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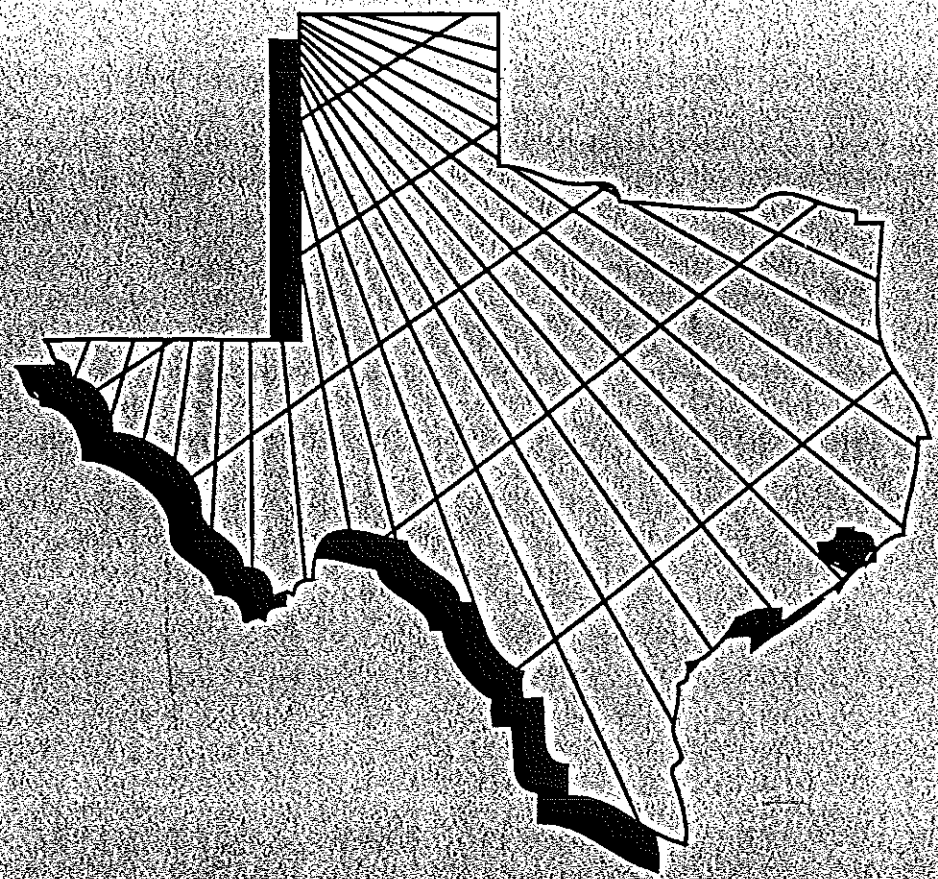

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A Rapid Bioassessment Study of Central Texas Watersheds

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Introduction

In 1993 the U. S. D. A. - Soil Conservation Service contracted with the Edwards Aquifer Research and Data Center at Southwest Texas State University to carry out a two year water quality study of Central Texas watersheds. The study began in October, 1993. This paper presents results obtained through August, 1994.

Eight sampling stations were established on six streams within five major watersheds of the Brazos River Basin. Streams included in the study are Big Elm, Buttermilk, Donahoe, Nolan, Rumsey, and Willis Creeks. A major goal of the study is to compare water quality of streams primarily impacted by agricultural row crop operations, livestock grazing operations and urban activity. The Big Elm, Donahoe, and Willis Creek watersheds contain large amounts of cultivated cropland. Buttermilk and Rumsey Creeks are located within a watershed primarily devoted to livestock grazing of native rangeland. The Nolan Creek watershed is heavily influenced by urban activities.

In order to evaluate levels of biological impairment, U.S. E.P.A.'s Rapid Bioassessment Protocols (RBP) II and V for Streams and Rivers were used (Plafkin et al, 1989). These protocols were specifically developed to obtain basic aquatic life data for use in planning and management. Concurrent with biological sampling, water analyses were conducted on samples collected at each location. The water analyses included the following parameters: fecal coliform, fecal streptococcus, fecal coliform /fecal streptococcus ratio, five-day biological oxygen demand (BOD_5), total organic carbon (TOC), pH, temperature, conductivity, dissolved oxygen, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, total kjeldahl nitrogen (TKN), sulfate, orthophosphate, total phosphate, chlorides, turbidity, and total suspended solids. Additionally, pesticide scans were run on water samples collected at all sampling locations on two sampling dates.

