NORTHEAST OHIO REGIONAL SEWER DISTRICT

2012 Lake Erie Nutrient Study

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

Over the last few years, there has been an increase in the occurrence of harmful algal blooms within the central basin of Lake Erie. In 2011, an algal bloom, the majority of which consisted of the potentially toxic *Microcystis*, spread east of Cleveland and persisted there until the middle of October. The increase in algae throughout the lake is thought to be due to increases in dissolved reactive phosphorus and other nutrients (Ohio EPA, 2011). Northeast Ohio Regional Sewer District (NEORSD) facilities, such as Easterly Wastewater Treatment Plant, Westerly Wastewater Treatment Center (WWTC) and combined sewer overflows (CSOs), could be a potential source of nutrients to the lake. The extent to which these potential sources, along with other ones within the study area, are contributing to the problem is not well known.

The purpose of this study was to monitor the levels of nutrients and algae in Lake Erie near the greater Cleveland area from May through October and attempt to establish temporal and spatial trends among them. Chlorophyll *a* was measured as a means of determining the total quantity of algae present. Nutrient analyses included both phosphorus and nitrogen. Other water quality parameters that may also influence algal production were also measured.

Figure 1 is a map of the sampling locations evaluated on Lake Erie during the study, and Table 1 indicates the sampling locations with respect to latitude/longitude and description. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance Division (WQIS).

