

# ***Changes in Detroit Lake HAB Populations?***

**Kurt Carpenter  
USGS Oregon Water Science Center**

## **Key Questions:**

- **Given the shifts in cyanotoxins, has there also been changes in the phytoplankton biovolumes or species composition?**
- **If so, what are the main drivers?**
- **How do the different years compare?**
  - **Snowpacks and hydrology**
  - **Reservoir fill rate and timing**
  - **Sunshine, precipitation, and wind**
- **What about nutrients from the 2020 wildfires?**
- **What spurred the large blooms in 2017 and 2018?**



# ***Data Analyses & Approach***

## **Multivariate Statistics (Primer)**

- **Multivariate Ordination & Bubble Plots**
- **Similarity Percentages (SIMPER)**
- **Biota-Environment (Bio-ENV) “BEST” Analyses**
- **Relate to Test for Global change over years**
- **Iterative process**

## **Datasets (2011-2022):**

- **USACE/USGS: continuous water quality and flow monitors  
dam operations, hydrology, water temperature**
- **City of Salem: Boat-based sampling (3 locations)  
phytoplankton, toxins, nutrients, sonde parameters (EXO)**
- **USDA/USFS: met station near Mongold State Park**
- **precipitation, solar, wind speed & direction**

# Phytoplankton Assemblages

# Environmental Variables

**Metadata** 3 sites: Log boom, Heater Creek and Blowout Creek Arms  
Phytoplankton biovolume, averaged over each week  
Percent biovolume, averaged over each week  
April through October, 2011-2022  
Samples: Log boom (n=254), All sites (n=632)

**Algae ID** Data harmonized and consolidated  
Combined Rhodomonas & Plagioselmis  
*Dolichospermum* - many species, inconsistent evaluation (speciated in early years, but not in latter years)

Combined Species into Genera

**Final dataset: 48 Genera**

## Hydrology

Lake elevation  
Outflow-Inflow (Q difference)  
Precipitation-24h  
Precipitation-accumulation

## Sun/temperature

Solar-accumulation  
Surface temperature  
Thermocline depth  
Degree days  
Air temp (min)  
Air temp (max)  
Air temp (avg)  
Evapotranspiration (ET)  
Relative humidity  
Dew point

## Wind

Wind average 24  
Wind peak  
Wind run (m/d)  
Wind direction

## Nutrients

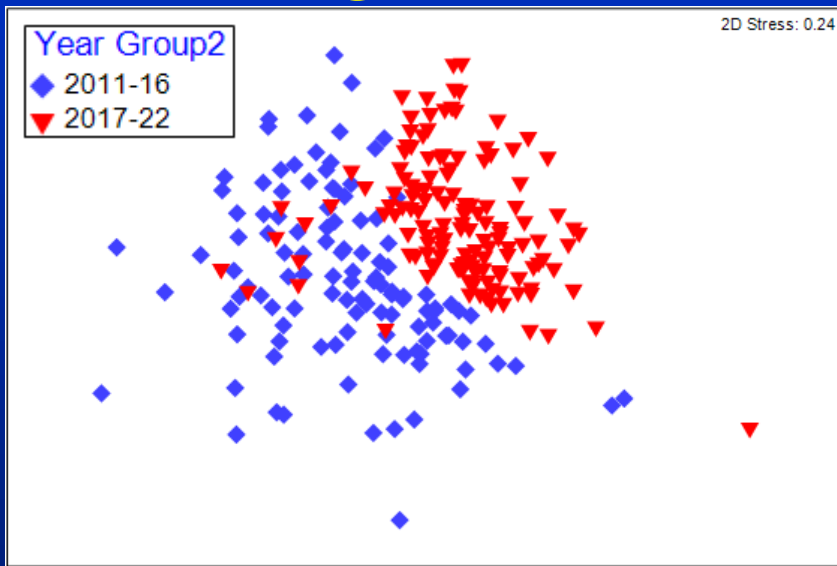
Ammonium-nitrogen  
Nitrite+nitrate-nitrogen  
Total nitrogen



