

## Session G7: Monitoring and Modeling Cyanobacteria Blooms, Session 2

Room C124  
3:30 – 5:00 pm

**0406**  
**G7-1**

### Phytoplankton Community Dynamics in 28 North American Reservoirs/Lakes: A Multivariate Analysis

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Phytoplankton community dynamics were investigated across a broad range of latitude, trophic state and climate conditions using multiyear databases from 28 individual reservoirs/lakes in 7 distinct aquatic systems consisting of 1,862 sample observations: Upper Missouri River Reservoirs (MT), Middle Missouri River Reservoirs (ND/SD/NE), Northern Colorado Reservoirs, Cheney Reservoir (KS), Lake Mead (AZ/NV), Central Florida Lakes, and Lake Okeechobee (FL). An inherent problem in analyzing large phytoplankton data sets is that data reduction to algal divisions is often too coarse to detect community patterns yet evaluating all algal species is unwieldy for statistical analyses. In our study phytoplankton data sets were initially reduced to taxonomic groupings (usually genus) based on at least one occurrence constituting 5 percent of the total biovolume of a sample in a particular water body. Groupings of similar algal composition were identified using Principal Component Analyses (PCA) followed by Canonical Correlation Analyses (CCA) with environmental variables.

PCA identified meroplanktonic diatoms (*Aulacoseira* spp., Fragilariaceae) as being important phytoplankton components in 23 of the reservoirs/lakes which were either shallow or riverine in nature. Of the environmental variables considered in this study, CCA identified water temperature as having the strongest correlations in all systems except for the Central Florida Lakes, and explained most of the observed seasonal and spatial changes in phytoplankton community succession. Phytoplankton communities in northern latitudes, composed mostly of diatoms, were negatively correlated with low water temperatures while phytoplankton communities in more southern latitudes, composed mostly of cyanobacteria, were positively correlated with water temperature. Environmental variables related to light availability (Secchi disk transparency, turbidity) were also significantly correlated but varied in significance based on hydrologic events within individual water bodies (inflows related to spring melt, drought and major storm events). Total nitrogen was not significantly correlated with phytoplankton community structure and total phosphorus was positively correlated only in Lake Mead. These results underscore the varying importance of temperature, light availability, hydrologic inflows and morphometric factors in explaining phytoplankton community dynamics over multiyear time scales in individual reservoirs/lakes across a broad range of latitudes and environmental conditions.

**0457**  
**G7-2**

### Spatial and Temporal Dynamics of Microcystins and their Relation to Other Water Quality Variables in Upper Klamath Lake, Oregon

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Phytoplankton blooms dominated by cyanobacteria that occur annually in hypereutrophic Upper Klamath Lake, Oregon, produce microcystins at concentrations that may contribute to the decline in populations of endangered Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers. During the 2007-2011 monitoring seasons (May-October), water, sediment, and benthic invertebrate samples were collected to determine the presence and concentrations of dissolved and particulate microcystins and to relate the spatial and temporal occurrences of microcystins to water quality and other environmental variables. Samples collected in 2007 and 2009 (years with a heavy early bloom of *Aphanizomenon flos-aquae*) contained the highest and most variable concentrations of microcystins, whereas concentrations were substantially lower in 2008, 2010, and 2011 (years with a light early bloom of *A. flos-*

*aquae*). Microcystins occurred primarily in dissolved and large (> 63 µm) particulate forms in all years, and overall, depth-integrated water column concentrations were highest at the deepest site sampled, which is also where bloom density and the severity of bloom decline was generally greatest (as indicated by chlorophyll a concentrations). Microcystin concentrations per mass of bed sediment and sediment trap material were lower than concentrations measured in water-column particulate samples, but sediment trap samples, just above the lakebed, contained higher concentrations of microcystins than suspended-sediment surface samples, with a peak in one sediment trap sample (1,107 µg g<sup>-1</sup> from the most northwesterly site that exceeded the maximum concentration measured in any other water or sediment sample from the lake. In addition, results of quantitative polymerase chain reaction (qPCR) analysis of water samples collected in 2011 show temporal changes in the relative proportion of *Microcystis aeruginosa* in the cyanobacterial population and the percentage of potentially microcystin-producing strains. Understanding the ecological interactions between these species may be key to predicting periods of elevated toxicity and has important implications for management of this lake.

