Water Quality in the Saco River:

Indicators of Watershed Health

Tyler Spillane

Stephan Zeeman, PhD

Shelby Braese, Claire Whalen, Linda Jordan, Emily Brzycki, Amanda Liebau, Allegra Tedder, Kim Malkoski, Stephen Giunta, Bailey Rahn, Megan Perry, Marissa Redding, Amanda Rosa

This activity is supported by National Science Foundation award #EPS-0904155 to Maine EPSCoR at the University of Maine

Outline

- Water Quality
- Indicator Bacteria
- Population Growth
- Chlorophyll
- Nutrients
- Dissolved Oxygen
- Indicator Status
- Future Issues

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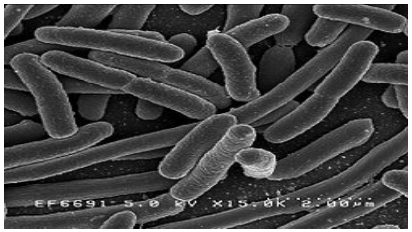
Why Monitor Bacteria?

- Indicator Bacteria: Bacteria used to measure levels of other pathogens and contaminants in water.
- Used for testing in:
  - Recreational waters
  - Shellfish growing water
  - Public water
- Types:
  - coliform bacteria:
    - *Escherichia coli*
  - enterococci and streptococci

A Maine Beach.
http://jeskeonline.net/Pictures/Oct13/Maine%20beach.JPG



E. coli bacteria
http://upload.wikimedia.org/wikipedia/commons/thumb/3/32/EscherichiaColi_NIAID.jpg/250px-EscherichiaColi_NIAID.jpg

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The other reason

- Indicator bacteria are just that – they indicate sources of other possible pollutants.
- Mostly point source – from treated sewage discharges, but also some non-point sources – wildlife, runoff, etc.
- What other kinds of pollutants?
  - Pharmaceuticals, personal care products, other organic pollutants, nutrients

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The Saco River and Bacteria

- Watershed spans 1700 square miles
- Runs through 29 towns, 3 counties, and 2 states, with 11 drainage areas.

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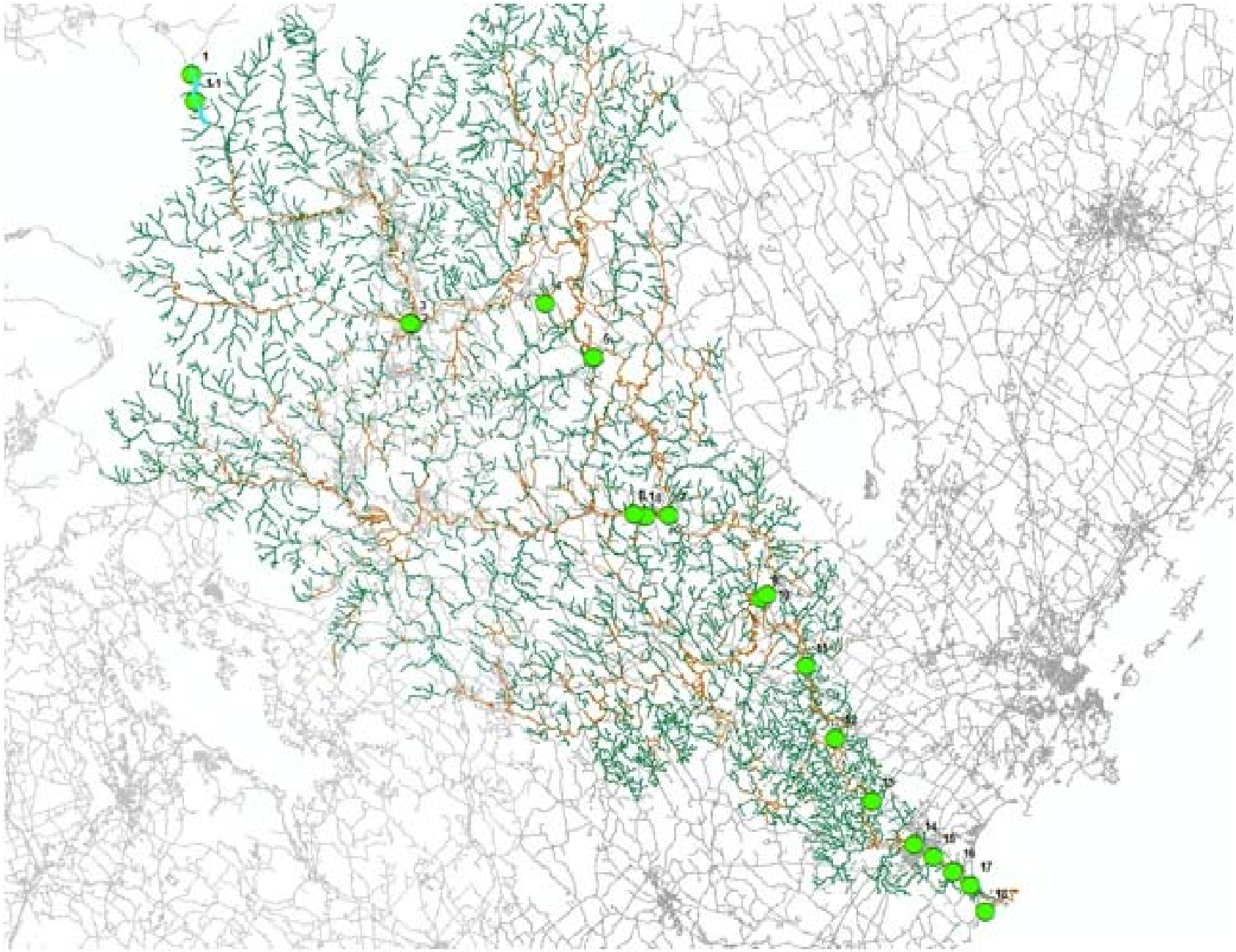

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Saco River Watershed

0 3 6 12 18 24

Kilometers

- Open Water
- Developed Land
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

Data Obtained or Derived from Maine GIS Data Catalog, New Hampshire GRANIT, and The USGS National Map Seamless Server

Created By Amy Carlson, GIS Technician for Phil Yund, Ph.D. University of New England

Last Updated August 13, 2009

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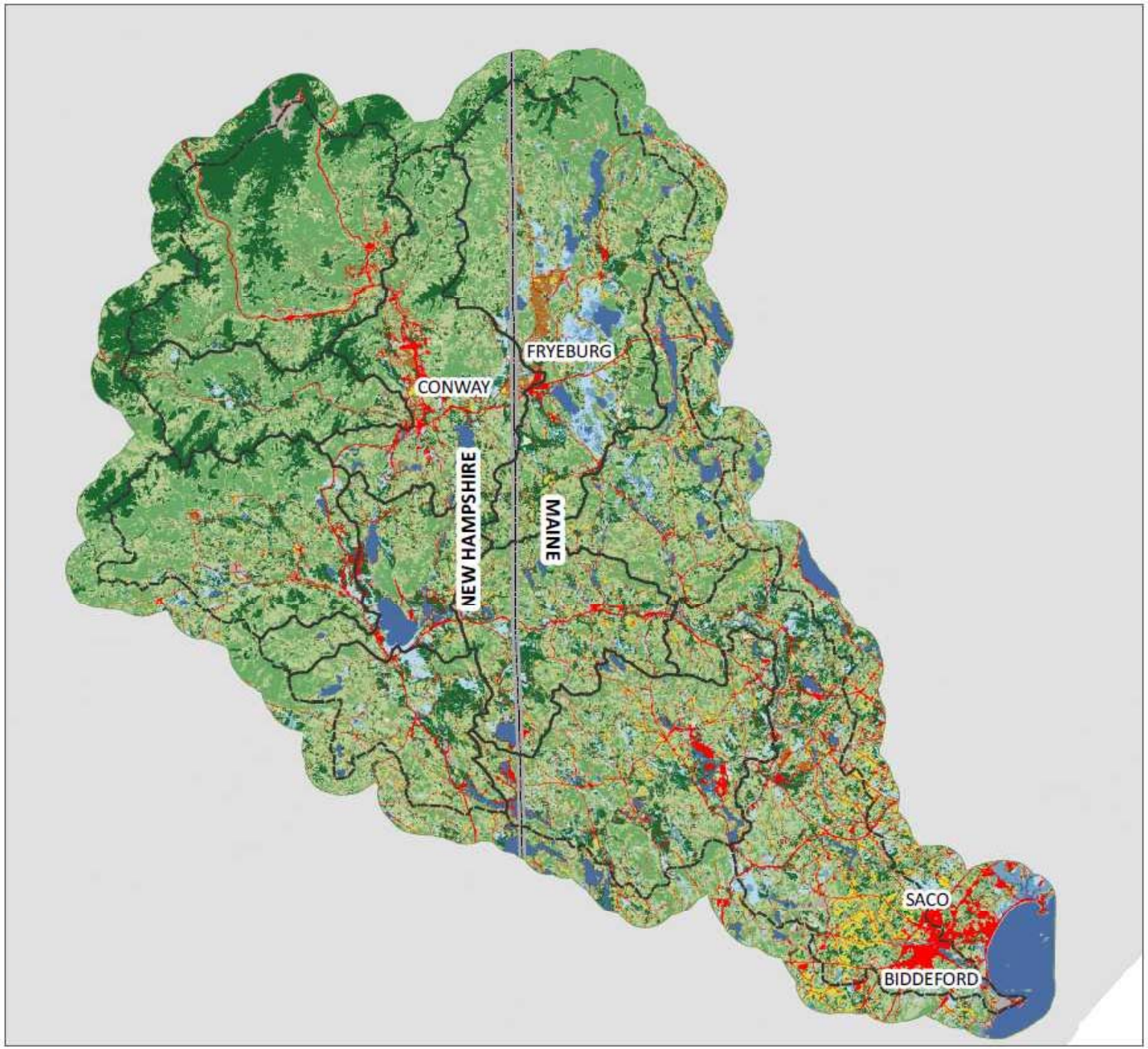

Sampling

- Sampling
  - 18 sites along the river
  - Sampled roughly monthly since December 2010
    - Somewhat more inconsistent since 2013.
  - Measured –
    - Total coliform bacteria and *E. coli* – very good (mostly)
    - Dissolved oxygen - excellent
    - Nutrients – very good
    - Chlorophyll – very good

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Methods: Monitoring Bacteria

- Sample entire river once a month
  - Collect 100ml samples in sterile bottles
  - Samples are kept on ice until brought in for processing.
- Samples are processed using the Idexx Colilert-18© system
  - Most Probable Number (MPN)

Image 1: positive yellow wells under normal light, represents total coliforms

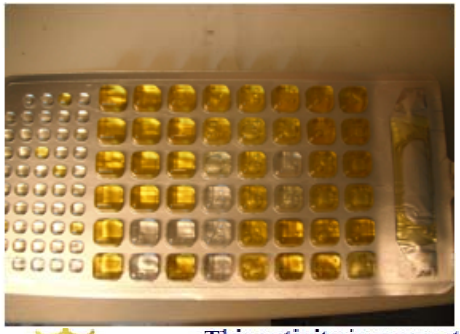
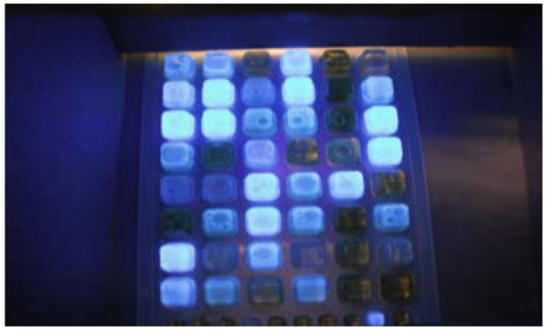


Image 2: Positive wells under uv light ,represents *e. coli*.



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2012Recreational Water Quality Criteria

Table 4. Recommended 2012 RWQC.

Criteria Elements	Estimated Illness Rate (NGI): 36 per 1,000 primary contact recreators			Estimated Illness Rate (NGI): 32 per 1,000 primary contact recreators	
	Magnitude			Magnitude	
Indicator	GM (cfu/100 mL)[a]	STV (cfu/100 mL)[a]	OR	GM (cfu/100 mL)[a]	STV (cfu/100 mL)[a]
Enterococci – marine and fresh	35	130		30	110
OR					
E. coli – fresh	126	410		100	320
Duration and Frequency: The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a ten percent excursion frequency of the selected STV magnitude in the same 30-day interval.					

[a] EPA recommends using EPA Method 1600 (U.S. EPA, 2002a) to measure culturable enterococci, or another equivalent method that measures culturable enterococci and using EPA Method 1603 (U.S. EPA, 2002b) to measure culturable *E. coli*, or any other equivalent method that measures culturable *E. coli*.