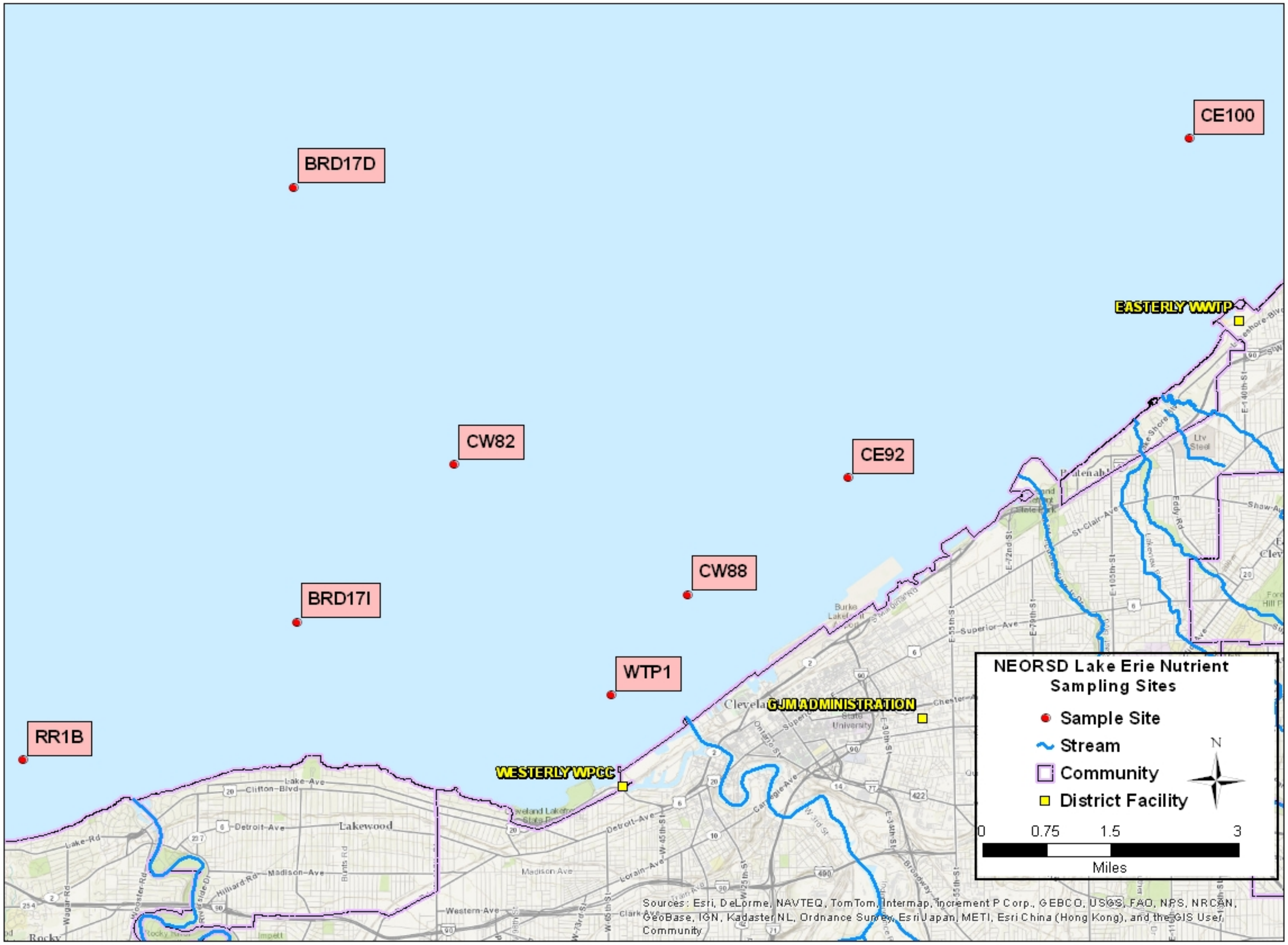


Figure 1. Sampling Locations

Table 1. Sample Locations			
Latitude	Longitude	Station ID	Location Information
41.49720	-81.86200	RR1B	Near Rocky River
41.59630	-81.80000	BRD17D	About 7 miles off shore of Lakewood
41.52080	-81.80000	BRD17I	Near Lakewood
41.54800	-81.76400	CW82	Near Garrett Morgan Water Intake
41.50765	-81.72907	WTP1	Near Westerly WWTC Diffusers
41.52500	-81.71170	CW88	Outside the City of Cleveland's Breakwall
41.54500	-81.67500	CE92	Outside the City of Cleveland’s Breakwall
41.60333	-81.59717	CE100	2 miles north of Easterly WWTP outfall

Water Chemistry Sampling

Methods

Water chemistry sampling was conducted six times between May 2nd and October 9th on Lake Erie at all locations. Techniques used for sampling and analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009a). Chemical water quality samples from each site were collected with one 4-liter disposable polyethylene cubitainer with disposable polypropylene lid, one 473-mL plastic bottle, one 1-liter amber glass jar, and one 100-mL plastic bottle. The 473-mL plastic bottle was field preserved with trace sulfuric acid. Filtering of the dissolved reactive phosphorus sample was done in the field for all samples after June 7th. All water quality samples were collected as grab samples. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 10% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

Formula 1:
$$RPD = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate sample

Generally, an RPD of 40% is allowable for field samples; those that are higher may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards.

Results and Discussion

Five sets of duplicate samples and five field blanks were collected during the study. None of the field blanks showed evidence of contamination. All of the parameters, except for turbidity, were below the PQL. A copy of all analyses is available upon request by contacting the NEORSD's WQIS division.

There was one instance in which the RPD between duplicate samples was greater than 60% and therefore rejected. This occurred at CE100 on July 12th for turbidity. It was noted on that day that there were some small suspended solids in the water, which may have resulted in the difference in measurements between the two samples.

During the study, the highest average total phosphorus, nitrate + nitrite, and total suspended solids (TSS) concentrations were measured at the Westerly WWTC Diffusers site (WTP1) (Table 2). However, TSS was the only parameter that was statistically higher at that location[1]. Average effluent TSS concentrations from Westerly WWTC during the same period as the study were slightly higher than the concentrations measured at that site and, therefore, the treatment center could be the source of the higher concentrations. However, the average concentrations in the effluent were still well below what is allowable based on the NPDES permit. For the other two parameters, there were no significant differences among any of the sites. The current target for total phosphorus in the central basin is 0.01 mg/L (Lake Erie Nutrient Science Task Group, 2009); the average concentrations at all of the sites were above this value. For dissolved reactive phosphorus (DRP), the highest concentration was at one of the sites near Lakewood (BRD17I), although it was not significantly different than the others.

