Hydrology & Water Chemistry in Isolated Pools along an Urban Ephemeral Stream in South Central Texas

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Introduction

- Ephemeral streams are common globally and flow into perennial rivers and floodplains following precipitation
- Urbanization has altered the hydrology & increased pollutants loads from runoff
- Multiple isolated pools exists within the dry channel that hold water for various periods of time in Central Texas
- Algae are the primary producers in isolated pools within ephemeral streams
  - No known studies have evaluated the hydrology & water quality of these isolated pools

Upper Section of Leon Creek

Channel at Bankfull

Isolated & contracting ephemeral pool

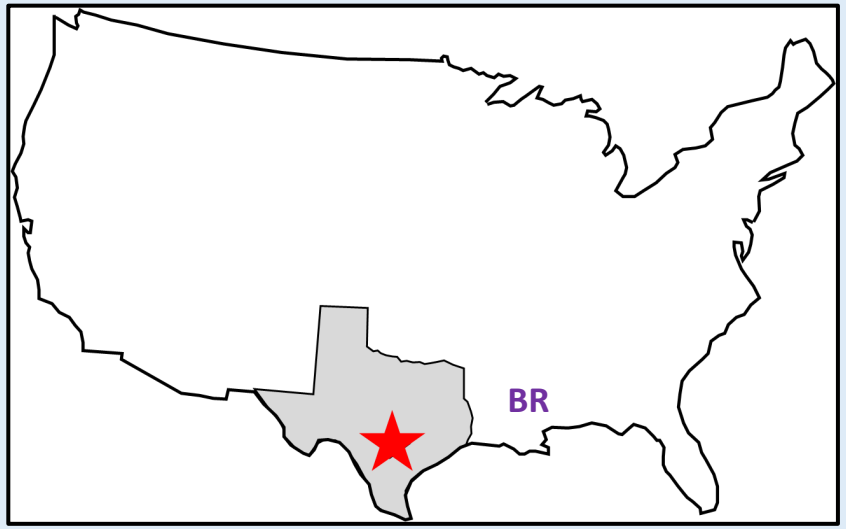
Flow recedes within 24-48 hours and pools become isolated within 3-5 days

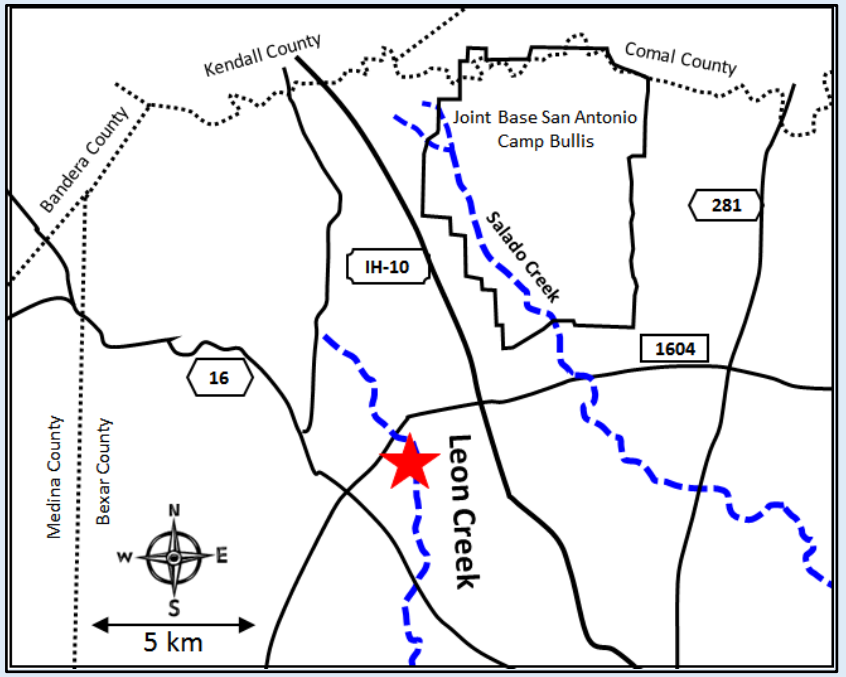
Objectives

- Estimate predictors of hydroperiod in isolated pools based on rainfall & other variables
- Evaluate water quality in isolated pools weekly over two years based on chlorphyll concentrations
- Determine predictors of algae biomass based on chlorophyll a and phycocyanin concentrations

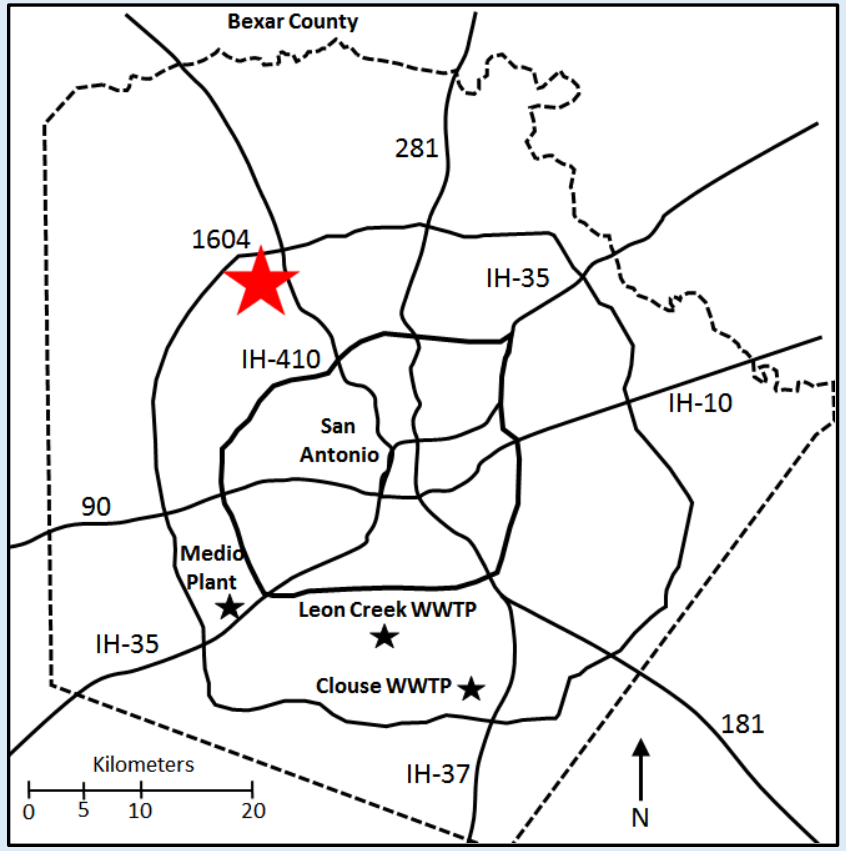
Methods

- Study occurred along a 1.5 km segment in the upper section of Leon Creek
- Isolated pools (n = 12) were sampled weekly (n = 107) after flow ceased from June 2021 to June 2023
- Eighteen (18) variables were analyzed in each pool (if water was present)
- Data was analyzed with an Anova or Kruskal-Wallis test, multiple regression, and Non-metric Multidimensional Scaling (NMDA)



