Phosphorus Transport in Wetlands

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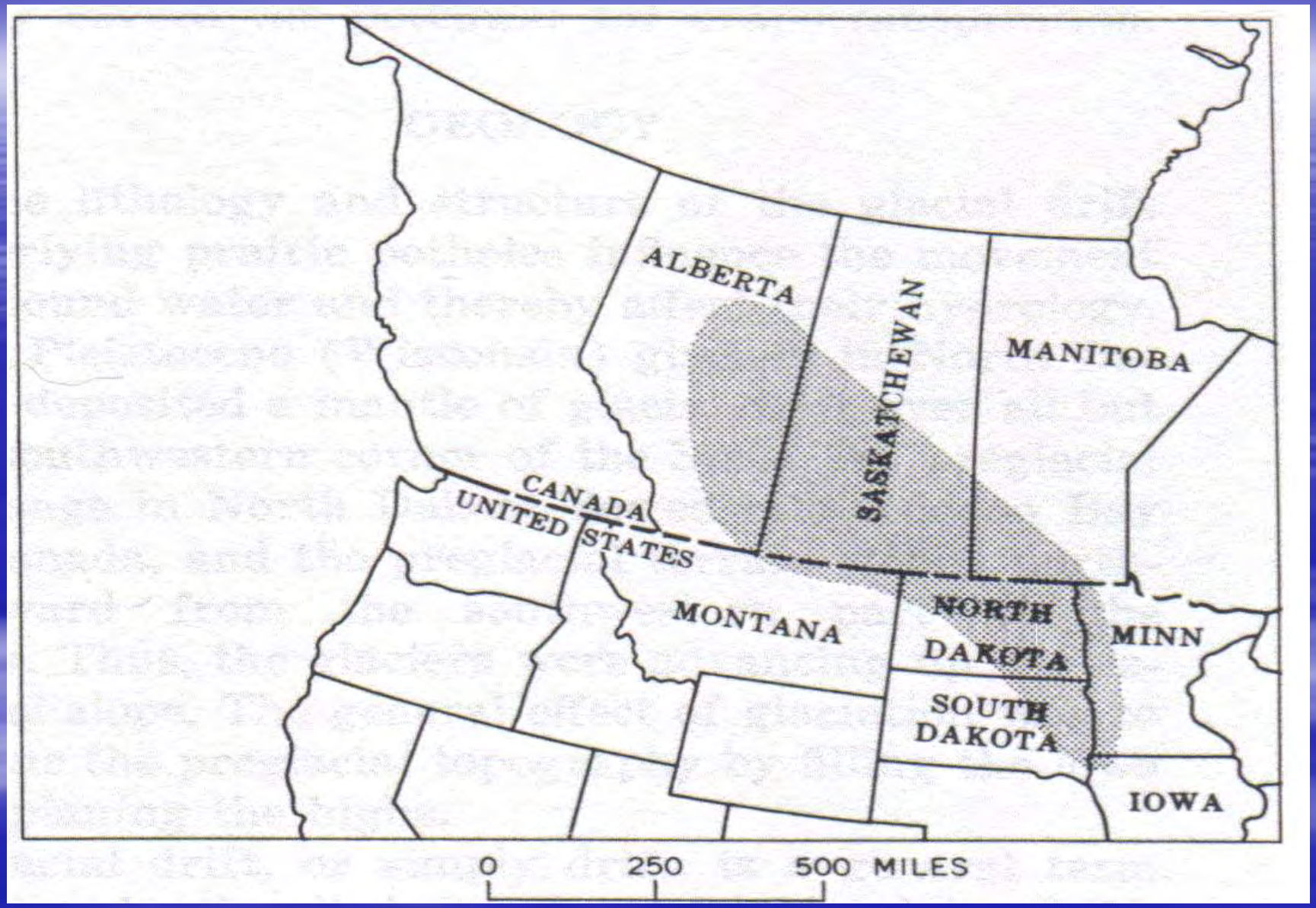
Outline

- Introduction
- Research Goal & Objectives
- Study Area
- Field Methods
- Results & Discussion
- Summary & Future work

Introduction

- Wetlands in Prairie Pothole Region (PPR) in North America known to support diverse species of biota, regulate flooding, control water quality, and recharge ground water
- About 50% of these wetlands are lost
- Restoration efforts by state and federal agencies are in progress


ALBERTA
SASKATCHEWAN
MANITOBA
CANADA
UNITED STATES
MONTANA
NORTH DAKOTA
MINN
SOUTH DAKOTA
IOWA
0
250
500 MILES

Introduction Contd.,

- Evaluate restoration using measurements such as
  - nutrients, vegetation, fish and wildlife
- Present research interested in water quality in wetlands; and nutrients chosen as measurement to evaluate restoration
- Phosphorus chosen for study
  - because, among nutrients, phosphorus major limiting nutrient

Research Scope & Objectives

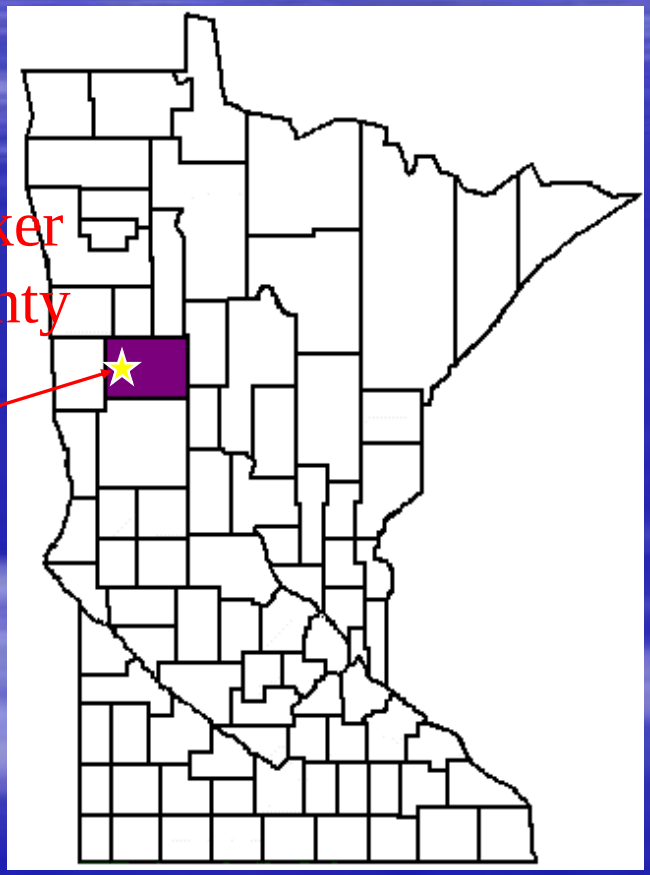
- Goal
  - Study phosphorus transport within various wetland components (soil, water and biota)
- Objectives
  - Determine phosphorus forms and concentrations in wetland water, soil, and plants
  - Study the variations in phosphorus concentrations with space and time in wetland water column

- Objectives contd.
  - Study water quality changes with space and time in the selected wetlands
  - Determine the factors contribute to phosphorus transformations in wetland components

Study Location

- Hamden Slough National Wildlife Refuge (NWR), located in Buffalo Red River watershed, Becker County, Minnesota
- Almost 100% of all wetlands in the refuge have been drained for agricultural activities
- Migratory Bird Conservation Commission approved Hamden Slough NWR as the 452nd refuge in 1989 to restore lost wetlands

