Abiotic and Biotic Influences on Algal Bloom Cycling in Two Shallow Mesotrophic Lakes

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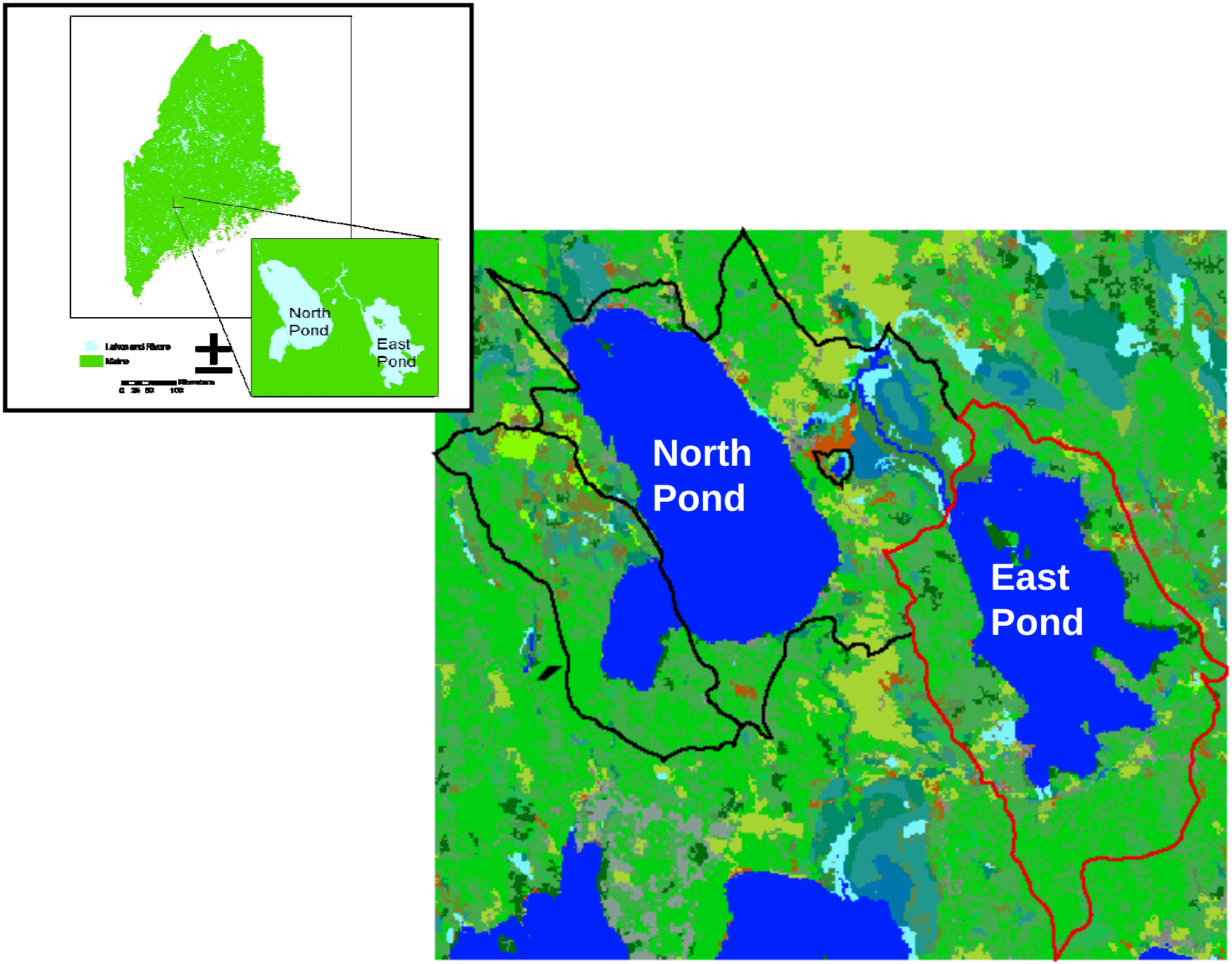
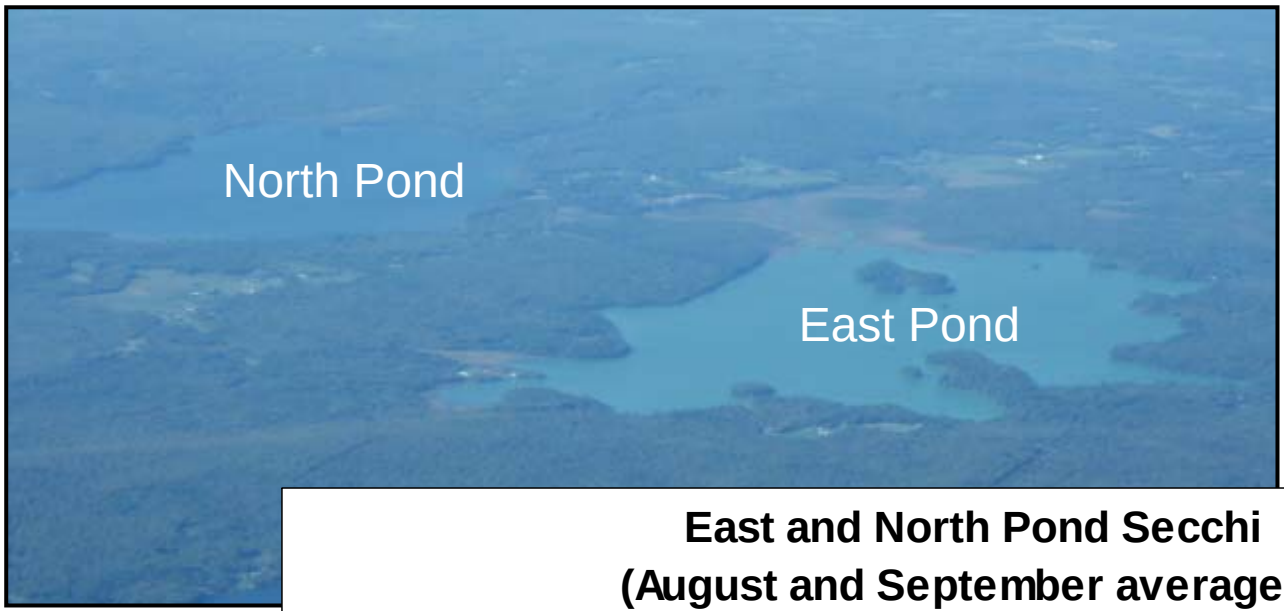
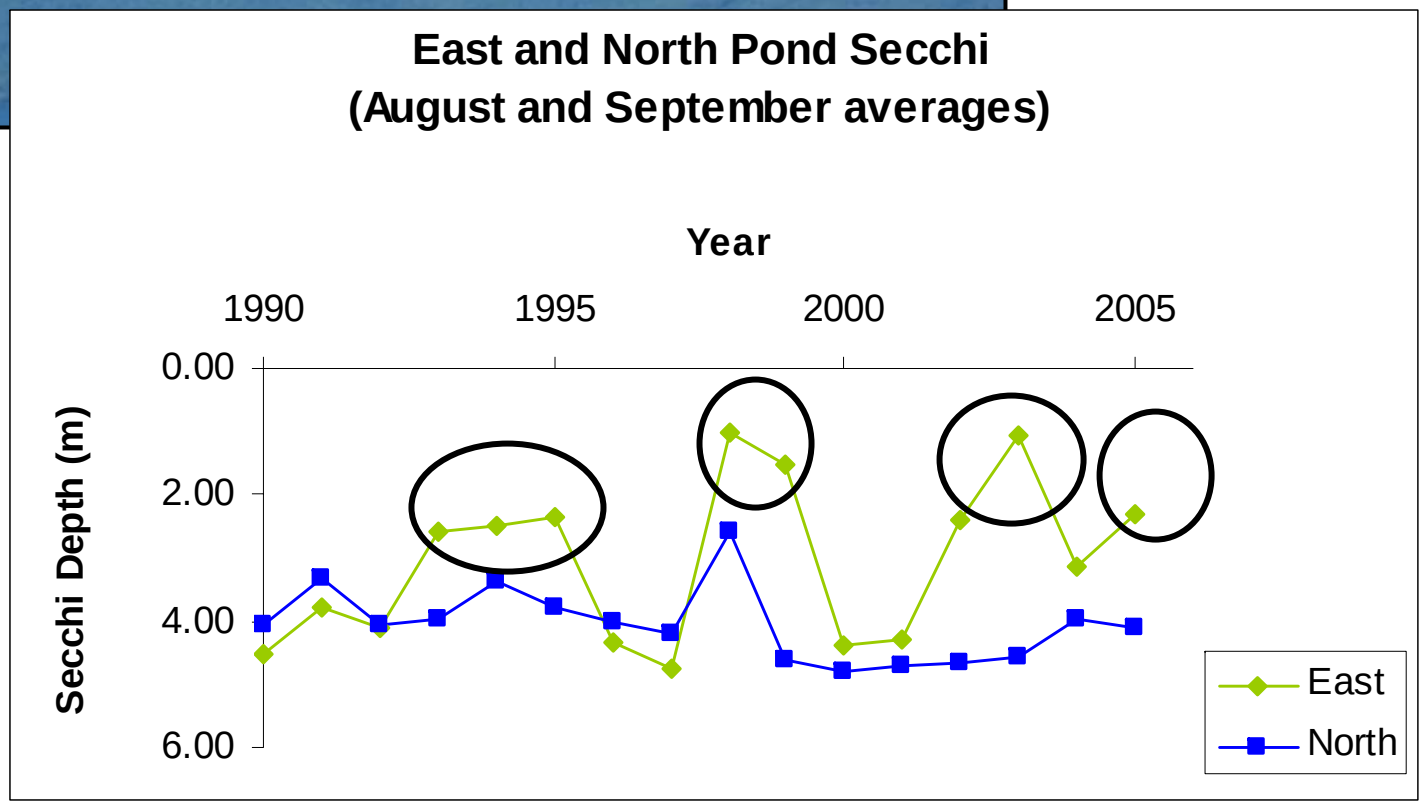
1865 THE UNIVERSITY OF MAINE

