Comparative Assessment of the Physico-Chemical and Bacteriological Qualities of Selected Streams in Louisiana

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Abstract: The objective of this research was to compare the chemical/physical parameters and bacterial qualities of selected surface water streams in Louisiana, including a natural stream (control) and an animal waste related stream. Samples were collected and analyzed for fecal coliforms. Fecal coliforms isolated from these samples were identified to the species level. Chemical analysis was performed following standard test protocols (LaMotte 2002). An analysis of biological oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total dissolved solids (TDS), conductivity, pH, temperature, ammonia nitrogen, nitrate nitrogen, iron, copper, phosphate, potassium, sulfate, turbidity, zinc and bacterial levels was performed following standard test protocols as presented in Standard Methods for the Examination of Water and Wastewater [9]. Results of the comparisons of the various surface water streams showed that phosphate levels, according to Mitchell and Stapp, were considered good for Lake Claiborne (control) and Bayou Dorcheat. The levels were found to be .001 mg/L and .007 mg/L respectively. Other streams associated with animal waste, had higher phosphate levels of 2.07 mg/L and 2.78 mg/L, respectively. Conductivity and total dissolved solids (TDS) levels were the lowest in Lake Claiborne and highest in the Hill Farm Research Station stream. It can be concluded from the data that some bacterial levels and various nutrient levels can be affected in water resources due to non-point source pollution. Many of these levels will remain unaffected.

Keywords: Non-point source pollution, fecal coliform, total organic carbon (TOC), biological oxygen demand (BOD), chemical oxygen demand (COD)

Introduction

It is predicted that by the turn of the next century, water shortages will become more widespread. Predictions from the Water Resource Council allude to increases in the consumption of fresh water by almost 27%. The problem is even worse if groundwater is considered separately from other water sources. The Global 2000 study concluded that pollution, gross national products (GNP), and resource projections all imply rapidly increasing demands for fresh water [1].

With the demand for fresh water growing, agriculture is under increasing pressure to ensure that its practices do not contribute to the decline of water quality both nationally and in the state of Louisiana. According to the U.S. EPA Louisiana 1996 305(b) report, fecal coliform bacteria are the most common pollutant in rivers and streams. It has been noted that of the waterways in Louisiana that were surveyed, 37% of the river miles, 31% of lakes, and 23% of estuarine water in Louisiana had some level of contamination [2]. Possible sources of elevated coliform counts include sewage discharges from municipal treatment plants and septic tanks, storm water overflows, and runoff from pastures and range lands.

Many Louisiana waterways continue to have elevated levels of unhealthy bacteria due to human and natural contaminants. Studies conducted during the summer of 2001 by the Department of Health and Hospitals on the Tangipahoa River showed a strong correlation between high water caused by rain and increased levels of bacteria [3].

Research conducted in 1999 on the Ross Barnett reservoir located in central Mississippi concluded that there exists a potential public health concern with respect

to microbial contamination of the water. In most cases in this study, it was shown that the bacterial counts exceeded both the federal and state guidelines for minimizing the health risks associated with water-contact activities [4].

Bursting and overflowing manure lagoons have spawned environmental disasters around the country, sending animal waste flowing into rivers, groundwater and coastal wetlands. In 1995, an 8-acre hog waste lagoon in North Carolina burst, spilling 25million gallons of animal waste into the New River. The spill killed as many as 10 million fish and closed 364,000 acres of coastal wetlands to shell fishing [5].

According to the water quality standards set by the EPA, *E.coli* is the most reliable of fecal bacterial contamination of surface waters in the U.S. An extensive epidemiological study demonstrated that *E. coli* concentrations are the best predictors of swimming-associated gastrointestinal illness.

The EPA recommended recreational water quality standard for *E. coli* is based on two criteria: 1) a geometric mean of 126 organisms/100ml based on several samples collected during dry weather conditions or 2) 235 organisms/100ml for a single water sample [6]. The geometric mean is calculated by the equation: geometric mean of $y = n^{th}$ root of $y_1 * y_2 * y_3 \dots y_n$. If either criterion is exceeded, the site is not in compliance with water quality standards and not recommended for swimming. The current EPA water quality standard for *E. coli* corresponds to approximately 8 gastrointestinal illnesses per 1000 swimmers [7].

This study was designed to compare the chemical/physical parameters and bacterial qualities of selected surface water streams in Louisiana, including a natural stream (control) and an animal waste related stream.

