Water Quality Documentation of Algae Bloom in Barton Creek, Austin, Texas, November 2000

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ABSTRACT

One of the difficulties in determining cause and effect of short-term biological events such as algae blooms in creeks is the lack of documentation of surrounding water quality, physical habitat, and ecological context of the event. In many cases, the correlation of these conditions with antecedent hydrology is also necessary to understand the event. A brief summary of sampling and analysis associated with a November 2000 bloom in Barton Creek reported to the City of Austin Watershed and Development Review Department (WPDRD) is provided in an effort to standardize such documentation. Using this data, along with that from ongoing studies, the likely cause of this particular bloom was high post-drought discharge of nutrients from urban tributaries after an early November rainfall.

INTRODUCTION

In November 2000, an algae bloom in Barton Creek was reported to City of Austin WPDRD staff by Environmental Board member Tim Jones. The bloom consisted of the blue green algae *Oscillatoria* sp., which was thickly growing in Barton Creek from upstream of Barton Springs Pool to small areas near Lost Creek Blvd. At its peak, the algae presented a solid mass of mottled green coverage, completely obscuring the normally visible bedrock of Barton Creek in the riffles of the affected areas, immediately upstream of Campbell's Hole and upstream of Barton Springs Pool.

Oscillatoria is a genus of opportunistic, bloom-producing, cyanobacteria (blue-green algae). Populations of *Oscillatoria* are known to increase when temperatures decrease, and they are known to be tolerant of organic enrichment (Vymazal, 1995). This genus is also known for causing problems such as slime, coloration, and corrosion of steel piping in drinking water supplies (Palmer, 1959). Some species of *Oscillatoria* are known to produce toxic substances.

Identification of a bloom of *Oscillatoria* in Barton Creek could be significant because species taxonomy has been used as an indicator of water quality degradation or eutrophication of surface waters. As a body of water becomes more eutrophic through excessive nutrient loading, *O. rubescens* increases in population as *O. agardhii* decreases in population. However, these changes could not be documented using available Barton Creek data because identification to species level was inconsistent due to the number of undescribed and poorly known species in samples collected.

A bloom of *Oscillatoria* could be significant because some species of this widely distributed genus are toxic to humans and animals. Like many algae, *Oscillatoria* can enter a toxic phase and be indistinguishable from the nontoxic algae around it. *Oscillatoria* are known to produce both neurotoxins called anatoxins and hepatotoxins called microcystins. Anatoxins can block the transmission of signals from neuron to neuron and neuron to muscle, while microcystins cause bleeding in the liver; this threat is typically larger for livestock than for humans (Hagedorn, 2001). The potential for toxicity is of concern due to recreational uses of Barton Creek and Barton Springs Pool and the potential transport of algae into Barton Springs salamander habitat during high flows. However, no reports of suspected toxicity impacts from this particular bloom were reported to WPDRD.

