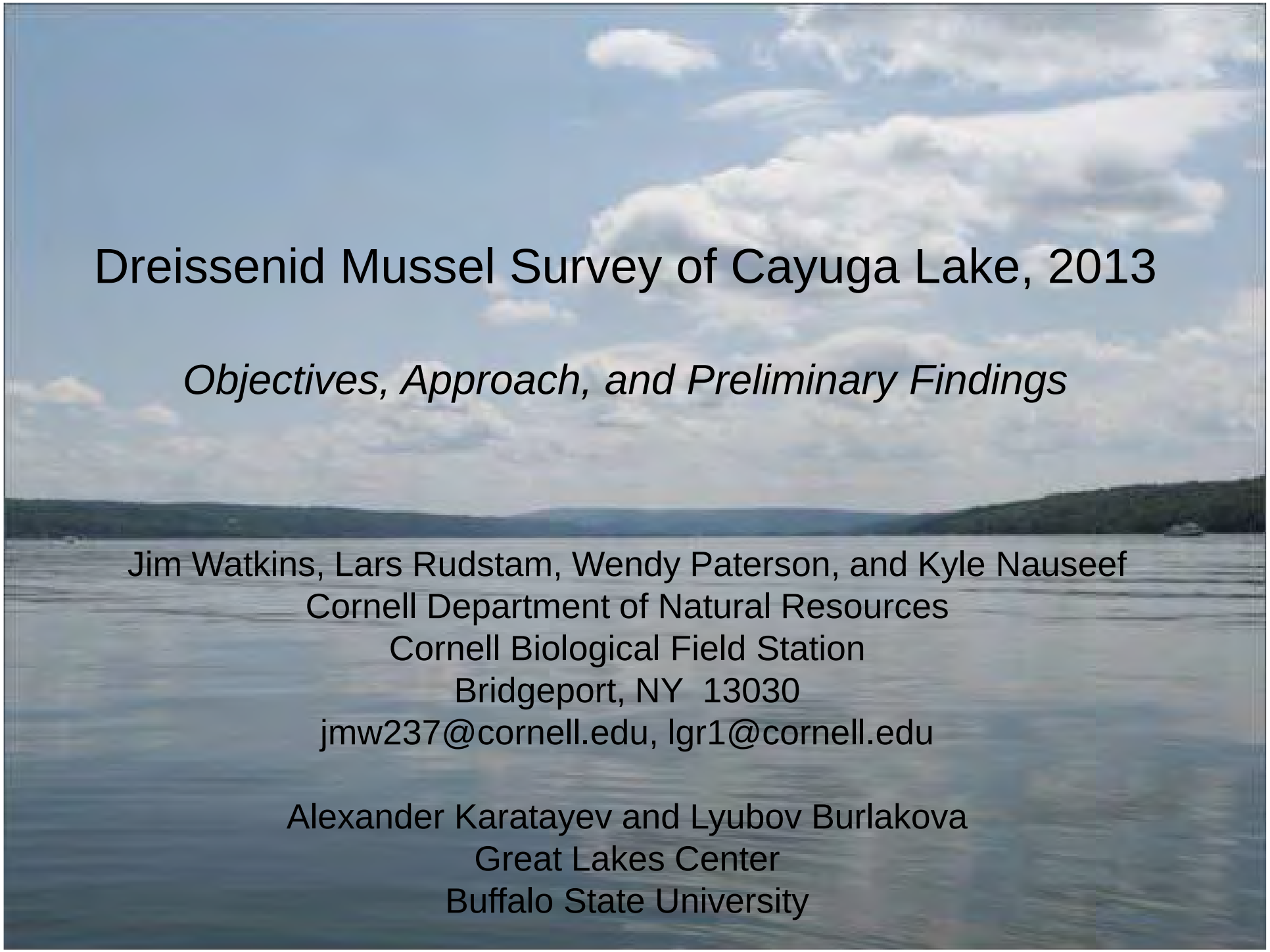
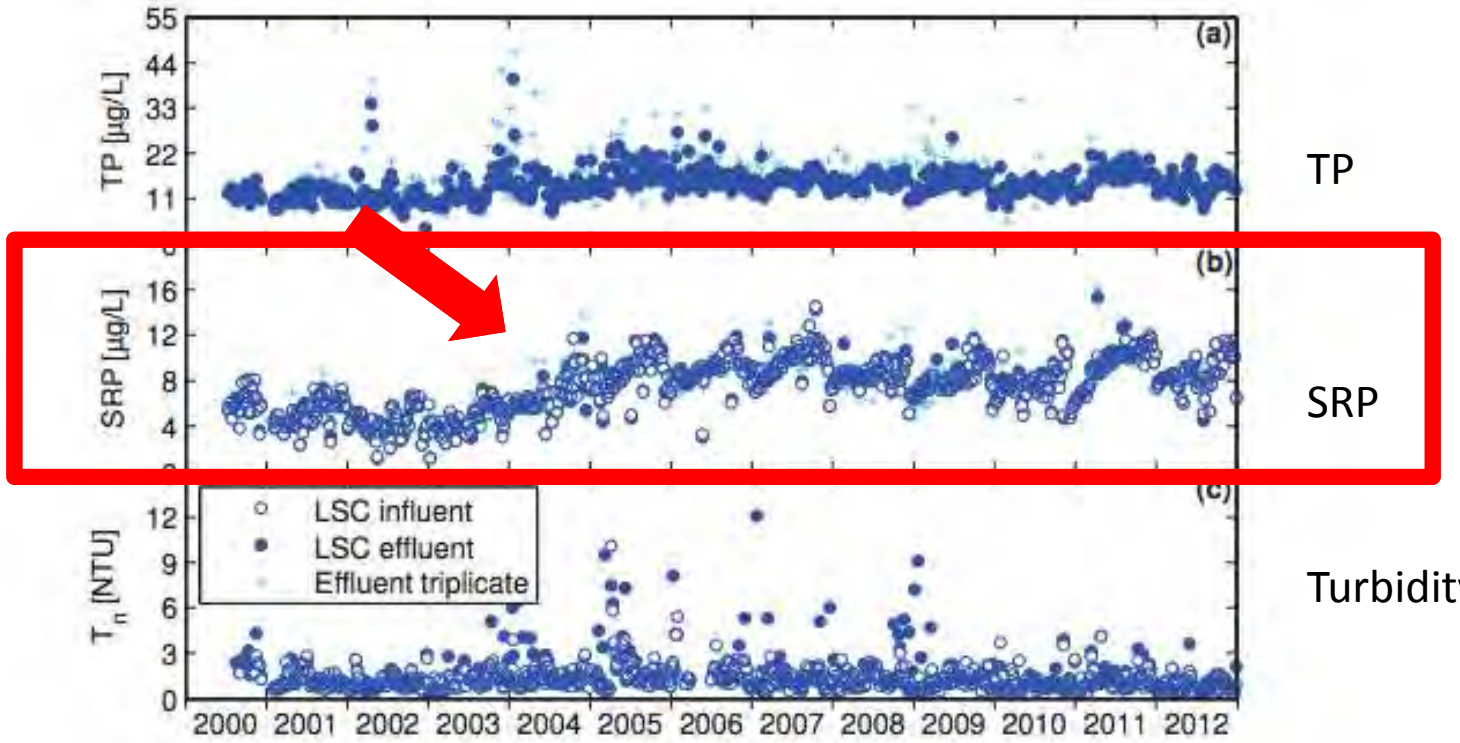


Dreissenid Mussel Survey of Cayuga Lake, 2013

Objectives, Approach, and Preliminary Findings

Jim Watkins, Lars Rudstam, Wendy Paterson, and Kyle Nauseef
Cornell Department of Natural Resources
Cornell Biological Field Station
Bridgeport, NY 13030
jmw237@cornell.edu, lgr1@cornell.edu

Alexander Karatayev and Lyubov Burlakova
Great Lakes Center
Buffalo State University