Materials and Methods

Materials

A portable pH/EC/TDS/Temperature meter was purchased from A.Daigger and Company, Inc. (Vernon Hills, IL). The SMART 2 Colorimeter, 25 mm test vials and reagents for ammonia nitrogen, copper, Phosphate, potassium, sulfate and zinc tests were also purchased from A. Daigger and Company, Inc. (Vernon Hills, IL). Other materials used such as COD Standard Range Mercury Free Tubes and a COD reactor, 110v were purchased from A. Daigger and Company, Inc. (Vernon Hills, IL) as well. A COD heater block was purchased from Bioscience, Inc. (Bethlehem, PA).

Method

A comparison of the data collected from Lake Claiborne to data collected from the Bayou Dorcheat, Hill Farm Research Station stream and Ray Pond was done. According to the Department of Environmental Quality, Lake Claiborne has the designated uses of primary contact recreation, secondary contact recreation, propagation of fish and wildlife and as a drinking water supply. It is because of these designated uses that Lake Claiborne was selected to serve as a control in the experiments. Bayou Dorcheat has been designated by DEQ as having uses such as primary contact recreation, secondary contact recreation, propagation of fish and wildlife, agriculture and as being outstanding natural resource water [8]. The Hill Farm Research Station stream was selected for this portion of the study because of its location and affiliation with cattle waste. The Hill Farm stream is located on LSU AgCenter property and is surrounded by cattle. The possibility of the influence of any other type of animal waste involvement or the influence of pollution from other areas is low. Ray Pond was selected for its association with broiler litter. The property surrounding Ray Pond is the site of a commercial broiler/egg company. The levels of nitrate nitrogen, ammonia nitrogen, phosphate, potassium, copper, zinc, pH, temperature, conductivity, turbidity, BOD, COD, TOC and the type and numbers of bacteria in these water resources were compared. The accuracy of all equipment was determined by using known standards. All test conducted were referenced from the SMART 2 Colorimeter manual [9] as well as the 20th edition of the Standard Methods for the Examination of Water and Wastewater [10].

Collection of Samples

All liquid samples were collected with a volume of not less than 100ml. A space of at least 2.5 cm was left in the bottle to facilitate mixing by shaking. The containers used were according to the 20th edition of Standard Methods for the Examination of Water and Wastewater. Samples were collected in nonreactive glass or plastic bottles that had been cleansed and rinsed carefully, given a final rinse with distilled water, and sterilized [10]. Containers were lowered to a depth of not greater than 2ft below the surface to fill. The samples were placed immediately on ice in order to have a temperature of less than 10°C during a maximum transport time of 6h [10]. All sample collections were conducted during the summer months. Five duplicate samples from each site were collected once weekly for a period of ten weeks. Samples from Hill Farm Research Station were collected for a period of twelve months. Samples from Lake Claiborne (control) were taken from a site located at the bank of the spillway to avoid the proximity of any septic systems. This area of Lake Claiborne is static. Bayou Dorcheat samples was collected at a bank at least one mile away from community housing to avoid the possibility of septic systems in the area. The Bayou Dorcheat area has public sewage. The sample areas for Hill Farm Research Station stream and Ray Pond were located near the bank. The area of sample collection used for Hill Farm Research Station and Bayou Dorcheat had a minimal flow rate. The sample collection area of Ray Pond was static.

Temperature

Prior to placing the sample on ice, the temperature was taken by placing the probe of the portable pH/EC/TDS/Temperature meter into the collected sample.

pH

The pH was measured by using the conductivity/pH/TDS meter. The pH selection was chosen on the instrument and the probe was then inserted into the water sample. The appropriate pH reading was taken.

Fecal Coliform Count

Ten ml of water sample were vortexed and filtered onto a membrane filter using a sterile filtration unit. The approved technique used was from Clesceri et al. [10].

After filtration, forceps were used to place the membrane filter on an MFC agar plate. The plate was then incubated in an incubator at 45 °C for 24 hours. The plates were then checked for bacteria colony growth.

API 20 E System

The API 20E System was used in conjunction with the API Profile Recognition System (bioMerieux, Inc., Hazelwood, MO) so that members of the family Enterobacteriaceae and other Gram-negative bacteria could be accurately identified.

