Flow-Ecology Workshop
Big Cypress Bayou – Caddo Lake
May 4-5, 2005
(As issued July 2005)
Workshop Summary

Workshop Agenda and Purpose

A flow-ecology workshop was convened in Jefferson, Texas for the purpose of compiling information about the linkages between river flows and ecological conditions in Big Cypress Bayou and Caddo Lake. Eighty-seven scientists, water managers, and local community members participated in the two-day workshop. A list of participants is included as Appendix A.

The workshop agenda is included as Appendix B. The workshop began with a presentation by Brian Richter of The Nature Conservancy (TNC), covering the purpose of the workshop and expected products. This opening talk was followed by five presentations by Texas A&M University scientists, highlighting key sections of the Summary Report that was disseminated to all participants prior to the workshop: hydrology (Brad Wilcox), fluvial geomorphology (Anne Chin), nutrients, productivity & aquatic plants (Dan Roelke), riparian and floodplain vegetation (Steve Davis), and aquatic and terrestrial fauna (Kirk Winemiller).

Following lunch, the workshop participants were divided into two break-out groups for the purpose of developing "building blocks" describing the expected ecological responses or conditions associated with specific river flows or lake level fluctuations. One break-out group focused on Big Cypress Bayou, and the other group discussed Caddo Lake. After reporting their findings, the groups were re-assembled into two new break-out groups, one focusing on low flows and the other on high-flow pulses and floods. The products of these break-out groups are discussed below.

On the second morning, participants discussed data collection and research needs, resulting in a list of priorities for improving understanding of flow or lake level influences on ecological conditions in Big Cypress Bayou or Caddo Lake (discussed under "Data Collection and Research Needs"). Following lunch, Paul Rodman of the Corps of Engineers provided an overview of the operations of Lake o' the Pines and its role in flood management and water supply. This presentation led to a discussion of next steps for implementation and monitoring, as discussed in the "Monitoring" and "Implementation" sections in this summary.

Flow-Ecology Building Blocks for Big Cypress Bayou

The flow-ecology building blocks for Big Cypress Bayou are presented in Figure 1. Each of the building blocks portrayed in this figure represents an ecological outcome that would be expected if certain flow conditions were attained. The river flows denoted in Figure 1 would be generated by water releases from Lake o' the Pines into Big Cypress Bayou. The river flows noted in Figure 1 are targets for the "old" USGS flow-gauging

location at Jefferson, Texas. It should be noted that the flood flows suggested in Figure 1 cannot be attained until structural modifications are made to Ferrell's Bridge Dam (Lake o' the Pines), as discussed further under "Implementation" below.