Department of Environmental Protection

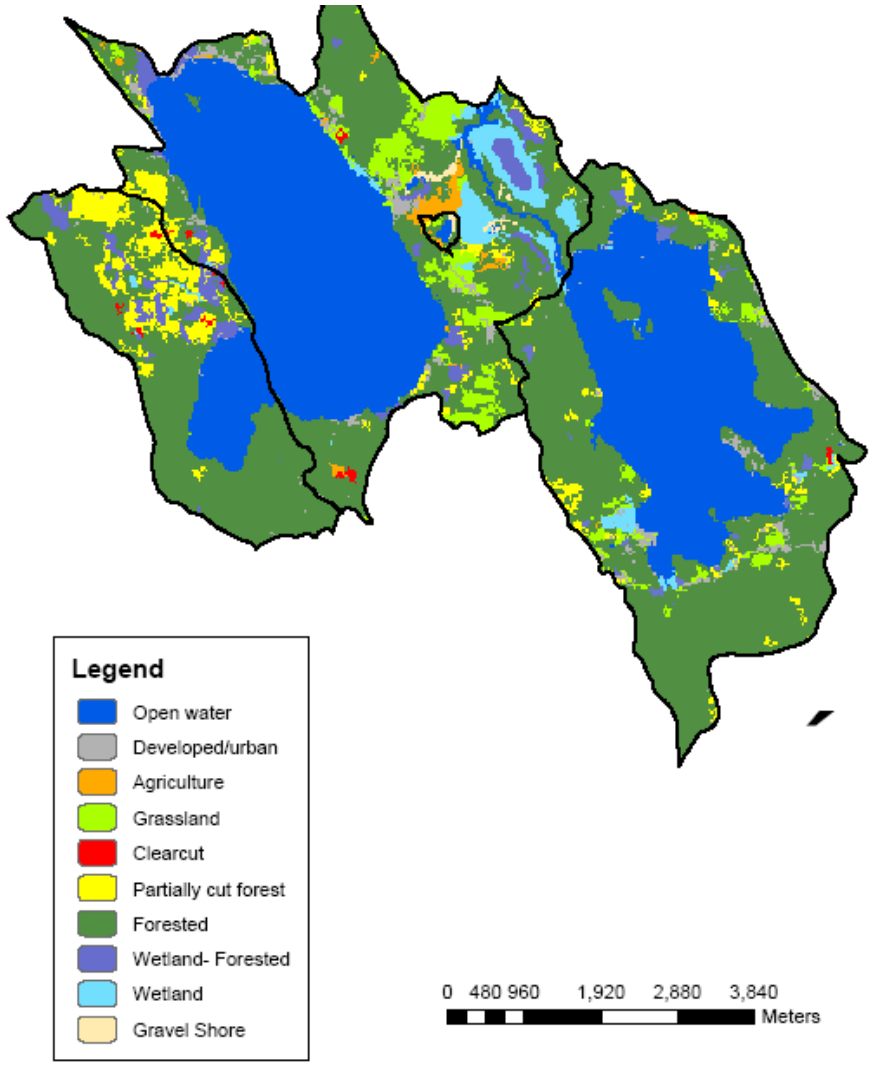

North
Pond
East
Pond
North
Pond
East
Pond


North Pond
East Pond

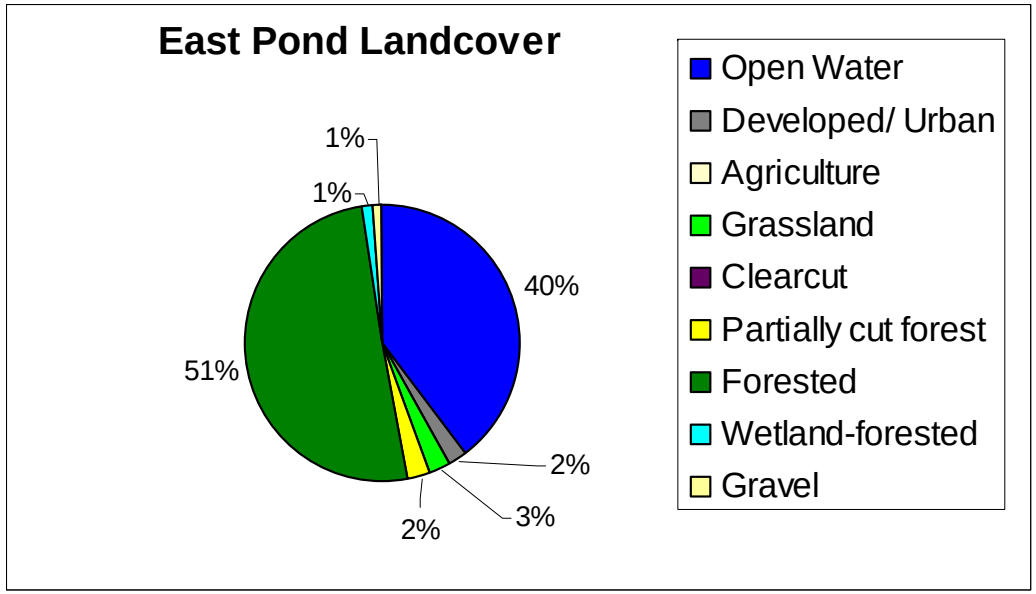

East and North Pond Secchi
(August and September averages)
Year
1990
1995
2000
2005
Secchi Depth (m)
0.00
2.00
4.00
6.00
East
North

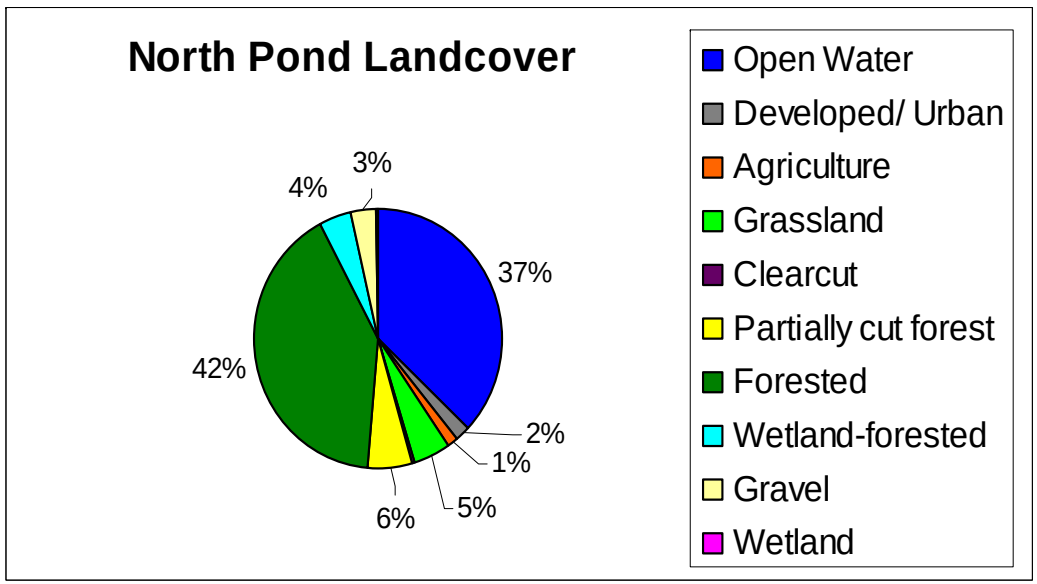
	North Pond	East Pond
Lake Area (ha)	1024	695
Average depth (m)	3.9	5.5
Max Depth (m)	6.1	8.2
Flushing Rate (yr^{-1})	0.98	0.25
Total Phosphorus(µg/L) (Yearly average 1970-2004)	16.8	18.6

Ten Reclassified Landcover Categories



Landcover comparison between watersheds





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Watershed land use		
% Forested	67	85
% Residential	3	3
% Agriculture	1	<1

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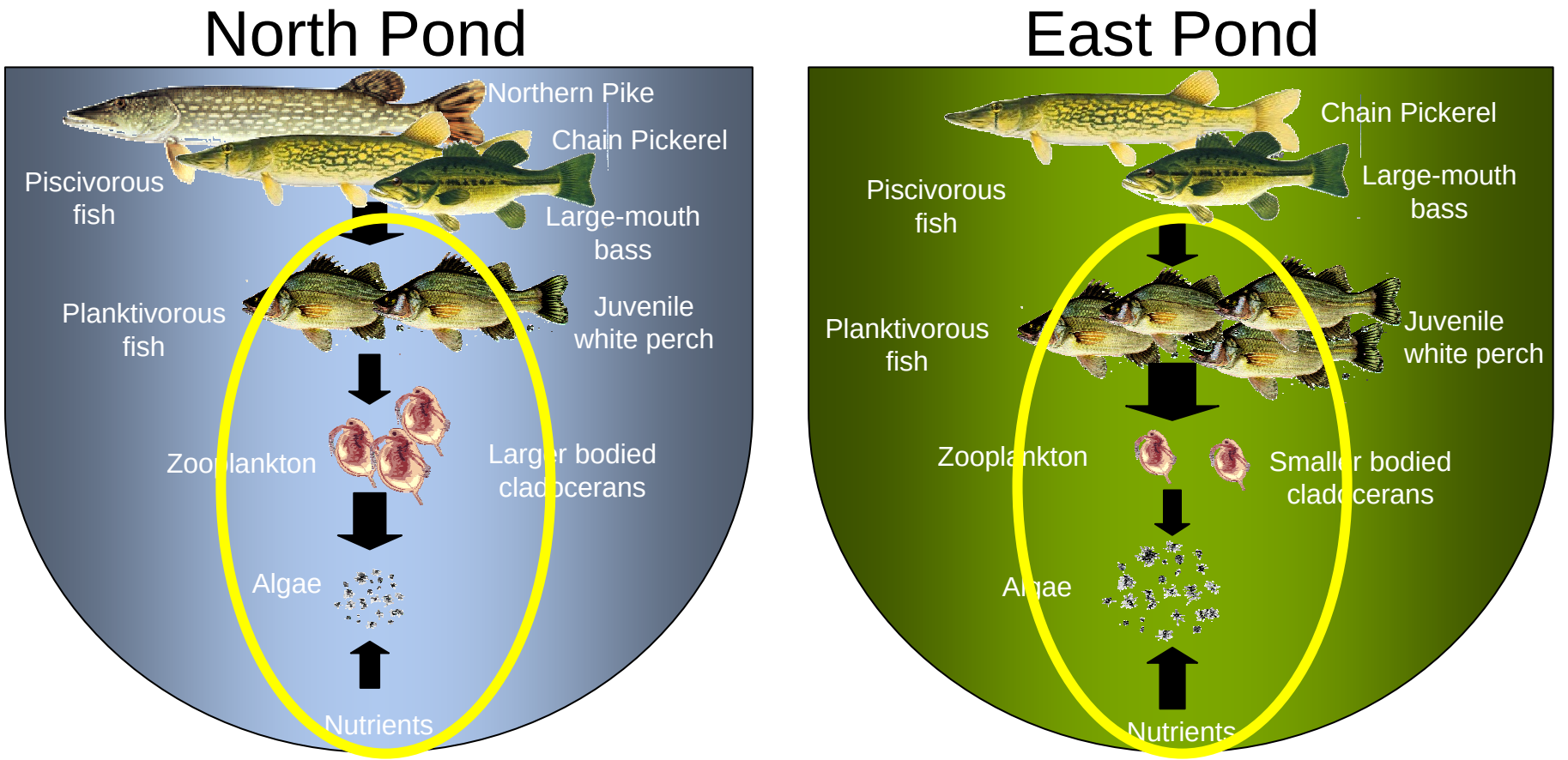
% Residential	3	3
% Agriculture	1	<1
Adult White perch population estimate (2004 and 2005)	77,000 ± 23,000	174,000 ± 11,000

Top down?

(Grazing)

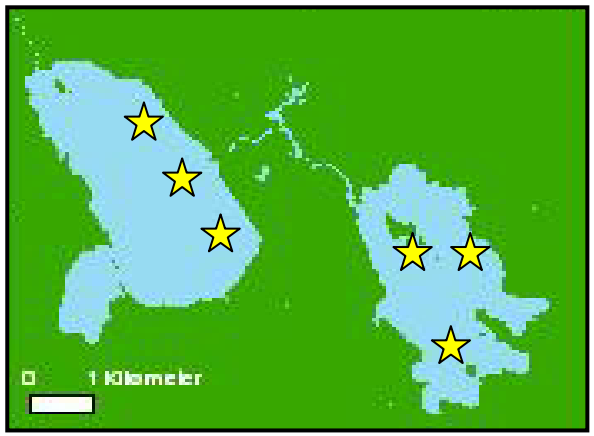
Bottom up?

