Angler Use and Harvest Surveys on Stockade Lake, South Dakota, 1999 and 2003 With a Evaluation of the Aeration System Effectiveness

By

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Completion Report

Dingell-Johnson Project F-21-R-32 & 36
Job Numbers 2102 and 2109
Date February, 2005

PREFACE

The data and summaries presented in this report were collected from 1997 through 2003. Copies of this report and references to the data can be made with permission from the author or the Director of the Division of Wildlife, South Dakota Department of Game, Fish and Parks, 523 E. Capitol, Pierre, South Dakota, 57501-3182.

The author would like to acknowledge the following individuals who assisted with the data collection, data entry, and editing this manuscript from the South Dakota Department of Game, Fish and Parks; Gene Galinat, Dan James, Ron Koth and Custer State Park staff. Special thanks go to Will Sayler, John Carreiro and Ron Koth for edits to this document.

The collection of data for these surveys was funded, in part, by Federal Aid in Sport Fish Restoration, (D-J) project F-21-R, “Statewide Fish Management Surveys.” Some of these data have been presented in previous annual reports.

EXECUTIVE SUMMARY

This report summarizes the results of two years of water chemistry monitoring, two separate creel surveys and changes in fish growth over a four-year period for Stockade Lake, Custer County, South Dakota. Water chemistry parameters were sampled at least monthly during the summer since 1999. Chemical parameters measured were chlorophyll A, total phosphorus and Secchi depth. Together these parameters make up a Trophic State Index (TSI). This information is important for determining the "age" of the lake. Currently, Stockade Lake has maintained a TSI measurement over 40. This figure classifies Stockade Lake as a mesotrophic lake and the trend indicates continued improvement.

The objectives of installation and operation of the aeration system at Stockade Lake were breakdown of the thermocline, improvement in water clarity and improvement of predatory fish growth. For each of these objectives positive results were obtained. Another positive result was an increase in angler satisfaction. Installation of the aeration system occurred in the fall of 1998 with the operational startup taking place on May 11, 1999.

Data from water sampling showed immediate improvement in both water temperature and dissolved oxygen profiles. The breakdown of the thermocline provides more available habitat for various fish species by increasing the area suitable for fish survival.

Catch and harvest of fish during the two creel surveys (1999, 2003) indicates that anglers utilize the panfish in Stockade Lake. Black crappie and yellow perch were the two most numerous fish in both catch and harvest. Anglers rarely harvested the picivorous species in the lake; these include largemouth bass, smallmouth bass and northern pike. Summer angling hours increased from just over eight thousand hours in 1999 to well over thirteen thousand hours by 2003. Angler catch and harvest also increased during this time period (1999-2003). Most anglers were men and were residents of the Black Hills area.

Lake survey information shows an improvement in the major indices of freshwater fisheries management (Relative weight, Proportional Stock Density, Relative Stock Density, and Catch Per Unit Effort) during the period of the lake aeration operation. A largemouth bass regulation requiring the release of all largemouth bass less than 15 inches was in effect during the entire period of this analysis. Yearly growth of largemouth bass improved from the pre-aeration through the aerated period. The number of stock length bass increased. Only slight increases in Relative Stock Density of preferred size fish (RSD-P) were noted, as catch remained stable. Seven species of fish were sampled during the lake surveys.

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INTRODUCTION

Stockade Lake (Custer County) is a 120-acre (48.6 hectares) reservoir and is one of the few in western South Dakota that provide boat, shore and ice fishing opportunities (Figure 1). The 2003 creel survey was not only a measure of the anglers catch, harvest, and satisfaction but also designed to determine the success of the aeration system on the lake. Information from lake survey data was used to measure increases in predatory fish growth.

An aeration system was installed in Stockade Lake as the final step in lake renovation following the cessation of municipal sewage discharge. Stockade Lake was showing signs of early eutrophication. Water chemical profiles, unsightly algal blooms, occasional fish kills and reduced growth of picivorous fish were all indicating that the lake was approaching eutrophic conditions. Installation of the aeration system occurred in the fall of 1998 with the operational startup taking place on May 11, 1999.

Since the construction of Stockade Lake in 1935, an increased nutrient load was induced into the lake via a faulty municipal sewer system located upstream (Table 1). The results of the nutrient loading became evident in the mid 1960's with an increase in aquatic weeds; more algae present and trout die-offs. Twice before, aeration has been a consideration at improving water quality at Stockade Lake. The first aeration system determined if it was feasible in totally mixing the lake. This first system showed some success as it was later used in 1971 as a preventative measure to prevent a fish die off. The second system was developed in an effort to determine the extent a system could be used to totally mix the entire lake. The second system was removed because of high operational costs. Steps were then taken to address the source of the nutrient loading. The sewer system of the city of Custer went through three stages. Primary sewage treatment and discharge into French Creek (the major tributary of Stockade Lake) existed until 1974 when a secondary treatment facility including the use of digesters and stabilization ponds were installed. In 1986 the discharge of the treatment was moved into a different watershed that consisted of only temporary flows. A final attempt in the water quality improvement occurred from 1987-1989 when removal of the in-lake sediment via dredging took place. Even with all of these attempts of water quality improvement, a fully functional aeration unit was needed as issues involving lake stratification, fish kills and the occurrence of algal blooms still existed.

Due to the surrounding terrain, Stockade Lake does not receive large amounts of wind. This lack of wind prevents the lake from mixing, and sets up a condition of temperature stratification. In the stratified condition, the waterbody will exhibit situations where oxygen is present in the warmer, upper portions of the lake and absent in the lower cold water segment (below thermocline). It is generally

accepted that stratified conditions reduce the area of coldwater fish habitat and thereby affect fish growth and survival.

Table 1. Timeline of work performed at Stockade Lake.

Construction of Stockade Lake	1935
Public concerns over trout die-offs	1959-1960
First aeration attempt	1971
Secondary sewage treatment occurs in Custer	1974
Second aeration attempt	1981
Custer water treatment moved to different watershed	1986
Dredging of lake	1987-1989
Installation of third aeration system	1988
Running of thrid aeration system	1989-current

Many efforts to improve water quality in Stockade Lake have occurred throughout its history. As mentioned before, in 1967-68 an experimental aeration system was setup in Stockade Lake to determine if airflow alone would be enough to "breakup" the lake stratification conditions (Van Ray 1969). During the 1980's a variety of modifications were performed at Stockade Lake, including removal of 175,000 cubic yards of silt. A second aeration system was tested in 1981 and showed through dye studies that the aeration system would fully "mix" the lake (Anonymous 1981a). Conditions in the watershed improved greatly after 1986 when the city of Custer began pumping sewage effluent to a different drainage. However, the much of the enriched sediment still was present in the lake even after an extensive dredging effort. Finally, in 1999 a new aeration system was installed that would allow more oxygen in the lake due to the breakup of lake stratification or at least the lowering of the thermocline.

Three objectives were identified for the 1999 aeration project, breakdown of the thermocline (as seen by temperature and oxygen stratification), improved water clarity, and improved predatory fish growth. Measuring angler satisfaction and increase in size of fish caught by anglers was added to further evaluate the effectiveness of the aeration system.

Sediment Loading and Eutrophication

Problems concerning Stockade Lake have been studied and potential solutions worked on since the late 1950's. Anecdotal information from 1959-60 indicate that fishermen were expressing to Game, Fish and Parks concerns about the poor trout catch rates (Van Ray 1969). Analysis of the water chemistry determined that there were several problems associated with Stockade Lake. These problems included increased sedimentation and nutrient loading. Beyond

this, there were readily observable features such as summerkills of the fish population and increased algae presence. The occasional summer fish die-offs and increased primary productivity occurred in spite of dredging and water re-route efforts.

Testing performed in the late 1970's indicated that there was an increase in sediment loading in Stockade Lake (Anonymous 1981b). At that time the sediment loading was primarily attributed to the number of gravel/dirt roads in the Custer area. Studies performed in the early 1980's determined that the lake sediment was organic in nature and presumed to be from decaying plant material (Glover 1987).

Linked to the lake sediment increases were significant water quality changes (Van Ray 1969). Water samples indicate that the lake was "hypereutrophic." High levels of phosphorus and nitrogen were the two parameters used for this determination. Consistent summer algal blooms were the final indicator that pointed to Stockade Lake as being highly eutrophic.

There have been two earlier aeration efforts at Stockade Lake. In 1970 and 1981 the aeration of Stockade Lake was attempted. Some success was observed from these efforts, yet the first attempt was removed for cost considerations. The second aeration attempt was performed as a study to determine if a lake aeration system would work in mixing the entire lake. Positive results from these two studies indicated that Stockade Lake water quality could be improved through a permanent aeration system.

Organic inputs into the Stockade Lake have been identified as coming from two specific sources (Anonymous 1981b). For a number of years, the city of Custer experienced effluent problems with their wastewater treatment plant and this was suggested as the source of phosphorus in the system. Nitrogen was also being added upstream of Stockade Lake, it reportedly was coming from nearby barnyards/stables. Numerous ideas to remedy these conditions were explored. Eventually, dredging of the lake bottom was performed at Stockade Lake in the 1980's.

Design of the Aeration System

Scott and Foley (1919) described lake aeration, yet it was not until 1949 that the topic was again brought forth to the scientific public (Mercier and Perret 1949). Currently, two basic systems of lake aeration have been developed. Destratification is the earliest, most common, and the type installed in Stockade Lake. It involves pumping of air from a shore station into the lake through air lines and terminating at an air stone. The air is then released into the water column and the water currents set up by this process produce something close to an isothermal condition. The presence of the thermocline is thereby eliminated

with the net effect of more habitat available to fish. Hypolimnetic systems are the second type of aeration units devised to aerate lakes. These systems can be much more complicated and involve the injection of pure oxygen into the lake through a vertical apparatus.

Cooperators and Operation

The setup of the aeration system in Stockade Lake has been complex in regards to the funding, design and operation of the system itself. Coor's Brewing Company through the Clean Water 2000 grant program, which dedicated monies for clean water projects, provided part of the funding. Aquaculture Research/Environmental Associates, Inc (A.R.E.A) designed the original system. A.R.E.A. developed the design of the aeration apparatus (PVC and air stones) and provided suggestions for the needs of the pumps, plastic air hose, weights (to hold the air hose down on the bottom), and manifold design. Design flaws were detected soon after installation. The first issue arose during the installation phase when the cinder block recommended was not of sufficient density to sink the two-inch air hose. Later, problems around the pumping system itself appeared. The two-inch hose attachments to the three pumps were designed to be directly connected. In one instance, the hose itself distorted due to heat generated from air pumps. Once running for a short period of time the hose itself became overheated and distorted. Next, the enclosures designed to house the pumps themselves were too small resulting in the overheating and mechanical failure of the air pumps. Finally, the air pumps originally specified were not designed to operate on a continual basis. These items have been remedied so that the system now works throughout the summer months.

For two reasons it was decided early on in the project phase that the aeration system would only function during the summer months. First, the lake stratification would occur primarily during the summer months. Second, Stockade Lake experiences heavily ice-fishing pressure and with a aeration system running the ice conditions might be of reduced quality making for unsafe conditions.

SAMPLING METHODS

STUDY AREA
Physical and Chemical Monitoring

Water chemistry has been monitored bi-weakly or monthly during summers at Stockade Lake in order to evaluate the effectiveness of the aeration system. This sampling was performed in order to determine timing of the breakdown of the temperature and oxygen profile or whether stratification even took place. Water clarity as measured by secchi depth was also recorded to measure any water clarity improvements.

The aeration system was installed in Stockade Lake during the fall of 1998 and has operated through most of the ice-free months (middle of May to middle of October) since that time. Occasional interruptions to operations of the system have occurred throughout its history, including a major disruption in the summer of 2000 where the system was only operational from May to the first week in July due to equipment failure. Other operational failures have occasionally occurred during the early stages of operation. For example, a change from galvanized wire to stainless steel cable to ensured the longevity of the weight/aeration hose connection. Chemical profiles and water grab samples were collected from Stockade Lake both before the installation process and afterwards. During the early stages of operation water chemistry was measured on a biweekly basis to determine the effect aeration had on water quality in the lake. Later, sampling occurred monthly.

Three sites were established and sampled to measure chemical parameters (Figure 1). The locations of the monitoring sites were selected in order to determine effects of the aeration system at different depths. Field measurements included temperature profile, dissolved oxygen, pH, chlorophyll A, total phosphorus, conductivity and transparency. Temperature and dissolved oxygen were measured using an YSI model 51B dissolved oxygen meter. Specific conductance values, expressed as umhos/cm at 25 ^{o}C, were measured with an YSI #33 conductivity meter. Water transparency was estimated using a 20 cm Secchi disk. A pHTestr 1, model 35624-00 by Oakton was used to measure pH. Water samples were collected from one-foot below the surface and sent to the laboratory for total phosphorus and chlorophyll A analysis.

Trophic State Indices (TSI) for Secchi disk transparency, chlorophyll A and total phosphorus were calculated from data collected at the deepest site according to criteria developed by Carlson (1977). The TSI range is from 1-100. Lakes with low TSI values (<40) are considered oligotrophic, while those with higher values (>50) indicate eutrophic conditions.

Angler Use and Sport Fish Survey

Two creel surveys were initiated in order to evaluate the angler responses to potentially changed fish populations and physical changes in the lake from the aeration system at Stockade Lake. One creel was conducted immediately after installation and then again four years later. The first creel survey was conducted during the summer months (June-August) of 1999. Four years later (2003), another creel survey continued for an entire year to document the change in fishing pressure, harvest during the ice free season and to document the amount of ice fishing pressure on the lake. To allow direct comparison: only the summer months of the 2003 survey will be included in this report. Each survey comprised two independent parts: instantaneous pressure counts along the route and angler interviews conducted between pressure counts. Only completed fishing trips were used for this analysis. Angler interviews provided information on trip length, species caught, and number of fish caught and released, angling method and angler satisfaction and type of fishing license purchased. A stratified random creel survey was used. Creel Days were divided into two strata, 1) weekend/holiday and 2) weekdays.

Since Stockade Lake is located in a popular state park, the 2003 creel was separated into two distinct sections. The winter period consisted of the months January thru March and September thru December. During the winter months the creel survey was performed during the weekends only. A single shift (7am to 3pm) was used during the winter phase of this creel survey. The summer period was defined as April thru August. Due to high tourism around the lake, it was felt that higher fishing pressure would occur during this time period and thus more effort was dedicated to this period. During each week both weekend days were sampled with the remaining hours randomly spread over the weekday period. Days were stratified by AM (7am-1pm) and PM (2pm-8pm) shifts. For each month, half of all shifts were randomly assigned to be conducted in the AM and half were conducted in the PM. Pressure count and angler interview data from both creel surveys were entered into Creel Application Software (CAS) (Soupir and Brown 2002).

