

Iowa Tribe of Oklahoma

FY2006 305(b) Report

Office of Environmental Services

Dena Hartzell

Executive Summary

The Iowa Tribe of Oklahoma, located in central Oklahoma, has an established water quality monitoring program since 2001. The program concentrates on surface waters; mainly creeks and wetlands. The goals of this program are as follows:

1. To gather baseline data on Tribal water bodies in order to develop Tribal water quality standards,
2. To determine the condition of creeks, wetlands, and ponds on Tribal and adjacent property,
3. To conserve, enhance, and restore the quality and biological diversity of creeks and ponds,
4. To conserve, enhance, and restore the quality, quantity, and biological diversity of wetlands,
5. To expand Tribal capacity and authority to manage and protect water resources on Tribal property.

This 305(b) report has been written to inform the Tribal community about the condition of creeks and wetlands located on Tribal property. The information given here is only from the year 2007.

The Iowa Tribe of Oklahoma's draft water quality standards were used to determine decision criteria required for surface waters to support designated uses. Designated uses evaluated for creeks included aquatic life use and primary body contact recreation. Evaluated wetland designated uses were aquatic life use and agricultural use (livestock and irrigation). To determine if creeks were nutrient threatened or not, Oklahoma's water quality standards were used.

Creeks within the Tribe's jurisdiction were sampled four times throughout the year for *E. coli*, metals, and hardness. Creeks were also sampled for total dissolved solids, alkalinity, chlorides, basic water chemistry, macroinvertebrates and nutrients three times this past year. Wetlands were only sampled in spring for the above mentioned parameters as well as pesticides. Creeks were also sampled for pesticides and toxicology

in the spring. Parameter analysis was completed by Accurate Environmental Labs, OSU Ecotoxicology and Water Quality Research Lab, and the Office of Environmental Science Lab.

For 2007, sampling was difficult because of the amount of precipitation received. Central Oklahoma received approximately 14 inches more rainfall than normal which made 2007 the wettest year on record. This complicated sampling because of the high water flows and danger entering the creeks. Also, access to many of the creek sites was limited because of flooding and impassible roads or fields. Many stream banks collapsed with the amount of water flowing through the stream channels. This caused many of the trees to enter to the stream channels and decreased the amount of canopy cover over the creeks.

Three of the eight creeks sites were found to support aquatic life. The remaining sites had high turbidity levels which places these sites in the threatened category. No creeks supported primary body contact. The *E. coli* levels exceeded the criteria for this use. Dugout Creek (both sites) was determined to be nutrient threatened because of elevated ortho-phosphate levels. All creeks were found to support fish and wildlife propagation because all metals were below the criteria for this use. All creeks were also found to support agricultural uses.

Six of the nine wetlands sampled supported aquatic life. Aquatic life use was threatened in two wetlands because of turbidity and was not supported in one wetland which had very low levels of dissolved oxygen in addition to elevated turbidity levels. All wetlands were found to support agricultural uses. One wetland had high levels of zinc which placed it in the threatened category for fish and wildlife propagation.

The main cause of impairment is agricultural practices. Many cattle are allowed directly in creeks or wetlands which will increase pathogen and nutrient levels because of defecation. Also, cattle remove riparian vegetation which is important in the removal of excess nutrients and sediment as well as decreasing erosion by slowing water flow. Farmers also farm to the edge of wetlands or creeks in order to have as much land under production as possible. Once again this is removing riparian vegetation. Another cause of impairment for 2007 is the amount of precipitation. This amount of precipitation is not normally seen in this area. Most of the precipitation entered the creeks as runoff. For this reason and the fact that most of the stream beds are clay or sand, turbidity levels were higher than normal.

All creeks and wetlands passed the toxicology test with greater than 90% of the *Daphnia pulex* surviving. For creeks and wetlands, pesticides were observed below detectable limits. Macroinvertebrates in creeks were most abundant in Dugout and Headquarters Creeks. There were no trends observed between the seasons or sites. Most creeks had lower macroinvertebrate numbers in June when the water levels and flow were the highest. Chironomids were the most abundant macroinvertebrates and were present in almost every sample. A greater number of Trichopteran genera were observed in September than the other months. This increased the percentage of Ephemeroptera, Plecoptera, and Trichoptera. Site diversity varied between each site and each season.

TABLE OF CONTENTS

Background	1
Surface Water Assessment.....	6
Monitoring Program.....	6
Methods used for 2006.....	11
Quality Assurance Program	13
Data Management	14
Assessment Methodology and Water Quality Standards	14
Water Quality Assessment Summary.....	16
Use Support Determination Summary	24
Cause of Impairment.....	25
Baseline Assessment Information.....	28
Literature Cited	31

LIST OF FIGURES

Figure 1: The location of the Iowa Tribe of Oklahoma’s jurisdictional boundary.	2
Figure 2: The location of Iowa Tribe lands within the jurisdictional boundary.	3
Figure 3: The drainage basin within the Iowa Tribe of Oklahoma’s jurisdictional boundary.....	4
Figure 4: The permanent streams and intermittent streams within the Iowa Tribe of Oklahoma’s jurisdictional boundary.	5
Figure 5: The location of wetland and creek sampling sites for water quality monitoring in 2006.....	10
Figure 6: The 2007 <i>E. coli</i> geometric means for the creeks.....	21
Figure 7: The <i>E. coli</i> levels from June 2006 to August 2007.....	21
Figure 8: A comparison of coliform results from Dugout Creek and precipitation amounts.	22
Figure 9: The change in canopy cover from July 2006 to September 2007.....	22
Figure 10: The total number of macroinvertebrate taxa observed at each of the creek sampling sites.	29
Figure 11: The number of macroinvertebrates observed at each sampling site.....	30
Figure 12 : Macroinvertebrate site diversity for each sampling site for 2007	30

LIST OF TABLES

Table 1: The approximate amount of surface waters located with in the Iowa Tribe of Oklahoma’s jurisdictional boundary and land holdings.....	1
Table 2: The approximate stream miles monitored upstream and downstream of the sampling site.....	8
Table 3: A list of water parameters measured during water assessments and the last time they were sampled.....	10
Table 4: The decision criteria for pH, temperature (Temp), dissolved oxygen (DO) and turbidity (Turb) used to determine aquatic life use support (fish and wildlife propagation).	15
Table 5: The decision criteria for metals used to determine fish and wildlife propagation.....	15
Table 6: The ability of wetlands to support the agricultural use including livestock and irrigation was based on total dissolved solids and was determined using the following criteria	15
Table 7: The ability of creeks to obtain the primary body contact recreation use was determined by the following criteria for fecal coliform and <i>Escherichia coli</i> (<i>E. coli</i>).....	16
Table 8: This table shows the criteria for a creek to be considered nutrient threatened. ..	16
Table 9: The data collected to determine a creeks nutrient threatened status.....	23
Table 10: The miles of creeks that either fully supports the designated use, the data indicates support of the use but the use is threatened, or the designated use is not supported.	26
Table 11: The wetland acres that either fully supports the specific use, the data indicates support of the use but the use is threatened, or the designated use is not supported.	26
Table 12: A summary of each site’s support of a particular designated use and which pollutants caused the impairment.....	27

Background

The Iowa Tribe of Oklahoma is located in central Oklahoma within Lincoln, Logan, Payne, and Oklahoma counties (Figure 1). Most of the Tribally owned property and allotment lands are located in Lincoln and Payne counties with a few properties in Logan County (Figure 2).

Table 1 indicates the amount of surface waters located within the Iowa Tribe of Oklahoma’s jurisdictional boundary and on Tribally owned or allotment lands. There are six 12-digit hydrologic unit code (HUC) watersheds that flow into the Cimarron River and eight 12-digit HUC watersheds that flow into the Deep Fork River (Figure 3). Ten streams have segments with permanent water (Figure 4).

