Lake & Watershed Management Plans for Lakes Rippowam, Oscaleta and Waccabuc

Town of Lewisboro, Westchester County, NY

Michael R. Martin, CLM

Three Lakes Council Public Presentation – October 25, 2019

Background

- 2003
  - Initial investigations
- 2004
  - Lake and Watershed Management Plan
- 2004-Present
  - CSLAP Monitoring
  - Management Plan Implementation
- 2018-2019
  - Management Plan Update

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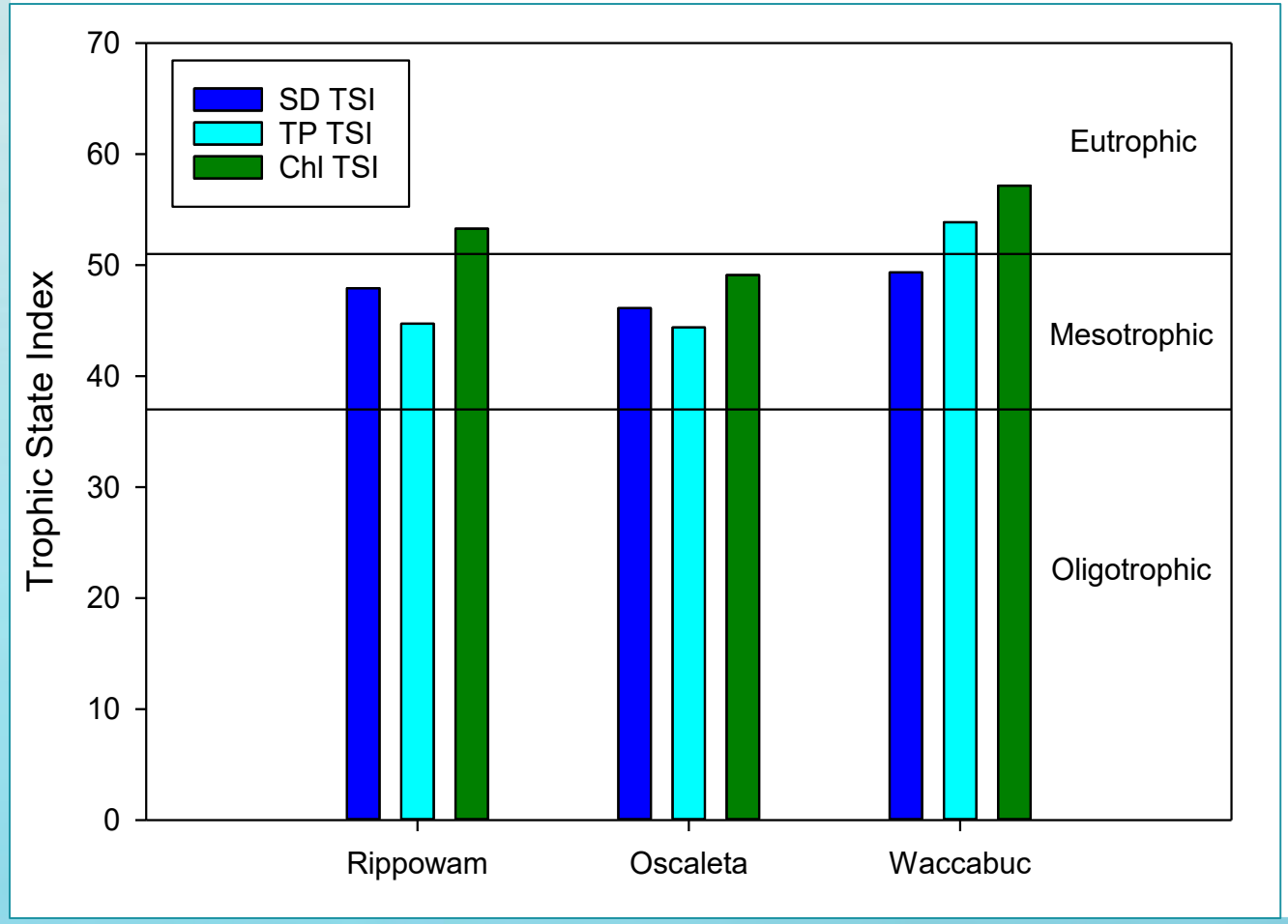
Problem Statement

- Excess Nutrients
- Hypolimnetic Anoxia
- Harmful Algal Blooms
- Excessive growth of aquatic macrophytes



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Scope of Work
Lake & Watershed Management Plan

- Review & Analyze Water Quality Data
- Watershed Investigation
  - On-site Watershed Survey
  - GIS Analysis of Watershed
- Update Nutrient Budgets
- Establish Management Goals & Lake Response Modeling
- Evaluate and Recommend Management Alternatives

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Selected Morphological Characteristics

Lake Characteristic	Lake Rippowam	Lake Oscaleta	Lake Waccabuc
Surface Area	**33.9 ac** 13.7 ha	**65.2 ac** 26.4 ha	**138.0 ac** 55.9 ha
Maximum Depth	**20 ft** 6.1 m	**36 ft** 10.8 m	**44 ft** 13.4 m
Mean Depth	**13.5 ft** 4.1 m	**19.4 ft** 5.9 m	**23.3 ft** 7.1 m
Lake Volume	150 million gallons 566,536.1 m^3	412 million gallons 1,557,959.9 m^3	3696 million gallons 13,990,063.4 m^3
Hypolimnion Volume	0.1 million gallons 456 m^3	61 million gallons 230,898 m^3	369 million gallons 1,398,107 m^3
Flushing Rate	**4.7 times/year**	**3.2 times/year**	**1.4 times/year**
Phosphorus Retention Coefficient	**0.48**	**0.48**	**0.55**

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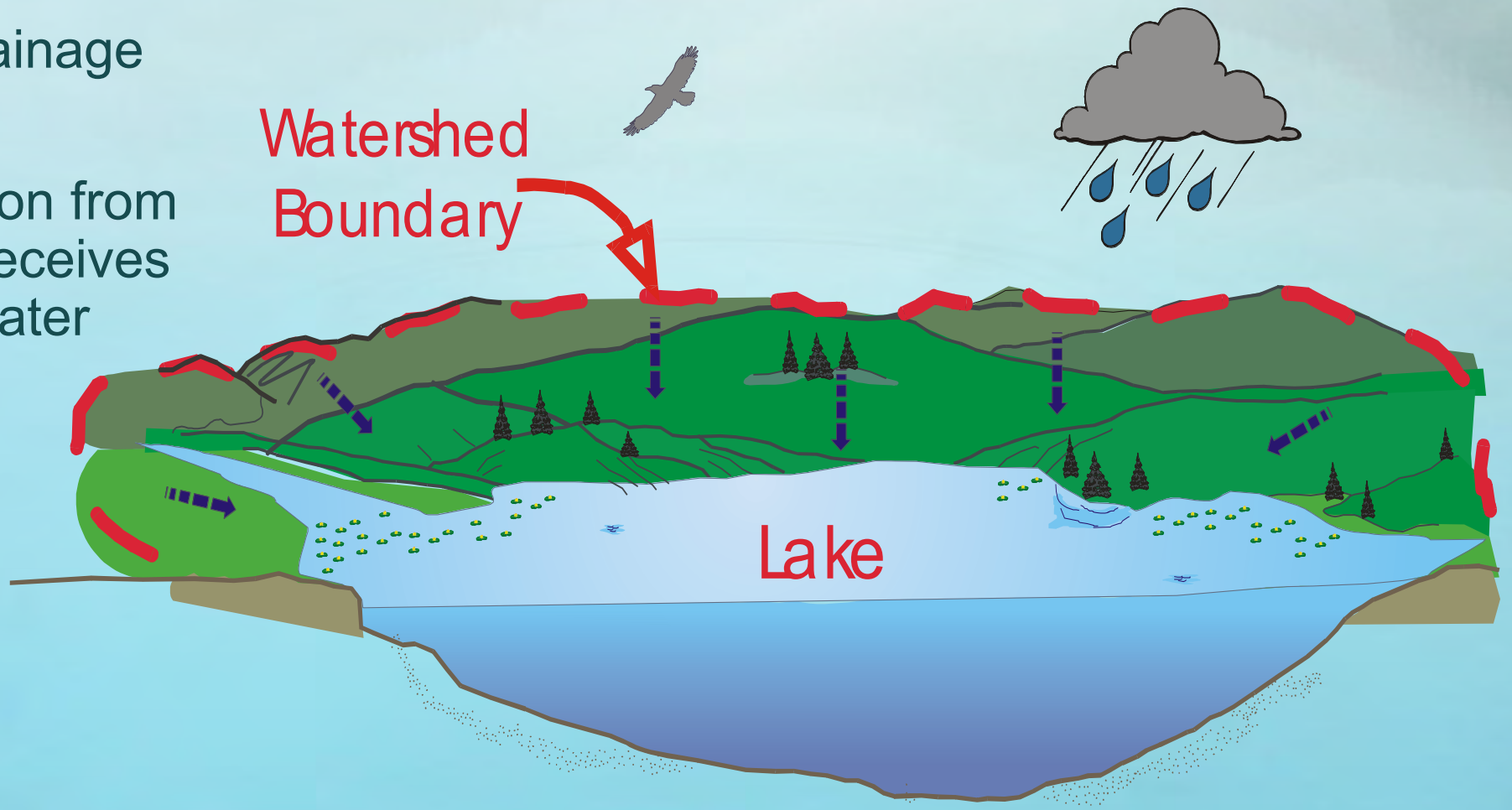
The Watershed

What is a watershed?

- the line of separation between two contiguous drainage valleys
- the whole region from which a lake receives its supply of water



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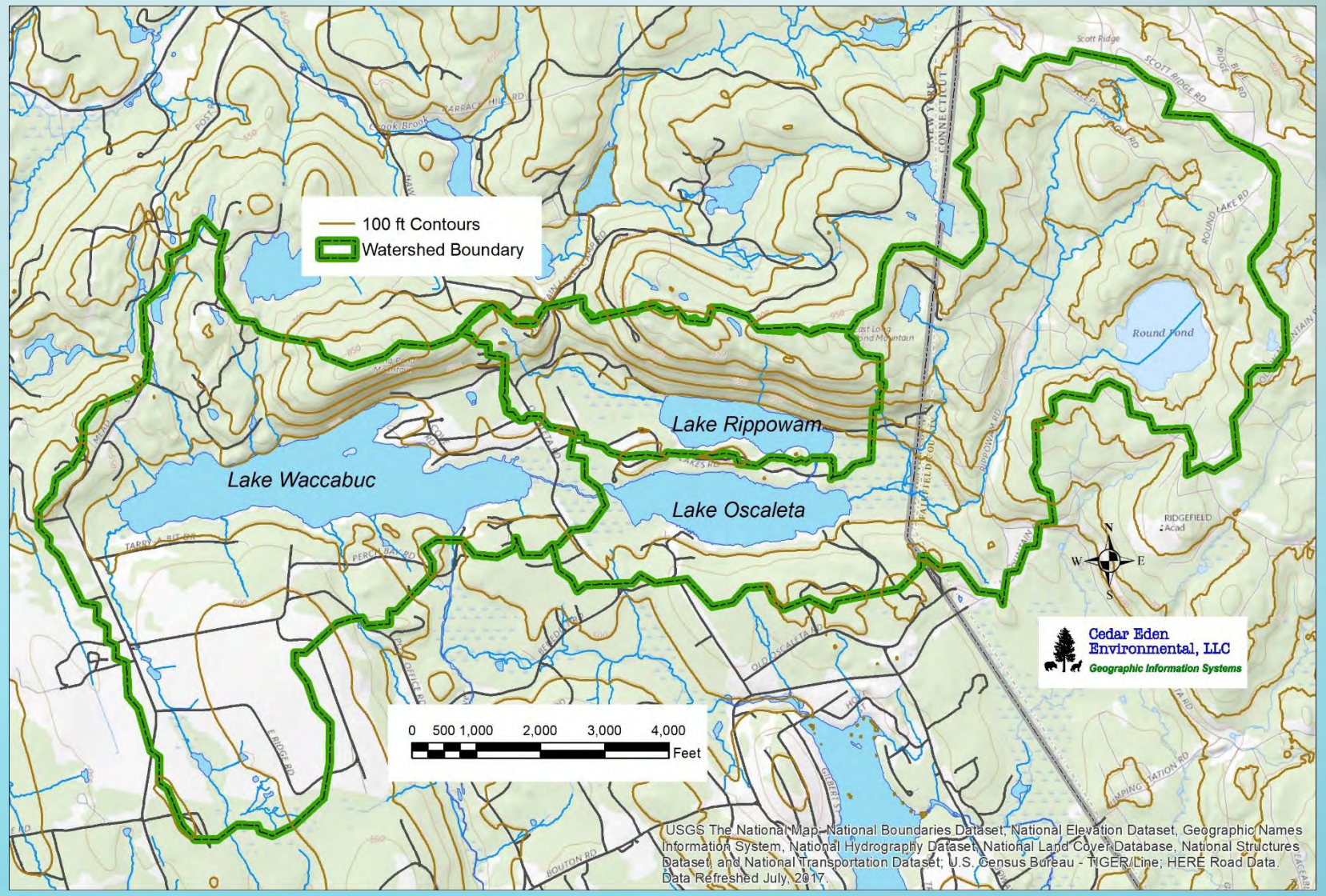
Watershed Characteristics

- Rippowam
  279 acres
- Oscaleta
  1,282 acres
- Waccabuc
  2,196 acres



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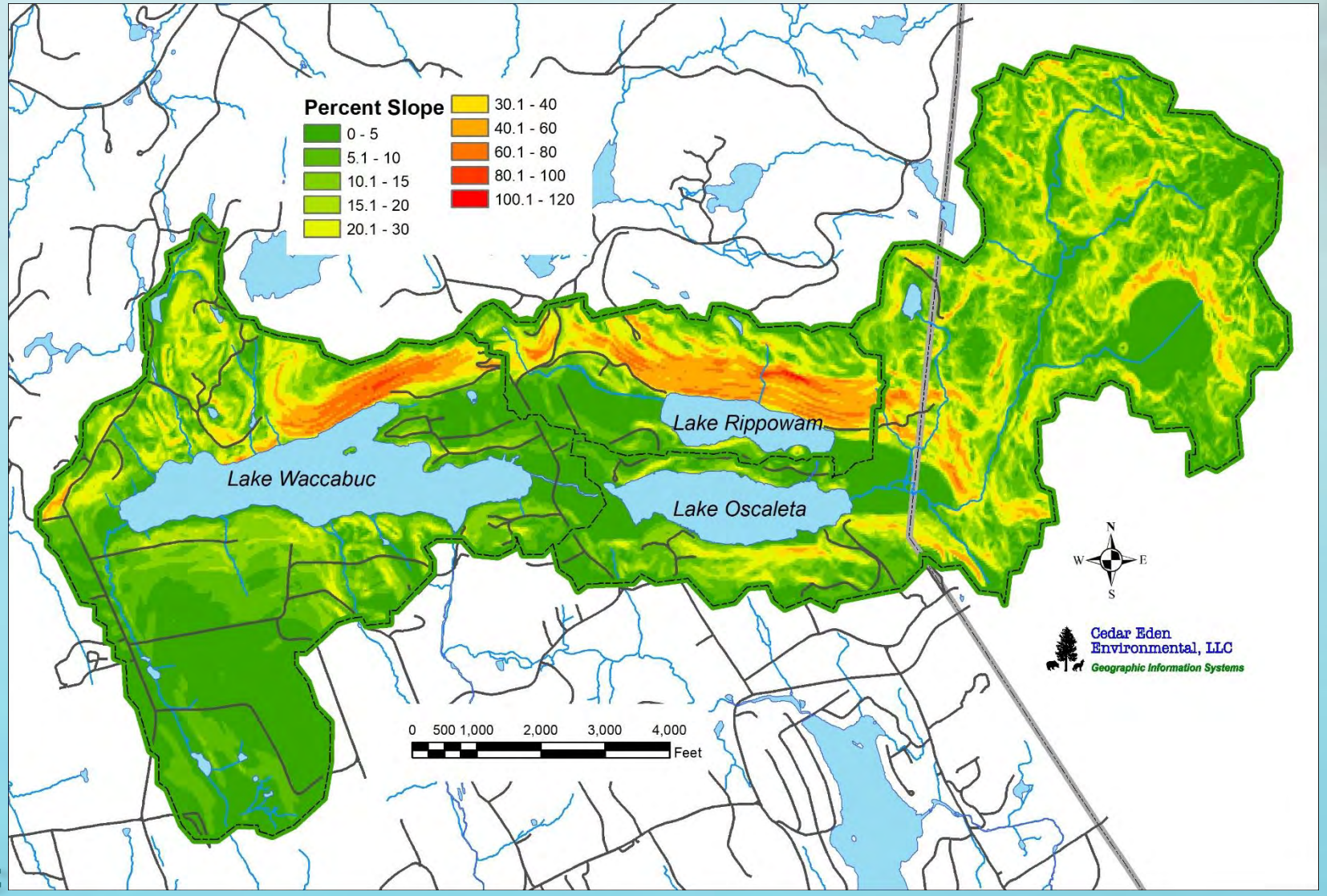
Topography



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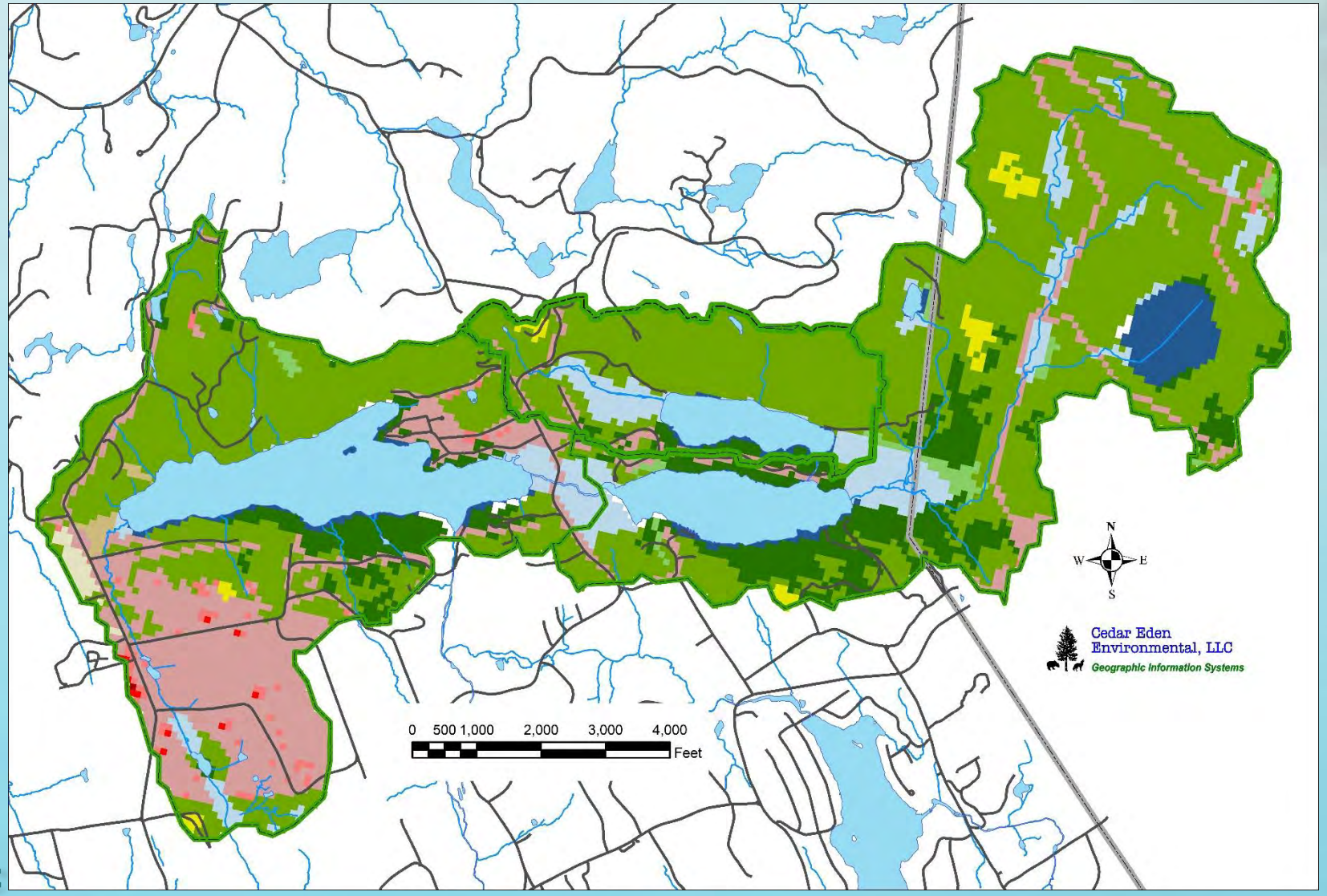
Land Use

