Methodological analysis of algal toxins

Comparing ELISA and LC/MS methods for toxin production

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NOTES: 2016-07-26 added new maps for regional area, and updated individual locations added air temperature data from NOAA created plots for the microcystins data started microcystin analysis

Project Summary

Overview

Collaborators

Daniel D. Snow, PhD, University of Nebraska-Lincoln Water Sciences Center

Project questions

1.

List of abbrevations

NDEQ: Nebraska Department of Environmental Quality US EPA: United States Environmental Protection Agency US COE: United States Army Corp of Engineers USGS: United States Geological Survey NOAA: National Oceanic and Atmospheric Administration

Contents

Project Summary **1**

Material and Methods **3**

Sample collection and analysis 3

Statistical analysis 6

Results **7**

Summary of major results 7

Temporal Trends 8

Air and water temperatures for the Pawnee Lake region from 1996 - 2016 8

Nutrients and chlorophyll 9

NDEQ Total microcystins 10

WSL Algal toxins 11

Other algal toxins 12

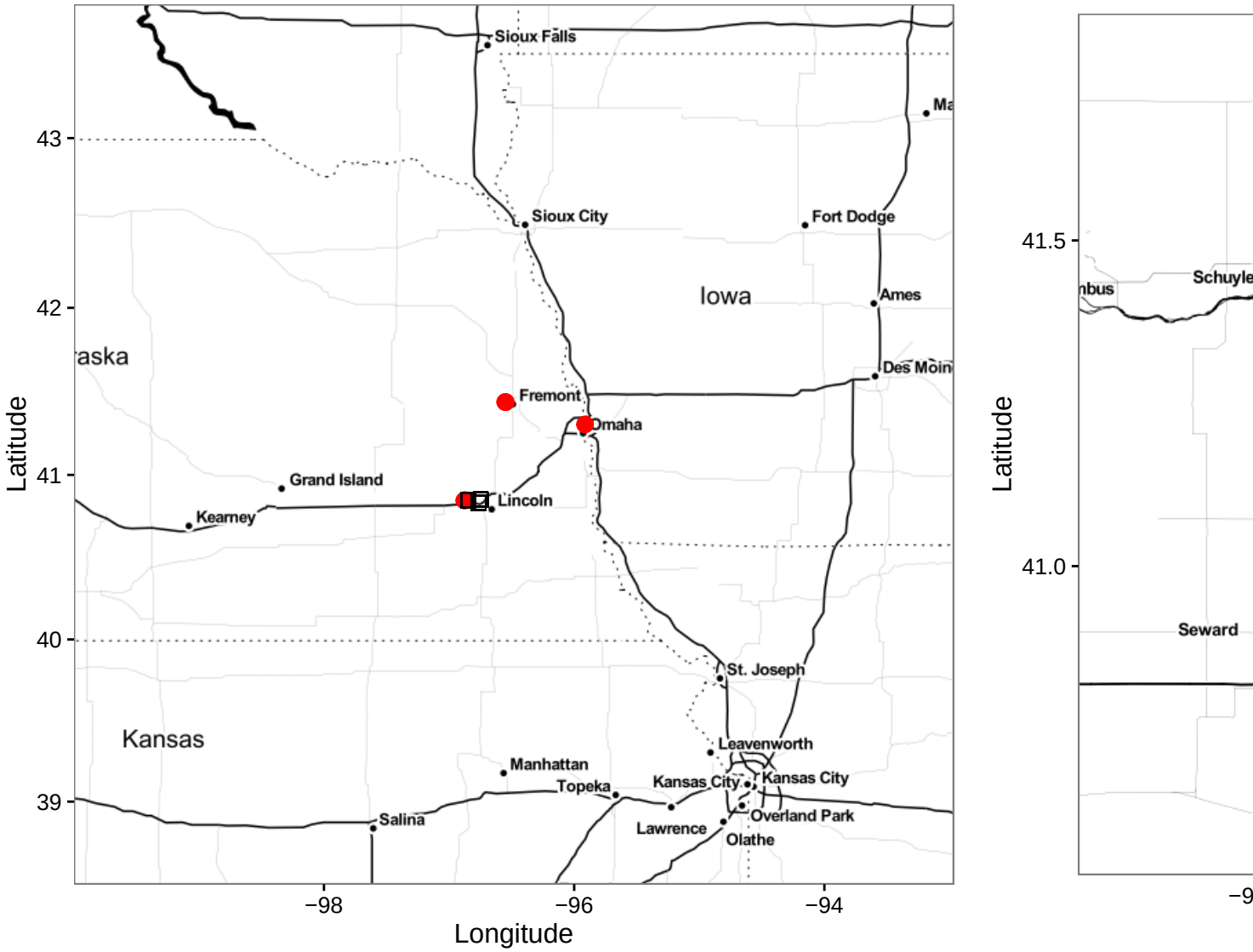
Methodological Comparison 14

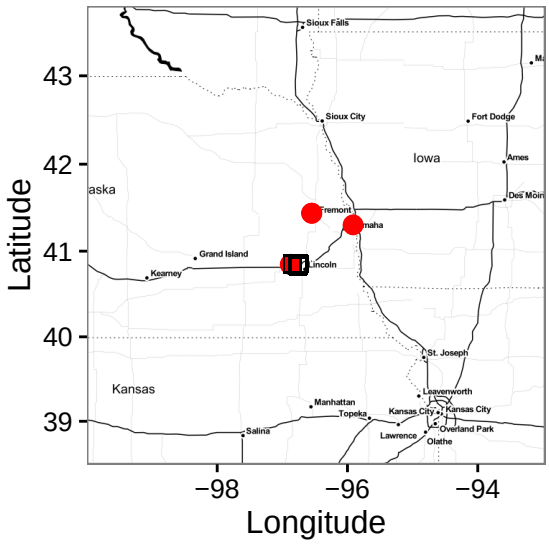
Material and Methods

Sample collection and analysis

Reservior and monitoring programs Pawnee Lake (Lancaster County, Nebraska) is one of X freshwater ecosystems consisently monitored for algal toxins and coliform bacteria by the NDEQ over the last decade as part of the Ambient Lake Monitoring Program. Pawnee Lake was formed as an irrigation reservoir (?) in 19XX by the GROUP by adding an earthen dam at the southeast corner. Chemical and physical traits of Pawnee Lake are monitored by the NDEQ, USCOE, and USGS with data publically available from the National Water Quality Database Climatic data for the area was obtained from NOAA.

Microcystin sample collection and analysis NDEQ personnel collect **grab** samples from each of the two swimming beaches to monitor concentration levels of microcystins, cyclic peptides produced by the cyanobacteria *Microcystis*, with an ELISA ADDA Kit. The NDEQ closes a beach or lake if the concentration of the toxin is equal to or higher than 20 ug/ul.

