FISH COMMUNITY INDICES

FOR

LONG TERM MONITORING

IN RESPONSE TO

IMPLEMENTATION OF ENVIRONMENTAL FLOW RECOMMENDATIONS

IN THE CADDO LAKE WATERSHED

TRUNGALE ENGINEERING & SCIENCE

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Holistic Monitoring Program for Caddo Watershed Environmental Flows Project

The Caddo Lake Institute (CLI) initiated the environmental flows project ("Project") to restore and protect healthy flows in the Caddo Lake watershed and larger Cypress Basin in 2004 as part of the Sustainable River Project (SRP) (a cooperative program between the U.S. Army Corps of Engineers (USACE) and the Nature Conservancy (TNC)). The initial goal was to seek changes to reservoir operations at Lake O' the Pines (LOTP) to meet a recommended flow regime to restore and maintain the ecological health of Big Cypress Creek and Caddo Lake while also meeting the water needs of people. The Project has since expanded its scope to include recommendations for flow regimes to other major tributaries to Caddo Lake and within the Cypress Basin.

The overall objective is assuring a sound ecological environment, which is defined as

> *"A resilient, functioning ecosystem characterized by intact, natural processes, and a balanced, integrated, and adaptive community of organisms comparable to that of the natural habitat of a region." (TIFP 2008)*

Monitoring is necessary to determine if the recommended flow regimes, and any steps to obtain them, such as changes to reservoir operations at LOTP, are having their intended results and to adjust the recommendations for environmental flows, if necessary. In 2013, the Project developed a holistic approach for monitoring in the Caddo Lake watershed based on an approach developed by TNC and the USACE (Higgins et al 2011. This holistic approach includes monitoring in three areas, which include monitoring of 1. the implementation of environmental flow recommendations, 2. short-term responses to support adaptive management, and 3. long-term ecosystem status and trends. Within the long-term monitoring plan, the project identified two primary areas for evaluation: 1. fish community indices and 2. riparian vegetation community. The riparian vegetation community evaluations are the subject of other on-going data collection and analysis. This report deals with the development of fish community indices to track long-term status and trends in response to the implementation of environmental flow regime recommendations in the Caddo Lake watershed.

The most widespread and consistent biological monitoring program currently taking place in Texas is the Surface Water Quality Monitoring Program (SWQM), which is administered by the Texas Commission on Environmental Quality (TCEQ) as part of the state's Clean Rivers Program (CRP). The SWQM program is designed to characterize existing conditions or identify emerging problems, evaluate the effectiveness of water quality control programs, and identify trends. Data and analysis generated by the SWQM program is primarily used to determine compliance with the Texas Surface Water Quality Standards. Widespread application of the program and a consistent and well-documented data collection program make the SWQM program an attractive model for the development of the monitoring program for this Project; however, a number of modifications to the SWQM approach would be needed to make it more useful for monitoring response to the implementation of environmental flow regimes. Chief among these is the need to develop indices and indicator ranges that are tied to hypotheses that relate specially to the kinds of flow alterations that are proposed in the flow recommendations. As implied above, the SWQM program is primarily designed to address issues resulting from water quality impairments. Thus the primary metric developed from the SWQM program, the Index of Biotic Integrity (IBI) is designed to detect response to degradation of water quality. While the framework, and possibly much of the underlying data, used to develop IBI metrics may be useful for indicators to access response to changes in flow regimes, it is likely that IBI metrics may miss specific components of the overall community that are impacted by altered flow regimes and that thresholds identifying impacts may be different. Therefore, the IBI metrics will serve as a starting point for the development of metrics specific to evaluating response to flow regime alterations.