2011 NLCD Land Cover

Land Use Class

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Woody Wetlands
- Emergent Herbaceous Wetlands



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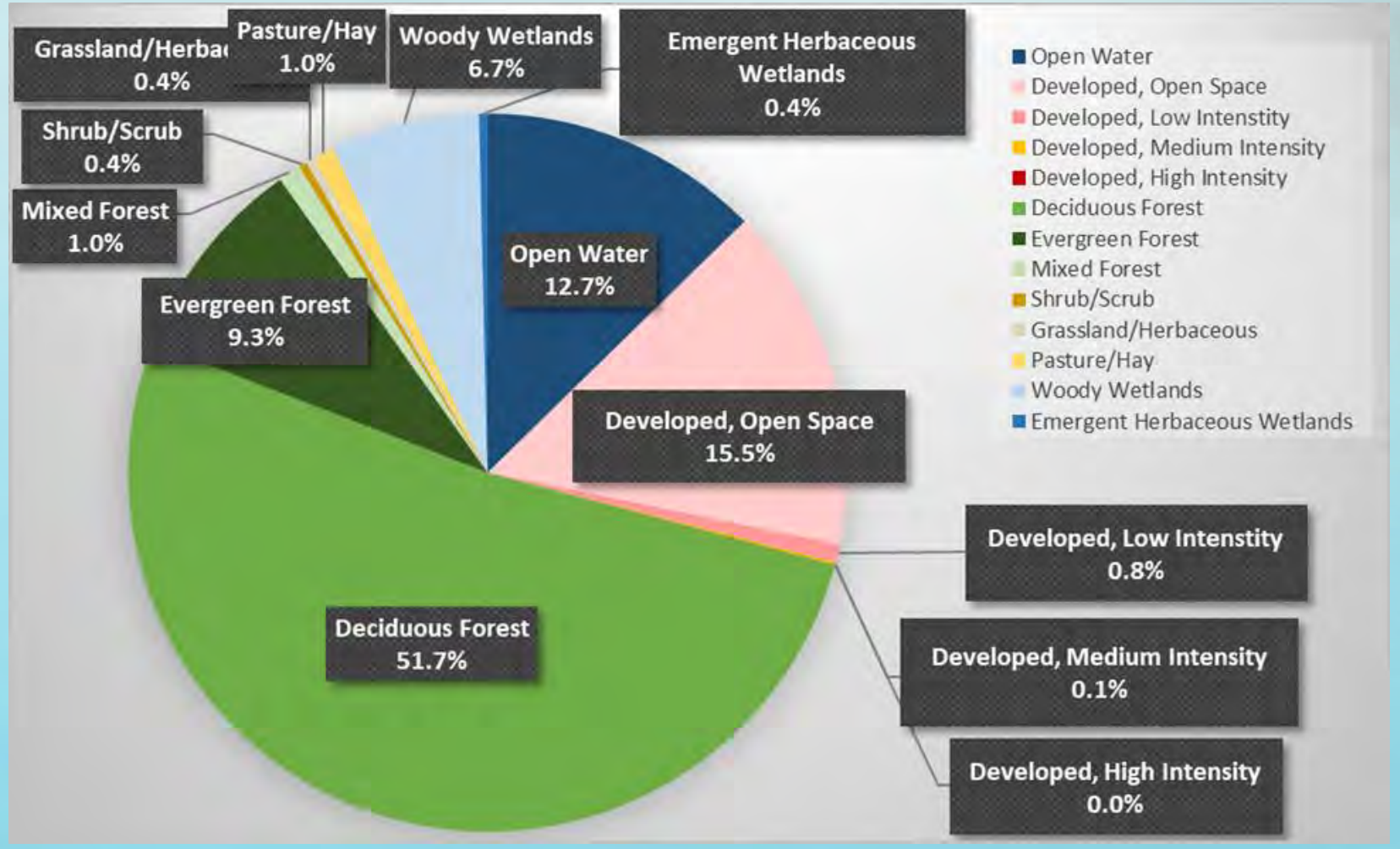
Land Use



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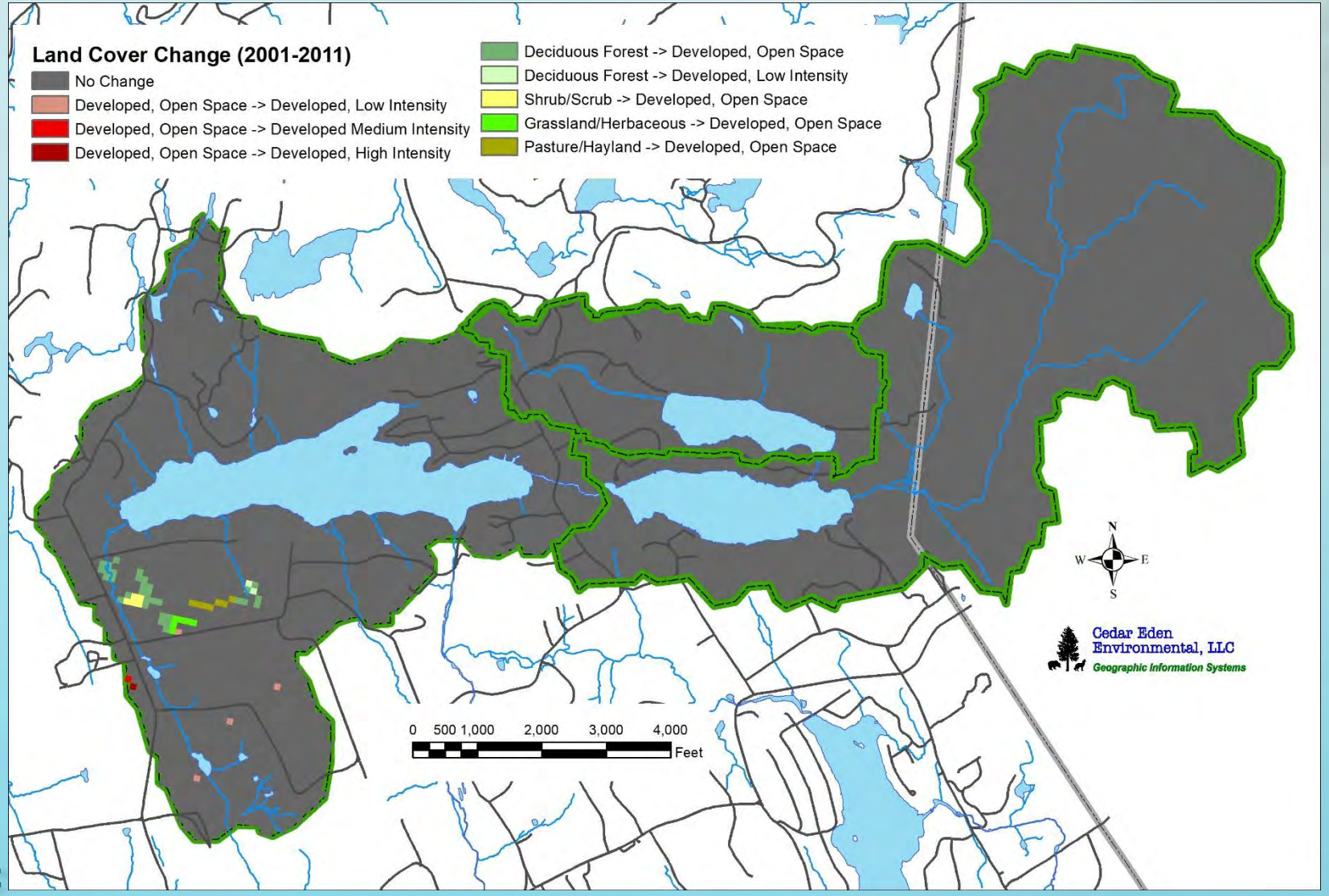
Land Use Change 2001-2011



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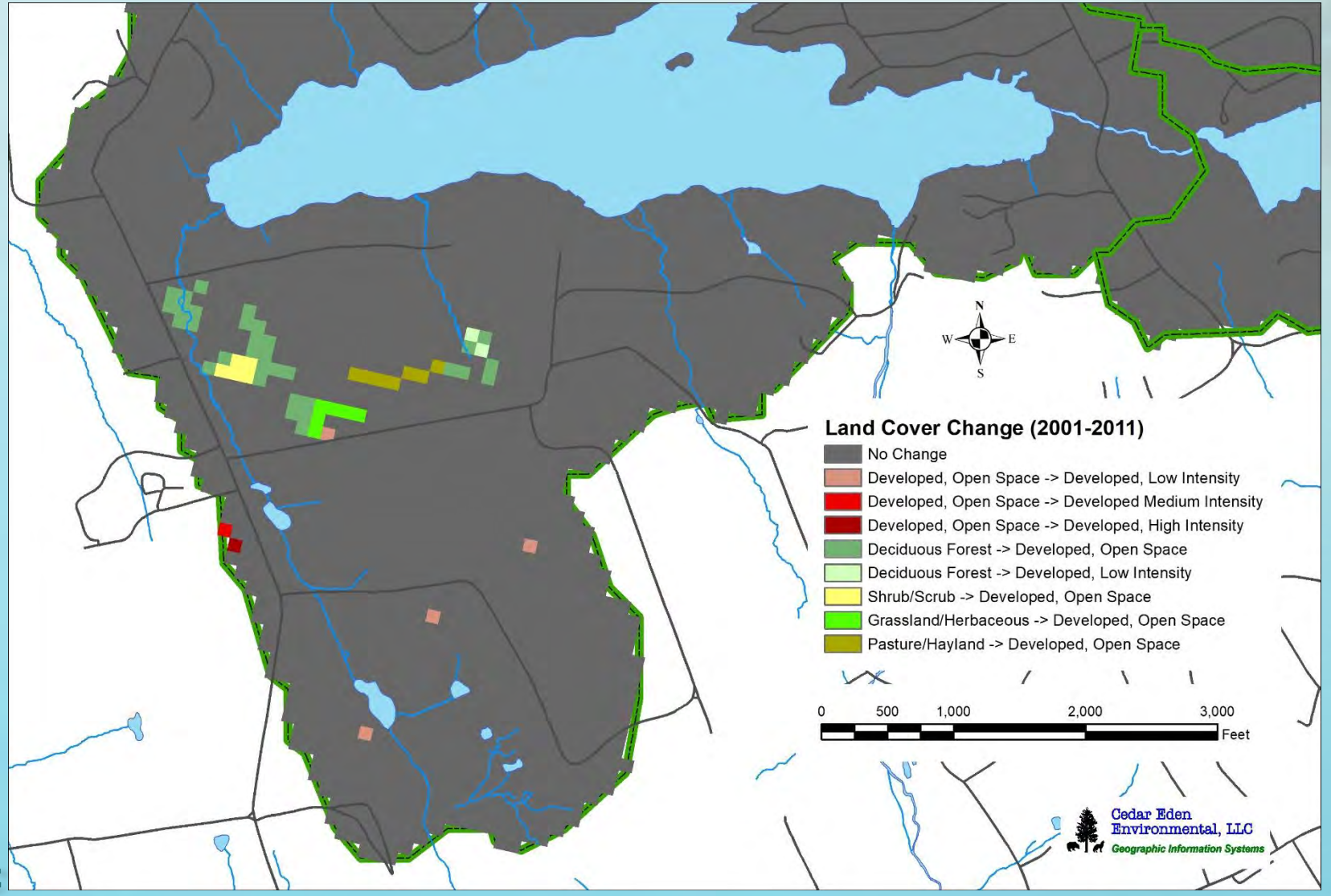
Land Use Change 2001-2011

- Approx. 13 acres



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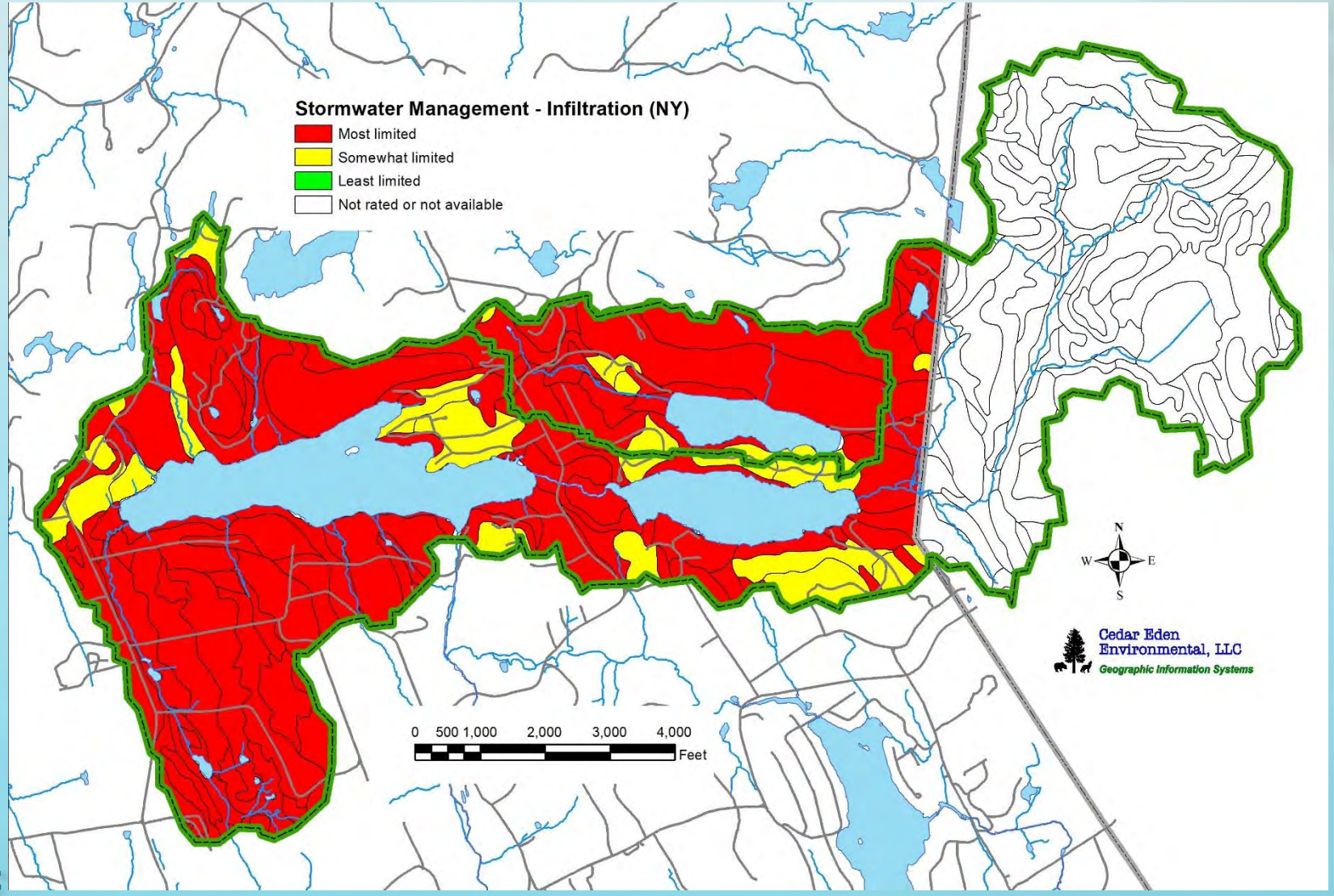
Soil Limitations for Stormwater Management



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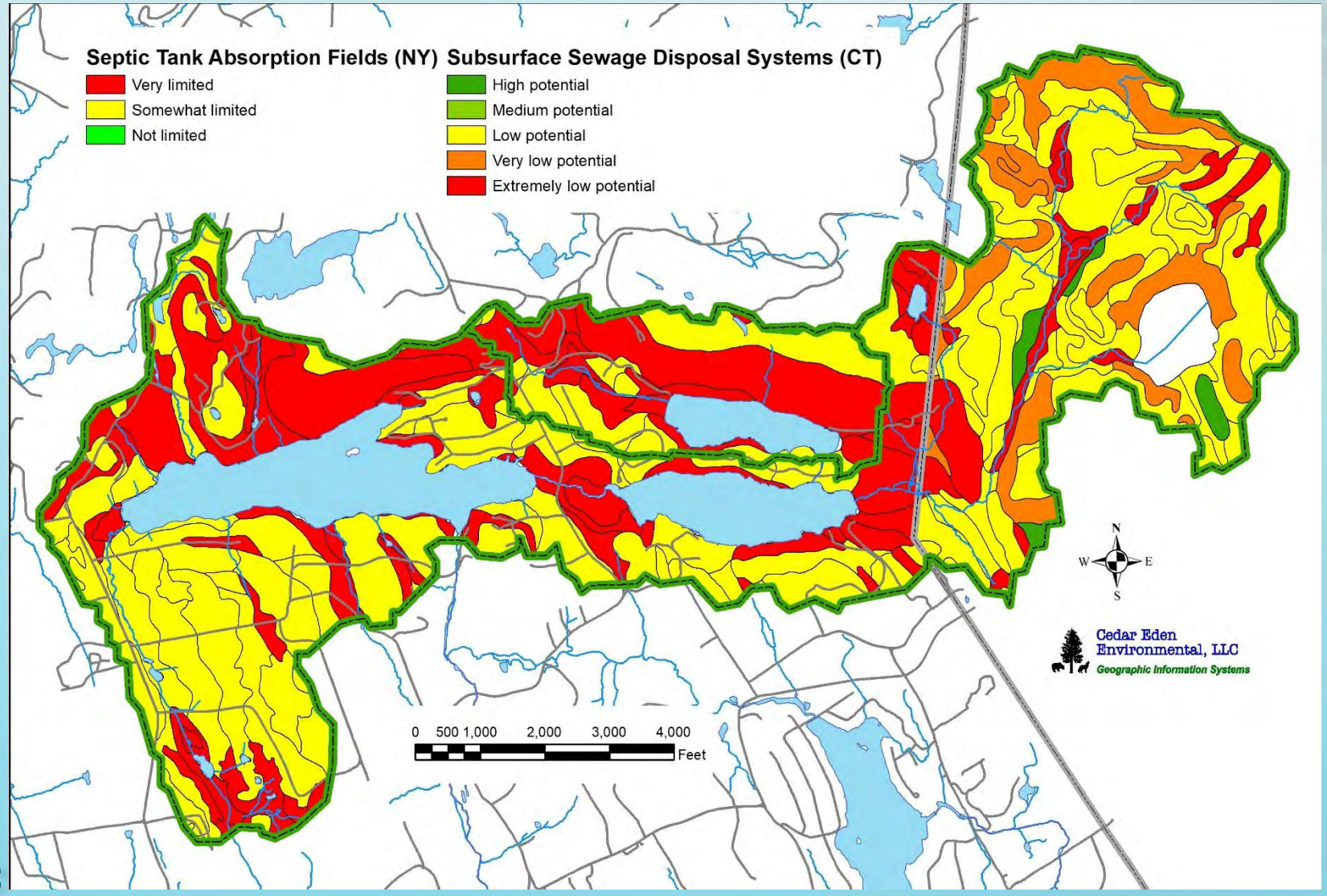
Soil Limitations for Septic Systems



