



MURKY LAKES increase in the US: Implications for food webs

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My Interests:

Effects of human-induced environmental change on aquatic communities

Structure

- Species diversity
- Abundance
- Distribution

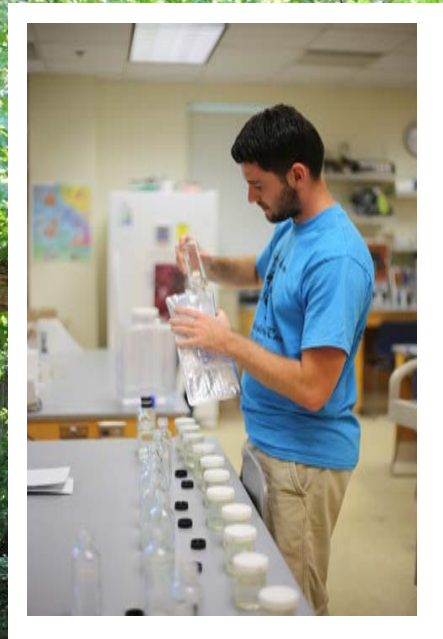
Function

- Predation
- Food Web Stability
- Biogeochemical Cycling



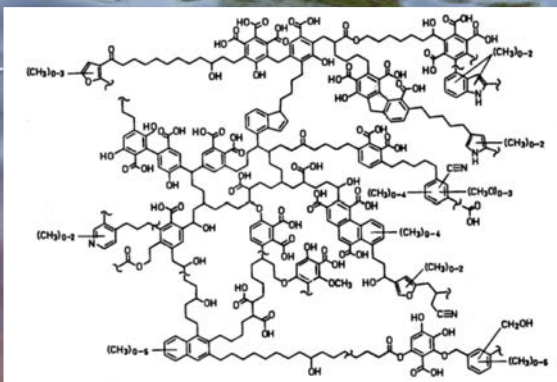


**CLEAN
VIRGINIA
WATERWAYS**



Appomattox River Watershed Monitoring

Dissolved Organic Matter



Color Spectrum of Lakes



Blue



Green

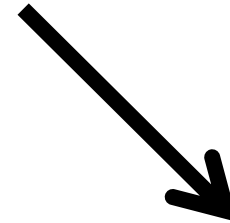
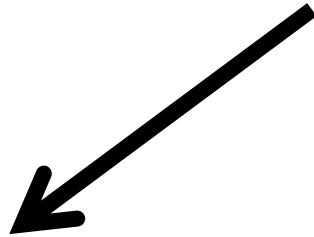


