How Healthy Are Our Lakes?

NH Lakes

Working for Clean & Healthy Lakes Webinar Series

July 22, 2020 @ 7:00 p.m.

Dave Neils

Chief Aquatic Biologist

&

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Aquatic Ecologist

New Hampshire Department of Environmental Services

Overview of Presentation

1) Surface water monitoring strategy and how the public can participate
2) Summary of 2020 monitoring efforts during the pandemic
3) Outcomes of statewide analysis of lake data
4) Synthesis of findings
5) Q&A

How do we answer “How healthy are our lakes?”?

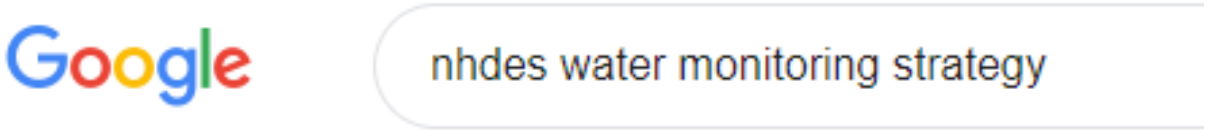
THERE IS NO ONE SINGLE MEASURE OF LAKE HEALTH.

BUT

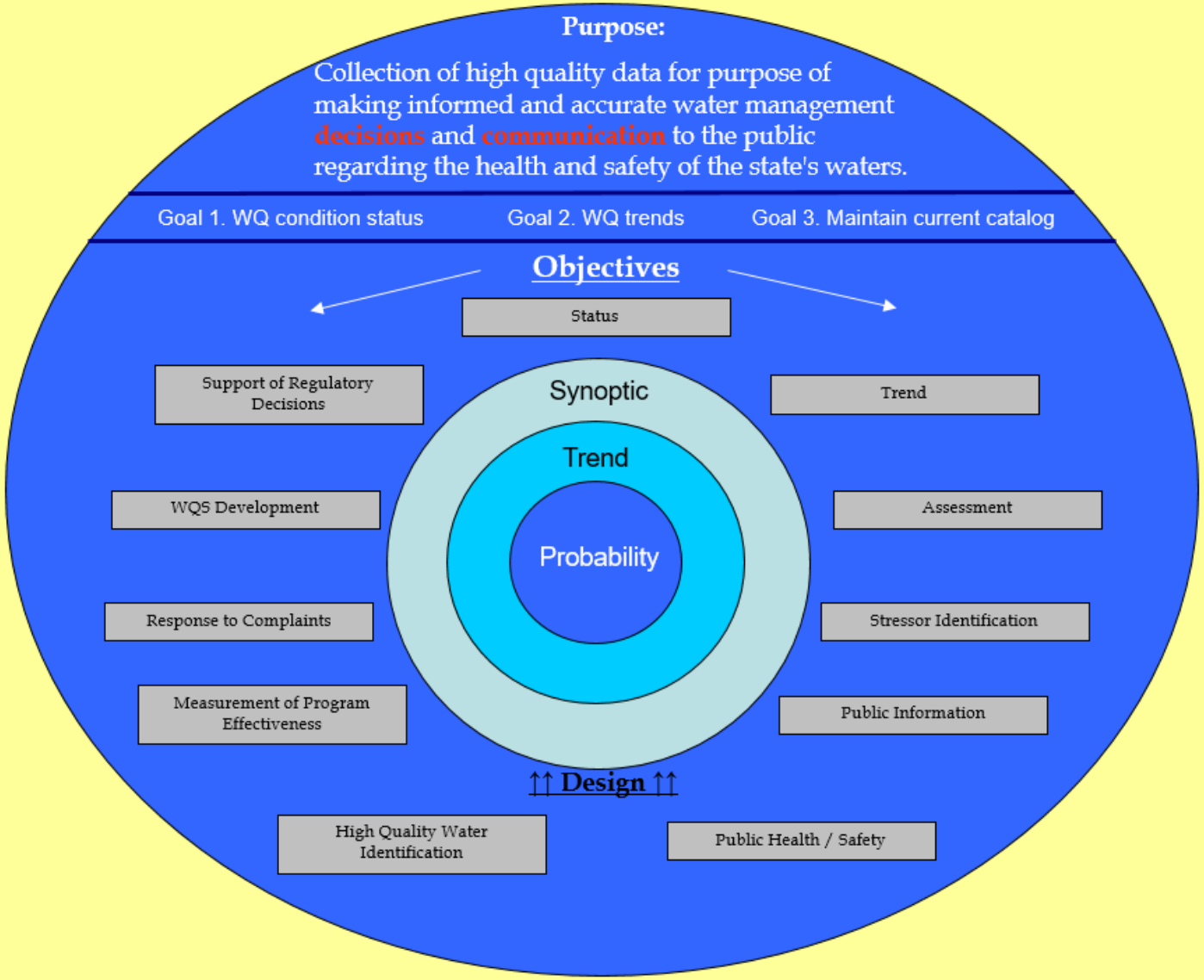
The key is to have a well defined plan….NHDES Water Monitoring Strategy, 2016

https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/r-wd-16-02.pdf

OR



NHDES water monitoring strategy purpose and design elements



Primary design "elements"

1) **Probability-based monitoring:** Census approach; sample a few waterbodies and say something about the entire population.

2) **Trend monitoring:** Repetitive sampling of a fixed set of waterbodies and track conditions over time.

3) **Synoptic monitoring:** Targeted selection of waterbodies for sampling for purpose of maintaining a catalog.

How can the public participate in lake monitoring?

Statewide flagship volunteer lake water quality monitoring programs:

- NHDES Volunteer Lake Assessment Program (VLAP) (Currently not able to accept new lakes)
- UNH Lay Lakes Monitoring Program (LLMP) (Bob Craycraft, bob.craycraft@unh.edu)

Invasive aquatic plant monitoring:

- NHDES volunteer weed watcher program (Amy Smagula, amy.smagula@des.nh.gov)

Cyanobacteria detection and reporting:

- NHDES Harmful Algal Bloom Program (Amanda McQuaid, HAB@des.nh.gov)
- Cyanobacteria Monitoring Collaborative (CMC) (Hilary Snook, EPA; www.cyanos.org)

MORE INTERESTED IN RIVERS?

