

Wolf and Broad Lake Watershed Restoration Project Completion Report



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Executive Summary

The Wolf – Broad Lake water body was evaluated as impaired and included on the Mississippi 303(d) list of impaired waterbodies. As such, the EPA 319 (h) program, through the Mississippi Department of Environmental Quality selected this water body and its associated watershed for landscape improvement, with the goal of moving towards improving the lakes water quality, meeting associated evaluated total maximum daily loads (TMDL's), and ultimately removing or de-listing the waterbody for total suspended sediments (TSS) impairment. A study was undertaken for two years to evaluate and document appropriate changes to the TSS concentrations (mg/L) and overall lake turbidity. These two objectives were analyzed with monthly surface sampling events of turbidity using automated sampling technology (Eureka – Manta 2, automated data-son) as well as 20 random samples per sampling trip for TSS analysis. All analyses were quality assured and quality controlled. Total suspended sediments were analyzed using the Standard EPA approved Method 2480D for TSS analysis. All analysis and data manipulation occurred within the Mississippi State Universities Water Quality Laboratory. With best management practice (BMP) implementation between June 2008 and September 2009, there were declines in TSS and turbidity levels, those the declines were not statistically different pre and post BMP implementation. Turbidity and TSS levels did statistically decline between May 2009 and May 2010 in both mean and median values. Results from the non-parametric Kruskal-Wallis analysis indicate a significant month-by-year effect on turbidity and TSS (Chi-square = 76.08, $P = 0.001$), but reach (Chi-square = 2.45, $P = 0.784$) and depth by reach (Chi-square = 2.44, $P = 0.784$) did not show significant effects on turbidity. There were no significant correlations between TSS and turbidity concentrations and two day, and seven day summed or mean rainfall. Spearman correlation analysis for TSS indicated significant correlations between TSS and mean two day ($r^2 = 0.62$, $P = 0.002$) and seven day ($r^2 = 0.51$, $P = 0.014$) wind speeds. All other variables used in the analysis did not show significant correlation with TSS ($P > 0.05$). This suggests that wind conditions, rather than rainfall predict the greatest variability in TSS and turbidity in Wolf Lake. Furthermore, the shallow nature of Wolf Lake (Max depth: 20 ft; Median depth: 8 ft), and the attractiveness for recreational water skiers and wake boarders will promote within water column turbulence and increased suspended sediment levels without the influence of rainfall or runoff. Thus, correlating BMPs that reduce sediment loads by increasing hydraulic residence, slowing runoff velocities and increasing sedimentation with downstream water quality improvements is logically improbable. Unmanageable environmental conditions (wind speed and direction), and limited temporal monitoring scales (1 ½ years post BMP implementation) decrease the possibility of demonstrating success of water quality improvement within Wolf Lake a 303(d) listed water body.

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Introduction

The implementation of the Federal Water Pollution Control Amendments of 1972 and Clean Water Act in 1977 brought about an increased awareness of the status of our nation's water bodies and necessitated programs geared towards the improvement of aquatic systems health in the United States. Though non-point source contaminants (sediments, pesticides, etc.) are not specifically covered under these legislations, the negative effects of non-point source pollutants on water quality are well documented and their mitigation is considered to be very important for the future improvement of impaired water bodies (Cech 2010, Mitsch and Gosselink 2000, Pennington and Cech 2010). Agricultural and industrial run-off are just a couple of the main contributors of non-point sources pollutants, and increasing human expansion and agricultural production will likely increase the volume of these pollutants and the negative effects associated with them.

Areas in which agriculture dominates a major portion of land usage are particularly susceptible to harmful effects of non-point source pollutants. The Mississippi Delta (part of the Mississippi Alluvial Plain) is an area that has benefited from historic flooding of the Mississippi River and subsequent depositing of organic matter/soils conducive to agricultural use. Agricultural crops such as corn, rice, and cotton are grown in this fertile region, utilizing fertilizers for improved yields, which in association with storm run-off, draws large quantities of sediment and organic nutrients from the land and deposits them in the regions lakes, rivers, and streams. Mississippi's water quality standard for sediment reads as follows: "*Waters shall be free from materials attributed to municipal, industrial, agricultural or other discharges producing color, odor, taste, total suspended or dissolved solids, sediment, turbidity, or other*

conditions in such degree as to create a nuisance, render the waters injurious to public health, recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality, or impair the waters for any designated use” (MDEQ 2002). Clearly the alleviation of non-point source pollutants (such as sediments) from Mississippi water bodies is of great importance. In the Mississippi Delta, much of the focus on water quality improvement has been placed on the numerous oxbow lakes of the region which are seeing increases in recreational and development activities.

Wolf Lake, Broad Lake, and Tobeka Bayou (here forth as a whole referred to as Wolf Lake) were once part of the Yazoo River. Current hydrology and drainage of these lakes and its watershed are mostly attributed to modifications made for the purpose of flood control. Before Yazoo River levee construction, the watershed drained through Panther Creek and into the Yazoo River. Currently the watershed has one central outlet at the confluence of Wolf Lake which drains through two channels into the landside ditch of the Wittington Canal. Ironically, this connection leaves the watershed un-protected from high water events on the Mississippi River (noted during the study when Wolf Lake was closed due to unusually high water levels). Lake levels typically fluctuate around 88 ft, however, floodwaters from the Mississippi River can push the lake level much higher, flooding farmland and residences in the watershed. Surface water levels in the watershed are maintained by rainwater, the Mississippi River alluvial aquifer, and the Yazoo River. Ground water withdrawals for agricultural use (primarily irrigation) are made from the alluvial aquifer and surface water, with a majority coming from the alluvial aquifer.

Approximately 27,113 acres of land drain through Wolf Lake, with the watershed being predominantly rural and agricultural. Approximately 44% of the watershed is in production

agriculture, with the remaining 66% percent of watershed area split among bottomland hardwood forest, non-cropland (pasture, afforested cropland, etc.), aquaculture, and residential development. More than 2/3 of the watershed is comprised of highly productive soil types of the Dundee and Dubbs silty loam series of soils, which includes some moderate to extreme clay contents of the Alligator and Sharkey soil series. Agricultural run-off of sediments and nutrients of these soils is of particular concern to Wolf Lake users. Wolf Lake is a popular recreation destination for fishing, water skiing, wakeboarding and together with the increased recreational activity and development on Wolf Lake, has driven the need for water quality improvement as continual deposition of sediments and other non-point source pollutants into the lake from the surrounding watershed threatens the continuation of those activities.

There is not a routine water quality monitoring station in the Wolf Lake watershed. One major water quality study was conducted by FTN Associates in 1991 (FTN 1991). Data from that study indicated that Broad Lake was more turbid than Wolf Lake, algae populations were low in the spring and summer due to turbid conditions, and whole fish analyses indicated DDT to be persistent in Wolf Lake. Wolf Lake had a tendency to be more nutrient rich than other Delta lakes, with the majority of nitrogen, phosphorous, and sediment loads originating from agricultural activities. Although the FTN study is the most recent, other studies on pesticides, water quality, and fisheries have been completed. Summaries of these studies can be found in the 1991 FTN report on pages a.10-1 – a10.4.

The Wolf Lake watershed has been evaluated as impaired is included on the Mississippi 303 (d) List (MDEQ 2004). One total maximum daily load study (TMDLs) has been completed for sediment/siltation and organic enrichment/low dissolved oxygen (MDEQ 2003). There are

currently no numerical criteria for nutrient concentrations in Mississippi surface waters, so a TMDL for nutrients was not developed.

Best management practices can be used to help mitigate some of the harmful effects of erosion and sedimentation, and the goals of the Wolf Lake watershed plan can most likely be achieved through the implementation of agricultural BMPs. To reduce sediment loading, structural measures can be installed to allow sediment loads to “fall out” before reaching the lake. This can be done through the installation of sediment retention structures (grade stabilization structures, slotted board risers, slotted pipes, sediment basins) on the fields before they reach the drains. Sloughing and/or head cutting in main ditches can be addressed by stabilizing the ditch banks with alterations of slope, hydro-seeding, and installing low-grade weirs. Low-grade weirs are rip-rap structures that increase the hydraulic capacity of the drainage ditch and are an innovative technology that have great potential for sediment reduction (Kröger *et al.* 2008). All technologies employed and installed, increase hydraulic residence, decrease runoff velocity, and increase sedimentation.

A project was developed and undertaken by Mississippi State University in conjunction with Delta F.A.R.M. (Farmers Advocating Resource Management) and Mississippi Department of Environmental Quality to implement solutions associated with decreasing sediment concentrations in Wolf Lake. The current study evaluated temporal changes in turbidity and total suspended sediments (TSS) within Wolf Lake to monitor whether BMP installation within the watershed showed a downstream improvement in sediment load within the water column, and thus a water quality improvement to the lake as a whole.

Materials and Methods

Study Site

The Wolf Lake watershed is approximately 27,113 acres and is extremely rural and predominately agricultural. The watershed is underlain by Mississippi River alluvium. The topography of the watershed is primarily flat, with some ridge and swale topography provided by river terraces (MDEQ 2000). Approximately 44% of the watershed is in production agriculture, with the remaining 66% percent of watershed area split among bottomland hardwood forest, non-cropland (pasture, afforested cropland, etc.), aquaculture, and residential development. The geology of the watershed comprises highly productive soil types that include the Dundee and Dubbs silty loam series of soils. The balance of the soils are found to have moderate to extreme clay contents and include the Alligator and Sharkey soil series. Wolf Lake is a 417 hectare oxbow located in the Lower Mississippi Alluvial Valley (MAV) near Yazoo City, Mississippi ($32^{\circ}54'38.76''N$, $90^{\circ}27'39.72''W$) (Figure 1). The morphology of the lake is elongated with a varying length, depending on the water level, of approximately 13.8 km. Width similarly varies up to 0.3 km. Wolf Lake is known for highly turbid waters that are common throughout lakes in the region (McHenry *et al.* 1982). Similar to other lakes in the Mississippi Alluvial Valley, water conditions have been affected by past landscape modifications used to control flooding and support agriculture (Cooper and McHenry 1989, Cooper and Moore 2003, Cooper *et al.* 2003). Between June 2008 and September 2009 BMPs were put into place in pre-determined areas of the Wolf Lake Watershed based on accessibility, land-owner cooperation and site placement. Eighty (80) slotted pipes and 12 low grade weirs (Figure 2) were installed in various agricultural

ditches to decrease sediment/nutrient loads in run-off and slow down erosive processes in the watershed which in turn should lead to decreases in turbidity and TSS throughout Wolf Lake.

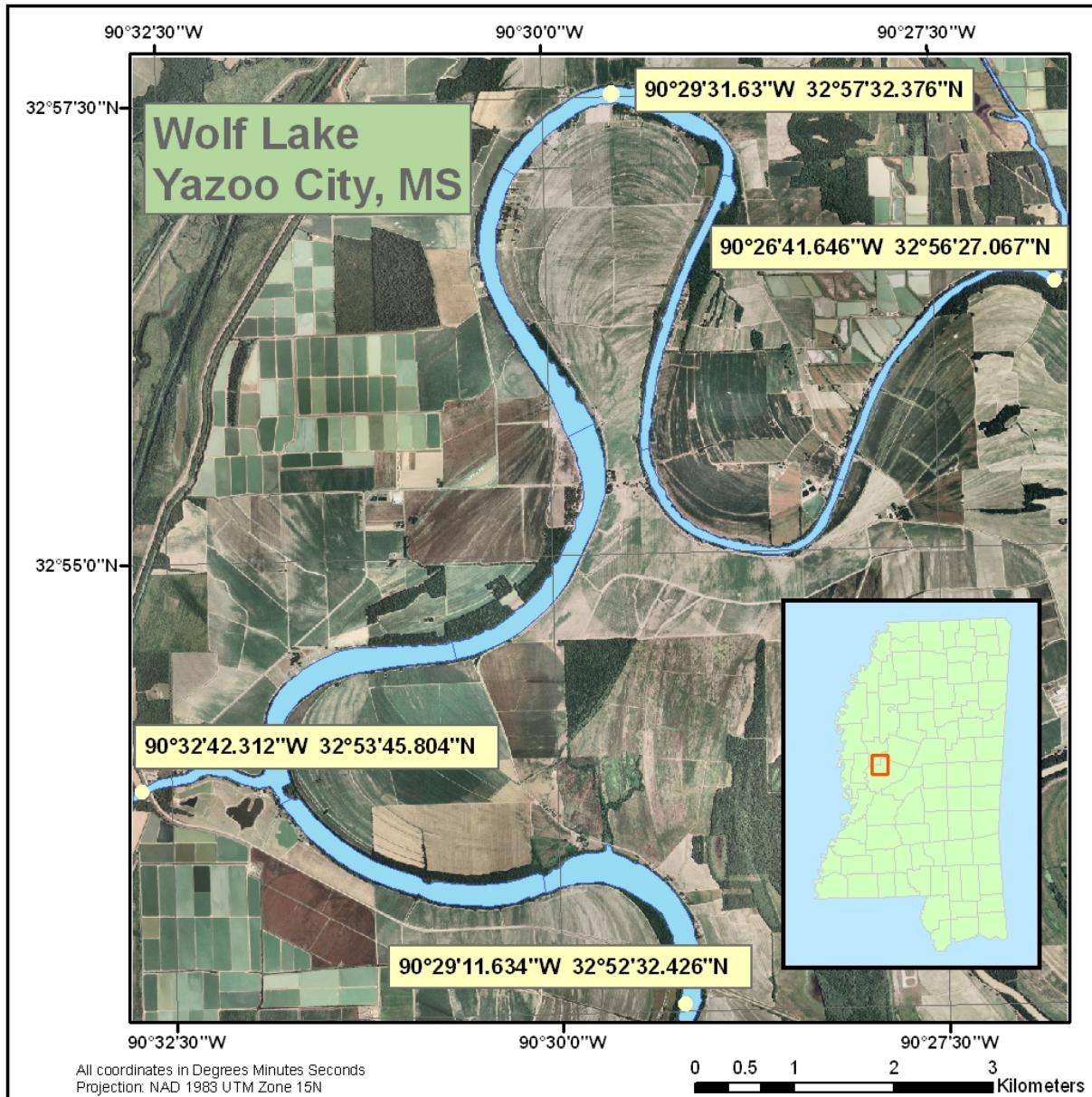


Figure 1. A GIS image of Wolf – Broad Lake complex illustrating position within Mississippi, and GPS co-ordinates within the lake.

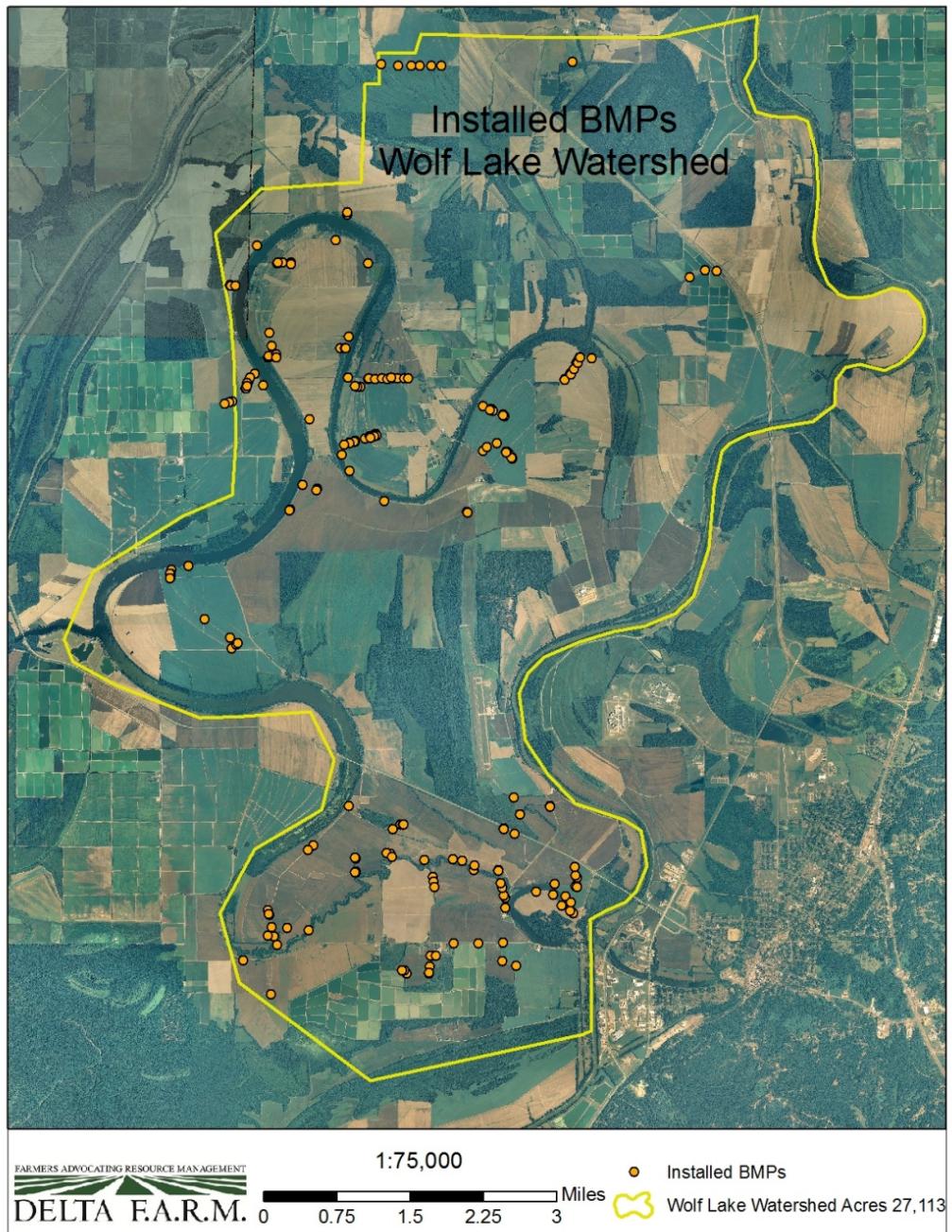


Figure 2. The Wolf Lake Watershed highlighting the installed BMPs from Delta F.A.R.M throughout the project. Site location, and BMP location were based on landowner cooperation as well as site accessibility.

Data Collection

To determine variability and distribution of turbidity and TSS within the lake, water samples were collected once a month from June 2008 to June 2010 using a Eureka Manta multiprobe (Eureka Environmental Engineering, Austin, TX). The multiprobe was attached to the boat, and a pumped, flow-through system, similar to the method used by Peterson (2007) was used to sample 0.3 m below the water surface of the lake. This system pumped small volumes of lake water from the lake, through a manufacturer supplied flow-cell which houses the sensors (from bottom to top), and back to the lake. Data were collected at 10 second intervals while traveling in a series of “zigzag” transects across the lake, similar to the methods used in Brydsten et al. (2004) (Figure 3).

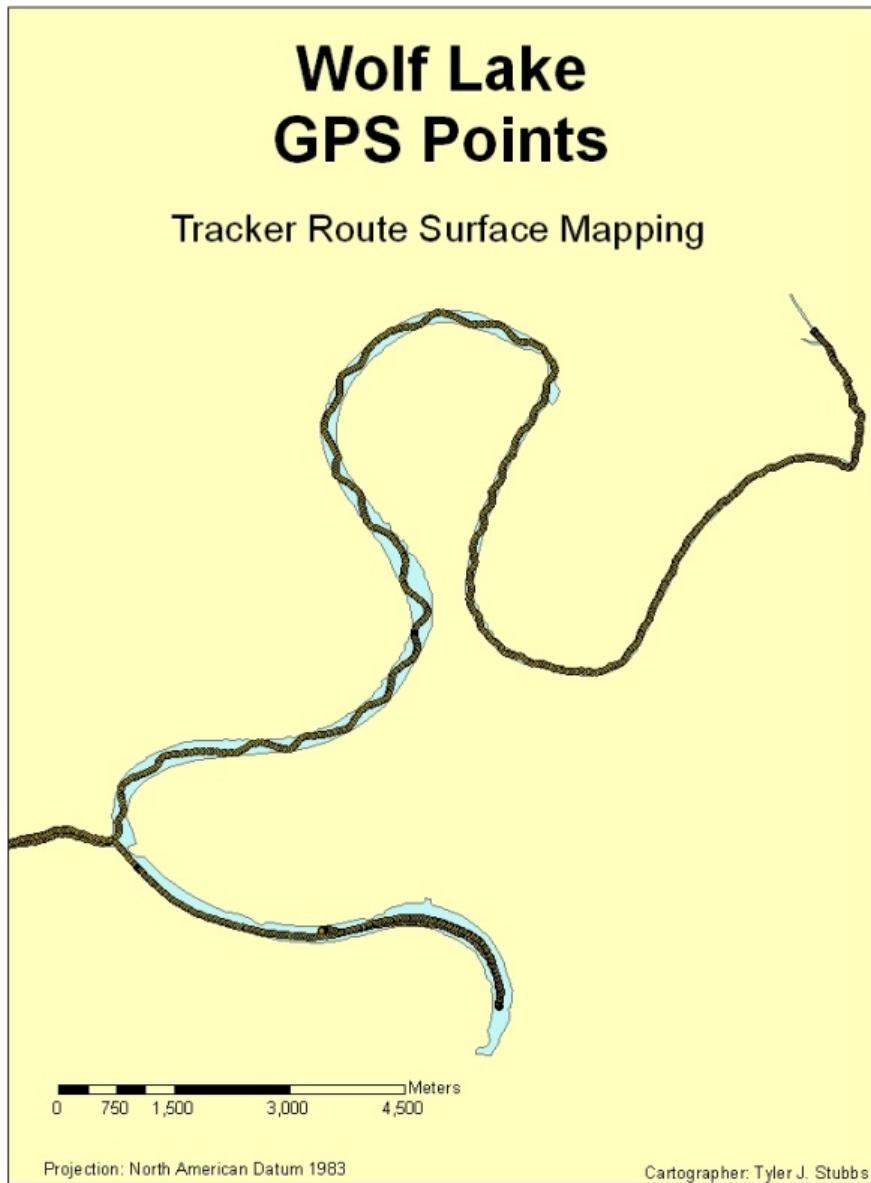


Figure 3. Tracker Route of automated datason for surface mapping of *in situ* water quality parameters of temperature, specific conductance, turbidity, dissolved oxygen and pH.

The Eureka Manta system simultaneously collected GPS coordinates along with water quality data at each time interval which allowed for the mapping of turbidity distributions across the surface of Wolf Lake. Cleaning and decontamination of Eureka Manta multi-probes and *in situ* Eureka Manta sampler, proper maintenance, deployment, and operation procedures were run according to the Eureka Manta Manual. Total suspended solids (TSS) samples were collected at 20 randomly selected locations monthly in conjunction with the surface water turbidity measurements, including required replicate and blank sampling for quality control/assurance. Grab samples were collected in 3-L (>500 ml) polyethylene cubitainers at the surface, at a depth < 0.5 m. The 20 collection sites were changed monthly to ensure appropriate representation of the conditions across the surface of the lake. Sampling locations were spatially stratified within Wolf Lake to ensure an adequate sampling of the entire lake. At each stratified sampling location, the sample was randomly taken. Samples were brought back and analyzed at the Mississippi State University (MSU) Department of Wildlife and Fisheries Water Quality Laboratory using Standard Method 2450D (EPA) (Appendix A). Grab samples were shaken in the field for homogenization and, once back in the lab, re-suspended to ensure homogeneity within the sample prior to analysis. Samples were refrigerated at 4°C if not analyzed immediately upon return. Water samples collected for TSS analysis did not require acidification preservation and were analyzed within seven days. Data quality was measured and evaluated in terms of the following specific data quality objectives: precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity. Those indicators were used to determine whether project data quality objectives had been achieved. One field duplicate sample was collected for every 10 random samples collected. For 20 samples collected there were two field duplicates and one lab duplicate per analysis run. Precision and accuracy of lab analyses

were assessed through routine analysis of duplicates and laboratory control samples. Results that were determined to be outside acceptance criteria required repeated analysis and/or sampling.

Data Analysis

ArcMap (ESRI 2010) was used to build water quality distribution maps to visualize the spatial distribution of turbidity throughout Wolf Lake (all months Appendix B). Spatial distribution maps of dissolved oxygen were also created and have been placed in Appendix C. Point data from each month during the study period ($n = 19$) collected with the Eureka multi-probe were plotted in ArcMap using GPS coordinates (latitude/longitude; ESRI 2010). For each month, turbidity values (NTU) were interpolated using Inverse Distance Weighting (IDW), using the lake edge as a barrier. Wolf Lake was divided into six reaches (five main channel sections and one outlet section) (Figure 4). Zonal statistics (count, area, minimum, maximum, range, mean, standard deviation, and sum) were calculated for each reach using the ArcGIS Spatial Analyst geoprocessing toolbox. Two sediment statistics were focused on: total suspended sediments (TSS) and turbidity.

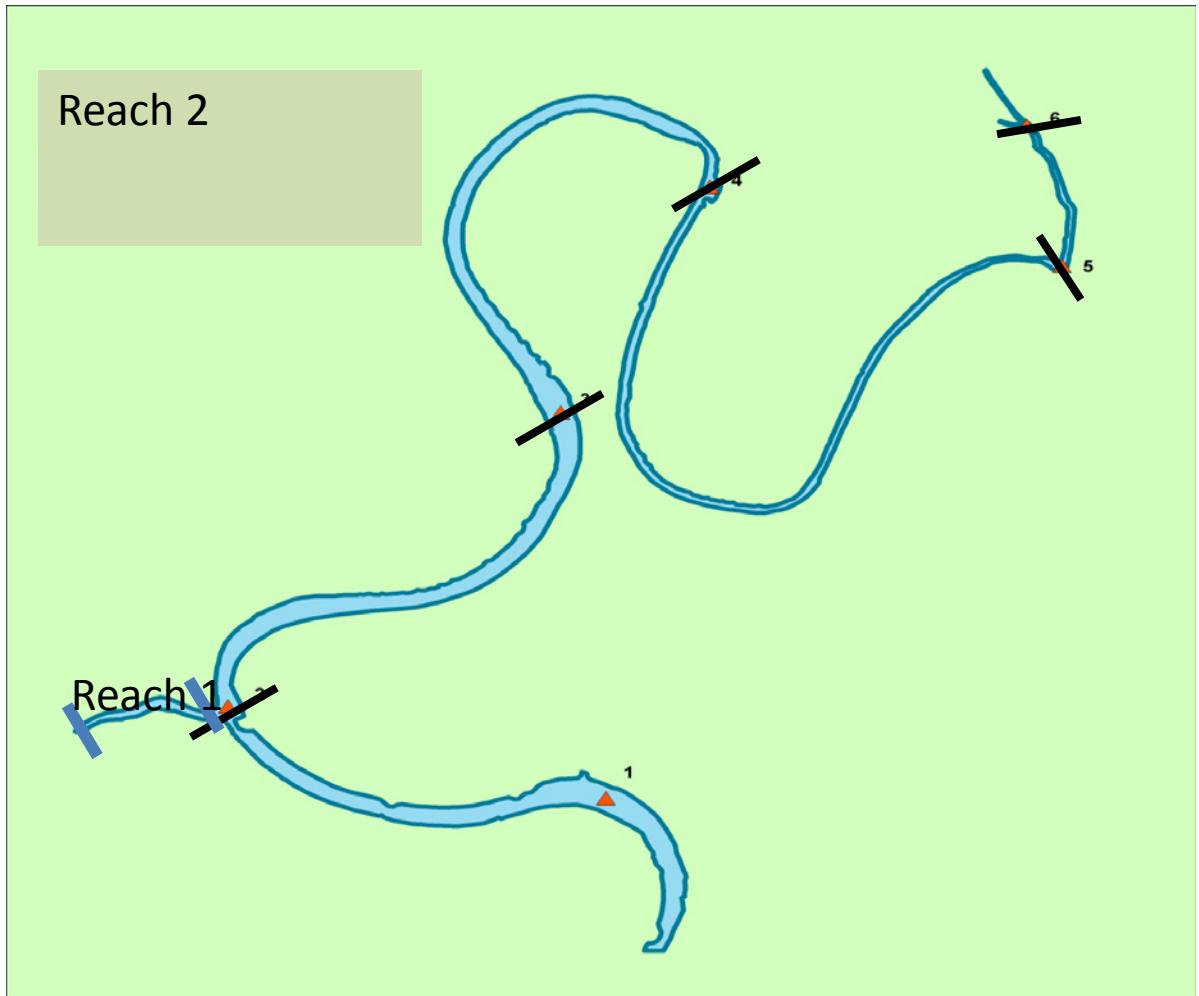


Figure 4. Delineated reaches within Wolf Lake

For turbidity and TSS statistical analysis, normal probability plots and Shapiro-Wilk values generated from Proc univariate (SAS Institute Inc 2008) were used to test assumptions of normality. The turbidity and TSS data were found to be significantly non-normal and various transformations were unable to normalize the data. As a consequence of the inability to normalize the turbidity data, a non-parametric Spearman correlation analysis (Proc Corr) was developed to examine possible correlation between mean turbidity and reach and mean reach depth. Mean and sum seven and two day precipitation measurements (inches), and mean seven and two day wind speeds prior to the monthly sampling date were also included in the correlation analysis for turbidity, as well as in a separate Spearman correlation involving TSS. Precipitation and wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County east of Yazoo City (approximately 20 miles directly east). For visual trend analysis, graphs of mean turbidity and TSS versus the different environmental variables across months of the study were created. A graph of mean TSS and turbidity versus two day wind direction (from the Mayday site) was also created, with a vector direction chosen between the two day wind direction vectors if they did not come from the same direction for both days. Due to the sinusoidal shape of Wolf Lake, however, inferences made from that graph were limited.

A non-parametric Kruskal-Wallis analysis (Proc npar1way) SAS Institute Inc., Cary N.C. 2008) was used to test for significant month-by-year effects on TSS and turbidity which could indicate the effectiveness of the BMPs in the Wolf Lake watershed. Models directly tested the effect of month-by-year on turbidity and TSS, as well as the effects of reach and mean reach depth on turbidity. Multiple Kruskal-Wallis analyses (Proc npar1way) (SAS Institute Inc 2008) were developed to test for significant differences in turbidity and TSS by corresponding months

before and after BMP implementation. All statistical analyses for both TSS and turbidity were run at an alpha value of 0.05.