Fish Population Surveys

Standard population sampling since 1992 will allow comparison of pre-aeration populations to populations following onset of aeration. Largemouth bass was selected as the predatory species for determination of changes in age and growth characteristics. Largemouth and smallmouth bass were specifically targeted using night boat-electroshocking equipment. Other fish populations were sampled using frame and gill nets.

Beginning in 1999, gill netting in Stockade Lake was slightly altered from standard protocol in order to determine fish usage of upper, mid and deep-water habitat. This modification involved suspending gill nets through three layers of the water column. To verify fish presence, gill net sets were located near the aerators to determine if the apparatus was affecting fish distribution within the water column (Figure 1). At the deepest site (chemistry Site 3), one net was suspended 10' below the surface, another at mid-depth (approximately 20' below surface) and a third on the bottom (approximately 45' below surface). Two-gill nets were set at chemistry Site 2. One net was suspended 10' below the surface and a second net was set on the bottom approximately 25' deep. Water depth at chemistry Site 1 is 12 feet and only one gill net was set on the bottom.

Timing of gill netting and frame netting occurred each year during the second week of July. Each gill net measured 45.7 m (150-ft) long and 1.8 m (6-ft) deep with six 7.6 m (25-ft) panels of bar mesh sizes: 12.7 mm (½ in), 19.1 mm (¾ in), 25.4 mm (1 in), 31.8 mm (1¼ in), 38.1 mm (1½ in), and 50.8 mm (2 in). Eight trap nets were set over two nights. All trap nets measured 1.3 X 1.5-m frame, 19.1 mm (¾ inch) mesh and a 1.2- X 23-m (3.9- X 75.5-ft) lead. Day and night boat electrofishing occurred in mid August. All of these sampling methods were used to determine the fish population and document the fisheries indices for sport fish within the reservoir. Standard frame and gill net locations were established as well as electrofishing stations (Figure 1). Night electroshocking involved eight passes totaling 80 minutes of effort. All fish were measured (TL; mm) and weighed (g). Scales were collected from the first five fish of each centimeter group for black crappie, northern pike, yellow perch, largemouth bass and smallmouth bass.

Age and growth characteristics were measured for game fish species. Back calculations of fish growth, proportional stock density (PSD), relative stock density (RSD) and relative weights were calculated for sportfish using FISHCALC (Missouri DOC 1989) and WinFin (Nebraska GPC 1997). Fish population parameters, confidence intervals and standard errors for standard netting and night electrofishing were computed using WinFin Analysis (Francis 2000). Abundance was expressed as the mean catch per unit effort. Actual pedal time (time the electrofishing unit produced current) was recorded from the digital display on the Coffelt control box and used to calculate electrofishing CPUE. Population structural characteristics were expressed through stock density indices (PSD and RSD-P). Fish condition was expressed as mean Wr.

By comparing pre-aeration lake survey data and that obtained four years after aeration commenced; an evaluation in fish growth and population structure was possible. To assess improvement in growth, comparison with mean length at age was employed using a paired t-test. Chi-squared was used to determine any improvement in PSD.

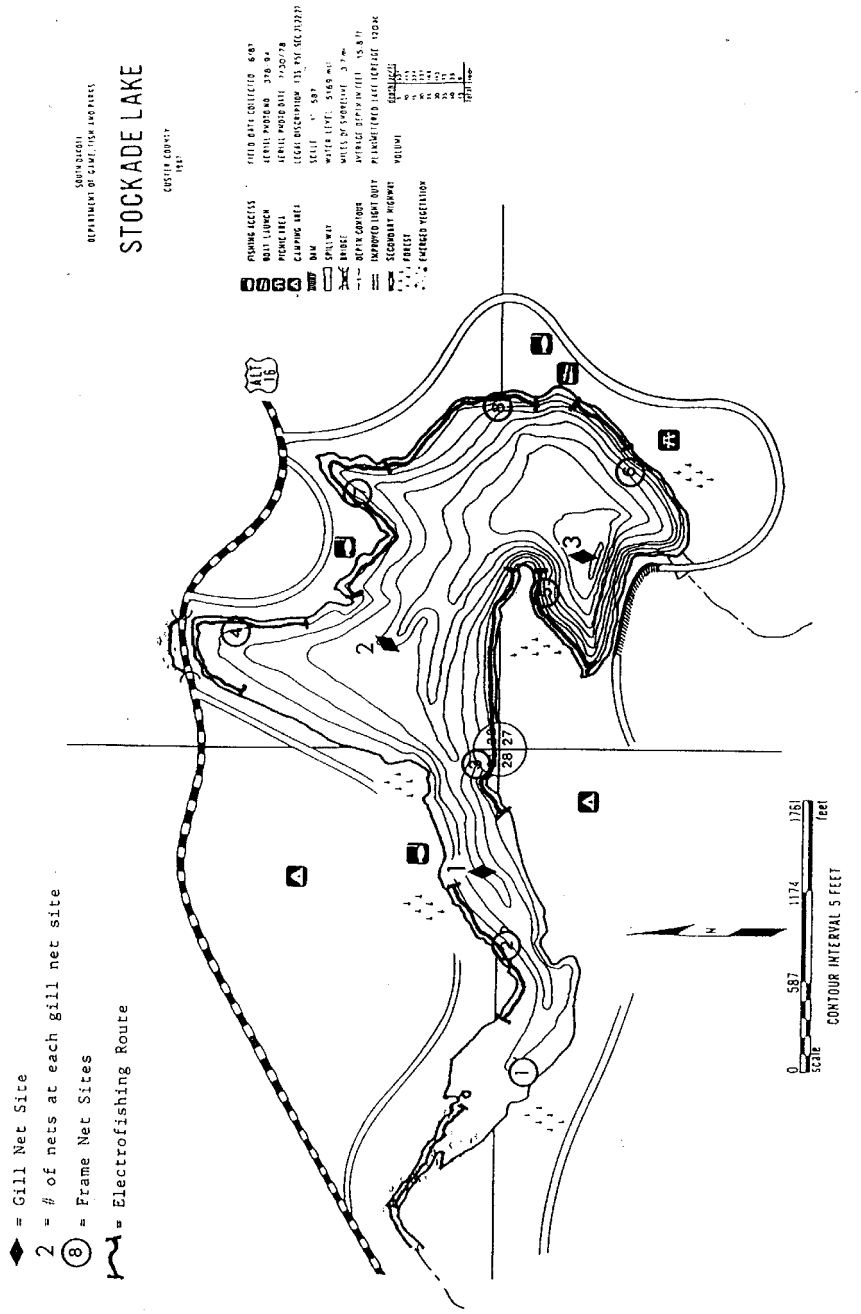

Figure 1. Map of Stockade Lake showing sampling locations during recent fish population surveys.

RESULTS & DISCUSSION

Chemical/Physical Parameters

Water Column Changes

One of the primary objectives of the aeration project on Stockade Lake was to completely mix the water column. To determine if this took place, water chemistry profiles were developed from Stockade Lake data throughout the operational period of the system. There was no attempt to make year-to-year calendar day comparisons of the water profile; however, a comparison is easily made detailing pre-aeration and during aeration to a near calendar day. To show some changes due to the aeration system, the following are examples of temperature and dissolved oxygen profiles seen while performing the water chemistry work on Stockade Lake. A compilation of all temperature and dissolved oxygen data series is located in the Appendix Figure 1.

Temperature Series

To understand the situation in Stockade Lake a historical view of pre-aeration is needed. Data from 1998 revealed that the lake was stratified with a thermocline (1 degree Celsius drop per 1-meter increase in depth) by May 21 (Figure 2). Starting at the surface the temperature was constant until about six feet in depth. From the six foot depth to approximately 20 feet the profile shows that a rapid decline in temperature indicating that this section of the profile was the thermocline. Finally, at about the 20 foot mark the temperature declines steadily; delineating the end of the thermocline. This profile is typical of those taken before the installation and operation of the aeration system.

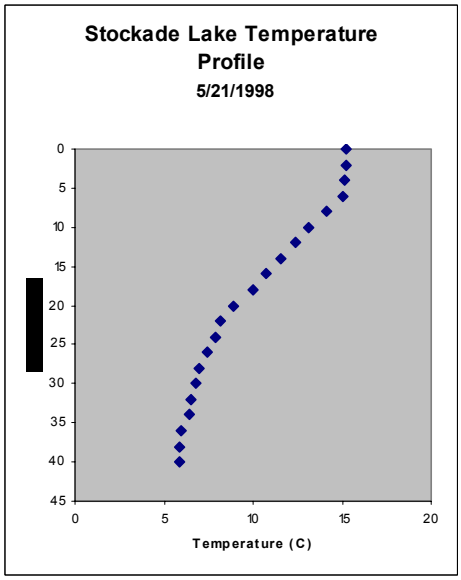

Figure 2. Temperature profile of Stockade Lake on May 21, 1998.

A temperature profile during aeration shows that the temperature is more linear in shape than pre-aeration conditions (Figure 3). Historically, Stockade Lake would have normally stratified with a distinct thermocline by this date. Since no thermocline was present, the 5-degree change in temperature from top to bottom was linear.

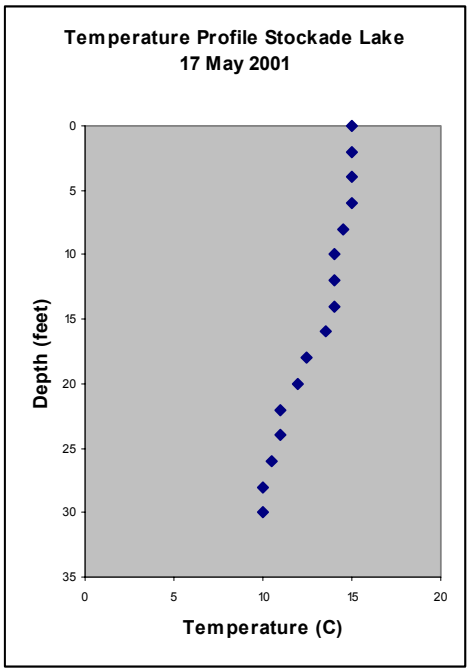

Figure 3. Temperature profile of Stockade Lake on May 17, 2001.

Dissolved Oxygen Series

Examination of dissolved oxygen during, the pre-aeration period at Stockade Lake showed conditions typical of a deep eutrophic lake. Adequate oxygen levels are present in the upper levels (> 15 feet) but decrease drastically below 20 feet (Figure 4). Below the twenty-foot depth little if any oxygen was left; meaning little useable habitat for fishes. The dissolved oxygen ranged from 8.6 parts per million (ppm) at the surface of the lake and dropped to 0.1 ppm at the 35 foot mark. Overall, the dissolved oxygen profile was similar in nature to that of temperature with a steep drop in oxygen corresponding to the steep drop in temperature.

After the installation and startup of the aeration system, the dissolved oxygen profile of Stockade Lake changed (Figure 5). Similar to that seen with temperature, the dissolved oxygen profile became much more linear showing that the amount of useable water for various fish species was greater. The overall drop of oxygen was from 7.6 ppm at the surface to 4.4 ppm at the 35-foot mark.

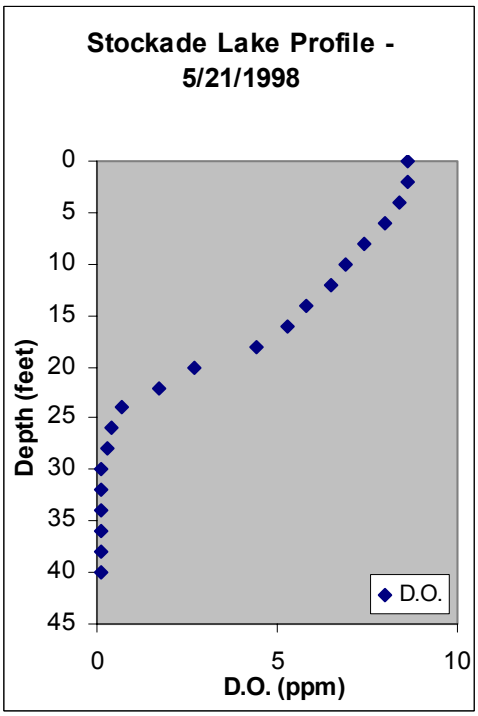

Figure 4. Dissolved oxygen profile of Stockade Lake on May 21, 1998.

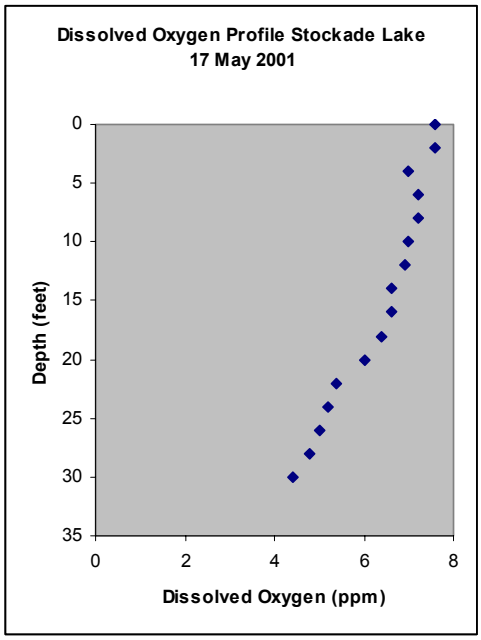

Figure 5. Dissolved oxygen profile of Stockade Lake on May 17, 2001.

Breakup of the Thermocline

As presented above, the data from the water chemistry work seems to indicate that the aeration system was effective in breaking up the thermocline. During the summer of 2001, however, the profiles showed development of a thermocline. In late July, the temperature and dissolved oxygen profiles showed that a thermocline was starting to setup at around about ten feet below the surface (Figure 6). Due to the presence of a developing thermocline; the decision was made to increase the air delivery system stop and/or breakdown thermocline development. No water chemistry samples were taken between 24 July and 12 September, however, samples from 12 September (Figure 7) show that the increase in air volume was effective in limiting thermocline development. This was during the period of hottest summer days.

