

Pea Porridge Ponds Water Quality and Lake Management

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DES VLAP Program Coordinator

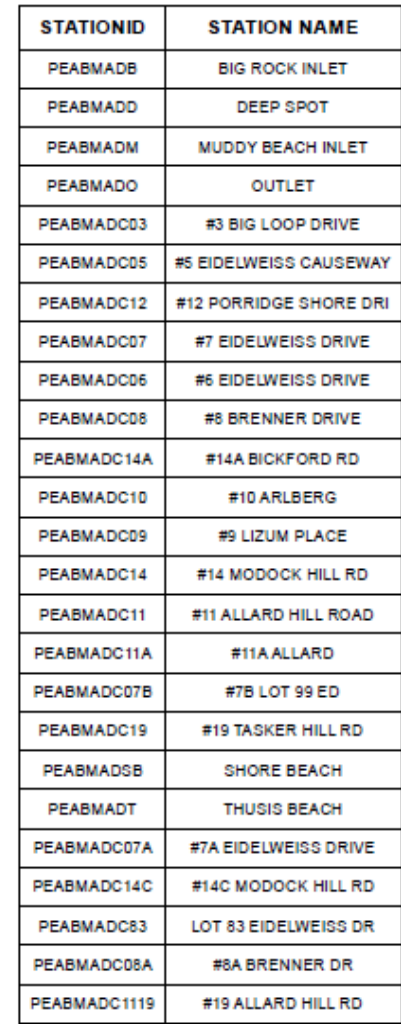


Presentation

- Water quality trends
- Hot Topics
- Discussion



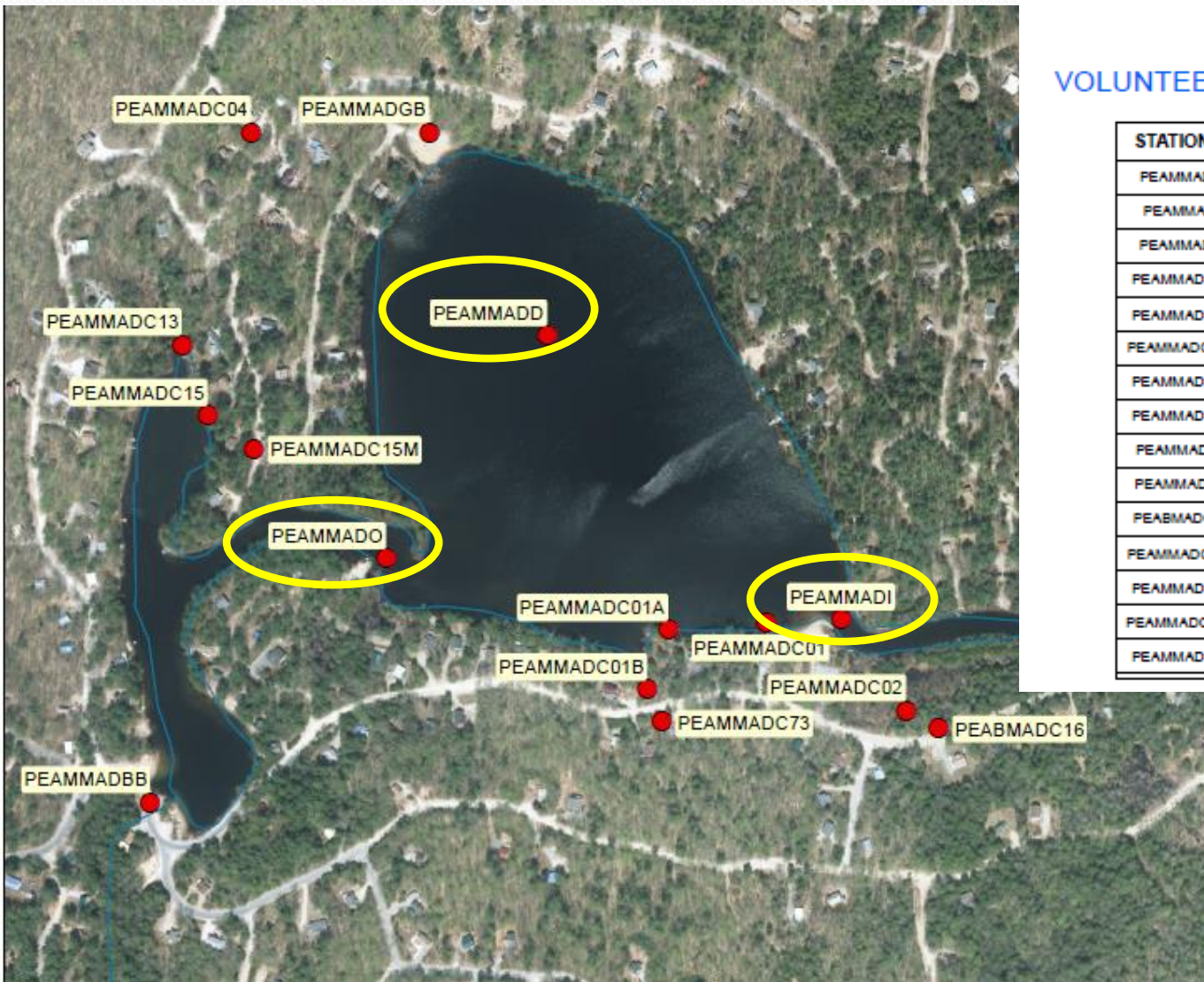
VOLUNTEER LAKE ASSESSMENT PROGRAM



Middle Pea Sample Stations

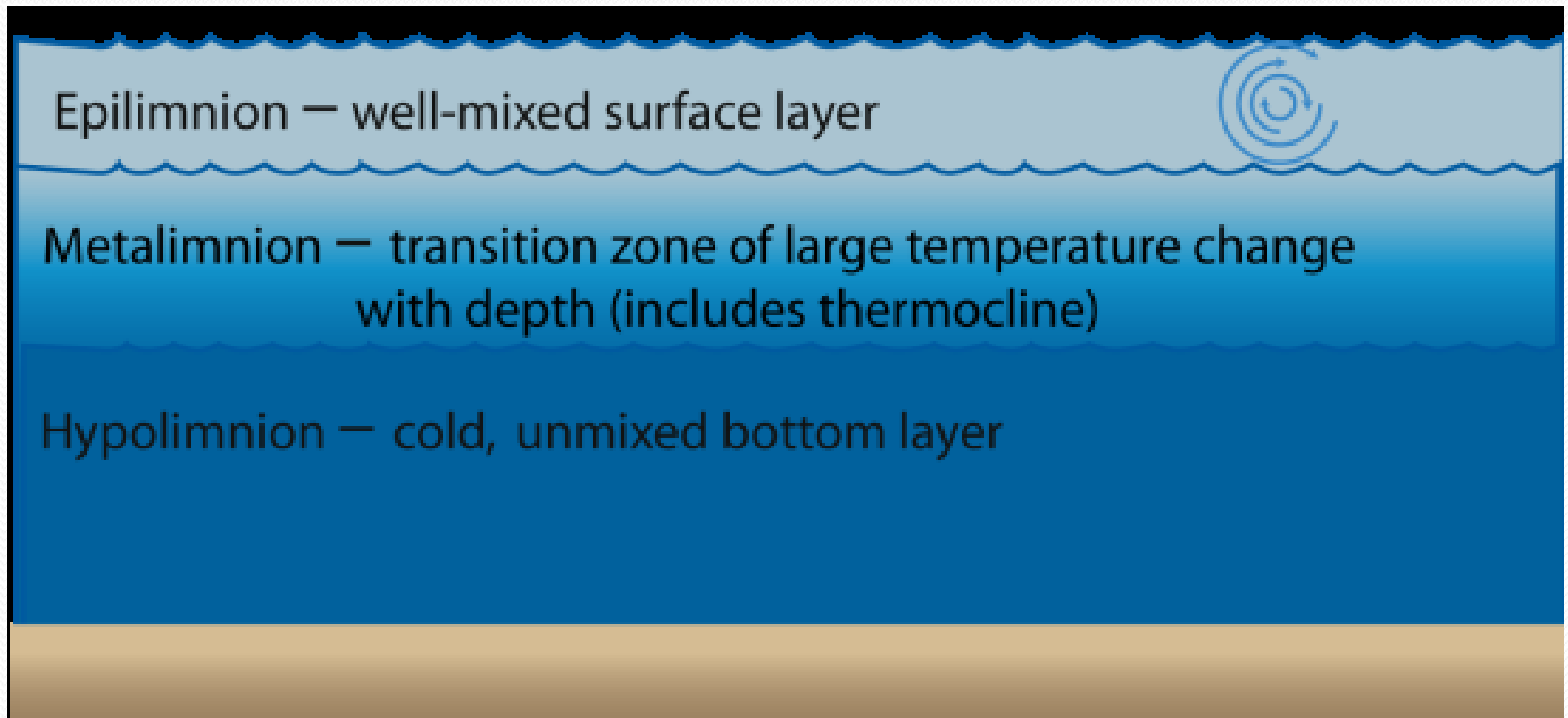
MIDDLE PEA PORRIDGE POND MADISON

VOLUNTEER LAKE ASSESSMENT PROGRAM



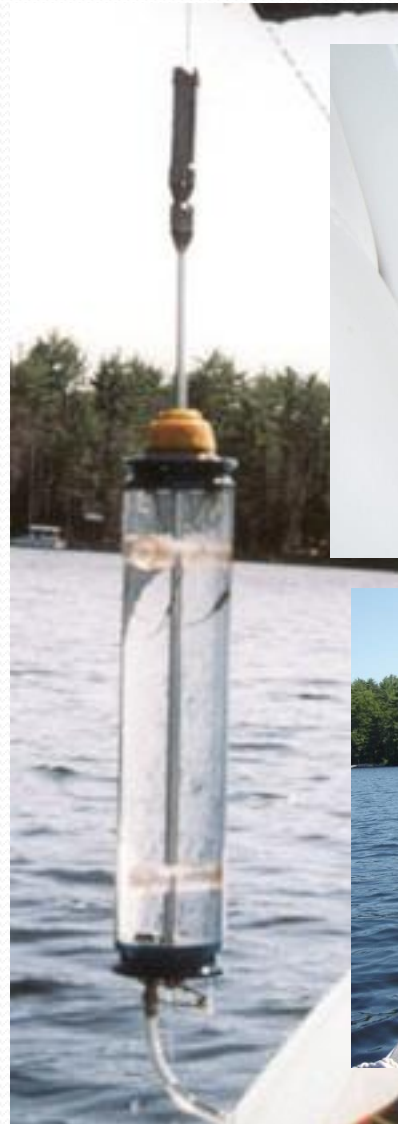
STATIONID	STATION NAME
PEAMMADD	DEEP SPOT
PEAMMADI	INLET
PEAMMADO	OUTLET
PEAMMADC13	#13 LITTLE SHORE DR
PEAMMADC15	#15 LITTLE SHORE DR
PEAMMADC01A	#1A
PEAMMADC01	#1 EIDELWEISS DRIVE
PEAMMADC02	#2 EIDELWEISS DRIVE
PEAMMADBB	BOULDER BCH
PEAMMADGB	GENEVA BCH
PEAMMADC16	#16 EIDELWEISS DRIVE
PEAMMADC01B	#1B EIDELWEISS DR
PEAMMADC04	#4 MIDDLE SHORE PL
PEAMMADC15M	#15 MIDDLE SHORE PL
PEAMMADC73	LOT 73 EIDELWEISS DR

VLAP Monitoring



VLAP Monitoring

- Samples analyzed for variety of parameters.
- Indicators of lake health:
 - Chlorophyll-a
 - Transparency
 - Total Phosphorus
 - pH
- Can you swim and recreate?
- Can aquatic life thrive?

