Fisheries Use Attainability Study for Oyster Creek (Segment 1110)

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Oyster Creek, located within the San Jacinto-Brazos 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 fish community in the creek.

Study Site

Oyster Creek (Segment 1110) extends 128.4 km from the Brazos River Authority diversion dam at the Flat Bank Creek confluence in Fort Bend County to a point about 90 m upstream from the FM 2004 bridge in Brazoria County. The dam at Flat Bank Creek diverts unused or return irrigation water, originally pumped from the Brazos River into Oyster Creek via Jones Creek in the north part of Fort Bend County back into the Brazos River. Intermittent runoff, seepage around dams, and treated wastewater effluent constitute the only flow in Oyster Creek from the diversion dam to a point downstream where the Harris Reservoir discharge enters the creek near Holiday Lakes (Kirkpatrick 1977). Water from the Brazos River is pumped into Harris Reservoir for storage, released into Oyster Creek, and then transported via canal systems to the Dow Chemical Company water treatment plant in Freeport. Thus, the majority of water in both the upper and lower portions of Oyster Creek, although completely separated, originates from the Brazos River (Kirkpatrick 1977).

Four stations were surveyed in this study (Figure 1). Bottom substrate varied from soft silt at FM 1462 to firm clay and gravel at the Providence Road station. The bottom was fairly uniform (typical of channelized systems) at FM 521 and Walker Road. Some undercutting of banks was noted at the Walker Road site. Sticks and fallen timber were observed in the creek at all stations. Canopy cover was 60% at FM 1462 and Providence Road, 30% at FM 521, and 50% at Walker Road. Stream width and depth are listed in Table 1. Overall, habitat appeared adequate for a relatively diverse fishery.

Methods

Fish were collected on July 1-3, 1987. Representative habitats were sampled by common sense seine, experimental gill net, and electrofishing. The seine measured 4.5 m in length, 1.2 m in depth, and was composed of 3.1 mm ace weave mesh. The gill net was constructed of monofilament and was 60 m long, 2.4 m deep, and was composed of eight 7.5 m long panels varying in bar mesh size from 12.5 to 100 mm. The electrofishing unit was boat-mounted and equipped with multiple anodes suspended from a boom extending about four feet in front of the boat. The unit used a portable generator of 3000 watts and a converter that produced pulsed DC output.

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 the presence of disease and other abnormalities. All fish were preserved in 10% formalin and transported to the laboratory for identification. Taxonomic references included Eddy and Underhill (1978), Hubbs (University of Texas unpublished 1970 manuscript), and Pflieger (1975).

One gill net was set overnight at the Walker Road station for 15 hours. The net was set on the inside bank of a meander with the small mesh abutting the shoreline. An electrofishing boat was employed for one 15-minute period at each of the FM 521 and Walker Road stations. Fish collected by both techniques were identified, weighed, measured, and examined for disease and other abnormalities before their release. High turbidity precluded effective electrofishing.

Dissolved oxygen, pH, temperature, and conductivity were measured at each station using a Hydrolab Surveyor II. Stream width was measured by a tape measure, flow was measured with a flow velocity meter (Montedoro-Whitney Model PVM-2A), and depth was measured with an electronic depth finder or a staff. Discharge (m^3/sec) was calculated according to Orth (1983). Water transparency was measured with a Secchi disk and canopy cover

