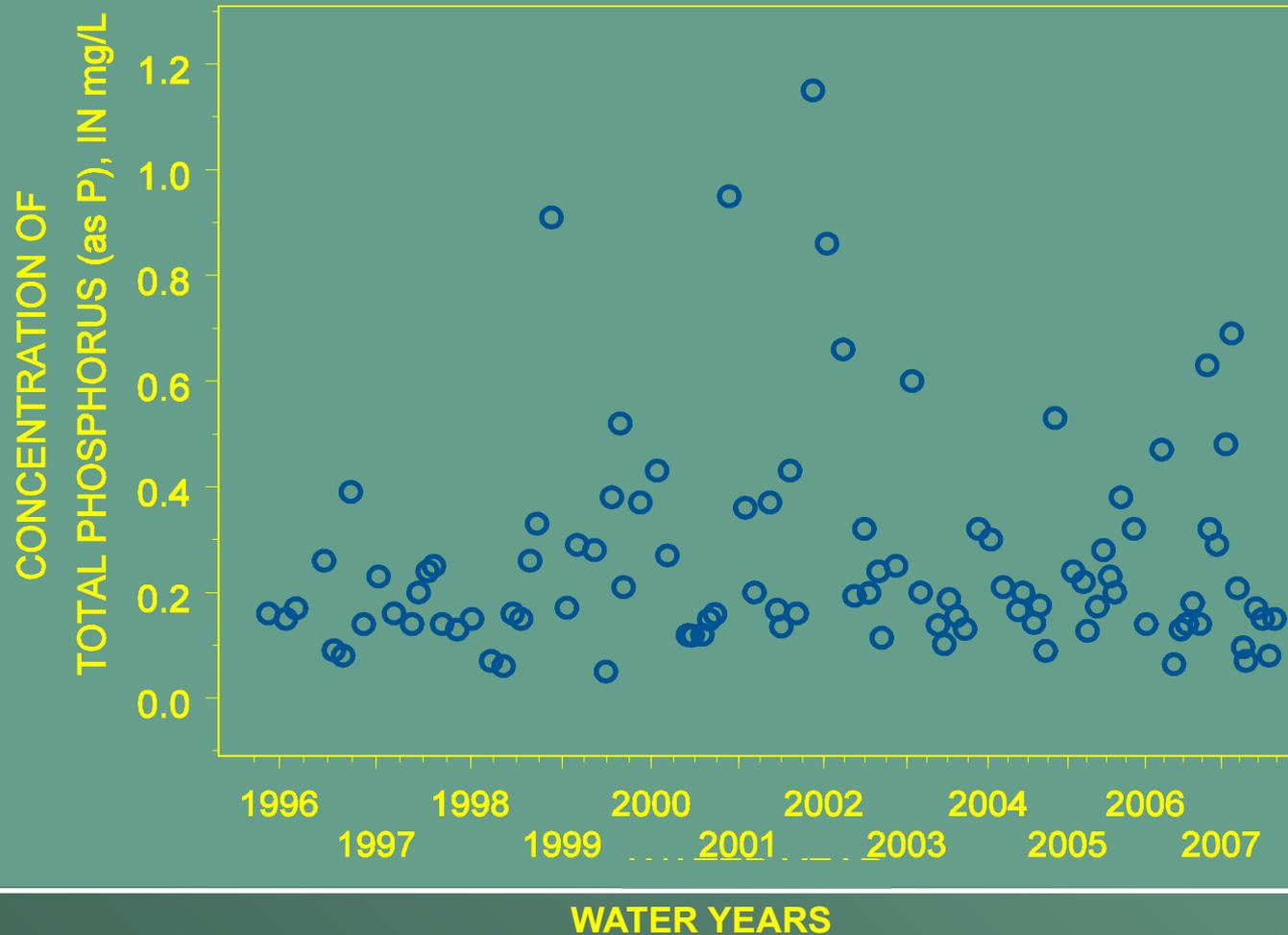
Still River at Brookfield Center, CT

Total Nitrogen Concentration Relative to Discharge



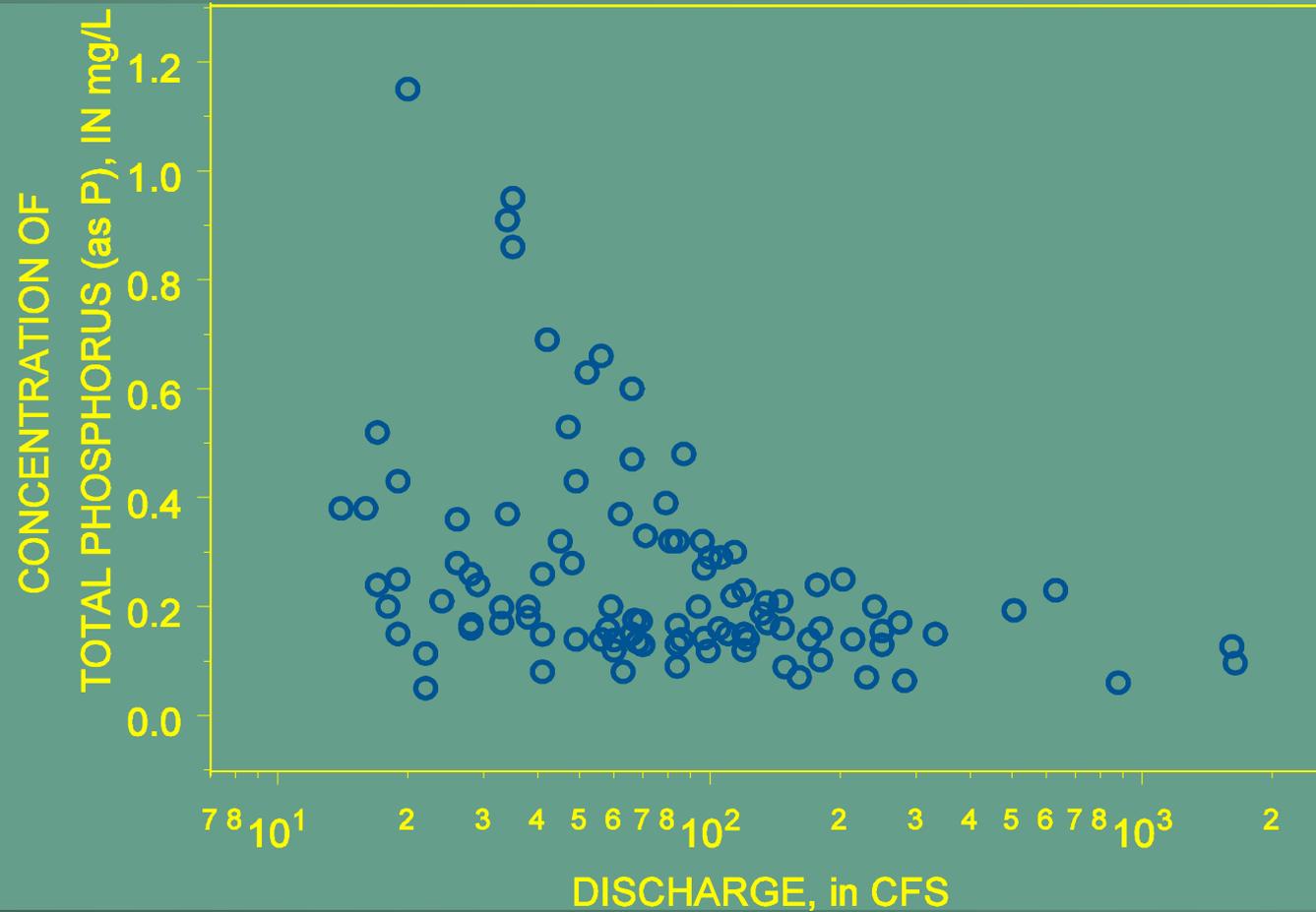
Still River at Brookfield Center, CT

Total Phosphorus Concentration 1996-07



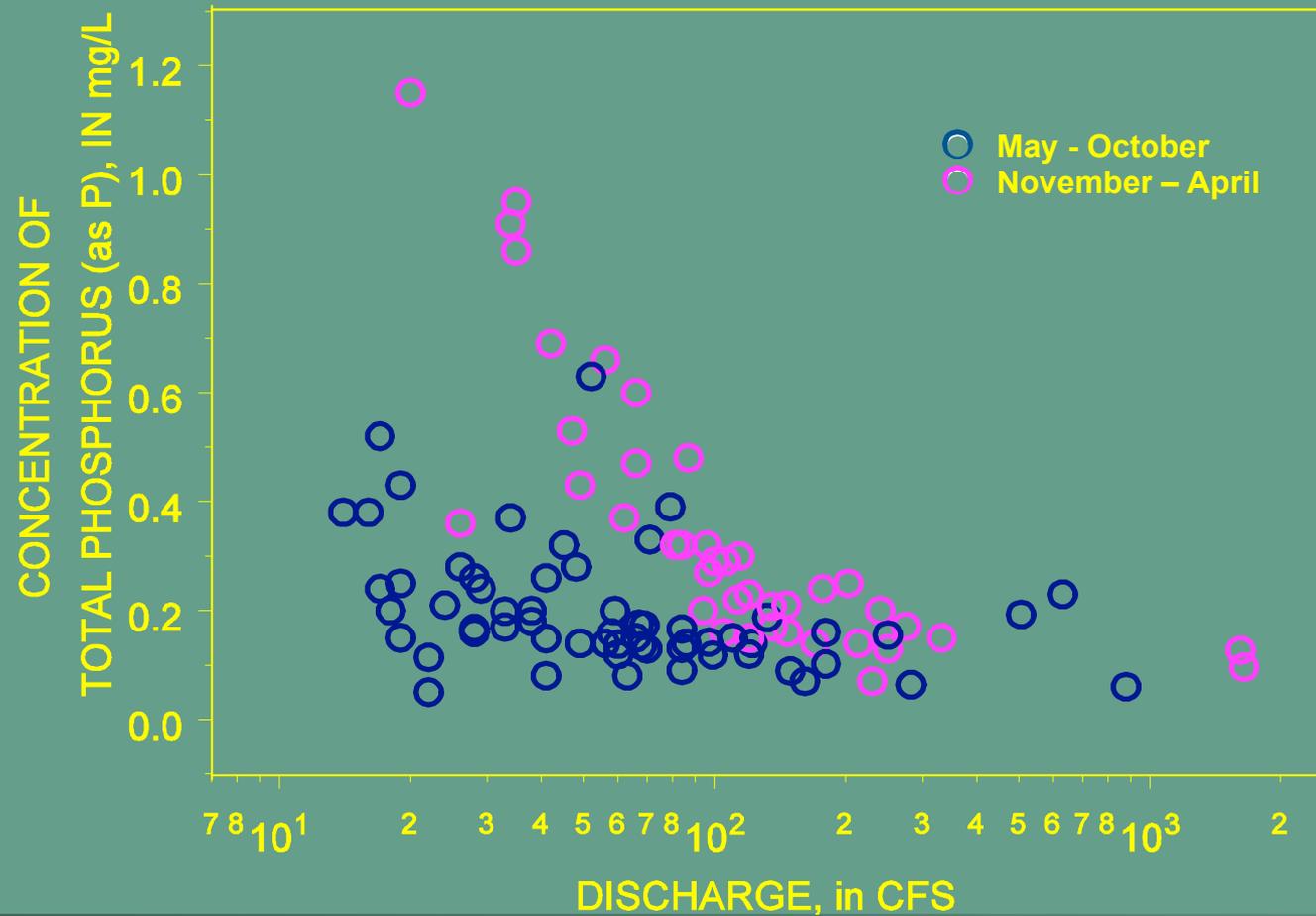
Still River at Brookfield Center, CT

Total Phosphorus Concentration Relative to Discharge



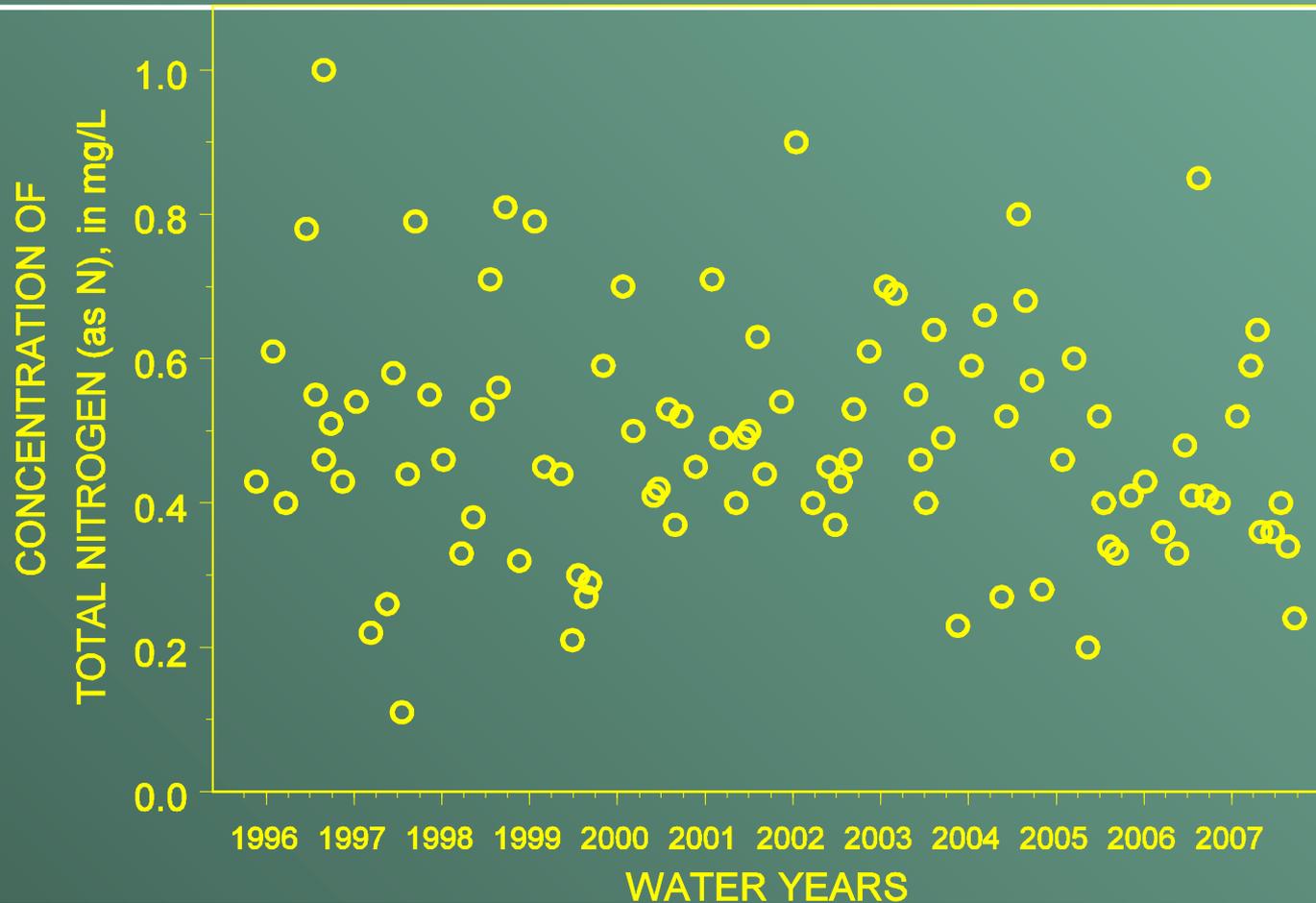
Still River at Brookfield Center, CT

Total Phosphorus Concentration Relative to Discharge



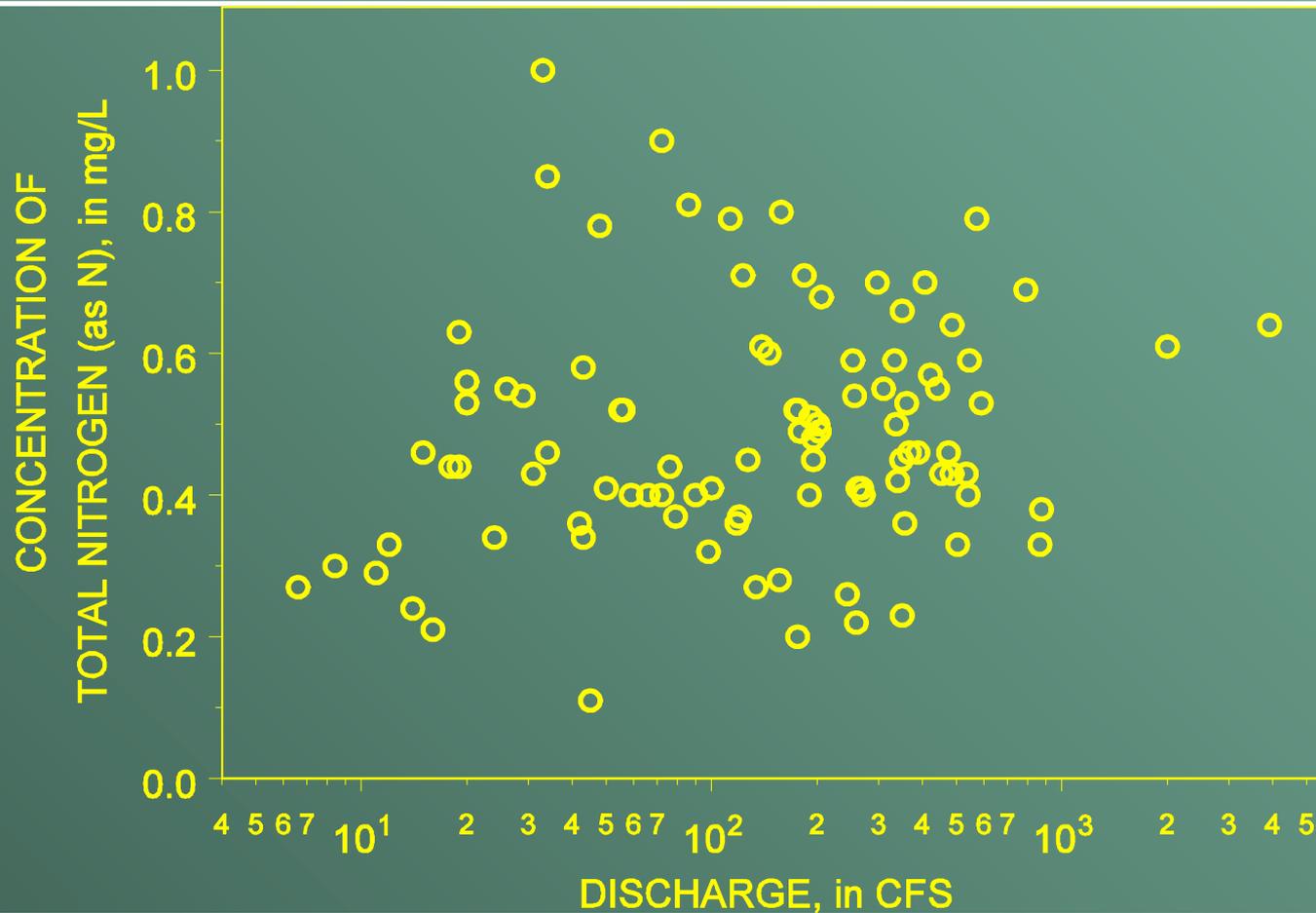
Shepaug River near Roxbury, CT

Total Nitrogen Concentration 1996-2007



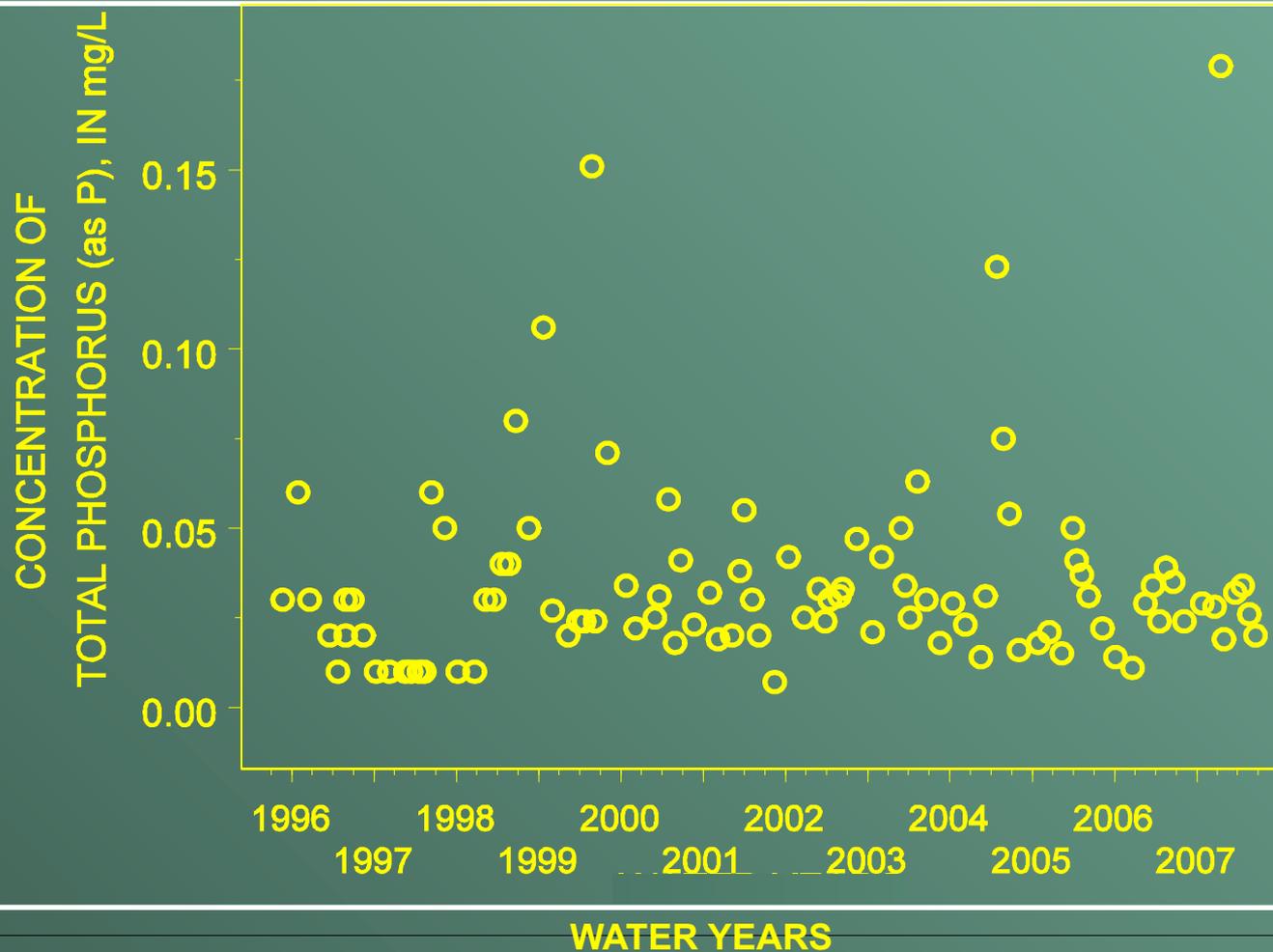
Shepaug River near Roxbury, CT

Total Nitrogen Concentration Relative to Discharge



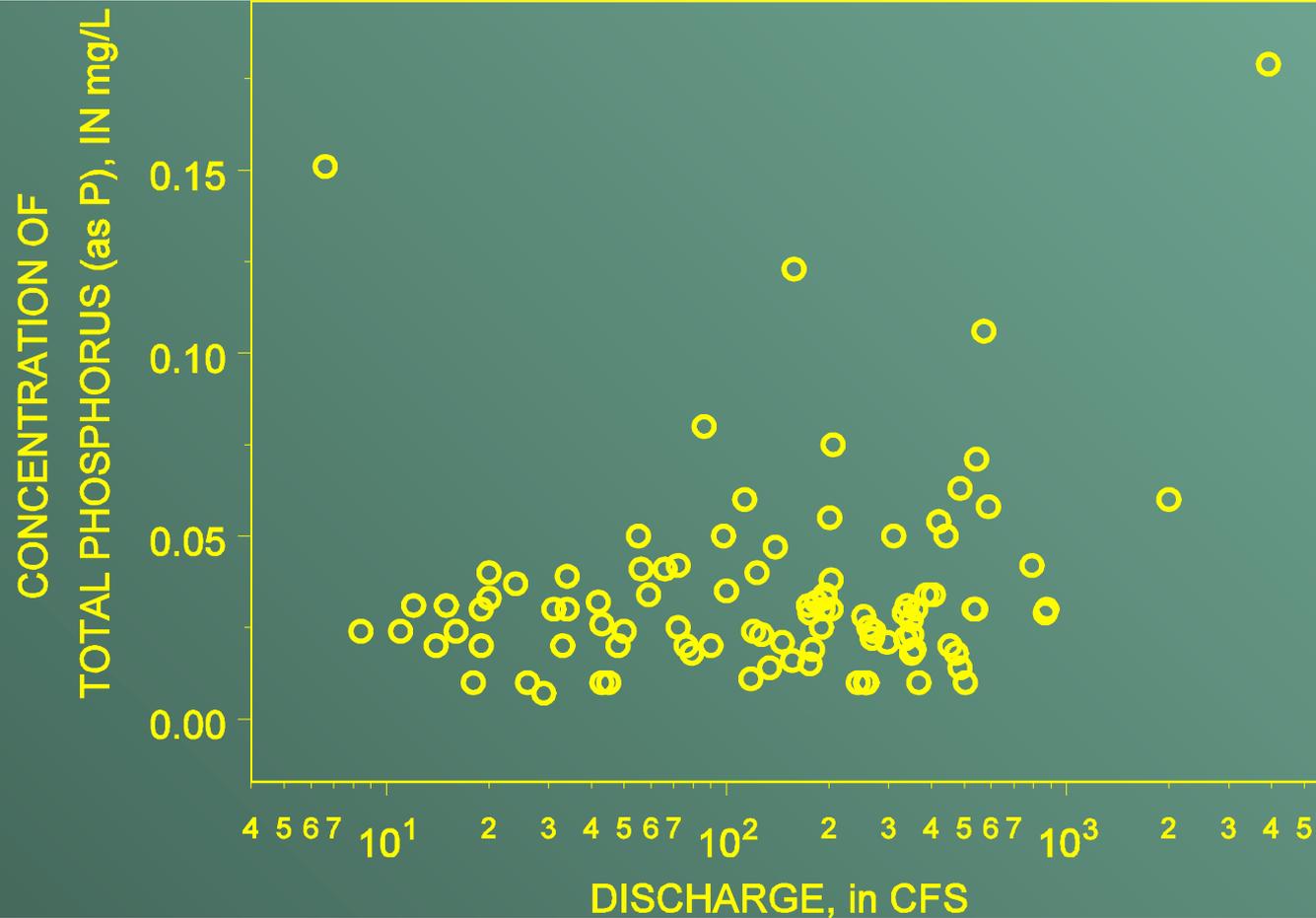
Shepaug River near Roxbury, CT

Total Phosphorus Concentration 1996-2007

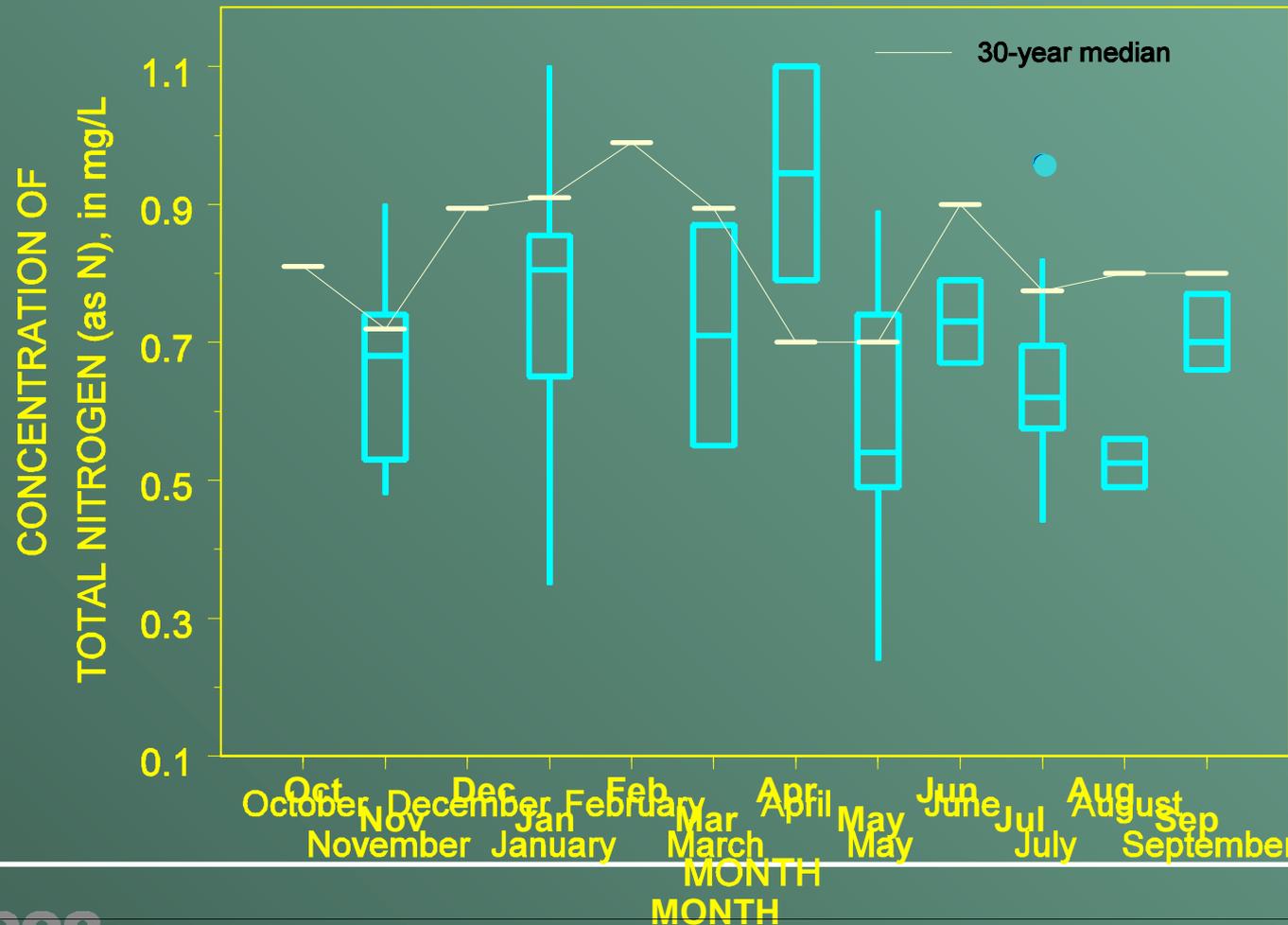


Shepaug River near Roxbury, CT

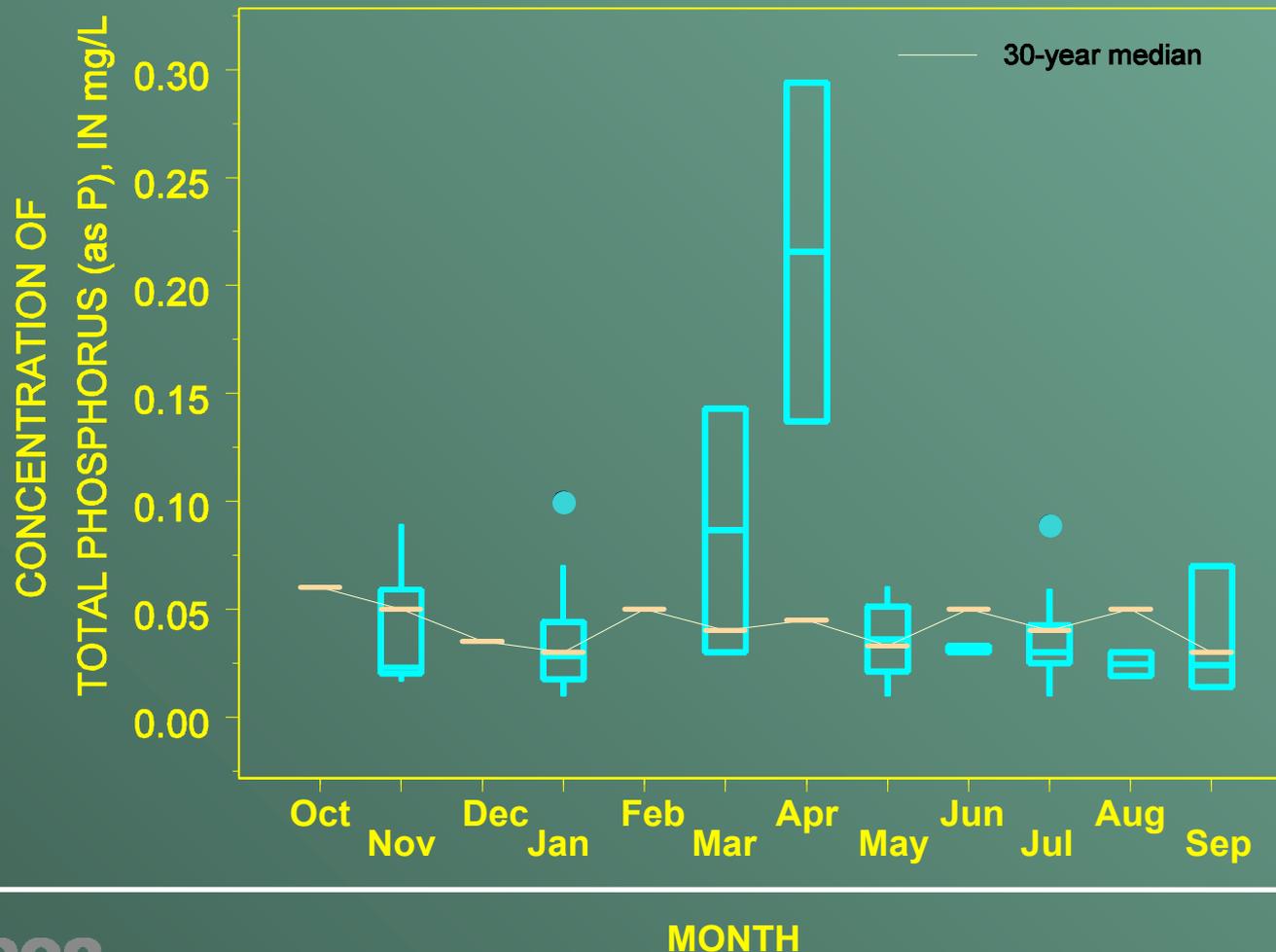
Total Phosphorus Concentration Relative to Discharge



