TMDL INVESTIGATION

OF

WATER QUALITY IMPAIRMENTS

TO

BIG CREEK DITCH
and
LOST CREEK DITCH

CRAIGHEAD COUNTY, ARKANSAS

SEPTEMBER 1998
WQ98-10-1

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INTRODUCTION

The total maximum daily load (TMDL) process was established by Section 303(d) of the Clean Water Act and promulgated in 40 CFR 130.7(b). A TMDL is a process where parameters which result in an impairment of a waterbody are identified and quantified, and an implementation program is developed to remediate the impairment. The primary steps in the TMDL process include: (1) identification of water quality limited water bodies, (2) priority ranking and targeting such waters for TMDL activities, (3) development of TMDL, implementation of control actions, and assessment of water quality-based control actions.

Data collected at the ambient water quality monitoring station on Bayou DeView (WHI26), indicated high turbidity and nutrient values may be impairing the aquatic life uses. In 1994, Bayou DeView was listed on the 303(d) list of Water Quality Limited Water bodies. The headwaters of Bayou DeView is also known as Big Creek Ditch and these names will be used synonymously throughout this report.

Big Creek Ditch is the receiving stream for the City of Jonesboro-West municipal wastewater treatment facility (WWTF), Northern Mobile Home Park, and Olivetan Benedictine Sisters, Inc. A TMDL investigation was conducted to determine the level of impact these discharges are having on the water quality and aquatic inhabitants of the receiving stream. This investigation was conducted July 15-17, 1996 and consisted of water quality sampling, fish and macroinvertebrate collection, and the deployment of Hydrolab continuous dissolved oxygen recorders. Sampling was performed in Big Creek Ditch and Lost Creek Ditch, a tributary to Big Creek Ditch.

HISTORICAL DATA

Waterway Description

Big Creek Ditch originates in the southern portion of Greene County where it flows in a southwesterly direction through west central Craighead County and into Bayou DeView in the northern edge of Poinsett County. Elevation drops from 460 feet to 270 feet during its course. This is a mean gradient of 8 ft/mile. The channel in the study area ranges from 25 to 50 feet wide with a substrate of hard-packed clay, mud, sand and gravel. This ditch drains a watershed of approximately 50 square miles above the Jonesboro-West WWTF.

Lost Creek Ditch, a major tributary to Big Creek Ditch, is included in this study. It originates 4.5 miles south of the origin of Big Creek, flows 10 miles SW to its confluence with Big Creek 2 miles WSW of Jonesboro. It has a mean stream gradient of 9 ft/mi. The unnamed tributary receiving the WWTF effluent appears as a natural watercourse that was isolated by the Big Creek Ditch channelization project. The upper segment of this stream was ditched to carry the WWTF effluent, but most of the stream maintains natural stream meanders. The majority of Big Creek Ditch and Lost Creek Ditch in the study area have been channelized and are maintained for drainage purposes.

Big Creek Ditch is in the Delta Ecoregion and is classified as a Channel-altered Delta Ecoregion fishery with designated beneficial uses of primary and secondary contact recreation; and for domestic, industrial, and agricultural water supply. The dissolved oxygen (DO) standard for this stream for the primary and critical seasons are 5 mg/L and 3 mg/L, respectively. During the critical season a 1 mg/L diurnal drop in DO is allowed for no more than 8 hours.

Previous Studies

The results of the water chemistry analyses from the ambient water quality station WHI 26 were retrieved for the period of January 1991- December 1995. This station was also sampled during this study. The results of historical data from WHI 26 will be addressed in the data results section of this report. Discharge Monitoring Reports (DMR) were also retrieved for the same time frame for the facilities discharging into Big Creek Ditch and its tributaries in this vicinity. An evaluation of these data did not reveal any significant periods of excursion from permit limitations, except for periodic failure of permit required toxicity testing from the Jonesboro-West WWTF. The NPDES permit limits for these dischargers include:

	NPDES Permit #	BOD mg/L	TSS mg/L	F/C col/100ml	CHRONIC TOXICITY	NH3-N mg/L
Jonesboro	AR0037907	15	20	200 Apr.-Sept. 1000 Oct.-Mar.	WET limit	7 May-Oct 10 Nov-Apr
Northern MHP	AR0042188	10	15	"	none	5 May-Oct 10 Nov-Apr
Olivetan Benedictine Sisters	AR0044211	20 May-Oct. 30 Nov-Apr	30	1000	none	5 May-Oct

In 1987, ADPC&E conducted a Stream Assimilative Capacity Study on an unnamed tributary to Big Creek Ditch in order to determine the City of Jonesboro's effluent limits required to maintain water quality standards. This unnamed tributary is included in this survey. Big Creek Ditch was not modeled because the effluent stream modeling indicated the existing dissolved oxygen standard was maintained in the receiving stream, thus no violations of Big Creek Ditch DO standards would occur.

CURRENT STUDY

Station Description

Five sampling stations were established on Big Creek Ditch, three in Lost Creek Ditch, and two in the unnamed tributary that receives the Jonesboro-West WWTF effluent. The station descriptions are as follows:

Station

BCD01A- Big Creek Ditch above the Jonesboro-West WWTF effluent stream confluence.

BCD01E- Jonesboro-West WWTF effluent.

BCD02E- Jonesboro-West WWTF effluent stream at the low water crossing in the natural channel (approx. 3/4 mile below outfall).

BCD03- Big Creek Ditch at the Highway 63 Spur bridge below the confluence of the WWTF stream.

BCD04- Big Creek Ditch at the Highway 63 bridge.

BCD05- Big Creek Ditch at the Highway 349 bridge 1 ½ miles below BCD03.

WHI26- Big Creek Ditch at Highway 226 (ambient station).

LCD01A- Lost Creek Ditch at Highway 141 bridge.

LCD02- Lost Creek Ditch at the WWTF road bridge, adjacent to Highway 63 Spur.

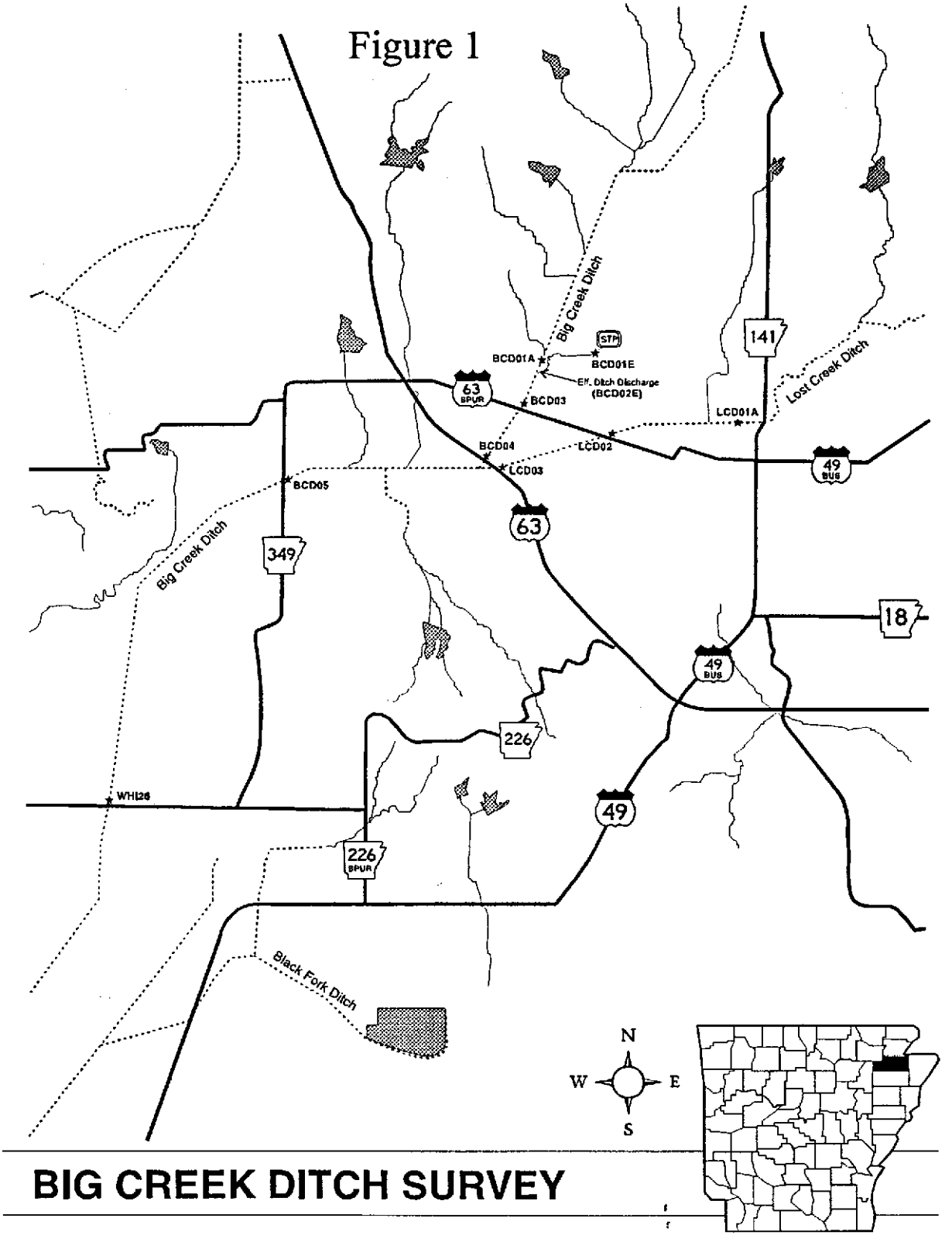
LCD03- Lost Creek Ditch at Highway 63 bridge.