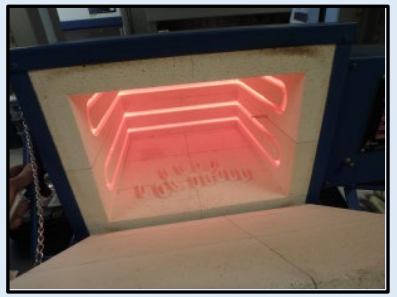


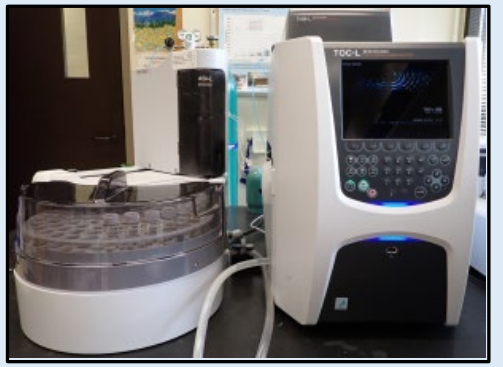
Leon Creek Greenway



Study Area

Variables Evaluated



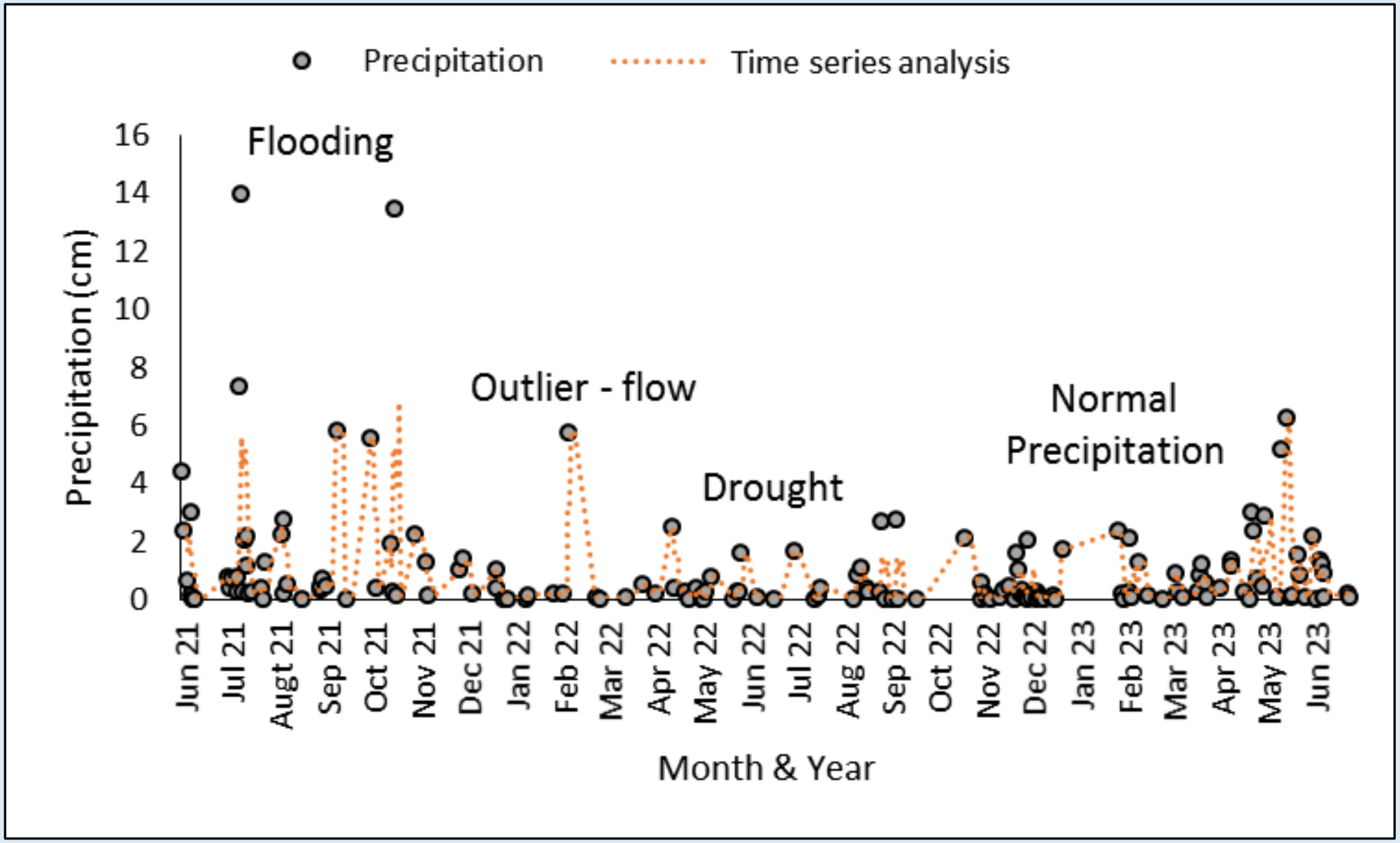


- **Season (S-F-W-Sp)**
- **Pools (1-12)**
- **Chlorophyll a (μg / L)**
- **Phycocyanin (μg / L)**
- Water temperature (°C)
- pH
- Conductivity (μs / cm)
- Turbidity (NTU)
- Dissolved oxygen (mg / L)

