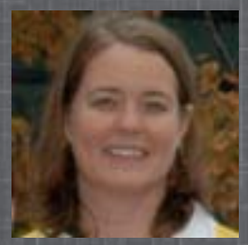
MMIC (Mitigating Microcystis in the Chesapeake)

Treatment Options For A Cyanotoxin Impacted Lake in Denton Maryland

Shannon Roche, Holly A. Bowers, Yonghui Gao, Ernest Williams, Kevin Sellner, and Allen R. Place



Algae bloom shuts down lake

By DANIEL DIVILIO Staff Writer | Posted Aug 3, 2011

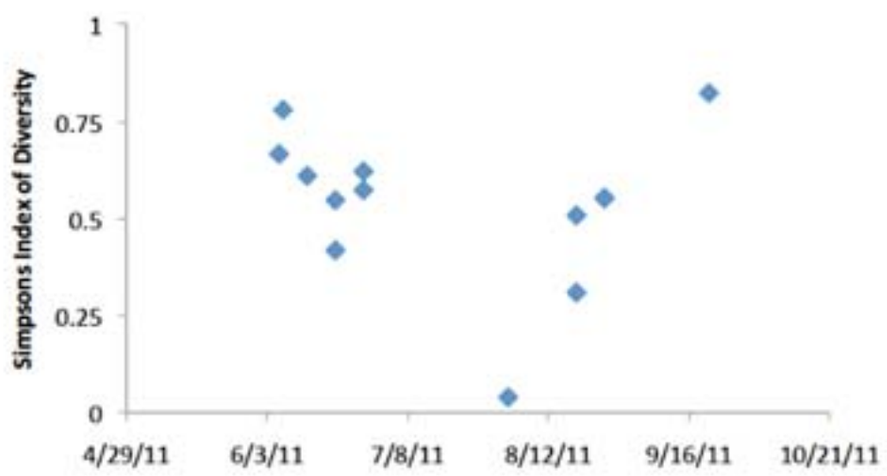
DENTON An algae bloom has shut down Lake Williston a private lake off state Route 16 near Denton and owned by the Girl Scouts for two summers in a row and officials are trying to find a way to rid the water of the toxic organisms.

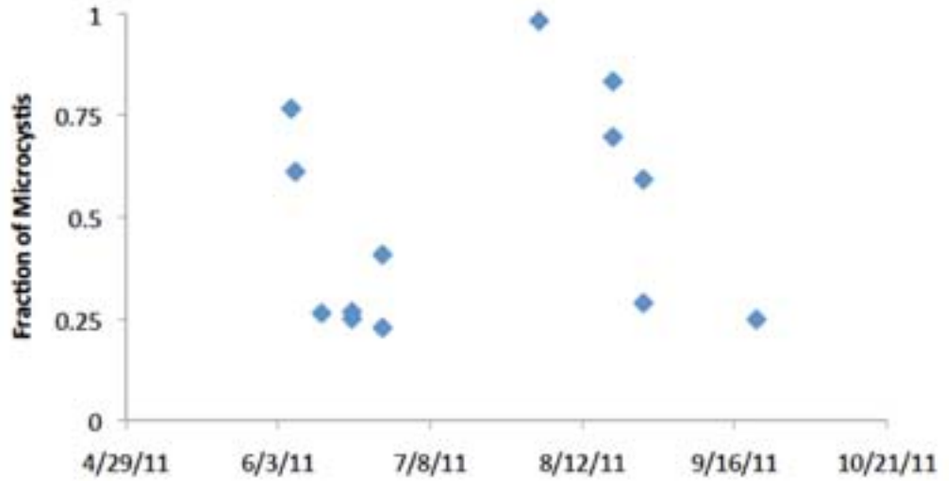
The Caroline County Health Department issued earlier this summer water contact advisories for Lake Williston, noting the presence of unhealthy levels of microcystis caused by the blue-green algae bloom. The lake, which covers about 60 acres and has an average depth of 8 feet, also closed late last summer due to the algae.

Health Department officials are warning people not to swim in or drink the lake water and to keep pets and livestock away from it as well. If contact is made with the water at Lake Williston, health department officials recommend cleaning off with fresh water and seeing a health care professional if any skin irritation occurs.

"It's a pretty serious problem," said Bob Foote, property manager for the Girl Scouts camp located on Lake Williston, on July 25.

Species Composition

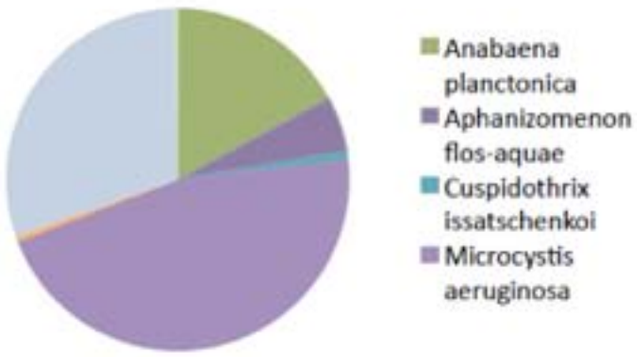




Simpson's Index of Diversity indicates infinite diversity of a value of 1.

Williston Lake is dominated by *Anabaena* species throughout June, while *Microcystis* species dominated August.

6/6/11 ★



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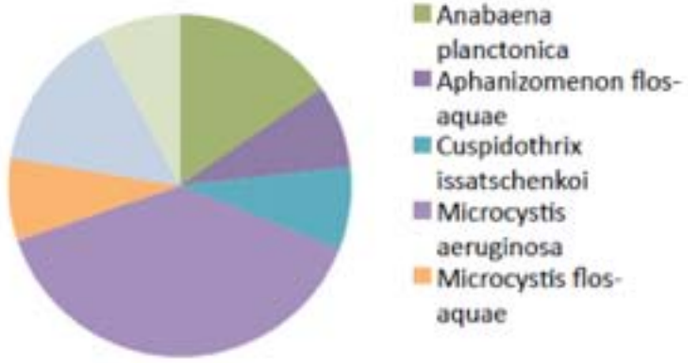

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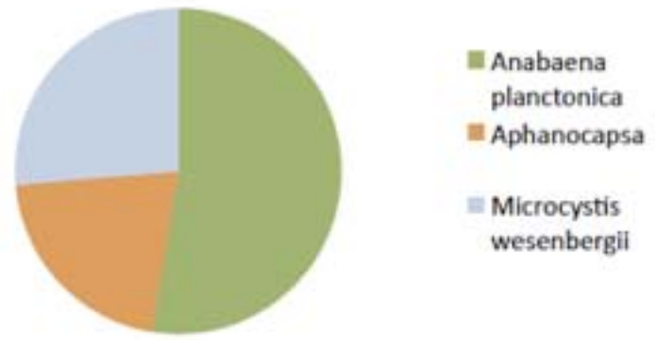

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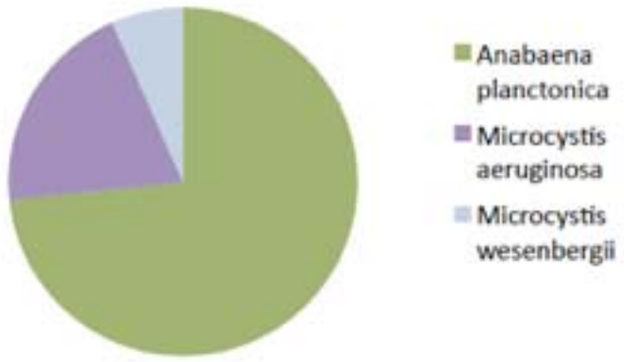
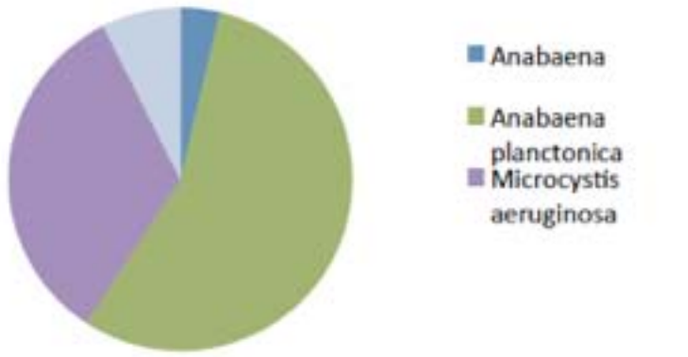
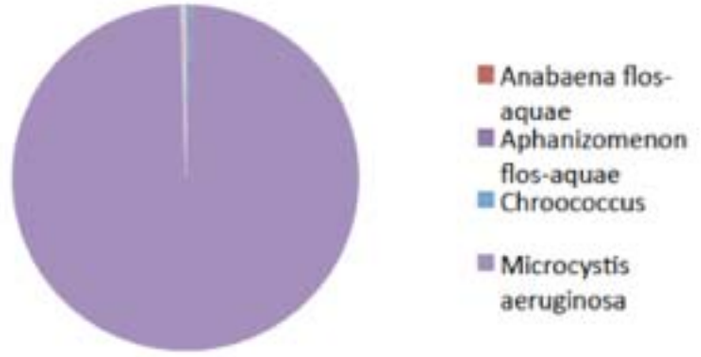


