An Assessment of Benthic Macroinvertebrate Communities from Three Wadeable Streams in Central Texas

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Acronyms

ALU	Aquatic Life Use
BIBI	Benthic Index of Biotic Integrity
FM	Farm to Market
ppm	parts per million
QAPP	Quality Assurance Project Plan
SH	State Highway
s.u.	Standard Units
SWQM	Surface Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TPWD	Texas Parks and Wildlife Department

Executive Summary

Benthic macroinvertebrates were collected and identified from three streams in the middle Brazos River Basin as a vehicle for a biologist to gain experience in study design and working with an unfamiliar taxonomic group. The three streams selected for the study were among the few streams that continued to flow in the middle Brazos River Basin during an extreme drought in 2011. The sample sites were the Leon River at FM 1829, Salado Creek at Pace Park in Salado and Tehuacana Creek upstream of FM 2491.

All three streams shared similar substrate and cover at the sample sites. Benthic macroinvertebrates were collected from riffles dominated by cobble, algae and leaf debris. Flow varied among the three streams, ranging from 1.0 ft^3/s at Tehuacana Creek to 6.6 ft^3/s at Salado Creek. Instantaneous physico-chemical data varied among the three streams as well.

Benthic macroinvertebrate taxa were most numerous at Salado Creek with 29 collected. Tehuacana Creek and Leon River taxa were 19 and 15, respectively. Numbers and types of individuals collected from each creek translated into an aquatic life use (ALU) scores that are the sum of 12 individual metrics. Salado Creek's ALU ranked high (score = 37), the Leon River scored intermediate (26), and Tehuacana Creek scored intermediate (28).

Data results agreed with field observations and instantaneous physico-chemical data, and the study challenged the novice benthic macroinvertebrate taxonomist.

Introduction

This project provided an opportunity for a biologist who has not worked extensively with benthic macroinvertebrates to design a study that promoted learning their taxonomy. Study design is based on the Texas Commission on Environmental Quality's (TCEQ's) Surface Water Quality Monitoring (SWQM) program requirements (TCEQ 2003, 2005) and uses accumulated knowledge from several previous TPWD projects (Bronson and Radloff 2007, Bronson 2007, Radloff et al. 2010).

Project Area

Site Selection

Streams sampled during the study were selected based on three main criteria; 1) located in the Brazos River Basin, 2) wadeable and 3) flowing during an extreme drought. The sampling location at each stream needed to be accessible, have minimal obstructions and include a riffle. Stream flow characteristics were considered for the selected sites. Stream flow dominated by different sources (wastewater discharges or spring flows) promotes varied benthic macroinvertebrate communities and a potential for greater species variation.

Leon River

The Leon River is formed by the confluence of its North, Middle, and South forks in Eastland County within the Cross Timber Ecoregion. The river flows for approximately 185 miles southeast through Eastland, Comanche, Hamilton, and Coryell counties to its confluence with the Lampasas River and Salado Creek to form the Little River (Handbook of Texas Online 2012a). The banks of the Leon are steep, muddy, and lined with vegetation consisting of elm, willow, sycamore, and pecan (TPWD 1973).

Approximately 9 miles southeast of Gatesville, TX (Figure 1), the Leon River flows under FM 1829. A riffle downstream of the FM 1829 road crossing was sampled for benthic macroinvertebrates on 16 November 2011 (N 31.33576, W-97.64262). The riffle habitat included algae and leaf debris with partial canopy cover (Figure 2).

Salado Creek

Salado Creek is a clear, spring-fed stream that originates in Williamson County (Handbook of Texas Online 2012b) and then flows into the Lampasas River in Bell County. The stream flows through the Cross Timbers and Rolling Prairies of east central Texas. Many springs, mineral outcrops, unusual geological formations, Indian camps, and historic sites are found along the streams waterways (TPWD 1973).

Benthic macroinvertebrates were collected from a riffle at Pace Park within the Village of Salado (Figure 1) on 17 November 2011 (N30.64581, W-97.53347). The substrate habitat was bedrock and large rubble with algae and leaf debris present (Figure 3).

