Lake Austin and Lake Travis Algae Counts.

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Abstract

Water with high algae content may have a bad smell, a bad taste, or cause illness depending on the type of algae. Therefore, the City of Austin currently analyzes water at two of its water treatment plants on Lake Austin, Davis and Ullrich, and from the shoreline at Mansfield Park on Lake Travis for abundance and type of algae in the water. Daily counts of total algae, blue-green algae, green algae, flagellate algae, and diatoms are collected at the intakes to the Davis and Ullrich Water Treatment Plants, while samples are taken less frequently at Mansfield Park. Data collected from January 1992 to August 2010 were summarized and analyzed for temporal trends. Summary statistics for the algae counts show that Mansfield Park seems to have higher counts than either water treatment plant intake site. Temporal trends indicated an increase in green algae counts at both water treatment sites on Lake Austin and an increase in blue-green algae counts during blooms at the Davis and Ullrich Water Treatment Plants.

Introduction

Austin Water Utility currently samples the intake at the Davis Water Treatment Plant (Davis WTP) and the Ullrich Water Treatment Plant (Ullrich WTP) on Lake Austin for abundance and type of algae in the water column. Mansfield Park on Lake Travis is also sampled for algae abundance and type. Certain algae add unpleasing odors or tastes to the water and some may even cause illness. Therefore, it is important for the City of Austin to closely monitor the amount and type of algae in the water at the intakes to the city's drinking water treatment plants. Because of the relatively high frequency of these measurements, the algae count data also may be used to assess changes in the trophic status of the lakes.

Methods

Austin Water Utility collected algae samples in Lake Austin at the Davis WTP, Lake Austin at the Ullrich WTP, and Lake Travis at Mansfield Park. Samples were collected daily at Ullrich WTP and Davis WTP, and may have been collected directly from the intake pipe or from the shoreline as different collectors have used different methods. Samples from Lake Travis were collected from the shoreline. Blue-green algae, green algae, flagellates, diatoms, and total algae were counted in natural units, where colonies and filaments are counted as a single organism, and extrapolated to organisms/mL. Counts collected from January 1992 to August 2010 were analyzed in this report.

Summary statistics for each algae grouping for each site were computed in SAS 9.1. Quantile regression and least-squares regression were used to detect any temporal trends to the algae counts at each site. Quantile regression is useful in examining the trends in the extreme data points (Koenker 1978; Koenker 2001). The 0.5 (median) quantile was used to test for overall trends in the data while the 0.75 and 0.95 quantiles were used to test for trends in the extreme data points of the data (i.e. algae blooms). The residuals of the median quantile regression were inspected for outliers and least-squares regression was performed after outlier detection. Alpha levels were set to 0.05 for all analysis.

Results

The maximum, minimum, mean, and median density for each category of algae analyzed is listed in Table 1. Means and medians for total algae, blue-green algae, green algae, and diatoms were higher in Lake Travis at Mansfield Park than at Davis WTP or Ullrich WTP; however, Davis and Ullrich WTP had comparable means for algae counts. Most blue-green algae blooms (increased blue-green algae counts) occurred from August to November. The maximum counts of blue-green algae occurred in the fall of 2009 for each site.

Table 1: Number of samples, maximum, mean, median, and minimum plankton counts from January 1990 to August 2010 in Lake Austin and Lake Travis. The maximum, mean, median, and minimum are reported as organisms/mL.

SITE	PARAMETER	# OF SAMPLES	MAX	MEAN	MEDIAN	MIN
DAVIS WTP	ALGAE BLUE-GREEN	2748	14000	235.79	100	0
	ALGAE GREEN	2735	3917	129.68	80	0
	ALGAE FLAGELLATE	2763	37774	3217.65	2900	0
	TOTAL PLANKTON	2764	20200	3816.93	3365	180
	DIATOM COUNT	2727	6750	249.46	143	0
ULLRICH WTP	ALGAE BLUE-GREEN	2038	16000	283.41	100	0
	ALGAE GREEN	2036	1400	130.89	81	0
	ALGAE FLAGELLATE	2055	80800	3318.16	2900	82
	TOTAL PLANKTON	2056	80800	3934.77	3386.5	20
	DIATOM COUNT	2024	6700	231.25	143	0
LAKE TRAVIS - MANSFIELD PARK	ALGAE BLUE-GREEN	391	9900	866.99	163	0
	ALGAE GREEN	391	4900	237.47	160.5	0
	ALGAE FLAGELLATE	382	11322	2948.26	2530	450
	TOTAL PLANKTON	380	16135	4592.33	4100	800
	DIATOM COUNT	381	9200	548.6	163	0

Least-squares regression indicated that the counts of flagellate algae at Ullrich WTP were declining slightly while the green algae counts at Davis WTP and Ullrich WTP were increasing slightly ($p < 0.05$) (Table 2). While the trends are significant the R^2 values are not above 0.02 for the linear trends. This indicates large variability in the data.