Housatonic River near New Milford, CT Total Nitrogen Concentration 1996-2007

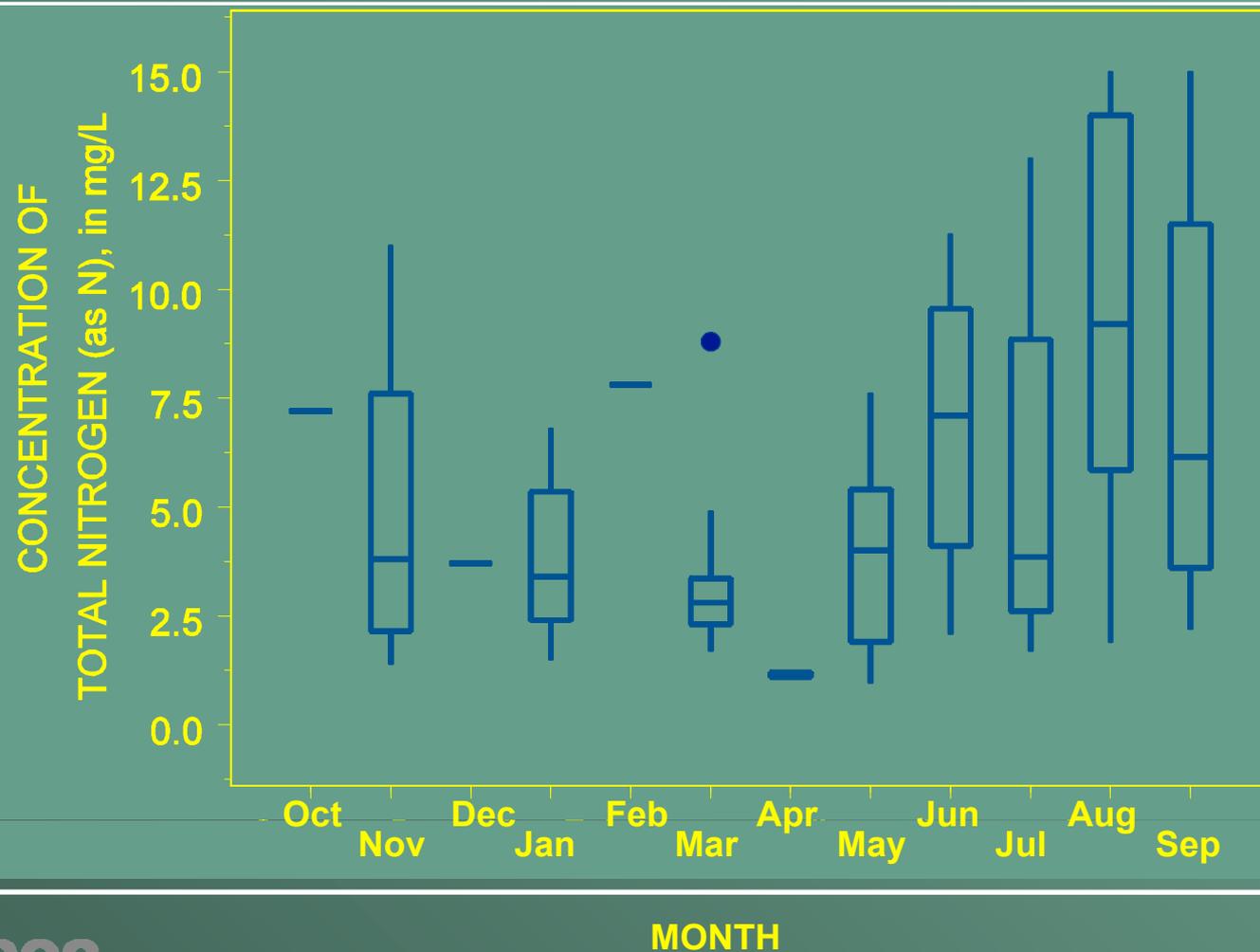


Housatonic River near New Milford, CT Total Phosphorus Concentration 1996-2007



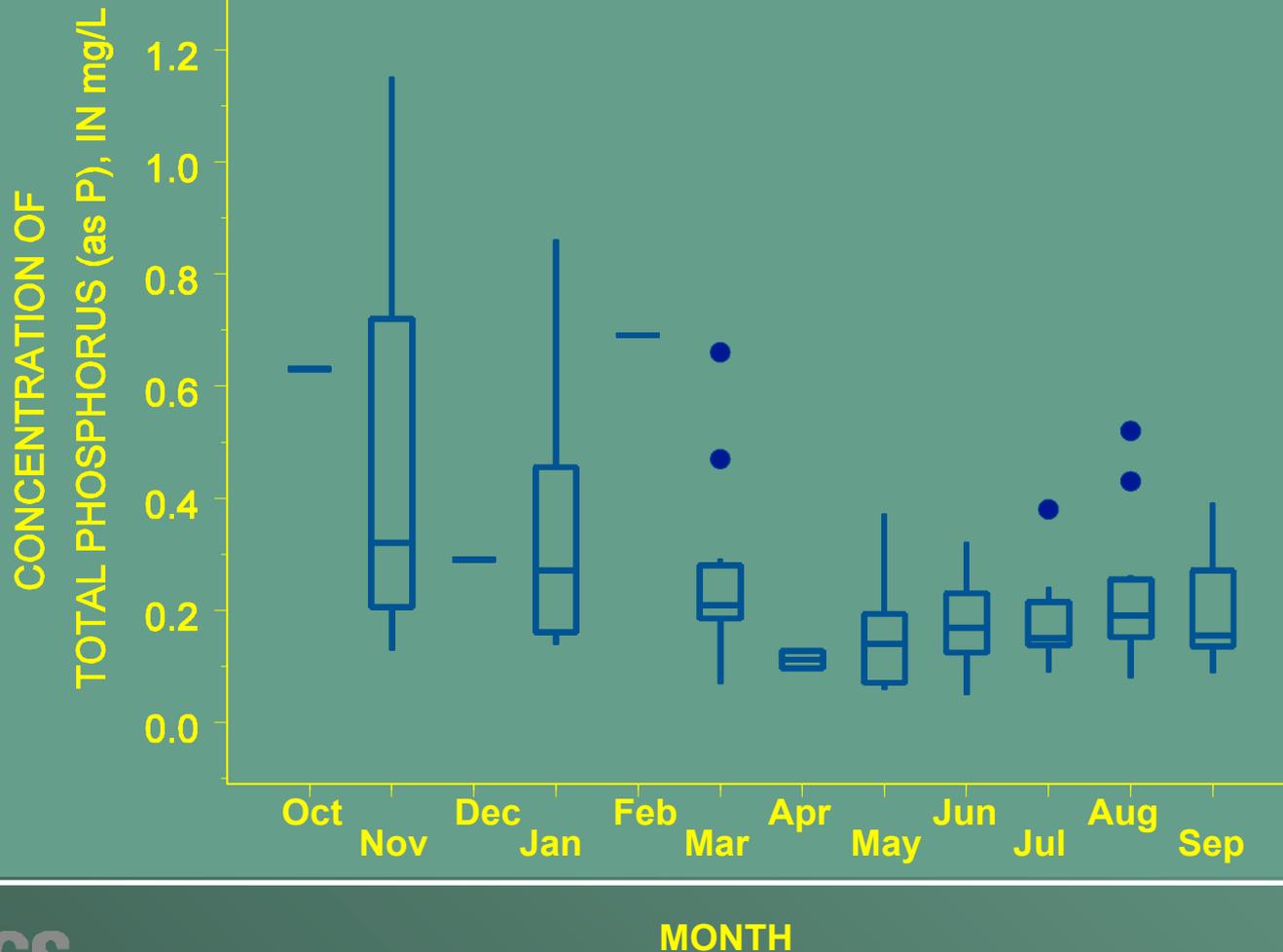
Still River at Brookfield Center, CT

Total Nitrogen Concentration 1996-2007



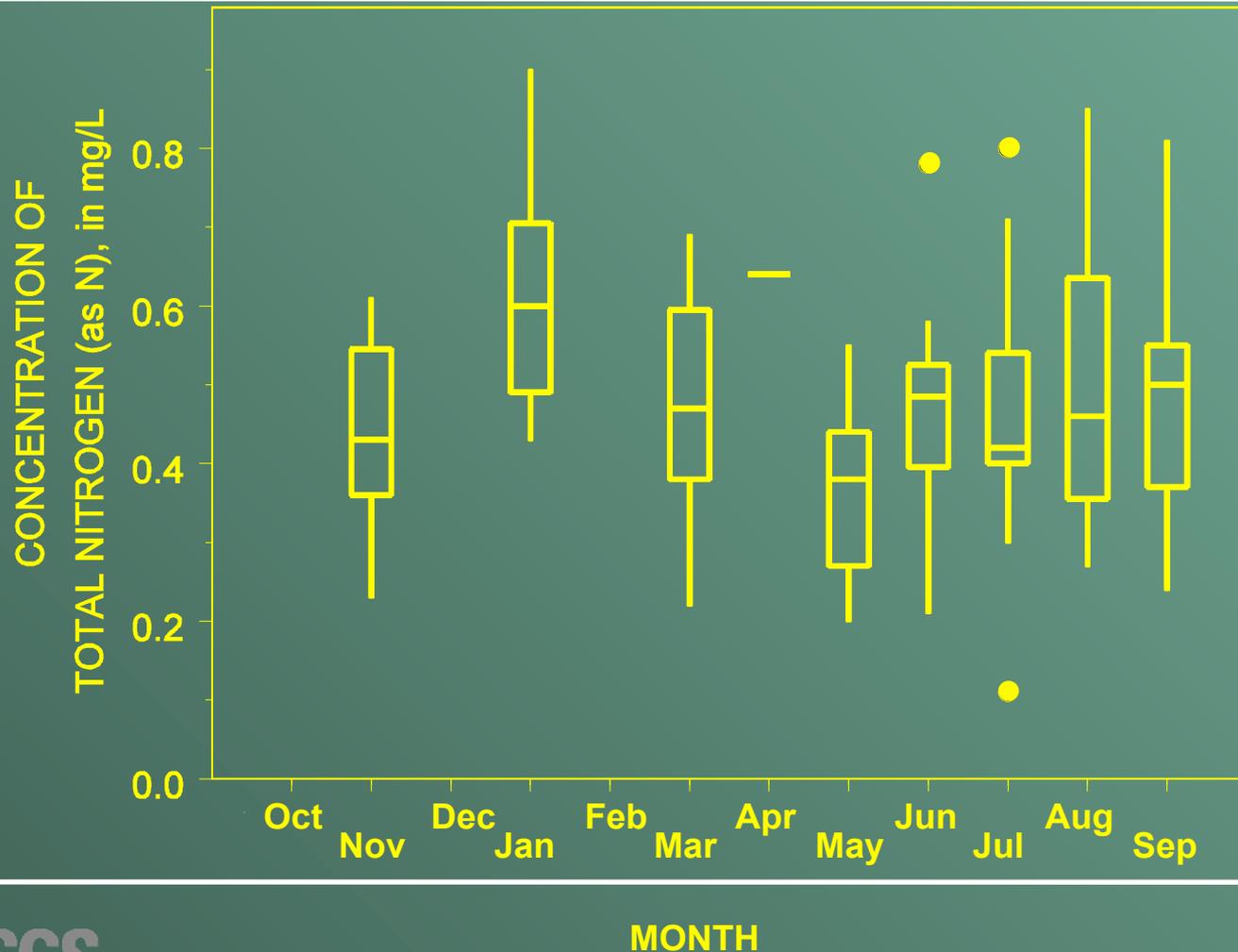
Still River at Brookfield Center, CT

Total Phosphorus Concentration 1996-2007



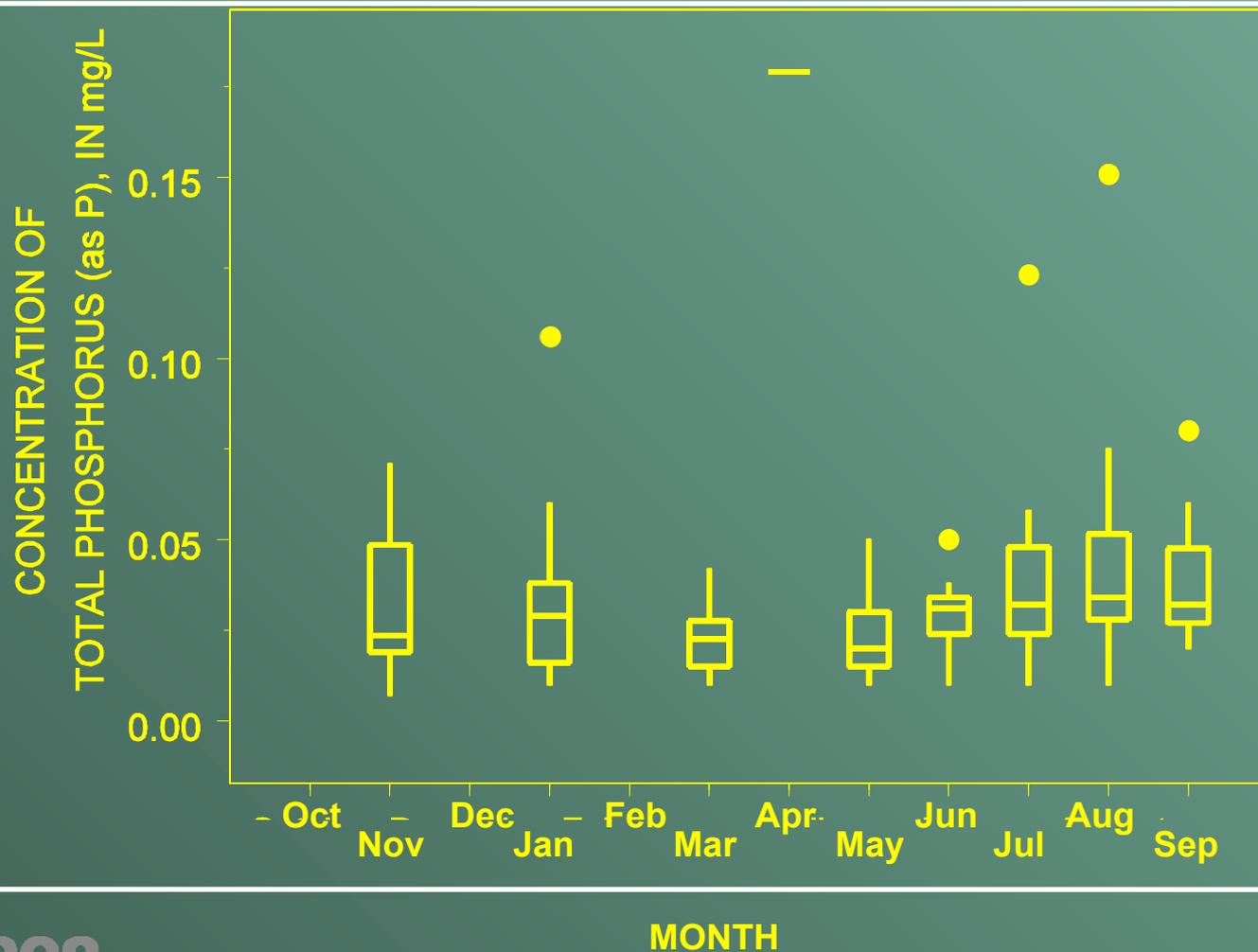
Shepaug River near Roxbury, CT

Total Nitrogen Concentration 1996-2007



Shepaug River near Roxbury, CT

Total Phosphorus Concentration 1996-2007



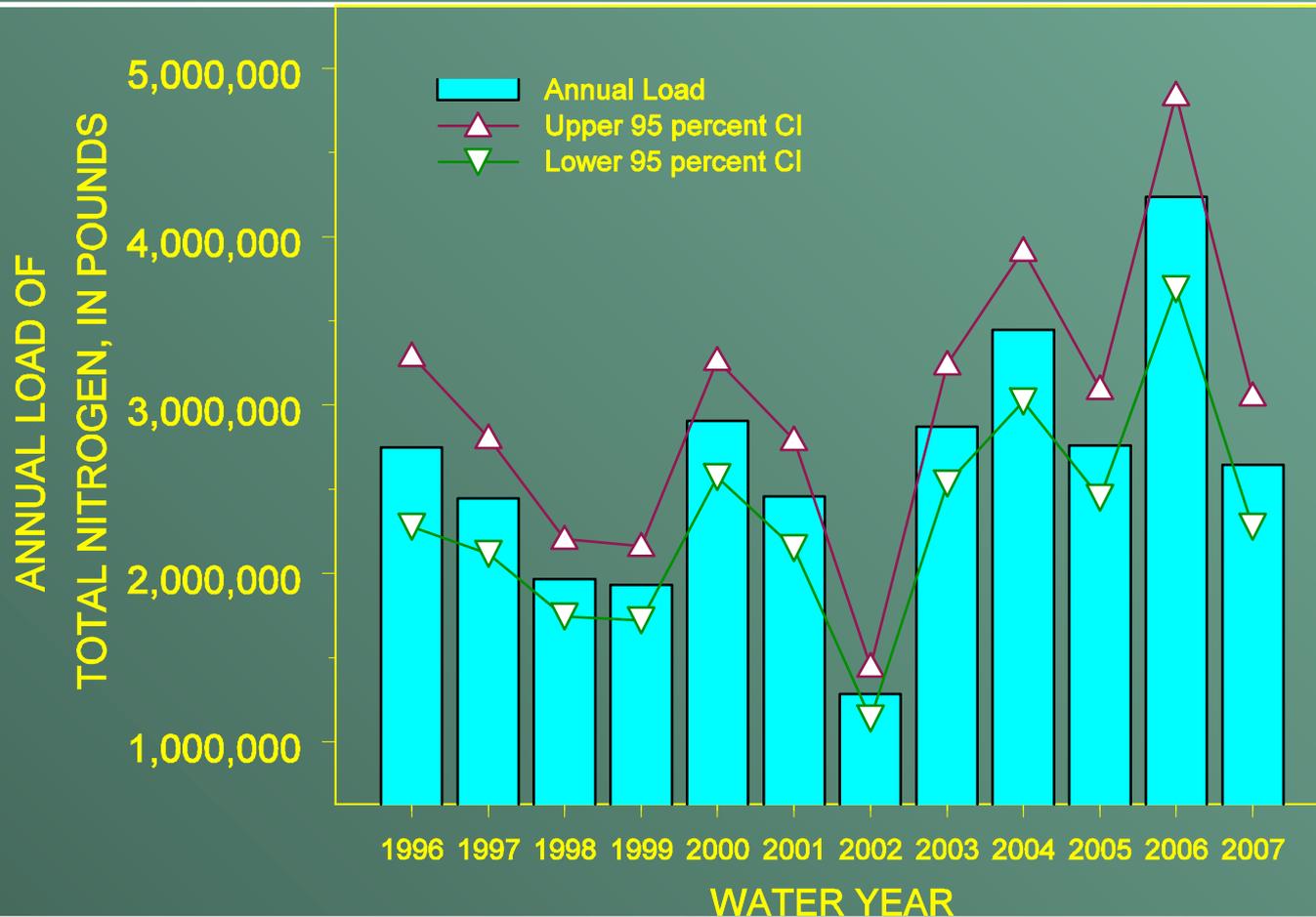
Constituent Load Calculations

LOADEST a regression based model by R.L. Runkel and others, 2004

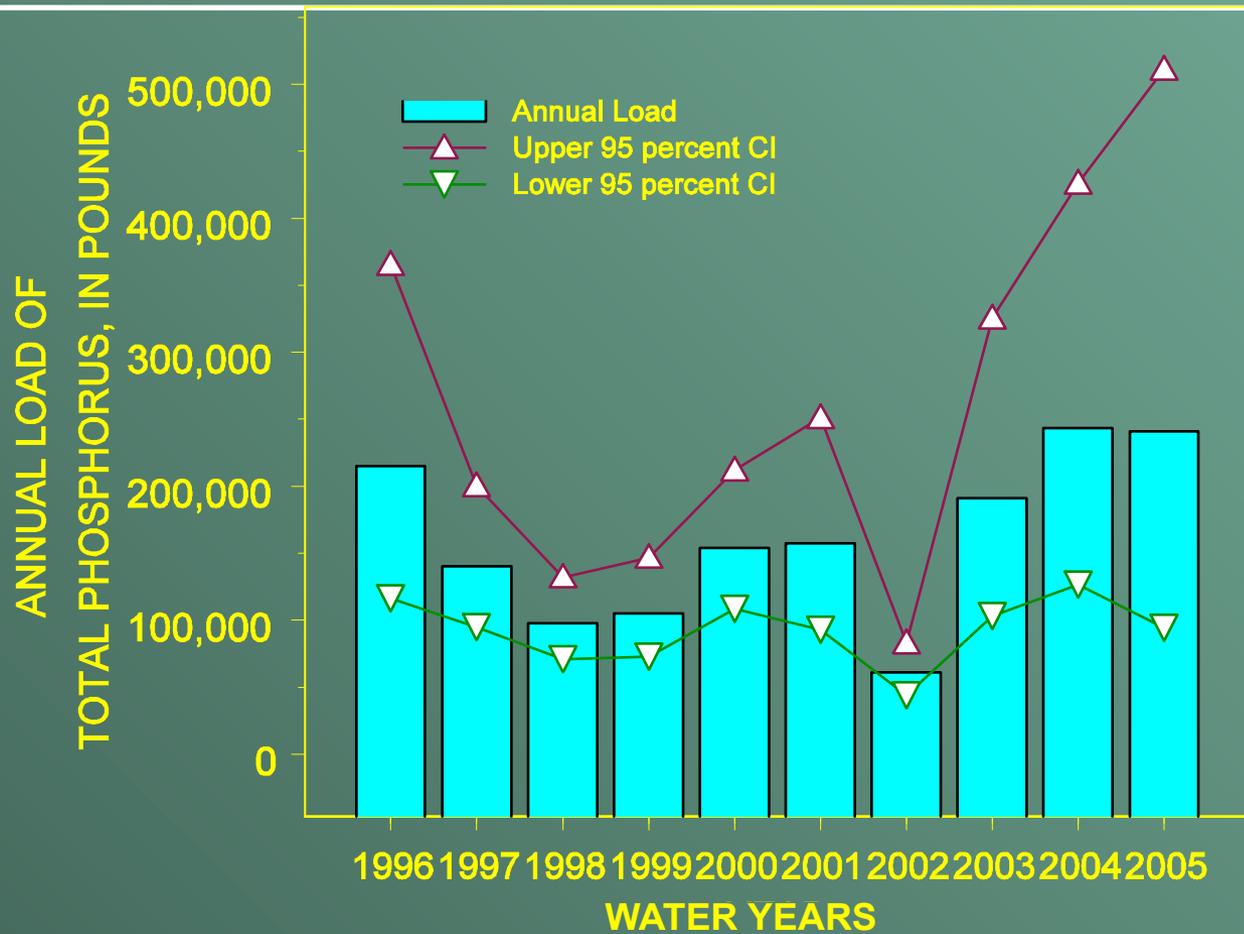
Regression model terms

- **Streamflow**
- **Time**
- **Seasonality**

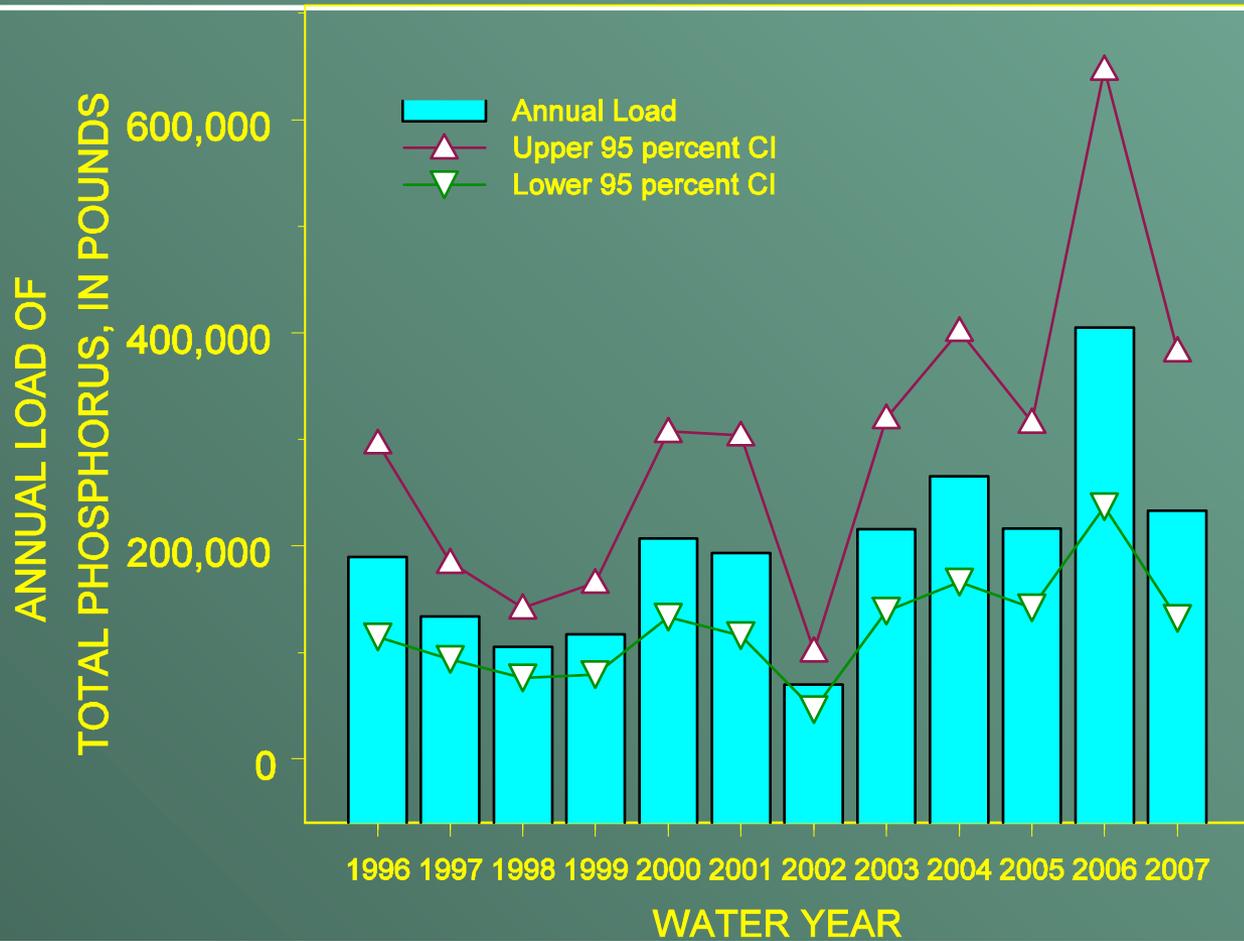
Housatonic River near New Milford, CT Annual Load of Total Nitrogen 1996-2007