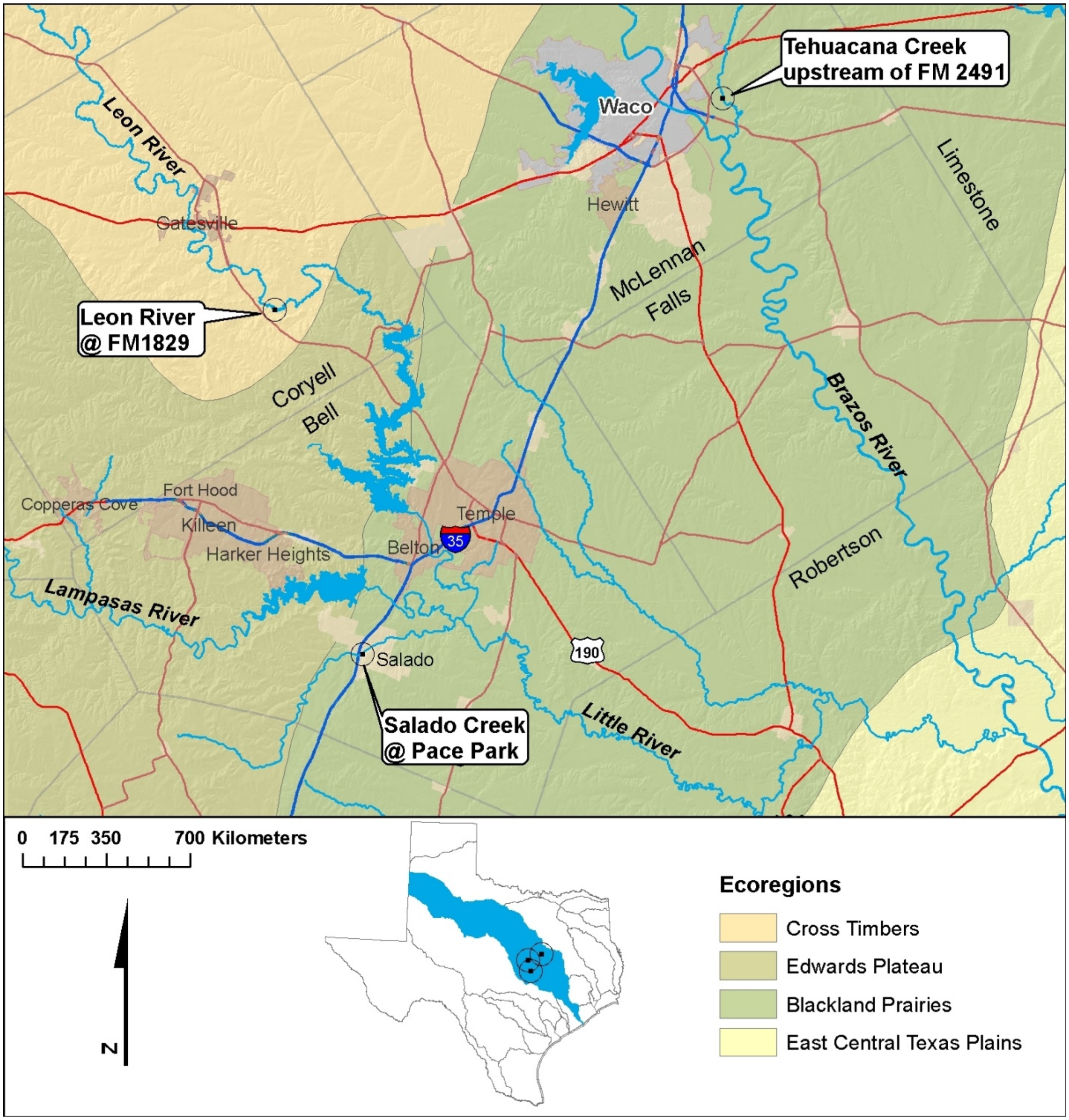

Figure 1. Stream locations sampled during the benthic macroinvertebrate study.

Tehuacana Creek

Tehuacana Creek watershed originates in Hill County and flows 31 miles from Hill to McLennan County and joins the Brazos River south of SH 6, about five miles east of Waco (Figure 1). Located in the Texas Blackland Prairie Ecoregion (Griffith 2004), the naturally fertile soils consist of rich minerals weathered from limestone, shale, and marl (USDA 1992). These fertile soils provide rangeland for beef and dairy cattle. Corn, wheat, hay, grain sorghums, soybeans, and nursery crops are the main crops grown in McLennan County (Ramos 1999). The flat-to-rolling terrain also supports mesquite, cacti, water-tolerant hardwoods, conifers, and grasses (Handbook of Texas Online 2012c).