Figure 1 provides a map of sampling station locations.

Data Acquisition

The Big Creek Ditch survey was initiated on July 15, 1996 when continuous dissolved oxygen meters were deployed at two of the five stream stations on Big Creek Ditch (BCD01A & WHI26), one in Lost Creek Ditch (LCD03) and one in the unnamed tributary which receives the WWTF discharge (BCD02E). These locations were selected to determine the effluent's zone of impact and the extent of the diurnal fluctuation. Also on the 15th of July, fish and macroinvertebrate sampling was initiated. The biological assessments were performed at

Figure 1



BIG CREEK DITCH SURVEY

BCD01A, BCD02E, BCD03 and LCD03. Physical habitat assessments were completed in conjunction with the biological sampling. Flow measurements were recorded at BCD01A, BCD02E, BCD03, BCD04, LCD03 and WHI26. Water quality sampling was performed at all stations..

Parameters

In addition to the biological samples, water samples were analyzed for dissolved oxygen (DO), temperature, pH, flow, chlorides, total organic carbon (TOC), five day biochemical oxygen demand (BOD_5), total suspended solids (TSS), total dissolved solids (TDS), ammonia nitrogen (NH_3N), nitrite+nitrate nitrogen ($NO_2 + NO_3$), orthophosphorus (O-phos), and total phosphorus (T-phos). The dissolved metals concentrations were also determined and include aluminum, boron, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, vanadium, and zinc.

Collection, Preservation and Measurements

Water quality grab samples were collected, preserved, and analyzed according to the 18th Edition of Standard Methods for Examination of Water and Wastewater. Analysis was conducted under ADPC&E's existing Quality Assurance Program. Dissolved oxygen and stream temperature were measured using an Orion Model 840 portable dissolved oxygen meter, which was calibrated according to the manufacturers instructions prior to use. Four Hydrolab continuous dissolved oxygen recorders were used to determine diurnal variation in the dissolved oxygen concentration in the Big Creek Ditch study area. Stream pH was measured using an Orion Model 230A portable pH meter, which was calibrated using buffer solutions of pH 4 and 7. Stream flow was measured using a Marsh-McBirney Model 2000 Flow Mate meter by obtaining a representative number of velocities and depths across suitable stream locations. Macroinvertebrates were collected using a Turtox Indestructible benthos net using rapid bioassessment protocol as adapted for Arkansas by Shackleford (1988). An attempt was made to sample similar structure and habitat at each location so that data collected could be compared. The fish community was sampled with a Smith-Root Model 15-B DC backpack electrofisher. Riffle areas were sampled by driving the fish into a seine, while the fish in the pools were collected by electroshocking favorable habitat areas. The smaller specimens and those unidentifiable in the field were preserved in a ten percent (10%) formalin solution and returned to the lab for identification.

DATA RESULTS

Dissolved Oxygen and Temperature

Hydrolab Recorder multi-parameter water quality sampling meters were used to measure the diel fluctuation of both D.O. and temperature. Dissolved oxygen concentrations in Big Creek Ditch above the Jonesboro-West WWTF (BCD01A) ranged from 7 mg/L to 8.5 mg/L with D.O. saturation values between 88% and 111%. Water temperatures at this site ranged from 24.6°C to 27.5°C (Figure 2).

Figure 2
BCD01A

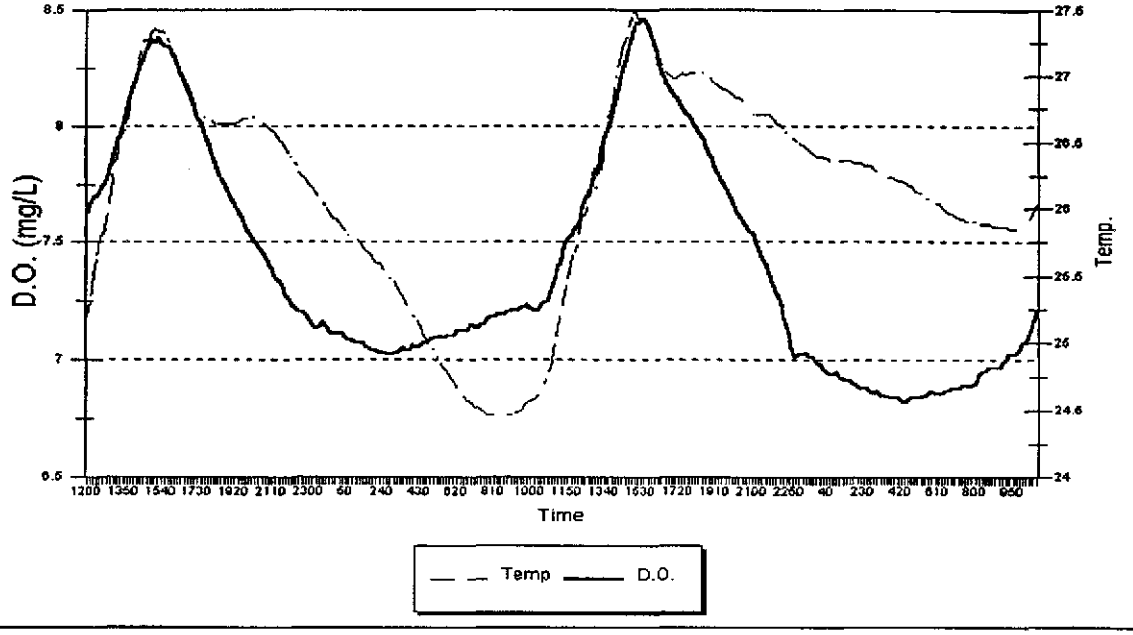
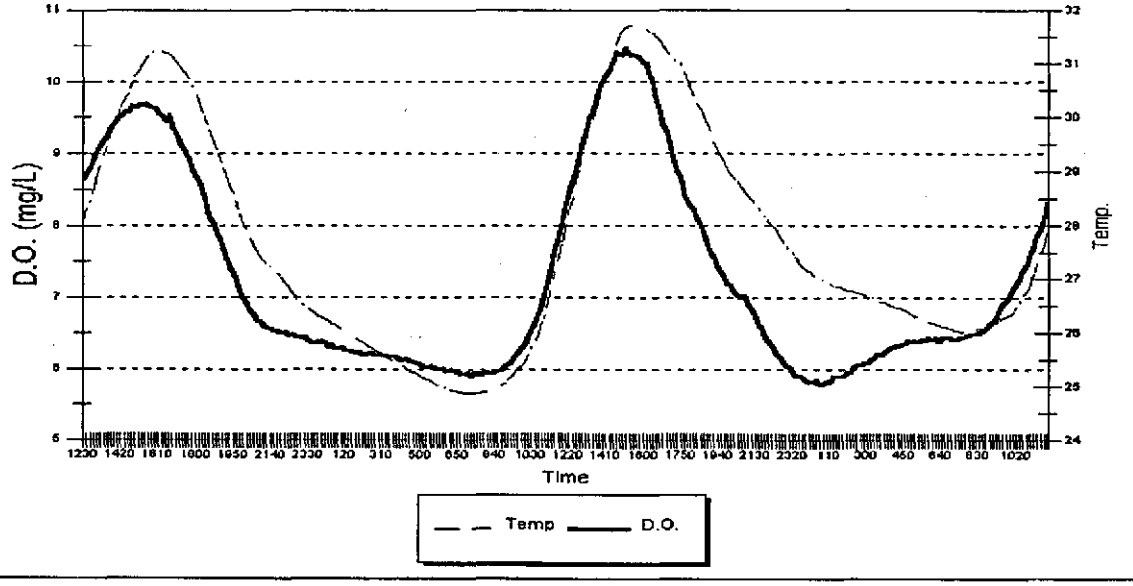


Figure 3
WHI26



At WHI26, the station farthest downstream, concentrations ranged from 6 mg/L to 10.4 mg/L with D.O. saturation values from 74% to over 100%. Temperatures at this site ranged from 25°C to 31.5°C (Figure 3).