The highest average chlorophyll *a* concentration also occurred at WTP1 (Figure 2), but the differences between that site and the others were not found to be significant. The average chlorophyll *a* concentrations at all of the sites were greater than the 2.6 ug/L target in the Great Lakes Water Quality Agreement (Lake Erie Nutrient Science Task

[1] Differences among groups of data were evaluated using the Kruskal-Wallis Test with an alpha of 0.05.

Group, 2009), although there were some individual measurements that met the target (Table 3).

Table 2. 2012 Lake Erie Average Values*

	TP	DRP	NO_3-NO_2	Alkalinity	TSS	pH	Conductivity	DO	Temperature	Turbidity
Site	mg/L	mg/L	mg/L	mg/L CaCO3	mg/L	S.U.	uS/cm	mg/L	C	NTU
RR1B	0.022	0.007	0.41	88.40	2.00	8.27	242	10.42	14.83	6.17
BRD17D	0.021	0.006	0.28	90.93	1.78	8.40	249	10.44	17.625	2.86
BRD17I	0.021	0.009	0.37	89.87	2.80	8.28	237	10.66	14.93	5.31
CW82	0.017	0.005	0.27	91.30	2.05	8.48	250	10.17	17.95	3.66
WTP1	0.027	0.006	0.60	91.95	4.03	8.29	279	10.70	16.60	5.72
CW88	0.019	0.004	0.32	90.83	2.30	8.48	275	10.26	18.70	2.84
CE92	0.019	0.005	0.31	91.18	1.69	8.51	279	10.35	18.70	2.56
CE100	0.019	0.005	0.29	91.58	1.80	8.51	258	10.40	18.23	3.21

*Only data for dates in which chlorophyll *a* was also measured are included

Figure 2. Lake Erie Average Chlorophyll *a* Concentrations (µg/L)

