FACTORS AFFECTING THE TOXIC CYANOBACTERIA *NODULARIA SPUMIGENA* IN FARMINGTON BAY GREAT SALT LAKE, UTAH

Great Salt Lake Tech Team

January 13, 2015

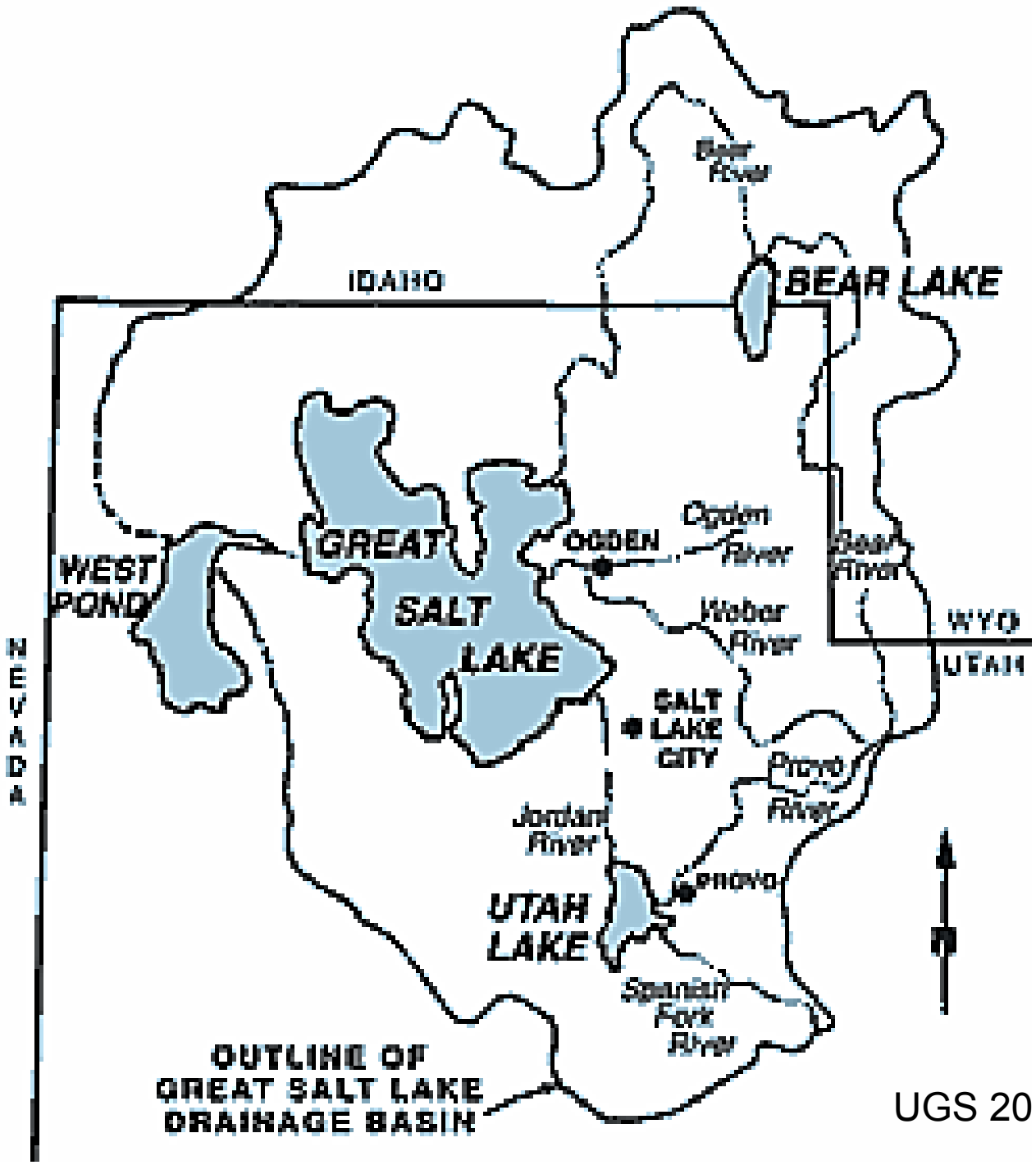
Eric McCulley

Acknowledgements

- Central Davis Sewer District
- Utah Division of Forestry, Fire and State Lands
- Utah Division of Water Quality
- All those that helped with field and research

Study Area

Logan
Ogden
Wasatch Range
Great Salt Lake
Farmington Bay
Great Salt Lake Desert
Salt Lake City
Your are here
Image Landsat
© 2014 Google
Google earth
Imagery Date: 4/9/2013 12 T 388056.21 m E 4553436.95 m N elev 4207 ft eye alt 165.27 mi


Bear River
IDAHO
BEAR LAKE
GREAT SALT LAKE
WEST POND
OGDEN
Ogden River
Bear River
Weber River
WYO
UTAH
NEVADA
SALT LAKE CITY
Provo River
Jordan River
PROVO
UTAH LAKE
Spanish Fork River
N
OUTLINE OF GREAT SALT LAKE DRAINAGE BASIN

UGS 2014

Why is Farmington Bay important?

- Western Hemisphere Shorebird Reserve Network (WHSRN)
- Millions of birds migrating along flyway
- American Avocets
- Wilson's Phalaropes
- Wintering Bald Eagles
- Brown ducks
- Hunting and bird watching

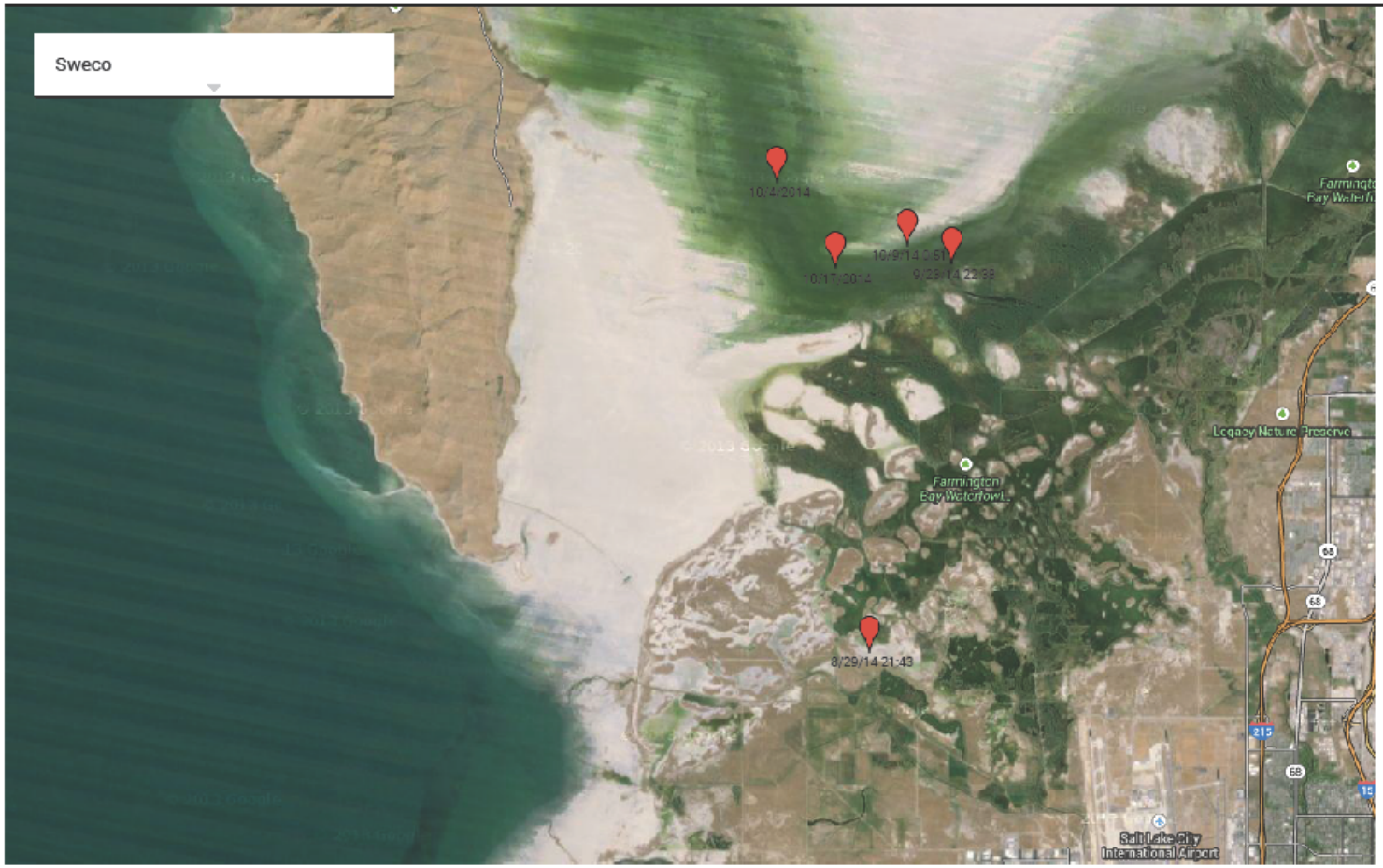
- *Nodularia* also found in the Baltic Sea and in Australia in coastal estuaries

A

A 3.0 Farmington (0.40 mg/L)

12/4/2014 Sweco

+You Search Images Maps Play YouTube News Gmail More Sign in



10/22/14 0:52

Map data ©2014 Google Imagery ©2014 TerraMetrics Terms

https://mapsengine.google.com/mapviewer?mid=zrW2AkaFEw5Y.kt5RJw_tsoa0 1/1

Study Objectives

Extend our knowledge of conditions across the bay, based on knowledge of cyanobacteria and cyanotoxins from previous studies.

