CADDO LAKE INSTITUTE

ENVIRONMENTAL FLOWS IN THE CYPRESS RIVER BASIN

Trinity and San Jacinto Rivers and Galveston Bay Stakeholders Committee

November 13, 2008

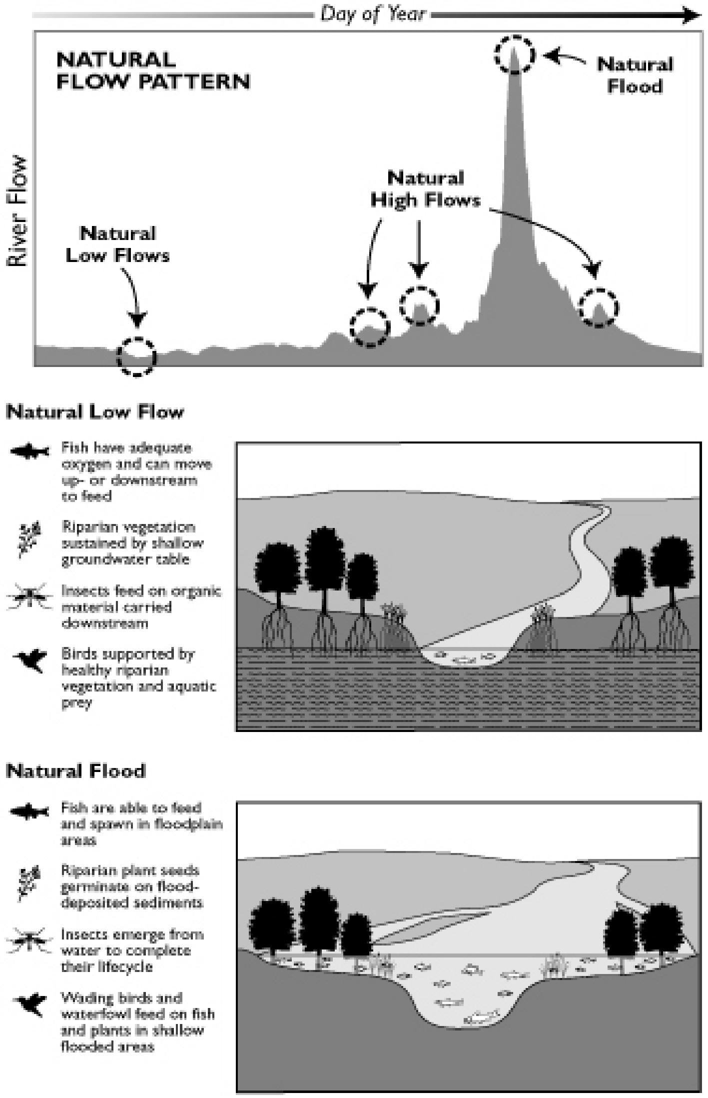
San Jacinto River Authority Offices

Conroe, Texas

Sustainable Rivers Project

US Army Corps of Engineers®

The Nature Conservancy
Protecting nature. Preserving life.™



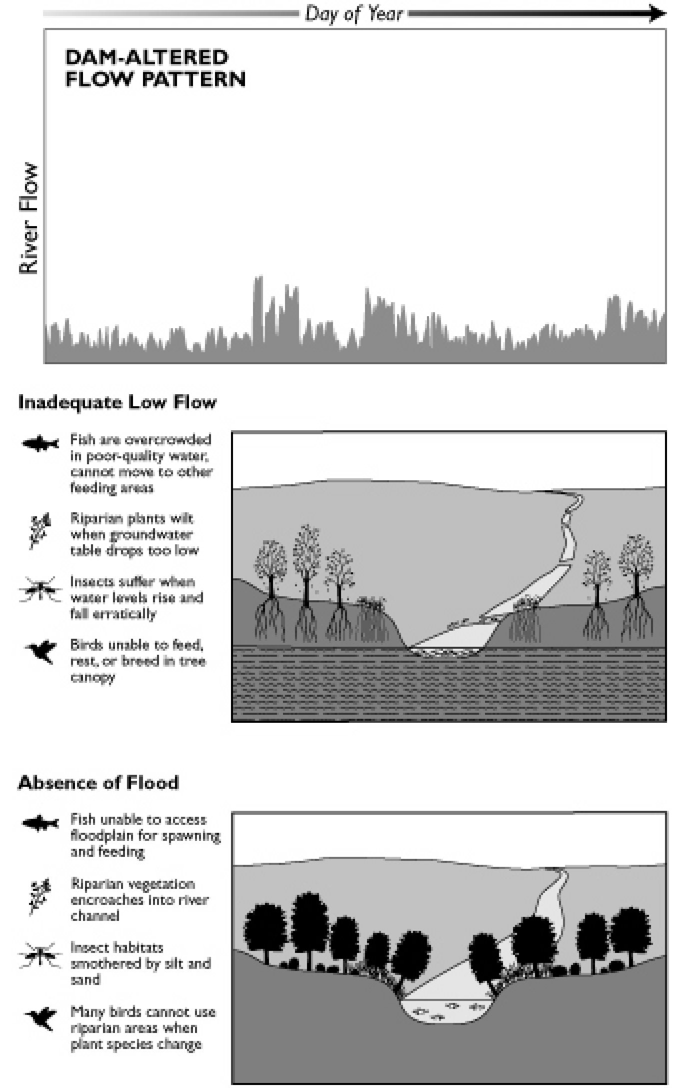
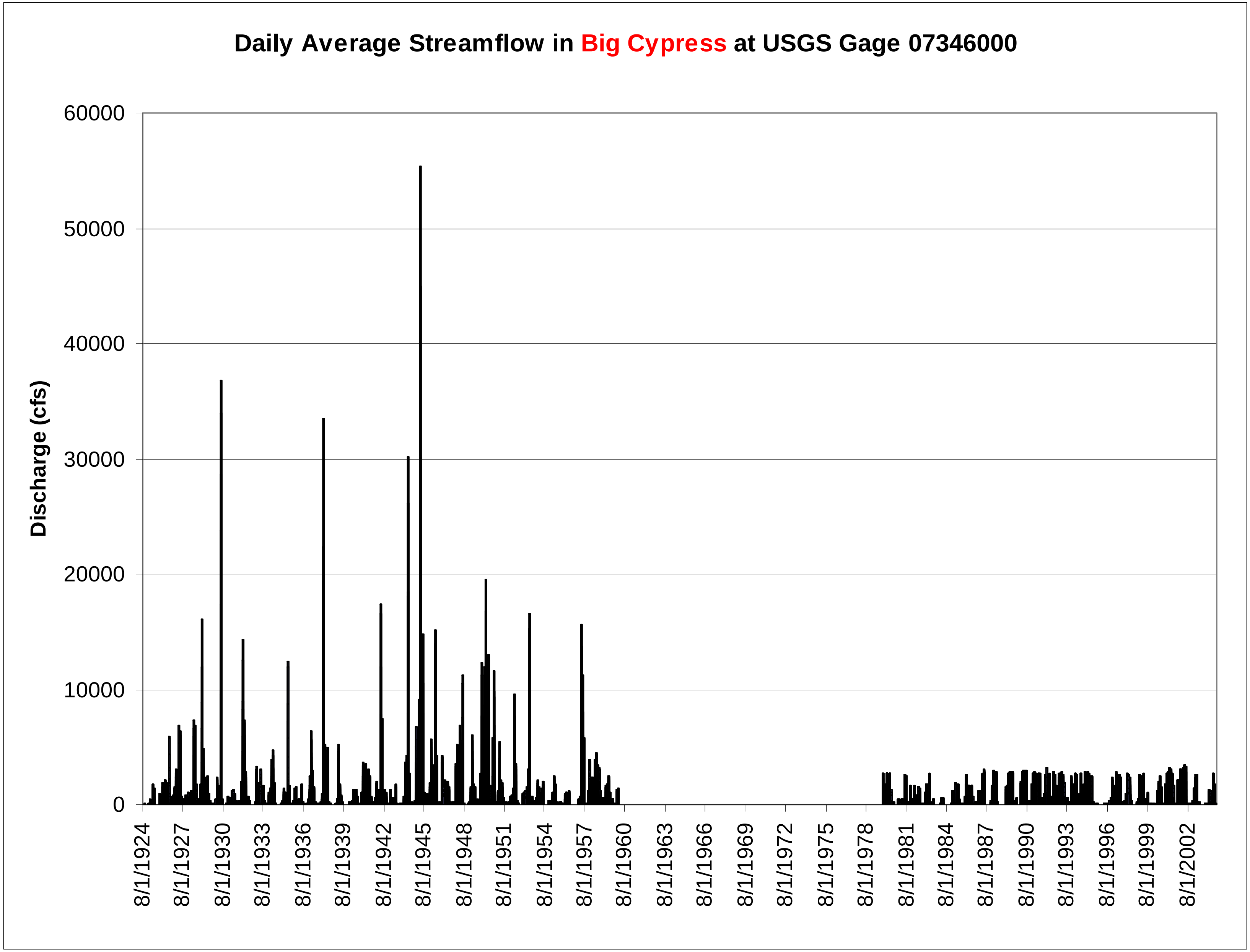