Brown

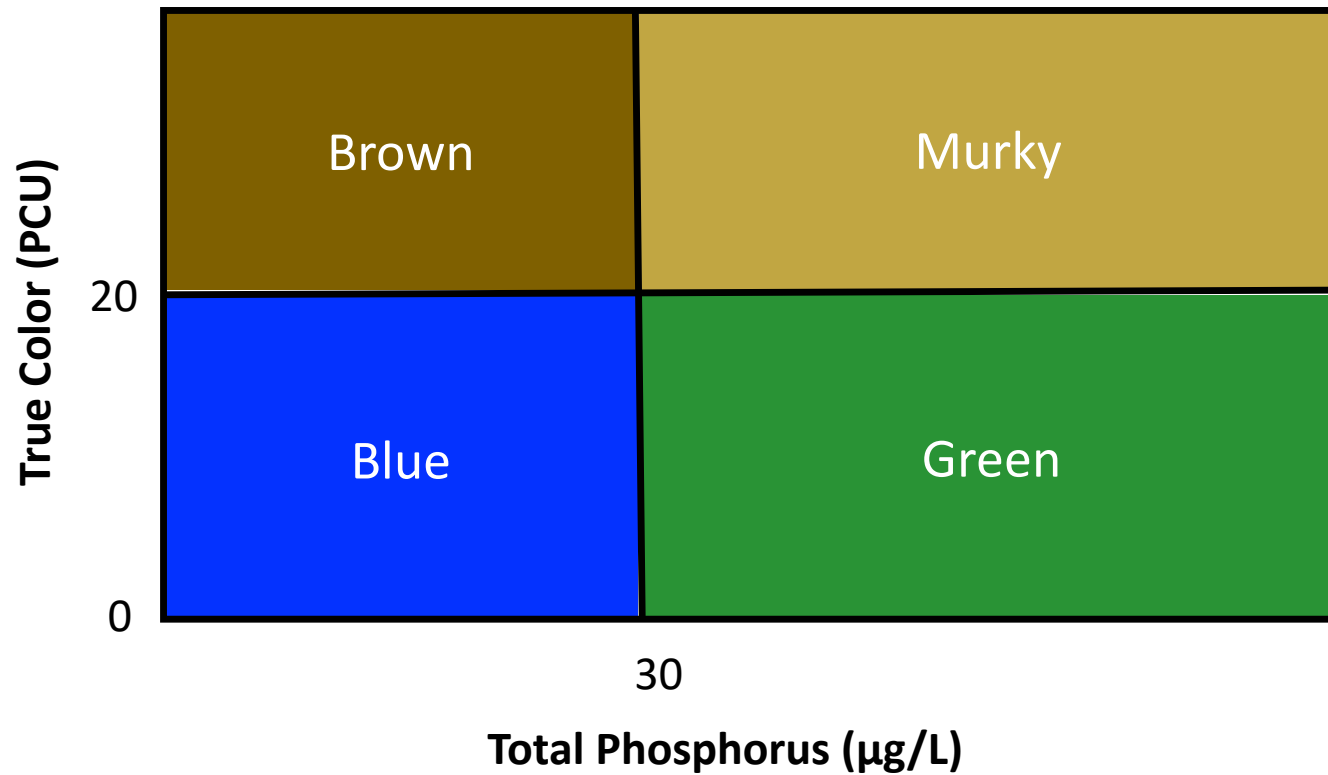


Murky

Eutrophication and Brownification



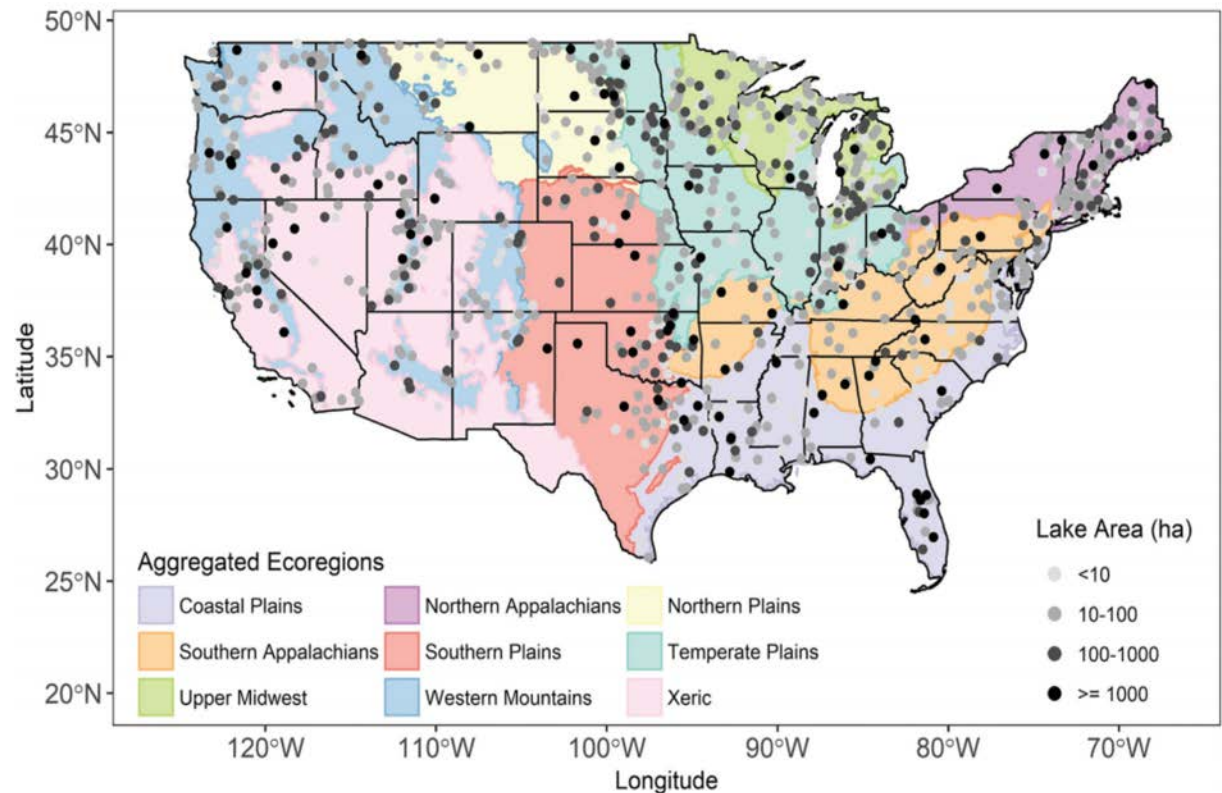
Lake Nutrient-Color Status





US EPA National Lakes Assessment

- Five Year Cycle
 - 2007
 - 2012
- Sample 1000+ lakes
- Stratified, randomized design



Virginia Lakes Surveyed, 2012

County	Lake	County	Lake
ALBEMARLE	Wentworth Pond	PATRICK	Talbott Reservoir
AMELIA	Beaver Pond	PETERSBURG	Bremco Park Pond
CAROLINE	Dalton Millpond	POWHATAN	Pohatten Pond
CHESTERFIELD	Unnamed	PRINCE EDWARD	Spring Creek Lake
CULPEPER	Bald Run Reservoir	PRINCE WILLIAM	Lake Montclair
DINWIDDIE	Wheeler's Pond	PULASKI	Gatewood Reservoir
DINWIDDIE	Jordon Lake	ROANOKE	Waterfall Pond
FAIRFAX	Lake Anne	ROANOKE	Waterfall Pond
FAUQUIER	Nissley Pond	ROCKINGHAM	Shoemaker River Resorvior
FRANKLIN	Bowmans Pond	RUSSELL	Lake Bonaventure