Lake Source Cooling Report, 2013

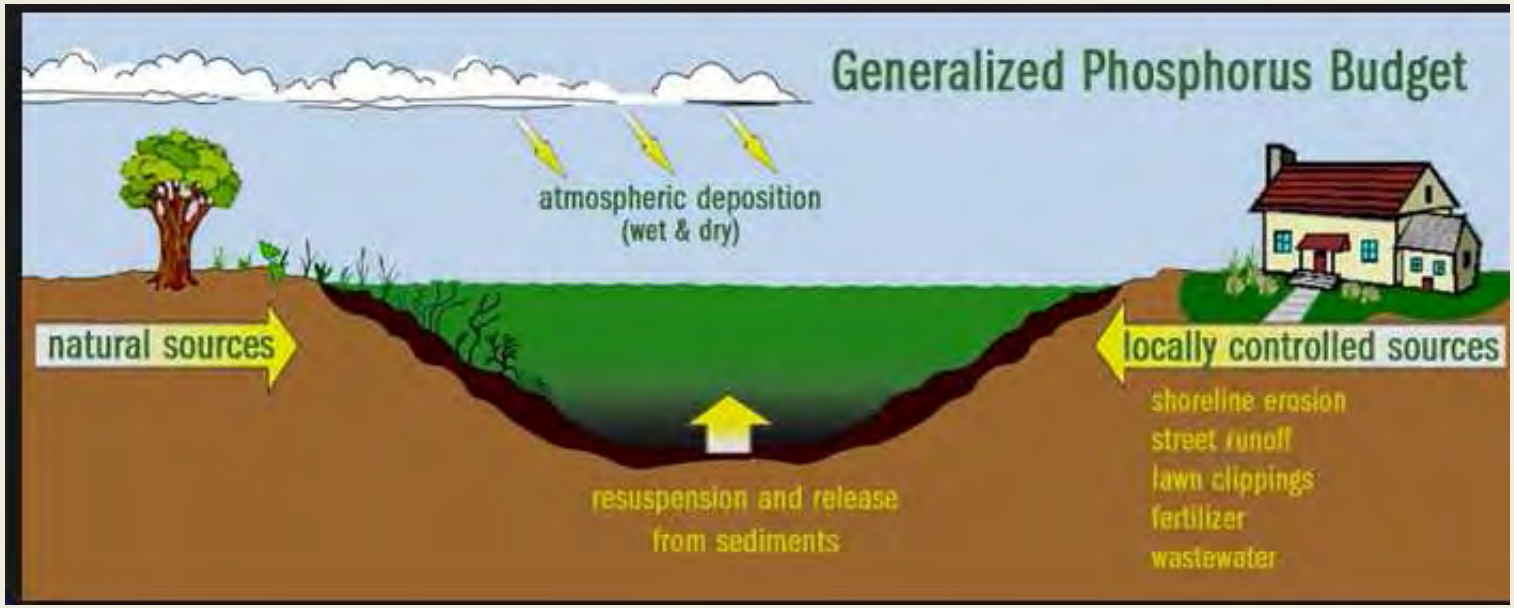
Figure 10: Time series of concentrations measured weekly in the LSC effluent for the 2000 - 2012 interval: (a) total phosphorus, (b) soluble reactive phosphorus, and (c) turbidity. The median of triplicate samples was used as the representative value. "+" symbols represent additional triplicate sample values.

Key Observation:

Increase in hypolimnetic SRP from 2003-2005 from 4 to 10 ug/L

What process could explain this increase in deep water phosphorus during the 2000s?

-Watershed inputs?
-Release from sediments?
-Biological Source?



What changes occurred during this time period in Cayuga Lake?

Introduction and expansion of exotic dreissenid mussels

Dreissena polymorpha
(zebra)
1991
(north outlet)

Dreissena rostriformus bugensis
(quagga)
1994
(power plant intake)

Limited Benthic Surveys

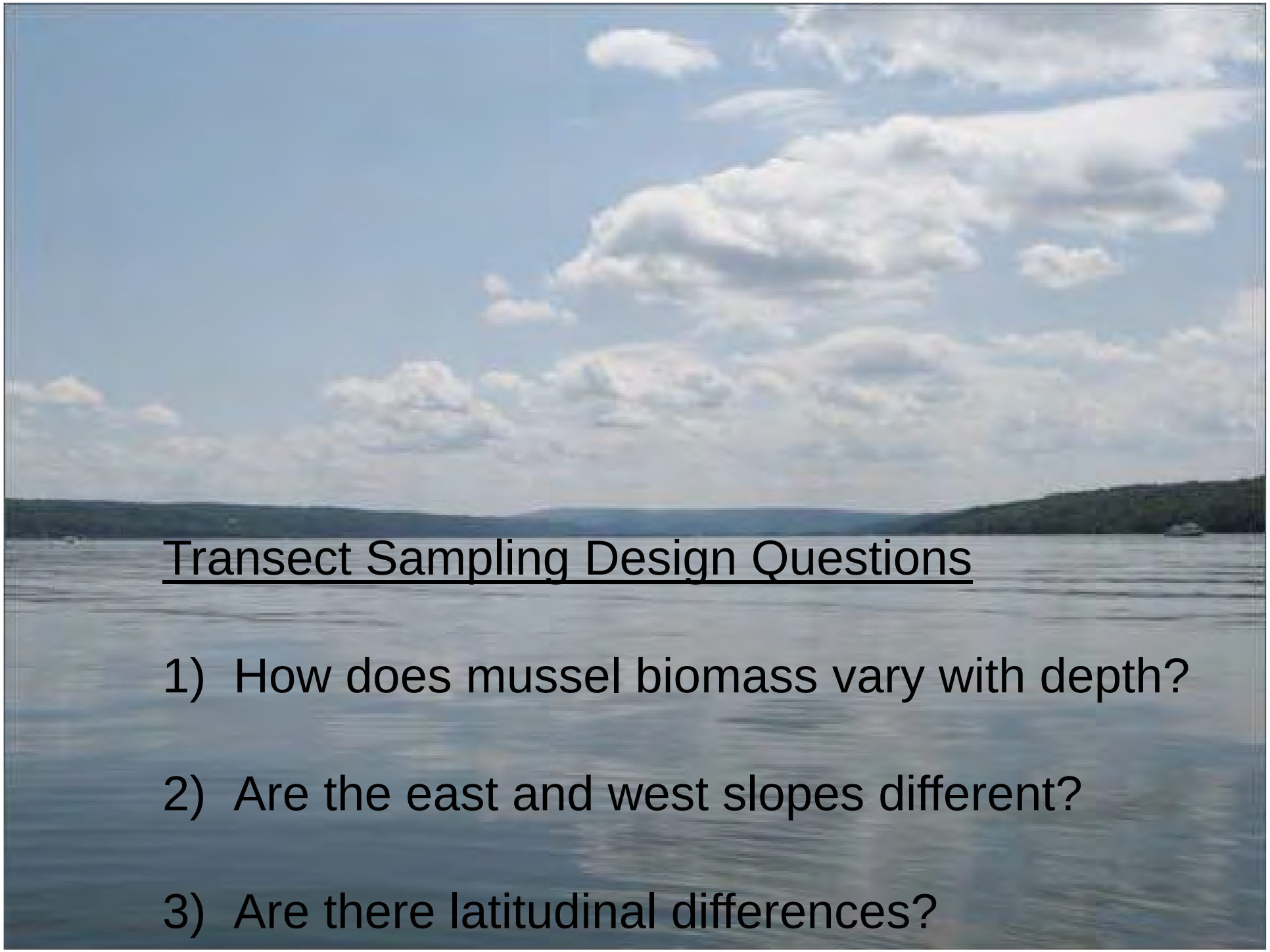
1994	Ed Mills	no mussels reported
2000/2001	Ed Mills	mussels not differentiated
2007-2010	Jim Watkins	primarily quagga mussels

Objective: Are exotic mussels capable of increasing hypolimnetic SRP on a lakewide scale?

Approach:

1) Quantify mussel density and biomass for both species.

2) Apply phosphorus excretion rates.



Transect Sampling Design Questions

1) How does mussel biomass vary with depth?

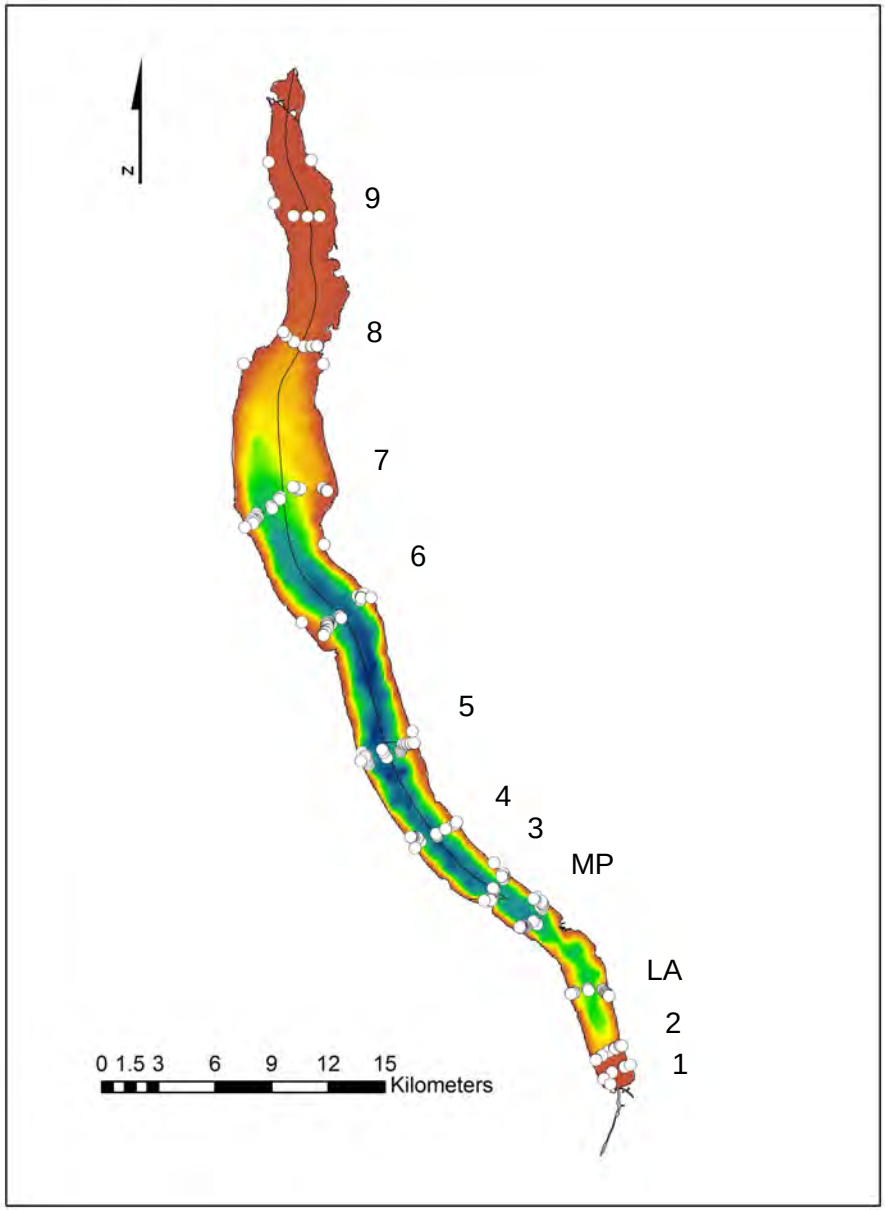
2) Are the east and west slopes different?