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Sioux City
Fort Dodge
Iowa
Ames
Des Moin
Fremont
maha
Grand Island
Kearney
Lincoln
St. Joseph
Kansas
Leavenworth
Manhattan
Topeka
Kansas City
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Salina
Lawrence
Overland Park
Olathe
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42
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Latitude
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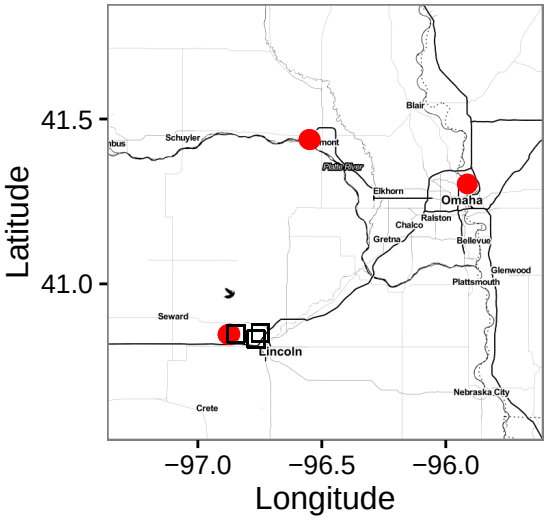
−96
−94
Longitude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Omaha
Ralston
Chalco
Gretna
Bellevue
Glenwood
Plattsmouth
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Nebraska City
Crete
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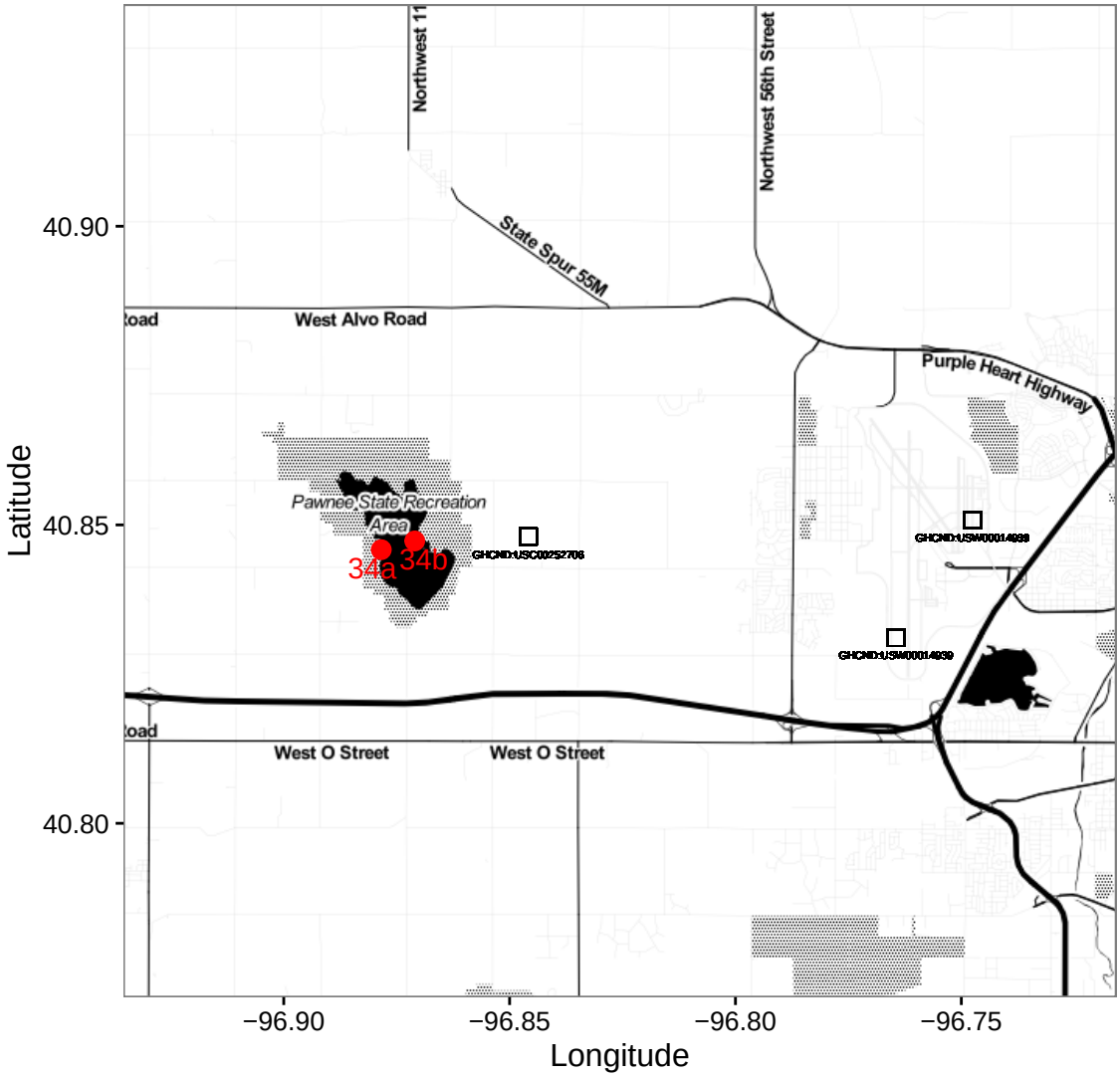
41.0
Latitude
−97.0
−96.5
−96.0
Longitude