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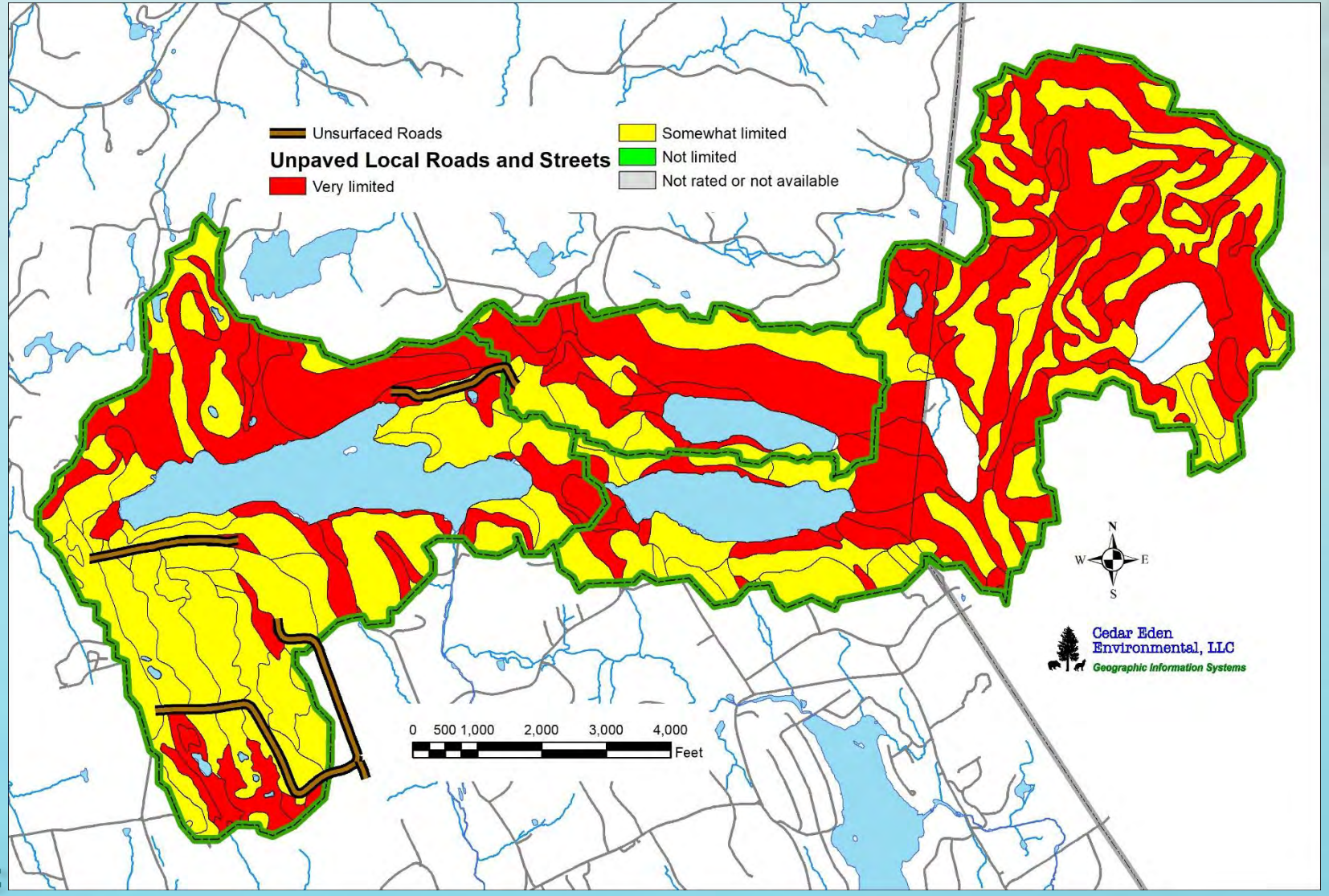
Soil Limitation for Unpaved Local Roads



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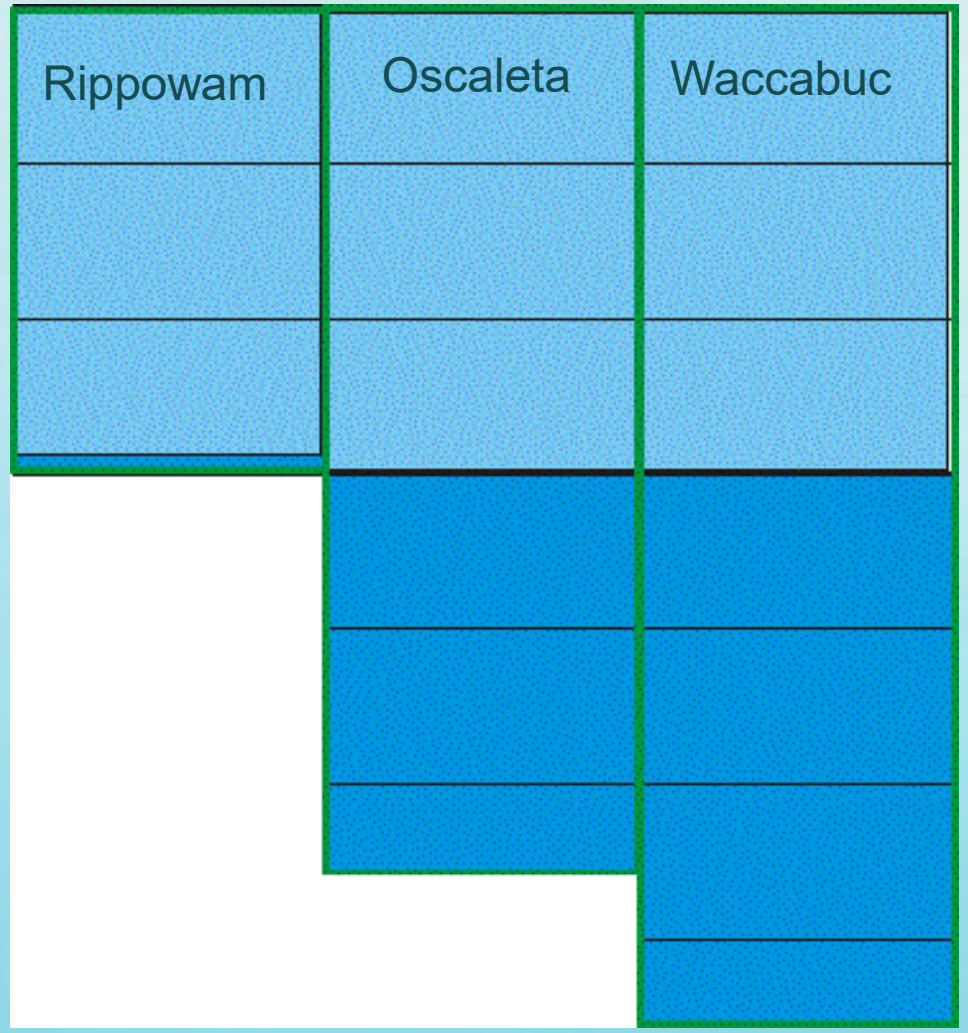
Water Quality

Lake Stratification



WARM
LIGHT
WATER = epilimnion

COLD
DENSE
WATER = hypolimnion

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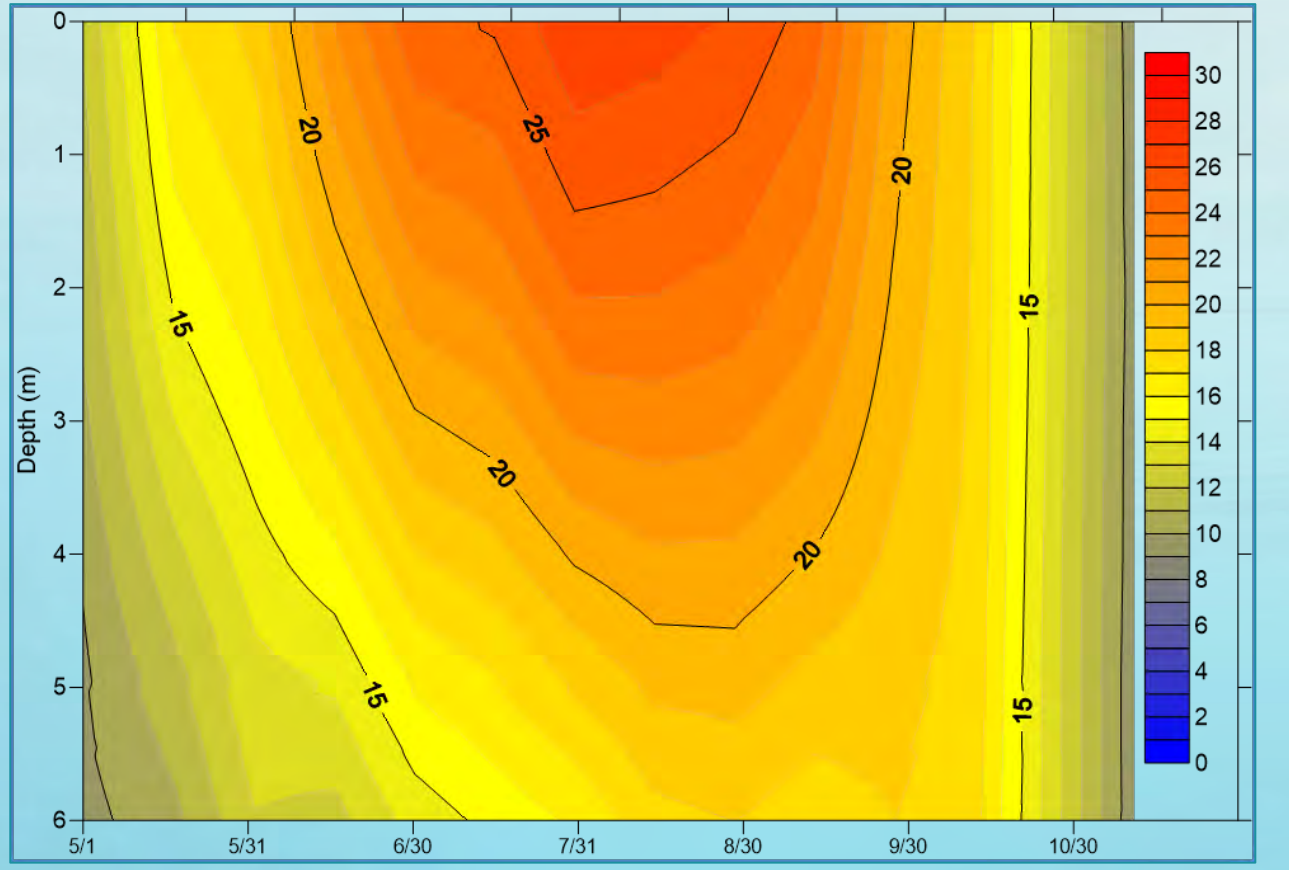
Lake Rippowam Dissolved Oxygen & Temperature

Temperature Isopleths



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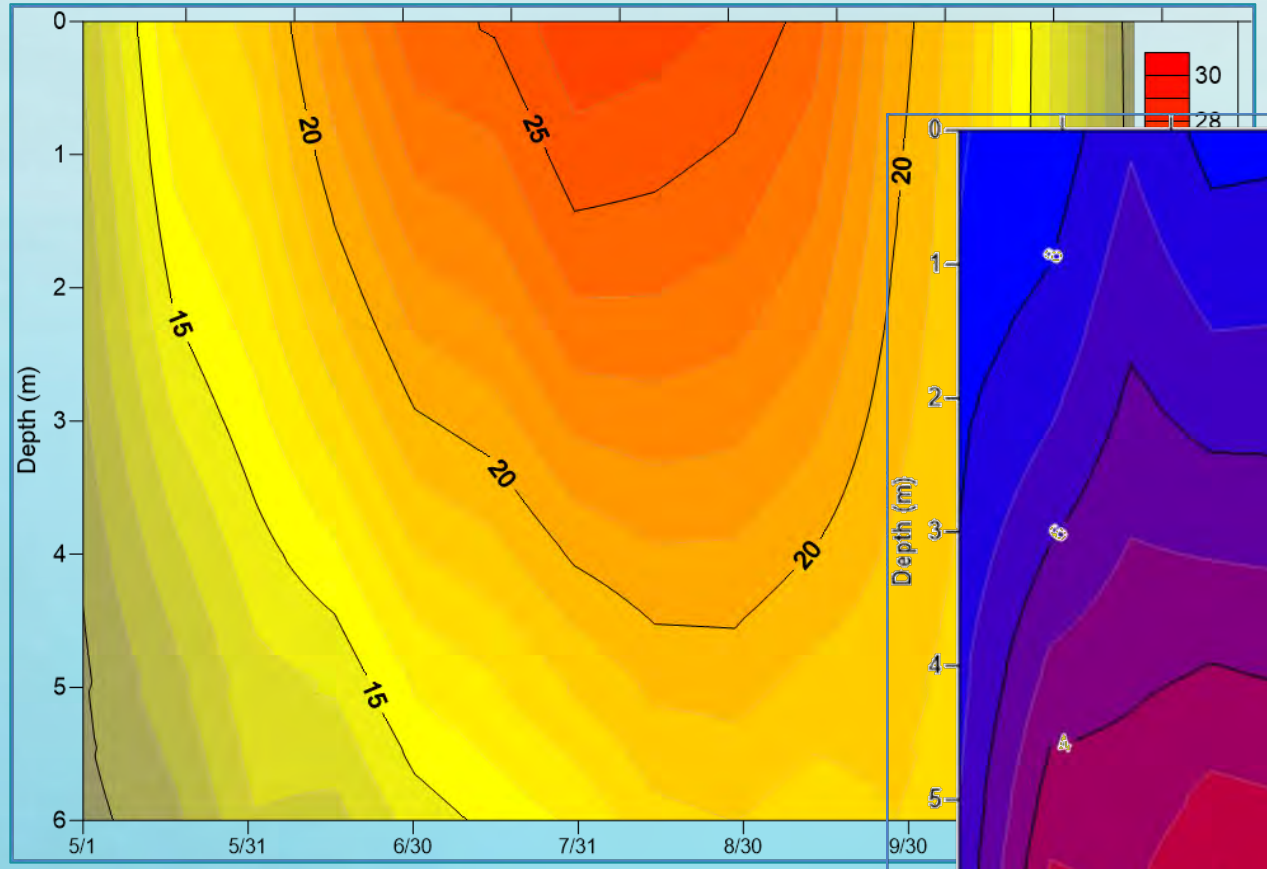
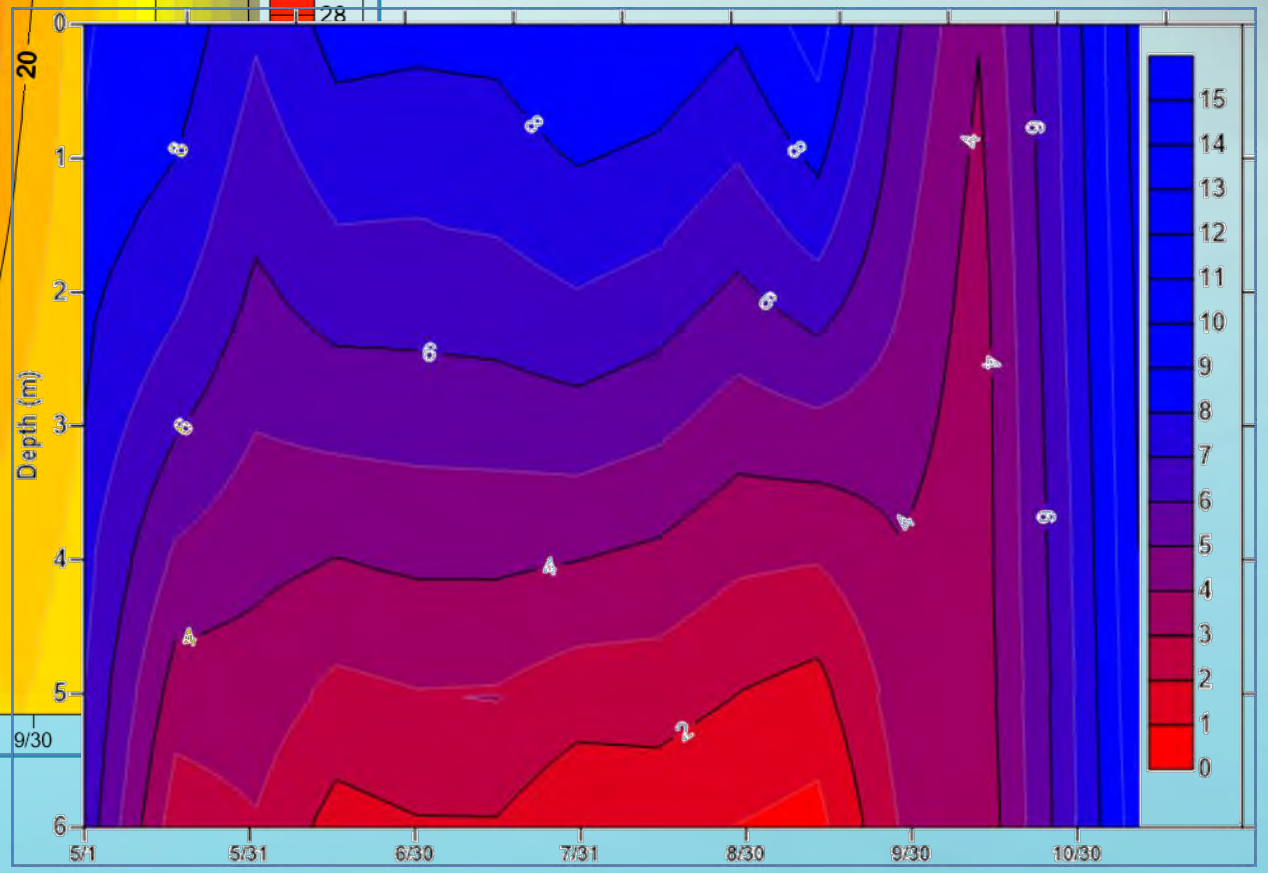
Lake Rippowam Dissolved Oxygen & Temperature

Temperature Isopleths



Dissolved Oxygen Isopleths



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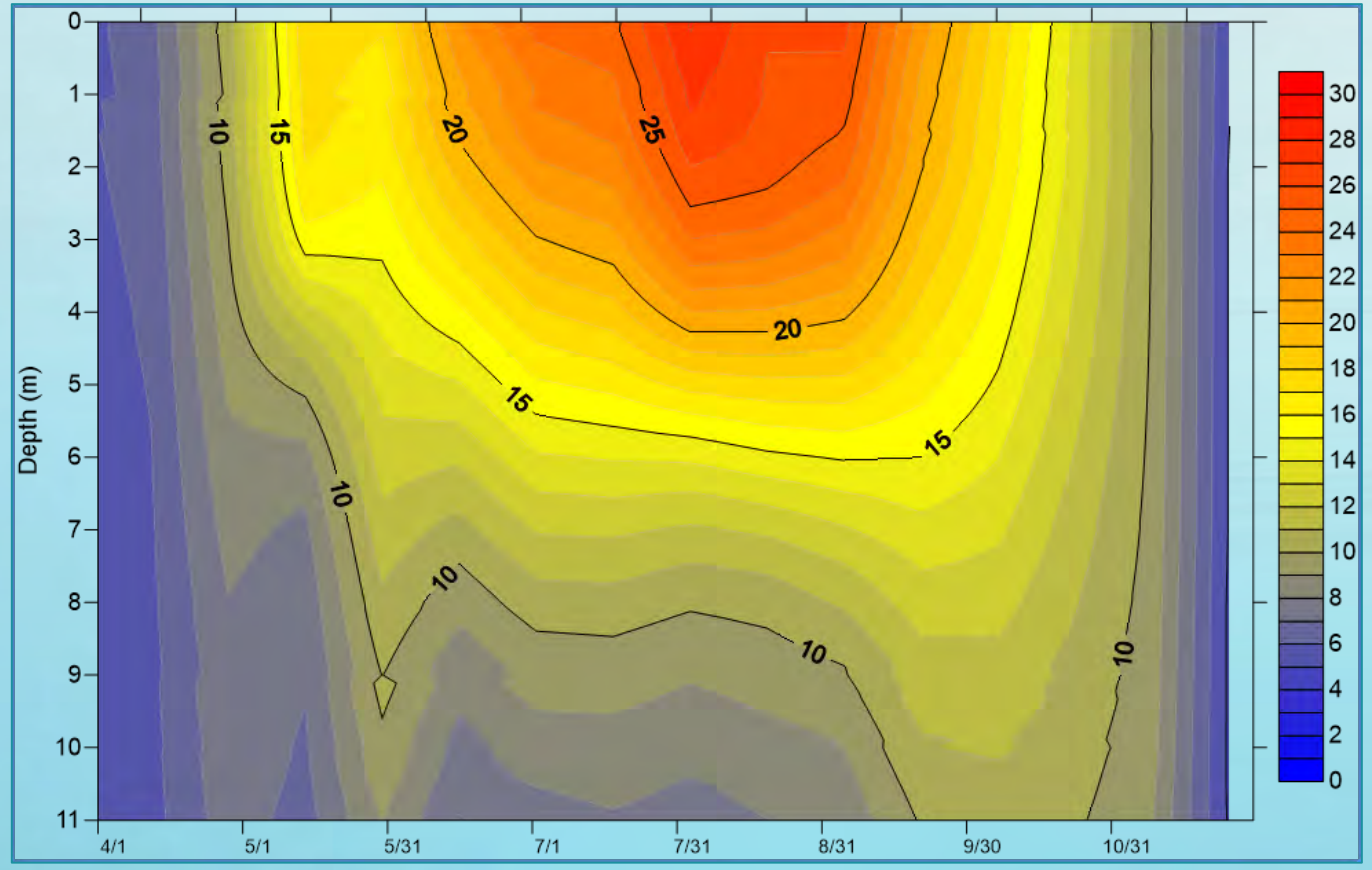
Lake Oscaleta Dissolved Oxygen & Temperature