Table 1: The approximate amount of surface waters located with in the Iowa Tribe of Oklahoma’s jurisdictional boundary and land holdings. Land holdings include Tribally owned lands, trust lands, and allotment lands. The numbers in the table are based on the data available at the time of the report and are not exact. (ND = not determined)		
Topic	Jurisdictional Boundary	Land Holdings
Surface area (acres)	231,454	2,049
Tribal population residing on these lands	ND	ND
Total miles of rivers and streams	847.1	7.9
Miles of perennial rivers/streams	65.9	3.0
Miles of intermittent rivers/streams	732.9	4.6
Border miles of shared rivers/streams	48.3	0.3
Number of lakes/reservoirs/ponds	ND	14
Acres of lakes/reservoirs/ponds	ND	15
Acres of freshwater wetlands	ND	22

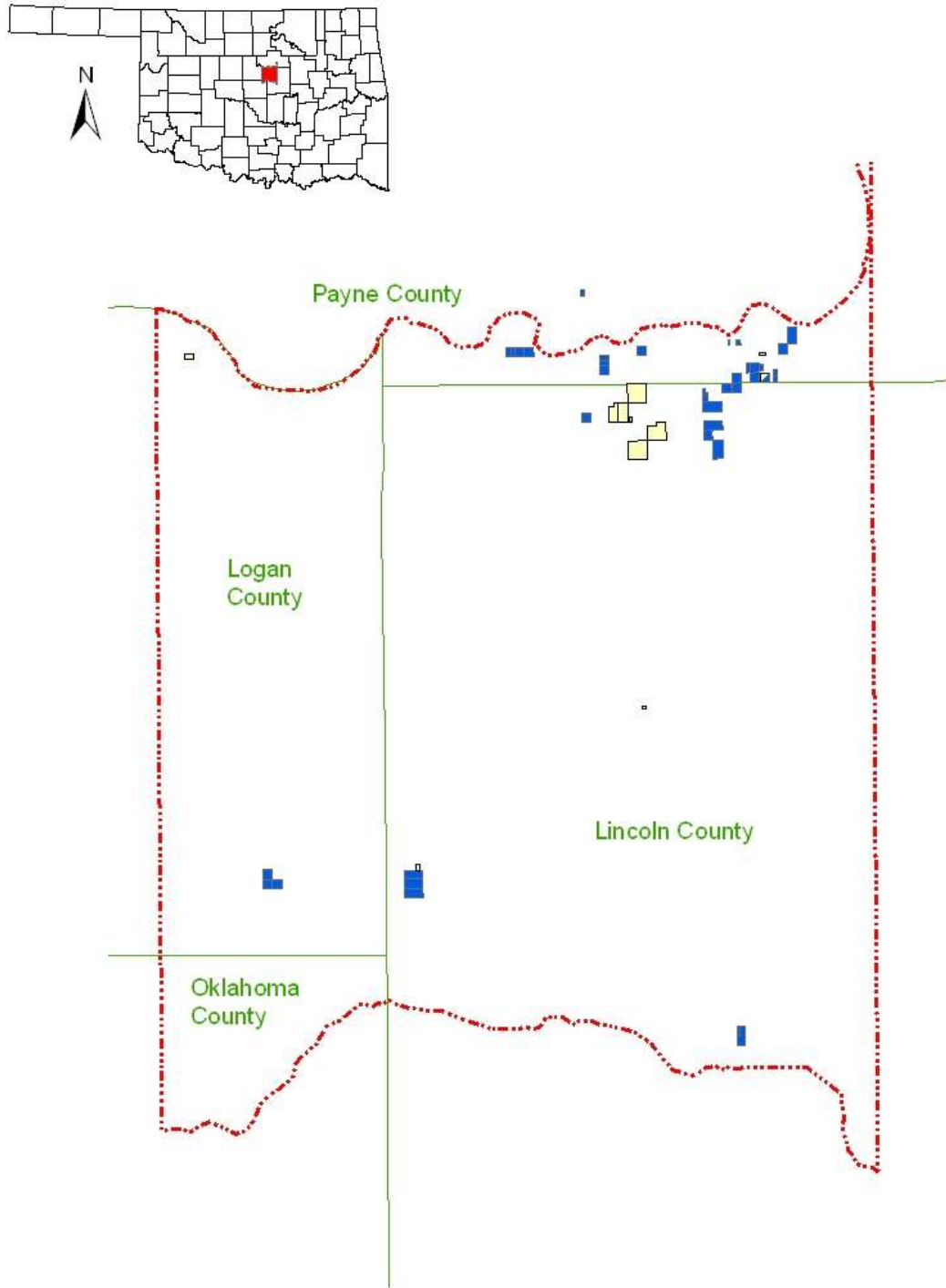


Figure 2: The location of Iowa Tribe lands within the jurisdictional boundary. Blue properties are trust or allotment properties and yellow properties are fee lands.

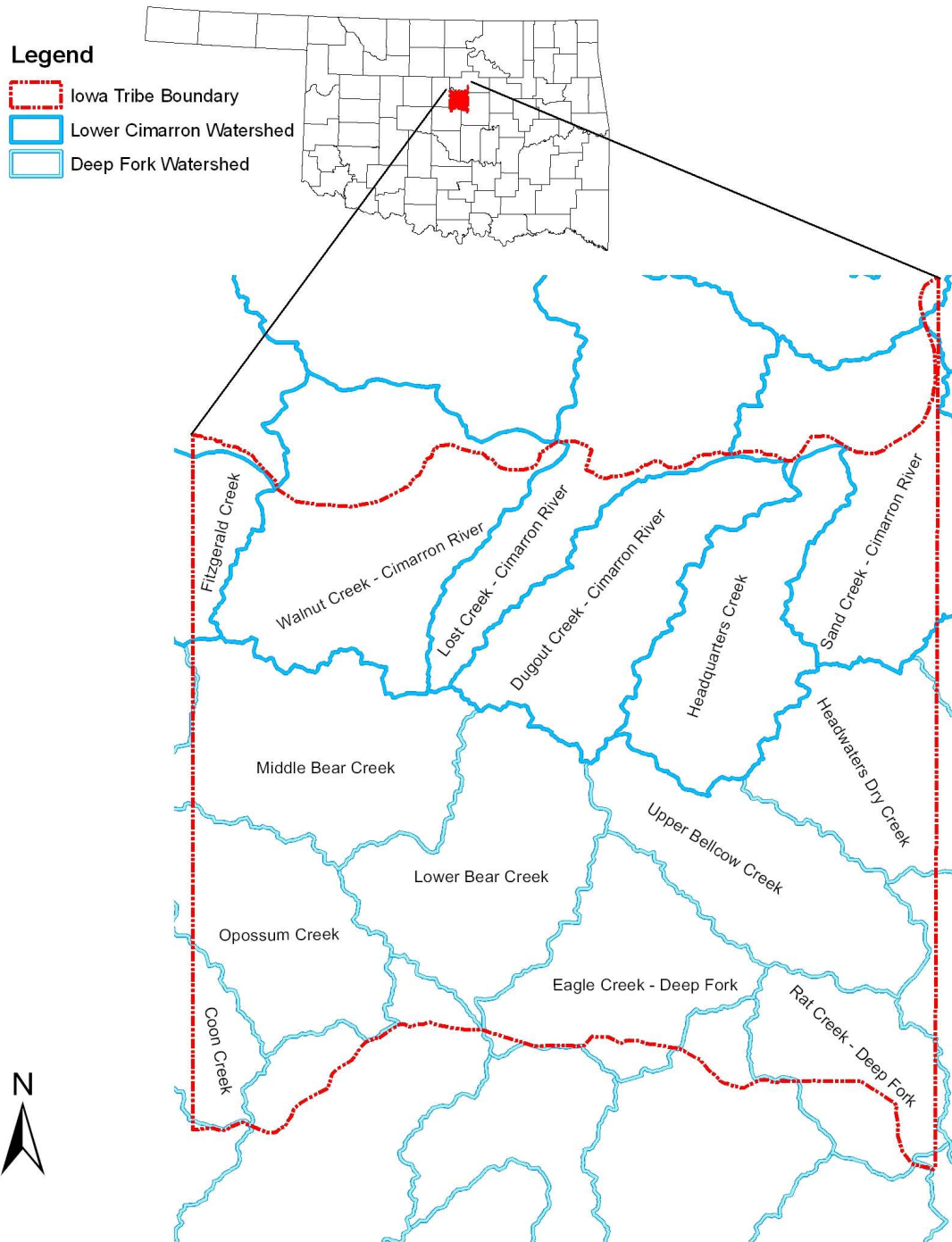


Figure 3: The 12-digit HUC watersheds within the Iowa Tribe of Oklahoma’s jurisdictional boundary. The northern boundary is the Cimarron River and the Deep Fork River is the southern boundary.