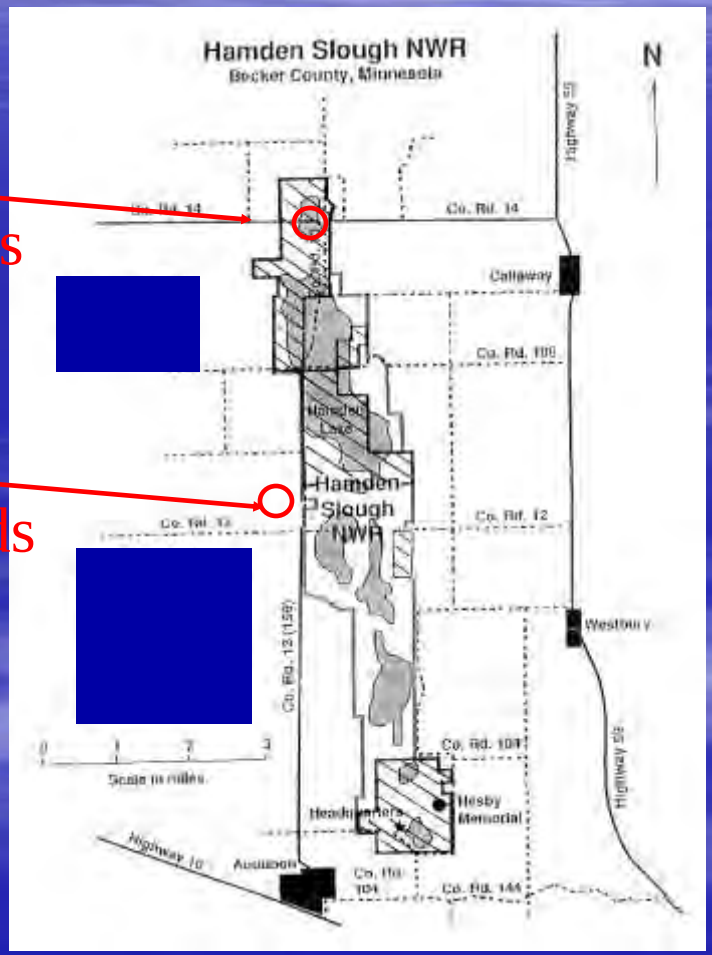
Study area



Becker County

Project Area

Minnesota



Bisson Wetlands

Hass Wetlands

○ Project sampling locations

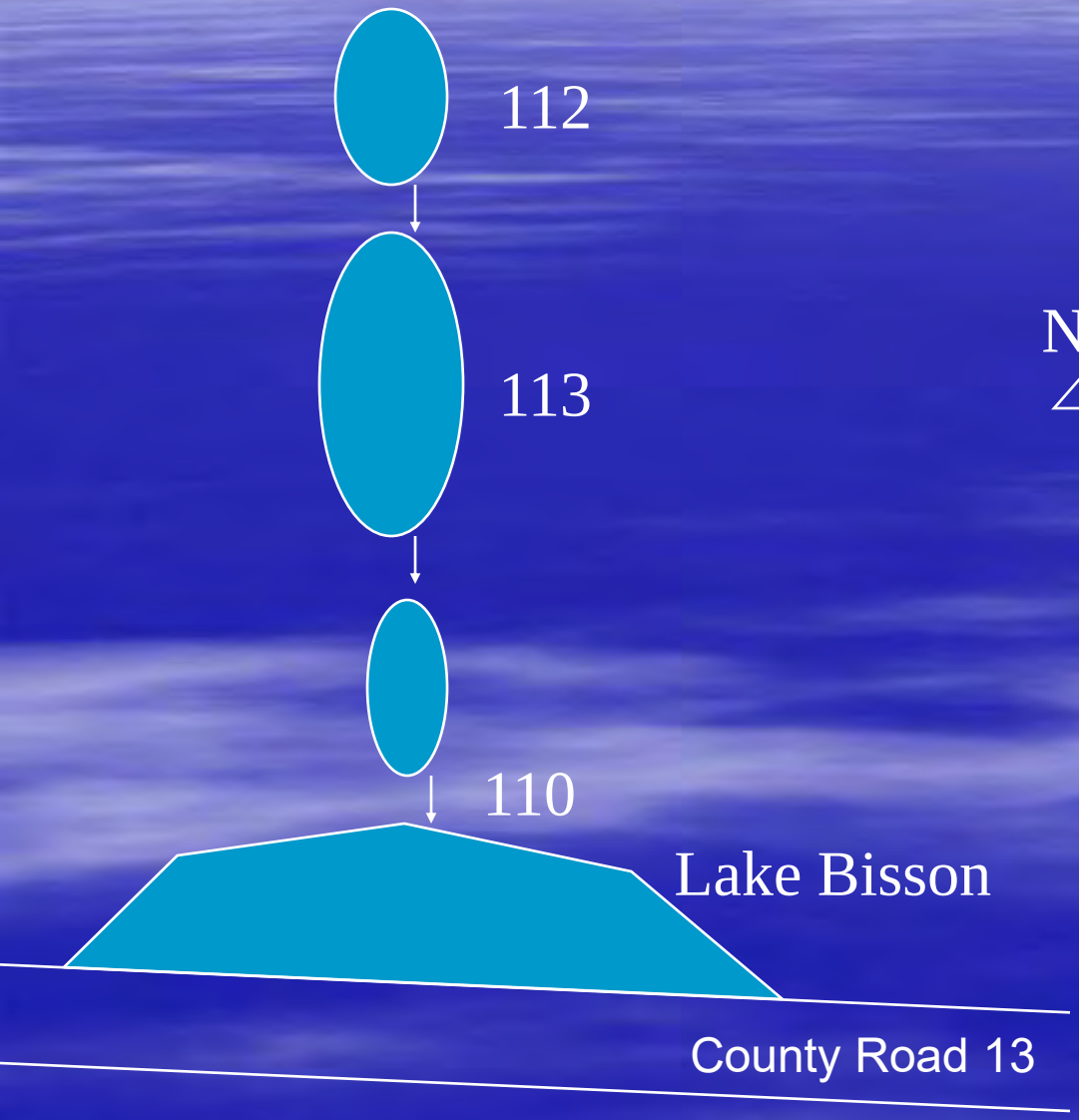
Present condition

- High phosphorus levels in soil and water in restored and excavated wetlands
- High phosphorus levels in Lake Bisson (much greater than 100 µg/L of total phosphorus, which can lead to eutrophication (USEPA, 2000))

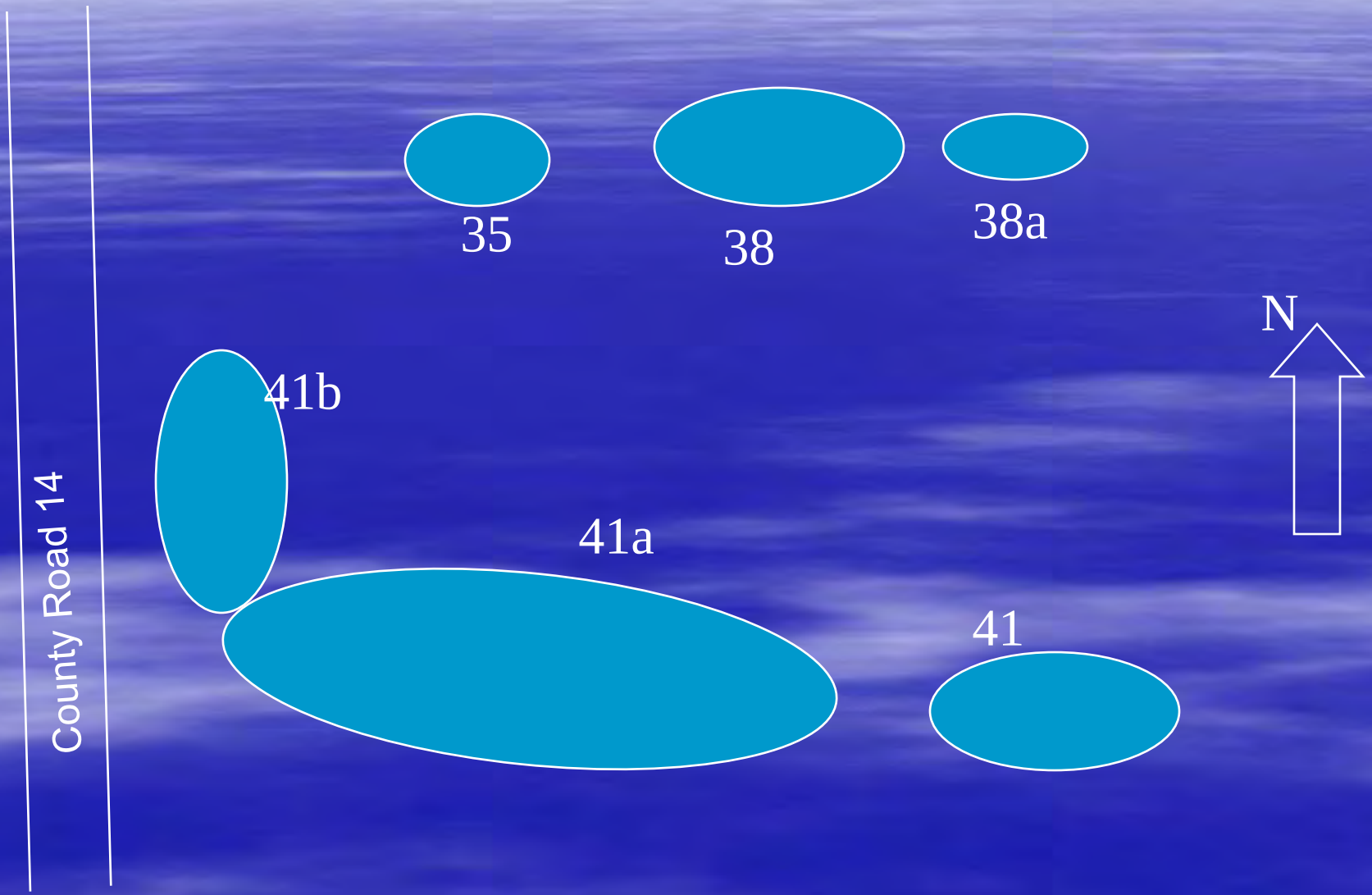
Selected Wetlands

- Bisson Wetlands
  - wetlands 112, 113 and 110
- Hass wetlands
  - Wetlands 35, 38, 38a, 41a, 41b and 41