Housatonic River near New Milford, CT Annual Load of Total Phosphorus 1996-2005

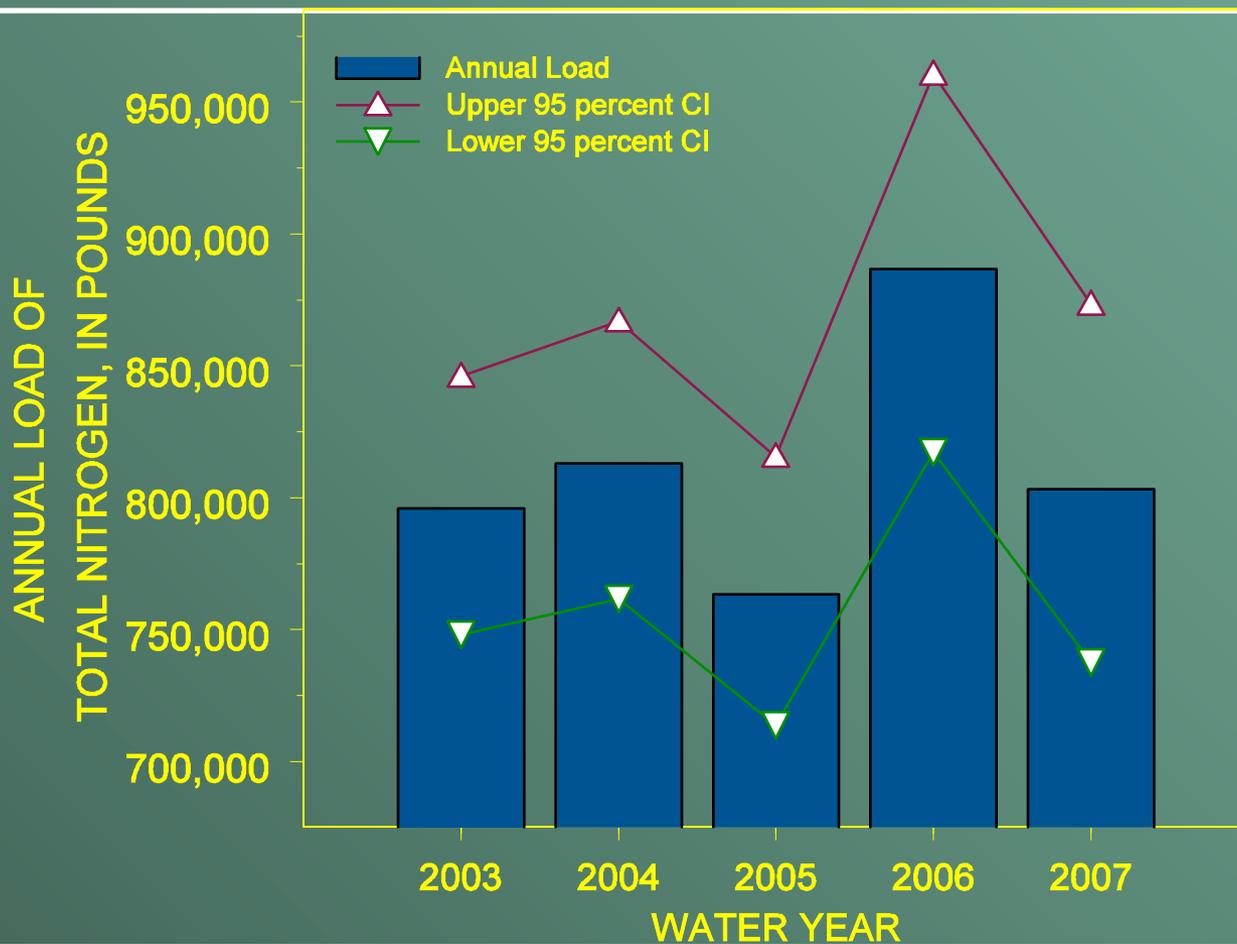


Housatonic River near New Milford, CT Annual Load of Total Phosphorus 1996-2007



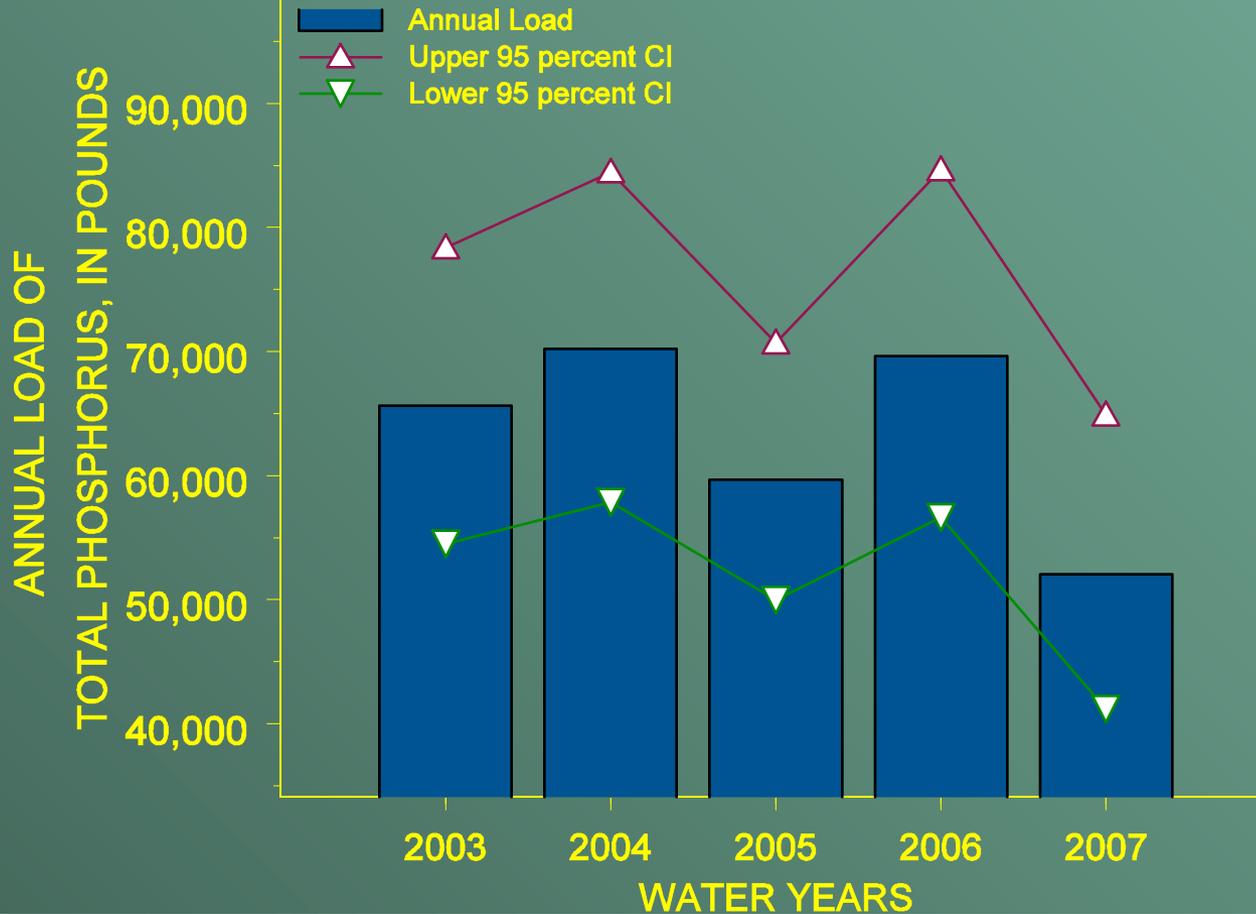
Still River at Brookfield Center, CT

Annual Load of Total Nitrogen 2003-2007



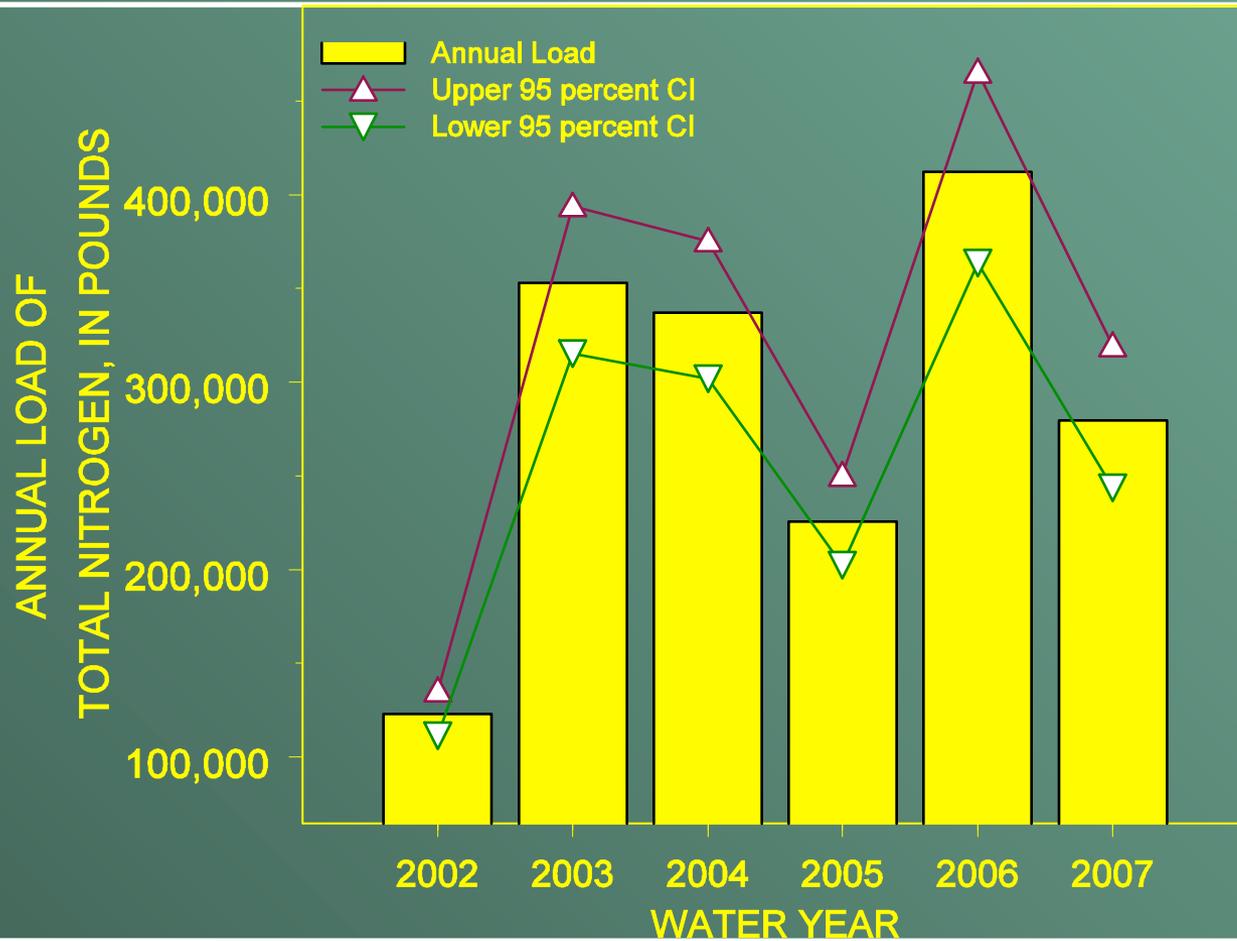
Still River at Brookfield Center, CT

Annual Load of Total Phosphorus 2003-2007



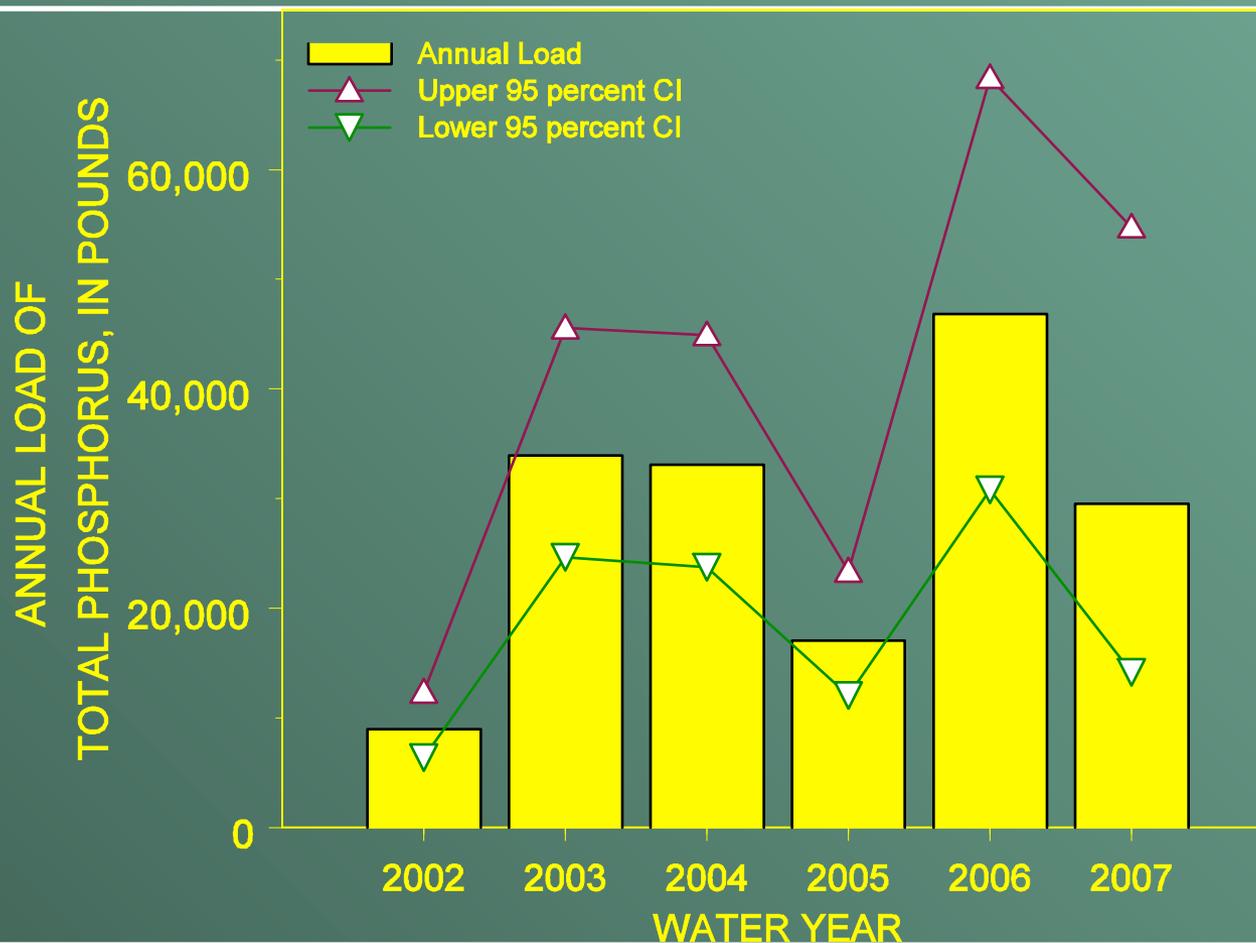
Shepaug River near Roxbury, CT

Annual Load of Total Nitrogen 2002-2007

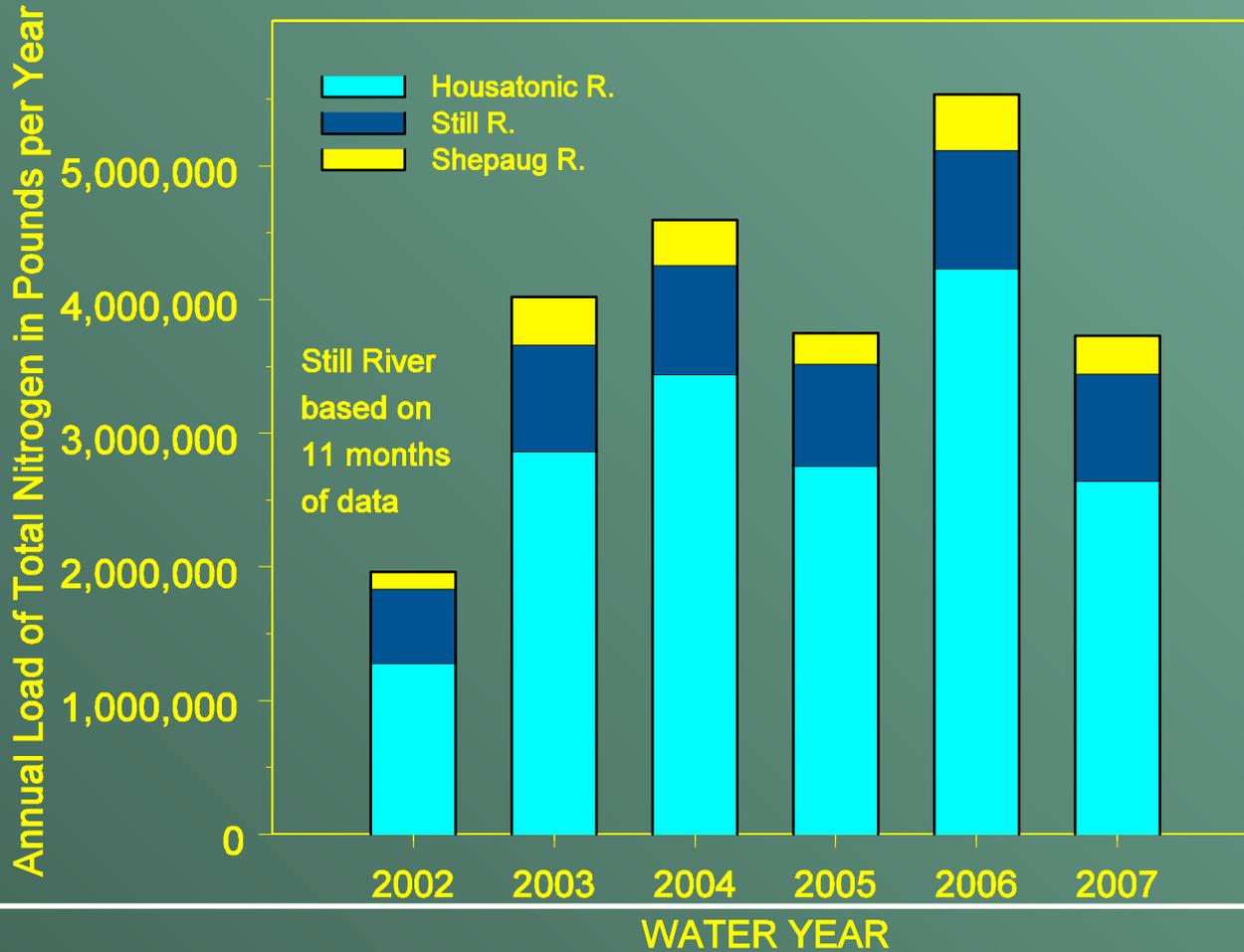


Shepaug River near Roxbury, CT

