SURVEYS OF AQUATIC BIOTA FOR THE EXELON VICTORIA COUNTY STATION SITE

Final Report
January-December 2008

Submitted to:

Tetra Tech NUS
900 Trail Ridge Road
Aiken, South Carolina 29803

Prepared by:

BIO-WEST, Inc.
1812 Central Commerce Court
Round Rock, Texas 78664

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1.0 INTRODUCTION

The purpose of this final report is to summarize activities conducted, present data collected, and demonstrate analyses performed relating to aquatic biota surveys for the Exelon Victoria County Station Project. This information will support Tetra Tech NUS, Inc. in preparing an Environmental Report to supplement the Combined Construction and Operating License Application (COLA) for a proposed nuclear facility in Victoria County, Texas (Figure 1-1). This comprehensive year-end report covers aquatic data collected by BIO-WEST, Inc. for the project from January through December 2008. The report provides a description of activities and summary of results relating to aquatic sampling at 1) 12 locations within the boundaries of the Exelon Victoria County Station Site and 2) seven off-site locations on the Guadalupe River and associated canals.

Figure 1- 1. Location of the Exelon Victoria County Station Site.

2.0 EXELON VICTORIA COUNTY STATION SITE

2.1 Station Locations and Descriptions

Twelve on-site aquatic sampling stations were selected by Tetra Tech NUS personnel within the boundaries of the 11,000-acre Exelon Victoria County Station Site (Figure 2-1). These stations were sampled quarterly (Spring, Summer, Fall, and Winter) in 2008. A brief description of conditions observed at each station is presented below, along with GPS coordinates for each station in the NAD83 coordinate system. Photographs from each on-site station are provided in Appendix A.

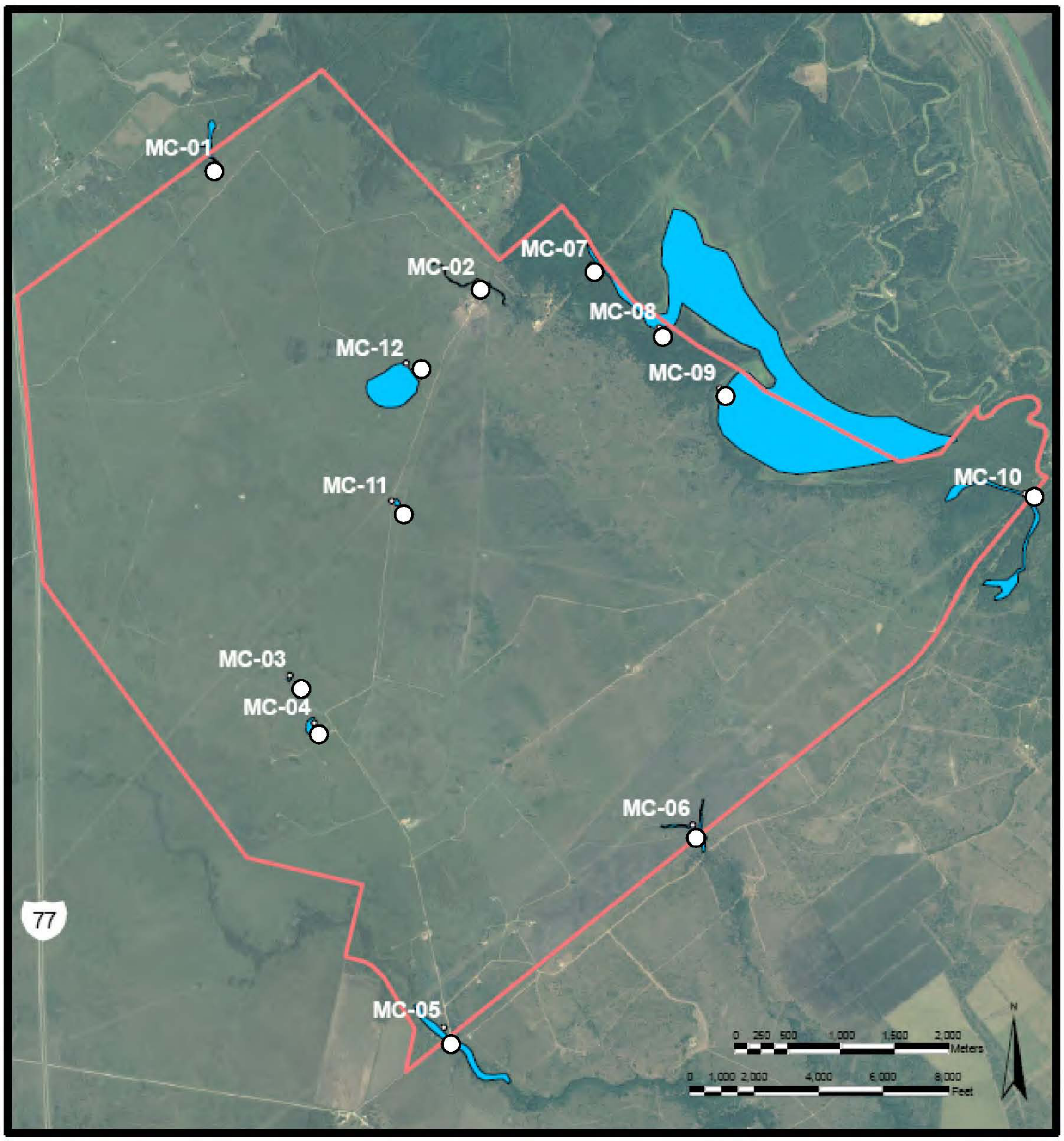

Figure 2- 1. Location of 12 on-site sampling stations.

Station MC-01 - N 28°38'4.9" W 97°01'32.8"
MC-01 was located on a small tributary to Black Bayou along the northern boundary of the site. Just downstream of this station, on the adjacent property, the creek was dammed to form a small reservoir. MC-01 was located in the extreme upper end of this reservoir where it pooled water into the creek on the McCan property. During the April (Spring) sampling event, the creek was approximately 10 meters (m) (35 feet [ft]) wide with an average depth of approximately 1 m (3.3 ft). MC-01 was almost entirely covered in floating primrose willow (*Ludwigia peploides*). Substrate consisted of firm clay with some organic deposition. Adjacent to the creek banks, which were slightly eroded, woody vegetation included live oak (*Quercus virginiana*) and Chinese tallow (*Triadica sebifera*). During the April sampling effort, areas upstream of MC-01, where water levels were not influenced by the aforementioned dam, were completely dry. During the July (Summer) sampling effort, the water level had dropped approximately 1 meter (3.3 ft). The water level remained similar during the October (Fall) sampling effort, and had risen approximately 1 meter (3.3 ft) by the December (Winter) sampling effort.

Station MC-02 - N 28°37'27.53" W 97°0.0'2.90"
MC-02 was located on an intermittent tributary of Black Bayou/Linn Lake which during the April sampling effort consisted of a few small isolated pools. Three separate pools were sampled. Pool 1 was approximately 2 m (6.5 ft) wide and 7 m (22 ft) across, with a maximum depth of 0.5 m (1.5 ft); pool 2 was approximately 2.5 m (8 ft) wide and 7 m (24 ft) across; and pool 3 was approximately 2.5 m (8 ft) wide and 4.5 m (15 ft) across. Substrate in all three pools was composed mainly of sand with small amounts of organic matter. No aquatic vegetation was observed in the pools; however, floating primrose willow, swamp smartweed (*Polygonum hydropiperoides*), and a species of millet were observed in dry areas of the streambed between the three pools. This station was completely dry during the July sampling effort and remained dry during October and December sampling.

Station MC-03 - N 28°35'28.4" W 97°01'10.1"
MC-03 was a small pond located near the center of the site used primarily to provide water for livestock. During the April sampling effort, the pond was approximately 16 m (55 ft) by 22 m (72 ft) with an average depth of 0.7 m (2.3 ft). The pond was moderately clear and two species of submerged aquatic vegetation were quite abundant - muskgrass (*Chara* spp.) and bushy pondweed (*Najas guadalupensis*). The margin of the pond was dominated by squarestem spikerush (*Eleocharis quadrangulata*), intermixed with sedges (*Cyperus* spp.), floating primrose willow, and a colony of cattails (*Typha* spp.). Along the southern margin of the pond, grassland pasture was intermixed with huisache (*Acacia farnesiana*) and mesquite (*Prosopis glandulosa)*. Sugar hackberry (*Celtis laevigata*), Macartney rose (*Rosa bracteata*), and an introduced species of bamboo occur north of the pond. During the July sampling effort, this pond had receded to a shallow puddle only inches deep which was almost completely covered with floating primrose willow. This station was dry during the October and December sampling events.

Station MC-04 - N 28°35'13.7" W 97°01'1.9"
MC-04 was a larger pond, located directly south of MC-03, and also used as a water source for livestock. During the April sampling effort, it was approximately 35 m (114 ft) by 70 m (228 ft) with an average depth of 0.5 m (1.5 ft). Heavy livestock activity was evident around the margins of the pond. The water was turbid, and no submerged aquatic vegetation was observed. The

margin of the pond was dominated by floating primrose willow extending approximately 1 m (3.3 ft) into the water along the southern bank. Other vegetation associated with the pond included rattlebush (*Sesbania drummondii*), squarestem spikerush, and jungle rice (*Echinochloa colona*). The area surrounding MC-04 consisted of grassland pasture with intermixed huisache and mesquite. During July, the water level of this pond had dropped substantially, and average depth was less than 0.3 m (1 ft). By October, only a small puddle of water remained. This station was completely dry during the December sampling event.

Station MC-05 (Kuy Creek) - N 28°33'36.9" W 97°00'18.6"
MC-05 was located along Kuy Creek within a riparian woodland near the southern entrance to the site. During the April sampling effort, the creek was approximately 1.5 m (5 ft) wide with an average depth of 0.5 m (1.5 ft). However, a deep pool occurred directly below the bridge crossing with an average depth of 1 m (3.3 ft). The water in the creek was relatively clear with a soft to moderately firm bottom. No submerged aquatic vegetation was observed. The creek was stagnant with a thin sheen of pollen on the water's surface. Considerable debris and litter was scattered throughout the creek with the highest concentration near and below the bridge. MC-05 occurs beneath a dense canopy of trees dominated by box elder (*Acer negundo*), sugar hackberry, American elm (*Ulmus americana*), live oak, cedar elm, and pecan trees (*Carya illinoinensis*). The herbaceous layer was dominated by poison ivy (*Rhus toxicodendron*), plantago (*Plantago* spp.), wild rice (*Zizania* spp.), and various sedge species (*Carex* spp.). During July, the creek was no longer flowing, and the only water present was in the deep pool immediately below the bridge. This station was dry during the October sampling effort. During the December sampling effort, there was a small puddle approximately 0.5 m (1.5 ft) deep directly below the bridge.

Station MC-06 (Dry Kuy Creek) - N 28°34'38.39" W 96°58'49.31"
MC-06 was located along Dry Kuy Creek, an intermittent tributary of Kuy Creek, near the southeastern boundary of the site. During the April sampling effort, only two small stagnant pools remained in channel depressions. Pool 1 measured approximately 1 m (3.3 ft) by 2 m (6.5 ft), and pool 2 was even smaller. Water was extremely turbid due to recent livestock traffic through the pools. Substrate consisted of soft silt and sand, and no aquatic vegetation was present. This station was dry during the July sampling effort and remained dry in October and December.

Station MC-07 (Black Bayou) - N 28°37'25.6" W 96°59'28.7"
Station MC-07 was located on Black Bayou at a pipeline crossing a short distance above its confluence with Linn Lake. During the April sampling effort, the stream was approximately 27 m (90 ft) in width with a maximum depth of approximately 1.2 m (4 ft). Very little flow was evident. Water in the bayou was turbid and the substrate was composed of moderately firm clay with some organic and soft silt deposition. No submerged aquatic vegetation was observed; however, some floating filamentous algae mats were present along the shoreline. Woody debris in the form of cypress knees and fallen branches was present along the perimeter of the bayou. An adjacent bottomland forest was dominated by species of black willow (*Salix nigra*) and box elder. During the July sampling effort, the bayou was not flowing and the water line had receded 3-4 m (10-13 ft). This left much of the woody debris present along the banks well above the water line. The water line continued to drop 1-2 m (3-7 ft) during both the October and December sampling efforts.

Station MC-08 (Linn Lake) - N 28°37'12.4" W 96°59'0.2"
MC-08 was located in Linn Lake, a large oxbow lake, near the inflow of Black Bayou. During April, width at the mouth of the bayou was approximately 27 m (90 ft) with an average depth of 0.7 m (2.5 ft). However, the bayou empties into a shallow flat of Linn Lake (>100 m in width) that, in April, was extremely shallow with depths of less than 0.3 m (1 ft). Substrate was composed of moderately firm clay and soft silt with an abundance of organic deposition. No submerged vegetation was observed. Shoreline vegetation in the area was dominated by species of black willow and box elder. During the July sampling effort, this station was completely dry and remained dry in October and December.

Station MC-09 (Linn Lake) - N 28°37'0.4" W 96°58'33.4"
MC-09 was located in the main basin of Linn Lake, directly southeast and across a large peninsula from MC-08. In April, Linn Lake was extremely shallow in this area with an average depth of <0.5m (1.5 ft). This depth was relatively consistent for several hundred meters into the lake. Substrate consisted of soft silt and clay, and no submerged vegetation was noted. Water clarity was turbid due to considerable wind action. Woody vegetation along the banks consisted of black willow, dwarf palmetto (*Sabal minor*), and bald cypress (*Taxodium distichum*). During July, the water line of Linn Lake had receded approximately 100 m (328 ft) exposing a large mud flat at this station. Only a few inches of water remained near the center of the lake. This station was completely dry during the October and December sampling efforts.

Station MC-10 (Upper Cypress Lake) - N 28°36'24.7" W 96°56'51.2"
MC-10 was located in the headwaters of Cypress Lake just upstream of the railroad trestle that marks the site boundary. During April, the sample area included a small swampy pooled area and creek channel with a maximum depth of approximately 1 m (3.3 ft). The substrate was moderately firm sand with some silt in quiescent areas. Vegetation along shorelines and islands included bald cypress, black willow, and box elder. Large bald cypress trees were also present in the stream channel. No submerged aquatic vegetation was observed other than some limited filamentous algae occurring along the banks. During the July sampling effort, this station was completely dry and remained dry in October and December.

Station MC-11 - N 28°36'21.1" W 97°00'33.7"
MC-11 was another pond used as a water source for livestock. During April, the pond was approximately 42 m (138 ft) by 45 m (150 ft) with an average depth of 1.4 m (4.5 ft). Substrate in the pond consists of loose silty clays and sand. The water was very turbid with no evidence of submerged aquatic vegetation. No aquatic vegetation was observed along the pond edges, most likely as a result of heavy use by livestock. The shoreline was bare of vegetation except for scattered woody vegetation such as rattlebush. During July, the water line of the pond had dropped approximately 2-3 m (7-10 ft). Heavy use by livestock was evident around the pond margins. The water line at this station continued to drop 1-2 m (3-7 ft) during both the October and December sampling efforts.

Station MC-12 - N 28°37'5.9" W 97°00'26.5"
MC-12 consisted of a large, ephemeral emergent wetland, which during April, ranged from partially saturated soils to being fully inundated by water. At this time, one small open area occurred in the middle of the wetland that was approximately 25 m (84 ft) by 37 m (120 ft) with

an average depth of 13 cm (5 in). The water was clear, and substrate was composed of moderately soft soil with abundant organic deposition. The emergent wetland was dominated by squarestem spikerush and rattlebush. Other associated vegetation consisted of American lotus (*Nelumbo lutea*), longbarb arrowhead (S*agittaria longiloba*), grassy arrowhead (*S. graminea*), spider lily (*Hymenocallis occidentalis*), and swollen bladderwort (*Utricularia vulgaris*). During the July sampling effort, this station was completely dry and remained dry in October and December.

2.2 Sampling Schedule

Sampling dates for each of the four on-site aquatic surveys are presented in Table 2-1. The dry conditions experienced in south Texas during 2008 had a considerable impact on water availability at the Exelon Victoria County Station Site. In April, all stations had at least some water. By the July sampling effort, five of the 12 stations were dry due to drought conditions in central and southern Texas. In October and December, water was present at only four of the 12 stations.

Table 2- 1. Dates of on-site aquatic sampling at the Exelon Victoria County Station Site.

Sampling Event	Date
Spring	April 21-25, 2008
Summer	July 22-25, 2008
Fall	October 13-15, 2008
Winter	December 16-18, 2008

2.3 Fish

2.3.1 Methods

Due to the variation in habitats observed at the 12 on-site stations, a variety of sampling methods was employed to efficiently capture resident fishes. Active sampling techniques included backpack electrofishing and seining. Backpack electrofishing was conducted using a Smith-Root model LR-24 backpack electrofisher. A minimum of 500 seconds of shock time was conducted when electrofishing was used. Two seines were employed depending on conditions encountered. A 9.1 m x 1.8 m x 6.4 mm mesh (30 ft x 6 ft x 1/4" mesh) beach seine was used for open water habitats, and a smaller 4.6 m x 1.8 m x 4.8 mm mesh (15 ft x 6 ft x 3/16" mesh) seine was used for near-shore habitats.

Passive sampling techniques used included minnow traps, sunfish traps, and gill nets. Gee-style minnow traps and funnel-style sunfish traps were used at every station. Traps were baited with dry dog food and placed in littoral areas overnight. Gill nets were deployed overnight at two stations (MC-08 and MC-11) in April when water depth was appropriate. The specific sampling techniques used at each station are listed in Table 2-2.

Once fish were captured, they were placed in a large bucket with water until sampling at that station was complete. Fish were then identified to species, enumerated, and measured (total length in mm). Specimens large enough to register on a digital scale (sensitivity of 10 grams [g]) were then weighed (g). Weight was not recorded for specimens less than 10 g. All fish were then released, excluding voucher specimens.

Table 2- 2. Techniques used to sample fish at the Exelon Victoria County Station Site.

Station	Traps	Seines	Gill Nets	Backpack Electrofisher
MC-01 (unnamed stream)	√	√		√
MC-02 (unnamed stream)	√	√		
MC-03 (borrow pit)	√	√		
MC-04 (borrow pit)	√	√		
MC-05 (Kuy Creek)	√	√		√
MC-06 (Dry Kuy Creek)	√	√		
MC-07 (Black Bayou)	√	√		√
MC-08 (Linn Lake)	√	√	√	
MC-09 (Linn Lake)	√	√		
MC-10 (Upper Cypress Lake)	√	√		√
MC-11 (stock pond)	√	√	√	
MC-12 (wetland)	√			√

In addition to fish data, detailed notes were taken on the conditions observed at each station. These notes included dominant substrate, aquatic and riparian vegetation, water level/depth, weather conditions, water clarity, and presence of other wildlife. Observations of other wildlife will not be discussed in this report, but are presented in the final report for the Herpetological and Small Mammal Survey conducted by BIO-WEST (BIO-WEST 2008a).

2.3.2 Results and Discussion

2.3.2.1 Fishes Captured

On-site fish sampling resulted in capture of 4,215 individuals representing 16 families and 36 species (Table 2-3). Western mosquitofish (*Gambusia affinis)* were the most abundant species overall and represented 24% of all fish captured. This is not surprising given that habitat at some of the stations consisted of small stagnant pools. Western mosquitofish are very tolerant of poor water quality conditions and are often the last fish to survive in such habitats. At the family level, the sunfishes (Centrarchidae) were the most abundant family, comprising 42% of all fish captured. Abundant centrarchids included white crappie (*Pomoxis annularis;* 12% relative abundance), warmouth (*Lepomis gulosus;* 11%), bluegill (*Lepomis macrochirus;* 10%), and green sunfish (*Lepomis cyanellus;* 4%).

Black bullhead (*Ameiurus melas*) was the second most abundant species (13%). However, this was mainly a result of a large school of juvenile bullheads (513 individuals) captured at MC-01 in July.

Table 2- 3. Number collected (#) and percent relative abundance (%) of fishes captured at 12 locations on the Exelon Victoria County Station Site in 2008.