Are there high concentrations of toxic cyanobacteria and nutrients in the bay?

How does salinity relate to phytoplankton?

Important to understand if there are any issues with cyanotoxins and wildlife or their aquatic food chain

(UDWQ beneficial uses)

Study Objectives

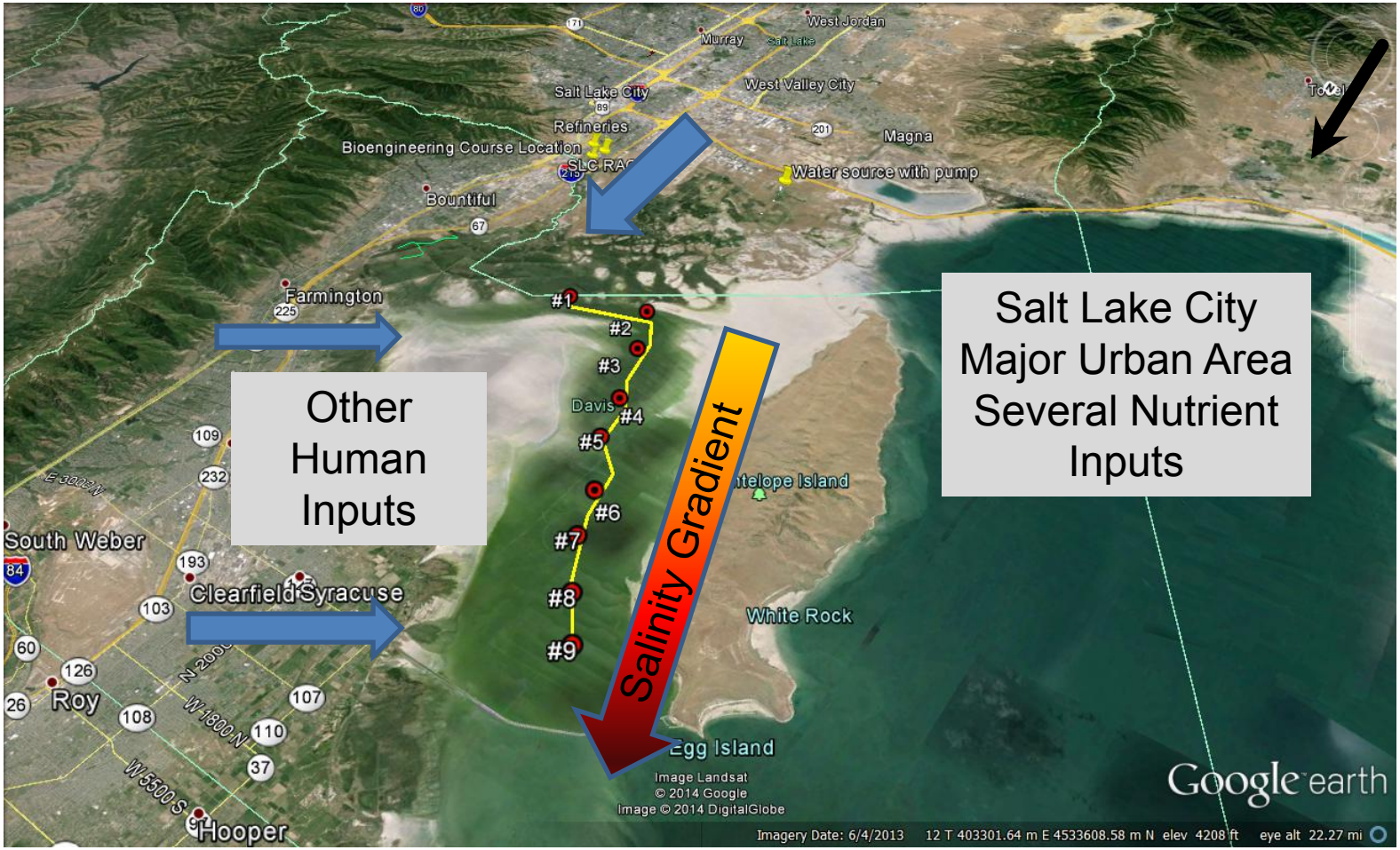
Hypothesis 1:

Salinity is a key driver of ecosystem structure in phytoplankton

Hypothesis 2:

High levels of nutrients in Farmington Bay stimulate the growth of cyanobacteria to extreme levels