Results

Results from the non-parametric Kruskal-Wallis analysis indicate a significant month-by-year effect on turbidity (Chi-square = 76.08, $P = 0.001$), but reach (Chi-square = 2.45, $P = 0.784$) and depth by reach (Chi-square = 2.44, $P = 0.784$) did not show significant effects on turbidity. Decreases in mean turbidity after the implication of BMPs were seen between November 2008 (mean turbidity= 72.27 NTU, SE = 31.14) and November 2009 (mean turbidity = 40.77 NTU, SE = 5.55) (Figure 5), December 2008 (mean turbidity = 296.18 NTU, SE = 50.46) and December 2009 (mean turbidity = 290.70 NTU, SE = 77.11) (Figure 6), and May 2009 (mean turbidity= 141.60 NTU, SE= 17.07) and May 2010 (mean turbidity = 93.70 NTU, SE = 8.43) (Figure 7). Comparing median turbidity values (more appropriate indicators of central tendency for non-normal data), the November 2008 (median turbidity = 38.34 NTU) to November 2009 (median turbidity = 40.21 NTU) interval showed an increase in median turbidity level, while the December 2008 (median turbidity = 268.15 NTU) to December 2009 (median turbidity = 231.63 NTU) and May 2009 (median turbidity = 161.15 NTU) to May 2010 (median turbidity = 96.34) intervals showed decreases in median turbidity levels. The May 2009 to May 2010 period was the only interval of the three above that was found to have a statistically significant decrease in turbidity (Chi-square = 4.59, $P = 0.032$). Interestingly, rainfall over July – October in 2009 had the largest summed precipitation in the state of Mississippi for more than 73 years. There was no statistical difference between median turbidity values between October 2008 (median turbidity = 88 NTU) and October 2009 (median turbidity = 85 NTU), while there was a statistical difference

(Chi-square = 8.34, $P = 0.001$) in daily summed rainfall (October 2008: 2.04"; October 2009: 11.04") (Figure 8).

Mean seven and two day precipitation values were similar for months in each time interval, but mean seven and two day winds speeds differed between months within each time interval (Table 1). Though the variable reach did not significantly affect turbidity, Table 2 shows a large discrepancy in mean turbidity levels for Reach 1 as compared to all of the other reaches. Median turbidity levels, however, did not differ as greatly between reaches which may be an indication of large ranges of turbidity values and significantly non-normal turbidity data by reach.

Results from the Spearman correlation analysis indicate significant correlations between turbidity and mean two day ($r^2 = 0.53, P < 0.05$) and seven day ($r^2 = 0.38, P < 0.05$) wind speeds (Figures 9 and 10). All other variables considered in the analysis showed no significant correlation with turbidity ($P > 0.05$), including mean two day and summed seven day precipitation. Figure 11 highlights how a northerly wind may lead to larger turbidity levels on Wolf Lake. Due to small sample sizes of turbidity measurements by direction, no statistical comparisons could be performed and results should be interpreted only for possible trends and further analysis in the future.

For TSS, the Kruskal-Wallis non-parametric analysis indicated a significant month-by-year affect on mean TSS (Chi-square= 362.15, $P < 0.05$). Decreases in mean TSS after the implication of BMPs were seen between July 2008 (mean TSS= 15.38 mg/L, SE= 2.95) and July 2009 (mean TSS= 14.45 mg/L, SE= 4.40), November 2008 (mean TSS= 31.50 mg/L, SE= 1.96) and November 2009 (mean TSS= 18.08 mg/L, SE= 0.81), December 2008 (mean TSS= 175.80 mg/L, SE= 17.85) and December 2009 (mean TSS= 172.44 mg/L, SE= 24.24), April 2009 (mean

TSS= 103.20, SE= 10.36) and April 2010 (mean TSS= 57.54, SE= 8.29), and May 2009 (mean TSS= 98.49 mg/L, SE= 5.65) and May 2010 (mean TSS= 37.34 mg/L, SE= 7.47)(Figure 12). Median TSS levels for all intervals above also decreased during the given time periods. Pair-wise Kruskal-Wallis analysis of the above intervals showing decreases in mean TSS found that only the November 2008 to November 2009 (Chi-square= 23.89, $P < 0.05$), April 2009 to April 2010 (Chi-square= 8.22, $P = 0.004$), and May 2009 to May 2010 (Chi-square= 22.71, $P < 0.05$) intervals showed statistically significant decreases in mean TSS after BMP implementation.

Spearman correlation analysis for TSS indicated significant correlations between TSS and mean two day ($r^2 = 0.62$, $P = 0.002$) and seven day ($r^2 = 0.51$, $P = 0.014$) wind speeds (Figures 13 and 14). All other variables used in the analysis, including mean and summed two and seven day precipitation, did not show significant correlation with TSS ($P > 0.05$). Interestingly, a spearman correlation analysis of rainfall and TSS pre-BMP implementation (June 2008 - July 2009), showed statistically significant correlations between summed and mean seven day precipitation ($r^2 = 0.126$; $P = 0.04$). A spearman correlation analysis between rainfall and TSS post-BMP implementation (August 2009 – June 2010) showed no statistically significant correlations between TSS and rainfall (mean and summed two and seven day). Looking at Figure 15, it appears that a northerly wind may lead to larger TSS levels on Wolf Lake which is similar to what was found for turbidity. Like the turbidity analysis, small sample sizes of TSS measurements by direction made statistical comparisons of TSS by wind direction inappropriate and results should be interpreted only for possible trends and further analysis in the future.

Table 1. Environmental parameter averages and associated standard errors used for Spearman correlation analyses with turbidity and TSS. Precipitation and wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County, east of Yazoo City.

Sample Date	Mean 7-Day Precipitation (Inches)	Standard Error	Mean 2-Day Precipitation (Inches)	Standard Error	Mean 7-Day Wind Speed (MPH)	Standard Error	Mean 2-Day Wind Speed (MPH)	Standard Error
05/29/08	0.16	0.14	0.07	0.06	5.94	0.64	6.70	0.40
07/22/08	0.00	0.00	0.00	0.00	2.61	0.18	2.10	0.10
08/08/08	0.18	0.11	0.00	0.00	3.80	0.44	3.00	0.50
09/07/08	0.54	0.30	0.06	0.06	7.23	1.48	5.25	0.95
10/30/08	0.26	0.25	0.00	0.00	5.60	0.98	7.05	2.85
11/21/08	0.05	0.05	0.00	0.00	5.37	1.07	5.55	1.05
12/13/08	0.77	0.45	1.28	0.75	9.61	1.94	15.00	0.40
01/29/09	0.04	0.04	0.00	0.00	7.36	1.01	6.30	2.10
02/20/09	0.06	0.05	0.05	0.05	7.47	1.43	11.40	3.40
03/05/09	0.04	0.03	0.00	0.00	10.54	1.37	7.00	1.40
04/17/09	0.07	0.07	0.00	0.00	9.64	1.36	6.25	0.95
05/10/09	0.62	0.33	0.01	0.00	6.59	0.68	7.10	1.70
06/28/09	0.00	0.00	0.00	0.00	3.27	0.32	2.10	0.40
07/08/09	0.01	0.00	0.01	0.01	4.10	0.53	5.45	1.15
10/30/09	0.16	0.09	0.29	0.28	4.96	1.09	4.95	0.15
11/18/09	0.05	0.05	0.18	0.18	3.91	1.29	3.20	1.90
12/10/09	0.29	0.21	0.92	0.58	5.80	1.08	8.05	2.95
01/27/10	0.15	0.07	0.02	0.02	7.66	0.83	7.40	1.20
02/17/10	0.08	0.05	0.11	0.11	5.54	1.28	7.15	2.35
03/10/10	0.00	0.00	0.00	0.00	4.77	1.22	3.70	0.99
04/21/10	0.00	0.00	0.01	0.01	5.00	0.72	6.30	1.90
05/25/10	0.23	0.15	0.00	0.00	4.70	0.68	3.40	0.60
06/11/10	0.04	0.03	0.02	0.02	4.64	0.51	4.25	0.25

Table 2. Mean and median turbidity values with associated standard errors for the six reaches of Wolf Lake, near Yazoo City, Mississippi. Sampling took place from June 2008 thru June 2010.

Reach	Mean Turbidity (NTU)	Median Turbidity (NTU)	Standard Error
1	233.49	152.16	54.65
2	143.47	176.49	20.42
3	144.48	159.25	22.79
4	144.96	128.18	29.03
5	129.17	107.63	23.59
Outlet	138.46	177.21	29.15

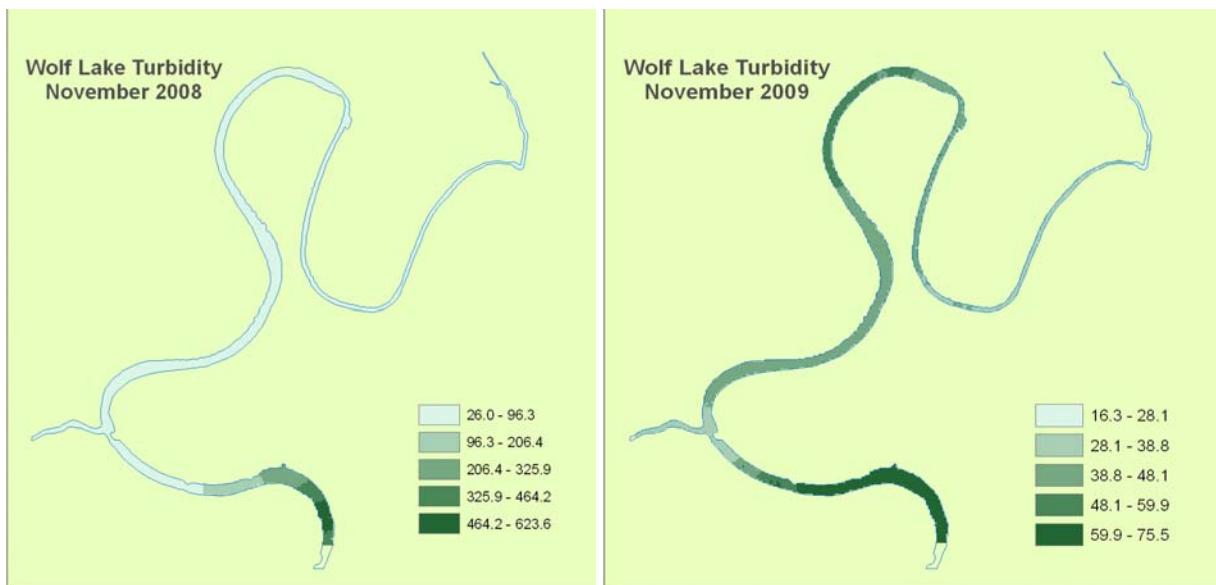


Figure 5. Maps showing changes in turbidity ranges (NTU) in Wolf Lake for November 2008 to November 2009. Best management practices (BMPs) were implemented in the Wolf Lake watershed from August 2008 thru June 2009.

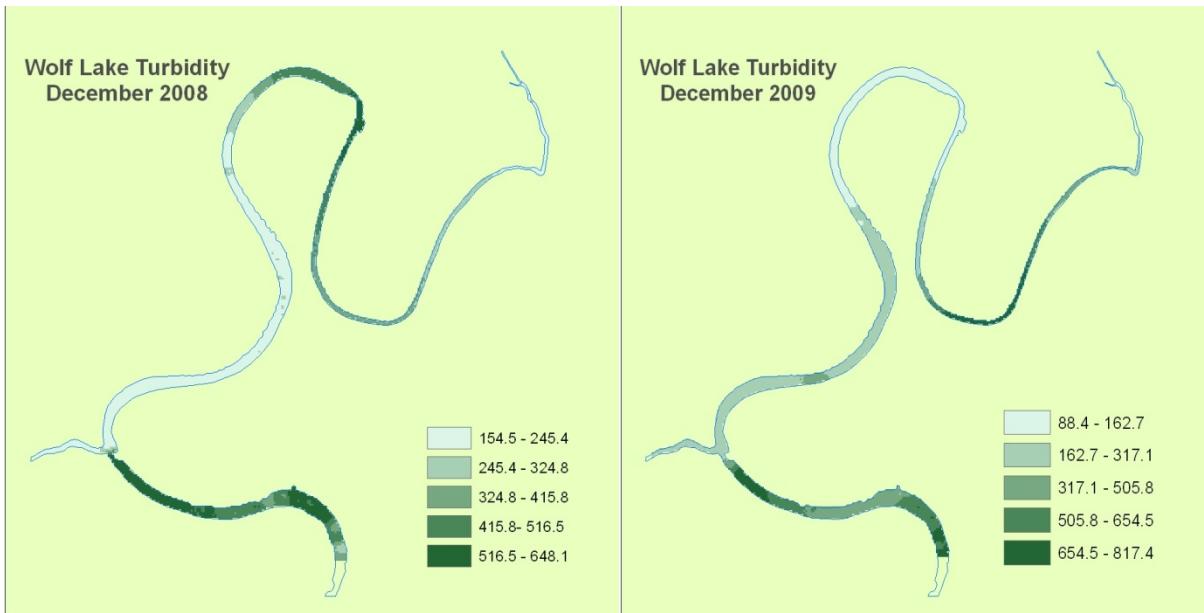


Figure 6. Maps showing changes in turbidity ranges (NTU) in Wolf Lake for December 2008 to December 2009. Best management practices (BMPs) were implemented in the Wolf Lake watershed from August 2008 thru June 2009.

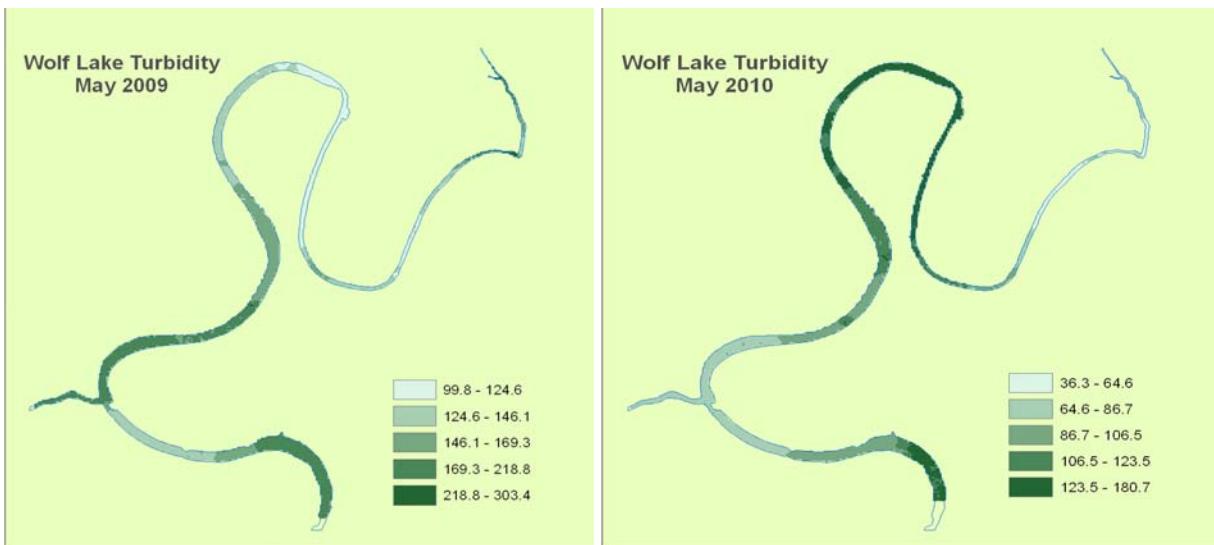


Figure 7. Maps showing changes in turbidity ranges (NTU) in Wolf Lake for May 2009 to May 2010. Best management practices (BMPs) were implemented in the Wolf Lake watershed from August 2008 thru June 2009.

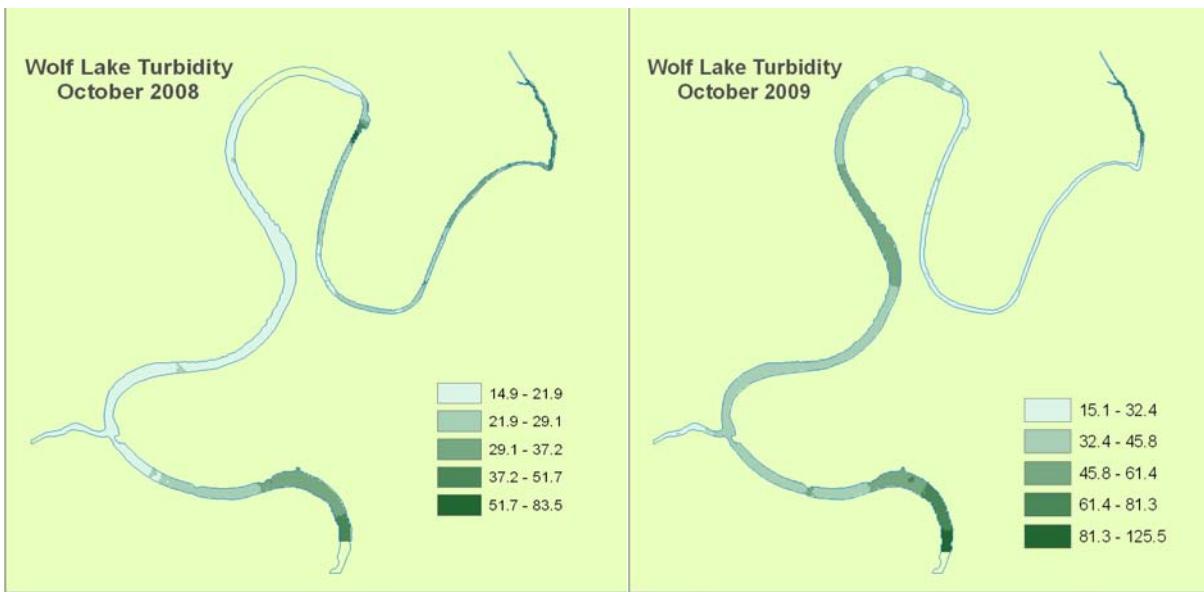


Figure 8. Maps showing changes in turbidity ranges (NTU) in Wolf Lake for October 2008 to October 2009. Best management practices (BMPs) were implemented in the Wolf Lake watershed from August 2008 thru June 2009, while Mississippi experience the highest summed rainfall in a 73 year history between July and October 2009.

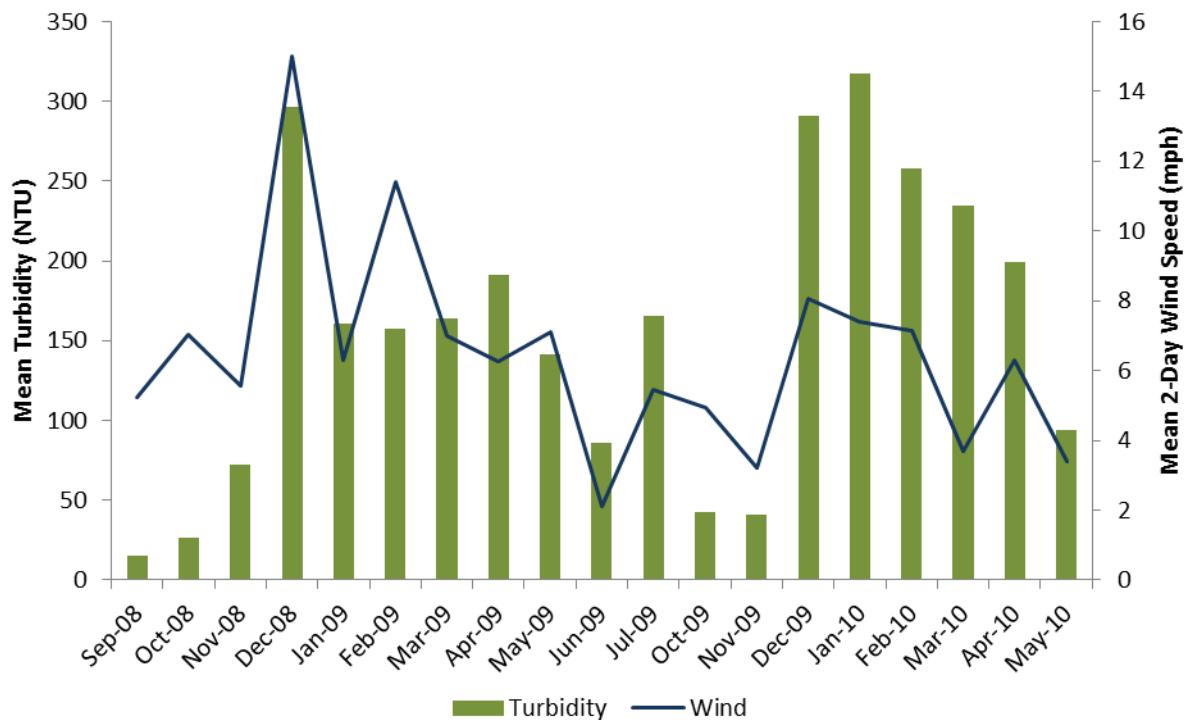


Figure 9. Mean turbidity levels (NTU) for Wolf Lake by month with mean two day wind speeds (mph) prior to sampling dates. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County, east of Yazoo City.



Figure 10. Mean turbidity levels (NTU) for Wolf Lake by month with mean seven day wind speed (mph) prior to sampling dates. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County, east of Yazoo City.

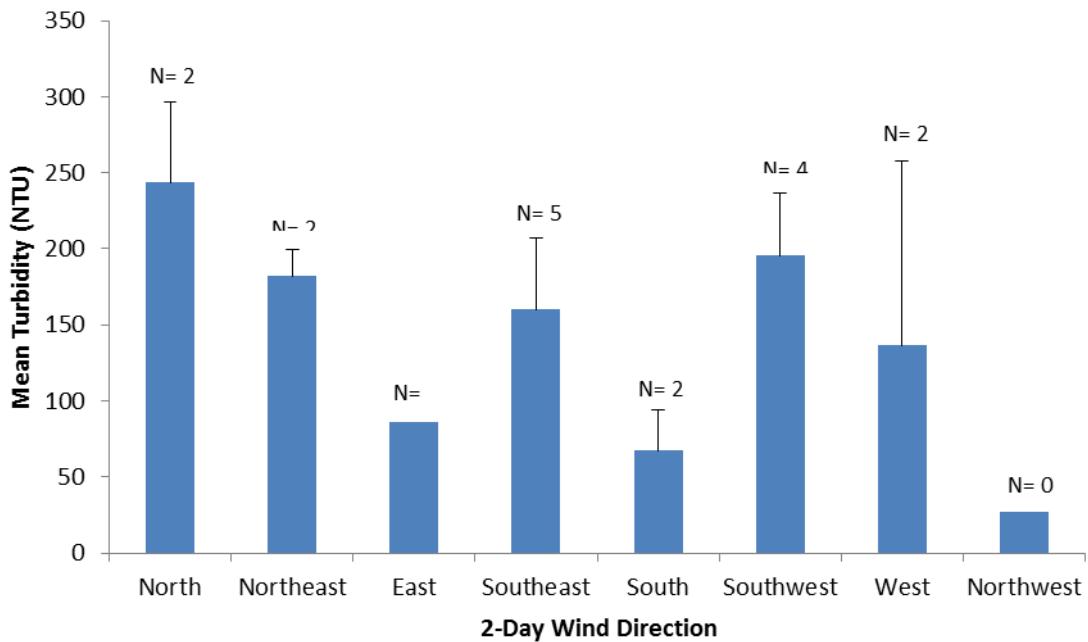


Figure 11. Mean turbidity levels (NTU) for Wolf Lake by mean two day wind direction. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County, east of Yazoo City.

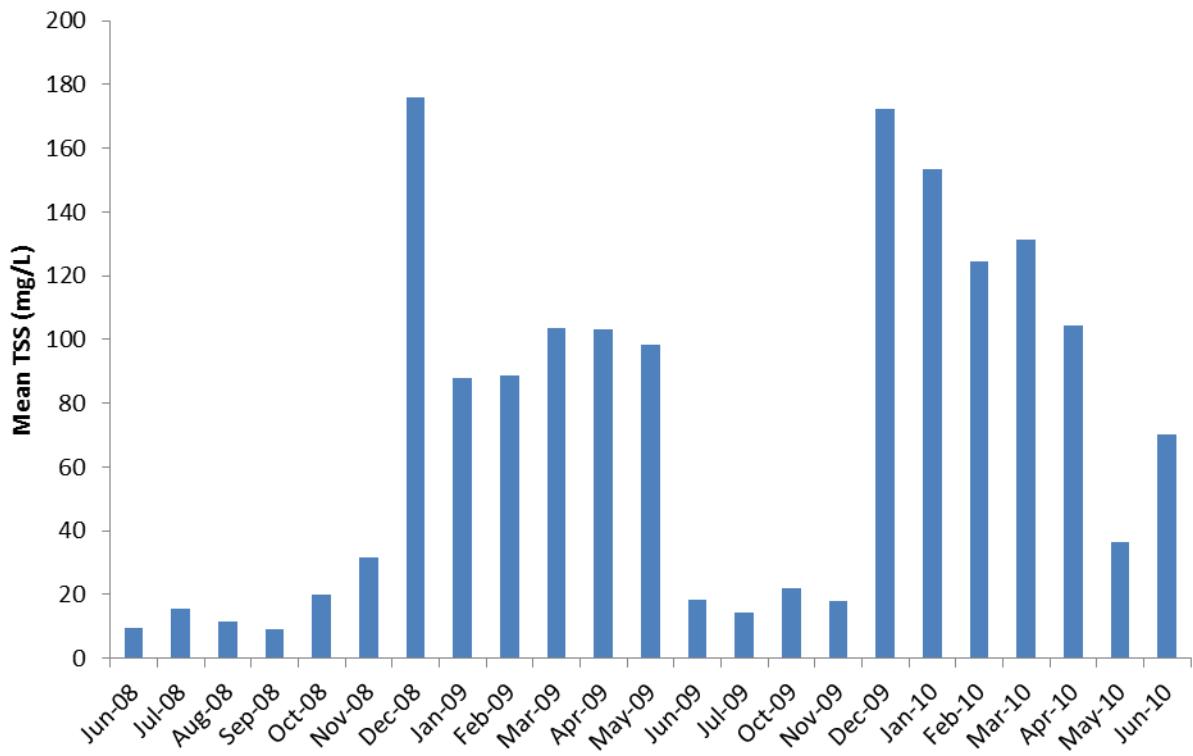


Figure 12. Mean TSS levels (mg/L) for Wolf Lake by month. Best management practices (BMPs) were implemented in the Wolf Lake watershed from August 2008 thru June 2009.

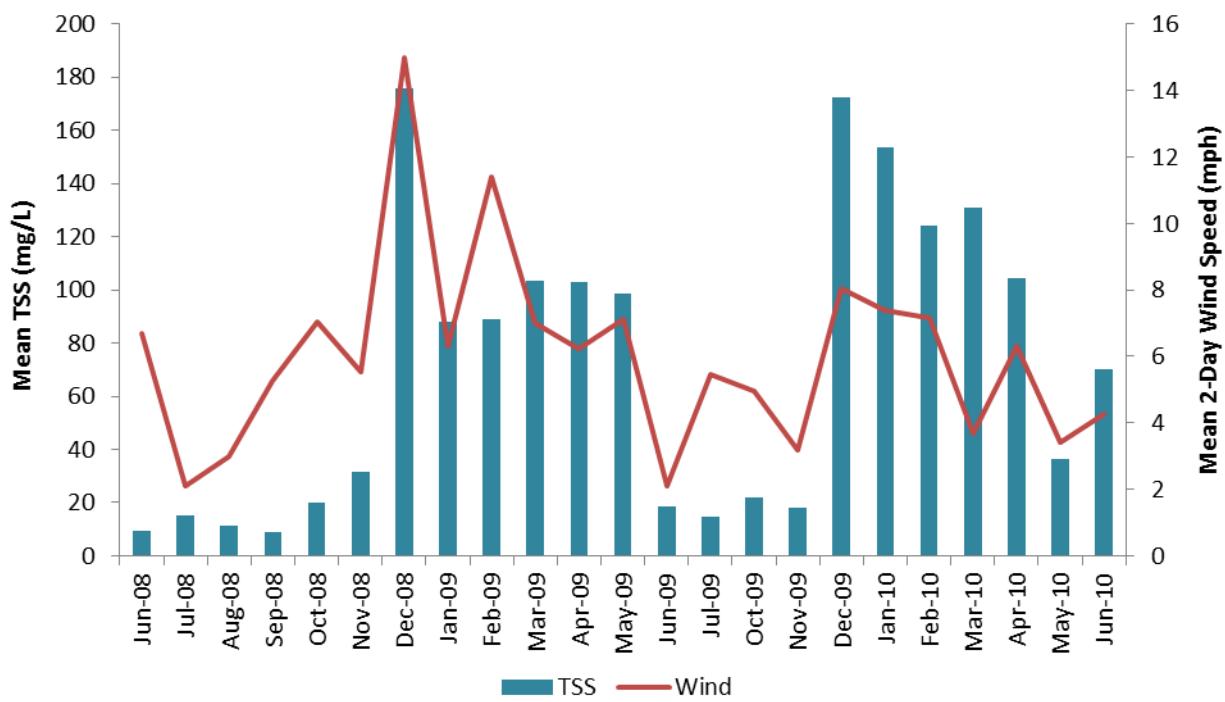


Figure 13. Mean TSS levels (mg/L) for Wolf Lake by month with mean two day wind speed (mph) prior to sampling dates. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County east of Yazoo City.