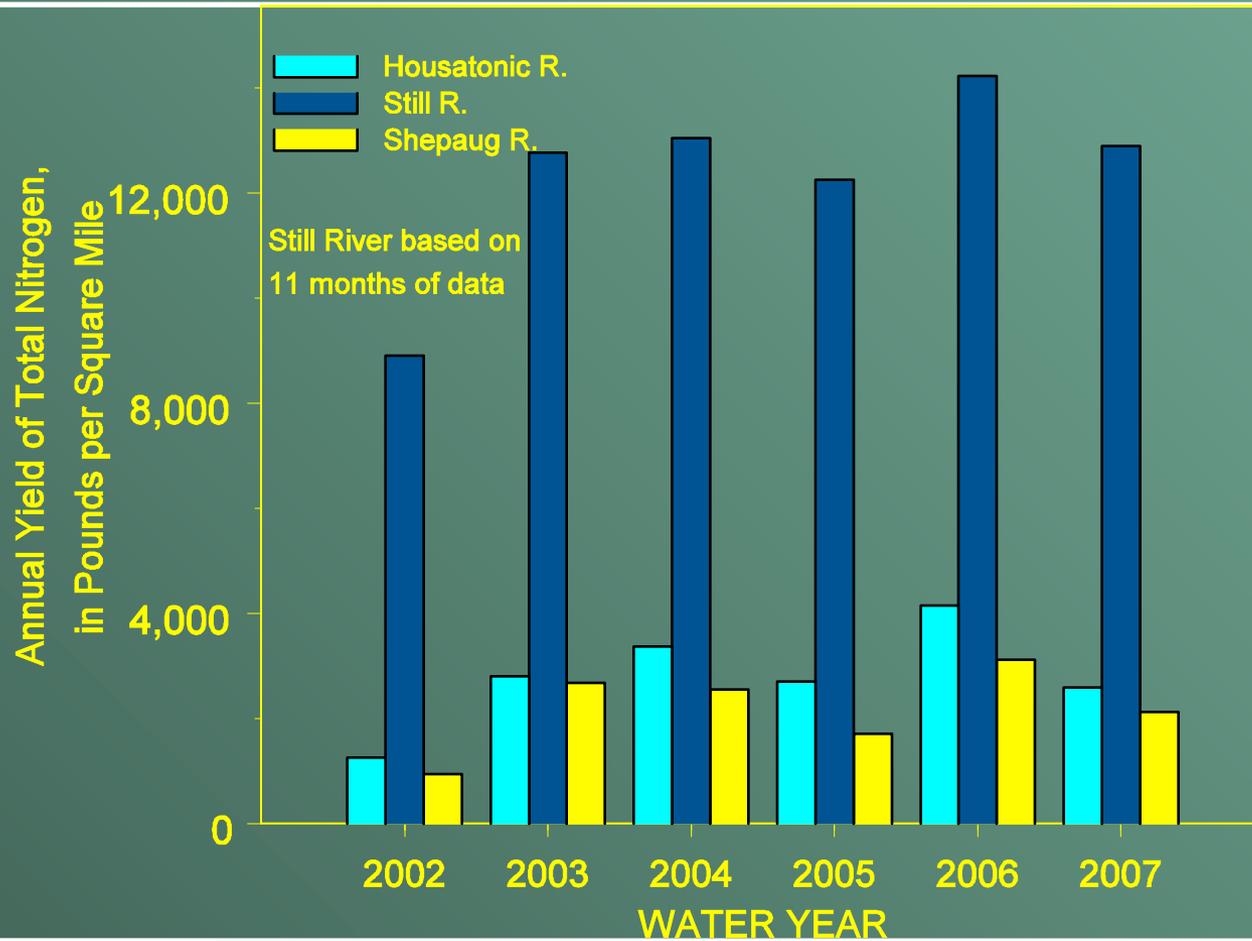
Annual Load of Total Phosphorus 2002-2007



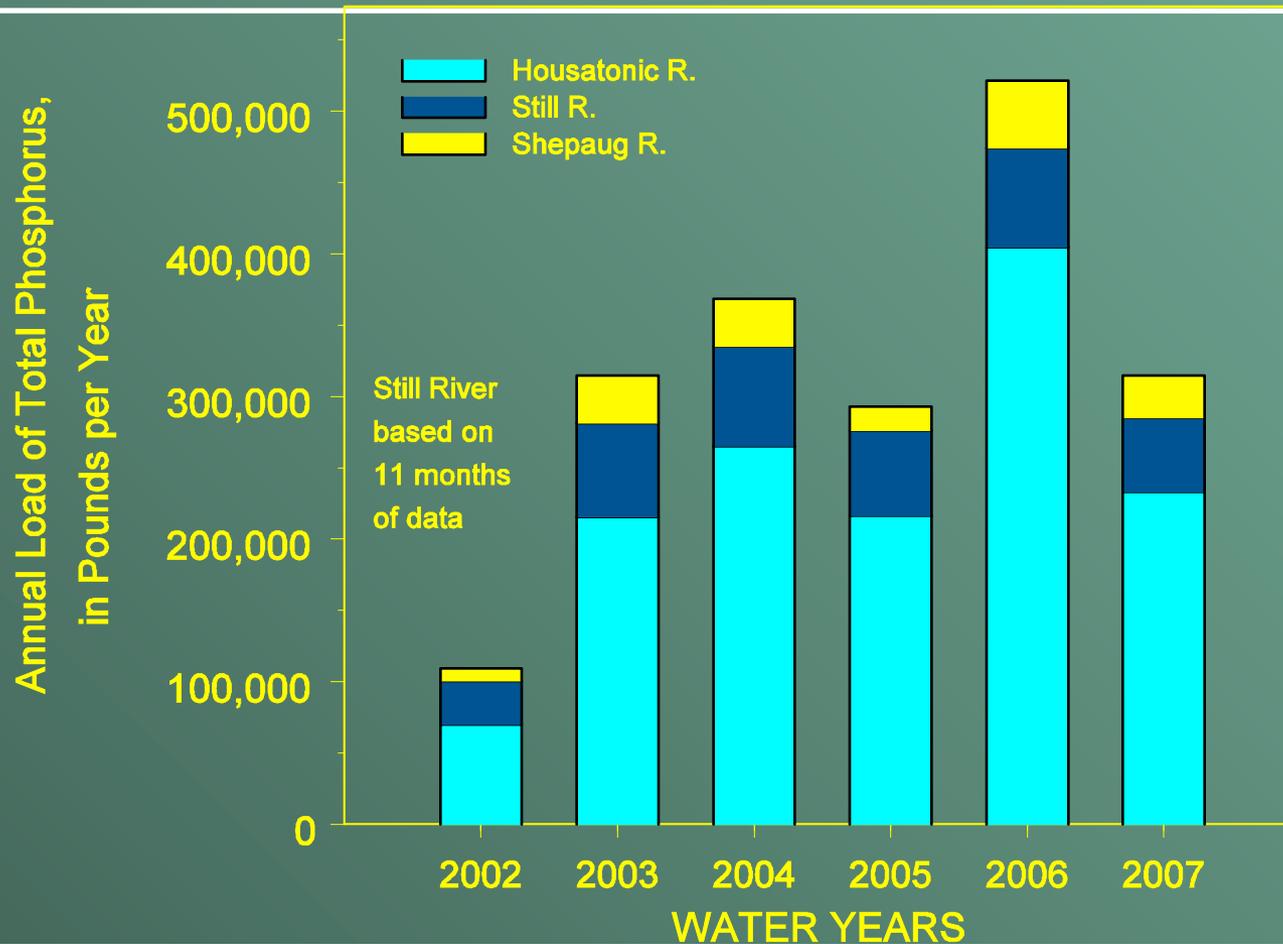
Annual Loads of Total Nitrogen 2002-2007



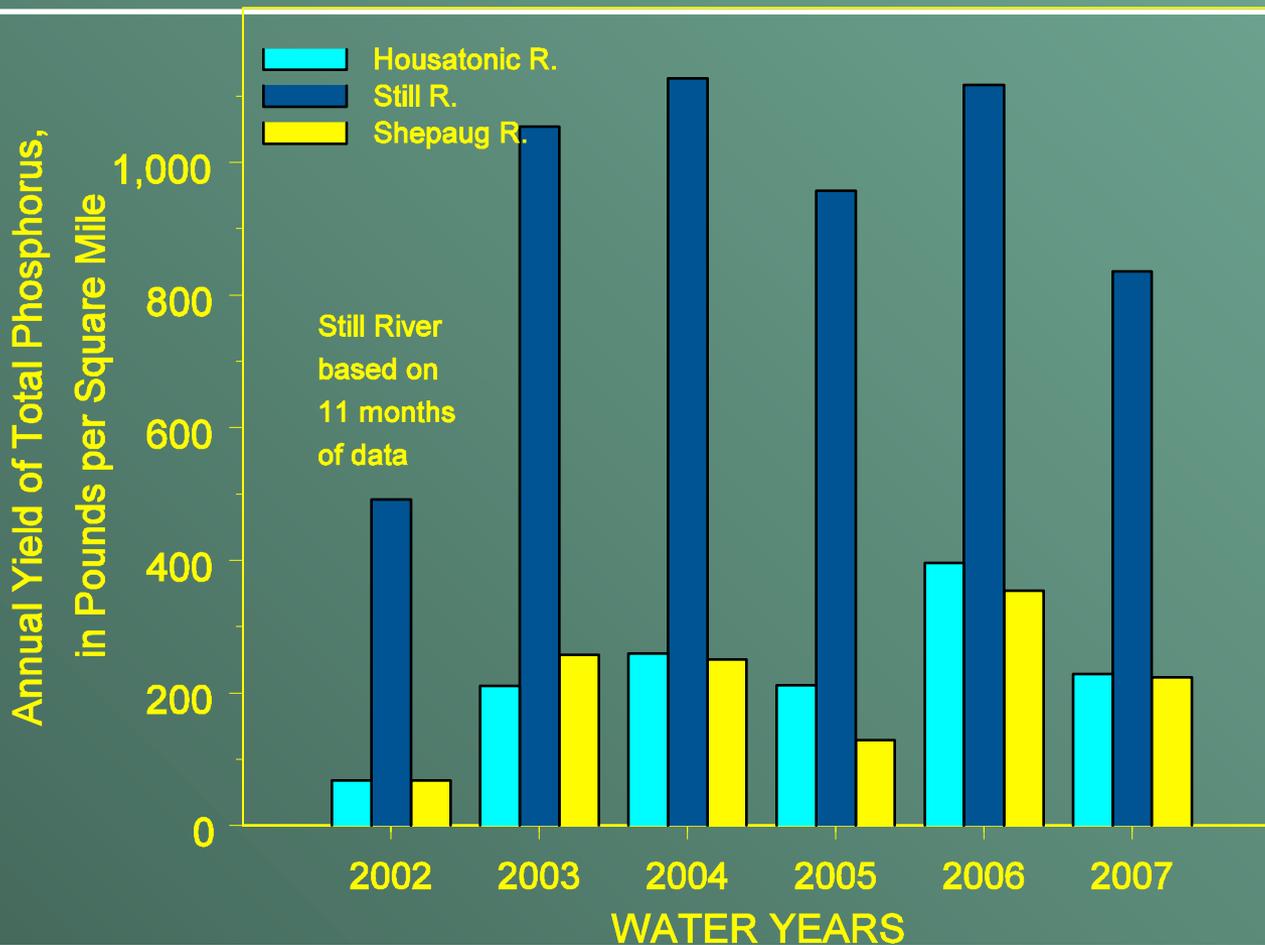
Annual Yields of Total Nitrogen 2002-2007



Annual Loads of Total Phosphorus 2002-2007



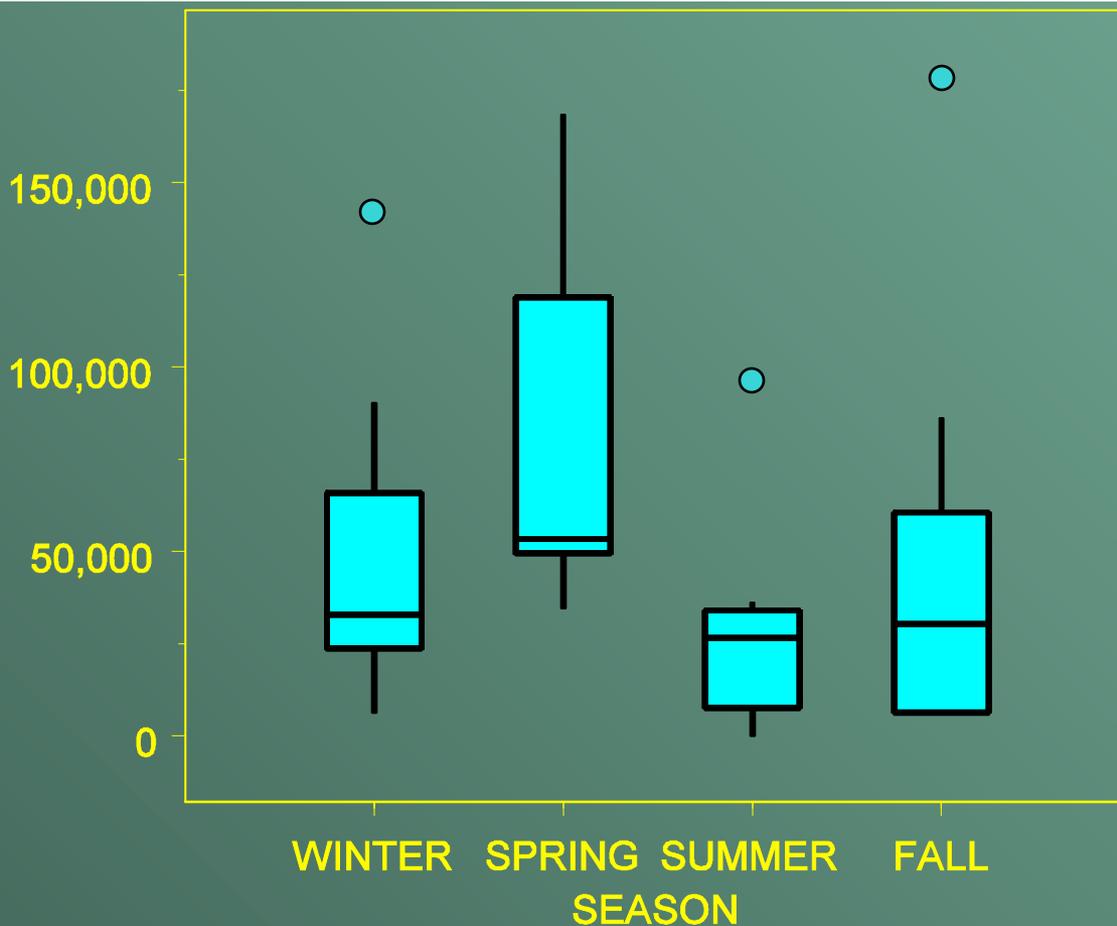
Annual Yields of Total Phosphorus 2002-2007



Housatonic River near New Milford, CT

Seasonal Load of Total Phosphorus 1996-2007

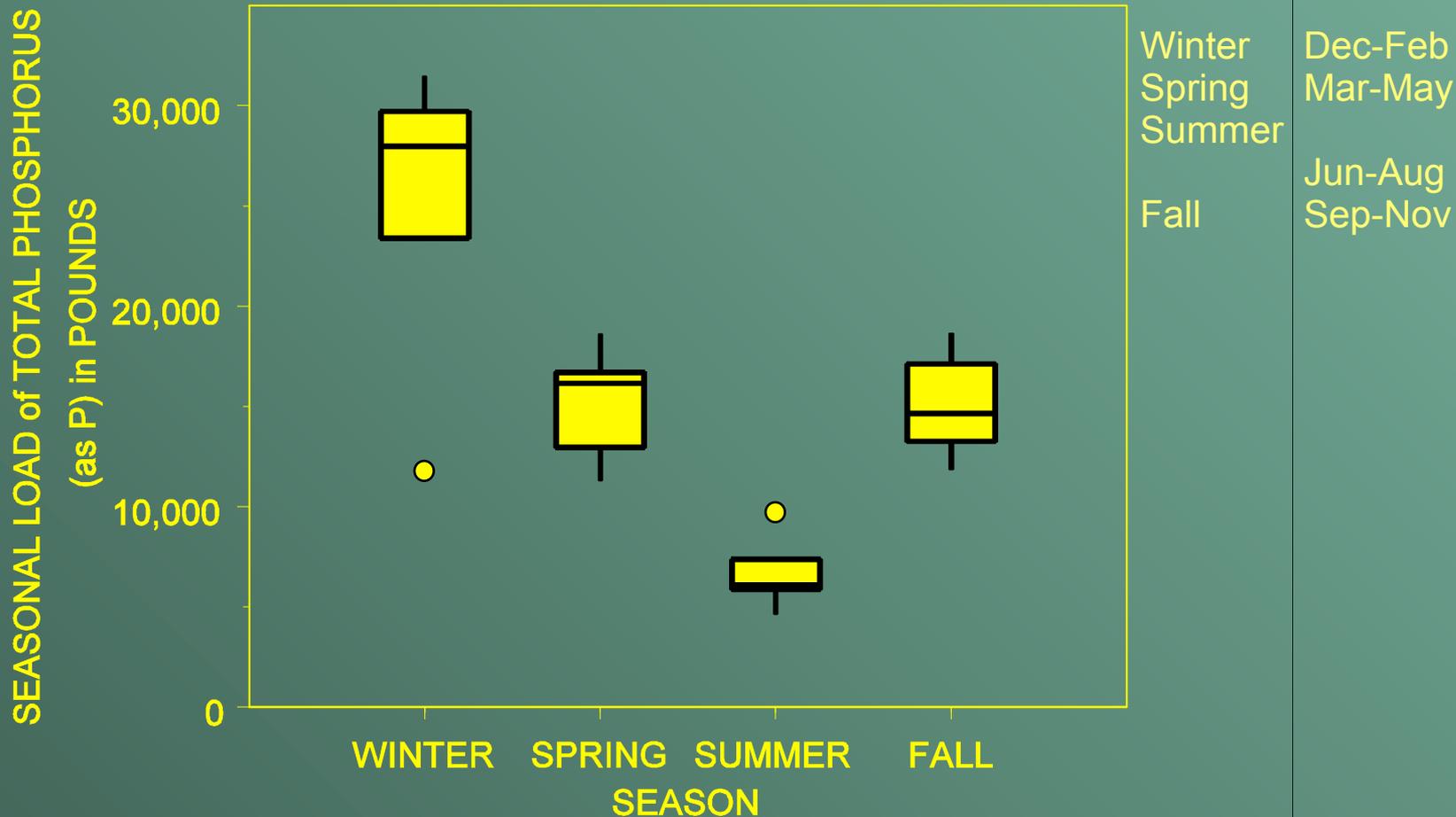
SEASONAL LOAD OF TOTAL PHOSPHORUS
(as P) in POUNDS



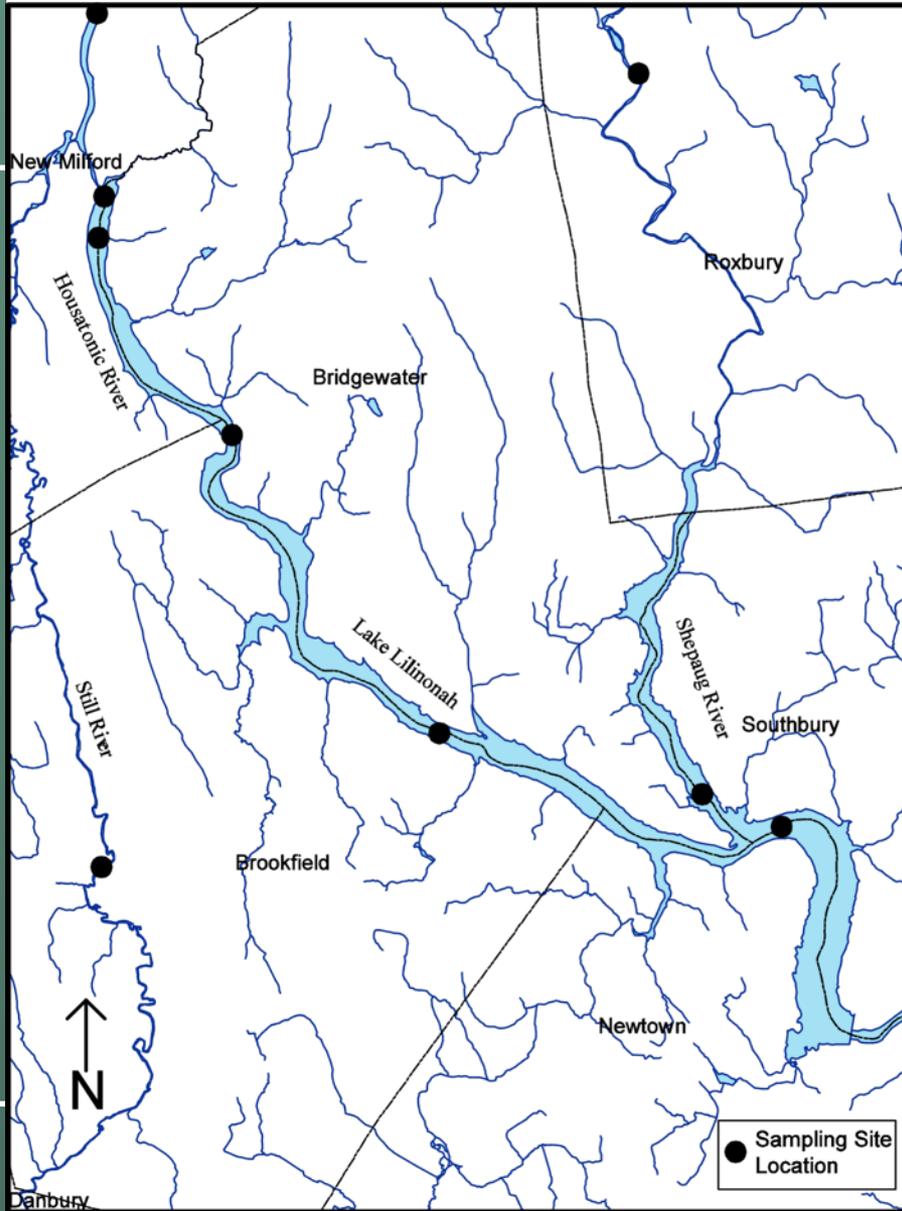
Winter Dec-Feb
Spring Mar-May
Summer Jun-Aug
Fall Sep-Nov

