Arkansas Department of Environmental Quality

PILOT STUDY:

Draft Evaluation Protocol for Assessing Nutrient Indicators for Streams and Rivers of the Upper Saline River Watershed, Arkansas

Water Division 2010

WQ10-10-01

Water Division Planning Branch

Mr. Steve Drown, Chief of the Arkansas Department of Environmental Quality (ADEQ) Water Division, is actively involved with the activities of Water Division's Planning Branch. The Planning Branch consists of ecologists and geologists who are responsible for managing the State Water Quality Monitoring Networks for both surface and ground waters, as well as investigating the physical, chemical, and biological characteristics of watersheds and/or aquifers. The data generated from these activities are used to prepare the biennial "Integrated Water Quality Monitoring and Assessment Report (305(b))," the "List of Impaired Water Bodies, (303(d) list)," and develop Total Maximum Daily Loads for impaired water bodies. The data are also used to develop water quality standards and criteria for the evaluation of designated use attainment and to prioritize restoration and remediation activities.

The Groundwater Section is currently engaged in development of statewide groundwater standards and management of remediation projects that do not fall under the purview of other ADEQ divisions. This section also oversees portions of the Groundwater Protection Program that are delegated to the Arkansas Department of Health (Wellhead Protection Program) and the Arkansas Natural Resources Commission (Groundwater Protection and Management Program).

The Education and Outreach Section develops and implements outreach and educational materials and programs. This section also coordinates and implements the activities of the Arkansas Watershed Advisory Group; a group of federal, state, local, and private citizens working together to assist watershed groups in protecting and enhancing the natural environment in Arkansas.

The Planning Branch staff continues to develop and enhance ecoregion-based, biological assessment criteria for both fish and macroinvertebrates. The staff is also active in the development and updating of water quality standards, as well as technical review and administration of the National Pollutant Discharge Elimination System Permits Biomonitoring Program. Staff members represent ADEQ on numerous federal, state, local, and watershed-based advisory boards and technical support groups.

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To learn more about the Water Division and other divisions of the Arkansas Department of Environmental Quality and to view a list of publications by the Planning Branch, visit www.adeq.state.ar.us or call at (501) 682-0744.

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EXECUTIVE SUMMARY

Development of numeric nutrient criteria has become an increasingly important goal among state regulatory agencies. The purpose of this pilot study was to test and refine methodologies outlined in the State of Arkansas Nutrient Criteria Development Plan within the upper Saline River watershed, with the final objective of developing standard methods to establish statewide numeric nutrient criteria for Arkansas's streams and rivers. Nutrient concentrations observed during this study were equal to or less than those of previous studies conducted in the upper Saline River watershed. Nutrient enriched sites (75^{th} percentile) exhibited only slightly higher nutrient concentrations than least-disturbed sites (25^{th} percentile), and mostly lacked significant differences among the aquatic biota. Macroinvertebrate communities in the upper Saline River watershed showed little spatial or temporal differences and were mostly similar between nutrient enrichned and least-disturbed sites. Taxa richness and EPT richness for the least-disturbed sites were only slightly higher than those for the nutrient enrichned sites. The small sample size of this study prevented the identification of concentration thresholds for nutrients using aquatic life. Results of this study indicate that the use of weight-of-evidence and the classification of 75^{th} percentile sites based on water quality in streams with low level nutrient concentrations are inappropriate for the Saline River. Future nutrient critera studies in Arkansas must utilize large ecoregion specific datasets encompassing an array of nutrient concentrations in order to develop specific nutrient criterion.

INTRODUCTION

Background

State water quality reports submitted to the United States Environmental Protection Agency (EPA) indicate that nutrients are the second leading cause of impairment to the nation's streams and rivers. In fact, forty percent of streams in the United States are classified as impaired by excessive nutrient loads in the states' impaired waters (303(d)) lists (EPA 1998). Nutrients are essential to the integrity and function of aquatic ecosystems. However, when concentrations of the primary nutrients phosphorus and nitrogen exceed a waterbody's assimilation capacity, hypereutrophic conditions occur. Nutrient loading often results in algal blooms, episodic hypoxia and/or anoxia, overabundance of primary producers, loss of vascular plant life, fish kills, and overall decreased biological diversity. Sources of and factors influencing nutrient enrichment and productivity include, but are not limited to: fertilizers, sewage treatment plants, detergents, septic systems, combined sewer overflows, sediment mobilization, animal manure, atmospheric deposition, internal nutrient recycling from sediments, light attenuation, improper land-use practices, and imbalances between primary and secondary producers (EPA 1998).

Currently, Arkansas maintains the following narrative nutrient standard in the Arkansas Pollution Control & Ecology Commission's (APCEC) Regulation No. 2 "Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas":

> Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the water body. Impairment of a water body from excess nutrients are dependent on the natural water body characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of water body, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any established numeric water quality standard, the water body will be determined to be impaired by nutrients.

In 1998, EPA published the National Strategy for the Development of Regional Nutrient Criteria (National Strategy). The National Strategy described the approach EPA would follow in developing numeric nutrient criteria on a regional basis for different types of waterbodies (i.e. streams, lakes, coastal waters, and wetlands). Based on the National Strategy, in 2001 EPA published recommended, regional numeric nutrient criteria for rivers and streams under section 304(a) of the Clean Water Act (66 FR 1671). EPA's intention was that states, tribes, and interstate commissions would use these recommendations as guidelines for developing and adopting enforceable numeric nutrient criteria as part of state water quality standards.

Portions of Arkansas are contained within three EPA aggregate nutrient ecoregions (EPA 2001):

IX – South Eastern Temperate Forested Plains and Hills
X – Texas Louisiana Coastal and Mississippi Alluvial Plains
XI – Central and Eastern Forested Uplands

Table 1. EPA recommended criteria for rivers and streams in aggregate ecoregions IX, X, and XI.

Rivers and Streams	**Ecoregion IX**	**Ecoregion X**	**Ecoregion XI**
Total phosphorus (µg/L)	36.56	128.00	10.00
Total nitrogen (mg/L)	0.69	0.76	0.31
Chlorophyll a (µg/L)	0.93	2.1	1.61
Turbidity (FTU/NTU)	5.7	17.5	2.3
Secchi disk depth (meters)	N/A	N/A	N/A

A major difficulty with EPA's National Strategy is that it is a "one number fits all" approach. The National Strategy does not account for the dynamic characteristics of aquatic ecosystems and their ability to assimilate nutrients and resist anthropogenic impacts. Some of these characteristics include, but are not limited to: flow, gradient, canopy cover, substrate type, water clarity, pH, dissolved oxygen, channel stability, temperature, spatial and temporal variability, and trophic status. Furthermore, large, generalized data sets, such as EPA's regional database, do not account for the natural conditions of aquatic ecosystems. Therefore, criteria established under the National Strategy may be based on unnatural reference conditions. The National Strategy also makes no attempt to determine levels for predicting excessive levels of benthic algae. Finally, generalized nutrient criteria do not provide mechanisms for predicting or differentiating between in-stream total nutrient concentrations attributable to non-point versus point sources.

In 2001, EPA requested each state and authorized tribe to develop a Nutrient Criteria Development Plan to outline the specific strategies, milestones, and schedule for developing and adopting nutrient criteria, while considering specific situations, needs, and processes. In February of 2005, ADEQ submitted the State of Arkansas Draft Nutrient Criteria Development Plan to EPA Region 6, which was mutually agreed upon July 17, 2008.

Study Purpose

The purpose of this study was to evaluate/validate the procedures outlined in the State of Arkansas Nutrient Criteria Development Plan. The primary objective of this pilot study was to describe a process of identifying water quality indicators for use in evaluating waterbodies for nutrient impacts beginning with the upper Saline River watershed in central Arkansas (HUC 08040203) (Figure 1).

Study Area

The upper Saline River watershed consists of four main tributaries: the North Fork Saline River, which drains the predominately forested eastern portion of the watershed; the Alum Fork Saline River, which drains the central portion of the watershed and is impounded in the uppermost reaches to form Lake Winona; the Middle Fork Saline River, which drains the western most portion of the watershed; and the South Fork Saline River, which is the southern most tributary. All four forks occur within the Ouachita Mountains ecoregion of Arkansas, which is classified as part of Ecoregion XI, or the Central and Forested Uplands Ecoregion, by the EPA's National Strategy (Table 1). North Fork is the largest of the upper Saline River tributaries with a drainage area of 182 mi^2, followed by Alum Fork, South Fork, and Middle Forks, which drain 169 mi^2, 167 mi^2, and 107 mi^2, respectively.

The upper Saline River watershed was selected as the pilot study for the rivers and streams of the State for several reasons. All four forks of the Saline River are recognized by APCEC as both Extraordinary Resource Waters (ERW) and Ecologically Sensitive Waterbodies (ESW) under Regulation No. 2. In 1982, the National Park Service designated all four forks and the main stem Saline River as Nationwide Rivers Inventory (NRI) streams for their remarkable scenic, recreational, fish, wildlife, historic, and/or geologic values (NPS 2004). Despite the apparent pristine conditions of the upper Saline River watershed, several point sources of nutrients exist throughout each tributary, which create reaches of nutrient enrichment, specifically within the Middle Fork Saline River (Galloway et al. 2008). Because the upper Saline River watershed contains both least disturbed and relatively enriched reaches it provides ideal conditions for the evaluation and subsequent determination of nutrient enrichment criteria.

Another desirable quality of this watershed is the large amount of available data. Intensive water quality monitoring has been conducted in the upper Saline River watershed, providing ADEQ with a long-term dataset. From July 1993 until September 1994, ADEQ conducted a survey of the upper Saline River watershed in an effort to characterize the water quality conditions and evaluate designated use attainment of the North Fork (ADEQ 1995). The study found that the water quality in the upper Saline River forks were of excellent quality. From 2003 to 2005, ADEQ collaborated with the U.S. Geological Survey (USGS) to assess the nutrient concentration and aquatic life of the Middle Fork Saline River watershed and potential impacts of Hot Springs Village (Galloway et al. 2008). The study found that nutrient concentrations were generally greatest in the Middle Fork immediately downstream from its confluence with Mill Creek below Hot Springs Villages' wastewater treatment facility, but dissipated farther downstream, likely due to dilution and algal uptake.

Land Use

Percentages of land coverage types within each sub-watershed were calculated from a 2006 Land-Use-Land-Cover Geographic Information System (GIS) layer (Center for Advanced Spatial Technologies 2010). Land coverage in all four watersheds is composed primarily of forest, with silviculture as the most common land use type (Figures 2-5). The Alum Fork watershed has the largest percentage of forested area

(91%) and lowest percentage of urban land use (<1%). Conversely, the South Fork Saline River watershed contains the highest percentage of urban land use (15%), and lowest percentage of forested area (72%). Percentages of barren land, herbaceous, and agriculture (row crop and pastureland) coverages were all comparable among the four sub-watersheds.

Active NPDES permits were enumerated for each sub-watershed using the 2008 Integrated Water Quality Monitoring and Assessment Report (ADEQ 2008). Locations of confined animal feeding operations (CAFOs) were derived from a 2006 GIS layer (CAST 2010). The number of NPDES permitted facilities and CAFOs were divided by each respective watershed area to estimate site density (number sites per square mile) (Table 2).

Table 2. Cumulative percentages of land use, land coverage, and watershed size for the four sub-watersheds of the upper Saline River watershed.

Basin	Watershed area (mi^2)	Perc. Urban	Perc. Barren Land	Perc. Water	Perc. Herbaceous	Perc. Forest	Perc. Agriculture/Cropland	Perc. Other	No. CAFO	CAFO/mi^2	No. Permitted Facilities	NPF/mi^2
Alum Fork	169	1.01	2.47	1.15	6.35	91.00	0.04	4.44	2	0.01	0	0
North Fork	182	8.47	0.10	1.08	5.50	77.35	0.10	7.37	1	0.01	4	0.02
Middle Fork	107	10.52	0.05	1.08	6.93	75.75	0.09	5.58	0	0.00	4	0.04
South Fork	167	15.34	0.09	1.04	4.14	72.20	0.12	7.05	7	0.04	4	0.02

Geology

Womble Shales comprise the majority of the geologic formations within the upper Saline River watershed. Blakely Sandstone Formations are located along the fringes of the watershed, and a Jackfork Sandstone Formation underlies the upper Alum Fork area. These formations are the foundations for the eight major soil units within the watershed, which range from soils that are poorly drained to excessively drained; gravelly, stone to loamy soils, and steep sloped to nearly level soils. Elevations range from 1,800 feet above mean sea level near Lake Winona to 270 feet near the City of Benton.

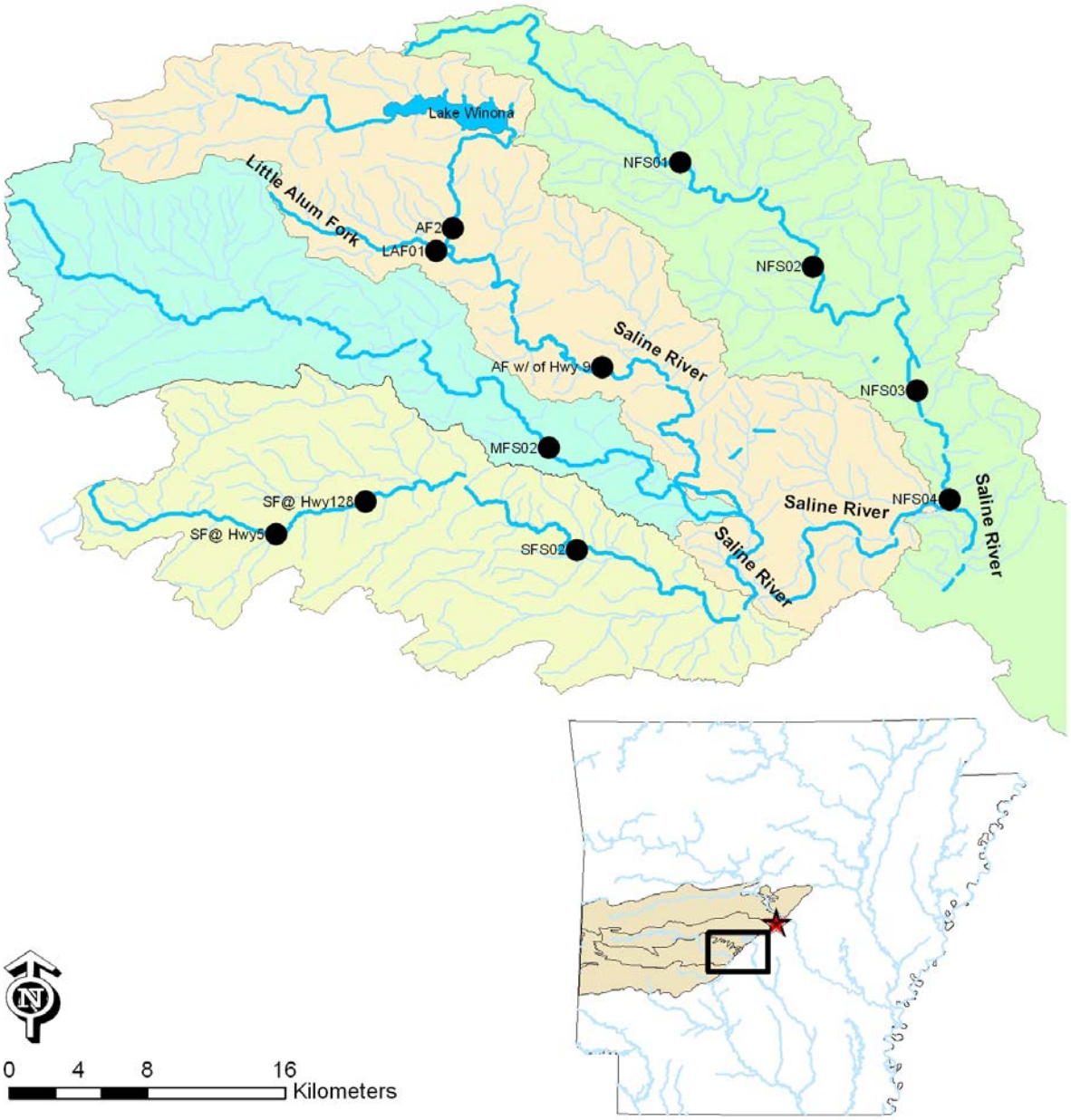

Figure 1. Eleven sampling locations were distributed among the four drainages of the upper Saline River watershed, which is located in the Ouachita Mountain Ecoregion of Arkansas.

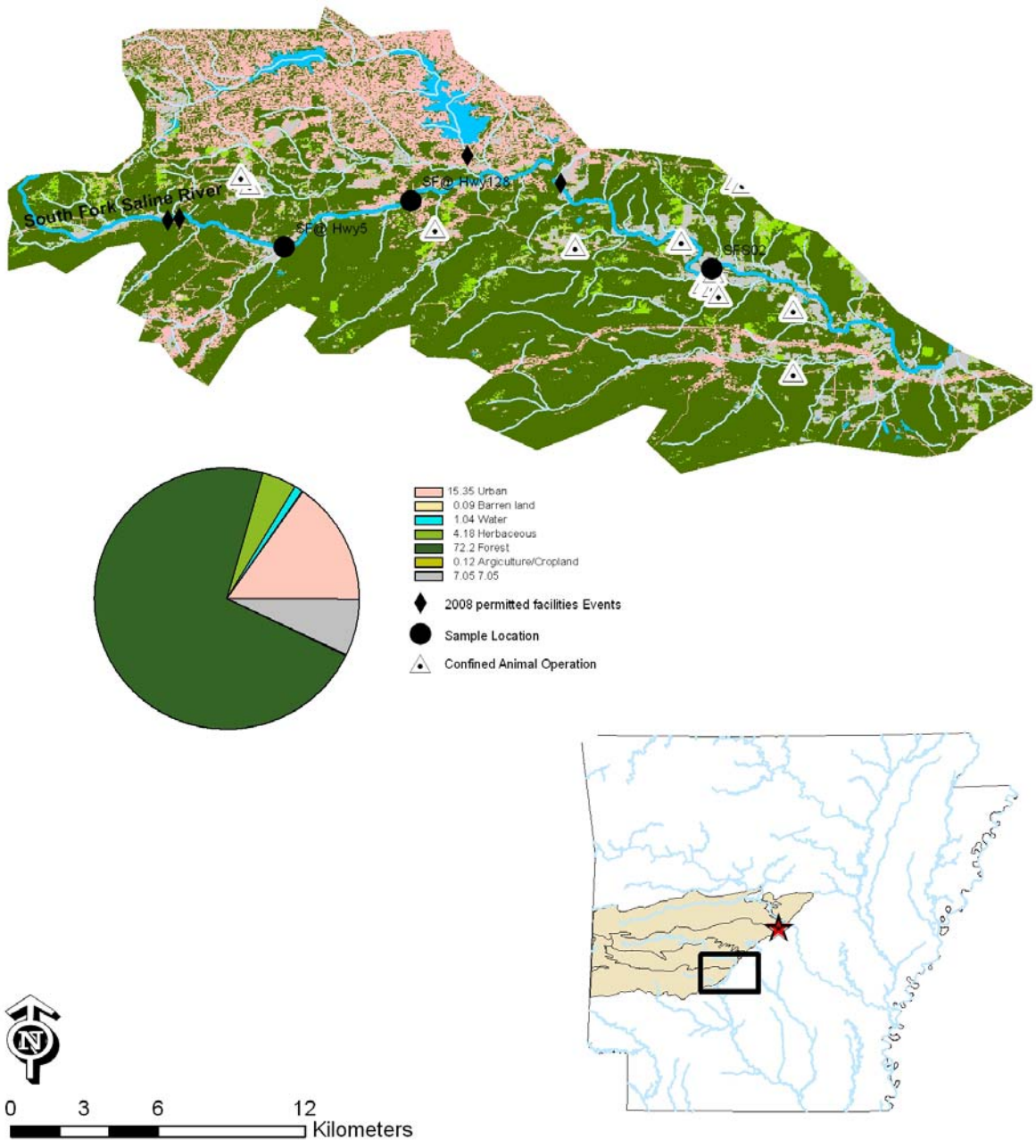

Figure 2. Land use, CAFOs, NPDES permitted facilities, and sample locations for the South Fork Saline River.

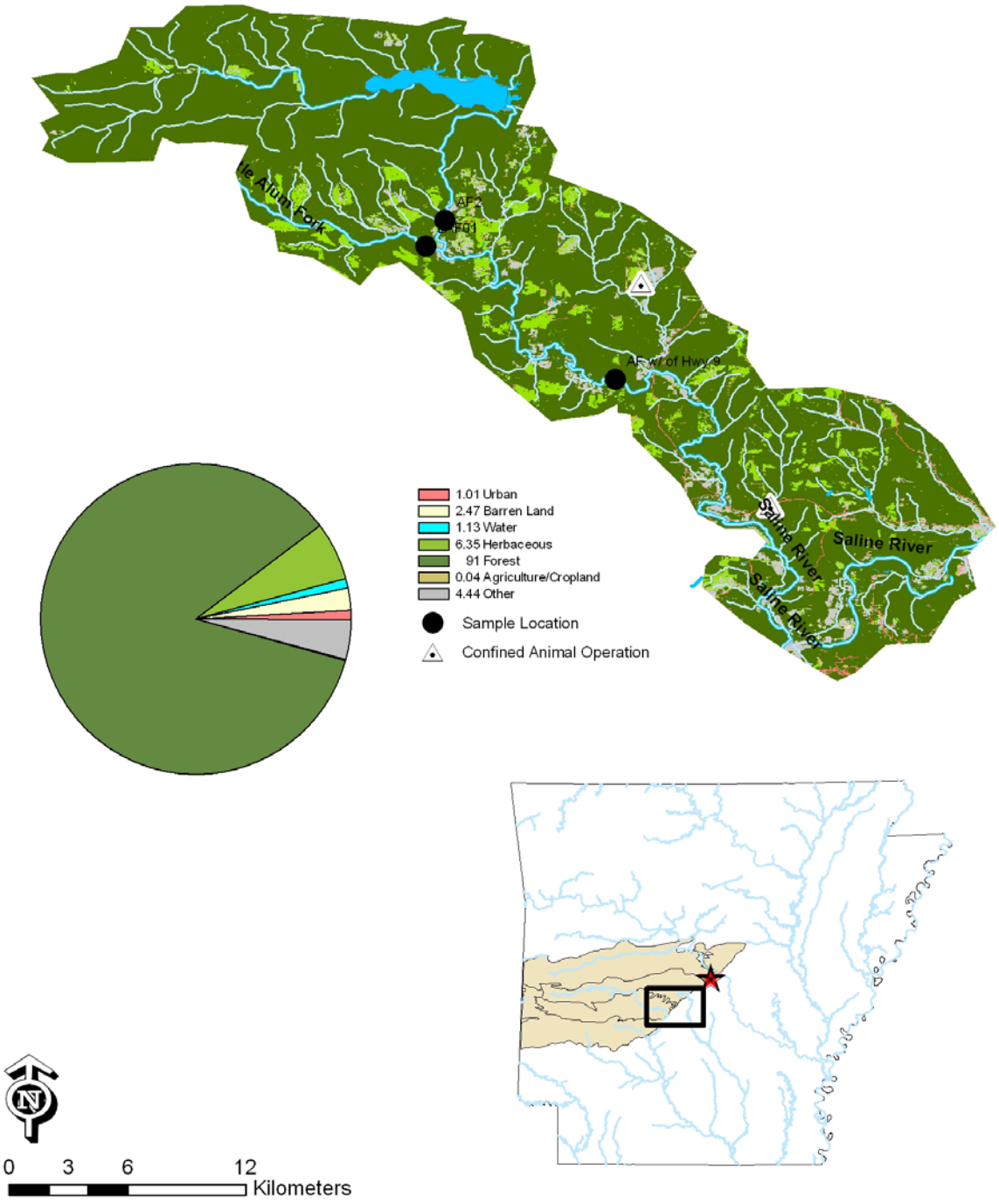

Figure 3. Land use, CAFOs, NPDES permitted facilities, and sample locations for the Alum Fork Saline River.

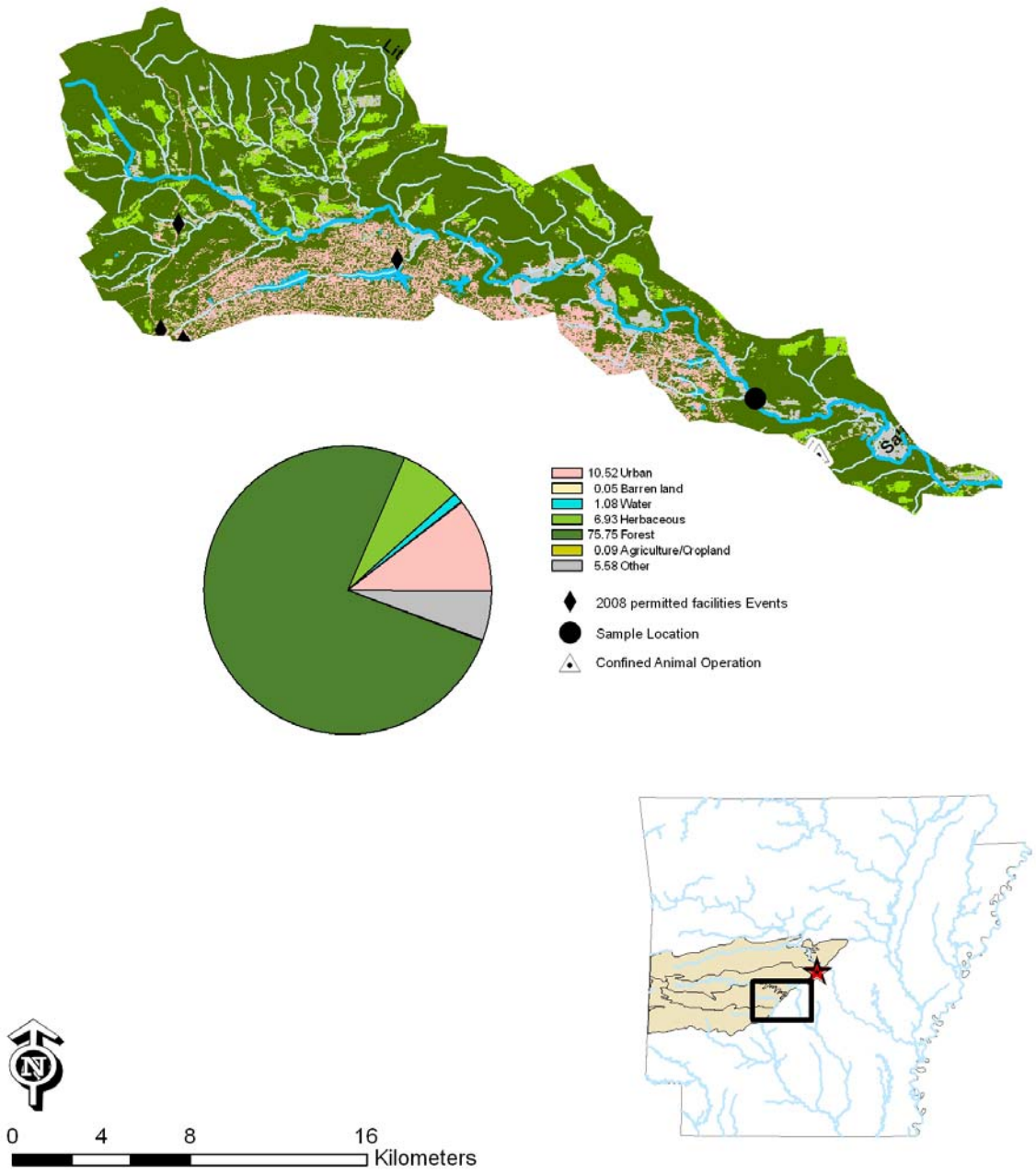

Figure 4. Land use, CAFOs, NPDES permitted facilities, and sample locations for the Middle Fork Saline River.

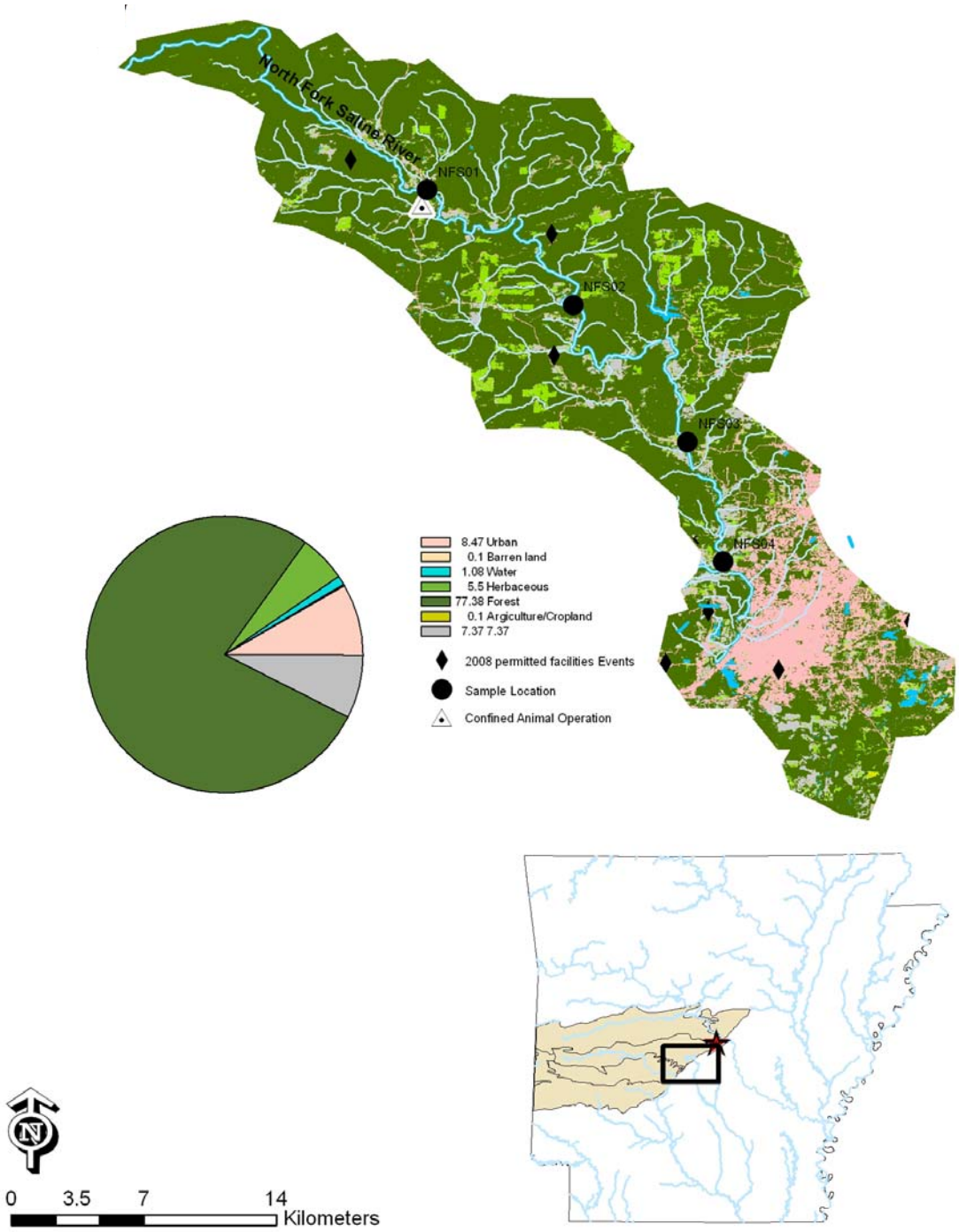

Figure 5. Land use, CAFOs, NPDES permitted facilities, and sample locations for the North Fork Saline River.

SAMPLING METHODOLOGY

A three-level approach was employed to evaluate the ecological conditions of each site. Level I assessments involved gathering and organizing water quality data and establishing standards (25^{th} and 75^{th} percentiles for each variable) against which site-wise water quality parameters could be compared. Sample sites for the Level II assessment were determined based on adherence to the standards established by the Level I assessment. Sites where water quality conditions fell into or below the 25^{th} percentile were chosen to represent least-disturbed conditions. Sites that exceeded the 75^{th} percentile, as well as dissolved oxygen and turbidity standards set by APCEC Regulation No. 2, were also included as candidates for Level II sampling as nutrient enriched sites.

Level II assessments were used to characterize the water quality conditions of 25^{th} and 75^{th} percentile sites. These assessments involved performing *in situ* water quality and instream habitat assessments, and included 72-hour diurnal dissolved oxygen measurements and water quality sampling during the critical season (when the water temperature exceeds 22^{o} C).

Level III assessments involved intensive physical, chemical, and biological field surveys. This level required a second sampling of critical season water quality. It also required macroinvertebrate community sampling during the early spring and late fall, and fish community sampling in late summer at sites that do not substantially desiccate during the critical season. Biological metrics were used as response variables in bivariate and multivariate community analyses, and generalized characterizations of ecological integrity were made based on each of the above indicators.

A combination of two approaches suggested by EPA (EPA 2001) and modified to fit ADEQ's nutrient criteria development approach were utilized to meet the following objectives:

1) Develop numeric nutrient criteria that fully recognize localized conditions to protect specific designated uses using EPA's Technical Manual.

2) Develop a scientifically defensible methodology utilizing:
   a. Causality-based studies to identify quantitative relationships
   b. Empirical approaches
   c. Appropriate conceptual and statistical models
   d. Appropriate spatial and temporal scales
   e. Other

Sampling Design for Potential Nutrient Impacted and Least-Disturbed Sites

Level I

Level I assessments required calculating 25th and 75th percentiles of the past ten years' worth of data from ADEQ's water quality database for roving and ambient water quality monitoring sites. Data collected outside of the critical season were excluded from these calculations as per APCEC Regulation No. 2. Water quality parameters and associated criteria include:

- Dissolved oxygen less than water quality standard (6 mg/L) (Reg. 2.505)
- The 25th and 75th percentiles of the following parameters measured were reviewed:
  - Total Kjeldahl nitrogen (TKN)
  - Nitrite + nitrate-nitrogen (NO_2+NO_3-N)
  - Ammonia as nitrogen (NH_4-N)
  - Total phosphate as phosphorus (TP)
  - Ortho-phosphate as phosphorus (OP)
  - Total organic carbon (TOC)
  - Turbidity
  - Total dissolved solids (TDS)
  - Total suspended solids (TSS

Level I assessments characterize water quality trends for each ecoregion and summarize sites that may potentially require additional field assessments. Sites that exceeded the 25th and 75th percentile in three or more of the above parameters were included as candidates for Level II assessment.

Level II

Level II assessments consisted of a minimum of two site visits to collect the following data:

- Photo documentation
- 72-hour diurnal dissolved oxygen
- pH
- Water temperature
- Potential nutrient sources
- Nitrite + nitrate-nitrogen (NO_2+NO_3 – N)
- Ammonia as nitrogen (NH-$_4$-N)
- Total Kjeldahl nitrogen (TKN)
- Total phosphate as phosphorus (TP)
- Ortho-phosphate as phosphorus (OP)
- Total organic carbon (TOC)
- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Periphyton thickness
- Percent canopy cover*
- Bank stability*
- Riparian habitat*
- Vegetative protection*
- Percentage of algal cover*
- Algal filament length
- Turbidity

*These physical measurements are indices estimated in the field based on Rapid Bioassement Protocol (RPB) (Barbour et al. 2002).

All water quality data, including diurnal data, were collected during the months of June through early October when water temperatures were greater than 22^{o}C.

