Barton Creek Surface Water Algae Update 2006
SR-07-09

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Physical, chemical and algae transect data were assessed in Barton Creek during baseflow conditions for spatial and temporal trends. This update examines data collected by the City of Austin since 1993 with United States Geological Services data included (where available) for longer periods of record. Statistical differences in nitrate concentrations between downstream, urbanized sites compared with rural upstream sites correspond to increases in the frequency and percent cover of nuisance alga. Temporal decreases in dissolved oxygen concentrations appear in the midsection of Barton Creek. Temporal increases in conductivity are evident in upstream sites and downstream of Barton Springs Pool.

Introduction

Barton Creek is a large waterway flowing through Travis and Hays counties in the Central Texas hill country that discharges into Town Lake in Austin, Texas. The Barton Creek watershed encompasses 120 square miles, 8 of which are in the recharge zone of the Barton Springs segment of the Edwards Aquifer (BSEA) and 112 are in the contributing zone. (Santos Loomis and Associates 1995). The creek is a gaining waterway in the upstream section and losing (recharging) waterway in the downstream sections. The aquifer is vulnerable to pollution due to the large number of recharge features that allow for rapid transmittal of water from the surface to the aquifer and then discharge directly to the springs associated with the system (Barton, Cold, Eliza Old Mill and Upper Barton) (City of Austin 1997)

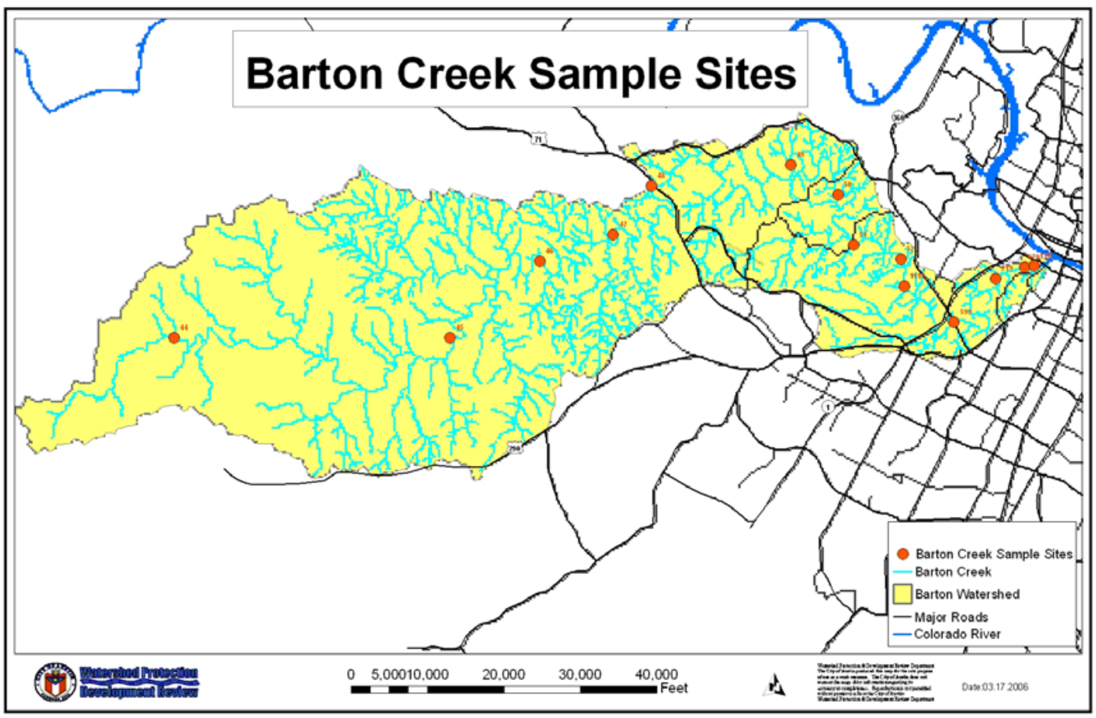

Figure 1. Barton Creek watershed illustrating sampling sites

The City of Austin (COA) Environmental Resource Management (ERM) has a monitoring program for surface water in Barton Creek. This program was initiated in 1990 due to concerns about rapid watershed development. The United States Geological Service (USGS) has been monitoring water chemistry on Barton Creek since the 1970s and that data has been included in this analysis where available.

Monitoring of surface water quality includes chemical, physical and biological parameters in the perennial pools on the Barton Creek mainstem. Previously the monitoring concentrated on Barton Creek west of Edwards Aquifer recharge zone (COA, 1997). In year 2000, several sites in the recharge zone were added to the surface water monitoring to fully represent waters entering Town Lake and those used for recreational purposes by the citizens of Austin.

Site Selection

The study area initially included 9 relatively undeveloped rural plus increasingly urbanized reaches of Barton Creek from the headwaters to just downstream of the recharge zone at Barton Creek greenbelt. (COA 1997) For extensive discussion of the site selection method see the Barton Creek Report published by the City of Austin in 1997.

In 2000, we added 4 sites in the recharge zone that include Barton Creek at Loop360 #599, Campbell's Hole #219, a site above Barton Springs Pool #879, and a site below Barton Springs Pool #178 to give a total of 13 sites. Barton Creek at Backdoor Spring #1111 was monitored for a total of 3 years. Although some of these added sites may show temporal trends they cannot be compared to other sites with a period of record that includes far more sufficient seasonal and weather variations.

Sampling Protocol

COA Water chemistry samples were collected during baseflow conditions in the 13 sites quarterly. Physical parameters were measured with various Hydrolab multi probe instruments. Flow was measured using a Marsh McBirney Flomate 2000. Standard collection methods according to TCEQs Surface Water Quality Monitoring Procedures Manual (2003) were employed.

Chemical analyses were performed in accordance with Standard Methods for the Examination of Water and Wastewater or in an EPA approved laboratory. USGS sampling protocol for collection of chemical and physical parameters are described in U.S. Geological Survey, 20006, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.

Methods

Analysis was performed using Statistica v6.0, non parametric 2 tailed independent variable Kruskal wallis anova, for analyses between sites. Linear regressions were used for temporal analyses. Confidence limits were 5% or less for all analyses.

Monitoring Results

Monitoring results were evaluated graphically and statistically for parameters of flow, nutrient concentrations, dissolved oxygen concentration and algae percent cover from transect data.