NHDES Volunteer River Assessment Program (VRAP) (Ted Walsh, ted.walsh@des.nh.gov)

NHDES Surface Water Monitoring 2020

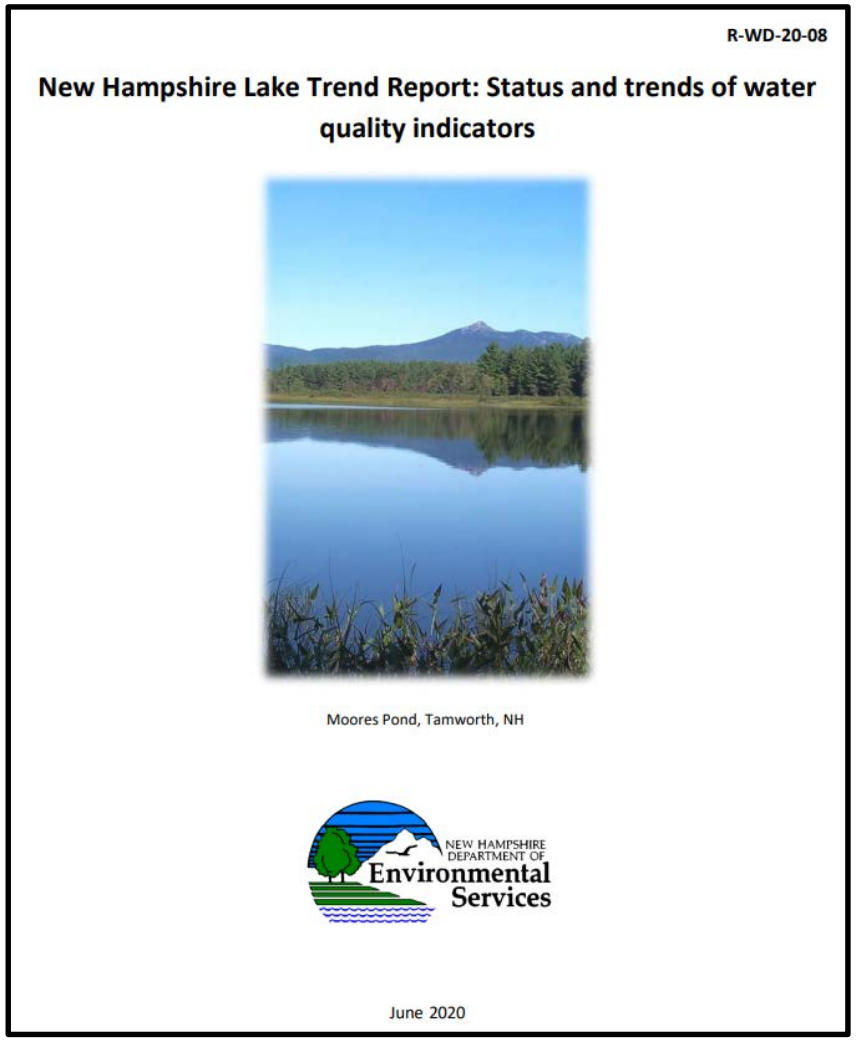
The ongoing COVID-19 pandemic has impacted our surface water monitoring efforts

- Reduction in VLAP – limited to two sampling events and no biologist visits
- Lake Trophic Surveys (LTS) – No new lakes for 2020
- River synoptic sampling – cancelled
- River trend sampling – ongoing but no bacteria samples
- Beach sampling – Coastal beaches as normal; limited sampling at freshwater beaches

Overall monitoring efforts have been reduced by about 1/3

Main Event

New Report: "New Hampshire Lake Trend Report: Status and trends of water quality indicators"



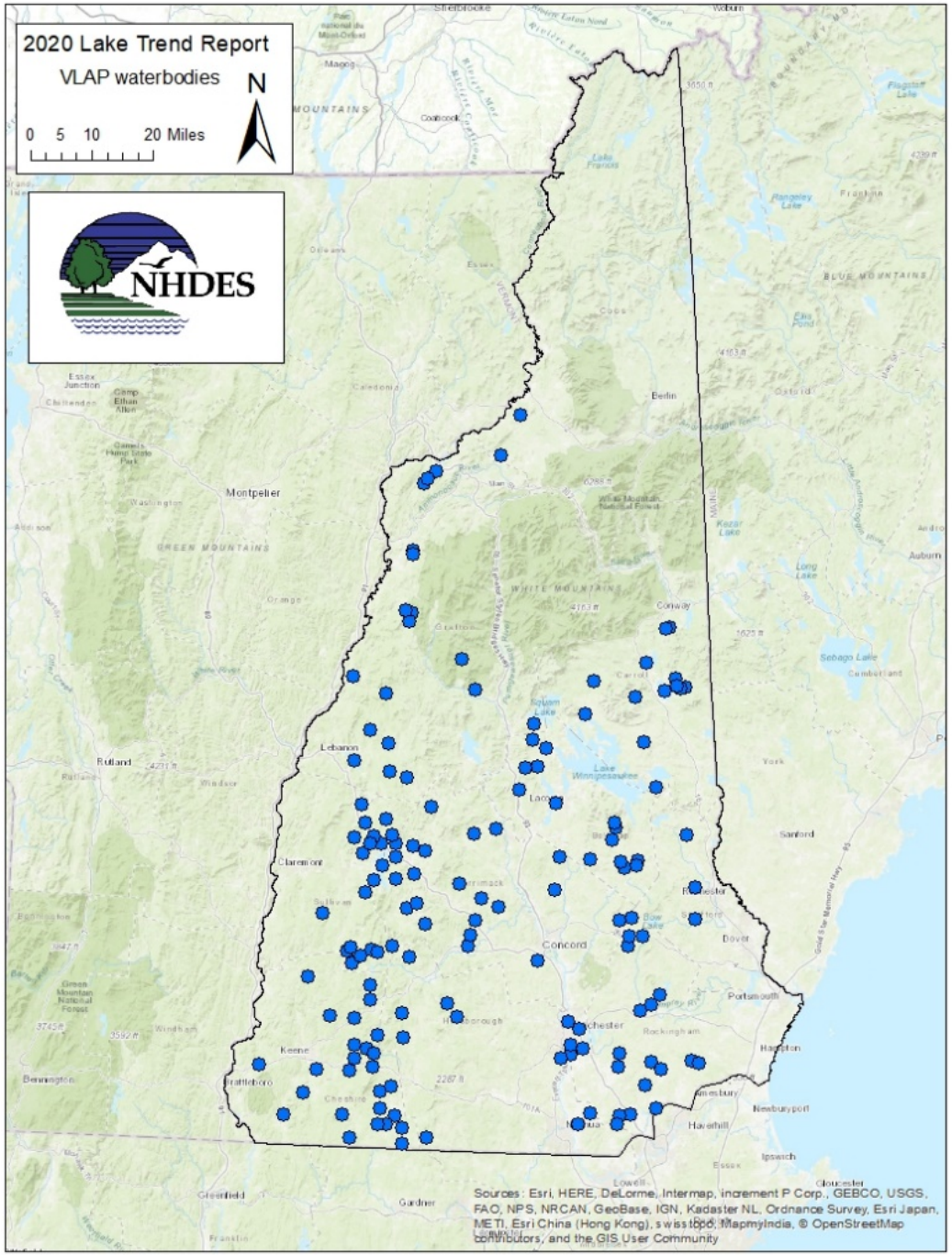
- Part of the "Trend" design element of the NHDES water monitoring strategy
- First-of-its-kind report scheduled to be issued every 5 years
- Relies heavily on volunteer monitoring data.
- Provides a robust analysis of lake water quality on three time scales
- Regional and waterbody-specific analysis completed

A huge **THANK YOU** to all volunteers that contributed to the collection of the data and financial support for processing samples. And, of course, our tireless VLAP coordinator, Sara Steiner.

Volunteer Lake Assessment Program (VLAP)

- Initiated 1985
- ~500 volunteers for 170 lakes
- Trains volunteers to collect high quality data

- 150 lakes & ponds used in these analyses
- Minimum 10 years of data
- 1991 – 2018
- Long-term datasets are extremely valuable!