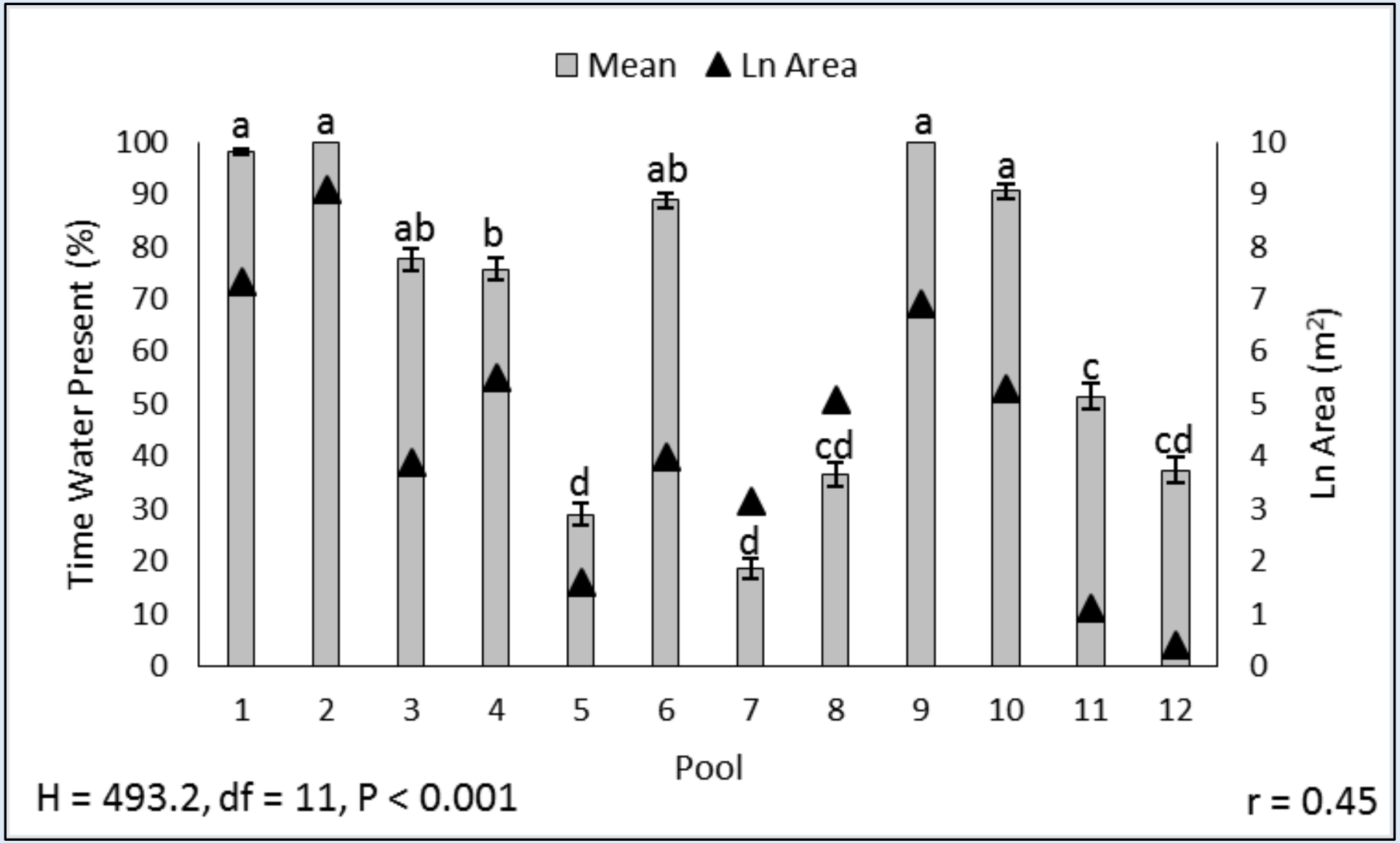
- ORP (mV)
- Canopy cover (%)
- Organic carbon (mg / L)
- Total nitrogen (mg / L)
- Sediment organic matter (%)
- Precipitation (cm; daily)
- Pool area (m^2)
- Mean depth (m)
- Hydrology (% time with water)

