Big Platte Lake

Shoreline *Cladophora*, Phosphorus and *E. Coli* Survey
June – September 2003

Final Report

Prepared For:
Platte Lake Improvement Association

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Introduction

Cladophora is very commonly associated with calcareous freshwater systems. Many of the marl bottom lakes of Northwest Lower Michigan are ideal hosts for this classic indicator of nutrient enrichment. The rapid growth potential, sensitivity to available phosphorus and readily visible colonization of the lake substrate make *Cladophora* an ideal species to monitor over time during routine shoreline surveys.

Cladophora will most commonly utilize any solid substrate such as rocks and logs, but can also attach to macrophytes. In many lakes the most favorable *Cladophora* habitat is found near shore in less than two feet of water. This proximity to shoreline coupled with a rapid growth response to pulses of introduced nutrients allow for a qualitative correlation between *Cladophora* colony growth and available nutrients to the near shore environment.

Monitoring *Cladophora* beds through the growing season and comparing those results over many years is a relatively quick and easy method of determining changes in available nutrients from adjacent shoreline run-off or tributary stream input. Changes in land use and shoreline habitat greatly influence the amount of soluble nutrients carried into adjoining water bodies. Natural shorelines with intact riparian vegetation filter out more nutrients than developed landscapes with manicured lawns. In fact, lawn care and gardening practices are commonly found to be a major source of nutrient enrichment when native riparian vegetation has been removed.

In addition to shoreline vegetation type, the actual shoreline composition can also play a critical role in the link between shoreline health and water quality. Native plants and shrubs contribute to shoreline stabilization and nutrient uptake. Cement rip-rap, cobble or sand fill and break walls all constitute an abrupt change from land to the aquatic environment, thereby preventing nutrients from being filtered out of surface run-off as it flows into the receiving water body.

Dense *Cladophora* growth is typical on suitable substrates adjacent to shorelines with such abrupt transitions from land to water. Natural shorelines retain much greater nutrient filtration capacities, however tributaries along natural shorelines can carry nutrient rich run-off from distant uplands. Dense *Cladophora* colonies are often found where these tributaries empty into a main water body. Monitoring changes in the area and average density of *Cladophora* colonies can allow for a qualitative analysis of how the immediate shoreline area is influencing the near-shore water quality.

Throughout this study, *Cladophora* was identified by field observations only, samples were not examined using a microscope.

Methods

The Platte Lake shoreline was canoed on June fourteenth and fifteenth and September sixth and seventh of 2003. Samples sites were chosen primarily at areas with visible *Cladophora* growth. At each site, 100 mL water samples were collected for phosphorus (µg/L) and *E. coli* (#/dL) analyses. In addition, global coordinates using a handheld, Garmin eTrex Legend Global Positioning System unit, were recorded in decimal degrees; water temperature, type of shoreline (B ñ break or seawall, L ñ manicured lawn, N ñ natural, O ñ outflow, R ñ rocky, S ñ sand), and the relative density of *Cladophora* growth (with an estimate of total bed size in square feet, for medium to high densities) were collected. Approximately two photographs were taken at each site, one of the shoreline and one of the lake bottom including *Cladophora* when present.

Water samples were stored in coolers before being delivered to the laboratory for analyses.

Data were entered into Excel spreadsheets and ArcView 3.2 Geographic Information Systems. The data were sorted both as a function of collection date and shoreline type, and analyzed using ANOVA ($\alpha = 0.05$).

Results

Phosphorus (µg/L) values collected in June were not significantly different (p-value = 0.25) from those collected in September (Figure 1). *E. coli* counts however, were significantly lower (p-value = 0.02) in September than they were in June (Figure 1).

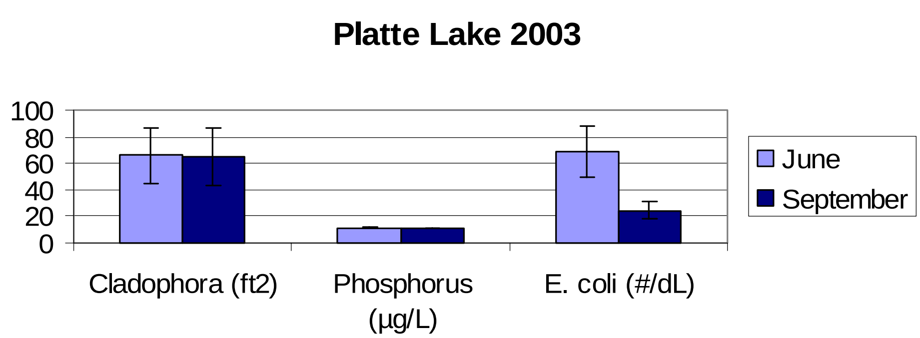


Figure 1. Mean *Cladophora* (ft^2), phosphorus (µg/L) and *E. coli* (#/dL) values collected from Platte Lake in June and September 2003. Y ñ error bars indicate standard error.

In June, *Cladophora* beds were noted at 65% of the sample sites, compared to 61% in September. The medium to high density *Cladophora* beds (Appendix B1) in June approximated 4466 ft^2, whereas those in September totaled approximately 4640 ft^2 and are not significantly different (p-value = 0.97).

Data collected at sites with a shoreline designation of breakwall were not significantly different when comparing *Cladophora* area (p-value = 0.46), phorphorus (p-value = 0.72), nor *E. coli* (p-value = 0.58) from June to September (Table 1).

Table 1. Mean and standard error of *Cladophora* bed area (ft^2), phosphorus (µg/L) and *E. coli* (#/dL) in Platte Lake at sites with break or sea-walls.

Breakwall

	Cladophora Area (ft2)		Phosphorus (µg/L)		*E. coli* (#/dL)	
	mean	standard error	mean	standard error	mean	standard error
June	96.71	43.51	11.47	1.32	79.79	57.78
September	65.30	18.43	10.94	0.84	48.40	23.49

Sites with natural shorelines were not significantly different from June to September in terms of mean *Cladophora* area (p-value = 0.82), phosphorus (p-value = 0.97), nor *E. coli* (p-value = 0.56) (Table 2).

Table 2. Mean and standard error of *Cladophora* bed area (ft^2), phosphorus (µg/L) and *E. coli* (#/dL) in Platte Lake at sites with natural shorelines.

Natural

	Cladophora Area (ft2)		Phosphorus (µg/L)		*E. coli* (#/dL)	
	mean	standard error	mean	standard error	mean	standard error
June	21.84	12.95	10.88	1.36	45.36	24.36
September	17.21	15.76	10.93	0.65	28.42	10.91

Outflow sites were not significantly different from June to September when comparing *Cladophora* area (p-value = 0.51) and phosphorus (p-value = 0.08). They were, however when comparing *E. coli* (p-value = 0.04).

Table 3. Mean and standard error of *Cladophora* bed area (ft^2), phosphorus (µg/L) and *E. coli* (#/dL) in Platte Lake at sites with outflows including streams, springs or pipes.

Outflow

	Cladophora Area (ft2)		Phosphorus (µg/L)		*E. coli* (#/dL)	
	mean	standard error	mean	standard error	mean	standard error
June	130.25	88.25	13.97	2.72	134.75	52.46
September	232.45	124.70	8.65	0.70	16.00	4.47

Cladophora bed area, phosphorus and *E.coli* were not significantly different (p-values of 0.88, 0.71 and 0.07 respectively) from June to September at sites with rocky shores.

Table 4. Mean and standard error of *Cladophora* bed area (ft^2), phosphorus (µg/L) and *E. coli* (#/dL) in Platte Lake at sites with outflows such as stream, springs or pipes.

Rocky

	Cladophora Area (ft2)		Phosphorus (µg/L)		*E. coli* (#/dL)	
	mean	standard error	mean	standard error	mean	standard error
June	26.22	13.18	9.48	1.44	19.56	8.96
September	28.53	9.91	9.98	0.52	5.93	1.26

In June, mean values of *Cladophora* beds were greatest at sites with breakwalls, manicured lawns or outflows (Figure 2a). Sites with breakwalls and outflows similarly contained the highest mean values of *Cladophora* beds in September (Figure 3a). Mean phosphorus values did not vary greatly among shoreline types (Figures 2b, 3b). *E. coli* counts were quite variable in June, with high values at most shoreline types (Figure 2c); overall, mean September counts were lower, with smaller standard errors (Figure 3c).

Hot spots, or sites containing extremely high values of observed or measured variables were determined by comparing all values recorded for June and September and are projected in Appendix A6 and listed as follows: *Cladophora* (Figure 4, Table 5), phosphorus (Figure 5, Table 6) and *E. coli* (Figure 6, Table 7).

Discussion

The decrease in *E.coli* levels over time may be the result of reduced rainfall and runoff in the later summer leading to less introduction of *E.coli* from adjacent uplands. The greater

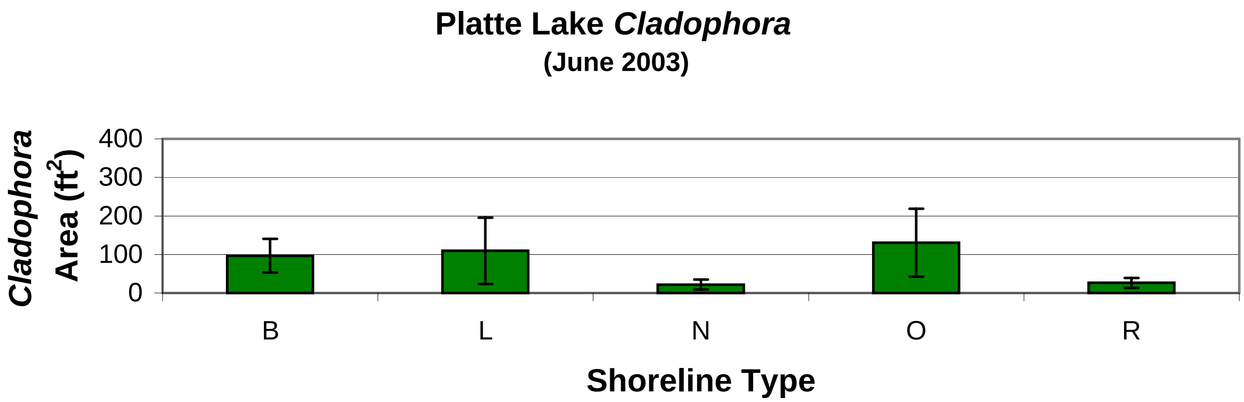


Figure 2a. Mean values of *Cladophora* beds (ft^2) at different shoreline types (B - breakwall, L - manicured lawns, N - natural, O - outflow, R - rocky) in Platte Lake 2003. Y - error bars indicate standard error.

