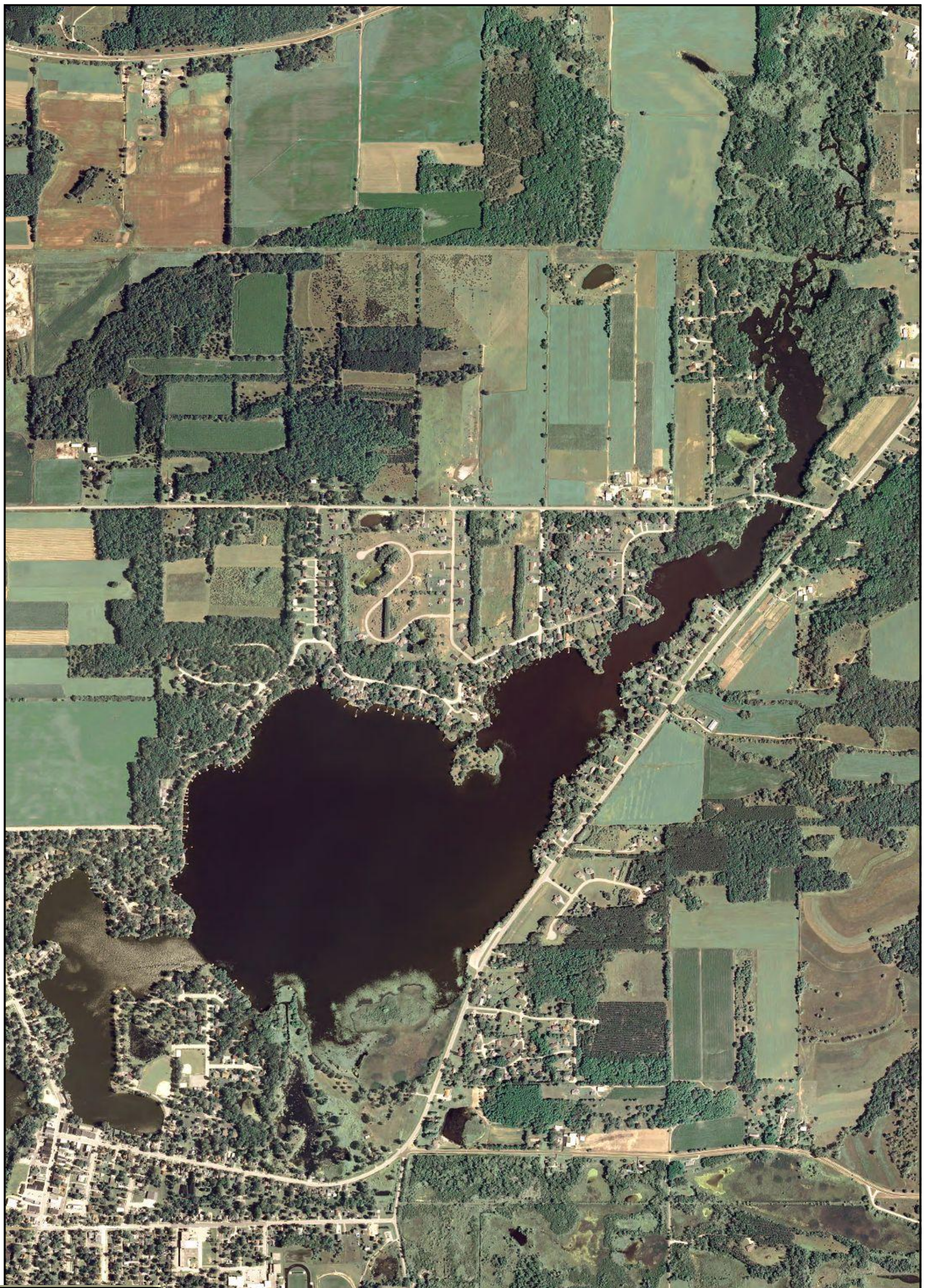
Total Maximum Daily Load:
Park Lake
Columbia County, WI



LPT 339-09
Report Prepared by the Columbia County Land and Water Conservation Department

Wisconsin Department of Natural Resources
Bureau of Watershed Management

Phosphorous and Sediment Total Maximum Daily Load for Park Lake.

INTRODUCTION

Park Lake (Hydrological Unit Code 040320101) is a shallow, warm water, unidirectional, unstratified impoundment of the Fox River. The lake is geographically located within the Village of Pardeeville, Wisconsin**.** The lake is upper eutrophic to lower hypereutrophic productivity category, exhibiting excessive algae growth defined by blue-green algae. The Wisconsin Department of Natural Resources (WDNR) placed the Park Lake water body on the state's 303(d) Impaired Waters List in 2006 as medium priority due to total phosphorus and sediment/total suspended solids from agricultural runoff (Table 1).

Table 1. Designated Uses of Park Lake and Impaired Waters Listing

Water body Name	WBIC	TMDL ID	Impaired Lake Size	Existing or Current Use	Codified Use	Pollutant	Impairment
Park Lake	180300	?	312	Recreation	WWSF	Phosphorous	Excess Algal Growth
Park Lake	180300	?	312	Recreation	WWSF	Sediment/Total Suspended Solids	Eutrophication

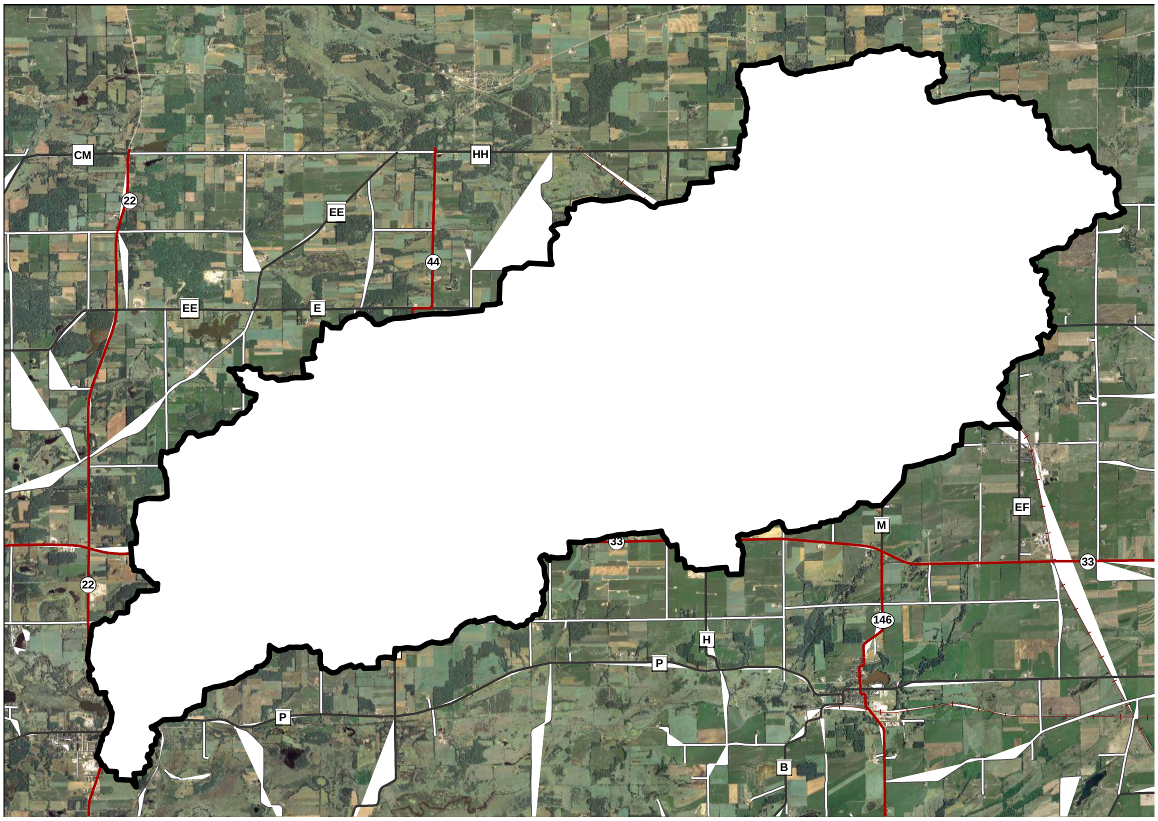


Figure 1. Park Lake Watershed

PROBLEM STATEMENT

Prior to 1997 Park Lake had a diversity of 15 aquatic plant species and abundance providing coverage throughout much of the lake. Park Lake had an excellent fishery dominated by bluegill, bass, and northern pike. Since 1997 the diversity of the aquatic plant community has declined from 12 species in 1998 to 6 species and can now only be found in less than 3 feet of depth. In a very short time, Park Lake had switched from a clear(er)-water system dominated by aquatic plant community, to a turbid state, dominated by algal plant community(Appendix D)., decreased water clarity and decreased plant abundance and diversity (Appendix D). The turbid-water condition led to a severe decrease in plant communities, which has resulted in a slow and steady decrease in quality and quantity of fish community (Appendix C).

This waterbody is highly eutrophic and exhibits excessive concentrations of phosphorus and chlorophyll a (a measure of algal densities) in its surface waters during the summer month. Sediment and phosphorus from nonpoint sources of pollution enters Park Lake via the Fox River and groundwater. Phosphorus is bound to the sediment particles, and once in the system, sediment has the capacity to transfer phosphorus into solution. Park Lakes shallow depth, phosphorus-laden sediments and excessive water column phosphorus levels, cause the lake to experience severe algal blooms during the “growing” season (May-October). These eutrophic conditions have significantly impaired body contact recreational activities. The algal community in Park Lake is defined by the dominance of blue-green algae.

APPLICABLE WATER QUALITY STANDARDS

Park Lake is included on the Wisconsin Department of Natural Resources (WDNR) 2006 303(d) list of impaired waters. The lake is a medium priority due to total phosphorus and sediment/total suspended solids from agricultural runoff. The external load is dominated by nonpoint source pollution, with no industrial or municipal wastewater treatment plant discharges to the lake.

Due to excessive total phosphorous and total suspended solids/sediment, Park Lake is currently not meeting applicable narrative water quality criterion as defined in NR 102.04 (1); Wisconsin Administrative Code:

"To preserve and enhance the quality of waters, standards are established to govern water management decisions. Practices attributable to municipal, industrial, commercial, domestic, agricultural, land development or other activities shall be controlled so that all waters including the mixing zone and the effluent channel meet the following conditions at all times and under all flow conditions:

> (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water, shall not be present in such amounts as to interfere with public rights in waters of the state.
> (b) Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to interfere with public rights in waters of the state.
> (c) Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state.
> (d) Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts which are acutely harmful to animal, plant or aquatic life."

Sediment and phosphorus are combining to the degraded state of Park Lake. In addition, Park Lake is currently supporting a rough fish fishery defined by the existence of Gizzard Shad and not its WWSF codified use (Table 1). The designated uses applicable to this water body are a warm water sport fish communities. The designated use for Park Lake is full body contact recreational use, with a warm water sport fishery as described in S. NR 102.04 (3) intro, (a) and (c), Wisconsin Administrative Code as:

"FISH AND OTHER AQUATIC LIFE USES. The department shall classify all surface waters into one of the fish and other aquatic life subcategories described in this subsection. Only those use subcategories identified in pars. (a) to (c) shall be considered suitable for the protection and propagation of a balanced fish and other aquatic life community as provided in federal water pollution control act amendments of 1972, P.L. 92-500; 33 USC 1251 et.seq.

“Warm water sport fish communities. This subcategory includes surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish”

Wisconsin has a numeric criterion describing acceptable water quality conditions and guides the WDNR in setting a numerical target pollutant concentration as follows:

STREAMS AND RIVERS. To protect the fish and aquatic life uses established in s. NR 102.04 (3) on rivers and streams that generally exhibit unidirectional flow, total phosphorus criteria are established as follows:

46. Yahara River from outlet of Lake Kegonsa to Rock River.
(b) Except as provided in subs. (6) and (7), all other surface waters generally exhibiting unidirectional flow that are not listed in par. (a) are considered streams and shall meet a total phosphorus criterion of 75 ug/L.

RESERVOIRS AND LAKES. Except as provided in sub. (1), to protect fish and aquatic life uses established in s. NR 102.04 (3) and recreational uses established in s. NR 102.04 (5), total phosphorus criteria are established for reservoirs and lakes, as follows:

(a) For stratified reservoirs, total phosphorus criterion is 30 ug/L. For reservoirs that are not stratified, total phosphorus criterion is 40 ug/L.

Table 2. Phosphorus Criterion

Water Body	**Water Body Type**	**P ug/L**
Fox River	Stream	75 ug/L
Park Lake	Unilateral, Un stratified, Impoundment	40 ug/L

Based on the current numeric criterion listed in NR 102 for non stratified impoundments is an average growing season TP concentration of 40 ug/L in 7 of 10 years. Our modeling suggests a 50% reduction in TP load will result in an average growing season mean concentration of 60 ug/L, Our data and model is limited in its’ capacity to predict load reductions and the resulting TP concentrations.

Historical and Environmental Setting

Park Lake was created as a result of two small dams constructed in 1856 flooding a deep water march of the Fox River (Board of Commissioners of Public Lands, 1851). Park Lake is a126.261 hectares (312 acre) in size. Park Lake is physically divided into a larger, shallow basin and a smaller, deeper western basin. The lake has with a maximum depth of 27 feet and average depth of 7 feet in the eastern basin and 12 feet in the western basin (Kammer, 1996; Park Lake Committee 1990). The volume of Park Lake is 2,187 acre-feet (Kammerer, 1996). The Park Lake Watershed is a 54.01 sq. mile watershed located in Columbia and Green Lake County (Figure1).

The Clean Water Act and US EPA regulations require TMDLs be developed for each water on the Impaired Waters List. The purpose of this TMDL is to identify load allocations and management actions that will help restore the biological integrity of Park Lake. Park Lake is a shallow warm water impoundment on the Fox River. Unlike other nutrient rich shallow water systems Park Lake has progressed from a nutrient rich, clear(er)-water, plant-dominated water body to a hypereutrophic turbid, algal dominated, water body. Once a system like this progresses into a turbid condition, they become very stable, this stability creates challenges which limit the options for their return to a clear-water, plant dominated water body and healthier fishery. Historically, Park Lake has had an excellent fishery dominated by panfish, largemouth bass and northern pike, walleye were stocked as a secondary species. The panfish consisted of bluegill, yellow perch, black crappie and pumpkinseed. Between 1996 and 2007 bluegill numbers dropped from 458 per net day to 62, crappie from 340 to 26, and largemouth bass from 23 per mile to seven. In the end the picscovore to planktivore ratio shifted creating an unbalanced fishery defined by planktivores (Figure 3).

Table 3. Park Lake Land Use (2002)

Land Use in Park Lake Watershed	**Percent Cover**
Cropland and Pasture	**77.2**
Woodland	**18**
Developed Areas	**2.2**
Wetland	**1.3**
Lake	**1.3**

Park Lake Watershed predominately agriculture with 77 percent of the land in cropland and pasture(Table 3)(Figure2). The principal aquifers in Columbia County are the sandstone aquifer and the sand and gravel aquifer. The high-yielding sandstone aquifer is composed of Cambrian and Ordovician rock units and extends down to the Precambrian igneous and metamorphic rocks; this aquifer is absent northwest of Pardeeville where the Precambrian crops out, but can be up to 700 feet thick elsewhere. The sand and gravel aquifer consists of unconsolidated glacial materials, mostly in the area surrounding the Fox River. Yields from this aquifer are sufficient to meet domestic needs.* (Water Resource Management Workshop 2002)

The quality of groundwater in Columbia County is generally good, with the exception of some high nitrates. The water can be hard as a result of passing through rock with large amounts of calcium and magnesium (Harr et al., 1978).*(Water Resource Management Workshop 2002)

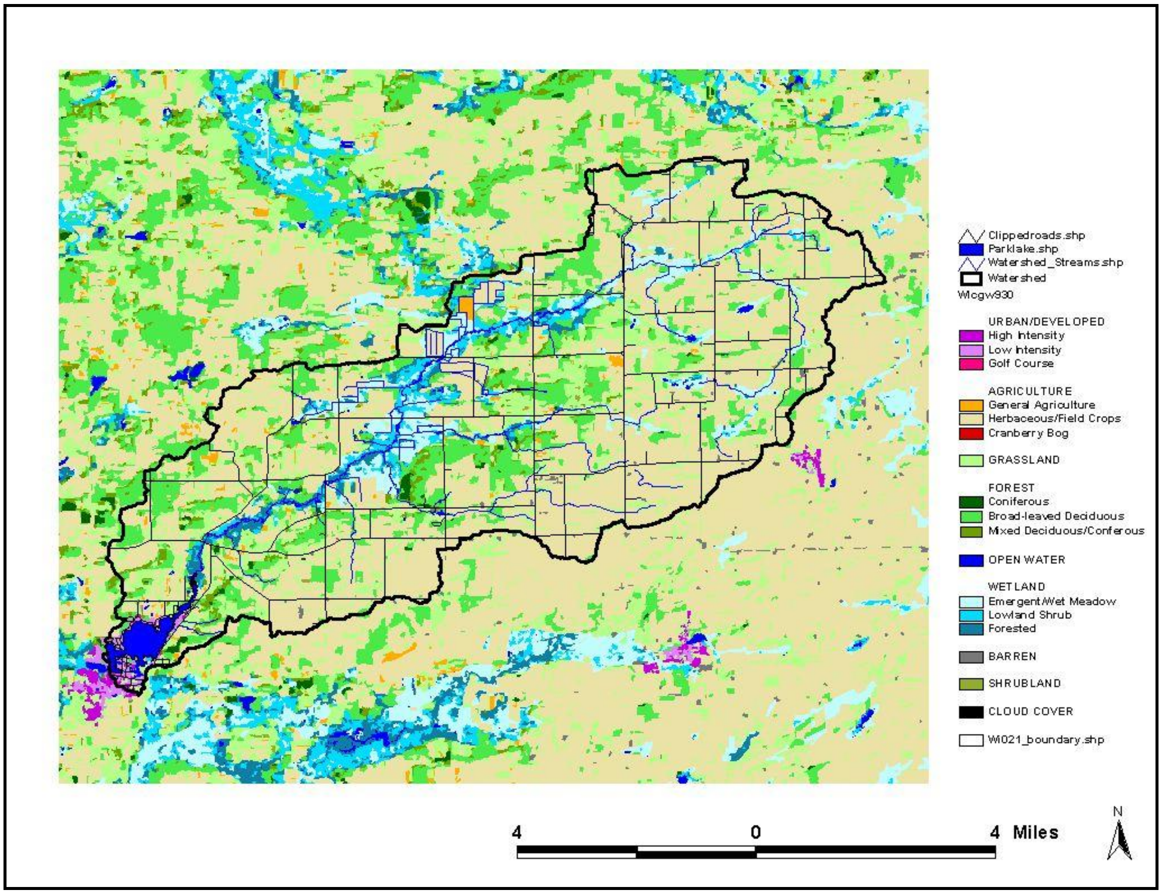


Figure 2. Park Lake Watershed Land Use Map

The CCLWCD deliberate and comprehensive approach toward Watershed Management in Park Lake first began in 2006 when the Columbia County Land and Water Conservation Department applied for a Wisconsin Department of Natural Resources Lake Planning Grant for the Park Lake Watershed to conduct a NR 151 Livestock Inventory. Livestock operations were inventoried based on a multitude of parameters as stated in NR 151, thus defining the best management practices needed to remedy the sites.

The Columbia County LWCD has a history of applying for Targeted Runoff Management (TRM) grants through WDNR and plans on continuing to do so. TRM grants are competitive financial awards to support small-scale, short term projects (24 months) completed locally to reduce runoff pollution. Both urban and agricultural projects can be funded through TRM grants which require a local contribution to the project. The state cost share is capped at $150,000 per grant. Projects that correct violations of the performance standards and prohibitions and reduce runoff pollution to impaired waters are a high priority for this grant program.

Park Lake's complete study history leading up to the present TMDL**.**

- **1979 WDNR Pre-Drawddown Evalution Survey (Aquatic Plant Survey, Fish Survey, & Over winter In-Lake Do)**
- **1993 Water Resources Data Wisocnisn Water Year 1993, Volume 1. St Lawrence River basin, B.K. Holmstrom, P.A. Kammerer, Jr., and B.R. Ellefson**
- **2002 Improving the Water Water Quality of Park Lake: Recommendations and Options for the Future, Water Resources Management Workshop 2001, Gaylord Nelson Institute for Environmental Studies Univeristy of Wisconsin-Madison**
- **2006 WDNR-Lake Planning Grant LPL- 1072-06, NR151 Park Lake Watershed Inventory**
- **2007 WDNR-Lake Planning Grant LPL-1107-07, Park Lake Comprehensive Watershed Plan**
- **2008 WDNR-Lake Protection Grant LPT-339-09, Park Lake Total Maximum Daily Load Study**

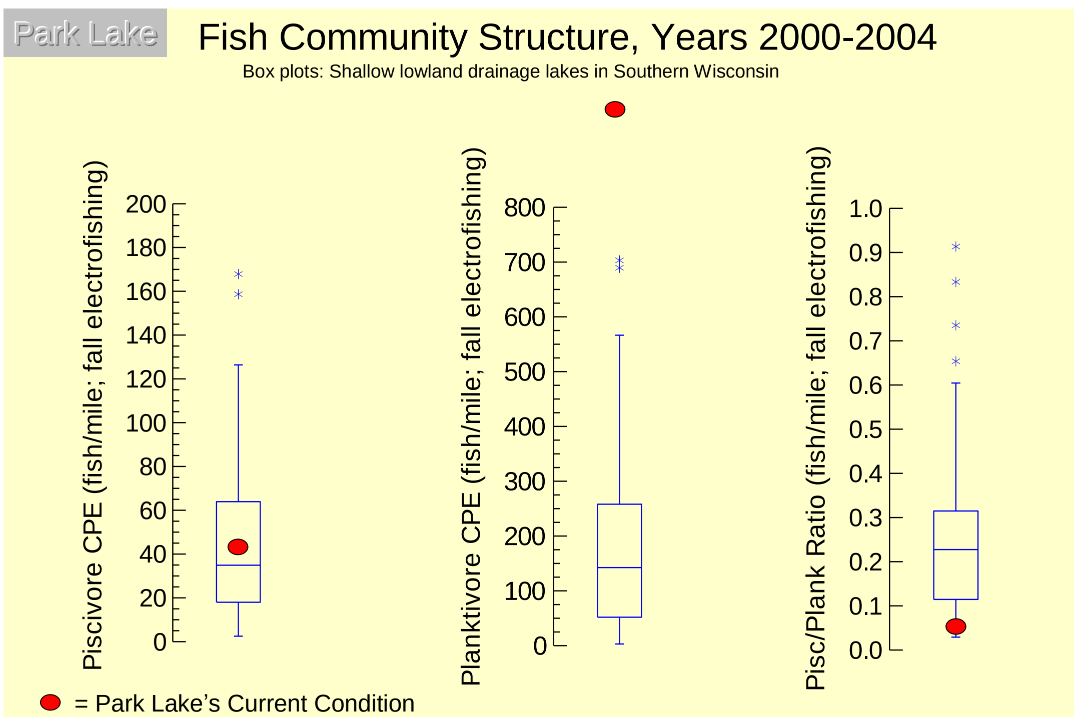


Figure 3. Picovore/Planktivore Fish Community Structure

SOURCE ASSESSMENT

Point Sources

There are no point sources discharging to the Fox River up river of Park Lake or Park Lake. This means no facilities have a WPDES permits (MS4s, CAFOS, POTWS, Industrial sites, etc**).**

Nonpoint Sources

The Park Lake Watershed is primarily agricultural, with approximately 78 percent of the land in cropland and pasture, 18 percent in woodland, 1.3 percent in lakes, 1.3 percent in wetlands and 1.2 percent in developed areas (Kammerer, 1996).

LINKAGE ANALYSIS

Sedimentation often acts as a transport mechanism for other pollutants, such as phosphorus, that will impact the water chemistry. The primary concern of sediment loading to Park Lake is the capacity to transfer phosphorus from the watershed to the lake bottom. These phosphorus-laden sediments greatly contribute to summer algal blooms, especially under anoxic conditions. The TMDL is derived from load reductions needed to meet in lake phosphorus criterion. As measures are taken to reduce TP loading via sedimentation, phosphorus transport to the stream will decrease and phosphorus values in the lake will decrease. The growing season mean (figure 4)(May-October) is related to the growing season TP Load (figure 5).

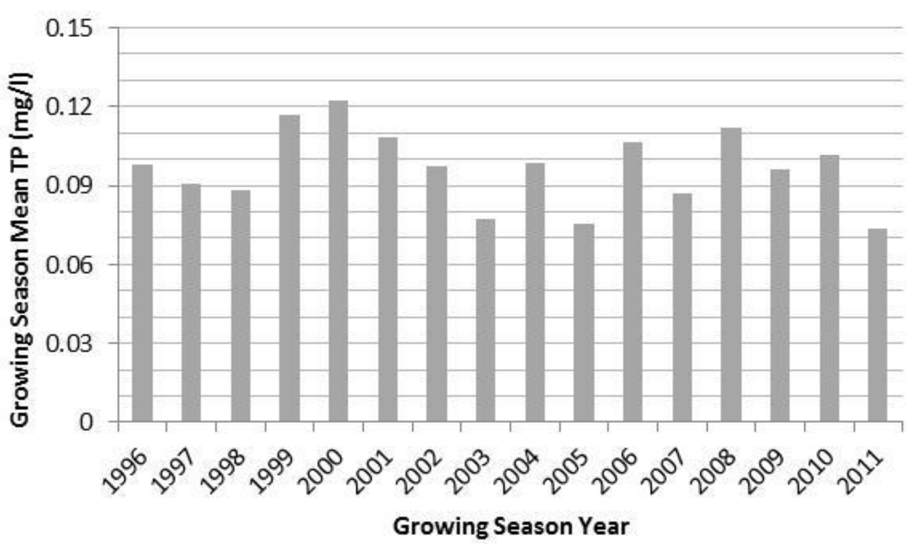


Figure 4. Average growing season total phosphorus in Park Lake from average of daily simulated values in the lake model from May through October.

