COUGARS

Predictive Analytics Applied to Nutrient Concentrations and Chlorophyll in Otter Lake

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OUTLINE

OTTER LAKE INSPIRATION

TOXINS BACKGROUND

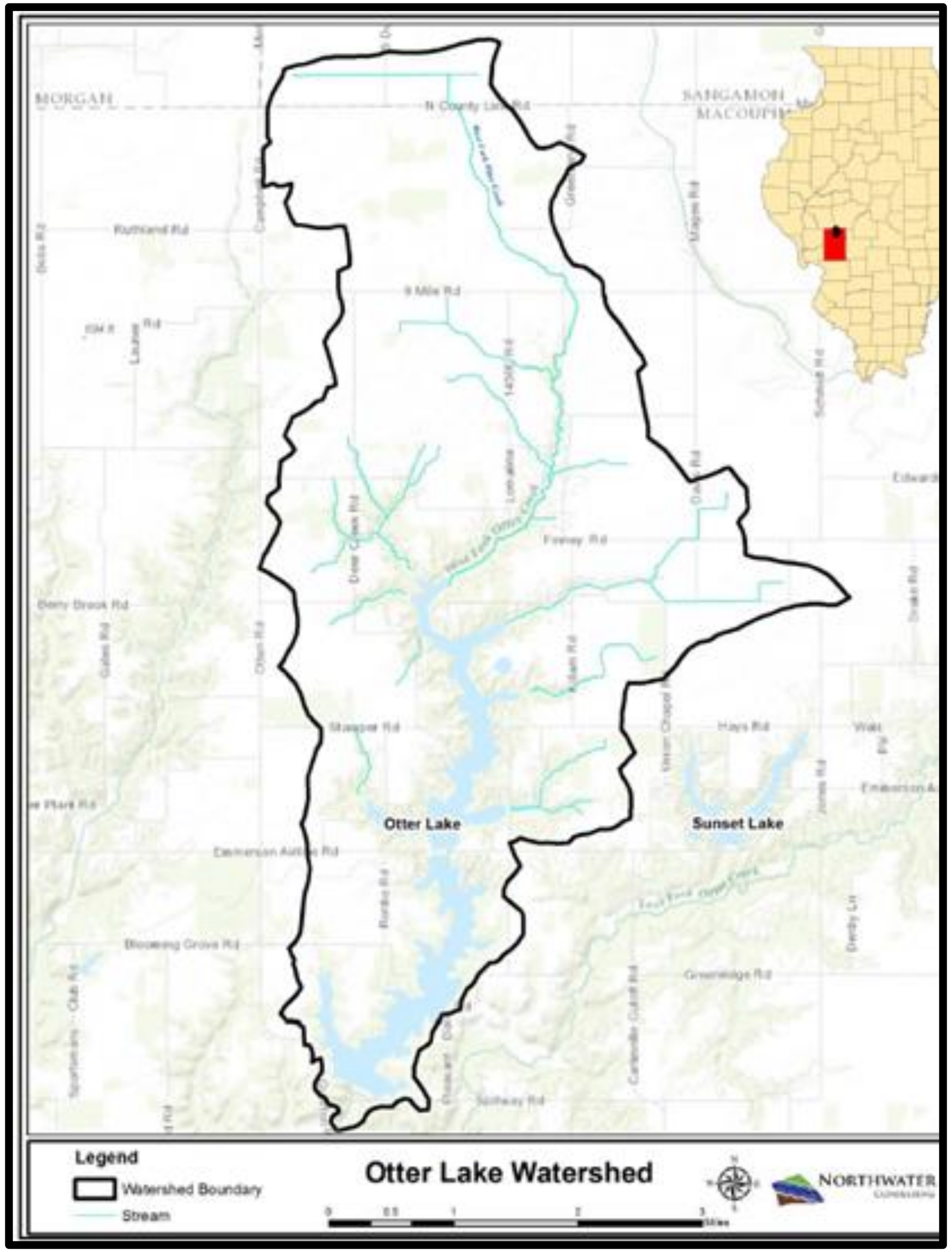
TECHNIQUES

EVIDENCE

REPERCUSSIONS

OTTER LAKE

- Southern Lake located in Macoupin County, Illinois.
- The lake was shut down from 2006 to 2012 due to excessive algae growth from high nutrient loads.[3]
  - Mercury, Manganese, and Phosphorus
- Global warming can be a huge contribution to the growth of Harmful Algae Blooms, **HABs.**
  - These occur when colonies of microscopic algae grow out of control.[5]
- **<u>Goal:</u>** To compare chlorophyll concentration levels with nutrient levels to detect when HABs occur.



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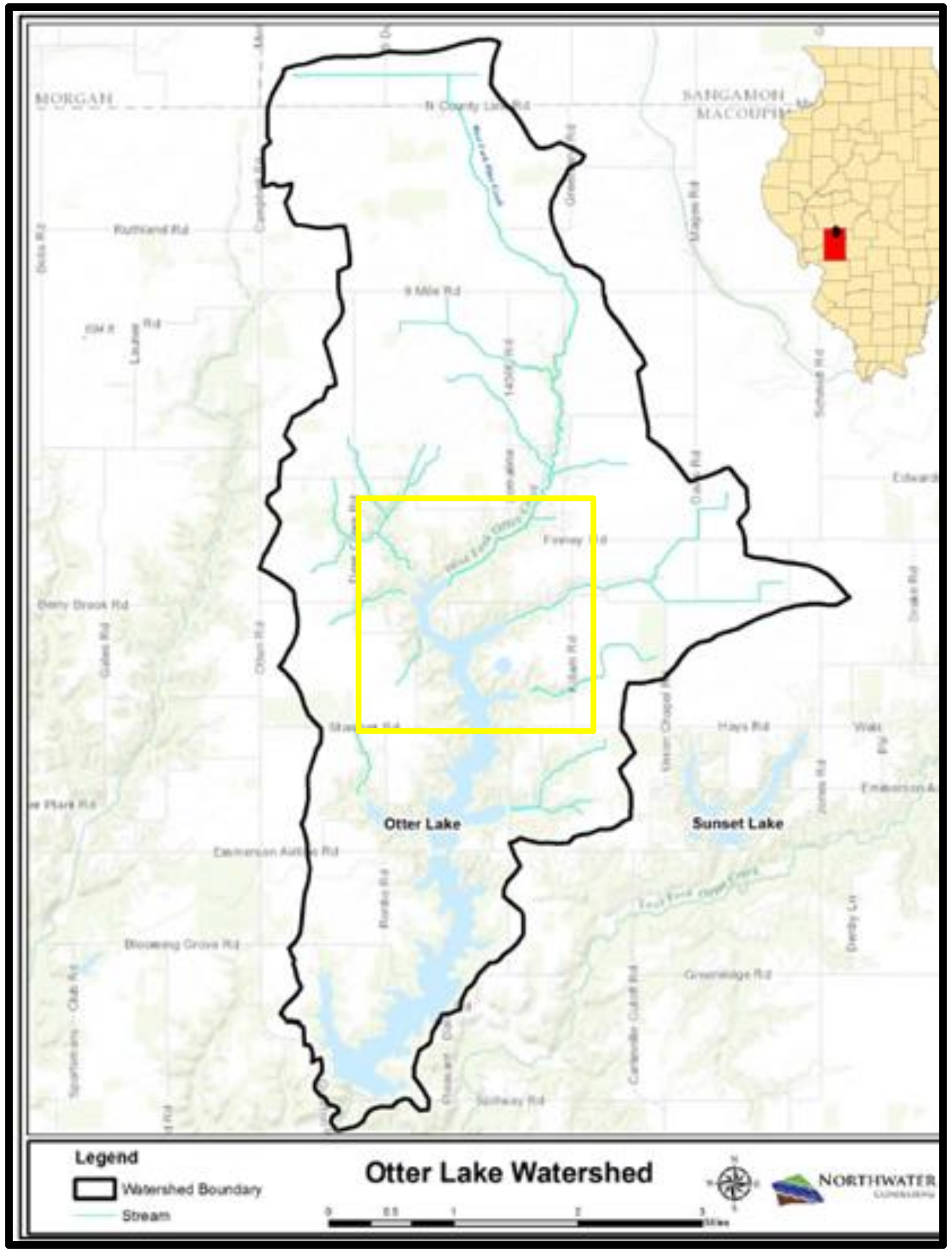

