THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

Reflections on RI's Water Quality

Linda Green & Elizabeth Herron

URI Watershed Watch

RI Land and Water Summit

March 9, 2013

URI WATERSHED WATCH

THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

Presentation Overview

- URI Watershed Watch overview
- Limno-oceanology in 10 minutes
- 25 years of results on >500 sites in 15 minutes
- Harmful algal blooms (HABs)-cyanobacteria
- Aquatic Invasives (AIS) – plant focus
- Questions

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URI WATERSHED WATCH

THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

Essential Ingredients

- science-based
- involve local organizations & the public
- educational, not regulatory
- provide good, useful information
- cost effective (stable funding)

an ecological monitoring program,
to note conditions and track trends

URI WATERSHED WATCH

THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

Program Sponsors

D·E·M

- Lake/watershed Associations
- Municipalities (NK)
- Narragansett Indian Tribe
- Environmental Organizations (STB)
- Sporting Organizations (TU)
- Fire Districts
- Businesses (QDC, RIAC)
- Hurley Endowment
- Sharpe Family Foundation

77 since 1988

45+ currently

Lots of Great Volunteers!

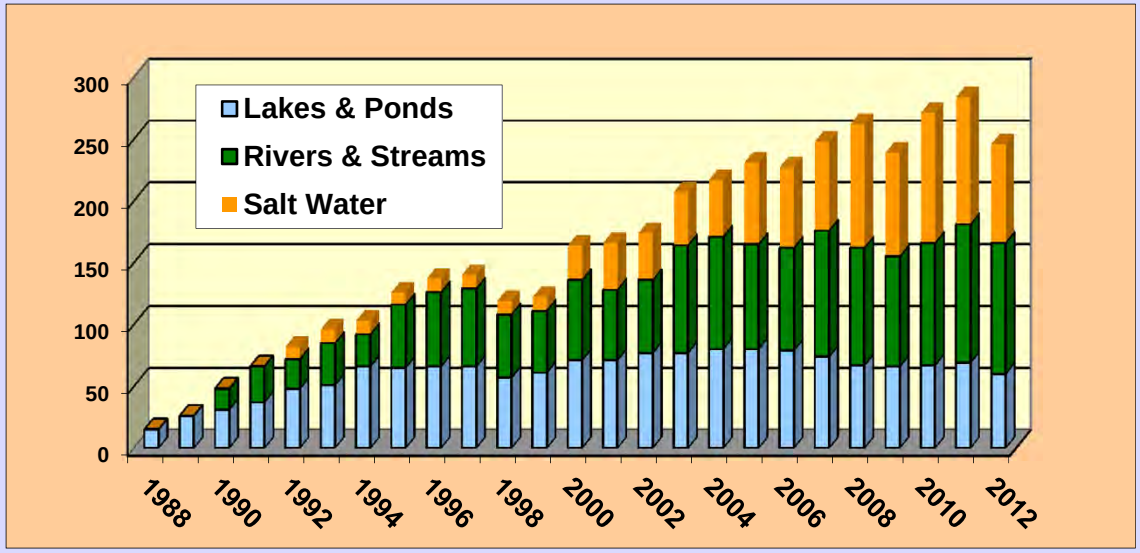
400+ currently

- **all ages**
- **varied backgrounds**
- **no experience A-OK**
- **WW provides training, supplies**
- **time commitment** (1 season to life)
- **boat** (some sites)

Credibility doesn't mean having the most exacting techniques. It means delivering on your promises, no matter how small or large they are.

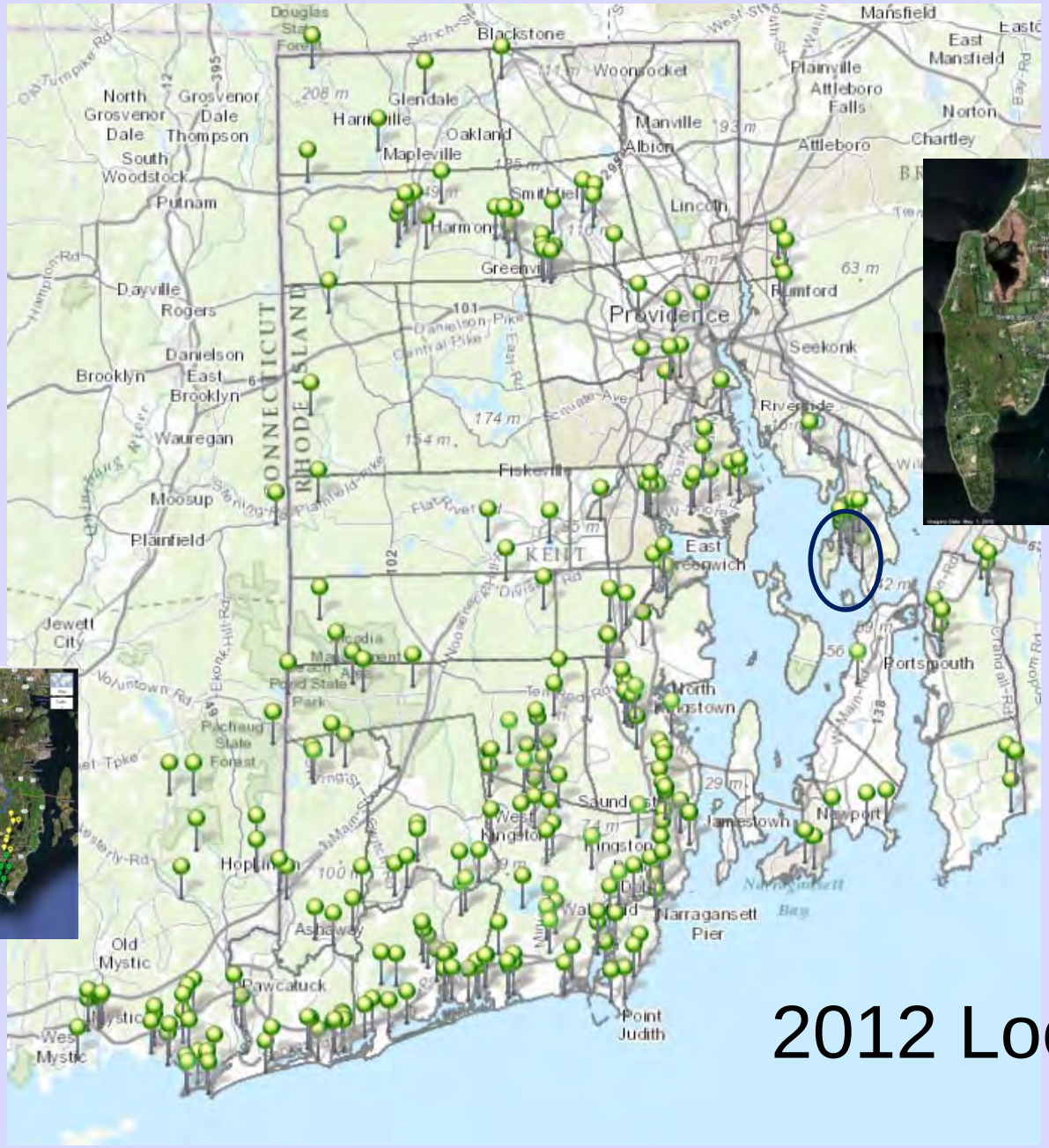
-Meg Kerr
RI River Rescue

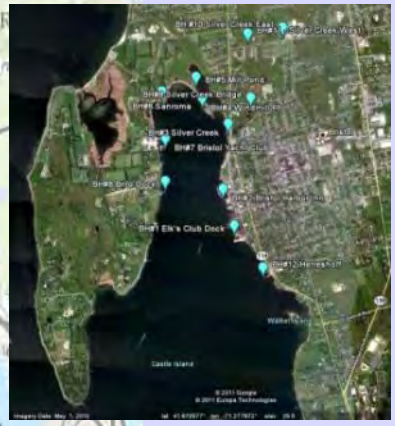
Nearly 550 sites have been monitored since 1988



246 sites in 2012

- 60 Lakes & ponds
- 106 Rivers & streams
- 14 Surfing sites
- 66 Salt & estuarine sites