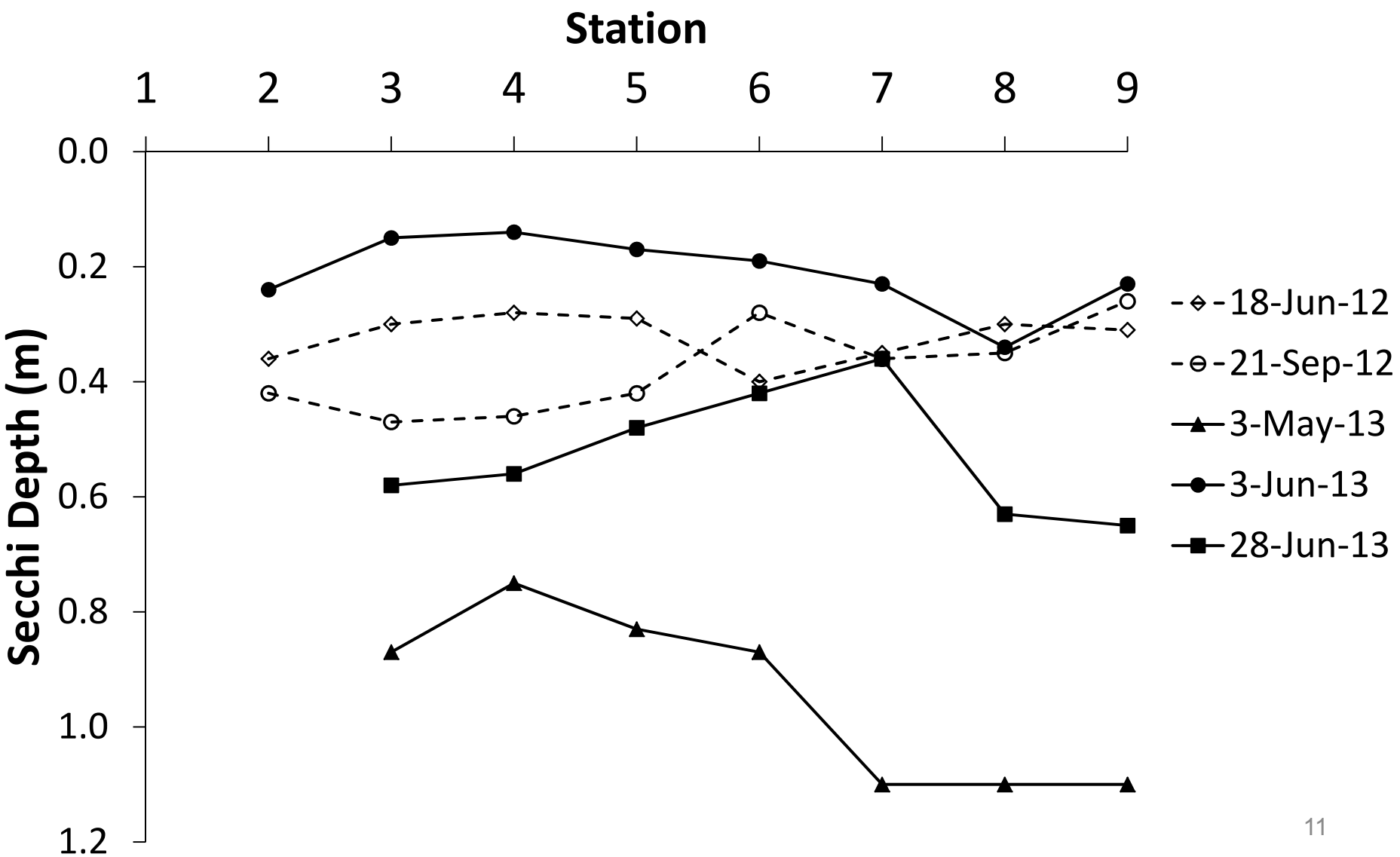
South to North Transect 2012-2013



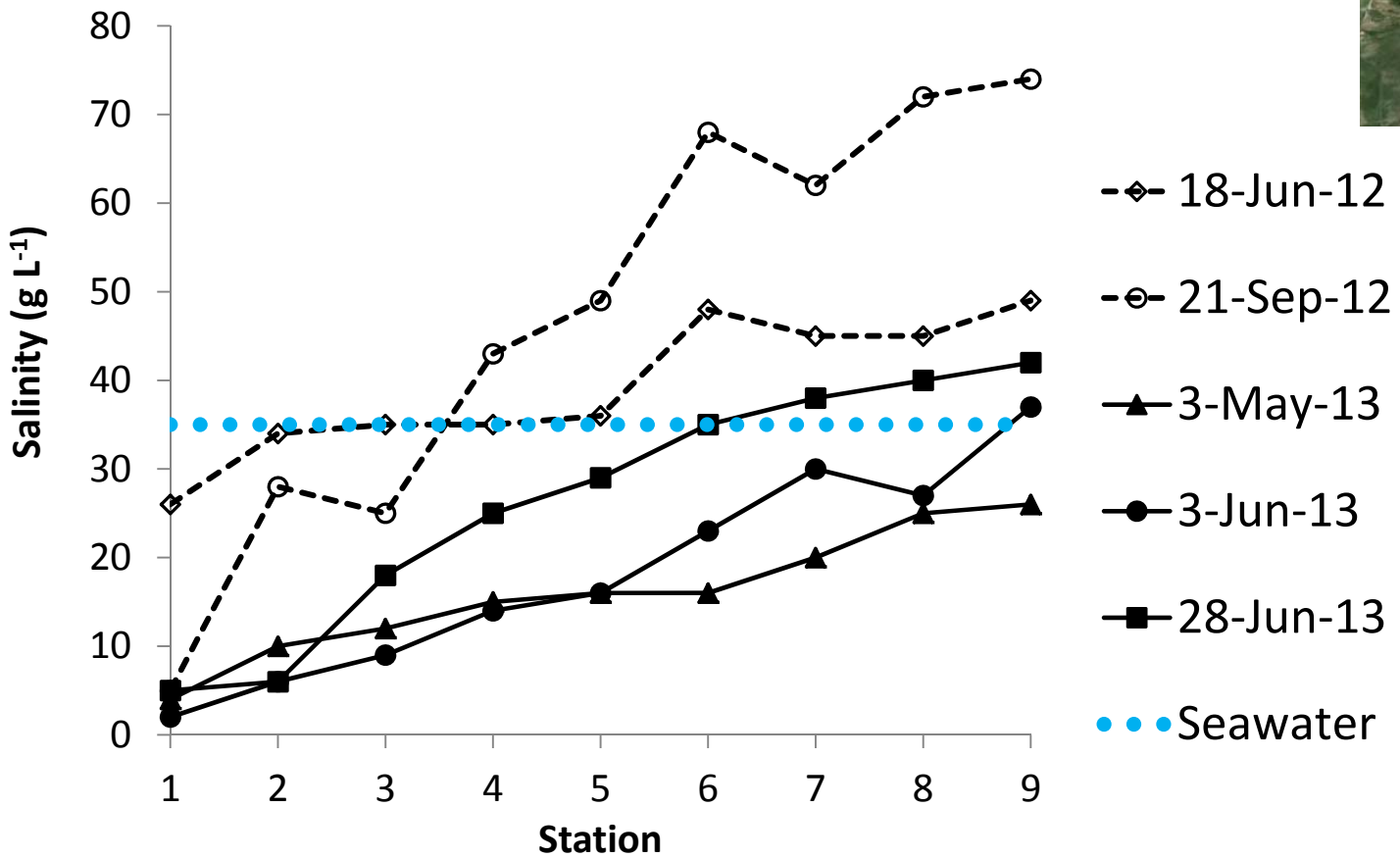
Methods

- Field surveys for physical parameter measurement and grab sample collection
- Lab analyses of nutrients, isotopes of C and N, pigments, and metals
- Phytoplankton and cyanobacteria counts
- Zooplankton identification and counts

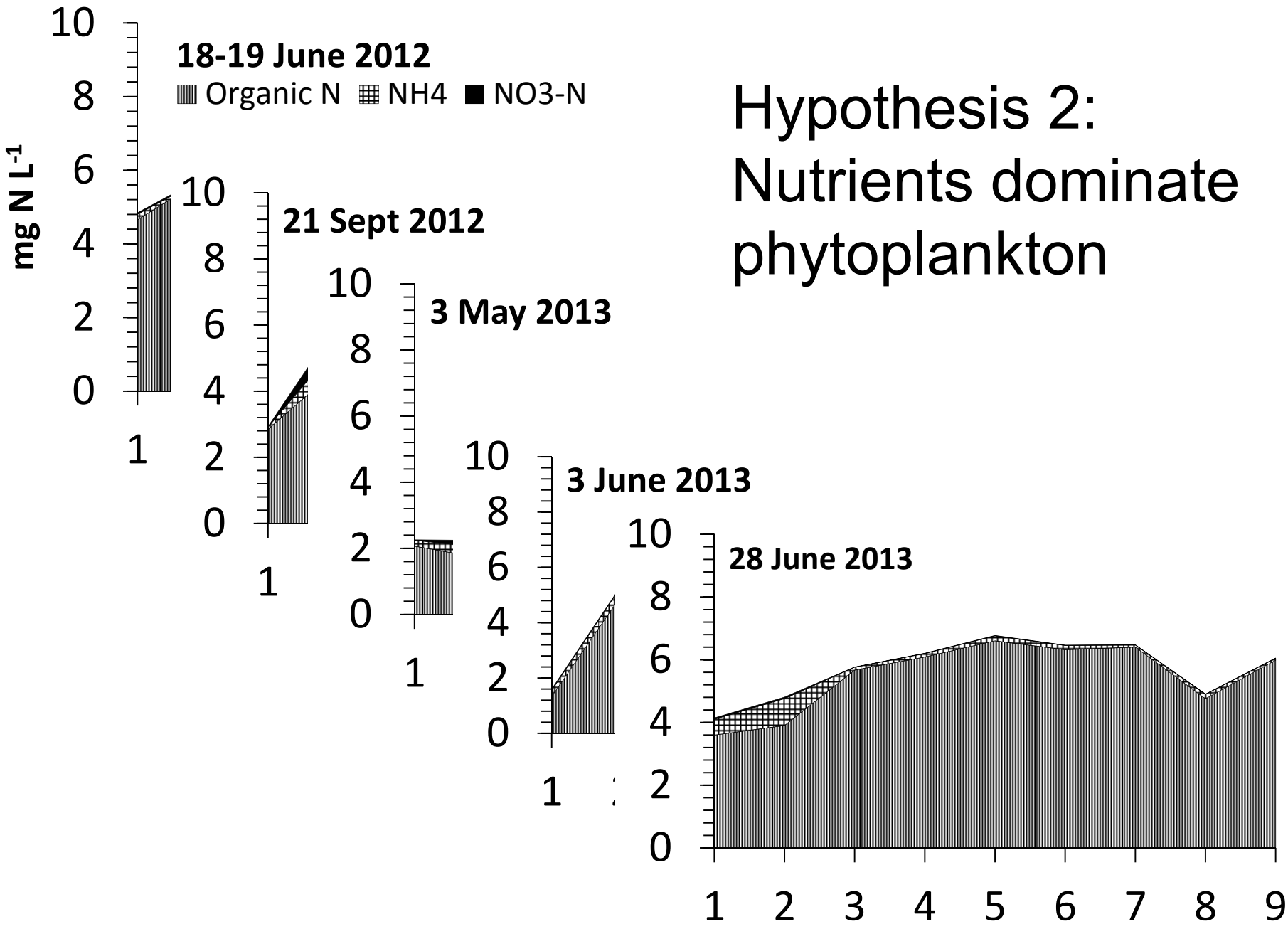
Physical conditions



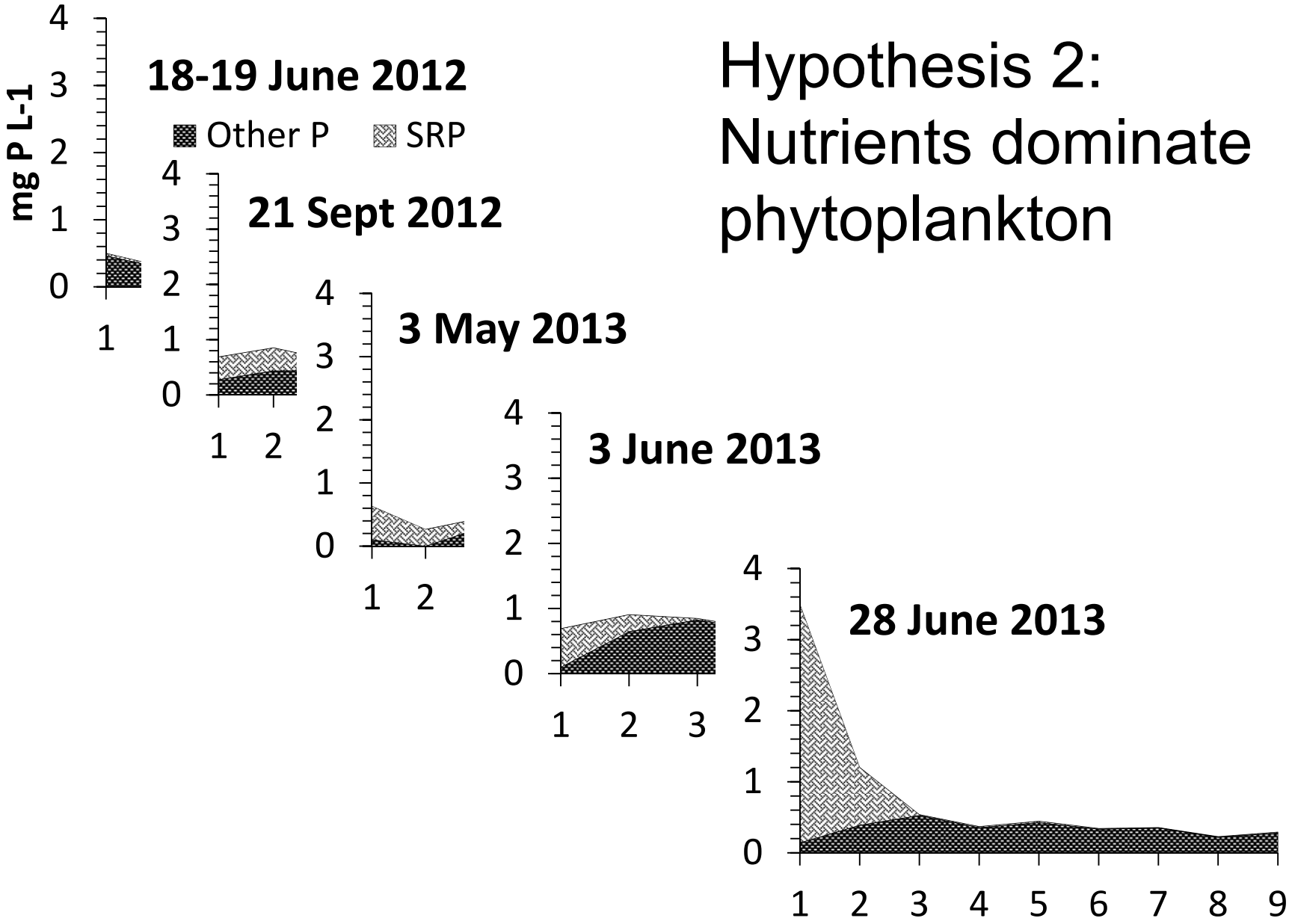
Hypothesis 1: Salinity gradient dominates ecology



