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Let it Snow! What Can Winter Water Quality Data Tell Us?

Anthony Prestigiacomo, Research Scientist

Lewis McCaffrey, Aimee Clinkhammer, Scott Cook

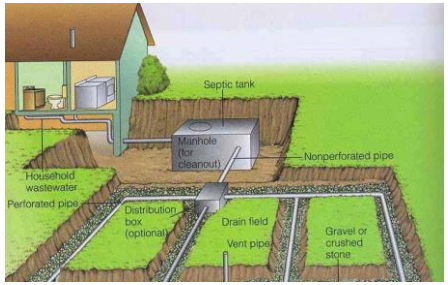
NYSDEC, Division of Water, Bureau of Water Assessment & Management, Finger Lakes Watershed Hub

NYSFOLA
May 3, 2019

The Finger Lakes

11 large glacially formed lakes in CNY

- Economically important resources
- Range in water quality, size, volume, and uses
  - Drinking water
  - Primary and secondary contact recreation
  - Fishing


Septic tank
Manhole (for cleanout)
Nonperforated pipe
Household wastewater
Perforated pipe
Distribution box (optional)
Drain field
Vent pipe
Gravel or crushed stone


Hemlock and Canadice


Honeoye


Canandaigua


Otisco


Seneca


Cayuga


Owasco


Skaneateles

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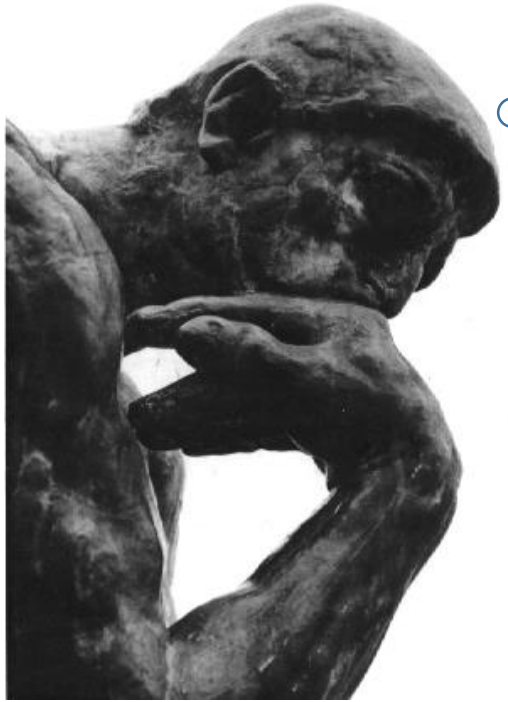
Why Winter Limnology?

- Twiss and Stryszowska (2016)
  - lack of winter data in the Great Lakes . . . major knowledge gap and a limit “into ecosystem function.”
- Lack of seasonal lake data
  - an important gap at the SUNY-ESF/NYSDEC Research Symposium (May 2017).
- Utility in lake monitoring and assessments and modeling
- Important historical perspective for the Finger Lakes

DEC Winter Limnology Started with a Question . . .

I wonder what frostbite feels like?

Winter Limnology Started with a Question . . .



Are we missing anything?

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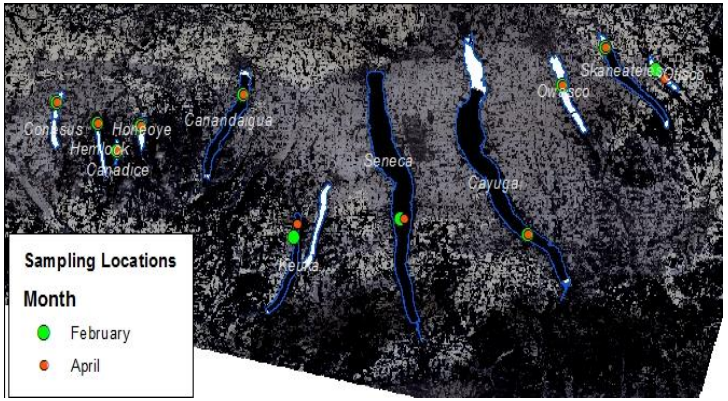
The Program, 2018

Eleven Finger lakes

- February and April 2018
- Chemistry samples in upper waters and deeper waters
  - N, P, carbon, silica
  - chlorophyll-a and microcystin
- Field measurements and conditions
  - Multiprobe, Secchi depth
- Biology samples
  - Zooplankton, phytoplankton, *in situ* fluorometer



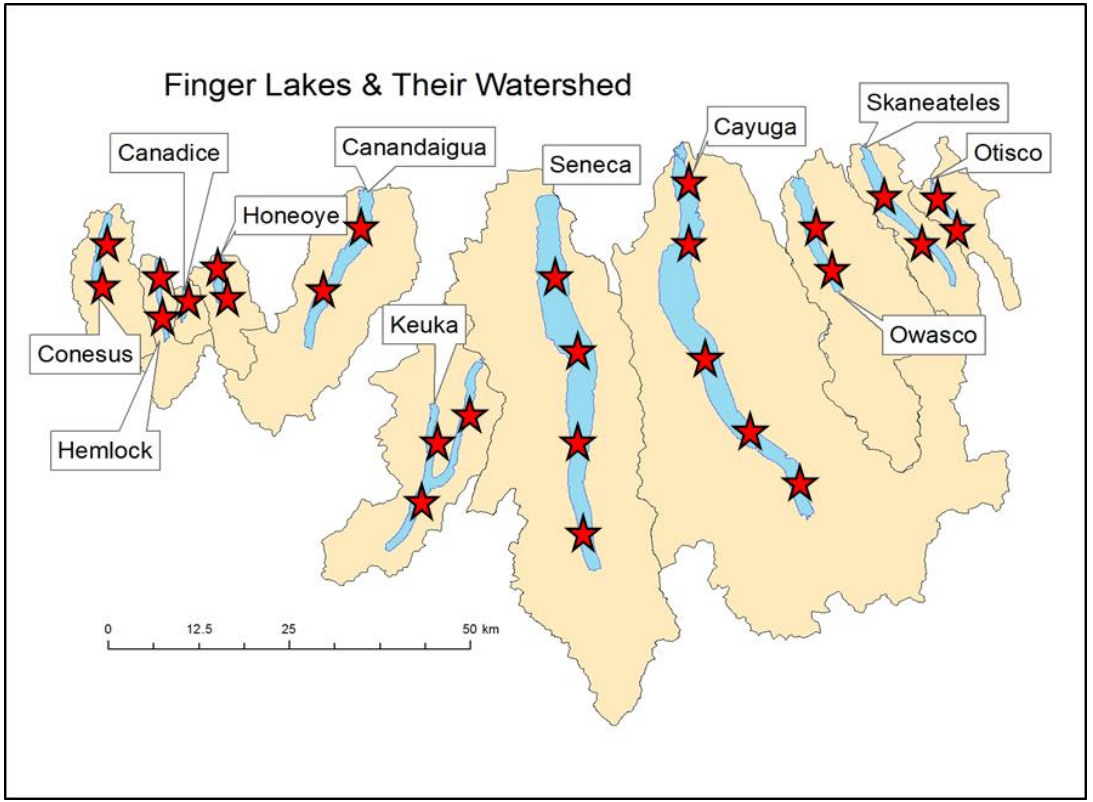
NYSDEC CSLAP in the Finger Lakes

22-26 Locations on 11 lakes

Twice per month, June – September

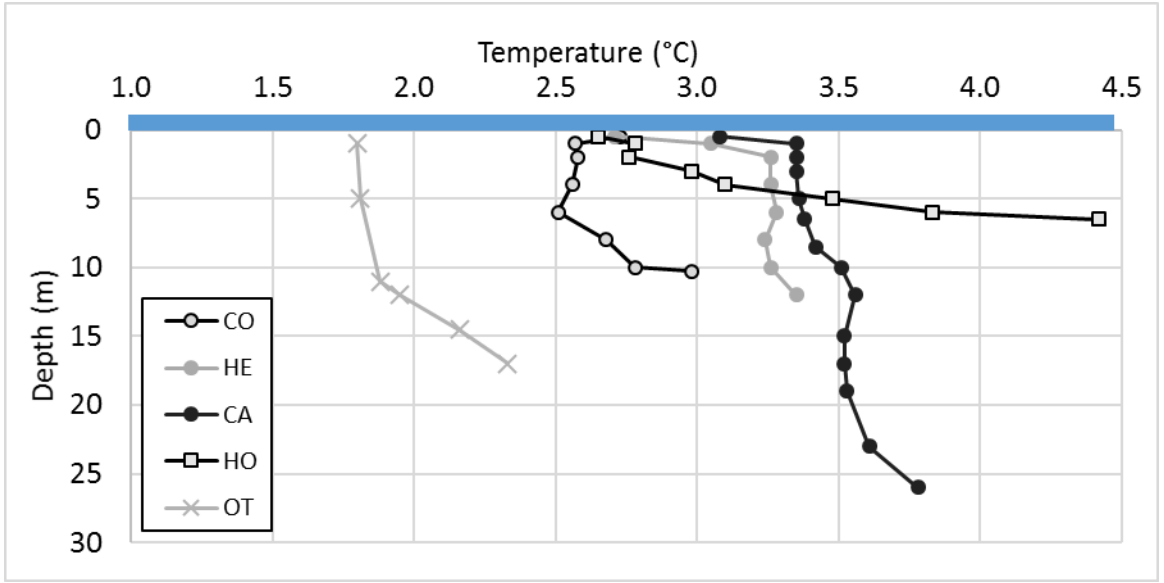
Analyses:

- Nutrients/forms (phosphorus and nitrogen)
- Chlorophyll-a, algae indicators, and toxins
- Clarity (Secchi disk), user perception
- Calcium, pH, conductivity
- Dissolved carbon