Northwest 11
Northwest 56th Street
State Spur 55M
West Alvo Road
Purple Heart Highway
Pawnee State Recreation Area
34a
34b
GHCND:USC00252706
GHCND:USW00014939
GHCND:USW00014939
West O Street
West O Street
40.90
40.85
40.80
−96.90
−96.85
−96.80
−96.75
Latitude
Longitude

Statistical analysis

Results

Data for this project was collected from Pawnee Lake swimming beaches as grab samples by the NDEQ

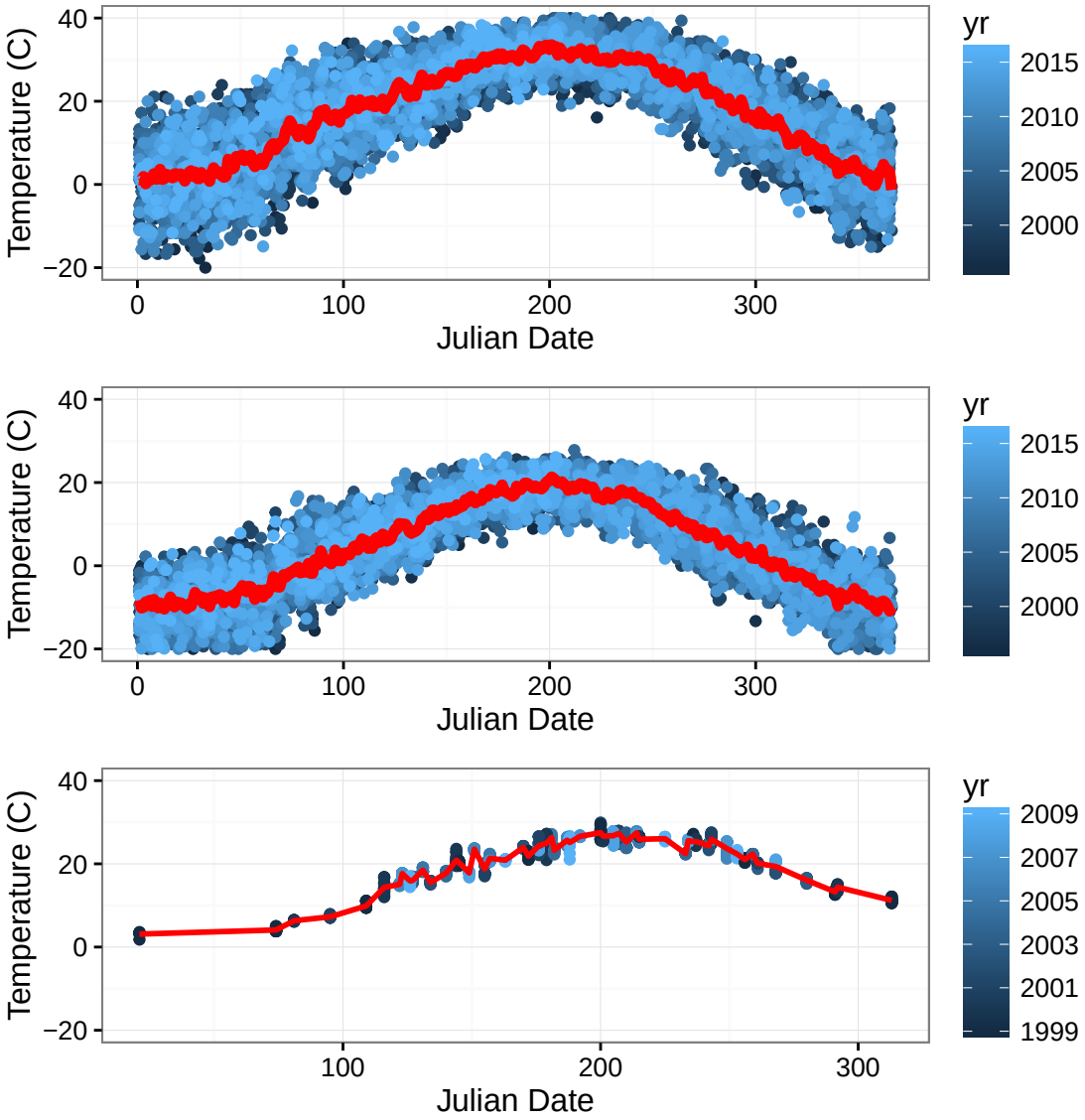
Summary of major results

1. **Temporal lake properties**
2. **ELISA ADDA analysis**
3. **LC/MS analysis**
4. **Statistical correlation**

Temporal Trends

Air and water temperatures for the Pawnee Lake region from 1996 - 2016

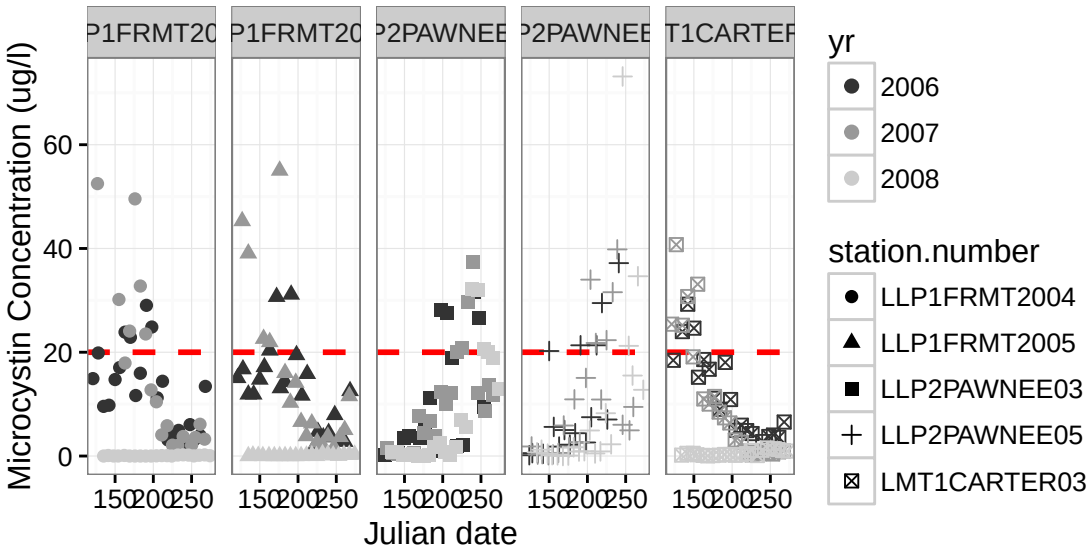
Air temperature (minimum and maximum) data were obtained from NOAA; Water temperature readings were obtained from USACOE.