Temperature Isopleths



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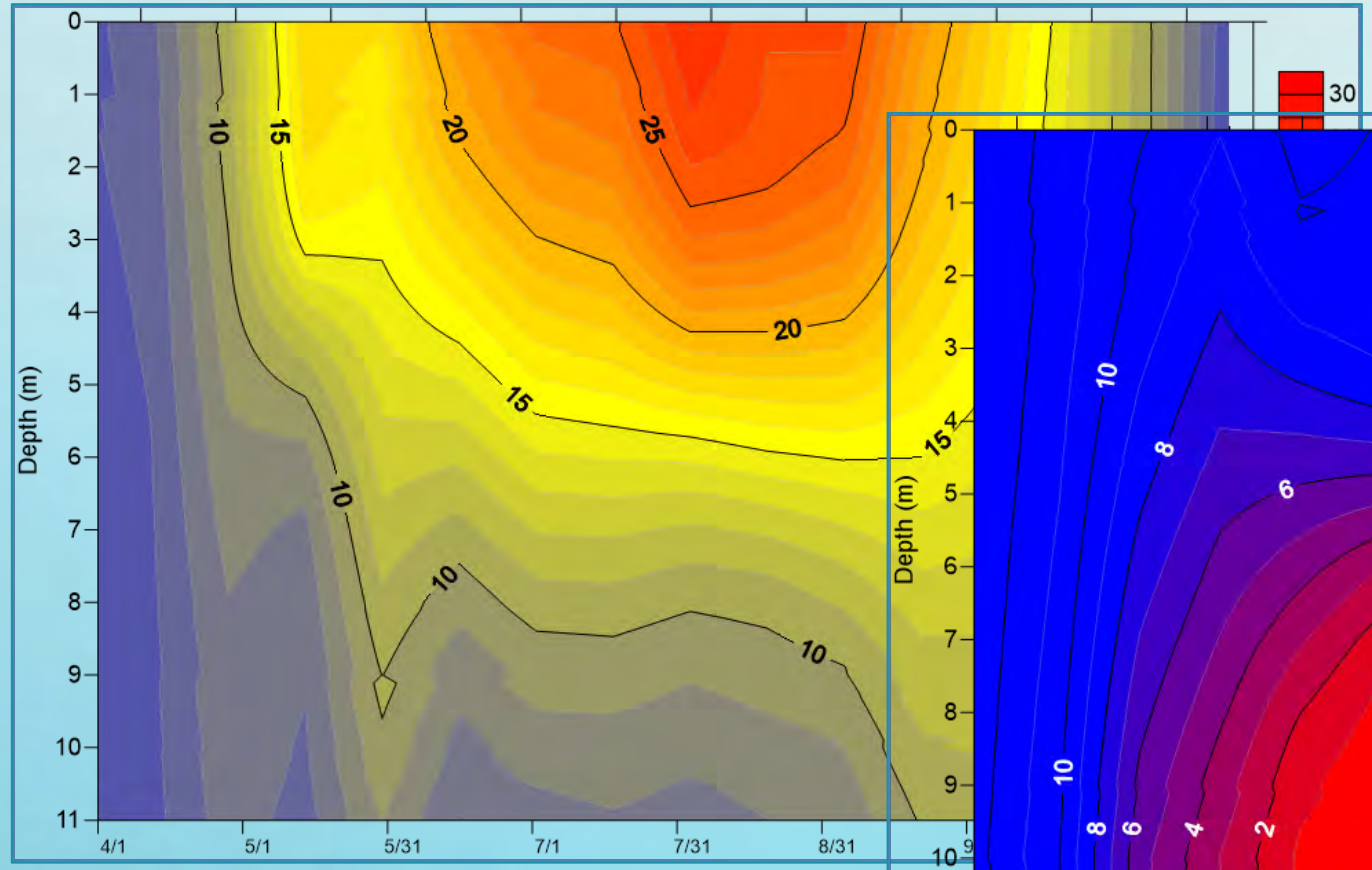
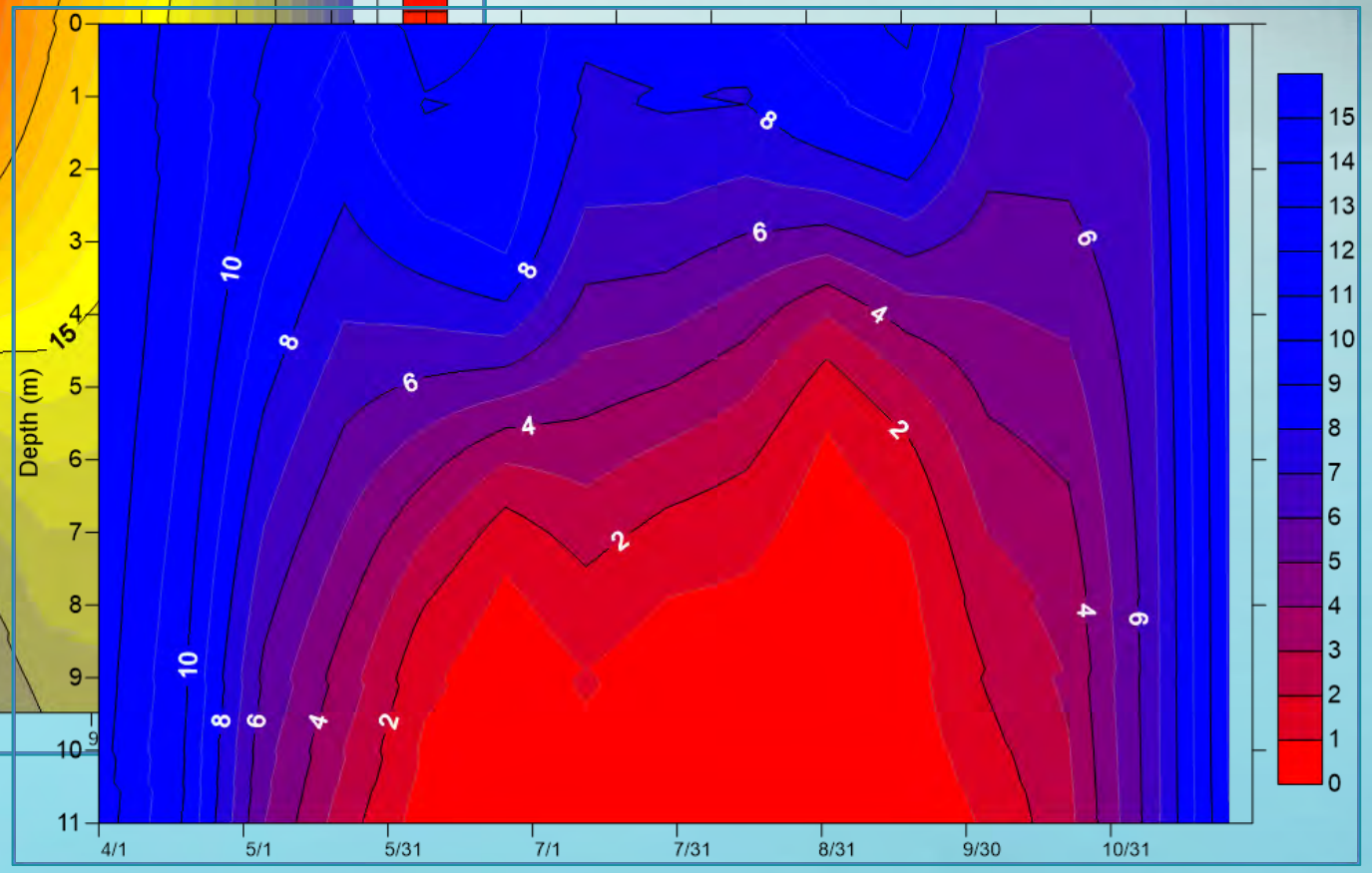
Lake Oscaleta Dissolved Oxygen & Temperature

Temperature Isopleths



Dissolved Oxygen Isopleths



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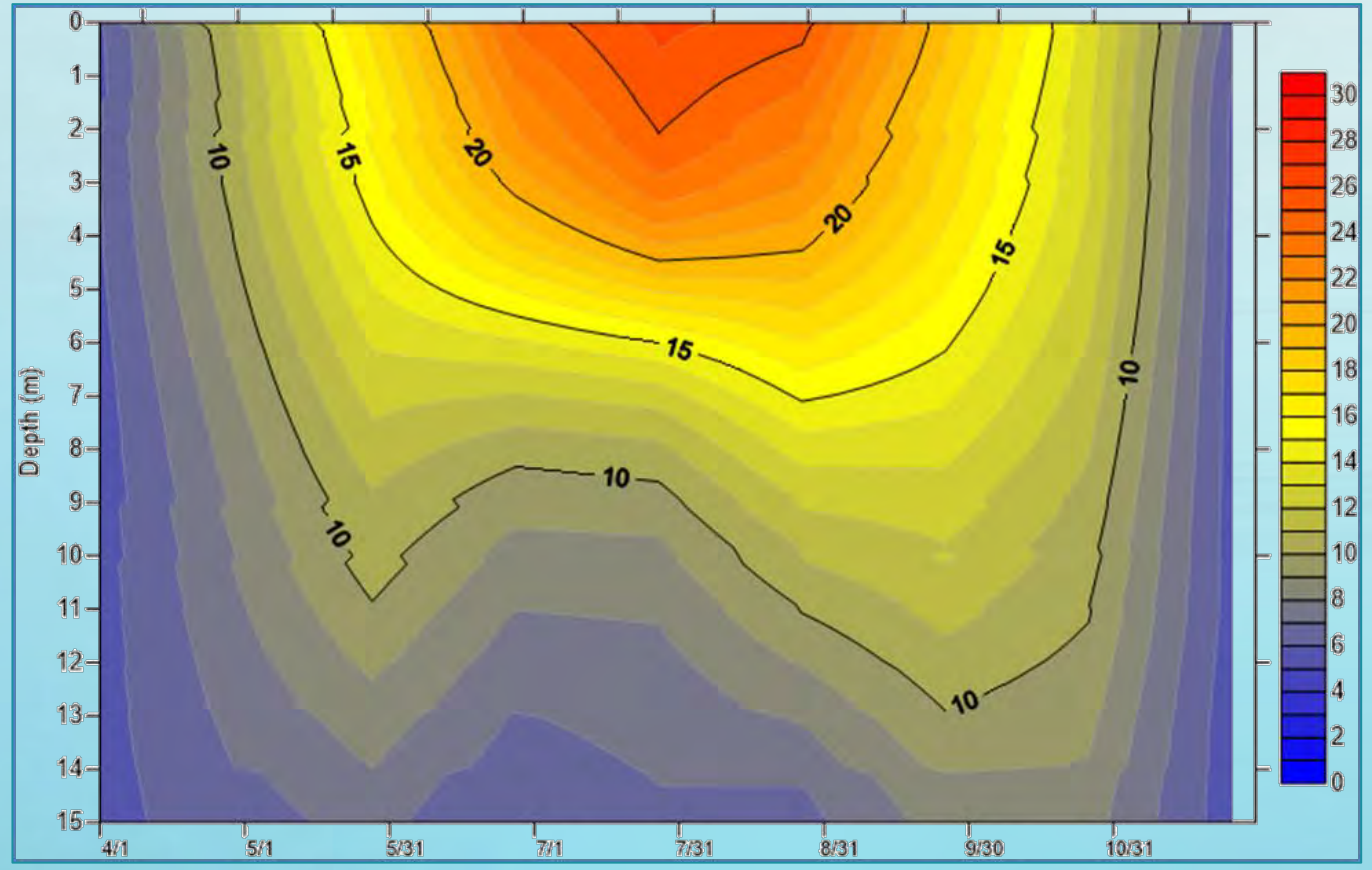
Lake Waccabuc Dissolved Oxygen & Temperature

Temperature Isopleths



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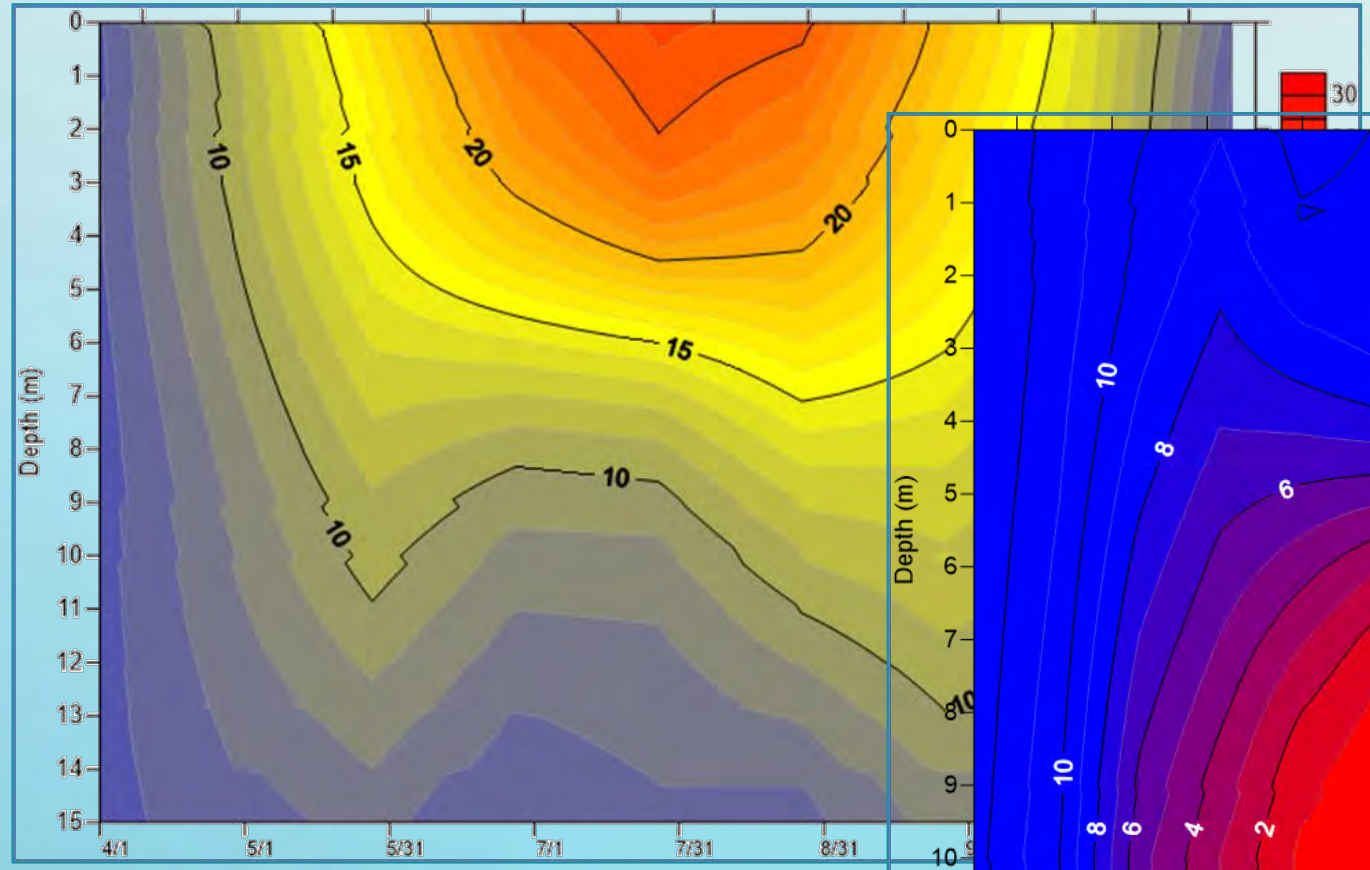
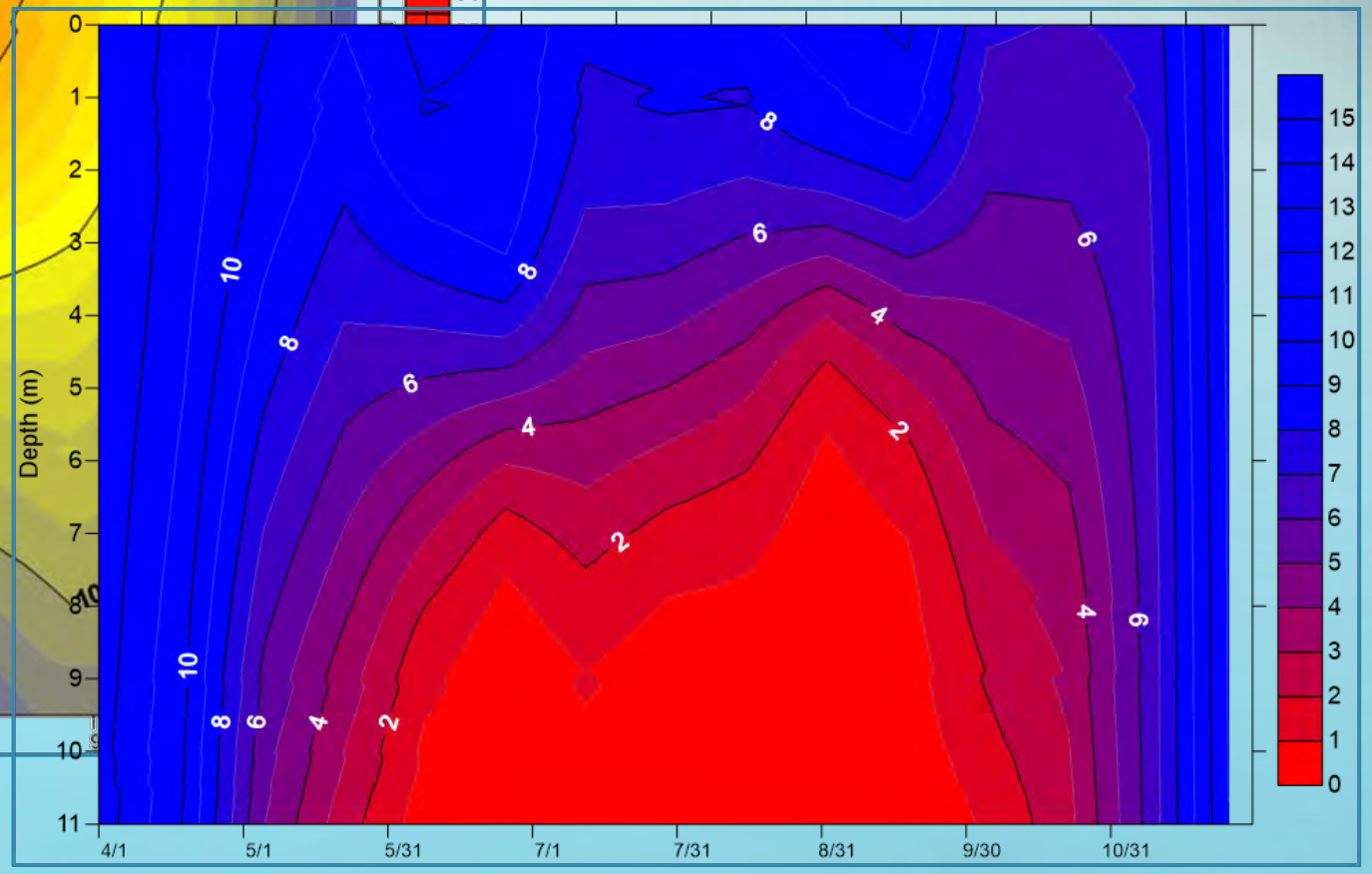
Lake Waccabuc Dissolved Oxygen & Temperature