Flow in Barton Creek

Linear regressions were performed using USGS flow gage measurements at sites #48 (Barton Creek at Highway 71), #51 (Barton Creek at Lost Creek) and #599 (Barton Creek at Loop 360). These analyses yielded no statistically significant trends in the annual mean, annual median or daily means in flow.

Nutrients in Barton Creek

Nitrite nitrogen is rapidly converted to nitrate, so the combination of these two parameters was measured. Orthophosphous also is primarily dissolved phosphorus.

Nitrate/ Nitrite as Nitrogen

Analyses for nitrate/nitrite include both USGS and City of Austin (COA) baseline data. Figure 2 illustrates temporal nitrate/nitrite values. There are no statistically significant increases. Two sites, Barton Creek Above Pool #879 and Below Pool #178 show increasing trends; however, these are not statistically significant. Loop 360 #599 shows a statistically significant decrease in nitrate/nitrite concentrations.

As is illustrated below in Figure 3, nitrate/nitrite concentrations are low in the upstream headwaters sites, and increase substantially as you move downstream. An increase in value is indicated at site# 48, Highway 71, measured downstream of a confluence with a large tributary (Little Barton Creek). Nitrate/nitrite values decrease in the 2 following sites, where Barton Creek flows through a Nature Conservancy property and several large private properties. An increase is again indicated at Lost Creek #51, which is downstream of several tributaries, golf courses and residential inputs. Site # 52 is located in the Barton Creek greenbelt, the site is surrounded by acres of woods, left in a natural state, and this site shows a decrease in nitrate/nitrite concentrations. Large increases in nitrate/nitrite are observed in sites downstream of Loop 360. High between site variations in concentrations suggest a correlation between land use and water quality. Spring inputs and anthropogenic affects caused by urbanization are most likely the source of this increase in concentration. Nonparametric multiple comparison tests using the data illustrated in Figure 3 indicate that sites # 44,45,46,47, 49, have no statistical difference. Site #48 is statistically different from all other sites monitored, nitrate values are higher than the headwater sites (graphically illustrated in Figure 4), lower than the downstream sites and higher than site #52. Sites #879 and #178, upstream and downstream of Barton Springs Pool, are statistically different from all sites except each other. Both are heavily influenced by the large Barton and Upper Barton springs, and both can on occasion be considered spring flow only. Sites #51and #599 are statistically different from all sites except for each other. Site #599 (Loop 360) has along history of going dry during the summer months.

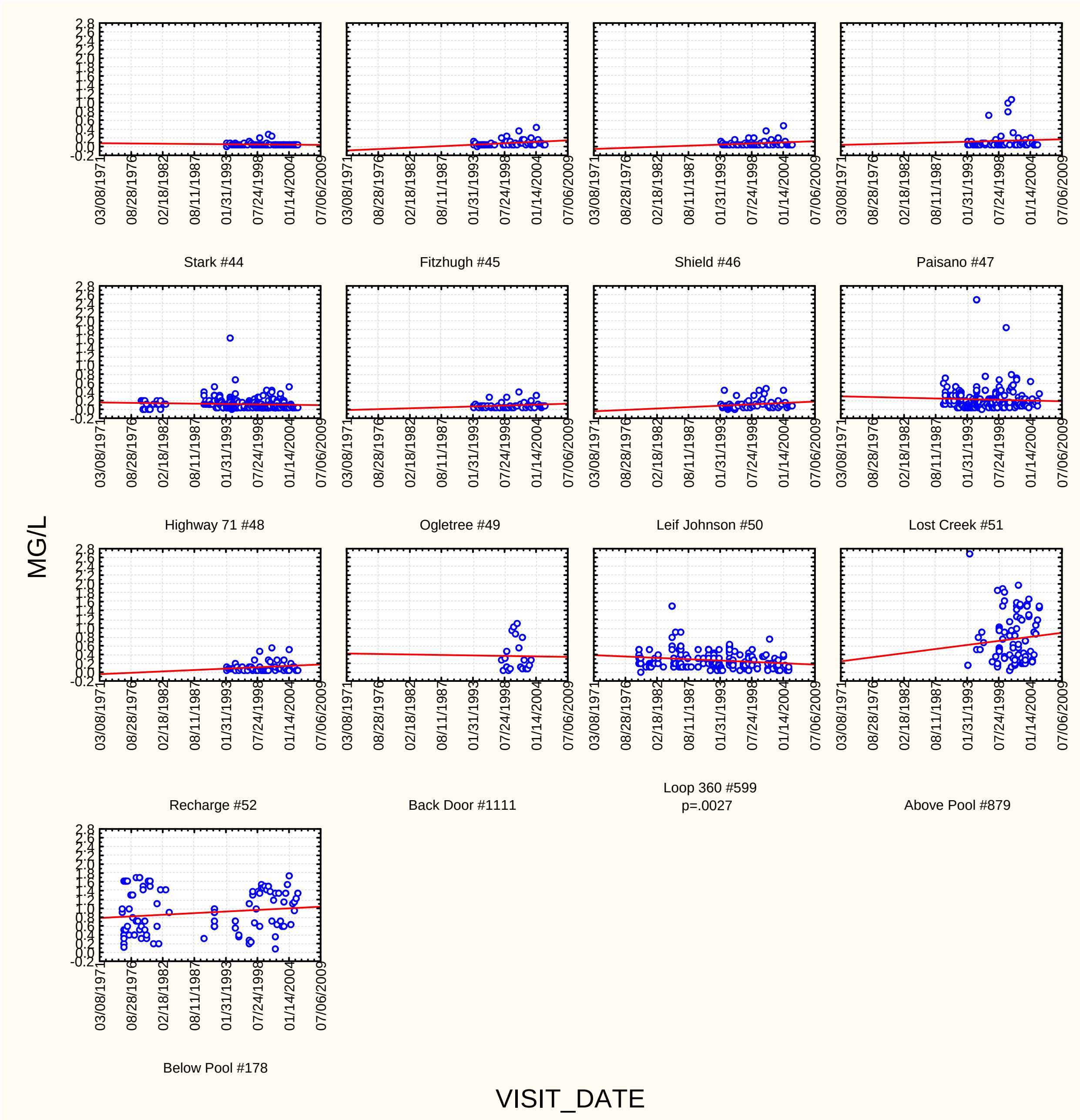

Figure 2. Temporal regressions of nitrate concentrations in Barton Creek 1976-2005