Preliminary Results

February: Ice Covered Lakes



Some vertical structure in temperature in ice-covered lakes

- Not much change but enough for environmental significance

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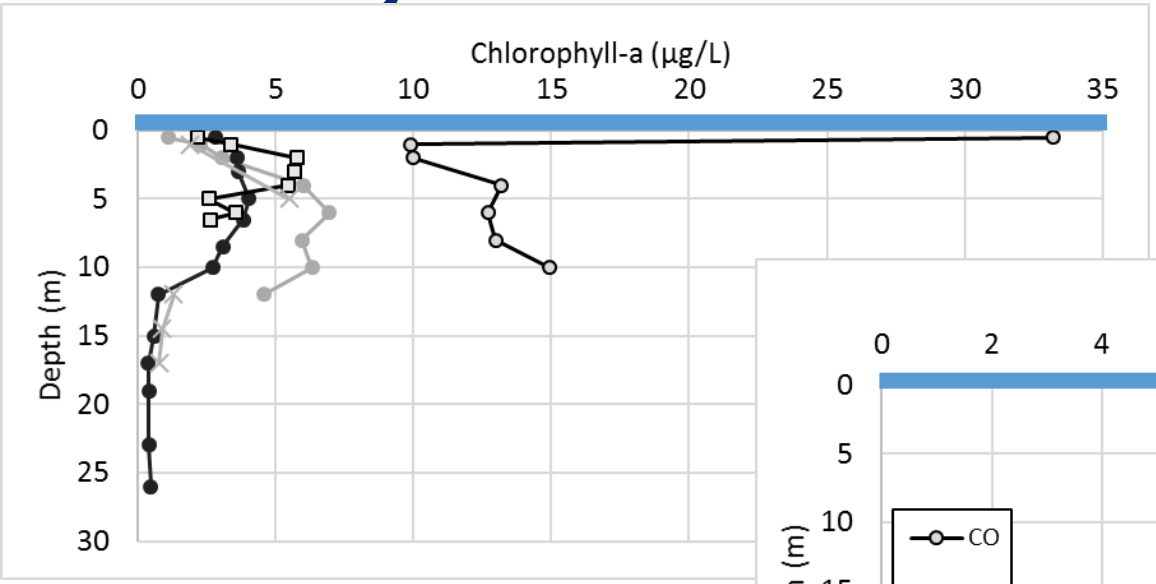
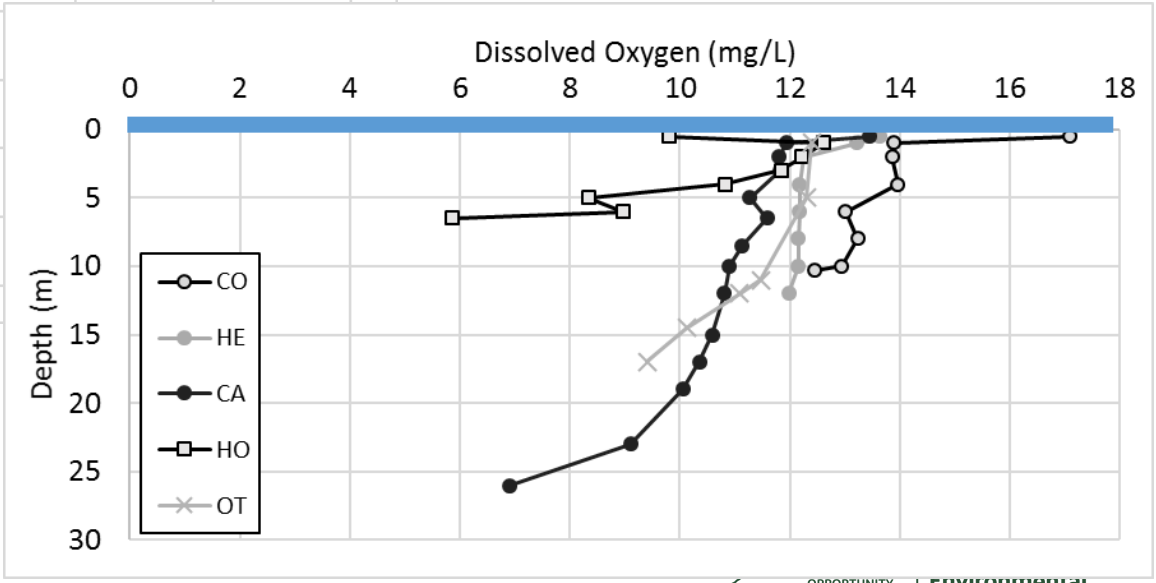
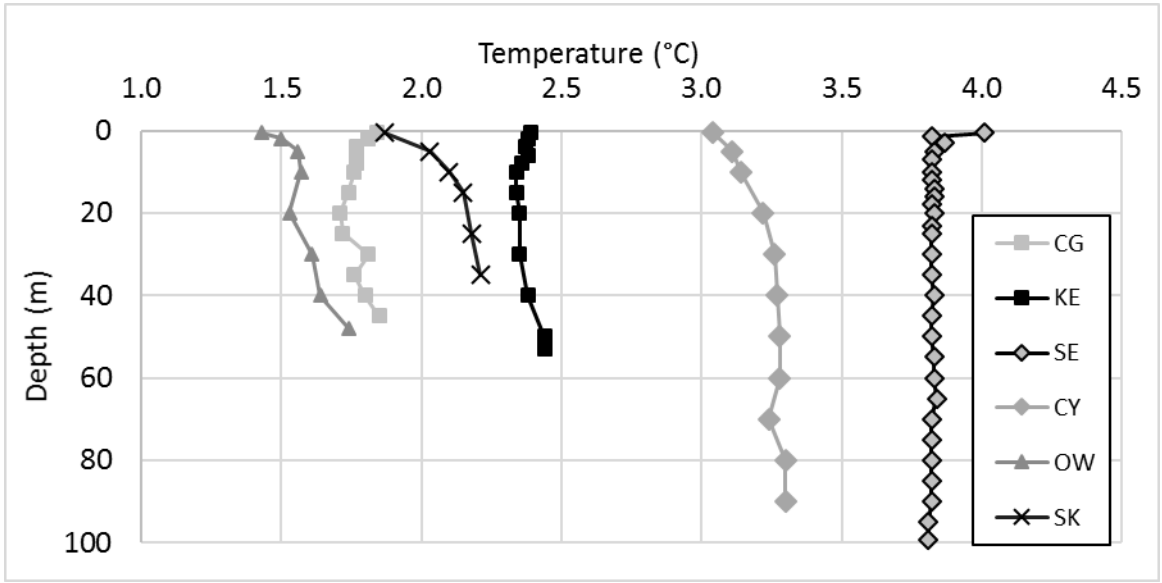
February: Ice Covered Lakes





February: Open Water Lakes



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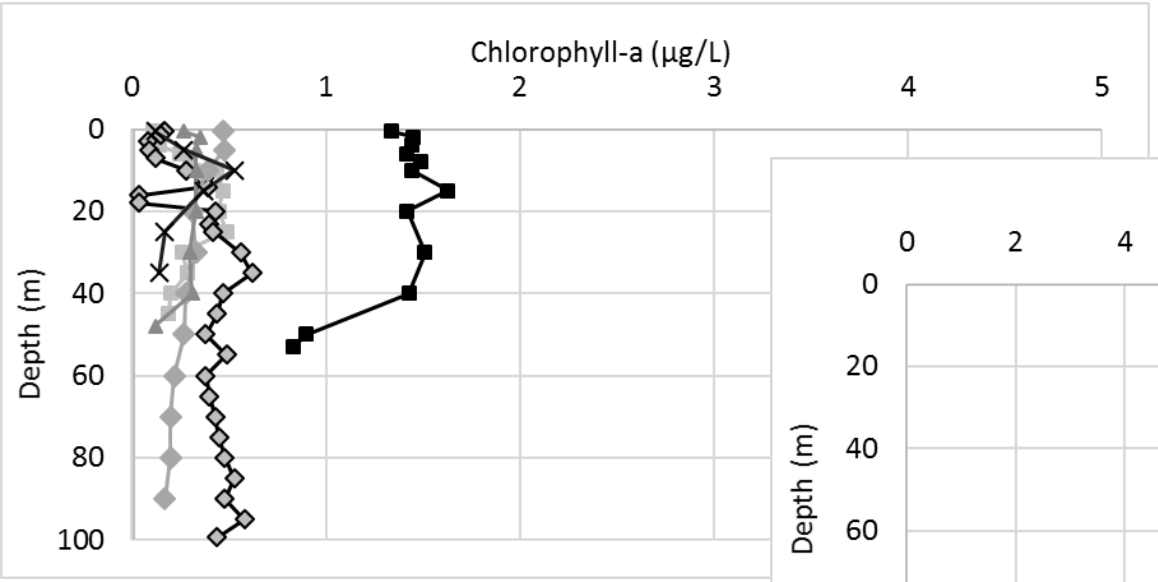
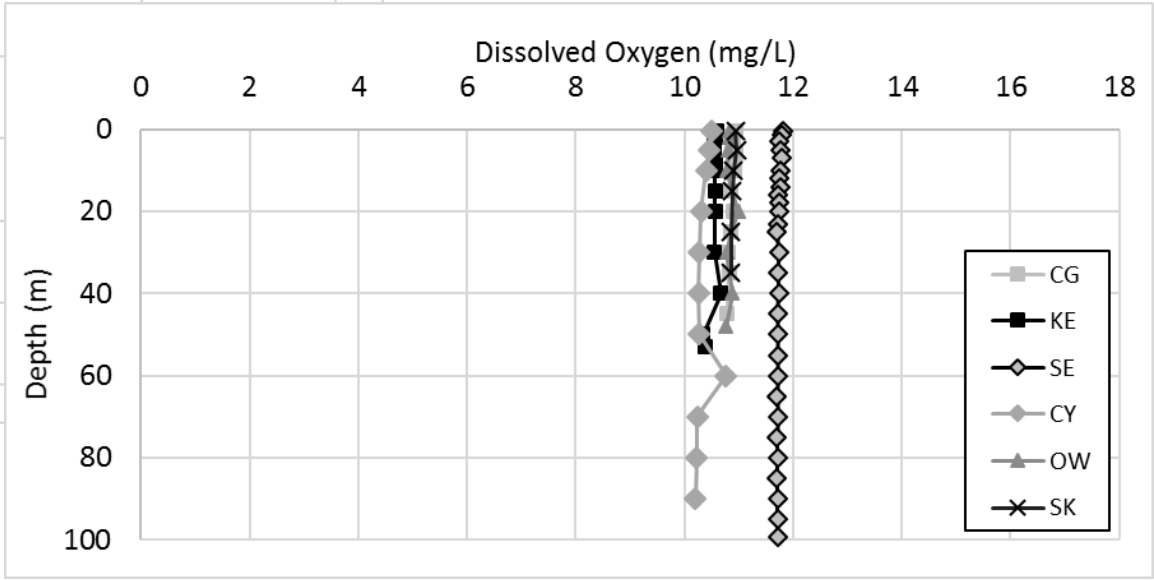
February: Open Water Lakes