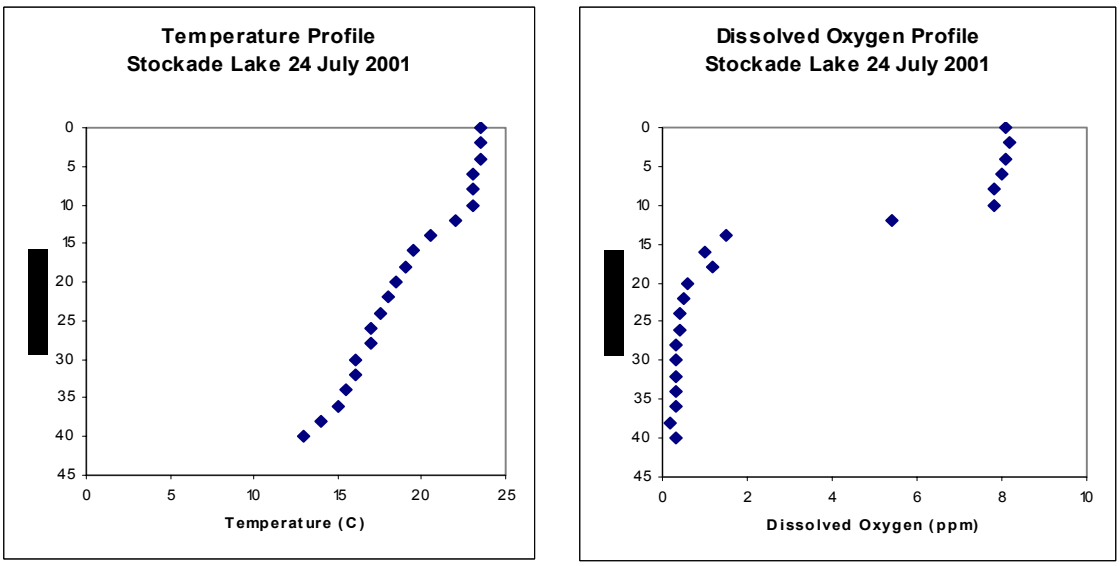

Figure 6. Dissolved Oxygen and Temperature profiles of Stockade Lake on July 24, 2001.

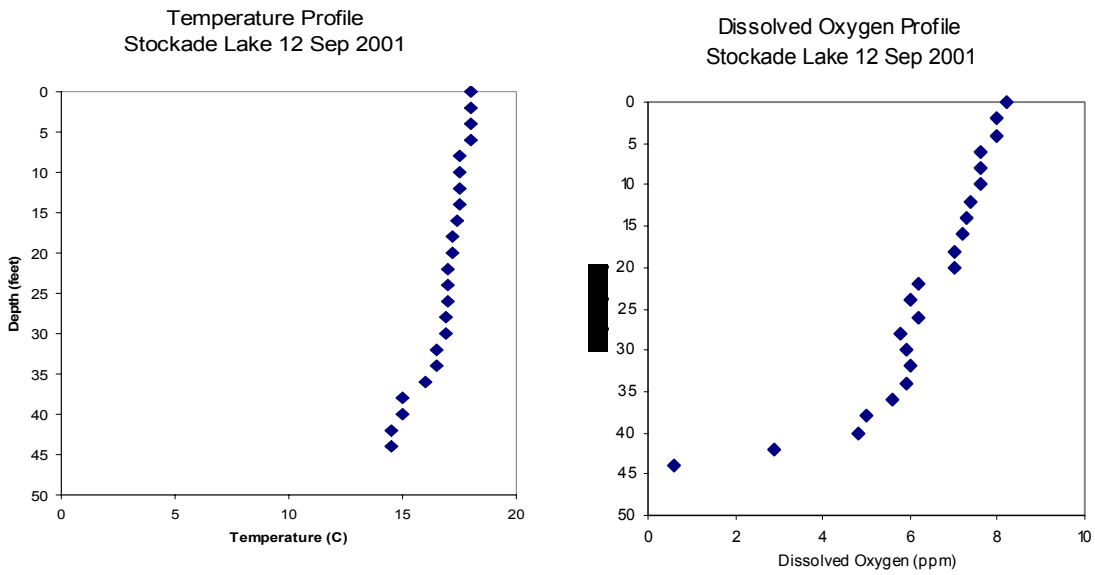

Figure 7. Dissolved Oxygen and Temperature profiles of Stockade Lake on September 12, 2001.

Trophic State Index (TSI)

The trophic state of a lake represents its position along a continuum of the amount of biomass in a lake at a specific location and time. Carlson (1977) developed an easy to understand process for determining the trophic state of a

body of water known as the Trophic State Index (TSI). Carlson noted three easily obtained values to determine the TSI: Chlorophyll A, Total Phosphorus and Secchi depth. Water samples from Stockade Lake have been analyzed since 1999 to determine the general trend of these TSI values.

Overall TSI trend in Stockade Lake

Trophic State Indices (TSI) from Stockade Lake show some variability throughout the summer months (Figures 8, 9 and 10). Each TSI value (chlorophyll A, total phosphorus and secchi depth) was obtained from data originally collected at Site A (the deepwater site) according to criteria developed by Carlson (1977). The TSI ranking is from 1-100. Lakes with low TSI values (<40) are considered oligotrophic, while those with higher values (>50) indicate eutrophic conditions. Trend data from 1998 - 2000 shows slight eutrophication occurring (Figure 8). The amount of water entering Stockade Lake has been limited in recent years due to regional drought conditions. This fact may help explain the drop in the overall chlorophyll A TSI values. Originally, the TSI was developed to indicate the trophic transitions temperate lakes make throughout their history. The main assumption with TSI is that changes in algal biomass indicate where the lake is along the continuum. Carlson first noted that chlorophyll A was to be considered a direct measure of the amount of algal biomass. Total phosphorus and secchi disk are two other measures taken to determine the amount of algae present.

The overall trend of TSI for total phosphorus shows a slight degradation in the condition of water in Stockade Lake. Over the long term, the TSI trend was around 50 when first measured (Figure 9). In just two years, the trend is approaching 60, thus showing some potential negative results during early stages of the aeration project. However, the Stockade Lake aeration system was began operation at the onset of one of the worst regional droughts in many years. From this perspective, the situation may have been much worse if the aeration system was not in operation. Other considerations include sediment nutriment release from lake bottom sediments as a result of the aeration system operation.

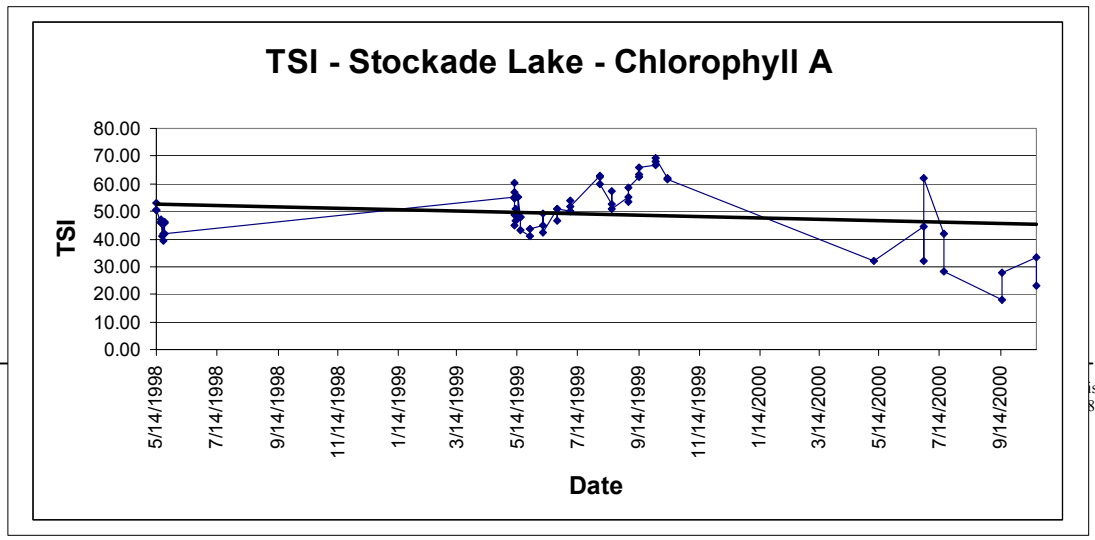

Figure 8. Trophic state index values and trend chlorophyll A data for Stockade Lake, Custer County, 1991-2000. The trend of the chlorophyll A data is depicted by the bold dark line running horizontally across the figure.

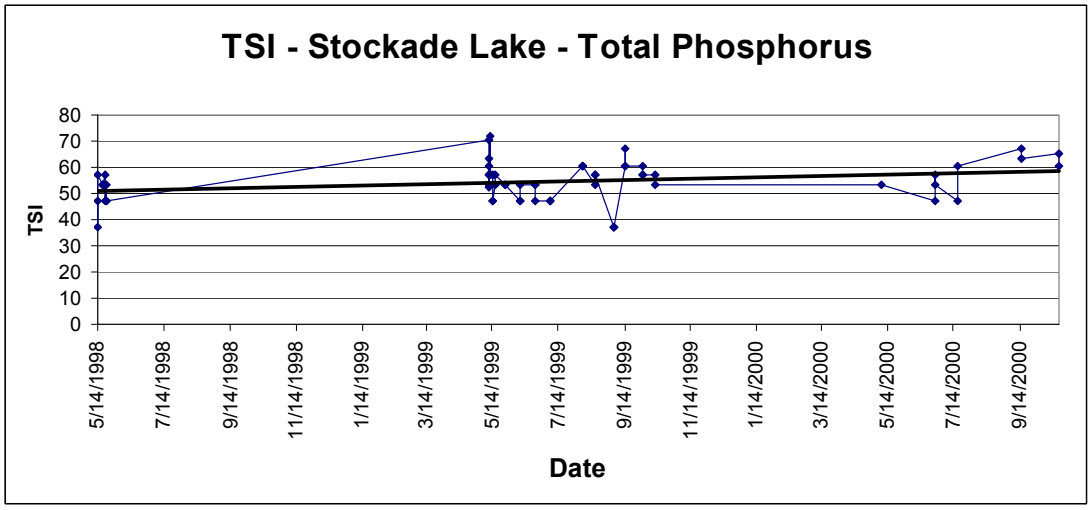

Figure 9. Trophic state index values and trend total phosphorus data for Stockade Lake, Custer County, 1991-2000. The trend of the total phosphorus data is depicted by the bold dark line running horizontally across the figure.

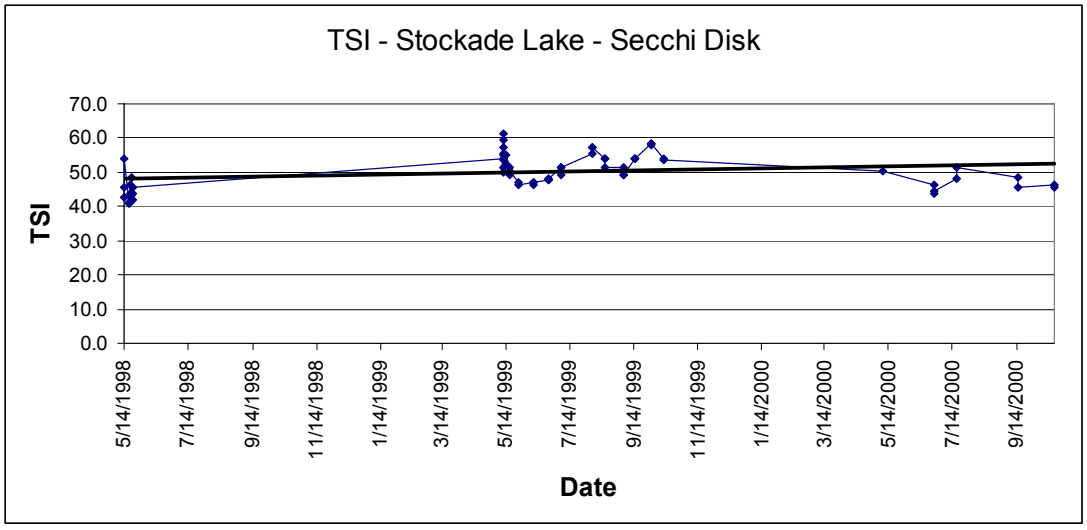

Figure 10. Trophic state index values and trend Secchi disk data for Stockade Lake, Custer County, 1991-2000. The trend of the Secchi disk data is depicted by the bold dark line running horizontally across the figure.

The amounts of phosphorus in the water along with transparency (secchi depth) are the two other factors used in determining TSI. The major assumption with these two constituents is that they will covary with the biomass of the algae. If these two variables do covary with algal biomass then the assumptions are that transparency, as measured by secchi depth, is an indirect measure of the biomass. Phosphorus is the chemical constituent that is used by the algae themselves. The presence of phosphorus in either high or low levels should be indicative as a predictor of potential algal biomass. The relationship between chlorophyll A and secchi depth is an inverse relationship. Rationale for the inverse relationship is that the as the amount of chlorophyll increases the transparency of the water should decrease, resulting in a lower secchi depth reading.

The calculated TSI for total phosphorus show a gradual but steady incline from about 50 to approximately to 60 (Figure 9). Throughout the two summers of water chemistry work on Stockade Lake variations were seen. As explained above, the total phosphorus in the lake is one of three parameters that are investigated in calculation of a waterbody's TSI. The fluctuations observed in total phosphorus may arise from the presence of the aeration system itself. One of the outcomes from disrupting the stagnant water/silt on the lake floor is that nutrients will be released into the water column. While no direct evidence pointed to this occurring there are some indirect observations that may indicate what is occurring. The data taken in May of 1998 (pre-aeration system) showed lower variability in total phosphorus levels that those seen in 1999 and 2000 (active aeration system) (Figure 9).

Secchi depth is the third measurement that Carlson used for determining the trophic state of a lake. The general trend of TSI from Secchi disk readings shows a slight decline in water quality (Figure 10). The variable TSI readings in 1999 ranged from the high 40's to well over 60. The TSI readings in 2000 again resembled those obtained from the pre-aeration data of 1998.

The use of secchi readings exclusively has been stated as being of "dubious importance" (Carlson 1980). The overall problem with secchi readings involves other constituents that may play a role in water transparency. The use of secchi readings are best used when no other biomass indicators are available (Carlson 1980). Even though the importance of secchi readings in diminished in potential usefulness, the trend of the data showed only a slight increase from just under 50 to just over 50 during the study period (Figure 10). It may well be that the fluctuations seen in the secchi readings were due, in part, to the released nutrients from the sediment.

Angler Use and Preference

Angling Pressure

Summer of 1999

Anglers fished an estimated 8,409 hours on Stockade Lake during the summer of 1999 (Table 2). This equates to 159.8 hours of fishing per hectare during the summer months. During this time an estimated 17,127 fish were caught and 5,434 of these were harvested by anglers on Stockade Lake which represents a rate of 2.04 fish per hour. No statewide averages are available for a fishery of this size; however, the catch rate is higher than other Black Hills fisheries.