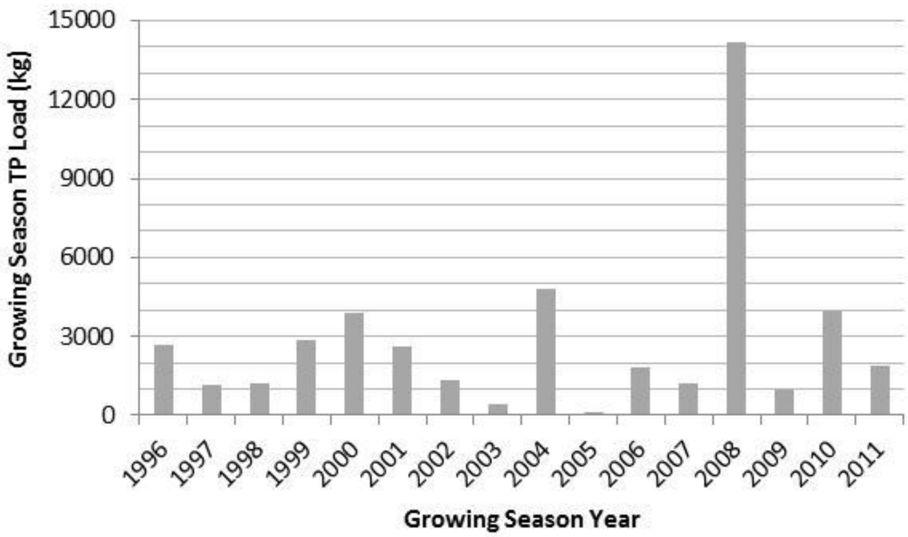


Figure 5. Growing season total phosphorus load to Park Lake from the daily simulated watershed model.

As stated above, phosphorus enters the water body bound to sediment particles typically during rainfall and runoff events transported from barnyards, overgrazed pastures, and nutrient rich manure spreading close to surface water or areas of concentrated flow. In the Park Lake Watershed this relationship can be seen in at monitoring locations at Larson Road, Highway E and 44(Appendix E, Figure E2, E3, E4) Phosphorus loading in water bodies can cause eutrophication of lakes characterized by excessive plant (macrophyte) growth and dense algal growth. In severe cases such as Park Lake the high abundance of plants can be overcome by turbidity, removing available light thus replacing the plant community with an algal community defied by blue green algal. Algal blooms result in pH increases due to removal of carbon dioxide from water during photosynthesis (by macrophytes and algae). In lakes with minimal buffering capacity such as Park Lake, this reduction in carbon dioxide levels during daylight causes a significant increase in pH. A reduction in phosphorus levels would result in a decrease in chlorophyll levels (a measure of productivity) and a reduction in maximum pH levels.

TMDL DEVELOPMENT

A TMDL is a quantitative analysis of the amount of specific pollutants reaching an impaired lake or stream to the extent that water quality standards will be met. As part of a TMDL, the amount of pollutant that the water can assimilate and still meet water quality standards must be identified. The goal of this TMDL is to reduce TP loads to Park Lake to a level that numerical criterion meet the standard for reservoirs that are not stratified of 40 ug/L.

In addition to identification of pollutant loading, a TMDL also identifies critical environmental conditions used when defining allowable pollutant levels. As can be seen in years 199, 2000, 2001, and 2008 (Appendix E, Figure E2,E3 &E4) the TP concentrations measured result from runoff based events. Reducing surface runoff will reduce the sediment loading to the Fox River; as a result, reduce In-Lake TP concentrations in Park Lake.

Mid Lake Sampling

Water quality data were collected from Park Lake, Harris Pond, and Lake Montello from April 2009 to October 2010. This consisted of one site visit in the spring, and fall. The sites were also visited five times during the summer, in approximately 1 month intervals. Mid-lake measurements were collected at the deepest point of the lake, which was based on historic bathymetric maps provided by the DNR and local knowledge. Secchi disk measures were collected during all the site visits except in the winter, and were made on the shady side of the boat. For each site visit, in-situ vertical profiles were conducted. In-situ sampling involved the use of a Hydrolab Model 4600 data sonde to collect temperature, dissolved oxygen, conductivity, and pH data throughout the entire depth of the lake. A YSI was used to collect temperature and dissolved oxygen vertical profiles during some site visits. Water samples were collected during each visit with an integrated bailer. Samples were transferred to two 60 mL polypropylene bottles that contained sulfuric acid (H2SO4). One 60 mL bottle was unfiltered and the other was filtered through a 0.45 micron membrane filter. They were kept on ice until transferred to the UWSP WEAL to be analyzed for total phosphorus (TP), reactive phosphorus (RP), total Kjeldahl-N (TKN), ammonium-N (NH4-N), nitrate+nitrite-N (NO2+NO3-N), and chloride (Cl). During the summer visits, chlorophyll a samples were collected from the lake, pumped through a 934/AH glass fiber filter, and placed in aluminum foil and kept on ice until received by the UWSP WEAL.

Stream Data Collection

Grab samples were collected at the primary monitoring sites PL01, PL02, PL03, PL04, PL05 and PL06 on a fixed interval basis of approximately 14 days from 4/14/2008 to 11/18/2008, and 6/2/2009 to 11/10/2009. In-situ water chemistry measures were made with the same equipment as the impoundments. Samples were also collected at the primary monitoring sites during certain runoff events, which were either collected by siphon samplers or as manual grab samples. Discharge measurements and in-situ water chemistry were collected periodically throughout the entire study period. Velocities were measure using a Marsh McBirney Flo-Mate Model 2000 flow meter or at times a swoffer Model 2100, and in-situ water chemistry conducted with the same equipment as the impoundments.

Continuous Stage Recorders

Solinst Levelogger Model 3001 Gold Series pressure transducers were used to obtain continuous measurements of stream temperature and stream depth, or stage, at the primary monitoring sites. Pressure transducers were installed to “T” posts and secured to the stream bottom in areas of placid flow and at the same water surface elevation of the staff gauge. The pressure transducer data was adjusted for changes in barometric pressure by using a barometric (baro) logger exposed to the atmosphere. The baro logger was located in Portage.

Watershed Model

The watershed model was developed using the Soil and Water Assessment Tool (SWAT). SWAT is a dynamic simulation tool that models crops and hydrology in a watershed. The simulation is performed within different hydrologic response units (HRUs). The Park Lake watershed model was developed in SWAT 2005 in ArcMap Version 9.3. Appendix E, Figure E1 shows the subbasin delineation in the model. Appendix E, Table 1 summarizes the HRUs.

Lake Model

The lake model used the watershed daily flow and phosphorus export as inputs to a daily time-step lake model that used a mass balance to simulate a daily phosphorus concentration. The model accounted for the mass entering the lake from the watershed, the mass leaving the lake in the outflow, the mass settling in the lake and the mass released to the lake from the sediment and P. crispus decay. The model was a simplified representation of the lake in that it assumed the lake was completely mixed and the sedimentation rate (10 m/yr) was constant during the year. The daily mass in to the lake was based on the SWAT model simulation, the mass out of the lake was based on the daily flow into the lake and the concentration of phosphorus simulated in the lake. The sediment and plant release was assumed to occur during the summer. Sediment release was simulated to occur at the summer rate (5 mg/m2/d) from June through August and then at a reduced rate (0.5 mg/m2/d) during the remainder of the year. P. crispus release of phosphorus (35 mg/m2/d) was based on an estimated plant density and was assumed to occur only from a portion of the lake during the first ten days of July.

ALLOCATIONS

The total daily loading capacity for TP is the sum of the waste load allocations for permitted point sources, the load allocations for non-point sources, and the margin of safety, as generally expressed in the following equation:

TMDL Load Capacity = WLA + LA + MOS

WLA = Waste load Allocation (From Point Sources)
LA = Load Allocation (From Nonpoint Sources)
MOS = Margin of Safety

Waste Load Allocation

Since there are no point sources in the watershed, the waste load allocation is zero. If a point discharge were proposed, one of the following would need to occur:

- An effluent limit of zero sediment load would be included in the WPDES permit
- An offset would need to be created through some means, such as pollutant trading.

- A re-allocation of sediment load would need to be developed and approved by EPA.

Load Allocation

The load allocation (LA) component defines the load capacity for a pollutant that is associated with non point pollution. The LA was calculated by subtracting the margin of safety (MOS) from the TMDL. To achieve the TP LA, reductions are necessary in the agricultural land use areas of the watershed.

Reduction- 50%TP load reduction to obtain 60 ug/L in lake. Based on the data collected and the current model the ability to predict necessary reductions to obtain the NR 102 standard for reservoirs that are not stratified of total phosphorus criterion is 40 ug/L is limited.

MOS

A margin of safety (MOS) is a required component of the TMDL to account for uncertainty in the relationship between pollutant loads and quality of the receiving waterbody. The MOS accounts for potential uncertainty in data and analysis, or in the actual effect management controls will have on loading reductions and receiving water quality.

For the Park Lake TMDL an implicit MOS was chosen through the use of conservative assumptions in modeling. The modeled reductions only account for the relationship between external loading and inlake TP concentrations; however, as a decrease external load is realized a decreased internal load will follow. The unmodeled internal TP load lag is representing the MOS.

Table 4. TMDL Summary for TP for Park Lake

Current Load	The median growing season phosphorus load over 1996 through 2011 was 1,853 kilograms (4085 pounds) or 10.07 kilograms (22.2 pounds) daily.
TMDL	The average daily TP load (kg/l) over the median growing season is 5 kg (11.0231 pounds) daily
WLA	0, No point sources exist
Load Allocation	The load allocation is 5kg (11.0231pounds) daily
MOS	Built into model
Reduction	50% TP Load reduction to obtain 60 ug/L

SEASONAL VARIATION (SEASONALITY)

As the term implies, TMDLs need to be expressed as maximum daily loads. However, TMDLs may be expressed in other terms when appropriate. In this case, the TMDL is expressed in median average for the growing season.

During spring, the combination of short residence times, cold temperatures and high runoff flows cause much of the P laden water to flush through the lake with minimal impact on algae blooms. However, runoff that occurs during October – April does contribute phosphorus laden sediments. The sediment releases phosphorus to the water column during summer, especially under anoxic conditions. During summer, warm temperatures, increased residence time and anoxia in the hypolimnion increases internal recycling of phosphorus, contributing to blue green algae blooms.

Increased TP loading is dependant on flow conditions rather than seasonality. The spectrum of flow conditions that would be expected during the entire year are used in the SWAT modeling for this TMDL. Growing season (May –September) daily flow and phosphorus export as predicted by the SWAT modeling scenarios was used as inputs to a daily time-step lake model that used a mass balance to simulate a daily phosphorus concentration. The lake model accounted for the mass entering the lake from the watershed, the mass leaving the lake in the outflow, the mass settling in the lake and the mass released to the lake from the sediment and P. crispus decay. It is important to note, that the summer seasonal P load has a more direct impact on algal growth than that which occurs during other time periods, but by implementing BMPs to control runoff of phosphorus and sediment in the watershed all time periods will be addressed.

REASONABLE ASSURANCE

The Clean Water Act requires that states provide a “reasonable assurance” that the TMDL will be implemented. Reasonable assurance will be provided through a variety of voluntary and/or regulatory means in the Park Lake Watershed. The TMDL will be implemented through enforcement of existing regulations, financial incentives and various local, state and federal water pollution control programs. Following are some activities, programs, requirements and institutional arrangements that will provide a reasonable assurance that the Park Lake TMDL is implemented and the water quality goal will be achieved.

In general, Wisconsin’s Section 319 Management Plan (approved by EPA) describes a variety of financial, technical and educational programs in the state. The primary state program described in the 319 Management Plan is the Wisconsin Nonpoint Source Water Pollution Abatement Program (s. 281.65 Wis. Stats. and ch. NR 120 Wis. Admin. Code). The Park Lake TMDL and the implementation plan (when completed) will be incorporated as an amendment to the area wide water quality management plan under ch. NR 121(Wis. Admin. Code).

Wisconsin Administrative Code NR151 identifies performance standards and prohibitions to control polluted nonpoint source runoff. The rule also sets urban performance standards to control construction site erosion and manage runoff from urban development.

The WDNR and Columbia County Conservation Department (LWCD) will implement agricultural and non-agricultural performance standards and manure management prohibitions (Wis. Admin. Code NR 153) to address sediment and nutrient loadings in the Park Lake Watershed. Many landowners voluntarily install Best Management Practices (BMPs) to help improve water quality and comply with the performance standards. Cost sharing may be available for many of these BMPs.

The Columbia County Land and Water Conservation Department (CCLWCD) has begun implementation of a Watershed Management Plan for the Park Lake Watershed using the data from an NR 151 Watershed Livestock Inventory and watershed based water chemistry data to prioritize operations, Best Management Practices (BMP's) and geographical micro watersheds. Once operations are prioritized and necessary BMP's are determined, the 70% funding can be secured to move forward implementing BMP's with landowners, as stated in the statutory requirements listed in Wisconsin Department of Natural Resources Administrative Rule, Chapter NR 151, Runoff Management. If cost-share money is offered, those in violation of the standards are obligated to comply with the rule.
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Lake Protection grants are available to assist lake users, lake communities and local governments to undertake projects that protect and restore lakes and their ecosystems. This program is administered under Wisconsin Administrative Code NR 191, and typically provides up to 75% state cost sharing assistance up to $200,000 per project. These projects may include watershed management projects, lake restoration, shoreland and wetland restoration, or any other projects that will protect or improve lakes.

The Environmental Quality Incentive Program (EQIP) is another option available to farmers. EQIP is a federal cost-share program administered by the Natural Resources Conservation Service (NRCS) that provides farmers with technical and financial assistance. Farmers receive flat rate payments for installing and implementing runoff management practices. Projects include terraces, waterways, diversions, and contour strips to manage agricultural waste, promote stream buffers, and control erosion on agricultural lands.

USDA Farm Service Agency's (FSA) Conservation Reserve Program (CRP) is a voluntary program available to agricultural producers to help them safeguard environmentally sensitive land. Producers enrolled in CRP plant long term, resource conserving covers to improve the quality of water, control soil erosion, and enhance wildlife habitat. In return, FSA provides participants with rental payments and cost share assistance.

Post Restoration Water Quality Monitoring

Upon completion of the restoration of the Park Lake and watershed will need to be monitored to assess water quality. The timeframe for monitoring in the lake protection grant will be two years, following the same monitoring time frames established for plants. The approach will consist of in lake and watershed monitoring every other week, from ice out to ice up. The "deep hole" will be monitored taking Chlorophyll A and Total Phosphorus samples. Depth profiles will also be taken for ph, dissolved oxygen, specific conductivity, and temperature. In the watershed one location at Highway 44 will be monitored every other week, from ice out to ice up. The water will be tested for No2+N03, Ammonium (N), Total Kjeldahl Nitrogen, Total Phosphorus, Reactive Phosphorus, and Chloride, as well as, monitored for Specific Conductivity, Dissolved Oxygen, Temperature, and ph.

Table 5. Post TMDL In Lake Monitoring

Post TMDL In Lake Monitoring		
In Lake	**Test**	**Quantity**
	Depth Profile	6
	Chl A	18
	TP	18
Watershed Tributary		
	River Package	**Quantity**
One Location	Highway 44	18

The post restoration monitoring as discussed is for the purposes of the TMDL

The WDNR or agreed upon entity will monitor Park Lake based on the rate of implementation of the TMDL, including the sites where implementation of Targeted Runoff Management (TRM) grants are aimed at phosphorus and sediment reductions. Monitoring will continue until it is deemed that the water body has responded to the point where it is meeting its codified use or until funding for these studies are discontinued. The monitoring will consist of metrics contained in WDNR's baseline protocol for river/ impoundment.

PUBLIC PARTICIPATION

This section will be completed once a minimal 30-day comment period is conducted for your TMDL. The WDNR will fill out this section when the time presents.

This TMDL was subject for public review from [date] through [date]. On [date] a press release was sent to: newspapers, television stations, radio stations, interest groups, and interested individuals in the west central region portion of the state. The news release indicated the public comment period and how to obtain copies of the public notice and the draft TMDL. The news release, public notice, and draft TMDL were also placed on the DNR's website. If comments are received, there should be a summary of comments and responses within one of the Appendices of the TMDL.

REFERENCES

Please list any references here.

APPENDIX A

These may include: data, maps, pictures that reflect the impairments, stream or lake classifications and descriptions, etc.

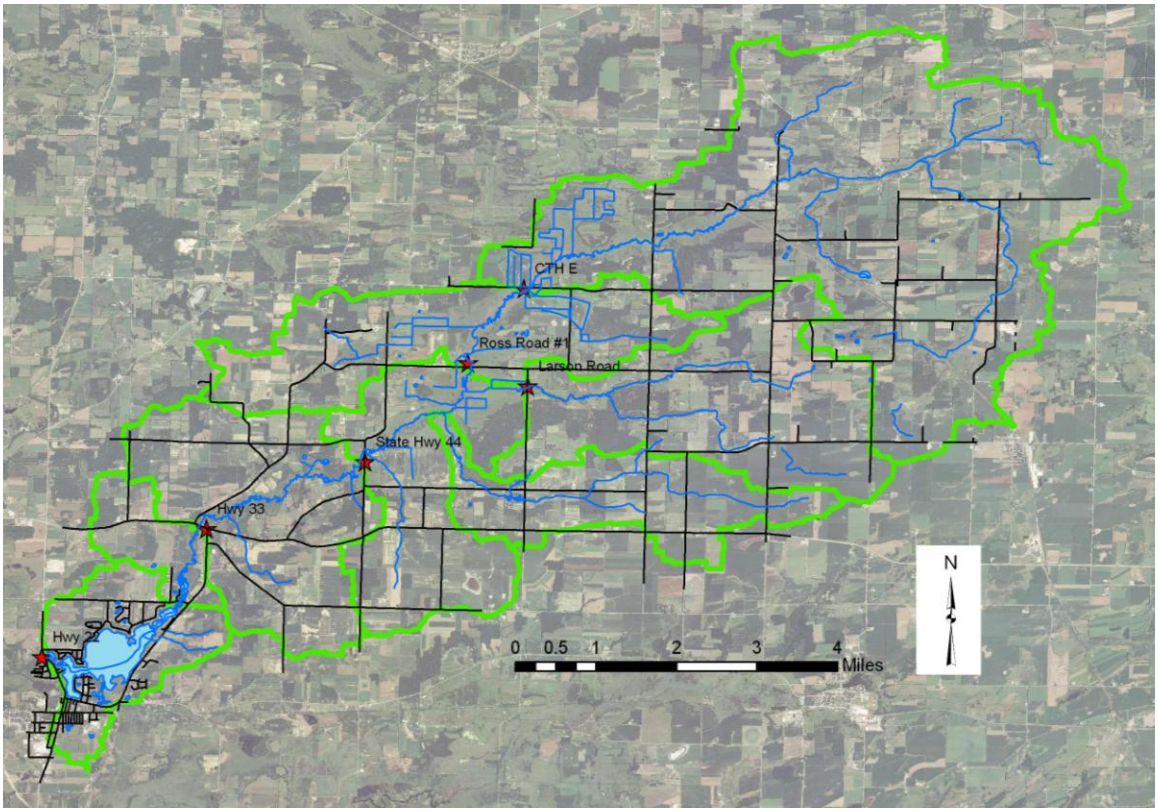

Figure A1. Park Lake Sampling Locations and Sub Watersheds

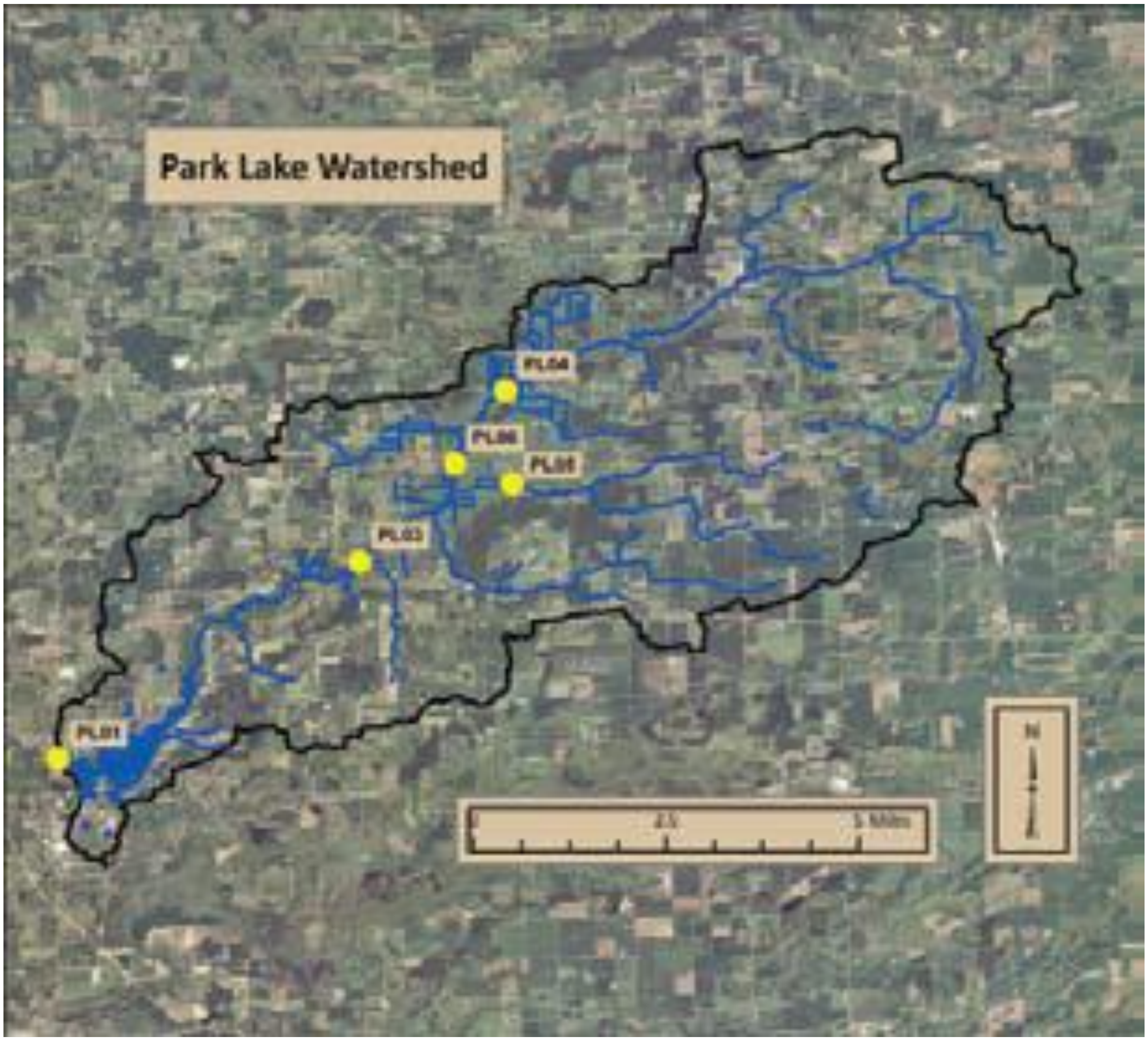

Figure A2. Sampling Identification, Road Crossings and Stream Name

Table A1. Park Lake Sampling Identification, Road Crossing and Stream

Sampling Identification	Road Crossing	Stream Name
PL 01	Highway 22	Outlet
PL 03	Highway 44	Fox River
PL 04	Highway E	Fox River
PL 05	Larson Road	Sand Spring Creek
PL 06	Ross Road	Fox River

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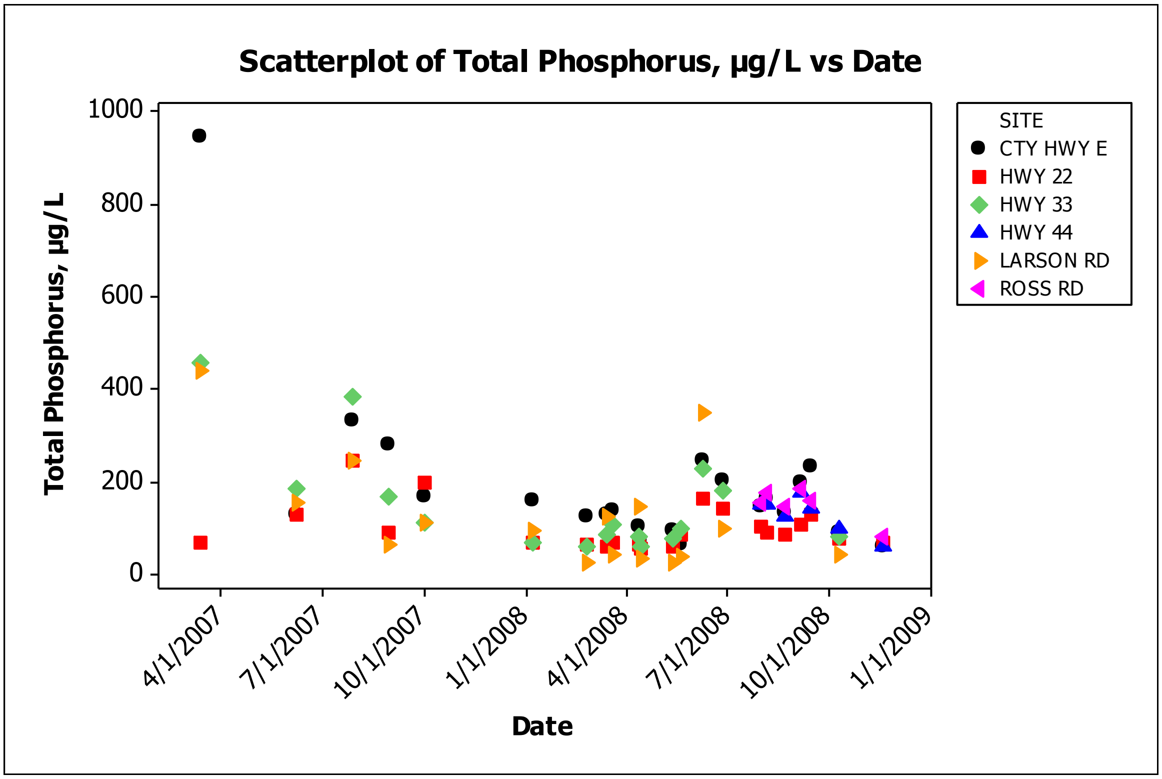
Appendix B: Water Quality Monitoring Data