Water Monitoring Strategy Parameters

Primary Indicator

- Bacteria (E. coli)
- Chlorophyll-a
- Cyanobacteria
- Exotic aquatic plants
- pH
- Secchi depth
- Specific conductance
- Total phosphorus

Accessory Indicator

- Alkalinity
- Dissolved oxygen
- Ice in/out records
- Water temperature

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How Healthy Are Our Lakes?

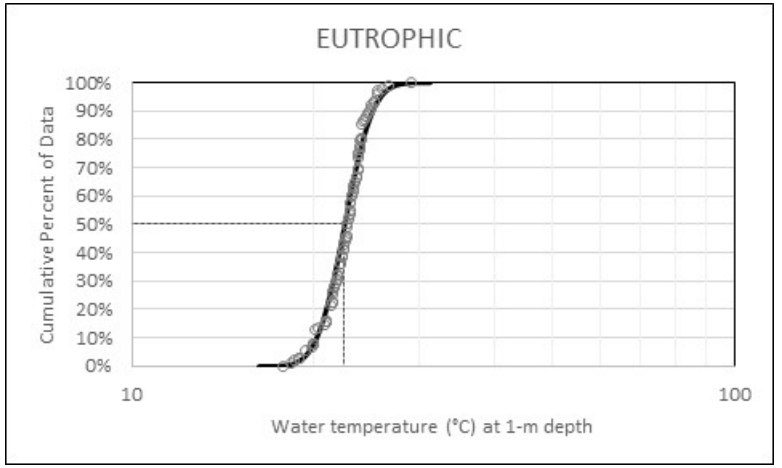

Chlorophyll-a
Secchi Depth
How Healthy Are Our Lakes?
Total Phosphorus
Water Temperature
Specific Conductance

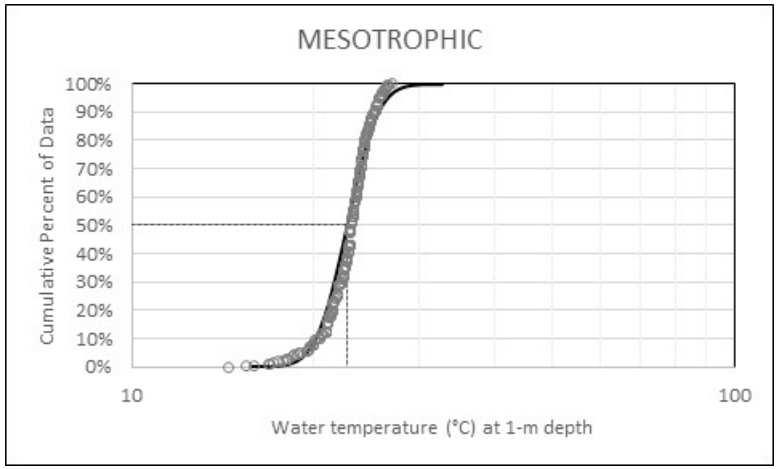

Oligotrophic
Mesotrophic
How Healthy Are Our Lakes?
Eutrophic

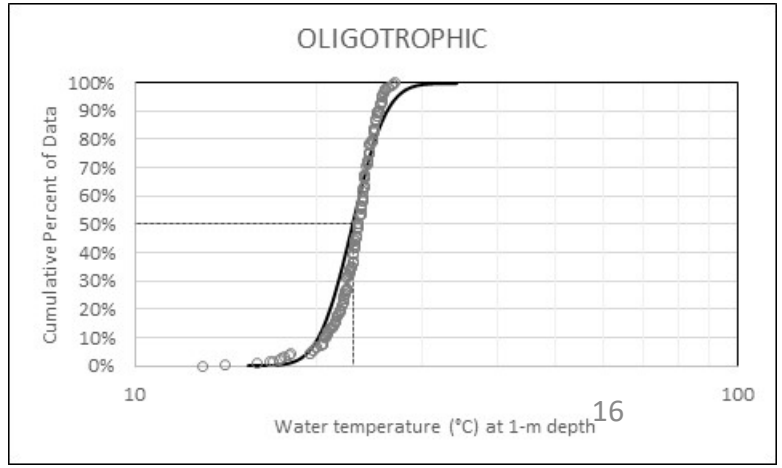

Current Condition
Long Term Trend
How Healthy Are Our Lakes?
Short Term Change

Current Condition

- Statewide frequency distribution by trophic class
- All available lake data, 1991 – 2018
- Determine percentiles
  - < 25th percentile
  - > 75th percentile





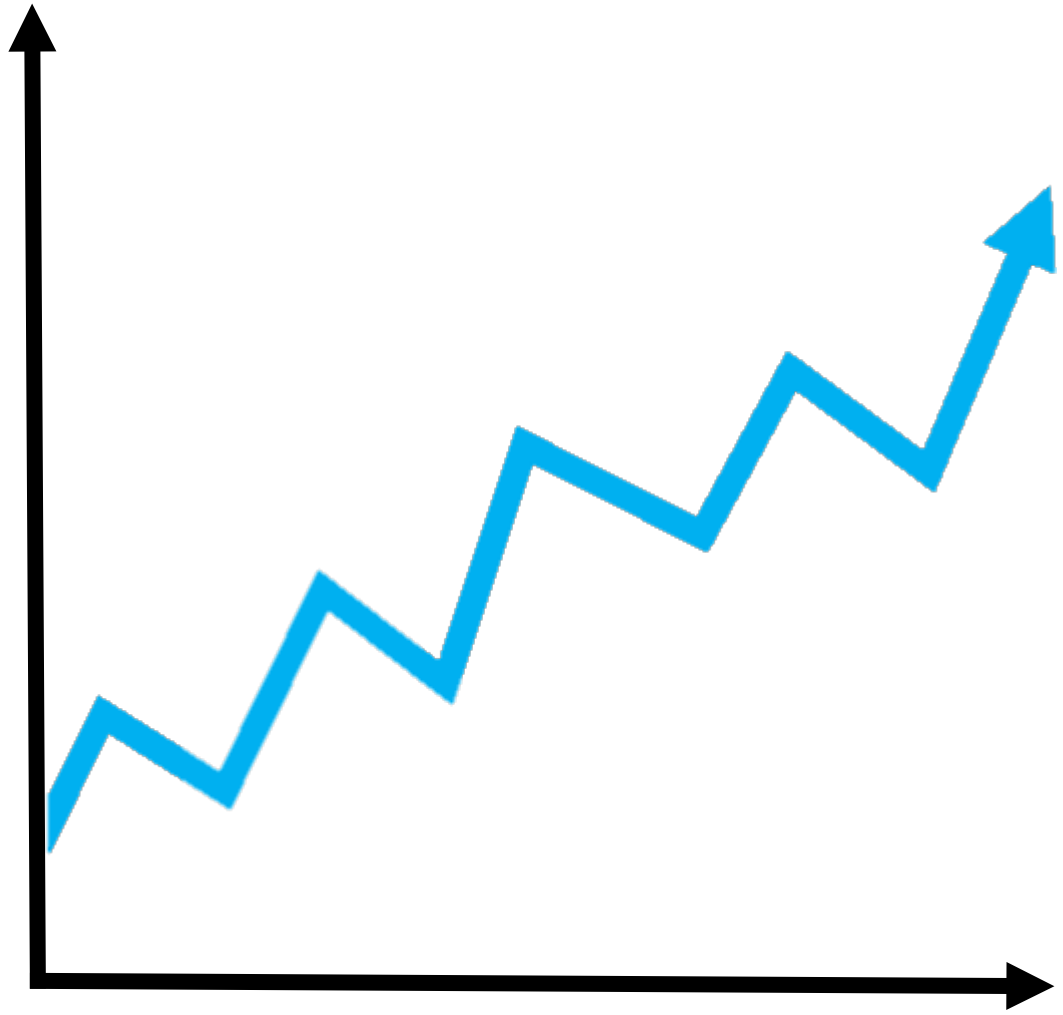


Massasecum Lake, Bradford

Percentiles				
Chlorophyll-a	Secchi Depth	Specific Conductance	Total Phosphorus	Water Temperature
24.8	**94.5**	38.2	**8.1**	57.9