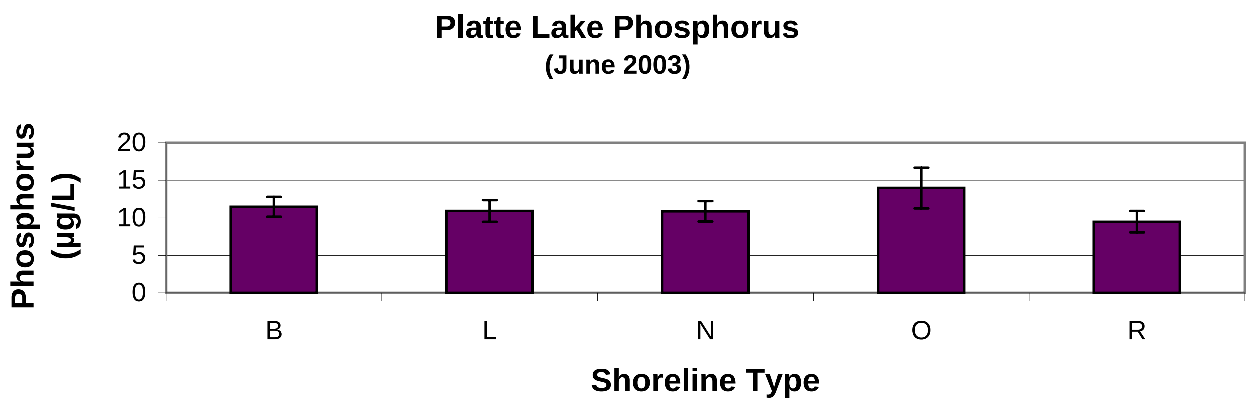


Figure 2b. Mean values of phosphorus (µg/L) at different shoreline types (B - breakwall, L - manicured lawns, N - natural, O - outflow, R - rocky) in Platte Lake 2003. Y - error bars indicate standard error.

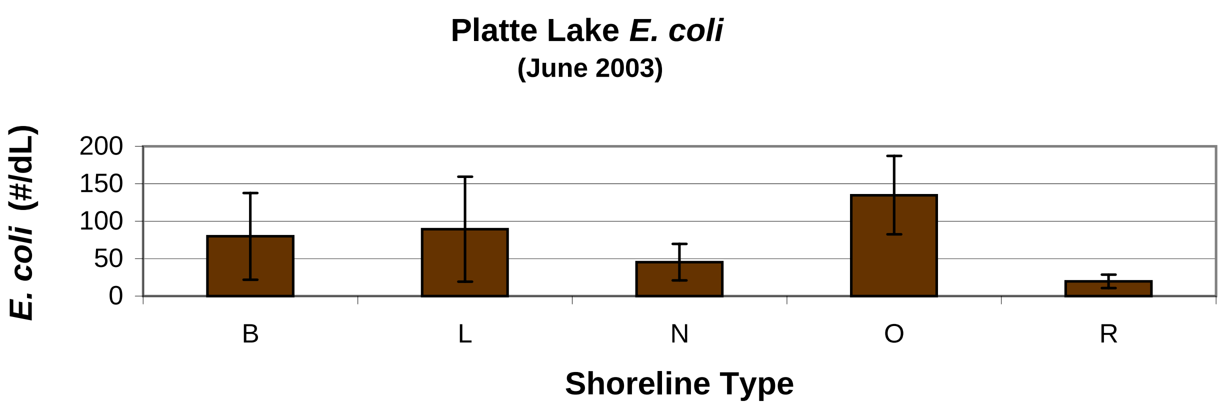


Figure 2c. Mean counts of E. coli (#/dL) at different shoreline types (B - breakwall, L - manicured lawns, N - natural, O - outflow, R - rocky) in Platte Lake 2003. Y - error bars indicate standard error.

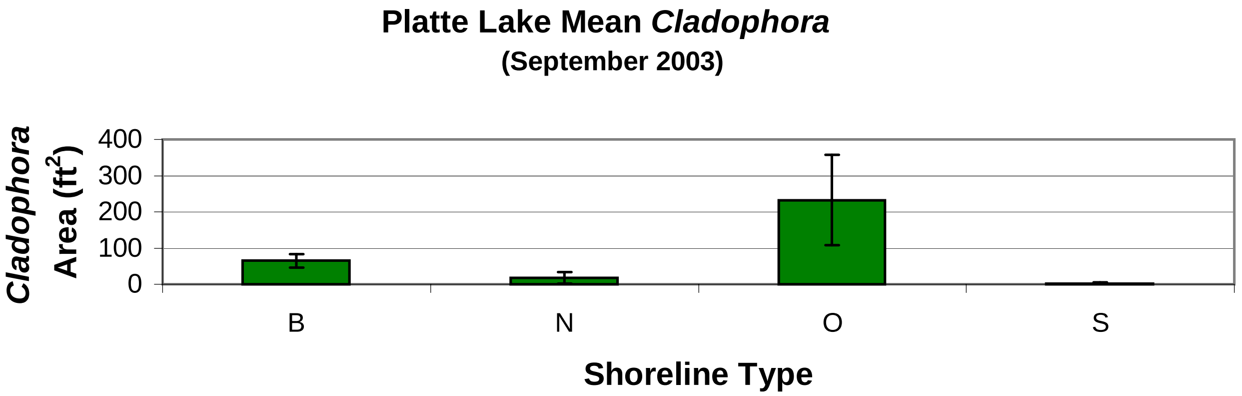


Figure 3a. Mean values of *Cladophora* beds (ft^2) at different shoreline types (B - breakwall, N - natural, O - outflow, S - sandy) in Platte Lake 2003. Y - error bars indicate standard error.

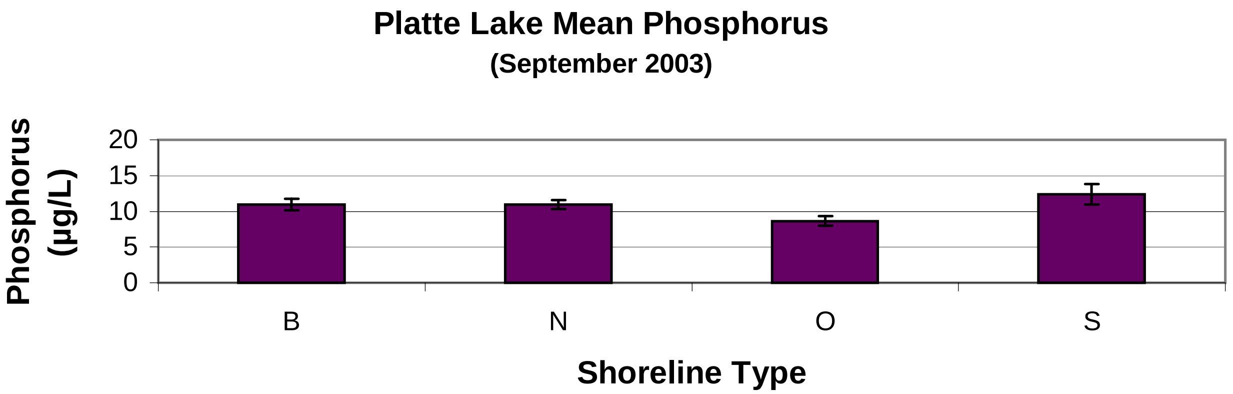


Figure 3b. Mean values of *Cladophora* beds (ft^2) at different shoreline types (B - breakwall, N - natural, O - outflow, S - sandy) in Platte Lake 2003. Y - error bars indicate standard error.

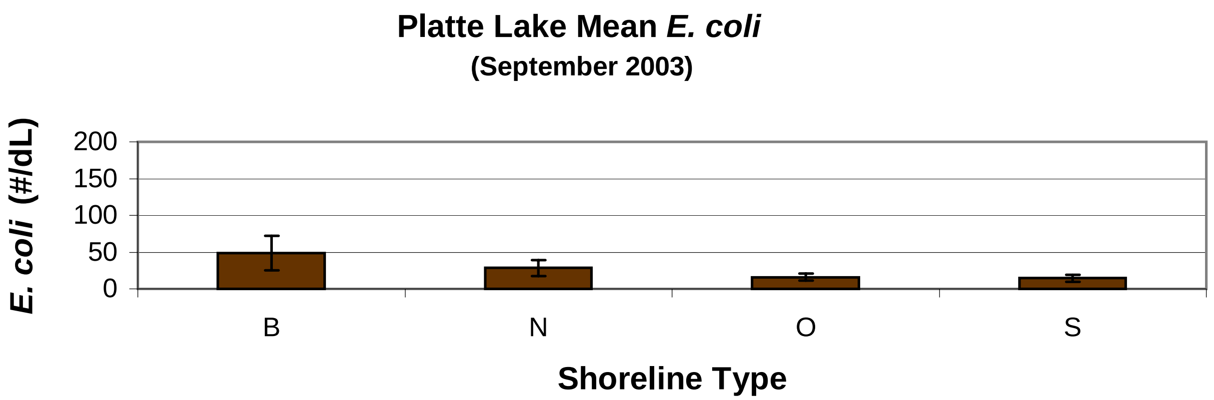


Figure 3c. Mean values of *Cladophora* beds (ft^2) at different shoreline types (B - breakwall, N - natural, O - outflow, S - sandy) in Platte Lake 2003. Y - error bars indicate standard error.

surface run-off in the sub-watersheds of these tributary outflows during the wetter late spring/early summer has the potential to carry much more fecal material as compared to the much drier late summer/early fall period reflected in the September data. Although statistical comparison of shoreline type and *Cladophora* presence did not prove significant, it is felt that the influence of tributary streams on *Cladophora* beds led to the high incidence of *Cladophora* along natural shorelines that had outflows present. The authors felt that the natural shoreline incidences of *Cladophora* could be attributed to the nutrients carried by the outflow and not necessarily from the adjacent shoreline.