HENRY	Lester Pond	RUSSELL	Lake Laurel Bed
JAMES CITY	Jolly Pond	SOUTHAMPTON	
JAMES CITY	Little Creek Lake	SPOTSYLVANIA	Wrights Pond
JAMES CITY	Woodstock Pond	SUFFOLK	Fishing Lake
KING AND QUEEN	Ice House Pond	VIRGINIA BEACH	North Bay
LANCASTER	Blakemore Millpond	VIRGINIA BEACH	Lake Number 1
LOUISA	Merle-Smith Lake	YORK	Cheatham Pond
NEW KENT	Unnamed	YORK	Waller Mill Pond

Data Analysis

- **Water Quality**
 - Total phosphorus
 - Water color
- **Biological Samples**
 - Phytoplankton
 - Zooplankton
- **Field Sampling**
 - Sampled once in the summer
 - Deepest point in lake



Hypotheses

- Lake Nutrient-Color Status

- **Blue** → Decrease
- **Green, Brown, Murky** → Increase

- Biological Characteristics

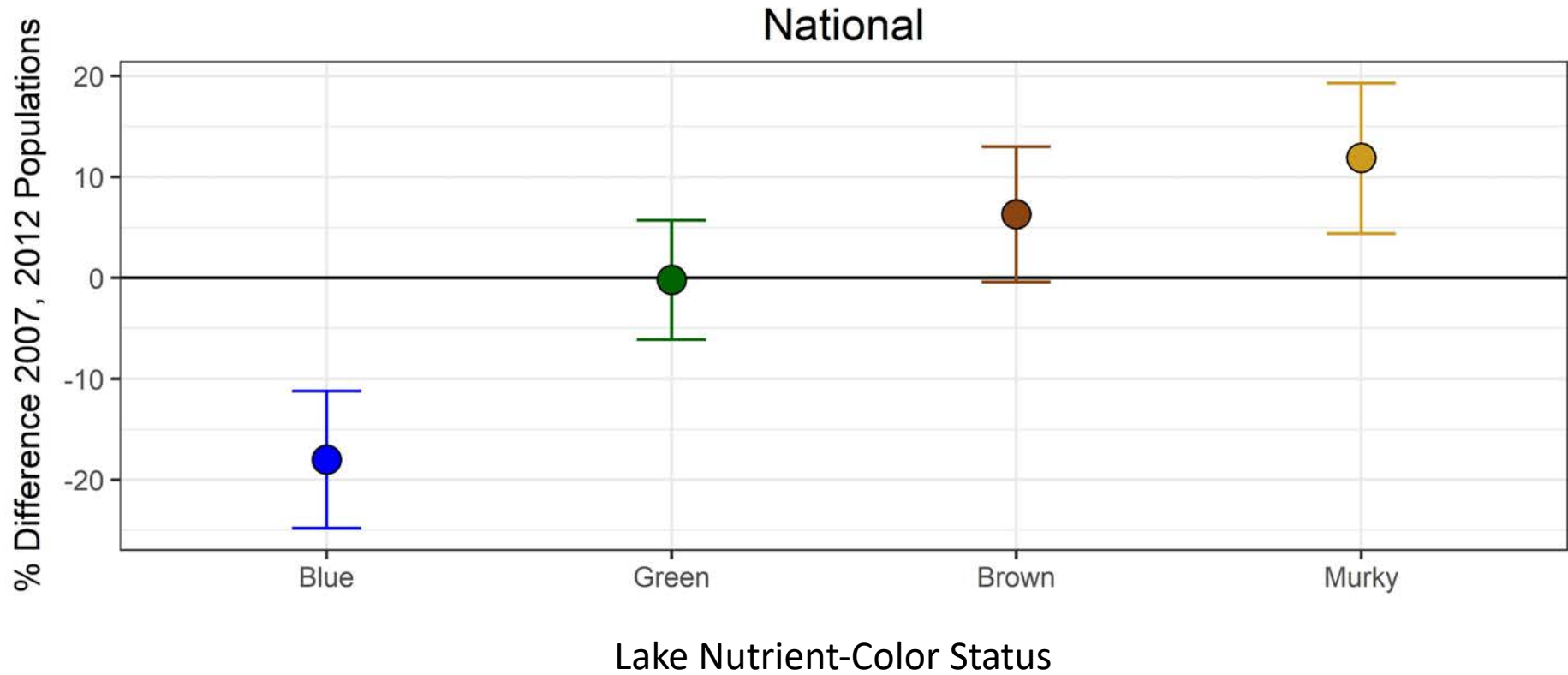
- Phytoplankton: **Blue** < **Brown** < **Green** < **Murky**
- Zooplankton: **Blue** < **Brown** < **Green** < **Murky**