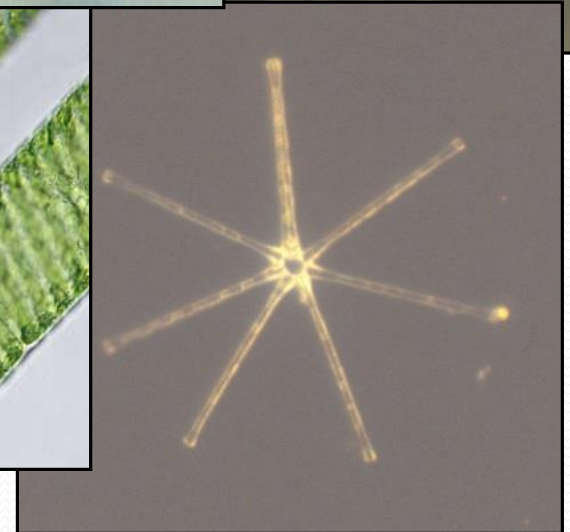
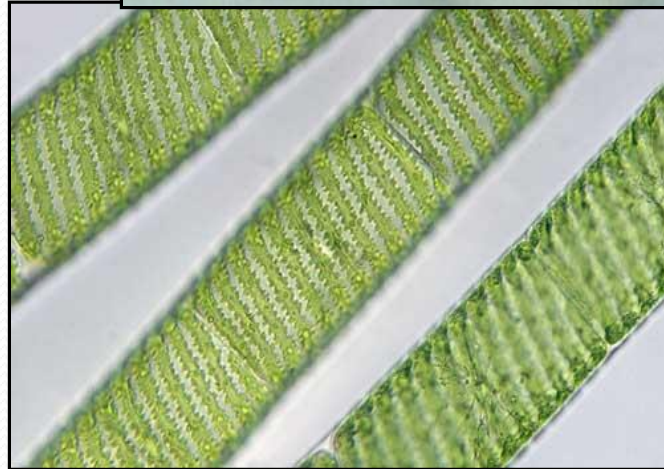
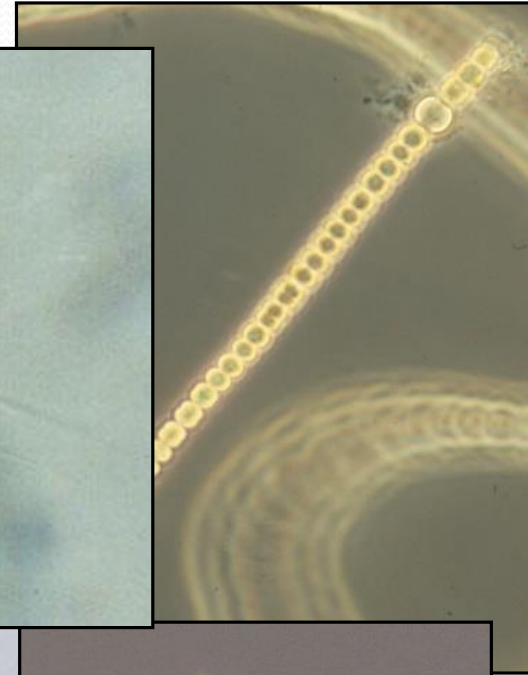


Water Analyses

Chlorophyll-a:

Photosynthetic pigment in plants, algae and cyanobacteria.

- Provides general indication of algal or cyanobacteria abundance.
- High Chl-a concentrations can indicate algal blooms caused by too many nutrients.



Pea Porridge Deep Spot

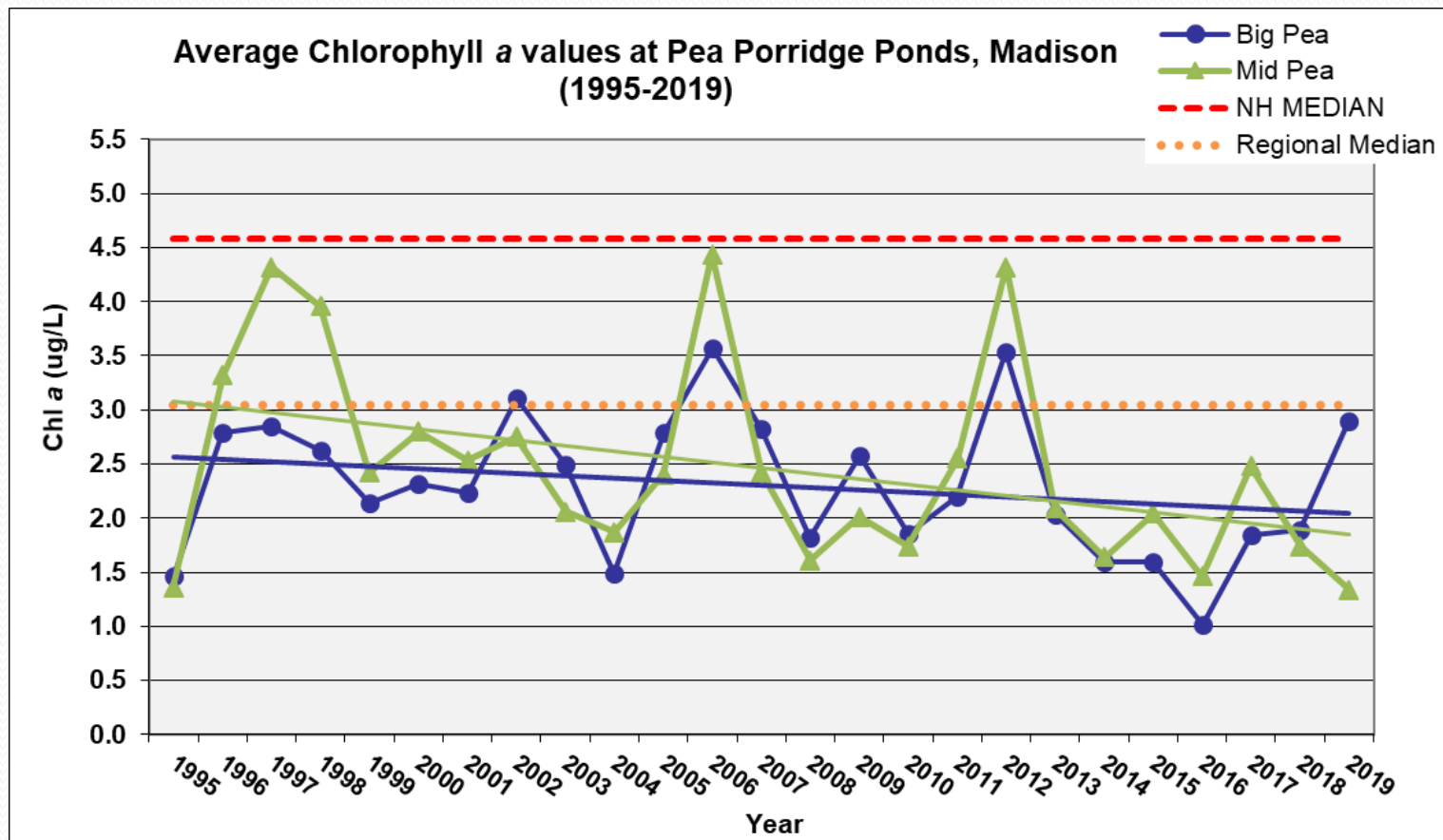
Water Quality Trends

Chlorophyll-a: mean chlorophyll-a concentrations have ranged between 1.02 and 4.44 ug/L

Median: 2.23 ug/l - 2.42 ug/L **Regional Median:** 3.05 ug/L

Good Range: 0.0 – 5.0 ug/L **Algal blooms:** > 15.0 ug/L

Stable trend with decreasing trend line.



Water Analyses

Transparency:

measurement of water clarity.

- Collected using a Secchi Disk.
- Factors affecting transparency:
 - Water color
 - Turbidity: sediments, fine particulate matter, algae



Pea Porridge Deep Spot

Water Quality Trends

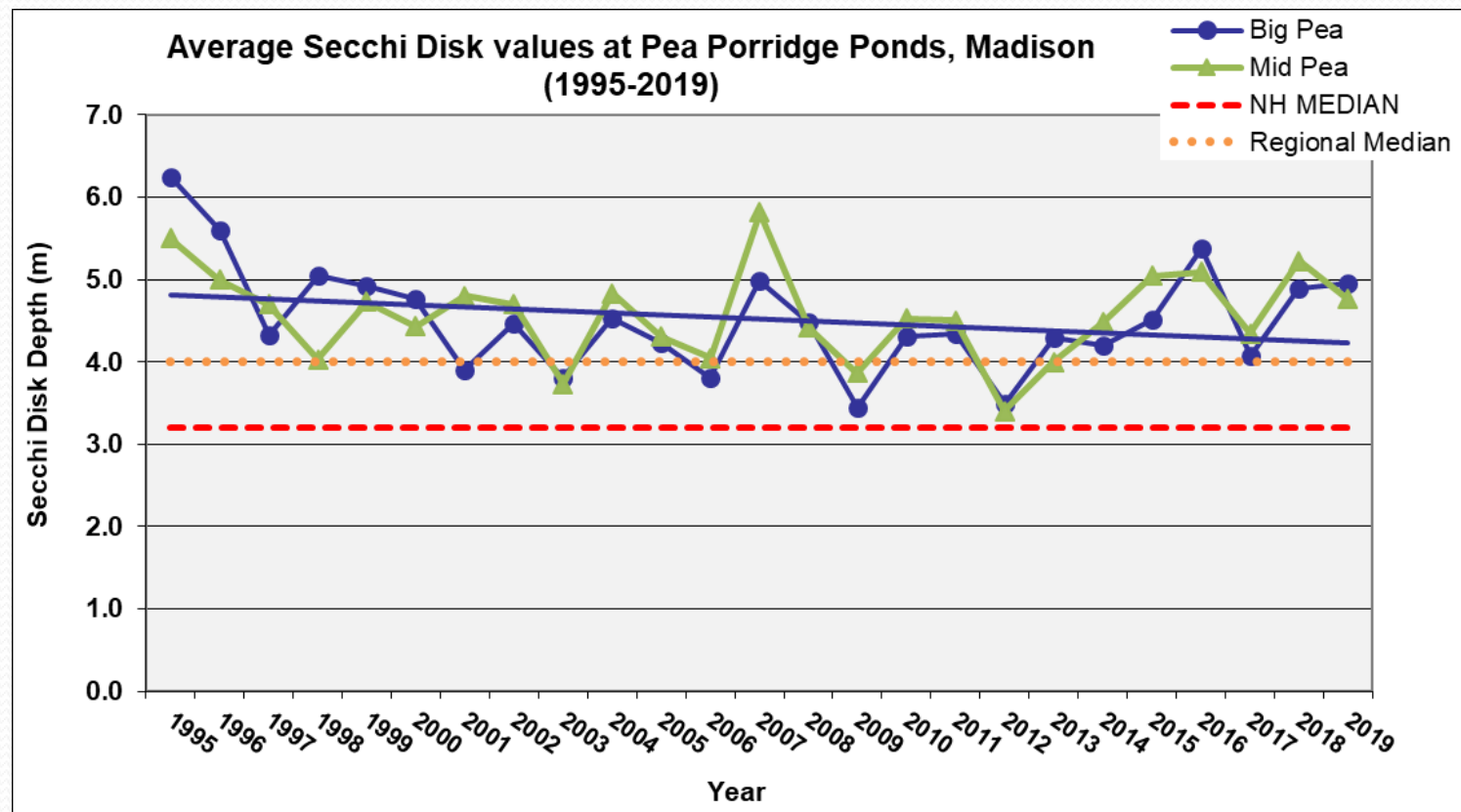
Transparency: mean transparency values have ranged between 3.40 and 6.25 meters.