Family	Common Name	Scientific Name	MC-01		MC-02		MC-03		MC-04		MC-05		MC-06		MC-07		MC-08		MC-09		MC-10		MC-11		MC-12		Total	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Lepisosteidae																												
	Alligator gar	*Atractosteus spatula*															5	7.4									5	0.1
	Spotted gar	*Lepisosteus oculatus*							2	0.4					20	2.9	1	1.5					11	1.9			34	0.8
Clupeidae																												
	Gizzard shad	*Dorosoma cepedianum*													14	2.0	3	4.4			2	1.0	20	3.5			39	0.9
	Threadfin shad	*Dorosoma petenense*													69	10.1			9	69.2	2	1.0					80	1.9
Cyprinidae																												
	Golden shiner	*Notemigonus crysoleucas**					65	14.2																			65	1.5
	Red shiner	*Cyprinella lutrensis*																			6	3.0					6	0.1
	Common carp	*Cyprinus carpio**					25	5.5	18	3.6	1	0.6			1	0.1			2	15.4			16	2.8			63	1.5
	Pugnose minnow	*Opsopoeodus emiliae*																			1	0.5					1	0.0
	Bullhead minnow	*Pimephales vigilax*													5	0.7	1	1.5			12	5.9					18	0.4
Catostomidae																												
	Smallmouth buffalo	*Ictiobus bubalus*									1	0.6			3	0.4	1	1.5					7	1.2			12	0.3
Characidae																												
	Mexican tetra	*Astyanax mexicanus**									4	2.2			17	2.5					1	0.5					22	0.5
Ictaluridae																												
	Black bullhead	*Ameiurus melas*	515	44.9	3	1.5	1	0.2			1	0.6											11	1.9			531	12.6
	Yellow bullhead	*Ameiurus natalis*					19	4.2	15	3.0	10	5.6											4	0.7			48	1.1
	Blue catfish	*Ictalurus furcatus*													1	0.1	5	7.4	1	7.7	1	0.5					8	0.2
	Channel catfish	*Ictalurus punctatus*													1	0.1					18	8.9					19	0.5
	Flathead catfish	*Pylodictis olivaris*																			1	0.5					1	0.0
Loricariidae																												
	Suckermouth armored catfish	*Pterygoplichthys anisitsi**													5	0.7											5	0.1
Mugilidae																												
	Striped mullet	*Mugil cephalus*													19	2.8											19	0.5
Atherinopsidae																												
	Inland silverside	*Menidia beryllina*													29	4.2	2	2.9			4	2.0					35	0.8
Fundulidae																												
	Golden topminnow	*Fundulus chrysotus*	42	3.7											1	0.1											43	1.0
Poeciliidae																												
	Western mosquitofish	*Gambusia affinis*	223	19.4	185	90.7	32	7.0	162	32.7	113	63.5	31	68.9	77	11.3	2	2.9			6	3.0	6	1.1	154	100.0	991	23.5
	Sailfin molly	*Poecilia latipinna*					30	6.6	205	41.3					77	11.3	22	32.4			9	4.5					343	8.1
Cyprinodontidae																												
	Sheepshead minnow	*Cyprinodon variegatus*													34	5.0											34	0.8
Moronidae																												
	White bass	*Morone chrysops*													3	0.4	1	1.5									4	0.1
Centrarchidae																												
	Green sunfish	*Lepomis cyanellus*			5	2.5	127	27.8	15	3.0	4	2.2															151	3.6
	Warmouth	*Lepomis gulosus*	137	11.9	11	5.4	146	31.9	49	9.9	37	20.8			44	6.4					21	10.4	12	2.1			457	10.8
	Orangespotted sunfish	*Lepomis humilis*																			2	1.0	108	19.0			110	2.6
	Bluegill	*Lepomis macrochirus*	39	3.4			3	0.7	16	3.2	7	3.9			200	29.3	23	33.8			67	33.2	46	8.1			401	9.5
	Longear sunfish	*Lepomis megalotis*													2	0.3					11	5.4					13	0.3
	Redear sunfish	*Lepomis microlophus*	4	0.3											14	2.0					2	1.0					20	0.5
	Bantam sunfish	*Lepomis symmetricus*	79	6.9					8	1.6					23	3.4					1	0.5					111	2.6
	Largemouth bass	*Micropterus salmoides*	8	0.7					1	0.2													5	0.9			14	0.3
	White crappie	*Pomoxis annularis*	100	8.7			9	2.0	5	1.0			14	31.1	21	3.1	1	1.5			35	17.3	321	56.5			506	12.0
	Black crappie	*Pomoxis nigromaculatus*													3	0.4											3	0.1
Sciaenidae																												
	Freshwater drum	*Aplodinotus grunniens*																	1	7.7			1	0.2			2	0.0
Cichlidae																												
	Rio Grande cichlid	*Cichlasoma cyanoguttatum**															1	1.5									1	0.0
Total			1147		204		457		496		178		45		683		68		13		202		568		154		4215	

*Exotic or introduced species

Golden shiners (*Notemigonus crysoleucas)* were documented in large numbers at MC-03 in April, but were not captured elsewhere. This species is often sold by local bait dealers and may represent the result of a bait-bucket introduction at this station. Other introduced or exotic species captured included Rio Grande cichlid (*Cichlasoma cyanoguttatum*), Mexican tetra (*Astyanax mexicanus*), common carp (*Cyprinus carpio*), and suckermouth armored catfish (*Pterygoplichthys anisitsi*). Golden shiners and common carp were the most abundant introduced species.

Species richness was highest at MC-07 where 24 species were captured, and was lowest at MC-12 where western mosquitofish were the only species captured. In general, stations located on perennial streams had the highest number of species. Occurrence of species at small ponds and intermittent streams were likely influenced by occasional restocking through human influence or overflow from other more persistent water bodies, respectively.

No state or federally listed threatened or endangered species were collected during the aquatic survey. Although not listed as threatened or endangered by TPWD or the United States Fish and Wildlife Service (USFWS), the American eel (*Anguilla rostrata)* is documented as rare within the state. This species spawns in the Atlantic Ocean, and adult females migrate up rivers along the Atlantic and Gulf Coasts to live out the majority of their lives before returning to the sea to spawn. Although none were captured, presence of American eels cannot be ruled out in the larger water bodies which are occasionally connected to the Guadalupe River (i.e, Black Bayou, Linn Lake, Cypress Lake, Kuy Creek).

Even though they were only captured at five stations, common carp dominated the overall biomass (Table 2-4). Other large contributors to overall biomass included spotted gar (*Lepisosteus oculatus*), smallmouth buffalo (*Ictiobus bubalus*), white crappie, alligator gar (*Atractosteus spatula*), and blue catfish (*Ictalurus furcatus*). Stations MC-11 and MC-07 exhibited the highest overall biomass, primarily because they were sampled during all four seasons. MC-08 and MC-03 also exhibited high biomass, despite a limited number of collections from these locations. In general, stations with high biomass exhibited high abundance of the large-bodied species described above. Although fish were captured from each station, several stations did not yield individuals large enough to register on the digital scale (sensitivity of 10 g), and thus no weight data is available for these stations.

Figure 2- 2. BIO-WEST personnel backpack electrofishing at MC-07.

Table 2- 4. Combined weight (g) and percent of total weight (%) for each species based on data collected from 537 individuals at 12 locations on the Exelon Victoria County Station Site in 2008.

Common Name	Scientific Name	MC-01		MC-02		MC-03		MC-04		MC-05		MC-06		MC-07		MC-08		MC-09		MC-10		MC-11		MC-12		Total	
		(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%	(g)	%
Alligator gar	*Atractosteus spatula*															7470	47.1									7470	6.9
Spotted gar	*Lepisosteus oculatus*							230	3.6					18490	66.4							5780	14.5			24500	22.6
Gizzard shad	*Dorosoma cepedianum*													30	0.1					20	0.9	550	1.4			600	0.6
Golden Shiner	*Notemigonus crysoleucas**					730	5.1																			730	0.7
Common carp	*Cyprinus carpio**					7560	53.2	2450	38.6	160	23.2			770	2.8							16000	40.2			26940	24.8
Smallmouth buffalo	*Ictiobus bubalus*													630	2.3	2500	15.8					9080	22.8			12210	11.3
Black bullhead Catfish	*Ameiurus melas*					1030	7.2			20	2.9											330	0.8			1380	1.3
Yellow bullhead catfish	*Ameiurus natalis*					1040	7.3	420	6.6	50	7.2											440	1.1			1950	1.8
Blue catfish	*Ictalurus furcatus*													670	2.4	4890	30.8			1130	50.0					6690	6.2
Channel catfish	*Ictalurus punctatus*													900	3.2					20	0.9					920	0.8
Flathead catfish	*Pylodictis olivaris*																			20	0.9					20	0.0
Suckermouth armored catfish	*Pterygoplichthys anisitsi**													730	2.6											730	0.7
Striped mullet	*Mugil cephalus*													2437	8.7											2437	2.2
Sailfin molly	*Poecilia latipinna*					40	0.3																			40	0.0
White bass	*Morone chrysops*															900	5.7									900	0.8
Green sunfish	*Lepomis cyanellus*					370	2.6	590	9.3	10	1.4															970	0.9
Warmouth	*Lepomis gulosus*					2800	19.7	1490	23.5	410	59.4			120	0.4					50	2.2					4870	4.5
Bluegill	*Lepomis macrochirus*	15	1.0			70	0.5	430	6.8	40	5.8			280	1.0					20	0.9					855	0.8
Longear sunfish	*Lepomis megalotis*																			50	2.2					50	0.0
Redear sunfish	*Lepomis microlophus*	10	0.7											40	0.1											50	0.0
Largemouth bass	*Micropterus salmoides*	20	1.4					300	4.7													5640	14.2			5960	5.5
White crappie	*Pomoxis annularis*	1406	96.9			570	4.0	430	6.8					2530	9.1	110	0.7			950	42.0	1850	4.7			7846	7.2
Black crappie	*Pomoxis nigromaculatus*													230	0.8											230	0.2
Freshwater drum	*Aplodinotus grunniens*																					110	0.3			110	0.1
Total		1451		0		14210		6340		690		0		27857		15870		0		2260		39780		0		108458	

*Exotic or introduced species

**Although fish were present at all sampling locations, specimens less than 10 grams could not be weighed.

2.3.2.2 Regionalized Index of Biotic Integrity

To further compare fish community condition between stations, data were examined using Regionalized Index of Biotic Integrity (IBI) protocols for Texas streams (Linam et al. 2002). This protocol is designed to use a series of metrics based on fish community data from wadeable streams to categorize streams into one of four Aquatic Life Use (ALU) categories: limited (LIM), intermediate (INT), high, or exceptional (EXC). Based upon their ALU ratings, streams are afforded varying levels of protection via water quality standards. Region-specific metrics have been developed for several ecoregions throughout the state. Sample stations from this survey fall into Ecoregion 34-Western Gulf Coastal Plain.

Two caveats must be mentioned when using data from this survey to calculate Regionalized IBI scores. First, this technique is designed for use in “wadeable” streams rather than lentic water bodies such as stock ponds (MC-03, MC-04, and MC-11) and Linn Lake (MC-08 and MC-09). Second, it is important to note that specific protocols commonly used for collection of fish community data used in IBI calculation were not followed in this study. For example, a wide variety of techniques were used to capture fish in this survey to meet the objective of a comprehensive inventory, and therefore, quantification of effort was difficult. To make a fair comparison between stations where different techniques were used, we used a standard value of 1,000 seconds of electrofishing time for each calculation. Because standard IBI protocols were not employed, and fewer than half of the waterbodies surveyed were wadeable streams, IBI scores derived from these data should not be used in a regulatory context to classify these waterbodies or assign water quality standards. However, IBI scores generated by this survey can still provide some insights into overall fish community condition at the various stations.

Table 2-5 provides IBI scores and resulting ALU designations for each station during each sampling period, as well as overall average scores for each station. On average, seven of the twelve stations received intermediate designations, four received limited designations, and MC-10, which was one of the most species-rich stations, received a high aquatic life use. All four stations which, on average, received a limited designation were lentic water bodies (i.e., ponds and Linn Lake). These water bodies would not be expected to score well with metrics designed for analyzing small streams.

Table 2- 5. IBI scores and resulting ALU designations for 12 stations on the Exelon Victoria County Station Site.

	MC-01		MC-02		MC-03		MC-04		MC-05		MC-06	
	Score	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**
April	37	INT	37	INT	27	LIM	23	LIM	37	INT	31	INT
July	29	LIM			21	LIM	25	LIM	33	INT		
October	41	HIGH					31	INT				
December	39	HIGH										
AVG	**37**	**INT**	**37**	**INT**	**24**	**LIM**	**26**	**LIM**	**35**	**INT**	**31**	**INT**

	MC-07		MC-08		MC-09		MC-10		MC-11		MC-12	
	Score	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**
April	37	INT	27	LIM	19	LIM	39	HIGH	31	INT	35	INT
July	33	INT							37	INT		
October	29	LIM							35	INT		
December	25	LIM							29	LIM		
AVG	**31**	**INT**	**27**	**LIM**	**19**	**LIM**	**39**	**HIGH**	**33**	**INT**	**35**	**INT**

2.3.2.3 Richness and Similarity

Species richness varied among stations from one species at MC-12 to 24 species at MC-07. MC-10 was also relatively species rich, with 19 species (Table 2-6).

Table 2- 6. Number of fish species captured at 12 stations on the Exelon Victoria County Station Site.

	MC-01	MC-02	MC-03	MC-04	MC-05	MC-06	MC-07	MC-08	MC-09	MC-10	MC-11	MC-12	Total
Species Richness	9	4	10	11	9	2	24	13	4	19	13	1	36

The percent similarity method of Renkonen (1938), as described by Krebs (1999) was used to assess fish community similarity among on-site sampling stations. Percent similarity has a possible range of 0–100%, with 0% indicating no similarity (i.e., no species in common) and 100% indicating complete similarity (i.e., identical communities).

Overall average percent similarity was approximately 23%, suggesting that there were large differences in species occurrence among stations. Stations which exhibited high similarity included: MC-02 and MC-03, MC-02 and MC-05, MC-04 and MC-11, and MC-07 and MC-10 (Table 2-7). MC-09 shared no species in common with several stations, and thus, received a 0% similarity value in those cases.

Overall, MC-09 was least similar to other stations, and exhibited an average similarity of only 4% with the other 11 stations. MC-12 was also unusual with an average similarity of 15% across all other stations. Only one species (western mosquitofish) was captured at MC-12. Stations with high average similarity included MC-04 (33%) and MC-11 (30%).

Table 2- 7. Percent similarity calculated among 12 stations on the Exelon Victoria County Station Site.

	MC-01	MC-02	MC-03	MC-04	MC-05	MC-06	MC-07	MC-08	MC-09	MC-10	MC-11	MC-12
MC-01		29%	29%	44%	29%	29%	36%	15%	0%	26%	33%	14%
MC-02			67%	33%	60%	25%	14%	8%	0%	11%	25%	25%
MC-03				33%	50%	17%	21%	15%	0%	16%	25%	17%
MC-04					56%	22%	29%	31%	11%	21%	67%	11%
MC-05						20%	21%	15%	0%	16%	33%	20%
MC-06							14%	15%	0%	11%	17%	50%
MC-07								43%	7%	63%	36%	7%
MC-08									8%	42%	46%	8%
MC-09										11%	8%	0%
MC-10											32%	5%
MC-11												8%
MC-12												

2.4 Benthic Invertebrates

2.4.1 Methods

Benthic data were collected from all 12 stations in April 2008 as part of an initial comprehensive inventory. During subsequent trips, only 6 of the 12 stations (MC-05, MC-06, MC-07, MC-08, MC-09, and MC-10) were sampled for benthos. During July, only three of these stations (MC-05, MC-07, and MC-09) had water. In October, only MC-07 had water. In December, only MC-05 and MC-07 were sampled. Therefore, Table 2-8 includes data from all 12 stations during April, as well as additional data from stations MC-05, MC-07, and MC-09.

Benthic macroinvertebrate samples were collected with an Ekman dredge. Three grabs were taken at each station, filtered through a sieve bucket to remove excess silt, and composited into one sample. Once fine sediments had been rinsed from the sample with the sieve bucket, contents were then transferred to a 1 liter plastic sample bottle and preserved in 95% ethanol for later processing in the laboratory.

In the laboratory, samples were sorted and identified to the lowest practical taxon with the aid of a digital zoom stereomicroscope. The number of individuals within each taxon was then enumerated for each station. Segmented worms (Phylum Annelida) were labeled as present or abundant due to difficulty in accurately determining the exact number present. These worms are easily broken during sample collection and processing, and counts of each piece can often misrepresent the actual number present. Some small molluscs were difficult to identify to genus, and therefore, the letters "A" and "B" were used to symbolize two distinct but unidentified taxa from the same family (Table 2-8).

Methods for determining Aquatic Life Use (ALU) based on macroinvertebrate samples collected from depositional habitats have not been developed by the Texas Commission on Environmental Quality (TCEQ 2007). However, metrics and scoring criteria for rapid bioassessment protocols associated with Surber samples do exist (TCEQ 2007). Therefore, in an attempt to provide some means of comparing community composition between stations, Ekman dredge data were analyzed with this protocol to determine ALU designations (Table 2-9). Caution should be taken in interpreting these designations due to inherent differences in sampling technique.

Table 2- 8. Invertebrate taxa collected from benthic samples at 12 locations on the Exelon Victoria County Station Site in 2008.

Common Name	Family	Genus	MC-01		MC-02		MC-03		MC-04		MC-05		MC-06		MC-07		MC-08		MC-09		MC-10		MC-11		MC-12		Total	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Mayflies	**Caenidae**	*Caenis*					8	27.6	3	30.0					1	0.9			1	1.3							13	2.9
	Baetidae	*Fallceon*													1	0.9											1	0.2
Dragonflies/Damselflies	**Libellulidae**	*Perithemis*					1	3.4																			1	0.2
	Gomphidae	*Aphylla*	2	2.4							2	4.7															4	0.9
Water boatmen	**Corixidae**	*Trichocorixa*													1	0.9							1	14.3	1	6.3	3	0.7
Caddisflies	**Hydroptilidae**	*Orthotrichia* pupa					1	3.4																			1	0.2
Beetles	**Hydrophilidae**	*Berosus*													1	0.9	1	25.0	2	2.7							4	0.9
	Elmidae	*Dubiraphia*																			1	16.7					1	0.2
	Scarabidae																		1	1.3							1	0.2
	Haliplidae	*Haliplus*					4	13.8																			4	0.9
		Peltodytes					1	3.4							1	0.9											2	0.5
	Curculionidae						1	3.4																			1	0.2
	Chrysomelidae										1	2.3															1	0.2
Flies and midges	Suborder: Brachycerca										3	7.0															3	0.7
	Ephydridae																		6	8.0							6	1.4
	Tabanidae	*Chrysops*					3	10.3																	1	6.3	4	0.9
	Ceratopogonidae	*Ceratopogon*	2	2.4					3	30.0	2	4.7			14	13.0	2	50.0	13	17.3	1	16.7					37	8.4
		Culicoides	1	1.2							1	2.3			2	1.9			9	12.0	2	33.3					15	3.4
		Probezzia	2	2.4											1	0.9											3	0.7
		Serromyia	1	1.2																							1	0.2
		Sphaeromias	1	1.2					1	10.0					2	1.9									2	12.5	6	1.4
	Chaoboridae	*Chaoborus*			42	72.4																					42	9.5
	Chironomidae	*Procladius*	25	29.4	10	17.2					3	7.0			20	18.5							1	14.3	2	12.5	61	13.8
		Clinotanypus	16	18.8							1	2.3															17	3.9
		Tanypus									1	2.3			15	13.9			30	40.0	1	16.7					47	10.7
		Rheotanytarsus	16	18.8					1	10.0							1	25.0	3	4.0							21	4.8
		Cryptochironomus	1	1.2											3	2.8							2	28.6			6	1.4
		Dicrotendipes									1	2.3							1	1.3							2	0.5
		Parachironomus	8	9.4					1	10.0																	9	2.0
		Polypedilum	4	4.7											1	0.9											5	1.1
		Chironomus									2	4.7			25	23.1							1	14.3	1	6.3	29	6.6
		Tanytarsus													1	0.9			1	1.3							2	0.5
		Coelotanypus													2	1.9			8	10.7							10	2.3
		Microchironomus													2	1.9											2	0.5
Mosquitoes	**Culicidae**	*Aedes*									19	44.2															19	4.3
Molluscs	**Physidae**		4	4.7	1	1.7	2	6.9	1	10.0															3	18.8	11	2.5
	Planorbidae						2	6.9																			2	0.5
	Ancylidae	*A*																							1	6.3	1	0.2
		B																							1	6.3	1	0.2
	Sphaeriidae	*A*	1	1.2			6	20.7			1	2.3			3	2.8					1	16.7					12	2.7
		B	1	1.2							3	7.0			3	2.8											7	1.6
	Unionidae														1	0.9											1	0.2
		Toxolasma texasiensis																					1	14.3			1	0.2
Crustaceans	**Palaemonidae**	*Palaemonetes*													8	7.4							1	14.3	4	25.0	13	2.9
	Cambaridae				5	8.6					3	7.0															8	1.8
Segmented Worms	Phylum: Annelida				P						P				P		P				P		P				P	
Totals			85		58		29		10		43		0		108		4		75		6		7		16		441	

*P = Present.