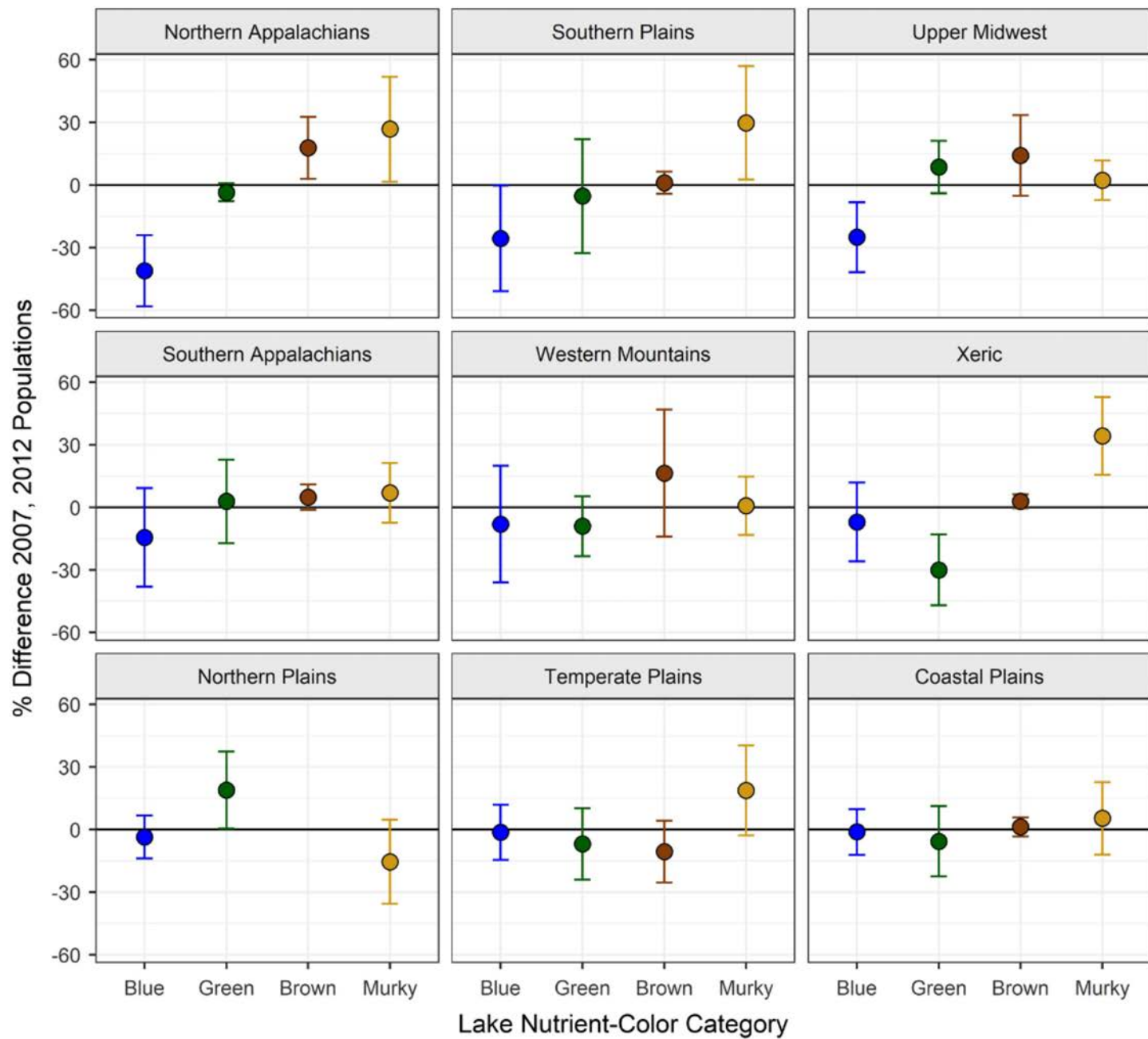


Results



Shifts in Lake Nutrient-Color Status





Population Estimates, NLA 2012

Lakes greater than >4 ha

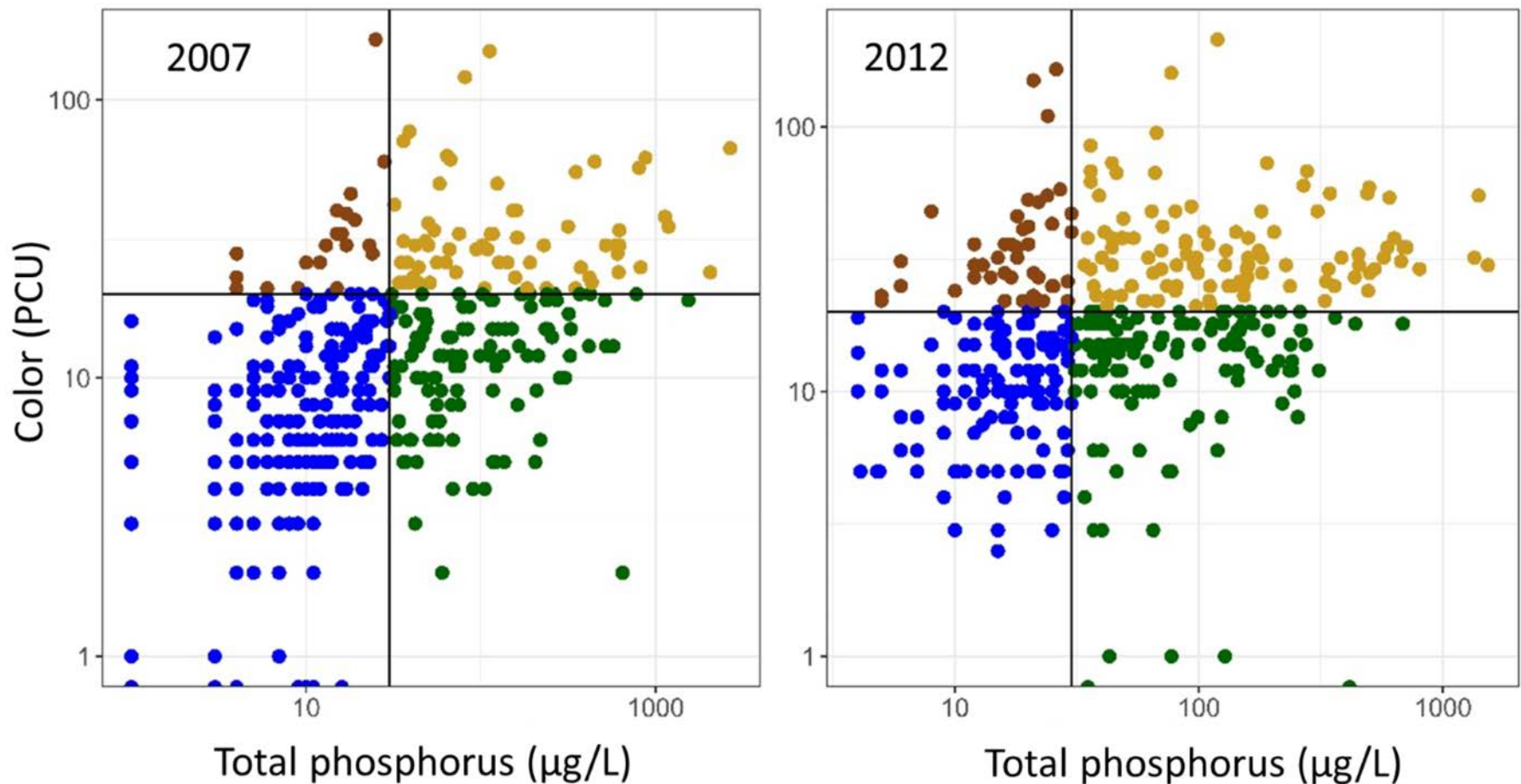
- Lake Nutrient-Color Status

	2007 vs 2012	# Lakes in 2012
• Blue	46 to 28%	31,309
• Green	21 to 21%	23,482
• Brown	10 to 16%	17,891
• Murky	23 to 35%	39,136

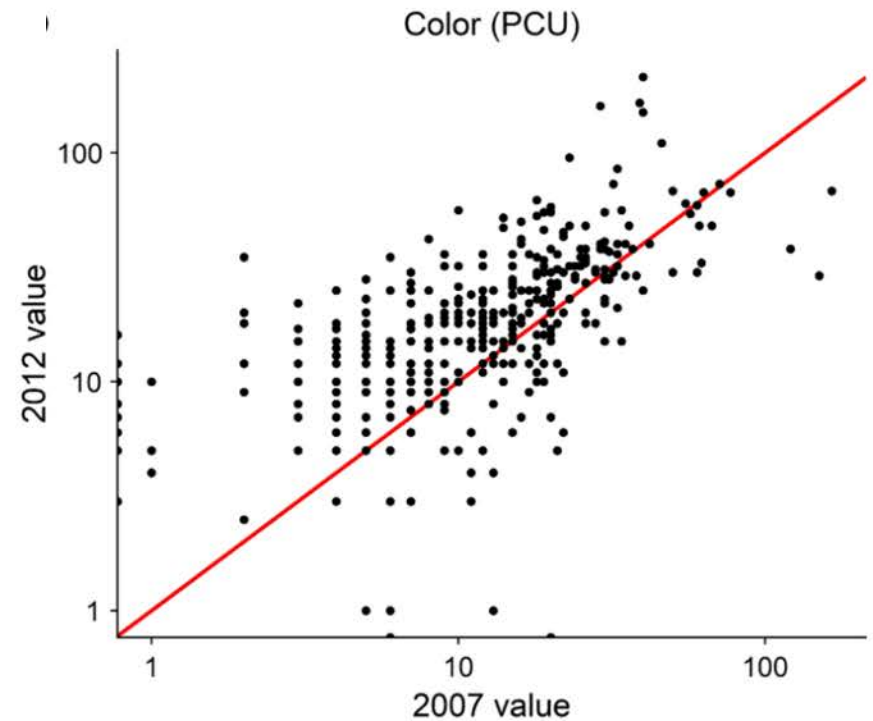
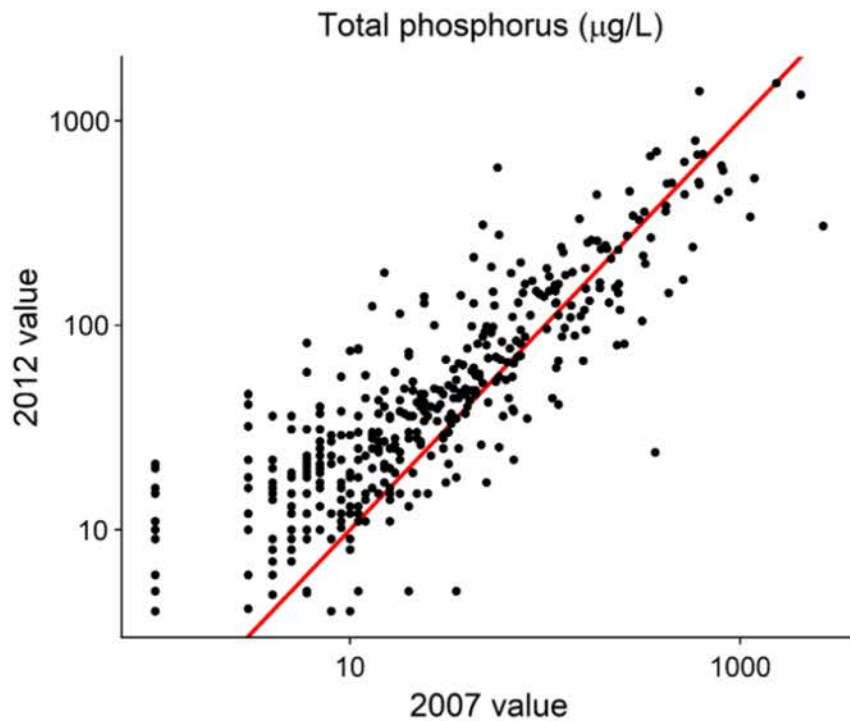