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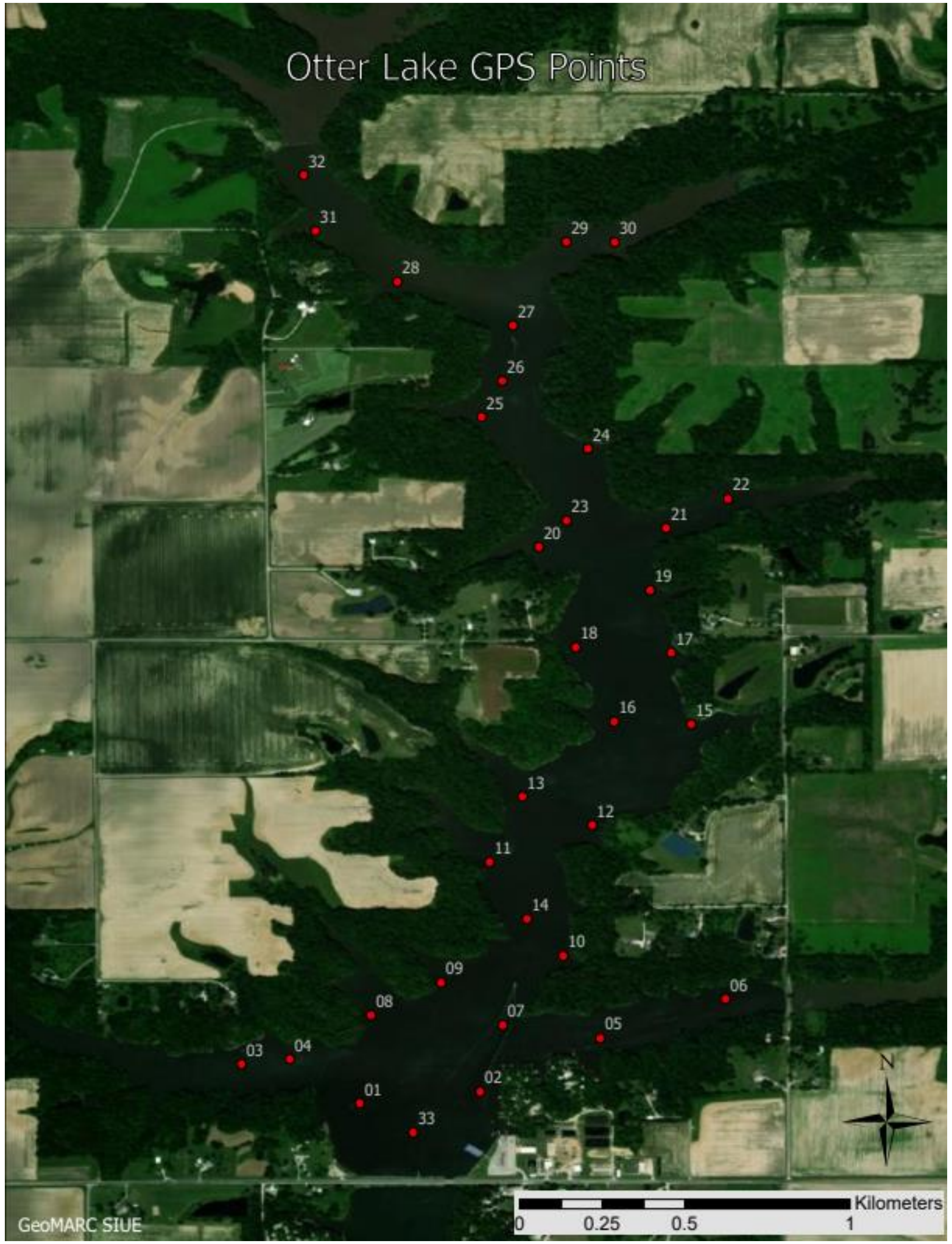
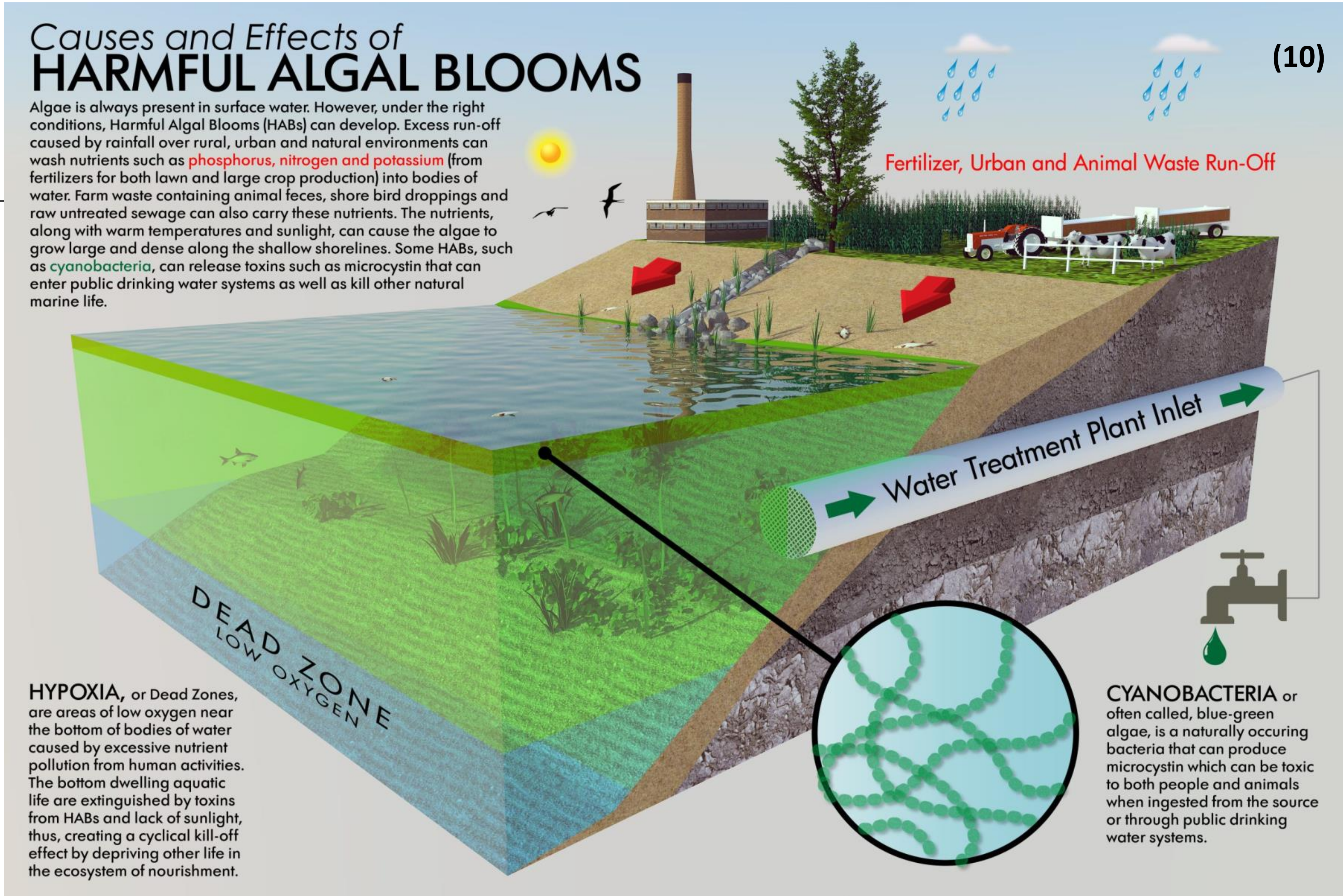


HARMFUL ALGAE BLOOMS

- A harmful algae bloom occurs when toxin-producing algae grow excessively in a body of water.[9]
  - Variety of forms and colors and cannot be identified just by the human eye.
- Harmful algal blooms can:
  - Create dead zones in the water
  - Cost a lot of money and time
  - Hurt industries that depend on clean water [9]


(8)


Causes and Effects of
HARMFUL ALGAL BLOOMS
(10)
Algae is always present in surface water. However, under the right conditions, Harmful Algal Blooms (HABs) can develop. Excess run-off caused by rainfall over rural, urban and natural environments can wash nutrients such as phosphorus, nitrogen and potassium (from fertilizers for both lawn and large crop production) into bodies of water. Farm waste containing animal feces, shore bird droppings and raw untreated sewage can also carry these nutrients. The nutrients, along with warm temperatures and sunlight, can cause the algae to grow large and dense along the shallow shorelines. Some HABs, such as cyanobacteria, can release toxins such as microcystin that can enter public drinking water systems as well as kill other natural marine life.
Fertilizer, Urban and Animal Waste Run-Off
Water Treatment Plant Inlet
DEAD ZONE
LOW OXYGEN
HYPOXIA, or Dead Zones, are areas of low oxygen near the bottom of bodies of water caused by excessive nutrient pollution from human activities. The bottom dwelling aquatic life are extinguished by toxins from HABs and lack of sunlight, thus, creating a cyclical kill-off effect by depriving other life in the ecosystem of nourishment.
CYANOBACTERIA or often called, blue-green algae, is a naturally occuring bacteria that can produce microcystin which can be toxic to both people and animals when ingested from the source or through public drinking water systems.

ANALYTES OF INTEREST

Compared 5 nutrient concentrations to chlorophyll concentrations to predict when harmful algae blooms occur

- Ammonia (NH_3)
- Nitrate (NO_3^-)
- Nitrite (NO_2^-)
- Total Kjeldahl Nitrogen (TKN)
- Total Kjeldahl Phosphorus (TKP)

→

- Chlorophyll a
- Chlorophyll b
- Chlorophyll $c_1 + c_2$

→

SAMPLE PREPARATION:
SAMPLING AND HANDLING

BOAT

- Loaded boat with wagon full of supplies
- Calibrated equipment
- GeoMARC located us to sites

Collect water samples in HDPE bottles either by surface or using a water dunker.

Collect on-site parameters: temperature, pH, conductivity, relative dissolved oxygen (RDO), and turbidity.

Samples are stored in cooler on ice.