**"A" and "B" represent two distinct but unidentified taxa from the same family.

Figure 2- 3. BIO-WEST personnel sampling benthos at MC-03 with an Ekman dredge and sieve bucket.

2.4.2 Results and Discussion

The number of each taxa collected, as well as their percent relative abundance at each station is presented in Table 2-8. A total of 441 specimens representing at least 27 families and 45 genera were identified. The number of specimens identified from each station varied from 0 at MC-06 to 108 at MC-07. The lack of invertebrate taxa collected at MC-06 is not surprising given the conditions observed at this station (see Section 2.1). As expected in shallow stagnant habitats, flies and midges (Order Diptera) were the most abundant organisms, and accounted for approximately 79% of all specimens collected. Two families of dipteran midge larvae (Chaoboridae and Chironomidae) were particularly abundant. Excluding dipterans, the most numerous taxonomic groups included molluscs, crustaceans, mayflies, and beetles.

All available data for a given station was combined to calculate aquatic life use designations. The ALU classifications calculated using metrics and scoring criteria for Surber samples are presented in Table 2-9 (INT=Intermediate, LIM=Limited). Six stations exhibited intermediate aquatic life use (Table 2-9). Only two stations, MC-03 and MC-05, were designated as high aquatic life use. Both of these stations contained large amounts of organic matter important for benthic organisms. Stations with limited designations (MC-02, MC-06, MC-09, and MC-11) were all devoid of aquatic and riparian vegetation, and thus had little available organic matter in littoral areas.

Table 2- 9. Aquatic life use designations based on benthic invertebrates from 12 locations at the Exelon Victoria County Station Site.

	MC-01	MC-02	MC-03	MC-04	MC-05	MC-06	MC-07	MC-08	MC-09	MC-10	MC-11	MC-12
Score	25	19	32	29	33	0	27	23	19	27	19	23
ALU	INT	LIM	HIGH	INT	HIGH	LIM	INT	INT	LIM	INT	LIM	INT

Two insect taxa are identified in the Texas Parks and Wildlife Department (TPWD) Rare, Threatened, and Endangered Species of Texas database as potentially occurring in Victoria County: a mayfly (*Tortopus circumfluus*) and the Texas asaphomyian tabanid fly (*Asaphomyia texensis).* Both have been designated as rare, with no regulatory listing status. Neither of these taxa was collected during 2008 on-site benthic sampling. However, *Tortopus* mayflies were collected during off-site sampling (see section 3.5).

2.5 Water Quality

2.5.1 Methods

A YSI model 6920 Data Sonde was used to measure water temperature (C), dissolved oxygen (mg/L), pH, specific conductance (mS/cm), and turbidity (nephelometric turbidity units, NTU) at each station. The shallow nature of the stations prevented measurement at multiple depths, so data was collected from approximately mid-depth at each location. Data were recorded in a water-proof data book along with observation of time, water depth, water clarity, and ambient conditions.

2.5.2 Results and Discussion

Water quality parameters measured at each of the twelve sampling stations are presented in Table 2-10. As expected given the variation in conditions observed, water quality parameters varied widely between stations.

Temperature varied from 5.39 C at MC-05 in December to almost 33 C at MC-09 in July. Conductivity ranged from 0.053 mS/cm at MC-09 in July to 2.09 mS/cm at MC-07 in July. Overall, station MC-01 typically exhibited low conductivity, whereas MC-07 (Black Bayou) usually exhibited relatively high conductivity. Dissolved oxygen (DO) levels were relatively low at several stations due to warm temperatures and stagnant conditions. In fact, DO levels were as low as 1.90 mg/L at MC-05 in July. Despite these conditions, a surprising number of fish were captured at this station. Due to the clay substrate, turbidity was relatively high at most stations, and ranged from 13.6 to more than 1700 NTU.

Table 2- 10. Water quality data from 12 locations on the Exelon Victoria County Station Site.

Date	Time	Site	Temperature (°C)	pH	Specific Conductance (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
4/23/2008	12:15	MC-01	22.06	7.36	0.133	2.50	250.2
4/23/2008	14:38	MC-02	28.12	7.21	0.171	2.48	582.0
4/21/2008	12:26	MC-03	23.01	9.31	0.231	6.69	37.5
4/21/2008	10:08	MC-04	22.25	8.25	0.202	7.04	1243.4
4/24/2008	8:49	MC-05	21.12	7.52	1.300	3.47	13.6
4/23/2008	17:00	MC-06	25.96	8.55	0.479	13.77	589.9
4/22/2008	12:24	MC-07	24.45	8.05	1.360	4.63	84.5
4/22/2008	14:30	MC-08	26.18	8.24	1.330	7.57	78.0
4/23/2008	10:04	MC-09	24.15	8.13	1.220	6.82	585.0
4/22/2008	16:32	MC-10	29.08	8.62	1.220	8.50	86.4
4/21/2008	16:00	MC-11	23.70	8.41	0.354	8.19	203.7
4/21/2008	15:03	MC-12	25.81	8.10	0.271	8.10	56.2
7/22/2008	10:14	MC-01	25.46	7.28	0.220	2.78	416.9
7/22/2008	1:15	MC-03	31.80	7.94	0.888	7.31	1778.6
7/22/2008	12:30	MC-04	32.35	7.63	0.855	2.27	50.5
7/23/2008	10:00	MC-05	22.91	7.83	0.906	1.90	118.0
7/22/2008	17:34	MC-07	32.31	8.86	2.091	14.27	217.9
7/22/2008	15:25	MC-09	32.99	9.15	0.053	10.42	38.5
7/22/2008	11:26	MC-11	27.51	7.81	0.596	2.83	310.6
10/14/2008	11:34	MC-01	23.30	8.40	0.171	6.43	181.2
10/14/2008	8:45	MC-07	21.57	8.98	1.514	3.10	335.2
10/14/2008	10:00	MC-11	22.41	7.95	0.548	4.72	506.0
10/14/2008	11:15	MC-04	**	**	**	**	**
12/17/2008	11:30	MC-01	6.99	7.66	0.174	9.16	118.8
12/17/2008	10:00	MC-05	5.35	7.62	0.592	4.69	36.8
12/17/2008	8:35	MC-07	5.84	7.96	2.003	10.32	65.2
12/17/2008	10:30	MC-11	5.96	8.27	0.586	10.53	273.6

*Several sites were dry during the July, October, and December sampling trips (see Section 2.1).

**In October, MC-04 consisted of a small puddle too shallow to measure with the multiprobe.

3.0 GUADALUPE RIVER AND ASSOCIATED CANALS

3.1 Station Locations and Descriptions

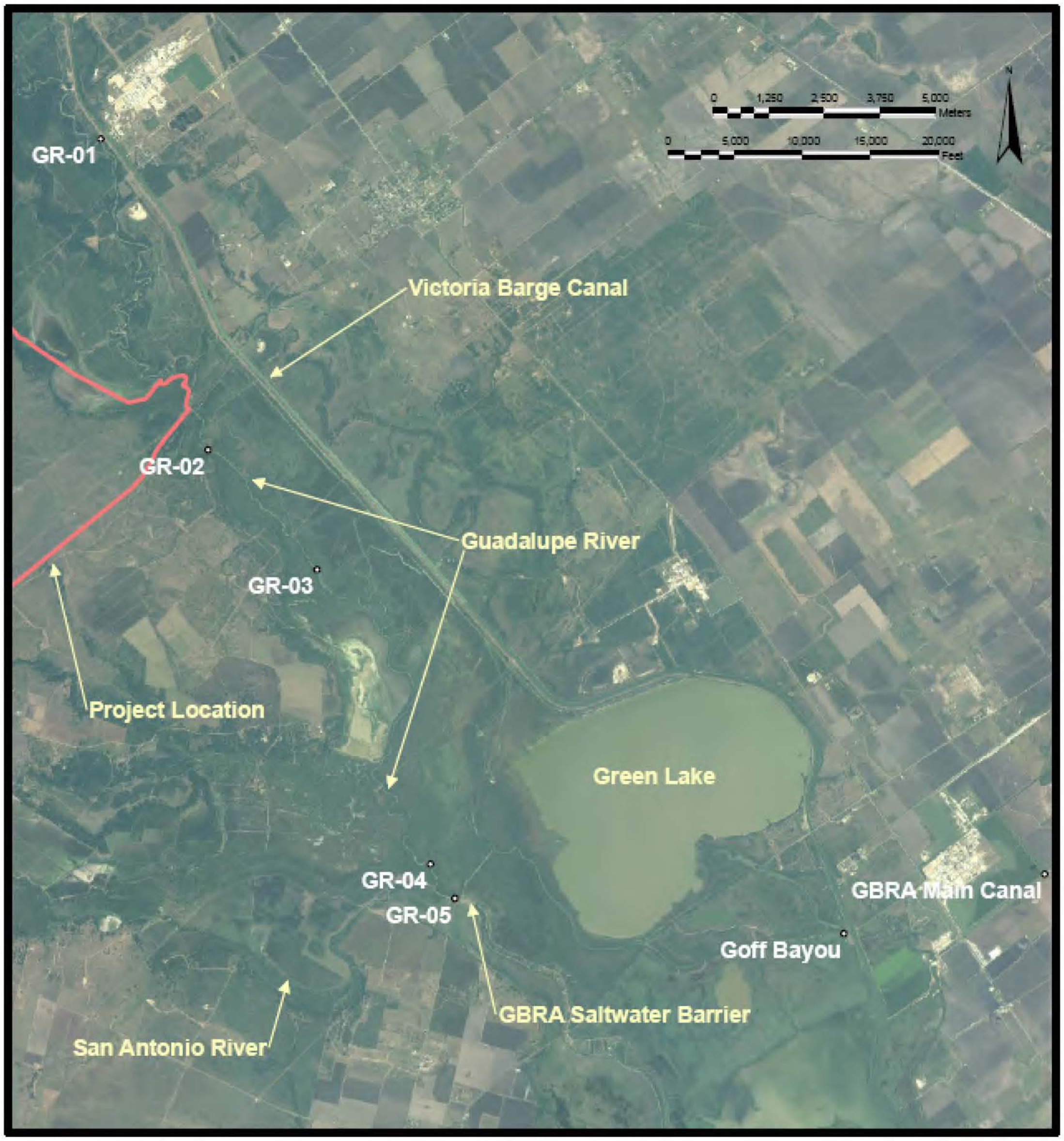

Figure 3- 1. Map of seven off-site sampling stations. Red line approximates property boundary of the Exelon Victoria County Station Site.

Seven sampling stations were identified for the off-site portion of this survey (Figure 3-1). Five of these stations are on the lower Guadalupe River between Victoria and the Guadalupe-Blanco River Authority (GBRA) saltwater barrier. The remaining two stations are located on Goff Bayou and the GBRA Main Canal (the Canal), which are part of the Lavaca-Guadalupe Coastal Basin (Basin 17, TCEQ 2004). Table 3-1 provides GPS coordinates for all seven study locations. Photographs from off-site sampling locations are presented in Appendix B.

Table 3- 1. GPS coordinates for the seven stations in the NAD 83 coordinate system.

Site	Coordinates	
GR-01	N 28° 39' 43.5"	W 96° 57' 56.9"
GR-02	N 28° 35' 54.8"	W 96° 56' 32.0"
GR-03	N 28° 34' 25.4"	W 96° 55' 03.4"
GR-04	N 28° 30' 48.2"	W 96° 53' 33.9"
GR-05	N 28° 30' 23.1"	W 96° 53' 14.1"
Goff Bayou	N 28° 29' 52.1"	W 96° 47' 51.5"
GBRA Main Canal	N 28° 30' 32.9"	W 96° 45' 04.4"

Due to the dry conditions experienced in central and southern Texas during 2008, flows in the lower Guadalupe River declined throughout the study period, causing a substantial drop in water level at the river stations. Flows at the USGS gauge on the Guadalupe River at Victoria (USGS #08176500) were highest during January [≈1100 cubic feet per second (cfs)], and dropped to approximately 350 cfs by October. Flows fluctuated between 300 and 500 cfs for most of October, November, and December (Figure 3-2). However, water levels in Goff Bayou and the Canal are controlled by GBRA diversions, and stayed relatively constant over the study period (with the exception of the Canal in September due to conditions associated with Hurricane Ike).

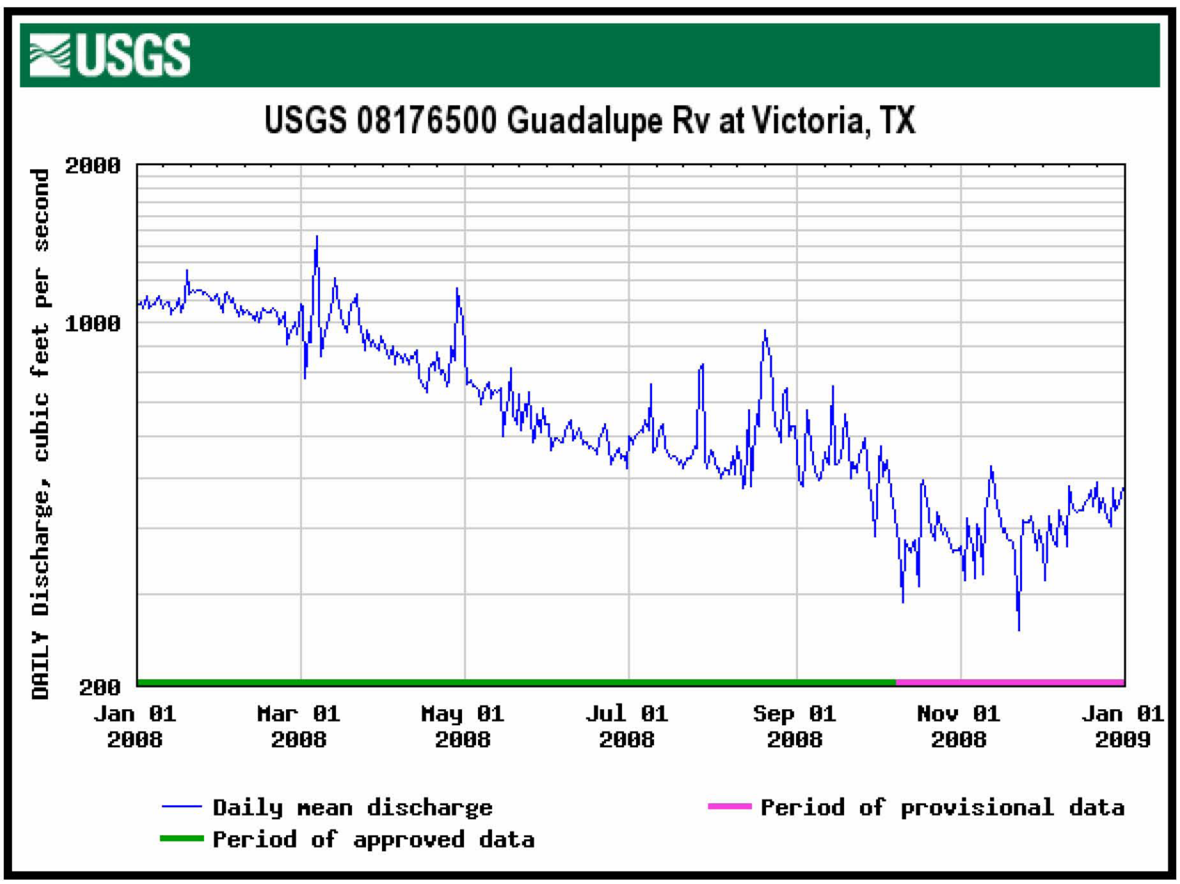

Figure 3- 2. Discharge (cfs) at the USGS gauge on the Guadalupe River near Victoria in 2008.

Station GR-01
GR-01 was located near the proposed discharge structure, southwest of the Invista Victoria Plant. Effluent from this plant enters the river near the middle of this station. Mud and silt substrates were common along the banks; however, considerable sand was present in swifter mid-channel areas and lining a shallow sandbar near the upstream end of the station. The river here was somewhat wider, shallower, and less-incised than at the other locations downstream. Large woody debris was abundant at this station. During January, at flows of approximately 1,100 cfs at the USGS gauge near Victoria, channel depths ranged from 2.2-4.9 m (7-16 ft), and channel width near the upstream boundary of station GR-01 was 54 m (177 ft).

Station GR-02
GR-02 was immediately downstream of the point at which Linn Bayou empties into the Guadalupe River. This station was located in a fairly straight stretch of river that is deeper and slower than GR-01. Mud and silt substrates dominated. Although a substantial amount of large woody debris was present, it was more widely scattered than at other stations. During January, at flows of approximately 1,100 cfs, depths ranged from 4.5-5.6 m (15-18 ft), and channel width was approximately 37 m (121 ft).

Station GR-03
GR-03 was located near the approximate center of the 18-mile-long study segment just upstream of a shallow area where a large log-jam often formed. As a result, considerable large woody debris was present along the south river bank at this station. Sand and silt substrates were dominant in this area. During January, at flows of approximately 1,100 cfs, depths ranged from 2.5–5.0 m (8-16 ft), and channel width near the upstream boundary was approximately 34 m (112 ft).

Station GR-04
GR-04 was located just downstream of the Kuy Creek-Guadalupe River confluence, and just upstream of the San Antonio River-Guadalupe River confluence. The river here was more incised than in upstream locations. During January, at approximately 1,100 cfs, channel width measured 32 m (105 ft), and depth exceeded 6 m (20 ft). A considerable amount of woody debris was present at this station, but was limited mainly to the river edges.

Station GR-05
GR-05 was located immediately upstream of the GBRA Saltwater Barrier, and downstream of the San Antonio River confluence. Mud and silt substrates dominated this reach. A considerable amount of woody debris was located along the banks, as at GR-04. At flows of approximately 1,100 cfs, stream width measured 36 m (118 ft) at the upstream boundary, and depths ranged from 3.9–4.5 m (13-15 ft).

Goff Bayou
The Goff Bayou station was considerably shallower and slower than the river stations with a maximum depth of 2.8 m (9 ft.). The invasive aquatic plants water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) were abundant at the Goff Bayou station. In fact, large mats of floating water hyacinth completely clogged the bayou at times, preventing access

via boat to certain areas. Although some woody debris was present in the form of fallen branches along the shoreline, Goff Bayou had much less woody debris than the river stations.

GBRA Main Canal
The Canal was a narrow [approximately 22 m (72 ft) width], shallow [maximum depth of 1.7 m (5.5 ft)], relatively barren waterway which had no woody debris. The only cover available in the Canal was limited to vegetation along the edges which consisted mainly of water hyacinth, water willow (*Justicia americana*), arrowhead (*Sagittaria* sp.), and water stargrass (*Heteranthera dubia*).