The D.O./temperature profile at LCD03 is difficult to interpret due to either unusual stream conditions or malfunction of the meter. Dissolved oxygen concentrations ranged from 0.1 mg/L to 10 mg/L with D.O. saturation levels between 1% and >100%. Water temperatures ranged from 26°C to 32°C. The meter installation site was in a deep, very slow flowing pool with a heavy phytoplankton bloom which could have resulted in a diurnal fluctuation of 10 mg/L; however, peak D.O. values occurred near 10 PM on the first day and around 7 to 8 PM the second day. Minimum D.O. values occurred about 7 to 10 AM each day (Figure 4).

In contrast, the diurnal fluctuation at BCD02E was only 0.6 to 0.7 mg/L, as illustrated by Figure 5. This site had near 100% canopy but was influenced by varying flows, chemical concentrations and post-aeration of the WWTF discharge. The minimum D.O. was approximately 5 mg/L. Temperatures ranged from 24°C to 25°C. Temperature measurements from all stations were within the range of fluctuations recorded in the ecoregion study of the Delta.

pH and Flow

The pH values measured in Big Creek Ditch were typical of streams in the Delta Ecoregion. The Lost Creek Ditch values were slightly higher. The Hydrolab continuous meters recorded values from 6.7 to 8.4 at LCD03. The highest pH value recorded at LCD02 was 8.7. This was probably a result of phytoplankton respiration.

According to U. S. Geologic Survey data, Bayou DeView has a Q7-10 of 0.0 cfs; however, during this survey BCD01A had a flow of 21.35 cfs. The WWTF effluent ditch (BCD02E) had a flow of 1.39 cfs. The contribution from Lost Creek Ditch was 0.89 cfs. At the ambient station the stream flow was measured as 15 cfs. This seems to indicate a negative water budget although flows were much higher than Q7-10 values. Big Creek Ditch is used heavily for row crop irrigation.

Chlorides, Sulfates, and Total Dissolved Solids

The Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas (Reg. 2) lists the chloride limit for Bayou Deview as 20 mg/L. ADPC&E's routine water monitoring network establishes a station on Big Creek Ditch near Gibson, AR (WHI26). Five years of monthly water quality data from this station was evaluated as a part of this survey. The five year mean for chlorides at WHI26 was 16 mg/L, with a range from 3 mg/L to 46 mg/L. The water quality sample taken during this study at the ambient station had a chloride concentration of 13.3 mg/L. In contrast, the upstream Big Creek Ditch sample at BCD01A had a chloride concentration of only 3.7 mg/L. This is more consistent with ecoregion data which indicate a background level of approximately 9 mg/L chlorides for Bayou DeView. The analysis of the WWTF sample from BCD01E had a chloride concentration of 75.4 mg/L. The effluent

Figure 4
LCD03

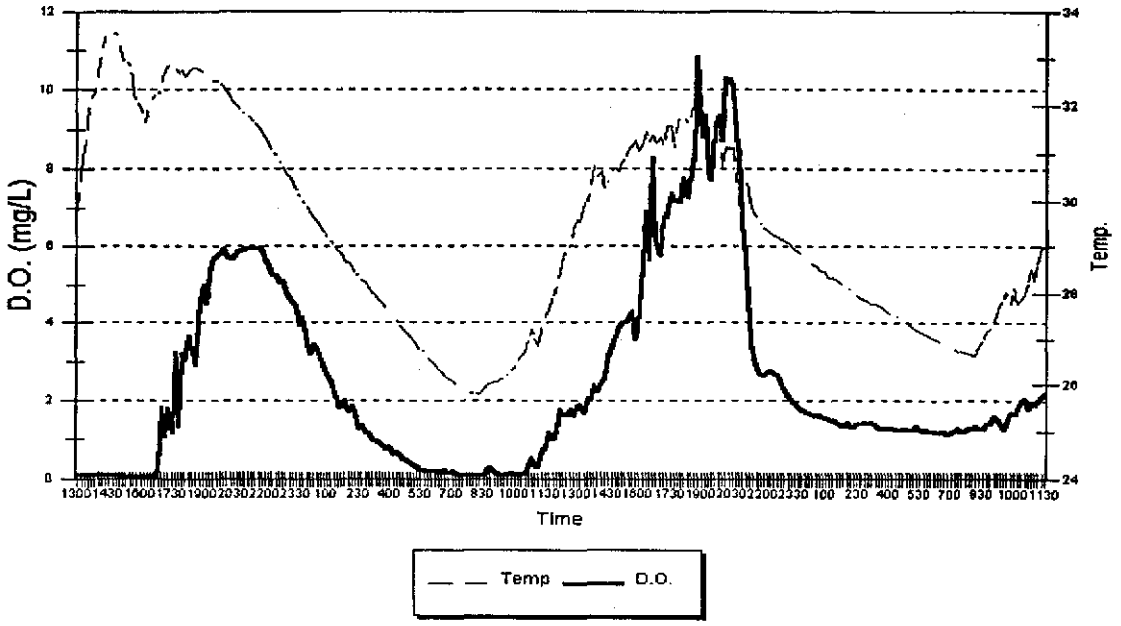
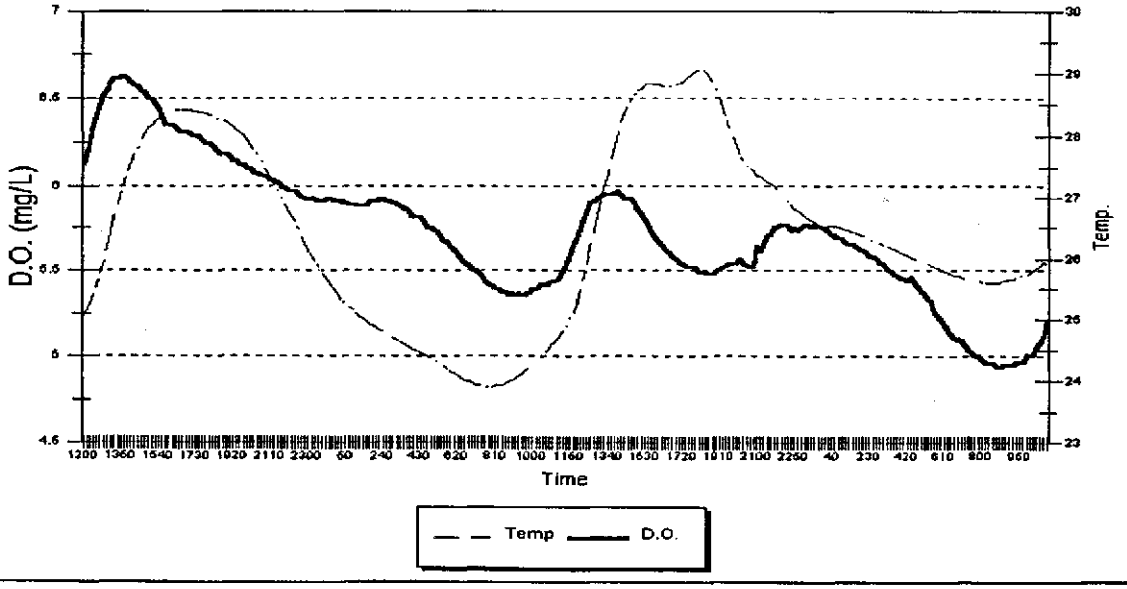


Figure 5
BCD02E



concentration is diluted to near 10 mg/L at BCD03 and BCD04 (Figure 6). Another spike in Cl concentration (60 mg/L) occurs at LCD02, indicating inflow from another point source.

Similar increases were noted in the total dissolved solids, even though they were below the ecoregion concentration of 230 mg/L. The mean value for TDS from the historical data from WHI26 was 182 mg/L with a range of 105 mg/L to 331 mg/L. The TDS concentration from this station during this survey was 153 mg/L. Reg. 2 lists the TDS limit as 270 mg/L. The upstream station BCD01A had TDS concentrations of 110 mg/L. The WWTF effluent (BCD01E) had a TDS concentration of 453 mg/L. This is a four fold increase over background levels. Figure 7 also shows the increase in dissolved solids at LCD02.

Sulfate concentrations in Big Creek Ditch and Lost Creek Ditch were lower than the summertime ecoregion average of 24 mg/L. The five years of data from WHI26 had a mean sulfate concentration of 14.9 mg/L ranging from 8 mg/L to 35 mg/L. All water quality data collected during this study is included as Appendix-A.

BOD, TSS, and Nutrients

Five-day biochemical oxygen demand (BOD_5) concentrations from the five years of data from WHI26 had an average concentration of 3.1 mg/L. These concentrations over this time frame ranged from 0.7 mg/L to a maximum value of 6.7 mg/L. The BOD_5 concentration during the current study from BCD01E was 7.3 mg/L compared to 4 mg/L at BCD01A. Lost Creek Ditch BOD_5's ranged from 2.5 mg/L to 3.2 mg/L.

Total suspended solids (TSS) data from WHI26 had values ranging from 3 mg/L to 936 mg/L with an average concentration of 80 mg/L. During this survey the concentration at the WWTF outfall was 7 mg/L. This is less than the upstream station (BCD01A) which had a concentration of 38.5. The highest TSS concentration (100 mg/L) was recorded at WHI26. The TSS concentration in Lost Creek Ditch ranged from 5.5 mg/L to 7 mg/L (Figure 8).