US EPA OFFICE OF WATER 820-F-12-058

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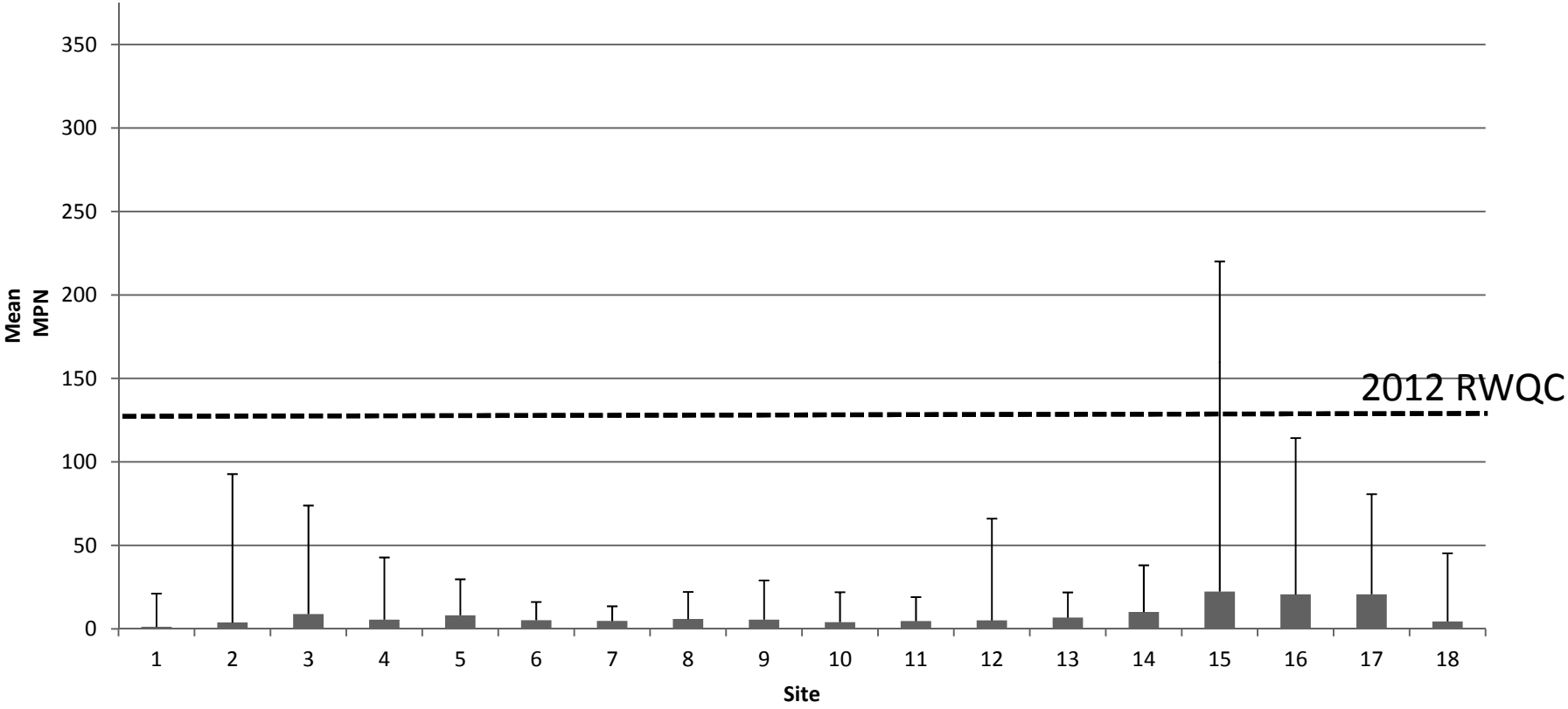
Geometric Mean *E. coli* numbers



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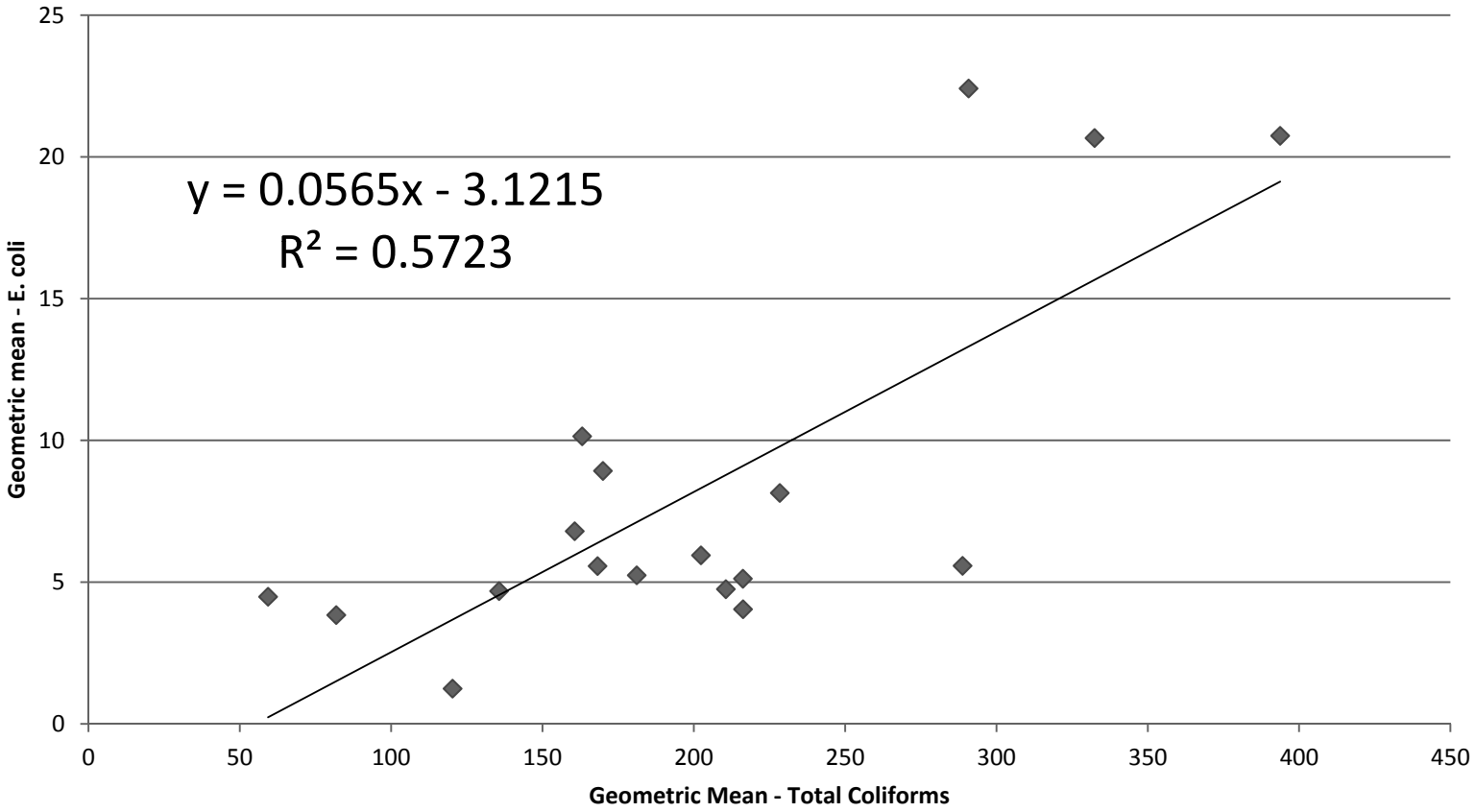
Relation of Total Coliform bacteria to *E. coli*



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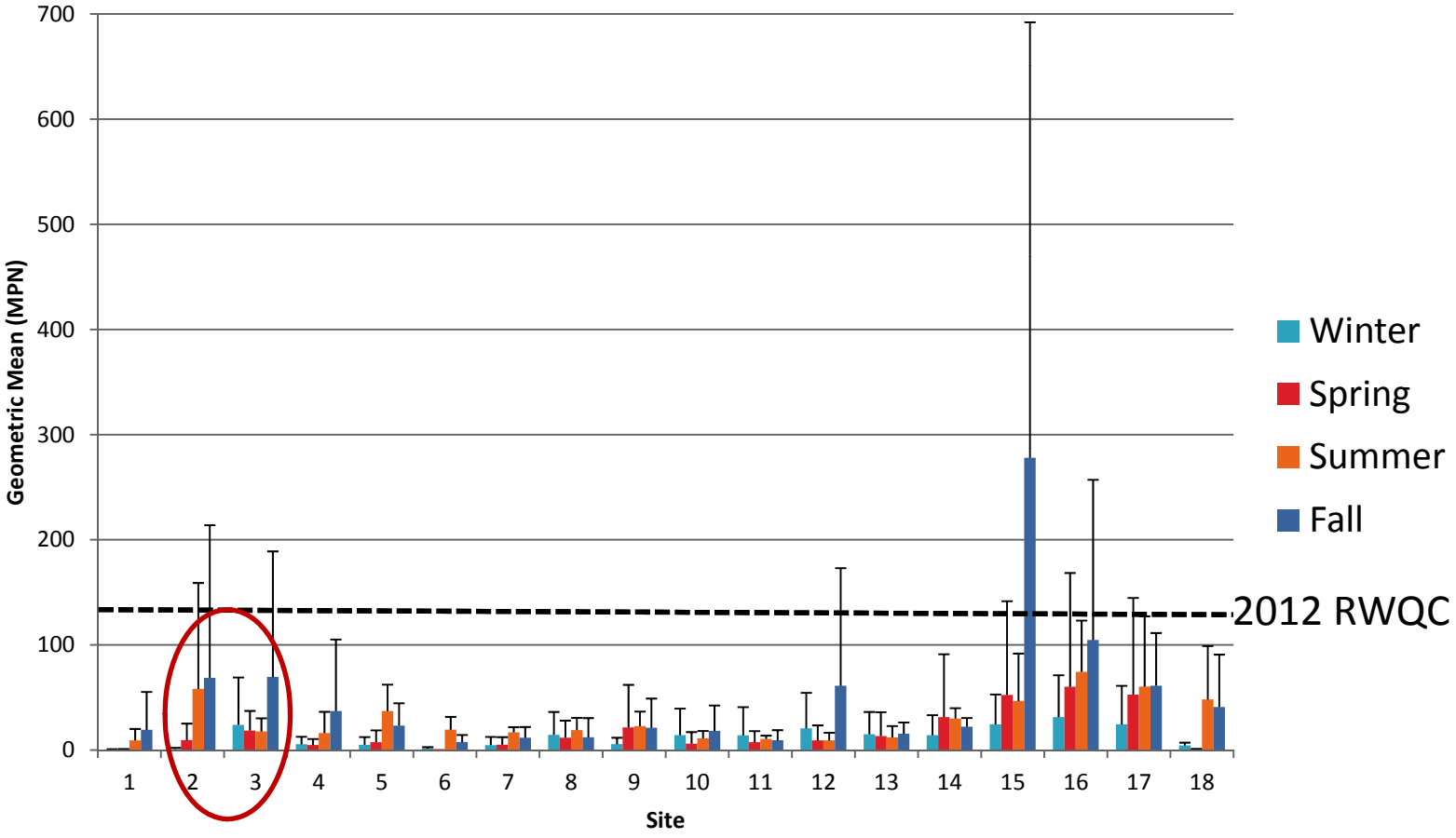
Seasonal Variability



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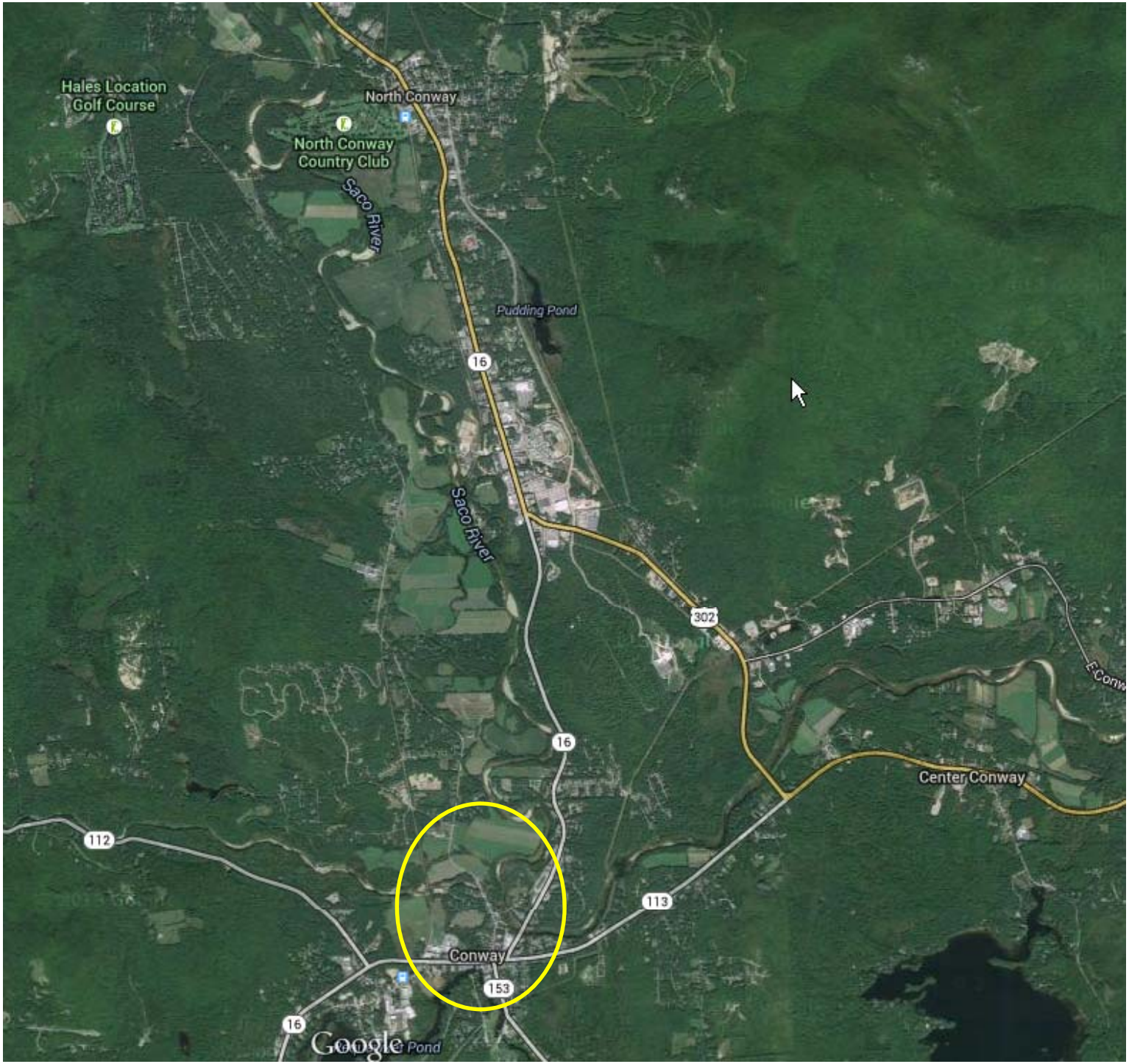
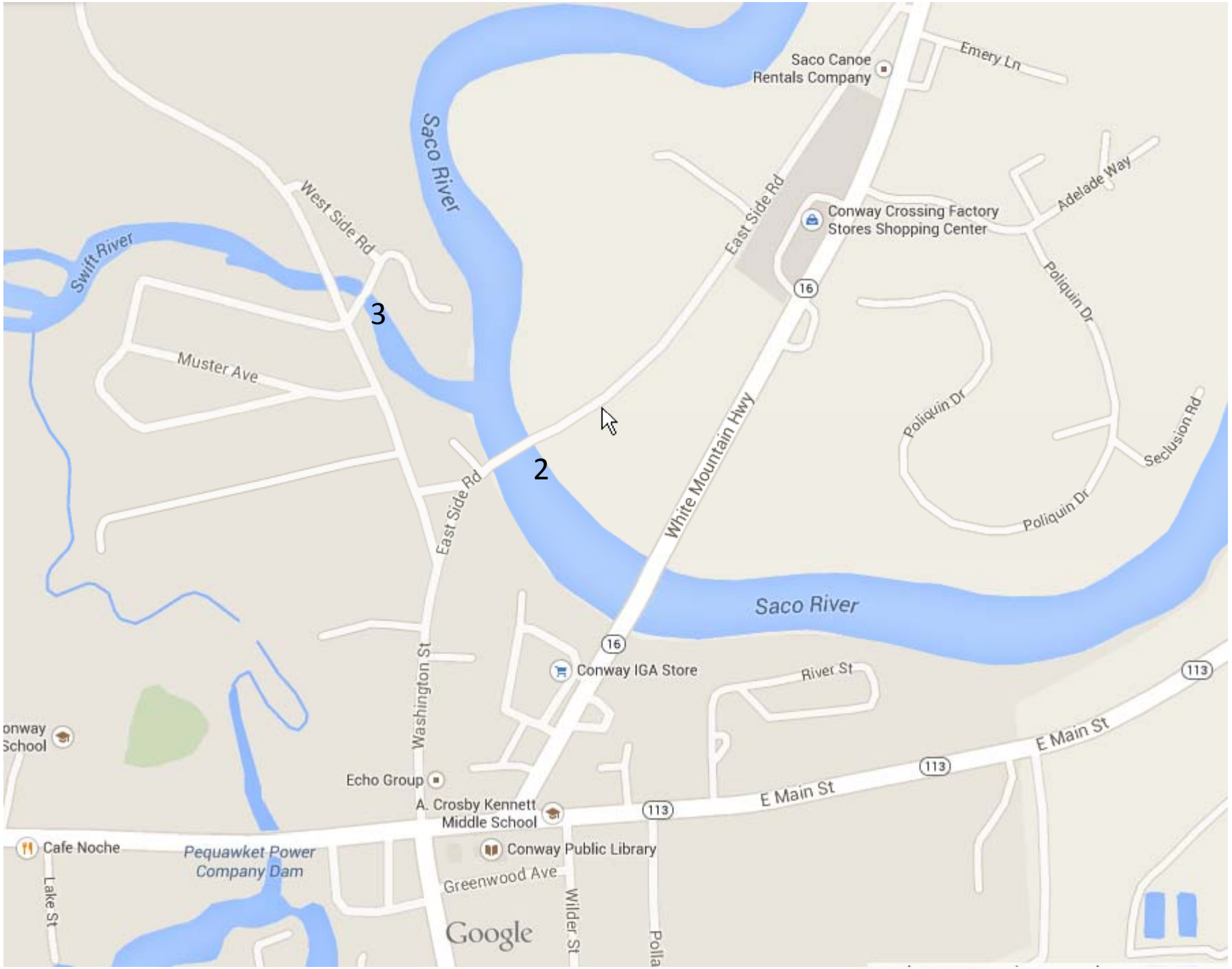