Median: 4.34 - 4.50 meters

Regional Median: 4.00 meters

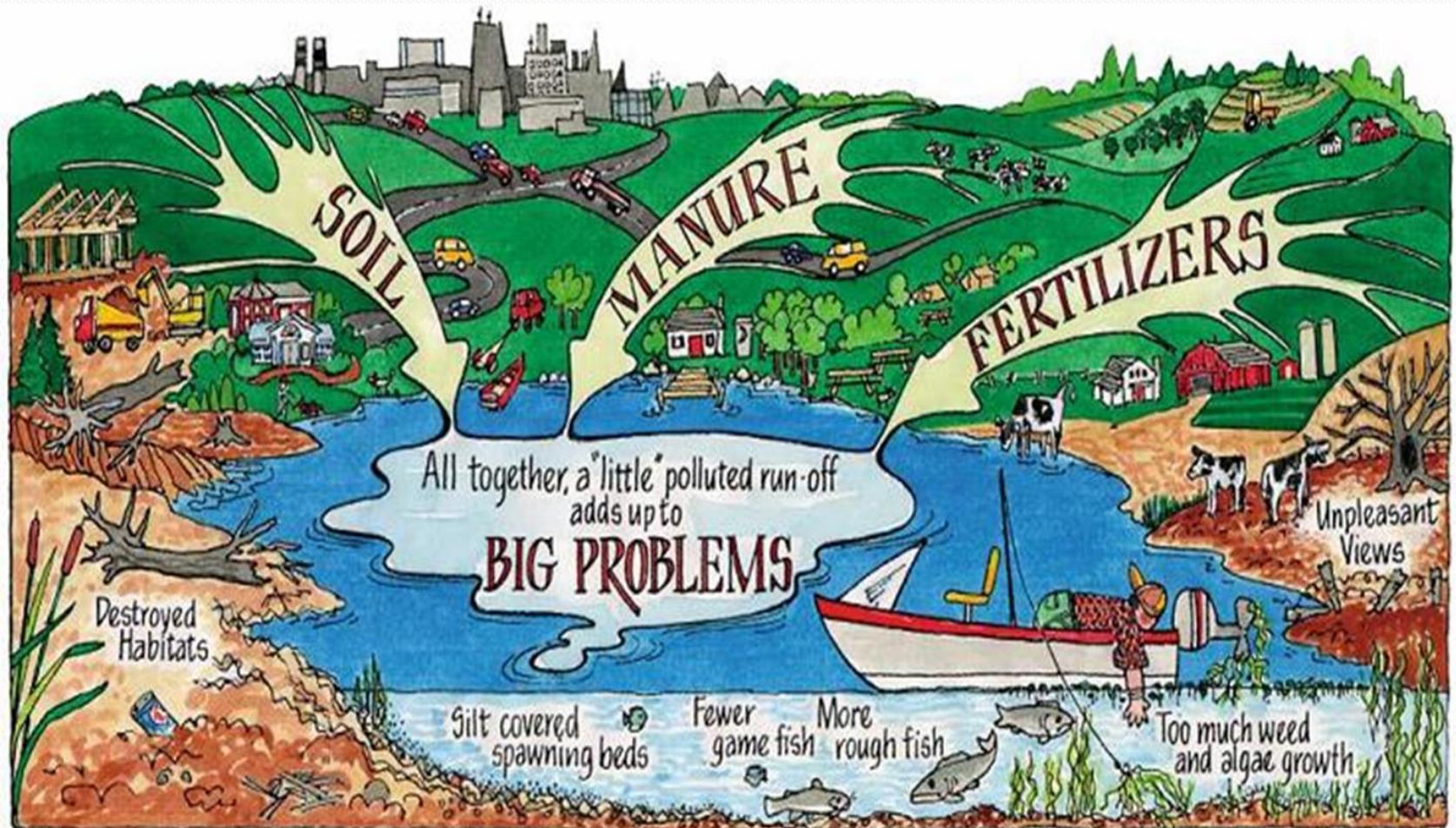
Good Range: 2.00 – 4.50 meters

Stable Trend



Water Analyses

Total Phosphorus: nutrient that promotes plant and algal growth.



Pea Porridge Deep Spot

Water Quality Trends

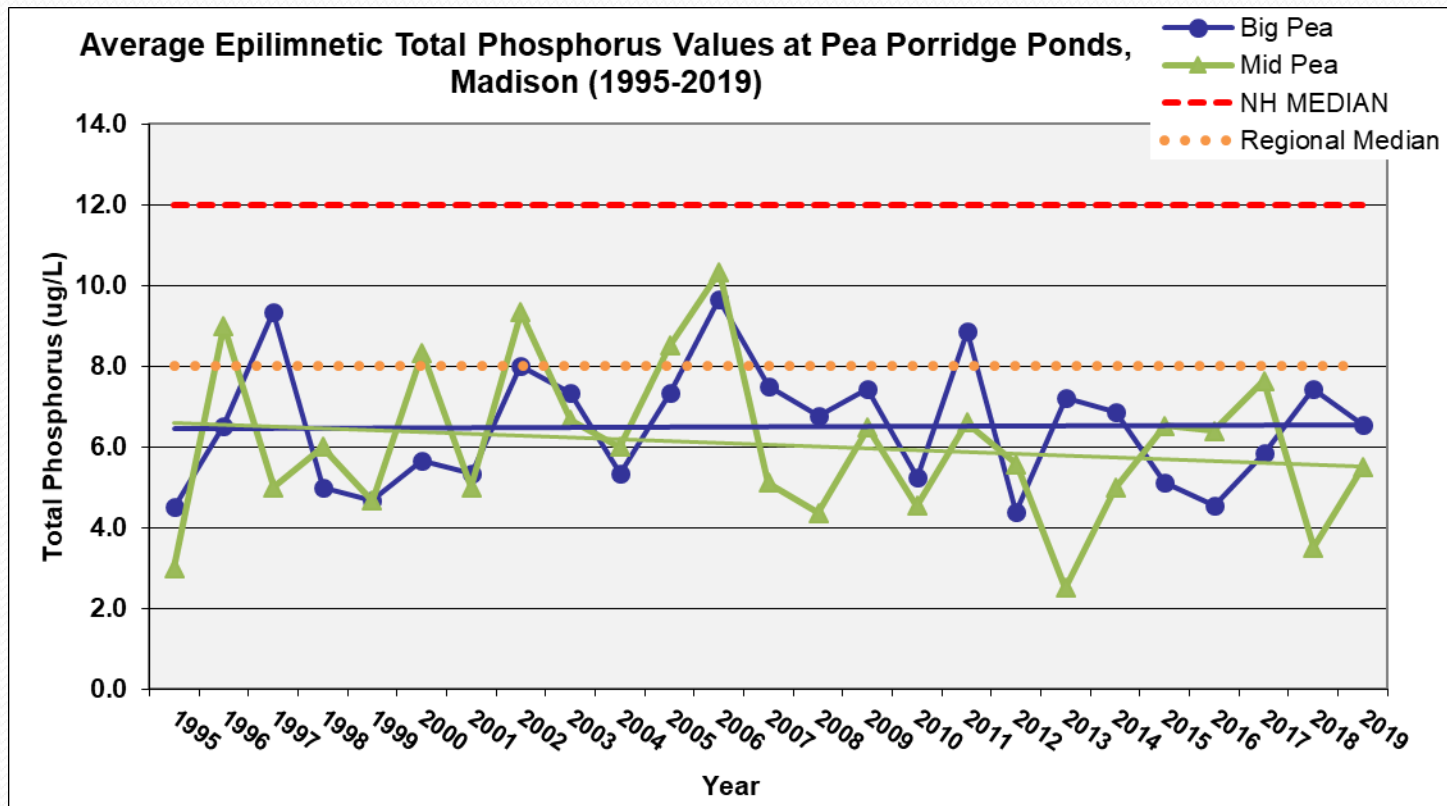
Epilimnetic Total Phosphorus: Mean epilimnetic phosphorus has ranged from 3 ug/L to 10 ug/L.

Median: 6 - 7 ug/L

Regional Median: 8 ug/L

Good Range: 1 – 12 ug/L

Stable Trend



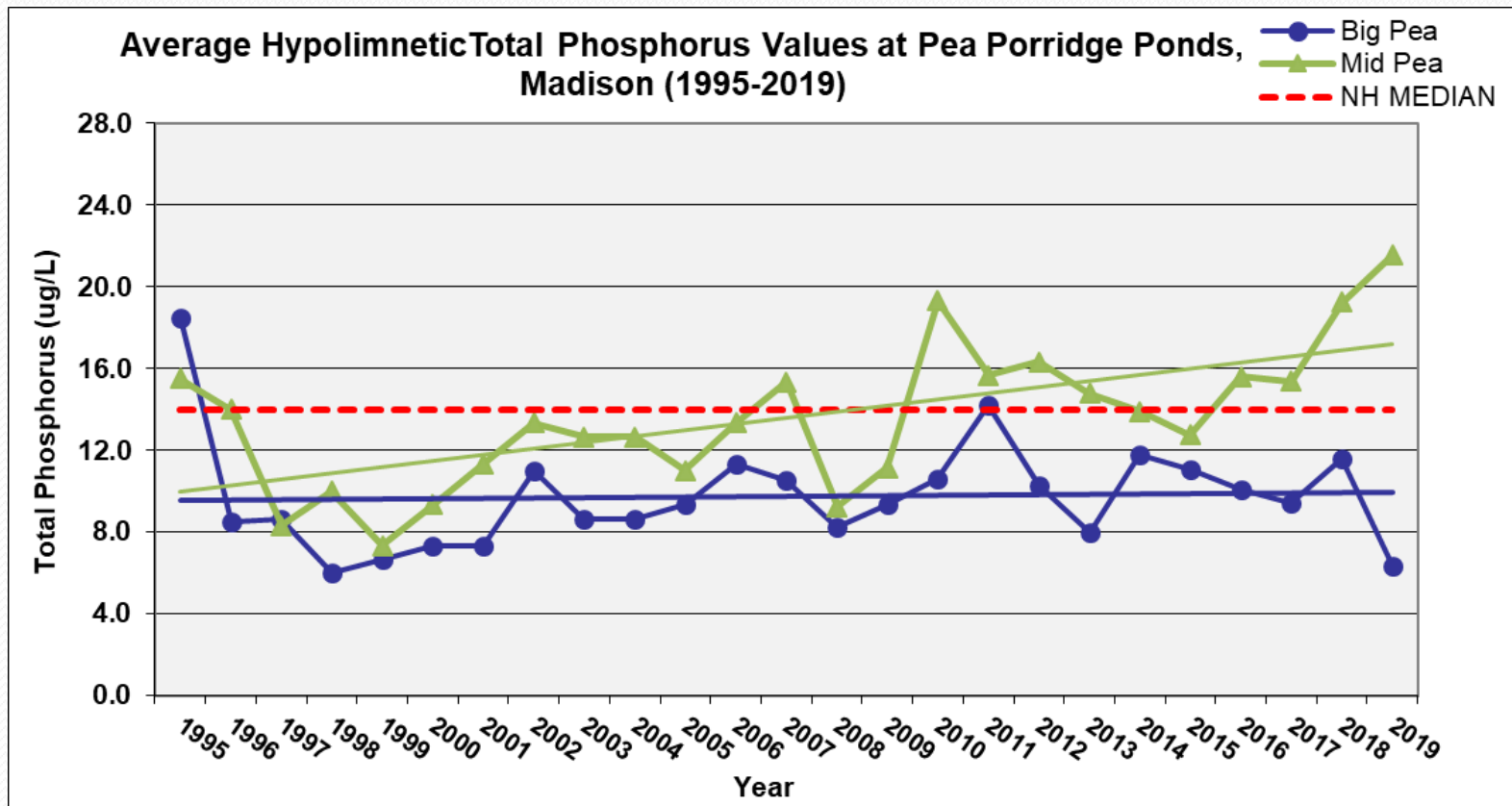
Pea Porridge Deep Spot

Water Quality Trends

Hypolimnetic Total Phosphorus: Mean hypolimnetic phosphorus has ranged from 6 ug/L to 19 ug/L.

