



Southeastern Lake Management  
Conference  
May 5, 2010

*Jef Morgan*



# MONITORING AND MITAGATING

## *Cyanobacteria*

# Monitoring for Cyanobacteria



## **Positive**

- Cell Count & ID
- Cyanotoxins
- Phycocyanin  
Fluorescence

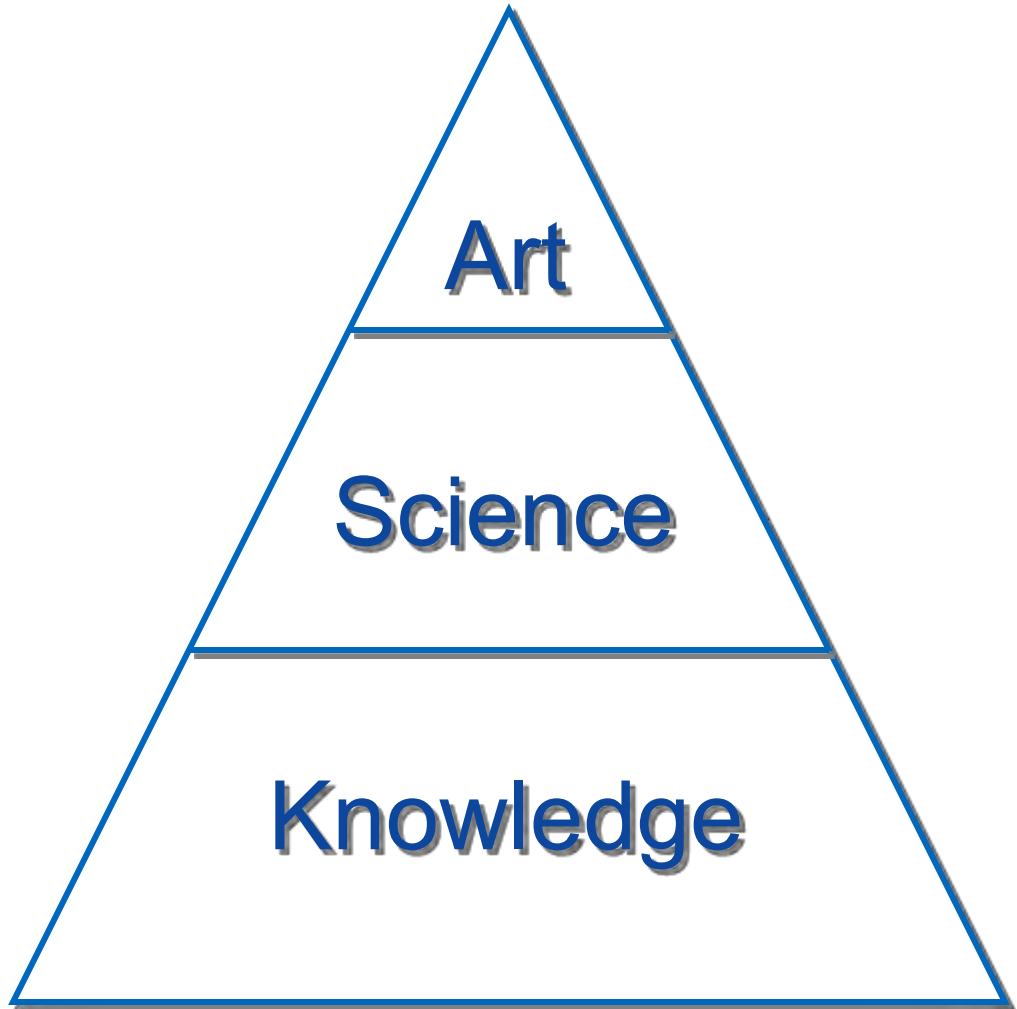
## **Indicator**

- Visual
- Total P
- pH
- Chlorophyll *a*
- Geosmin / MIB

# Monitoring Technology



- RTRM - Real Time Remote Monitoring
- FlowCAM - Flow Cytometry
- PCR - Polymerase Chain Reaction
- DNA Microarray Technology
- Aircraft and Satellite Imaging



**Art**

**Science**

**Knowledge**



- Knowledge and Science are fundamental
- People make the difference



# Introduction



- Cyanobacteria Ecology
- Dynamics of Bloom Formation
- Cyanobacteria Toxins
- City of Benicia, CA Algaecide Study

# Cyanobacteria: The Ecology



- **Prokaryotes: bacteria and cyanobacteria**

Microscopic, Membranous cell wall, No membrane-bound nuclei,  
Chlorophyll *a*, Nitrogen fixers, Buoyancy, Akinetes

- **Eukaryotes: true algae and vascular plants**

Macroscopic, True cell wall, Membrane-bound nuclei,  
Chlorophyll *a*, Non-nitrogen fixers, No buoyancy, Seeds and  
tubers

# Cyanobacteria: Undesirable



- “Pea soup” blooms look bad
- Poor base for aquatic food chain
- Relatively poor oxygenators
- Produce undesirable tastes and odors
- Produce toxins