Figure 1-4 Ecosystem functions supported by natural river flows

Figure 1-5 A large dam alters river flows and disrupts ecosystem functions

From “Rivers for Life: Managing Water for People and Nature” by Sandra Postel and Brian Richter (Island Press 2003)



Daily Average Streamflow in Big Cypress at USGS Gage 07346000
Discharge (cfs)
60000
50000
40000
30000
20000
10000
0
8/1/1924
8/1/1927
8/1/1930
8/1/1933
8/1/1936
8/1/1939
8/1/1942
8/1/1945
8/1/1948
8/1/1951
8/1/1954
8/1/1957
8/1/1960
8/1/1963
8/1/1966
8/1/1969
8/1/1972
8/1/1975
8/1/1978
8/1/1981
8/1/1984
8/1/1987
8/1/1990
8/1/1993
8/1/1996
8/1/1999
8/1/2002

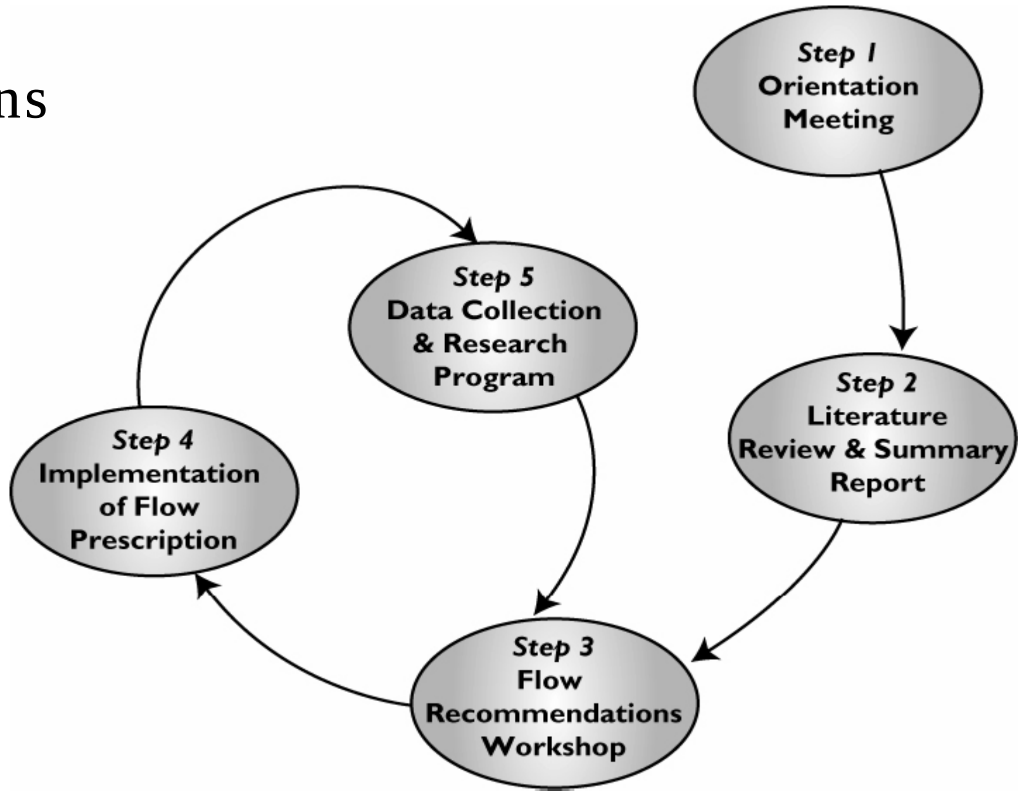
Developing Environmental Flows

Challenges Include:

- identifying what components of flow are ecologically most critical in river and bay systems
- quantifying those flow components to help guide development of flow standards
- achieving these tasks for all rivers within resource constraints while satisfying all stakeholder requirements
- short time line
- incorporating new knowledge and understanding into water management over time