The API 20 E strip consists of 20 microtubes containing dehydrated substrates. These tests were inoculated with the bacterial sample suspension. Each sample was incubated for 18-24 hrs. at 35-37ºC. This system is a standardized, miniaturized version of conventional procedures for the identification of *Enterobacteriaceae* and other Gram-negative bacteria.

Nitrate Nitrogen

Nitrate nitrogen was measured by using Waterworks Test Strips (Thomas Scientific Swedesboro, NJ). The test strip was placed into the water sample. The color change on the strip was compared to the chart provided with the strips.

Ammonia-Nitrogen - The Nesslerization Method

The colorimeter test vial was filled to the 10 ml line with the sample. The test vial was then placed into the colorimeter and scanned as a blank. The test vial was then removed and 8 drops of ammonia nitrogen reagent #1 was added and mixed. The mixture was allowed to sit for 1 minute. One ml of ammonia nitrogen reagent # 2 was added. After waiting 5 minutes, the test vial was inserted again and a reading was taken.

Phosphate-The Vanadomolybdophosphoric Acid Method

The test vial was filled with 10 ml of the sample water. The test vial was inserted into colorimeter and scanned as a blank. Two ml of VM Phosphate Reagent was added and mixed well. After waiting for a period of 5 minutes, a reading was obtained using the colorimeter.

Copper - Diethyldithiocarbamate Method

Ten ml of the sample water was added to the test vial and 5 drops of copper 1 reagent was added. The sample mixture was then mixed well. The solution turned yellow which indicated that copper is present. The test vial was then placed into the colorimeter and a reading was taken.

Zinc - The Zincon Method

A dilute zinc indicator solution was prepared by adding five ml of a zinc indicator solution to 17.8 ml of methyl alcohol. Afterwards, the indicator solution and methyl alcohol were mixed well. A colorimeter test vial was filled with the water sample to the 10 ml line. The test vial was then inserted into the colorimeter and scanned as a blank. One tenth of a gram of sodium ascorbate powder was added along with 0.5 g zinc buffer powder. The mixture was capped and shaken vigorously for 1 minute. Three drops of sodium cyanide, 10% was added to the mixture and mixed well. One ml of dilute zinc indicator solution was then added and mixed. Four drops of formaldehyde solution, 37% was added and was mixed by inverting 15 times. The test vial was then inserted into the colorimeter and scanned for a reading.

Sulfate - The Barium Chloride Method

The colorimeter tube was filled to the 10 ml line with the sample water and was then inserted into colorimeter and scanned as a blank. One tenth of a gram of the sulfate reagent was added. The test vial was then capped and shaken until powder dissolved.

The mixture was allowed to sit for 5 minutes. After mixing the tube again, it was then inserted into the colorimeter and scanned for a reading.

Potassium - The Tetraphenylboron Method

One hundreth of 5 g of Tetraphenylboron Powder was added to the test vial containing 10 ml of the sample water. The vial was then capped and shaken vigorously until all of the powder had dissolved. The mixture was allowed to stand undisturbed for 5 minutes. The same procedure was followed to make a blank. Prior to taking the measurement, the vials were mixed again to suspend any settled precipitate. The vials were then inserted into the colorimeter and scanned for a reading.

Dissolved Oxygen (DO) Winkler Colorimetric Method

The 25 mm test vial was with 10 ml of the sample water. Two drops of manganese sulfate solution was then added as well 2 drops of alkaline potassium iodide azide. The mixture was mixed by inverting several times. The resulting precipitate was allowed to settle. 8 drops of sulfuric acid 1:1 was added and was gently mixed until the precipitate has dissolved. The test vial was then inserted into the SMART 2 Colorimeter and a reading was taken.

Chemical Oxygen Demand (COD)—Mercury Free Digestion Method

The COD heater block was preheated to150 ± 2°C. Two ml of sample water was added and was mixed well.

All of the previous steps were repeated in order to make a blank. Both vials were then placed in the preheated COD block heater and maintained at that temperature for 2 hours. The vials were allowed to cool for 20 minutes. After cooling, the test vials containing the blank and the sample were inserted in the colorimeter to take a reading.

Conductivity and TDS (Total Dissolved Solids)

The conductivity and the TDS were both measured by using a portable Conductivity/pH/TDS Meter. The probe for the instrument was placed directly into the water sample. The type of measurement taken was then selected on the instrument panel. The correct measurement was taken by reading directly from the instrument panel.