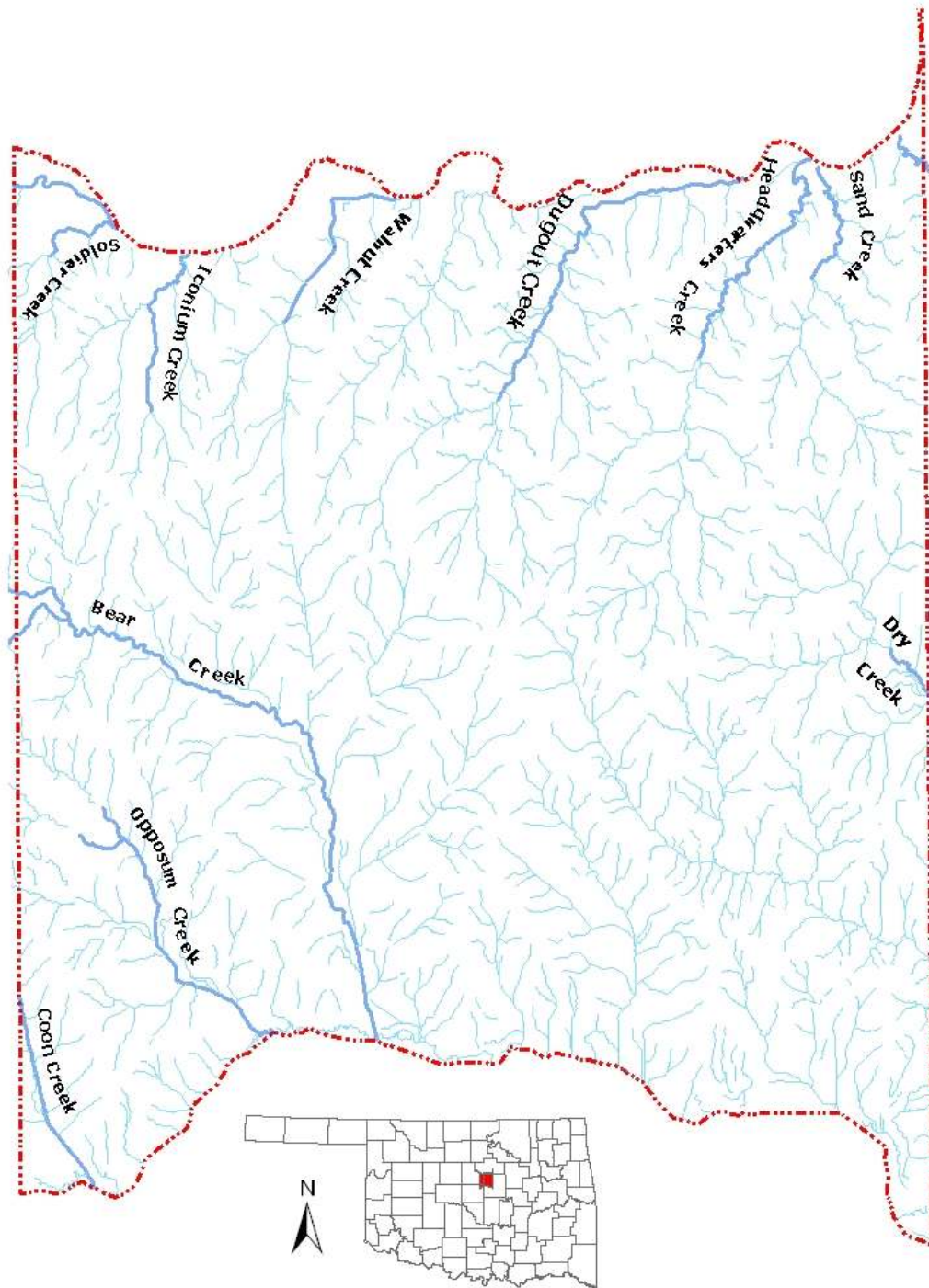


Figure 4: The permanent streams (dark blue) and intermittent streams (light blue) within the Iowa Tribe of Oklahoma's jurisdictional boundary.

Surface Water Assessment

Monitoring Program

The Iowa Tribe of Oklahoma has had a water quality assessment program supported by Clean Water Act Section 106 grants since 2001. This program is managed by the Office of Environmental Services (OES). The goals of this program are as follows:

1. To gather baseline data on Tribal water bodies in order to develop Tribal water quality standards,
2. To determine the condition of creeks, wetlands, and ponds on Tribal and adjacent property,
3. To conserve, enhance, and restore the quality and biological diversity of creeks and ponds,
4. To conserve, enhance, and restore the quality, quantity, and biological diversity of wetlands,
5. To expand Tribal capacity and authority to manage and protect water resources on Tribal property.

To meet these goals, the Tribe has been collecting baseline water chemistry and physical data on wetlands and ponds. Currently, the Tribe is concentrating on collecting baseline data from the creeks that flow through Tribal lands. A target designed sampling method is used at fixed locations on Tribally owned property and allotment lands (Figure 5). Because the Tribally owned property and allotment lands are not adjacent to each other, this sampling method allows the Tribe to monitor all creeks that flow through Tribal land. Table 2 shows the amount of stream miles monitored upstream and downstream of the creek sampling sites as well as acres of wetlands monitored. The number of miles upstream or downstream of the creek sampling sites was determined by evaluating the surrounding land use and vegetation. The number of miles upstream or downstream was terminated where the land use or vegetation changed.

Water assessments include chemical, physical, toxics, and biological monitoring. Table 3 shows the parameters measured and the analytical laboratory for water

assessments. The column for sampling frequency is the ideal sampling frequency for the water parameters in creeks once enough baseline data has been collected. Ideally, wetlands and ponds would be sampled bi-annually. Wetland and pond assessments should at least include basic water chemistry parameters, macroinvertebrates, and nutrients. Also, the Tribe should work towards completing hydrogeomorphic assessments on the known wetlands.

The Iowa Tribe of Oklahoma's OES owns a 6820 YSI multi-parameter probe and the IDEXX quantity tray system. The YSI probe is used to determine basic water chemistry parameters. Total coliforms, *E. coli*, and *Enterococcus* can be determined by the IDEXX system. Accurate Environmental Laboratory and Oklahoma State University Ecotoxicology and Water Quality Laboratory (OSU- EWQL) analyze the water samples for parameters the OES laboratory does not have the capability to analyze. Both laboratories are located in Stillwater, OK.

Table 2: The approximate stream miles monitored upstream and downstream of the sampling site. Also listed is the number of wetland acres monitored.			
Site Name	Miles Monitored		Acres Monitored
	Upstream	Downstream	
Bear1	2.44	0	
Bear2	0.19	1.46	
Dugout1	1.57	1.57	
Dugout2	0.90	1.26	
Headquarters1	0.75	0.46	
Headquarters2	1.16	1.23	
Sand1	0	2.05	
Sand2	0.53	0.20	
Wetland1			0.5
Wetland2			0.5
Wetland3			1.5
Wetland6			0.25
Wetland7			0.25
Wetland10			0.25
Wetland11			0.25
Wetland101			1.5
Wetland102			1.0

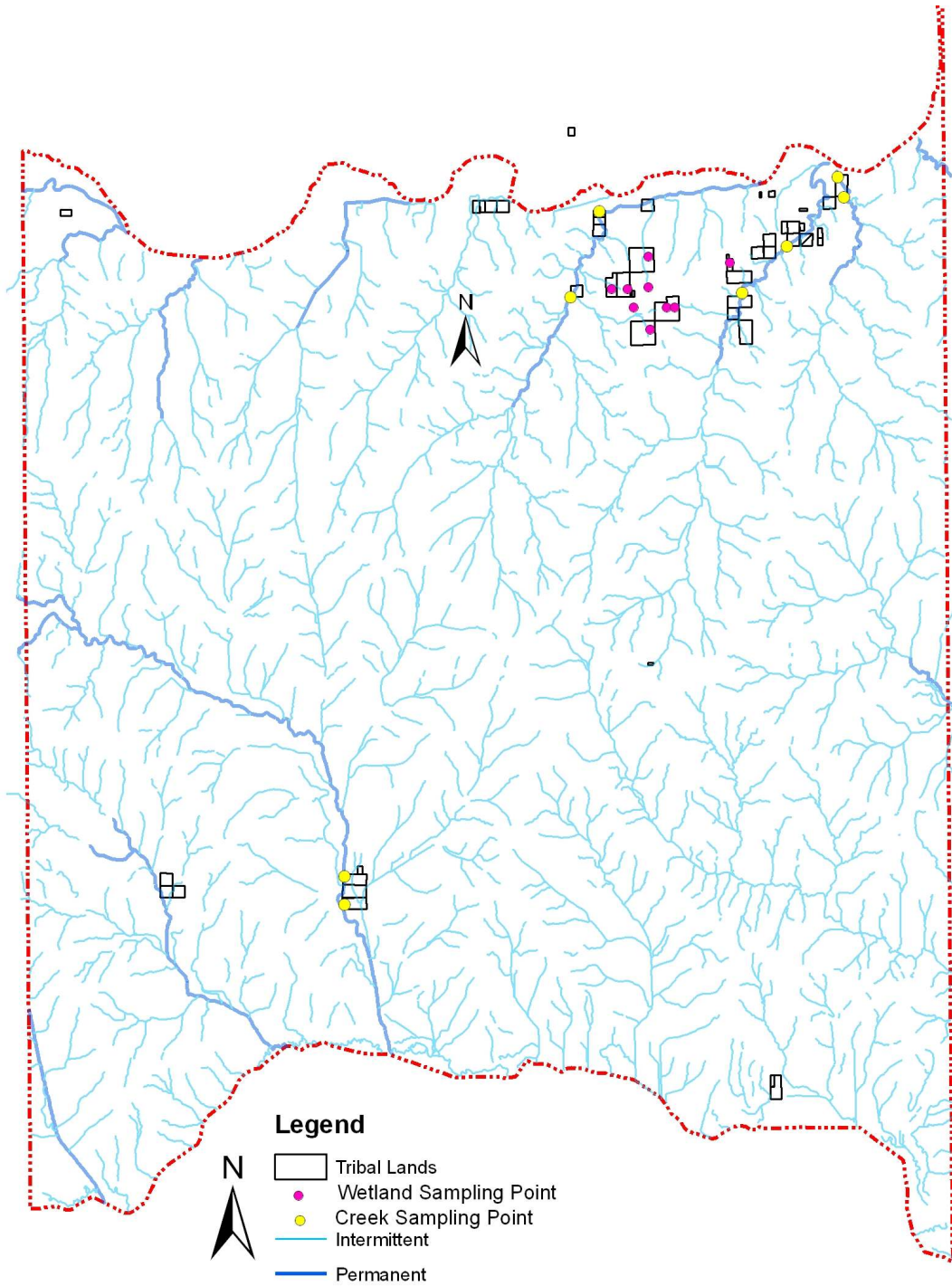


Figure 5: The location of wetland (pink dots) and creek (yellow dots) sampling sites for water quality monitoring in 2006. Two wetland sites are located on adjacent property to Tribal property.