Lack of significance between June and September nutrient levels would indicate a fairly uniform supply of available nutrients throughout the growing season for the near shore environment of Platte Lake.

Conclusions

Statistical analyses show that over time, *Cladophora* and phosphorus did not vary significantly. *E. coli* counts however, declined from June to September (confidence interval = 95%).

Cladophora densities were highest at shorelines with break or seawalls, manicured lawns and outflows, however they were not significantly different (confidence interval = 95%).

Phosphorus and *E. coli* did not vary significantly among shoreline types (confidence interval = 95%).

Recommendations for further studies would be to further evaluate *Cladophora* presence along natural shorelines in the vicinity of outflows compared to natural shorelines not in the vicinity of tributary outflows.

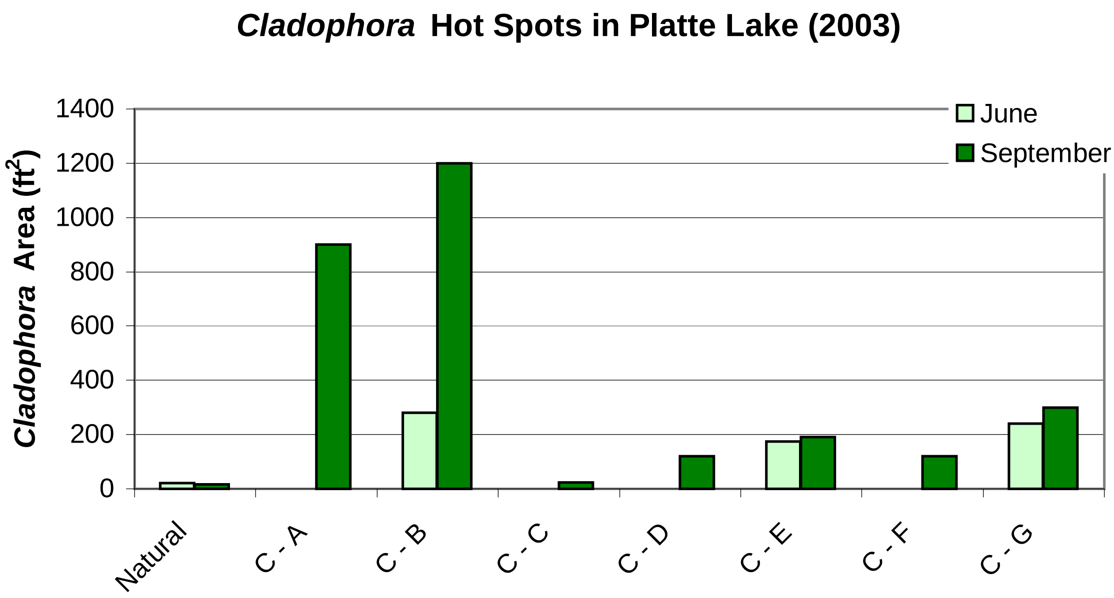


Figure 4. *Cladophora* bed (ft^2) hot spots and mean values along natural shorelines, in Platte Lake, 2003. Special Note: Location of above hot spots is not the same among measured variables. For specific location see table below.

Table 5. Area (ft^2) and locations of *Cladophora* hot spots in Platte Lake 2003.

	Site (June)	Latitude	Longitude	June	September
Natural				21.84	17.21
A	5	44.67673	-86.09301	0	900
B	9	44.67623	-86.08537	280	1200
C	22	44.67875	-86.06431	0	24
D	36	44.70078	-86.09027	0	120
E	37	44.70115	-86.09071	175	192
F	38	44.70161	-86.09104	0	120
G	66	44.68214	-86.10719	240	300

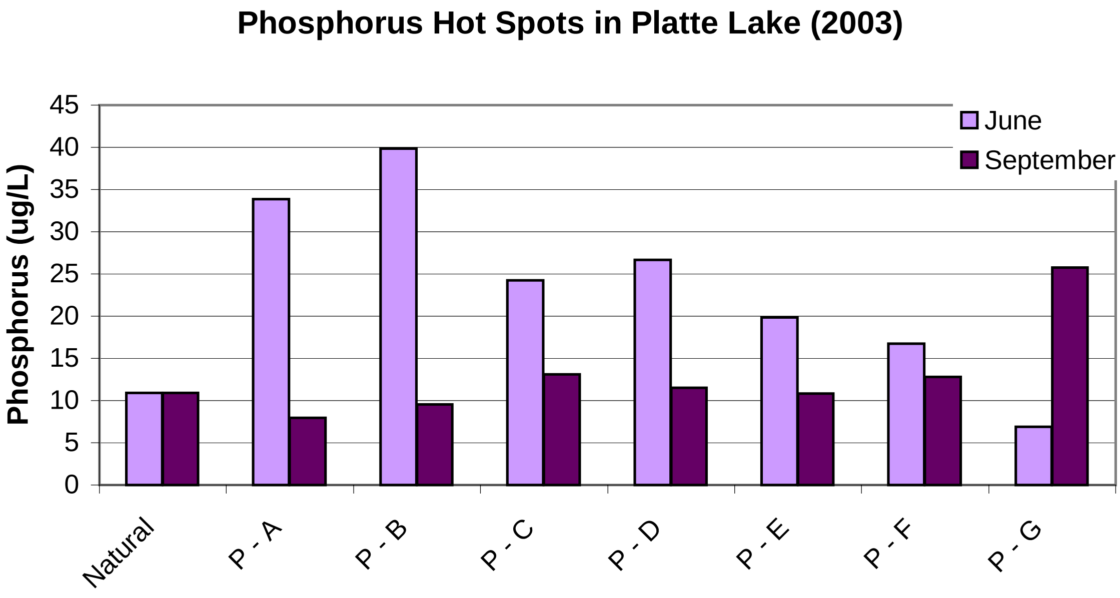


Figure 5. Phosphorus (ug/L) hot spots and mean values along natural shorelines, in Platte Lake, 2003. Special Note: Location of above hot spots is not the same among measured variables. For specific location see table below.

Table 6. Concentrations (ug/L) and locations of phosphorus hot spots in Platte Lake 2003.

	Site (June)	Latitude	Longitude	June	September
Natural				10.88	10.93
A	18	44.6748	-86.06575	33.89	7.99
B	19	44.6751	-86.06514	39.88	9.56
C	23	44.68103	-86.06588	24.22	13.09
D	25	44.68555	-86.0631	26.7	11.52
E	43	44.70477	-86.09765	19.83	10.82
F	44	44.70616	-86.09994	16.75	12.84
G	51	44.69997	-86.12084	6.86	25.74

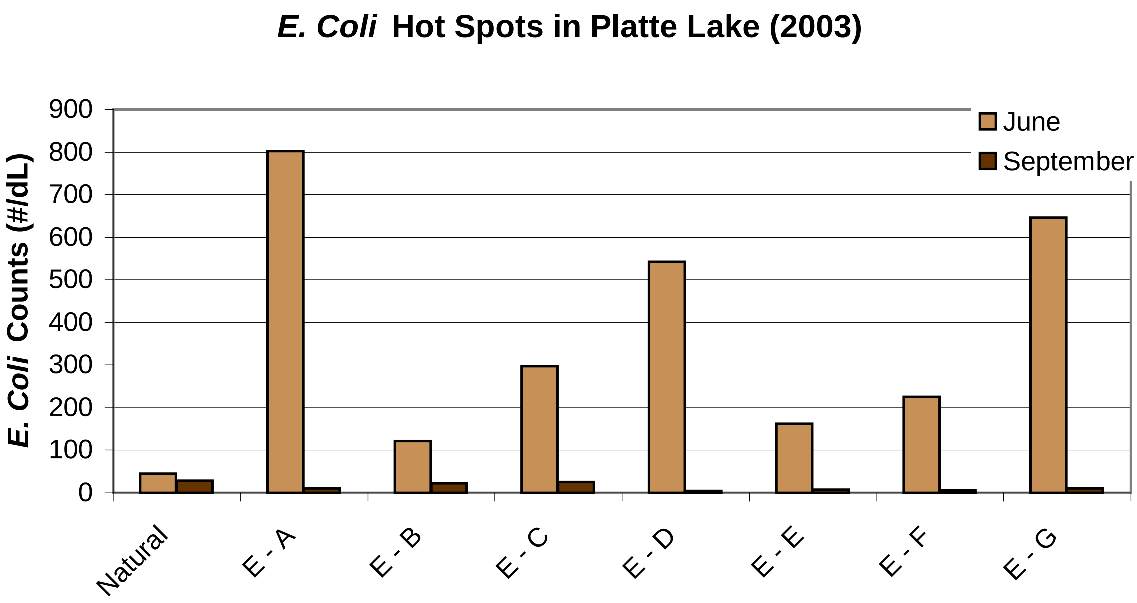


Figure 7. *E. coli* (#/dL) hot spots and mean values along natural shorelines, in Platte Lake, 2003. Special Note: Location of above hot spots is not the same among measured variables. For specific location see table below.

