Fisheries Use Attainability Study for Hillebrandt Bayou

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Hillebrandt Bayou, a major tributary of Taylor Bayou located within the Neches-Trinity coastal basin, was sampled by Texas Parks and Wildlife Department (TPWD) Resource Protection Division staff as part of a use attainability analysis being prepared by the Texas Water Commission (TWC). The role of TPWD was to provide the TWC with a characterization of the fishery in the bayou.

Study Site

Four stations were sampled (Figure 1) on Hillebrandt Bayou. Channel width ranged from 30 m at Highway 124 to more than 75 m at Humble Road (Table 1). Water at the upper stations was tannin stained and darkened to a coffee color at Hillebrandt Road. Bottom substrate consisted mainly of silt. Aside from the channel width, the greatest distinction between the upper and lower stations were the many oxbows and back sloughs found in the Humble-Hillebrandt Road areas contrasted with the channelized nature of the upper sections. Terrestrial vegetation bordered the channel for its entire length, with the densest vegetation being found at the upper stations.

The Beaumont Wastewater Treatment Plant discharges into Hillebrandt Bayou below Highway 124. Low flow in Hillebrandt Bayou is regulated by drainage from rice fields and operation of saltwater gates and barge locks. Flow was sluggish during the sampling period with wind action creating a reverse current. Stage heights recorded by the United States Geological Survey May 25-30, 1987, ranged from 1.83 m to 1.91 m at a water stage recorder near the Humble Road station. Historical maximum and minimum heights are 3.7 m and 0.70 m, respectively.

Methods

Fish were collected May 26-29, 1987. Representative habitats were sampled by common sense seine and experimental gill nets. The seine measured 4.5 m in length, 1.2 m in depth, and was composed of 3.1 mm ace weave mesh. Gill nets were constructed of monofilament and were 60 m in length, 2.4 m in depth, and were composed of eight 7.5 m panels varying in bar mesh size from 12.5 to 100 mm.

Each station was seined for three 5-minute periods. Weight (g) and total length (mm) were recorded for larger individuals. Twenty-five randomly chosen fish from each sample were examined for disease and other abnormalities. All fish were preserved in 10% formalin and transported to the laboratory for identification. Taxonomic references include Eddy and Underhill (1978), Hubbs (University of Texas unpublished 1970 manuscript), and Pflieger (1975).

One gill net was set for 16 to 18 hours at each station. Sets were made so that the period sampled included dawn, dusk, and evening periods, when fish are more active. Gill nets were set on the inside banks of meanders with the small mesh abutting the shoreline. Fish were identified, weighed, measured, and examined for disease and other abnormalities before their release.

Dissolved oxygen, pH, temperature, and conductivity were sampled in situ at each station using direct reading meters (Table 1). Water transparency was measured with a Secchi disk, and stream width was measured by estimation and by rangefinder. A constant reading Hydrolab was placed at Hillebrandt Road to examine diurnal trends in dissolved oxygen, pH, temperature, and conductivity.

Fish captured by seine and gill net at each station were considered as one sample for data analysis, because the main intent of the study was to compare values among sites as opposed to literature values. Equal sampling effort was exerted at each station, so the combination of collections was justified. Several methods were utilized in analyzing the data, as discussed below.

Species diversity was calculated according to the equation presented in Wilhm (1970):