3) Are there latitudinal differences?

Benthic Survey Fall 2013

Field Summary:
372 Grabs
124 Sites
11 Transects

Transect:
9 (North End, Cayuga)
8 (Union Springs)
7 (Wells College, Aurora)
6 (Long Point)
5 (West-Side Wine Country)
4 (Power Plant, Deepest)
3 (Taughannock)
MP (Myers Point)
LA (Lansing)
2 (CU Sailing Club)
1 (South End)



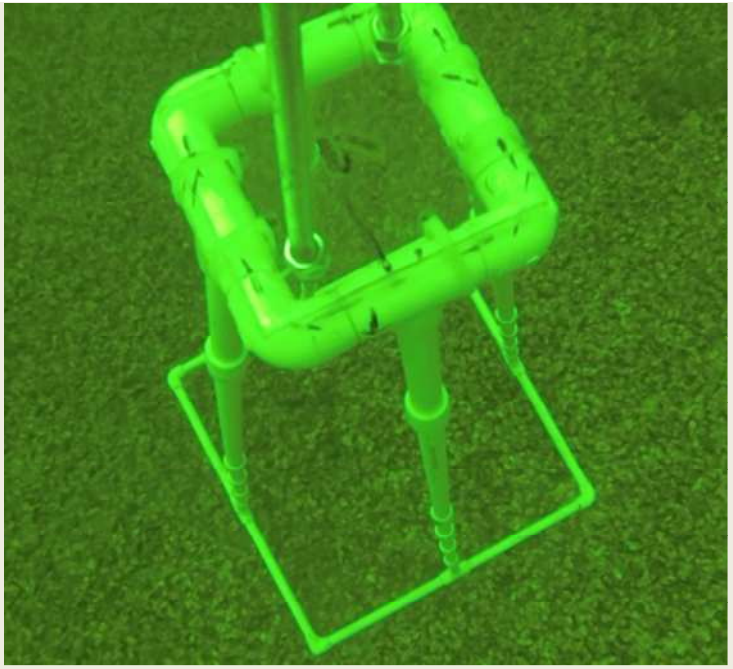
Field Work

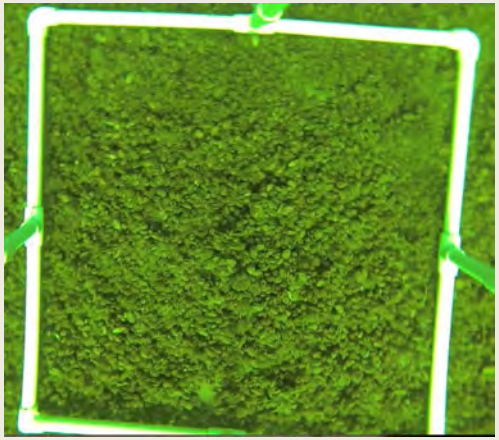
- Benthic Sampling
  - Petite Ponar ® with "lobster pot hauler"
  - Triplicate samples
  - Depth range:

    Shore 0.15 and 1 m
    Boat 2 m to 124 m
  - 500 um sieve
- GoPro Hero3 Video

Video Footage

GoPro Hero 3





19 m, Transect 4

75 m, Myers Pt

115 m, Myers Pt

Mussel Sizing

Sort and Measure

- Total counts:
  - Quaggas and Zebras
  - <0.5 cm and >0.5cm
- Wet weight:
  - All Quaggas and Zebras
- Dry Weight:
  - Calculated from size

Size with ImageJ

Mussel Sizing

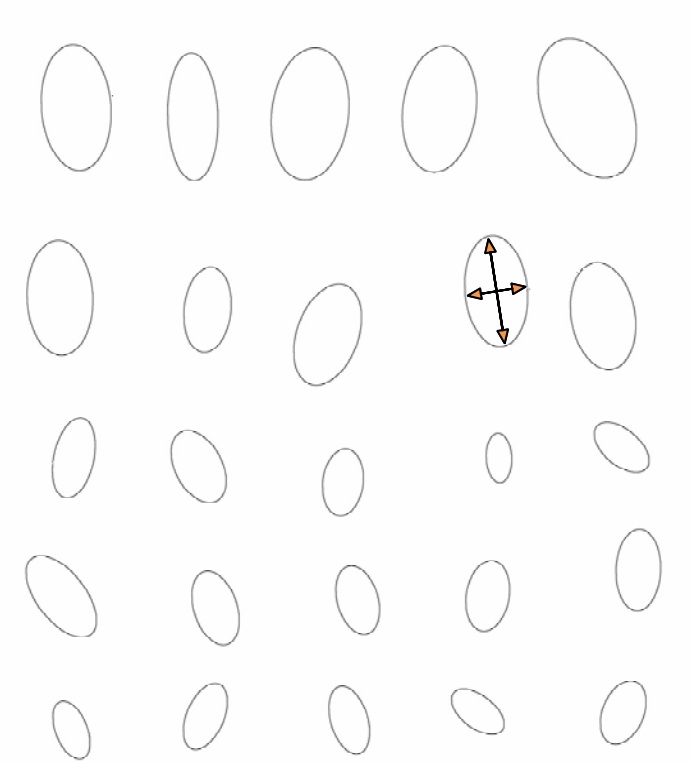
Sort and Measure

- Total counts:
  - Quaggas and Zebras
  - <0.5 cm and >0.5cm
- Wet weight:
  - Quaggas and Zebras

  (shell included)
- Dry Weight:
  - Calculated from length

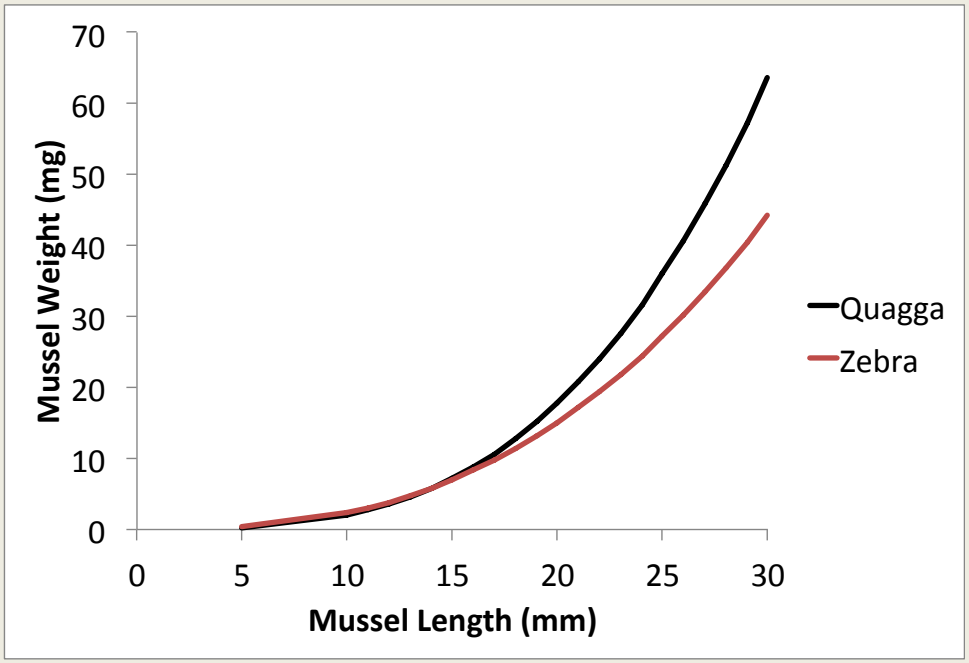
  (shell not included)

Size with ImageJ



Ellipse major axis is length

Length-Weight Regression for Dreissenids



Nalepa et al. 2010

Matches Cayuga LW equation for 2007 Quaggas (unpub)