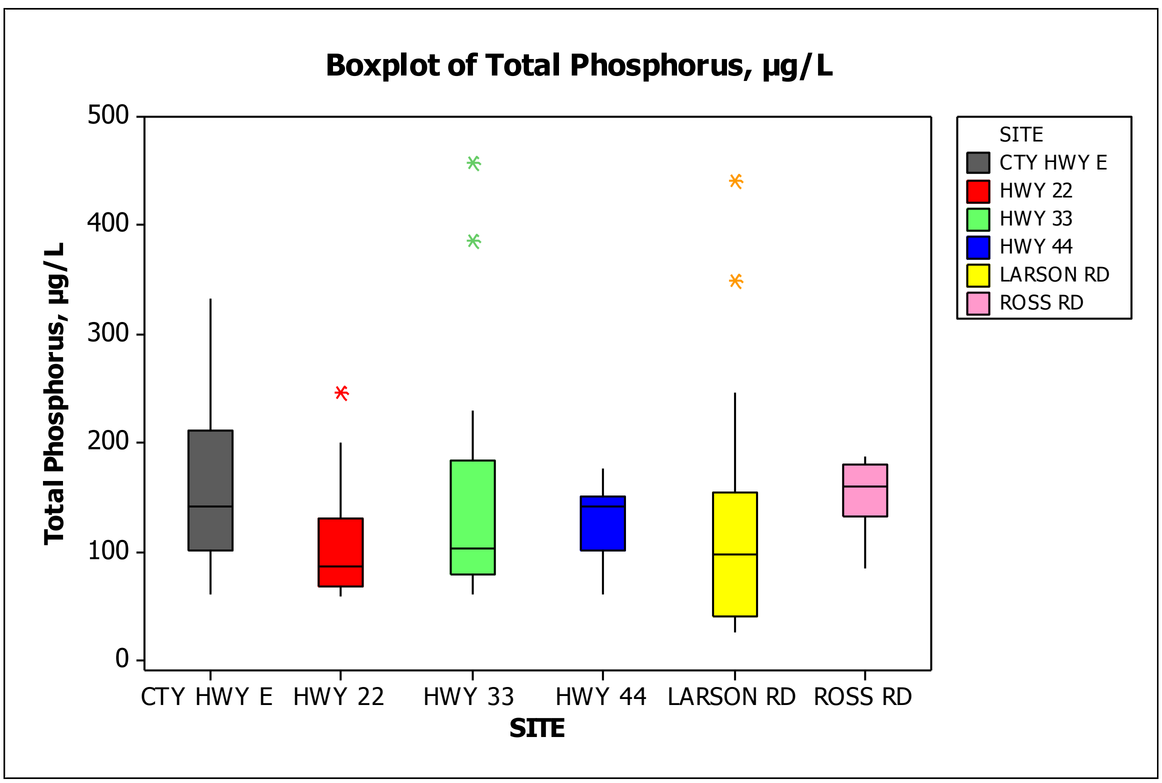
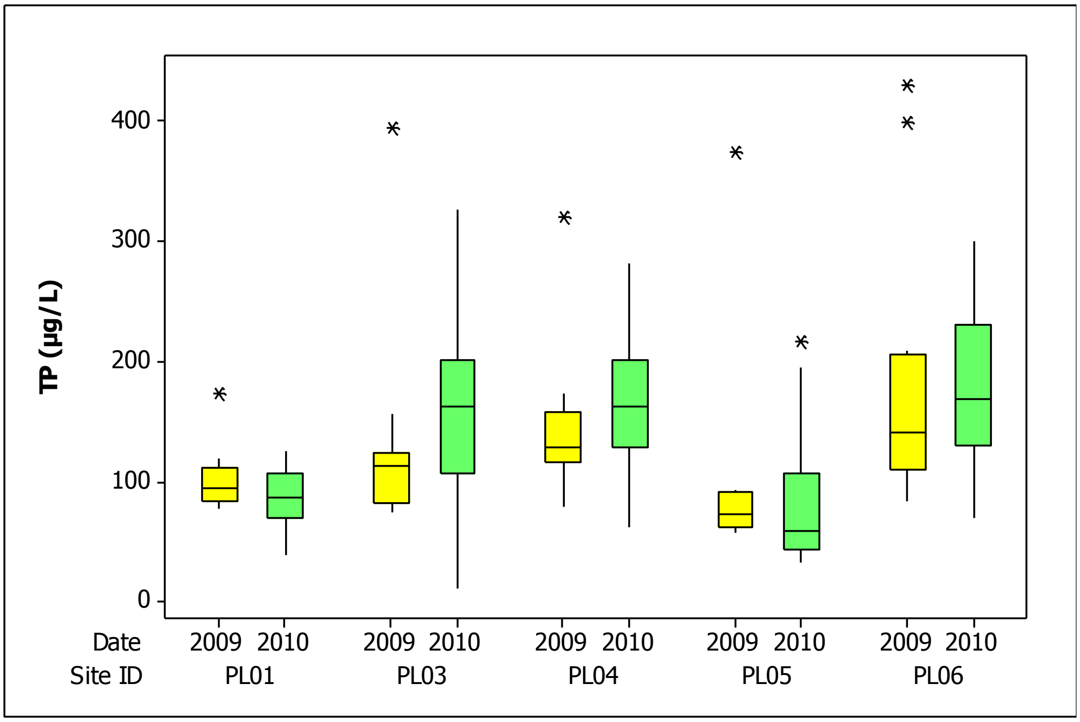


Figure B1. Park Lake Watershed Total Phosphorus Concentrations Scatter plot and Box plot (2007-2009)



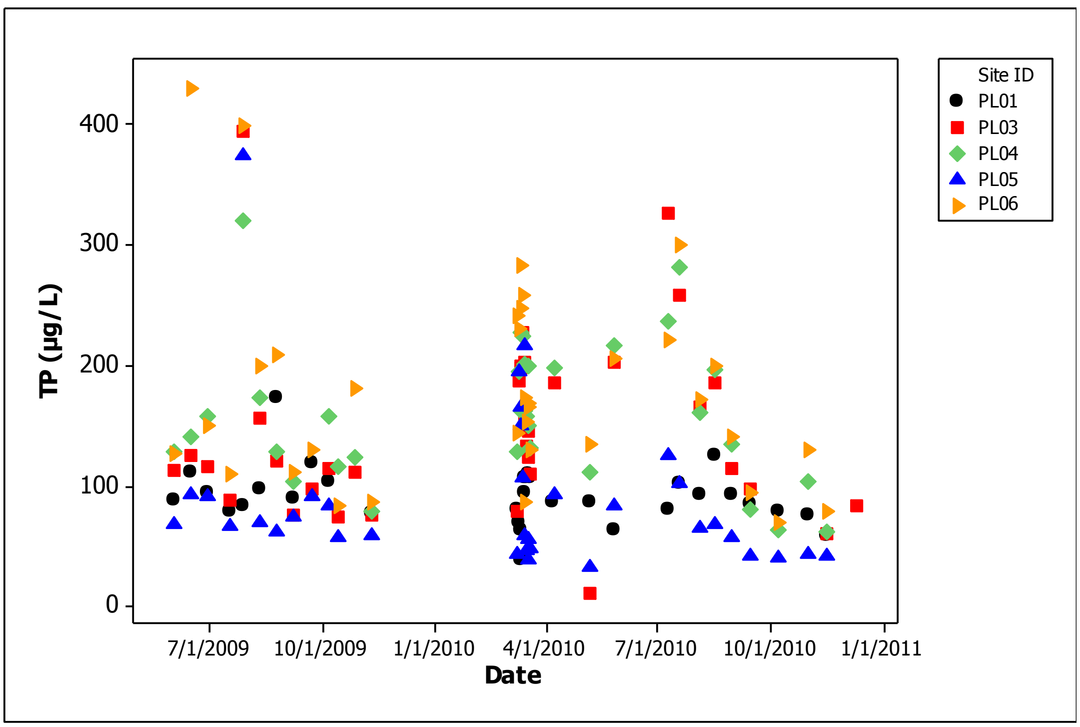
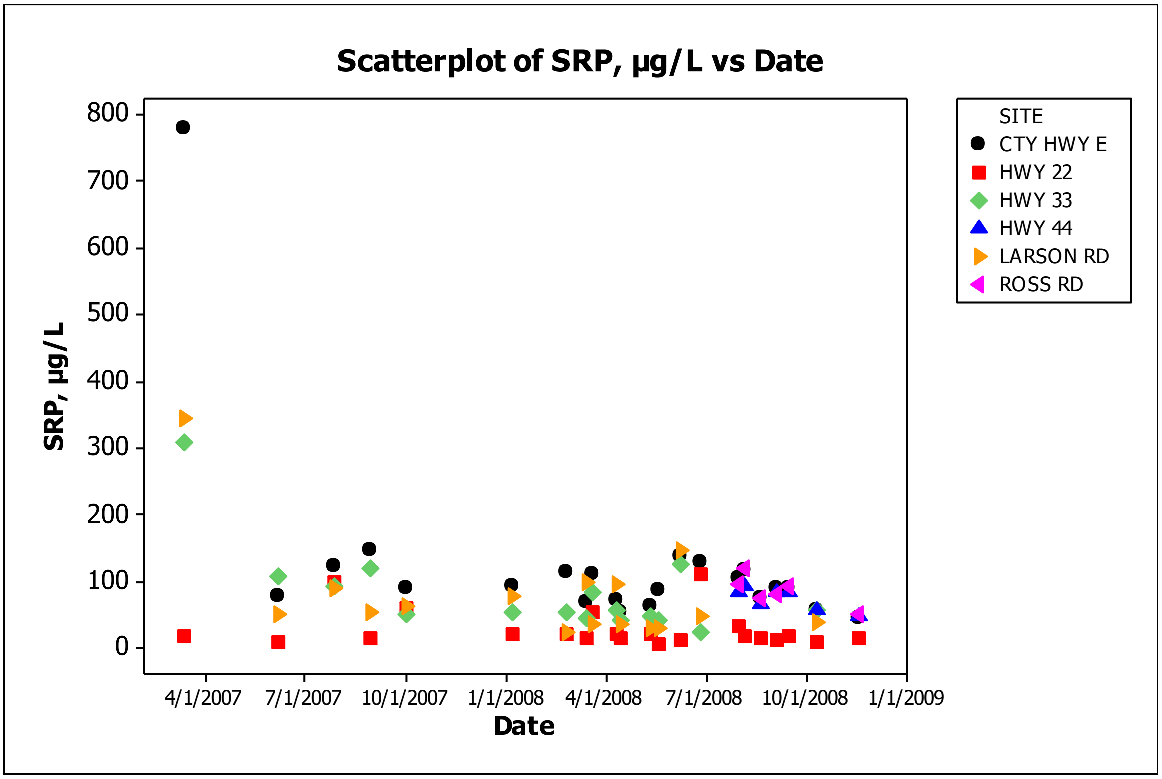


Figure B2. Park Lake Watershed Total Phosphorus Concentrations Scatter plot and Box plot (2009-2010)



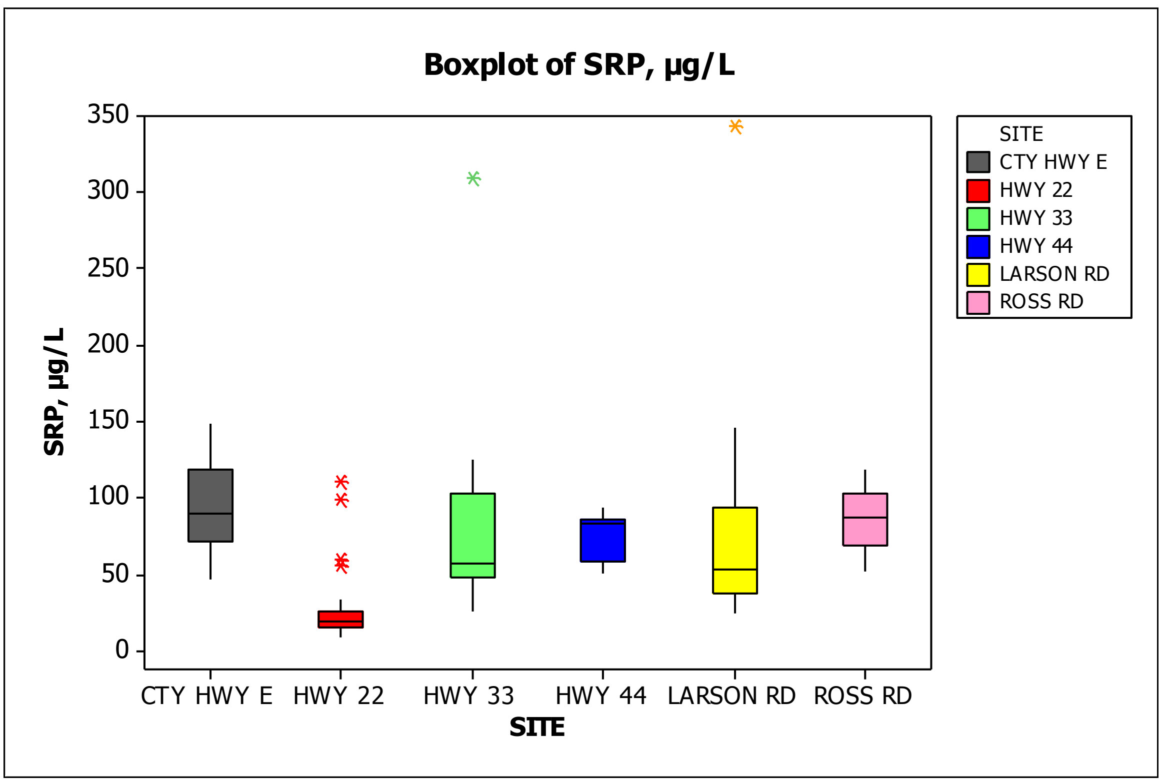


Figure B3. Park Lake Watershed Soluble Reactive Phosphorous Concentrations Scatter plot and Box plot ((2007-2009)

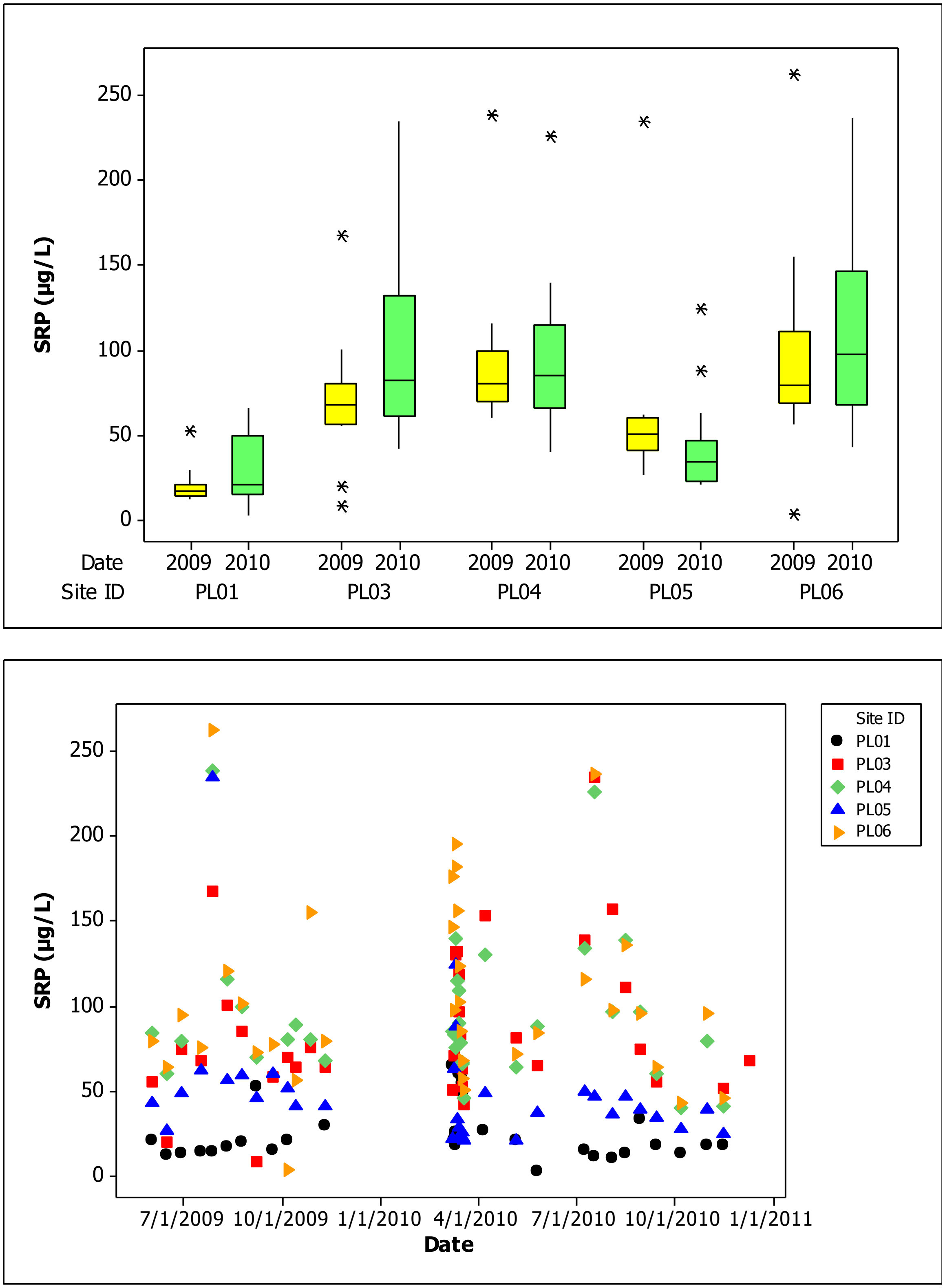
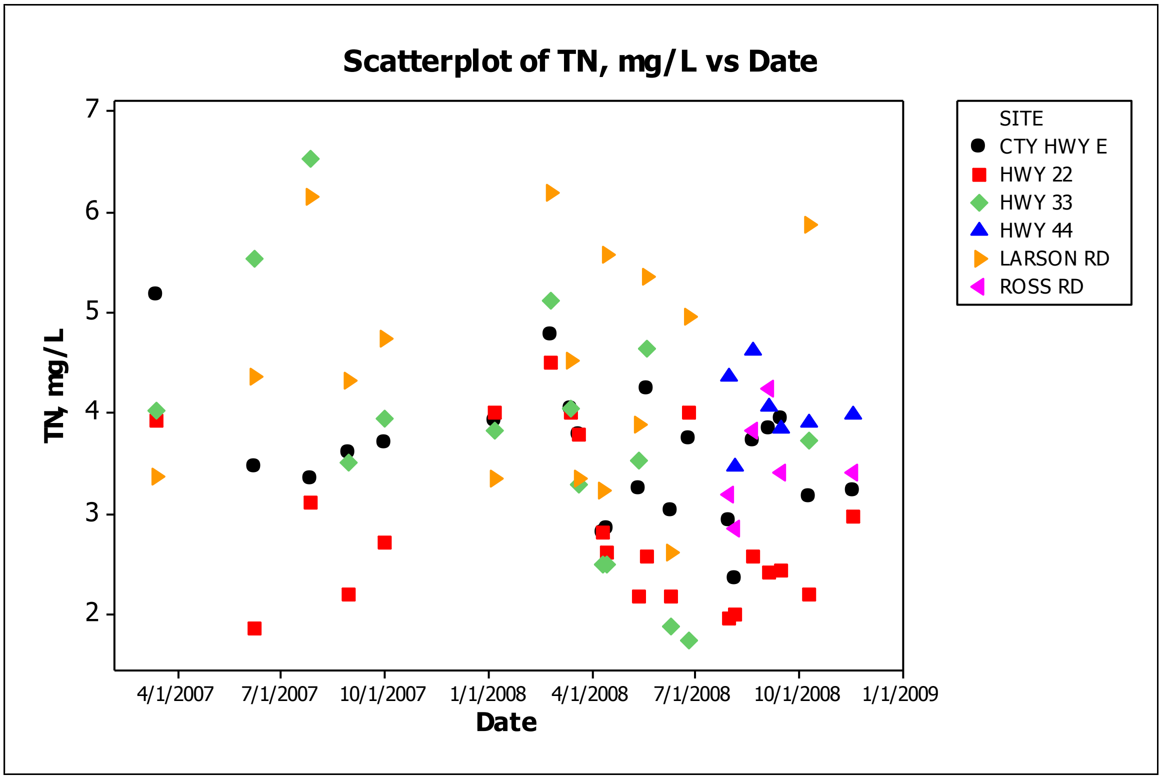


Figure B4. Park Lake Watershed Soluble Reactive Phosphorous Concentrations Scatter plot and Box plot (2009-2010)



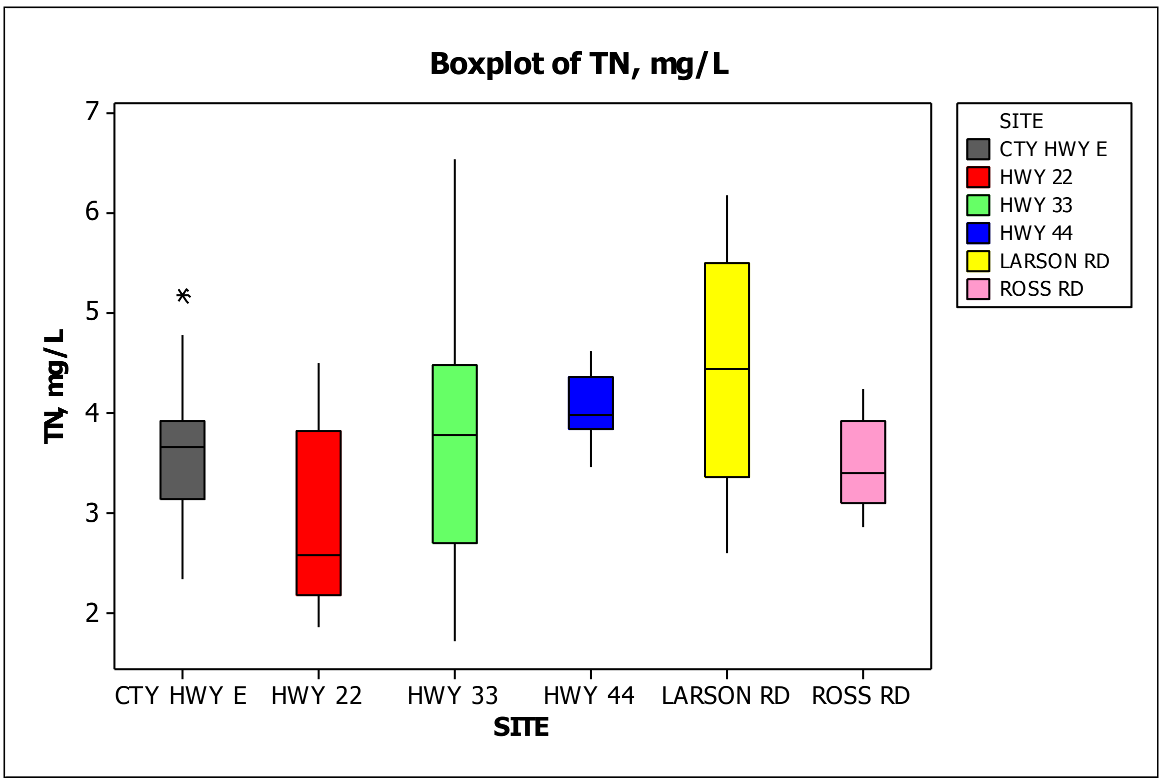
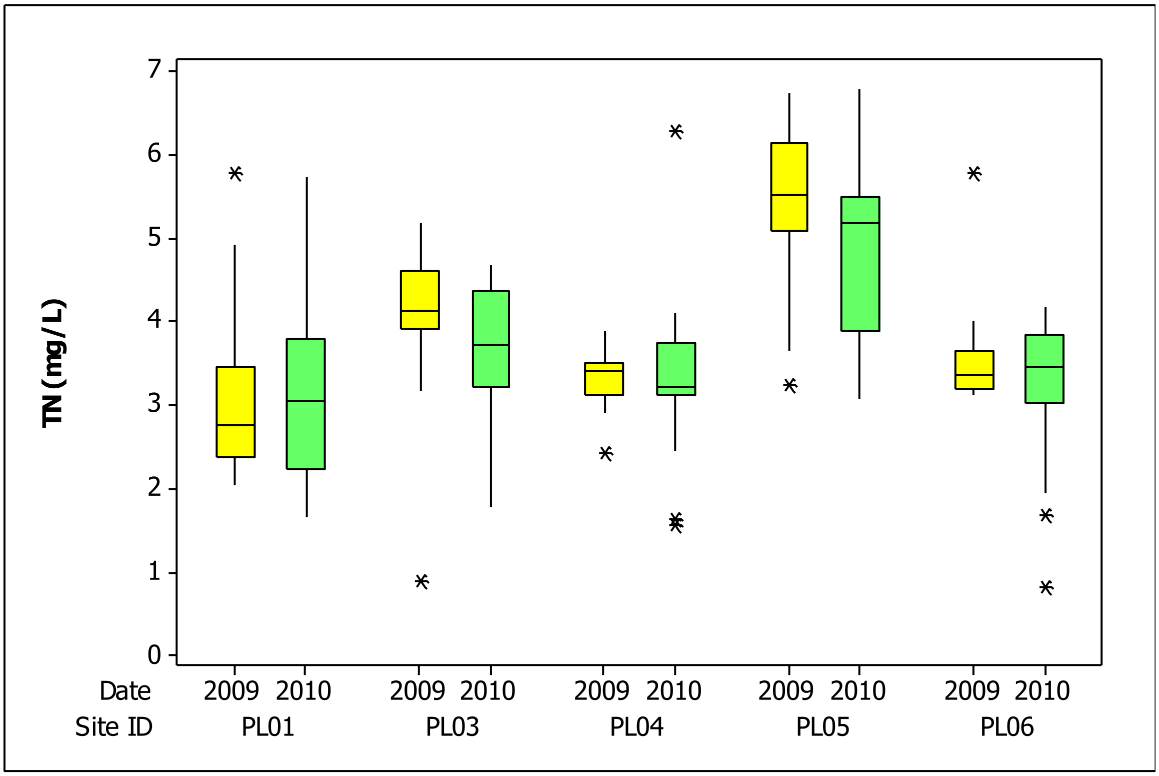


