

# **Blue-green Algal Toxins in Minnesota Lakes**

## **Harmful Algal Bloom Workshops 2008**

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# Outline

- Brief history on MN algal toxin issues;
- Overview 3 studies that examine blue-green algal toxins in MN – focus on microcystin (MC);
- Overview of findings
- Recommendations based on studies to date;

# MN History With Algal Toxins

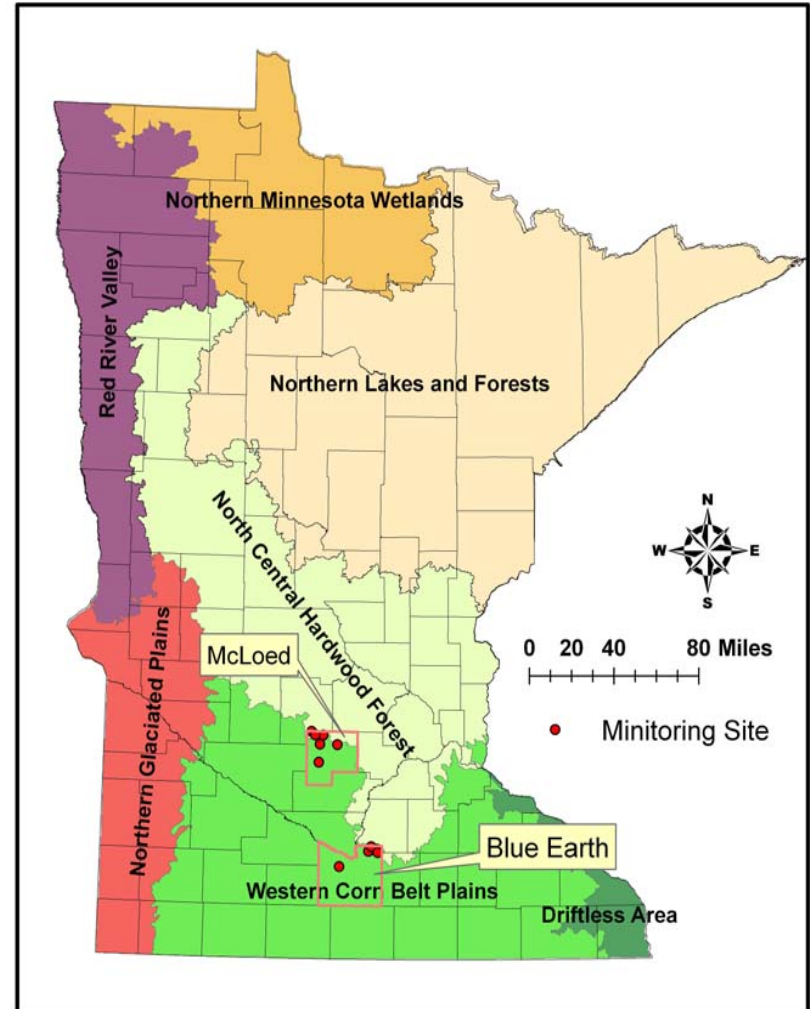
- Accounts of algal toxicity in MN go back to 1800's on live stock
- Increasing concern and reports world wide
- Three dog deaths in 2004 (Fish and Benton) prompted further work on this issue.
- 2005 MPCA joined MDNR, MDH and the Minnesota Veterinary Medicine Association (MVMA) to form the Minnesota Blue-green Algal Toxicity Workgroup
- 2006 study conducted to examine MC in several eutrophic lakes in two south central MN counties
- 2007
  - Five confirmed dog deaths
  - Very high MC results (>80,000 µg/l)
  - National Lake Assessment assessed MC in 50 randomly-selected lakes;
  - MC monitored in 35 southern MN lakes;

# Questions addressed in the 2006 study

- What is the range in MC in eutrophic / hypereutrophic MN Lakes
- Is there a significant difference in near-shore MC as compared to mid-lake?
- Is there seasonality to MC concentrations?
- What limnological and physical factors appear to be associated with high MC?
- How can these findings be used to communicate risk to lake users?

# 2006 South-Central MN Study

- 12 eutrophic –hyperutrophic lakes
- Sampled six times May- Sept.;
- Mid-lake “pelagic” site – full water chemistry
- Near-shore (bloom hunting) site, typically downwind or distinctly higher algal concentration;



# Methods

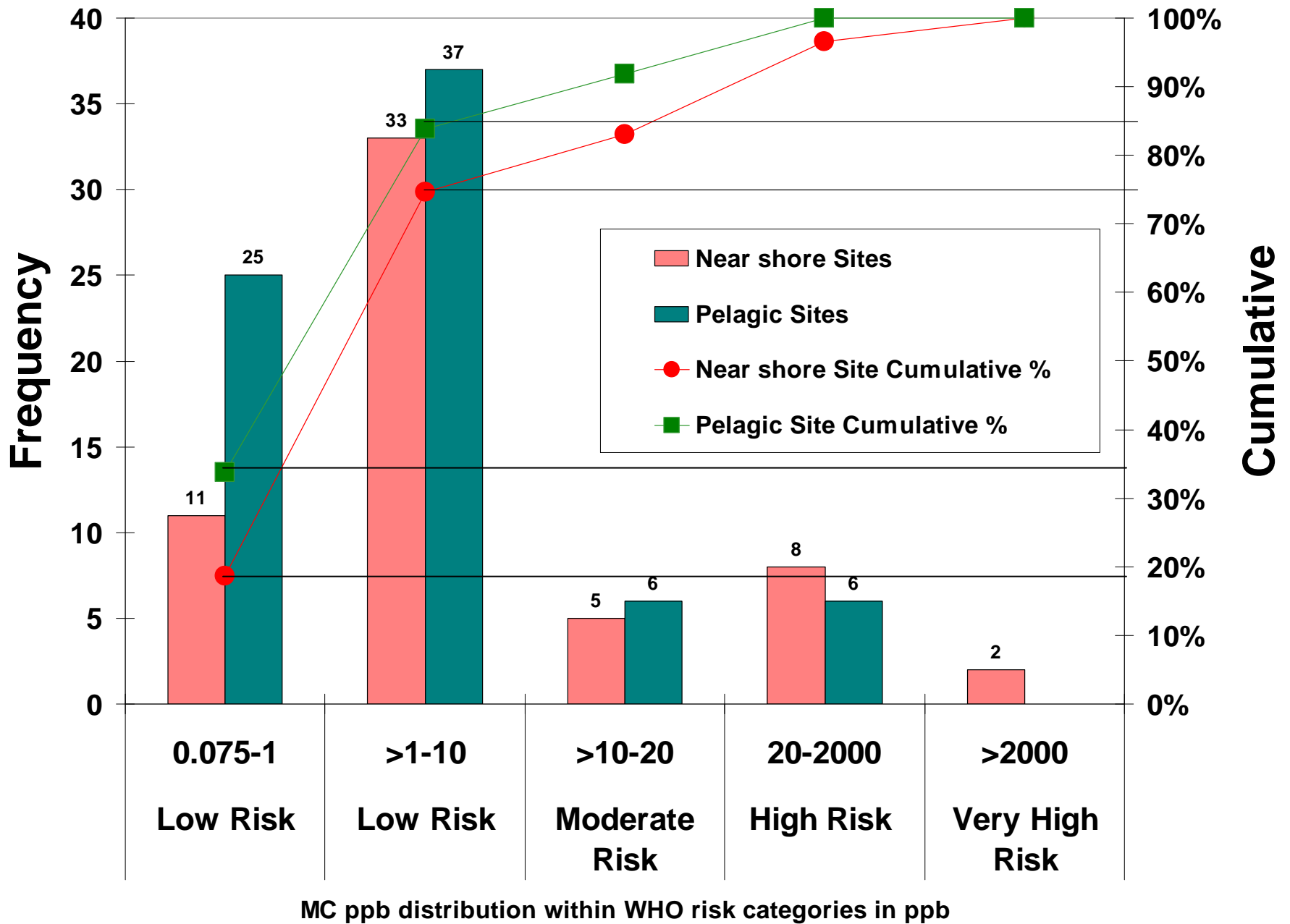
- Surface grab samples were taken monthly
- MC samples underwent triple freezing, cell lysis procedure.
- MC analysis was done at MDH
  - ELISA (Enzyme-Linked ImmunoSorbent assay)
  - Method detection limit (MDL) 0.15 µg/L.
  - The analysis tests for total MC