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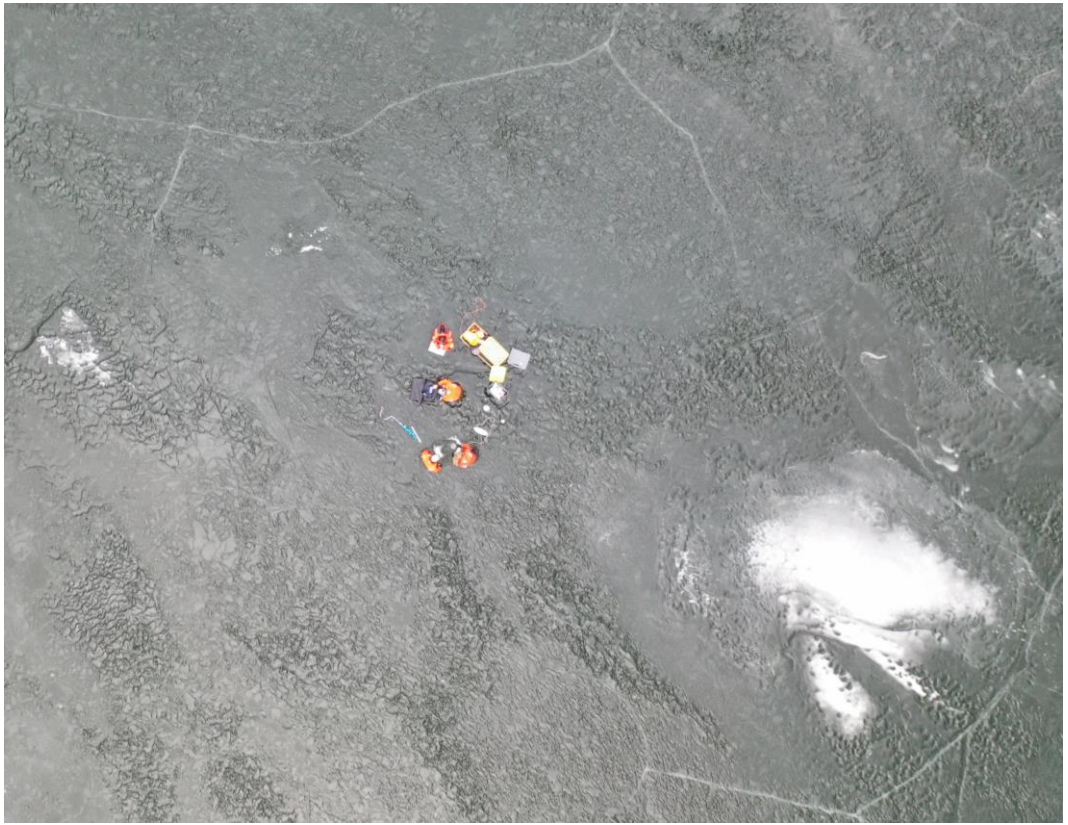
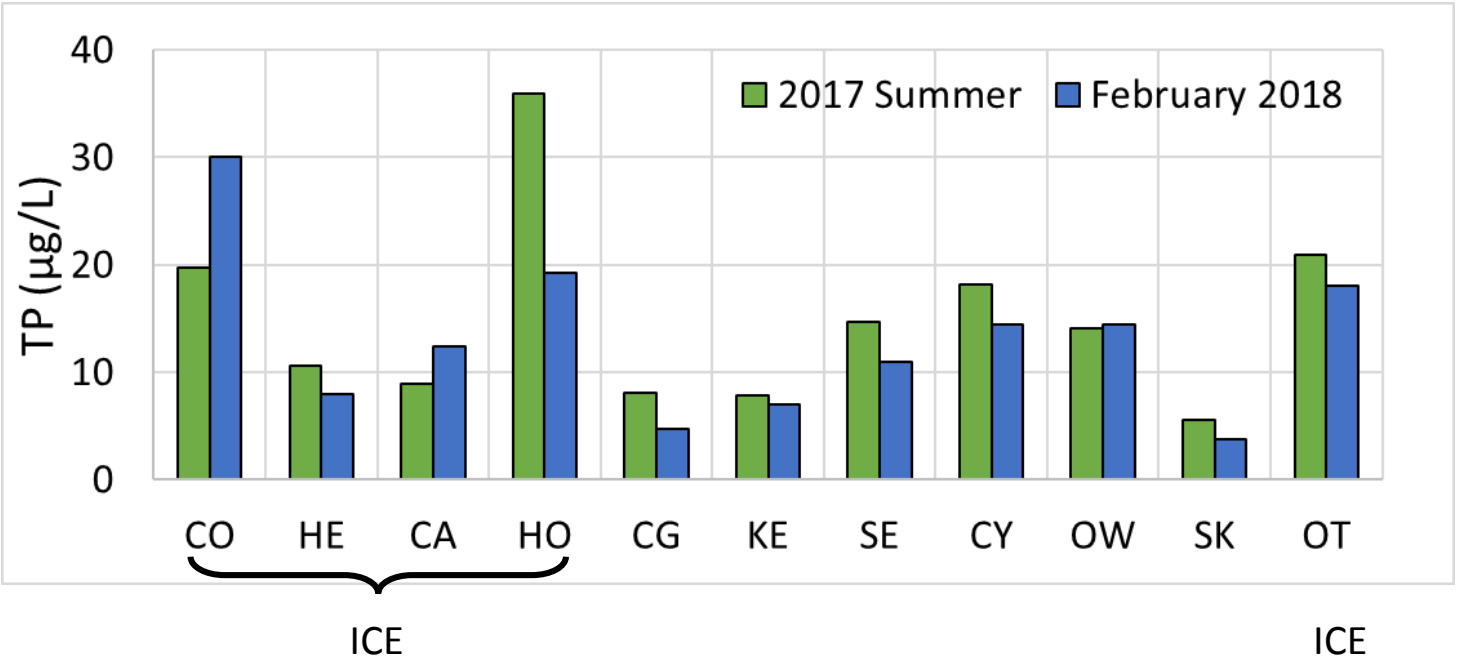


Summer vs Winter: Total P



Some major differences in TP Summer and February

- Conesus
- Honeoye

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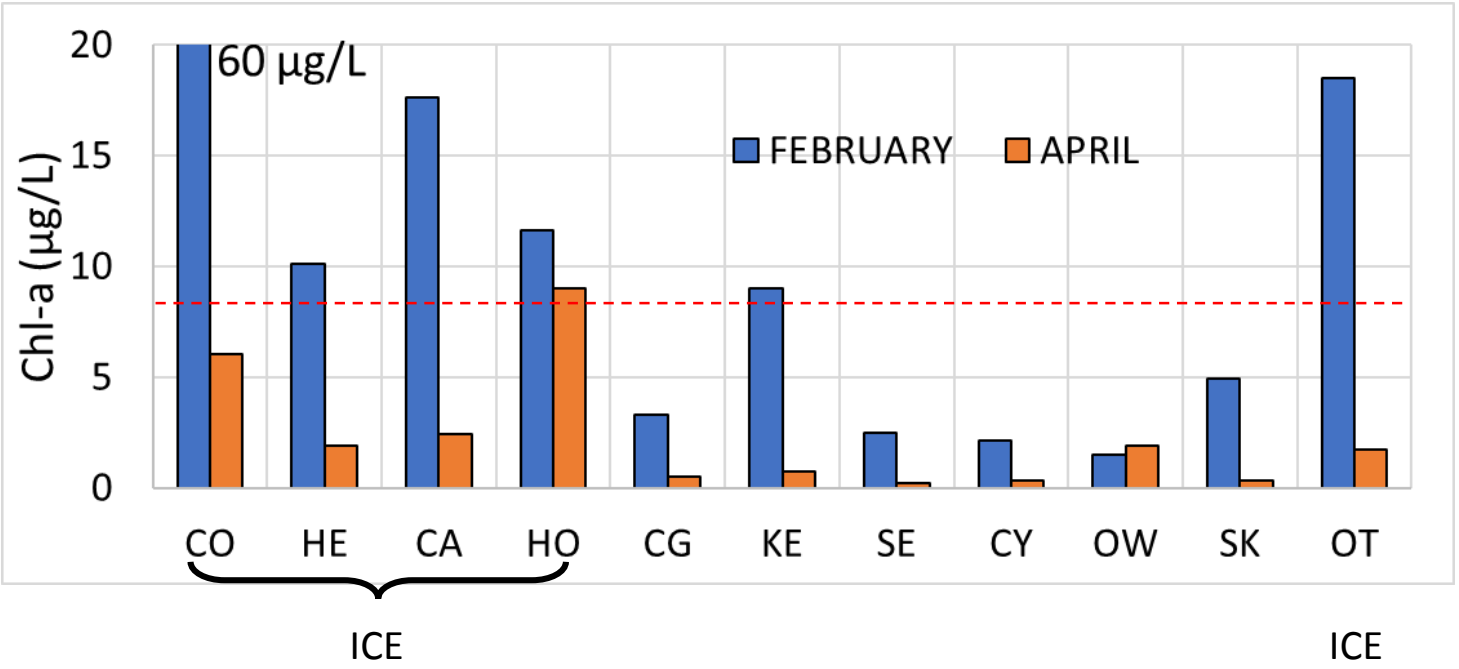
Winter Productivity*