LAB

TKN & TKP

150 mL

~25 mL 6M H_2SO_4

NH_3

~2 mL 1M NaOH

50 mL

NO_3^- & NO_2^-

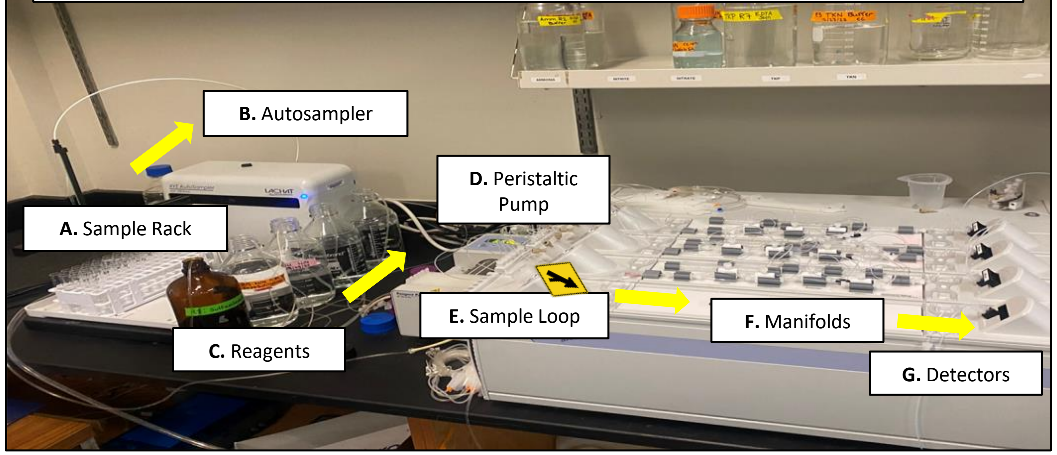
There were 2 filter pads saved per sample site. They were wrapped in aluminum foil and stored in freezer until ready for UV-Vis analysis

All water samples were stored in fridge until ready for digestion or flow injection analysis.

SAMPLE PREPARATION:
DIGESTION, EXTRACTIONS, AND ANALYSIS

NUTRIENTS

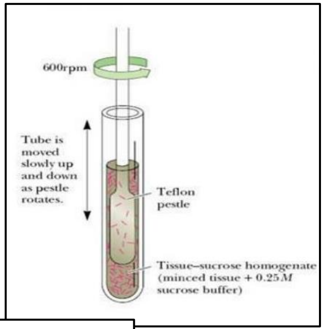

ACID DIGESTION
- **TKP:** Phosphorous → Orthophosphate anion (PO_4^{-3})
- **TKN:** Sum of Free Ammonia, Ammonium, & Organic Nitrogen → Ammonium Sulfate $(NH_4)_2SO_4$
- **Digestion Solution:** Potassium Sulfate, Concentrated Sulfuric Acid, and Copper Sulfate.



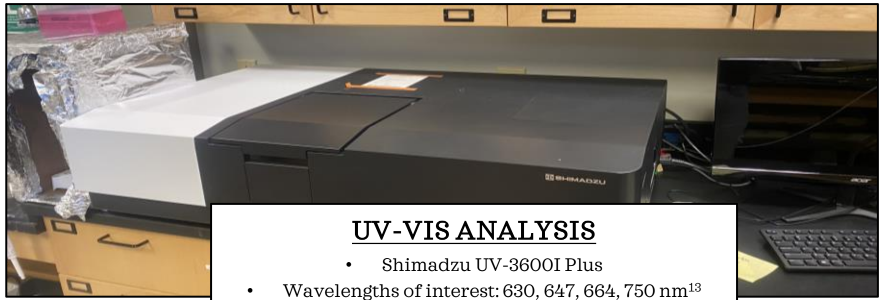
FLOW INJECTION ANALYSIS
- QuikChem 8500
- Followed QuikChem™ Methods for Ammonia[16], Nitrate[17], Nitrite[17], TKN[18], and TKP.[19]

PIGMENTS





CHLOROPHYLL EXTRACTION METHOD



UV-VIS ANALYSIS
- Shimadzu UV-3600I Plus
- Wavelengths of interest: 630, 647, 664, 750 nm[13]

QUIKCHEM™ METHODS [18]

17. TABLE, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

17.1. DATA SYSTEM PARAMETERS FOR QUIKCHEM 8000/8500

The timing values listed below are approximate and will need to be optimized using graphical events programming.

Sample throughput: 120 samples/h*, 25 s/sample
Pump Speed: 35
Cycle Period: 25

Analyte Data:

Concentration Units: mg N/L
Peak Base Width: 25 s
Inject to Peak Start: 45 s
Chemistry: Direct/Bipolar

Calibration Data:

Level	1	2	3	4	5	6	7	8
Concentration mg N/L	25.0	12.5	6.25	2.5	1.25	0.625	0.25	0

Calibration Rep Handling: Average
Calibration Fit Type: 2nd Order Polynomial
Weighting Method: None
Force through zero: No

Sampler Timing:

Min. Probe in Wash Period: 9 s
Probe in Sample Period: 10 s

Valve Timing:

Load Period: 6 s
Inject Period: 6 s

QUIKCHEM™ METHODS [18]

7. REAGENTS AND STANDARDS

7.1. PREPARATION OF REAGENTS

Use ASTM Type II water for all solutions. (See Standard Specification for Reagent Water D1193-77 for more information).

Degassing with helium:

To prevent bubble formation, degas all solutions except the standards with helium. Use He at 140kPa (20 lb/in^2) through a helium degassing tube (Lachat Part No. 50100.) Bubble He through the solution for one minute.

Reagent 1. Digestion Solution

By Volume: In a **1 L** volumetric flask, add **134.0 g potassium sulfate** (K_2SO_4) and **134 mL concentrated sulfuric acid** (H_2SO_4) to approximately **700 mL water**. Add **7.3g copper Sulfate** ($CuSO_4$). Dilute to the mark with water and invert to mix. Keep tightly sealed when not in use to decrease the possibility of contamination by ambient ammonia. Prepare fresh monthly.

Reagent 2. Diluent for Non-digested Standards and Over-range Samples

By Volume: To a **1 L** volumetric flask containing about 400 mL of DI water, add 400 mL of Reagent 1 (Digestion solution). Dilute to the mark with water and stir to mix. Keep tightly sealed when not in use to decrease the possibility of contamination by ambient ammonia. Prepare fresh monthly.

Reagent 3. Buffer

Note: To reduce the possibility of the potassium tartrate being contaminated it is recommended that the tartrate buffer is boiled for 10 minutes. To verify that the tartrate buffer is pure enough compare the reagent baseline to the DI baseline. The baseline, with all reagents flowing should show no greater than 0.15V difference from just the DI water pumping in all the lines.

By Volume: In a **1 L** container add **900 mL water, 50 g potassium tartrate** (or potassium sodium tartrate, D,L-$NaKC_4H_4O_6 \cdot 4H_2O$) **50 g sodium hydroxide** (NaOH), and **26.8 g sodium phosphate dibasic heptahydrate** ($Na_2HPO_4 \cdot 7H_2O$) mix until dissolved. Boil for 10 minutes. Cool to room temperature and transfer to a 1 L volumetric flask. Dilute to the mark and invert to mix.

Reagent 4. Salicylate Nitroprusside

By Volume: In a **1 L** volumetric flask dissolve **150.0 g sodium salicylate** [salicylic acid sodium salt, $C_6H_4(OH)(COO)Na$], and **1.00 g sodium nitroprusside** [sodium nitroferricyanide dihydrate, $Na_2Fe(CN)_5NO \cdot 2H_2O$] in about **800 mL water**. Dilute to the mark and invert to mix. Store in a dark bottle and prepare fresh monthly, or when the solution develops a blue to green coloration.

Working Standards (Prepare Daily)	A	B	C	D	E	F	G	H
Concentration mg N/L	25.0	12.5	5.0	2.50	1.25	0.5	0.25	0

By Volume

Volume (mL) of **Standard 3** diluted to 100 mL with **Reagent 2**	100	50	20	10	5	2	1	0