(Nutrients)


North Pond
Northern Pike
Chain Pickerel
Piscivorous fish
Large-mouth bass
Planktivorous fish
Juvenile white perch
Zooplankton
Larger bodied cladocerans
Algae
Nutrients
East Pond
Chain Pickerel
Large-mouth bass
Piscivorous fish
Planktivorous fish
Juvenile white perch
Zooplankton
Smaller bodied cladocerans
Algae
Nutrients

Research Questions

- What controls algal bloom frequency in East Pond?
  - Can nutrient dynamics explain algal bloom cycles?
  - Does cladoceran grazing (or lack thereof) influence algal bloom frequency?



Biweekly Sampling (mid-May to October)

- Temperature
- Dissolved Oxygen
- Secchi
- Total Phosphorus- epilimnion

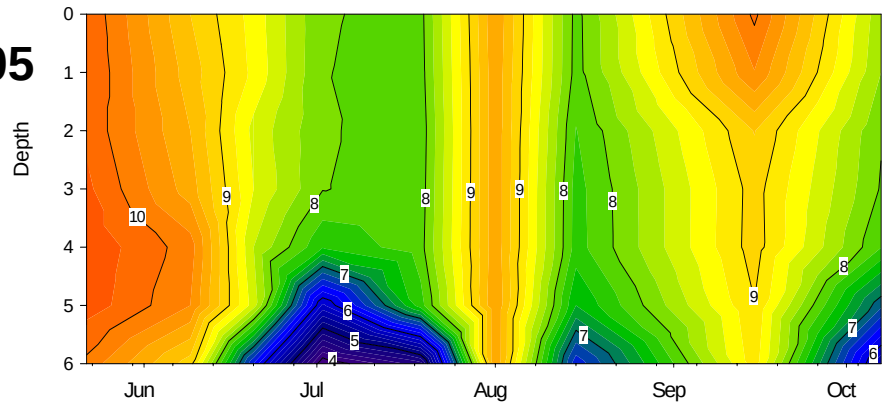
Abiotic

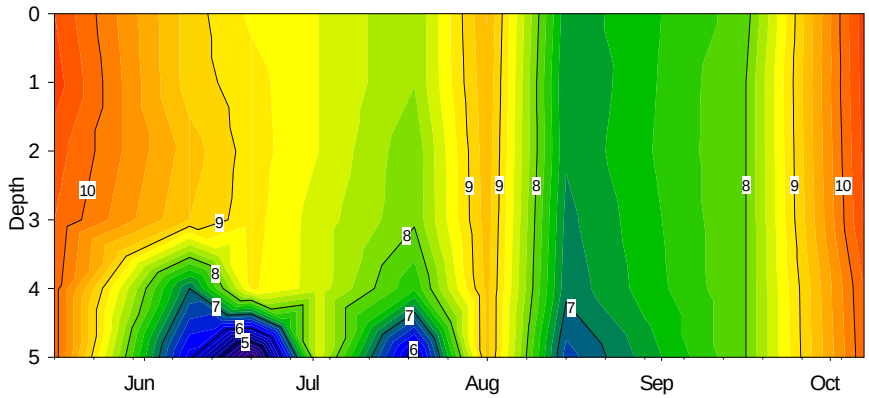
Dissolved Oxygen (mg/L)