Temperature Isopleths



Dissolved Oxygen Isopleths



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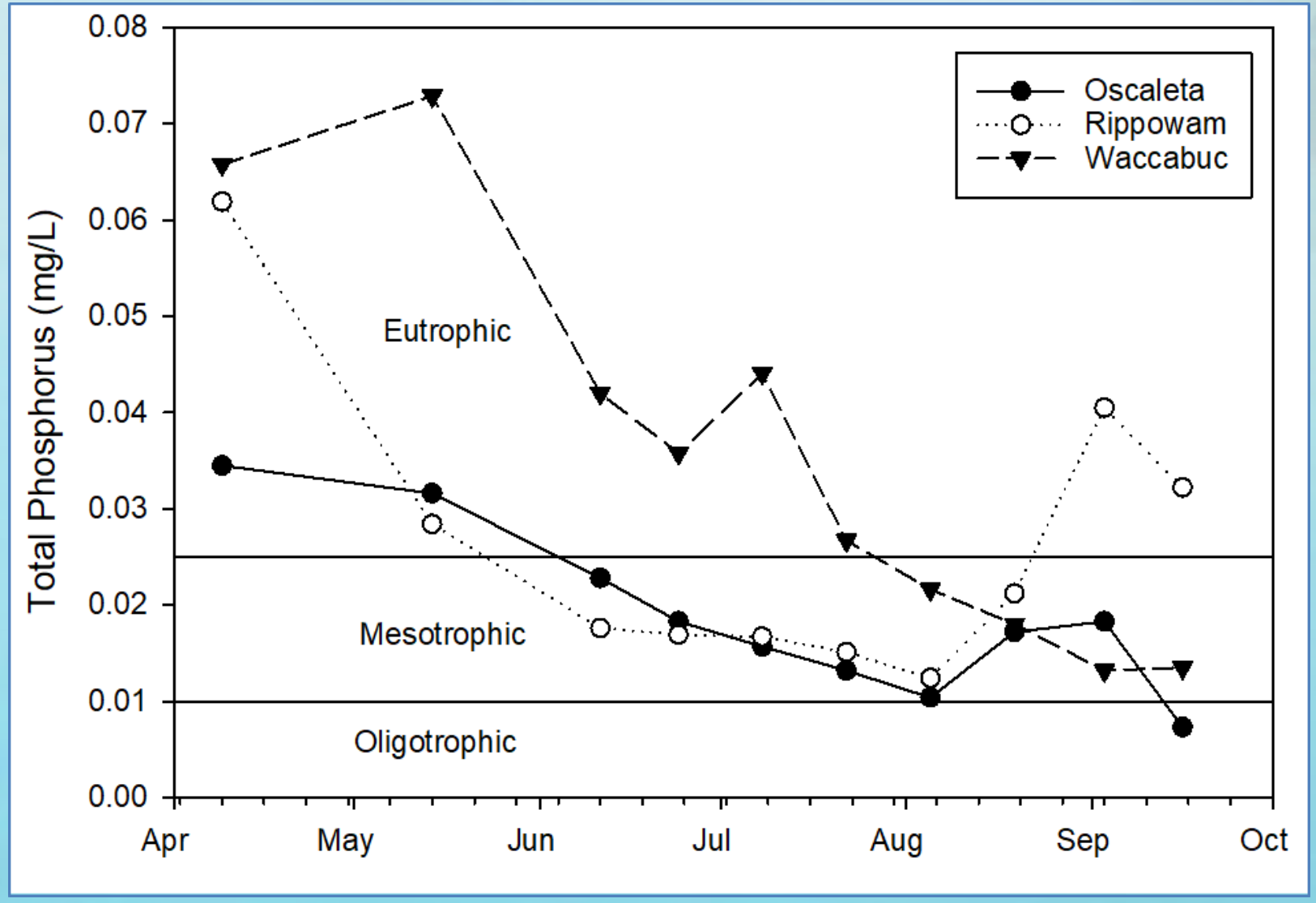
Total Phosphorus (epilimnia)



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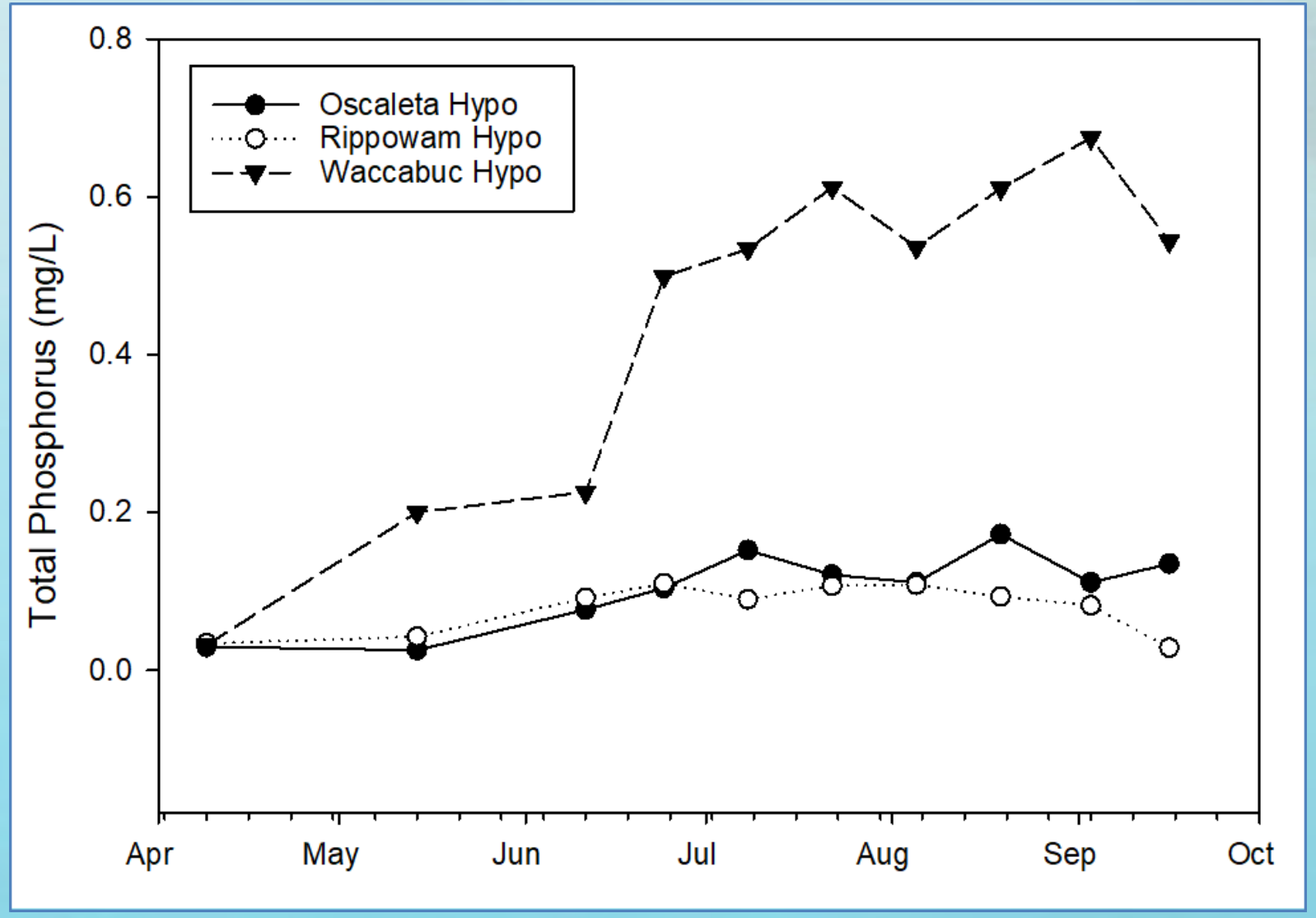
Total Phosphorus (hypolimnia)



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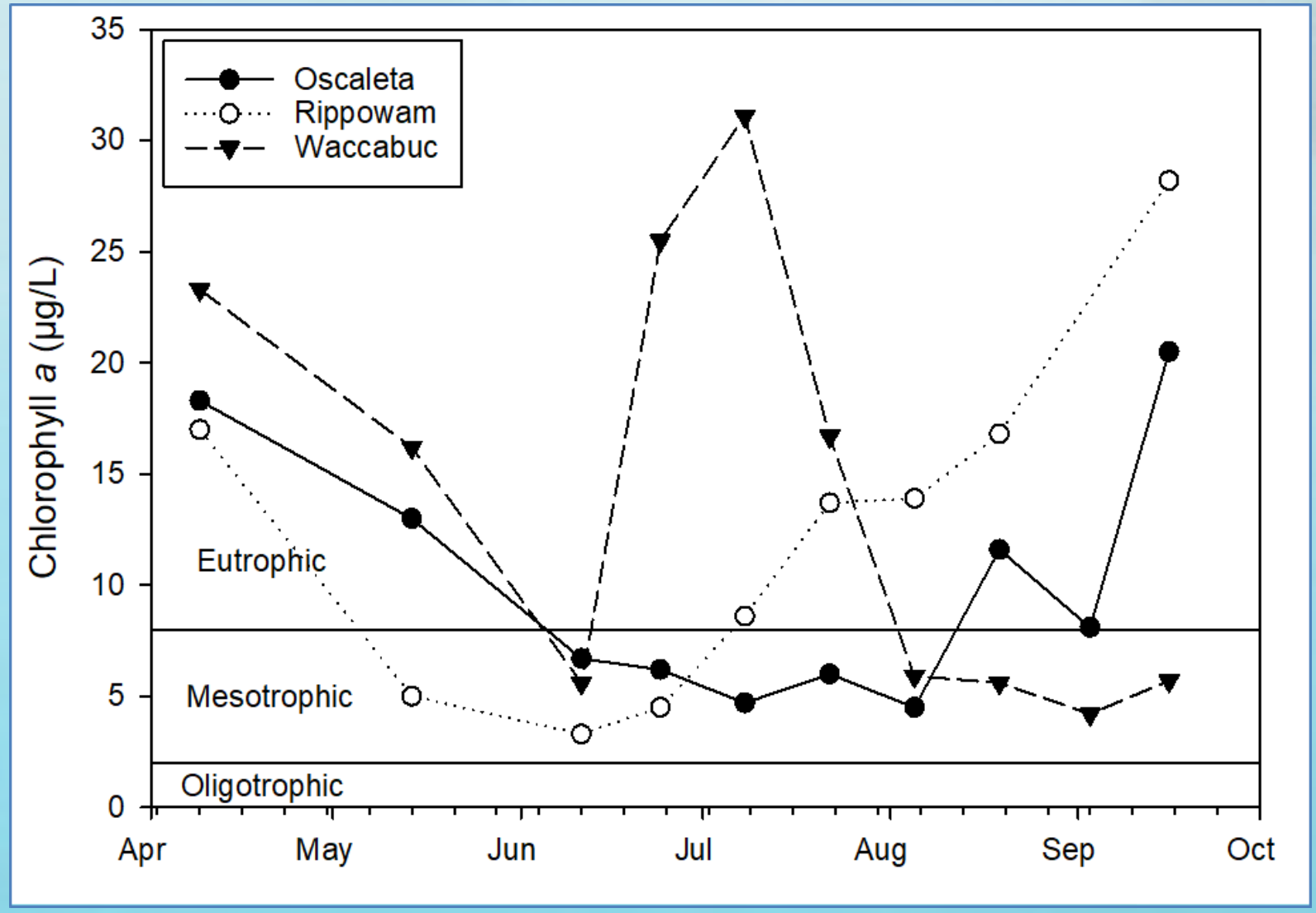
Chlorophyll *a*



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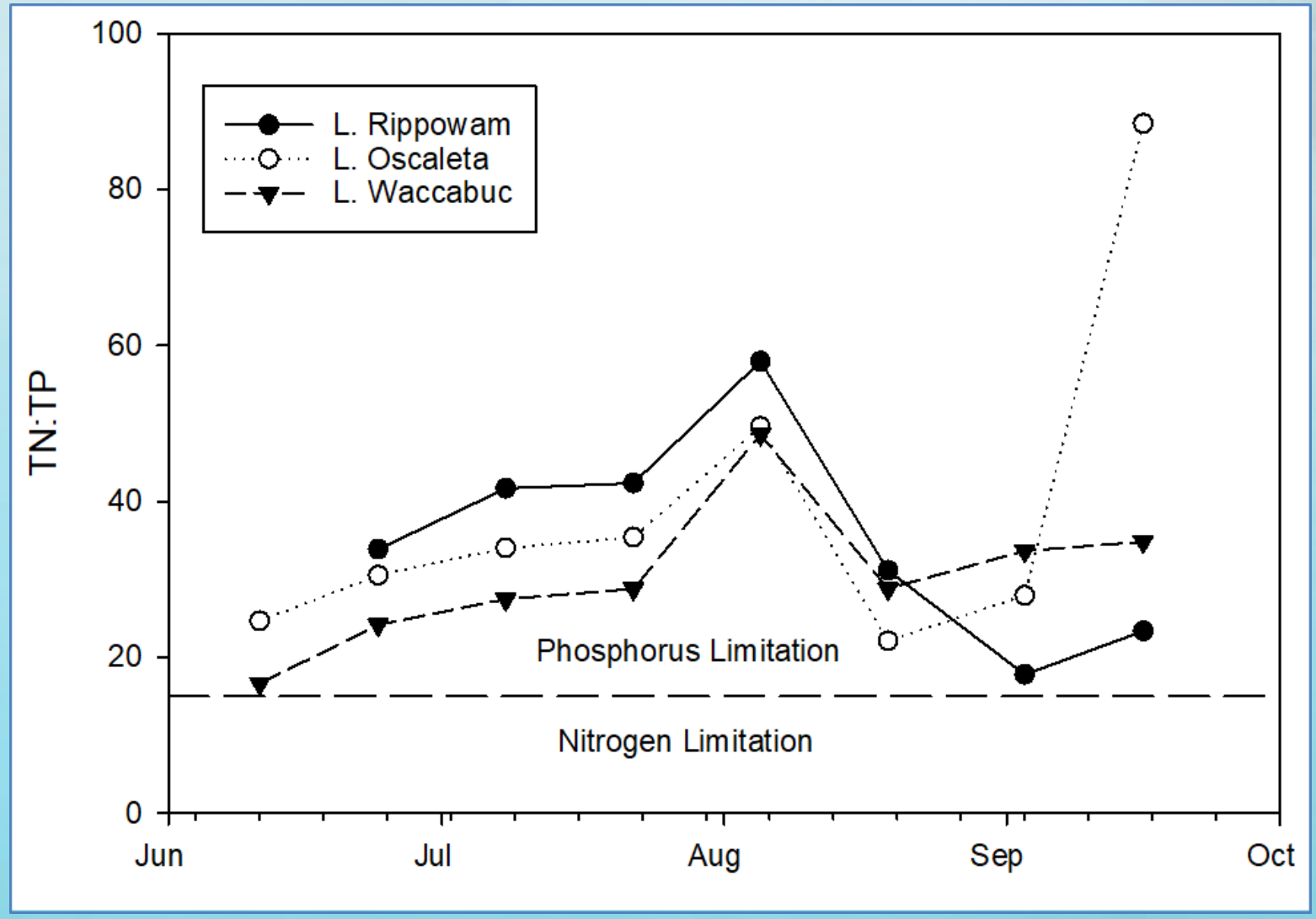
Limiting Nutrient



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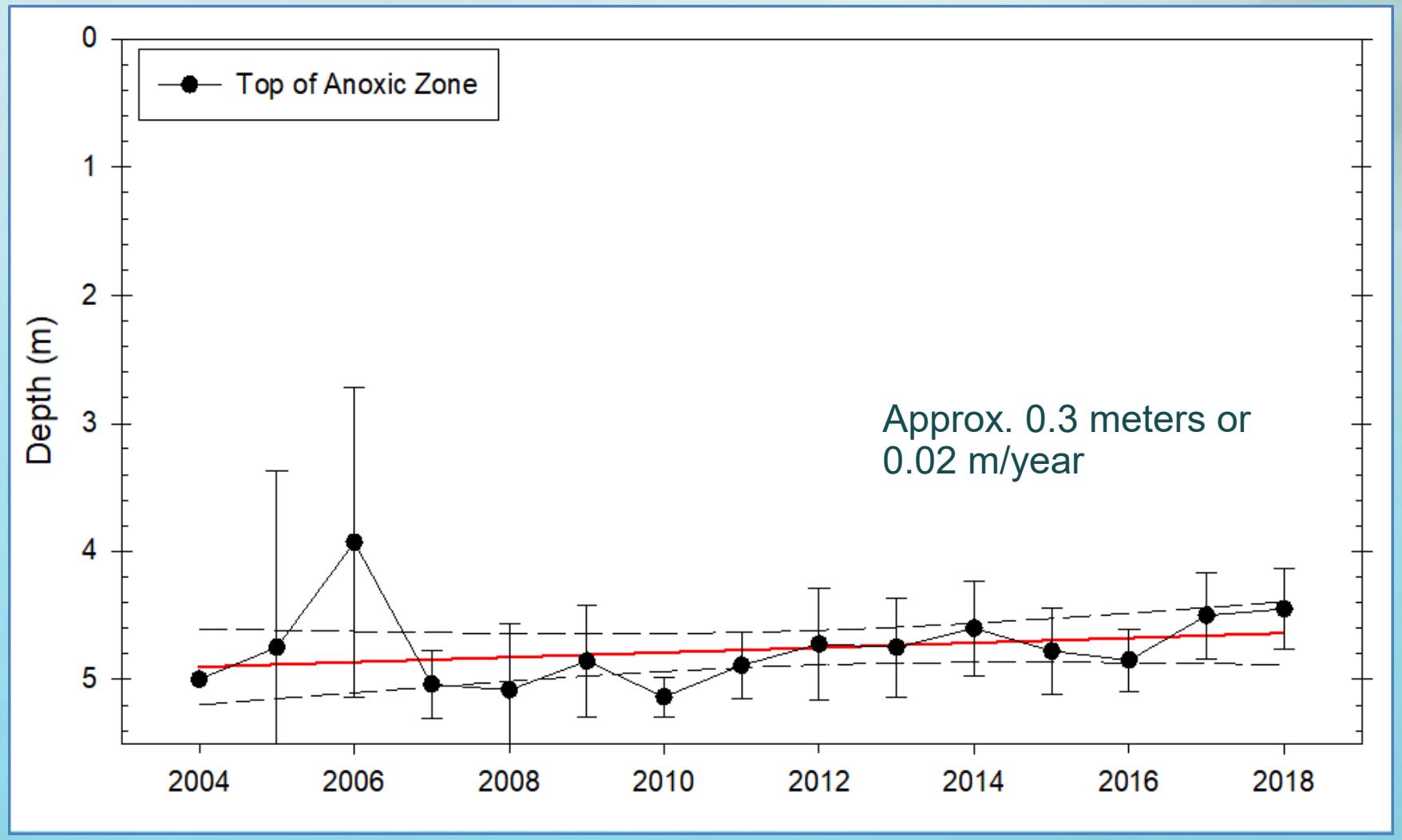
Lake Rippowam Anoxia Trend



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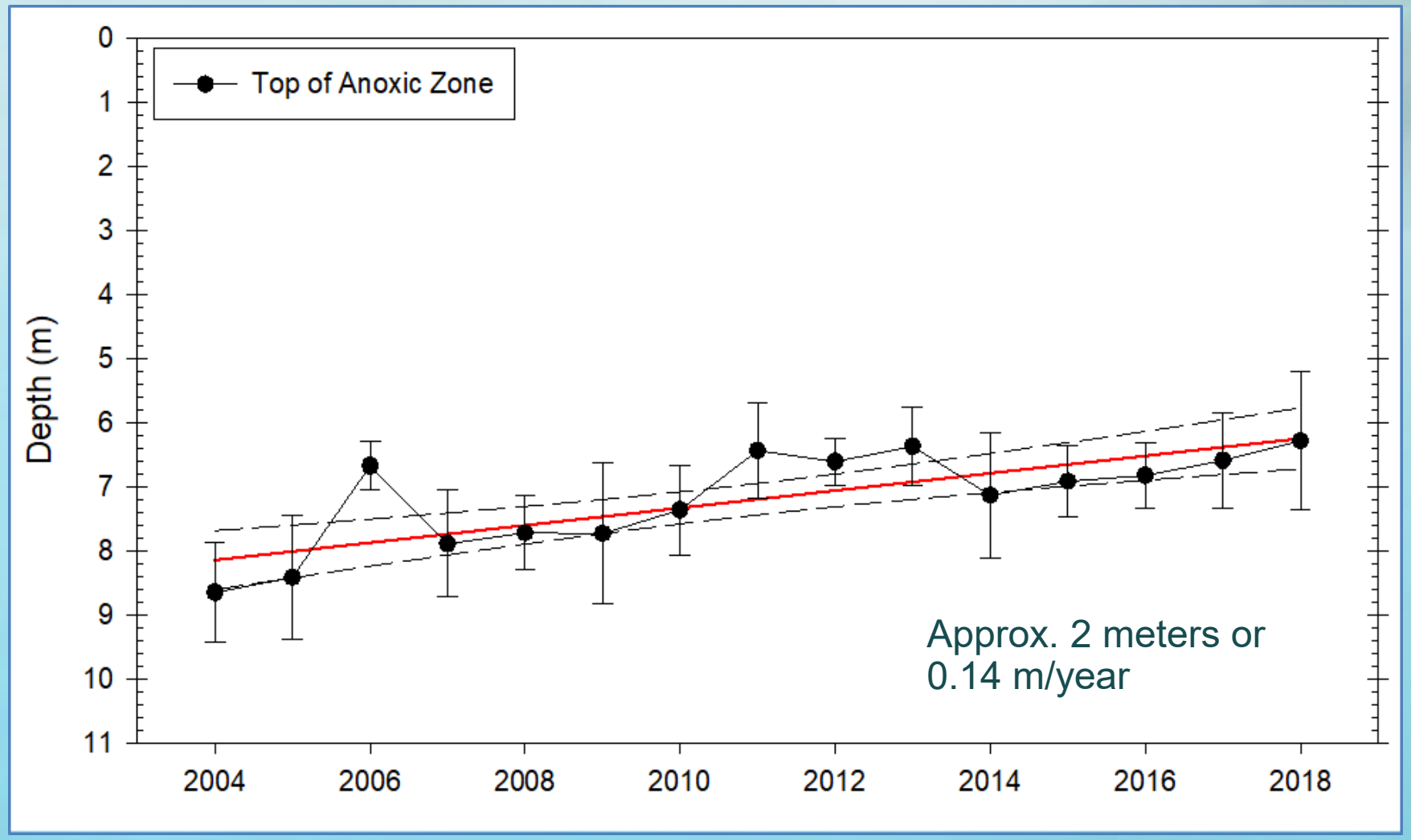
Lake Oscaleta Anoxia Trend