Summer of 2003

The estimated angling hours on Stockade Lake in the summer of 2003 were 13,342 (254 hours/ha). Anglers in 2003 caught an estimated 43,799 fish and kept 16,747. In order to achieve this level of success the catch rate was 3.28 fish per hour. The trip length in combination with the overall catch rate indicates that fishermen caught an average of just over one fish during their stay.

Year long total – 2003

Throughout the entire year of 2003, 507 interviews were conducted (Table 2). These interviews indicate a total fishing pressure of 25,212 hours (479/ha). An estimated total number of fish caught at Stockade Lake during 2003 was 79,358 with a harvest of 39,423. Overall catch rate was 3.15 per hour.

Comparing the data from the two creel surveys shows promising results. For the three summer months, fishing pressure at Stockade Lake increased by nearly 5000 hours (Table 2). The number of fish caught increased by 26,652 during this same period. Harvest of fish was also higher than that observed four years earlier. Although no compilation of data is available, the overall catch rate of fish per acre (749/ha) in Stockade during 2003 is rather high and may rank close to the highest in the state. Anglers appear to accept length limits on the largemouth bass as indicated by their low harvest numbers (Table 3). Another possibility is that there were no large bass in the lake during the study period. Later in this report, data concerning the population dynamics will be investigated.

Stockade Lake can easily be said to be a panfish fishery. For Stockade; the panfish species with the highest catch and harvest are black crappie and yellow perch (Table 3). For each of the creel surveys crappie and perch were by far the most harvested fish (1999- 307 of 318, 97%; 2003- (summer months) 725 of 767, 95%; 2003- (yearlong) 2242 of 2345, 96%). The low harvest of predatory fish (northern pike, smallmouth bass, and largemouth bass), may result from these

fishes being small, of undesirable sizes, below legal length or from catch and release angling. Low harvest allows for a greater population density of these species. A higher density of predators helps to keep panfish in lower numbers and usually of a slightly greater size and condition.

Table 2. Summary report of creel survey information taken in 1999 and 2003 at Stockade Lake, Custer Co.

	Summer		Year Long
Year	1999	2003	2003
Interviews	245	219	507
Total Species	9	6	6
Party Size	2.0	2.08	2.18
Completed Trip Length	2.08	2.8	2.95
Pressure	8,409	13,342	25,212
Pressure per hectare	159.8	253.6	479.2
Catch per hour	2.04	3.28	3.15
Harvest per hour	0.65	1.25	1.56
Release per hour	1.39	2.03	1.58
Total Catch	17,127	43,779	79,358
Total Harvest	5,434	16,747	39,423
Total Release	11,693	27,031	39,934
Catch per hectare	325	832	1,508
Harvest per hectare	103	318	749
Release per hectare	222	514	759

Table 3. Summary report detailing reported catch, and harvest along with release values obtained by creel clerk from Stockade Lake, 1999 – 2003.

	1999- 3 month			2003- 3 month			2003- Year long		
	Catch	**Release**	**Harvest**	**Catch**	**Release**	**Harvest**	**Catch**	**Release**	**Harvest**
White sucker	2	2	0	0	0	0	0	0	0
Black bullhead	3	3	0	0	0	0	0	0	0
Northern pike	34	30	4	182	161	21	282	222	60
Rainbow trout	1	0	1	2	1	1	12	6	6
Rock bass	1	1	0	0	0	0	0	0	0
Smallmouth bass	70	68	2	79	76	3	153	139	14
Largemouth bass	318	314	4	365	348	17	467	444	23
Black crappie	340	169	171	1,038	554	484	2,398	1,025	1,373
Yellow perch	261	125	136	645	404	241	1,686	817	869
Totals	1,030	712	318	2,311	1,544	767	4,998	2,653	2,345

Angling Harvest

Summer 1999

Harvest of fish during the summer of 1999 totaled 5,434 (Table 2). This total harvest represented 103 fish per hectare or 254 per acre. This is a harvest rate of 0.65 (fish/hour). For Black Hills lakes there is no prescribed goal of harvested fish, however, one stated goal for stocked catchable trout is to achieve 0.5 trout per hour. The overall harvest rate in 1999 greatly exceeds the goal for catchable trout in the Black Hills.

Summer 2003

The 2003 survey showed marked improvements in the total number of fish harvested from Stockade Lake. All categories, harvest rate, total harvest, harvest per hectare and percentage of fish harvested, were higher than that observed four years earlier (Table 2). Harvest rates increased to 1.25 fish per hour. A total harvest of fish was calculated to be 16,747 producing a harvest per hectare of 318. These harvest numbers were much higher than those seen in 1999.

Year long total – 2003

The rate of harvest for all fish species was 1.56 per hour (Table 2). This equates to an estimated 39,423 or 50% of all fish caught were kept throughout the entire year. For 2003 there were an estimated 749 fish kept per hectare of water or 1,850 per acre.

Release Rates

Release rates of fish from Stockade Lake varied between species (Table 3). Largemouth bass, which have a 15-inch length limit, had a 95 percent release rate. Anglers rarely kept smallmouth bass. Northern pike were released at the highest rate of all fish species. Amongst those species that had low release rates (or high harvest rates) were the two panfish species, black crappie and yellow perch.

Although there is no stated preferred level of angler harvest or release rates for impounded waters in the Black Hills the rate of bass released is certainly high and not endangering the population. The high rate of harvest for the panfish

species is also good as their populations are being kept below a stunting threshold. Between the high harvest of panfish and high release of both large and smallmouth bass, a preferred fishery for the high numbers of shore anglers may be satisfied.

Angler Satisfaction

A new topic of concern to fisheries managers is the satisfaction of the angler. How satisfied an angler is can be important towards determining acceptance of regulations and can reveal how the managing agency is performing. Recent creel surveys address this subject by asking how satisfied the anglers are with the day's trip (Simpson 2004). This question was asked of anglers at Stockade Lake in both 1999 and 2003. Data from 1999 data shows that anglers responses were widely spread out over the options available (Figure 11). In contrast, 2003 data showed much higher angler satisfaction. For comparisons with statewide averages, groupings were combined into three main categories: satisfied, neutral and dissatisfied. In these categories, the responses for 1999 and 2003 yielded: satisfied (43%) and (86%), neutral (21%) and (4%), and dissatisfied (36%) and (10%), respectively. A statewide average of 76.4% satisfaction may be considered as a goal for Stockade Lake. Stockade improved in overall satisfaction level from 1999 to 2003.

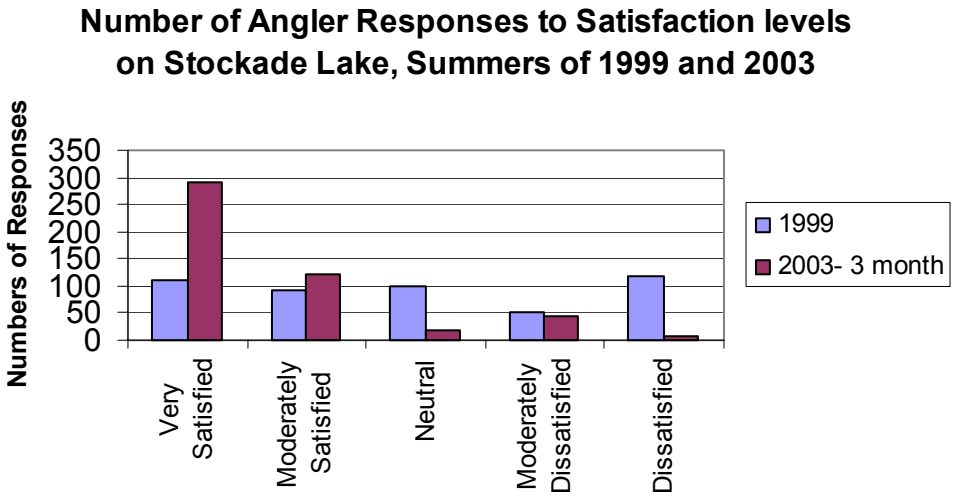

Figure 11. Numbers of anglers and their satisfaction levels from Stockade Lake during the summers of 1999 and 2003.

Demographics

Of the fishermen interviewed, the overwhelming percentage of anglers were male (Figure 12). Similar results were obtained in earlier studies across South Dakota (Mendelsohn 1994 and Stone 1996). The majority of anglers considered themselves Black Hills residents (Table 4). A total of nineteen states were represented by anglers using Stockade Lake in 2003. These data are consistent with other statewide studies (Mendelsohn 1994 and Stone 1996).

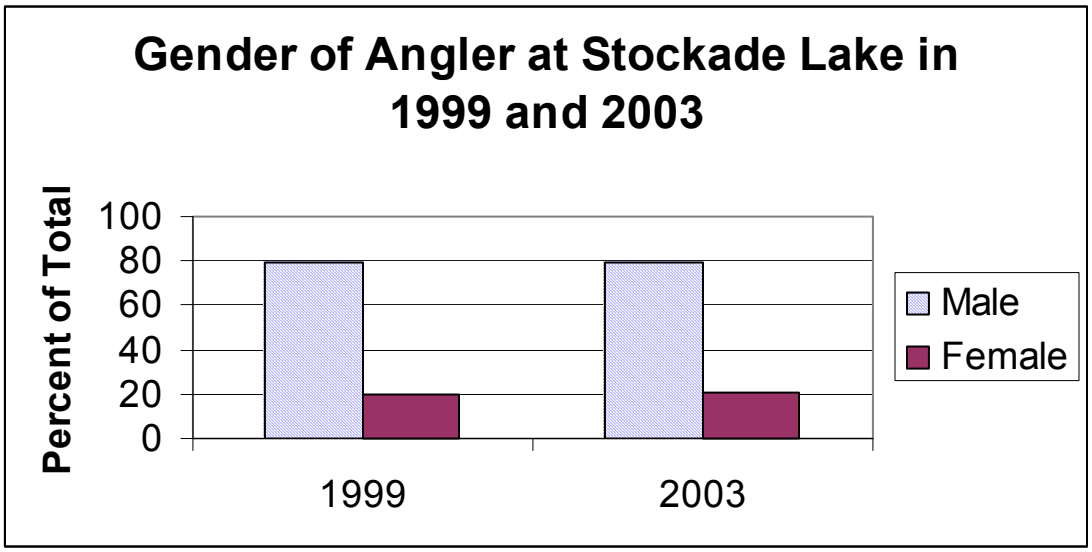

Figure 12. Percent of anglers separated as to type on Stockade Lake, 1999.

Table 4. Residency of anglers using Stockade Lake in 2003.

State Name	Count	Percent of Total (%)	Percent of Non-Residents (%)
Arizona	1	0.09	0.64
Colorado	20	1.81	12.74
Conneticut	2	0.18	1.27
Florida	2	0.18	1.27
Illinois	15	1.36	9.55
Indiana	5	0.45	3.18
Iowa	2	0.18	1.27
Kansas	3	0.27	1.91
Maryland	4	0.36	2.55
Michigan	6	0.54	3.82
Minnesota	15	1.36	9.55
Missouri	13	1.18	8.28
Nebraska	6	0.54	3.82
Ohio	4	0.36	2.55
Oregon	2	0.18	1.27
South Dakota	947	85.78	---
Texas	6	0.54	3.82
Wisconsin	15	1.36	9.55
Wyoming	36	3.26	22.93

	N	**Percent (%)**
Residents	947	85.78
Non-Residents	157	14.22
Total	1,104	100.00

Fish Population Surveys

Species Composition and Relative Abundance

Lake surveys have been conducted on Stockade Lake yearly since 1991. Because the fish population survey was a minor portion of this study, only the 2002 data are presented to communicate the species present in the lake.

Results from the eight frame net sets were similar to that from gill nets (Tables 5 and 6). Yellow perch were the most common sportfish species captured via frame net followed by black crappie. Smallmouth bass, northern pike, black bullhead and white sucker were also sampled with the frame nets. A single rainbow trout was caught in the gill nets, yet none were sampled by frame nets during the 2002 survey.

Daytime electrofishing showed that black crappie, yellow perch and largemouth bass were apparently very successful in reproducing in the spring of 2002 (Table 7). Black crappie were the most common species encountered (n = 99) during the day electroshocking. Largemouth bass was the second most common species sampled during the daylight electrofishing (n = 47). Yellow perch were only slightly behind in total numbers via this sampling method (n = 41). Northern pike, smallmouth bass and white sucker were also caught during daytime electroshocking. The presence of both young-of-the-year individuals along with adults shows reproduction and the presence of prey for the predatory species.

Yellow perch, largemouth bass, northern pike and black crappie were identified in order, as species preferred by anglers fishing small water bodies in South Dakota (Mendelsohn 1994 and Stone 1996). Stockade Lake currently has each of these species and in densities easily caught by anglers. Walleye was the only species that ranked higher by anglers than those noted above and it currently does not exist in Stockade Lake.

Table 5. Total catch for six 150-ft. experimental, sinking, monofilament gill nets on Stockade Lake, Custer County, 20-21 August 2002. Total number, catch per net night (CPUE, 80% CI), catch per net night of stock length fish (CPUE-S, 80% CI), proportional stock densities (PSD, RSD-P with 90% CI), and condition factor (Wr for fish ≥ stock length, 90% CI) were reported.

Species	N	CPUE	CPUE-S	PSD	RSD-P	Wr≥S
Smallmouth bass	3	0.5 (0.7)	0.5 (0.7)	100 (0)	100 (0)	97.4 (9.2)
Northern pike	4	0.7 (0.7)	0.7 (0.7)	25 (59)	--	93.0 (5.0)
Yellow perch	47	7.8 (5.0)	7.8 (5.0)	45 (12)	4 (5)	88.7 (0.9)
Black crappie	22	3.7 (4.8)	3.7 (4.8)	41 (18)	--	109.1 (1.0)
Black bullhead	5	0.8 (0.8)	0.7 (0.6)	75 (25)	25 (59)	79.2 (42.5)
White sucker	37	6.2 (4.5)	6.2 (4.5)	100 (0)	100 (0)	94.5 (1.5)
Hatchery rainbow trout	1	0.2 (0.2)	0.2 (0.2)	--	--	--
Totals	119					

Table 6. Total catch of 8 overnight frame net sets on Stockade Lake, Custer County, 22-23 August 2002. Total number, catch per net night (CPUE, 80% CI), catch per net night of stock length fish (CPUE-S, 80% CI), proportional stock densities (PSD, RSD-P with 90% CI), and condition factor (Wr for fish ≥ stock length, 80% CI) were reported.