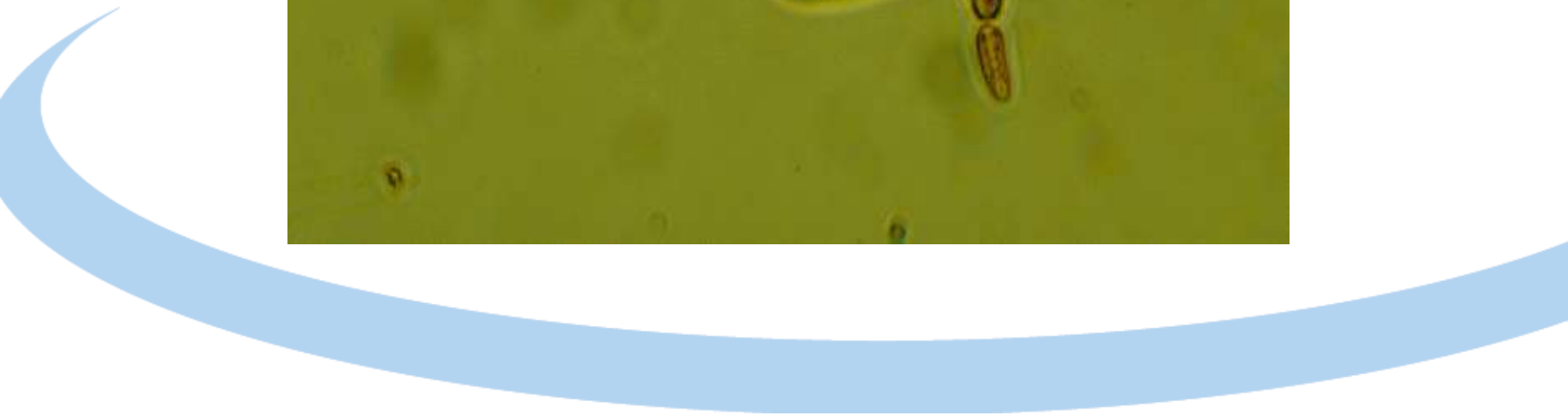
# Anabaena



# Aphanizomenon



# Cylindrospermopsis



# Microcystis



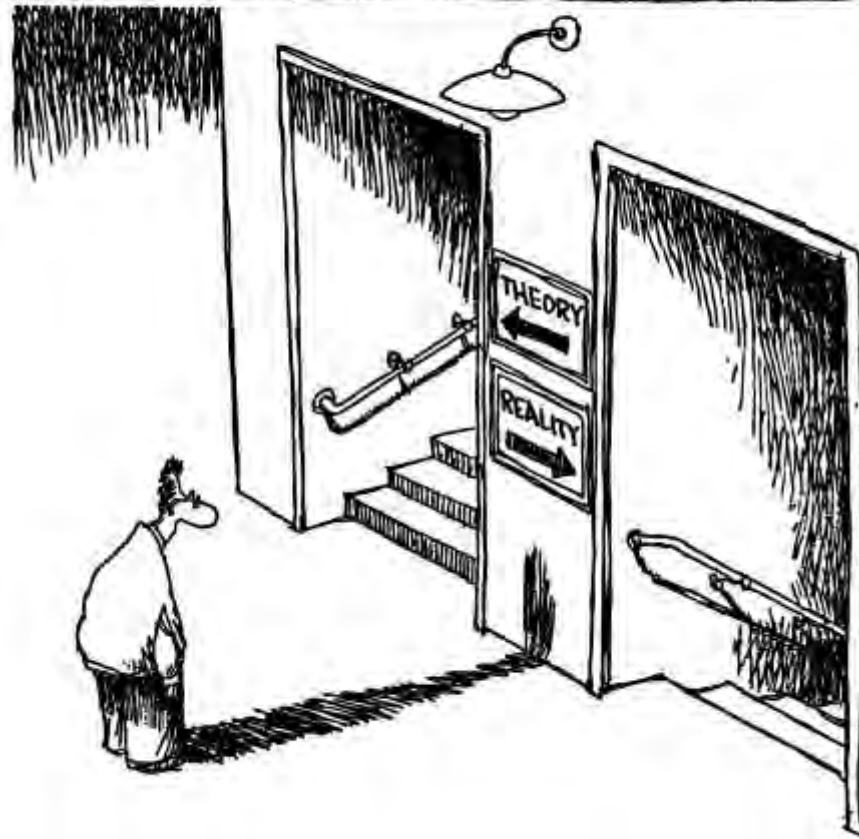
# Cyanobacteria Blooms



- High nutrient load
- Warm water temperature
- Stable water column
- High light intensity