Table 7. Counts (#/dL) and locations of *E. coli* hot spots in Platte Lake 2003.

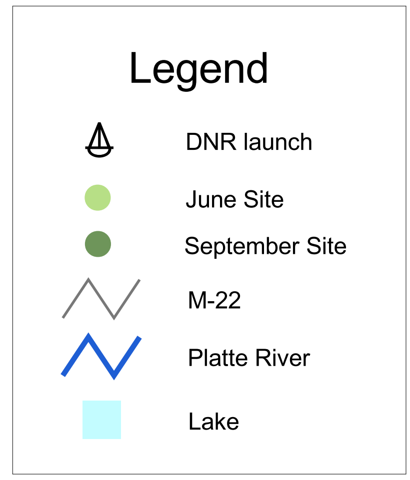
	Site (June)	Latitude	Longitude	June	September
Natural				45.36	28.42
A	1	44.67693	-86.09885	803	11
B	9	44.67623	-86.08537	121	23
C	11	44.67580	-86.08262	298	26
D	17	44.67572	-86.06737	542	5
E	19	44.64510	-86.06514	162	8
F	25	44.68555	-86.0631	226	6
G	62	44.68835	-86.11543	646	10

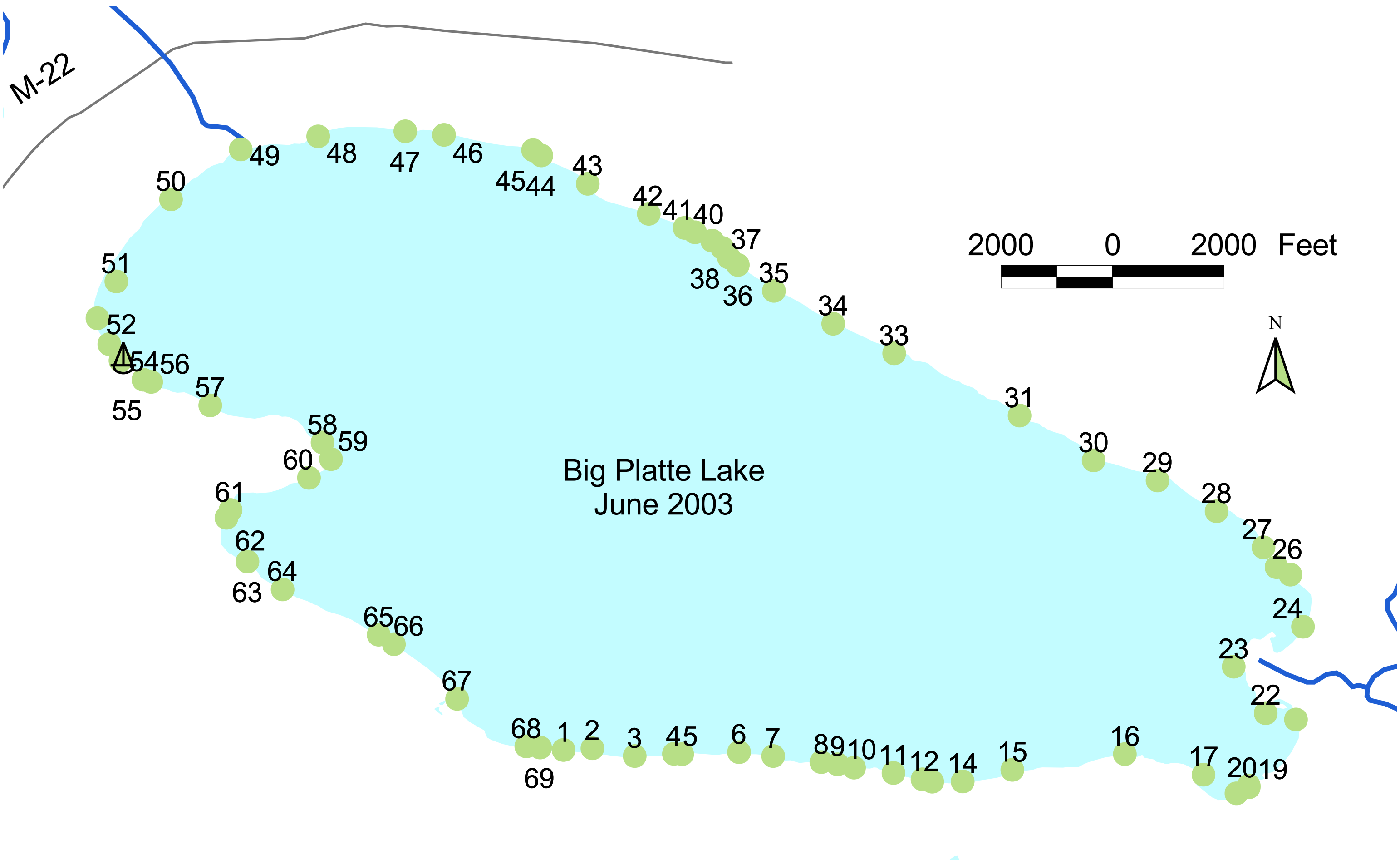
APPENDIX A - MAPS

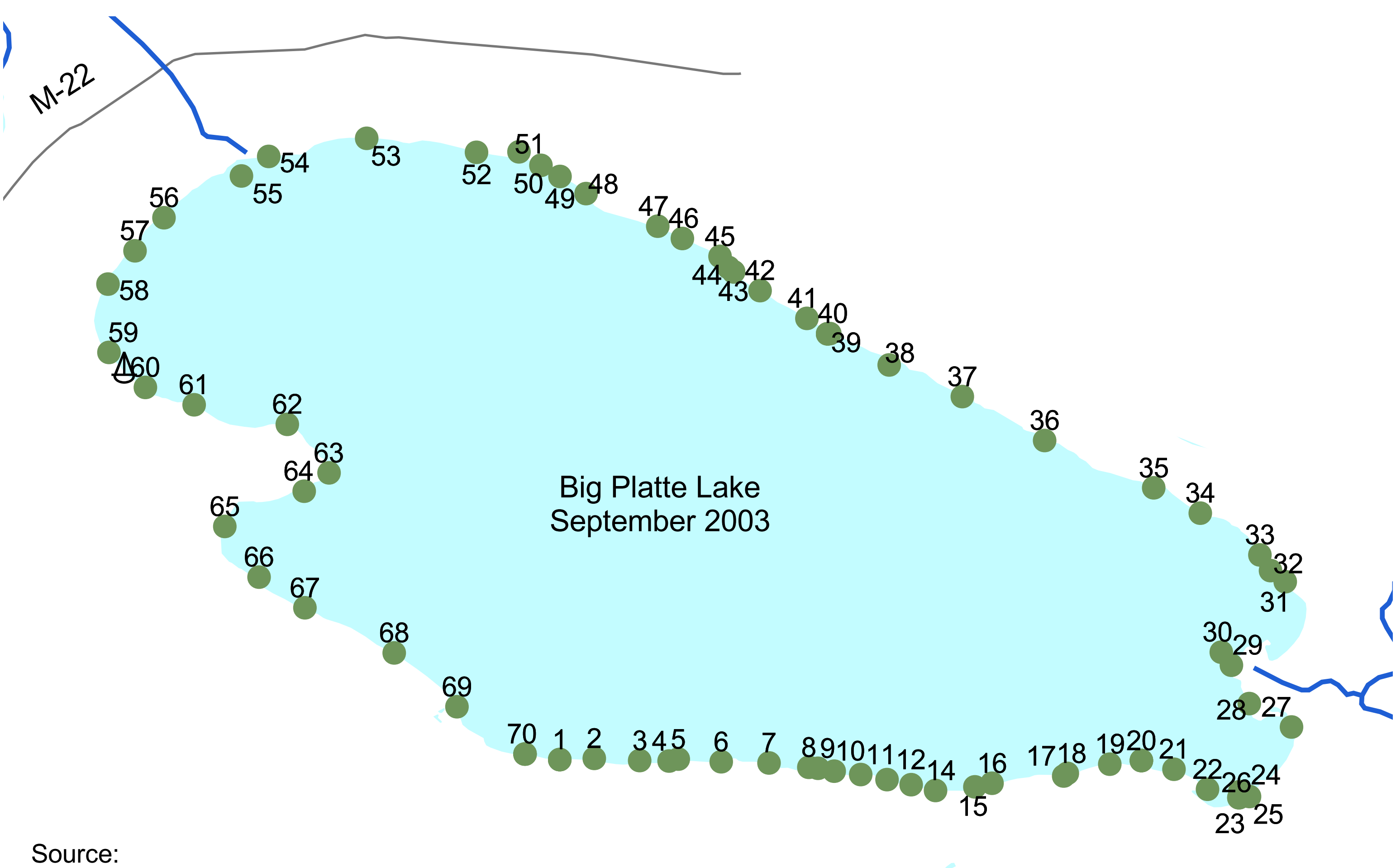
A1. Sample Sites
A2. *Cladophora* Density
A3. Phosphorus Concentration
A4. *E. Coli* Counts
A5. Shoreline Type
A6. Hot Spots