Species	N	CPUE	CPUE-S	PSD	RSD-P	WR≥S
Smallmouth bass	1	0.1 (0.2)	0.1 (0.2)	100 (0)	100 (0)	109.3 (na)
Northern pike	5	0.6 (0.4)	0.5 (0.4)	--	--	86.8 (5.8)
Yellow perch	24	3.0 (2.4)	3.0 (2.4)	38 (17)	4 (7)	86.9 (2.7)
Black crappie	49	6.1 (2.4)	6.1 (2.4)	51 (12)	--	106.2 (1.1)
Black bullhead	6	0.8 (0.3)	0.8 (0.3)	100 (0)	50 (45)	84.6 (8.0)
White sucker	106	13.3 (8.7)	13.3 (8.7)	100 (0)	100 (0)	93.8 (0.2)
Totals	191					

Table 7. Total catch of 8 ten-minute day electrofishing passes on Stockade Lake, Custer County, 23 August 2002. Station, species, young of year (yoy), and age-1+ fish numbers were reported.

Station	Black Crappie		Yellow Perch		Largemouth Bass		Smallmouth Bass		Northern Pike		White Sucker	
	yoy	*1+*	*yoy*	*1+*	*yoy*	*1+*	*yoy*	*1+*	*yoy*	*1+*	*yoy*	*1+*
1	0	6	1	9	4	2	0	3	0	0	0	5
2	7	3	3	0	11	0	0	1	0	1	0	0
3	7	3	0	7	4	2	0	1	0	0	0	0
4	16	7	15	1	17	1	0	0	0	0	0	0
5	2	24	1	9	3	0	0	0	1	1	0	0
6	15	8	1	10	2	0	0	1	0	1	0	0
7	22	10	17	0	3	0	0	0	0	0	0	0
8	30	6	3	0	3	1	0	0	1	1	0	0
Sub Total	***99***	***67***	***41***	***36***	***47***	***6***	***0***	***6***	***2***	***4***	***0***	***5***
Total	**166**		**77**		**53**		**6**		**6**		**5**	

Fish Growth

The third and final objective of the Stockade Lake aeration project was to determine if a change occurred in the fisheries component. A potential effect of the improved water clarity was an improvement in the growth rates of sight feeding predators. Largemouth bass were selected as the species of study for growth change. Since 1995, a 15-inch length limit on largemouth bass has been in effect at Stockade Lake. This regulation was left unchanged throughout the period of study of the aeration project.

Pre-aeration Survey

Largemouth bass in Stockade Lake experienced slow growth for a number of years. The regulation allowing only 15-inch (381 mm) largemouth bass to be harvested was enacted to improve bass survival. Data from 1997 shows that it would take a bass approximately 10 years to reach the 15-inch length limit (Table 8). Other South Dakota waters produced bass to the 15-inch mark at six years of age and the regional mean of back-calculated lengths shows that in the upper Great Plains, largemouth bass made this length by seven years of age.

Table 8. Mean back-calculated total length (mm) at age for largemouth bass collected by night electrofishing in Stockade Lake from 1999-2002 compared with Region 1 (western SD), SD, and regional (MI, MN, SD, and WI) means developed by Willis (2001) and Carlander (1977).

		Age							
Location	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Stockade	2002	74	158	218	275	316	337	336	
Stockade	2001	76	142	199	262	300	333	338	376
Stockade	2000	68	115	191	237	297	322	344	352
Stockade	1999	58	124	193	246	282	302	336	377
Stockade	1997	61	124	181	227	262	297	324	345
Region 1	2001	78	154	214	272	318			
SD	2001	96	182	250	305	342			
Regional	1977	94	184	255	294	336	364	390	414

Aerated Survey

Back-calculation of fish scales shows that largemouth bass in 2002 were reaching sizes at a given age consistent with other Game, Fish and Parks Region 1 waters (Table 8). However, the largemouth bass growth still lags behind the data typified for all South Dakota waters and those of regional waters from surrounding states. During the 2002 sampling season, no largemouth bass were collected that were at least 15-inches in length.

Comparison between Years

Between year comparisons of largemouth bass length at age shows that there has been an increase in each of the ages present (Figure 13). Only a very slight increase was seen for the first year of growth (½ inch greater growth), but the following years demonstrate much improvement. For ages 2 through 5, the increase in growth for each year from 1997 to 2002 were 1.4, 1.5, 1.9 and 2.1 inches, respectively. These growth characteristics demonstrate that there were significant increases in growth from each age of the aerated (2002) data over the pre-aeration (1997) data ($P = 0.55$, $df = 6$). The slight increase in growth seen for age 1 fish may reside in the fact that few of these individuals have likely converted to a total fish diet at that point. In later ages (ages 2-5) the growth increase may likely be due to an overall change of largemouth bass to a fish diet. The improvement in largemouth bass growth from pre-to-post aeration may presumably be caused from the improved water clarity. The hypothesis between improved bass growth and water clarity was that the bass would be more efficient predators when the improved water clarity allowed them to more easily see prey fish.

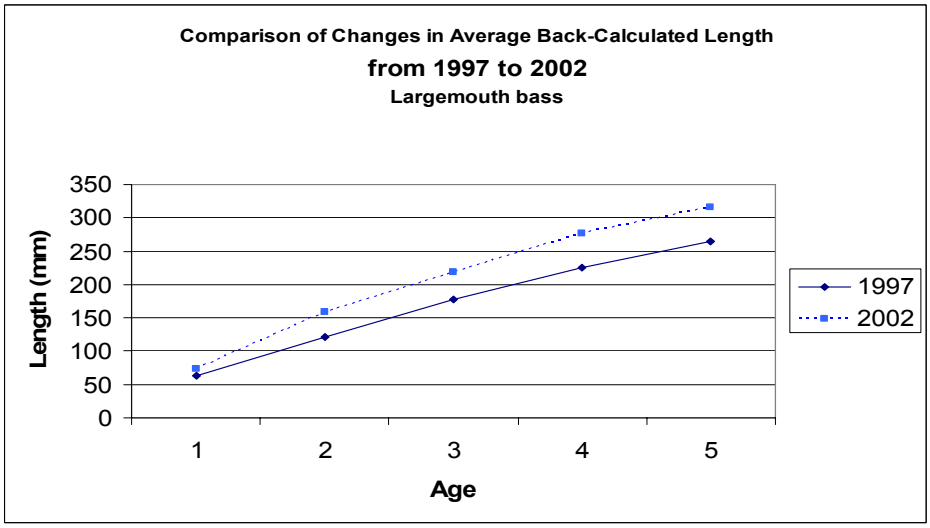

Figure 13. Comparison of growth at back-calculated age of largemouth bass from Stockade Lake from 1997 and 2002.

Condition and Population Indices

Growth is not the only way to determine the status of predatory fish. Measurement of fish condition (or plumpness) is one parameter biologists use to ascertain general fish health (Bister et al 2000). The condition indices (Wr) value for largemouth bass has changed little since the installation of the aeration system (Figure 14). While this may indicate that the bass had sufficient forage to eat before the aeration system there may be other possibilities. For instance, no knowledge exists as to what the bass were actually consuming before or after aerator installation. A pre and post-food habit study would have been beneficial in order to document any potential changes in the prey consumption of largemouth bass via the improved water clarity.

Other population indices notably catch, proportional stock density and relative stock density, show some variability in their overall trends (Figure 14). The catch of bass from Stockade Lake shows some cycling (from a historical sense) of different year classes moving through the system. Overall, the PSD increases during the operation of the aeration system. These PSD values are significantly higher in 2002 than in 1997 ($X^2(1, N=168) = 3.84$, $p < 0.05$). The RSD-P changed little over time.

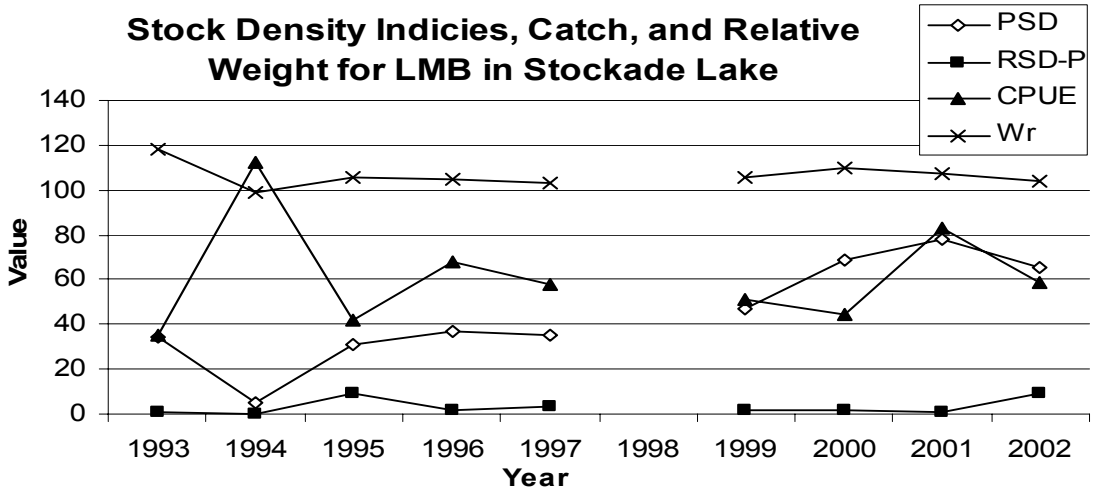

Figure 14. Stock density indices, catch per unit effort, and relative weights for largemouth bass captured during night electrofishing on Stockade Lake, Custer County, from 1993-2002. No fish sampling occurred on Stockade Lake in 1998.

RECOMMENDATIONS

1. Continue usage of aeration system in Stockade Lake. Benefits in the form of improved fish growth and angler satisfaction have been documented. Reduction of algal blooms during normal rainfall years is also expected.

2. Because largemouth bass are able to reproduce in Stockade Lake and population parameters are within ranges accepted as beneficial towards panfish management the 15-inch minimum length limit on largemouth bass should be kept. Also, the harvest of bass appears to be low and the public has not shown adverse reactions towards the regulation.

3. Future evaluations of the 15-inch minimum length regulation should occur on a bi-yearly basis. Evaluation will be conducted via a combination of netting and electrofishing. Adult bass populations will be monitored via night electroshocking. The size structure for largemouth bass will be managed for PSD and RSD-P levels that are suitable for panfish management. Mortality estimates will be calculated each year using two consecutive years of age data. Growth of largemouth bass will be monitored to detect if any improvement or decline. Prey fish size structures will be monitored using gill and frame nets. Species composition will also be monitored during these efforts.

4. Stockade Lake is a water body that receives catchable trout intended for streams when conditions are unsuitable for trout survival. Excess trout fingerlings may also be stocked into Stockade Lake. Continue irregular brown and rainbow trout stockings.

5. Schedule future fisheries management survey work to be done during mid-August. Survey work itself shall include gill netting, frame netting, day and night electroshocking. Efforts for such work shall be consistent with state guidelines and previously used protocols.

6. Continue collecting lake chemistry during the regular fish survey. Parameters to collect include dissolved oxygen, temperature, pH, chlorophyll A, total phosphorus and Secchi depth.

7. Success of the aeration system in Stockade Lake has been proven. Operation of the system should occur starting in mid-May and continuing to the end of September.

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Appendix

Appendix Table 1. Standard Response Page used on Stockade Lake during the 1999 creel survey.

Black Hills Creel Survey - Response Page
(Stockade Lake)

Interview #: _____ Clerk: _____ AM/PM (Circle one) 1. Date/Time: ____ - ____ - ____/_____
dd - mmm - yy

2. Type of Fishing: _____ 3. Bait or lure: _____

4. Fishing for: _____ 5. Hours (Completed trip only): _____ (hh:mm)

6. Species	# Caught	# Released	# Kept
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

7. Species Lengths Note: measure trout, bass, perch, crappie, northern pike and bullheads.

_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

8. ☐ Check (√) if angler **DOES** plan to fish tonight (after dark) in the area.

9. Satisfaction Level: _____ 10. License Type: _____ ☐ Check (√) if no license

11. Live in the Black Hills: Yes/No (Circle one) 12. If "No" is reason: Primary/Secondary (Circle one)

13. Non-Black Hills Residents: Days in Area: _____ Distance Traveled: _____

14. Male/Female (Circle one)

15. Comments: _____

N:Common\Fish\Bhcreel\Stockade Creel 99.doc July 10, 1999 3:31 PM

Appendix Table 2. Standard Response Page used on Stockade Lake during the 2003 creel survey.

South Dakota Department of Game, Fish and Parks

Stockade Lake Creel Survey Fishing Pressure Report

Form Pressure/Aerial or Roving or Fixed	
Pressure ID	Office Space Only

Data Entry into Creel Database	
Date Entered/Initials	

Pressure Count #1

	Date			Survey Time (Military)										Starting Location	Travel Direction
	Month	Day		Arrival	Departure										

Type Of Fishing	Total	Running Tally
Fishing Boats		
Bank/Shore		

Pressure Count #2

Water Body	Date			Survey Time (Military)		Access Area	Creel Clerk	Air Temp	Cloud Cover	Wind Speed	Wind Dir	Precip	Water Temp		Water
	Month	Da	2003	Arrival	Departure										

Type Of Fishing	Total	Running Tally	Starting Location	Travel Direction
Fishing Boats				
Bank/Shore				

Pressure Count #3

	Date		Survey Time (Military)											
	Month	Day	Arrival	Departure										

Type Of Fishing	Total	Running Tally
Fishing Boats		
Bank/Shore		

Appendix Table 3. Standard Response Page used on Stockade Lake during the 2003 creel survey.

Interview ID	Office Space Only

Data Entry into Creel Database

Date Entered/Initials	

South Dakota Department of Game, Fish and Parks

Stockade Lake

Given Value Survey (**X**)	

Creel Survey

Page _____ of _____

Clerk Info

Water Body	Date: Month	Date: Day	Date: Year	Time (Military): Arrival	Time (Military): Departure	Access Area	Creel Clerk

Angler Info

Refused Interview (X)	Time (Military): Interview Time	Time (Military): Started Fishing	Time (Military): Stopped Fishing	Time Not Fished (Minutes)	Completed (X)	Type Of Fishing	Fish Species Sought	Party Size
							1	
							2	

Angler	Gender	Age	Distance Traveled	Zip Code	State	Question Series	Question 1
1						0 1	
2						0 1	
3						0 1	
4						0 1	
5						0 1	

Series 01 Preference Questions:

1) Considering all factors, how satisfied are you with your fishing trip today?
01=Very satisfied
02=Moderately satisfied
03=Neutral
04=Moderately Dissatisfied
05=Very Dissatisfied

	Species	Number: Kept	Number: Release	Number: Illegal
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

	Species	Length (mm)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

	Species	
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

	Species	Length (mm)
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

	Species	Length (mm)
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		

Comments: _____
_____

Interview Continued (✓)	

Appendix Table 4. Summary report (angler hours), catch rates (catch/hour), harvest rates (harvest/hour), release rates (release/hour), standard error (SE) and confidence intervals (+/- CI) totaled over selected strata from Stockade Lake, 1 June - 31 August 1999.