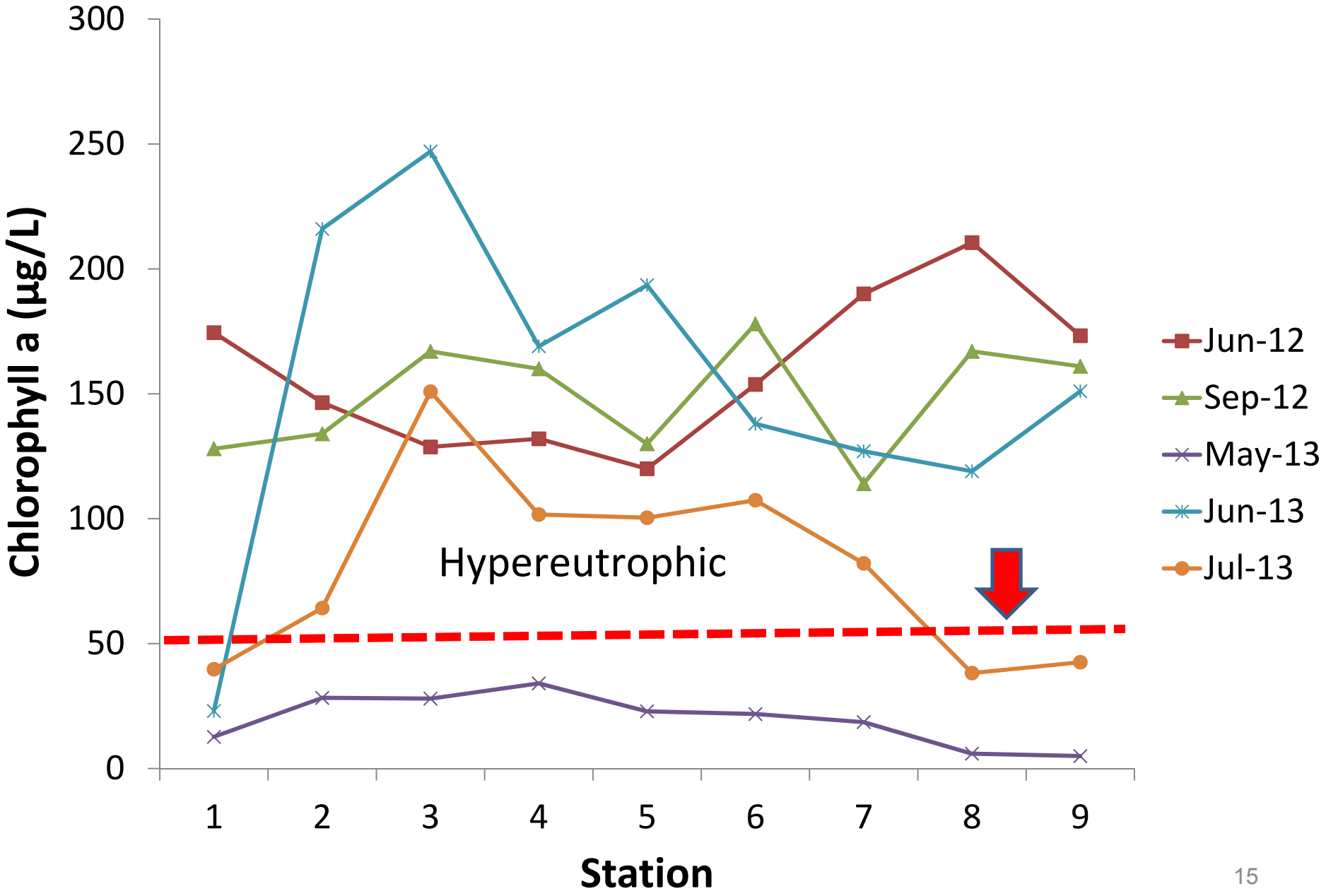
Hypothesis 2: Nutrients dominate phytoplankton