Hales Location
Golf Course
North Conway
North Conway
Country Club
Saco River
Pudding Pond
16
Saco River
302
16
Center Conway
112
113
Conway
153
16
Google


Saco River
Swift River
West Side Rd
Muster Ave
East Side Rd
Saco Canoe
Rentals Company
Emery Ln
Conway Crossing Factory
Stores Shopping Center
Adelade Way
Poliquin Dr
Seclusion Rd
White Mountain Hwy
16
3
2
Saco River
Washington St
Conway IGA Store
River St
113
E Main St
Echo Group
A. Crosby Kennett
Middle School
Cafe Noche
Pequawket Power
Company Dam
Conway Public Library
Greenwood Ave
Lake St
Wilder St
Google

North Conway Treatment Plant

- No direct discharge to the river
  - Rapid infiltration to groundwater
- Uses a nitrogen and phosphorus removal process

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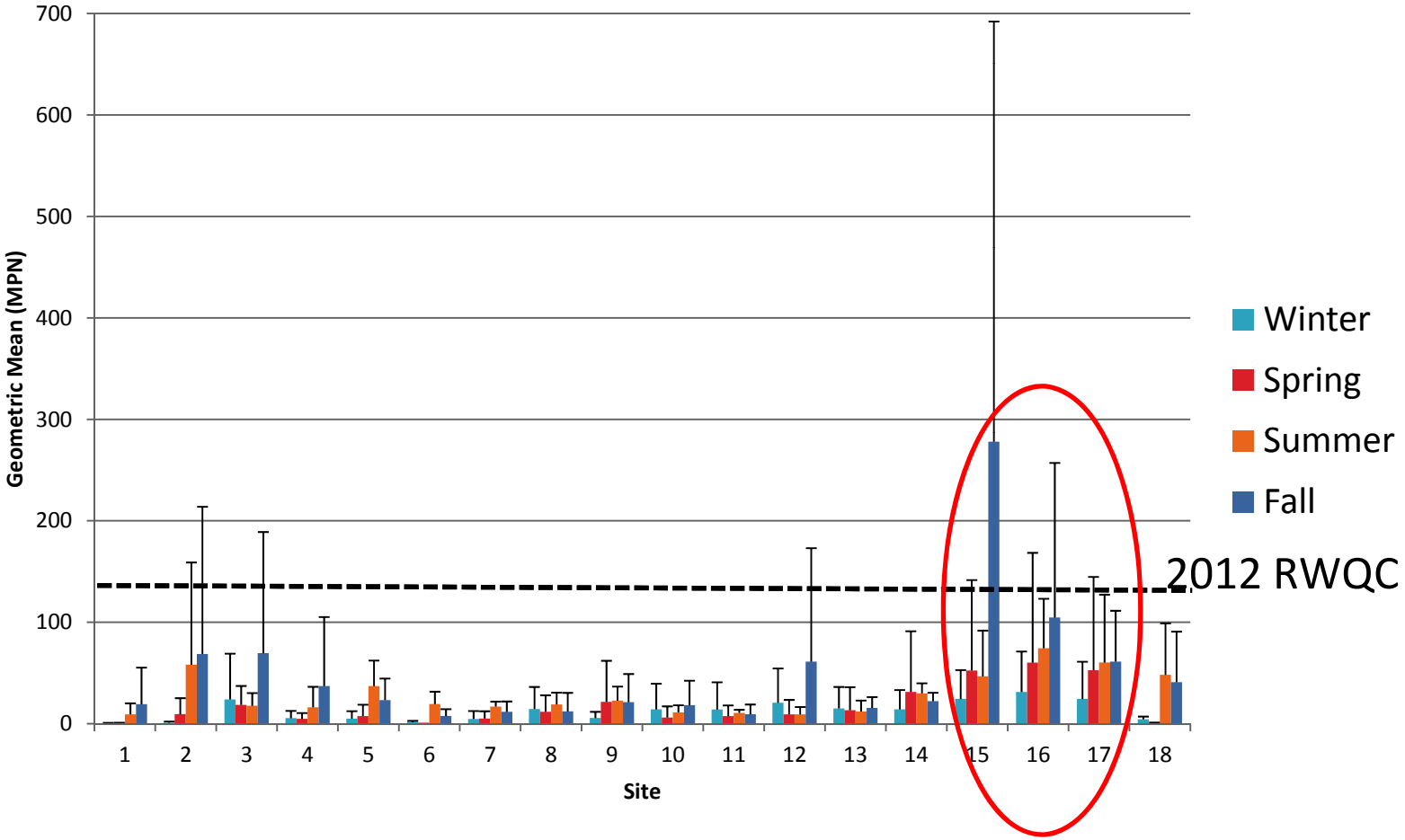
Seasonal Variability



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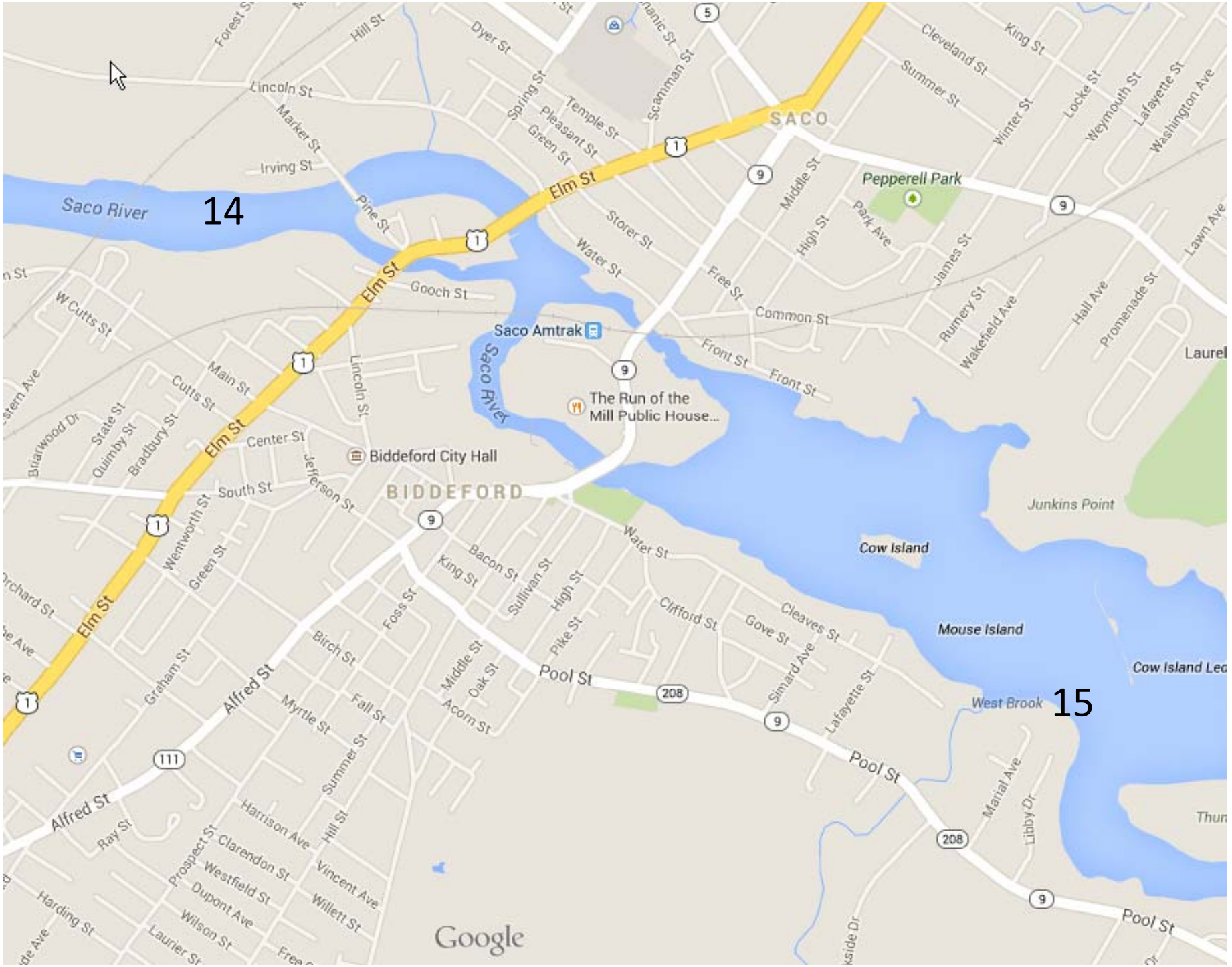
14
15
Saco River
Elm St
Lincoln St
Irving St
Market St
Pine St
Gooch St
Water St
Storer St
Free St
Common St
Front St
Saco Amtrak
Saco River
The Run of the Mill Public House...
Biddeford City Hall
BIDDEFORD
SACO
Pepperell Park
Middle St
High St
Park Ave
James St
Rumery St
Wakefield Ave
Hall Ave
Promenade St
Lawn Ave
Laurel
Junkins Point
Cow Island
Mouse Island
Cow Island Lec
West Brook
Pool St
Alfred St
Main St
Cutts St
W Cutts St
Center St
South St
Jefferson St
Lincoln St
Wentworth St
Green St
Graham St
Birch St
Foss St
Bacon St
King St
Sullivan St
High St
Pike St
Clifford St
Gove St
Cleaves St
Simard Ave
Lafayette St
Fall St
Myrtle St
Summer St
Middle St
Oak St
Acorn St
Harrison Ave
Hill St
Vincent Ave
Willett St
Clarendon St
Westfield St
Dupont Ave
Wilson St
Prospect St
Ray St
Harding St
Laurier St
Marial Ave
Libby Dr
Cleveland St
King St
Summer St
Winter St
Locke St
Neymouth St
Lafayette St
Washington Ave
Dyer St
Spring St
Temple St
Pleasant St
Green St
Scamman St
Hill St
Forest St
Briarwood Dr
State St
Quimby St
Bradbury St
Stern Ave
Orchard St
Google

Saco River Corridor Commission

- The SRCC has collected water quality data for many years.
- Some sites near the Saco/Biddeford:
  - Swan Pond Brook – Impaired (*E. coli*)
  - Thatcher Brook – Impaired (urban stormwater, non-point source)
  - Saco River Estuary – Impaired (CSO)

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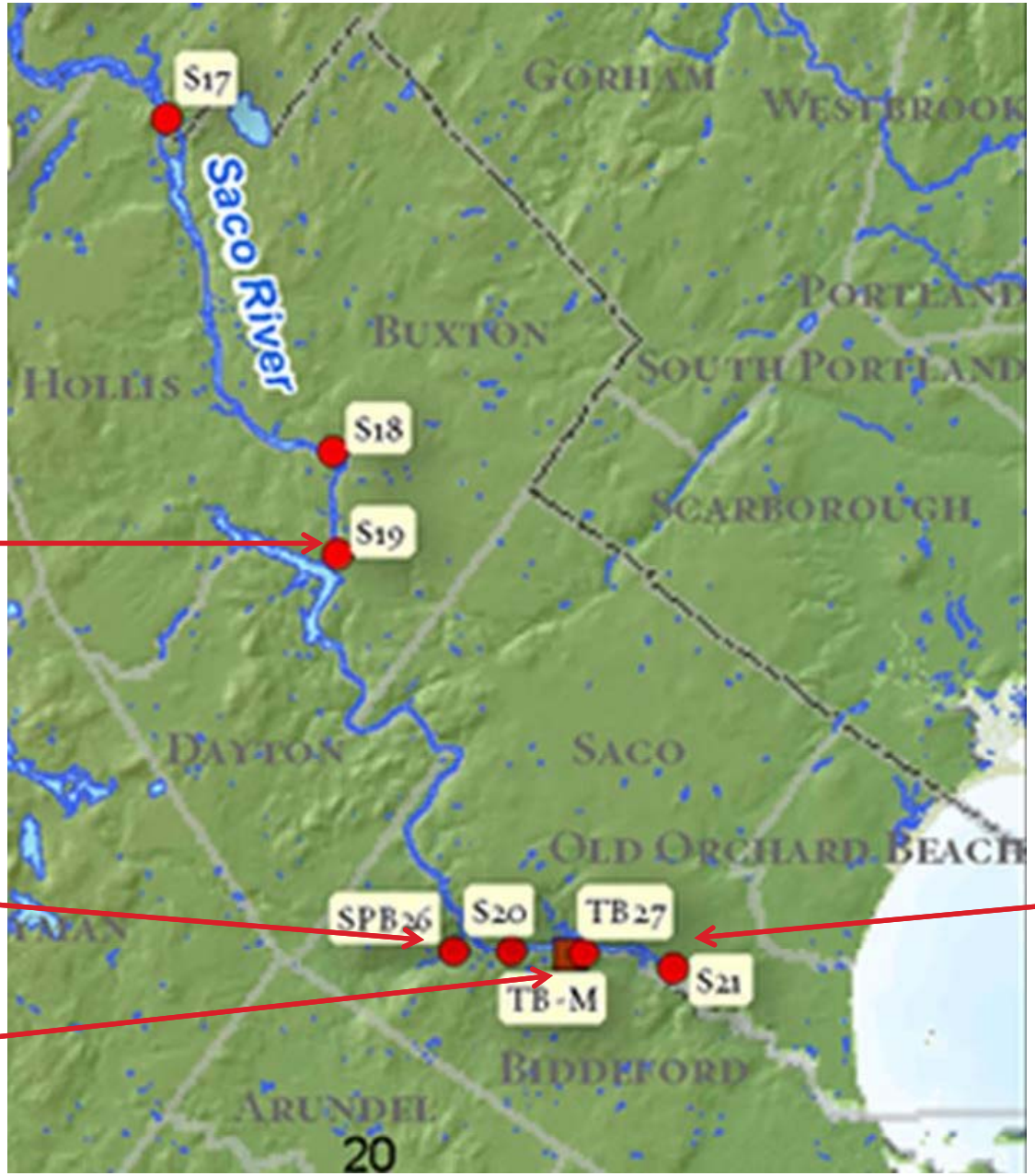