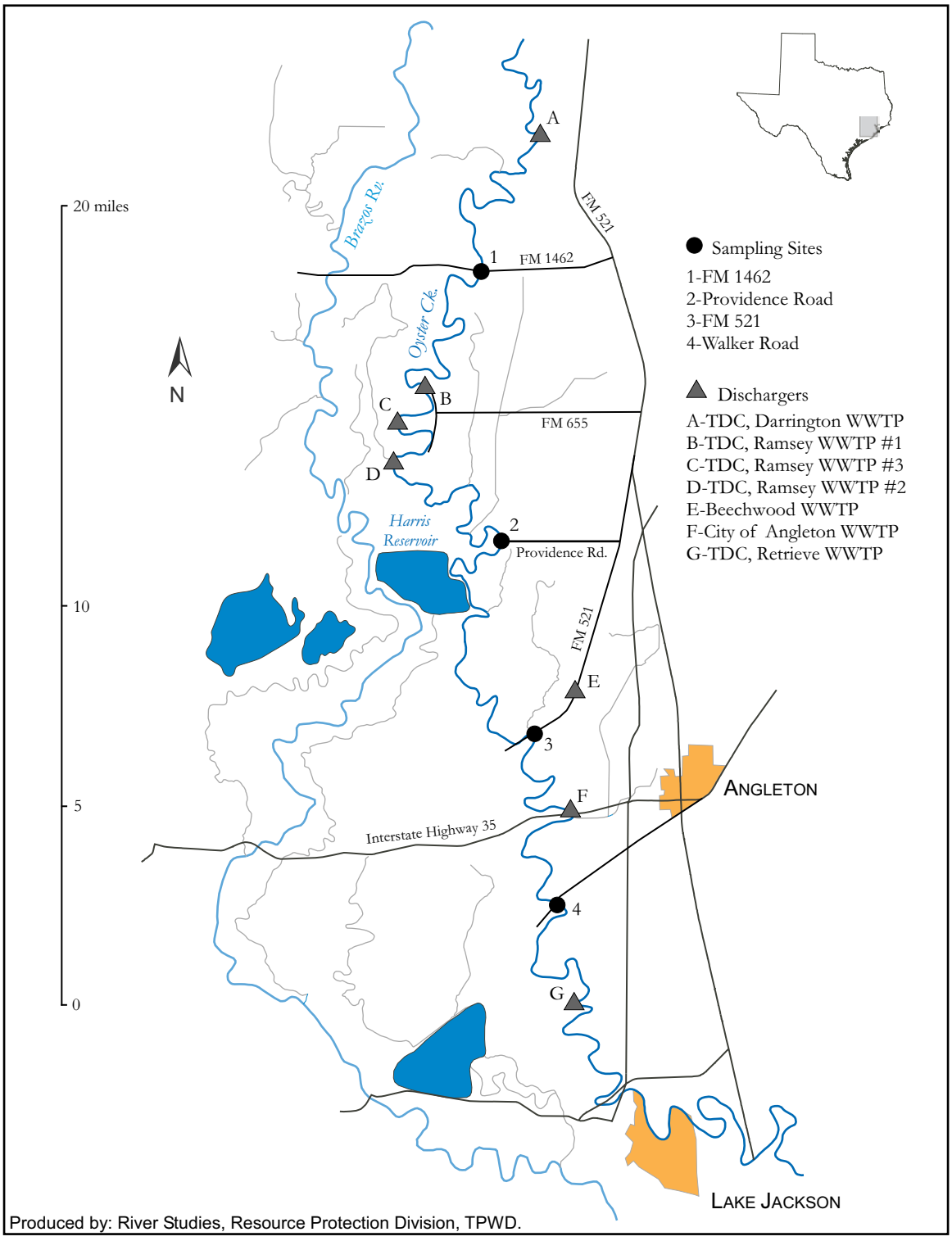

FIGURE 1.—Map of study area, including sampling sites and dischargers.

Table 1. Physiochemical measurements on Oyster Creek (July 1987).

Station	Date	Time	Channel Width (m)	Mean Depth (m)	Discharge (m^3/s)	DO (mg/l)	pH	Temp. (°C)	Cond. (*u*mhos)	Secchi Transparency (m)
FM 1462	7/2/87	1603	8.5	0.40	0.039	2.91	7.21	28.73	505	0.20
Providence Road	7/2/87	1409	5.7	0.39	0.395	3.58	7.35	29.10	552	0.05
FM 521	7/3/87	0919	10.5	1.58	3.460	5.21	8.09	29.53	742	0.18
Walker Road	7/2/87	0835	13.5	2.15	3.490	5.29	7.27	27.80	796	0.20

overhanging the stream channel was estimated by visual observation.

Seine data were used to calculate species diversity, index of similarity, and index of biotic integrity (IBI). Condition factors were calculated for fish collected by all methods.

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

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

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. A value of 0 indicates the sites are dissimilar, whereas a value of 1.0 indicates maximum similarity.

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 fish size, but larger values are generally indicative of better fish condition.