ENVIRONMENTAL MANAGEMENT CAN'T  
WAIT FOR SCIENTIFIC CERTAINTY



VILEY 04



# Secchi Disc



# St Johns River Bloom





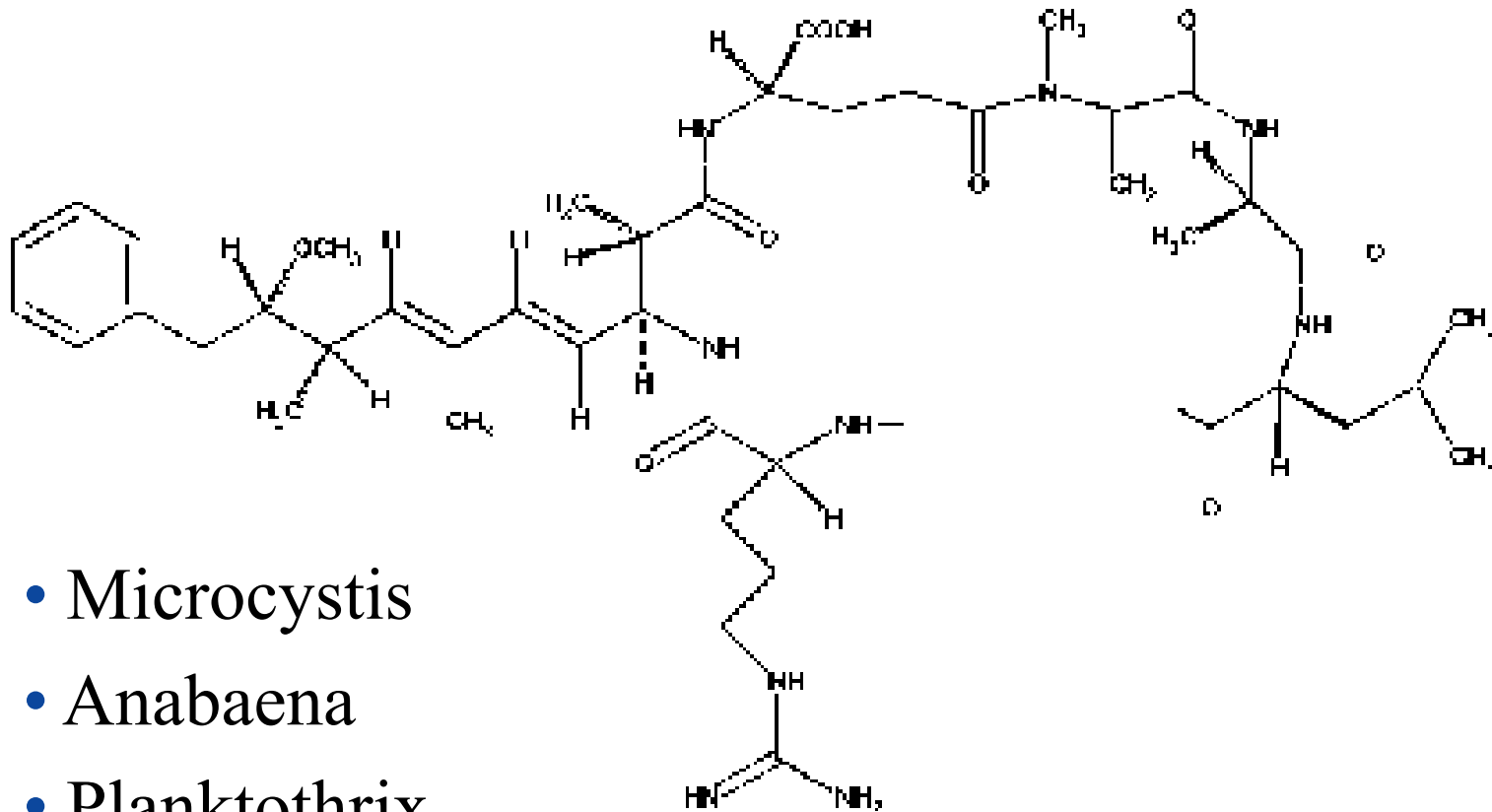
# Cyanobacteria Toxins



- Neurotoxins
- Hepatotoxins
- Other: Respiratory, Dermatological

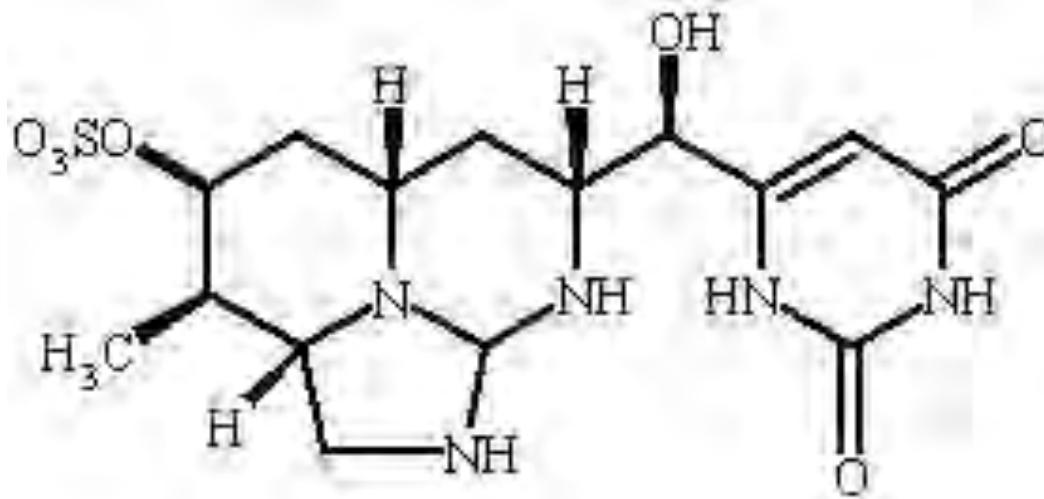


# Microcystin LR



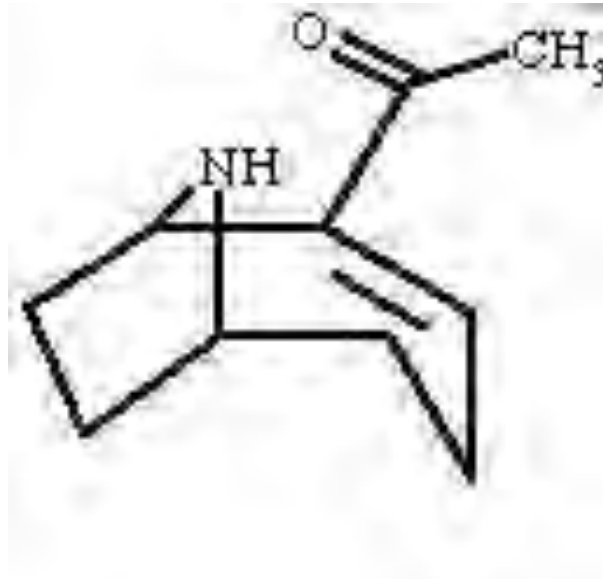
- Microcystis
- Anabaena
- Planktothrix

# Cylindrospermopsin



- Cylindrospermopsis
- Aphanizomenon

# Anatoxin A



- Anabaena
- Aphanizomenon
- Planktothrix



# PAK™27

*An Environmentally Safe Algaecide*



# PAK™ 27 Registrations



- EPA Registration No. 68660-9
- NSF Certified
- California License No. 34816

# PAK™ 27



- Properties
- Efficacy
- Environmental Assessment
- Conclusions



# PAK™27 Properties



- White, granular, free flowing
- Active ingredient: hydrogen peroxide ( $\text{H}_2\text{O}_2$ )
- Inert Ingredient: Soda ash (support for  $\text{H}_2\text{O}_2$ )

# PAK™27 Chemistry



- On dissolution, it releases the individual components



- Degradation leads to water and oxygen



# PAK™27 Efficacy



- Selective algaecide against cyanobacteria at low doses

PAK™27 dose (lb/ac-ft)	Equivalent Hydrogen Peroxide Concentration in Reservoir (ppm)
2.5	0.3
6.5	0.7
14.5	1.5

- Can be used as algaestat to prevent cyanobacteria growth

# Application of PAK™27



- Effective dosing rate dependent on:
  - Species
  - Stage of Algae Growth
  - Density of Algae
  - Light Intensity
  - Water Temperature
  - Water Quality
    - Metals Concentration
    - Turbidity
    - Organic Content