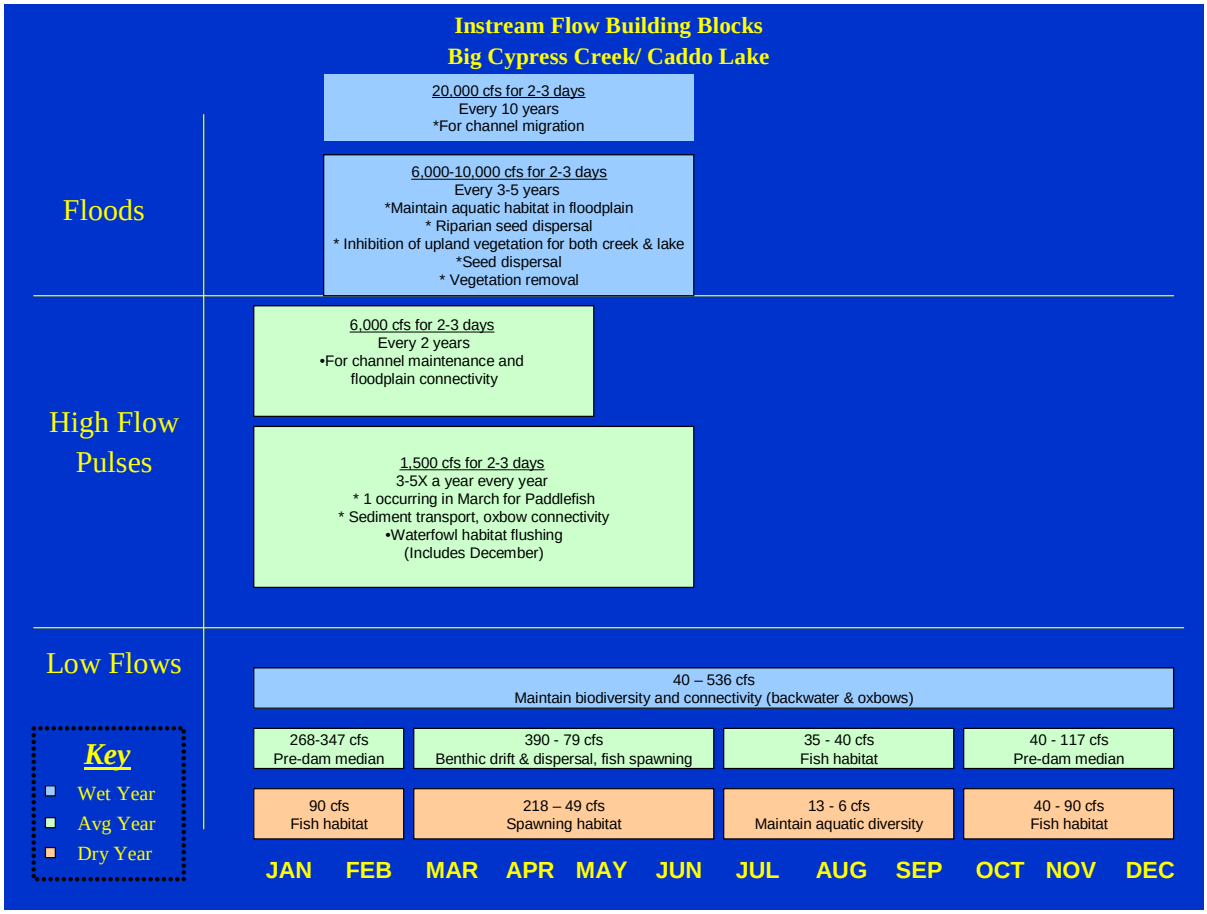

Figure 1. Flow-ecology building blocks for Big Cypress Bayou

The low-flow targets noted in Figure 1 are based upon a variety of ecological objectives. More detail on these low-flow targets is provided in Appendix C. The fish habitat objectives are based upon fish habitat simulation modeling performed by the US Fish & Wildlife Service (Cloud, T. 1984. Planning aid report on the aquatic resources of the Cypress Bayou Basin, Texas. USFWS, Ecological Services, Arlington, Texas; USFWS. 1993. Waterfowl Technical Appendix for the Red River Waterway Shreveport to Daingerfield Reach Evaluation Study—Appendix 6, USFWS, Atlanta, May 1993). Other targets were based upon the fish habitat modeling results as well as a review of the pre-dam low-flow conditions for each month, as derived from the "Indicators of Hydrologic Alteration" (IHA) software. For instance, the 25th percentiles of the pre-dam flows were largely used as a basis for the July-September flows in dry years, medians were used for setting the October-February average flows, and the 75th percentiles were used as a reference in setting wet year flows.

The high-pulse flows in December-June were based upon pre-dam flow records, ecological information provided in the Summary Report, and professional judgment. Fish biologists participating in these discussions felt that fish and other mobile aquatic and amphibious organisms would be able to move into or out of secondary channels and oxbow lakes fairly quickly (e.g., during a single day) during these high-flow pulses. The duration of these events was set at 2-3 days to allow for some ramping time on the rising and falling limbs of these high-flow pulses. Fluvial geomorphologists similarly felt that necessary sediment transport could also occur during these short pulses. After some discussion about the fact that the median duration of high-flow pulses was 11 days during the pre-dam period, workshop participants agreed that the high-flow pulse duration deserved close attention during the implementation and adaptive management phase of the project. Similarly, because high-flow pulses occurred with a median frequency of 7 times per year in the pre-dam period, the number of pulses to be targeted should be closely examined.

One of the flood building blocks calls for a flow of 6,000 cfs for the purpose of channel maintenance. This target level is based upon the assumption that the pre-dam 2-year flood magnitude approximates the bankfull discharge level. It is well-established in the geomorphic literature that the bankfull discharge is the level at which the majority of sediment transport occurs, and is therefore a primary determinant of channel geometry (i.e., width and depth of the river channel). As discussed below in the "Data Collection and Research Needs" section, an accurate determination of the bankfull discharge level has been identified as a top-priority research need. Based upon this research, the flow magnitude and necessary recurrence interval for this building block can be refined.

Somewhat less frequently (i.e., at 3-5 year intervals), a flow of 6,000-10,000 cfs would be needed to provide additional ecological benefits including riparian seed dispersal, maintenance of aquatic habitats in the floodplain, and maintenance of riparian vegetation diversity. Even less frequently (10 year intervals), a flood of 20,000 cfs would be needed to drive channel migration across the floodplain, which is an important mechanism for creating or maintaining habitat for both aquatic and terrestrial organisms.

Lake-level Building Blocks for Caddo Lake

One interesting outcome of the workshop was a conclusion that management of flows in Big Cypress Bayou did not need to be adjusted for the benefit of Caddo Lake. This conclusion is based largely upon the fact that Big Cypress Bayou contributes only 32% of the total average inflow to Caddo Lake, and the other 68% of the volume entering Caddo Lake is largely unaffected by human activities. These relatively natural inflows can cause a considerable rise in the lake level during flood periods, as evidenced by a graph of historic lake level fluctuations prepared by Bob Keeland of the USGS (Figure 2).

Presently, the outlet weir on Caddo Lake is fixed at an elevation of 168.5 NGVD. Under present conditions, the lake level will occasionally drop below the weir elevation due to evapotranspiration losses, but these lake-level drops do not exceed 2 feet. The

workshop participants felt that it would be desirable to install a variable-level control outlet that would provide the ability to lower lake levels further to facilitate nutrient control, cypress regeneration, and invasive macrophyte control.