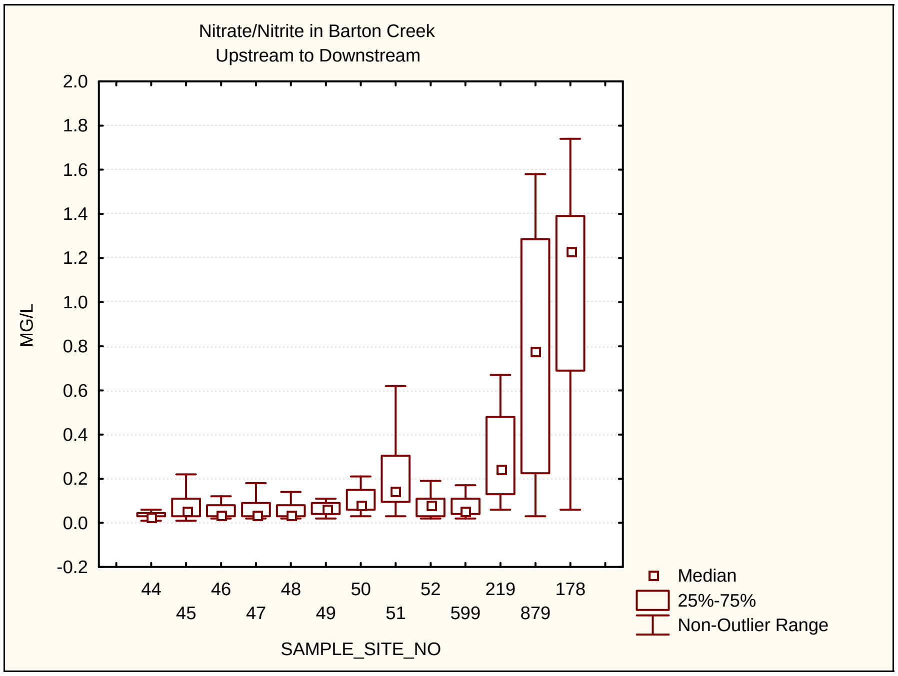

Figure 3. Nitrate/ Nitrite mean concentrations in Barton Creek from upstream to downstream 1976-2005

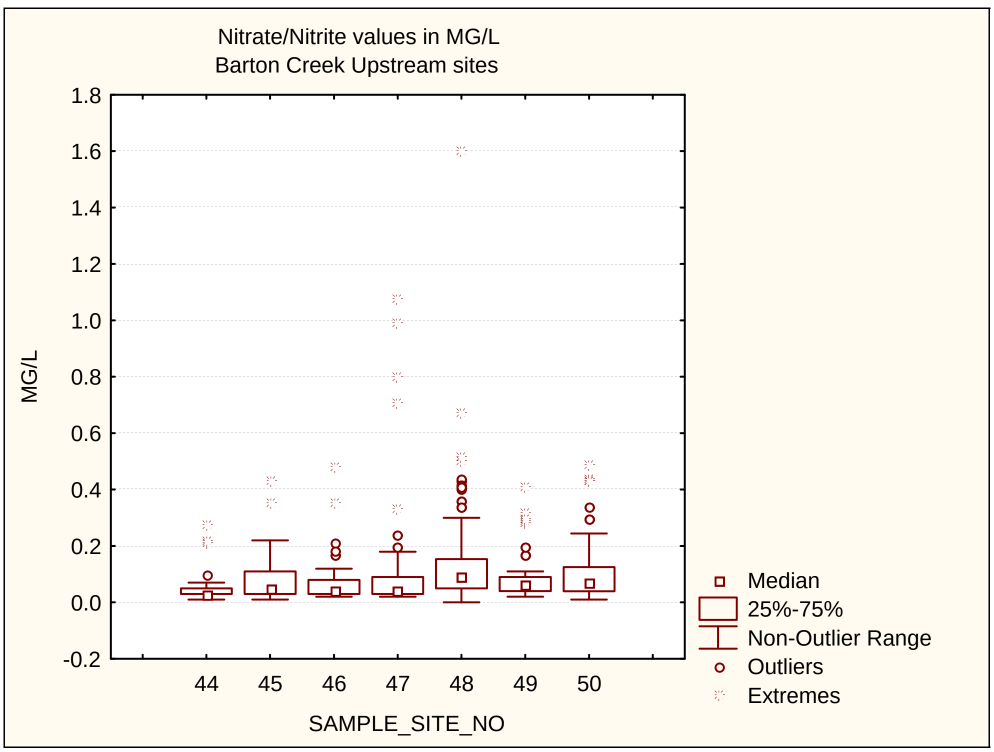

Figure 4. Nitrate/Nitrite values in Barton Creek upstream sites illustrating Site #48 difference

Orthophosphorus As P
There are minimal differences in the median concentration of orthophosphorous between sites or over time on Barton Creek. The majority of the samples measure below detection limits and the occasional spike in concentrations soon returned to low levels. Differences in detection limits, which range between 0.01 to 0.06 mg/L, make statistical comparisons difficult. The differences in means between sites are so slight as to have minimal chemical or biological importance at this time and the majority of results represent the changes in laboratory detection limits.

Ammonia as N
Ammonia in Barton Creek is normally found in low or nondetect concentrations. Rapid oxidation into nitrites and nitrates ensures these low values. No statistically significant temporal increases or decreases in ammonia concentrations were found in the Barton Creek mainstem. In addition, all sites have similarly low concentrations between sites. The occasional spike in concentrations soon returned to low levels,

<u>Dissolved Oxygen</u>
Slight temporal decreases in dissolved oxygen concentrations in Barton Creek are evident in the regression graphs (Figure 5). These decreases are statistically significant at sites #47, 49, 50, 51. Analyses run adjusting for flows, time of day and temperature show that dissolved oxygen concentrations have a stronger statistical relationship to visit date. All other sites show no statistically significant decreases or increases. Loop 360 #599 shows an increase graphically, however, there is insufficient data for temporal analysis. There are statistical differences between sites (Figure 6) with the Kruskal Wallis analyses $p= 0.000009$. However, the differences between the means are not biologically significant. Paisano #47 has a slightly lower mean than all other sites. Paisano #47 has also had the lowest recorded value of dissolved oxygen of 2 mg/L.