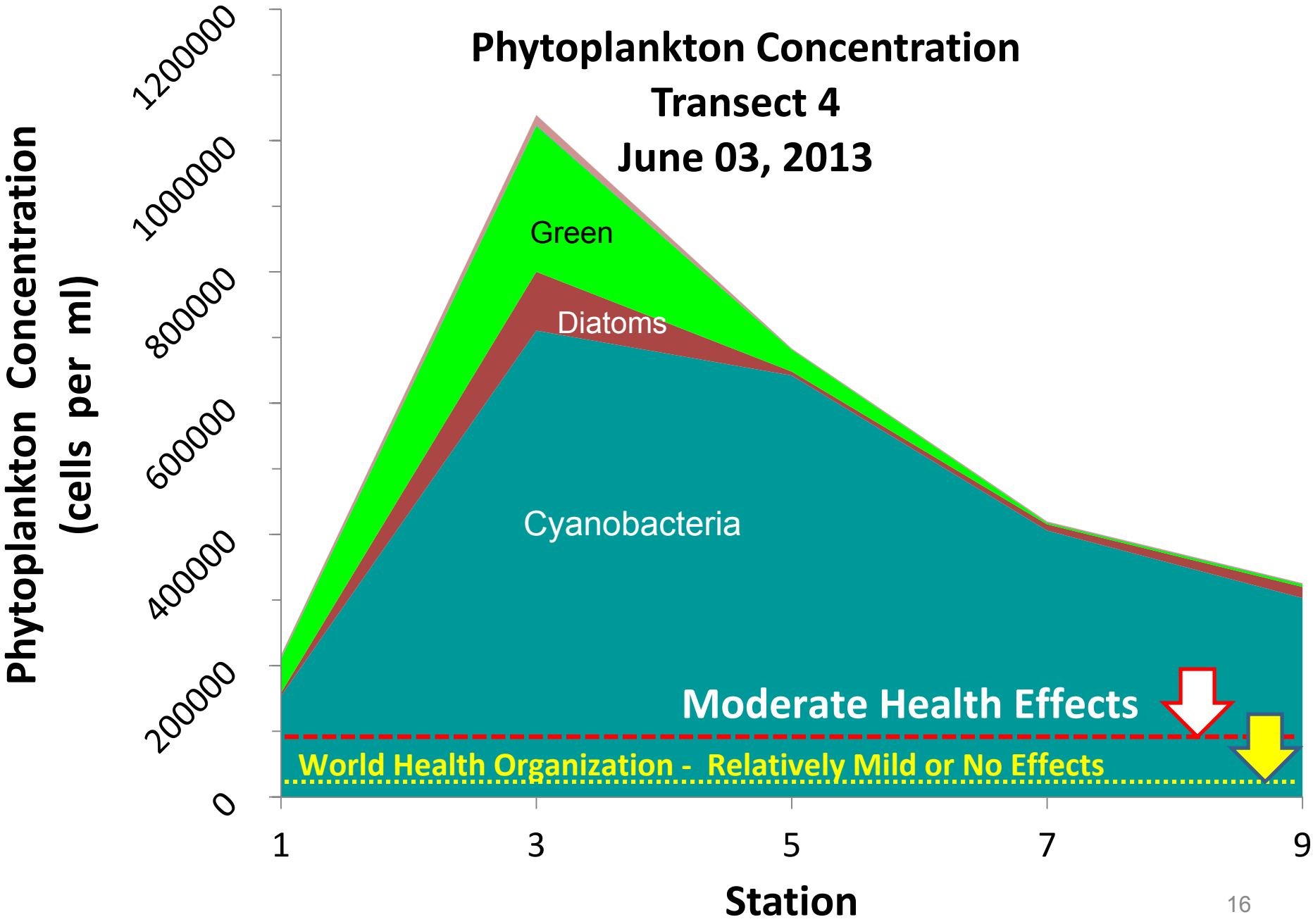


Hypothesis 2: Nutrients dominate phytoplankton

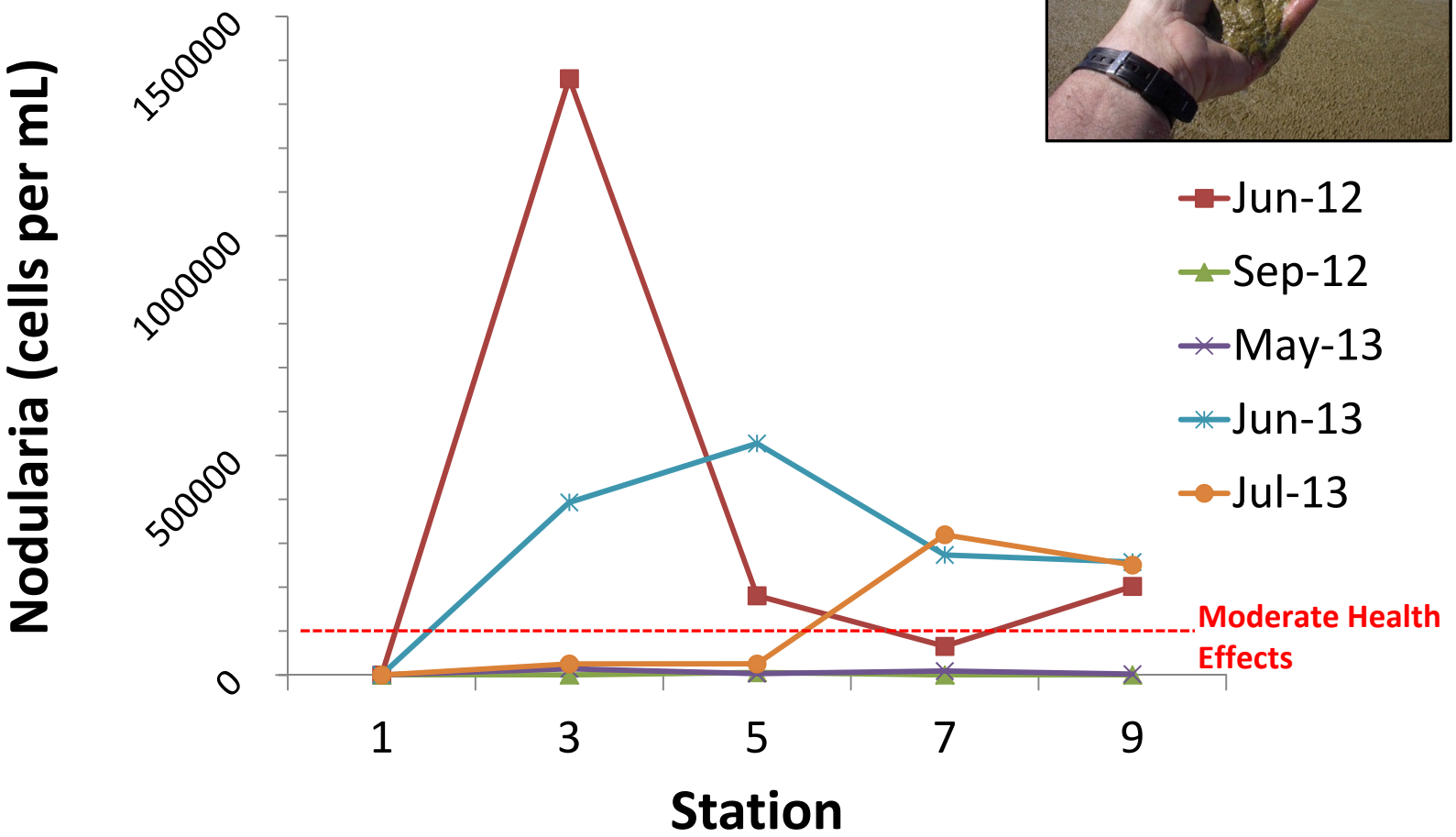


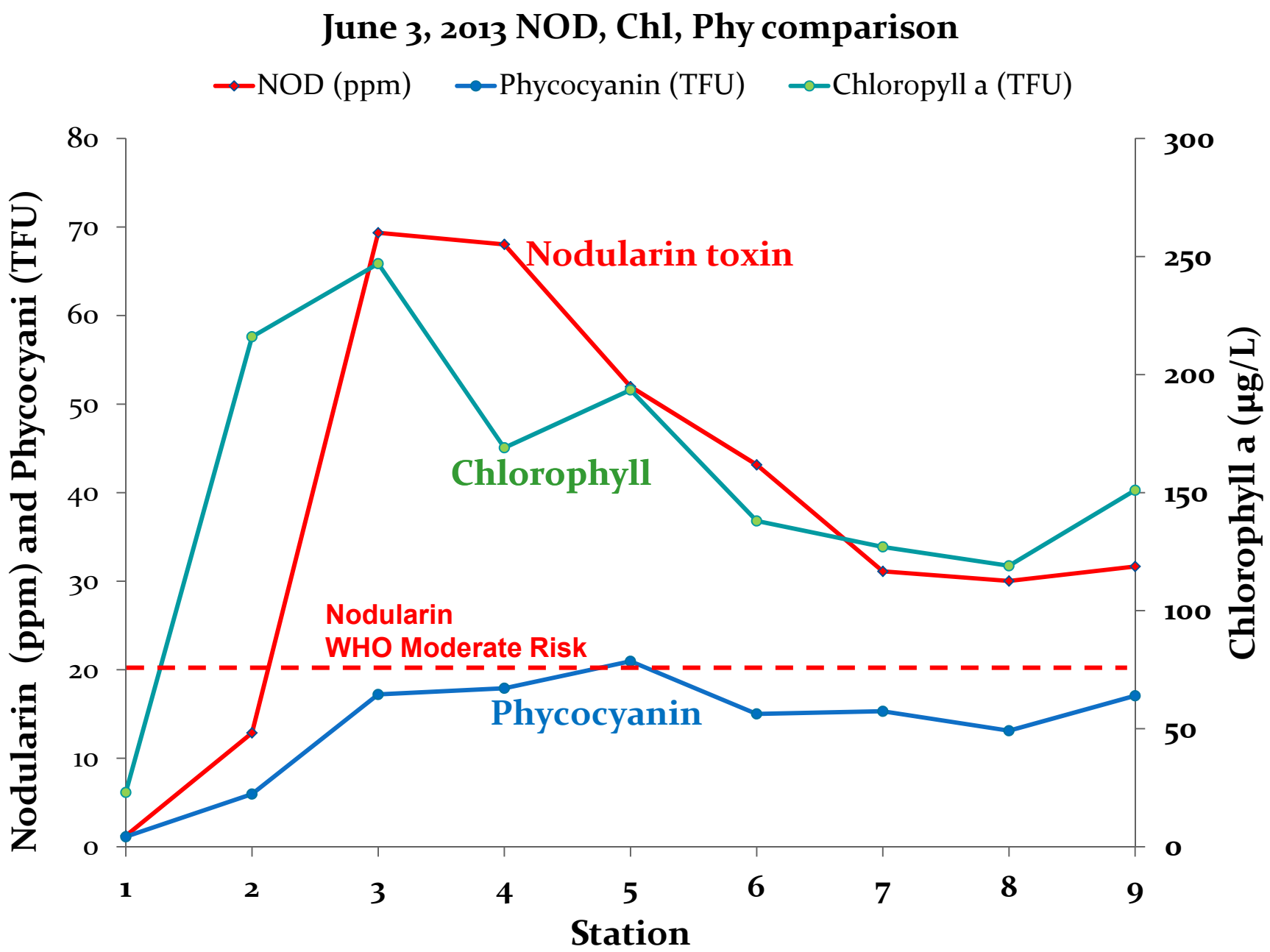
Chlorophyll *a* across transects

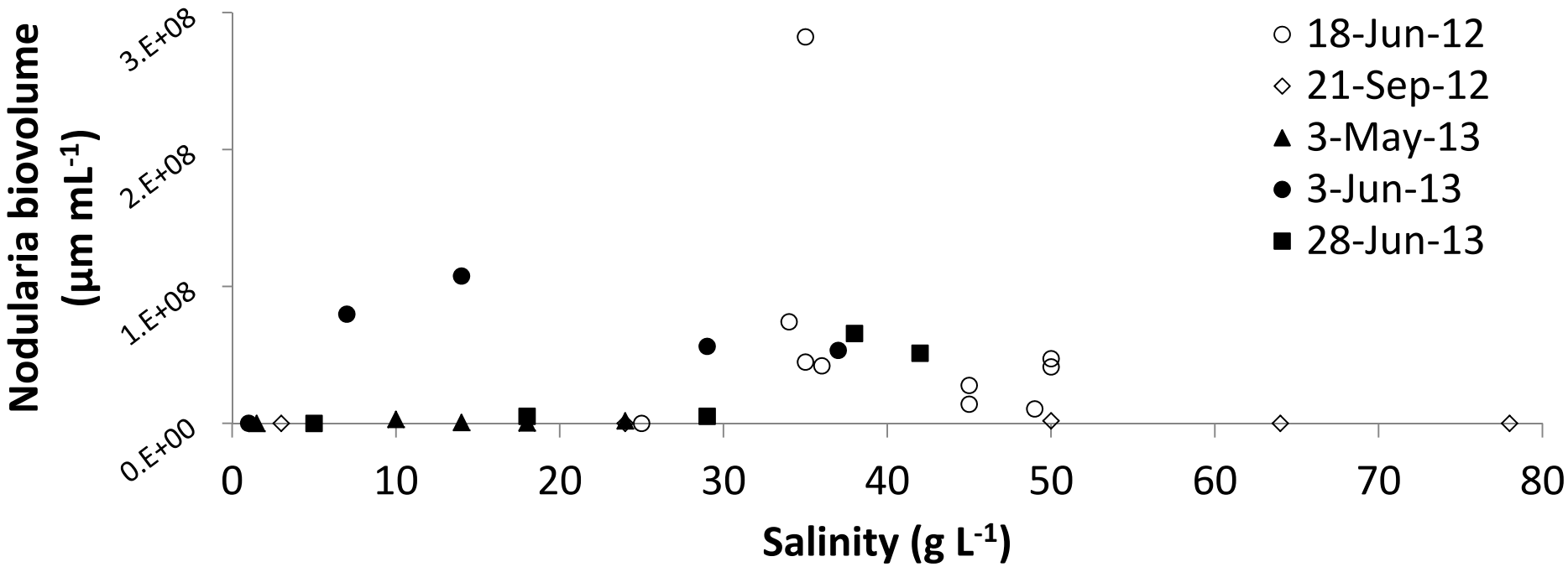


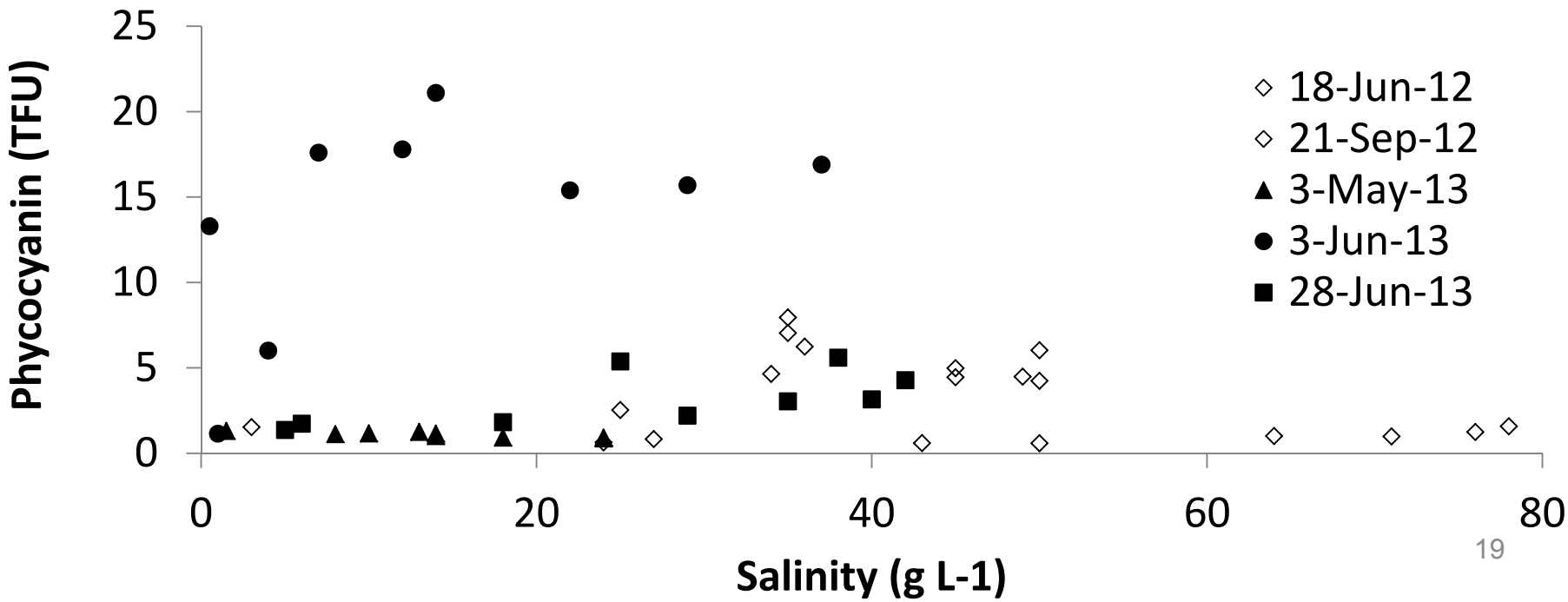

Phytoplankton Concentration
Transect 4
June 03, 2013
Phytoplankton Concentration
(cells per ml)
1200000
1000000
800000
600000
400000
200000
0
Green
Diatoms
Cyanobacteria
Moderate Health Effects