Table 2: Trend direction and R2 values for significant trends using least-squares regression on data collected from Lake Austin and Lake Travis from January 1990 to August 2010.

SITE	PARAMETER	TREND DIRECTION	R-SQUARE
Davis WTP	ALGAE GREEN	Increase	0.0019
Ullrich WTP	ALGAE GREEN	Increase	0.0067
	ALGAE FLAGELLATE	Decrease	0.0120

Quantile regression using the 0.95 quantile indicated that the counts of flagellate algae were significantly decreasing at Ullrich WTP ($p<0.0001$) and Davis WTP ($p<0.0001$), while the green algae counts were significantly increasing at Ullrich WTP ($p = 0.0211$) and Mansfield Park on Lake Travis ($p = 0.0051$). The upper extremes of the flagellate algae counts decreased with time and the upper extremes of the green algae counts increased over time. The quantile regression using the 0.95 quantile also indicated that the blue-green algae counts were increasing at Davis WTP ($p<0.0001$) (Figure 1) and Ullrich WTP ($p<0.0001$) (Figure 2). While no overall trend to the blue-green algae counts existed, the upper extremes of the data appear to have increased with time, so when blue-green algae blooms occurred they were becoming significantly larger at these two sites. The blooms most frequently occur from August to November. In order to classify a blue-green bloom the data was standardized by subtracting the mean for each site and dividing by the standard deviation (value = (x – Mean)/std). These data were graphed and a bloom was seen to occur when the standard values were above 0.5 on this scale. The number of samples where the standardized blue-green algae counts were above 0.5 was recorded. Because the samples were not taken daily, days between sample dates where the standardized value was above 0.5 were also classified as days in a bloom. The extrapolated number of days where a bloom was thought to be occurring was recorded in Table 3. In 2007 and 2009 the number of days in a bloom were higher than other years, however, the number of days was also high in 1996 so no upward trend in duration seems to be occurring. Since 2002, there appears to be an algae bloom every other year, while in the ten years prior to 2002 there were only three blooms at Davis and two blooms at Ullrich.

Table 3. Dynamics of annual algae blooms, based on duration, for two sites on Lake Austin, 1992-2009.

SITE	PARAMETER	1992	1996	1997	2002	2004	2006	2007	2009
Davis WTP	Number of days in a bloom	21	39	28	15	10	28	52	60
	Longest bloom duration (days)	21	32	28	7	9	27	52	49
	Maximum count (Org/mL)	2305	3223	1877	3400	1800	2800	6900	14000
Ullrich WTP	Number of days in a bloom	.	35	2	20	4	26	37	60
	Longest bloom duration (days)	.	28	2	15	3	26	36	47
	Maximum count (Org/mL)	.	3448	1163	3600	8200	3500	7500	16000