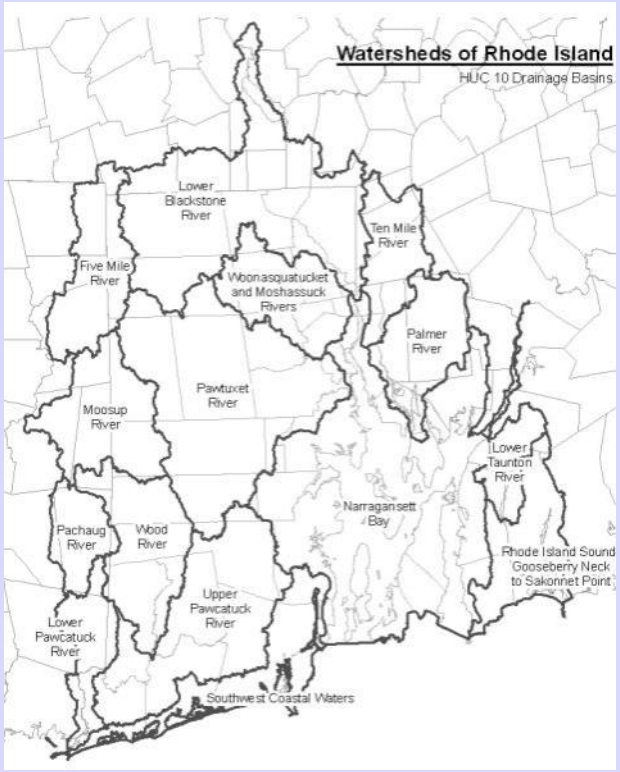


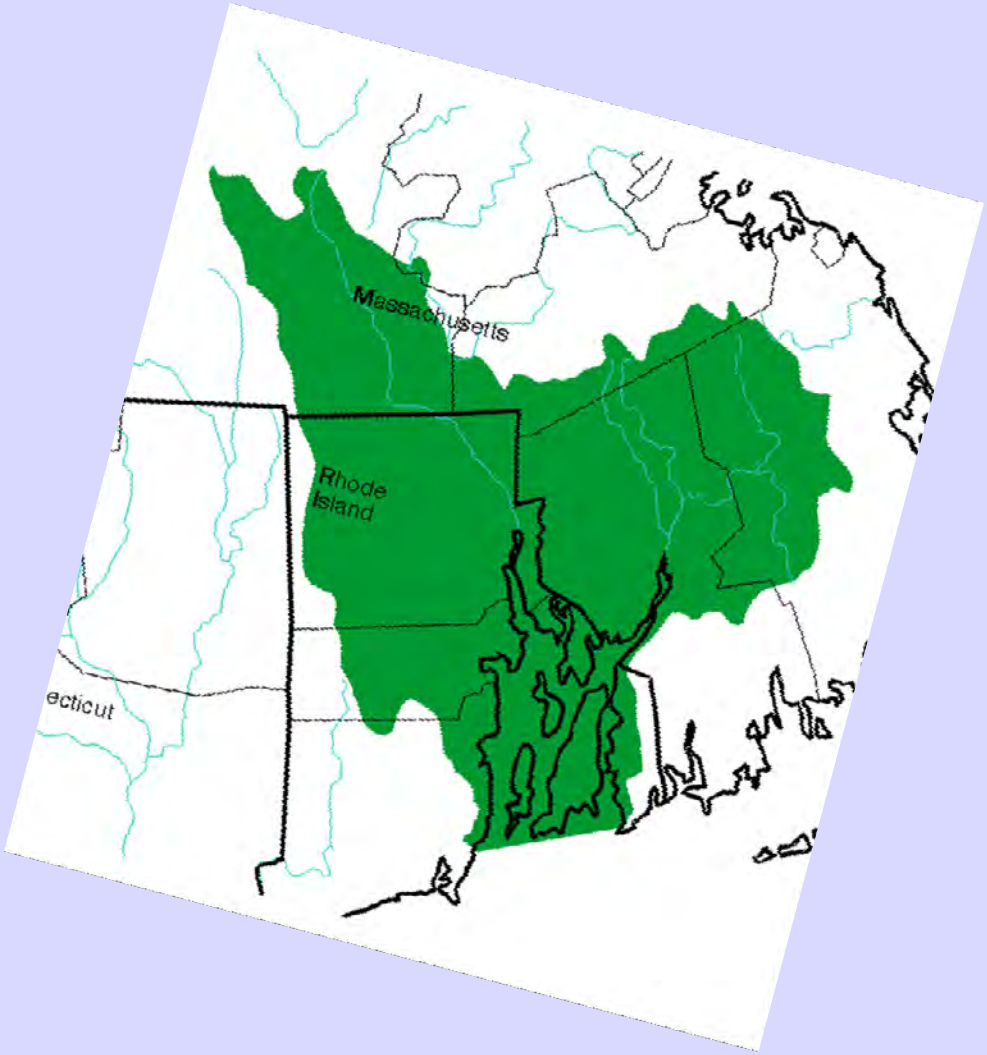


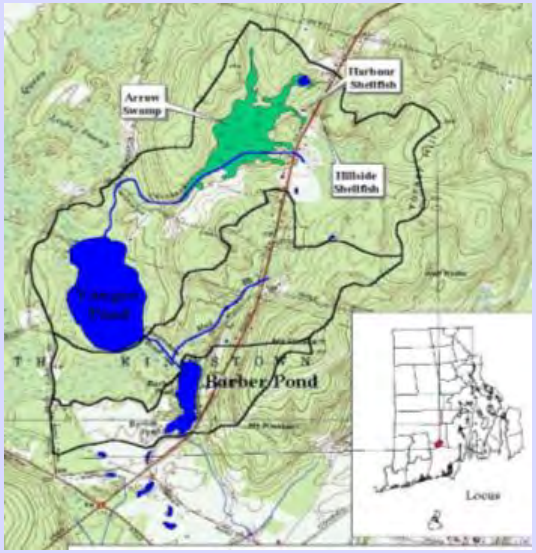
2012 Locations

WATER QUALITY IS PARTLY A REFLECTION OF THE ACTIVITIES IN THE LANDS AND WATERS SURROUNDING AND LYING UPSTREAM

What's going on in your watershed?


Watersheds of Rhode Island
HUC 10 Drainage Basins
Lower Blackstone River
Ten Mile River
Five Mile River
Woonasquatucket and Moshassuck Rivers
Palmer River
Pawtuxet River
Moosup River
Lower Taunton River
Narragansett Bay
Pachaug River
Wood River
Rhode Island Sound Gooseberry Neck to Sakonnet Point
Upper Pawcatuck River
Lower Pawcatuck River
Southwest Coastal Waters


Massachusetts
Rhode Island
ecticut


Harbour Shellfish
Arrow Swamp
Hillside Shellfish
Barber Pond
Locus

Rainfall

Amount
Distribution


Non-point Source Pollution
The #1 water quality problem in the U.S.
From URI NEMO program