Still River at Brookfield Center, CT

Seasonal Load of Total Phosphorus 2003-07



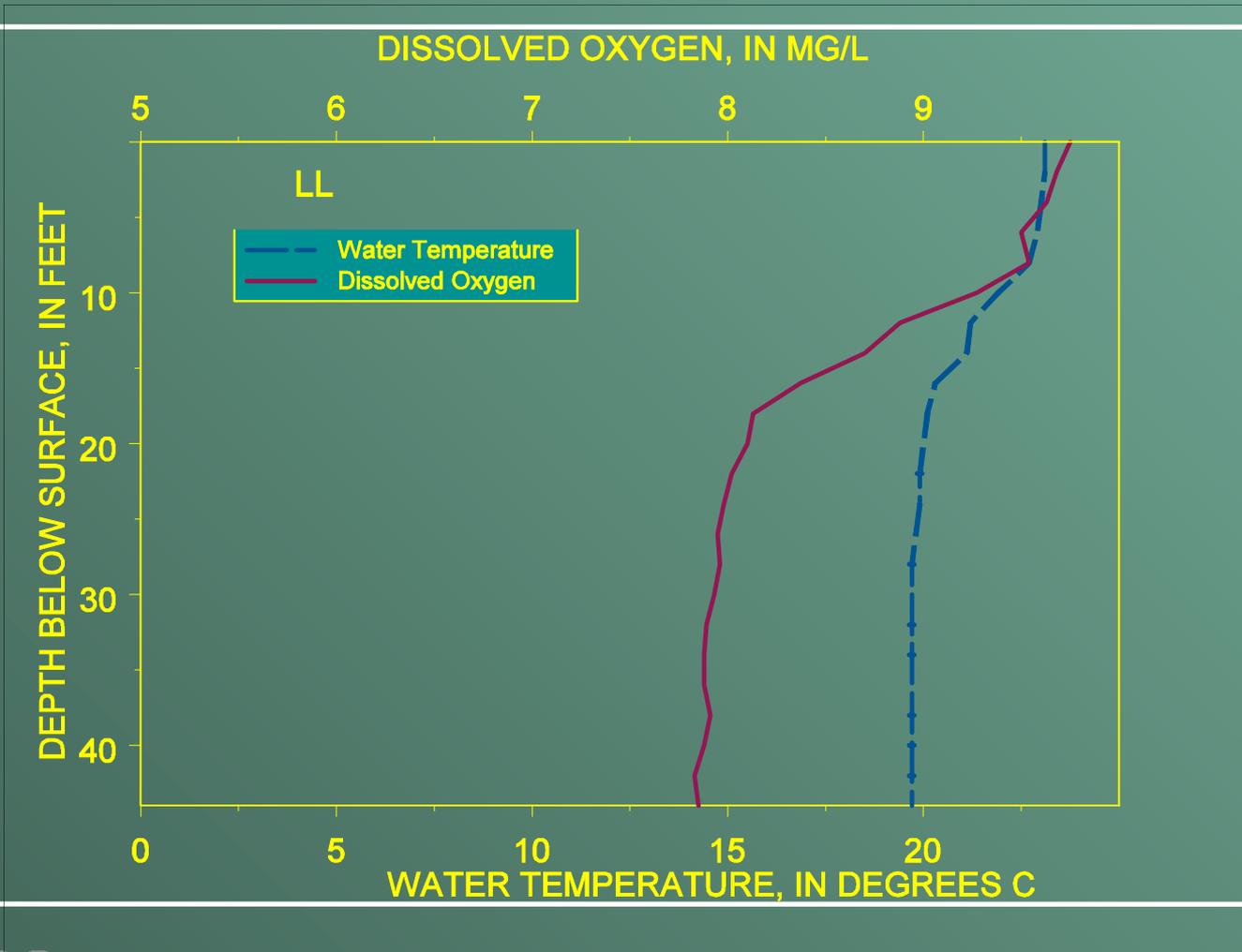
LAKE LILLINONAH, CONNETICUT



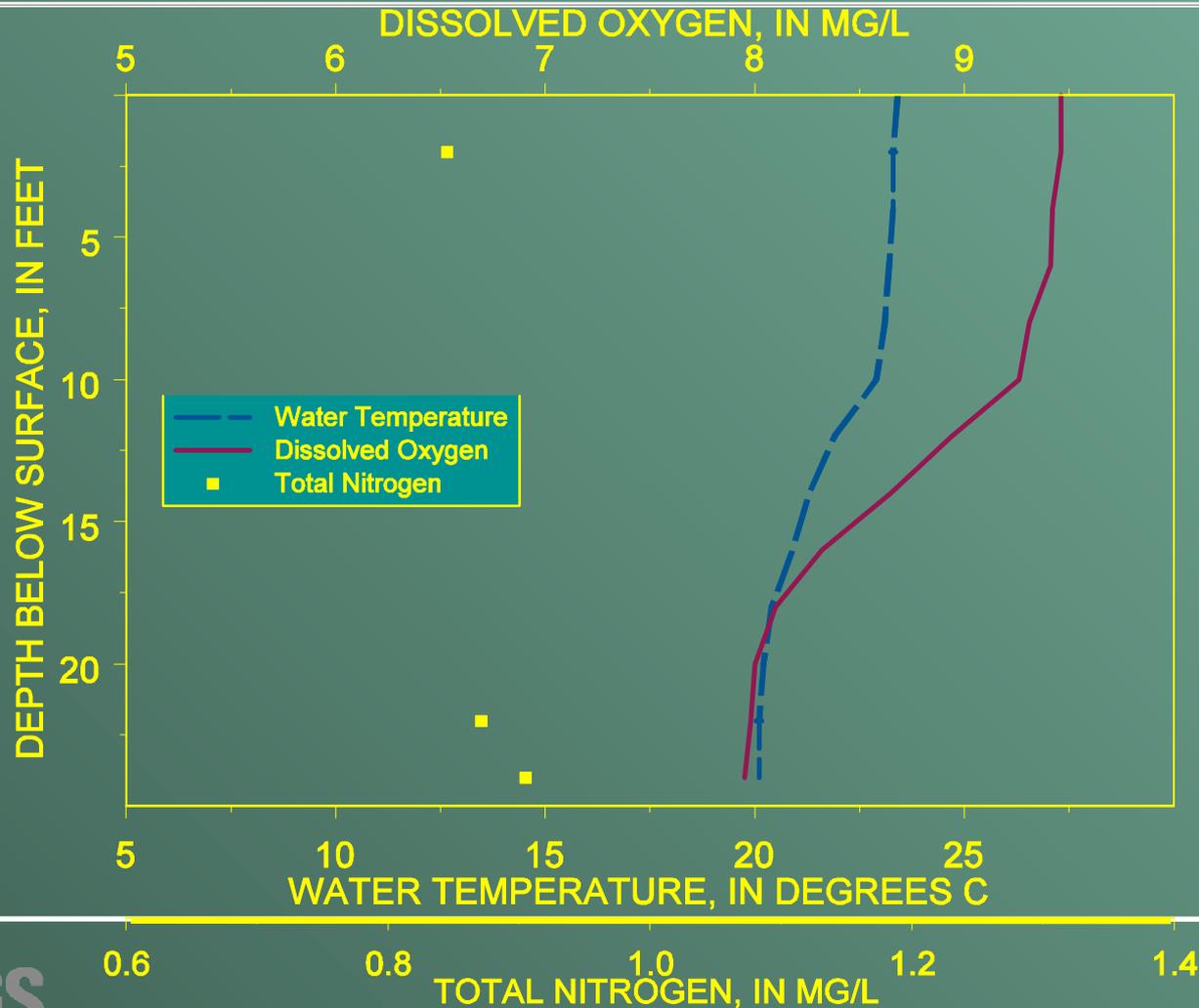
● Sampling site

Lake Lillinonah at Lover's Leap

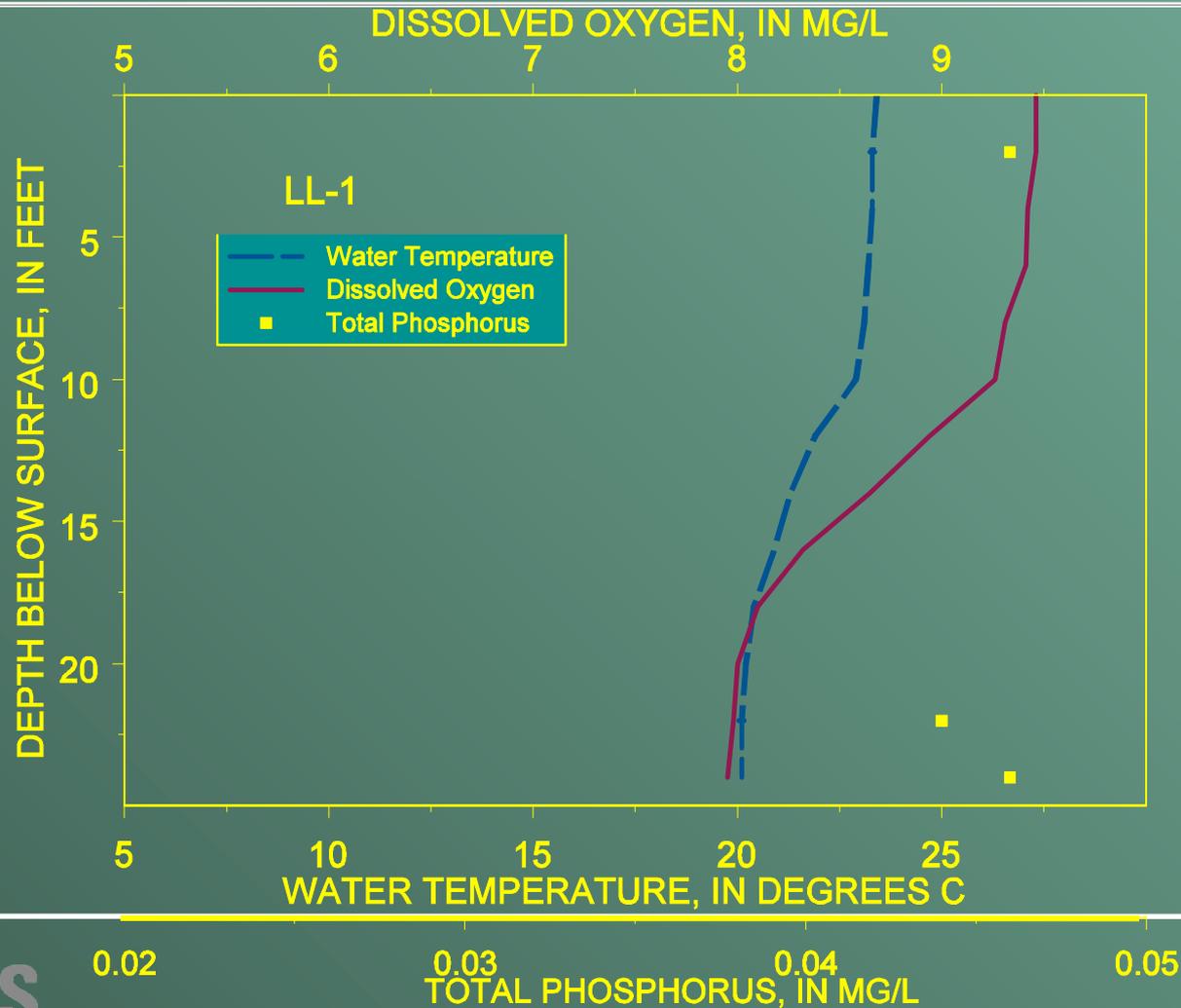
August 22, 2007



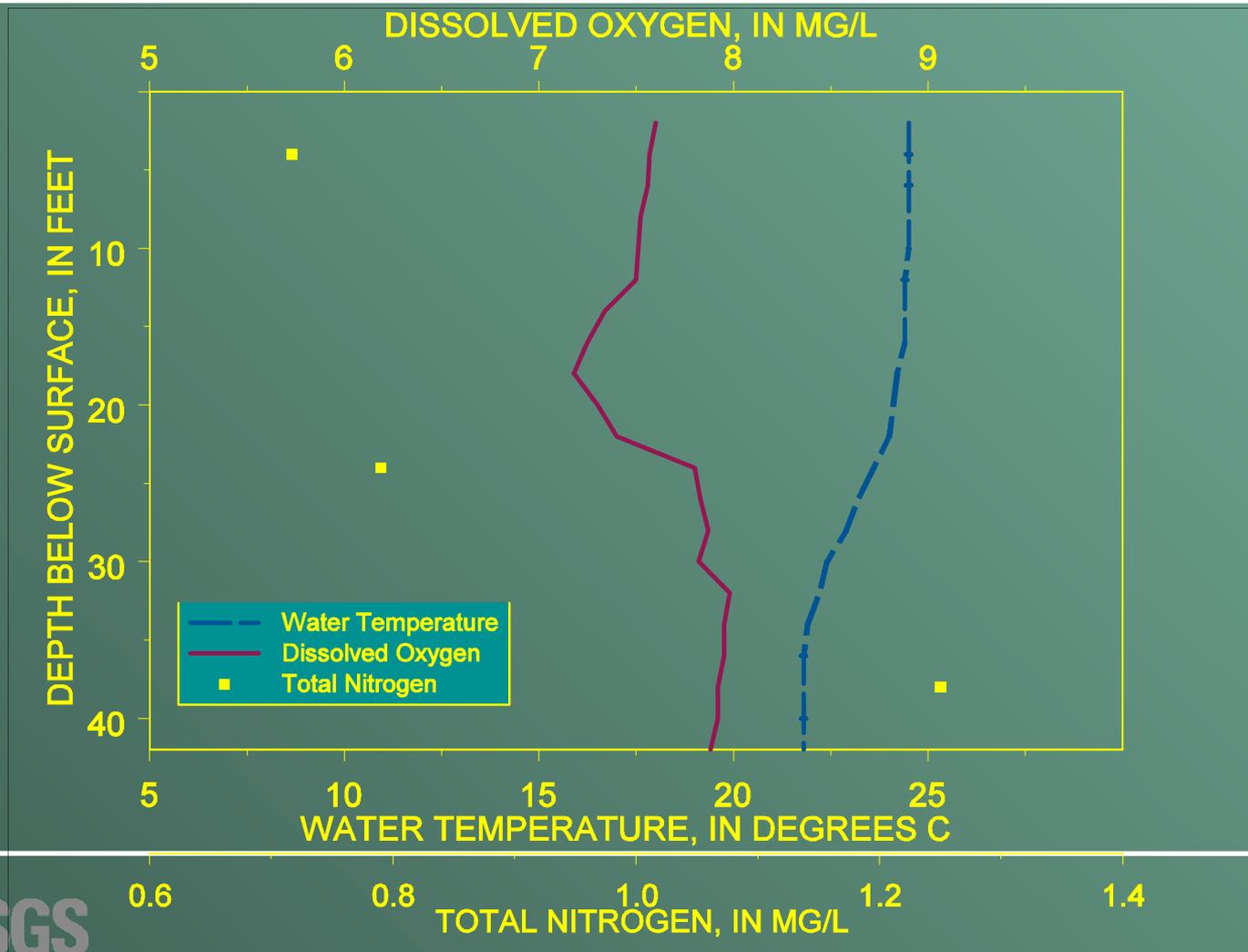
Lake Lillinonah near Goodyear Island August 22, 2007



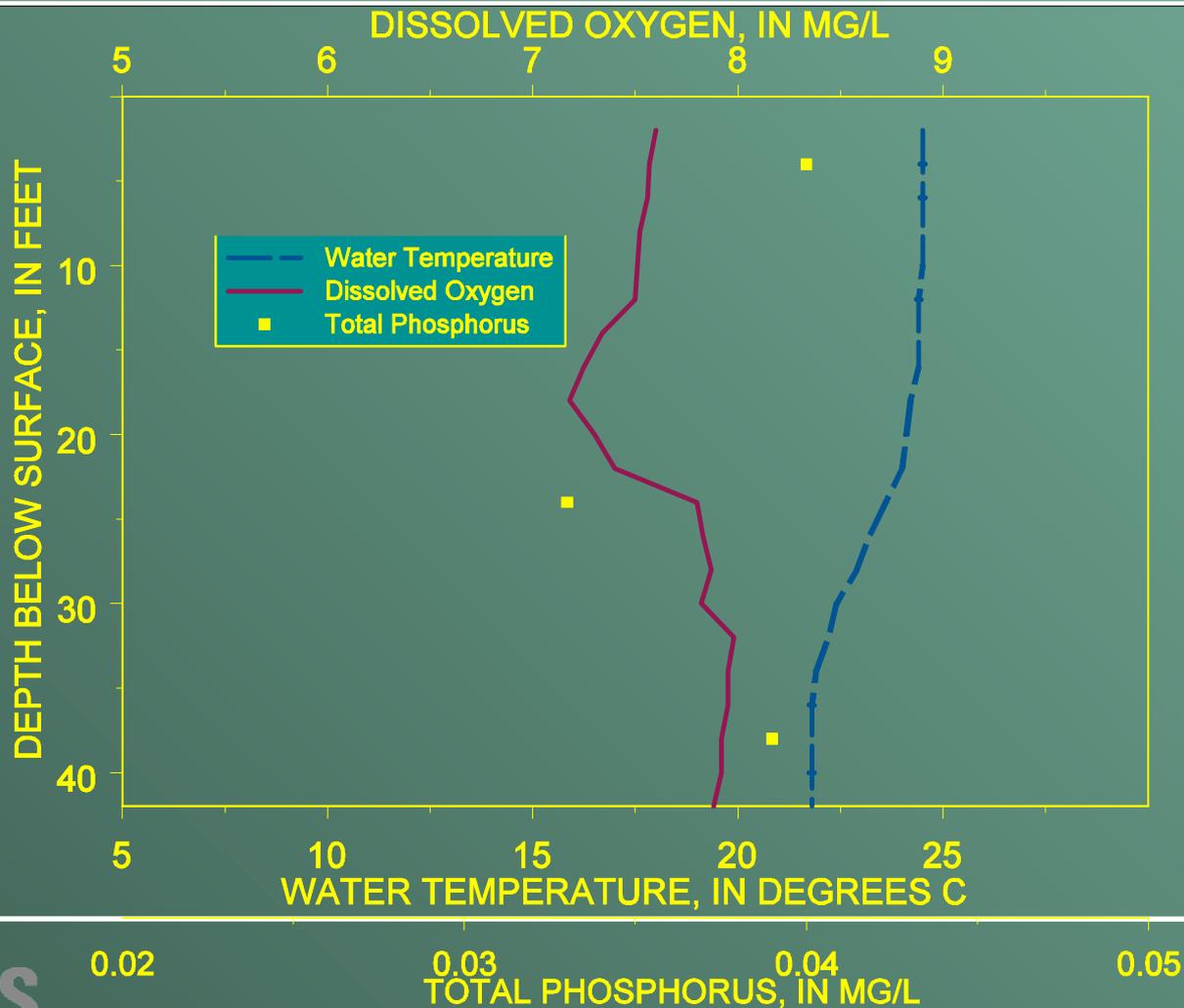
Lake Lillinonah near Goodyear Island August 22, 2007



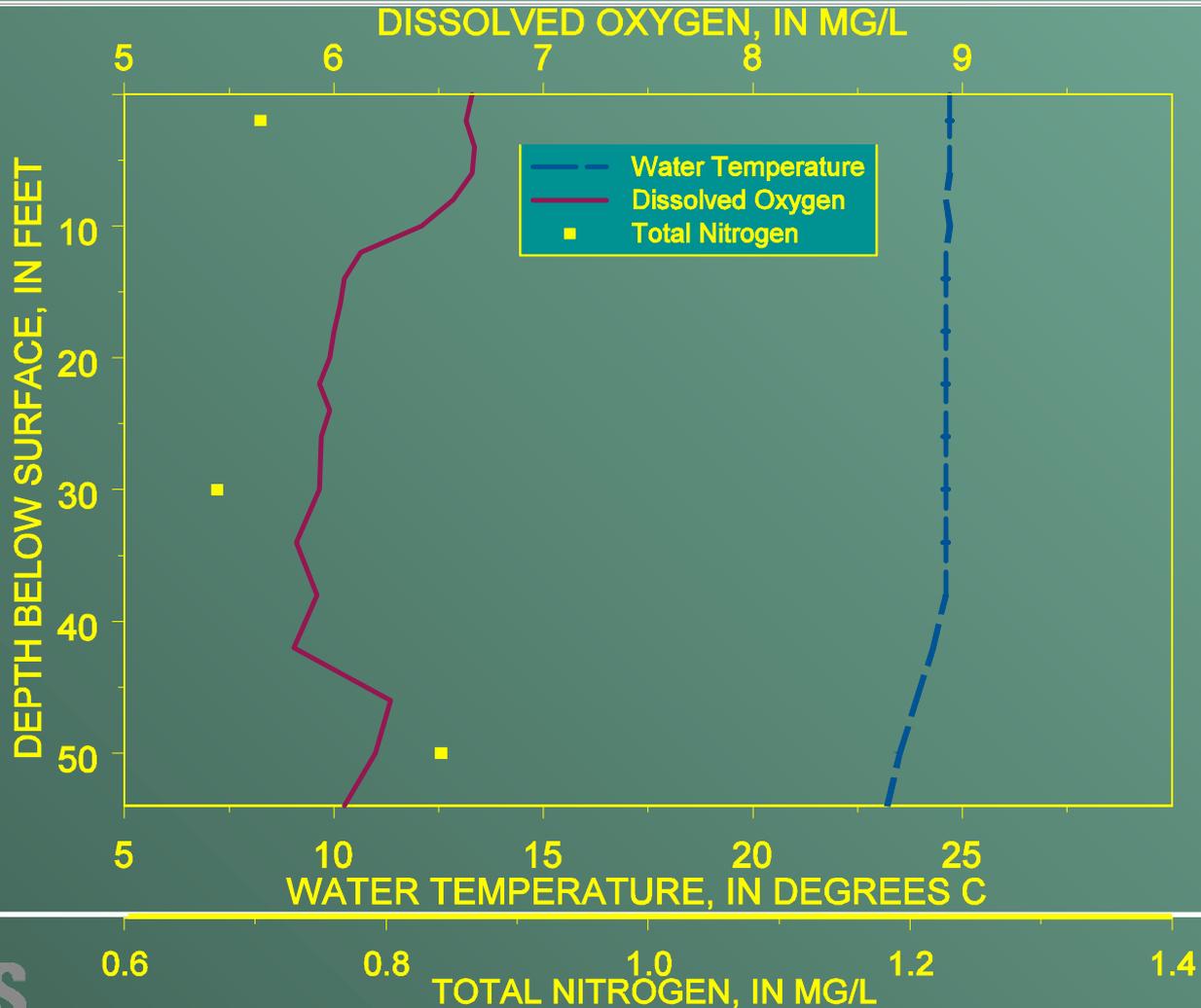
Lake Lillinonah near Bridgewater August 22, 2007