Table 3: A list of water parameters measured during water assessments and the last time they were sampled in creeks. The sampling frequency is the ideal sampling frequency in creeks after enough baseline data has been collected. The laboratory that analyzes the parameters is also listed.

Water Parameter	Sampling Frequency	Last Time Sampled	Analytical Lab
Alkalinity	Annually	2007	Accurate Environmental
Arsenic	Bi-annually	2007	Accurate Environmental
Cadmium	Bi-annually	2007	Accurate Environmental
Canopy Cover – creeks	Bi-annually with other nutrient parameters	2007	OES personnel
Chloride	Annually	2007	YSI probe
Chlorophyll a	Tri-annually	2005	Accurate Environmental
Chromium	Bi-annually	2007	Accurate Environmental
Copper	Bi-annually	2007	Accurate Environmental
Dissolved Oxygen	Annually	2007	YSI probe
<i>Enterococcus</i>	Annually	N/A	OES lab – IDEXX
<i>E. coli</i>	Annually	2007	OES lab – IDEXX
Fecal Coliform	Bi-annually	2006	Accurate Environmental
Habitat Assessment	Annually	2007	OES personnel
Hardness	Annually	2007	Accurate Environmental
Lead	Bi-annually	2007	Accurate Environmental
Macroinvertebrates survey	Bi-annually	2006 (wetlands) 2007 (creeks)	OSU – EWQL or OES lab
Mercury	Bi-annually	2005	Accurate Environmental
Nitrate	Annually	2007	YSI probe
Nitrate-Nitrite	Bi-annually	2007	Accurate Environmental
N&P Pesticides	Tri-annually	2007	Accurate Environmental
Organochlorines	Tri-annually	2007	Accurate Environmental
Ortho-Phosphate	Bi-annually	2007	Accurate Environmental
pH	Annually	2007	YSI probe
Specific Conductivity	Annually	2007	YSI probe
Sulfates	Bi-annually	2005	Accurate Environmental
Temperature	Annually	2007	YSI probe
Total Chlorophyll	Tri-annually	2005	YSI probe
Total Dissolved Solids	Bi-annually	2007	Accurate Environmental
Toxicity tests	Tri-annually	2007	OSU- EWQL
Turbidity	Annually	2007	YSI probe
Vegetation Survey – wetlands/ponds	Bi-annually	2007	OES personnel
Zinc	Bi-annually	2007	Accurate Environmental

Methods used for 2007

Stream order and stream slope were determined in 2006 and the same data was used in 2007. Stream order for each creek was determined using topographic maps in ArcGIS. Stream slope was determined using the National Elevation Dataset (<http://ned.usgs.gov>). First, the elevation 0.5mi upstream and downstream of the sampling site was determined. Then, these values were entered into Microsoft Excel to calculate slope (ft/mi). In April and September, canopy cover surveys were determined using a densiometer model A. Because of high water flows in April and June 2007, canopy cover surveys could not be completed at both sites on Bear Creek. The results from July 2006 were used for Bear Creek to determine nutrient threatened levels for April and June 2007. Results from the April 2007 canopy surveys were used on the remaining streams to determine July nutrient threatened levels because canopy surveys could not be completed on any of the streams in June 2007 because of high water levels.

Creeks were sampled in April, May, June, and September for *E. coli*, metals, and hardness. Additionally, total dissolved solids, alkalinity, chlorides, and nutrients were determined for creeks in April, June, and September. During the month of April, both creeks and wetlands were sampled for toxicology testing and pesticides. Additionally, creeks were sampled for toxicology testing in June. Wetlands were only sampled in April to obtain spring baseline data for total dissolved solids, alkalinity, hardness, chlorides, nutrients, and metals. The YSI probe was used to determine pH, temperature, specific conductivity, turbidity, and dissolved oxygen of both wetlands and creeks during every sampling event. The YSI was also used to determine nitrates and chlorides for creeks and wetlands during specific sampling periods.

Water was collected from the middle of the water column in the center of the creek or wetland (Oklahoma Water Resources Board, 1999) in bottles provided by Accurate Environmental or that were purchased. Measurements with the calibrated YSI probe were also taken at this point. All samples were stored on ice until they were delivered to the proper lab. A quality control water sample was collected once a sampling period by collecting a composite sample which was split into a quality control sample and an original sample. The quality control water samples were collected to check laboratory analyses. Water samples were analyzed by Accurate Environmental Labs for alkalinity, hardness, metals, pesticides, total dissolved solids (TDS), nitrite-nitrate, and ortho-phosphate (ortho-P). Coliform samples were analyzed by the OES lab. Oklahoma State University Environmental Water Quality and Toxicology Lab analyzed water samples for toxicity.

During sampling days when the water flow was extremely high, a different method was used to collect samples. This method consisted of using a plastic jug weighted by a rock and tied to a rope. The plastic jug and rock were washed three times with laboratory soap and rinsed with nitric acid and deionized water. These items air dried before used for sampling. The jug was lowered down into the water and lifted to the bank when full. The YSI was placed in the jug to obtain measurements. This method was only used when *E. coli* samples were taken. The jug was rinsed with deionized water after each creek and before placement into a new site.

Three macroinvertebrate samples were collected from each creek sampling site using a Surber sampler during the months of April, June, and September 2007. Both sites in Bear Creek were not sampled in June for macroinvertebrates because of the

excessively high water flow. Sand 2 was not sampled for macroinvertebrates in September because the water level was higher than normal and stagnant. All samples were taken within a riffle when possible (Barbour et al., 1990). All rocks were scrubbed with a wire brush and the substrate was disturbed to dislodge benthic macroinvertebrates (BLM Training Center, 2005). Samples were preserved in 70% ethanol and were transported to OES where they were analyzed.

Quality Assurance Program

A Quality Assurance Project Plan (QAPP) is written and submitted to EPA Region 6 at the beginning of the project. This document details the sampling design used, all sampling methods and sample handling, quality control measures, data management, decision criteria, and record management required for this project. The QAPP has to be approved by EPA Region 6 before any sampling is conducted. This document ensures that the project will meet the designated goals as well as collect scientifically sound data.

A Quality Management Plan (QMP) for the entire OES was written and approved by EPA Region 6. This document describes the quality policies and procedures used by OES as well as the roles and responsibilities of each individual to ensure quality data is gathered. Reviews of the quality system and the QMP are completed annually.

Both the QAPP for this project and QMP are located in the OES building. Please contact the office if further information about these documents is needed.

Data Management

All data collected in the field is recorded in a field notebook which is kept by the project coordinator at the OES. All data is then entered into a Microsoft Access database. This database includes the location of each sampling site including longitude/latitude and legal description and sampling site information including slope, stream order, vegetation surveys, canopy cover, and surrounding land use. Any calculations that are completed are done in Microsoft Excel. Ten percent of these calculations are completed by hand to double check the equations.

Assessment Methodology and Water Quality Standards

According to the Iowa Tribe of Oklahoma's draft water quality standards (WQS), the four creeks monitored have designated uses of fish and wildlife propagation, agricultural (livestock and irrigation), primary body contact recreation, and aesthetics. The monitored wetlands were determined to have designated uses of fish and wildlife propagation and agricultural (livestock and irrigation). The Tribe's draft WQS were used to determine the parameters critical values in order to support late warm water aquatic communities, primary body contact recreation, and agricultural uses (livestock and irrigation). To determine if the creeks were nutrient threatened, Oklahoma's water quality standards were used (Sec. 785:46-15-10). The following tables indicate how use support was determined.

Table 4: The decision criteria for pH, temperature (Temp), dissolved oxygen (DO) and turbidity (Turb) used to determine aquatic life use support (fish and wildlife propagation). The degree of support was based on the percentage of samples not meeting the decision criteria.

	Decision Criteria	Supporting	Not Supporting
All Life Stages	pH = 6.5 – 9.0	≤25% samples without 6.5 – 9.0 pH and >50 NTU	>25% samples without 6.5 – 9.0 pH or >50 NTU
	Turb = 50 NTU		
Early Life Stages (4/1 to 6/15)	DO = 5.0 mg/L	≤25% samples with <5.0 mg/L DO and >25°C	>25% samples with <5.0mg/L DO and >25°C
	Temp = 25°C		
Late Life Stages (6/16 to 10/15)	DO = 4.0 mg/L	≤25% samples with <4.0 mg/L DO and >32°C	>25% samples with <4.0mg/L DO and >32°C
	Temp = 32°C		

Table 5: The decision criteria for metals used to determine fish and wildlife propagation.