Nutrients and chlorophyll

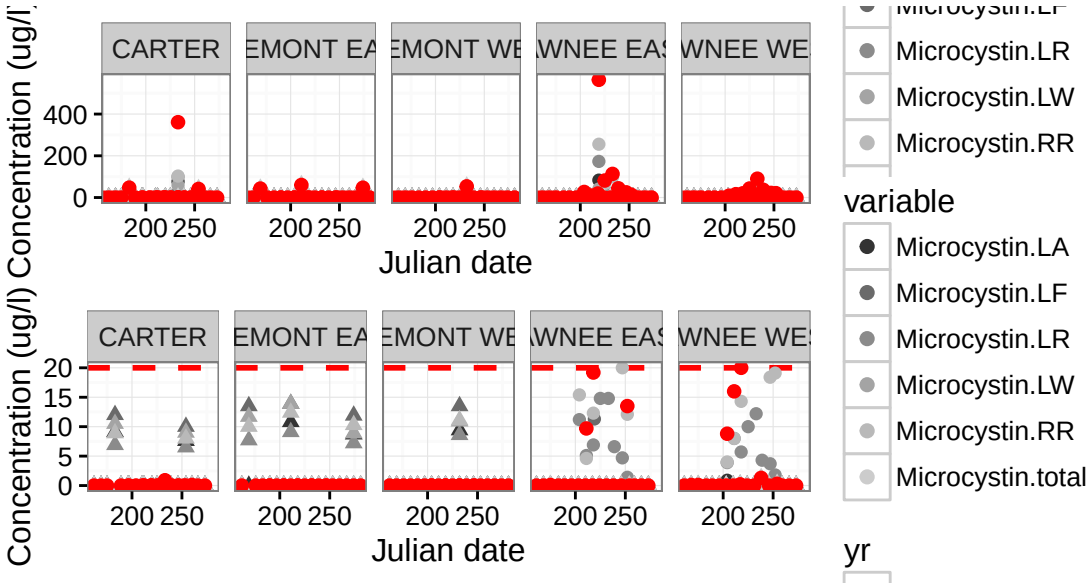
NDEQ Total microcystins

```
## 'data.frame':    323 obs. of  7 variables:
##  $ station.number  : Factor w/ 5 levels "LLP1FRMT2004",..: 5 5 5 5 5 5 5 5 5 5 ...
##  $ lake.name       : Factor w/ 12 levels "Carter Lake @ North Boat Ramp",..: 2 2 2 2 2 2 2 2 2
##  $ lake            : Factor w/ 5 levels "CARTER","FREMONT EAST",..: 1 1 1 1 1 1 1 1 1 ...
##  $ sample.date.time: Factor w/ 169 levels "05-15-06","05-22-06",..: 37 39 1 2 3 41 47 4 6 49 ..
##  $ sample.date     : Factor w/ 107 levels "2006-05-01","2006-05-03",..: 2 4 5 6 7 8 9 10 12 14
##  $ sampler         : Factor w/ 1 level "NDEQ": 1 1 1 1 1 1 1 1 1 1 ...
##  $ mic.con         : Factor w/ 249 levels " >55.00","> 35",..: 124 4 160 170 162 113 125 118 90
```

