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FINAL PROJECT REPORT

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FINAL REPORT

Project Title: Water Quality in the Coldwater River Basin: Comparing Traditional Measures of Water and Habitat Quality to Index of Biotic Integrity Findings

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Abstract:
The US Army Corps of Engineers in conjunction with the Mississippi Department of Environmental Quality has worked to determine the quality of water in the streams of the Mississippi Delta region using an Index of Biotic Integrity (IBI) approach. This approach to water quality monitoring seeks to use information extracted from fish community composition and habitat parameters to provide an integrated and comprehensive picture of water quality that is reported to be superior to traditional grab samples analyzed for chemical water quality parameters. We have been working to collect water samples from a subset of these sampling sites and analyzing this water using traditional measures of water quality. These samples have been analyzed for a variety of chemical (Nitrite÷Nitrate-Nitrogen, Ammonium-Nitrogen, Soluble Reactive Phosphorus, Oxygen, pH), biological measures (Total Coliform bacteria, Fecal Coliform bacteria, Chemical Oxygen Demand), and physical measures (suspended sediments, temperature). We compared these data sets by examining correlations between IBI scores and quantitative measures of water quality. This approach did not help substantiate the value of the IBI approach or provide guidance for mitigation and restoration activities that likely would benefit these streams.

Data:
Raw data are presented in table 1.
Figure 1 displays the locations of the sampling sites used in this study. Sites marked in red were those with IBI scores of 13 or less and sites marked in blue were those with IBI scores above 13. Overall IBI score for the 2 sites ranged from 9 to 20.
Data from earlier wetland plant investigations were reported previously in our 2007 final report.

Results:
Linear relationships for select parameters compared to IBI scores for the sampling location are presented in Figure 2.

Temperature: The relationship between temperature and IBI score is basically flat, suggesting little relationship between the measures. Given the limited range of temperatures encountered this finding was not unexpected. It was hoped that temperature might serve as a surrogate measure for canopy cover or land use characteristics, based on these results there is little suggestion that these relationships would be informative.

Dissolved Oxygen: The overall relationship between dissolved oxygen concentrations and IBI score is negative, with increasing IBI score associated with lower dissolved oxygen concentrations. However this relationship is misleading for 2 reasons; first there are 3 highly influential data points in the lower right quadrant that shifted the slope of the line negative. These 3 points had lower dissolved oxygen concentrations then would have been expected. If these points are not included there would have been a positive relationship with dissolved oxygen concentrations, a finding better supported by the literature. The fish used in the IBI analysis are, in part, scored based on their environmental tolerances of which dissolved oxygen is an essential component, higher quality fish require higher dissolved oxygen concentrations. The second factor that causes the dissolved oxygen data to be potentially misleading is that the majority of the data used in this analysis involved dissolved oxygen concentrations that exceeded saturation. This is not uncommon in stream systems that usually are kept near saturation by flow-induced introductions of atmospheric oxygen and supplemented by photosynthetically provided oxygen. Once oxygen concentrations approach saturation there is little added benefit to biota from supersaturation.

Turbidity: The relationship between turbidity and IBI scores is the opposite of that which was expected. As with the dissolved oxygen data there were 4 points in the lower right quarter that appeared to be lower than would have been expected. The broader relationship tended to suggest that IBI scores increased with higher levels of turbidity. High levels of turbidity are generally associated with poor water quality conditions and poor fish communities. It is possible that certain turbidity tolerant fish species could dominate these systems resulting in the observed trend.

Suspended Sediments: Suspended sediments are directly related to turbidity as the measurements both (in different ways) evaluate material in the water column. In general the same relationship is observed in the turbidity and suspended sediment data. The suspended sediment data do not show the same degree of upward trend as turbidity was more profoundly impacted by the highest measured values.

Ammonia, Nitrate, and Phosphorus: Collectively the relationship between this group of inorganic nutrients would be expected to be strongly negative. Usually high concentrations of these constituents is associated with extremely high levels of periphyton and macrophytic growth. While moderate growth is essential for providing organic matter needed for metabolism, high levels of production produce extreme diurnal dissolved oxygen concentration variability that is deleterious to fish. The data presented here do not suggest that this occurred as the linear relationships were generally only slightly positive or negative. The moderated impact of these inorganic nutrients is likely a result of the high inorganic turbidity which reduces light penetration needed for photosynthetic growth. Alternatively the sediments may not provide an appropriate substrate for growth.

Chemical Oxygen Demand: Chemical oxygen demand is a measure of organic compounds dissolved in the water that can be oxidized chemically. It is similar to biochemical oxygen demand, except that the oxidation is performed chemically. In general the negative relationship between chemical oxygen demand and IBI scores is as would have been anticipated, lower levels of organic matter were associated with higher quality fish assemblages. There is a cluster of 3 values at middle IBI levels that had disproportionately high chemical oxygen demands. The exclusion of these points would have improved the overall relationship.