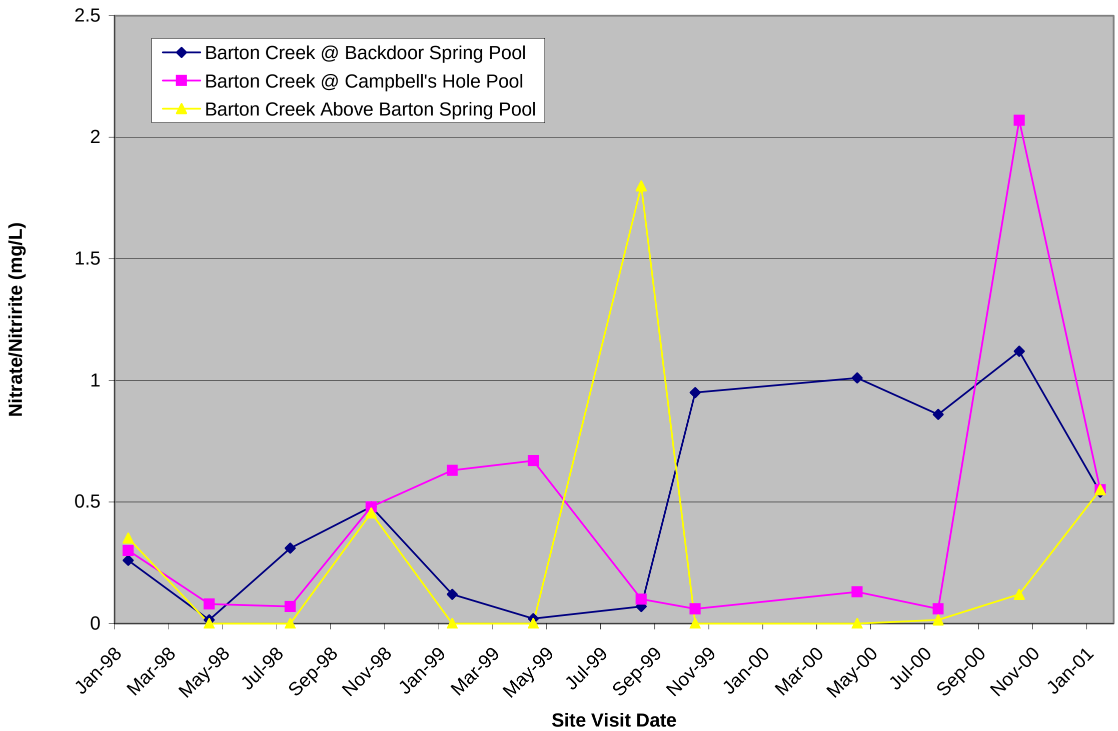
RESULTS

At the time of the observed bloom, drought conditions of the previous 2 years had left the recharge area of Barton Creek without measurable baseflow. Campbell's Hole and Back Door Spring were stagnant, seep-fed pools, and the areas immediately upstream of Barton Springs were completely dry. In late October 2000, the Austin area received substantial rainfall, and on the first routine Barton Creek mainstem sampling date post rainfall, October 30, 2000, a significant increase in nitrate concentrations was observed at this location. At the time, no flow was present in the recharge area of Barton Creek. After more rainfall on November 2, 2000, Barton Creek started flowing in the recharge area; Loop 360 hydrographs show flow increasing from 0 to just under 500 cfs within 24 hours. By November 26, 2000, large blooms of *Oscillatoria* were reported. The initial investigation on November 29, 2000, into possible causes revealed a slight increase in nitrates compared to typical concentrations in the Campbell's Hole area of Barton Creek. Nitrate concentrations ranged from 0.33 to 0.44 mg/L (ERM in-house laboratory) in the area between Campbell's Hole and the Spyglass access to Barton Creek. These are not unusually high concentrations, but it is probable that the algae bloom had incorporated any abnormal nutrient load into biomass after the initial rainfall event of October 30, 2000.

Laboratory results (Walnut Creek Water /Wastewater Laboratory) for samples collected on October 30, 2000, show Barton Creek at Campbell's Hole increased nitrate/nitrite concentration from <0.03 prior to the storm to over 2.0 mg/L afterward. Back Door Pool (located upstream of Loop 360 and downstream of the recharge area of Barton Creek) increased in concentration from 0.86 to over 1.12 mg/L. The area immediately upstream of Barton Springs Pool that was dry prior to the storm measured 0.25 mg/L afterward (elevated for this site). Concentrations at all three sites were only slightly elevated at just over 0.5 mg/L in January 2001, as shown in Figure 1.

Consumption of nutrients by algae and dilution from continued heavy rainfall may have overcome the initial post-drought flushing of nutrients, resulting in the lower concentrations of nitrates in the mainstem of Barton Creek by January 2001.

Figure 1. Nitrate concentrations in Mainstem Barton Creek, January 1998- January 2001



In addition to quarterly mainstem Barton Creek monitoring, COA staff perform monthly monitoring of several Canyon tributaries to Barton Creek, both in and upstream of the areas affected by the algae bloom. Ten of these tributaries are considered urban and are in the recharge zone of Barton Creek. Seven tributaries are classified as rural and are upstream of the recharge zone in the Barton Creek watershed. All tributaries flow directly into Barton Creek.

When examining laboratory results during the period in question, it was observed that in the urban tributaries concentrations of nitrates increased during the post drought period. In one example of a residential urban tributary, nitrate concentrations increased from 1.44 mg/L during drought conditions on July 18, 2000, to 4.68 mg/L on November 28, 2000. The nitrates in this tributary continued to increase to an eventual high concentration of 8.88 mg/L in January 2001 after several storm events.