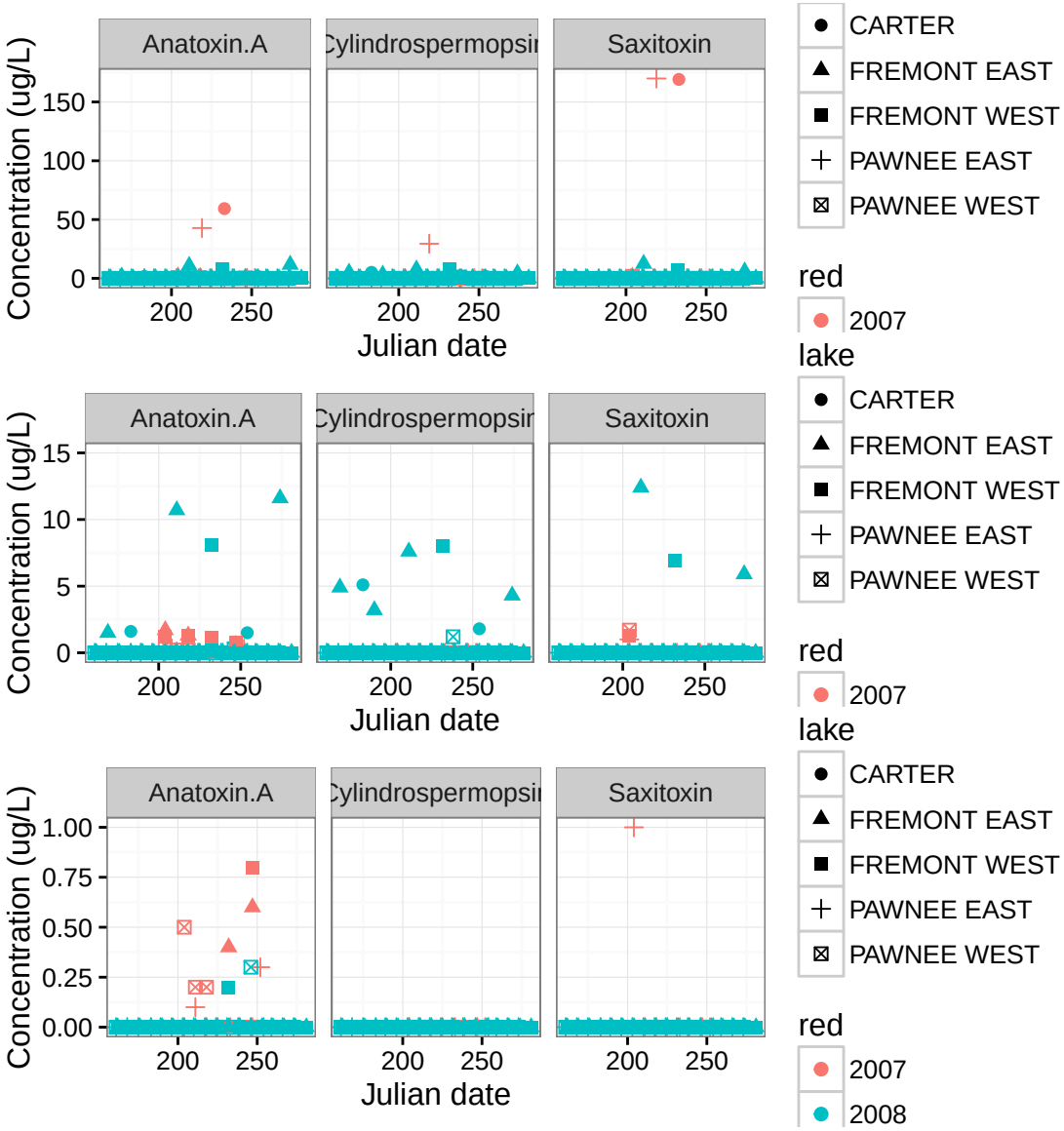


WSL Algal toxins

```
## 'data.frame':    282 obs. of  15 variables:
##  $ Lab_ID_String     : Factor w/ 282 levels "07-1010","07-1011",..: 279 280 278 81 167 168 179
##  $ Sample_ID         : Factor w/ 207 levels "A2","A2 LFM",..: 1 2 3 4 5 6 7 8 9 10 ...
##  $ lake              : Factor w/ 40 levels "","A2","A2 LFM",..: 2 3 4 5 5 5 5 5 5 5 ...
##  $ Collection_Date   : Factor w/ 65 levels "2006-10-01","2007-04-10",..: 1 1 1 17 28 30 32 34 3
##  $ Anatoxin.A        : num  NA NA NA 59.3 NA NA NA 1.6 NA NA ...
##  $ Cylindrospermopsin: num  NA NA NA NA NA NA NA 5.1 NA NA ...
##  $ Microcystin.LA    : num  NA 106.7 NA 76.9 NA ...
##  $ Microcystin.LF    : num  NA 29.3 NA 23.8 NA NA NA 12 NA NA ...
##  $ Microcystin.LR    : num  NA 158.4 NA 98.7 NA ...
##  $ Microcystin.LW    : num  NA 176.8 NA 58.8 NA ...
##  $ Microcystin.RR    : num  NA 35.4 NA 102.8 NA ...
##  $ Saxitoxin         : num  NA NA NA 169 NA ...
##  $ Batch             : Factor w/ 16 levels "W07003","W07054",..: 1 1 1 8 10 10 10 10 11 11 ...
##  $ Analysis.Date     : Factor w/ 6 levels "","2007-02-12 0:00",..: 2 2 2 3 6 6 6 6 6 6 ...
##  $ X.Imidazolidine   : num  NA NA NA 81.9 55.1 ...
```