Waterbody	2,101 Stockade Lake
Work Period	Totaled Over: 6, 7, 8 -- June, July, August
Day Type	Totaled Over: 1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over: 1 -- Stockade Lake
Type of Fishing	Totaled Over: 1,2,3 -- Shore, Boat, Tube

		Catch				Harvest				Release			
Estimate Type	Species	CPE	SE	80% CI	95% CI	HPE	SE	80% CI	95% CI	RPE	SE	80% CI	95% CI
All Anglers	White sucker	0.0027	0.0024	0.0031	0.0047	0.0000	0.0000	0.0000	0.0000	0.0027	0.0024	0.0031	0.0047
All Anglers	Black bullhead	0.0080	0.0051	0.0065	0.0099	0.0000	0.0000	0.0000	0.0000	0.0080	0.0051	0.0065	0.0099
All Anglers	Northern pike	0.0560	0.0136	0.0174	0.0266	0.0110	0.0086	0.0110	0.0168	0.0450	0.0082	0.0106	0.0161
All Anglers	Rainbow trout	0.0021	0.0017	0.0022	0.0033	0.0021	0.0017	0.0022	0.0033	0.0000	0.0000	0.0000	0.0000
All Anglers	Rock bass	0.0021	0.0022	0.0029	0.0044	0.0000	0.0000	0.0000	0.0000	0.0021	0.0022	0.0029	0.0044
All Anglers	Smallmouth bass	0.1530	0.0544	0.0697	0.1066	0.0072	0.0063	0.0080	0.0123	0.1458	0.0525	0.0673	0.1028
All Anglers	Largemouth bass	0.4860	0.1135	0.1456	0.2225	0.0170	0.0092	0.0117	0.0179	0.4690	0.1130	0.1448	0.2214
All Anglers	Black crappie	0.8742	0.2639	0.3383	0.5173	0.4310	0.1712	0.2194	0.3355	0.4432	0.1391	0.1784	0.2727
All Anglers	Yellow perch	0.4527	0.1489	0.1909	0.2919	0.1780	0.0867	0.1112	0.1700	0.2747	0.0939	0.1204	0.1841
Overall		2.0368	0.6069	0.7781	1.1896	0.6462	0.3692	0.4733	0.7237	1.3906	0.3594	0.4608	0.7045
Targeted	Northern pike	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Targeted	Rainbow trout	0.0489	0.0000	0.0000	0.0000	0.0489	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Targeted	Smallmouth bass	0.5184	0.2266	0.2906	0.4442	0.0000	0.0000	0.0000	0.0000	0.5184	0.2266	0.2906	0.4442
Targeted	Largemouth bass	1.3126	0.3203	0.4106	0.6278	0.0273	0.0152	0.0195	0.0298	1.2853	0.3186	0.4084	0.6244
Targeted	Black crappie	1.7342	1.2232	1.5681	2.3974	1.3596	1.3206	1.6930	2.5884	0.3746	0.3492	0.4477	0.6844
Targeted	Yellow perch	1.2610	0.8527	1.0932	1.6714	0.9409	0.8249	1.0575	1.6168	0.3202	0.4677	0.5996	0.9167
Targeted Any	Anything	1.7621	0.4509	0.5781	0.8838	0.5159	0.3238	0.4152	0.6347	1.2462	0.2857	0.3663	0.5600

Appendix Table 5. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 June - 31 August 2003.

Waterbody	2,101 Stockade Lake
Work Period	Totaled Over: 6, 7, 8 -- June, July, August
Day Type	Totaled Over: 1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over: 1 -- Stockade Lake
Type of Fishing	Totaled Over: 1,2,3 -- Boat, Shore, Ice

		Catch				Harvest				Release			
Estimate Type	Species	CPE	SE	80% CI	95% CI	HPE	SE	80% CI	95% CI	RPE	SE	80% CI	95% CI
All Anglers	Northern pike	0.1514	0.0351	0.0449	0.0687	0.0178	0.0055	0.0071	0.0108	0.1336	0.0325	0.0416	0.0636
All Anglers	Rainbow trout	0.0044	0.0030	0.0038	0.0059	0.0022	0.0021	0.0027	0.0042	0.0022	0.0023	0.0029	0.0045
All Anglers	Smallmouth bass	0.0861	0.0125	0.0161	0.0246	0.0046	0.0015	0.0020	0.0030	0.0815	0.0131	0.0168	0.0257
All Anglers	Largemouth bass	0.3761	0.0682	0.0874	0.1336	0.0305	0.0188	0.0241	0.0368	0.3455	0.0600	0.0769	0.1176
All Anglers	Black crappie	1.6039	0.3976	0.5097	0.7793	0.8450	0.2571	0.3296	0.5039	0.7589	0.2860	0.3667	0.5606
All Anglers	Yellow perch	1.0595	0.2414	0.3094	0.4731	0.3551	0.0940	0.1205	0.1843	0.7044	0.2066	0.2648	0.4049
Overall		3.2814	0.5730	0.7345	1.1230	1.2553	0.2990	0.3833	0.5859	2.0261	0.3827	0.4906	0.7501
Targeted	Northern pike	0.5416	0.2328	0.2984	0.4563	0.0615	0.0862	0.1105	0.1689	0.4801	0.2372	0.3041	0.4649
Targeted	Rainbow trout	0.0526	0.0804	0.1031	0.1576	0.0000	0.0000	0.0000	0.0000	0.0526	0.0804	0.1031	0.1576
Targeted	Smallmouth bass	0.2610	0.0724	0.0928	0.1419	0.0000	0.0000	0.0000	0.0000	0.2610	0.0724	0.0928	0.1419
Targeted	Largemouth bass	0.9021	0.1829	0.2345	0.3585	0.0289	0.0214	0.0274	0.0419	0.8733	0.1838	0.2356	0.3602
Targeted	Black crappie	10.4292	3.3889	4.3446	6.6422	4.3931	2.0207	2.5906	3.9606	6.0361	2.8069	3.5984	5.5014
Targeted	Yellow perch	3.0628	0.8850	1.1346	1.7347	2.0474	0.6884	0.8826	1.3493	1.0154	0.3117	0.3996	0.6109
Targeted Any	Anything	2.7441	0.4510	0.5781	0.8839	0.7751	0.2522	0.3233	0.4943	1.9690	0.3430	0.4398	0.6724

Appendix Table 6. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 January - 31 December 2003.

Waterbody	2,101 Stockade Lake
Work Period	Totaled Over: 1, 10, 11, 12, 2, 3, 4, 5, 6, 7, 8, 9 -- January, October, November, December, February, March, April, May, June, July, August, September
Day Type	Totaled Over: 1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over: 1 -- Stockade Lake
Type of Fishing	Totaled Over: 1,2,3 -- Boat, Shore, Ice

		Catch				Harvest				Release			
Estimate Type	Species	CPE	SE	80% CI	95% CI	HPE	SE	80% CI	95% CI	RPE	SE	80% CI	95% CI
All Anglers	Northern pike	0.1196	0.0207	0.0265	0.0405	0.0228	0.0052	0.0066	0.0101	0.0968	0.0184	0.0236	0.0360
All Anglers	Rainbow trout	0.0078	0.0032	0.0041	0.0062	0.0040	0.0022	0.0028	0.0042	0.0038	0.0024	0.0030	0.0047
All Anglers	Smallmouth bass	0.0787	0.0177	0.0227	0.0347	0.0073	0.0027	0.0035	0.0054	0.0714	0.0170	0.0218	0.0334
All Anglers	Largemouth bass	0.2687	0.0361	0.0463	0.0708	0.0184	0.0098	0.0125	0.0192	0.2502	0.0324	0.0415	0.0635
All Anglers	Black crappie	1.5528	0.5540	0.7103	1.0859	0.9317	0.4503	0.5773	0.8827	0.6211	0.1939	0.2485	0.3800
All Anglers	Yellow perch	1.1200	0.3907	0.5009	0.7659	0.5794	0.2370	0.3038	0.4645	0.5406	0.1621	0.2079	0.3178
Overall		3.1476	0.5243	0.6722	1.0277	1.5636	0.3090	0.3962	0.6057	1.5839	0.2666	0.3418	0.5226
Targeted	Northern pike	0.3260	0.1030	0.1321	0.2019	0.0385	0.0379	0.0486	0.0743	0.2875	0.1036	0.1328	0.2031
Targeted	Rainbow trout	0.0761	0.0557	0.0715	0.1092	0.0228	0.0336	0.0430	0.0658	0.0533	0.0445	0.0571	0.0872
Targeted	Smallmouth bass	0.3372	0.1579	0.2025	0.3096	0.0019	0.0025	0.0032	0.0050	0.3353	0.1578	0.2023	0.3093
Targeted	Largemouth bass	0.7584	0.1224	0.1569	0.2399	0.0201	0.0143	0.0184	0.0281	0.7384	0.1227	0.1573	0.2405
Targeted	Black crappie	7.4359	1.9643	2.5183	3.8501	3.8394	1.2598	1.6151	2.4693	3.5965	1.4449	1.8524	2.8321
Targeted	Yellow perch	2.3852	0.4500	0.5770	0.8821	1.6960	0.3529	0.4525	0.6918	0.6892	0.1854	0.2377	0.3633
Targeted Any	Anything	2.4799	0.4883	0.6261	0.9572	1.0171	0.3280	0.4205	0.6429	1.4628	0.2940	0.3770	0.5763

Appendix Table 7. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 June - 31 August 1999.

Waterbody	2,101 Stockade Lake
Work Period	Totaled Over: 6, 7, 8 -- June, July, August
Day Type	Totaled Over: 1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over: 1 -- Stockade Lake
Type of Fishing	Totaled Over: 1,2,3 -- Shore, Boat, Tube

		Catch				Harvest				Release			
Estimate Type	Species	N	SE	80% CI	95% CI	N	SE	80% CI	95% CI	N	SE	80% CI	95% CI
All Anglers	White sucker	22.89	19.95	25.58	39.11	0.00	0.00	0.00	0.00	22.89	19.95	25.58	39.11
All Anglers	Black bullhead	67.55	42.24	54.15	82.79	0.00	0.00	0.00	0.00	67.55	42.24	54.15	82.79
All Anglers	Northern pike	471.15	109.97	140.98	215.54	92.37	52.89	67.81	103.67	378.79	117.29	150.37	229.89
All Anglers	Rainbow trout	17.31	14.03	17.99	27.50	17.31	14.03	17.99	27.50	0.00	0.00	0.00	0.00
All Anglers	Rock bass	17.31	18.69	23.96	36.64	0.00	0.00	0.00	0.00	17.31	18.69	23.96	36.64
All Anglers	Smallmouth bass	1,286.63	349.88	448.55	685.77	60.26	50.28	64.46	98.55	1,226.37	342.42	438.98	671.14
All Anglers	Largemouth bass	4,086.40	830.05	1,064.13	1,626.90	142.68	81.90	105.00	160.53	3,943.73	816.10	1,046.24	1,599.56
All Anglers	Black crappie	7,350.90	1,694.67	2,172.57	3,321.55	3,624.33	1,092.79	1,400.95	2,141.86	3,726.57	1,109.35	1,422.19	2,174.33
All Anglers	Yellow perch	3,806.90	907.78	1,163.78	1,779.25	1,496.69	574.09	735.99	1,125.22	2,310.21	695.99	892.26	1,364.15
Overall		17,127.05	2,836.26	3,636.08	5,559.06	5,433.63	2,671.63	3,425.03	5,236.39	11,693.42	1,491.95	1,912.68	2,924.22

Appendix Table 8. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 June - 31 August 2003.

Waterbody	2,101	Stockade Lake
Work Period	Totaled Over:	6, 7, 8 -- June, July, August
Day Type	Totaled Over:	1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over:	1 -- Stockade Lake
Type of Fishing	Totaled Over:	1,2,3 -- Boat, Shore, Ice

		Catch				Harvest				Release			
Estimate Type	**Species**	**N**	**SE**	**80% CI**	**95% CI**	**N**	**SE**	**80% CI**	**95% CI**	**N**	**SE**	**80% CI**	**95% CI**
All Anglers	Northern pike	2,019.88	354.85	454.92	695.51	237.13	62.54	80.18	122.58	1,782.75	341.67	438.02	669.67
All Anglers	Rainbow trout	58.88	38.23	49.00	74.92	29.44	26.52	34.00	51.98	29.44	31.19	39.98	61.13
All Anglers	Smallmouth bass	1,149.09	270.01	346.16	529.23	61.58	20.83	26.70	40.82	1,087.51	269.94	346.06	529.08
All Anglers	Largemouth bass	5,017.44	578.79	742.01	1,134.43	407.37	230.39	295.36	451.57	4,610.07	547.69	702.14	1,073.48
All Anglers	Black crappie	21,398.82	4,964.83	6,364.91	9,731.07	11,274.37	3,235.87	4,148.39	6,342.31	10,124.45	3,751.24	4,809.09	7,352.43
All Anglers	Yellow perch	14,135.23	2,144.87	2,749.73	4,203.95	4,737.67	1,116.88	1,431.83	2,189.08	9,397.56	2,098.90	2,690.79	4,113.85
Overall		43,779.35	6,318.16	8,099.88	12,383.60	16,747.57	3,600.83	4,616.26	7,057.62	27,031.78	4,403.28	5,645.01	8,630.43

Appendix Table 9. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 January - 31 December 2003.

Waterbody	2,101	Stockade Lake
Work Period	Totaled Over:	1, 10, 11, 12, 2, 3, 4, 5, 6, 7, 8, 9 -- January, October, November, December, February, March, April, May, June, July, August, September
Day Type	Totaled Over:	1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over:	1 -- Stockade Lake
Type of Fishing	Totaled Over:	1,2,3 -- Boat, Shore, Ice

		Catch				Harvest				Release			
Estimate Type	**Species**	**N**	**SE**	**80% CI**	**95% CI**	**N**	**SE**	**80% CI**	**95% CI**	**N**	**SE**	**80% CI**	**95% CI**
All Anglers	Northern pike	3,014.64	401.94	515.29	787.80	573.87	111.87	143.42	219.26	2,440.78	380.36	487.62	745.50
All Anglers	Rainbow trout	195.89	79.85	102.37	156.50	100.24	52.93	67.85	103.74	95.64	60.84	78.00	119.25
All Anglers	Smallmouth bass	1,984.14	383.61	491.79	751.88	184.58	75.22	96.43	147.43	1,799.56	358.77	459.94	703.18
All Anglers	Largemouth bass	6,773.93	613.38	786.36	1,202.23	464.94	231.56	296.86	453.86	6,308.99	583.30	747.79	1,143.27
All Anglers	Black crappie	39,150.44	11,106.83	14,238.96	21,769.39	23,491.36	9,753.12	12,503.49	19,116.11	15,659.08	4,208.66	5,395.51	8,248.98
All Anglers	Yellow perch	28,238.82	5,499.52	7,050.38	10,779.06	14,608.36	3,303.00	4,234.44	6,473.88	13,630.47	2,755.36	3,532.37	5,400.50
Overall		79,357.87	9,005.99	11,545.68	17,651.74	39,423.36	5,651.33	7,245.01	11,076.61	39,934.51	5,215.86	6,686.73	10,223.08

Appendix Table 10. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 June - 31 August 1999.