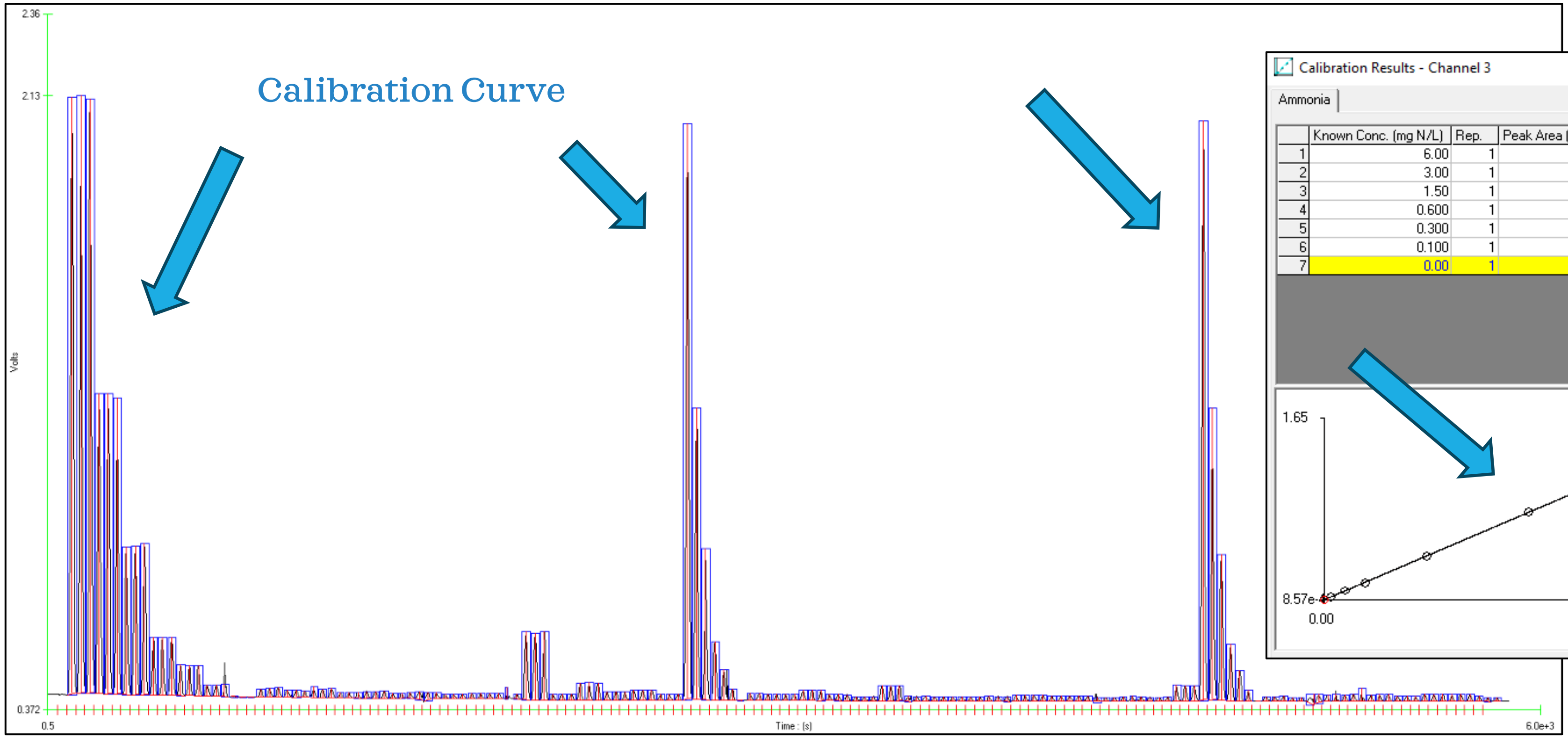
By Weight

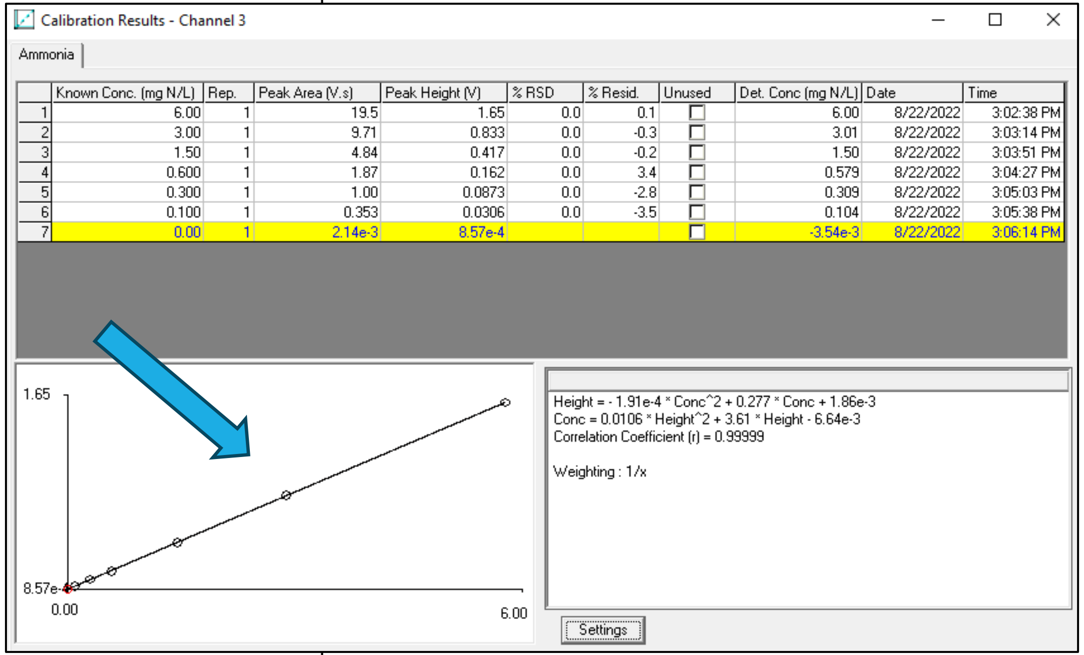
Weight (g) of **Standard 3** diluted to final weight (~100 g) divide by **factor** below with **Reagent 2**	100.0	50	25	10	5	2	1	0
Division Factor Divide exact weight of the standard by this **factor** to give final weight	1.00	0.50	0.25	0.10	0.05	0.02	0.01	0