Potentially nutrient impacted and least-disturbed sites would require a Level III assessment if three or more of the following conditions are observed:

- Algal cover > 50% in nutrient impacted, or < 50% in least-disturbed
- Periphyton thickness > 0.5 - 1.0 mm in nutrient impacted, or < 0.5 - 1.0 mm in least-disturbed
- Algal filament length > 4 inches in nutrient impacted, or < 4 inches in least-disturbed
- pH < 6 su or > 9 su in nutrient impacted, or > 6 su or < 9 su in least-disturbed
- Nitrite + nitrate-nitrogen (NO_2 +NO_3 – N) greater than the 75th percentile or less than the 25th percentile
- Total phosphorus (TP) greater than the 75th percentile or less than the 25th percentile
- Ortho-phosphate as phosphorus greater than the 75th percentile or less than the 25th percentile
- 72 hour diurnal dissolved oxygen:
    - Dissolved oxygen > 125% saturation in nutrient impacted, or < 125% in least-disturbed
    - Dissolved oxygen (mg/L) less than or greater water quality standard of 6.0 mg/L (Reg. 2.505)
- Turbidity greater than or less than water quality standard of 10 NTU (Reg. 2.503)

Level III

During the critical season, a comprehensive assessment of water quality and the aquatic life was conducted. This included, but was not limited to, sampling of the following parameters: water temperature; pH; dissolved oxygen (mg/L); percent canopy; and 72-hour diurnal dissolved oxygen, pH, and water temperature (using YSI Data Sondes). As indicated by the Level II assessment, the aquatic life communities, particularly benthic macroinvertebrates and fish, were collected with coinciding habitat and water quality samples for metals, anions, field and routine parameters. Detailed methodologies for the sampling of aquatic life communities are discussed in the next section of this report. These data were not used directly to make nutrient evaluations, but were used to make correlations between water quality and any changes in the macroinvertebrate communities that were not correlated to other factors.

Following the completion of the Level III assessment, the following parameters were considered for use in determining nutrient impacted and least-disturbed sites (three or more of the following should occur):

- pH between 6 su and 9 su
- Dissolved oxygen concentration (mg/L) meets water quality standards (Reg. 2.505)
- Dissolved oxygen saturation < 125%
- Nitrite + nitrate-nitrogen (NO_2 +NO_3 – N) is at or below the 25th percentile

- Total phosphorus (TP) is at or below the 25th percentile
- Ortho-phosphate as phosphorus is at or below the 25th percentile
- Algal cover < 50%
- Algal filament length < 4 in
- Periphyton thickness < 0.5 mm
- Aquatic life
    - Macroinvertebrate community metrics
    - Similarity to ADEQ Ecoregion Fish and Macroinvertebrate Reference Streams

Water-Quality Data Collection

All water quality samples were collected, processed, and analyzed per the methodologies in Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan (ADEQ 2010).

In situ measurements included pH, dissolved oxygen (mg/L and percent saturation), water temperature (°C), and conductivity (µS/cm^3).

Water quality samples were analyzed for:

Ammonia as Nitrogen (mg/L)	Aluminum (µg/L)	Magnesium (µg/L)
Chlorides (mg/L)	Barium (µg/L)	Manganese (mg/L)
Nitrate-Nitrite as Nitrogen (mg/L)	Beryllium (µg/L)	Nickel (µg/L)
Ortho-phosphate as Phosphorus (mg/L)	Boron (µg/L)	Potassium (mg/L)
Sulfates (mg/L)	Cadmium (µg/L)	Sodium (mg/L)
Total Dissolved Solids (TDS) (mg/L)	Calcium (mg/L)	Vanadium (µg/L)
Total Hardness (mg/L)	Chromium (µg/L)	Zinc (µg/L)
Total Organic Carbon (mg/L)	Cobalt (µg/L)	
Total Phosphorus (TP)(mg/L)	Copper (µg/L)	
Total Suspended Solids (TSS) (mg/L)	Iron (µg/L)	
Turbidity (NTU)	Lead (µg/L)	

Aquatic Life Data Collection

All benthic macroinvertebrate and fish samples were collected, processed, and analyzed per the methodologies in Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan (QAPP) (ADEQ 2010).

Benthic Macroinvertebrate Communities

Macroinvertebrate communites were sampled following ADEQ's Standard Operating Procedure for wadeable streams (located in the 2010 QAPP); with collections following the systematic transect methodology (ADEQ 2010).

Fish Communities

Depending on stream size, fish communities were sampled with either a Smith-Root model 15-B backpack electrofishing device or a Smith-Root GPP 5.0 portable electrofisher barge unit with pulsed DC current. Samples were collected from all available habitats in the summer of 2008. Crews consisted of six to eight workers: two to three to operate probes or carry backpacks, two to three to net stunned fish, one to steer the barge when applicable, and one to carry a bucket for stunned fish. Reaches of 250 to 500 meters were sampled from downstream to upstream. In riffles, two workers positioned a twenty-foot seine at the toe of the riffle while other workers electrofished and disturbed substrate; this allowed stunned fish to drift downstream into the net. This method proved more effective at sampling riffles than the traditional method of hand-netting stunned individuals.

Reaches were electrofished until the crew leader determined all meso- (i.e. pool, riffle, run) and microhabitats (i.e. pool tails and margins, glides, etc…) had been sufficiently represented in the sample. When possible, large individuals (≥ 250 mm) were identified to species in the field and released. Remaining individuals were preserved in 10% formalin and transported to the ADEQ biology lab for identification. Fish were identified to the lowest possible taxonomic level following Robison and Buchanan (1988) and nomenclature followed (Nelson et al. 2004).

Physical Habitat

Benthic Macroinvertebrate Community Habitat

A two-tier approach was employed to evaluate aquatic macroinvertebrate habitat for all study streams. This approach employs more quantitative data collection, which allowed for a higher level of precision when comparing sites. Physical habitat data were used to calculate metrics on the following attributes: wetted width and mean channel depth; bank characteristics; substrate embeddedness, mean diameter, and stability; in-channel cover; channel habitat types; and riparian vegetation structure, complexity and disturbance. The close connectivity of various parameters should impact multiple metrics if habitat alteration is occurring.

Tier one used an observational (qualitative) approach to assessing various habitat parameters that assigns a numeric score (0-20) to each parameter (Barbour et al. 1999). Scores were separated into four broad categories/conditions consisting of poor (0-5), marginal (6-10), sub-optimal (11-15), and optimal (16-20). Epifaunal substrate/available cover, sediment deposition, channel flow status, channel alteration, bank stability, vegetative protection, riparian vegetative zone width, frequency of riffles (or bends), velocity/depth regime, and embeddedness were assessed in all streams.

Tier two combined both a qualitative (visual estimates) and quantitative (in-stream measurements) approach to developing a habitat profile for each sample reach based on several broad categories. These categories include measurements/estimates of the in-channel cover, substrate, canopy cover, large woody debris within bankfull width, flow,

visual riparian quality, and human influence estimates. Wetted widths were measured on 10 transects spaced 10 meters apart. Flow velocity and depth were measured at 10 equidistant points along furthest upstream transect.

No physical habitat activities were conducted in the stream until all biological collections were completed. Any deviations from the previously mentioned methods were noted in the project field notebook. All information was recorded in the field on appropriate data forms. A photograph was taken at each site.

Fish Community Habitat

Fish habitat evaluations were performed at all study sites and consisted of five variable suites, each consisting of three to seven variables. These suites included: 1) habitat type, 2) habitat quantity, 3) substrate quantity, 4) instream cover availability, and 5) embededness. Measures of substrate type and instream cover were given a score depending on its abundance. Scores given to substrate variables were multiplied by an adjustment factor based relatively to fish habitat quality. Length, depth, and width measurements were estimated for each habitat type.

A total score for each habitat type was calculated by summing the scores for the substrate type, instream cover, and sediment on substrate embededness. The scores from similar habitat types were averaged for each site. The lengths of each habitat type were also summed. Total habitat type lengths were divided by 100 and multiplied by the average habitat type score.

Data Analyses

Water-Quality

Water quality analytical procedures are discussed in detail in *Arkansas's Assessment Methodology for the Preparation of the 2010 Integrated Water Quality Monitoring and Assessment Report*. This information can be found in the 2010 Integrated Water Quality Monitoring and Assessment Report, available online at http://www.adeq.state.ar.us/water.

Benthic Macroinvertebrate Communities

Analyses of the benthic macroinvertebrate communities consisted of relating 23 response metrics to various measures of nutrient enrichment among sites and Ouachita Mountain Ecoregion reference streams (Table 3). Metrics measured included, but were not limited to: taxa richness, abundance, percent tolerant/intolerant taxa, percent Ephemeroptera, Plecoptera, Trichoptera, percent Diptera, percent Chironomidae, and Hilsenhoff Biotic Index (HBI). Tolerance values from 0-3 were classified as intolerant and values from 7-10 were calssified as tolerant (Barbour et al. 1999). The HBI was developed by Hilsenhoff (1977) to summarize overall organic pollution tolerance of the benthic arthropod community with a single value (Table 4). Currently, the HBI is used to detect organic loading and low dissolved oxygen in lotic systems. Calculation of the HBI is completed by summing the number in a given taxa multiplied by its tolerance value, and then dividing by the total number of organisms in the sample.

Table 3. Definitions of metrics and expected direction of metric response to increasing perturbation of Arkansas's six major ecoregions. Metrics in bold were selected based on low variability and high discriminatory power (ADEQ unpublished data).

Category	Metric	Definition	Expected response to increasing perturbation
Richness Measures	**No. of taxa**	**Measures the overall variety of the macroinvertebrate assemblage**	**Decrease**
	No. of EPT taxa	**Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)**	**Decrease**
	No. of Ephemeroptera taxa	Number of taxa of mayfly nymphs	Decrease
	No. of Plecoptera taxa	Number of taxa of stonefly nymphs	Decrease
	No. of Trichoptera taxa	Number of taxa of caddisfly larvae	Decrease
	No. of Coleoptera taxa	Number of beetle taxa (adult and larval)	Decrease
	No. of Diptera taxa	Number of taxa of classified as dipterans	Decrease
Composition Measures	Shannon-Weiner Index	Incorporates both richness and evenness in a measure of general diversity and composition	Decrease
	% Dominant taxon	**Measure the dominance of the single most abundant taxon**	**Increase**
	% EPT	Percent of mayfly nymphs, stonefly nymphs and caddisfly larvae	Decrease
	% Ephemeroptera	Relative abundance of mayfly larvae	Decrease
	% Plecoptera	Relative abundance of stonefly larvae	Decrease
	% Trichoptera	Relative abundance of caddisfly larvae	Decrease
	% Diptera	**Relative abundance of dipterans**	**Increase**
	% Chironomidae	Relative abundance of midge larvae	Increase
	% Isopoda	Relative abundance of isopods	Increase
Tolerance Measures	**Hilsenhoff Biotic Index**	**Tolerance value multiplied by number of organisms divided by total number of organisms**	**Increase**
	No. Intolerant taxa	Number of taxa with a tolerance value < 3	Decrease
	% Tolerant taxa	Relative abundance of taxa with a tolerance value ≥ 7	Increase
Trophic Measures	% Shredders	Percent of the shredder functional feeding group	Decrease
	% Collectors	**Percent of the collector functional feeding group**	**Variable**
	% Filterers	Percent of the filterer functional feeding group	Decrease
	% Scrapers	Percent of the scraper functional feeding group	Decrease
	% Predator	Percent of the predator functional feeding group	Variable

Table 4. Degrees of organic pollution based on HBI scores.

Score	Interpretation	Degree of Perturbation
3.51 – 4.50	Very good	Possible slight organic pollution
4.51 – 5.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
6.51 – 7.50	Fairly poor	Significant organic pollution
7.51 – 8.50	Poor	Very significant organic pollution
8.51 – 10.0	Very poor	Severe organic pollution

Table 5. Least-disturbed benthic macroinvertebrate community metrics for the Ouachita Mountain ecoregion (ADEQ unpublished data).

	Metric Value				
Metric	**Minimum**	**25th percentile**	**Mean**	**75th percentile**	**Maximum**
			Spring		
HBI	3.35	3.71	3.92	4.24	4.54
No. of taxa	16	20	22	23	28
No. of EPT	10	11	12	14	14
No. of Diptera taxa	1	2	3	4	5
No. of intolerant taxa	5	5	7	9	12
EPT (% relative abundance)	47.8	55.7	61.7	67.2	85.1
Diptera (% relative abundance)	3.7	12.6	18.9	26.9	28.8
Chironomidae (% relative abundance)	3.4	5.2	14.0	20.7	26.1
Isopoda (% relative abundance)	0.0	0.0	0.7	0.9	2.8
Tolerant taxa (% relative abundance)	0.0	0.9	2.9	3.7	7.5
Shredders (% relative abundance)	0.0	0.7	3.3	4.7	8.8
Collectors (% relative abundance)	31.3	37.9	48.7	57.7	70.6
Filterers (% relative abundance)	0.9	2.0	6.5	6.0	25.0
Scrapers (% relative abundance)	11.0	25.2	21.0	37.2	49.5
Predators (% relative abundance)	2.9	7.3	10.3	13.3	18.7
			Fall		
HBI	3.73	4.27	4.36	4.54	4.81
No. of taxa	15	16	20	22	26
No. of EPT	7	8	9	9	11
No. of Diptera taxa	1	2	2	3	4
No. of intolerant taxa	3	4	5	5	6
EPT (% relative abundance)	32.2	57.5	61.6	73.0	74.0
Diptera (% relative abundance)	2.0	5.8	7.0	8.2	102.0
Chironomidae (% relative abundance)	2.0	3.1	4.9	7.0	7.9
Isopoda (% relative abundance)	0.0	0.0	0.0	0.0	0.0
Tolerant taxa (% relative abundance)	3.0	3.9	11.4	19.4	27.1
Shredders (% relative abundance)	0.0	0.0	0.3	0.0	1.2
Collectors (% relative abundance)	26.7	29.4	38.8	48.0	50.4
Filterers (% relative abundance)	4.1	4.7	10.1	13.3	23.6
Scrapers (% relative abundance)	26.8	34.0	41.7	49.0	53.7
Predators (% relative abundance)	3.1	6.3	9.1	12.6	18.6

Fish Communities

As part of Level III assessment, fish communities were evaluated by comparing community structure at each site to the communities of least-disturbed, Ouachita Mountains ecoregion reference streams of similar watershed sizes. A fish community similarity index (CSI) was calculated using parameters based on ecoregion reference stream data to generate the scoring criteria. Seventeen different parameters were compared between each of the communities and the ecoregion stream data (Table 6).

The fish CSI was determined by summing the scores of each metric for each community. The relative scores were developed from average values of data collected from least disturbed ecoregion reference streams to determine similarity (Table 7). The different scores were based on one and two standard deviation units from the average.

Table 6. Fish community biocriteria for the Ouachita Mountain ecoregion.

Ouachita Mountains (>10 mi^2 Watershed)			
Metric (% community, except Diversity Index)	SCORE 4	2	0
Cyprinidae	45 - 60	36 - 46 or 60 - 67	<36 or >67
Ictaluridae	>1[1]	<1 – 0.5[1]	<0.5 or >2% bullheads
Centrarchidae	8 - 26[2]	3 - 8 or 26 - 33[2]	<3 or >33 or >7% Green sunfish
Percidae	>14	8 - 14	<8
Sensitive Individuals	>24	16 - 24	<16
Primary TFL	<48	48 - 58	>58
Key Individuals	>23	20 - 23	<10
Diversity Index	>2.63	2.63 – 2.11	<2.11

1 – no more that 2% bullheads 2 – no more than 7% Green sunfish

Table 7. Fish community scoring criteria for the Ouachita Mountain ecoregion.

Total Score	Similarity Explanation
0-8	Not Similar
9-16	Somewhat Similar
17-24	Generally Similar
25-32	Most Similar

Statistical Analysis

Differences in biotic community metrics between 25th and 75th percentile sites were examined using a Mann-Whitney test at α=0.05. Seasonal variability in macroinvertebrate community metrics were evaluated using a Kruskal-Wallis test at α=0.05. Simple linear regression was used to evaluate trends among land-use and land coverage.

Spearman correlations were used to relate macroinvertebrate and fish community metrics to key nutrient constituents and a combined nutrient index based on total phosphorus and total nitrogen (Justus et al. 2009). Methodologies described by Justus et al. (2009) were followed for this study; however, Microsoft Excel, rather than Primer, was used to standardize data.

Principal components analysis (PCA) (PC-ORD 4.0) was used in an attempt to explain whether nutrient enrichment or other water quality parameters had stronger influences on aquatic life (McCune and Mefford 1999). PCA reduces multivariate data to manageable axes by identifying variance components (as eignen vectors) that describe large portions of datasets. This allows for variables to be combined, thus identifying relationships while eliminating opportunities for spurious correlations to arise. PCA was performed with the CSI and the six selected macroinvertebrate metrics as the primary matrix. Physical habitat and water quality parameters were used as two different secondary matrices.

RESULTS

Water Quality

The critical season of 2008 was plagued by heavy rains from two hurricanes, Gustav and Ike. During a two-week period, approximately 12 inches of rain fell within the upper Saline River watershed (Table 8). Due to the scouring of high flow events, algal communities were nonexistent and thus were removed from this study.

Table 8. USGS gauge of the Alum Fork Saline River at Reform, AR illustrating high flows during the critical seasons of 2008 and 2009.

	Gage height (ft) (Mean)	Discharge (cfs) (Mean)
2005	2.31	0.36
2006	2.34	0.67
2007	2.68	4.9
2008	3.03	86.03
2009	3.1	41.62

The entire year of 2009, including the critical season, was affected by heavy rains. The National Weather Service reported the year of 2009 as the wettest year on record for Arkansas. Central Arkansas received 82 inches of rain, compared to an average of 59 inches. This was evident within the upper Saline watershed (Table 2). Due to the high flow events, algal communities were nonexistent and were removed from this study.

Level I

Most water samples collected in the past 10 years were collected during the 2003-2006 Middle Fork Saline River special project (Galloway et al. 2008). A total of 100 samples from 30 sites, collected from 2003 to 2006, were analyzed to identify 25th and 75th percentiles. Resulting data were used to determine sites in need of Level II sampling (Table 9). Seventeen of the sites were observed to be either at or below the calculated 25th percentile, 12 sites were within the 50th percentile, and the remaining 5 sites were at or above the 75th percentile (Table 9).

Level II

Prior to the initiation of Level II assessment, 11 of the original 17 Level I sites were removed from this study due to inaccessibility, habitat alteration, or desiccation during the critical season. Five replacement sites were selected based on accessibility and data availability (Table 10). A total of 58 water samples were collected from 11 sites during the critical seasons of 2007 and 2008. Five of these sites were within the 25th percentile and two were 75th percentile. The remaining sites were within the 50th percentile, as they did not exceed a minimum of three criteria.

The 25th percentile for nitrite+nitrate nitrogen (NO_2+NO_3) during Level II assessment was 0.03mg/L, with a median of 0.04 mg/L and mean of 0.10 mg/L (SD 0.28) for the two sites; 75th percentile was 0.17 mg/L, with a median of 0.17 mg/L and mean of 0.16 mg/L (SD 0.20). The calculated 25th and 75th percentiles for ortho-phosphate as phosphorus were 0.01 mg/L and 0.03 mg/L, respectively. Median and mean ortho-phosphate as phosphorus for the 25th percentile were 0.01 and 0.01 mg/L (SD 0.01); 75th percentile median and mean were 0.04 and 0.03 mg/L (SD 0.01). The 25th and 75th percentiles for TKN were 0.15 mg/L and 0.28 mg/L, respectively, with a median of 0.22 mg/L. Median total phosphorus was 0.03 mg/L with the 25th and 75th percentile values of 0.02 mg/L and 0.06 mg/L, respectively (Table 10).

Nutrient indices ranged from 0.10 at LAF01 to 0.30 at SFS02 with a median of 0.16. The mean nutrient index was 0.18 (SD 0.07) and was significantly different ($t = -3.63$, $p<0.01$) between the 25th and 75th percentile sites.

During the critical season of 2008, Sondes were deployed for two 72-hour periods to measure dissolved oxygen concentrations, pH, and temperature (Appendix I). On September 8, 2008 dissolved oxygen fluctuations exceeded 2.0 mg/L at one site (South Fork at Hwy 128). During this deployment, dissolved oxygen plummeted over a 12 hour period from 7.41 mg/L to 1.64 mg/L, after which it began to climb above 6.0 mg/L. A second site (NFS03) was below the ecoregion standard of 6.0 mg/L during the entire deployment, with dissolved oxygen concentrations ranging from 5.5 to 4.0 mg/L. Due to extremely high levels of rainfall, Sondes were only deployed once during the 2008 and 2009 critical seasons.

Level III

Level III water quality sampling occurred during the 2009 critical season and was primarily limited to Sonde deployment. Sondes were deployed once at all 11 sites; water samples were collected at the time of deployment. The greatest diurnal dissolved oxygen fluctuations occurred at MFS02, NFS01, and NFS03. Each experienced a fluctuation of nearly 2.0 mg/L. MFS02 and NFS01 were the only two sites with dissolved oxygen concentrations below the Ouachita Mountain ecoregion standard of 6.0 mg/L (Appendix I).

Physical Habitat

Sites exhibited little temporal variability among habitat scores and were categorized as optimal or suboptimal. Habitat values ranged from 76 (marginal) to 172 (optimal) (Table 11). The two lowest scores were observed at NFS03 during fall 2008 and spring 2010; conversely this site had the second highest optimal score, 163, in the spring of 2008. The most probable cause for the variability observed at NFS03 was the habitat assessment of two different individuals. Accordingly, speculation on seasonal variation would be inappropriate.

Aquatic Life

Macroinvertebrate Communities

A total of 10,459 individuals and 187 taxa were collected over five sampling seasons (Appendix II). Highest and lowest taxa richness was observed during spring 2008 at LAF01 and MFS02 with 44 and 13 genera, respectively. Fall 2007 and spring 2008 sampling seasons had consistently lower taxa richness than the remaining three sampling seasons, with the exception of LAF01 in the spring of 2008. Taxa richness among all sampling seasons was comparable to or greater than values for least-disturbed Ouachita Mountain ecoregion reference streams (Table 5, ADEQ, unpublished data).

Percentages of intolerant taxa, or those taxa with tolerance values of 1-3, ranged from 3.3% at SFS02 during spring 2008 to 46.6% at NFS02 during the fall of 2008. Mean values for 25th and 75th percentile sites were 24.7% (SD 0.05) and 17.6% (SD 0.07), respectively, with no significant difference (t= -3.65, p= 0.72). Tolerant taxa (taxa with a tolerance value from 7-10) ranged from a percent relative abundance of 2.9% at LAF01 during the fall of 2007 to 73.2% at NFS04 for spring 2009. Mean tolerant taxa values for 25th percentile and 75th percentile sites were 30.4% and 32.8%, with no significant differences between the two (t_9= -0.53, p= 0.61).

Of the 187 taxa collected, only a small fraction dominated communities at one or more of the sites during all sample seasons. Chironomidae was the dominant taxa at 53% of all sites sampled during all seasons; fall 2007 was the only season during which no sites were dominated by Chironomidae. The second most abundant taxa was *Maccaffertium* (Ephemeroptera: Heptageniidae), occurring in 4 of the 42 sites (9.5%). Of the 75th percentile sites, SFS02 was the only site that was not dominated by Chironomidae during any season. SFS02 was instead dominated by Simuliidae, *Isonychia* (Ephemeroptera: Isonychidae), *Cheumatopsyche* (Trichoptera: Hydropsychidae), and *Hyalella* (Amphipoda: Hyalellidae). All of the 25th percentile sites were dominated by Chironomidae during at least one sample season.

There were no seasonal differences among total taxa (t_3= -0.01, p= 0.99), total EPT taxa (t_3= -0.58, p= 0.60), percent Diptera (t_3= -2.48, p= 0.09), percent dominant taxa (t_3=-0.24, p= 0.82), percent collector/filterer (t_3= 1.61, p= 0.21), or HBI (t_3= -1.05, p= 0.37). The lack of temporal differences allowed for the linear combination of spring and fall data.

Overall mean taxa richness, 29 (SD 3.77), and mean EPT richness, 14 (SD 3.19), were higher among the 25th percentile sites than the 75th percentile sites, with 26 (SD 2.47) and 11 (SD 0.35), respectively. While the two metrics were numerically higher, there was no statistical difference between percentiles of taxa richness (t_9= 0.35, p= 0.73) and EPT richness (t_9= 14.0, p= 0.72). Mean percent Diptera, percent collector/filterer, and HBI values were all higher at 75th percentile sites (Table 12). There were no statistically significant differences between the 25th percentile and the 75th percentile sites among total percent Diptera (t_9= 1.22, p= 0.25), percent dominant taxa (t_9= 0.86, p= 0.41), percent collector/filterer (t= 2.02, p= 0.07), or HBI (t_9= 1.72, p= 0.12) values at α= 0.05.

Fish Community

A total of 14,205 individuals and 50 taxa were collected during the summer of 2009 (Appendix III). Taxa richness ranged from 36 at SFS02 to 17 at AF2 (Table 13). Although Galloway et al. (2008) reported a positive relationship between taxa richness and drainage area in the Middle Fork Saline River, such a phenomenon was not observed during this study. Nonetheless, drainage area may still contribute to community structure variability. Galloway et al. (2008) also reported a total of 42 taxa at MFS02, whereas the current study only observed 29. However, the 13 taxa not present in the current study were represented by five or fewer individuals in the 2008 study by Galloway et al. The unrepresented taxa were evenly distributed between tolerant and intolerant taxa.

Abundances of central stonerollers (C*ampostoma anomalum*), a primary trophic feeding level (TFL) consumer, often increase in reaches with high levels of nutrient enrichment (ADEQ 1997, Petersen 1998, Petersen 2004). Percentages of central stonerollers ranged from 2.6% at NFS02 to 54.0% at AF2. The second most abundant primary trophic level consumer, the bluntnose minnow (*Pimephales notatus*), had lower relative abundance than central stonerollers among all sites except NFS02, where the relative abundance was 11.3%. There were no significant differences between the percentages of Cyprinidae (t_9= -0.86, p= 0.41), TFL species (t_9= -2.00, p= 0.07), and abundances of TFL species (t_9= -0.29, p= 0.78) between 25th percentile and 75th percentile sites.

The number of sensitive taxa ranged from 4 at NFS01 and AF2 to 12 at NFS04. Abundance of sensitive individuals was highest at SFS02 (a 75th percentile site) with 690 sensitive individuals observed, comprising 34.8% of the collected community. The lowest abundance of sensitive individuals (44) was collected at LAF01, which only comprised 7.5% of community. There were no significant differences between the number of sensitive taxa (t_9= -0.91, p= 0.39) and percent relative abundance of sensitive taxa (t_9= -1.45, p= 0.18) at the 25th percentile and 75th percentile sites; however, there were statistically significant differences between the abundance of sensitive individuals at 25th percentile and 75th percentile sites (t_9= -4.65, p <0.01).

Community Structure Index scores ranged from 30 at SFS02 to 16 at LAF01; indicating that all fish communities were from most similar to somewhat similar to Ouachita Mountain ecoregion reference streams (Table 14). Mean CSI values for 25th percentile sites were 21.3 and increased to 28.0 for the 75th percentile sites, with no significant differences (t_9= -2.13, p= 0.06).

Correlations between Nutrient Enrichment and Aquatic Life

Of the eight fish community metrics, only four were correlated to nutrient enrichment. Percent Catostomidae and Shannon-Weaver diversity indices were both positively correlated (r= 0.70, p= 0.02 and r= 0.67, p= 0.02) with total phosphorus, while TFL showed a negative relationship (r= -0.63, p= 0.04) to total phosphorus. The Shannon-Weaver diversity index was the only metric correlated to the nutrient index. While not statistically significant, other correlations were detected between CSI and ortho-phosphate as phosphorus and the nutrient index, percent relative abundance of sensitive

taxa and total phosphorus, percent relative abundance of cyprinids and total phosphorus, percent relative abundance of percids and TKN and nutrient index, and the Shannon-Weaver diversity index and nitrite+nitrate nitrogen (Table 15).

All 23 macroinvertebrate community metrics were related to five nutrient values using Spearman's rho correlations. Independent nutrient variables include nitrite+nitrate nitrogen, total TKN, ortho-phosphate as phosphorus, total phosphorus as phosphorus, and the calculated nutrient index. Significant negative correlations to nitrite+nitrate nitrogen were observed in percent EPT ($r= -0.60$, $p= 0.05$), percent EPT-percent Hydropsychidae ($r= -0.77$, $p= 0.01$), percent shredders ($r= -0.71$, $p= 0.01$), and percent predators ($r= -0.71$, $p= 0.01$). Only HBI ($r= 0.62$, $p= 0.03$) was positively correlated to nitrite+nitrate nitrogen (Table 15). Percent EPT- percent Hydropsychidae and percent predator were negatively correlated to ortho-phosphate as phosphorus ($r= -0.60$, $p= 0.05$ and $r= -0.64$, $p= 0.04$, respectively). Only one metric, percent predators, was correlated with total phosphorus. Macroinvertebrate metrics showed no significant correlations with TKN or the nutrient index, although number of Plecoptera taxa showed a slight negative correlation with TKN, as did percent predators to the nutrient index (Table 16).

Initial PCA clustering of the biological parameters were divided into four groups (Figure 6). SFSO2 comprised Group 1. The site was separated from other groups due to high CSI scores, which are indicative of excellent water quality. Group 2 included AF2, SF5, NFS01, and NFS04; these sites were grouped due to their similarity of high CSI values, macroinvertebrate taxa richness, and number of EPT taxa. However, CSI values were not as high as Group 1 and macroinvertebrate metrics were not as high as in group 3. Group 3 (AF9, NFS02, NFS03, SF128 and LAF01) was separated based on the high quality of the macroinvertebrate metrics, specifically taxa richness and number of EPT taxa and low HBI values. The disconnection of Group 4, MFS02, was based on the high HBI values, high relative abundance of the dominant taxa, and the percentage of dipertan taxa; all of which are indicative of perturbation.

Principal component (PC) 1 had an eigen value of 2.7 and explained 38.9 of the variability. For PC 1, CSI, total taxa abundance, total EPT abundance, percent collector/filter all showed negative correlations; conversely, percent Diptera, percent dominant taxa, and HBI were all positively correlated (Figure 6). The positive and negative correlations observed are most attributable to the expected response of these metrics to perturbation. Principal component 2 explained 27.6 of the variability and had an eigen value of 1.9. Within the second principal component CSI, percent collector/filter, and HBI were positively correlated and total taxa abundance, total EPT abundance, percent Diptera, and percent dominant taxa were negatively correlated. Total variability explained between the two principal components was 66.5%.

The secondary water quality and habitat matrices showed very little association with the main matrix. The secondary habitat matrix exhibited only one association (channel flow status), which was most associated to Group 3 (Figure 7). Therefore, sites that had increased channel flow status generally had higher quality macroinvertebrate

communities. Within the water quality matrix, ortho-phosphate as phosphorus was most associated with Groups 1 and 2, both of which had high CSI scores (Figure 8)

Relationships of Land-Use and Low-Level Nutrient Enrichment

Total phosphorus and turbidity decreased as percent forest increased; an opposite trend was observed with percent urban land-use. Nitrite+nitrate nitrogen increased drastically with an increase in CAFO/mi^2 and percentages of urban land-use.

Increases in the density of CAFOs and NPDES permitted facilities within sub-basins were associated with increased nutrient index levels within that basin. Confined animal feeding operation density was not associated with any land-use type. Permitted facility density was positively related to percentages of urban land-use (Appendix VI).

Table 9. The 25th and 75th percentile values calculated during Level I preliminary investigation.

Actual Sample ID	Nitrite+Nitrate-N (mg/L)	Ortho-phosphate as phosphorus (mg/L)	Total dissolved solids (mg/L)	Total Kjeldahl nitrogen as nitrogen (mg/L)	Total organic carbon (mg/L)	Total phosphorus as phosphorus (mg/L)	Total suspended solids (mg/L)	Turbidity (NTU)
AF-1			28		**4.25**	0.03	1.00	
AFS01	0.08	0.01	101	0.26	3.71	0.03	2.00	
Alum @ Crows	0.01	0.01		0.30		0.02		
Alum below Winona	0.01	0.01		0.28		0.02		
Alum Hwy 229	0.03	0.01	79.17	0.26	3.36	0.04	**9.60**	**17.18**
Alum w/ Hwy 9	0.03	0.01	78	**0.32**	3.65	0.02	**12.40**	1.97
AlumFork@Nickel Bill James	0.01	0.01	93.5	0.19	3.12	0.02	1.90	3.54
MFS01	0.17	0.03	94.31	0.27	3.65	0.05	4.13	6.13
MFS01B	0.16	0.03	100.3	0.25	3.60	0.04	3.44	4.62
MFS02	0.13	0.03	105.85	**0.43**	3.84	0.05	4.35	7.72
MFS03	0.34	**0.07**	104.7	0.27	3.21	**0.10**	4.50	6.49
MFS04	**1.24**	**0.21**	110.75	**0.34**	**4.28**	**0.23**	4.18	7.80
MFS04B	**3.33**	**0.44**	**138.67**	0.27	2.51	**0.47**	6.53	7.47
MFS05	0.03	0.01	**122.7**	0.23	3.47	0.03	3.76	**8.30**
Mill Creek below 04E	**10.70**	**1.47**	195	**0.44**	**4.63**	**1.57**	1.00	1.61
Mill Creek Hwy 128	0.08	0.01	79.5	0.07	0.37	0.03	3.25	1.41
NF-5	0.02	0.01	67.75	**0.33**	3.97	0.02	1.00	4.37
NFS02	0.01	0.01	87.5	0.21	3.36	0.02	1.00	2.42
NFS03	0.04	0.01		0.27		0.02		
NFS04	0.05	0.01	77.33	0.20	3.00	0.02	1.17	2.41
OUA0026	0.03	0.01	81.57	0.25	3.93	0.02	2.47	5.63
OUA0041	**0.54**	**0.06**	93.6	0.33	**4.81**	**0.10**	4.20	**8.04**
S-1	0.01	0.01	74	0.26	3.85	0.02	3.00	6.25
SFS01	0.07	0.01	87.7	0.23	2.70	0.04	3.10	**9.03**
SFS02	**0.47**	**0.06**	92.25	**0.35**	**4.41**	**0.10**	5.20	**11.82**
South Fork Hwy 128	0.05	0.01	75.33	0.26	2.23	0.05	**21.77**	**21.99**
South Fork Hwy 5	0.07	0.01	71.5	0.07	1.03	0.03	1.25	1.36
South Fork Hwy 7	0.15	0.01	57.75	0.18	1.18	0.04	**7.75**	2.35
25th percentile	0.01	0.01	81.5	0.22	2.93	0.02	1.00	2.95
75th percentile	**0.33**	**0.05**	**111.5**	**0.32**	**4.03**	**0.08**	**6.75**	**7.86**

Sites selected for Level II assessment must exceed a parameters percentile a minimum of three times

Table 10. Level II water quality and identification of 25th and 75th percentile streams.