Benthic macroinvertebrate samples were collected from a riffle upstream of the FM 2491 bridge located approximately six miles east of Waco in McLennan County (Figure 1) on 18 November 2011 (N31.56645, W-97.04913). The riffle substrate consists of large cobble, woody and leaf debris and a fine layer of sediment. Low-hanging canopy cover was present over a large portion of the riffle (Figure 4).

Figure 2. Leon River at FM 1829 looking upstream at the riffle sampled for benthic macroinvertebrates.

Figure 3. The portion of the riffle sampled for benthic macroinvertebrates at Pace Park on Salado Creek.

Figure 4. Upstream look at the riffle habitat sampled on Tehuacana Creek.

Methods

The data collected for the study included instantaneous flow and instantaneous physico-chemical measurements and benthic macroinvertebrate samples. Each data type was sampled once at Leon River, Salado Creek and Tehuacana Creek.

Data collection techniques followed TCEQ SWQM Manual, Volumes I and II (TCEQ 2003 and 2005) and the Water Quality Program Quality Assurance Project Plan (TPWD 2011). Sampling and data processing methods are summarized below.

A YSI 600 XLM multi-parameter datasonde was used to measure dissolved oxygen, temperature, pH and specific conductance, and a Marsh-McBirney electronic flow meter measured velocity allowing for calculation of stream discharge. Instantaneous physico-chemical measurements were collected before instantaneous flow and benthic macroinvertebrate data were gathered to ensure accuracy and eliminate any influence from a disturbed stream bottom.

Benthic macroinvertebrate samples were collected using kick-nets in a cobblestone riffle following TCEQ SWQM Manual Vol. II (2005) protocols. Effort was recorded in five-minute intervals of kick-net sampling. Samples were processed in the field to ensure that enough benthic macroinvertebrates were collected at each station. The target number was 175 organisms ± 20%. The benthic macroinvertebrates were placed into labeled jars with 70% isopropyl alcohol and transported back to the lab.

Once preserved, the specimens were identified in the laboratory using Merritt et. al. (1996) for insects; McCafferty (1983) for insects and non-insects; and Pennak (1989) for non-insects. The taxonomic level of identification for each specimen followed TCEQ (2005) protocols. Jack Davis with the Brazos River Authority, Pete Diaz with US Fish and Wildlife Service and Chad Norris with Texas Parks and Wildlife Department assisted with taxonomic quality assurance. All specimens collected for the three streams were saved in a voucher collection in the TPWD Waco office.

Results

Instantaneous Physico-chemical and Flow Data

Instantaneous physico-chemical and flow data provide a point-in-time view of the water conditions during benthic macroinvertebrate collections (Table 1).

Instantaneous physico-chemical parameters were collected for the Leon River at the riffle used for benthic macroinvertebrate collection. The pH reading in the riffle was high (9.0 s.u.) and may be due to an algal bloom upstream, but chlorophyll-*a* samples would be needed to confirm (Table 1).

Table 1. Instantaneous physico-chemical and flow data from the Leon River, Salado Creek and Tehuacana Creek.

Stream	Date	Depth (m)	Dissolved Oxygen (mg/L)	pH (standard units)	Temperature (°C)	Specific Conductance (µS/cm)	Stream Discharge[1] (ft^3/s)
Leon River	16 Nov 2011	0.1	7.8	9.0	18.4	460	2.4
Salado Creek	17 Nov 2011	0.2	11.2	7.1	18.9	550	6.6
Tehuacana Creek	18 Nov 2011	0.2	8.4	8.1	12.7	2083	1.0

[1]Days since last significant rainfall >7 days for all three streams

Salado Creek physico-chemical measurements were collected in a riffle and an elevated dissolved oxygen reading was observed. This may result from the combination of enough flow over the cobble for proper re-aeration (6.6 ft^3/s) and the presence of filamentous algae.