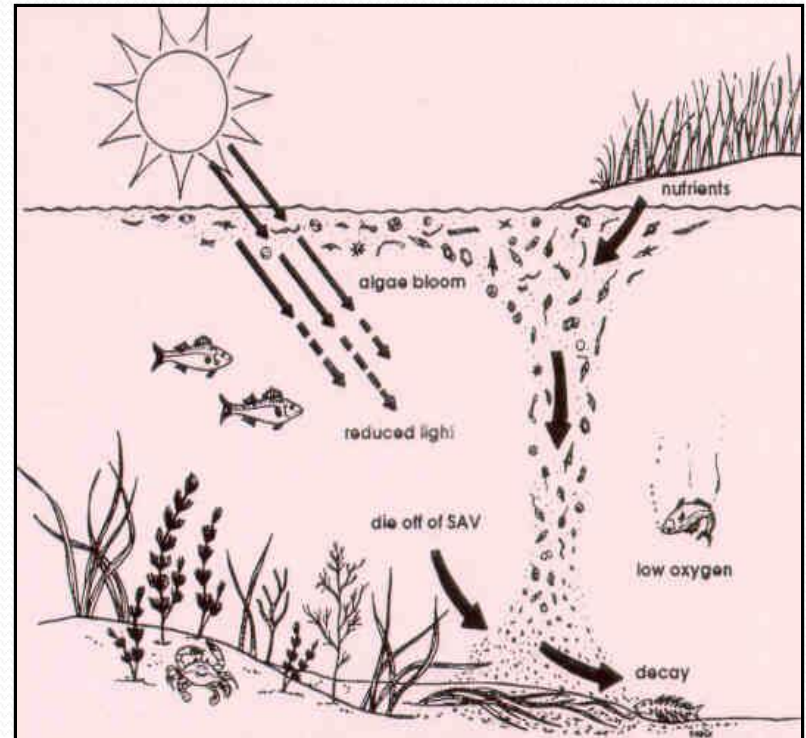
Median: 9 – 13 ug/L

Stable Trend at Big Pea. Significantly increasing (worsening) trend at Middle Pea.



Nutrients : Algae : Clarity Relationships

- Increases in nutrients
- ↓
- Increases in algae
- ↓
- Decreases in lake clarity
- ↓
- Decreases in property values!



Water Analyses

- **Conductivity:**
Ability of water to conduct electrical current.
- Salts and minerals
- Natural occurring
- Human influences

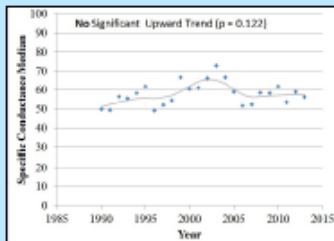
Lake Conductivity Trends

Individual Lake Trend

- ▲ Significant Increasing Trend
- No significant trend
- ▼ Significant Decreasing Trend
- ~ Basin Boundaries
- Town Boundaries

0 5 10 20 30 40 Miles

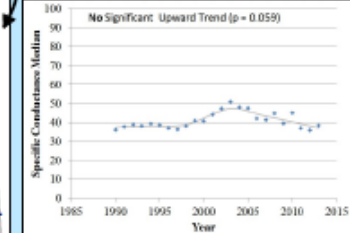
Connecticut River Watershed



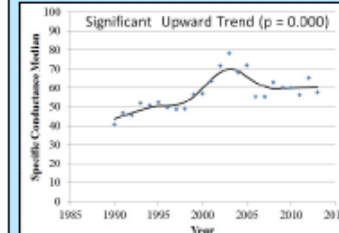
Androskoggin River Watershed

No lakes with sufficient datasets for trend analysis.

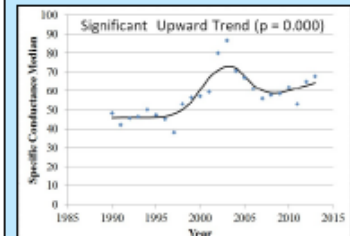
Saco River Watershed



Pemigewasset / Merrimack River Watershed



Piscataqua River / Coastal Watershed



Pea Porridge Deep Spot

Water Quality Trends

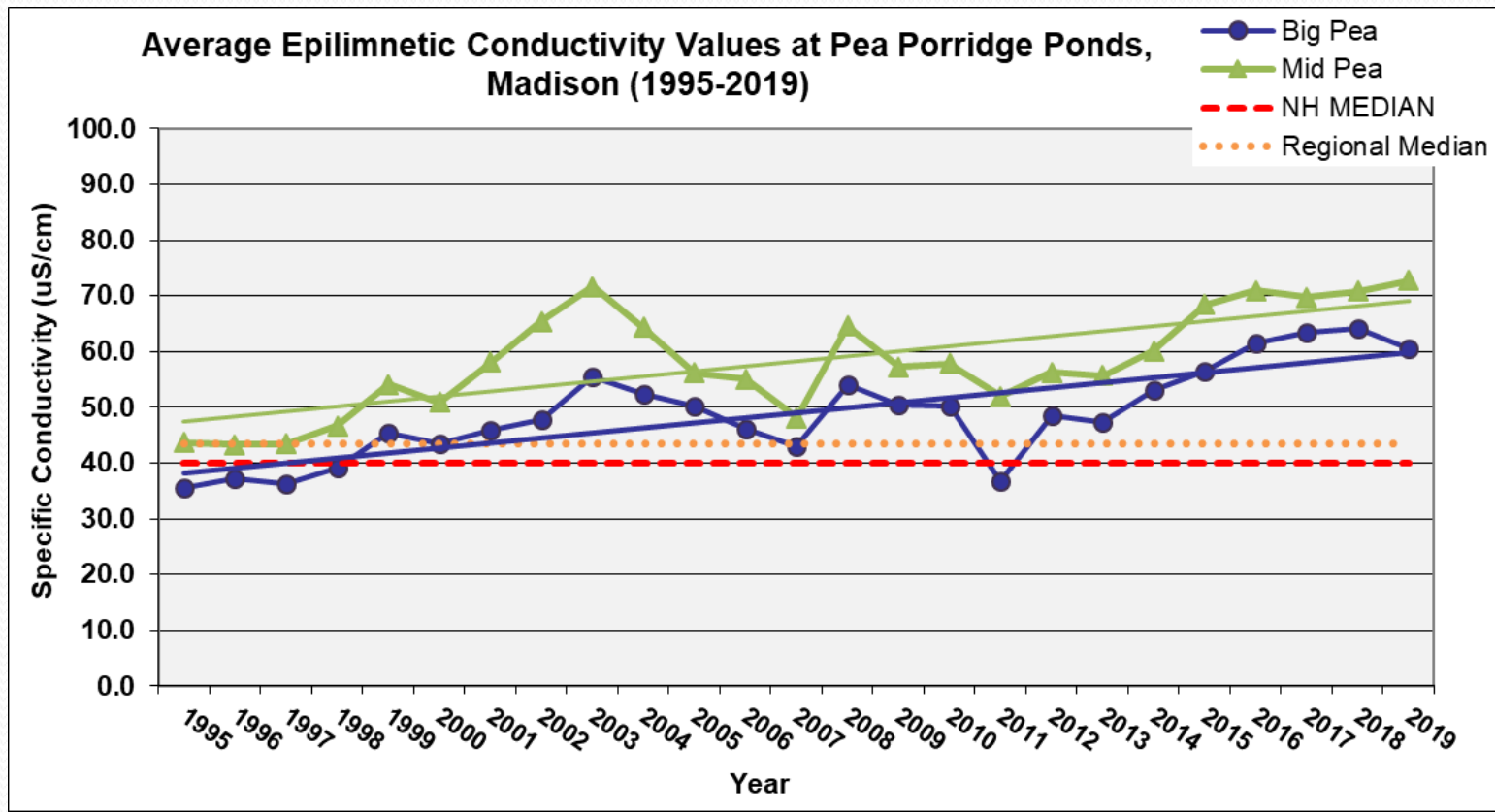
Epilimnetic Conductivity: Mean epilimnetic conductivity has ranged from 47.8 uS/cm to 57.1 uS/cm.

Median: 47.9 – 56.3 uS/cm

Regional Median: 43.5 uS/cm

Good Range: < 100 uS/cm

Improving trend: Data significantly decreasing.



Water Analyses

- **pH:** How acidic is the water?
- Naturally occurring
- Human influences



Pea Porridge Deep Spot

Water Quality Trends

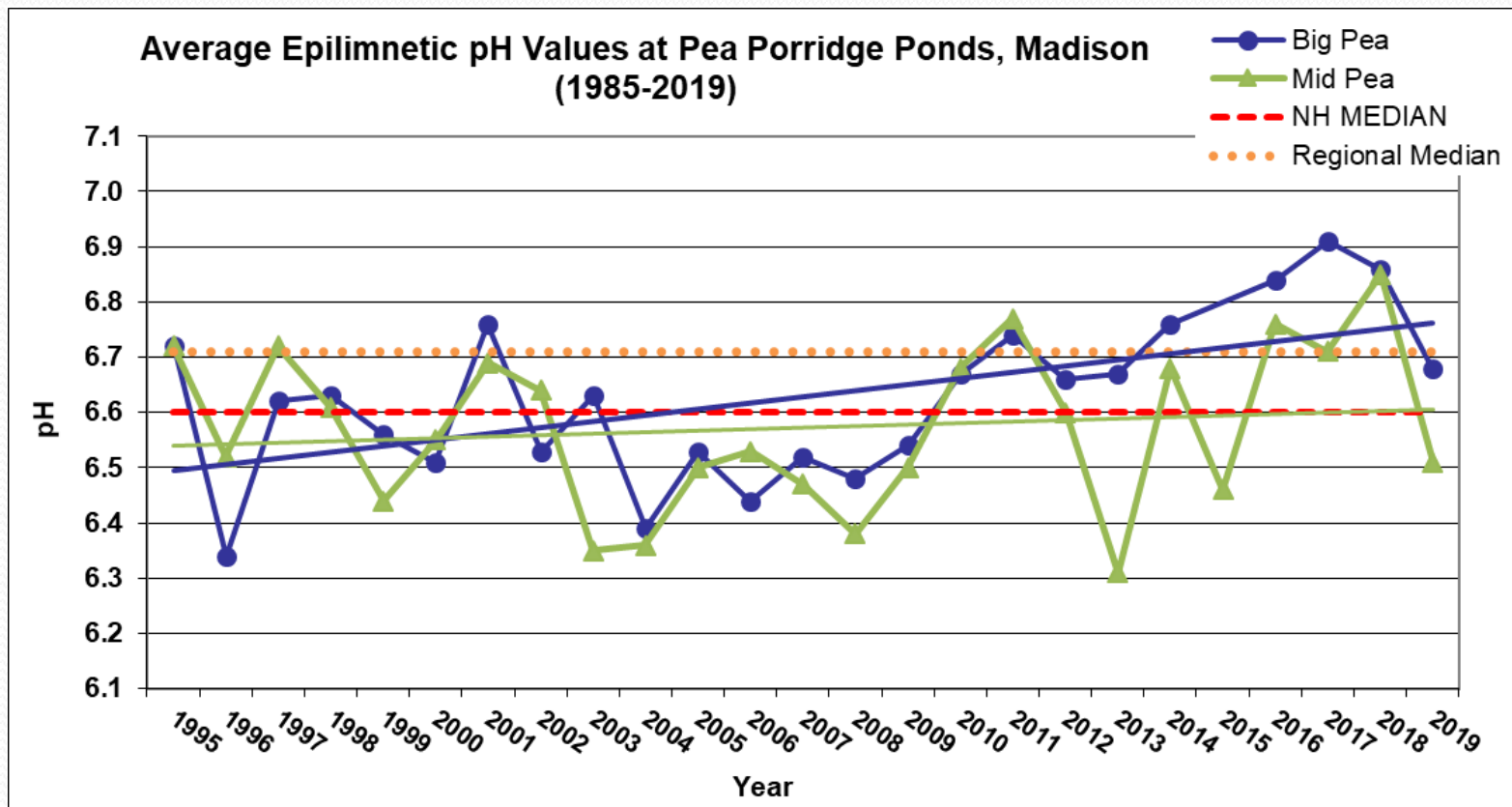
Epilimnetic pH: Mean epilimnetic pH has ranged from 6.31 to 6.91

Median: 6.55 – 6.63

Regional Median: 6.71

Good Range: 6.5 – 8.0

Trend significantly increasing (improving) trend at Big Pea. Stable trend at Middle Pea.



