Analysis of *Prymnesium parvum* blooms in Lake Whitney, Texas

Richard L. Kiesling[1,2]

[1]United States Geological Survey, Water Resource Division, Texas District, 8027 Exchange Drive, Austin, TX, 78754

[2]Dept. Chemistry & Geosciences, Tarleton State University, Stephenville, TX, 76402

Overview

- Problems:
  - Winter-Spring blooms of *Prymnesium parvum* in numerous Texas reservoirs (PK, Granbury, Whitney)
  - Frequent blooms of *P. parvum* in the upper Colorado River
  - Associated fish kills in reservoirs, rivers, and fish hatcheries

Overview

- Questions Identified by Texas HAB Team:
  - What factors control the development of *P. parvum* blooms in Texas reservoirs?
  - What physical, chemical, and biological characteristics trigger the build-up of *P. parvum* populations?
  - What causes toxin production in *P. parvum*?

Overview

- What factors contribute to *P. parvum* blooms?
  - Is there a relationship between environmental conditions and development of blooms?
  - Is this relationship mediated through algal population dynamics or trophic-level interactions?

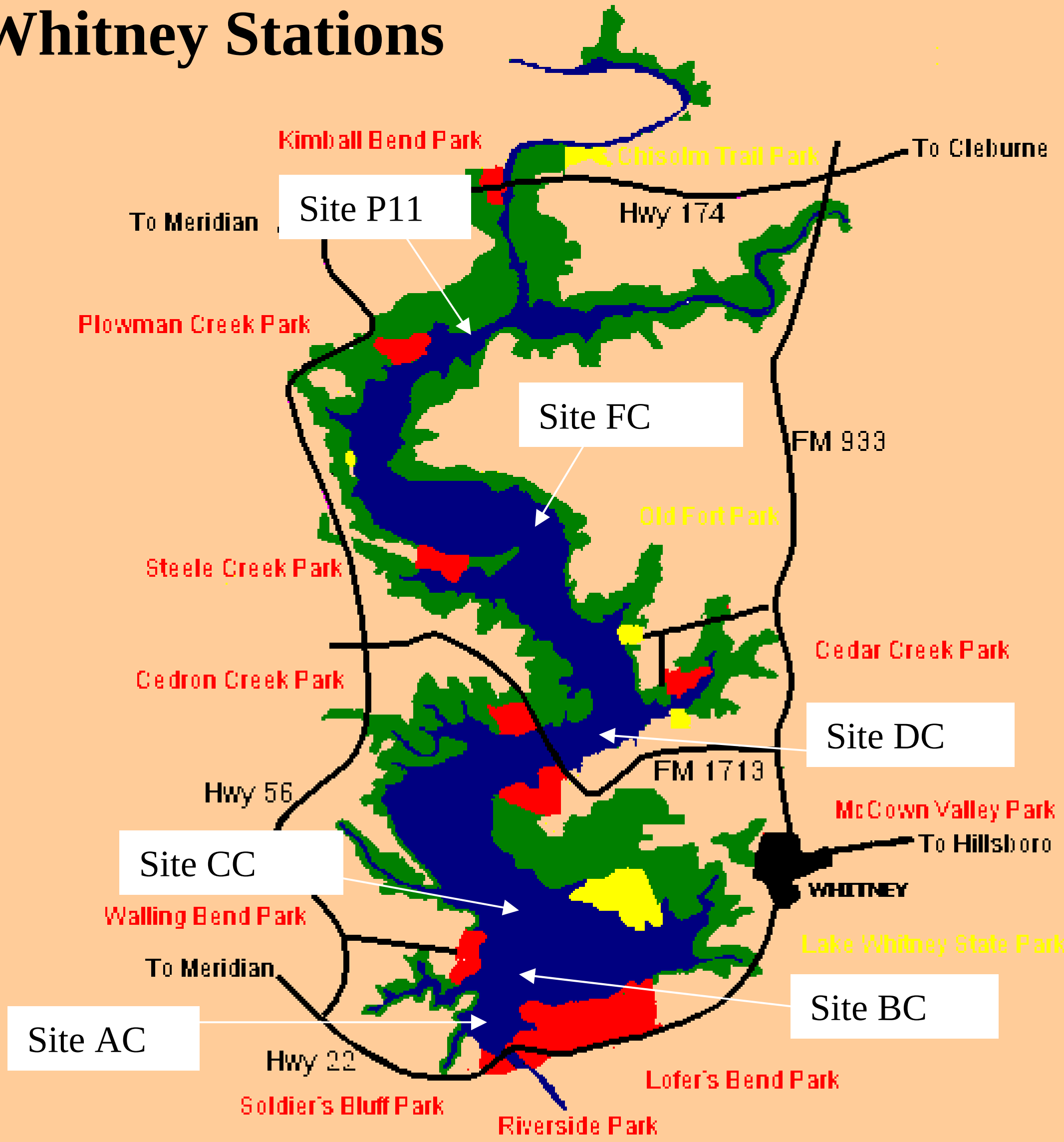
Approach - proposed studies

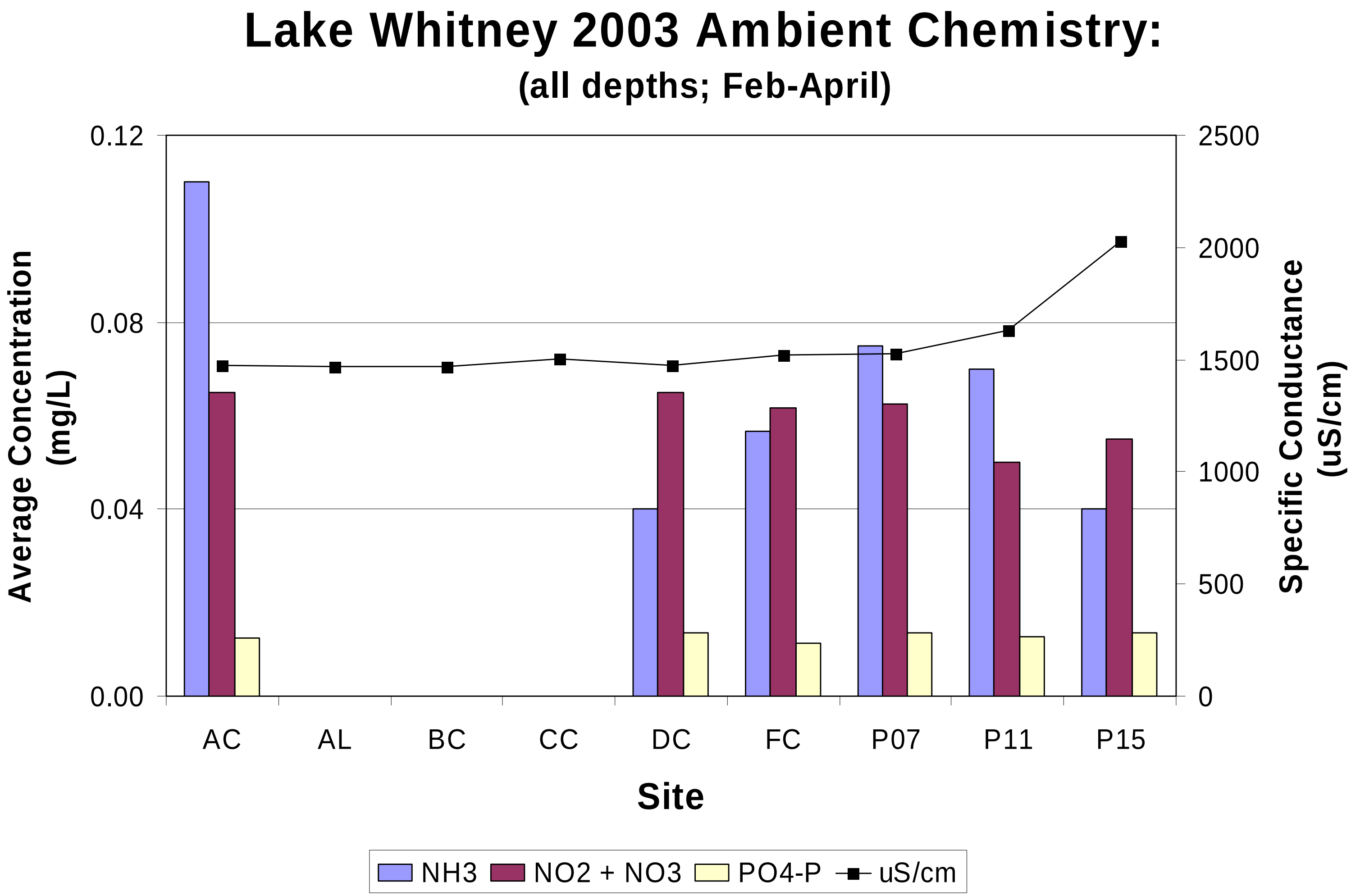
- Synoptic sampling of paired reservoirs during *P. parvum* blooms
  - Simultaneously assess population densities and the physical and chemical environmental gradients
  - Correlate biological responses to environmental gradients
- Experimental manipulation of important gradients
  - Nutrient enrichment experiments to ID potential limitation
  - Dilution bioassays to estimate importance of grazing
  - Functional response to limiting factors