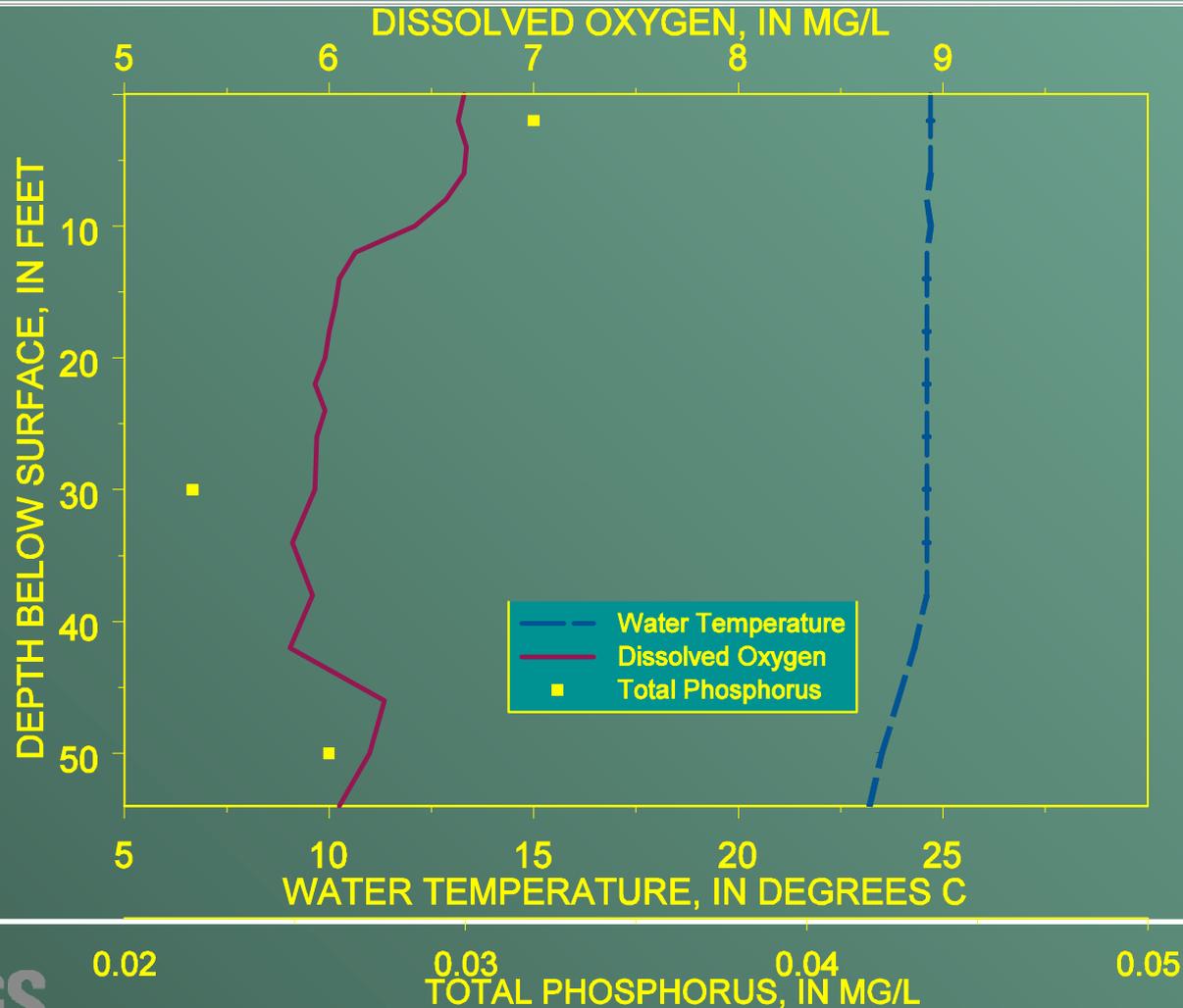
Lake Lillinonah near Bridgewater August 22, 2007



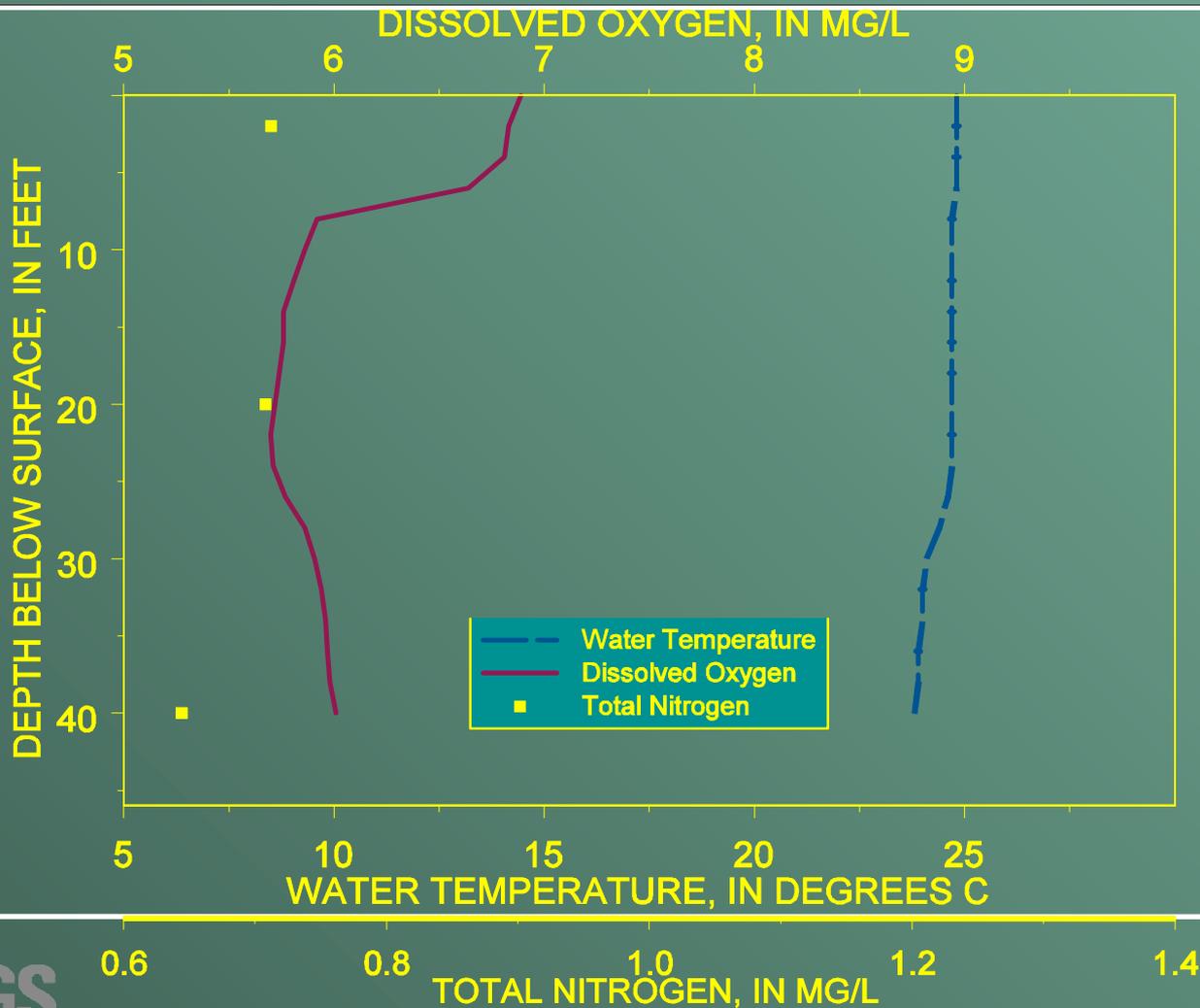
Lake Lillinonah above Route 133 bridge August 22, 2007



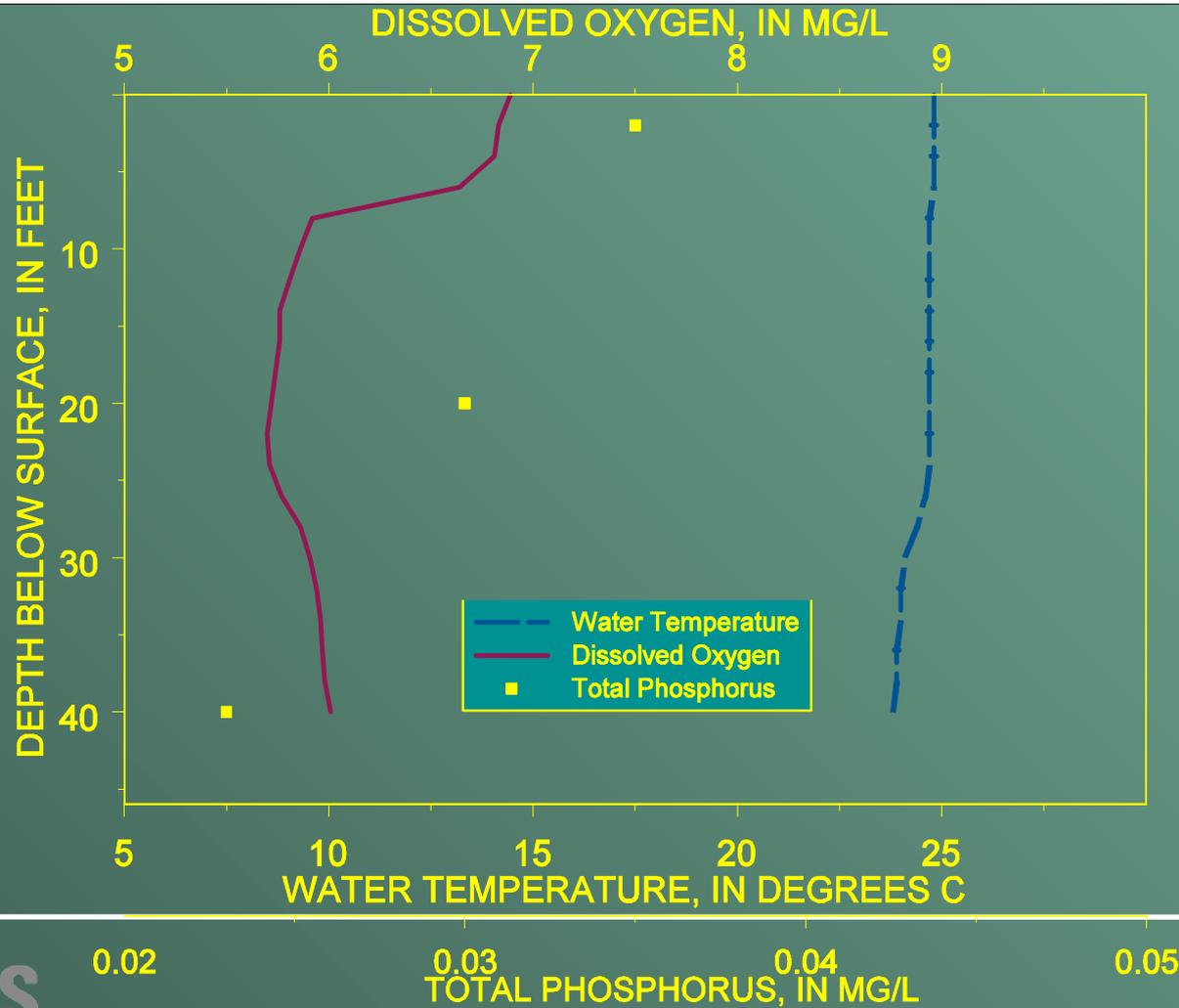
Lake Lillinonah above Route 133 bridge August 22, 2007



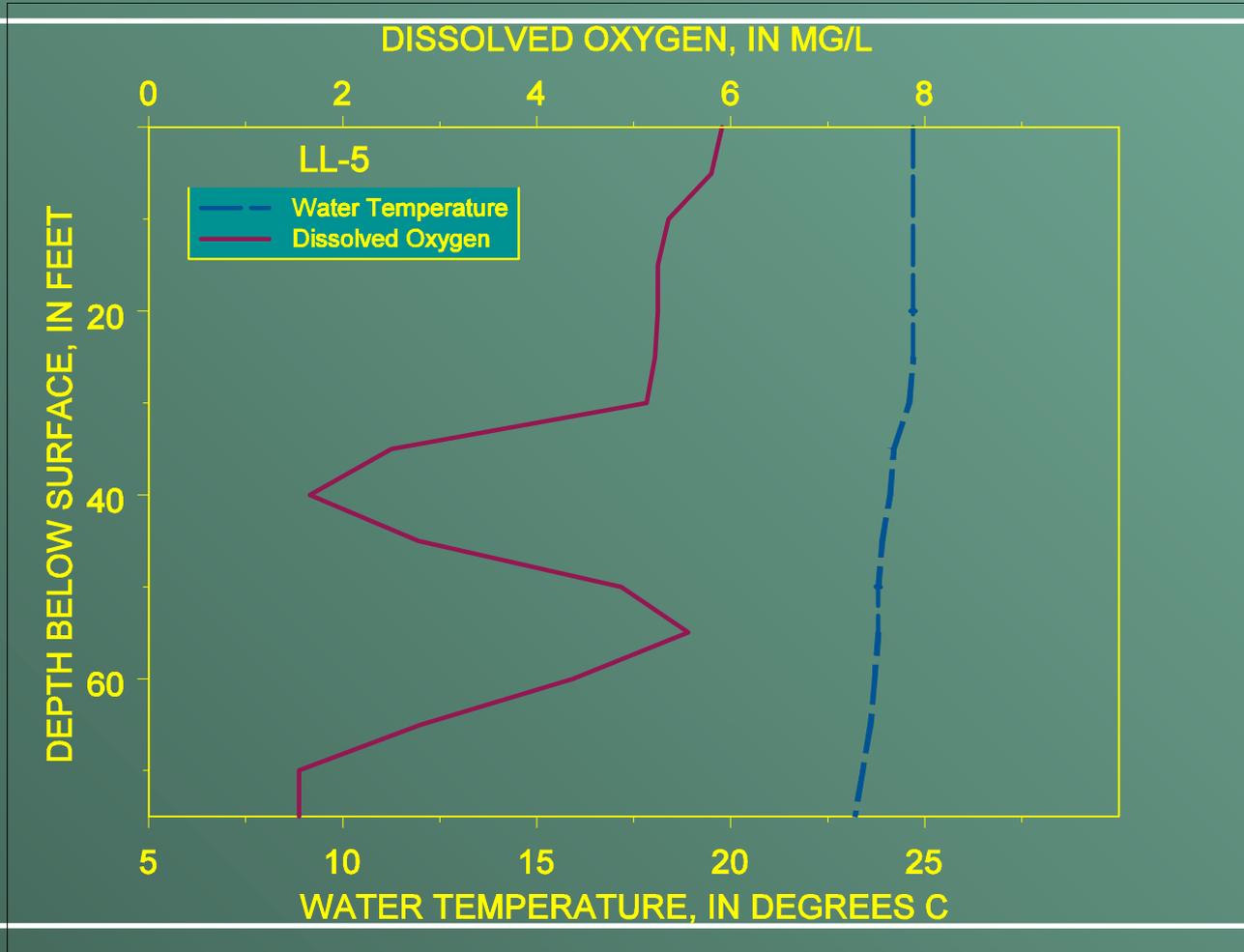
Lake Lillinonah in Shepaug River arm August 22, 2007



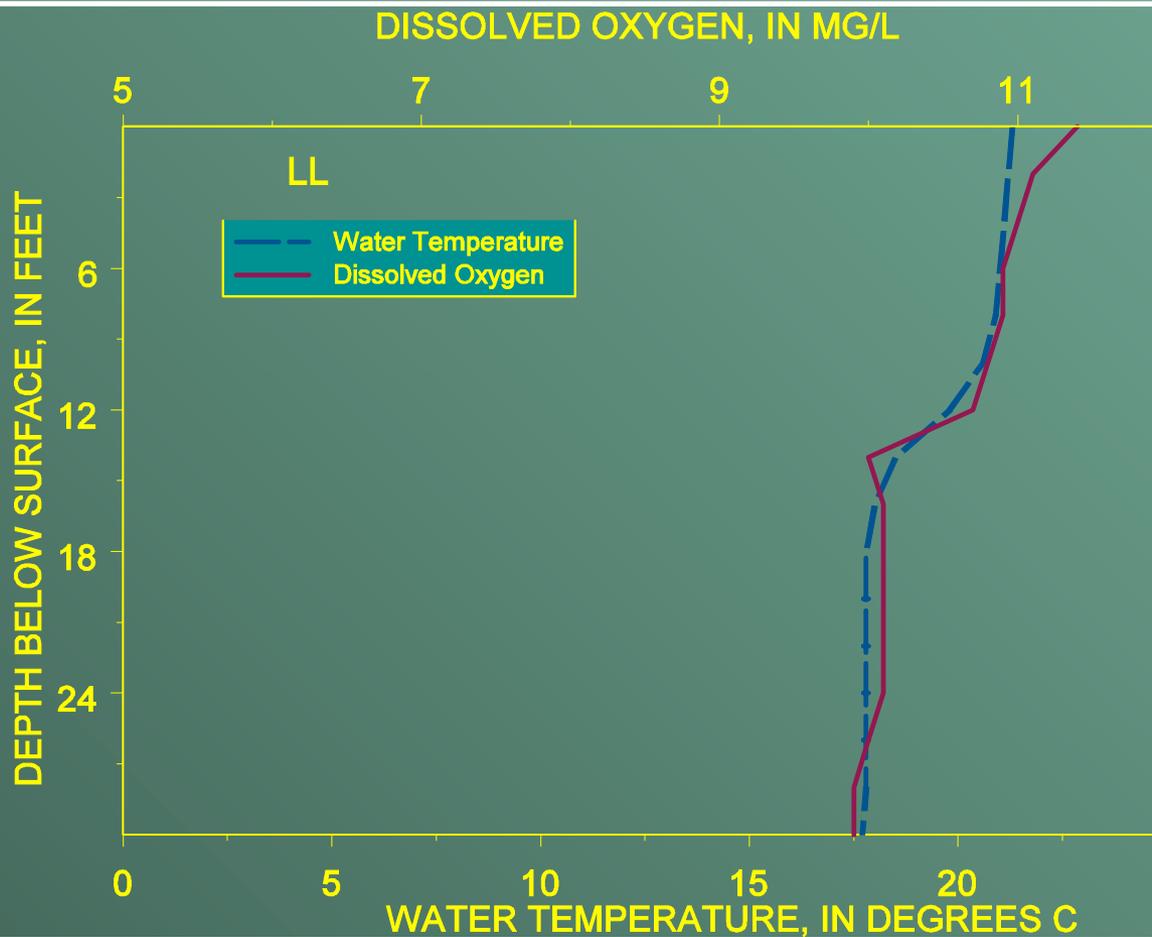
Lake Lillinonah in Shepaug River arm August 22, 2007



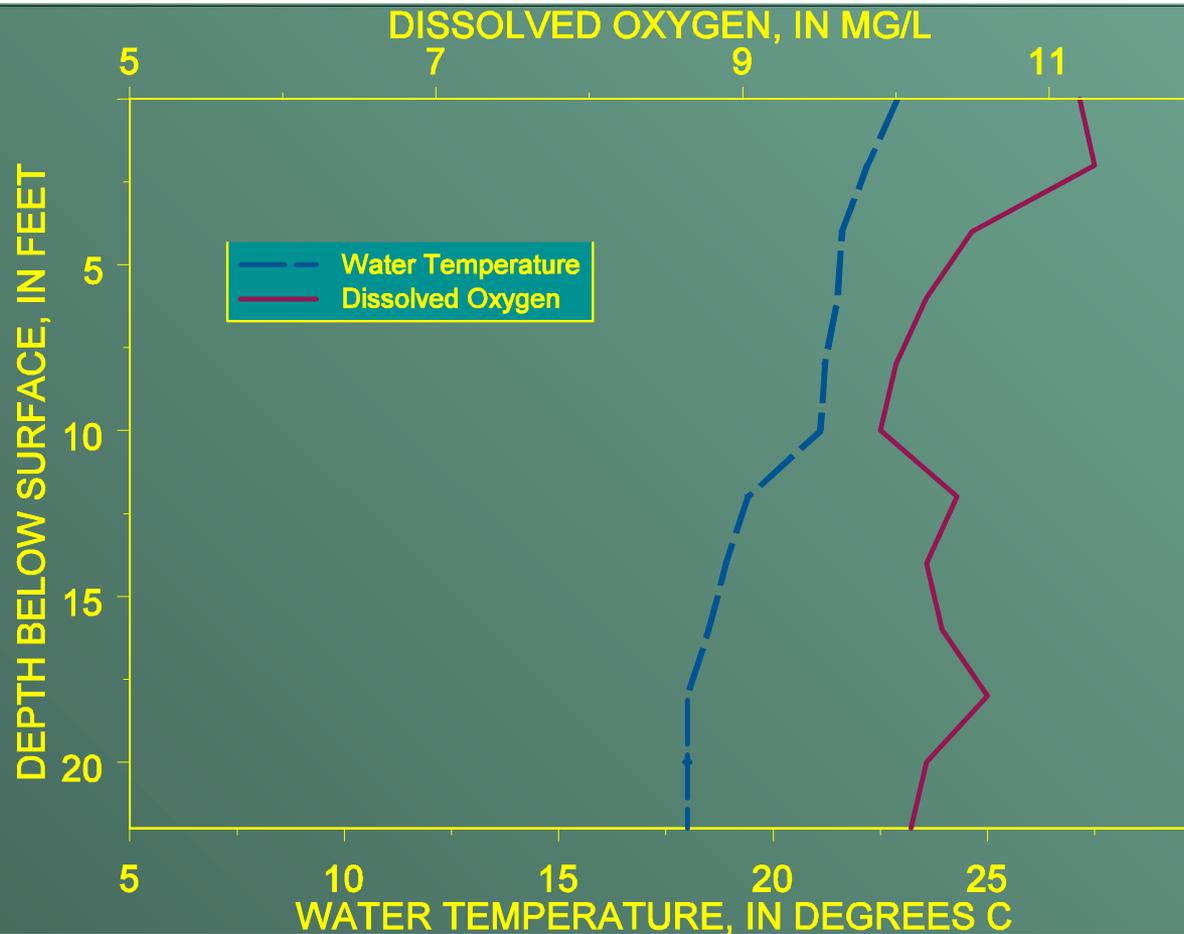
Lake Lillinonah below confluence with Shepaug River August 22, 2007



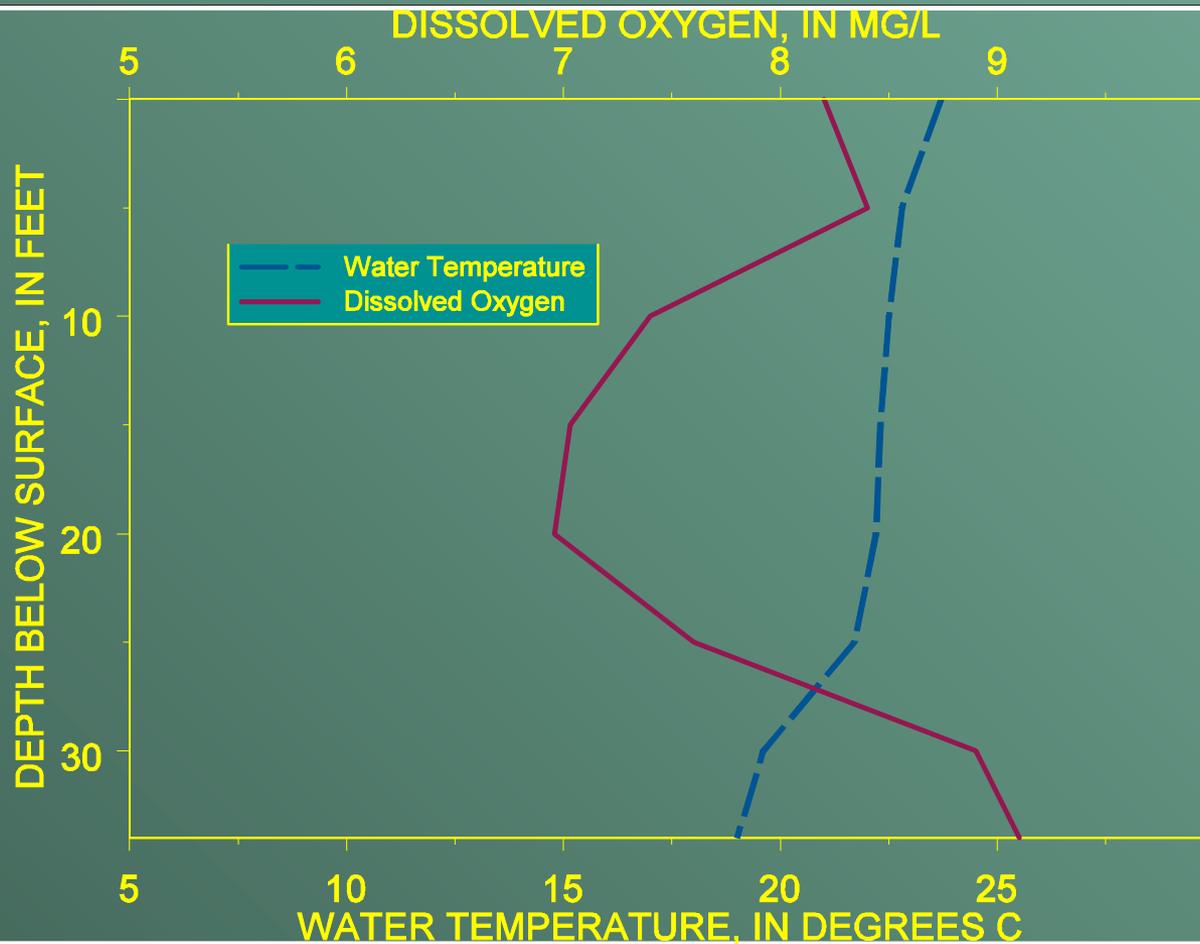
Lake Lillinonah at Lover's Leap September 19, 2007