Much of the discussion of nutrient control in the lake was led by Dan Roelke of Texas A&M University. Dan hypothesized that nutrient levels in Caddo Lake (believed to contribute to the undesirable abundance of aquatic plants, phytoplankton blooms, and conditions of low dissolved oxygen and pH) could only be substantially reduced by a combination of source controls in the contributing watershed and periodic flushing of nutrients from the lake. Such lake flushing could more efficiently be accomplished by drawing down the lake during summer months when nutrients (dissolved and particulate) would be highest in the water column. Refilling of the lake could commence immediately following draw down. The volume of the lake that could be discharged would be a function of the lake's bathymetry. Similarly, the expected time necessary, i.e., the number of years a summer draw down would be conducted, would be a function of the volume discharged. Larger discharge volumes each year would require fewer consecutive years to produce the same effect if the discharge volumes were smaller. This nutrient removal effort should be carried out adaptively, using monitoring to inform decisions about the necessary design and duration of the project. An important precursor to implementing such nutrient control in the lake would be the development of a nutrient budget for the entire Caddo Lake basin, which has been identified as a top-priority research need (see "Data Collection and Research Needs"). This nutrient budget would reveal whether the influent waters from Big Cypress, Little Cypress, and Black Cypress (and other smaller tributaries) are sufficiently lower in nutrient concentration to facilitate the gradual replacement of nutrient-enriched lake water with waters of lesser nutrient concentration as the lake is repeatedly flushed.

[Figure 2. Insert lake level fluctuation graph from Bob Keeland]

There are many public concerns that would need to be addressed as part of the design of this nutrient control project. Potential impacts on the sport fishery as well as other aquatic and terrestrial organisms would need to be addressed. Ecotourism and

aesthetic values of the lake would have to be considered. The potential for rapid hydrilla invasion, facilitated by reduction in macrophytic vegetation is an additional concern. There is concern that an accelerated hydrilla invasion could jeopardize the existence of other aquatic plants in the lake, reducing plant diversity toward monotypic areas of hydrilla. After much discussion about the use of lake lowering to facilitate macrophyte control, the workshop participants came to a conclusion that other means (e.g., mechanical or chemical control) would likely be much more effective for this purpose. It might be that after refilling of Caddo Lake (immediately following a draw down) chemical treatment of hydrilla would be necessary so that native plants could re-establish themselves (presumably at biomass levels lower than before). In any lake-lowering effort, impacts on areas downstream of the lake would also need to be addressed.

Another potential benefit of lake lowering would be to facilitate cypress regeneration in areas that presently do not dry sufficiently to allow seed germination and seedling recruitment. Bob Keeland suggested that the drawdown would need to occur in at least two consecutive growing seasons to enable cypress regeneration.

Based upon these lake discussions, the workshop participants prepared the building blocks shown in Figure 3.