# Standards or guidelines

- *No MN standards*
- World Health Organization (WHO) Risk Categories (*used as reference in our study*)
  - $<1 \mu\text{g/L}$  (ppb) very low (below drinking water guideline),
  - 1-10  $\mu\text{g/L}$  Low,
  - 10-20  $\mu\text{g/L}$  Moderate,
  - 20-2000  $\mu\text{g/L}$  High
  - $>2000 \mu\text{g/L}$  Very high

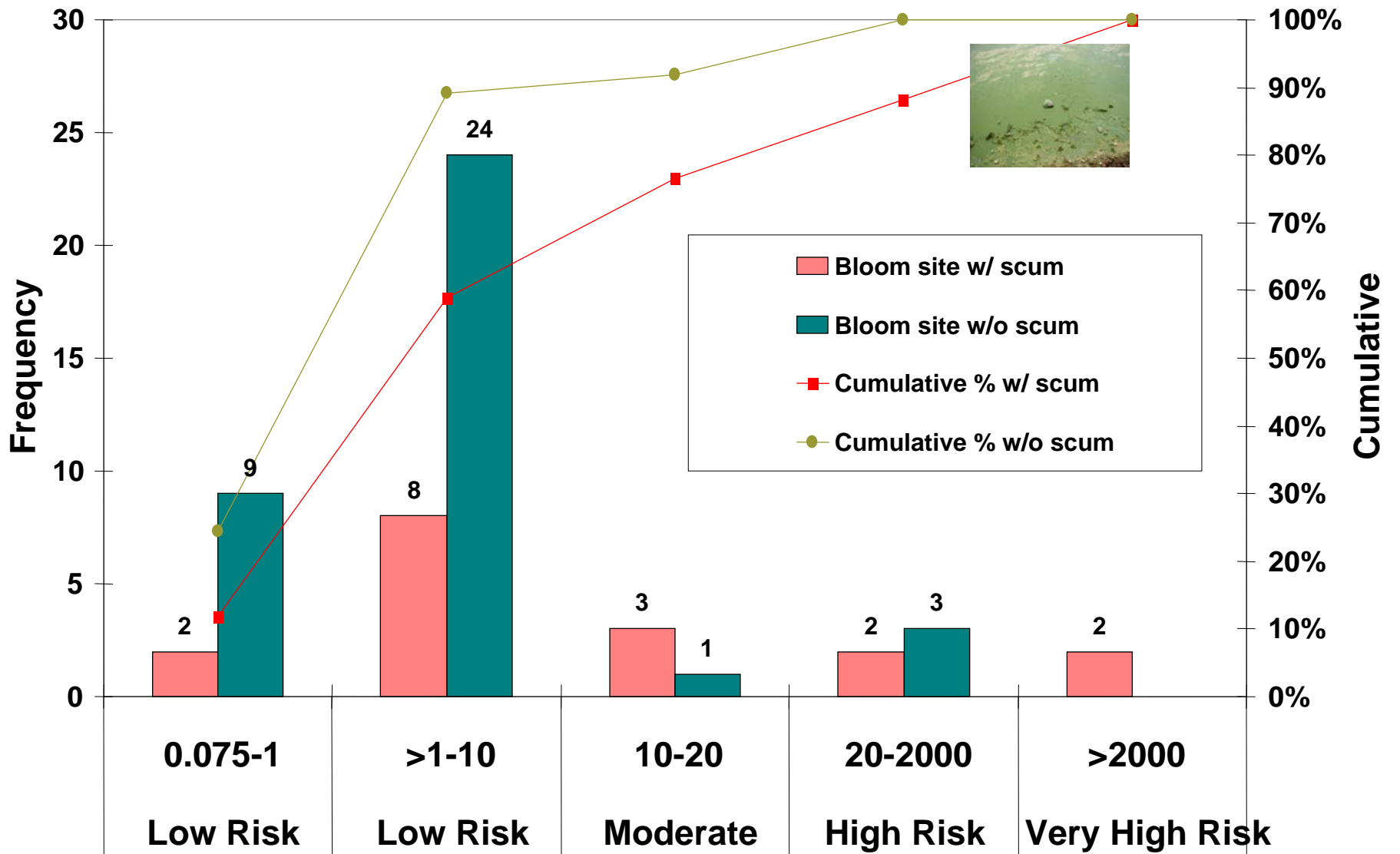
Guidelines for safe recreational water environments (WHO, 2003).