Bisson Wetlands



Hass Wetlands



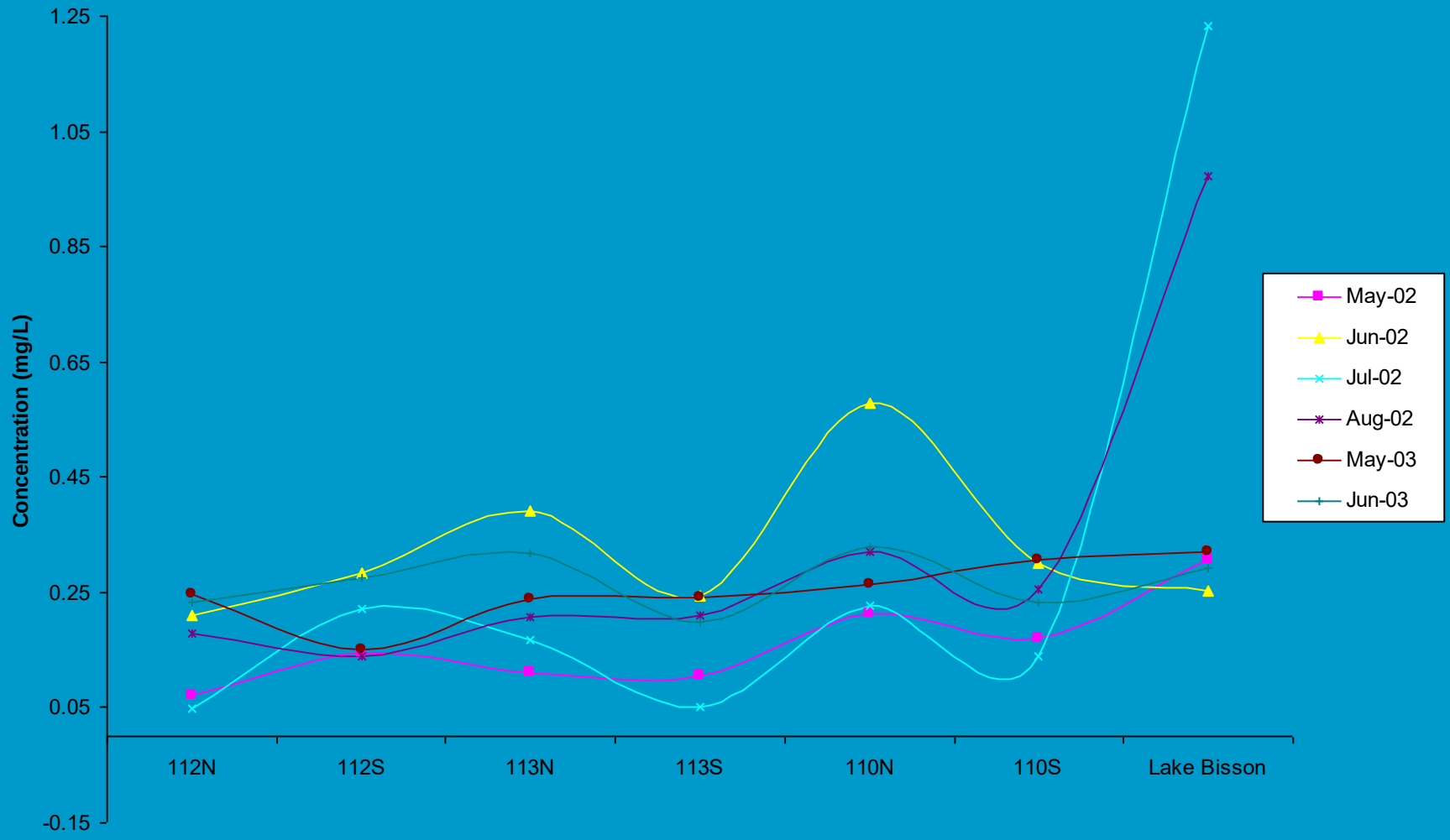
Field Methods

- Water sampling
  - Water Sampling done monthly once starting from May through August for 3 years (2001(June only), 2002, 2003)
  - Sampling locations - on the ends of each wetland in the direction of flow
  - Sample analysis
    - pH, total phosphorus, orthophosphate, HCO_3^-, CO_3^-, Cl^-, Fe^{+2}, Mn^{+2} , Ca, and Mg

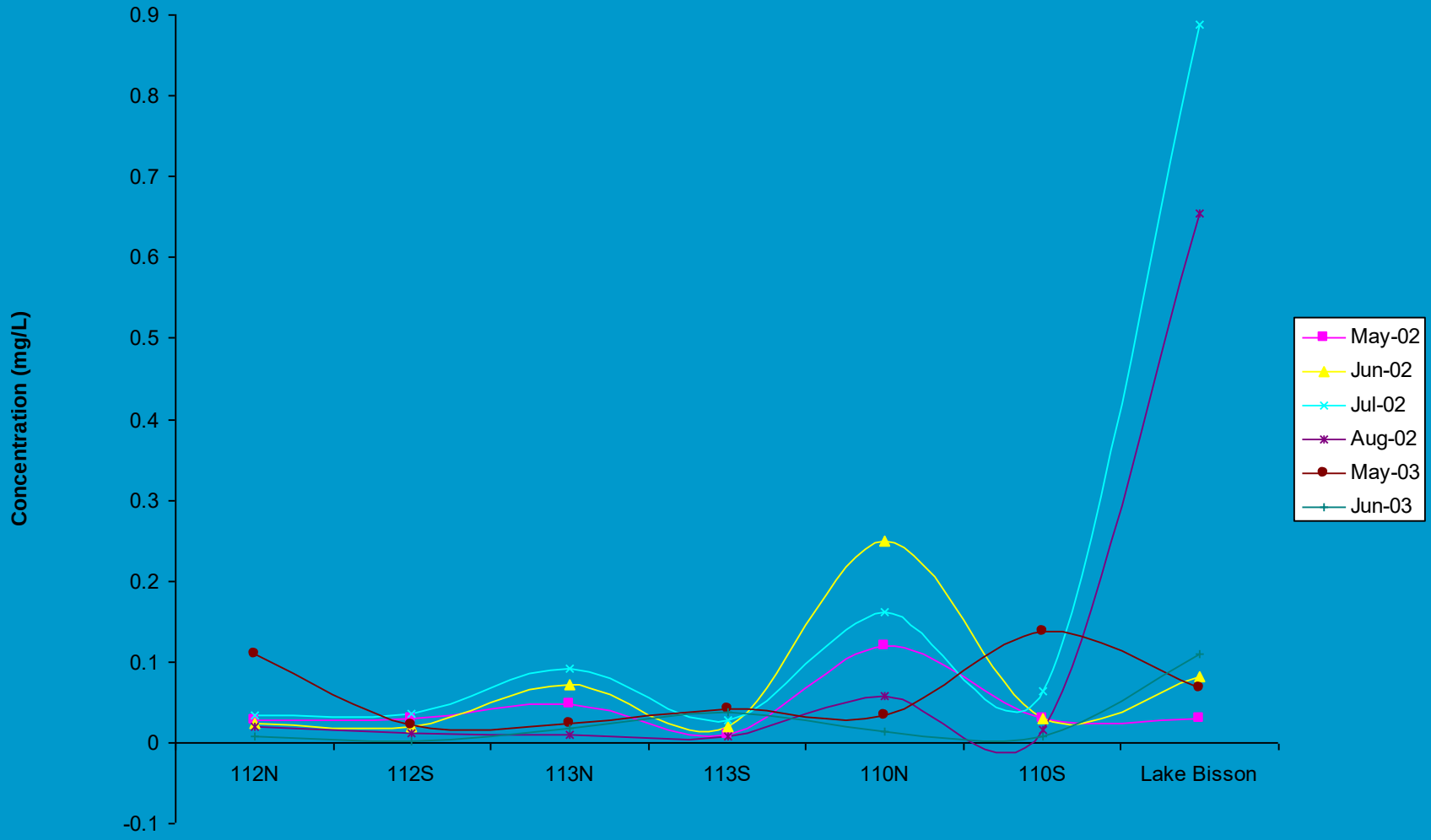
- Soil sampling
  - Samples collected only once (June 2001)
  - Sampling locations are at approximately 20’ distance from each other
  - Samples collected at 18” deep for profiling
- Sample analysis
  - P, K, Fe, Mn, Ca, Mg, Na, pH, EC, Organic matter and Cation exchange capacity