	Decision Criteria	Supporting	Not Supporting
Arsenic	360.0 µg/L	≤25% samples with > 360.0 µg/L	>25% samples with > 360.0 µg/L
Cadmium	$e(1.128 [\ln(\text{hardness})]-1.6774)$	≤25% samples with values greater than the decision criteria	>25% samples with values greater than the decision criteria
Copper	$e(0.9442 [\ln(\text{hardness})]-1.3844)$		
Lead	$e(1.273 [\ln(\text{hardness})]-1.460)$		
Zinc	$e(0.8473 [\ln(\text{hardness})]+0.8604)$		

Table 6: The ability of creeks and wetlands to support the agricultural use including livestock and irrigation was based on total dissolved solids and chlorides. The following criteria were used to determine if the use was supported.

	Decision Criteria	Supporting	Not Supporting
TDS Yearly Standard Mean	7941 mg/L	≤7941 mg/L	>7941 mg/L
Chloride Yearly Standard Mean	4084 mg/L	≤4084 mg/L	>4084 mg/L

Table 7: The ability of creeks to obtain the primary body contact recreation use was determined by the following criteria for *Escherichia coli* (*E. coli*). The values are based on the collection of 5 samples within a 30 day period.

	Decision Criteria	Supporting	Not Supporting
<i>E. coli</i>	126	Geometric Mean ≤ 126	Geometric Mean > 126
	406	$\leq 10\%$ of site samples > 406	$> 10\%$ of site samples > 406

Table 8: This table shows the criteria for a creek to be considered nutrient threatened. The table is a dichotomous key where you need to determine stream order before advancing to stream slope and so on. If any measurements for ortho-P or nitrite-nitrate do not meet the criteria, proceed to canopy cover. If canopy cover does not meet the criteria, proceed to turbidity. If the turbidity levels do not meet the criteria, the creek is determined to be nutrient threatened. If any of the water parameters and canopy cover criteria are met, the creek is determined to be not nutrient threatened.

Constituent	Decision Criteria				
Stream Order	↓	≤ 3		> 3	
Stream Slope (ft/mi)		≥ 17	< 17	≥ 17	< 17
Ortho-P (mg/L)		< 0.24	< 0.15	< 1.0	< 0.36
Nitrite-Nitrate (mg/L)		< 4.95	< 2.4	< 4.65	< 5.0
Canopy Cover (%)		> 80	-	< 80	-
Turbidity (NTU)		< 20	≥ 20	≥ 20	< 20

Water Quality Assessment Summary

During 2007, Central Oklahoma experienced the most precipitation on record with approximately 52 inches of precipitation (Oklahoma Climatological Survey, 2008). This is approximately 14 inches more precipitation than normal and is contradictory to the amount of precipitation experienced in 2006 (a total of approximately 9 inches). Most of the precipitation came in the months of May and June when over 10 inches of rain fell in Perkins, OK in both months. This amount of precipitation made the sampling season a challenge by having extremely high creek flows and saturated pastures which made it difficult to drive to sampling sites. To ensure all sampling was conducted, the bucket sampling method described in the Methods Section was used. On July 2, 2007 three sites

could not be sampled because of the amount of flooding that occurred en-route to the sampling site.

Only Headquarters Creek (sites 1 and 2) and Sand Creek site 1 met all criteria for aquatic life at all stages as well as warm water community at the early and late life stages throughout the sampling period. Bear (sites 1 and 2), Dugout (sites 1 and 2), and Sand (site 2) Creeks did not meet criteria for aquatic life at all stages but did meet criteria for the warm water community at the early and late life stages. These sites did not meet the criteria for aquatic life at all stages because of high turbidity levels. Out of the 22 or 21 samples taken at a site throughout the year, Bear1, Bear2 and Dugout1 had greater than 40% of the samples with turbidity levels greater than 50 NTU. Dugout2 had 38% of the samples exceed the turbidity criteria and Sand 2 had greater than 52% of the samples exceed the turbidity criteria.

The average pH level in creeks was 7.60 with a range from 6.63 to 8.81. Turbidity ranged from 4 NTU in Sand 1 on 9/17/2007 to 1685.4 NTU in Sand 2 on 9/11/2007. During the flooding, the water was allowed to collect and become stagnant at Sand 2. This allowed algae to grow at the site which seemed to increase as the water level decreased. This made the water extremely cloudy and to some extent thick. The average turbidity value for all creeks was 81.5 NTU. The average dissolved oxygen level was 10.11 mg/L and ranged from 5.06 mg/L to 23.72 mg/L. Temperature ranged from 7.96 °C to 28.81°C with an average of 21.00°C. The water depth of the creeks decreased throughout the year because the amount of precipitation decreased.

Wetlands 2, 10, and 11 also had turbidity levels greater than 50 NTU and therefore, did not meet the criteria for aquatic life at all stages. All wetlands met the

criteria for aquatic life warm water community at early life stages expect for Wetland2. Wetland2 had a dissolved oxygen level of only 4.85 mg/L. Dissolved oxygen in wetlands ranged from 4.85 mg/L to 15.54 mg/L and temperature ranged from 10.65°C to 18.94°C. In wetlands, pH ranged from 6.5 to 8.92 and turbidity ranged from 9.5 NTU to 392.6 NTU (Wetland 11 on 4/17/2007). The average turbidity in wetlands was 97.9 NTU.

All creeks had metal levels below the criteria for fish and wildlife propagation for arsenic, chromium, copper, lead, and zinc. The highest levels of metals observed were as follows: 3.1µg/L of arsenic, 6.7µg/L of chromium, 11µg/L of copper, 2.1µg/L of lead, and 34µg/L of zinc. Cadmium was never observed in creeks throughout the sampling period.

All wetlands had metal levels below the criteria for fish and wildlife propagation for arsenic, chromium, and copper. Wetland1 had elevated levels of zinc (303.2µg/L) but all other wetlands had zinc levels below the criteria. Cadmium and lead were never observed in wetlands. The highest levels of metals observed were as follows: 4.7µg/L of arsenic, 8.5µg/L of chromium, and 8.4µg/L of copper.

All creeks and wetlands met the criteria for total dissolved solids (TDS) and chlorides. The range for TDS was 293mg/L to 1290mg/L for creeks and 84mg/L and 320mg/L for wetlands. The highest values for chlorides were 882.3 mg/L for creeks and 374.7 mg/L for wetlands.

Each creek did not meet the *E. coli* geometric mean criteria for the primary body contact beneficial use at least two out of the four months sampled (Figure 6). Headquarters1 was the only site to meet the geometric mean criteria for the month of April. All creeks did not meet the geometric mean criteria during the months of May and

June. Sand Creek (sites 1 and 2) did not meet the geometric mean criteria in the month of September but all the remaining creeks did.

All sites had greater than 10% of their samples exceed 406 MPN. Bear1 had 10.5% of the samples exceed the sample criteria and Bear2 had a percentage of 16.67%. Sand Creek had the highest percentage of samples exceed the criteria (site 1 – 78.95%, site 2 – 77.78%).

When comparing 2006 *E. coli* results with 2007 *E. coli* results, there is an obvious trend with precipitation. Figure 7 shows the *E. coli* levels for July 2006, June 2007, and August 2007 for Bear, Dugout, and Headquarters Creeks. The *E. coli* levels were greater in June 2007 when the precipitation amounts were higher than the other two months. There was a severe drought in this area in 2006 which would explain why the *E. coli* levels are lower than June 2007. There was a decrease in *E. coli* levels when the precipitation levels decreased in 2007. This can be seen in Figure 8 where coliform results for Dugout Creek are plotted against precipitation data between June 2007 and September 2007. The September coliform results are on average lower than the June/July results.

Table 9 shows the values for all parameters necessary to determine nutrient threatened status. All water samples had nitrate-nitrite levels below detectable limits for the nitrate-nitrite test. The detectable limit is 0.500 mg/L and therefore, all creeks had nitrate-nitrite limits below the criteria. Also, the detectable limit for ortho-phosphate is 0.050 mg/L. Most of the samples analyzed were determined to be below the detectable limit for ortho-phosphate. The highest ortho-phosphate level was 0.114 mg/L in Dugout2 on June 11, 2007. This level is lower than the average (0.330 mg/L) seen at Dugout2 in

2006. Overall, the ortho-phosphate levels decreased from 2006 to 2007. The average ortho-phosphate level in 2006 for all creeks was 0.120 mg/L and in 2007 the average was 0.020 mg/L. For the past two years, both sites at Dugout Creek have shown higher levels of ortho-phosphate than any of the other streams. Dugout Creek should be monitored to ensure the stream does not become nutrient threatened the future.

Another interesting observation made during this project is the decrease in canopy cover after the flooding in spring 2007. This can be seen in Figure 9 which shows that there was a decrease in canopy cover between April 2007 and September 2007.

Headquarters2 actually showed an increase in canopy cover. There were no trees or vegetation down at this site in September 2007. The largest decreases in canopy cover were seen at Headquarters1, Sand1, Bear1, and Bear2 where many of the trees fell into the creek beds. The graph also shows that there was an increase in the amount of canopy cover from July 2006 to April 2007. There are two explanations for this: 1) there was a difference in the vegetation between a dry summer and a wet spring or 2) the difference in personnel conducting the canopy surveys caused the difference.