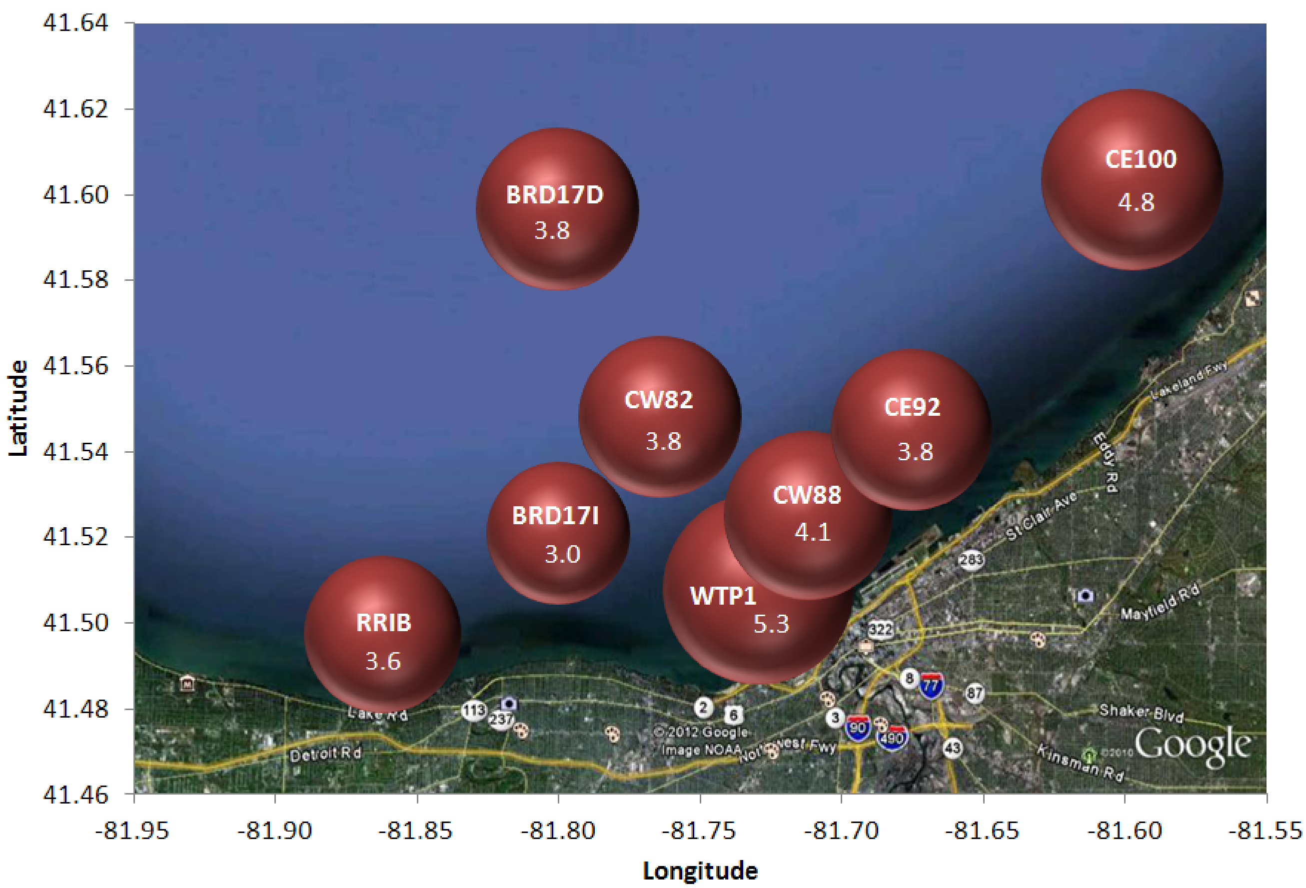


Table 3. 2012 Lake Erie Chlorophyll *a* Concentrations (ug/L)						
Site	5/2 - 5/24/2012*	6/7/2012	8/13/2012	8/29/2012	10/9/2012	Average
RR1B	2.51	3.65	-	2.77	5.40	3.58
BRD17D	2.39	1.28	7.87	1.93	5.78	3.85
BRD17I	3.30	1.66	-	1.97	4.97	2.98
CW82	2.91	1.94	8.47	1.69	3.97	3.80
WTP1	4.70	6.80	-	3.41	6.28	5.30
CW88	3.27	2.57	6.09	1.98	6.64	4.11
CE92	2.86	1.87	5.47	1.71	6.95	3.77
CE100	6.19	0.89	5.45	1.78	9.49	4.76
Average	3.52	2.58	6.67	2.15	6.19	

Meets GLWQA Target

* Date range that samples were collected; not all were taken on same day.

Although there were no statistically significant differences for chlorophyll *a* among the sample locations, there was a difference when comparing some of the sampling dates. Two of the dates, August 13th and October 9th, were significantly higher than the others. When the samples from May were considered to be a single sampling event, they were also statistically higher than the June 7th and August 29th events. For the two sampling events with the highest concentrations, there was a heavy rainfall in the area either two or three days beforehand. It is possible that the wet weather resulted in an increase in nutrients being discharged into the lake from stormwater runoff and/or CSOs.

Individual parameter results were also compared to determine if any relationships existed between them. An analysis of chlorophyll *a* versus total phosphorus, using the data from all the sites, showed a statistically significant correlation[2] between the two, with a general increase in the former corresponding with an increase in the latter (Figure 4). There was no significant correlation between chlorophyll *a* and either DRP (Figure 5) or nitrate + nitrite (Figure 6). This was contrary to previous monitoring that has suggested increases in DRP have caused increases in algal production in the lake in recent years.

[2] Correlations were evaluated using Kendall's Tau and an alpha level of 0.05.