Turbidity - The Absorptimetric Method

Ten ml of the water sample was placed into the colorimeter tube and scanned using the SMART 2 colorimeter for a measurement.

Biochemical Oxygen Demand and Total Organic Carbon TOC

The testing of the samples for BOD and TOC was conducted by Gulf States Environmental Laboratories, Inc. (Shreveport, LA). The protocol followed by Gulf States Environmental Laboratories, Inc. was in according to the 20th edition of Standard Methods for the Examination of Water and Wastewater [10].

Statistical Analysis

Descriptive statistics were applied to determine the mean values of all physical/chemical and bacterial parameters evaluated. Standard deviations were computed as measures of variance. Statistical analysis was performed using GraphPad InStat program version 3.00 for Windows 95, GraphPad Software, San Diego, California. The Dunn's Multiple Comparisons test was applied to determine significant differences in mean values of each studied parameter among the sampling sites. The level of significance was considered at $p \leq 0.05$.

Results

A comparative analysis involving the use of natural water sources that may or may not be associated with animal waste was conducted. Each site was selected based upon its designated use and/or association with animal waste. The sample sites chosen were Bayou Dorcheat, Hill Farm Research Station stream, Lake Claiborne, and Ray Pond. The mean values of chemical oxygen demand-COD (mg/L) for each sample site were found to be 44.07 ± 0.46, 21.13 ± 0.35, 23.73 ± 0.70, and 48.86 ± 0.35 mg/L, respectively. The mean values of biochemical oxygen demand -BOD (mg/L) were determined to be 6.63 ± 0.14, 5.56 ± 0.01, 3.96 ± 0.01, and 16.63 ± 0.22 mg/L, respectively in Bayou Dorcheat, Hill Farm Research Station stream, and Lake

Ray Pond. Total organic carbon- TOC levels were found to be 11.51 ± 0.005, 5.02 ± 0.004, 7.29 ± 0.004, and 6.53 ± 0.004 mg/L in Bayou Dorcheat, Hill Farm Research Station stream, Lake Claiborne, and Ray Pond, respectively. Figures 1, 2, and 3 show the mean levels of COD, BOD, and TOC for each of the sample sites. It was determined that variations found among the BOD means for each sample site were highly significant ($p<0.0001$).
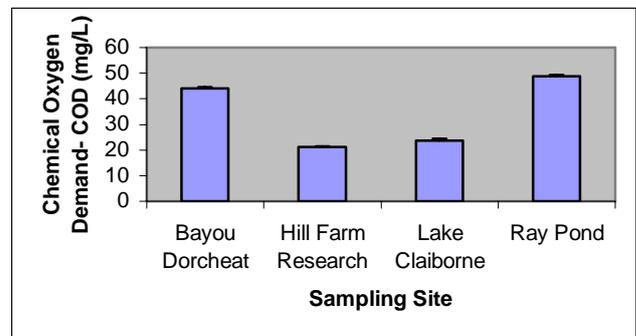

Figure 1: Mean values of chemical oxygen demand COD (mg/L) at each sample site (n=15).
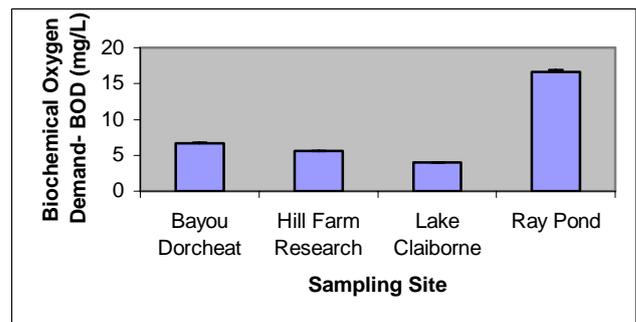

Figure 2: Mean values of biochemical oxygen demand BOD (mg/L) at each sample site (n=15).
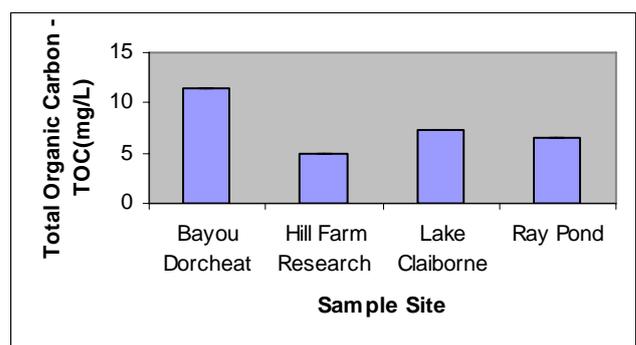

Figure 3: Mean values of total organic carbon TOC (mg/L) at each sample site (n=15).