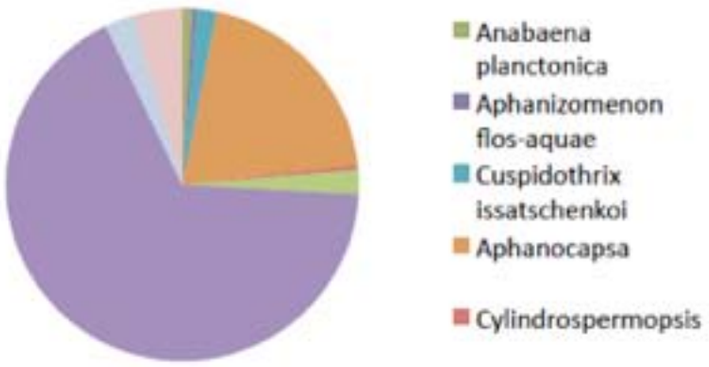
6/27/11 ★



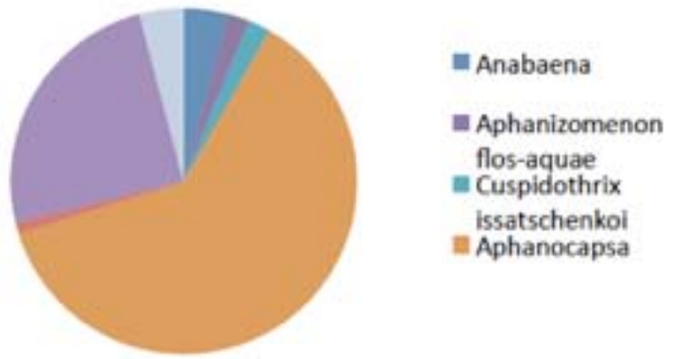
8/2/11



8/19/11



8/26/11

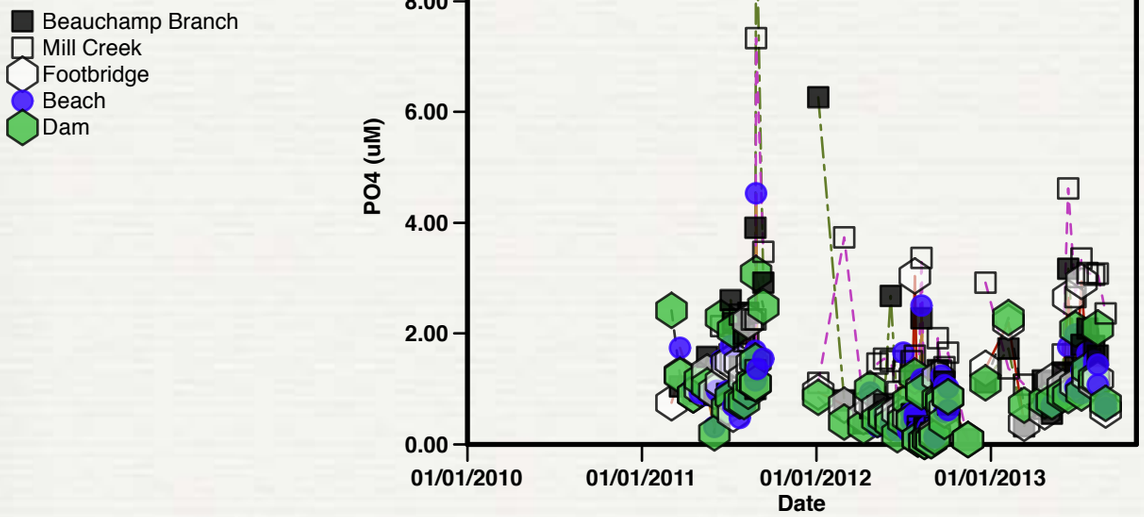


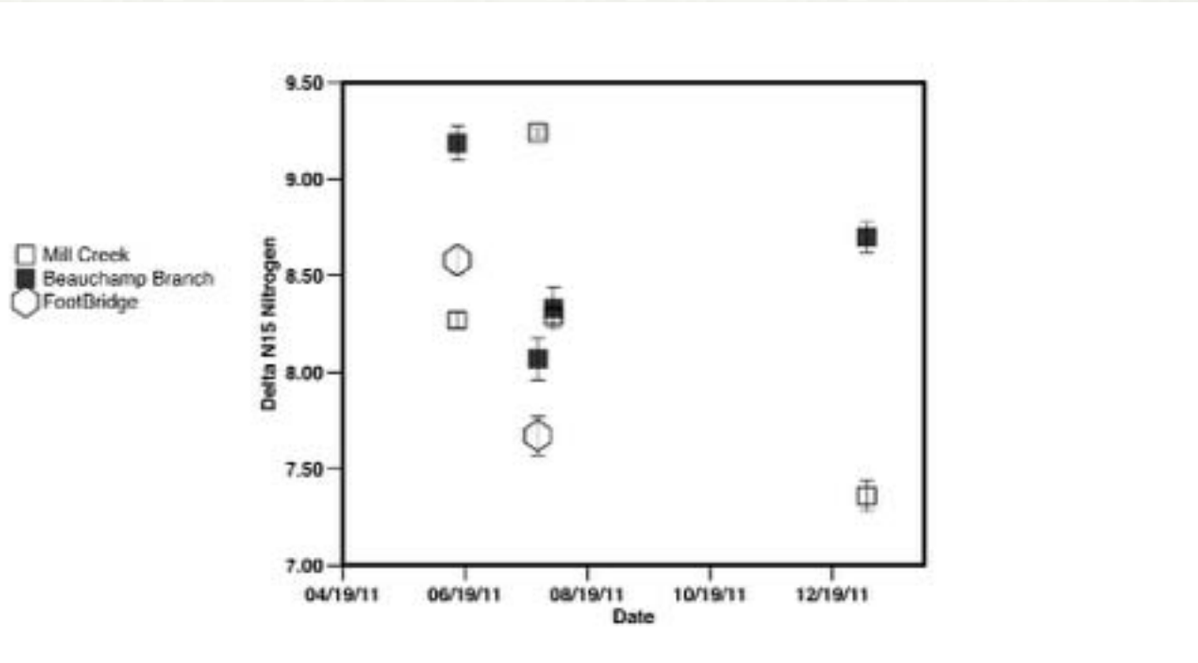
Species Distribution in Williston Lake Beach

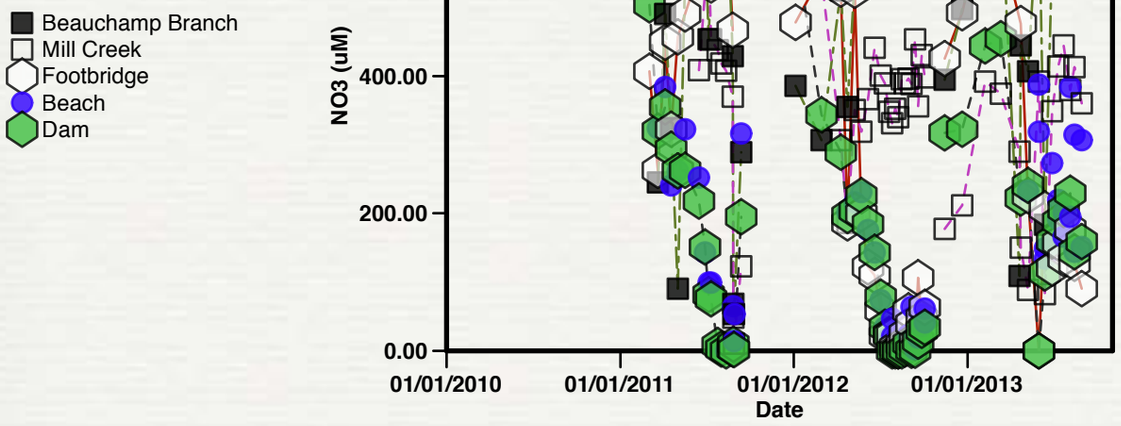
★ Indicates high anatoxin-a levels

Sampling Sites

The Problem
Nutrients







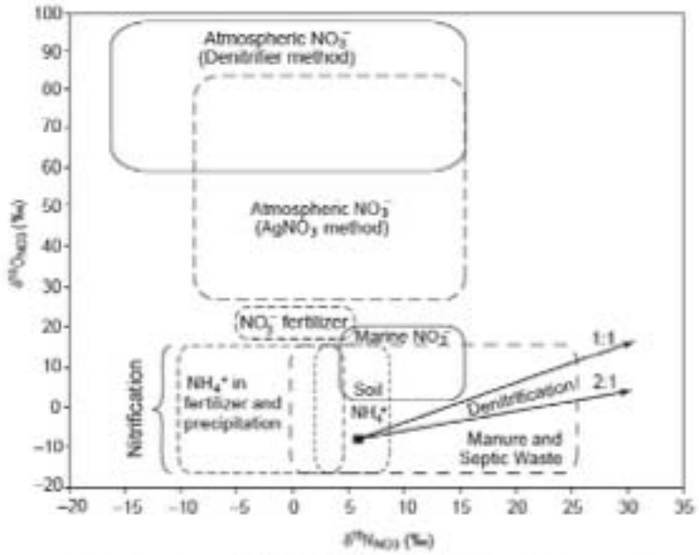


Figure 12.1 Typical values of $\delta^{15}N$ and $\delta^{18}O$ of nitrate derived or nitrified from various N sources. Atmospheric $\delta^{18}O_{NO_3}$ data are divided into the ranges observed for samples analyzed using the denitrifier and $AgNO_3$ (non-denitrifier) methods. The two arrows indicate typical expected slopes for data resulting from denitrification of nitrate with initial $\delta^{15}N = +6‰$ and $\delta^{18}O = -9‰$. The typical ranges of $\delta^{18}O_{H_2O}$ values produced by nitrification of ammonium and organic matter are denoted by "nitrification".