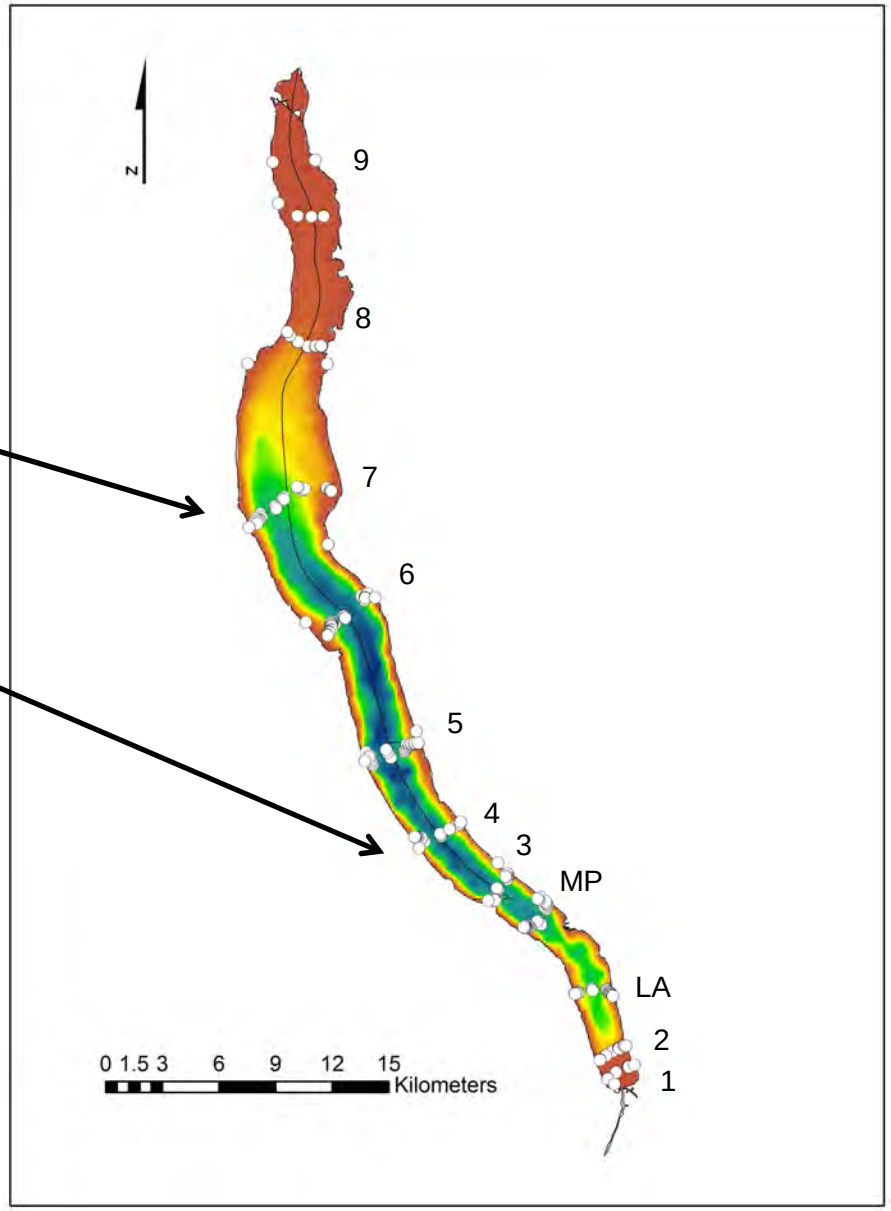
Length	Dry Weight
5 mm	0.2 mg
10 mm	2.0 mg
20 mm	17.8 mg
30 mm	63.7 mg

Does not include shell weight

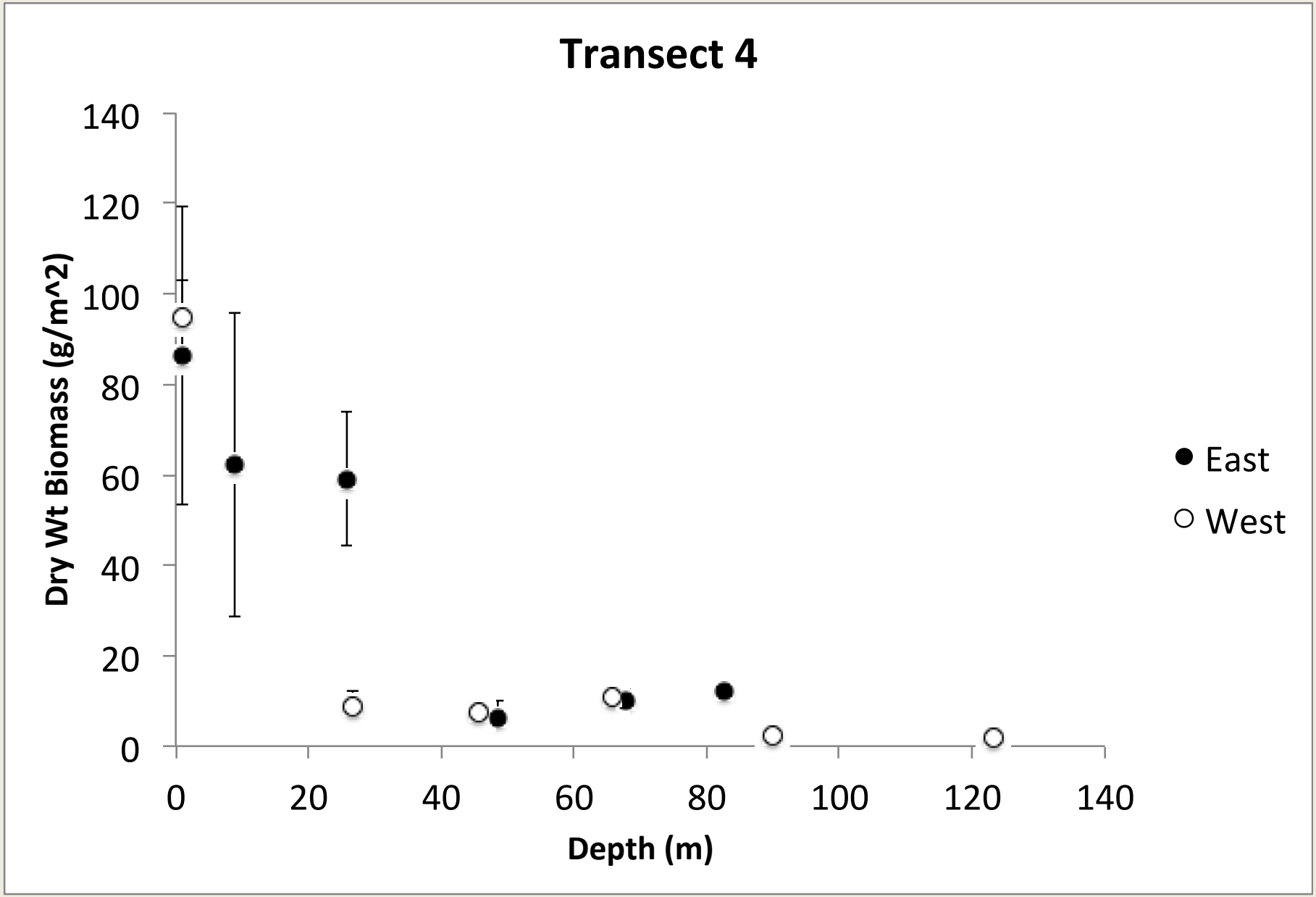
Preliminary Findings

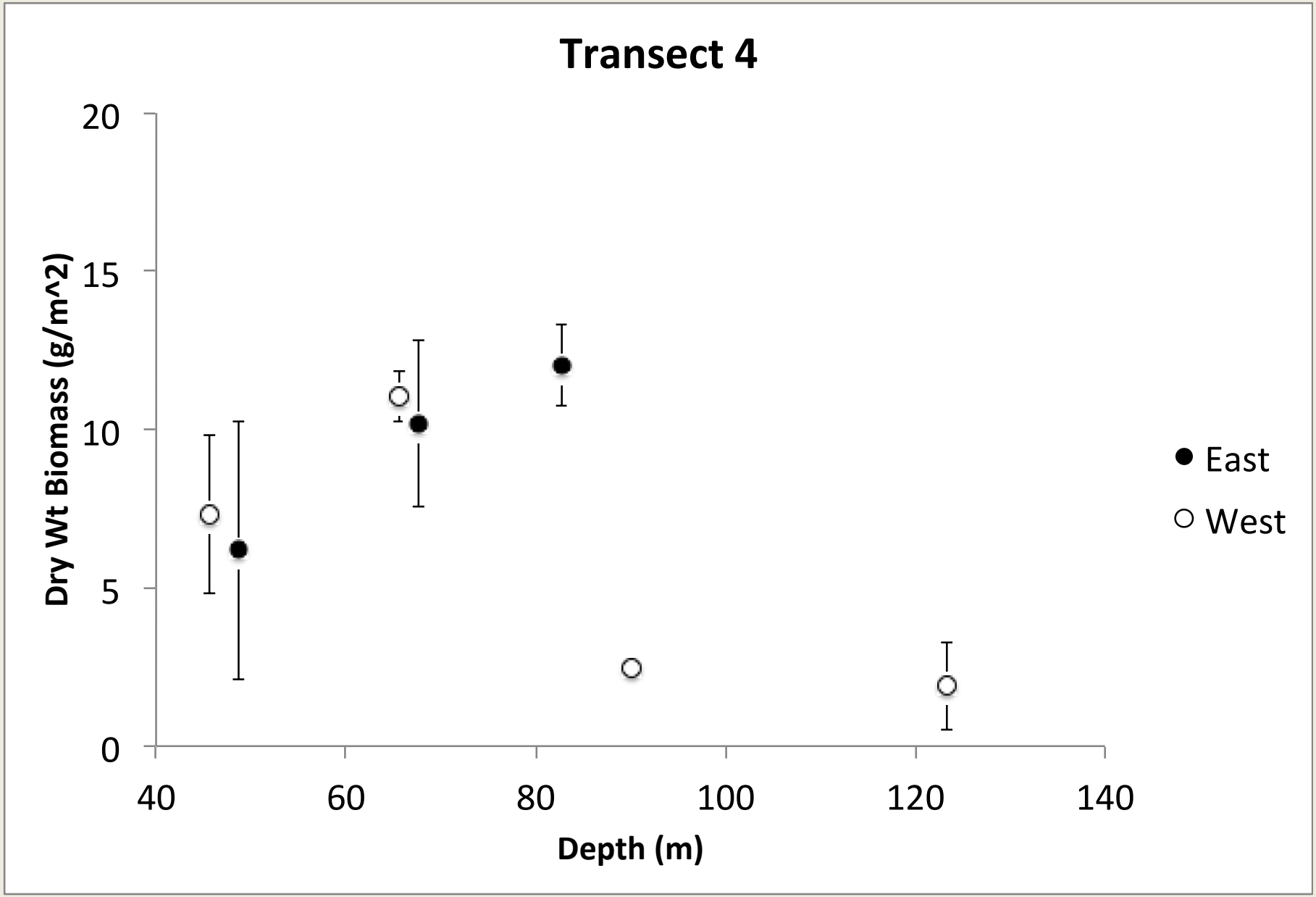
<u>Cross-Lake Transects</u>

9 (North End, Cayuga)
8 (Union Springs)
7 (Wells College, Aurora)
6 (Long Point)
5 (West-Side Wine Country)
4 (Power Plant, Deepest)
3 (Taughannock)
MP (Myers Point)
LA (Lansing)
2 (CU Sailing Club)
1 (South End)