Actual Sample ID	Field pH (SU)	Nitrite+Nitrate-N (mg/L)	Ortho-phosphate as phosphorus (mg/L)	Total Kjeldahl nitrogen as nitrogen (mg/L)	Total phosphorus as phosphorus (mg/L)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%sat)
AF-2	6.81	0.06	0.01	0.23	0.02	4.06	7.6	89.4
Alum w/ Hwy 9	6.66	0.05	0.01	**0.28**	0.04	8.12	6.7	81.2
LAF01	6.98	0.03	0.01	0.15	0.03	2.74	7.5	89.4
MFS02	7.28	0.13	**0.03**	**0.25**	**0.06**	6.44	**5.2**	61.7
NFS01	6.35	0.02	0.01	**0.30**	0.04	6.53	**5.9**	69.1
NFS02	6.10	0.02	0.02	0.24	0.03	2.83	-	-
NFS03	6.96	0.03	0.01	0.21	0.03	7.68	**5.4**	66.5
NFS04	7.22	0.04	0.02	0.22	0.03	7.26	6.8	85.6
SFS02	7.13	**0.21**	**0.03**	0.24	**0.06**	6.86	6.6	77.3
South Fork Hwy 128	7.01	**0.47**	0.02	0.16	0.04	8.38	8.1	94.4
South Fork Hwy 5	6.85	0.14	0.02	0.17	0.05	**12.35**	7.3	85.9
25th percentile	6.79	0.03	0.01	0.17	0.03			
75th percentile	**7.30**	**0.17**	**0.03**	**0.25**	**0.06**			
Ouachita Mtn. ecoregion standard	**6.00**	-	-	-	-	**10.00**	6	125

Table 11. Rapid bioassessment protocol habitat scores for the upper Saline River watershed for 2007-2010.

		Epifaunal Substrate	Embeddedness	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Riffle Frequency	Left Bank Stability	Right Bank Stability	Left Bank Vegetative Zone Width	Right Bank Vegetative Zone Width	Total Score	Characterization
Fall 2007	AF2	16	18	8	18	8	19	16	6	7	9	9	134	Suboptimal
	AF West of Hwy 9	17	19	14	19	14	19	6	5	8	9	9	139	Suboptimal
	LAF01	18	19	17	18	15	13	14	6	7	7	9	143	Optimal
	NFS01	16	17	5	13	17	14	16	7	6	9	9	129	Suboptimal
	SFS02	12	14	15	9	16	13	12	5	8	6	9	119	Suboptimal
	SF at Hwy 5	17	15	17	13	14	13	18	4	7	4	9	131	Suboptimal
Spring 2008	AF2	16	18	8	18	8	19	16	6	7	9	9	134	Suboptimal
	AF West of Hwy 9	18	18	17	13	11	14	14	9	8	9	9	140	Optimal
	LAF01	19	19	17	19	15	20	13	8	9	9	10	158	Optimal
	NFS01	18	14	14	16	9	15	17	9	9	9	9	139	Suboptimal
	NFS03	19	19	20	18	19	19	13	9	7	10	10	163	Optimal
	NFS04	15	18	18	18	19	17	18	8	9	9	8	157	Optimal
	SFS02	18	10	18	10	15	17	15	9	8	10	10	140	Optimal
	SF at Hwy 5	17	7	14	8	8	13	14	5	6	7	7	106	Suboptimal
	MFS02	17	11	17	7	13	13	14	8	5	8	5	118	Suboptimal
Fall 2008	AF2	17	17	18	17	15	16	15	8	8	9	9	149	Optimal
	AF West of Hwy 9	13	16	16	11	16	15	14	6	7	9	9	132	Suboptimal
	LAF01	9	7.5	16	11	12	15	17	8	7	9	9	121	Suboptimal
	NFS01	9	18	13	14	9	14	12	8	7	8	8	120	Suboptimal
	NFS02	12	20	16	10	12	20	14	4	7	8	6	129	Suboptimal
	NFS03	12	4	16	7	7	13	10	7	6	5	7	94	Marginal
	NFS04	17	5	18	10	15	18	15	8	6	8	8	128	Suboptimal
	SF at Hwy 128	15	20	18	19	19	16	12	9	9	9	10	156	Optimal
	SFS02	12	9	10	10	8	15	13	6	7	7	9	106	Suboptimal
	SF at Hwy 5	-	-	-	-	-	-	-	-	-	-	-		
	MFS02	10	7	18	3	12	13	8	6	7	8	9	101	Suboptimal
Spring 2009	AF2	-	-	-	-	-	-	-	-	-	-	-		
	AF West of Hwy 9	17	7	16	13	12	11	8	8	6	9	6	113	Suboptimal
	LAF01	14	19	19	20	20	20	20	10	10	10	10	172	Optimal
	NFS01	16	12	17	18	17	10	17	9	9	7	7	138	Suboptimal
	NFS02	17	11	18	15	15	18	13	6	9	9	7	138	Suboptimal
	NFS03	15	14	19	12	13	10	14	6	7	7	8	125	Suboptimal
	NFS04	15	15	17	11	16	10	14	8	8	6	8	128	Suboptimal
	SF at Hwy 128	13	16	14	17	17	19	18	8	9	8	8	147	Optimal
	SFS02	18	18	17	14	16	15	15	10	9	10	10	152	Optimal
	SF at Hwy 5	15	9	16	11	15	18	10	8	9	9	5	125	Suboptimal

Table 11. Rapid bioassessment protocol habitat scores for the upper Saline River watershed for 2007-2010 (cont.)

		Epifaunal Substrate	Embeddedness	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Riffle Frequency	Left Bank Stability	Right Bank Stability	Left Bank Vegetative Zone Width	Right Bank Vegetative Zone Width	Total Score	Characterization
Fall 2009	MFS02	10	7	10	5	14	16	6	6	8	5	9	96	Suboptimal
	NFS02	14	16	17	10	17	19	15	8	9	9	7	141	Optimal
	NFS03	16	14	12	15	14	13	15	7	8	7	8	129	Suboptimal
	NFS04	16	13	19	5	10	10	18	7	5	8	8	119	Suboptimal
	SF at Hwy 128	14	6	13	16	17	18	19	9	9	6	8	135	Suboptimal
	MFS02	14	9	14	11	14	10	10	5	7	2	5	101	Suboptimal
Spring 2010														
	NFS02	17	16	17	14	12	19	11	5	4	10	7	132	Suboptimal
	NFS03	11	8	8	6	14	9	9	3	3	2	3	76	Marginal
	SF at Hwy 128	12	10	12	18	17	13	15	8	9	2	5	121	Suboptimal

Table 12. Mean (combined spring and fall) metric value of benthic macroinvertebrate communities at sites in the upper Saline River watershed.

	AF-2	Alum w/ Hwy 9	LAF01	NFS01	NFS02	NFS03	NFS04	South Fork Hwy 5	South Fork Hwy 128	MFS02	SFS02
Total Organisms	197	197	261	212	258	204	186	143	286	151	263
Total Taxa	22	22	31	26	33	29	25	24	34	17	27
No. Total EPT	76	76	140	112	103	103	74	66	99	31	123
No. of Ephemeroptera Taxa	3	3	6	5	8	8	7	4	8	4	5
No. of Plecoptera Taxa	2	2	4	2	6	4	2	2	4	1	2
No. of Trichoptera Taxa	3	3	3	3	6	4	4	3	5	2	3
No. EPT Taxa	9	15	15	11	19	15	13	11	17	11	11
% EPT	34.64%	34.64%	52.18%	52.49%	38.97%	52.30%	47.36%	47.11%	34.10%	27.92%	46.48%
% Hydropsychidae	1.81%	1.81%	1.18%	1.44%	2.75%	2.45%	1.41%	7.07%	7.94%	1.59%	14.91%
% EPT - % Hydropsychidae	32.83%	32.83%	51.00%	51.05%	36.23%	49.86%	45.95%	40.04%	26.16%	26.33%	31.57%
% Isopoda	28.13%	28.13%	0.68%	10.23%	0.37%	2.86%	17.14%	0.00%	0.00%	1.02%	2.57%
% Chironomidae	14.17%	14.17%	9.44%	13.37%	28.39%	23.30%	7.87%	18.28%	29.64%	44.19%	10.75%
% Diptera	17.75%	17.75%	12.61%	16.29%	37.41%	27.70%	10.56%	20.97%	38.34%	50.85%	23.76%
% scrapers	17.80%	17.80%	31.17%	42.21%	16.84%	14.21%	28.98%	26.03%	12.65%	13.78%	15.74%
% shredders	7.03%	7.03%	17.26%	12.35%	11.67%	9.12%	25.33%	7.06%	2.01%	1.02%	4.67%
% collector/filter	13.25%	13.25%	6.62%	6.97%	8.92%	7.77%	2.82%	13.80%	13.24%	4.99%	29.49%
% predator	8.47%	8.47%	9.23%	8.57%	10.56%	10.49%	2.70%	5.68%	7.81%	4.48%	3.24%
% Herpobenthos (BU+SP)	30.43%	30.43%	32.23%	34.64%	45.19%	42.96%	41.25%	42.66%	41.84%	75.65%	31.88%
% Haptobenthos (CR+CLG)	70.33%	70.33%	35.40%	68.07%	51.35%	54.32%	65.25%	52.05%	52.08%	24.15%	64.76%
Hilsenhoff Biotic Index (HBI)	5.45	5.45	3.96	4.44	4.54	4.43	4.57	4.52	5.08	5.45	4.94
% Dominant Taxa	32.43%	25.81%	37.42%	30.90%	0.34%	0.26%	36.02%	32.27%	0.20%	21.26%	48.67%
No. Dominant Taxa	70	70	67	70	30	29	52	27	31	88	55
% Inolerant (1-3)	24.77%	24.77%	18.13%	25.01%	29.00%	26.25%	22.55%	27.61%	35.39%	10.69%	20.02%
% Tolerant (7-10)	42.87%	42.87%	10.80%	25.41%	7650.00%	5825.00%	26.24%	19.30%	8875.00%	45.61%	22.02%
SW Diversity Index	5.91	6.92	6.09	4.86	6.20	5.34	4.74	4.66	5.99	2.74	5.85

Table 13. Calculated metric values for the fish communities collected during 2008.

SITE	CSI Score	Total Taxa	Total Individuals	No. Sensitive Taxa	No. Sensitive Individuals	% Sensitive Taxa	% Cyprinidae	% Catostomidae	% Ictaluridae	% Centrachidae	% Percidae	No. TFL	% TFL	No. Key Individuals	% Key Individuals	Diversity Index
LAF01	16	22	589	6	44	7.5	35.1	1.4	2.7	46.5	8.3	107.0	18.2	154	26.1	2.1
AF2	18	17	461	4	52	11.3	59.0	0.2	11.7	13.9	13.9	250.0	54.2	56	12.1	1.6
AF west 9	18	32	2065	10	294	14.2	41.3	3.7	3.1	38.9	11.0	387.0	18.7	862	41.7	3.4
NFS01	20	21	366	4	89	24.3	27.3	1.9	13.7	36.1	6.6	35.0	9.6	141	38.5	3.5
NFS02	18	23	662	7	180	27.2	41.5	4.8	0.0	48.5	1.1	92.0	13.9	403	60.9	3.0
NFS03	26	28	1675	11	423	25.3	59.5	1.4	2.1	27.1	7.7	705.0	42.1	651	38.9	2.9
NFS04	26	33	2656	12	390	14.7	50.7	0.5	1.2	29.3	16.4	857.0	32.3	802	30.2	3.1
SFSat5	24	23	763	8	125	16.4	37.6	3.4	7.2	25.4	23.1	227.0	29.8	173	22.7	2.4
SFSat128	26	24	380	10	144	37.9	32.4	5.5	2.9	31.3	22.4	59.0	15.5	151	39.7	3.6
SFS02	30	36	1981	11	690	34.8	49.9	4.5	1.3	27.1	14.7	506.0	25.5	786	39.7	3.9
MFS02	26	29	2607	9	672	25.8	63.6	3.0	1.7	21.3	7.5	854.0	32.8	900	34.5	3.2
Mean 25th percentile	**21.3**	**24.8**	**1068.6**	**8.0**	**193.4**	**19.9**	**42.7**	**2.5**	**5.0**	**33.0**	**12.3**	**302.1**	**26.0**	**377.0**	**34.5**	**2.8**
Mean 75th percentile	**28.0**	**32.5**	**2294.0**	**10.0**	**681.0**	**30.3**	**56.8**	**3.8**	**1.5**	**24.2**	**11.1**	**680.0**	**29.2**	**843.0**	**37.1**	**3.6**

Table 14. Community Structure Index values for 11 upper Saline River sites; Somewhat Similar (SS), Generally Similar (GS), Most Similar (MS) to Ouachita Mountain ecoregion reference streams.

	LAF01	AF2	AF west 9	NFS01	NFS02	NFS03	NFS04	MFS02	SFSat5	SFSat128	SFS02
% Sensitive Individuals	0	0	0	4	4	4	0	4	2	4	4
% Cyprinidae	0	4	2	0	2	4	4	2	2	0	4
% Ictaluridae	4	4	4	4	0	4	4	4	4	4	4
% Centrachidae	0	4	0	0	0	2	2	4	4	2	2
% Percidae	2	2	2	0	0	0	4	0	4	4	4
% Primary TFL	4	2	2	4	4	4	4	4	4	4	4
% Key Individuals	4	2	4	4	4	4	4	4	2	4	4
Diversity Index	2	0	4	4	4	4	4	4	2	4	4
Biocriteria Score	16	18	18	20	18	26	26	26	24	26	30
	SS	**GS**	**GS**	**GS**	**GS**	**GS**	**GS**	**MS**	**GS**	**MS**	**MS**

Table 15. Spearman rank correlations coefficients between nutrient concentrations and fish community metrics.

	Nitrite-Nitrate		**TKN**		**Ortho-phosphate**		**TP**		**Nutrient Index**	
	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value
CSI	0.30	0.38	-0.13	0.70	*0.54*	*0.09*	0.31	0.35	*0.53*	*0.09*
Total Taxa	-0.07	0.83	0.02	0.95	0.09	0.79	0.14	0.69	0.26	0.45
Total Individuals	-0.41	0.21	-0.07	0.83	-0.14	0.69	-0.20	0.56	-0.09	0.79
No. Sensitive Taxa	-0.17	0.62	-0.13	0.70	0.02	0.96	-0.04	0.90	0.17	0.62
No. Sensitive Individuals	-0.13	0.71	0.15	0.67	0.14	0.69	0.15	0.67	0.15	0.67
% Sensitive Taxa	0.34	0.31	0.11	0.75	0.35	0.30	*0.59*	*0.06*	0.42	0.20
% Cyprinidae	-0.46	0.15	-0.03	0.94	-0.25	0.45	*-0.54*	*0.09*	-0.38	0.25
% Catostomidae	0.37	0.26	0.11	0.75	0.15	0.67	**0.70**	**0.02**	0.45	0.17
% Ictaluridae	0.48	0.13	-0.04	0.92	0.23	0.50	0.05	0.89	0.32	0.34
% Centrarchidae	-0.31	0.36	0.32	0.34	-0.35	0.28	0.13	0.71	-0.32	0.34
% Percidae	0.45	0.16	*-0.55*	*0.08*	0.23	0.50	0.07	0.83	*0.57*	*0.07*
No. TFL	-0.40	0.22	-0.15	0.67	-0.10	0.77	-0.44	0.18	-0.15	0.65
% TFL	-0.25	0.45	-0.34	0.31	-0.12	0.73	**-0.63**	**0.04**	-0.19	0.57
No. Key Individuals	-0.36	0.27	0.02	0.96	-0.09	0.79	-0.03	0.94	-0.04	0.92
% Key Individuals	-0.06	0.85	0.50	0.12	-0.22	0.52	0.35	0.30	0.02	0.96
Diversity Index	*0.53*	*0.10*	0.37	0.26	0.44	0.18	**0.67**	**0.02**	**0.66**	**0.03**

$\alpha<0.05$

Table 16. Spearman rank correlations coefficients between nutrient concentrations and macroinvertebrate community metrics.

Metric	Nitrite-Nitrite		TKN		Ortho-phosphate		TP		Nutrient Index	
	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value	Spearman rho	P-value
Total Organisms	0.03	0.94	0.03	0.94	-0.24	0.48	-0.05	0.89	0.20	0.56
Total Taxa	-0.22	0.52	-0.27	0.42	-0.28	0.41	-0.22	0.51	-0.21	0.53
No. Total EPT	-0.39	0.23	0.13	0.70	-0.45	0.16	-0.21	0.53	-0.14	0.68
No. of Ephemeroptera Taxa	-0.23	0.50	-0.15	0.66	-0.27	0.42	-0.20	0.55	-0.21	0.54
No. of Plecoptera Taxa	-0.23	0.49	*-0.53*	*0.09*	-0.08	0.82	-0.32	0.33	-0.38	0.25
No. of Trichoptera Taxa	-0.35	0.28	-0.36	0.28	-0.27	0.42	-0.36	0.28	-0.38	0.25
No. of EPT Taxa	-0.15	0.67	-0.01	0.98	-0.42	0.20	-0.49	0.12	-0.33	0.32
% EPT	**-0.60**	**0.05**	0.05	0.89	*-0.56*	*0.07*	-0.22	0.52	-0.17	0.61
% Hydropsychidae	0.49	0.13	-0.06	0.85	0.28	0.40	0.36	0.27	0.23	0.50
% EPT - % Hydropsychidae	**-0.77**	**0.01**	-0.04	0.92	**-0.60**	**0.05**	-0.37	0.26	-0.47	0.14
% Isopoda	-0.20	0.56	0.44	0.18	-0.26	0.45	-0.27	0.42	-0.01	0.98
% Chironomidae	0.15	0.67	0.22	0.52	0.01	0.98	0.05	0.89	0.00	1.00
% Diptera	0.31	0.36	0.26	0.43	0.27	0.42	0.25	0.47	0.25	0.45
% scrapers	*-0.54*	*0.09*	-0.08	0.81	-0.44	0.18	-0.23	0.50	-0.23	0.50
% shredders	**-0.67**	**0.02**	-0.39	0.23	-0.25	0.45	-0.42	0.20	-0.45	0.16
% collector/filter	0.31	0.36	0.00	1.00	-0.01	0.98	0.12	0.73	0.11	0.75
% predator	**-0.71**	**0.01**	-0.13	0.71	**-0.64**	**0.04**	**-0.71**	**0.01**	*-0.59*	*0.06*
% Herpobenthos (BU+SP)	-0.10	0.77	-0.04	0.92	0.24	0.48	0.12	0.73	-0.20	0.56
% Haptobenthos (CR+CLG)	-0.05	0.89	0.26	0.43	-0.43	0.19	-0.18	0.59	0.03	0.94
Hilsenhoff Biotic Index (HBI)	**0.65**	**0.03**	0.25	0.47	0.47	0.14	0.31	0.36	0.31	0.36
% Intolerant (1-3)	*-0.54*	*0.09*	-0.17	0.61	-0.48	0.13	-0.43	0.19	-0.43	0.19
% Tolerant (7-10)	0.15	0.65	0.38	0.25	-0.06	0.85	-0.19	0.57	-0.05	0.89
% Dominant Taxa	0.07	0.83	0.02	0.96	0.12	0.73	0.24	0.48	0.14	0.69
Shannon Diversity Index	-0.29	0.39	-0.12	0.73	-0.46	0.15	*-0.54*	*0.09*	-0.32	0.34

$\alpha<0.05$

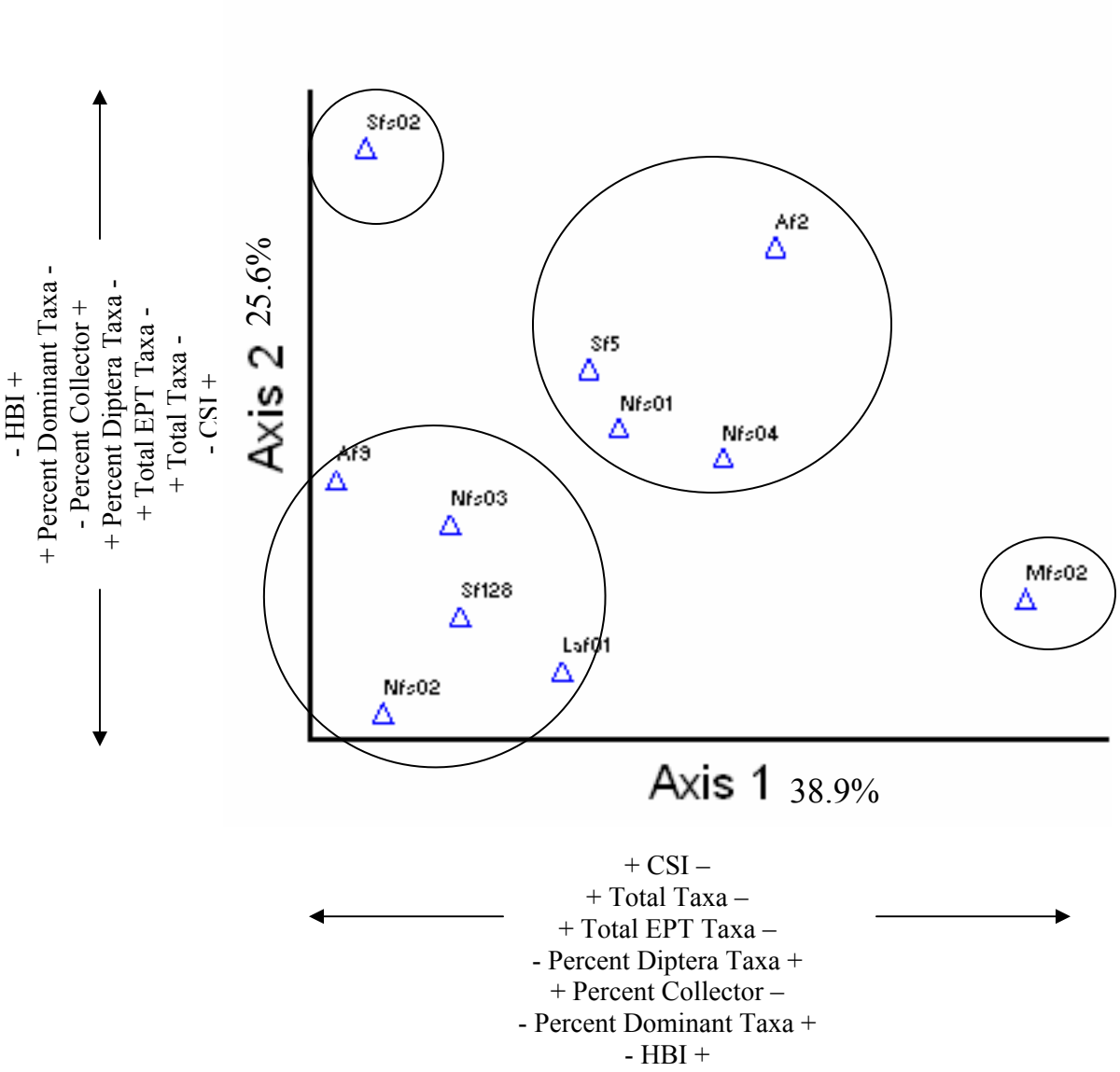

Figure 6. Fish and macroinvertebrate community metric scores of the 11 sites from the upper Saline River watershed were clustered into four distinct groups. Axis 1 and Axis 2 explained 66.5 percent of the variability.

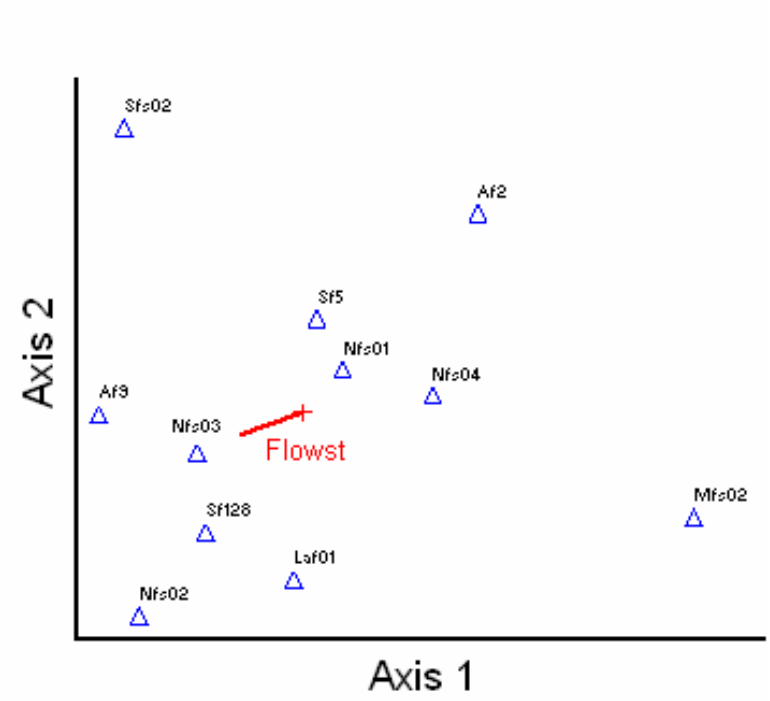

Figure 7. Addition of the habitat rapid bioassessment protocol scores as the secondary matrix indicated sites with high quality of channel flow status.

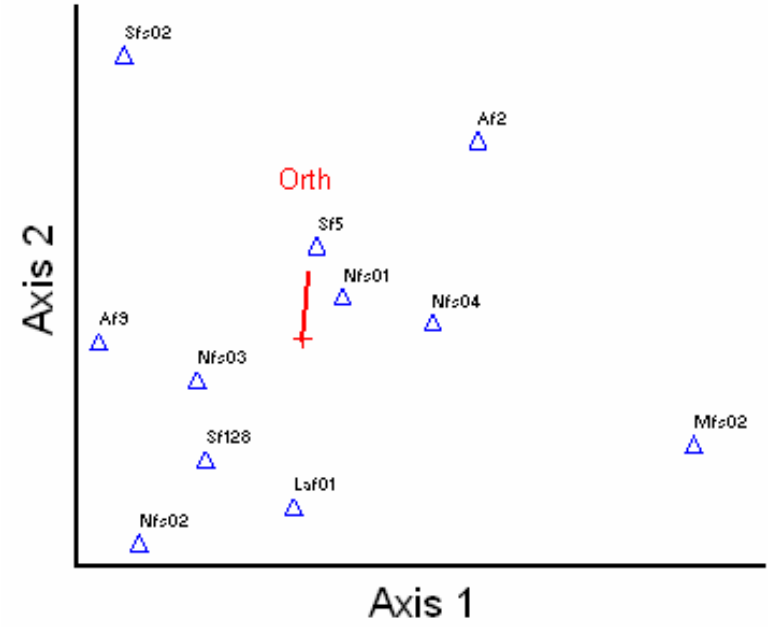

Figure 8. Addition of the nutrient values and nutrient index scores as the secondary matrix indicated sites with elevated levels of ortho-phosphate as phosphorus.

SUMMARY

Nutrient concentrations observed during this study were equal to or less than those of previous studies conducted in the upper Saline River watershed (ADEQ 1995, Galloway et. al 2008). Mean total phosphorus and nitrogen concentrations were, however, higher than values published by EPA for Ecoregion XI and values observed during the Wadeable Stream Assessment. ADEQ's 1995 study found that the North Fork of the Saline River had the least amount of nitrite+nitrate nitrogen of all four forks and was potentially less apt to develop a nuisance algal community. This study also found that the North Fork of the Saline River had the lowest levels of nitrite+nitrate nitrogen, which is most attributable to increasing urbanization in the Alum, Middle, and South Fork watersheds. ADEQ (1995) also reported the lowest concentrations of nitrite+nitrate nitrogen and total phosphorus within the North Fork of the Saline River with highest concentrations observed within the other three forks, particularly the Middle Fork Saline River. In a more recent study of the Middle Fork, Galloway et al. (2008) reported the highest nitrogen and phosphorus loads at MFS02. During that study, the authors reported increased nutrient concentrations at MFS02 were due to a wastewater treatment facility located on Mill Creek, a tributary of the Middle Fork of Saline River.

Dissolved oxygen levels below the ecoregion standard have been previously reported during the critical season for streams within the Ouachita Mountains (ADEQ 1995, Galloway et. al 2008). During this study, dissolved oxygen concentrations fell below 6.0 mg/L at NFS01 and MFS02. Both of which have been reported to have low levels of dissolved oxygen during the critical season. No study to date concludes that these low levels are negatively impacting aquatic life in the upper Saline River watershed. However, during this study the two critical season periods where plagued with heavy rains and thus periphyton communities were not present due to high flows. Therefore, naturally occurring low dissolved oxygen levels could be exacerbated by the increased periphyton communities (Allen 1995).

Macroinvertebrate communities in the upper Saline River watershed showed little spatial or temporal differences. Taxa richness and EPT richness of the 25th percentile were only slightly higher than those of the 75th percentile. On average, several metrics indicative of nutrient or organic enrichment were higher at the 75th percentile sites, but were not statistically significant. Of the two 75th percentile sites the macroinvertebrate community at MFS02 exhibited more signs of impairment; while the community of SFS02 more closely resembled 25th percentile sites and ADEQ reference streams. Galloway et al. (2008) reported similar taxa richness, but lower HBI and dipterian taxa, specifically Chironomidae, among sites.

The small sample size of this study prevented the identification of nutrient concentration thresholds for nutrients using aquatic life. Wang et al. (2007) reported macroinvertebrate thresholds for total phosphorus ranging from 0.09 mg/L for EPT taxa and HBI to 0.04 mg/L for taxa richness in Wisconsin streams. In the same study, total nitrogen thresholds ranged from 0.85 mg/L for taxa richness to 1.68 mg/L for percent EPT taxa. King and Richardson (2003) observed a 20% decrease of percent sensitive taxa at total

phosphorus levels near 0.015 mg/L. In a more recent regional study, Justus et al. (2009) observed that biotic metrics within the Ozark Highlands were inversely related to increased total nitrogen and total phosphorus and were generally higher when total nitrogen and total phosphorus values were below 0.40 mg/L and 0.18 mg/L, respectively. While nitrogen levels for this study were at or below those of previous studies, total phosphorus concentrations were slightly higher than background concentrations reported by Justus et al. (2009). As expected with similar nutrient concentrations, the macroinvertebrate communities within this study exhibited similar inverse relationships to increased nitrogen (nitrite+nitrate nitrogen and TKN), total phosphorus, and the nutrient index. Although relationships existed the threshold of biological impairment was never reached.

Fish communities among the 25th and 75th percentile sites were highly variable. Variability among 25th percentile sites is likely due to instream habitat variability associated with drainage size. An explanation of the higher CSI scores for the 75th percentile sites is more difficult. Many studies report decreased percentages of carnivorous taxa and intolerant taxa and increase of primary feeders with increasing nutrient enrichment (Wang et al. 2007, Justus et al. 2009). The results of this study were slightly opposite. Differences between the 75th percentile sites were noticeable as SFS02 had the highest taxa richness, number of sensitive individuals, and diversity indices. MFS02 was among the lowest for percent percids and the highest for percent cyprinids, of which were dominated by central stonerollers, a strong indicator of nutrient enrichment. The division among the 75th percentile communities suggests that MFS02 may be more impacted by enrichment than SFS02. However, neither site's fish community suggests impairment.

Very few biotic metrics were correlated with individual nutrient values. When combined into indices, however, correlations between nutrient enrichment and fish communities became more apparent. This was not the case for macroinvertebrates, as they were not correlated to the nutrient index, most significant correlations between macroinvertebrate metrics and nutrients were observed with nitrite+nitrate nitrogen.

Principal Components Analysis results indicate that the two 75th percentile sites were not similar and were being driven by different biotic factors, primarily the fish community. Available instream habitat, CAFO, and NPDES facility density, and land-use were less important factors in distinguishing sites using PCA. This study observed influences of land-use on nutrient concentrations. Phosphorus, nitrogen concentrations, and turbidity were negatively related to percent forested land area; while increased urban land-use had an inverse relationship.

IMPLICATIONS

Development of numeric nutrient criteria has become an increasingly important goal among state regulatory agencies. The purpose of this pilot study was to test and refine methodologies outlined in the State of Arkansas Nutrient Criteria Development Plan within the upper Saline River watershed, with the final, long-term objective of developing standard methods to establish statewide numeric nutrient criteria for Arkansas's streams and rivers. Results of this study indicate that the use of weight-of-evidence and the classification of the 75th percentile sites based on water quality in streams with low level nutrient concentrations are inappropriate for the Saline River. The 75th percentile sites exhibited only slightly higher nutrient concentrations and mostly lacked significant differences among the aquatic biota. An alternative to the percentile classification is to use regression modeling (EPA 2000, Dodds and Oakes 2004). Recent studies have identified nutrient thresholds using regression modeling (Wang et al. 2007, Justus et al. 2009). Efforts were made within this study to correlate current ADEQ biotic metrics to nutrient values. Due to the small sample size, only moderate success was observed with the correlation testing, which ultimately prevented the use of this approach to identify thresholds. It is imperative that future studies have a large enough sample size to adequately account for the variability of such stochastic system. While many recommend against the narrowed ecoregion approach, Herlihy and Sifneos (2008) report that broad national criteria are too coarse and should be refined at a finer scale. Arkansas's distinctive geologic composition causes streams in various portions of the state to function very differently from one another. Accordingly, future studies at ADEQ will continue to approach nutrient criteria development at the ecoregion level.