The Problem

Not New

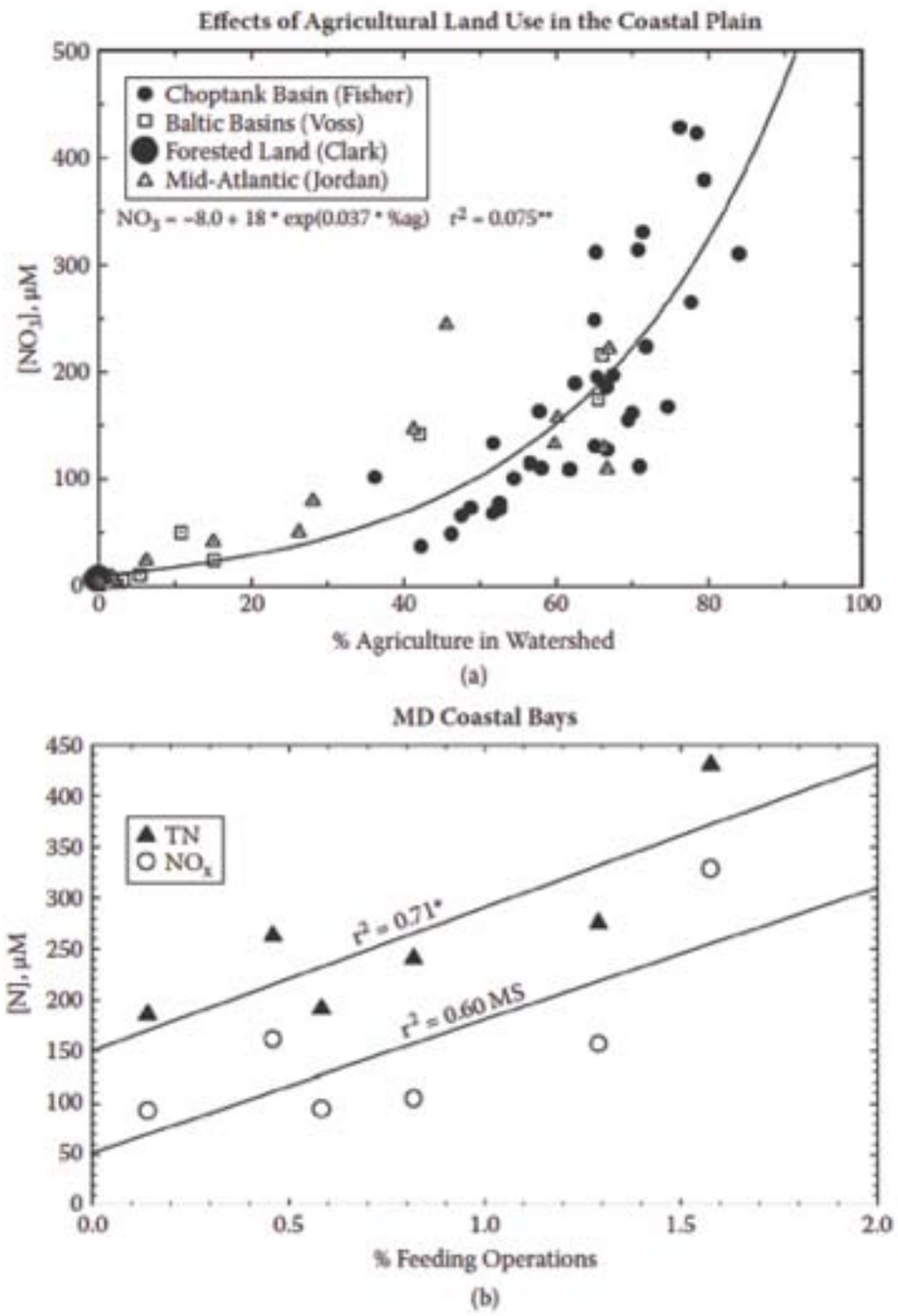
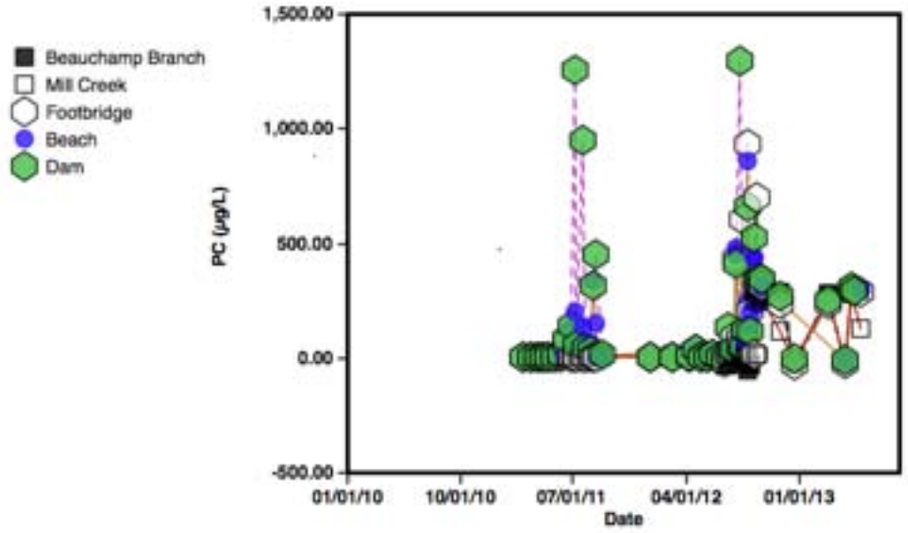
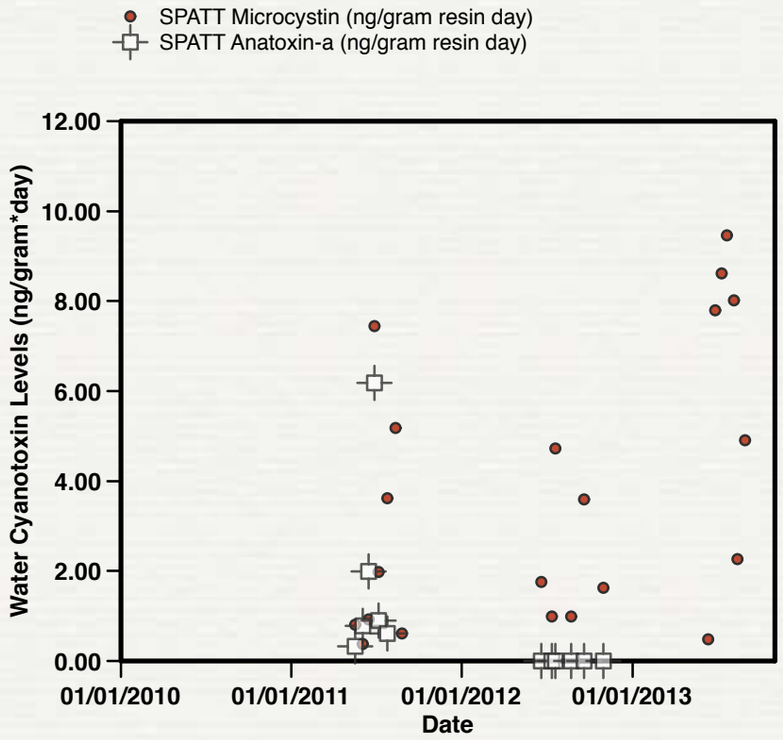
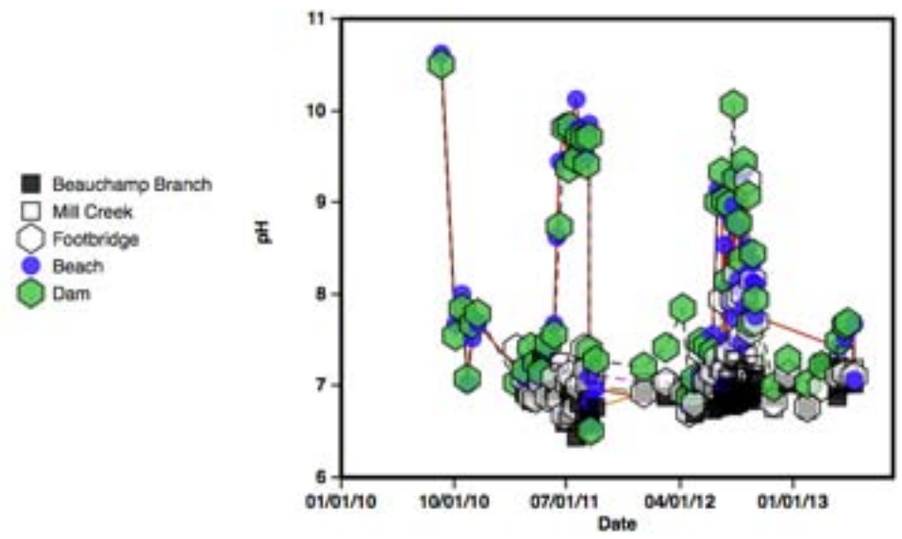


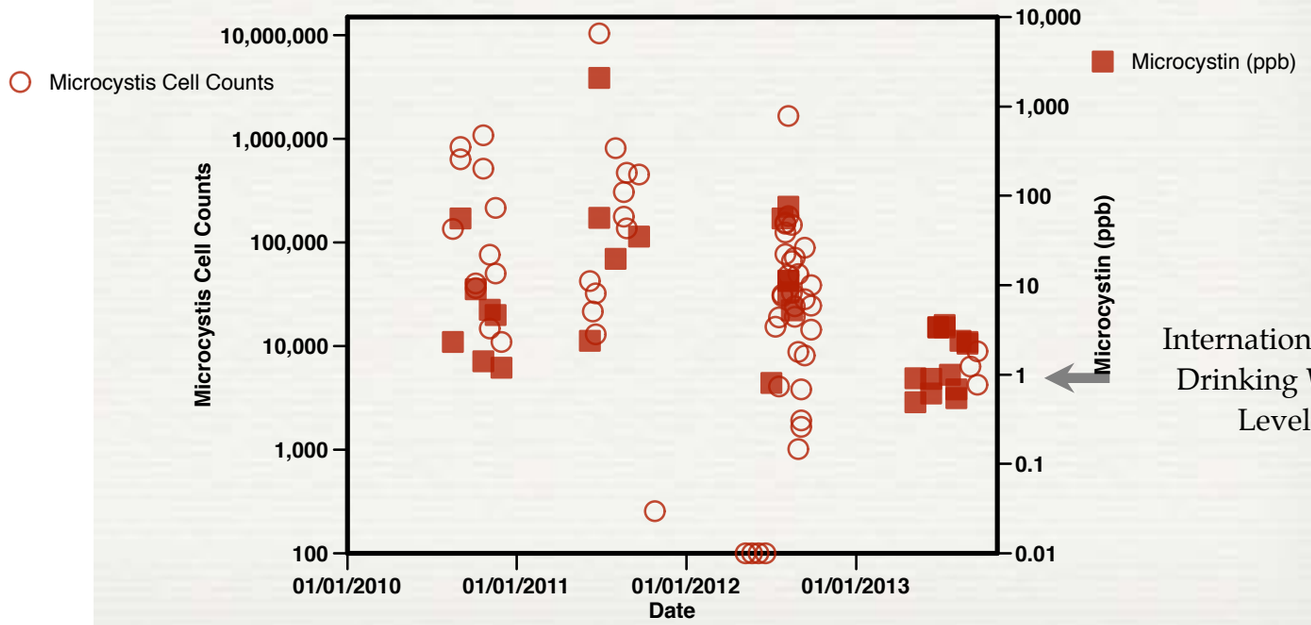
FIGURE 7.8 (a) Effects of percent agriculture (cropland) on nitrate concentrations [NO_3^-] in coastal plain watersheds. The exponential curve was forced through the extensive summary by Clark et al. (2000) on forested lands (= 0% agriculture). (b) Effects of animal feeding operations on average stream N in the St. Martin Basin in the Maryland coastal bays (Beckert 2008). The correlation with TN is significant, whereas the nitrate correlation is marginally significant ($p = 0.07$ and not significant for ammonium ($p > 0.10$).