World Health Organization - Relatively Mild or No Effects
1
3
5
7
9
Station

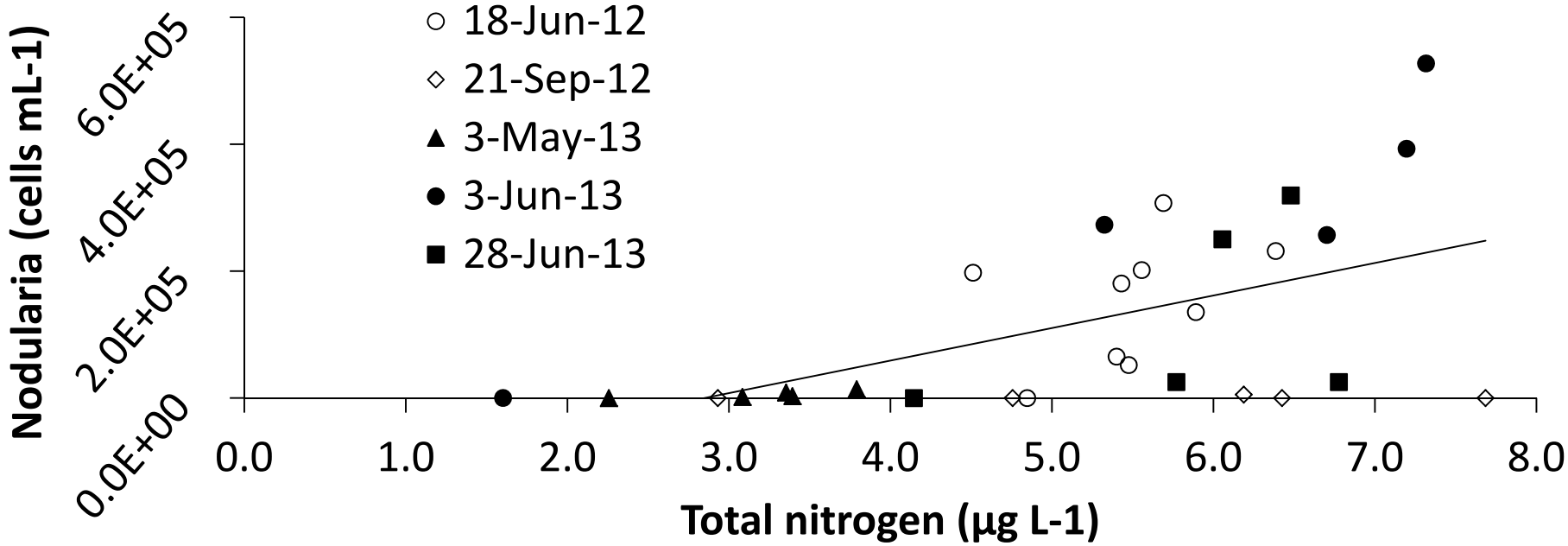
Nodularia spumigena across the Bay

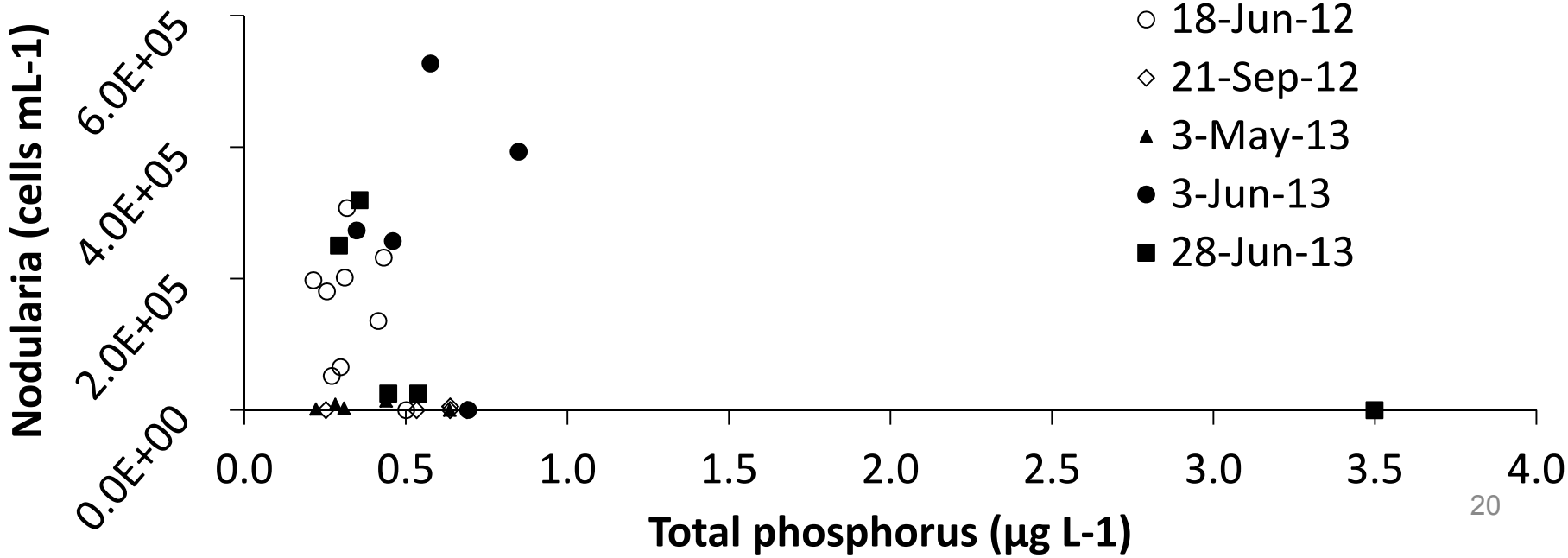



June 3, 2013 NOD, Chl, Phy comparison
NOD (ppm)
Phycocyanin (TFU)
Chloropyll a (TFU)
Nodularin toxin
Chlorophyll
Nodularin
WHO Moderate Risk
Phycocyanin
Nodularin (ppm) and Phycocyani (TFU)
Chlorophyll a (µg/L)
Station
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
1
2
3
4
5
6
7
8
9