Rural tributaries showed a slight increase in nitrates, but not to the same extent as urban tributaries. For example, one rural tributary increased from 0.05 to 0.15 mg/L and by January 2001, had returned to pre-storm event values. The following figures display the averages of nitrate/nitrite concentrations during pre-and post-drought conditions in urban and rural tributaries (Figures 2 and 3). Both figures represent historical data before October 30, 2000, and post-drought data between October 30, 2000, and the end of February 2001. The difference in scales on the y-axis of these two graphs should be noted. In Figure 2, (urban tributaries) the scale is from 0 to 6 mg/L. In Figure 3 (rural tributaries) the range is from 0 to 0.5 mg/L.

Figure 2. Mean Nitrate Concentrations in Urban Tributaries to Barton Creek
Pre and Post 10/30/2000

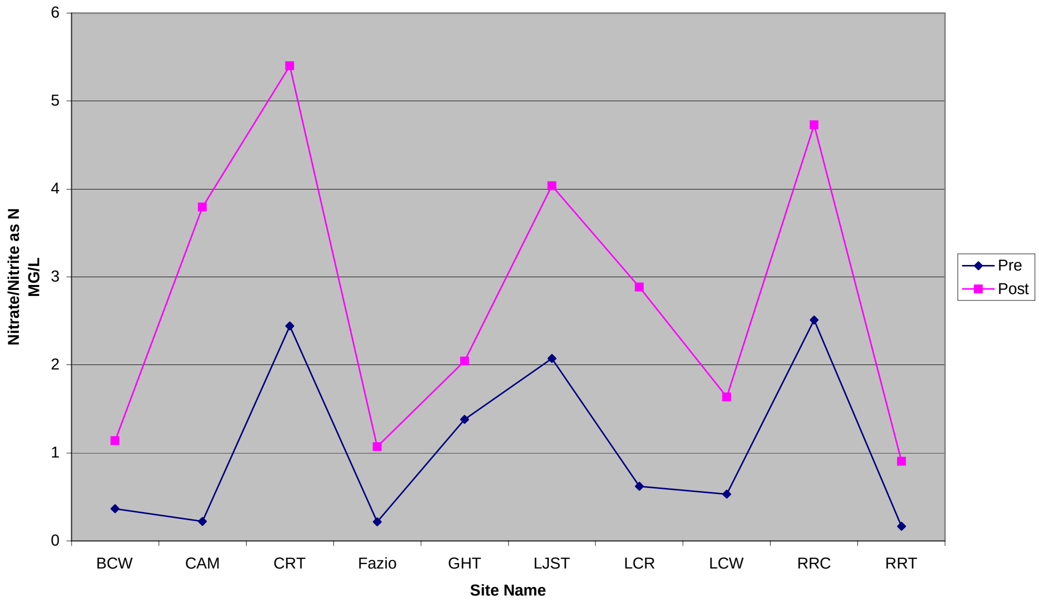
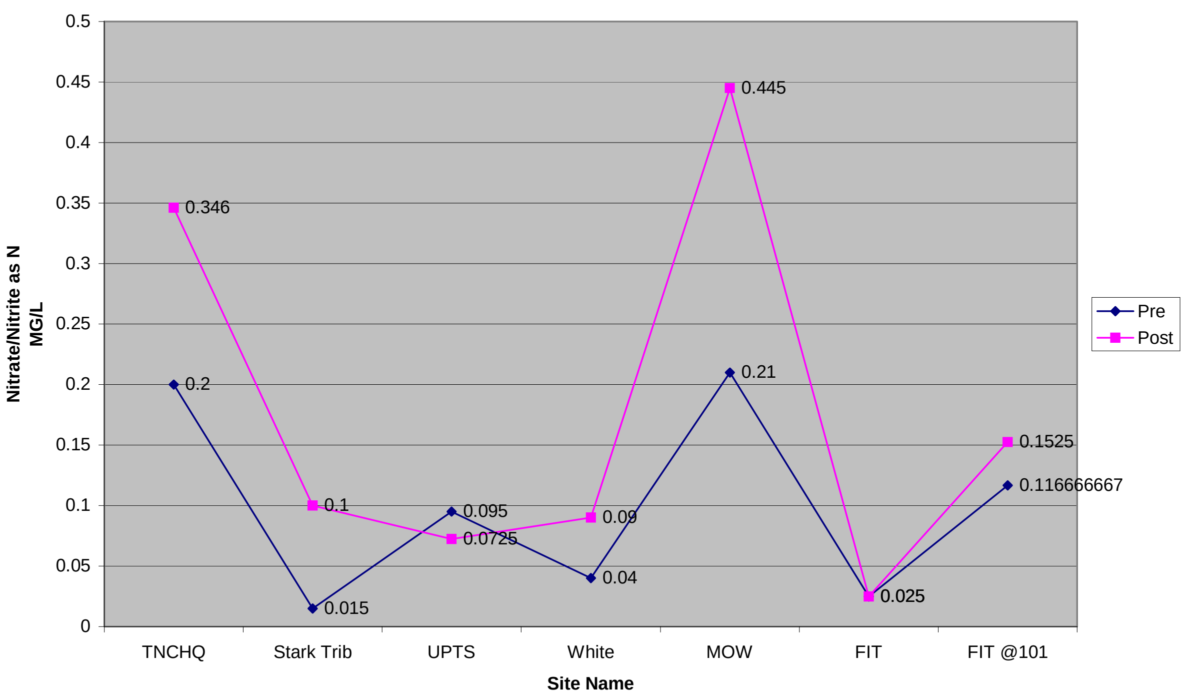