Incorporating a monitoring program designed to detect responses to flow regime alternations within the established program such as SWQM would have a number of advantages (Maidment et. al. 2005), however after reviewing the current SWQM program in the Cypress Basin it was determined that, at least at this early stage, the level of effort required, both in terms of the special extent and frequency of occurrence, would be better addressed with a collection effort directed specifically at this task. Fortunately, the Texas Park and Wildlife Department (TPWD) has a program called "BioBlitz" that they were able to direct to the Caddo watershed in 2014. A BioBlitz is an intensive effort to collect and categorize fish, insects, mussels, etc. and survey habitat. The sampling protocol of the BioBlitz program is in many ways consistent with SWQM and TNC and CLI were able to meet with TPWD staff and provide input to the BioBlitz sampling protocol to address the specific interests of the Project. The remainder of this report describes three steps in the development of fish community indices for long term monitoring of response to implementation of environmental flow regime recommendations in the Caddo Lake watershed. These are:

1. Review existing historical fish sampling data and develop hypotheses of responses in fish community to alterations from natural flow regimes,
2. Collect additional data for tracking long term trends in fish community
3. Propose specific metrics and threshold levels that will be carried forward as part of the long-term monitoring program.

1 Review of Existing Historic Fish Sampling Data

Analysis of existing fish community data has been and continues to be an integral part of the Project. (CLI, 2008) The earliest data collection efforts in the Cypress Basin were made in the 1950s by the Texas Game and Fish Commission. (TGFC 1953, 1959). These collections describe a community dominated by cyprinids (Figure 1-1).

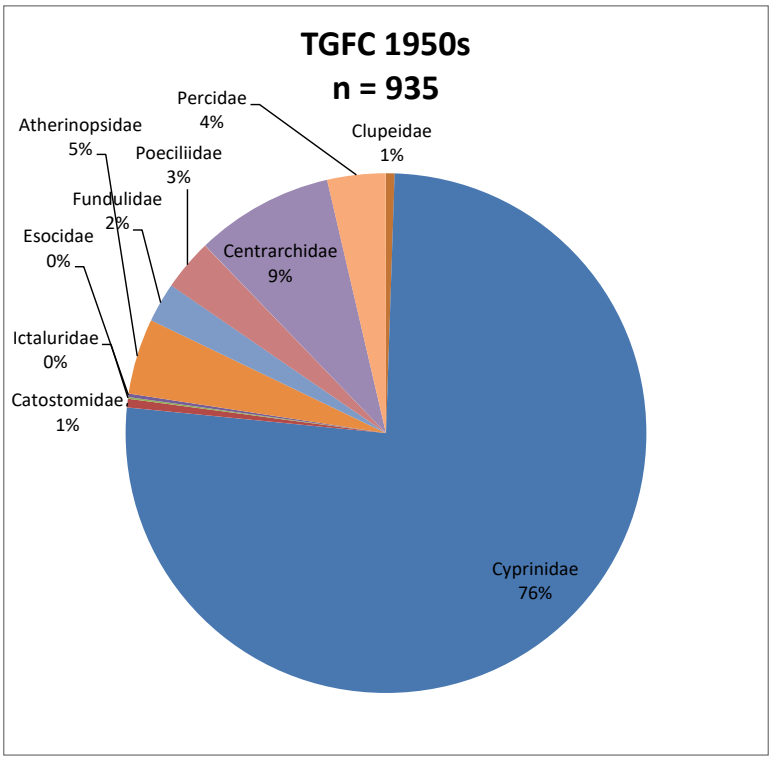

Figure 1-1 Percent by family of fish community in Big Cypress in the 1950s

During the 1980s and 1990s several water proposed development projects lead to the collection of additional data by the USACE and USFWS. These collections show a marked change in the distribution of families (Figure 1-2).