Environmental Flow Recommendations:
A Collaborative and Adaptive Approach

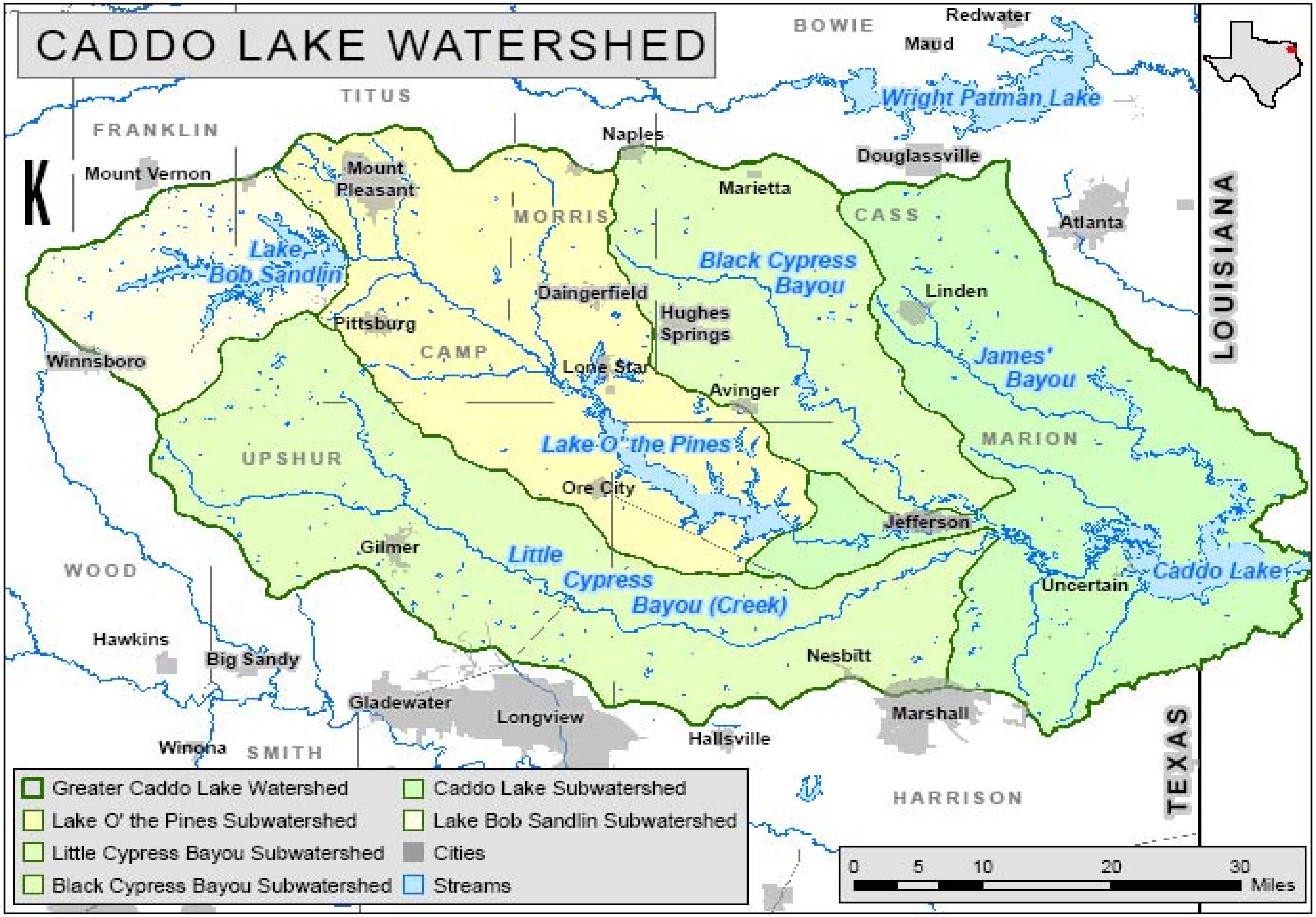
- Adaptive
  - Initial recommendations based on best available science
  - Refinement following flow experiments
- Flexible
  - Inter-disciplinary
  - Accommodates any inputs
  - Time constraints



From Richter et al. 2006. A collaborative and adaptive process for developing environmental flow recommendations. River Research and Applications 22:297-318

Utility for SB3 Environmental Flow Allocation Process

- Its foundation is a synthesis of existing science and analysis tools by an interdisciplinary team of scientists, experts, and stakeholders
- Incorporates and integrates of all types of information (e.g., field studies, hydraulic model outputs), not just IHA
- Generates robust initial recommendations even with limited inputs
- Initial phases are not particularly costly
- Not necessarily just for dams
- One issue: has been utilized primarily in site-specific applications – are other tools for regional or basin-wide scales (e.g., Ecological Limits of Hydrologic Alteration)


CADDO LAKE WATERSHED
BOWIE
Redwater
Maud
TITUS
Wright Patman Lake
FRANKLIN
Naples
Douglassville
Mount Vernon
Mount Pleasant
Marietta
MORRIS
CASS
Atlanta
Lake Bob Sandlin
Black Cypress Bayou
Linden
Daingerfield
Hughes Springs
Pittsburg
CAMP
James' Bayou
Winnsboro
Lone Star
Avinger
LOUISIANA
Lake O' the Pines
MARION
UPSHUR
Ore City
Jefferson
Gilmer
Little Cypress Bayou (Creek)
Uncertain
Caddo Lake
WOOD
Hawkins
Big Sandy
Nesbitt
Gladewater
Longview
Marshall
Hallsville
Winona
SMITH
TEXAS
HARRISON
Greater Caddo Lake Watershed
Lake O' the Pines Subwatershed
Little Cypress Bayou Subwatershed
Black Cypress Bayou Subwatershed
Caddo Lake Subwatershed
Lake Bob Sandlin Subwatershed
Cities
Streams
0 5 10 20 30 Miles

Goals

1. **An Environmental Flow Regime:** Now, a SB 3 Set Aside.

   But more than the SB 3 process

2. **New Operating Plan for Releases from Lake O' the Pines.**

3. **An Long-term Adaptive Management Process:** For continuation of the work.

Answer a Few Questions

Funding

Flows work supported primarily by federal & private funding.
WPP work supported Primarily by EPA, TCEQ and NETMWD