The Problem
Algae and Cyanotoxins









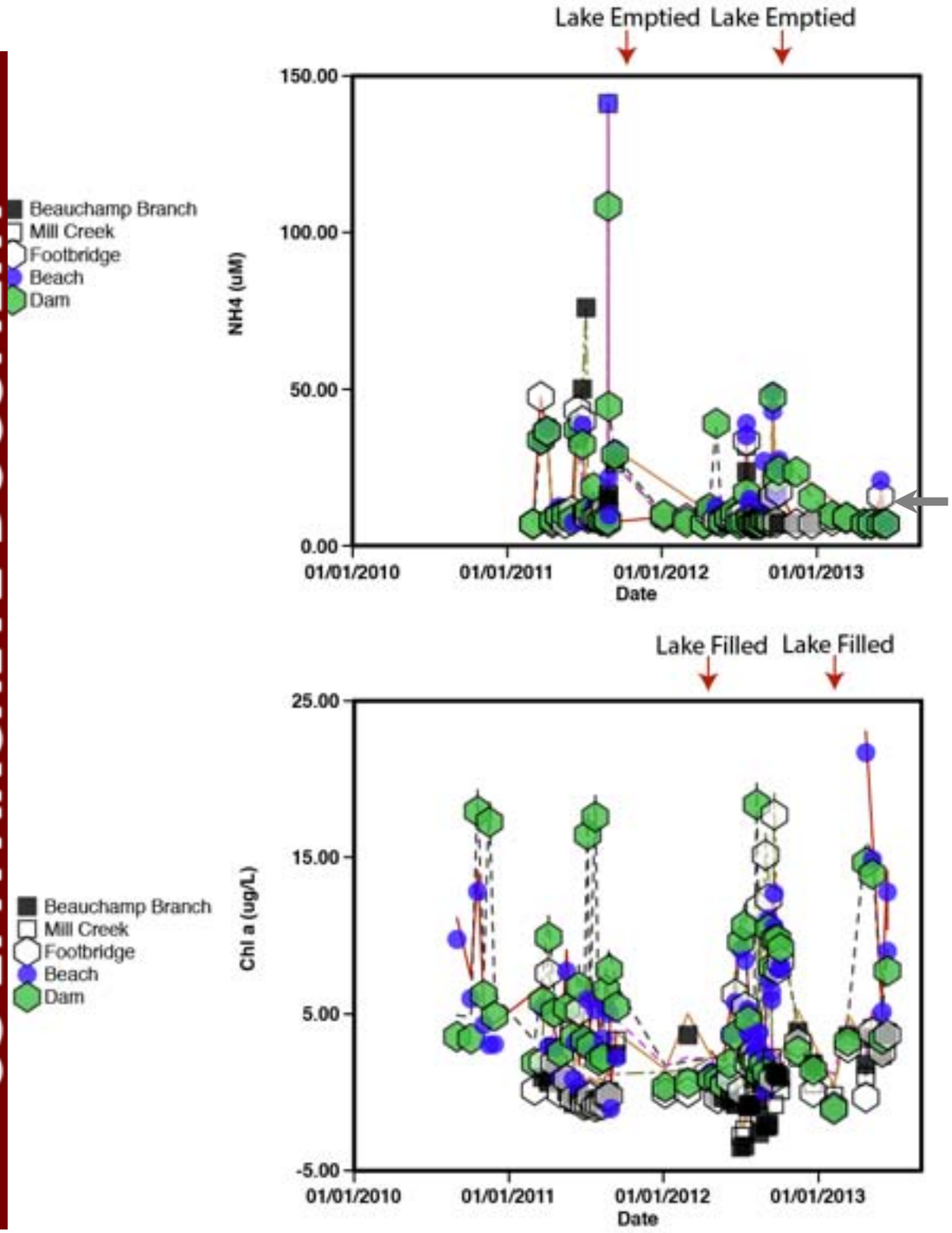
International Safe Drinking Water Levels