# Application of PAK™27

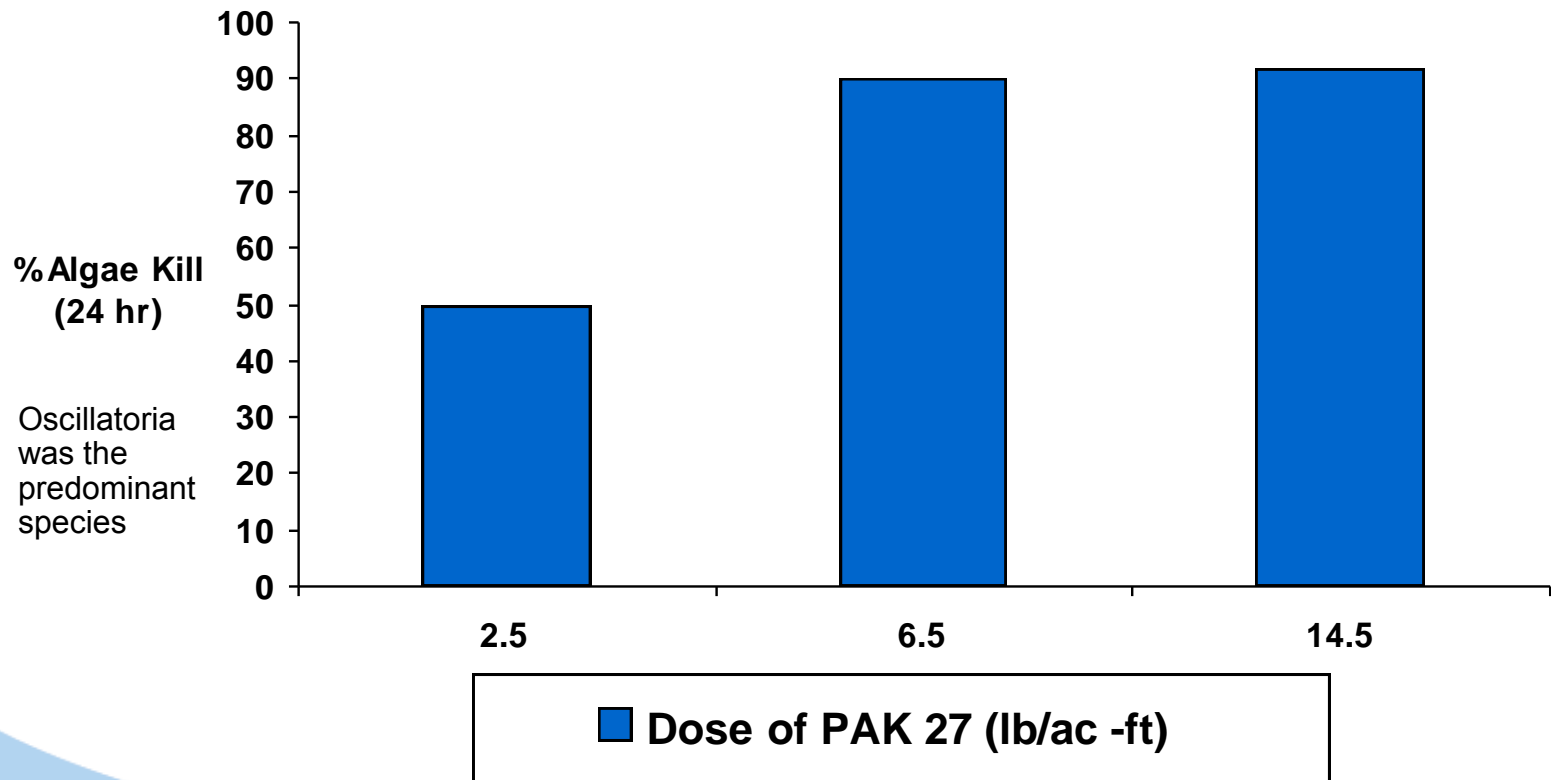


- Dosing Considerations
  - Decaying cyanobacteria creates biological oxygen demand (BOD) which can deplete dissolved oxygen levels. Excessive DO depletion can lead to fish kill.
  - Apply PAK™27 early enough so that 8-10 hours of sunlight remain. Do not reapply within 48 hours.
  - Large lakes, heavy blooms should be treated in stages, allowing 2-3 days between applications.