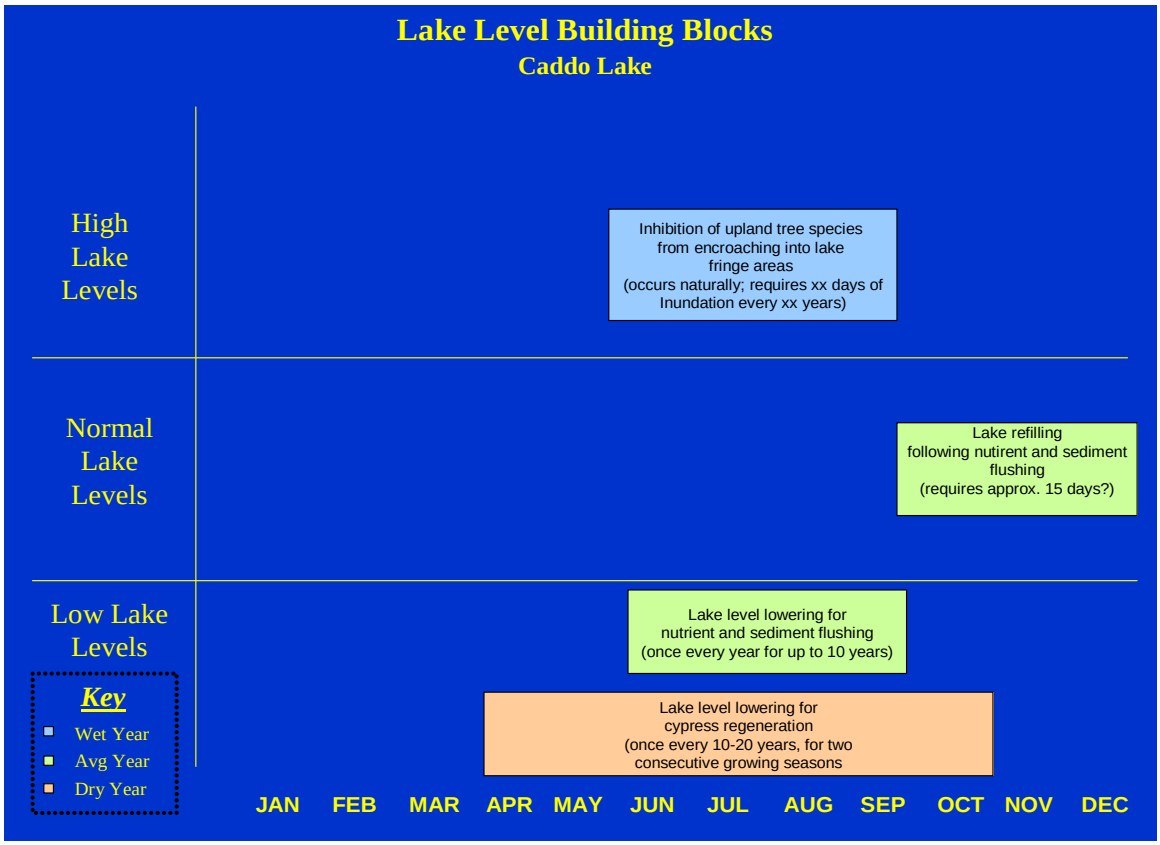

Figure 3. Lake level-ecology building blocks for Caddo Lake.

Data Collection and Research Needs

During the effort to construct the building blocks for Big Cypress Bayou described above, a number of uncertainties and data gaps were identified. On the morning of the second day, a discussion of these data and knowledge gaps generated a prioritized list of data collection and research needs. The full list is provided in Appendix D. The top-priority needs are listed here.

Hydrology:

- Develop correlation between old and new Jefferson flow gauging sites, or re-establish gauge at old Jefferson site.
- How much gain/loss (from ground water, ET, and diversions) of water between Lake o' the Pines and Caddo Lake?
- Assess floodwater accumulation (flood magnitude-frequency relationships) and backwater hydraulics below confluence of Little Cypress and Black Cypress.

Fluvial Geomorphology:

- Estimate sediment budget and develop better characterization of sediment composition along entire creek.
- Collect baseline geomorphological data to better assess the responses during and following flow releases (includes sediment characteristics, channel cross section and general assessment of channel condition)
- Floodplain inundation: see aquatic ecology

Aquatic Ecology:

- How much of floodplain is inundated and how much fish access is available at various flow levels (>2000 cfs?) in various reaches of the creek? (including bankfull discharge level)
- Paddlefish and bluehead shiner ecology (including, is enough spawning area left in Big Cypress Bayou to support viable populations of each)

Terrestrial ecology:

- Flood inundation-vegetation relationships

During the workshop discussion of these needs, it was decided that small groups of scientists would be asked to prepare short (2-3 page) research proposals addressing each of these needs. Texas A&M scientists will lead these efforts to develop short proposals: Brad Wilcox (hydrology); Anne Chin (fluvial geomorphology); Kirk Winemiller (aquatic ecology); and Steve Davis (terrestrial ecology).

Additionally, the nutrient control project in Caddo Lake needs to be designed. Dan Roelke and Steve Davis volunteered to prepare this proposal. A nutrient budget for Caddo Lake would be constructed over a two-year period with weekly and monthly sampling intervals, where inflows and in-stream nutrient concentrations are measured for all tributaries and from the outflow from the lake; a more detailed seasonal sampling of the lake's water column is produced; sediment nutrient release experiments from multiple sediment types under varied redox conditions are performed; and nutrient "pump"

experiments are conducted looking at the role of macrophytes as a source of nutrients to the water column. In addition, a bathymetric survey would need to be conducted to determine current volumes and shoreline positions with various levels of lake draw down.

Implementation

During the afternoon of the second day, workshop participants discussed implementation challenges and opportunities. This discussion began with a presentation by Paul Rodman of the Army Corps of Engineers, in which Paul discussed the operations of Lake o' the Pines and its influence on reducing downstream flooding. Becky Griffith of the Corps and Walt Sears of the Northeast Texas Water Management District supplemented Paul's presentation with valuable additional information and insight.

Paul's presentation made it very clear that lakeshore residents at both Caddo Lake and Lake o' the Pines experience substantial flood damage even with Lake o' the Pines in place. Paul provided a number of photos and graphs describing the effects of the 2001 flood. He also emphasized that a major consideration for Lake o' the Pines operations during flood control is the backwater effect at Caddo Lake; when the lake is high, the goal for management of Lake o' the Pines is to do everything possible to minimize the amount of water coming down Big Cypress Bayou that would contribute to flooding problems around Caddo Lake. In 2001, the level of Caddo Lake rose seven feet above its normal level (see Figure 2).

Presently, maximum releases from Lake o' the Pines are constrained to 3,000 cfs whenever possible. This is substantially lower than the 6-20,000 cfs flood flows suggested by three of the building blocks in Figure 1. Paul stated that due to the design of the outlet works and associated infrastructure near the dam, releases higher than 3,000 cfs begin to cause structural damage. Brian Richter pointed out that in other places where The Nature Conservancy is working with the Corps as part of a national partnership called the "Sustainable Rivers Project," and they have found that they can oftentimes substantially reduce flood damage risk by allowing the dam manager to use higher releases of water from the flood control reservoir during early stages of a flood. By evacuating water quickly, reservoir managers are able to reduce the likelihood of having to make high releases later in the flood. By modifying the outlet works and enabling Lake o' the Pines to release flows higher than 3,000 cfs, it may be possible to gain better flood control, reduce damages to property owners at Caddo Lake and Lake o' the Pines, and attain some of the important building blocks in Figure 1.