Saco R. 19

Swan Pond Brook

Thatcher Brook

Saco R. Estuary

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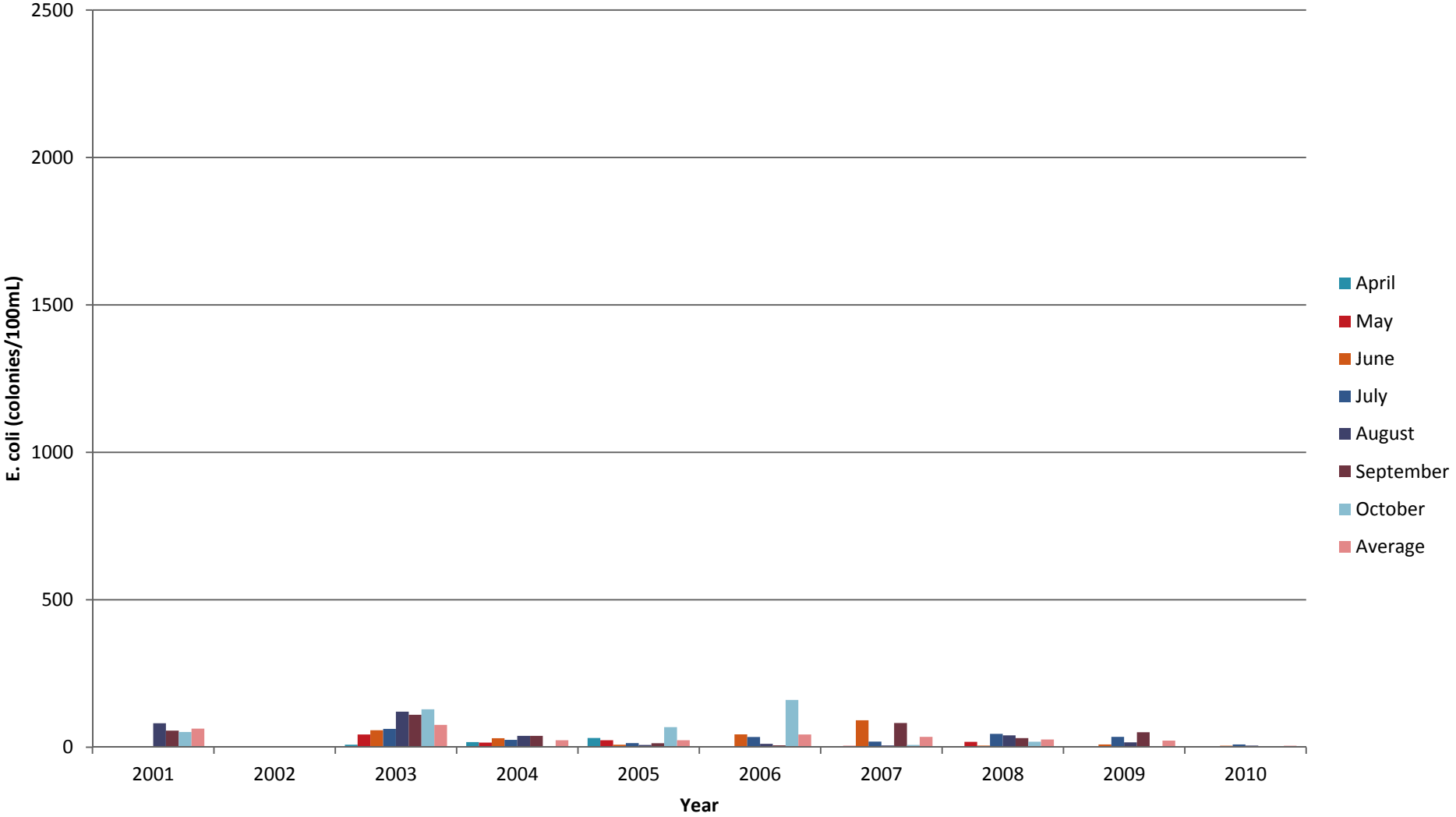
Saco River 19, *Escherichia coli*

Above Skelton Dam



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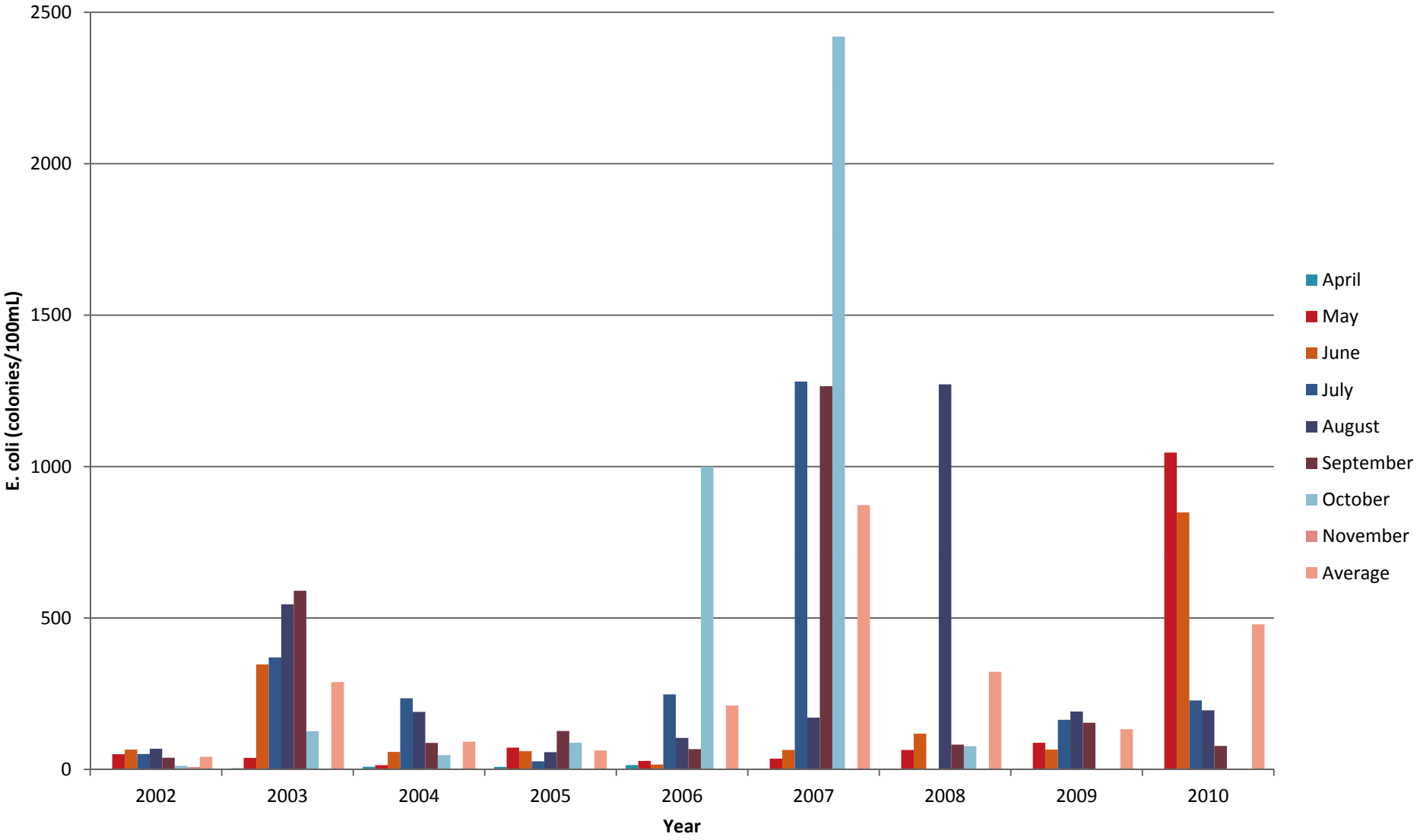
Swan Pond Brook 26 Escherichia coli



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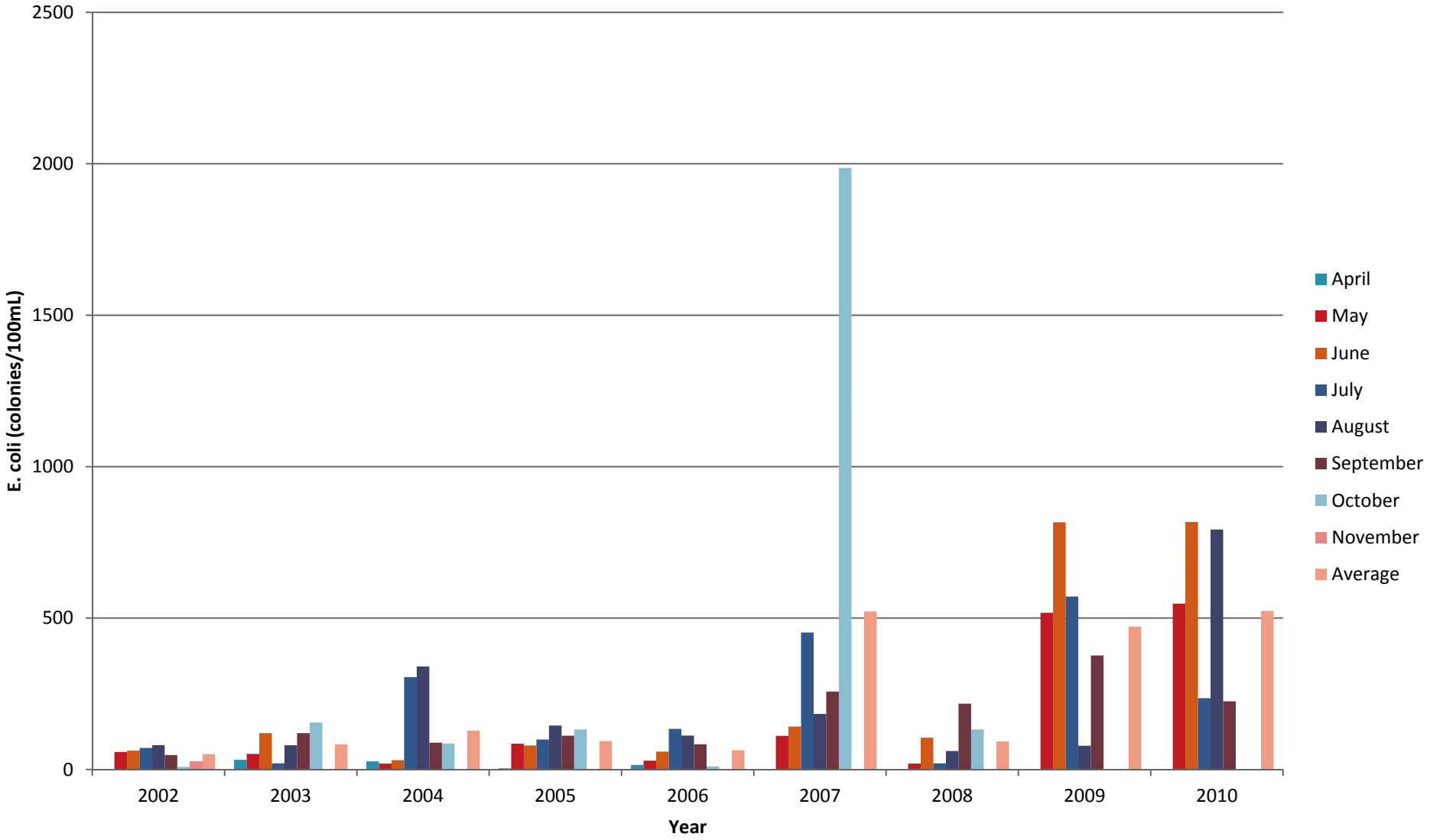
Thatcher Brook 27, *Escherichia coli*