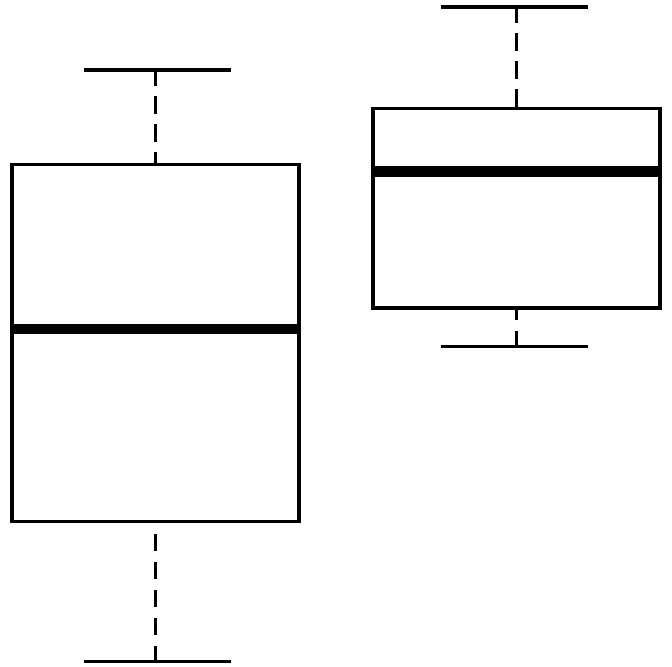
Long-Term Trend

- Annual medians, 1991 - 2018
  - Individual waterbody & trophic class
- Mann Kendall non-parametric trend test
  - ≥ 5 waterbodies/year
- Significance at $p < 0.05$

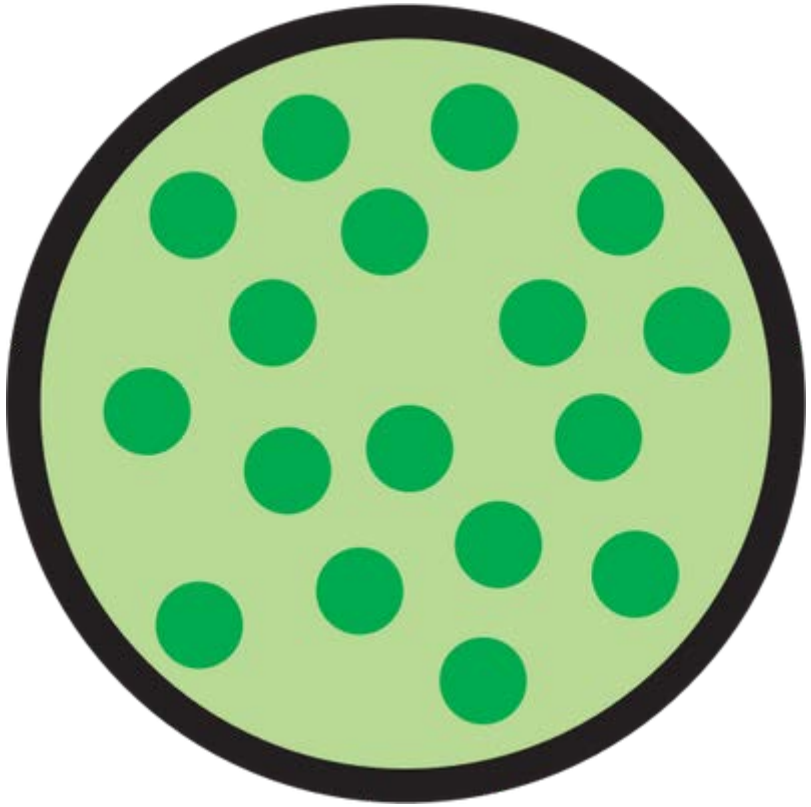


Short-Term Change

- Data from Group 1 (2009 – 2013) vs. Group 2 (2014 – 2018)
- Wilcoxon Rank Sum Test (a.k.a. Mann-Whitney U Test)
- Significance at $p < 0.05$
- Early warning sign
- Fewer waterbodies used



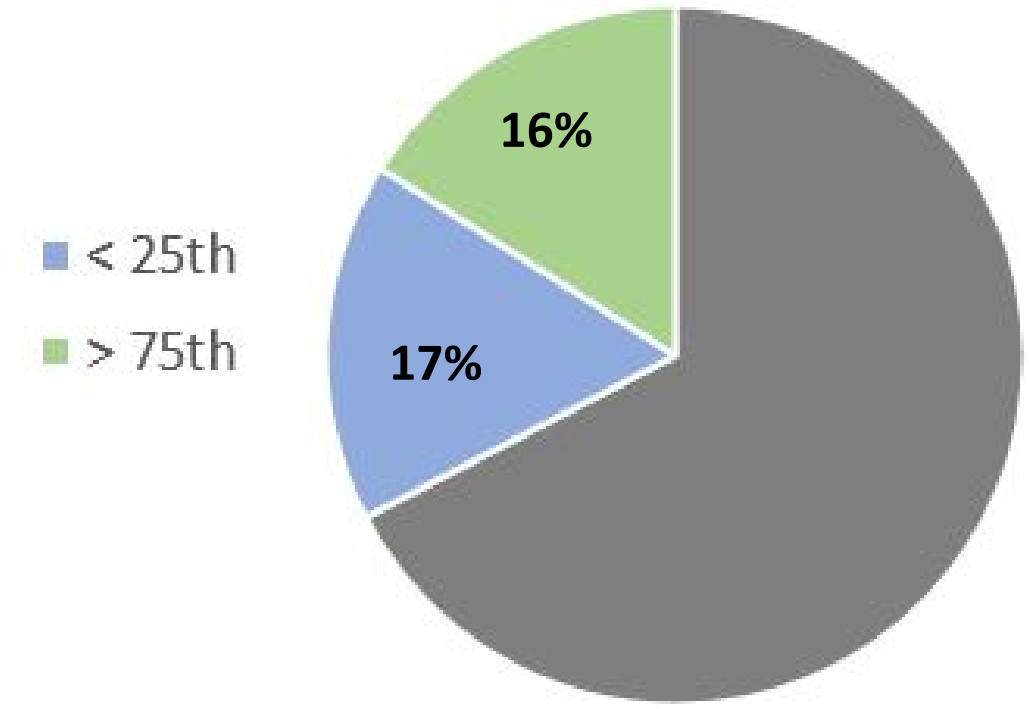
Chlorophyll-a



- A photosynthetic pigment found in plants
- Measure of the abundance of suspended algae.
- Affected by light, nutrient availability, & temperature
- Different levels expected for different trophic classes
  - Oligotrophic: ≤ 3.3 µg/L
  - Mesotrophic: ≤ 5 µg/L
  - Eutrophic: ≤ 11 µg/L