The water flow rate for each of the sites was estimated at being minimal for Hill Research Station stream and Bayou Dorcheat. A static flow rate was noticed for Ray Pond and Lake Claiborne. Total dissolved solids TDS were evaluated at each of the sample sites. As shown in Figure 4, the lowest TDS was associated with Lake Claiborne. This number was noted to be $13.13 \pm .01$mg/L while the highest TDS was associated with Hill Farm Research Station at $49.07 \pm .8.50$ mg/L. The TDS levels for Bayou Dorcheat and Ray Pond

30.80 ± 2.20mg/L and was 21.27 ± 3.20mg/L, respectively. Comparisons of variations between the mean TDS levels for the sampling sites Hill Farm and Lake Claiborne, Hill Farm and Ray Pond and Bayou Dorcheat and Lake Claiborne show highly signicant differences (*p*<0.001). There were no significant differences in TDS concentrations (*p*>0.05) between the sampling sites of Bayou Dorcheat and Hill Farm, Bayou Dorcheat and Ray Pond, and Lake Claiborne and Ray Pond.
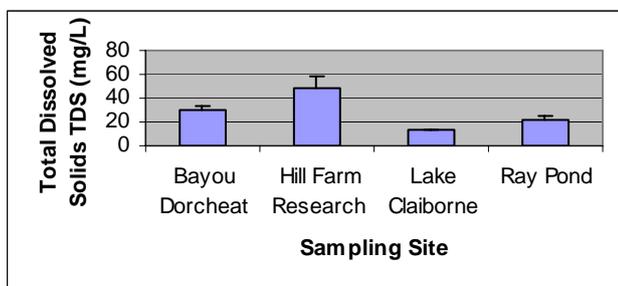

Figure 4: Mean values of total dissolved solids TDS (mg/L) at each of the sampling sites. Differences in mean levels at sampling sites are highly significant (p<0.001), n=15.

Visual observations determined that Lake Claiborne was the clearest of the water sample sites. Further testing of the turbidity determined the levels to be similar to the visual observations in that Lake Claiborne also had the lowest turbidity level of 15.0 ± 2.1 NTUs. As seen in Figure 5, the other sampling sites had turbidity levels that were very similar to one another but were greater than that found in Lake Claiborne. Bayou Dorcheat had the highest turbidity level among all of the sampling sites at 40.70 ± 2.20 NTUs. Hill Farm had a level of 30.70 ± 5.30 NTUs and Ray Pond had a turbidity level of 35.47± 7.80 NTUs. Comparisons among mean levels of turbidity revealed highly significant (*p*<0.0001) variations among sampling sites.
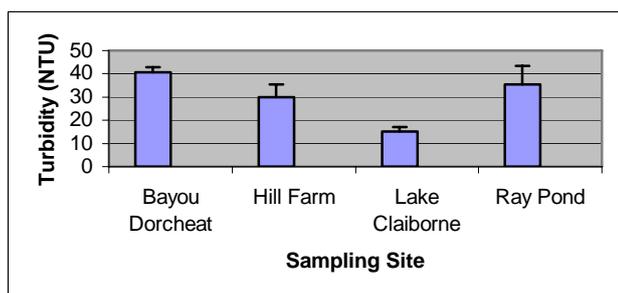

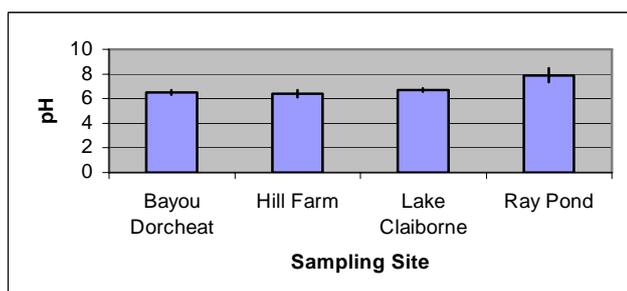**Figure 5:** Mean values of turbidity (NTU), (n=15) at each sampling site.