3.2 Sampling Schedule

Sampling dates for off-site sampling are presented in Table 3-2. Electrofishing was conducted monthly at all seven stations, and benthic invertebrate samples were taken monthly from each of the five river stations beginning in April. Ichthyoplankton was conducted at three stations (GR-05, Goff Bayou, and the Canal) once in February, twice per month from March-July, and once a month from August-October. The only exception to this sampling schedule occurred at the Canal in September. Due to high tides from Hurricane Ike which introduced saltwater into the GBRA water delivery system, pumps feeding the Canal were shut off, and it was almost dry during the September sampling period. Therefore, no samples were collected from the Canal in September.

Table 3- 2. Dates of off-site aquatic sampling for the Exelon Victoria County Station Site in 2008.

Month	Electrofishing, Water Quality, and Benthic Sampling	Ichthyoplankton
January	January 28-29*	
February	February 19-20*	February 21-22
March	March 17-19*	March 4-5, and March 19-20
April	April 14-15	April 1-2, and April 16-17
May	May 19-21	May 8-9, and May 21-22
June	June 16-17	June 5-6, and June 18-19
July	July 14-15	July 2-3, and July 16-17
August	August 18-20	August 20-21
September	September 16-17	September 17-18
October	October 20-21	October 21-22
November	November 18-19	
December	December 10-12	

* Benthic sampling was not conducted from January-March.

3.3 Fish

3.3.1 Methods

From January through December 2008, fish community sampling was conducted monthly at each off-site sampling location with a Smith-Root Model 5.0 GPP Electrofisher mounted on a 15-foot aluminum john boat. A minimum of 900 seconds of electrofishing was conducted beginning at the downstream boundary of a previously established transect. Sampling was conducted with a crew of three biologists: one driving the boat, one operating the electrofishing probe, and one netting the stunned fish. The crew sampled in an upstream direction, covering all available habitats thoroughly. An attempt was made to sample all habitats (woody debris, etc.) in proportion to their availability within the station. Sampling was not conducted at the Canal during September, since this station was dry due to complications from Hurricane Ike.

Once fish were captured, they were placed in a large livewell with river water until sampling at that station was complete. Fish were then identified to species, enumerated, and measured (total length in mm). Specimens large enough to register on a digital scale (sensitivity of 10 grams [g]) were then weighed (g). Weight was not recorded for specimens less than 10 g. All fish were then released, excluding voucher specimens. Except for very large fish, at least one individual of each species was preserved in 10% formalin and retained as a voucher. Digital photographs were used as vouchers for larger specimens. Photographs of many of the fish species collected during this survey are displayed in Appendix C.

3.3.2 Results, Analysis, and Discussion

3.3.2.1 Fishes Captured

Monthly off-site fish sampling resulted in capture of 12,903 individuals representing 23 families and 51 species (Table 3-3). At the family level, Cyprinidae (45% relative abundance) was the most abundant family, followed by Clupeidae (14%), and Centrarchidae (11%).

The large number of cyprinids was due mainly to the high abundance of red shiners (*Cyprinella lutrensis*), which accounted for 39% of all fishes captured. Abundance of red shiners was highest at GR-01 and decreased downstream. This was likely due to the presence of a shallow sandbar at GR-01 which provides habitat for riverine adapted cyprinids such as red shiners. As the river moved downstream toward GR-05, it became deeper and more incised and such sandbar habitats were uncommon.

When data from the five river stations were combined (GR-All in Table 3-3), relative abundance of red shiners was much higher in the River (49%) than in Goff Bayou (1%) or the Canal (3%). Besides red shiners, the most abundant species in the River included gizzard shad (*Dorosoma cepedianum*; 7%), threadfin shad (*D. petenense*; 6%), spotted gar (6%), and striped mullet (*Mugil cephalus*; 5%).

Abundant species at Goff Bayou included striped mullet (18%), gizzard shad (17%), Gulf menhaden (*Brevoortia patronus*; 9%), spotted gar (9%), and threadfin shad (7%). Except for Gulf menhaden, all of these species also exhibited high abundance in river collections. Abundance of Gulf menhaden was strongly influenced by the saltwater intrusion which occurred in September as a result of Hurricane Ike. High tides from this storm overtopped the saltwater barriers on Hog and Goff Bayous, thus inundating the system with saltwater from San Antonio Bay. GBRA officials quickly flushed the system by diverting additional freshwater from the Guadalupe River; however, large numbers of Gulf menhaden and bay anchovies (*Anchoa mitchilli*) seem to have become trapped in Goff Bayou. Of the 119 Gulf menhaden captured during the study, 112 came from Goff Bayou in the months of September and October

Table 3- 3. Number collected (#) and percent relative abundance (%) of fishes captured by electrofishing from five stations on the lower Guadalupe River, Goff Bayou, and the GBRA Main Canal during January-December 2008.

Family	Common Name	Scientific Name	GR-01		GR-02		GR-03		GR-04		GR-05		GR-All		Goff		Canal		Total	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Lepisosteidae	Alligator gar	*Atractosteus spatula*							3	**0.2**			3	**0.0**					3	**0.0**
	Spotted gar	*Lepisosteus oculatus*	147	**2.7**	71	**4.7**	61	**6.2**	195	**15.9**	91	**7.7**	565	**5.5**	116	**8.9**	15	**1.2**	696	**5.4**
	Longnose gar	*Lepisosteus osseus*	39	**0.7**	27	**1.8**	35	**3.6**	36	**2.9**	34	**2.9**	171	**1.7**	10	**0.8**			181	**1.4**
Elopidae	Ladyfish	*Elops saurus*													1	**0.1**			1	**0.0**
Anguillidae	American eel	*Anguilla rostrata†*									1	**0.1**	1	**0.0**					1	**0.0**
Clupeidae	Skipjack herring	*Alosa chrysochloris*			1	**0.1**							1	**0.0**					1	**0.0**
	Gulf menhaden	*Brevoortia patronus*													117	**9.0**	2	**0.2**	119	**0.9**
	Gizzard shad	*Dorosoma cepedianum*	273	**5.1**	168	**11.1**	47	**4.8**	130	**10.6**	137	**11.5**	755	**7.3**	219	**16.9**	21	**1.6**	995	**7.7**
	Threadfin shad	*Dorosoma petenense*	554	**10.3**	5	**0.3**	2	**0.2**	19	**1.5**	14	**1.2**	594	**5.8**	91	**7.0**	4	**0.3**	689	**5.3**
Engraulidae	Bay anchovy	*Anchoa mitchilli*							3	**0.2**	2	**0.2**	5	**0.0**	72	**5.5**	31	**2.4**	108	**0.8**
Cyprinidae	Grass carp	*Ctenopharyngodon idella**									2	**0.2**	2	**0.0**					2	**0.0**
	Red shiner	*Cyprinella lutrensis*	3419	**63.4**	760	**50.0**	444	**45.1**	195	**15.9**	178	**15.0**	4996	**48.5**	18	**1.4**	43	**3.3**	5057	**39.2**
	Common carp	*Cyprinus carpio**	3	**0.1**	1	**0.1**	6	**0.6**	22	**1.8**	20	**1.7**	52	**0.5**	50	**3.9**	13	**1.0**	115	**0.9**
	Ribbon shiner	*Lythrurus fumeus*	1	**0.0**									1	**0.0**					1	**0.0**
	Burrhead chub	*Macrhybopsis marconis*	1	**0.0**									1	**0.0**					1	**0.0**
	Pugnose minnow	*Opsopoeodus emiliae*	7	**0.1**	9	**0.6**			49	**4.0**	18	**1.5**	83	**0.8**	7	**0.5**	83	**6.4**	173	**1.3**
	Bullhead minnow	*Pimephales vigilax*	117	**2.2**	76	**5.0**	60	**6.1**	25	**2.0**	42	**3.5**	320	**3.1**	14	**1.1**	57	**4.4**	391	**3.0**
Catostomidae	Smallmouth buffalo	*Ictiobus bubalus*	18	**0.3**	17	**1.1**	37	**3.8**	18	**1.5**	33	**2.8**	123	**1.2**	69	**5.3**	12	**0.9**	204	**1.6**
	Gray redhorse	*Moxostoma congestum*															1	**0.1**	1	**0.0**
Characidae	Mexican tetra	*Astyanax mexicanus**	127	**2.4**	36	**2.4**	40	**4.1**	65	**5.3**	53	**4.5**	321	**3.1**	15	**1.2**	23	**1.8**	359	**2.8**
Ictaluridae	Yellow bullhead	*Ameiurus natalis*															1	**0.1**	1	**0.0**
	Blue catfish	*Ictalurus furcatus*	31	**0.6**	18	**1.2**	21	**2.1**	8	**0.7**	19	**1.6**	97	**0.9**	24	**1.8**			121	**0.9**
	Channel catfish	*Ictalurus punctatus*	1	**0.0**	9	**0.6**	25	**2.5**	11	**0.9**	16	**1.3**	62	**0.6**	3	**0.2**	1	**0.1**	66	**0.5**
	Tadpole madtom	*Noturus gyrinus*															6	**0.5**	6	**0.0**
	Flathead catfish	*Pylodictis olivaris*			6	**0.4**	19	**1.9**	5	**0.4**	3	**0.3**	33	**0.3**	6	**0.5**			39	**0.3**
Loricariidae	Suckermouth armored catfish	*Pterygoplichthys anisitsi**					1	**0.1**	3	**0.2**	5	**0.4**	9	**0.1**	3	**0.2**	10	**0.8**	22	**0.2**
Mugilidae	Striped mullet	*Mugil cephalus*	191	**3.5**	7	**0.5**	14	**1.4**	77	**6.3**	265	**22.3**	554	**5.4**	227	**17.5**			781	**6.1**
Atherinopsidae	Inland silverside	*Menidia beryllina*	180	**3.3**	6	**0.4**	1	**0.1**	46	**3.7**	35	**2.9**	268	**2.6**	37	**2.9**	102	**7.9**	407	**3.2**
Fundulidae	Golden topminnow	*Fundulus chrysotus*									1	**0.1**	1	**0.0**					1	**0.0**
	Bluefin killifish	*Lucania goodei**													3	**0.2**	2	**0.2**	5	**0.0**
Cyprinodontidae	Sheepshead minnow	*Cyprinodon variegatus*									1	**0.1**	1	**0.0**					1	**0.0**
Syngnathidae	Gulf pipefish	*Syngnathus scovelli*															2	**0.2**	2	**0.0**
Poeciliidae	Western mosquitofish	*Gambusia affinis*	71	**1.3**	50	**3.3**	19	**1.9**	71	**5.8**	52	**4.4**	263	**2.6**	59	**4.5**	184	**14.2**	506	**3.9**
	Sailfin molly	*Poecilia latipinna*	15	**0.3**	6	**0.4**	2	**0.2**	39	**3.2**	23	**1.9**	85	**0.8**	9	**0.7**	62	**4.8**	156	**1.2**
Moronidae	White bass	*Morone chrysops*	1	**0.0**							3	**0.3**	4	**0.0**	2	**0.2**			6	**0.0**
Centrarchidae	Green sunfish	*Lepomis cyanellus*			1	**0.1**	2	**0.2**					3	**0.0**					3	**0.0**
	Warmouth	*Lepomis gulosus*	11	**0.2**	21	**1.4**	6	**0.6**	40	**3.3**	27	**2.3**	105	**1.0**	8	**0.6**	106	**8.2**	219	**1.7**
	Orangespotted sunfish	*Lepomis humilis*	14	**0.3**	1	**0.1**	2	**0.2**					17	**0.2**			1	**0.1**	18	**0.1**
	Bluegill	*Lepomis macrochirus*	42	**0.8**	61	**4.0**	34	**3.5**	72	**5.9**	42	**3.5**	251	**2.4**	56	**4.3**	90	**6.9**	397	**3.1**
	Longear sunfish	*Lepomis megalotis*	85	**1.6**	98	**6.5**	43	**4.4**	26	**2.1**	21	**1.8**	273	**2.6**	26	**2.0**	304	**23.5**	603	**4.7**
	Redear sunfish	*Lepomis microlophus*					1	**0.1**					1	**0.0**					1	**0.0**
	Bantam sunfish	*Lepomis symmetricus*							1	**0.1**	2	**0.2**	3	**0.0**			3	**0.2**	6	**0.0**
	Spotted bass	*Micropterus punctulatus*	9	**0.2**	19	**1.3**	26	**2.6**	28	**2.3**	7	**0.6**	89	**0.9**	2	**0.2**	2	**0.2**	93	**0.7**
	Largemouth bass	*Micropterus salmoides*	2	**0.0**					1	**0.1**	1	**0.1**	4	**0.0**	13	**1.0**	2	**0.2**	19	**0.1**
	White crappie	*Pomoxis annularis*	3	**0.1**	5	**0.3**			15	**1.2**	11	**0.9**	34	**0.3**	6	**0.5**	6	**0.5**	46	**0.4**
	Black crappie	*Pomoxis nigromaculatus*	5	**0.1**	5	**0.3**	1	**0.1**	15	**1.2**	17	**1.4**	43	**0.4**	9	**0.7**	1	**0.1**	53	**0.4**
Sparidae	Pinfish	*Lagodon rhomboides*															1	**0.1**	1	**0.0**
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*	7	**0.1**	7	**0.5**	4	**0.4**	6	**0.5**	8	**0.7**	32	**0.3**	4	**0.3**			36	**0.3**
Cichlidae	Rio Grande cichlid	*Cichlasoma cyanoguttatum**	15	**0.3**	28	**1.8**	32	**3.2**	5	**0.4**	3	**0.3**	83	**0.8**	1	**0.1**	104	**8.0**	188	**1.5**
Paralichthyidae	Southern flounder	*Paralichthys lethostigma*													1	**0.1**			1	**0.0**
Achiridae	Hogchoker	*Trinectes maculatus*							1	**0.1**			1	**0.0**					1	**0.0**
Total			5389		1519		985		1230		1187		10310		1298		1295		12903	

*Exotic or introduced species, †Observed but not collected (immediately following Hurricane Ike). Their abundance subsequently declined, and only one Gulf menhaden was caught at Goff Bayou in December.

The fish assemblage at the Canal was somewhat different from the other two stations and was dominated by members of the family Centrarchidae, which represented 40% of all fishes captured at this station. The most abundant species at the Canal included longear sunfish (*Lepomis megalotis*; 24%), western mosquitofish (14%), warmouth (8%), Rio Grande cichlid (8%), and inland silverside (*Menidia beryllina*; 8%).

It is important to note that several estuarine species were collected during this survey. These included pinfish (*Lagodon rhomboides)*, Gulf pipefish (*Syngnathus scovelli)*, bay anchovy, Gulf menhaden, ladyfish (*Elops saurus)*, hogchoker (*Trinectes maculatus*), southern flounder (*Paralichthys lethostigma*), skipjack herring (*Alosa chrysochloris*), and sheepshead minnow (*Cyprinodon variegatus*). Only one or two individuals were captured for the majority of these species; and therefore, they likely represent sporadic migrants into the study area from nearby San Antonio Bay. High abundance of Gulf menhaden and bay anchovy in fall collections from Goff Bayou were likely due to a saltwater intrusion resulting from Hurricane Ike, as explained above.

Over 21 hours of electrofishing (76,646 seconds) were conducted during the off-site portion of this survey. Catch-per-unit-effort (CPUE) data is reported by station in Table 3-4. Total shock time was lowest at the Canal (7,561 seconds) since this station was not sampled in September as a result of complications from Hurricane Ike - pumps which divert water from Goff Bayou to the Canal were closed (leaving only a few inches of water in the bottom of the Canal) while GBRA officials flushed saltwater out of Goff Bayou. Total shock time for the other six stations varied from 11,357 seconds at GR-04 to 11,650 seconds at GR-02. Since effort was relatively similar between stations (with the one exception being the Canal in September), trends in CPUE are relatively similar to those in relative abundance data presented in Table 3-3.

Table 3-5 provides a summary of weight data for the 2,949 individuals for which this data was collected. Spotted gar (24%), smallmouth buffalo (22%), and striped mullet (12%) dominated the relative biomass at the river stations. Blue catfish (9%), longnose gar (*Lepisosteus osseus*; 8%), and common carp (8%) were also large contributors to overall biomass in the River. Given that blue catfish exhibited the highest relative abundance of any game fish, it is not surprising that most fishermen in the area target blue catfish.

The major contributors to biomass at Goff Bayou included smallmouth buffalo (32%), striped mullet (25%), spotted gar (13%), common carp (12%), and flathead catfish (*Pylodictis olivaris*; 5%).

In the Canal, biomass was dominated by common carp (30%), spotted gar (28%), and smallmouth buffalo (25%). Largemouth bass (*Micropterus salmoides*; 5%) and warmouth (3%) also made considerable contributions to biomass at the Canal.

Table 3- 4. Number collected (#) and catch-per-unit-effort (CPUE, # fish/hr) of fishes captured by electrofishing from five stations on the lower Guadalupe River, Goff Bayou, and the GBRA Main Canal during January-December 2008.