RESULTS

RESULTS

Ammonia August 2022

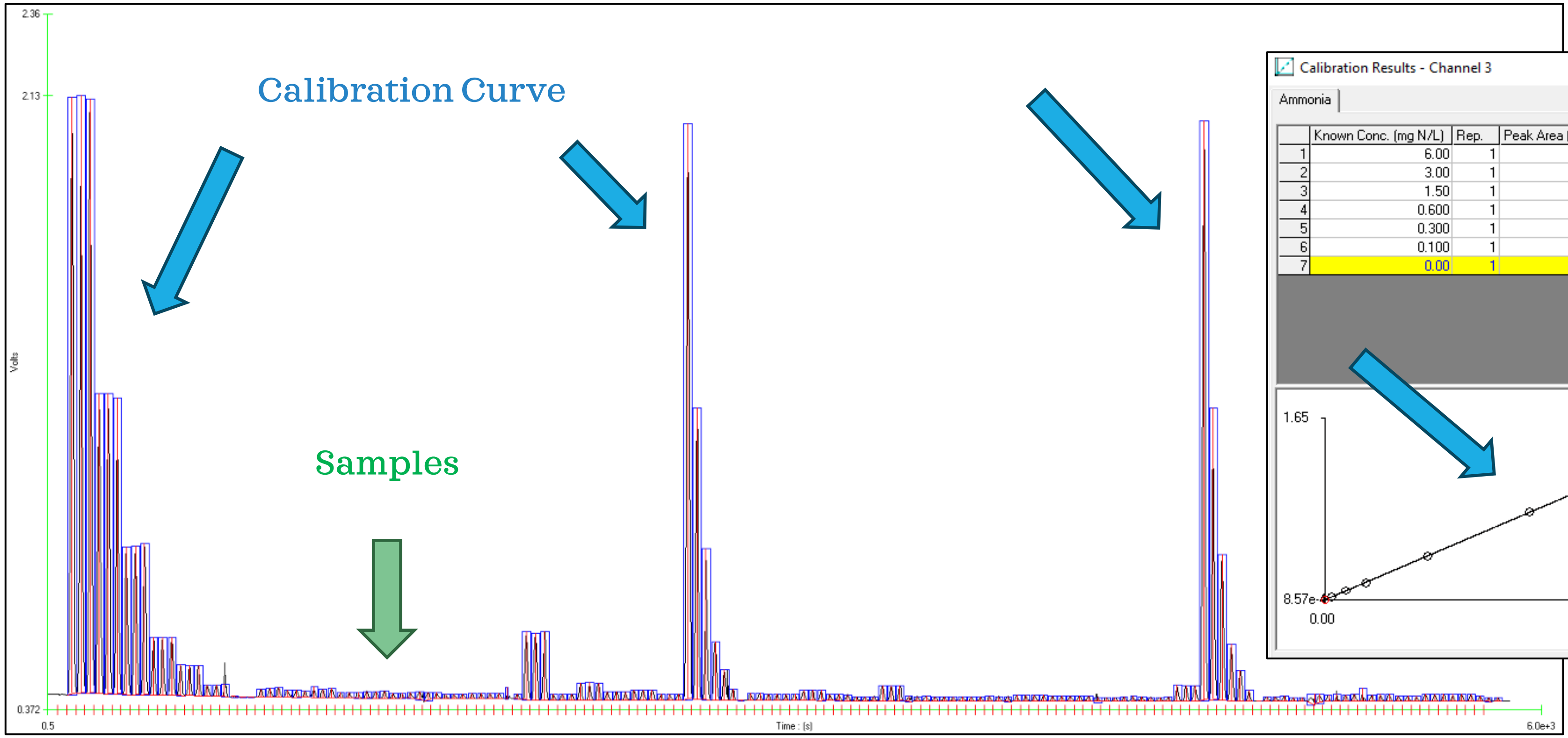


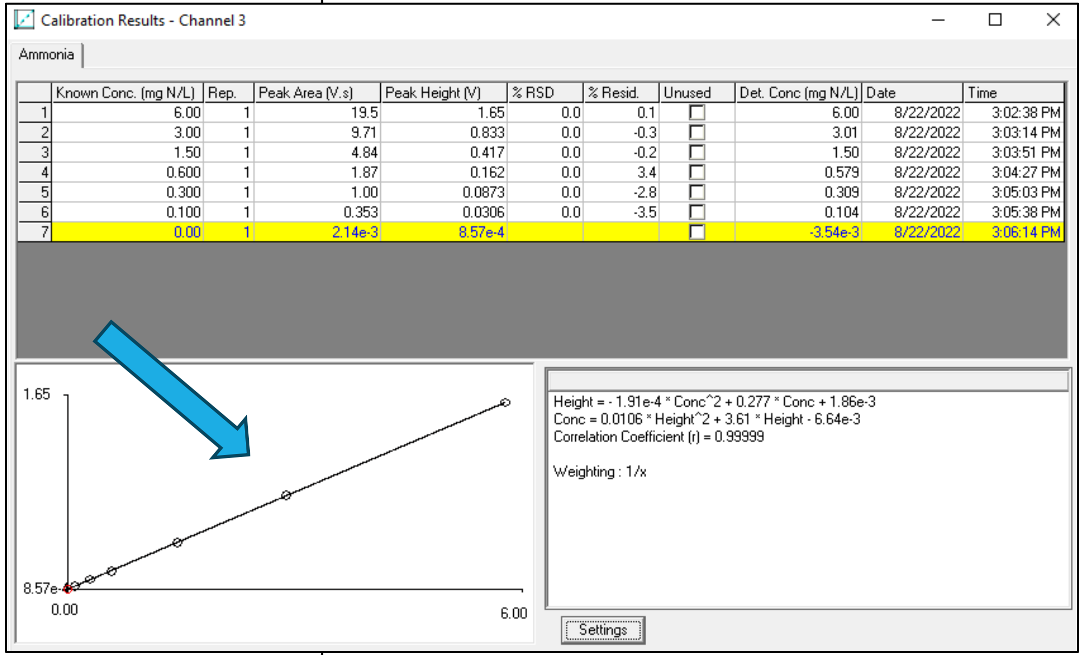


	Known Conc. (mg N/L)	Rep.	Peak Area (V.s)	Peak Height (V)	% RSD	% Resid.	Unused	Det. Conc (mg N/L)	Date	Time
1	6.00	1	19.5	1.65	0.0	0.1	☐	6.00	8/22/2022	3:02:38 PM
2	3.00	1	9.71	0.833	0.0	-0.3	☐	3.01	8/22/2022	3:03:14 PM
3	1.50	1	4.84	0.417	0.0	-0.2	☐	1.50	8/22/2022	3:03:51 PM
4	0.600	1	1.87	0.162	0.0	3.4	☐	0.579	8/22/2022	3:04:27 PM
5	0.300	1	1.00	0.0873	0.0	-2.8	☐	0.309	8/22/2022	3:05:03 PM
6	0.100	1	0.353	0.0306	0.0	-3.5	☐	0.104	8/22/2022	3:05:38 PM
7	0.00	1	2.14e-3	8.57e-4			☐	-3.54e-3	8/22/2022	3:06:14 PM

RESULTS

Ammonia August 2022





Calibration Results - Channel 3

Ammonia

	Known Conc. (mg N/L)	Rep.	Peak Area (V.s)	Peak Height (V)	% RSD	% Resid.	Unused	Det. Conc (mg N/L)	Date	Time
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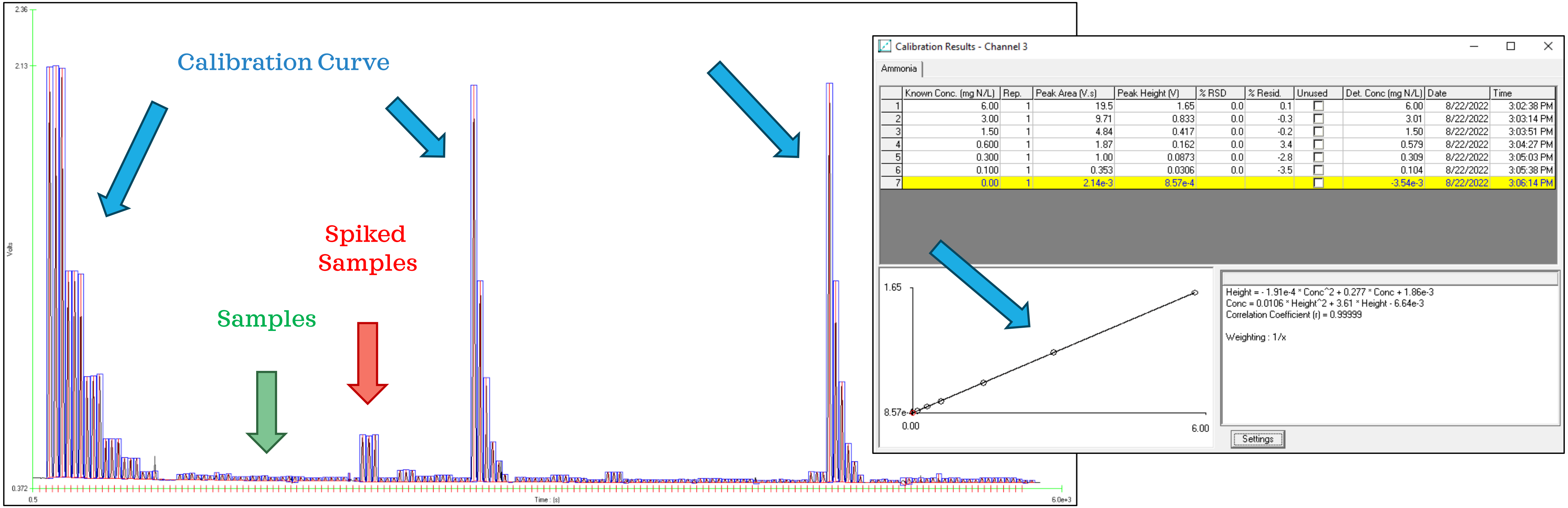
Height = - 1.91e-4 * Conc^2 + 0.277 * Conc + 1.86e-3
Conc = 0.0106 * Height^2 + 3.61 * Height - 6.64e-3
Correlation Coefficient (r) = 0.99999

Weighting : 1/x

Settings

RESULTS

Ammonia August 2022



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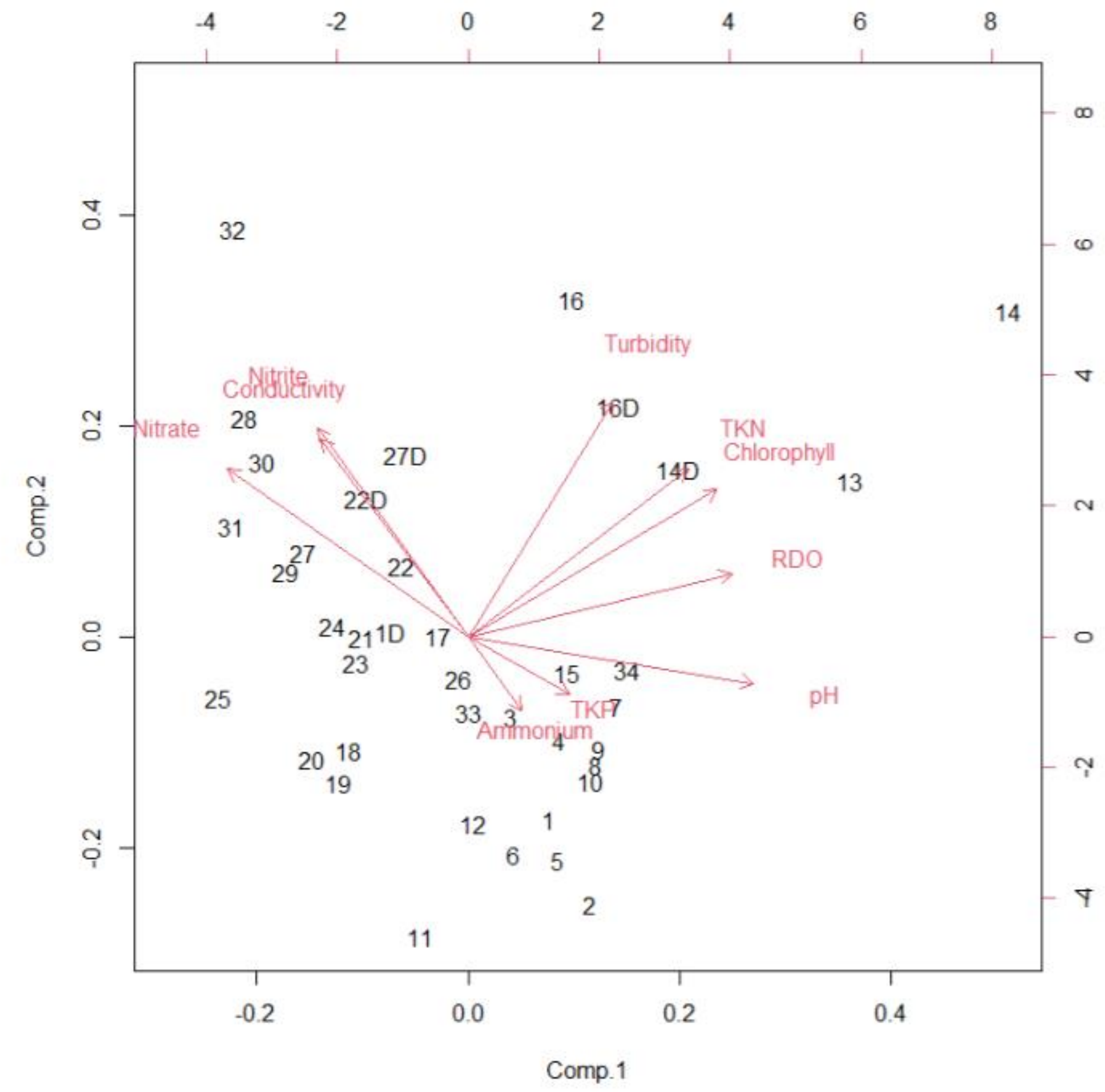