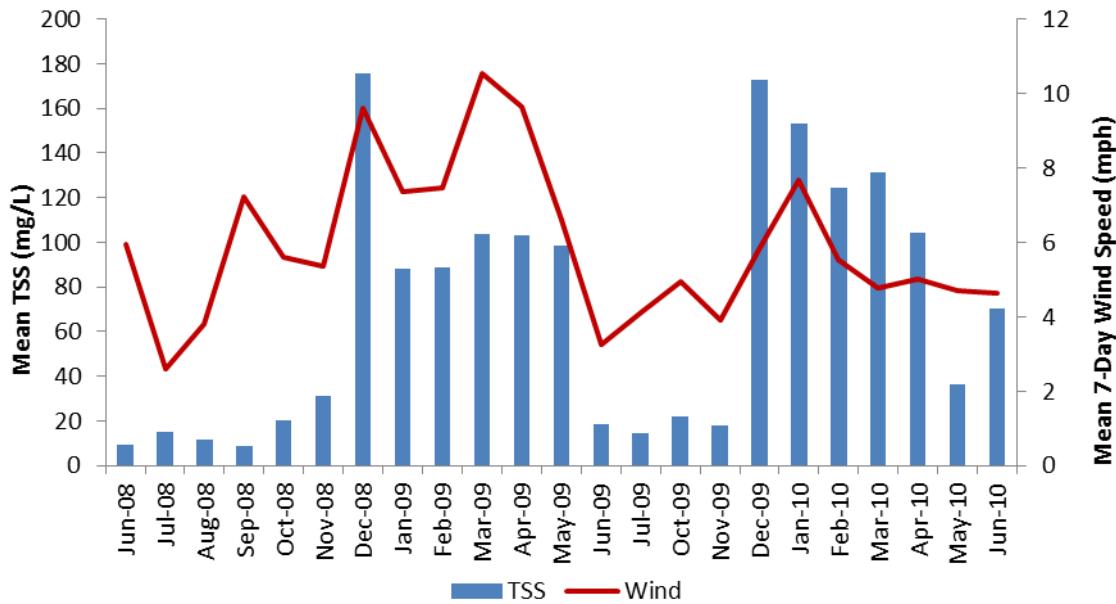


Figure 14. Mean TSS levels (mg/L) for Wolf Lake by month with mean seven day wind speed (mph) prior to sampling dates. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County north of Yazoo City.

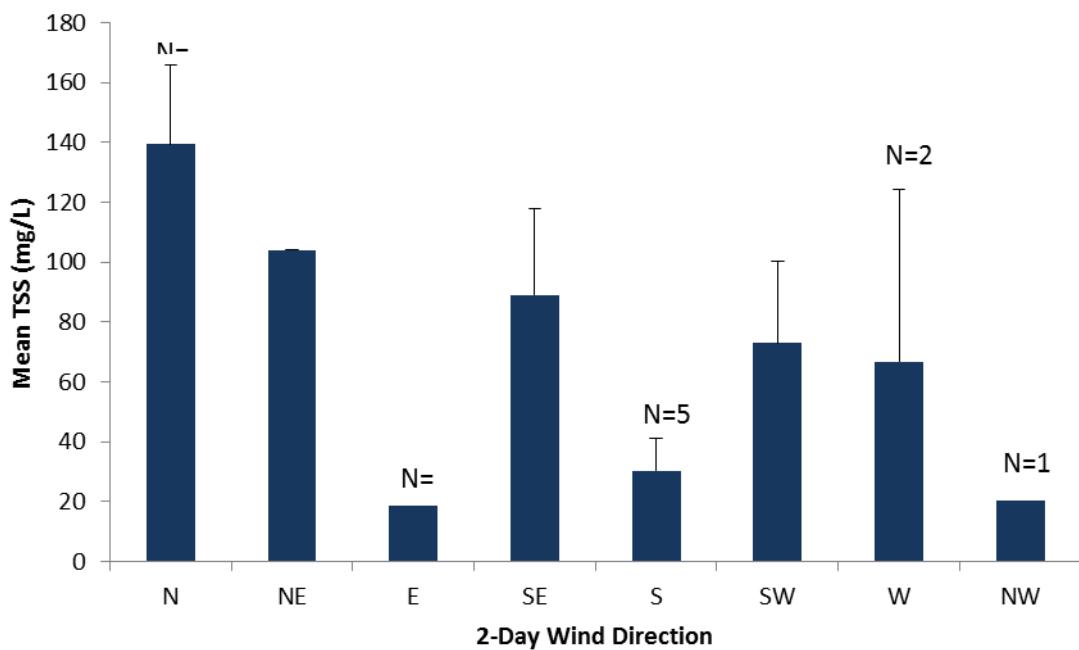


Figure 15. Mean TSS levels (mg/L) for Wolf Lake by mean two day wind direction. Wind data were collected from the USDA SCAN site at Mayday, which is in Yazoo County east of Yazoo City.

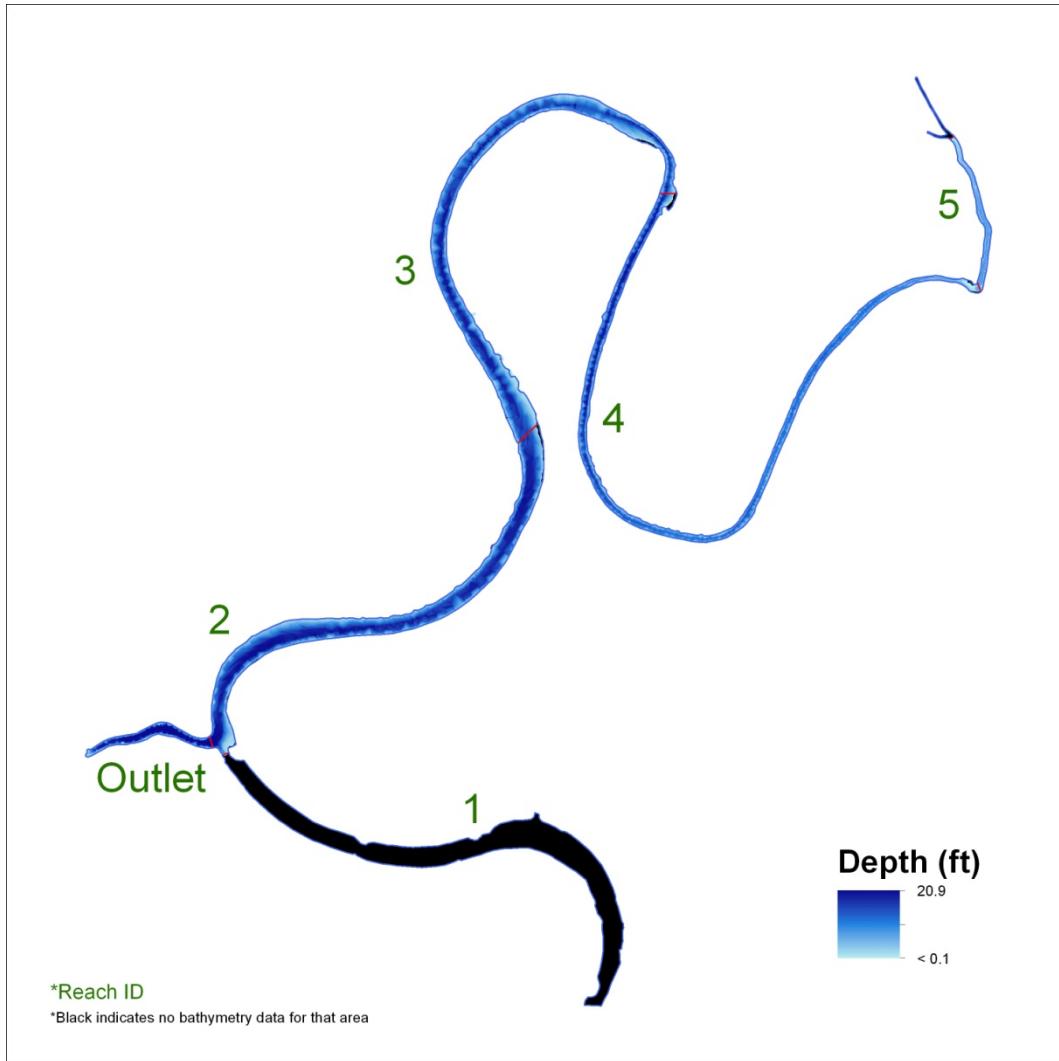


Figure 16. Bathymetry map of Wolf and Broad Lake split by reach. The sinusoidal shape shows longitudinal variations in depth as well as lateral gradient along the old river channel. Reach 1 has no depth data associated with it.

Discussion

In several watersheds nonpoint source pollutants, typically from agriculture, are major contributors to water quality problems (Moore *et al.* 2001, Park *et al.* 1994, Sharpley *et al.* 2000). The implementation of best management practices (BMPs) in landscapes that avoid, control or trap nonpoint source pollutants before runoff reaches downstream ecosystems is a viable management strategy to improve downstream water quality (Watson *et al.* 1994). Demonstrating this success of implementation on downstream water quality is vital for understanding how management translates to environmental integrity improvement. This management for water quality is no more vitally important than in the Mississippi River Basin where runoff and degraded water conditions result in hypoxic conditions in the Gulf of Mexico, resulting in severe economic and environmental consequences.

The EPA 319 (h) program office has provided funds that are used for improving watersheds landscape management to decrease and create attainable water quality conditions in 303(d) impaired waters. Wolf Lake is a listed 303(d) impaired water body in the Delta region of Mississippi (FTN 1991, MDEQ 2003, MDEQ 2004), and this current projects objective was to demonstrate significant improvements in TSS and turbidity within Wolf Lake through BMP implementation. The majority of BMPs installed advocated increasing hydraulic residence time on the landscape (Cooper and Lipe 1992) by installing slotted pipe and drop pipe structures on the edge of field, creating improved drainage channels with herbaceous vegetation, and installing low-grade weirs within the drainage channels (Kröger *et al.* 2008). Environmental circumstances, however, can reduce the ability to detect water quality improvements and thus success of BMP implementation and 319(h) fund appropriation. Though there were several instances where distinct improvements of water quality occurred, significant correlations to unmanageable

environmental variables suggests that external factors could bias data collection and ultimate success determination, and TMDL attainment within Wolf Lake.

Demonstration of success suggests measurable and statistical decreases in TSS and turbidity levels through time as a direct result of BMP implementation. From May 2009 (during BMP implementation) to May 2010 (6-10 months post implementation) there were statistically significant declines in TSS and turbidity. There was no statistical difference between median turbidity values between October 2008 (median turbidity = 88 NTU) and October 2009 (median turbidity = 85 NTU); however, there was a statistical difference (Chi-square = 8.34, $P = 0.001$) in daily summed rainfall between months (October 2008: 2.04"; October 2009: 11.04") (Figure 16). This suggests that even though rainfall and runoff had increased fivefold, there was no commensurate increase in TSS or turbidity. This lack of increase in sediments can only be explained by structures on the landscape, retaining water, slowing water, and increasing sedimentation. Other months showed no statistical differences in TSS and turbidity concentrations pre and post BMP implementation. Difficulty arises when temporal periods of BMP success have not been adequately defined in the scientific community. Questions arise to how long post BMP installation would be adequate for statistically significant differences to be documented? Interestingly a study by Cooper et al. (2003) and Knight et al. (*in press*) on Beasley lake, in the Mississippi Delta, has showed statistically significant declines in lake TSS levels as a result of BMP implementation in the watershed. These results, if documented and published within three years of project initiation, would have shown negligible effects of BMP implementation on TSS levels in Beasley Lake. Only 15 years of data collection on the site has shown a significant declining trend of TSS with time. This lag period has been classified as a transitional-period condition (Walker 1994, Walker and Graczyk 1993). This transitional period

recognizes that BMP implementation and effectiveness are not mutually exclusive. There is a certain time period required for the system with BMPs implemented, to mature, stabilize and begin to provide effective non-point source pollutant mitigation. Early success in demonstrating statistical differences within the transitional period documents the benefit of BMP implementation; however, longer monitoring will provide a greater understanding of the effectiveness of BMP implementation.

BMP implementation / pre – post demonstration of success

Often it is difficult to demonstrate success in improvements to water quality with BMP implementation within limited temporal periods. This study has documented that external environmental conditions play significant roles in demonstrating BMP success. The current study highlighted no significant relationships between TSS or turbidity and mean or summed two day or seven day rainfall. There were, however, statistically significant correlations between lake TSS and turbidity levels and mean two day and seven day wind speeds (Turbidity: $r^2= 0.62, P= 0.002$; $r^2= 0.51, P= 0.014$; TSS: ($r^2= 0.53, P< 0.05$; $r^2= 0.38, P< 0.05$). This suggests that though BMP implementation advocated a reduction in sediment load being delivered to Wolf Lake, monitoring efforts towards documenting this decline were thwarted by wind conditions increasing lake turbidity and TSS. The fetch and sinuosity of Wolf Lake, as well as shallow reaches (Figure 16) provided perfect conditions for wind to create turbulent, agitated conditions that consistently suspend sediments throughout the water column. Wolf Lake has a maximum depth of 20 ft, creating a median lake depth of 8 ft. The long fetch reaches of Wolf Lake, and the increased edge to surface area ratio due to sinuosity suggests that monitoring declines in TSS and turbidity would be difficult. Interestingly dividing the spearman correlation in time for pre-BMP implementation (June 2008 – July 2009) and post BMP implementations (August 2009 – June

2010) shows statistical differences in the relationship between TSS and rainfall. Pre-BMP, mean or summed precipitation was positively correlated with TSS levels in Wolf Lake (i.e., higher rainfall resulted in higher TSS concentrations). Post-BMP, however, this correlation was not statistically significant. The cause and effect of BMP implementation, reductions of TSS and lack of correlation with rainfall cannot be inferred, though the result suggests that BMP implementation maybe a factor in controlling lake TSS levels.

Furthermore, an added human dimension also limits the success of monitoring changes to sediment characteristics within Wolf Lake. Wolf Lake is a popular destination for recreational water sports such as waterskiing and wakeboarding. The longitudinal nature of Wolf Lake lends itself to ideal water skiing and wakeboarding conditions during the spring and summer months. Through personal observation, a busy weekend of recreational activities over the summer could elevate TSS and turbidity values. Increased turbulence from props, boat and skier wakes stirring shallow littoral zone sediments and general overall mixing of the water column in three dimensions (lateral, vertical and longitudinal) will increase TSS and turbidity levels within Wolf lake, and could artificially elevate and thus bias or skew interpretations of BMP success.

Proposed recommendations for Wolf Lake

It is clear that the temporal aspect of TSS monitoring within Wolf Lake has limited the ability to determine the documentation of success of TSS reductions through BMP implementation. This lack of documentation could be a result of two distinct temporal lags. The first time lag is BMP post installation maturity. There is no evidence as yet that documents changes in sediment and other pollutant reductions with BMP installations with time. Theory suggests that the settling and stabilization of the installed BMP and the surrounding disturbed landscape, with time, will only improve reduction efficiency. The second time lag is the time lag

associated with BMP reductions and measurable concentration reductions in Wolf Lake. Scientific evaluations of management practice studies in the Delta from the USDA-ARS have shown only measurable, and significant decreases in *in-lake* TSS concentrations with extended temporal monitoring of the system (at least 5 years). This monitoring was not time or labor intensive, but occurred at fixed spatial locations with a fixed temporal sampling schedule. This routine through time has shown declining trends in TSS, with measured spikes correlated with peaks in rainfall and or other external environmental conditions. Furthermore, this study showed no statistical relationship between TSS and rainfall (mean or summed) post BMP installation. Though the number of data points for that correlation was only 10. More data points with time, will increase the power and strength of the correlation analysis and provide a more definitive demonstration of success in terms of BMP installation and *in-lake* TSS levels.

Conclusion

When determining and demonstrating success of BMP implementation with downstream improvements of water quality, it is important to holistically interpret environmental circumstances within each watershed. Important components of the environment (i.e. wind conditions), recreation (water skiers) and time are three major factors that contribute a significant amount of variation to overall TSS and turbidity loads within an aquatic system, specifically Wolf Lake. Best Management practices that increase hydraulic residence time on the agricultural landscape, slow runoff velocities and increase sedimentation are beneficial to decreasing downstream effects of suspended sediment loads. The probability of demonstrating this success will improve with increased temporal monitoring of the Lake system, as well as being cognizant at the outset of potential bias from environmental stochasticity.

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Appendix A

Standard Method 2540 D determination of Total Suspended Solids

Standard Methods for the Examination of Water and Wastewater

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2540 SOLIDS# (1)*

2540 A. Introduction

Solids refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and may induce an unfavorable physiological reaction in the transient consumer. For these reasons, a limit of 500 mg dissolved solids/L is desirable for drinking waters. Highly mineralized waters also are unsuitable for many industrial applications. Waters high in suspended solids may be esthetically unsatisfactory for such purposes as bathing. Solids analyses are important in the control of biological and physical wastewater treatment processes and for assessing compliance with regulatory agency wastewater effluent limitations.

1. Definitions

“Total solids” is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids includes “total suspended solids,” the portion of total solids retained by a filter, and “total dissolved solids,” the portion that passes through the filter. The type of filter holder, the pore size, porosity, area, and thickness of the filter and the physical nature, particle size, and amount of material deposited on the filter are the principal factors affecting separation of suspended from dissolved solids. “Dissolved solids” is the portion of solids that passes through a filter of 2.0 µm (or smaller) nominal pore size under specified conditions. “Suspended solids” is the portion retained on the filter. “Fixed solids” is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called “volatile solids.” Determinations of fixed and volatile solids do not distinguish precisely between inorganic and organic matter because the loss on ignition is not confined to organic matter. It includes losses due to decomposition or volatilization of some mineral salts. Better characterization of organic matter can be made by such tests as total organic carbon (Section 5310), BOD (Section 5210), and COD (Section 5220). “Settleable solids” is the term applied to the material settling out of suspension within a defined period. It may include floating material, depending on the technique (Section 2540F.3b).

2. Sources of Error and Variability

Sampling, subsampling, and pipeting two-phase or three-phase samples may introduce serious errors. Make and keep such samples homogeneous during transfer. Use special handling to insure sample integrity when subsampling. Mix small samples with a magnetic stirrer. If suspended solids are present, pipet with wide-bore pipets. If part of a sample adheres to the sample container, consider this in evaluating and reporting results. Some samples dry with the formation of a crust that prevents water evaporation; special handling is required to deal with this. Avoid using a magnetic stirrer with samples containing magnetic particles.

The temperature at which the residue is dried has an important bearing on results, because weight losses due to volatilization of organic matter, mechanically occluded water, water of crystallization, and gases from heat-induced chemical decomposition, as well as weight gains due to oxidation, depend on temperature and time of heating. Each sample requires close

attention to desiccation after drying. Minimize opening desiccator because moist air enters. Some samples may be stronger desiccants than those used in the desiccator and may take on water. Residues dried at 103 to 105°C may retain not only water of crystallization but also some mechanically occluded water. Loss of CO₂ will result in conversion of bicarbonate to carbonate. Loss of organic matter by volatilization usually will be very slight. Because removal of occluded water is marginal at this temperature, attainment of constant weight may be very slow. Residues dried at 180 ± 2°C will lose almost all mechanically occluded water. Some water of crystallization may remain, especially if sulfates are present. Organic matter may be lost by volatilization, but not completely destroyed. Loss of CO₂ results from conversion of bicarbonates to carbonates and carbonates may be decomposed partially to oxides or basic salts. Some chloride and nitrate salts may be lost. In general, evaporating and drying water samples at 180°C yields values for dissolved solids closer to those obtained through summation of individually determined mineral species than the dissolved solids values secured through drying at the lower temperature. To rinse filters and filtered solids and to clean labware use Type III water. Special samples may require a higher quality water; see Section 1080. Results for residues high in oil or grease may be questionable because of the difficulty of drying to constant weight in a reasonable time. To aid in quality assurance, analyze samples in duplicate. Dry samples to constant weight if possible. This entails multiple drying-cooling-weighing cycles for each determination. Analyses performed for some special purposes may demand deviation from the stated procedures to include an unusual constituent with the measured solids. Whenever such variations of technique are introduced, record and present them with the results.

3. Sample Handling and Preservation

Use resistant-glass or plastic bottles, provided that the material in suspension does not adhere to container walls. Begin analysis as soon as possible because of the impracticality of preserving the sample. Refrigerate sample at 4°C up to the time of analysis to minimize microbiological decomposition of solids. Preferably do not hold samples more than 24 h. In no case hold sample more than 7 d. Bring samples to room temperature before analysis.

4. Selection of Method

Methods B through F are suitable for the determination of solids in potable, surface, and saline waters, as well as domestic and industrial wastewaters in the range up to 20 000 mg/L. Method G is suitable for the determination of solids in sediments, as well as solid and semisolid materials produced during water and wastewater treatment.

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2540 D. Total Suspended Solids Dried at 103–105°C

1. General Discussion

a. Principle: A well-mixed sample is filtered through a weighed standard glass-fiber filter and the residue retained on the filter is dried to a constant weight at 103 to 105°C. The increase in weight of the filter represents the total suspended solids. If the suspended material clogs the filter and prolongs filtration, it may be necessary to increase the diameter of the filter or decrease the sample volume. To obtain an estimate of total suspended solids, calculate the difference between total dissolved solids and total solids.

b. Interferences: See Section 2540A.2 and Section 2540B.1. Exclude large floating particles or submerged agglomerates of nonhomogeneous materials from the sample if it is determined that their inclusion is not representative. Because excessive residue on the filter may form a water-trapping crust, limit the sample size to that yielding no more than 200 mg residue. For samples high in dissolved solids thoroughly wash the filter to ensure removal of dissolved material. Prolonged filtration times resulting from filter clogging may produce high results owing

to increased colloidal materials captured on the clogged filter.

2. Apparatus

Apparatus listed in Section 2540B.2 and Section 2540C.2 is required, except for evaporating dishes, steam bath, and 180°C drying oven. In addition:

Aluminum weighing dishes.

3. Procedure

a. Preparation of glass-fiber filter disk: If pre-prepared glass fiber filter disks are used, eliminate this step. Insert disk with wrinkled side up in filtration apparatus. Apply vacuum and wash disk with three successive 20-mL portions of reagent-grade water. Continue suction to remove all traces of water, turn vacuum off, and discard washings. Remove filter from filtration apparatus and transfer to an inert aluminum weighing dish. If a Gooch crucible is used, remove crucible and filter combination. Dry in an oven at 103 to 105°C for 1 h. If volatile solids are to be measured, ignite at 550°C for 15 min in a muffle furnace. Cool in desiccator to balance temperature and weigh. Repeat cycle of drying or igniting, cooling, desiccating, and weighing until a constant weight is obtained or until weight change is less than 4% of the previous weighing or 0.5 mg, whichever is less. Store in desiccator until needed.

b. Selection of filter and sample sizes: Choose sample volume to yield between 2.5 and 200 mg dried residue. If volume filtered fails to meet minimum yield, increase sample volume up to 1 L. If complete filtration takes more than 10 min, increase filter diameter or decrease sample volume.

c. Sample analysis: Assemble filtering apparatus and filter and begin suction. Wet filter with a small volume of reagent-grade water to seat it. Stir sample with a magnetic stirrer at a speed to shear larger particles, if practical, to obtain a more uniform (preferably homogeneous) particle size. Centrifugal force may separate particles by size and density, resulting in poor precision when point of sample withdrawal is varied. While stirring, pipet a measured volume onto the seated glass-fiber filter. For homogeneous samples, pipet from the approximate midpoint of container but not in vortex. Choose a point both middepth and midway between wall and vortex. Wash filter with three successive 10-mL volumes of reagent-grade water, allowing complete drainage between washings, and continue suction for about 3 min after filtration is complete. Samples with high dissolved solids may require additional washings. Carefully remove filter from filtration apparatus and transfer to an aluminum weighing dish as a support. Alternatively, remove the crucible and filter combination from the crucible adapter if a Gooch crucible is used. Dry for at least 1 h at 103 to 105°C in an oven, cool in a desiccator to balance temperature, and weigh. Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until the weight change is less than 4% of the previous weight or 0.5 mg, whichever is less. Analyze at least 10% of all samples in duplicate. Duplicate determinations should agree within 5% of their average weight. If volatile solids are to be determined, treat the residue according to 2540E.

4. Calculation

Where:

A = weight of filter + dried residue, mg, and

B = weight of filter, mg.

5. Precision

The standard deviation was 5.2 mg/L (coefficient of variation 33%) at 15 mg/L, 24 mg/L (10%) at 242 mg/L, and 13 mg/L (0.76%) at 1707 mg/L in studies by two analysts of four sets of 10 determinations each.

Single-laboratory duplicate analyses of 50 samples of water and wastewater were made with a standard deviation of differences of 2.8 mg/L.

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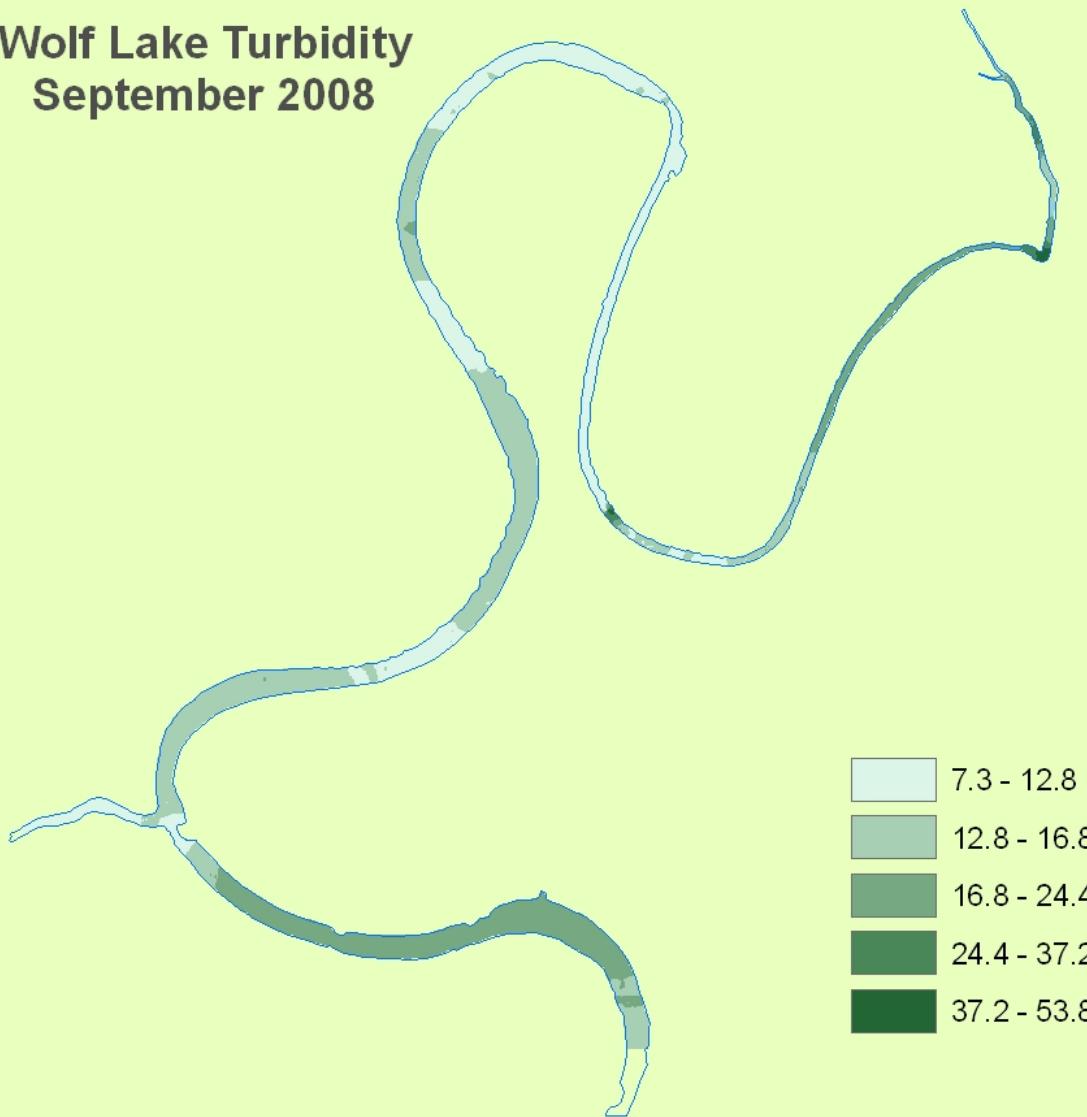
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Appendix B

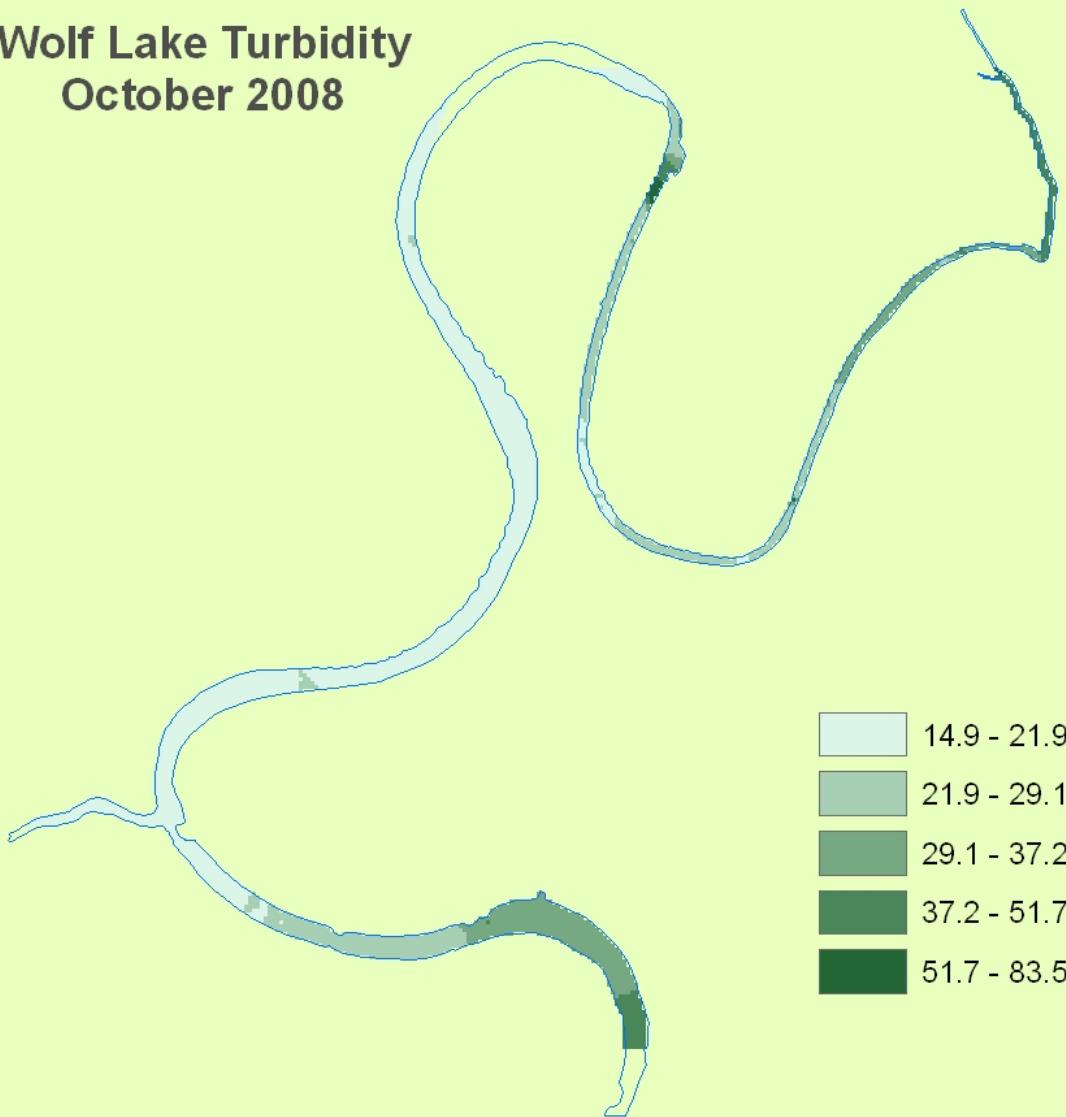
Spatial distribution maps of turbidity (NTU) within Wolf Lake by month