Common Name	Scientific Name	GR-01		GR-02		GR-03		GR-04		GR-05		GR-All		Goff		Canal		Total	
		#	CPUE	#	CPUE	#	CPUE	#	CPUE	#	CPUE	#	CPUE	#	CPUE	#	CPUE	#	CPUE
Alligator gar	*Atractosteus spatula*							3	**1.0**			3	**0.2**					3	**0.1**
Spotted gar	*Lepisosteus oculatus*	147	**45.7**	71	**21.9**	61	**19.0**	195	**61.8**	91	**28.6**	565	**35.3**	116	**36.4**	15	**7.1**	696	**32.7**
Longnose gar	*Lepisosteus osseus*	39	**12.1**	27	**8.3**	35	**10.9**	36	**11.4**	34	**10.7**	171	**10.7**	10	**3.1**			181	**8.5**
Ladyfish	*Elops saurus*													1	**0.3**			1	**0.0**
American eel	*Anguilla rostrata†*									1	**0.3**	1	**0.1**					1	**0.0**
Skipjack herring	*Alosa chrysochloris*			1	**0.3**							1	**0.1**					1	**0.0**
Gulf menhaden	*Brevoortia patronus*													117	**36.7**	2	**1.0**	119	**5.6**
Gizzard shad	*Dorosoma cepedianum*	273	**84.8**	168	**51.9**	47	**14.6**	130	**41.2**	137	**43.1**	755	**47.2**	219	**68.7**	21	**10.0**	995	**46.7**
Threadfin shad	*Dorosoma petenense*	554	**172.1**	5	**1.5**	2	**0.6**	19	**6.0**	14	**4.4**	594	**37.1**	91	**28.5**	4	**1.9**	689	**32.4**
Bay anchovy	*Anchoa mitchilli*							3	**1.0**	2	**0.6**	5	**0.3**	72	**22.6**	31	**14.8**	108	**5.1**
Grass carp	*Ctenopharyngodon idella**									2	**0.6**	2	**0.1**					2	**0.1**
Red shiner	*Cyprinella lutrensis*	3419	**1062.1**	760	**234.8**	444	**138.1**	195	**61.8**	178	**56.0**	4996	**312.2**	18	**5.6**	43	**20.5**	5057	**237.5**
Common carp	*Cyprinus carpio**	3	**0.9**	1	**0.3**	6	**1.9**	22	**7.0**	20	**6.3**	52	**3.2**	50	**15.7**	13	**6.2**	115	**5.4**
Ribbon shiner	*Lythrurus fumeus*	1	**0.3**									1	**0.1**					1	**0.0**
Burrhead chub	*Macrhybopsis marconis*	1	**0.3**									1	**0.1**					1	**0.0**
Pugnose minnow	*Opsopoeodus emiliae*	7	**2.2**	9	**2.8**			49	**15.5**	18	**5.7**	83	**5.2**	7	**2.2**	83	**39.5**	173	**8.1**
Bullhead minnow	*Pimephales vigilax*	117	**36.3**	76	**23.5**	60	**18.7**	25	**7.9**	42	**13.2**	320	**20.0**	14	**4.4**	57	**27.1**	391	**18.4**
Smallmouth buffalo	*Ictiobus bubalus*	18	**5.6**	17	**5.3**	37	**11.5**	18	**5.7**	33	**10.4**	123	**7.7**	69	**21.6**	12	**5.7**	204	**9.6**
Gray redhorse	*Moxostoma congestum*															1	**0.5**	1	**0.0**
Mexican tetra	*Astyanax mexicanus**	127	**39.5**	36	**11.1**	40	**12.4**	65	**20.6**	53	**16.7**	321	**20.1**	15	**4.7**	23	**11.0**	359	**16.9**
Yellow bullhead	*Ameiurus natalis*															1	**0.5**	1	**0.0**
Blue catfish	*Ictalurus furcatus*	31	**9.6**	18	**5.6**	21	**6.5**	8	**2.5**	19	**6.0**	97	**6.1**	24	**7.5**			121	**5.7**
Channel catfish	*Ictalurus punctatus*	1	**0.3**	9	**2.8**	25	**7.8**	11	**3.5**	16	**5.0**	62	**3.9**	3	**0.9**	1	**0.5**	66	**3.1**
Tadpole madtom	*Noturus gyrinus*															6	**2.9**	6	**0.3**
Flathead catfish	*Pylodictis olivaris*			6	**1.9**	19	**5.9**	5	**1.6**	3	**0.9**	33	**2.1**	6	**1.9**			39	**1.8**
Vermiculated sailfin catfish	*Pterygoplichthys disjunctivus**					1		3	**1.0**	5	**1.6**	9	**0.6**	3	**0.9**	10	**4.8**	22	**1.0**
Striped mullet	*Mugil cephalus*	191	**59.3**	7	**2.2**	14	**4.4**	77	**24.4**	265	**83.4**	554	**34.6**	227	**71.2**			781	**36.7**
Inland silverside	*Menidia beryllina*	180	**55.9**	6	**1.9**	1	**0.3**	46	**14.6**	35	**11.0**	268	**16.7**	37	**11.6**	102	**48.6**	407	**19.1**
Golden topminnow	*Fundulus chrysotus*									1	**0.3**	1	**0.1**					1	**0.0**
Bluefin killifish	*Lucania goodei**													3	**0.9**	2	**1.0**	5	**0.2**
Sheepshead minnow	*Cyprinodon variegatus*									1	**0.3**	1	**0.1**					1	**0.0**
Gulf pipefish	*Syngnathus scovelli*															2	**1.0**	2	**0.1**
Western mosquitofish	*Gambusia affinis*	71	**22.1**	50	**15.5**	19	**5.9**	71	**22.5**	52	**16.4**	263	**16.4**	59	**18.5**	184	**87.6**	506	**23.8**
Sailfin molly	*Poecilia latipinna*	15	**4.7**	6	**1.9**	2	**0.6**	39	**12.4**	23	**7.2**	85	**5.3**	9	**2.8**	62	**29.5**	156	**7.3**
White bass	*Morone chrysops*	1	**0.3**							3	**0.9**	4	**0.2**	2	**0.6**			6	**0.3**
Green sunfish	*Lepomis cyanellus*			1	**0.3**	2	**0.6**					3	**0.2**					3	**0.1**
Warmouth	*Lepomis gulosus*	11	**3.4**	21	**6.5**	6	**1.9**	40	**12.7**	27	**8.5**	105	**6.6**	8	**2.5**	106	**50.5**	219	**10.3**
Orangespotted sunfish	*Lepomis humilis*	14	**4.3**	1	**0.3**	2	**0.6**					17	**1.1**			1	**0.5**	18	**0.8**
Bluegill	*Lepomis macrochirus*	42	**13.0**	61	**18.8**	34	**10.6**	72	**22.8**	42	**13.2**	251	**15.7**	56	**17.6**	90	**42.9**	397	**18.6**
Longear sunfish	*Lepomis megalotis*	85	**26.4**	98	**30.3**	43	**13.4**	26	**8.2**	21	**6.6**	273	**17.1**	26	**8.2**	304	**144.7**	603	**28.3**
Redear sunfish	*Lepomis microlophus*					1	**0.3**					1	**0.1**					1	**0.0**
Bantam sunfish	*Lepomis symmetricus*							1	**0.3**	2	**0.6**	3	**0.2**			3	**1.4**	6	**0.3**
Spotted bass	*Micropterus punctulatus*	9	**2.8**	19	**5.9**	26	**8.1**	28	**8.9**	7	**2.2**	89	**5.6**	2	**0.6**	2	**1.0**	93	**4.4**
Largemouth bass	*Micropterus salmoides*	2	**0.6**					1	**0.3**	1	**0.3**	4	**0.2**	13	**4.1**	2	**1.0**	19	**0.9**
White crappie	*Pomoxis annularis*	3	**0.9**	5	**1.5**			15	**4.8**	11	**3.5**	34	**2.1**	6	**1.9**	6	**2.9**	46	**2.2**
Black crappie	*Pomoxis nigromaculatus*	5	**1.6**	5	**1.5**	1	**0.3**	15	**4.8**	17	**5.3**	43	**2.7**	9	**2.8**	1	**0.5**	53	**2.5**
Pinfish	*Lagodon rhomboides*															1	**0.5**	1	**0.0**
Freshwater drum	*Aplodinotus grunniens*	7	**2.2**	7	**2.2**	4	**1.2**	6	**1.9**	8	**2.5**	32	**2.0**	4	**1.3**			36	**1.7**
Rio Grande cichlid	*Cichlasoma cyanoguttatum**	15	**4.7**	28	**8.7**	32	**10.0**	5	**1.6**	3	**0.9**	83	**5.2**	1	**0.3**	104	**49.5**	188	**8.8**
Southern flounder	*Paralichthys lethostigma*													1	**0.3**			1	**0.0**
Hogchoker	*Trinectes maculatus*							1				1	**0.1**					1	**0.0**
Total		**5389**		**1519**		**985**		**1230**		**1187**		**10310**		**1298**		**1295**		**12903**	

*Exotic or introduced species, †Observed but not collected

Table 3- 5. Combined weight (kg) and percent of total weight (%) for each species based on data collected from 2,949 individuals at five stations on the Guadalupe River, Goff Bayou, and the GBRA Main Canal during January-December 2008.

Common Name	Scientific Name	GR-01		GR-02		GR-03		GR-04		GR-05		GR-All		Goff		Canal		Total	
		(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%	(kg)	%
Alligator gar	*Atractosteus spatula*							8	3.2			8	0.7					8	0.6
Spotted gar	*Lepisosteus oculatus*	73	25.2	26	25.4	30	16.5	99	37.5	41	14.6	269	24.1	46	12.8	7	28.1	321	21.5
Longnose gar	*Lepisosteus osseus*	26	8.9	9	8.4	28	15.3	10	3.7	17	6.1	89	8.0	9	2.5			98	6.5
Ladyfish	*Elops saurus*													<1	0.0			<1	0.0
Skipjack herring	*Alosa chrysochloris*			<1	0.2							<1	0.0					<1	0.0
Gulf menhaden	*Brevoortia patronus*													<1	0.0			<1	0.0
Gizzard shad	*Dorosoma cepedianum*	28	9.4	20	20.0	9	4.7	15	5.9	14	5.0	86	7.7	9	2.5	<1	0.5	95	6.4
Threadfin shad	*Dorosoma petenense*	<1	0.0	<1	0.0							<1	0.0					<1	0.0
Grass carp	*Ctenopharyngodon idella**									28	10.2	28	2.5					28	1.9
Common carp	*Cyprinus carpio**	2	0.5	<1	0.4	6	3.3	48	18.2	33	11.9	89	8.0	44	12.4	7	29.6	140	9.4
Smallmouth buffalo	*Ictiobus bubalus*	38	13.0	21	21.0	77	42.4	35	13.2	73	26.1	244	21.9	113	31.7	6	25.1	363	24.2
Gray redhorse	*Moxostoma congestum*															<1	0.5	<1	0.0
Mexican tetra	*Astyanax mexicanus**			<1	0.0	<1	0.0			<1	0.0	<1	0.0					<1	0.0
Blue catfish	*Ictalurus furcatus*	58	20.0	13	12.4	15	8.4	6	2.4	10	3.5	102	9.2	14	3.8			116	7.8
Channel catfish	*Ictalurus punctatus*	<1	0.2	1	1.1	1	0.3	2	0.7	4	1.3	8	0.7	3	0.8			10	0.7
Flathead catfish	*Pylodictis olivaris*			3	3.2	4	2.2	5	1.8	2	0.9	14	1.3	17	4.8			32	2.1
Suckermouth armored catfish	*Pterygoplichthys anisitsi**					<1	0.0	<1	0.2	1	0.3	1	0.1	1	0.3			2	0.2
Striped mullet	*Mugil cephalus*	56	19.2	2	1.7	7	3.8	25	9.7	46	16.7	137	12.2	90	25.2			226	15.1
White bass	*Morone chrysops*	<1	0.1							1	0.4	2	0.1	1	0.2			2	0.1
Warmouth	*Lepomis gulosus*	<1	0.0	<1	0.1	<1	0.0	1	0.4	<1	0.2	2	0.2	<1	0.0	1	2.9	3	0.2
Bluegill	*Lepomis macrochirus*	<1	0.1	1	0.6	<1	0.1	1	0.2	1	0.4	3	0.2	1	0.2	<1	1.2	4	0.2
Longear sunfish	*Lepomis megalotis*	<1	0.1	<1	0.3	<1	0.1	<1	0.1	<1	0.0	1	0.1	<1	0.0	<1	1.2	1	0.1
Spotted bass	*Micropterus punctulatus*	1	0.3	1	1.3	1	0.6	4	1.5	1	0.3	8	0.7	1	0.2	<1	0.7	9	0.6
Largemouth bass	*Micropterus salmoides*	1	0.2					<1	0.1	<1	0.1	1	0.1	6	1.6	1	5.3	8	0.5
White crappie	*Pomoxis annularis*	<1	0.1	<1	0.2			1	0.4	1	0.2	2	0.2	1	0.2	1	2.8	3	0.2
Black crappie	*Pomoxis nigromaculatus*	1	0.3	1	0.9	<1	0.0	1	0.5	2	0.7	5	0.5	1	0.2	<1	0.4	6	0.4
Freshwater drum	*Aplodinotus grunniens*	7	2.3	2	2.4	3	1.8	1	0.5	4	1.3	17	1.6	<1	0.1			18	1.2
Rio Grande cichlid	*Cichlasoma cyanoguttatum**	<1	0.0	<1	0.3	1	0.5					1	0.1			<1	1.8	2	0.1
Southern flounder	*Paralichthys lethostigma*													1	0.3			1	0.1
Total		292		102		182		263		278		1116		355		24		1495	

*Exotic or introduced species

**Specimens less than 10 grams could not be weighed.

Figure 3- 3. Blue catfish (*Ictalurus furcatus*) captured at GR-01 in November 2008.

No state or federally listed threatened or endangered species were collected during this survey. Two fish species are identified in the TPWD Rare, Threatened, and Endangered Species of Texas database as potentially occurring in Victoria, Calhoun, Refugio, or Aransas counties. The Opossum pipefish (*Microphis brachyurus*) is listed as a state threatened species potentially occurring in Refugio and Aransas counties. Although little information is available regarding the biology or distribution of this species, breeding adults are apparently found in freshwater, whereas young migrate to saltwater areas. The American eel (*Anguilla rostrata*), although not listed as threatened or endangered by TPWD or USFWS, is documented as rare within the state. This species spawns in the Atlantic Ocean, and adults migrate up rivers throughout North America to live out the majority of their lives before returning to the sea to spawn. One American eel was observed, but not captured, while electrofishing at station GR-05 in April.

Bluefin killifish (*Lucania goodei;* Figure 3-4) were captured at Goff Bayou and the Canal. Although specimens from this study were originally thought to be the first collected in Texas (see April interim report, BIO-WEST 2008b), the species was reported in an article published in the February 2008 issue of the Texas Journal of Science (Gallaway et al. 2008). Gallaway et al. (2008) suggest that the species was introduced with wetland vegetation imported from a nursery in Florida to an artificial wetland built on the DuPont/Invista plant near Victoria. Bluefin killifish were first noted from this wetland in 1998, and have since spread to the Guadalupe River. Our collections of bluefin killifish were from a location at least 20 miles downstream of the Invista Plant, suggesting that this species is successfully dispersing through the river.

Figure 3- 4. Bluefin killifish (*Lucania goodei*) captured from Goff Bayou.

3.3.2.2 Regionalized Index of Biotic Integrity

To assess differences in fish community condition between stations, data were compared using Regionalized Index of Biotic Integrity (IBI) protocols for Texas streams (Linam et al. 2002). This protocol uses a series of metrics based on fish community data to categorize wadeable streams into one of four Aquatic Life Use (ALU) categories: limited (LIM), intermediate (INT), high, or exceptional (EXC). Based upon their ALU ratings, streams are afforded varying levels of protection via water quality standards. Region-specific metrics have been developed for several ecoregions throughout the state. Sample stations from this survey fall into Ecoregion 34-Western Gulf Coastal Plain.

Two caveats must be mentioned when using data from this survey to calculate Regionalized IBI scores. First, this technique is designed for use in smaller "wadeable" streams rather than a large river such as the lower Guadalupe. Second, specific protocols commonly used (seines and backpack electrofisher) for collection of fish community data used in IBI calculation were not used in this study. However, despite these caveats, IBI scores derived from data collected during this survey can still provide insight into overall fish community condition at the various stations.

Eleven metrics are used to assign scores for the Western Gulf Coastal Plain ecoregion. These include calculations such as: total number of fish species, number of native cyprinid species, percent of individuals as invertivores, and percent of individuals as tolerant species. Of the 51 species captured during the survey, 16 receive tolerance classifications based on Linam and Kleinsasser (1998) (Table 3-6). Fifteen of the 16 classified species are considered tolerant, whereas only one species, the tadpole madtom (*Noturus gyrinus*), is designated as intolerant. All species not classified are considered intermediate.

Table 3- 6. Tolerance designations for species collected during this survey, based on Linam and Kleinsasser (1998). (T=Tolerant, I=Intolerant)

Family	Common Name	Scientific Name	Tolerance Designation
Lepisosteidae	Alligator gar	*Atractosteus spatula*	T
	Spotted gar	*Lepisosteus oculatus*	T
	Longnose gar	*Lepisosteus osseus*	T
Clupeidae	Gizzard shad	*Dorosoma cepedianum*	T
Cyprinidae	Grass carp	*Ctenopharyngodon idella**	T
	Red shiner	*Cyprinella lutrensis*	T
	Common carp	*Cyprinus carpio**	T
Ictaluridae	Channel catfish	*Ictalurus punctatus*	T
	Tadpole madtom	*Noturus gyrinus*	I
Cyprinodontidae	Sheepshead minnow	*Cyprinodon variegatus*	T
Poeciliidae	Western mosquitofish	*Gambusia affinis*	T
	Sailfin molly	*Poecilia latipinna*	T
Centrarchidae	Green sunfish	*Lepomis cyanellus*	T
	Warmouth	*Lepomis gulosus*	T
	Bluegill	*Lepomis macrochirus*	T
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*	T

*Exotic or introduced species

Regionalized IBI scores calculated from data collected during each station visit are presented in Table 3-7. Although scores fluctuate depending on the occurrence and abundance of various species captured each month, average values provide a nice comparison between stations. On average, all Guadalupe River stations except GR-05 received an intermediate ALU designation, whereas GR-05 received a limited designation. On average, Goff Bayou ranked as limited, and the Canal ranked high.

The lower designation at GR-05 relative to the other river stations was mainly a result of the lower percentage of invertivores (fewer red shiners) and higher percentage of non-natives (more common carp). High ALU designations at the Canal are, at first glance, somewhat surprising considering it is a man-made canal. Several factors strongly influencing scores at the Canal included a high percent of individuals as omnivores, a high percent of individuals as invertivores, and a low percent of individuals as non-native species. Although the tadpole madtom, an intolerant species, was only collected at the Canal, this did not influence the IBI score. In contrast to the Canal, a higher percentage of individuals collected at Goff Bayou were non-native species, resulting in a lower average score. Although IBI scores are informative for comparison purposes, the habitat conditions at GR-05 and Goff Bayou are considerably better than those at the man-made canal. Therefore, these IBI results must be viewed with caution in light of the caveats described, contradictory habitat conditions present, and biomass statistics described in the following section.

Table 3- 7. Regionalized IBI score and resulting ALU designation for each station visit.

	GR-01		GR-02		GR-03		GR-04		GR-05		Goff		Canal	
	Score	ALU	Score	ALU	Score	ALU	Score	ALU	Score	ALU	Score	ALU	Score	ALU
Jan	37	INT	41	HIGH	29	LIM	35	INT	31	INT	31	INT	47	HIGH
Feb	37	INT	29	LIM	27	LIM	35	INT	33	INT	31	INT	43	HIGH
Mar	39	HIGH	37	INT	35	INT	43	HIGH	37	INT	29	LIM	45	HIGH
Apr	31	INT	39	HIGH	37	INT	33	INT	35	INT	27	LIM	43	HIGH
May	33	INT	31	INT	27	LIM	35	INT	29	LIM	23	LIM	41	HIGH
Jun	35	INT	29	LIM	29	LIM	29	LIM	29	LIM	27	LIM	31	INT
Jul	35	INT	35	INT	37	INT	31	INT	27	LIM	25	LIM	43	HIGH
Aug	33	INT	37	INT	35	INT	23	LIM	25	LIM	25	LIM	49	EXC
Sep	41	HIGH	39	HIGH	33	INT	25	LIM	23	LIM	35	INT	N/A	N/A
Oct	37	INT	39	HIGH	35	INT	33	INT	35	INT	33	INT	31	INT
Nov	33	INT	37	INT	33	INT	25	LIM	27	LIM	27	LIM	33	INT
Dec	37	INT	37	INT	21	LIM	25	LIM	21	LIM	25	LIM	37	INT
AVG	**36**	**INT**	**36**	**INT**	**32**	**INT**	**31**	**INT**	**29**	**LIM**	**28**	**LIM**	**40**	**HIGH**

3.3.2.3 Richness and Statistical Comparisons

Species richness varied from 27 species at GR-02, to 34 species at GR-05 (Table 3-8). When all river stations were combined, species richness was greatest in the River (GR-All; 42) and lowest in the Canal (32). A total of 51 species were captured across all stations.

Table 3- 8. Number of fish species collected at the seven off-site sampling stations.

	GR-01	GR-02	GR-03	GR-04	GR-05	GR-All	Goff	Canal	Total
Species Richness	29	28	27	31	34	42	33	32	51

To further evaluate differences, statistical methods were used to compare fish abundance, fish biomass, and overall community structure between off-site sampling stations.

Fish Abundance

To statistically compare abundance among sampling stations, data were first assessed for normality using a Ryan-Joiner test (Ryan and Joiner 1967). Because some data were not normally distributed, fish abundance was compared among stations using a Kruskal-Wallis (K-W) test (Zar 1999). When K-W test results suggested a difference among locations, visual assessment of the data was used to initially identify specific stations with different fish abundance. These stations were then compared using a pair-wise Mann-Whitney U-test. All analyses were conducted using $\alpha = 0.05$, and performed using MINITAB 12.2.

Results of the K-W test indicated that fish abundance was not equal across stations. Visual assessment of the data (Figure 3-5) suggested that GR-01 had higher abundance than other stations, while there appeared to be little difference among the others. Results of the pair-wise Mann-Whitney test confirmed this. GR-01 had significantly higher fish abundance than did all other stations (experiment-wise $\alpha = 0.05$). This is mainly due to the large number of red shiners usually captured at GR-01.

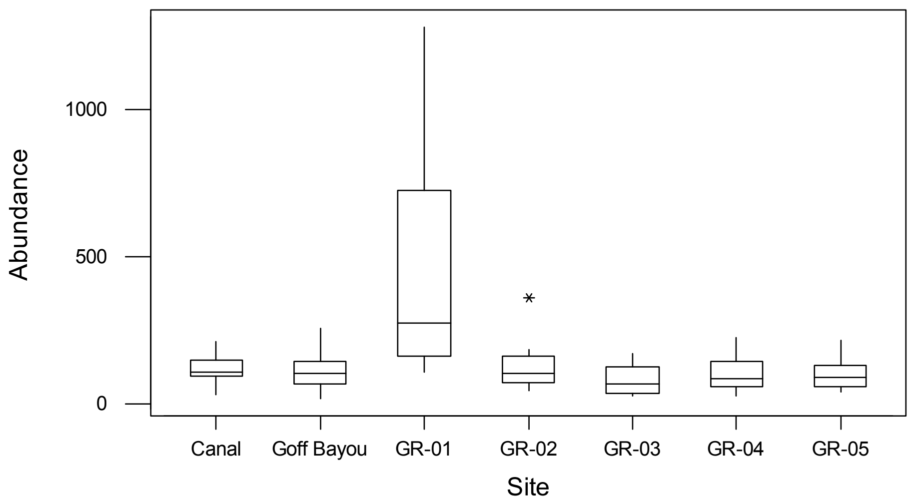

Figure 3- 5. Boxplots of fish abundance at the seven off-site locations. Horizontal lines indicate the median, boxes extend to the first and third quartiles, and vertical lines extend 1.5 times the interquartile range. Asterisks indicate any data points that lie outside 1.5 times the interquartile range.