The five year mean concentrations of ammonia and nitrate-nitrogen at WHI26 were 0.12 mg/L and 0.85 mg/L, respectively. Ammonia concentrations in Big Creek Ditch ranged from 0.11 mg/L (BCD01A)to 0.07 mg/L at WHI26. The effluent and effluent stream ammonia values were 0.48 mg/L and 0.41 mg/L, respectively. Ammonia was not detected in Lost Creek Ditch. Nitrate concentrations were also fairly consistent through Big Creek Ditch, ranging from 0.3 mg/L at BCD01A to 1.0 mg/L at WHI26. The highest concentrations were recorded at BCD01E and BCD02E, they measured at 8.4 mg/L and 7.5 mg/L, respectively (Figure 9). Lost Creek Ditch contributed negligible amounts of nitrates. Figure 10 illustrates a similar pattern for T-phos and O-phos. The highest concentrations (~9mg/L) occur in the tributary stream receiving the Jonesboro-West WWTF effluent. The stations downstream of this tributary are about an order of magnitude higher than the upstream station (BCD01A). A significant phosphorus input was also noticed at LCD02.

Figure 6

Chlorides and Sulfates

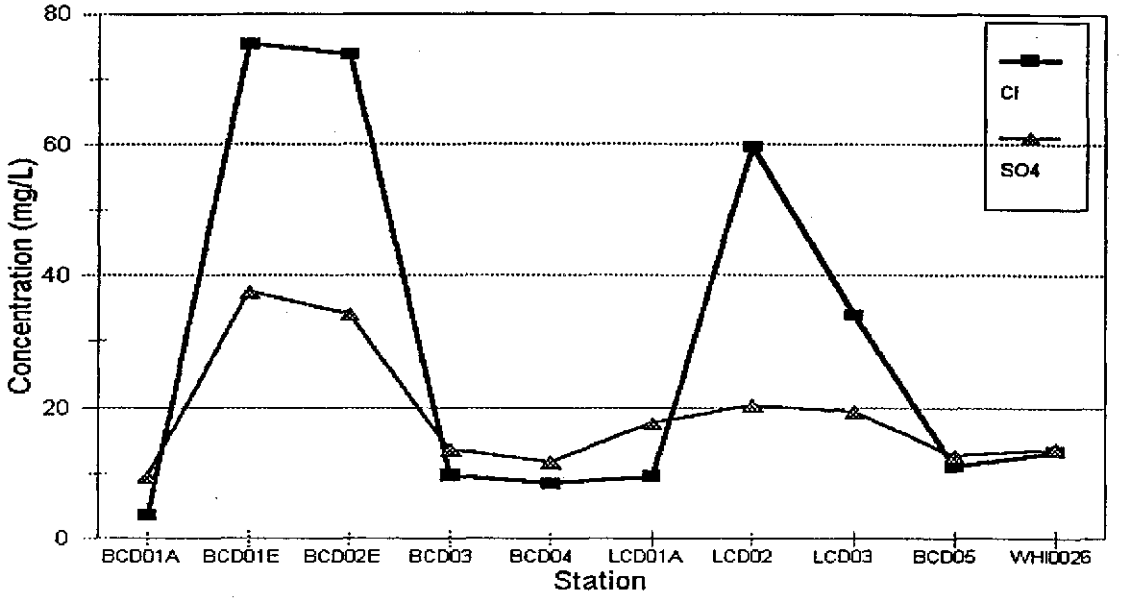


Figure 7

Total Dissolved Solids

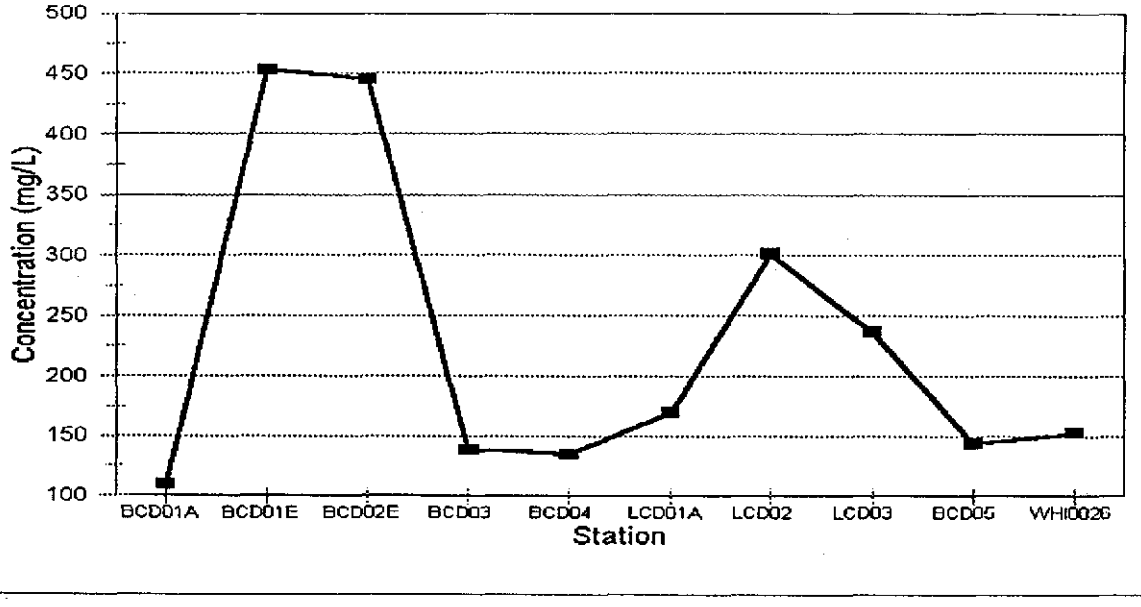


Figure 8

Total Suspended Solids

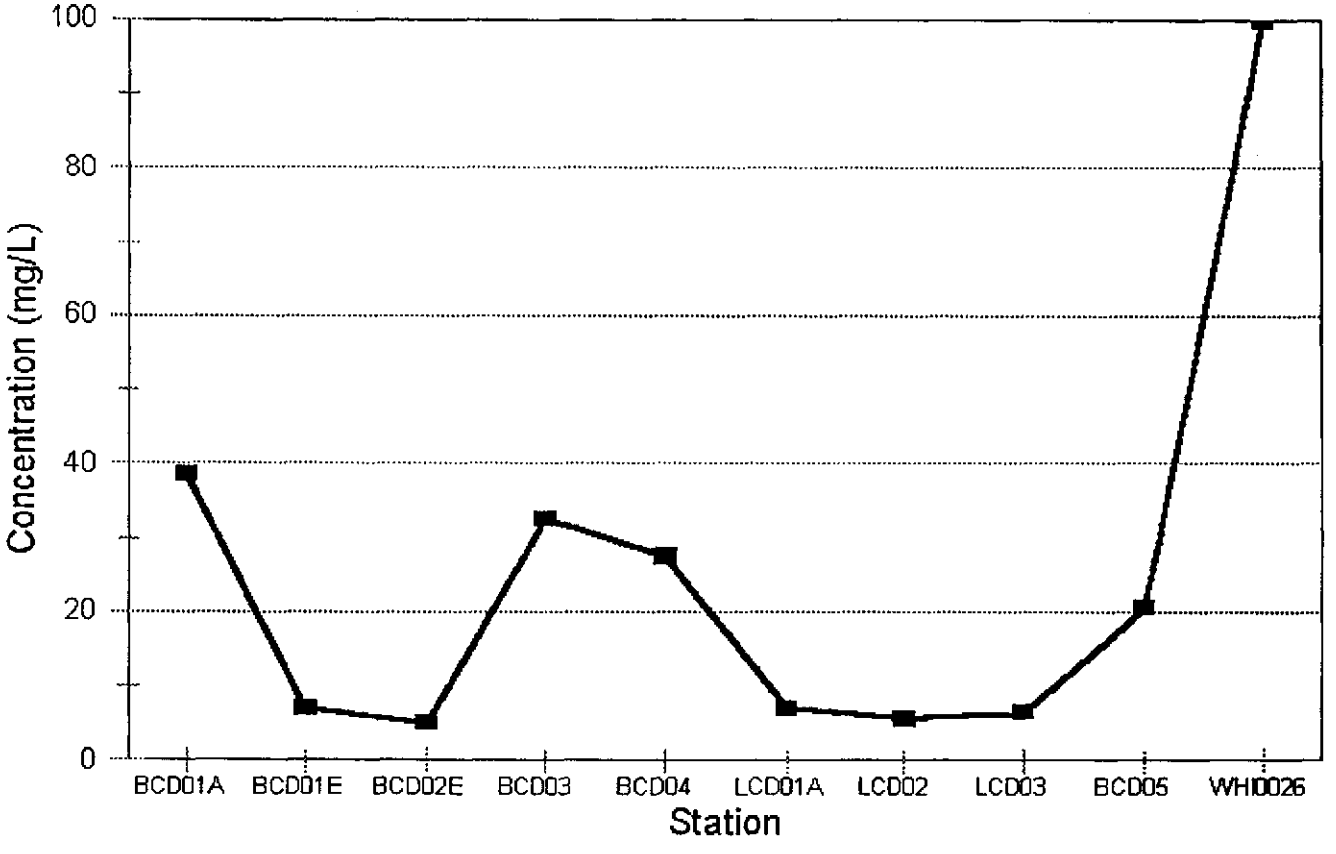


Figure 9

Ammonia and Nitrate-nitrogen

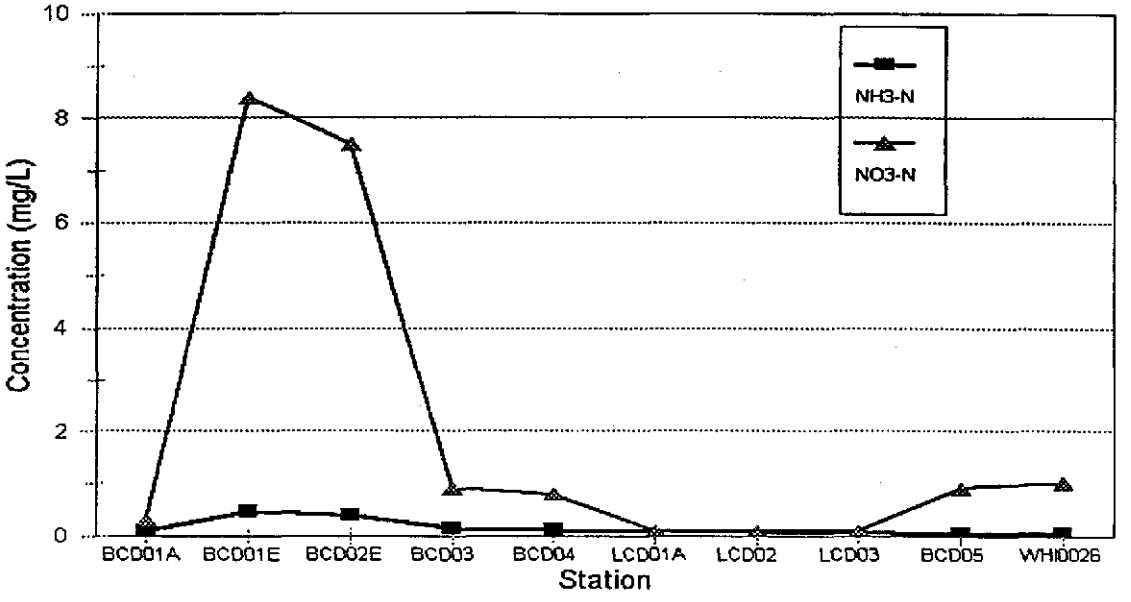
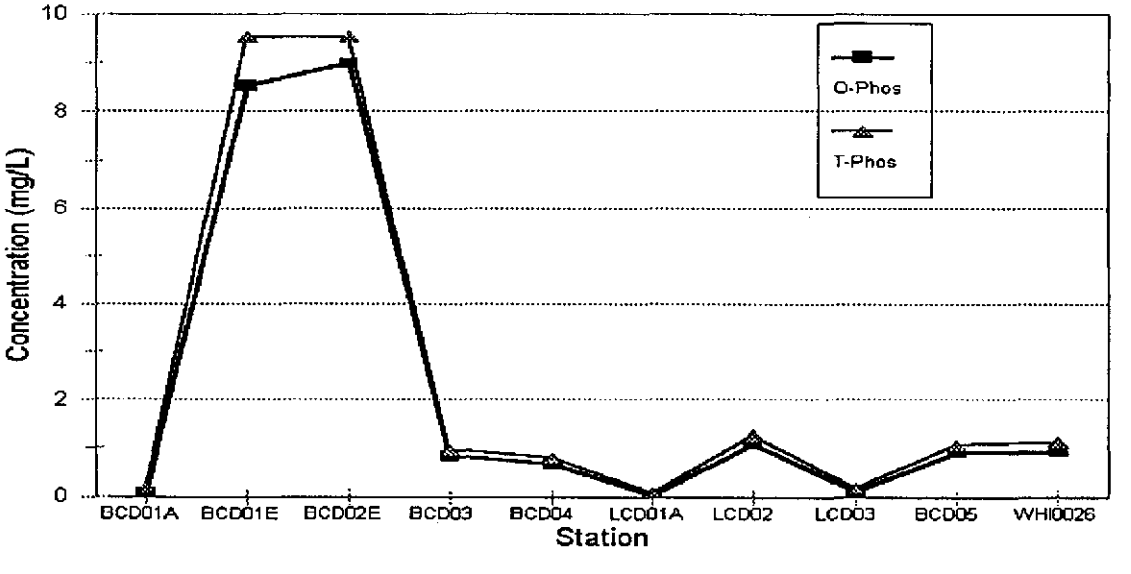


Figure 10

Ortho- and Total Phosphorus



Dissolved Metals

None of the dissolved metals were found in toxic concentrations during this study. However, the concentrations of zinc and copper are approaching levels of concern at two locations. Zinc concentrations at BCD01E and BCD02E were 23.3 μg/L and 21.5 μg/L, respectively. The copper concentrations at these two sites were 13 μg/L and 7.6μg/L. There is also a mysterious vanadium hit at LCD02. All metals data can be found in Appendix A.

Aquatic Macroinvertebrates

Methods

Aquatic macroinvertebrates and habitat data were collected June 15 and 17, 1996 using standardized methods. Organisms were collected with an aquatic macroinvertebrate dip net for five minutes at each site. All available microhabitats within the site were sampled to collect the maximum number of taxa filling the greatest number of niches.

In the lab, all organisms, organic and inorganic material were placed in a dissecting pan. A 10 cm (4 in.) ring was placed in the pan to delimit a subsample and all organisms were removed from the ring until the ring was depleted of organisms. This process was continued until 100 organisms were removed. In cases where additional organisms remained in the ring after removal of 100 organisms, the additional organisms were placed in the subsample to reduce biasing the sample. In instances of <100 organisms, the entire sample was used to derive scores.

RBA scores from multi metric analysis are derived for each site. Each site's score is compared to the reference site score to determine percent comparable estimate (%BCE) which determines the impairment status. Impairment categories are:

Biological Condition	%BCE	Attributes
No significant impairment	> 83%	Comparable to reference site.
Slight Impairment	54-79%	Community structure less than reference site. Taxa richness lower and tolerant forms are more prevalent.
Moderate Impairment	21-50%	Obvious decline in community structure with loss of intolerant forms. EPT index reduced.
Severe Impairment	< 20%	Community dominated by 1 or 2 taxa, few taxa present.

Taxa Richness is an expression of diversity. Normally, a diverse community will be comprised of a large number of taxa. However, a community can have a high number of taxa and still contain greater than 75 percent of one taxon. EPT Taxa is another expression of taxa richness, only from the insect orders of Ephemeroptera, Plecoptera and Trichoptera. These taxa are usually considered less tolerant of pollution but tolerant EPT taxa exist. Scraper abundance to scraper + filterer feeder abundance is another community balance metric involving the feeding mechanisms of the community. An overabundance of any one feeding group reflects an unstable community.

Hilsenhoff's Biotic Index is a scoring mechanism based on tolerance to organic pollution. Organisms are ranked from least tolerant to most tolerant on a scale of zero to five. The Percent Contribution of Dominant Taxa is a comparison of the communities based on the percentage of the dominant taxa. Normally communities living in waters of good quality will have lower values for this metric. Community Loss Index is a metric to evaluate community similarity between sites.

This rapid bioassessment (RBA) also includes physical site evaluations. Physical evaluations are necessary to ensure each site can physically support the community found at the reference or "least impacted" site. Physical parameters are scored and scores are compared to the reference. A %PCE is calculated to determine comparability of stations to the reference. Percent comparable estimates are:

Assessment Category	%PCE
Comparable to Reference	≥90%
Supporting	75-88%
Partially Supporting	60-73%
Non-Supporting	≤58%

Results and Discussion

Two analyses were conducted for this survey due to habitat compatibility. Due to stream alteration in the watershed, BCD01A and BCD04 were considered to be more similar to each other while LCD03 and BCD02E were more similar to each other. Each site was capable of supporting the community found at the site with which it was paired (Table 1).

In the overall scheme of things, the most important comparison is above and below the point where the effluent enters Big Creek. According to the data that were collected, moderate impairment was evident below the effluent. The site's score was 22, which was 48% of the above effluent site (46) and is the upper end of the moderate impairment scale (Table 2). Taxa richness and EPT index values were reduced while the tolerance to organic pollution (HBI) was slightly

Table 1. Physical attributes and scores for aquatic macroinvertebrate sites in the Big Creek Ditch Survey.