Pea Porridge Deep Spot

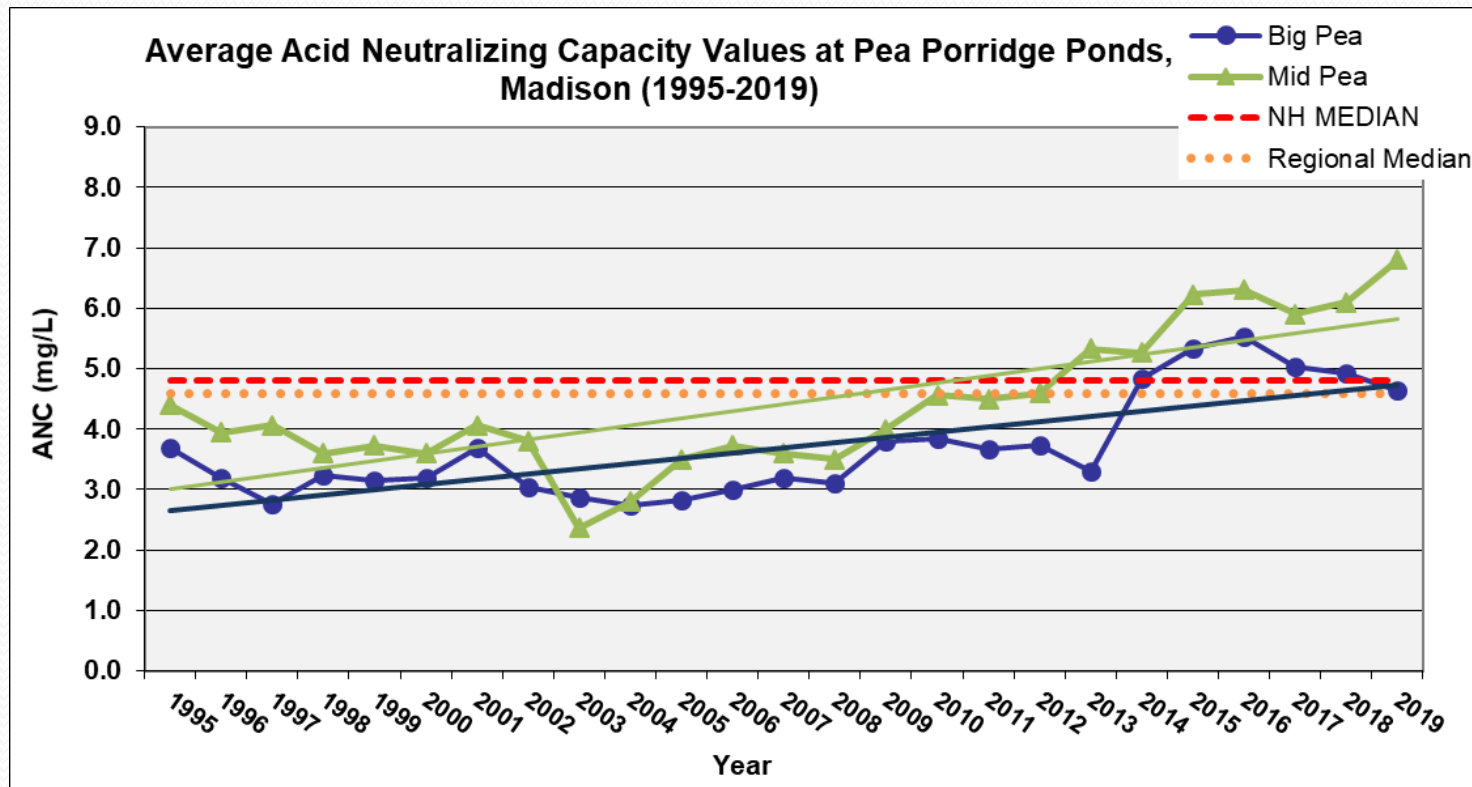
Water Quality Trends

Acid Neutralizing Capacity (ANC): Mean ANC has ranged from 2.36 mg/L to 6.30 mg/L

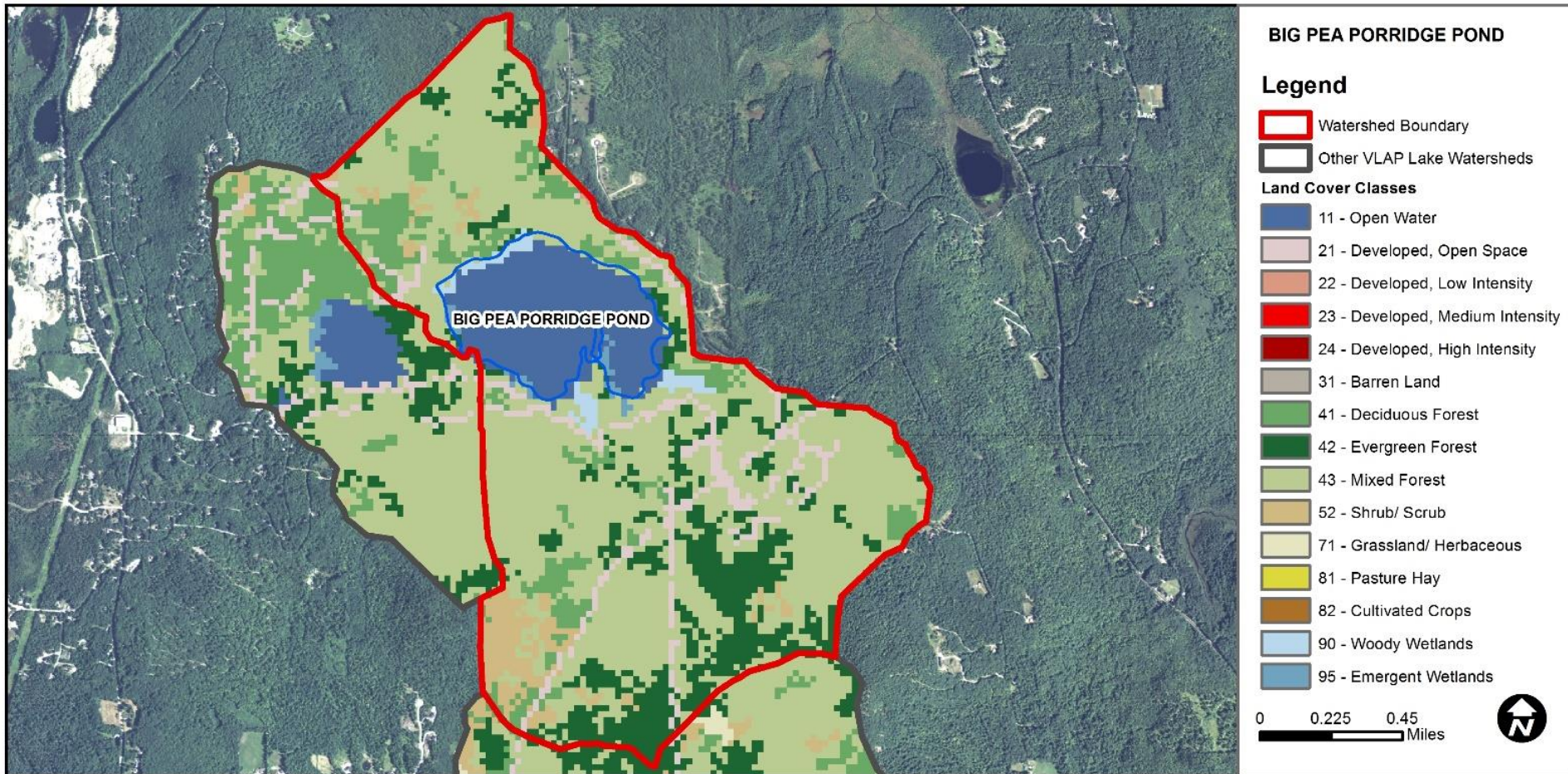
Median: 3.23 – 4.00 mg/L = moderately vulnerable **Regional Median:** 4.6 mg/L

Good Range: 10.1 – 25 mg/L

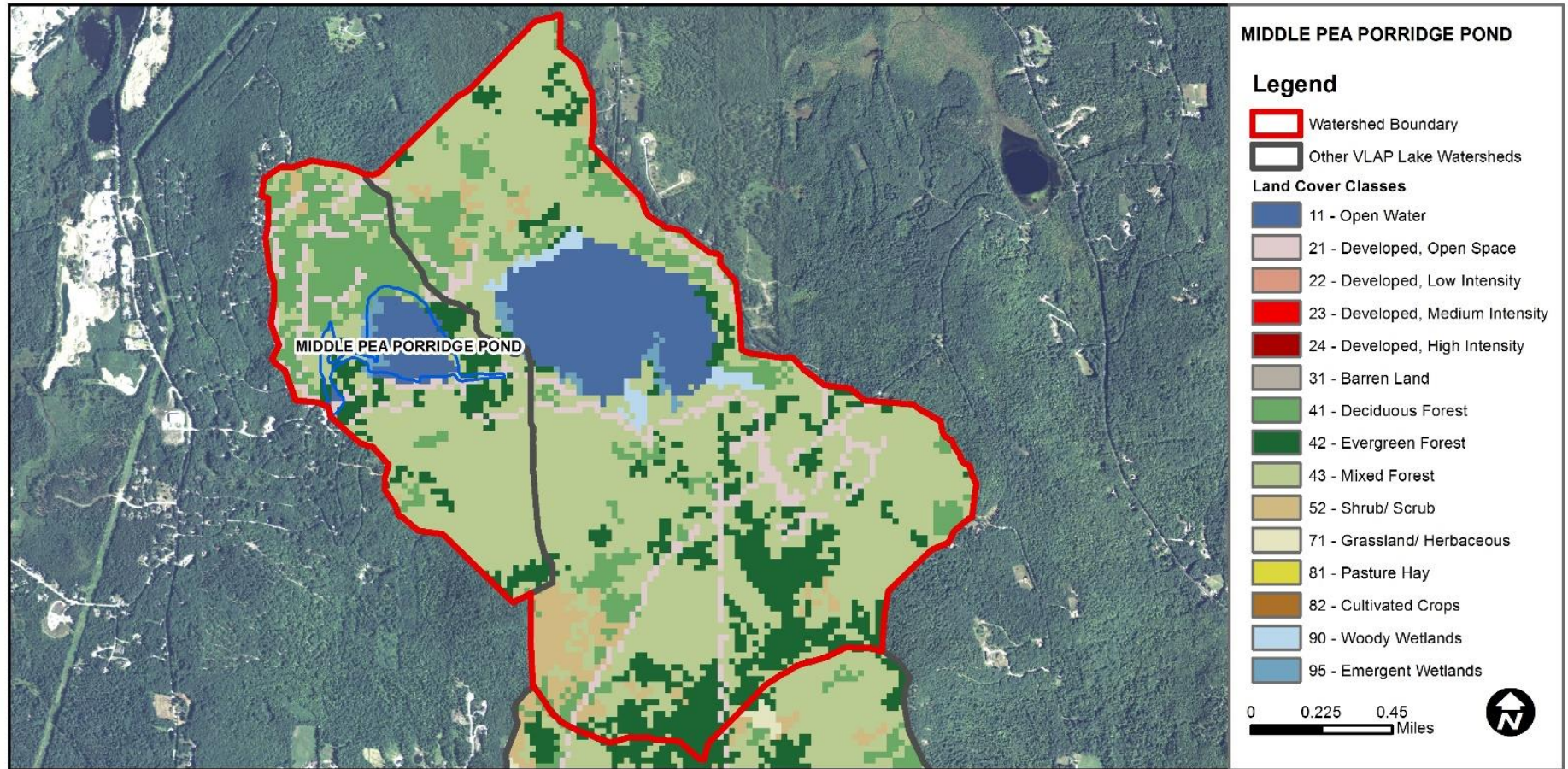
Trend line indicates increase over time.