Data were also pooled across all river stations, and compared to fish abundance in Goff Bayou and the Canal (Figure 3-6). Results of the K-W test found no difference in fish abundance among the three areas.

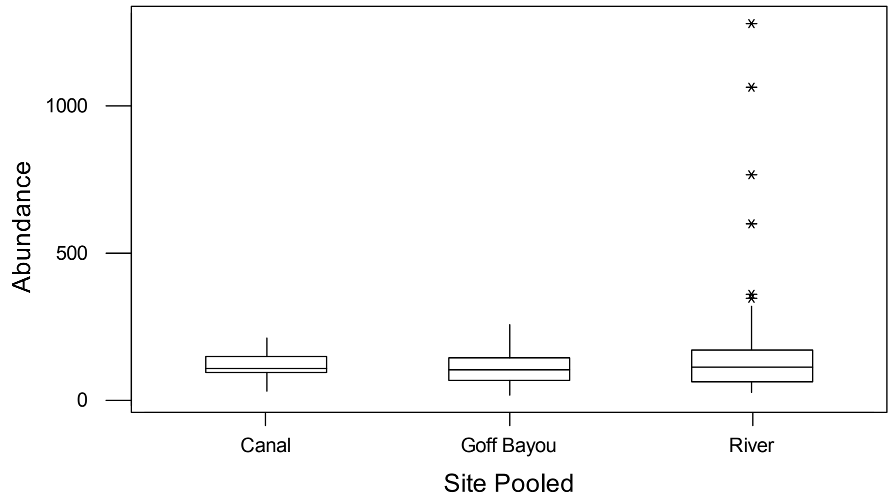

Figure 3- 6. Boxplots of fish abundance in three areas. Horizontal lines indicate the median, boxes extend to the first and third quartiles, and vertical lines extend 1.5 times the interquartile range. Asterisks indicate any data points that lie outside 1.5 times the interquartile range.

Biomass
Since all fish were not weighed, weights for some specimens were estimated based on total length using weight:length relationships determined either from the literature or by regression analysis.

To assess differences in biomass among sampling stations, we first summed total mass of all fish captured at each station during each visit. Each station visit constituted a sample. Due to equipment difficulties, we were unable to weigh fish at four of the stations during the February visit. Therefore, February data for all stations were excluded from the dataset. Fish data were assessed for normality using a Ryan-Joiner test (Ryan and Joiner 1976). Because data were not normally distributed, we then compared the median mass across visits among the seven stations using the Kruskall-Wallis test (K-W; Zar 1999). Then K-W data were visually assessed using boxplots to determine the station pairs between which the differences most likely occurred. Pairwise comparisons were then performed on these station pairs using the Mann-Whitney U-test (Zar 1999). Analyses were performed using MINITAB 12.2 using $\alpha = 0.05$.

The results of the K-W test indicated that biomass was unequal among study locations ($\alpha < 0.05$). Visual assessment of the results (Figure 3-7) suggested that mean biomass differed between the Canal and other stations, whereas differences among the rest of the stations were less certain. Data for all river stations were then pooled, and compared with data from Goff Bayou and the Canal. Results of this analysis clearly indicated that all three areas (Goff Bayou, the Canal, and the River) had significantly different ($\alpha < 0.05$) levels of fish biomass, with Goff Bayou having the highest, the Canal having the lowest, and the River having intermediate levels (Figure 3-8).

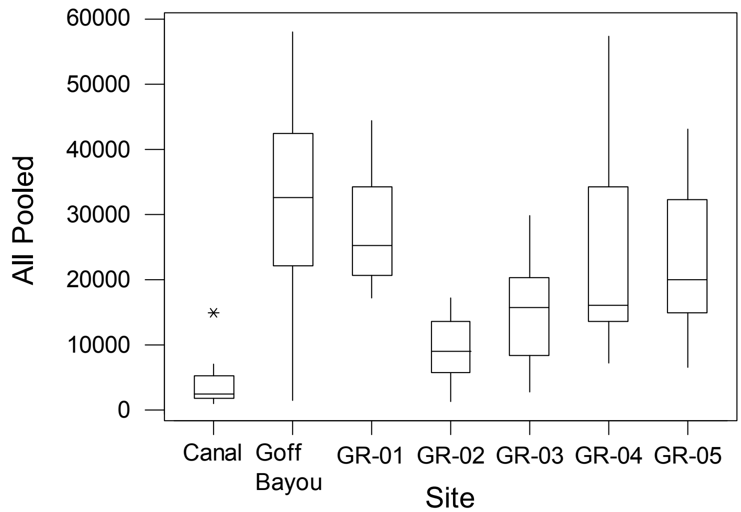

Figure 3- 7. Boxplots of fish biomass at the seven study locations. Horizontal lines indicate the median, boxes extend to the first and third quartiles, and vertical lines extend 1.5 times the interquartile range. Asterisks indicate any data points that lie outside 1.5 times the interquartile range.

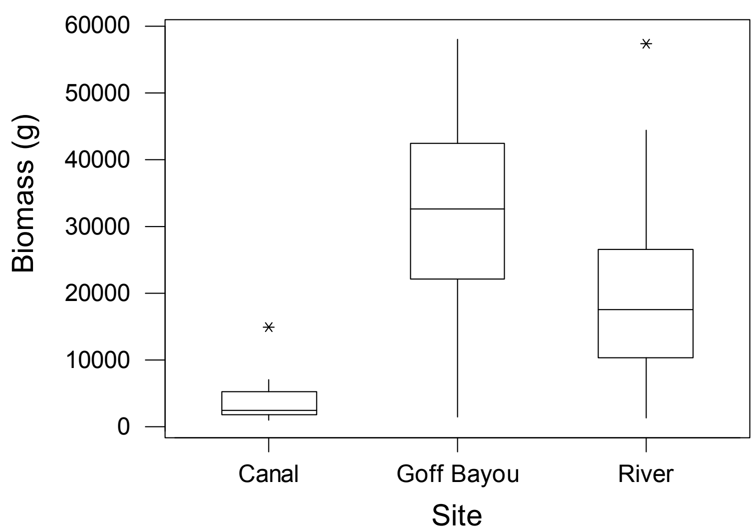

Figure 3- 8. Boxplots of fish abundance in three areas. Horizontal lines indicate the median, boxes extend to the first and third quartiles, and vertical lines extend 1.5 times the interquartile range. Asterisks indicate any data points that lie outside 1.5 times the interquartile range.

Fish Community Similarity
Fish community similarity for off-site sampling stations was assessed using the percent similarity method of Renkonen (1938), as described by Krebs (1999). Percent similarity has a possible range of 0–100%, with 0% indicating no similarity (i.e., no species in common) and 100% indicating complete similarity (i.e., identical communities). Results indicate that river stations were in general most similar to other nearby river stations (Table 3-9). Goff Bayou was most similar to GR-05. The Canal fish community did not exhibit a strong similarity to any other station.

Table 3- 9. Fish community similarity indices calculated among the seven off-site stations.

	Canal	Goff Bayou	GR-01	GR-02	GR-03	GR-04	GR-05
Canal		28%	19%	33%	28%	42%	34%
Goff Bayou			31%	36%	33%	54%	66%
GR-01				70%	65%	43%	42%
GR-02					82%	56%	56%
GR-03						53%	54%
GR-04							77%
GR-05							

3.4 Ichthyoplankton

3.4.1 Methods

Ichthyoplankton sampling was conducted at three stations: GR-05, Goff Bayou, and the Canal. Sampling trips were conducted once in February, twice during the peak spawning months of March-July, and once in the months of August-October. During each trip, samples were collected in the afternoon and at night (at least 2 hours after recorded sunset). Sampling was conducted by towing paired nets (335-micron mesh, 0.5 m diameter) just below the surface and at mid-depth using a custom designed sampling apparatus mounted to a 15-foot aluminum john boat (Figure 3-9). Using this custom apparatus, a single net was deployed on each side of the boat, adjusted to the desired depth, and towed through the water for a minimum of five minutes in order to collect the desired sample volume. Flow meters attached to the front of each net were used to ensure that the desired volume was collected, as well as to calculate the total volume sampled. Once sampling was complete, nets were detached from the sampling apparatus, and contents were washed into the sample cup at the back of the net. Contents of each cup were then rinsed into labeled sample bottles and fixed with 10% formalin.

Figure 3- 9. Ichthyoplankton sampling apparatus in design phase (left) and during a sampling effort (right).

At the BIO-WEST laboratory, samples were washed into large trays and fish were sorted, separated from other contents (invertebrates, aquatic vegetation, detritus, etc.), and placed in separate vials with 5% formalin for long-term storage. Identification of larval and juvenile fish was then conducted with the aid of a digital zoom stereomicroscope. An attempt was made to identify all larval fish to species; however, larval descriptions for some species are lacking, and therefore, some specimens were keyed only to genus (Figure 3-10).

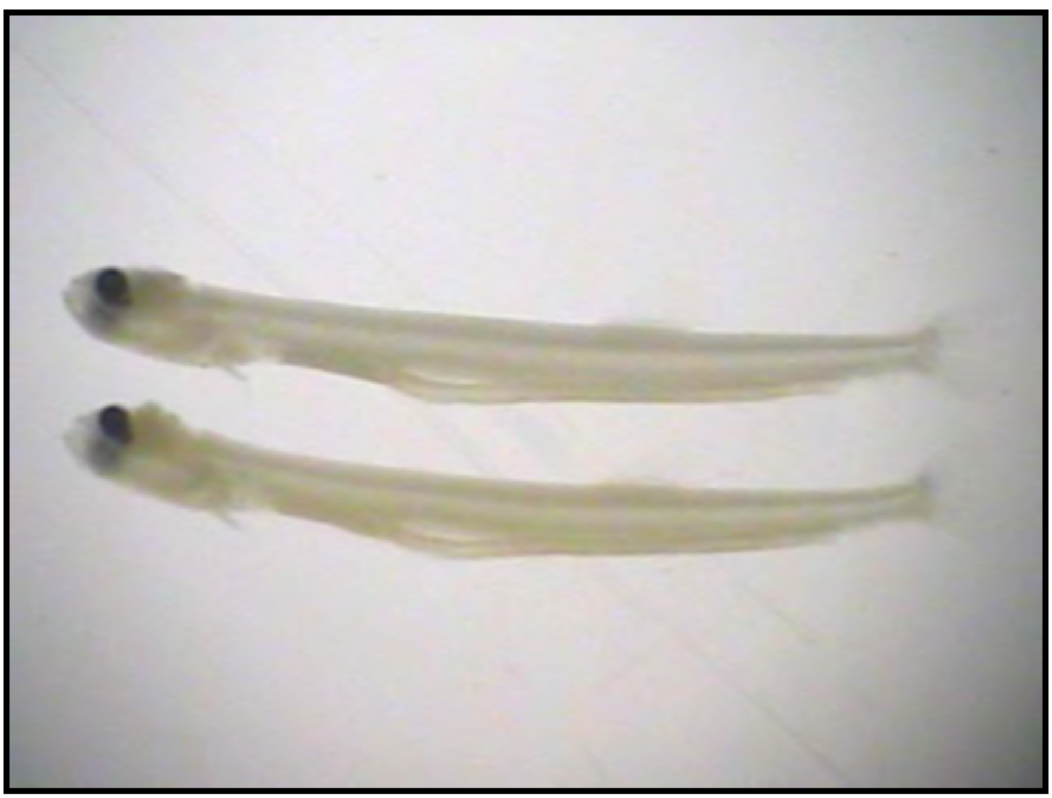

Figure 3- 10. Larval shad (*Dorosoma* sp.) from ichthyoplankton samples.

3.4.2 Results and Discussion

3.4.2.1 Larval Fishes

Defining the early life history stages of fishes can be somewhat complicated, since it is an attempt to force a dynamic process into a static framework. For the purpose of this survey, the larval stage is defined as that from hatching of the embryo (egg) to acquisition of an adult body form with a full complement of fin rays. The juvenile period encompasses development of an adult body form through sexual maturation (Kelso and Rutherford 1996).

Tables containing raw ichthyoplankton data can be found in Appendix D. No fish embryos were collected during ichthyoplankton sampling. This is not surprising given that most of the fishes that inhabit this area spawn demersal adhesive eggs which sink to the bottom and stick to the substrate. A total of 7,210 fishes representing at least 21 different species were captured. Only one of these species, the naked goby (*Gobiosoma bosc*), was not captured during electrofishing surveys (see section 3.2.2.1). All six naked gobies captured were caught during night sampling, suggesting that the nocturnal habits of this species may have precluded their capture during daytime electrofishing surveys.

A total of 2,092 larval fish representing 11 taxa were identified from ichthyoplankton samples (Table 3-10). The great majority of larval fish (2,005) were captured at Goff Bayou. Higher abundance of larval fish at Goff Bayou when compared to the other two stations was mainly a result of the high numbers of shad larvae (*Dorosoma* sp.; 1,784) and inland silverside larvae (155) collected there. Numbers of larval sunfish (*Lepomis* sp.; 36) and crappie (*Pomoxis* sp.; 19) were also relatively abundant at Goff Bayou when compared to the other stations. In fact, Goff Bayou was the only location where larval crappies were collected.

The Canal ranked second in larval fish abundance among the three stations, but had far fewer larval fish than Goff Bayou. At the Canal, larval shad (21), sunfish (20), and inland silversides (14) were the most abundant taxa in ichthyoplankton samples. Four pugnose minnow (*Opsopoeodus emiliae*) larvae were also collected here.

Only 25 larval fish were collected from GR-05, and the majority of these (18) were common carp captured in March. Other larval fish documented at GR-05 included inland silverside (3), red shiner (2), sunfish (1), and shad (1).

Afternoon ichthyoplankton samples contained higher abundance of larval fish than did night samples (Table 3-11). However, this is due to the larger number of shad larvae captured during afternoon samples. When shad larvae are removed from the analysis, daytime samples contain far fewer larval fish (88) than night samples (198).

Seasonal trends in larval fish abundance were also apparent. For example, abundance of larval shad increased in March, peaked during early April, and steadily decreased throughout the summer. In contrast, common carp and crappie were only found in spring (March-April) samples.

Table 3- 10. Number (#) and percent relative abundance (%) of larval fishes collected during ichthyoplankton sampling at three off-site sampling stations.

Common Name	Scientific Name	Goff		Canal		GR-05		Total	
		#	%	#	%	#	%	#	%
Shad spp.	*Dorosoma sp.*	1784	*89.0*	21	*33.9*	1	*4.0*	1806	*86.3*
Inland silverside	*Menidia beryllina*	155	*7.7*	14	*22.6*	3	*12.0*	172	*8.2*
Pugnose minnow	*Opsopoeodus emiliae*	1	*0.0*	4	*6.5*			5	*0.2*
Red shiner	*Cyprinella lutrensis*	1	*0.0*	1	*1.6*	2	*8.0*	4	*0.2*
Bluefin killifish	*Lucania goodei*	4	*0.2*	1	*1.6*			5	*0.2*
Crappie spp.	*Pomoxis sp.*	19	*0.9*					19	*0.9*
Sunfish spp.	*Lepomis sp.*	36	*1.8*	20	*32.3*	1	*4.0*	57	*2.7*
Naked goby	*Gobiosoma bosc*	3	*0.1*					3	*0.1*
Bay anchovy	*Anchoa mitchilli*	1	*0.0*					1	*0.0*
Common carp	*Cyprinus carpio*			1	*1.6*	18	*72.0*	19	*0.9*
Largemouth bass	*Micropterus salmoides*	1	*0.0*					1	*0.0*
TOTAL		**2005**		**62**		**25**		**2092**	

Table 3- 11. Number (#) and percent relative abundance (%) of larval fishes collected during day and night ichthyoplankton sampling.

Common Name	Scientific Name	Day		Night		Total	
		#	%	#	%	#	%
Shad spp.	*Dorosoma sp.*	1306	*93.7*	500	*71.6*	1806	*86.3*
Inland silverside	*Menidia beryllina*	27	*1.9*	145	*20.8*	172	*8.2*
Pugnose minnow	*Opsopoeodus emiliae*	0	*0.0*	5	*0.7*	5	*0.2*
Red shiner	*Cyprinella lutrensis*	1	*0.1*	3	*0.4*	4	*0.2*
Bluefin killifish	*Lucania goodei*	3	*0.2*	2	*0.3*	5	*0.2*
Crappie spp.	*Pomoxis sp.*	1	*0.1*	18	*2.6*	19	*0.9*
Sunfish spp.	*Lepomis sp.*	49	*3.5*	8	*1.1*	57	*2.7*
Naked goby	*Gobiosoma bosc*	0	*0.0*	3	*0.4*	3	*0.1*
Bay anchovy	*Anchoa mitchilli*	1	*0.1*	0	*0.0*	1	*0.0*
Common carp	*Cyprinus carpio*	6	0.4	13	*1.9*	19	*0.9*
Largemouth bass	*Micropterus salmoides*	0	*0.0*	1	*0.1*	1	*0.0*
TOTAL		**1394**		**698**		**2092**	
TOTAL - Shad spp.		**88**		**198**		**286**	

3.4.2.2 Juvenile Fishes

A total of 5,118 juvenile and adult fishes representing 11 families and 18 species were collected during ichthyoplankton sampling (Table 3-12). Although this value includes a small number of adults of several small-bodied species such as red shiners, western mosquitofish, and inland silversides, it is comprised mainly of young juveniles (<20 mm TL) of several species. This dataset is swamped by the extremely large number of bay anchovies (3,416) collected at Goff Bayou during September. Only 12 bay anchovies were captured prior to September. However, high tides from Hurricane Ike overtopped the saltwater barrier system on Goff Bayou only a few days before sampling was conducted in September. The resulting influx of saltwater from San Antonio Bay appears to have caused a dramatic increase in the number of juvenile bay anchovies collected during ichthyoplankton sampling. Results of this saltwater intrusion are also evident in the number of Gulf menhaden captured during the Goff Bayou electrofishing survey conducted in September (see Section 3.3.2).

Even with bay anchovies removed from the dataset, the number of juvenile and adult fishes captured during ichthyoplankton sampling was still much higher at Goff Bayou (780) than at the Canal or GR-05 (250 and 177, respectively). Besides bay anchovies, abundant species at Goff Bayou included threadfin shad (274), inland silverside (266), western mosquitofish (58), and suckermouth armored catfish (53).

The Canal ranked second in abundance of juvenile and adult fishes captured from ichthyoplankton sampling. Channel catfish (*Ictalurus punctatus*; 76) were the most abundant juvenile species captured at the Canal, followed by inland silverside (72), suckermouth armored catfish (41), and red shiner (26). Juvenile Gulf pipefish (13) also exhibited their highest abundance at the Canal.

Among stations, ichthyoplankton samples from GR-05 contained the fewest juvenile and adult fish. However, blue catfish (84) exhibited their highest abundance at GR-05. Other abundant species collected included western mosquitofish (53) and inland silverside (23). Five specimens of juvenile suckermouth armored catfish were also captured at GR-05.

Juvenile fishes were much more abundant at night (4,987) than during afternoon samples (131) (Table 3-13). In fact, juveniles of several species (e.g., blue catfish, channel catfish, and suckermouth armored catfish) were only captured at night. Similarly, out of the 3,911 bay anchovies collected, only two were collected during the day.