Figure 3. Mean Nitrate Concentrations in Rural Tributaries to Barton Creek
Pre and Post 10/30/2000



The prolonged drought conditions could have allowed nutrients and organic material to buildup in the watershed to the extent that subsequent heavy rainfall caused a spike in nitrate concentrations. This increase gave these opportunistic algae the impetus to produce the large blooms in the urbanized section of Barton Creek. Such a mechanism would represent a typical build-up/washoff model of stormwater pollutant discharge such as has been documented in many non-point source pollution studies. This model has not been found to adequately describe single land use watershed data in Barton Creek (Charbeneau, 1998). However, the data from this algae bloom would support the hypothesis that some permutation of build-up/washoff of nitrates is occurring in Barton Creek tributaries.

The sampling of urban tributaries continued to indicate the input of nitrates during several months of sampling, while the rural tributaries assimilated these nutrients by the next sampling event and returned to background levels. This observation may help explain why no reported *Oscillatoria* blooms were made in the undeveloped (rural) areas of Barton Creek. The rapid incorporation of nutrients in rural tributaries described above was also observed in the Bull Creek watershed during the same time period. Sampling from urbanized tributaries indicated spikes in nitrates post rainfall, with corresponding *Oscillatoria* blooms. The rural tributaries did not indicate increased concentrations of nitrates, and no *Oscillatoria* blooms were reported or observed.

Sources of nitrates in an urbanized area associated with residential and golf course land use include application of excessive fertilizers used for residential and commercial lawn care, leaking wastewater lines, domestic animal droppings, failing septic systems, and atmospheric deposition. Fertilizers are the most commonly cited source of nitrate non-point source pollution, due to their pervasive use in the residential landscape, common misuse, and intensely concentrated form.

Several studies have shown that increased nitrogen loading from urbanized watersheds has stimulated algae and other aquatic plant growth. When plant growth becomes intense, night time dissolved oxygen levels can become critically low. The community structure ultimately could be altered in favor of the organisms capable of exploiting the increasing plant growth. As a reference, under natural conditions, algae growth is observed to constitute only 1 percent of energy budgets of headwater streams (Klein, 1979). In the more unbalanced urban tributaries, this proportion could be much higher.

CONCLUSIONS

A combination of conditions apparently contributed to the November 2000 algae bloom in Barton Creek. The accumulation of materials during the long drought prior to the late October rainfall was probably the largest factor influencing the bloom. Nutrient loading from washoff of this material would have been considerable, and it was reflected in nitrate-nitrogen data collected in Barton Creek tributaries and mainstem pools during this period. Monitoring of these tributaries also indicates more rapid and complete assimilation of nitrogen in rural tributaries without reaching algae bloom conditions when compared to urban tributaries that have a higher average concentration of nutrients.

REFERENCES

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