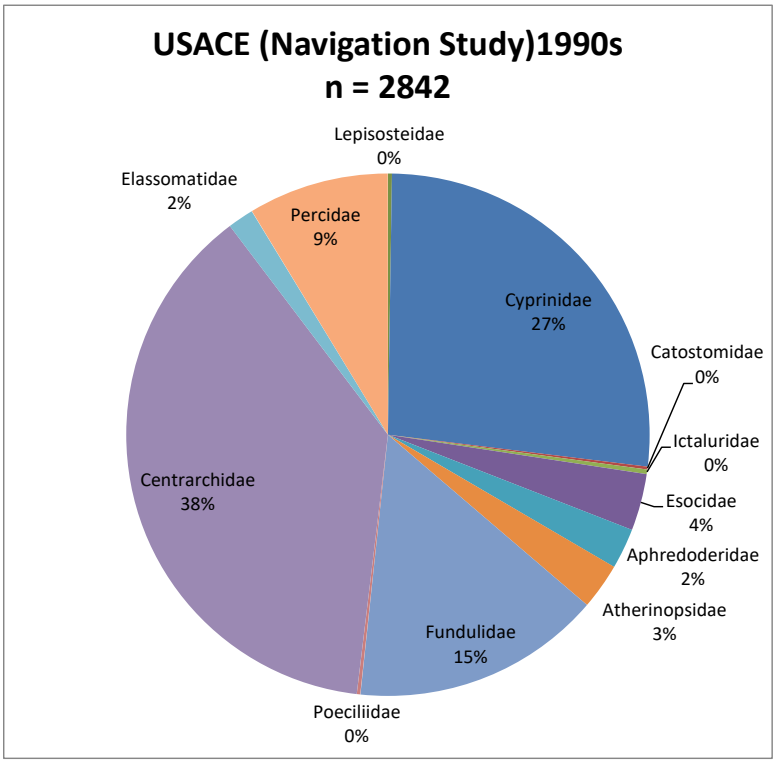

Figure 1-2 Percent by family of fish community in Big Cypress in the 1990s

A review of this data lead to the conclusion that "the ichthyofauna of the Cypress Creek basin appears to have shifted from assemblages dominated by cyprinids, percids, and cyprinidontids in the 1950s to assemblages dominated by centrachids, other cyprinids, clupeids, and atherinids in the 1980s." (Hoover unpublished manuscript). More recent community level sampling efforts conducted as part of the Caddo SRP project have been consistent with this finding. (Figure 1-3)