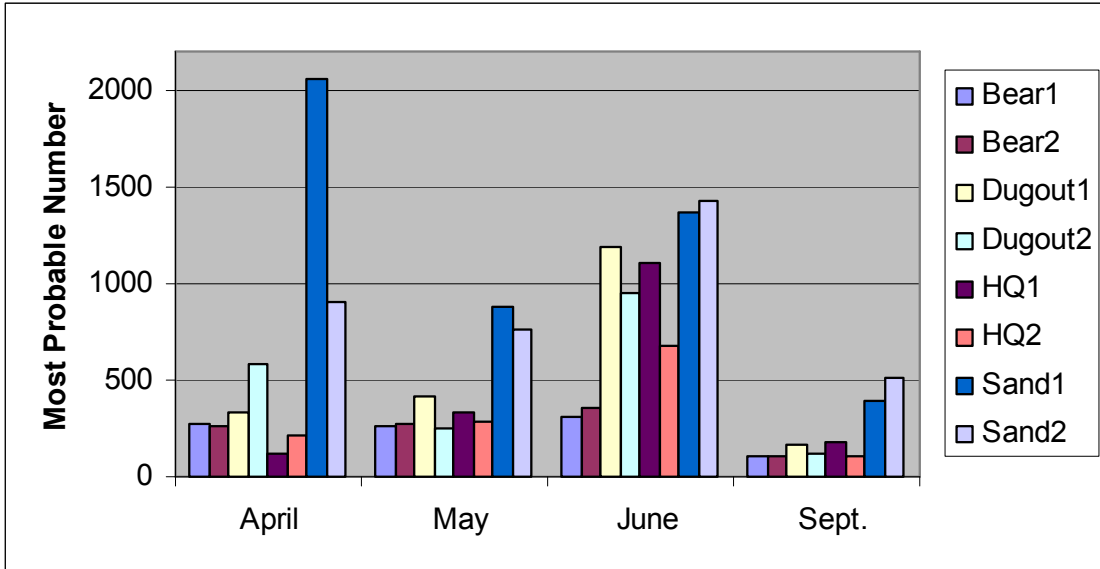


Figure 6: The 2007 *E. coli* geometric means for the creeks. The red dotted line indicated the geometric mean criteria of 126 MPN. HQ = Headquarters

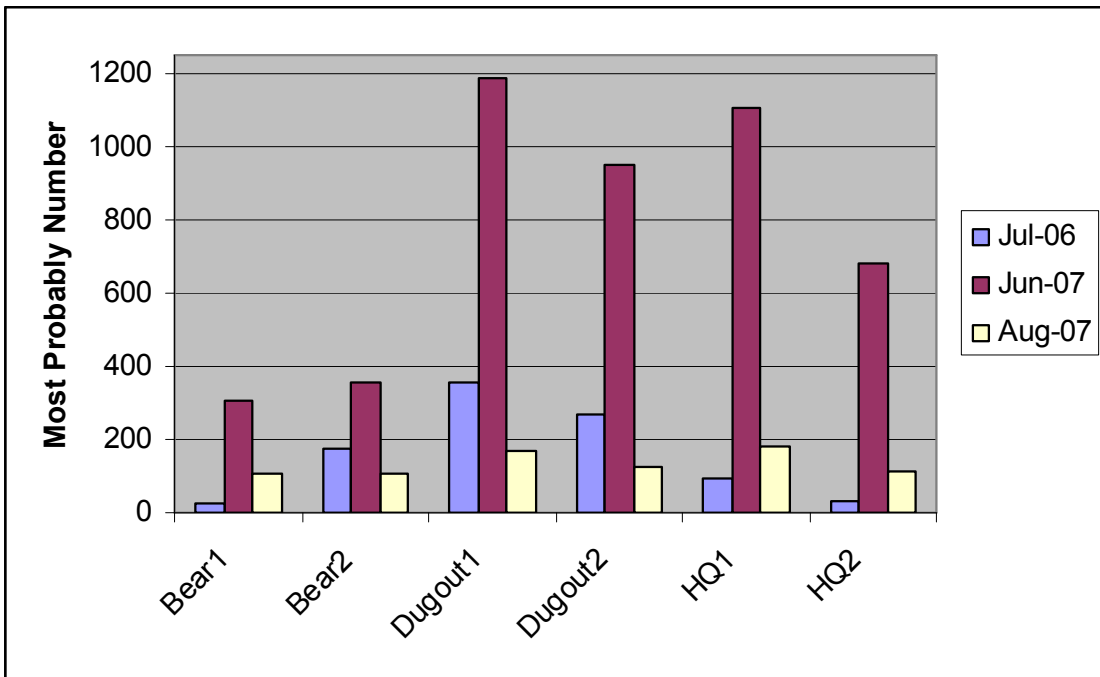


Figure 7: The *E. coli* levels from June 2006 to August 2007.

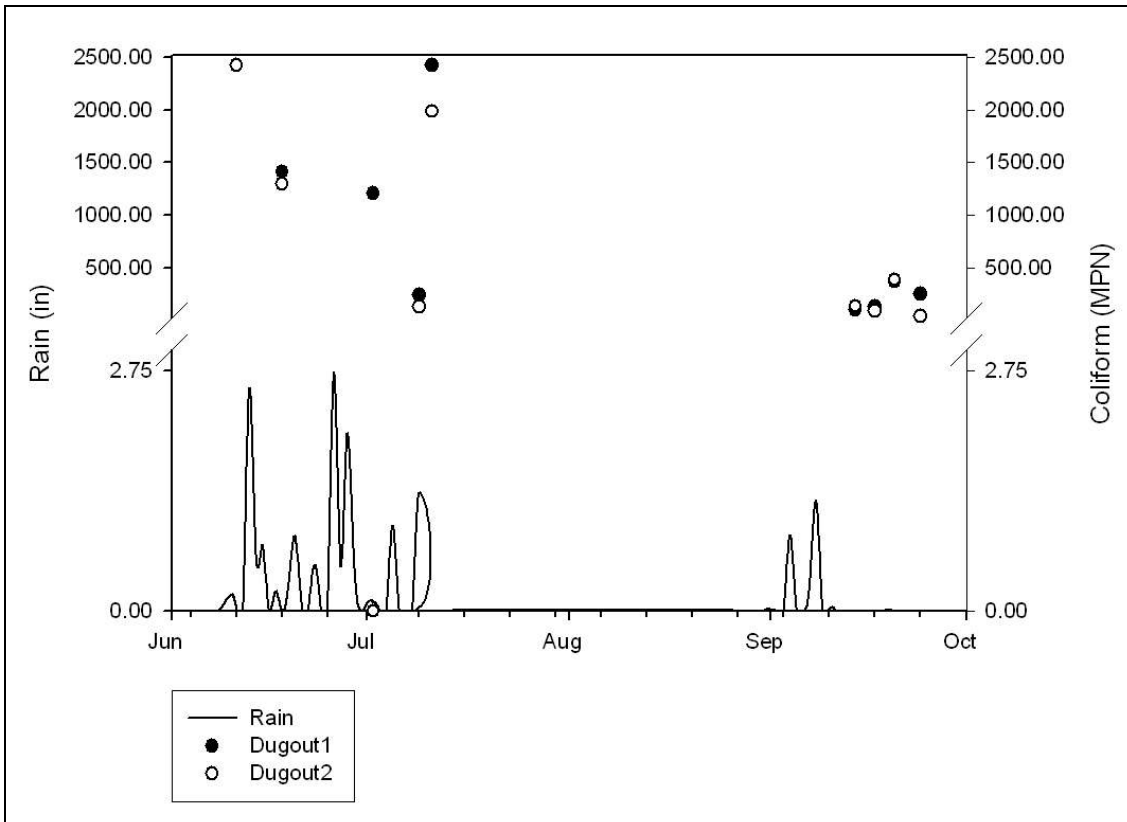


Figure 8: A comparison of coliform results from Dugout Creek and precipitation amounts.