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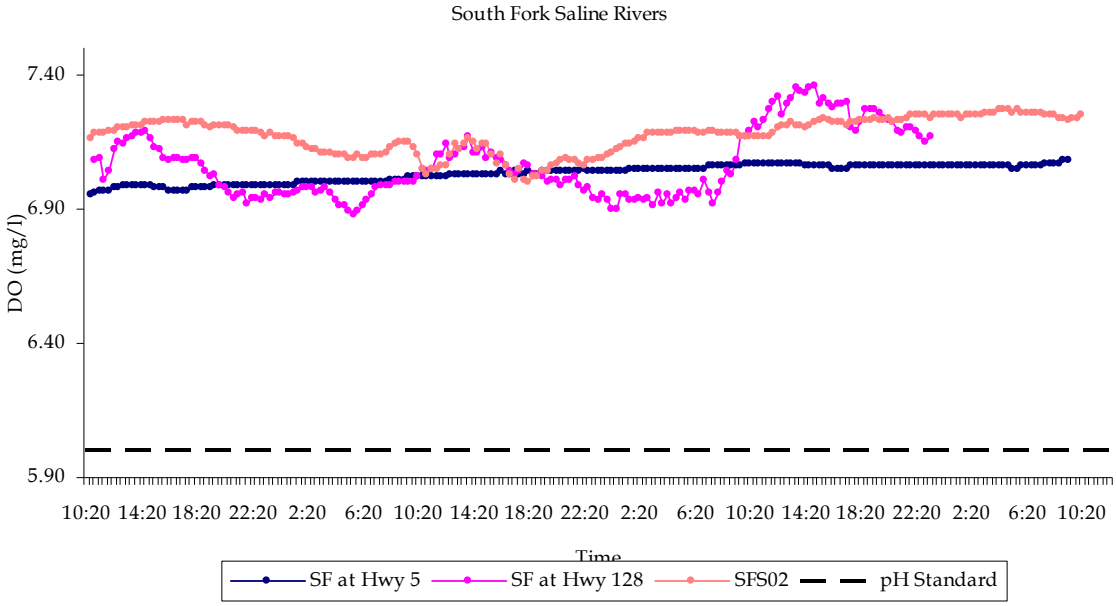
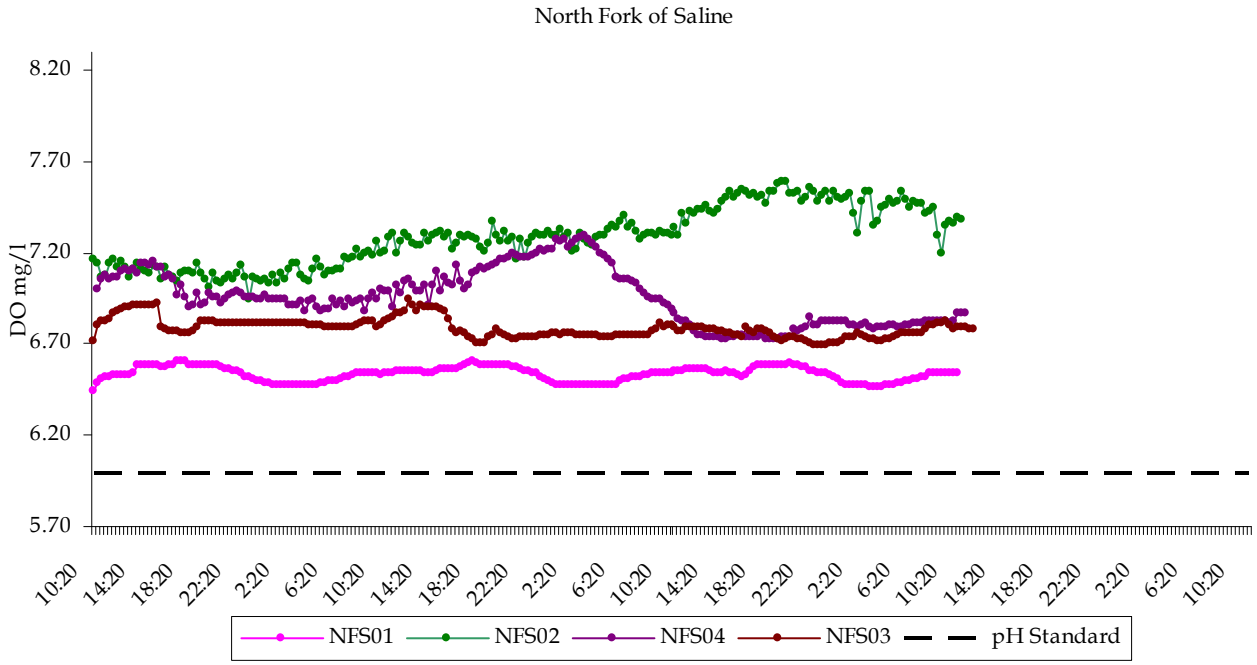
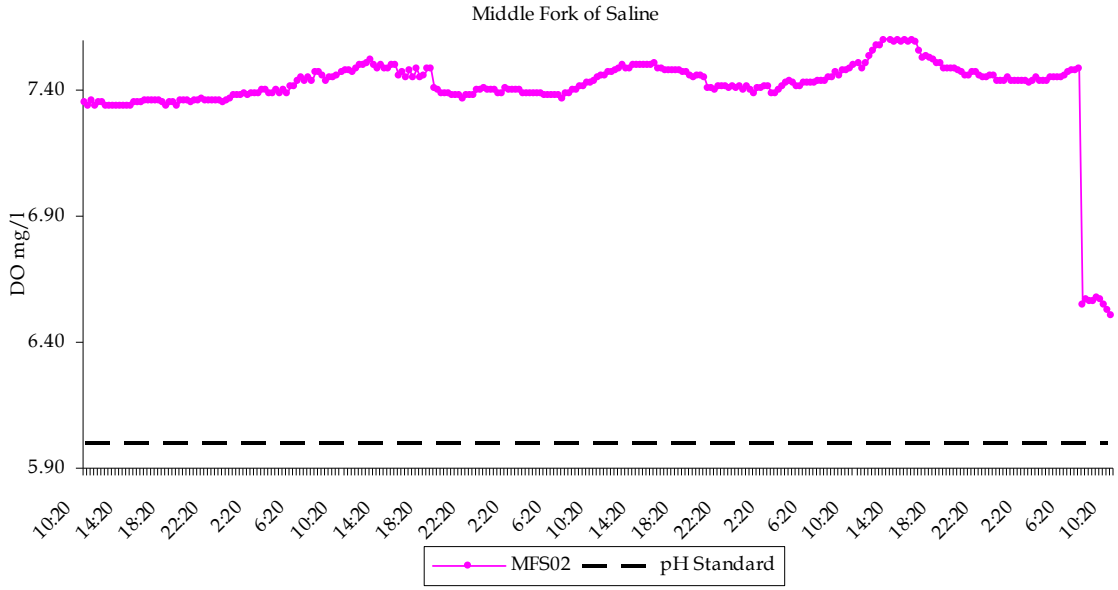
Appendix I

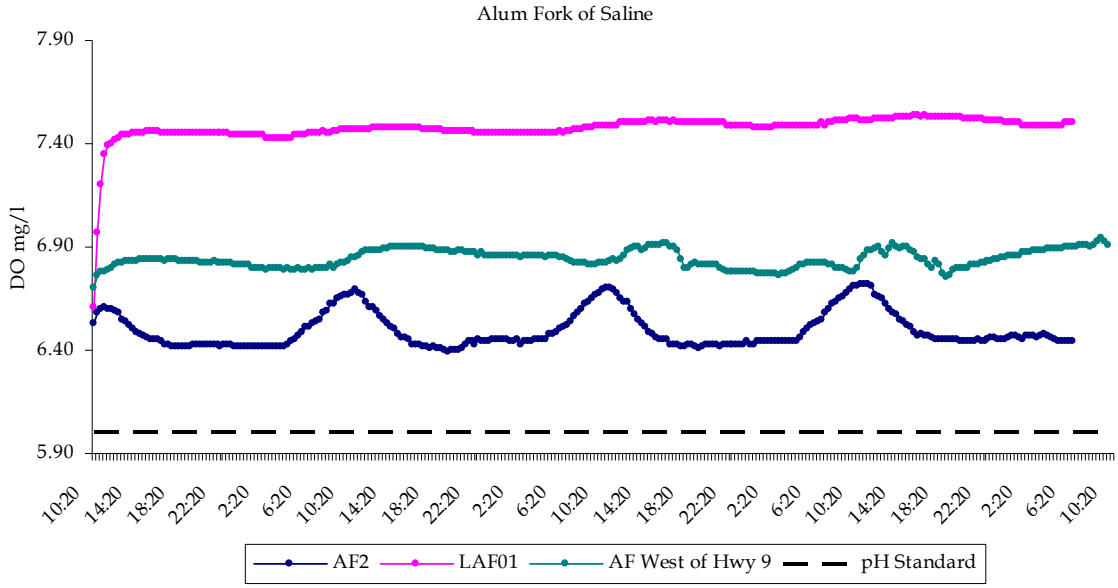
Graphs of 72-hour diurnal dissolved oxygen, temperature, and pH for 2008 and 2009.

2008 Sonde Deployment

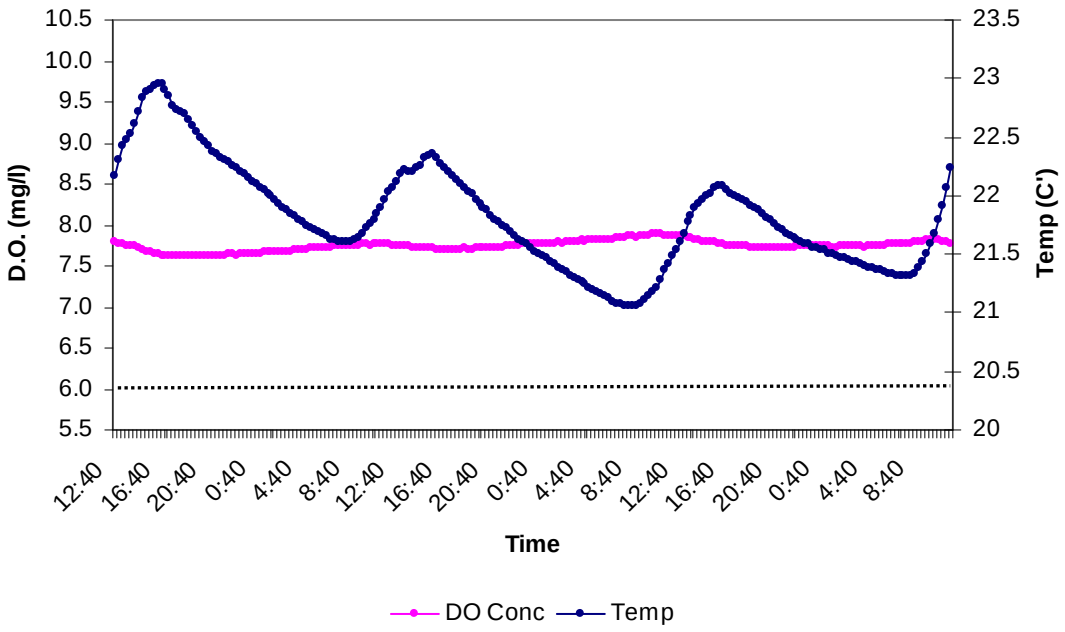




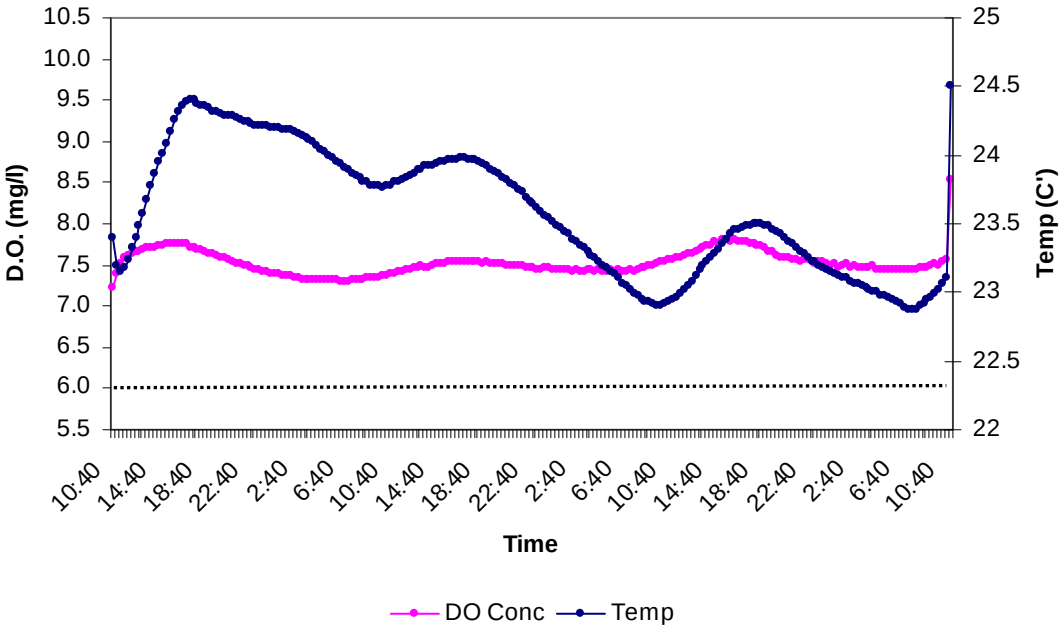

Middle Fork of Saline
DO mg/l
7.40
6.90
6.40
5.90
10:20
14:20
18:20
22:20
2:20
6:20
10:20
14:20
18:20
22:20
2:20
6:20
10:20
14:20
18:20
22:20
2:20
6:20
10:20
MFS02
pH Standard


Alum Fork of Saline
DO mg/l
7.90
7.40
6.90
6.40
5.90
10:20
14:20
18:20
22:20
2:20
6:20
10:20
14:20
18:20
22:20
2:20
6:20
10:20
14:20
18:20
22:20
2:20
6:20
10:20
14:20
18:20
22:20
2:20
6:20
10:20
AF2
LAF01
AF West of Hwy 9
pH Standard

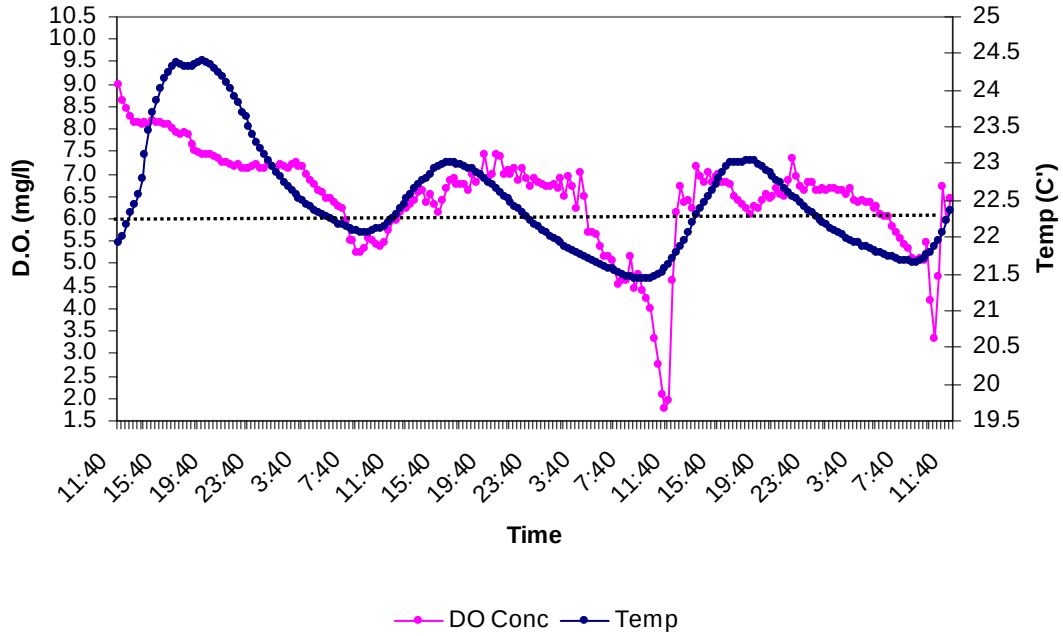
SF@Hwy5


D.O. (mg/l)
Temp (C')
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
23.5
23
22.5
22
21.5
21
20.5
20
12:40
16:40
20:40
0:40
4:40
8:40
12:40
16:40
20:40
0:40
4:40
8:40
12:40
16:40
20:40
0:40
4:40
8:40
Time
DO Conc
Temp

SFS02



SF@hwy128



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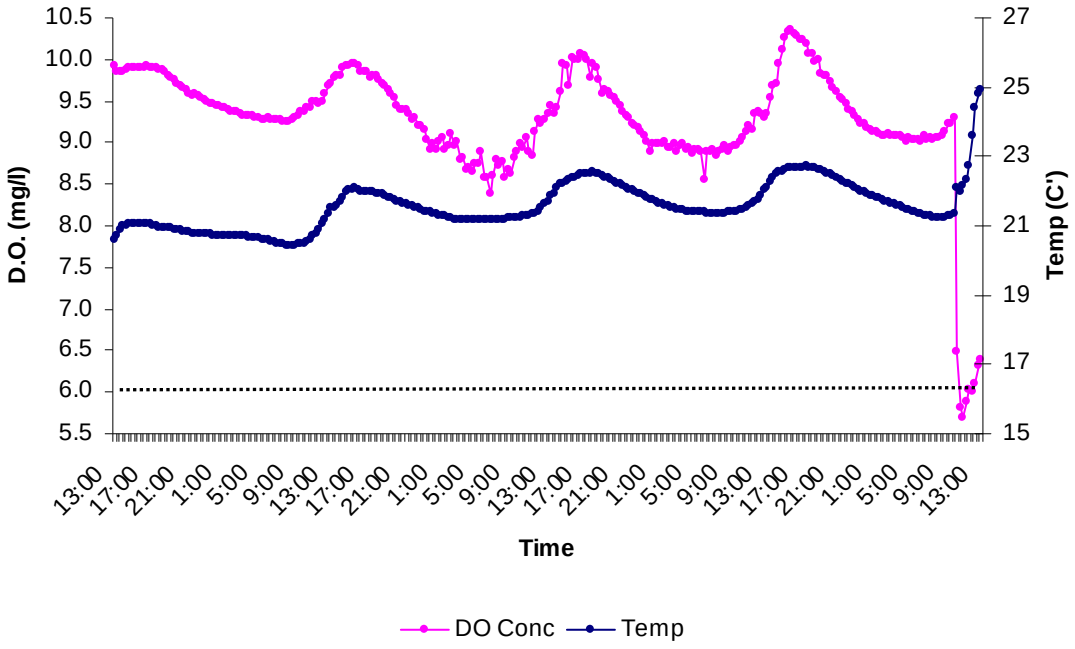
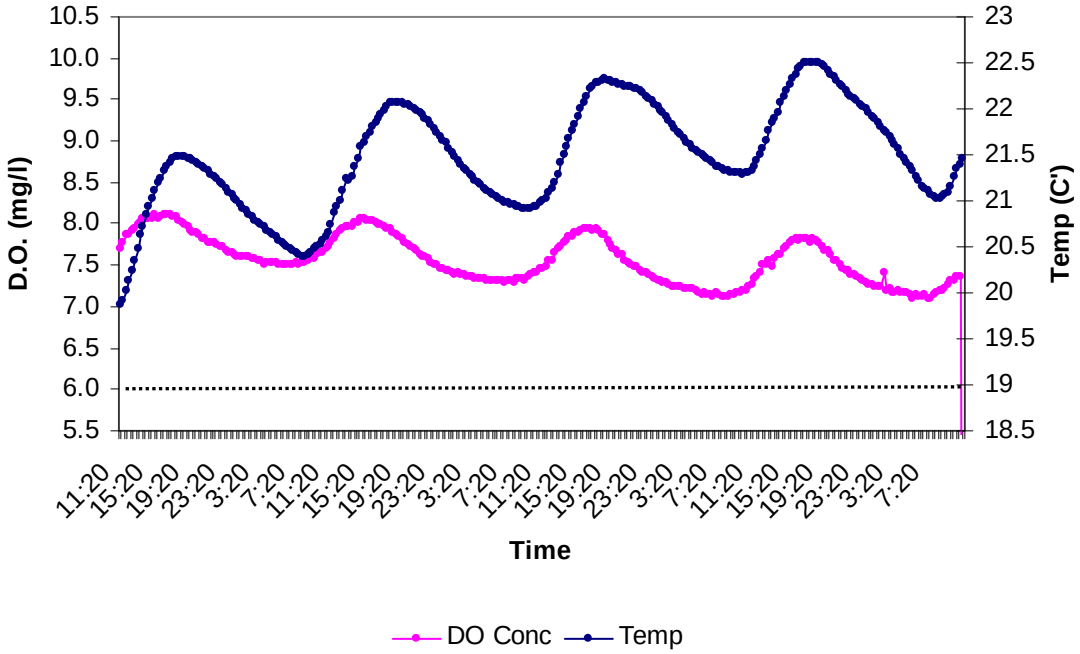
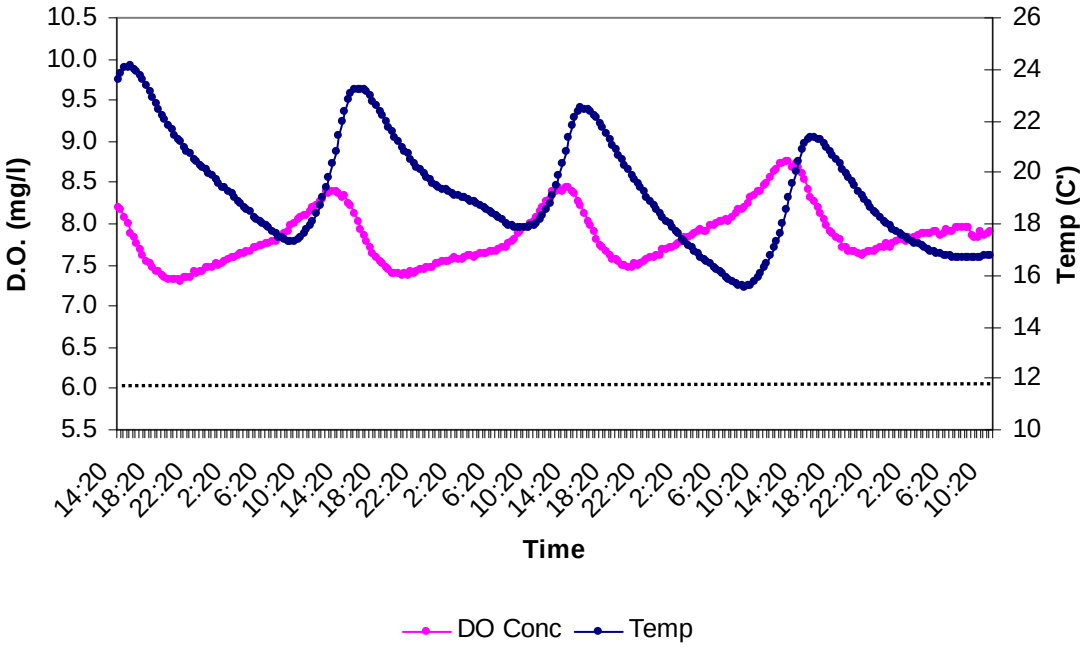


Alum Fork @Hwy9



AF2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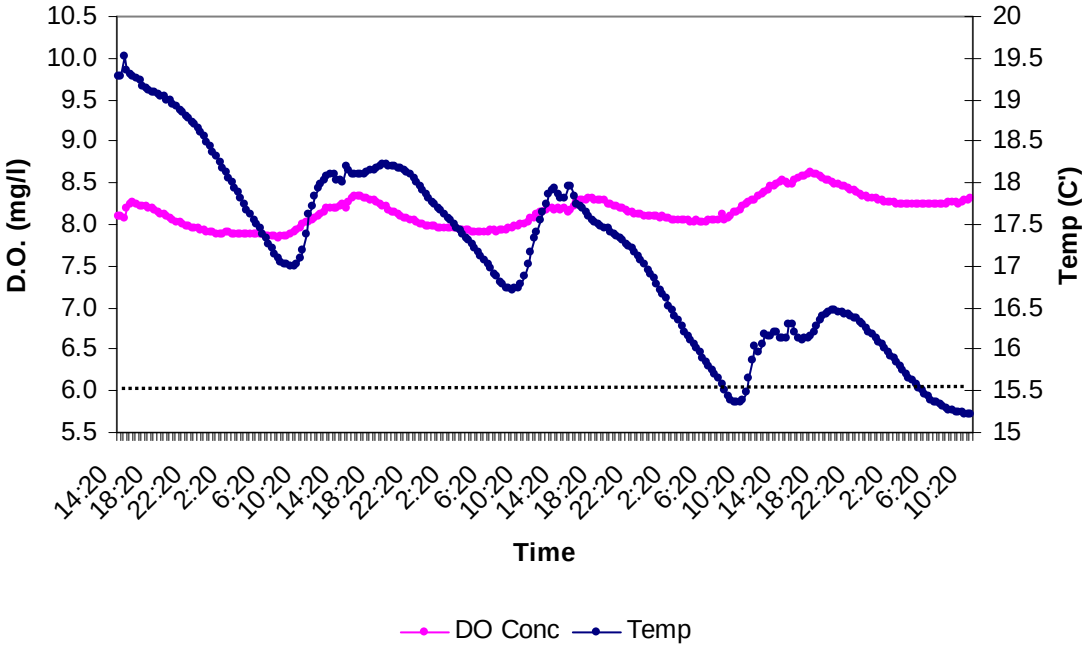
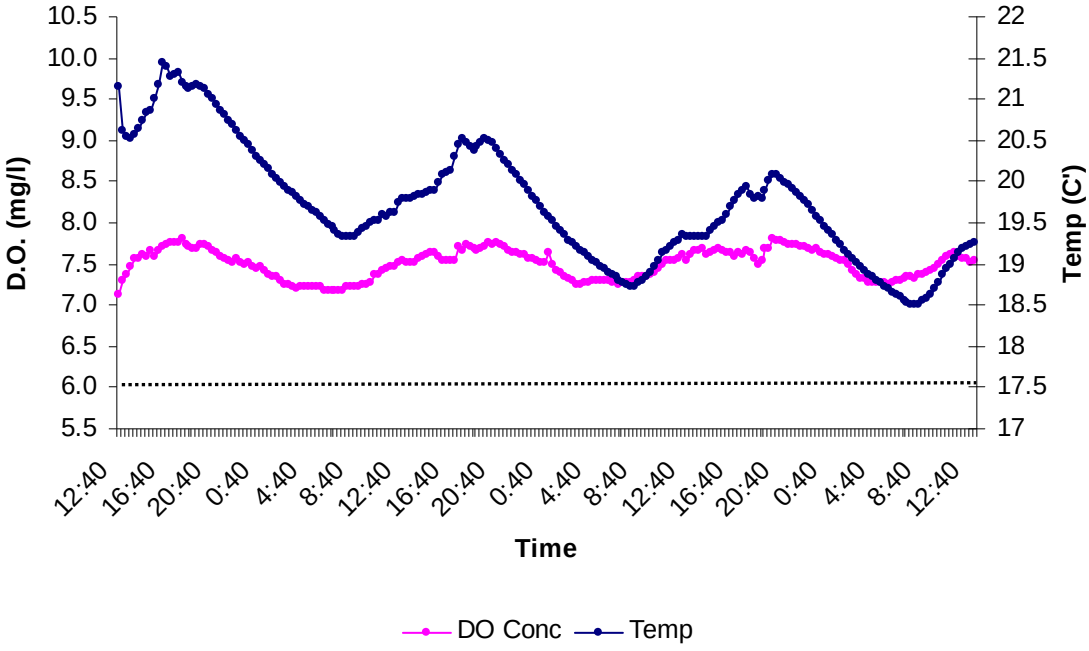
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
D.O. (mg/l)
26
24
22
20
18
16
14
12
10
Temp (C')
14:20
18:20
22:20
2:20
6:20
10:20
Time
DO Conc
Temp

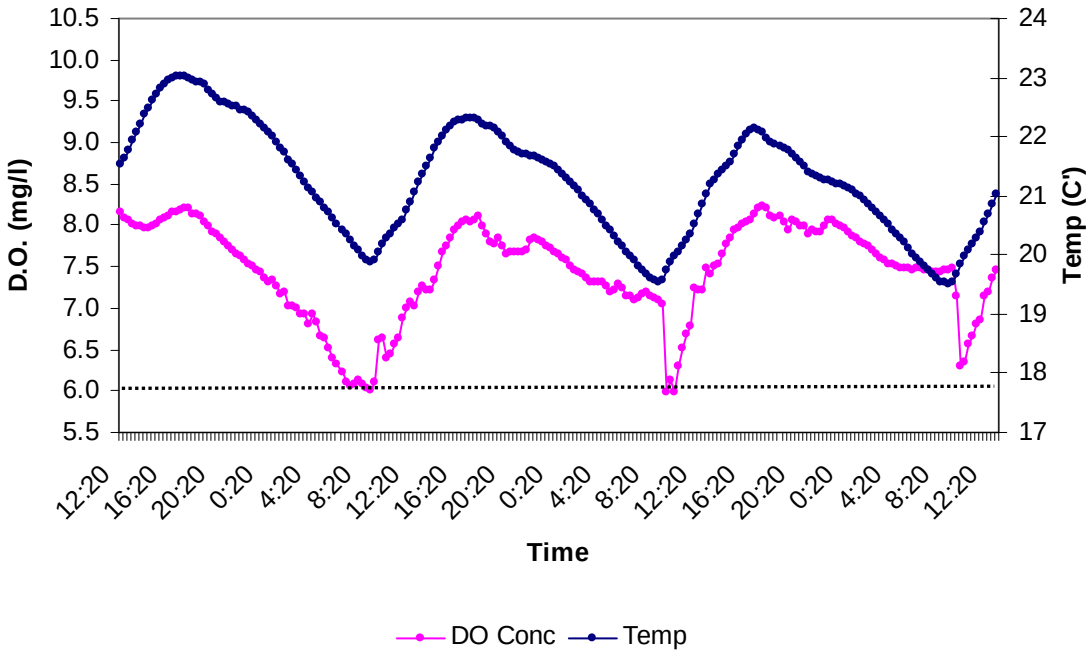
LAF01


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
D.O. (mg/l)
20
19.5
19
18.5
18
17.5
17
16.5
16
15.5
15
Temp (C')
14:20
18:20
22:20
2:20
6:20
10:20
Time
DO Conc
Temp

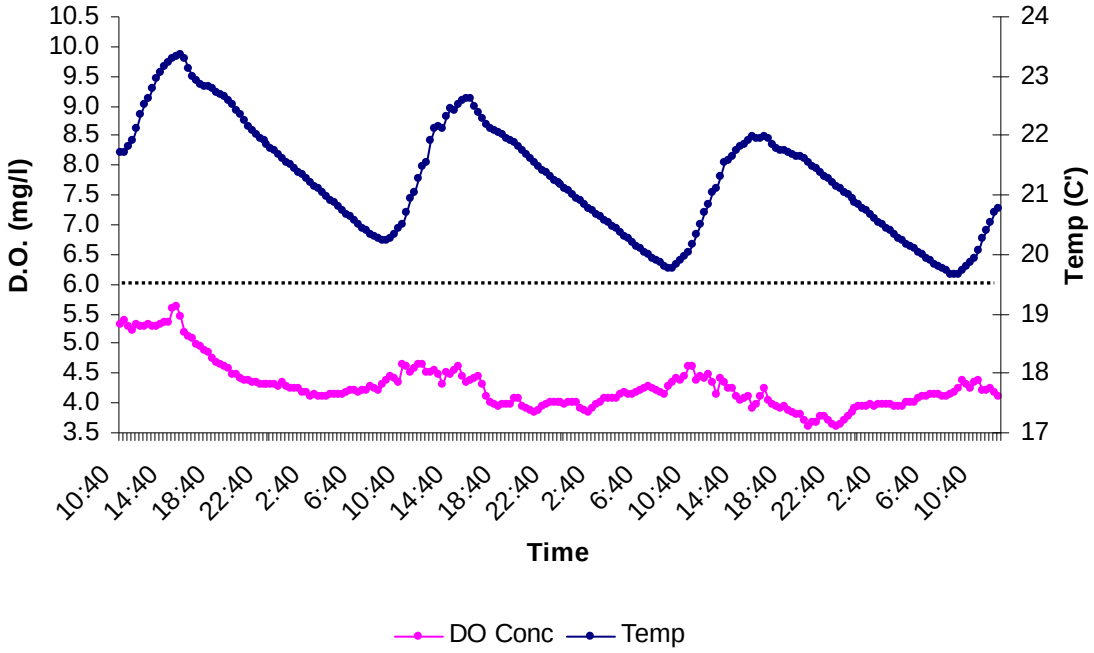
NFS01


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
22
21.5
21
20.5
20
19.5
19
18.5
18
17.5
17
D.O. (mg/l)
Temp (C')
12:40
16:40
20:40
0:40
4:40
8:40
12:40
16:40
20:40
0:40
4:40
8:40
12:40
16:40
20:40
0:40
4:40
8:40
12:40
Time
DO Conc
Temp

NFS02


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
24
23
22
21
20
19
18
17
D.O. (mg/l)
Temp (C')
12:20
16:20
20:20
0:20
4:20
8:20
12:20
16:20
20:20
0:20
4:20
8:20
12:20
16:20
20:20
0:20
4:20
8:20
12:20
Time
DO Conc
Temp

NFS03



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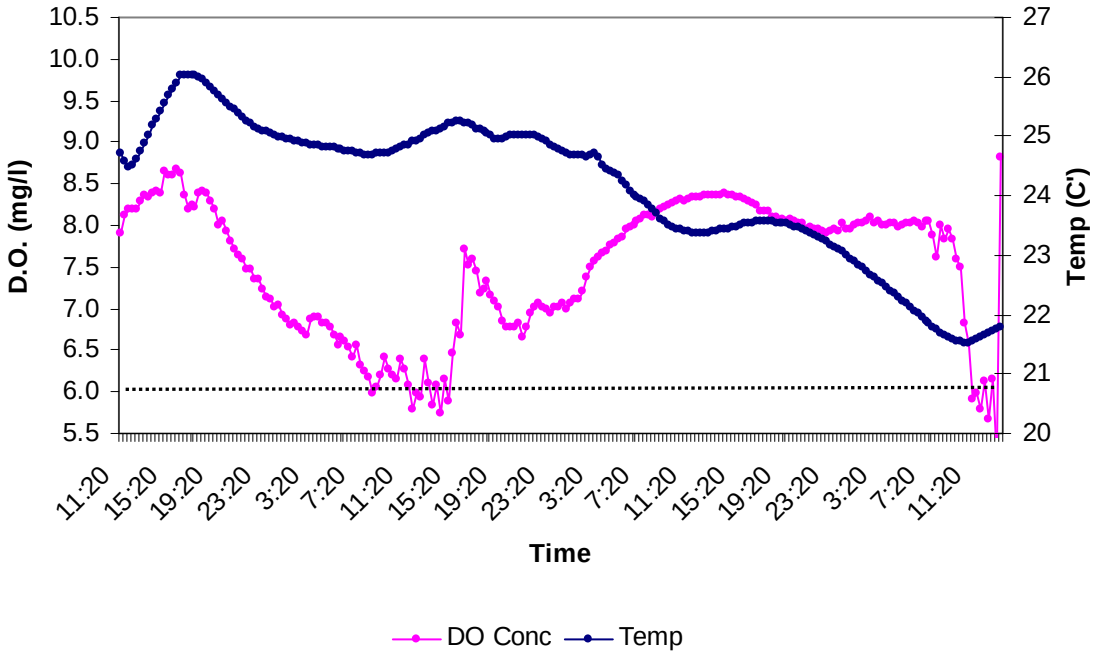
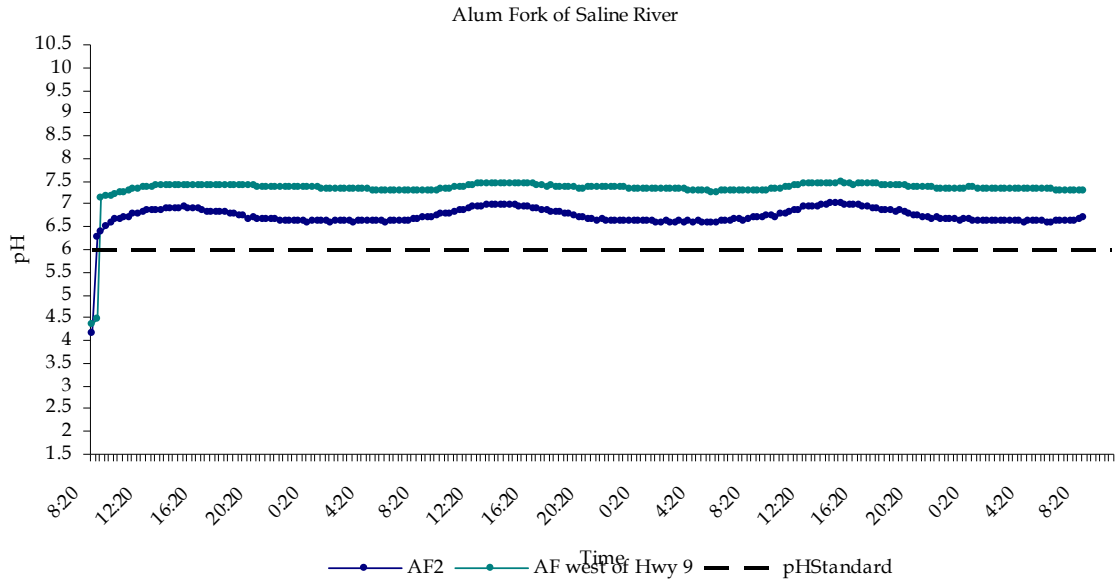
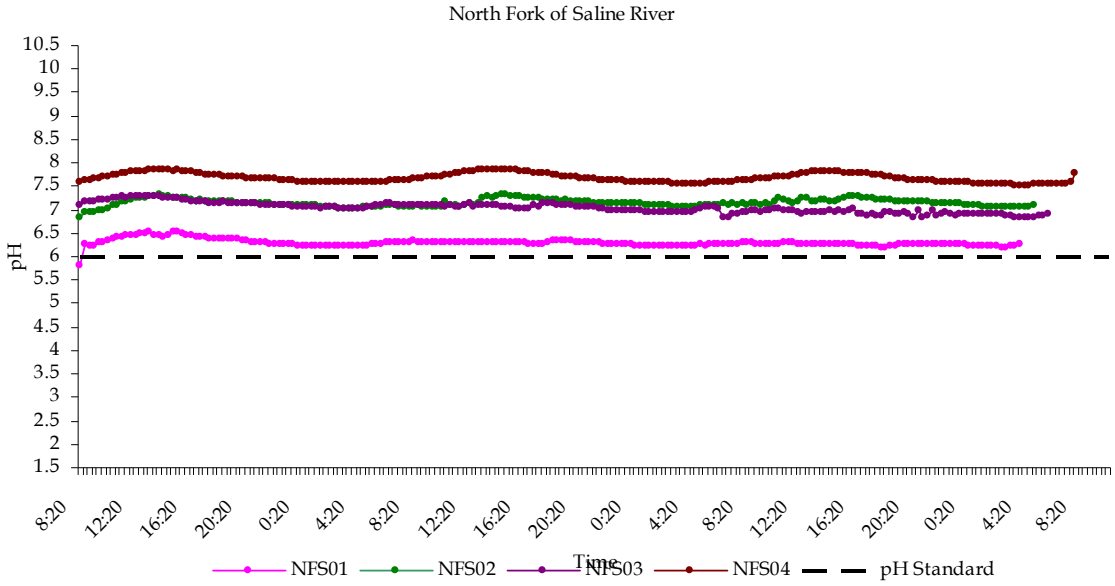