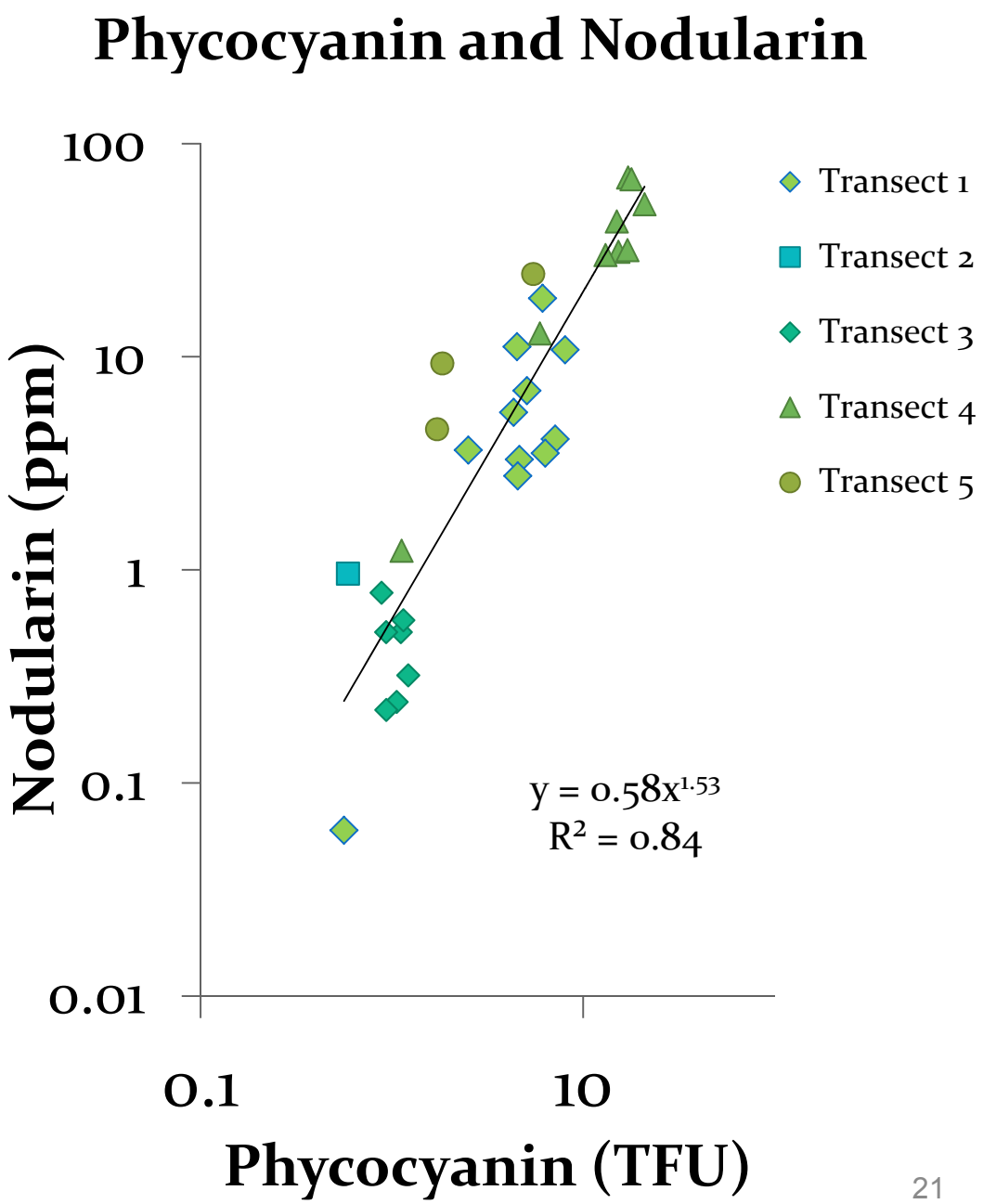

Nodularia biovolume (µm mL-1)
3.E+08
2.E+08
1.E+08
0.E+00
0
10
20
30
40
50
60
70
80
Salinity (g L-1)
18-Jun-12
21-Sep-12
3-May-13
3-Jun-13
28-Jun-13


Phycocyanin (TFU)
25
20
15
10
5
0
0
20
40
60
80
Salinity (g L-1)
18-Jun-12
21-Sep-12
3-May-13
3-Jun-13
28-Jun-13


18-Jun-12
21-Sep-12
3-May-13
3-Jun-13
28-Jun-13
Nodularia (cells mL-1)
0.0E+00
2.0E+05
4.0E+05
6.0E+05
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Total nitrogen (µg L-1)

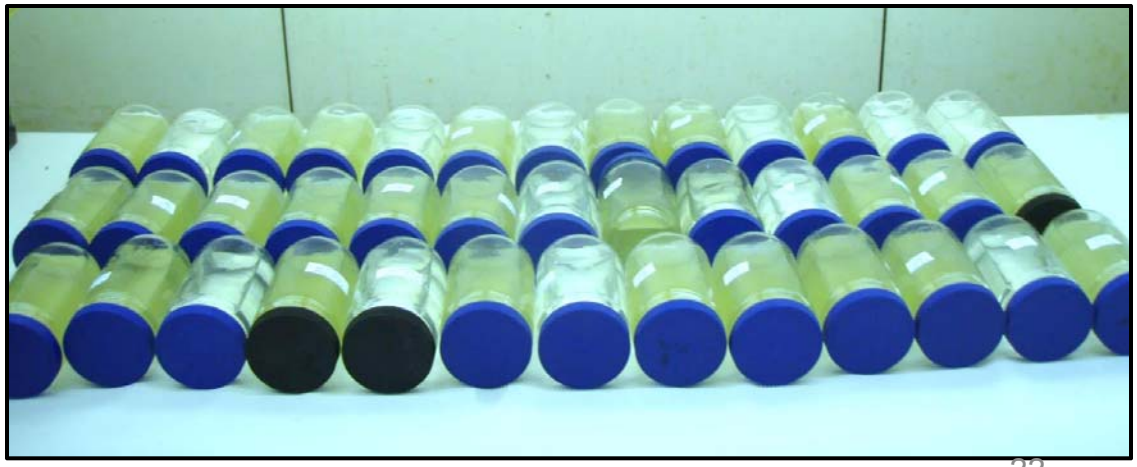

18-Jun-12
21-Sep-12
3-May-13
3-Jun-13
28-Jun-13
Nodularia (cells mL-1)
0.0E+00
2.0E+05
4.0E+05
6.0E+05
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Total phosphorus (µg L-1)

Phycocyanin, a pigment specific to cyanobacteria, is a correlate of the toxin Nodularin



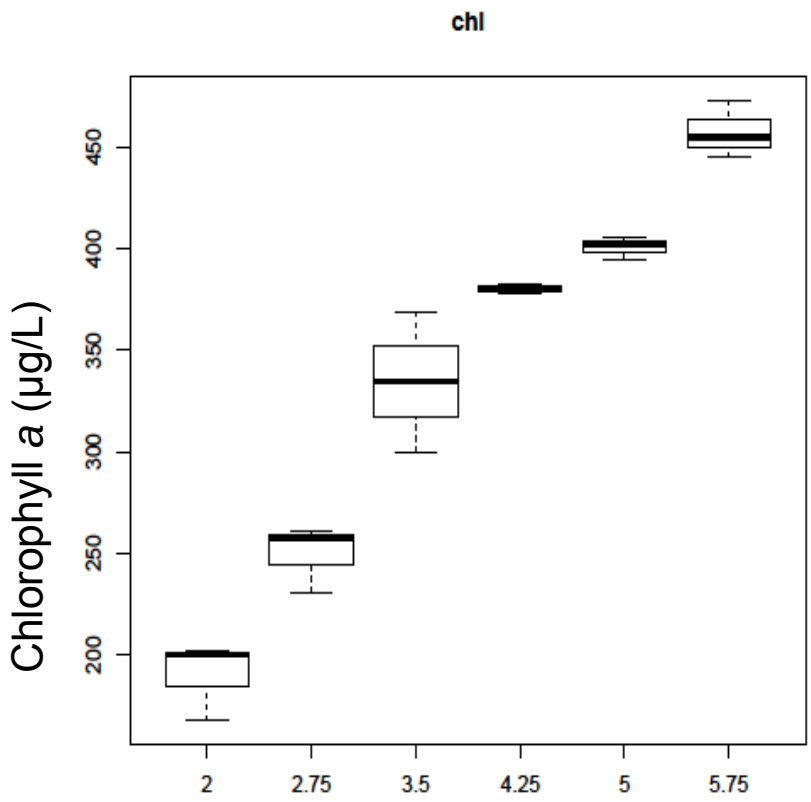
Bioassay methods

Nutrient Addition Bioassay (June 3 to June 7, 2013) Four days					
Station	Salinity	N	P	N and P	control
Station 1	3 g L^{-1}	¤	¤	¤	¤
Station 5	16 g L^{-1}	¤	¤	¤	¤
Station 9	37 g L^{-1}	¤	¤	¤	¤
Salinity Bioassay (June 28 to July 3, 2013) Eight days					
Station 5	16 g L^{-1}			¤	¤
Station 5	26 g L^{-1}			¤	
Station 5	37 g L^{-1}			¤	
Station 5	48 g L^{-1}			¤	
Station 5	59 g L^{-1}			¤	
Nutrient Addition Bioassay (June 28 to July 3, 2013) Eight days					
Station 5	16 g L^{-1}	¤	¤	¤	¤