Figure 6: Mean pH values (n=15) for each sampling site.

The pH was measured for each of the sampling sites. The pH values recorded were 6.46 ± 0.18 for Bayou Dorcheat, 6.40 ± 0.30 for Hill Farm, 6.70 ± 0.15 for Lake Claiborne and 7.90 ± 0.58 for Ray Pond. The pH values for the sampling sites are shown in Figure 6.

Conductivity levels as well as the temperature were checked at all sampling sites. These levels are presented in Figures 7 and 8. Lake Claiborne had the lowest conductivity level (27 ± 1.07μS/cm) of all of the sampling sites. The highest conductivity level (92.70 ± 14.09μS/cm) was detected at the Hill Farm Research Station location. Bayou Dorcheat and Ray Pond were found to have conductivity levels of 61.60 ± 4.09μS/cm and 43.87 ± 12.17μS/cm, respectively.
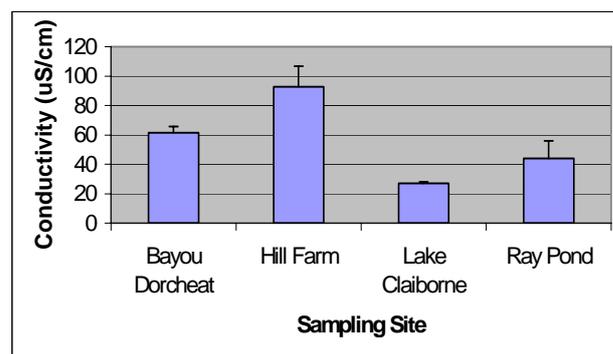

Figure 7: Mean values of conductivity (μS/cm) at each sampling site. Differences in mean values among the sampling sites are highly significant (p<0.0001).
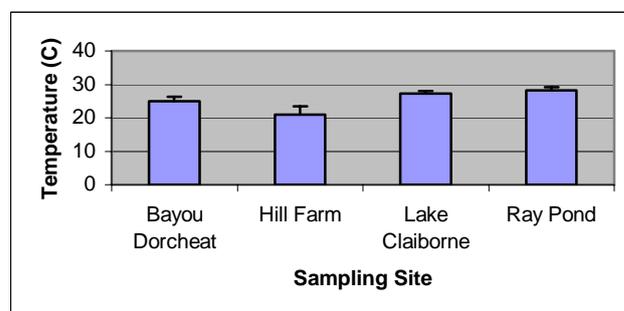

Figure 8: Mean values (n=15) of temperatures (°C) at each sampling site.

The temperature levels were similar for all the sampling sites. These temperatures were found to be 24.88 ±1.40°C, 20.97 ±2.50°C, 27.31 ± 0.62°C, and 28.22 ± 0.92°C, respectively for Bayou Dorcheat, Hill Farm, Lake Claiborne, and Ray Pond.

The chemical parameters such as phosphate and sulfate were checked and it was noted that Lake Claiborne also had the lowest phosphate level of all the sample sites. The phosphate level was observed at 0.001 ± .003ppm for Lake Claiborne while Bayou Dorcheat had a measurement of .007 ± .004ppm. Hill Farm and Ray Pond had phosphate levels of 2.07±1.2ppm and 2.780 ± 0.770ppm, respectively. Figure 9 shows the mean values (n=15) of phosphate while figure 10 shows those of sulfate. The sulfate levels detected for Lake Claiborne were found to be the lowest value among all of the sampling sites of 5.67 ± 0.00ppm. Hill Farm was

found to have the highest sulfate level at 6.20± 1.70 ppm. Bayou Dorcheat and Ray Pond had sulfate levels of 5.73 ± .70ppm and 5.93 ± 0.90ppm respectively.