The physico-chemical parameters for Tehuacana Creek were all within normal ranges with the exception of the specific conductance, for which the instantaneous reading was 2083 µS/cm. TCEQ implements water quality standards using the total concentration of dissolved solids (minerals and salts, (TDS)). The TDS annual average criteria for segment 1242 (the Brazos River above Navasota River) is 1000 mg/L (TCEQ 2010) and the ambient value is 693 mg/L (TCEQ 2012). Tehuacana Creek is a tributary to segment 1242 and the TDS criteria is applicable to Tehuacana Creek (segment number 1242N). The specific conductance measurement can be converted to TDS by multiplying the measured specific conductance by 0.67, resulting in a calculated TDS value of 1396 mg/L. The calculated TDS exceeds the segment annual average criteria of 1000 mg/L and is about twice the ambient value of 693 mg/L for segment 1242. At the time of collection, the majority of the flow in Tehuacana Creek was likely treated effluent from an industrial processing plant upstream which started discharging into Tehuacana Creek in 2007.

Flow is a major influence on benthic macroinvertebrate populations. If flow ceases, flow-obligate benthic macroinvertebrates are negatively affected by stressed conditions. The intolerant taxa numbers may become reduced while some tolerant taxa can thrive. During high flows resulting from rain events, an entire benthic macroinvertebrate community might be washed downstream. The project data collection included instantaneous flow measurements which can only explain stream flow conditions at the time of sampling. The discharge for the Leon River and Tehuacana Creek showed lower flows (2.4 and 1.0 ft^3/s, respectively). Salado Creek receives flow from springs upstream of the sampling site and was flowing much faster (6.6 ft^3/s) than the Leon River and Tehuacana Creek.

Benthic Macroinvertebrate Collections

Benthic macroinvertebrates collected from the Leon River at FM 1829 included a total of 180 individuals from 15 taxa and eight orders (Table 2). The most dominant taxa collected were *Simulium* sp. (89 individuals), *Stenelmis* sp. (23) and Chironomidae sp. (20) (Table 3). *Simulium* sp. in the Family Simuliidae are black flies. Black fly larvae live in flowing waters and feed by filtering food from the water column and are considered an intolerant species. The Family Elmidae provides the second most abundant taxa collected, the riffle beetles *Stenelmis* sp. Riffle beetles typically scrape periphyton from surfaces, filter particles from the water to survive, and are tolerant of changes in water chemistry. Family Chironomidae, non-biting midges (Order Diptera), are the most widespread of all aquatic insect families with very short life cycles. In general the family's functional feeding groups are collector-gatherers (deposit feeders) and predators tolerant of disturbance and low water quality (Merritt 1996).

The 221 individuals collected in Salado Creek represent 29 taxa and 13 orders (Table 2). *Fallceon* sp. (38), *Dugesia* sp. (30), and *Ambrysus* sp. (23) are the top three most abundant taxa (Table 3). *Fallceon* sp., the most numerous taxon collected, is from the Family Baetidae or Small Minnow Mayflies. *Fallceon* sp., and most mayflies, feed by scraping or collecting and are not tolerant of water pollution (Merritt 1996). The second most abundant taxon is *Dugesia* sp. (Platyhelminthes). These flatworms are tolerant to water quality conditions and prey on other soft tissue organisms (Pennak 1989). *Ambrysus* sp. (Family Naucoridae) are true water bugs that feed by predation and lack designation as tolerant or intolerant (Merritt 1996).

Table 2. Total number of benthic macroinvertebrates and their functional feeding groups collected at the Leon River, SaladoCreek and Tehuacana Creek, Nov 2011.