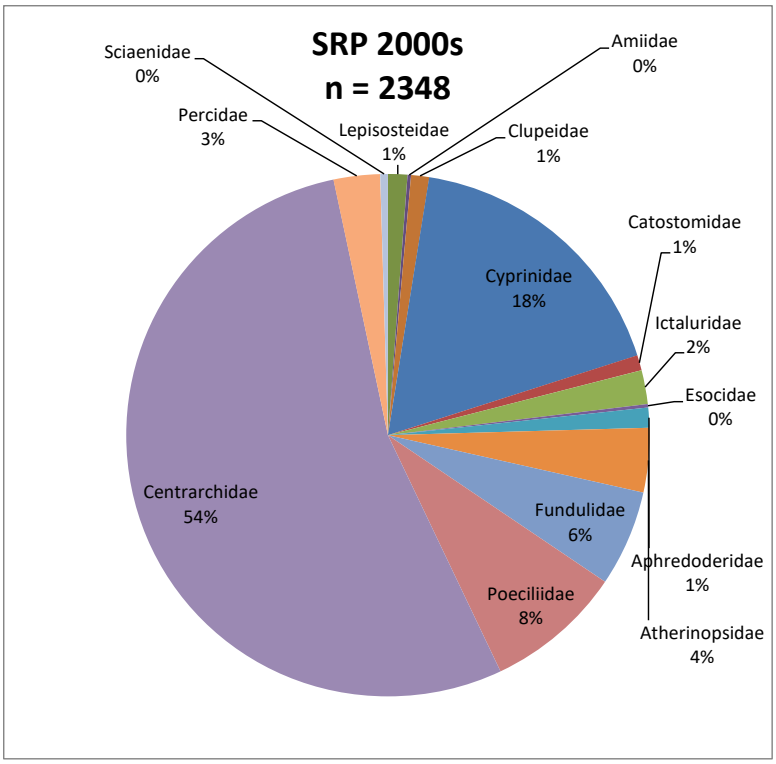

Figure 1-3 Percent by family of fish community in Big Cypress in the 2000s

This shift in the community from riverine specialists to generalist is a well-documented response to altered flow regimes. It has been the working hypothesis of this Project that a restoration of critical components of the natural flow regime will provide the habitat conditions supportive of a balanced, integrated, and adaptive community of organisms comparable to that of the natural habitat of the region. More specific than the family level analysis, the hypothesis relates habitat conditions provided by different flow regimes and is supported by data analysis indicating that reproductive guilds that include riverine obligate species appear to be declining while more generalist species appear to be increasing.

Table 1 Trends in reproductive guilds in terms of relative abundances. (Pelagophils: Obligate riverine species, broadcast-pawn buoyant eggs within current, Lithophils: Includes most centrarchidae, spawn elliptical egg envelopes over rock or gravel nests.)

Reproductive Guild	1953-54	1995	2006
Non guarders			
Open Substratum			
Pelagophilis	22.49	7.25	0.072
Guarders			
Nest Spawners			
Lithophils	7.38	42.58	56.15

2 Data Collection

The BioBlitz sampling program is based on TPWD guidelines that have been used by the SB2 Texas Instream Flow Program and is consistent with procedure and methods used in the SWQM protocol. The goal of the fish sampling effort was to collect a representative sample of the species present in their relative abundances. All available habitats and combinations of habitats were sampled. Beyond the minimum efforts, sampling continued until no

additional species were collected. In most streams, fish were collected using multiple gear types—seines and electrofishers. The habitat team will worked with the sampling team and recorded habitat data for each seine haul and electrofishing effort.

Fish, benthic macroinvertebrate, mussel, water quality and riparian, and instream habitat data were collected at one oxbow and sites on Big, Little and Black Cypress Bayous upstream of Caddo Lake. The complete details of the sampling efforts and summary of results are provided in the attached BioBlitz report prepared by TPWD. A brief summary is provided below.

The summary of the activity includes: At least 26 species of fish were collected. The fish samples are still being processed, so the species number will likely increase. Fish collected include at least 6 species of sunfish, Spotted and Largemouth Bass, Spotted and Longnose Gar, Bowfin (pictured above), Spotted Sucker, Pirate Perch, 3 species of darters, Channel Catfish, madtoms and several minnow species. Of the fish species collected, at least one, the Blackside Darter, is listed as state threatened by TPWD. A healthy mussel population was also found in the bayous (9 species collected in photo below), including one state threatened species, the Texas Pigtoe.

On top of collecting fish and invertebrate data, the overall stream health was measured by assessing the riparian corridor and instream habitat and stream water quality. All of the data collected will serve as a benchmark to measure how the river changes through time. This study will serve as a new starting point for a continued biological monitoring program in the watershed.

3 Analysis and Recommendations

Once the BioBlitz report is completed, data will be analyzed and appropriate metrics calculated. Deviations from expected results (e.g. presence or absence of expected species) will be noted. Potential explanations for deviation will be hypothesized and sampling protocol will be adjusted as necessary.

The indicators will consist of a suite of metrics to evaluate the response of flow-sensitive species to restoration of natural flow regimes. The development of indicators will begin with review of the IBI (Index of Biotic Integrity). An IBI combines several metrics within three broad categories (species richness and composition, trophic composition, and fish abundance and condition) to produce an IBI score and, based on that score, classify the integrity of the stream (limited, intermediate, high or exceptional). In Texas, the IBI has been used primarily for receiving water assessments and the metrics and scores that have been developed are considered sensitive to changes in water quality.