Big Pea Porridge Watershed Map



Middle Pea Porridge Watershed Map



VLAP Reports

2018 Lake Reports

- Morphometric data.
- Waterbody report card and impairment status.
- Watershed map and land use data.



MORPHOMETRIC DATA						TROPIC CLASSIFICATION		KNOWN EXOTIC SPECIES
Watershed Area (Ac.):	1,856	Max. Depth (m):	13.4	Flushing Rate (yr ⁻¹)	5.3	Year	Trophic class	
Surface Area (Ac.):	43	Mean Depth (m):	4.7	P Retention Coef:	0.45	1989	OLIGOTROPHIC	
Shore Length (m):	1,400	Volume (m ³):	831,500	Elevation (ft):	636	2001	MESOTROPHIC	

The Waterbody Report Card tables are generated from the DRAFT 2018 305(b) report on the status of N.H. waters, and are based on data collected from 2008-2017. Detailed waterbody assessment and report card information can be found at www.des.nh.gov/organization/divisions/water/wmb/swqa/index.htm

Designated Use	Parameter	Category	Comments
Aquatic Life	Phosphorus (Total)	Good	Sampling data is better than the water quality standards or thresholds for this parameter.
	pH	Slightly Bad	Data periodically exceed water quality standards or thresholds for this parameter by a small margin.
	Oxygen, Dissolved	Encouraging	Limited data for this parameter predicts water quality standards or thresholds are being met; however more data are necessary to fully assess the parameter.
	Dissolved oxygen saturation	Encouraging	Limited data for this parameter predicts water quality standards or thresholds are being met; however more data are necessary to fully assess the parameter.
	Chlorophyll-a	Good	Sampling data is better than the water quality standards or thresholds for this parameter.
Primary Contact Recreation	Escherichia coli	Very Good	All sampling data meet water quality standards or thresholds for this parameter.
	Chlorophyll-a	Very Good	All sampling data meet water quality standards or thresholds for this parameter.

WATERSHED LAND USE SUMMARY

Fry, J., Xian, G., Jin, S., Dewitz, J., Homer, C., Yang, L., Barnes, C., Herold, N., and Wickham, J., 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States, PERS, Vol. 77(9):858-864. For larger image contact NHDES.



Land Cover Category	% Cover	Land Cover Category	% Cover	Land Cover Category	% Cover
Open Water	10.9	Barren Land	0	Grassland/Herbaceous	0
Developed-Open Space	6.3	Deciduous Forest	11.92	Pasture Hay	0
Developed-Low Intensity	0.05	Evergreen Forest	13.67	Cultivated Crops	0
Developed-Medium Intensity	0	Mixed Forest	51.2	Woody Wetlands	1
Developed-High Intensity	0	Shrub-Scrub	3.78	Emergent Wetlands	0.86



VOLUNTEER LAKE ASSESSMENT PROGRAM INDIVIDUAL LAKE REPORTS

BIG PEA PORRIDGE POND, MADISON

2018 DATA SUMMARY

RECOMMENDED ACTIONS: Pond chlorophyll and phosphorus levels were indicative of oligotrophic, or high quality, conditions. However, conductivity levels have worsened, and an enhanced sampling effort in the spring identified several problematic areas with high conductivity and chloride levels. Now that some problem areas have been identified, efforts to educate local road agents, private winter maintenance companies and watershed residents on ways to reduce application of de-icing products and dust suppressants on roads, walkways and driveways can help reduce the pollutant load. NWDES's Watershed Assistance Program website and UWM Technology Transfer Center's Road Salt Reduction website are excellent resources. Keep up the great work!

VLAP Reports

2018 Lake Report

- Current year data summary.
- Trend analysis.
- Observations and recommendations.

OBSERVATIONS (Refer to Table 1 and Historical Deep Spot Data Graphics)

- CHLOROPHYLL-a:** Chlorophyll levels were within a low range in June and decreased slightly in August. July chlorophyll results were invalidated due to an analytical error. Average chlorophyll level remained stable with 2017, was much less than the state median, and well within the range expected for an oligotrophic pond. Historic trend analysis indicates stable chlorophyll levels since monitoring began.
- CONDUCTIVITY/CHLORIDE:** Epilimnetic (upper water layer), Metalimnetic (middle water layer), Hypolimnetic (bottom water layer), Big Rock Inlet, and Outlet conductivity levels fluctuated within a narrow, slightly elevated range throughout the summer. However, conductivity levels were not above a level of concern. Muddy Beach inlet conductivity levels were slightly elevated in June and July but decreased to an average range by August. Epilimnetic, Big Rock Inlet and Muddy Beach Inlet chloride levels were slightly greater than the state median however much less than the state chronic chloride standard. However, historical trend analysis indicates significantly increasing (worsening) epilimnetic conductivity levels since monitoring began. An intensified sample event during April to pinpoint sources of elevated chloride and conductivity identified Brenner At Townline, Allard & Gottens, #7 Edelweiss Dr, and #8 Brenner Dr. as the highest (worst) sources.
- COLOR:** Apparent color was measured in the epilimnion and indicated lightly tea colored water in June and July and increased to moderate tea colored water in August following above average rainfall early in the month.
- E. coli:** Shore and Thuis Beach E. coli levels were low and remained much less than the state standard for public beaches.
- TOTAL PHOSPHORUS:** Epilimnetic, Metalimnetic, and Hypolimnetic phosphorus levels were low in June, slightly elevated in July, and returned to within a low to average range in August. Big Rock Inlet phosphorus levels fluctuated within a moderate range throughout the summer. Muddy Beach Inlet and Outlet phosphorus levels were low. Average epilimnetic phosphorus level increased slightly from 2017 but remained less than the state median and the threshold for oligotrophic lakes. Historic trend analysis indicates relatively stable epilimnetic phosphorus levels since monitoring began.
- TRANSPARENCY:** Transparency measured without the viewscope (NVS) increased (improved) from average to above average as the summer progressed. Average NVS transparency was increased (improved) from 2017 and was much higher (better) than the state median. Historical trend analysis indicates relatively stable transparency since monitoring began. Viewscope transparency (VS) was higher (better) than NVS transparency and likely a better measure of visual conditions.
- TURBIDITY:** Epilimnetic and Metalimnetic turbidity levels were slightly above average in June and decreased to low levels as the summer progressed. Hypolimnetic turbidity levels were within an average range in June and July and decreased to a low range by August. Big Rock Inlet turbidity level was elevated in June potentially due to low flow conditions. Muddy Beach inlet turbidity levels were slightly elevated in July and sediment was noted in the sample. Outlet turbidity levels were slightly elevated in June and decreased to a low range in July and August.
- pH:** Epilimnetic, Metalimnetic, Big Rock Inlet, Muddy Beach Inlet, and Outlet pH levels were within the desirable range of 6.3-8.0 units. Hypolimnetic pH levels were slightly acidic and below the desirable range. Historic trend analysis indicates significantly increasing (improving) epilimnetic pH levels since monitoring began.

NH Water Quality Standards: Numeric criteria for specific parameters. Results exceeding criteria are considered a water quality violation.

Chloride: > 230 mg/L (chronic)
E. coli: > 88 cts/100 mL - public beach
E. coli: > 406 cts/100 mL - surface waters
Turbidity: > 10 NTU above natural level
pH: between 6.5-8.0 (unless naturally occurring)

NH Median Values: Median values for specific parameters generated from historic lake monitoring data.

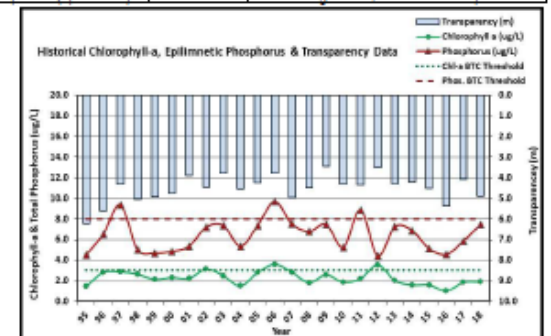
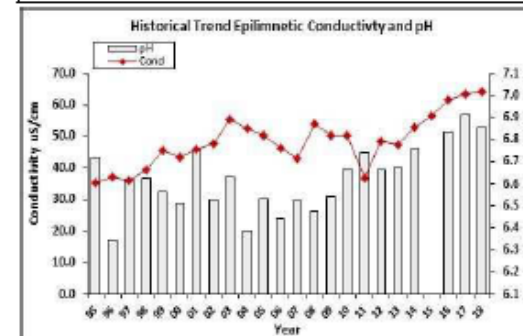
Alkalinity: 4.5 mg/L
Chlorophyll-a: 4.99 mg/m³
Conductivity: 42.3 us/cm
Chloride: 3 mg/L
Total Phosphorus: 11 ug/L
Transparency: 3.3 m
pH: 6.6

Station Name	Alk. mg/l	Chlor-a ug/l	Chloride mg/l	Color pcu	Cond. us/cm	E. Coli mpn/300ml	Total P ug/l	Trans. m	Turb. ntu	pH	
								NVS	VS		
Epilimnion	4.9	1.89	12	30	64.3		7	4.90	5.38	0.71	6.5
Metalimnion					69.2		9			1.00	6.6
Hypolimnion					69.2		12			1.23	6.1
Big Rock Inlet			16		75.6		14			4.42	6.7
Muddy Bch Inlet			11		57.6		4			1.05	6.6
Outlet					61.4		3			0.84	6.8
Shore Beach						7					
Thuis Beach						3					

Station Name	Chloride mg/l	Cond. us/cm
#11A Allard Hill Rd.	12	51.5
#14A Bidford Rd.	7	31.8
#14C Modock Hill Rd.	19	86.2
#7 Edelweiss Dr.	60	212.0
#7A Edelweiss Dr.	4	26.6
#8 Brenner Dr.	40	150.5
#9 Lizum Place	22	93.5
99 Edel	9	44.8
Arnborg & Brenner	20	91.1
Arnborg End	9	56.3
#7B Lot 99 Ed	2	18.8
Allard & Gottens	83	293.0
Brenner At Townline	220	745.0
Curve Sign Allard Hill	8	43.9
Modock at Log Cabin	21	99.6

HISTORICAL WATER QUALITY TREND ANALYSIS

Parameter	Trend	Explanation	Parameter	Trend	Explanation
Conductivity	Worsening	Data significantly increasing.	Chlorophyll-a	Stable	Trend not significant; data show low variability.
pH (epilimnion)	Improving	Data significantly increasing.	Transparency	Stable	Trend not significant; data moderately variable.
			Phosphorus (epilimnion)	Stable	Trend not significant; data moderately variable.