PHYLUM, Class	Order	Family	Genus	Functional[1] Feeding Group (FFG)	Leon	Salado	Tehuacana
ANNELIDA							
Hirudinea				PR		1	
Oligochaeta				CG	2	10	
ARTHROPODA							
Crustacea	Amphipoda	Taltridae	*Hyalella*	CG, SHR,	3	9	4
	Ostracoda			CG		5	2
Hydracarina				PR		4	1
Insecta	Coleoptera	Dryopidae	*Helichus*	SCR, CG	3		
			Liodessus	PR		1	
		Elmidae	*Macrelmis*	SCR, CG		5	
			Heterelmis	SCR, CG	1		
			Microcylloepus	SCR, CG		2	
			Stenelmis	SCR, CG	23		48
		Hydrophilidae	*Berosus*	CG, PR			1
		Psephenidae	*Psephenus*	SCR		10	
	Diptera	Chironomidae		CG,FC,PR	20	13	13
		Simuliidae	*Simulium*	FC	89		93
	Ephemeroptera	Baetidae	*Baetodes*	SCR		1	
			Camelobaetidius	SCR, CG		9	
			Fallceon	SCR, CG	7	38	1
		Caenidae	*Caenis*	SCR, CG	4		
		Leptohyphidae	*Vacupernius*	CG		2	
		Leptophlebiidae	*Neochoroterpes*	SCR, CG	7	15	
			Thraulodes	SCR, CG	1		
		Tricorythidae	*Tricorythodes*	CG		10	
	Hemiptera	Corixidae		PR, SCR			1
		Naucoridae	*Ambrysus*	PR		23	
	Lepidoptera	Pyralidae	*Petrophila*	SCR			2
	Odonata	Coenagrionidae	*Argia*	PR	1	4	20
			Enallagma	PR			2
		Gomphidae	*Erpetogomphus*	PR		4	6

PHYLUM, Class	Order	Family	Genus	FFG	Leon	Salado	Tehuacana
		Libellulidae	*Libellula*	PR			1
	Trichoptera	Helicopsychidae	*Helicopsyche*	SCR		2	
		Hydropsychidae	*Cheumatopsyche*	FC	4	5	3
		Hydroptilidae	*Hydroptila*	SCR		1	
		Leptoceridae		CG, SHR, SCR			1
			Nectopsyche	CG, SHR,PR		1	
		Odontoceridae	*Marilia*	SHR		5	
		Philopotamidae	*Chimarra*	FC		1	3
		Polycentropodidae	*Polycentropus*	FC, PR		2	
MOLLUSCA							
Gastropoda	Mesogastropoda	Hydrobiidae		SCR		1	
		Pleuroceridae	*Elimia*	SCR		7	
PLATYHELMINTHES							
Turbellaria			*Dugesia*	PR	13	30	

[1]Functional feeding group: CG – collector gatherer, PR – predator, SCR – scrapper, SHR – shredder, FC – filtering collector

Table 3. Top three abundant taxa for the Leon River, Salado Creek and Tehuacana Creek.

Creek	Phylum	Class	Order	Family	Genus	Sample	Tolerance
Leon	Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	89	Intolerant
			Coleoptera	Elmidae	*Stenelmis*	23	Tolerant
			Diptera	Chironomidae		20	Tolerant
Salado	Arthropoda	Insecta	Ephemeroptera	Baetidae	*Fallceon*	38	Intolerant
	Platyhelminthes	Turbellaria	-	-	*Dugesia*	30	Tolerant
	Arthropoda	Insecta	Hemiptera	Naucoridae	*Ambrysus*	23	NA
Tehuacana	Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	93	Intolerant
			Coleoptera	Elmidae	*Stenelmis*	48	Tolerant
			Odonata	Coenagrionidae	*Argia*	20	Tolerant

Tehuacana Creek benthic macroinvertebrate samples represent nine orders, 19 taxa and 205 individuals (Table 2). The three dominant species were *Simulium* sp. (93), *Stenelmis* sp. (48) and *Argia* sp. (20) (Table 3). The black fly larvae, *Simulium* sp. (Family Simuliidae), are also the most abundant taxon collected from Leon River. *Simulium* sp. are filters-feeders and intolerant to water pollution. The riffle beetles, *Stenelmis* sp. are the second most abundant taxa collected from the Leon River. *Stenelmis* sp. are scrapers and considered a tolerant taxa. The third most abundant taxon, *Argia* sp., is Odonates from the Family Coenagrionidae. *Argia* sp. are predatory, eat other organisms and are considered tolerant.

From a total of 606 individuals, 47 taxa were represented across the three sampled streams (including non-insect taxa) (Table 2). The five most abundant taxa collected from the three streams totaled 388 of 606 individuals (Table 4). Salado Creek provided the most taxa (29) followed by Tehuacana Creek (19) and Leon River (15) (Table 5). Two of the top five taxa (*Simulium* sp. and *Fallceon* sp.) are intolerant and the other three taxa are considered tolerant (*Stenelmis* sp., Chironomidae and *Dugesia* sp.) (Table 3).