Very high Chl-a in February

- Conesus ~ 60 µg/L
- Eutrophic Lakes by NYS Chl-a standard (8 µg/L)

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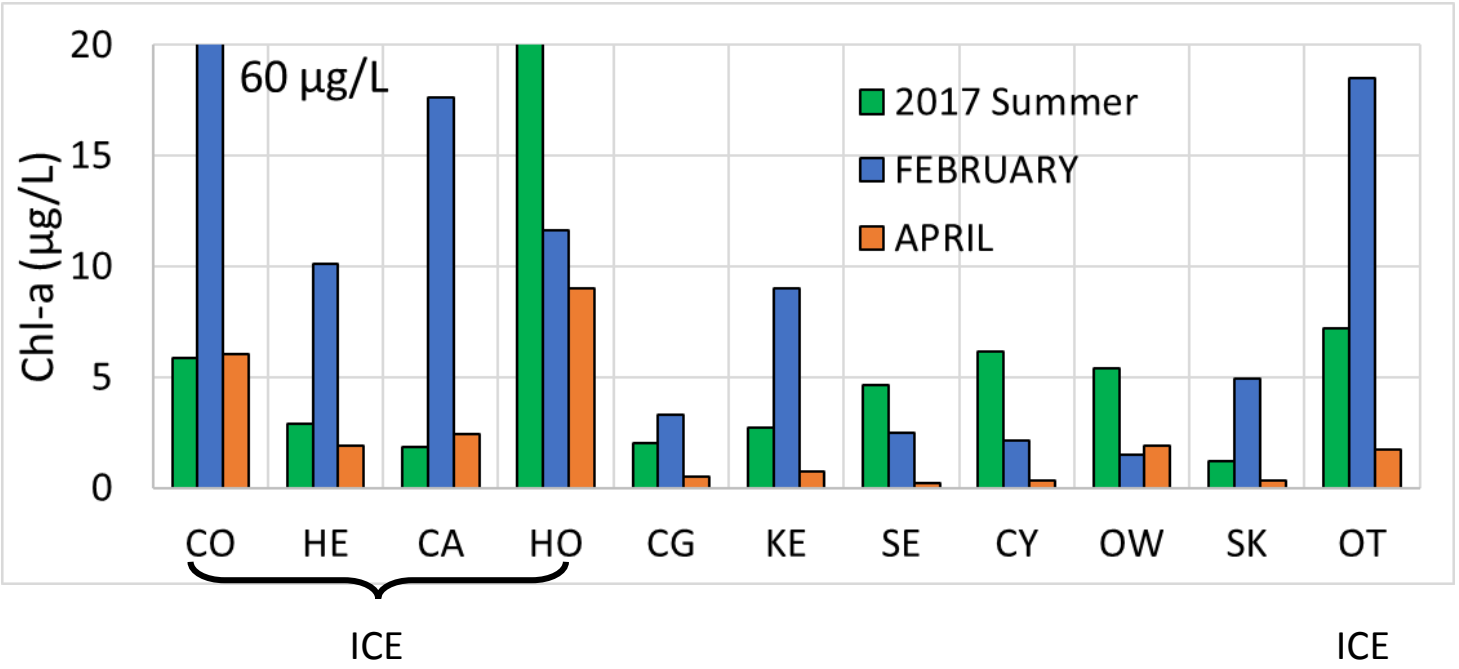
Summer vs Winter: Chlorophyll-a



Some lakes had higher Chl-a in February compared with the summer average

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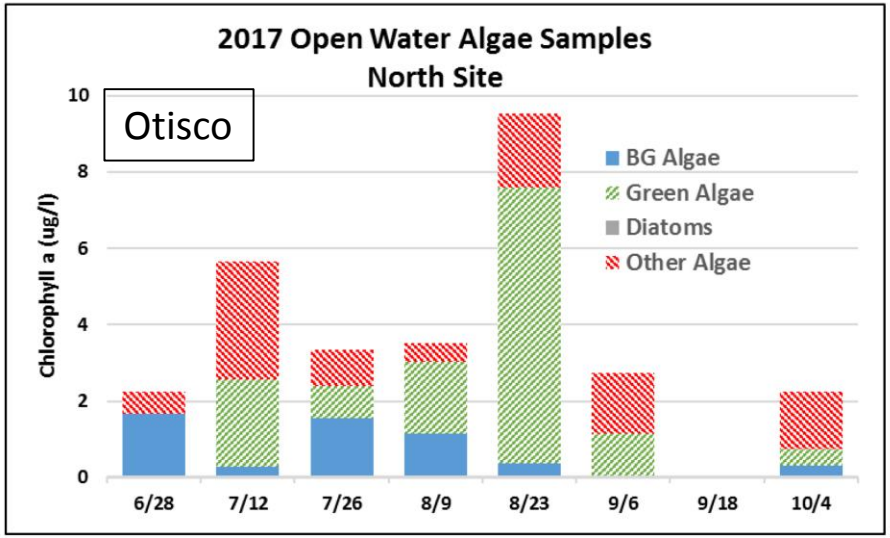
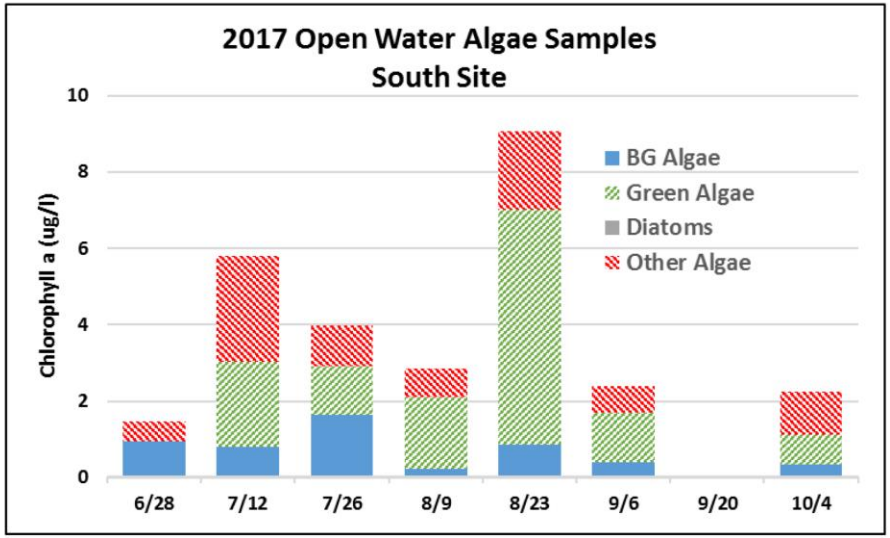
Summer Phytoplankton Community





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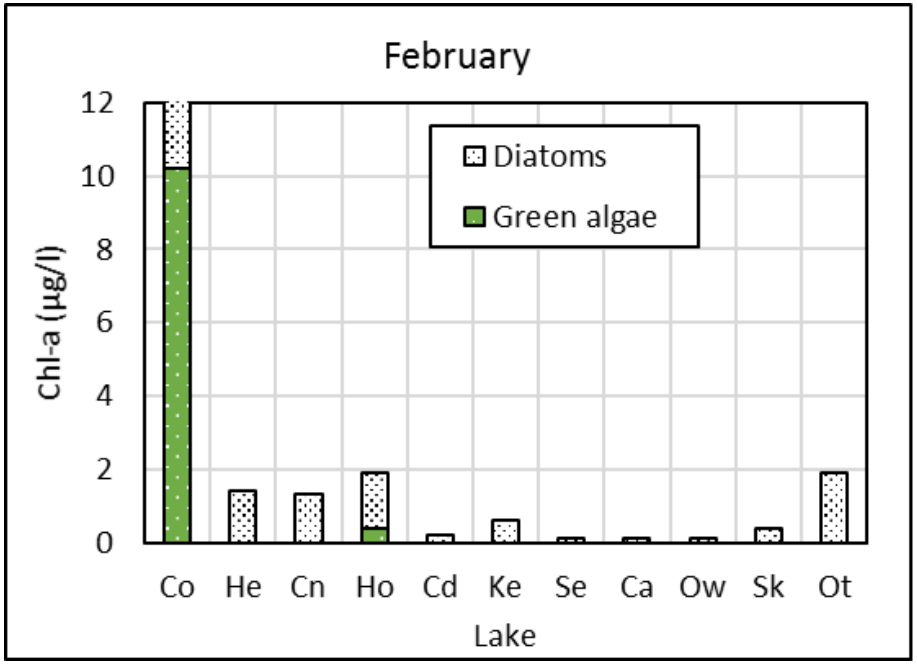
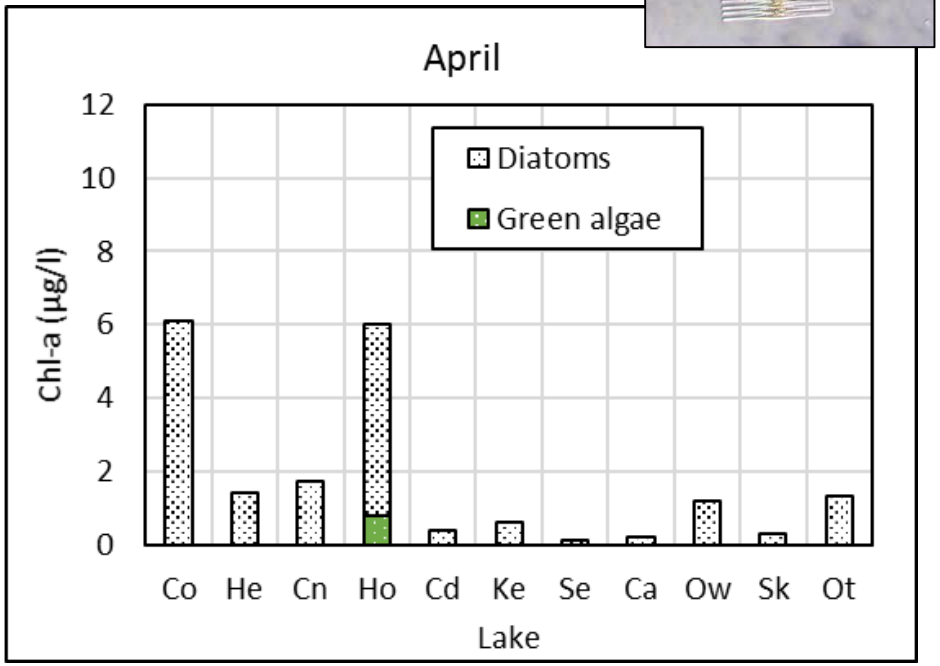
Winter Phytoplankton