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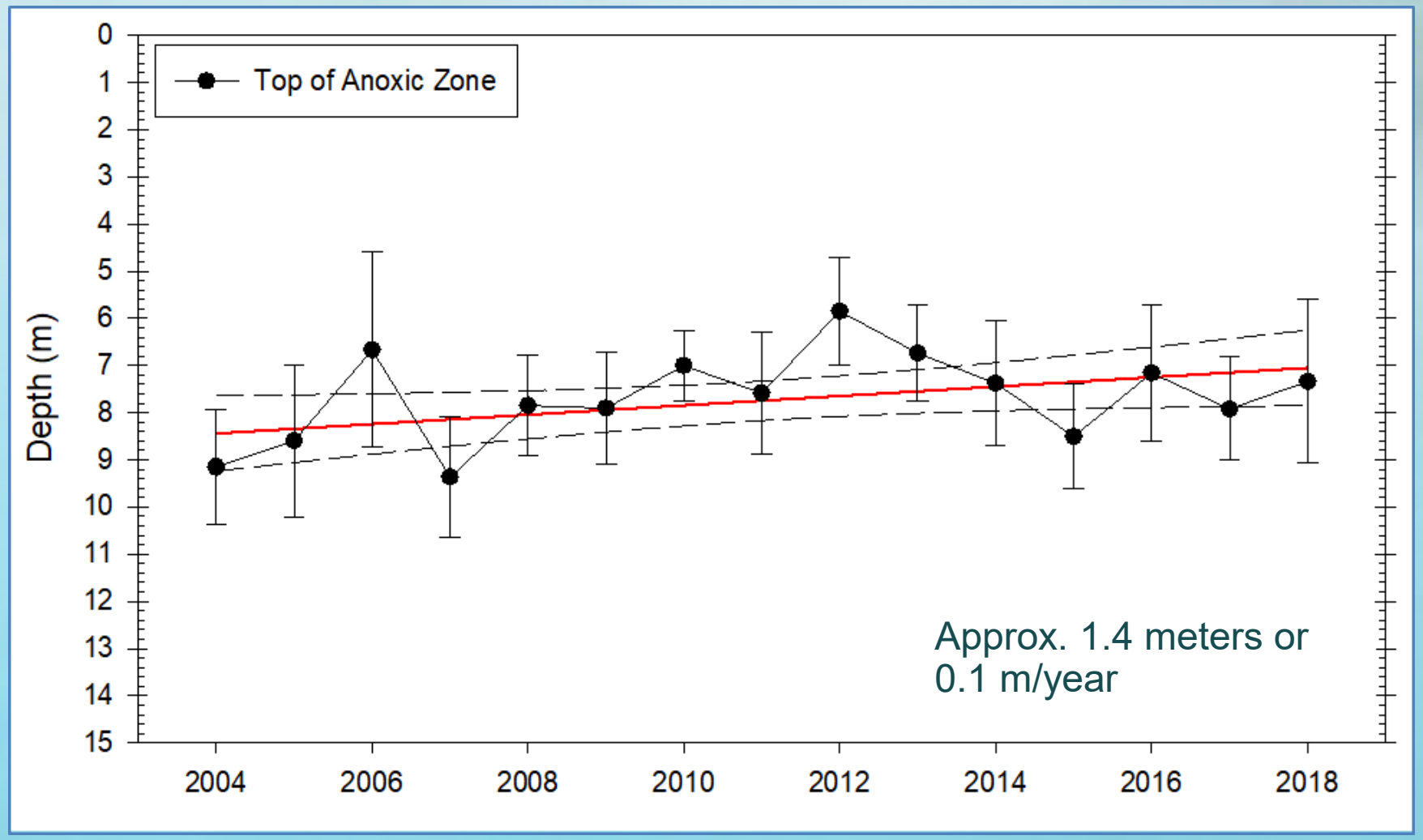
Lake Waccabuc Anoxia Trend



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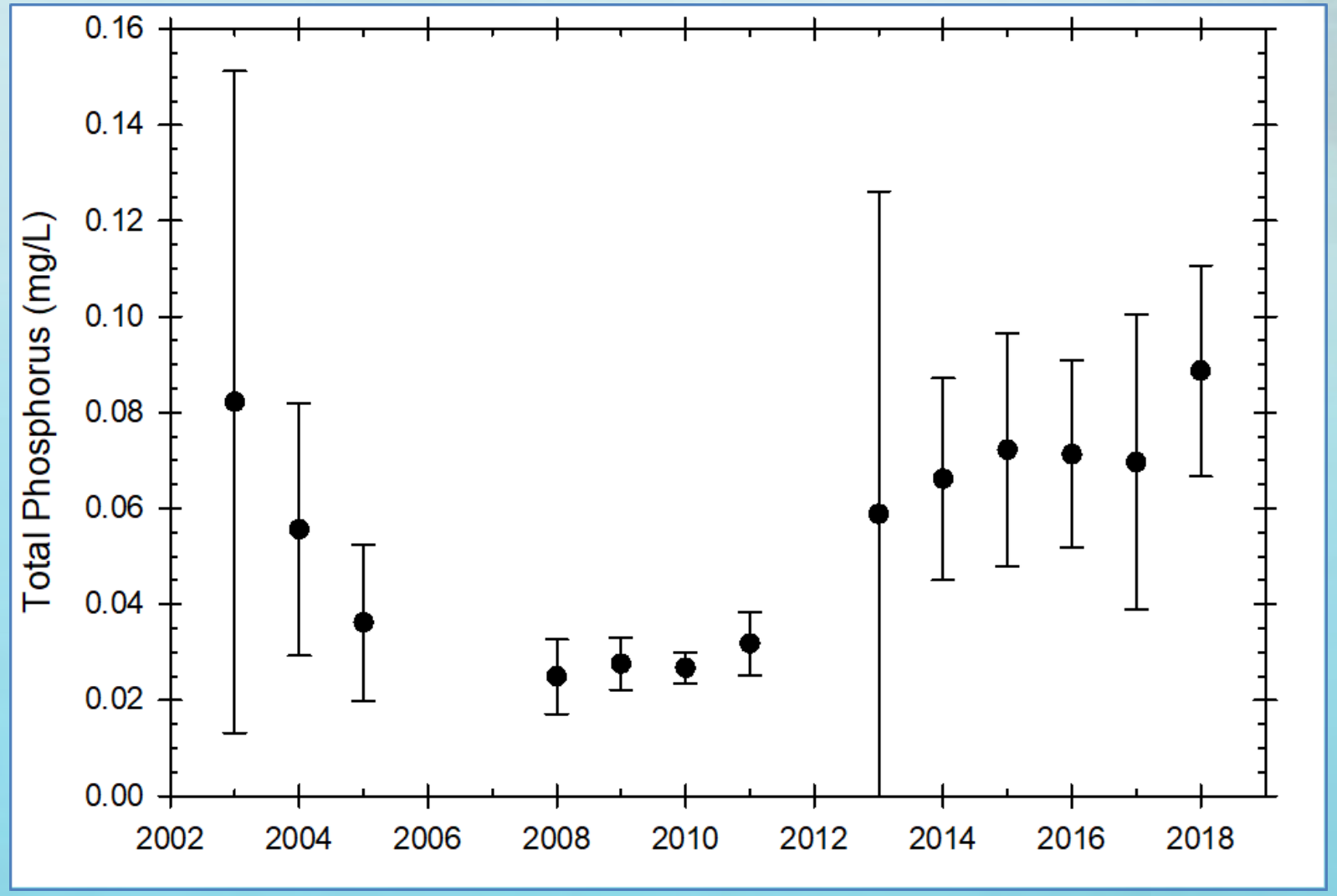
Lake Rippowam Hypolimnetic Total Phosphorus Trend



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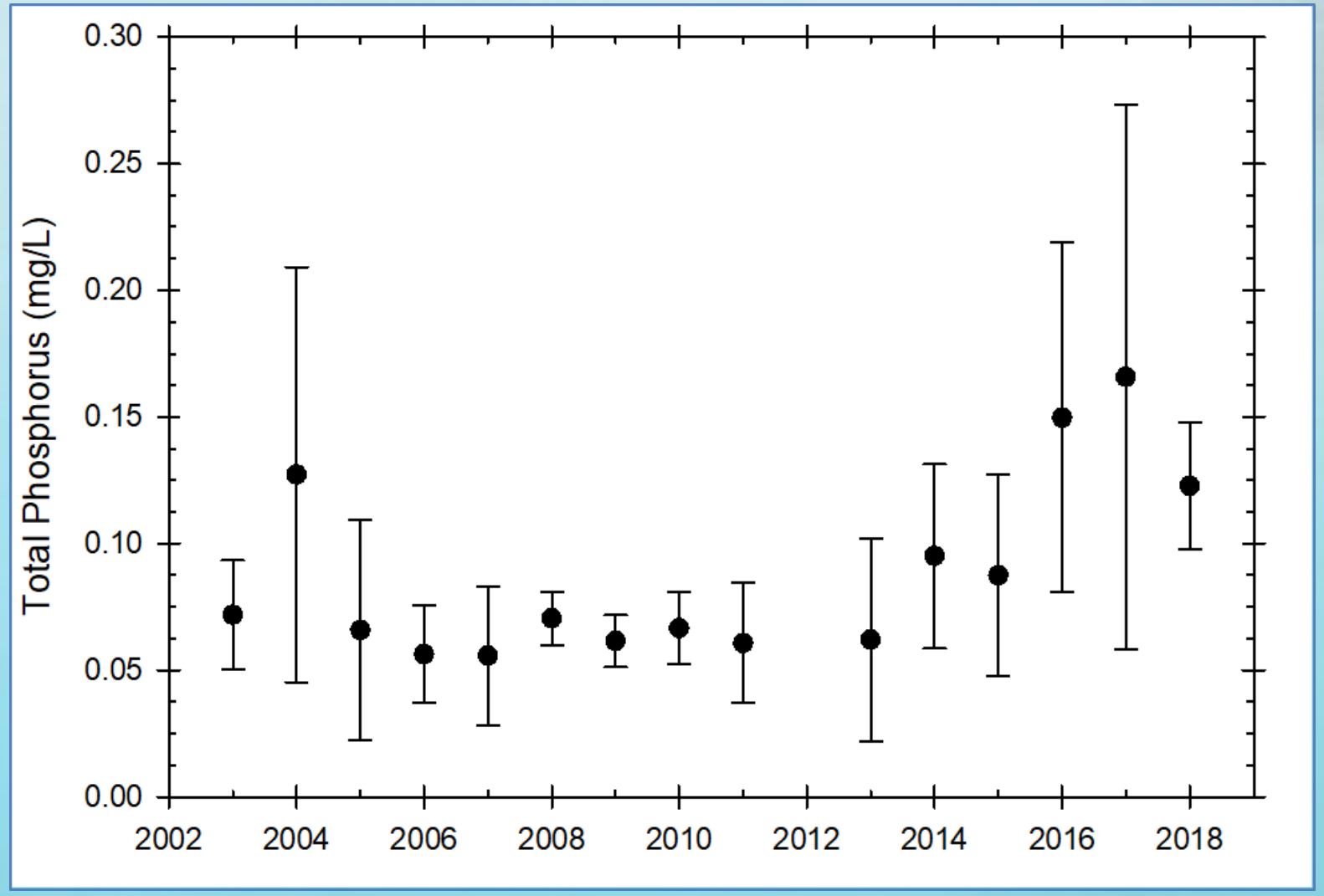
Lake Oscaleta Hypolimnetic Total Phosphorus Trend



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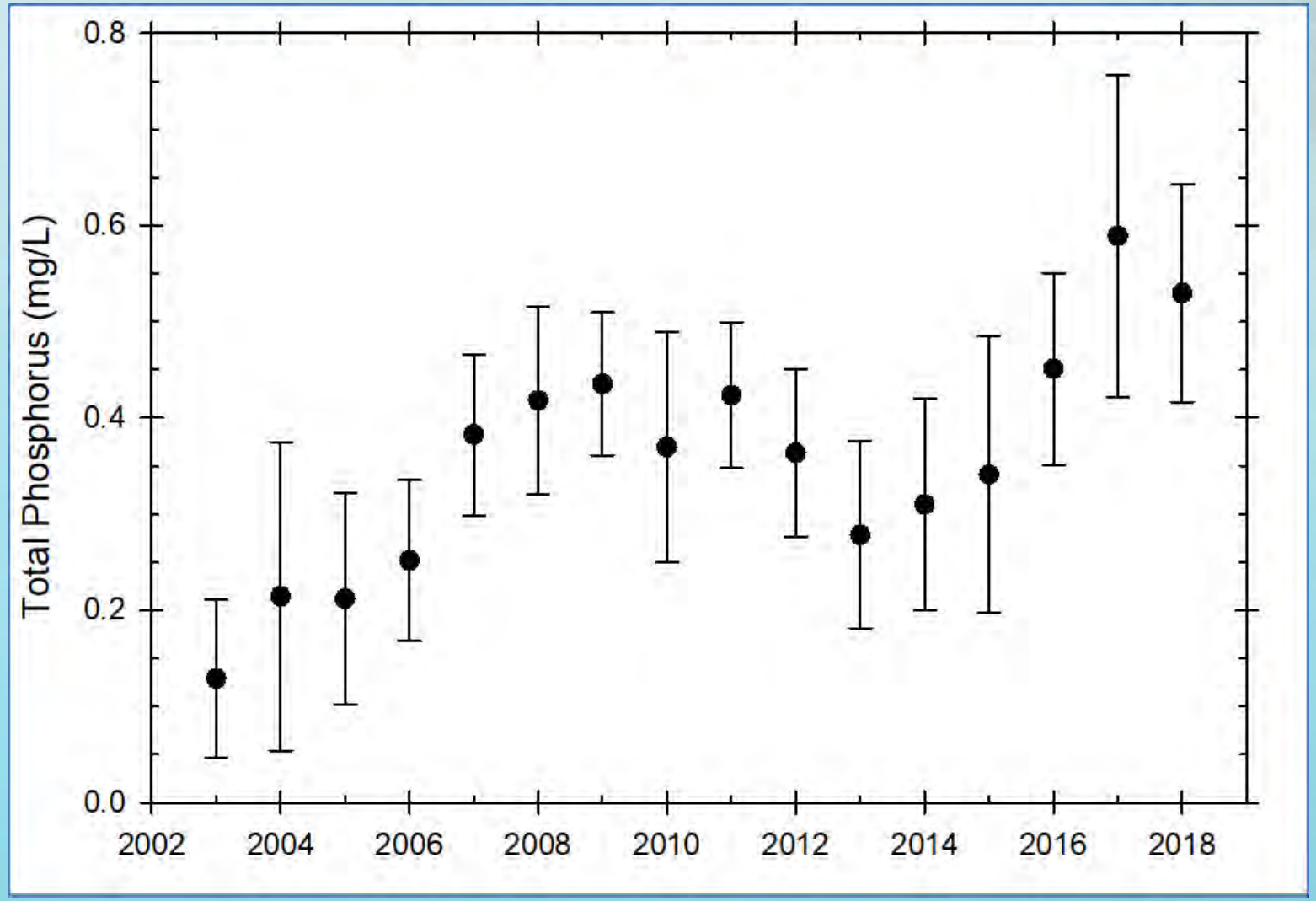
Lake Waccabuc Hypolimnetic Total Phosphorus Trend



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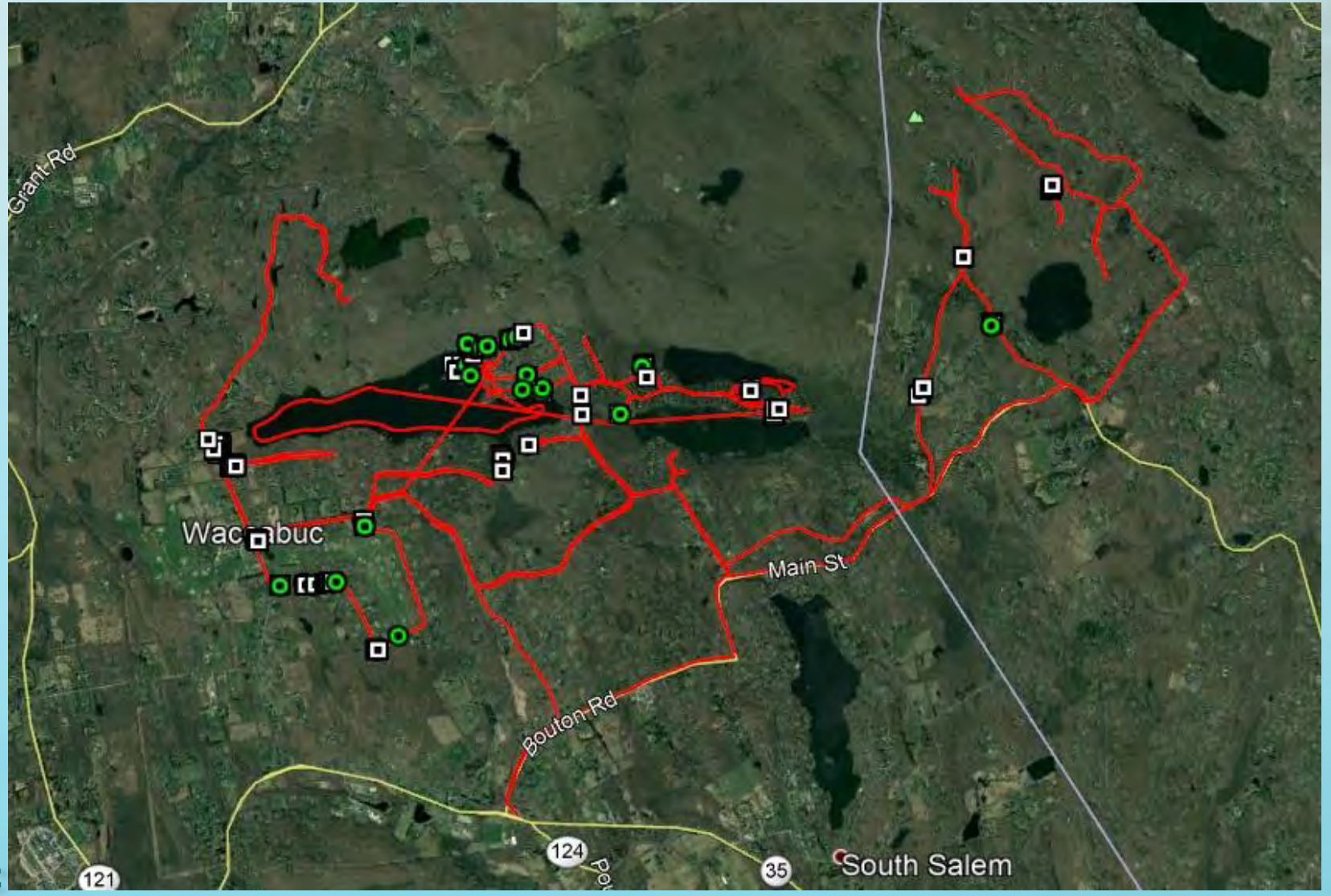
Watershed Nonpoint Source Investigation