Description of Study Area

The study area is located entirely within the drainage basin of the Little River, in Bell and Williamson Counties. The Little River system, which consists of the San Gabriel, Leon, Lampasas and Little Rivers, is a principal tributary of the Brazos River. Bell and Williamson Counties contain portions of two ecoregions, the Central Texas Plateau and the Texas Blackland Prairie. The eastern portions of both counties lie within the Texas Blackland Prairie, while the western portions are within the Central Texas Plateau. The boundary between the two ecoregions roughly follows the path of U. S. Interstate Highway 35 through both counties.

The area has a humid, subtropical climate. Average annual rainfall throughout the region is about 34 inches (86 cm), with the majority, about 20 inches (51 cm) falling during the months of April–June and September–November. Temperatures range from an average daily maximum of about 97° F (36° C) in August to an average daily minimum of about 35° F (1.7° C) in January.

Big Elm Creek, Donahoe Creek, and Willis Creek lie within the Texas Blackland Prairie. The area was historically a tallgrass prairie. The native grass has been virtually eliminated due to cultivation of agricultural crops. Soils in the area are nearly level to gently sloping deep to shallow clayey soils that formed in marine marls, clayey alluvium, soft limestone and chalk. These soils are found along ancient stream terraces and undulating uplands (Huckabee et al, 1977; Werchan et al, 1983).

Buttermilk Creek, Nolan Creek, and Rumsey Creek lie within the Central Texas Plateau. The area was historically a juniper-oak savanna. Although encroachment of tree and shrub species has been severe, the area is still extensively used for ranching activities. Soils within the area are thin, stony, gently sloping to sloping soils which formed in limestone, or limestone and marl.

They occur in broad ridges and in intervening long, shallow valleys of deeper soils (Huckabee et al, 1977; Werchan et al, 1983).

Eight sampling sites have been established throughout the region. The sites are numbered 1–8, in order, from south to north. Sites 1 and 2 are located in northern Williamson County, and Sites 3–8 are located in Bell County. Sites were selected to represent a variety of aquatic habitat types. Each site contains at least one riffle and a pool and/or stream run. A summary of the eight sites is presented in Table 1.

Table 1. Streams included in the Texas Blackland Prairie and Central Texas Plateau rapid bioassessment study.

Sampling Site	Stream	Site Location	Watershed Size (Acres)	Ecoregion	Primary Source of Potential Impact
1	Willis Creek	West of Granger, Williamson County	12,200 (4,937 ha)	Texas Blackland Prairie	row crop agriculture
2	Donahoe Creek	Southwest of Bartlett, Williamson County	15,490 (6,269 ha)	Texas Blackland Prairie	row crop agriculture
3	Rumsey Creek	Southwest of Salado, Bell County	5,020 (2,032 ha)	Central Texas Plateau	livestock grazing
4	Buttermilk Creek	Southwest of Salado, Bell County	8,350 (3,379 ha)	Central Texas Plateau	livestock grazing
5	upper Nolan Creek	West of Belton, Bell County	66, 580 (26,945 ha)	Central Texas Plateau	urban activities
6	lower Nolan Creek	East of Belton, Bell County	75,530 (30,567 ha)	Central Texas Plateau	urban activities
7	lower Big Elm Creek	South of Red Ranger, Bell County	78,160 (31,631 ha)	Texas Blackland Prairie	row crop agriculture
8	upper Big Elm Creek	Northwest of Troy, Bell County	14, 870 (6,018 ha)	Texas Blackland Prairie	row crop agriculture

Methods and Materials

Physical, Chemical and Bacteriological Data

Physical, chemical and bacteriological samples were collected at about 40-day intervals, concurrent with RBP II sampling. Temperature, dissolved oxygen, and pH data were taken in the field using a YSI® Model 58 Water Quality Instrument and a HANNA® pocket pH meter, respectively. The remainder of the parameters were analyzed in the laboratory at the Edwards Aquifer Research and Data Center from samples collected in the field.