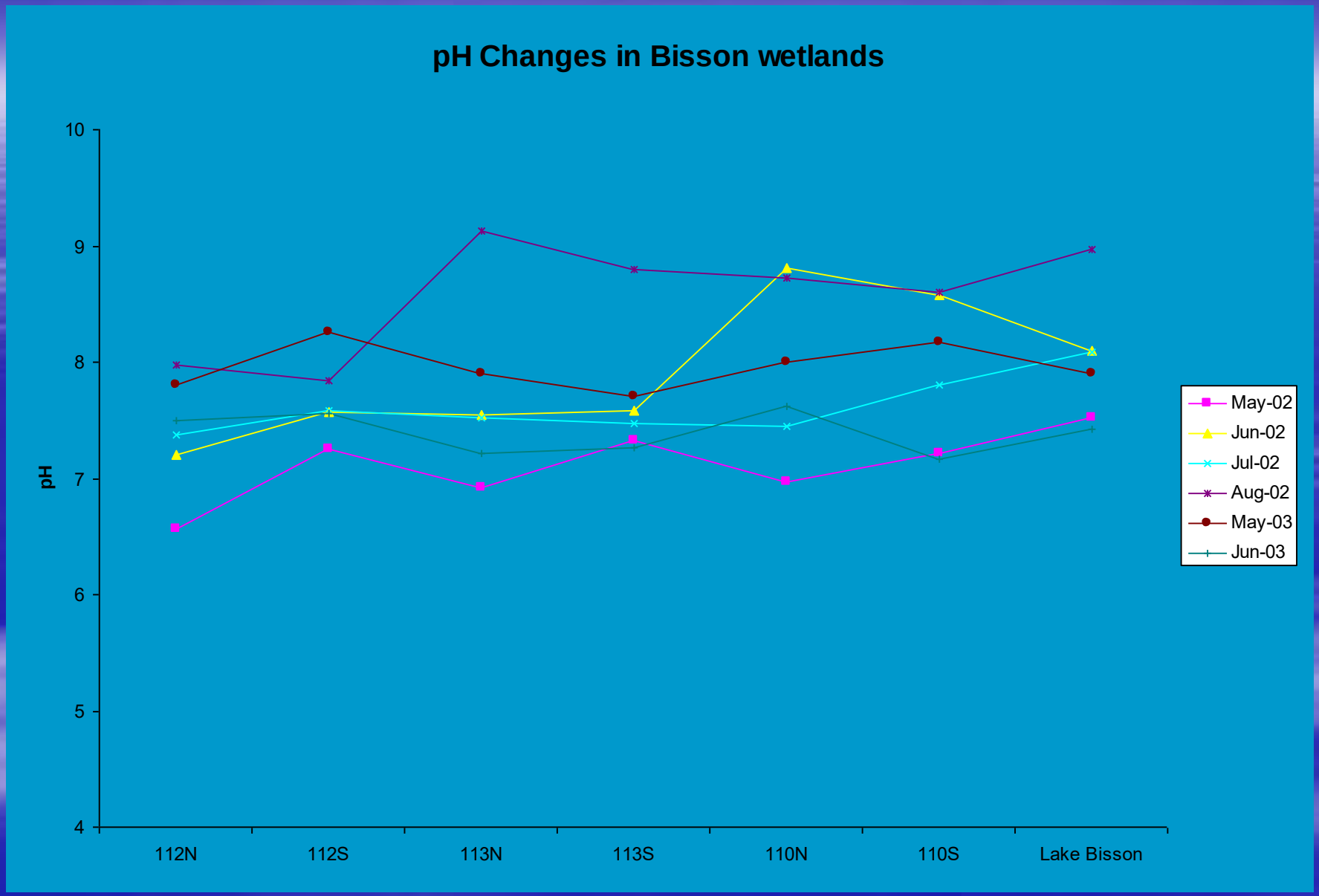
Results & Discussion

Total Phosphorus changes in Bisson Wetlands

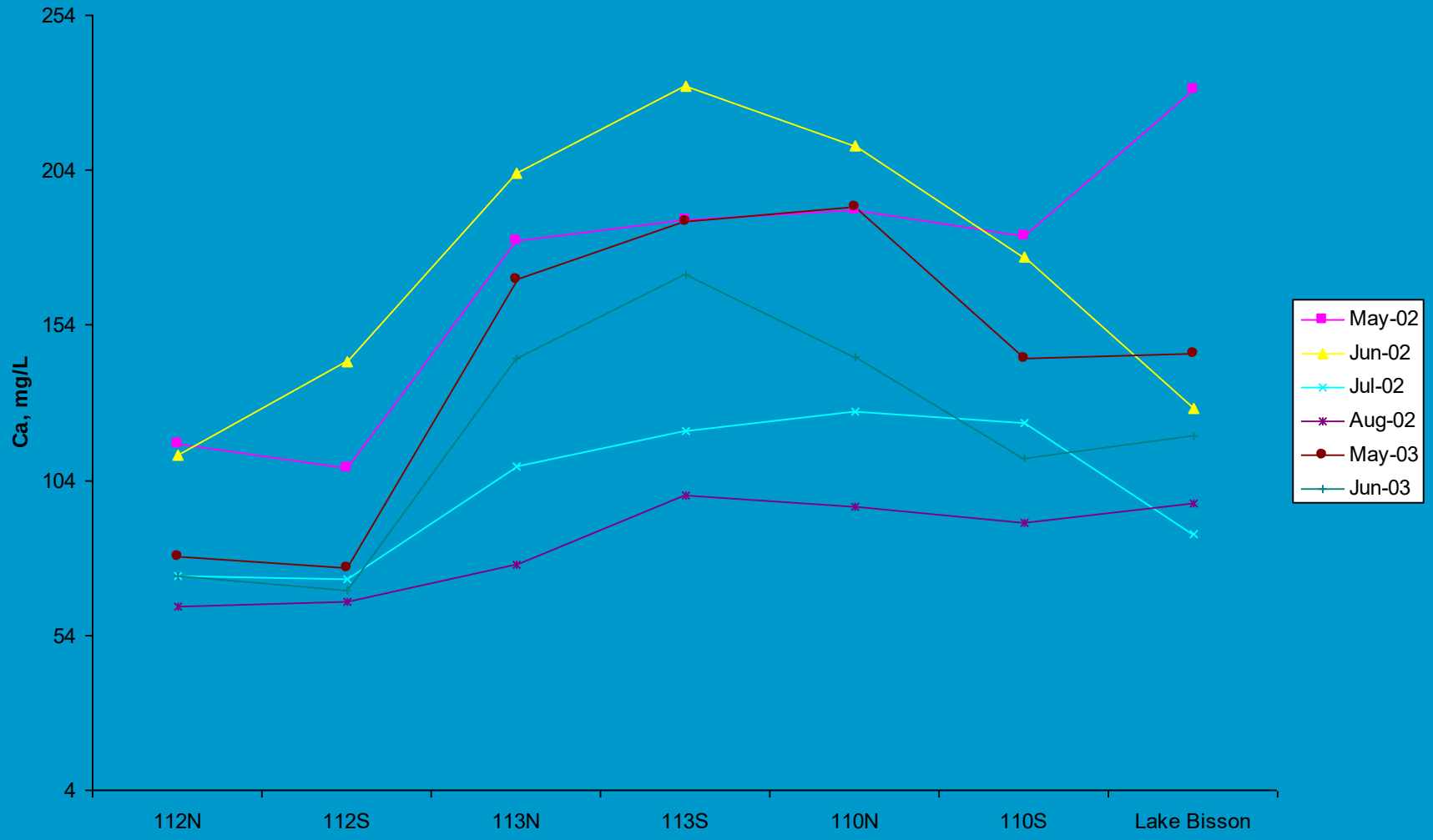


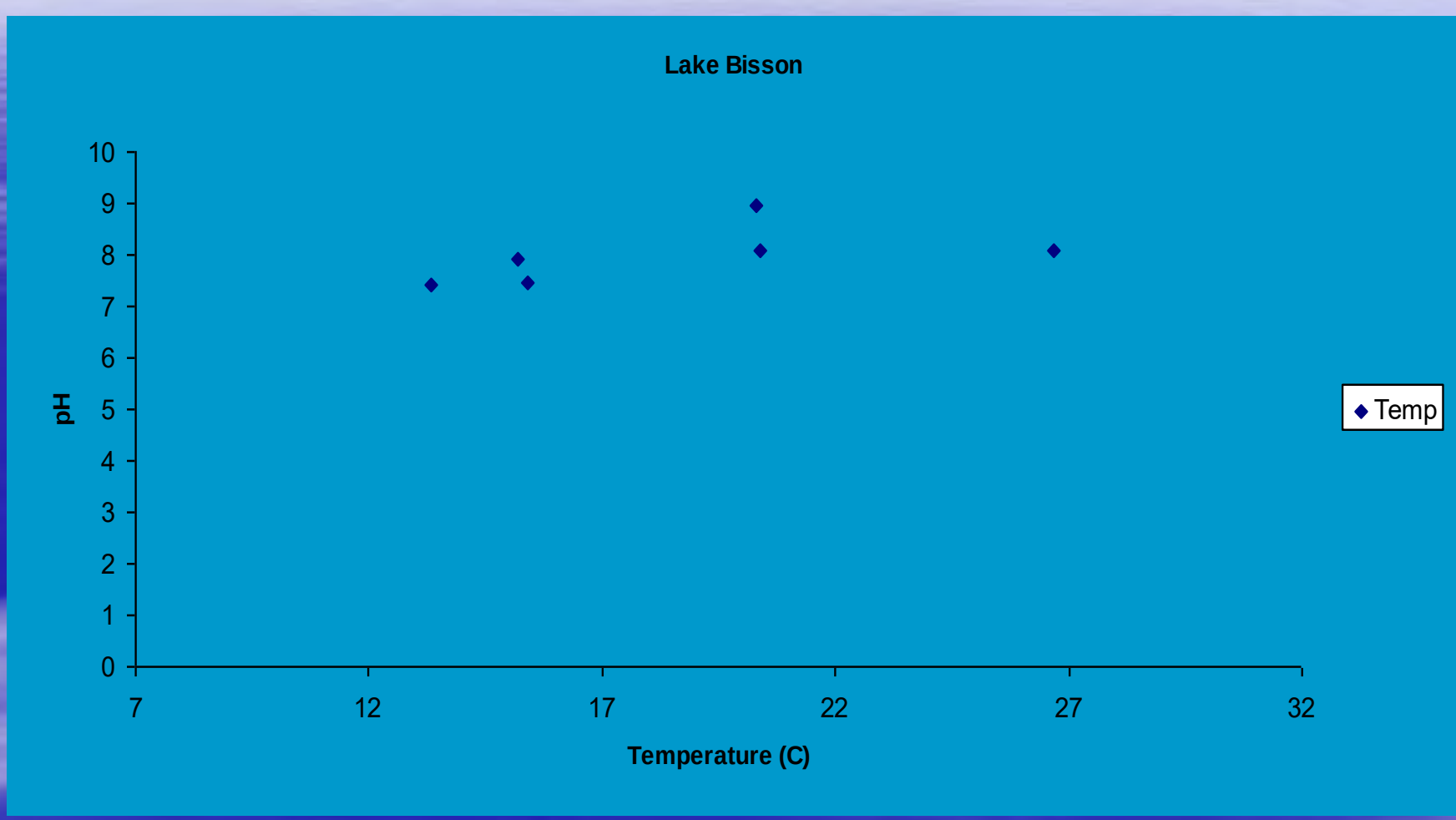
Orthophosphate changes in Bisson Wetlands