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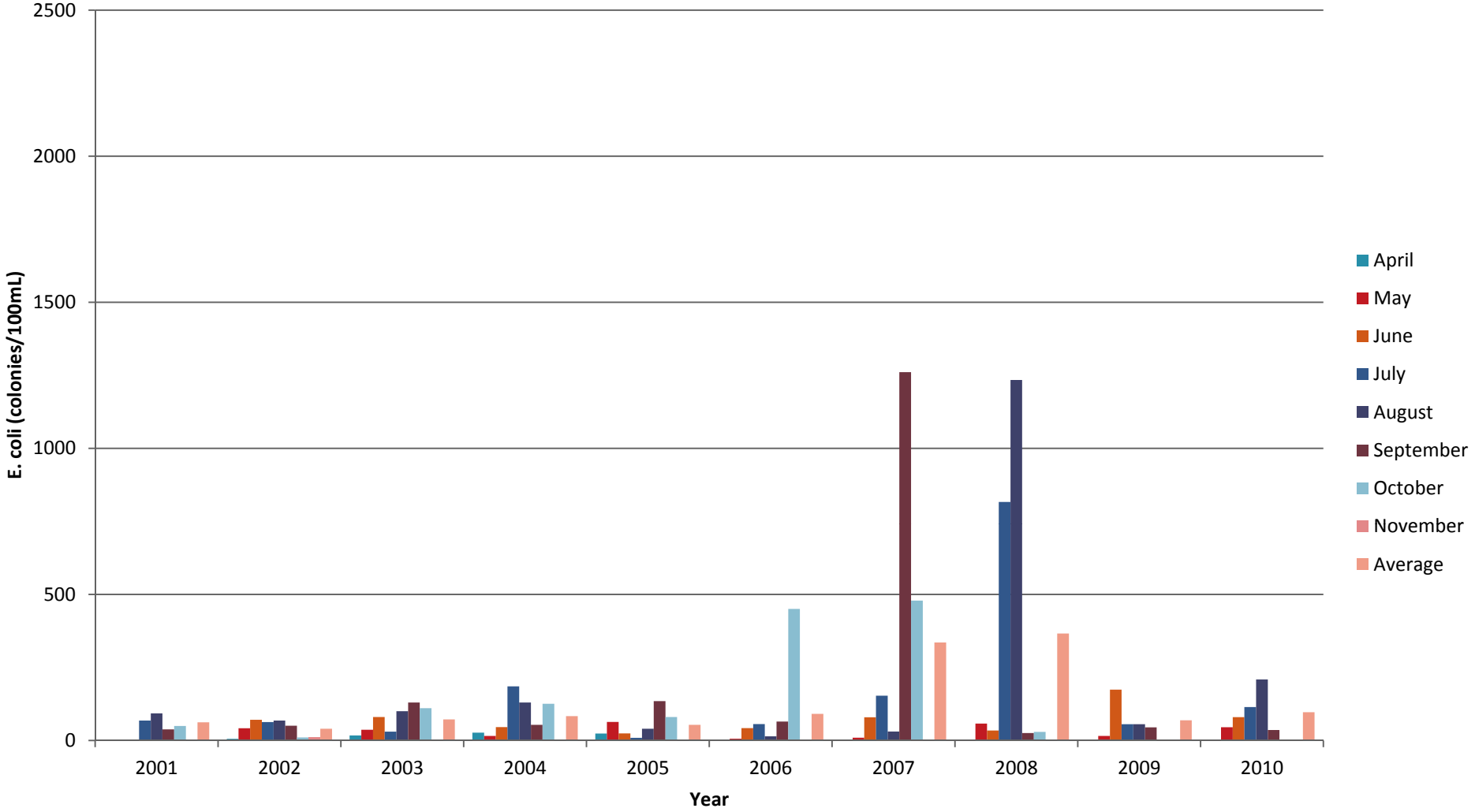
Saco River 21, *Escherichia coli*

Saco Bay Yacht Club ramp



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Saco River Corridor Commission Results

- The SRCC data also confirm the lower values upstream from Biddeford and Saco, and higher values in the estuary.
- They point to localized “hot spots” in some tributaries.

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Bottom line

- Most of the time the *E. coli* along the river are below EPA criteria.
- Higher levels are observed near Conway, NH and below the dam at Saco and Biddeford.
- Seasonal trends are observed with higher values in summer and fall.
  - Spring, summer and fall around Biddeford and Saco.

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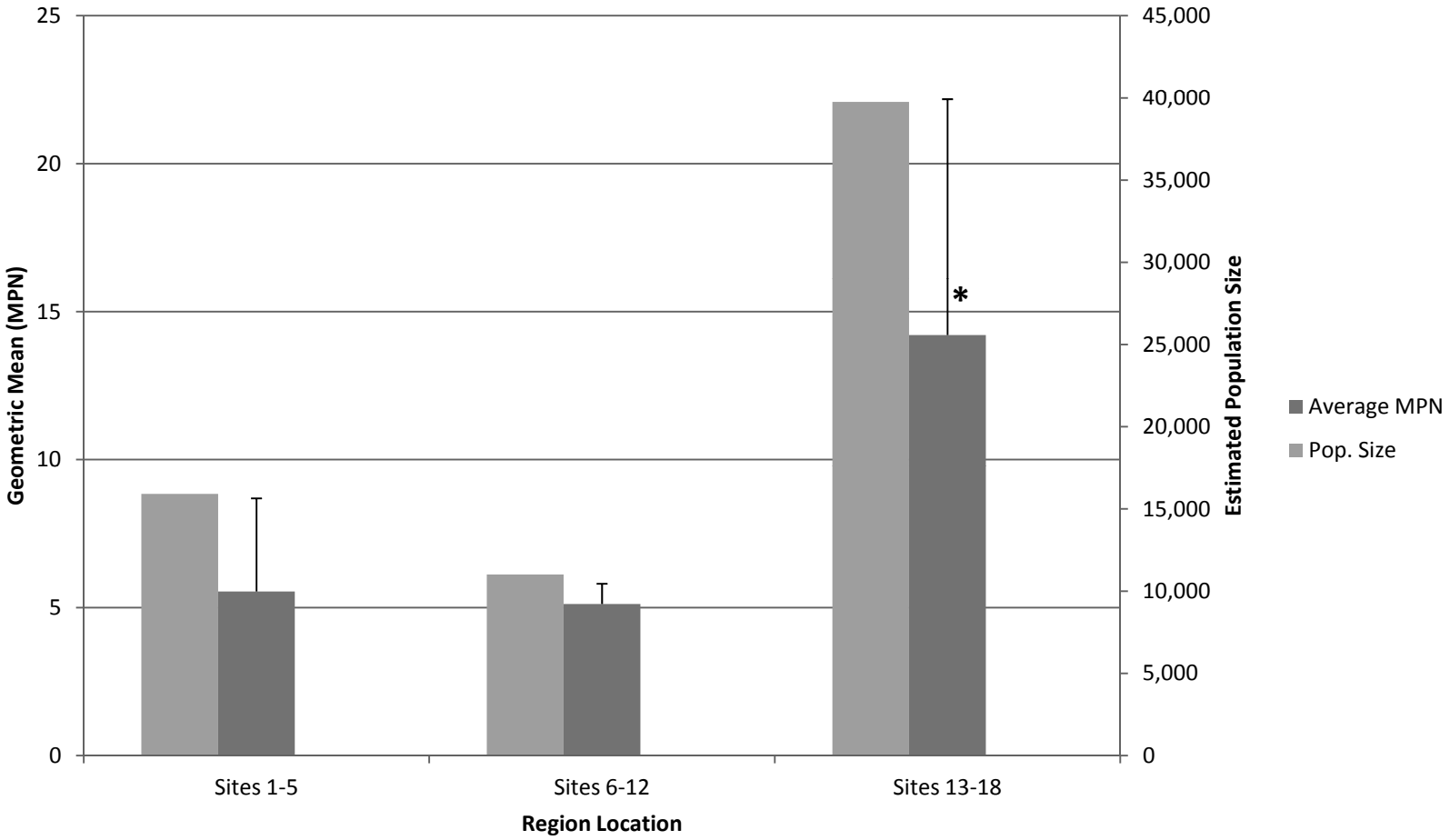
Relation to Population Size



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Population Growth

- To model population growth and land use changes we looked at Conway, NH, as an example.
- We used IDRISI from Clark Labs and its Land Change Modeler
- Using Data from 1992, 2001, and 2010 we predicted conditions for 2030.

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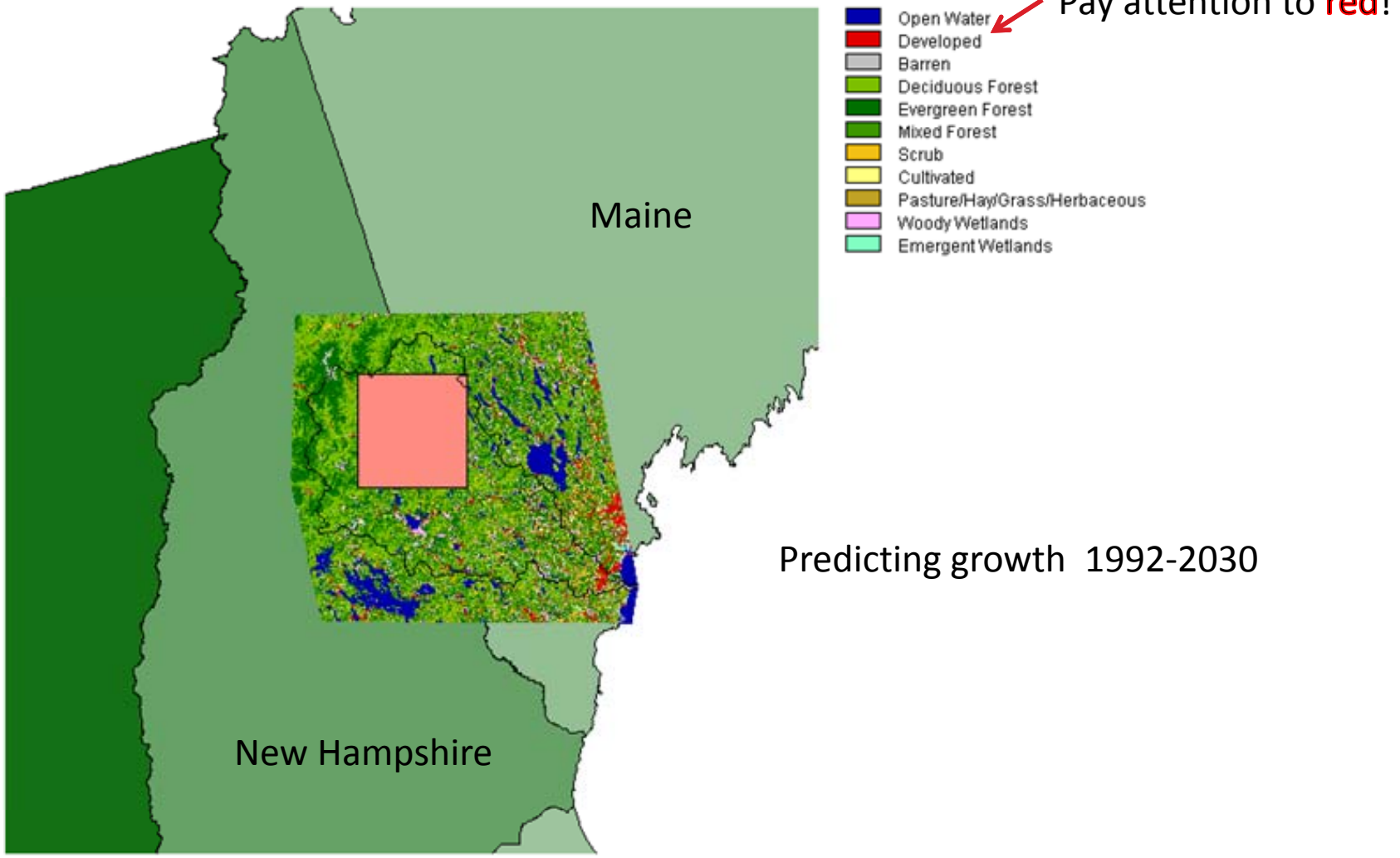
Conway, NH



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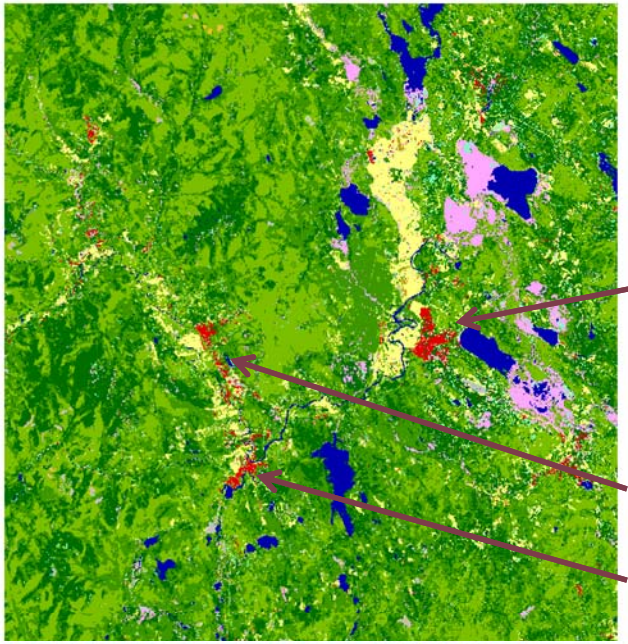
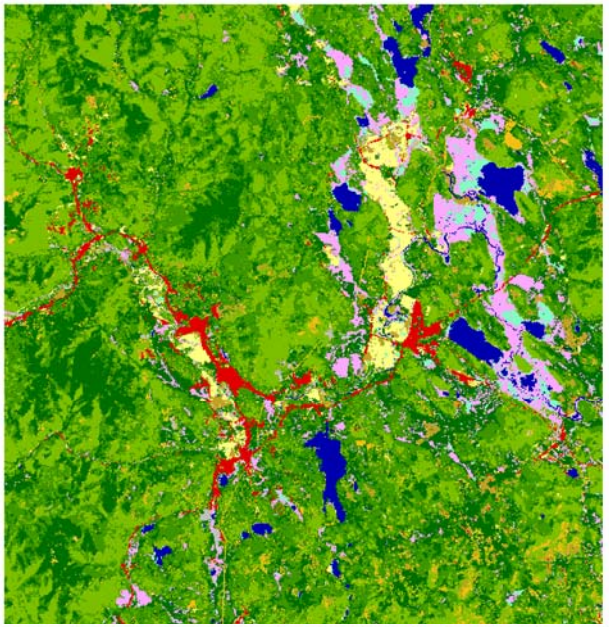