East Pond

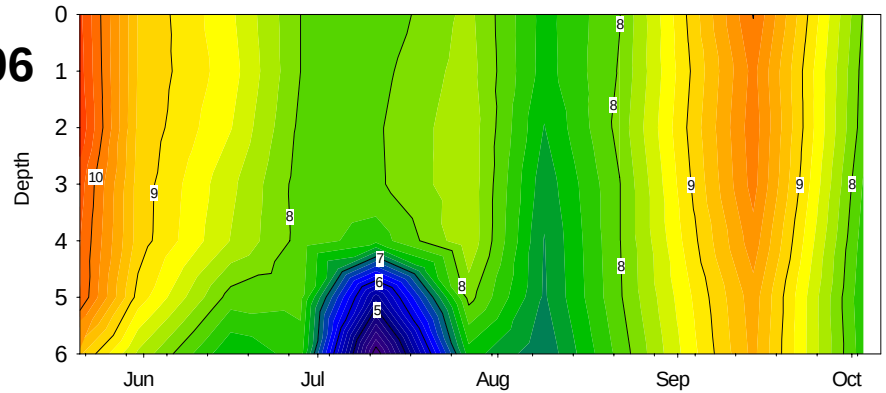
North Pond

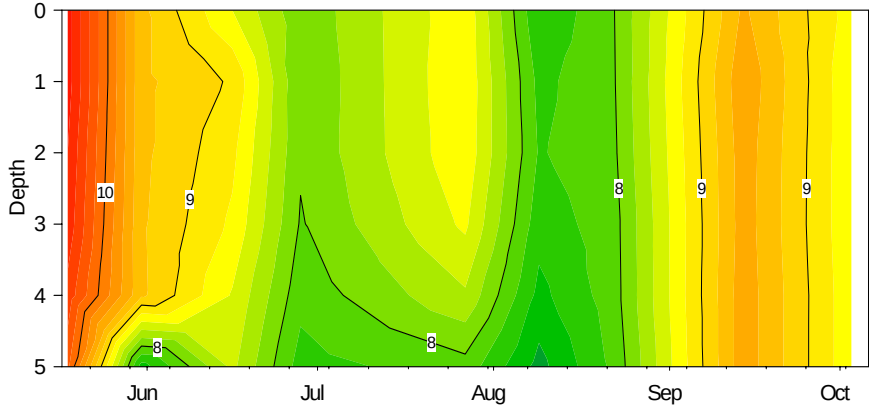
2005



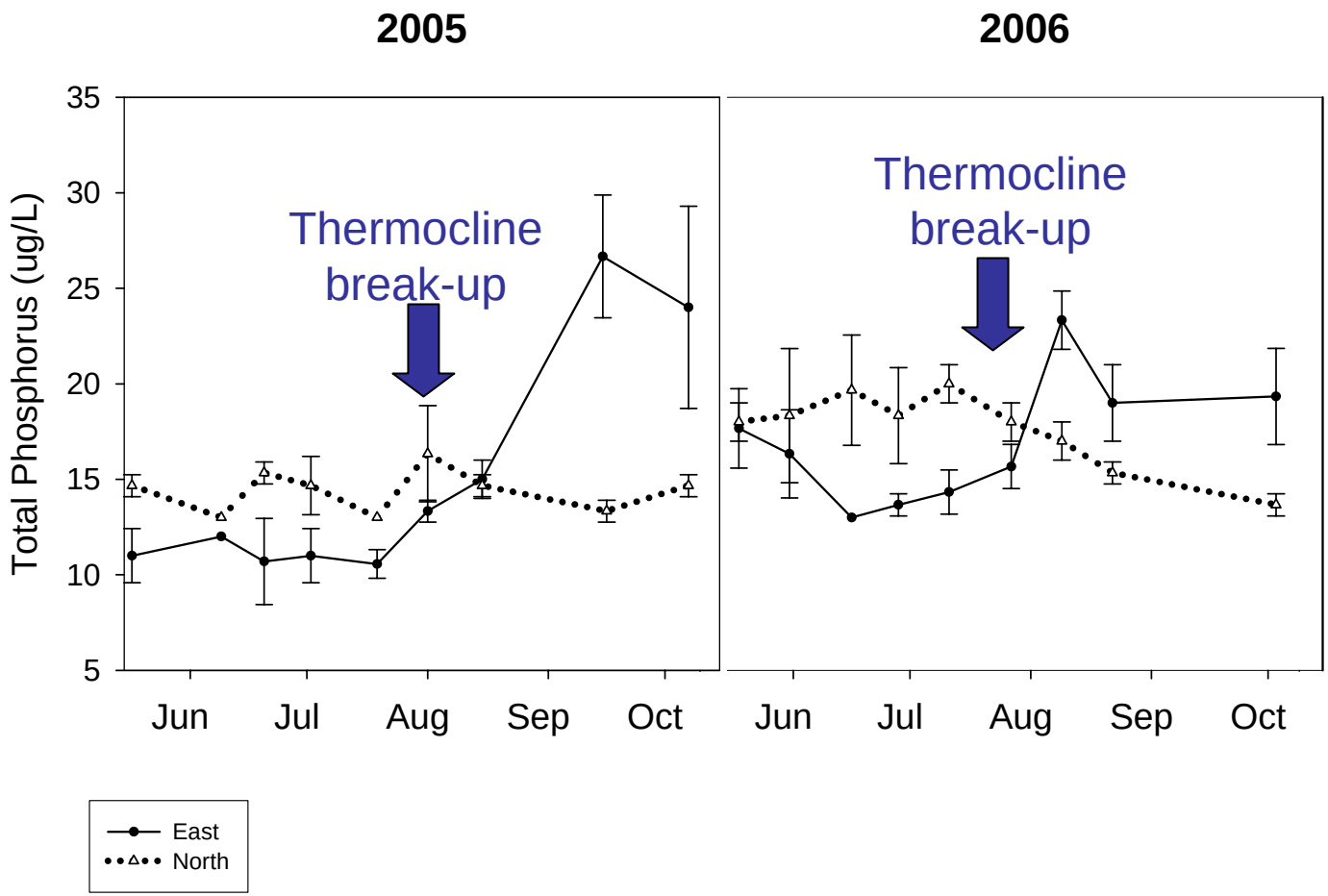


2006

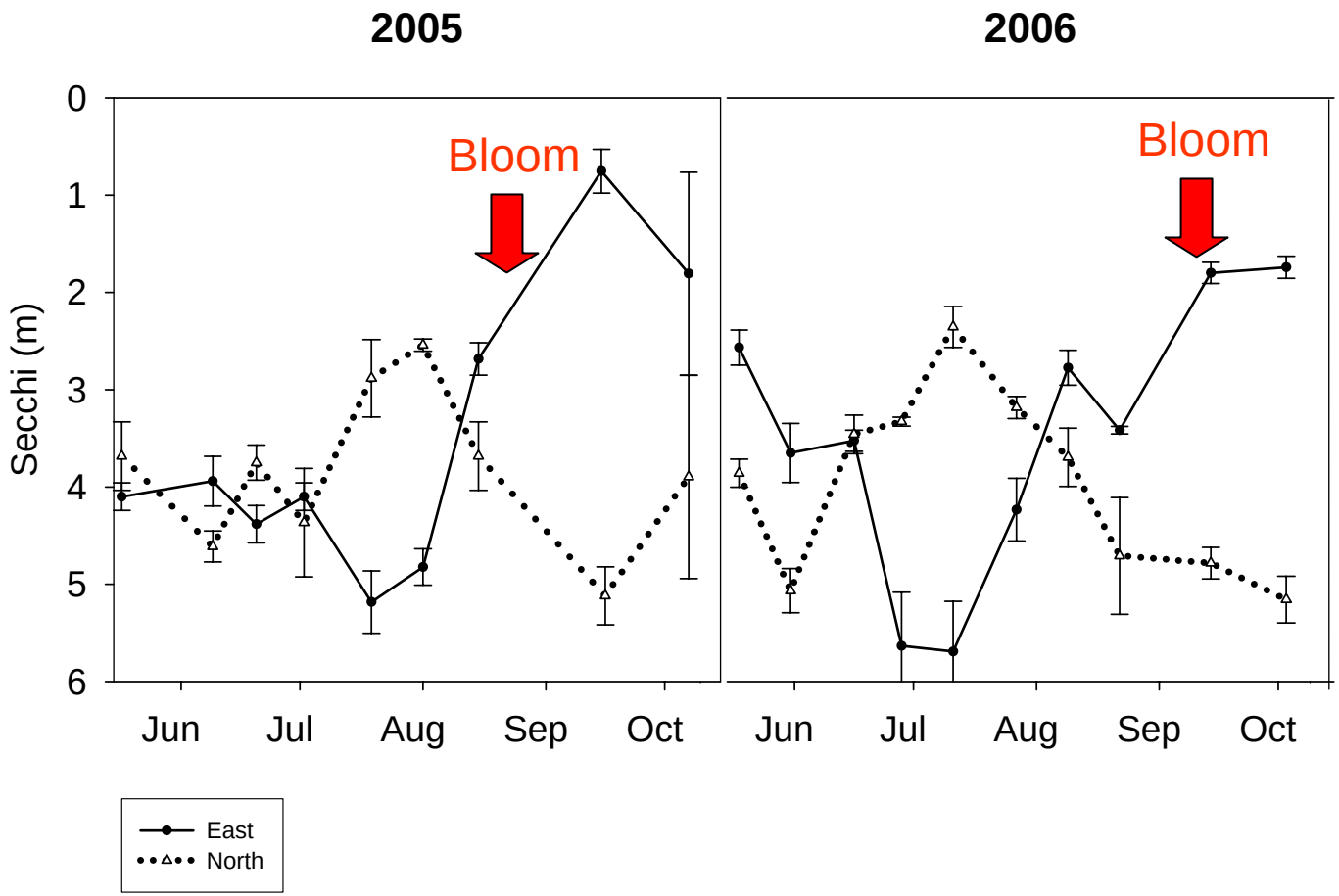




Total Phosphorus (µg/L)

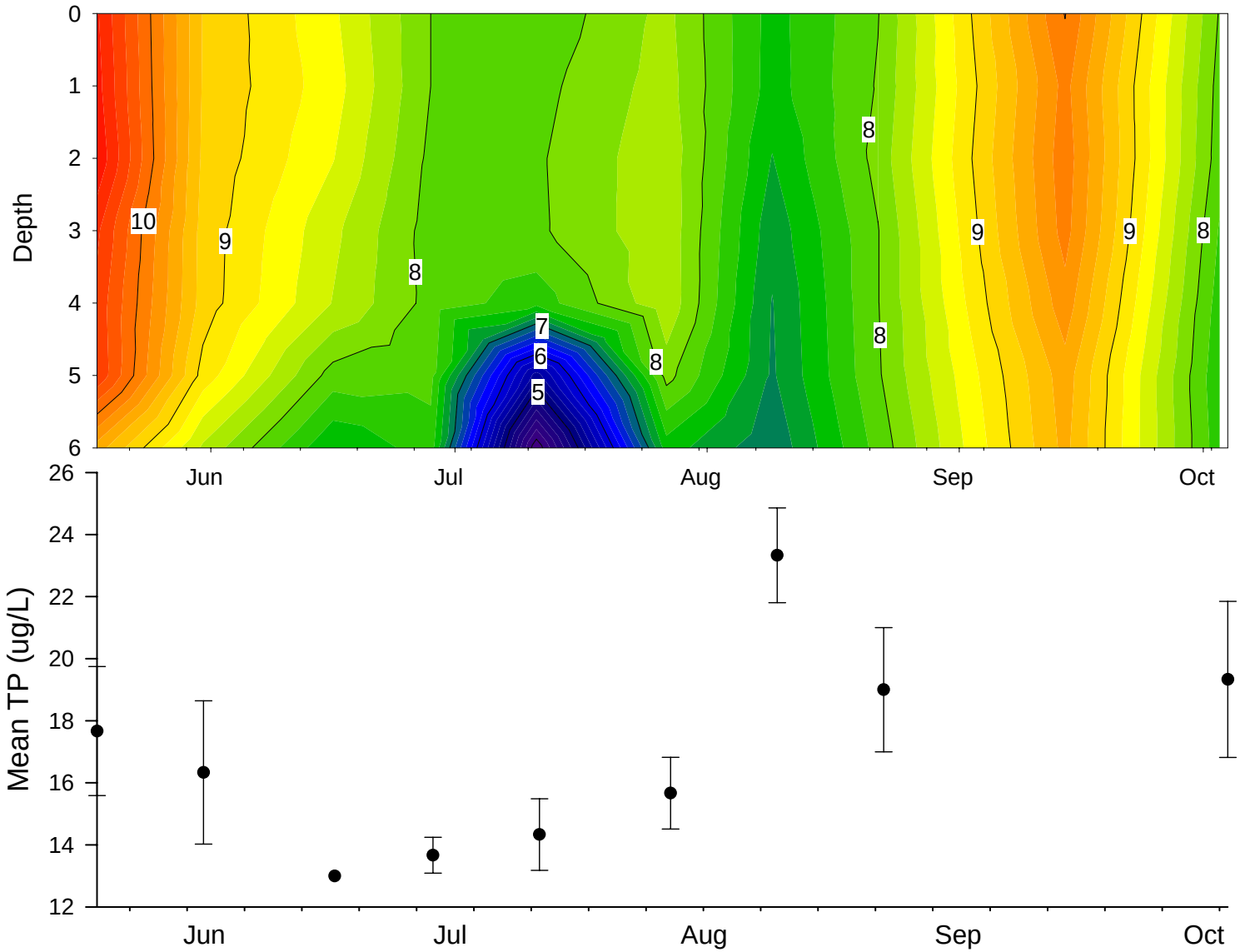


Secchi (m)


2005
2006
Bloom
Bloom
Secchi (m)
0
1
2
3
4
5
6
Jun
Jul
Aug
Sep
Oct
East
North

Abiotic

TP Release Post-Stratification

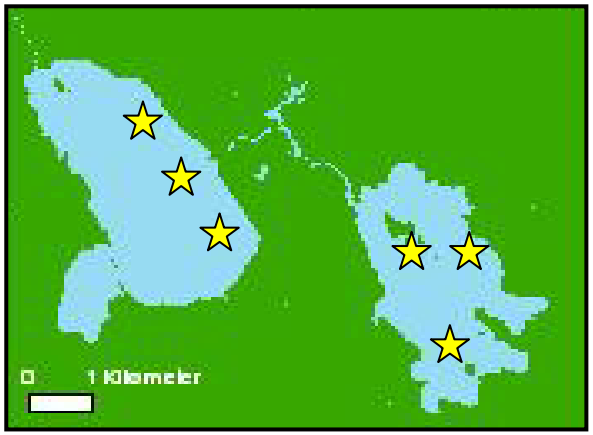


Can nutrients dynamics explain algal bloom cycles in East Pond?

- North Pond TP levels slightly higher than East until late summer for both years
- East Pond experienced algal blooms in 2005 and 2006
- East Pond TP increase correlated with lake mixing events

Research Questions

- Can nutrient dynamics explain algal bloom cycles?
- Does cladoceran grazing (or lack thereof) influence algal bloom timing?
    - Zooplankton
    - White Perch
        - diets
        - isotope



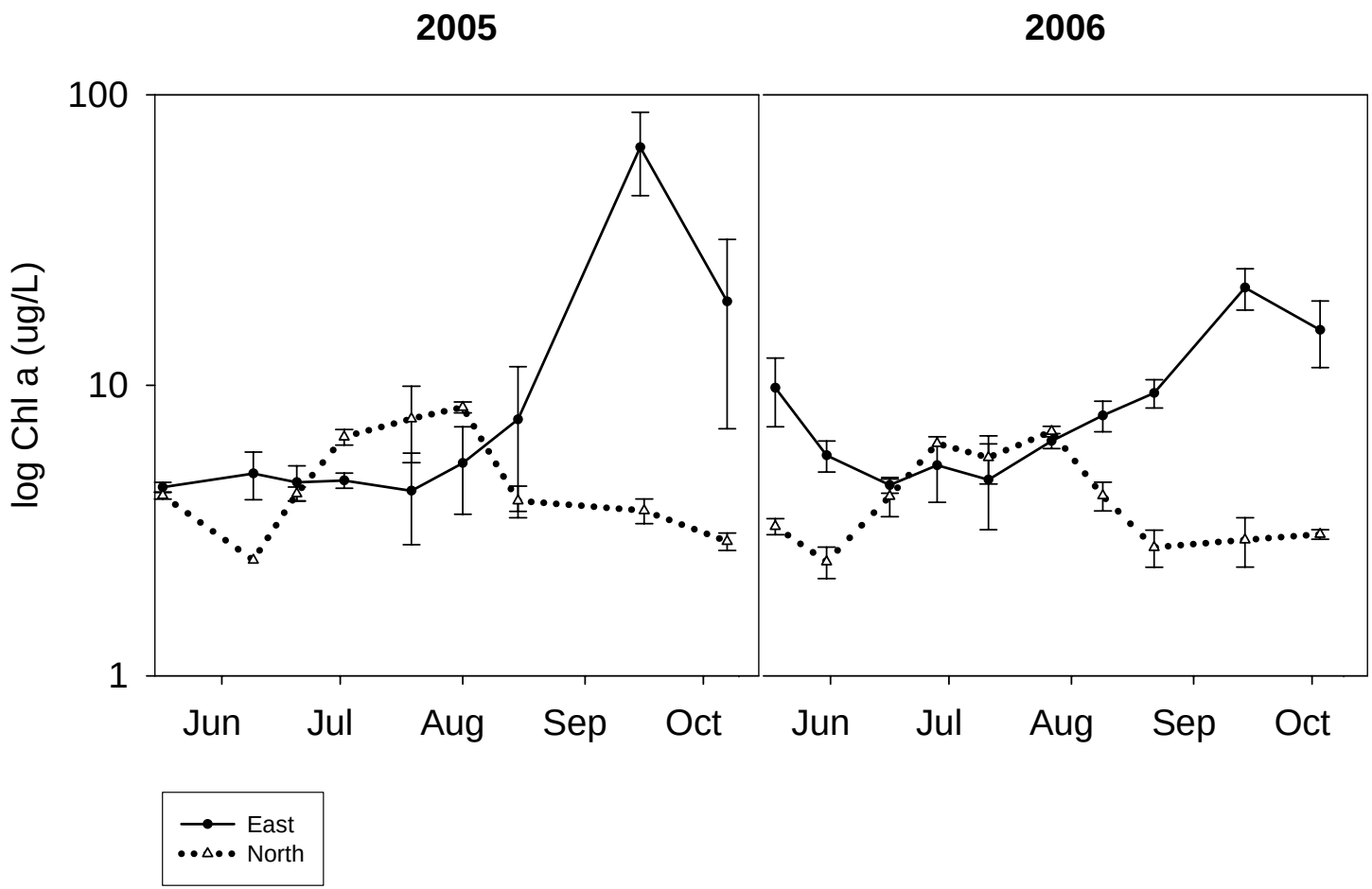
Biweekly Sampling (mid-May to October)