Figure B5. Park Lake Watershed Total Nitrogen Concentrations Scatter plot and Box plot (2007-2009)



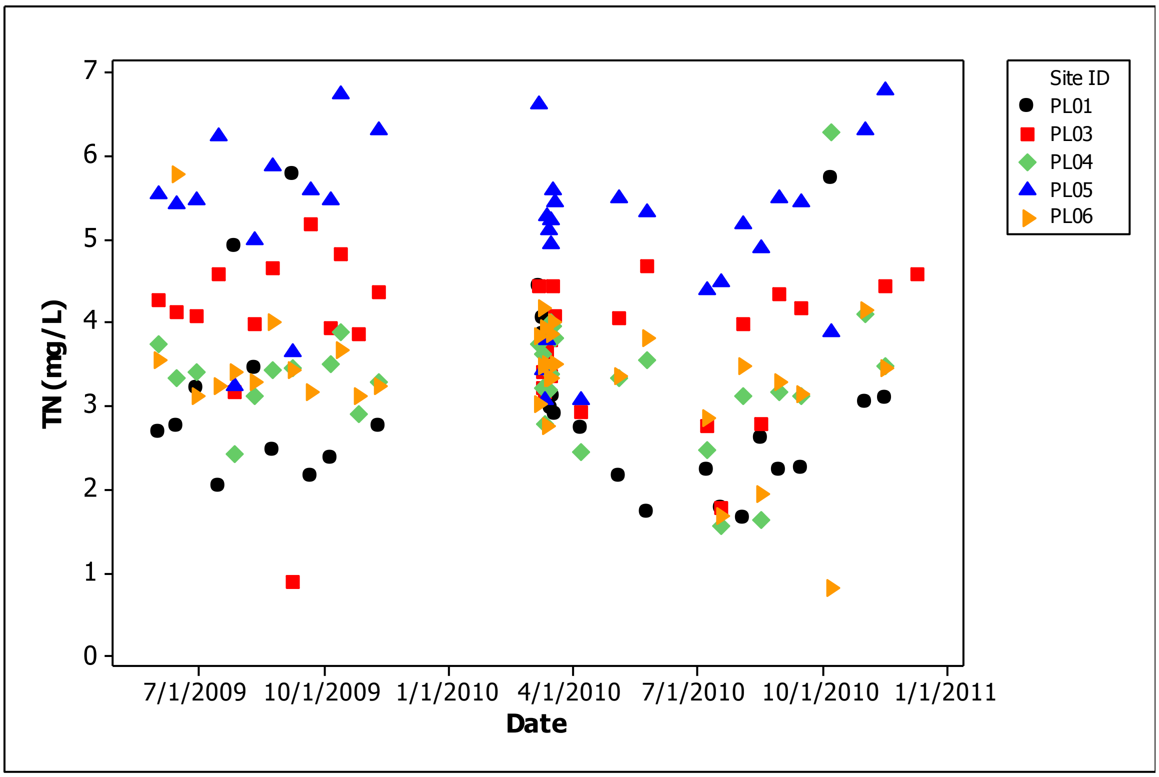
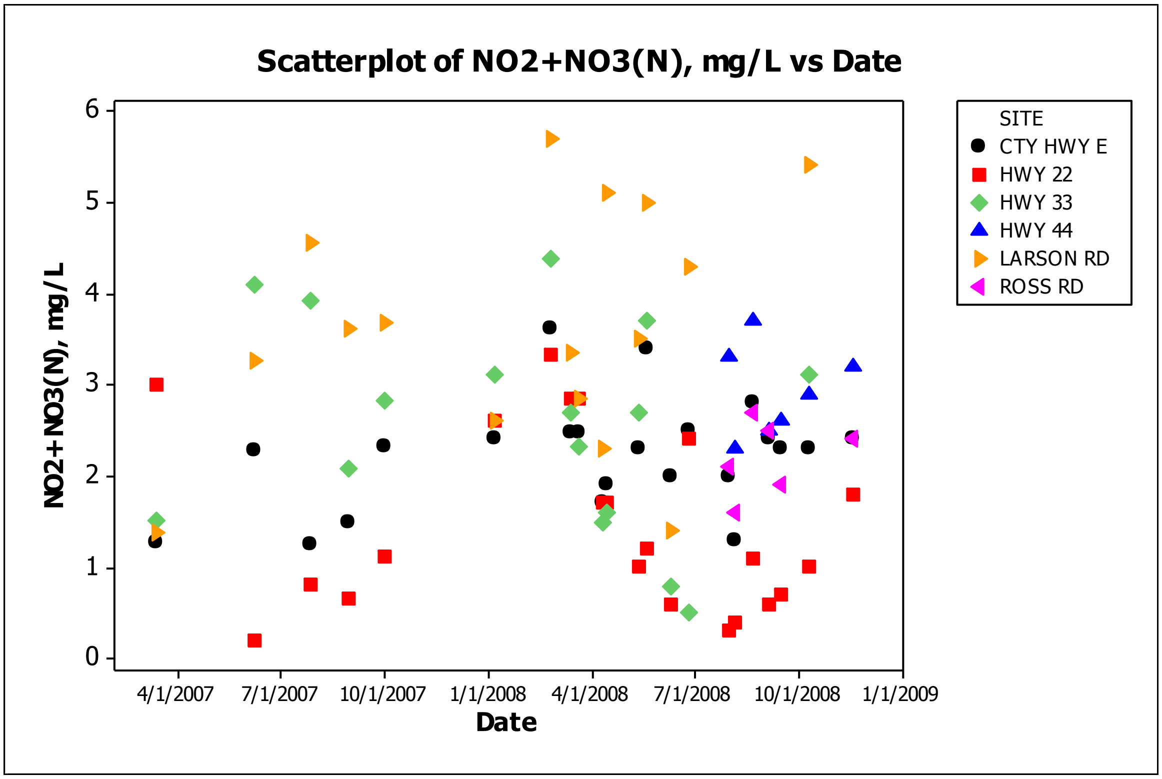


Figure B6. Park Lake Watershed Total Nitrogen Concentrations Scatter plot and Box plot (2009-2010)



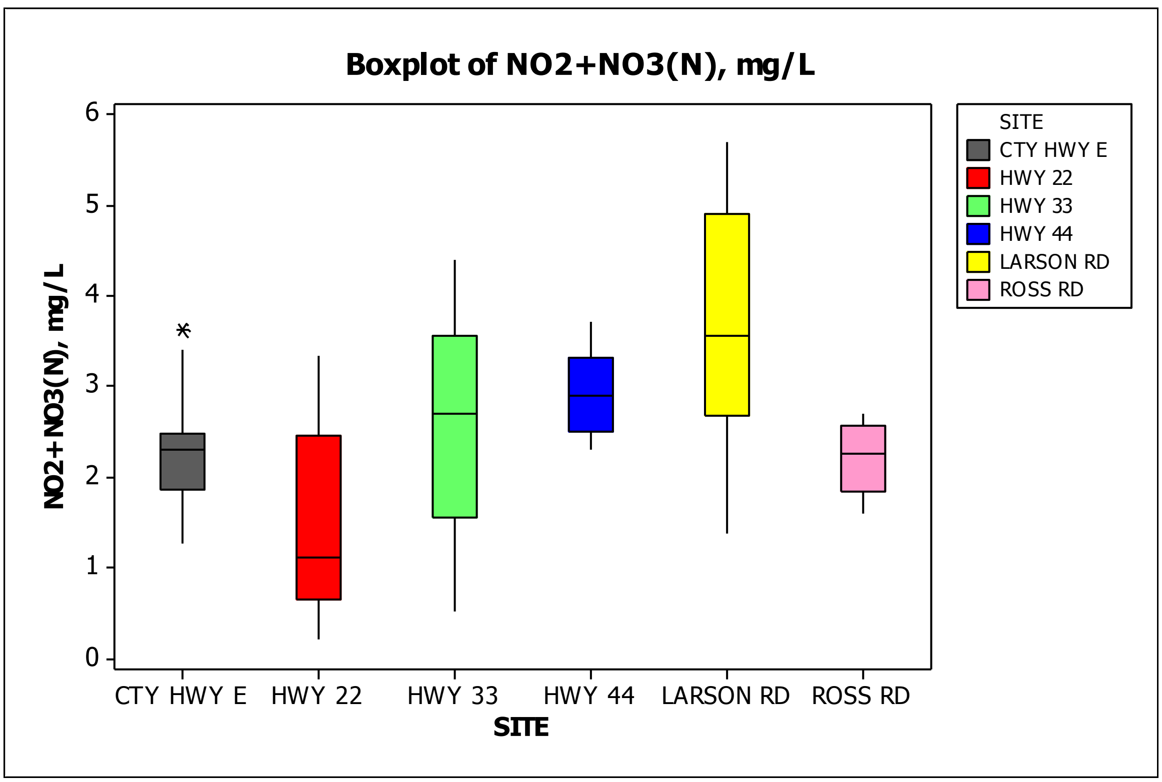
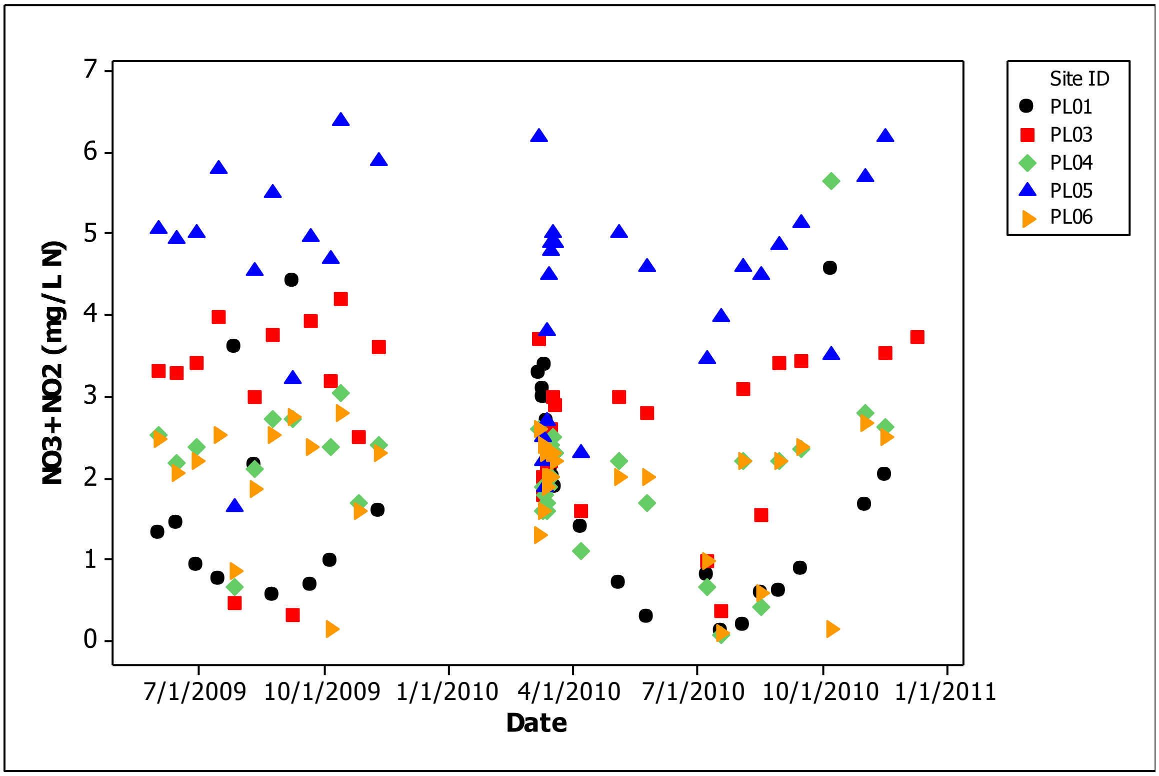


Figure B7. Park Lake Watershed NO2 + NO3 (N) Concentrations Scatter plot and Box plot (2008-2009)



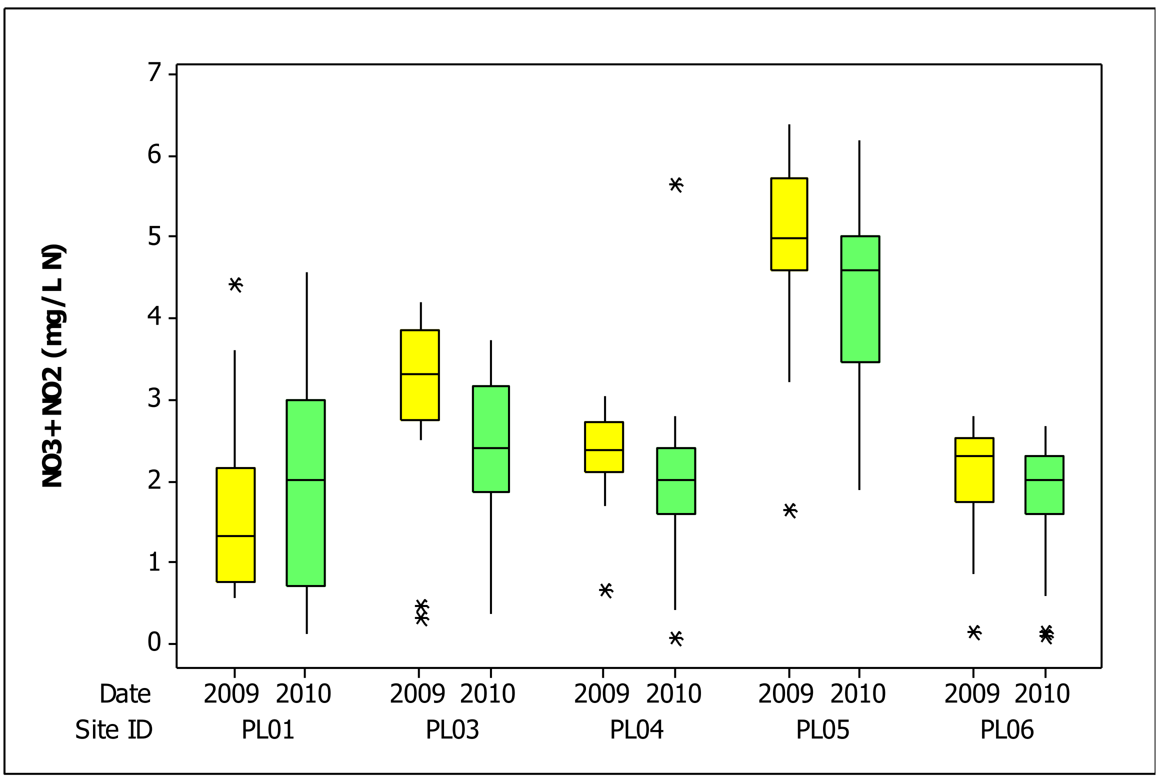
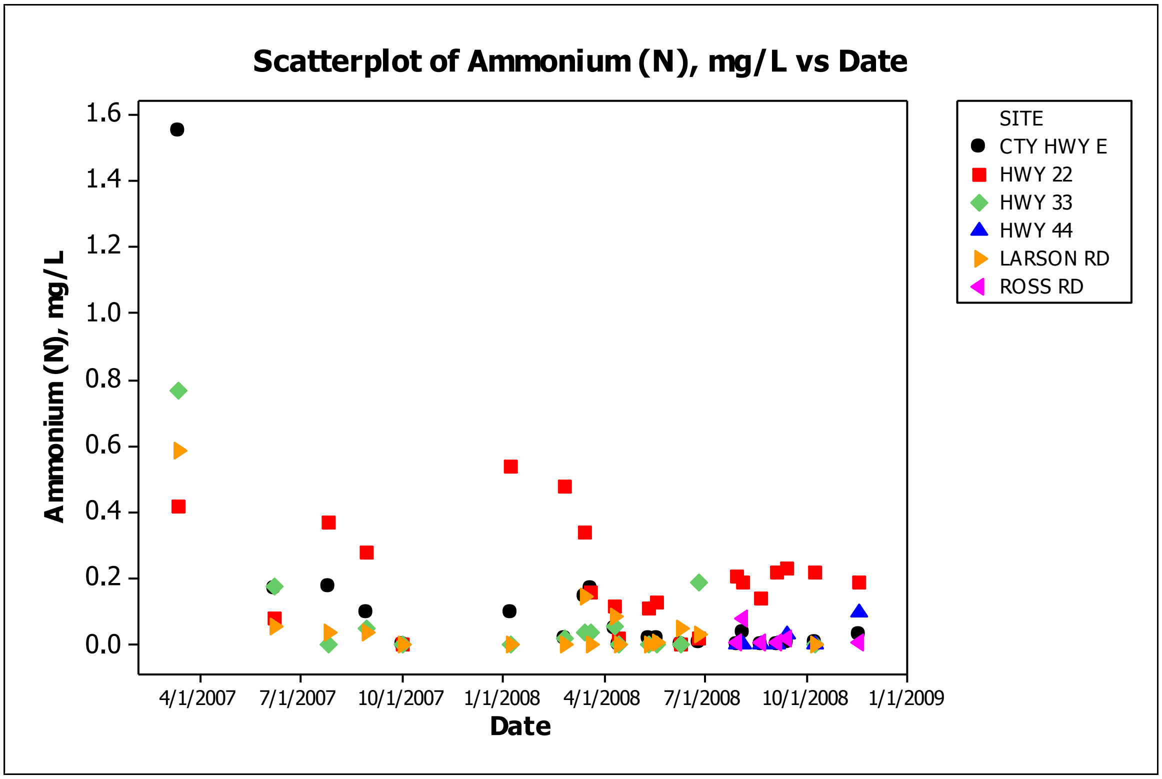


Figure B8. Park Lake Watershed NO2 + NO3 (N) Concentrations Scatter plot and Box plot (2009-2010)



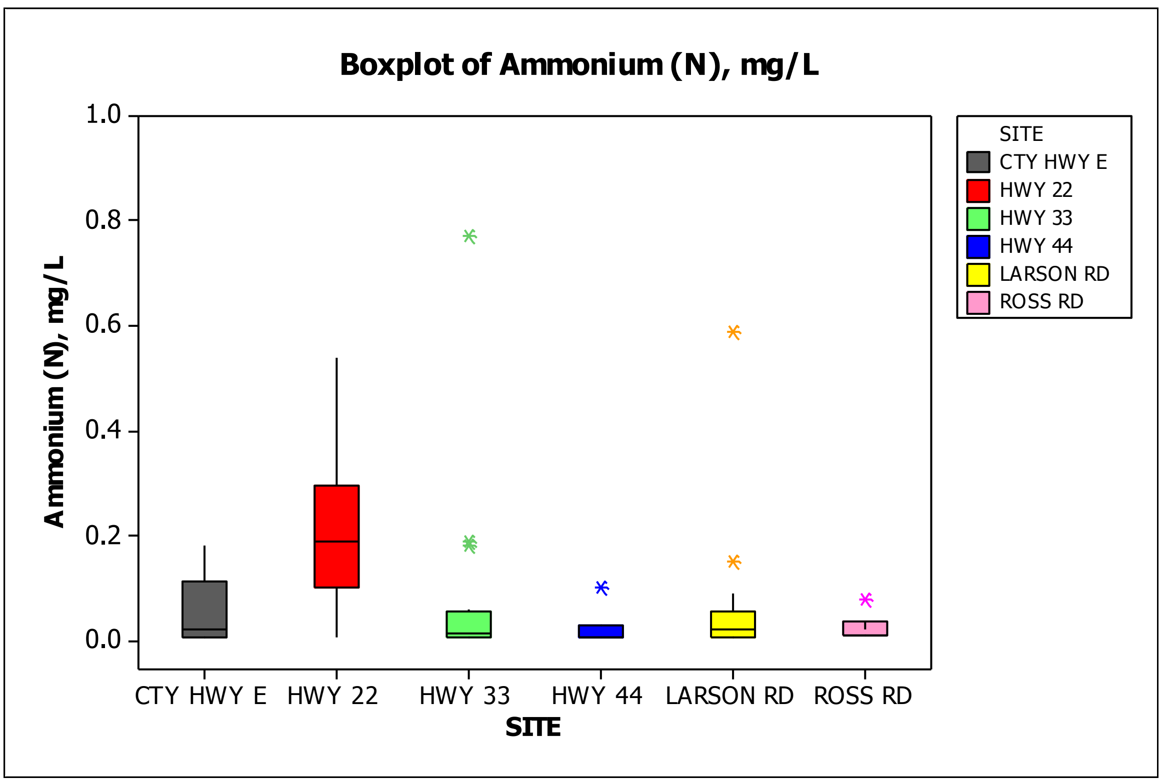
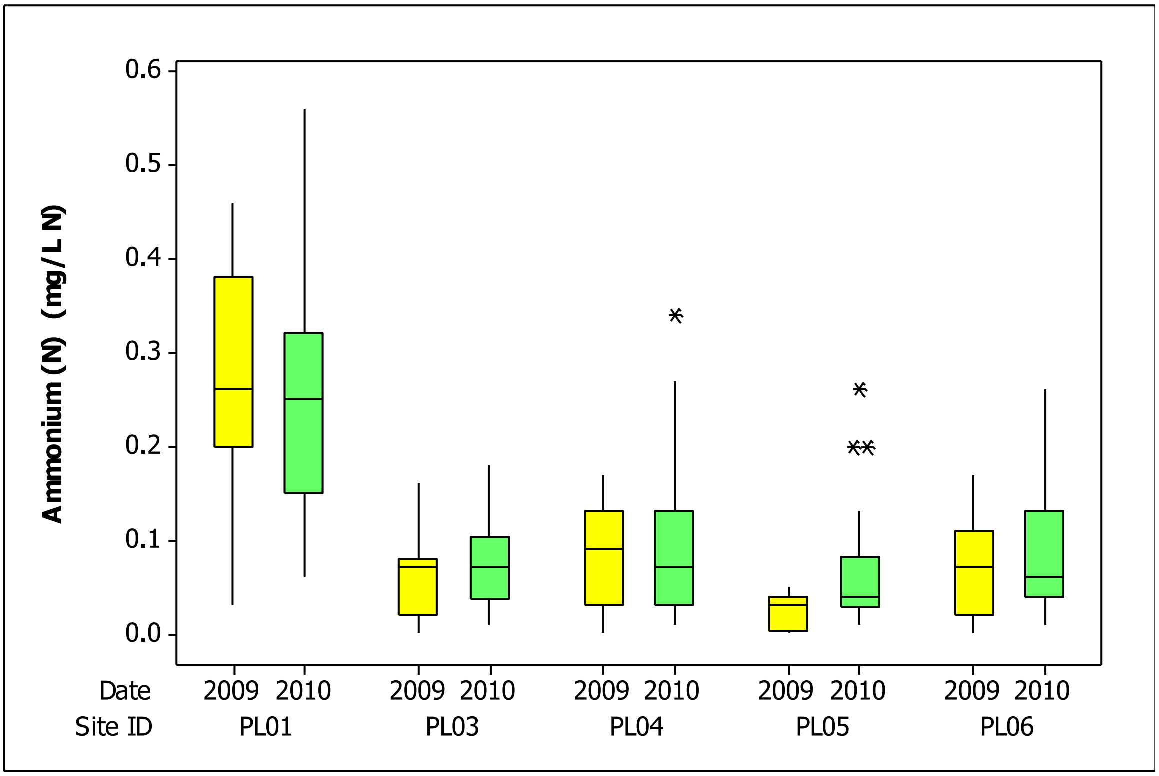


Figure B9. Park Lake Watershed Ammonium (N) Concentrations Scatter plot and Box plot (2007-2009)



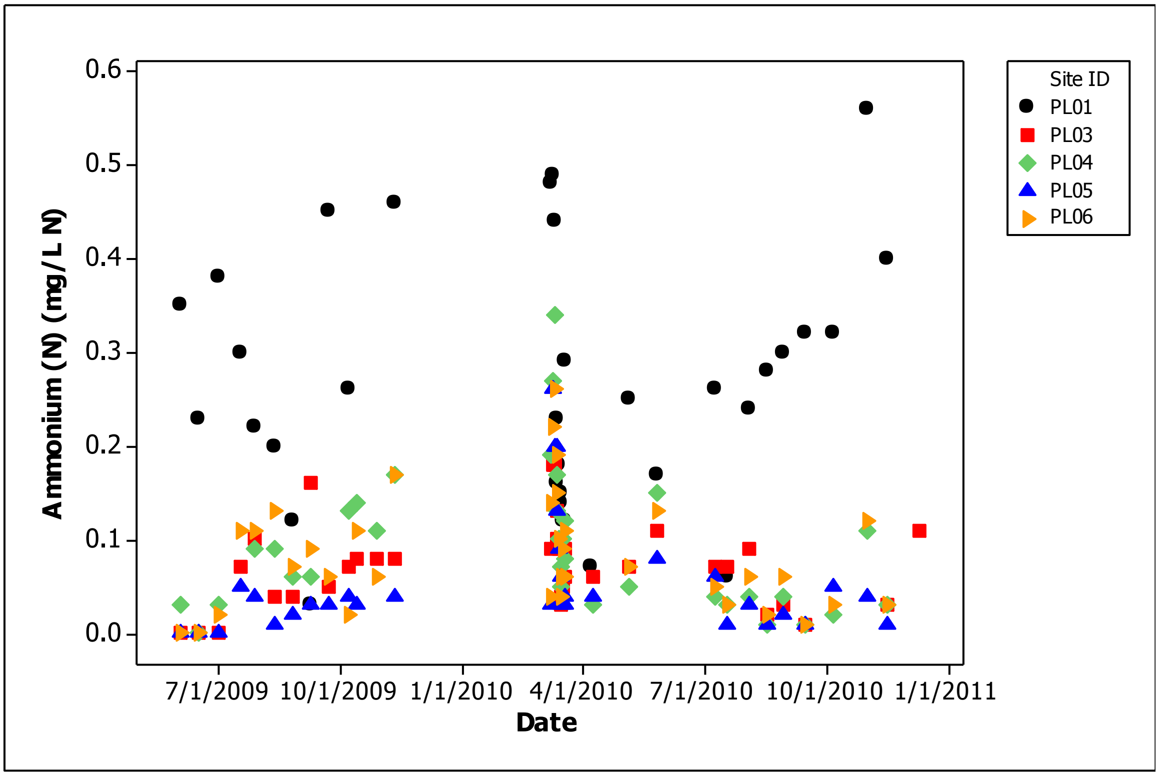
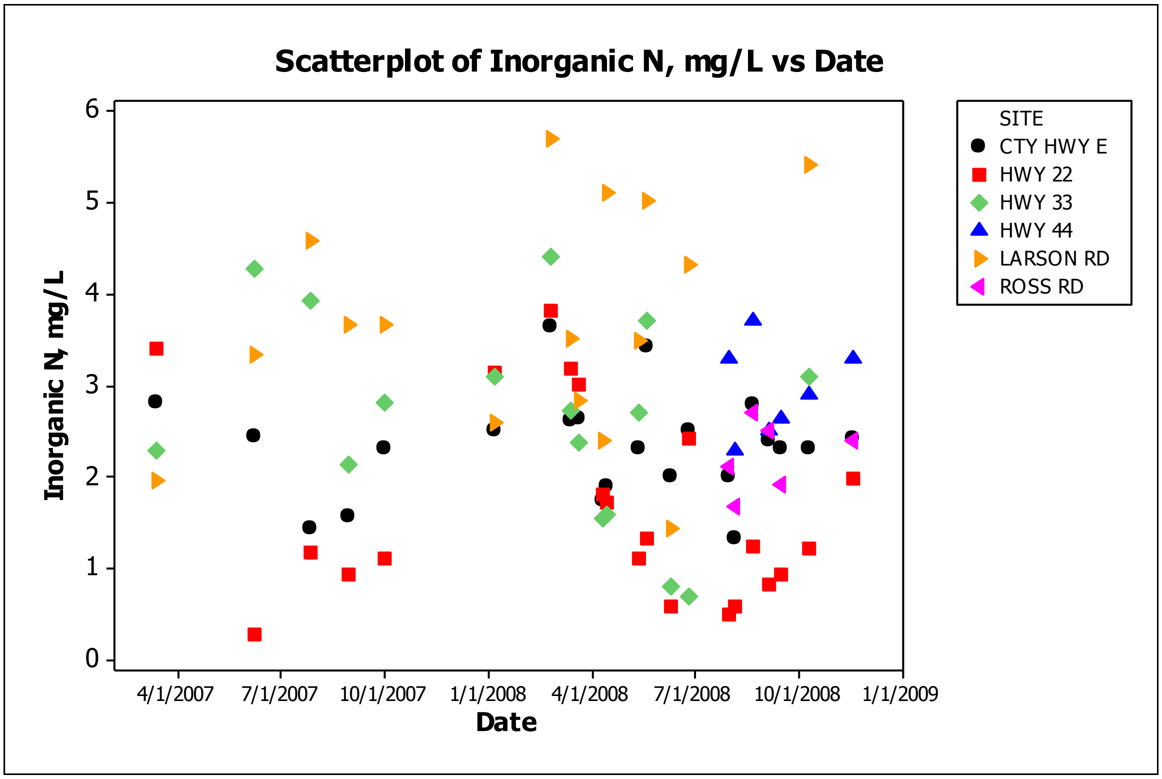