Particulates

Storm Runoff

- sediments
- organic matter

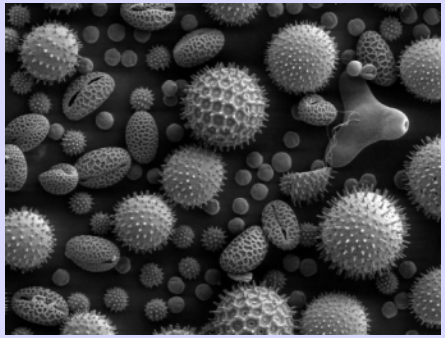
Discharge to waterways…

- nutrients,
- pesticides,
- adsorbed to above

- Bacterial contamination




- Airborne particulates
  - dust
  - pollen

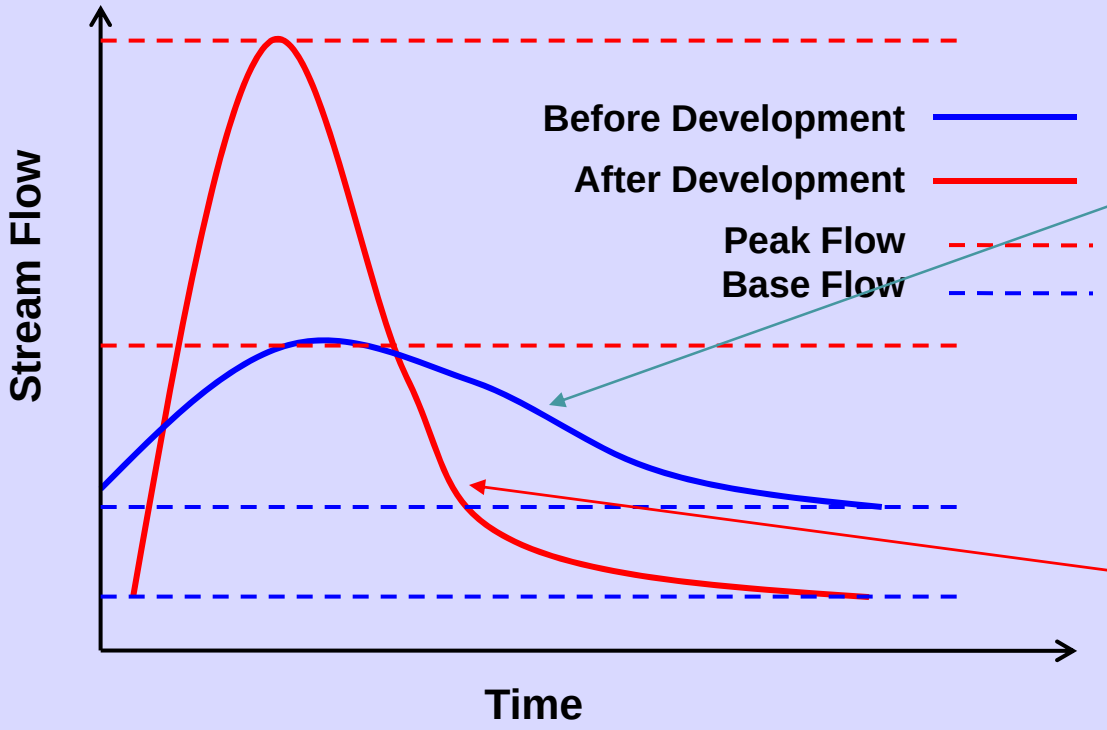



Wastewater discharges

Residential lawn and gardens

Effect of Development on Stream Flow

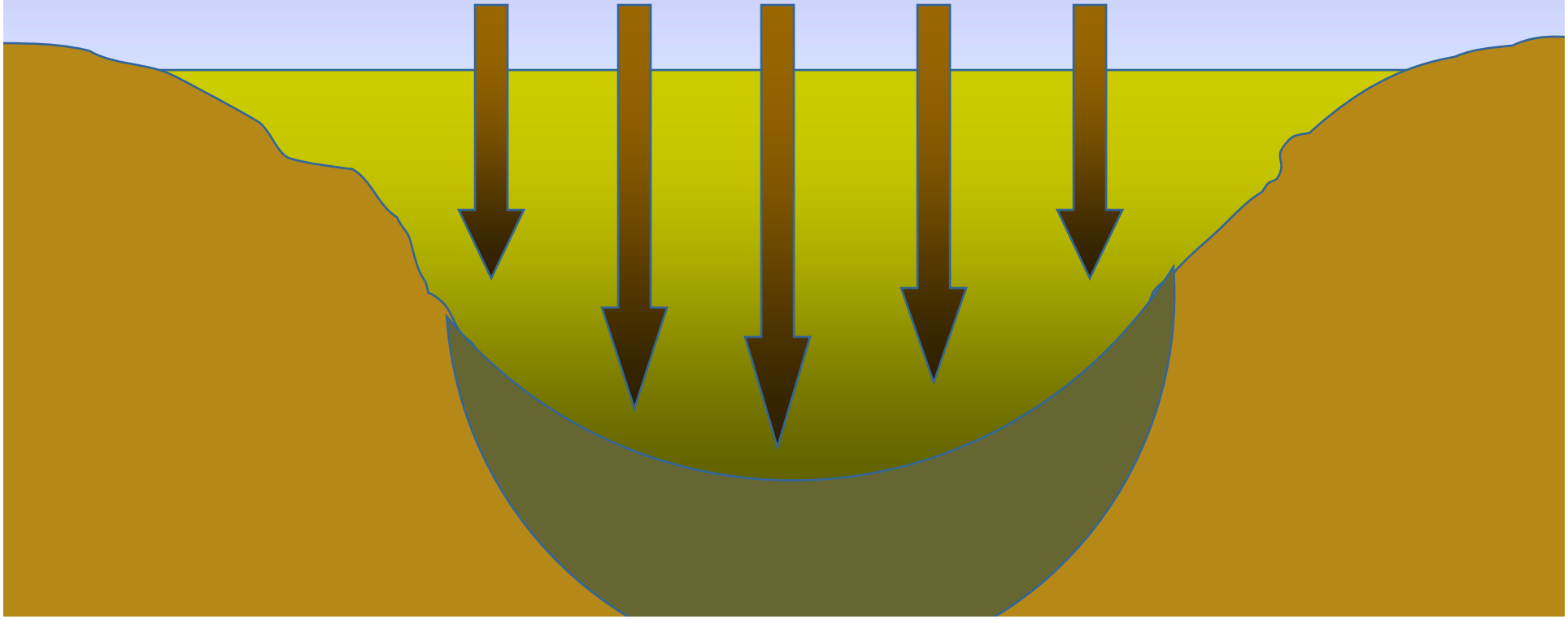
Storm Hydrograph of Stream Flow Before and After Development



Graph: Caitlin Chaffee, top photo L. Green,

Accumulation

- Nutrients
- Sediment
- Organic Material
  - Decaying plants, algae etc.
  - Leaves



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Presentation Overview

- URI Watershed Watch overview
- **Limno-oceanology**
- 25 years of results
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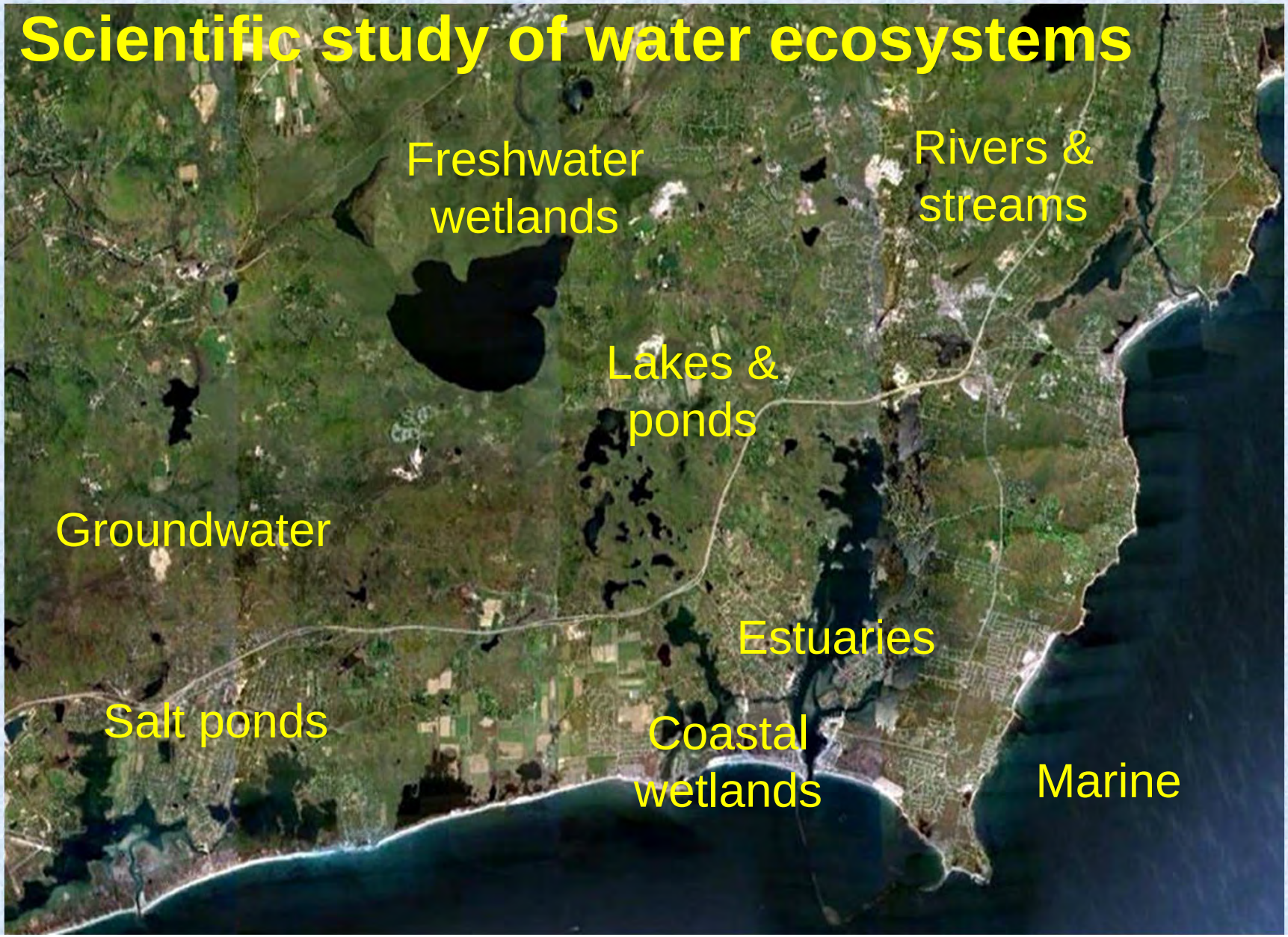
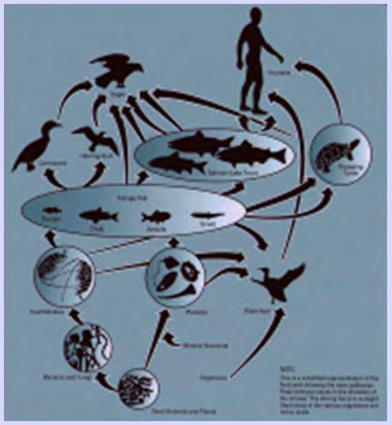
URI WATERSHED WATCH

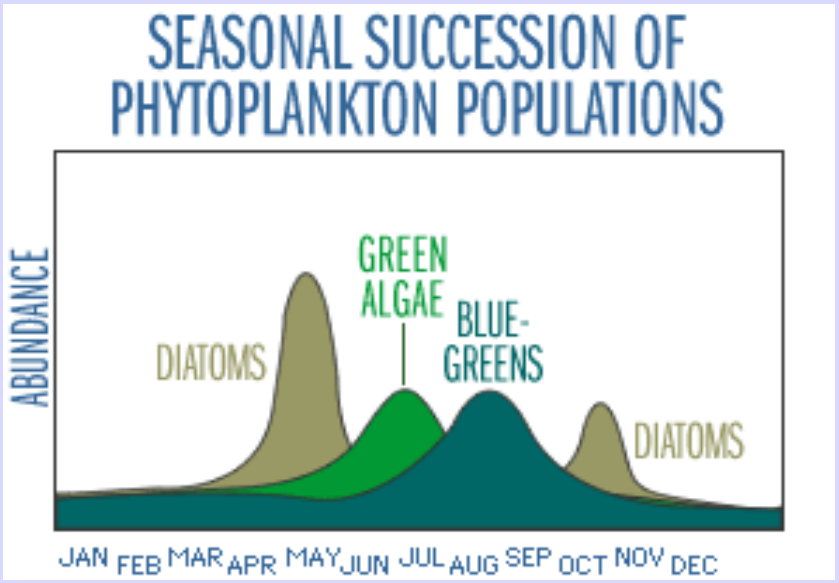
Limno-oceanology:

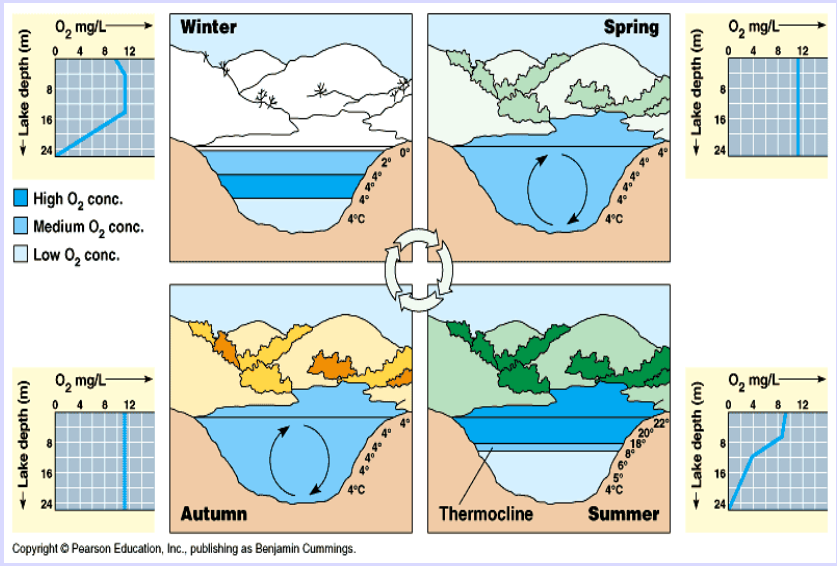
Scientific study of water ecosystems



Water quality also reflects in-water processes: biology, chemistry, physics



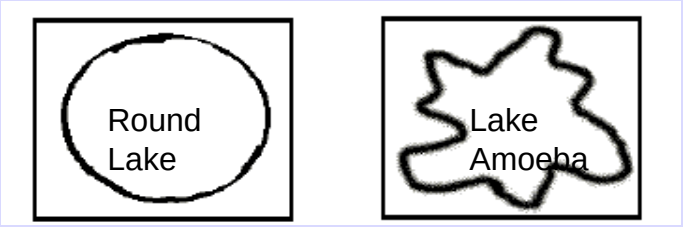


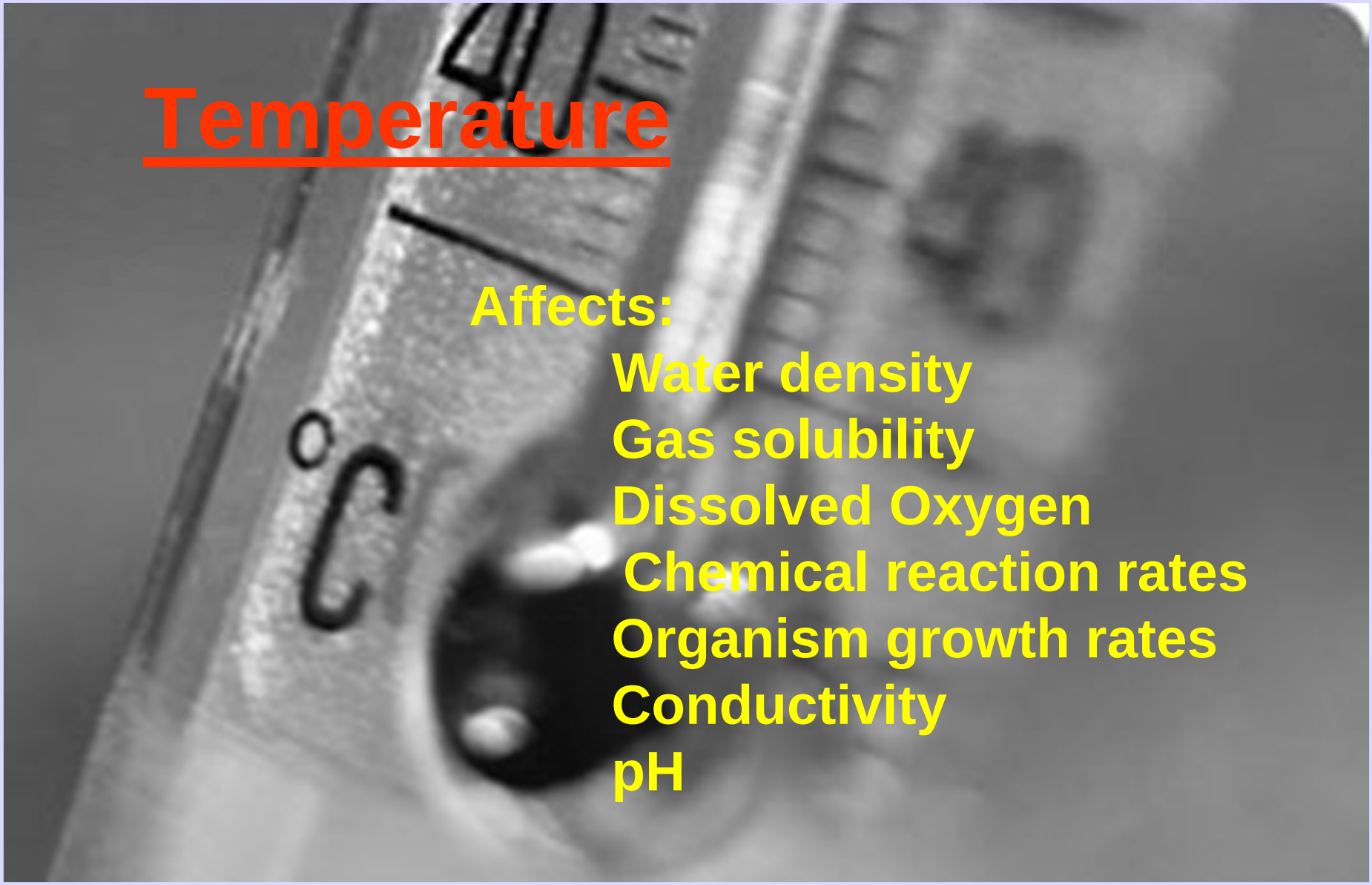


http://www.epa.gov/greatlakes/atlas/glat-ch2.html

…and its history

- Geology, soils
- Chemical constituents
- Surface area
- Watershed area
- Shape
- Retention/residence time





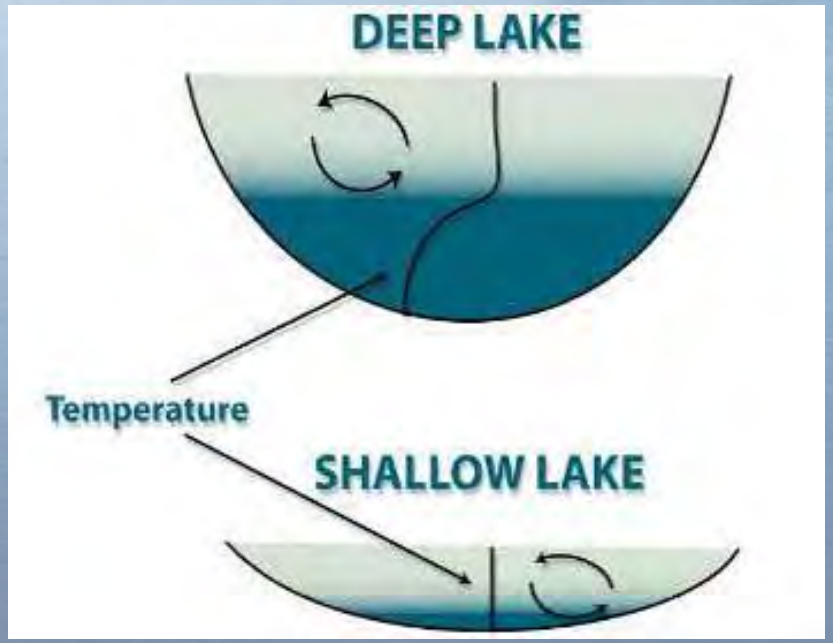
Temperature

Affects:

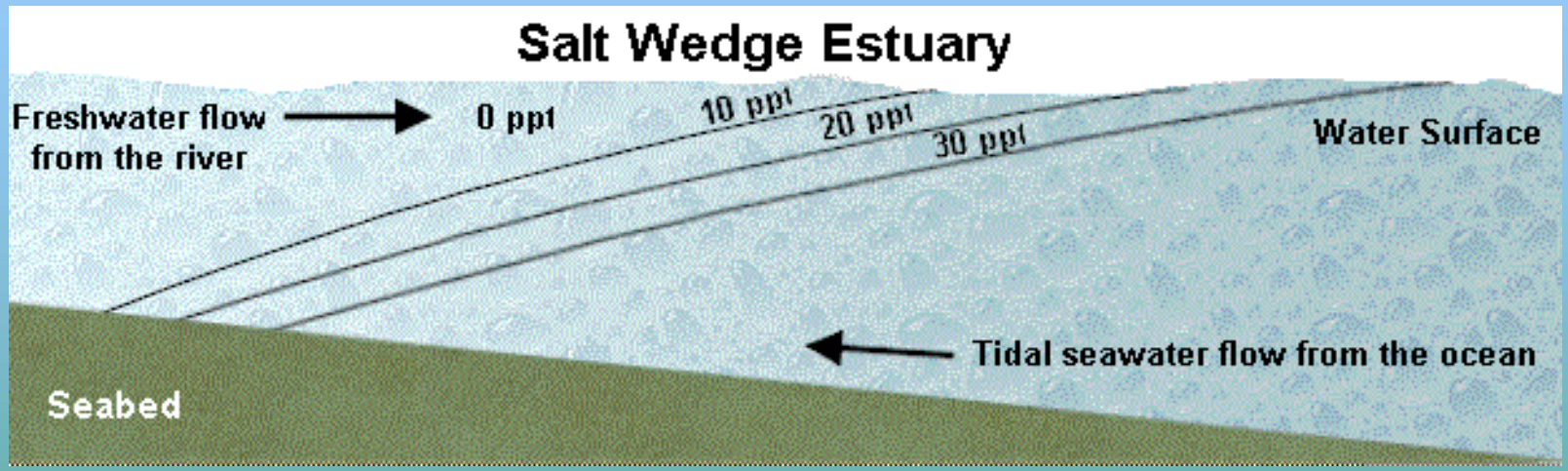
- **Water density**
- **Gas solubility**
- **Dissolved Oxygen**
- **Chemical reaction rates**
- **Organism growth rates**
- **Conductivity**
- **pH**