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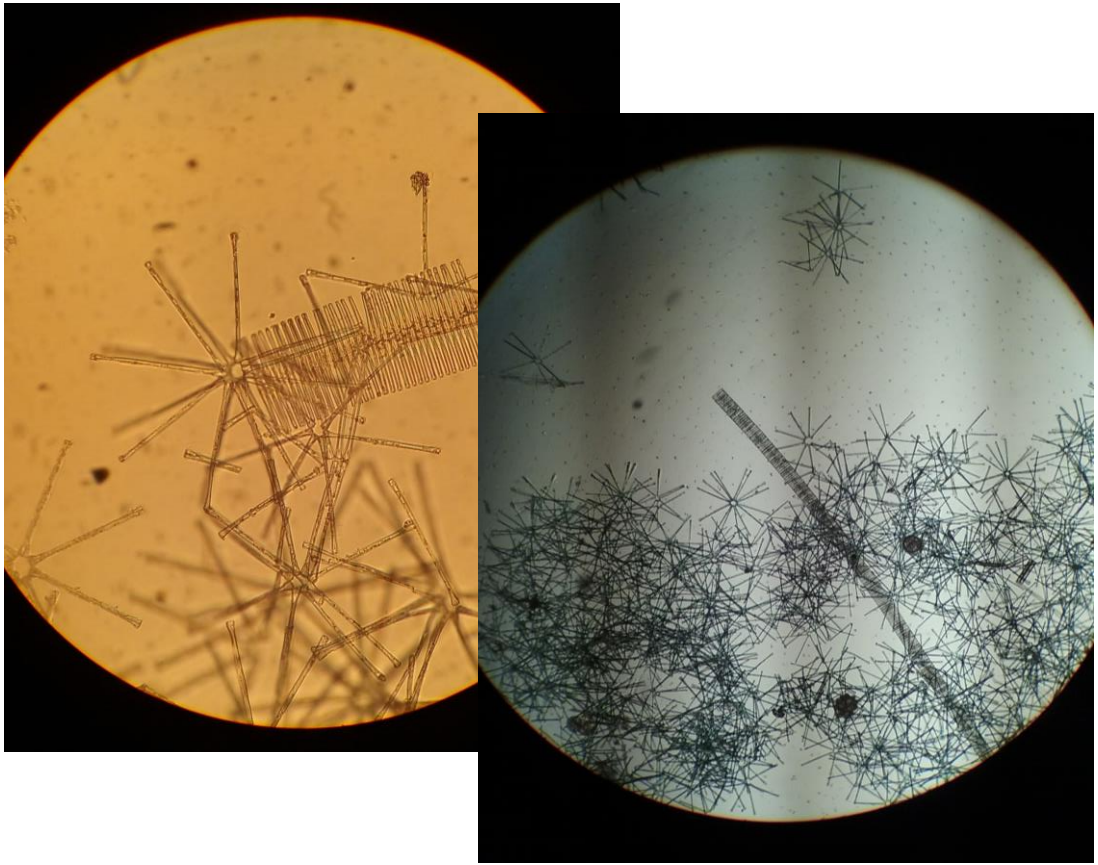

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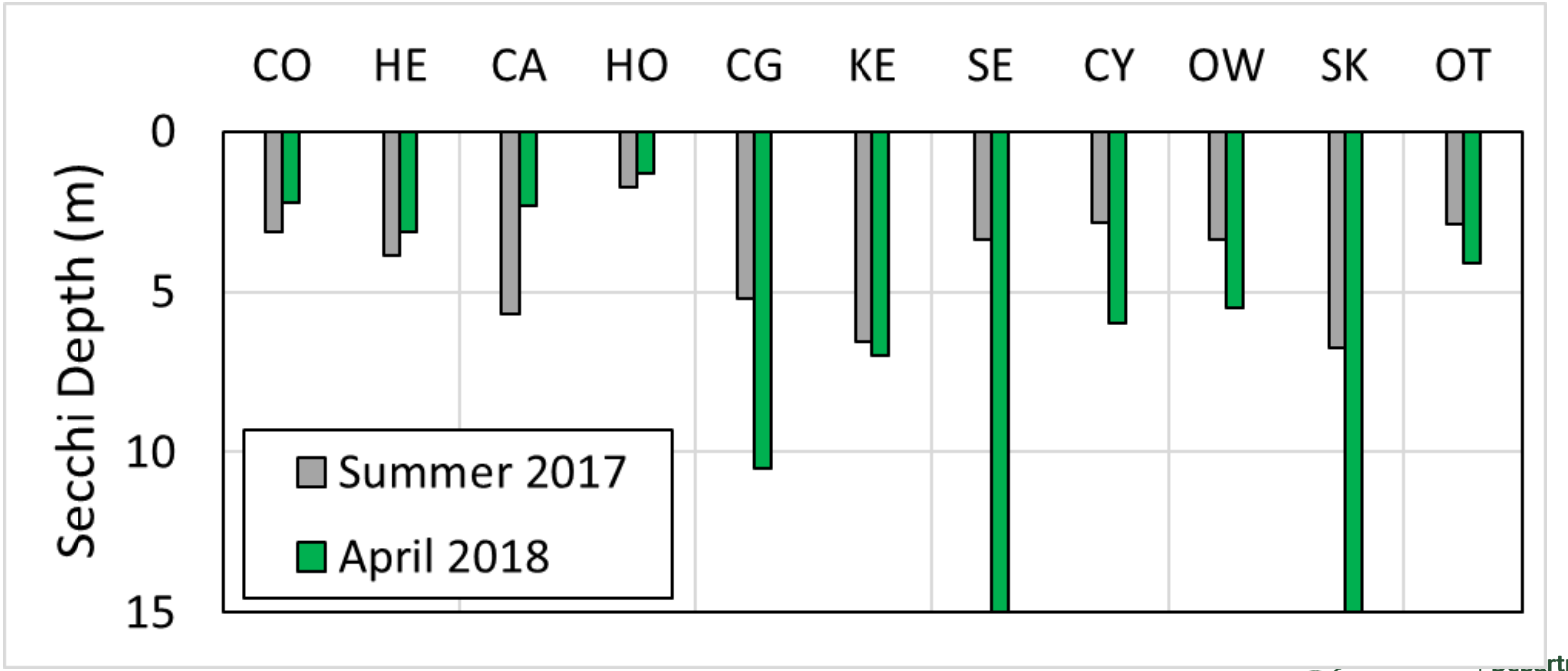
Clarity on Ice-Covered Lakes

- Difficult due to Secchi size, augur hole
- Interpreting is difficult
  - the light field under ice is different than through the hole

Clarity: April vs. Summer



A Historical Perspective

Winter/spring TP concentration *had* historically been used as a metric of water quality

- Sawyer 1974, Sakamoto 1967
- Dillon and Rigler 1974a

➢ Olgesby and Schaffner, 1978

  - loading and trophic state analysis of 13 NYS lakes (all 11 Finger Lakes)