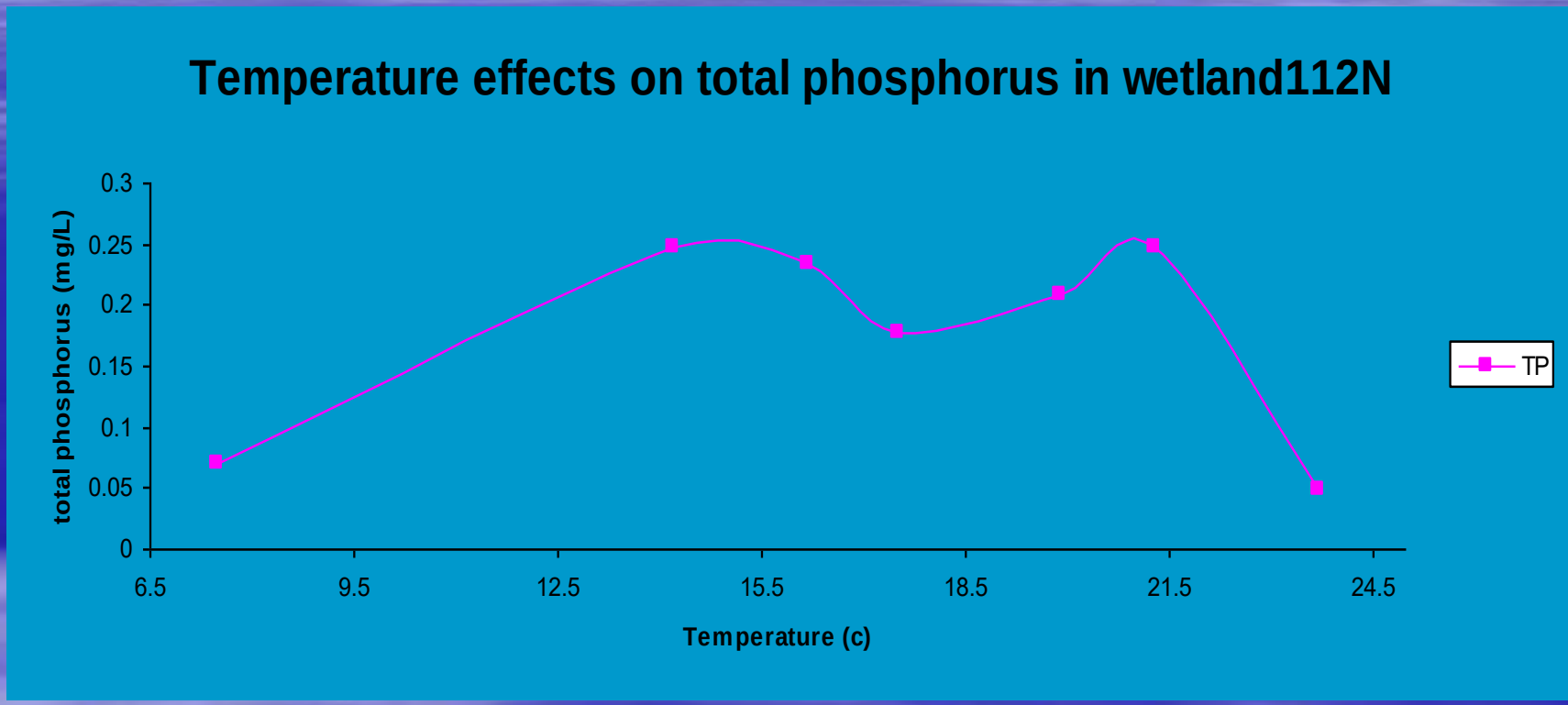


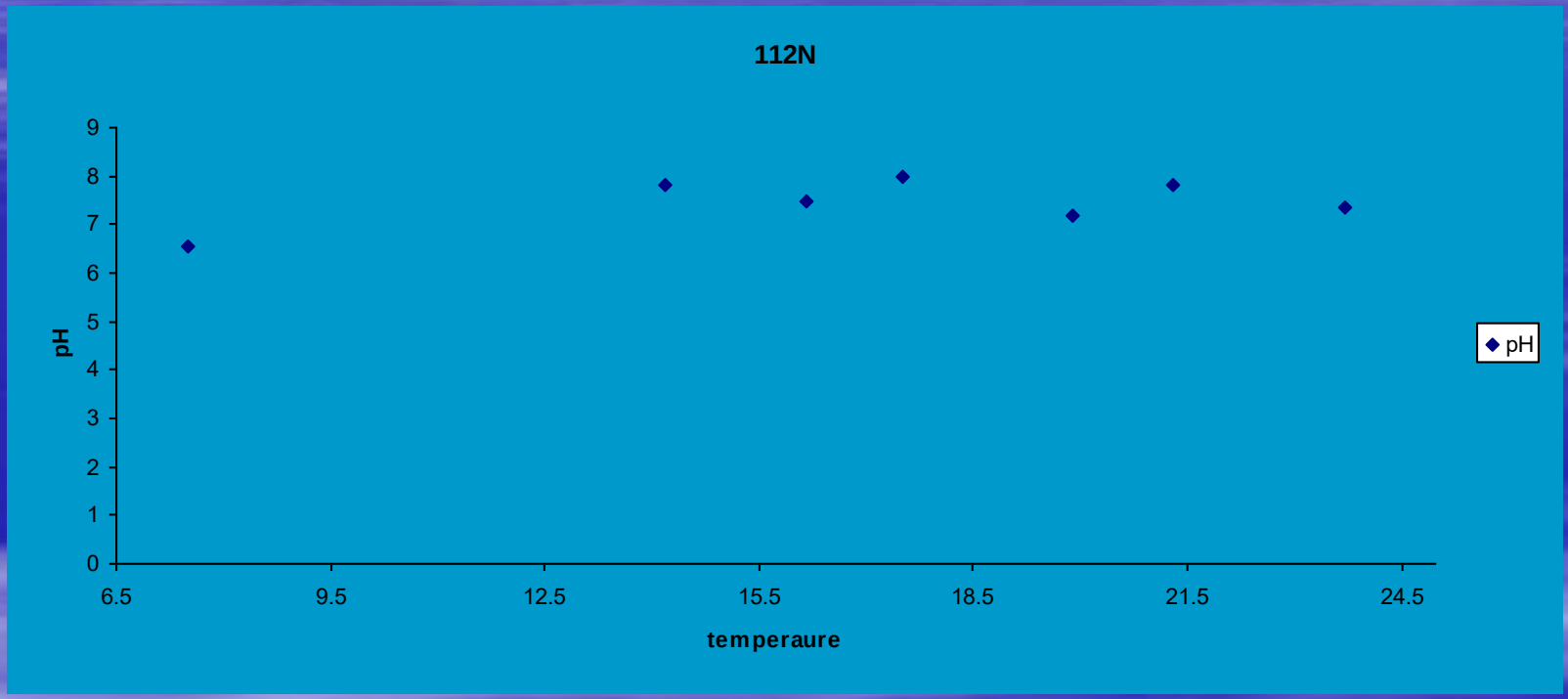

pH Changes in Bisson wetlands
pH
10
9
8
7
6
5
4
112N
112S
113N
113S
110N
110S
Lake Bisson
May-02
Jun-02
Jul-02
Aug-02
May-03
Jun-03

Calcium Changes in Bisson wetlands




Lake Bisson
10
9
8
7
6
5
4
3
2
1
0
pH
7
12
17
22
27
32
Temperature (C)
Temp

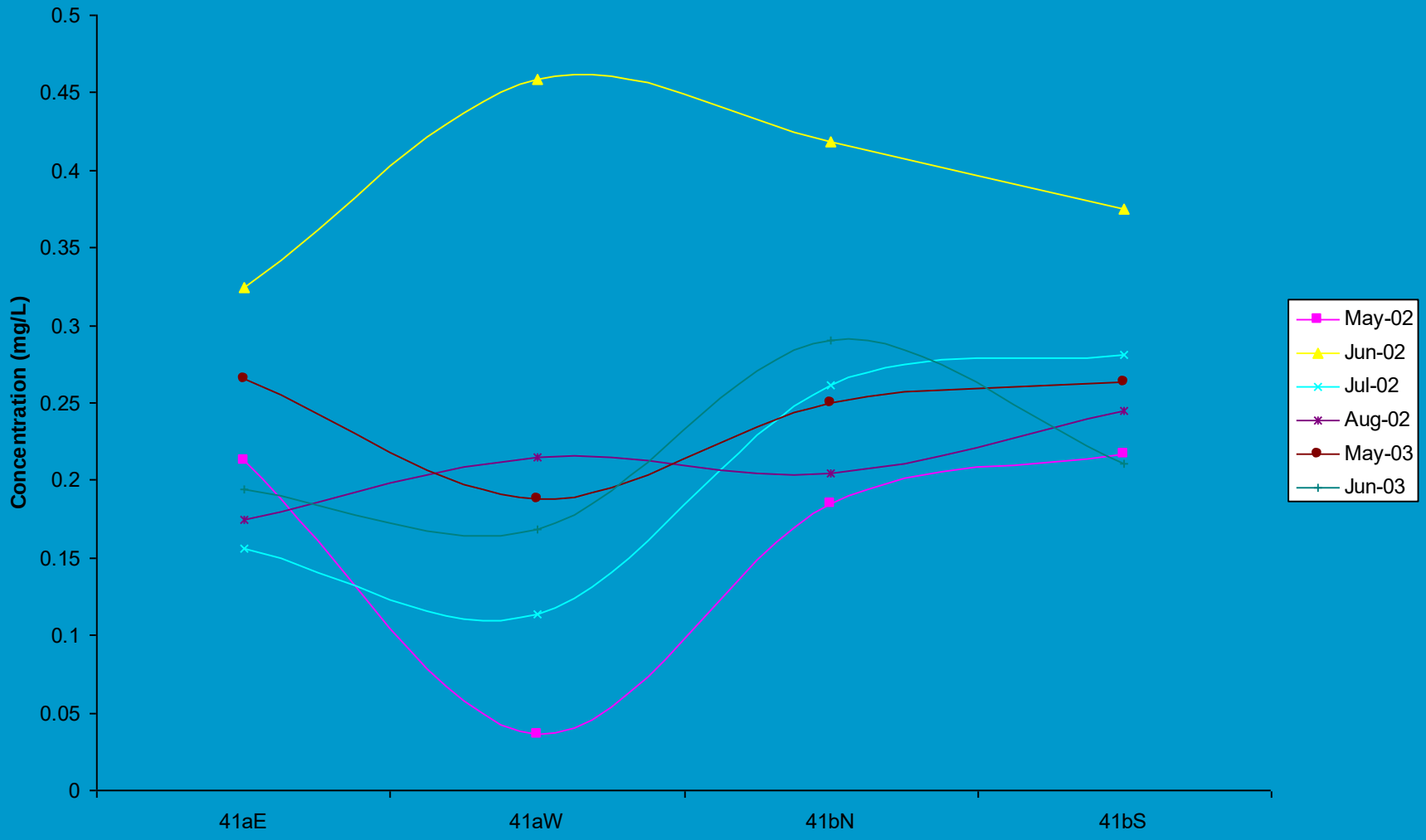

Temperature effects on total phosphorus in wetland112N
total phosphorus (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
6.5
9.5
12.5
15.5
18.5
21.5
24.5
Temperature (c)
TP