Lake vs Pond
(Pay no attention to the name)

- Lakes stratify:
  - Light not visible to the bottom
  - Deep enough for summer stratification(>5m or 15ft)
  - Dissolved oxygen depletion in the bottom (low to no)
- Ponds stay mixed:
  - Light visible to bottom
  - Transient stratification
  - Nutrients recycle
  - Less than 5-7 m deep



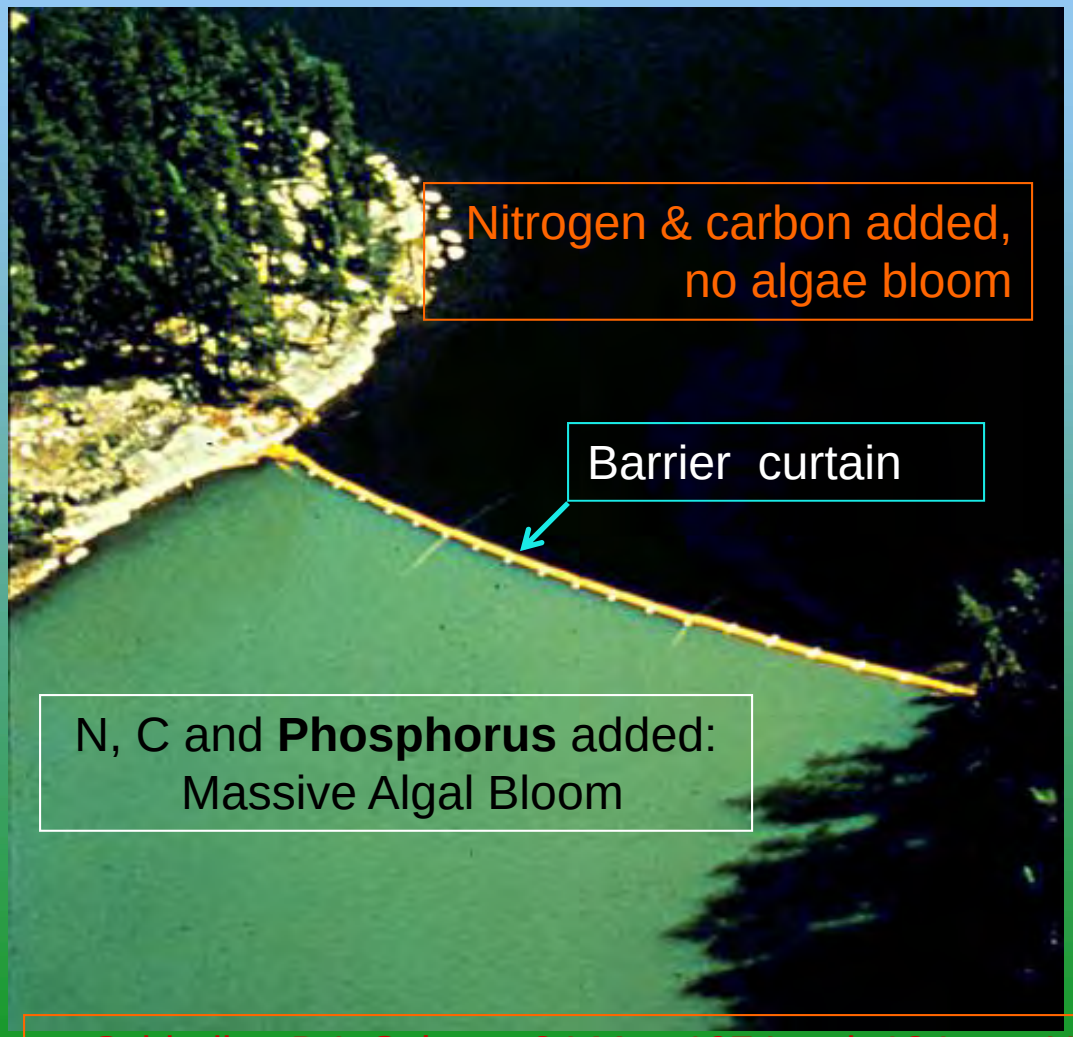
Estuarine Stratification



Salt water is denser than freshwater

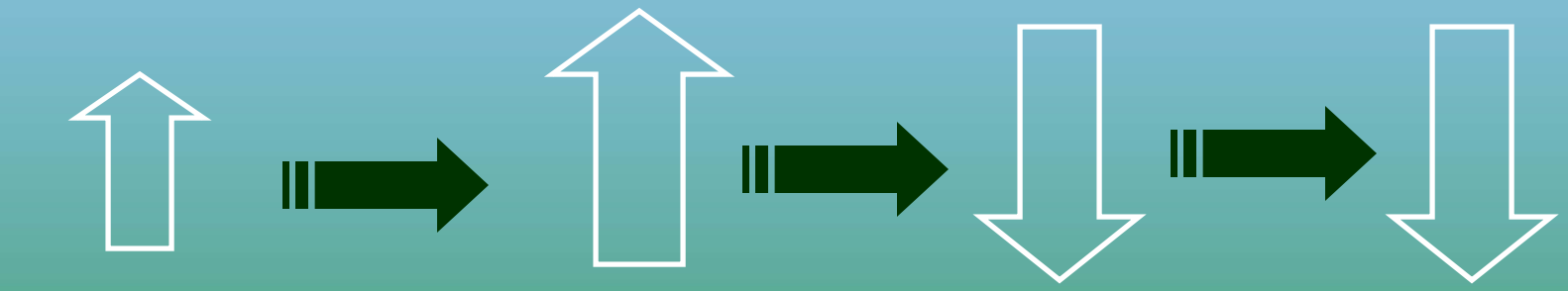
PHOSPHORUS LIMITATION

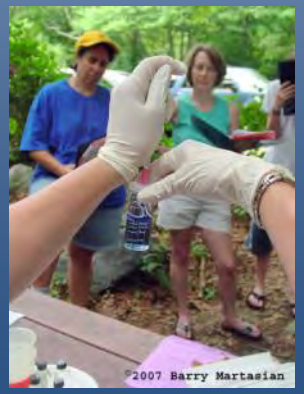
Famous Experiment (1974): Canadian Lake 226



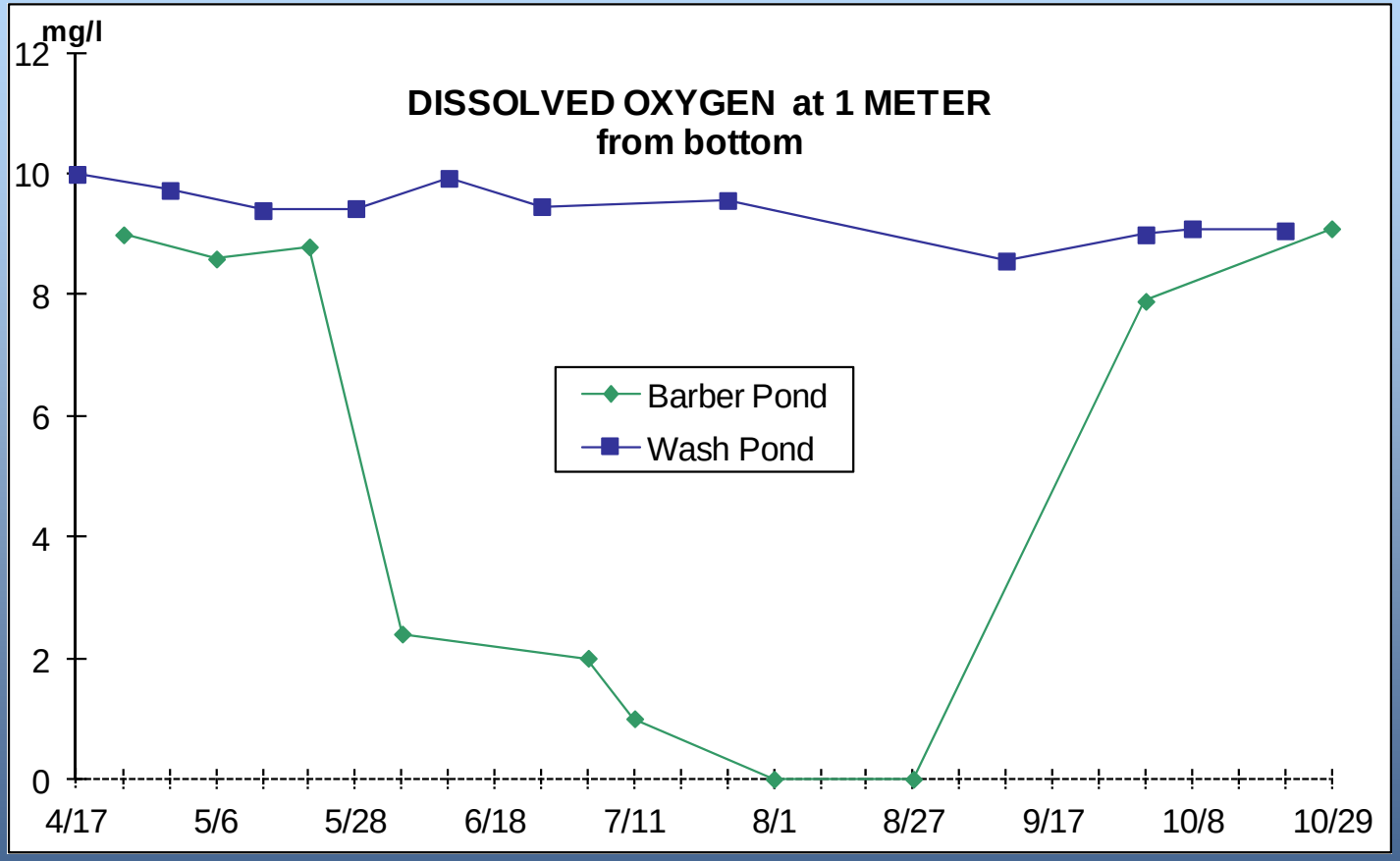
Schindler, D.L *Science* 24 May 1974: vol. 184 no. 4139, pp. 897-899