PCA Biplot

Average Nutrient Concentrations from 2021 to 2023

May 2021

	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Conductivity	Nitrite	Nitrate	Ammonium	ChlorNext
Chlorophyll	1										
TKP	-0.03305804	1									
TKN	-0.05841172	0.5296213	1								
pH	0.26822447	0.61353369	-0.2489723	1							
Turbidity	-0.07337467	0.22003855	-0.16729387	0.20471526	1						
RDO	0.12604111	-0.19152578	-0.1292811	0.29742443	0.1611014	1					
Conductivity	-0.19612108	0.06734949	-0.04466152	-0.42705138	0.04425064	-0.13511488	1				
Nitrite	-0.28897077	0.07428012	-0.22066873	0.27806894	0.80383386	0.15780653	-0.03291032	1			
Nitrate	-0.28128922	0.1741498	-0.23263519	0.16241244	0.85030199	0.08194377	0.03330267	0.94871307	1		
Ammonium	0.23420883	0.02477598	-0.43375283	0.08276852	0.12824301	0.01084872	-0.09164766	0.11697124	0.12756527	1	
ChlorNext	0.09024701	-0.17542918	0.02575878	-0.05666015	-0.32020406	-0.03629151	-0.00146435	-0.277929	-0.28345945	-0.01898628	1

May 2022

	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium	ChlorNext	ChlorB	ChlorC	Pheophytin
Chlorophyll	1														
TKP	0.46252032	1													
TKN	0.15174141	-0.31965931	1												
pH	0.08641963	-0.0490447	0.00070678	1											
Turbidity	0.57709893	0.42809959	-0.19759026	-0.05867195	1										
RDO	0.27918142	0.28332172	-0.23719861	0.34649773	0.37507314	1									
Temp	-0.07922074	0.16189273	-0.20247898	0.35856951	-0.06493522	0.43668885	1								
Conductivity	0.11043237	0.11098244	-0.15670243	-0.36899215	-0.01294156	-0.10478305	-0.06282267	1							
Nitrite	0.14611758	-0.02730759	-0.00837222	0.16270843	0.59312111	0.41625687	0.2057628	-0.20099124	1						
Nitrate	0.48744423	0.39154	-0.16441106	-0.13382017	0.96979133	0.31220393	-0.10780116	0.00269827	0.60354625	1					
Ammonium	0.00071322	-0.18666798	0.23372052	0.16118969	-0.11598347	-0.65812413	-0.01265942	-0.02971939	-0.06122566	-0.10997079	1				
ChlorNext	0.23618301	0.13078275	0.10501622	0.0055596	0.24525804	0.0621131	-0.17195397	0.02623615	0.0368327	0.21575749	-0.04752001	1			
ChlorB	0.78135753	0.31144686	0.27230178	-0.17144205	0.26881625	-0.09052908	-0.10249262	0.24985544	-0.14068092	0.21927128	0.1012295	0.19716043	1		
ChlorC	0.81960918	0.33269929	0.26601902	-0.14066039	0.30836089	-0.04086854	-0.10462246	0.24249487	-0.11642602	0.2548652	0.0755464	0.20072817	0.99699023	1	
Pheophytin	0.14755318	0.21725545	0.21219631	-0.16571053	-0.11716474	-0.0232501	-0.19667662	-0.06321554	-0.12584942	-0.08572068	-0.18174189	0.19605106	0.10444691	0.11142008	1

May 2023

	Chlorophyll	Chloro.B	Chloro.C	Total.Chl	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium
Chlorophyll	1													
Chloro.B	0.85769201	1												
Chloro.C	0.87149192	0.99948709	1											
Total.Chl	-0.66622436	-0.67877161	-0.68067343	1										
TKP	-0.26467114	-0.20857632	-0.20904313	0.06572622	1									
TKN	0.22619021	0.12054949	0.12680012	-0.06713095	0.06815734	1								
pH	0.15745929	0.17202752	0.17367814	-0.10886664	0.01425139	0.14758121	1							
Turbidity	0.38203742	0.07257882	0.09013668	-0.03119141	-2.9714E-05	0.2340496	0.08811213	1						
RDO	0.02276056	0.08624827	0.08044346	-0.14606031	-0.08390443	0.0853846	-0.13770036	-0.19122151	1					
Temp	-0.09565384	0.24970626	0.23784955	0.19220831	0.17954704	-0.3265966	0.02641871	-0.26721097	0.10996972	1				
Conductivity	0.15118684	0.21696325	0.21817405	0.08438306	0.057371	-0.12718042	0.1337397	0.07219217	-0.13416655	0.34553766	1			
Nitrite	0.01318103	0.14718161	0.13970084	-0.18510542	0.01376077	-0.17201406	0.02318756	0.01539157	0.21032369	0.42221832	-0.09534391	1		
Nitrate	0.2098835	0.27464185	0.27073515	0.01219957	0.00616544	-0.01842074	0.14136743	0.3222596	0.18839823	0.44844039	0.04926367	0.75197617	1	
Ammonium	-0.09334779	-0.2598494	-0.25481402	0.19846542	-0.24764806	-0.2943071	-0.05287235	0.13427972	-0.14407726	-0.18017349	-0.02816448	-0.21350607	-0.17796653	1

SPRING TRENDS

- **pH** positively correlates to algae growth
- **Nitrate & Nitrite** concentrations are higher in the spring months

SUMMER TRENDS

July 2021

	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium	ChlorNext
Chlorophyll	1											
TKP	0.50167733	1										
TKN	0.14945622	0.42486765	1									
pH	0.09226299	-0.1021481	-0.01364172	1								
Turbidity	0.59522245	0.48297027	-0.06066982	0.08048818	1							
RDO	0.22570167	0.37346227	-0.17025845	0.21554766	0.61925102	1						
Temp	0.83588925	0.05608764	0.22449538	-0.47849371	0.54348098	-0.9043312	1					
Conductivity	0.48675491	0.29290898	-0.1564109	-0.18123157	0.59042699	0.5162127	0.38079862	1				
Nitrite	0.48507251	0.41645878	0.14710158	0.11285776	0.52789774	0.34672718	-0.38943054	0.41775787	1			
Nitrate	0.57963307	0.51217066	0.00049907	0.11819619	0.8251437	0.70870981	-0.90568616	0.73162785	0.74159796	1		
Ammonium	0.06933749	0.18420502	-0.63212078	0.05276072	0.18879775	0.21763858	0.4544462	0.08719929	0.21335766	0.19243264	1	
ChlorNext	0.25257836	0.18161025	0.14720993	0.27342584	0.30823323	0.06369652	0.68851283	-0.10022981	0.31815251	0.21558024	-0.1122867	1

July 2022

	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium	ChlorNext	ChlorB	ChlorC	Pheophytin
Chlorophyll	1														
TKP	-0.23669823	1													
TKN	0.09789691	0.32486811	1												
pH	0.14915549	-0.43880703	0.1755786	1											
Turbidity	0.14370942	-0.05011207	0.35838744	0.76867223	1										
RDO	0.1850963	-0.23866703	0.40946103	0.62528204	0.37170458	1									
Temp	-0.03887494	-0.18454838	0.26962955	0.54881038	0.2330474	0.81181026	1								
Conductivity	-0.25953514	0.20570894	-0.45716324	-0.50229829	-0.40028194	-0.89898158	-0.66183467	1							
Nitrite	-0.16166631	0.05003887	-0.51156964	-0.39835342	-0.19327611	-0.73363862	-0.64840215	0.62272824	1						
Nitrate	0.12841119	0.45944686	0.11245847	-0.19973628	0.02435455	-0.08819419	0.03352157	0.01849449	0.07940818	1					
Ammonium	-0.48329949	0.43475224	-0.11291962	-0.50230908	-0.26620427	-0.44817703	-0.30124635	0.42422059	0.4805756	0.07405833	1				
ChlorNext	0.12242107	0.32456392	0.24480313	-0.33547265	-0.02315369	-0.33332803	-0.39882346	0.20762383	0.0201666	0.11077644	0.10244411	1			
ChlorB	0.91086925	-0.17713009	0.01990403	0.08794585	0.08892146	0.00793574	-0.11522075	-0.05110402	-0.01806634	0.20172122	-0.38805982	0.13851988	1		
ChlorC	0.92875397	-0.20600915	-0.0100548	0.09115879	0.09712419	0.00814794	-0.13527478	-0.06948605	-0.04399976	0.17729407	-0.41074866	0.1296434	0.98001002	1	
Pheophytin	0.27608057	-0.15001879	-0.19467161	-0.18260577	-0.04509826	-0.24895651	-0.28670504	0.03225533	0.24932881	0.01467249	0.12912934	0.13055909	0.17788556	0.27971388	1