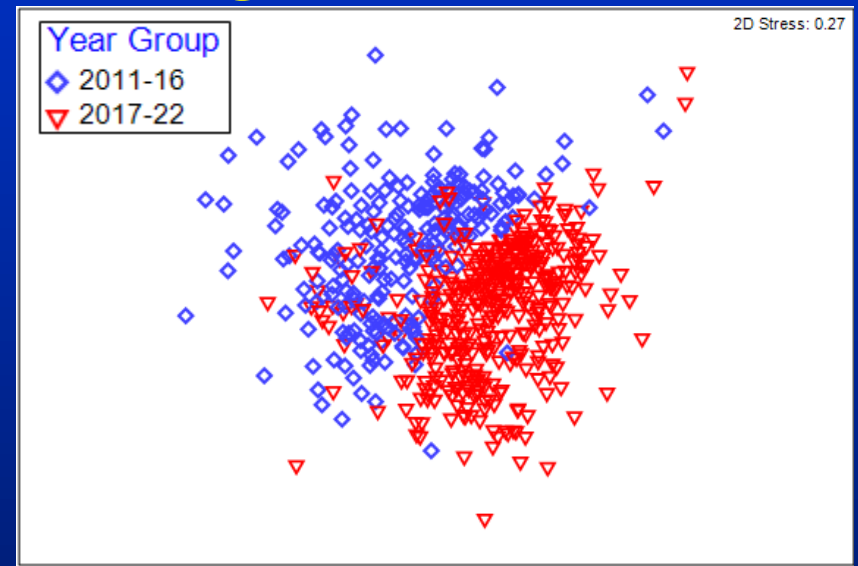
# Ordination Results

- Separation of 2011-2016 vs. 2017-2022 samples
- Based on Genus biovolumes

## *Log boom*



## *Log boom & Arms*



*What changed in 2017?*

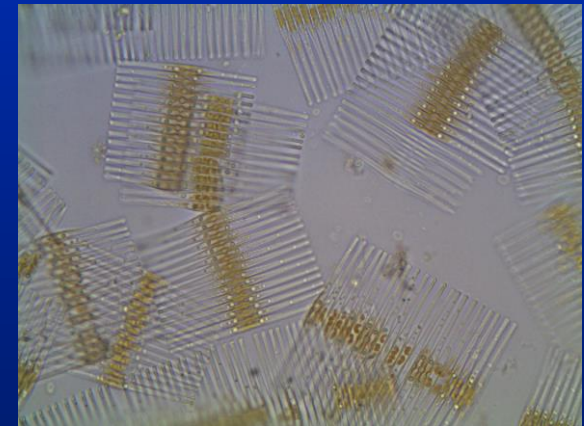
# SIMPER Results

- Six taxa showed notable increases in average percent biovolumes
- *Dolichospermum* was nearly twice as abundant in recent years

Taxa	Group Averages (%BV)		
	2011-2016	2017-2022	Change
<i>Dolichospermum</i> spp.	32	29	no change
<i>Asterionella formosa</i>	12	8	no change
<i>Plagioselmis</i> & <i>Rhodomonas</i>	10	9	no change
<i>Cryptomonas</i>	6	5	no change
<i>Fragilaria crotonensis</i>	8	15	++
<i>Aulacoseira</i>	3	6	++
<i>Cyclotella</i>	1	5	++
<i>Gloeotrichia</i>	0	4	++
<i>Aphanizomenon</i>	4	1	--