Figure B10. Park Lake Watershed Ammonium (N) Concentrations Scatter plot and Box plot (2009-2010)



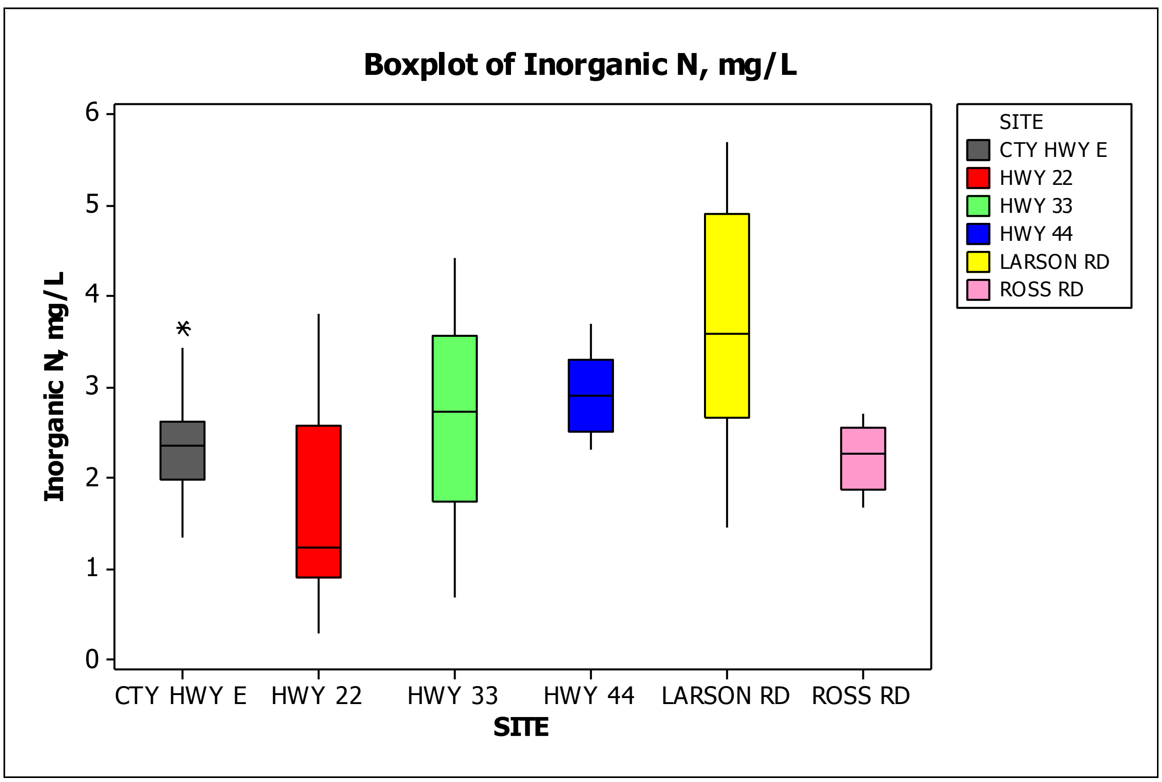
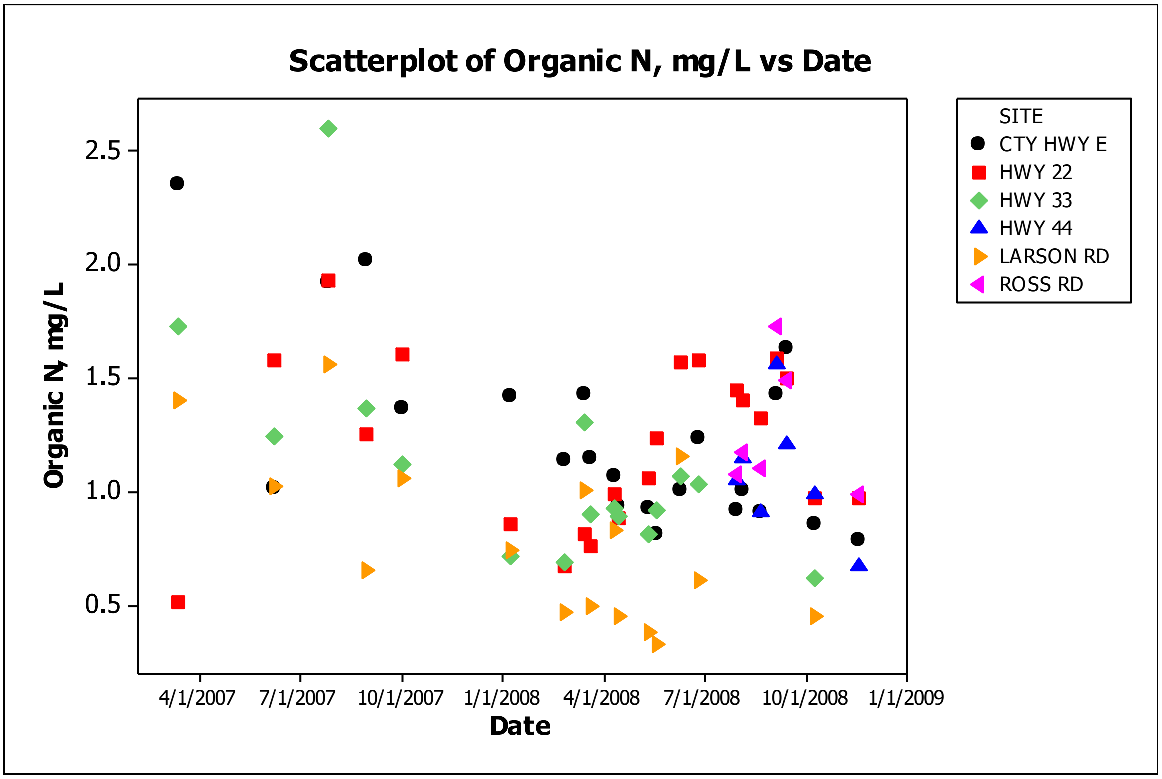


Figure B11. Park Lake Watershed Inorganic N Concentrations Scatter plot and Box plot (2007-2009)



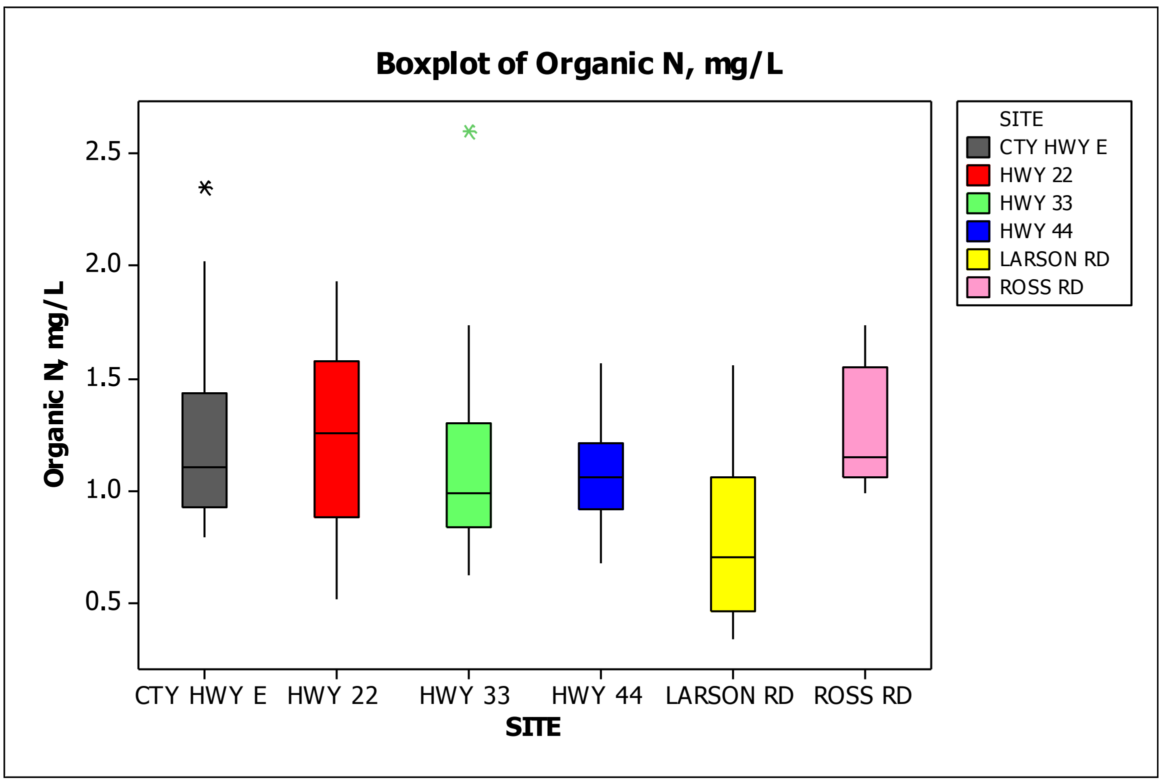
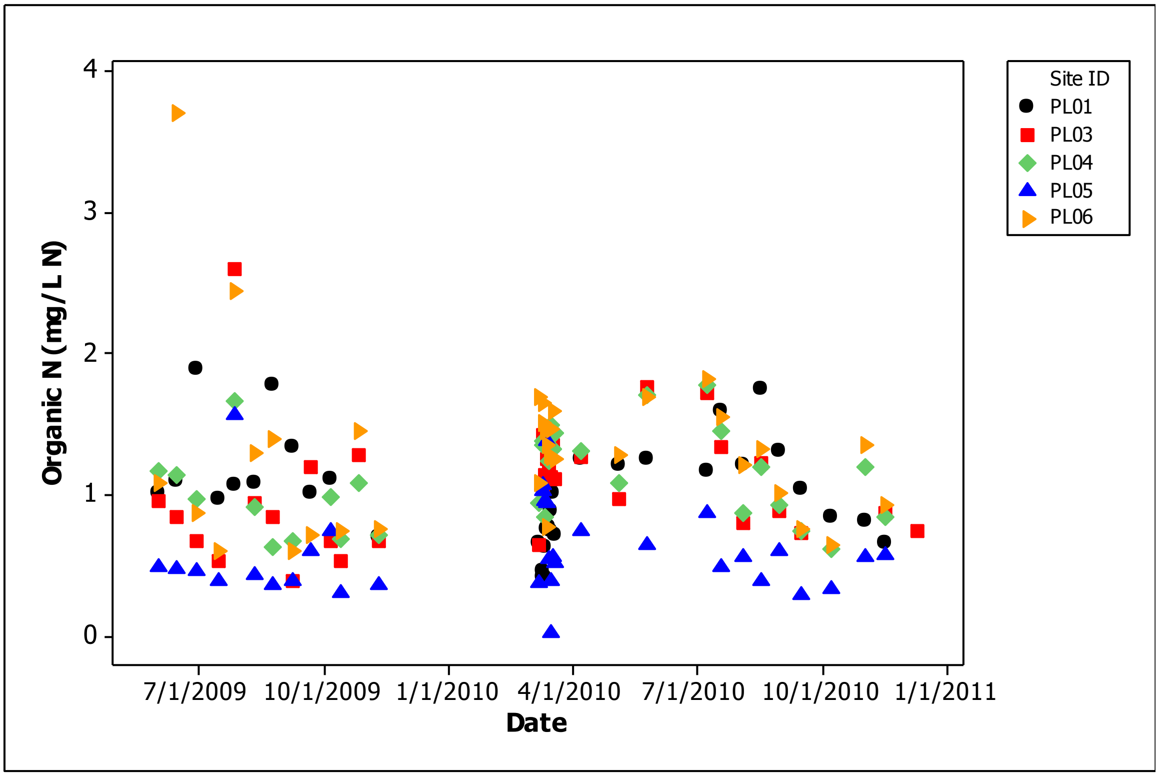


Figure B12. Park Lake Watershed Organic N Concentrations Scatter plot and Box plot (2007-2009)



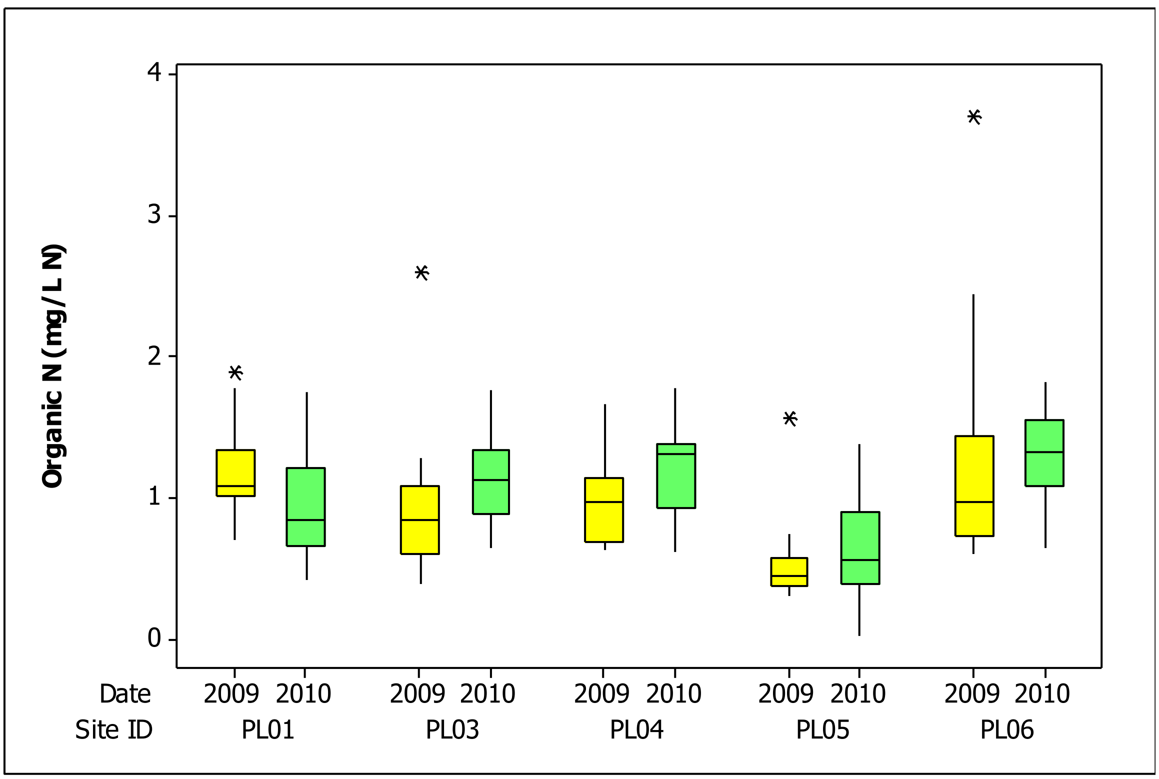
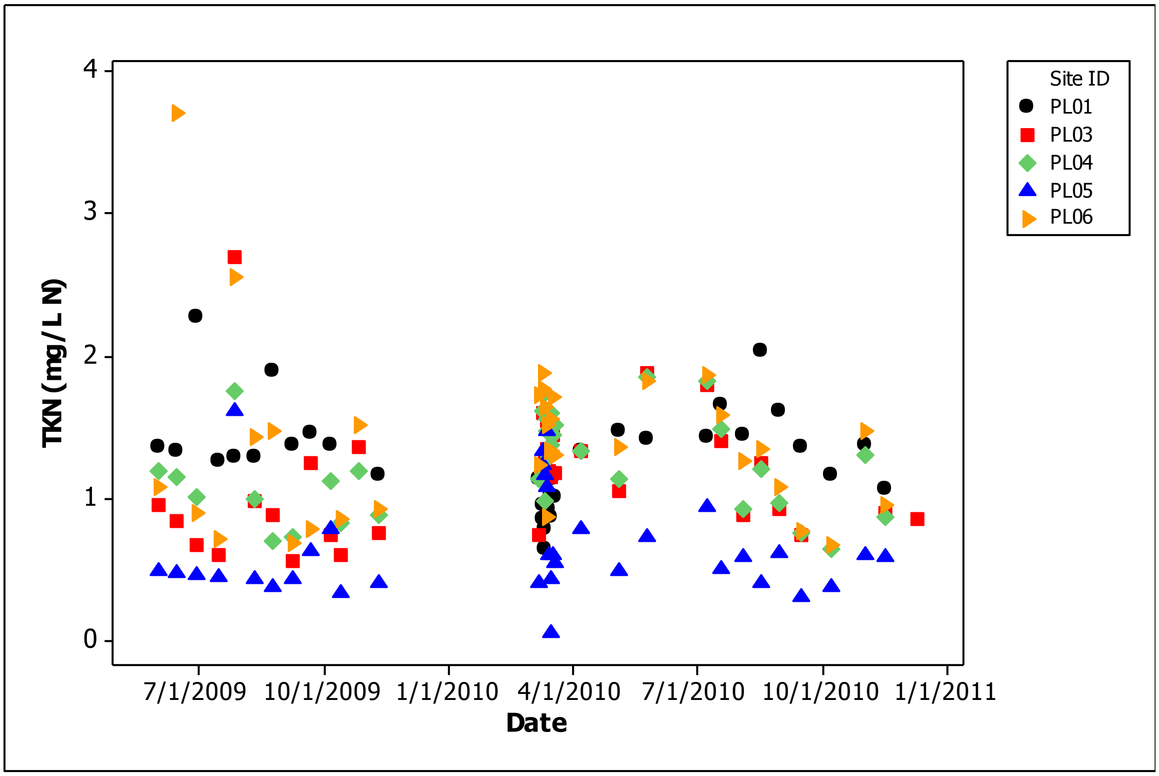


Figure B13. Park Lake Watershed Organic N Concentrations Scatter plot and Box plot (2009-2010)



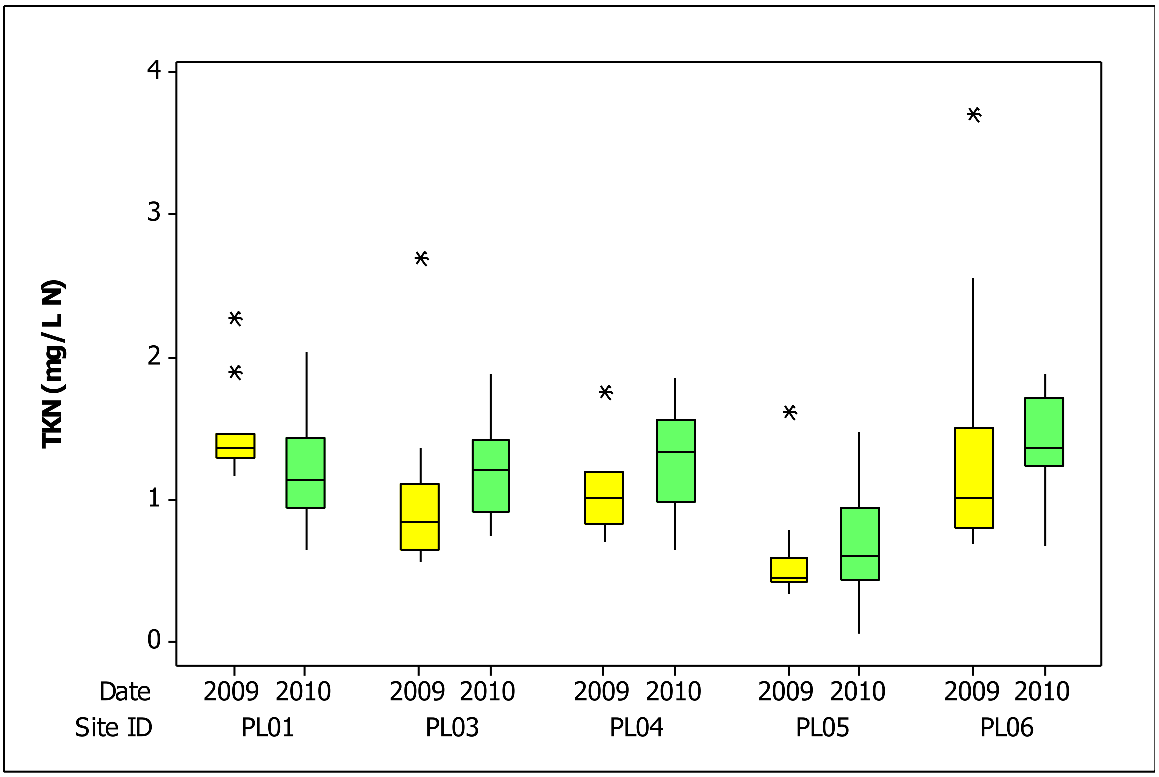
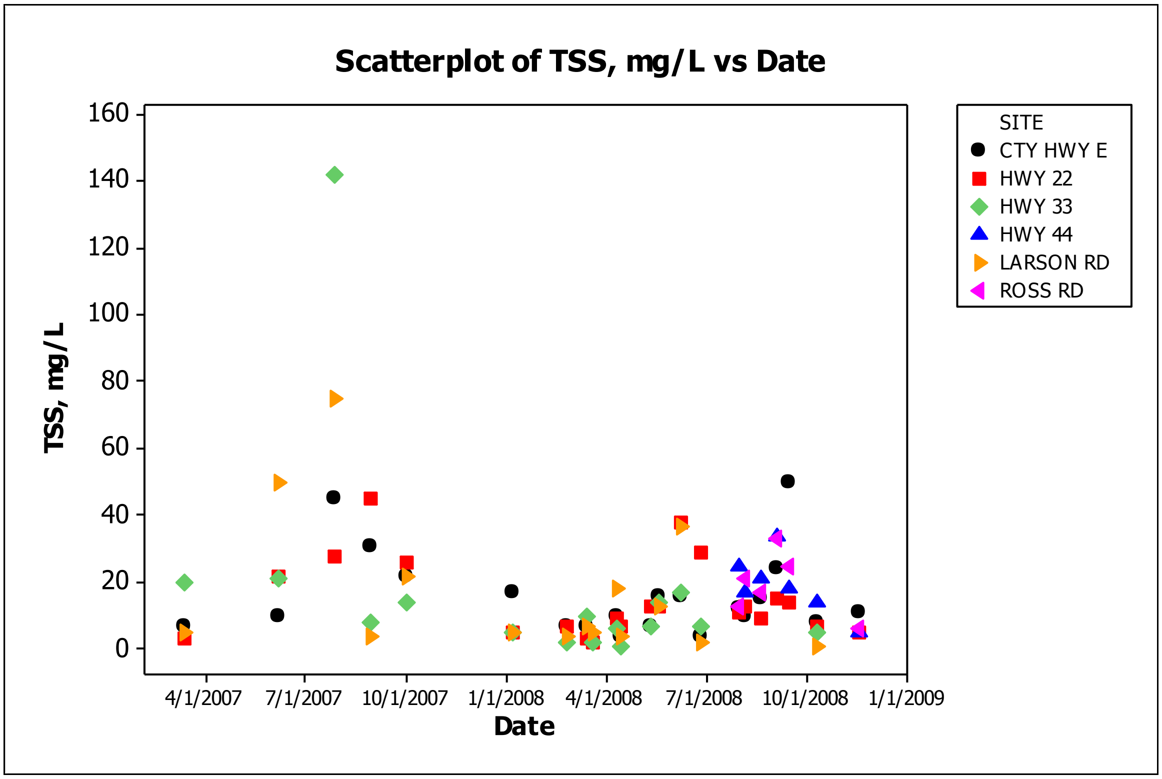


Figure B14. Park Lake Watershed Total Kjeldahl Nitrogen (TKN) Concentrations Scatter plot and Box plot (2009-2010)