Chemical and bacteriological samples were collected using one gallon plastic cubitainers, 120 ml sterile plastic containers and 50 ml amber, screw top bottles. Water samples were kept on ice during transportation and were refrigerated at 37° F (3° C) upon returning to the lab. The following methods (APHA, 1989) were used to test the water samples: fecal coliform - membrane filtration technique (Method 9222 D); fecal streptococcus - membrane filtration technique (Method 9230 C); biological oxygen demand - 5-day BOD test (Method 5210 B); total organic carbon - combustion-infrared (Method 5310 B); conductivity - Cole-Palmer® conductivity meter, model 1481-60; nitrate - automated cadmium reduction (Method 4500-NO_3^- F); nitrite - automated cadmium reduction (Method 4500-NO_3^- F); ammonia - automated phenate (Method 4500-NH_3 H); sulfate - turbidimetric (Method 4500-SO_4^{2-} E); ortho-phosphate - ascorbic acid (Method 4500-P); total-phosphate - ascorbic acid (Method 4500-P); chlorides - mercuric nitrate (Method 4500-Cl^- C); turbidity - HF Instruments® turbidimeter, model DRT 100 B; total suspended

solids - total suspended solids (Method 2540 D). Total kjeldahl nitrogen (TKN) was tested for using the colorimetric, semi-automated block digester AAII method ([Method 351.2] EPA-600/4-79-020) (EPA, 1979).

Pesticide Analyses

Water samples for pesticide analysis were collected twice at each site (during February and May sampling). Samples were collected in three, one-liter Hexane-washed glass bottles with plastic screw-on caps. The samples were kept on ice during transportation, and were refrigerated at 37° F (3° C) upon returning to the lab. Samples were analyzed for Aldrin; α-BHC; β-BHC; γ-BHC (Lindane); δ-BHC; α-chlordane; δ-chlordane; Dieldrin; Endosulfan I; Endosulfan II; Endosulfan Sulfate; Endrin; Endrin Aldehyde; Endrin Ketone; Heptachlor; Heptachlor Epoxide; 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; and Methoxychlor. Pesticide samples were run according to Gas Chromatographic Method 6630B (APHA, 1989).

RBP II - Benthic Macroinvertebrates

Benthic macroinvertebrates were sampled at approximately 40-day intervals. On each sampling date benthic macroinvertebrates were collected using a 4 ft. x 2 ft. (1.2 m x 0.6 m) kick screen made of two 5 ft. (1.5 m) wood handles and 500m mesh netting. The substrate just upstream from the kick screen was disturbed by kicking and organisms which were dislodged from the substrate washed into the net. Two 45-second kicks were made, one in a fast moving riffle and one in a slow moving riffle. These two samples were composited on the screen and returned to shore for sorting to order-level. Sorting was carried out for approximately 30 minutes, or until at least 100 organisms were collected from the screen. The collected organisms were stored in 80% Ethanol and returned to the lab. In the lab, organisms were sorted to family-level, and the number from each family was recorded.

Macroinvertebrate families were given pollution tolerance values (Plafkin et al, 1989 ; Kolbe and Luedke, 1993) and functional feeding group assignments (Merritt and Cummins, 1984; Thorp and Covich, 1991; and Pennak, 1989). Several insect families have been assigned multiple functional feeding group classifications by Merritt and Cummins. In order to clarify these multiple classifications, organisms were further identified to genus, and where possible, to species. The community structure data thus recorded was used to score seven metrics for Rapid Bioassessment Protocol II (RBP II) (Plafkin et al, 1989). The metrics which were scored in the study were:

1. Taxa richness: total number of families collected at the site
2. Family Biotic Index (modified): $\sum (x_i t_i)/n$, where
   x_i = number of individuals within a family
   t_i = tolerance value for the family
   n = total number of organisms in the sample
3. Ratio of scrapers/filtering collectors: number of scrapers/(number of scrapers + number of filtering collectors)
4. Ratio of EPT and Chironomid abundances: number of EPT individuals/(number of EPT individuals + number ofChironomids), EPT = Ephemeroptera, Plecoptera, and Trichoptera
5. Percent contribution of dominant Family: percent contribution of the dominant family to the total number of organisms collected
6. EPT Index: number of families belonging to the Orders Ephemeroptera, Plecoptera, and Trichoptera which were collected
7. Community Loss Index: (taxa richness at the reference site - taxa common to reference and sampling sites)/taxa richness at the sampling site