Key Cost

Literature review and report (TX A&M) $70,000

Participation by Scientists

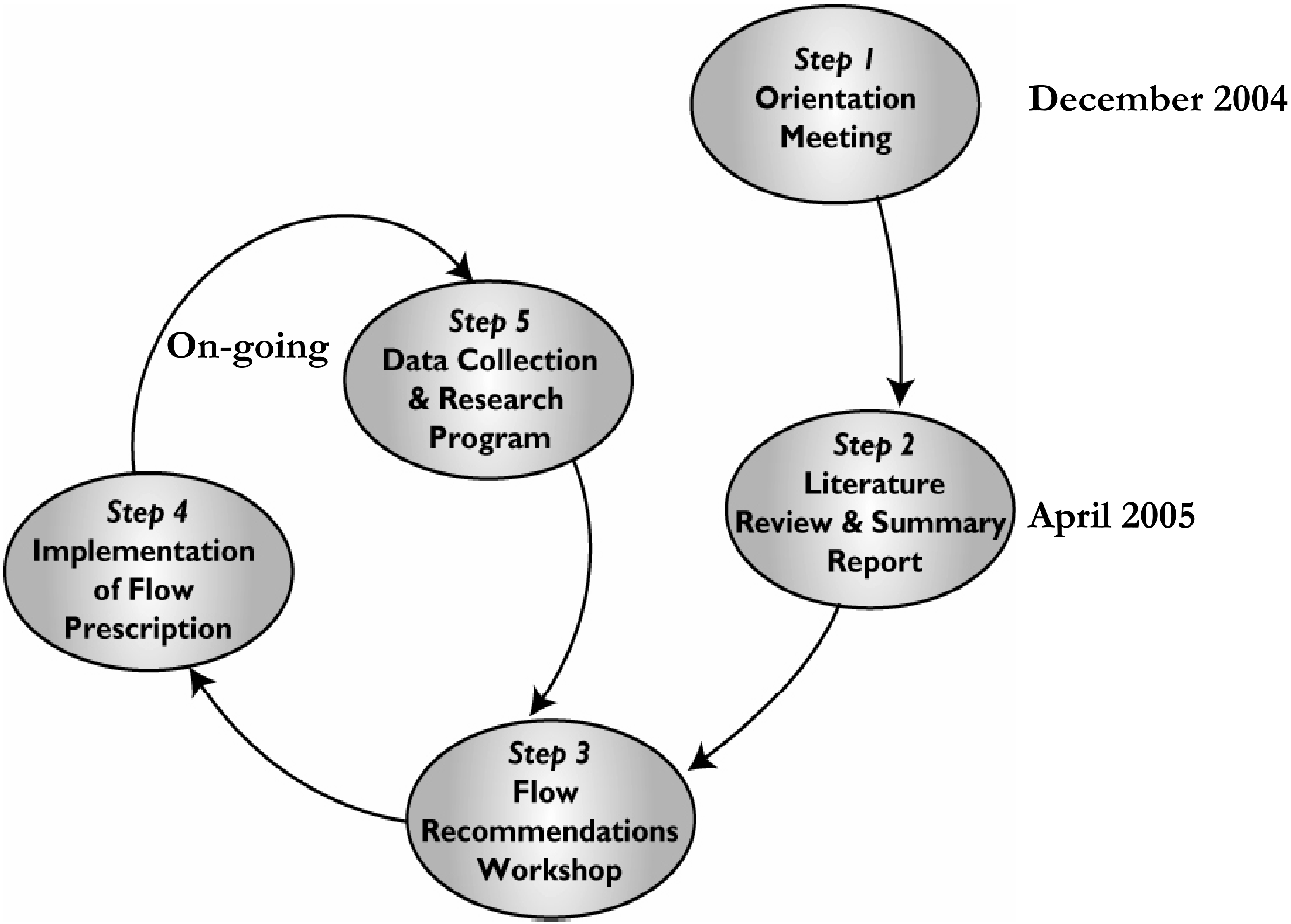
Due to their past work, e.g., proposed reservoirs, barge canal, etc

Stakeholder Engagement

Involved in discussions on reservoirs, barge canal., etc

Examples of 175+ Participants in the Work to Date

- **Local & Regional Governments** – NETMWD, CVND, some local counties and cities.
- **Tx & La State Agencies** – TPWD, TWDB, TCEQ, TSSWCB, LDEQ
- **Federal Agencies** – Corps of Engineers, USGS, USF&WS, National Wetlands Research Center
- **Universities** – East Texas Baptist University, Texas A&M, Texas Tech, LSU Shreveport, TCU, Texas State.
- **Reps from Business and industries** – AEP, Nestle Waters NA, Caddo Lake Chamber of Commerce
- **Others** – Red River Valley Assn., Landowners, Bass Clubs, Ducks Unlimited, Nat. Wildlife Fed.



May 2005, October 2006 & December 2008

Orientation Meeting

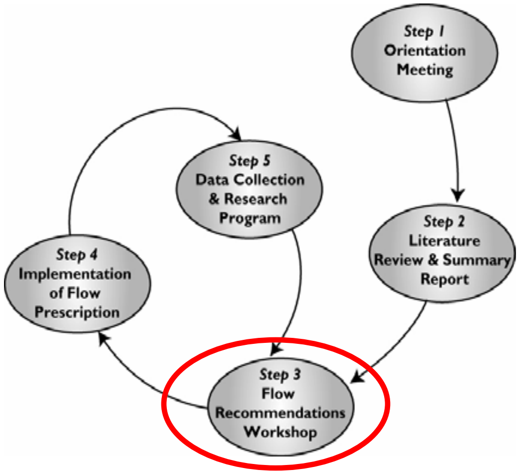
December 2004

- Explanation of the Process
- Assessment of Available Resources (personnel and data)
- Field Reconnaissance

Literature Review & Summary Report

December 2004 - April 2005

- Riverine Components - Hydrology, Physical Processes, Water Quality, Biology (Aquatic and Terrestrial), Lake and Wetland Issues
- Appendices include land use maps, output from IHA and species lists.
- Annotated Bibliography



Ecosystem Flow Workshop

May 2005

- 2 days, 87 scientists, water managers and local community
- Overview of process and expected results and Presentations of the Summary Report
- Two break-out sessions with two groups each session defined ecological flow recommendations for:
  1. Big Cypress Creek and Caddo Lake
  2. Low Flows and High Flow Pulses/Floods
- Building Blocks for River and Lake
- Prioritized Research Needs
- Operational Constraints, Stakeholder Concerns and Monitoring

Developing Environmental Flows

A Multi-Level Approach

The Common Denominator

- **Low Flows** – Determine the amount of habitat available, necessary energy expenditures.
- **High Flow Pulses** – Open up additional habitat area, bring additional food material from upstream areas, moderate temperatures and oxygen levels, clean spawning gravels, and provide cues for migration to spawning areas
- **Floods** – Create the physical template of the river ecosystem, including formation of oxbows (backwaters) and secondary channels, floodplains, and spawning bars, and keep introduced species populations in check

Instream Flow Building Blocks

Big Cypress Creek/ Caddo Lake

Floods

6,000-10,000 cfs for 2-3 days
Every 3-5 years
*Maintain aquatic habitat in floodplain
* Riparian seed dispersal
* Inhibition of upland vegetation for both creek & lake
*Seed dispersal
* Vegetation removal
20,000 cfs for 2-3 days
Every 10 years
*For channel migration

High Flow Pulses

6,000 cfs for 2-3 days
Every 2 years
* For channel maintenance

1,500 cfs for 2-3 days
3-5X a year every year
* 1 occurring in March for Paddlefish
* Sediment transport, oxbow connectivity
•Waterfowl habitat flushing
(Includes December)

Low Flows

40 – 536 cfs
Maintain biodiversity and connectivity (backwater & oxbows)