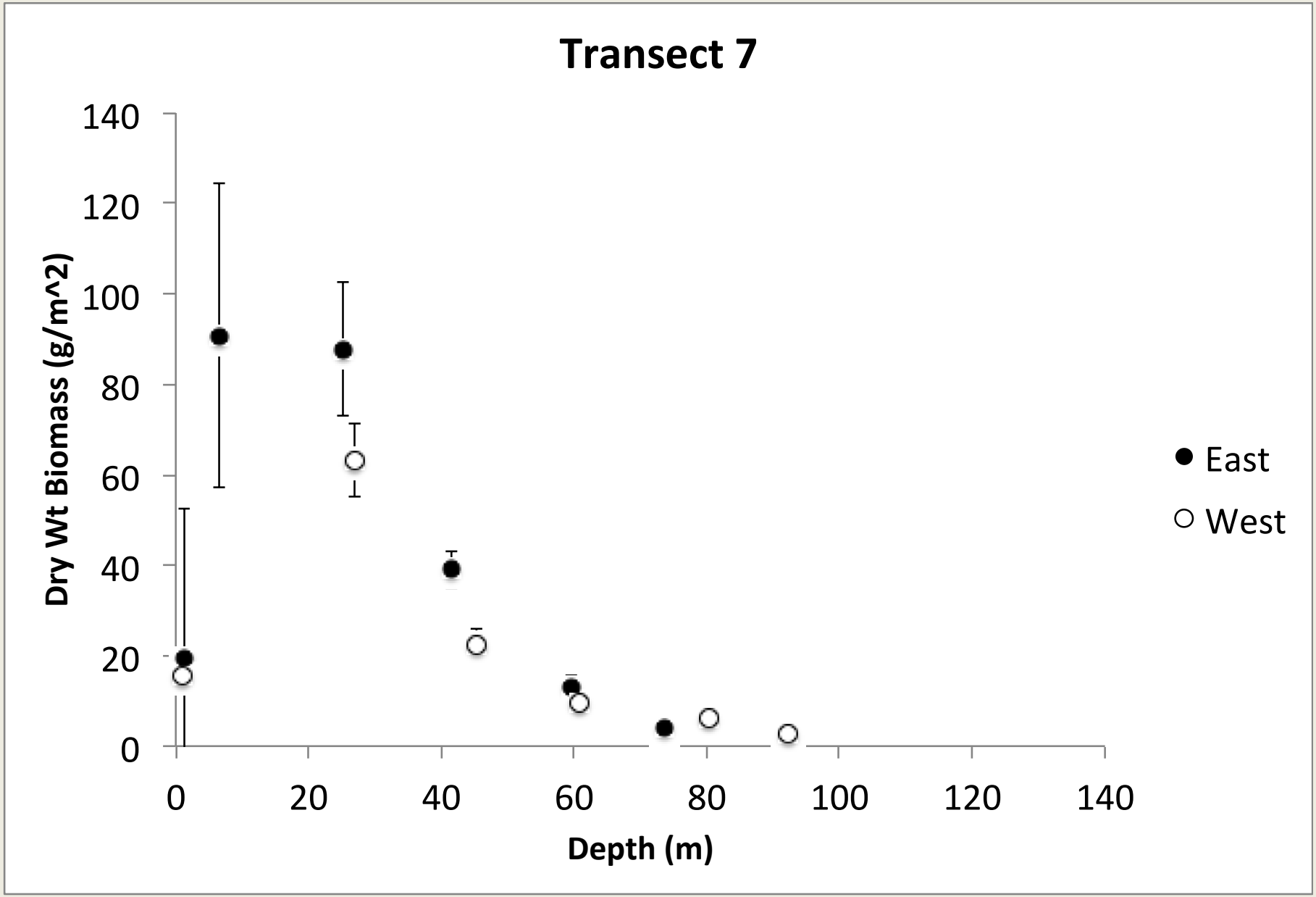


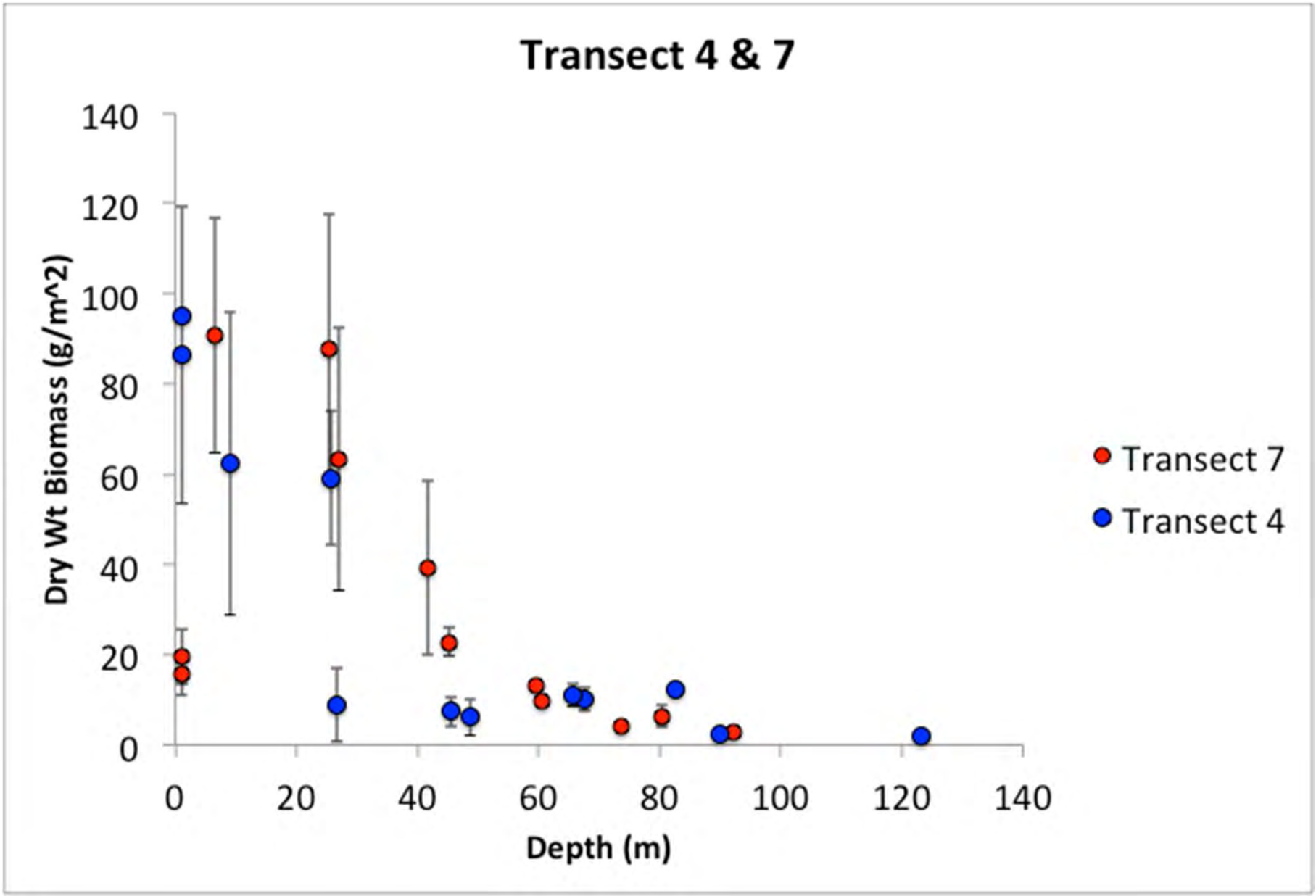
Transect 4

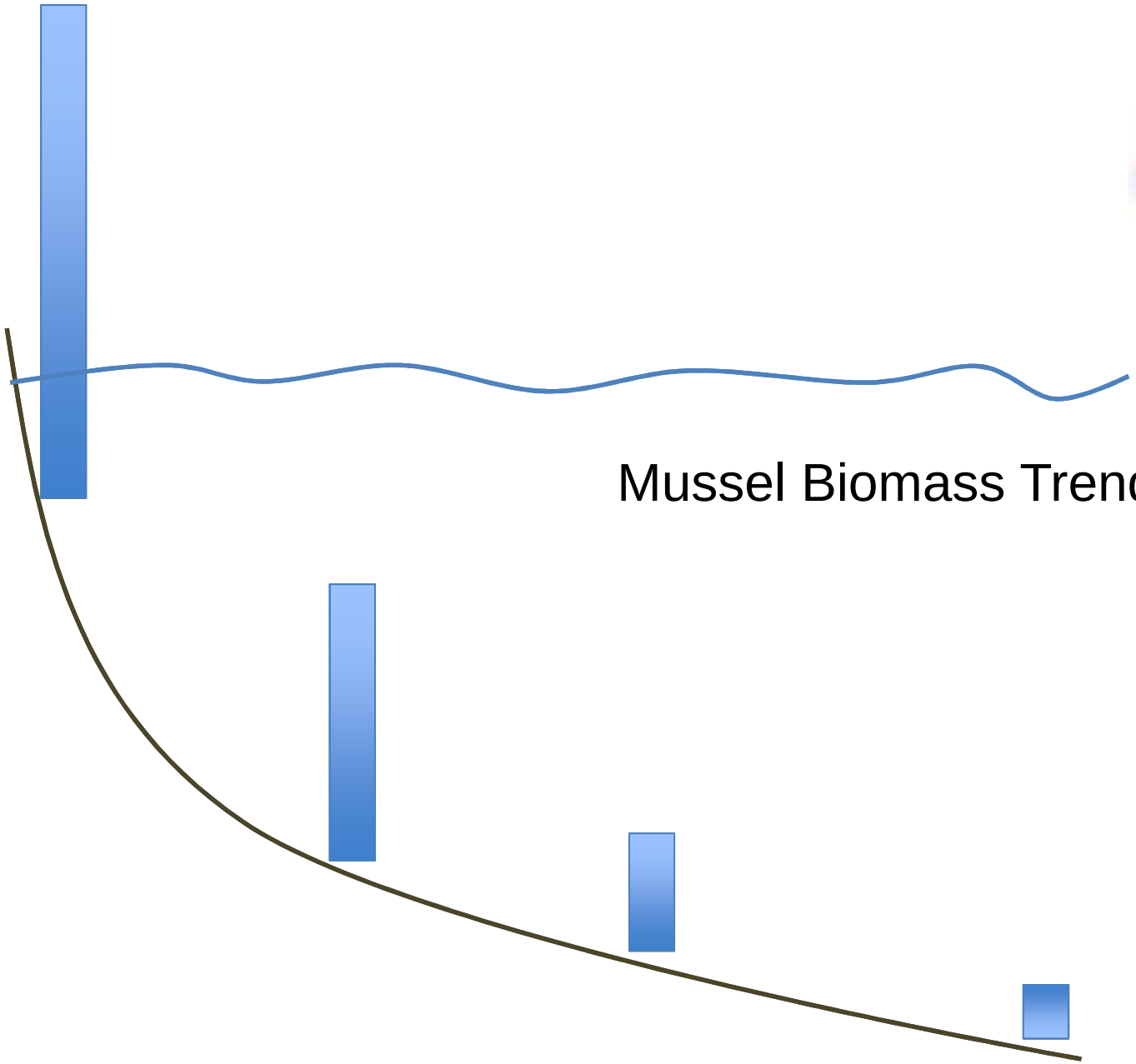

Transect 4
Dry Wt Biomass (g/m^2)
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
Depth (m)
East
West


Transect 4
Dry Wt Biomass (g/m^2)
20
15
10
5
0
40
60
80
100
120
140
Depth (m)
East
West

Transect 7 (Wells College)


Transect 7
Dry Wt Biomass (g/m^2)
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
Depth (m)
East
West


Transect 4 & 7
Dry Wt Biomass (g/m^2)
140
120
100
80
60
40
20
0
0
20
40
60
80
100
120
140
Depth (m)