During subsequent discussions about the low-flow building blocks, Walt Sears of the Northeast Texas Water Management District expressed his agency's commitment to implementing a scientifically-sound low-flow regime for Big Cypress Bayou and Caddo Lake. Walt summarized existing water supply needs, and explained that now is the time to define low-flow needs for Big Cypress Bayou because the available water storage in the lake will be increasingly sought after by other entities in the near future.

There was little discussion of the feasibility of installing a variable-level outlet control on Caddo Lake. However, participants agreed that this should be discussed with

both Corps districts (Ft. Worth and Vicksburg) and considered as part of a flood control and nutrient-reduction strategy for Caddo Lake.

A critically important next step on the path toward implementing the building blocks identified for the creek and lake will be to convene a meeting between key parties in the next 30-60 days. This meeting will include representatives from the Corps, the water management district (NETWMD), The Nature Conservancy, and Caddo Lake Institute. Together, these groups will develop an initial plan for: (1) conducting necessary baseline monitoring of ecological conditions in Big Cypress Bayou in 2005 (see "Monitoring" section below); (2) implementing Big Cypress Bayou low-flow and high-flow pulse building blocks beginning in 2006; (3) examining the feasibility of modifying the Lake o' the Pines outlet works for flood-control and ecological benefits; (4) examining the feasibility of modifying the outlet weir on Caddo Lake for nutrient-control, cypress regeneration, and flood-control benefits.

Monitoring

A monitoring program needs to be designed and implemented prior to the initiation of a new water management program for Lake o' the Pines or Caddo Lake. These monitoring needs are divided into two categories for discussion here: (1) pre-implementation baseline monitoring in Big Cypress Bayou, and tracking ecological responses in Big Cypress Bayou as various building blocks are being implemented; and (2) designing and assessing a nutrient-control and cypress-regeneration program for Caddo Lake.

Monitoring of Big Cypress Bayou – Some degree of pre-implementation monitoring needs to be conducted to adequately characterize existing (baseline) conditions along Big Cypress Bayou. Ideally, much of this baseline documentation could occur in 2005, so that some of the building blocks in Figure 1 could be implemented beginning in 2006.

At present, the water management district (NETWMD) supports a fairly comprehensive aquatic monitoring program for Big Cypress Bayou using "rapid biological assessment" protocols developed by the State of Texas (TCEQ). The workshop participants agreed that this program could be very useful in both establishing the baseline ecological conditions of Big Cypress Bayou, and in tracking the response of the aquatic system to changes in low-flow conditions. A number of workshop participants volunteered to work with NETWMD to assess any needed enhancements in this aquatic monitoring program, such as measuring benthic and fish diversity and abundance, and benthic drift and dispersal. Volunteers included Roy Darville of ETBU, Bruce Moring of USGS, Kirk Winemiller of TAMU, and Kevin Mayes plus regional staff of TPWD. In assessing needed enhancements, these parties should thoroughly consider the hypothesized ecological conditions associated with each of the building blocks in Figure 1, and identify indicators that can best represent these ecological outcomes.

Additionally, a number of the building blocks in Figure 1 pertain to "special" concerns that will likely be beyond the scope of the aquatic monitoring program sponsored by

NETWMD. These include paddlefish and bluehead shiner spawning and rearing conditions and population measures; sediment transport; and waterfowl utilization of oxbows and backwater habitats. The following workshop participants volunteered to help with designing a monitoring and research programs that could address these issues:

- Paddlefish – Kevin Mayes (TPWD), KirkWinemiller (TAMU)
- Sediment transport – Anne Chin (TAMU)
- Oxbow connectivity and fish utilization – Kirk Winemiller (TAMU) and Tim Osting (TWDB)
- Waterfowl utilization – TPWD, Carl Fentress (Advanced Ecology, Inc)

Monitoring of Caddo Lake – As described above, there are many questions and issues surrounding the design of a nutrient-reduction program for Caddo Lake. Workshop participants agreed that an essential first step is to conduct a nutrient budget, as discussed above under "Data Collection and Research Needs." Fortunately, Dan Roelke and Steve Davis of TAMU have volunteered to take a first stab at designing the scope of work for this nutrient budgeting effort. Any efforts to design a long-term implementation and monitoring program for the lake will be delayed until the nutrient budget is complete.

Additionally, a cypress regeneration monitoring plan will need to be developed for tracking cypress response to any future lake-lowering plan. However, any decisions about modifying the outlet weir on Caddo Lake will likely hinge on the results of the nutrient budget analysis. Therefore, the design of the cypress monitoring program will be delayed as well.

In addition, it will be important to monitor geomorphological responses in Big Cypress Bayou. Identifying geomorphological change is important and tied directly to ecological conditions.