- Chlorophyll a
- Zooplankton

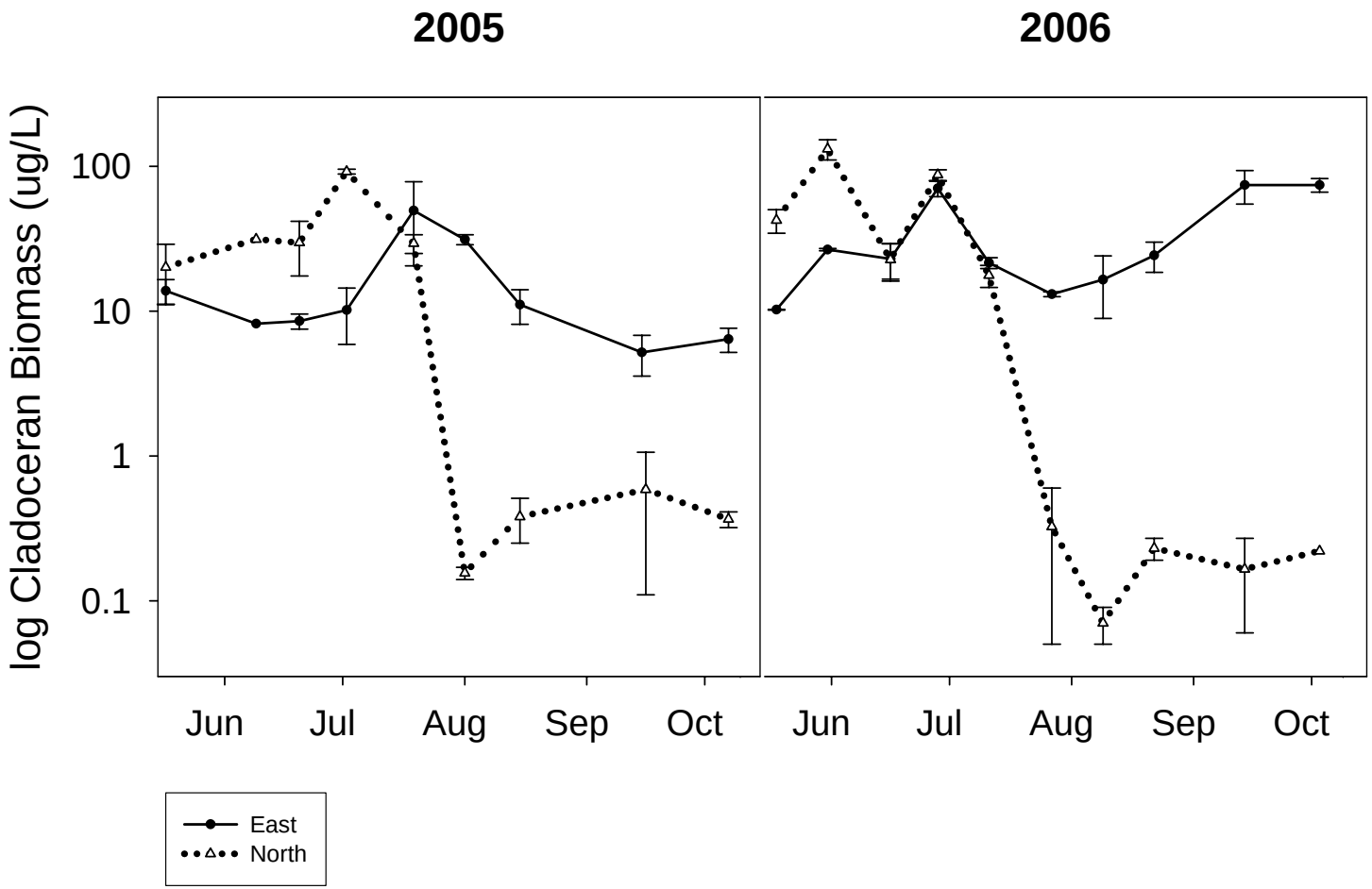
Monthly Sampling (July- September)

- White Perch diets
- Foodweb Isotopes

Chlorophyll a (µg/L)



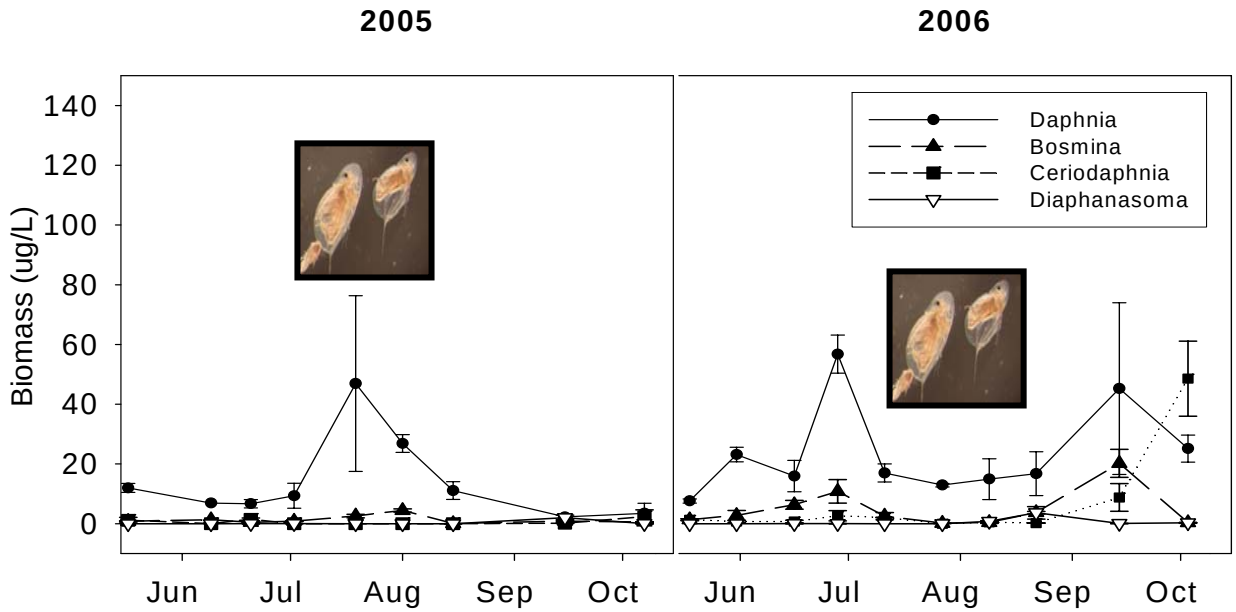
Cladoceran Biomass (µg/L)