Fryeburg

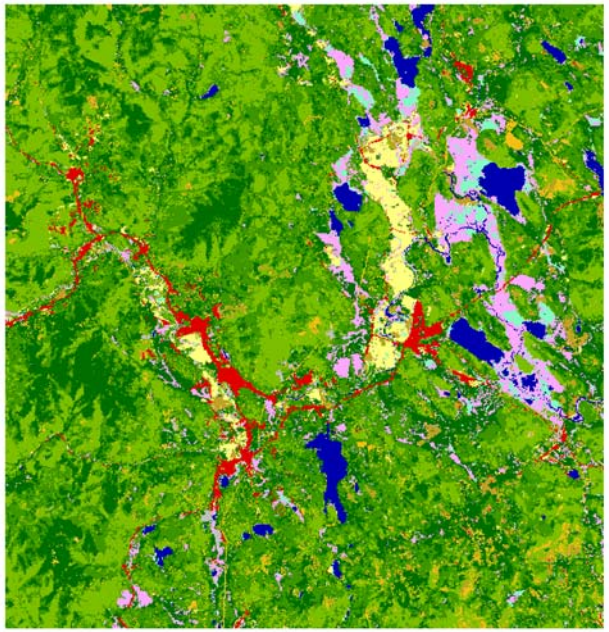
North Conway

Conway

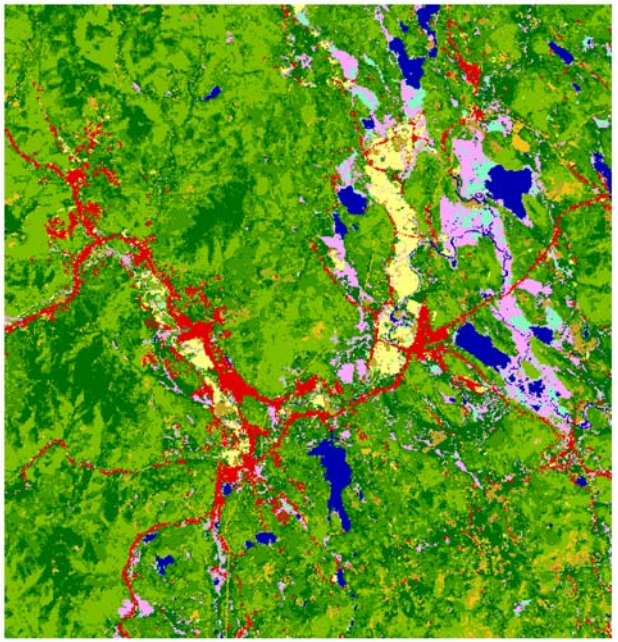
1992



2001



2010



2030
predicted

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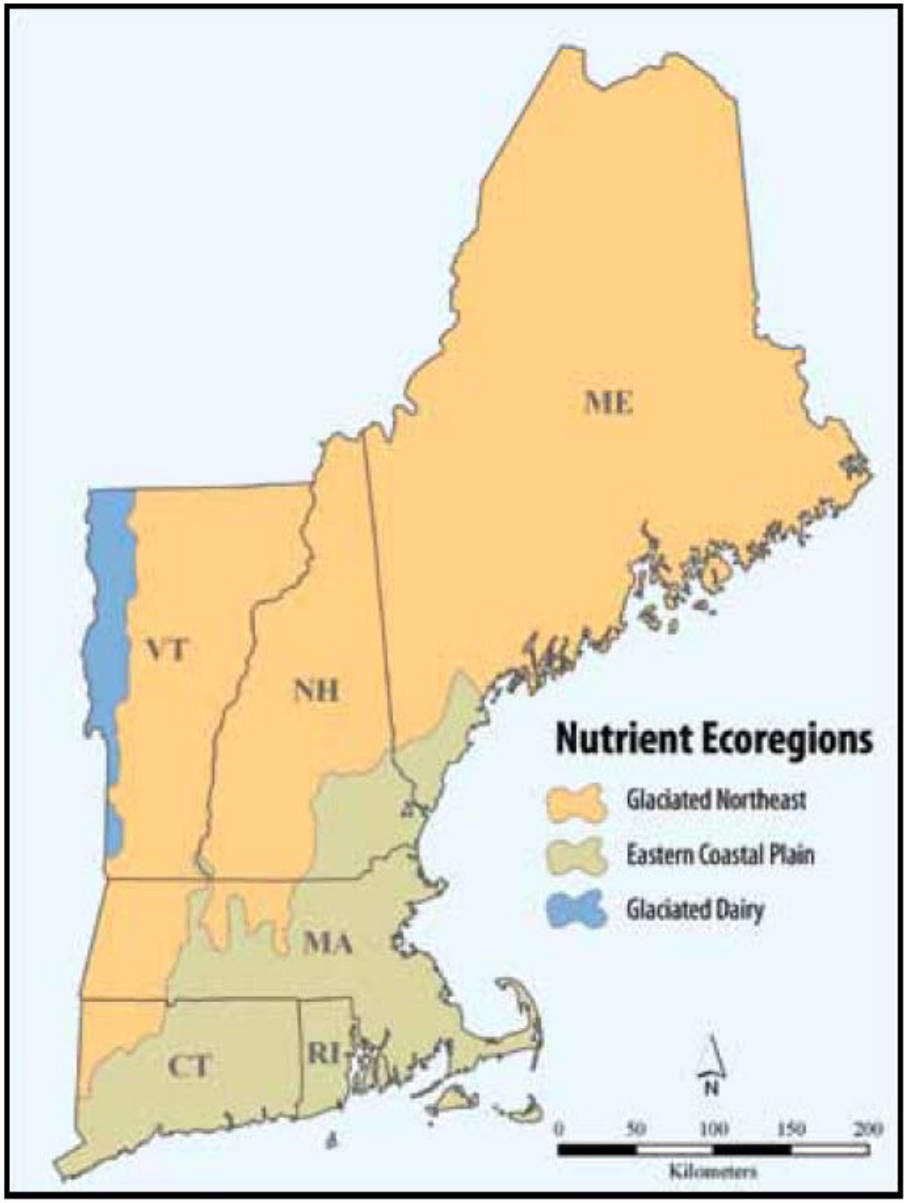

Figure 3-2. *Three nutrient ecoregions in New England were used to set water quality thresholds for this report.*

Gauging the Health of New England's Lakes and Ponds,
New England Interstate Water Pollution Control Commission, 2010

This activity is supported by National Science Foundation award #EPS-0904155 to Maine EPSCoR at the University of Maine

Threshold	Reference Ecoregion	Total Nitrogen µg/L	Total Phosphorus µg/L	Chlorophyll µg/L	ANC µeq/L
Good-Fair	Glaciated Dairy	828	24	8.6	50
	Glaciated Northeast	666	16	7.6	50
	Eastern Coastal Plain	629	26	29	50
Fair-Poor	Glaciated Dairy	1410	102	46	0
	Glaciated Northeast	1174	36	13	0
	Eastern Coastal Plain	2311	75	76	0

Table 3-2. *Threshold condition categories based on regional reference lake conditions.*

Gauging the Health of New England's Lakes and Ponds,
New England Interstate Water Pollution Control Commission, 2010

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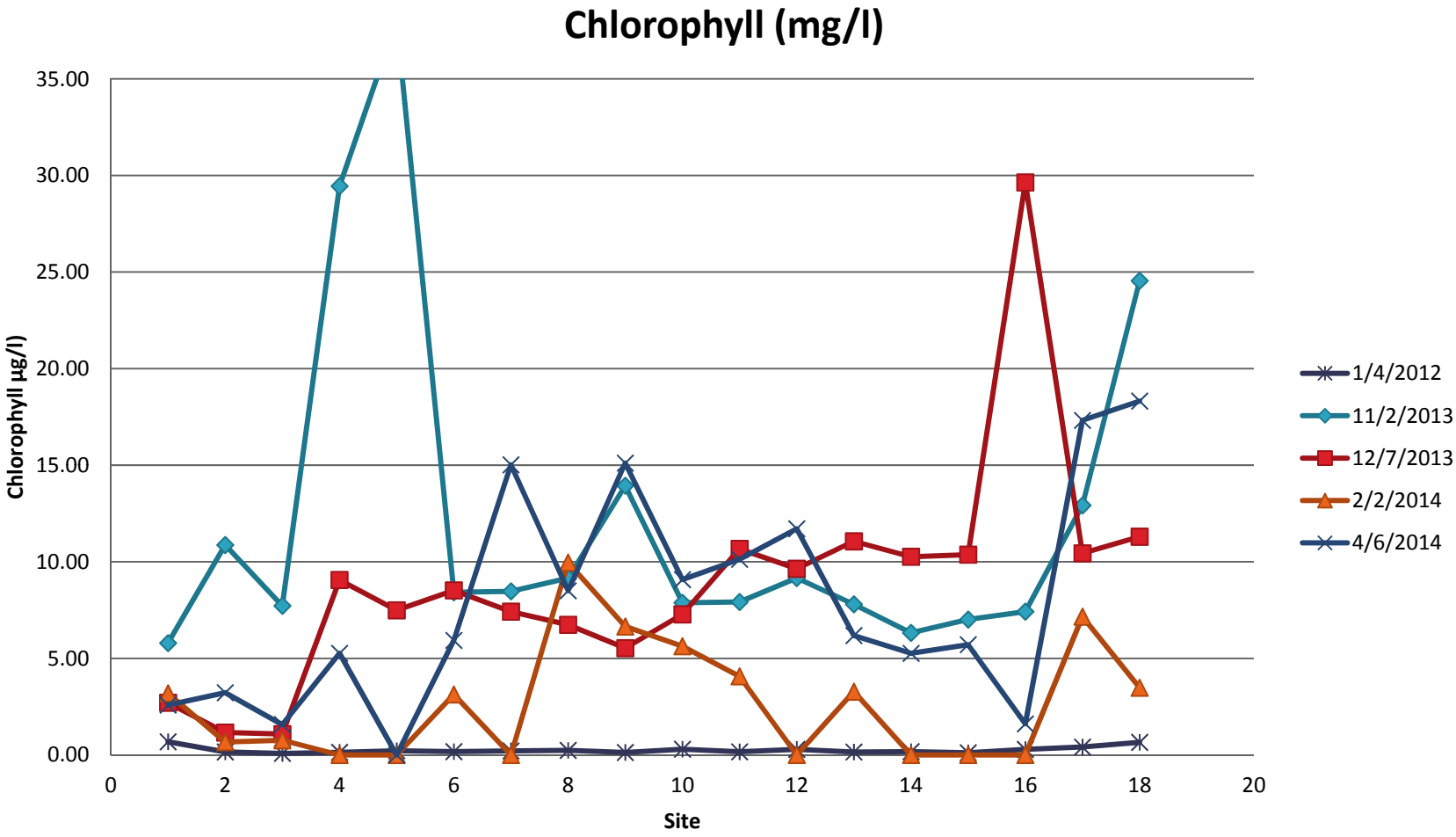
Chlorophyll



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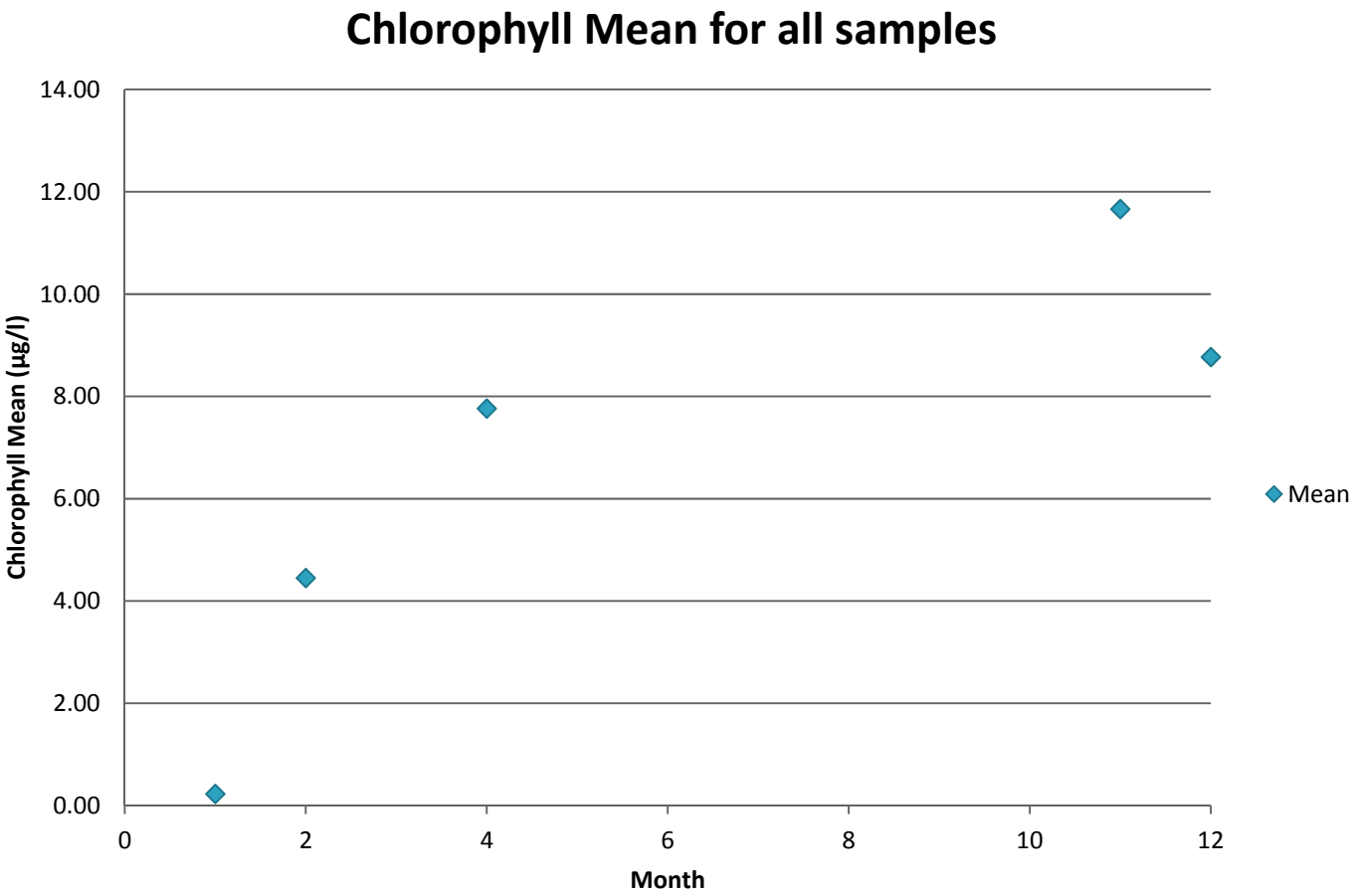
Chlorophyll – Seasonal Trend



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Nutrients

- Nutrients are substances required for growth
  - In the case of water quality, it refers specifically to plant or algae growth
- The important plant nutrients are
  - Nitrogen
    - Nitrate, nitrite, ammonium
  - Phosphorus
    - Soluble reactive phosphorus