$$\overline{H} = -\sum_{i-1}^{s} (n_i/n) \log_2 (n_i/n),$$

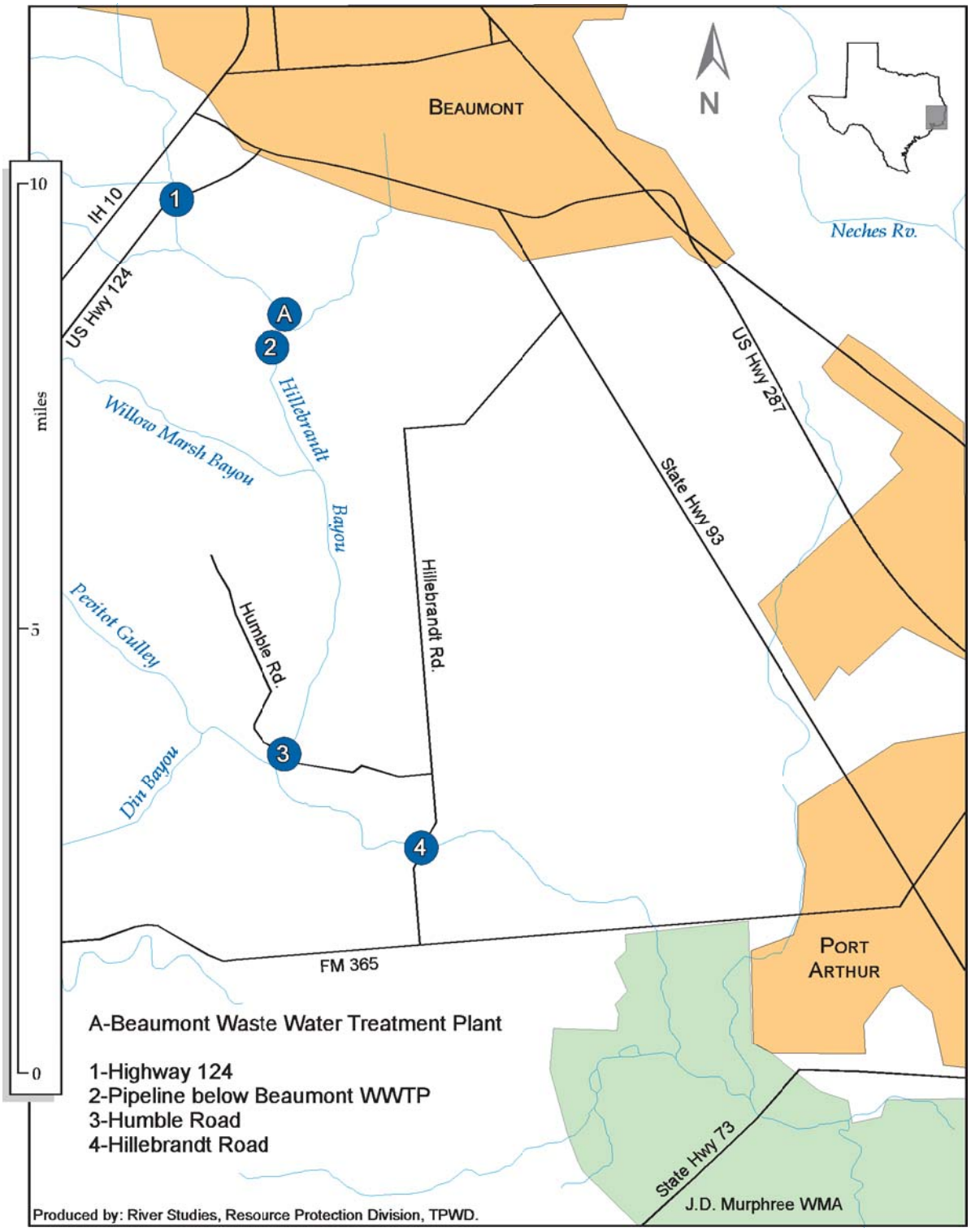

Figure 1. — Map of sampling area.

Table 1. Physiochemical measurements taken on Hillebrandt Bayou (May 1987).

Station	Date	Time	Channel Width (m)	DO[1] (mg/L)	pH[2]	Temp.[3] (°C)	Cond.[4] (*u*mhos)	Secchi Transparency (m)
Hwy. 124	5/27/87	1707	30.0	13.2	8.39	29	390	0.30
	5/28/87	1900	30.0	6.0	7.62	27	390	0.38
Pipeline below Beaumont WWTP	5/27/87	1643	37.5	9.4	7.50	29	575	0.45
	5/28/87	1025	37.5	4.3	7.36	28	650	0.45
Humble Road	5/26/87	1830	75.6	10.6	7.95	30	390	0.32
	5/27/87	1112	75.6	10.6	7.33	29	410	0.32
Hillebrandt Road	5/26/87	1708	72.0	6.6	7.12	29	340	0.32
	5/27/87	0910	72.0	6.8	6.80	28	400	0.32

[1]Measured with YSI Model 57

[2]Measured with Nester Model 3000

[3]Measured with YSI Model 57

[4]Measured with YSI Model 33

where $\overline{H}$ = species diversity, n_i = number of individuals in the i^{th} species, n = number of individuals in the sample, and S = number of species. Generally, values less than 1.0 indicate severely degraded conditions, 1.0 - 3.0 indicate moderately polluted streams, and greater than 3.0 indicate clean water streams (Wilhm and Dorris 1968).