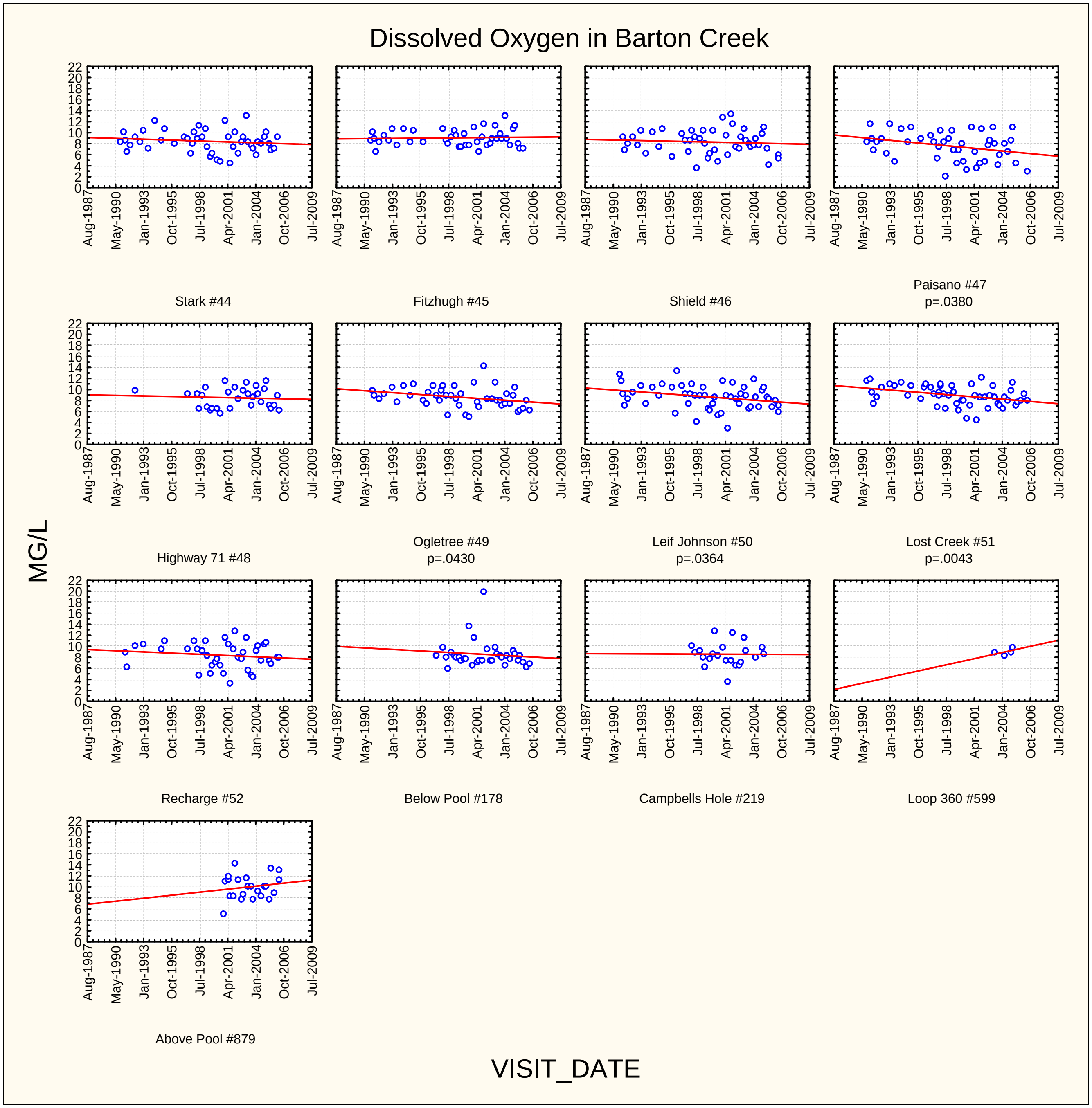

Figure 5. Dissolved oxygen concentration temporal regressions 1990-2005 in mg/L in Barton Creek mainstem.