July 2023

	Chlorophyll	Chloro.B	Chloro.C	Total.Chl	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium
Chlorophyll	1													
Chloro.B	0.97321837	1												
Chloro.C	0.97440371	0.99994785	1											
Total.Chl	0.9975542	0.97819321	0.97933373	1										
TKP	-0.06108311	0.00346017	0.00300311	-0.05741248	1									
TKN	-0.07011323	-0.15894613	-0.15686823	-0.0767832	-0.04753515	1								
pH	-0.27495533	-0.20525989	-0.20609854	-0.26415548	0.00531208	-0.0661357	1							
Turbidity	-0.0737205	-0.12577734	-0.12724023	-0.05780456	0.05020775	0.31083184	-0.05577838	1						
RDO	0.25753035	0.30562096	0.30477317	0.2594295	-0.01237114	-0.06178795	0.17447931	-0.17007355	1					
Temp	0.20861152	0.28064909	0.27734612	0.2272302	0.22612377	-0.17156445	0.11814404	0.34882341	0.24563236	1				
Conductivity	-0.09893825	-0.18874649	-0.18875166	-0.09537235	0.03777244	0.11492519	-0.46159383	0.64308387	-0.30304043	0.29545559	1			
Nitrite	-0.08389823	-0.10110975	-0.10210888	-0.08431755	0.19004679	0.03644432	0.1030974	0.49239216	-0.10962779	0.15201766	0.34408714	1		
Nitrate	-0.04575539	-0.11863026	-0.11515685	-0.06434721	-0.2857416	0.03109275	-0.06351807	-0.30596079	-0.14420707	-0.6163612	-0.28509809	-0.42414777	1	
Ammonium	-0.17442763	-0.21820824	-0.2192045	-0.17106348	-0.03971544	-0.01667646	0.05677394	0.14729584	-0.32492493	-0.00183863	0.1369007	0.3268601	0.02420468	1

- **pH** positively correlates to algae growth
- **Turbidity, RDO, and Temperature** positively correlate to algae growth
- **Ammonia** continues to have a negative correlation to algae growth

FALL TRENDS

- **pH** positively correlates to algae growth
- **Nitrate & Nitrite** concentrations are depleted in the fall months

Sept. 2021

	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Conductivity	Nitrite	Nitrate	Ammonium	Orthop	HydroP	TP	ChlorNext
Chlorophyll	1													
TKP	0.03927227	1												
TKN	0.35999826	-0.73992896	1											
pH	0.41361739	0.11793571	0.10841354	1										
Turbidity	-0.22966948	-0.11227963	-0.06858555	0.0932336	1									
RDO	0.18914452	0.07033309	0.1324449	0.19829282	-0.08532083	1								
Conductivity	-0.56598127	-0.00259268	-0.37711721	-0.60348984	0.54160283	-0.37070086	1							
Nitrite	-0.08287535	-0.22625224	0.18291002	-0.63076513	-0.45061045	0.0632725	0.02393501	1						
Nitrate	-0.12017213	-0.01579621	-0.12058197	0.03243264	-0.03388389	-0.05475529	0.07966529	-0.14176762	1					
Ammonium	0.03958482	0.94692711	-0.78219855	0.14695305	-0.13895997	0.05400752	-0.04069514	-0.24457728	-0.00990849	1				
Orthop	-0.09835546	0.00642079	-0.06883079	-0.36438482	-0.12060004	-0.01310745	0.14486445	0.31432408	-0.06008853	0.03112416	1			
HydroP	0.11095436	-0.10623537	-0.04269211	0.22529686	0.34708913	0.11985311	0.11307318	-0.43715598	-0.10575148	-0.04463345	-0.11529397	1		
TP	-0.25430122	-0.1108862	0.05928107	-0.13261791	-0.21769202	-0.09027514	-0.0906323	0.23780196	0.03434164	-0.09475099	-0.19983016	-0.64190962	1	
ChlorNext	-0.1480091	-0.20355469	0.09220325	-0.03890203	0.43286658	0.03054651	0.26106382	-0.05333869	0.16830875	-0.19689767	0.00587716	0.02451004	0.03165636	1

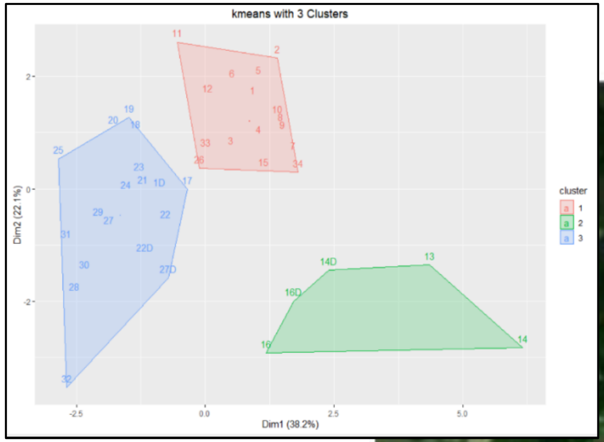
Sept. 2022

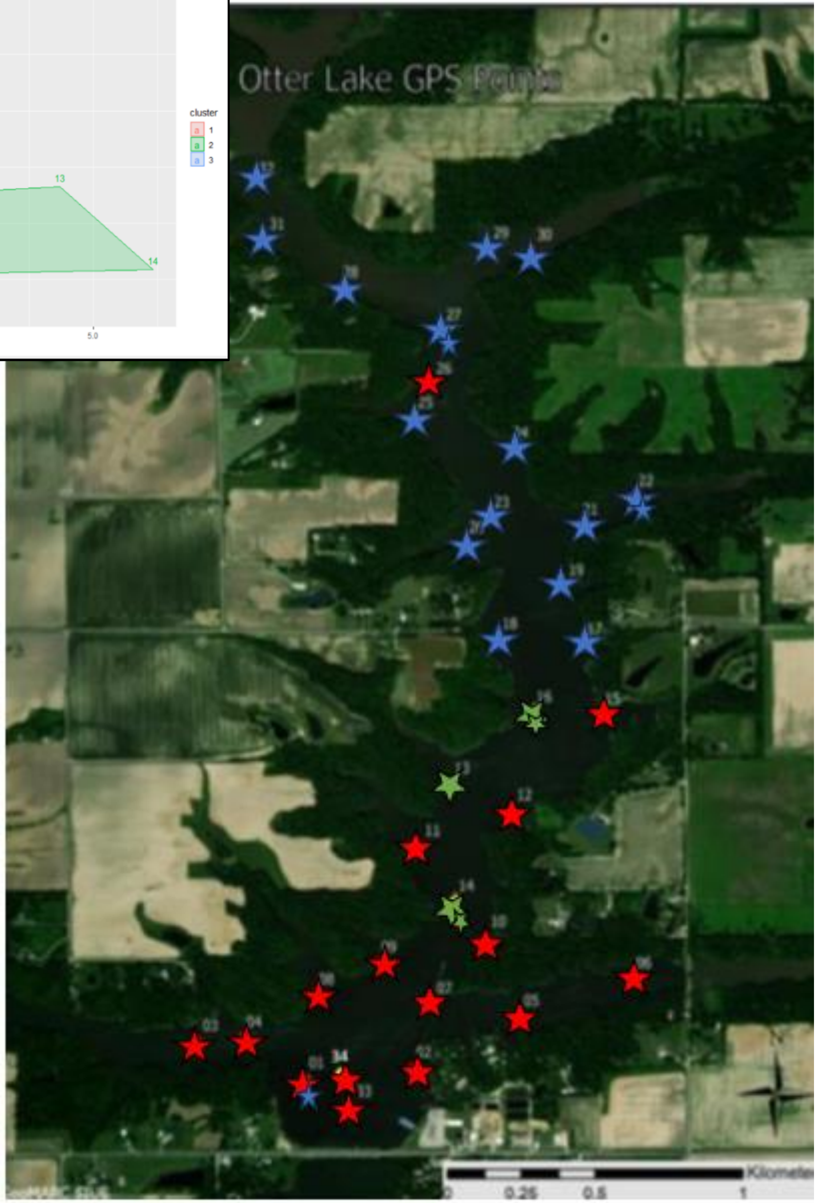
	Chlorophyll	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium	ChlorB	ChlorC	Pheophytin
Chlorophyll	1													
TKP	-0.09449548	1												
TKN	-0.34646359	0.69010336	1											
pH	0.04638387	-0.16340904	-0.06160519	1										
Turbidity	0.45533256	-0.37801162	-0.44692017	0.1693408	1									
RDO	0.26400049	-0.01923204	0.03109933	0.81877972	0.22415197	1								
Temp	-0.29853274	0.04790067	0.14330853	0.30161692	-0.55138764	0.11070071	1							
Conductivity	-0.19365645	0.10505433	0.14807878	-0.62815951	-0.02638902	-0.47925254	-0.58247486	1						
Nitrite	-0.11088201	-0.40155852	-0.10175468	0.20891806	0.20590221	0.26352327	-0.00880745	0.12861429	1					
Nitrate	0.31898635	-0.33977586	-0.36083358	0.31065877	0.45523359	0.35364042	-0.13989241	-0.13899445	0.03252293	1				
Ammonium	-0.28513289	0.13814166	0.15271896	-0.64985336	-0.27566541	-0.79965797	0.10055814	0.35713103	-0.29576557	-0.3893638	1			
ChlorB	0.76262456	0.01562597	-0.24322833	-0.30442827	0.23083283	-0.19188821	-0.38981663	0.15244279	-0.24000913	0.09114811	0.04409873	1		
ChlorC	0.7837517	0.01332493	-0.2344002	-0.27035766	0.25273187	-0.16078051	-0.38183445	0.13058106	-0.22716299	0.10379223	0.02075904	0.9973031	1	
Pheophytin	0.18791503	-0.16447426	-0.23035611	0.05736985	-0.13510044	0.07662331	0.33570613	-0.14592305	0.1887317	-0.02793262	-0.05546816	0.03299201	0.0444393	1