Chlorophyll-a

Current Condition

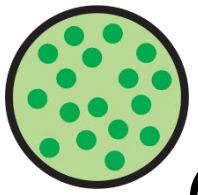


The very lowest percentiles:

- Pillsbury Lake, Webster
- Granite Lake, Stoddard
- Nubanusit Lake, Hancock
- Conner Pond, Ossipee

The very highest percentiles:

- Perkins Pond, Sunapee
- Warren Lake, Alstead
- Robinson Pond, Hudson
- Sebbins Pond, Bedford



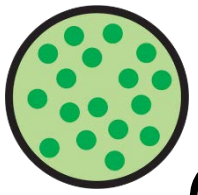
Chlorophyll-a

Long Term Trend (1991 – 2018)

- No trends by trophic class
- 3.3% (5 waterbodies) increased
- 13.3% (20 waterbodies) decreased

Short Term Change (2009 – 2018)

- 3.4% (4 waterbodies) increased (current > previous)
- 10.3% (12 waterbodies) decreased (current < previous)



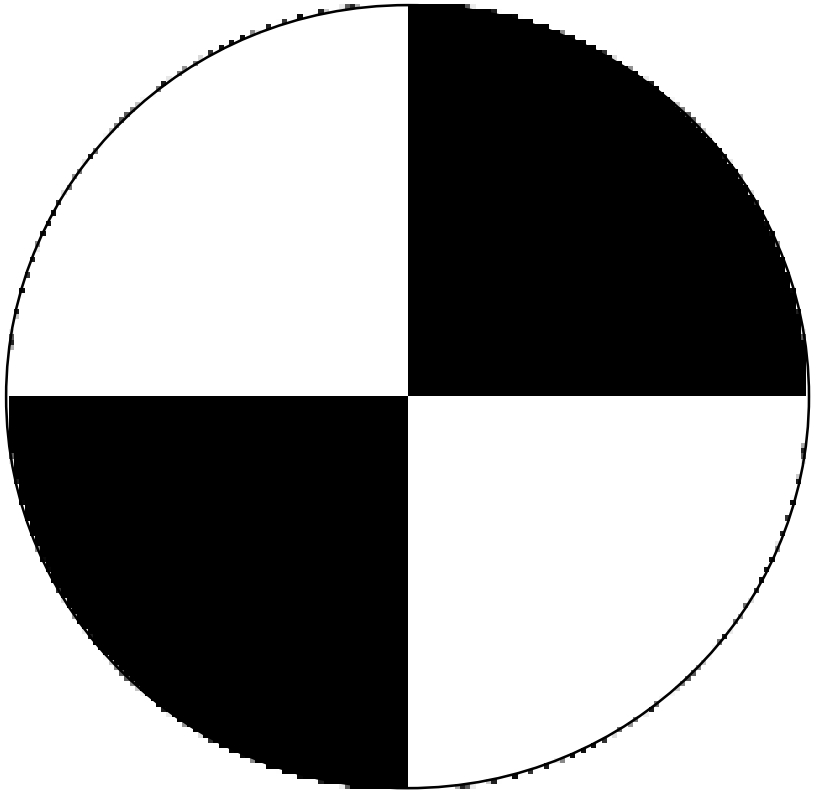
Chlorophyll-a

What is causing the changes?

- Total Phosphorus
  - Pet waste, Septic, Lawn fertilizer, Stormwater run-off

- Lake Browning
  - Increases in Dissolved Organic Carbon (DOC) can make water darker, inhibiting light availability
    - DOC increases have been attributed to acid rain recovery and increases in extreme weather events

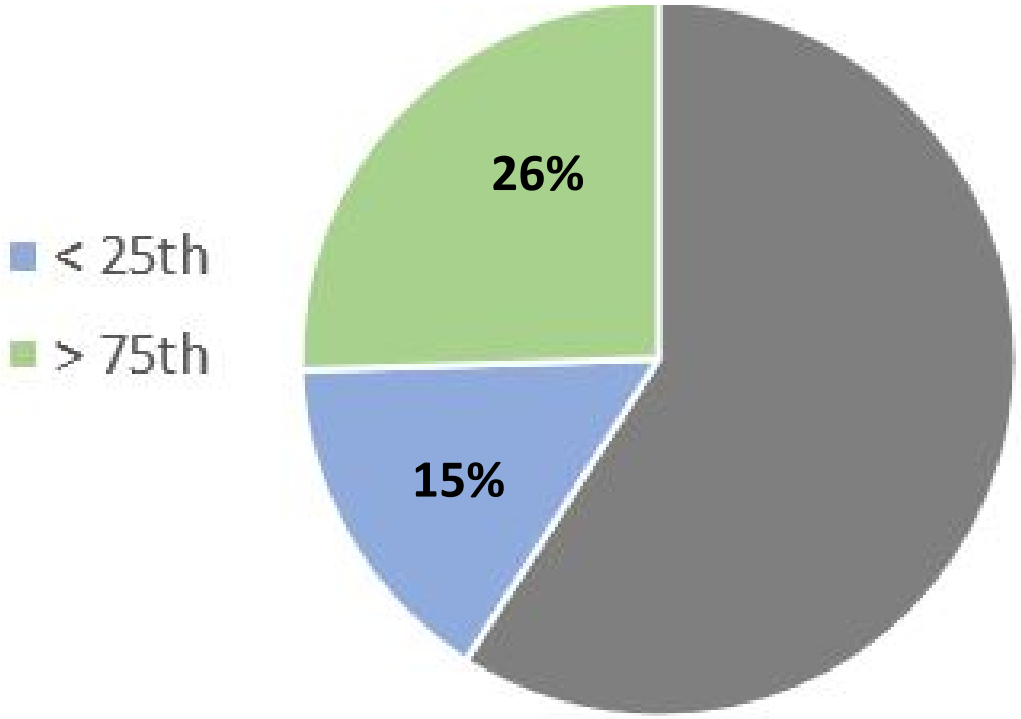
Secchi Depth



- A measure of water clarity
- Affected by suspended algae, type of sediment deposits, watershed land use, & exposure to acid rain
- Different levels expected for different trophic classes
  - Oligotrophic: > 4 meters
  - Mesotrophic: 1.8 – 4 meters
  - Eutrophic: < 1.8 meters

Secchi Depth

Current Condition



The very lowest percentiles:

- Dutchman Pond, Springfield
- Perkins Pond, Sunapee
- Warren Lake, Alstead
- Dorrs Pond, Manchester
- Sunrise Lake, Middleton

The very highest percentiles:

- Hermit Lake, Sanbornton
- Lake Winona, Center Harbor
- Nubanusit Lake, Hancock
- Conner Pond, Ossipee