Shifts in Lake Nutrient-Color Status

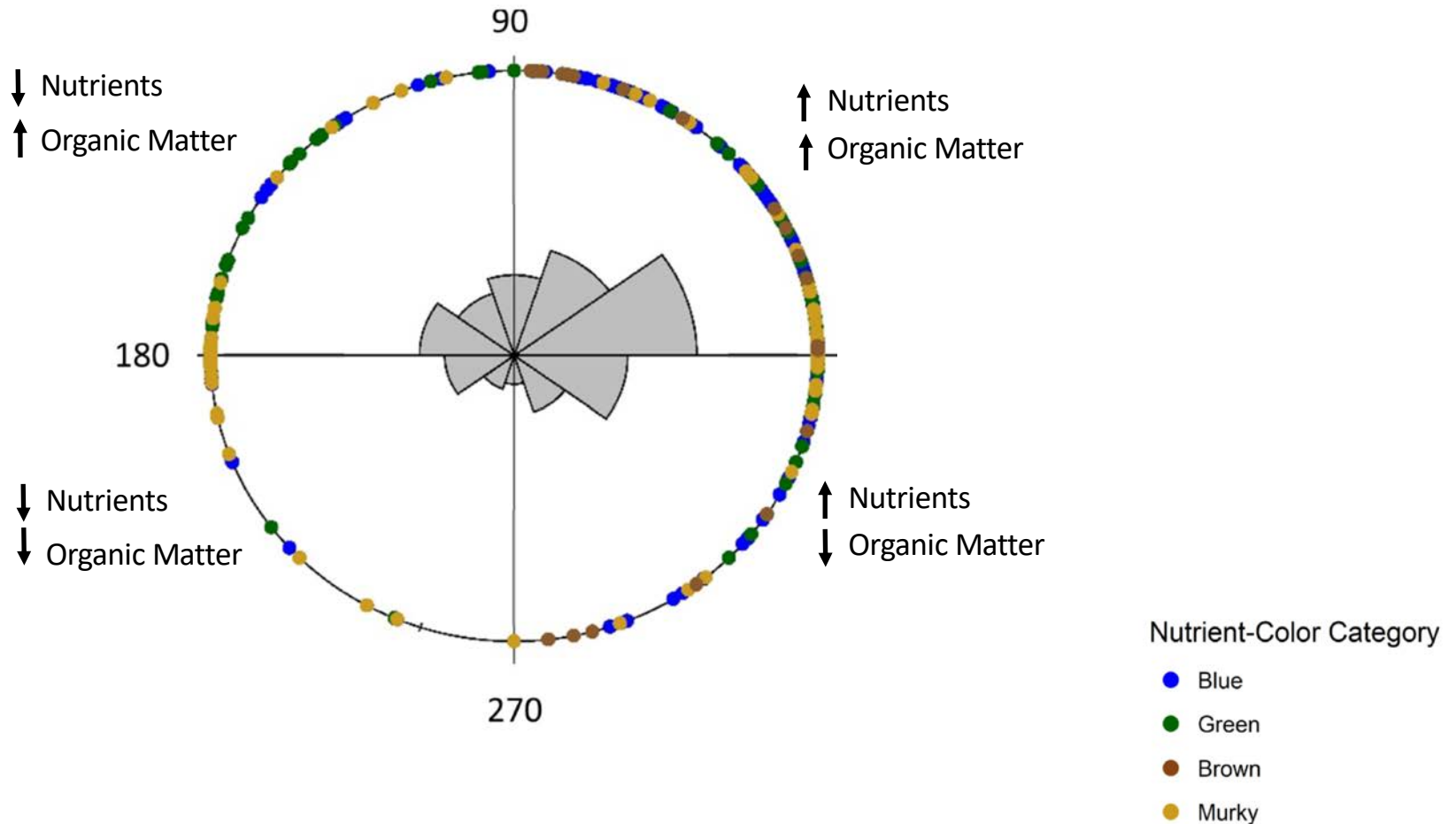
Resampled Lakes



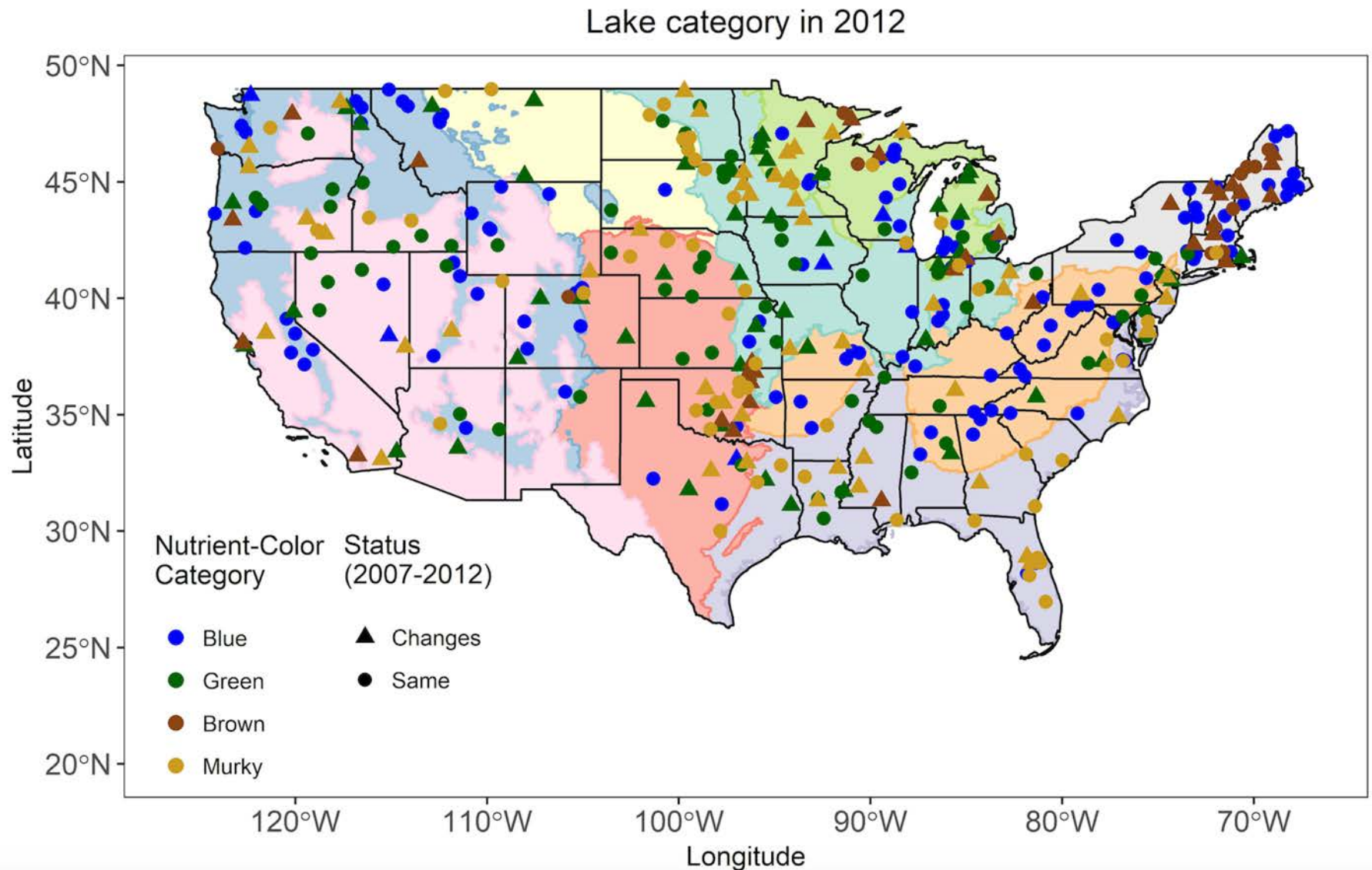
Shifts in Lake Nutrient-Color Status



Shifts in Lake Nutrient-Color Status



Shifts in Lake Nutrient-Color Status



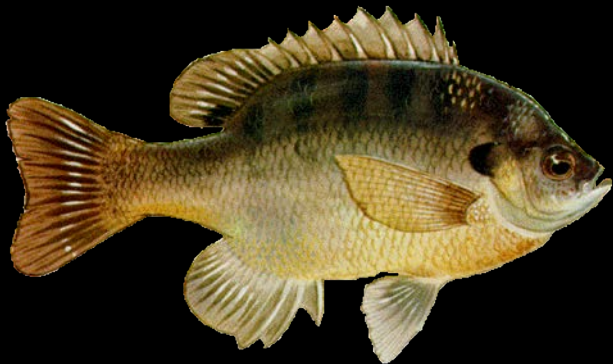
Shifts in Lake Nutrient-Color Status

(NLA 2007 vs. NLA 2012)