Index of similarity, a measure of the degree of resemblance in species composition between two sites, was calculated according to the equation presented in Odum (1971)

$$S = 2C/A + B,$$

where S = index of similarity, A = number of species in sample A, B = number of species in sample B, and C = number of species common to both samples. Values can range from 0, meaning the sites are dissimilar, to 1.0, indicating the two sites are the same.

Condition factors, a measure of the well-being or plumpness of a fish, were calculated according to the equation presented in Carlander (1969, 1977):

$$K = W10^5/L^3,$$

where K = condition factor, W = weight in grams, L = length in millimeters, and 10^5 is a factor to bring the value of K near unity. K-factors were calculated only for species for which Carlander (1969, 1977) presents comparative data. In selecting values for comparisons, an effort was made to find data in Carlander (1969, 1977) for fish from a similar geographical area and of a similar size to that collected in this study. K-factors vary with species and size, but generally, larger values are indicative of better fish condition.

Index of biotic integrity (IBI) was calculated according to Karr *et al*. (1986), though the scoring criteria were modified to rate Hillebrandt Bayou (Table 2). Darter species were not expected nor found, so this metric was assigned a value of 5 at each station because no comparable species could be substituted (Karr *et al*. 1986). The proportion of individuals as tolerants was substituted for occurrences of green sunfish (*Lepomis cyanellus*) to make the index less susceptible to the presence or absence of a single species. Green sunfish, carp (*Cyprinus carpio*), mosquitofish (*Gambusia affinis*), and sheepshead minnow (*Cyprinodon variegatus*), were considered tolerant species. As suggested by Karr et. al. (1986), the proportion of individuals as insectivores was substituted for insectivorous cyprinids. IBI integrity class scores and attributes are listed in Appendix A. Proportions mentioned in the text refer to IBI metrics listed in Table 2.

Species richness and index of biotic integrity were emphasized in characterizing the fishery. A gauge of system health is the number and types of species present, with a greater number of species typically suggesting a more stable and healthy system. This reasoning must be used with care, but as Young *et al*. (1973) point out, the presence of some fish species upstream of an entry point of waste and their absence downstream of that point suggests the waste is limiting their occurrence. In addition, the index of biotic integrity provides a means of assigning a score to a stream station by integrating information from individual, population, community, zoogeographic, and ecosystem levels into a single ecologically based index. Together, these two methods provide a sound characterization of the fishery.

Less emphasis was placed on species diversity, similarity indices and condition factors. They are not reliable indicators in themselves, but when used in conjunction with other methods can provide additional information for characterizing the system.

Results and Discussion

Water Quality Parameters

Physiochemical data are presented in Tables 1 and 3. The lowest dissolved oxygen readings recorded in Table 1 were found at the site downstream from the Beaumont Wastewater Treatment Plant. Data from the continuous reading Hydrolab (Table 3) indicate the lowest dissolved oxygen level was 3.48 mg/1 at 9:00 a.m. No dissolved oxygen levels appeared sufficiently low to cause problems for the fish species collected in Hillebrandt Bayou.

Fisheries Parameters

Species collected by seine and gill net are presented in Tables 4 and 5. A total of 25 different fish species were collected in Hillebrandt Bayou. This compares favorably with historical data collected in nearby Taylor Bayou by Wenger (1966), where 25 species were also collected. Due to variations in

Table 2. Scoring criteria used for rating the index of biotic integrity of Hillebrandt Bayou.