Appendix A

List of Workshop Participants

12/2-3/04 FLOWS ORIENTATION & FLOTILLA ATTENDEES
5/4 - 5/05 FLOWS PRESCRIPTION CONFERENCE ATTENDEES

	FEDERAL RESOURCE AGENCIES
	USFWS
Broska, James	James Broska, Hydrologist, US Fish and Wildlife Service, 500 Gold Ave SW, Albuquerque, NM 87102
Cloud, Tom	Tom Cloud, Field Supervisor, US Fish ands Wildlife Service, Arlington ESFO
Neal, Jim	Jim Neal, US Fish and Wildlife Service, PO Box 4655 SFA Station; Nacogdoches TX 75692
Williams, Mark	Caddo Lake NWR Refuge Manager
	USNRC
Keeland, Robert	Bobby D. Keeland PhD, USGS, National Wetland Research Center, 700 Cajundome Blvd. Lafayette LA 70506.
	USGS
East, Jeffrey	Jeffery East, 802US Geological Survey, 7 Exchange Drive, Austin TX 78754
Moring, Bruce	J. Bruce Moring, PhD, U.S. Geological Survey, Research and Investigations Section, 8027 Exchange Drive, Austin, Texas 78754
Wilson, Jennifer	Jennifer T. Wilson, Hydrologist, U.S. Geological Survey, 8027 Exchange Dr, Austin, TX 78754-4733

	USACE
Bransford, Mike	James M. (Mike) Bransford; Natural Resources Manager Piney Woods Project Office; U.S. Army Engineer District, Fort Worth;
Griffith, Becky	Rebecca S. Griffith Chief, Planning Branch U.S. Army Engineer District, Fort Worth
Jones, Tommy	Tommy Jones, Forester; Forestry Management Section; U.S. Army Corps of Engineers, Vicksburg District, Louisiana Field Office; Bayou Bodcau Dam & Reservoir; 171 Ben Durden Road, Haughton, LA 71037-7319
King, Wendell	
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	TX AGENCIES
	TPWD
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Mason, Corey	Corey Mason, Texas Parks & Wildlife Dept., Regional Waterfowl/Wetland Biologist - East Texas, PO Box 30, Athens, Texas 75751,

Mayes, Kevin	Kevin Mayes, Aquatic Biologist, TPWD-Inland Fisheries, Freshwater Resources POB 1685, San Marcos, TX 78667-1685
Moss, Randy	Randy Moss, Senior Scientist, TPWD-Inland Fisheries, Freshwater Resources POB 1685, San Marcos, TX 78667-1685
Ryan, Mike	Mike Ryan; TPWD; Caddo Lake/North East Texas Regional Freshwater Fisheries Biologist ; 3802 East End Blvd. Marshall Texas 75670
Whisenant, Adam	Adam Whisenant; TPWD 11942 FM 848, Tyler, Texas 75707
	TWDB
Osting, Tim	Tim D. Osting, P.E., Surface Water Resources, Instream Flow Program, Texas Water Development Board, 1700 N. Congress Avenue (Shipping address), P.O. Box 13231 Austin, TX 78711-3231
	NETMWD
Sears, Walt	Walt Sears, Manager North East Texas Municipal Water District; Hwy 259 South, PO Box 955, Hughes Springs Texas 75656
Pafford, Howard	Howard Pafford, Watershed Protection Team Leader, Northeast Texas Municipal Water District
Brown, William	
	SRA
Parsons, David	David Parsons, Regional Operations Manager Upper Sabine River Authority, 353 Private Road 5183, Quitman Texas 75783

	Region D Water Planning Group
La Tourneau, Richard	Richard La Tourneau; Region D Water Planning Group, Executive Committee member; PO Box 12071
	LA AGENCIES
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	TAMU
Chin, Anne	Anne Chin, Associate Professor, Department of Geography, Texas A&M, University
Davis, Stephen	Stepnen E. "Steve" Davis, III, Assistant Professor; College of Agriculture & Life Science; Department of Wildlife & Fisheries Sciences, 201BA Old Heep Building; 2258 TAMU, College Station, Texas 77843-4096
Roelke, Dan	Daniel L. Roelke; Associate Professor, Aquatic Ecology Departments of Wildlife and Fisheries Sciences and Oceanography Texas A&M University, 2258 TAMUS College Station, TX 77843-2258

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Winemiller, Kirk	Kirk O. Winemiller; Ecology & Evolutionary Biology; Dept. of Wildlife and Fisheries Sciences Texas A&M University; 2258 TAMU; College Station, TX 77843-2258
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	WILEY COLLEGE
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Plata, Ernest PhD	Ernest Plata, Ph.D.; Wiley College Department of Science; 711 Wiley Avenue Marshall TX 75670

	NGOs
	JI (Jeffersonian Institute)
Alexander, Corby	Corby Alexander; City Hall, 102 N. Polk, Jefferson TX 75657
Chitwood, Juanita	Juanita Chitwood, City Hall, 102 N. Polk, Jefferson, TX 75657
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Haden, Bryon	
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	TNC
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Richter, Brian PhD	Brian D. Richter, Director, Sustainable Waters Program, The Nature Conservancy, 490 Westfield Road, Charlottesville, VA 22901