# PAK™27 Efficacy

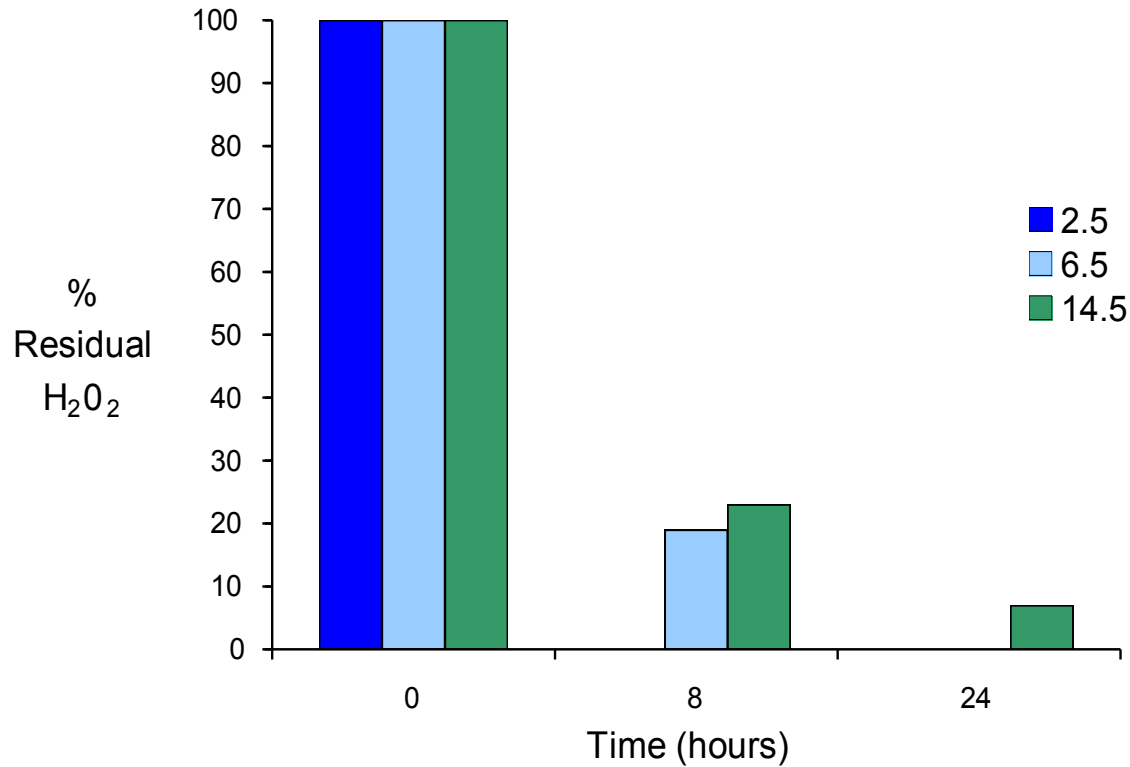


## Bill Evers Reservoir



# Environmental Assessment

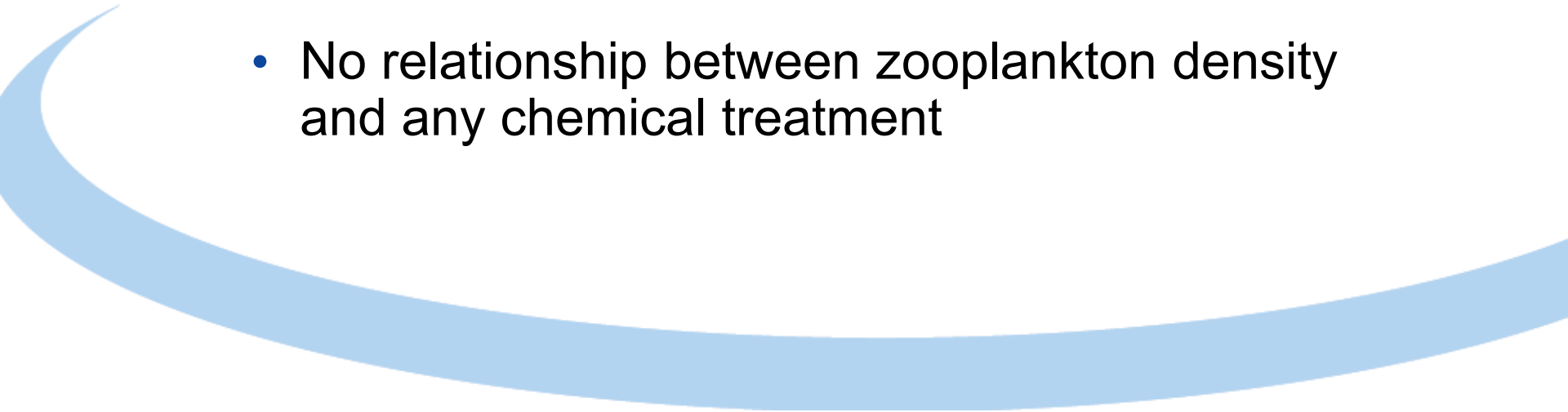
- Environmental Fate of PAK™27



# Environmental Assessment

- Effect of PAK™ 27 on Zooplankton


A statistical analysis of the zooplankton population of the Bill Evers Reservoir was performed.

- Species and density vary throughout the year.
  - No relationship between zooplankton density and any chemical treatment
- 

# Environmental Assessment

- Effect of PAK™27 on Higher Organisms

Several studies revealed no significant effect of H<sub>2</sub>O<sub>2</sub> on vascular plants or fish at the doses recommended

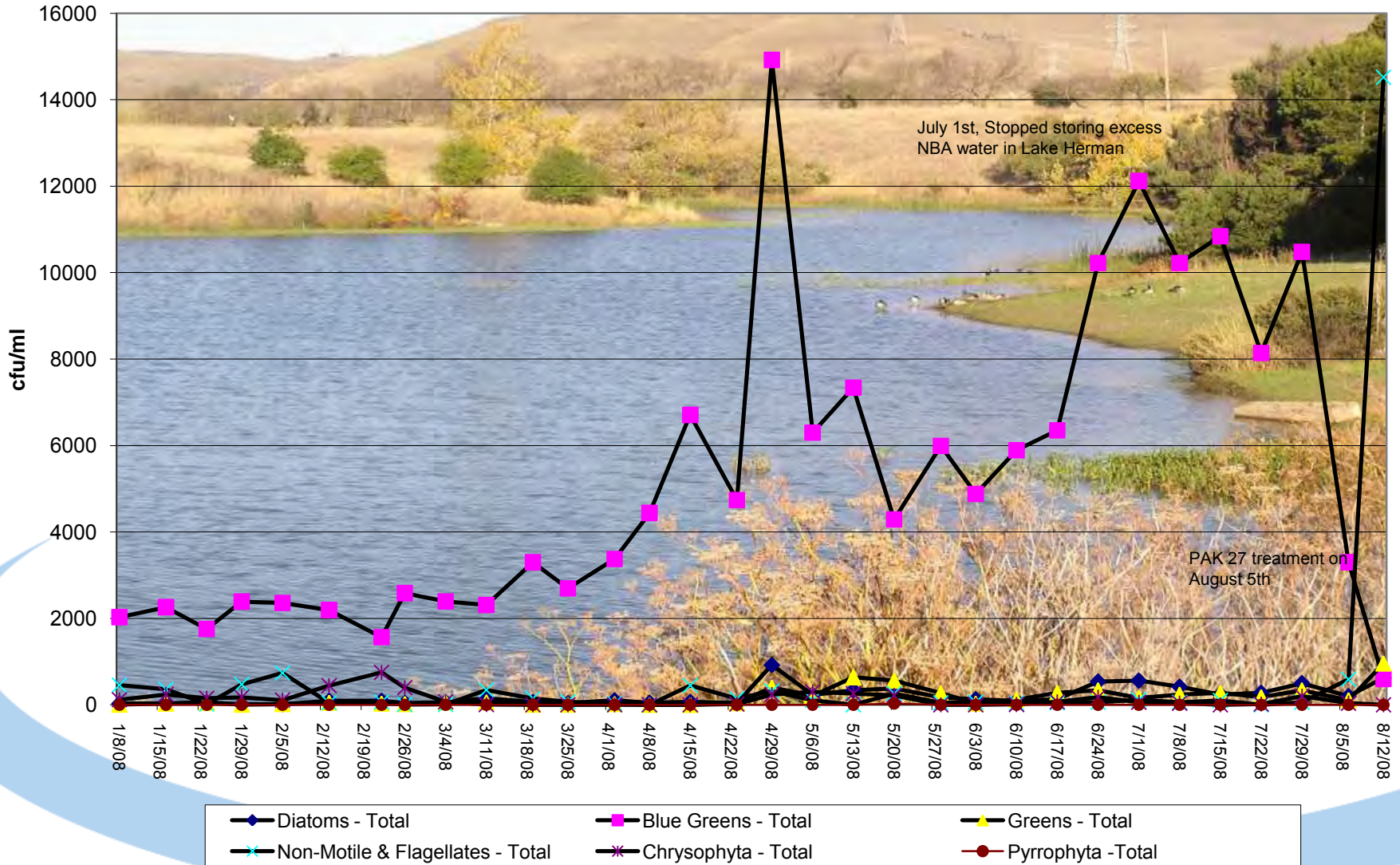
- Fish, Pimephales promelas, LC<sub>50</sub> (mg/L) 70.7
  - Crustaceans, Daphnia pulex, EC<sub>50</sub> (mg/L) 4.9
- 