Watershed Nonpoint Source Survey



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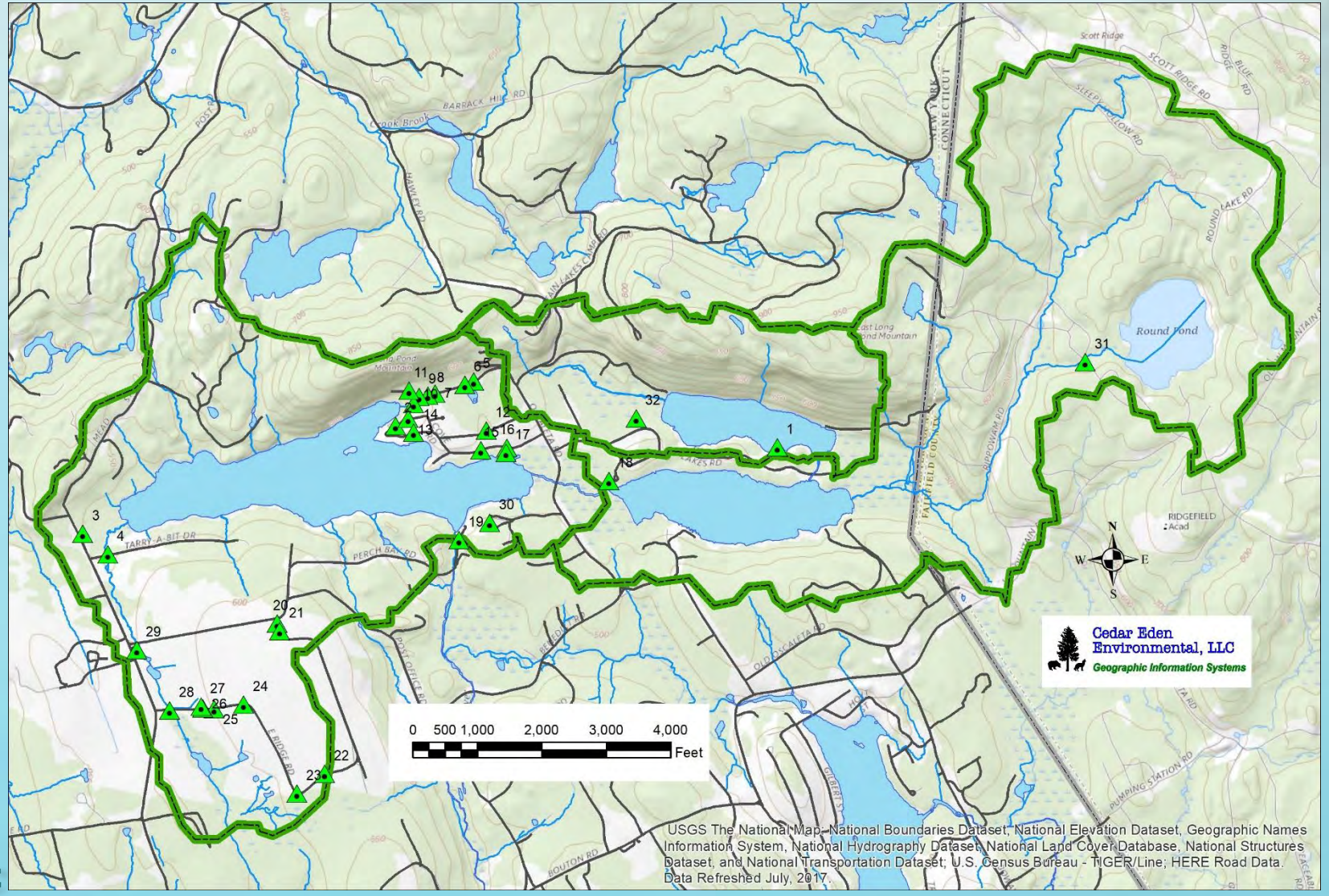
Watershed Nonpoint Source Problem Areas



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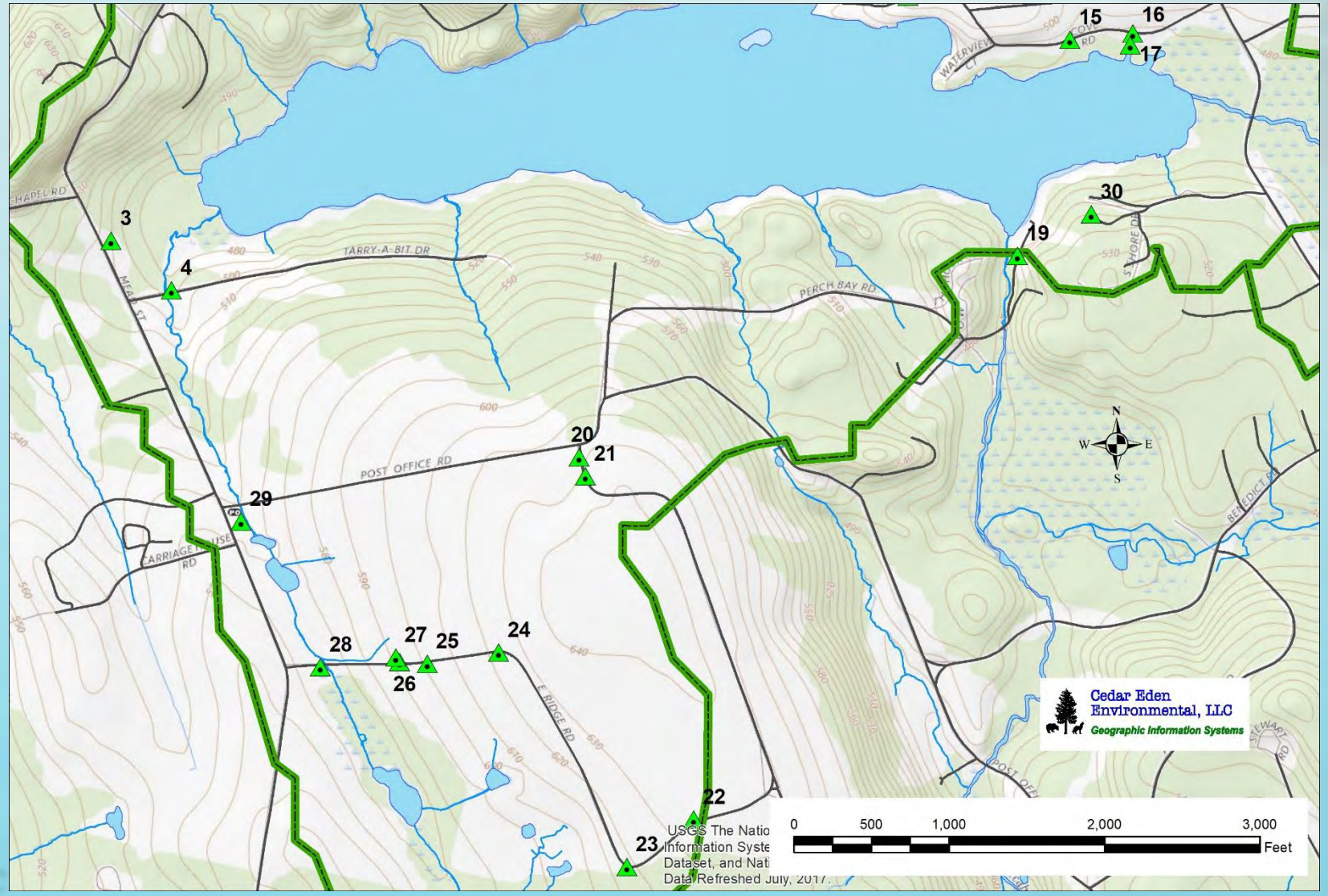
Watershed Nonpoint Source Problem Areas



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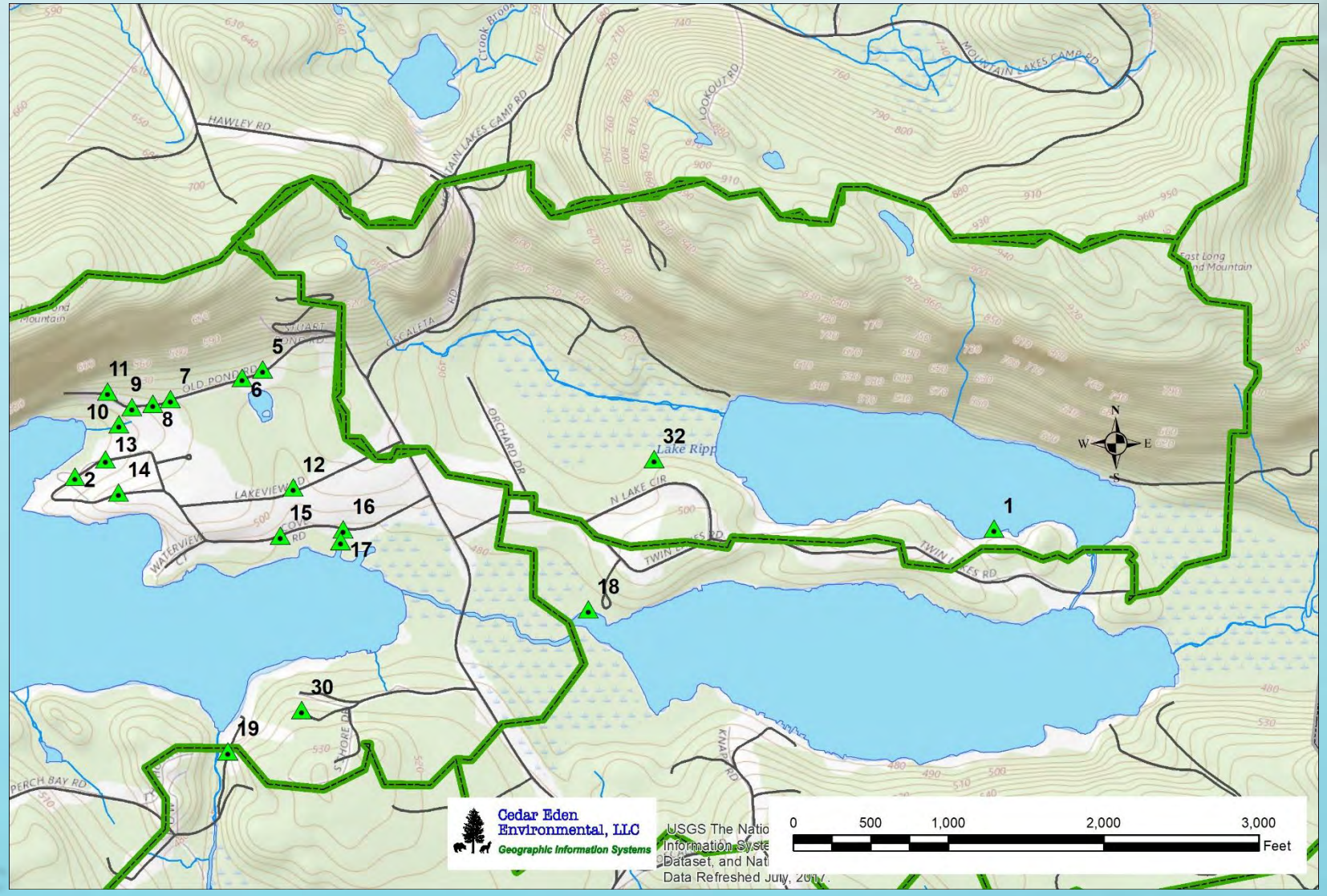
Watershed Nonpoint Source Problem Areas



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Nonpoint Source Problems: Eroding Gravel Roads

Tarry-A-Bit Road

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Nonpoint Source Problems: Eroding Gravel Roads

Tarry-A-Bit Road

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Nonpoint Source Problems: Eroding Gravel Roads

Old Pond Road

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Nonpoint Source Problems: Eroding Gravel Roads

East Ridge Road
Old Pond Road

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Nonpoint Source Problems: Stormwater Runoff

Mead Street/
Post Office Lot

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Nonpoint Source Problems: Stormwater Runoff

Mead Street/
Post Office Lot

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Nonpoint Source Problems: Stormwater Runoff

Lakeview Road

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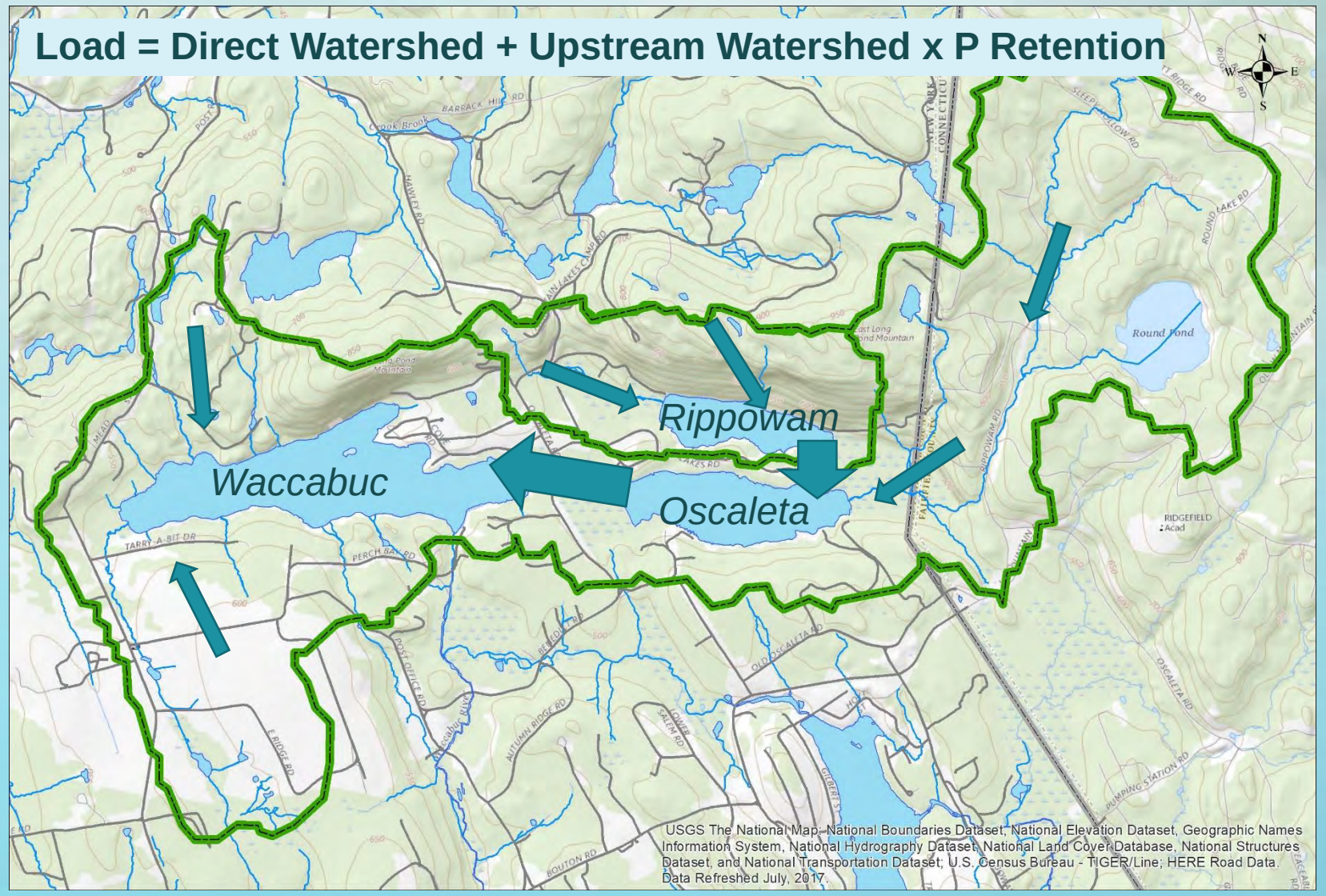
Nutrient (Pollutant) Budgets

Calculating Pollutant Budgets for Lake Chains

- Rippowam 279 acres
- Oscaleta 1,282 acres
- Waccabuc 2,196 acres



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Lake Rippowam Nutrient Budgets

Nutrient Budget Calculations and Results for Lake Rippowam Watershed							
Land Use	Area (ha)	Loading Coefficients (kg/ha/yr)		Annual Load (kg/year)		Annual Load (Percent)	
		TP	TN	TP	TN	TP	TN
Open Water	14.45			0.0	0.0	0.0%	0.0%
Open Lands	6.54	1.1	5.5	7.2	36.0	26.3%	11.9%
Mod./High Dens. Residential	0.00	1.1	5.5	0.0	0.0	0.0%	0.0%
Forest	91.77	0.0685	2.0	6.3	183.5	23.0%	60.6%
Low Dens. Residential	0.00	0.725	4.335	0.1	0.4	0.2%	0.1%
Water Supply				6.9		25.2%	0.0%
Internal Loading				0.1		0.3%	0.0%
Precipitation	14.45	0.4715	5.75	6.8	83.1	24.9%	27.4%
Totals				**27.3**	**303.0**	**100%**	**100%**

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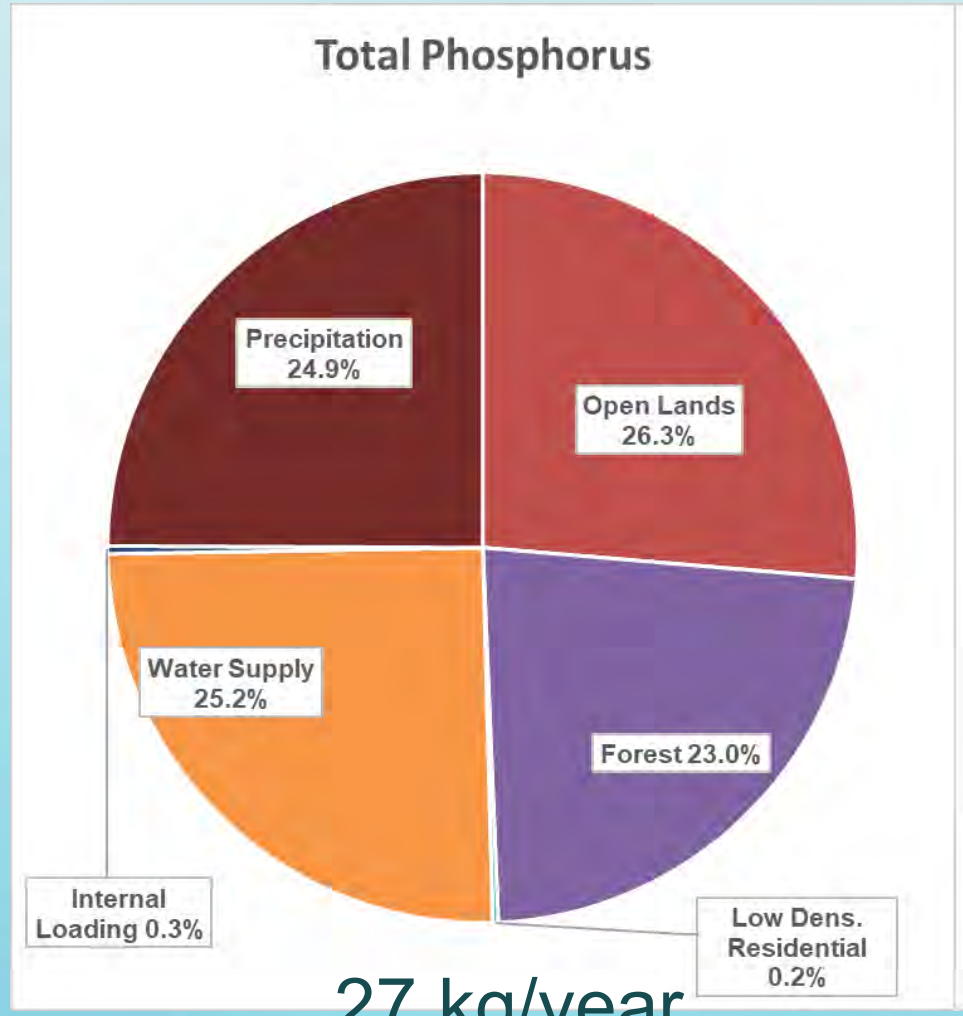
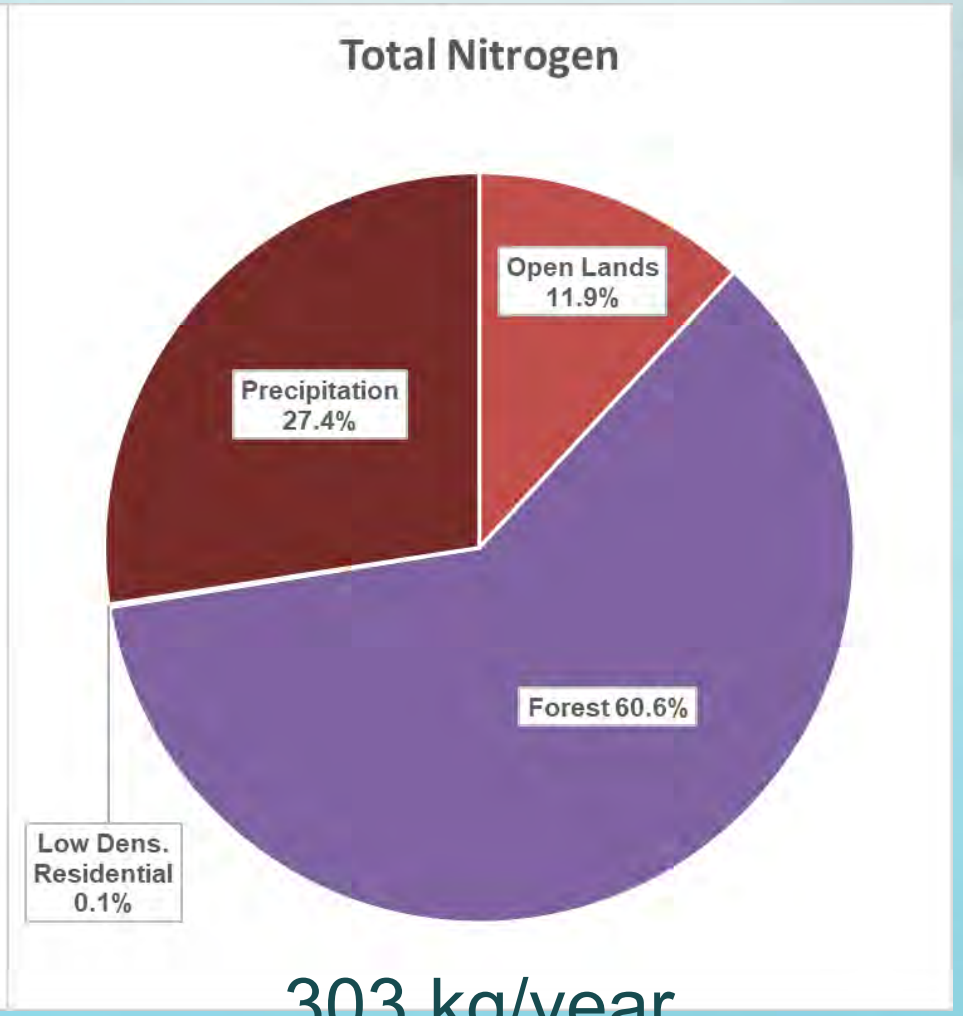
Lake Rippowam Annual Pollutant Budgets