Sept. 2023

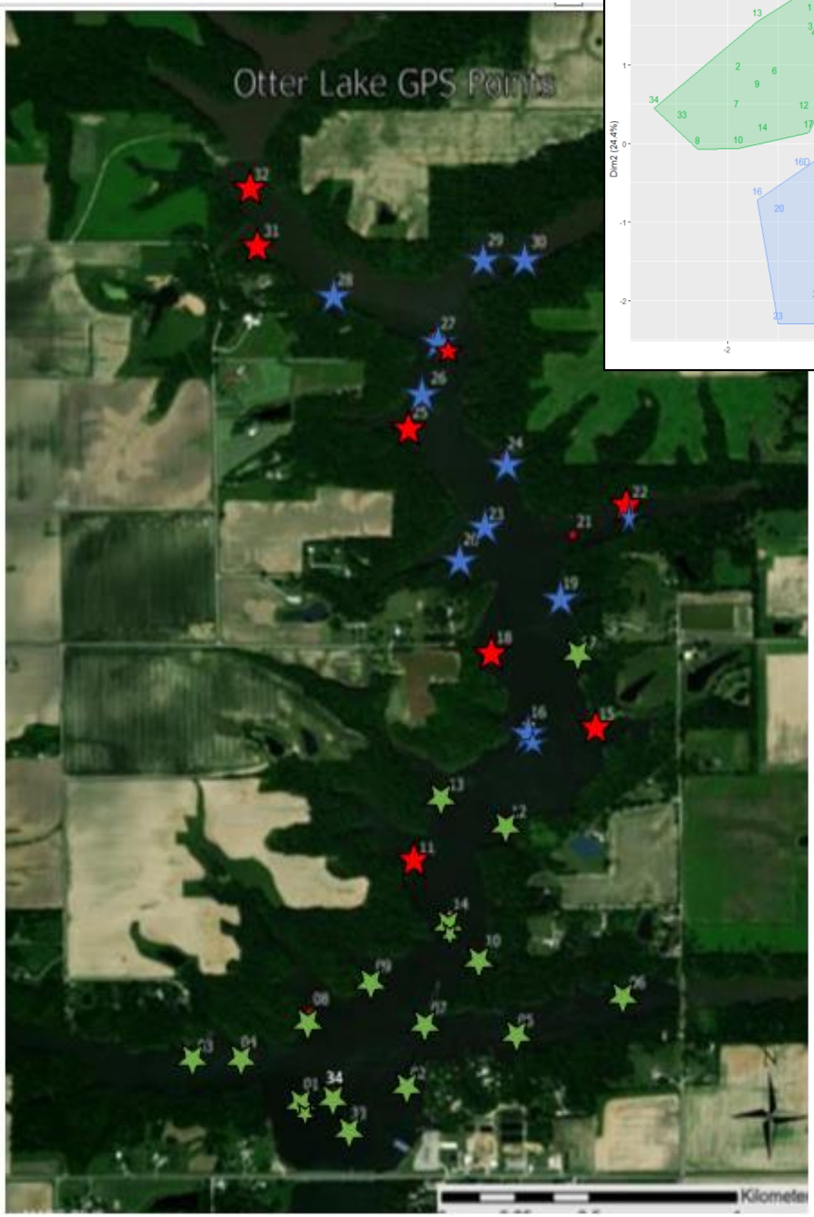
	Chlorophyll	Chloro.B	Chloro.C	Total.Chl	TKP	TKN	pH	Turbidity	RDO	Temp	Conductivity	Nitrite	Nitrate	Ammonium
Chlorophyll	1													
Chloro.B	0.88027182	1												
Chloro.C	0.89324084	0.99934045	1											
Total.Chl	0.99593835	0.91301909	0.92401181	1										
TKP	0.00530998	-0.07944925	-0.07784425	-0.01319901	1									
TKN	-0.00142169	0.03149646	0.03262731	0.00234585	-0.19894802	1								
pH	0.15054737	-0.06377378	-0.04577755	0.11374828	0.01318375	0.33483749	1							
Turbidity	-0.05087734	0.10192549	0.08991779	-0.04002973	-0.03978843	0.00895649	-0.40785077	1						
RDO	0.28174129	0.06649394	0.08193865	0.25230328	0.08788128	0.29028238	0.74279441	-0.08864613	1					
Temp	-0.19110063	-0.25557887	-0.24989401	-0.20006231	0.12752924	-0.0873571	0.0997387	-0.48650218	-0.30108841	1				
Conductivity	-0.05241847	0.04252157	0.03383896	-0.04973304	0.00539074	0.10459076	-0.32288834	0.86859726	0.0449311	-0.52306911	1			
Nitrite	-0.00149577	0.17096634	0.16023765	0.03195663	-0.10028196	0.05254657	-0.41240334	0.60391154	-0.1591952	-0.27425287	0.56388439	1		
Nitrate	-0.11165756	0.06806142	0.0452764	-0.08949236	0.21285869	-0.05270554	-0.51134964	0.50989757	-0.34322992	-0.13176843	0.42053786	0.67634448	1	
Ammonium	-0.27453793	-0.1316287	-0.1403755	-0.25042276	-0.38458748	-0.04809079	-0.46702069	0.35787491	-0.53523275	-0.02590306	0.33997629	0.52734224	0.30574327	1

October 2022





October 2023

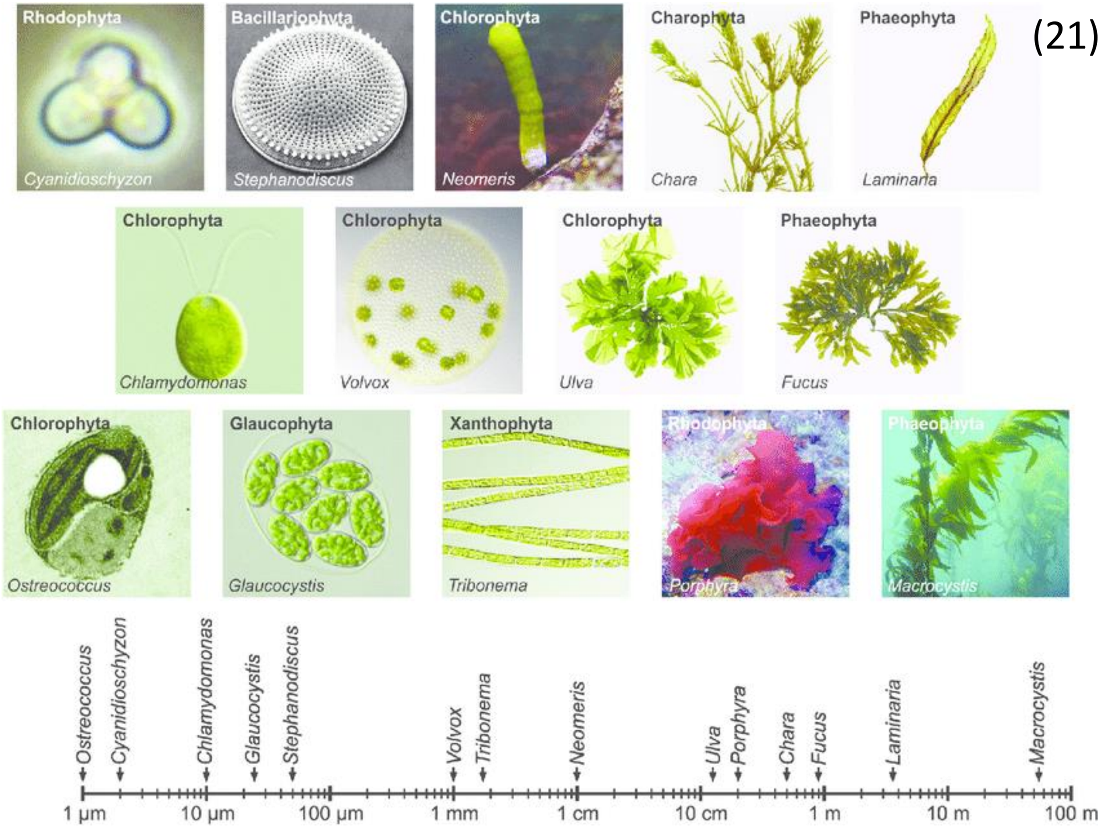


SUMMARY

- pH positively correlated with chlorophyll concentrations all year around. The lake consistently held the same pH of 6.5 – 7.9 all year around.
- Turbidity and temperature are also highly correlated with chlorophyll because algae particles cause light scattering.
- Nitrate and nitrites concentrations are higher in the spring months and nitrates and nitrite levels are depleted in the summer and fall months.
- TKN had a higher positive correlation to chlorophyll growth based off the yearly PCA Biplot.

FUTURE GOALS

- Be able to identify a harmful algae bloom and treat a certain algae bloom before hurtful to aquatic life and people.
- **Be able to compare taste and odor compounds such as Geosmin and 2-MIB in algae genuses using GC-MS.**
- **Be able to speciate toxic vs non-toxic algae genuses in a lake using a linear benchtop MALDI MS.**



(21)

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Undergraduate Research and Creative Activities

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Questions
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