Waterbody Report Card

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Primary Contact Recreation	Escherichia coli	Very Good	All sampling data meet water quality standards or thresholds for this parameter.
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Orange/Red = “impaired”

Nutrient Thresholds

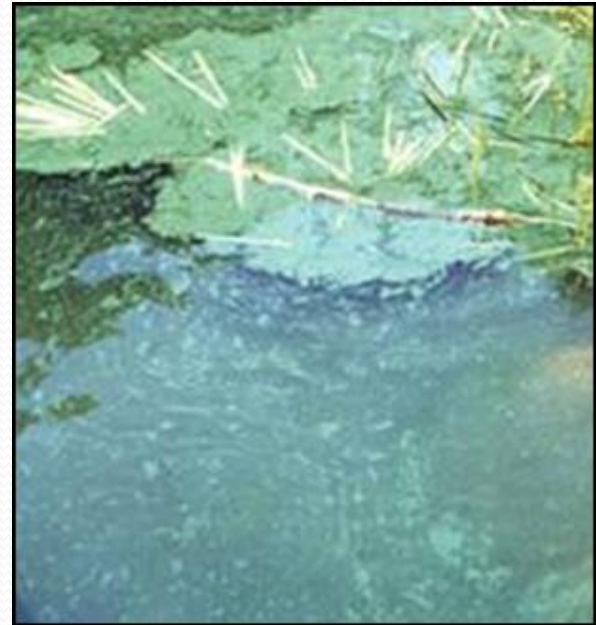
- Nutrient thresholds were developed to assess the ability of a waterbody to support aquatic life.
- The thresholds are based on a waterbody's trophic classification.
- Pea Porridge Ponds Best Trophic Class = **OLIGOTROPHIC**
- Use the best trophic classification to determine nutrient impairments.

	Total Phosphorus (ug/L)	Pea Porridge Median Epi TP	Chlorophyll-a (ug/L)	Pea Porridge Median Chl-a
Oligotrophic	< 8.0	6.0 - 7.0	< 3.3	2.20 -2.40
Mesotrophic	≤ 12.0		≤ 5.0	
Eutrophic	≤ 28		≤ 11	

Hot Topics for NH Lakes

(aka, *Aquatic Invasive Species*)

- Exotic Aquatic Species (aka, Aquatic Invasive Species)
- Cyanobacteria (aka, Blue-Green Algae)



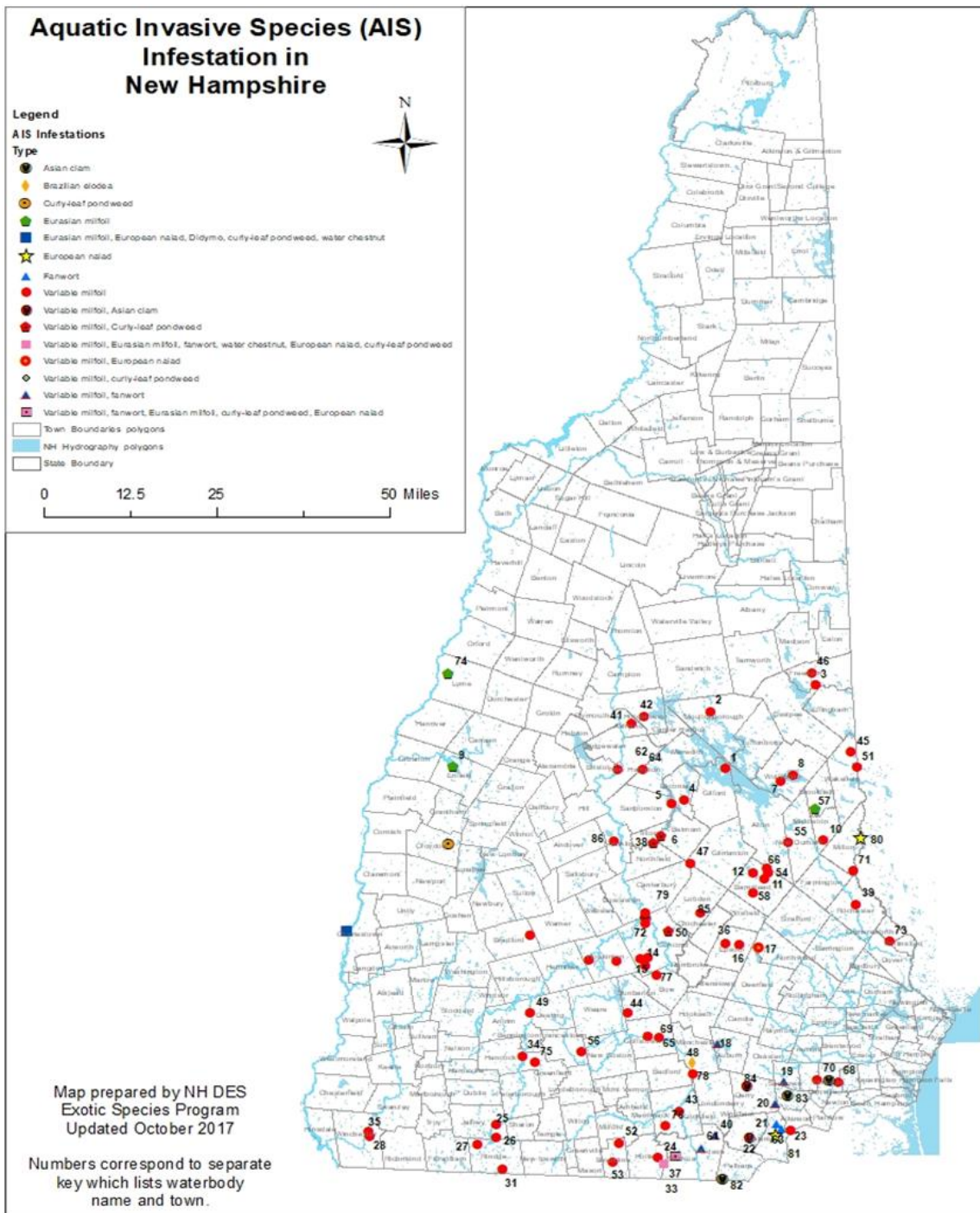
NH Prohibited Aquatic Plant List

- Red font indicates species already documented in NH

Latin Name	Common Name
<i>All Myriophyllum species</i>	Milfoils or feather-foils
<i>All Cabomba species</i>	Fanworts
<i>Hydrilla verticillata</i>	Hydrilla or Anacharis
<i>All Trapa species</i>	Water chestnut
<i>Potamogeton crispus</i>	Curly-leaf pondweed
<i>Lythrum salicaria</i>	Purple loosestrife
<i>Phragmites australis</i> or <i>P. communis</i>	Common reed
<i>Egeria densa</i>	Brazilian elodea
<i>Hydrocharis morsus-ranae</i>	European frogbit
<i>Butomus umbellatus</i>	Flowering rush
<i>Najas minor</i>	European naiad
<i>Nymphoides peltata</i>	Yellow floating heart
<i>Crassula helmsii</i>	Swamp stonecrop
<i>Epilobium hirsutum</i>	Great willow herb or hairy willow herb
<i>Glyceria maxima</i>	Reed sweet grass or manna grass
<i>Hygrophila polysperma</i>	East Indian Hygrophila
<i>Ipomoea aquatica</i>	Water spinach
<i>Iris pseudocarus</i>	Yellow iris or yellow flag iris
<i>Lagarosiphon major</i>	African oxygen weed
<i>Limnophila sessiliflora</i>	Ambulia
<i>Marsilea quadriflora</i>	Water fern
<i>Myosotis scorpioides</i>	Water forget-me-not
<i>Sagittaria japonica</i>	Double flowering arrowhead, Japanese arrowhead, or Old World arrowhead
<i>Sagittaria sagittifolia</i>	Giant sagittaria
<i>Salvinia molesta</i>	Giant salvinia
<i>Typha gracilis</i>	Slender Cattail
<i>Typha laxmanii</i>	Dwarf cattail or Laxman's cattail
<i>Typha minima</i>	Miniature cattail or micro-mini cattail

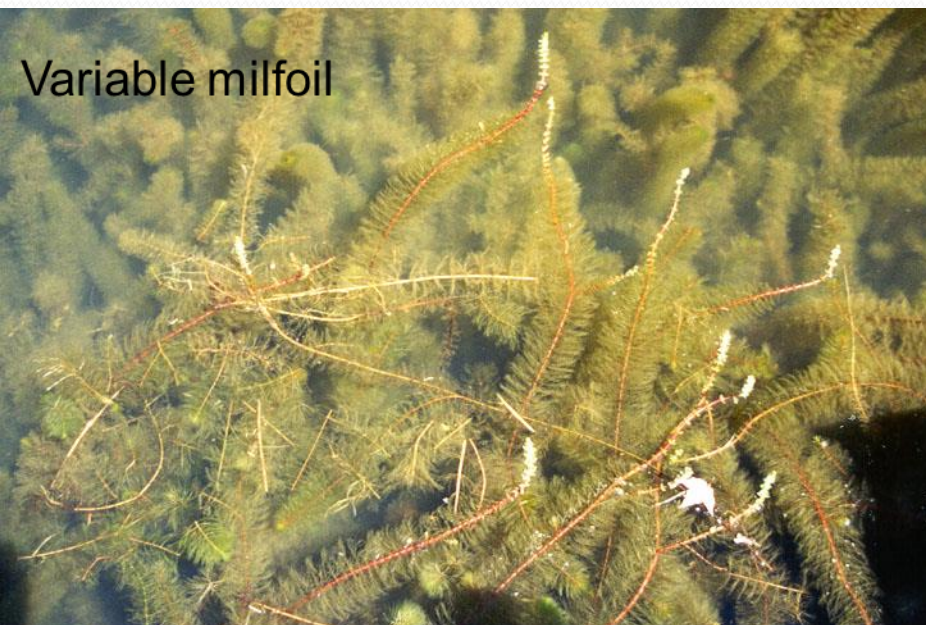
Exotic Aquatic Species in NH

- 88 infested waterbodies
 - 11 Rivers
 - 77 Lakes and Ponds
- 107 infestations
 - Some waterbodies have more than one species, a few have as many as 6 different invasives.