Results

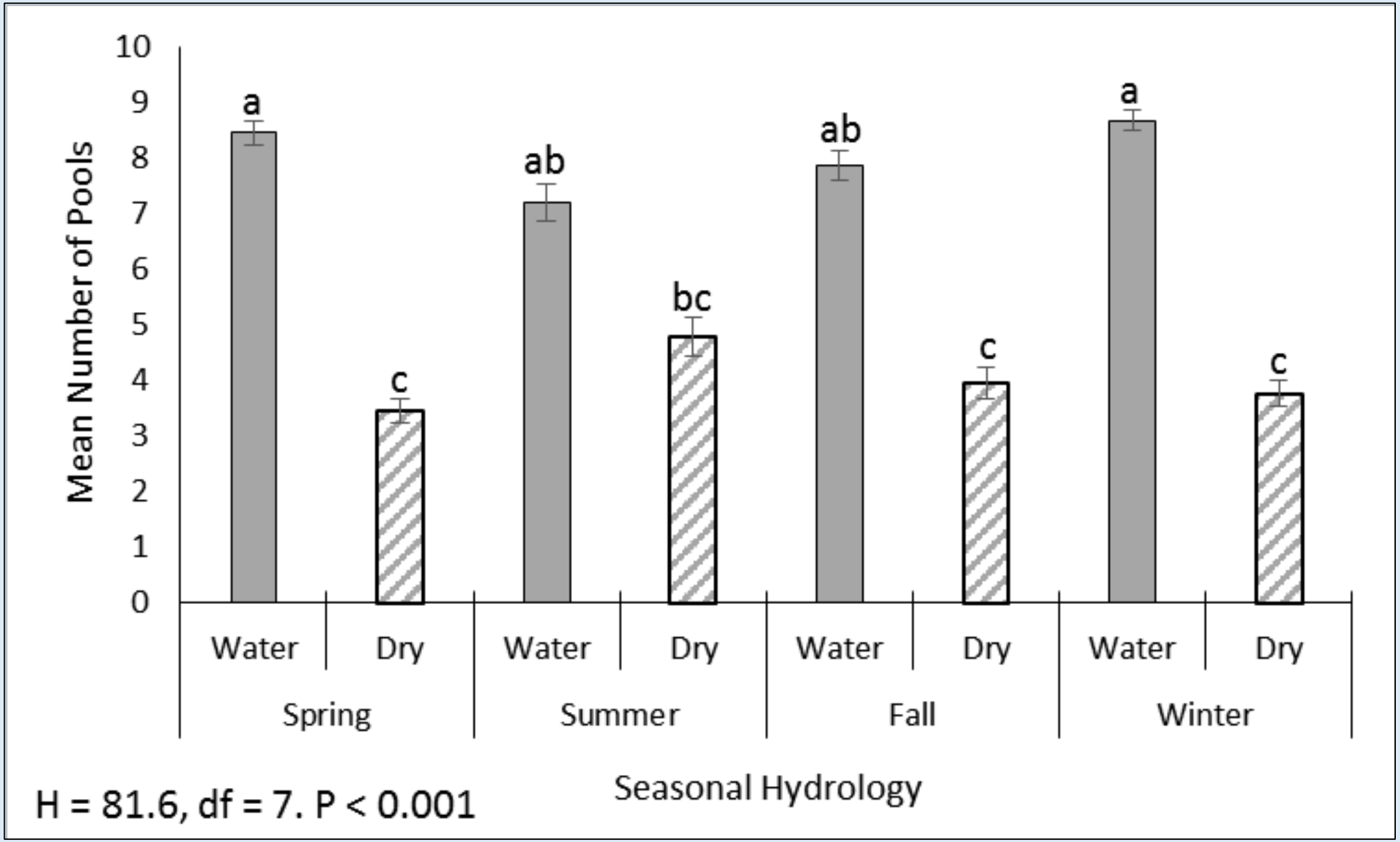
Precipitation Patterns During Study



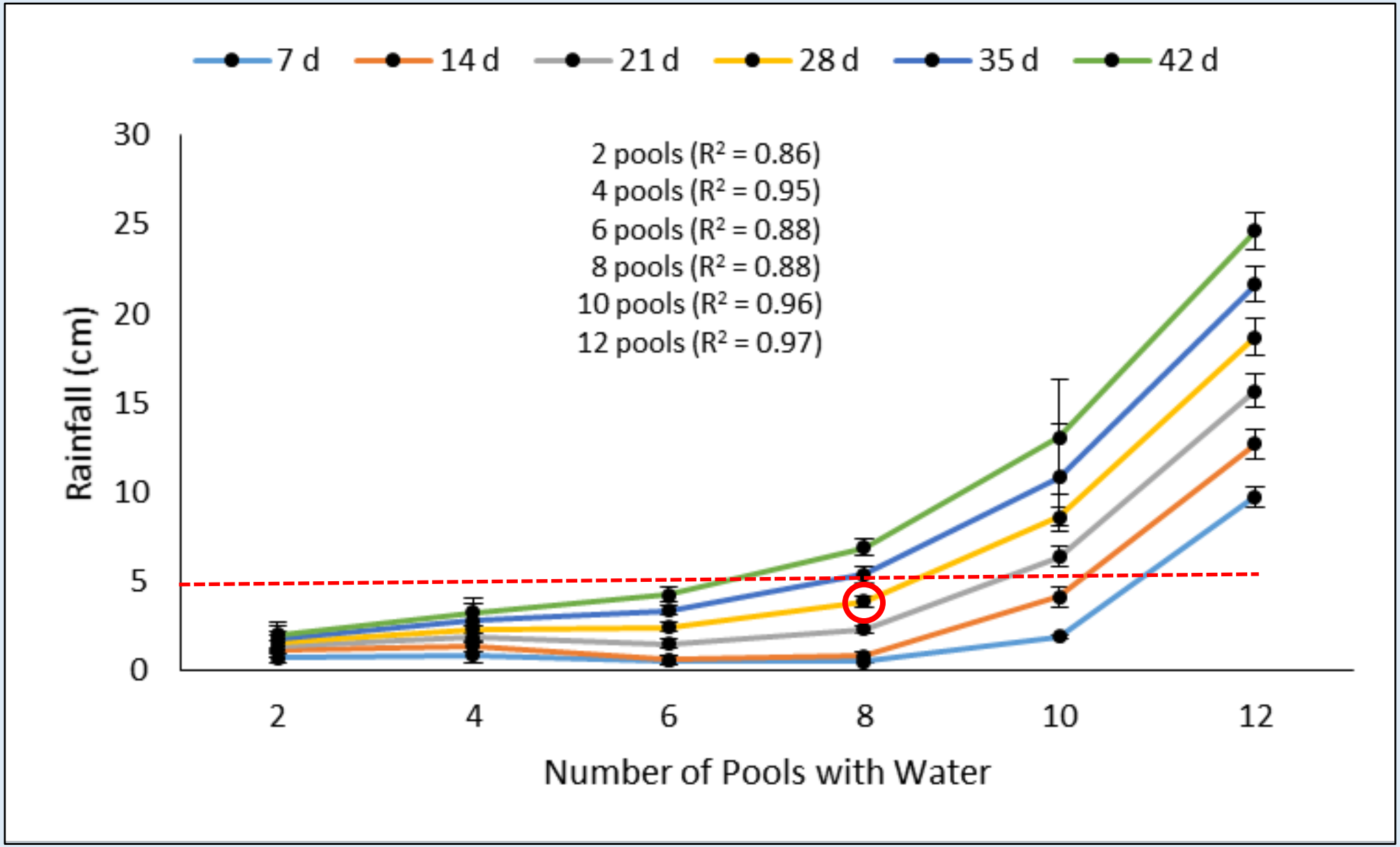
Pool Hydrology over the study period & area (Ln)



Seasonal Hydrology



Number of Pools with Water based on Cumulative Precipitation in last 7 to 42 Days



With 3.2 cm of precipitation over 28 days, 8 of the pools contain some volume of water

Pool Hydroperiod (% time with water)

Variable	Coeff.	Std Coeff.	Std Error	P-value
Constant	11.61		2.05	
ORP	-2.22	-0.55	0.45	<0.001
Max Depth	0.55	0.39	0.14	<0.001
Season	0.29	0.54	0.08	0.001
Temp (C)	1.13	0.49	0.35	0.002
OM%	-0.33	-0.33	0.12	0.009
Pool	-0.05	-0.26	0.02	0.047

$F(6, 41) = 13.3$, $P < 0.001$; $R^2 = 0.66$

Seasonal Differences Among Pools

Variable	Coeff.	Std Coeff.	Std Error	P-value
Constant	-0.34		4.53	
ORP	3.08	0.40	0.72	< 0.001
Temperature (°C)	-3.07	-0.70	0.32	< 0.001
DO	-1.73	-0.27	0.50	0.001
Hydroperiod	0.43	0.22	0.16	0.012
Canopy Cover	-0.25	-0.20	0.10	0.015
Organic carbon (mg/L)	-0.43	-0.17	0.21	0.044

$F(6, 41) = 27.4, P < 0.001; R^2 = 0.80$

Chlorophyll a Concentrations ($\mu g\ L^{-1}$)

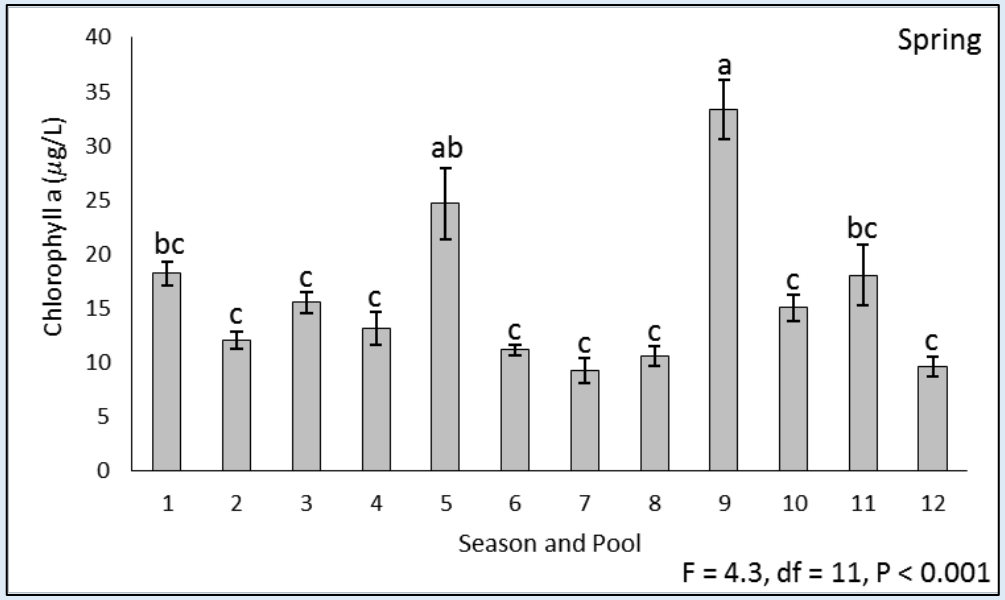
Variable	Coeff.	Std Coeff.	Std Error	P-value
Constant	-12.82		2.50	
pH	6.32	0.67	1.07	< 0.001
Precipitation (cm; daily)	0.69	0.51	0.17	< 0.001
Organic carbon (mg/L)	0.58	0.50	0.15	< 0.001
Total nitrogen (mg/L)	0.22	0.29	0.09	0.02
Turbidity (NTU)	-0.11	-0.26	0.05	0.03