Transect 7
Transect 4



Mussel Biomass Trend with Depth

Objective 2: Applying Excretion Rates

Approaches

Lab Increase of SRP in filtered lake water

Downstream vs. Upstream Effler et al. 1997, 2004

In situ Ozersky et al. 2009, Bootsma unpub.

Reporting

"Specific" umol gDW^{-1} h^{-1}

"Areal" umol m^{-2} h^{-1} (considers biomass)

1 umol P = 31 ug L^{-1} P

General Laboratory Approach

1) Start with filtered lake water of low baseline SRP.

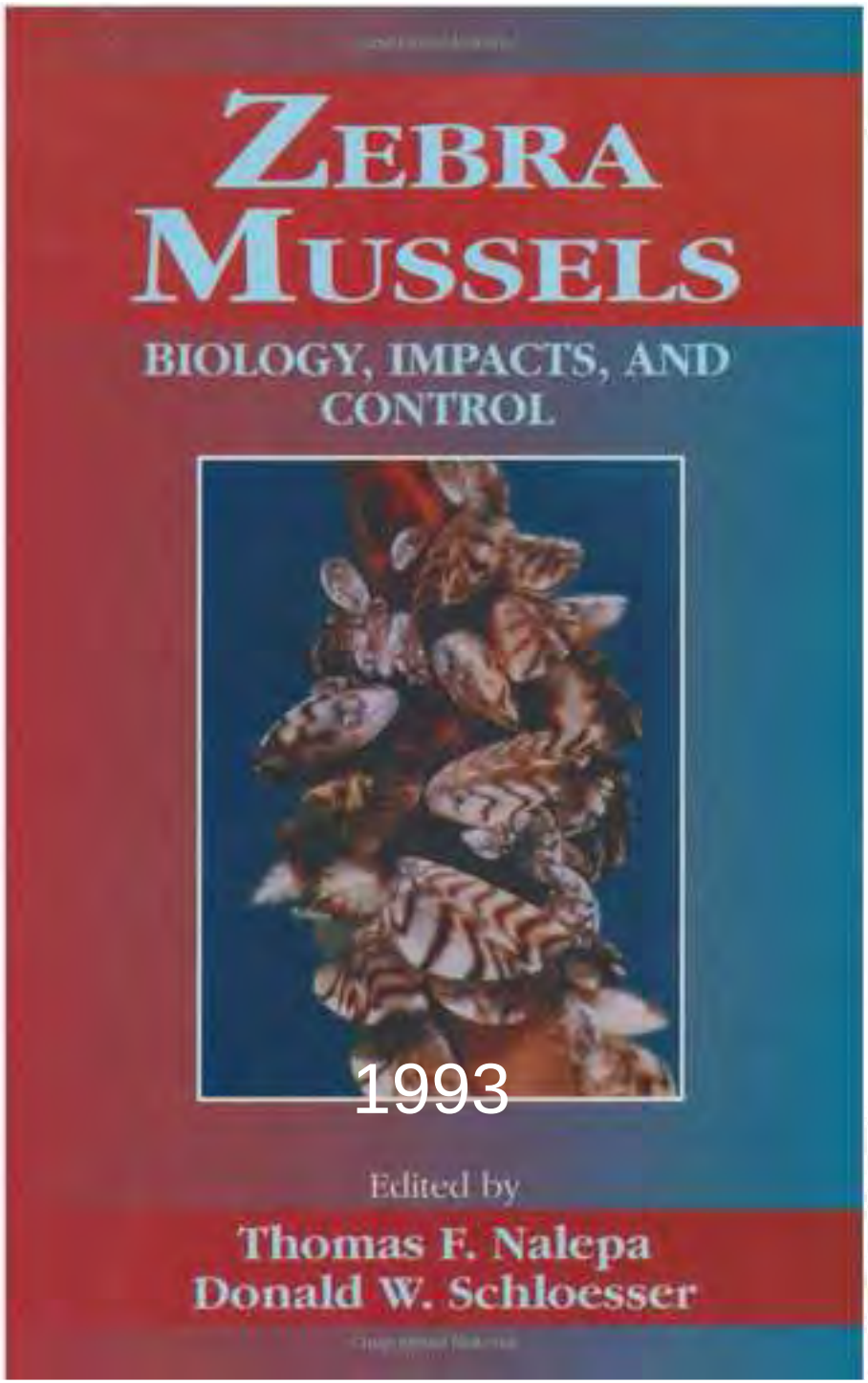
2) One no-mussel control, triplicate mussel treatments for each temperature.