Secchi Depth

Long Term Trend (1991 – 2018)

- Significantly decreasing trend for mesotrophic & oligotrophic classes
- 2.0% (3 waterbodies) increased
- 16.1% (24 waterbodies) decreased

Short Term Change (2009 – 2018)

- 6.1% (7 waterbodies) increased (current > previous)
- 4.4% (5 waterbodies) decreased (current < previous)

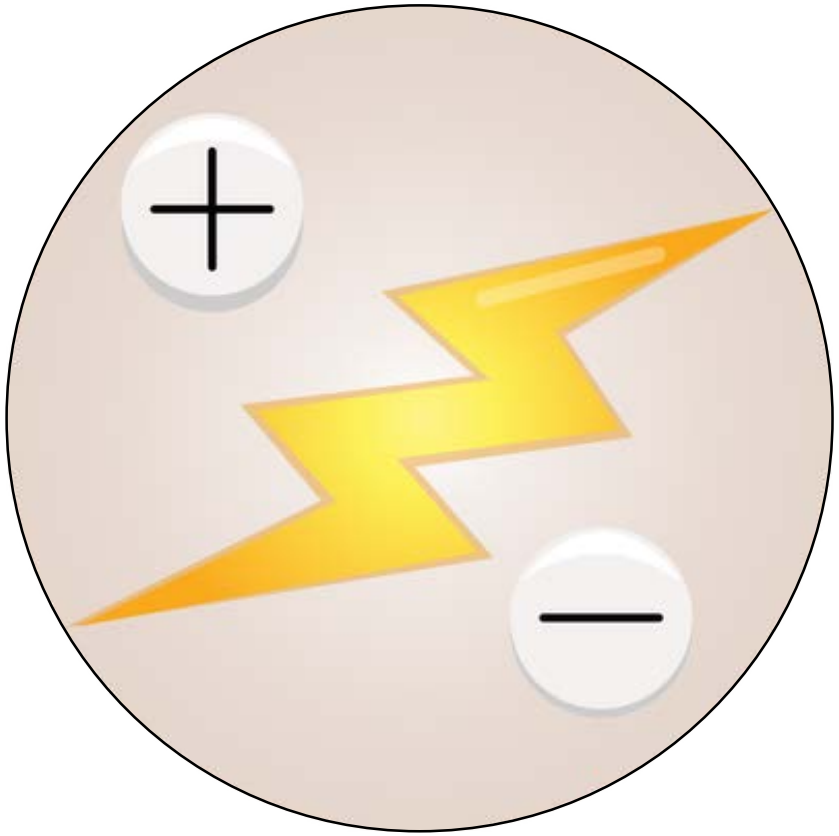
Secchi Depth

What is causing the changes?

- Algae & Sediment
  - Stormwater run-off, excess nutrient load can cause issues

- Lake Browning
  - Increases in Dissolved Organic Carbon (DOC) can make water darker, inhibiting light availability
    - DOC increases have been attributed to acid rain recovery and increases in extreme weather events

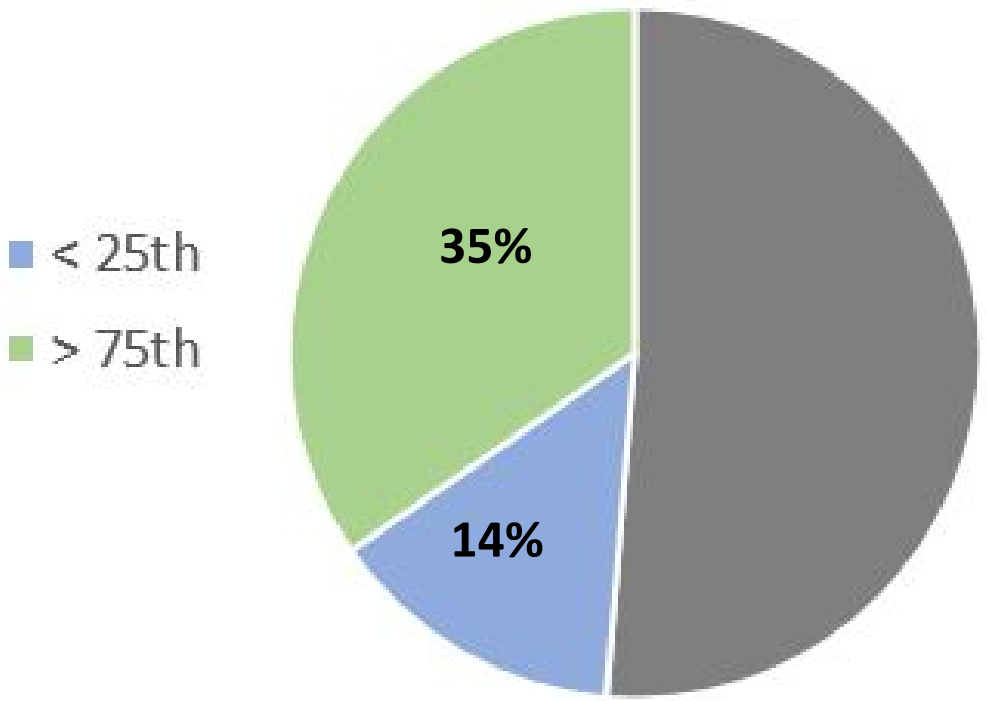
Specific Conductance



- A measure of water's ability to conduct electricity
- Affected by road salts, fertilizers, other chemical compounds & local geology
- NH in-lake specific conductance tends to be low (< 50 µS/cm)
- Higher levels associated with urbanized watersheds & greater road density
- Chloride can be toxic to aquatic life

Specific Conductance

Current Condition



The very lowest percentiles:

- Ledge Pond, Sunapee
- Long Pond, Lempster
- Reservoir Pond, Dorchester
- Nubanusit Lake, Hancock
- Conner Pond, Ossipee

The very highest percentiles:

- Canobie Lake, Salem
- Cobbetts Pond, Windham
- Dorrs Pond, Manchester
- Nutt Pond, Manchester
- Stevens Pond, Manchester

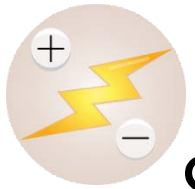
Specific Conductance

Long Term Trend (1991 – 2018)

- Significantly increasing trend for mesotrophic & eutrophic classes
- 41.3% (62 waterbodies) increased
- 8.0% (12 waterbodies) decreased

Short Term Change (2009 – 2018)

- 79.8% (95 waterbodies) increased (current > previous)
- 0% (0 waterbodies) decreased (current < previous)