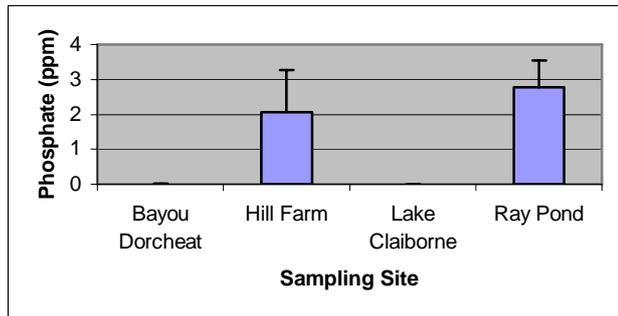**Figure 9:** Mean (n=15) values of phosphate (ppm) levels at each sampling site.
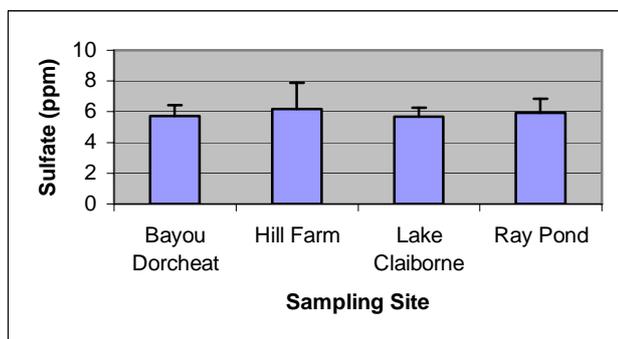

Figure 10: Mean (n=15) values of sulfate (ppm) levels at each sampling site

Samples from the Hill Farm stream were collected once per month for a period of one year. The results showed that only ten months of the sampled year had *E. coli* colonies found in the water samples. The Hill Farm stream had *E. coli* colony numbers ranging in numbers from 90 CFUs/100 ml to 1,800 CFUs/100 ml. Only two months showed colony numbers higher than 1,000 CFUs/100 ml for the Hill Farm stream.

Comparisons of bacterial parameters between Lake Claiborne (control) and Hill Farm Research Station showed that the Hill Farm Research Station stream had higher counts of bacterial colonies present than that of Lake Claiborne. Analysis of ten weekly samples from Lake Claiborne only had two in which fecal coliform were present. An analysis over a ten month period on the Hill Farm Research Station stream revealed fecal coliform present during each sampling. Of the two positive analyses for Lake Claiborne, the bacterial counts were 100 CFUs/100 ml of sample and 200 CFUs/100 ml of sample. All colonies were identified as being *E. coli.* As mentioned earlier, the Hill Farm stream had *E. coli* colony numbers ranging in numbers from 90 CFUs/100 ml to 1,800 CFUs/100 ml. Six of the monthly data of the number of colonies found in the Hill Farm stream were higher than the colony counts of Lake Claiborne, three of the monthly data were equivalent and only one monthly data was lower than the colony numbers found in Lake Claiborne. The mean levels of bacteria in Lake Claiborne and Hill Farm Research station stream differ significantly ($p < 0.0199$). Figure 11 shows the mean

numbers of the bacterial colonies found at each sampling site. The mean values of *E. coli* CFUs/100 ml for Lake Claiborne, Bayou Dorcheat, Hill Farm Research Station Stream and Ray Pond were 30.00 ± 67.50 CFUs/100 ml, 25.40 ± 22.39 CFUs/100 ml, 482.00 ± 555.43 CFUs/100 ml and 249.60 ± 181.64 CFUs/100 ml, respectively. Differences in bacterial levels among sampling sites were highly significant ($p < 0.0001$).
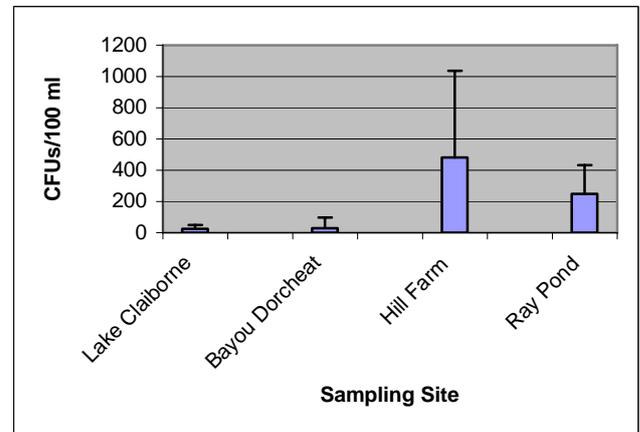

Figure 11: Mean values of *E. coli* colonies/100 ml for each sampling site.