Big Platte Lake
Benzie County, Michigan

Sample Sites



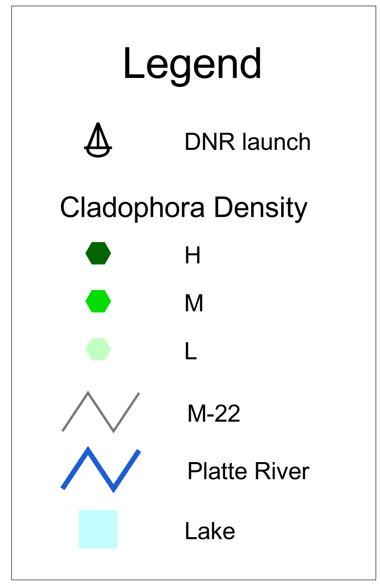


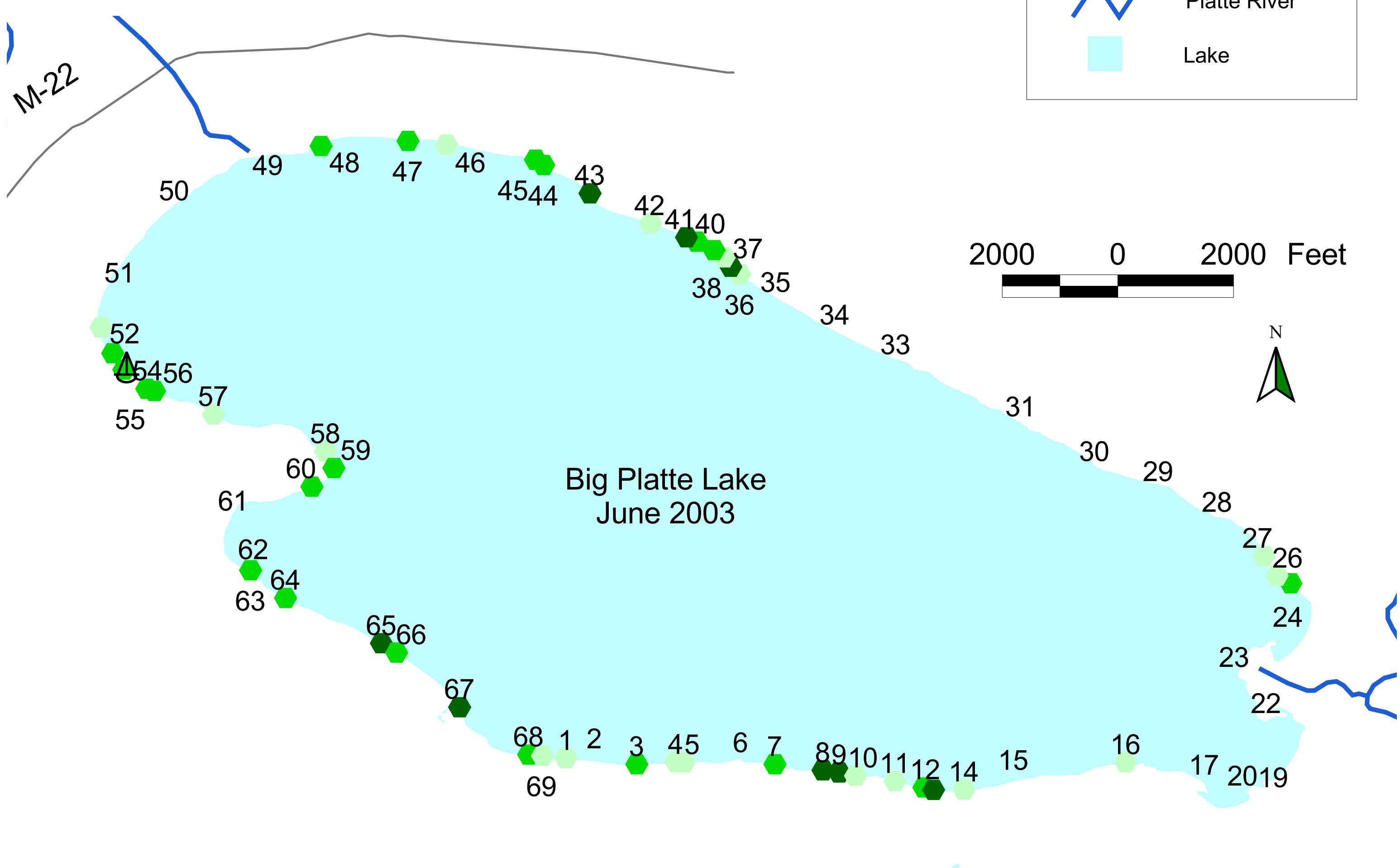


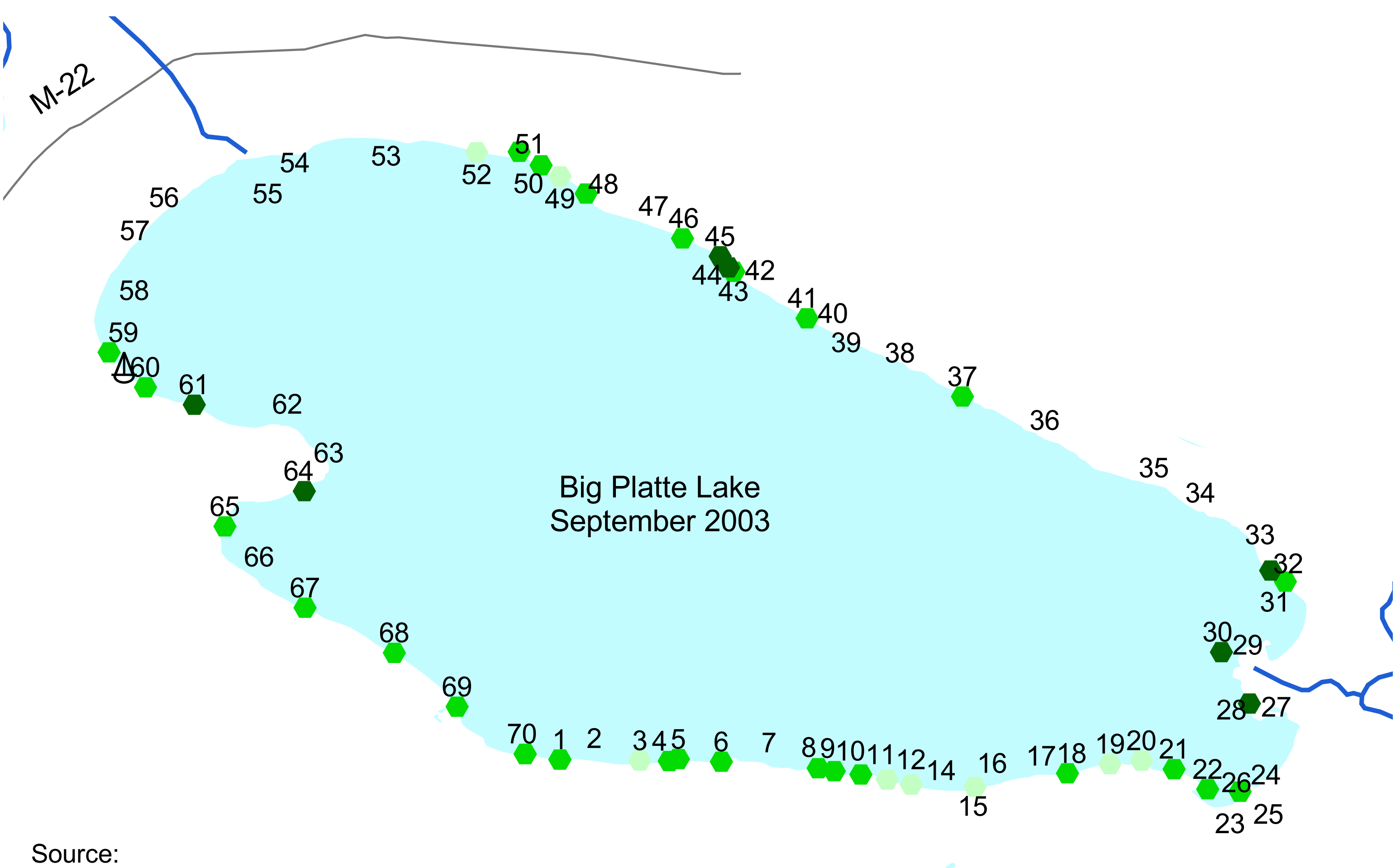
Source:
Roads and Hydrology provided by MDNR (MIRIS 1:24,000 scale)