112N
9
8
7
6
5
4
3
2
1
0
pH
6.5
9.5
12.5
15.5
18.5
21.5
24.5
temperaure
pH

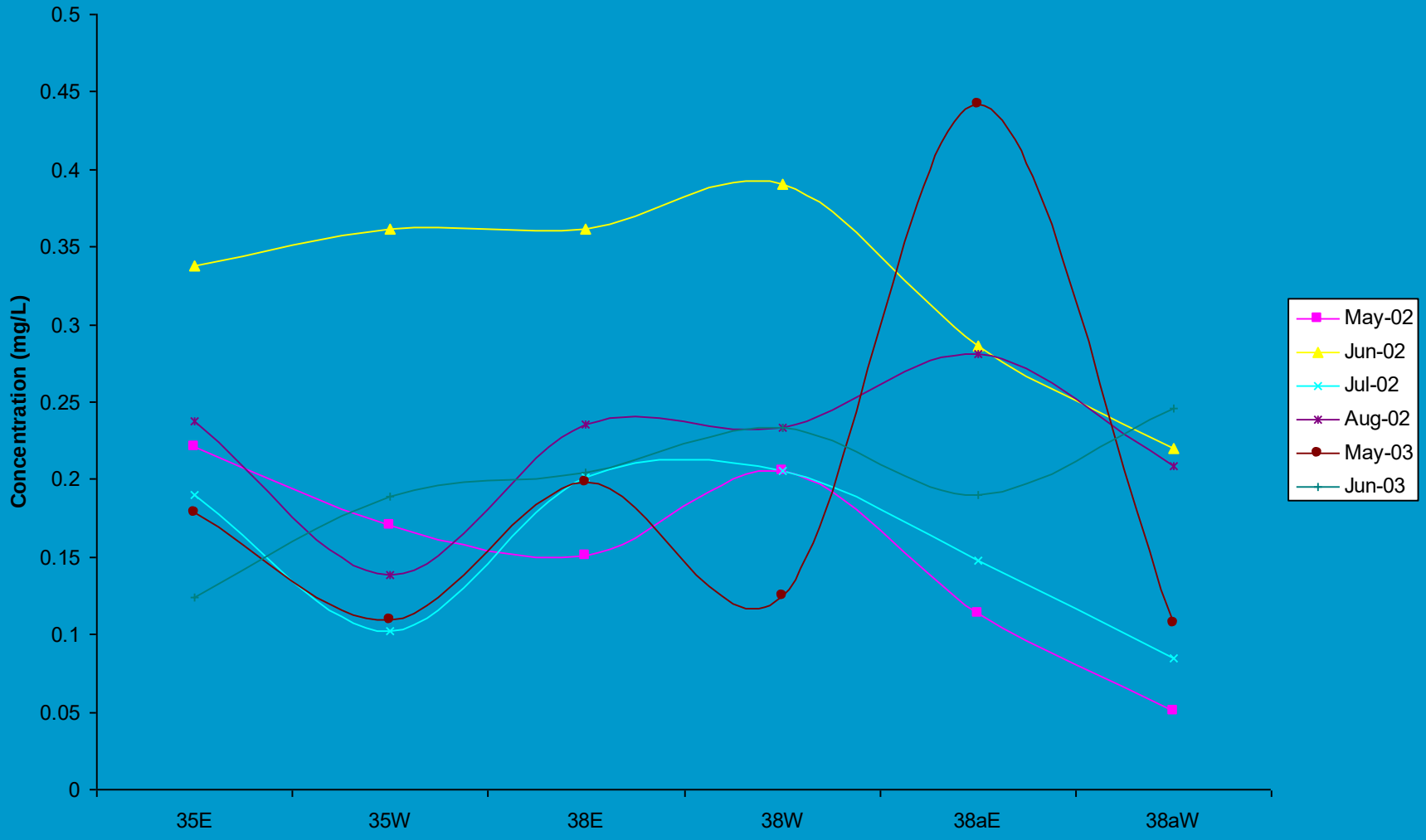
Discussion

- Increase in orthophosphate levels at north end of each wetland due to reduced conditions
- Increase in total phosphorus levels at north end of each wetland
- Temperature has significant effect on pH and total phosphorus
- High pH conditions favorable for Calcium phosphate (apatite) formation

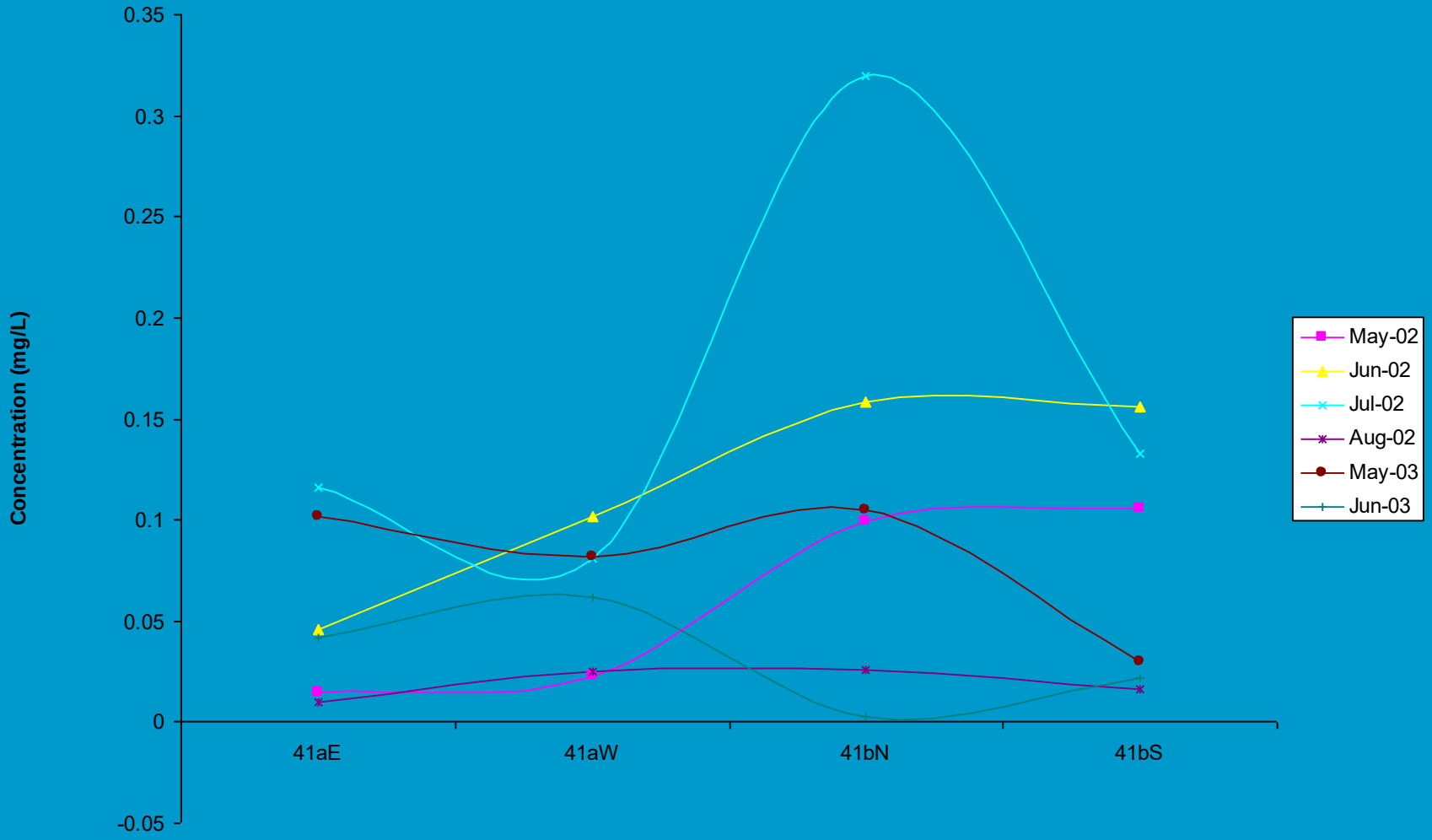
Total Phosphorus changes in Hass Wetlands