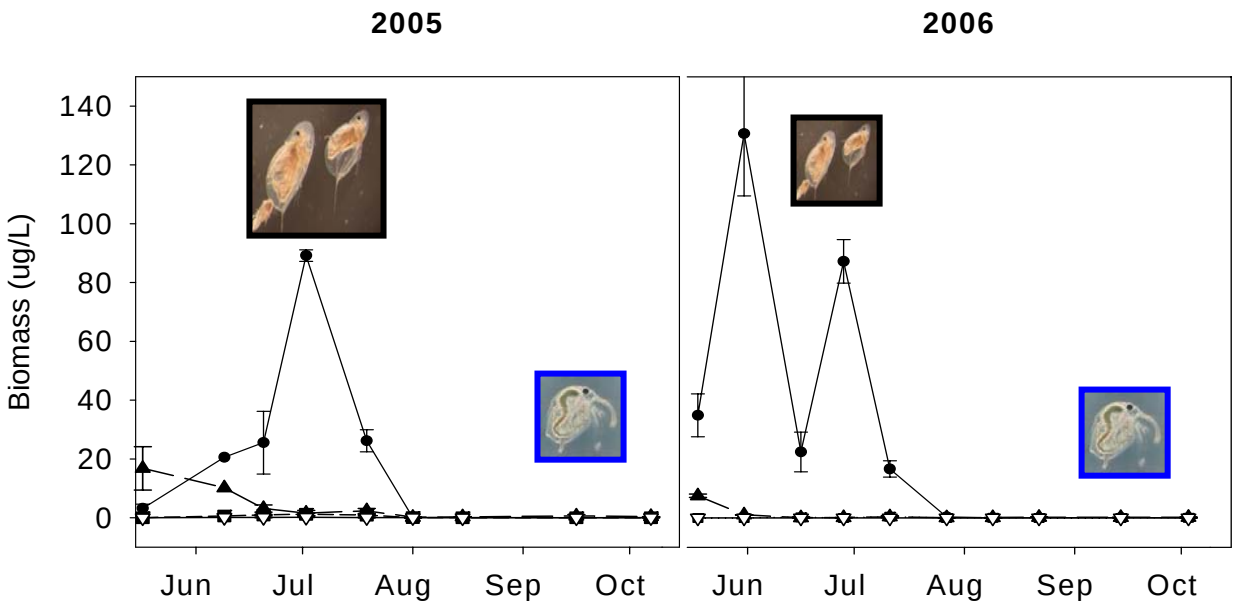
Cladoceran Community Composition

Biotic

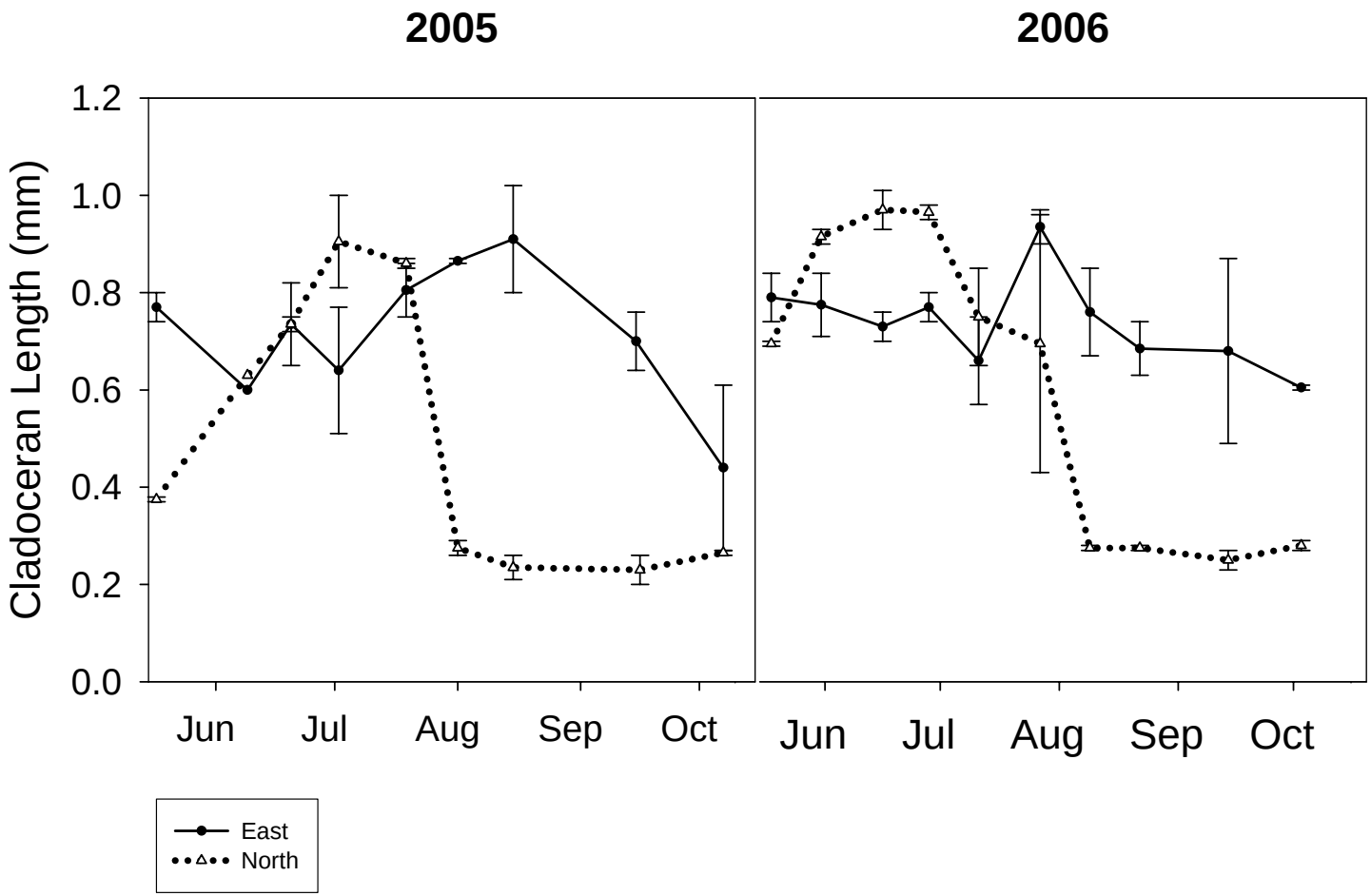
East Pond



North Pond



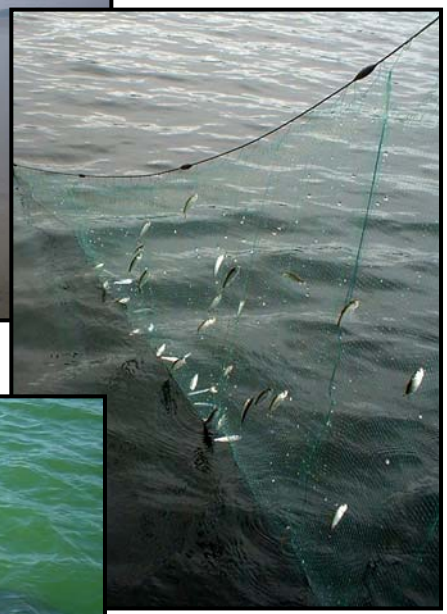
Cladoceran Mean Length (mm)

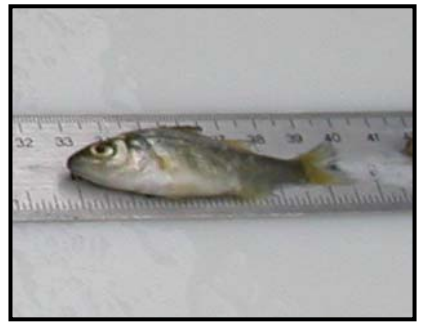


Can cladoceran dynamics explain algal bloom cycles in East Pond?

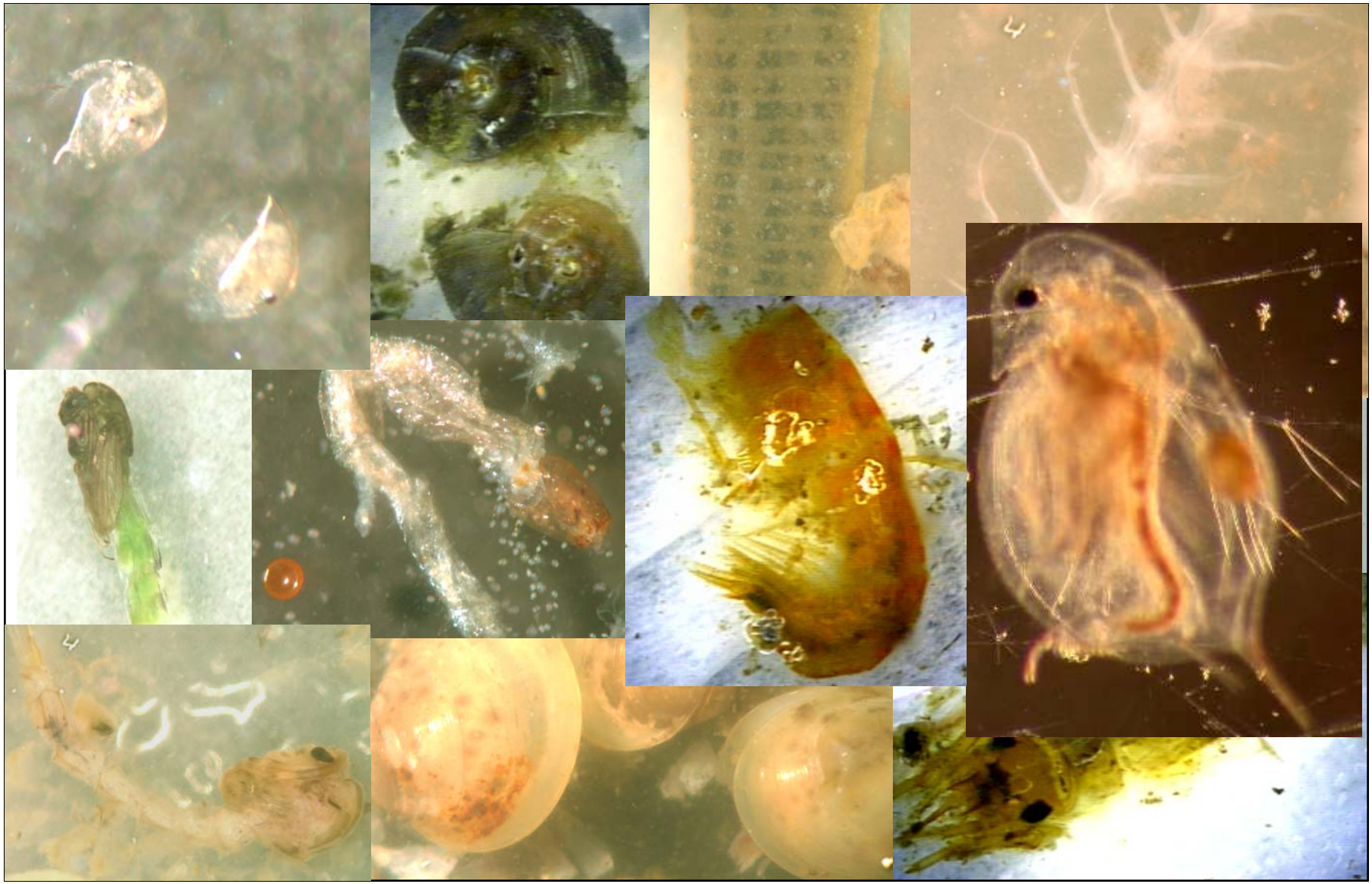
- Low Chl a levels in both ponds for most of summer
- North Pond cladoceran densities and biomass peaked earlier than East Pond, size decreased for August and September