Lake Williston

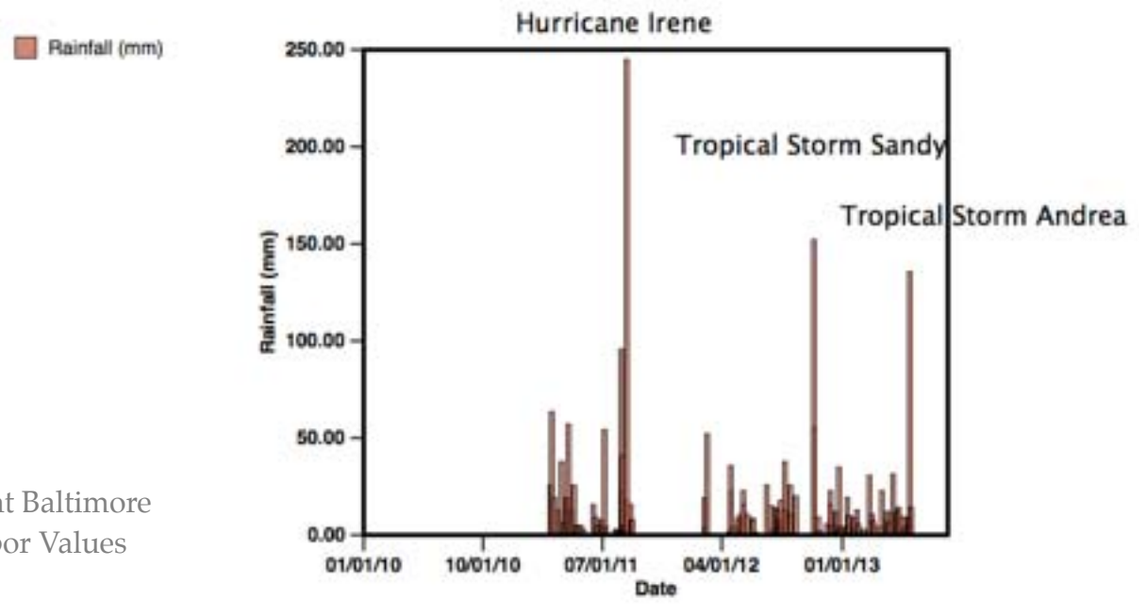
Girl Scout Camp
Operated Since 1935

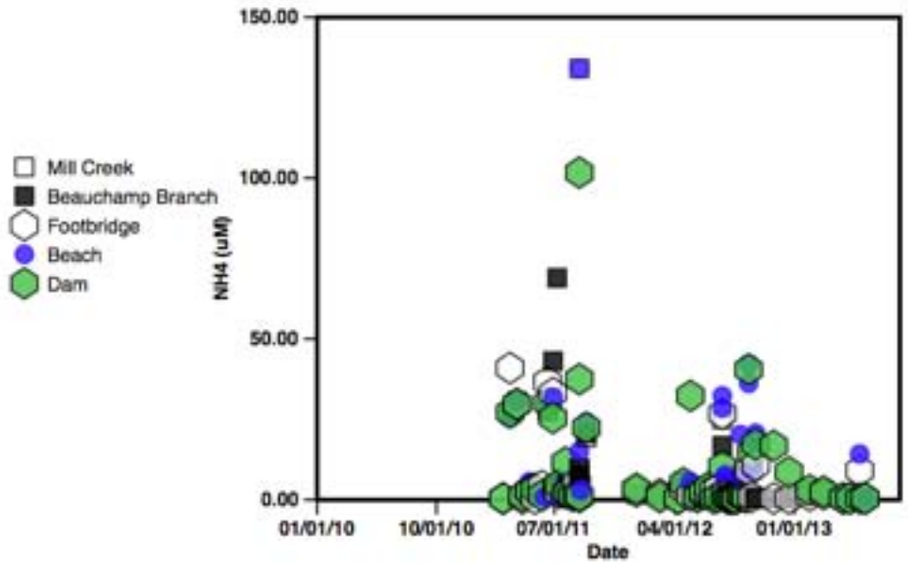
Lake Williston
July 12, 2012

The Solution Part 1
Hydraulic Flushing



Current Baltimore Harbor Values



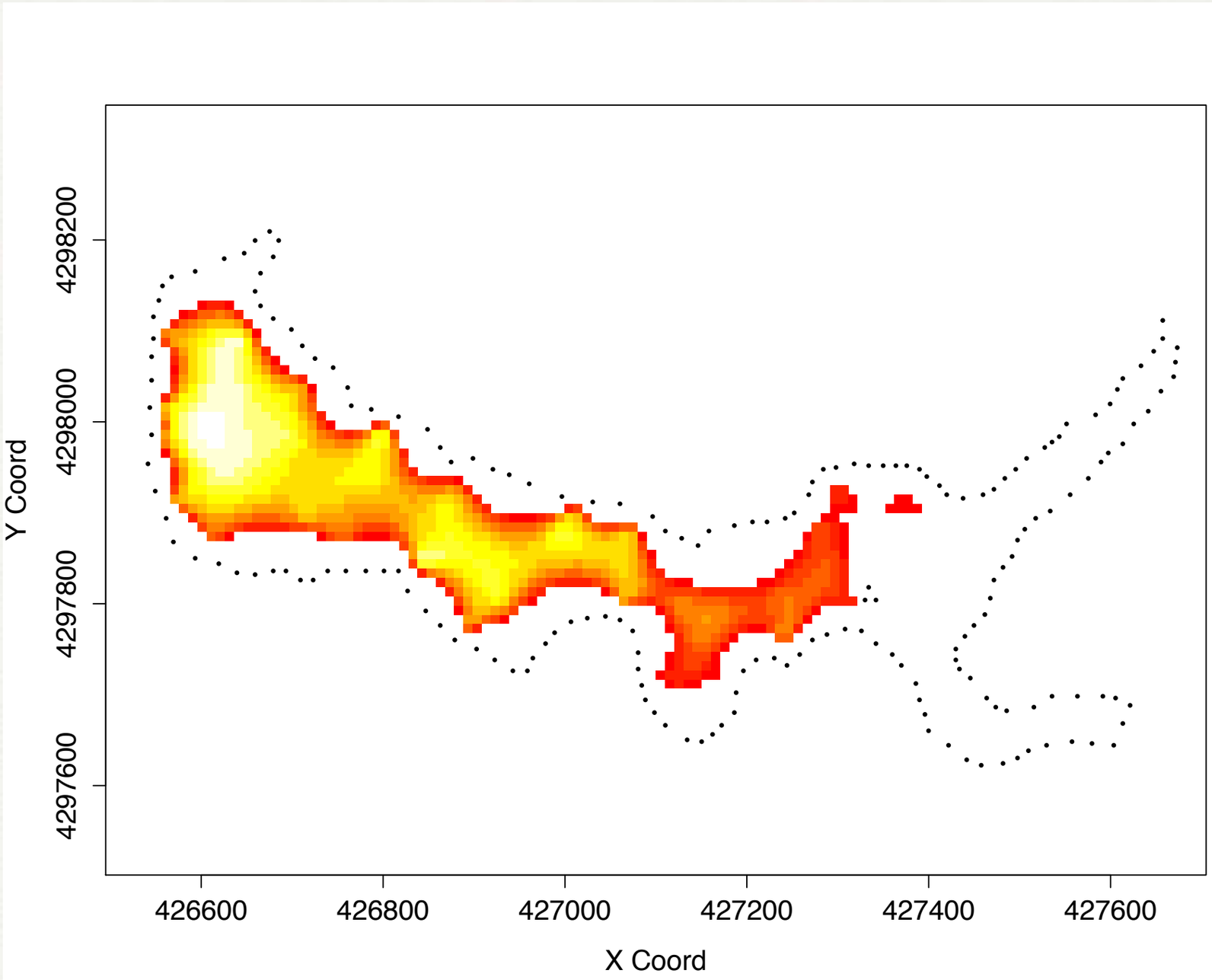


Drain the Lake

September 12, 2011

February 28, 2012

Drain the Lake



Initial Volume
464, 297 m^3

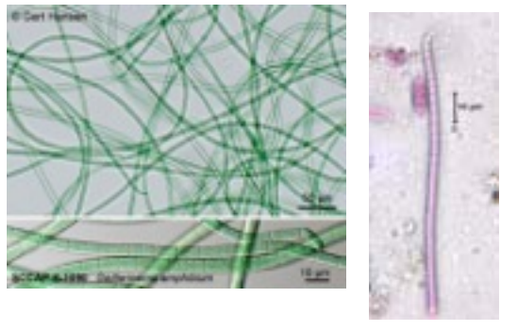
Drained Volume
98,234 m^3

79.8 % Volume Reduction

Cyanobacteria from Cores

- Cores from littoral zone of refilled lake, May 2012
- Water over core transferred to tubes and incubated L and D in windowsill
- Added 100 mL filtered lake water into each core and placed in windowsill
- Read IVF of overlying water and tubes after 19 d (20°C)
- Transferred to 25°C and read IVF after 8 d
- Increased to 28.5°C and after 7 d read IVF and removed samples for PP counts/IDs for samples with Chl/PC <10

Geitlerinema acutissimum



Pseudanabaena sp.

Synechococcus

RESULT: No Microcystis from cores or overlying water

Refill the Lake

April 24, 2012

May 8 2012

Allow Grasses to Regrow

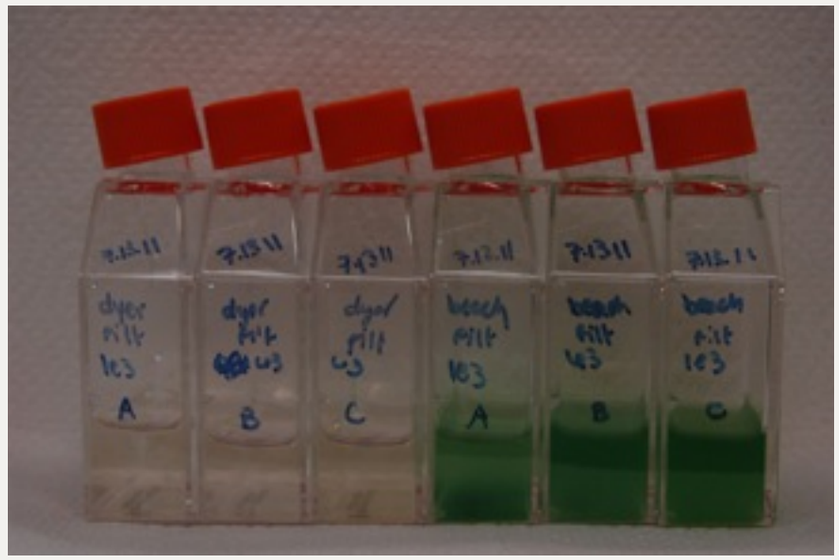
April 9, 2012

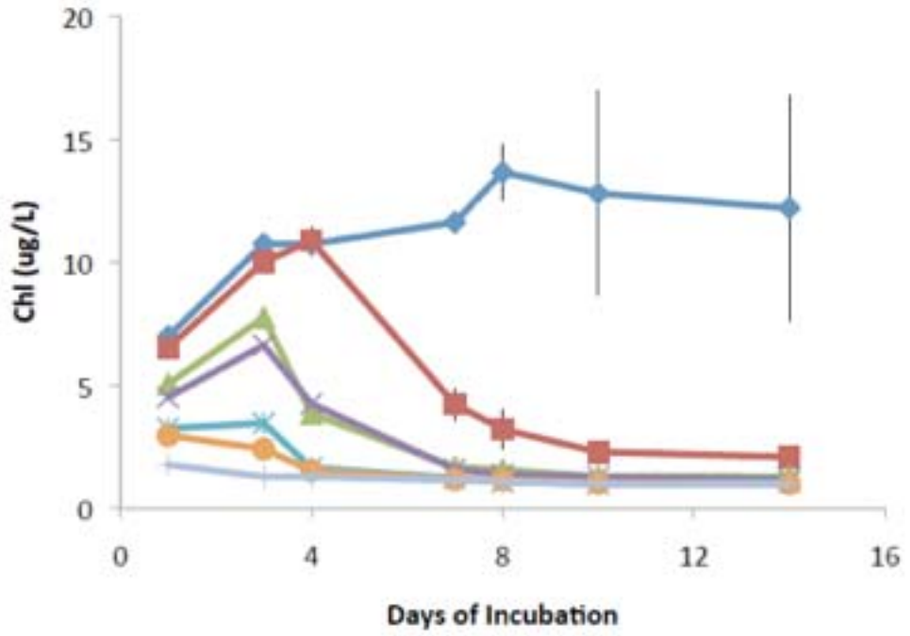
April 9, 2012

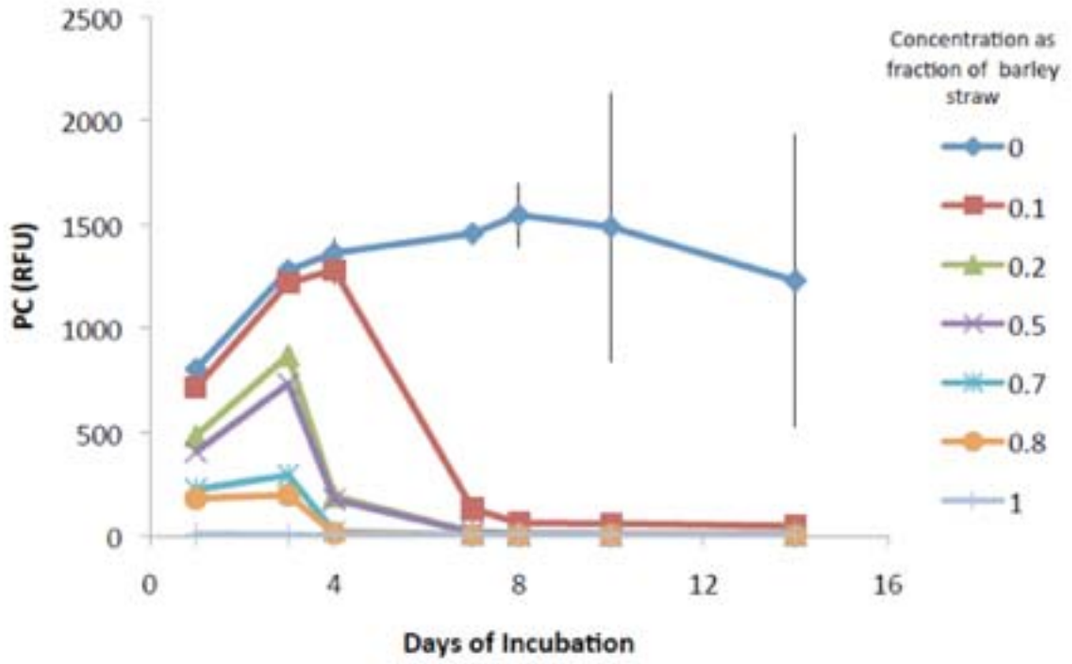
Repeat The Process

The Solution Part 2

Barley Straw







Varying concentrations of barley straw dosage were set up in the lab to replicate last experiment using filtered pond water and unfiltered lake water as innoculum.

	pH	NH4+ (µM)	NO2- (µM)	PO4 (µM)	NO3 (µM)
0	7.02	0.449	0.587	1.864	417.870
0.1	7.04	0.959	0.824	1.763	380.131
0.2	7.07	1.468	1.061	1.661	342.392
0.5	7.14	2.996	1.772	1.358	229.175
0.7	7.19	4.015	2.245	1.156	153.697
0.8	7.21	4.525	2.482	1.055	115.958
1	7.26	5.544	2.956	0.853	40.481

ELSEVIER

Bioresource Technology 77 (2001) 177–181

BIORESOURCE TECHNOLOGY

Algal growth control by a barley straw extract

Andrew S. Ball *, Matthew Williams, David Vincent, James Robinson

Department of Biological Sciences, John Tabor Laboratories, University of Essex, Wivenhoe Park, Colchester, Essex CO4 3SQ, UK

Received 2 August 2000; received in revised form 4 September 2000; accepted 14 September 2000