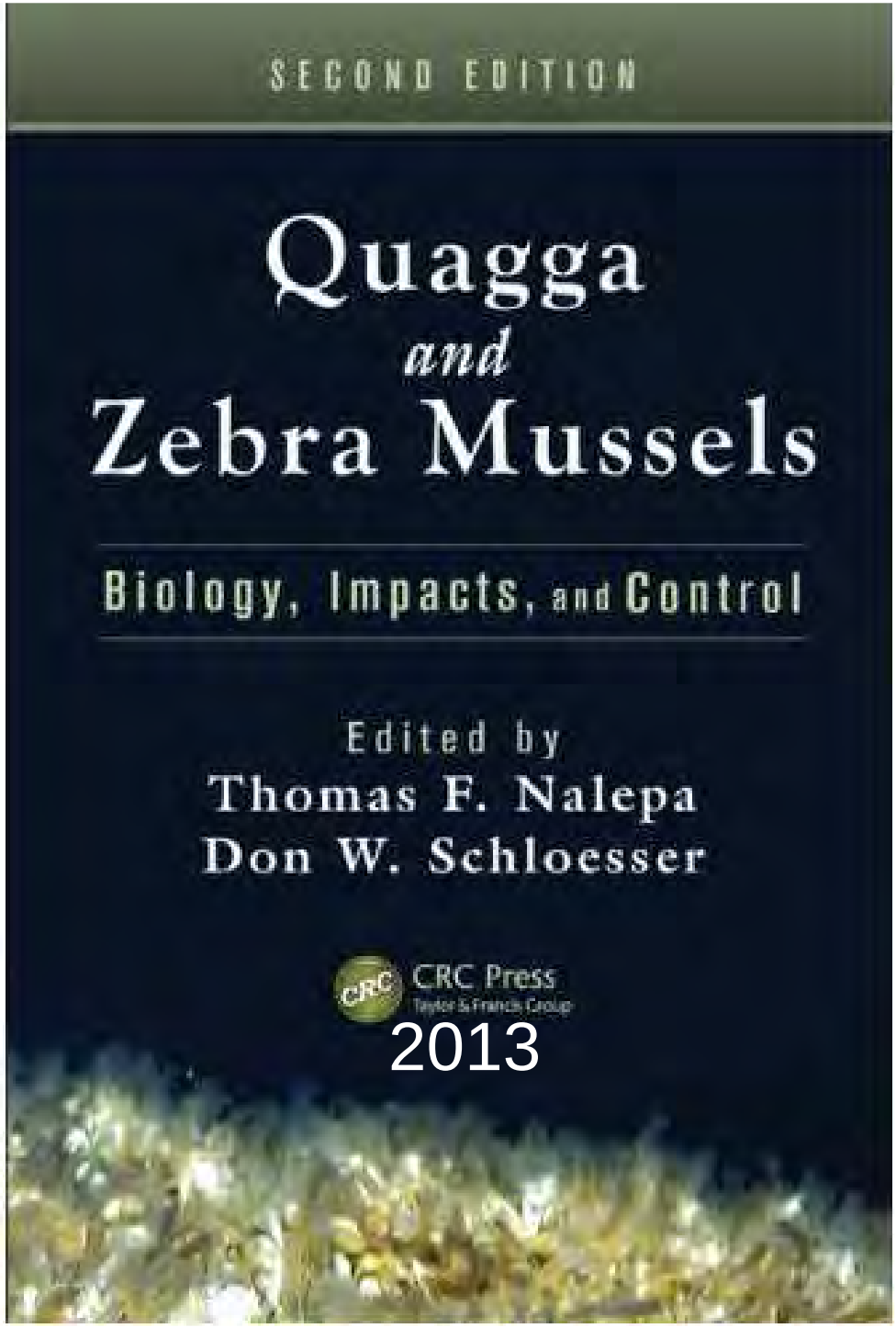
3)Add mussels of known size.

4)Collect SRP samples over time.

5)Calculation includes

-SRP change (ug/L or umol)
-volume of water (liters)
-time period (hours)
-total dry weight of mussels (g, not including shells)


ZEBRA MUSSELS
BIOLOGY, IMPACTS, AND CONTROL
1993
Edited by
Thomas F. Nalepa
Donald W. Schloesser


SECOND EDITION
Quagga
and
Zebra Mussels
Biology, Impacts, and Control
Edited by
Thomas F. Nalepa
Don W. Schloesser
CRC Press
Taylor & Francis Group
2013

Excretion Rates

(Table 35.1 pg. 557 Nalepa 2013 Book)

Ranges for Dreissenids

Phosphorus 0.08 to 3.4 umol P gDW^{-1} h^{-1}

Nitrogen 1.4 to 26 umol N gDW^{-1} h^{-1}

Average Values for Phosphorus Excretion

Zebra 0.67 +/- 0.56 umol gDW^{-1} h^{-1}

Quagga 0.33 +/- 0.18 umol gDW^{-1} h^{-1}

Temperature Effect on Excretion Rate

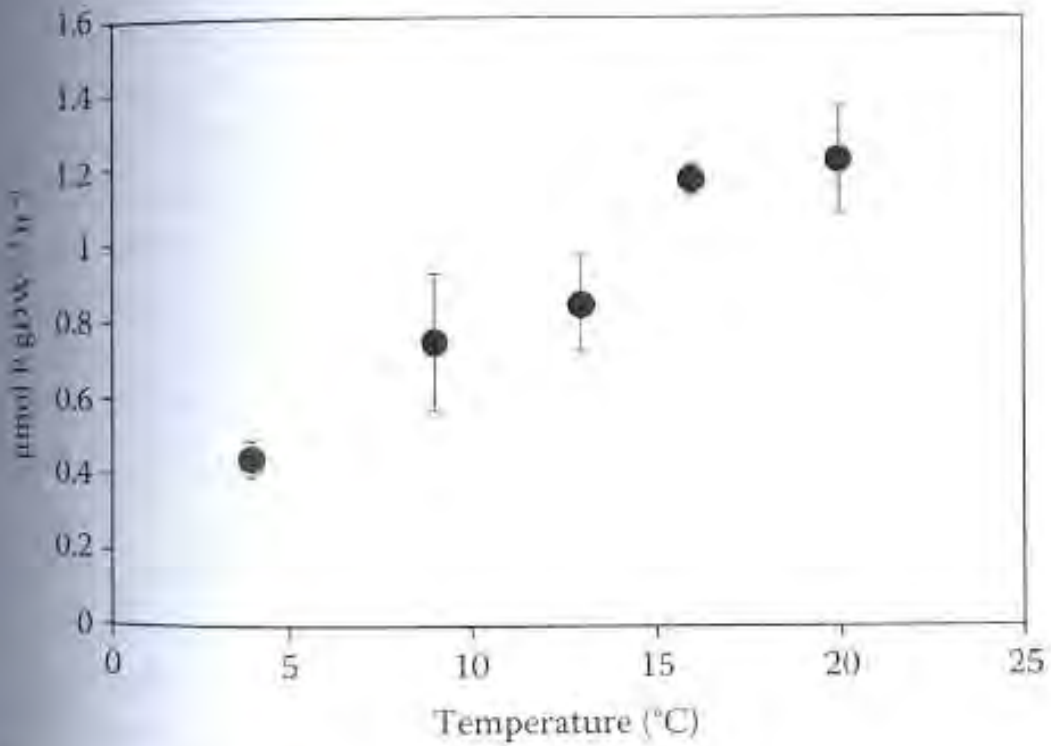


Figure 35.2 Excretion rates of soluble reactive P (μmol P gDW^{-1} h^{-1}) by quagga mussels at five different temperatures. Mussels were collected from Lake Michigan in March 2010. Mussels were fed a monoculture of *Scenedesmus quadricauda* (particulate carbon concentration = 25–33 μmol L^{-1}) and acclimated to experimental temperatures for 3 days prior to measurement of excretion rates. Mussel length was between 16 and 18 mm. Excretion rate was measured as SRP accumulation over 1.5 h after mussels were placed in filtered lake water.

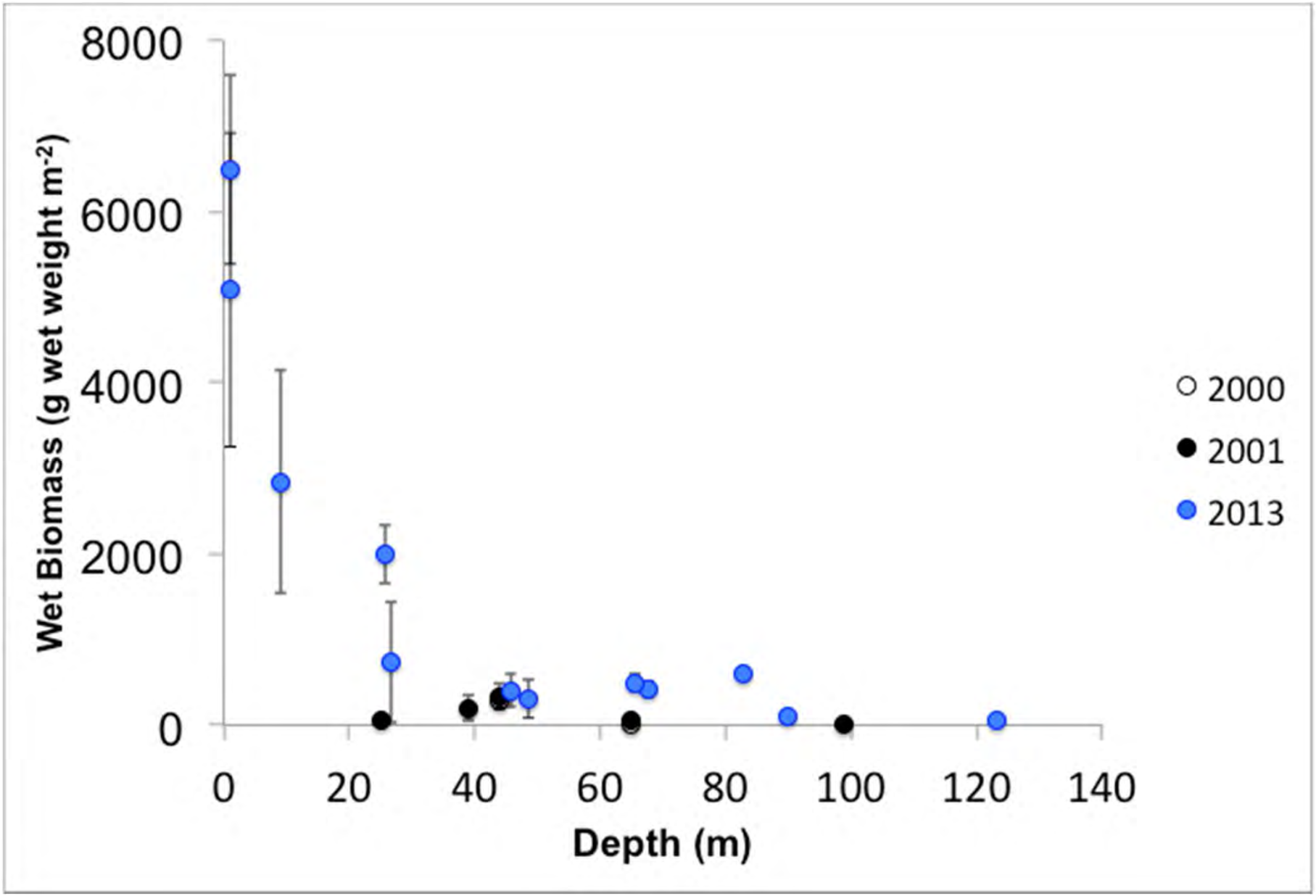
Nalepa (unpub)