Habitat Parameter	BCD01A	BCD04	LCD03	BCD02E
Bottom Substrate	2	3	6	2
Embeddedness	0	0	0	0
Flow	20	20	4	6
Channel Alteration	0	0	12	12
Bottom scour/deposition	3	3	3	3
Pool/riffle ratio	0	0	0	0
Bank Stability	8	8	8	7
Bank Vegetative Stability	9	9	9	9
Streamside Cover	7	6	5	9
Score	49	49	47	48
% Score	Ref	100	Ref	102.1

Table 2. Metric scores from aquatic macroinvertebrate sites in the Big Creek Ditch survey.

Metric	BCD01A		BCD04		LCD03		BCD02E	
	Raw	BCE	Raw	BCE	Raw	BCE	Raw	BCE
% Dom. Taxa	29	4	45	0	38	2	36	2
Taxa Richness	15	6	9	2	20	6	13	4
EPT Index	4	6	3	2	3	6	3	6
HBI	2.8	6	3.0	6	3.2	6	3.3	6
CLI	NA	6	1.9	4	NA	6	1.1	4
Taxa Similarity (%)	NA	6	51	2	NA	6	25	0
Scraper/ Scraper+Filterer	1.0	6	0.0	0	1.0	6	0.8	6
# Functional Groups	4	6	3	6	4	6	5	3
Total Score		46		22		44		31
%BCE Score		*REF		48		*REF		70

*REF=Reference Site

higher below the effluent. Predator species dominated the feeding groups of both sites but above the effluent collectors comprised almost the same percentage of the community as predators. Below the collectors comprised only 26% of the community. Scrapers were also found above the effluent while none were found below. One should use caution when comparing these two sites since only 31 organisms were collected and used for analysis of the downstream site BCD04. However, the low number of organisms may also be a sign of impairment.

The tributary carrying the effluent to Big Creek was compared to Lost Creek Ditch and was found to be slightly impaired. The score for the effluent tributary (BCD02E), 31, was 70% of the reference site (LCD03) score of 44. The reference site contained 20 taxa while the effluent tributary contained only 13. EPT taxa were similar between sites and HBI values were not significantly different (3.2 and 3.3, for LCD03 and BCD02E, respectively). Predator species dominated the community at both sites but collectors comprised a larger portion of the community at LCD03. A list of taxa is included as Appendix B

FISH COMMUNITY

In July 1996, fish community surveys were conducted at the stations listed below:

STATION DESCRIPTION

BCD02E Effluent stream from Jonesboro's west WWTP near its confluence with Big Creek Ditch to approximately 300 yards upstream. (Sec 11, T14N, R3E).

BCD01A Big Creek Ditch upstream of the effluent stream, to approximately 600 yards upstream. (Sec 11, T14N, R3E).

BCD03 Big Creek Ditch from U.S. 63 Spur bridge downstream approximately 660 yards. (Sec 15, T14N, R3E).

LCD03 Lost Creek Ditch from U.S. 63 bridge upstream approximately 540 yards. (Secs 10 & 11, T14N, R3E).

METHODOLOGY

A Smith-Root model 15-B backpack electro fishing device with pulsed DC current was used to collect fish from these sites. The device was used in the shallow pools and along the pool edges while wading upstream and removing the stunned fishes from the water with dip nets. The riffles were collected by posting a twenty foot seine near the toe of the riffle, then shocking in a downstream direction through the riffle. The bottom substrate was disturbed and the fish were herded into the seine or washed in by the current.

Fish species of all types were collected from all available habitat within the sample area until a fully representative sample of the species in the area was thought to be obtained. Larger

specimens were identified and released. The smaller specimens and those unidentifiable in the field were preserved in a ten percent (10%) formalin solution and returned to the lab for identification.

HABITAT EVALUATION

Habitat evaluations were performed at all sites and were comprised of five parameters each consisting of three to seven variables. These parameters included: 1) habitat type; 2) habitat quantity; 3) quantity of substrate type based on fish use 4) quantity of instream cover; and 5) sediment on substrate. Each parameter for substrate type and instream cover was given a score depending on its abundance. The scores given to the substrate parameters were multiplied by a factor to adjust these scores based on how they relate to fish habitat quality. Habitat type, length, depth and width measurements were estimated for each habitat and recorded in feet. The sediment on substrate parameter was scored according to the amount of sedimentation present.

A total score for each habitat type was calculated by summing the scores for the substrate type, in-stream cover and sediment on substrate. The scores from like habitat types were averaged for each sampling station. The lengths of each habitat type were also summed giving a total length of habitat type sampled per sampling station. The total habitat type lengths were then divided by 100 and multiplied by the average habitat type score. This score is the Ichthyofauna Habitat Index (IHI). Table F-1 summarizes the fish habitat evaluations and includes the IHI for all tributary stations sampled.

Table F-1

Fish Habitat Evaluation

SITE	Riffle				Run				Pool			
	Number Sampled	Total Length	Average Habitat Score	IHI*	Number Sampled	Total Length	Average Habitat Score	IHI	Number Sampled	Total Length	Average Habitat Score	IHI
BCD02E	1	35	55.8	19.5	2	300	35.0	105.0	4	550	33.0	181.5
BCD01A					2	700	29.4	205.8	2	1100	29.0	319.0
BCD03	2	154	23.1	35.8	7	1080	27.6	298.1	5	880	25.0	220.0
LCD03	2	130	24.6	32.0	5	630	22.3	140.5	3	850	28.8	244.8

*- Ichthyofauna Habitat Index - Total Length of habitat in hundredths multiplied by the Average Habitat Score.

RESULTS

Fish community samples were collected at all stations on July 16 and 17, 1996. They were evaluated by comparing different metrics and basic community structure. The sample collected at LCD03 was used as reference for comparison to the site located below the wastewater treatment facility, BCD02E. In addition, the sample collected above the effluent stream, BCD01A, was used to compare with the downstream site, BCD03. Also, the fish community from Bayou Deview, a Delta Ecoregion reference stream, was used to compare the fish community in Lost Creek Ditch to an typical Delta Ecoregion reference stream.

There were six species of fish collected in the effluent stream, 20 at BCD01A, 13 at BCD03, and 18 collected at LCD03. Appendix C is a list of species collected from each site, the number of specimens per species collected, and the percent community composition of each species. Table F-2 depicts the family comparisons between sampling stations, percent and total sensitive, key and primary trophic levels species, and the diversity index of each sample based on the Shannon-Wiener diversity index as percent community. Table F-3 depicts the similarity indices between sample sites based on species distribution as percent community.

TABLE F-2

COMMUNITY STRUCTURE (as percent total community)						
Family	BCD02E	BCD01A	BCD03	LCD03	Bayou DeView	CDL* Brushy Cr.
Cyprinidae	2.80	40.16	38.83	14.17	56.30	17.80
Catostomidae	0.00	3.28	6.87	8.15	2.10	0.20
Ictaluridae	0.70	2.46	4.47	7.32	18.50	43.10
Centrarchidae	59.44	39.34	49.14	61.04	6.20	3.80
Percidae	1.40	0.82	0.00	0.00	4.80	0.20
Total Species Collected	6	20	13	18	22	21
No. Sensitive Species	0	1	0	1	1	0
No. Sensitive Individuals	0	1	0	17	4	0
% Sensitive Individuals	0	0.82	0	2.01	1.00	0
No. Primary TFL	4	6	0	1	14	438
% Primary TFL	2.8	4.92	0.00	0.12	3.33	23.9
No. Key Individuals	0	11	7	35	10	1120
% Key Individuals	0	9.02	2.41	4.13	2.38	61.20
Diversity Index	1.62	3.57	2.44	2.91	3.19	2.42

*CDL - Channel-Altered Delta Waterway

TABLE F-3

FISH COMMUNITY INDICES							
Odum				% Similarity			
	BCD01A	BCD03	LCD03		BCD01A	BCD03	LCD03
BCD02E	0.308	0.421	0.417	BCD02E	0.440	0.542	0.622
BCD01A		0.727	0.622	BCD01A		0.700	0.625
BCD03			0.839	BCD03			0.747
B. DeView	0.571	0.457	0.450	B. DeView	0.457	0.439	0.435
Brushy Cr.	0.585	0.471	0.510	Brushy Cr.	0.535	0.462	0.491

The fish community in the effluent stream (BCD02E) below the City of Jonesboro's west WWTP was comprised of only six species, but 143 specimens were collected. The Centrarchids dominated the community with almost 60% of the individuals. The longear sunfish comprised over 50% of the total community. The mosquitofish accounted for almost 36% of the total community. The rest of the community was comprised of the golden shiner, yellow bullhead, green sunfish, and the slough darter. There were no sensitive and/or key species collected. Primary feeders represented three percent (3%) of the community. The catch per unit effort was 3.90 fish/minute, but the diversity index was only 1.62. This was because of the longear sunfish and mosquitofish population made up 86% of the community. The habitat at this site consisted mainly of long, somewhat shallow pools caused by a series of beaver dams. The one small riffle was caused by a road crossing. The canopy cover was near 100%, and there was an excellent riparian zone on either side of the creek. The in-stream flow is dominated by the WWTP effluent and probably remains less than two cubic feet per second for most of the year. The in-stream cover in each of the habitats sampled scored higher than at any of the other sites sampled during this survey, but the IHIs for each of the habitats was lower due to the smaller size (total length sampled) of each of the habitats.