Category		Metric	Scoring criteria 5	3	1
Species richness and composition	1.	Total number of fish species	≥10	9-4	3-0
	2.	Total number of darter species	N/A	N/A	N/A
	3.	Total number of sunfish species	≥2	1	0
	4.	Total number of sucker species	≥2	1	0
	5.	Total number of intolerant species	≥3	2-1	0
	6.	Proportion of individuals as tolerants	<5%	5-20%	>20%
Trophic composition	7.	Proportion of individuals as omnivores	<20%	20-45%	>45%
	8.	Proportion of individuals as insectivores	>80%	>40-80%	≤40%
	9.	Proportion of individuals as piscivores	>5%	5-1%	<1%
Fish abundance and condition	10.	Number of individuals in sample	>200	>50-200	0-50
	11.	Proportion of individuals as hybrids	0%	>0-1%	>1%
	12.	Proportion of individuals with disease or other anomaly	≤2%	>2-5%	>5%

Table 3. Physiochemical measurements taken by a continuous reading Hydrolab placed at the Hillebrandt Road station on Hillebrandt Bayou (May 1987).

Date	Time	D.O. (mg/L)	pH	Temp. (°C)	Conductivity (*u*mhos)
5/27/87	1000	5.44	7.25	28.34	342
	1100	5.98	7.28	28.51	342
	1200	6.45	7.34	28.84	342
	1300	6.91	7.40	29.10	341
	1400	7.45	7.51	29.42	338
	1500	7.86	7.64	29.63	338
	1600	8.34	7.73	29.75	337
	1700	8.39	7.79	29.77	337
	1800	8.67	7.89	29.85	337
	1900	7.96	7.70	29.64	338
	2000	7.32	7.56	29.45	337
	2100	6.85	7.45	29.23	338
	2200	6.42	7.37	29.01	339
	2300	5.89	7.29	28.83	339
5/28/87	0000	5.79	7.28	28.65	339
	0100	5.41	7.23	28.47	340
	0200	5.06	7.20	28.34	340
	0300	4.76	7.15	28.19	340
	0400	4.54	7.13	28.00	340
	0500	4.72	7.14	28.00	347
	0600	4.21	7.09	27.95	348
	0700	4.36	7.07	27.87	348
	0800	4.11	7.08	27.85	348
	0900	4.78	7.14	27,81	347
	1000	4.38	7.11	27.84	346
	1100	4.46	7.11	27.95	344
	1200	5.48	7.21	28.26	345

Table 3. (Continued).

Date	Time	D.O. (mg/L)	pH	Temp. (°C)	Conductivity (*u*mhos)
	1300	6.37	7.31	28.72	347
	1400	6.48	7.33	28.99	348
	1500	6.72	7.36	29.31	348
	1600	7.44	7.50	29.61	348
	1700	7.69	7.55	29.75	347
	1800	7.83	7.61	29.73	347
	1900	7.48	7.53	29.51	348
	2000	7.16	7.47	29.26	348
	2100	6.58	7.38	28.95	350
	2200	5.85	7.27	28.63	350
	2300	5.77	7.24	28.47	350
5/29/87	0000	5.34	7.19	28.33	350
	0100	5.16	7.17	28.23	350
	0200	4.88	7.14	28.06	350
	0300	4.89	7.14	28.15	358
	0400	4.48	7.12	27.94	357
	0500	4.43	7.12	27.83	357
	0600	4.09	7.08	27.66	351
	0700	3.55	7.01	27.53	352
	0800	4.15	7.07	27.64	357
	0900	3.48	7.01	27.61	356
	1000	4.11	7.05	27.94	360
	1100	5.35	7.16	28.16	363
	1200	4.85	7.12	28.25	364
	1300	5.36	7.17	28.25	363

Table 4. Fishes collected by seine from Hillebrandt Bayou (May 1987).

Taxa	Common Name	Hwy. 124	Pipeline below Beaumont WWTP	Humble Road	Hillebrandt Road
Astyanax mexicanus	Mexican tetra			1	
Cyprinodon variegatus	Sheepshead minnow	17	1501	24	48
Fundulus chrysotus	Golden topminnow		1		
Gambusia affinis	Mosquitofish	885	1237	1048	2783
Gambusia geiseri	Largespring gambusia	3		1	
Lepomis cyanellus	Green sunfish		1		1
Lepomis gulosus	Warmouth			1	
Lepomis macrochirus	Bluegill sunfish	12		48	183
Lucania parva	Rainwater killifish		6	1	
Menidia beryllina	Tidewater silverside	140	1	27	34
Micropterus salmoides	Largemouth bass	10		1	3
Morone mississippiensis	Yellow bass				2
Notemigonus crysoleucas	Golden shiner			40	
Notropis emiliae	Pugnose minnow	20	1	8	3
Poecilia latipinna	Sailfin molly	1	11	12	2

Table 5. Fishes collected by gill net from Hillebrandt Bayou (May 1987).