The most evident temporal trend in juvenile fish abundance was the influx of bay anchovies at Goff Bayou in September. However, as explained above, this was likely the result of a rare saltwater intrusion. Seasonal shifts in abundance of several juvenile fishes were noted. Juvenile blue catfish, which were not captured until late May, peaked in early July, and were not captured after late July. Juvenile channel catfish were captured from early May through late August. Also, suckermouth armored catfish were only captured in June, July, and August collections.

Table 3- 12. Number (#) and percent relative abundance (%) of juvenile and adult fishes collected during ichthyoplankton sampling at three off-site sampling stations.

Common Name	Scientific Name	Goff		Canal		GR-05		Total	
		#	%	#	%	#	%	#	%
Gulf pipefish	*Syngnathus scovelli*	6	*0.1*	13	*5.0*			19	*0.4*
Inland silverside	*Menidia beryllina*	266	*5.7*	72	*27.8*	23	*12.8*	361	*7.1*
Pugnose minnow	*Opsopoeodus emiliae*	14	*0.3*	8	*3.1*			22	*0.4*
Bluefin killifish	*Lucania goodei*	1	*0.0*					1	*0.0*
Bullhead minnow	*Pimephales vigilax*	7	*0.1*	2	*0.8*			9	*0.2*
Naked goby	*Gobiosoma bosc*	2	*0.0*	1	*0.4*			3	*0.1*
Red shiner	*Cyprinella lutrensis*	24	*0.5*	26	*10.0*	2	*1.1*	52	*1.0*
Threadfin shad	*Dorosoma petenense*	274	*5.9*	4	*1.5*	3	*1.7*	281	*5.5*
Gizzard shad	*Dorosoma cepedianum*	41	*0.9*					41	*0.8*
Bay anchovy	*Anchoa mitchilli*	3900	*83.3*	9	*3.5*	2	*1.1*	3911	*76.4*
Western mosquitofish	*Gambusia affinis*	58	*1.2*	5	*1.9*	53	*29.6*	116	*2.3*
Tadpole madtom	*Noturus gyrinus*	1	*0.0*			2	*1.1*	3	*0.1*
Bluegill	*Lepomis macrochirus*					1	*0.6*	1	*0.0*
Channel catfish	*Ictalurus punctatus*	5	*0.1*	76	*29.3*			81	*1.6*
Blue catfish	*Ictalurus furcatus*	1	*0.0*			84	*46.9*	85	*1.7*
Sailfin molly	*Poecilia latipinna*	2	*0.0*			4	*2.2*	6	*0.1*
Armored catfish	*Pterygoplichthys anisitsi*	53	*1.1*	41	*15.8*	5	*2.8*	99	*1.9*
Gulf menhaden	*Brevoortia patronus*	25	*0.5*	2	*0.8*			27	*0.5*
TOTAL		**4680**		**259**		**179**		**5118**	

Table 3- 13. Number (#) and relative abundance (%) of juvenile and adult fishes collected during day and night ichthyoplankton sampling.

Common Name	Scientific Name	Day		Night		Total	
		#	%	#	%	#	%
Gulf pipefish	*Syngnathus scovelli*	4	*3.1*	15	*0.3*	19	*0.4*
Inland silverside	*Menidia beryllina*	65	*49.6*	296	*5.9*	361	*7.1*
Pugnose minnow	*Opsopoeodus emiliae*			22	*0.4*	22	*0.4*
Bluefin killifish	*Lucania goodei*	1	*0.8*			1	*0.0*
Bullhead minnow	*Pimephales vigilax*			9	*0.2*	9	*0.2*
Naked goby	*Gobiosoma bosc*			3	*0.1*	3	*0.1*
Red shiner	*Cyprinella lutrensis*	12	*9.2*	40	*0.8*	52	*1.0*
Threadfin shad	*Dorosoma petenense*	4	*3.1*	277	*5.6*	281	*5.5*
Gizzard shad	*Dorosoma cepedianum*	16	*12.2*	25	*0.5*	41	*0.8*
Bay anchovy	*Anchoa mitchilli*	2	*1.5*	3909	*78.4*	3911	*76.4*
Western mosquitofish	*Gambusia affinis*	25	*19.1*	91	*1.8*	116	*2.3*
Tadpole madtom	*Noturus gyrinus*	1	*0.8*	2	*0.0*	3	*0.1*
Bluegill	*Lepomis macrochirus*			1	*0.0*	1	*0.0*
Channel catfish	*Ictalurus punctatus*			81	*1.6*	81	*1.6*
Blue catfish	*Ictalurus furcatus*			85	*1.7*	85	*1.7*
Sailfin molly	*Poecilia latipinna*	1	*0.8*	5	*0.1*	6	*0.1*
Armored catfish	*Pterygoplichthys anisitsi*			99	*2.0*	99	*1.9*
Gulf menhaden	*Brevoortia patronus*			27	*0.5*	27	*0.5*
TOTAL		**131**		**4987**		**5118**	

3.5 Benthic Invertebrates

3.5.1 Methods

Benthic macroinvertebrate samples were collected monthly at the five Guadalupe River stations beginning in April 2008. Sampling was conducted with a standard manually operated Petite Ponar Dredge. Three sediment grabs were taken at each station (one along each bank and one in mid-river) and then composited into one sample. Samples were then filtered through a sieve bucket to remove excess silt. Once fine sediments had been rinsed from the sample, it was transferred to a 1 liter plastic sample bottle and preserved in 95% ethanol for later processing in the laboratory.

In the laboratory, samples were sorted and identified to the lowest practical taxon with the aid of a digital zoom stereomicroscope. The number of individuals within each taxon was then enumerated for each station. Segmented worms (Phylum: Annelida) were labeled as present or abundant due to difficulty in accurately determining the exact number present. These worms are easily broken during sample collection and processing, and counts of each piece can often misrepresent the actual number present.

Methods for determining ALU based on Ponar dredge samples have not been developed by TCEQ (TCEQ 2007). However, metrics and scoring criteria for rapid bioassessment protocols (RBP) associated with Surber samples do exist (TCEQ 2007). Therefore, in an attempt to provide some means of comparing community composition between stations, Ponar dredge data were analyzed with this protocol to determine ALU designations. Caution should be taken in interpreting these designations due to inherent differences in sampling technique.

3.5.2 Results and Discussion

The number of each taxa collected, as well as their percent relative abundance at each station is presented in Table 3-14. The most abundant invertebrate taxa overall was a gastropod mollusc (Hydrobiidae) which was collected in extremely high numbers at several stations. An invasive bivalve mollusc, the Asiatic clam (*Corbicula* sp.), was found at all five river stations. *Corbicula* exhibited their highest abundance at GR-03 and GR-01, yet only five individuals were collected at GR-05. Due to the high abundance of Hydrobiids, molluscs were the most common taxonomic group, comprising 86% of all organisms captured. Other common groups included mayflies (Order Ephemeroptera; 5.7% relative abundance), flies and midges (Order Diptera; 5.6%), and beetles (Order Coleoptera; 1%). The most common mayflies collected were *Hexagenia* sp., members of the burrowing mayfly family (Ephemeridae).

Two insect taxa are identified in the Texas Parks and Wildlife Department's (TPWD) Rare, Threatened, and Endangered Species of Texas database as potentially occurring in Victoria, Calhoun, Refugio, or Aransas counties: a mayfly (*Tortopus circumfluus*) and the Texas asaphomyian tabanid fly (*Asaphomyia texensis)* are both designated as rare. *T. circumfluus* is designated as rare due to distribution, since it has only been collected in Victoria County. During this survey, *Tortopus* mayflies were collected at GR-01 and GR-02. Unfortunately, these *Tortopus* larvae could only be keyed to genus (the adult form is needed to get to species). Therefore, it is uncertain if any of these individuals represent *T. circumfluus*.

To further analyze community composition between stations, rapid bioassessment protocols (RBPs) were used to assess aquatic life use (ALU) monthly at each station. Although there was some variation from month to month, on average, all five river stations received intermediate aquatic life use designations (Table 3-15).

Table 3- 14. Invertebrates collected from five stations on the lower Guadalupe River in 2008.

Common Name	Family	Genus	GR-01		GR-02		GR-03		GR-04		GR-05		Total	
			#	%	#	%	#	%	#	%	#	%	#	%
Mayflies	Ephemeridae	*Hexagenia*	94	**20.5**	99	**9.7**	19	**0.5**	26	**11.4**	24	**20.0**	262	**4.8**
	Polymitarcyidae	*Tortopus*	6	**1.3**	1	**0.1**							7	**0.1**
		Campsurus			3	**0.3**	1	**0.0**	1	**0.4**			5	**0.1**
	Caenidae	*Cercobrachys*	2	**0.4**			1	**0.0**					6	**0.1**
		Caenis	1	**0.2**			7	**0.2**			1	**0.8**	9	**0.2**
		Brachycercus	8	**1.7**	1	**0.1**							9	**0.2**
	Palingeniidae	*Pentagenia vittegera*	5	**1.1**					4	**1.7**	1	**0.8**	10	**0.2**
	Baetidae	*Apobaetis*	1	**0.2**									1	**0.0**
Stoneflies	Perlidae		1	**0.2**									1	**0.0**
Caddisflies	Leptoceridae	*Oecetis*	2	**0.4**	4	**0.4**	2	**0.1**	2	**0.9**			10	**0.2**
		Nectopsyche			2	**0.2**	1	**0.0**					3	**0.1**
	Polycentropodidae	*Neureclipsis*					1	**0.0**					1	**0.0**
		Cyrnellus			1	**0.1**	3	**0.1**					4	**0.1**
	Hydroptilidae	*Hydroptila*					1	**0.0**			1	**0.8**	2	**0.0**
		Neotrichia					3	**0.1**					1	**0.0**
Dragonflies/Damselflies	Gomphidae	*Gomphus*	5	**1.1**	1	**0.1**	2	**0.1**			4	**3.3**	12	**0.2**
		Dromogomphus			1	**0.1**							1	**0.0**
		Stylurus			2	**0.2**			2	**0.9**	2	**1.7**	6	**0.1**
	Coenagrionidae				1	**0.1**							1	**0.0**
		Argia			1	**0.1**							1	**0.0**
	Macromiidae	*Macromia*					1	**0.0**	1	**0.4**			2	**0.0**
Beetles	Scarabaeidae								1	**0.4**			1	**0.0**
	Elmidae	*Stenelmis*	6	**1.3**	11	**1.1**	13	**0.4**	4	**1.7**	6	**5.0**	40	**0.7**
		Dubiraphia	2	**0.4**	1	**0.1**			1	**0.4**	2	**1.7**	1	**0.0**
		Heterelmis	2	**0.4**			5	**0.1**					7	**0.1**
		Hexacylloepus			1	**0.1**					1	**0.8**	2	**0.0**
	Chrysomelidae				1	**0.1**							1	**0.0**
	Dryopidae	*Helichus*	1	**0.2**									1	**0.0**
Flies and midges	Ceratopogonidae	*Probezzia*	4	**0.9**			2	**0.1**					6	**0.1**
		Sphaeromias	8	**1.7**	10	**1.0**	7	**0.2**	14	**6.1**	6	**5.0**	45	**0.8**
		Culicoides									2	**1.7**	2	**0.0**
	Chironomidae	*Procladius*					1	**0.0**					1	**0.0**
		Ablabesmyia	1	**0.2**			3	**0.1**					4	**0.1**
		Microspectra	7	**1.5**									7	**0.1**
		Cryptochironomus	12	**2.6**	4	**0.4**	21	**0.6**	12	**5.2**	17	**14.2**	66	**1.2**
		Cryptotendipes							7	**3.1**			7	**0.1**
		Dicrotendipes			4	**0.4**			2	**0.9**	7	**5.8**	13	**0.2**
		Fissimentum			1	**0.1**							1	**0.0**
		Stelenchomyia									1	**0.8**	1	**0.0**
		Paracladopelma	1	**0.2**			1	**0.0**					2	**0.0**
		Polypedilum			12	**1.2**	6	**0.2**	7	**3.1**	2	**1.7**	27	**0.5**
		Chironomus			24	**2.4**	5	**0.1**					29	**0.5**
		Microchironomus			2	**0.2**	1	**0.0**					3	**0.1**
		Axarus	2	**0.4**			1	**0.0**	1	**0.4**	2	**1.7**	6	**0.1**
		Eukiefferiella			1	**0.1**							1	**0.0**
		Endochironomus	1	**0.2**									1	**0.0**
		Stictochironomus	2	**0.4**	7	**0.7**	2	**0.1**	5	**2.2**	2	**1.7**	18	**0.3**
		Xestochironomus					3	**0.1**					3	**0.1**
		Epoicocladius			2	**0.2**							2	**0.0**
		Rheocricotopus					1	**0.0**					1	**0.0**
		Cardiocladius							1	**0.4**			1	**0.0**
		Larsia	3	**0.7**									3	**0.1**
		Ablabesmyia			3	**0.3**	1	**0.0**	1	**0.4**			5	**0.1**
		Tanypus			7	**0.7**			2	**0.9**	1	**0.8**	10	**0.2**
		Coelotanypus			5	**0.5**	1	**0.0**	9	**3.9**	2	**1.7**	17	**0.3**
		Paramerina	1	**0.2**	6	**0.6**	5	**0.1**	3	**1.3**	3	**2.5**	18	**0.3**
		Tanytarsus					1	**0.0**	1	**0.4**			2	**0.0**
		Cladotanytarsus							3	**1.3**			3	**0.1**
Molluscs	Corbiculidae		20	**4.4**	17	**1.7**	24	**0.7**	16	**7.0**	5	**4.2**	82	**1.5**
	Hydrobiidae		253	**55.1**	752	**73.9**	3412	**95.4**	96	**41.9**	23	**19.2**	4536	**84.0**
	Ancylidae				4	**0.4**							4	**0.1**
	Planorbidae	*Menetus*			1	**0.1**							1	**0.0**
	Unionidae		1	**0.2**	1	**0.1**	1	**0.0**					3	**0.1**
	Physidae		1	**0.2**	3	**0.3**	2	**0.1**	1	**0.4**			7	**0.1**
	Sphaeriidae		1	**0.2**	12	**1.2**	5	**0.1**	3	**1.3**			21	**0.4**
	Marine Gastropod								1	**0.4**			1	**0.0**
Leeches	*Subclass: Hirudinea*				2	**0.2**	4	**0.1**	1	**0.4**	1	**0.8**	8	**0.1**
Flatworms	Planariidae										1	**0.8**	1	**0.0**
Crustaceans	Palaemonidae	*Palaemonetes*	5	**1.1**	6	**0.6**			1	**0.4**			12	**0.2**
	Gammaridae	*Gammarus*					5	**0.1**			3	**2.5**	8	**0.1**
	Order: Podocopida				1	**0.1**	1	**0.0**					2	**0.0**
	Class: Branchiura						1	**0.0**					1	**0.0**
Segmented worms	*Phylum: Annelida*		P		P		P		P		P		P	
Totals			459		1018		3577		229		120		5403	

*P = Present.

Table 3- 15. RBP scores and resulting ALU designations for monthly samples from five stations on the lower Guadalupe River.

	GR-01		GR-02		GR-03		GR-04		GR-05	
	Score	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**	**Score**	**ALU**
April	29	INT	27	INT	35	HIGH	25	INT	29	INT
May	25	INT	25	INT	29	INT	21	INT	25	INT
June	29	INT	29	INT	25	INT	25	INT	27	INT
July	35	HIGH	29	INT	25	INT	35	HIGH	29	INT
August	37	HIGH	25	INT	25	INT	29	INT	33	HIGH
September	33	HIGH	31	HIGH	25	INT	33	HIGH	27	INT
October	31	HIGH	35	HIGH	25	INT	27	INT	27	INT
November	29	INT	33	HIGH	25	INT	29	INT	33	HIGH
December	25	INT	35	HIGH	27	INT	37	HIGH	25	INT
AVG	**30**	**INT**	**30**	**INT**	**27**	**INT**	**29**	**INT**	**28**	**INT**

3.6 Water Quality

3.6.1 Methods

Water quality data were collected during monthly electrofishing trips at each of the seven off-site locations. A YSI 6920 Data Sonde (Figure 3-11) was used to measure water temperature (C), dissolved oxygen (mg/L), pH, specific conductance (mS/cm), and turbidity (nephelometric turbidity units, NTU). In an effort to help explain differences in abundance of estuarine fishes between stations, salinity was also recorded beginning in May. At each station during each monthly electrofishing trip measurements were taken at the surface (1 m depth), at mid-depth, and at the bottom. Data were recorded in a water-proof data book along with observation of time, river level, water clarity, and ambient conditions.

Additional water quality data was also collected during each ichthyoplankton sampling trip. Water quality data from ichthyoplankton sampling is presented in Appendix D.

Figure 3- 11. BIO-WEST personnel collecting water quality data at the GBRA Main Canal.

3.6.2 Results and Discussion

Little variation in water quality parameters was evident based on depth, and no strong stratification was observed at any of the stations (Table 3-16, Table 3-17). The lack of stratification is not surprising with the strong current in the River and considerable wind-mixing associated with the shallower Goff Bayou and the Canal. Therefore, data collected at the surface (depth of 1 meter) were used to analyze differences between stations (Figure 3-12).

Water temperature varied from less than 10 C in the Canal in December to over 30˚C at two stations in June. Across stations, temperatures observed over the year were relatively similar; however, due to their shallowness, Goff Bayou and the Canal did exhibit slightly larger variation in temperature (Figure 3-12).

Conductivities ranged from 0.406 to 1.810 mS/cm. Conductivity typically increased slightly moving downstream from GR-01 to GR-04. However, GR-05, Goff Bayou, and the Canal exhibited consistently higher conductivities than the other stations upstream. The San Antonio River confluence is located between GR-04 and GR-05, and therefore, higher conductivities at GR-05, Goff Bayou, and the Canal are likely a result of the influx of higher conductivity water from the San Antonio River. Conductivity in the San Antonio River a short distance upstream from the confluence measured 1.15 mS/cm in September. This is considerably higher than conductivity values measured in the Guadalupe River upstream of the confluence (Table 3-16, Table 3-17).

Table 3- 16. Water quality data collected from five stations on the lower Guadalupe River, Goff Bayou, and the GBRA Main Canal during January-June 2008.