Index of biotic integrity was calculated according to Karr *et al*. (1986); however, the scoring criteria were modified (as suggested by Karr *et al*. 1986) to rate the Oyster Creek community (Table 2), which was estimated to be a third to fourth order stream. Scoring criteria for the total number of fish species was based on work performed in the Plum Creek drainage basin of south-central Texas and the Otter Creek drainage basin of north-central Oklahoma. In Plum Creek, a maximum number of 12 fish species were found in third and fourth order streams (Whiteside and McNatt 1972), while Harrel *et al*. (1967) found that total numbers of species collected from third and fourth order streams in Otter Creek were seven and 12, respectively. The values for both of these studies fall within expected ranges presented by Karr *et al*. (1986) for midwestern streams and were used to formulate scoring criteria for IBI Metric 1 (Table 2). 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. Mosquitofish (*Gambusia affinis*), goldfish (*Carassius auratus*), and green sunfish 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.

Emphasis was placed on species richness and the index of biotic integrity for characterizing the fish community. 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 information must be used with care, but as Young *et al*. (1973) point out the presence of fish species above an entry point of waste and their absence downstream from that point suggests the waste is limiting their occurrence. In addition, the index of biotic integrity provides a method 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. None of these indices are reliable indicators by themselves, but when used in conjunction with other methods, they can provide additional information for characterizing the system.

Table 2. Scoring criteria used for rating the index of biotic integrity of Oyster Creek.

Category		Metric	Scoring criteria 5	3	1
Species richness and composition	1.	Total number of fish species	≥12	6-11	0-5
	2.	Number and identity of darter species	≥3	1-2	0
	3.	Number and identity of sunfish species	≥2	1	0
	4.	Number and identity of sucker species	≥2	1	0
	5.	Number and identity of intolerant species	≥3	1-2	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%	1-5%	<1%
Fish abundance and condition	10.	Number of individuals in sample	>200	>50-200	≤50
	11.	Proportion of individuals as hybrids	0%	>0-1%	>1%
	12.	Proportion of individuals with disease or other anomaly	<2%	>2-5%	>5%

Results and Discussion

Water Quality Parameters

Physiochemical data are presented in Table 1. Dissolved oxygen proved a concern, as it dipped below 3.0 mg/L at FM 1462 despite the fact that readings were taken in early afternoon on a sunny day. D.0. was only slightly above 3.0 mg/L at Providence Road. Oyster Creek has a history of dissolved oxygen violations (Kirkpatrick 1986) and fish kills. This chronic problem probably stems from extensive diversion of water, the influence of wastewater discharges, and high turbidity with the resulting lack of aquatic macrophytes in the creek.

Fisheries Parameters

Species collected by gill net, electrofishing, and seine are presented in Tables 3 and 4. A total of 29 different species were collected in Oyster Creek, three of which are considered pollution intolerant by the United States Environmental Protection Agency (1983). These include longear sunfish (*Lepomis megalotis*), pugnose minnow (*Notropis emiliae*), and tadpole madtom (*Noturus gyrinus*).

FM 1462 Station

Species richness was greatest at this station. Fourteen of the 26 total fish species taken by seine were collected here (Table 4), including two pollution intolerant species. This station also had the highest number of sunfish species.

Species diversity (Table 5) was in the range considered indicative of moderate pollution (H of 1.0 - 3.0; Wilhm and Dorris 1968). The index of similarity between this station and the station at FM 521 was the highest in the study, whereas the lowest index of similarity was between this station and the station at Walker Road (Table 6).

When compared with values from Carlander (1969, 1977), condition factors calculated for this station were very low for gizzard shad (*Dorosoma cepedianum*) and white crappie (*Pomoxis annularis*); similar for bluegill sunfish (*Lepomis macrochirus*); and very high for largemouth bass (*Micropterus salmoides*) and longear sunfish (Table 7).

The station was assigned a rating of fair (Table 8) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for this rating include the absence of darter species (which according to Page 1983 are particularly sensitive to degradation of benthic habitat, due to their specificity for reproduction and feeding in that habitat); the absence of sucker species (which are often intolerant of habitat and chemical degradation); the high proportion of pollution tolerant individuals; and an imbalanced trophic structure.

Providence Road Station

Thirteen fish species were collected at this station (Table 4), including two pollution intolerant species. This station had the most imbalanced trophic structure and the lowest proportion of pollution tolerant individuals for this study.