Taxa	Common Name	Hwy. 124	Pipeline below Beaumont WWTP	Humble Road	Hillebrandt Road
Aplodinotus grunniens	Freshwater drum			1	
Cyprinus carpio	Carp			1	
Dorosoma cepedianum	Gizzard shad	53	8	20	11
Dorosoma petenense	Threadfin shad	21			3
Ictalurus furcatus	Blue Catfish	1	1	4	1
Ictalurus punctatus	Channel catfish	2	2	2	5
Ictiobus bubalus	Smallmouth buffalo			9	5
Lepisosteus oculatus	Spotted gar	24	10	2	7
Lepomis macrochirus	Bluegill sunfish				1
Micropterus salmoides	Largemouth bass			2	
Morone mississippiensis	Yellow bass				2
Mugil cephalus	Striped mullet			11	4
Pomoxis annularis	White crappie				3

habitat and stream characteristics between the two bayous, some differences in the fish populations, such as species composition, were expected.

Nine species (mostly piscivores) found in Taylor Bayou were not collected in Hillebrandt Bayou, while eight species (mostly omnivores) found in Hillebrandt Bayou were not collected in Taylor Bayou. Longear sunfish (*Lepomis megalotis*) and pugnose minnow (*Notropis emiliae*) both considered pollution intolerant by the United States Environmental Protection Agency (1983) were collected in Taylor Bayou, whereas only the pugnose minnow was found in Hillebrandt Bayou.

Hwy 124

Thirteen of the 25 fish species collected in Hillebrandt Bayou were found at this station (Tables 4 and 5). Proportion of pollution tolerant individuals was lowest at this station, but was sufficient to suggest some degradation. Proportion of individuals as piscivores was highest at this station. Sportfish reproduction was evident by the collection of juvenile largemouth bass (*Micropterus salmoides*) and bluegill sunfish (*Lepomis macrochirus*). The largest number of pugnose minnow was collected at this station.

Species diversity was highest at this station (Table 6), but was in the range normally associated with moderately polluted water ($\overline{H}$ of 1.0-3.0; Wilhm and Dorris 1968). The index of similarity between this station and the station at Hillebrandt Road was the highest in the study (Table 7).

Condition factors at this station (Table 8) for blue catfish (*Ictalurus furcatus*) were similar to values from Carlander (1969, 1977), low for channel catfish (*Ictalurus punctatus*), and high for gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*Dorosoma petenense*). The low value for channel catfish may be attributed to seasonal stress or a low abundance of bottom food organisms, whereas the high condition factors for shad suggest an abundance of suspended food particles. The condition factor for blue catfish suggests an adequate prey base.

The station was assigned a rating of fair to good (Table 9) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for a less than excellent score include the absence of sucker species (which are often intolerant of habitat and water quality degradation), a low number of sunfish species (which are particularly responsive to the degradation of pool habitat and to other aspects of habitat structure as instream cover; Gammon *et al*. 1981; Angermeier 1983), low number of intolerant species, low proportion of piscivores, and a high proportion of tolerant individuals.

Pipeline below Beaumont Wastewater Treatment Plant

The lowest species richness occurred at this station with 12 fish species collected (Tables 4 and 5). Proportions of pollution tolerant individuals and individuals as omnivores were highest of all stations sampled. No piscivores and only one pugnose minnow were collected at this station. No indication of sportfish reproduction was evident even though habitat was similar to that at the station upstream from the wastewater treatment plant.