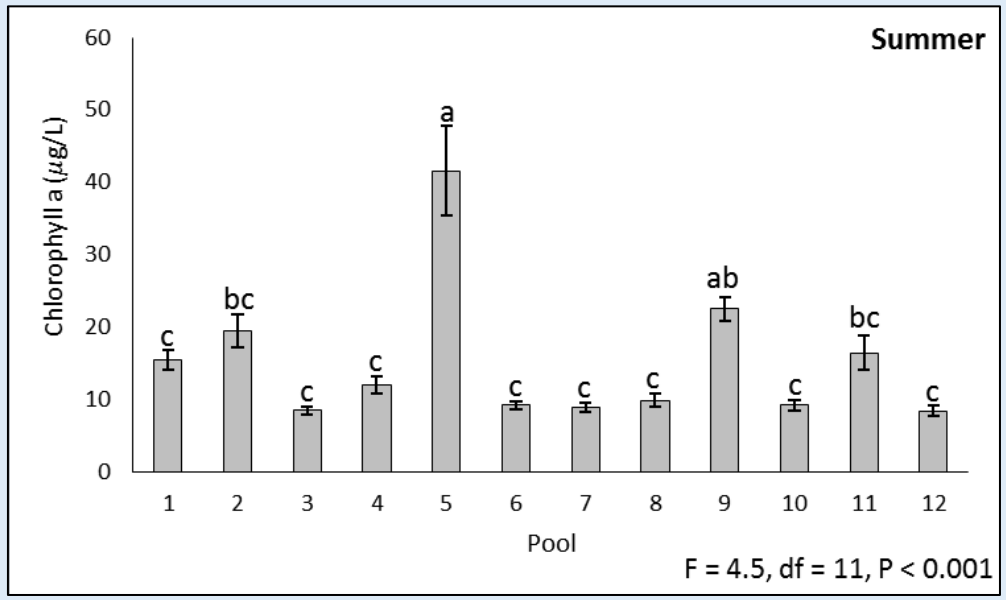
$F\ (5, 42) = 12.6,\ P < 0.001;\ R^2 = 0.60$

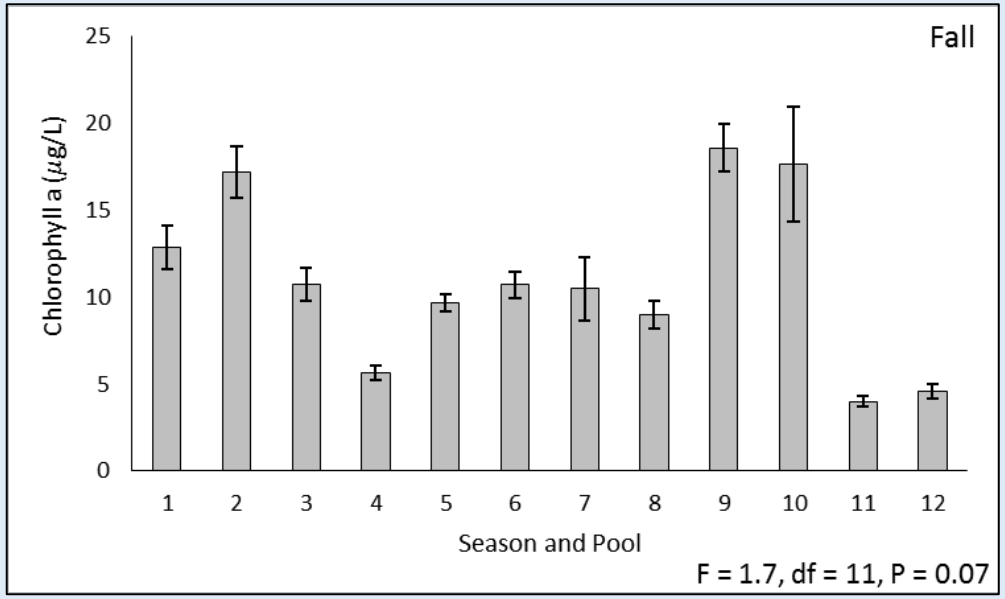
Chlorophyll a Concentrations by Season & Pool

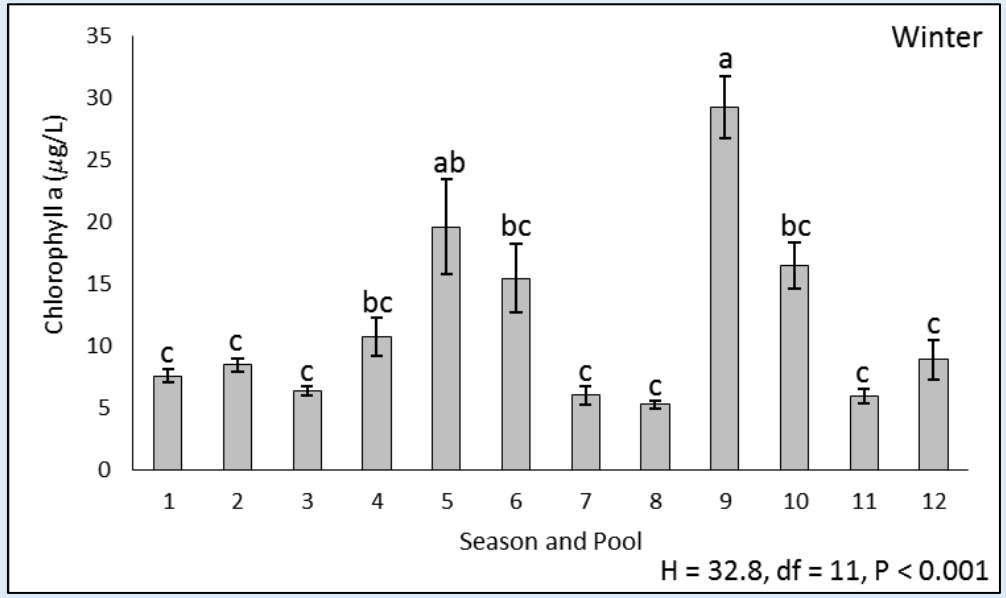
Season:
F = 16.2
df = 3
P < 0.001

Spring [a]
Summer [a]
Fall [b]
Winter [b]









Phycocyanin Concentrations ($\mu g\ L^{-1}$)