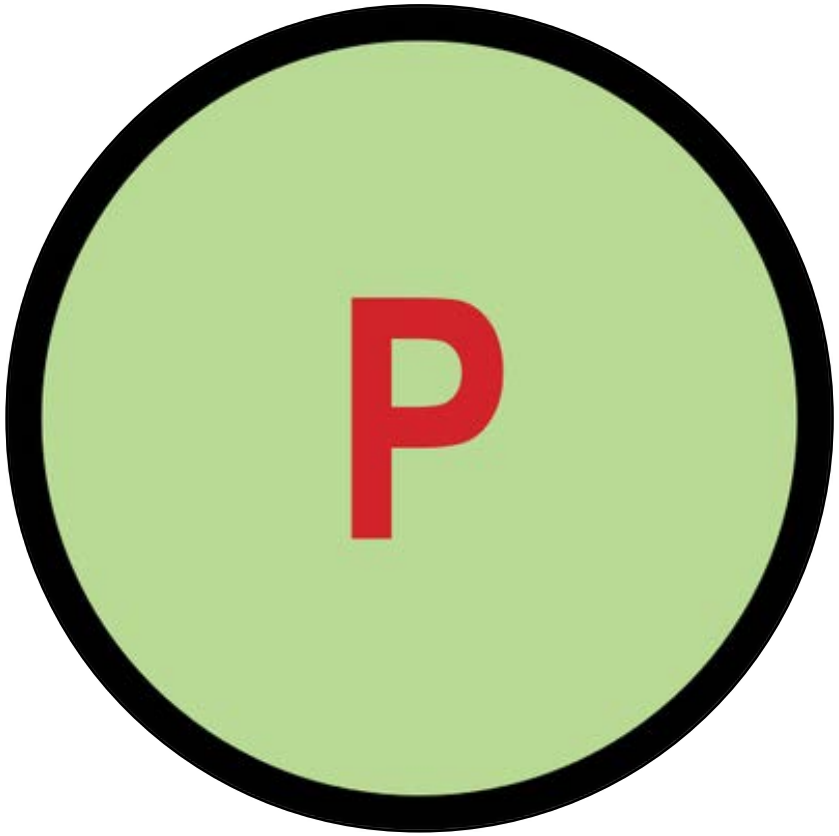


Specific Conductance

What is causing the changes?

- Road salt
  - 18 -23 million metric tons per year (Dugan et al. 2017, USGS 2010)
  - Increasing chloride levels throughout the Northeast
  - No natural process by which salt is broken down
- Water softeners
- Balance of safety vs overuse

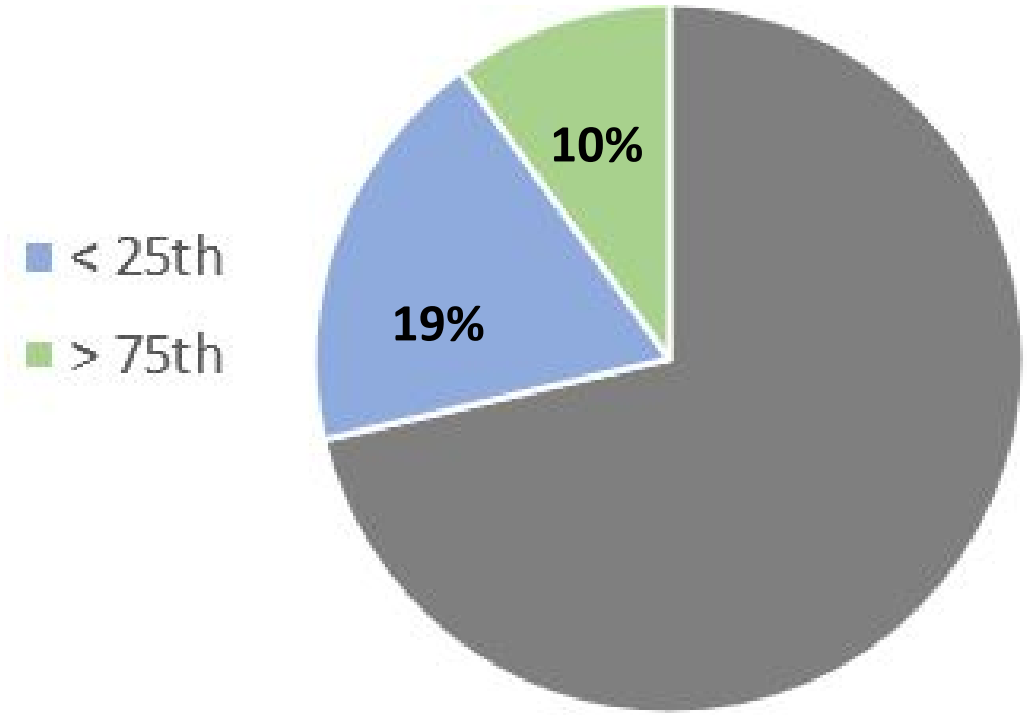
Total Phosphorus



- Limiting nutrient for aquatic plants and algae in NH
- Affected by natural (type of sediment deposits) & anthropogenic (watershed land use, fertilizers, septic systems) sources
- Different levels expected for different trophic classes
  - Oligotrophic: < 8 µg/L
  - Mesotrophic: ≤ 12 µg/L
  - Eutrophic: ≤ 28 µg/L

Total Phosphorus

Current Condition



The very lowest percentiles:

- Hermit Lake, Sanbornton
- Dublin Pond, Dublin
- Silver Lake, Harrisville
- Conner Pond, Ossipee
- Moores Pond, Tamworth

The very highest percentiles:

- Locke Lake, Barnstead
- Dorrs Pond, Manchester
- Governors Lake, Raymond

P

Total Phosphorus

Long Term Trend (1991 – 2018)

- Significantly increasing trend for eutrophic class
- 4.0% (6 waterbodies) increased
- 7.3% (11 waterbodies) decreased

Short Term Change (2009 – 2018)

- 4.2% (5 waterbodies) increased (current > previous)
- 5.9% (7 waterbodies) decreased (current < previous)

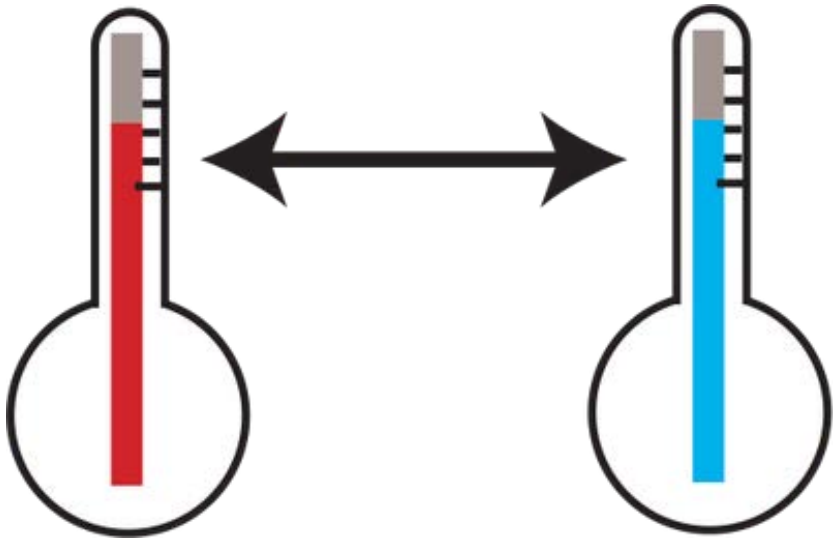
Total Phosphorus

What is causing the changes?