*Dolichospermum*  
Photo by Barry Rosen

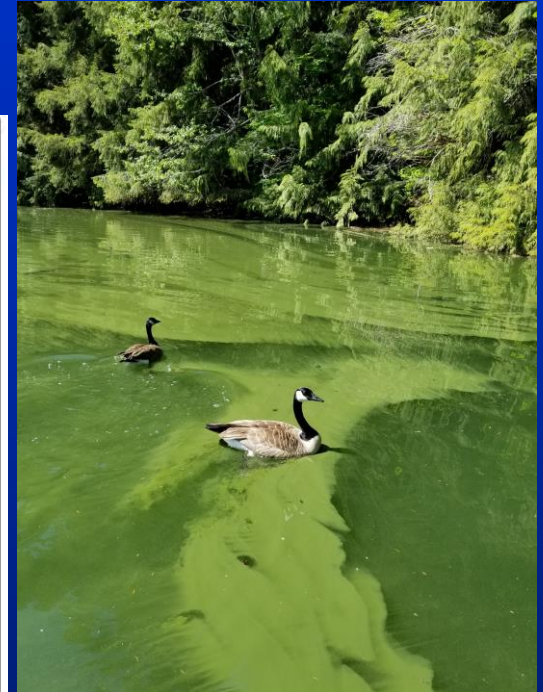
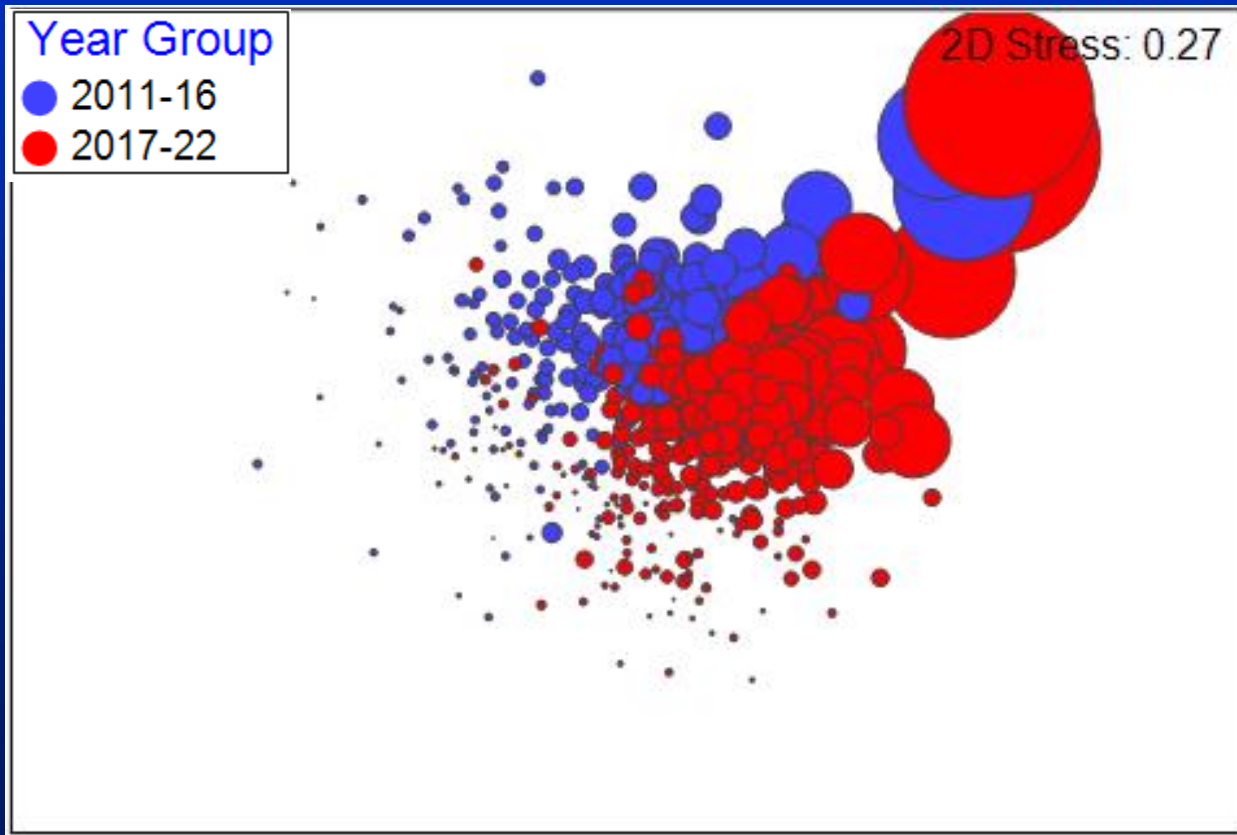


*Fragilaria crotonensis*

# Bubble Plot Results

- *Dolichospermum* biovolume strongly governed the distribution of samples in the ordination