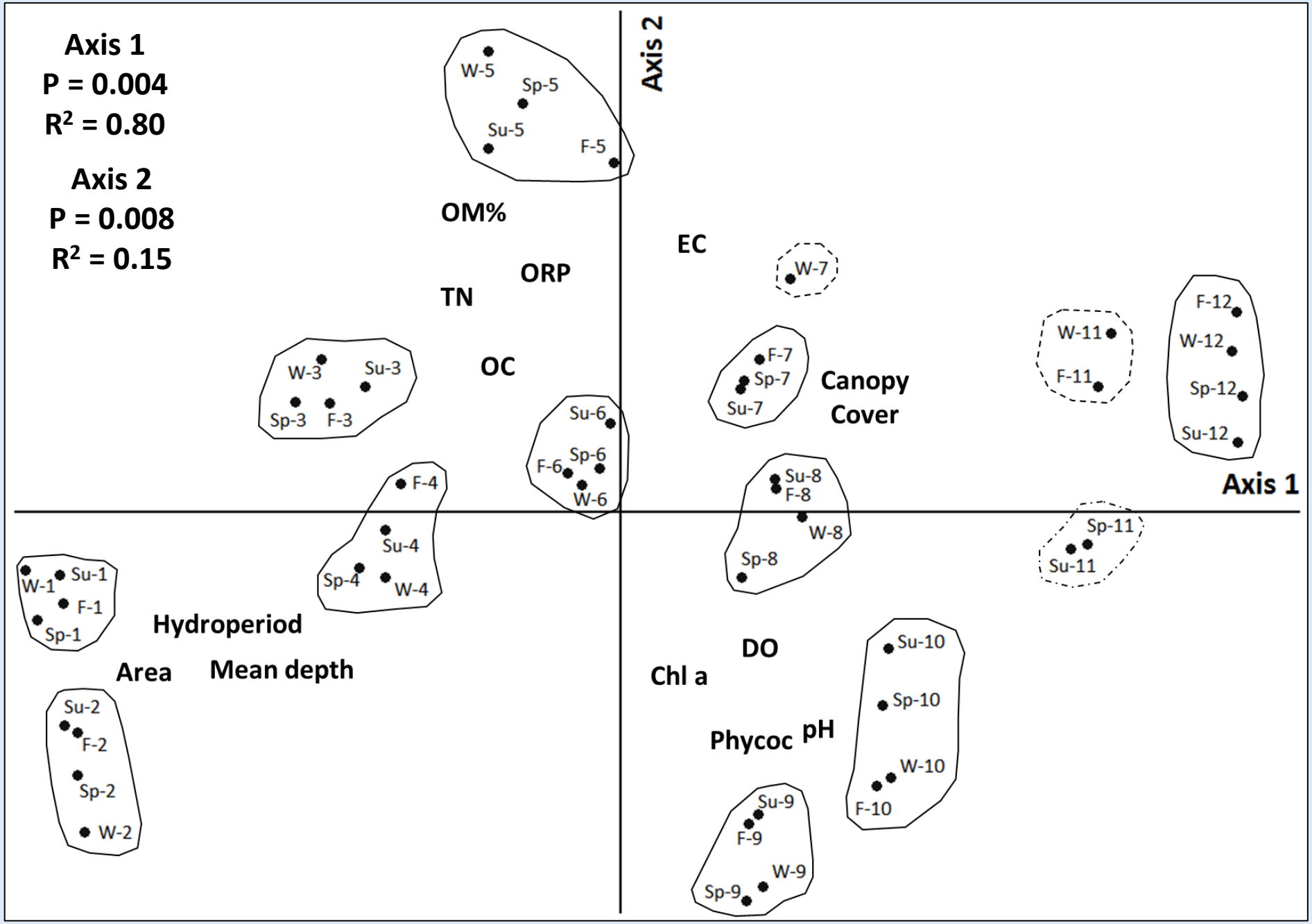
Variable	Coeff.	Std Coeff.	Std Error	P-value
Constant	-49.2		7.91	
pH	19.9	0.72	3.40	< 0.001
Organic carbon (mg/L)	2.07	0.61	0.40	< 0.001
Precipitation (cm; daily)	1.39	0.35	0.46	0.004

$F\ (3, 44) = 14.62,\ P < 0.001;\ R^2 = 0.50$

NMS Model

Final Stress = 9.83

	r-value	
Variable	Axis 1	Axis 2
pH	-0.046	**-0.673**
EC	-0.013	**0.600**
DO	0.188	**-0.462**
Phycoc	-0.325	**-0.431**
CanCov	**0.358**	0.301
TN	-0.176	**0.346**
OM (%)	**-0.533**	0.445
Area	**-0.658**	**-0.812**
Depth	-0.445	**-0.637**
Hydro.	-0.436	**-0.693**



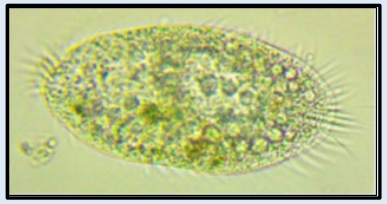
Total Nitrogen (mg/L) by Season & Pool

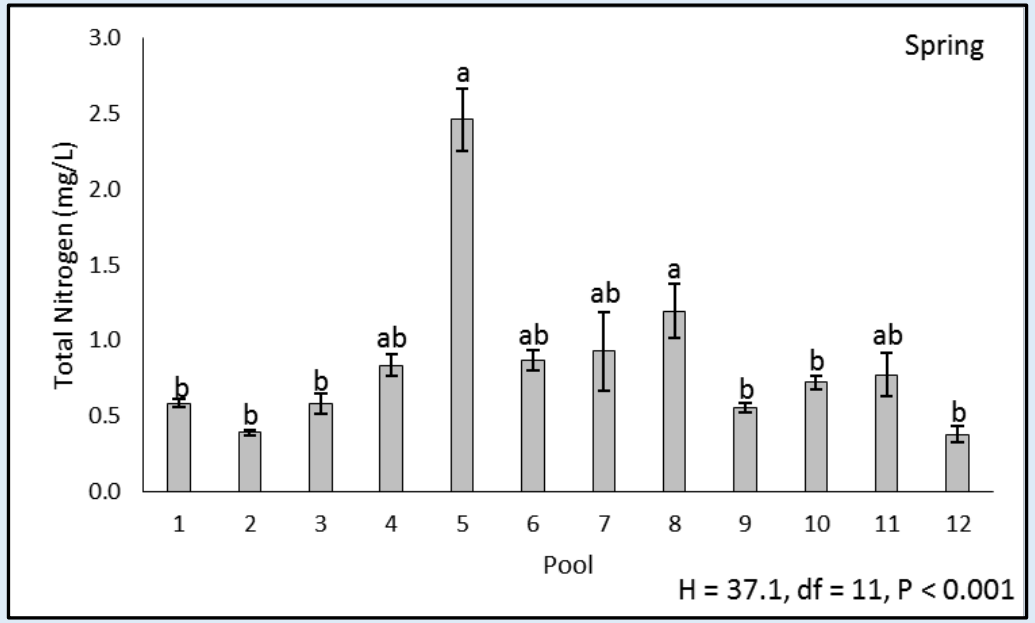
Season:

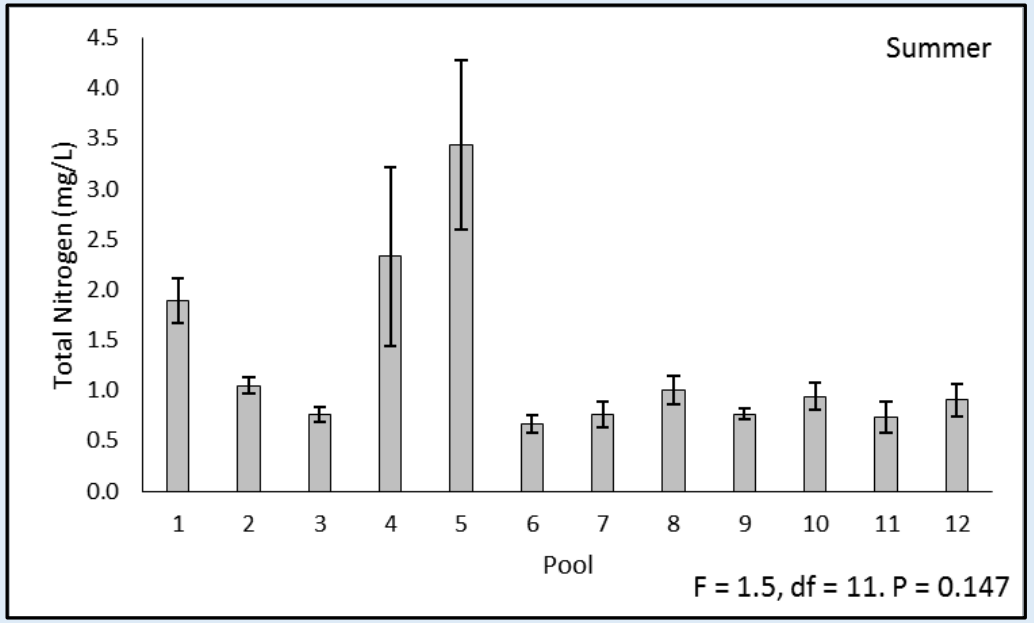
F = 2.68

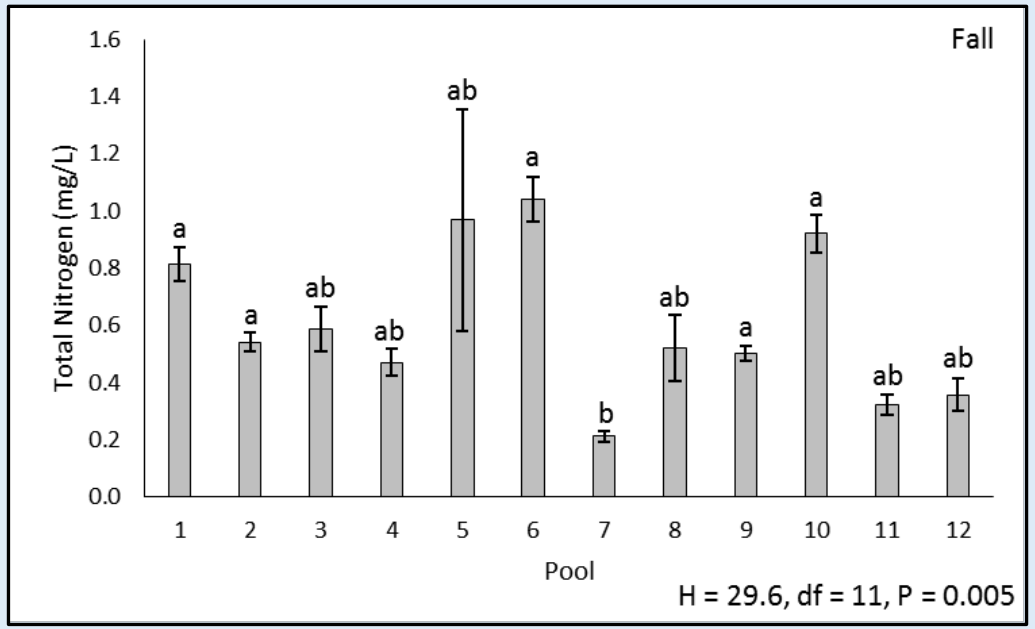
df = 3

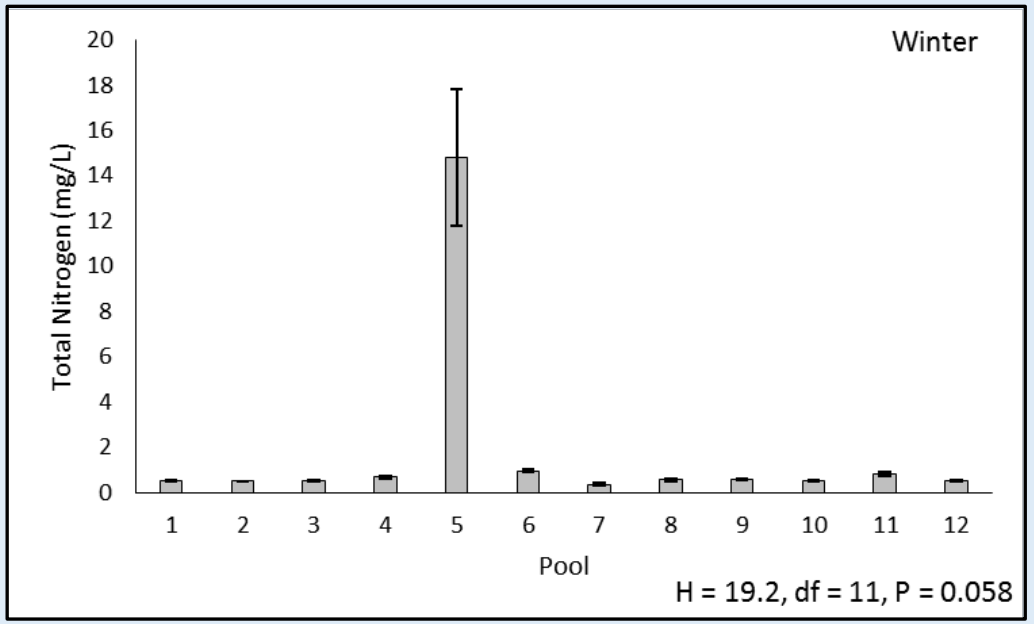
P = 0.052











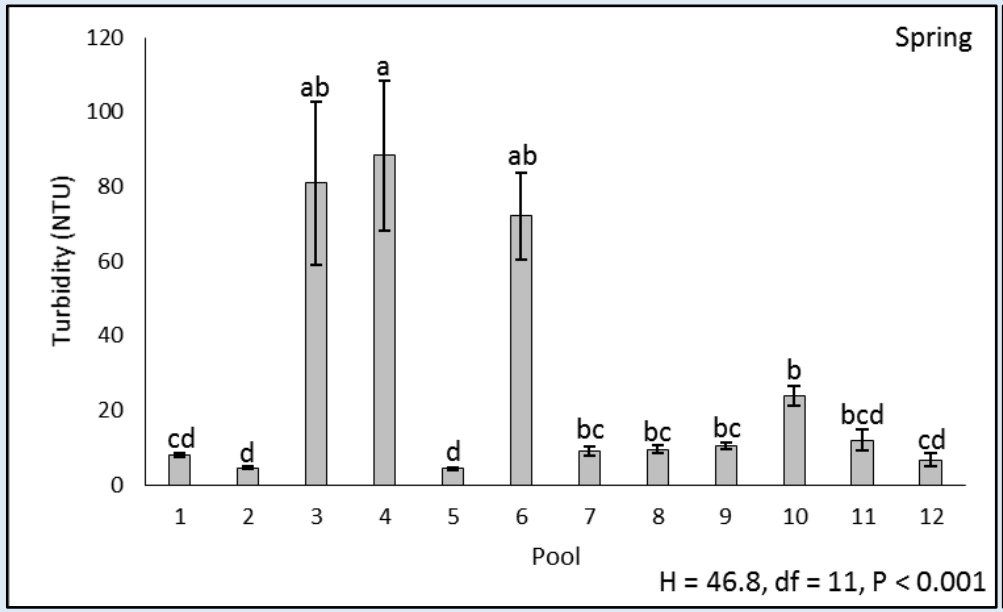
Turbidity (NTU) by Season & Pool

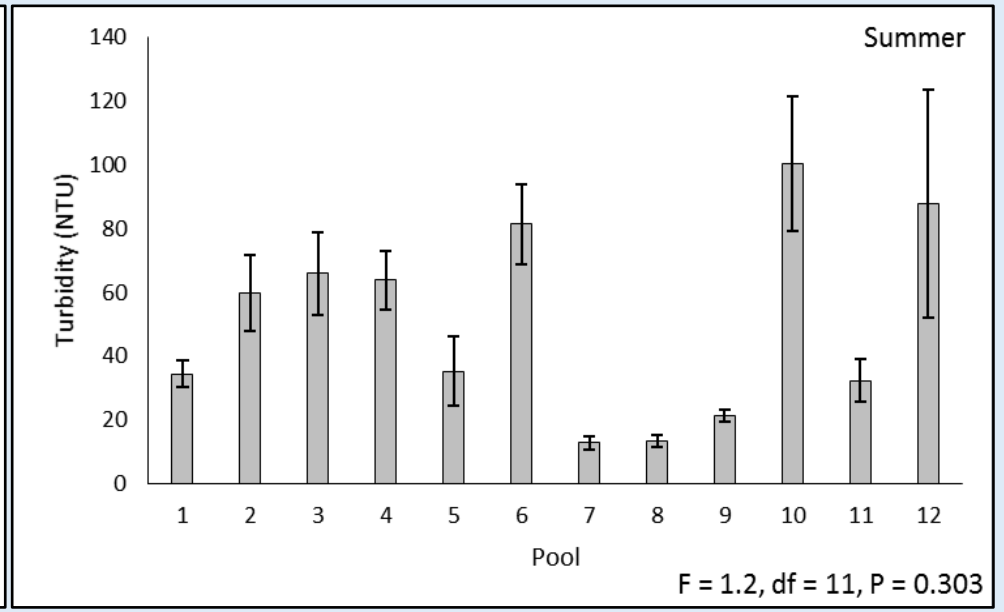
Season:

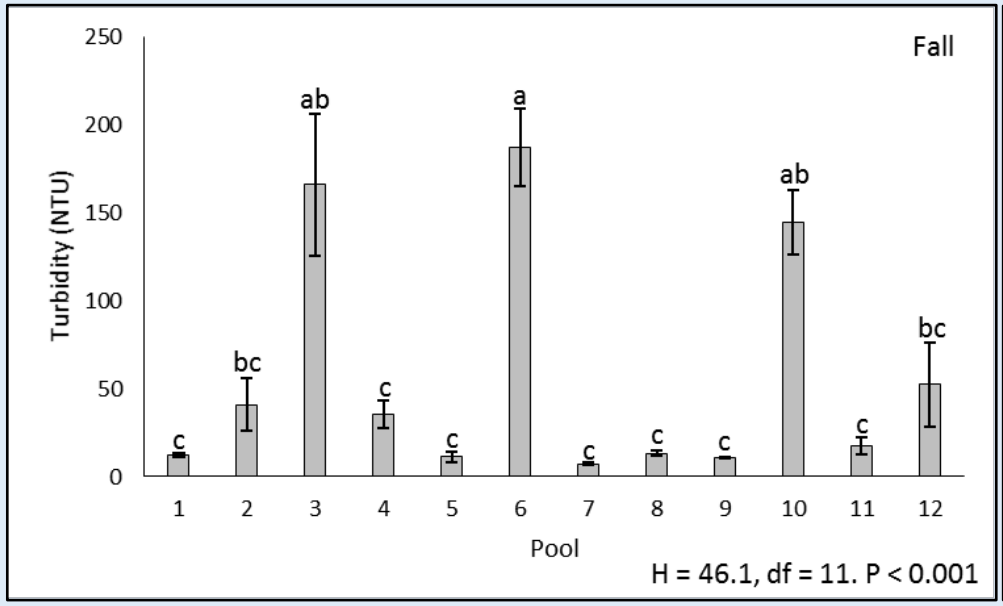
F = 2.05

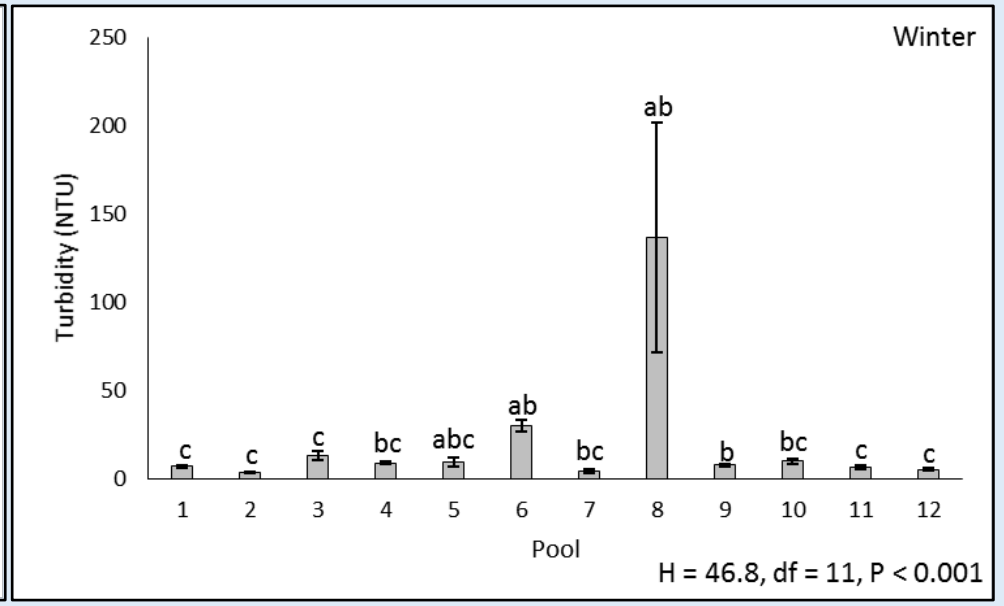
df = 3

P = 0.121









Conclusions

- Pool hydrology was consistent seasonally while precipitation was variable
- With 3.2 cm of precipitation over 28 days, eight pools contained water
- Temperature and ORP were the strongest indicators of differences among pools but exhibited opposite trends over the total study and seasonally
- Chlorophyll a was highly associated with pH and to some degree precipitation
  - Greater concentrations in Spring & Fall

Conclusions (cont.)

- Based on the NMS model, pools were distinctly different
  - Smaller size pools were associated with > sediment OM, EC, TN, & OC, and < ORP
  - Intermediate size pools were associated with > DO, pH, Chl a, and < canopy cover
  - Larger pools were associated with greater mean depth & longer hydroperiods
- Pulses in TN may be attributable to precipitation and rewetting of pools & increased heterotrophic activity
- Turbidity was highly variable but likely due to animal use of pools

Questions