The habitat at BCD01A was a typical periodically maintained channelized ditch. The sample area was comprised of two long runs of approximately 700 feet in total length and two long pools with a total length of 1100 feet. The in-stream cover was somewhat limited but was scored higher than the downstream site and the Lost Creek Ditch site (Table F-1). The canopy cover was usually greater than 50% throughout the entire sample area. There were 20 species of fish collected from this site which was the most of any of the sample areas. This included 122 specimens which was the least of any of the samples. Thus, the diversity index for this sample was greater than any of the other samples but the catch per unit effort was the lowest at 2.06 fish per minute. The Cyprinids and the Centrarchids co-dominated the community, each comprised about 40% of the community and included five to six species. The blacktail shiner comprised almost 24% of the total community, making it the dominant species. The green sunfish was the next dominant, comprising over 15% of the community, and the longear sunfish and the blackspotted topminnow

were next, each comprising nine percent (9%) of the community. There were also good populations of the redfin shiner, bullhead minnow, largemouth bass, white crappie and channel catfish (Appendix 2). This collection included eleven individuals from two key species which comprised nine percent (9%) of the total community, and six total individuals from three primary feeding species which comprised almost five percent (5%) of the community.

The overall fish community at BCD01A seems to be lacking in quantity. There is also a noticeable lack of percids at this site. Both of these problems may be the result of the lack of suitable in-stream cover and habitat. There were no riffles located in the sample area and the in-stream fish cover was somewhat limited. There were no meanders, undercut banks, definite thalweg, or shallow spawning areas. The creek was a constant 80 to 100 feet wide with straight-slope banks of approximately two feet high.

The BCD03 site consisted of two riffle habitats totaling 154 feet in length, seven runs totaling almost 1080 feet, and five pools totaling about 880 feet. In-stream habitat was slightly less abundant in the runs and pools at this site than at BCD01A. There were 291 specimens collected at this site representing only 13 species; thus the diversity index of 2.44 was significantly lower than at the upstream site. However, the catch per unit effort of 3.92 fish per minute was higher. The dominant family was the Centrachids, comprising 49% of the community, while the Cyprinids were sub-dominant comprising, 39% of the community. The blacktail shiner was the dominant specie, comprising 35% of the community, followed by the longear sunfish at 29% and the green sunfish at 18%. These three species comprised over 80% of the total fish community. There were also good populations of the creek chubsucker (7%), yellow bullhead, channel catfish, and largemouth bass. Even though there were two riffle habitats sampled, there were no percid species collected. There were also no sensitive or primary feeder species collected, but there were seven individuals of key species collected representing 2.4% of the community.

There was a definite shift in dominance in the species from the upstream site, BCD01A, to BCD03. There was also a definite increase in the blacktail shiner, longear sunfish, and creek chubsucker populations at the downstream site, and a noticeable decrease in the population of the redfin shiner, bullhead minnow, blackspotted topminnow and white crappie. The reason for these shifts is not known, but it is more likely related to habitat differences than water quality.

The sample area in Lost Creek Ditch consisted of two riffles totaling 130 feet, five runs totaling 630 feet, and three pools totaling 850 feet in length. The in-stream habitat in the riffle was about the same quality as that at the BCD03 site, the run habitat was not as good as in the other sites, and the pool habitat quality was about the same as both Big Creek Ditch sites. However, there was a larger variance in depth between habitats in Lost Creek Ditch as compared to the other sites. The water depth in Lost Creek Ditch varied from less than six inches to more than five feet with a bottom substrate consisting of packed mud to silt. The fish community at this site consisted of 847 specimens representing 18 species. The catch per unit effort was 12.98 fish per minute. This was over three time greater than the other sites. The community was dominated by the sunfish family, representing 61% of the total. The longear sunfish and the green sunfish comprised over 92% of the sunfish community. Because of this large sunfish dominance, the

diversity index for this site was only 2.91. The cyprinids comprised over 14% of the community with the blacktail shiner making up over 55% of the minnow community. There were also good populations of the creek chubsucker, yellow bullhead and the mosquitofish. There were no darter species collected, although there were two riffle habitats sampled. There were no sensitive species collected. Only one specimen of a primary feeder was collected, and 35 individuals from two key species were collected representing over four percent of the community.

The fish community in the Delta Ecoregion reference stream, Bayou DeView, was dominated by the Cyprinids, 56% of the total community. The Ictalurid family comprised 18% of the community, mostly comprised of channel catfish, the catostomids only two percent (2%), the percids almost five percent (5%), and the cyprinid family about six percent (6%) of the community. There were 22 species of fish collected from the site; only four individuals of one sensitive species was collected; 14 individuals of a primary feeder were collected, 3.3% of the community; and 10 key individuals were collected, 2.4% of the community. The diversity index at this site was 3.19.

The fish community in Brushy Creek, a channel-altered Delta Ecoregion reference stream, was dominated by Ictaluridae, 43% of the total community, almost entirely comprised of channel catfish. The Cyprinids comprised almost 18% of the community, and the centrarchids comprised only four percent (4%) of the community. There were 21 species of fish collected from the site; only four individuals of one sensitive species was collected; 14 individuals of a primary feeder were collected, 3.3% of the community; and 10 key individuals were collected, 2.4% of the community. The diversity index at this site was 3.19.

The similarity indices depicted in Table F-3 illustrate that the ecoregion reference stream, Bayou DeView, and the channel-altered Delta stream, Brushy creek, are not very similar to the survey stream sites. Bayou DeView and Brushy Creek are more similar to the effluent stream, BCD02E, than they are to any of the other sampled areas. Also, the sampled area above and below the effluent stream in Big Creek Ditch, and the Lost Creek Ditch site are all very similar to one another. This may be indicating that nonpoint source impacts are occurring in both Big Creek Ditch and Lost Creek Ditch and are affecting the fish communities in both systems. Some of these nonpoint source impacts are possibly effects from row-crop agriculture activities, stream channelization, and/or the reduction or total loss of the riparian zone adjacent to the stream. All of these activities can lead to a loss of instream habitat, sediment deposition, and water temperature and dissolved oxygen fluctuations that can impact the fish communities.

The waste water treatment facility does not seem to be impacting the fish community in Big Creek Ditch but is probably having some impact on the effluent stream. This is indicated by the composition of the fish community in the effluent stream.. Almost 94% of the community is comprised of pollutant tolerant species- the mosquitofish, and the green and the longear sunfish. Some of this may be due to the uniform in-stream habitat and the beaver dams causing upstream migration problems, and perhaps due to some in-stream water quality impairments.

CONCLUSIONS

1. The relatively high concentrations of nutrients and minerals discharged by the Jonesboro-West WWTF and Lost Creek Ditch were diluted by the Big Creek Ditch background flow during this study period.

2. Minerals and phosphorus concentrations increase substantially between LCD01A and LCD02, indicating the possibility of an unknown point source discharge. This, combined with the WWTF effluent, contribute to a gradual increase in Cl, SO4 and TDS at WHI26. However, phosphorus levels decline downstream in Lost Creek Ditch, possibly due to plankton and periphyton uptake. In contrast, phosphorus levels maintain a gradual increase downstream in Big Creek Ditch apparently from nonpoint source inputs.

3. There is a five-fold increase in TSS between BCD05 and WHI26. This may be the result of algae growth due to nutrient enrichment or nonpoint sources related to agricultural activities along this stream segment.

4. A well defined diurnal dissolved oxygen curve did not occur at BCD02E although nutrient values were very high. The heavy and total canopy cover prevented aquatic plant oxygen production in this stream segment. A pronounced DO swing did occur at LCD03 and phytoplankton production was heavy at this site..

5. Fish and macroinvertebrate communities at all sites were below expectations although the upstream (reference) site on Big Creek Ditch would be considered to be generally supporting a channel-altered Delta fishery. Nutrient enrichment was reflected in the biological communities at LCD03 even though this community was more diverse and had higher abundances than the other sites below the point source discharges. Many of the impacts at other sites may be habitat related.

6. No definitive impairment source was identified, but numerous activities are resulting in cumulative and variable impacts on these waterbodies. These include:

    1. Elevated nutrients from the Jonesboro-West WWTF,
    2. Elevated nutrients from an unknown source in Lost Creek Ditch,
    3. Channel alteration of most sections of the study streams,
    4. Elevated suspended solids in the lower section of Big Creek Ditch from agriculture nonpoint source runoff, and
    5. During drought periods, irrigation withdrawals from these waters causes loss of aquatic habitat and concentration of pollutants.