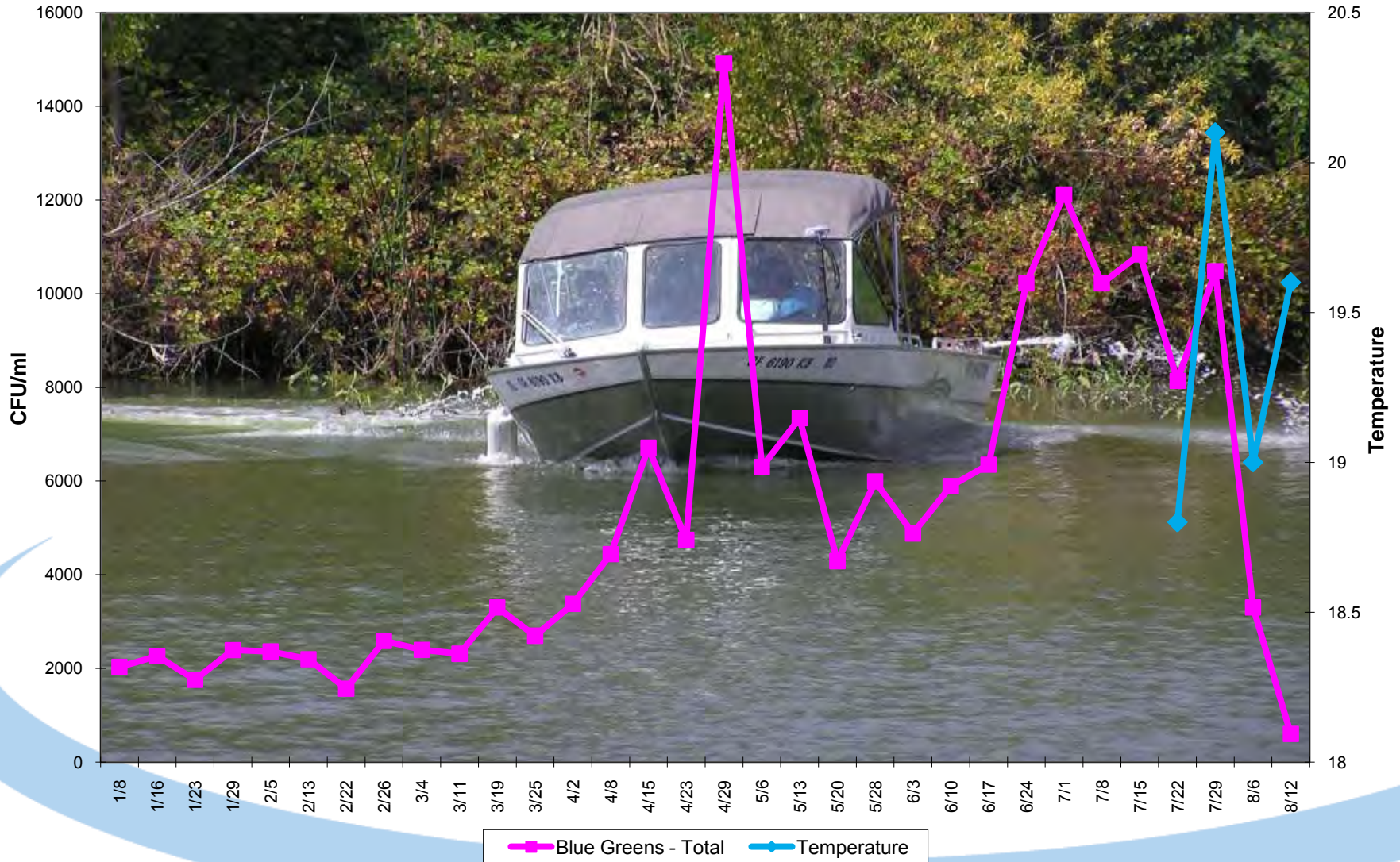
# City of Benicia, CA



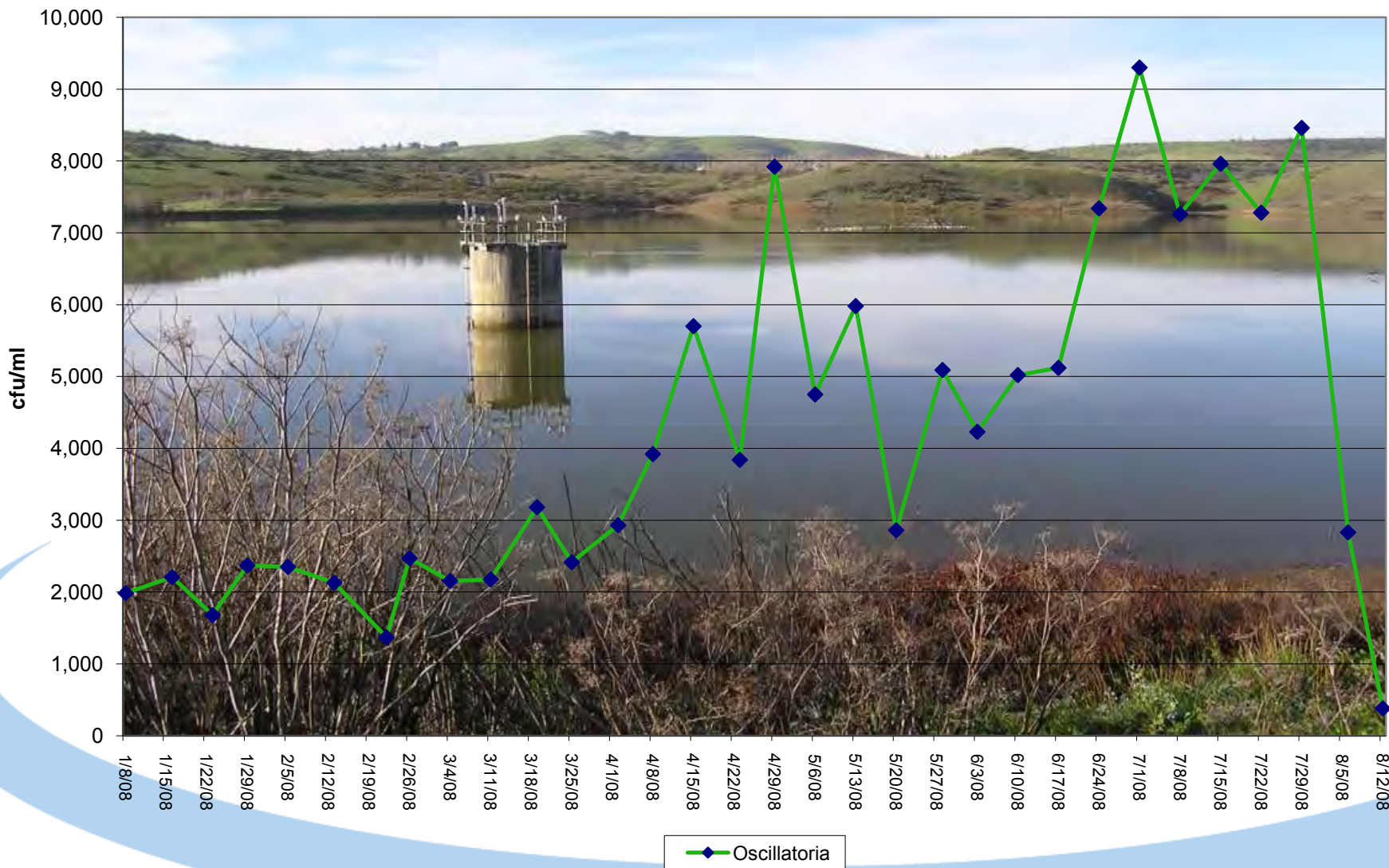
# Lake Herman Pytoplankton Data



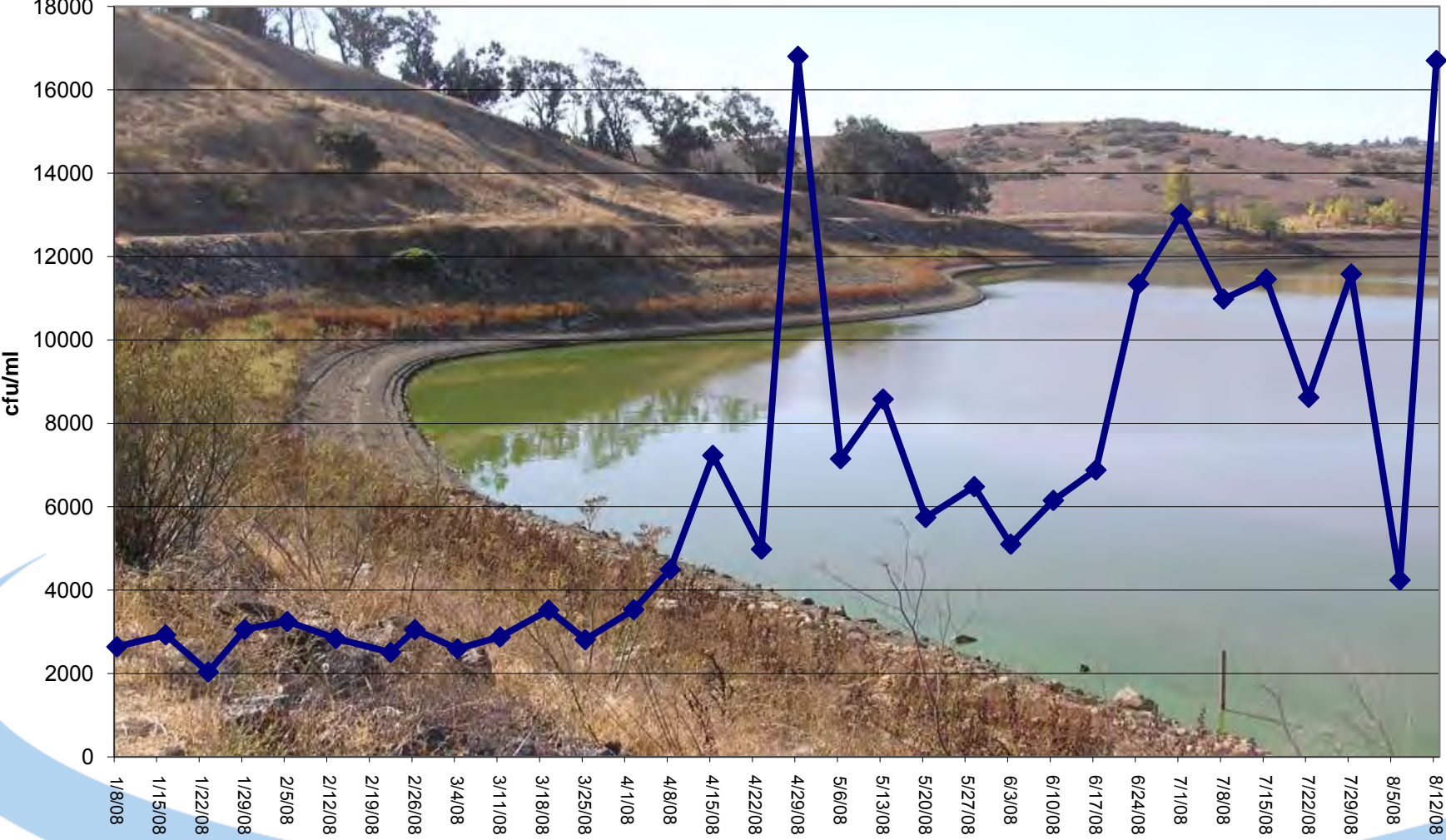
# Blue Greens and Temp



# Oscillatoria



# Phyto Count - Total



Phyto Count - Total

# Additional Benefits



- Effective at all reservoir pH's
- Could degrade cyanobacteria resistant to  $\text{CuSO}_4$
- Improvement in taste and odor characteristics
- Facilitates degradation of pollutants (unregistered product used in wastewater detoxification and bio-remediation applications)
- Long term use may alleviate problems associated with disposal of dredged material

# Conclusions



- Selective to cyanobacteria at the recommended doses
- Can be used as an algae-stat to prevent blooms
- Non-persistent, degrades quickly to innocuous materials - soda ash, oxygen, and water
- Has no significant negative effect on the ecosystem
- Non-bioaccumulative
- Increases DO levels in the water which results in additional benefits.







QuickTime™ and a  
displays. If you are  
are needed to see this picture.



# Acknowledgements



- Scott Rovanner, City of Benicia, CA
- Jay Kasheta, Clean Lakes, Inc.





# Questions ?

Peroxygen Solutions  
[www.peroxygensolutions.com](http://www.peroxygensolutions.com)

# Title Here

- New text here
- Bullet number two
- And a third bullet here
- And so on



**CA-NV AWWA**

*Jef Morgan*



# Application of PAK™27



- Dosing Considerations
  - At the recommended application rates, PAK™27 provides selective control of cyanobacteria.
  - If it is necessary to control green algae populations, copper compounds may be applied as part of a comprehensive treatment program which alternates treatment with PAK™27 and copper.
  - Copper treatments and PAK™27 treatments could be staggered to maximize the efficacy.