Species diversity was lower than at the upstream station (Table 6) and in the range considered indicative of moderate pollution ($\overline{H}$ of 1.0-3.0; Wilhm and Dorris 1986). This station was the least closely related to the others. The upper station showed the greatest similarity to this station, whereas the index of similarity between this station and the Humble Road station was the lowest in the study (Table 7).

Condition factors calculated at this station for gizzard shad were similar to values from Carlander (1969, 1977), low for channel catfish, and much higher for blue catfish (Table 8). The lower value for channel catfish may be attributed to seasonal stress or a low abundance of bottom food organisms. The high value for blue catfish may be a sampling artifact since only one fish was collected.

The station was assigned a rating of poor to fair (Table 9) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for this lower rating include the absence of sucker species (water quality), a very high proportion of tolerant individuals, an imbalance in trophic structure, a low number of sunfish species, and a low number of intolerant species.

Humble Road

The highest species richness for this study occurred at this station with 20 species collected (Tables 4 and 5). The channel was wider than in upstream stations and possessed suitable spawning habitat for sportfish, as evidenced by juvenile bluegill sunfish collected. The second highest number of pugnose minnow was collected at this station.

Species diversity was second highest at this station

Table 6. Fish community indices calculated for each station on Hillebrandt Bayou (May 1987).

Station	Species Richness	Species Diversity
Hwy. 124	13	1.46
Pipeline below Beaumont WWTP	12	1.14
Humble Road	20	1.24
Hillebrandt Road	18	0.70

Table 7. Index of similarity results on fish species composition among each possible combination of stations on Hillebrandt Bayou (May 1987).

	Hwy. 124	Pipeline below Beaumont WWTP	Humble Road	Hillebrandt Road
Hwy. 124	-	-	-	-
Pipeline below Beaumont WWTP	0.72	-	-	-
Humble Road	0.73	0.63	-	-
Hillebrandt Road	0.77	0.67	0.74	-

Table 8. Mean condition factors calculated for fishes collected in Hillebrandt Bayou (May 1987). Values from Carlander (1969, 1977) are included for comparison. Values in parentheses indicate the number of fish used. Standard deviations for each species are listed when condition factors for at least three specimens were calculated.

Species	Hwy. 124	Pipeline below Beaumont WWTP	Humble Road	Hillebrandt Road	Carlander
Ictalurus furcatus	0.90(2)	1.01(1)	0.96(4) ±0.026	0.94(1)	0.93
Ictalurus punctatus	0.78(2)	0.85(2)	0.87(2)	1.03(5) ±0.143	0.90
Dorosoma cepedianum	1.00(25) ±0.228	0.94(7) ±0.046	1.12(2) ±0.536	0.99(11) ±0.190	0.94
Dorosoma petenense	0.98(19) ±0.128			0.70(3) ±0.041	0.93
Cyprinus carpio			1.53(1)	1.24(1)	1.40
Ictiobus bubalus			1.78(9) ±0.151	2.05(4) ±0.512	1.39
Lepomis macrochirus				1.85	2.35
Micropterus salmoides			1.66(1)		1.19
Pomoxis annularis				1.48(2)	1.26

Table 9. Summary table for calculating the index of biotic integrity (IBI) for the stations on Hillebrandt Bayou (May 1987). The metric ratings are given in parenthesis for each station and summed to generate the final index value.

Species	Hwy. 124		Pipeline below Beaumont WWTP		Humble Road		Hillebrandt Road	
Number of species of: (metrics 1-5)								
Total	13	(5)	12	(5)	20	(5)	18	(5)
Darters[a]	-	(5)[a]	-	(5)	-	(5)	-	(5)
Sunfishes	1	(3)	1	(3)	2	(5)	2	(5)
Suckers	0	(1)	0	(1)	1	(3)	1	(3)
Intolerants	1	(3)	1	(3)	1	(3)	1	(3)
Proportion of individuals as: (metrics 6-9, 11-12)								
Tolerants	76%	(1)	98%	(1)	85%	(1)	91%	(1)
Omnivores	8%	(5)	54%	(1)	8%	(5)	2%	(5)
Insectivores	89%	(5)	45%	(3)	90%	(5)	97%	(5)
Piscivores	3%	(3)	0%	(1)	1%	(3)	1%	(3)
Hybrids	0%	(5)	0%	(5)	0%	(5)	0%	(5)
Diseased	0%	(5)	0%	(5)	0%	(5)	0%	(5)
Total number of individuals in the sample (metric 10)	1189	(5)	2781	(5)	1264	(5)	3102	(5)
IBI total score		46		38		50		50
Integrity class (Appendix A)	Fair to Good		Fair		Good		Good	

[a] Darter species were not expected nor found. Since no comparable species could be substituted, this metric was assigned a value of 5.