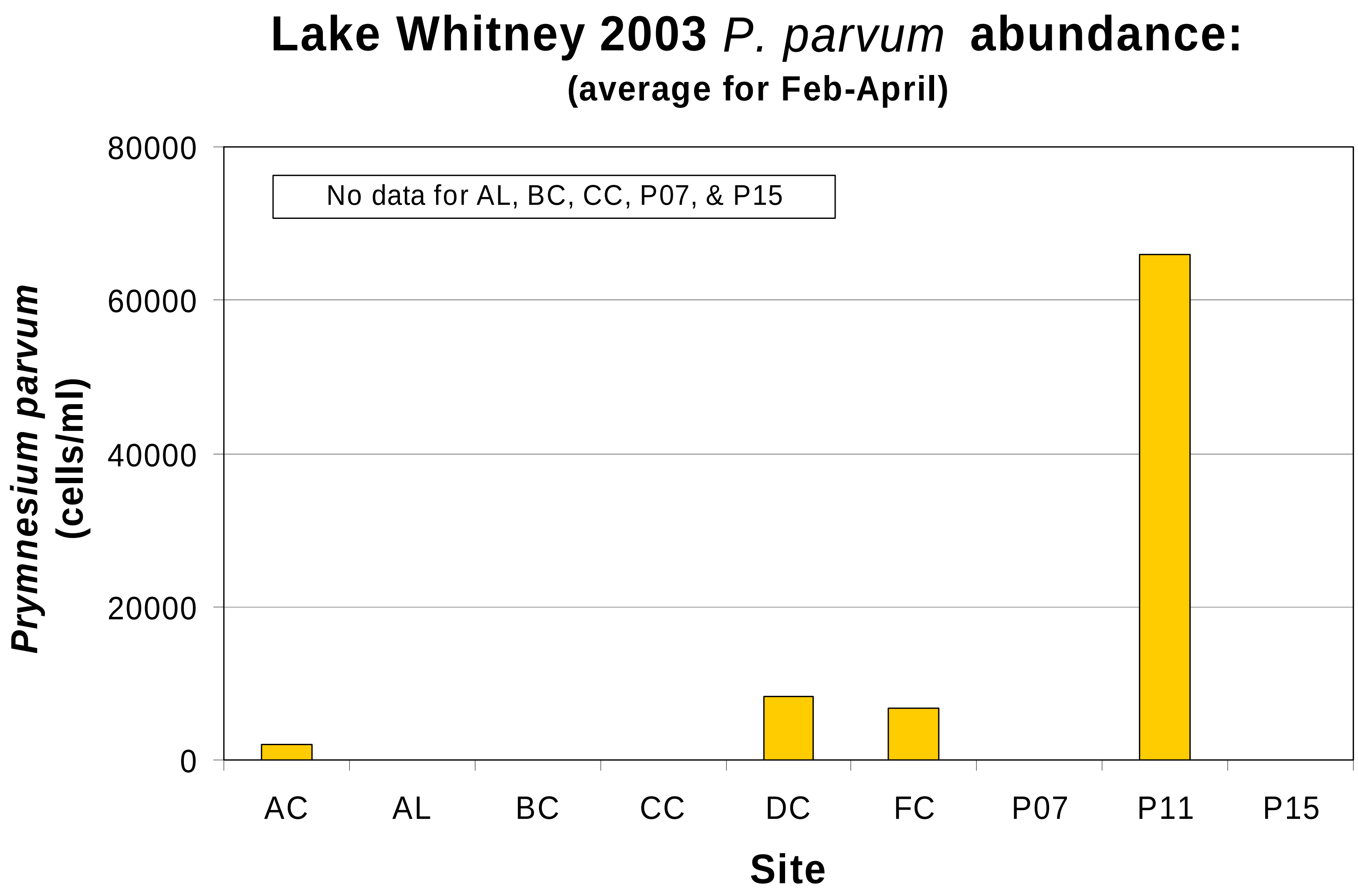
Pilot Study on Lake Whitney

- Assessment of biological responses to gradients in Lake Whitney
  - Synoptic cruises during the *P. parvum* bloom to document physical and chemical gradient
  - Experimental nutrient enrichment gradients to assess potential for nutrient limitation of *P. parvum* populations
  - Experimental grazing gradients to assess loss rates (dilution and addition)