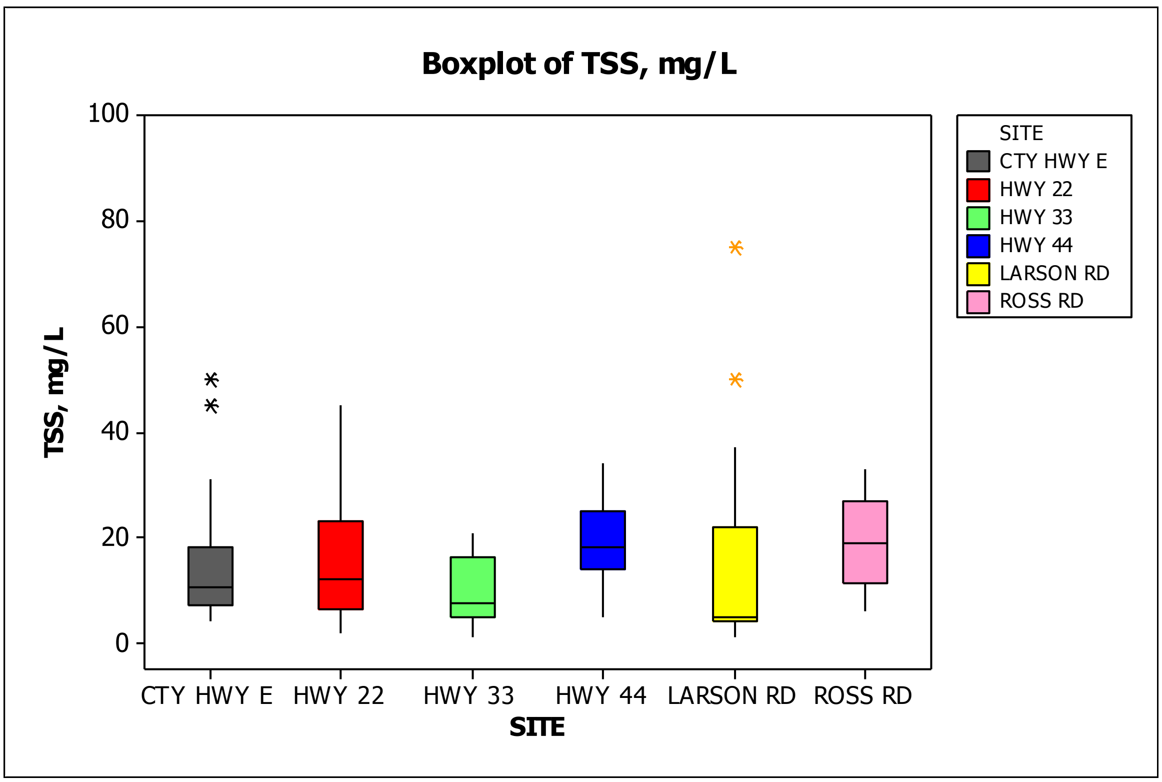
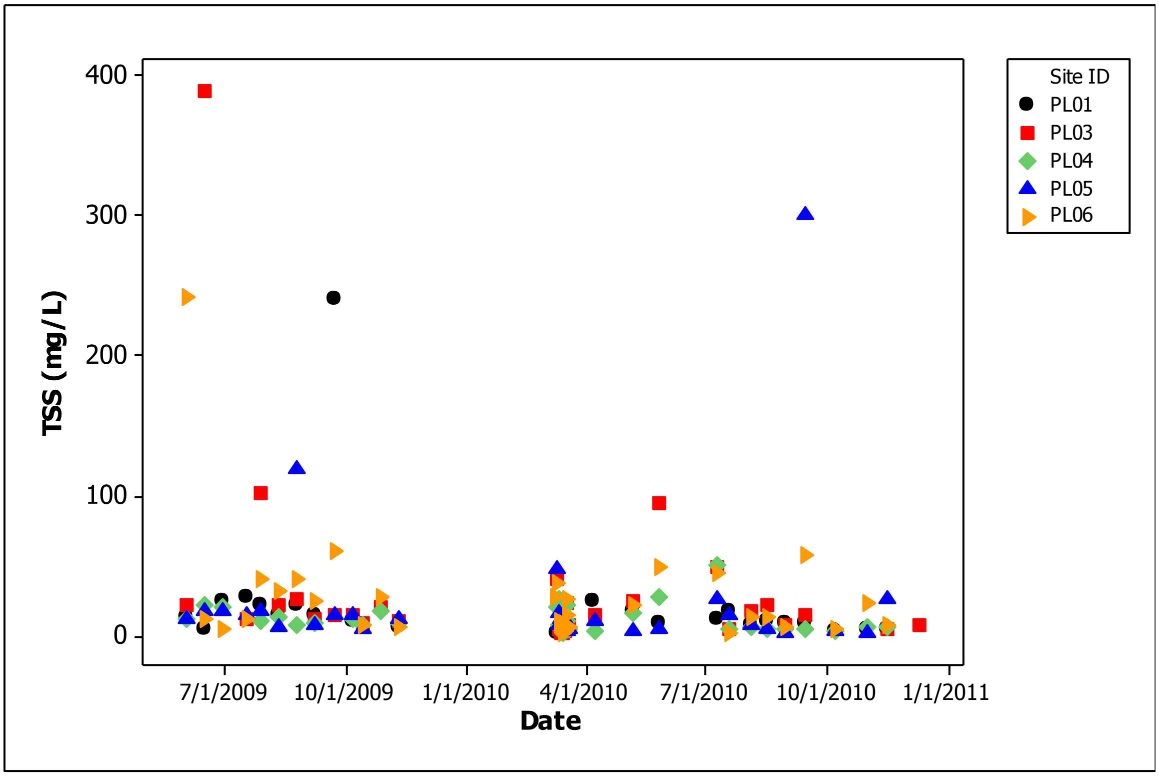


Figure B15. Park Lake Watershed Total Suspended Solids Concentrations Scatter plot and Box plot (2007-2009)



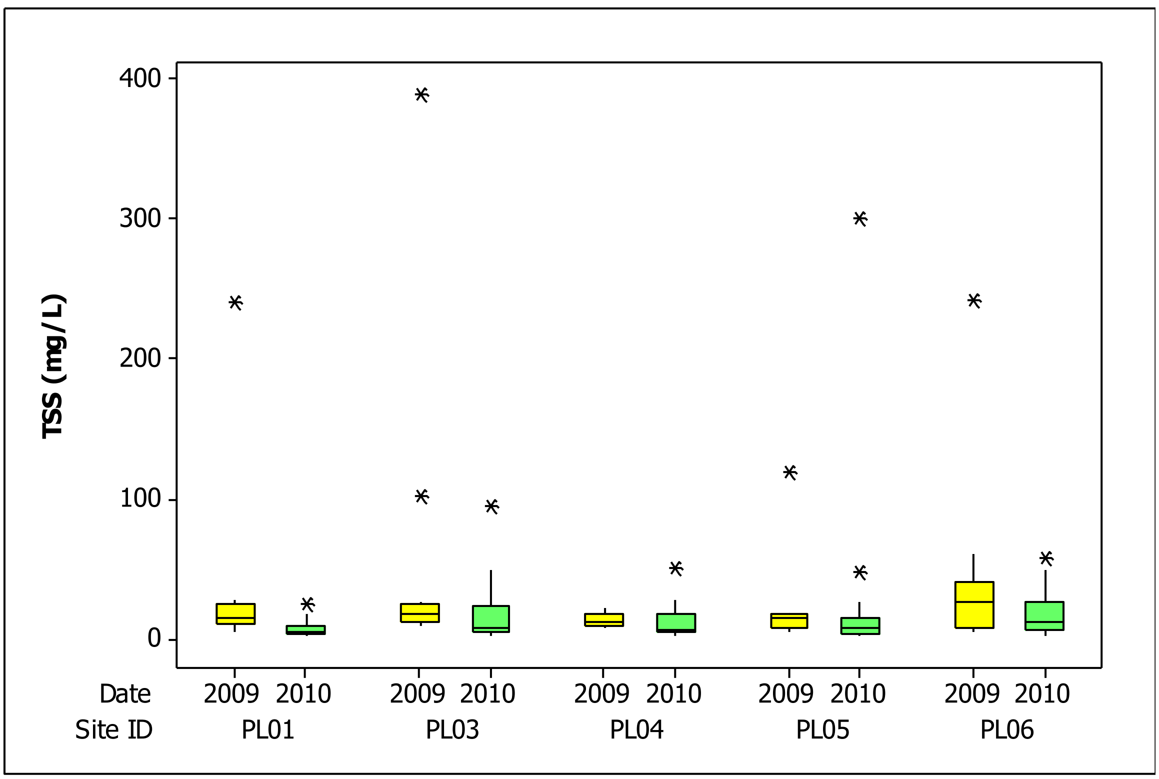
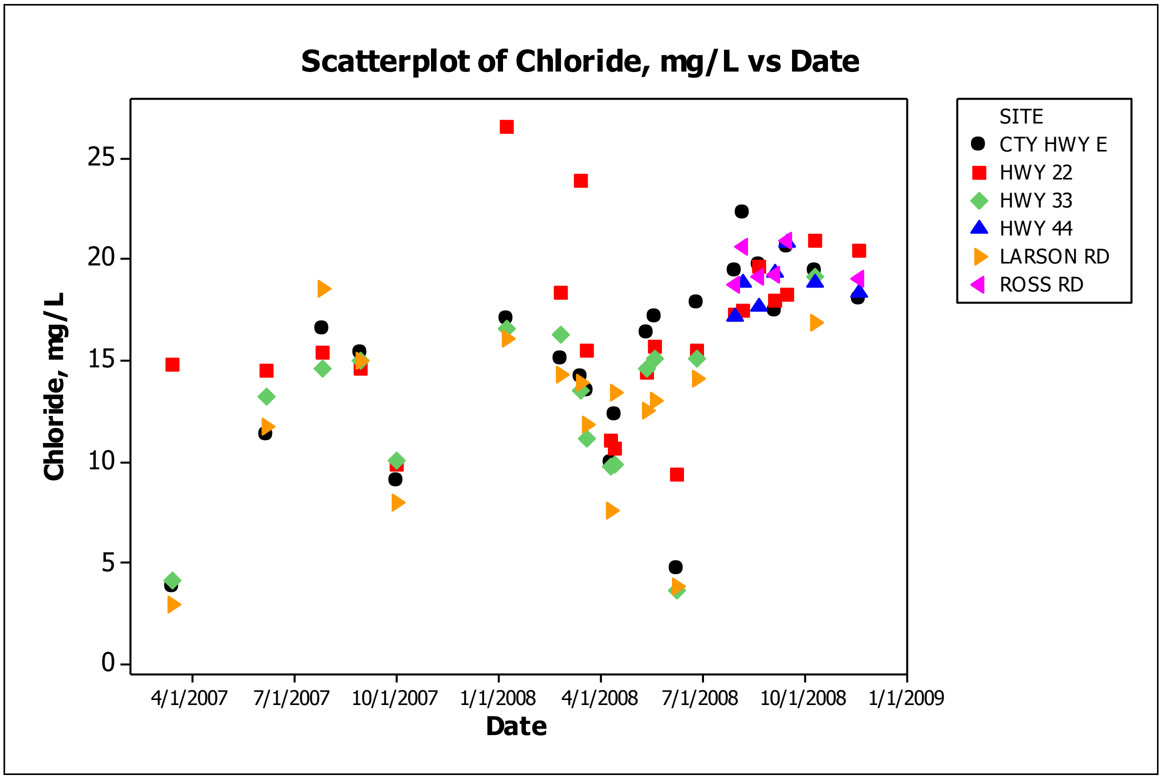


Figure B16. Park Lake Watershed Total Suspended Solids Concentrations Scatter plot and Box plot (2009-2010)



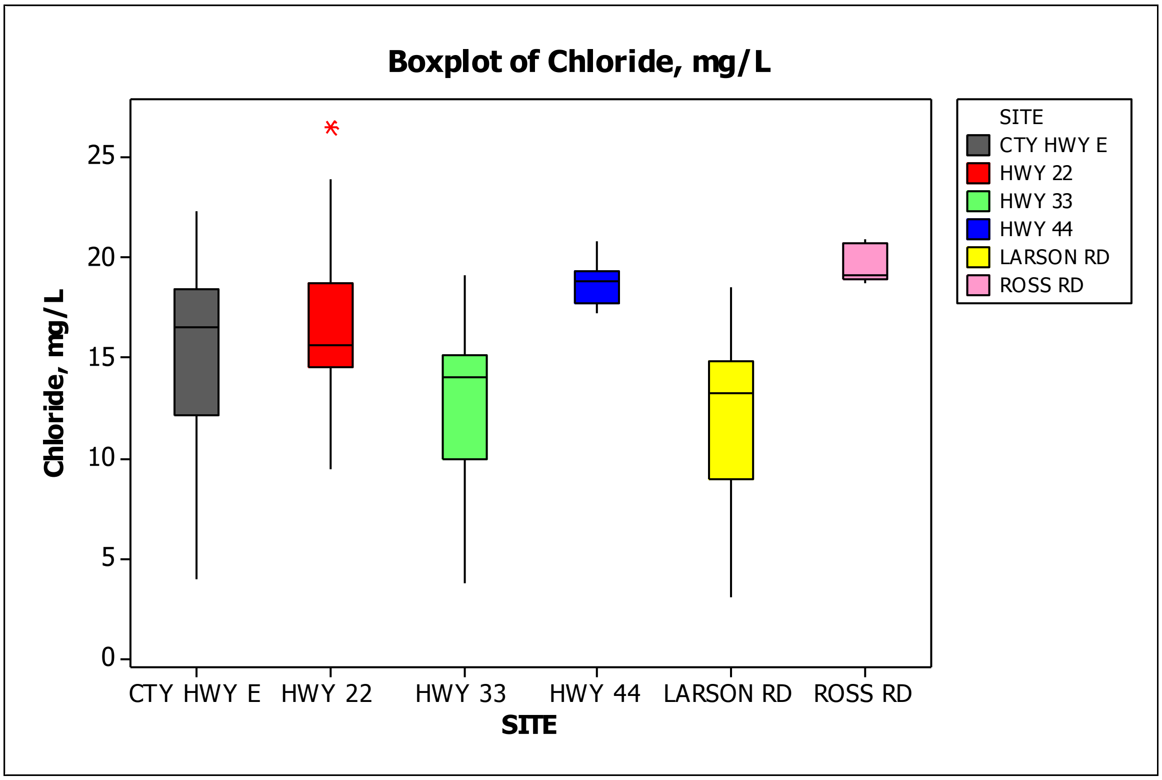
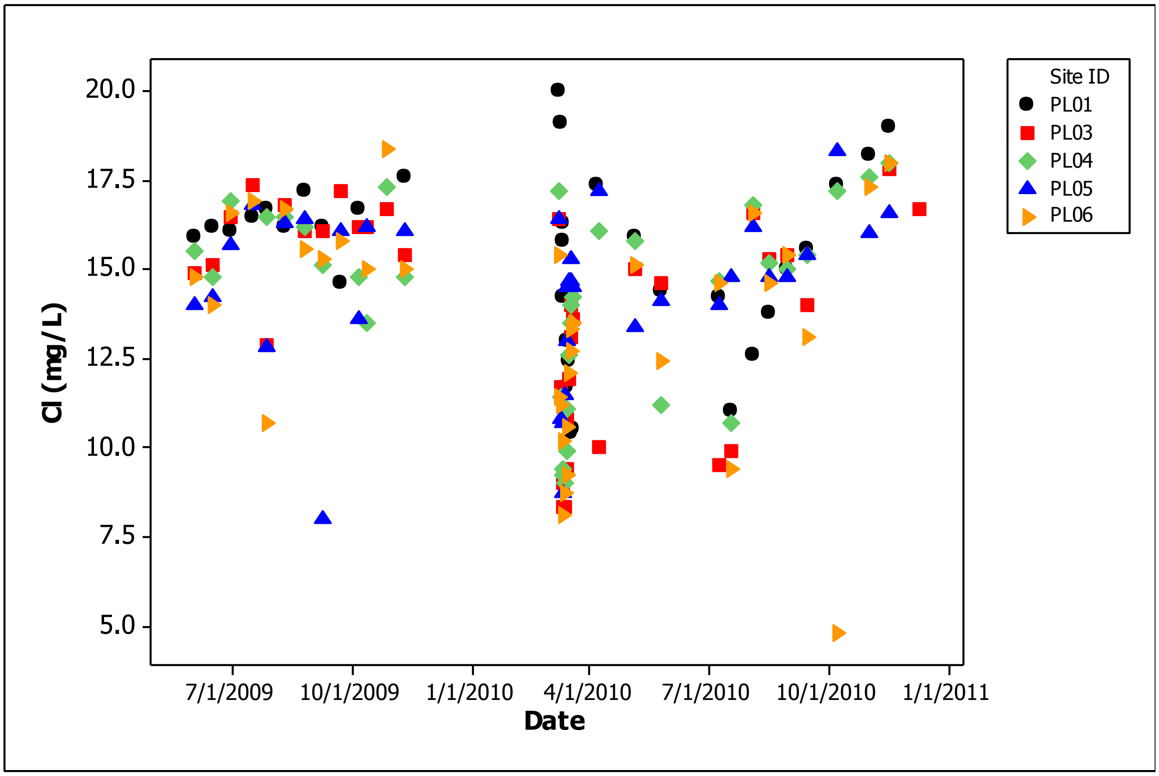


Figure B17. Park Lake Watershed Chloride Concentrations Scatter plot and Box plot (2007-2009)



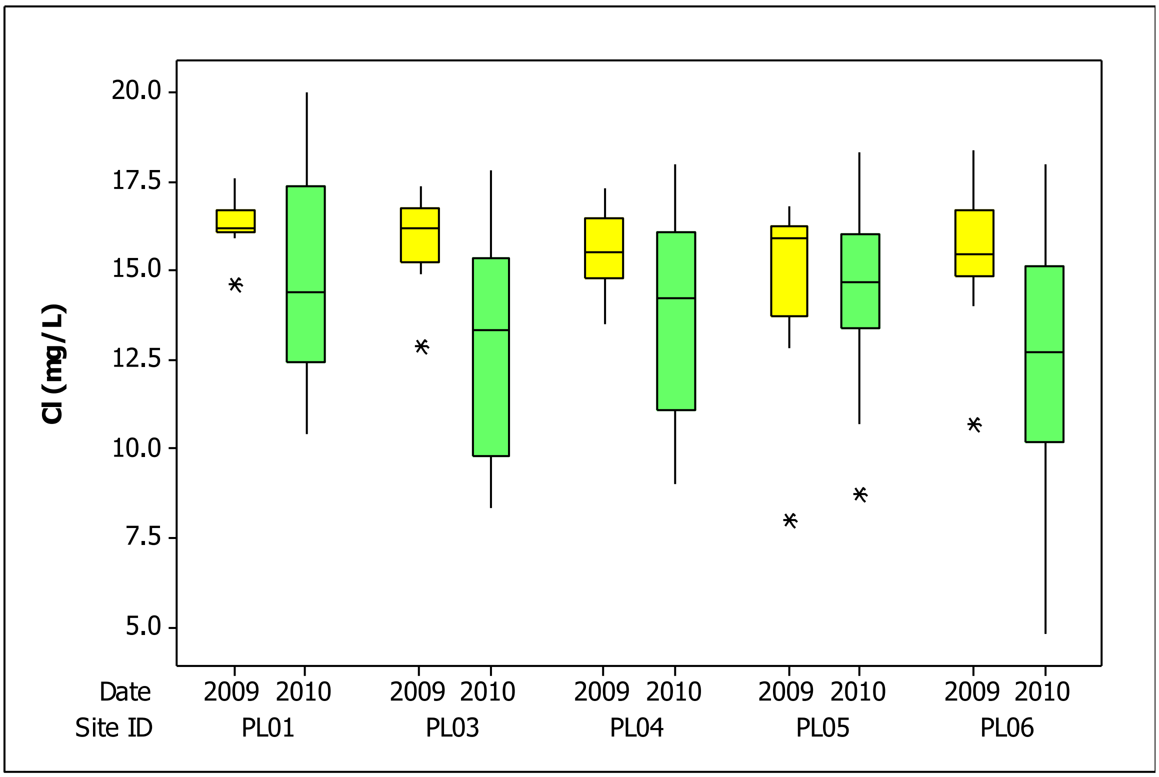
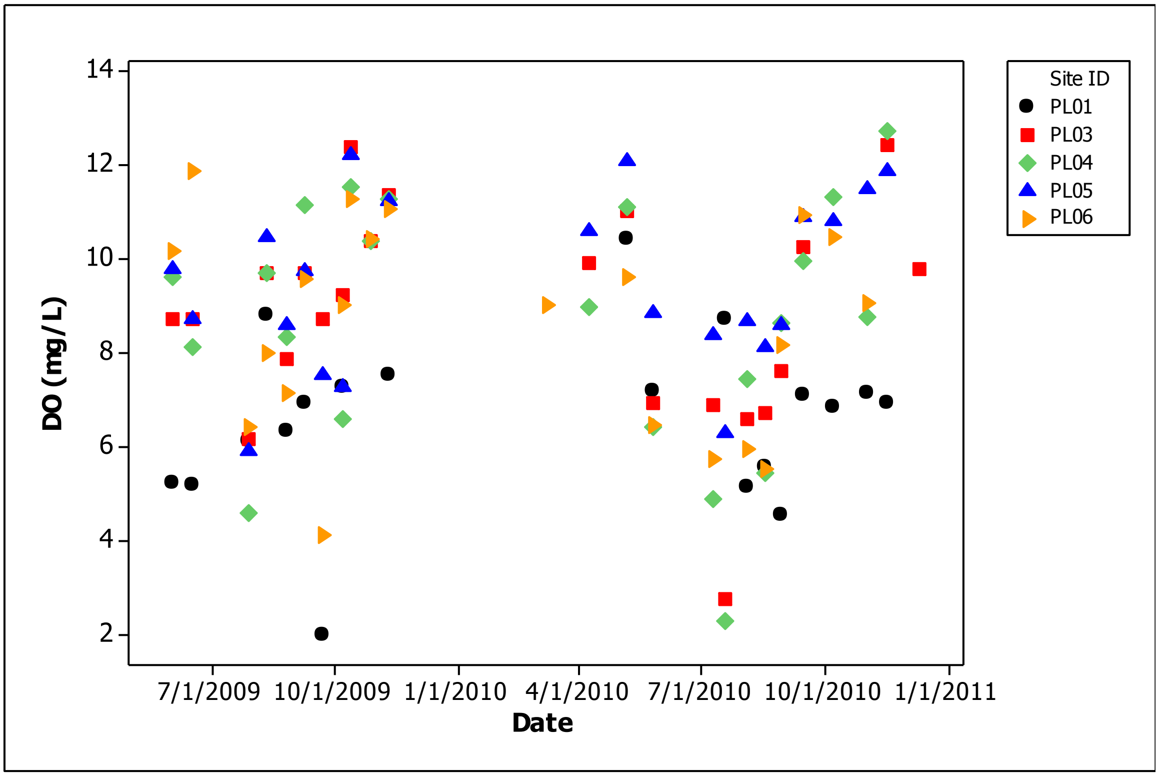


Figure B18. Park Lake Watershed Chloride Concentrations Scatter plot and Box plot (2009-2010)



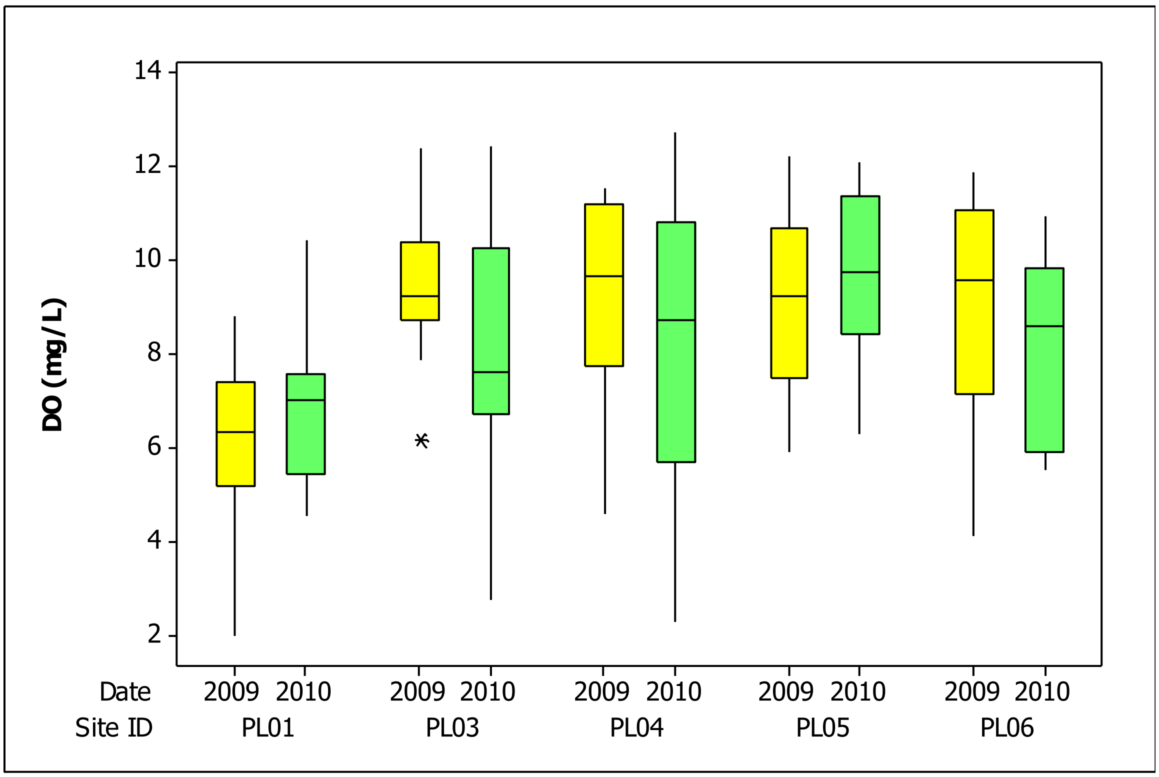
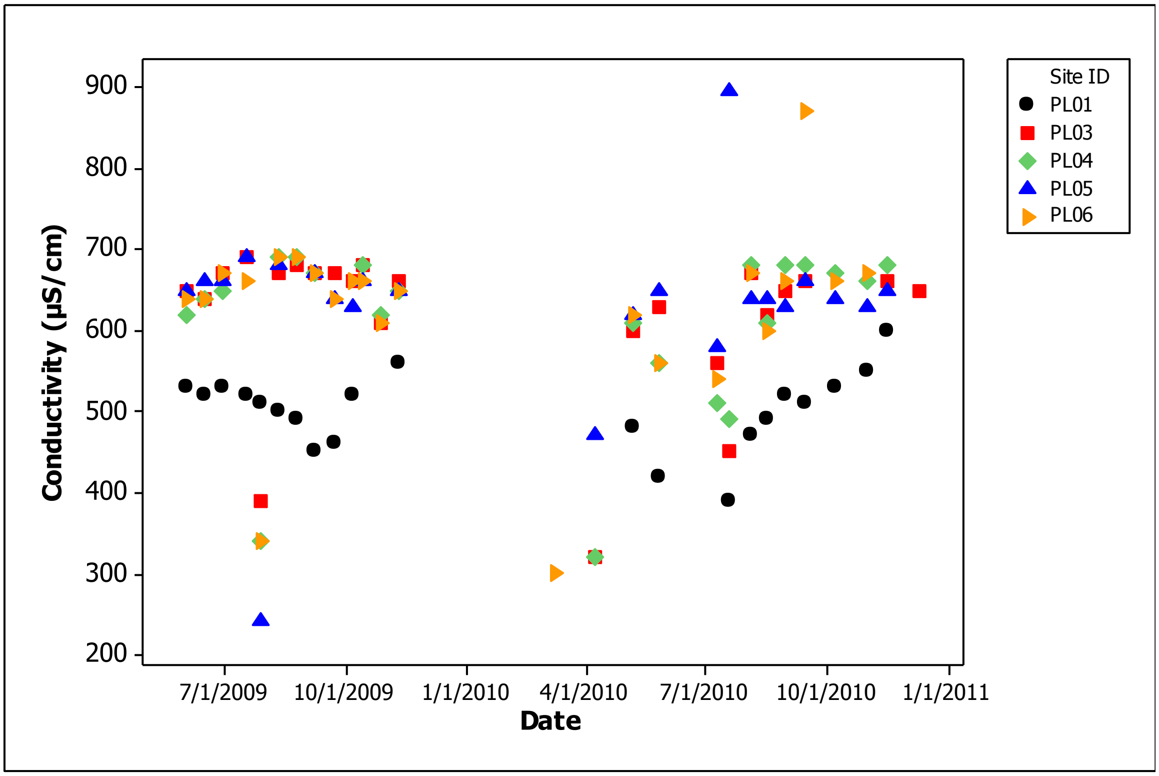