Biotic





Diet



Young of the Year White Perch Diets

(% composition), n=10

August

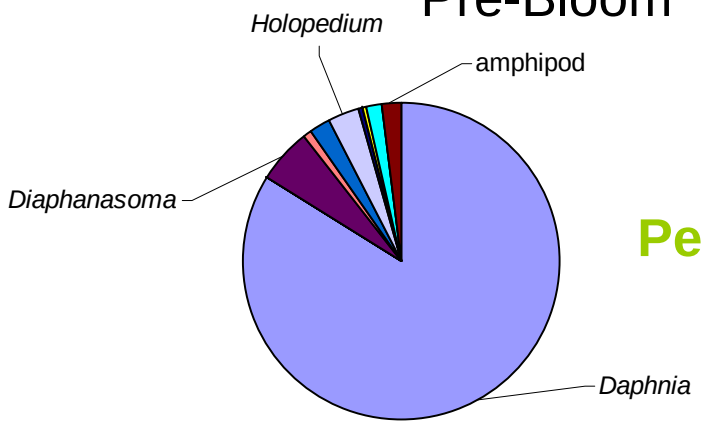
September

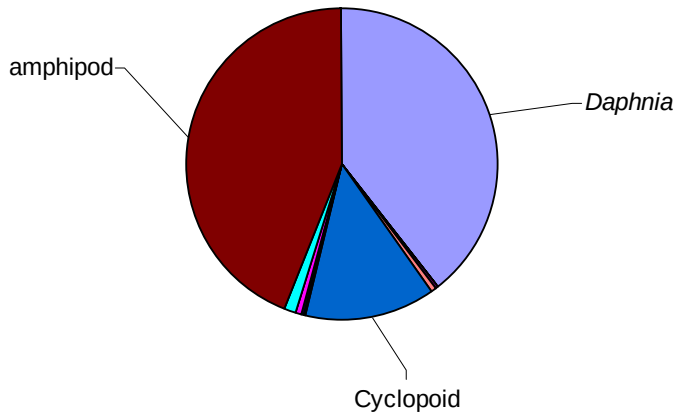
Pre-Bloom

During Bloom

East Pond

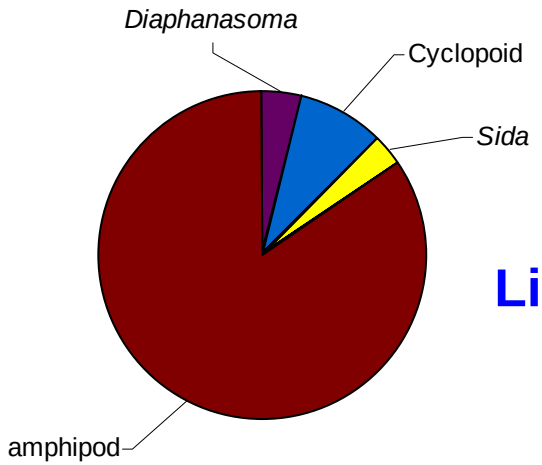
Pelagic

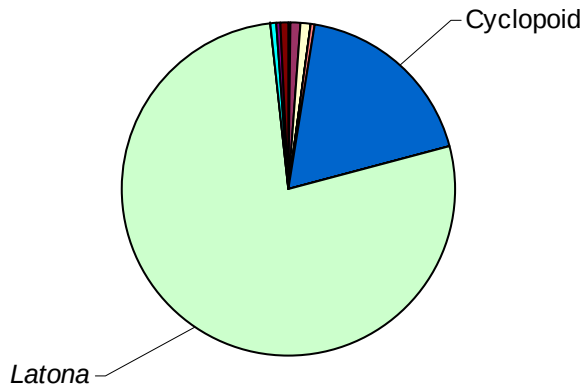




North Pond

Littoral





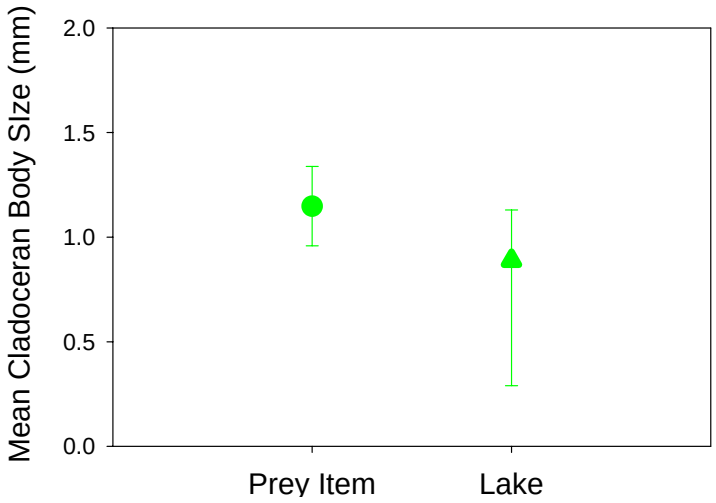
Biotic

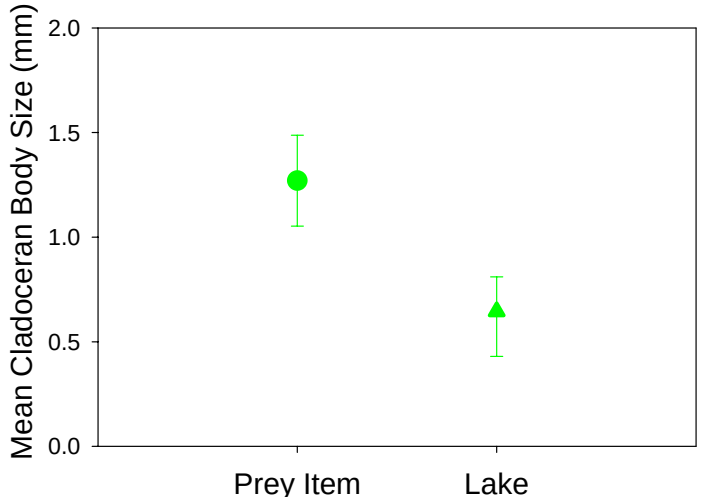
Body Size (mm) of Prey Items vs. Within Lake