2009 Sonde Deployment




North Fork of Saline River
pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
8:20
12:20
16:20
20:20
0:20
4:20
8:20
12:20
16:20
20:20
0:20
4:20
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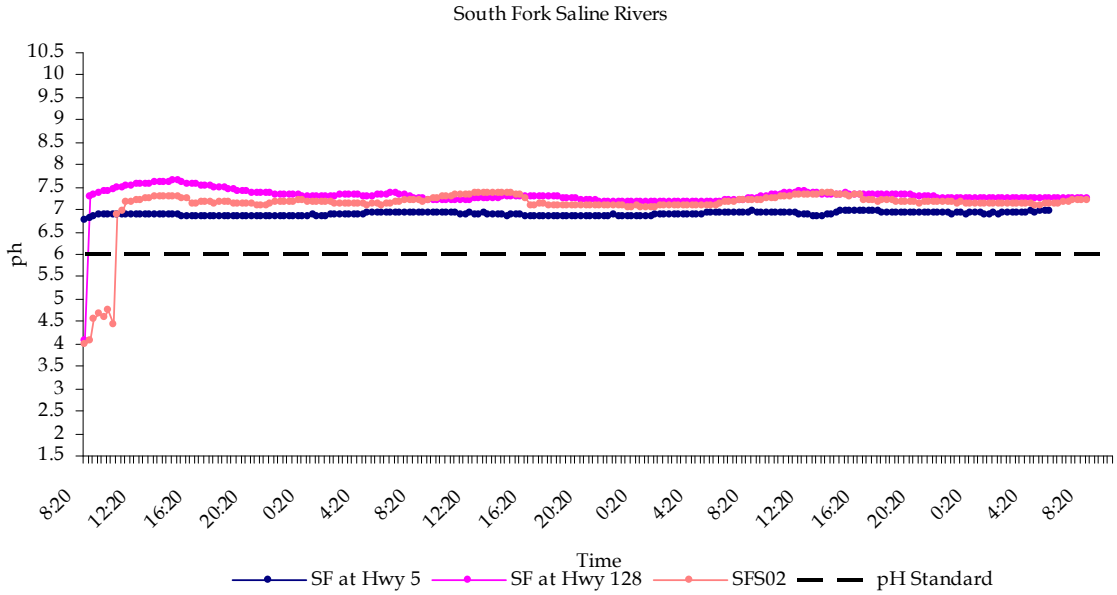
8:20
Time
NFS01
NFS02
NFS03
NFS04
pH Standard


South Fork Saline Rivers
ph
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
8:20
12:20
16:20
20:20
0:20
4:20
8:20
12:20
16:20
20:20
0:20
4:20
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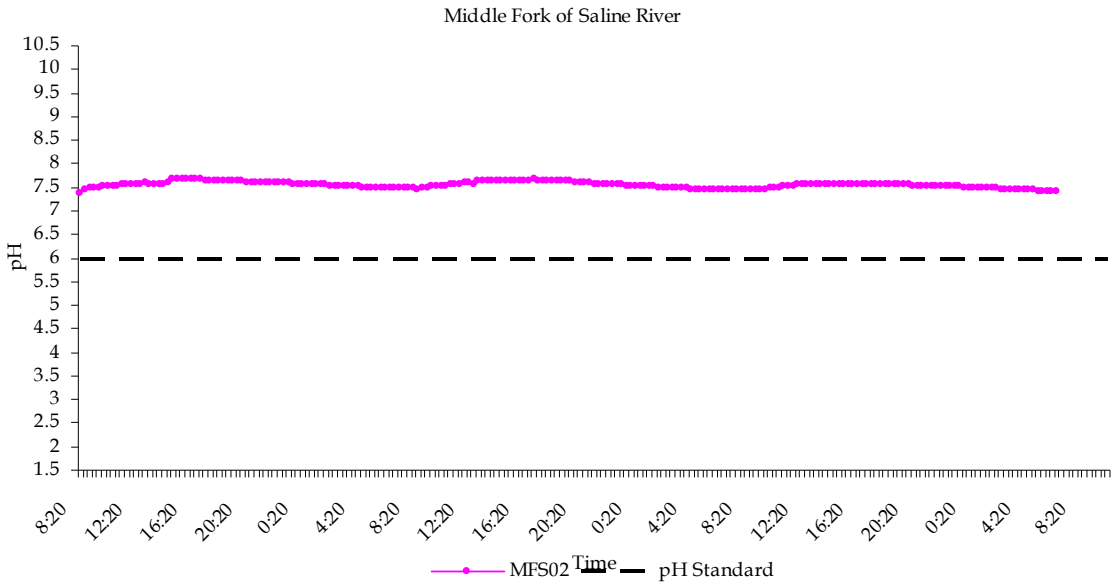
Time
SF at Hwy 5
SF at Hwy 128
SFS02
pH Standard


Middle Fork of Saline River
pH
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
8:20
12:20
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4:20
8:20
12:20
16:20
20:20
0:20
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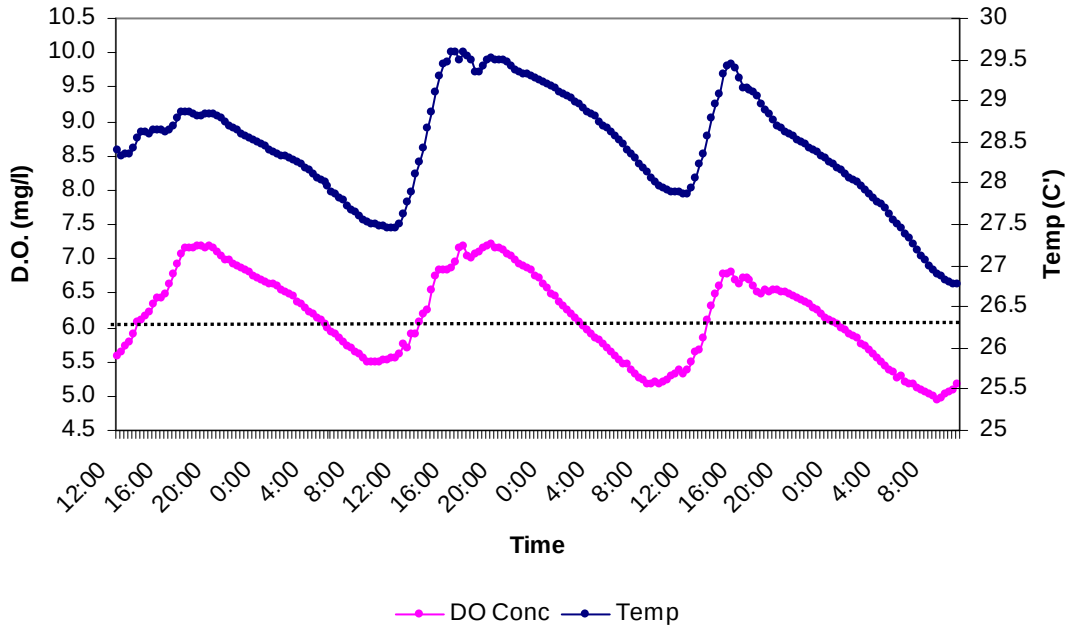
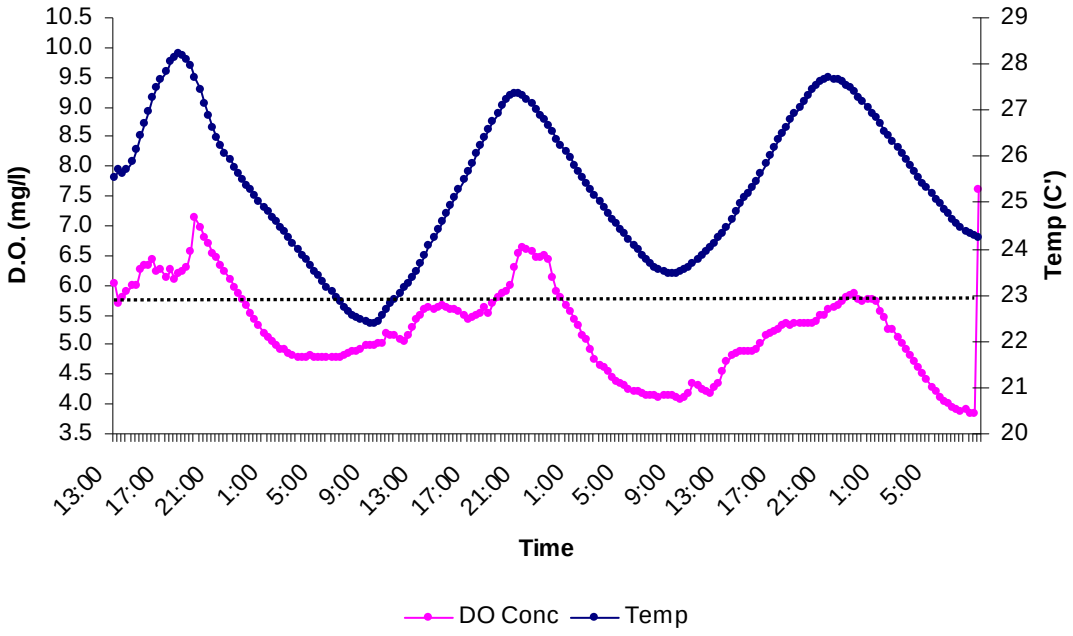
4:20
8:20
Time
MFS02
pH Standard

MFS02


D.O. (mg/l)
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
Temp (C')
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
25
12:00
16:00
20:00
0:00
4:00
8:00
12:00
16:00
20:00
0:00
4:00
8:00
12:00
16:00
20:00
0:00
4:00
8:00
Time
DO Conc
Temp

NFS01



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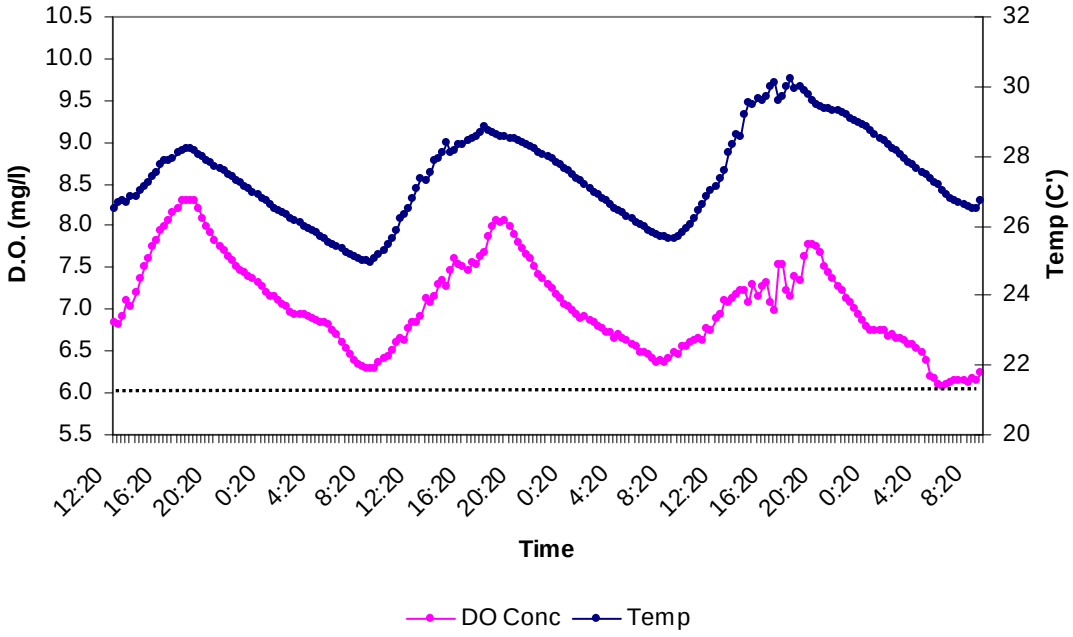

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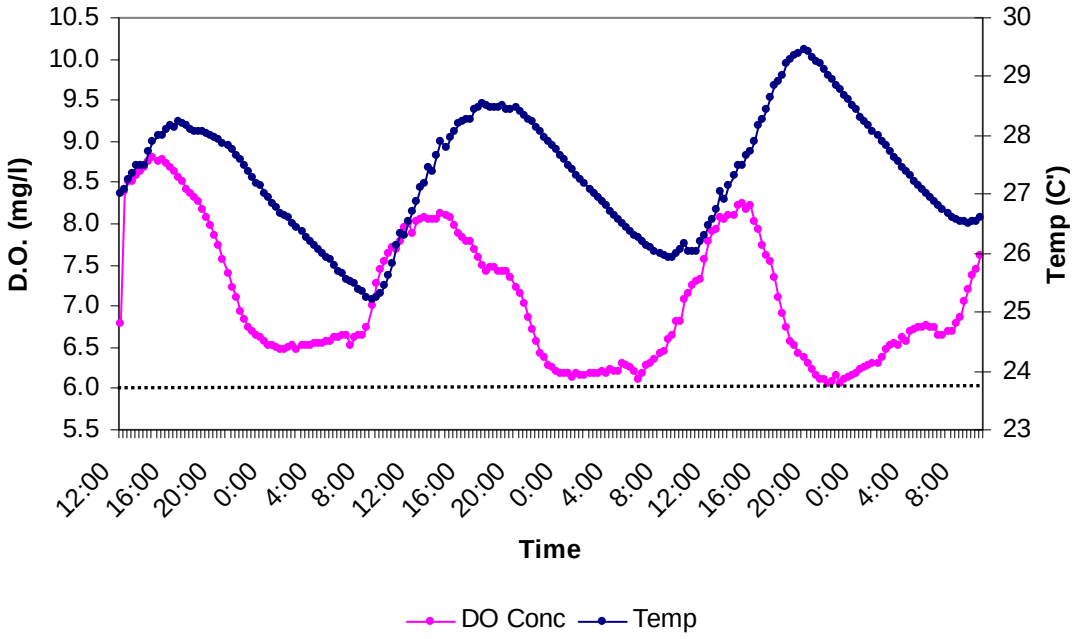
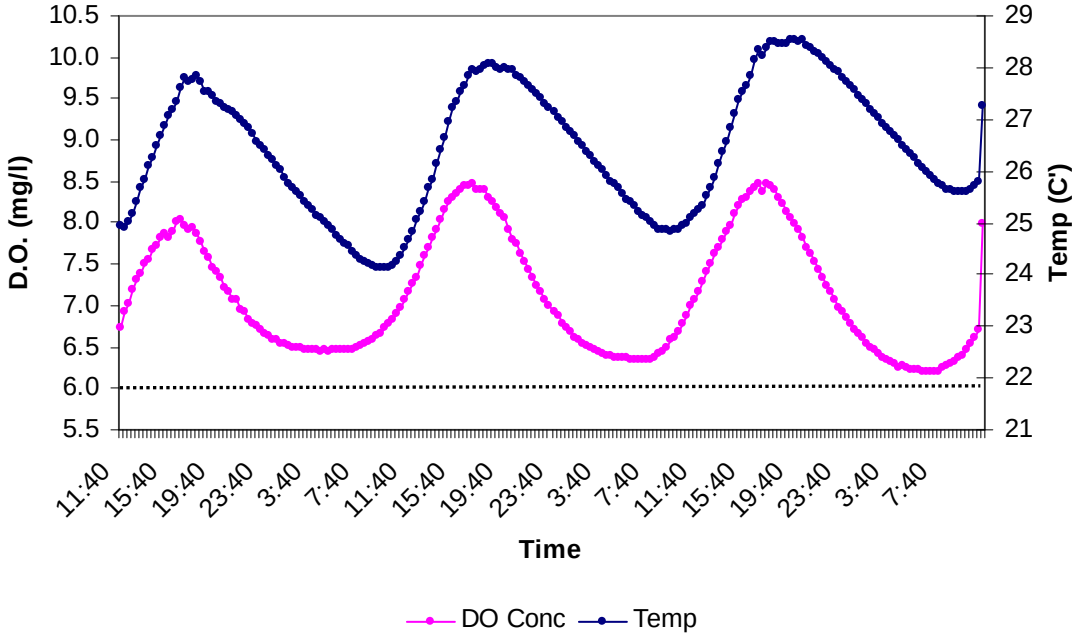

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
30
29
28
27
26
25
24
23
D.O. (mg/l)
Temp (C')
12:00
16:00
20:00
0:00
4:00
8:00
12:00
16:00
20:00
0:00
4:00
8:00
12:00
16:00
20:00
0:00
4:00
8:00
Time
DO Conc
Temp

NFS04


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
29
28
27
26
25
24
23
22
21
D.O. (mg/l)
Temp (C')
11:40
15:40
19:40
23:40
3:40
7:40
11:40
15:40
19:40
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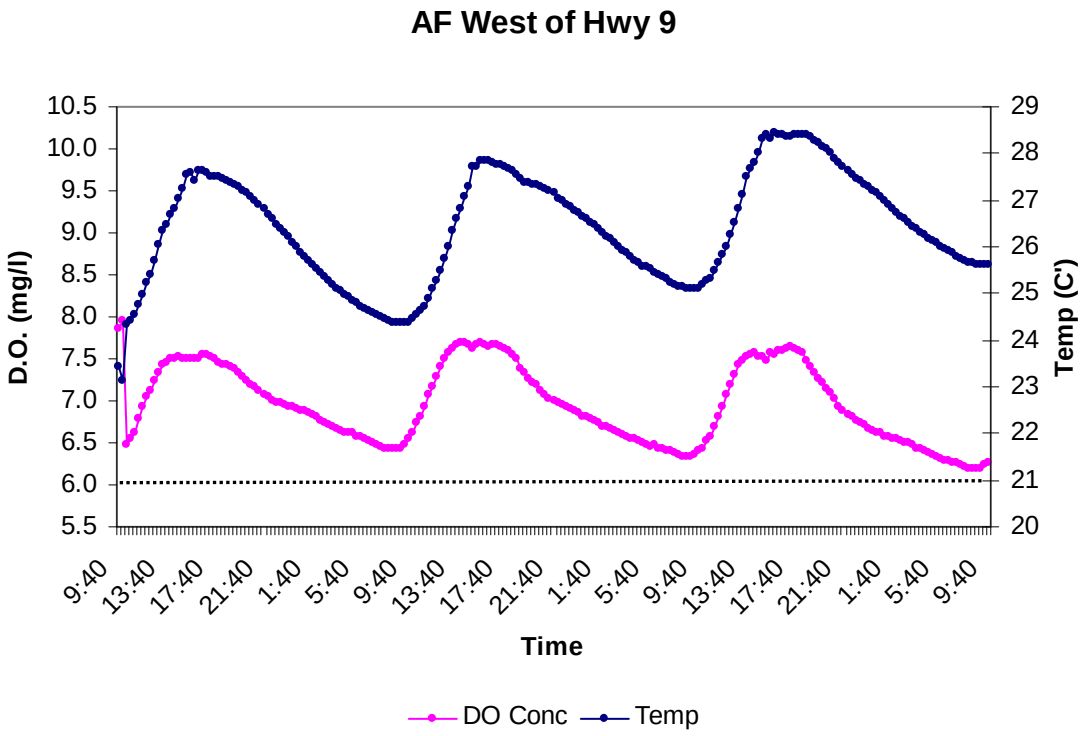
23:40
3:40
7:40
Time
DO Conc
Temp


AF West of Hwy 9
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
D.O. (mg/l)
29
28
27
26
25
24
23
22
21
20
Temp (C')
9:40
13:40
17:40
21:40
1:40
5:40
9:40
13:40
17:40
21:40
1:40
5:40
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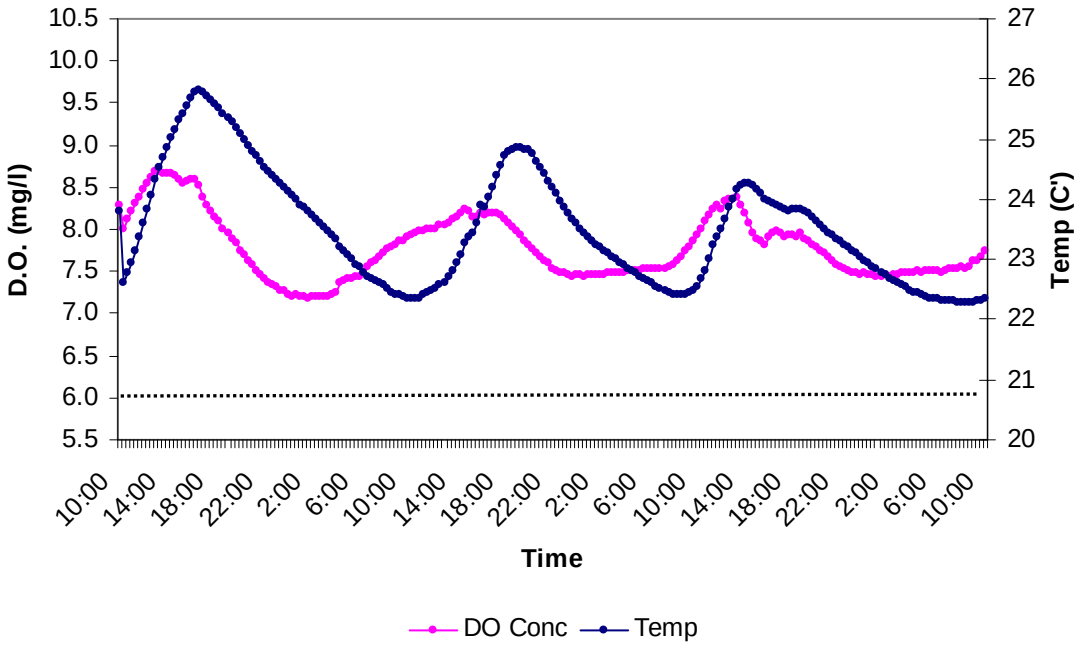
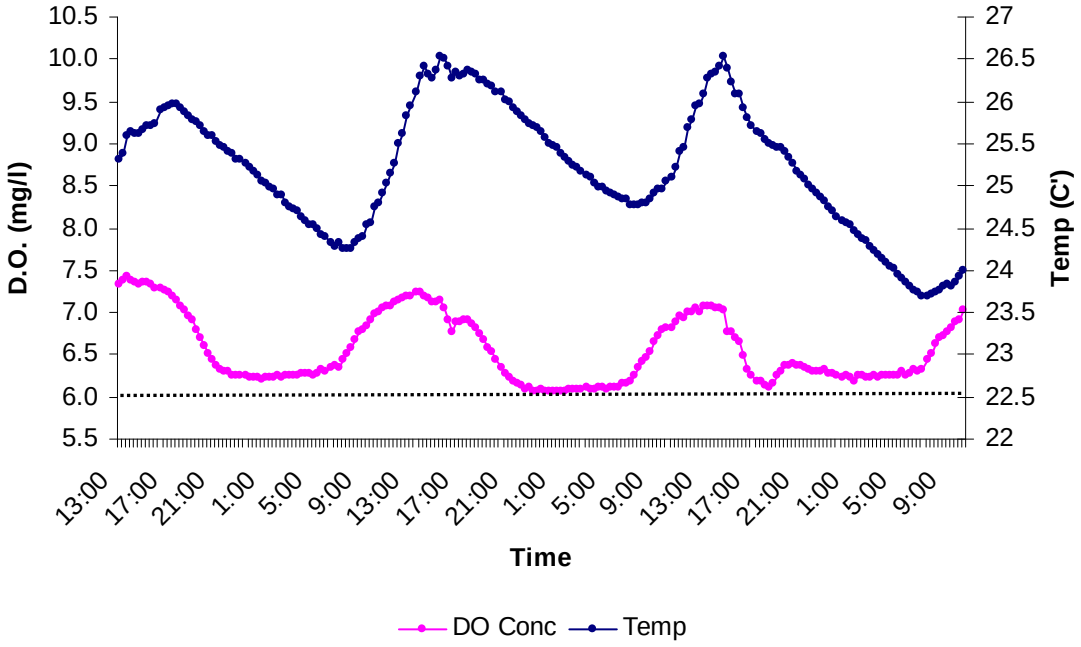
13:40
17:40
21:40
1:40
5:40
9:40
Time
DO Conc
Temp

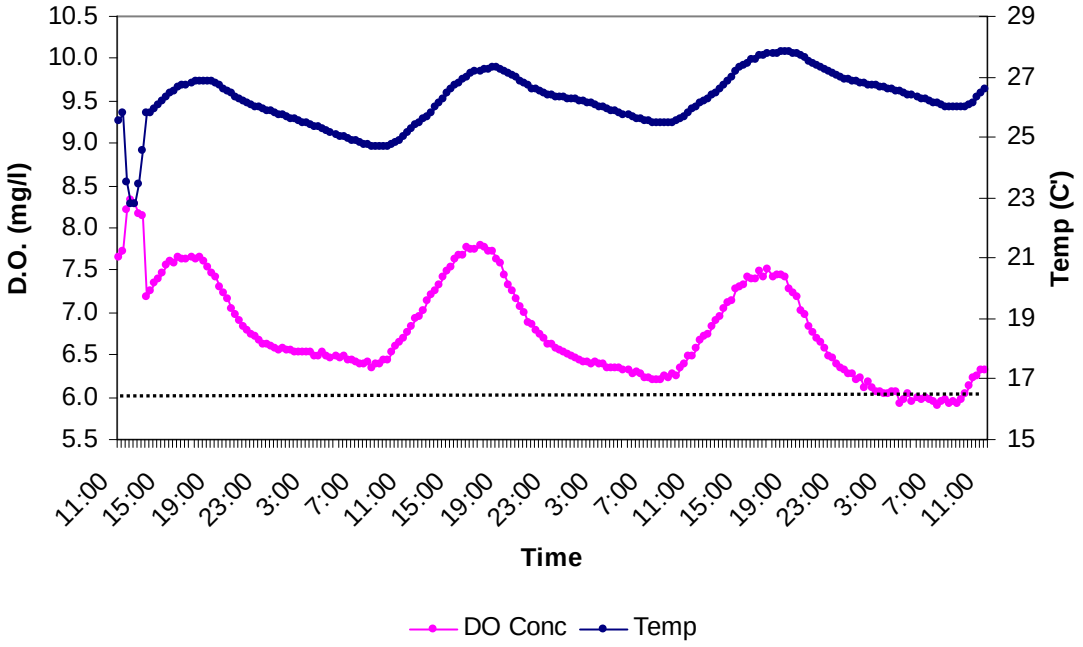
SF at Hwy 128



SF at Hwy 5



SFS02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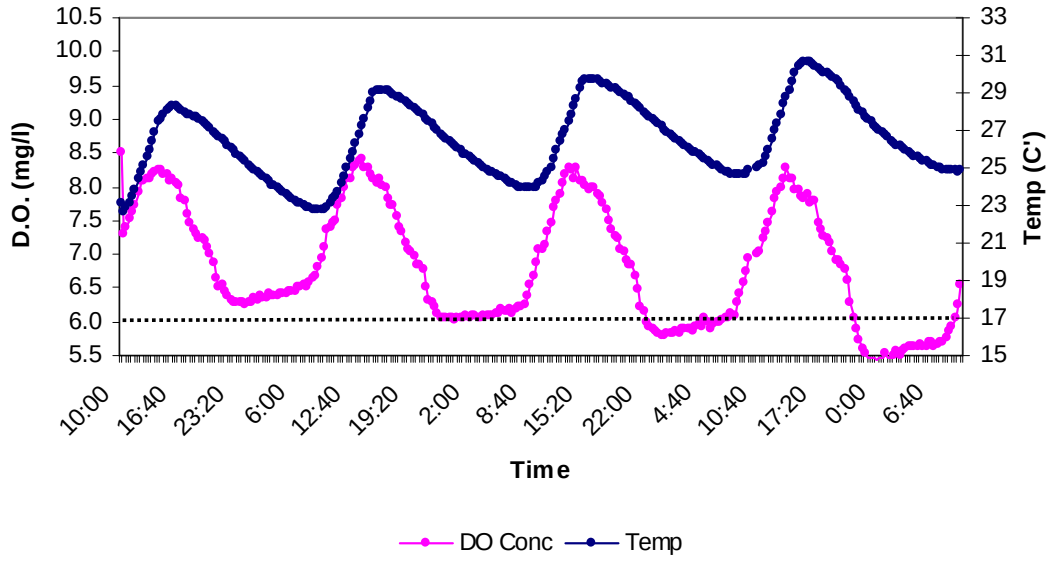
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
D.O. (mg/l)
29
27
25
23
21
19
17
15
Temp (C')
11:00
15:00
19:00
23:00
3:00
7:00
11:00
15:00
19:00
23:00
3:00
7:00
11:00
15:00
19:00
23:00
3:00
7:00
11:00
Time
DO Conc
Temp

AF2


10.5
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9.5
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8.5
8.0
7.5
7.0
6.5
6.0
5.5
D.O. (mg/l)
33
31
29
27
25
23
21
19
17
15
Temp (C')
10:00
16:40
23:20
6:00
12:40
19:20
2:00
8:40
15:20
22:00
4:40
10:40
17:20
0:00
6:40
Time
DO Conc
Temp

Appendix II

Macroinvertebrate taxa list collected from 2007-2010 within the upper Saline River watershed.