Big Platte Lake
Benzie County, Michigan

Cladophora Density







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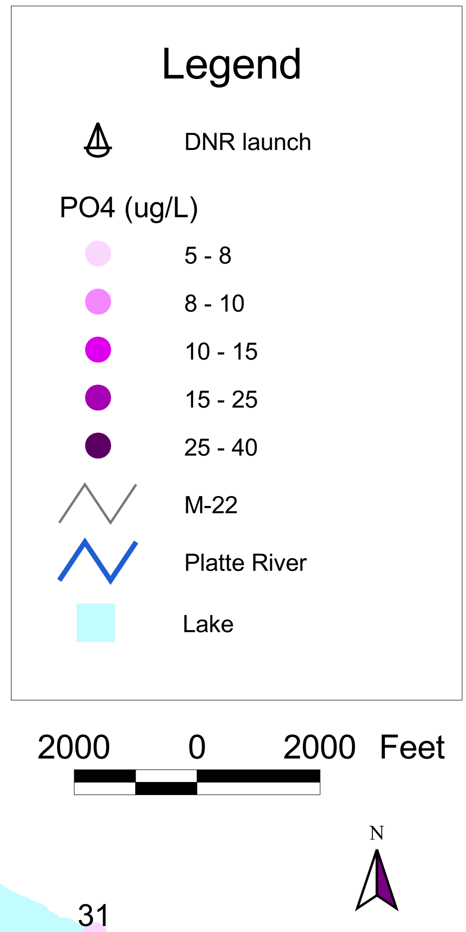
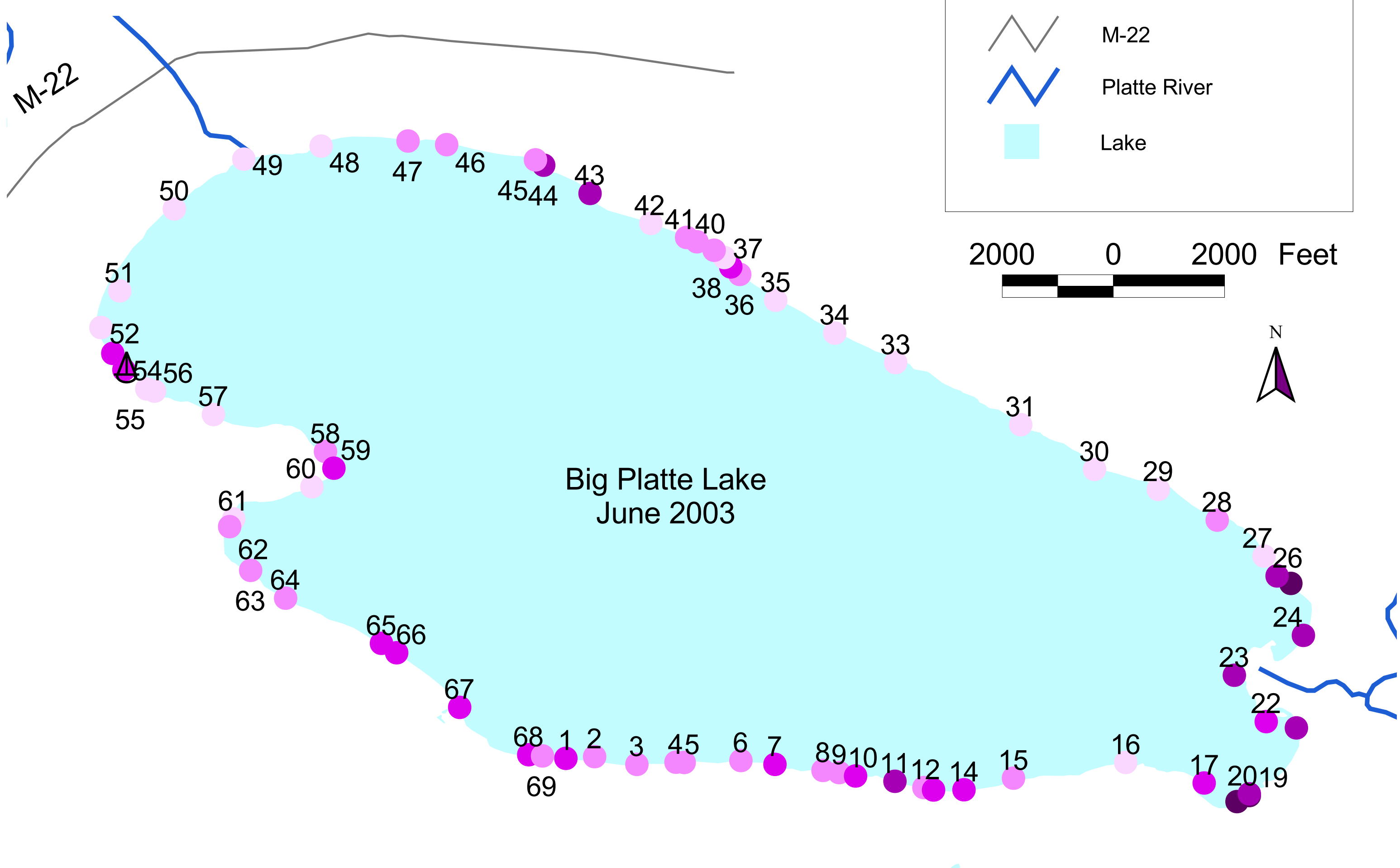
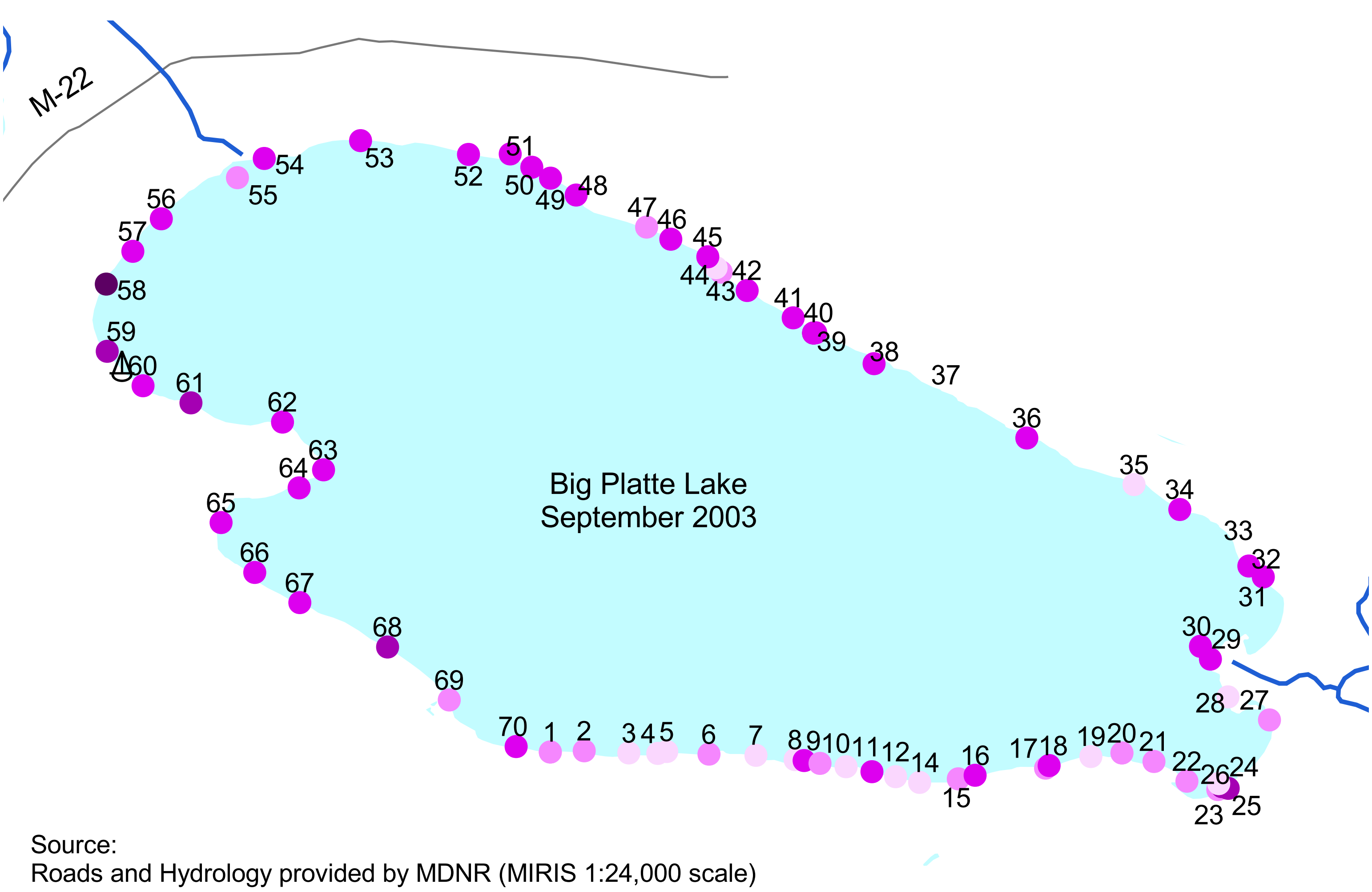
Big Platte Lake
Benzie County, Michigan

Phosphate (ug/L)