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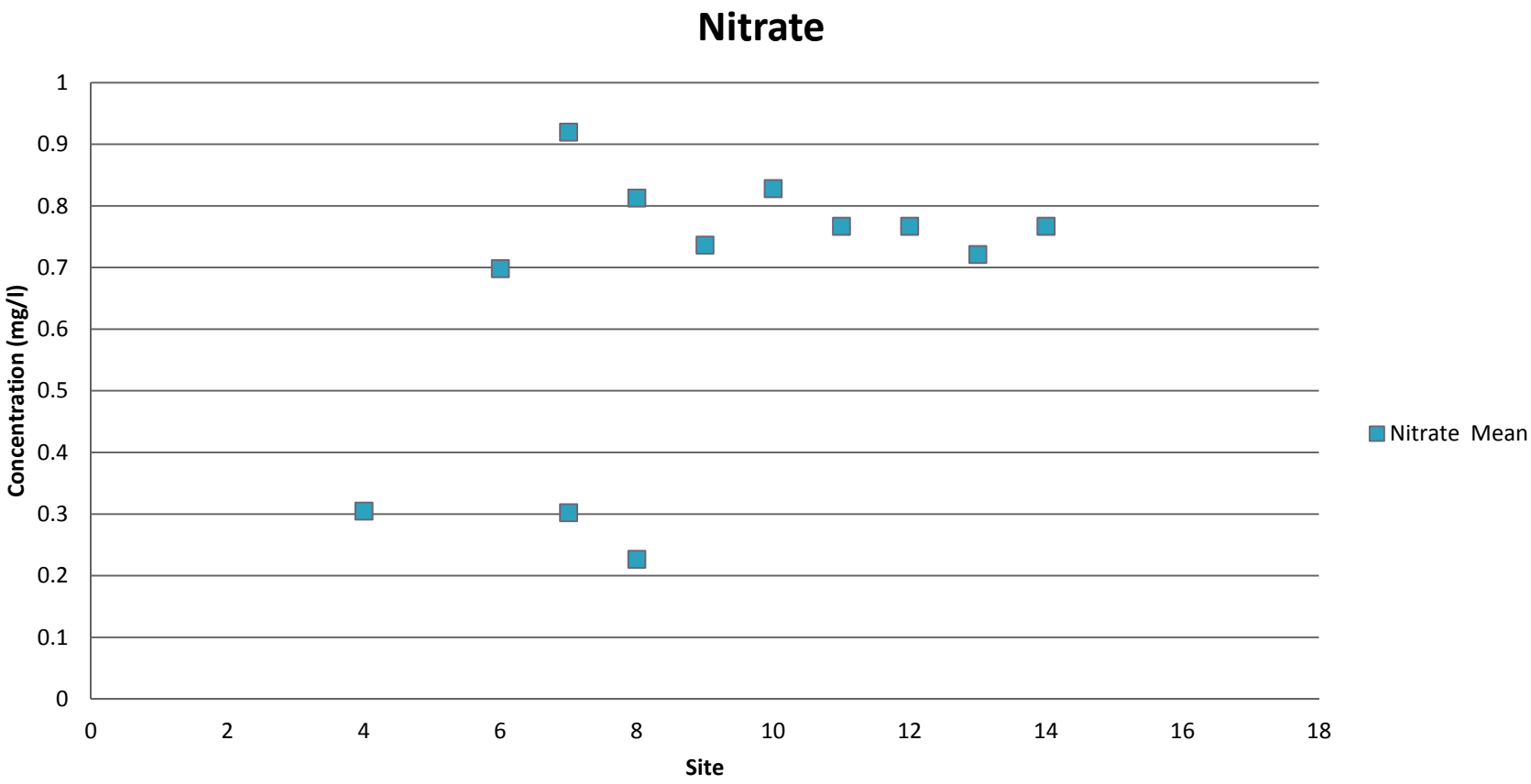
Nitrate



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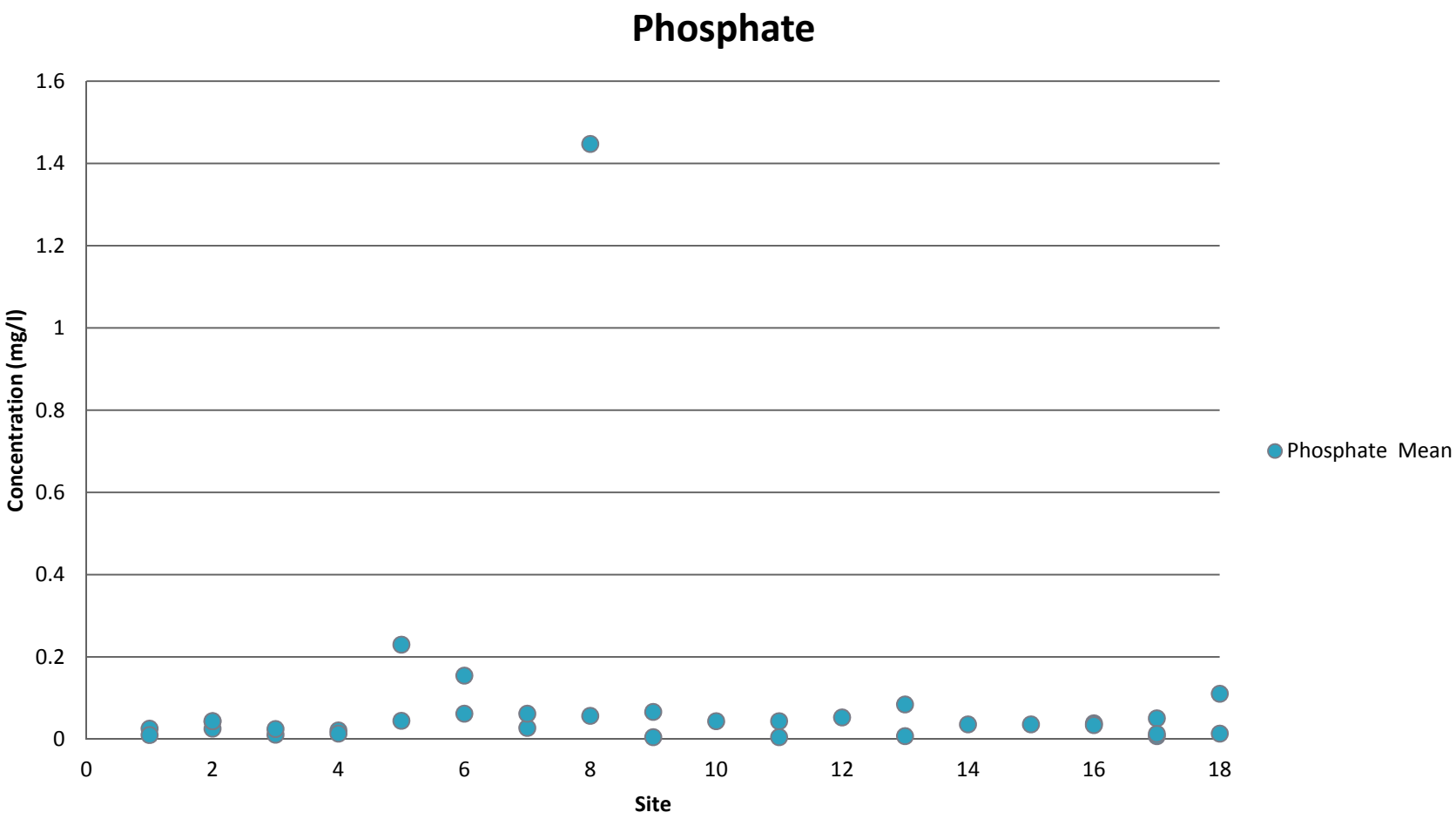
Phosphate



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Saco Bay Nutrients

- EPA sampling 7/2/2010

Site		Depth	TP (mg/l)	TN (mg/l)
	1.00	Surface	0.0249	0.22
	1.00	Mid	0.0316	0.24
	1.00	Bottom	0.0380	0.35
	2.00	Surface	0.0216	0.21
	2.00	Mid	0.0228	0.20
	2.00	Bottom	0.0494	0.37

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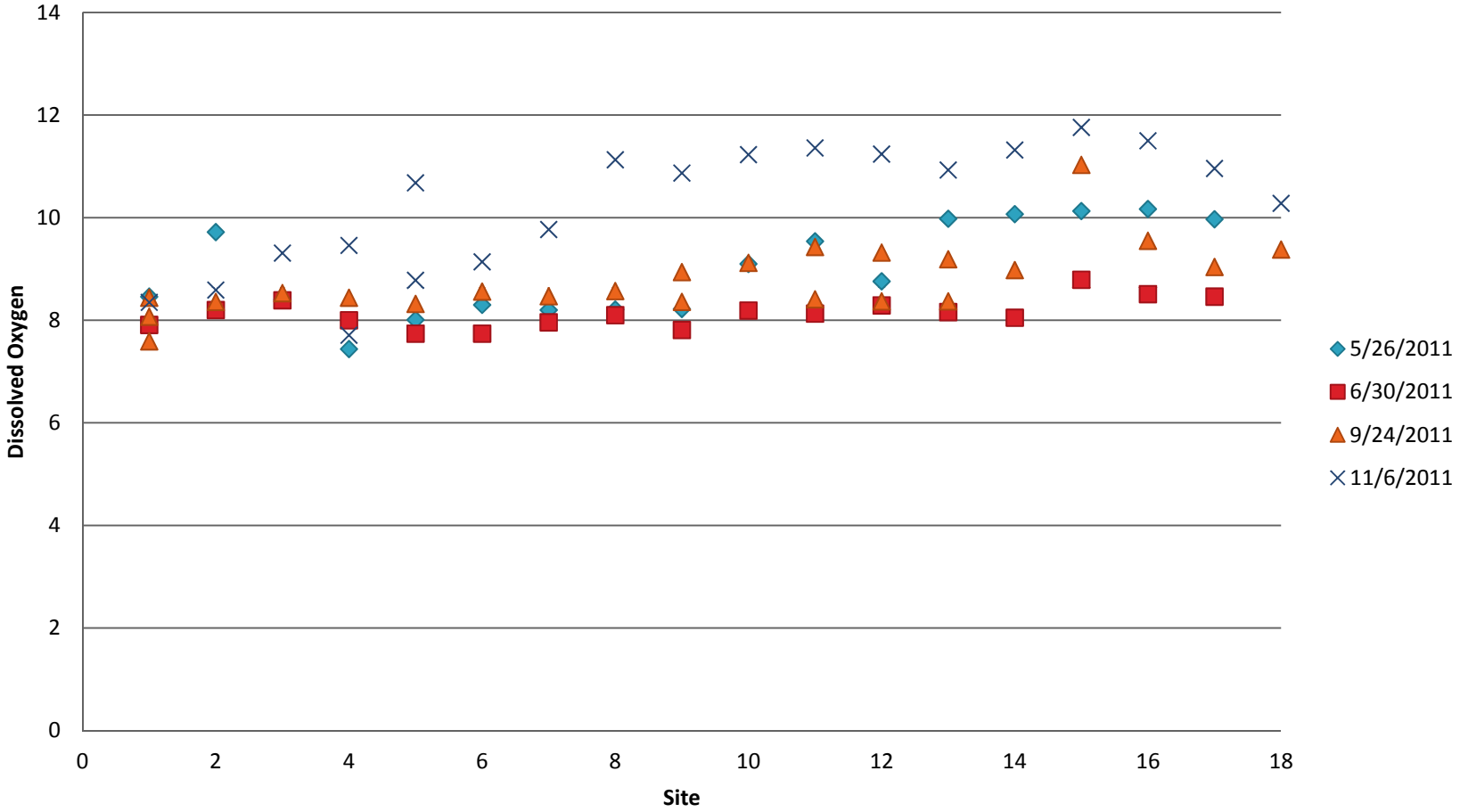
Dissolved Oxygen



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Report Summary

- Water Quality
  - *E. coli* – very good (mostly)
  - Chlorophyll – very good
  - Nutrients – very good
  - Dissolved oxygen – excellent

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Report Summary - Caveats

- There are areas and times that show reduced water quality
- Future growth may have deleterious effects unless we plan for it.

- New and legacy pollutants may be problematic – we did not measure these.

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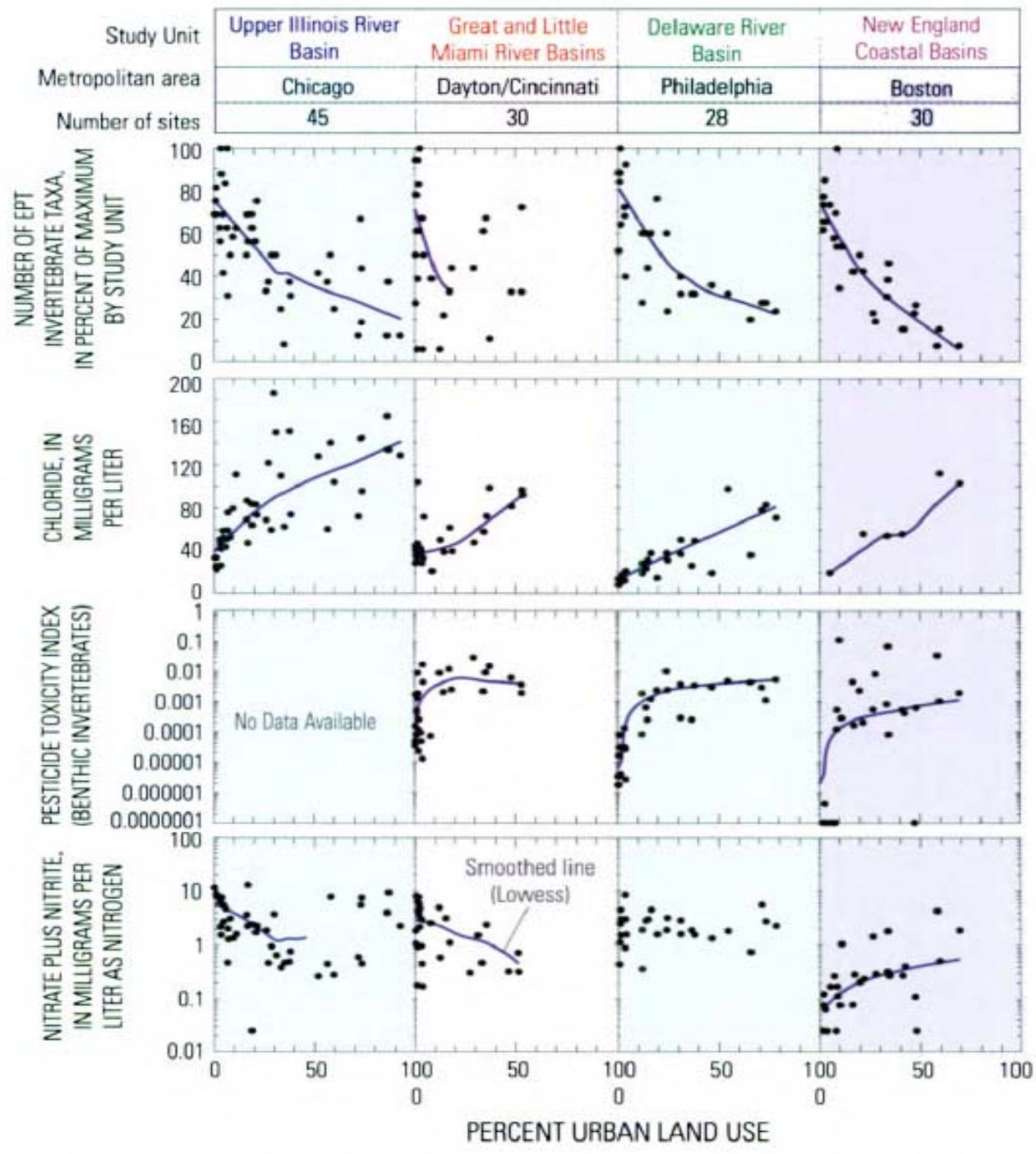

Water Quality in the New England Coastal Basins, Maine, New Hampshire, Massachussets and Rhode Island, 1999-2001. Robinson et. al. 2004. USGS Circular 1226.