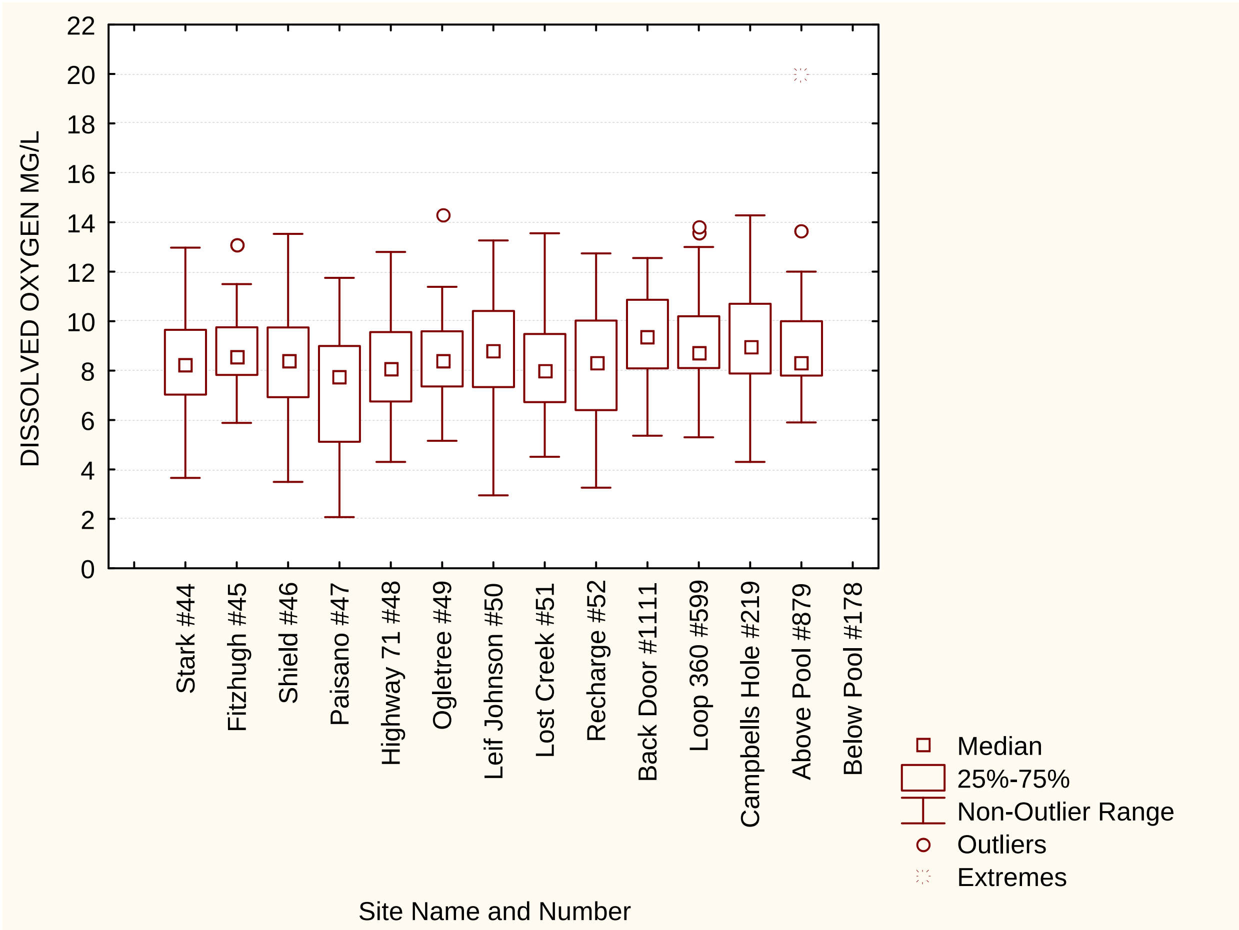

Figure 6. Dissolved oxygen concentrations in MG/L in Barton Creek mainstem between sites

Increases in conductivity are indicated in the graphs shown in Figure 7. Statistically significant increases are evident at Above Pool #879, Highway 71 # 48, Paisano #47, Shield #46, Fitzhugh #45, and Stark #44. Although the annual mean for flow is not decreasing (see flow page 2?) drought conditions can contribute to less dilution and therefore higher conductivity readings. Anthropogenic sources of ions can also contribute to increases in conductivity.

The pH values follow the same trend in Barton Creek, the sites located above and below Barton Springs Pool #879 and #178 are statistically different from all other sites (Figure 8). This decrease is probably due to the inputs of the large springs in the area. An increase in spring influents in the downstream sites leads to decreasing pH values. Temporally, a statistically significant decrease in pH values is evident in Paisano(#47)and Loop 360 (#599) pools.

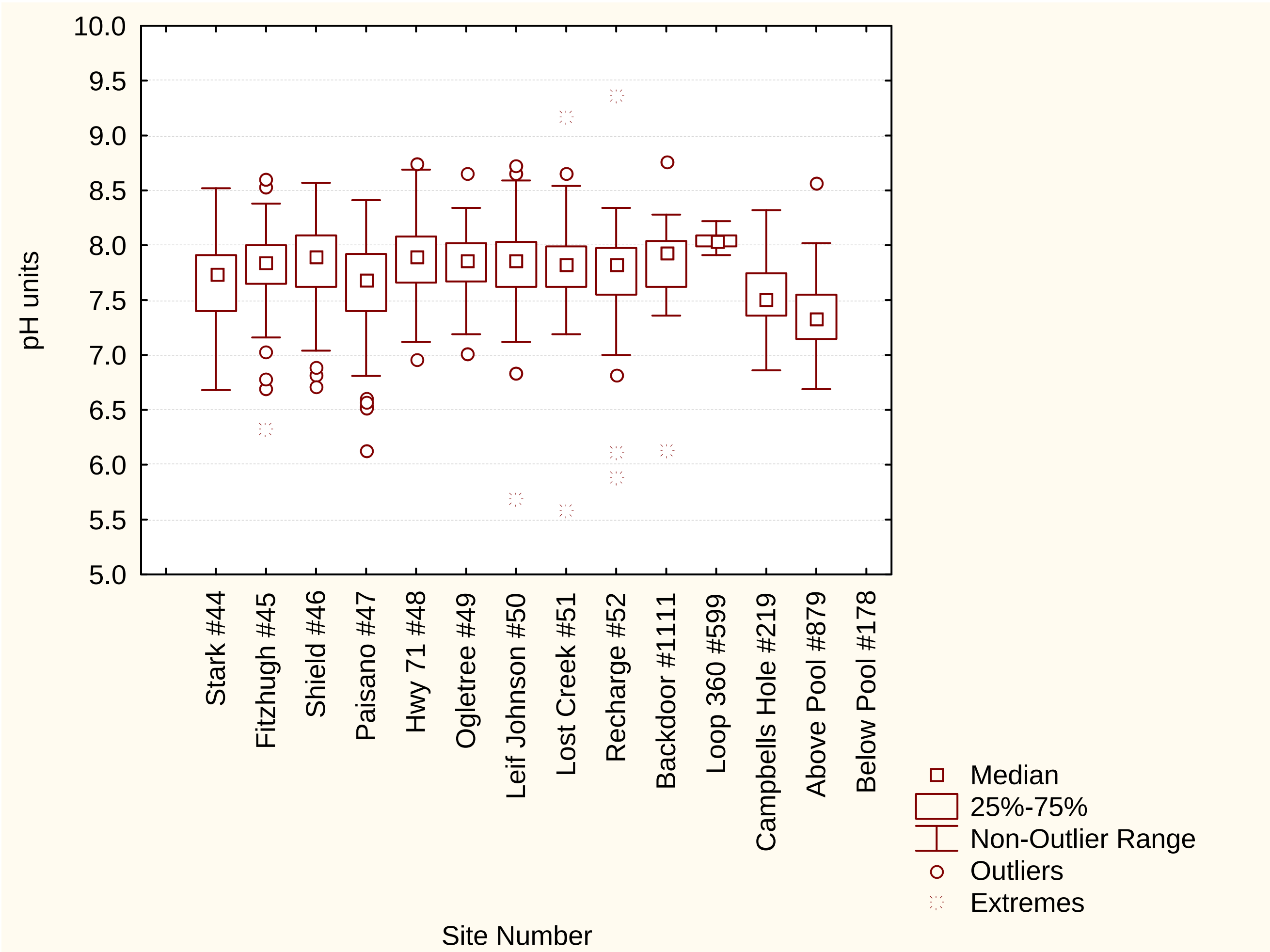

Figure 9. pH values between sites in Barton Creek mainstem

Transect Data

Nuisance algae in Barton Creek consists of the Blue greens (cyanophyta), oscillatoria sp and spirogyra sp. and the green (chlorophyta) Cladophora sp.. For the purposes of this analysis, these three algae types were combined to determine percent cover totals in the Barton Creek mainstem. Beneficial plants and alga that normally do not degrade and provide habitat include macrophytes, Chara sp, Nitella sp. Utricularia sp.