Journal of Fisheries and Aquatic Science 5 (5): 394-401, 2010
ISSN 1816-4927

The Use of Barley Straw for Controlling of Cyanobacteria Under Field Application

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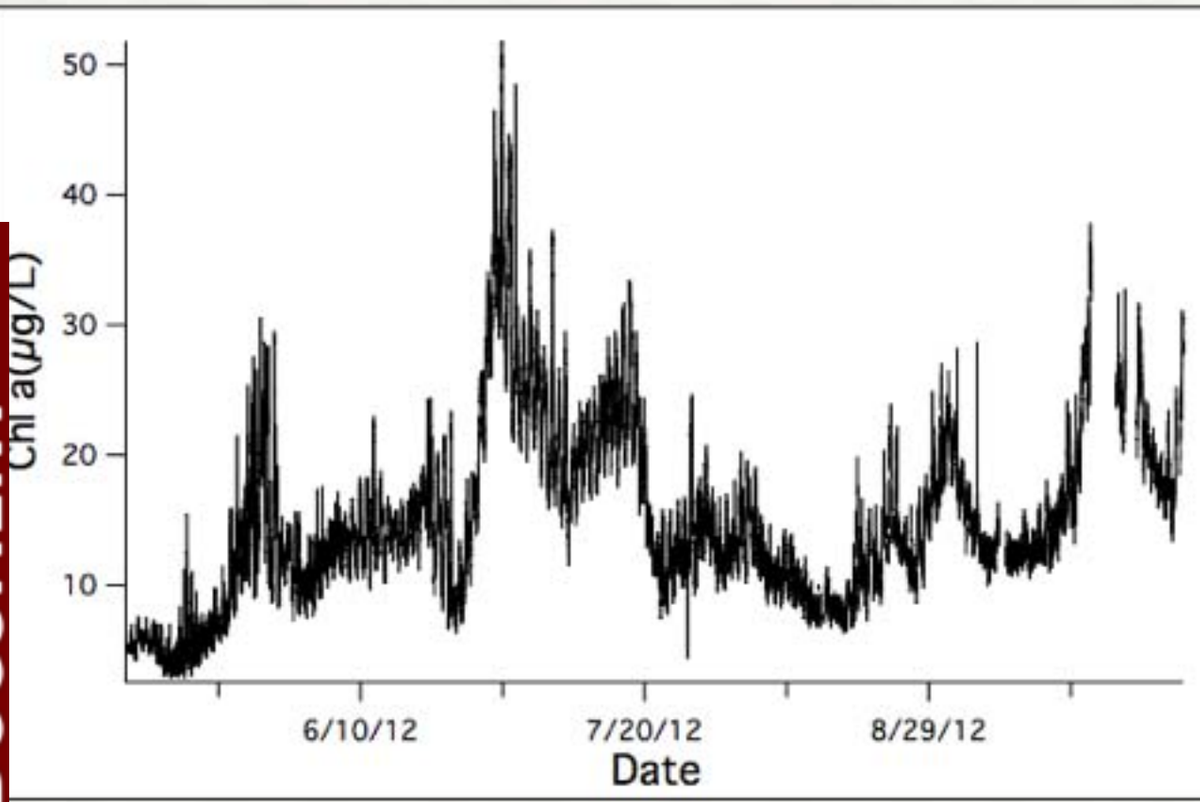
J Appl Phycol (2009) 21:333–340
DOI 10.1007/s10811-008-9373-x

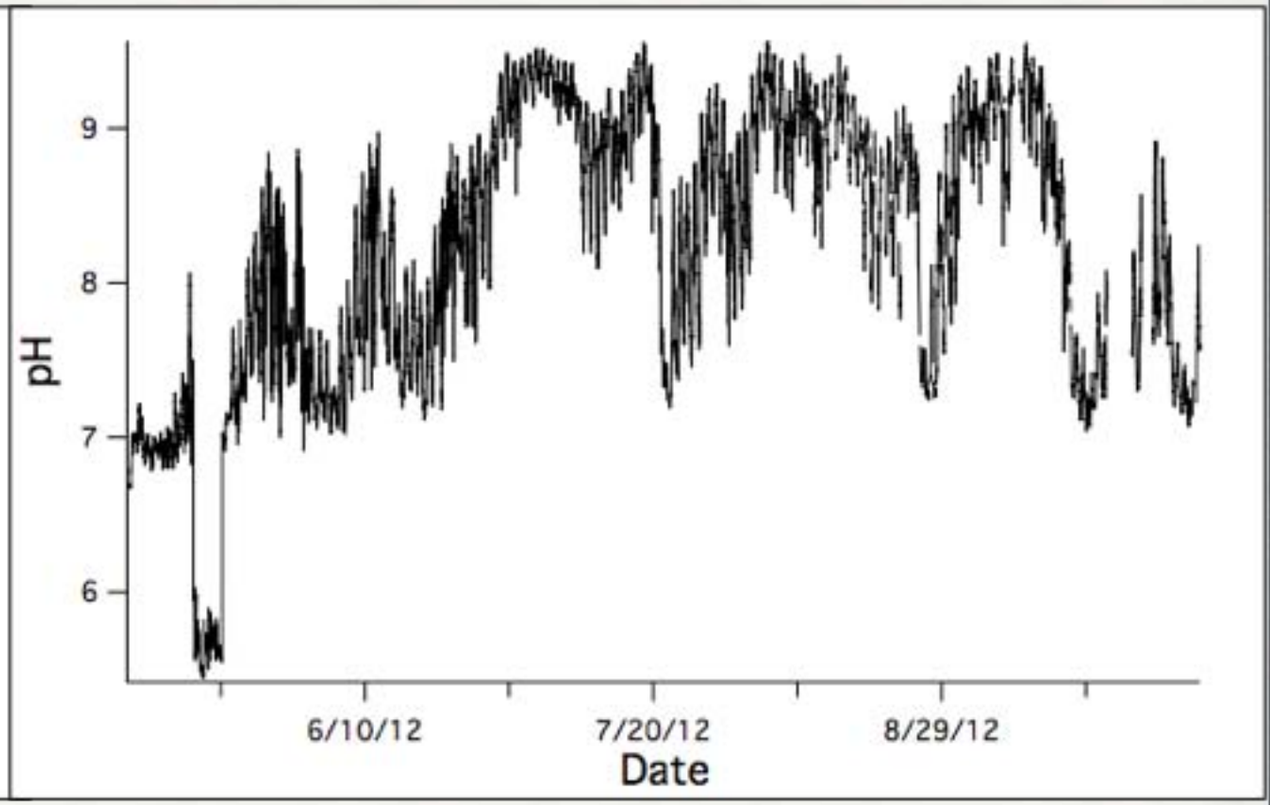
Chemical characterization of the aqueous algistatic fraction of barley straw (*Hordeum vulgare*) inhibiting *Microcystis aeruginosa*

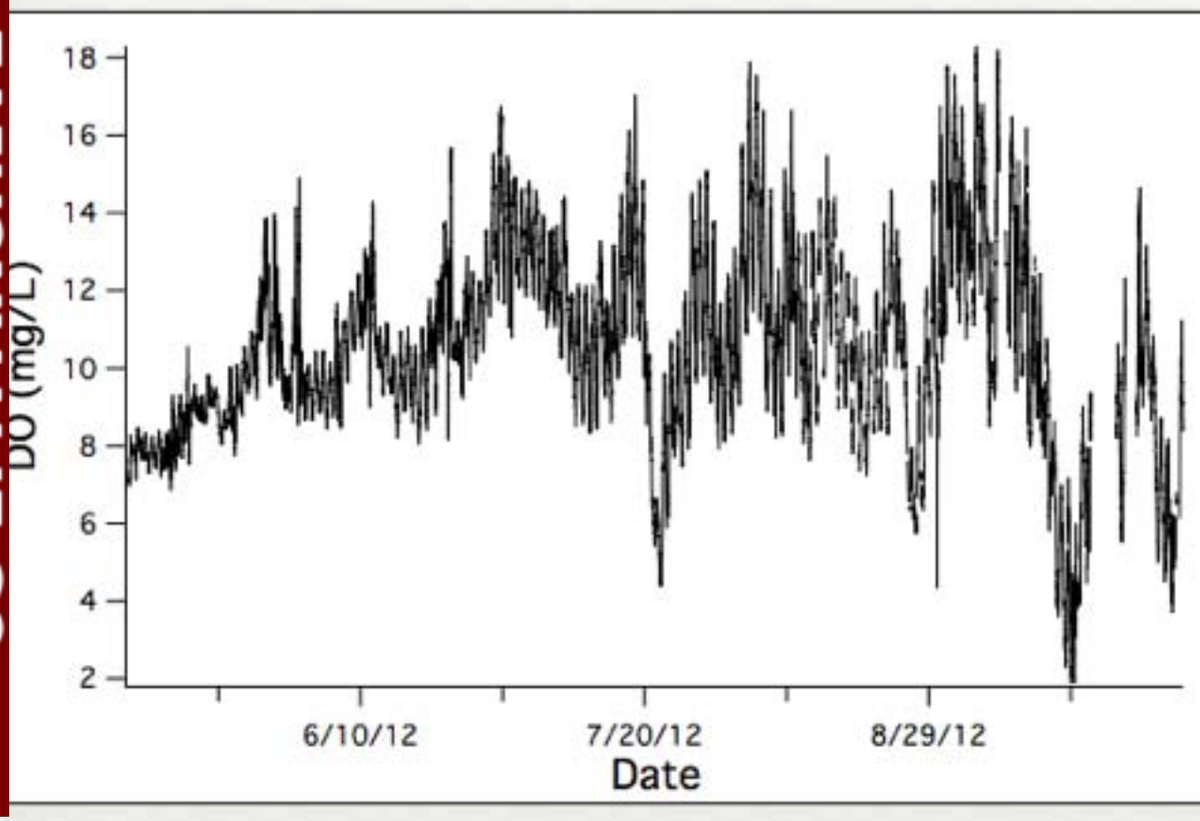
Timothy J. Waybright · Daniel E. Terlizzi · M. Drew Ferrier