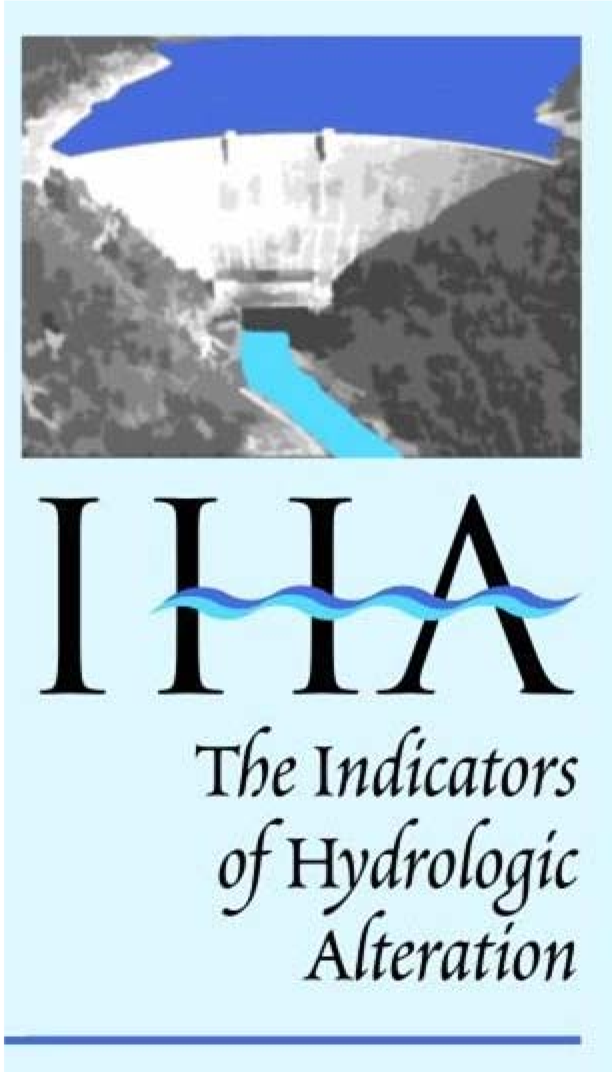
	JAN – FEB	MAR – JUN	JUL – SEP	OCT – DEC
Avg Year	268-347 cfs Pre-dam median	390 - 79 cfs Benthic drift & dispersal, fish spawning	35 - 40 cfs Fish habitat	40 - 117 cfs Pre-dam median
Dry Year	90 cfs Fish habitat	218 – 49 cfs Spawning habitat	13 - 6 cfs Maintain aquatic diversity	40 - 90 cfs Fish habitat

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Key

- Wet Year
- Avg Year
- Dry Year

Low Flow Targets

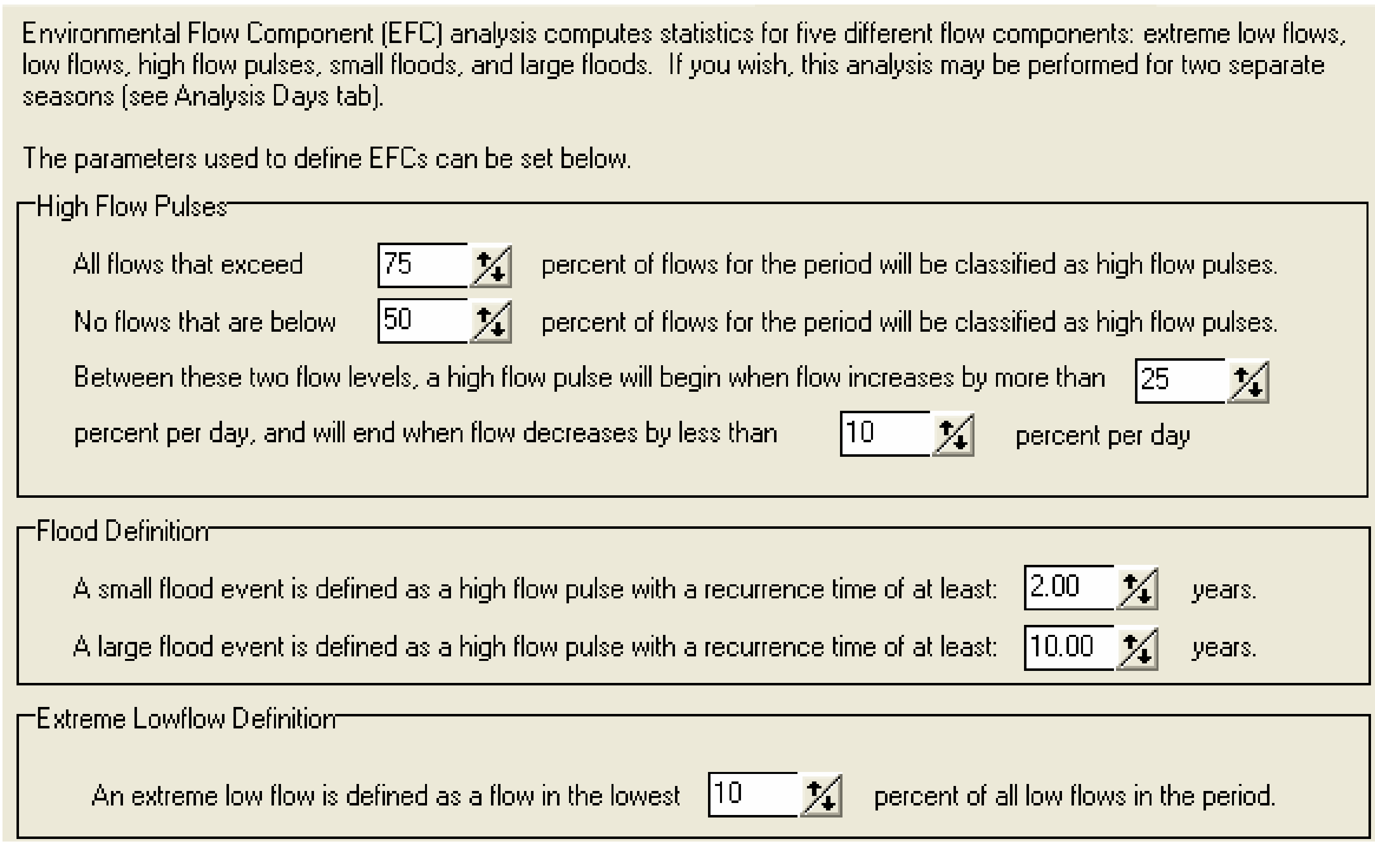


- Magnitude, Duration, Frequency, Timing, Rate of Change
- Range of Variation Analysis
- Wet, Normal, Dry
- Flow Regime – Environmental Flow Components

Indicators of Hydrologic Alteration – Environmental Flow Component (EFC)