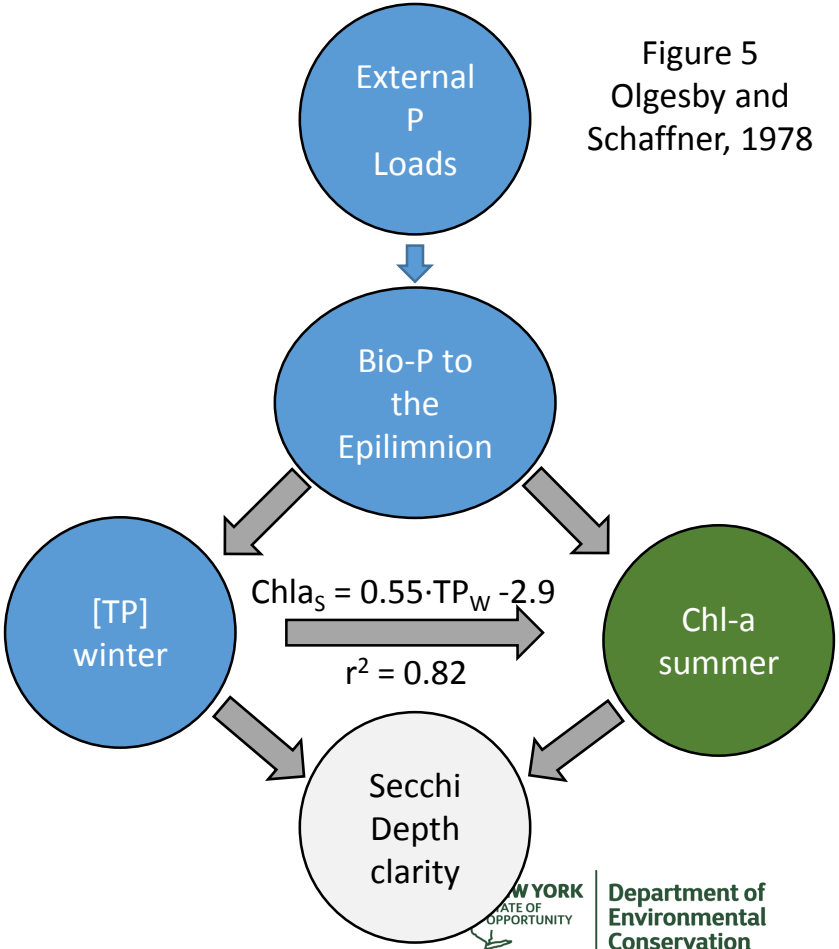
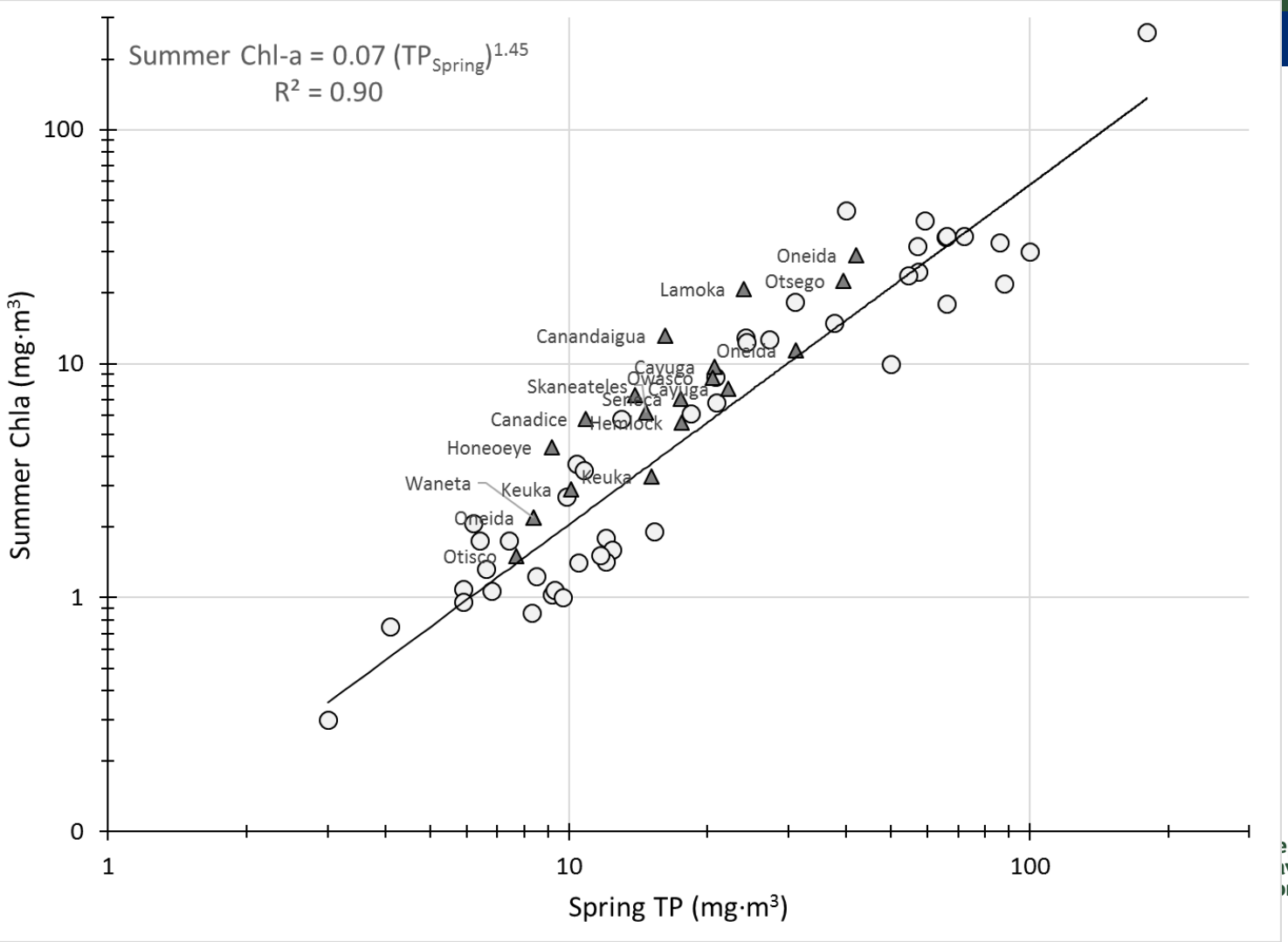
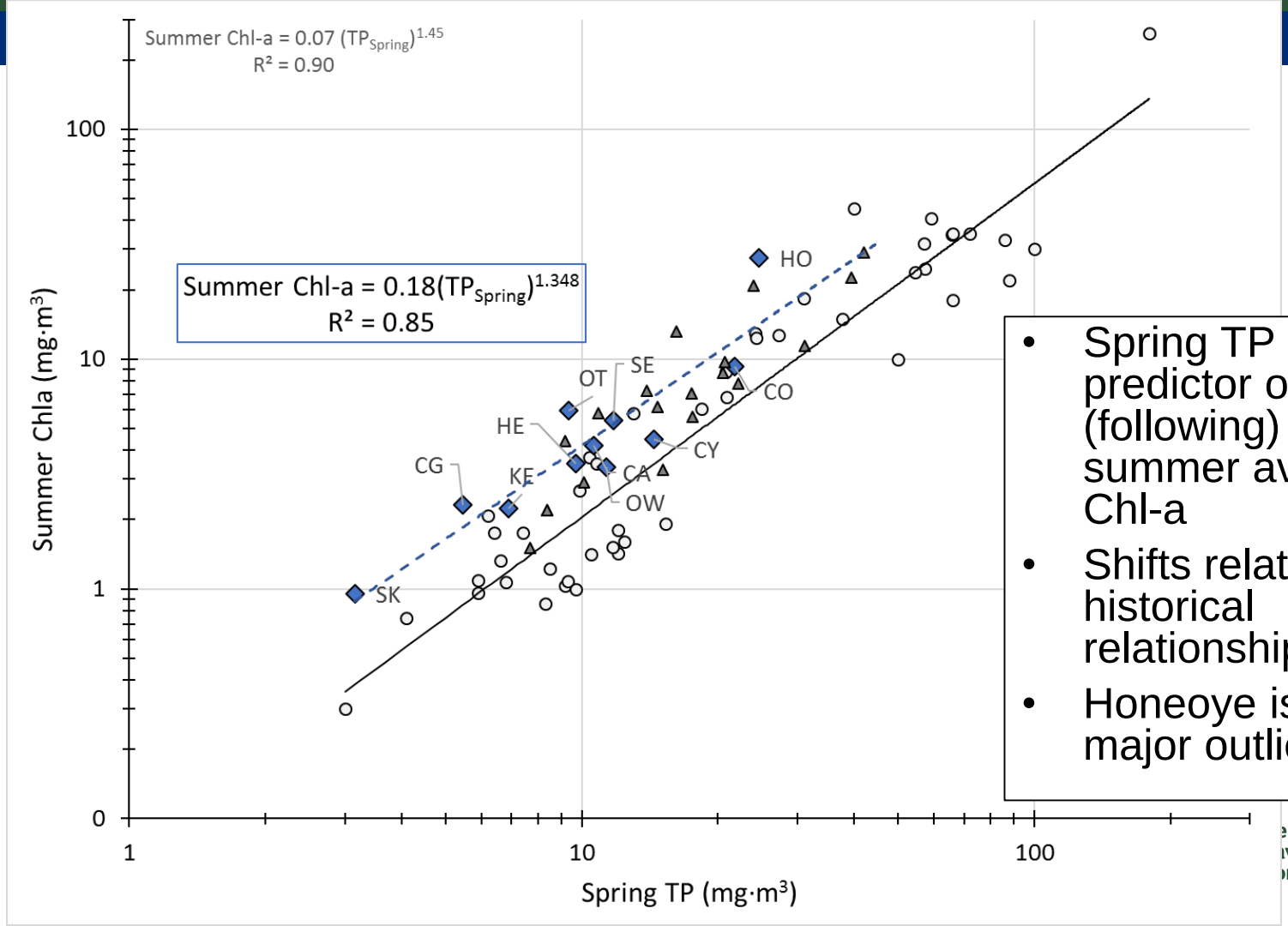
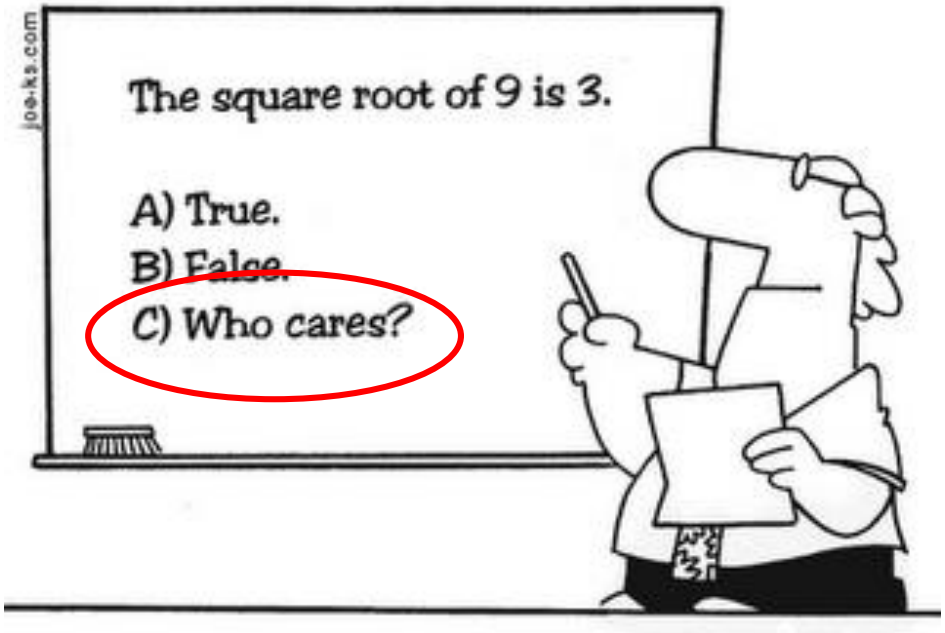