Waterbody	2,101	Stockade Lake
Work Period	Totaled Over:	6, 7, 8 -- June, July, August
Day Type	Totaled Over:	1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over:	1 -- Stockade Lake
Type of Fishing	Totaled Over:	1,2,3 -- Shore, Boat, Tube

			Catch				Harvest				Release			
Surface Area	Estimate Type	Species	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI
53.00	All Anglers	White sucker	0.4350	0.3793	0.4863	0.7434	0.0000	0.0000	0.0000	0.0000	0.4350	0.3793	0.4863	0.7434
53.00	All Anglers	Black bullhead	1.2840	0.8029	1.0293	1.5736	0.0000	0.0000	0.0000	0.0000	1.2840	0.8029	1.0293	1.5736
53.00	All Anglers	Northern pike	8.9554	2.0902	2.6797	4.0969	1.7557	1.0054	1.2889	1.9705	7.1998	2.2294	2.8581	4.3696
53.00	All Anglers	Rainbow trout	0.3290	0.2667	0.3419	0.5228	0.3290	0.2667	0.3419	0.5228	0.0000	0.0000	0.0000	0.0000
53.00	All Anglers	Rock bass	0.3290	0.3553	0.4555	0.6964	0.0000	0.0000	0.0000	0.0000	0.3290	0.3553	0.4555	0.6964
53.00	All Anglers	Smallmouth bass	24.4555	6.6504	8.5258	13.0348	1.1454	0.9557	1.2252	1.8732	23.3101	6.5085	8.3438	12.7566
53.00	All Anglers	Largemouth bass	77.6721	15.7771	20.2263	30.9232	2.7119	1.5568	1.9958	3.0513	74.9602	15.5120	19.8864	30.4035
53.00	All Anglers	Black crappie	139.7218	32.2113	41.2949	63.1342	68.8892	20.7711	26.6285	40.7113	70.8325	21.0859	27.0321	41.3284
53.00	All Anglers	Yellow perch	72.3594	17.2546	22.1204	33.8191	28.4482	10.9120	13.9892	21.3876	43.9112	13.2291	16.9597	25.9290
53.00	Overall		325.5413	53.9099	69.1125	105.6635	103.2794	50.7808	65.1010	99.5303	222.2618	28.3581	36.3551	55.5818

Appendix Table 11. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 June - 31 August 2003.

Waterbody	2,101	Stockade Lake
Work Period	Totaled Over:	1, 10, 11, 12, 2, 3, 4, 5, 6, 7, 8, 9 -- January, October, November, December, February, March, April, May, June, July, August, September
Day Type	Totaled Over:	1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over:	1 -- Stockade Lake
Type of Fishing	Totaled Over:	1,2,3 -- Boat, Shore, Ice

			Catch				Harvest				Release			
Surface Area	Estimate Type	Species	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI
53.00	All Anglers	Northern pike	38.3928	6.7449	8.6469	13.2199	4.5073	1.1887	1.5239	2.3299	33.8855	6.4942	8.3256	12.7287
53.00	All Anglers	Rainbow trout	1.1192	0.7266	0.9315	1.4241	0.5596	0.5041	0.6463	0.9881	0.5596	0.5928	0.7600	1.1619
53.00	All Anglers	Smallmouth bass	21.8412	5.1323	6.5796	10.0592	1.1706	0.3958	0.5075	0.7759	20.6707	5.1309	6.5778	10.0565
53.00	All Anglers	Largemouth bass	95.3686	11.0014	14.1037	21.5627	7.7431	4.3792	5.6141	8.5832	87.6255	10.4102	13.3459	20.4040
53.00	All Anglers	Black crappie	406.7367	94.3687	120.9806	184.9626	214.2969	61.5056	78.8502	120.5510	192.4399	71.3014	91.4084	139.7508
53.00	All Anglers	Yellow perch	268.6745	40.7686	52.2653	79.9064	90.0509	21.2289	27.2155	41.6087	178.6236	39.8947	51.1450	78.1936
53.00	Overall		832.1331	120.0920	153.9580	235.3804	318.3283	68.4425	87.7433	134.1473	513.8048	83.6951	107.2971	164.0423

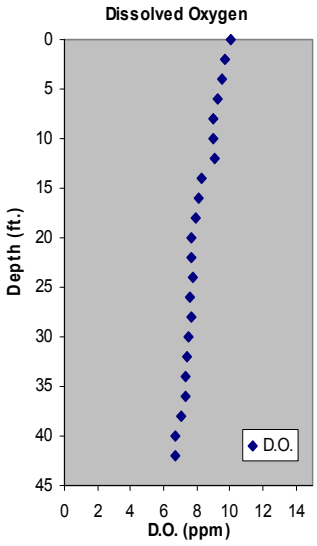
Appendix Table 12. Stockade Lake estimated angling pressure and catch rates by shift and month for all fish by all fishermen, 1 January - 31 December 2003.

Waterbody	2,101	Stockade Lake
Work Period	Totaled Over:	1, 10, 11, 12, 2, 3, 4, 5, 6, 7, 8, 9 -- January, October, November, December, February, March, April, May, June, July, August, September
Day Type	Totaled Over:	1,2,3 -- Weekend/Holiday, Weekday, Weekend/Holiday or Weekday (1 or 2)
Zone	Totaled Over:	1 -- Stockade Lake
Type of Fishing	Totaled Over:	1,2,3 -- Boat, Shore, Ice

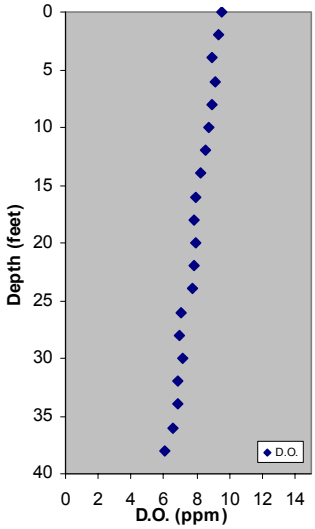
			Catch				Harvest				Release			
Surface Area	Estimate Type	Species	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI	N/Area	SE	80% CI	95% CI
53.00	All Anglers	Northern pike	57.3006	7.6398	9.7943	14.9741	10.9077	2.1263	2.7260	4.1676	46.3929	7.2296	9.2684	14.1700
53.00	All Anglers	Rainbow trout	3.7233	1.5177	1.9457	2.9747	1.9053	1.0060	1.2897	1.9718	1.8180	1.1565	1.4826	2.2667
53.00	All Anglers	Smallmouth bass	37.7134	7.2915	9.3477	14.2914	3.5084	1.4297	1.8329	2.8022	34.2049	6.8192	8.7423	13.3657
53.00	All Anglers	Largemouth bass	128.7551	11.6588	14.9466	22.8513	8.8374	4.4014	5.6426	8.6267	119.9177	11.0871	14.2136	21.7307
53.00	All Anglers	Black crappie	744.1493	211.1123	270.6460	413.7801	446.5105	185.3817	237.6593	363.3481	297.6389	79.9959	102.5547	156.7919
53.00	All Anglers	Yellow perch	536.7475	104.5317	134.0097	204.8822	277.6674	62.7815	80.4859	123.0518	259.0801	52.3723	67.1413	102.6497
53.00	Overall		1,508.3893	171.1807	219.4536	335.5142	749.3367	107.4173	137.7090	210.5379	759.0525	99.1401	127.0976	194.3146

Appendix Figure 1. Compilation of Stockade Lake dissolved oxygen profiles taken during the summer of 1999.

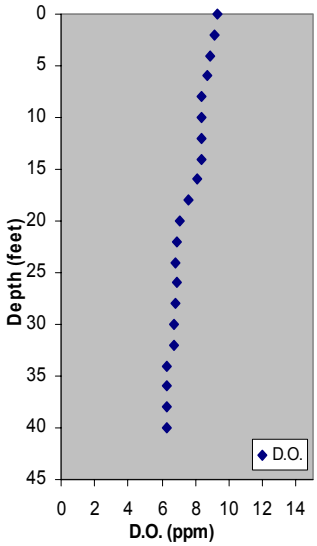
Baseline 5/11/99
Site A1



5/12/99
Site A1



5/14/99
Site A1



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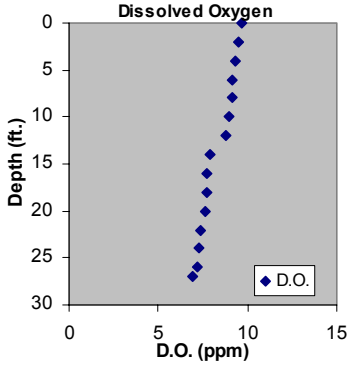

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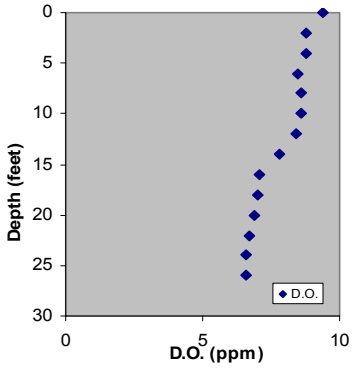

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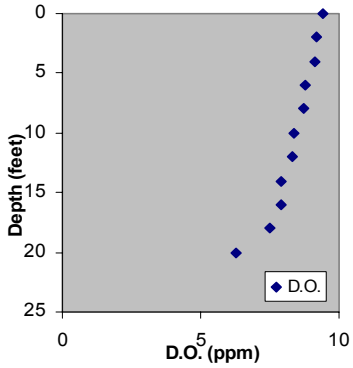

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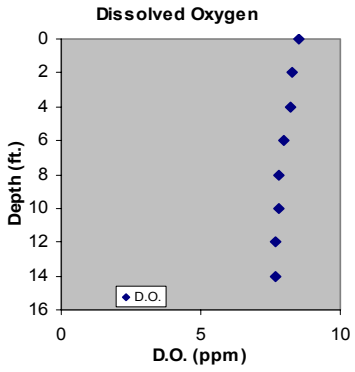

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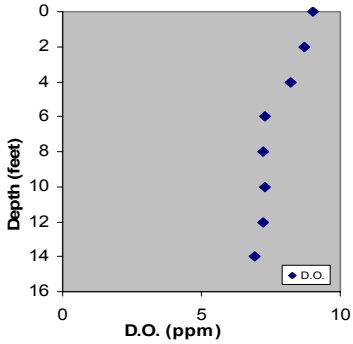

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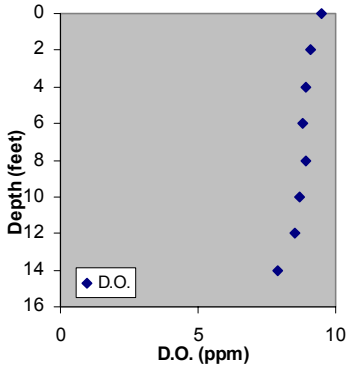

Appendix Table 13 (continued)

5/17/99
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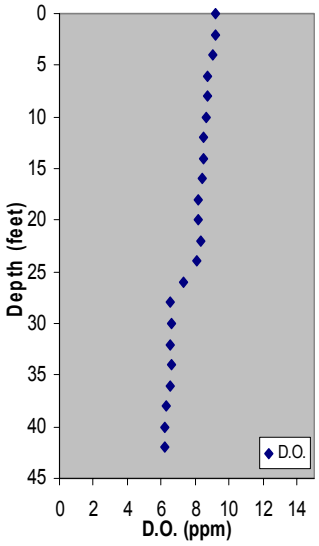

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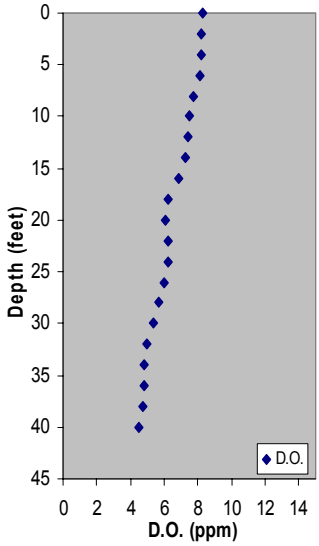

6/9/99
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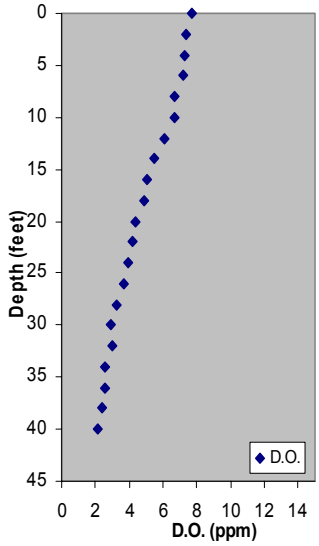

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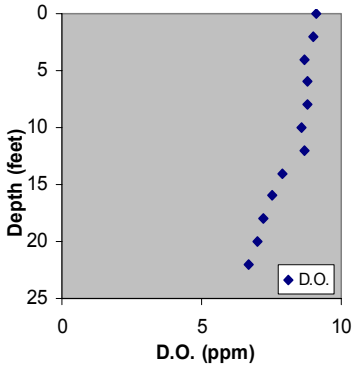

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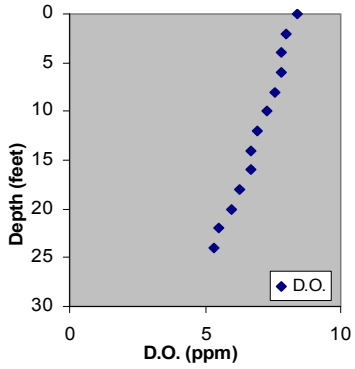