Appendix - A

Water Chemistry

Big Creek Ditch Survey
July 16, 1996
Water Quality

STATION	BCD01A	BCD01E	BCD02E	BCD03	BCD04	LCD01A	LCD02	LCD03	BCD05	WHI0026
Flow (cfs)	21.35	(1)	1.39	22.28	(1)	(1)	(1)	0.89	(1)	15.11
DO (mg/L)	6.9	8.5	5.3	6.9	7.2	11.1	9	9.7	8.5	9.2
pH (SU)	7.4	7.3	7.2	7.3	7.4	8.5	8.7	7.9	7.7	8
Water Temp (C)	24.4	26.1	24	26.3	26.5	35	34.1	31.1	29.1	30.3
CBOD (mg/L)	0.4	7.3	11.0	0.7	1.0	2.5	3.2	3.2	0.9	1.4
NH3-N (mg/L)	0.11	0.48	0.41	0.15	0.13	<0.05	<0.05	<0.05	0.071	0.067
CL (mg/L)	3.7	75.4	73.9	9.8	8.5	9.6	59.6	34.0	11.1	13.3
NO3-N (mg/L)	0.3	8.4	7.5	0.9	0.8	0.1	0.1	0.1	0.9	1.0
0-PHOS (mg/L)	0.07	8.52	8.97	0.83	0.66	<0.03	1.09	0.11	0.91	0.94
T-PHOS (mg/L)	0.19	9.52	9.52	0.95	0.78	0.08	1.25	0.18	1.05	1.12
SO4 (mg/L)	9.5	37.4	34.1	13.7	11.7	17.7	20.4	19.5	12.7	13.7
TOC (mg/L)	8.9	20.4	17.3	10.0	9.6	17.6	14.8	11.9	9.8	10.6
TSS (mg/L)	38.5	7.0	5.0	32.5	27.5	7.0	5.5	6.5	20.5	100.0
TDS (mg/L)	110.0	453.0	445.0	139.0	135.0	170.0	301.0	237.0	144.0	153.0
Hardness (mg/L)	22.0	106.0	104.0	30.0	28.0	95.0	117.0	125.0	32.0	37.0
Turbidity (NTU)	59	8.2	5.6	52.0	53.0	10.0	5.1	9.5	48.0	51
Dissolved Metals										
Al (ug/L)	110.4	96.0	89.5	275.9	360.5	75.4	51.3	68.2	329.9	287.2
B (ug/L)	17.4	216.8	211.4	35.0	30.1	37.4	64.6	21.5	35.9	40.5
Ba (ug/L)	33.8	4.9	6.5	36.8	34.7	39.5	36.3	78.4	33.2	36.2
Be (ug/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Ca (ug/L)	5.2	26.9	26.3	7.2	6.7	25.3	24.3	29.5	7.7	9.0
Cd (ug/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co (ug/L)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Cr (ug/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu (ug/L)	<2.0	13.0	7.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Fe (ug/L)	64.5	151.0	156.0	182.0	224.0	29.0	9.4	39.8	207.0	168.0
K (mg/L)	1.7	47.6	51.3	4.1	3.8	3.6	9.4	2.3	4.6	5.0
Mg (mg/L)	2.2	9.4	9.3	2.8	2.7	7.7	13.6	12.4	3.1	3.5
Mn (ug/L)	93.3	74.0	71.0	111.0	103.0	255.0	68.4	224.0	87.6	25.5
Na (mg/L)	<0.04	66.5	65.0	4.1	1.9	6.4	49.9	21.7	4.8	6.8
Ni (ug/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pb (ug/L)	<2.0	2.6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
V (ug/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	7.4	<5.0	<5.0	<5.0
Zn (ug/L)	<2.0	23.3	21.5	3.9	4.1	2.5	<2.0	7.3	4.5	4.6

(1) No Flow Recorded

Appendix B - Taxa list for aquatic macroinvertebrate sites in Lost Creek and Big Creek ditches.

HBI	FEEDING GROUP	EPT TAXA	TAXA	BCD01A	BCD02E	LCD03	BCD04
				# COL	# COL	# COL	# COL
3	COL	N	*Paleomanetes*	12			
3	COL	N	Cambaridae #1			1	
3.5	COL	Y	*Siphlonurus*	6	5	17	5
3	SCR	Y	*Stenonema*	7			
2	COL	Y	*Caenis*	21		3	2
3.2	PRE	Y	*Aeschna*		1		
2	PRE	N	*Erpetogomphus*	1			
2	PRE	N	*Gomphus*			1	
3	PRE	N	*Macromia*			1	
4.5	PRE	N	*Somatochlora*	1			
4.7	PRE	N	*Erythemis*			2	
4.8	PRE	N	*Libellula*			1	
3	PRE	N	*Orthemis*			1	
5	PRE	N	*Perithemis*			4	
5	PRE	N	*Pachydiplax*		3	2	
3	PRE	N	*Argia*		1	1	
4	PRE	N	*Enallagma*	2	2	5	
4.5	PRE	N	*Ischnura*			3	
2.8	PIE	N	*Tricocorixa*	1			
4	PRE	N	*Sialis*	1			
2.5	SHR	N	*Archanara*		1		
3	FIL	Y	*Cheumatopsyche*	2	1		1
1	COL	Y	*Psychomyia*			1	
4.3	PIE	N	*Peltodytes (L)*			2	
3	PRE	N	*Dytiscidae (L)*			1	
2.5	PRE	N	*Berosus (L)*			36	
3.3	SHR	N	*Hydrochus*			1	
3	COL	N	*Dubiraphia*	1			1
3	COL	N	*Chrysops*		1		
3	PRE	N	*Tabanus*		1		1
4.7	PRE	N	*Chaoborus*		5		
3	PRE	N	Chironomid 1	2			
3	PRE	N	Chironomid 2	3			
3	PRE	N	Chironomid 3				1
3	PRE	N	Tanypodini	27	29	10	14
3	PRE	N	Chironomini	5	26		5
4	SCR	N	*Physa*		4	2	
3	FIL	N	*Corbicula*				1
			Total	92	80	95	31

APPENDIX C - Fish Community

FAMILY & SPECIES	COMMON NAME	SEN	TFL	KEY	BCD02E		BCD01A		BCD03B		LCD03	
					Num	% Com	Num	% Com	Num	% Com	Num	% Com
Clupeidae	Herrings											
Dorosoma cepedianum	Gizzard shad		P				3	2.46				
Cyprinidae	Minnows											
Cyprinella venustus	Blacktail shiner						29	23.77	102	35.05	66	7.79
Cyprinus carpio	Common carp		P				2	1.64				
Lythrurus umbratilis	Redfin shiner						8	6.56	2	0.69	32	3.78
Notemigonus crysoleacus	Golden shiner		P		4	2.80	1	0.82			1	0.12
Pimephales vigilax	Bullhead minnow						9	7.38	9	3.09	4	0.47
Semotilus atromaculatus	Creek chub										17	2.01
Catostomidae	Suckers											
Erimyzon oblongus	Creek chubsucker						2	1.64	20	6.87	69	8.15
Minytrema melanops	Spotted sucker						2	1.64				
Ictaluridae	Freshwater catfishes											
Ameiurus melas	Black bullhead										5	0.59
Ameiurus natalis	Yellow bullhead				1	0.70			6	2.06	55	6.49
Ictalurus punctatus	Channel catfish						3	2.46	7	2.41	2	0.24
Aphredoderidae	Pirate perches											
Aphredoderus sayanus	Pirate perch						1	0.82			1	0.12
Cprinodontidae	Killifishes											
Fundulus olivaceus	Blackspotted Topminnow						11	9.02	1	0.34	13	1.53
Poeciliidae	Livebearers											
Gambusia affinis	Mosquitofish				51	35.66	1	0.82	1	0.34	65	7.67
Centrarchidae	Sunfishes											
Lepomis cyanellus	Green sunfish				13	9.09	19	15.57	51	17.53	216	25.50
Lepomis gulosus	Warmouth sunfish						1	0.82	1	0.34	2	0.24
Lepomis macrochirus	Bluegill sunfish			K			7	5.74	2	0.69	30	3.54
Lepomis megalotis	Longear sunfish				72	50.35	12	9.84	84	28.87	262	30.93
Lepomis hybrid	Hybrid sunfish										2	0.24
Micropterus salmoides	Largemouth bass			K			4	3.28	5	1.72	5	0.59
Pomoxis annularis	White crappie						5	4.10				
Percidae	Perches											
Etheostoma gracile	Slough darter				2	1.40						
Percina maculata	Blackside darter	S					1	0.82				
Scianidae	Drums											
Aplodinotus grunniens	Freshwater drum						1	0.82				
	TOTAL SPECIES					6		20		13		18
	TOTAL NUMBERS					143		122		291		847
	Effort (sec)					2201		3550		4459		3916
	Catch/Minute					3.90		2.06		3.92		12.98