Figure 5
Olgesby and Schaffner, 1978

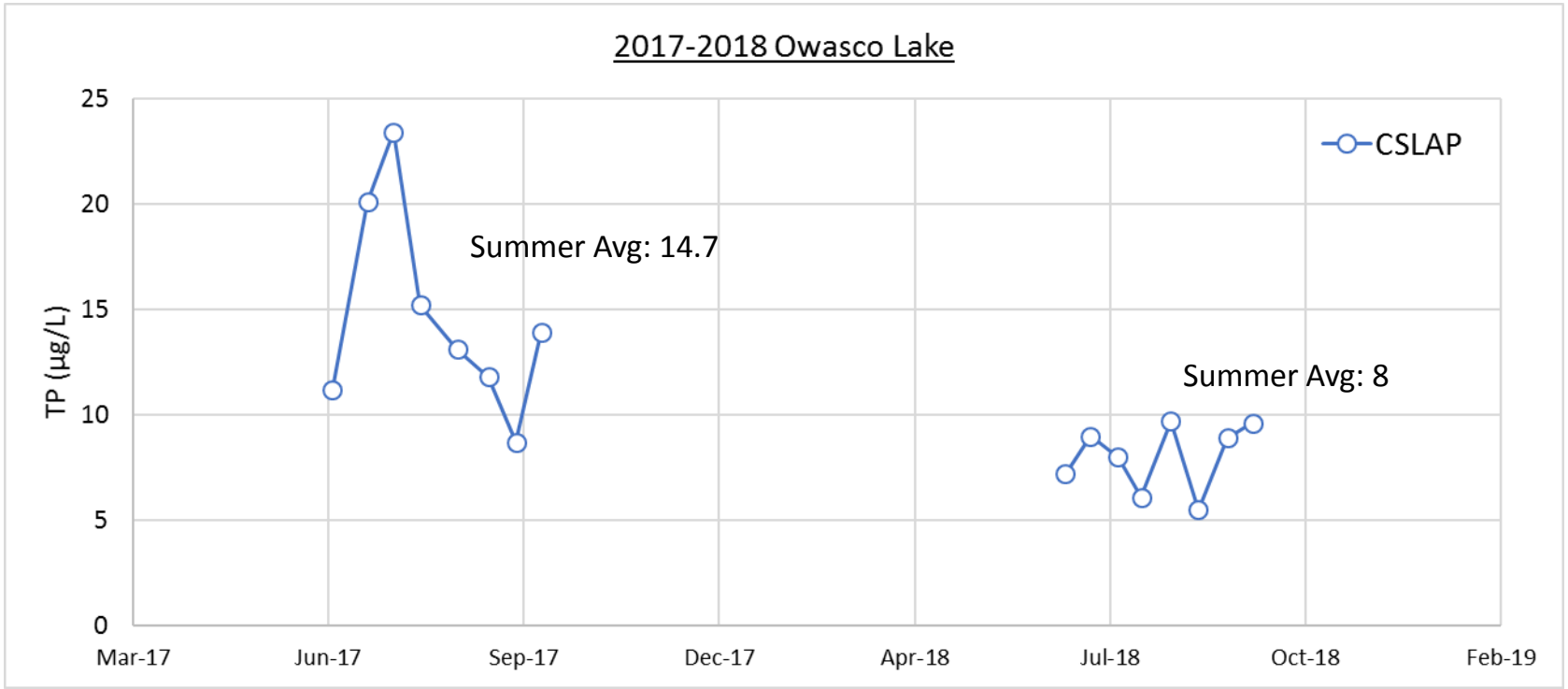

Summer Chl-a = 0.07 (TP$_{Spring}$)$^{1.45}$
R^2 = 0.90
Summer Chla (mg·m^3)
Spring TP (mg·m^3)
0
1
10
100
1
10
100
Oneida
Otsego
Lamoka
Canandaigua
Oneida
Cayuga
Owasco
Skaneateles
Cayuga
Seneca
Canadice
Hemlock
Honeoeye
Keuka
Waneta
Keuka
Oneida
Otisco



- Spring TP a good predictor of (following) summer average Chl-a
- Shifts relative to historical relationship?
- Honeoye is an major outlier


joe-ks.com
The square root of 9 is 3.
A) True.
B) False.
C) Who cares?

Utility: Understanding Trends



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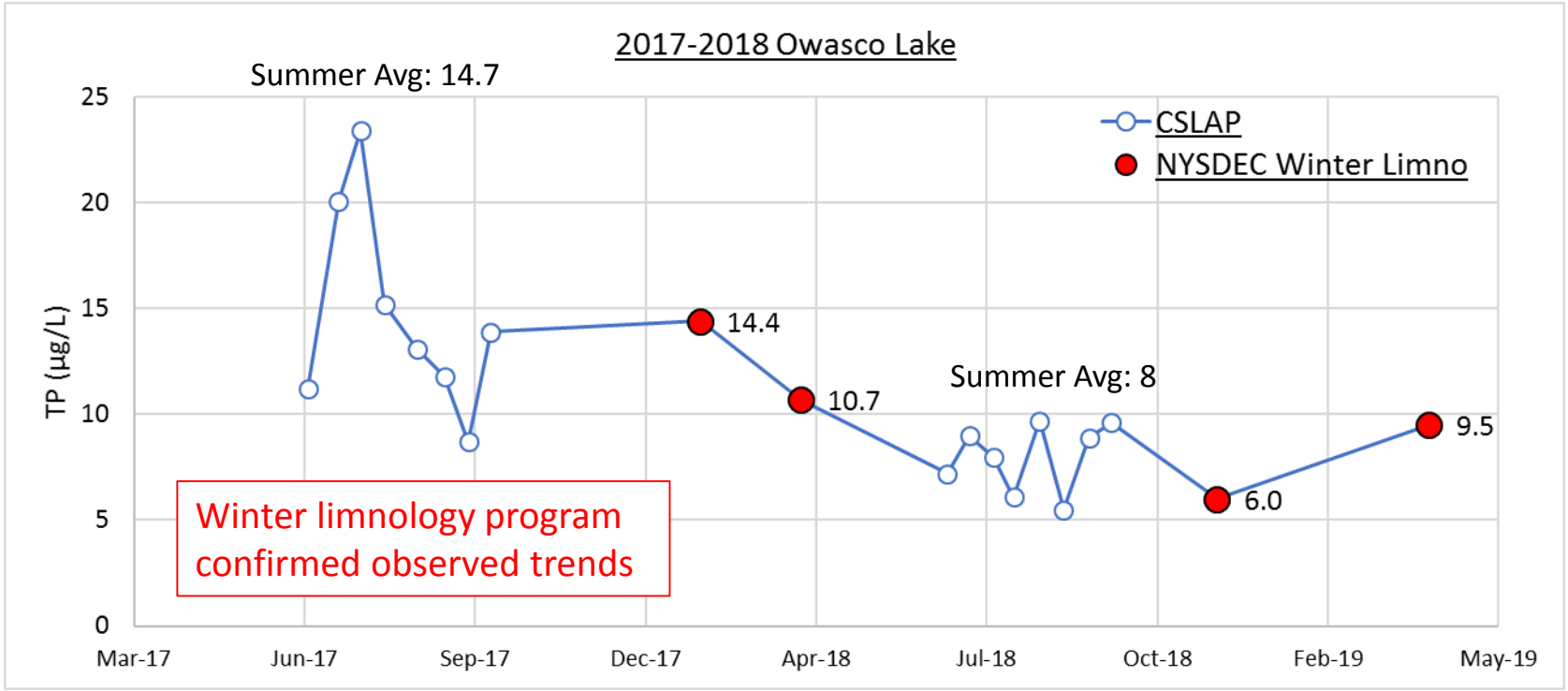
Utility: Understanding Trends



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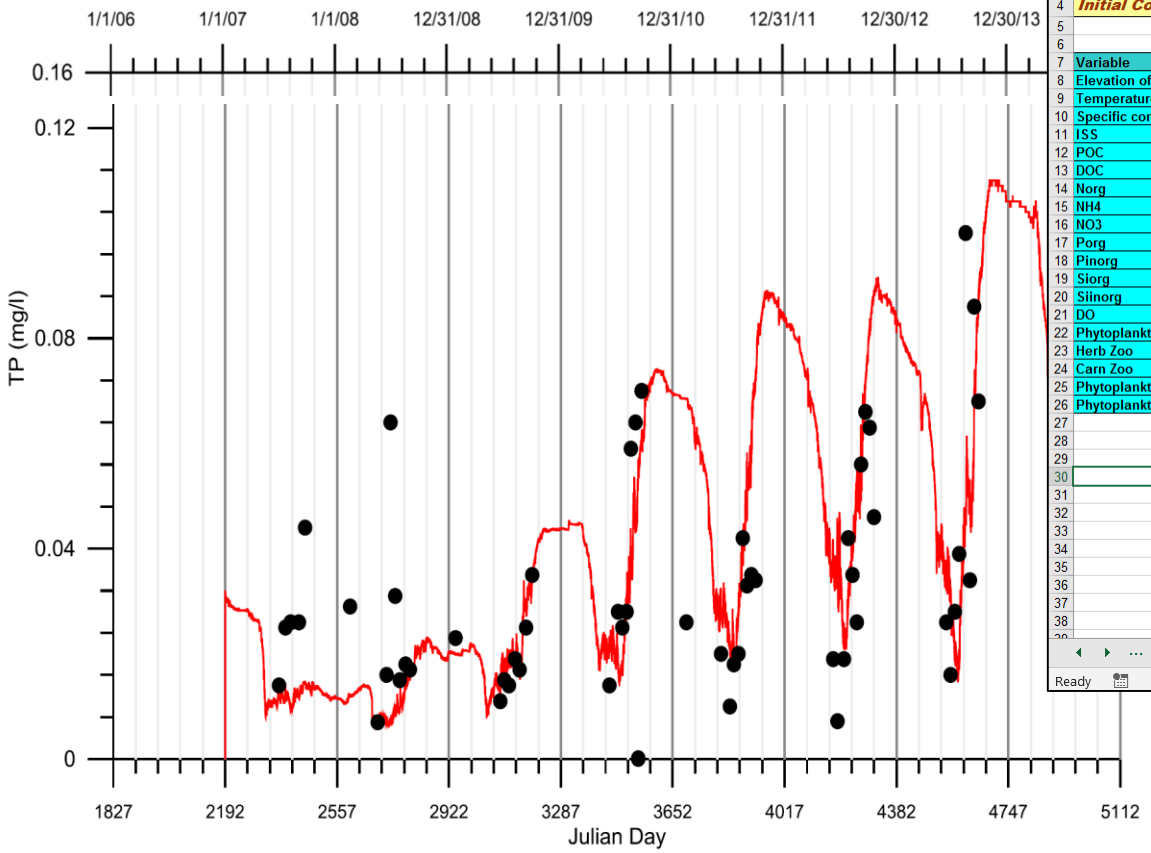
Utility: Use in Modeling