Algae transects began in the Barton Creek upstream pool sites in 1991, initial sites included #'s 44,45,46,47,48,49,50,51,52. Monitoring sites located in the recharge zone and riffle monitoring was initiated during the algae blooms in the year 2000. Recharge sites added include #219 and #879. Riffle monitoring was added to site #'s 46, 48 and 51.

Although decreases in nuisance algae percent cover are obvious in the graphs (Figure 10), only Stark #44 and Above Pool #879 are statistically significant decreases. Other sites indicate decreases, but the values are too variable or there are not enough data for a statistical analysis. Large cladophora blooms occurred in Barton Creek in the mid 1990's in most areas of the watershed, especially in the mid section and downstream portions of the creek and large oscillatoria blooms occurred in the downstream portions of Barton Creek in the early 2000s (COA 2001). The decreasing occurrence of these blooms has affected the statistical analysis and indicates a decrease in algae cover in Barton Creek. In addition, decreasing trends are evident in macrophyte cover for this time period (Figure 17), however, these trends are not statistically significant except at Stark #44 and Lost Creek #51. A slight statistical increase in macrophyte percent cover is evident at Highway 71 #48.

Figure 11 illustrates how frequently nuisance algae were observed compared to the number of surveys performed. Nuisance algae was recorded in over 70 % of visits to Leif Johnson #50, Lost Creek #51 and Above Pool #879. In addition to high frequency, these sites have the highest percent cover of nuisance algae (Figure 12) Figure 13 illustrates the relationship between nutrients (nitrate/nitrite) and nuisance algae. Increases in nutrients appear to lead to increases in nuisance algae.

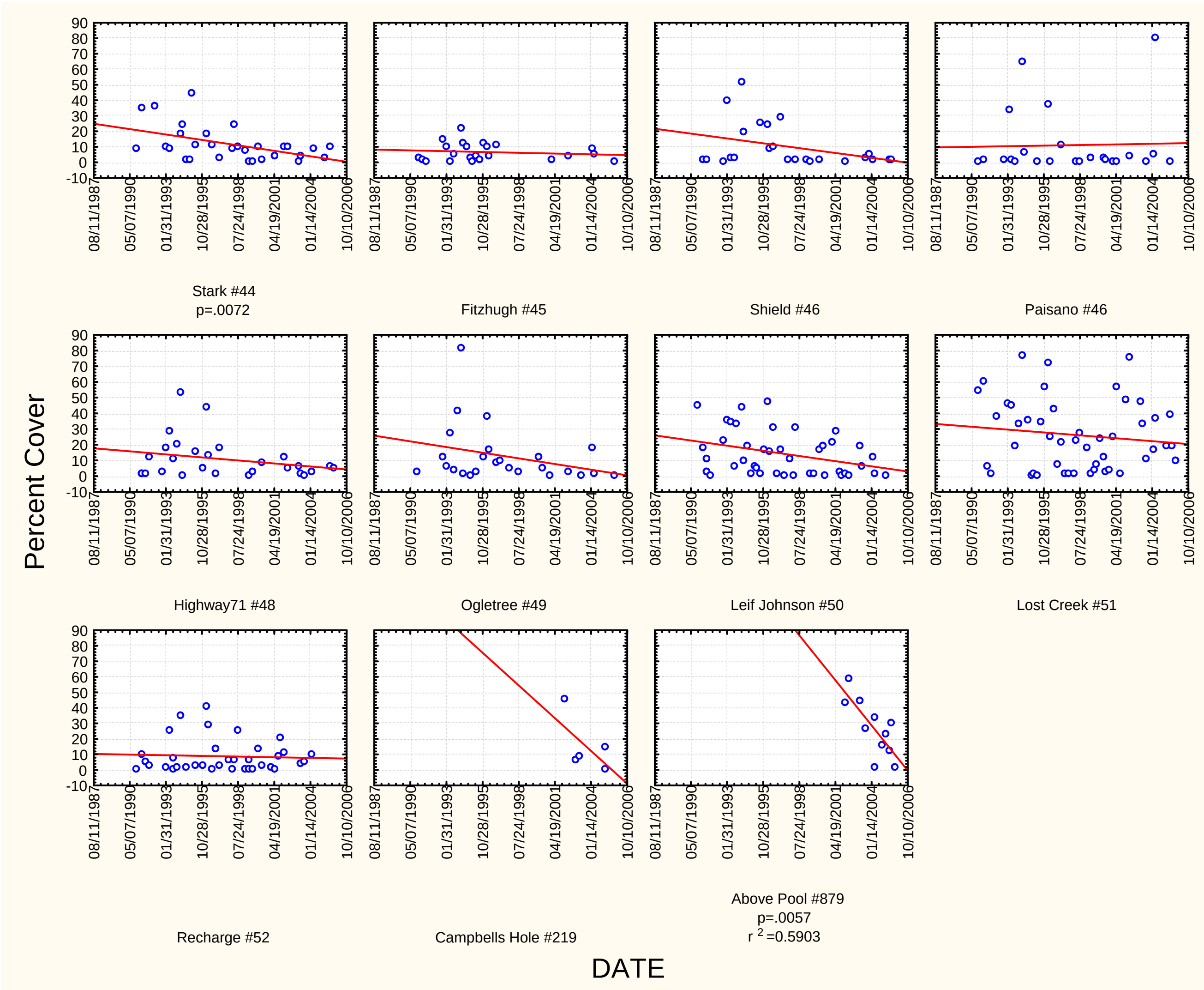

Figure 10. Temporal regression plots of percent cover nuisance algae in Barton Creek 1993-2005