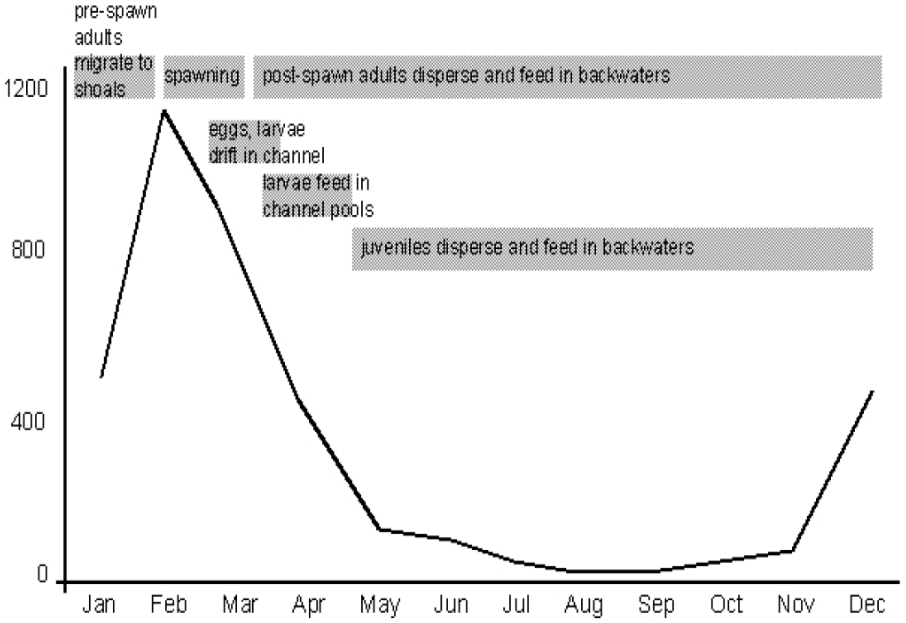
- Divides the hydrograph into high flow (>75th percentile) and low flow (<50th percentile)
- High flows are further divided into Large Floods (10 year recurrence), Small Floods (2 year recurrence) and High Flow Pulses (rise faster than 25% and fall faster than 10%)
- Low flows also include Extreme Low Flows (<10th percentile)
- Percentile statistics of the low flows for each month are also generated

EFC Defaults



Relationship between Flow and Life History needs

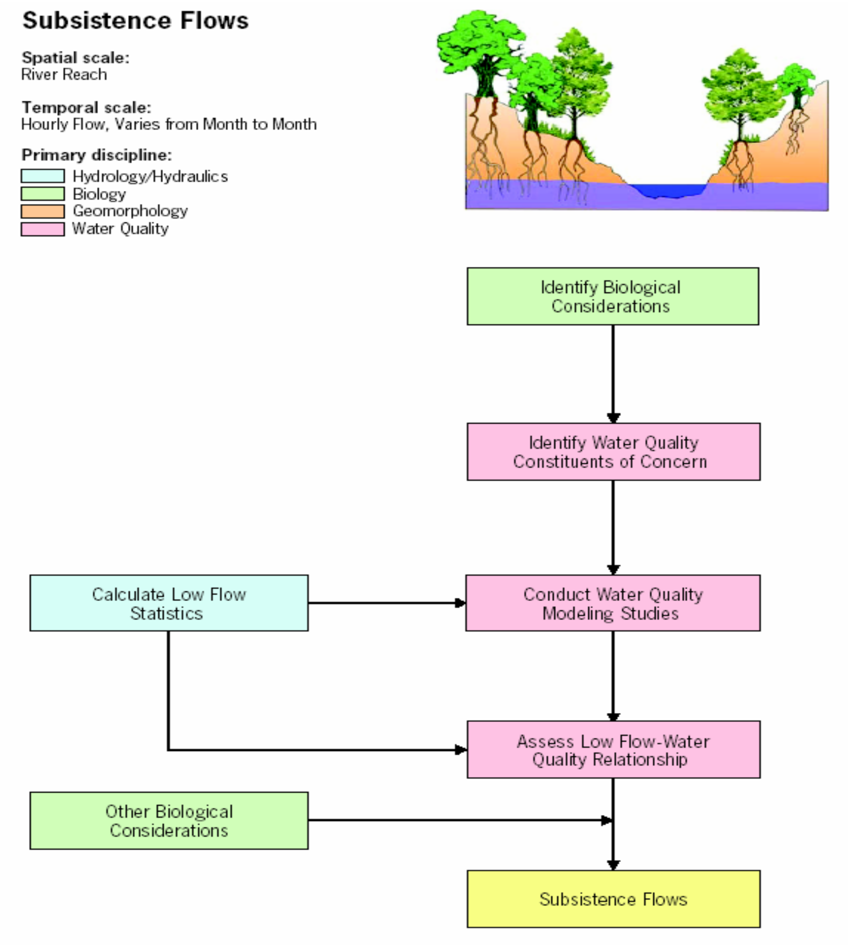
	Pre-impact period: 1924-1956 (33 years) Pre-Impact				
	10%	25%	50%	75%	90%
EFC Monthly Low Flows					
January-Low Flow	79.60	116.13	267.75	395.88	540.70
February-Low Flow	140.90	195.13	346.50	500.00	521.50
March-Low Flow	153.90	218.25	389.00	535.50	629.00
April-Low Flow	130.60	197.50	332.50	444.00	511.60
May-Low Flow	96.10	113.50	150.00	263.50	478.60
June-Low Flow	24.40	48.88	79.00	139.63	383.30
July-Low Flow	7.69	12.50	39.00	69.50	117.20
August- Low Flow	3.22	5.80	11.50	41.00	62.00
September-Low Flow	2.65	5.65	12.25	31.50	62.15
October-Low Flow	3.92	6.07	26.00	49.00	109.15
November-Low Flow	10.42	26.00	56.00	93.50	306.00
December-Low Flow	29.10	61.25	117.00	274.75	410.40