Total and Fecal Coliform Bacteria: Coliform bacteria are used as indicators of water quality in streams that are susceptible to loading from waste products of warm blooded organisms. As is apparent in table 1 and figure 2 total coliform concentrations were greater than the upper detection limit, 200 cells ml^{-1}, in all samples collected. This prevented us from obtaining information from this parameter. Fecal coliforms are a subset of the total coliform and while they were less frequently above the upper detection limit, the explanatory value of this data is extremely low. Taken as a whole the coliform data do not suggest high quality, un-impacted waters in the Coldwater Basin.

Recommendations:
Further refinement of the IBI procedures are needed prior to their use as surrogate measures of water quality. The extremely low level of correlation between traditional measures of water quality and IBI scores were worse than anticipated. While the IBI procedure is defined by its ability to integrate water quality over long periods of time by using the fish community as an indicator was expected to result in relatively low levels of correlation, the extremely poor correlations were unexpected. A review of any of the parameters considered demonstrated that high or low levels of the parameter can be associated with high or low IBI scores. It may be necessary to re-evaluate the IBI scoring criteria in light of these results.

Budget: **I do not have access to this information any longer. I suggest you contact Becky Springer for the needed details.**

Presentations:

Bried, J. T. and G. N. Ervin. 2008. Making invasiveness count in floristic quality assessments. Society of Wetland Scientists, Washington, DC, May 26-30, 2008.

Tietjen, T.E. 2008. Stream Water Quality in the Mississippi Delta: Rankings Based on Index of Biotic Integrity Scores and Limnological Measures. Joint Meeting of the Mississippi and Arkansas Chapters of the American Fisheries Society. Tunica, MS

Tietjen, T.E. 2008. Assessing Water Quality in Streams of the Mississippi Alluvial Valley. Annual Meeting of the North American Benthological Society. Salt Lake City, UT.

Tietjen, T.E., G. Ervin. 2008. Comparing Index of Biotic Integrity Scores to Traditional Measures of Water Quality: Exploring the Causes of Impairment in Streams of the Mississippi Delta. Mississippi Water Resources Conference. Jackson, MS.

Students:

Christopher Doffitt	Ph.D. Student	Biological Sciences
D. Christopher Holly	Ph.D. Student	Biological Sciences* graduated August, 2008
Hawken Brackett	Undergraduate	Wildlife and Fisheries
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Figure 1. Location of sampling sites in the Mississippi Alluvial Valley. Sites marked in red were those with IBI scores of 13 or less and sites marked in blue were those with IBI scores above 13. Overall IBI score for the 2 sites ranged from 9 to 20.