Increase in nutrient enrichment
= Eutrophication



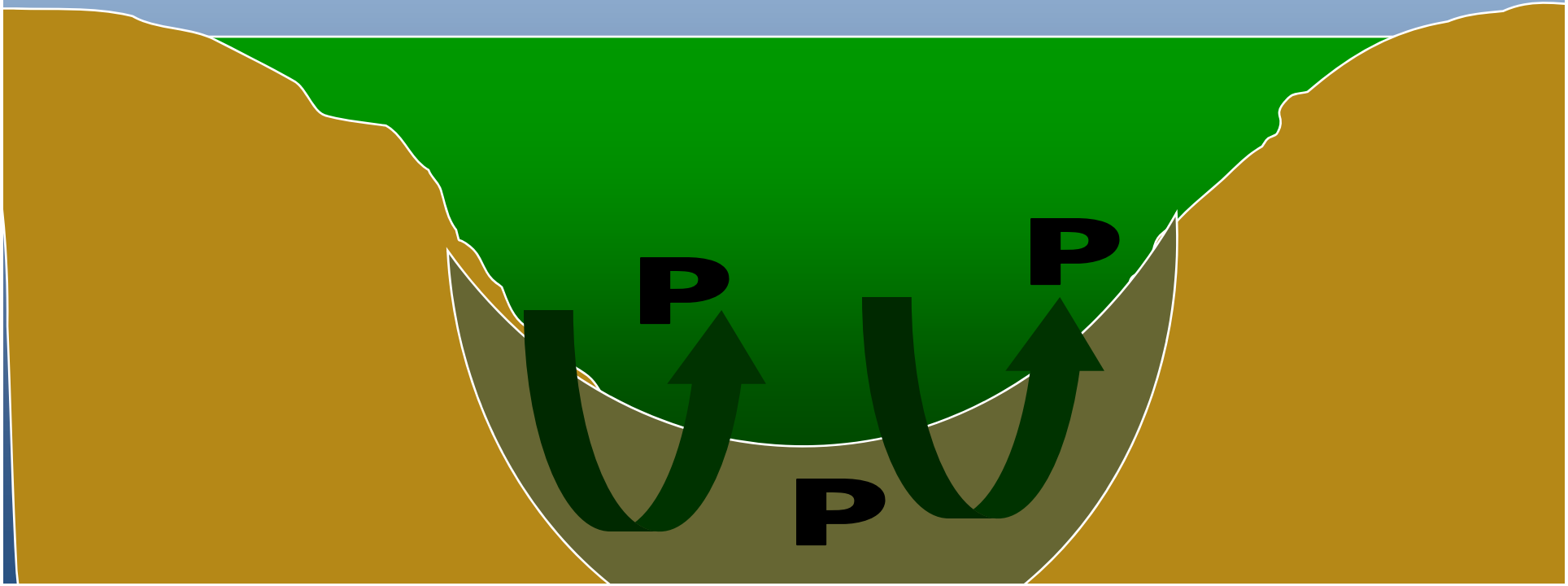


Dissolved Oxygen



With No Oxygen in Deep Water (Anoxia)

- Algae die and fall to bottom
- Organic matter decomposed
- Phosphorus cycles back into water, available for algae to use



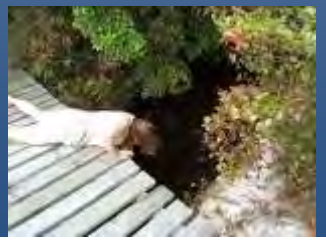
Water Quality Indicators

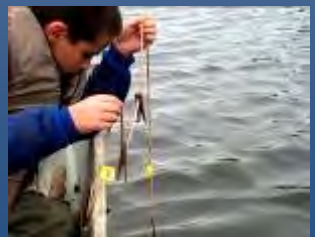
We measure:

- Secchi Depth
- Chlorophyll
- Phosphorus & nitrogen
- D.O. & temp.
- Bacteria

To indicate:

- Water clarity
- Algae
- Nutrient levels
- Aquatic health
- Safe for swimming



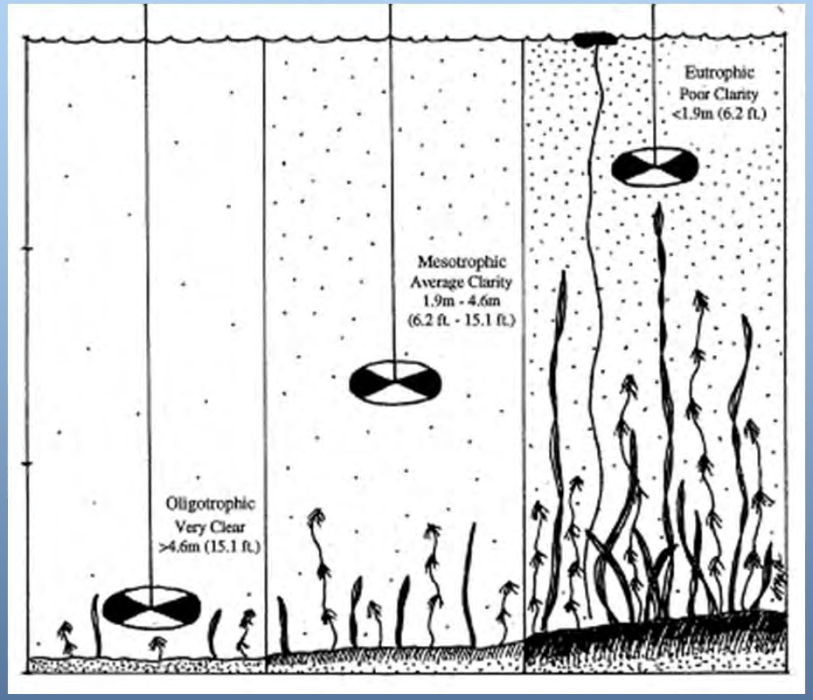


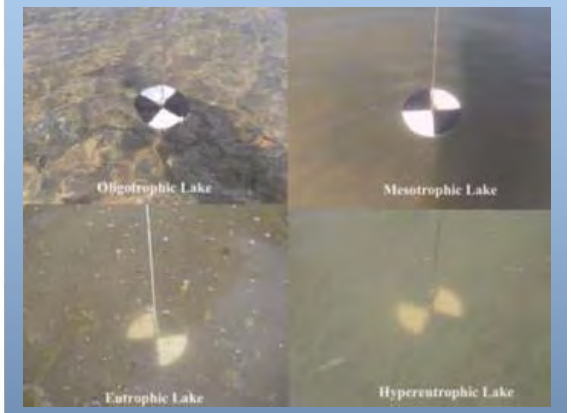
Monitoring Supplies

- Monitoring Manual
- Secchi Disk and View Tube (lakes & ponds)
- Postcards (on-line data entry available)
- Deep or Shallow Sampler
- Sample Bottles
- Chlorophyll Supplies kits
- Thermometer
- Dissolved Oxygen Kit
- Salinity refractometer

After classroom & field training and everyone monitors multiple indicators weekly, biweekly, monthly, May-October