Table 4. Number of individuals in the dominant taxa from the Leon River, Salado Creek and Tehuacana Creek.

PHYLUM Class	Order	Family	Genus	Leon	Salado	Tehuacana	Total
ARTHROPODA							
Insecta	Coleoptera	Elmidae	*Stenelmis*	23		48	71
	Diptera	Chironomidae		20	13	13	46
		Simuliidae	*Simulium*	89		93	182
	Ephemeroptera	Baetidae	*Fallceon*	7	38	1	46
PLATYHELMINTHES							
Turbellaria			*Dugesia*	13	30		43
Totals				152	81	155	388

Benthic macroinvertebrates provide information about the health of streams and rivers. Many taxa characteristics have been studied and have shown sensitivity to habitat disturbance and changes in water quality and water chemistry. These characteristics are useful metrics for indices of biotic integrity. Taxa which are especially sensitive to disturbance are considered intolerant and are typically found in streams and rivers of good water quality. Other taxa are tolerant of disturbance, heavy sedimentation and poor water quality. Many of the tolerant taxa are the first to re-establish an area after a scouring event or habitat disruption. When benthic macroinvertebrates are evaluated, benthic index of biotic integrity (BIBI) can be calculated (TCEQ 2005). There are 12 different metrics assessed to provide a final aquatic life use (ALU) score (TCEQ 2005, Table 5) describing the overall health of the benthic macroinvertebrate community in the assessed stream. The ALU scores for each creek follow; Salado Creek ALU scored 37 (exceptional ALU), Leon River scored 26 (intermediate ALU) and Tehuacana Creek scored 28 (intermediate ALU) (Table 5 and Table 6).

Table 5. Benthic index of biotic integrity scores for all three streams.

	Leon River		Salado Creek		Tehuacana Creek	
Metric	Value	Score	Value	Score	Value	Score
Taxa Richness	15	3	29	4	19	3
EPT Index	5	2	13	4	4	2
HBI	5.04	2	4.84	2	5.17	2
% Chironomidae	11.11	2	5.88	3	6.34	3
% Dominant Taxon	49.44	1	17.19	4	45.37	1
% Dominant FFG	57.37	1	32.88	4	50.90	2
% Predators	12.59	4	32.88	2	19.13	3
Intolerant : Tolerant	1.50	1	1.50	1	1.10	1
% Total Trichoptera as Hydropsychidae	100.00	1	29.41	3	42.86	3
Number of Non-Insect Taxa	3	2	8	4	3	2
% CG	18.43	4	31.98	2	16.58	4
% n as Elmidae	13.33	3	3.17	4	23.41	2
AQUATIC LIFE USE SCORE	26		37		28	
AQUATIC LIFE USE RATING	Intermediate		Exceptional		Intermediate	

Table 6. Scoring criteria for aquatic life use using the benthic index of biotic integrity (TCEQ 2005).

Kicknet (Qualitative) Scoring Criteria	
Exceptional	>36
High	29 – 36
Intermediate	22 – 28
Limited	<22

Discussion

The three streams sampled during the study shared similar riffle substrate; all having cobble available, algae growth and leaf debris. Similarities of the available habitat are reflected in the type of functional feeding groups (FFGs) collected from each stream. The most abundant species from each stream's FFG feed on algae, microscopic particulates or eat the organisms feeding on the available food source (predation). The most abundant taxa for each stream include scrapers, collector-gatherers, filtering-collectors and predators (Table 2). Although the instream habitat was similar, the instantaneous physico-chemical data shared few similarities (Table 1) including variations in dissolved oxygen levels, pH, temperature, flow and specific conductance.

Stream discharge has a large effect on benthic macroinvertebrate communities (NIDIS 2012). None of the three sampled areas had received rain in over eight days before sampling; and none received more than 0.6 inches in the month of November. The extreme drought reduced flow in the Leon River and Tehuacana Creek, while Salado Creek flow was less affected because its flow is largely from springs. Sampling in Salado Creek occurred downstream of Big Boiling Spring which was flowing during the benthic macroinvertebrate collection. The ALU scores reflect the reduced flow occurring in the Leon River and Tehuacana Creek. Salado Creek's exceptional ALU score suggests more consistent flows available from the springs upstream of the sampling site (Table 5).

