Fisheries Use Attainability Study for the Nolands River (River Segment 1227)

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The Nolands River (Segment 1227), located within the Brazos River 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 river.

Study Site

The Nolands River (Segment 1227) extends 17.3 miles from the tailwaters of Lake Pat Cleburne to its confluence with the Brazos River in the headwaters of Whitney Reservoir. The river is used primarily for irrigation and watering of livestock, and to a lesser extent for recreation (Dick 1977). Three stations were surveyed for this report (Figure 1). Stream width increased from 8.3 meters at FM 1111 to 15.4 meters at FM 916 to 25.3 meters at FM 933 (Table 1). Average stream depth decreased from 0.5 meters at FM 1111 and FM 916, to 0.3 meters at FM 933 as stream width increased (Table 1). The greatest distinction between the upper and lower stations was the shift from a predominantly riffle habitat to more of a pool habitat punctuated by infrequent riffles. The bottom substrate at the upper and middle stations consisted of gravel and large rocks, whereas the lower station had a sandy bottom with scattered gravel. Terrestrial vegetation bordered the river for its entire length, with the densest vegetation being found at the upper station where 50% of the narrow channel was shaded by the canopy.

Discharge recorded by the United Stated Geological Survey on the day of the study was 1.7 m^3/sec at FM 933. Historically, minimum and maximum recorded discharges at FM 933 were 0 m^3/sec and 1675 m^3/sec, respectively (Buckner et al. 1985). Mean discharge over the last 20 years has been 2.3 m^3/sec (Buckner et al. 1985). No controlled releases are discharged from Lake Pat Cleburne. The only water entering the Nolands River is that which spills over the dam and that contributed by seven small tributaries, six of which are intermittent much of the year and contribute little flow to the main stream (Dick 1977). Buffalo Creek is the only stable source of water. The City of Cleburne Wastewater Treatment Plant discharges into Buffalo Creek and maintains the steady flow of the creek into the river. During low flow conditions, 90% of the flow in Buffalo Creek is estimated to be treated domestic sewage from the City of Cleburne (Dick 1977).

Methods

Fish were collected June 24, 1987. Representative habitats were sampled with a common sense seine measuring 4.5 m in length, 1.2 m in depth, and composed of 3.1 mm ace weave mesh.

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).

Dissolved oxygen, pH, temperature, and conductivity were monitored at each station using a Hydrolab Surveyor II. Stream width was measured with a tape measure, whereas average depth and canopy cover were estimated by visual observation.

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

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

where $\bar{H}$ = 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, species diversity 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