Figure B19. Park Lake Dissolved Oxygen Concentrations Scatter plot and Box plot (2009-2010)



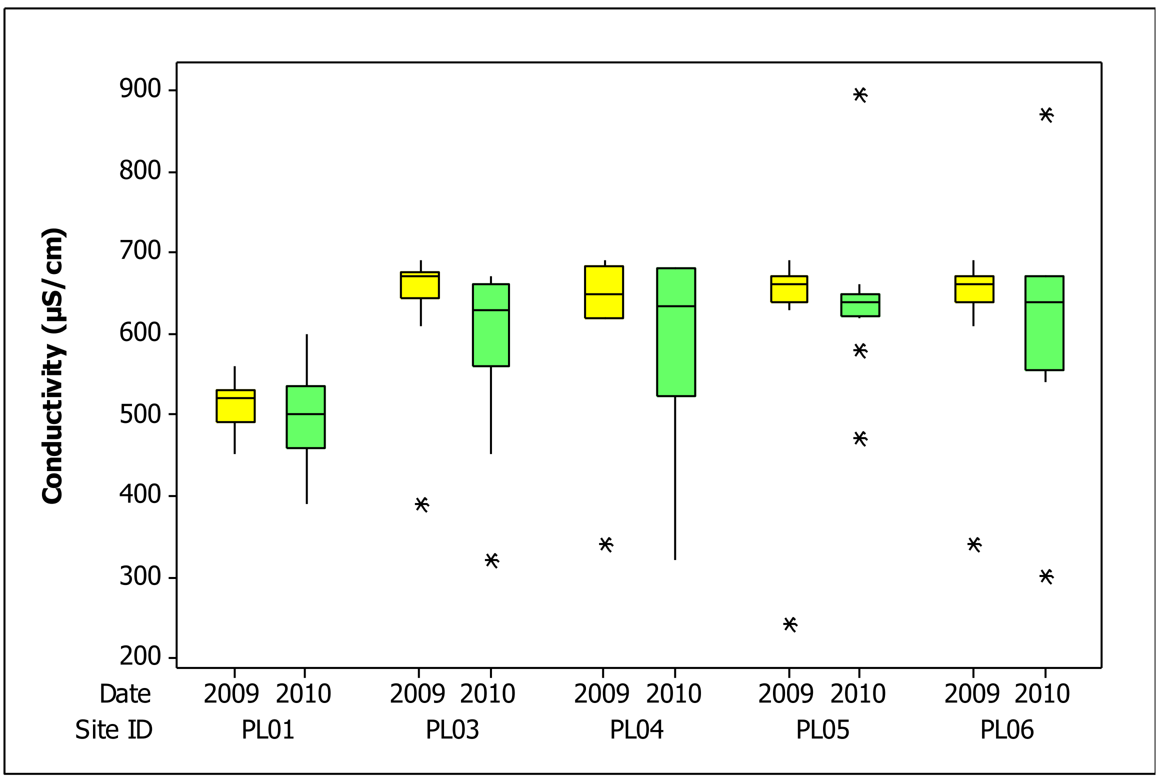
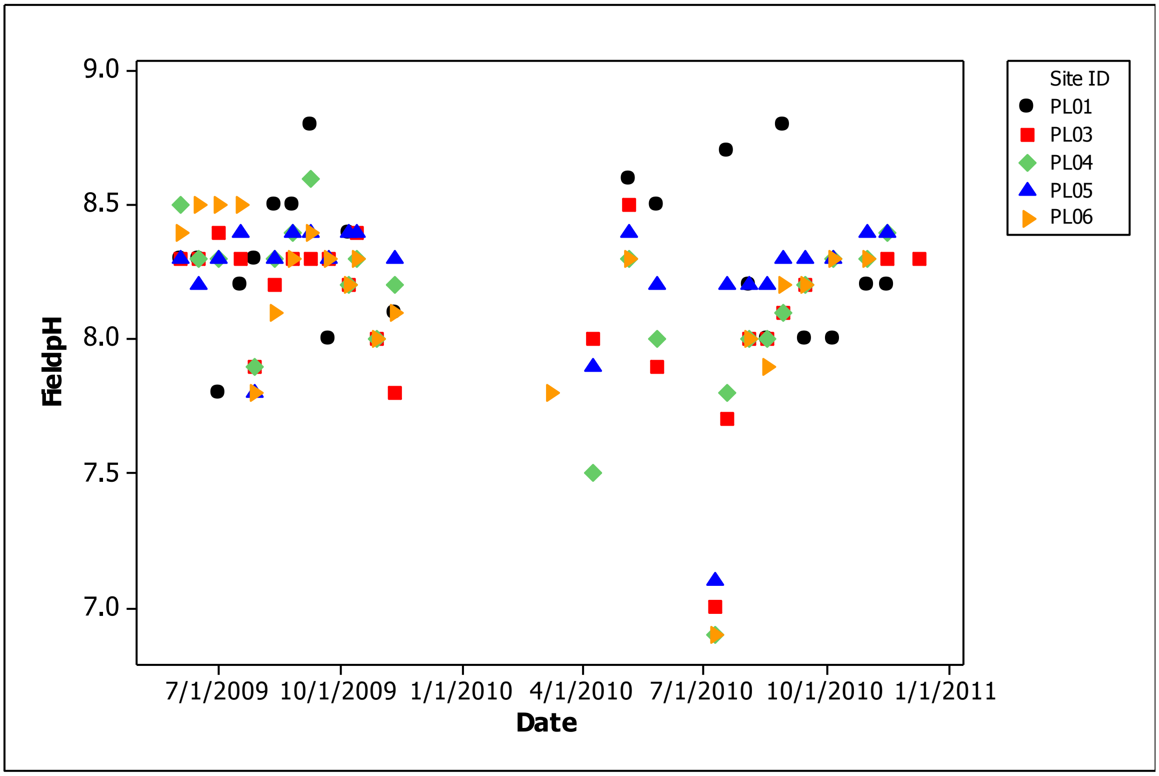


Figure B20. Park Lake Dissolved Oxygen Concentrations Scatter plot and Box plot (2009-2010)



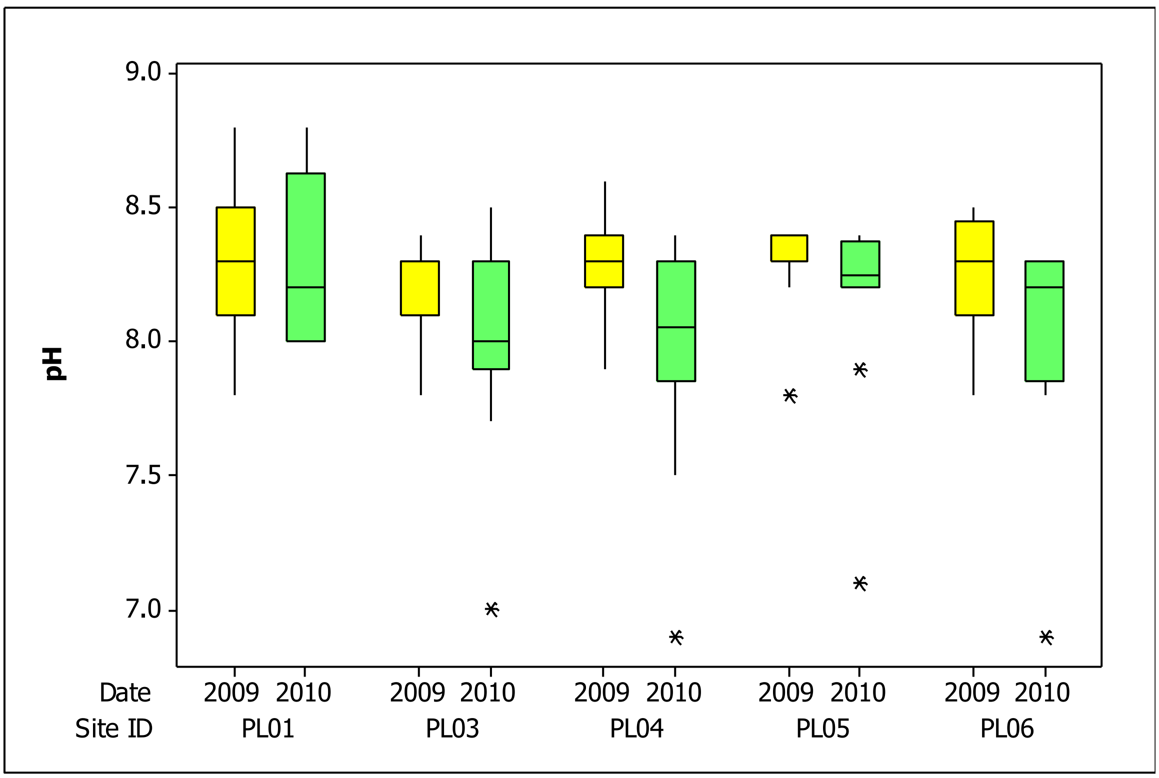


Figure B21. Park Lake pH Scatter plot and Box plot (2009-2010)

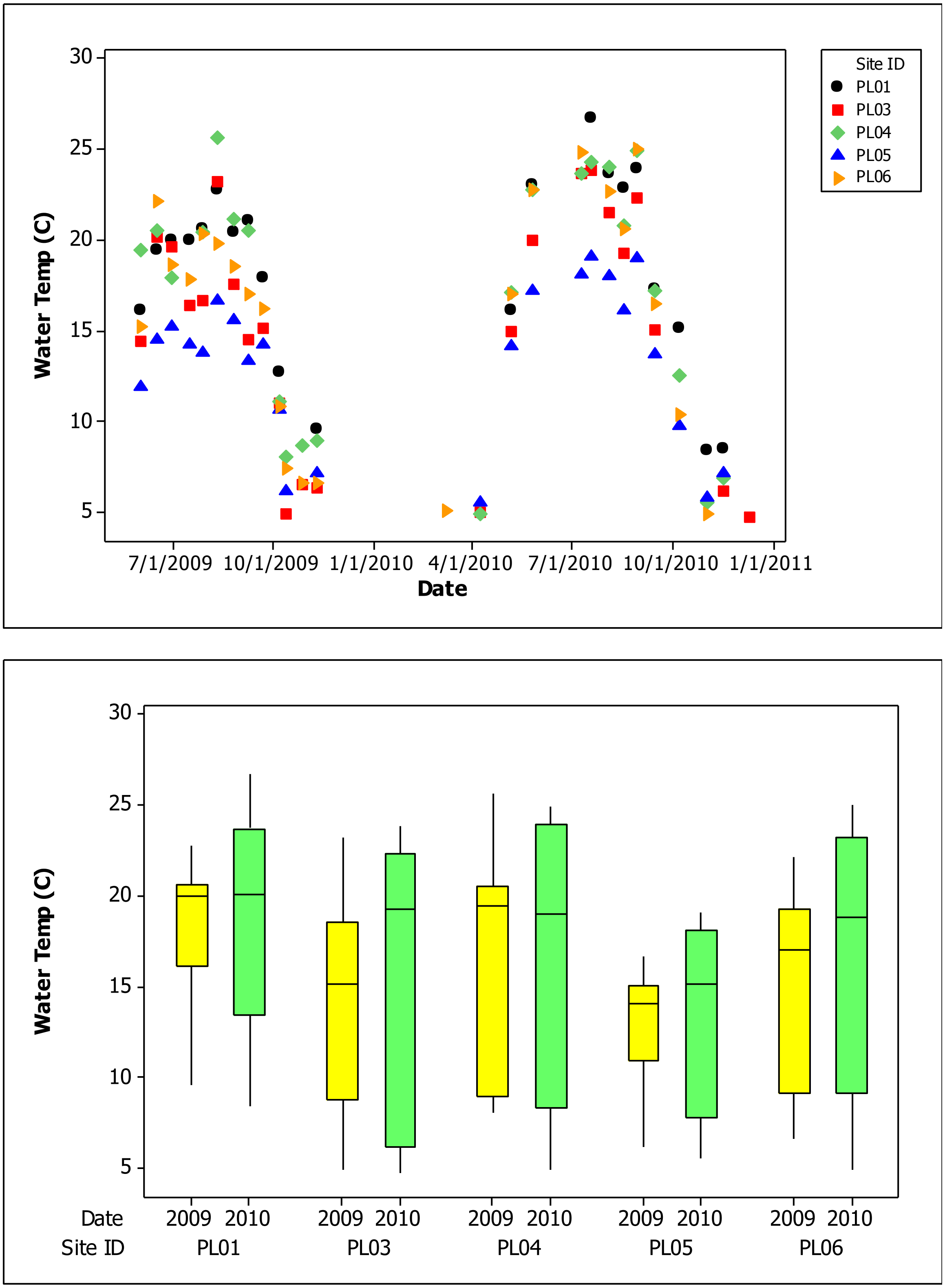


Figure B22. Park Lake Water Temperature © Scatter plot and Box plot (2009-2010)

Appendix C: Fish Data

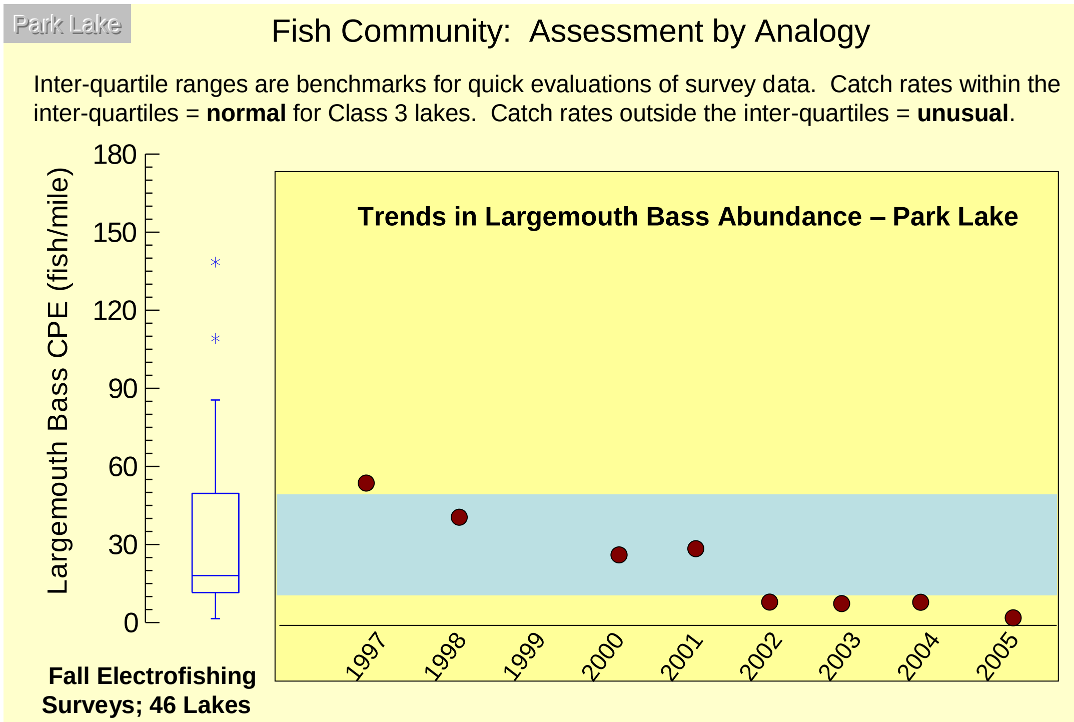


Figure C1. Trends in Largemouth Bass Abundance (1997-2006)

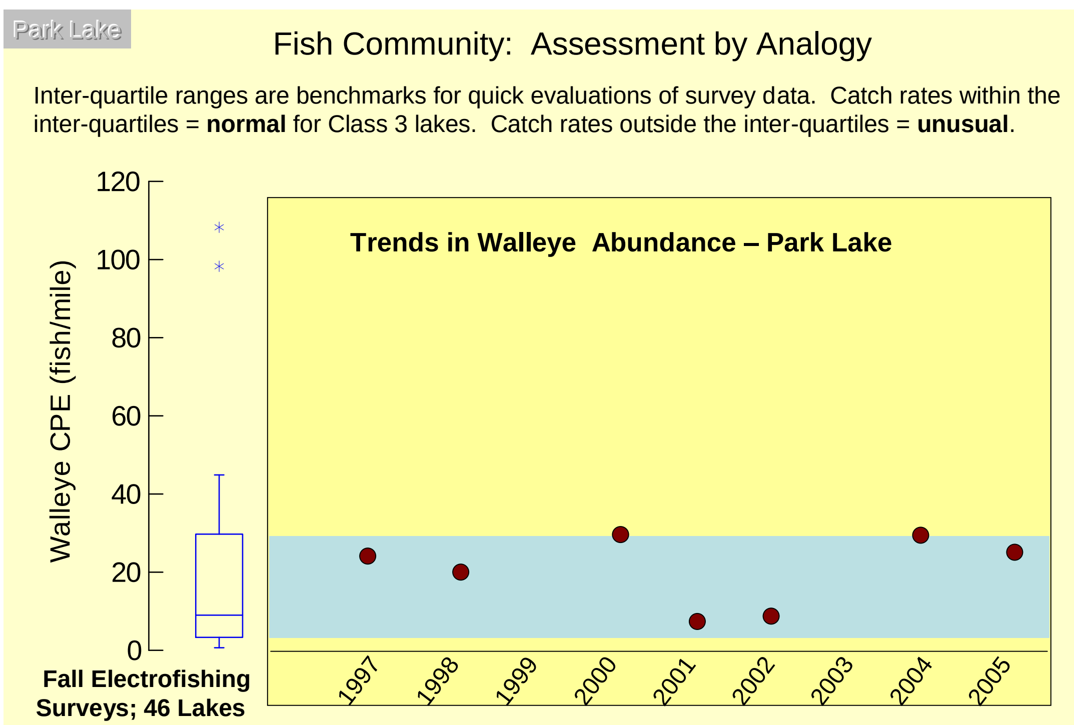


Figure C2. Trends in Walleye Abundance (1997-2005)

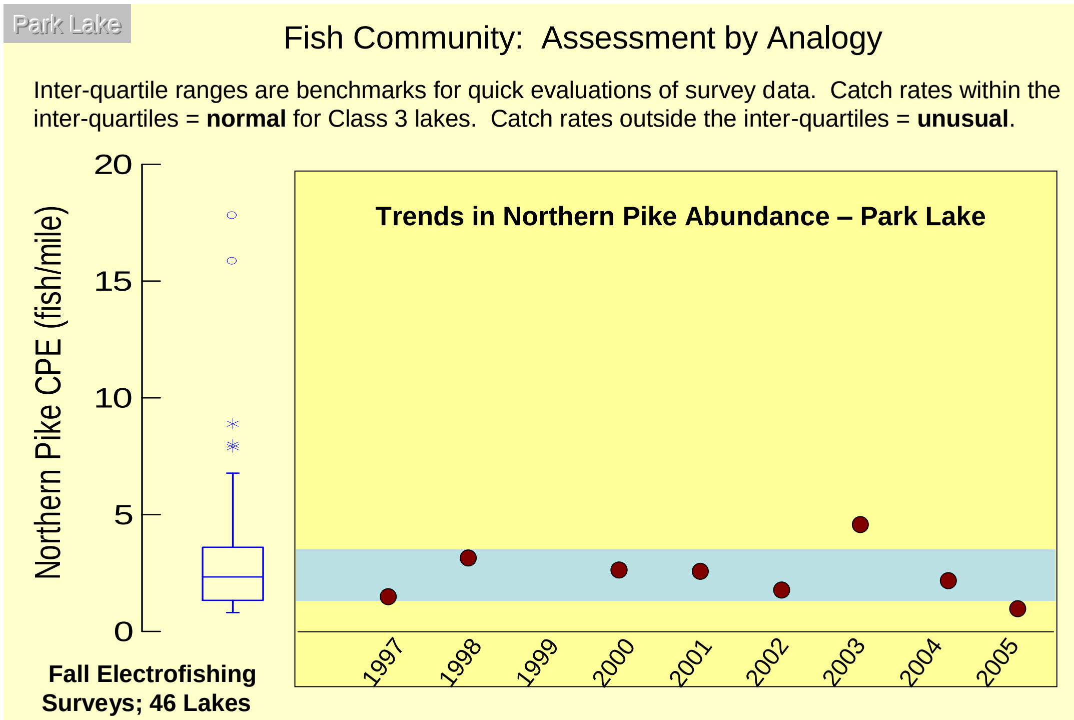


Figure C3. Trends in Northern Pike Abundance (1997-2005)

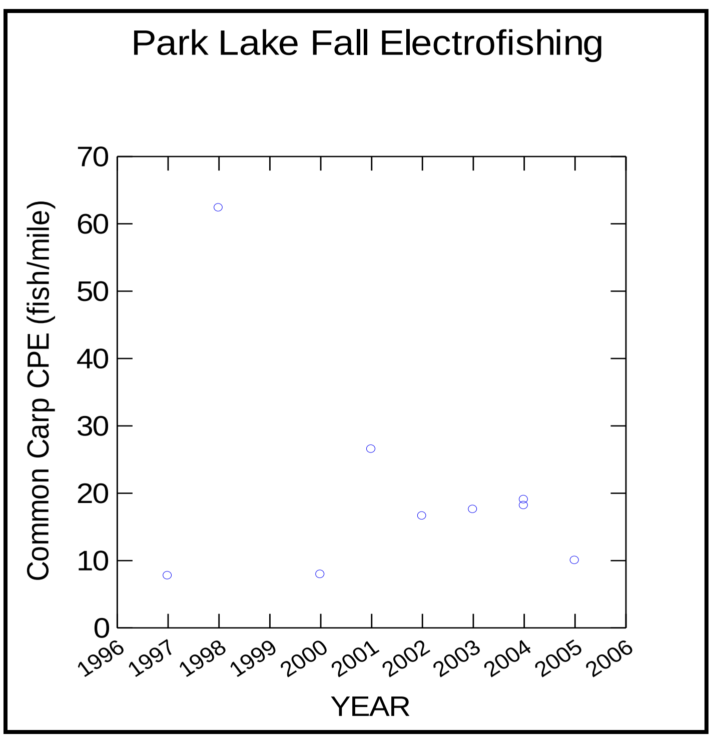


Figure C4. Common Carp Park Lake Fall Electrofishing

Appendix D: PLANT DATA

Table D1. Park Lake Aquatic Plant Species Abundance and Diversity from 1978 – 2003

Species	Common Name	1978	1998	2001	2003
Ceratophyllum Demersum	Coontail	X	X	X	
Elodea Species	Elodea	X	X		
Lemna Species	Duckweed	X			
Myriophyllum Exalbescens	Water milfoil	X			
Myriophyllum Spicatum	Eurasian water-milfoil		X	X	X
Najas Flexilis	Slender Naiad	X	X		
Nelumbo Lutea	American lotus				
Nuphar Variegata	Bull head pond-lily	X	X	X	X
Nymphea Odorata	Fragrant Water lily	X	X	X	X
Potamogeton Crispus	Curly pondweed	X	X		
Potamogeton Illinoensis	Illinois pondweed		X		
Potamogeton Nodosus	Longleaf pondweed				
Potamogeton Pectinatus	Sago pondweed	X	X		X
Potamogeton Praelongus	White stem pondweed	X			
Potamogeton Pusillus	Small pondweed	X			
Potamogeton Zosteriformis	Flatstern pondweed	X	X		
Sagittaria Species	Arrowleaf	X			
Scirpus Validus	Soft-stem bulrush	X	X	X	X
Typha Latifolia	Broadleaf cattail	X		X	X
Vallisneris Americana	Wild Celery				
Zosterella Dubia	Water stargrass				

Table D2. Algal community Species

Appendix E: PARK LAKE WATERSHED AND LAKE MODEL

Prepared by Columbia County Land and Water Conservation Department and Center for Watershed Science and Education at the University of Wisconsin-Stevens Point

A. Introduction

A watershed hydrology and nutrient export model was combined with a lake response model to better understand the relationship between Park Lake and its watershed. This report describes the development of this modeling tool and demonstrates its application.