Aquatic life use scores for each stream were consistent with observations. Salado Creek receives flow from springs and observations made during sample collection suggest a least-impacted habitat when compared to the Leon River and Tehuacana Creek. Habitat observations for Salado Creek include little if any sedimentation on the stream substrate and bubbling waters over the riffle supporting the high ALU score. Historically, Tehuacana Creek is an intermittent stream with perennial pools, but the new industrial discharge into the creek causes perennial flow even during drought conditions. Habitat observations (dark-tinted water and a fine layer of sediment over the cobble) are consistent with the intermediate ALU. The Leon River's intermediate ALU score was consistent with field observations and instantaneous water quality measurements (reduced flow, algae and a higher pH reading, 9.0 s.u.) suggesting water quality concerns.

Aquatic life use data is available for Tehuacana Creek from surveys in 2006 and 2008 (Bronson and Radloff 2007; Bronson 2007). In 2006, prior to initiation of the industrial discharge and during a drought, sampling a perennial pool at the same location scored intermediate aquatic life use (28). In 2008 the permitted industrial discharge had just increased to maximum capacity (1.7 million gallons a day) creating perennial flow and the ALU was high (31). 2011 data gave an intermediate (28) ALU score (Table 5). Habitat observations made as part of this study showed dark-tinted water and a fine layer of sediment over the cobble that was not present in 2006 and only the dark-tinted water was present in 2008. Tehuacana Creek instantaneous water temperature was lower than temperatures in the Leon River and Salado Creek. The stream bed morphology above the sampling site on Tehuacana Creek consists of long, deep and shaded perennial pools (Bronson and Radloff 2007; Bronson 2007) allowing for water temperatures to cool compared to the shallower and wider stream beds upstream of the Leon River and Salado Creek. However, to understand the changes in aquatic life use, a more intensive study would need to compare water chemistry, habitat and fish communities as well as benthic macroinvertebrates. That type of analysis exceeds the scope of this study.

An individual look at the streams' most abundant taxa provides a snapshot of the current conditions. Salado Creek's three most abundant taxa included both intolerant and tolerant taxa, while Tehuacana Creek had two tolerant taxa. Salado Creek's top three collected taxa had similar densities compared to densities of the most abundant taxa in the Leon River and Tehuacana Creek, for which densities for the most abundant taxa doubled or tripled those of the second most abundant taxa. *Simulium* sp. dominated both the Leon River and Tehuacana Creek suggesting a potential taxa specific population explosion.

The dominant taxa in the Leon River, Salado Creek and Tehuacana Creek represent scrapers, collector-gatherers, filtering collector and predator functional feeding groups (FFG). Algae and leaf debris on the riffle habitat at the three steams provides the needed food for the FFG. The presence of four of the five FFG among the three streams suggests a balanced benthic community. Salado Creek is the exception with the three abundant taxa FFG including scrapers, collector-gatherers and predators.

Conclusions

The purpose of the study was to collect benthic macroinvertebrates following TCEQ protocols, and to provide an opportunity to learn about benthic macroinvertebrates' ecology and taxonomy. All study purposes were achieved. The three streams sampled provided enough variety of taxa to challenge a novice taxonomist and to calculate a BIBI, part of TCEQ protocols.

Leon River and Tehuacana Creek intermediate ALU scores represent available habitat and current water quality conditions during sampling. Drought conditions (reduced flows), which stress benthic macroinvertebrate communities, are one reason for the intermediate ALU scores. Salado Creek's exceptional ALU score suggests stable benthic macroinvertebrate community and water quality conditions.

The FFG associated with the three most abundant species for each creek agree with habitat observations and measured parameters. The Leon River and Tehuacana Creek both scored intermediate ALUs, and two of the abundant taxa are the same for each creek (*Stenelmis* sp. and *Simulium* sp.). Both streams third most abundant taxa FFG is predators even though the taxa are different. Salado Creek's abundant taxa only share similarities in FFG with the other two streams. When looking at the three streams together, the presence of four of the five feeding groups suggests a balanced benthic community within the river basin.

In order to provide a well-rounded understanding of each creek more data is needed from different seasons. An integrated bioassessment approach that includes water quality, habitat and fish assessments, and additional benthic macroinvertebrate samples would be valuable.

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