One metric which is included in the EPA Protocols, Ratio of Shredders/Total, was not evaluated due to the lack of abundance of coarse particulate organic matter at the study sites. Each

Results and Discussion

Physical, Chemical and Bacteriological Data

A summary of the physical, chemical and bacteriological data collected during the study is given in Table 2. The State of Texas does not have stream quality standards established for any of the streams in the study, with the exception of Nolan Creek. For purposes of comparison, the standards which have been established for various stream segments of the Brazos River Basin were used to evaluate the physical, chemical and bacteriological data obtained during the survey period. Donahoe Creek (Site 2) and Big Elm Creek (Sites 7 and 8) were compared with Segment 1213 (Little River from the confluence with the Brazos River in Milam County to the confluence of the Leon River and the Lampasas River in Bell County) because both of the creeks drain directly into the Little River. Segment 1218 (Nolan Creek from the confluence with the Leon River in Bell County to a point 100 meters [110 yards] upstream of the most upstream crossing of US 190 near the intersection of US 190 and Loop 172 in Bell County) includes both of the sites on Nolan Creek. Rumsey Creek (Site 3) and Buttermilk Creek (Site 4) were compared to Segment 1243 (Salado Creek from the confluence with the Lampasas River in Bell County to the confluence of North Salado Creek and South Salado Creek in Williamson County) because both streams are tributaries of Salado Creek. Willis Creek (Site 1) flows into Granger Lake, and was compared to Segment 1247 (Granger Lake - from Granger Dam in Williamson County to a point 1.9 kilometers [1.2 miles] downstream of SH 95 in Williamson County, up to the normal pool elevation of 504 feet [impounds San Gabriel River]). So far, sampling has been conducted on nine dates. Comparisons of the data obtained at the sampling sites with these reference standards are given below.

Average sulfate levels at Site 1 were above Segment 1247 standards (30 mg/l). Average sulfate levels at Sites 5, 6, and 7 were above standards for Segments 1218 and 1213 (75 mg/l). Average chloride levels at Site 7 were slightly above standards for Segment 1213 (75 mg/l), due to a very high reading (238.4 mg/l) on the April 24 sampling date. Fecal coliform levels at Sites 1 and 2 exceeded standards for Segments 1247 and 1213 (200 colonies/100 ml) on five and four sampling dates, respectively. Dissolved oxygen levels below 5 mg/l were measured at Sites 1, 2 and 7. At Site 1, this event happened on the August 22 sampling date. At Site 2, this event happened on the July 6 sampling date. At Site 7, this event happened on both the July 6 and the August 22 sampling dates. The pH level at Site 1 fell below 6.5 on November 21 and February 6. The pH level at Site 2 dropped to 6.5 on May 31, but did not fall below this level. The pH levels at Sites 3–8 fell below 6.5 either on the April 24 or May 31 sampling dates. Total dissolved solids were not measured directly during the study. Total dissolved solids levels were estimated by multiplying conductivity levels by a factor of 0.5 (Texas Water Commission, 1988), and were found to be within stream quality standards at all sites. Stream temperatures at all sites were consistently below 90° F (32° C).

Desired levels of total phosphorous in surface waters are < 0.2 mg/l. Combined ammonia + nitrate levels should be < 1.0 mg/l (Kolbe and Luedke, 1993). Higher levels could indicate eutrophication. Total phosphorous levels were consistently found to be > 0.2 mg/l at Sites 5, 6, and 7. Combined ammonia + nitrate levels were consistently > 1.0 mg/l at Sites 1, 2, 5, 6, and 7 and were > 1.0 mg/l on four or more sampling dates at Sites 3, 4, and 8.

Segment 1218 (Nolan Creek) has been identified by the Texas Natural Resource Conservation Commission (formerly Texas Water Commission) as not able to support the fishable/swimmable designated uses (Texas Water Commission, 1992).

Table 2. Minimum, maximum and average values for the physical, chemical and bacteriological parameters obtained during the Central Texas rapid bioassessment study from 10/10/93–8/22/94.