Wolf Lake Turbidity
September 2008



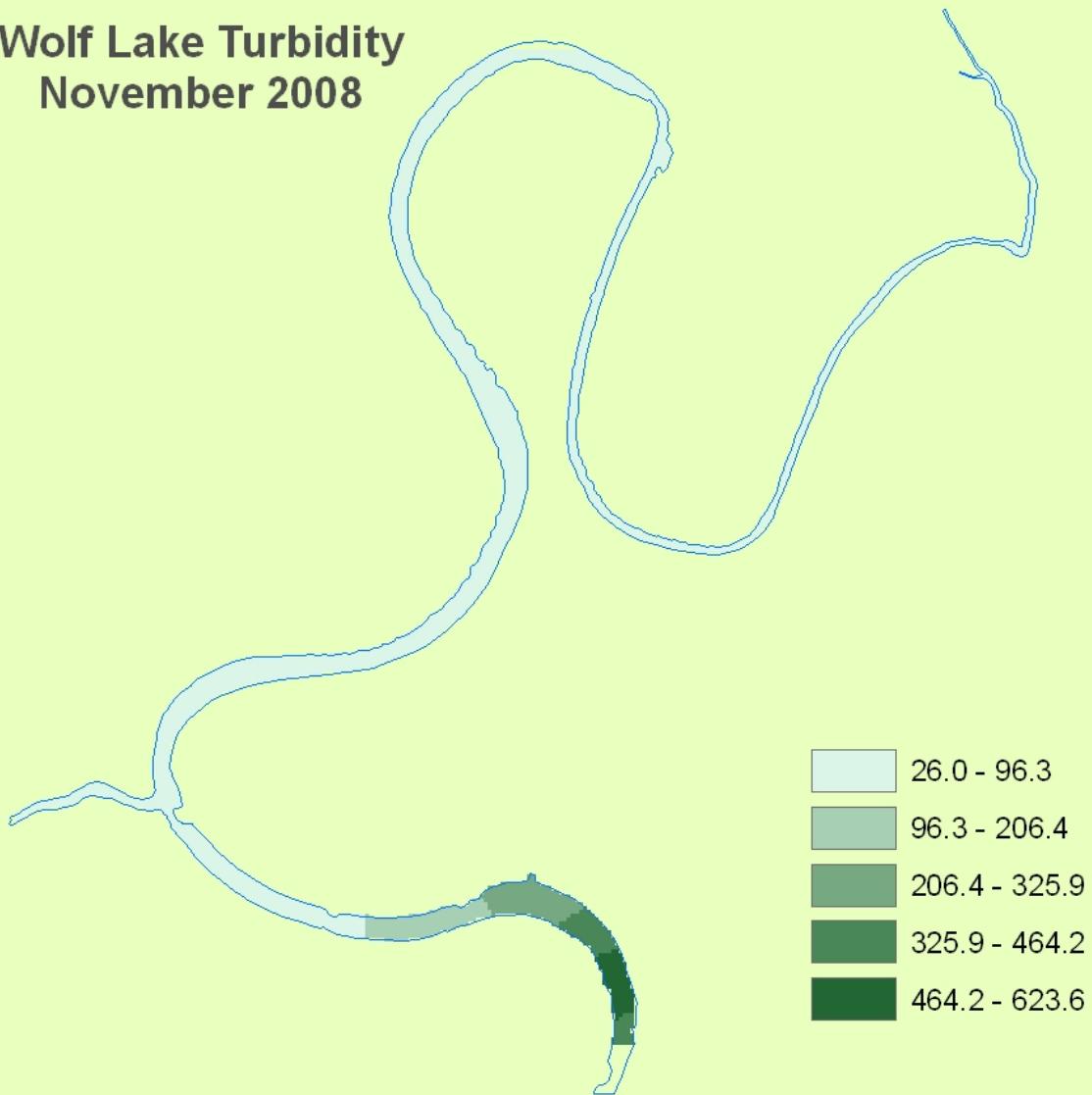
September 2008 – Wolf Lake Turbidity

Wolf Lake Turbidity
October 2008



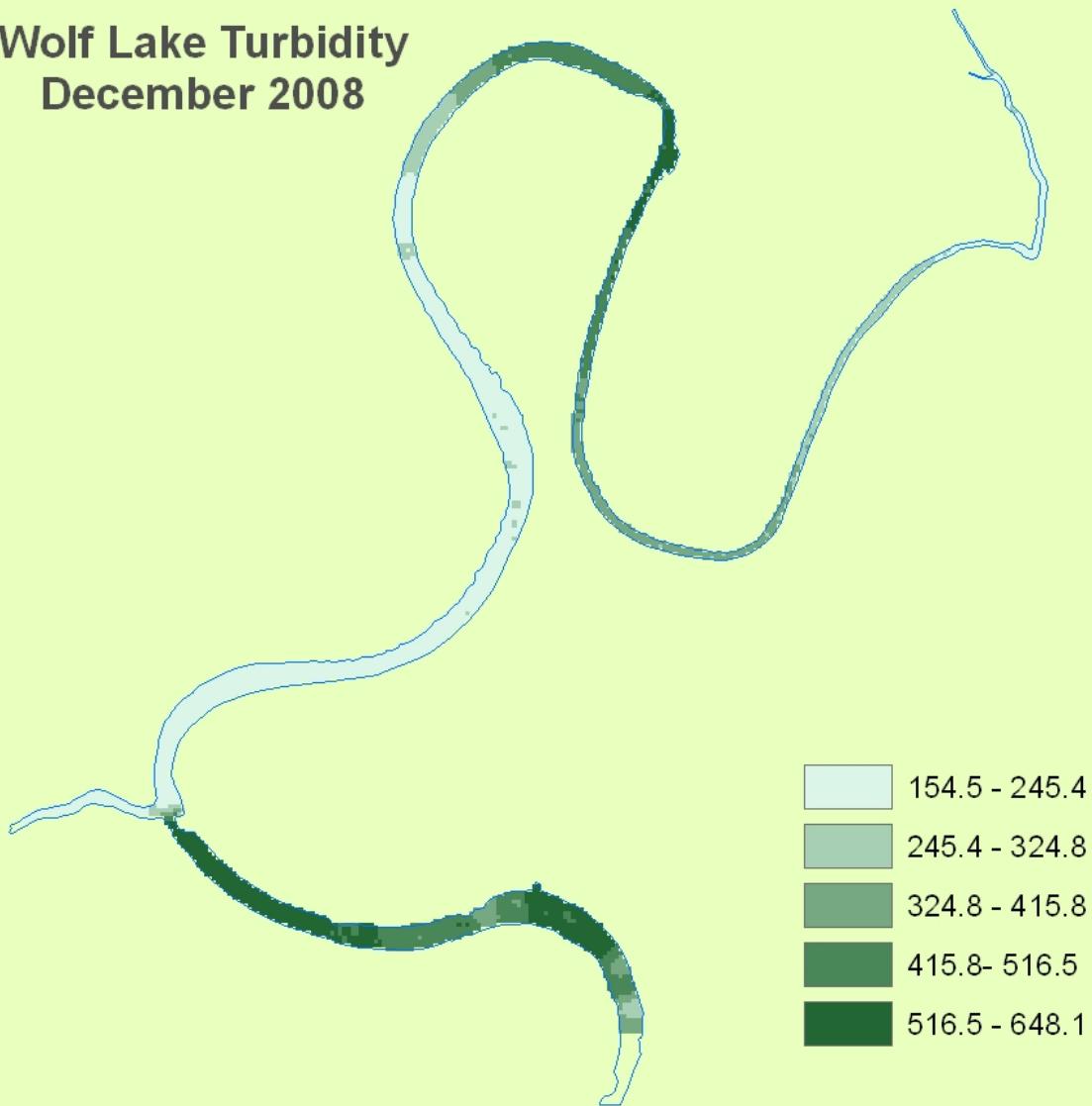
October 2008 – Wolf Lake Turbidity

Wolf Lake Turbidity
November 2008



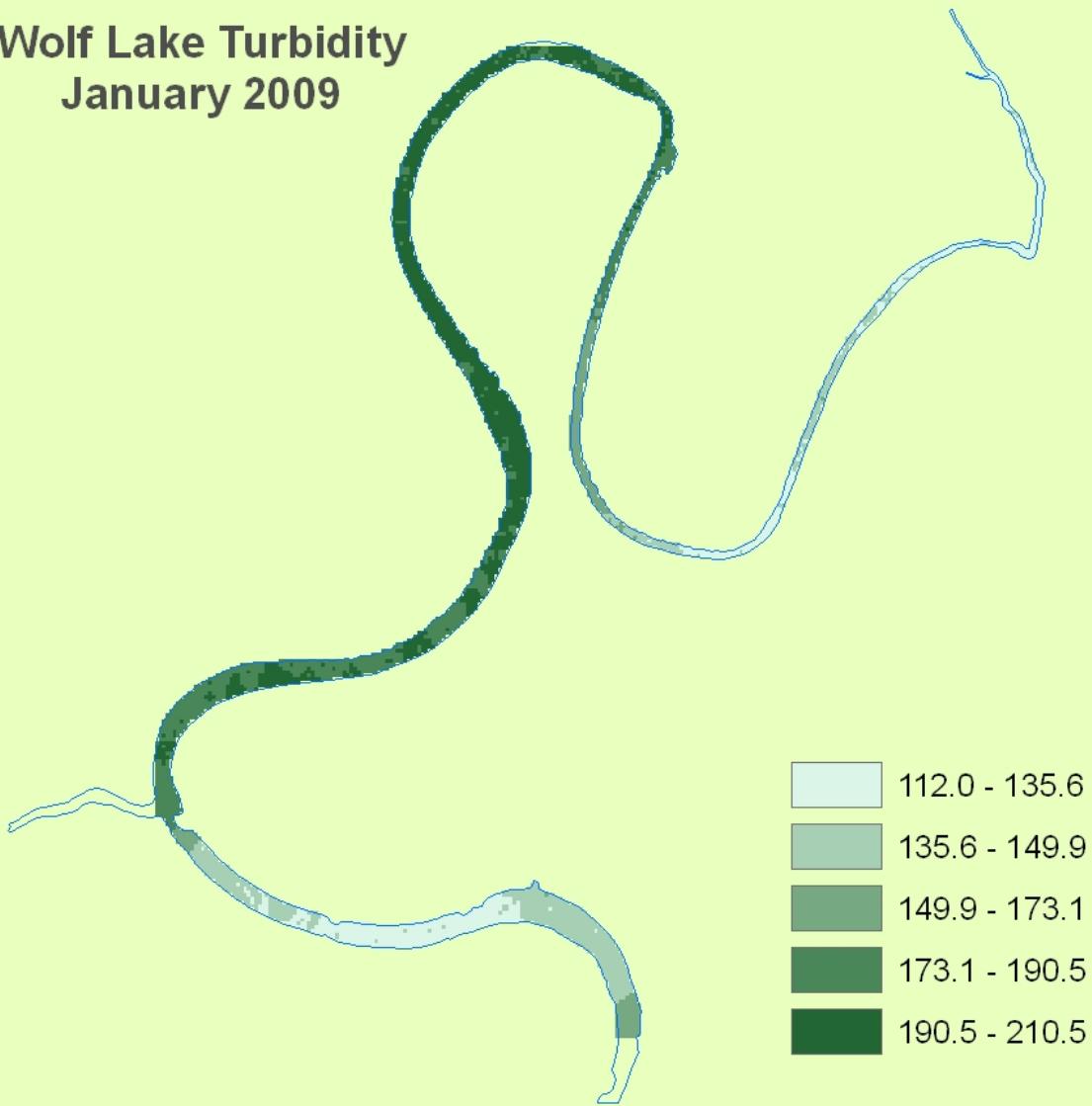
November 2008 – Wolf Lake Turbidity

Wolf Lake Turbidity
December 2008



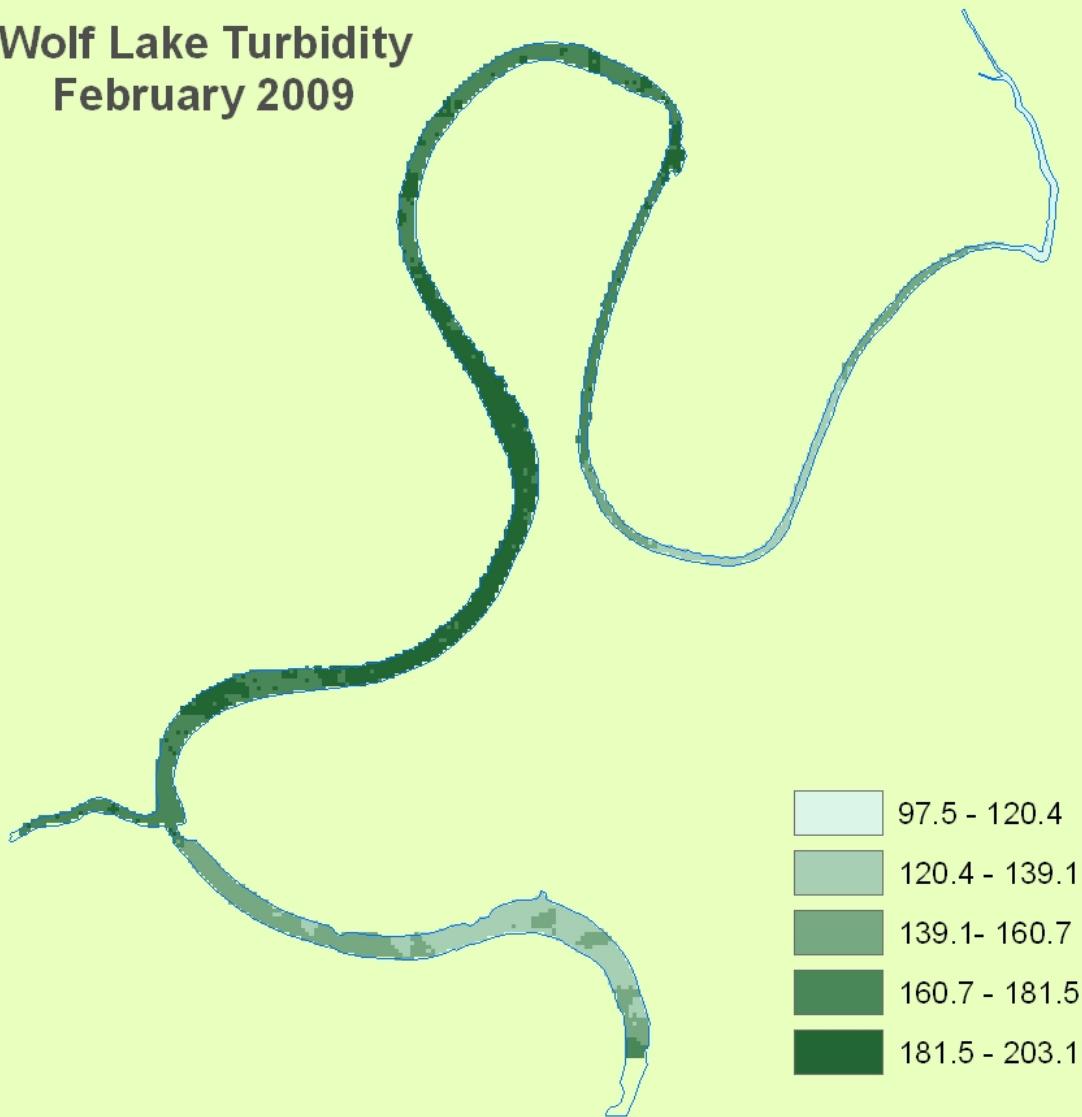
December 2008 – Wolf Lake Turbidity

Wolf Lake Turbidity
January 2009



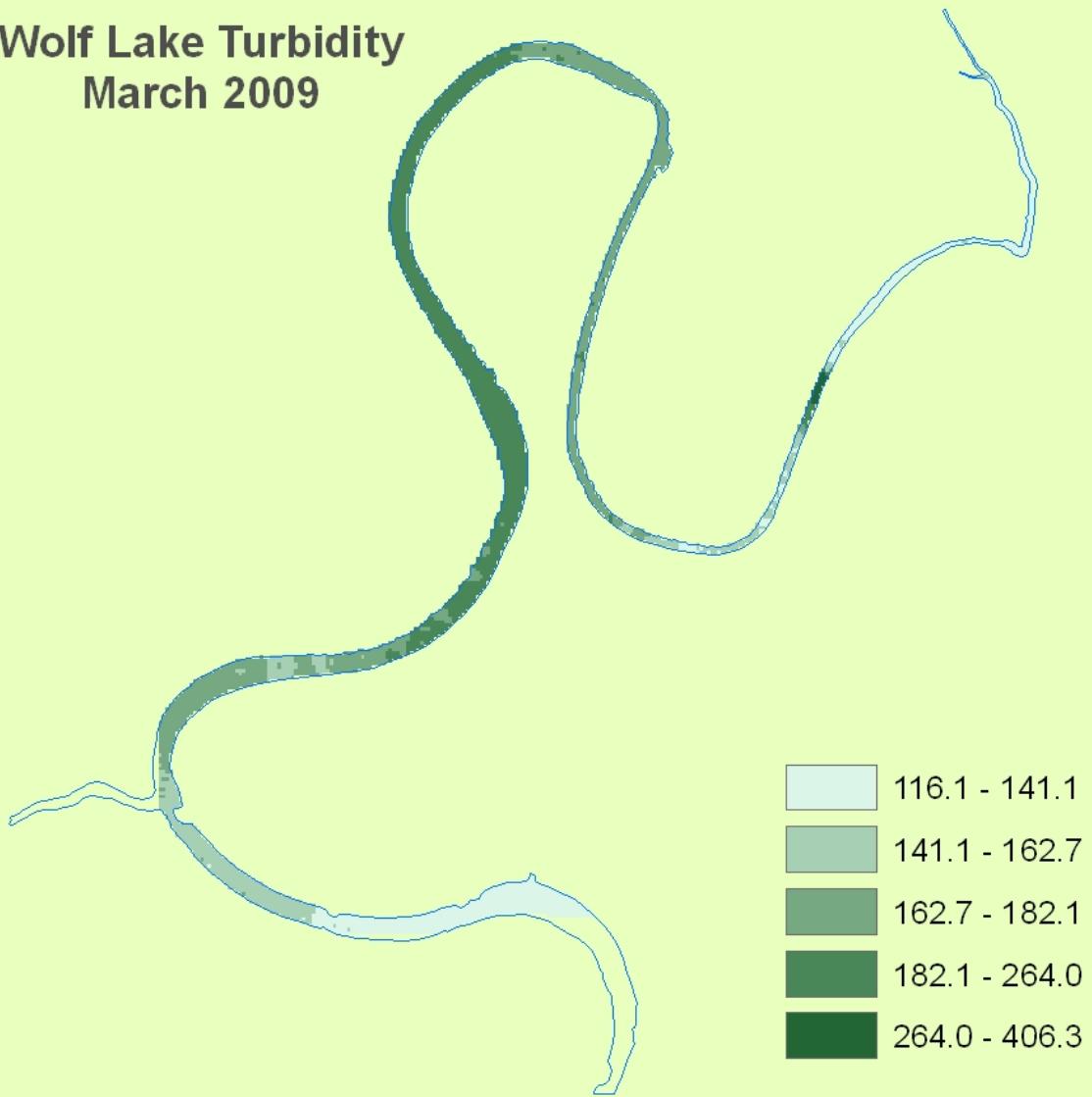
January 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
February 2009



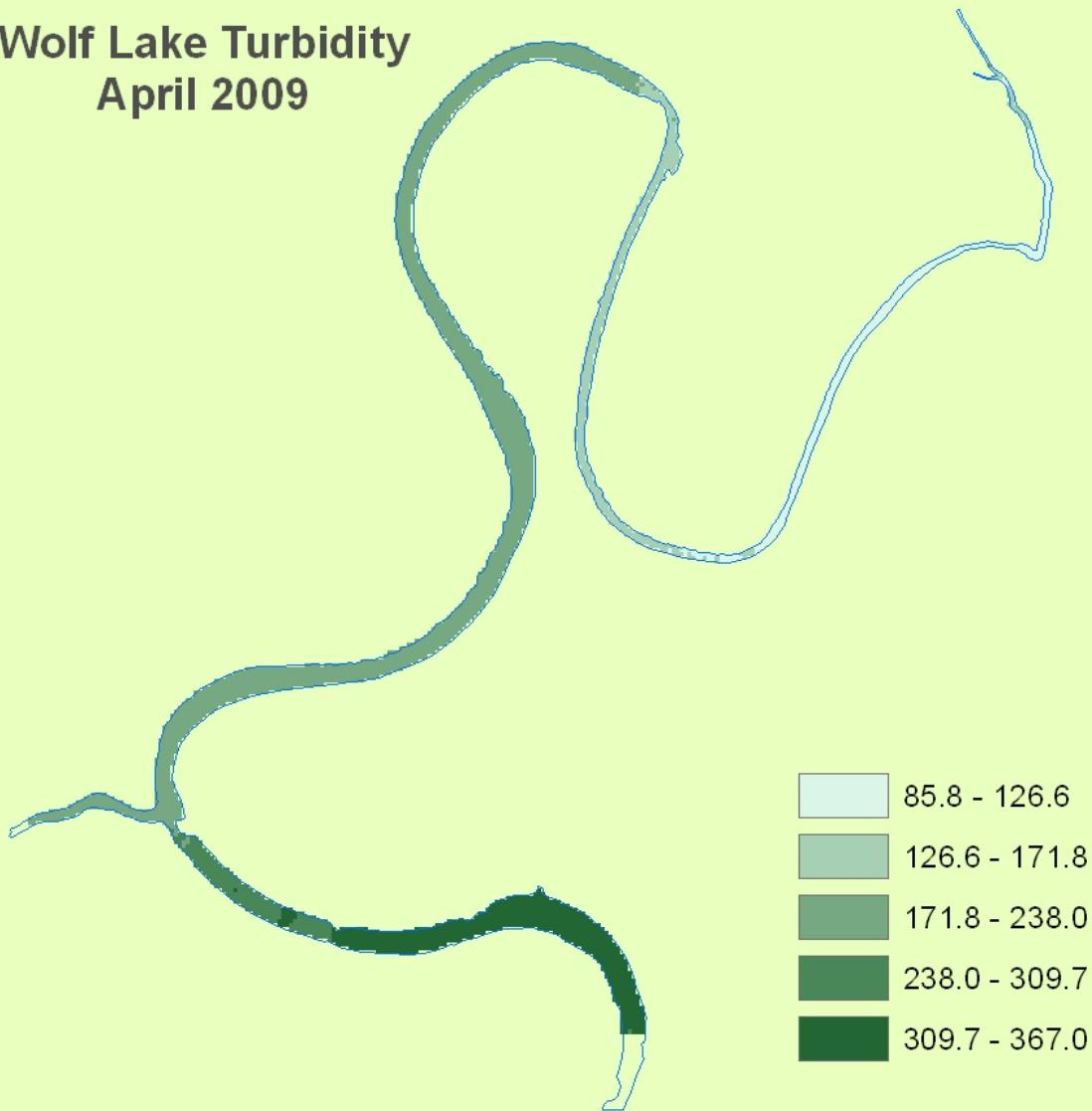
February 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
March 2009



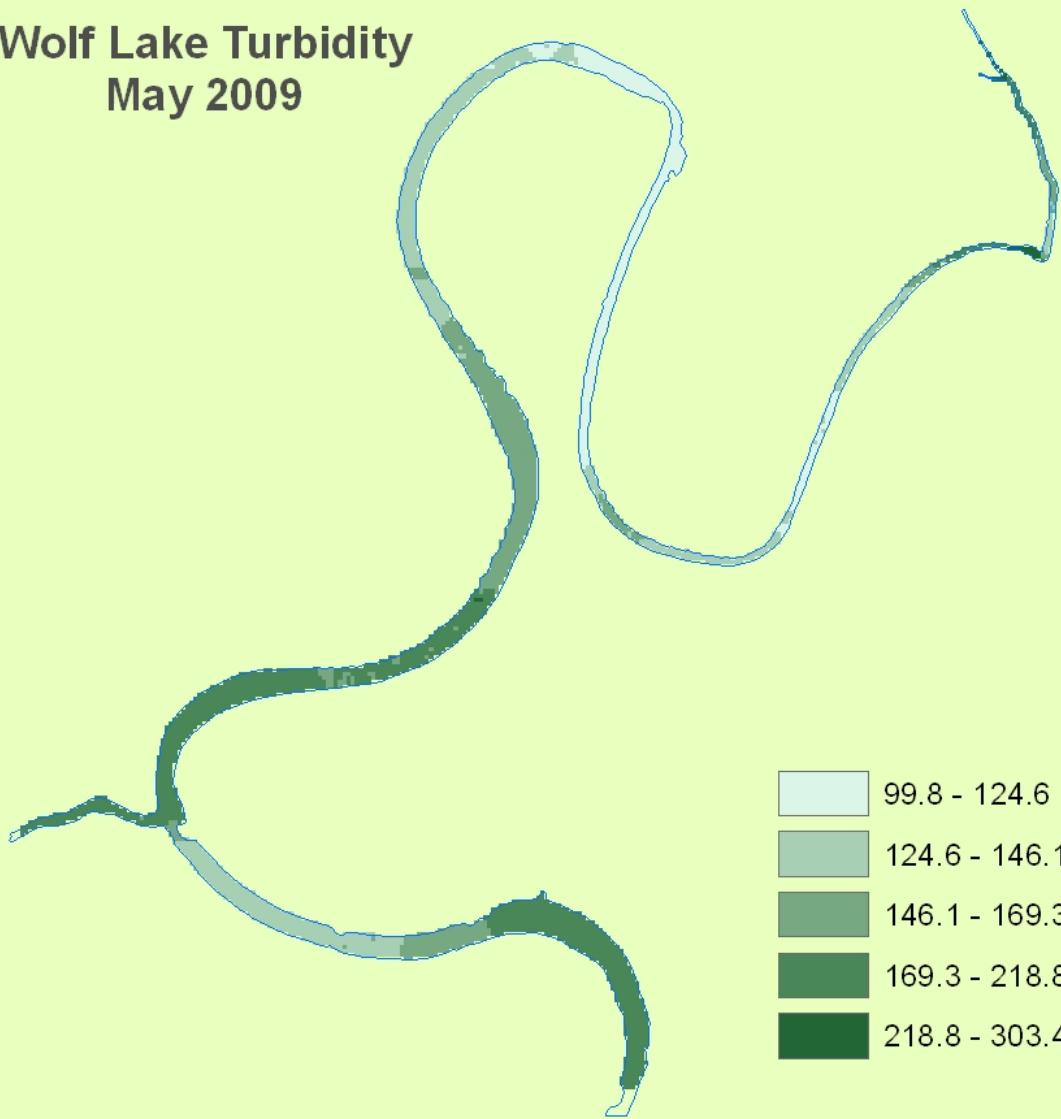
March 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
April 2009