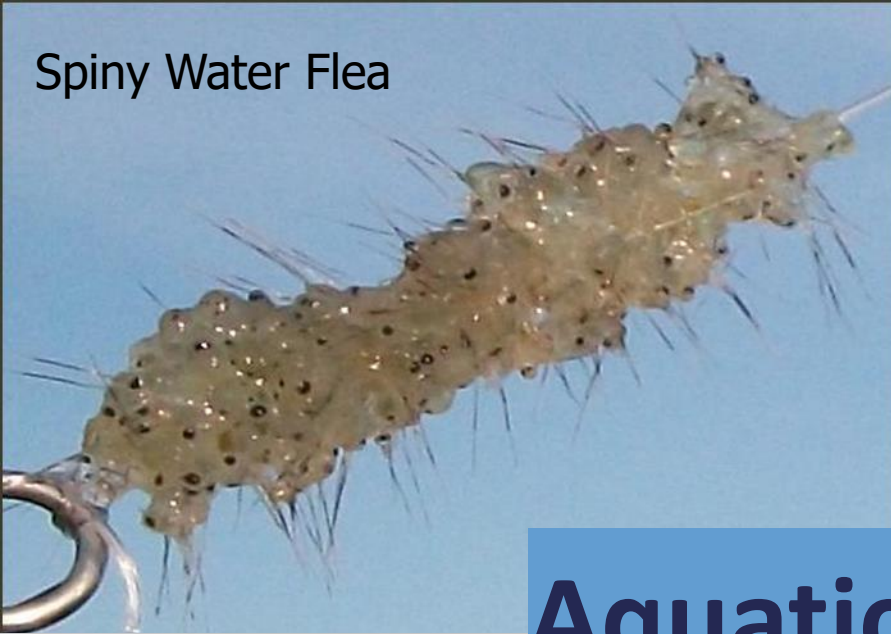




Aquatic Invasive Plants



Spiny Water Flea



Zebra Mussel



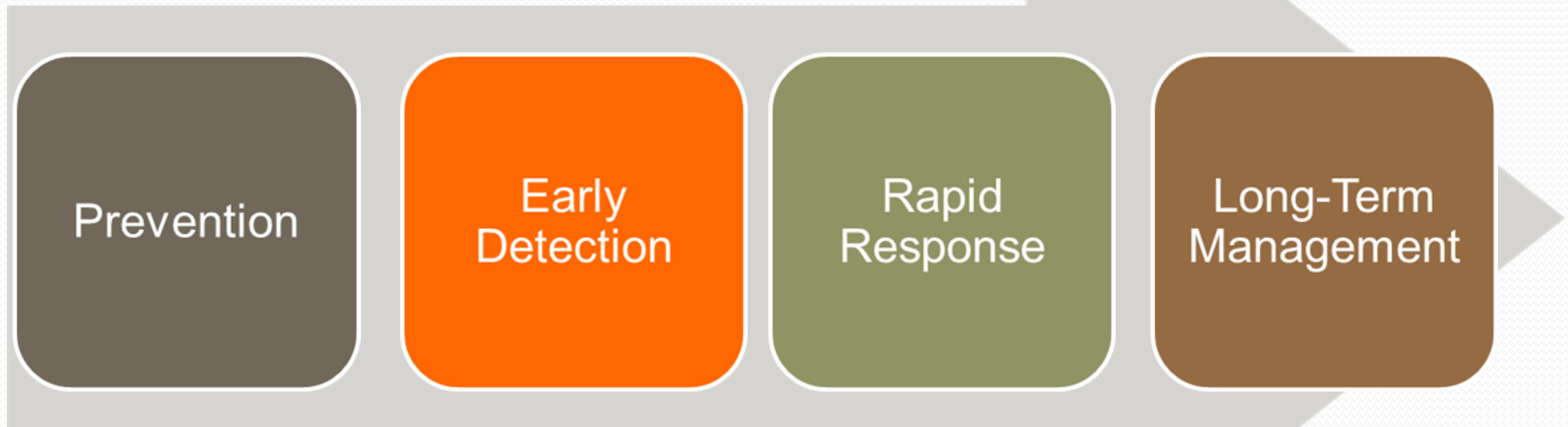
Aquatic Invasive Animals

Chinese Mystery Snail



Asian Clam

Addressing the Problem of Invasives



- Prevention and early detection are far easier and cheaper than long-term management
- Infestations do happen, but it is best to find them early, when eradication is most feasible
- Most eradication success stories are those tied to infestations that are found early, when they are small patches or single stems
- Long-term management can reduce large-scale and complicated infestations to less than 10% of a vegetation matrix in a waterbody, but costs are high and routine maintenance is needed.

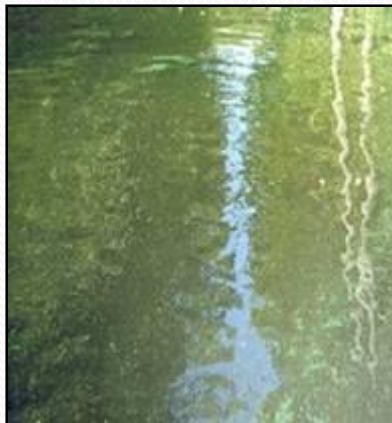
What are cyanobacteria?

- Formerly blue-green algae
- Single cell life w/o a nuclear membrane

Contain photosynthetic pigments

Chlorophyll-a (green) and Phycobilins (blue)

- Can produce toxins



Lake Monomonac, Rindge



Bow Lake, Northwood



Examples of cyanobacteria blooms

Showell Pond, Sandown

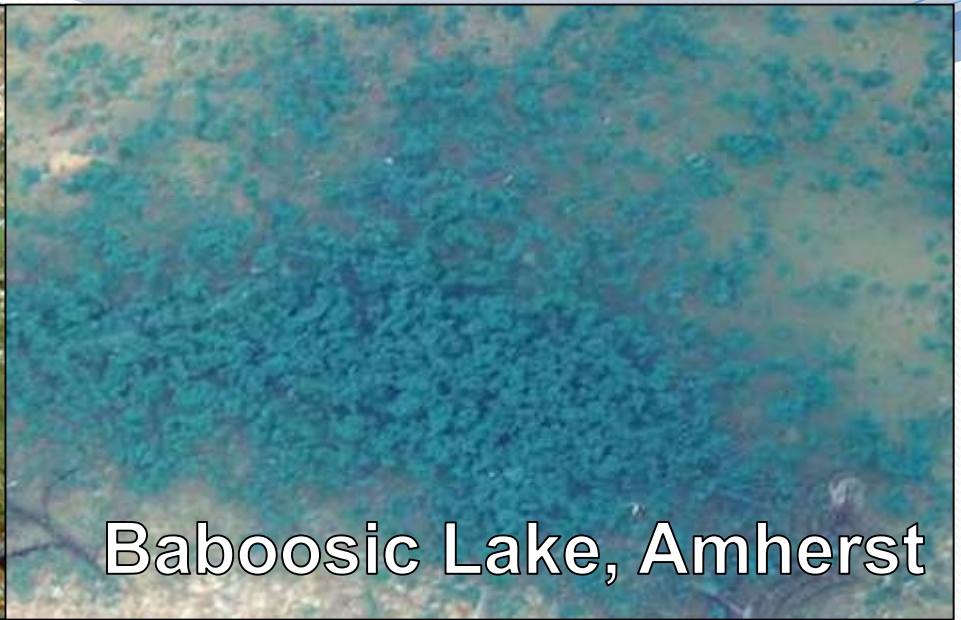


March's Pond, New Durham



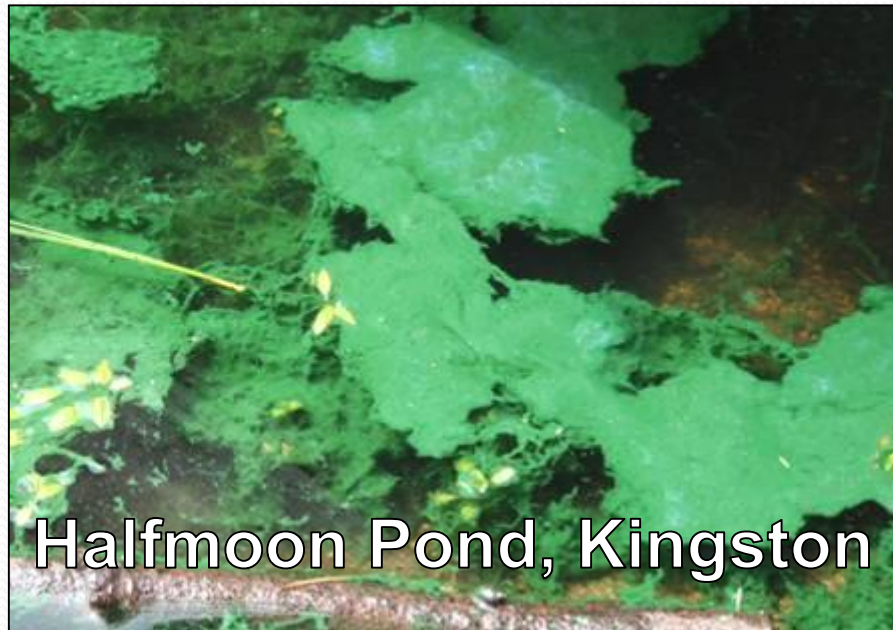


Robinson Pond, Hudson



Baboosic Lake, Amherst

Examples of cyanobacteria blooms



Halfmoon Pond, Kingston



Willand Pond, Somersworth

Why should we be concerned?



Webster Lake, Franklin, 2007



Unsightly



Taste Problems



Odor Problems



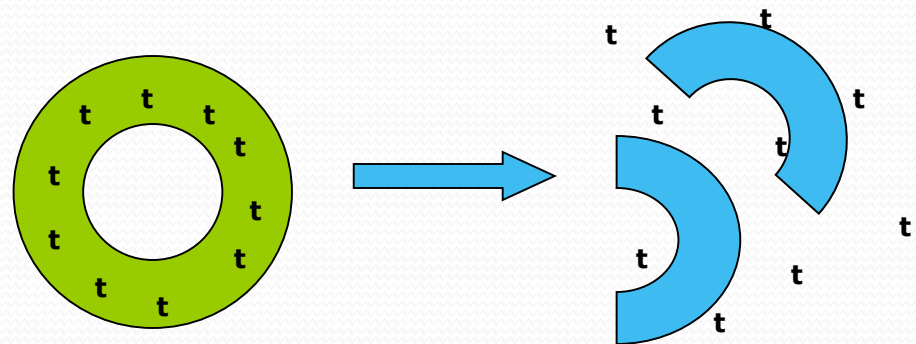
Fish Kills



Toxins

Toxins

- Cyanobacteria produce biotoxins, collectively referred to as cyanotoxins
- Biotoxins: a toxin produced by a living organism (plant, fungi, animal, bacterium)
- Toxins stored in cells are released when cell dies



Health Effects of Cyanotoxins

- Microcystins → Liver

Acute Exposure: Compromises liver function

Chronic Exposure: Doses cause cancer

- Anatoxins → Nerve connections

Convulsions; death of dogs & birds

- β -N-methylamino-L-alanine (BMAA)

→ Nerves

Maybe linked to neurological diseases

What levels might be harmful

**>50% toxin-
producing
cyanobacteria
OR
70,000 cells/ml**

ADVISORY

High levels of potentially toxic
CYANOBACTERIA
have been identified in this water

**WATER CURRENTLY NOT
SUITABLE FOR WADING
OR SWIMMING!**

Exposure to blue-green scums may cause nausea, vomiting, diarrhea, or fever in humans and pets.

Anyone who comes in contact with blue-green scum should rinse off with fresh water

All current advisories posted at www.des.nh.gov.
Click "beach advisory" in left column

CONTACT INFORMATION:
NHDES Beach Program
29 Hazen Dr.; Concord, NH
(603) 271-0698
beaches@des.nh.gov



What Can We Do?

- **Education and Outreach**
 - Educate lake front property owners and watershed residents about land use activities that could negatively impact the pond
 - Educate lake front property owners about what they CAN do
 - New stormwater management guide for homeowners
<http://des.nh.gov/organization/divisions/water/stormwater/stormwater-mgmt-homeowners.htm>



This is what we don't want to see



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How Can We Prevent These Problems?



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How Can We Prevent These Problems?



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What Are Septic Socials?

Septic Socials are:

...workshops that suggest easy and inexpensive practices you can adopt to keep your system running effectively and to also know when you have a problem. Not only can a failing septic system cost you thousands of dollars and lower your property value, but the pollution from them seeps into our local waterways, closing clam flats and causing swimming bans. Results of these serious water pollution problems have been documented in a report about Kittery's Spruce Creek Watershed.¹

...happening everywhere. Septic Socials have taken place on a smaller scale in the Town of Kittery as well as other towns in Maine, across the country, and Canada.

THANK YOU!

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Photo courtesy of Kittie Wilson