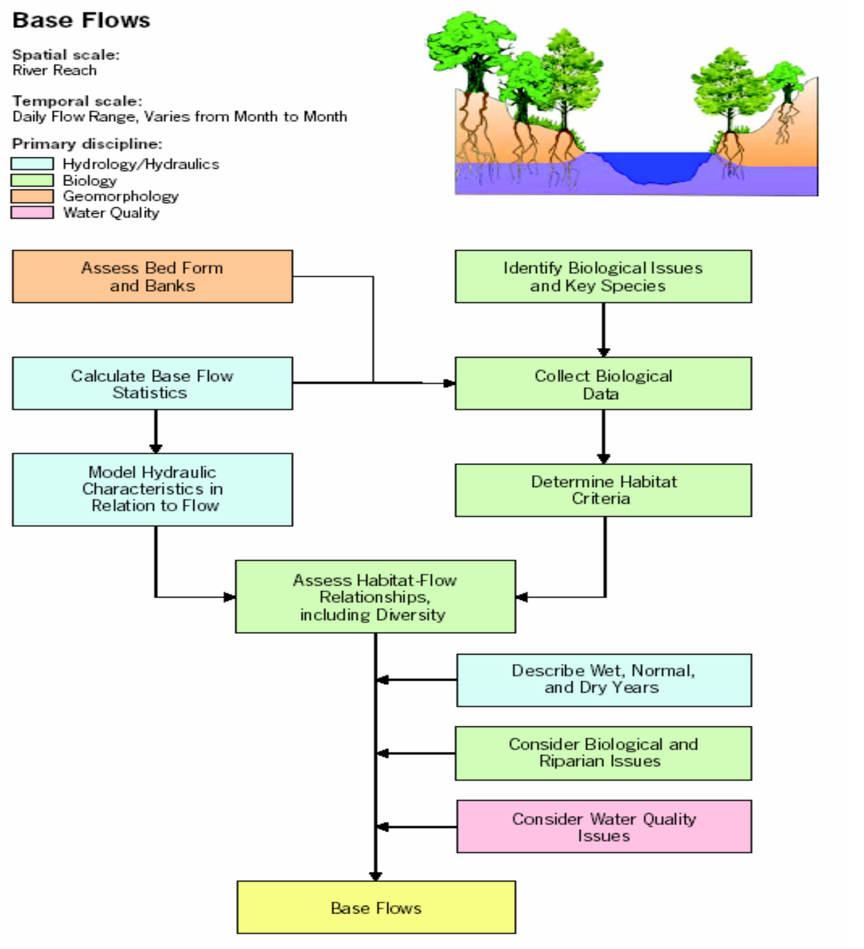


IHA-EFC Statistics for Big Cypress 1924-1956 (33 years)

	EFC Low Percentiles			Low Flow Building Blocks		
	25th	50th	75th	Dry	Normal	Wet
Jan	116	268	396	**90**	268	396
Feb	195	347	500	**90**	347	500
Mar	218	389	536	218	390	536
Apr	198	333	444	198	330	445
May	114	150	264	114	150	264
Jun	49	79	140	49	79	140
Jul	13	39	70	13	35	70
Aug	6	12	41	6	**40**	41
Sep	6	12	32	6	**40**	**40**
Oct	6	26	49	**40**	**40**	49
Nov	26	56	94	**90**	**90**	94
Dec	61	117	275	**90**	117	275

SB2 Subsistence and Base Flows





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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Key
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- Avg Year
- Dry Year

High Flow
Ecosystem Benefits

- Channel Maintenance - Flushing accumulated fine sediments from gravel, scouring pools, building riffles, removing vegetation from active channel inundating bars and maintaining channel capacity.
- Flood Plain connectivity and spawning cues
- Channel Forming – large scale fluvial geomorphic adjustments

High Flow
Concepts and Approaches

- Bankfull Discharge – Connectivity
- Effective, Dominate or Channel Forming Discharge – Sediment Transport

- Measure water surface elevation at bankfull
- Model sediment transport capacity
- 2 year return flow

Effective discharge calculation : a practical guide / by David S. Biedenharn ... [et al.] ; prepared for U.S. Army Corps of Engineers. 2000

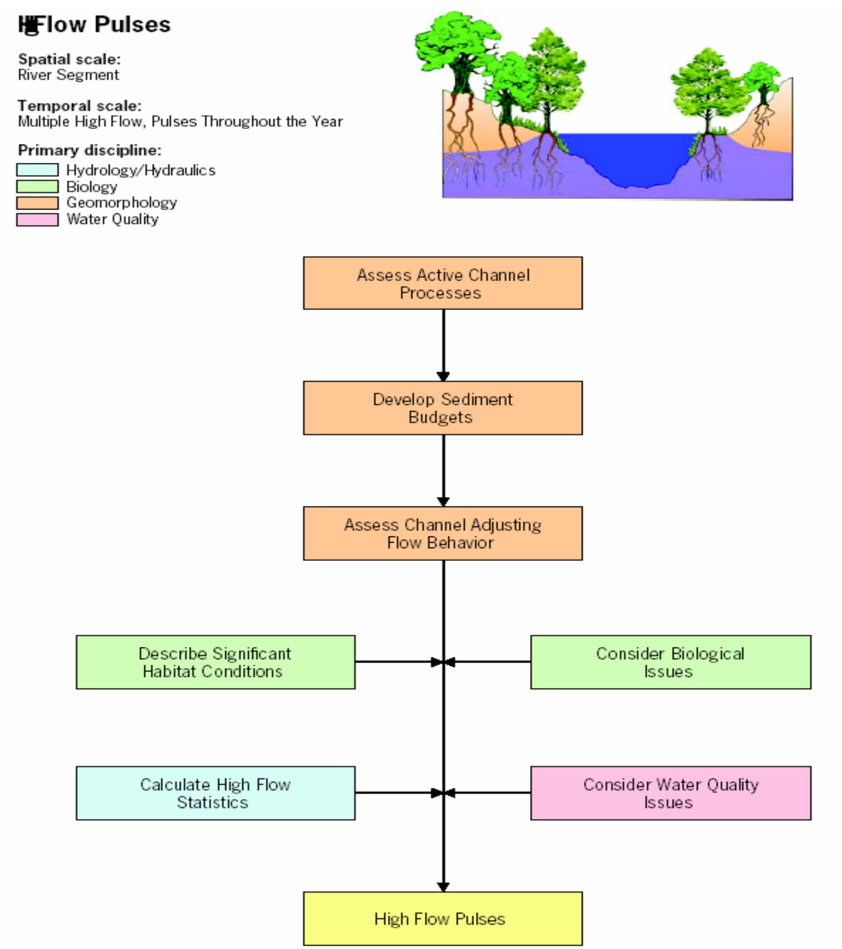
Big Cypress High Flow Recurrence

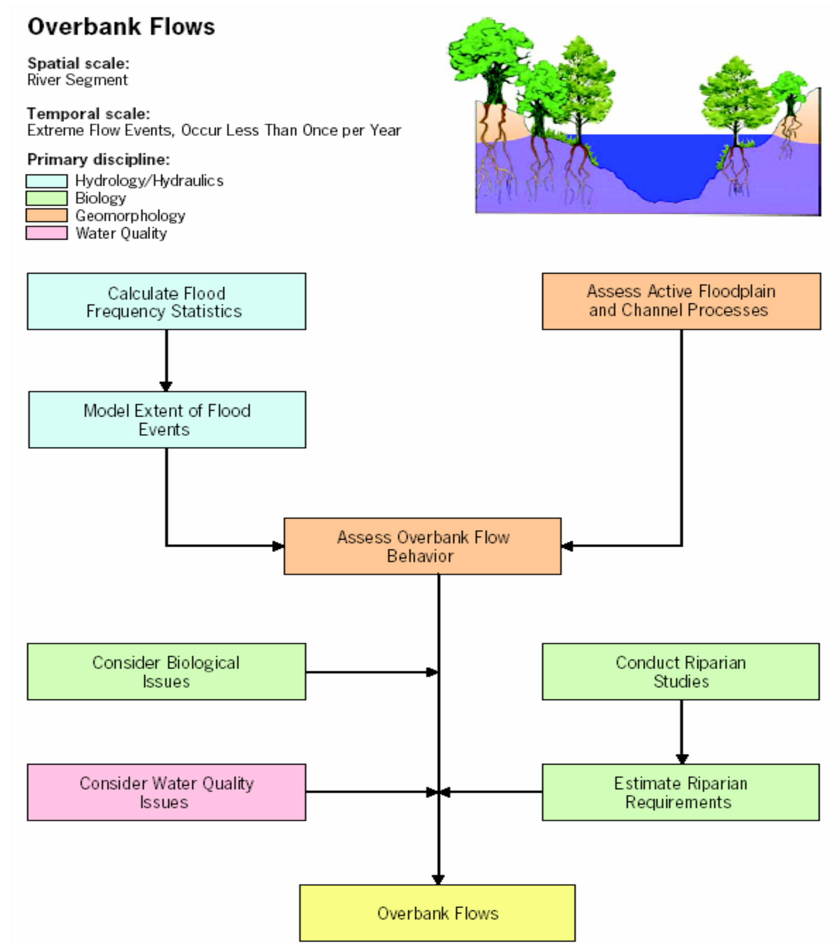
Recurrance	PeakFQ	Target
1.5	4,207	
2.0	6,485	6,000
4.0	12,693	
10.0	23,295	20,000