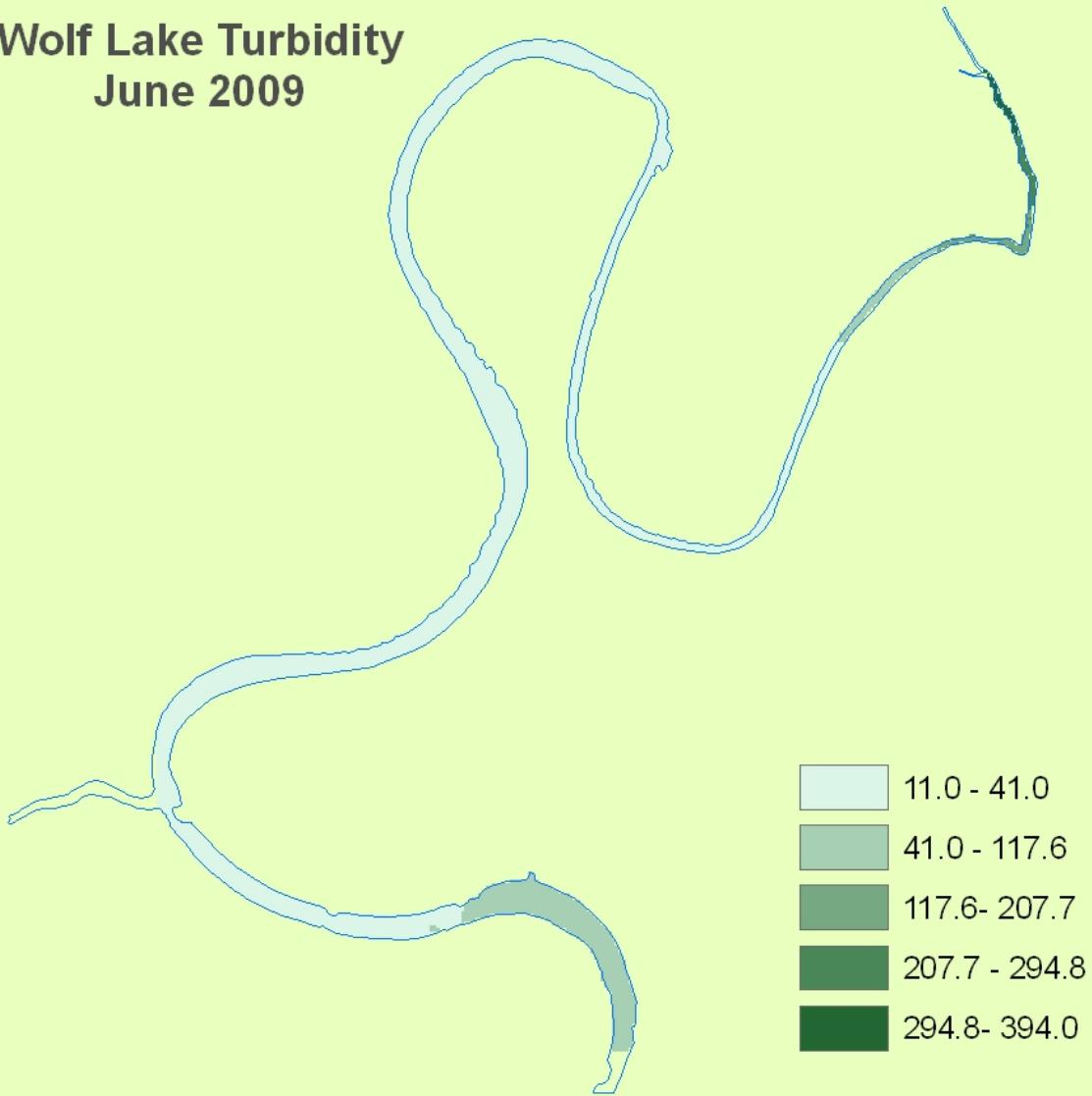
April 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
May 2009

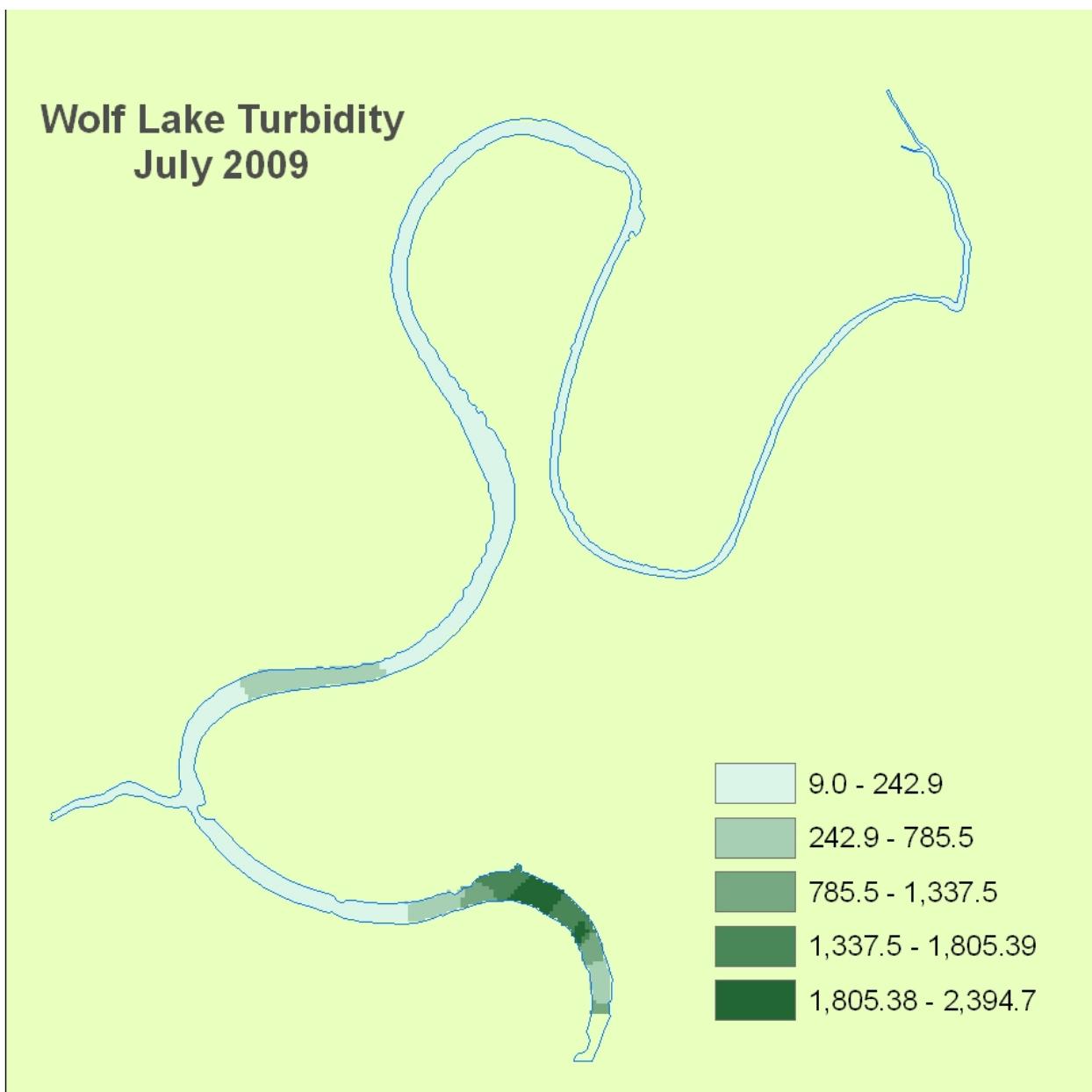


May 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
June 2009



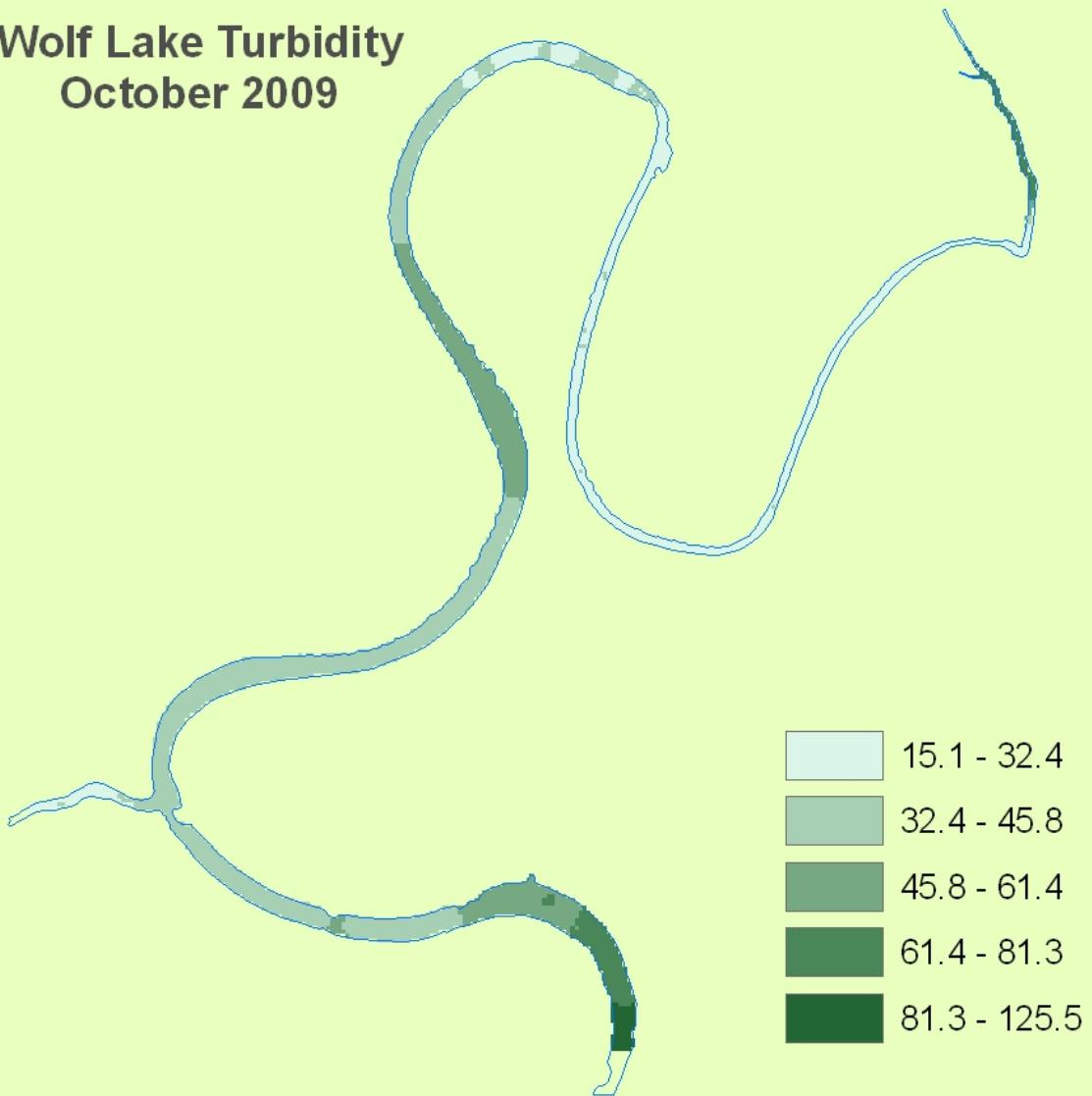
June 2009 – Wolf Lake Turbidity



July 2009 – Wolf Lake Turbidity

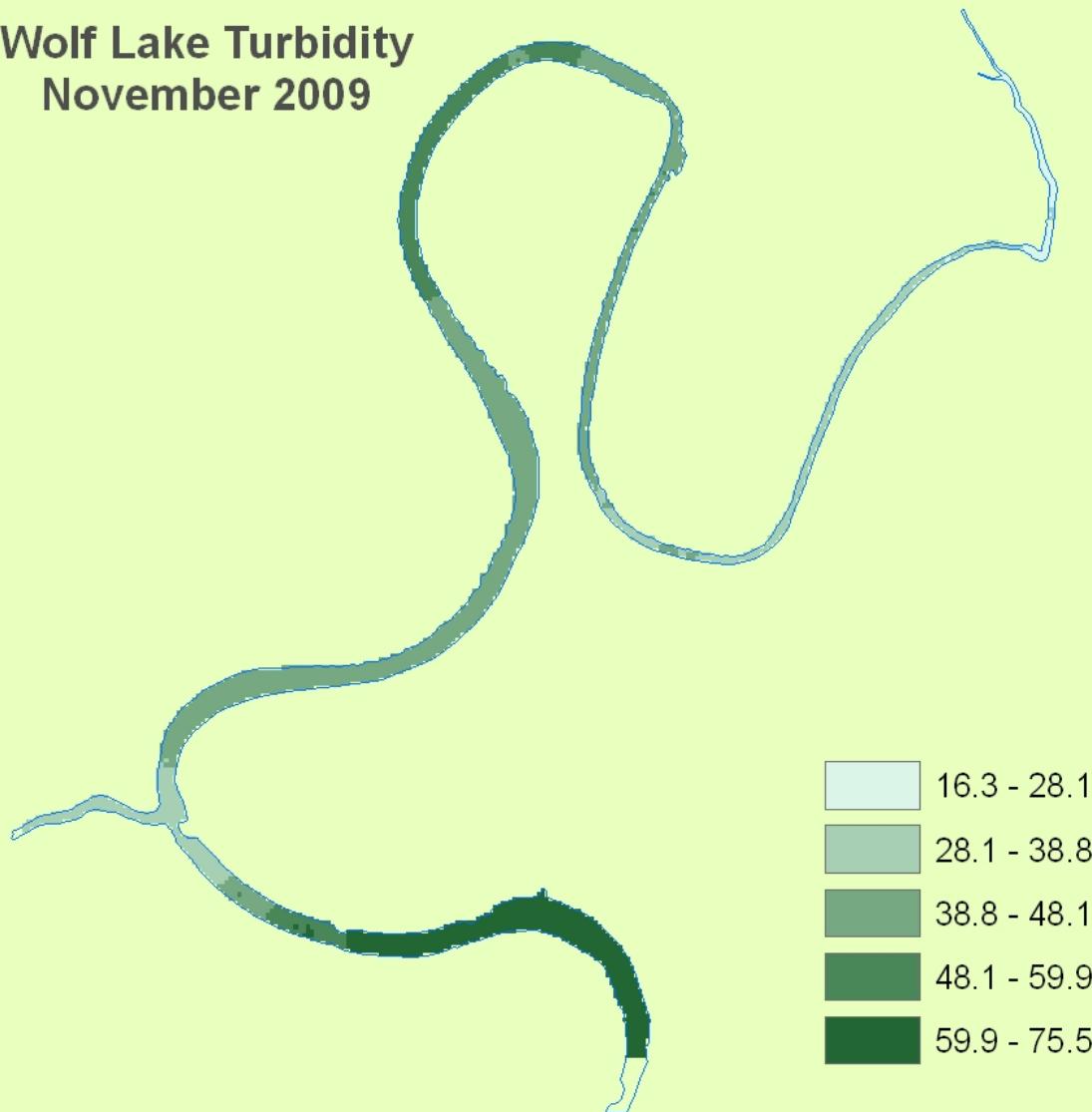
August and September 2009 – Wolf Lake Turbidity not collected due to high water levels and closures of boat ramps within Wolf Lake

Wolf Lake Turbidity
October 2009



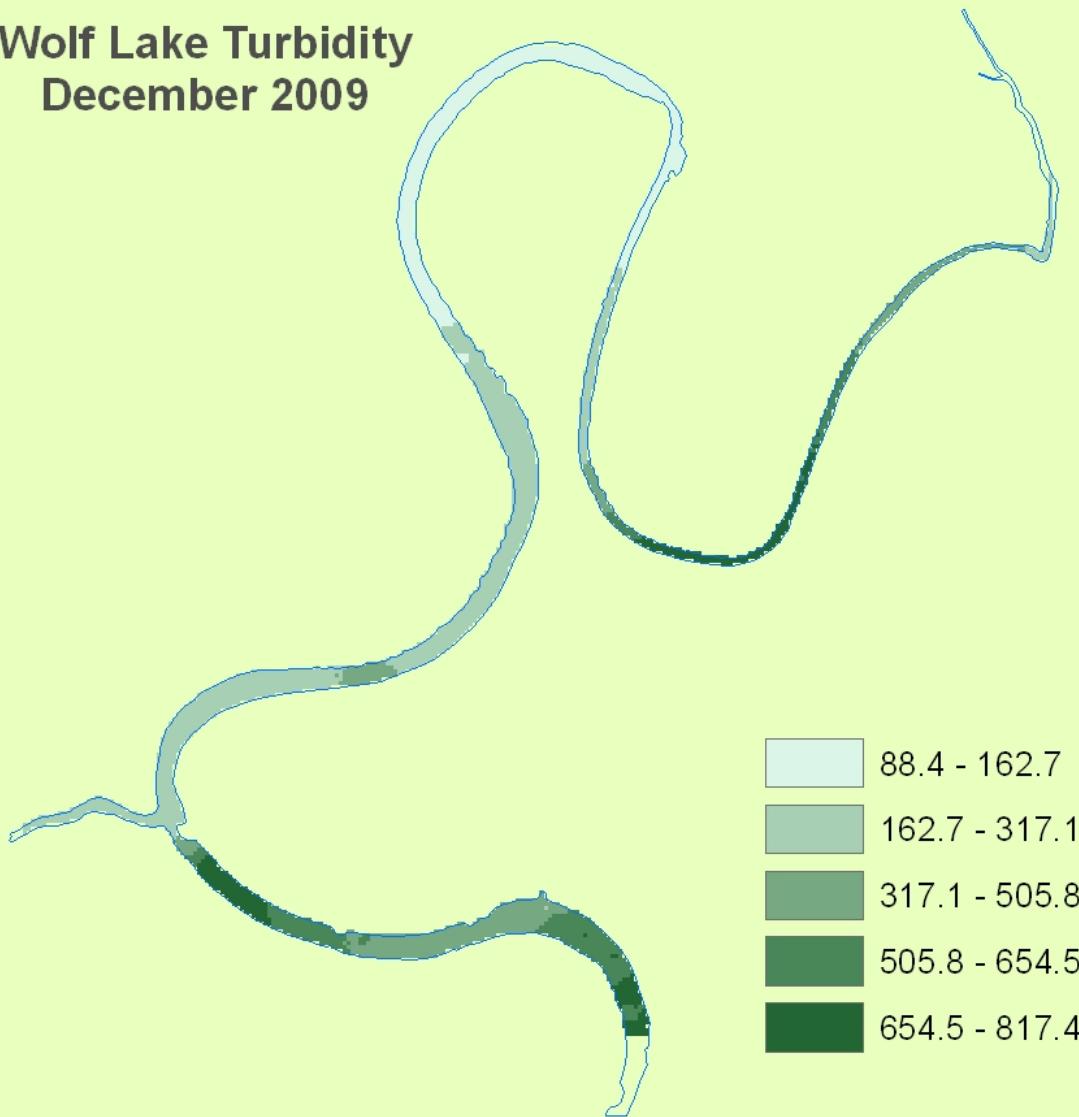
October 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
November 2009



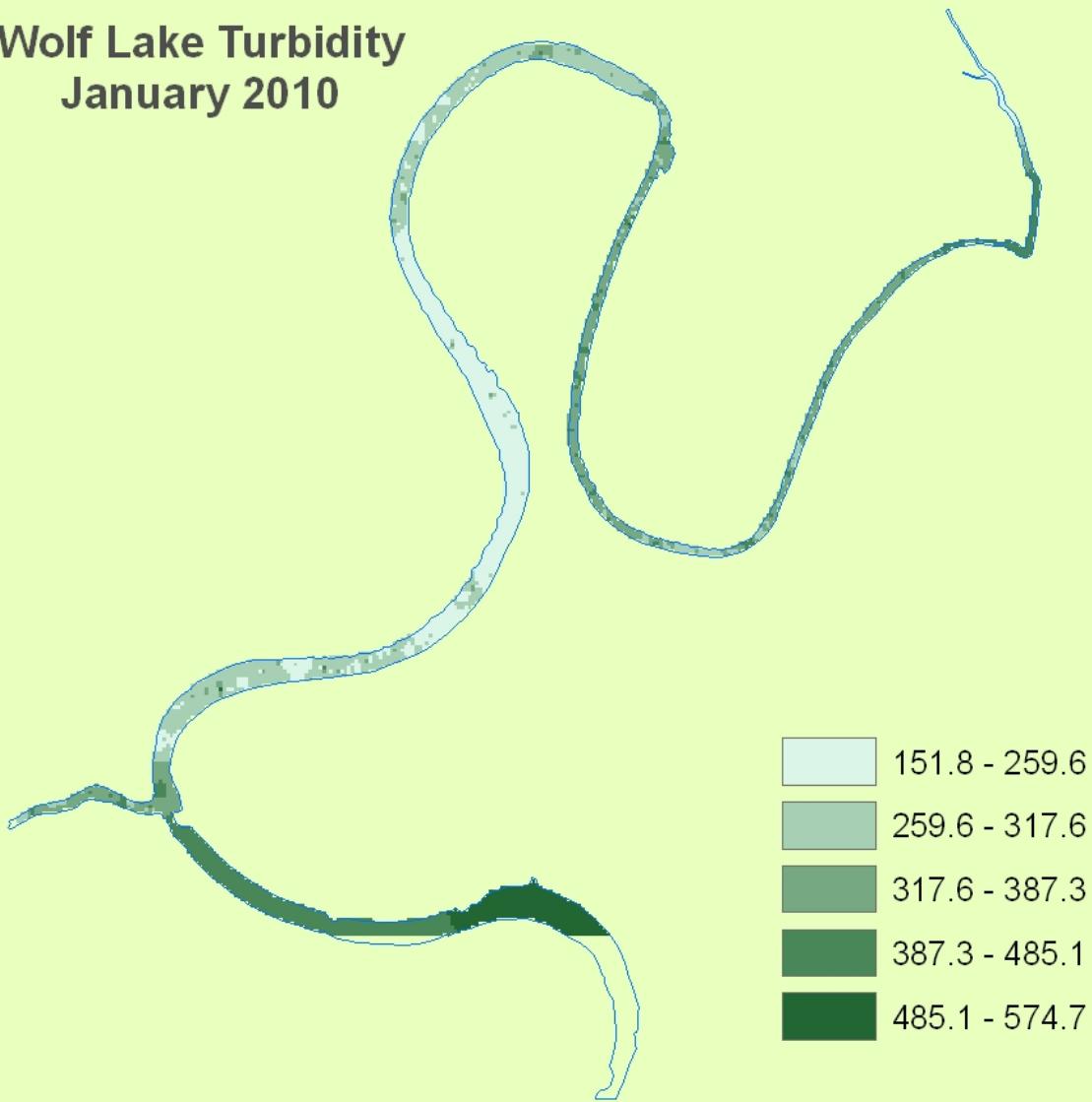
November 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
December 2009