Secchi Disk, the world's most widely used monitoring instrument



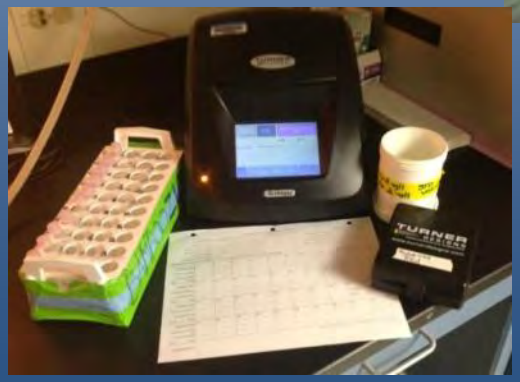


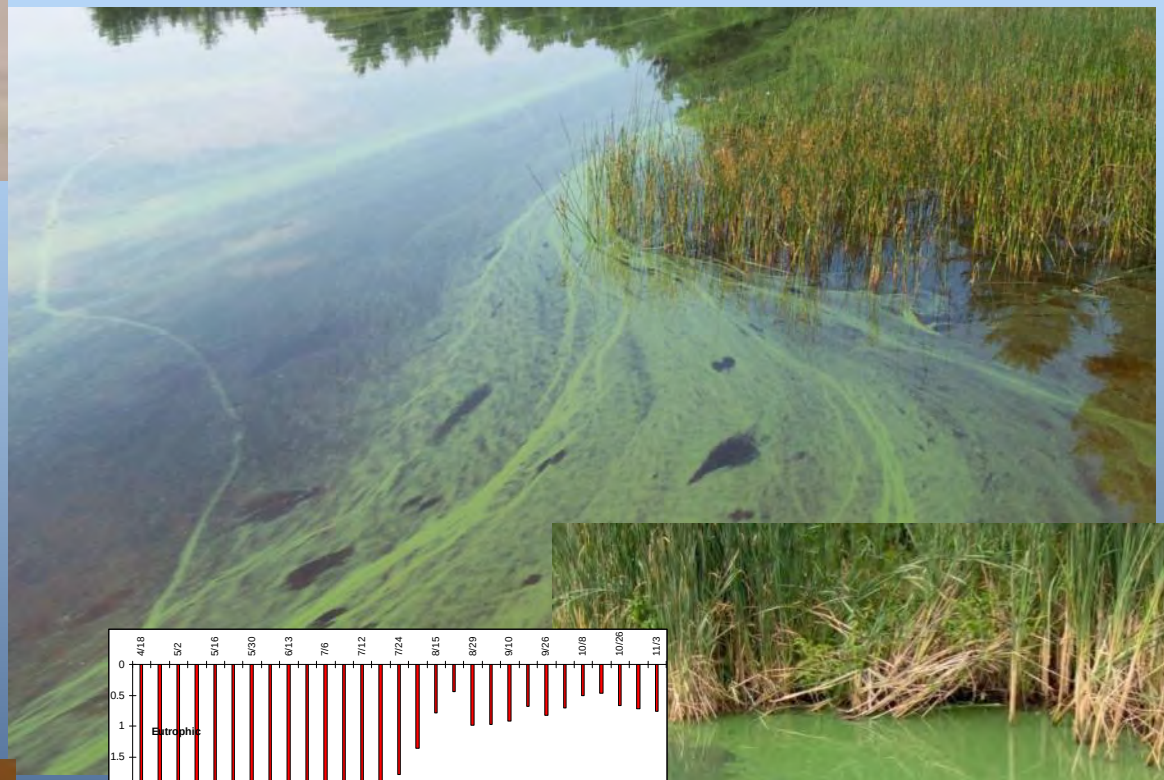
Nearly 1 million Secchi readings 1903-present collected by Canfield & Carlson

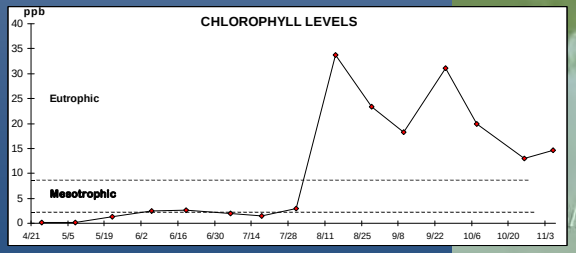
Shallowest ~1"

Deepest 41.2m Crater Lake (Tahoe deeper)

Document Algal Blooms

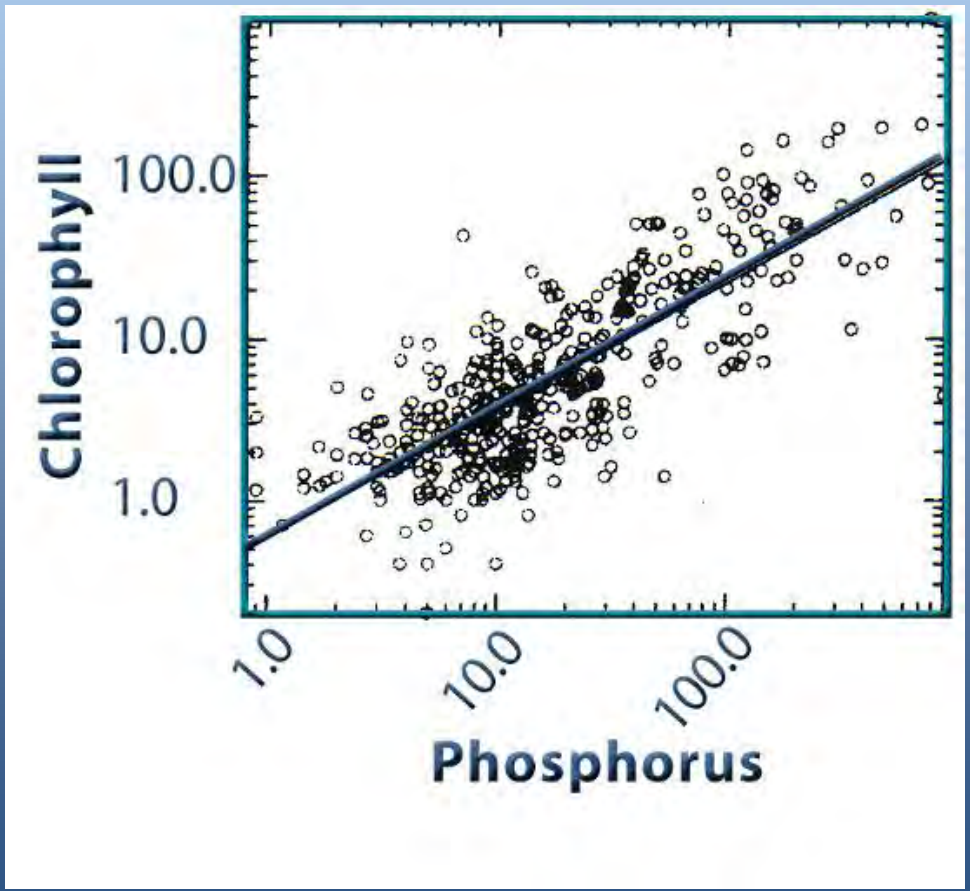




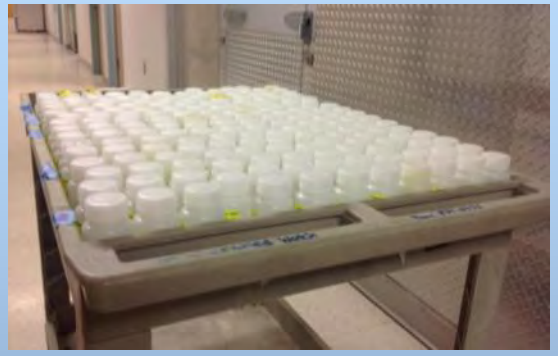


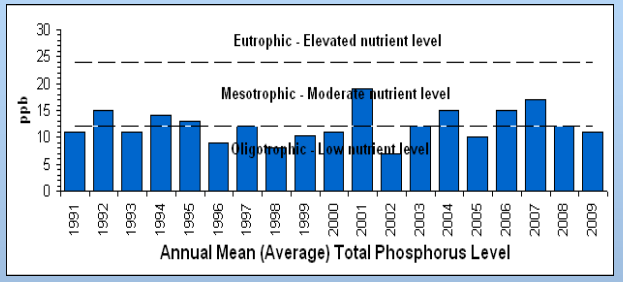
Total Phosphorus/ Chlorophyll-a Relationship

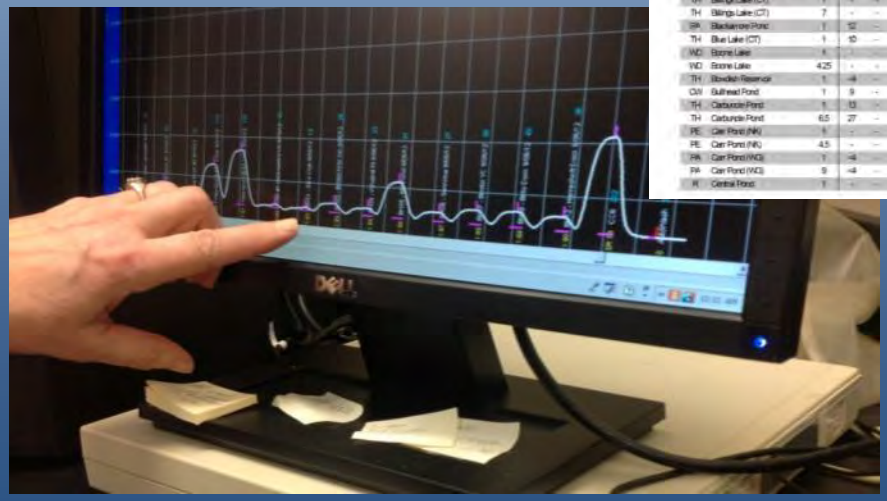
- Phosphorus causes algae to grow
- Chlorophyll levels indicate algal biomass
- Parts per billion = BIG changes



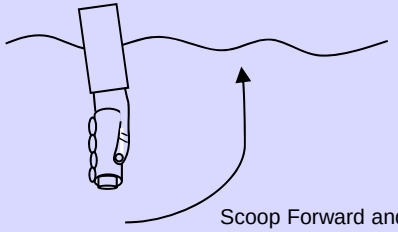
Analyzing for N & P







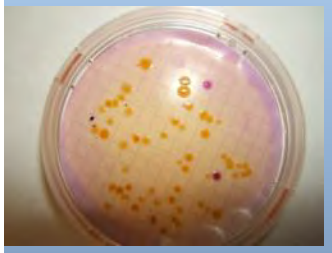
URI WATERSHED WATCH



Scoop Forward and Up

Bacteria Results

Paired with factsheets



2012 Bacteria Data - Rivers and Streams Enterococci Data

RI Department of Health standards for recreational contact (i.e.swimming):
Fresh Waters - Single sample not to exceed 61 enterococci per 100 mL.
RI Department of Environmental Management Enterococci Standards:
Non-designated Bathing Beach (Fresh) Waters Geometric Mean Density - Not to exceed 54 enterococci per 100 mL.
Designated Bathing Beach (Fresh) Waters Geometric Mean Density - Not to exceed 33 enterococci per 100 mL.