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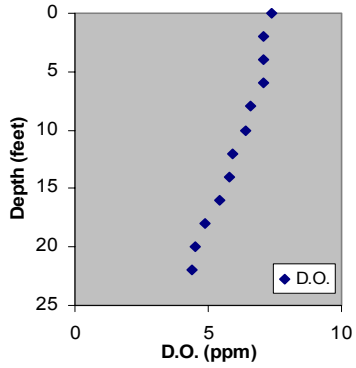

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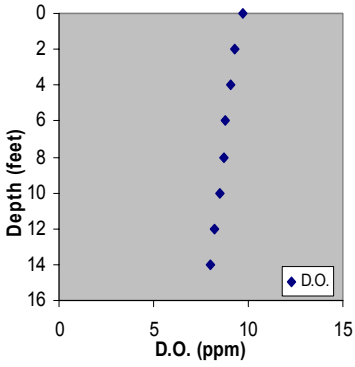

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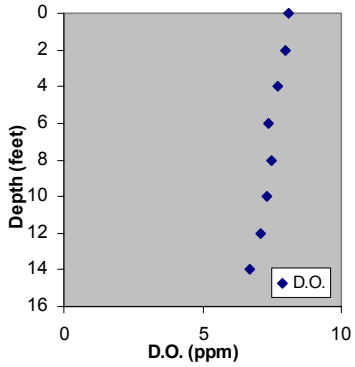

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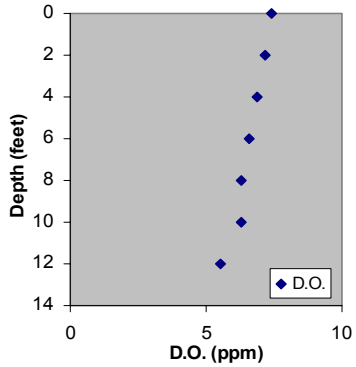

Appendix Table 13 (continued)

6/23/99
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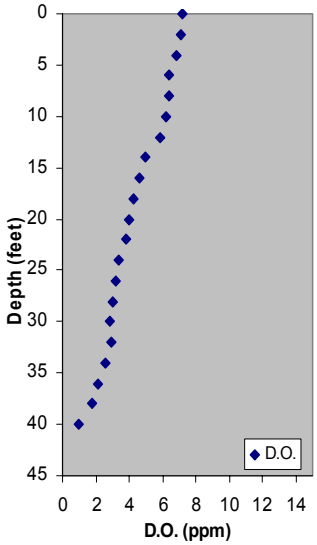

7/6/99
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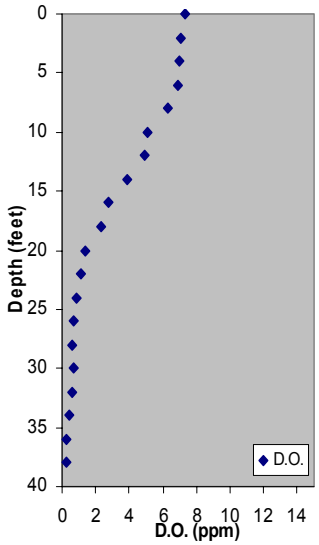

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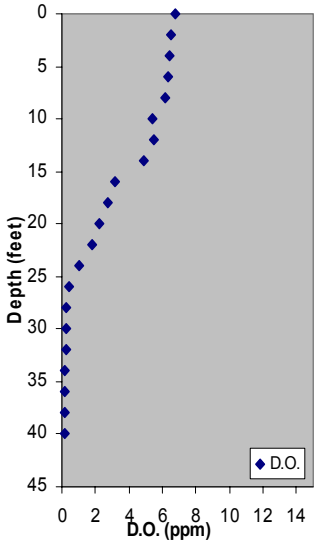

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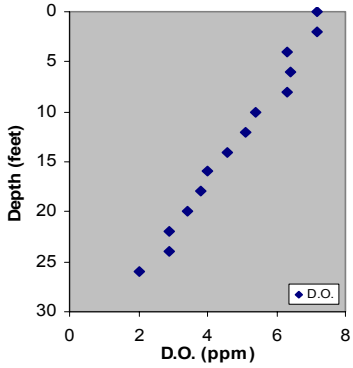

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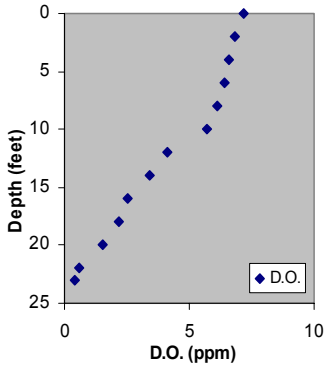

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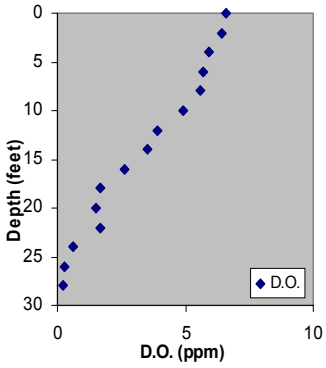

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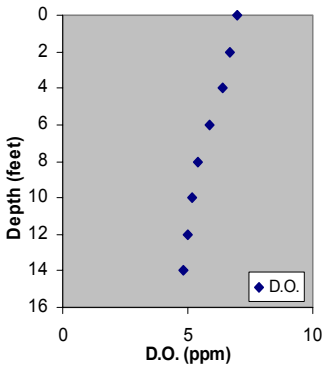

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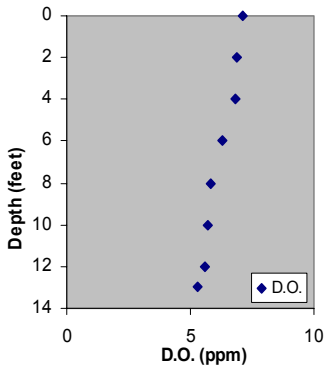

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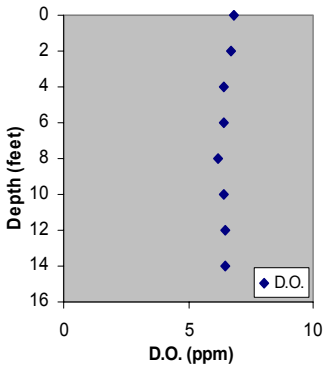

Appendix Table 13 (continued)

8/5/99
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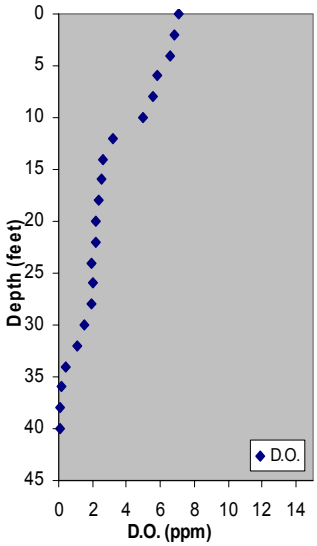

8/17/99
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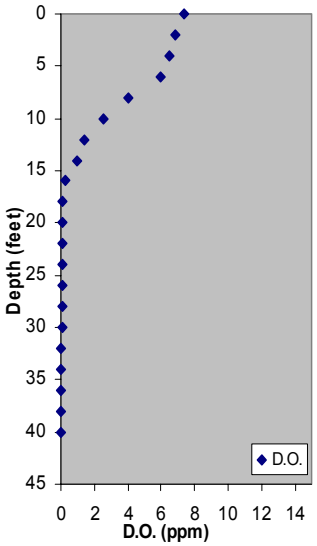

9/3/99
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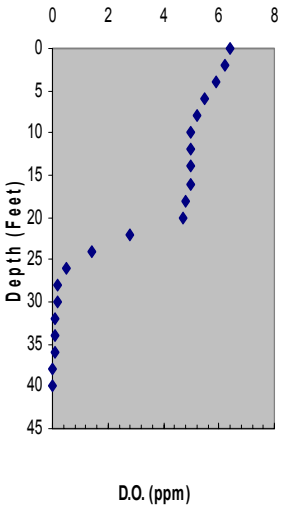

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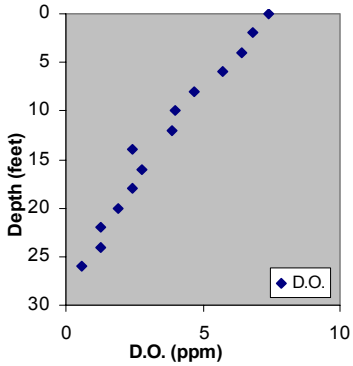

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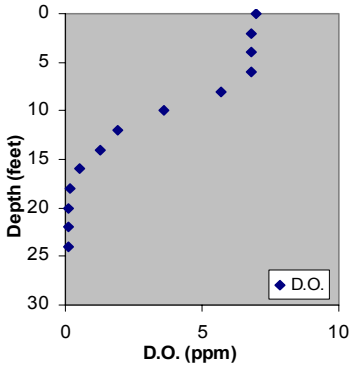

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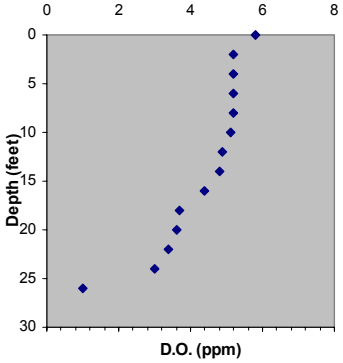

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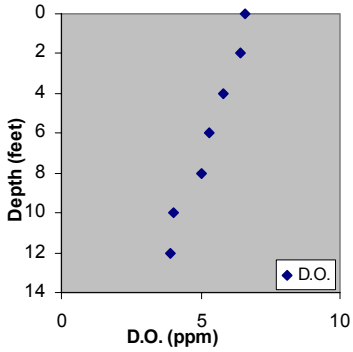

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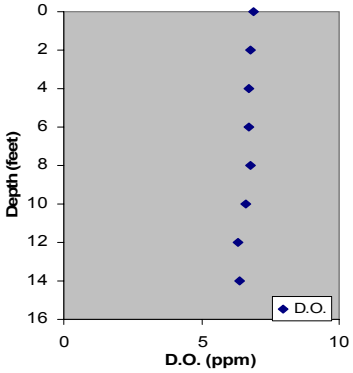

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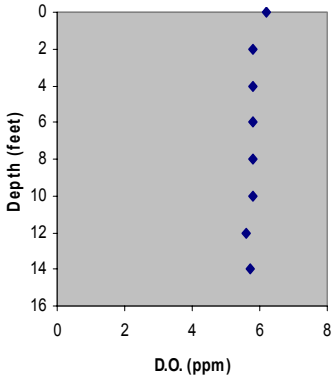

9/14/99
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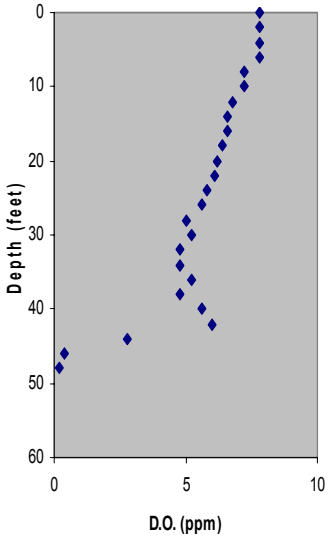

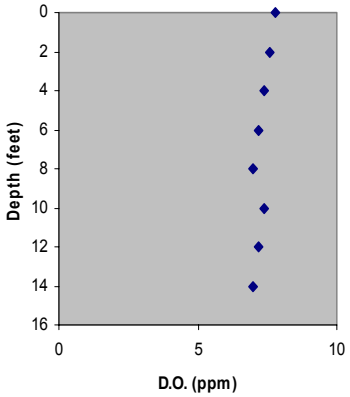

9/30/99
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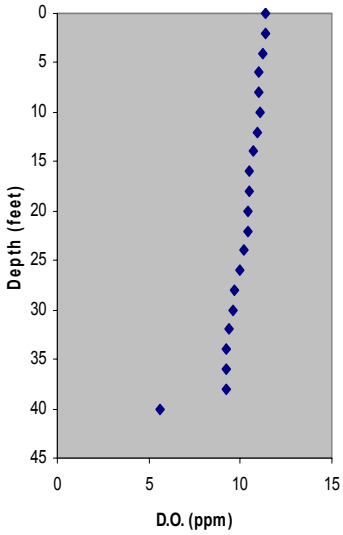

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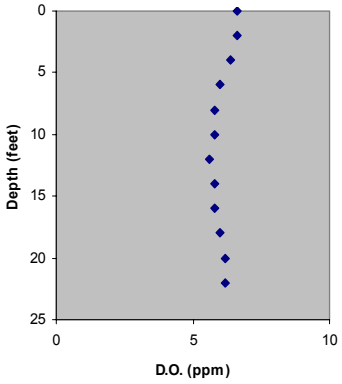

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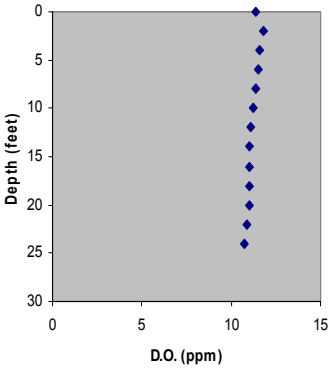
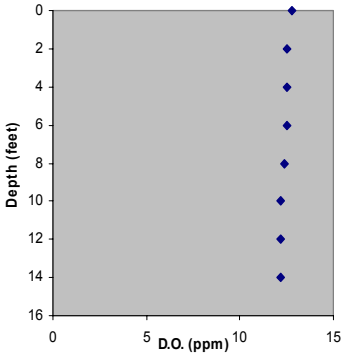


Site C3

Site C3



10/12/99
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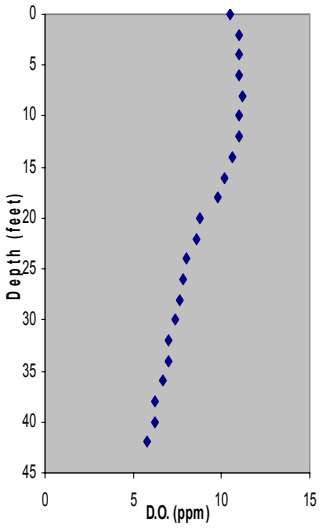

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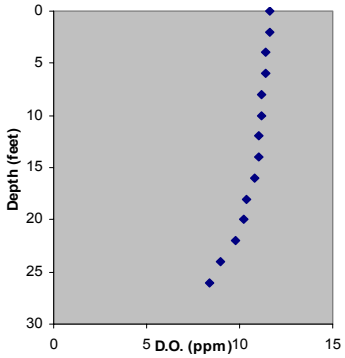

Site C3