Other algal toxins

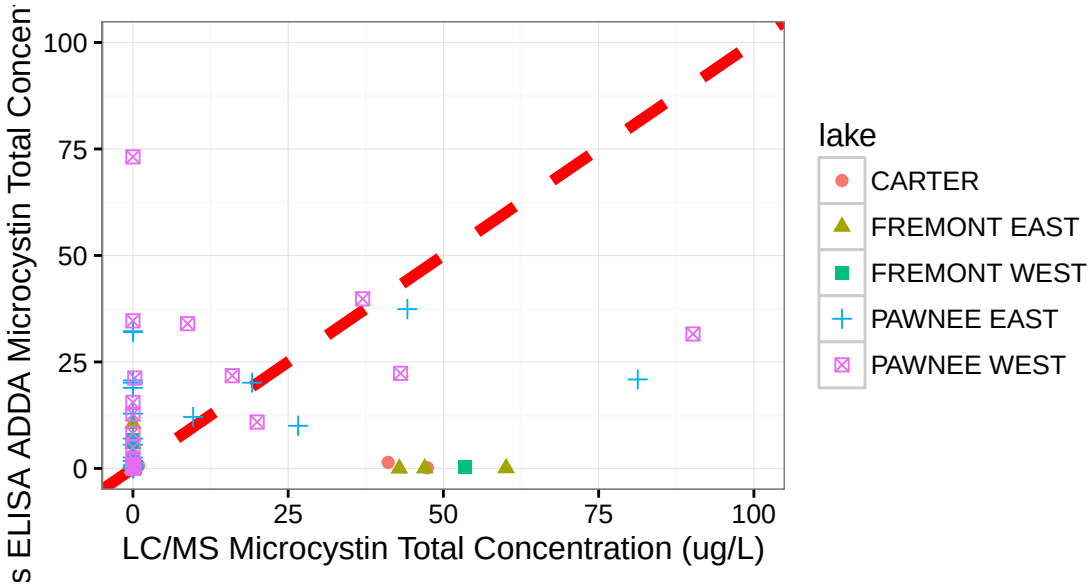


The State of Nebraska only monitors the concentration of microcystins as an aggregate group and issues health advisories for recreational water bodies as a total toxin concentrations greater than 20 ug/L. Other states issue both *public health advisories* (PHA) and *no contact advisories* (NCA) depending on the type of cyanobacterial toxin. For example, Ohio regularly tracks microcystin-LR, anatoxin-a, saxitoxin, and cylindrospermopsin and issues both PHA and NCA throughout the season (Table 1).

State	Compound	PHA	NCA
Nebraska	Microcystin aggregate	NA	20
Ohio	microcystin-LR	6	20
	anatoxin-a	80	300
	saxitoxin	0.8	3
	cylindrospermopsin	5	20
California	microcystin	0.8	NA
	anatoxin-a	90	NA
	cylindrospermopsin	4	NA
Indiana	microcystin-LR	4	20

State	Compound	PHA	NCA
Vermont	cylindrospermopsin	NA	5
	microcystin-LR	NA	6
	anatoxin-a	NA	10

Methodological Comparison




```
## [1] 0.1330515
```

The Abraxis ELISA ADDA kit quantifies the concentration of both microcystins and nodularins.

Total microcystin concentration is based on the detection and quantification of five congers (LR, LW, RR, LR, and LA).