- Channel Maintenance flow – High Flow Pulse 1,500 cfs from IHA
- Bankfull Flow – 2 year recurrence
- Channel Forming Flow – 10 year recurrence

Durations of occurrence adjusted based on professional judgment
Magnitude of bankfull identified as a top research priority

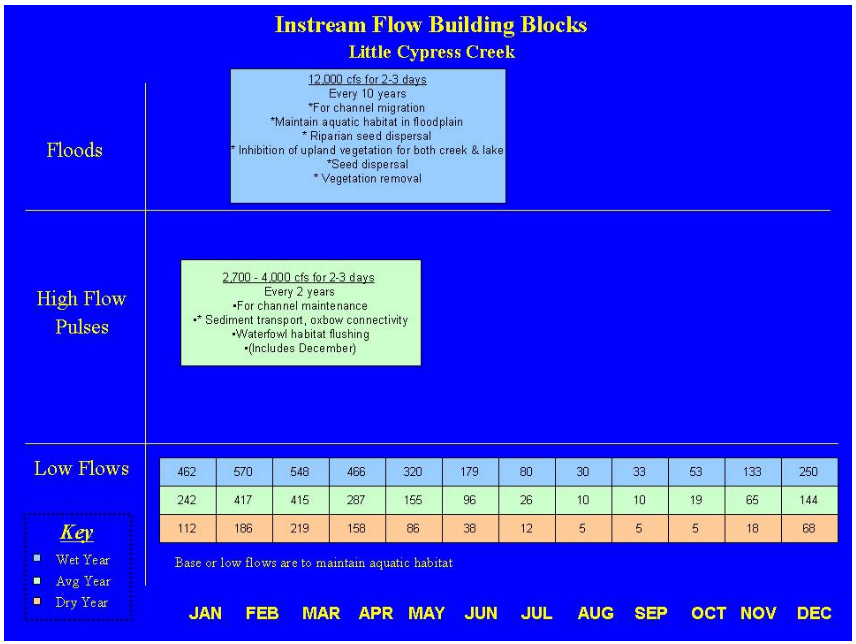
SB2 High Flow Pulses and Overbank Flows

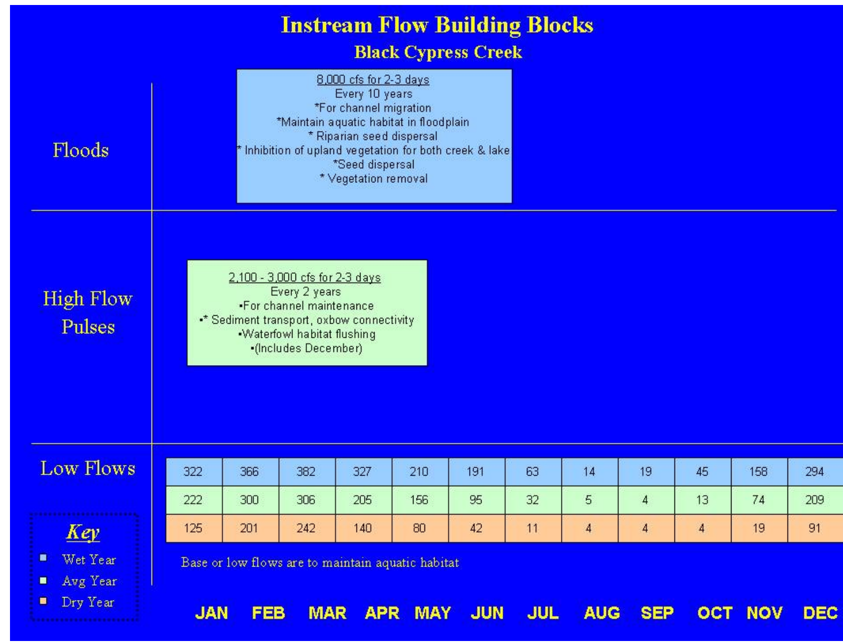




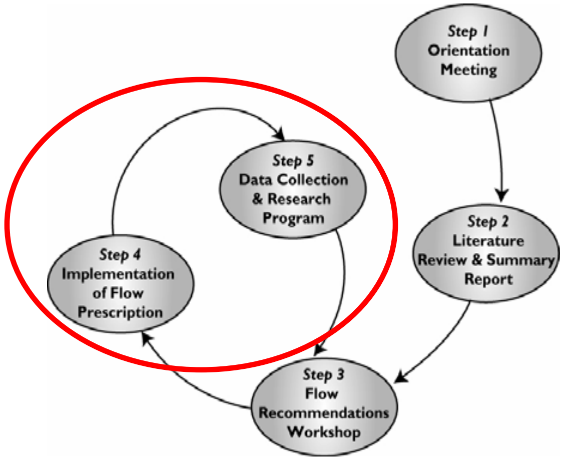
Second Ecosystem Flow Workshop

October 2006 (80 participants)





Implementation of Flow Prescription & Data Collection and Research Program



- Installation of new stream gage on Big Cypress at Karnack
- Museum study of historical fish data
- Characterize segment and reach-scale channel geomorphologic features
- Baseline collections of the fish assemblage
- Establish instrumented cross-sections at non-gauged locations.
- Habitat requirements of target organisms
- Modeling to develop Flow-Habitat response Curves & habitat time Series
- Measurements to quantify overbank discharge
- Cross section surveys on Big Cypress to support HEC-RAS development
- Flow-Inundation mapping
- Watershed Protection Plan

Combined Meeting of the Flow-Ecology Project & Hydrology Workgroup of the Watershed Protection Plan
www.CaddoLakeInstitute.us

December 2 -4, 2008, Jefferson

Tuesday Dec. 2:	Afternoon: Field trips.
Wednesday Dec. 3:	All day meetings
Thursday Dec. 4:	Morning meetings

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Science: Reevaluate flow regimes based on new info;

Goals & Limits: Reevaluate based on stakeholder input.