# MC Distribution by Site and Risk Category



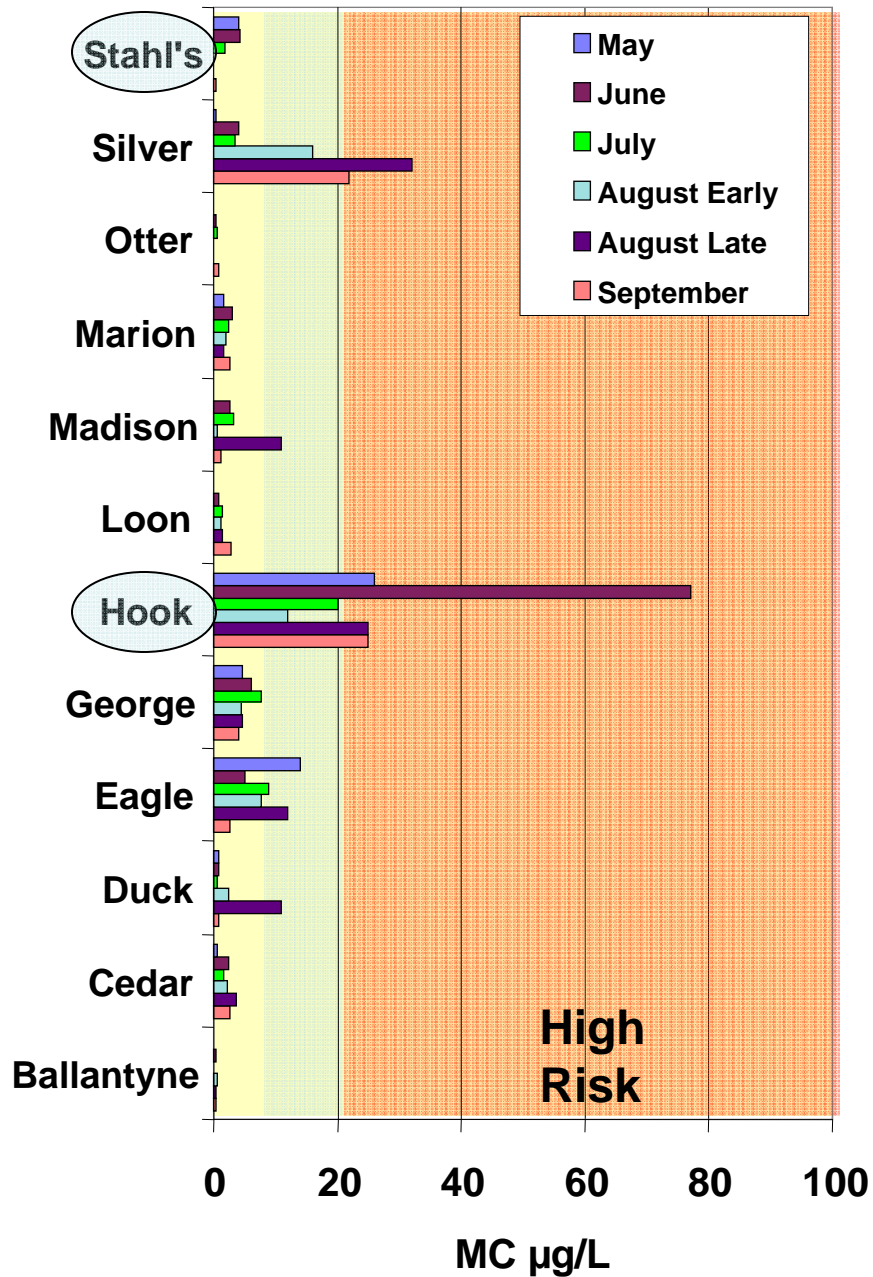


## Near-shore: Scum vs. no Scum



MC  $\mu\text{g/L}$  Range and WHO risk categories

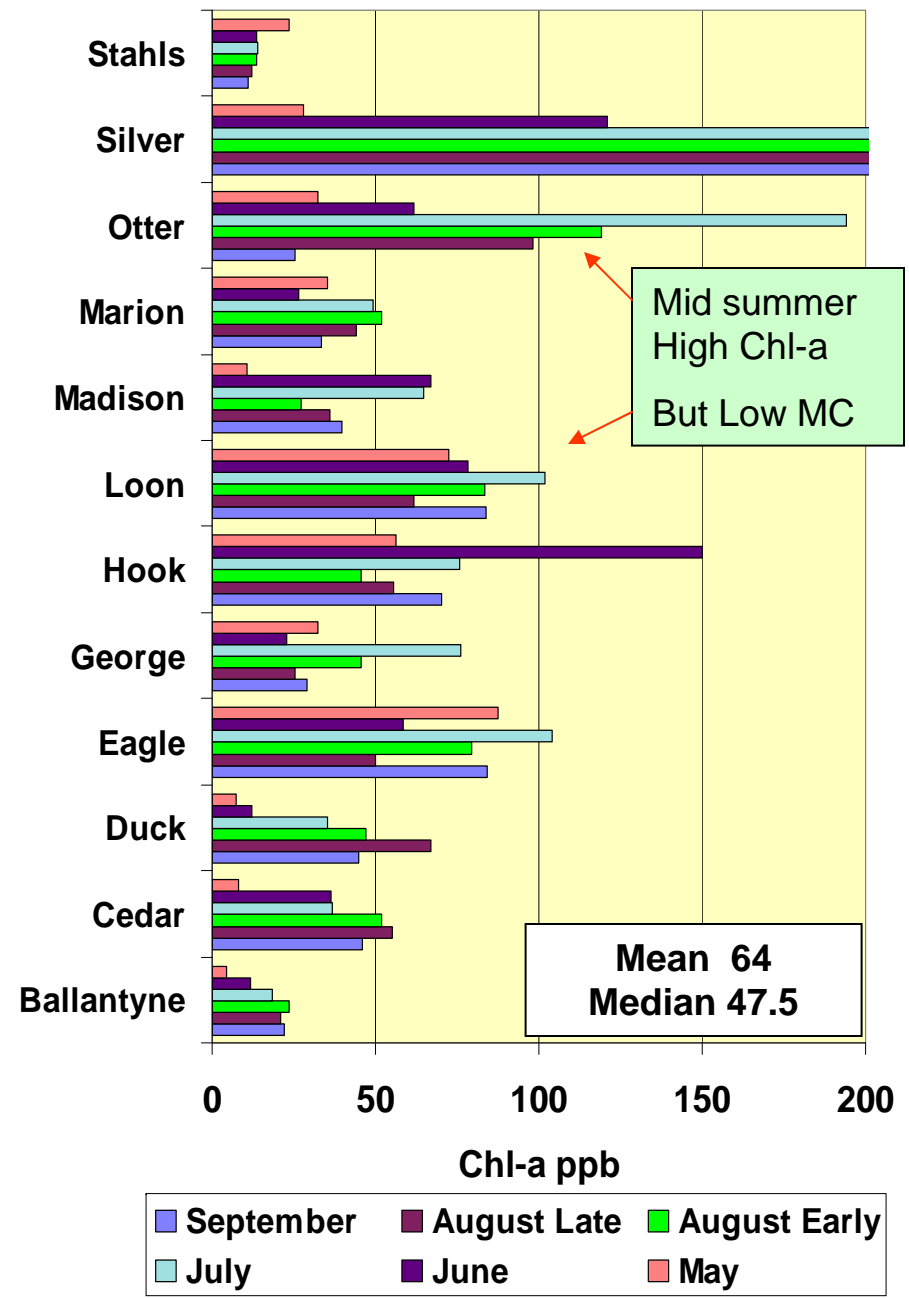
### Pelagic sites



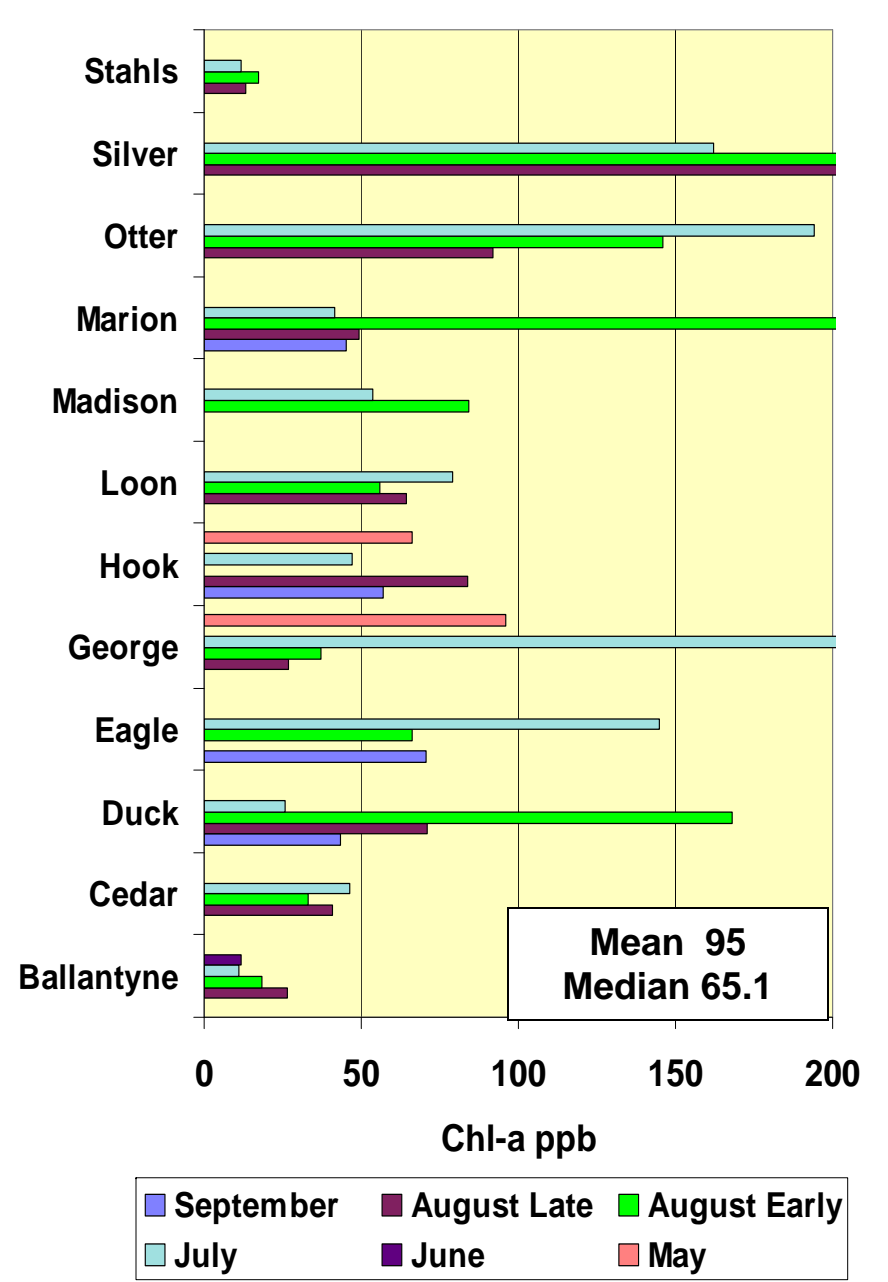
### Near Shore sites



## Pelagic Sites

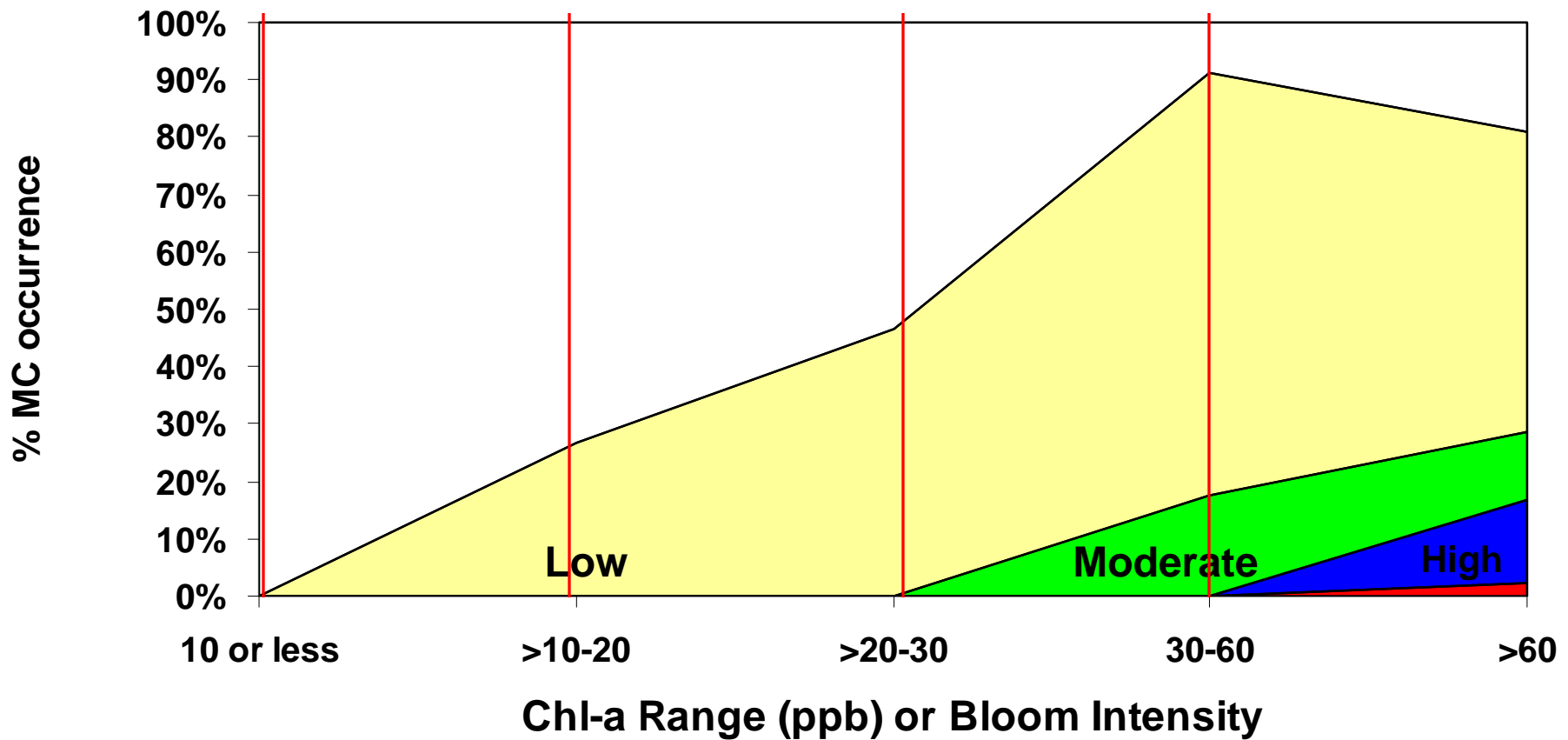


## Near Shore Sites



# Percent occurrence of MC risk levels relative to algal bloom intensity

MC versus bloom intensity. Based on 109 pairs of MC & chl-a data

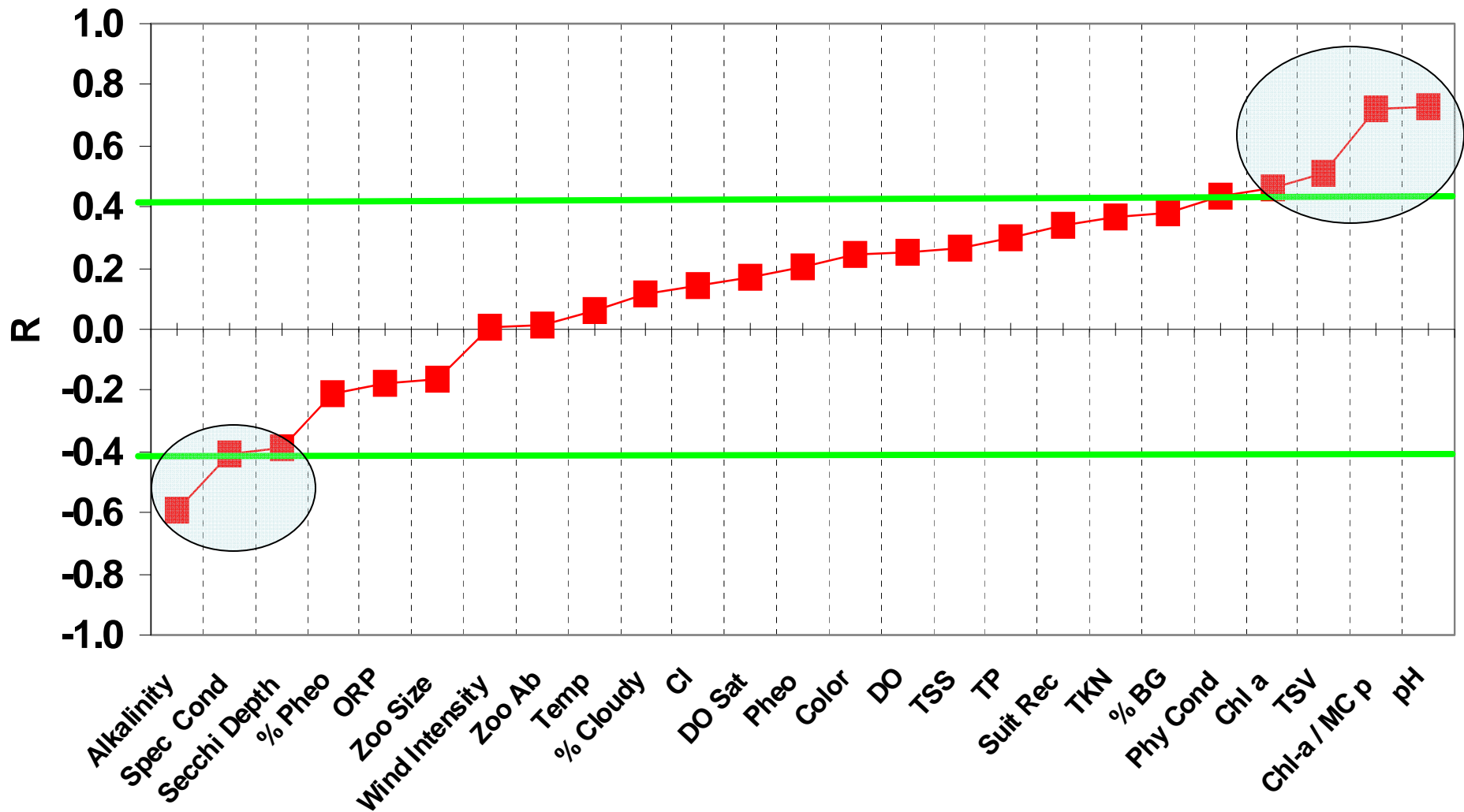


**>2000**   **>20-2000**   **>10-20**   **>1-10**   **.075-1**

# Spearman Rank Correlations for MC and Select Variables:

Sig. pos (+): pH, chl-a attributed to MC producers & chl-a/TSV

Sig. neg (-): alkalinity, conductivity, Secchi