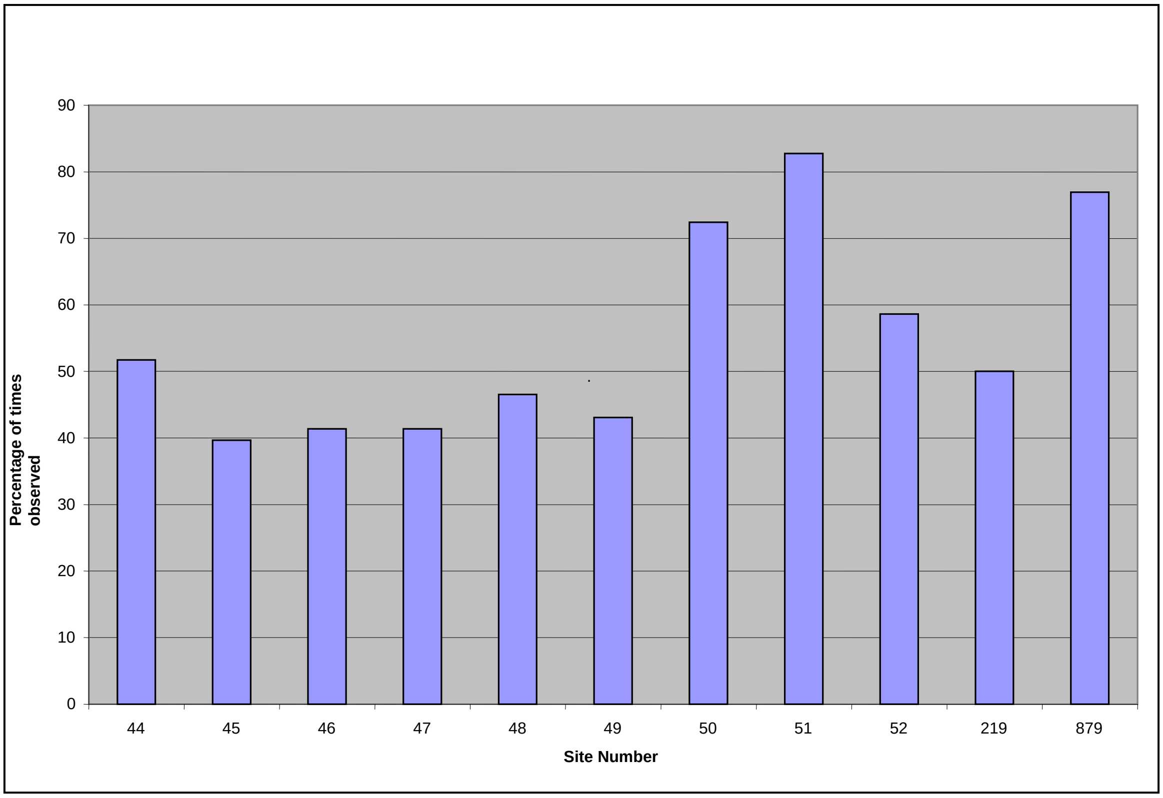

Figure 11. Percent of survey events when nuisance algae was observed in Barton Creek mainstem pools.

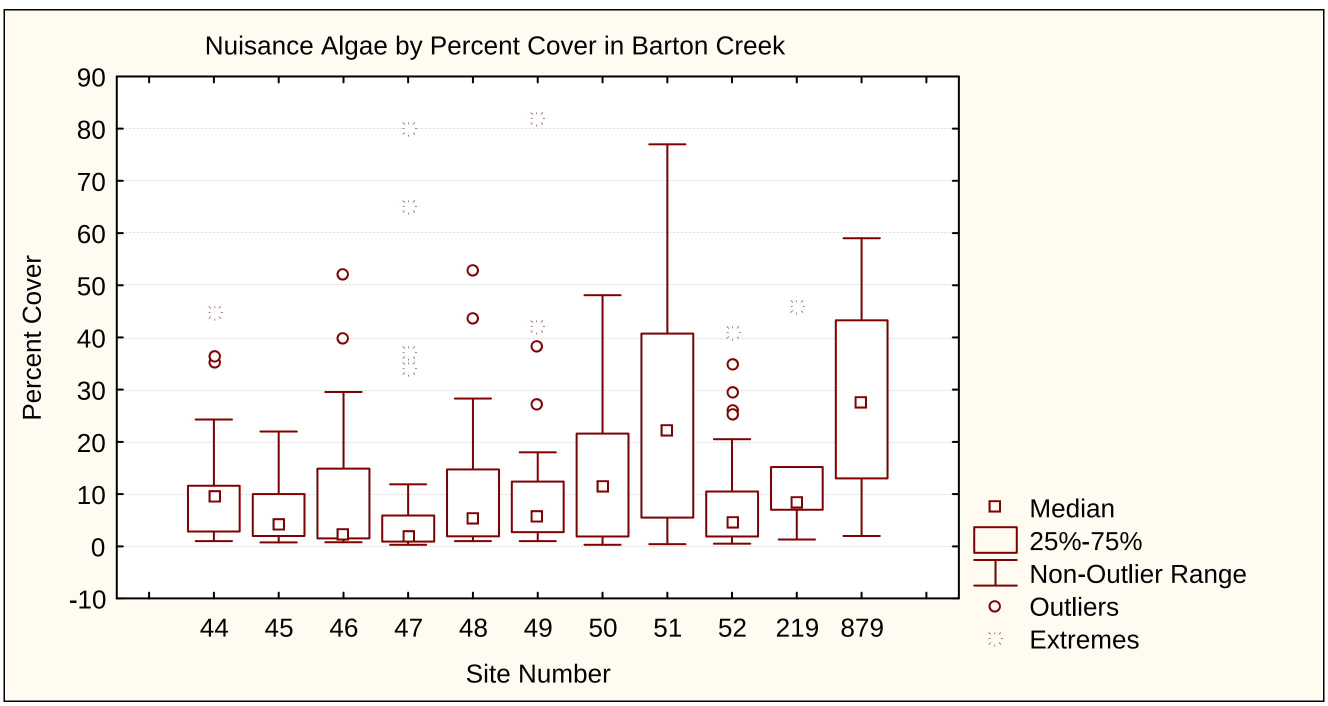

Figure 12. Nuisance algae medians by percent cover in Barton Creek Mainstem 1993- 2005.