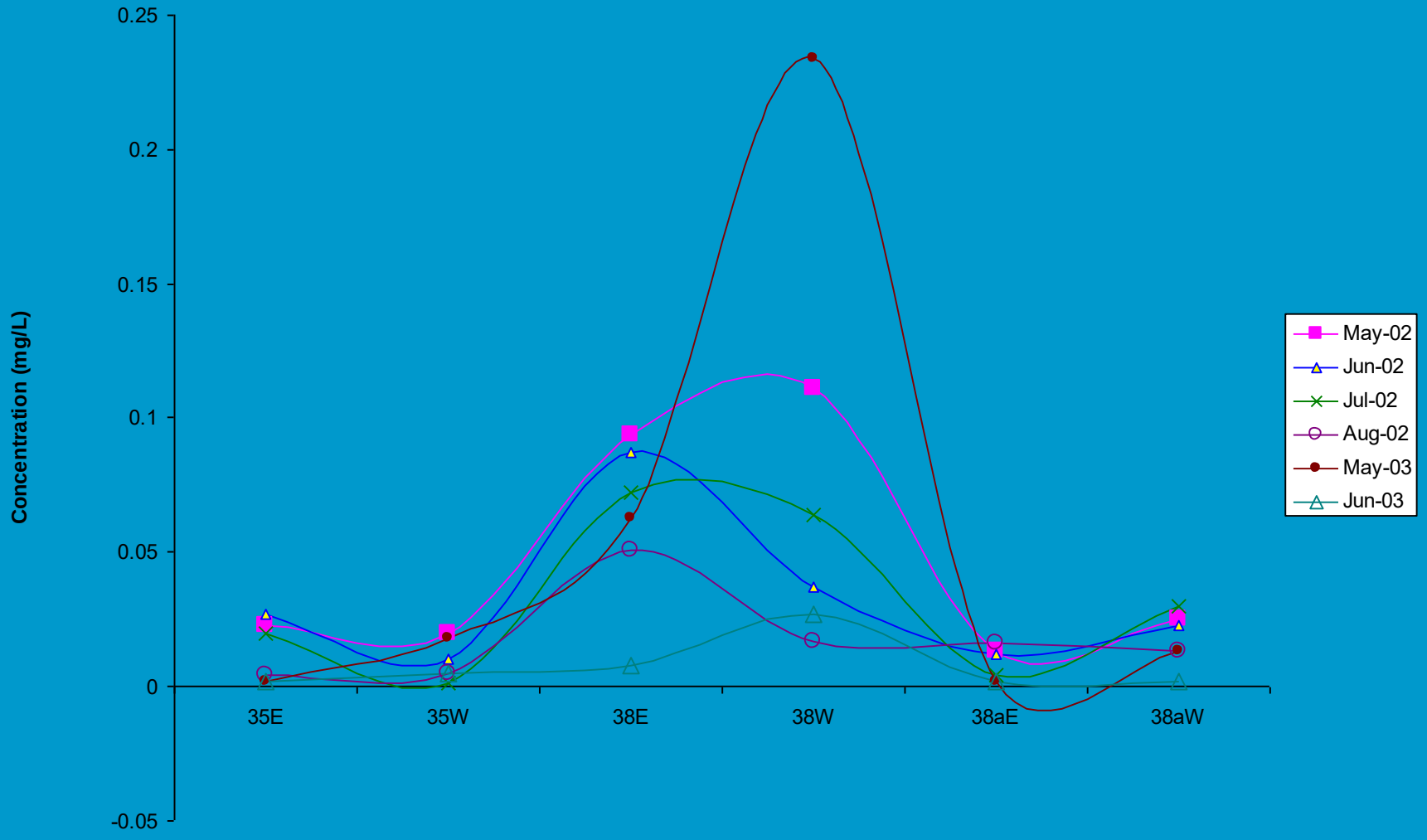
Total Phosphorus changes in Hass Wetlands