27 kg/year



303 kg/year

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Lake Oscaleta Nutrient Budgets

Nutrient Budget Calculations and Results for Lake Oscaleta Watershed							
Land Use	Area (ha)	Loading Coefficients (kg/ha/yr)		Annual Load (kg/year)		Annual Load (Percent)	
		TP	TN	TP	TN	TP	TN
Open Water	44.87			0.0	0.0	0.0%	0.0%
Open Lands	33.22	1.1	5.5	36.5	182.7	28.4%	14.5%
Mod./High Dens. Residential	0.00	1.1	5.5	0.0	0.0	0.0%	0.0%
Forest	327.68	0.0685	2.0	22.4	655.4	17.5%	52.1%
Low Dens. Residential	0.72	0.725	4.335	0.5	3.1	0.4%	0.2%
Water Supply				6.9		5.3%	0.0%
Internal Loading				26.8		20.8%	0.0%
Precipitation	44.87	0.4715	5.75	21.2	258.0	16.5%	20.5%
Upstream Watershed				14.2	157.6	11.1%	12.5%
Totals				**128.5**	**1256.7**	**100%**	**100%**

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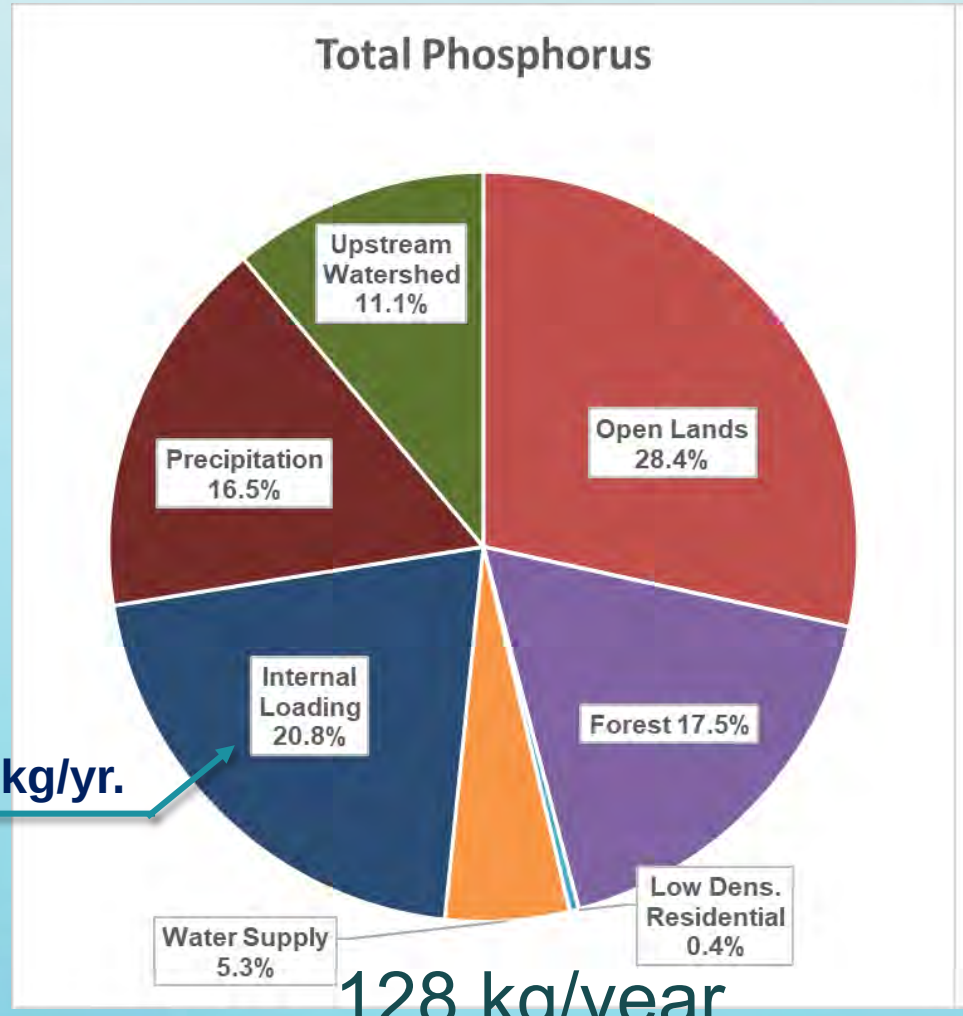
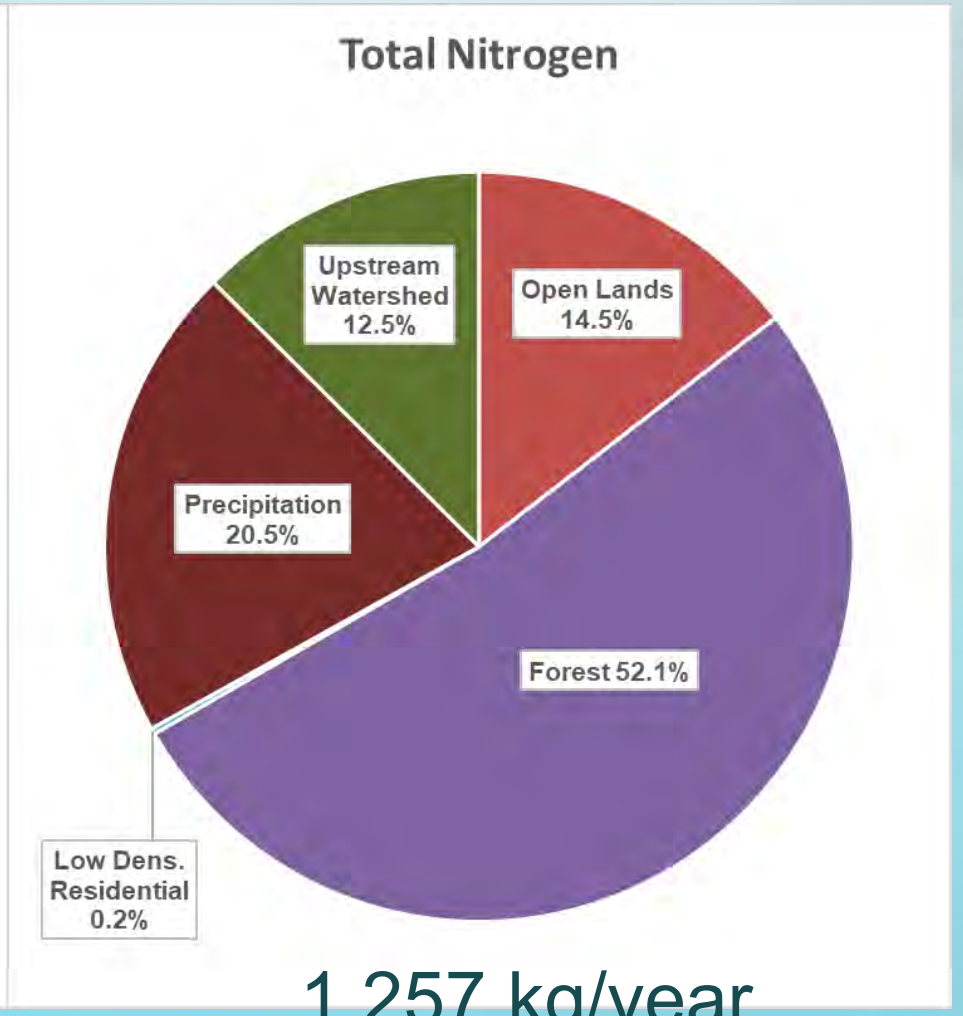
Lake Oscaleta Annual Pollutant Budgets



27 kg/yr.

128 kg/year



1,257 kg/year

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Lake Waccabuc Nutrient Budgets

Nutrient Budget Calculations and Results for Lake Waccabuc Watershed							
Land Use	Area (ha)	Loading Coefficients (kg/ha/yr)		Annual Load (kg/year)		Annual Load (Percent)	
		TP	TN	TP	TN	TP	TN
Open Water	56.74			0.0	0.0	0.0%	0.0%
Open Lands	110.44	1.1	5.5	121.5	607.4	12.3%	30.2%
Mod./High Dens. Residential	1.09	1.1	5.5	1.2	6.0	0.1%	0.3%
Forest	195.44	0.0685	2.0	13.4	390.9	1.4%	19.4%
Low Dens. Residential	6.39	0.725	4.335	4.6	27.7	0.5%	1.4%
Water Supply						0.0%	0.0%
Internal Loading				755.0		76.3%	0.0%
Precipitation	56.74	0.4715	5.75	26.8	326.2	2.7%	16.2%
Upstream Watershed				66.8	653.5	6.8%	32.5%
Totals				**989.3**	**2011.7**	**100%**	**100%**

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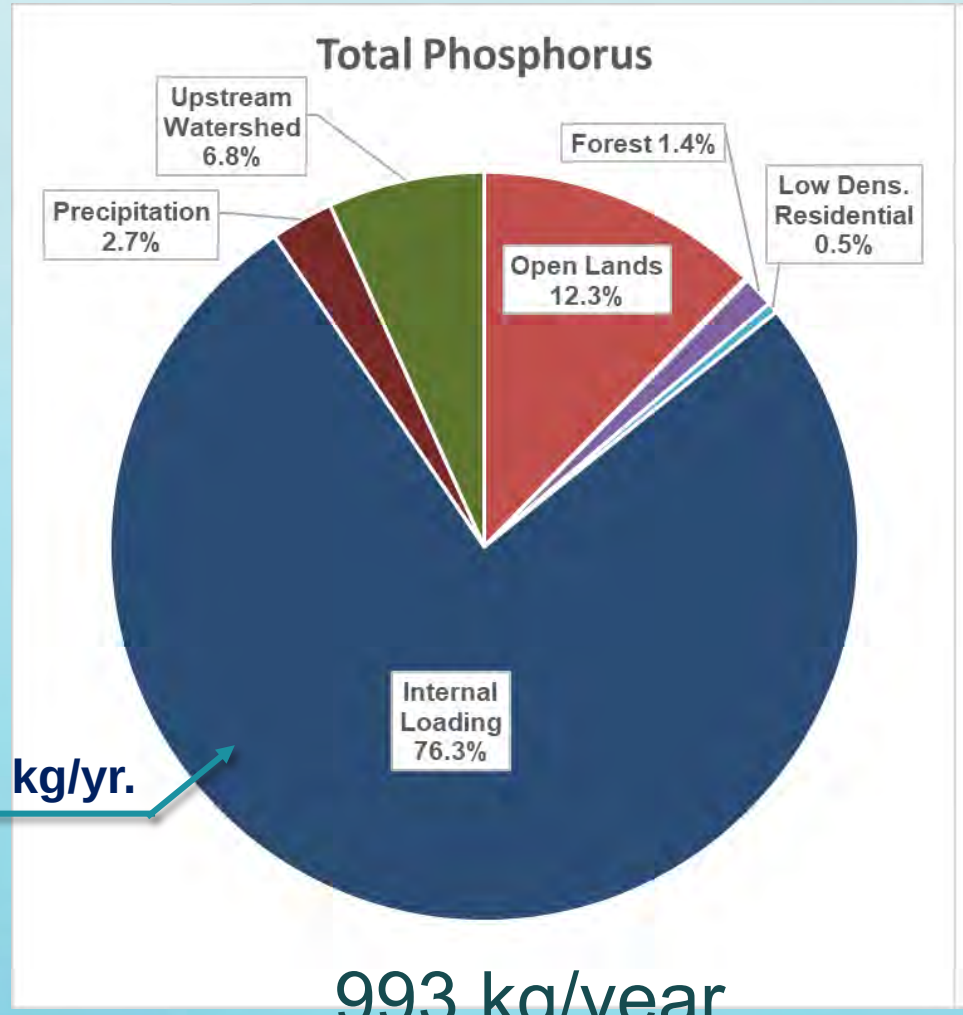
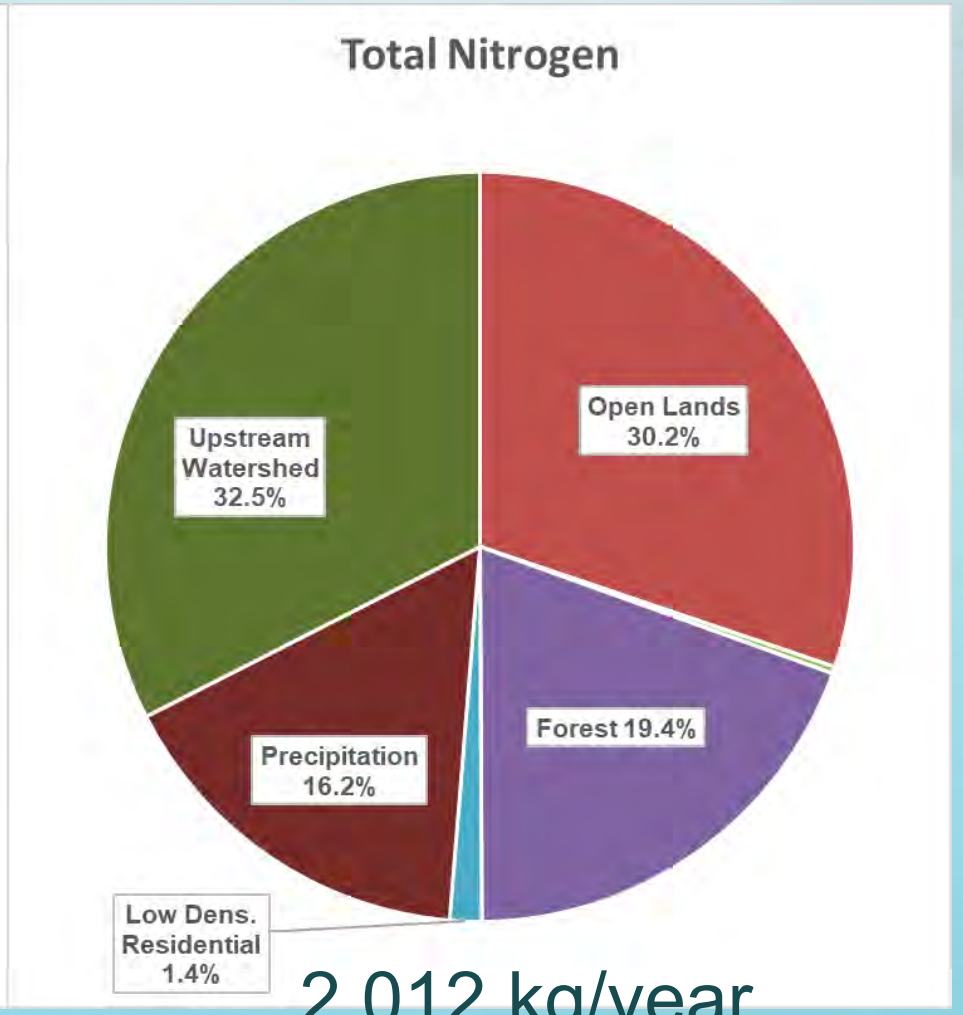
Lake Waccabuc Annual Pollutant Budgets



993 kg/year



2,012 kg/year

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Phosphorus Reduction to Reach *0.20 mg/L and Recommended Management Practices

- Lake Rippowam: 8.3 kg/year (30 percent)
  - Switching to alternate water supply anti-corrosion measure (25%)
  - Modest changes in SW management of impervious surface runoff
- Lake Oscaleta: 34.5 kg/year (0-14 percent)
  - Switching to alternate water supply anti-corrosion measure (5%)
  - Modest changes in SW management of impervious surface runoff
  - Minimizing internal phosphorus load (Aeration, Alum or PhosLock®) (21%)
- Lake Waccabuc: 873-928 kg/year (88-94 percent)
  - Minimizing internal phosphorus load (Aeration, Alum or PhosLock®) (76%)
  - Moderately aggressive stormwater management
    - Dirt & gravel roads, Impervious surfaces, Untreated runoff from paved roads

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*DEC State Standard

Watershed Management Recommendations

- Install Stormwater Management measures at Mead Street and Post Office parking lot
- Install Stormwater Management measures and replace aggregate on Tarry-A-Bit and Old Pond Roads
- Reduce residential runoff using rain barrels and rain gardens (infiltration)
- Seek alternative anti-corrosion method for water supply
  - HABs study recommends targeting dissolved bio-available forms of phosphorus

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In-Lake Management Recommendations

- Rippowam
  - Seek alternative anti-corrosion method for water supply
- Oscaleta
  - Seek alternative anti-corrosion method for water supply
  - Phosphorus inactivation using aluminum salts (alum)
    - $193,000 (versus PhosLock at $562,545)
- Waccabuc
  - Phosphorus inactivation using aluminum salts (alum)
    - $391,000 (versus PhosLock at $1.2M)

Internal Loading Alternative: Aeration

- Bubble plume diffusers
  - Installation cost $0.5M to $2.5M
  - Annual operating cost $30K to $140K
- Whole Lake Circulation NOT Recommended
  - Destroys stratification
  - Eliminates cold-water habitat
  - May not eliminate internal loading

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Monitoring Recommendations

- Continue annual lake monitoring
- Map aquatic plants annually
- Develop a comprehensive aquatic plant management plan, including rapid response plan
- Continue to test cyanobacteria blooms for toxins
- Conduct a fisheries study to assess health of fisheries and develop scientifically-based recommendations for stocking

Thank you . . .

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THREE LAKES COUNCIL

CEDARWOOD ENGINEERING & ENVIRONMENTAL SERVICES, PLLC