## Log boom & Arms



*Dolichospermum* bloom  
Photo by Brandin Hilbrandt

# Bio-ENV Results

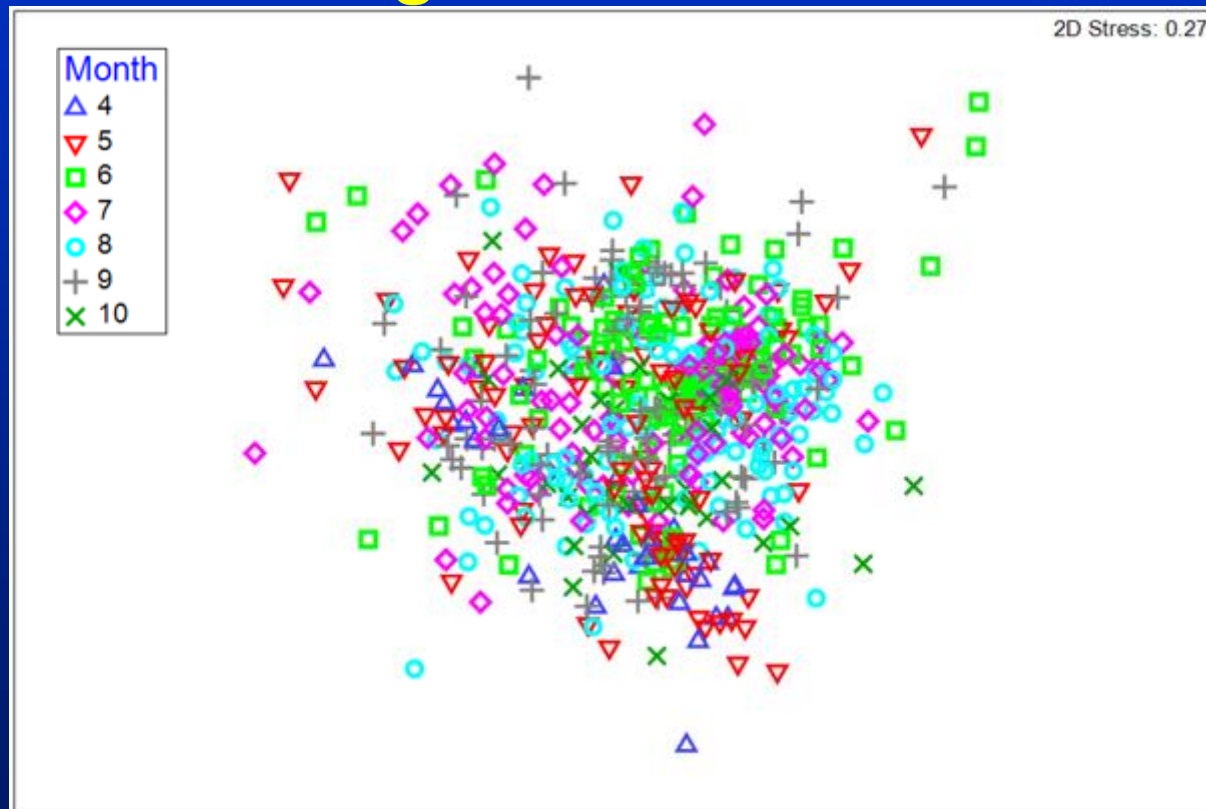
- Highest Rho values for **temperature related variables**
- Wind direction (East wind events?)
- Depth to spillway (dam operations?)

		LB	LB & Arms
Top Single "BEST" Variable	Significance level	Rho	Rho
**Surface water temperature	$p < 0.01$	0.203	0.157
Minimum air temperature	--	--	0.134
Average air temperature	--	--	0.112
Thermocline depth	$p < 0.01$	0.124	0.103
Q difference (outflow-inflow)	--	--	0.09
Wind direction	$p < 0.01$	0.078	0.09
Maximum air temp	$p < 0.01$	0.065	0.087
Depth to spillway	$p < 0.01$	0.059	0.082
<b>Top 2-Variable model</b>			
**Surface water temperature & Depth to spillway	$p < 0.01$		0.176
<b>Top Multi-Variable model</b>			
**Surface water temperature & Min air temp, Wind direction, Depth to spillway	$p < 0.01$		0.191
<b>**Top models</b>			