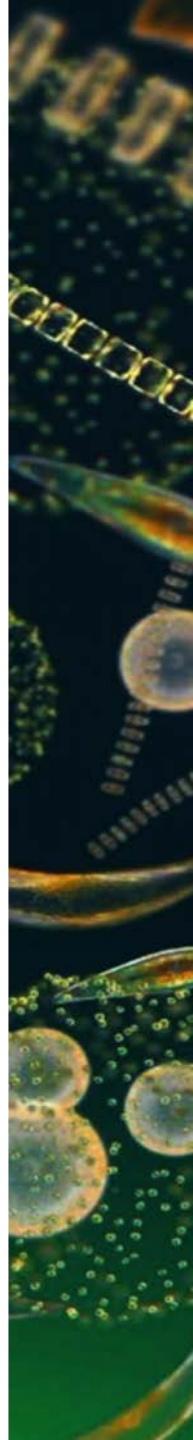
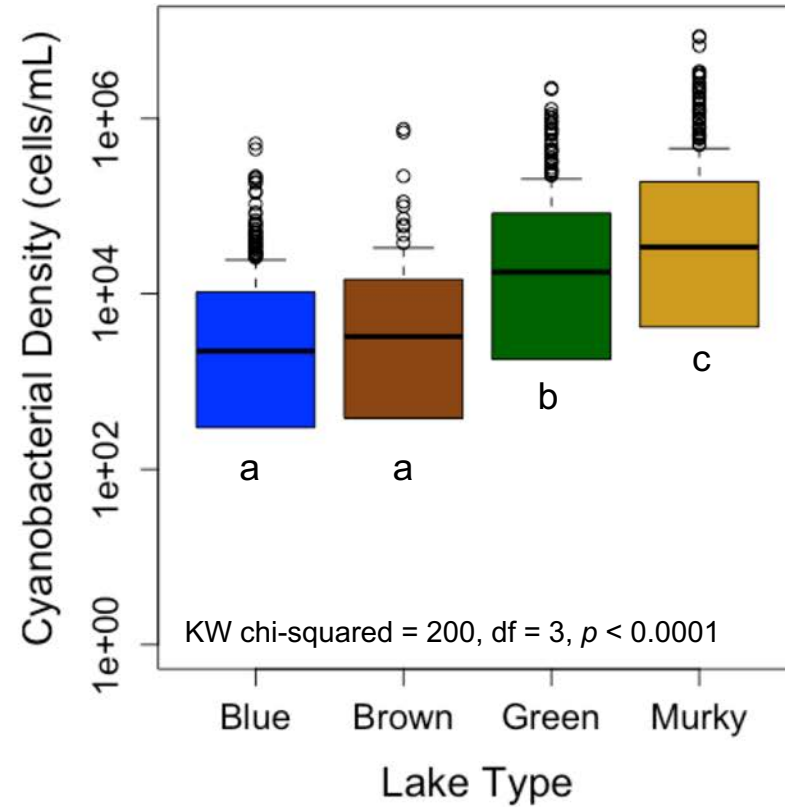
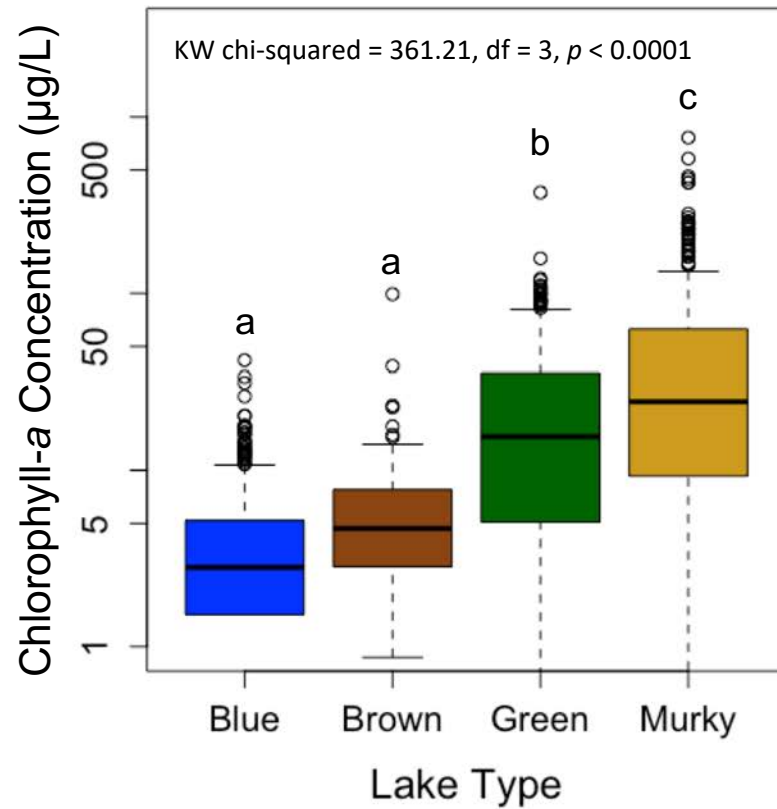
- **Blue lakes** decreased
- **Murky lakes** increased
 - By 2012, most dominant lake type
- No significant change in **Green** and **Brown** lakes