# Conclusions from the 2006 Study

- Likelihood of encountering measurable MC at pelagic site?
  - 94% MC results were above mdl at all sites (n=79)
- How do they compare to WHO guideline levels?
  - 25% of the results were above the WHO low risk category
- Do MC conc. differ between near-shore and pelagic sites?
  - Significantly different distributions
  - 40 % of mid-lake were less than 1 µg/L vs. 23% of near-shore
  - Greater occurrence of high risk levels at near-shore
  - The likelihood of a moderate to high risk MC at a near-shore with a scum is 25%

# Continued

- Is there seasonality to MC levels in these lakes?
  - No distinct seasonal trend evident;
- As bloom intensity increases is there a greater likelihood of encountering high MC values?
  - Yes, as chl-a exceeded 30 µg/L (severe nuisance bloom levels) risk of high MC increased to ~ 15%; in contrast at lower bloom levels all MC was in the low risk category.
- What limnological factors appear to be associated with high MC?
  - + association with: pH, TSV and chl-a of MC producers
  - association with: alkalinity, Cond. and Secchi
- How can these findings be used to communicate risk to lake users?
  - Highest risk MC is most often associated with severe nuisance blooms that result in low transparency (0.5 m or less), high pH (9.0 or more), and that occur most frequently in downwind near shore areas;

## Algal Toxin studies: 2007

- NLAP study with mid-lake & near-shore MC measures for 50 lakes;
- 35 lakes in SW MN included Saxitoxin as well as MC;
- Responding to reports of severe blue-green blooms, dog deaths and related concerns – as early as June;