# Other Ordination Results - BV

- Except for April, much overlap in sample months suggests different seasonal patterns among the various years

## Log boom & Arms

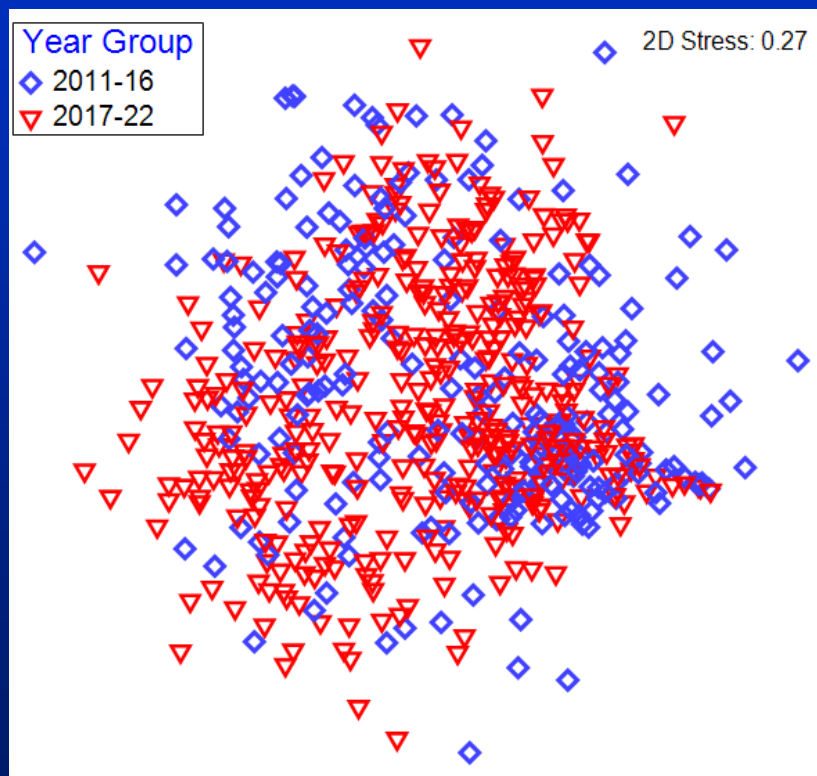




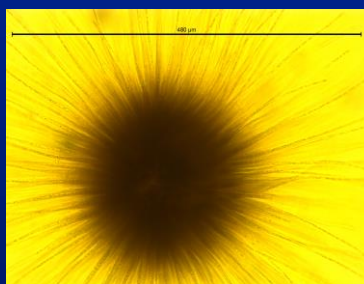
# Other Ordination Results - %BV

- Much overlap in samples among year groups suggests minimal changes in the phytoplankton assemblage character

## Log boom & Arms



Genera	Group Averages (%BV)		
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<i>Gloeotrichia</i>	0	4	++
<i>Aphanizomenon</i>	4	1	--



*Gloeotrichia*  
Photo by Barry Rosen



*Gloeotrichia*  
Photo by Brandin Hilbrandt

# Conclusions

- Ordinations point to a change after 2016, with notable increases in the biovolumes of *Dolichospermum* and other algae suggesting more favorable growing conditions
- While phytoplankton populations were larger in Detroit Lake in the recent years, the species composition hasn't changed substantially—*Dolichospermum* is still dominant, *Fragilaria crotonensis* & *Asterionella* are still subdominant
- High similarity among sample BVs from the log boom and the two Arms suggest mixing and exchange by wind and currents, although the sheltered Arms had higher BV of *Dolichospermum* and scums
- Bio-ENV analyses identified water temperature as having the greatest influence on phytoplankton assemblage composition and biovolume
- Wind speed and direction, and depth from surface to spillway, were also statistically significant variables being correlated with the phytoplankton assemblages
- Taken together, these results support a hypothesis that dam operations (use of the spillway) could have an important governing influence over the growth rates of algae and HABs in Detroit Lake through effects on residence times and temperature in the sunlit surface layer of the lake.