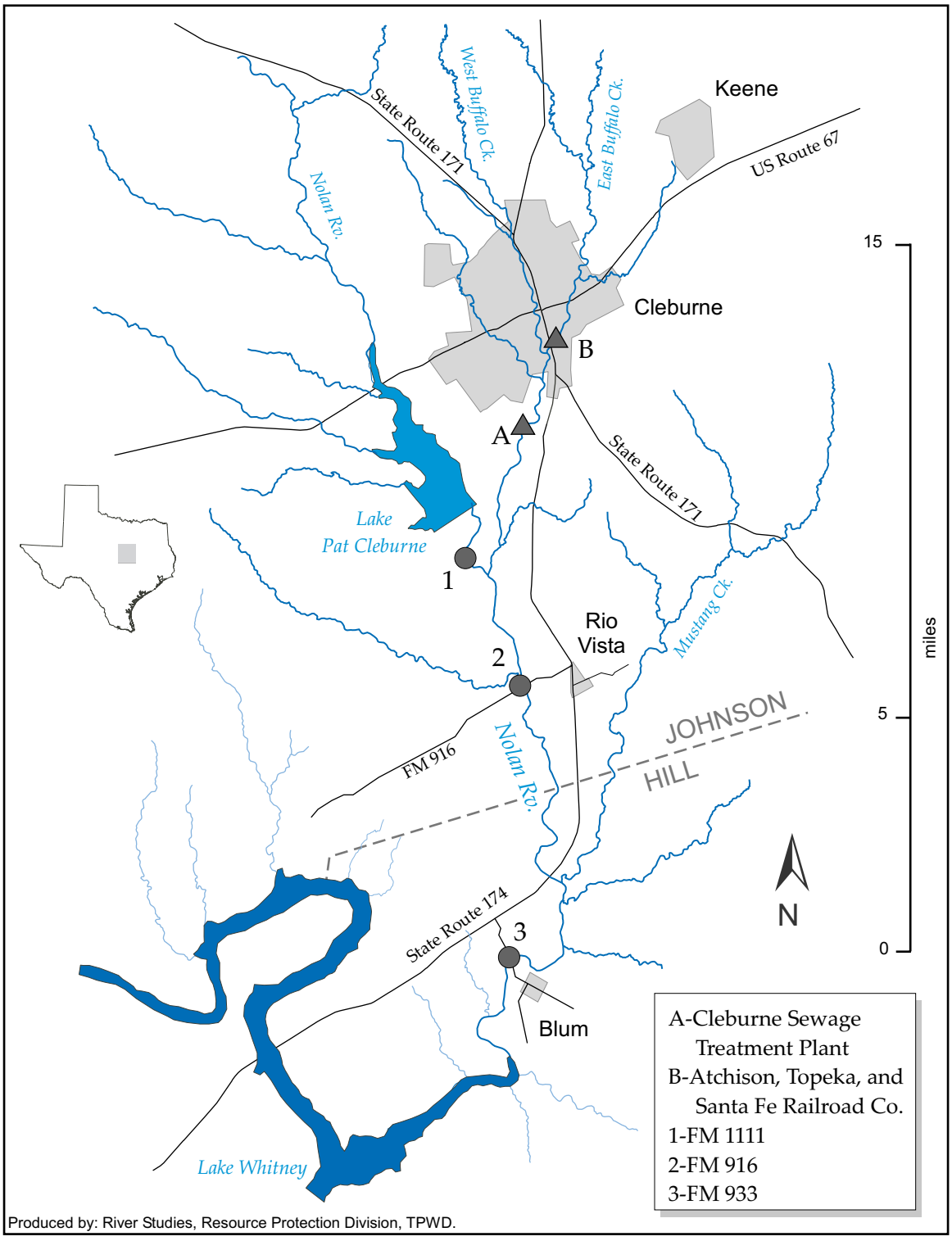

Figure 1. — Map of sampling area.

Table 1. Physiochemical measurements on the Nolands River (June 1987).

Station	Date	Time	Channel Width (m)	Average Depth (m)	DO (mg/l)	pH	Temp. (°C)	Cond. (*u*mhos)
FM 1111	6/24/87	1157	8.3	0.5	6.79	7.58	27.58	358
FM 916	6/24/87	1426	15.4	0.5	7.04	7.57	27.80	501
FM 933	6/24/87	1545	25.3	0.3	11.73	8.22	30.77	526

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 (IBI) was calculated according to Karr *et al.* (1986), though the scoring criteria were modified (as suggested by Karr *et al.* 1986) to rate the Nolands River 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 five and 11, 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*), and green sunfish were both 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 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 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.

Results and Discussion

FM 1111 Station

The lowest species richness occurred at this station where seven of the 16 total fish species in this Nolands River study were collected (Table 3). Physiochemical data reflect conditions at the time of sampling that would not limit use of the area by aquatic organisms (Table 1). This station was the only location where no sunfish or intolerant species were collected. The highest proportion of diseased fish was also collected at this station. Trophic structure at this station was balanced except for the low proportion of piscivorous individuals.

Species diversity (Table 4) was the lowest of any station sampled in this study and in the range considered indicative of heavy pollution ($\overline{H} < 1.0$; Wilhm and Dorris 1968). Species diversity was depressed due to the disproportionally large numbers of tidewater silverside (*Menidia beryllina*). The

Table 2. Scoring criteria used for rating the index of biotic integrity of the Nolands River (June 1987).