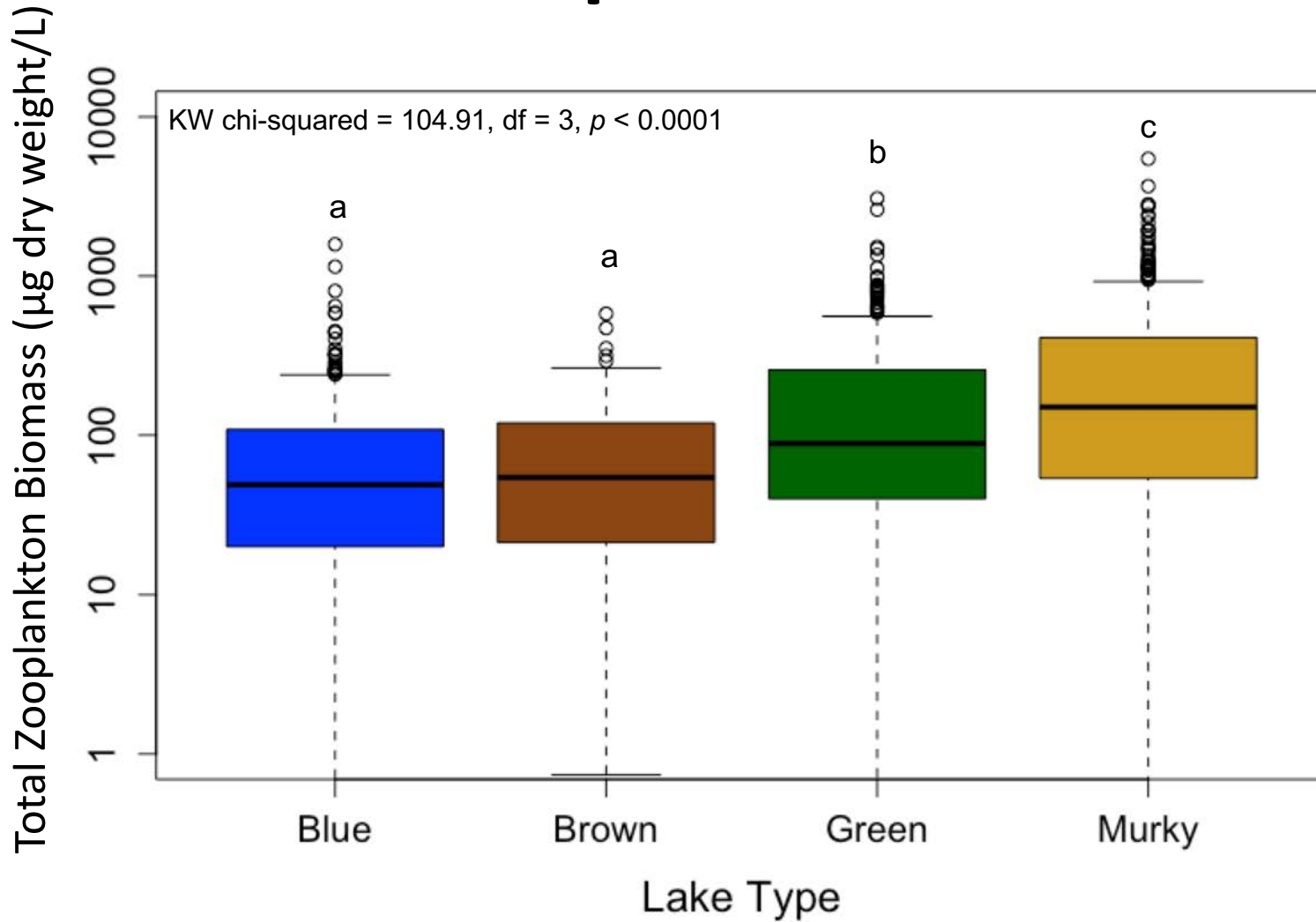
Food Web



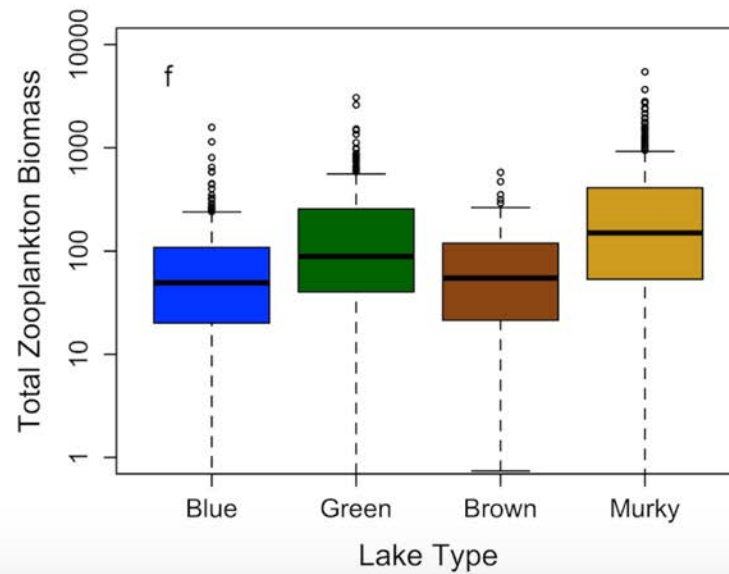
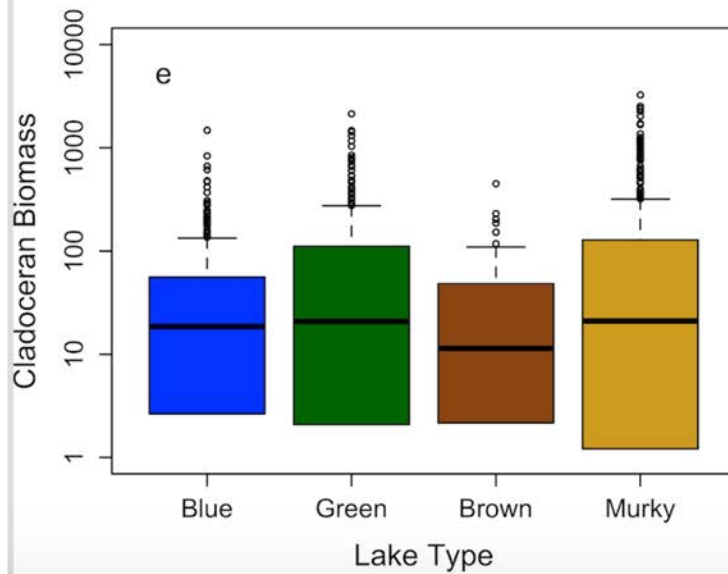
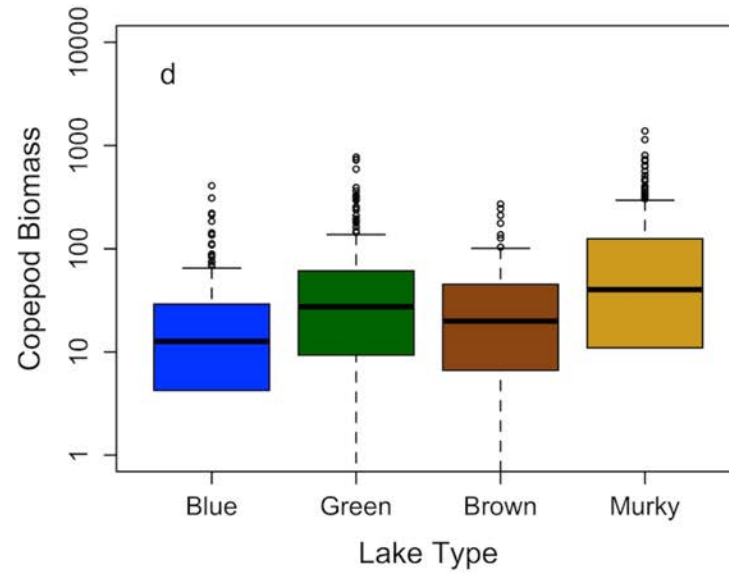
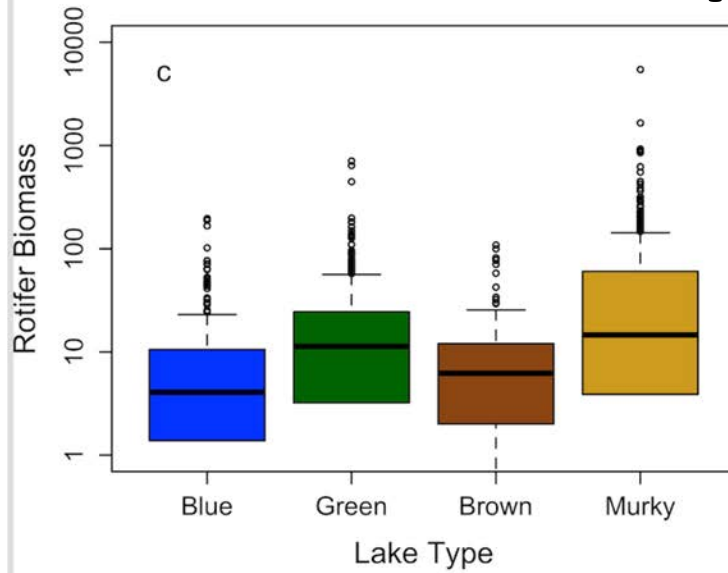
Phytoplankton