								Fall 2007			
Order	Family	Genus	Tolerance value	Trophic Function	Habit	AF2	NFS01	SFS02	Alum Fork West of Hwy 9	SF at Hwy 5	LAF01
Amphipoda	Hyalellidae	*Hyalella azteca*	8	collector/gather	crawler	2	2	53		1	3
Amphipoda	Gammaridae	*Gammarus*	6	collector/gather	crawler						
Annelida	Hiurinidae			parasite				1			
Arachnida	Hydracacina	*Arrhenurus*	6	predator	clinger			1			
Arachnida	Hydracacina		6	predator	clinger	1					
Bivalvia	Corbiculidae	*Corbicula*	6	collector/filter	burrower	3	2	6	5	2	
Coleoptera	Gyrinidae	*Dineutus*									
Coleoptera	Hydrophilidae		5	predators	swim/dive						
Coleoptera	Hydrophilidae	*Paracynus*	5	burrowers					1		
Coleoptera	Hydrophilidae	*Sphaeridiinae*									
Coleoptera	Dryopidae	*Helichus*	5	scraper	clinger		1				
Coleoptera	Dytiscidae			predator	climber/swimmer						
Coleoptera	Dytiscidae	*Celina*	5	predator	swim/dive					1	
Coleoptera	Dytiscidae	*Desmopachria*	6	predator	swim/dive						
Coleoptera	Dytiscidae	*Hydaticus*	5	predator	swim/dive						
Coleoptera	Dytiscidae	*Hygrotus*	5	predator	swim/dive						
Coleoptera	Elmidae		4	collector/gather	clinger						
Coleoptera	Elmidae	*Ancyronyx*	6	scraper	clinger			1			
Coleoptera	Elmidae	*Ampumixis*	4	collector/gather	clinger						
Coleoptera	Elmidae	*Dubiraphia*	6	collector/gather	clinger			10	7	10	1
Coleoptera	Elmidae	*Gonielmis*	5		clinger				3		
Coleoptera	Elmidae	*Heterelmis*	4	collector/gather	clinger						
Coleoptera	Elmidae	*Macronychus*	4.7	collector/gather	clinger	7					
Coleoptera	Elmidae	*Microcylloepus*	3	scraper	clinger	6	3	4			9
Coleoptera	Elmidae	*Neoelmis*									1
Coleoptera	Elmidae	*Optioservus*	2.75	scraper	clinger						
Coleoptera	Elmidae	*Oulimnius*	4	scraper	clinger						1
Coleoptera	Elmidae	*Stenelmis*	3	scraper	clinger	17		12	29	3	13
Coleoptera	Gyrinidae	*Dineutus*	6	predator	diver				3		
Coleoptera	Gyrinidae	*Gyretes*			swim/dive						
Coleoptera	Gyrinidae	*Gyrinus*	6.3	predator	swim/dive						
Coleoptera	Psephenidae	*Ectopria*	4.3	scraper	clinger	1				3	
Coleoptera	Staphylinidae			collector/gather	clinger						
Coleoptera	Scirtidae	*Scittes*									
Coleoptera	Psephenidae	*Psephenus*	4	scraper	clinger	23		1	35	11	2
Collembola	Entomobryidae			collector/gather	sprawler/sktr					2	
Collembola	Isotomidae	*Isotoma*	4	collector/gather	sprawler/sktr						
Collembola	Isotomidae	*Semicurura*		collector/gather	sprawler/sktr						
Copoda	Cyclopidae		8	collector/gather				1			
Decapoda	Cambaridae		6	collector/gather	generalist						
Decapoda	Cambaridae	*Cambarus*	6	collector/gather	generalist					1	
Decapoda	Cambaridae	*Procambarus*									
Decapoda	Cambaridae	*Orconectes*	6	collector/gather	generalist		1				
Decapoda	Paleomonetes	*Paleomonetes*	5	collector/gather	generalist						
Diptera	Brachychera										
Diptera	Ceratopogonidae		5.7	predator	sprawler						
Diptera	Ceratopogonidae	*Bezzia*	6	predator	burrower						
Diptera	Ceratopogonidae	*Dasyhelea*	6	collector/gather	sprawler	2					
Diptera	Ceratopogonidae	*Probezzia*	6	predator	burrower						
Diptera	Ceratopogonidae	*Serromyia*	6	predator	burrower			1			
Diptera	Ceratopogonidae	*Forcipomyia*	6	collector/gather	sprawler					2	
Diptera	Chironomidae		7	collector/gather	burrower	25	8	9	13	27	
Diptera	Dixidae	*Dixella*		collector/filter	swimmer						2
Diptera	Empididae										
Diptera	Empididae	*Clinocera*	6		clinger						
Diptera	Empididae	*Hemerodromia*	6	predator	sprawler/burrower	3		1			
Diptera	Empididae	*Trichoclinocera*									
Diptera	Simulidae		6	collector/filter	clinger					1	
Diptera	Simulidae	*Simulium*	6	collector/filter	clinger		1				
Diptera	Stratiomyidae			collector/filter	sprawler						
Diptera	Tabanidae	*Haematopota*			sprawler/burrower						1
Diptera	Tabanidae	*Merycomia*									
Diptera	Tabanidae	*Tabanus*	9	predator	burrower						
Diptera	Tipulidae			shredder/detritivore	burrower						
Diptera	Tipulidae	*Antocha*	2.2	collector/gather	clinger				1		
Diptera	Tipulidae	*Brachypremna*			burrower						
Diptera	Tipulidae	*Hexatoma*	5	shredder	burrower	1					
Diptera	Tipulidae	*Pedicia*	6	predator	burrower						
Diptera	Tipulidae	*Leptotarsus*			burrower						
Diptera	Tipulidae	*Tipula*	6	shredder/detritivore	burrower	2	1				
Ephemeroptera											

							Fall 2007					
Order	Family	Genus	Tolerance value	Trophic Function	Habit	AF2	NFS01	SFS02	Alum Fork West of Hwy 9	SF at Hwy 5	LAF01
Ephemeroptera	Baetidae	*Acerpenna*	3.7	collector/gather	swimmer/clinger						
Ephemeroptera	Baetidae	*Acentrella*	3.6	collector/gather	swimmer						
Ephemeroptera	Baetidae	*Americabaetis*	5	collector/gather	clinger						
Ephemeroptera	Baetidae	*Baetis*	5.5	collector/gather	clinger						
Ephemeroptera	Baetidae	*Callibaetis*	9.3	collector/gather	swimmer/clinger						
Ephemeroptera	Baetidae	*Fallceon*	4	collector/gather	clinger						
Ephemeroptera	Baetidae	*Heterccloen*	3.6	scraper	swimmer/clinger						
Ephemeroptera	Baetidae	*Paracloedes*	8.7	scraper	swimmer/clinger						
Ephemeroptera	Baetidae	*Procloen*	4	collector/gather	clinger						
Ephemeroptera	Baetidae		4	collector/gather	clinger						1
Ephemeroptera	Baetiscidae	*Baetisca*	1.4	collector/gather	sprawler/clinger				1		
Ephemeroptera	Caenidae	*Caenis*	3.1	collector/gather	sprawler	6	1	37	6	12	1
Ephemeroptera	Ephemeridae	*Ephemera*	1.1	collector/gather	burrower				1		
Ephemeroptera	Ephemeridae	*Hexegenia*	4.7	collector/gather	burrower						
Ephemeroptera	Ephemerellidae	*Attenella*	2.6	collector/gather	clinger						
Ephemeroptera	Ephemerellidae	*Dannella*	1.2	collector/gather	clinger						
Ephemeroptera	Ephemerellidae	*Eurylophella*	2.5	collector/gather	crawler						18
Ephemeroptera	Ephemerellidae	*Serratella*	2.1	collector/gather	clinger						
Ephemeroptera	Ephemeridae	*Ephmemerlla*	3.1	collector/gather	burrower						
Ephemeroptera	Heptageniidae		4	scraper	clinger						
Ephemeroptera	Heptageniidae	*Heptagenia*	2.4	scraper	clinger	16					
Ephemeroptera	Heptageniidae	*Leurocuta*	2	scraper	clinger						
Ephemeroptera	Heptageniidae	*Macaffertium*	4	scraper	clinger				77	15	43
Ephemeroptera	Heptageniidae	*Rhithrogena*	0	scraper	clinger						
Ephemeroptera	Heptageniidae	*Stenacron*	4	collector/gather	clinger						1
Ephemeroptera	Heptageniidae	*Stenonema*	4	scraper	clinger		42	9			1
Ephemeroptera	Heptageniidae		3	scraper	clinger						
Ephemeroptera	Isonychidae	*Isonychia*	3	collector/filter	clinger	1	3	4	19	5	
Ephemeroptera	Leptophlebiidae		4	collector/gather	clinger						
Ephemeroptera	Leptophlebiidae	*Choroterpes*	4	collector/gather	clinger						
Ephemeroptera	Leptophlebiidae	*Leptophlebia*	6.4	collector/gather	swimmer/clinger						
Ephemeroptera	Leptohyphidae	*Tricorythodes*		collector/gather	sprawler			7	4	2	
Ephemeroptera	Potamanthidae	*Anthopotamus*	3.2								
Ephemeroptera	Siphonluridae					6					
Ephemeroptera	Siphonluridae	*Siphlonurus*	7	collector/gather	clinger						
Gastropoda	Ancyllidae	*Ferrissia*	6	scraper	sprawler		7	1			12
Gastropoda	Physsidae	*Physsa*	9.1	scraper	sprawler				5		
Gastropoda	Pleuroceridae		6	scraper	sprawler			27		31	
Gastropoda	Planorbidae		7	scraper	sprawler	1	1			1	
Gastropoda	Planorbidae	*Heliosoma*	6	scraper	sprawler						1
Gastropoda	Viviparidae		6	scraper	sprawler						43
Hemiptera	Corixidae	*Trichocorixia*	5	predator	swimmer/climber						
Hemiptera	Herbridae	*Lipogomphus*		predator	climber						1
Hemiptera	Mesoveliidae	*Mesovelia*		predator	skater				1		
Hemiptera	Veliidae	*Microvelia*	6	predator	skater						
Hemiptera	Veliidae	*Rhagavelia*	5	predator	skater						
Hiurenidae											
Isopoda	Asellidae	*Lirceus*	8	shredder	sprawler	6	31	2			4
Lepidoptera	Crambidae		6	shredder					1		
Lepidoptera	Crambidae	*Elophila*		shredder	climber						
Lepidoptera	Crambidae	*Parapoynx*	5	shredder	climber	1					
Lepidoptera	Crambidae	*Petrophila*	2.7	scraper	clinger						
Megaloptera	Corydalidae	*Corydalus*	2.4	predator	clinger				1		
Megaloptera	Corydalidae	*Nigronia*	2.7	predator	clinger		1				5
Megaloptera	Sialidae	*Sialis*	7.4	predator	burrower		1		1		
Odonata	Aeshinidae	*Anax or Aeshna*	4	predator	climber						
Odonata	Aeshinidae	*Basianeschna*	7.7	predator	climber						
Odonata	Aeshinidae	*Boyeria*	6.3	predator	climber						
Odonata	Calopterygidae	*Caleopteryx*	3.7	predator	clinger	1		2			
Odonata	Calopterygidae	*Hetaerina*	2	predator	clinger				1		
Odonata	Coenargionidae		6.1	predator	climber					1	
Odonata	Coenargionidae	*Amphiagrion*									
Odonata	Coenargionidae	*Argia*	5.1	predator	climber	4			9		
Odonata	Coenargionidae	*Chromagrion*		predator	climber			8			3
Odonata	Coenargionidae	*Enallagma*	9	predator	climber						
Odonata	Corduliidae										
Odonata	Corduliidae	*Neurocordulia*	4	predator	climber						
Odonata	Corduliidae	*Somatochlora*	8.9	predator	sprawler						
Odonata	Gomphidae			predator	burrower						
Odonata	Gomphidae	*Arigomphus*		predator	burrower						6
Odonata	Gomphidae	*Dromogomphus*	6.3	predator	burrower	35				2	

									Fall 2007			
Order	Family	Genus	Tolerance value	Trophic Function	Habit	AF2	NFS01	SFS02	Alum Fork West of Hwy 9	SF at Hwy 5	LAF01
Odonata	Gomphidae	*Erpetogomphus*	4	predator	burrower						
Odonata	Gomphidae	*Gomphus*	5	predator	burrower				9		
Odonata	Gomphidae	*Hagenius*	4.1	predator	sprawler						
Odonata	Gomphidae	*Lanthus*	2.7	predator	burrower						
Odonata	Gomphidae	*Stylogomphus*	4	predator	burrower					1	
Odonata	Libellulidae	*Dythemis*		predator	sprawler						
Odonata	Libellulidae	*Erythemis*	7.7	predator	sprawler						
Odonata	Macromiidae	*Macromia*	6.7	predator	sprawler						
Oligochaeta	Oligochaeta	*Oligochaeta*	5	collector/gather	burrower	2			1	2	3
Ostercoda											
Plecoptera											6
Plecoptera	Capniidae		3	shredder/ditritivore	clinger						
Plecoptera	Capniidae	*Allocapnia*	3	shredder/ditritivore	clinger			3		16	
Plecoptera	Chloroperlidae		1	predator	clinger						1
Plecoptera	Chloroperlidae	*Alloperla*	1	predator	clinger						
Plecoptera	Chloroperlidae	*Haploperla*	1.3	predator							
Plecoptera	Chloroperlidae	*Suwallia*	1	predator	clinger						
Plecoptera	Chloroperlidae	*Swelsta*	1	predator	clinger						
Plecoptera	Neumoridae	*Amphinemura*	3	shredder/ditritivore	clinger						
Plecoptera	Neumoridae	*Paranemoura*									
Plecoptera	Neumoridae	*Prostoia*	6.1	shredder							
Plecoptera	Neumoridae		2	shredder/ditritivore	clinger						
Plecoptera	Pletoperlidae	*Tallaperla*	1.4	shredder/ditritivore	clinger	1					
Plecoptera	Perlidae		1	predator	clinger						
Plecoptera	Perlidae	*Acroneuria*	1.5	predator	clinger						1
Plecoptera	Perlidae	*Atteneuria*									
Plecoptera	Perlidae	*Eccoptura*	4	predator	clinger				2		
Plecoptera	Perlidae	*Neoperla*	3.1	predator	clinger	13					4
Plecoptera	Perlidae	*Perlesta*	2	predator	clinger						
Plecoptera	Perlidae	*Perlinella*									
Plecoptera	Perlodidae		2	predator	clinger					2	
Plecoptera	Perlodidae	*Clioperla*	4.8								
Plecoptera	Perlodidae	*Helopicus*	0.4	predator							
Plecoptera	Perlodidae	*Hydroperla*	0.4	predator	clinger						
Plecoptera	Perlodidae	*Isoperla*	2	predator	clinger						
Plecoptera	Taeniopterygidae		2	shredder	sprawler				5		
Plecoptera	Taeniopterygidae	*Taeninopteryx*	3	shredder	sprawler	7	3	5		8	2
Plecoptera	Taeniopterygidae	*Strophopteryx*	2.5								
Trichoptera											25
Trichoptera	Brachycentridae	*Brachycentrus*	1.1	collector	clinger						
Trichoptera	Brachycentridae	*Micrasema*	0	shredder	clinger						
Trichoptera	Glossomatidae		0	scraper	clinger						
Trichoptera	Glossomatidae	*Agapetus*	0.5	scraper	clinger						
Trichoptera	Glossomatidae	*Glossoma*	1.5	scraper	clinger		14				
Trichoptera	Heliopsychidae	*Helicopsyche*	1.8	scraper	clinger				6		
Trichoptera	Hydropsychidae		4	collector	clinger						
Trichoptera	Hydropsychidae	*Ceratopsyche*	2	collector/filter	clinger						
Trichoptera	Hydropsychidae	*Cheumatopsyche*	6	collector/filter	clinger			13		7	5
Trichoptera	Hydropsychidae	*Homoplectra*	2	collector/filter	clinger						
Trichoptera	Hydropsychidae	*Hydropsyche*	2.6	collector/filter	clinger	2			1		
Trichoptera	Hydropsychidae	*Parapsche*	0	collector	clinger						
Trichoptera	Hydropsychidae	*Potamyia*	2.5	collector	clinger						
Trichoptera	Hydroptillidae	*Hydroptilla*	6	piercers	clinger						
Trichoptera	Hydroptillidae	*Orthotricia*									
Trichoptera	Lepidostomatidae	*Lepidostoma*	1.1	shredder/detritivore	climber	7				1	
Trichoptera	Leptoceridae		4	collector	climber						
Trichoptera	Leptoceridae	*Ceraclea*	2.6	collector/gatherer	clinger						
Trichoptera	Leptoceridae	*Nectopsyche*	4.2	shredder	climber						
Trichoptera	Leptoceridae	*Oecetis*	5.7	predator	climber				1		
Trichoptera	Leptoceridae	*Triaenodes*	4.3	shredder	climber						
Trichoptera	Limnephilidae								1		
Trichoptera	Limnephilidae	*Limnephulis*	5	shredder	climber						
Trichoptera	Limnephilidae	*Pycnopsyche*	3.3	shredder/detritivore	climber			1			9
Trichoptera	Philopotomodae	*Chimarra*	2.6	collector/filter	clinger		5	2	25	7	14
Trichoptera	Philopotomodae	*Wormaldia*	3	collector/filter	clinger						
Trichoptera	Polycentropodidae			collector	clinger						
Trichoptera	Polycentropodidae	*Cernotina*		predator	clinger						
Trichoptera	Polycentropodidae	*Neureclipsis*	2.7	collector/filter	clinger	3					
Trichoptera	Polycentropodidae	*Polycentropus*	3.4	predator	clinger						
Trichoptera	Psychomiidae	*Lype*	4.3	scraper							
Trichoptera	Psychomiidae	*Psychomia*	2	collector/gather	clinger						
Trichoptera	Rhyacophilidae	*Rhyacophila*	1	predator	clinger						

			Spring 2008								
Order	Family	Genus	LAF01	SF at Hwy 5	AF-2	NFS03	SFS02	MFS02	AF West of Hwy 9	NFS04	NFSO1
Amphipoda	Hyalellidae	*Hyalella azteca*					1			4	
Amphipoda	Gammaridae	*Gammarus*									
Annelida	Hiurinidae				1						5
Arachnida	Hydracacina	*Arrhenurus*									
Arachnida	Hydracacina									1	
Bivalvia	Corbiculidae	*Corbicula*	2		8	5	2	1	3		
Coleoptera	Gyrinidae	*Dineutus*									
Coleoptera	Hydrophilidae						1				
Coleoptera	Hydrophilidae	*Paracynus*									
Coleoptera	Hydrophilidae	*Sphaeridiinae*									
Coleoptera	Dryopidae	*Helichus*									1
Coleoptera	Dytiscidae										
Coleoptera	Dytiscidae	*Celina*									
Coleoptera	Dytiscidae	*Desmopachria*	1								
Coleoptera	Dytiscidae	*Hydaticus*									
Coleoptera	Dytiscidae	*Hygrotus*									
Coleoptera	Elmidae					1					
Coleoptera	Elmidae	*Ancyronyx*									
Coleoptera	Elmidae	*Ampumixis*									
Coleoptera	Elmidae	*Dubiraphia*									
Coleoptera	Elmidae	*Gonielmis*									
Coleoptera	Elmidae	*Heterelmis*			1	1	1		1	19	3
Coleoptera	Elmidae	*Macronychus*	1								
Coleoptera	Elmidae	*Microcylloepus*	1		2						
Coleoptera	Elmidae	*Neoelmis*	2	1	3		4				8
Coleoptera	Elmidae	*Optioservus*									
Coleoptera	Elmidae	*Oulimnius*									
Coleoptera	Elmidae	*Stenelmis*	17	5	8	5	4	2	18	38	26
Coleoptera	Gyrinidae	*Dineutus*				1			1		2
Coleoptera	Gyrinidae	*Gyretes*									
Coleoptera	Gyrinidae	*Gyrinus*									
Coleoptera	Psephenidae	*Ectopria*									
Coleoptera	Staphylinidae								11		
Coleoptera	Scirtidae	*Scittes*									
Coleoptera	Psephenidae	*Psephenus*	37	2		1	1		9	3	2
Collembola	Entomobryidae										
Collembola	Isotomidae	*Isotoma*									
Collembola	Isotomidae	*Semicurura*									
Copoda	Cyclopidae										
Decapoda	Cambaridae		10	2							
Decapoda	Cambaridae	*Cambarus*									
Decapoda	Cambaridae	*Procambarus*									
Decapoda	Cambaridae	*Orconectes*	1		2		1				13
Decapoda	Paleomonetes	*Paleomonetes*	1	5					4		
Diptera	Brachychera										
Diptera	Ceratopogonidae						2				
Diptera	Ceratopogonidae	*Bezzia*									
Diptera	Ceratopogonidae	*Dasyhelea*	1		1						
Diptera	Ceratopogonidae	*Probezzia*									
Diptera	Ceratopogonidae	*Serromyia*									
Diptera	Ceratopogonidae	*Forcipomyia*									
Diptera	Chironomidae		21	23	80	3	50	12	53	15	34
Diptera	Dixidae	*Dixella*									
Diptera	Empididae										
Diptera	Empididae	*Clinocera*									
Diptera	Empididae	*Hemerodromia*			5						
Diptera	Empididae	*Trichoclinocera*									
Diptera	Simulidae			1	1		66	4	6	13	
Diptera	Simulidae	*Simulium*					38				1
Diptera	Stratiomyidae										
Diptera	Tabanidae	*Haematopota*	5								
Diptera	Tabanidae	*Merycomia*									
Diptera	Tabanidae	*Tabanus*									
Diptera	Tipulidae										1
Diptera	Tipulidae	*Antocha*									
Diptera	Tipulidae	*Brachypremna*	1								
Diptera	Tipulidae	*Hexatoma*		3							
Diptera	Tipulidae	*Pedicia*									1
Diptera	Tipulidae	*Leptotarsus*									1
Diptera	Tipulidae	*Tipula*								1	
Ephemeroptera											

			Spring 2008								
Order	Family	Genus	LAF01	SF at Hwy 5	AF-2	NFS03	SFS02	MFS02	AF West of Hwy 9	NFS04	NFSO1
Ephemeroptera	Baetidae	*Acerpenna*									
Ephemeroptera	Baetidae	*Acentrella*	3								
Ephemeroptera	Baetidae	*Americabaetis*									
Ephemeroptera	Baetidae	*Baetis*									
Ephemeroptera	Baetidae	*Callibaetis*									
Ephemeroptera	Baetidae	*Fallceon*	3			14					
Ephemeroptera	Baetidae	*Hetercloen*									
Ephemeroptera	Baetidae	*Paracloedes*									
Ephemeroptera	Baetidae	*Procloen*									
Ephemeroptera	Baetidae			17	5		8		5		
Ephemeroptera	Baetiscidae	*Baetisca*									
Ephemeroptera	Caenidae	*Caenis*	9	2	18	4	6	14	9	18	4
Ephemeroptera	Ephemeridae	*Ephemera*									
Ephemeroptera	Ephemeridae	*Hexegenia*							2	1	
Ephemeroptera	Ephemerellidae	*Attenella*									
Ephemeroptera	Ephemerellidae	*Dannella*									
Ephemeroptera	Ephemerellidae	*Eurylophella*	6							2	
Ephemeroptera	Ephemerellidae	*Serratella*								2	
Ephemeroptera	Ephemeridae	*Ephmemerlla*	1							3	
Ephemeroptera	Heptageniidae			8		8	16				
Ephemeroptera	Heptageniidae	*Heptagenia*									
Ephemeroptera	Heptageniidae	*Leurocuta*				2					
Ephemeroptera	Heptageniidae	*Macaffertium*			4	1		1	61	27	
Ephemeroptera	Heptageniidae	*Rhithrogena*									
Ephemeroptera	Heptageniidae	*Stenacron*	1						4		
Ephemeroptera	Heptageniidae	*Stenonema*	5		11	1			5		119
Ephemeroptera	Heptageniidae										
Ephemeroptera	Isonychidae	*Isonychia*	5		2		2		14	3	2
Ephemeroptera	Leptophlebiidae										
Ephemeroptera	Leptophlebiidae	*Choroterpes*	1								
Ephemeroptera	Leptophlebiidae	*Leptophlebia*									
Ephemeroptera	Leptohyphidae	*Tricorythodes*	2			1				7	16
Ephemeroptera	Potamanthidae	*Anthopotamus*				1					
Ephemeroptera	Siphonluridae		9								
Ephemeroptera	Siphonluridae	*Siphlonurus*									
Gastropoda	Ancyllidae	*Ferrissia*			1			1			4
Gastropoda	Physsidae	*Physsa*							13		
Gastropoda	Pleuroceridae		39	5		5	3	6	15	5	
Gastropoda	Planorbidae		1	1					1		4
Gastropoda	Planorbidae	*Heliosoma*									
Gastropoda	Viviparidae										
Hemiptera	Corixidae	*Trichocorixia*	1								
Hemiptera	Herbridae	*Lipogomphus*									
Hemiptera	Mesoveliidae	*Mesovelia*	1								
Hemiptera	Veliidae	*Microvelia*									
Hemiptera	Veliidae	*Rhagavelia*			1						
Hiurenidae											
Isopoda	Asellidae	*Lirceus*	1		2	2	16	1	2	80	7
Lepidoptera	Crambidae										
Lepidoptera	Crambidae	*Elophila*									
Lepidoptera	Crambidae	*Parapoynx*									
Lepidoptera	Crambidae	*Petrophila*									
Megaloptera	Corydalidae	*Corydalus*	1		1						1
Megaloptera	Corydalidae	*Nigronia*	3								
Megaloptera	Sialidae	*Sialis*	1								
Odonata	Aeshinidae	*Anax or Aeshna*									
Odonata	Aeshinidae	*Basianeschna*									
Odonata	Aeshinidae	*Boyeria*									
Odonata	Calopterygidae	*Caleopteryx*		1							
Odonata	Calopterygidae	*Hetaerina*									
Odonata	Coenargionidae										
Odonata	Coenargionidae	*Amphiagrion*									
Odonata	Coenargionidae	*Argia*	2	1	1			1	1		
Odonata	Coenargionidae	*Chromagrion*				2					
Odonata	Coenargionidae	*Enallagma*									
Odonata	Corduliidae										
Odonata	Corduliidae	*Neurocordulia*								1	
Odonata	Corduliidae	*Somatochlora*									
Odonata	Gomphidae		1								
Odonata	Gomphidae	*Arigomphus*	9		4						
Odonata	Gomphidae	*Dromogomphus*									

			Spring 2008								
Order	Family	Genus	LAF01	SF at Hwy 5	AF-2	NFS03	SFS02	MFS02	AF West of Hwy 9	NFS04	NFSO1
Odonata	Gomphidae	*Erpetogomphus*									
Odonata	Gomphidae	*Gomphus*									
Odonata	Gomphidae	*Hagenius*									
Odonata	Gomphidae	*Lanthus*									
Odonata	Gomphidae	*Stylogomphus*							4	1	
Odonata	Libellulidae	*Dythemis*									
Odonata	Libellulidae	*Erythemis*									
Odonata	Macromiidae	*Macromia*									
Oligochaeta	Oligochaeta	*Oligochaeta*	6	2			2	2	1	6	3
Ostercoda											
Plecoptera											
Plecoptera	Capniidae										
Plecoptera	Capniidae	*Allocapnia*									
Plecoptera	Chloroperlidae										
Plecoptera	Chloroperlidae	*Alloperla*									
Plecoptera	Chloroperlidae	*Haploperla*									
Plecoptera	Chloroperlidae	*Suwallia*	12	6		10	1	3		4	
Plecoptera	Chloroperlidae	*Swelsta*									
Plecoptera	Neumoridae	*Amphinemura*									
Plecoptera	Neumoridae	*Paranemoura*									
Plecoptera	Neumoridae	*Prostoia*									
Plecoptera	Neumoridae										
Plecoptera	Pletoperlidae	*Tallaperla*									
Plecoptera	Perlidae						2				
Plecoptera	Perlidae	*Acroneuria*									
Plecoptera	Perlidae	*Atteneuria*	1								
Plecoptera	Perlidae	*Eccoptura*									
Plecoptera	Perlidae	*Neoperla*	1		7				7		1
Plecoptera	Perlidae	*Perlesta*	7						21		4
Plecoptera	Perlidae	*Perlinella*									
Plecoptera	Perlodidae										
Plecoptera	Perlodidae	*Clioperla*									
Plecoptera	Perlodidae	*Helopicus*									
Plecoptera	Perlodidae	*Hydroperla*									
Plecoptera	Perlodidae	*Isoperla*									
Plecoptera	Taeniopterygidae										
Plecoptera	Taeniopterygidae	*Taeninopteryx*									
Plecoptera	Taeniopterygidae	*Strophopteryx*									
Trichoptera											
Trichoptera	Brachycentridae	*Brachycentrus*									
Trichoptera	Brachycentridae	*Micrasema*									
Trichoptera	Glossomatidae										1
Trichoptera	Glossomatidae	*Agapetus*									
Trichoptera	Glossomatidae	*Glossoma*						1			
Trichoptera	Heliopsychidae	*Helicopsyche*	1	6			1		4		
Trichoptera	Hydropsychidae						2				
Trichoptera	Hydropsychidae	*Ceratopsyche*							35		
Trichoptera	Hydropsychidae	*Cheumatopsyche*			1		72				11
Trichoptera	Hydropsychidae	*Homoplectra*									
Trichoptera	Hydropsychidae	*Hydropsyche*	2	11	6					5	
Trichoptera	Hydropsychidae	*Parapsche*							1		
Trichoptera	Hydropsychidae	*Potamyia*									
Trichoptera	Hydroptillidae	*Hydroptilla*									
Trichoptera	Hydroptillidae	*Orthotricia*									
Trichoptera	Lepidostomatidae	*Lepidostoma*									
Trichoptera	Leptoceridae										2
Trichoptera	Leptoceridae	*Ceraclea*									
Trichoptera	Leptoceridae	*Nectopsyche*									
Trichoptera	Leptoceridae	*Oecetis*									
Trichoptera	Leptoceridae	*Triaenodes*									
Trichoptera	Limnephilidae										
Trichoptera	Limnephilidae	*Limnephulis*									
Trichoptera	Limnephilidae	*Pycnopsyche*									
Trichoptera	Philopotomodae	*Chimarra*	4	6	43				8	2	7
Trichoptera	Philopotomodae	*Wormaldia*									
Trichoptera	Polycentropodidae										
Trichoptera	Polycentropodidae	*Cernotina*									
Trichoptera	Polycentropodidae	*Neureclipsis*									
Trichoptera	Polycentropodidae	*Polycentropus*									
Trichoptera	Psychomiidae	*Lype*									
Trichoptera	Psychomiidae	*Psychomia*									
Trichoptera	Rhyacophilidae	*Rhyacophila*									

			Fall 2008										
Order	Family	Genus	NFS01	SF at Hwy 128	AF west of 9	NFS02	NFS03	AF2	NFS04	MFS02	SFat5	SFS02	LAF01
Amphipoda	Hyalellidae	*Hyalella azteca*	1	51	1			1	1	2			
Amphipoda	Gammaridae	*Gammarus*					6				8	8	
Annelida	Hiurinidae								1				
Arachnida	Hydracacina	*Arrhenurus*											
Arachnida	Hydracacina		1		2								1
Bivalvia	Corbiculidae	*Corbicula*	2		2	5	5	3		1		4	
Coleoptera	Gyrinidae	*Dineutus*											
Coleoptera	Hydrophilidae												
Coleoptera	Hydrophilidae	*Paracynus*											
Coleoptera	Hydrophilidae	*Sphaeridiinae*											
Coleoptera	Dryopidae	*Helichus*											
Coleoptera	Dytiscidae				1								
Coleoptera	Dytiscidae	*Celina*											
Coleoptera	Dytiscidae	*Desmopachria*											
Coleoptera	Dytiscidae	*Hydaticus*											
Coleoptera	Dytiscidae	*Hygrotus*			1								
Coleoptera	Elmidae												
Coleoptera	Elmidae	*Ancyronyx*		4					1	1			
Coleoptera	Elmidae	*Ampumixis*									3		
Coleoptera	Elmidae	*Dubiraphia*	1	9	3		2	1	1	1	3	4	
Coleoptera	Elmidae	*Gonielmis*											
Coleoptera	Elmidae	*Heterelmis*		2		7						1	
Coleoptera	Elmidae	*Macronychus*						2					
Coleoptera	Elmidae	*Microcylloepus*		1				2	2			2	
Coleoptera	Elmidae	*Neoelmis*											1
Coleoptera	Elmidae	*Optioservus*								1			4
Coleoptera	Elmidae	*Oulimnius*											
Coleoptera	Elmidae	*Stenelmis*	25	5	2	13	5	18		10		5	1
Coleoptera	Gyrinidae	*Dineutus*	1			1							
Coleoptera	Gyrinidae	*Gyretes*		2									
Coleoptera	Gyrinidae	*Gyrinus*		2									
Coleoptera	Psephenidae	*Ectopria*			2		1		2			1	
Coleoptera	Staphylinidae												
Coleoptera	Scirtidae	*Scittes*											
Coleoptera	Psephenidae	*Psephenus*			1	4		27	2		2	1	2
Collembola	Entomobryidae		10										
Collembola	Isotomidae	*Isotoma*				2							
Collembola	Isotomidae	*Semicurura*							8				
Copoda	Cyclopidae		4	2	1							1	
Decapoda	Cambaridae						1	3					
Decapoda	Cambaridae	*Cambarus*		2									
Decapoda	Cambaridae	*Procambarus*											
Decapoda	Cambaridae	*Orconectes*											
Decapoda	Paleomonetes	*Paleomonetes*											
Diptera	Brachychera												
Diptera	Ceratopogonidae												
Diptera	Ceratopogonidae	*Bezzia*											
Diptera	Ceratopogonidae	*Dasyhelea*											
Diptera	Ceratopogonidae	*Probezzia*											
Diptera	Ceratopogonidae	*Serromyia*											
Diptera	Ceratopogonidae	*Forcipomyia*											
Diptera	Chironomidae		49	79	66	60	71	16	11	161	64	31	58
Diptera	Dixidae	*Dixella*											
Diptera	Empididae												
Diptera	Empididae	*Clinocera*											
Diptera	Empididae	*Hemerodromia*	2	1	3			3					
Diptera	Empididae	*Trichoclinocera*											
Diptera	Simulidae		9		1	12	3	7		13	60	8	14
Diptera	Simulidae	*Simulium*											
Diptera	Stratiomyidae					1							
Diptera	Tabanidae	*Haematopota*						2					
Diptera	Tabanidae	*Merycomia*											
Diptera	Tabanidae	*Tabanus*											
Diptera	Tipulidae												
Diptera	Tipulidae	*Antocha*											
Diptera	Tipulidae	*Brachypremna*											
Diptera	Tipulidae	*Hexatoma*	1				1	3					
Diptera	Tipulidae	*Pedicia*											
Diptera	Tipulidae	*Leptotarsus*											
Diptera	Tipulidae	*Tipula*	1	1									2
Ephemeroptera													

			Fall 2008											
Order	Family	Genus	NFS01	SF at Hwy 128	AF west of 9	NFS02	NFS03	AF2	NFS04	MFS02	SFat5	SFS02	LAF01
Ephemeroptera	Baetidae	*Acerpenna*											
Ephemeroptera	Baetidae	*Acentrella*											
Ephemeroptera	Baetidae	*Americabaetis*											
Ephemeroptera	Baetidae	*Baetis*	3	1									1
Ephemeroptera	Baetidae	*Callibaetis*										5	
Ephemeroptera	Baetidae	*Fallceon*										3	
Ephemeroptera	Baetidae	*Hetercloen*											
Ephemeroptera	Baetidae	*Paracloedes*											
Ephemeroptera	Baetidae	*Procloen*											
Ephemeroptera	Baetidae			8	9	3				1	7		
Ephemeroptera	Baetiscidae	*Baetisca*		1			3		1				
Ephemeroptera	Caenidae	*Caenis*	5	7	17	4	37	4	4	11	2	7	
Ephemeroptera	Ephemeridae	*Ephemera*											
Ephemeroptera	Ephemeridae	*Hexegenia*											
Ephemeroptera	Ephemerellidae	*Attenella*											
Ephemeroptera	Ephemerellidae	*Dannella*											
Ephemeroptera	Ephemerellidae	*Eurylophella*	2	15	9	5	7		14		4		8
Ephemeroptera	Ephemerellidae	*Serratella*											
Ephemeroptera	Ephemeridae	*Ephmemerlla*											
Ephemeroptera	Heptageniidae				15	2				3			
Ephemeroptera	Heptageniidae	*Heptagenia*											
Ephemeroptera	Heptageniidae	*Leurocuta*											
Ephemeroptera	Heptageniidae	*Macaffertium*	1	7	6	1		57	24		6	35	14
Ephemeroptera	Heptageniidae	*Rhithrogena*											
Ephemeroptera	Heptageniidae	*Stenacron*			2	1							
Ephemeroptera	Heptageniidae	*Stenonema*	30	1	17	5	26			1	1		
Ephemeroptera	Heptageniidae		1										
Ephemeroptera	Isonychidae	*Isonychia*	8		19	3	5	17		3	4	39	1
Ephemeroptera	Leptophlebiidae				1					7			
Ephemeroptera	Leptophlebiidae	*Choroterpes*											
Ephemeroptera	Leptophlebiidae	*Leptophlebia*	1				2						
Ephemeroptera	Leptohyphidae	*Tricorythodes*		2			3					6	
Ephemeroptera	Potamanthidae	*Anthopotamus*							2				
Ephemeroptera	Siphonluridae												
Ephemeroptera	Siphonluridae	*Siphlonurus*											
Gastropoda	Ancyllidae	*Ferrissia*			3								
Gastropoda	Physsidae	*Physsa*											
Gastropoda	Pleuroceridae			18	5		4		1	5	12	11	1
Gastropoda	Planorbidae												
Gastropoda	Planorbidae	*Heliosoma*											
Gastropoda	Viviparidae					19						1	
Hemiptera	Corixidae	*Trichocorixia*											
Hemiptera	Herbridae	*Lipogomphus*											
Hemiptera	Mesoveliidae	*Mesovelia*											
Hemiptera	Veliidae	*Microvelia*		1									
Hemiptera	Veliidae	*Rhagavelia*		2									
Hiurenidae													
Isopoda	Asellidae	*Lirceus*	9				2	38	4			4	
Lepidoptera	Crambidae												
Lepidoptera	Crambidae	*Elophila*											1
Lepidoptera	Crambidae	*Parapoynx*											
Lepidoptera	Crambidae	*Petrophila*											
Megaloptera	Corydalidae	*Corydalus*						4					
Megaloptera	Corydalidae	*Nigronia*											
Megaloptera	Sialidae	*Sialis*						1					
Odonata	Aeshinidae	*Anax or Aeshna*						2					
Odonata	Aeshinidae	*Basianeschna*	1										
Odonata	Aeshinidae	*Boyeria*			1								
Odonata	Calopterygidae	*Caleopteryx*		3				2			2		
Odonata	Calopterygidae	*Hetaerina*											
Odonata	Coenargionidae								1				
Odonata	Coenargionidae	*Amphiagrion*										2	
Odonata	Coenargionidae	*Argia*					1					1	
Odonata	Coenargionidae	*Chromagrion*	1	11						1			
Odonata	Coenargionidae	*Enallagma*											
Odonata	Corduliidae												
Odonata	Corduliidae	*Neurocordulia*											
Odonata	Corduliidae	*Somatochlora*		3									
Odonata	Gomphidae												
Odonata	Gomphidae	*Arigomphus*											
Odonata	Gomphidae	*Dromogomphus*						1					