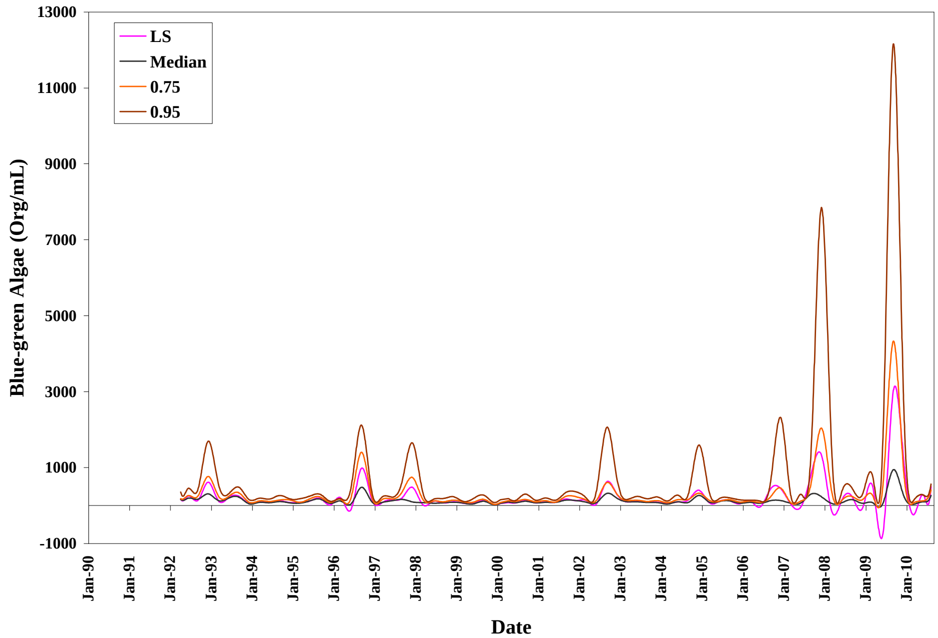

Figure 1: Least-squares regression curve (LS), median quantile (Median), 0.75 quantile (0.75), and 0.95 quantile (0.95) fitted curves using cubic B-spline method for blue-green algae counts collected at Davis WTP on Lake Austin. Quantile regressions shows a significant increase in the blue-green algae counts using the 0.95 quantile ($p < 0.0001$).

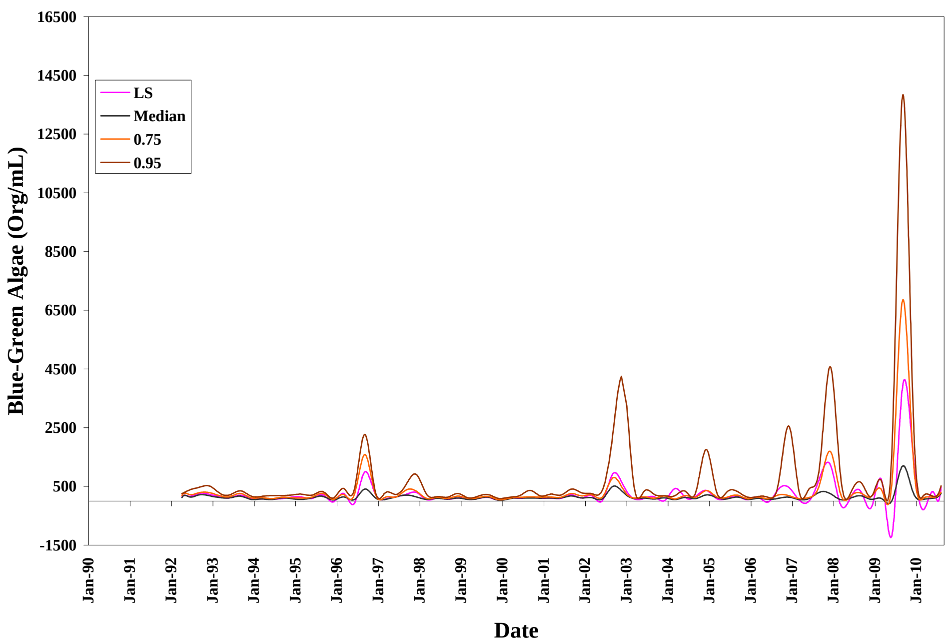

Figure 2: Least-squares regression curve (LS), median quantile (Median), 0.75 quantile (0.75), and 0.95 quantile (0.95) fitted curves using cubic B-spline method for blue-green algae counts collected at Ullrich WTP on Lake Austin. Quantile regressions shows a significant increase in the blue-green algae counts using the 0.95 quantile ($p < 0.0001$).

Conclusions

- Mansfield Dam Park on Lake Travis had higher total algae counts then either Lake Austin site.
- The flagellate algae counts appear to be decreasing at the Ullrich WTP.
- Green algae counts appear to be increasing at the Davis WTP and the Ullrich WTP.
- Extreme flagellate algae counts appear to be decreasing at Davis WTP.
- The number of blue-green algae in a bloom (severity of the bloom) appears to be increasing over time at the Davis WTP and the Ullrich WTP.
- Durations for blue-green algae blooms do not appear to have a trend but the 2007 and 2009 blooms consisted of more days than any previous blooms.
- Blooms appear to occur every other year recently, but before 2002 blooms occurred much less frequently.
- The severity, frequency, and duration of recent blue-green algae blooms may indicate a trend towards a more eutrophic status of the lake.
- Monitoring should continue by AWU methods in order to examine future blue-green algae growth.
- Phytoplankton growth potential bioassays and phytoplankton productivity tests could be done to more accurately determine the trophic status of phytoplankton in Lake Austin (Herrington and Scoggins 2006, Kiesling et. al. 2001).
- Genera-specific data could be obtained from AWU. More useful metrics may be calculated with more specific information (Porter 2008).

References

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