Paterno-Pai, Diedre	Diedre Paterno-Pai, Outreach Manager, Sustainable Waters Program,The Nature Conservancy, 2424 Spruce Street, Boulder, CO 80302
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Weber, Dan	Dan Weber, The Nature Conservancy, Northwest Louisiana Program Manager, PO Box 72419, Bossier City, LA 71172
Wigington, Robert	Robert Wigington, Western Water Counsel, The Nature Conservancy; Western Resource Ofice; 2424 Spruce Street, Ste 100, Boulder CO 80302;
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Johns, Norman	Norman D. Johns, PhD Water Resources Scientist National Wildlife Federation Gulf States Natural Resource Center 44 East Avenue, Suite 200 Austin, Texas 78701-4334
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Echols, William T	Col. (USACE Ret.) William T. (Terry) Echols, 22329 FM 134; Karnack, TX 75661
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Gordon, John	John Gordon, 4406 Rebel Lane, Marshall, TX 75672
Hamblin, Russell	Russell Hamblin, 101 Dorough Road, Karnack TX 75661
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Purvis, Marcia	Marcia T. Purvis 10100 Lime Creek Road Volente, Texas 78641
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Shellman, Dwight JD	Dwight K. Shellman, Jr., President & General Counsel, The Caddo Lake Institute, Field Office: 5447 E. Cypress Drive, Karnack TX 75661.
Speight, Robert	Robert Speight; Caddo Lake Water Supply Co Manager; 2757 Blairs Landing, Karnack, TX 75661
Turner, Michael	
Walker, Tom	Tom Walker; 500 PR 7222; Jefferson, TX 75657

Weaver, Pamela	
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Werneke, Jean	Jean Werneke; Caddo Lake Area Chamber of Commerce & Tourism; 112 Mossy Brake, Uncertain, TX 75661
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Bird, Mike	Mike Bird, CEO Advanced Ecology, Inc. 2557 State Hwy 7 East Center, Texas 75935
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	Bradbury Consulting
Bradbury, Henry	Henry Bradbury, Principal, Environmental Management and Development, 3918 Bobbin Lane, Addison, TX 75001
	Guice Engineering Sciences/Guice Engineering
Guice Ph.D., W. Lee	Guice Engineering Sciences/ Guice Engineering Inc. 300 East Tyler St., P.O. Box 3632 Longview, TX 75606
Forrester, Pamela	Pamela Forrester, Guice Engineering Sciences/ Guice Engineering Inc. 300 East Tyler St., P.O. Box 3632 Longview, TX 75606

	V.A. Stephens Company
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	Red River Valley Association
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	Senator Todd Staples Office
Stripling, Kelley	Kelley Stripling; 202 E. Pillar St., Ste. 208 Nacogdoches, Texas 75961
	State Rep. Stephen Frost's Office
Martin, Marie	Marie Martin, State Representative Stephen Frost, PO Box 248, New Boston, Texas 75570
	AEP- American Electric Power
Carter, Greg W.	Greg Carter, P.E.; Senior Engineer, Plant Engineering; AEP American Electric Power; PO Box 21106; 520 N Allen Ave;

	Shreveport, LA 71156;
Meyer, Jennifer K.	Jennifer K. Meyer; Regional Environmental Consultant, Environmental Support; AEP American Electric Power; 1187 County Road 4865; Pittsburg, TX 75686

Appendix B

Flow-Ecology Workshop Agenda
Big Cypress Bayou and Caddo Lake
May 4-5, 2005
Jefferson, Texas

Wednesday, May 4th

9 - 10 am	Welcome and discussion of workshop objectives (Brian Richter, TNC)
10 am – 12 noon	Presentations by Texas A&M scientists: Brad Wilcox- hydrology Anne Chin- sediments & geomorphology Dan Roelke- nutrients, production & aquatic plants Steve Davis- riparian/floodplain vegetation Kirk Winemiller- aquatic and terrestrial fauna
Noon – 1 pm	Lunch (provided)
1 – 3 pm	Break-out sessions: Flow-ecology relations in Caddo Lake Flow-ecology relations in Big Cypress Bayou
3 – 3:30 pm	Reports from break-out sessions
3:30 – 5:30 pm	Break-out sessions: Low flow needs High pulse/flood needs
5:30 – 6:00 pm	Reports from break-out sessions

Thursday, May 5th

9 – 10 am	Compilation of flow building blocks
10 am – 12 noon	Discussion of priority research needs
Noon – 1 pm	Lunch (provided)
1 – 4 pm	Discussion of implementation challenges, monitoring needs Presentation by Ft. Worth District, Corps of Engineers
4:30 pm	Adjourn

Appendix C. Low Flow Summary
Big Cypress Bayou at Jefferson, TX (old site)