			Fall 2008											
Order	Family	Genus	NFS01	SF at Hwy 128	AF west of 9	NFS02	NFS03	AF2	NFS04	MFS02	SFat5	SFS02	LAF01
Odonata	Gomphidae	*Erpetogomphus*											
Odonata	Gomphidae	*Gomphus*											
Odonata	Gomphidae	*Hagenius*											
Odonata	Gomphidae	*Lanthus*						14					
Odonata	Gomphidae	*Stylogomphus*											
Odonata	Libellulidae	*Dythemis*						1					
Odonata	Libellulidae	*Erythemis*		1									
Odonata	Macromiidae	*Macromia*								1		1	
Oligochaeta	Oligochaeta	*Oligochaeta*	4	1	8		1	2	2	12	1	3	1
Ostercoda													
Plecoptera													
Plecoptera	Capniidae												
Plecoptera	Capniidae	*Allocapnia*			24	34	4						
Plecoptera	Chloroperlidae												
Plecoptera	Chloroperlidae	*Alloperla*											
Plecoptera	Chloroperlidae	*Haploperla*											
Plecoptera	Chloroperlidae	*Suwallia*	31						2			3	
Plecoptera	Chloroperlidae	*Swelsta*											
Plecoptera	Neumoridae	*Amphinemura*											
Plecoptera	Neumoridae	*Paranemoura*									81	11	
Plecoptera	Neumoridae	*Prostoia*							16				119
Plecoptera	Neumoridae			1		6							
Plecoptera	Pletoperlidae	*Tallaperla*											
Plecoptera	Perlidae												
Plecoptera	Perlidae	*Acroneuria*											
Plecoptera	Perlidae	*Atteneuria*											
Plecoptera	Perlidae	*Eccoptura*											
Plecoptera	Perlidae	*Neoperla*				1	6	9			2		20
Plecoptera	Perlidae	*Perlesta*											
Plecoptera	Perlidae	*Perlinella*											
Plecoptera	Perlodidae												
Plecoptera	Perlodidae	*Clioperla*				2							
Plecoptera	Perlodidae	*Helopicus*				2							
Plecoptera	Perlodidae	*Hydroperla*				1							
Plecoptera	Perlodidae	*Isoperla*				3							
Plecoptera	Taeniopterygidae												
Plecoptera	Taeniopterygidae	*Taeninopteryx*	7		3	41	5	3	2			6	14
Plecoptera	Taeniopterygidae	*Strophopteryx*			3								
Trichoptera													
Trichoptera	Brachycentridae	*Brachycentrus*											
Trichoptera	Brachycentridae	*Micrasema*				2							
Trichoptera	Glossomatidae									1			
Trichoptera	Glossomatidae	*Agapetus*				20							9
Trichoptera	Glossomatidae	*Glossoma*											
Trichoptera	Heliopsychidae	*Helicopsyche*				1	1	3	3		1		
Trichoptera	Hydropsychidae												
Trichoptera	Hydropsychidae	*Ceratopsyche*										5	
Trichoptera	Hydropsychidae	*Cheumatopsyche*		2	32	14				8			
Trichoptera	Hydropsychidae	*Homoplectra*											
Trichoptera	Hydropsychidae	*Hydropsyche*	1					6	1		8	35	2
Trichoptera	Hydropsychidae	*Parapsche*											
Trichoptera	Hydropsychidae	*Potamyia*					16						
Trichoptera	Hydroptillidae	*Hydroptilla*											
Trichoptera	Hydroptillidae	*Orthotricia*											
Trichoptera	Lepidostomatidae	*Lepidostoma*											
Trichoptera	Leptoceridae												
Trichoptera	Leptoceridae	*Ceraclea*											
Trichoptera	Leptoceridae	*Nectopsyche*							1				
Trichoptera	Leptoceridae	*Oecetis*			1								
Trichoptera	Leptoceridae	*Triaenodes*		1									
Trichoptera	Limnephilidae				1								
Trichoptera	Limnephilidae	*Limnephulis*									1		
Trichoptera	Limnephilidae	*Pycnopsyche*	2		6	4	3	7	2				5
Trichoptera	Philopotomodae	*Chimarra*			19	1	12	7	1	8	20	22	17
Trichoptera	Philopotomodae	*Wormaldia*			1								
Trichoptera	Polycentropodidae					1	1						
Trichoptera	Polycentropodidae	*Cernotina*											
Trichoptera	Polycentropodidae	*Neureclipsis*											
Trichoptera	Polycentropodidae	*Polycentropus*		4	1								
Trichoptera	Psychomiidae	*Lype*											
Trichoptera	Psychomiidae	*Psychomia*											
Trichoptera	Rhyacophilidae	*Rhyacophila*	10				1						

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Order	Family	Genus	SFS02	SF at 128	AF west of 9	MFS02	NFS04	LAF01	AF2	NFS02	SF at 5	NFS03	NFS01
Amphipoda	Hyalellidae	*Hyalella azteca*	2		5	1			1	2	2		
Amphipoda	Gammaridae	*Gammarus*	2										
Annelida	Hiurinidae												
Arachnida	Hydracacina	*Arrhenurus*											
Arachnida	Hydracacina												
Bivalvia	Corbiculidae	*Corbicula*	7	4	2	2			4	7			
Coleoptera	Gyrinidae	*Dineutus*							1	3			
Coleoptera	Hydrophilidae												
Coleoptera	Hydrophilidae	*Paracynus*											
Coleoptera	Hydrophilidae	*Sphaeridiinae*											1
Coleoptera	Dryopidae	*Helichus*											
Coleoptera	Dytiscidae											1	
Coleoptera	Dytiscidae	*Celina*											
Coleoptera	Dytiscidae	*Desmopachria*											
Coleoptera	Dytiscidae	*Hydaticus*											
Coleoptera	Dytiscidae	*Hygrotus*			1						1		2
Coleoptera	Elmidae												
Coleoptera	Elmidae	*Ancyronyx*			2	1							
Coleoptera	Elmidae	*Ampumixis*										1	
Coleoptera	Elmidae	*Dubiraphia*		1	1	1				1		1	
Coleoptera	Elmidae	*Gonielmis*						2				2	
Coleoptera	Elmidae	*Heterelmis*	5	6	1	3	4	1	8	4		2	
Coleoptera	Elmidae	*Macronychus*	2									1	
Coleoptera	Elmidae	*Microcylloepus*											
Coleoptera	Elmidae	*Neoelmis*			4	2	3			5		4	3
Coleoptera	Elmidae	*Optioservus*						1					
Coleoptera	Elmidae	*Oulimnius*											
Coleoptera	Elmidae	*Stenelmis*	3	6	4	2	1	7	13	15	4	7	12
Coleoptera	Gyrinidae	*Dineutus*											
Coleoptera	Gyrinidae	*Gyretes*											
Coleoptera	Gyrinidae	*Gyrinus*											
Coleoptera	Psephenidae	*Ectopria*	1		1								
Coleoptera	Staphylinidae												
Coleoptera	Scirtidae	*Scittes*											1
Coleoptera	Psephenidae	*Psephenus*			1				2	1	1	3	
Collembola	Entomobryidae			1									
Collembola	Isotomidae	*Isotoma*											
Collembola	Isotomidae	*Semicurura*											
Copoda	Cyclopidae												
Decapoda	Cambaridae			1	1	1					1		1
Decapoda	Cambaridae	*Cambarus*											
Decapoda	Cambaridae	*Procambarus*				1							
Decapoda	Cambaridae	*Orconectes*								1			
Decapoda	Paleomonetes	*Paleomonetes*			1								
Diptera	Brachychera					11							
Diptera	Ceratopogonidae												
Diptera	Ceratopogonidae	*Bezzia*				1	1		1	1		1	
Diptera	Ceratopogonidae	*Dasyhelea*											
Diptera	Ceratopogonidae	*Probezzia*											
Diptera	Ceratopogonidae	*Serromyia*											
Diptera	Ceratopogonidae	*Forcipomyia*											
Diptera	Chironomidae		32	93	82	199	157	217	67	43	170	82	35
Diptera	Dixidae	*Dixella*											
Diptera	Empididae							1					
Diptera	Empididae	*Clinocera*											
Diptera	Empididae	*Hemerodromia*		4				2	6	1	1		4
Diptera	Empididae	*Trichoclinocera*											
Diptera	Simulidae		68	67	5	20		25	13	38	12	28	30
Diptera	Simulidae	*Simulium*											
Diptera	Stratiomyidae												
Diptera	Tabanidae	*Haematopota*											
Diptera	Tabanidae	*Merycomia*			1								
Diptera	Tabanidae	*Tabanus*						1					
Diptera	Tipulidae												
Diptera	Tipulidae	*Antocha*		1									
Diptera	Tipulidae	*Brachypremna*											
Diptera	Tipulidae	*Hexatoma*							2		1		2
Diptera	Tipulidae	*Pedicia*											
Diptera	Tipulidae	*Leptotarsus*											
Diptera	Tipulidae	*Tipula*						2	1			2	
Ephemeroptera								4					

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Order	Family	Genus	MFS02	NFS02	NFS03	NFS04	SF at 128
Ephemeroptera	Baetidae	*Acerpenna*					
Ephemeroptera	Baetidae	*Acentrella*					
Ephemeroptera	Baetidae	*Americabaetis*					
Ephemeroptera	Baetidae	*Baetis*					
Ephemeroptera	Baetidae	*Callibaetis*					
Ephemeroptera	Baetidae	*Fallceon*		1	2	9	5
Ephemeroptera	Baetidae	*Hetercloen*			1		
Ephemeroptera	Baetidae	*Paracloedes*					
Ephemeroptera	Baetidae	*Procloen*		1			1
Ephemeroptera	Baetidae		1		1		
Ephemeroptera	Baetiscidae	*Baetisca*		1	1		
Ephemeroptera	Caenidae	*Caenis*	25	2	19	3	21
Ephemeroptera	Ephemeridae	*Ephemera*					
Ephemeroptera	Ephemeridae	*Hexegenia*					1
Ephemeroptera	Ephemerellidae	*Attenella*					
Ephemeroptera	Ephemerellidae	*Dannella*					
Ephemeroptera	Ephemerellidae	*Eurylophella*			3	2	2
Ephemeroptera	Ephemerellidae	*Serratella*					
Ephemeroptera	Ephemeridae	*Ephmemerlla*					
Ephemeroptera	Heptageniidae				5		
Ephemeroptera	Heptageniidae	*Heptagenia*					
Ephemeroptera	Heptageniidae	*Leurocuta*					
Ephemeroptera	Heptageniidae	*Macaffertium*	7	2	3		2
Ephemeroptera	Heptageniidae	*Rhithrogena*					
Ephemeroptera	Heptageniidae	*Stenacron*				1	
Ephemeroptera	Heptageniidae	*Stenonema*	27	2	12	8	13
Ephemeroptera	Heptageniidae						
Ephemeroptera	Isonychidae	*Isonychia*	5	2			6
Ephemeroptera	Leptophlebiidae						
Ephemeroptera	Leptophlebiidae	*Choroterpes*					
Ephemeroptera	Leptophlebiidae	*Leptophlebia*			5		
Ephemeroptera	Leptohyphidae	*Tricorythodes*	9	1	6	3	1
Ephemeroptera	Potamanthidae	*Anthopotamus*			1		
Ephemeroptera	Siphonluridae						
Ephemeroptera	Siphonluridae	*Siphlonurus*					
Gastropoda	Ancyllidae	*Ferrissia*					
Gastropoda	Physsidae	*Physsa*					
Gastropoda	Pleuroceridae						
Gastropoda	Planorbidae						
Gastropoda	Planorbidae	*Heliosoma*					
Gastropoda	Viviparidae		14	5		7	13
Hemiptera	Corixidae	*Trichocorixia*					
Hemiptera	Herbridae	*Lipogomphus*					
Hemiptera	Mesoveliidae	*Mesovelia*					
Hemiptera	Veliidae	*Microvelia*					
Hemiptera	Veliidae	*Rhagavelia*					
Hiurenidae							
Isopoda	Asellidae	*Lirceus*			6	6	
Lepidoptera	Crambidae						
Lepidoptera	Crambidae	*Elophila*					
Lepidoptera	Crambidae	*Parapoynx*					
Lepidoptera	Crambidae	*Petrophila*					
Megaloptera	Corydalidae	*Corydalus*			1		1
Megaloptera	Corydalidae	*Nigronia*					
Megaloptera	Sialidae	*Sialis*					
Odonata	Aeshinidae	*Anax or Aeshna*					
Odonata	Aeshinidae	*Basianeschna*					
Odonata	Aeshinidae	*Boyeria*					
Odonata	Calopterygidae	*Caleopteryx*	1				2
Odonata	Calopterygidae	*Hetaerina*					
Odonata	Coenargionidae						
Odonata	Coenargionidae	*Amphiagrion*					
Odonata	Coenargionidae	*Argia*	4		1	5	2
Odonata	Coenargionidae	*Chromagrion*					
Odonata	Coenargionidae	*Enallagma*					
Odonata	Corduliidae				1		
Odonata	Corduliidae	*Neurocordulia*					
Odonata	Corduliidae	*Somatochlora*					
Odonata	Gomphidae						
Odonata	Gomphidae	*Arigomphus*					
Odonata	Gomphidae	*Dromogomphus*	3				

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Order	Family	Genus	SFS02	SF at 128	AF west of 9	MFS02	NFS04	LAF01	AF2	NFS02	SF at 5	NFS03	NFS01
Odonata	Gomphidae	*Erpetogomphus*									1		
Odonata	Gomphidae	*Gomphus*						2					
Odonata	Gomphidae	*Hagenius*										1	
Odonata	Gomphidae	*Lanthus*											
Odonata	Gomphidae	*Stylogomphus*	2	2					6	3			
Odonata	Libellulidae	*Dythemis*											
Odonata	Libellulidae	*Erythemis*											
Odonata	Macromiidae	*Macromia*											
Oligochaeta	Oligochaeta	*Oligochaeta*							3				4
Ostercoda													
Plecoptera													
Plecoptera	Capniidae												
Plecoptera	Capniidae	*Allocapnia*											
Plecoptera	Chloroperlidae												
Plecoptera	Chloroperlidae	*Alloperla*	6			3	2	5	2	5	13	14	8
Plecoptera	Chloroperlidae	*Haploperla*						5					
Plecoptera	Chloroperlidae	*Suwallia*								3			
Plecoptera	Chloroperlidae	*Swelsta*											
Plecoptera	Neumoridae	*Amphinemura*	4	2			9	8		2	3	1	2
Plecoptera	Neumoridae	*Paranemoura*											
Plecoptera	Neumoridae	*Prostoia*											
Plecoptera	Neumoridae												
Plecoptera	Pletoperlidae	*Tallaperla*											
Plecoptera	Perlidae							1					
Plecoptera	Perlidae	*Acroneuria*						1					
Plecoptera	Perlidae	*Atteneuria*		1									
Plecoptera	Perlidae	*Eccoptura*											
Plecoptera	Perlidae	*Neoperla*			1				4				
Plecoptera	Perlidae	*Perlesta*	11		5	4	1	1	6	3	5	9	3
Plecoptera	Perlidae	*Perlinella*											
Plecoptera	Perlodidae							1					1
Plecoptera	Perlodidae	*Clioperla*											
Plecoptera	Perlodidae	*Helopicus*											
Plecoptera	Perlodidae	*Hydroperla*											
Plecoptera	Perlodidae	*Isoperla*			2			13	1	1	1	3	5
Plecoptera	Taeniopterygidae												
Plecoptera	Taeniopterygidae	*Taeninopteryx*								1			
Plecoptera	Taeniopterygidae	*Strophopteryx*											
Trichoptera								1					
Trichoptera	Brachycentridae	*Brachycentrus*								1			
Trichoptera	Brachycentridae	*Micrasema*				3							
Trichoptera	Glossomatidae						1						
Trichoptera	Glossomatidae	*Agapetus*		1				2		8			15
Trichoptera	Glossomatidae	*Glossoma*											
Trichoptera	Heliopsychidae	*Helicopsyche*		1			1	1	2				
Trichoptera	Hydropsychidae												
Trichoptera	Hydropsychidae	*Ceratopsyche*											
Trichoptera	Hydropsychidae	*Cheumatopsyche*	22	9				1	10		1		
Trichoptera	Hydropsychidae	*Homoplectra*											
Trichoptera	Hydropsychidae	*Hydropsyche*	15	7		3	12					19	
Trichoptera	Hydropsychidae	*Parapsche*											
Trichoptera	Hydropsychidae	*Potamyia*											
Trichoptera	Hydroptillidae	*Hydroptilla*											1
Trichoptera	Hydroptillidae	*Orthotricia*											
Trichoptera	Lepidostomatidae	*Lepidostoma*											
Trichoptera	Leptoceridae												
Trichoptera	Leptoceridae	*Ceraclea*		1									
Trichoptera	Leptoceridae	*Nectopsyche*	1									1	
Trichoptera	Leptoceridae	*Oecetis*					1				1	1	
Trichoptera	Leptoceridae	*Triaenodes*											
Trichoptera	Limnephilidae												
Trichoptera	Limnephilidae	*Limnephulis*											
Trichoptera	Limnephilidae	*Pycnopsyche*			1			1					
Trichoptera	Philopotomodae	*Chimarra*	24	6	4		2	2				2	2
Trichoptera	Philopotomodae	*Wormaldia*			9			2		3		1	3
Trichoptera	Polycentropodidae												
Trichoptera	Polycentropodidae	*Cernotina*									1		
Trichoptera	Polycentropodidae	*Neureclipsis*											
Trichoptera	Polycentropodidae	*Polycentropus*											
Trichoptera	Psychomiidae	*Lype*								1			
Trichoptera	Psychomiidae	*Psychomia*							1				
Trichoptera	Rhyacophilidae	*Rhyacophila*				1				1			

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Order	Family	Genus	SFS02	SF at 128	AF west of 9	MFS02	NFS04	LAF01	AF2	NFS02	SF at 5	NFS03	NFS01	
Ephemeroptera	Baetidae	*Acerpenna*												
Ephemeroptera	Baetidae	*Acentrella*							18					
Ephemeroptera	Baetidae	*Americabaetis*												
Ephemeroptera	Baetidae	*Baetis*	1	4						7		5	7	
Ephemeroptera	Baetidae	*Callibaetis*												
Ephemeroptera	Baetidae	*Fallceon*		35	6	4			1	10		4	2	
Ephemeroptera	Baetidae	*Hetercloen*						2						
Ephemeroptera	Baetidae	*Paracloedes*											1	
Ephemeroptera	Baetidae	*Procloen*		3	12	12					5			
Ephemeroptera	Baetidae		1		5		12		5		9	18		
Ephemeroptera	Baetiscidae	*Baetisca*				1								
Ephemeroptera	Caenidae	*Caenis*		2	29	8	12		14	3	2			
Ephemeroptera	Ephemeridae	*Ephemera*			1									
Ephemeroptera	Ephemeridae	*Hexegenia*												
Ephemeroptera	Ephemerellidae	*Attenella*				1				5				
Ephemeroptera	Ephemerellidae	*Dannella*				1								
Ephemeroptera	Ephemerellidae	*Eurylophella*		3	6			11	1		20		2	
Ephemeroptera	Ephemerellidae	*Serratella*												
Ephemeroptera	Ephemeridae	*Ephmemerlla*	10			3	2				1			
Ephemeroptera	Heptageniidae													
Ephemeroptera	Heptageniidae	*Heptagenia*												
Ephemeroptera	Heptageniidae	*Leurocuta*												
Ephemeroptera	Heptageniidae	*Macaffertium*	3	3	6			3	3	2				
Ephemeroptera	Heptageniidae	*Rhithrogena*					1			3				
Ephemeroptera	Heptageniidae	*Stenacron*						2						
Ephemeroptera	Heptageniidae	*Stenonema*	23	1	16	3	3	2	6	13	4	11	6	
Ephemeroptera	Heptageniidae													
Ephemeroptera	Isonychidae	*Isonychia*	25	6	1	2		1	2	1			1	
Ephemeroptera	Leptophlebiidae													
Ephemeroptera	Leptophlebiidae	*Choroterpes*												
Ephemeroptera	Leptophlebiidae	*Leptophlebia*												
Ephemeroptera	Leptohyphidae	*Tricorythodes*	1	1		1								
Ephemeroptera	Potamanthidae	*Anthopotamus*												
Ephemeroptera	Siphonluridae													
Ephemeroptera	Siphonluridae	*Siphlonurus*												
Gastropoda	Ancyllidae	*Ferrissia*												
Gastropoda	Physsidae	*Physsa*		1							1			
Gastropoda	Pleuroceridae													
Gastropoda	Planorbidae													
Gastropoda	Planorbidae	*Heliosoma*			1									
Gastropoda	Viviparidae		4	13			6			5	1			
Hemiptera	Corixidae	*Trichocorixia*												
Hemiptera	Herbridae	*Lipogomphus*												
Hemiptera	Mesoveliidae	*Mesovelia*												
Hemiptera	Veliidae	*Microvelia*												
Hemiptera	Veliidae	*Rhagavelia*												
Hiurenidae					1									
Isopoda	Asellidae	*Lirceus*	24		4	2	45	2	56	3		13	2	
Lepidoptera	Crambidae													
Lepidoptera	Crambidae	*Elophila*											1	
Lepidoptera	Crambidae	*Parapoynx*												
Lepidoptera	Crambidae	*Petrophila*												
Megaloptera	Corydalidae	*Corydalus*	1		1									
Megaloptera	Corydalidae	*Nigronia*												
Megaloptera	Sialidae	*Sialis*												
Odonata	Aeshinidae	*Anax or Aeshna*												
Odonata	Aeshinidae	*Basianeschna*												
Odonata	Aeshinidae	*Boyeria*									1			
Odonata	Calopterygidae	*Caleopteryx*	1			1		1			1	1		
Odonata	Calopterygidae	*Hetaerina*		1										
Odonata	Coenargionidae								1					
Odonata	Coenargionidae	*Amphiagrion*												
Odonata	Coenargionidae	*Argia*												
Odonata	Coenargionidae	*Chromagrion*												
Odonata	Coenargionidae	*Enallagma*			1									
Odonata	Corduliidae													
Odonata	Corduliidae	*Neurocordulia*												
Odonata	Corduliidae	*Somatochlora*												
Odonata	Gomphidae													
Odonata	Gomphidae	*Arigomphus*												
Odonata	Gomphidae	*Dromogomphus*												

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Order	Family	Genus	SFS02	SF at 128	AF west of 9	MFS02	NFS04	LAF01	AF2	NFS02	SF at 5	NFS03	NFS01
Odonata	Gomphidae	*Erpetogomphus*									1		
Odonata	Gomphidae	*Gomphus*						2					
Odonata	Gomphidae	*Hagenius*										1	
Odonata	Gomphidae	*Lanthus*											
Odonata	Gomphidae	*Stylogomphus*	2	2					6	3			
Odonata	Libellulidae	*Dythemis*											
Odonata	Libellulidae	*Erythemis*											
Odonata	Macromiidae	*Macromia*											
Oligochaeta	Oligochaeta	*Oligochaeta*							3				4
Ostercoda													
Plecoptera													
Plecoptera	Capniidae												
Plecoptera	Capniidae	*Allocapnia*											
Plecoptera	Chloroperlidae												
Plecoptera	Chloroperlidae	*Alloperla*	6			3	2	5	2	5	13	14	8
Plecoptera	Chloroperlidae	*Haploperla*						5					
Plecoptera	Chloroperlidae	*Suwallia*								3			
Plecoptera	Chloroperlidae	*Swelsta*											
Plecoptera	Neumoridae	*Amphinemura*	4	2			9	8		2	3	1	2
Plecoptera	Neumoridae	*Paranemoura*											
Plecoptera	Neumoridae	*Prostoia*											
Plecoptera	Neumoridae												
Plecoptera	Pletoperlidae	*Tallaperla*											
Plecoptera	Perlidae							1					
Plecoptera	Perlidae	*Acroneuria*						1					
Plecoptera	Perlidae	*Atteneuria*		1									
Plecoptera	Perlidae	*Eccoptura*											
Plecoptera	Perlidae	*Neoperla*			1				4				
Plecoptera	Perlidae	*Perlesta*	11		5	4	1	1	6	3	5	9	3
Plecoptera	Perlidae	*Perlinella*											
Plecoptera	Perlodidae							1					1
Plecoptera	Perlodidae	*Clioperla*											
Plecoptera	Perlodidae	*Helopicus*											
Plecoptera	Perlodidae	*Hydroperla*											
Plecoptera	Perlodidae	*Isoperla*			2			13	1	1	1	3	5
Plecoptera	Taeniopterygidae												
Plecoptera	Taeniopterygidae	*Taeninopteryx*								1			
Plecoptera	Taeniopterygidae	*Strophopteryx*											
Trichoptera								1					
Trichoptera	Brachycentridae	*Brachycentrus*								1			
Trichoptera	Brachycentridae	*Micrasema*				3							
Trichoptera	Glossomatidae						1						
Trichoptera	Glossomatidae	*Agapetus*		1				2		8			15
Trichoptera	Glossomatidae	*Glossoma*											
Trichoptera	Heliopsychidae	*Helicopsyche*		1			1	1	2				
Trichoptera	Hydropsychidae												
Trichoptera	Hydropsychidae	*Ceratopsyche*											
Trichoptera	Hydropsychidae	*Cheumatopsyche*	22	9				1	10		1		
Trichoptera	Hydropsychidae	*Homoplectra*											
Trichoptera	Hydropsychidae	*Hydropsyche*	15	7		3	12					19	
Trichoptera	Hydropsychidae	*Parapsche*											
Trichoptera	Hydropsychidae	*Potamyia*											
Trichoptera	Hydroptillidae	*Hydroptilla*											1
Trichoptera	Hydroptillidae	*Orthotricia*											
Trichoptera	Lepidostomatidae	*Lepidostoma*											
Trichoptera	Leptoceridae												
Trichoptera	Leptoceridae	*Ceraclea*		1									
Trichoptera	Leptoceridae	*Nectopsyche*	1									1	
Trichoptera	Leptoceridae	*Oecetis*					1				1	1	
Trichoptera	Leptoceridae	*Triaenodes*											
Trichoptera	Limnephilidae												
Trichoptera	Limnephilidae	*Limnephulis*											
Trichoptera	Limnephilidae	*Pycnopsyche*			1			1					
Trichoptera	Philopotomodae	*Chimarra*	24	6	4		2	2				2	2
Trichoptera	Philopotomodae	*Wormaldia*			9			2		3		1	3
Trichoptera	Polycentropodidae												
Trichoptera	Polycentropodidae	*Cernotina*									1		
Trichoptera	Polycentropodidae	*Neureclipsis*											
Trichoptera	Polycentropodidae	*Polycentropus*											
Trichoptera	Psychomiidae	*Lype*								1			
Trichoptera	Psychomiidae	*Psychomia*							1				
Trichoptera	Rhyacophilidae	*Rhyacophila*				1				1			

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Order	Family	Genus	MFS02	NFS02	NFS03	NFS04	SF at 128
Amphipoda	Hyalellidae	*Hyalella azteca*			1	2	2
Amphipoda	Gammaridae	*Gammarus*					
Annelida	Hiurinidae						
Arachnida	Hydracacina	*Arrhenurus*					
Arachnida	Hydracacina		2				
Bivalvia	Corbiculidae	*Corbicula*	9	9	1	1	
Coleoptera	Gyrinidae	*Dineutus*					
Coleoptera	Hydrophilidae						
Coleoptera	Hydrophilidae	*Paracynus*					
Coleoptera	Hydrophilidae	*Sphaeridiinae*					
Coleoptera	Dryopidae	*Helichus*					
Coleoptera	Dytiscidae						
Coleoptera	Dytiscidae	*Celina*					
Coleoptera	Dytiscidae	*Desmopachria*					
Coleoptera	Dytiscidae	*Hydaticus*					
Coleoptera	Dytiscidae	*Hygrotus*					1
Coleoptera	Elmidae		1				
Coleoptera	Elmidae	*Ancyronyx*			1		1
Coleoptera	Elmidae	*Ampumixis*					
Coleoptera	Elmidae	*Dubiraphia*	15	4	11	1	7
Coleoptera	Elmidae	*Gonielmis*	1				1
Coleoptera	Elmidae	*Heterelmis*	10	19	4	8	21
Coleoptera	Elmidae	*Macronychus*					
Coleoptera	Elmidae	*Microcylloepus*		8			
Coleoptera	Elmidae	*Neoelmis*			4		
Coleoptera	Elmidae	*Optioservus*					
Coleoptera	Elmidae	*Oulimnius*					
Coleoptera	Elmidae	*Stenelmis*	14	15	13	15	21
Coleoptera	Gyrinidae	*Dineutus*			1		1
Coleoptera	Gyrinidae	*Gyretes*					
Coleoptera	Gyrinidae	*Gyrinus*					
Coleoptera	Psephenidae	*Ectopria*		4			2
Coleoptera	Staphylinidae						
Coleoptera	Scirtidae	*Scittes*					
Coleoptera	Psephenidae	*Psephenus*	1	5			1
Collembola	Entomobryidae						
Collembola	Isotomidae	*Isotoma*					
Collembola	Isotomidae	*Semicurura*					
Copoda	Cyclopidae				1		
Decapoda	Cambaridae		4	2		1	
Decapoda	Cambaridae	*Cambarus*					
Decapoda	Cambaridae	*Procambarus*					
Decapoda	Cambaridae	*Orconectes*					
Decapoda	Paleomonetes	*Paleomonetes*					
Diptera	Brachychera			1			
Diptera	Ceratopogonidae						
Diptera	Ceratopogonidae	*Bezzia*	1		2	2	
Diptera	Ceratopogonidae	*Dasyhelea*			2		
Diptera	Ceratopogonidae	*Probezzia*					
Diptera	Ceratopogonidae	*Serromyia*					
Diptera	Ceratopogonidae	*Forcipomyia*					
Diptera	Chironomidae		48	58	66	27	34
Diptera	Dixidae	*Dixella*					
Diptera	Empididae						
Diptera	Empididae	*Clinocera*					
Diptera	Empididae	*Hemerodromia*	1			1	
Diptera	Empididae	*Trichoclinocera*					
Diptera	Simulidae		2		1	38	
Diptera	Simulidae	*Simulium*		13			19
Diptera	Stratiomyidae						
Diptera	Tabanidae	*Haematopota*					
Diptera	Tabanidae	*Merycomia*					
Diptera	Tabanidae	*Tabanus*					
Diptera	Tipulidae						
Diptera	Tipulidae	*Antocha*					
Diptera	Tipulidae	*Brachypremna*					
Diptera	Tipulidae	*Hexatoma*		1	3		
Diptera	Tipulidae	*Pedicia*					
Diptera	Tipulidae	*Leptotarsus*					
Diptera	Tipulidae	*Tipula*		2		1	1
Ephemeroptera							

Fall 2009

Order	Family	Genus	MFS02	NFS02	NFS03	NFS04	SF at 128
Ephemeroptera	Baetidae	*Acerpenna*					
Ephemeroptera	Baetidae	*Acentrella*					
Ephemeroptera	Baetidae	*Americabaetis*					
Ephemeroptera	Baetidae	*Baetis*					
Ephemeroptera	Baetidae	*Callibaetis*					
Ephemeroptera	Baetidae	*Fallceon*		1	2	9	5
Ephemeroptera	Baetidae	*Hetercloen*			1		
Ephemeroptera	Baetidae	*Paracloedes*					
Ephemeroptera	Baetidae	*Procloen*		1			1
Ephemeroptera	Baetidae		1		1		
Ephemeroptera	Baetiscidae	*Baetisca*		1	1		
Ephemeroptera	Caenidae	*Caenis*	25	2	19	3	21
Ephemeroptera	Ephemeridae	*Ephemera*					
Ephemeroptera	Ephemeridae	*Hexegenia*					1
Ephemeroptera	Ephemerellidae	*Attenella*					
Ephemeroptera	Ephemerellidae	*Dannella*					
Ephemeroptera	Ephemerellidae	*Eurylophella*			3	2	2
Ephemeroptera	Ephemerellidae	*Serratella*					
Ephemeroptera	Ephemeridae	*Ephmemerlla*					
Ephemeroptera	Heptageniidae				5		
Ephemeroptera	Heptageniidae	*Heptagenia*					
Ephemeroptera	Heptageniidae	*Leurocuta*					
Ephemeroptera	Heptageniidae	*Macaffertium*	7	2	3		2
Ephemeroptera	Heptageniidae	*Rhithrogena*					
Ephemeroptera	Heptageniidae	*Stenacron*				1	
Ephemeroptera	Heptageniidae	*Stenonema*	27	2	12	8	13
Ephemeroptera	Heptageniidae						
Ephemeroptera	Isonychidae	*Isonychia*	5	2			6
Ephemeroptera	Leptophlebiidae						
Ephemeroptera	Leptophlebiidae	*Choroterpes*					
Ephemeroptera	Leptophlebiidae	*Leptophlebia*			5		
Ephemeroptera	Leptohyphidae	*Tricorythodes*	9	1	6	3	1
Ephemeroptera	Potamanthidae	*Anthopotamus*			1		
Ephemeroptera	Siphonluridae						
Ephemeroptera	Siphonluridae	*Siphlonurus*					
Gastropoda	Ancyllidae	*Ferrissia*					
Gastropoda	Physsidae	*Physsa*					
Gastropoda	Pleuroceridae						
Gastropoda	Planorbidae						
Gastropoda	Planorbidae	*Heliosoma*					
Gastropoda	Viviparidae		14	5		7	13
Hemiptera	Corixidae	*Trichocorixia*					
Hemiptera	Herbridae	*Lipogomphus*					
Hemiptera	Mesoveliidae	*Mesovelia*					
Hemiptera	Veliidae	*Microvelia*					
Hemiptera	Veliidae	*Rhagavelia*					
Hiurenidae							
Isopoda	Asellidae	*Lirceus*			6	6	
Lepidoptera	Crambidae						
Lepidoptera	Crambidae	*Elophila*					
Lepidoptera	Crambidae	*Parapoynx*					
Lepidoptera	Crambidae	*Petrophila*					
Megaloptera	Corydalidae	*Corydalus*			1		1
Megaloptera	Corydalidae	*Nigronia*					
Megaloptera	Sialidae	*Sialis*					
Odonata	Aeshinidae	*Anax or Aeshna*					
Odonata	Aeshinidae	*Basianeschna*					
Odonata	Aeshinidae	*Boyeria*					
Odonata	Calopterygidae	*Caleopteryx*	1				2
Odonata	Calopterygidae	*Hetaerina*					
Odonata	Coenargionidae						
Odonata	Coenargionidae	*Amphiagrion*					
Odonata	Coenargionidae	*Argia*	4		1	5	2
Odonata	Coenargionidae	*Chromagrion*					
Odonata	Coenargionidae	*Enallagma*					
Odonata	Corduliidae				1		
Odonata	Corduliidae	*Neurocordulia*					
Odonata	Corduliidae	*Somatochlora*					
Odonata	Gomphidae						
Odonata	Gomphidae	*Arigomphus*					
Odonata	Gomphidae	*Dromogomphus*	3				