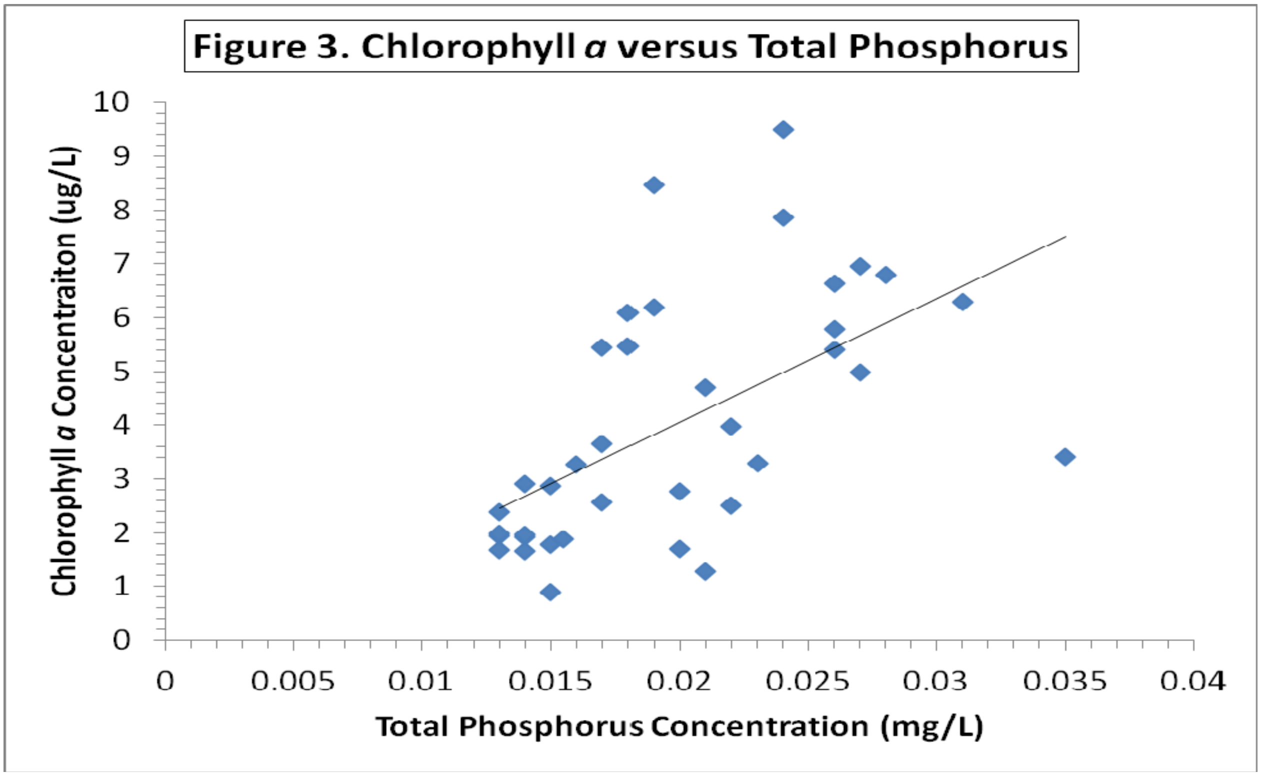


Figure 3. Chlorophyll a versus Total Phosphorus
Chlorophyll a Concentraiton (ug/L)
0
1
2
3
4
5
6
7
8
9
10
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
Total Phosphorus Concentration (mg/L)