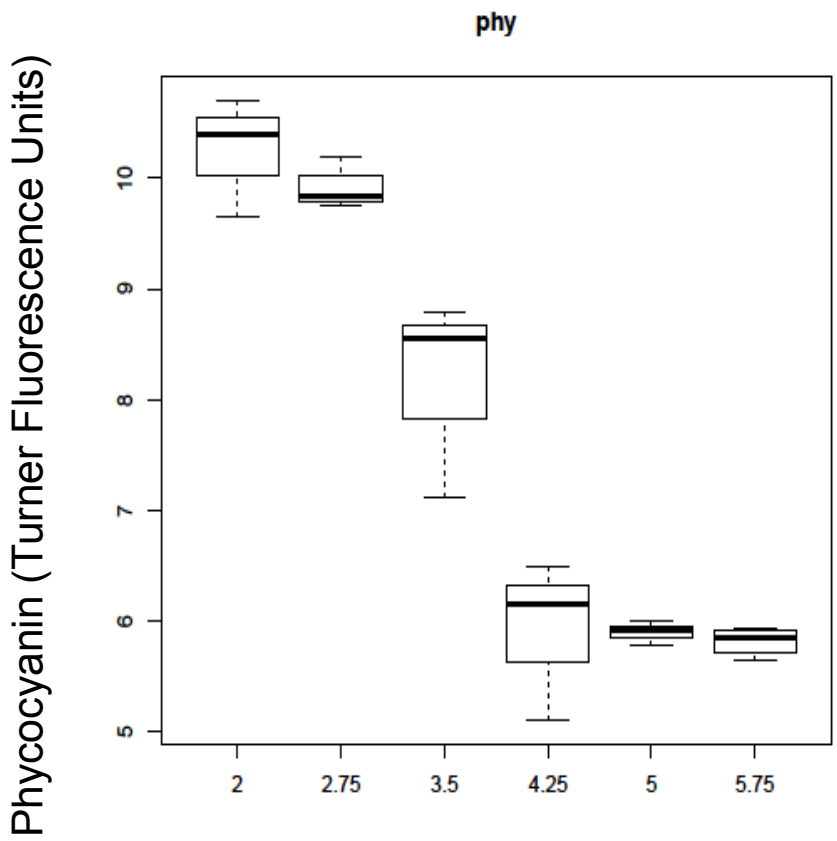


- Nutrient addition
- Salinity change

June 28 salinity bioassay (day 8)
Station 5

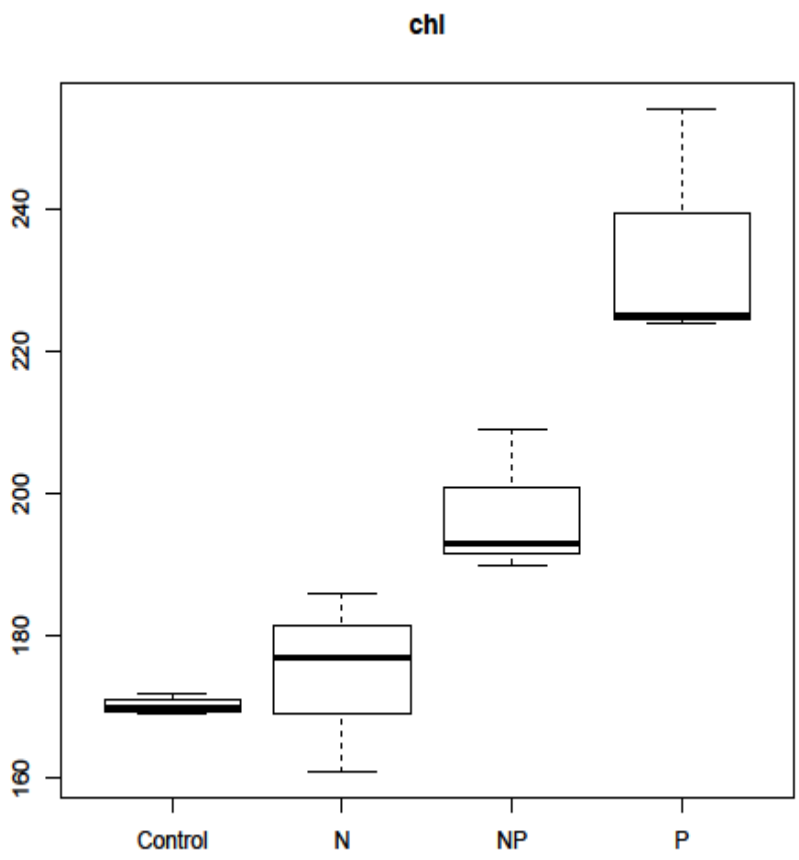


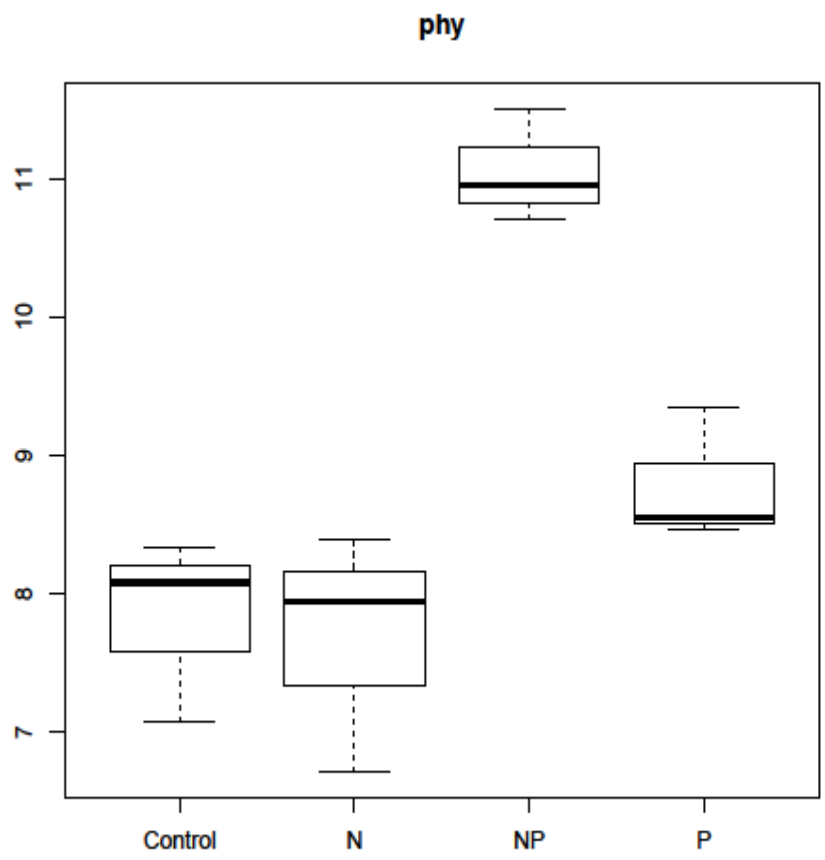
Sum Sq = 162801 F-value = 102.7
p-value = 5.59e-10 ***



Sum Sq = 67.98F-value = 50.79
p-value = 4.47e-8 ***

June 28, 2013 nutrient bioassay results (day 8)
Station 5



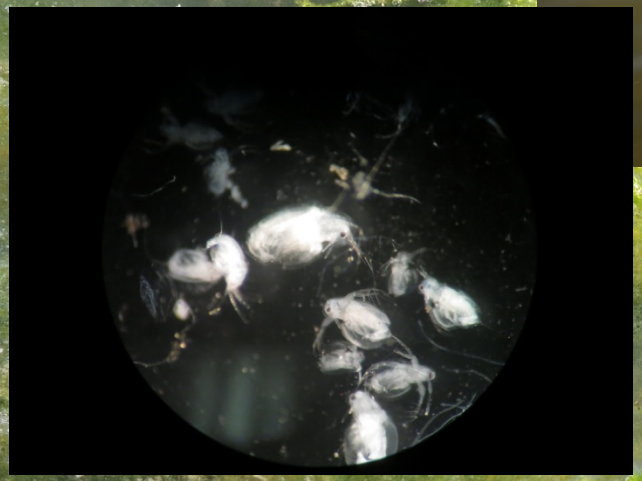


Sum Sq = 16.700 F-value = 91.392
P-value = 1.63e-07 ***

Sum Sq =10.117 F-value= 53.18
p-value = 0.00111 **

June 3, 2013 nutrient bioassay results (day 4)
Stations 1, 5, and 9

Conclusions

- Toxic cyanobacterial and other algal densities are extreme in Farmington Bay
- High levels of total nitrogen is correlated with high levels of *Nodularia* and cyanotoxin, but total phosphorus is not
- *Nodularia spumigena* dominates the phytoplankton biomass at times
- Salinity may play a role in governing growth

Questions?