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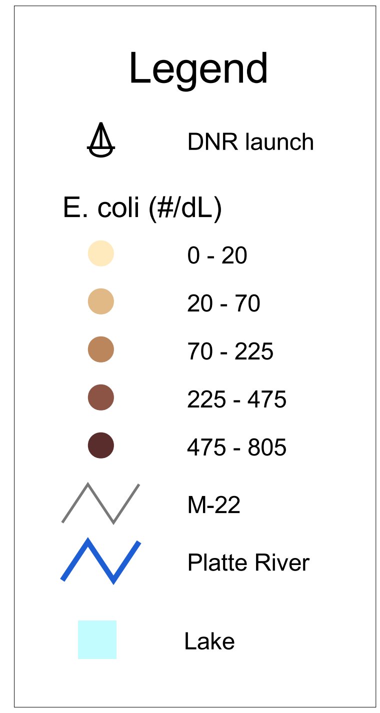
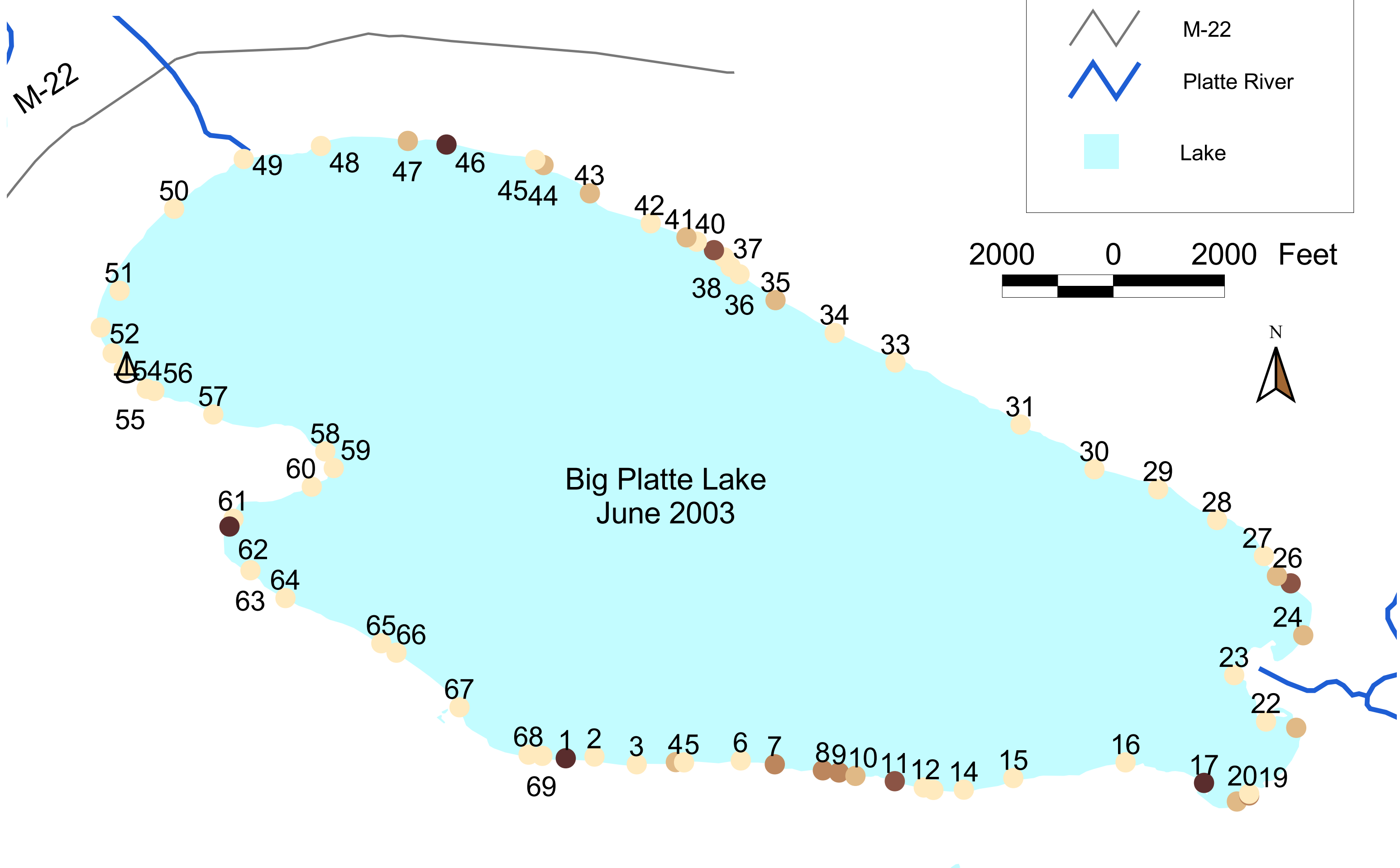
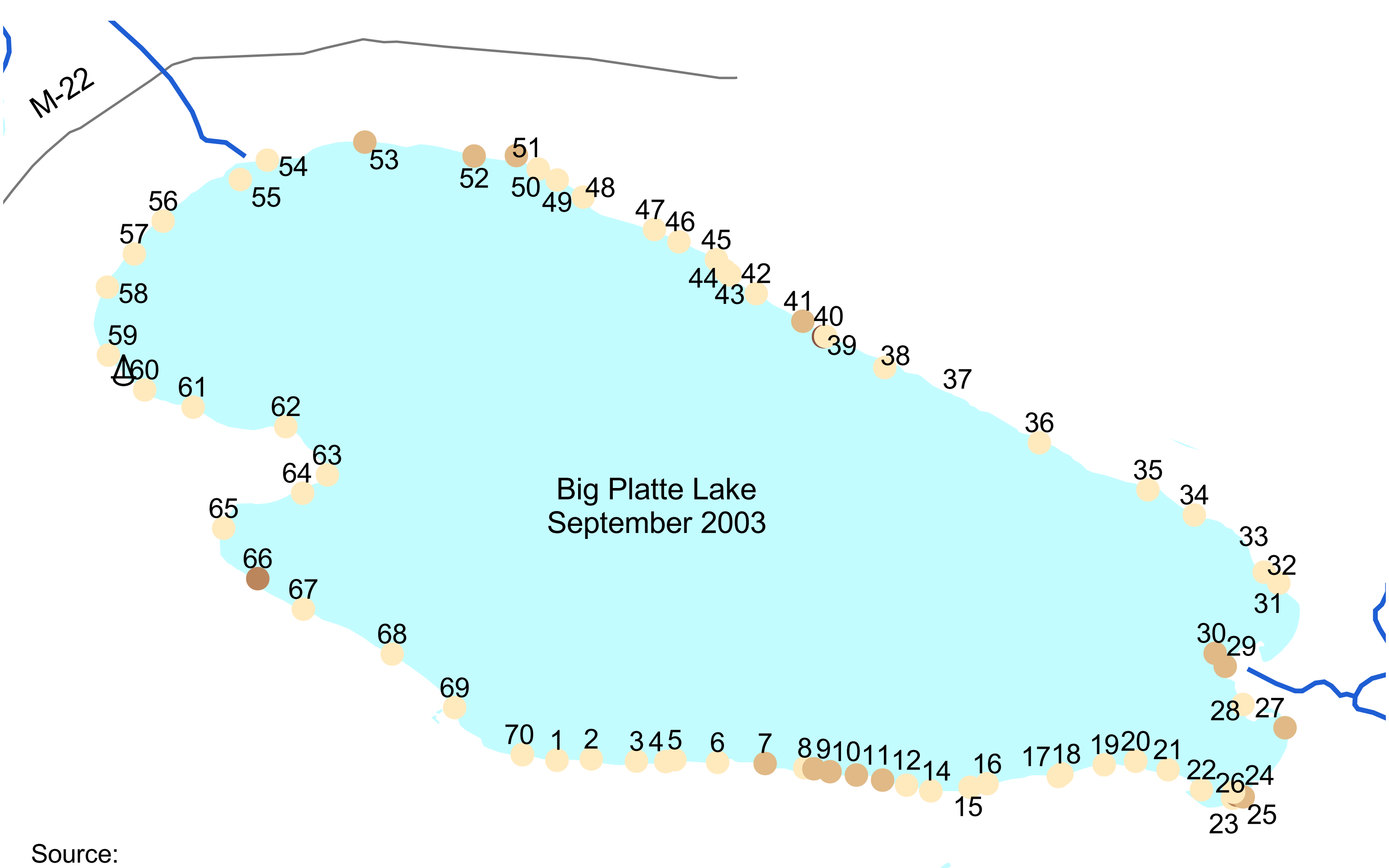
Big Platte Lake
Benzie County, Michigan