Month	Dry	Average	Wet	Justification
January	90	268	396	Dry: fish habitat Average: median pre-dam Wet: sustain biodiversity and maintain connectivity
February	90	347	500	Dry: fish habitat Average: median pre-dam Wet:
March	218	390	536	Dry: spawning habitat Average: benthic drift & dispersal, fish spawning Wet: sustain biodiversity and maintain connectivity
April	198	330	445	Dry: spawning habitat Average: benthic drift & dispersal, fish spawning Wet: sustain biodiversity and maintain connectivity
May	114	150	264	Dry: spawning habitat Average: benthic drift & dispersal, fish spawning Wet: sustain biodiversity and maintain connectivity
June	49	79	140	Dry: spawning habitat Average: benthic drift & dispersal, fish spawning Wet: sustain biodiversity and maintain connectivity
July	13	35	70	Dry: maintenance of aquatic diversity Average: fish habitat Wet: sustain biodiversity and maintain connectivity
August	6	40	41	Dry: maintenance of aquatic diversity Average: fish habitat Wet: sustain biodiversity and maintain connectivity
September	6	40	40	Dry: maintenance of aquatic diversity Average: fish habitat Wet: sustain biodiversity and maintain connectivity
October	40	40	49	Dry: fish habitat Average: fish habitat Wet: sustain biodiversity and maintain connectivity
November	90	90	94	Dry: fish habitat Average: fish habitat Wet: sustain biodiversity and maintain connectivity
December	90	117	275	Dry: fish habitat Average: median pre-dam Wet: sustain biodiversity and maintain connectivity

Appendix D

Data Collection and Research Needs

River System

Hydrology:

- Develop correlation between old and new Jefferson flow gauging sites
- What was the pre-dam duration of small floods?
- How much gain/loss (from ground water, ET, and diversions) of water between Lake o' the Pines and Caddo Lake?
- Assessment of floodwater accumulation (flood magnitude-frequency relationships) and backwater hydraulics below confluence of Little Cypress and Black Cypress

Fluvial Geomorphology:

- Estimate sediment budget and better characterization of sediment composition along entire creek
- Collect baseline geomorphological data to better assess the responses during and following flow releases (includes sediment characteristics, channel cross section and general assessment of channel condition)
- Duration of off-channel connectivity and persistence of water in floodplain required for fish and other aquatic organisms
- Floodplain habitat mapping and tie to geomorphic features and historical development
- Floodplain inundation and bankfull discharge levels (also see Aquatic ecology)

Aquatic ecology:

- How much of floodplain is inundated and how much fish access is available at various flow levels (>2000 cfs?) in various reaches of the creek? (including bankfull discharge level)
- Paddlefish and bluehead shiner ecology (including, is enough spawning area left in Big Cypress Bayou to support viable populations of each)
- Assessment of instream habitat availability at different low-flow levels
- Survey of non-game fishes (including 14 spp. of fish not documented recently) and benthic invertebrates (especially mussels) throughout basin.

Terrestrial ecology:

- Flood inundation-vegetation relationships
- Comparison of floodplain vegetation communities in Big Cypress with other tributaries
- Historical analysis of vegetation change (including use of GLO survey data)

Implementation concerns:

- Public participation in flow restoration program and input to goal-setting for adaptive management

- Articulation of expected ecological and ecosystem service benefits associated with flow restoration (for communication with stakeholders and water managers)
- Assessment of public interest and concerns associated with water management
- Potential flood impacts on communities downstream of Lake o' the Pines
- Impacts of human developments on flooding and water quality (including impediments to flood implementation)
- Implications of flow restoration on other water uses and needs (including Lake o' the Pines)
- Improvements in ability to forecast climate and water availability

Lake System and Drawdown Project

General:

- Bathymetry of lake (and relationship to drawdowns)
- Summation of cumulative inflows (daily) into Caddo Lake and assessment of relative impact of Lake o' the Pines on these cumulative inflows
- Lake level variation associated with inflow variation (and relationship to Marshall and industrial intakes)
- Flow needed in tributaries to flush sediment from upper end of lake
- Water flow patterns associated with inflows in upper lake areas
- Amphibian and mammal data gaps throughout basin
- Avian faunal (incl. waterfowl) data gaps throughout basin

Cypress Regeneration:

- Lake fringe (area) exposed at different lake levels (for cypress regeneration)
- Lake levels (and duration) needed to knock back bottomland hardwood tree species around lake fringe
- Targeted relative abundance or area for different bottomland-hardwood communities

Aquatic vegetation control and nutrient reduction:

- Conduct nutrient and sediment budgets for tributaries and lake
- How much flow is needed in Big Cypress to flush nutrients and pollutants in lake when other tributaries are simultaneously contributing water?
- Control strategies for invasive shrubs and other plants that could invade during lake drawdowns (e.g., hydrilla, Chinese tallow, buttonbush, water elm)
- How do we use lake level to knock back hydrilla without losing diversity of other plant species?
- Phytoplankton: what's here, conduct survey in late summer
- Investigate results of drawdowns in other lakes to control hydrilla and nutrients (including Reelfoot Lake in KY/TN)
- Time required to refill lake after drawdowns
- Extent (depth) of drawdown necessary to gain desired nutrient reduction effect
- Rate of drawdown needs to be evaluated

Implementation concerns:

- Effects of lake drawdown on sport fishery and economy of Caddo Lake area

- Public participation in flow restoration program and input to goal-setting for adaptive management
- Articulation of expected ecological and ecosystem service benefits associated with flow restoration (for communication with stakeholders and water managers)
- Assessment of public interest and concerns associated with water management
- Potential flood impacts on communities around and downstream of Caddo Lake
- Impacts of human developments on flooding and water quality (including impediments to flood implementation)