Lake Whitney Stations



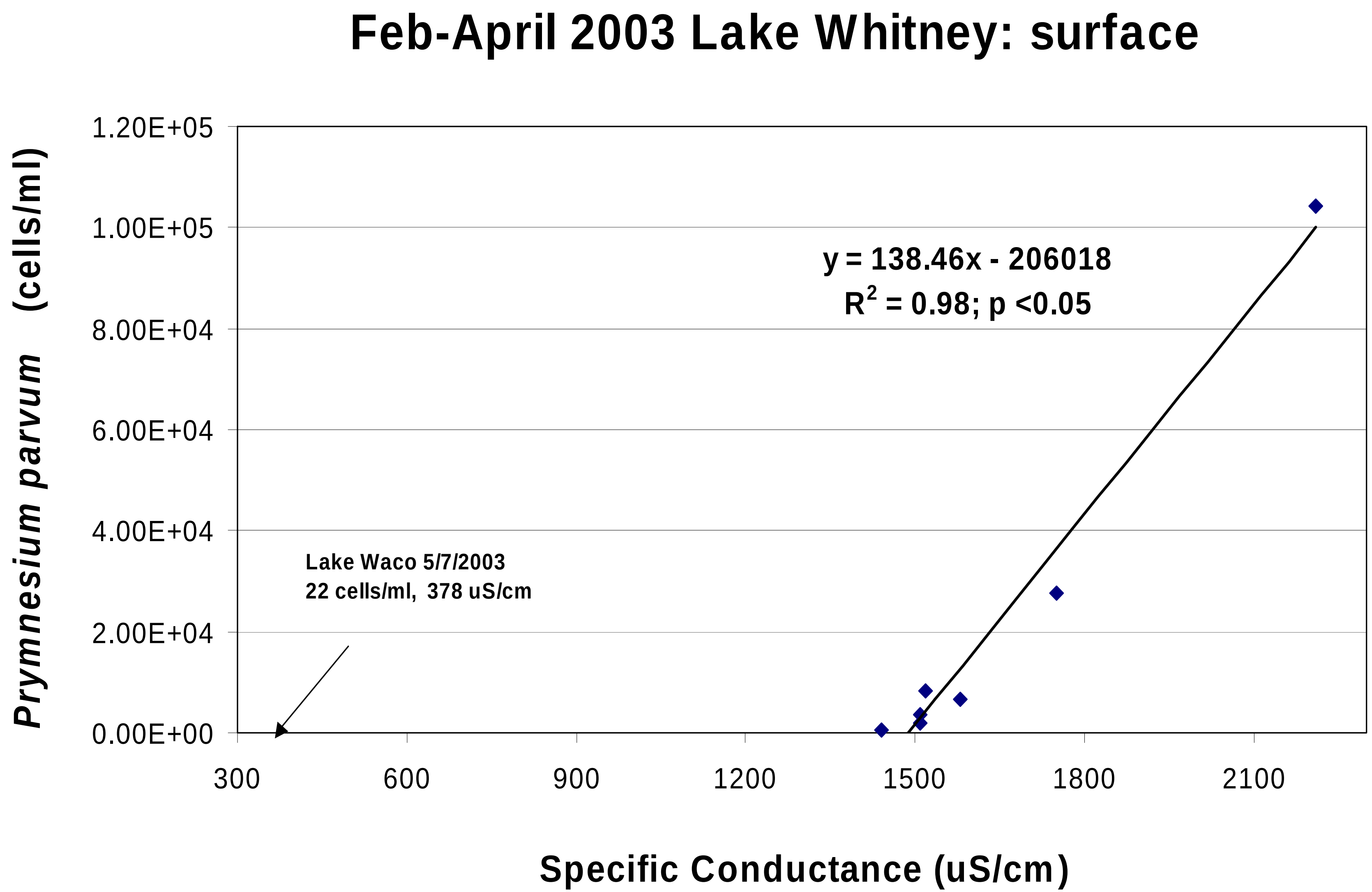

Lake Whitney 2003 Ambient Chemistry:
(all depths; Feb-April)
Average Concentration (mg/L)
0.12
0.08
0.04
0.00
Specific Conductance (uS/cm)
2500
2000
1500
1000
500
0
AC
AL
BC
CC
DC
FC
P07
P11
P15
Site
NH3
NO2 + NO3
PO4-P
uS/cm



Lake Whitney 2003 *P. parvum* abundance:
(average for Feb-April)
No data for AL, BC, CC, P07, & P15
Prymnesium parvum (cells/ml)
80000
60000
40000
20000
0
AC
AL
BC
CC
DC
FC
P07
P11
P15
Site

Correlations between *P. parvum* densities and selected variables

Lake Whitney *P. parvum* Surface Densities, Composite Nutrient Data					
	Cond.	NH_3-N	NO_2+NO_3	PO_4-P	CELLS/ML
Cond.	1.00	-0.49	-0.78	0.36	0.98
NH_3-N		1.00	-0.01	-0.46	-0.51
NO_2+NO_3			1.00	0.16	-0.72
PO_4-P				1.00	0.50
CELLS/ML					1.00


Feb-April 2003 Lake Whitney: surface
y = 138.46x - 206018
R2 = 0.98; p <0.05
Lake Waco 5/7/2003
22 cells/ml, 378 uS/cm
Prymnesium parvum (cells/ml)
1.20E+05
1.00E+05
8.00E+04
6.00E+04
4.00E+04
2.00E+04
0.00E+00
300
600
900
1200
1500
1800
2100
Specific Conductance (uS/cm)