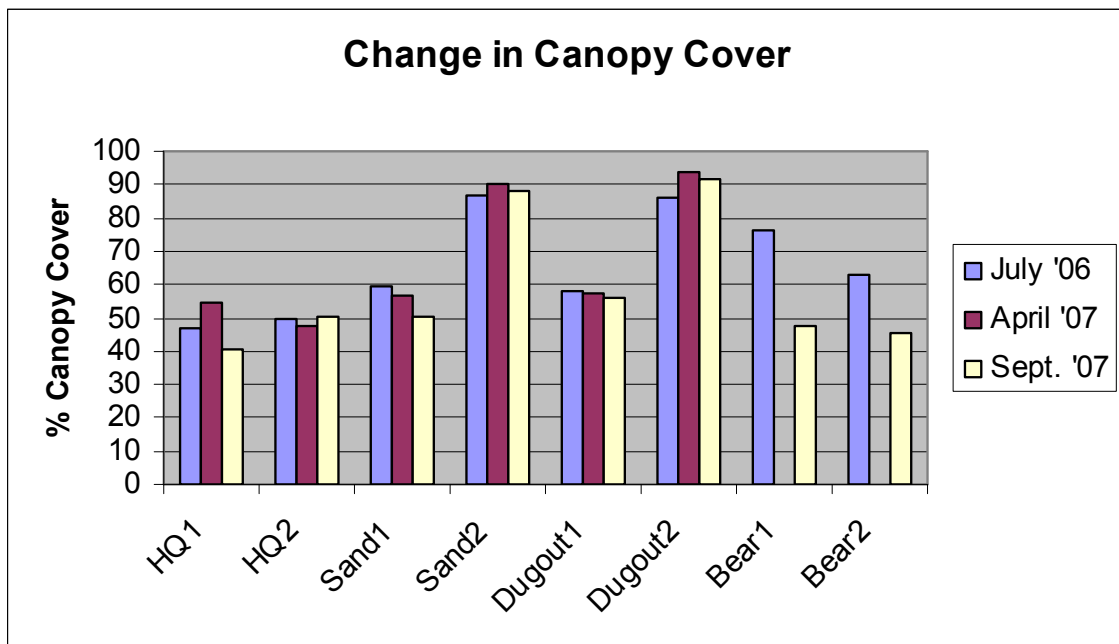


Figure 9: The change in canopy cover from July 2006 to September 2007.

Table 9: The data collected to determine a creeks nutrient threatened status.

Site	Date	Stream Order at Site	Slope (ft/mi)	Ortho-Phosphorus	Nitrate-Nitrite	Canopy Cover (%)	Turbidity (NTU)
Bear1	4/19/07	4	19.52	0	0	76.55	110
	6/11/07			0.094	0	76.55	600.1
	9/17/07			0	0	47.69	13.3
Bear2	4/19/07	4	14.56	0	0	62.78	116
	6/11/07			0.085	0	62.78	569.7
	9/17/07			0	0	45.14	13.3
Dugout1	4/19/07	4	2.26	0	0	57.38	110.4
	6/11/07			0.111	0	57.38	147.9
	9/17/07			0	0	56.18	7.0
Dugout2	4/19/07	4	5.71	0	0	34.27	178
	6/11/07			0.114	0	34.27	331.5
	9/17/07			0	0	91.73	5.4
Headquarters1	4/19/07	4	5.83	0	0	54.26	62.2
	6/11/07			0	0	54.26	23.8
	9/17/07			0	0	40.60	6.7
Headquarters2	4/19/07	4	8.96	0	0	47.74	76
	6/11/07			0	0	47.74	18.2
	9/17/07			0	0	50.20	4.0
Sand1	4/19/07	3	7.19	0	0	56.39	13.9
	6/11/07			0.064	0	56.39	46.4
	9/17/07			0	0	50.69	4.0
Sand2	4/19/07	3	8.00	0	0	89.95	40
	6/11/07			0.064	0	89.95	31
	9/17/07			0	0	88.44	11.4

Use Support Determination Summary

Based on the above data, the creeks and wetlands were placed in three use support categories (Tables 10, 11 and 12). The ‘support’ category is for the sites that fully supported that specific use based on the decision criteria. The ‘support but threatened’ category is for sites that have data that meet the decision criteria but have elevated levels of certain parameters or did not meet the decision criteria during certain sampling periods. For example, Bear1 did not meet the second criterion for fecal coliform and *E. coli* but did meet the first criterion. Therefore, it was determined that this site is threatened and may eventually not support primary body contact. The ‘not supporting’ category is for sites that do not meet the decision criteria.

The only creek sites to meet all aquatic life use criteria were Headquarters1, Headquarters2, and Sand 1 (Table 12). The remaining creek sites had elevated turbidity levels which placed them in the support but threatened category. All creek sites fully supported the fish and wildlife propagation use and agricultural use. All creek sites did not support the primary body contact recreation use because of elevated *E. coli* levels. Dugout Creek was the only creek that may be threatened by nutrients in the future based on elevated levels of ortho-phosphates.

Wetlands 10 and 11 were found to support aquatic life but were threatened because of elevated turbidity levels (Table 12). Wetland 2 did not support aquatic life because of elevated turbidity levels and low dissolved oxygen levels. All wetlands supported fish and wildlife propagation except Wetland1 which had elevated levels of zinc. All wetlands supported agricultural uses.

Cause of Impairment

From the data, the main cause of most of the creeks and wetlands not meeting the decision criteria is the surrounding agricultural land use. There is evidence of cattle in creeks and that farmers use the creeks as a source of water for their cattle. Pathogen levels will increase because cattle with direct access to water will also defecate in the water bodies. Cattle also greatly disturb the buffer zone surrounding water bodies because they consume the vegetation. Riparian vegetation is important because it filters runoff before entering water bodies, it impedes runoff, and it consumes some of the water and nutrients from the runoff. In addition to cattle removing riparian vegetation, the flooding in 2007 removed some of the riparian vegetation from the creeks systems. The buffer zone surrounding water bodies is removed to allow for more farm land so that as many acres as possible can be in production. Removal of the riparian vegetation will allow more water, sediment, and nutrients to enter water bodies as well as increase erosion.

The amount of precipitation this year was also a cause of some of the creeks to be impaired. Central Oklahoma does not normally see this amount of precipitation and most of the precipitation entered the water bodies through run off. For this reason and the fact that most of the stream beds in this area are clay or sand, the turbidity levels were higher than normal.

Table 10: The miles of creeks that either fully supports the designated use, the data indicates support of the use but the use is threatened, or the designated use is not supported.			
Use	Size Supporting	Size Supporting but Threatened	Size Not Supporting
Aquatic Life Support	5.65	10.12	0
Fish and Wildlife Propagation	15.77	0	0
Primary Body Contact Recreation	0	0	15.77
Not Nutrient Threatened	10.47	5.3	0

Table 11: The wetland acres that either fully supports the specific use, the data indicates support of the use but the use is threatened, or the designated use is not supported.			
Use	Size Supporting	Size Supporting but Threatened	Size Not Supporting
Aquatic Life Support	5.0	0.5	0.5
Fish and Wildlife Propagation	5.5	0.5	0
Agricultural (livestock/irrigation)	6.0	0	0

Site Name	Designated Uses ¹						Pollutant ²
	Aquatic Life	Fish & Wildlife Propagation	Agricultural	Primary Body Contact Recreation	Nutrient Threatened		
Bear1	TH	S	S	NS		TURB, EC	
Bear2	TH	S	S	NS		TURB, EC	
Dugout1	TH	S	S	NS	NT	TURB, EC, OPO ₄	
Dugout2	TH	S	S	NS	NT	TURB, EC, OPO ₄	
Headquarters1	S	S	S	NS		EC	
Headquarters2	S	S	S	NS		EC	
Sand1	S	S	S	NS		EC	
Sand2	TH	S	S	NS		TURB, EC	
Wetland1	S	TH	S	ND	ND	ZN	
Wetland2	NS	S	S	ND	ND	TURB, DO	
Wetland3	S	S	S	ND	ND		
Wetland6	S	S	S	ND	ND		
Wetland7	S	S	S	ND	ND		
Wetland10	TH	S	S	ND	ND	TURB	
Wetland11	TH	S	S	ND	ND	TURB	
Wetland101	S	S	S	ND	ND		
Wetland102	S	S	S	ND	ND		

¹ S: Use is supported, TH: Use is threatened, NS: Use is not supported, NT: Site is nutrient threatened, ND: Not determined

² EC: *E. coli*, OPO₄: Ortho-phosphate, DO: Dissolved Oxygen, TURB: Turbidity, ZN: Zinc

Baseline Assessment Information

The acute toxicity tests revealed that all creeks do not contain toxic water. There was 100% survival of *Daphnia pulex* (water flea) at all eight sites in the four creeks monitored. The acute toxicity tests also revealed that all wetland do not contain toxic water. Most wetlands had 100% survival of *Daphnia pulex* except Wetland 11 and Wetland 101 (95% and 90% survival, respectively).

The pesticide analysis of both creeks and wetlands revealed that pesticides were below the detectable limit for both water body types.

From the macroinvertebrate data collected, there were no obvious trends in total taxa observed, site abundance, or site diversity. Headquarters1 consistently had higher numbers of macroinvertebrate taxa and individuals (Figure 10 and 11). For Dugout2, Headquarters2, and Sand1 the total taxa and site abundance dropped in June when the water levels and water flow were high. This was not the case for Dugout1 or Headquarters1 even though these numbers were lower in June than April. Except for Bear1 and Dugout2, total taxa observed in September were lower than April. Site abundance was higher in September than April levels in all sampled sites except in Dugout1 and Headquarters1 where levels were lower.

Macroinvertebrate diversity was fairly constant for each site except Dugout2 and Headquarters1 where the diversity significantly increased in September (Figure 12). In June, both Dugout1 and Headquarters2 had diversity indices of 0 because the only macroinvertebrates observed were chironomids. Chironomids were the most numerous taxa and were present in almost every sample. The percent Ephemeroptera, Plecoptera, and Trichoptera was highest in September in Headquarters1 (68%). The highest

percentages for April and June were 33.3% (Headquarters2) and 14.8% (Dugout1), respectively. The high EPT percentage in September was mainly due to the number of Trichoptera observed in the September samples. There were 8 genera and over 120 individuals present in the Trichoptera order in September.