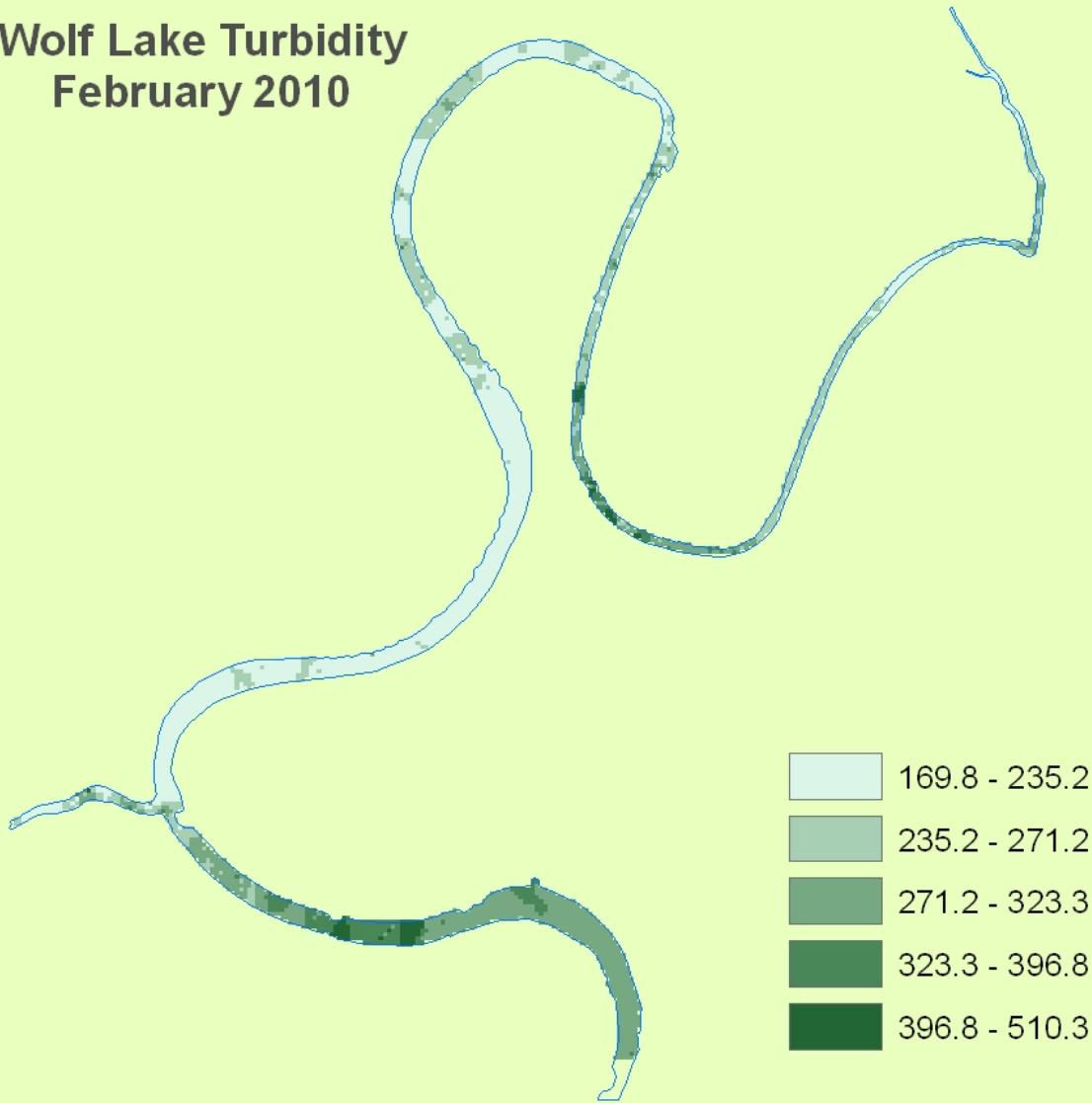
December 2009 – Wolf Lake Turbidity

Wolf Lake Turbidity
January 2010



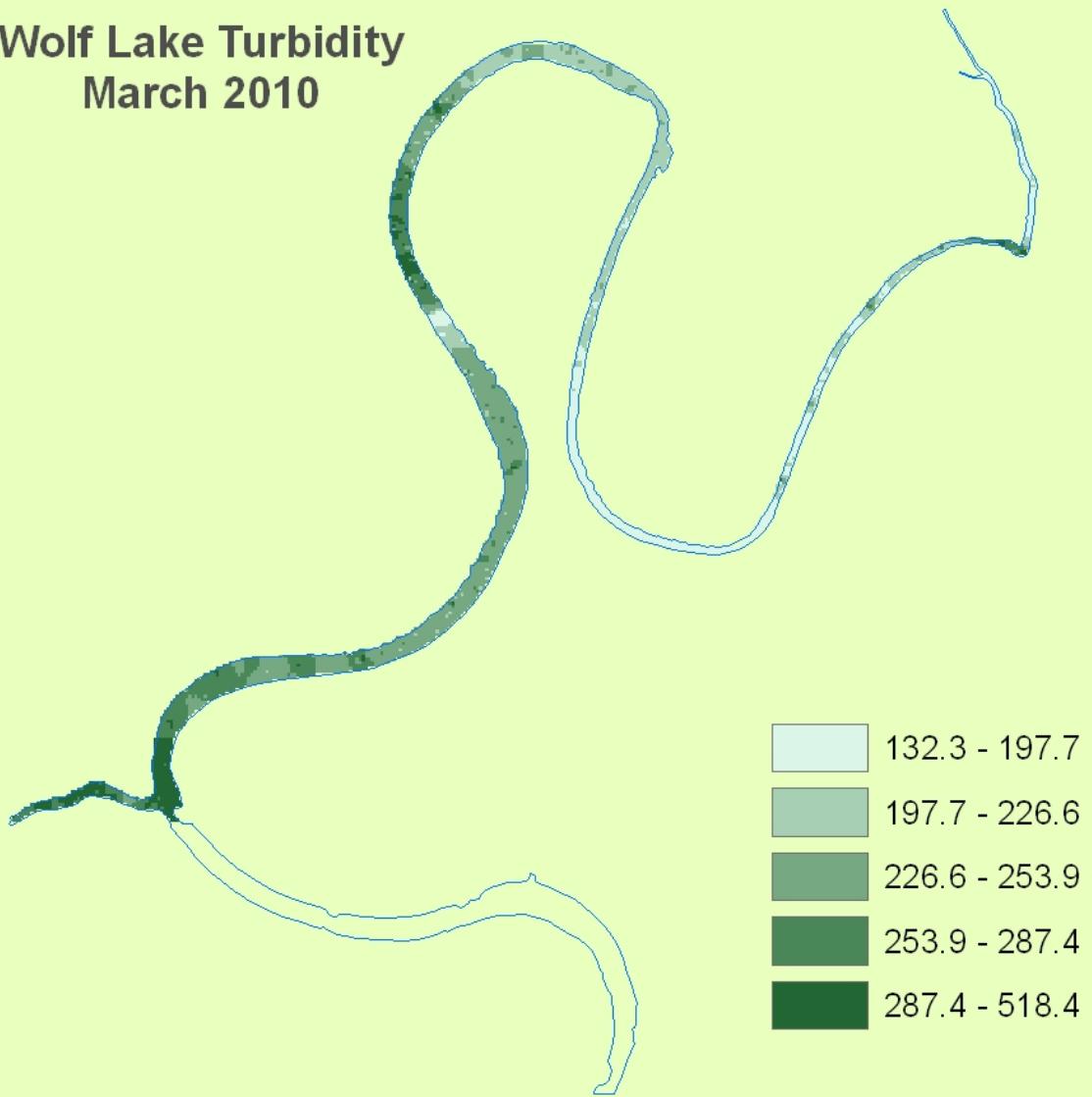
January 2010 – Wolf Lake Turbidity

Wolf Lake Turbidity
February 2010



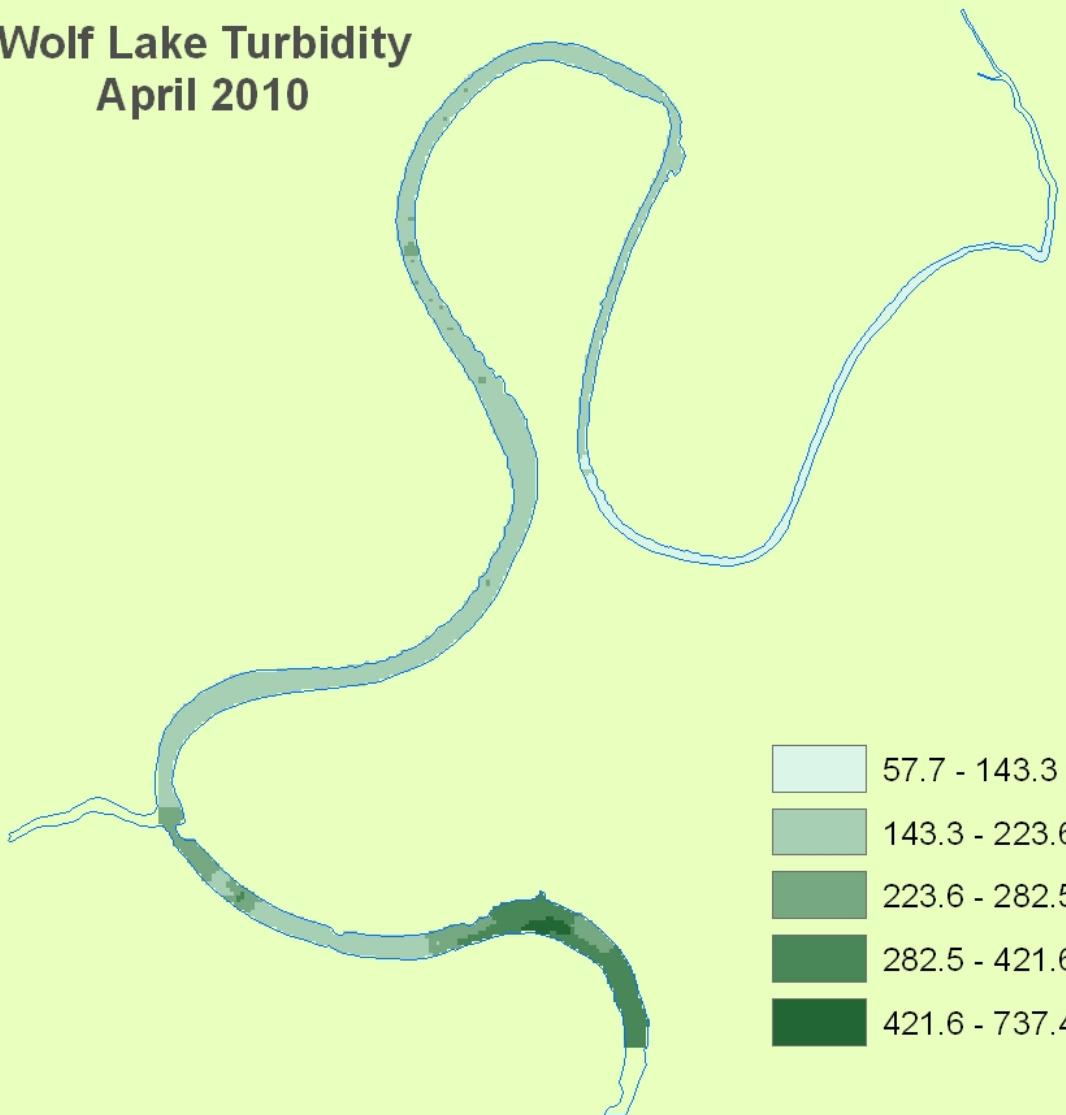
February 2010 – Wolf Lake Turbidity

Wolf Lake Turbidity
March 2010



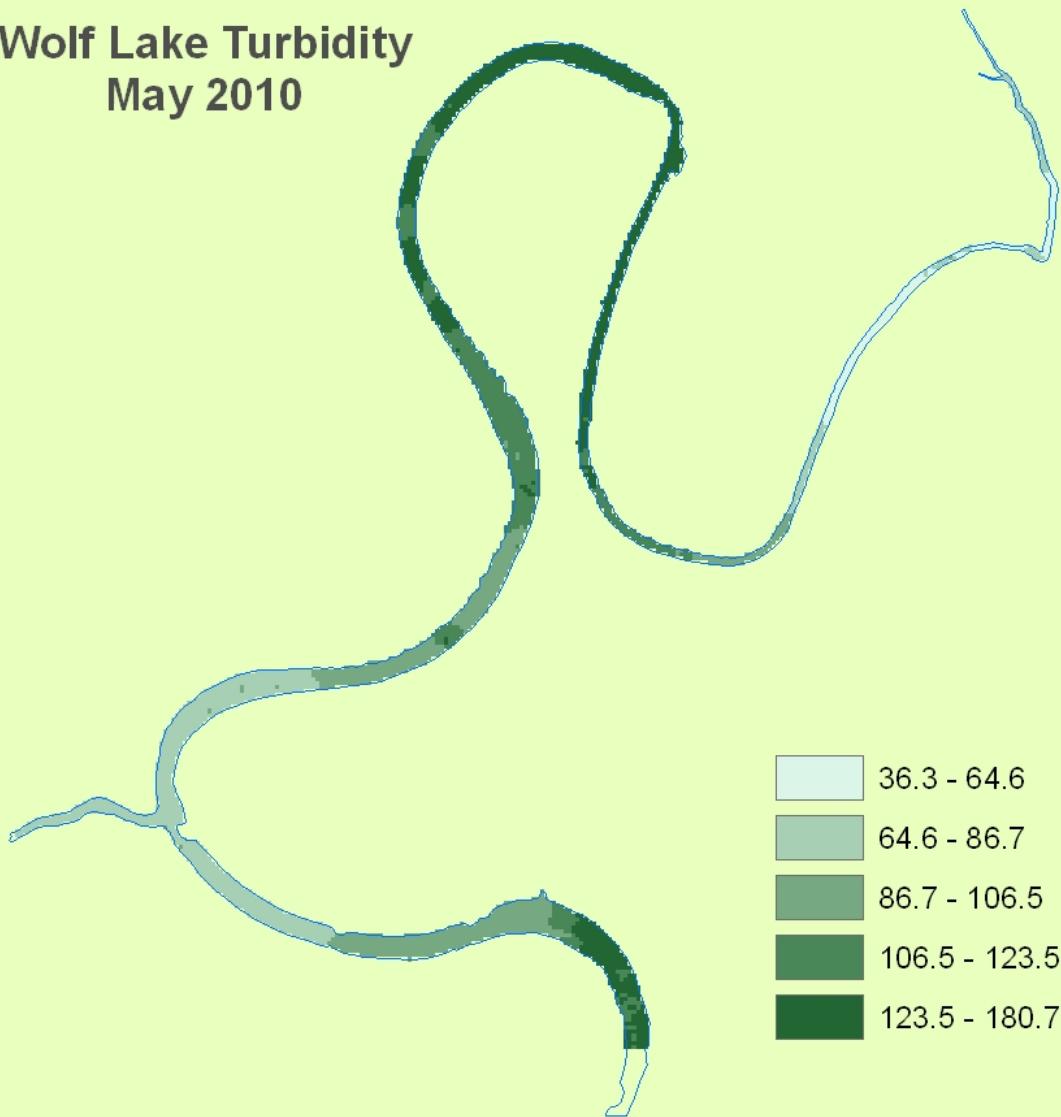
March 2010 – Wolf Lake Turbidity

Wolf Lake Turbidity
April 2010



April 2010 – Wolf Lake Turbidity

Wolf Lake Turbidity
May 2010

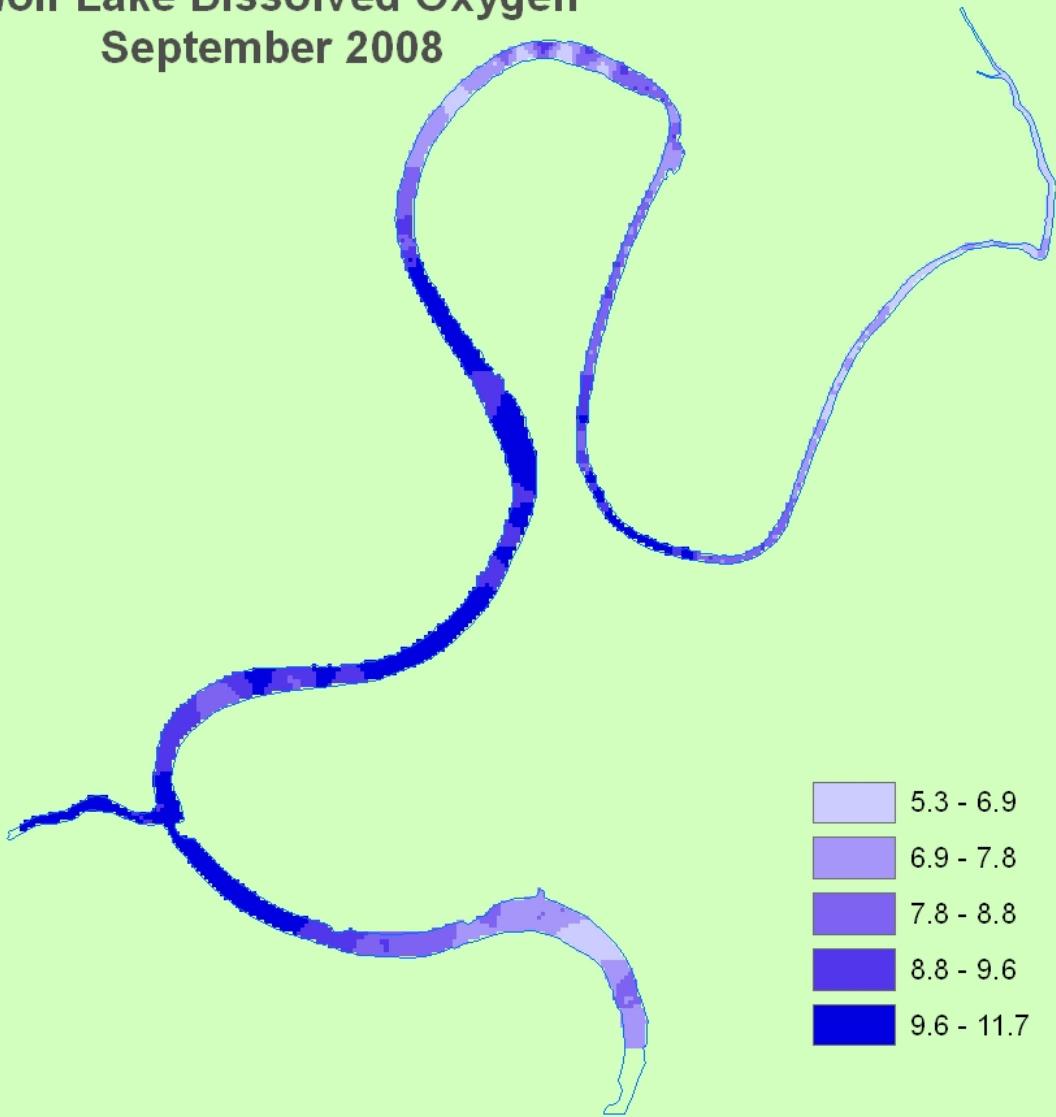


May 2010 – Wolf Lake Turbidity

Appendix C

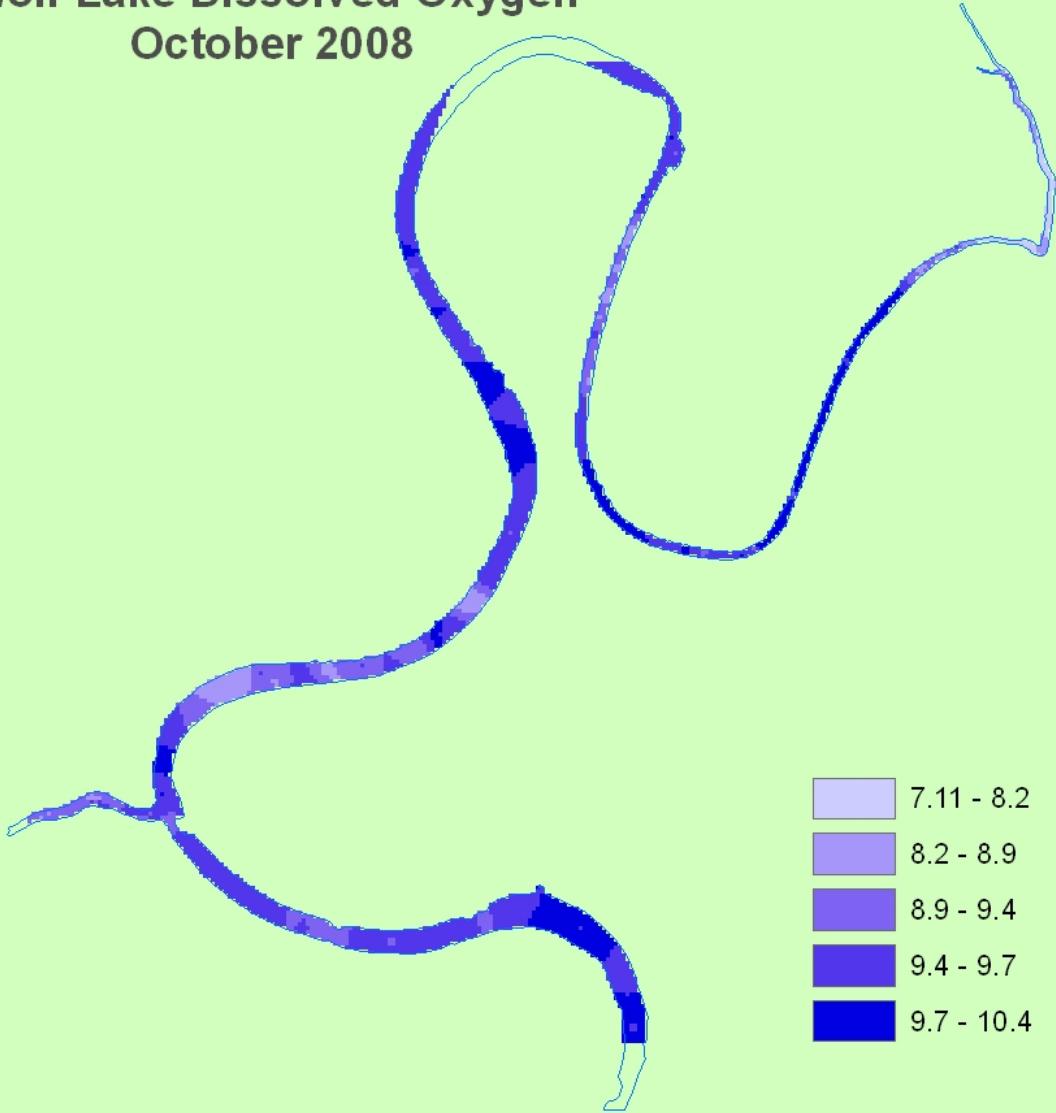
Spatial distribution maps of dissolved oxygen (mg/L) within Wolf Lake by month

Wolf Lake Dissolved Oxygen
September 2008



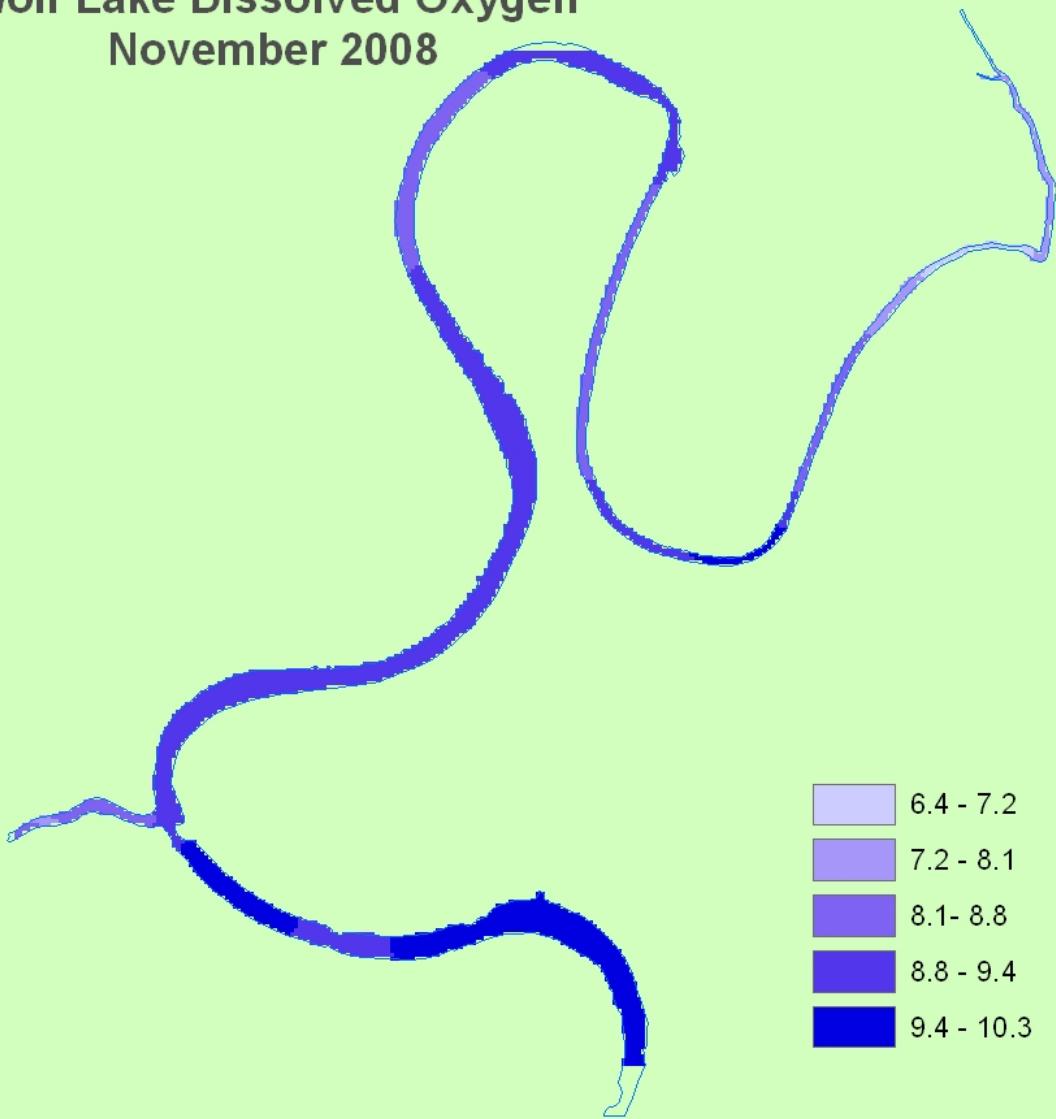
September 2008 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
October 2008



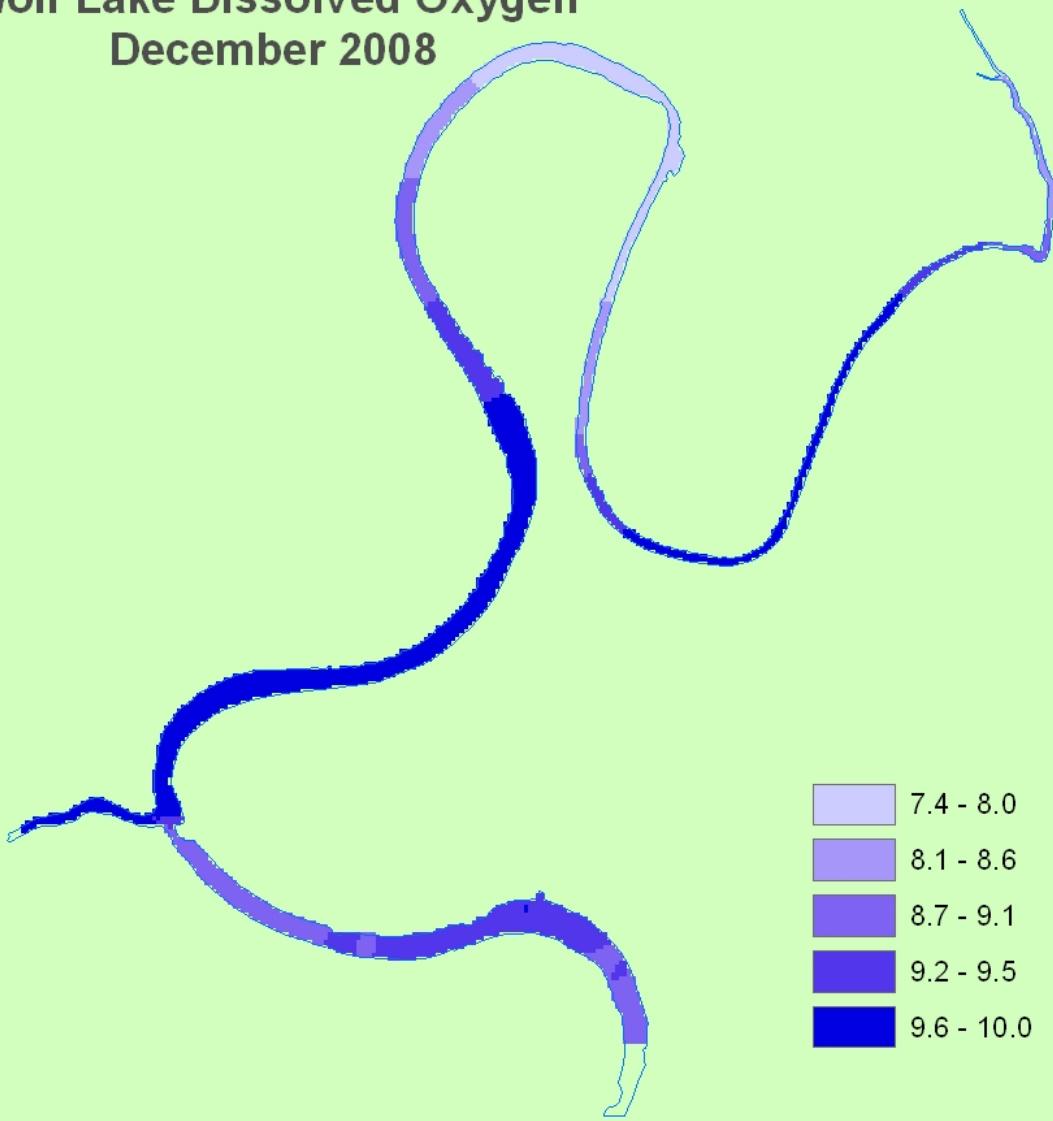
October 2008 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
November 2008



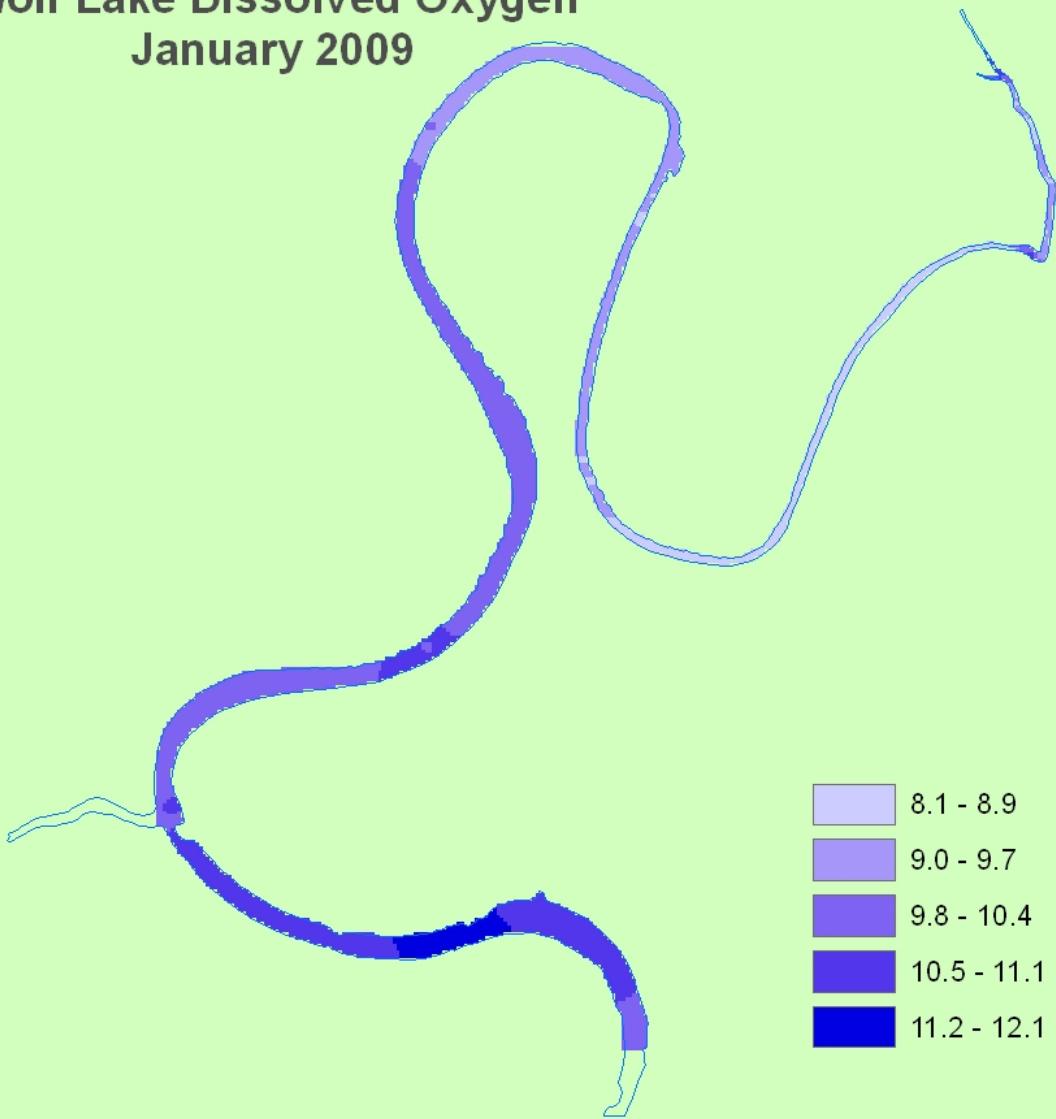
November 2008 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
December 2008



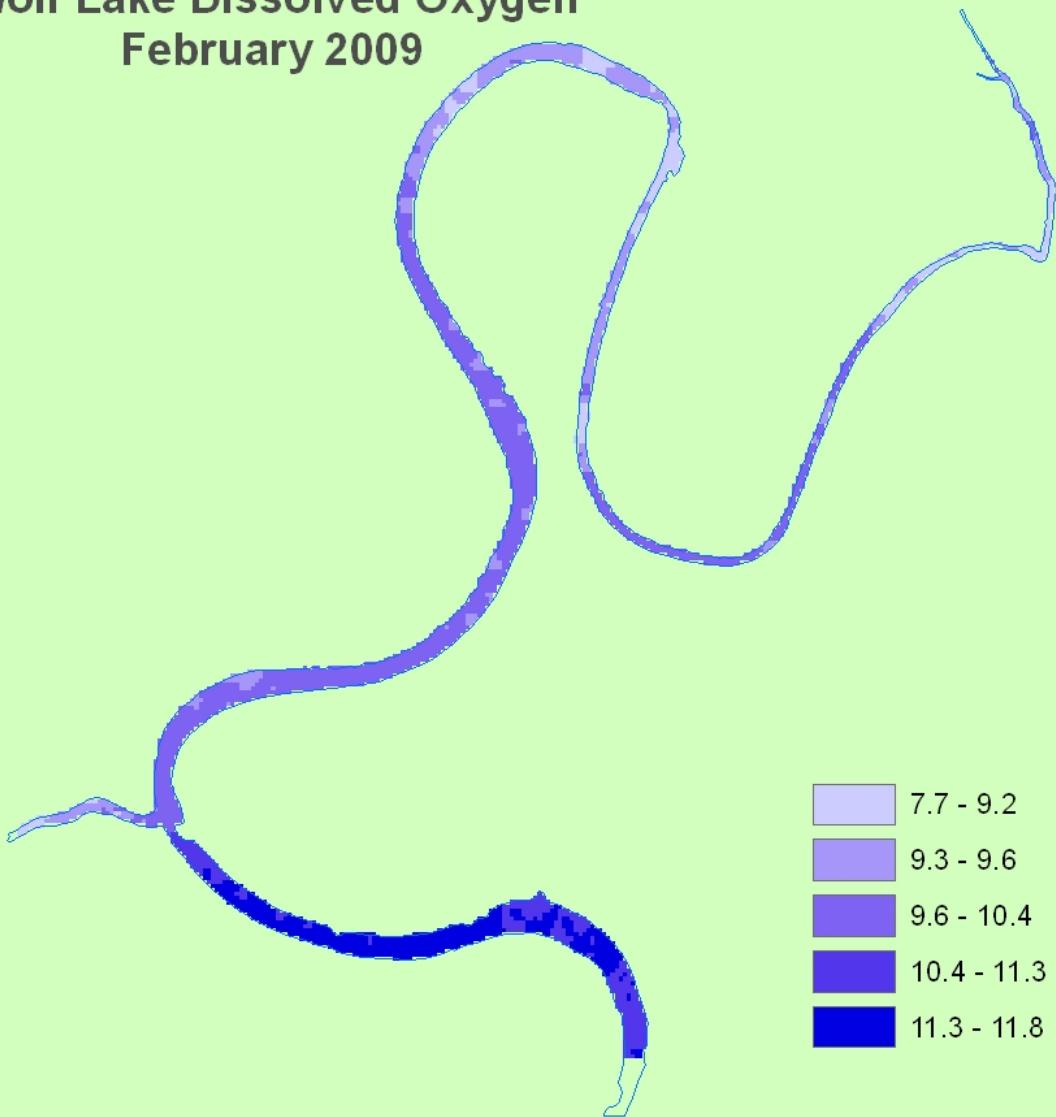
December 2008 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
January 2009