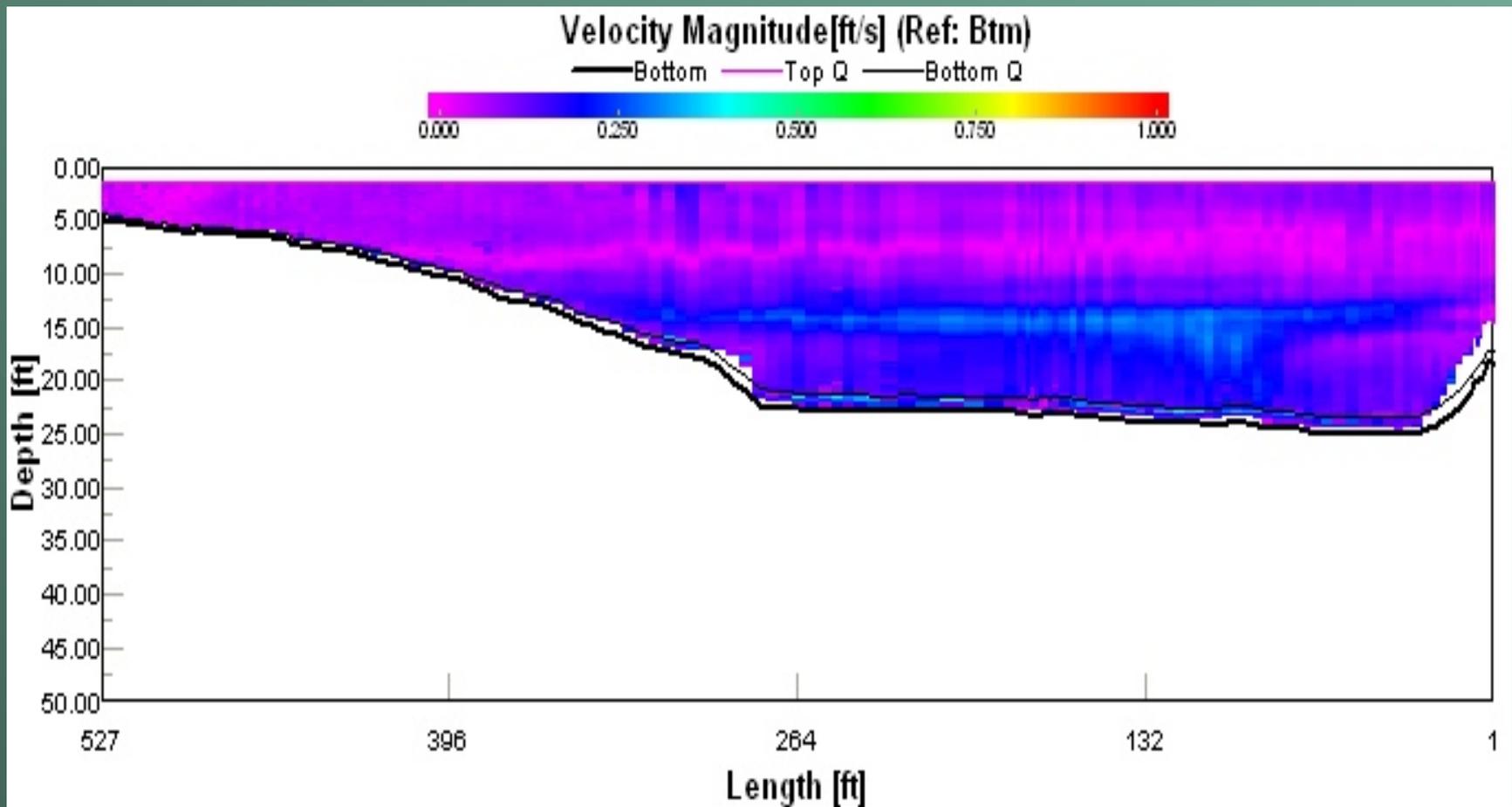
Lake Lillinonah near Goodyear Island September 19, 2007



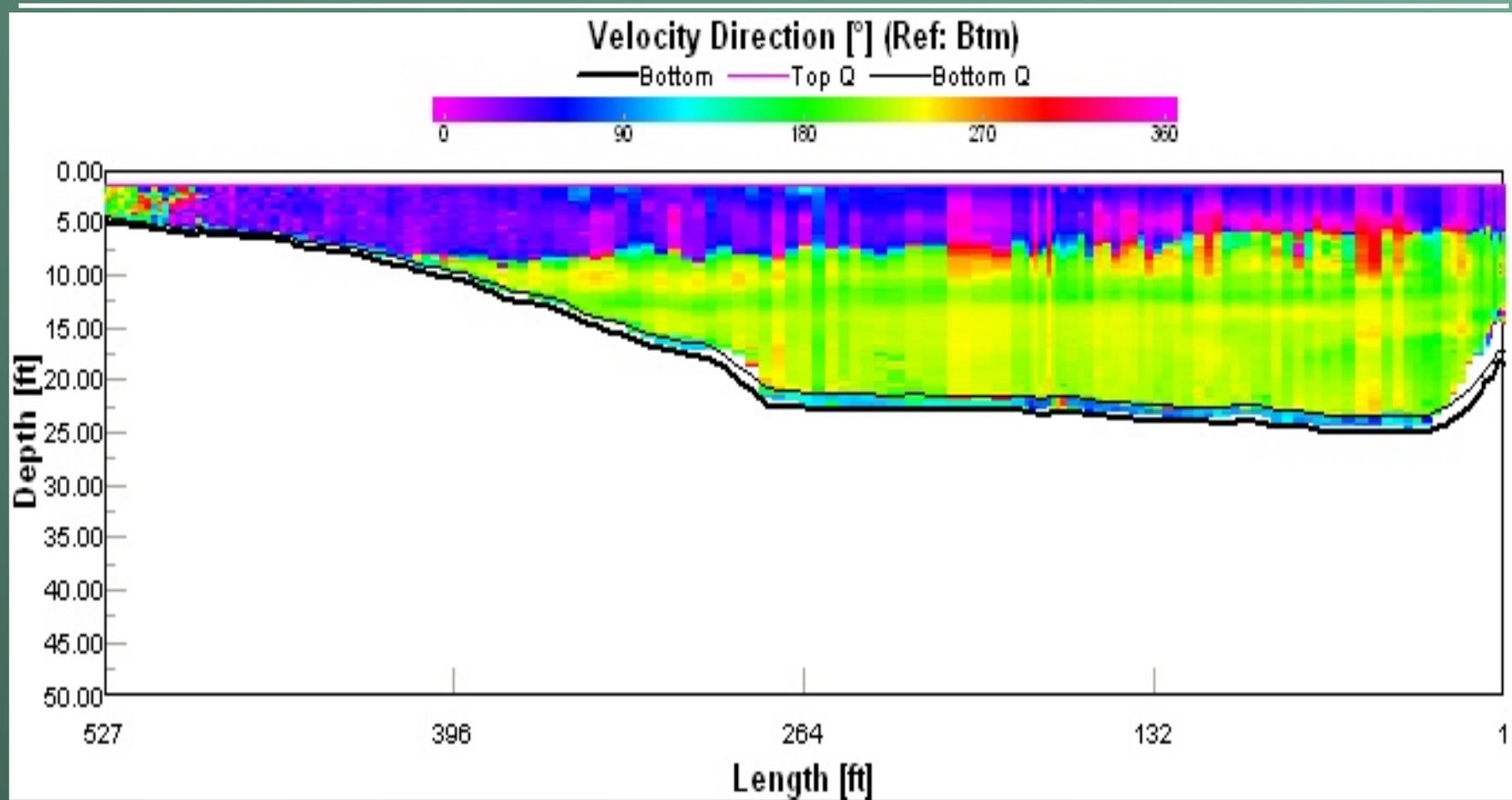
Lake Lillinonah near Bridgewater September 19, 2007



Lake Lillinonah below Goodyear Island ADCP measurement September 19, 2007



Lake Lillinonah below Goodyear Island ADCP measurement September 19, 2007



Summary

- Approximately 2/3 of the load (mass) of total phosphorus to Lake Lillinonah is from the main stem of the Housatonic River
- Total nitrogen and total phosphorus yields from the Still River watershed are by far the highest of the 3 watersheds studied

Summary

- **New daily discharge data was used for the Shepaug River at Roxbury station to calculate nutrient loads and yields**
- **Additional water-quality samples were collected at high flows at the Housatonic and Shepaug Rivers to calculate nutrient loads and improve confidence intervals**

Summary

- **Water-quality and surface-water data collection at the 3 stations was used to improve the model predictions and allow for comparison during same time periods**
- **Continue in-lake work toward mass-balance approach**
- **Consider downstream site for future lake mass-balance calculations**

Status of Monitoring Activities (2010)

- Still and Housatonic River Streamgages are Active
- Shepaug River Streamgage has been Discontinued (2007)
- Nutrient Sampling Frequencies have been Reduced to 8 Times per Year from Monthly

Thank You

- For more Information

Please Contact:

Jonathan Morrison 860-291-6761

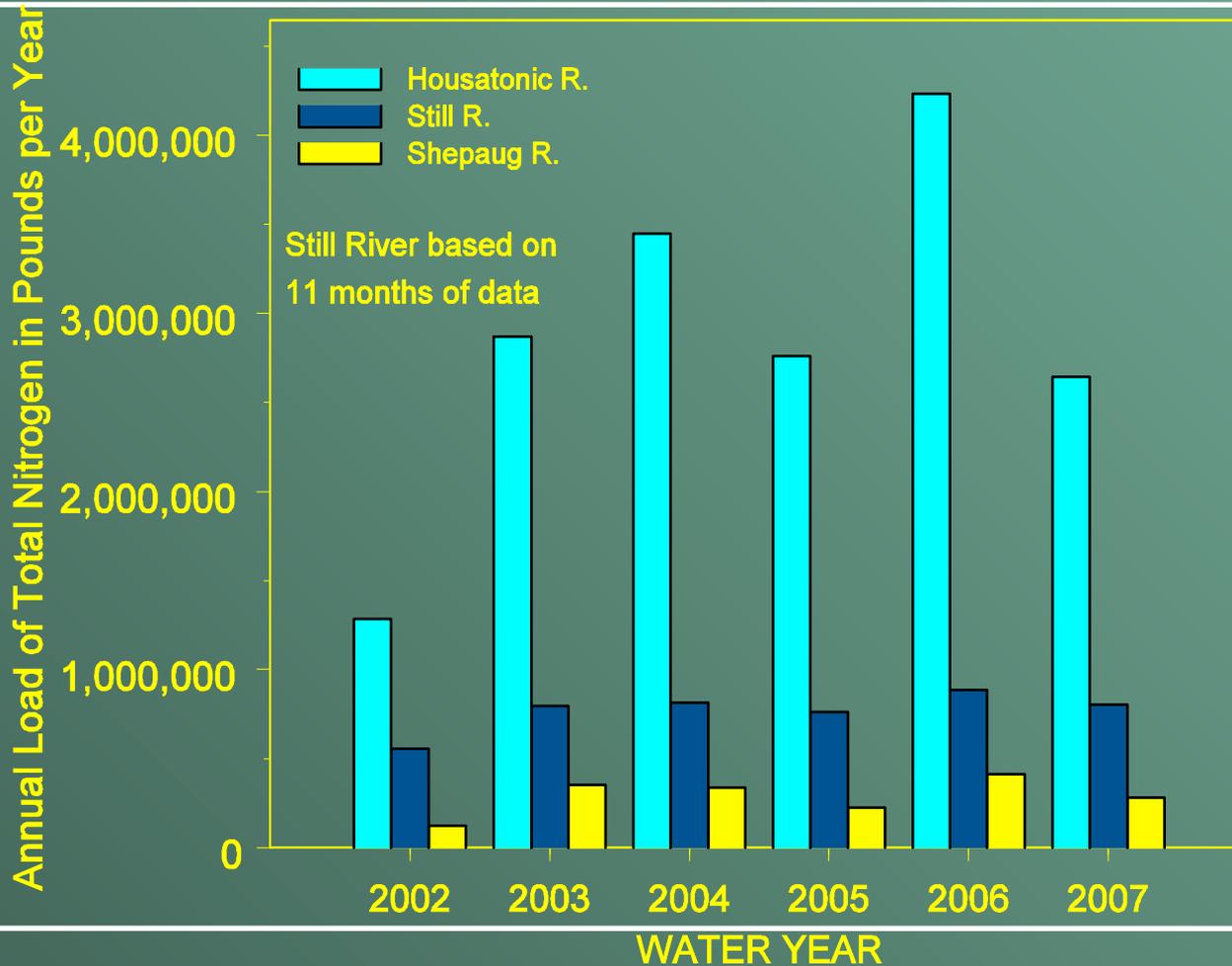
jmorriso@usgs.gov

or

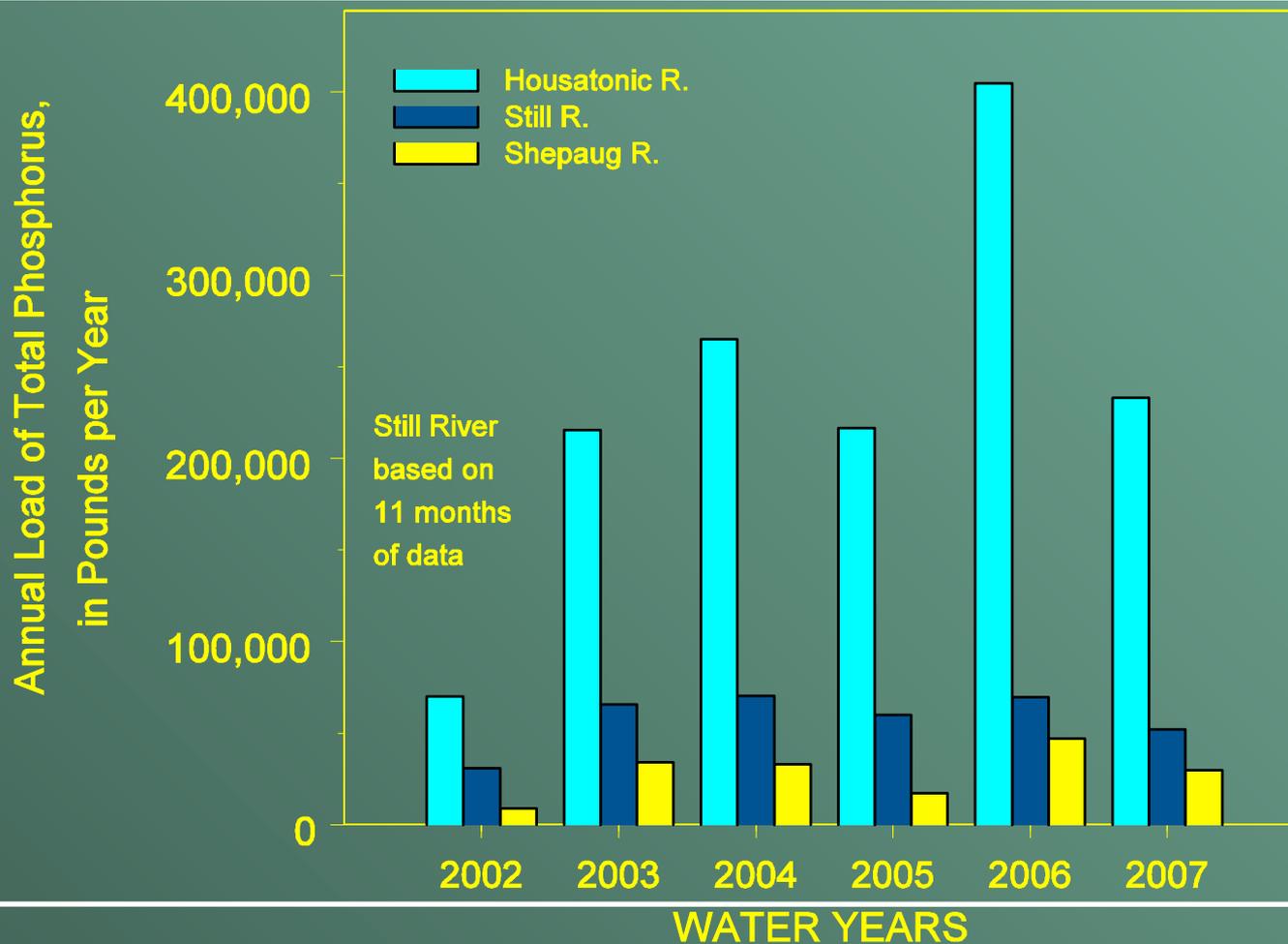
Michael Colombo 860-291-6751

mjcolomb@usgs.gov

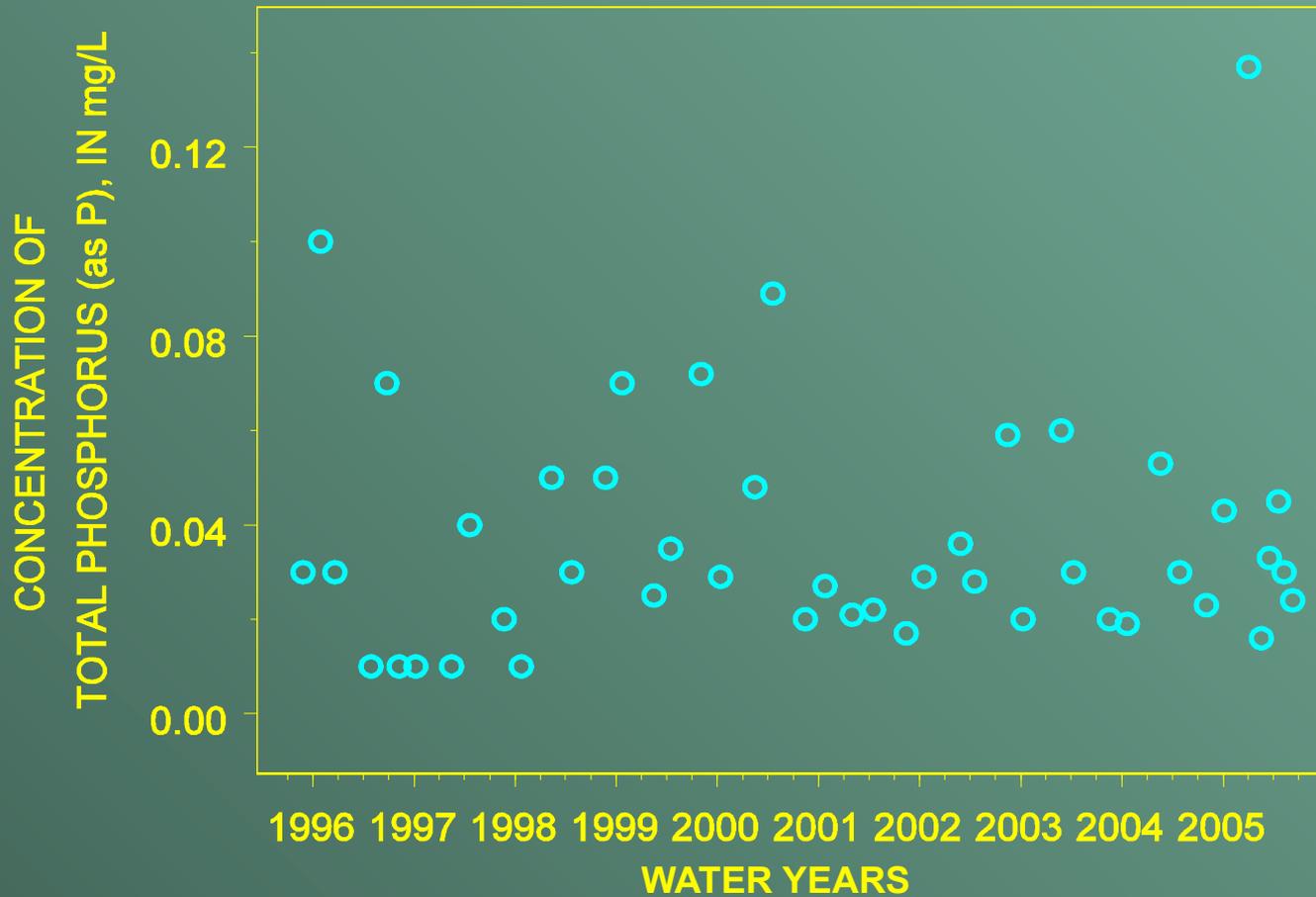
Annual Loads of Total Nitrogen 2002-2007



Annual Loads of Total Phosphorus 2002-2007



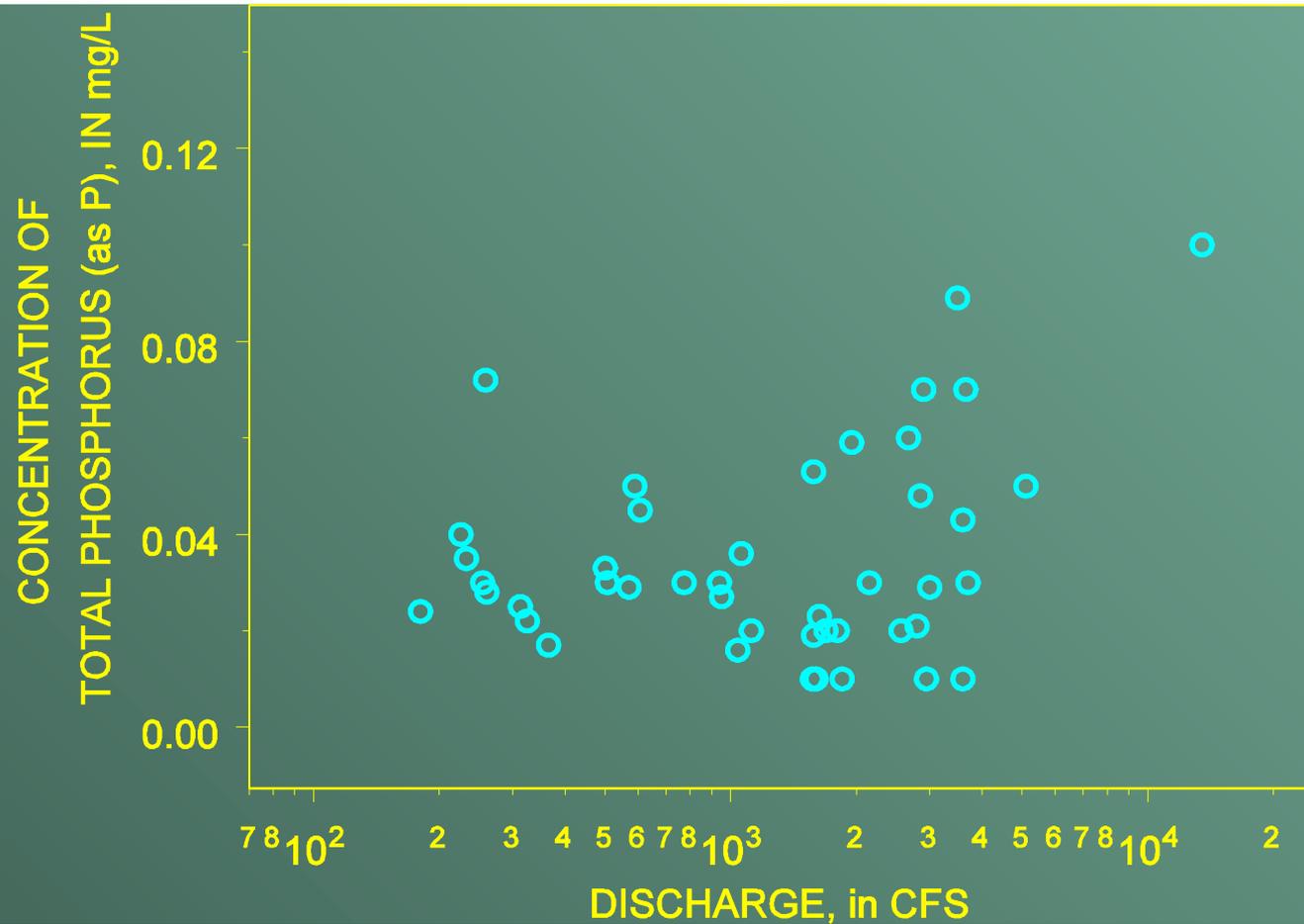
Housatonic River near New Milford, CT Total Phosphorus Concentration 1996-2005