	A	B	C	D	E	F	G
1	LAKE2K						
2	Lake Water Quality Model						RUN
3	Canandaigua Lake						
4	Initial Conditions						Open Old File
5							
6							
7	Variable	Epilimnion	Metalimnion	Hypolimnion	Units		
8	Elevation of top of layer	84.000	74.000	64.000	m		
9	Temperature	1.800	1.760	1.850	C		
10	Specific conductance	390.000	390.000	390.000	umhos		
11	ISS	0.500	0.500	0.500	mgD/L		
12	POC	0.100	0.100	0.100	mgC/L		
13	DOC	3.000	3.000	2.900	mgC/L		
14	Norg	210.000	210.000	210.000	µgN/L		
15	NH4	45.000	45.000	47.000	µgN/L		
16	NO3	264.000	264.000	299.000	µgN/L		
17	Porg	1.500	1.500	1.500	µgP/L		
18	Pinorg	3.500	3.500	3.500	µgP/L		
19	Siorg	140.000	140.000	140.000	µg Si/L		
20	Siinorg	290.000	290.000	290.000	µg Si/L		
21	DO	10.900	10.900	10.800	mgO2/L		
22	Phytoplankton	2.500	2.500	2.500	µgA/L		
23	Herb Zoo	0.02000	0.02000	0.02000	mgC/L		
24	Carn Zoo	0.01000	0.01000	0.01000	mgC/L		
25	Phytoplankton 2	0.000	0.000	0.000	µgA/L		
26	Phytoplankton 3	0.000	0.000	0.000	µgA/L		
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							

... Inflow | Outflow | Initial Conditions | Vertical Mixing | Meteorology | Ice

Ready

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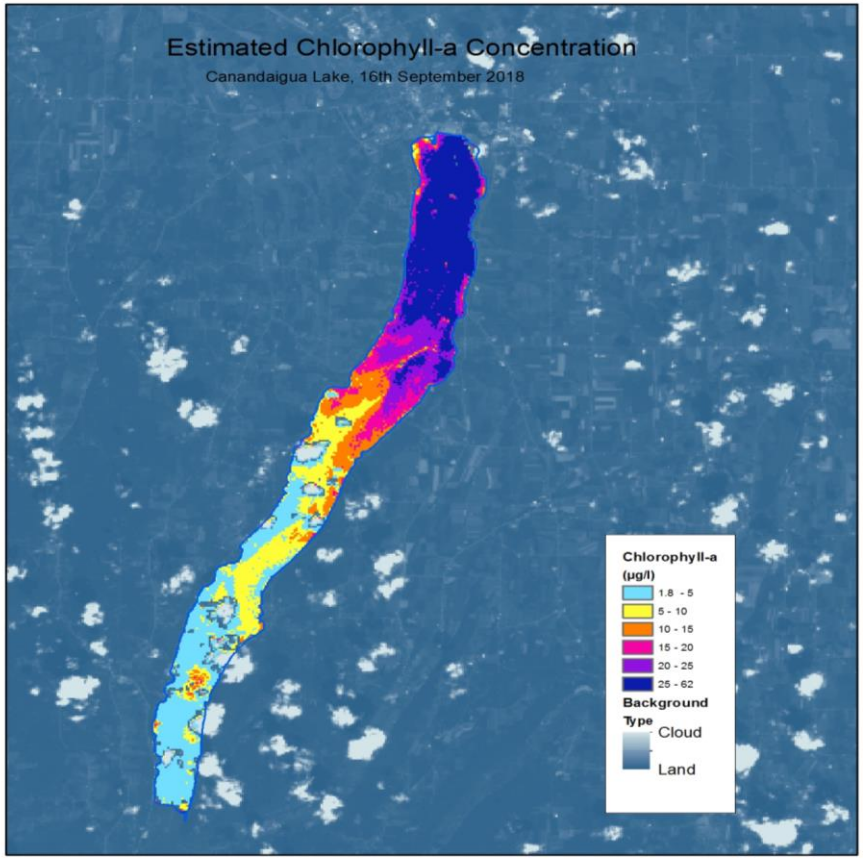

Utility: Odds and Ends

- Remote sensing
  - Satellite imagery calibration
  - Verification of drone photos
- Confirmation
  - lack of cyanotoxins in winter 2018
- Public relations

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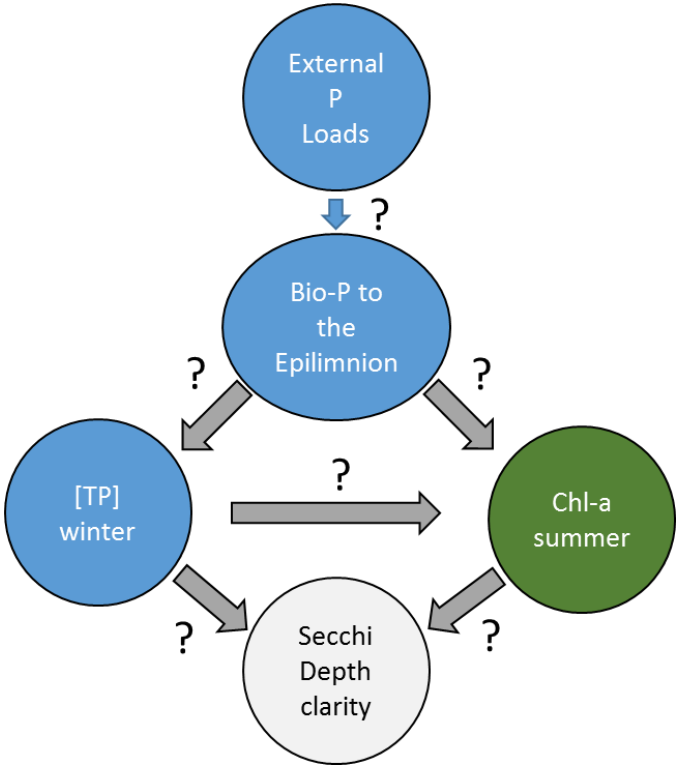
FUTURE

- Data collection in 2019-2020
  - Continued analysis
- Evaluation of current empirical models
  - Changes from past relationships?
- Finalize assessments with winter water quality data
  - Winter vs. summer differences



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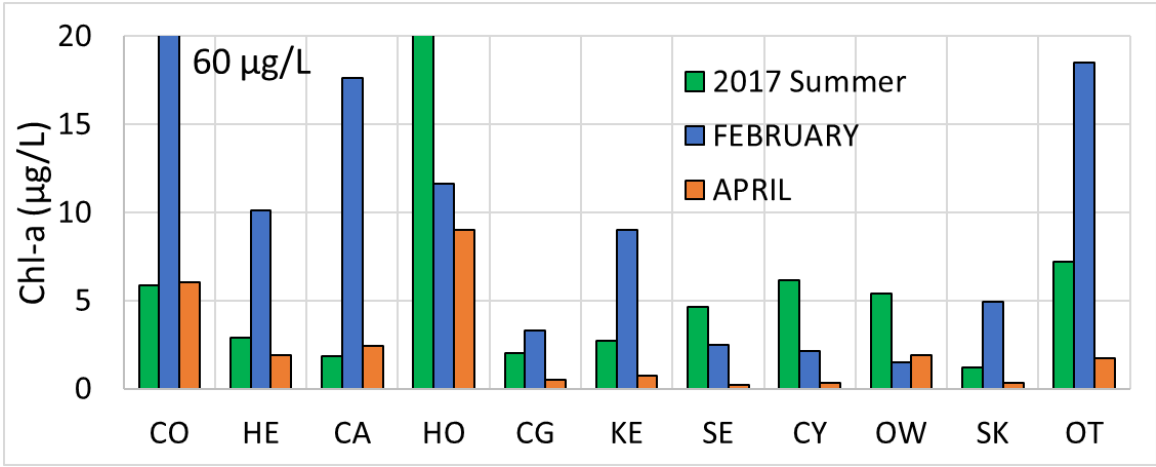
Summer vs. Winter: Source Water

Winter data may be very insightful for assessing source water quality

- Callinan et al. 2013
- Lake productivity → organic matter → drinking water quality?



Thank You

Anthony Prestigiacomo

Research Scientist 2
615 Erie Blvd. West; Syracuse, NY 13204
Anthony.Prestigiacomo@dec.ny.gov
(315) 426-7452

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