# NLAP Methods

## Collection



index site for EPA & MPCA



random near-shore site

## Analysis



Cells were lysed



Analyzed with ELISA for total MC



MDH Lab for PCA



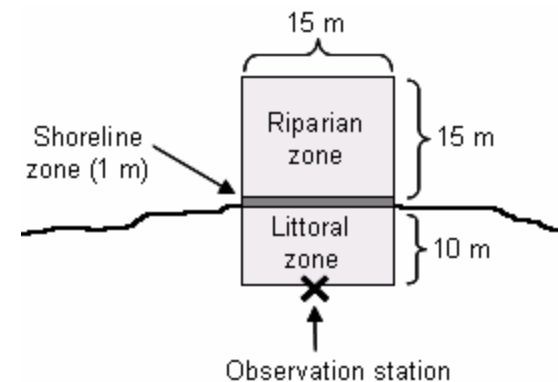
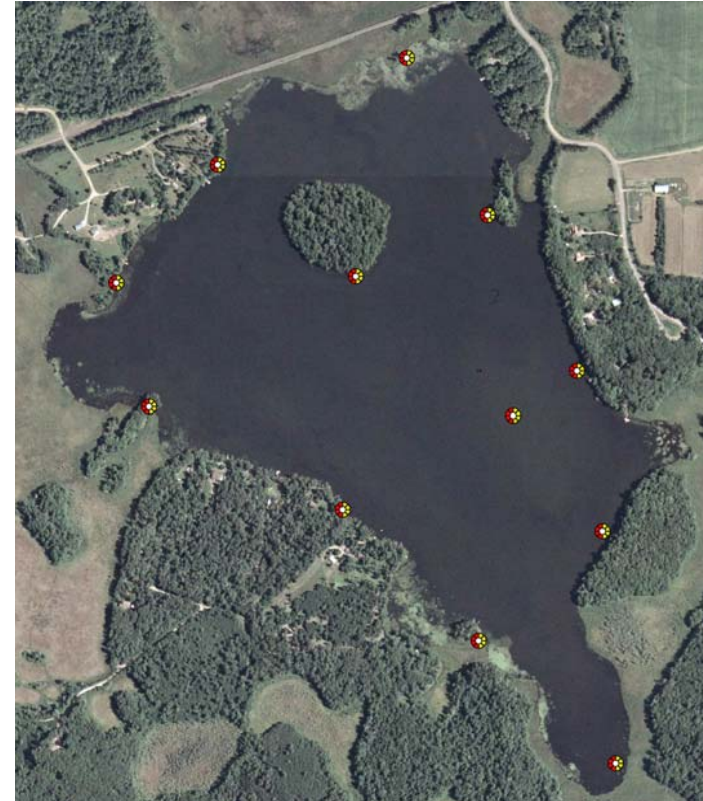
USGS Lawrence KS for EPA samples



10 of EPA samples will be scanned

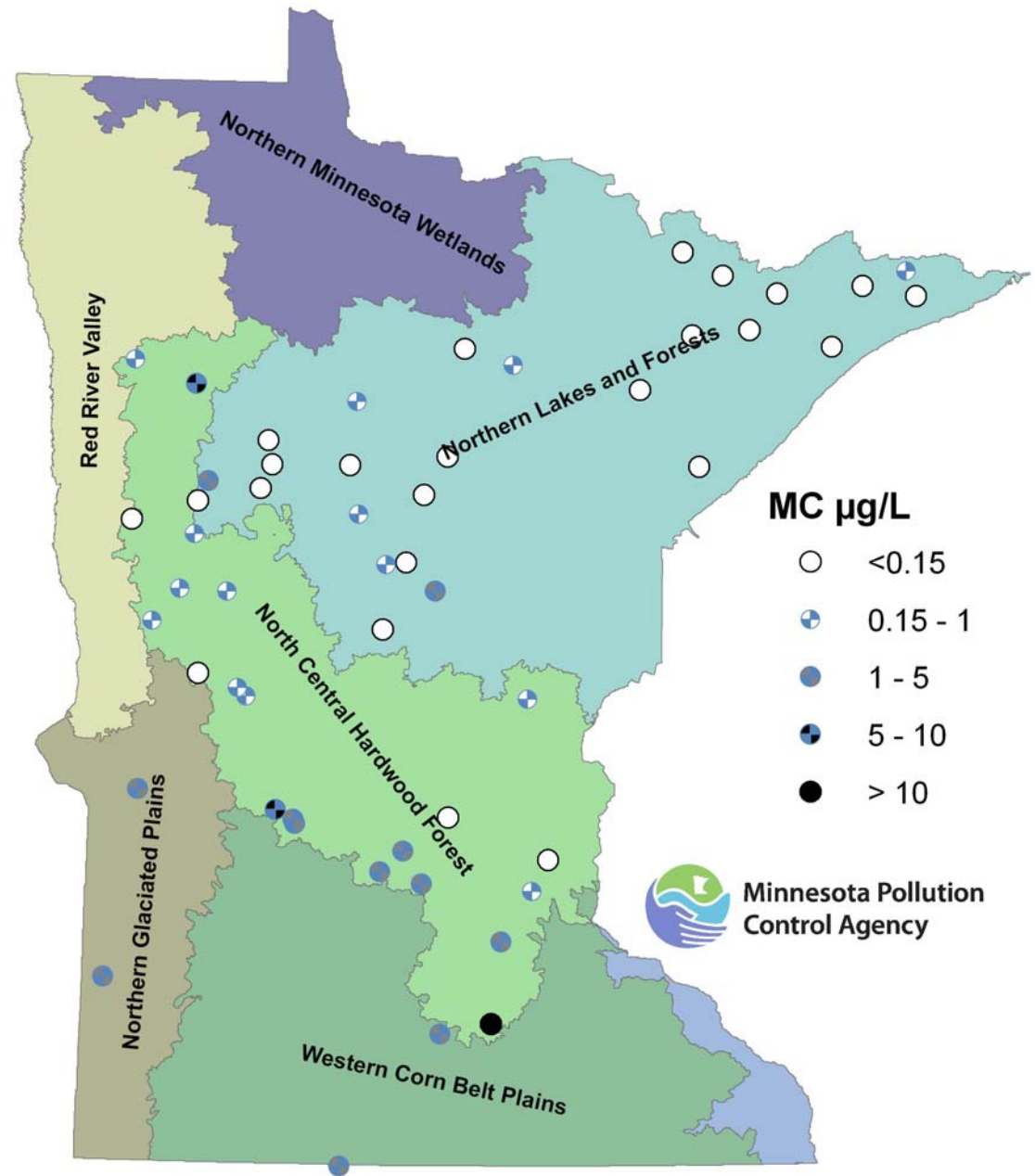


MDL 0.15  $\mu\text{g/L}$ .