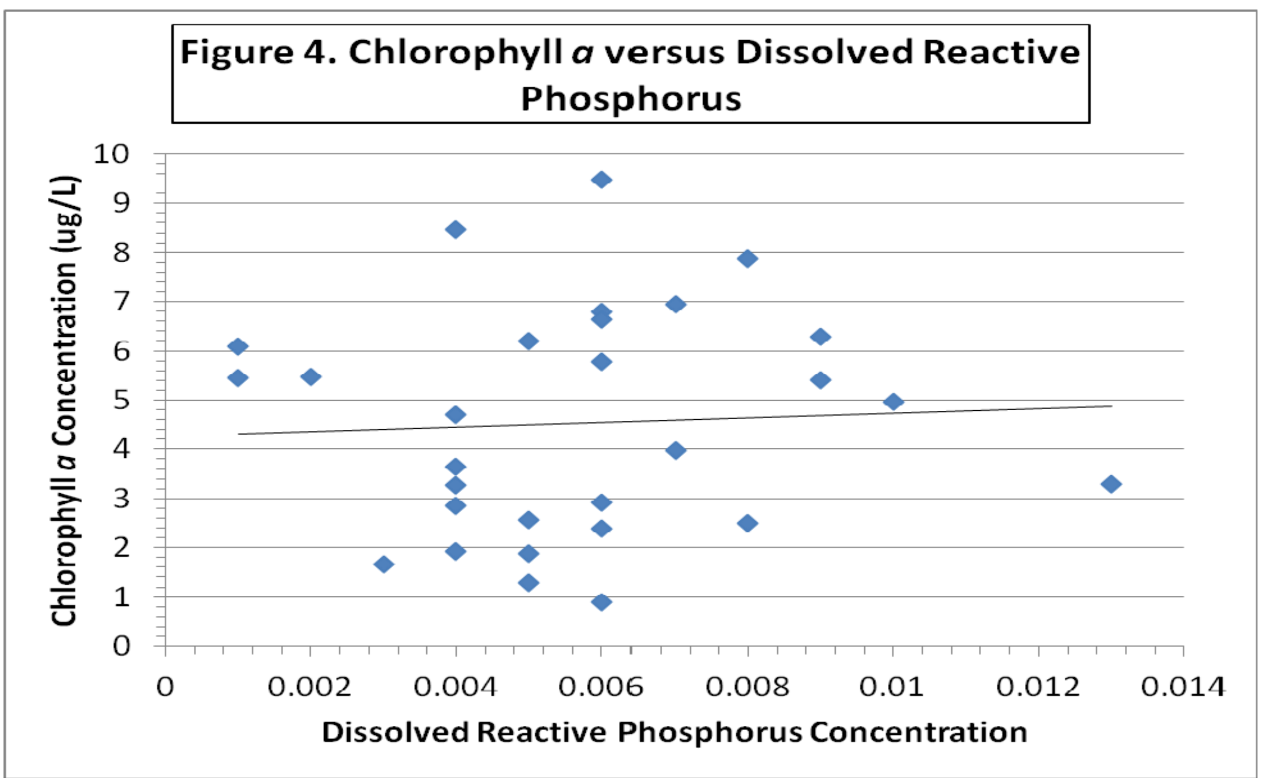
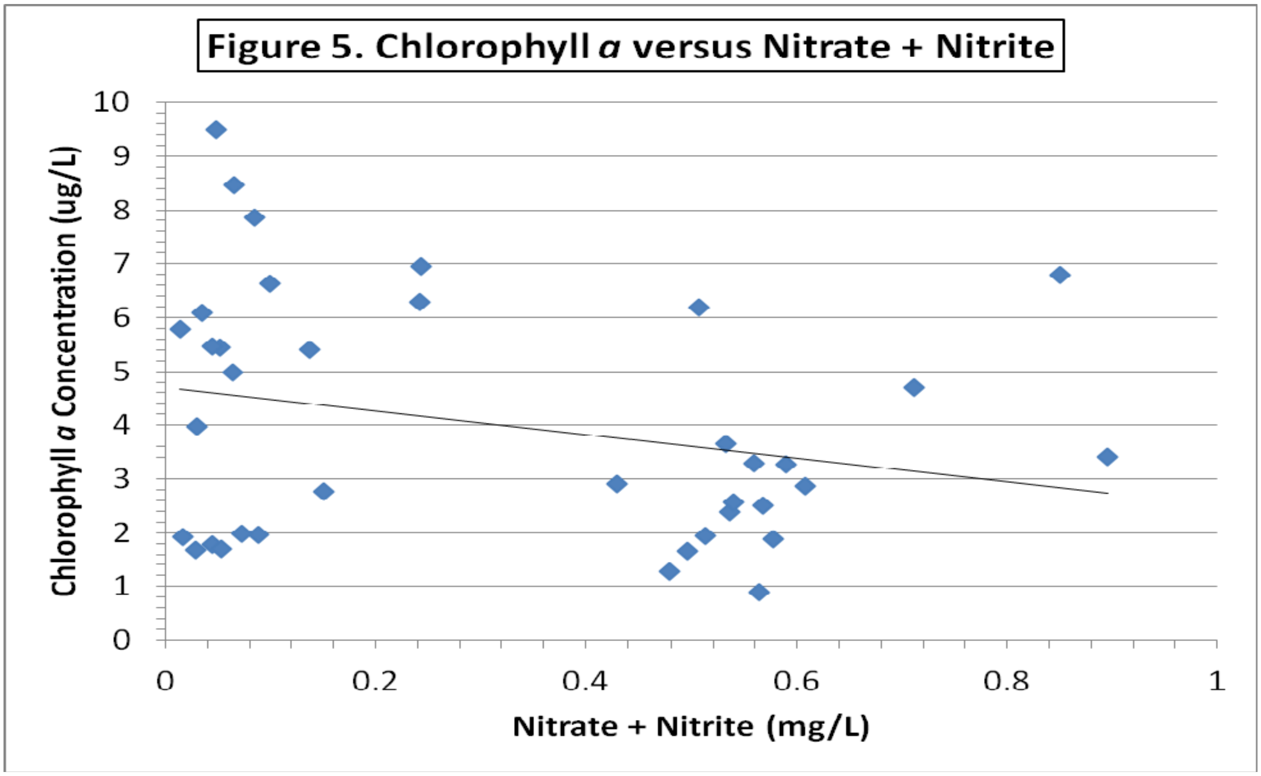