Discussion

According to the Department of Environmental Quality, Lake Claiborne has the designated uses of primary contact recreation, secondary contact recreation, propagation of fish and wildlife and as a drinking water supply. It is because of these designated uses that Lake Claiborne was selected to serve as a control in the experiments. Bayou Dorcheat has been designated by DEQ as having uses such as primary contact recreation, secondary contact recreation, propagation of fish and wildlife, agriculture and as being outstanding natural resource water [8]. The Hill Farm Research Station stream was selected for this portion of the study because of its affiliation with cattle waste and Ray Pond was selected for its association with broiler litter.

All of the pH levels received for the natural water sources were found to be within a normal range and ranked as either good or excellent. The pH for natural water is usually between 6.5 and 8.5 although variations are known to occur. At extremely high or low pH values such as greater than 9.6 or less than 4.5, the water becomes unsuitable for most organisms [11]. The pH for Lake Claiborne was considered excellent, while Bayou Dorcheat, Hill Farm and Ray Pond had a pH that was considered good and within the normal range.

The total dissolved solids -TDS level of all of the sampling sites were within the requirements of DEQ of not exceeding 200 mg/L. The conductivity levels were parallel to the TDS results in that both data showed Lake Claiborne as being the lowest and next in increasing order was Ray Pond and Bayou Dorcheat with Hill Farm being the highest. All of the temperatures received for each site were within the requirements of not exceeding 32°C [8]. A comparison of the data from the chemical oxygen demand- COD and the total organic carbon-TOC

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measurements showed that the Hill Farm Research Station stream had the lowest COD and TOC as compared to the other three sampling sites. Bayou Dorcheat was found to have the highest TOC while Ray Pond had the highest COD measurements. The biochemical oxygen demand -BOD was lowest for Lake Claiborne. At 3.96mg/L, this is ranked as good. Bayou Dorcheat and Hill Farm sampling sites had BOD measurements of 6.70mg/L and 5.56mg/L, respectively. Both of these readings are ranked as being fair. Ray Pond had a BOD measurement of 16.70mg/L and is ranked as being poor. It seems that the only one of the sampling sites having an acceptable level is Lake Claiborne. This lake is also the only sampling site having drinking water as one of its designated uses. BOD is a measure of the quantity of oxygen used by micro organisms in the aerobic oxidation of organic matter. The addition of nutrients to a water source can be a major force in having a high BOD. In waters of high BOD, a low diversity of aquatic organisms will replace the ecologically stable and complex relationships present in waters containing a high diversity of organisms [11].

Turbidity levels for all sampling sites were rated as good except in the case of Bayou Dorcheat. The rating for Bayou Dorcheat in turbidity was fair. It is known that at high levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Water becomes warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall [11].

A comparison of the sampling site sulfate levels showed that none exceeded 15 mg/L [8]. The only sampling site utilized as a source of drinking water, Lake Claiborne, had the lowest sulfate value. The phosphate values showed that Bayou Dorcheat and Lake Claiborne were within the range of excellent. Hill Farm and Ray Pond which are both closely associated with cattle and poultry respectively, were within the range of good.

Lake Claiborne was found to have fewer bacteria colonies than any of the other sampling sites. Over the course of ten months, only two were positive for coliform bacteria. The other samples were negative. The two positive months had colony numbers that were 100 CFUs/100ml and 200 CFUs/100ml of sample water collected. For surface water used as a primary contact recreation, the fecal coliform content shall not exceed a log mean of 200 CFUs/100ml [8]. Lake Claiborne did not exceed the bacteria criteria. Bayou Dorcheat reported a small number of coliform colonies for each of the ten months tested, but all of the positive months were also below the criteria established by DEQ. Hill Farm Research Station stream and Ray Pond both had a mean number of coliform colonies that exceeded the criteria. The mean numbers of coliform colonies were 482CFUs/100 ml and 249 CFUs/100 ml, respectively. The Hill Farm Research Station stream had *E. coli* numbers that exceeded the DEQ criteria during six of the ten months that were analyzed.

Conclusions

It was proven by this experiment that natural water sources in close proximity of cattle and poultry farms will experience some negative effects on water quality over time. Amount of animal waste in regards to the volume of the water source can impact the degree of the negative impact. This was seen in the data collected from Hill Farm Research Station and Ray Pond. This negative effect is only obvious when the comparison was to Lake Claiborne which was the only natural water source analyzed that was used as a source of drinking water. This site served as the control within the experiments.

It can be concluded from the data that some bacterial levels and various nutrient levels can be affected in water resources due to non-point source pollution. Many of these levels will remain unaffected.

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