			Surface (1 m)						Mid-Depth						Bottom					
Date	Time	Site	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
1/28/2008	12:51	GR-01	12.49	9.95	0.714		12.94	15.1	12.48	9.94	0.715		13.03	15.1	12.46	9.92	0.711		12.91	86.4
1/28/2008	14:57	GR-02	12.61	9.39	0.737		13.62	16.0	12.61	9.36	0.737		13.68	15.3	12.62	9.32	0.738		12.34	20.3
1/28/2008	16:20	GR-03	12.69	9.49	0.736		12.09	14.3	12.68	9.49	0.737		12.43	15.3	12.69	9.49	0.736		11.28	15.2
1/29/2008	8:33	GR-04	14.99	9.43	0.893		11.07	22.9	14.85	9.42	0.883		10.96	23.2	14.60	9.41	0.912		11.23	22.4
1/29/2008	10:22	GR-05	14.62	9.37	0.875		7.86	21.9	14.60	9.36	0.882		8.50	21.9	14.60	9.34	0.874		10.33	22.3
1/29/2008	13:08	Goff Bayou	13.06	9.31	0.956		8.92	36.5	12.13	9.31	1.743		7.84	22.2	12.18	9.28	1.810		7.58	28.2
1/29/2008	15:30	GBRA Canal	14.67	9.17	1.067		6.82	47.4	14.67	9.17	1.067		6.82	47.4	15.54	9.25	1.038		6.22	72.2
2/21/2008	10:30	GR-01	17.24	8.15	0.648		8.20	7.6	17.24	8.16	0.648		8.17	7.9	17.24	8.17	0.647		8.17	7.8
2/21/2008	11:55	GR-02	17.23	8.14	0.657		8.04	7.2	17.23	8.15	0.657		7.99	7.5	17.24	8.16	0.656		7.83	7.5
2/21/2008	13:15	GR-03	17.24	8.13	0.696		8.22	6.6	17.25	8.14	0.656		8.27	6.9	17.25	8.16	0.656		8.36	6.9
2/20/2008	10:55	GR-04	16.68	8.01	0.761		8.00	8.6	16.67	8.01	0.761		7.99	8.7	16.67	8.01	0.761		8.10	9.7
2/20/2008	10:45	GR-05	16.73	8.03	0.825		7.94	9.0	16.76	8.04	0.824		7.96	8.5	16.74	8.05	0.812		8.09	8.9
2/20/2008	13:40	Goff Bayou	17.12	7.82	0.778		6.95	11.5	17.12	7.82	0.778		6.95	11.5	17.01	7.82	0.781		7.50	16.3
2/20/2008	16:40	GBRA Canal	17.92	7.85	0.782		7.76	8.5	17.92	7.85	0.782		7.75	8.5	17.92	7.85	0.782		7.75	8.5
3/17/2008	11:48	GR-01	19.82	8.14	0.622		9.37	128.0	19.82	8.14	0.619		9.29	130.0	19.82	8.13	0.622		9.66	134.0
3/17/2008	14:12	GR-02	20.28	8.16	0.637		9.12	51.0	20.26	8.16	0.637		9.09	54.4	20.27	8.16	0.637		9.06	57.3
3/17/2008	15:50	GR-03	20.46	8.16	0.635		7.05	52.8	20.46	8.17	0.635		7.83	52.6	20.46	8.18	0.635		9.29	54.4
3/18/2008	9:05	GR-04	20.87	7.95	0.762		6.34	56.3	20.87	7.95	0.762		6.53	58.0	20.87	7.95	0.761		7.31	56.7
3/18/2008	11:00	GR-05	20.85	7.98	0.830		6.52	53.7	20.85	7.98	0.829		6.75	54.0	20.85	7.98	0.832		7.25	55.0
3/19/2008	10:00	Goff Bayou	19.68	7.78	0.738		6.55	58.2	19.68	7.78	0.738		6.84	65.7	19.67	7.80	0.737		7.30	61.7
3/18/2008	13:36	GRBA Canal	21.55	8.04	0.742		5.81	75.2	21.55	8.04	0.742		5.81	75.2	21.54	8.07	0.740		6.78	65.0
4/14/2008	11:15	GR-01	21.31	8.27	0.653		*	66.2	21.31	8.27	0.648		*	65.9	21.30	8.27	0.655		*	66.2
4/14/2008	13:45	GR-02	22.25	8.31	0.644		*	70.1	22.22	8.31	0.644		*	75.0	22.21	8.31	0.644		*	87.1
4/14/2008	15:35	GR-03	22.51	8.31	0.640		*	71.8	22.46	8.31	0.640		*	71.0	22.49	8.34	0.639		*	74.0
4/15/2008	9:14	GR-04	20.64	8.19	0.736		8.64	60.9	20.64	8.19	0.737		8.84	60.6	20.64	8.18	0.737		8.66	61.4
4/15/2008	11:27	GR-05	20.65	8.19	0.838		10.27	60.6	20.64	8.19	0.839		9.42	62.0	20.63	8.19	0.842		9.28	61.0
4/15/2008	14:30	Goff Bayou	22.26	8.12	0.837		8.34	46.0	22.26	8.12	0.837		8.34	46.0	22.07	8.12	0.837		8.04	52.1
4/15/2008	17:03	GBRA Canal	23.72	8.15	0.839		9.09	47.5	23.72	8.15	0.839		9.09	47.5	23.35	8.13	0.841		8.75	67.7
5/19/2008	12:13	GR-01	25.09	8.11	0.598	0.29	8.90	5.2	25.03	8.11	0.590	0.28	8.92	5.9	25.05	8.14	0.593	0.29	8.34	6.6
5/19/2008	14:48	GR-02	25.85	8.16	0.594	0.29	9.21	5.1	25.80	8.16	0.594	0.29	9.22	5.6	25.77	8.18	0.595	0.29	9.34	7.6
5/19/2008	16:20	GR-03	25.95	8.16	0.592	0.29	8.69	5.3	25.97	8.17	0.593	0.29	8.74	5.3	25.96	8.20	0.593	0.29	8.83	5.3
5/20/2008	8:45	GR-04	25.35	8.17	0.657	0.32	7.46	4.9	25.35	8.18	0.657	0.32	7.53	5.0	25.35	8.23	0.656	0.32	7.73	5.1
5/20/2008	10:08	GR-05	25.26	8.19	0.817	0.40	7.10	5.5	25.25	8.19	0.817	0.40	7.12	5.6	25.25	8.24	0.817	0.40	7.32	5.8
5/20/2008	12:30	Goff Bayou	26.55	8.10	0.834	0.41	7.05	3.1	26.44	8.09	0.833	0.41	7.00	3.4	25.92	8.07	0.834	0.41	6.41	5.5
5/20/2008	14:45	GBRA Canal	28.03	8.02	0.832	0.40	6.17	4.2	28.03	8.02	0.832	0.40	6.17	4.2	27.87	8.15	0.832	0.40	6.43	13.7
6/16/2008	12:30	GR-01	29.46	7.97	0.573	0.27	6.21	43.0	29.50	8.00	0.559	0.27	6.30	51.0	29.37	8.01	0.558	0.27	6.31	57.9
6/16/2008	14:45	GR-02	30.11	8.09	0.582	0.28	6.75	40.0	30.11	8.09	0.582	0.28	6.75	42.4	30.12	8.11	0.581	0.28	6.02	42.0
6/16/2008	15:50	GR-03	29.88	8.02	0.580	0.28	6.22	36.8	29.89	8.04	0.580	0.28	6.25	39.0	29.87	8.09	0.580	0.28	6.35	42.6
6/17/2008	9:05	GR-04	29.28	7.97	0.595	0.29	5.16	32.8	29.28	7.98	0.595	0.29	5.19	33.5	29.25	8.00	0.595	0.29	5.19	32.0
6/17/2008	8:00	GR-05	28.97	7.99	0.820	0.40	5.16	38.7	28.97	8.01	0.820	0.40	5.19	40.3	28.96	8.11	0.819	0.40	5.35	40.9
6/17/2008	11:20	Goff Bayou	29.21	7.95	0.845	0.41	4.97	31.0	29.22	7.96	0.845	0.41	4.96	44.0	29.12	7.98	0.845	0.41	4.91	48.5
6/17/2008	13:00	GBRA Canal	30.39	7.86	0.870	0.42	4.97	35.5	30.39	7.86	0.870	0.42	4.97	35.5	30.34	7.92	0.868	0.42	5.10	50.0

*Measurement error

Table 3- 17. Water quality data collected from five stations on the lower Guadalupe River, Goff Bayou, and the GBRA Main Canal during July-December 2008.

			Surface (1 m)						Mid-Depth						Bottom					
Date	Time	Site	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Temperature (°C)	pH	Specific Conductance (mS/cm)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
7/14/2008	14:24	GR-01	29.54	8.33	0.563	0.27	7.47	10.0	29.51	8.35	0.563	0.27	7.46	10.8	29.49	8.38	0.563	0.27	7.51	12.6
7/14/2008	12:40	GR-02	29.46	8.34	0.549	0.26	7.51	8.6	29.46	8.35	0.549	0.26	7.52	9.6	29.33	8.38	0.549	0.26	7.45	12.3
7/14/2008	11:15	GR-03	28.77	8.22	0.547	0.26	6.35	8.7	28.77	8.25	0.547	0.26	6.37	8.6	28.76	8.33	0.548	0.26	6.38	8.6
7/15/2008	11:34	GR-04	29.17	8.33	0.562	0.27	6.50	7.2	29.17	8.37	0.563	0.27	6.49	7.4	29.17	8.49	0.565	0.27	6.82	7.7
7/15/2008	13:17	GR-05	29.12	8.14	0.776	0.38	6.28	9.5	29.07	8.16	0.775	0.38	6.29	10.4	29.06	8.20	0.777	0.38	6.36	10.5
7/15/2008	9:31	Goff Bayou	28.86	8.70	0.858	0.42	6.22	11.4	28.77	8.26	0.859	0.42	5.97	13.0	28.75	8.28	0.859	0.42	5.95	15.8
7/15/2008	7:51	GBRA Canal	28.10	8.14	0.881	0.43	4.83	7.6	28.10	8.11	0.882	0.43	4.63	7.3	28.10	8.18	0.881	0.43	4.78	8.0
8/18/2008	11:20	GR-01	27.36	8.29	0.542	0.26	8.80	53.4	27.33	8.33	0.533	0.26	8.86	56.1	27.32	8.64	0.532	0.26	9.28	69.8
8/19/2008	9:13	GR-02	26.56	8.16	0.494	0.24	6.74	72.2	26.56	8.19	0.494	0.24	6.94	77.6	26.57	8.29	0.495	0.24	6.96	81.8
8/19/2008	10:29	GR-03	26.63	8.08	0.526	0.25	6.70	70.3	26.63	8.09	0.526	0.25	6.69	70.5	26.64	8.11	0.526	0.25	7.01	72.9
8/19/2008	12:16	GR-04	26.67	8.10	0.519	0.25	6.37	64.5	26.67	8.14	0.529	0.25	6.57	63.0	26.66	8.25	0.582	0.25	6.99	62.5
8/18/2008	2:15	GR-05	27.70	8.16	0.764	0.37	7.87	50.4	27.70	8.17	0.764	0.37	7.92	55.4	27.70	8.19	0.766	0.37	7.95	77.0
8/20/2008	9:20	Goff Bayou	25.96	7.90	0.762	0.37	4.76	51.8	25.96	7.92	0.762	0.37	4.87	66.7	25.97	7.96	0.762	0.37	4.39	90.6
8/19/2008	7:12	GBRA Canal	25.43	7.81	0.792	0.39	6.16	52.6	25.49	7.96	0.794	0.39	6.17	51.4	25.47	7.93	0.794	0.39	6.35	53.6
9/16/2008	11:42	GR-01	23.86	8.52	0.412	0.20	7.73	50.4	23.83	8.63	0.410	0.20	7.73	53.0	23.83	8.86	0.406	0.19	7.69	54.5
9/16/2008	13:38	GR-02	25.28	8.18	0.435	0.21	7.32	46.4	25.22	8.27	0.437	0.21	7.39	53.0	25.22	8.44	0.439	0.21	7.78	61.5
9/16/2008	15:18	GR-03	25.53	8.09	0.461	0.22	7.19	40.0	25.52	8.14	0.462	0.22	7.24	41.0	25.58	8.23	0.561	0.22	7.45	41.9
9/17/2008	8:26	GR-04	24.51	8.28	0.461	0.22	6.85	31.2	24.51	8.36	0.460	0.22	6.89	30.7	24.51	8.46	0.460	0.22	6.99	31.1
9/17/2008	9:42	GR-05	24.21	8.17	0.738	0.36	7.48	36.5	24.21	8.20	7.380	0.36	7.51	37.1	24.19	8.26	0.737	0.36	7.84	37.8
9/17/2008	14:08	Goff Bayou	25.53	8.03	1.385	0.69	7.22	30.5	24.57	7.97	1.523	0.76	5.24	38.4	24.50	8.05	1.568	0.79	5.24	44.0
10/20/2008	12:05	GR-01	21.04	7.52	0.571	0.28	8.24	29.4	21.01	7.51	0.568	0.28	8.30	38.6	21.00	7.62	0.862	0.27	8.52	33.3
10/20/2008	14:19	GR-02	21.73	7.46	0.573	0.28	8.44	39.6	21.72	7.47	0.573	0.28	8.51	38.6	21.70	7.51	0.574	0.28	8.71	42.7
10/20/2008	15:45	GR-03	21.49	7.54	0.571	0.28	8.00	32.5	21.49	7.54	0.571	0.28	8.05	33.9	21.49	7.59	0.572	0.28	8.29	34.3
10/21/2008	8:32	GR-04	21.06	7.83	0.569	0.28	7.22	21.7	21.06	7.85	0.690	0.28	7.30	22.4	21.06	7.92	0.569	0.28	7.77	24.0
10/21/2008	9:55	GR-05	20.66	7.36	0.850	0.42	7.38	44.3	20.66	7.32	0.853	0.42	7.48	44.6	20.66	7.36	0.855	0.42	7.78	47.7
10/21/2008	12:44	Goff Bayou	22.06	7.30	0.922	0.45	5.91	29.1	22.06	7.28	0.922	0.45	5.94	30.2	22.03	7.31	0.924	0.46	6.02	35.4
10/21/2008	15:25	GBRA Canal	22.36	7.26	0.908	0.45	6.94	32.1	22.14	7.25	0.910	0.45	6.86	33.9	22.07	7.24	0.910	0.45	6.84	34.4
11/18/2008	12:01	GR-01	14.13	7.68	0.594	0.29	9.96	20.1	14.07	7.67	0.590	0.29	9.97	21.1	14.05	7.70	0.590	0.29	9.96	21.3
11/18/2008	13:53	GR-02	14.66	7.80	0.578	0.28	9.75	27.1	14.63	7.81	0.578	0.28	9.78	32.4	14.63	7.88	0.579	0.28	9.85	34.8
11/18/2008	15:13	GR-03	14.51	7.83	0.577	0.28	9.29	28.8	14.51	7.84	0.577	0.28	9.30	31.0	14.51	7.86	0.577	0.28	9.31	50.2
11/19/2008	8:37	GR-04	14.06	8.17	0.578	0.28	8.74	22.2	14.06	8.15	0.578	0.28	8.77	23.7	14.06	8.13	0.578	0.28	8.93	23.9
11/19/2008	9:28	GR-05	13.69	8.18	0.844	0.42	8.95	28.3	13.67	8.16	0.850	0.42	8.98	31.2	13.67	8.16	0.853	0.42	9.18	30.7
11/19/2008	11:19	Goff Bayou	16.40	7.93	0.847	0.42	6.62	29.9	15.48	7.92	0.848	0.42	6.47	31.1	15.35	7.92	0.848	0.42	6.54	38.1
11/19/2008	13:24	GBRA canal	16.98	7.76	0.876	0.43	7.57	23.6	16.17	7.75	0.876	0.43	7.41	23.4	15.56	7.83	0.888	0.43	7.52	23.0
12/10/2008	11:40	GR-01	12.61	8.15	0.642	0.31	9.56	20.9	12.61	8.14	0.641	0.31	9.56	22.6	12.65	8.12	0.649	0.32	9.60	26.0
12/11/2008	12:09	GR-02	11.32	8.20	0.611	0.30	9.57	66.7	11.27	8.19	0.611	0.30	9.57	66.8	11.25	8.18	0.612	0.30	9.70	66.6
12/11/2008	13:22	GR-03	11.86	8.15	0.609	0.30	9.33	29.8	11.81	8.13	0.609	0.30	9.33	32.1	11.82	8.14	0.609	0.30	9.35	29.2
12/11/2008	16:08	GR-04	12.21	8.09	0.608	0.30	9.11	25.8	12.21	8.08	0.608	0.30	9.11	27.3	12.22	8.10	0.608	0.30	9.40	29.1
12/11/2008	15:11	GR-05	11.85	8.08	0.872	0.43	9.27	27.2	11.87	8.07	0.877	0.43	9.30	27.7	11.86	8.10	0.870	0.43	9.40	55.8
12/12/2008	9:08	Goff Bayou	10.34	8.14	0.888	0.44	8.59	27.4	10.32	8.14	0.888	0.44	8.59	29.1	10.32	8.14	0.887	0.44	8.59	34.4
12/12/2008	10:45	GBRA Canal	9.84	8.02	0.887	0.44	9.36	20.5	9.84	8.02	0.887	0.44	9.36	20.5	9.64	8.02	0.887	0.44	9.38	19.4

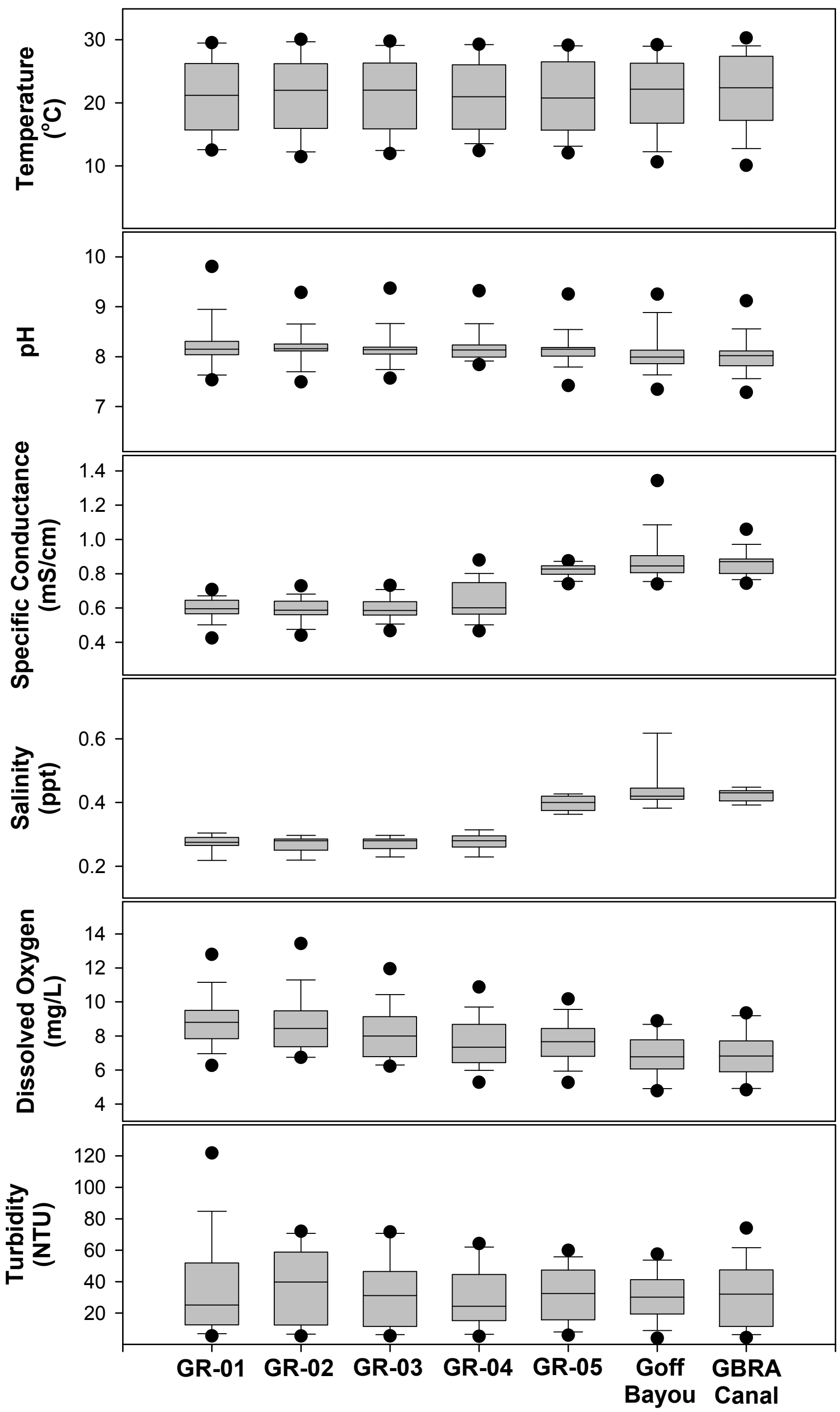

Figure 3- 12. Boxplots demonstrating the variation observed in water quality parameters measured monthly at five stations on the lower Guadalupe River, Goff Bayou, and the GBRA Main Canal during 2008. The middle line represents the median, boxes enclose the interquartile range (25th-75th percentiles), whiskers represent 10th and 90th percentiles, and black dots represent 5th and 95th percentiles.

Dissolved oxygen (DO) values were quite variable over the course of the study and fluctuated from 4.39 to 13.68 mg/L. Since DO levels typically exhibit large fluctuations depending on time of day and ambient conditions, comparisons of overall DO levels between stations is difficult. However, Figure 3-12 suggests that DO levels in Goff Bayou and the Canal are in general lower than at the river stations, most likely due to the lack of current induced mixing at these two stations.

The lower Guadalupe River, Goff Bayou, and the Canal are naturally turbid systems with turbidity values ranging from 3.1-134 NTU (Table 3-16, Table 3-17). Due to fluctuating flows, river stations exhibited larger variation in turbidity than did Goff Bayou or the Canal.

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