(Table 6) and in the range considered indicative of moderate pollution ($\overline{H}$ of 1.0-3.0; Wilhm and Dorris 1968). The index of similarity indicated that the fish community from this location was most like that at the Hillebrandt Road station (Table 7).

Condition factors at this station for blue catfish and channel catfish were similar to values from Carlander (1969, 1977), high for gizzard shad and carp, and much higher for smallmouth buffalo (*Ictiobus bubalus*) and largemouth bass (Table 8). The high condition factors for bottom feeding fish suggest a healthier benthic macroinvertebrate community than at the upstream stations. The high condition factor for largemouth bass may be a sampling artifact since only one fish was collected.

The station was assigned a rating of good (Table 9) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for a less than excellent score include the low number of intolerant species (including suckers), the low proportion of piscivores, and the high proportion of tolerant individuals.

Hillebrandt Road

Eighteen fish species were collected at this station (Tables 4 and 5). Proportion of individuals as omnivores was lowest of all stations sampled, whereas the proportion of individuals as insectivores was highest of any station sampled. Habitat was similar to that found at Humble Road. The percentage of juvenile fishes--sunfish, largemouth bass, and yellow bass (*Morone mississippiensis*)--was highest of all stations, indicating the most suitable spawning habitat. Pugnose minnow were also collected at this station.

Species diversity was lowest at this station (Table 6) and in the range indicative of heavy pollution ($\overline{H}$ <1.0; Wilhm and Dorris 1968). Species diversity was depressed by the disproportionally large numbers of mosquitofish. The index of similarity between this station and the Highway 124 station was the highest in the study (Table 7).

Condition factors at this station (Table 8) for gizzard shad and blue catfish were similar to values from Carlander (1969, 1977); much lower for threadfin shad, carp, and bluegill sunfish; high for channel catfish; and much higher for smallmouth buffalo and white crappie (*Pomoxis annularis*). The high condition factor values for bottom feeding fish suggest a healthy benthic macroinvertebrate community. The low condition factor for carp may be a sampling artifact due to only one fish being collected. The values for blue catfish and white crappie, both piscivores, suggest an adequate prey base.

The station was assigned a rating of good (Table 9) based on the index of biological integrity (Appendix A; Karr *et al*. 1986). Major reasons for a less than excellent score include the low number of intolerant species (including suckers), the low proportion of piscivores, and the high proportion of tolerant individuals.

Conclusion

Overall, data for Hillebrandt Bayou indicate the potential for a diverse and healthy fish community. Piscivore condition factors suggest an adequate prey base throughout the bayou, and condition factors for bottom feeders suggest ample bottom food organisms in the lower two stations. However, condition factors for bottom feeders were depressed at the upper stations. Juvenile sportfish were collected at three of the four stations, indicating that nursery habitat existed. Localized pollution stress was observed immediately below the Beaumont Wastewater Treatment Plant, as evidenced by the low species richness, absence of juvenile sportfish, poor to fair index of biotic integrity rating, and the high proportion of pollution tolerant individuals. Once limiting factors are removed, potential for recovery is good given the proximity of Taylor Bayou as a source for recruitment.

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APPENDIX A. Total Index of Biotic Integrity (IBI) scores, the designated integrity class, and the attributes of those classes as modified from Karr et al. (1986).

Total IBI score (sum of the 12 metric ratings)	Integrity class	Attributes
58-60	Excellent	Comparable to the best situations without human disturbance; all regional expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of age (size) classes; balanced trophic structure.
48-52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress.
40-44	Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g., increasing frequency of omnivores and green sunfish or other tolerant species); older age classes of top predators may be rare.
28-34	Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
12-22	Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.
	No fish	Repeated sampling finds no fish.