Category		Metric	Scoring criteria 5	3	1
Species richness and composition	1.	Total number of fish species	≥12	6-11	0-5
	2.	Total number of darter species	≥3	1-2	0
	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	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%

Table 3. Fishes collected by seine from the Nolands River (June 1987).

Taxa	Common Name	FM 1111	FM 916	FM 933
Campostoma anomalum	Central stoneroller	2		8
Dorosoma petenense	Threadfin shad			1
Fundulus notatus	Blackstripe topminnow	17	5	3
Gambusia affinis	Mosquitofish	6	97	19
Gambusia geiseri	Largespring gambusia		2	
Lepisosteus sp.	Gar		1	
Lepomis cyanellus	Green sunfish		2	1
Lepomis macrochirus	Bluegill sunfish		1	2
Lepomis megalotus	Longear sunfish		2	4
Lepomis microlophus	Redear sunfish			8
Menidia beryllina	Tidewater silverside	315	2	15
Micropterus salmoides	Largemouth bass		2	9
Notropis lutrensis	Red shiner	7	10	115
Notropis venustus	Blacktail shiner	14	5	26
Pimephales vigilax	Bullhead minnow			1
Pylodictus olivaris	Flathead catfish	2		

Table 4. Fish community indices for the Nolands River (June 1987).

Station	Species Richness	Species Diversity
FM 1111	7	0.86
FM 916	11	1.53
FM 933	13	2.35

Table 5. Index of similarity in fish species composition between each possible combination of stations on the Nolands River (June 1987).

	FM 1111	FM 916	FM 933
FM 1111	-	-	-
FM 916	0.56	-	-
FM 933	0.60	0.75	-

index of similarity between this station and the station at FM 916 was the lowest in the study (Table 5). Condition factors at this station for flathead catfish, *Pylodictus olivaris* (Table 6) were similar to those found in Carlander (1969)

The station was assigned a rating of poor to fair (Table 7) based on the index of biotic integrity (Appendix A; Karr *et al.* 1986). Major reasons for assigning this rating included: the absence of darter species which are particularly sensitive to degradation of benthic habitat (Page 1983), due to their specificity for reproduction and feeding in that habitat; the absence of sunfish species which are particularly responsive to the degradation of pool habitat and to other aspects of habitat structure such as instream cover (Gammon *et al.* 1981; Angermeier 1983); the absence of sucker species which are often intolerant of habitat and chemical degradation; and the absence of any species listed as intolerant by the United States Environmental Protection Agency (1983).

FM 916 Station

Eleven of the 16 total fish species collected during this study were found at this station (Table 3). As at the FM 1111 station, the physiochemical data reflect nonlimiting conditions for aquatic organisms (Table 1). The proportion of pollution tolerant individuals was the highest of any station sampled. No diseased fish were collected at this station. One species listed as intolerant by the United States Environmental Protection Agency (1983), the longear sunfish (*Lepomis megalotis*), was collected at this station. This station boasted the most balanced trophic structure, with only a slightly low proportion of piscivorous individuals.

The species diversity value for this station (Table 4) was higher than the upstream station and in the range considered indicative of moderate pollution ($\overline{H}$ of 1.0-3.0; Wilhm and Dorris 1968). The index of similarity between this station and the FM 933 station was the highest in the study, whereas the lowest index of similarity in the study was between this station and the FM 1111 station (Table 5). Condition factors at this station for largemouth bass (*Micropterus salmoides*) were similar to values from Carlander (1977) and low for green sunfish and longear sunfish (Table 6).

The station was assigned a rating of fair (Table 7) based on the index of biotic integrity (Appendix A; Karr *et al.* 1986). Major reasons for assigning the rating include the absence of darter species, the absence of sucker species and the high proportion of pollution tolerant individuals.