Step-wise Multiple-Regression Summary: CELLS/ML Surface Densities, Composite Nutrient Data						
	Beta	Beta SE	B	B SE	t(1)	p-level
Intercpt			3907	13932	0.28	0.83
COND	0.52	0.03	73	4	18.53	0.03
NH_3-N	-0.12	0.01	-113936	12177	-9.36	0.07
NO_2+NO_3	-0.37	0.02	-1869286	121535	-15.38	0.04
PO_4-P	0.32	0.01	1876156	71168	26.36	0.02
$R= .99$ Adjusted $R^2= .99$						
$F(4,1)=5297.0$ $p<.01030$ Std.Error of estimate: 615.29						

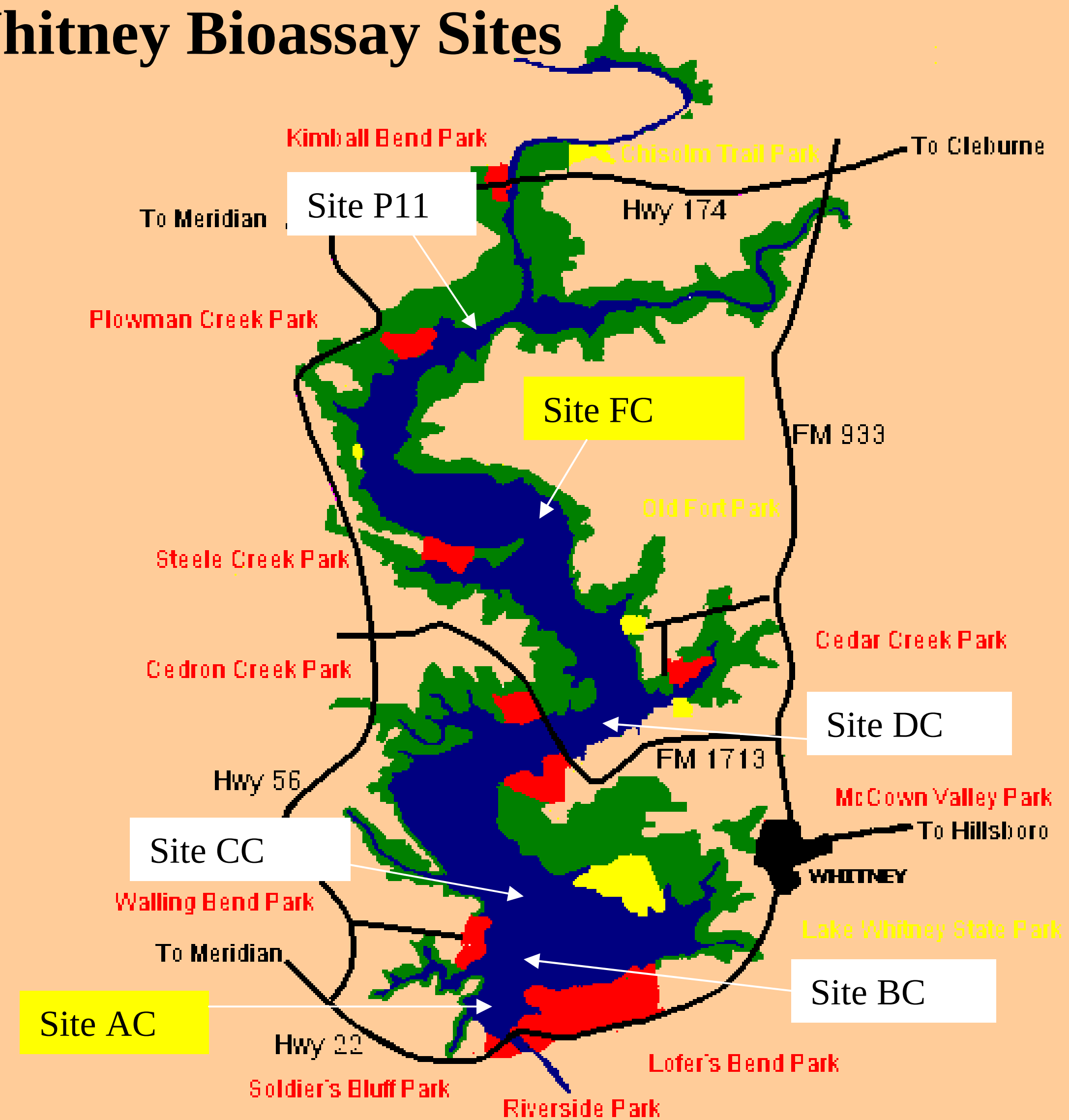
Lake Bioassay Methods

- Acclimated growth-rate method using IVF followed by cell counts to estimate daily growth (r)
- Treatments included N, P, and Si additions to ambient lake water
- Laboratory incubations at ambient temperature and light lasted 8 days

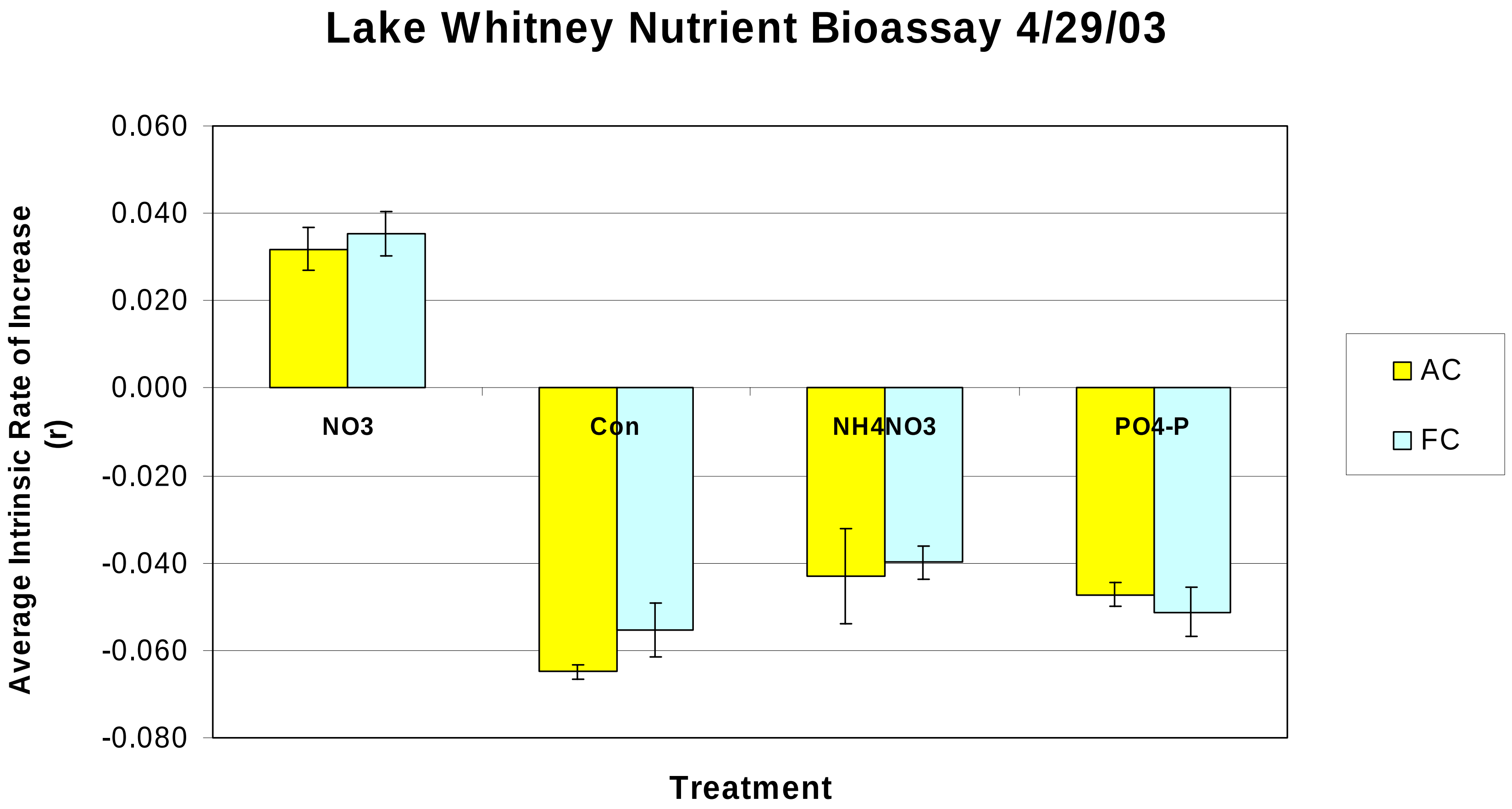
Lake Bioassay Methods (cont.)