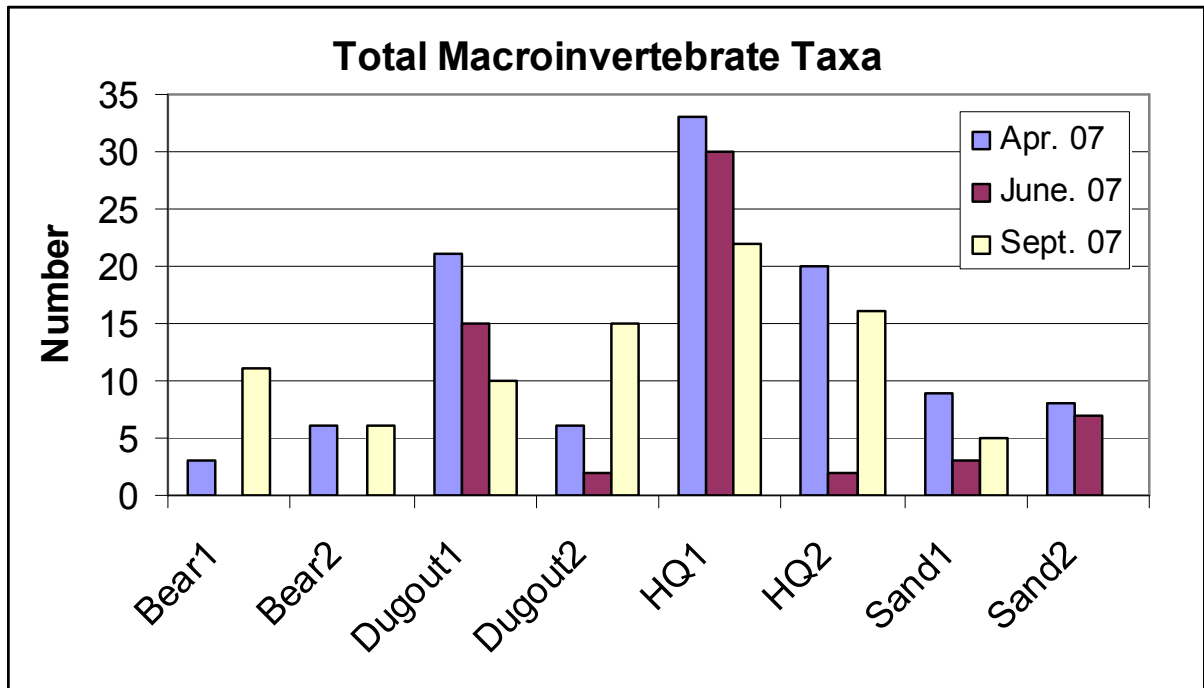


Figure 10: The total number of macroinvertebrate taxa observed at each of the creek sampling sites. Bear1 and Bear2 were not sampled in April and Sand2 was not sampled in September.

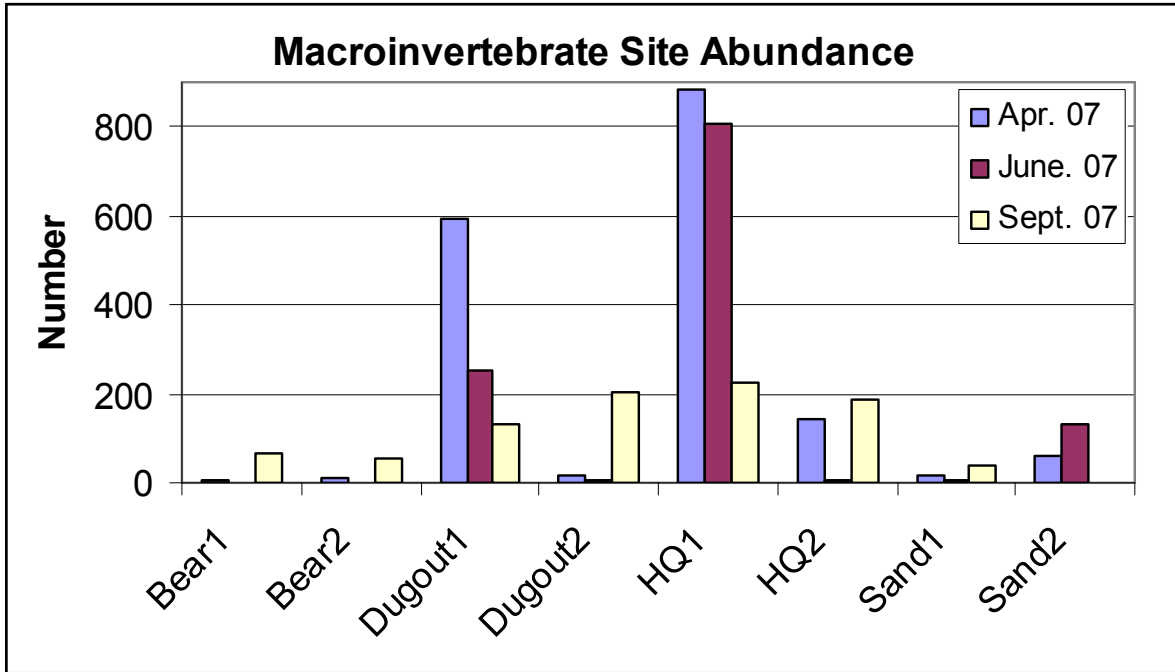


Figure 11: The number of macroinvertebrates observed at each sampling site. Bear1 and Bear2 were not sampled in June and Sand2 was not sampled in September.

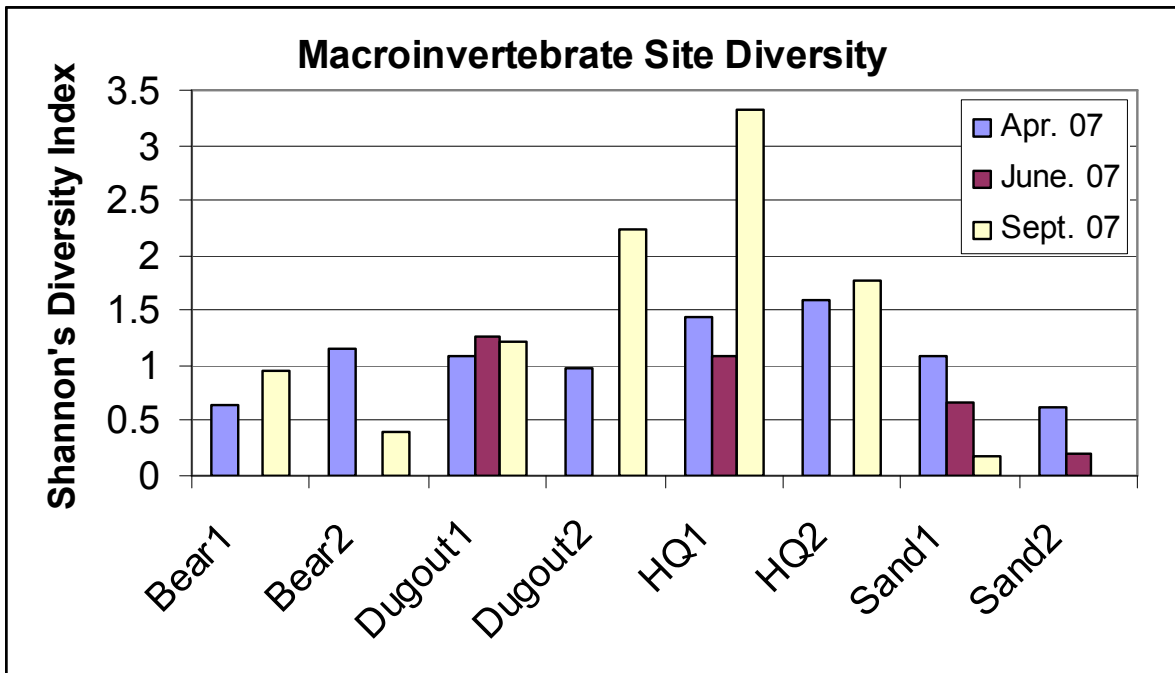


Figure 12 : Macroinvertebrate site diversity for each sampling site for 2007. Bear1 and Bear2 were not sampled in June and Sand2 was not sampled in September.

Literature Cited

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. U.S. Environmental Protection Agency; Office of Water; Washington, D.C. EPA 841-B-99-002.

BLM National Training Center, 2005. Aquatic Macroinvertebrate Sampling. BLM National Training Center, Phoenix, AZ. SS 6000-ST-5.

Oklahoma Climatological Society, 2008. MesoNet Summary Products, Monthly Summaries. Date Access: January 9, 2008.
<http://www.mesonet.org/public/summary.html>

Oklahoma Water Resources Board. 1999. BUMP Monitoring Report. River and Stream Monitoring. Water Quality Programs Division. Oklahoma City, OK.