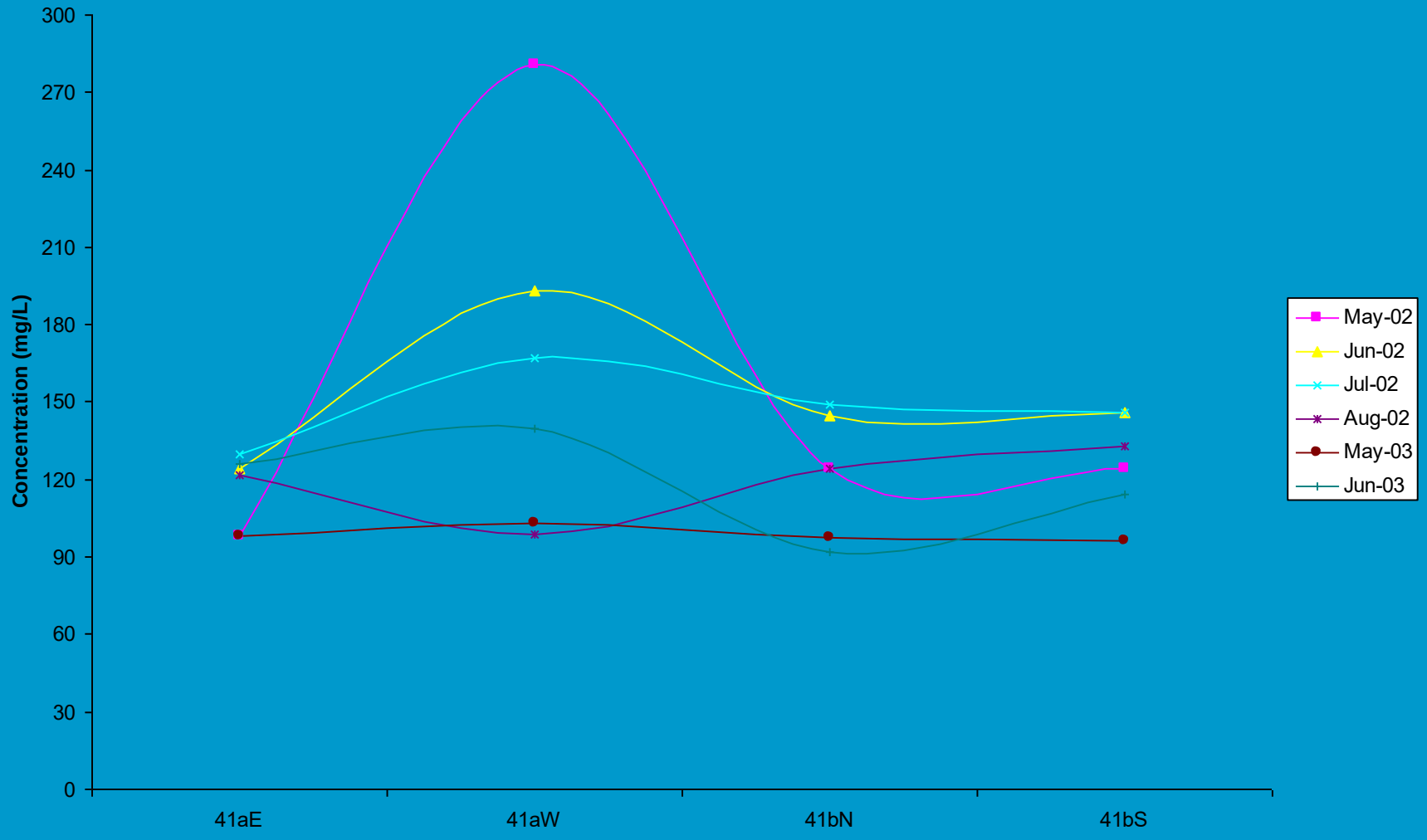
Orthophosphate changes in Hass Wetlands



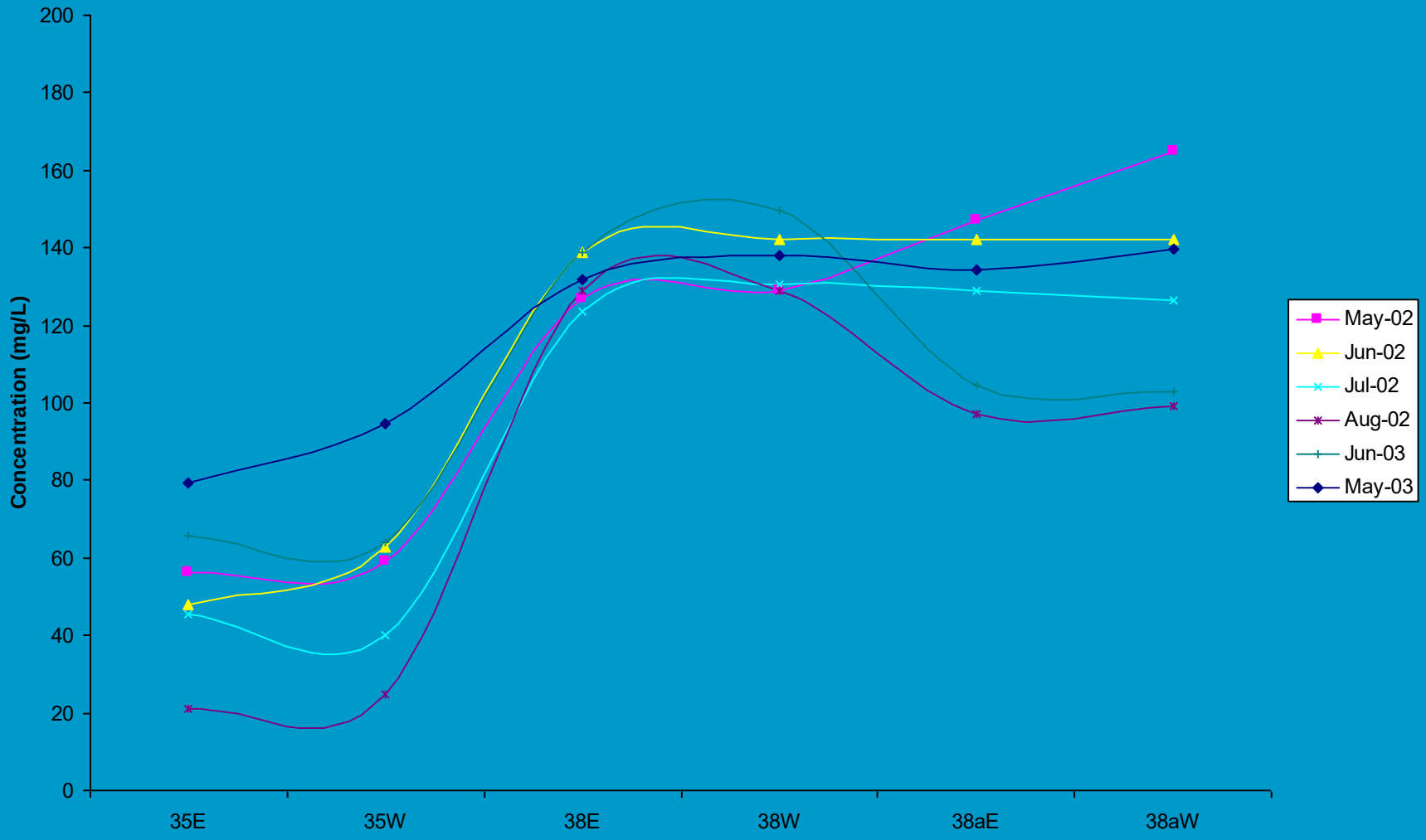
Orthophosphate changes in Hass Wetlands



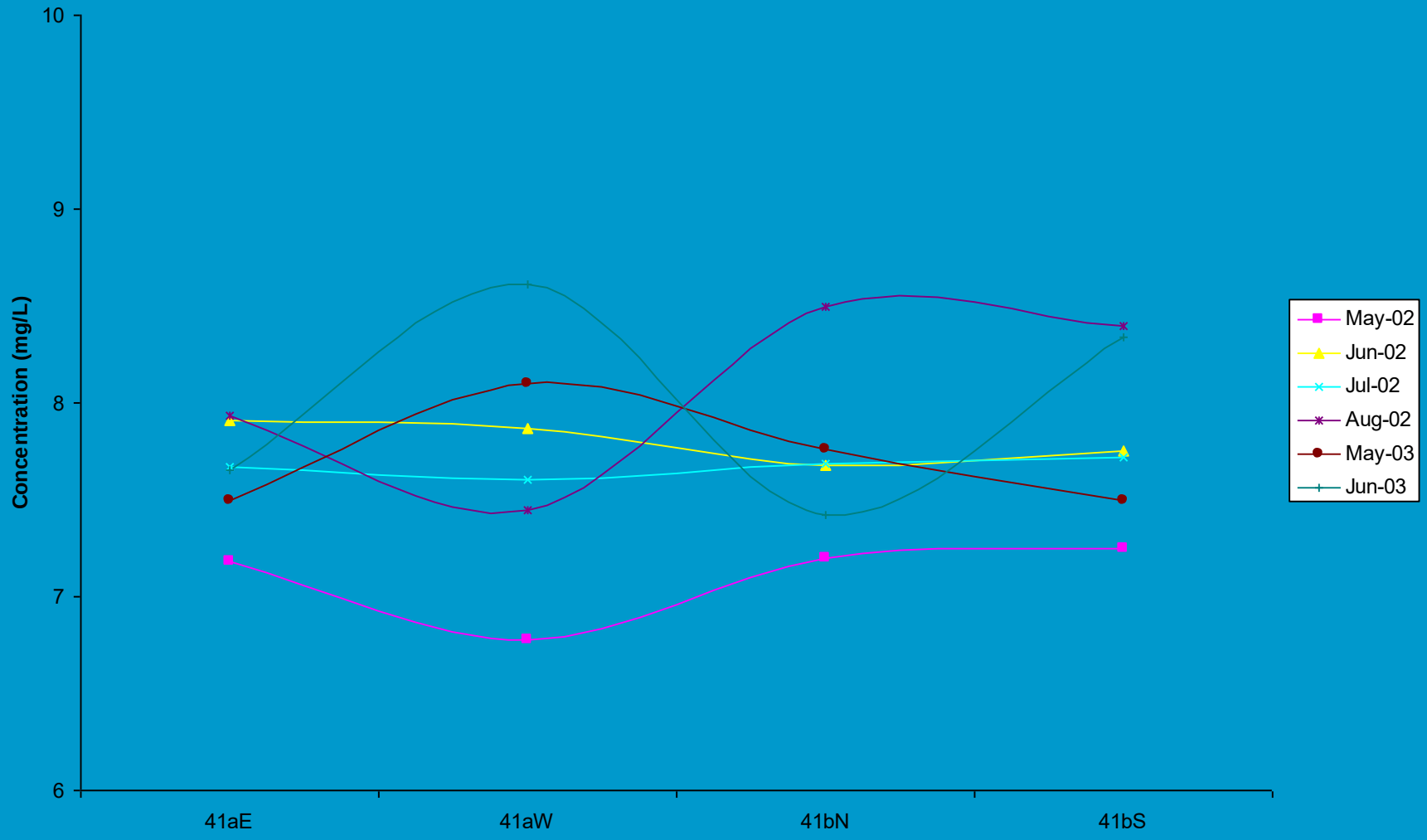
Calcium changes in Hass Wetlands



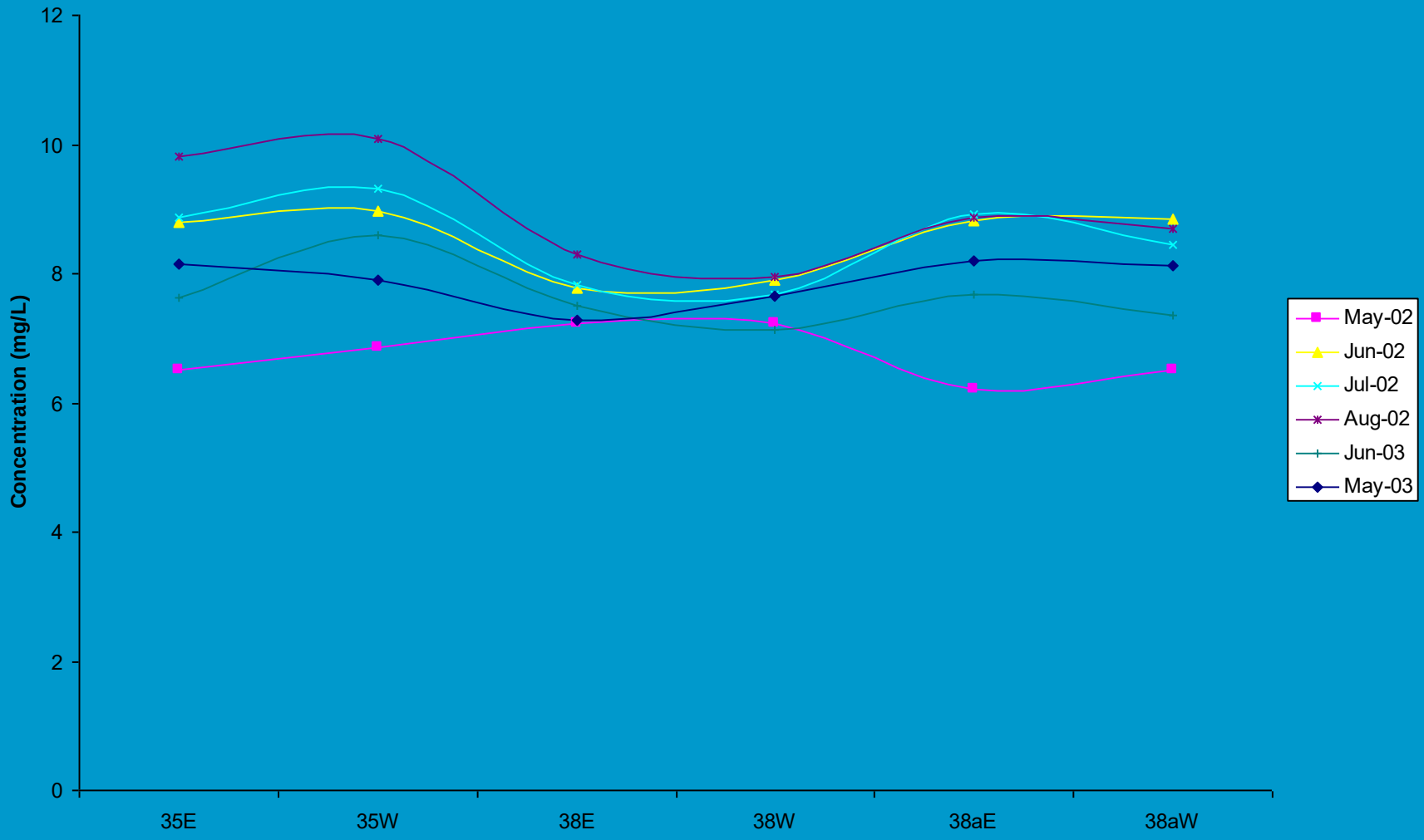
Calcium changes in Hass Wetlands



pH changes in Hass Wetlands



pH changes in Hass Wetlands



Results

- Calcium levels decreased with time in wetlands 41a and 41b; where as increased in 35, 38,and 38a
- Orthophosphate levels decreased and increased in alternative months in an year in wetlands 35, 38 and 38a; where increased in consecutive months and decreased in next months

Summary and Future work

- Different changes in TP and OP with time in different wetlands
- Modeling would help understand the dynamics better

Acknowledgements

- ND Water Resources Research Institute
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