- Human activity often linked with increases in Total Phosphorus
  - Stormwater run-off, fertilizers, septic systems
  - Increases can fuel algal blooms

- Decreases are associated with better land management practices
  - Shoreland Water Quality Protection Act (SWQPA)
    - Prohibits fertilizer use within 25 feet of public waters
    - From 25 to 250 feet, only slow or controlled release fertilizer may be used
    - Native vegetation within 50 feet of public waters may not be converted to lawn
    - From 50 to 150 feet, at least 25% of native vegetation must be left intact

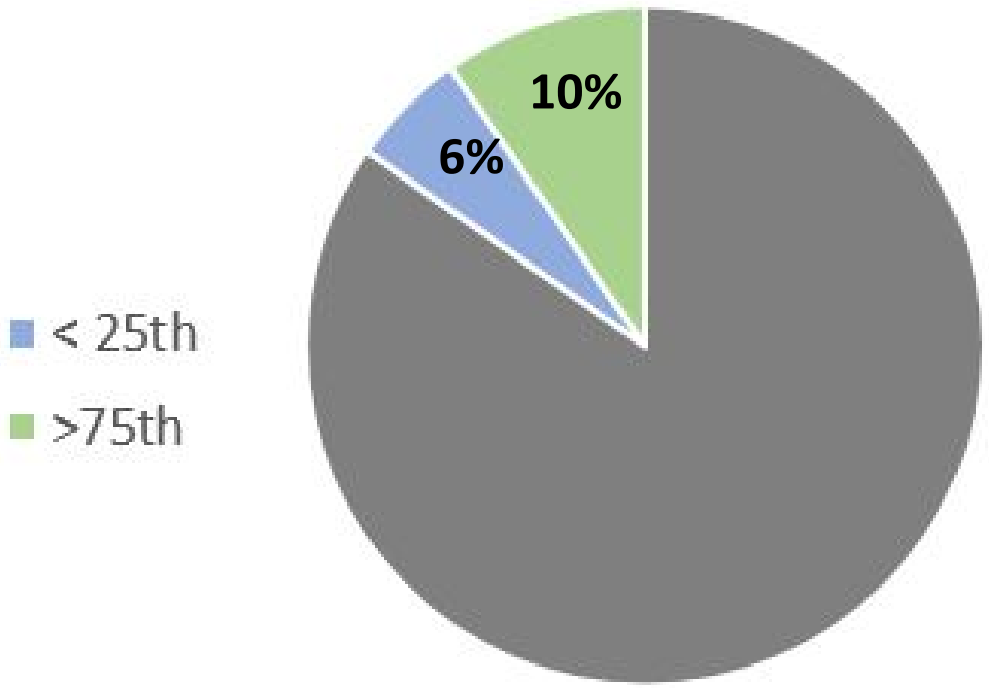
Water Temperature



- 1-meter below the surface
- Affected by air temperature, water clarity, & global climate patterns
- Affects dissolved oxygen levels, metabolic rates, nutrient cycling, & stratification

Water Temperature

Current Condition

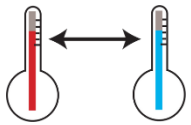


The very lowest percentiles:

- Armington Lake, Piermont
- Lake Katherine, Piermont
- Lake Tarleton, Piermont
- Russell Reservoir, Harrisville

The very highest percentiles:

- Canobie Lake, Salem
- Crystal Lake, Manchester
- Onway Lake, Raymond



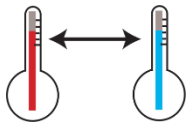
Water Temperature

Long Term Trend (1991 – 2018)

- Significantly increasing trend for mesotrophic & oligotrophic classes
- 18.1% (26 waterbodies) increased
- 1.4% (2 waterbodies) decreased

Short Term Change (2009 – 2018)

- 4.9% (2 waterbodies) increased (current > previous)
- 0% (0 waterbodies) decreased (current < previous)



Water Temperature

What is causing the changes?

- Increases in air temperature
  - Increased by almost 2° F from 1895 to 2011 (Kunkel et al. 2013)

- Lake browning
  - Increases in Dissolved Organic Carbon (DOC) can make water darker, absorbing heat
    - DOC increases have been attributed to acid rain recovery and increases in extreme weather events

Summary of Results

Chlorophyll-a

- More waterbodies decreasing than increasing

Secchi Depth

- Decreasing (becoming more shallow) for oligotrophic & mesotrophic classes

Specific Conductance

- Increasing for mesotrophic & oligotrophic classes
- Rapidly changing - ~80% waterbodies increased in last 10 years

Total Phosphorus

- Increasing for eutrophic class but overall few changes

Water Temperature

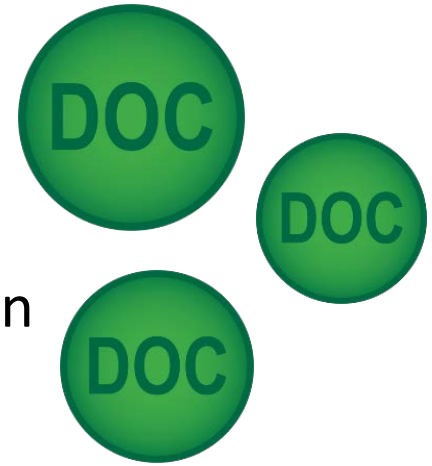
- Increasing for oligotrophic & mesotrophic classes
- More waterbodies increasing than decreasing

How Healthy Are Our Lakes?

Mostly!

…but changes are happening

Drivers of Change

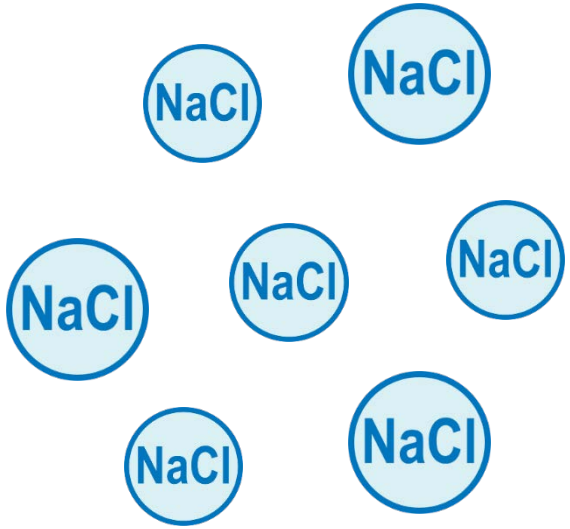


Lake Browning

- Increases in Dissolved Organic Carbon (DOC) can make water darker
- Recovery from acid rain & ongoing climate change

Salt

- Primarily from road salt
- Rapidly shifting



Climate Change

- More rain in less time
- Extreme events
- Warmer

How can I help?

- Reduce salt use!
- Shoreline buffers & stormwater management
- Volunteer
- Support water & climate-friendly policies

Resources

NH Lake Information Mapper
https://nhdes.maps.arcgis.com/apps/webappviewer/index.html?id=1f45dc20877b4b959239b8a4a60ef540

2020 Lake Trend Report

https://www.des.nh.gov/organization/divisions/water/wmb/documents/r-wd-20-08.pdf

Road Salt Reduction

https://www.des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/index.htm

Stormwater Management for Homeowners

https://www4.des.state.nh.us/SoakNH/

Climate Info

https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-nh.pdf

Questions?

Thanks to our many VLAP volunteers, VLAP interns, & Sara Steiner, VLAP coordinator!

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