Site (Sampling Times)		Fecal Coliform (colonies/ 100 ml)	Fecal Strep. (colonies/ 100 ml)	FC/FS Ratio	BOD 5 (mg/l)	TOC (mg/l)	pH	Temp (°C)	Conductivity (µmhos/cm)	DO (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Ammonia (mg/l)	TKN (mg/l)	Sulfate (mg/l)	O-Phos. (mg/l)	Total Phos. (mg/l)	Chlorides (mg/l)	Turbidity (NTU)	TSS (mg/l)
1 (0710–0745)	Minimum	32	64	0.038	< 2.0	1.72	6.3	6.6	334	4.70	0.98	< 0.10	< 0.10	< 0.05	21.63	< 0.01	< 0.01	7	0.2	0.04
	Maximum	520	844	8.13	5.18	17.48	8.0	25.0	534	8.97	14.52	0.17	0.16	5.97	58.63	0.028	0.073	36.29	14.5	33.27
	Average	260	278	2.08	-	5.59	-	16.1	442	6.88	6.17	-	-	-	37.41	-	-	12.25	3.80	6.84
2 (0750–0910)	Minimum	102	62	0.299	< 2.0	0.47	6.5	7.9	320	4.85	1.18	< 0.10	< 0.10	< 0.05	31.48	< 0.01	< 0.01	11.39	0.37	0.02
	Maximum	732	776	5.15	6.18	32.2	8.5	26.0	572	10.24	7.35	0.14	0.52	3.16	90.01	0.141	0.103	28.04	71.15	105.27
	Average	301	293	1.60	-	9.92	-	17.3	431	7.31	3.80	-	-	-	55.09	-	-	15.67	15.53	31.71
3 (0850–1045)	Minimum	20	56	0.152	< 2.0	2.22	6.4	9.0	323	6.21	0.38	< 0.10	< 0.10	< 0.05	9.64	< 0.01	< 0.01	8.75	0.1	0
	Maximum	374	916	1.32	-	7.84	8.3	26.9	433	10.86	1.90	-	0.32	25.97	27.59	-	0.046	23.29	1.87	4.04
	Average	140	296	0.65	-	4.37	-	16.9	399	9.04	1.16	-	-	-	15.31	-	-	11.18	0.67	1.34
4 (0915–1140)	Minimum	26	62	0.252	< 2.0	0.56	5.8	10.5	353	6.10	0.40	< 0.10	< 0.10	< 0.05	10.86	< 0.01	< 0.01	9.33	0.16	0
	Maximum	1034	572	3.06	3.89	14.86	8.0	24.8	477	12.02	2.22	-	0.10	4.81	27.91	-	0.026	31.79	0.74	2.72
	Average	316	250	1.14	-	4.54	-	18.0	429	8.63	1.00	-	-	-	19.61	-	-	12.98	0.44	1.12
5 (1315–1710)	Minimum	14	42	0.333	< 2.0	0.57	6.4	11.0	458	7.99	1.72	< 0.10	< 0.10	< 0.05	39.33	< 0.01	0.31	39.78	0.14	0.56
	Maximum	638	424	2	2.93	19.23	8.8	28.0	767	15.78	7.14	0.13	0.28	19.15	111.64	1.77	2.21	204.9	15.23	27.54
	Average	168	133	0.99	-	8.31	-	19.7	638	11.43	3.95	-	-	-	73.47	-	1.06	85.82	2.36	5.39
6 (1350–1800)	Minimum	30	26	0.472	< 2.0	1.72	6.2	10.6	267	7.68	1.40	< 0.10	< 0.10	< 0.05	47.07	0.25	0.23	24.1	0.16	0.44
	Maximum	268	638	1.81	5.47	25.04	8.5	27.4	748	13.95	6.35	0.15	0.15	4.25	311.92	1.34	1.41	272.9	15.08	48.88
	Average	106	174	1.08	-	6.70	-	19.0	586	10.72	3.18	-	-	-	101.81	0.84	0.79	80.52	3.00	8.31
7 (1055–1405)	Minimum	52	100	0.464	< 2.0	3.51	4.7	8.8	511	4.58	2.15	< 0.10	< 0.10	< 0.05	43.87	0.23	0.22	28.64	1.22	1.25
	Maximum	444	656	3.96	4.69	37.16	8.1	25.9	765	10.97	4.98	0.30	0.40	6.11	311.92	1.27	1.51	238.4	98.4	151.45
	Average	223	245	1.21	-	12.25	-	18.4	665	6.75	3.65	-	-	-	126.41	0.86	0.79	77.86	16.47	32.98
8 (1215–1545)	Minimum	14	2	0.320	< 2.0	2.87	4.5	9.7	265	5.44	< 0.10	< 0.10	< 0.10	< 0.05	24.85	< 0.01	< 0.01	8.1	0.32	0.51
	Maximum	118	500	37	2.41	19.48	8.4	28.4	397	12.39	1.48	0.10	0.16	24.3	73.62	0.02	0.13	35.29	56.9	69.0
	Average	82	124	5.40	-	7.28	-	20.0	312	9.19	0.84	-	-	-	49.88	-	-	12.79	17.43	27.13