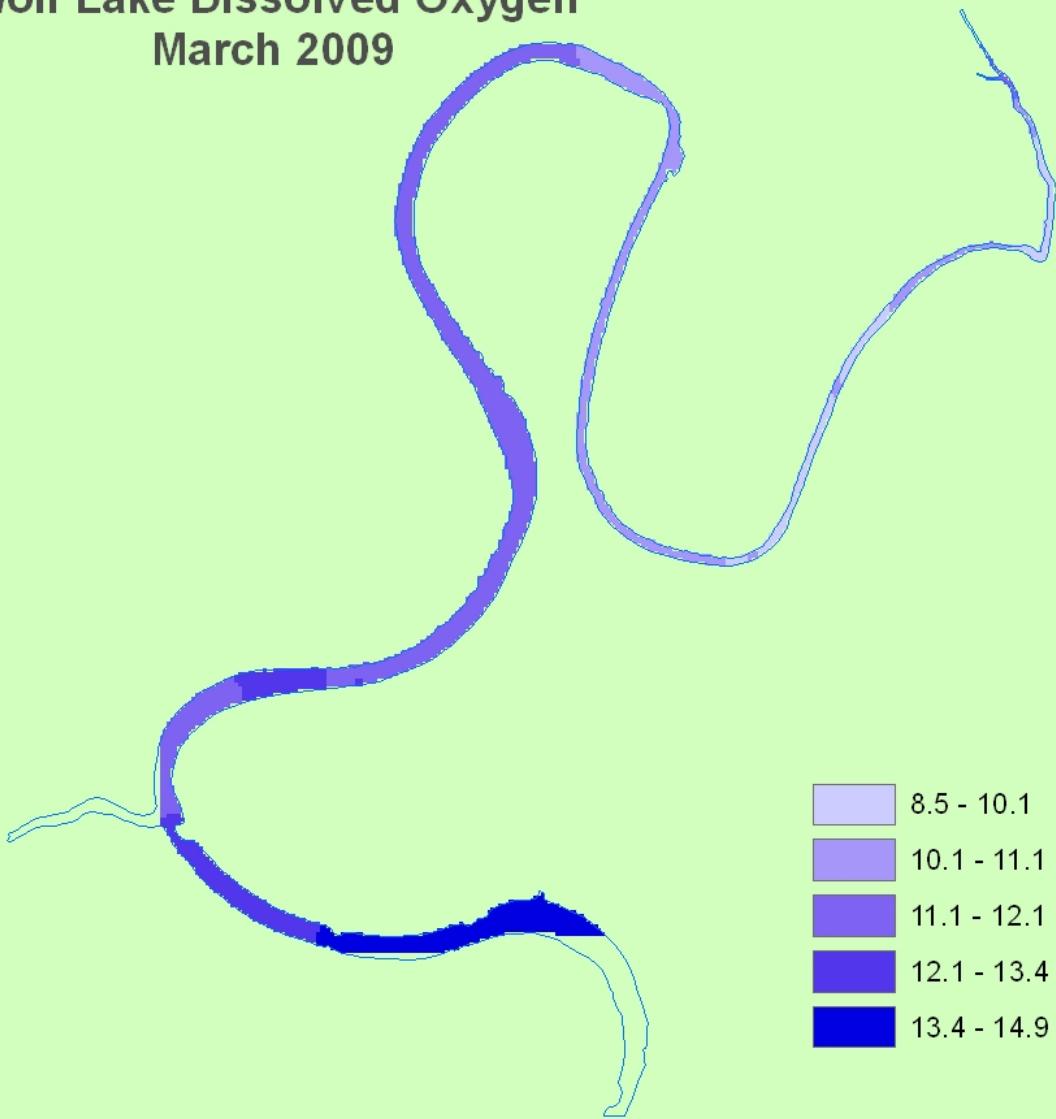
January 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
February 2009



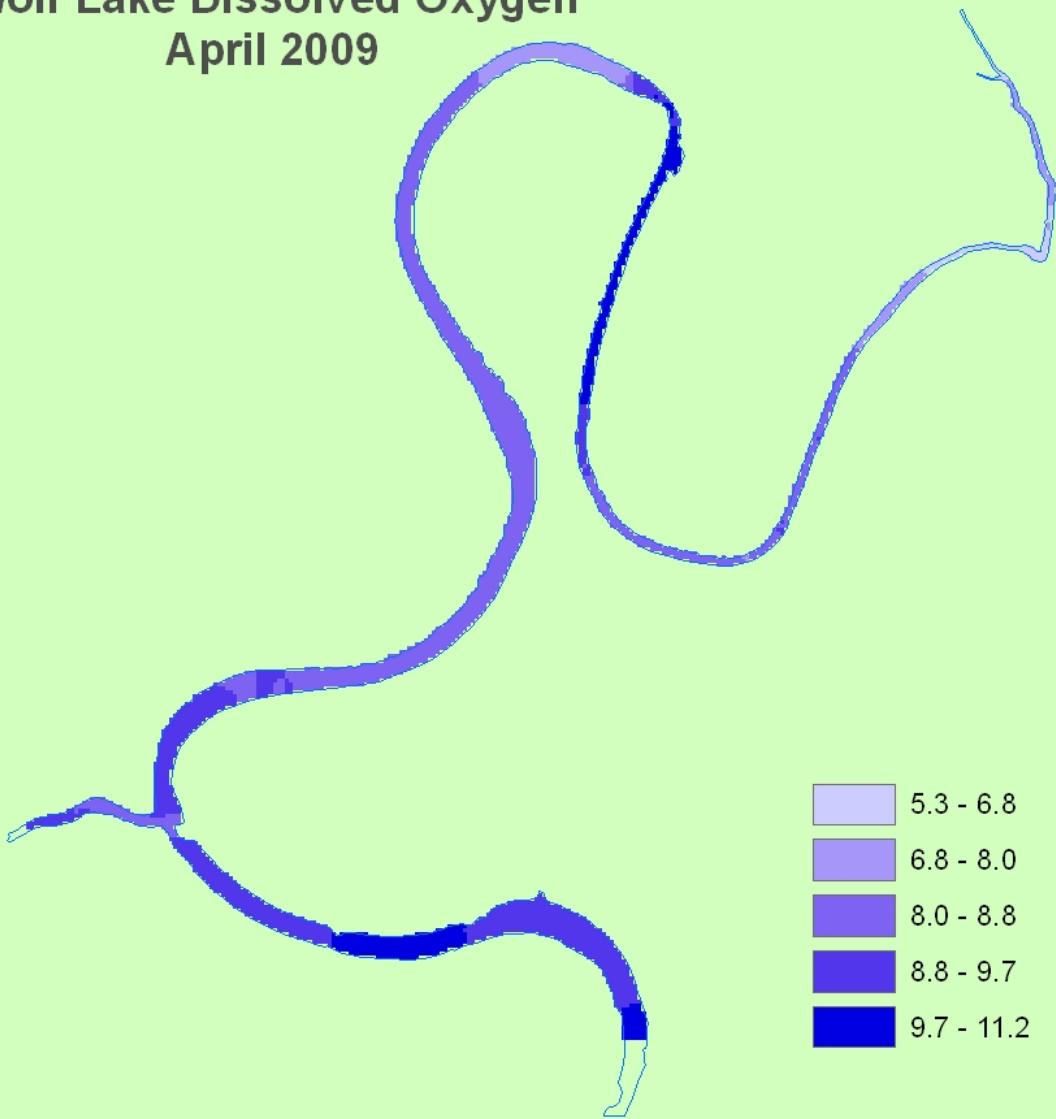
February 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
March 2009



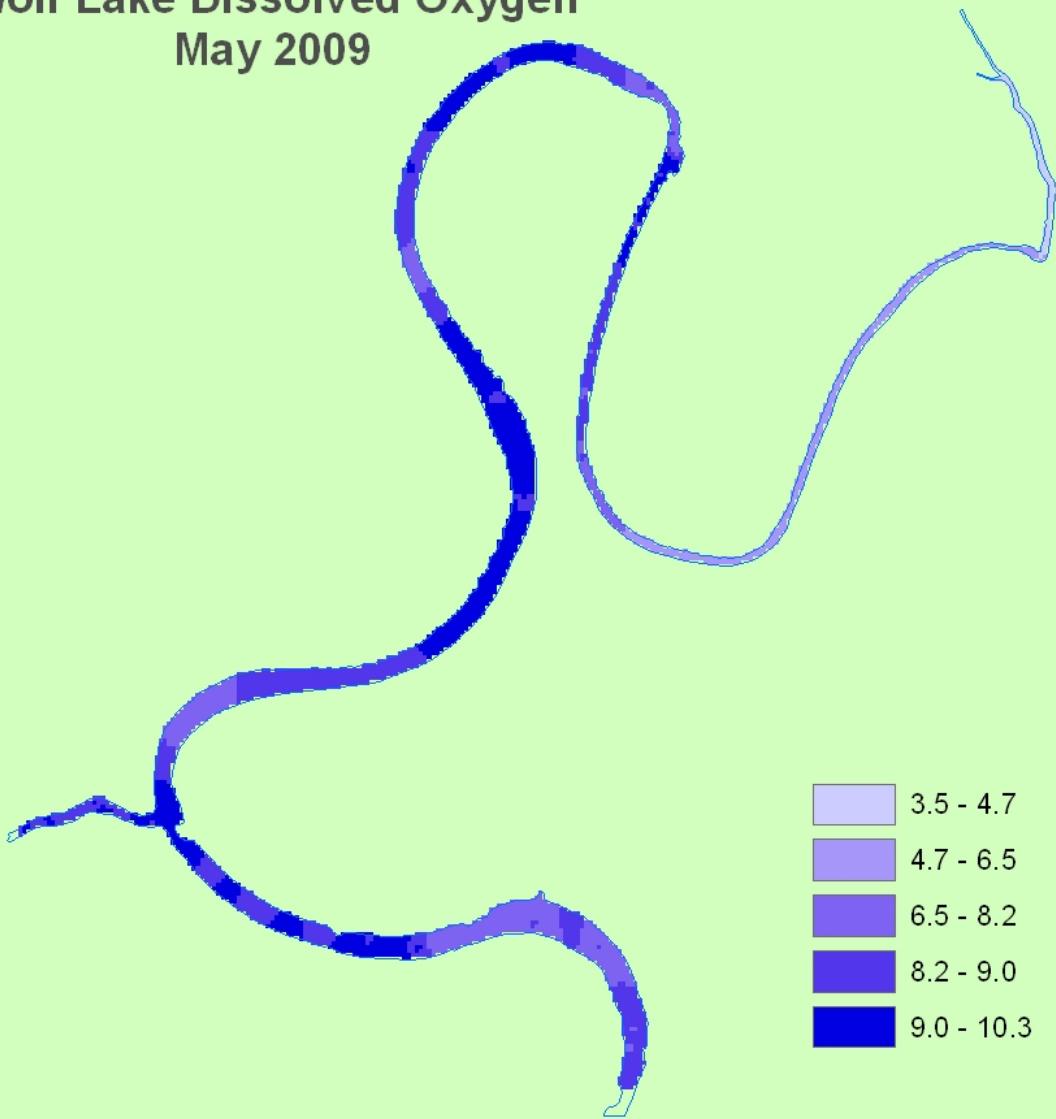
March 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
April 2009



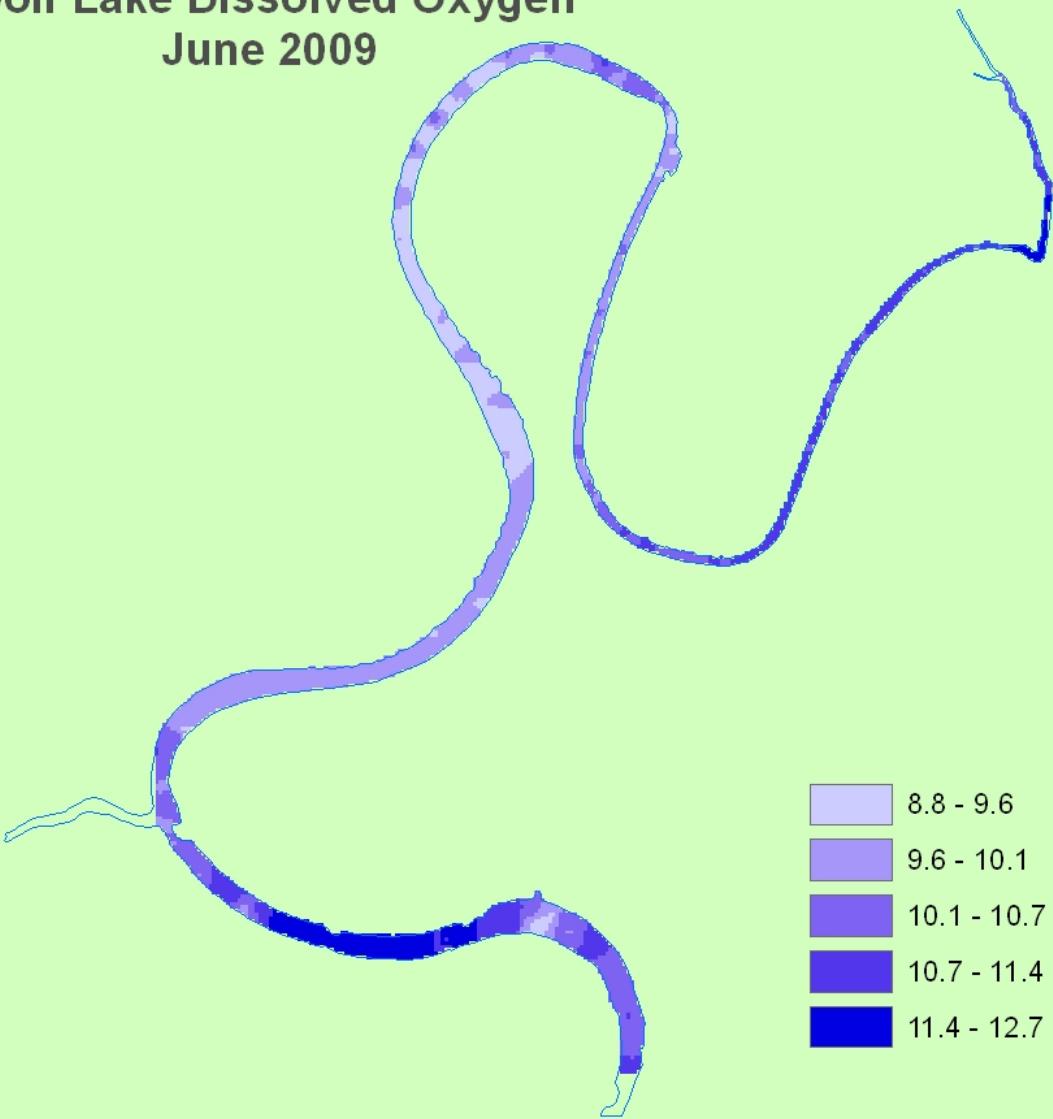
April 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
May 2009



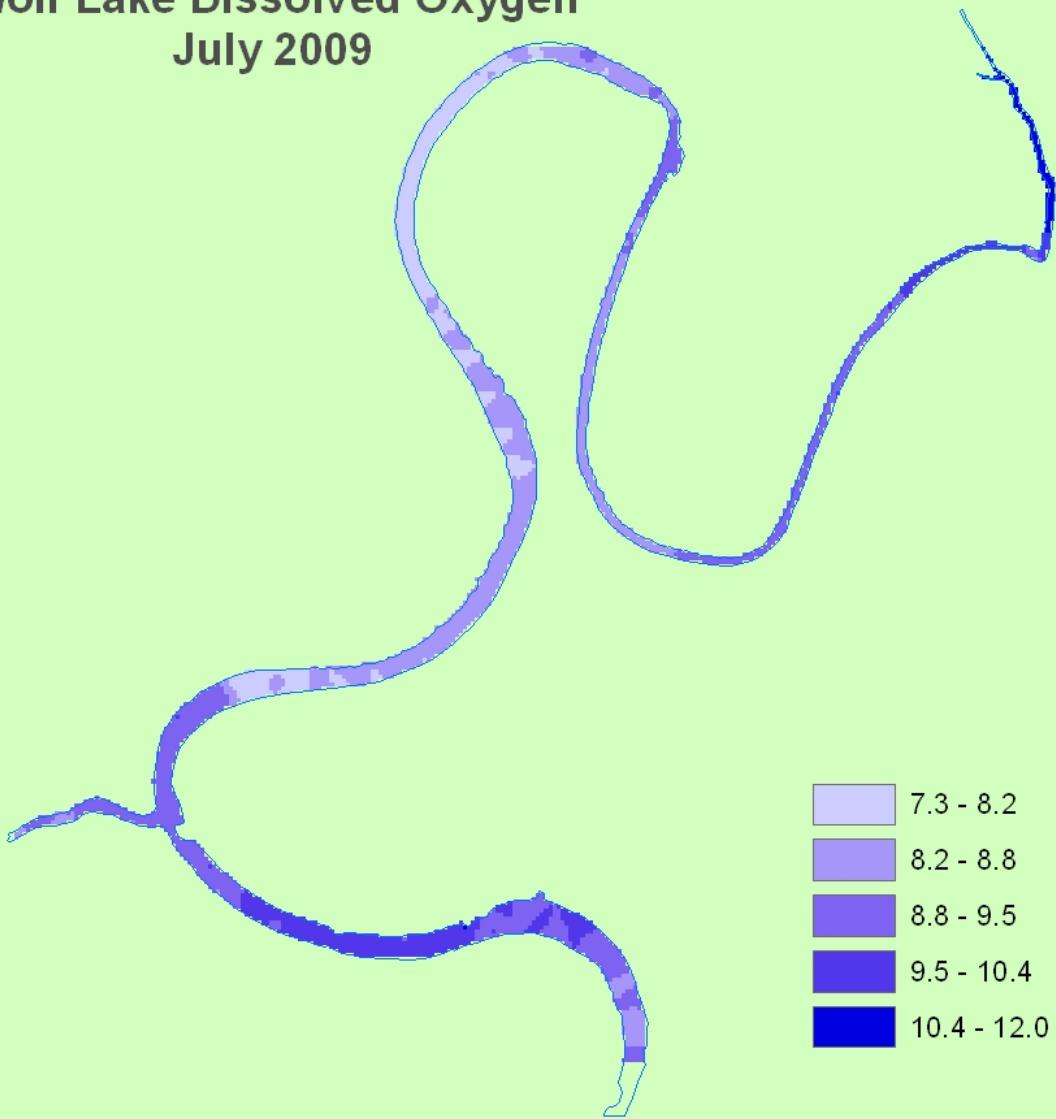
May 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
June 2009



June 2009 – Wolf Lake Dissolved Oxygen

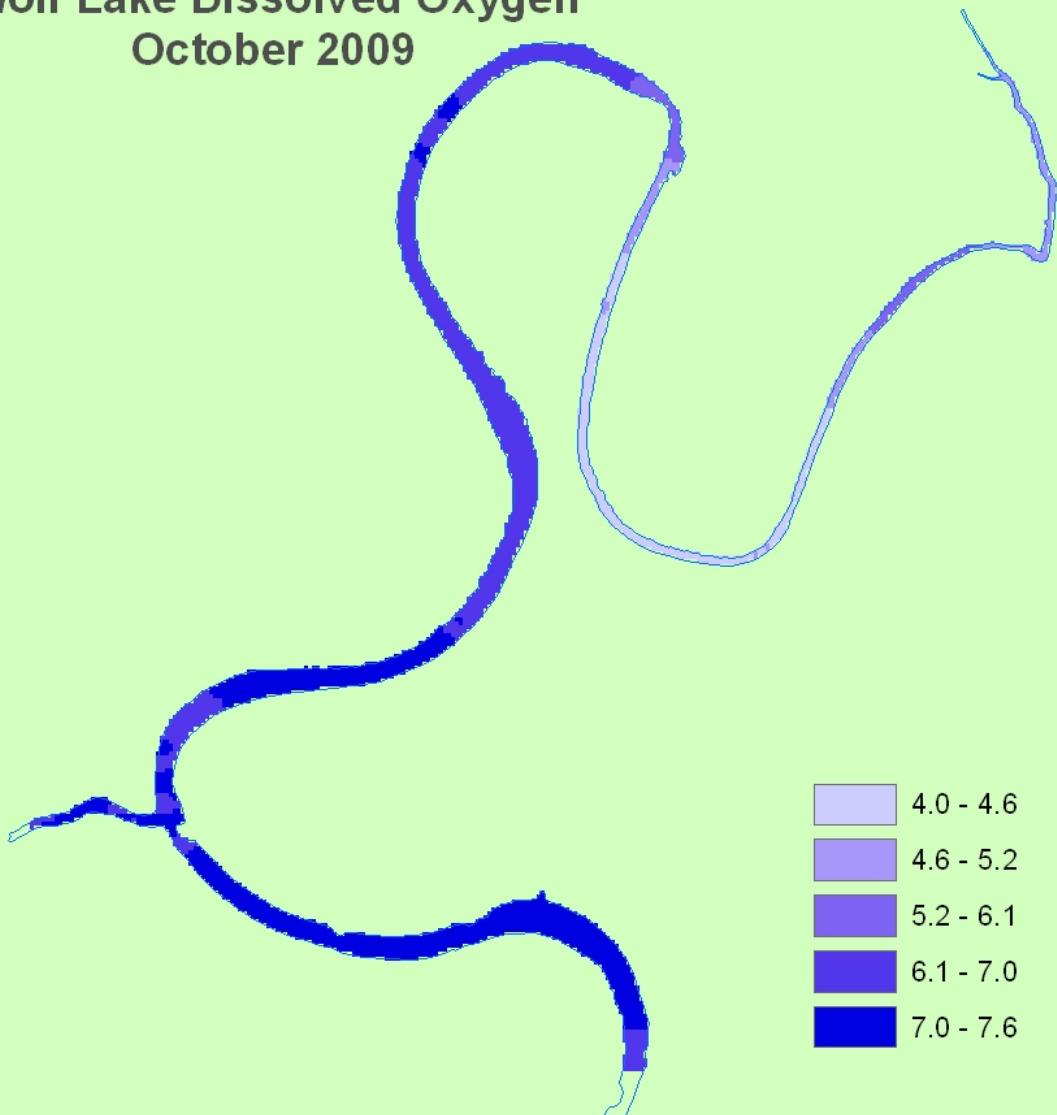
Wolf Lake Dissolved Oxygen
July 2009



July 2009 – Wolf Lake Dissolved Oxygen

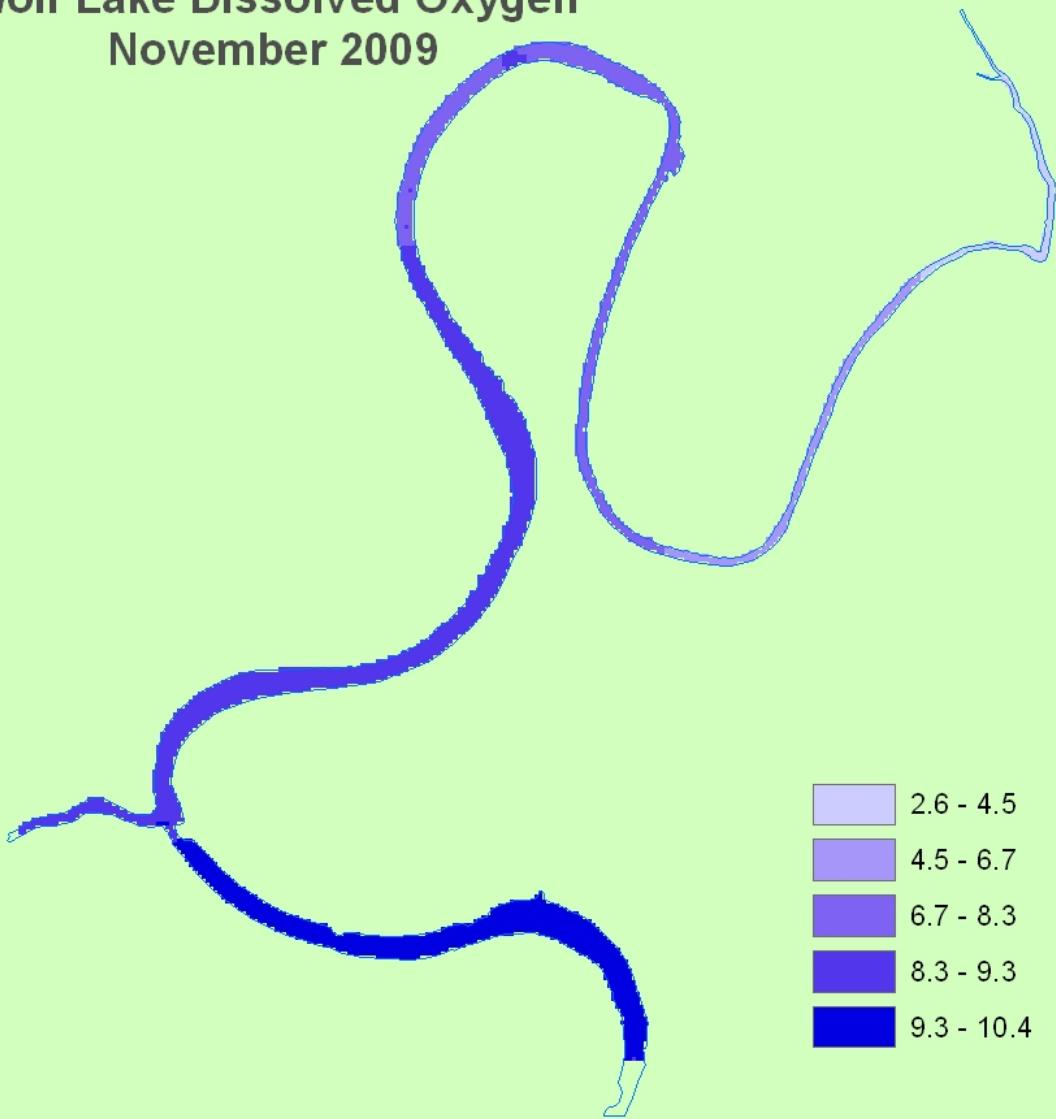
August and September 2009 – Wolf Lake Dissolved Oxygen not collected as water levels were too high, and boat ramps were closed within Wolf Lake

Wolf Lake Dissolved Oxygen
October 2009



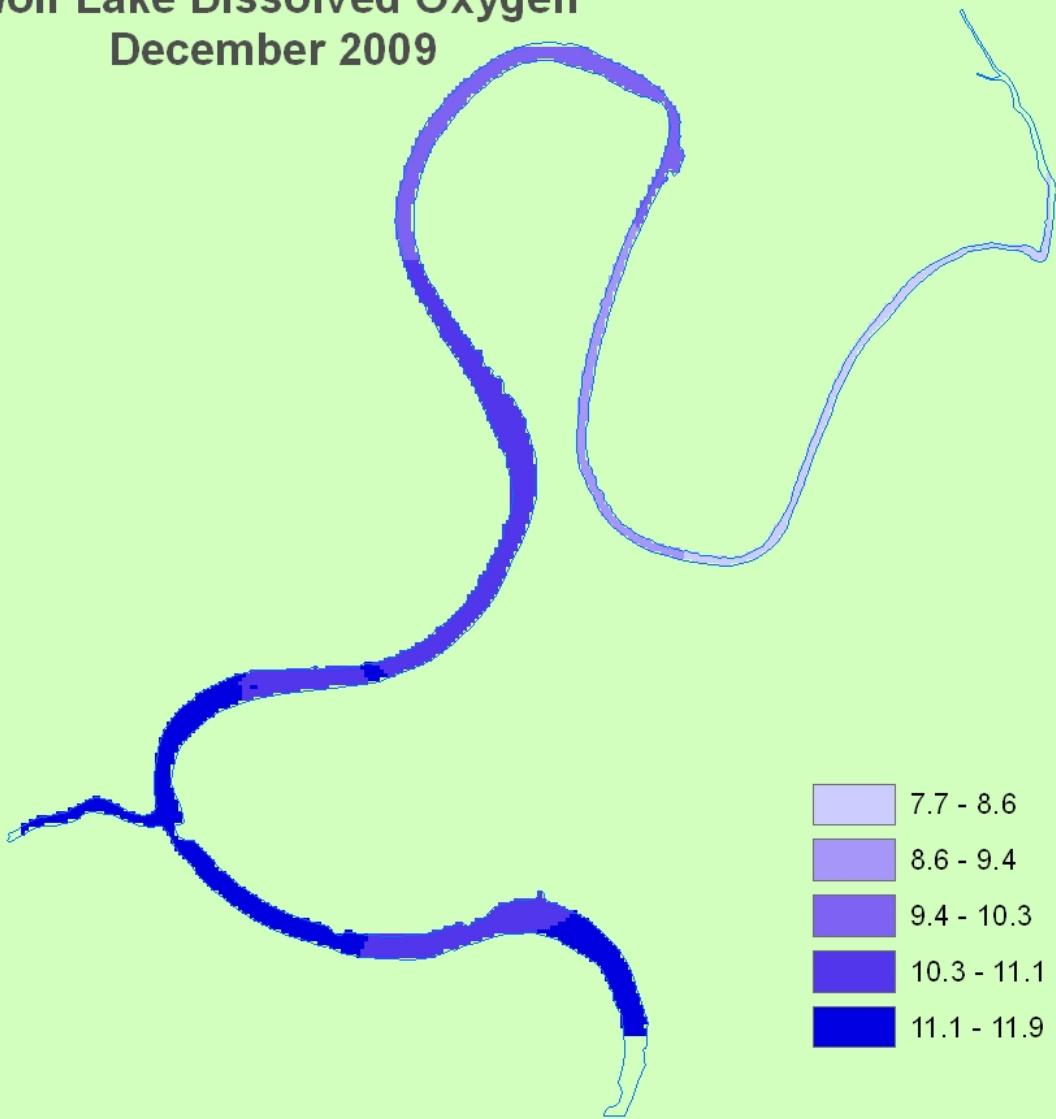
October 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen November 2009