Fall 2009

Order	Family	Genus	MFS02	NFS02	NFS03	NFS04	SF at 128
Odonata	Gomphidae	*Erpetogomphus*					
Odonata	Gomphidae	*Gomphus*					
Odonata	Gomphidae	*Hagenius*					
Odonata	Gomphidae	*Lanthus*					
Odonata	Gomphidae	*Stylogomphus*		7			2
Odonata	Libellulidae	*Dythemis*					
Odonata	Libellulidae	*Erythemis*					
Odonata	Macromiidae	*Macromia*					
Oligochaeta	Oligochaeta	*Oligochaeta*	14	11	5	2	5
Ostercoda							1
Plecoptera			3		7		4
Plecoptera	Capniidae			2			
Plecoptera	Capniidae	*Allocapnia*			41	11	
Plecoptera	Chloroperlidae		1		3		
Plecoptera	Chloroperlidae	*Alloperla*				2	
Plecoptera	Chloroperlidae	*Haploperla*					
Plecoptera	Chloroperlidae	*Suwallia*					
Plecoptera	Chloroperlidae	*Swelsta*		9			1
Plecoptera	Neumoridae	*Amphinemura*					
Plecoptera	Neumoridae	*Paranemoura*					
Plecoptera	Neumoridae	*Prostoia*					1
Plecoptera	Neumoridae		34				
Plecoptera	Pletoperlidae	*Tallaperla*					
Plecoptera	Perlidae						
Plecoptera	Perlidae	*Acroneuria*	1				
Plecoptera	Perlidae	*Atteneuria*					
Plecoptera	Perlidae	*Eccoptura*					
Plecoptera	Perlidae	*Neoperla*			12		1
Plecoptera	Perlidae	*Perlesta*					
Plecoptera	Perlidae	*Perlinella*				2	
Plecoptera	Perlodidae						
Plecoptera	Perlodidae	*Clioperla*					
Plecoptera	Perlodidae	*Helopicus*					
Plecoptera	Perlodidae	*Hydroperla*					
Plecoptera	Perlodidae	*Isoperla*					
Plecoptera	Taeniopterygidae						
Plecoptera	Taeniopterygidae	*Taeninopteryx*	4	19	11	10	6
Plecoptera	Taeniopterygidae	*Strophopteryx*					
Trichoptera							
Trichoptera	Brachycentridae	*Brachycentrus*					
Trichoptera	Brachycentridae	*Micrasema*					
Trichoptera	Glossomatidae						
Trichoptera	Glossomatidae	*Agapetus*					
Trichoptera	Glossomatidae	*Glossoma*					
Trichoptera	Heliopsychidae	*Helicopsyche*		1		2	
Trichoptera	Hydropsychidae						
Trichoptera	Hydropsychidae	*Ceratopsyche*					
Trichoptera	Hydropsychidae	*Cheumatopsyche*		4	5		8
Trichoptera	Hydropsychidae	*Homoplectra*					
Trichoptera	Hydropsychidae	*Hydropsyche*	3	6		8	42
Trichoptera	Hydropsychidae	*Parapsche*					
Trichoptera	Hydropsychidae	*Potamyia*					
Trichoptera	Hydroptillidae	*Hydroptilla*					
Trichoptera	Hydroptillidae	*Orthotricia*					
Trichoptera	Lepidostomatidae	*Lepidostoma*					1
Trichoptera	Leptoceridae						
Trichoptera	Leptoceridae	*Ceraclea*					
Trichoptera	Leptoceridae	*Nectopsyche*					
Trichoptera	Leptoceridae	*Oecetis*	2	1	1	3	2
Trichoptera	Leptoceridae	*Triaenodes*					
Trichoptera	Limnephilidae			3			
Trichoptera	Limnephilidae	*Limnephulis*					
Trichoptera	Limnephilidae	*Pycnopsyche*					
Trichoptera	Philopotomodae	*Chimarra*		1	8	2	14
Trichoptera	Philopotomodae	*Wormaldia*					
Trichoptera	Polycentropodidae						
Trichoptera	Polycentropodidae	*Cernotina*					
Trichoptera	Polycentropodidae	*Neureclipsis*					
Trichoptera	Polycentropodidae	*Polycentropus*	1				
Trichoptera	Psychomiidae	*Lype*					
Trichoptera	Psychomiidae	*Psychomia*					
Trichoptera	Rhyacophilidae	*Rhyacophila*		3			

			Spring 2010		
Order	Family	Genus	SF at 128	NFS02	NFS03
Amphipoda	Hyalellidae	*Hyalella azteca*			1
Amphipoda	Gammaridae	*Gammarus*			
Annelida	Hiurinidae				
Arachnida	Hydracacina	*Arrhenurus*			
Arachnida	Hydracacina				
Bivalvia	Corbiculidae	*Corbicula*		1	
Coleoptera	Gyrinidae	*Dineutus*			
Coleoptera	Hydrophilidae				
Coleoptera	Hydrophilidae	*Paracynus*			
Coleoptera	Hydrophilidae	*Sphaeridiinae*			
Coleoptera	Dryopidae	*Helichus*	1		
Coleoptera	Dytiscidae				
Coleoptera	Dytiscidae	*Celina*			
Coleoptera	Dytiscidae	*Desmopachria*			
Coleoptera	Dytiscidae	*Hydaticus*			
Coleoptera	Dytiscidae	*Hygrotus*			
Coleoptera	Elmidae				
Coleoptera	Elmidae	*Ancyronyx*			1
Coleoptera	Elmidae	*Ampumixis*			
Coleoptera	Elmidae	*Dubiraphia*	1		1
Coleoptera	Elmidae	*Gonielmis*			
Coleoptera	Elmidae	*Heterelmis*	34	23	5
Coleoptera	Elmidae	*Macronychus*	1		
Coleoptera	Elmidae	*Microcylloepus*			
Coleoptera	Elmidae	*Neoelmis*	3		
Coleoptera	Elmidae	*Optioservus*		1	
Coleoptera	Elmidae	*Oulimnius*			
Coleoptera	Elmidae	*Stenelmis*	16	11	16
Coleoptera	Gyrinidae	*Dineutus*			
Coleoptera	Gyrinidae	*Gyretes*			
Coleoptera	Gyrinidae	*Gyrinus*			
Coleoptera	Psephenidae	*Ectopria*			
Coleoptera	Staphylinidae				
Coleoptera	Scirtidae	*Scittes*			
Coleoptera	Psephenidae	*Psephenus*		2	
Collembola	Entomobryidae				
Collembola	Isotomidae	*Isotoma*			
Collembola	Isotomidae	*Semicurura*			
Copoda	Cyclopidae				
Decapoda	Cambaridae				
Decapoda	Cambaridae	*Cambarus*			
Decapoda	Cambaridae	*Procambarus*			
Decapoda	Cambaridae	*Orconectes*			
Decapoda	Paleomonetes	*Paleomonetes*			
Diptera	Brachychera				
Diptera	Ceratopogonidae				
Diptera	Ceratopogonidae	*Bezzia*			1
Diptera	Ceratopogonidae	*Dasyhelea*			
Diptera	Ceratopogonidae	*Probezzia*			3
Diptera	Ceratopogonidae	*Serromyia*			
Diptera	Ceratopogonidae	*Forcipomyia*			
Diptera	Chironomidae		141	145	151
Diptera	Dixidae	*Dixella*			
Diptera	Empididae				
Diptera	Empididae	*Clinocera*			1
Diptera	Empididae	*Hemerodromia*	1	3	2
Diptera	Empididae	*Trichoclinocera*	1		
Diptera	Simulidae				6
Diptera	Simulidae	*Simulium*		10	
Diptera	Stratiomyidae				
Diptera	Tabanidae	*Haematopota*			
Diptera	Tabanidae	*Merycomia*			
Diptera	Tabanidae	*Tabanus*			
Diptera	Tipulidae				
Diptera	Tipulidae	*Antocha*	3		
Diptera	Tipulidae	*Brachypremna*			
Diptera	Tipulidae	*Hexatoma*		1	1
Diptera	Tipulidae	*Pedicia*			
Diptera	Tipulidae	*Leptotarsus*			
Diptera	Tipulidae	*Tipula*			1
Ephemeroptera					

			Spring 2010		
Order	Family	Genus	SF at 128	NFS02	NFS03
Ephemeroptera	Baetidae	*Acerpenna*	2	8	
Ephemeroptera	Baetidae	*Acentrella*			
Ephemeroptera	Baetidae	*Americabaetis*			
Ephemeroptera	Baetidae	*Baetis*			
Ephemeroptera	Baetidae	*Callibaetis*			
Ephemeroptera	Baetidae	*Fallceon*	2		
Ephemeroptera	Baetidae	*Hetercloen*	21		8
Ephemeroptera	Baetidae	*Paracloedes*			
Ephemeroptera	Baetidae	*Procloen*			
Ephemeroptera	Baetidae				
Ephemeroptera	Baetiscidae	*Baetisca*			
Ephemeroptera	Caenidae	*Caenis*	6		12
Ephemeroptera	Ephemeridae	*Ephemera*			
Ephemeroptera	Ephemeridae	*Hexegenia*			
Ephemeroptera	Ephemerellidae	*Attenella*			
Ephemeroptera	Ephemerellidae	*Dannella*			
Ephemeroptera	Ephemerellidae	*Eurylophella*		2	
Ephemeroptera	Ephemerellidae	*Serratella*			
Ephemeroptera	Ephemeridae	*Ephmemerlla*	9	6	1
Ephemeroptera	Heptageniidae				
Ephemeroptera	Heptageniidae	*Heptagenia*			
Ephemeroptera	Heptageniidae	*Leurocuta*			
Ephemeroptera	Heptageniidae	*Macaffertium*		2	
Ephemeroptera	Heptageniidae	*Rhithrogena*		6	
Ephemeroptera	Heptageniidae	*Stenacron*			
Ephemeroptera	Heptageniidae	*Stenonema*	2	4	5
Ephemeroptera	Heptageniidae				
Ephemeroptera	Isonychidae	*Isonychia*	1	2	
Ephemeroptera	Leptophlebiidae				
Ephemeroptera	Leptophlebiidae	*Choroterpes*			
Ephemeroptera	Leptophlebiidae	*Leptophlebia*			
Ephemeroptera	Leptohyphidae	*Tricorythodes*			
Ephemeroptera	Potamanthidae	*Anthopotamus*			
Ephemeroptera	Siphonluridae				
Ephemeroptera	Siphonluridae	*Siphlonurus*			3
Gastropoda	Ancyllidae	*Ferrissia*			
Gastropoda	Physsidae	*Physsa*			
Gastropoda	Pleuroceridae				
Gastropoda	Planorbidae				
Gastropoda	Planorbidae	*Heliosoma*			
Gastropoda	Viviparidae		2		1
Hemiptera	Corixidae	*Trichocorixia*			
Hemiptera	Herbridae	*Lipogomphus*			
Hemiptera	Mesoveliidae	*Mesovelia*			
Hemiptera	Veliidae	*Microvelia*			
Hemiptera	Veliidae	*Rhagavelia*			
Hiurenidae					
Isopoda	Asellidae	*Lirceus*			24
Lepidoptera	Crambidae				
Lepidoptera	Crambidae	*Elophila*			
Lepidoptera	Crambidae	*Parapoynx*			
Lepidoptera	Crambidae	*Petrophila*	1		
Megaloptera	Corydalidae	*Corydalus*		1	
Megaloptera	Corydalidae	*Nigronia*			
Megaloptera	Sialidae	*Sialis*			
Odonata	Aeshinidae	*Anax or Aeshna*			
Odonata	Aeshinidae	*Basianeschna*			
Odonata	Aeshinidae	*Boyeria*			
Odonata	Calopterygidae	*Caleopteryx*			
Odonata	Calopterygidae	*Hetaerina*			
Odonata	Coenargionidae				
Odonata	Coenargionidae	*Amphiagrion*			
Odonata	Coenargionidae	*Argia*			
Odonata	Coenargionidae	*Chromagrion*			
Odonata	Coenargionidae	*Enallagma*			
Odonata	Corduliidae				
Odonata	Corduliidae	*Neurocordulia*			
Odonata	Corduliidae	*Somatochlora*			
Odonata	Gomphidae				
Odonata	Gomphidae	*Arigomphus*			
Odonata	Gomphidae	*Dromogomphus*			

			Spring 2010		
Order	Family	Genus	SF at 128	NFS02	NFS03
Odonata	Gomphidae	*Erpetogomphus*			
Odonata	Gomphidae	*Gomphus*	3		
Odonata	Gomphidae	*Hagenius*	1		
Odonata	Gomphidae	*Lanthus*			
Odonata	Gomphidae	*Stylogomphus*		1	
Odonata	Libellulidae	*Dythemis*			
Odonata	Libellulidae	*Erythemis*			
Odonata	Macromiidae	*Macromia*			
Oligochaeta	Oligochaeta	*Oligochaeta*		1	3
Ostercoda					
Plecoptera					
Plecoptera	Capniidae				
Plecoptera	Capniidae	*Allocapnia*	1		
Plecoptera	Chloroperlidae				
Plecoptera	Chloroperlidae	*Alloperla*	13	37	36
Plecoptera	Chloroperlidae	*Haploperla*			
Plecoptera	Chloroperlidae	*Suwallia*			
Plecoptera	Chloroperlidae	*Swelsta*			
Plecoptera	Neumoridae	*Amphinemura*	9	11	
Plecoptera	Neumoridae	*Paranemoura*			
Plecoptera	Neumoridae	*Prostoia*	2		
Plecoptera	Neumoridae				
Plecoptera	Pletoperlidae	*Tallaperla*			
Plecoptera	Perlidae		9		
Plecoptera	Perlidae	*Acroneuria*	2		
Plecoptera	Perlidae	*Atteneuria*			
Plecoptera	Perlidae	*Eccoptura*			
Plecoptera	Perlidae	*Neoperla*		1	2
Plecoptera	Perlidae	*Perlesta*		5	
Plecoptera	Perlidae	*Perlinella*			1
Plecoptera	Perlodidae				
Plecoptera	Perlodidae	*Clioperla*			
Plecoptera	Perlodidae	*Helopicus*			
Plecoptera	Perlodidae	*Hydroperla*			
Plecoptera	Perlodidae	*Isoperla*	14	19	5
Plecoptera	Taeniopterygidae				
Plecoptera	Taeniopterygidae	*Taeninopteryx*			
Plecoptera	Taeniopterygidae	*Strophopteryx*			
Trichoptera					
Trichoptera	Brachycentridae	*Brachycentrus*			
Trichoptera	Brachycentridae	*Micrasema*			
Trichoptera	Glossomatidae				
Trichoptera	Glossomatidae	*Agapetus*	7		
Trichoptera	Glossomatidae	*Glossoma*			
Trichoptera	Heliopsychidae	*Helicopsyche*		1	
Trichoptera	Hydropsychidae				
Trichoptera	Hydropsychidae	*Ceratopsyche*	2		
Trichoptera	Hydropsychidae	*Cheumatopsyche*	18		
Trichoptera	Hydropsychidae	*Homoplectra*			
Trichoptera	Hydropsychidae	*Hydropsyche*	3	5	
Trichoptera	Hydropsychidae	*Parapsche*			
Trichoptera	Hydropsychidae	*Potamyia*			
Trichoptera	Hydroptillidae	*Hydroptilla*			
Trichoptera	Hydroptillidae	*Orthotricia*		2	
Trichoptera	Lepidostomatidae	*Lepidostoma*			
Trichoptera	Leptoceridae				
Trichoptera	Leptoceridae	*Ceraclea*			
Trichoptera	Leptoceridae	*Nectopsyche*			
Trichoptera	Leptoceridae	*Oecetis*		1	
Trichoptera	Leptoceridae	*Triaenodes*			
Trichoptera	Limnephilidae				
Trichoptera	Limnephilidae	*Limnephulis*			
Trichoptera	Limnephilidae	*Pycnopsyche*			
Trichoptera	Philopotomodae	*Chimarra*	3	3	1
Trichoptera	Philopotomodae	*Wormaldia*			
Trichoptera	Polycentropodidae				
Trichoptera	Polycentropodidae	*Cernotina*			
Trichoptera	Polycentropodidae	*Neureclipsis*			
Trichoptera	Polycentropodidae	*Polycentropus*			
Trichoptera	Psychomiidae	*Lype*			
Trichoptera	Psychomiidae	*Psychomia*			
Trichoptera	Rhyacophilidae	*Rhyacophila*		4	

Appendix III

Taxa list for the fish communities collected during 2008 in the upper Saline River watershed.

Upper Saline River 2009					LAF01		AF2		AF west 9		NFS01		NFS02
FAMILY AND SPECIES	COMMON NAME	SEN	TFL	KEY	NUM	% COM	NUM	% COM	NUM	% COM	NUM	% COM	NUM
Petromyzontidae	**Lampreys**												
	ammoceote		P		4	0.68			2	0.10	1	0.27	
Lepisosteidae	**Gar**												
Lepisosteus osseus	longnose gar												
Anguillidae	**Freshwater Eels**												
Anguillia rostrata	American eel												
Clupeidae	**Shad**												
Dorosoma cepedianum	gizzard shad		P										
Esocidae	**Pikes**												
Esox americanus	redfin pickerel				1	0.17					7	1.91	1
Cyprinidae	**Minnows**												
Campostoma anomalum	central stoneroller		P		94	15.96	249	54.01	341	16.51	24	6.56	17
Cyprinella whipplei	steelcolor shiner	S											
Hybopsis x-punctata	gravel chub	S											
Luxilus chrysocephalus	striped shiner				98	16.64	17	3.69	299	14.48	13	3.55	19
Lythurus umbratilis	redfin shiner								23	1.11	14	3.83	3
Notemigonus crysoleucas	golden shiner		P										
Notropis boops	bigeye shiner	S		K	6	1.02	5	1.08	121	5.86	39	10.66	130
Pimephales notatus	bluntnose minnow		P		9	1.53	1	0.22	44	2.13	10	2.73	75
Pimephales vigilax	bullhead minnow												
Semotilus atromaculatus	creek chub												
	yoy unknown								25	1.21			31
Catostomidae	**Suckers**												
Erimyzon oblongus	creek chubsucker								20	0.97	7	1.91	1
Hypentelum nigricans	Northern hogsucker	S		K	5	0.85	1	0.22	15	0.73			3
Moxostoma carinatum	river redhorse												
Moxostoma duquesnei	black redhorse	S							41	1.99			28
Moxostoma erythrurum	golden redhorse				3	0.51							
Icatluridae	**Catfishes**												
Ameiurus melas	black bullhead								2	0.10			
Ameiurus natalis	yellow bullhead				8	1.36	9	1.95	10	0.48	1	0.27	
Ictalurus punctatus	channel catfish												
Noturus gyrinus	tadpole madtom										1	0.27	
Noturus lachneri	Ouachita madtom	S			6	1.02	41	8.89	8	0.39	48	13.11	

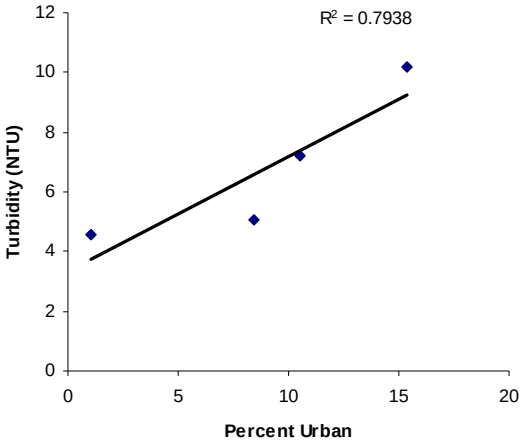
Upper Saline River 2009					LAF01		AF2		AF west 9		NFS01		NFS02
FAMILY AND SPECIES	COMMON NAME	SEN	TFL	KEY	NUM	% COM	NUM	% COM	NUM	% COM	NUM	% COM	NUM
Noturus miurus	brindled madtom												
Noturus nocturnus	freckled madtom			K	2	0.34	4	0.87	47	2.28			
Aphredoderidae	**Pirate Perch**												
Aphredoderus sayanus	pirate perch				9	1.53			5	0.24	8	2.19	5
Fundulidae	**Killifishes**												
Fundulus catenatus	Northern studfish	S			17	2.89			1	0.05			2
Fundulus olivaceus	blackspotted topminnow				4	0.68	6	1.30	8	0.39	36	9.84	7
Poeciliidae	**Livebearers**												
Gamubisa affinis	mosquitofish												
Atherinopsidae	**Silversides**												
Labidesthes sicculus	brook silverside								23	1.11	1	0.27	12
Centrachidae	**Sunfishes**												
Amblopites ariommus	shadow bass	S							13	0.63	1	0.27	5
Lepomis cyanellus	green sunfish				123	20.88	16	3.47	82	3.97	16	4.37	29
Lepomis glucosus	warmouth sunfish								6	0.29			
Lepomis macrochirus	bluegill sunfish				8	1.36	1	0.22	4	0.19	7	1.91	12
Lepomis megalotis	longear sunfish			K	135	22.92	46	9.98	659	31.91	102	27.87	260
Lepomis microlophus	redear sunfish								1	0.05			
Lepomis punctatus	spotted sunfish								5	0.24			
Micropterus dolomieui	smallmouth bass	S		K	6	1.02			20	0.97			10
Micropterus punctulatus	spotted bass								9	0.44	6	1.64	5
Micropterus salmoides	largemouth bass				2	0.34	1	0.22	4	0.19			
Pomoxis nigromaculatus	black crappie												
Percidae	**Perches**												
Etheostoma artesiae	redspot darter				25	4.24	54	11.71	43	2.08	15	4.10	2
Etheostoma blennoides	greenside darter	S			4	0.68	5	1.08	62	3.00	1	0.27	2
Etheostoma collettei	creole darter				17	2.89	4	0.87	109	5.28	8	2.19	3
Etheostoma histrio	harlequin darter	S											
Etheostoma nigrum	Johnny darter												
Etheostoma radiosum	orangebelly darter	S		K									
Etheostoma stigmaeum	speckled darter	S							1	0.05			
Etheostoma zonale	banded darter	S							12	0.58			
	yoy *Etheostoma*												
Percina caprodes	logperch				3	0.51	1	0.22					
Percina maculata	blackside darter	S											
Percina sciera	dusky darter	S											
	TOTALTAXA				22		17		32		21		23
	TOTAL INDIVIDUALS				589		461		2065		366		662
	Effort (sec)				2652		2819		4531		2638		3630
	Catch/Effort				13.33		9.81		27.34		8.32		10.94

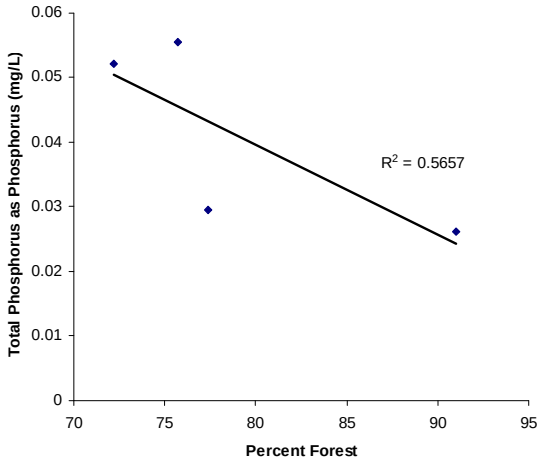
COMMON NAME	% COM	NFS03 NUM	NFS03 % COM	NFS04 NUM	NFS04 % COM	SFSat5 NUM	SFSat5 % COM	SFSat128 NUM	SFSat128 % COM	SFS02 NUM	SFS02 % COM	MFS02 NUM	MFS02 % COM
Lampreys													
ammoceote		4	0.24	4	0.15	5	0.66			1	0.06	13	0.50
Gar													
longnose gar				1	0.04								
Freshwater Eels													
American eel		1	0.06										
Shad													
gizzard shad												23	0.88
Pikes													
redfin pickerel	0.15			1	0.04					1	0.06	2	0.08
Minnows													
central stoneroller	2.57	642	38.33	718	27.03	218	28.57	45	11.84	373	22.28	666	25.55
steelcolor shiner		9	0.54	30	1.13			2	0.53	21	1.25		
gravel chub										20	1.19	13	0.50
striped shiner	2.87	15	0.90	334	12.58	19	2.49	7	1.84	55	3.29	7	0.27
redfin shiner	0.45			1	0.04								
golden shiner				1	0.04								
bigeye shiner	19.64	255	15.22	128	4.82	42	5.50	55	14.47	320	19.12	410	15.73
bluntnose minnow	11.33	59	3.52	134	5.05	4	0.52	14	3.68	132	7.89	152	5.83
bullhead minnow													
creek chub						4	0.52						
yoy unknown	4.68	17	1.01							67	4.00	411	15.77
Suckers													
creek chubsucker	0.15	1	0.06										
Northern hogsucker	0.45	9	0.54	5	0.19	23	3.01	11	2.89	36	2.15	16	0.61
river redhorse										1			
black redhorse	4.23	13	0.78	8	0.30	3	0.39			47	2.81	63	2.42
golden redhorse								10	2.63	5	0.30		
Catfishes													
black bullhead													
yellow bullhead		2	0.12	4	0.15	3	0.39	1	0.26	4	0.24		
channel catfish										1	0.06		
tadpole madtom													
Ouachita madtom		34	2.03	27	1.02	45	5.90	3	0.79	20	1.19		

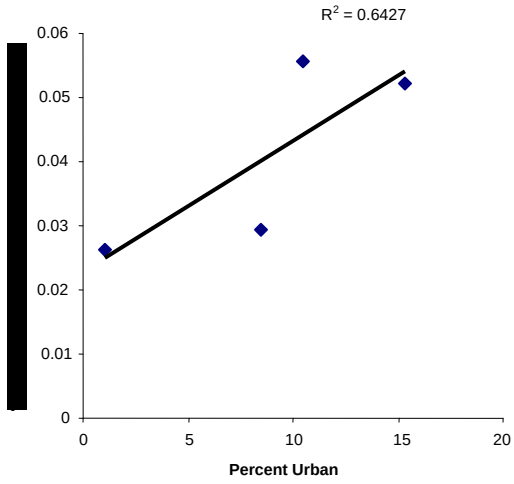
COMMON NAME	% COM	NFS03 NUM	% COM	NFS04 NUM	% COM	SFSat5 NUM	% COM	SFSat128 NUM	% COM	SFS02 NUM	% COM	MFS02 NUM	% COM
brindled madtom													
freckled madtom						7	0.92	7	1.84			44	1.69
Pirate Perch													
pirate perch	0.76	1	0.06	4	0.15	2	0.26	5	1.32	2	0.12	6	0.23
Killifishes													
Northern studfish	0.30	20	1.19	17	0.64	1	0.13	1	0.26	16	0.96	1	0.04
blackspotted topminnow	1.06	1	0.06	9	0.34	17	2.23	14	3.68	16	0.96	4	0.15
Livebearers													
mosquitofish										10	0.60	1	0.04
Silversides													
brook silverside	1.81	10	0.60	14	0.53			1	0.26	5	0.30	23	0.88
Sunfishes													
shadow bass	0.76	2	0.12	3	0.11	1	0.13	4	1.05	7	0.42	3	0.12
green sunfish	4.38	25	1.49	48	1.81	37	4.85	2	0.53	14	0.84	24	0.92
warmouth sunfish													
bluegill sunfish	1.81	13	0.78	38	1.43	47	6.16	35	9.21	49	2.93	59	2.26
longear sunfish	39.27	375	22.39	667	25.11	96	12.58	77	20.26	418	24.97	415	15.92
redear sunfish										1	0.06	5	0.19
spotted sunfish		1	0.06	3	0.11	6	0.79			13	0.78	8	0.31
smallmouth bass	1.51	12	0.72	2	0.08	5	0.66	1	0.26	12	0.72	15	0.58
spotted bass	0.76	14	0.84	18	0.68	2	0.26			14	0.84	25	0.96
largemouth bass		12	0.72							8	0.48	2	0.08
black crappie													
Perches													
redspot darter	0.30	46	2.75	25	0.94	26	3.41	9	2.37	42	2.51	28	1.07
greenside darter	0.30	60	3.58	103	3.88	5	0.66	51	13.42	134	8.00	121	4.64
creole darter	0.45	14	0.84	238	8.96	145	19.00	9	2.37	54	3.23	14	0.54
harlequin darter		2	0.12	7	0.26								
Johnny darter				3	0.11					3	0.18		
orangebelly darter													
speckled darter								1	0.26				
banded darter		7	0.42	58	2.18			15	3.95	57	3.41	30	1.15
yoy *Etheostoma*													
logperch										2	0.12	3	0.12
blackside darter				2	0.08								
dusky darter													
TOTALTAXA		30		33		23		24		36		29	
TOTAL INDIVIDUALS		1675		2656		763		380		1981		2607	
Effort (sec)		3245		4474		2727		3004		7800		3600	
Catch/Effort		30.99		35.62		16.79		7.59		15.24		43.45	

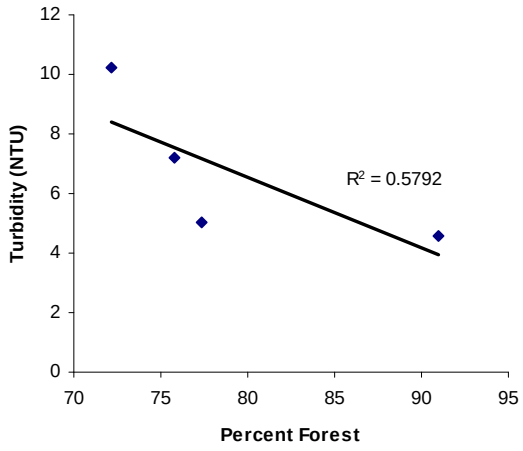
Appendix IV

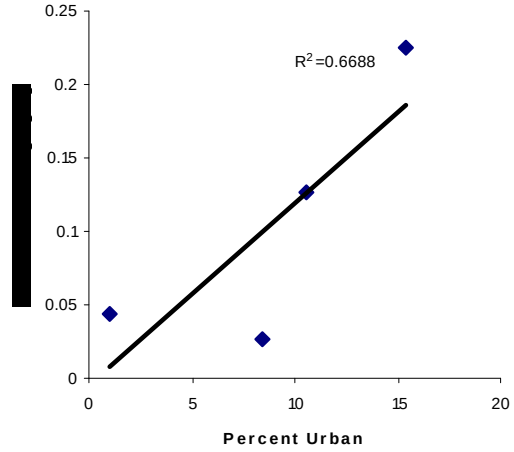
Scatter plots of water quality parameters in relationship to land use and land coverage of the upper Saline River watershed

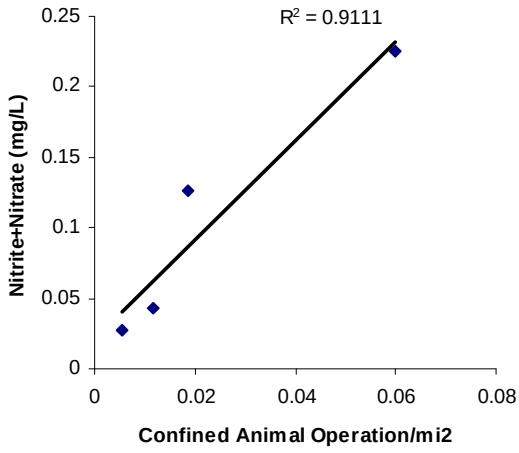

R² = 0.7938
Turbidity (NTU)
Percent Urban

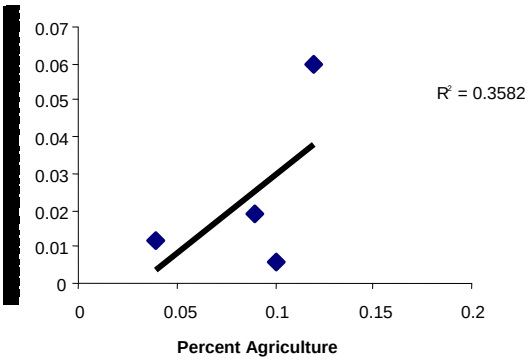

R² = 0.5657
Total Phosphorus as Phosphorus (mg/L)
Percent Forest

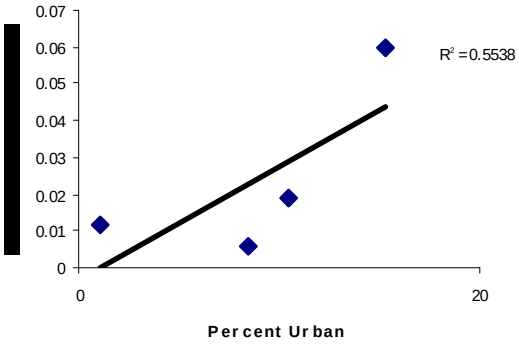

R² = 0.6427
Percent Urban

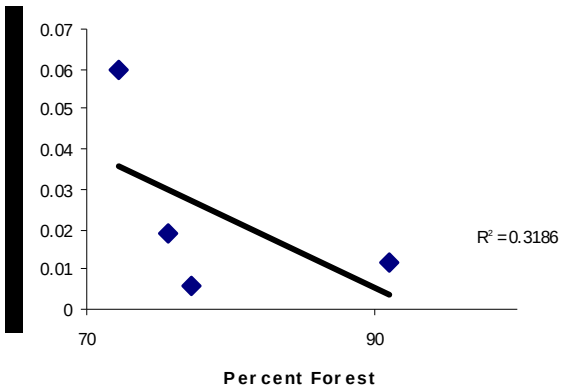

R² = 0.5792
Turbidity (NTU)
Percent Forest

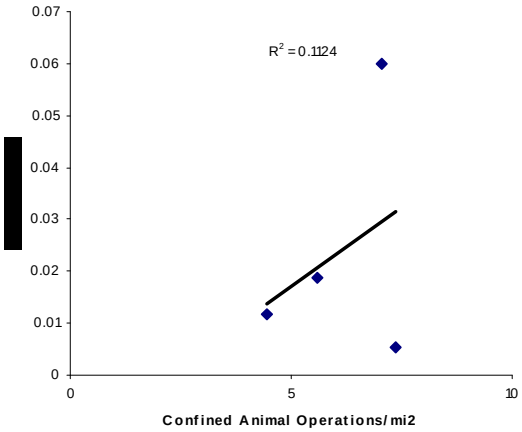

R² =0.6688
Percent Urban

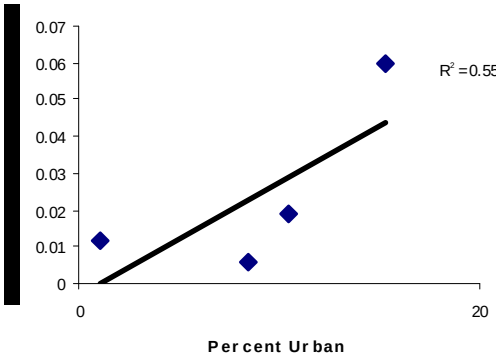

R² = 0.9111
Nitrite+Nitrate (mg/L)
Confined Animal Operation/mi2

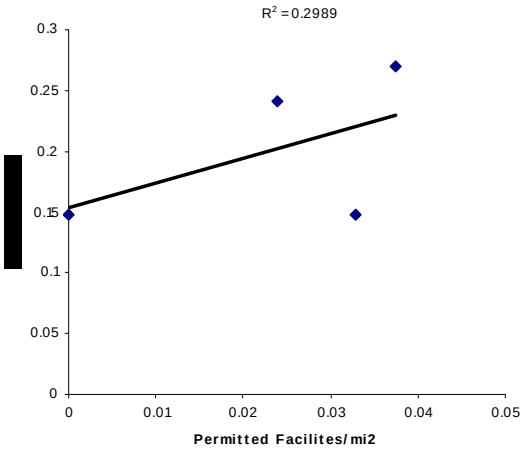

0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.05
0.1
0.15
0.2
R² = 0.3582
Percent Agriculture


0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
R² = 0.5538
Percent Urban


0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
70
90
R² = 0.3186
Percent Forest


0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
R² = 0.1124
Confined Animal Operations/mi2


0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
R² = 0.5538
Percent Urban


0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.01
0.02
0.03
0.04
0.05
R² = 0.2989
Permitted Facilites/mi2