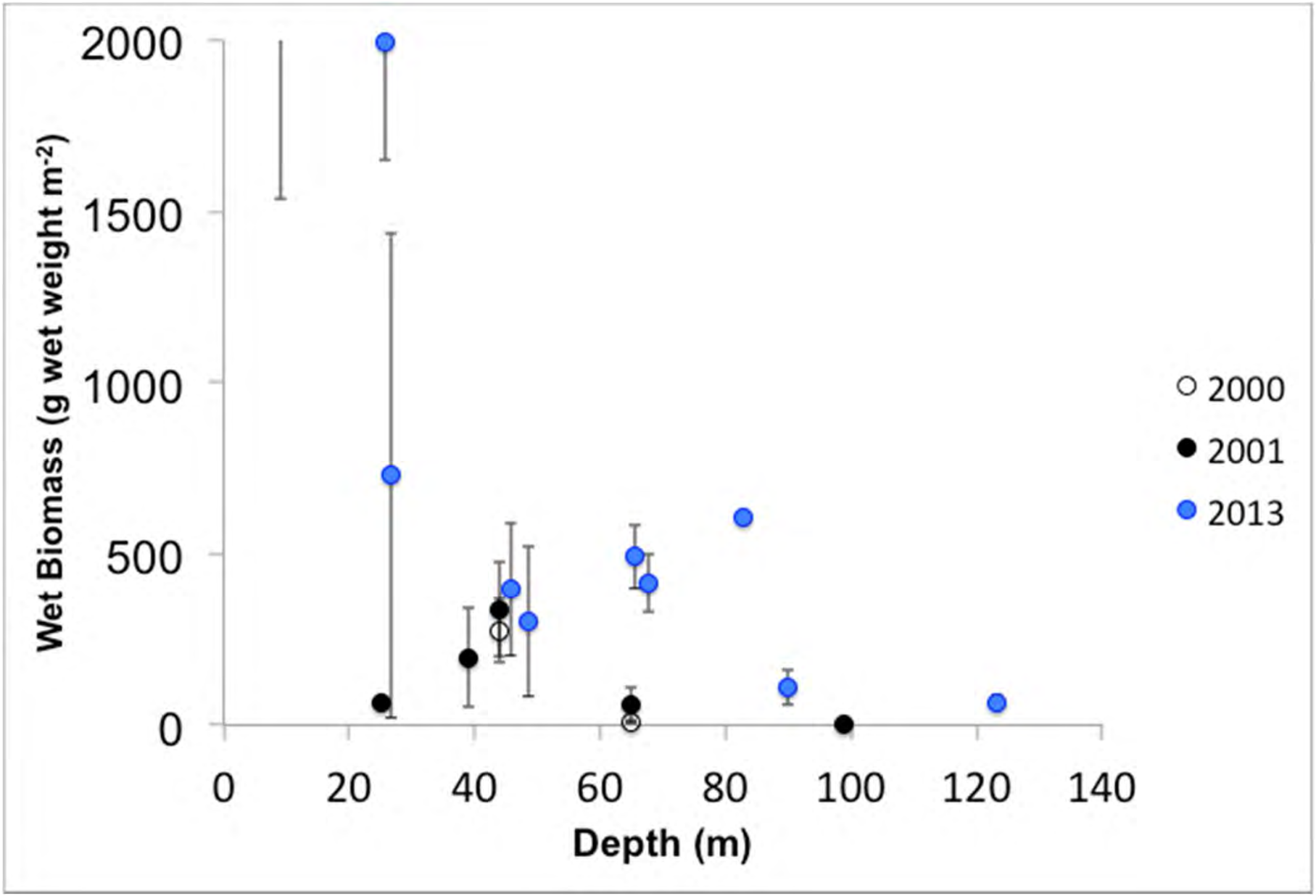
Depth (m)	DW Biomass m^{-2}	Specific Rate (T-Dependent)	Areal Rate
10 m	100 g	1.2 umol g^{-1} hr^{-1}	120 umol m^{-2} hr^{-1}
30 m	50 g	0.8	40
50 m	10 g	0.8	8
90 m	5 g	0.4	2

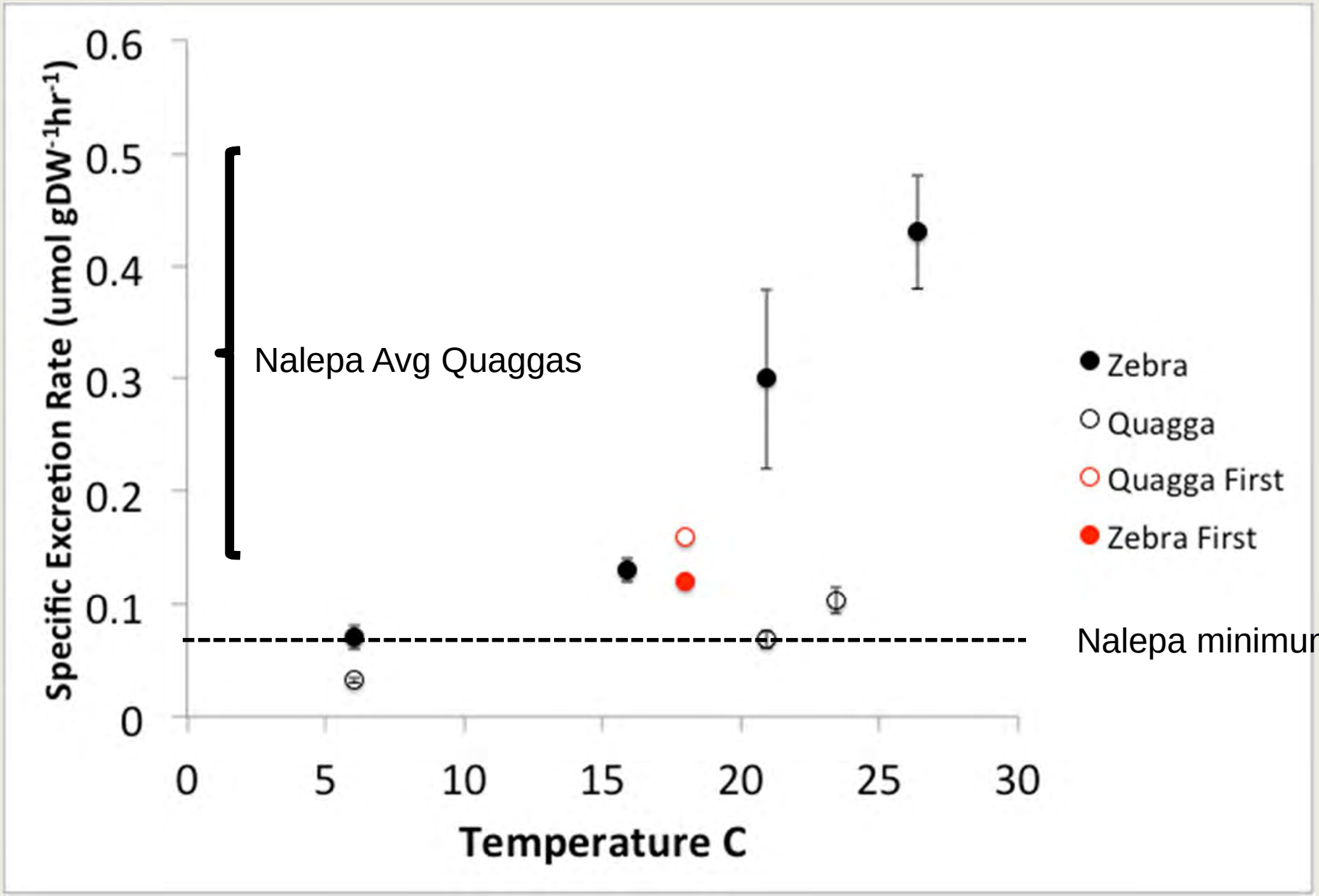
+ P

Excretion Rates Decrease with Temperature


Thank you!


8000
6000
4000
2000
0
Wet Biomass (g wet weight m-2)
0
20
40
60
80
100
120
140
Depth (m)
2000
2001
2013


Wet Biomass (g wet weight m-2)
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
Depth (m)
2000
2001
2013



Based on triplicates