The biological subcommittee will consider expansion and refinement of select metrics within the IBI that may be more sensitive to restoration of the natural flow regime. A similar approach has been initiated in the Sabine Basin, which may serve as a model for the development of metrics specific to the Cypress Basin.

The biological subcommittee will begin by addressing the following questions.

1. Which species or guilds have responded (increasing or decreasing) in response to altered flow regimes in Big Cypress?
2. What species, within families included above, would expect to show a response to a restoration of a more natural flow regime? Are particular guilds (habitat, reproductive, feeding) important indicators?
3. What specific metrics need to be calculated (richness, diversity, etc.) and would these need to be tied to specific life stages? This would be used to inform the next question.
4. Is the current clean rivers program protocol able to capture the data that are needed? If not, what modifications are needed?
5. Can a natural range of variability (NRV) or something analogous to an IBI score be developed to define expected results? What is good and what is bad based on sampling results and how can that be communicated in a way that would validate, refute or suggest modification to the flow recommendations? What is the expected time frame for seeing a response? Are there any means to control for or consider confounding variables?

Initially, thresholds will be defined based on application of metrics developed above to historical fish collections. Synoptic sampling efforts have been conducted during at least three time periods (in the 1950s, 1990s and 2000s) which will be used to construct baseline references for range of natural variability in biotic assemblages. Although the specific indicator indices have not yet been finalized, the biological sub-committee has been assembling and analyzing historical collections and made preliminary evaluations of long-term trends (Figure 3 and 4). Primary findings are consistent with previous hypotheses, namely that “The ichthyofauna of the Cypress Bayou basin appears to have shifted from assemblages dominated by cyprinids, percids, and cyprinidontids in the 1950s to assemblages dominated by centrachids, other cyprinids, clupeids, and atherinids in the 1980s.” This analysis may help to inform indicator selection, provide initial estimates of threshold targets and may direct short term monitoring efforts aimed at developing better understanding between flow and habitat.

4 References

Braun, C.L., and J.B. Moring. 2013. Baseline assessment of physical characteristics, aquatic biota, and selected water-quality properties at the reach and mesohabitat scale for reaches of Big Cypress, Black Cypress, and Little Cypress Bayous, Big Cypress Basin, northeastern Texas, 2010–11: U.S. Geological Survey Scientific Investigations Report 2013–5058, 90 p.

Caddo Lake Institute. 2014. Implementation of Building Blocks Recommendations at Lake O' the Pines on Big Cypress Creek, Sustainable Rivers Project.

Higgins, J. V., C. P. Konrad, A. Warner, and J. T. Hickey. 2011. A framework for monitoring, reporting and managing dam operations for environmental flows. Version 1.0. SRP measures working group.

Hoover et al. 1989. Fishes of the Cypress Bayou System in Northeast Texas and Northwest Louisinana. Unpublished manuscript.

Maidment, D., P. Montagna, A. Sansom, G. Ward, and K. Winemiller. 2008. Scientific Principles for Definition of Environmental Flows. Prepared for Environmental Flows Conference, Texas State University, San Marcos, 31 October 2005.

Texas Instream Flow Program (TIFP). 2008. Texas Instream Flow Studies: Technical Overview. Texas Water Development Board Report 369:1–137, Texas Water Development Board, Austin, TX.

The Nature Conservancy (TNC). 2002. Ecological Integrity Assessment: A Framework for Conservation Planning and Measuring Success. Report of the Ecological Systems Viability Workgroup, March 2002.

U.S. Army Corps of Engineers. 1994. Red River Waterway Project, Shreveport, LA, to Daingerfield, TX, Reach Reevaluation Study In-Progress Review.

Winemiller, K.O., , A. Chin, S. E. Davis, D. L. Roelke, L. M. Romero, and B. P. Wilcox. 2005. Summary Report Supporting the Development of Flow Recommendations for the Stretch of Big Cypress Creek Below Lake O' the Pines Dam.