Species diversity was highest at this station (Table 5), but was in the range normally associated with moderately polluted water (H of 1.0 - 3.0; Wilhm and Dorris 1968). The index of similarity indicated that the fish community from this station was most like that at the FM 521 station (Table 6).

When compared with values from Carlander (1969, 1977), condition factors calculated for this station (Table 7) were high for blue catfish (*Ictalurus furcatus*), bluegill sunfish, gizzard shad, and channel catfish (*Ictalurus punctatus*).

The station was assigned a rating of fair (Table 8) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for the rating include the absence of sucker species, the high proportion of pollution tolerant individuals, and an imbalanced trophic structure.

FM 521 Station

Ten of the 26 total fish species taken by seine were collected at this station (Table 4). Only one fish considered pollution intolerant by the United States Environmental Protection Agency (1983) was collected, thereby resulting in this station having the lowest number of intolerant fish. Proportions of pollution tolerant individuals and piscivorous individuals were highest of any station. Trophic structure at this station was balanced, with a slightly low proportion of insectivorous individuals.

Species diversity (Table 5) was in the range considered indicative of moderate pollution (H of 1.0 - 3.0; Wilhm and Dorris 1968). The index of similarity between this station and the station at FM 1462 was the highest in the study (Table 6).

Table 3. Fishes collected by gill net and electrofishing from Oyster Creek (July 1987).

Taxa	Common Name	FM 521	Walker Road
Dorosoma petenense	Threadfin shad	2[a]	1[b]
Ictiobus bubalus	Smallmouth buffalo	1[a]	1[a]
Lepisosteus oculatus	Spotted gar		1[b]
Notropis lutrensis	Red shiner		1[a]
Notropis venustus	Blacktail shiner	1[a]	5[b]

[a]--Electrofishing

[b]--Gill net

Table 4. Fishes collected by seine from Oyster Creek (July 1987).

Taxa	Common Name	FM 1462	Providence Road	FM 521	Walker Road
Aphredoderus sayanus	Pirate perch	2		4	
Carassius auratus	Goldfish		3		
Dorosoma cepedianum	Gizzard shad	4	104		
Etheostoma gracile	Slough darter		5		1
Fundulus chrysotus	Golden topminnow	1			
Fundulus notatus	Blackstripe topminnow	2			
Gambusia affinis	Mosquitofish	113	156	45	44
Ictalurus furcatus	Blue catfish		3		
Ictalurus natalis	Yellow bullhead		21	1	
Ictalurus punctatus	Channel catfish		3		
Lepisosteus sp.	Gar				1
Lepomis cyanellus	Green sunfish			5	
Lepomis gulosus	Warmouth	1			
Lepomis humilis	Orangespotted sunfish		9		
Lepomis macrochirus	Bluegill sunfish	10	2	10	3
Lepomis megalotis	Longear sunfish	1			
Menidia beryllina	Tidewater silverside				3
Micropterus salmoides	Largemouth bass	3		2	
Notemigonus crysoleucas	Golden shiner	7			
Noturus gyrinus	Tadpole madtom		24		
Notropis emiliae	Pugnose minnow	18	2	1	23
Notropis lutrensis	Red shiner	2	6		
Notropis shumardi	Silverband shiner				3
Pimephales vigilax	Bullhead minnow		3	1	
Poecilia latipinna	Sailfin molly	36		10	
Pomoxis annularis	White crappie	2		2	3
Total # of individuals/location		202	341	81	81
Total # of species/location		14	13	10	8
Mean # of species/sample		8.3	9.3	5.7	5.3
(± standard error)		±0.54	±0.19	±0.49	±0.50

Table 5. Fish community indices for Oyster Creek (July 1987).

Station	Species Richness	Species Diversity
FM 1462	14	2.19
Providence Road	13	2.21
FM 521	10	2.18
Walker Road	8	1.85

Table 6. Index of similarity in fish species composition between each possible combination of stations on Oyster Creek (July 1987).

	FM 1462	Providence Road	FM 521	Walker Road
FM 1462	-	-	-	-
Providence Road	0.37	-	-	-
FM 521	0.58	0.43	-	-
Walker Road	0.36	0.38	0.44	-

Table 7. Mean condition factors calculated for fishes collected in Oyster Creek (July 1987). Values from Carlander (1969, 1977) are included for comparison. Values in parentheses indicate numbers of fish used. Standard deviations for each species are listed when condition factors for at least three specimens were calculated.