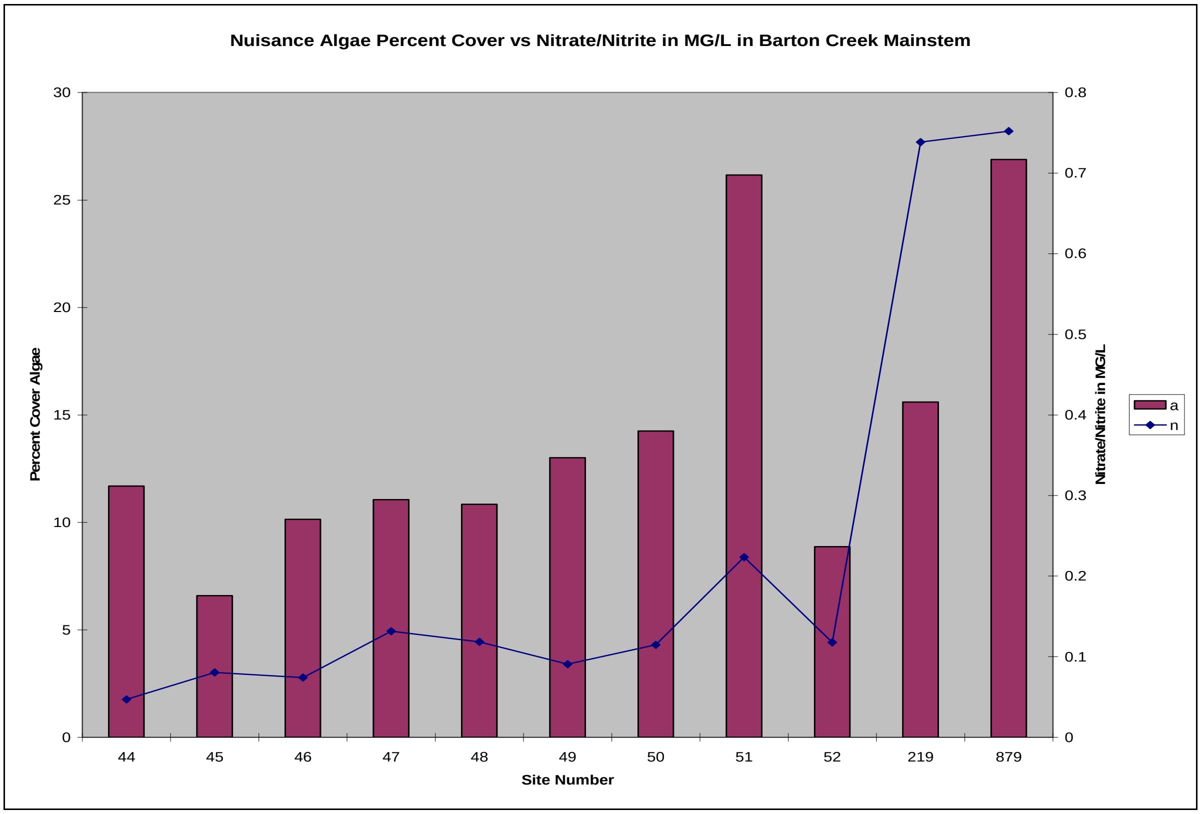

Figure 13. Nuisance algae percent cover medians versus Nitrate/nitrite means in MG/L in Barton Creek Mainstem 1993-2005

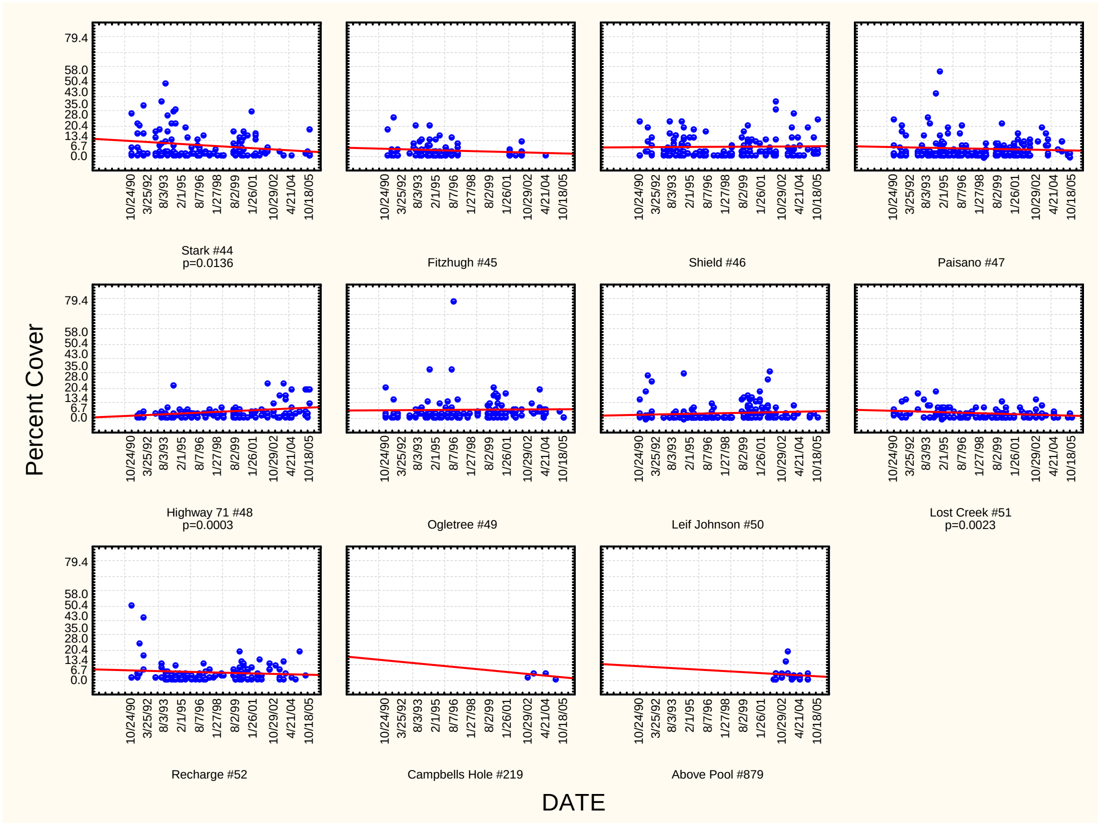

Figure 14. Temporal regression 1990-2005 of macrophyte and beneficial algae by percent cover in Barton Creek mainstem.

Conclusion

Although Barton Creek continues to show overall excellent water quality, especially when compared to urbanized watersheds (COA 2002) in downtown Austin, the decreasing dissolved oxygen concentrations and increasing conductivity are trends to investigate. Variability itself in measured parameters has been shown to be an indicator of urbanization and deteriorating water quality. (COA 2002) Considerable changes in land use in the mid section of the Barton Creek watershed could be contributing to the variability of some of these results.

A clear correlation is shown between nutrients, specifically nitrates, and increases in nuisance algae. Although some of this increase is likely due to spring influent, the majority is likely due to the increases in impervious cover and runoff in the urbanized portions of Barton Creek located close to city center.

References

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