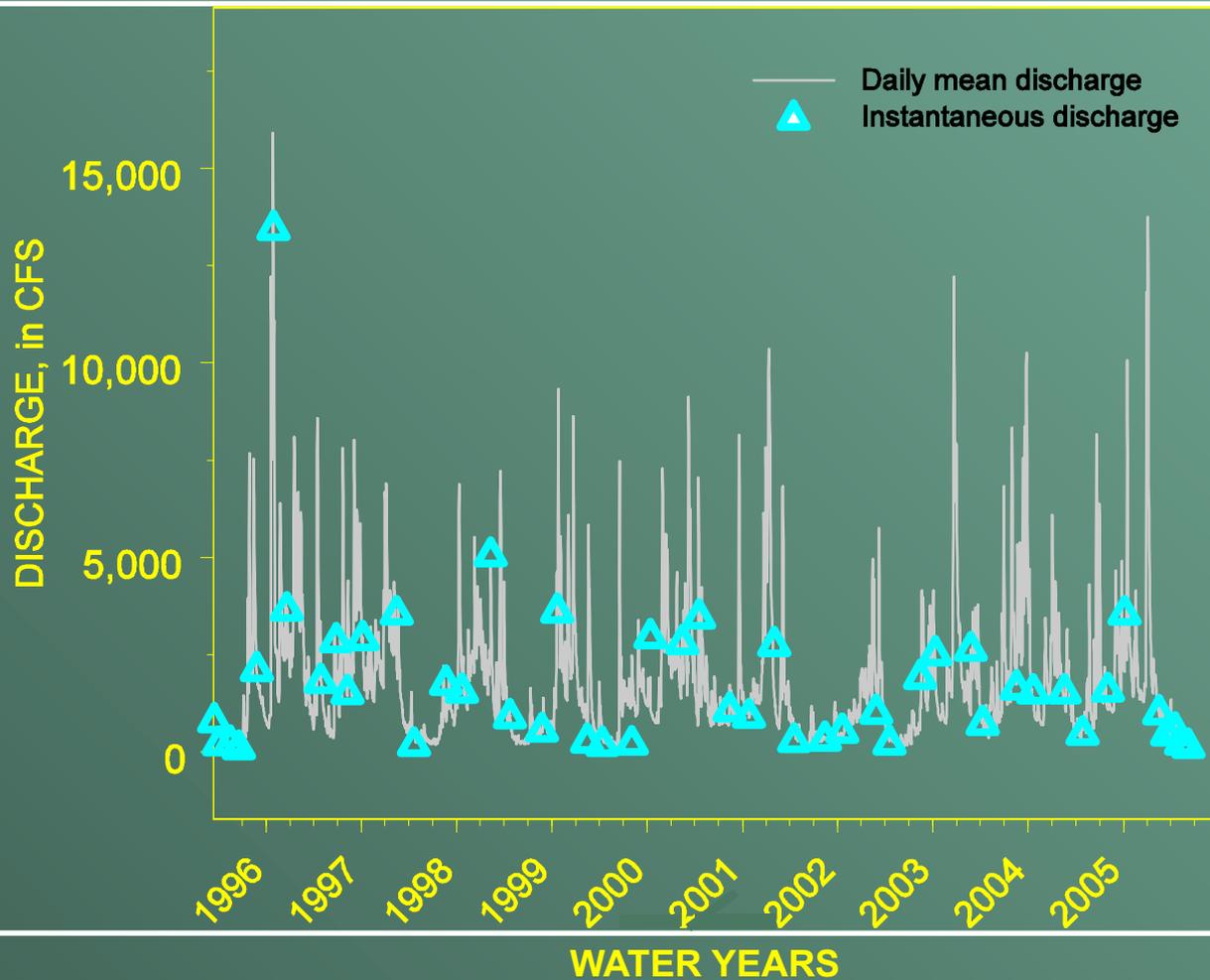
Housatonic River near New Milford, CT

Total Phosphorus Concentration Relative to Discharge

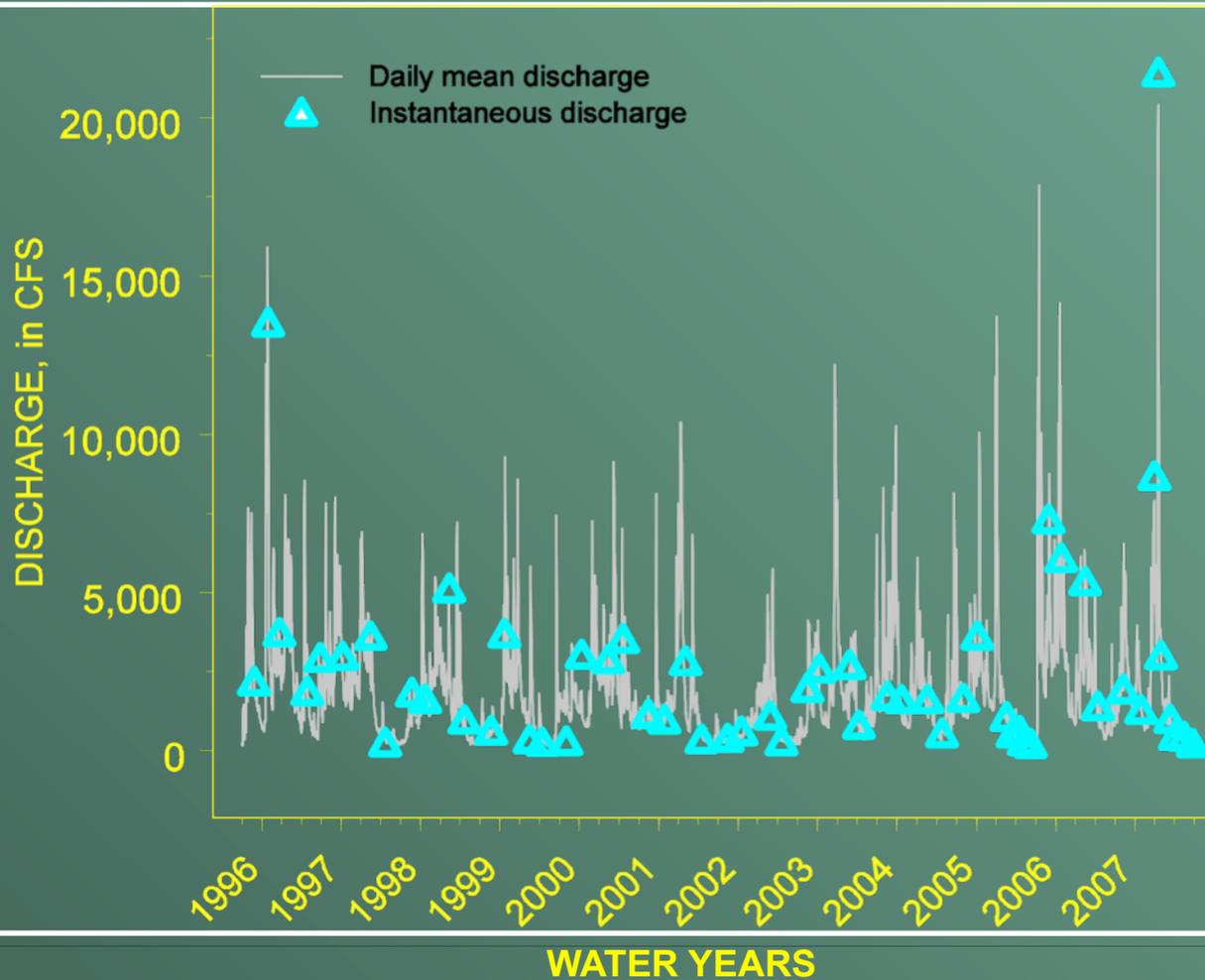
1996 - 2005



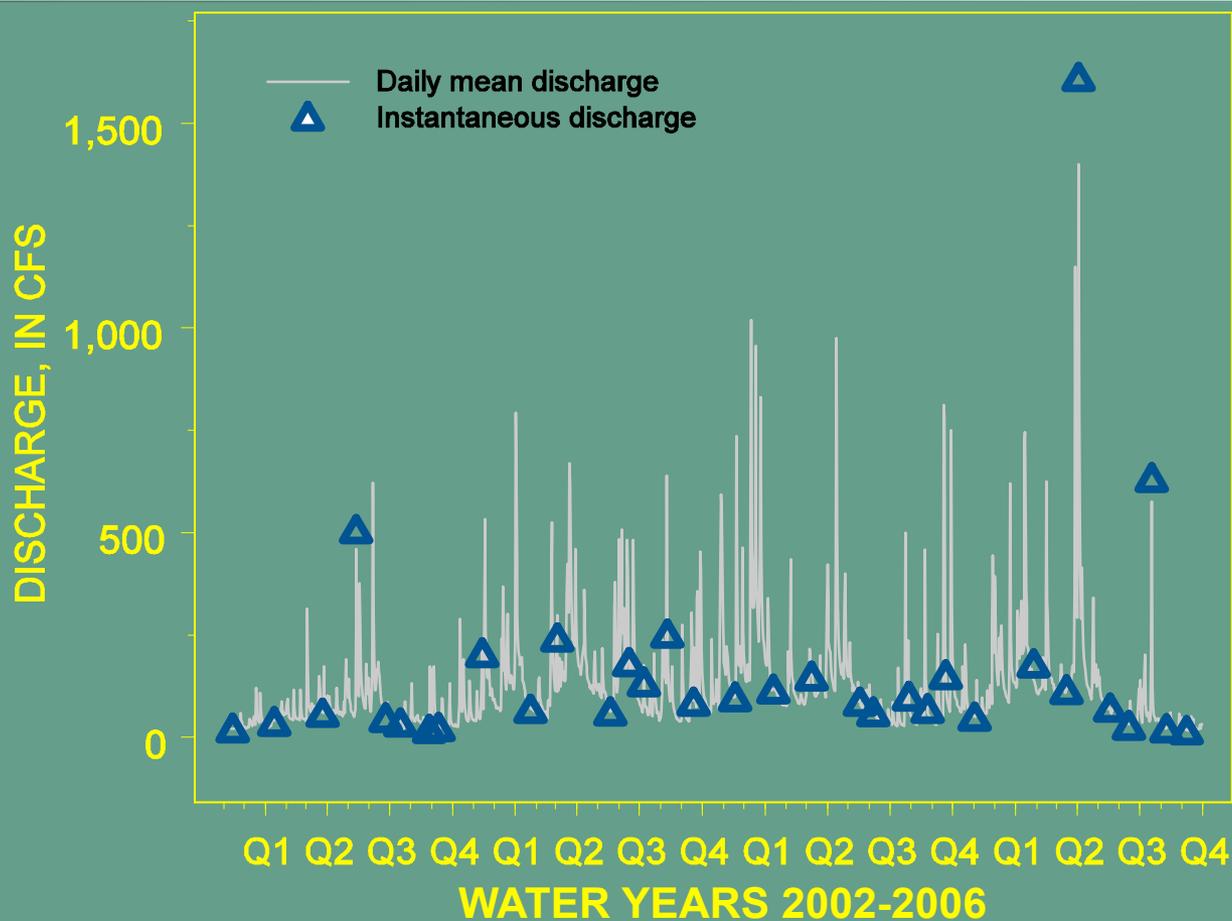
Housatonic River near New Milford, CT Discharge at Sample Time 1996-2005



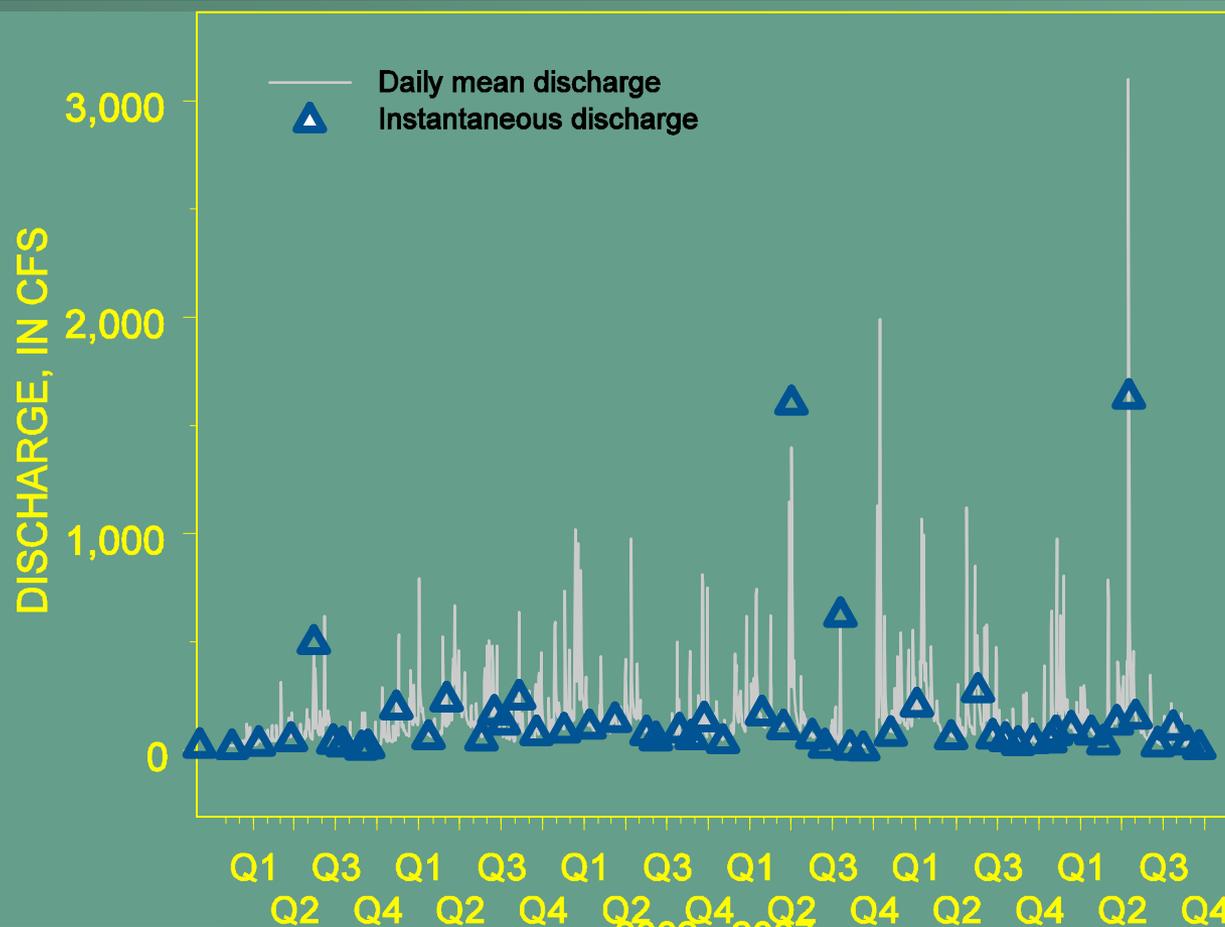
Housatonic River near New Milford, CT Discharge at Sample Time 1996-2007



Still River at Brookfield Center, CT Discharge at Sample Time 2002-2005

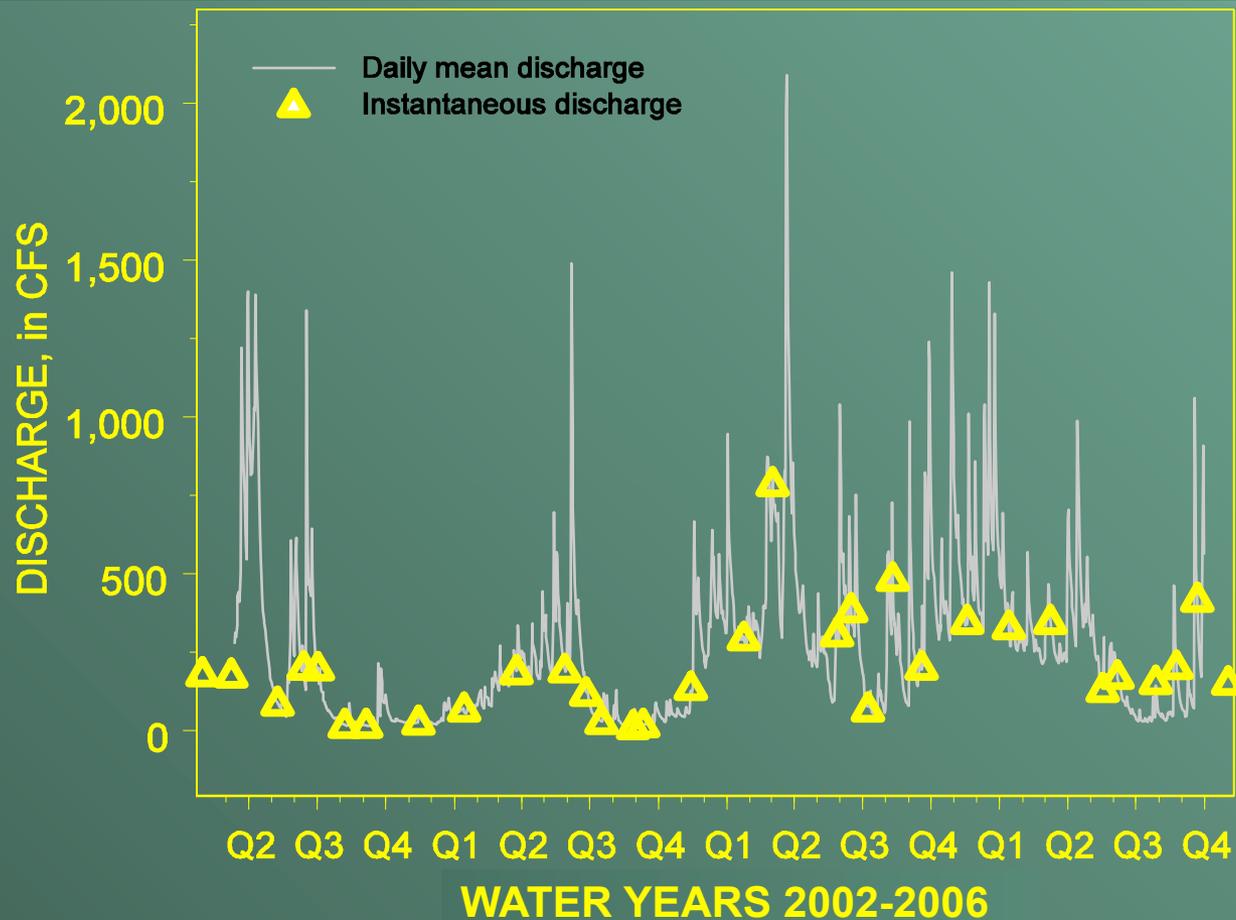


Still River at Brookfield Center, CT Discharge at Sample Time 2002-2007

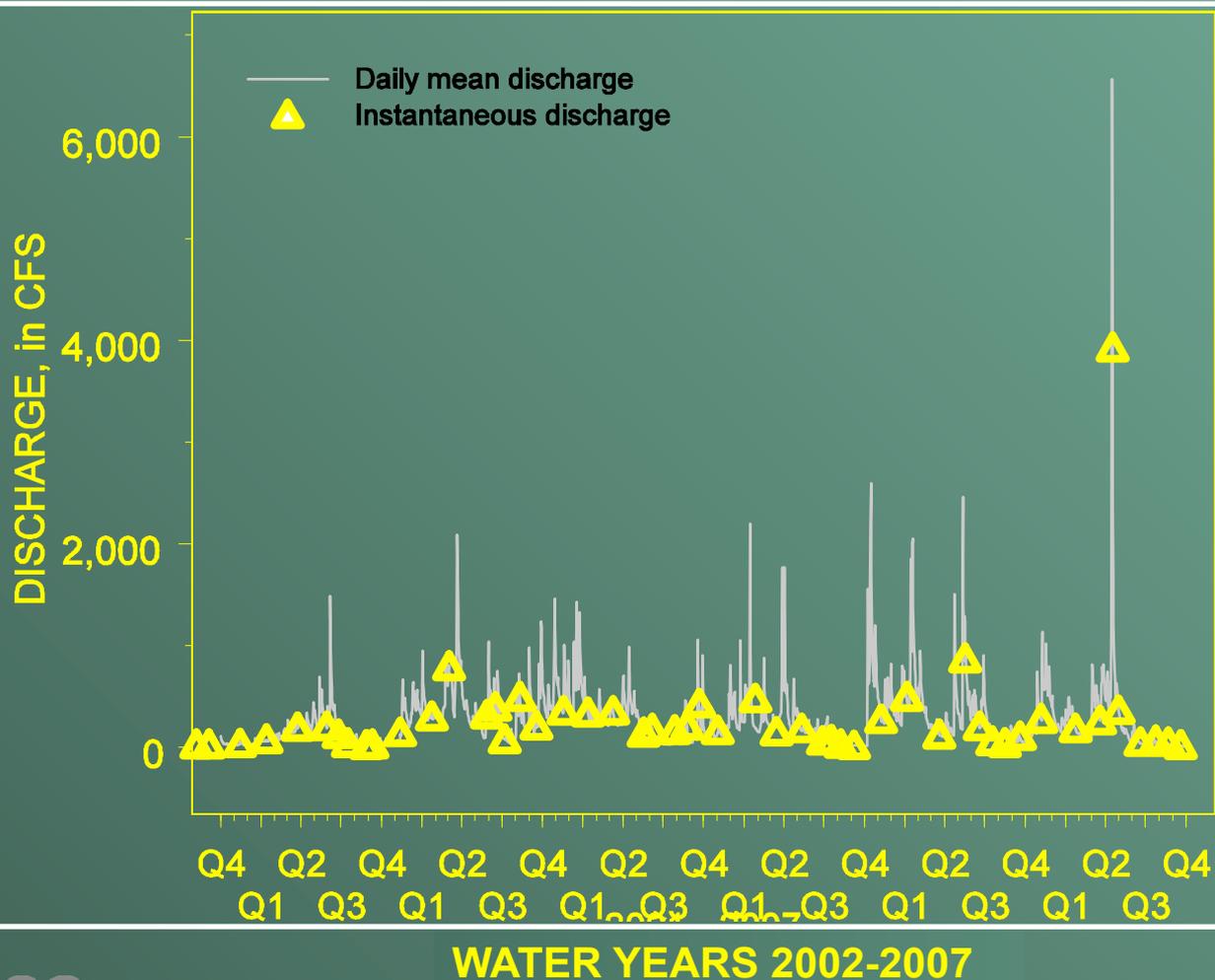


WATER YEARS 2002-2007

Shepaug River near Roxbury, CT Discharge at Sample Time 2001-2004

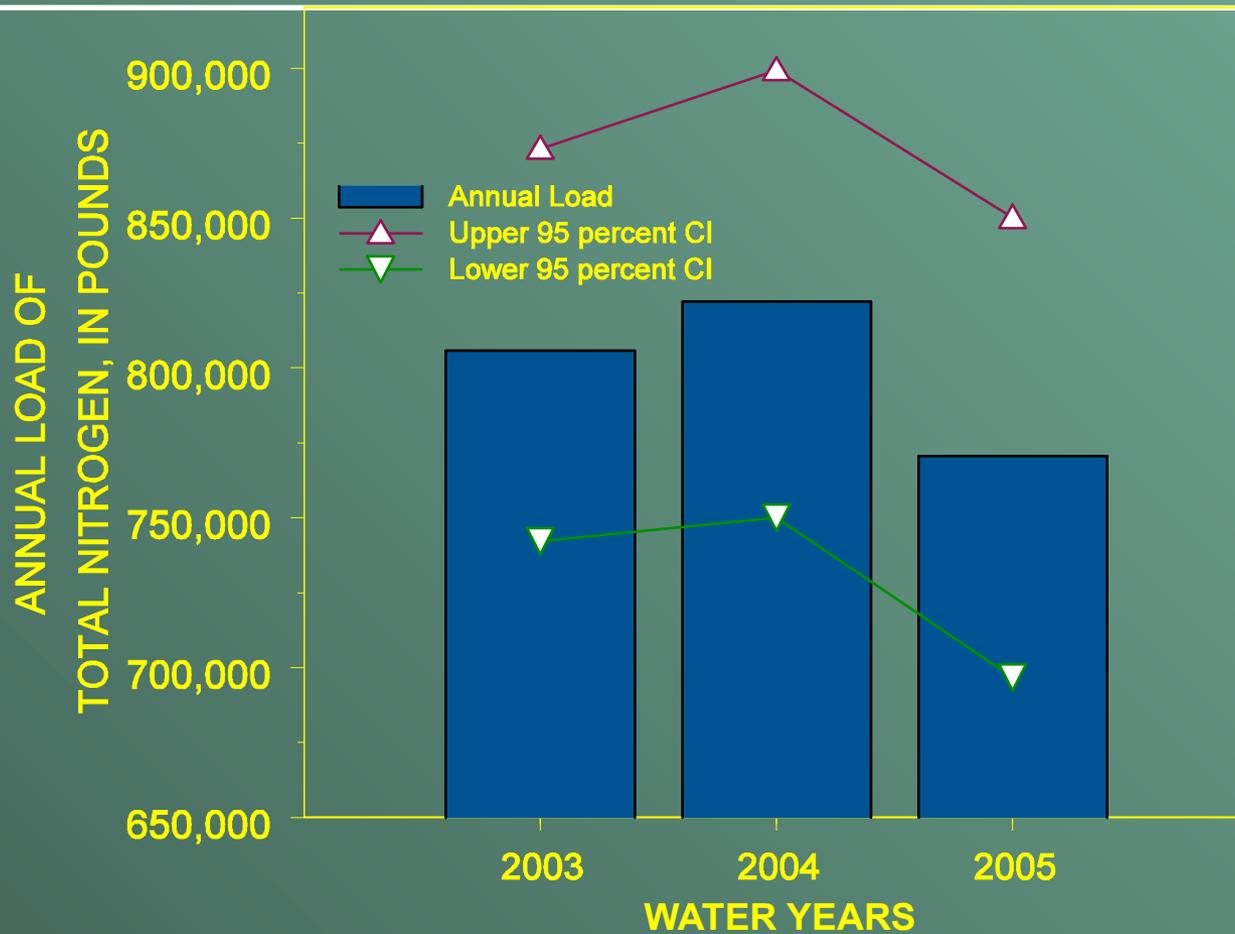


Shepaug River near Roxbury, CT Discharge at Sample Time 2001-2007



Still River at Brookfield Center, CT

Annual Load of Total Nitrogen 2003-2005



Still River at Brookfield Center, CT

Annual Load of Total Phosphorus 2003-2005