Species	FM 1462	Providence Road	FM 521	Walker Road	Carlander
Dorosoma cepedianum	0.53(2)	1.01(26) ±0.272			0.94
Dorosoma petenense			0.39(2)		0.91
Ictalurus furcatus		0.98 (1)			0.81
Ictalurus natalis			1.44(1)		1.27
Ictalurus punctatus		1.04 (1)			0.83
Ictiobus bubalus			1.65(1)	2.11(1)	1.53
Lepomis megalotis	2.41(1)				1.93
Lepomis macrochirus	1.43(4) ±0.303	1.75 (1)			1.49
Micropterus salmoides	1.30(4) ±0.575		1.48(2)		1.00
Pomoxis annularis	0.89(2)		0.79(2)	1.58(3) ±0.414	1.27

Table 8. Summary table for calculating the index of biotic integrity (IBI) for Oyster Creek (July 1987). The metric ratings are given in parenthesis for each station and summed to generate the final index value.

Category	FM 1462		Providence Road		FM 521		Walker Road	
Number of species of: (metrics 1-5)								
Total	14	(5)	13	(5)	10	(3)	8	(3)
Darters	0	(1)	1	(3)	0	(1)	1	(3)
Sunfishes	3	(5)	2	(5)	2	(5)	1	(3)
Suckers	0	(1)	0	(1)	0	(1)	0	(1)
Intolerants	2	(3)	2	(3)	1	(3)	1	(3)
Proportion of individuals as: (metrics 6-9, 11-12)								
Tolerants	56%	(1)	47%	(1)	62%	(1)	54%	(1)
Omnivores	24%	(3)	40%	(3)	14%	(5)	0%	(5)
Insectivores	73%	(3)	59%	(3)	75%	(3)	95%	(5)
Piscivores	3%	(3)	1%	(3)	11%	(5)	5%	(3)
Hybrids	0%	(5)	0%	(5)	0%	(5)	0%	(5)
Diseased	1%	(5)	1%	(5)	0%	(5)	0%	(5)
Total number of individuals in the sample (metric 10)	202	(5)	341	(5)	81	(3)	81	(3)
IBI total score	40		42		40		40	
Integrity class (Appendix A)	Fair		Fair		Fair		Fair	

Condition factors at this station were very low for white crappie and threadfin shad (*Dorosoma petenense*) compared to values from Carlander (1969, 1977); high for yellow bullhead (*Ictalurus natalis*) and smallmouth buffalo (*Ictiobus bubalus*); and very high for largemouth bass (Table 7).

The station was assigned a rating of fair (Table 8) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for the rating include the absence of darter and sucker species and the high proportion of pollution tolerant individuals.

Walker Road Station

The lowest species richness occurred at this station. Eight species were collected by seine (Table 4), including one pollution intolerant species. The lowest number of sunfish species occurred at this station. No omnivorous individuals were collected and the station boasted the highest proportion of insectivorous individuals. Trophic structure was balanced, with only a slightly low proportion of piscivorous individuals.

Species diversity was lowest at this station (Table 5) and in the range considered indicative of 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 FM 1462 was the lowest in the study (Table 6).

When compared with values from Carlander (1969, 1977), condition factors calculated for this station were high for white crappie and smallmouth buffalo (Table 7).

The station was assigned a rating of fair (Table 8) based on the index of biotic integrity (Appendix A; Karr *et al*. 1986). Major reasons for the rating include the absence of sucker species and the high proportion of pollution tolerant individuals.

Conclusion

Fisheries indices calculated for this study suggest potential for a diverse aquatic community. Though low dissolved oxygen levels were recorded, no localized impacts on the fish community were observed below any effluent discharge point. However, high rainfall in 1987 may have improved stream conditions over typical years when the creek would have been more effluent dominated. Problems might be alleviated if additional flow could be maintained in Oyster Creek other than that contributed by intermittent runoff, seepage around dams, and treated wastewater effluent.

If limiting factors are alleviated, potential for recovery is very good due to the possibility of fish reinvading Oyster Creek from the Brazos River and Harris Reservoir.

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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.