Pesticide Analyses

Pesticide residues were found to be within Texas surface water quality standards at all sites, with the following exceptions. Heptachlor concentrations were found to be above Texas surface water quality standards at Site 4 on the May sample date. On that date, Heptachlor concentrations were found to be 0.02034 µg/l. Texas surface water quality standards for Heptachlor are 0.0177 µg/l. Chlordane concentrations were found to be above Texas surface water quality standards at Site 5 on the February sample date. On that date, α-chlordane concentrations were found to be 0.06211 µg/l. Chlordane concentrations were found to be above Texas surface water quality standards at Site 7 on the February and May sample dates. On those dates, α-chlordane concentrations were found to be 0.1199 µg/l and 0.02136 µg/l, respectively. Texas surface water quality standards for Chlordane are 0.0210 µg/l. These standards refer to Technical Chlordane, which is considered to be a mixture that contains α-chlordane, δ-chlordane, Heptachlor, Chlordene and a variety of side reaction products from chlorination of Chlordene (EPA, 1985). Dieldren concentrations were found to be above Texas surface water quality standards at Sites 1 and 5 on the February sample date (0.01825 µg/l, and 0.00807 µg/l, respectively) and at Sites 1–8 on the May sample date (0.0067, 0.01213, 0.01141, 0.00801, 0.00653, 0.01236, 0.01061, and 0.01561 µg/l, respectively). Texas surface water quality standards for Dieldrin are 0.0012 µg/l.

RBP II - Benthic Macroinvertebrates

Results of the RBP II impairment assessment are given in Table 3. Compared to TNRCC reference site data, Sites 1, 2, 3, 5, and 7 consistently scored in the moderately impaired category. Sites 4 and 6 typically exhibited levels of moderate impairment, but also exhibited levels of non-impairment on three and four sampling dates, respectively. Site 8 scored in the nonimpaired category on six sampling dates. Based on average metric values, Sites 1–7 scored moderately impaired and Site 8 scored non-impaired. All sites, with the exception of Site 7, consistently scored at least within the upper portions of the moderately impaired category. Site 7 tended to score within the middle range of the moderately impaired category.

All sites tended to score low on the EPT Index metric and moderate on the Number of Taxa and Community Loss Index metrics. The number of EPT taxa collected at the reference sites ranged from 6–10. Although the total number of EPT taxa collected at the sampling sites through the course of the study ranged from 7–12, an average of only 3–6 EPT taxa were collected on any given sampling date. Similarly, although a total of 27–39 total taxa were collected at the sampling sites through the course of the study (compared with 20–35 collected at the reference sites), an average of only 10–18 taxa were collected on any given sampling date. Site 7 also tended to score low on the Number of Taxa and EPT/Chironomid metrics.

Site 2 scored on the borderline between moderately impaired and severely impaired, with a biological condition score of 28.6%, on the August 22 sample date. This site had very recently been extensively disturbed. A county maintenance crew had removed all vegetation from the site location, leaving mineral soil. Subsequent rains had resulted in heavy siltation. Site 4 scored severely impaired, with a biological condition score of 15.4%, on the August 22 sample date. Stream flow at this site had been extremely low until the previous day due to dry weather. Low stream flows could account for the severely impaired biological condition score which was obtained.

The habitat assessment comparison indicated that the habitats at all sites are either comparable to their regional reference sites or able to support a similar biological community.