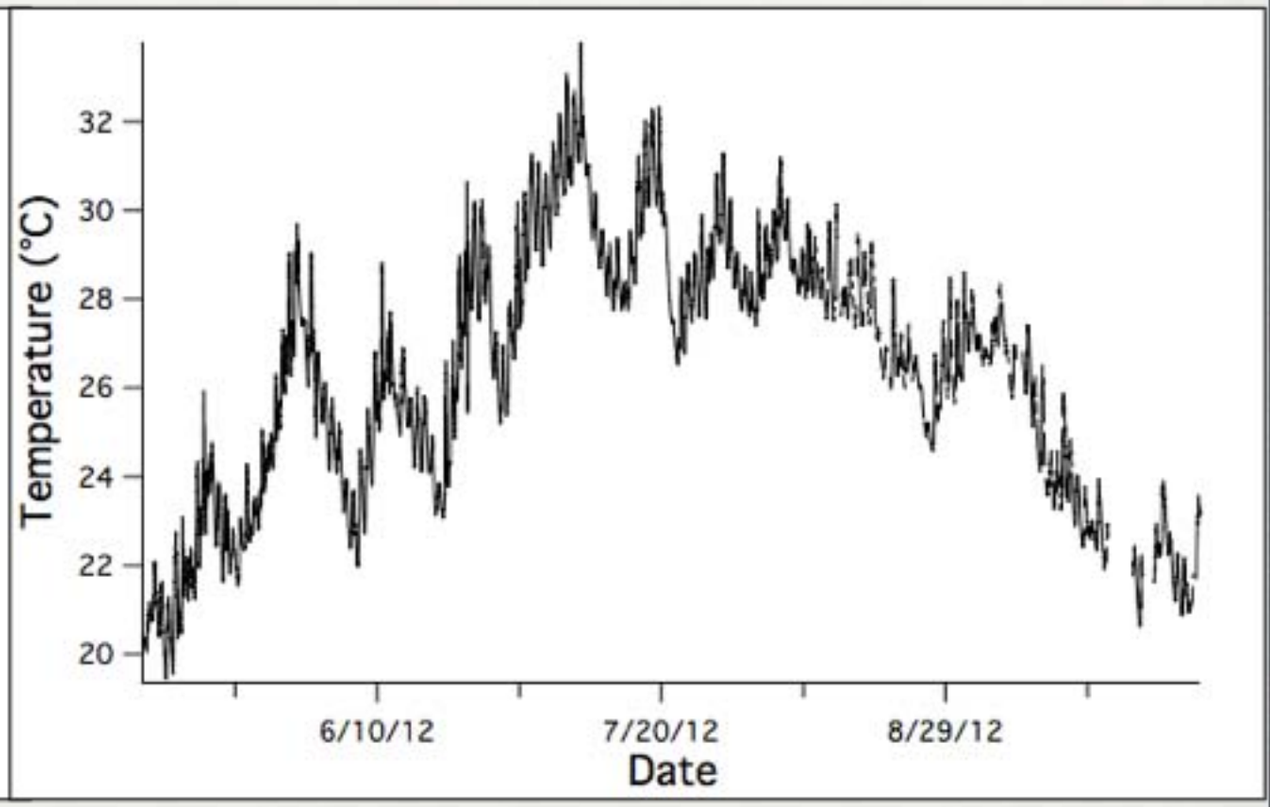
Deploy Barley Straw Bales

DNR YSI Continuous







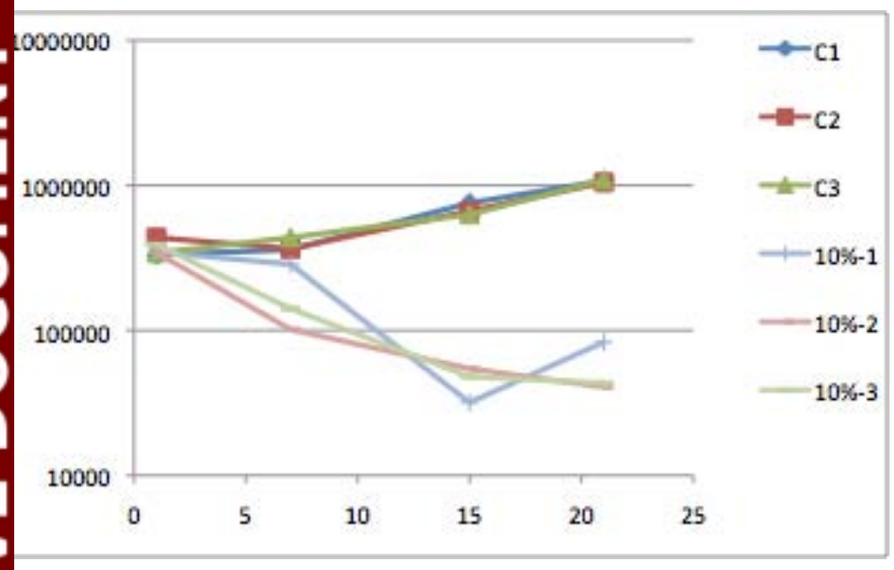


Sampling Locations

- Within 20 centimeters of the barley bales deployed in the South stream of the Williston Lake footbridge

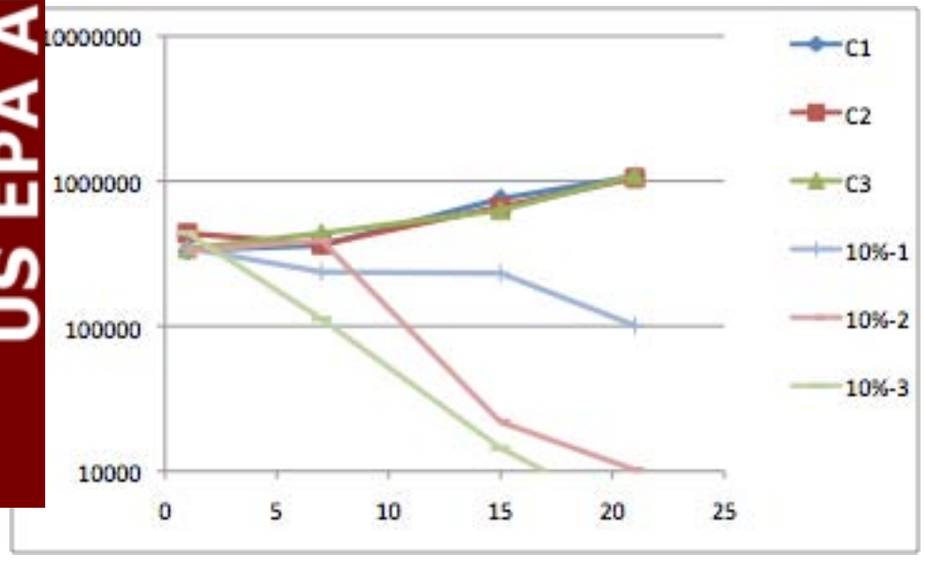
Williston footbridge late season

8/15/12

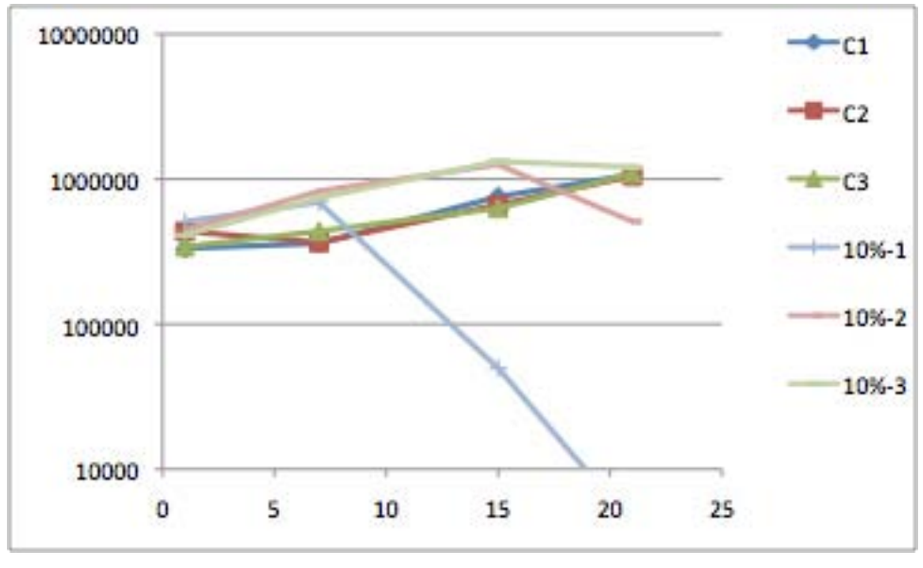


Activity of the footbridge barley water was evident through August and decreased in September.

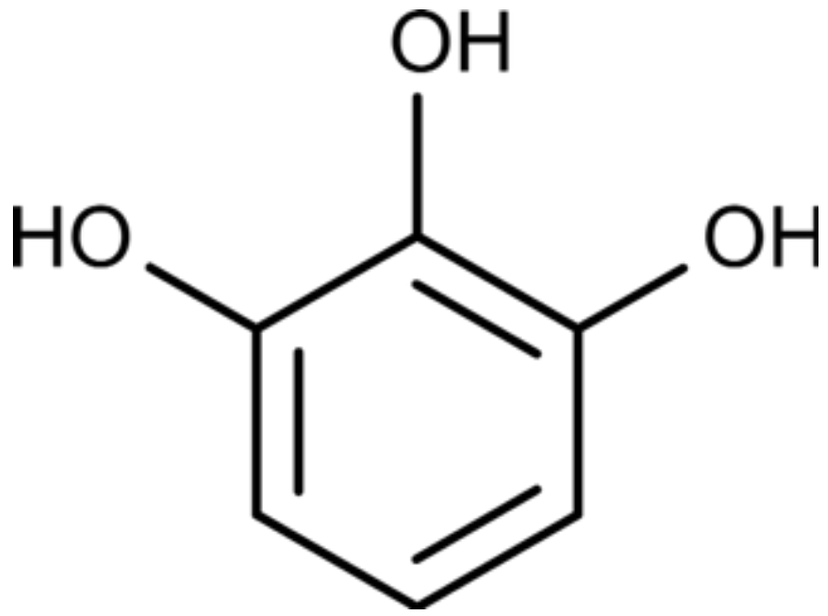
8/29/12



9/6/12



Pyrogallol- a potential barley straw breakdown product for direct treatment

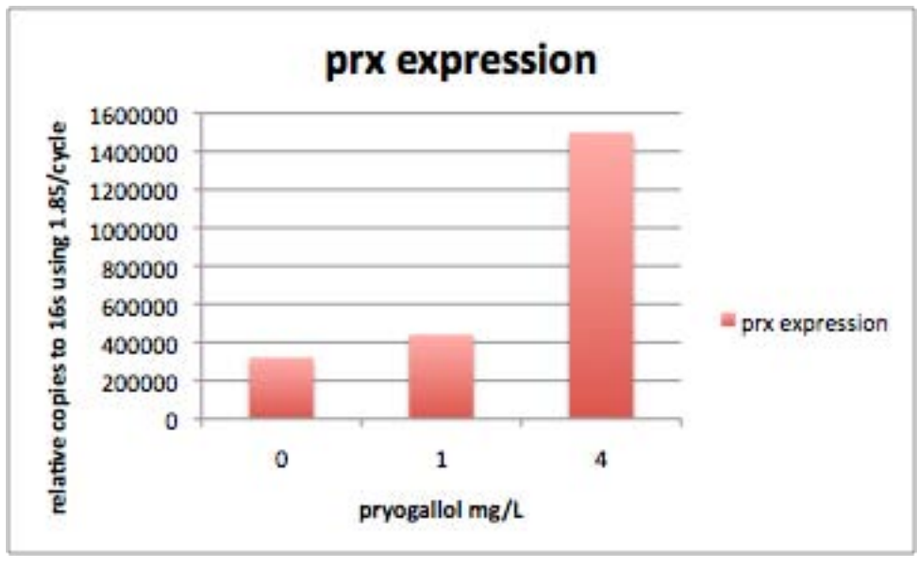


- Has been shown to up-regulate expression of several antioxidant and stress genes.
- The most linear correlation was observed with the peroxiredoxin gene.