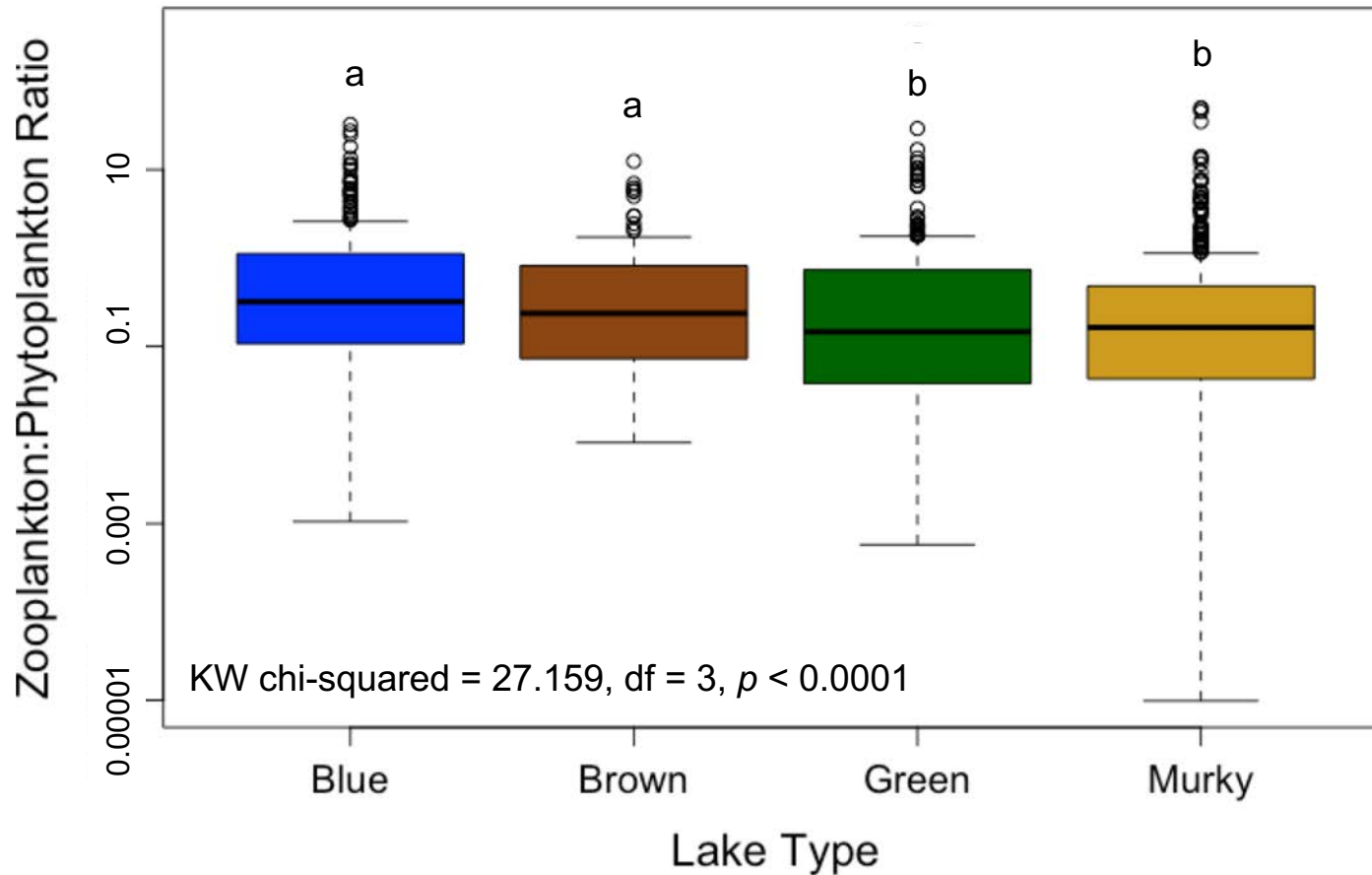
Zooplankton



Zooplankton



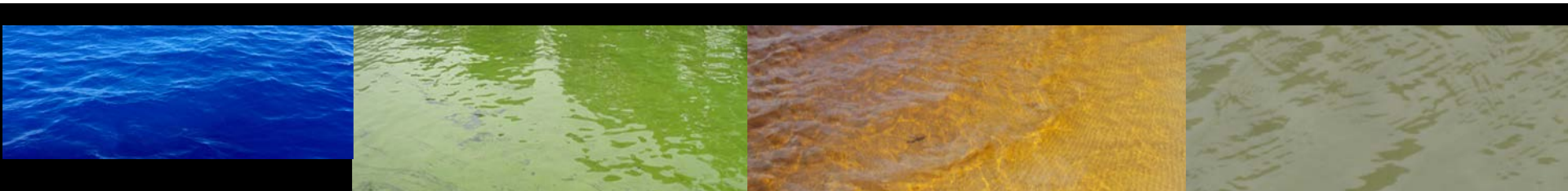
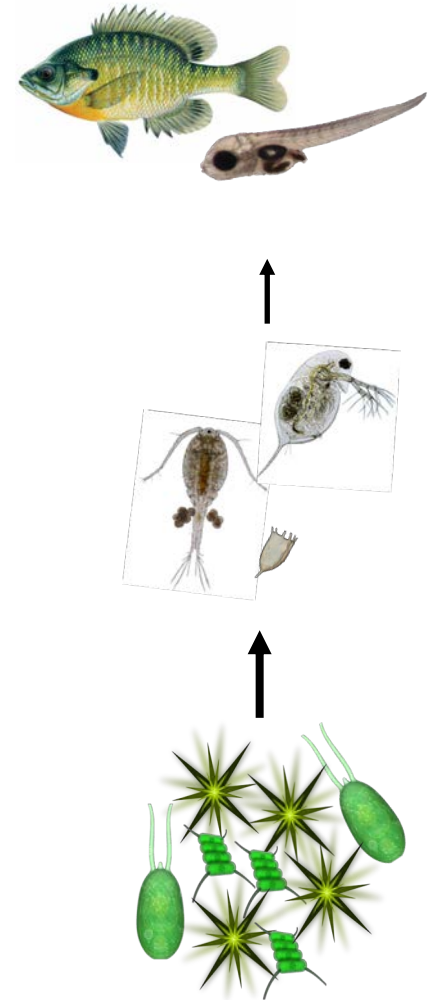
Zooplankton:Phytoplankton



Summary

- **Murky** lakes now the dominant lake type
- Declines in water quality
- Potential declines in food web stability

**** Published in *Limnology & Oceanography* (2018)**



A landscape photograph showing a calm pond or lake. On the left, there are several tall, dark evergreen trees and some bare deciduous trees. The water is still, reflecting the clear blue sky and the surrounding trees. In the foreground, there's a grassy bank with some fallen sticks and a small, dark object, possibly a bag or a piece of equipment. The overall scene is peaceful and natural.

Questions?