B. Watershed Model

The watershed model was developed using the Soil and Water Assessment Tool (SWAT). SWAT is a dynamic simulation tool that models crops and hydrology in a watershed. The simulation is performed within different hydrologic response units (HRUs) The Park Lake watershed model was developed in SWAT 2005 in ArcMap Version 9.3. Figure 1 shows the subbasin delineation in the model. Table 1 summarizes the HRUs.

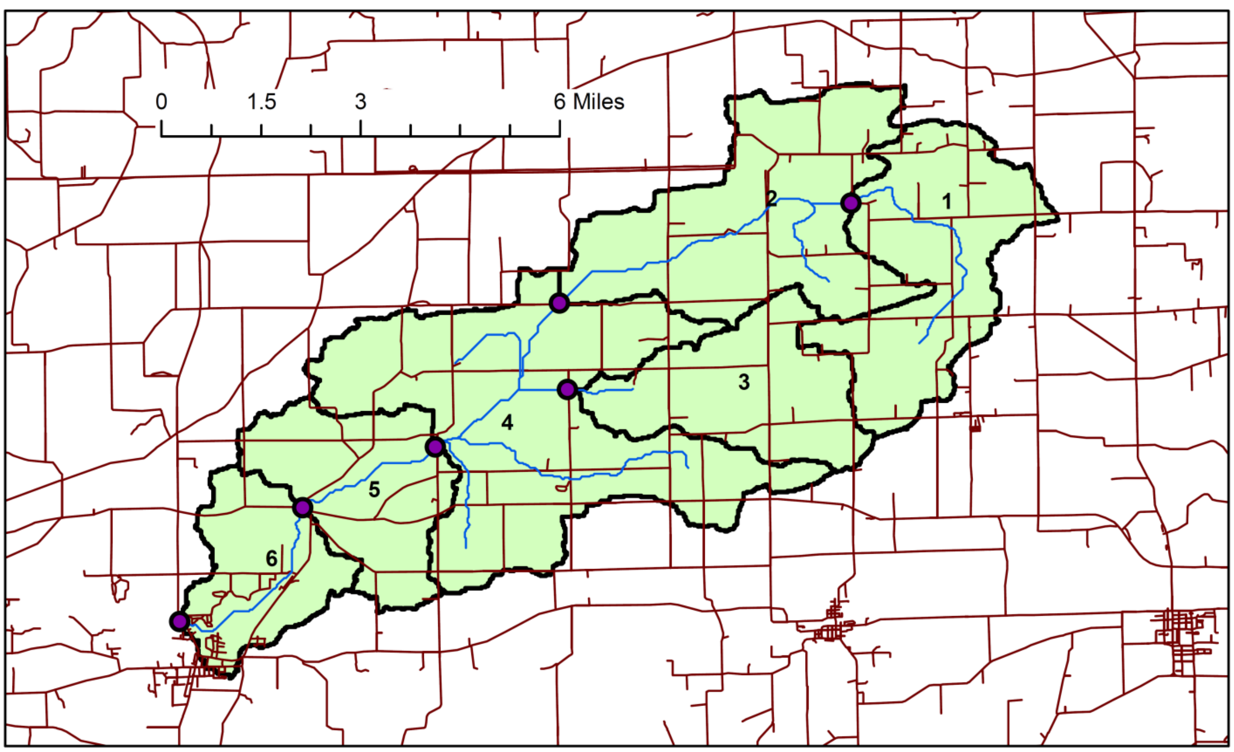


Figure E1. Park Lake Watershed model subbasin delineation

B.1. Subbasins and HRUs

The model was developed with six subbasins and 27 HRUs. Table 1 summarizes the general characteristics of these areas.

Table E1. Hydrologic Response Units in the Park Lake Model

SUB BASIN	Overall HRU #	Subbasin HRU	ACRES	SOIL	Cover/ Crop Rotation	Fraction of Sub
1			5,942			
1	**1**	1	1300	Lapper Fine Sandy Loam	Corn/Soy	0.22
1	**2**	2	1300	Lapper Fine Sandy Loam	Corn/Soy	0.22
1	**3**	3	2000	Lapper Fine Sandy Loam	Corn/Alfalfa	0.34
1	**4**	4	520	Lapper Fine Sandy Loam	Forest	0.09
2			7,190			
2	**5**	1	1200	Houghton Muck	Wetland	0.17
2	**6**	2	1000	Lapper Fine Sandy Loam	Corn/Soy	0.14
2	**7**	3	1000	Lapper Fine Sandy Loam	Corn/Soy	0.14
2	**8**	4	3000	Lapper Fine Sandy Loam	Corn/Alfalfa	0.42
2	**9**	5	850	Lapper Fine Sandy Loam	Forest	0.12
3			4,058			
3	**10**	1	1050	Plano Silt Loam	Corn/Soy	0.26
3	**11**	2	1000	Lapper Fine Sandy Loam	Corn/Soy	0.25
3	**12**	3	1000	Lapper Fine Sandy Loam	Corn/Alfalfa	0.25
3	**13**	4	750	Lapper Fine Sandy Loam	Forest	0.18
4			10,113			
4	**14**	1	1,716	Houghton Muck	Wetland	0.17
4	**15**	2	950	Lapper Fine Sandy Loam	Forest	0.09
4	**16**	3	3750	Lapper Fine Sandy Loam	Corn/Soy	0.37
4	**17**	4	1000	Lapper Fine Sandy Loam	Corn/Soy	0.10
4	**18**	5	1750	Lapper Fine Sandy Loam	Corn/Alfalfa	0.17
4	**19**	6	1000	Lapper Fine Sandy Loam	Corn/Soy	0.10
5			3790			
5	**20**	1	750	Lapper Fine Sandy Loam	Corn/Alfalfa	0.20
5	**21**	2	750	Lapper Fine Sandy Loam	Corn/Soy	0.20
	22	3	750	Lapper Fine Sandy Loam	Corn/Soy	0.20
5	**23**	4	1250	Lapper Fine Sandy Loam	Forest	0.33
6			3351			
6	**24**	1	500	Lapper Fine Sandy Loam	Urban	0.15
6	**25**	2	1050	Lapper Fine Sandy Loam	Corn/Soy	0.31
6	**26**	3	1050	Lapper Fine Sandy Loam	Corn/Soy	0.31
6	**27**	4	600	Lapper Fine Sandy Loam	Forest	0.18

B.2. Watershed Input Data

The objective of this modeling was to develop a relatively simple simulation tool for the Park Lake watershed yet include some differences between the hydrologic response units to distinguish the effect of different land uses. Most of the parameters used in the watershed model were based on default values in the SWAT model. Several adjustments were made to more closely match the measured flow and concentration.

The forested and wetland areas were simulated using default land management in SWAT2005. The agricultural rotations were simulated as either a corn and soybean rotation or a dairy rotation with two years of corn, a year of soybeans and four years of alfalfa. The dairy rotations were staggered in the watershed so that the beginning year in the rotation (Corn, soybean or alfalfa) varied throughout the watershed. The urban management assumed medium density residential (38% impervious / 30% directly connected).

The soils in the watershed were all classified as hydrologic soil group B with a surface saturated infiltration rate of 4.7 inches/hour.

Daily precipitation and temperature for the simulation was obtained from the Portage, WI (NCDC website). Missing temperature was estimated by averaging days before and after.

C. Lake Model

The lake model used the watershed daily flow and phosphorus export as inputs to a daily time-step lake model that used a mass balance to simulate a daily phosphorus concentration. The model accounted for the mass entering the lake from the watershed, the mass leaving the lake in the outflow, the mass settling in the lake and the mass released to the lake from the sediment and P. crispus decay. The model was a simplified representation of the lake in that it assumed the lake was completely mixed and the sedimentation rate (10 m/yr) was constant during the year. The daily mass in to the lake was based on the SWAT model simulation, the mass out of the lake was based on the daily flow into the lake and the concentration of phosphorus simulated in the lake. The sediment and plant release was assumed to occur during the summer. Sediment release was simulated to occur at the summer rate (5 mg/m2/d) from June through August and then at a reduced rate (0.5 mg/m2/d) during the remainder of the year. P. crispus release of phosphorus (35 mg/m2/d) was based on an estimated plant density and was assumed to occur only from a portion of the lake during the first ten days of July.

Results

D.1. Watershed Simulation

The results of the watershed simulation are shown in Figures 2, 3 and 4 for three monitoring locations within the watershed. The model was able to capture the general pattern of flow and total phosphorus concentration for periods of relatively high flow.

The model underestimated the total phosphorus concentration during the low flow summer period in subbasin 2 and subbasin 4. The flashier subbasin 3 did not exhibit the increased summer phosphorus concentrations and was more accurately simulated. While these elevated summer phosphorus concentrations may require more study, they were found during periods of relatively low flow and are not likely to be periods of large phosphorus export from the watershed.

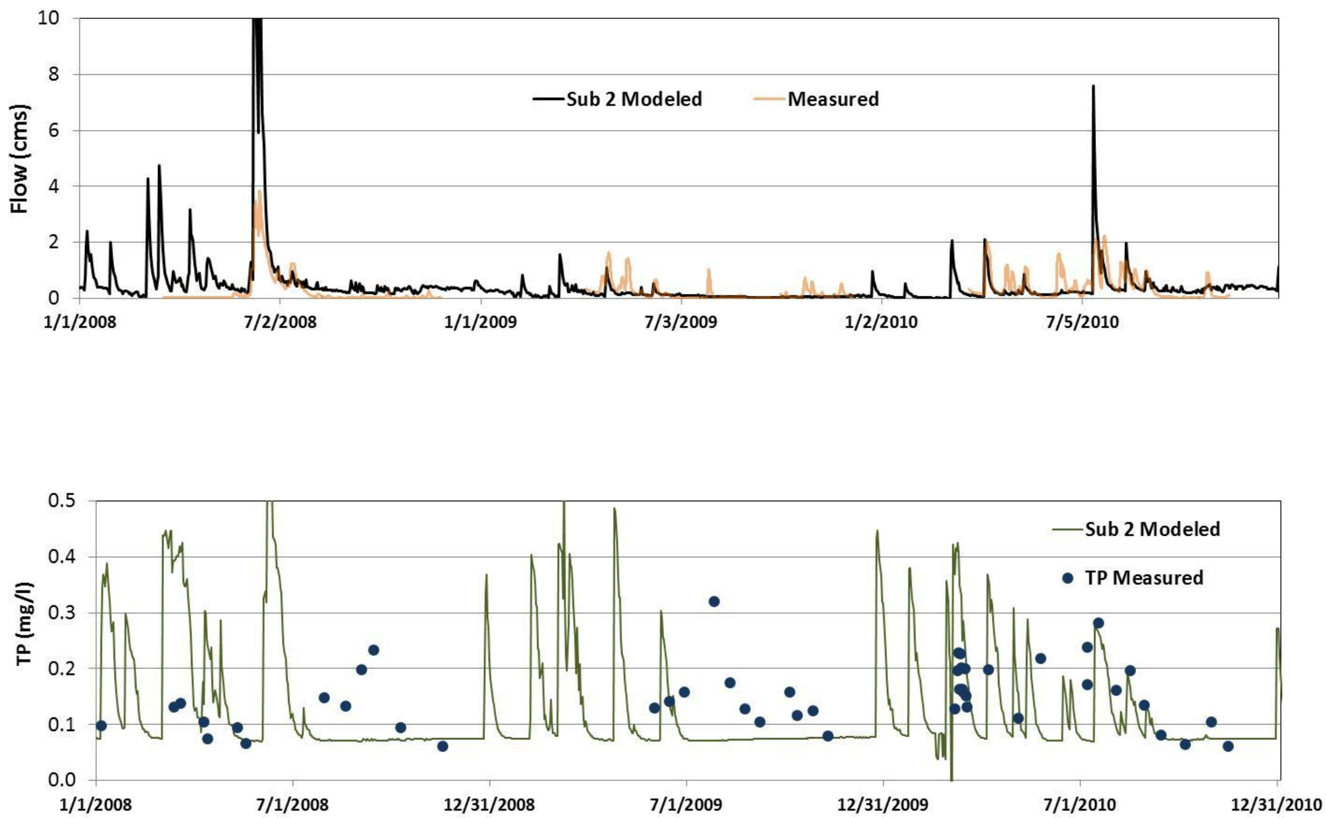


Figure E2. Measured and modeled flow (above) and total phosphorus (below) for Subbasin 2 (Cnty Hwy E).

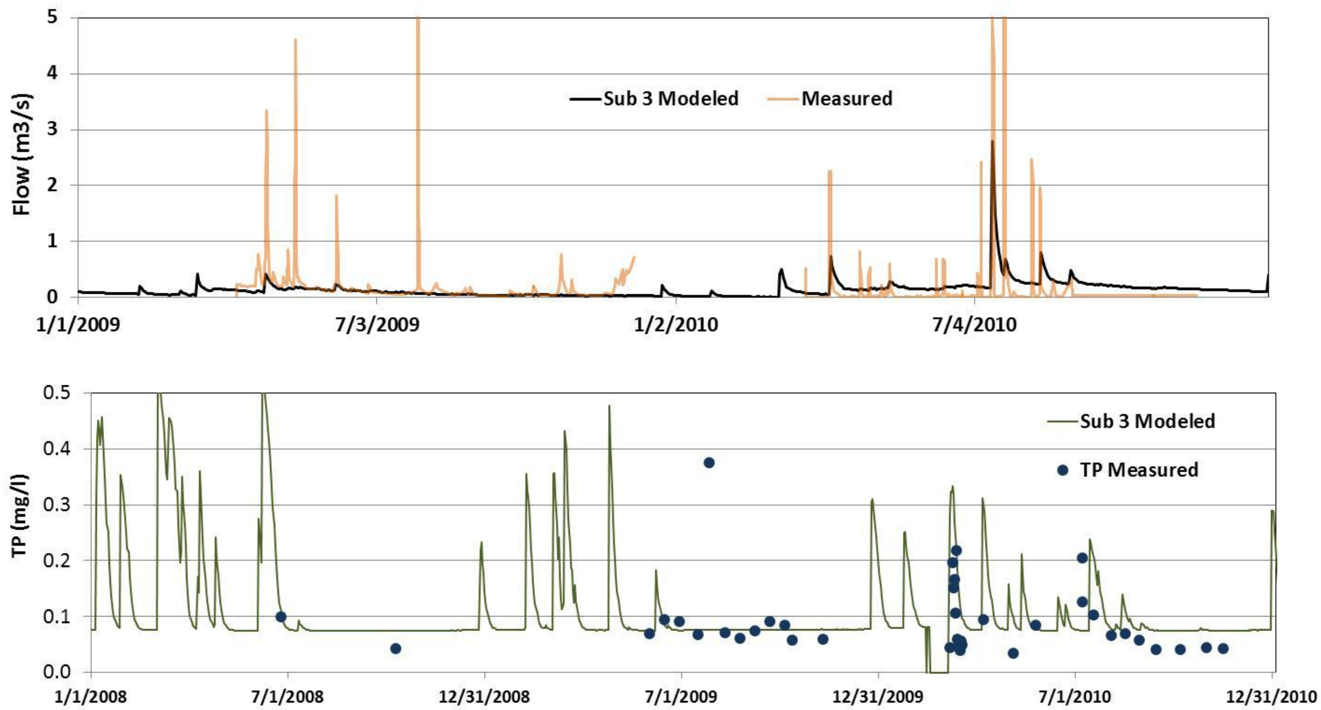


Figure E3. Measured and modeled flow (above) and total phosphorus (below) for Subbasin 3 (Larson Road).

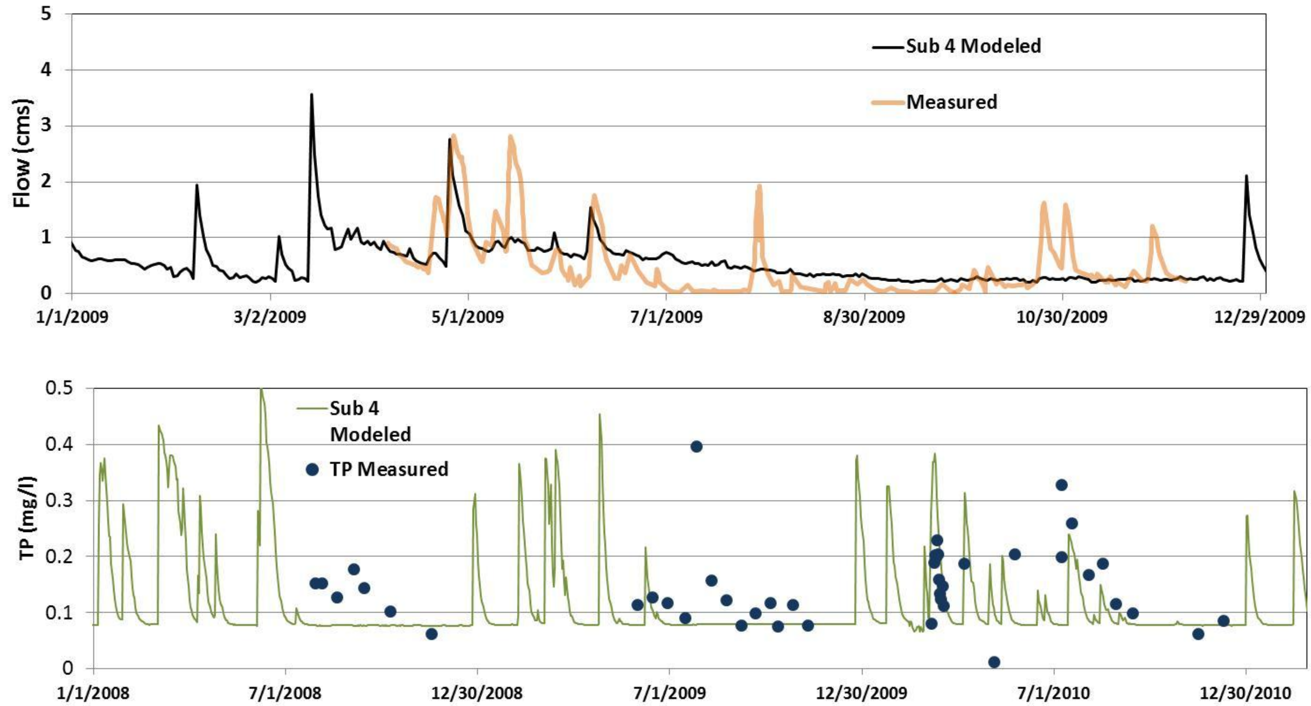


Figure E4. Measured and modeled flow (above) and total phosphorus (below) for Subbasin 4 (Hwy 44).

D.2. Lake Model Results

The results of linking the watershed model with the lake model are shown in Figure 5. The model simulates some of the variation in phosphorus concentration found in Park Lake, particularly during high flow periods such as the summer of 2008.

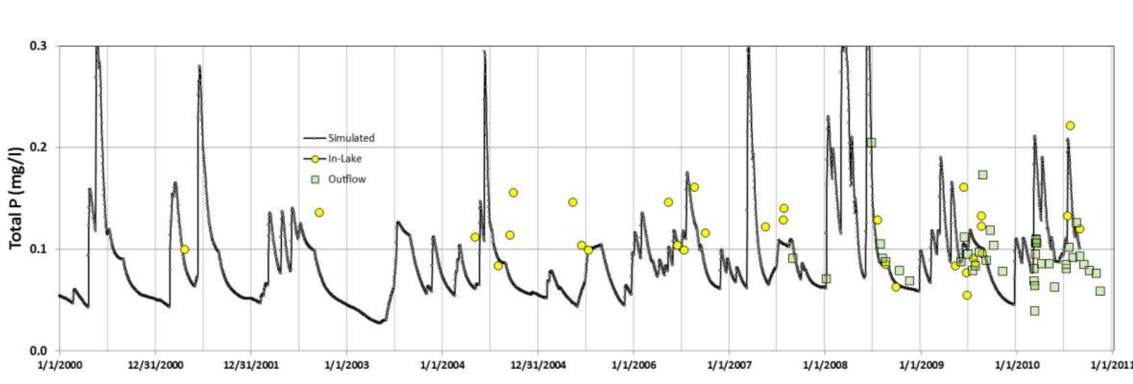


Figure E5. Simulated (line) and measured total phosphorus concentrations in Park Lake.

C. Load and Concentration Analysis

The watershed/lake model was used to estimate the growing season load and average concentration in the lake over time. The average of the growing season mean total phosphorus from 1996 through 2011 is 0.097 mg/l. The average growing season phosphorus load is 2,815 kilograms. A significant fraction of this load was estimated to have occurred in 2008. The median growing season phosphorus load over this period was 1,853 kilograms.

The relationship between phosphorus load and phosphorus concentration is complex because the concentration in the lake reflects the volume of incoming flow in addition to the quantity of phosphorus. To estimate the reduction in phosphorus load necessary to achieve lower concentrations in the lake, we assigned a reduction fraction to the phosphorus load and did not reduce the flow. The change in the mean growing season phosphorus concentration that would result from a reduction in the external phosphorus load is shown in Figure 8 below. In this calculation, the flow the lake is assumed to stay constant each day but the phosphorus mass in the streamflow is lowered by the percentage shown.

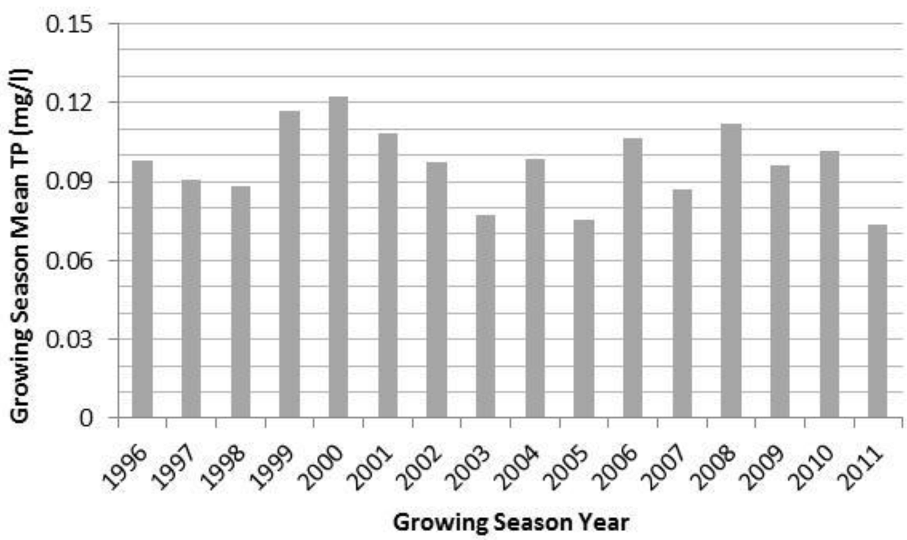


Figure E6. Average growing season total phosphorus in Park Lake from average of daily simulated values in the lake model from May through October.

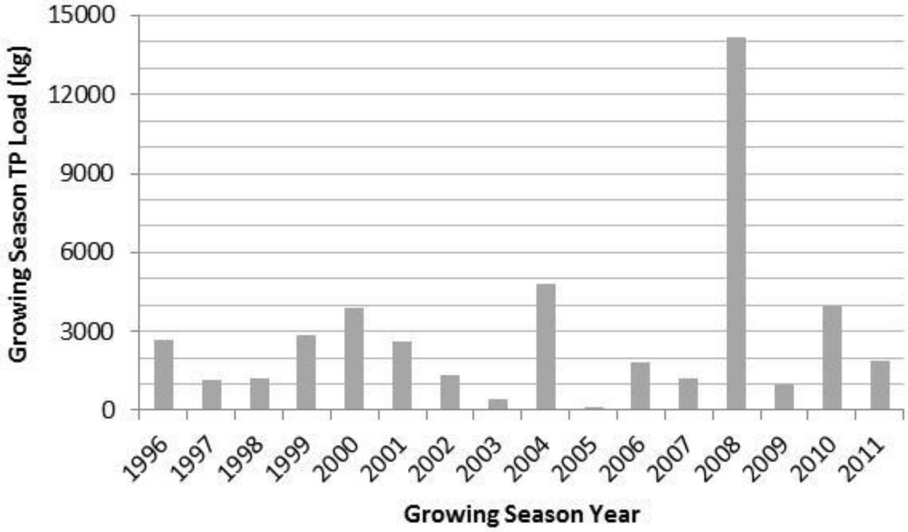


Figure E7. Growing season total phosphorus load to Park Lake from the daily simulated watershed model.

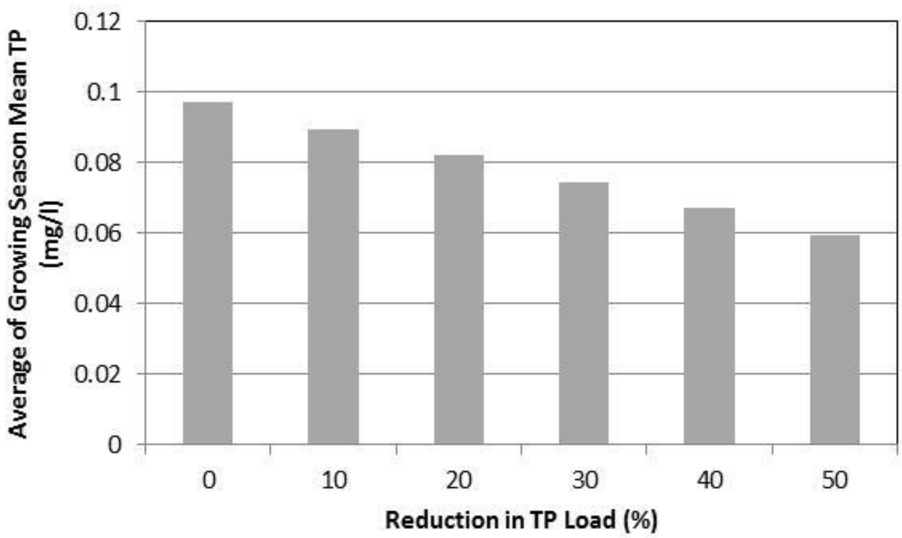


Figure E8. Projected average of the growing season mean total phosphorus concentrations projected with a reduction in the external phosphorus load to the lake.

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