RBP V - Fish

RBP V impairment assessment results are given in Table 4, and are summarized below. Biological condition scores were generally fair at Sites 1, 2, 3, and 6. Site 4 ranged from fair to good. Site 7 ranged from poor to fair. Site 8 ranged from poor to good. Site 5 generally scored poor. Sites 2, 3, 4, 5, and 8 scored good on at least one sampling date. Based on average metric score values, Site 4 scored good; Sites 1, 2, 3, 6, 7, and 8 scored fair; and Site 5 scored poor.

Sites 5, 6, and 7 tended to score low on the Total Number of Species metric. Generally, only 4–6 species were collected on any one sampling date at Sites 5 and 6, and only 4–8 species were collected on any one sampling date at Site 7. Sites 1, 2, 7, and 8 scored low on the Number of Darter and Catfish Species metric, mainly to low numbers of catfish species collected. Sites 1, 2, 3, 5, 6, and 7 scored low on the Number of Sunfish Species metric. Although seven species of sunfish were collected during the study, Sites 4 and 8 were the only sites were as many as five different sunfish species were collected. Sites 1, 5, and 7 scored low on the Number of Minnow Species metric. The total number of minnow species collected at these sites over the course of the study was comparable to the numbers expected from the species-waterbody size relationships (3–5 species), but only 1–3 minnow species were normally collected on any one sampling date. Sites 1–6, and Site 8 scored low on the Number of Intolerant Species metric. Only three fish species classified as "intolerant" were collected during the study. These were *Dionda episcopa* (roundnose minnow), *Noturus gyrinus* (tadpole madtom), and *Percina sciera* (dusky darter). Of these, only roundnose minnows were found at as many as five sites (Sites 4–8). Dusky darters were collected at Sites 6–8, and tadpole madtoms were only collected at Site 7. All sites tended to score low on the Total Number of Individuals metric.

Table 3. RBP II results obtained during the Central Texas rapid bioassessment study from 10/10/93–8/22/94.

Date	Site 1 % Comp. to Reference Score	Site 2 % Comp. to Reference Score	Site 3 % Comp. to Reference Score	Site 4 % Comp. to Reference Score	Site 5 % Comp. to Reference Score	Site 6 % Comp. to Reference Score	Site 7 % Comp. to Reference Score	Site 8 % Comp. to Reference Score
10/10/93	71.4	71.4	69.2	76.9	69.2	76.9	64.3	50.0
11/21/93	64.3	71.4	69.2	69.2	53.8	76.9	42.9	92.9
1/3/94	71.4	64.3	61.5	53.8	46.2	76.9	35.7	50.0
2/6/94	42.9	64.3	100.0	69.2	53.8	61.5	42.9	92.9
3/16/94	71.4	64.3	69.2	69.2	53.8	69.2	42.9	78.6
4/24/94	71.4	71.4	53.8	69.2	76.9	69.2	35.7	71.4
5/31/94	71.4	64.3	69.2	84.6	46.2	53.8	64.3	78.6
7/6/94	64.3	64.3	61.5	76.9	69.2	69.2	85.7	92.9
8/22/94	50.0	28.6	46.2	15.4	61.5	76.9	64.3	100.0
Minimum	42.9	28.6	46.2	15.4	46.2	53.8	35.7	50.0
Maximum	71.4	71.4	100.0	84.6	76.9	76.9	85.7	100.0
Average	64.3	64.3	61.5	53.8	61.5	69.2	57.1	92.9

RBP II impairment designation: > 72% = Nonimpaired, 21–72% = Moderately impaired, < 21% = Severely impaired

Table 4. RBP V results obtained during the Central Texas rapid bioassessment study from 11/21/93–7/6/94.

Date	Site 1 IBI Score	Site 2 IBI Score	Site 3 IBI Score	Site 4 IBI Score	Site 5 IBI Score	Site 6 IBI Score	Site 7 IBI Score	Site 8 IBI Score
11/21/93	38	38	42	44	32	38	36	38
1/3/94	38	42	46	44	30	30	40	30
4/24/94	36	42	42	50	30	40	34	44
7/6/94	42	52	44	50	46	44	34	48
Minimum	36	38	42	44	30	30	34	30
Maximum	42	52	46	50	46	44	40	48
Average	38	42	42	48	34	40	36	40

RBP V impairment designation: 53–60 = Excellent, 45–52 = Good, 35–44 = Fair, 23–34 = Poor, < 23 = Very poor

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