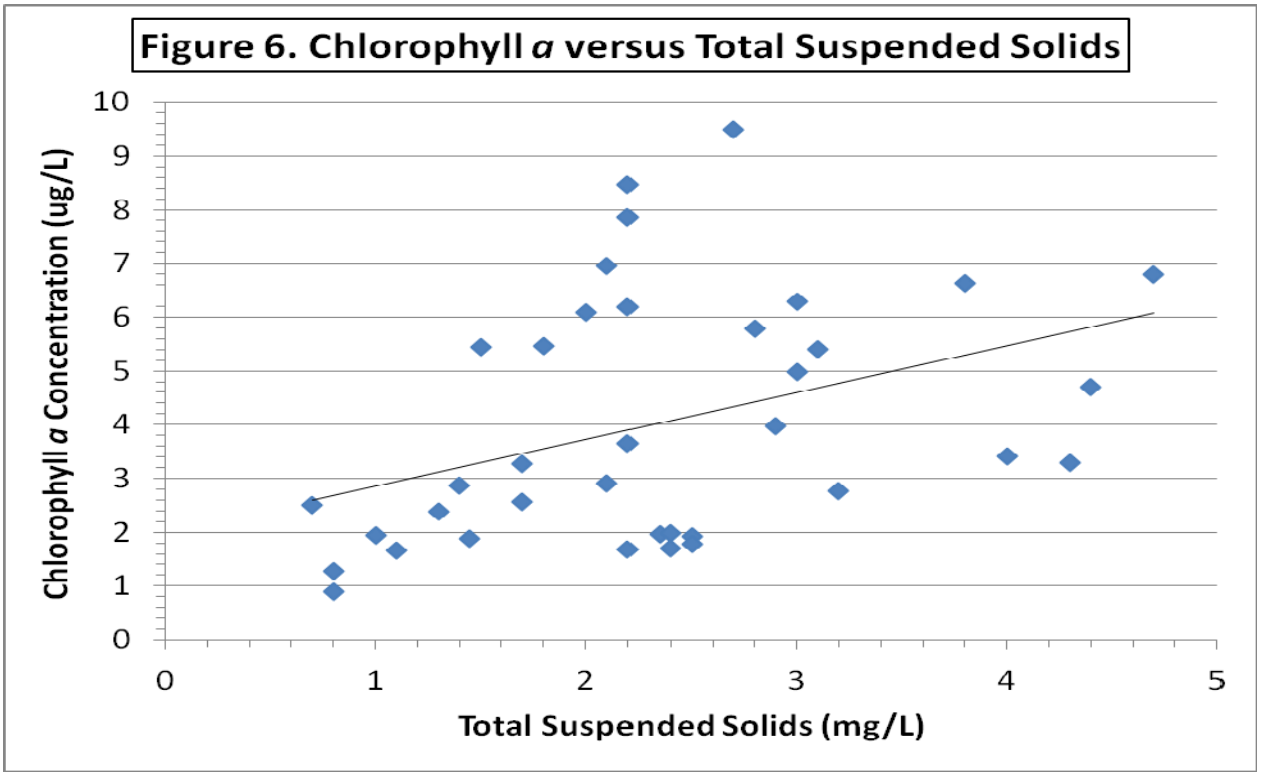