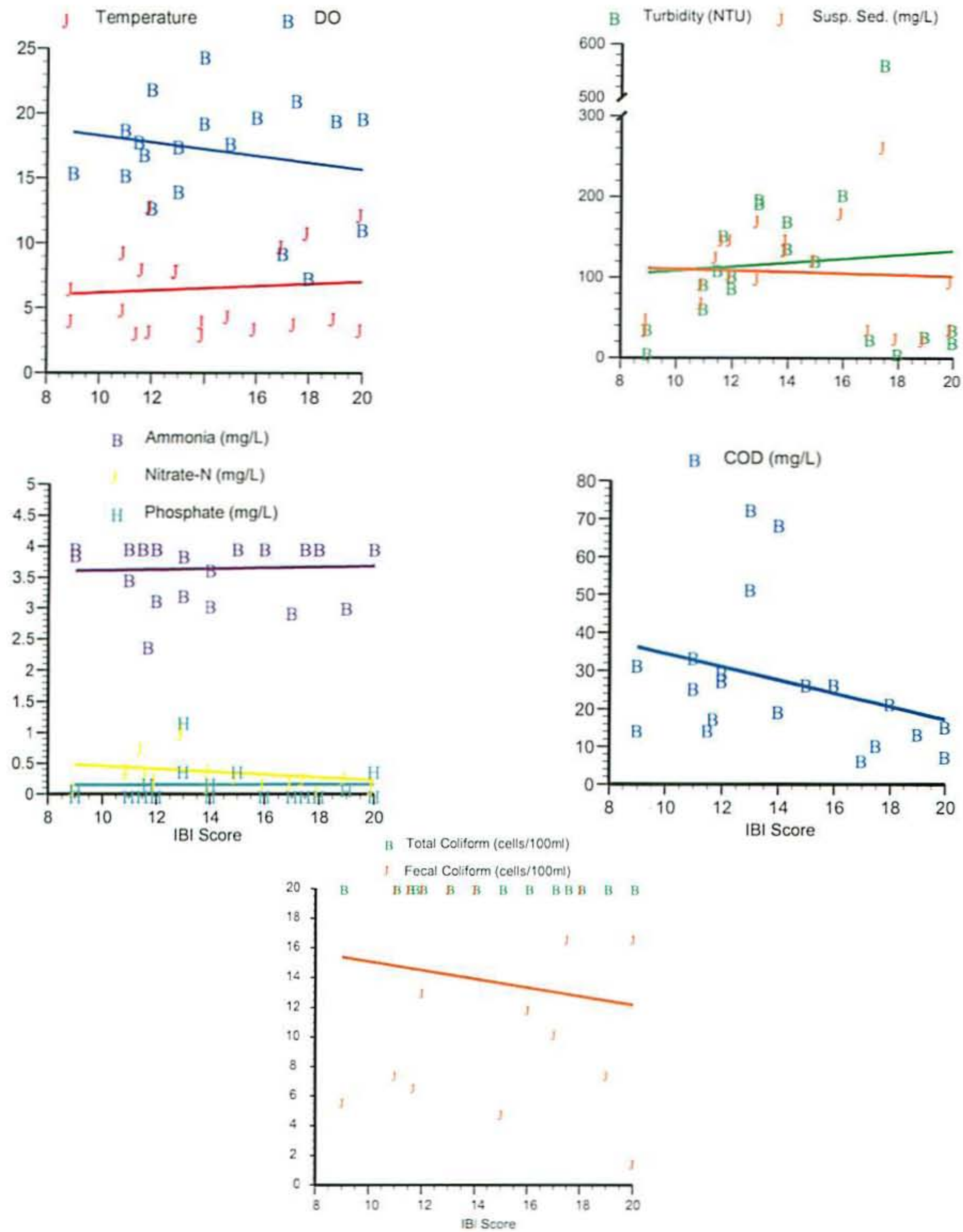

Figure 2. Water quality parameters plotted against their corresponding IBI scores. Lines represent linear relationships between the parameters.

Table 1. Raw data used in this analysis.

Site	IBI Score	Temperature °C	Specific Conductance µS cm^{-1}	Dissolved Oxygen mg O_2 L^{-1}	pH	Turbidity NTU	Dissolved Oxygen % Saturation	Total Coliform Cells 100 ml^{-1}	Fecal Coliform Cells 100 ml^{-1}	Suspended Sediments mg L^{-1}	Ammonia mg N L^{-1}	Nitrate mg N L^{-1}	Phosphate mg P L^{-1}	Silica mg Si L^{-1}	Chemical Oxygen Demand mg L^{-1}
1	13	8.07	199	17.64	8.29	198.9	150.3	200	200	100	3.88	1.15	1.2	7	73
2	13	8.01	213	14.20	8.00	194.6	120.84	200	200	172	3.24	1.03	0.4	7	52
3	11.7	8.17	177	17.03	7.87	154.2	145.51	200	200	149	2.41	0.38	0.2	9	18
4	11	9.46	236	15.43	7.74	62.8	135.98	200	200	70	3.5	0.45	0	3	26
5	19	4.4	127	19.65	8.38	28.6	152.6	200	15	24	3.04	0.3	0.1	7	14
6	8.5	6.65	252	20.79	8.00	37.2	171.07	200	56	50	4	0.1	0.1	6	32
7	14	4.14	172	19.45	8.78	172.1	150.01	200	200	149	3.07	0.42	0.2	10	20
8	15	4.58	202	17.88	8.16	123	139.56	200	119	124	4	0.32	0.4	9	27
9	12	3.38	685	22.07	8.66	103.7	167.16	200	130	149	4	0.27	0	5	30
10	14	3.13	126	24.57	8.38	138.4	184.49	200	48	136	3.66	0.16	0	8	69
11	11	5.05	295	18.90	7.92	93.4	149.4	200	200	94	4	0.39	0	8	34
12	16	3.6	175	19.89	8.19	204.8	151.23	200	102	182	4	0.18	0	10	27
13	11.5	3.26	143	18.02	7.77	110.8	135.75	200	66	127	4	0.78	0	5	15
14	17.5	3.98	97	21.20	8.28	565	162.81	200	200	264	4	0.28	0	1	11
15	18	11	104	7.54	7.93	6.7	68.94	200	74	26	4	0.07	0	9	22
15	18	5.84	85	11.89	8.35	20.3	95.83	200	21						
16	20	12.4	133	11.28	7.69	37.2	106.44	200	166	38	4	0.15	0	4	8
16	20	6.12	174	19.83	7.95	27.3	160.98	200	89						
17	17	9.94	82	9.43	7.79	25.1	84.08	200	166	37	2.96	0.21	0	6	7
17	17	4.82	67	20.17	8.14	28.9	158.32	200	200						
18	12	13	119	12.93	7.63	88.8	123.59	200	200	106	3.16	0.19	0	5	28
18	12	6.76	87	22.25	7.81	323.7	183.51	200	145						
19	7	4.25	72	15.61	8.46	7.1	120.76	200	74	36	3.9	0.12	0	1	15
20	20	3.51	201	19.81	8.00	21.3	150.31	200	166	97	4	0.12	0.4	14	16