# A Systematic Approach

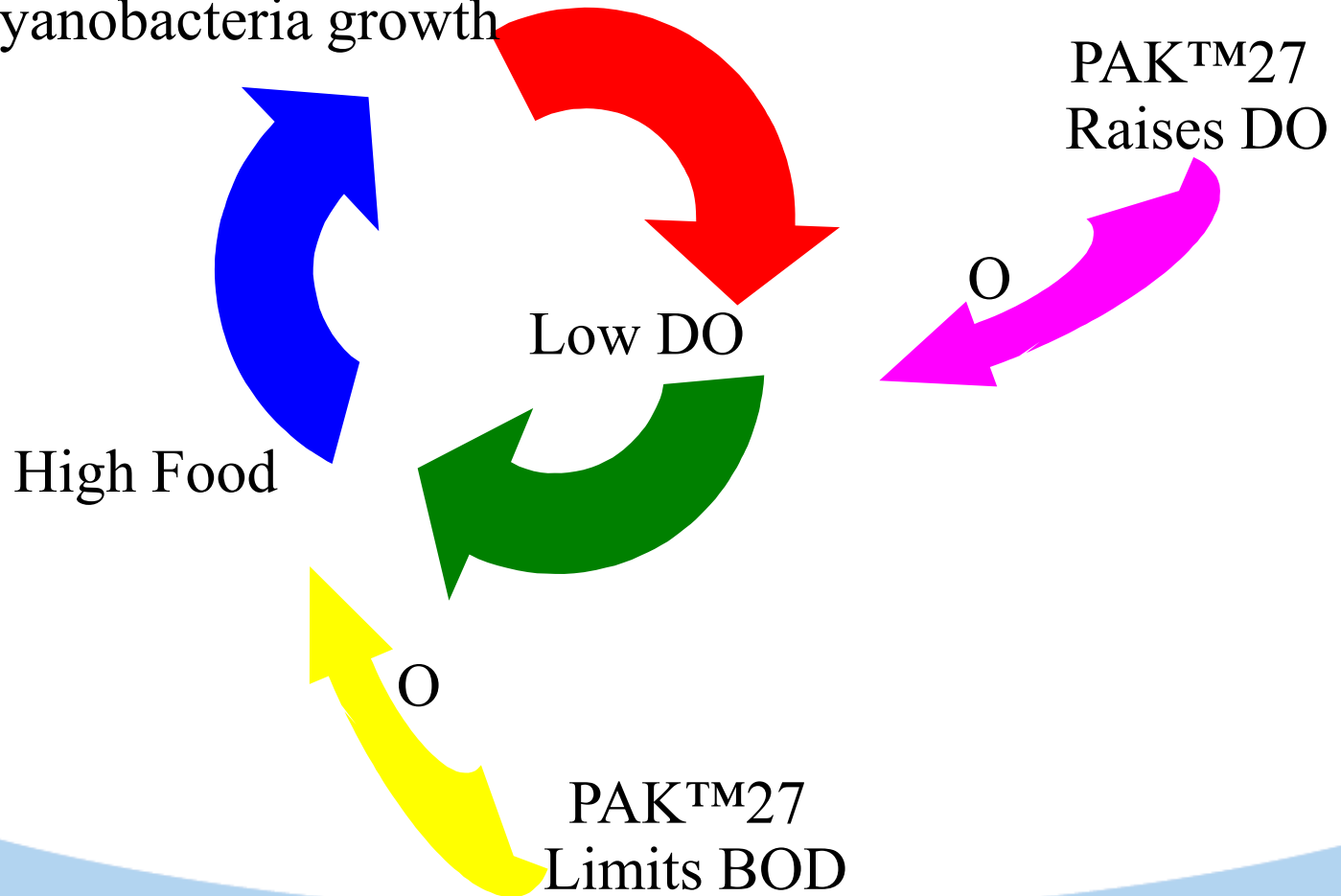


- Cyanobacteria are known to bloom in high nutrient, low dissolved oxygen conditions.
- PAK-27 is preferentially toxic to cyanobacteria via chemical reaction and by promotion of an oxygen rich environment.

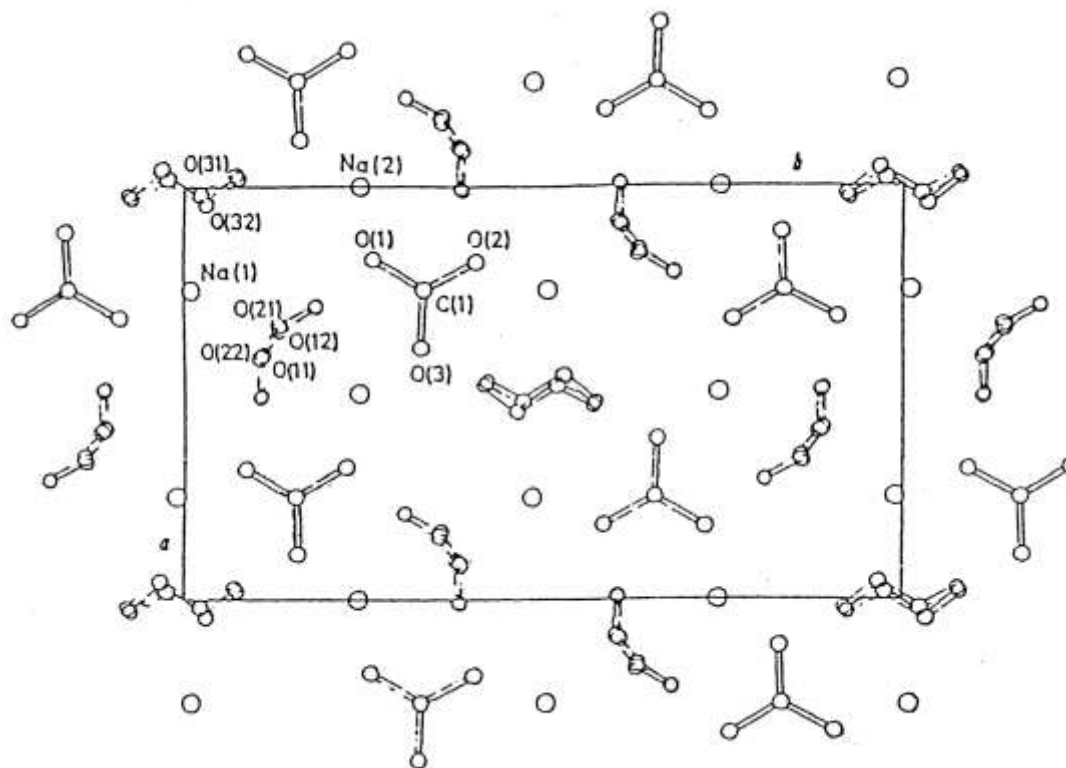
# A Simple System to Predict Cyanobacteria Growth



Cyanobacteria growth



# PAK™27 Crystal Structure



J.S.C. Dalton  
23, 2323 (1977)

$2\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}_2$  (~27.6%  $\text{H}_2\text{O}_2$ )

# Environmental Assessment

- Effect of PAK™ 27 on Green Algae