Figure 4. Chlorophyll a versus Dissolved Reactive Phosphorus
Chlorophyll a Concentration (ug/L)
0
1
2
3
4
5
6
7
8
9
10
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
Dissolved Reactive Phosphorus Concentration



A significant correlation also existed between chlorophyll *a* and total suspended solids (Figure 7), although it was not as strong as the correlation between chlorophyll *a* and total phosphorus. Generally, it would be expected that an increase in TSS would result in decreased chlorophyll *a* due to light inhibition within the water column. For the data that was collected in 2012, the opposite was true. One possible explanation for this is that during all the sampling events, the turbidity of the water was still low enough to not cause inhibition. The slight positive relationship between TSS and chlorophyll *a* may be an indication that the lake was stirred up during the wet weather events that preceded the days with the highest chlorophyll *a* concentrations, but had not completely returned to baseline conditions at the time of sampling. Bottom sediments are a potential source of phosphorus that could contribute to algal growth.



Conclusions

The limited sampling that was conducted in 2012 showed that average chlorophyll *a* concentrations in Lake Erie were above the target set by the Great Lakes Water Quality Agreement, although some individual samples were below it. In general, location did not appear to have much of an influence on the concentrations that were measured. Instead, wet weather events occurring a few days prior to sampling were a better indicator of when higher chlorophyll *a* concentrations occurred within the lake. This may be due to an influx of nutrients from stormwater runoff and/or CSOs that enables algae to grow. Total phosphorus concentrations were somewhat related to chlorophyll *a* concentrations, whereas DRP and nitrate + nitrite did not appear to be. All measured total phosphorus concentrations were above the current Lake Erie central basin target; no water quality standards currently exist for phosphorus.

It is recommended that additional sampling be conducted in the Lake in 2013. In general, the summer of 2012 was relatively dry. Because the data suggests that wet weather may influence chlorophyll *a* concentrations, additional sample collection during such times may help to determine if this is true. It may also help to establish any other controlling factors for algal production that were not apparent from the 2012 data set.

References

Lake Erie Nutrient Science Task Group. (2009). *Status of Nutrients in the Lake Erie Basin*.

Ohio Environmental Protection Agency. (2009). *Ohio EPA manual of surveillance methods and quality assurance practices*. Columbus, OH: Divisions of Surface Water and Environmental Services.

Ohio Environmental Protection Agency. (2011). *Draft Nutrient Reduction Strategy Framework for Ohio Waters*. Columbus, OH: Division of Surface Water.