Watershed code	MONITORING LOCATION	MAY	JUNE	JULY	AUG.	SEPT	OCT	GEOMEAN
		----	Most Probable Number of Enterococci per 100 mL					----
A	Annaquatucket - Belleville @ RR Xing	232.4	165.8	150	80	274.6	84.4	141.6
NA	Buckeye Brook #1 @ Novelty Rd	82	6970	487	284	146	132	339.3
NA	Buckeye Brook #2 @ Lockwood Brk	185	857	1632.8	775	583	96	473.2
NA	Buckeye Brook #3 @ Warner Brook	170	3640	60	-	-	-	333.6
NA	Buckeye Brook #4 @ Mill Cove	-	6240	4155	498	435	-	1539.3
WD	Falls River D - Step Stone	22	31.2	285.1	66	59.8	69.7	61.4
WD	Falls River C - Austin Farm	14.8	68.3	144.5	118	112.9	30.6	63.0
WD	Falls River B - Sand Banks	29.2	75.4	200.5	201	95.9	22.2	75.7
WD	Falls River A - Twin Bridges	19.6	109.1	94.5	101	98.7	15	55.8
GB	GB #2 - Burger King	31	>2419.6	157.2	3106	398	17329	>795
GB	GB #3 - Pipe @ Rte 115	62	>2419.6	80.4	27	41	19863	>253
GB	GB #4 - Mill Creek	52	>401	448	394	272	1091	>320
GB	GB #5 - Hardig Upstream	63	3465.8	758.6	345	788	8664	604.1
GB	GB #6 - Tuscatucket Br	20.8	194.8	96.4	<2	30	47.2	21.9
GB	GB #7 - Southern Creek	132	1511.2	813	792	187	9804	820.4
A	Himes River	4	147.6	278.8	48.6	73.6	1918	102.0
H	HW #1A - Scrabbletown Brk @ Falls	12.6	83.1	251.8	120.4	186	1553	144.7
H	HW #1B - Scrabbletown @ Rte 4 Bridge	16.8	118.4	90.4	59	90	19865	163.3
H	HW #5 - Sandhill Brook (Saw Mill Inlet)	62	201.4	471.6	333	112	2005	275.8
H	HW #6 - Hunt River @ Forge Rd.	85	123.6	90.4	63	81	75	84.4
TH	Moosup Upstream	20	1445	100	551	1317	>24196	>608
TH	Moosup A - Fairbanks Bridge	40.2	1445	112.6	48	144.6	19863	310.4
TH	Moosup C - Deerfield Drive	21.8	885	91.4	51	76.6	7701	193.7
Watershed code	MONITORING LOCATION	MAY	JUNE	JULY	AUG.	SEPT	OCT	GEOMEAN
		----	Most Probable Number of Enterococci per 100 mL					----
	Click here for Narrow River enterococci and fecal coliform data.							
WD	Pawcatuck River @ Bradford	21.6	54.8	114.6	16.4	21.6	79.8	39.6
PA	Pawtuxet River - near Rhodes	97	840	94	43.6	10	32	68.9
WD	Queen River @ Locke Brk	6.2	-	40.6	-	-	-	15.9
WD	Queen River @ Sherman Brk	<2	118.4	1454	215.2	143.4	-	63.9
WD	Shickasheen Brook @ Rte 2	135.4	DRY	DRY	26.8	48.4	4839	170.7
WD	Shickasheen @ Miskania Road	11.9	22.2	437.4	167.8	-	10	45.8
WD	Shickasheen @ Barber Pond Outlet	109.1	4.2	3.1	8.7	25.3	<2	6.3
WD	Shickasheen Brook @ Rte 138	74.6	200.5	176	50	258	31	101
WD	Shickasheen Brook @ Liberty Lane	43.2	47.8	215.4	64.6	96.4	73	76.6

Page 1 of 2

THE UNIVERSITY OF RHODE ISLAND COLLEGE OF THE ENVIRONMENT AND LIFE SCIENCES

Bacterial Monitoring

URI WATERSHED WATCH, Cooperative Extension
College of the Environment and Life Sciences (CELS)
Department of Natural Resources Science (NRS)
Coastal Institute in Kingston, 1 Greenhouse Road, Kingston, Rhode Island 02881-0804

Elizabeth Herron, Kelly Addy and Linda Green

URIWW-3, March 2003 (updated May 2010)

Why Monitor Bacteria?

Is it safe to swim in the water? That's a question we often hear when we say we are monitoring a favorite swimming spot. Researchers and regulatory agencies have determined that one way to answer that question is to conduct bacterial monitoring. They do this to identify the human health risk associated with recreational water contact. The bacteria selected for water quality monitoring rarely cause human illness directly; rather the presence of these bacteria indicates that fecal contamination may have occurred and pathogens may be present in the water. Pathogens are microorganisms that cause illnesses; they may be viruses, bacteria or protozoans. Measuring pathogens such as giardia, cryptosporidium, and Norwalk virus, directly is expensive and impractical because:

- There are innumerable types of pathogens that may be in waterbodies; it would be impossible to check for all these pathogens.
- The presence of one pathogen may not indicate presence of others.
- Generally, simple laboratory techniques do not exist to measure pathogens.

Bacterial monitoring is a practical method to determine the potential health risk of water exposure. Bacteria are microscopic, single-celled organisms that can be found in virtually any environment. Bacterial indicators of pollution are the species found in the intestines of warm-blooded animals, including humans, where many pathogens also originate. Indicator bacteria in a waterway come from many sources (Figure 1), e.g., animal droppings, faulty or leaking septic or sewage systems, combined sewage overflows (CSOs, see Box 1), stormwater runoff, boat sanitary waste and disturbed sediments.

Figure 1. Potential sources of bacteria to a waterway (from Ely, 1997)

What bacterial indicators are monitored?

Bacterial indicators should meet as many of the criteria listed in Box 2 as possible to ensure safe swimming water. Water quality monitors screen water samples most frequently for fecal coliform (F.C.). *Escherichia coli* or enterococci as bacterial indicators (see Box 3 for details). These indicators are prevalent in the intestines of warm-blooded animals and associated with fecal contamination. Total coliforms are a group of closely related bacteria; fecal coliforms are a subgroup of total coliforms and *E. coli* are a specific species of F.C. bacteria (Figure 2). Enterococci are another group of bacteria unrelated to the coliforms.

Box 1: Combined Sewage Overflows (CSOs)

Combined Sewage Overflow systems carry storm water from roadways and untreated sewage from homes and businesses in the same pipes. On a dry day, all this waste water is treated by the sewage treatment plant. However, on very rainy days, the sewage treatment plant may not be able to treat all the water and may need to release some untreated waste water into waterways. CSO control plans are in progress in the Providence area to minimize these inputs to Upper Narragansett Bay.

Posted online ASAP

Field monitoring postcards -saved forever!

LOCATION: *Super Salt Site #1* MONITOR(S): *Sea Star family*

DATE MONITORED: *07/25/10* (mo/day/yr) TIME: *0800* (military)

SECCHI DEPTH (measure 4 times):

_____ _____ _____ _____ meters

DEPTH TO BOTTOM: ___3__ meters. Is Secchi visible on bottom? yes or no

CHLOROPHYLL SAMPLES: FILTERED and FROZEN: yes or no

Record actual sampling depth

DEPTH MONITORED (meters)	Surface	1 meter	_2.5__m deep	2.5 m deep
WATER TEMPERATURE (deg. C)		28	28	25
DISSOLVED OXYGEN (mg/L) (Measure twice at each depth)	N/A	8.0 8.0	4.3¦4.2 ¦	4.4¦4.1 ¦
SALINITY (ppt)	N/A	31	31	31

(for below, circle best description, see monitoring manual for details)

LIGHT: 1= Distinct shadows 2= No shadows 3= Very overcast

WIND: 0= Calm 1= Light 2= Gentle 3= Moderate 4= Strong

RAIN W/IN 48 Hrs. 1= None 2= Light 3= Moderate 4= Heavy

STATE OF TIDE: EBB ___ FLOOD ___ HIGH __X_ LOW ___ N/A ___

(a mere 38,000+ since 1988)

Presentation Overview

- URI Watershed Watch overview
- Limno-oceanology
- **25 years of results**
- Harmful algal blooms (HABs)
- Aquatic Invasives (AIS) – plant focus
- Questions