Treatment of *M aeruginosa* with pyrogallol

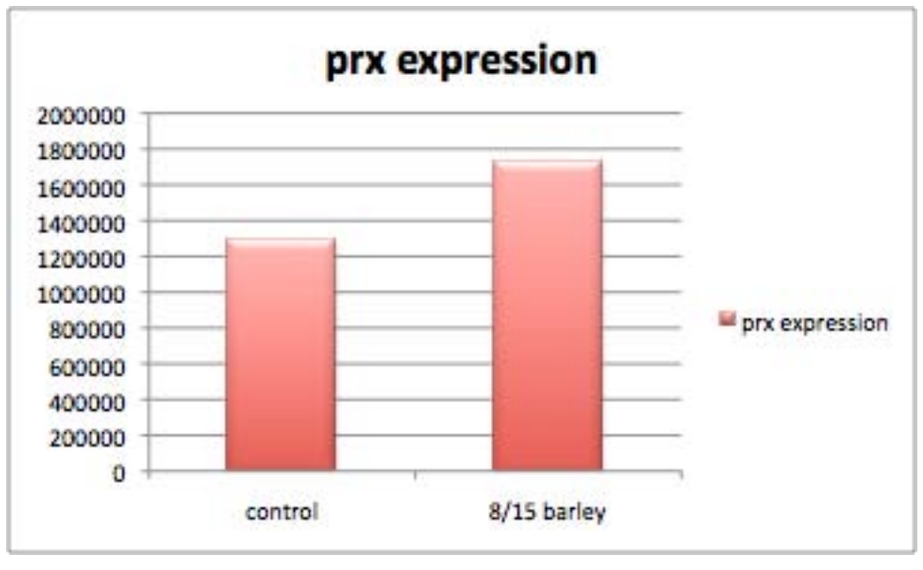
- Cultures of *M. aeruginosa* Le3 were treated with 0, 1, and 4 mg/L pyrogallol overnight.
- RNA was extracted and reverse transcribed
- qPCR was used to determine relative expression of the peroxiredoxin gene normalized to 16s

They were telling the truth



The results of Shao *et al.* 2009 were confirmed. However, the treated cultures were maintained for 8 days and no decrease in cell count was observed at these concentrations. Thus, the results of Nakai *et al.* 2000 were not confirmed.

Expression of peroxiredoxin following treatment with barley straw water



Treatment using barley straw water collected on 8/15 from the Williston Lake footbridge showed a slight increase in prx expression. Similar to the 1mg/L exposure of pyrogallol

Microcystis' Response to Light

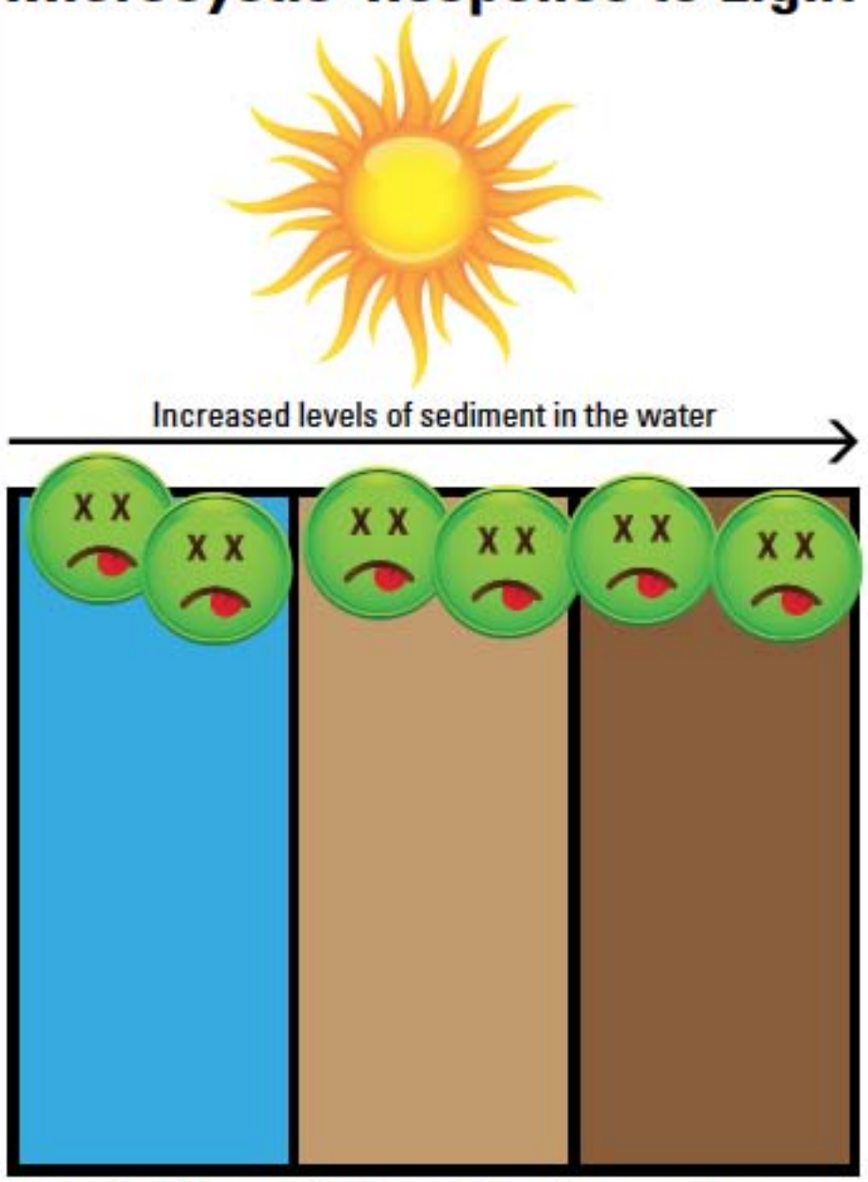


Figure A – *Microcystis* is damaged on calm, sunny days when they float on the surface of the water

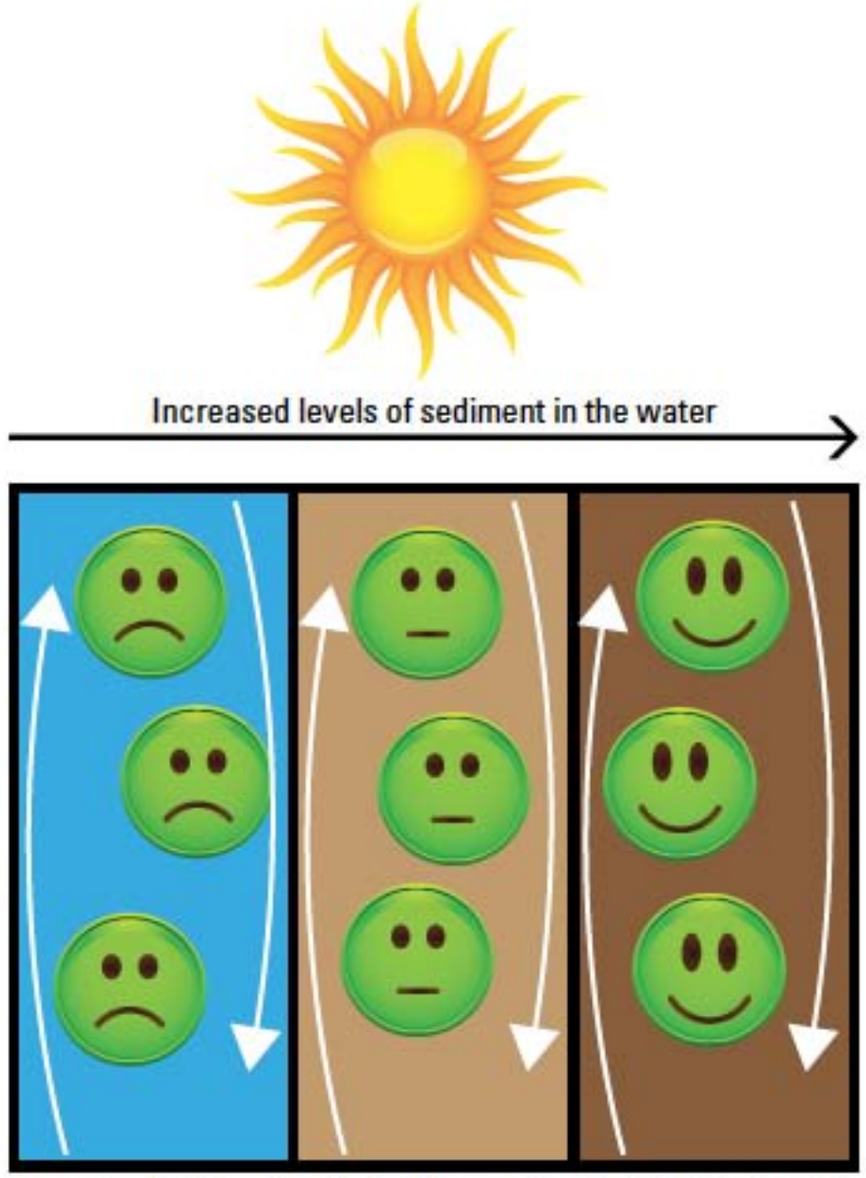


Figure B – Sediment protects *Microcystis* when the lake is mixing

Bright, direct sunlight in calm water can actually damage *Microcystis*, even if the water is muddy, because of its tendency to float on the water's surface (Figure A). However, when the water is filled with sediment and breezes mix the water column, muddiness acts as a protective shield, helping the *Microcystis* to thrive (Figure B).

Can we enhance the Activity?

- Performed controlled extracts of Barley straw at defined temperatures and light incidents.
- Compared nutrient content to the inhibitory effects of barley straw in stagnant conditions long term.
- Test the white rot fungus on it's ability to enhance the release of inhibitory compounds from barley straw.
- Test combinations of barley breakdown products to maximize inhibition.

White Rot Fungus

Trametes versicolor and C. subvermispora

Optimum Temperature 20-28°C

ENVIRONMENTAL Science & Technology

Article

pubs.acs.org/est

Bioaugmentation of Sewage Sludge with *Trametes versicolor* in Solid-Phase Biopiles Produces Degradation of Pharmaceuticals and Affects Microbial Communities

Carlos E. Rodríguez-Rodríguez,[†,‡,§] Aleksandra Jelić,[∥] M. Alcina Pereira,[∥] Diana Z. Sousa,[∥] Mira Petrović,[⊥,#] M. Madalena Alves,[∥] Damià Barceló,[§,#] Glòria Caminal,[†] and Teresa Vicent[*,†]

Inoculation of Barley Bales

Results from White Rot Inoculation

- 10 fold higher production of inhibitory activity with inoculation
- Bales need to be in open sunny areas to keep the bale temperature above 25°C
- Will the same effect be evident upon purification of the polyolignols?

IN THIS SECTION

C
THE SUNDAY STAR
JULY 15, 2012

Lessons of Williston Lake

Lucy Morris, left, and Madison Jones swim in Williston Lake on a summer day at Camp Todd.

Girl Scouts swim again in clean lake water

Future winter lake drains possible to prevent blue-green algae's return

Photo and Story by DUSTIN HOLT
Caroline Editor