**0463**  
**G7-3**

### **Environmental Influences on Toxic and Non-Toxic Microcystis Populations in Vancouver Lake, Washington**

Tammy Lee, Gretchen Rollwagen-Bollens and Steve Bollens

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The increasing frequency of harmful cyanobacteria blooms in freshwater systems has become a commonly recognized problem due to adverse effects on water quality. Current research suggests various biotic and abiotic interactions influence toxin production, bloom formation, persistence, and decay in freshwater systems.

Vancouver Lake has experience summer blooms for the past decade. We quantified cyanobacteria abundance and community composition, and measured several environmental variables (*i.e.*, nutrients, temperature, and pH) in Vancouver Lake, Washington over four years (2007-2010). In 2007, *Microcystis* and *Anabaena* were the most abundant cyanobacteria species present during the summer bloom. Blooms in subsequent years were dominated by *Anabaena* and *Aphanizomenon*. Non-metric multidimensional scaling revealed that high levels of orthophosphate was the environmental factor most strongly associated with seasonal cyanobacteria blooms in Vancouver Lake.

Beginning in May 2009, microcystin levels in Vancouver Lake were quantified using a commercially available ELISA kit. PCR was used to isolate the *mcyA* gene in microcystin-producing genera in lake water samples. Preliminary sequenced results of the isolated *mcyA* gene indicate that *Microcystis* was the only microcystin-producing species present in 2009 and 2010; however *Microcystis* individuals were rarely detected microscopically in 2009 and were not visually detected at all in 2010. This suggests that solely relying on microscopy for assessing cyanobacteria blooms may overlook other important, yet less abundant, species and might suggest false associations between toxin concentrations and cyanobacteria abundances. In addition, using qPCR we have been able to monitor changes in toxin and non-toxin producing *Microcystis* populations that are visually undetectable.

Our findings will provide new insights into how environmental variables influence phytoplankton community dynamics, generally, and persistence of seasonal toxic cyanobacteria blooms, specifically.

**0392**  
**G7-4**

### **Reassessment of Cyanotoxin Mixtures in the 2007 US EPA National Lakes Assessment**

Keith Loftin<sup>1</sup>, Jennifer Graham<sup>2</sup>, Elizabeth Hilborn<sup>3</sup>, Julie Dietze<sup>1</sup>, Sarah Lehmann<sup>4</sup>, Michael Meyer<sup>1</sup> and Andrew Ziegler<sup>2</sup>

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Microcystins have historically been the most frequently reported class of cyanotoxins. In the 2007 US EPA National Lake Assessment (2007 NLA), the USGS found that microcystins were detected in integrated photic zone samples from approximately 30 % of sampled lakes (n = 1028). Based on World Health Organization (WHO) microcystin recreational guidelines, 1 % of lakes were categorized as either moderate (> 10 µg/L) or high (> 20 µg/L) probable health risks based on total microcystin concentrations. However, health risk assessment by concurrently sampled chlorophyll and cyanobacterial abundance, two other metrics that can be used according to WHO recreational guidelines, resulted in approximately 42% and 27% of lakes being categorized as either moderate (chlorophyll > 10 µg/L or cyanobacterial abundance > 20,000 cells/mL) or high (chlorophyll > 50 µg/L or cyanobacterial abundance > 100,000 cells/mL) probable health risk, respectively. This demonstrates the possibility of a disconnect between the WHO metrics used to assess potential health risk because of to microcystin exposure in the United States. Review of the cyanobacteria data also demonstrated that

cyanobacteria were present in the 2007 NLA samples capable of producing other classes of cyanotoxins. Frozen, archived 2007 NLA samples were reanalyzed for cylindrospermopsins and saxitoxins by enzyme-linked immunosorbent assay. Preliminary results from this subset show that cylindrospermopsins (n = 659) and saxitoxins (n = 678) had a detection frequency of 5% and 8 %, respectively. Maximum concentrations for cylindrospermopsins and saxitoxins were 3.5 and 0.38 µg/L, respectively. Results indicate that co-occurrence of multiple toxin classes and variants do occur in US water bodies. Therefore, routine monitoring for microcystins alone may be insufficient to adequately assess exposure to cyanotoxins.

This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.