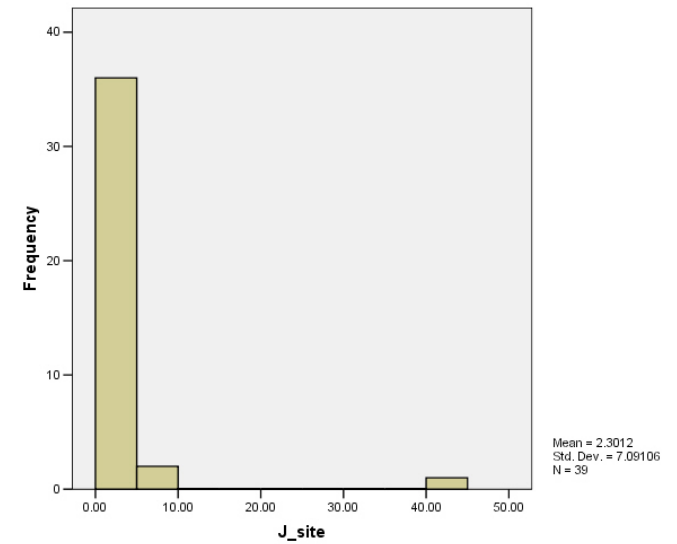
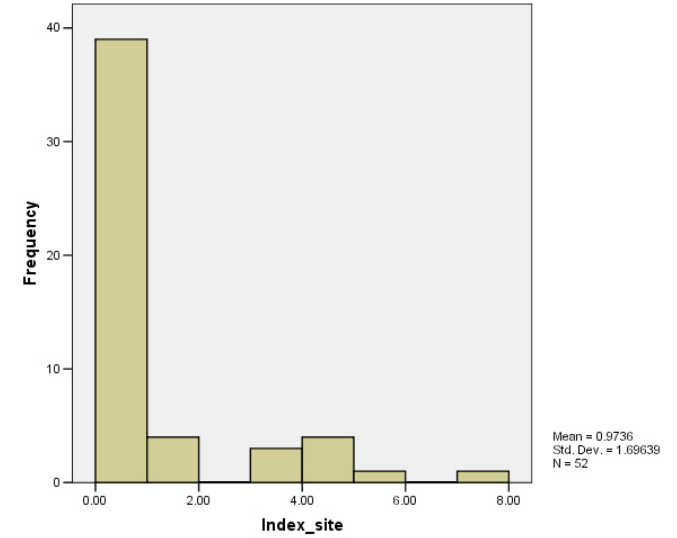
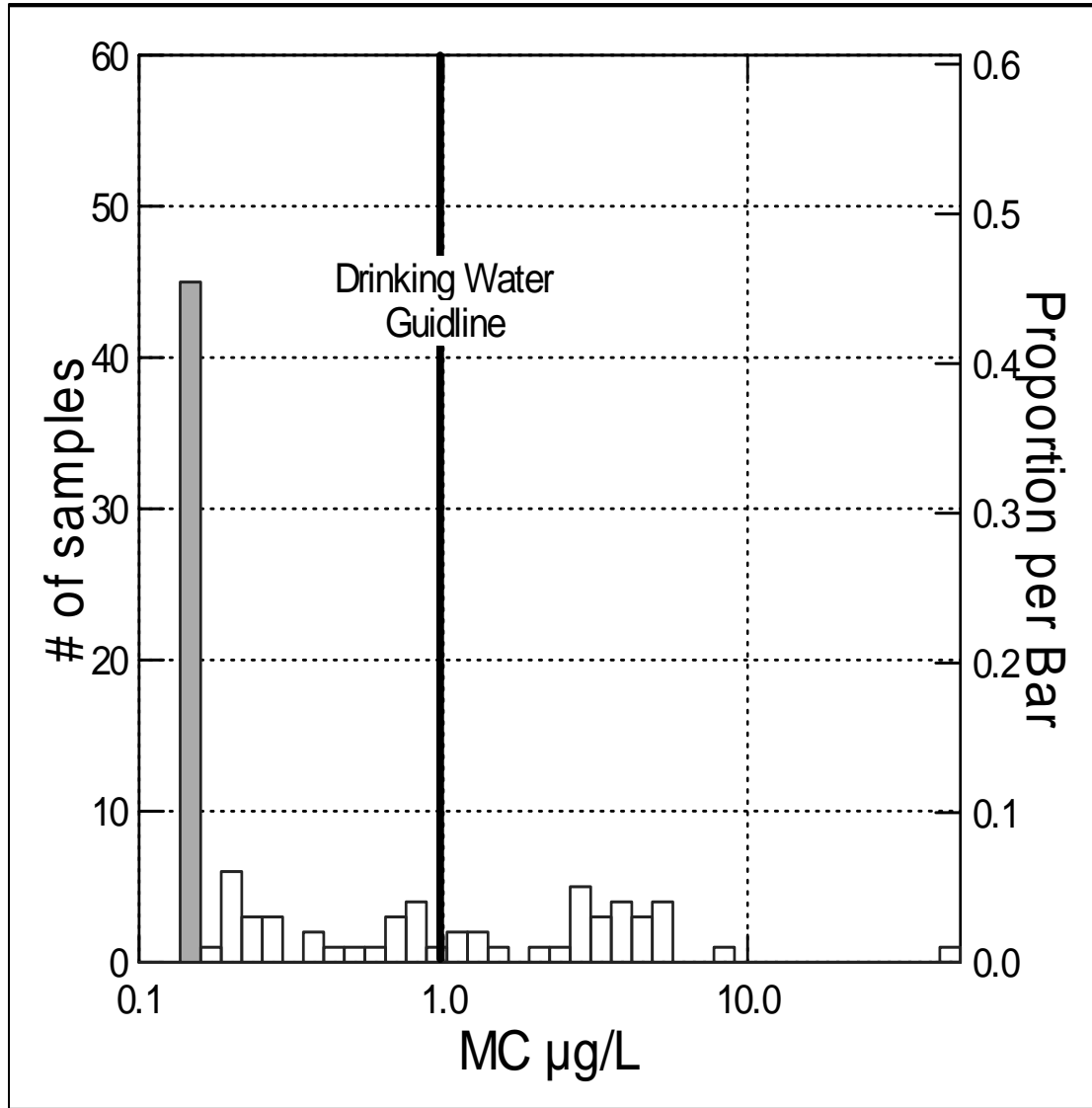