August

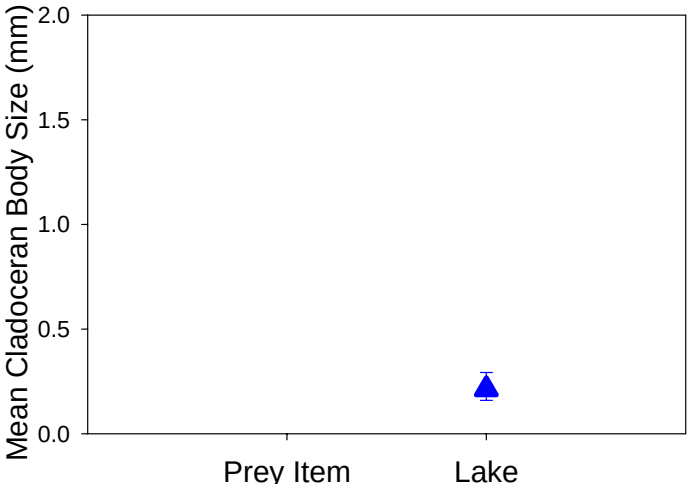
September

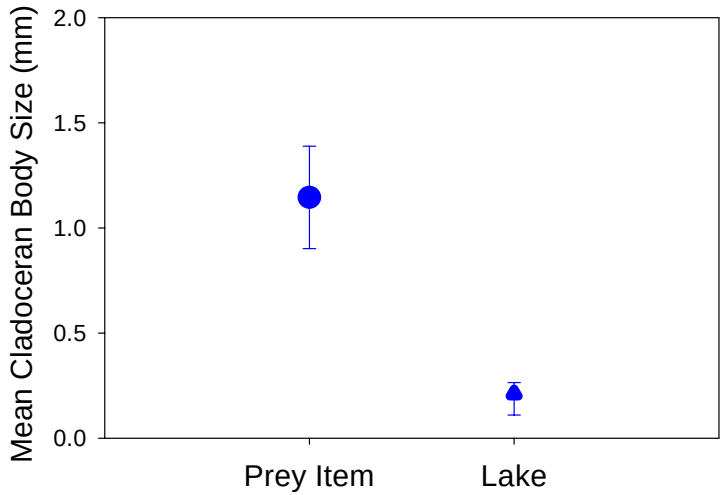
East Pond





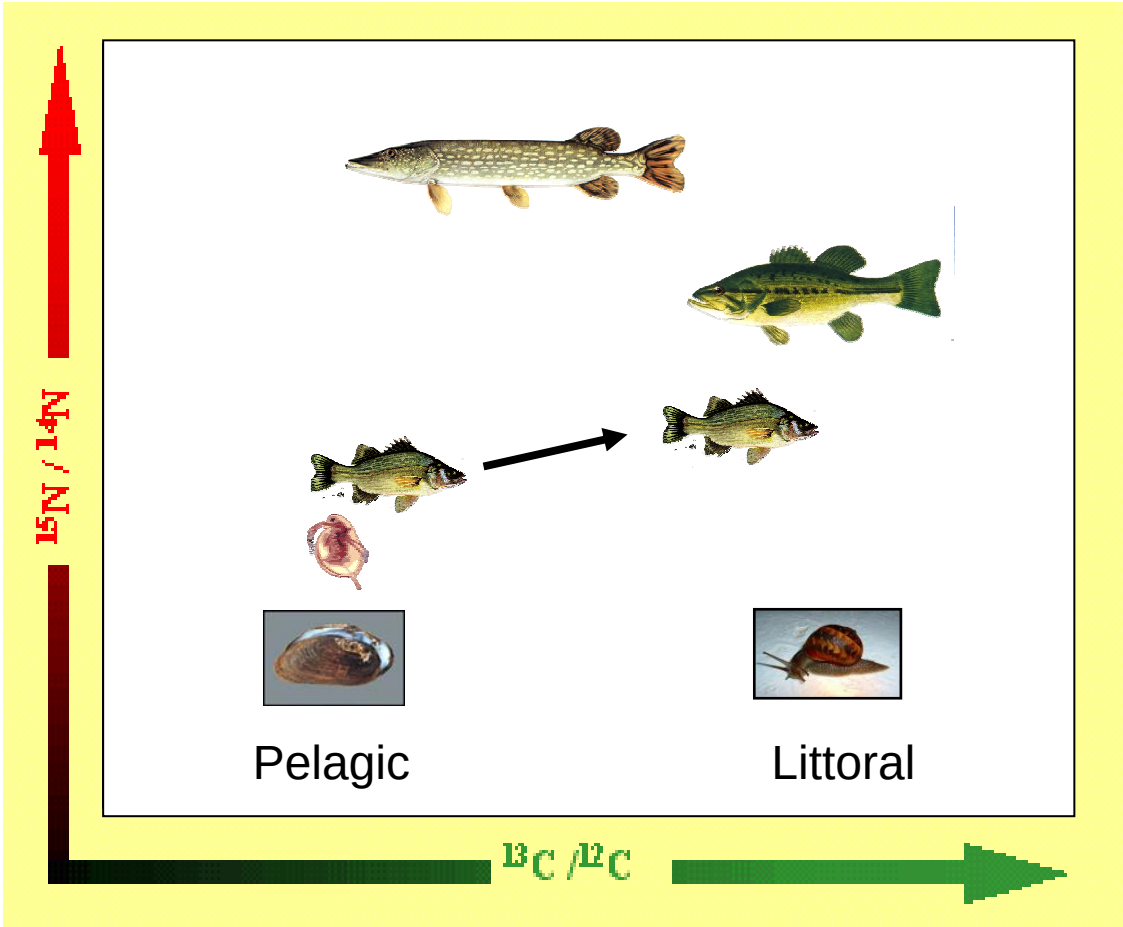
North Pond



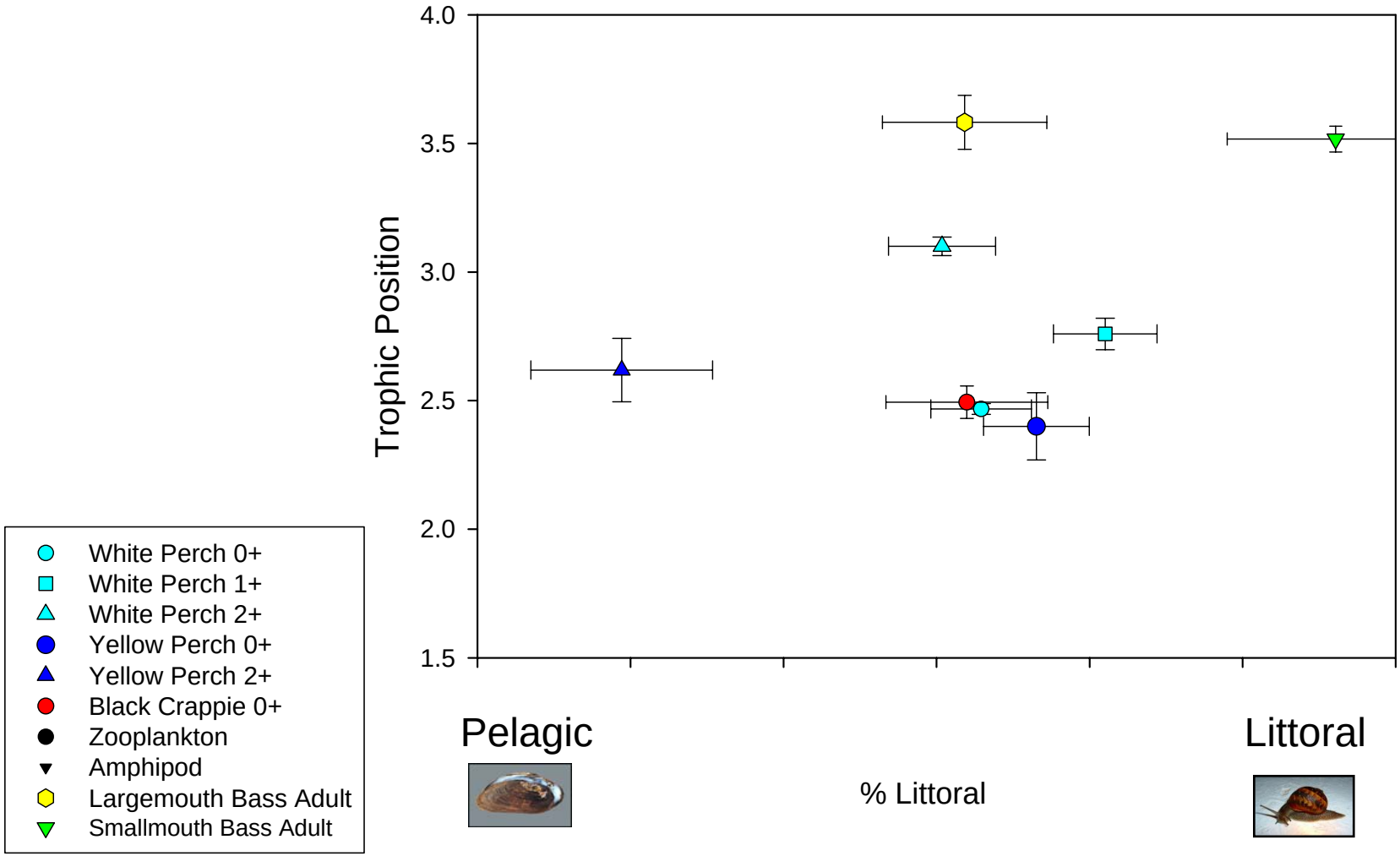


Stable Isotope Analysis

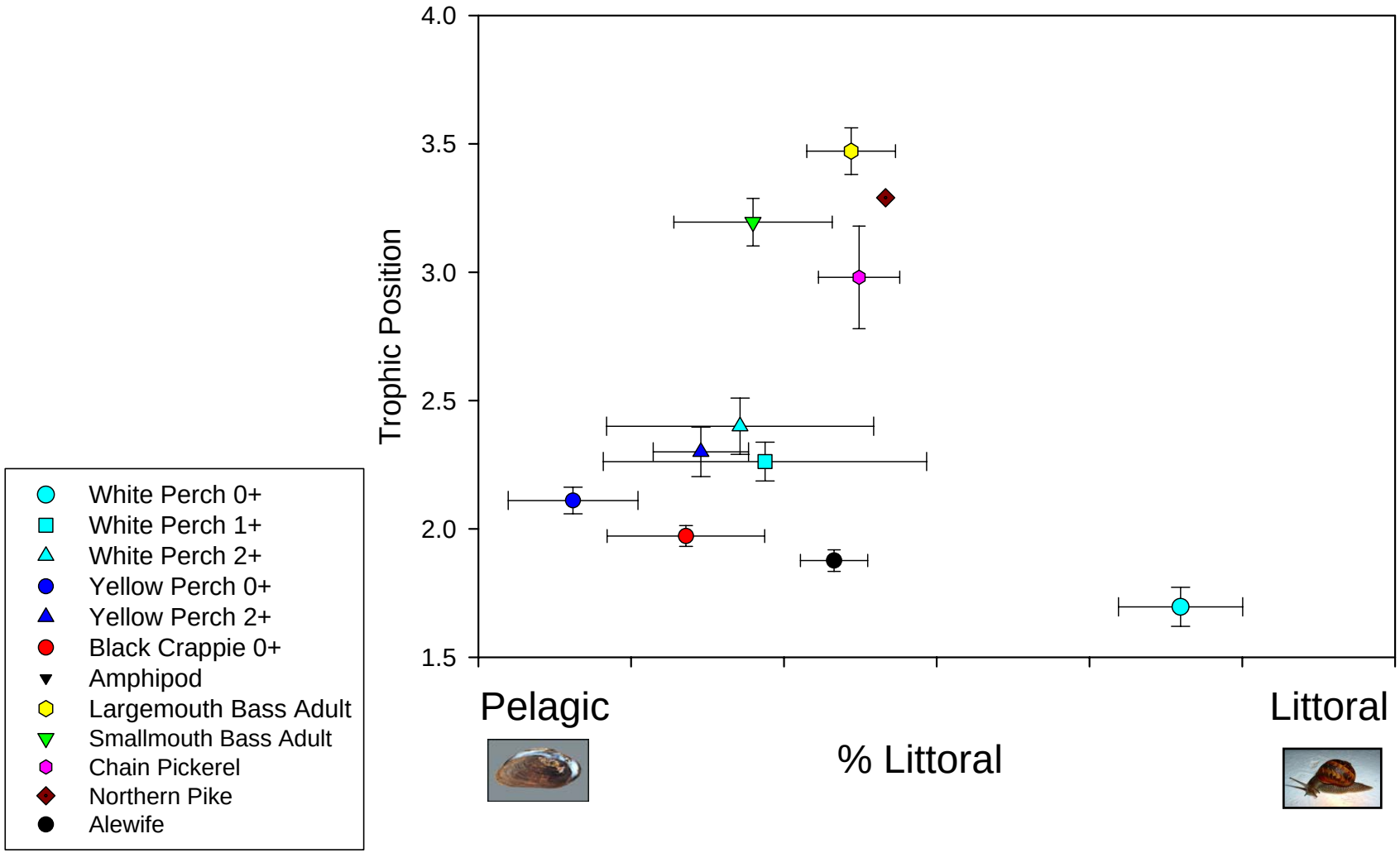
- Carbon isotopes enriched ~1% relative to diet
- Nitrogen isotopes enriched ~3-5% relative to diet



East Pond Isotopes 2005



North Pond Isotopes 2005



Is planktivory a factor in seasonal cladoceran dynamics in East and North Ponds?

- East Pond YOY white perch consumed mostly pelagic *Daphnia*, North Pond fish consumed littoral *Latona* and amphipods
- Zooplankton consumed by fish were significantly larger than zooplankton from net tows in both ponds
- Isotopes show YP were most pelagic in East Pond, and a general pelagic shift in North Pond

Does the data support a top-down hypothesis?

	Yes	No
Higher cladoceran density and biomass in East vs. North		X
Smaller cladoceran body size in North vs. East		X
Juvenile white perch prefer *Daphnia* in East Pond	X	
Juvenile white perch selected larger bodied cladocerans in both ponds	X	

Implications

- Part of a larger project to determine feasibility of a biomanipulation on East Pond

Acknowledgements

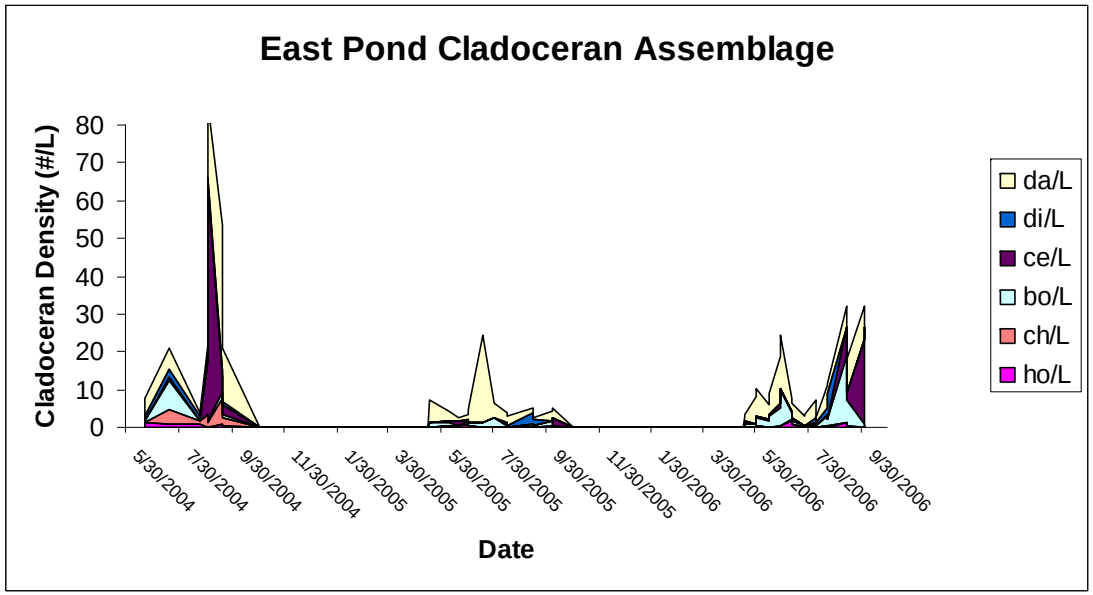
University of Maine- Dennis Anderson, Rebecca Norris, Kirsten Ness, Jon Hooper

Maine DEP- Melissa Evers, Linda Bacon, Roy Bouchard

Maine IF&W- Joe Dembeck, Bill Woodward

EPA- Hilary Snook

Funding- Maine Department of Environmental Protection/US EPA, University of Maine


East Pond Cladoceran Assemblage
Cladoceran Density (#/L)
80
70
60
50
40
30
20
10
0
5/30/2004
7/30/2004
9/30/2004
11/30/2004
1/30/2005
3/30/2005
5/30/2005
7/30/2005
9/30/2005
11/30/2005
1/30/2006
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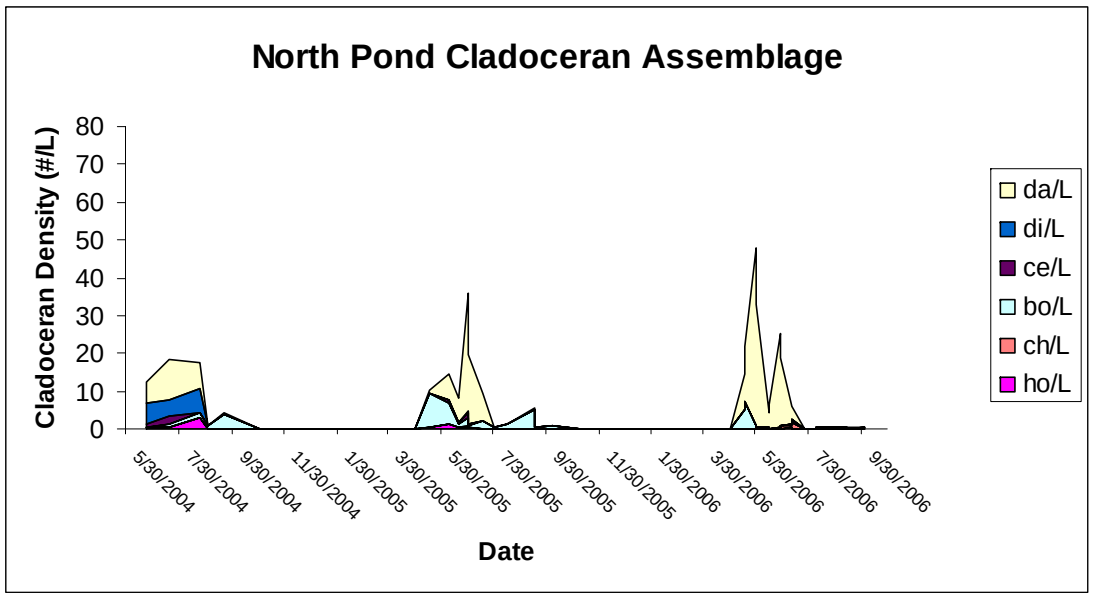
Date
da/L
di/L
ce/L
bo/L
ch/L
ho/L


North Pond Cladoceran Assemblage
Cladoceran Density (#/L)
80
70
60
50
40
30
20
10
0
5/30/2004
7/30/2004
9/30/2004
11/30/2004
1/30/2005
3/30/2005
5/30/2005
7/30/2005
9/30/2005
11/30/2005
1/30/2006
3/30/2006
5/30/2006
7/30/2006
9/30/2006
Date
da/L
di/L
ce/L
bo/L
ch/L
ho/L