FM 933 Station

The greatest species richness occurred at this station with the collection of 13 of the 16 total fish species found in this study (Table 3). As at the other stations, physiochemical data reflect nonlimiting conditions for use of the area by aquatic organisms (Table 1). The highest number of sunfish species, including the intolerant longear sunfish, were collected at this station, probably because of the availability of spawning habitat. This station had the highest proportion of piscivorous individuals. However, the trophic structure here was the most imbalanced of any station. Both the high proportion of omnivorous individuals, and the low proportion of insectivorous individuals indicate disturbed conditions.

The species diversity value (Table 4) was the highest of any station sampled, but was still within the range normally associated with moderately polluted water ($\overline{H}$ of 1.0-3.0). The index of similarity between this station and FM 916 was the highest in the study (Table 5).

Condition factors at this station (Table 6) for bluegill sunfish (*Lepomis macrochirus*) were similar to values from Carlander (1977), and low for longear sunfish and redear sunfish (*Lepomis microlophus*).

The station was assigned a rating of fair (Table 7) based on the index of biotic integrity (Appendix A; Karr *et al.* 1986). Major reasons for assigning the rating include the absence of darter species, the absence of sucker species and the imbalance of the trophic structure.

Conclusion

Physiochemical conditions in the river at the time of sampling were adequate to support a variety of aquatic life, and abundant habitat exists for spawning. However, the fish community appeared to be limited, as evidenced by the index of biotic integrity ratings and lower than optimal species richness at FM 1111 and FM 916. Flow (other than wastewater effluent) may be the limiting factor preventing the most diverse and healthy fish community from existing. The absence of sunfish

Table 6. Mean condition factors calculated for fishes collected in the Nolands River (June 1987). Values from Carlander (1969, 1977) are included for comparison. Values in parenthesis indicate the number of fish used. Standard deviations for each species are listed when condition factors for at least three specimens were calculated.

Species	FM 1111	FM 916	FM 933	Carlander
Lepomis cyanellus		1.23(2)		1.87
Lepomis macrochirus			1.46(2)	1.49
Lepomis megalotis		1.48(1)	1.73(7) ±0.53	1.93
Lepomis microlophus			1.31(8) ±0.14	1.72
Micropterus salmoides		1.19(1)		1.21
Pylodictus olivaris	1.02(2)			0.97

Table 7. Summary table for calculating the index of biotic integrity (IBI) for the Nolands River (June 1987). The metric ratings are given in parenthesis for each station and summed to generate the final index value.

Classification of Data	FM 1111		FM 916		FM 933	
Number of species of: (metrics 1-5)						
Total	7	(3)	11	(3)	13	(5)
Darters	0	(1)	0	(1)	0	(1)
Sunfishes	0	(1)	3	(5)	4	(5)
Suckers	0	(1)	0	(1)	0	(1)
Intolerants	0	(1)	1	(3)	1	(3)
Proportion of individuals as: (metrics 6-9, 11-12)						
Tolerants	2%	(5)	77%	(1)	9%	(3)
Omnivores	6%	(5)	12%	(5)	67%	(1)
Insectivores	93%	(5)	84%	(5)	25%	(1)
Piscivores	1%	(3)	4%	(3)	5%	(3)
Hybrids	0%	(5)	0%	(5)	0%	(5)
Diseased	3%	(3)	0%	(5)	2%	(5)
Total number of individuals in the sample (metric 10)	363	(5)	129	(3)	212	(5)
IBI total score	38		40		38	
Integrity class (Appendix A)	Poor to Fair		Fair		Poor to Fair	

species and intolerant species at the upper station (most distant from Lake Whitney) and the total absence of sucker and darter species provide further support for the suggestion that flow is the limiting factor. Lake Whitney probably serves as a refuge for most species during low flow periods. However, this refuge would be unsuitable for some fauna. Consequently, the potential for a healthier fish community appears to depend on a reliable flow of water other than that contributed by runoff and treated wastewater effluent. Unless that water supply is available, the fish community will probably be restricted to less sensitive species which are able to withstand wide fluctuations in stream conditions.

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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.