Things Not Measured

- PAHs, PCBs, pesticides, lead, mercury (and methyl mercury)

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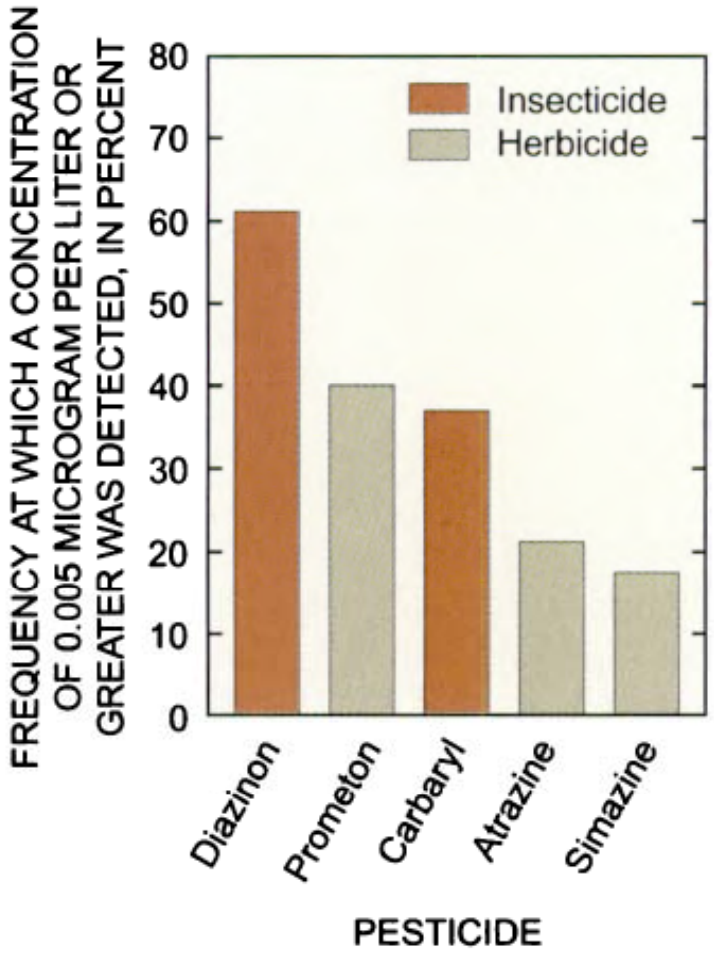

Figure 12. Diazinon, prometon, carbaryl, atrazine, and simazine were the most commonly detected pesticides in 31 rivers in the New England Coastal Basins.

Watersheds with less than 5% urbanization usually had no detections above 0.005 µg/l.

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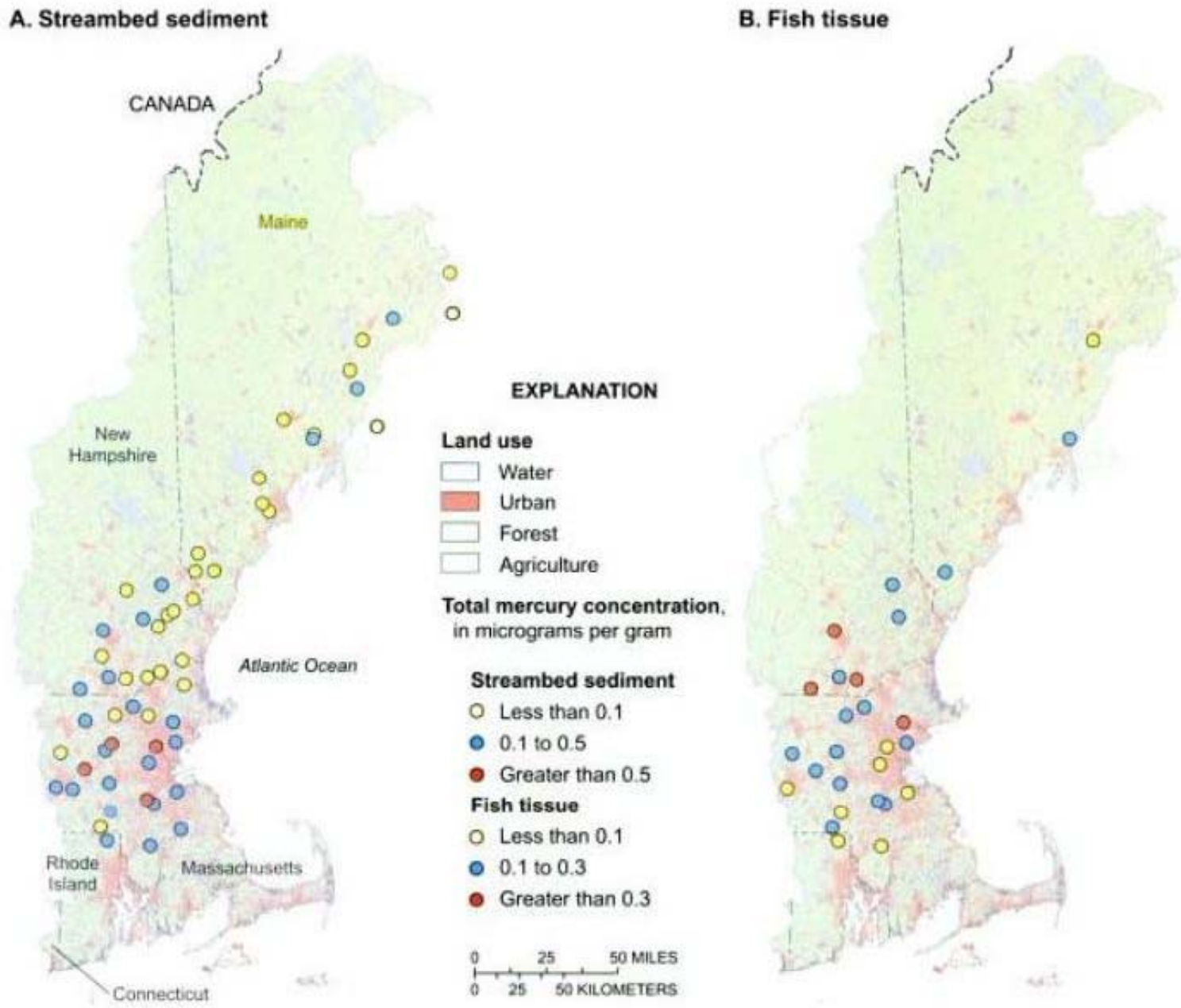
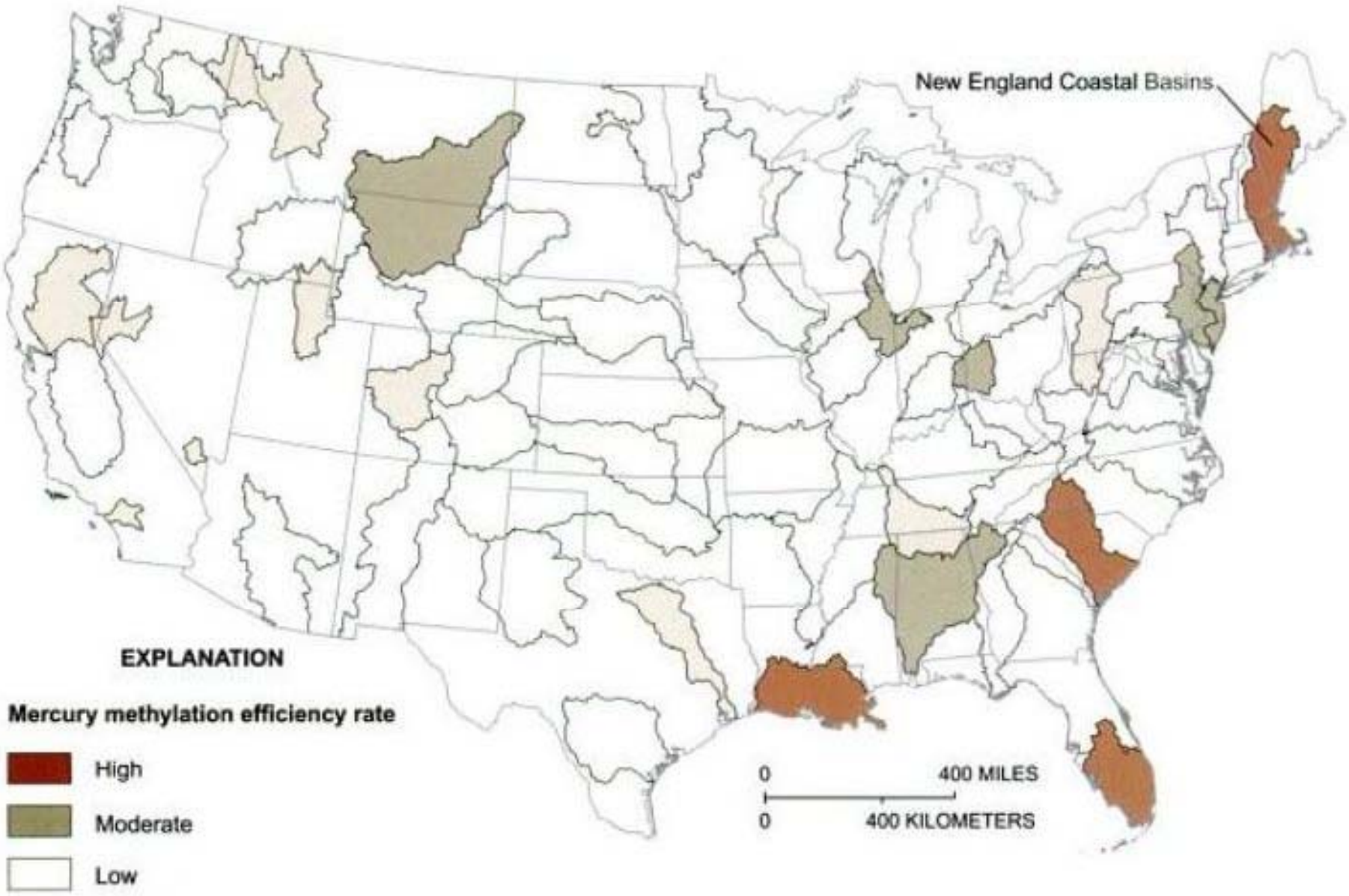


Figure 9. Concentrations of total mercury in streambed sediment (A) increased with increasing urbanization in the sampled watersheds, but total mercury in fish tissue (B) was greatest in less urbanized watersheds that are near urban centers.



The percentage of total mercury that is in the methyl form (methylmercury) in water is known as the methylation efficiency rate and is an indication of how much mercury is readily available for accumulation in fish (Krabbenhoft and others, 1999). Methylation efficiency rates are greatest in wetland-rich areas along the Gulf and Atlantic coasts of the United States.

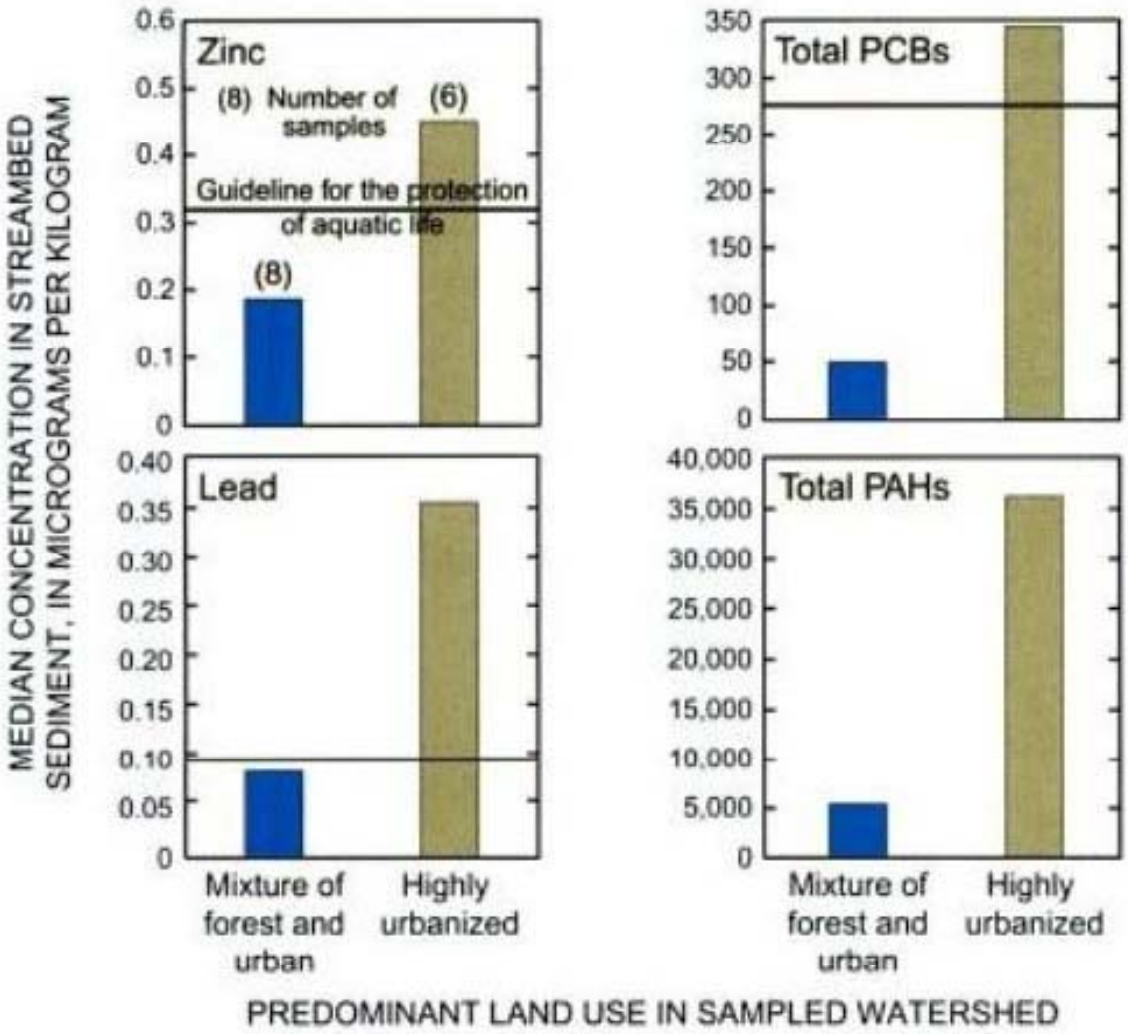


Figure 6. Zinc, lead, total PCBs, and total PAHs in streambed sediments were detected at highest concentrations and at levels exceeding guidelines for the protection of aquatic life in rivers draining highly urbanized watersheds in and near Boston and Providence. Concentrations were lower in mixed-land-use watersheds away from these major cities.

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