# NLAP: Geographic Distribution of MC

Highest MC concentration:  
Upper Sakatah 44 ug/L



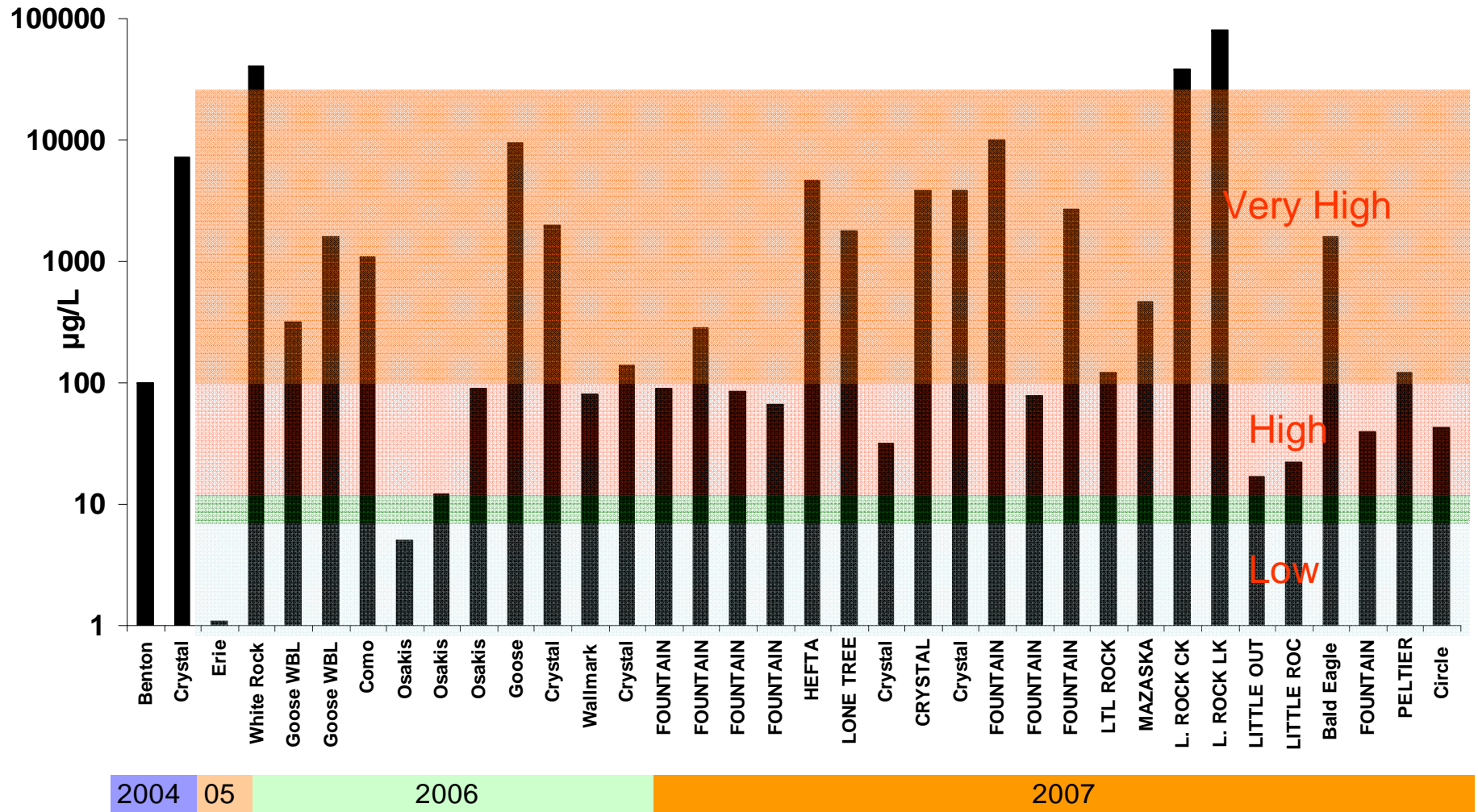
# NLAP MC distributions for mid-lake & near-shore



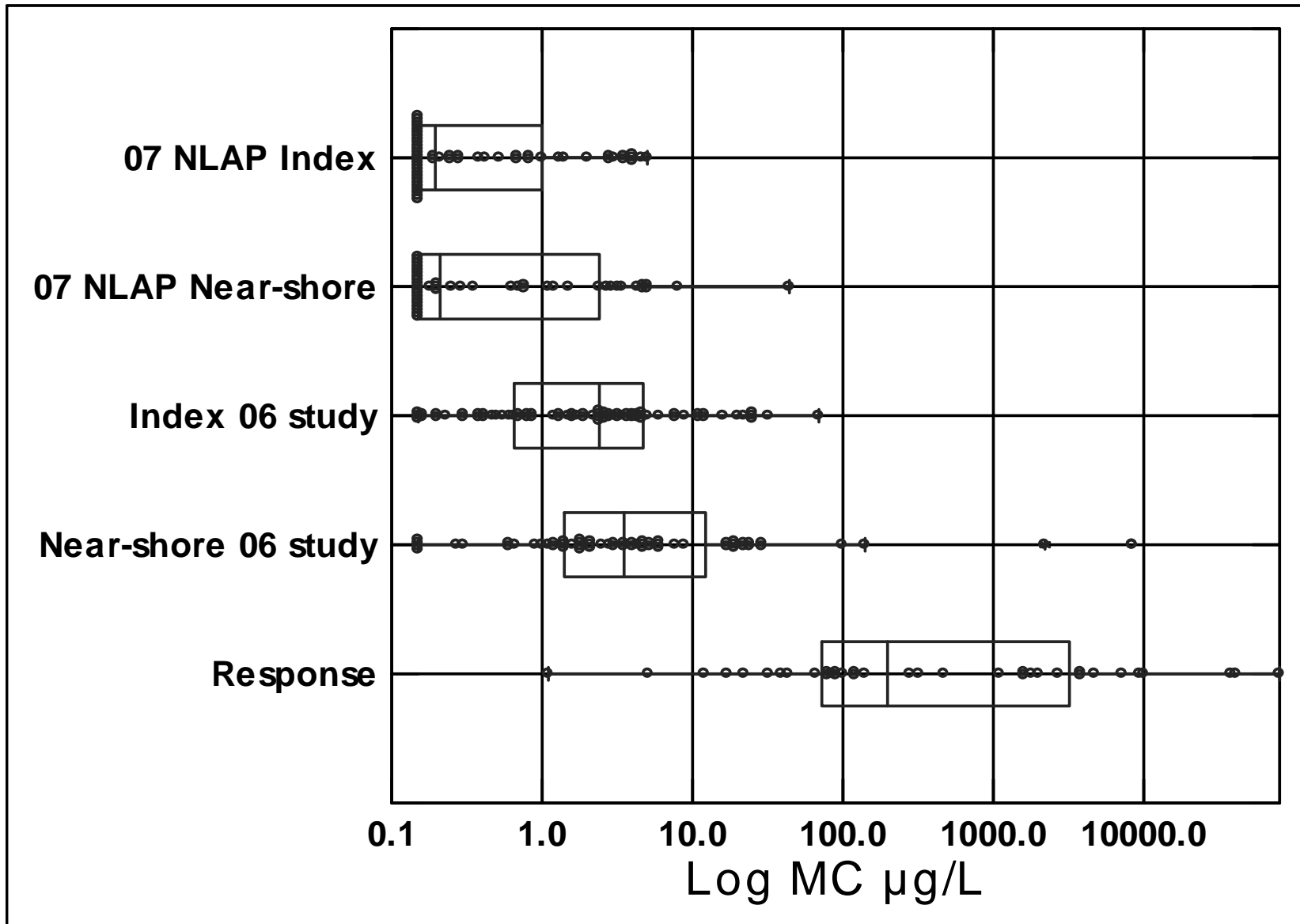
# NLAP MC Study Conclusions

- Stratified random MC results were lower than previous targeted studies (MC max 44 ppb)
- Somewhat of a geographic trend in MC distribution
- Index and Nearshore results were similar (when lakes and sites are selected randomly);

# Responding to Public Concerns



# Comparison of MC concentrations from: NLAP study, 2006 south-central MN lakes, & response –based monitoring.



# Summary

- **2006 study supplied useful information relative to the range, seasonality and association of MC and other factors in eutrophic MN lakes.**  
<http://www.pca.state.mn.us/water/lake.html>
- **2007 stratified-random study exhibited lower MC (relative to other studies); however it demonstrated that MC is present at measurable concentrations in a wide range of lakes in MN; (posted at:**  
<http://www.pca.state.mn.us/water/nlap.html> )
- **Incident response sampling often results in high MC levels;**
- **Based on these studies - Current recommendation to avoid contact with blue-green algal blooms is sound; further, blooms that yield very low transparency (< 0.5 m), high pH (>9.0), and distinct surface scums are highly likely to have high MC concentrations.**