- Five or six replicates per treatment
- Zooplankton removed using 153µm Nitex
- Results recorded using *in vivo* fluorescence
- Growth responses to treatments were calculated using an exponential growth model ($N_t = N_o e^{rt}$)
- Replicate estimates of *(r)* for each treatment

Lake Whitney Bioassay Sites



Lake Whitney Nutrient Bioassay 4/29/03				
Site	Treatment	Mean r	SDEV	95% CI
AC	NO_3	0.032	0.006	0.005
AC	Con	-0.065	0.002	0.002
AC	NH_4NO_3	-0.043	0.014	0.011
AC	PO_4-P	-0.047	0.003	0.003
FC	NO_3	0.035	0.006	0.005
FC	Con	-0.055	0.007	0.006
FC	NH_4NO_3	-0.040	0.004	0.004
FC	PO_4-P	-0.051	0.007	0.006



Lake Whitney Nutrient Bioassay 4/29/03
Average Intrinsic Rate of Increase (r)
0.060
0.040
0.020
0.000
-0.020
-0.040
-0.060
-0.080
NO3
Con
NH4NO3
PO4-P
Treatment
AC
FC

Lake Whitney Nutrient Bioassay 4/29/03: large volume, un-replicated design

Dilution Bioassay			
Site	Treatment	r	r_{uf}
FC	50%D NO_3	0.033	0.039
FC	50% D Con	-0.042	-0.037
FC	NO_3	0.035	0.023
FC	Con	-0.055	-0.063
FC	NH_4NO_3	-0.040	
FC	PO_4-P	-0.051	

Original Questions

- What factors contribute to *P. parvum* blooms?
  - Is there a relationship between environmental conditions and development of blooms?
  - Is this relationship mediated through algal population dynamics or trophic-level interactions?

Results to date – April 2003 survey of Lake Whitney

- *P. parvum* densities follow in-lake environmental gradient
- *P. parvum* growth is stimulated by nitrate addition during latter part of bloom
- *P. parvum* net growth rates may be sensitive to species interactions

Next steps?

- Continue paired-reservoir assessment between Lake Whitney and Lake Waco - add others
- Continue to assess importance of grazing and nutrient limitation for *P. parvum* populations
- Assess toxin levels as a function of P. parvum density, conductivity, and nutrient limitation
- Explore options for Lake Whitney sediment core analysis using *P. parvum* biomarkers

Acknowledgements

- Texas HAB Team, TPWD
- Joan Glass, TPWD
- Dan Roelke, TAMU
- US Army Corps of Engineers
- USGS
- Texas Commission on Environmental Quality

DY III Media Stock Addtions

Nutrient	Final Concentration
Na_2HPO_4	8 mg/L
NH_4NO_3	5 mg/L
$NaNO_3$	20mg/L
Na_2SiO_3-$9H_2O$	30 mg/L