E. coli Counts







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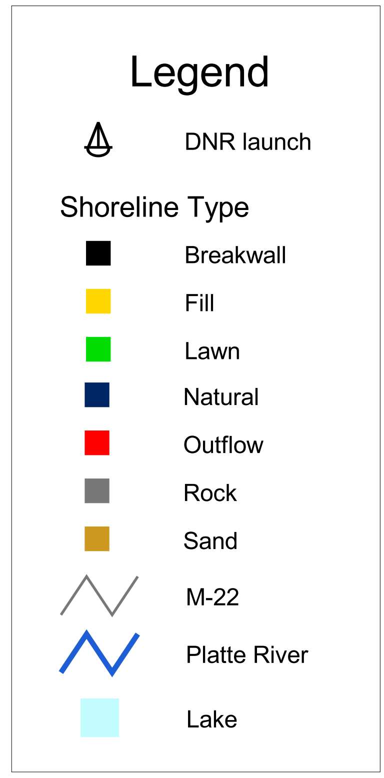
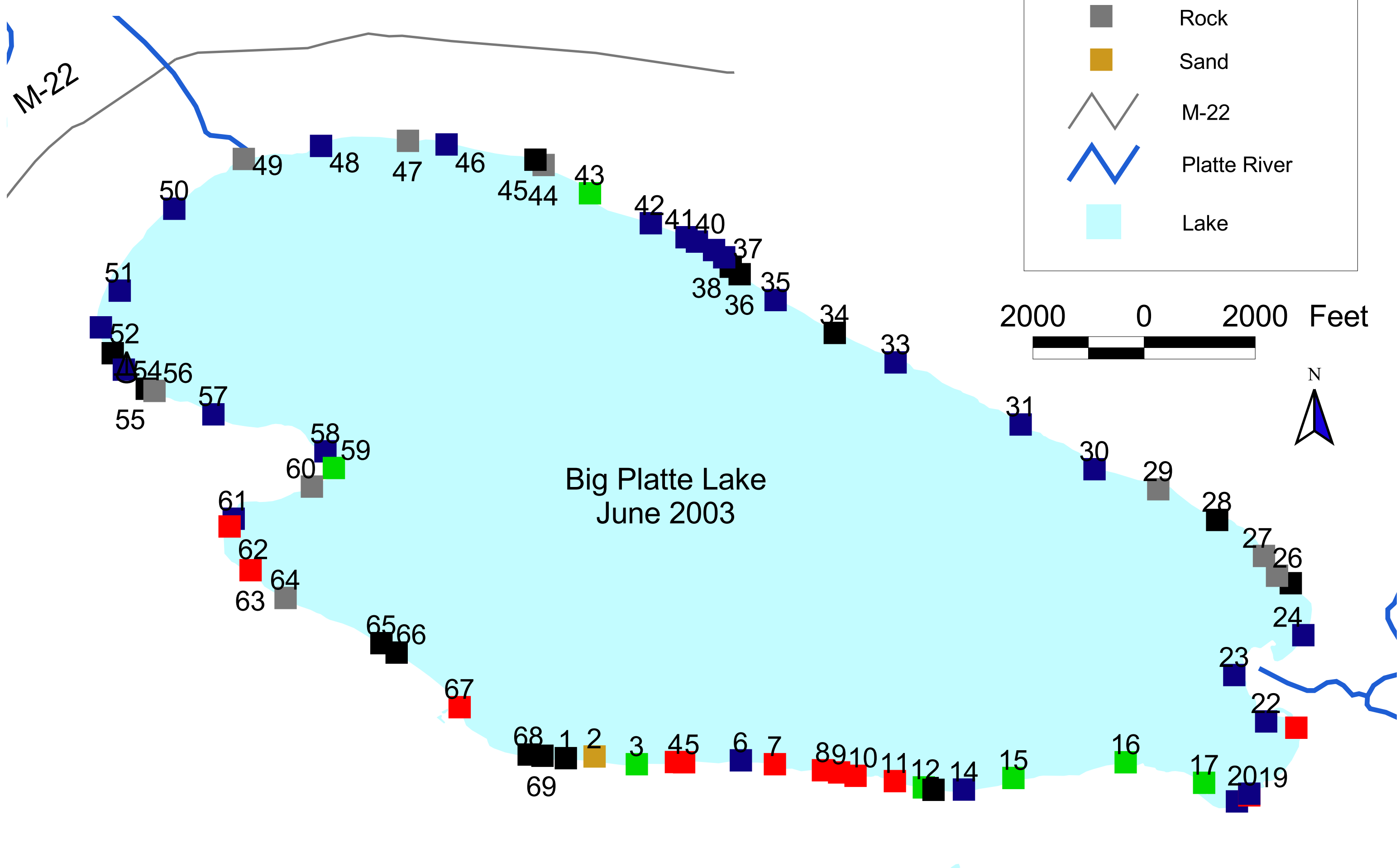
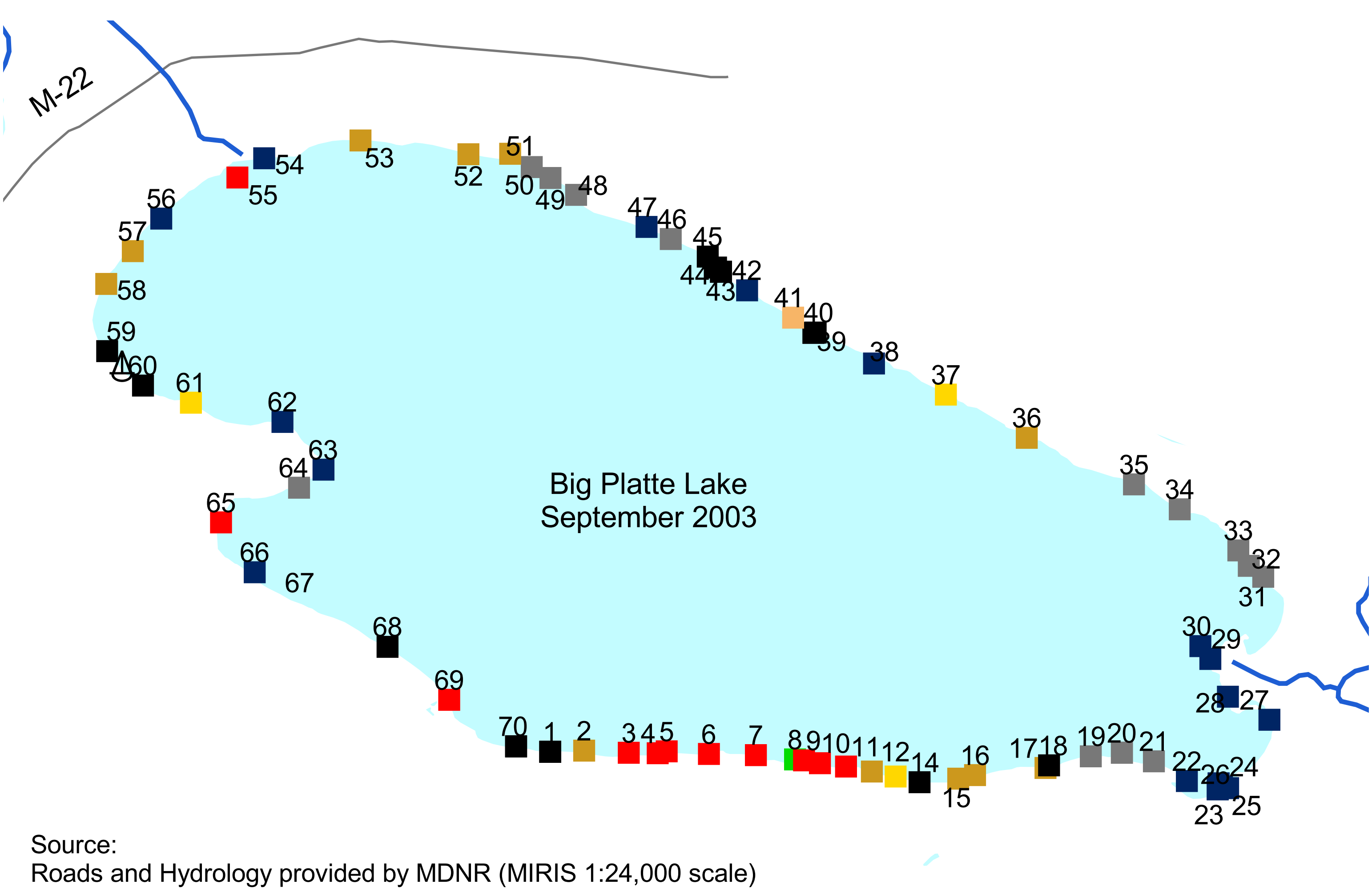
Big Platte Lake
Benzie County, Michigan

Shoreline Type







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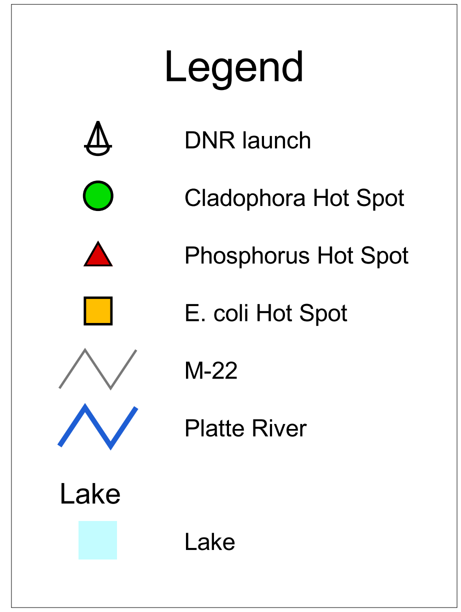
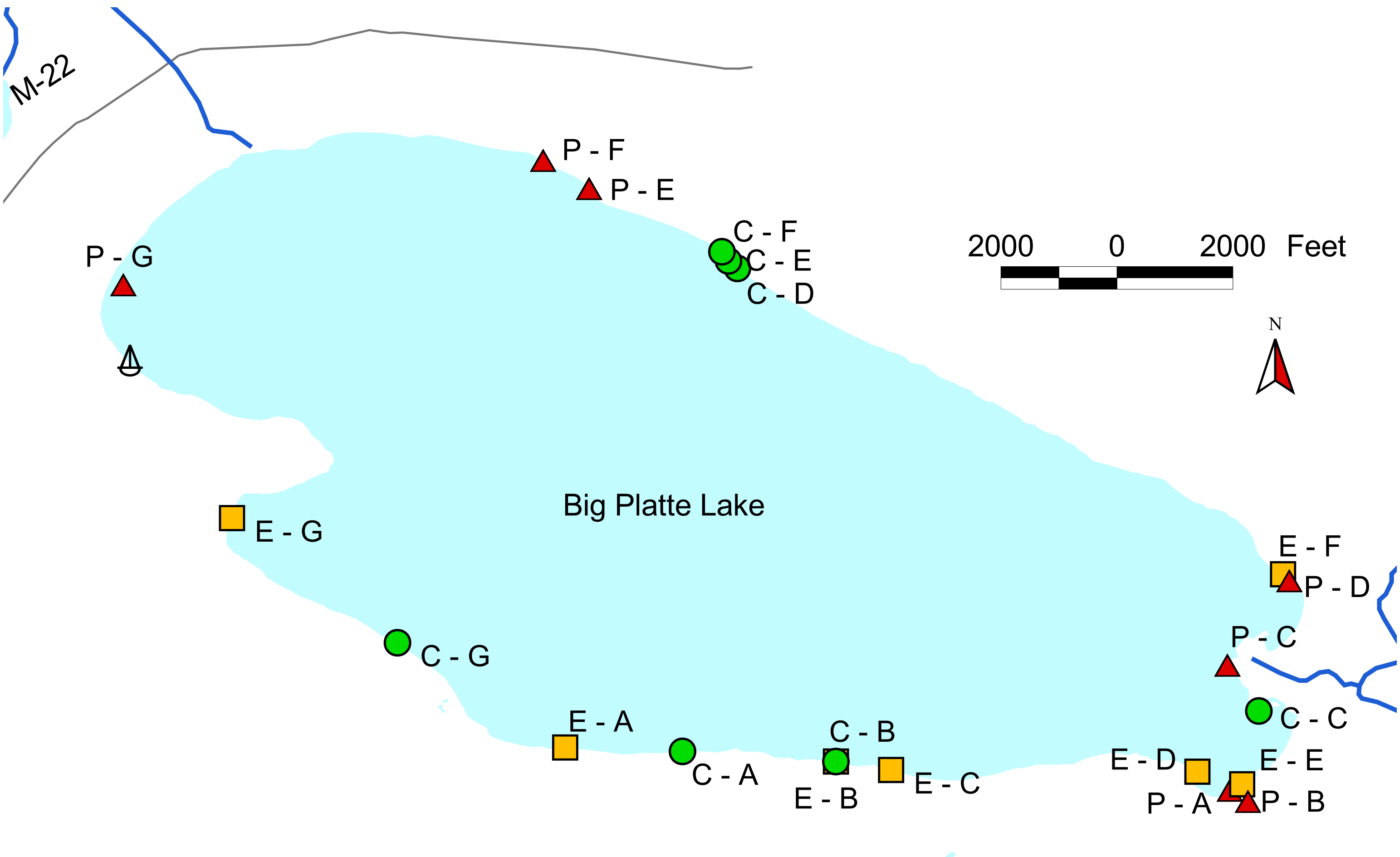
Big Platte Lake
Benzie County, Michigan

Hot Spots





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