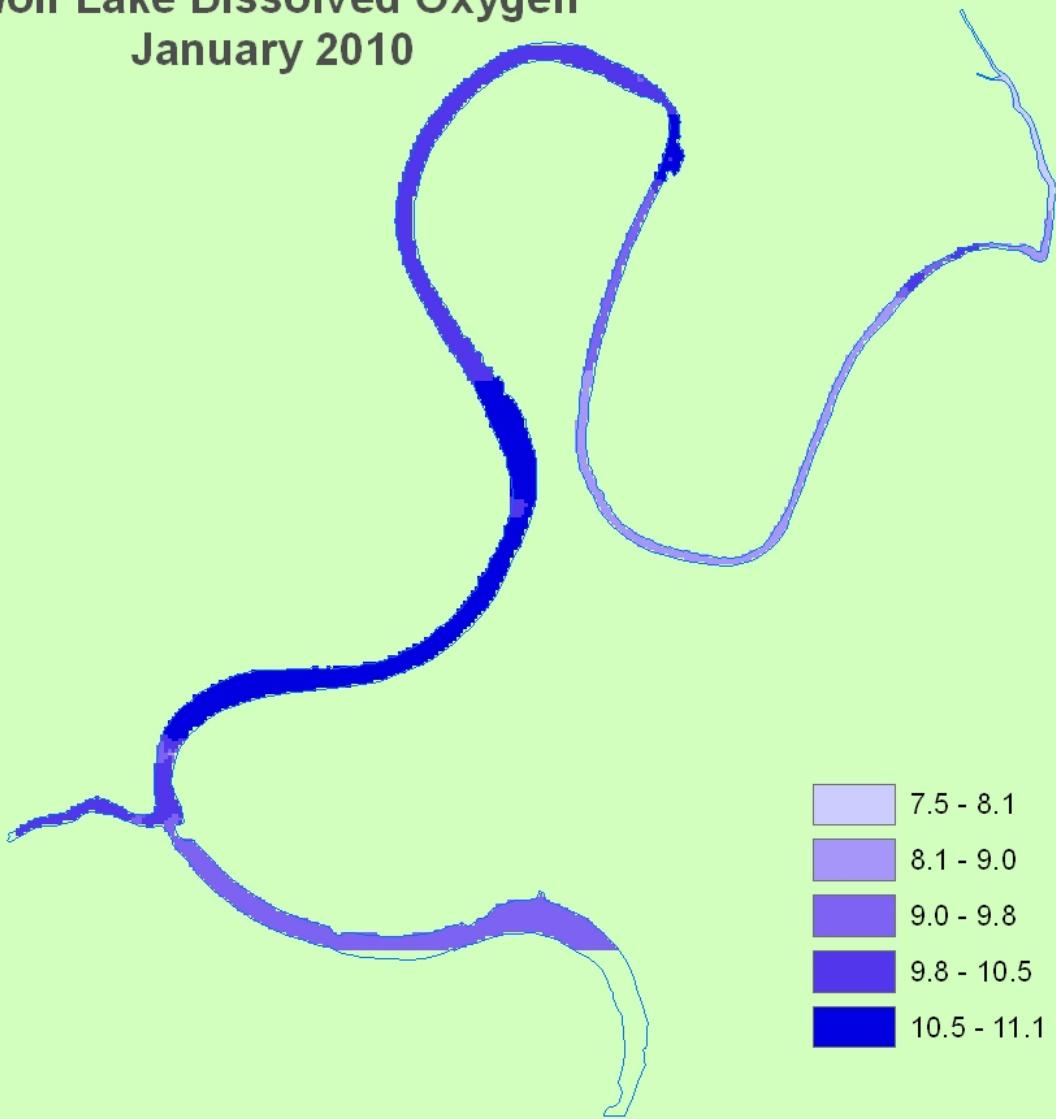
November 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen December 2009



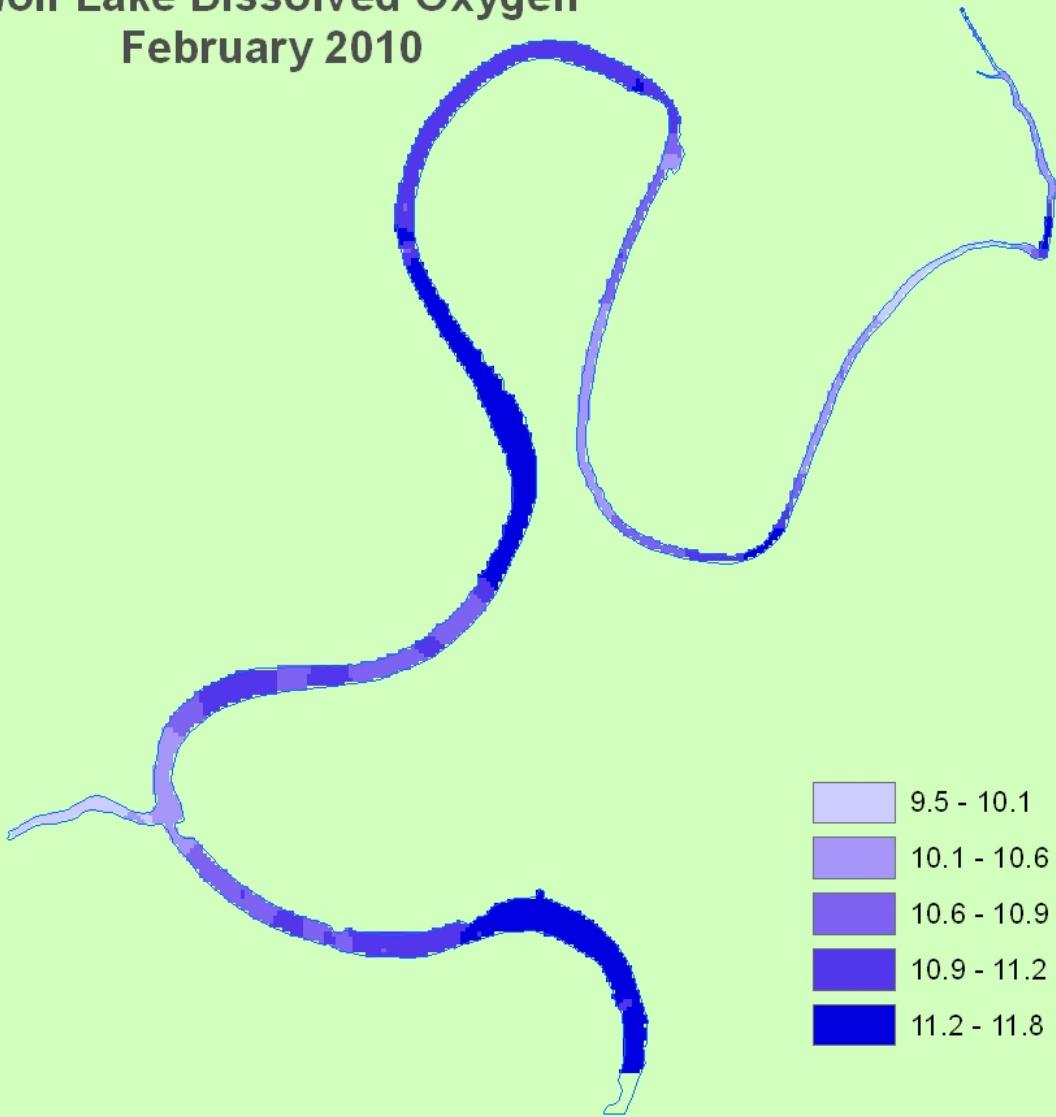
December 2009 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen January 2010



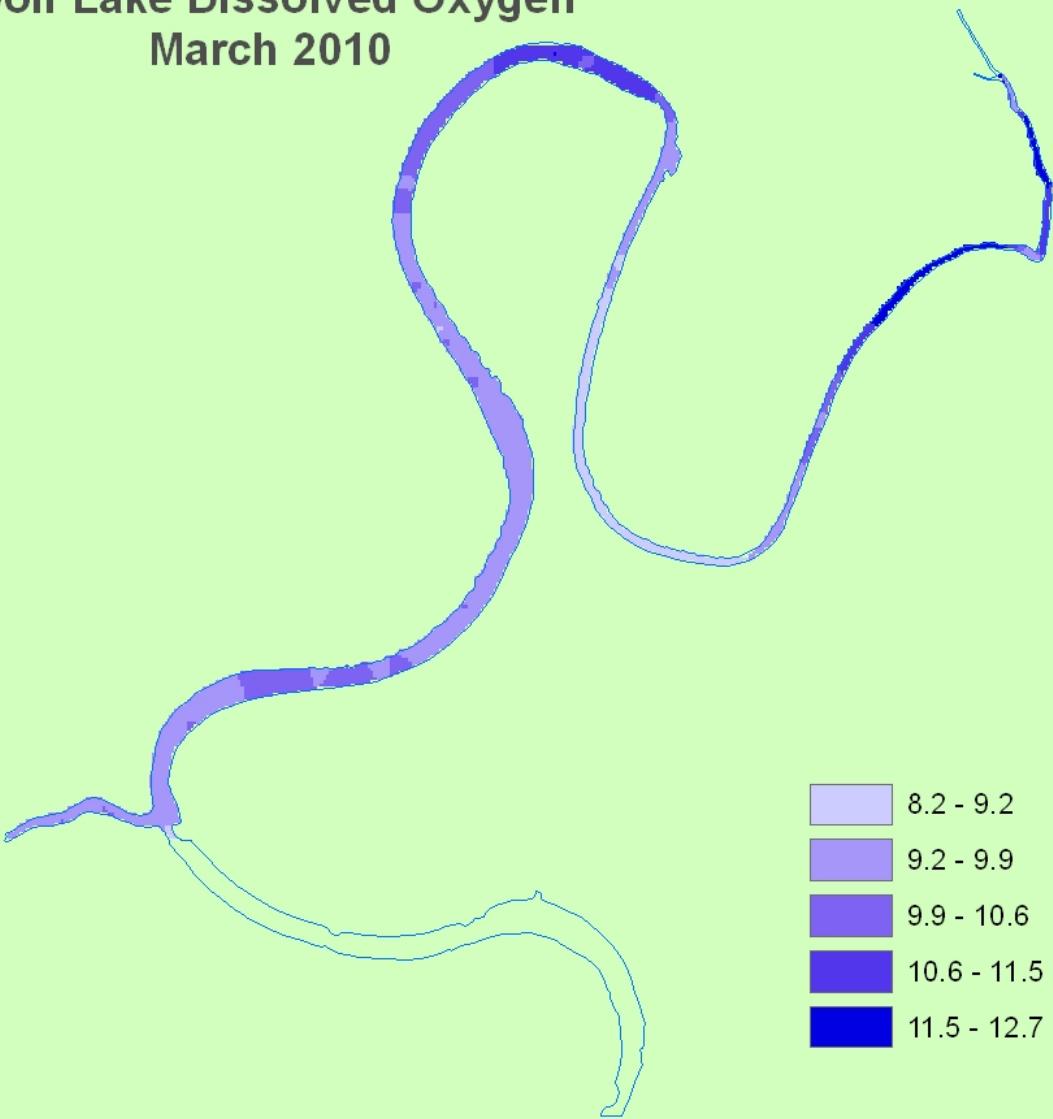
January 2010 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
February 2010



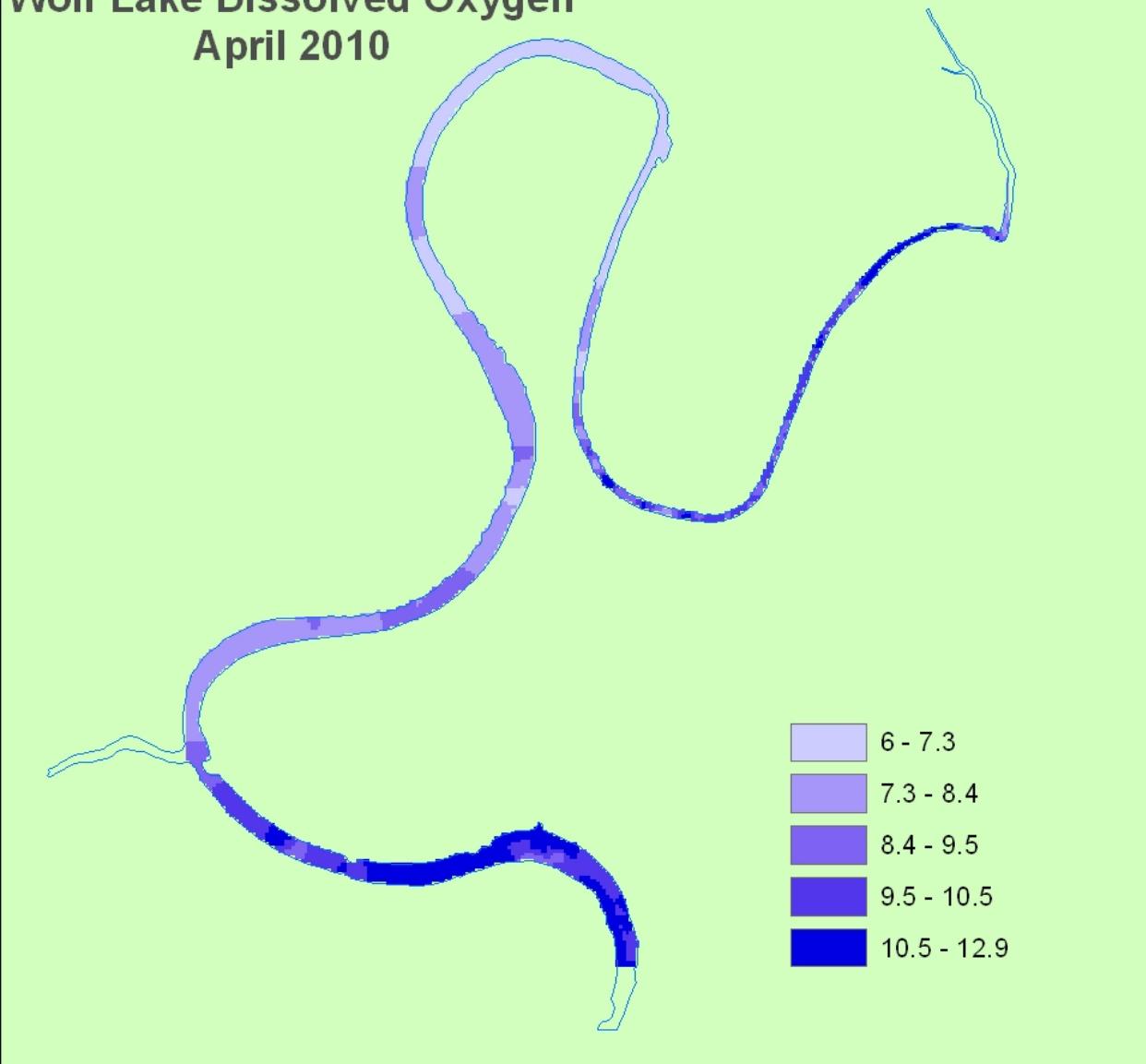
February 2010 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen
March 2010



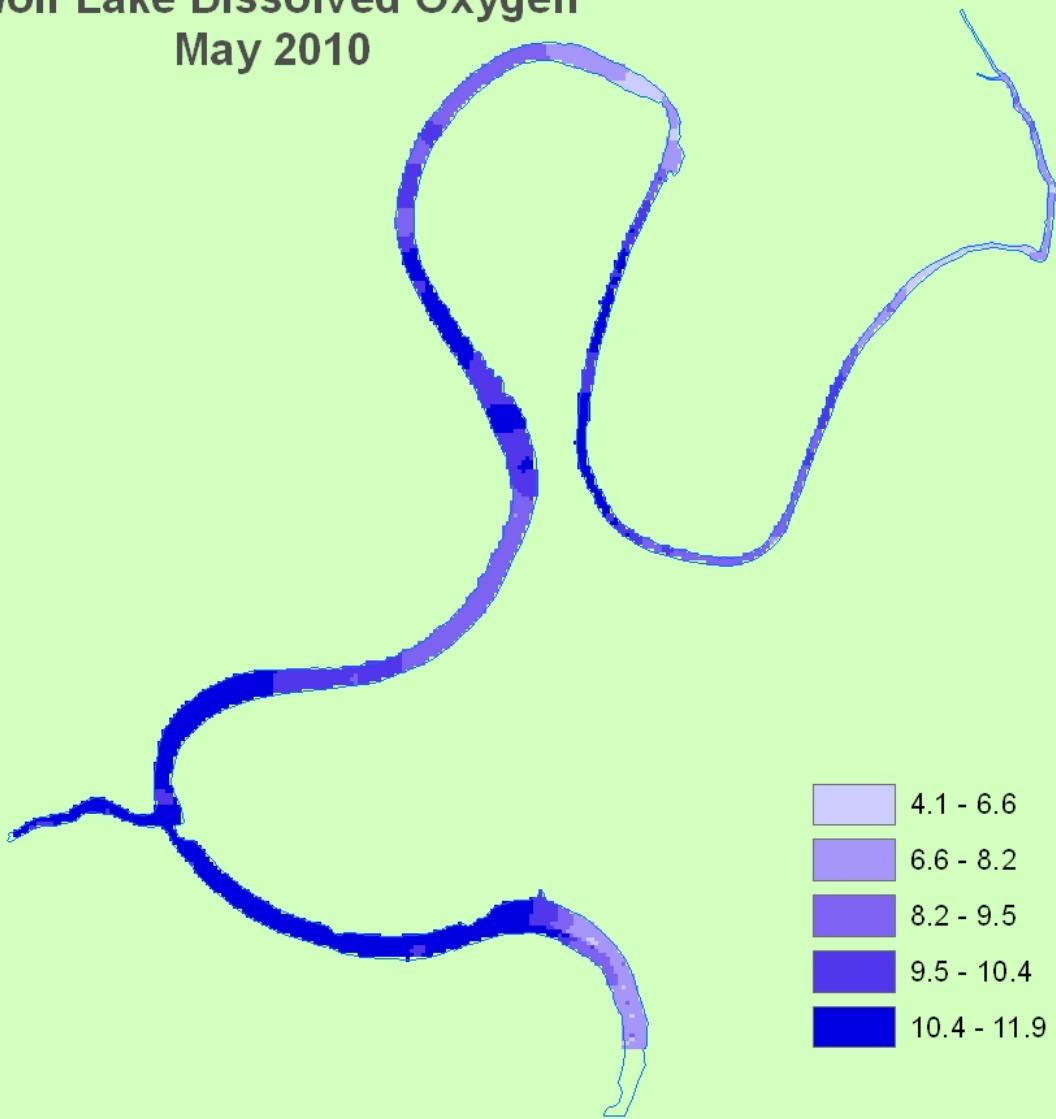
March 2010 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen April 2010



April 2010 – Wolf Lake Dissolved Oxygen

Wolf Lake Dissolved Oxygen May 2010



May 2010 – Wolf Lake Dissolved Oxygen

Appendix D

**QUALITY ASSURANCE / QUALITY CONTROL
DOCUMENTATION FOR WOLF LAKE, MISSISSIPPI
JUNE 2008 – JUNE 2010**

QUALITY ASSURANCE / QUALITY CONTROL
DOCUMENTATION WOLF LAKE, MISSISSIPPI
JUNE 2008 – JUNE 2010

Prepared for
Delta F.A.R.M. and Delta Wildlife Inc.
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Prepared by
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The purpose of this document is to provide the data quality objectives for the duration of the Wolf Lake / Broad Lake 319h monitoring effort towards TSS and turbidity sampling. The quality assurance project plan approved by MDEQ and EPA 319h requires data gathered towards understanding water quality metrics have quality assured and quality control standards associated with the gathered data. QA/QC measures provide a metric of data confidence and inclusion for policy making and understanding towards system improvements. This document will provide data quality objectives (where applicable) to each sampling effort and document.

1.0 Water Quality Monitoring

1.1 *Automated Long-term monitoring*

An automated, long term monitoring station was to be constructed at a location to be determined in cooperation with Delta F.A.R.M., Mississippi Department of Environmental Quality, Mississippi Department of Transportation and Mississippi State University. The criteria for site selection included: a representative location within Wolf Lake, a site that is influenced from runoff from adjacent agricultural lands implemented with BMPs, logically accessible, has cellphone reception for telemetry, and is in a location that is difficult to vandalize. A number of these criteria were unattainable for a number of reasons:

- **Cellphone:** the acquirement of a cellphone contract through the State government for this research project was non-negotiable. We were advised that it would not be possible. The option that Delta F.A.R.M. negotiated the cell contract was discussed but the complication of who was responsible for maintenance and service fees post the project lifetime added further logistical complications.
- **Backwater influences from the sunflower river:** Numerous times during the course of the project (August – October 2009) severe flooding resulted in several periods of backwater influences from the sunflower river into wolf lake which would have biased data collection. Furthermore, adjustments to the automated telemetry system would have been required for high water levels
- **MDOT:** Acquiring a site and permit for the data sonde placement provided extremely difficult once the unit was acquired and a designated spot was determined
- **Accessibility:** The bridge mount for the probe would have required difficult access for maintenance, repair and movement, and no safe, accessible location could be found that would have provided representative data for Wolf lake.

1.2 *Monthly Sampling*

Monthly sampling was conducted within Wolf Lake from June 2008 – June 2010. The monthly sampling consisted of sampling to monitor turbidity, total suspended solids, water temperature, dissolved oxygen, pH, and specific conductance of surface waters. All parameters, except for total suspended solids, were measured in-situ using a flow-through system (Eureka Manta multiprobe) while traveling along the length of the lake (Wolf Lake: coordinates range 32.87791N / 90.48669W – 32.95806N / 90.45041W). This system was designed with a 12v water pump, and tygon tubing to pump small volumes of lake water from the lake, through a manufacturer supplied flow-cell which houses the sensors, and back to the lake. Simultaneous

recording of position (GPS coordinates) and these parameters allowed us to assemble a geo-referenced data set of water quality data that can be correlated to specific management practices implemented throughout the basin. Total suspended solids (TSS) samples were collected at least 20 locations on each sampling trip, including required replicate and blank sampling for quality control/assurance. Sampling locations were spatially stratified within Wolf Lake to ensure an adequate sampling of the entire lake. At each stratified sampling location, the sample was randomly taken. A duplicate field sample was taken with every 10th sample, thus two field duplicates occurred for each sampling period.

TSS was run within the Water Quality lab at Mississippi State University using the EPA approved Standard Method 2450D for Total Suspended Solid Determination. Below is the step by step protocol followed for each sampling event.

In Field:

1. Collect 20 grab samples randomly throughout Wolf Lake, with 2 duplicates randomly selected from the 20 samples. (Keep in mind to distribute sample collections throughout entire lake)
2. Use clean 1 Liter containers for water grab samples (all containers should be numbered 1-20 with 2 duplicates with permanent markers)
3. Rinse containers once with lake water before collecting each grab sample.
4. After rinse, collect water sample from the surface water at a depth < 0.5 m, (must have > 500 ml of sample water for analyses)
5. Use a GPS waypoint to mark where sample was collected
6. Bring grab samples back to laboratory and place them in refrigerator (4° C) for storage until samples are analyzed
7. Field samples should be processed within 48 hours but no longer than 7 days.

In Laboratory:

1. Label aluminum weighing dishes to match number of grab samples, plus 1 weighing dish for blank sample.
2. Use glass microfiber filters (GC-B < 2µm) (47 mm) for filtration
3. Place glass filters on vacuum filtration device, measure >100 ml of distilled water to filter through glass filters
4. After water is filtered through glass filters, remove glass filters using forceps and place them in the aluminum dishes then transfer them to drying oven (place all weighing dishes on cookie sheet for ease of transference)
5. Drying oven temperature must be held constant at 103 to 105° C
6. Record temperature when filters are placed into the oven on the TSS data sheet.
7. Leave filters in oven overnight (24 hours)
8. After 24 hours, remove filters from oven and place them in a desiccator for cooling (1-2 hours). Record temperature of oven on TSS data sheet before filters are removed
9. Transfer filters to weighing station; use Scientech SA 210 (or best available balance) to weigh all filters and weighing dishes (make sure to re-zero after weighing each filter).
10. Record weight of dried filter in weighing dish on the TSS data sheet under column labeled, initial weight.
11. When transferring filter and dish for rest of procedure make sure to use forceps to minimize contact with weighed filtered dish.
12. Transfer filters to vacuum filtration device
13. Match filter dish with grab samples using the labeled numbers
14. Place filters onto filtration device
15. Shake grab samples for 15 seconds before measuring, to mix suspended particles
16. Measure water samples using a graduated cylinder
17. Measured water amount must be > 50 ml and < 150 depending on water clarity (the clearer the water appears the more water must be filtered to show difference in weight)
18. Record amount of water used for filtration on TSS data sheet
19. Use filtration device for all samples (20 samples + 2 duplicates + 1 blank)
20. After all samples have been filtered transfer them to drying oven and record temperature on TSS data sheet (overnight 24 hours)

21. Record temperature of drying oven before removing filters on TSS data sheet, remove filters using forceps and place them in desiccators (1-2 hours)
22. Remove filters from desiccators and transfer them to weighing station
23. Repeat procedures 9 and 10, record weight under column final weight
24. Calculate difference in weight and convert to mg
(example: weight diff. = 0.046 g = 4.6 mg)
25. Then divide the calculated difference by amount filtered in liters
(example: 150 ml filtered = 0.15 Liters)
(example: 4.6 mg / 0.15 L = 30.7 mg/L total suspended solids)
26. Record final TSS values on the data sheet
27. Dispose of filters in a trash can and empty leftover water from grab samples
28. Clean and dry sample containers
29. Complete and sign Chain of Custody Record forms
30. Transfer all data on TSS data sheet to a Excel file on the computer and name file as the month samples were collected

1.3 Data Quality Objectives for Monthly Sampling

June 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: No dups	[]
Duplicate 2:	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g

[x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period []
- Similar timing of sample collection between prior months sampling []
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

18/23 = 78%

July 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field/Lab Duplicates < 2 Reporting limits <100%

Duplicate 1: 102%	[]
Duplicate 2: 104%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

August 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 113% (<2 reporting limit)	[]
Duplicate 2: 14%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

21/23 = 91%

September 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 51%	[]
Duplicate 2: 41%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

October 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 4.3%	[x]
Duplicate 2: 13.8%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

November 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 3.2%	[x]
Duplicate 2: 1.8%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

December 2008

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 $\mu\text{S}/\text{cm}$) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 80.4%	[]
Duplicate 2: 26.3%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

January 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 10.9%	[x]
Duplicate 2: 2.8%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

February 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 3.5%	[x]
Duplicate 2: 4.0%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

March 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 7.3%	[x]
Duplicate 2:	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

21/23 = 91%

April 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 μ S/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 4.0%	[x]
Duplicate 2: 4.4%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

May 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 8.0%	[x]
Duplicate 2: 8.4%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

June 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 136% (<2 reporting limit)	[]
Duplicate 2: 50% (<2 reporting limit)	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

July 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 120% (<2 reporting limit)	[]
Duplicate 2: 33.3% (<2 reporting limit)	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

August 2009 ----BOAT RAMP CLOSED WOLF LAKE INACCESSIBLE---

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

- | | |
|---|-----|
| Temperature (within 0.5°C) | [] |
| Dissolved Oxygen (within 0.5mg/L) | [] |
| pH (within 0.5 units) | [] |
| Turbidity (within 3% > 300NTU; 1% < 400NTU) | [] |
| Conductivity (within 10%) | [] |

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

- | | |
|----------------------|-----|
| Duplicate 1: No dups | [] |
| Duplicate 2: | [] |

Representativeness:

- Appropriate sampling containers []
- Samples preserved or not preserved according to SOP []
- Samples held to appropriate holding times []

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g

Comparability:

- Appropriate SOP for TSS analysis in lab []
- Appropriate SOP for TSS sampling in field []
- Were all DQO's completed for the monthly sampling period []
- Similar timing of sample collection between prior months sampling []
- Appropriate sampling containers utilized []
- Were samples transported on ice []
- Were field duplicates taken []
- Appropriate Calibrations []

Completeness:

- Was there enough sample for analysis []
- Upon arrival no leaks, spills or loss of samples []
- Total number of containers transferred to lab from field []

Overall Monthly Completeness:

/23 = %

September 2009 ----BOAT RAMP CLOSED WOLF LAKE INACCESSIBLE---

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 μ S/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[]
Dissolved Oxygen (within 0.5mg/L)	[]
pH (within 0.5 units)	[]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[]
Conductivity (within 10%)	[]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: No dups	[]
Duplicate 2:	[]

Representativeness:

- Appropriate sampling containers []
- Samples preserved or not preserved according to SOP []
- Samples held to appropriate holding times []

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g []

Comparability:

- Appropriate SOP for TSS analysis in lab []
- Appropriate SOP for TSS sampling in field []
- Were all DQO's completed for the monthly sampling period []
- Similar timing of sample collection between prior months sampling []
- Appropriate sampling containers utilized []
- Were samples transported on ice []
- Were field duplicates taken []
- Appropriate Calibrations []

Completeness:

- Was there enough sample for analysis []
- Upon arrival no leaks, spills or loss of samples []
- Total number of containers transferred to lab from field []

Overall Monthly Completeness:

/23 = %

October 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 26.2%	[x]
Duplicate 2: 4.6%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

November 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 μ S/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 28%	[x]
Duplicate 2: 19%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

December 2009

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 5.8%	[x]
Duplicate 2: 8.8%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

January 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 17.2%	[x]
Duplicate 2: 4.5%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

February 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 50.1%	[]
Duplicate 2: 44.8%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

March 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 25.5%	[x]
Duplicate 2: 3.1%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

April 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 168%	[]
Duplicate 2: 141%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

20/23 = 87%

May 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 23.3%	[x]
Duplicate 2: 70%	[]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

21/23 = 91%

June 2010

Turbidity, DO, pH, Sp. Conductance – Eureka Manta Calibrated prior to sampling, appropriate calibration checks, 3-point standard for pH (4, 7 and 10- Eureka Scientific Standards), specific conductance (KCl, 147 µS/cm) and turbidity (7.6, 77 and 673 NTU), and DO saturation calibration.

Accuracy:

Field Instrument:

Temperature (within 0.5°C)	[x]
Dissolved Oxygen (within 0.5mg/L)	[x]
pH (within 0.5 units)	[x]
Turbidity (within 3% > 300NTU; 1% < 400NTU)	[x]
Conductivity (within 10%)	[x]

Matrix Spike – no TSS standard utilized as a result of discrepancy in sediments []

Precision: TSS RPD < 30%

Field Duplicates

Duplicate 1: 15%	[x]
Duplicate 2: 0%	[x]

Representativeness:

- Appropriate sampling containers [x]
- Samples preserved or not preserved according to SOP [x]
- Samples held to appropriate holding times [x]

Sensitivity:

- Minimum detection limit (balance / scale): 0.001 g
 - Filter – Blank, DI water 100ml = 0.0001g [x]

Comparability:

- Appropriate SOP for TSS analysis in lab [x]
- Appropriate SOP for TSS sampling in field [x]
- Were all DQO's completed for the monthly sampling period [x]
- Similar timing of sample collection between prior months sampling [x]
- Appropriate sampling containers utilized [x]
- Were samples transported on ice [x]
- Were field duplicates taken [x]
- Appropriate Calibrations [x]

Completeness:

- Was there enough sample for analysis [x]
- Upon arrival no leaks, spills or loss of samples [x]
- Total number of containers transferred to lab from field [22]

Overall Monthly Completeness:

22/23 = 96%

OVERALL PROJECT COMPLETENESS: **95.5%**